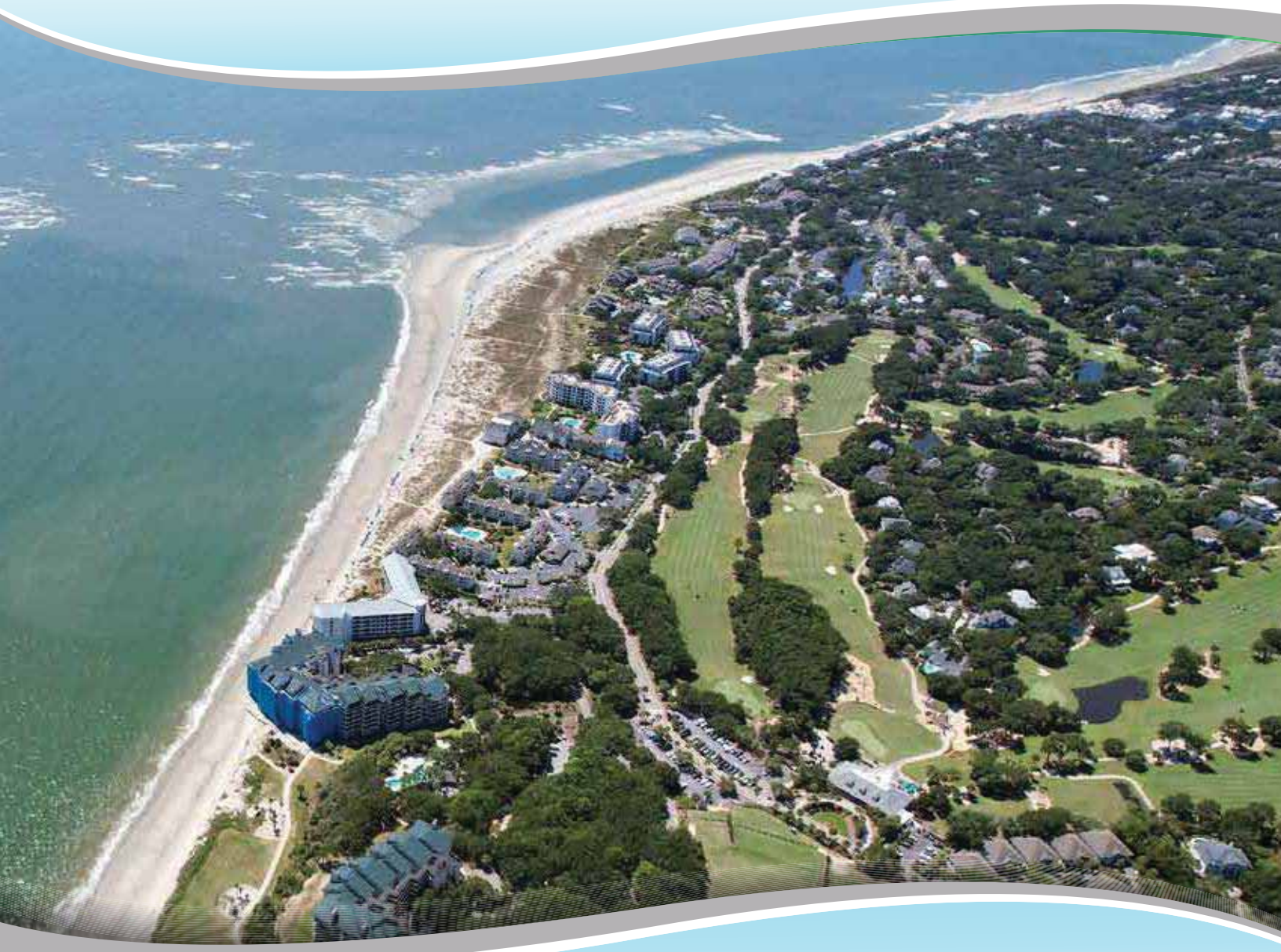
2018 Isle of Palms Restoration Project
Year 7 Monitoring Report

2025
MONITORING REPORT



Prepared for

City of Isle of Palms
Isle of Palms, South Carolina

COASTAL SCIENCE & ENGINEERING

CSE

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2018 Isle of Palms Restoration Project
Annual Beach and Inshore Surveys

Year 7 (2025) Monitoring Report

Prepared for:

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TABLE OF CONTENTS

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1.0 INTRODUCTION

This monitoring report is submitted to the City of Isle of Palms, SC (IOP) by Coastal Science & Engineering (CSE) as part of an ongoing beach monitoring effort that began in 2007 during planning for the 2008 Isle of Palms Beach Restoration Project (P/N 2007–02631–2IG) (CSE 2008). This report follows earlier monitoring reports submitted annually to the City, as well as additional reports and engineering documents related to shoal management and beach nourishment activities (P/N 2010–1041–2IG; 2016–00803 (CSE 2019). The report details the beach condition as surveyed in February and August 2025 and compares these conditions with selected earlier dates, including the pre-2018 project condition. This is the seventh annual monitoring report following the 2018 nourishment project. Certain portions of this report detail monitoring efforts required by state and federal permit conditions for the 2018 project.

Analyses in this report include detailed beach volume change along the ~7-mile beach, which spans from Breach Inlet to Dewees Inlet. It also includes comparisons of earlier beach conditions with the present condition, calculation of annual erosion rates, and measurements of linear shoreline change. Large-scale morphologic changes occurring in Breach Inlet and Dewees Inlet are also discussed, along with the anticipated impacts of these shifting shoals on the future beach condition. Ground and aerial photographs are included to provide a visual representation of the beach condition. These images document areas with dune escarpments, show dry-beach width, and delineate areas with existing or potential damage due to erosion.

This report also discusses general information about storm events occurring in 2025 and their impact on the beach, as well as updated sea level rise information for the Isle of Palms. Observations of escarpments, vegetation, sand fences, and other beach management considerations are discussed.

2018 Nourishment Project Summary

Sponsor: The beach restoration project was funded by the City of Isle of Palms, the State of South Carolina, Wild Dunes Community Association (including individual property owners and regimes), and Wild Dunes Resort. The City of Isle of Palms served as project owner and administrator.

Engineer: Coastal Science & Engineering (CSE, Columbia, SC)

Contractor: Great Lakes Dredge & Dock Co. (Oak Brook, IL)

Permit: SC048C–OCRM USACE P/N 2016–00803

Scope: Placement of 1,676,518 cubic yards (cy) of sand in the following areas.

Reach 1 (4,400 lf)	Sta 236+00–280+00	942,320 cy	214 cy/ft
Reach 2 (4,400 lf)	Sta 280+00–324+00	734,198 cy	167 cy/ft

Const. Cost: $13,545,585.70

Nourishment Schedule

- 13 December 2017 –Mobilization of equipment and pipe
- 16 January 2018 –First pumping near Beach Club Villas
- 24 February 2018 –Completion of Reach 1
- 23 March 2018 –Completion of Reach 2
- 1 April 2018 –All equipment removed from beach and offshore zone – Project Complete

Monitoring Events

- May 2017 –Pre-Project Annual Survey
- April 2018 –Post-Project Survey
- June 2019 –Year 1 Survey
- June 2020 –Year 2 Survey
- July 2021 –Year 3 Survey
- August 2022 –Year 4 Survey
- August 2023 –Year 5 Survey
- September 2024 –Year 6 Survey
- February 2025 –Year 7.1 Survey
- August 2025 –Year 7.2 Survey

2.0 SETTING

2.1 Project Setting

The Isle of Palms is a ~7-mile-long barrier island located north of Charleston Harbor. It has a southeast-facing shoreline bounded by Breach Inlet and Sullivan's Island to the south, with Dewees Inlet and Dewees Island to the north (Figure 2.1). The northern end of the island is wider due to periodic sand additions through shoal bypass events (Kana et al 1985; Kana 2002; Traynum and Kaczkowski 2015). These events result in a net accumulation of sand over several decades, which builds the updrift end of the island. The downcoast end of the island is narrower and terminates in a recurved spit at Breach Inlet. These characteristic morphologies are typical of 'drumstick' barrier islands (Hayes 1979) and occur along mixed energy coasts where both tides and waves influence shoreline evolution (Figure 2.1).

The eastern end of the island is typically more dynamic due to the influence of shoals associated with the Dewees Inlet ebb-tidal delta. Figure 2.2 shows aerial images of the east end of the island from 1944 to 1963. The photos document a large-scale shoal bypass event that impacted the shoreline encompassing the area now known as Wild Dunes. The shoal stretched for approximately two miles along the eastern end of the island. It was so large that a new ephemeral barrier beach was established over 1,000 feet (ft) seaward of the previous shoreline. This new beach ridge trapped a tidal lagoon that was flushed by a small channel, and the shoal attached to the beach sometime between 1944 and 1949. By 1957, the shoal had merged with the beach, buried the lagoon, and completely attached to the main portion of the island by 1963.

The emergence of this large shoal may be a result of the merging of several shoals in the delta, partially visible in the 1944 image (Fig 2.2, upper left), including two visible shoals at the northeastern tip of the island. These shoals were likely, at one point, a trailing ebb spit (see Kana 2002), and the sand from this spit merged with a shoal further west to create the large sand body that formed the lagoon. The shoal ultimately added well over 1,000,000 cubic yards (cy) of sand to the beach.

FIGURE 2.1. Schematic of the Isle of Palms showing the wider northeast end characteristic of a 'drumstick' barrier island.

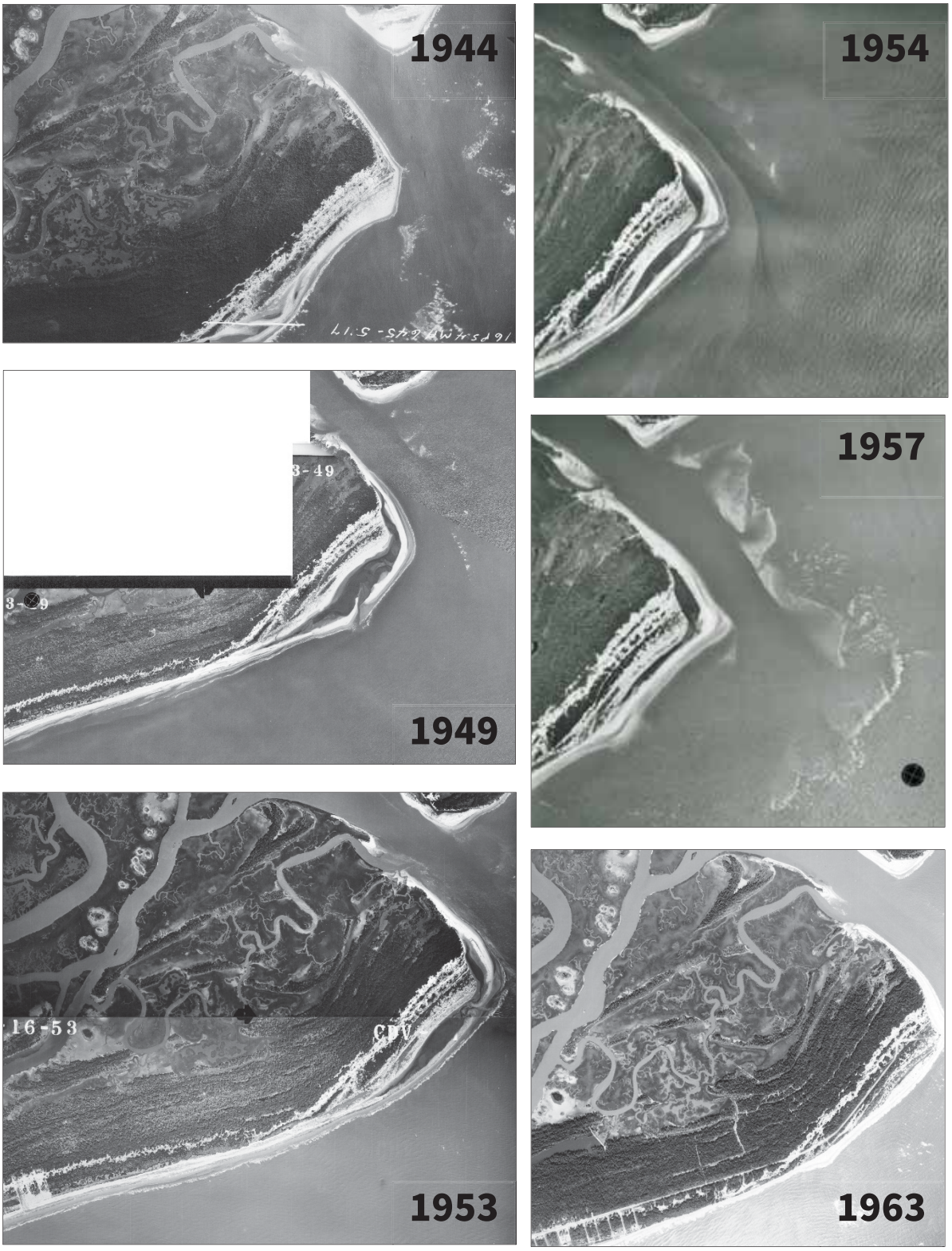

FIGURE 2.2. Historical aerials from CSE 2010 report page 56 (Figure 3.35).
Photo sequence begins (left column from top) in 1944, 1949, and 1953, then continues (right column from top) through 1954, 1957, and 1963. [Note that images are not at the same scale.]

This shoal attachment effectively built the shoreline at the northeast end of the island seaward ~500 ft between 1944 and 1963; however, much of this accreted sand eventually spread to downcoast areas. In short, the eastern end of the island (east of the present-day Beach Club Villas) was developed on sand that recently accreted to the beach and not on the stable upland area that had existed for decades, like most of the remainder of the island. Much of the development built in the late 1970s and early 1980s occurred in areas that were likely wet-sand beach in the 1930s–1940s.

Following the large-scale event mentioned previously, the eastern end of the island continued to experience shoal-bypass events, though all were smaller in magnitude than the 1940s–1960s event. These events generally attached along the central Wild Dunes area and are more characteristic of shoal-bypass events described by Kana et al (1985), with distinct stages of 1) emergence, 2) migration and attachment, and 3) spreading (Fig 2.3). These events have been responsible for focused erosion along various portions of the Wild Dunes area, including two events in the 1980s, another in the late 1990s, and a large event in the mid-2000s that led to the 2008 beach nourishment project.

FIGURE 2.3. **[LEFT]** Schematic of the shoal-bypass cycle originally modeled from a bypass event at Isle of Palms. **[RIGHT]** A shoal-bypass event at northeastern Isle of Palms corresponding to the schematic. The upper photo shows a shoal in Stage 1 (1996). The middle image illustrates Stage 2 (1997). The bottom photo shows Stage 3 (1998).

The addition of sand from shoal bypassing at the east end of the island has contributed to relatively steady accretion along the central and western portions of the island, resulting in a wide setback for most properties west of 58th Avenue. In the 1970s, properties along 46th Ave to 53rd Ave installed a seawall, and several groins were installed by 1984, as shown in Figure 2.4. Since 1984, the beach has accreted continuously, and all groins and seawalls have been buried.

FIGURE 2.4. A seawall and groins were in place in 1984 between 46th Ave to 53rd Ave. Today, due to continuous accretion, these groins and seawalls have been buried.

2.2 Previous Projects

As mentioned in the previous section, erosion mitigation measures at Isle of Palms began in the 1970s with the construction of seawalls and groins in the area between 41st Ave and 53rd Ave. Another groin was visible in 1973 near present-day 58th Avenue. In 1981, a concrete-filled geotextile bag groin was built near the tee of the 17th hole of the Links Course to reduce the erosion threat along the Dewees Inlet shoreline. In 1983, in response to a shoal attachment event, homeowners along Seagrove and Beach Club Villas constructed a rubble mound seawall (Kana et al 1985). Sand scraping was also attempted but proved insufficient to maintain a dry-sand beach under the localized but extreme erosion pressure. In late 1983, the first nourishment project along Isle of Palms was completed using sand dredged from the new marina at 41st Ave. Approximately 350,000 cy of sand was added to the erosional zones adjacent to the shoal as the shoal was beginning stage three of the bypass cycle. This resulted in a dramatic increase in beach width along Seagrove Villas, Beach Club Villas, and Mariners Walk, where erosion was most severe, augmenting the accretional shoal sand (Lana et al 1985).

From 1984 to 2007, sand scraping from accretional areas was the only mitigation attempted to combat shoal-induced erosion. CSE and its predecessors documented scraping efforts circa 1983, 1987, and 1998 (Figure 2.3) that attempted to move sand from accreting areas to erosional arcs. From 2004–2007, sandbags were installed to protect several structures from Shipwatch to Ocean Club and prevent additional shoreline retreat (Figure 2.5).

FIGURE 2.5. To prevent additional erosion, sandbags were installed along several structures from Shipwatch to Ocean Club from 2004 to 2007.

Erosion reached such severe conditions in 2007 that there was little-to-no beach along portions of the east end of the island, even at low tide (Figure 2.6). The Wild Dunes Community Association contracted with CSE to evaluate the causes of erosion and prepare a feasibility study outlining alternatives for restoration (CSE 2007). CSE recommended nourishing the beach using sand from an offshore borrow area and began the steps to obtain a permit for the work. The City of Isle of Palms then took ownership of the project and served as the permit applicant. Permits were obtained (P/N 2007–02631–2IG), and the City contracted with Weeks Marine for a project involving the nourishment of 847,000 cy of sand over 10,200 lf (linear feet) of beach. The project extended from 200 ft north of 53rd Avenue to the 17th green of the Links Course.

FIGURE 2.6. Isle of Palms in 2007 prior to beach nourishment.

The 2008 project was completed between 15 May and 15 July 2008 (Figure 2.7). As part of the project, Weeks Marine removed all sandbags from the project area, which totaled ~9,400 bags. Homeowners removed an additional 4,680 bags from under buildings. Averaging ~25,000 cy of sand per day, the dredge *RS Weeks* pumped sand from three borrow areas 2–3 miles from the beach. The nourishment was placed in three reaches and included ~270,000 cy between 53rd Ave and Dune Crest Ln (Reach A), 552,400 cy from Mariners Walk to the 18th fairway (Reach B), and 25,000 cy from the 18th tee to the 17th fairway (Reach C). Figure 2.8 shows the layout of the 2008 project. Figure 2.9 shows a post-project aerial photo (2008) that compares to the project area before renourishment (2007).

FIGURE 2.7. [ABOVE] 2008 beach nourishment project (completed on 15 July 2008).

FIGURE 2.8. [RIGHT] 2008 nourishment project map.

FIGURE 2.9. [LEFT] Isle of Palms in 2007 prior to nourishment. **[RIGHT]** The project area in 2008 following nourishment.

Following the 2008 project, CSE monitored the beach at least annually to document beach volume changes and project performance. Two shoal-bypass events occurred in 2009 and 2010, and another larger event began to emerge offshore in 2010. In anticipation of the need for potential remediation (and after observation of an erosional hotspot forming near the Ocean Club/Seascape area), the City sought a permit to manipulate the accretional shoal area, expedite attachment, and move sand to the erosional hotspots. An initial project was completed in 2012 that transferred ~80,000 cy of sand from the central portion of Wild Dunes to the east end near the Ocean Club. A larger project was completed in late 2014 through early 2015, which moved ~280,000 cy from two accretional areas (an attaching shoal centered near Beach Club Villas and from 53rd to 56th Avenues) to the beach fronting Beachwood East (~70,000 cy) and the area fronting Seascape/Ocean Club/18th hole (~210,000 cy). The project sought to transfer as much sand as possible from the shoal to the beach (Figure 2.10).

FIGURE 2.10. January 2015 aerial image of the 2014–2015 shoal management project showing equipment transferring sand from an attaching shoal to the eroded beach.

2.3 2018 Project

From 2015 to 2018, the beach along the eastern end of the island continued to respond to a shoal attachment event. Erosional hotpots were present along Beachwood East and near the 18th hole of the Links Course. In 2016, the City opted to pursue a permit for another large-scale renourishment project. CSE was retained to provide engineering services necessary to complete a permit application package with associated reports and documents. The project design called for the addition of 1,676,000 cy of sand along the eastern end of the island, with maximum fill densities of over 300 cubic yards per foot (cy/ft). The design fill would add over 600 ft of dry-sand beach in the largest fill areas.

Engineering for the project began with analyses to determine the volume of sand required to restore the beach to a desired condition. CSE initially prepared a fill plan based on the beach condition in 2015, when a recent shoal attachment created a bulge in the shoreline near the center of the project area. Following hurricane impacts in 2015, 2016, and 2017, as well as erosion of the attached shoal, CSE modified the fill template to account for erosion occurring in the center of the project area and substantial accretion at the eastern end. The final fill plan is listed in Table 2.1 and shown graphically in Figure 2.11. The data reflect the final design prior to a change order issued during the project that placed additional sand along the center of the project area. The fill density averaged 161.5 cy/ft over the length of the project area, with a maximum fill volume of ~325 cy/ft. The nourishment volume decreased along the center of the project area, with a minimum of 50 cy/ft added.

The fill template ranged in width based on the final design, reaching as much as 600 ft in the highest density areas. The berm width decreased along the central portion of the project area, as the pre-project beach was wider than adjacent areas. At either end of the project, the berm width tapered to the existing dune line (Figs 2.11 and 2.12).

Construction began on 16 January 2018 and was completed by 23 March 2018. Table 2.2 shows the design and actual fill volumes determined by TI Coastal, the independent surveyor retained by Great Lakes Dredge and Dock Company, the nourishment contractor. The 'Design Volume' column represents the volume of sand above the before dredge (BD) condition and below the design template. Note that this volume is less than the final contract amount due to accretion between the pre-project design surveys and TI Coastal's BD survey. The 'Fill Volume' column represents the total amount of sand placed on the beach. The rows highlighted in yellow represent the area repumped following the Hurricane *Irma* change order. In total, 1,725,942 cy of sand was added to the project area. Of that total, 974,374 cy were pumped west of Station 280+00 (Property Owners Beach House), and 751,568 cy were placed east of Station 280+00. The 49,424 cy of sand placed above the pay quantity of 1,676,518 cy was not paid.

TABLE 2.1. The modified fill schedule designed to account for variable erosion and beach widths along the project area, as well as substantial accretion at the eastern end of the island.

Station	Pre-Project Unit Volume (cy/ft)	Design Fill Vol (cy/ft)	Post-Project Unit Volume (cy/ft)
230 (56th Ave)	321.6	**0.0**	351.6
232	338.9	**0.0**	379.0
234	298.4	**0.0**	349.0
236	262.7	**0.0**	329.7
238	258.3	**26.4**	358.5
240	272.2	**59.0**	399.6
242	255.7	**73.9**	415.9
244	295.9	**170.8**	499.0
246	283.7	**233.3**	526.5
248	289.5	**277.7**	562.6
250	306.2	**296.6**	587.9
252	283.8	**307.5**	554.5
254	267.2	**315.2**	539.7
256	228.9	**320.6**	524.7
258	251.7	**325.8**	544.6
260	275.5	**314.6**	547.9
262	306.5	**298.2**	563.4
264	333.8	**260.0**	595.7
266	382.5	**240.0**	620.5
268	376.4	**210.0**	543.5
270	359.2	**150.0**	549.8
272	372.9	**120.0**	537.1
274	355.6	**90.0**	515.2
276 (Beach Club Villas)	442.8	**75.0**	576.2
278	426.6	**60.0**	587.3
280	534.3	**60.0**	771.4
282	436.3	**60.0**	652.7
284	450.9	**50.0**	746.0
286	520.6	**50.0**	760.5
288	456.4	**50.0**	705.7
290 (Mariner's Walk)	444.9	**60.0**	657.8
292 (Shipwatch Villas)	479.3	**60.0**	672.8
294	526.0	**80.0**	686.2
296	511.1	**110.0**	655.5
298	498.4	**130.0**	634.5
300	487.0	**160.0**	630.9
302	472.4	**190.0**	622.6
304	436.9	**225.0**	597.7
306	442.7	**250.0**	614.1
308	392.2	**250.0**	571.3
310 (Seascape Villas)	376.4	**250.0**	560.2
312	361.0	**225.0**	546.5
314	320.2	**180.0**	488.9
316	415.6	**140.0**	560.5
318	427.6	**90.0**	529.7
320	449.0	**30.0**	526.7
322	449.8	**20.0**	495.5
324	418.4	**0.0**	450.9
326	415.0	**0.0**	434.3
328 (18th Fairway)	420.0	**0.0**	451.0

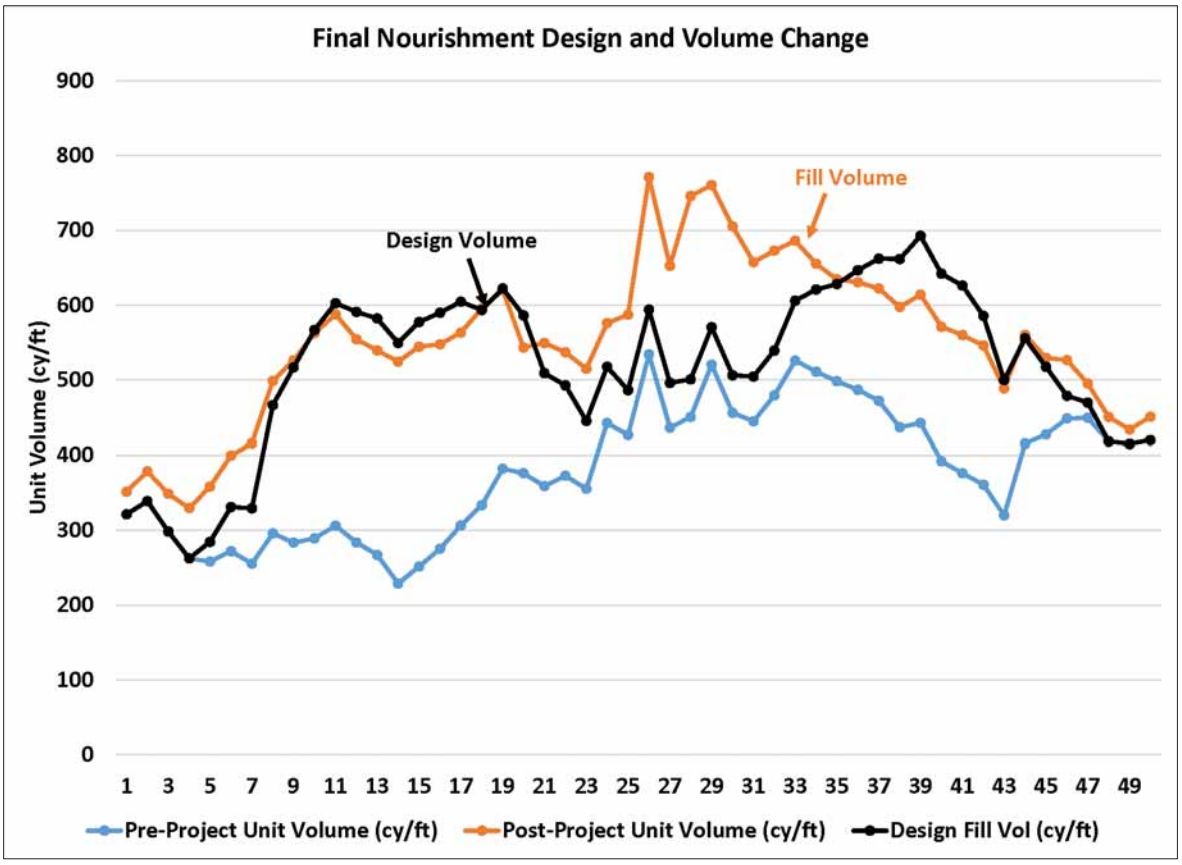

FIGURE 2.11. A graphic representation of the 2018 final fill template.

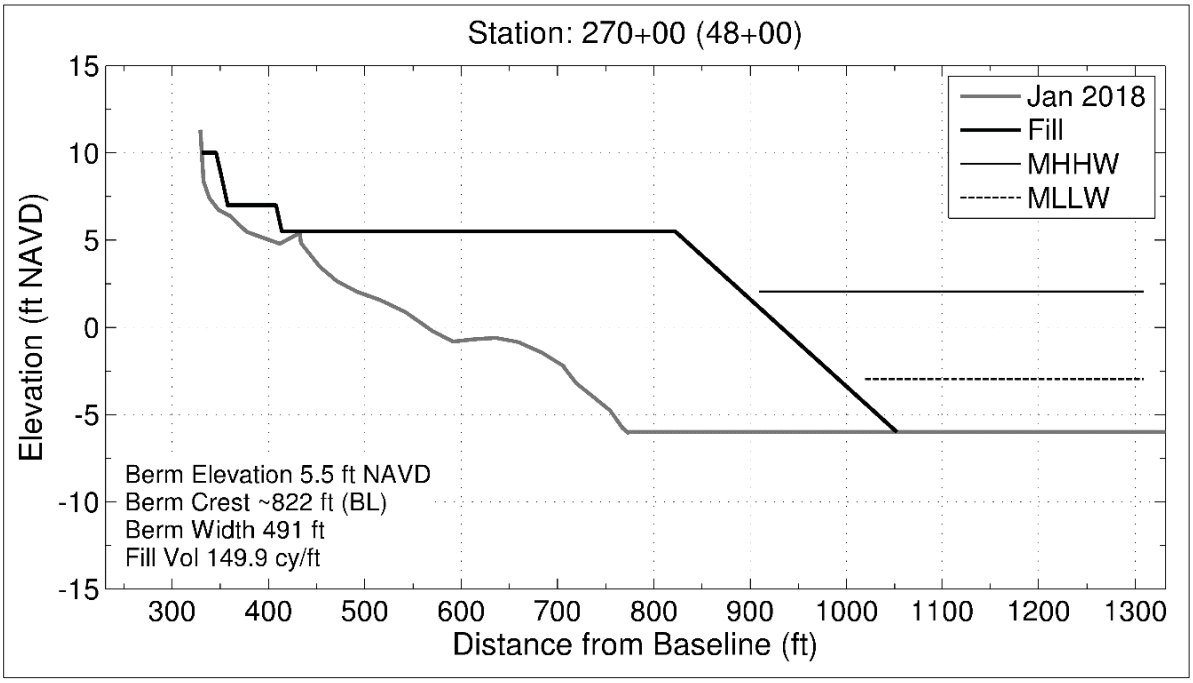

FIGURE 2.12. The 2018 design fill profile incorporated a dune, storm berm, wide fill berm, and sloping section.

3.0 METHODS

Monitoring efforts for the present report were performed in February and August 2025. Sand volume changes in the active beach zone were evaluated by obtaining topographic and bathymetric data along shore-perpendicular transects at established locations along the beach (herein referred to as the baseline) (Fig 3.1). The present baseline spans from the center of the Breach Inlet Bridge (Station 0+00) and continues to Cedar Creek spit at the northeastern end of the island (Station 376+00). Stationing relates to the distance along the shore, with the number before the "+" symbol representing 100 feet (ft). Therefore, Station 36+00 is 3,600 ft from Station 0+00. The baseline is generally set landward of the active beach to allow for future erosion/accretion. In 2024, profiles were changed to a more regular interval along the western portion of the island. This includes the addition of 500-foot profile spacing in between existing profiles 20+00 to 80+00.

Topographic data were collected via RTK-GPS (Trimble™ R10 and R12 GNSS), which provides position and elevation measurements at centimeter accuracy. Beach profiles were obtained by collecting data at low tide along the dunes, berm, and active beach to low tide wading depth. Overwater work was then performed at high tide to overlap the land-based work (Fig 3.2) and was collected with RTK-GPS coupled with an Odom CV100™ precision echosounder mounted on CSE's survey vessel, the *RV Southern Echo*.

Profiles were collected from the most landward accessible point in the dune system to a minimum of 1,500 ft from the baseline. Profiles along the northeast end of the island extended up to 6,000 ft offshore to encompass the shoals associated with Dewees Inlet. Alongshore spacing of the profiles ranged from 200 ft to 500 ft, with the more closely spaced profiles north of 53rd Avenue and along Breach Inlet. Comparative profiles from CSE's monitoring efforts are shown in Appendix A. The complexity of areas impacted by inlets requires a more detailed analysis (closer profile spacing) to fully incorporate volume changes associated with shoal-bypassing events and inlet migration.

To better understand regional sand volume changes, seven reaches are defined along the Isle of Palms. These reaches represent different portions of the island, based upon prevailing wind/wave conditions, beach width, and developed properties. They range in length from ~1,200 ft to ~7,200 ft. Combining several profiles into reaches makes it easier to identify overall sediment gains and losses over sizable portions of the beach. In the project area, the monitoring reaches differ from those used during construction to encompass areas where no work was performed.

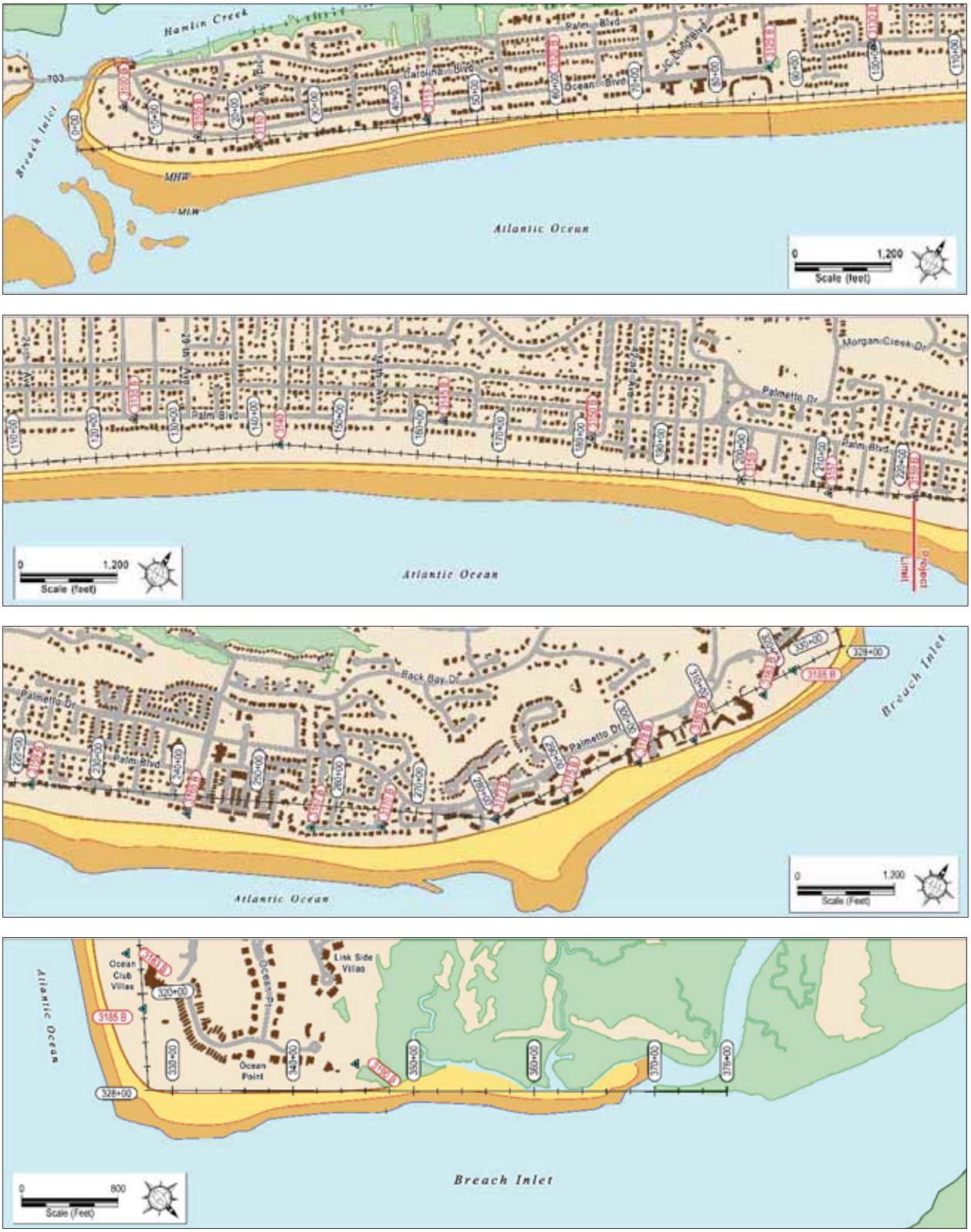

FIGURE 3.1. Baseline map of Isle of Palms showing the reference line used to establish monitoring profiles. Stationing increases to the north from Breach Inlet. Blue triangles mark SCDES-DCM reference stations.

FIGURE 3.2.
Surveying beach profiles involves collecting land-based data at low tide and hydrographic data overlapping the land-based work at high tide.

The reaches used for monitoring purposes are shown in Figure 3.3 and are defined as follows:

Reach 1	0+00 to 50+00	Breach Inlet to South of 6th Avenue
Reach 2	50+00 to 90+00	South of 6th Avenue to Beach Access 13
Reach 3	90+00 to 150+00	Beach Access 13 to 31st Avenue
Reach 4	150+00 to 222+00	31st Avenue to 53rd Avenue
Reach 5	222+00 to 280+00	53rd Avenue to Wild Dunes Property Owners Beach House
Reach 5a	222+00 to 240+00	53rd Avenue to 57th Avenue
Reach 5b	240+00 to 254+00	57th Avenue to Grand Pavillion Blvd
Reach 5c	254+00 to 280+00	Grand Pavillion Blvd to Wild Dunes Property Owners Beach House
Reach 6	280+00 to 330+00	Wild Dunes Property Owners Beach House to Dewees Inlet
Reach 6a	*280+00 to 290+00*	Wild Dunes Property Owners Beach House to Beach Club Villas
Reach 6b	*290+00 to 308+00*	Beach Club Villas to Seascape Villas
Reach 6c	*308+00 to 330+00*	Seascape Villas to Dewees Inlet
Reach 7	330+00 to 370+00	Dewees Inlet Shoreline

FIGURE 3.3. Reach limits used in the present monitoring report.

To determine changes in beach volume along Isle of Palms, beach profile data were entered into CSE's in-house custom software, Beach Profile Analysis System (BPAS), which converts 2D profile data in x–z (distance–elevation) format to 3D volumes. The software provides a quantitative and objective way of determining ideal minimum beach profiles and how the sand volume per unit length of shoreline compares with the desired condition. It also provides an accurate method of comparing historical profiles—as the volume method measures sand volumes in the active beach zone rather than extrapolating volumes based on single-contour shoreline position (ie – from aerial photography). Unit-volume calculations can distinguish the quantity of sediment in the dunes, on the dry beach, in the intertidal zone to wading depth, and in the remaining area offshore to the approximate limit of profile change (closure depth).

Figure 3.4 depicts the profile volume concept. The reference boundaries are site-specific but, ideally, encompass the entire zone over which sand moves each year. Sand volume was calculated between the primary dune and between −10 ft and −18 ft NAVD. The lower calculation limit was site-specific, as profiles in the center of the island and along Dewees Inlet have deeper closure depths than areas in the unstable inlet/shoal zones. Comparative volumes and volume changes were computed using standard procedures (average-end-area method, in which the average of the area under the profiles computed at the ends of each cell is multiplied by the length of the cell to determine the cell's sand volume). Certain adjustments were made to account for changes in the baseline direction and for volumes at the turn in the baseline at Dewees Inlet.

For the present report, several adjustments were made to the calculation limits for profiles showing significant erosion in recent years. The erosion has resulted in the active beach moving landward into areas not previously included in volume measures. Profile volumes for all previous surveys were

recomputed using these new limits to provide accurate comparisons. This results in report volumes for a given year being slightly different than volumes reported in earlier reports.

Sand volumes for offshore areas were calculated from digital terrain models (DTMs) produced by MATLAB® and GlobalMapper®. DTMs are digital 3D representations of the topography and bathymetry of an area and are useful for calculating changes in contour positions and sediment volumes. Position data were entered into the software as x–y–z coordinates and were processed to provide cross-section profiles and volumes. DTMs are compared with earlier collections to determine changes in shoal positions and volumes.

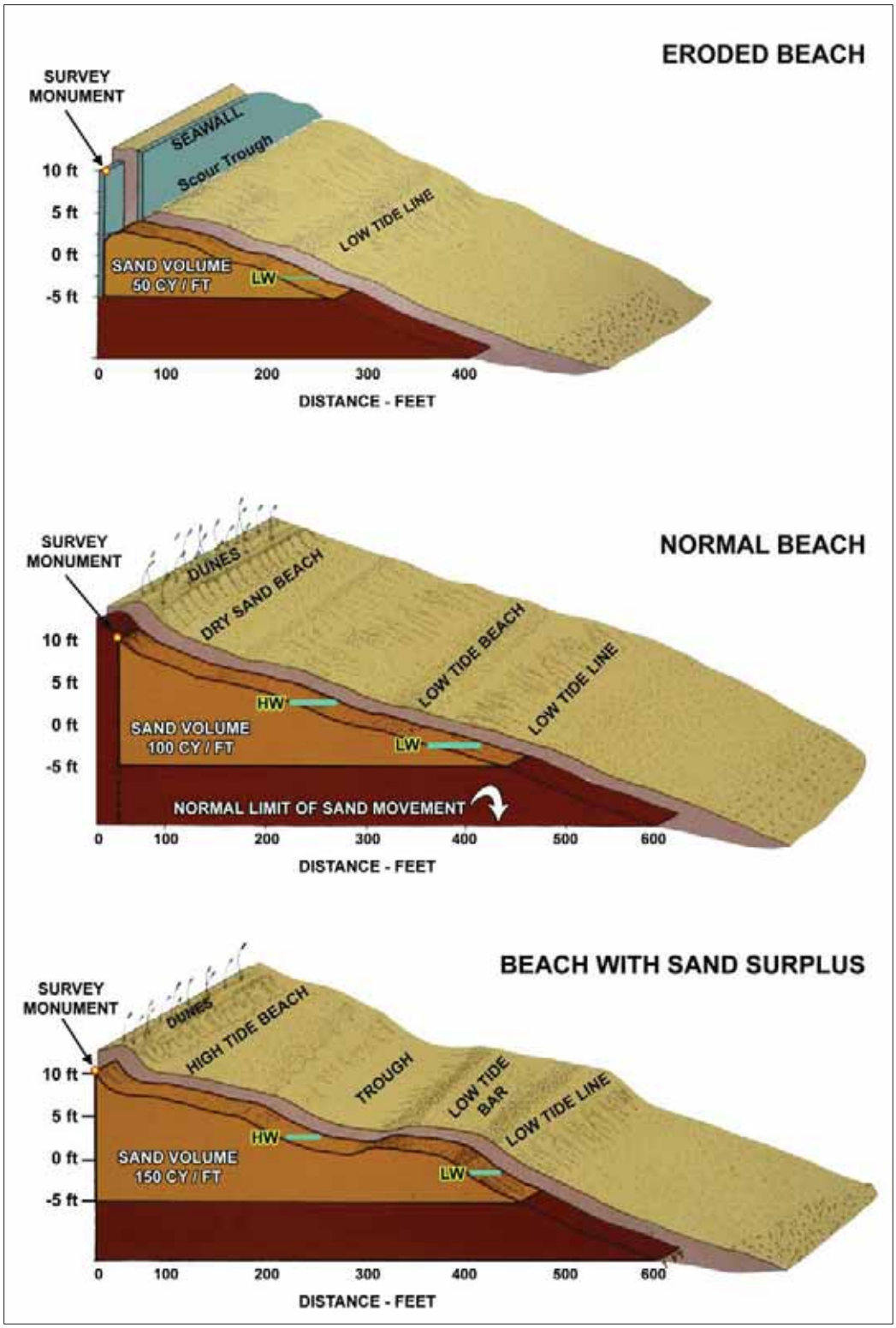

FIGURE 3.4. Illustration of the profile volume concept.

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4.0 RESULTS

Results of the beach monitoring effort presented in the following sections focus on changes occurring since the 2018 project but also address the condition relative to earlier periods, such as the pre-2008 project condition. CSE attempts to simplify the discussion of beach changes by focusing on larger reaches or areas rather than change measured at a single profile.

However, individual profiles are useful in visualizing how the shape of the beach changes over time, how shoals migrate onshore, and how the beach's condition is in front of specific properties or features. Volume change is first reported for the entire island, followed by localized changes in reaches 1–7.

4.1 Island-wide Changes

From September 2024 to February 2025 the island lost around 157,500 cy of beach sand, but gained ~229,500 cy from February 2025 to August 2025, resulting in a net gain of 72,000 cy compared to last year. Most of the accretion was due to shoal attachment near Beach Club Villas along with the beach fill being conducted by the USACE (Fig 4.1) in Reach 1. Despite the accretion, areas on either side of the shoal attachment zone eroded as wave energy focused at the margins of the shoal as it approached the beach. Across the entire island, the beach contains ~477,800 cy more sand than the 2017 pre-nourishment condition and ~296,200 cy more sand than in 2009 (Figure 4.3). Before 2009, surveys were limited to the northern end of the Island, which restricts direct comparisons with pre-nourishment conditions. Assuming the southern and central portions of the Island remained generally consistent with 2009 conditions, the Island currently contains approximately 1.46 million cubic yards more sand than prior to nourishment. These gains can be largely attributed to benefit of beach nourishment, with the most substantial increases occurring in the central portion of the Island.

Tables 4.1 and 4.2 provide beach volume data for selected dates from 2008 through 2025 for each project reach and profile. Table 4.2 provides unit volumes for each station.

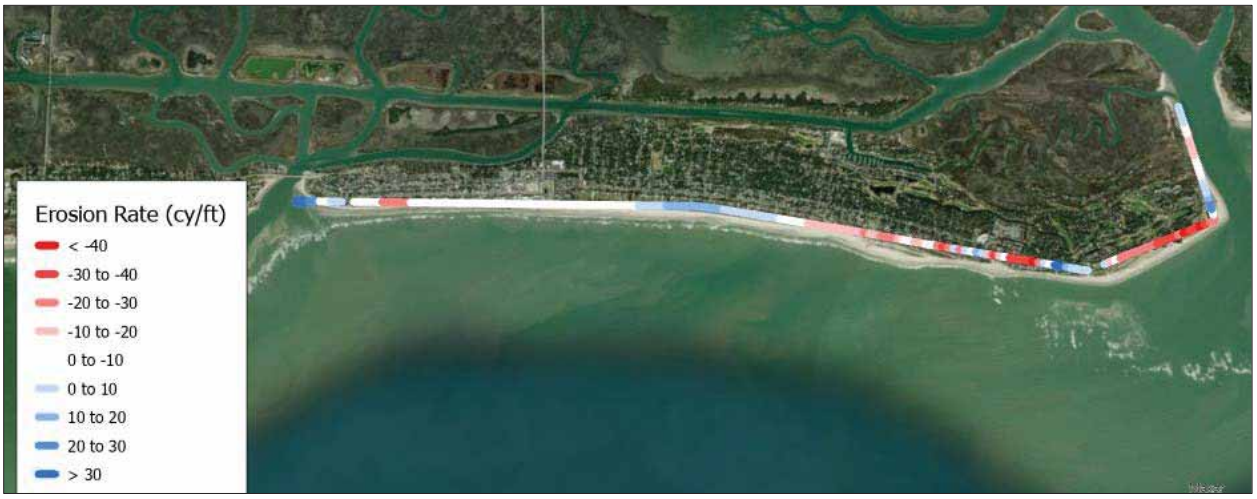


FIGURE 4.1. Line map showing variations in erosion and accretion patterns over Isle of Palms from September 2024 to August 2025. The shoal attachment zone along the eastern third of the island was the most dynamic over the last year. The central portion of the island exhibited a slightly positive beach volume change, while the Breach Inlet portion of the island lost sand at a greater rate than has been observed since 2021.

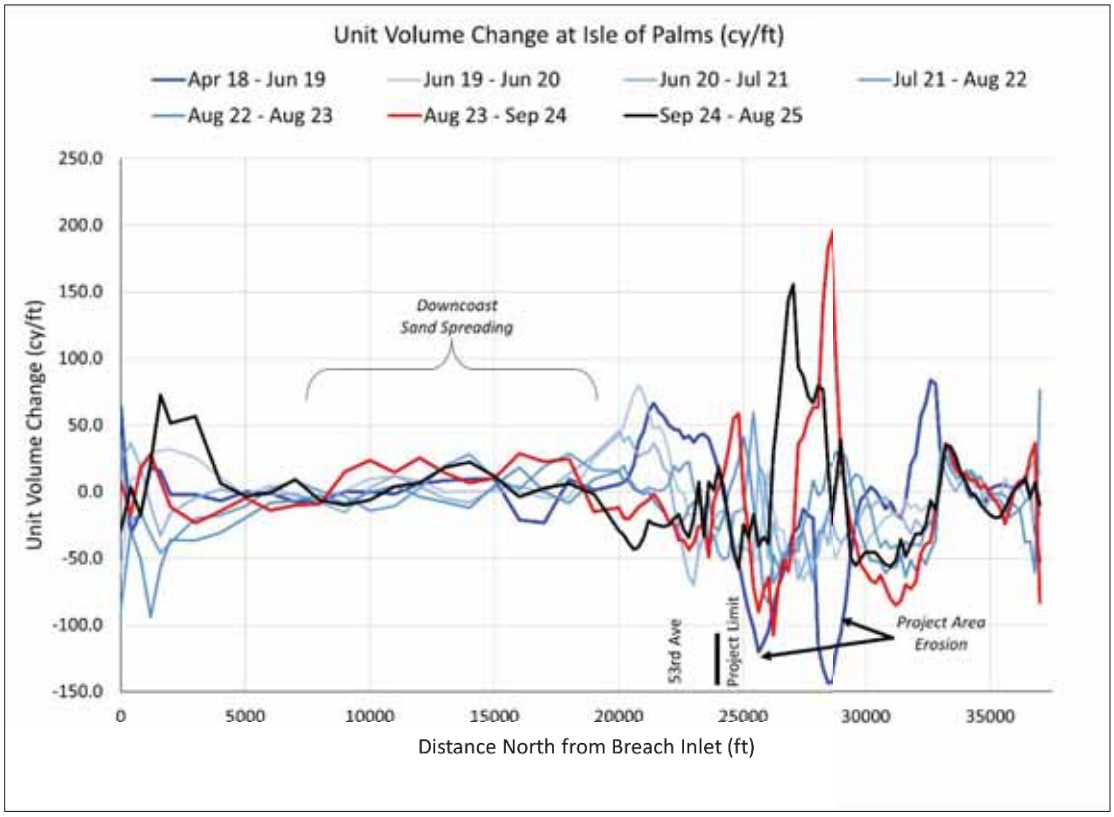


FIGURE 4.2. Beach unit volume change between each monitoring event at Isle of Palms. The X axis represents distance from Breach Inlet. This graph highlights the erosion occurring in the project area and the accumulation of spreading sand adjacent to the project area.

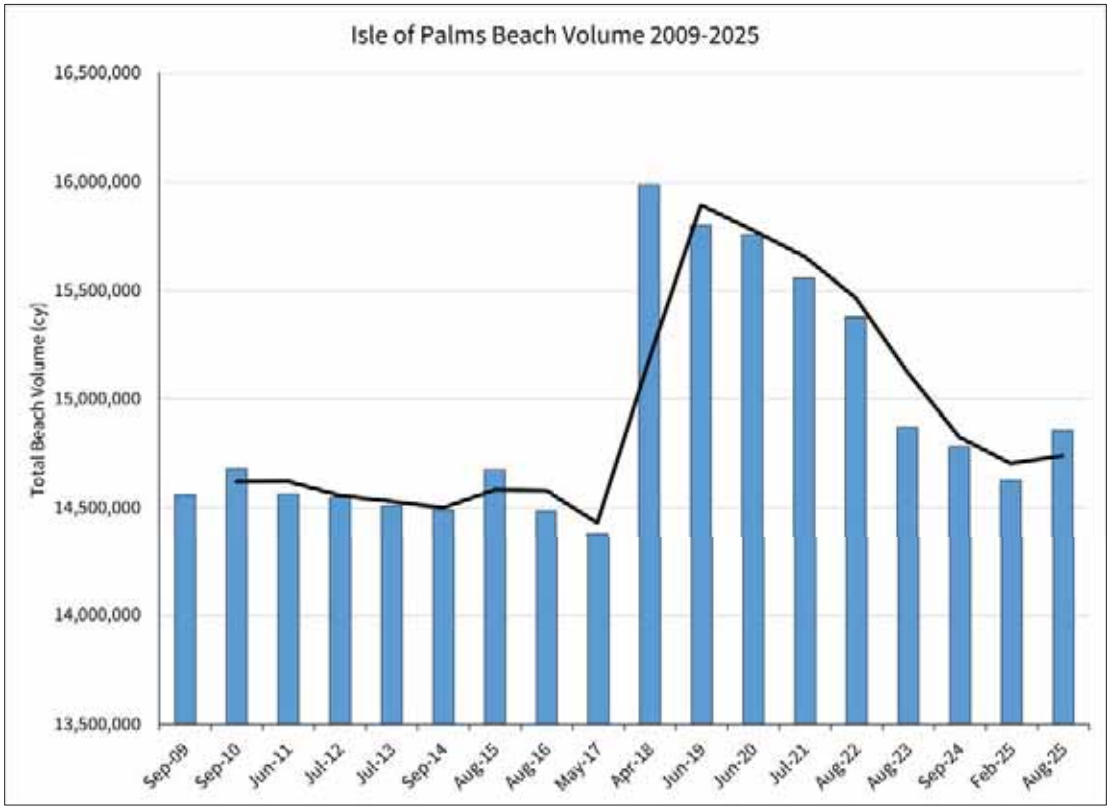


FIGURE 4.3. Total beach volume at Isle of Palms from 2009 to 2024. Effects of the 2018 project are seen in the rapid increase in the April 2018 island-wide beach volume.

TABLE 4.1. Beach volume data for selected dates since 2008 by reach**.** Beach nourishment occurred prior to the July 2008 and 2018 conditional survey.

Total Volume (cy)																					
	Length (ft)	Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19	Jun-20	Jul-21	Aug-22	Aug-23	Sep-24	Feb-25	Aug-25
Reach 1	5,000				2,183,274	2,244,170	2,193,538	2,113,890	2,062,238	2,110,589	2,104,284	2,003,311	1,990,294	2,025,974	2,023,197	2,101,433	2,095,764	1,985,588	1,773,712	1,741,987	1,744,748	1,865,394
Reach 2	4,000				1,319,448	1,345,644	1,333,646	1,383,589	1,421,544	1,396,447	1,368,764	1,384,387	1,379,184	1,380,570	1,368,605	1,364,335	1,344,024	1,347,856	1,318,484	1,288,565	1,274,011	1,283,832
Reach 3	6,000				1,905,012	1,969,085	1,949,667	1,998,276	2,077,151	2,078,183	2,121,948	2,124,384	2,134,005	2,136,169	2,163,682	2,194,707	2,194,573	2,223,764	2,202,750	2,299,847	2,311,051	2,345,674
Reach 4	7,200				2,351,358	2,422,156	2,468,297	2,576,604	2,661,530	2,660,099	2,728,813	2,705,968	2,710,775	2,752,856	2,815,395	2,972,310	3,103,395	3,196,082	3,216,526	3,247,824	3,185,219	3,175,344
Reach 5a	2,000	653,158	658,684	764,325	809,705	796,437	796,566	795,056	777,828	763,800	721,256	678,013	661,421	728,364	799,975	756,066	688,269	669,501	634,792	582,310	562,403	560,981
Reach 5b	1,400	514,652	504,800	634,300	617,149	599,522	589,698	566,157	566,366	527,994	505,677	429,816	408,186	748,920	660,834	602,633	554,598	549,529	561,782	562,773	531,975	518,908
Reach 5c	2,400	1,146,371	1,128,345	1,217,975	1,097,585	1,088,323	1,043,774	947,319	831,019	823,654	831,161	795,211	780,867	1,258,621	1,117,516	1,025,594	926,080	835,307	735,862	680,056	686,780	832,364
Reach 6a	1,200	654,722	659,722	698,503	814,421	763,879	719,290	636,307	655,888	730,912	812,210	762,471	665,247	838,273	689,204	648,241	609,561	601,449	624,155	759,832	821,459	790,440
Reach 6b	1,800	512,853	548,102	848,474	804,988	790,597	820,792	842,288	796,803	764,872	786,291	872,020	855,798	1,125,822	1,098,831	1,042,448	1,014,968	992,794	929,447	831,663	784,536	746,380
Reach 6c	2,000	311,422	487,062	774,002	707,478	690,647	651,408	651,236	607,222	553,330	613,218	640,396	737,364	967,316	1,027,888	1,005,533	967,501	900,906	804,928	694,792	630,441	633,376
Reach 7	4,000	1,849,010	1,917,298	1,913,616	1,949,506	1,970,095	1,997,775	2,039,469	2,052,416	2,080,721	2,084,096	2,089,238	2,055,262	2,021,073	2,034,427	2,042,148	2,058,100	2,074,035	2,069,693	2,094,565	2,094,040	2,103,432
Reaches 5-6	10,800	3,793,178	3,986,714	4,937,580	4,851,327	4,729,406	4,621,529	4,438,362	4,235,126	4,164,562	4,269,812	4,177,926	4,108,885	5,667,316	5,394,247	5,080,515	4,760,978	4,549,485	4,290,966	4,111,426	4,017,593	4,082,449
Total Island Volume	37,000				14,559,924	14,680,555	14,564,452	14,550,190	14,510,005	14,490,602	14,675,718	14,485,214	14,378,325	15,986,957	15,799,554	15,755,449	15,556,835	15,376,911	14,870,112	14,784,215	14,626,662	14,856,125
Unit Volume (cy/ft)																						
	Length (ft)	Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19	Jun-20	Jul-21	Aug-22	Aug-23	Sep-24	Feb-25	Aug-25
Reach 1	5,000				436.7	448.8	438.7	422.8	412.4	422.1	420.9	400.7	398.1	405.2	404.6	420.3	419.2	397.1	354.7	348.4	348.9	373.1
Reach 2	4,000				329.9	336.4	333.4	345.9	355.4	349.1	341.7	346.1	344.8	345.9	342.2	341.1	336.0	337.0	329.1	322.1	318.5	321.0
Reach 3	6,000				317.5	328.2	324.9	333.0	346.2	346.4	353.7	354.1	355.7	356.0	360.6	365.8	365.8	370.6	367.1	383.3	385.2	390.9
Reach 4	7,200				326.6	336.4	342.8	357.9	369.7	369.5	379.0	375.8	376.5	382.3	391.0	412.8	431.0	443.9	446.7	451.1	442.4	441.0
Reach 5a	2,000	326.6	329.3	382.2	404.9	398.2	398.3	397.5	388.9	381.9	360.6	339.0	330.7	364.2	400.0	378.0	344.1	344.8	317.4	291.2	281.2	280.5
Reach 5b	1,400	367.6	360.6	453.1	440.8	428.2	421.2	404.4	404.5	377.1	361.2	307.0	291.6	534.9	472.0	430.5	396.1	392.5	401.3	402.0	380.0	370.6
Reach 5c	2,400	477.7	470.1	507.5	457.3	453.5	434.9	394.7	346.3	343.2	346.3	331.3	325.4	524.4	465.6	427.3	385.9	348.0	306.6	283.4	286.2	346.8
Reach 6a	1,200	545.6	549.8	582.1	678.7	636.6	599.4	530.3	546.6	609.1	676.8	635.4	554.4	698.6	574.3	540.2	508.0	501.2	520.1	633.2	684.5	658.7
Reach 6b	1,800	284.9	304.5	471.4	447.2	439.2	456.0	467.9	442.7	424.9	436.8	484.5	475.4	625.5	610.5	579.1	563.9	561.6	516.4	462.0	435.9	414.7
Reach 6c	2,000	155.7	243.5	387.0	353.7	345.3	325.7	325.6	303.6	276.7	306.6	320.2	368.7	483.7	513.9	502.8	483.8	450.5	402.5	347.4	315.2	316.7
Reach 7	4,000	462.3	479.3	478.4	487.4	492.5	499.4	509.9	513.1	520.2	521.0	522.3	513.8	505.3	508.6	510.5	514.5	518.5	517.4	523.6	523.5	525.9
Reaches 1-7	37,000				393.5	396.8	393.6	393.2	392.2	391.6	396.6	391.5	388.6	432.1	427.0	425.8	420.5	415.6	401.9	399.6	395.3	401.5
Profile Volume Change Since Last Survey (cy)																						
	Length (ft)	Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19	Jun-20	Jul-21	Aug-22	Aug-23	Sep-24	Feb-25	Aug-25
Reach 1	5,000					60,896	-50,632	-79,648	-51,652	48,352	-6,305	-100,974	-13,017	35,680	-2,777	78,236	-5,669	-110,176	-211,876	-31,725	2,761	120,645
Reach 2	4,000					26,196	-11,998	49,943	37,955	-25,097	-29,683	17,623	-5,283	4,465	-14,964	-4,270	-20,311	3,932	-31,492	-27,899	-14,554	9,821
Reach 3	6,000					64,073	-19,418	48,609	78,875	1,033	43,764	2,437	9,621	2,164	27,513	31,025	-134	29,190	-21,013	97,097	11,203	34,623
Reach 4	7,200					70,798	46,141	108,307	84,926	-1,431	68,714	-22,845	4,807	42,081	62,539	156,915	131,085	92,688	20,444	31,298	-62,604	-9,876
Reach 5a	2,000		5,526	105,641	45,380	-13,268	129	-1,510	-17,228	-14,029	-42,544	-43,243	-16,591	66,943	71,611	-43,910	-67,796	-18,768	-34,709	-52,482	-19,907	-1,422
Reach 5b	1,400		-9,853	129,501	-17,152	-17,627	-9,824	-23,541	209	-38,371	-22,318	-75,861	-21,630	340,734	-88,087	-58,201	-48,035	-5,069	12,253	991	-30,798	-13,067
Reach 5c	2,400		-18,026	89,630	-120,390	-9,262	-44,549	-96,454	-116,300	-7,365	7,506	-35,950	-14,344	477,753	-141,105	-91,921	-99,514	-90,773	-99,445	-55,806	6,724	145,583
Reach 6a	1,200		5,000	38,782	115,918	-50,542	-44,588	-82,984	19,581	75,024	81,299	-49,739	-97,223	173,025	-149,069	-40,963	-38,680	-8,112	22,706	135,677	61,627	-31,019
Reach 6b	1,800		35,249	300,372	-43,486	-14,390	30,195	21,495	-45,485	-31,931	21,419	85,728	-16,221	270,023	-26,991	-56,383	-27,480	-22,174	-63,346	-97,784	-47,128	-38,156
Reach 6c	2,000		175,640	286,940	-66,524	-16,831	-39,239	-173	-44,013	-53,892	59,888	27,177	96,968	229,953	60,572	-22,355	-38,032	-66,596	-95,978	-110,136	-64,352	2,935
Reach 7	4,000		68,287	-3,682	35,890	20,589	27,680	41,694	12,947	28,304	3,376	5,142	-33,977	-34,189	13,355	7,721	15,952	15,935	-4,342	24,872	-525	9,393
Reaches 1-7	37,000					120,631	-116,103	-14,262	-40,186	-19,403	185,116	-190,504	-106,889	1,608,632	-187,403	-44,105	-198,614	-179,924	-506,799	-85,897	-157,553	229,463
Unit Volume Change Since Last Survey (cy/ft)																						
	Length (ft)	Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19	Jun-20	Jul-21	Aug-22	Aug-23	Sep-24	Feb-25	Aug-25
Reach 1	5,000					12.2	-10.1	-15.9	-10.3	9.7	-1.3	-20.2	-2.6	7.1	-0.6	15.6	-1.1	-22.0	-42.4	-6.3	0.6	24.1
Reach 2	4,000					6.5	-3.0	12.5	9.5	-6.3	-7.4	4.4	-1.3	1.1	-3.7	-1.1	-5.1	1.0	-7.9	-7.0	-3.6	2.5
Reach 3	6,000					10.7	-3.2	8.1	13.1	0.2	7.3	0.4	1.6	0.4	4.6	5.2	0.0	4.9	-3.5	16.2	1.9	5.8
Reach 4	7,200					9.8	6.4	15.0	11.8	-0.2	9.5	-3.2	0.7	5.8	8.7	21.8	18.2	12.9	2.8	4.3	-8.7	-1.4
Reach 5a	2,000		2.8	52.8	22.7	-6.6	0.1	-0.8	-8.6	-7.0	-21.3	-21.6	-8.3	33.5	35.8	-22.0	-33.9	-9.4	-17.4	-26.2	-10.0	-0.7
Reach 5b	1,400		-7.0	92.5	-12.3	-12.6	-7.0	-16.8	0.1	-27.4	-15.9	-54.2	-15.4	243.4	-62.9	-41.6	-34.3	-3.6	8.8	0.7	-22.0	-9.3
Reach 5c	2,400		-7.5	37.3	-50.2	-3.9	-18.6	-40.2	-48.5	-3.1	3.1	-15.0	-6.0	199.1	-58.8	-38.3	-41.5	-37.8	-41.4	-23.3	2.8	60.7
Reach 6a	1,200		4.2	32.3	96.6	-42.1	-37.2	-69.2	16.3	62.5	67.7	-41.4	-81.0	144.2	-124.2	-34.1	-32.2	-8.8	18.9	113.1	51.4	-25.8
Reach 6b	1,800		19.6	166.9	-24.2	-8.0	16.8	11.9	-25.3	-17.7	11.9	47.6	-9.0	150.0	-15.0	-31.3	-15.3	-12.3	-35.2	-54.3	-26.2	-21.2
Reach 6c	2,000		87.8	143.5	-33.3	-8.4	-19.6	-0.1	-22.0	-26.9	29.9	13.6	48.5	115.0	30.3	-11.2	-19.0	-33.3	-48.0	-55.1	-32.2	1.5
Reach 7	4,000		17.1	-0.9	9.0	5.1	6.9	10.4	3.2	7.1	0.8	1.3	-8.5	-8.5	3.3	1.9	4.0	4.0	-1.1	6.2	-0.1	2.3
Reaches 1-7	37,100					-6.8	-5.4	-9.6	-12.9	-2.9	7.3	-5.9	-7.0	103.0	-17.5	-20.7	-20.5	-13.2	-17.8	-10.5	-6.4	5.0

TABLE 4.2a. Beach volume data for selected dates since 2008 for each project reach and each monitoring profile. Reaches run from Breach Inlet to Dewees Inlet.

	Station	Distance to Next	Jul-07	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19	Jun-20	Jul-21	Aug-22	Aug-23	Sep-24	Feb-25	Aug-25
Reach 1	0	400				207.4	278.7	293.4	290.5	213.8	254.8	319.6	212.9	278.5	266.3	330.3	270.1	292.1	322.5	235.0	242.6	279.9	213.5
	4	400				434.6	458.6	430.7	412.0	374.1	393.3	435.5	386.8	409.9	425.1	393.7	403.6	440.1	418.0	388.6	371.1	397.7	374.4
	8	400				461.3	449.6	456.6	423.2	400.5	436.9	443.8	415.5	411.7	424.9	409.5	421.8	440.6	424.6	373.9	392.3	385.8	374.5
	12	400				627.5	624.2	590.5	553.3	580.5	596.6	551.5	529.6	544.4	533.3	551.5	580.7	570.4	538.0	443.9	472.0	479.8	493.3
	16	400				573.6	565.4	539.9	482.6	514.7	540.1	512.9	474.2	482.9	480.4	496.1	527.3	494.2	448.4	391.9	400.3	451.7	472.9
	20	1000				489.2	492.0	475.9	434.5	417.9	455.4	458.8	409.3	402.8	418.6	416.7	448.5	437.3	394.1	358.1	346.8	341.8	398.4
	30	1000				402.0	425.9	425.9	414.1	403.9	404.5	407.2	396.8	373.8	388.5	386.3	411.9	407.3	387.4	350.7	327.3	304.0	384.0
	40	1000				379.8	390.0	386.6	400.4	386.3	374.0	360.5	374.0	359.7	367.1	360.4	370.9	372.9	355.3	324.7	310.1	303.7	316.4
Reach 2	50	1000				365.5	378.0	364.6	377.3	377.4	351.2	348.3	361.9	359.1	357.1	357.0	354.7	352.7	341.9	322.6	318.1	311.6	314.9
	60	1000				340.2	347.7	343.9	353.4	361.1	347.6	341.5	348.9	352.6	343.4	342.2	346.9	344.8	347.0	338.6	324.7	322.1	323.7
	70	1000				342.7	340.9	343.9	357.6	369.5	361.8	354.1	354.7	354.5	358.7	351.3	347.8	346.4	354.6	347.8	337.7	336.0	346.9
	80	1000				300.5	310.0	305.0	318.7	334.0	336.0	325.0	328.0	321.0	330.1	323.7	318.6	310.6	311.1	308.7	299.5	293.1	293.2
Reach 3	90	1000				306.6	316.1	317.1	330.5	336.4	350.6	344.0	343.7	342.9	345.8	346.0	347.2	331.8	328.6	320.0	335.1	334.0	325.2
	100	1000				325.1	344.3	336.1	339.6	350.2	362.2	363.5	365.6	365.1	362.7	362.8	372.5	375.3	361.2	361.0	384.5	375.2	378.3
	110	1000				306.8	316.5	309.6	321.2	331.5	332.3	335.3	341.9	343.2	338.6	336.8	348.6	360.9	350.0	354.6	369.1	364.7	372.9
	120	1000				333.4	335.5	340.5	358.9	364.9	358.5	372.2	376.7	374.5	375.3	381.4	389.9	394.1	396.9	393.3	418.7	419.8	425.7
	130	1000				322.2	329.3	326.2	328.4	353.0	335.2	351.4	349.8	352.7	356.9	365.4	365.2	360.0	379.6	371.8	386.1	396.2	404.3
	140	1000				314.5	330.6	323.1	328.5	344.3	345.7	353.2	344.7	353.7	354.5	364.0	364.5	356.5	384.6	372.6	379.2	389.7	401.5
Reach 4	150	1000				299.5	309.7	311.3	313.0	330.1	337.9	348.7	347.8	346.6	350.6	360.5	361.0	363.9	374.3	379.1	389.4	396.8	401.0
	160	1000				284.6	283.1	291.6	305.0	316.3	328.2	355.4	349.6	347.2	377.0	356.1	356.2	360.3	362.5	380.7	409.2	418.1	405.5
	170	1000				291.8	293.4	289.8	317.0	335.4	339.3	361.1	364.5	366.0	388.0	364.8	360.1	359.6	378.6	378.7	401.2	399.8	404.2
	180	1000				318.3	336.3	337.9	354.6	373.8	373.4	387.1	391.3	407.6	395.6	404.9	400.8	414.3	443.1	434.4	459.2	445.3	465.2
	190	1000				318.7	336.5	353.7	370.6	374.3	366.8	375.9	371.6	378.1	372.3	373.5	398.7	426.0	442.1	451.5	436.7	424.8	435.1
	200	200				326.7	346.9	354.9	366.8	373.6	372.4	368.4	364.1	357.0	359.2	364.8	407.2	452.5	468.5	483.8	472.0	446.6	447.8
	202	200			320.6	365.1	377.3	381.1	391.4	400.4	395.5	400.0	391.1	384.9	386.4	393.6	443.4	481.2	500.7	508.7	489.0	471.0	456.4
	204	200			339.9	386.0	396.1	397.5	405.7	413.2	410.4	410.7	407.4	393.0	400.0	411.3	473.3	514.5	525.0	532.6	512.2	498.4	473.5
	206	200			337.6	375.3	380.6	385.3	393.5	402.8	400.6	401.8	394.6	389.0	389.1	409.6	465.5	517.1	522.1	523.9	508.0	483.2	464.9
	208	200			328.8	367.4	381.7	385.1	400.8	417.0	404.9	402.6	401.7	393.3	386.4	424.5	504.5	531.0	530.7	531.8	520.6	493.3	479.2
	210	200			354.1	394.3	407.7	412.5	421.1	434.4	436.8	428.4	423.0	413.4	413.4	458.7	531.2	560.0	561.4	559.4	550.7	523.8	516.4
	212	200			333.8	374.0	386.7	391.9	411.1	411.7	411.7	408.9	400.6	389.5	385.2	445.4	505.6	535.5	538.8	539.0	533.0	521.6	511.4
	214	200			326.9	380.8	381.8	396.8	410.3	415.8	392.1	406.3	385.2	382.1	388.6	455.1	502.1	538.5	540.3	533.6	532.0	526.1	507.7
	216	200			327.4	376.4	377.2	391.1	406.5	418.1	394.4	396.6	387.0	386.8	391.5	451.7	500.8	530.7	531.4	520.0	513.3	503.8	488.4
	218	200			349.3	387.7	393.6	407.5	417.6	427.3	419.3	415.3	407.8	406.5	409.2	465.7	509.4	527.1	528.6	513.4	499.8	489.0	473.6
	220	200			342.5	382.1	388.1	400.8	416.4	430.0	430.0	416.5	405.0	403.1	412.5	462.4	492.2	506.3	512.3	490.3	467.6	457.1	442.8
Reach 5a	222	200	295.9	302.4	310.3	343.8	352.6	368.2	382.3	383.7	388.2	364.8	359.3	360.2	367.3	414.2	424.9	414.1	433.7	407.4	383.5	373.9	363.4
	224	200	316.3	323.2	335.2	375.3	373.5	390.4	411.2	408.5	409.6	386.7	377.4	379.8	382.1	428.3	429.2	402.0	417.0	392.2	355.7	346.4	338.5
	226	200	299.7	303.2	310.8	372.4	362.8	367.4	386.4	377.0	383.6	356.8	341.8	343.7	341.5	381.5	379.9	332.2	352.7	332.1	295.8	267.7	267.2
	228	200	330.1	328.1	357.6	405.3	383.2	388.0	396.4	383.6	392.6	357.3	348.8	340.4	343.0	384.9	367.7	304.0	326.7	314.9	271.5	233.6	237.1
	230	200	390.7	370.4	422.4	438.2	414.5	389.8	399.9	407.0	406.1	380.9	356.4	349.9	354.8	392.1	374.7	305.1	308.6	300.7	262.5	234.6	242.9
	232	200	387.7	400.4	436.9	450.8	452.7	450.1	445.8	435.8	427.0	402.3	379.2	366.8	379.0	421.3	376.2	337.4	323.6	314.6	288.4	297.1	295.4
	234	200	325.3	342.6	417.1	424.5	416.4	414.2	398.4	394.8	378.8	356.6	327.6	318.6	347.0	390.4	359.1	325.7	314.0	297.9	273.8	250.0	240.8
	236	200	312.6	322.4	403.5	408.7	405.9	402.8	392.7	375.7	360.0	345.6	316.3	300.0	345.0	384.7	345.3	341.9	300.9	294.7	246.0	251.9	253.5
	238	200	299.1	299.2	389.0	394.0	392.4	390.8	374.4	364.1	343.8	330.1	300.9	286.3	358.4	386.9	351.0	328.6	296.0	270.3	263.2	259.7	264.5
	240	200	312.3	306.6	400.9	409.1	407.0	408.8	392.5	373.8	355.4	341.7	313.2	300.3	399.6	416.0	386.8	371.3	325.4	296.4	300.2	316.9	319.0
Reach 5b	242	200	287.8	292.4	385.9	396.6	395.2	392.8	373.0	354.2	336.3	331.9	297.6	282.3	415.9	413.2	396.1	382.1	331.3	312.7	325.6	334.2	328.6
	244	200	344.5	339.5	433.3	449.4	441.5	432.5	419.2	397.8	383.5	385.8	341.0	318.7	499.0	479.7	449.9	430.3	382.2	382.8	415.5	400.6	393.6
	246	200	359.6	355.9	445.0	446.0	440.2	436.5	414.1	390.4	387.4	393.5	336.4	315.9	526.5	484.5	448.8	398.5	382.2	392.7	447.7	413.0	403.0
	248	200	383.6	387.0	468.9	461.8	451.5	446.3	421.9	415.1	420.6	409.8	340.4	316.6	563.6	508.9	455.4	415.6	401.2	424.7	483.4	464.4	425.9
	250	200	396.5	403.5	496.2	474.8	467.8	459.2	432.8	441.4	437.2	415.5	340.3	319.3	587.9	515.6	474.6	433.1	419.9	461.2	459.5	454.1	435.0
	252	200	371.8	365.7	458.7	431.4	418.2	410.0	389.7	421.5	369.1	336.0	281.1	268.3	554.5	464.7	419.5	376.7	399.1	422.3	392.5	361.8	357.6
	254	200	370.5	346.4	447.2	415.4	390.2	381.7	372.1	397.0	324.4	288.9	237.4	243.9	539.7	437.8	385.2	336.4	396.0	385.2	313.9	276.0	296.9

TABLE 4.2b. Beach volume data for selected dates since 2008 for each project reach and each monitoring profile.

	Station	Distance to Next	Mar-08	Jul-08	Sep-09	Sep-10	Jun-11	Jul-12	Jul-13	Sep-14	Aug-15	Aug-16	May-17	Apr-18	Jun-19	Jun-20	Jul-21	Aug-22	Aug-23	Sep-24	Feb-25	Aug-25
Reach 5c	256	200	359.6	458.4	417.2	381.4	371.8	389.1	383.3	299.5	265.8	247.5	234.4	532.7	412.6	363.5	382.8	402.6	367.5	277.4	245.8	236.7
	258	200	380.4	474.2	429.6	390.1	389.8	411.1	366.6	311.5	269.0	253.6	239.6	534.0	420.6	408.3	393.7	407.0	330.5	256.3	224.2	222.3
	260	200	432.0	502.2	454.9	414.9	417.2	415.9	350.4	308.6	279.8	264.9	264.4	547.9	443.5	458.9	409.2	393.9	310.2	246.0	195.4	207.0
	262	200	424.3	487.7	442.9	415.5	405.1	391.0	381.7	279.2	302.9	272.3	271.4	540.5	453.1	439.1	417.0	348.6	301.4	193.8	171.3	223.5
	264	200	454.2	506.9	458.4	436.1	407.3	402.4	344.0	291.2	313.4	278.0	279.2	537.4	466.9	438.9	399.0	339.0	282.4	211.7	217.4	275.3
	266	200	461.0	510.0	454.4	438.4	413.9	388.4	320.2	302.5	316.9	285.3	284.5	520.4	459.8	430.5	376.5	331.3	278.6	227.4	221.2	330.7
	268	200	473.9	516.9	444.6	435.3	412.5	385.0	279.4	322.7	330.2	301.9	313.4	506.0	462.7	410.0	367.9	319.4	278.0	218.1	249.5	362.3
	270	200	498.0	536.0	458.1	458.7	425.2	373.2	338.9	364.8	370.2	344.4	370.4	514.7	483.9	431.3	387.8	341.4	295.5	261.2	311.1	416.8
	272	200	490.7	511.0	443.8	446.3	421.8	366.0	281.9	350.0	381.5	355.4	340.6	490.2	463.3	411.1	345.6	312.3	268.1	304.3	317.3	398.0
	274	200	517.9	526.2	466.5	489.5	470.5	404.3	342.5	394.1	411.6	408.8	387.0	508.3	495.2	428.6	372.5	342.5	317.6	359.0	366.4	445.8
	276	200	506.7	499.7	443.4	487.3	468.4	375.5	347.4	385.1	383.1	381.3	381.6	480.1	462.5	403.4	359.0	310.2	296.5	352.1	362.0	423.5
	278	200	541.4	510.6	455.0	530.1	517.9	400.5	375.2	419.3	413.3	433.4	408.5	519.7	500.0	432.6	381.2	315.1	323.8	387.0	395.9	453.7
Reach 6a	280	200	562.9	558.5	655.7	617.5	567.1	457.9	470.6	479.1	502.4	546.0	498.3	655.1	539.6	506.9	459.4	428.9	426.2	489.6	558.9	569.4
	282	200	631.7	568.1	753.6	683.5	561.3	480.2	507.5	556.7	600.3	580.1	516.6	652.7	520.2	495.4	469.5	439.8	441.1	582.6	778.9	659.2
	284	200	676.3	671.0	827.1	737.7	660.3	575.3	602.4	672.3	741.5	705.1	609.4	751.8	608.2	588.8	548.9	533.8	555.1	738.2	839.3	756.6
	286	200	651.2	646.9	772.8	709.0	666.5	590.8	600.3	700.8	782.3	711.7	633.9	759.9	617.3	579.6	563.8	559.9	579.8	775.1	776.4	750.9
	288	200	487.2	577.8	608.1	599.8	596.6	536.5	543.4	607.9	692.5	635.1	546.1	705.7	585.0	535.2	502.2	508.4	538.5	640.0	628.9	645.4
	290	200	382.0	486.4	521.6	524.9	547.5	500.6	515.4	573.4	653.0	595.0	506.4	657.6	550.8	510.0	472.3	488.1	517.1	544.0	541.9	583.3
Reach 6b	292	200	377.4	486.0	522.2	511.4	561.3	538.4	550.3	607.9	680.7	624.9	534.4	672.4	589.4	557.3	522.7	525.5	552.1	549.0	535.0	544.1
	294	200	385.8	514.9	535.1	527.6	555.3	571.9	573.0	585.9	667.2	659.8	576.9	686.2	639.5	608.4	579.9	586.9	593.1	567.5	543.5	517.8
	296	200	356.5	496.7	498.1	495.8	517.2	539.7	510.4	518.1	550.1	615.0	538.3	655.5	634.0	597.7	571.1	584.5	568.2	529.8	506.8	474.3
	298	200	320.0	483.9	471.5	467.6	486.0	490.9	479.8	446.3	468.0	562.2	512.2	634.5	628.7	586.6	568.4	579.5	548.3	493.7	469.2	443.5
	300	200	308.2	483.5	463.2	457.2	476.7	491.3	453.8	433.8	406.6	524.0	499.1	630.8	628.9	587.4	578.3	576.3	533.6	473.7	448.7	428.8
	302	200	279.5	474.9	441.9	436.7	450.2	463.0	443.4	405.7	373.0	468.6	478.6	622.6	626.4	593.5	580.6	568.6	516.8	450.5	427.3	405.3
	304	200	259.8	451.4	408.2	399.7	408.4	429.3	392.4	355.1	345.2	383.9	430.9	597.7	598.5	569.2	561.0	530.5	478.8	410.2	384.5	364.6
	306	200	269.8	460.1	404.9	399.7	407.8	421.7	398.1	364.6	348.5	377.2	428.1	614.1	608.7	584.3	577.4	535.6	482.4	419.8	389.5	369.5
	308	200	246.1	428.0	371.1	346.3	350.2	366.0	314.8	287.4	297.9	313.8	372.1	571.3	558.4	538.8	585.5	499.2	438.2	366.9	334.1	312.3
Reach 6c	310	200	252.2	412.0	339.7	333.2	342.8	336.8	286.2	246.8	269.5	286.4	351.3	560.2	552.7	535.4	522.8	480.3	423.6	343.6	313.1	287.7
	312	200	232.0	398.1	334.0	310.3	307.4	322.9	284.6	235.3	244.8	259.1	331.7	546.5	531.1	515.6	497.6	457.6	401.2	316.1	282.7	264.3
	314	200	192.1	348.7	272.6	274.0	261.0	279.6	220.5	204.4	207.3	220.2	286.2	489.0	469.4	451.8	435.7	385.4	336.9	255.0	226.6	219.3
	316	200	261.7	432.8	375.2	371.6	355.3	348.4	317.7	286.4	306.0	313.6	380.7	560.5	554.6	548.9	523.7	486.3	422.3	352.8	311.2	304.3
	318	200	246.7	428.2	370.0	358.9	340.3	355.4	288.6	275.1	315.7	327.8	393.3	529.7	550.2	538.2	507.1	466.4	415.2	342.1	304.1	302.4
	320	200	261.3	440.4	388.4	375.6	345.7	361.3	324.5	297.4	343.6	365.1	416.2	526.7	554.2	544.9	523.9	485.0	426.0	358.3	322.3	326.8
	322	200	267.0	435.2	387.1	379.2	351.8	334.4	328.7	297.3	337.6	370.7	416.2	495.5	551.2	536.6	511.2	470.8	422.4	375.8	328.5	344.0
	324	200	206.5	353.0	334.8	318.0	286.1	264.6	260.6	239.5	278.0	306.9	341.3	398.2	463.8	453.0	423.5	398.2	343.8	304.5	269.9	279.4
	326	200	248.7	365.9	383.9	369.7	339.8	325.7	335.1	323.2	358.9	368.0	398.5	434.3	517.5	506.0	483.9	461.1	417.0	379.7	355.7	373.3
	328	200	303.2	356.3	401.2	388.6	348.2	344.2	382.2	344.3	397.8	389.7	415.3	451.0	531.6	514.1	503.0	473.3	436.9	423.3	400.5	410.0
Reach 7	330	200	180.0	210.6	240.4	281.7	299.6	302.3	301.3	280.4	283.3	275.5	263.7	250.3	278.6	302.1	382.8	360.6	382.1	389.2	388.3	398.7
	332	200	507.1	561.3	574.5	619.8	632.9	650.7	670.7	685.0	674.6	706.9	665.3	630.3	656.8	681.9	696.6	722.6	758.7	795.1	823.0	830.6
	334	200	473.1	579.0	548.0	573.4	586.6	611.3	634.5	652.3	648.0	660.1	633.1	605.6	626.0	648.9	695.3	672.1	697.1	728.9	753.4	762.4
	336	200	459.8	518.7	516.9	526.0	551.7	567.2	586.9	612.2	610.9	612.4	609.7	584.2	609.9	620.4	620.6	632.4	648.5	666.6	681.3	693.7
	338	200	444.2	500.0	467.9	467.4	479.6	504.7	523.3	551.0	557.8	569.9	563.4	546.9	561.2	566.5	573.2	583.5	597.7	610.5	618.5	626.2
	340	200	438.0	495.3	448.3	441.8	457.7	472.8	494.1	514.8	519.1	525.1	521.5	509.3	513.6	519.2	527.6	543.6	553.9	567.9	570.7	576.1
	342	200	448.4	470.9	448.7	436.9	450.3	473.2	483.1	496.5	502.8	504.6	497.1	488.0	484.5	484.3	494.0	510.1	524.4	533.0	535.0	533.0
	344	200	444.6	456.2	444.4	431.6	438.4	459.1	469.7	479.0	488.4	479.0	473.7	462.9	459.3	458.3	462.5	475.3	483.5	492.5	489.8	489.7
	346	200	437.6	438.2	433.4	421.3	429.0	440.1	449.7	454.6	464.9	460.3	448.2	443.1	437.6	431.9	434.7	437.4	449.2	451.8	445.8	442.8
	348	200	423.8	424.0	421.6	407.5	424.3	430.8	440.0	444.5	456.3	450.2	453.4	444.1	436.5	436.2	424.0	428.6	430.9	436.1	428.1	422.6
	350	200	429.8	430.5	426.0	424.6	426.4	432.6	439.6	446.1	454.3	457.4	453.6	453.1	455.4	448.4	444.5	444.4	443.1	441.2	432.7	423.9
	352	200	431.3	432.3	423.4	427.0	429.1	431.2	441.9	446.7	453.8	451.4	451.8	454.2	458.3	452.0	445.4	443.6	437.5	431.1	418.6	411.7
	354	200	475.3	476.5	468.3	476.2	480.1	483.9	491.4	493.0	495.9	493.6	488.2	490.4	495.7	493.4	482.4	481.5	475.3	462.5	446.7	443.7
	356	200	523.8	528.1	516.7	524.8	529.9	529.1	537.0	532.9	531.7	523.1	521.1	521.8	526.8	537.4	517.9	514.7	502.2	478.2	466.4	466.0
	358	200	445.0	444.4	433.4	446.4	452.2	453.2	445.9	433.6	430.3	426.3	417.0	415.8	419.4	420.4	418.5	412.4	393.8	382.1	367.2	378.3
	360	200	482.5	482.2	471.4	486.5	496.9	489.1	480.6	463.9	454.5	448.0	436.1	434.1	435.3	438.9	440.2	429.7	413.8	417.9	417.3	420.4
	362	200	494.9	492.8	491.4	502.6	512.1	502.4	479.1	462.6	455.0	450.7	437.1	438.9	442.4	444.9	447.9	434.8	422.0	430.4	424.1	435.8
	364	200	586.9	592.3	605.8	614.6	596.5	586.7	574.7	559.3	545.9	539.0	528.3	513.8	526.5	520.6	534.0	527.1	489.4	495.8	498.6	506.0
	366	200	600.1	599.4	610.5	606.0	594.3	597.4	605.0	614.4	601.2	607.1	598.6	578.2	574.3	568.9	586.8	582.1	545.2	570.7	572.0	566.1
	368	200	584.2	590.7	587.2	582.4	575.3	585.9	588.9	614.3	619.5	622.2	623.4	631.9	605.5	580.8	604.6	609.4	548.9	585.6	589.8	592.7
	370	0	731.8		579.5	585.8	591.8	689.7	551.4	612.8	628.0	642.0	647.9	667.4	615.2	612.8	626.7	609.2	685.0	602.2	594.3	592.3

TABLE 4.2c. Beach volumetric change for selected dates for each project reach and each monitoring profile.

	Station	Distance to Next	Apr 18 - Jun 19	Jun 19 - Jun 20	Jun 20 - Jul 21	Jul 21 - Aug 22	Aug 22 - Aug 23	Aug 23-Sep 24	Sep 24 - Feb 25	Feb 25 - Aug 25	Sept 24 - Aug 25	Sep 09-Aug 25	May 17 - Aug 25
Reach 1	0	400	64.0	-60.3	22.0	30.4	-87.5	7.5	37.3	-66.4	-29.1	6.1	-65.0
	4	400	-31.5	9.9	36.5	-22.0	-29.4	-17.5	26.6	-23.3	3.3	-50.2	-35.5
	8	400	-15.4	12.3	18.8	-16.0	-50.7	18.4	-6.5	-11.3	-17.8	-86.8	-37.2
	12	400	18.2	29.2	-10.3	-32.4	-94.1	28.0	7.9	13.5	21.3	-134.2	-51.1
	16	400	15.7	31.2	-33.1	-45.8	-56.5	8.4	51.4	21.2	72.6	-100.7	-10.0
	20	1000	-1.9	31.8	-16.1	-38.2	-36.0	-11.3	-5.0	56.6	51.7	-90.7	-4.4
	30	1000	-2.2	25.6	-4.6	-20.0	-36.6	-23.5	-23.3	79.9	56.7	-18.1	10.1
	40	1000	-6.8	10.5	2.1	-17.7	-30.6	-14.5	-6.4	12.6	6.2	-63.5	-43.4
Reach 2	50	1000	-0.2	-2.2	-2.1	-10.7	-19.4	-4.5	-6.5	3.3	-3.2	-50.6	-44.1
	60	1000	-1.2	4.8	-2.1	2.2	-8.4	-13.9	-2.6	1.6	-1.0	-16.5	-28.9
	70	1000	-7.4	-3.5	-1.4	8.2	-6.8	-10.1	-1.7	10.9	9.2	4.2	-7.6
	80	1000	-6.4	-5.1	-8.1	0.5	-2.4	-9.2	-6.4	0.1	-6.4	-7.3	-27.8
Reach 3	90	1000	0.2	1.2	-15.4	-3.2	-8.6	15.1	-1.2	-8.8	-9.9	18.6	-17.7
	100	1000	0.1	9.7	2.8	-14.1	-0.3	23.5	-9.2	3.0	-6.2	53.2	13.2
	110	1000	-1.8	11.8	12.3	-10.8	4.5	14.5	-4.4	8.2	3.8	66.1	29.6
	120	1000	6.1	8.5	4.2	2.7	-3.6	25.5	1.0	5.9	7.0	92.3	51.2
	130	1000	8.6	-0.3	-5.2	19.6	-7.8	14.3	10.1	8.0	18.2	82.1	51.5
	140	1000	9.5	0.6	-8.0	28.1	-12.0	6.7	10.5	11.8	22.2	87.0	47.8
Reach 4	150	1000	9.9	0.4	2.9	10.4	4.8	10.3	7.5	4.2	11.6	101.5	54.3
	160	1000	-21.0	0.1	4.1	2.2	18.2	28.5	8.9	-12.6	-3.8	120.8	58.3
	170	1000	-23.2	-4.7	-0.6	19.0	0.1	22.5	-1.5	4.4	3.0	112.4	38.3
	180	1000	9.3	-4.0	13.5	28.7	-8.7	24.8	-13.9	19.9	6.0	147.0	57.6
	190	1000	1.2	25.3	27.3	16.1	9.4	-14.9	-11.9	10.3	-1.6	116.3	56.9
	200	200	5.6	42.4	45.4	16.0	15.4	-11.9	-25.3	-3.8	-29.2	116.1	85.8
	202	200	7.2	49.8	37.8	19.5	8.0	-19.7	-18.0	-14.7	-32.6	91.3	71.4
	204	200	11.4	62.0	41.1	10.5	7.6	-20.4	-13.7	-24.9	-38.7	87.5	80.5
	206	200	20.5	73.7	33.8	5.0	1.8	-15.9	-24.8	-18.3	-43.1	89.6	76.0
	208	200	38.1	79.9	26.5	-0.3	1.1	-11.2	-27.4	-14.1	-41.4	111.8	85.9
	210	200	45.3	72.5	28.8	1.4	-1.9	-8.8	-26.9	-7.3	-34.2	122.2	103.0
	212	200	60.2	60.2	29.9	3.3	0.2	-6.0	-11.4	-10.2	-21.6	137.4	121.9
	214	200	66.5	47.0	36.3	1.8	-6.6	-1.7	-5.9	-18.4	-24.3	127.0	125.6
	216	200	60.2	49.1	29.9	0.7	-11.4	-6.7	-9.5	-15.5	-25.0	112.0	101.5
	218	200	56.5	43.7	17.7	1.4	-15.2	-13.6	-10.8	-15.4	-26.2	85.9	67.1
	220	200	49.9	29.8	14.1	6.0	-22.0	-22.7	-10.5	-14.3	-24.8	60.7	39.7
Reach 5a	222	200	46.9	10.6	-10.8	19.6	-26.4	-23.8	-9.6	-10.5	-20.1	19.6	3.2
	224	200	46.3	0.9	-27.2	15.0	-24.8	-36.6	-9.3	-7.9	-17.1	-36.8	-41.3
	226	200	40.1	-1.6	-47.7	20.4	-20.6	-36.3	-28.1	-0.5	-28.6	-105.2	-76.5
	228	200	42.0	-17.2	-63.7	22.7	-11.8	-43.4	-37.9	3.5	-34.4	-168.2	-103.3
	230	200	37.3	-17.4	-69.7	3.6	-7.9	-38.2	-27.9	8.3	-19.6	-195.3	-107.0
	232	200	42.3	-45.1	-43.7	-8.8	-9.0	-26.2	8.7	-1.7	7.0	-155.4	-71.3
	234	200	43.4	-31.3	-33.5	-11.7	-16.1	-24.2	-23.8	-9.2	-33.0	-183.7	-77.8
	236	200	39.7	-39.4	-3.4	-41.0	-6.2	-48.7	5.9	1.6	7.5	-155.2	-46.5
	238	200	28.5	-35.9	-22.3	-32.7	-25.7	-7.1	-3.4	4.7	1.3	-129.5	-21.9
	240	200	16.4	-29.2	-15.5	-45.9	-29.1	3.8	16.7	2.1	18.8	-90.1	18.7
Reach 5b	242	200	-2.7	-17.2	-13.9	-50.9	-18.6	12.9	8.6	-5.6	3.0	-68.0	46.3
	244	200	-19.3	-29.9	-19.5	-48.1	0.6	32.7	-14.8	-7.1	-21.9	-55.9	74.9
	246	200	-42.0	-35.7	-50.3	-16.3	10.5	55.0	-34.7	-10.0	-44.7	-43.1	87.1
	248	200	-53.7	-53.5	-39.8	-14.3	23.5	58.7	-19.0	-38.5	-57.5	-36.0	109.3
	250	200	-72.3	-41.0	-41.5	-13.2	41.3	-1.7	-5.4	-19.1	-24.5	-39.8	115.7
	252	200	-89.8	-45.2	-42.8	22.4	23.2	-29.8	-30.7	-4.1	-34.8	-73.8	89.3
	254	200	-101.9	-52.6	-48.9	59.6	-10.8	-71.4	-37.9	20.9	-17.0	-118.5	53.0

TABLE 4.2d. Beach volumetric change for selected dates for each project reach and each monitoring profile.

	Station	Distance to Next	Apr 18 - Jun 19	Jun 19 - Jun 20	Jun 20 - Jul 21	Jul 21 - Aug 22	Aug 22 - Aug 23	Aug 23-Sep 24	Sep 24 - Feb 25	Feb 25 - Aug 25	Sep 24-Aug 25	Sep 09 - Aug 25	May 14- Aug 25
Reach 5c	256	200	-120.2	-49.0	19.3	20.0	-35.3	-90.1	-31.6	-9.1	-40.7	-180.6	2.3
	258	200	-113.5	-12.3	-14.5	13.2	-76.5	-74.2	-32.0	-1.9	-33.9	-207.2	-17.3
	260	200	-104.4	15.4	-49.7	-15.4	-83.7	-64.2	-50.6	11.6	-39.0	-248.0	-57.4
	262	200	-87.3	-14.0	-22.1	-68.4	-47.2	-107.6	-22.5	52.2	29.7	-219.5	-47.9
	264	200	-70.6	-28.0	-39.9	-60.0	-56.7	-70.7	5.7	58.0	63.7	-183.1	-3.8
	266	200	-60.6	-29.3	-54.0	-45.2	-52.8	-51.2	-6.2	109.5	103.3	-123.7	46.2
	268	200	-43.3	-52.7	-42.1	-48.5	-41.5	-59.9	31.4	112.8	144.1	-82.3	48.9
	270	200	-30.8	-52.6	-43.5	-46.4	-45.9	-34.3	49.9	105.7	155.5	-41.3	46.4
	272	200	-26.9	-52.2	-65.5	-33.2	-44.3	16.2	13.0	80.7	93.7	-45.8	57.4
	274	200	-13.1	-66.6	-56.1	-30.0	-24.8	41.4	7.4	79.4	86.8	-20.7	58.8
	276	200	-17.6	-59.1	-44.4	-48.8	-13.7	55.6	9.9	61.5	71.4	-19.9	41.8
	278	200	-19.7	-67.4	-51.5	-66.1	8.8	63.2	8.9	57.8	66.7	-1.3	45.2
Reach 6a	280	200	-115.5	-32.7	-47.6	-30.4	-2.7	63.4	69.4	10.5	79.9	-86.3	76.1
	282	200	-132.5	-24.8	-25.9	-29.6	1.3	141.5	196.3	-119.6	76.6	-94.4	142.6
	284	200	-143.6	-19.4	-39.9	-15.1	21.3	183.1	101.1	-82.7	18.4	-70.6	147.2
	286	200	-142.6	-37.7	-15.8	-3.9	19.9	195.4	1.3	-25.5	-24.2	-21.9	117.0
	288	200	-120.7	-49.8	-32.9	6.1	30.2	101.5	-11.1	16.5	5.4	37.4	99.3
	290	200	-106.8	-40.7	-37.7	15.8	29.0	76.9	-2.1	41.4	39.4	61.8	76.9
Reach 6b	292	200	-82.9	-32.1	-34.7	2.8	26.7	-3.1	-24.0	19.1	-4.9	21.9	9.7
	294	200	-46.7	-31.1	-28.5	7.1	6.1	-25.6	-23.9	-25.7	-49.7	-17.3	-59.1
	296	200	-21.6	-36.3	-26.5	13.4	-16.3	-38.4	-22.9	-32.5	-55.5	-23.8	-64.1
	298	200	-5.9	-42.1	-18.2	11.1	-31.2	-54.6	-24.5	-25.7	-50.2	-28.0	-68.7
	300	200	-1.9	-41.5	-9.1	-1.9	-42.7	-59.9	-25.0	-19.9	-44.9	-34.4	-70.3
	302	200	3.8	-32.9	-12.9	-12.0	-51.7	-66.4	-23.2	-22.0	-45.2	-36.6	-73.3
	304	200	0.8	-29.4	-8.2	-30.5	-51.7	-68.6	-25.7	-19.9	-45.6	-43.6	-66.3
	306	200	-5.4	-24.4	-6.9	-41.8	-53.2	-62.6	-30.3	-19.9	-50.3	-35.3	-58.6
	308	200	-13.0	-19.6	-3.3	-36.3	-61.0	-71.3	-32.8	-21.8	-54.6	-58.8	-59.9
Reach 6c	310	200	-7.5	-17.3	-12.6	-42.5	-56.6	-80.1	-30.4	-25.4	-55.9	-52.1	-63.6
	312	200	-15.4	-15.5	-18.0	-40.0	-56.4	-85.1	-33.3	-18.4	-51.7	-69.7	-67.4
	314	200	-19.6	-17.7	-16.0	-50.4	-48.5	-81.9	-28.4	-7.3	-35.7	-53.3	-66.9
	316	200	-5.9	-5.8	-25.1	-37.4	-64.0	-69.5	-41.6	-6.9	-48.5	-71.0	-76.5
	318	200	20.5	-12.1	-31.1	-40.7	-51.1	-73.1	-38.0	-1.8	-39.8	-67.7	-90.9
	320	200	27.6	-9.3	-21.1	-38.9	-59.1	-57.7	-36.0	4.6	-31.5	-61.6	-89.3
	322	200	55.6	-14.5	-25.4	-40.4	-48.4	-46.6	-47.3	15.5	-31.9	-43.2	-72.3
	324	200	65.6	-10.9	-29.5	-25.3	-54.4	-39.4	-34.6	9.5	-25.1	-55.4	-61.9
	326	200	83.3	-11.6	-22.0	-22.8	-44.1	-37.3	-24.0	17.6	-6.4	-10.5	-25.1
	328	200	80.7	-17.6	-11.0	-29.7	-36.4	-13.6	-22.9	9.5	-13.3	8.8	-5.3
Reach 7	330	200	28.3	23.5	30.7	27.8	21.5	7.1	-0.9	10.4	9.5	158.3	135.0
	332	200	26.5	25.1	14.6	26.0	36.1	36.4	27.9	7.7	35.6	256.2	165.4
	334	200	20.4	22.9	6.3	16.8	25.1	31.1	25.1	9.0	34.1	214.4	129.3
	336	200	25.8	10.4	0.3	11.7	16.1	18.1	14.7	12.5	27.1	176.8	84.0
	338	200	14.3	5.2	6.7	10.4	14.2	12.8	8.0	7.7	15.7	158.3	62.8
	340	200	4.4	5.6	8.4	15.9	10.3	14.0	2.9	5.4	8.2	127.8	54.6
	342	200	-3.5	-0.2	9.7	16.2	14.3	8.6	2.0	-2.1	-0.1	84.3	35.9
	344	200	-3.6	-0.9	4.1	12.8	8.2	9.1	-2.8	-0.1	-2.8	45.3	16.0
	346	200	-5.5	-5.8	2.8	2.7	11.7	2.6	-6.0	-3.0	-9.0	9.4	-5.4
	348	200	-7.6	-0.4	-12.2	4.6	2.4	5.2	-8.0	-5.6	-13.6	0.9	-30.8
	350	200	2.2	-7.0	-3.8	-0.2	-1.3	-1.9	-8.5	-8.8	-17.3	-2.1	-29.7
	352	200	4.1	-6.3	-6.6	-1.8	-6.1	-6.4	-12.6	-6.9	-19.4	-11.7	-40.1
	354	200	5.3	-2.3	-11.0	-0.9	-6.3	-12.7	-15.8	-3.0	-18.8	-24.6	-44.5
	356	200	5.1	10.6	-19.5	-3.2	-12.5	-24.0	-11.7	-0.4	-12.2	-50.7	-55.1
	358	200	3.6	1.1	-1.9	-6.1	-18.6	-11.7	-14.9	11.1	-3.7	-55.0	-38.7
	360	200	1.2	3.6	1.3	-10.6	-15.9	4.1	-0.6	3.1	2.5	-51.0	-15.7
	362	200	3.5	2.5	3.0	-13.1	-12.8	8.4	-6.4	11.7	5.4	-55.5	-1.2
	364	200	12.7	-6.0	13.4	-6.9	-37.8	6.4	2.9	7.3	10.2	-99.8	-22.4
	366	200	-3.9	-5.4	18.0	-4.7	-36.9	25.5	1.3	-5.9	-4.6	-44.4	-32.4
	368	200	-26.4	-24.7	23.8	4.8	-60.5	36.7	4.2	2.9	7.1	5.4	-30.7
	370	0	-52.2	-2.4	13.9	-17.4	75.7	-82.8	-7.9	-2.0	-9.9	12.8	-55.6

4.2 Project Area Reaches

The 2018 nourishment project placed sand along most of reaches 5 and 6 at the eastern end of the island. Reach 7 is included in this section as a portion of it was nourished in the 2008 project.

4.2.1 Reach 7

Reach 7 encompasses 4,000 ft between Lines 328 and 370 that span the shoreline fronting the Dewees Inlet channel (Figure 4.4). The inlet shoals shelter this portion of beach from the largest open-water waves, so the profile features a narrow, dry-sand berm and a steep beach face. The steep beach face reduces the total profile volume needed for a stable profile compared to oceanfront areas. The seaward end of the reach was included in the 2008 nourishment project and has traditionally exhibited relative stability in beach volumes.

FIGURE 4.4. Baseline stationing along Reach 7 encompassing the length of beach between Lines 330 and 370.

Except for erosional periods from 2017 to 2018 (hurricanes *Irma*, *Maria*) and 2022 to 2023 (Hurricane *Ian*), Reach 7 has remained stable or accreting since 2008 (Fig 4.5). From September 2024 to February 2025, the reach was stable (–0.1 cy/ft) and gained ~9,400 cy (2.3 cy/ft) between February and August 2025. Within the reach, the volume change pattern has remained the same over the past several years. The seaward end, near Reach 6, has experienced slight gains as sediment from the nourishment, and the recent shoal attachment moves west.

There is an inter-annual pattern of erosional 'waves' moving northwest (inland) and southeast (seaward) along Reach 7. The highest losses along individual profiles have shifted from Station ~340 between 2018 and 2019, north and west to Station ~368 between 2021 and 2022, and back toward Station ~350 between 2024 and 2025. Fortunately, these profiles are located along the undeveloped portion of the beach well within Dewees Inlet. This means that any minor to moderate chronic erosion does not represent a significant threat to life or property.

The long-term trend along Reach 7 is that of accretion as sand is eroded from the convex-shaped shoreline along the 'corner' of the island, where open-ocean wave energy is refracted across the inlet channels and concentrated on the corner. The accretion has resulted in an increase of over 270 ft of berm width since 2008, including over 60 ft of seaward advance in the high-water line since 2018 at Station 338.

All the stations seaward of the 17th tee (groin) show accretion at least 4.5 cy/ft more sand than the most eroded condition since 2008 (Fig 4.5). Stations 330 to 338 (along the eastern side of the 17th green), closer to Reach 6, showing significant accretion averaging 198.4 cy/ft. Ground photos from the reach reflect continued stability along the backshore, reflected by the maturing dune grass plant communities. Escarpments persist west of Station 350, in the lee of the exposed groin at the 17th tee. Ground photos highlight the continued maturation of dune habitat in areas east of the groin and scarping in stations west of the groin (Fig 4.6). As the profiles in Figure 4.6 show, the main channel of Dewees Inlet has not migrated toward Isle of Palms and remains positionally stable. Accretion along the upper profile (see Station 338+00 – Upper left in Figure 4.6) has moved the margin of the channel seaward despite its direct exposure to storm haves out of the Northeast. This is an important result of nourishment spreading from the oceanfront project area.

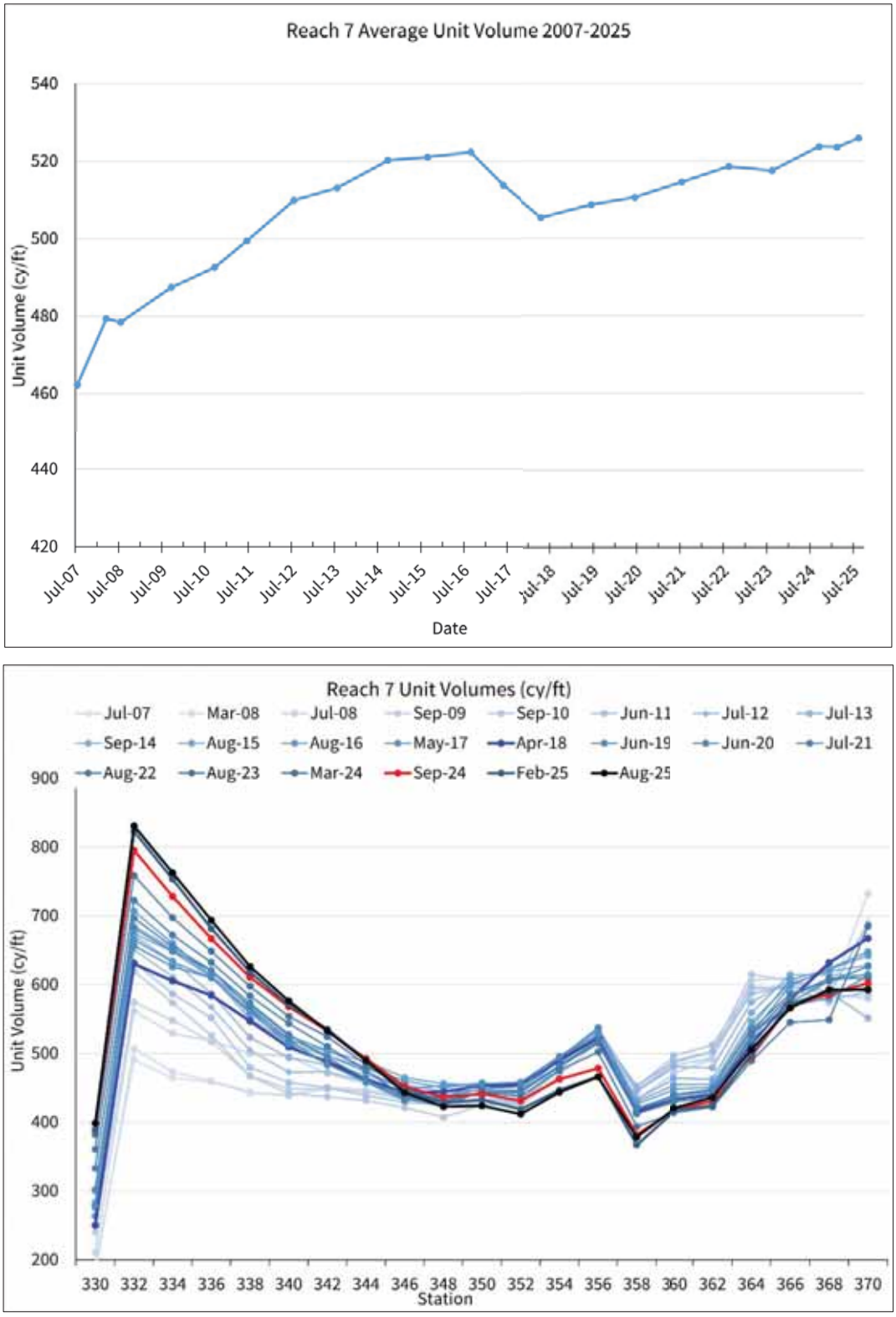
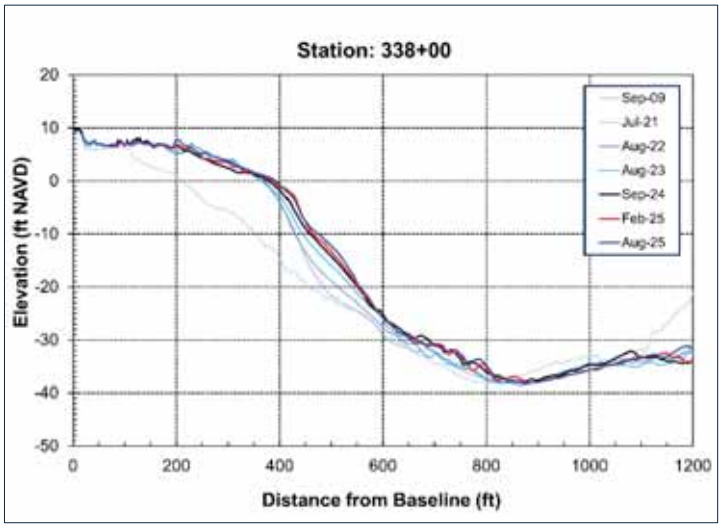


FIGURE 4.5. **[UPPER]** Average beach volume in Reach 7 since 2007. **[LOWER]** Profile unit volumes for each monitoring line in Reach 7.



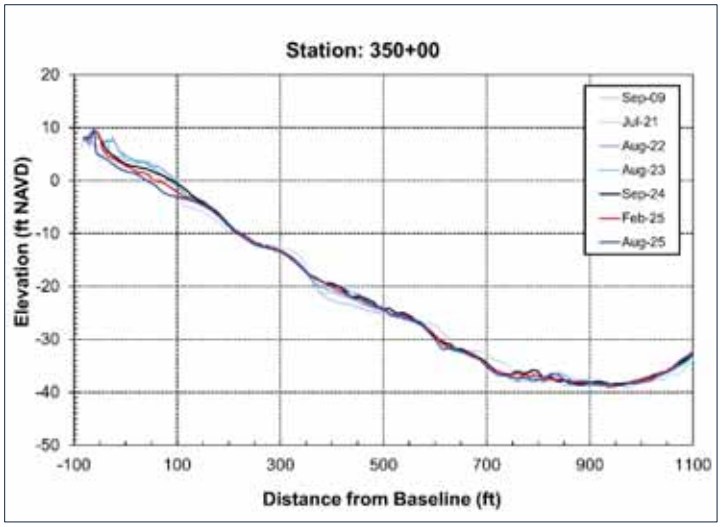


FIGURE 4.6.
[UPPER] Beach profiles from Reach 7.

[MIDDLE] Aerial photo of Reach 7 collected September 2025.

[LOWER] Ground photos from Station 338 **[LEFT]** and Station 350 **[RIGHT]** in August 2025.

4.2.2 Reach 6

Reach 6 encompasses ~5,000 linear feet of beach between the Wild Dunes Property Owners Beach House (Station 280) and the 18th hole of the Links Course (Station 328) (Figure 4.7). This area is along the 'corner' of the shoreline between Dewees Inlet and the open ocean and is where shoals attach as part of cyclical bypass events from the inlet. Depending on the location and magnitude of the bypass, the shoreline can move hundreds of feet landward or seaward over the course of just a few months (Kana et al 1985, Gaudiano 1998).

FIGURE 4.7. Baseline stationing along Reach 6 encompassing ~5,000 lf of beach between Wild Dunes Property Owners Beach House and the 18th hole of the Links Course.

Reach 6 experiences regular shoal attachment (bypass) cycles. The time elapsed between these events varies due to variations in the size and speed of an individual shoal; however, since the 1940s, these events have tended to occur approximately once every seven to ten years. (Gaudiano and Kana 2001) Due to the natural internal dynamics of these shoal bypass events (see Fig 2.3), Reach 6 often experiences dramatic erosion and accretion simultaneously. As a shoal approaches, volumes increase in the immediate vicinity of the attachment area between the shoal and beach. Wave refraction around the shoal concentrates erosion on either side, often just a few hundred feet up or down the coast. As the shoal attaches to the beach, sand spreads laterally and fills in the erosional arcs cut on either side of the attachment zone.

Since the 2008 project, CSE surveys have identified multiple attachment events along Reach 6. These events have led to variable rates of erosion and accretion along every profile in the reach, with the current shoal attachment impacting the beach now. To that point, Reach 6 lost ~49,850 cy (–10.0 cy/ft) from September 2024 to February 2025 and lost ~66,200 cy (–13.2 cy/ft) from February 2025 to August 2025. This resulted in a yearly net loss of ~116,050 cy from 2024 to 2025 (–23.2 cy/ft). This yearly loss is one of the highest erosion rates since monitoring began and was brought on by the shoal attaching to shore. Reach 6 has lost ~151,000 cy (–30.2 cy/ft) since the 2008 project and has lost ~88,200 cy (–17.6 cy/ft) since the 2018 project (Fig 4.8 upper). Historically, this reach has lost sand

between most surveys, but these losses have been somewhat offset by periodic shoal attachments. While bypassing shoals deliver significant sand volumes to the reach relatively quickly, they have not been sufficient to fully counteract long-term erosion. This dynamic is discussed in more detail in section 4.2.9.

Reach 6's erosion rate of 116,100 cy (–23.2 cy/ft) of sand from September 2024 to August 2025 is slightly higher than the long-term average losses since 2010 (~83,000 cy/yr). Since completing the 2018 project, Reach 6 has lost ~761,200 cy (–152.2 cy/ft). This represents more than 113% of the nourishment volume added in 2018; almost every station retains less sand than before that project. The only stations in Reach 6 containing more sand than the pre-2018 condition are 280 and 292 (Beach Club Villas), where the current shoal is attaching. Average erosion along all other stations is around 171.1 cy/ft compared to 2018.

Reach 6 has lost 88,200 cy (–17.6 cy/ft) since the pre-project condition survey in 2017; this total change belies the fact that the western third of the reach has actually gained sand over the same time period. That portion of the reach is where bypassing shoals tend to attach and begin spreading up- and downcoast. As a result, qualitative beach conditions along Reach 6 are varied.

It is likely that the shoal currently attaching to the western portions of Reach 6 contains around ~600,000 to 800,000 cy of sand that will spread to Reaches 5 and 6. The attaching shoal will result in a significant increase in beach volumes over the next 12 to 18 months, depending on prevailing conditions and storm impacts. The City has authorized another large-scale nourishment project that is expected to be constructed in the Summer or Fall of 2026. This project will help supplement the gains from the shoal attachment and build upon the beach to provide increased protection against erosion in the future. The current permitted plans call for a fill volume of up to ~900,000 cy between Stations 280 and 330.

Reach 6 was broken up into sub-reaches in 2025 to further evaluate the changes within this area, as it is highly dynamic with shoal attachment. Reach 6a covers from around the Wild Dunes Property Owners Beach House to around Beach Club Villas. It covers the area of initial shoal attachment and is highly accretional from September 2024 to February 2025 as the shoal moves onshore. It lost a portion of that material as it started to spread to areas alongshore. The next sub reach to the northwest is Reach 6b and is the area from the Beach Club Villas to around the Seascape Villas. Reach 6b has had volumetric loss in both semi-annual surveys, with erosion consistent in magnitude across the subreach. Reach 6c is from Seascape Villas to Dewees Inlet and was erosional September 2024 to February 2025. From February 2025 to August 2025, the reach was actually accretional; however, all of the accretion was toward the portions of beach fronting the golf course. It is expected that portions of 6b and 6c that were erosional will benefit from sand spreading from the shoal bypass; however, the newly exposed portion of the shoal may limit expected recovery.

Aerial and ground photos of the reach taken in September 2025 document the recent variability in beach and dune volumes (Figs 4.9 and 4.10). The western portion of the reach contains relatively healthy and continuous vegetation along the upper dry-sand beach and dunes, whereas vegetation along the eastern portions of the reach is sparse to nonexistent. Around the Ocean Club, there is little-to-no dry-sand beach protecting the buildings. Figure 4.8 (lower) shows that the beach volumes in August 2025 are near the lowest in 18 years around Stations 310 to 314.

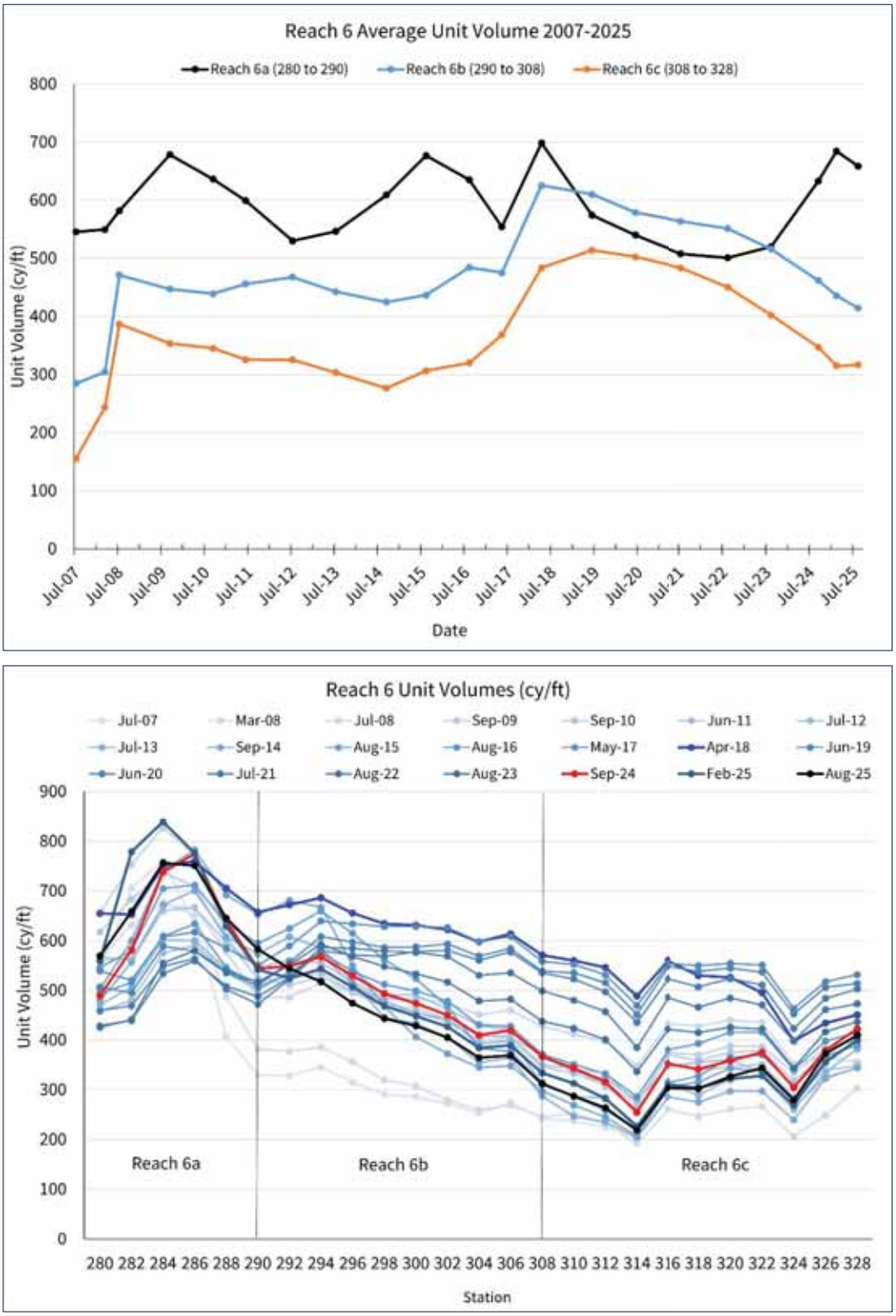
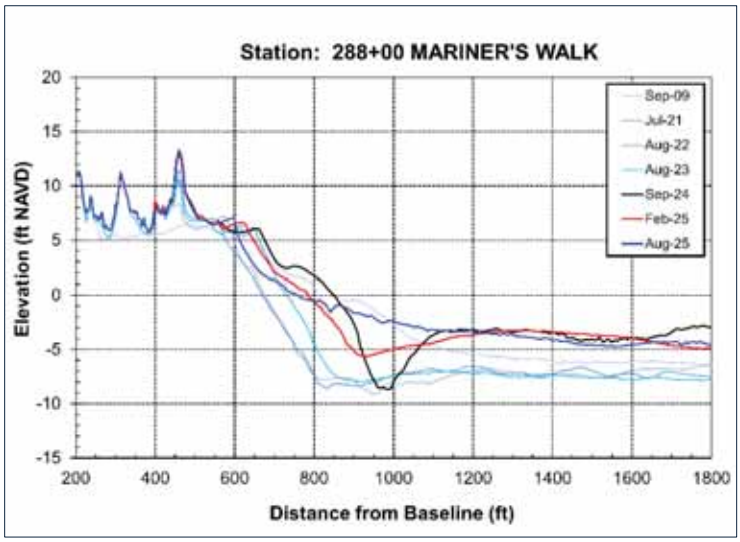


FIGURE 4.8. **[UPPER]** Average beach volume in Reach 6 since 2007. **[LOWER]** Profile unit volumes for each monitoring line in Reach 6.



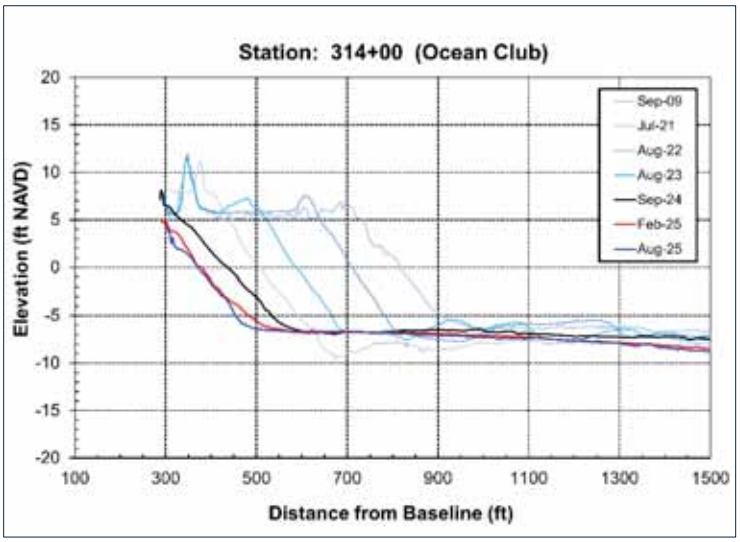


FIGURE 4.9. **[LEFT]** Reach 6 profiles. The erosion observed in this reach since 2018 has followed typical patterns of historic shoal bypassing. Over the past two years, the eastern end of the reach has eroded while the western end has been stable or accretional. **[RIGHT]** Aerial photos collected in September 2025.

FIGURE 4.10. Ground photos from Station 288 **[UPPER]** and Station 316 **[LOWER]** in August 2025.

4.2.3 Reach 5

Reach 5 includes ~5,800 lf of beach between 53rd Avenue and the Wild Dunes Property Owners Beach House (Stations 222–280 – Figure 4.11). The central and eastern portions of Reach 5 are strongly influenced by shoal-bypass events, much like Reach 6. Reach 5 tends to experience the waves of erosion and accretion during and after each shoal bypass event. Portions of the reach have experienced critically eroded conditions requiring emergency protective measures over the past 50 years.

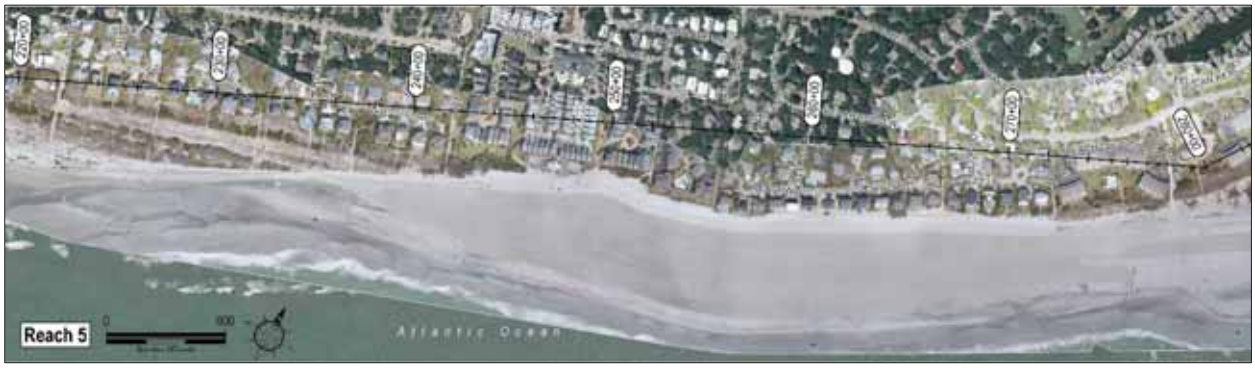


FIGURE 4.11. Baseline stationing along Reach 5, which spans ~5,800 lf of beach between 53rd Avenue and Wild Dunes Property Owners Beach House. The background photo is from just after the 2018 nourishment project.

The 2008 nourishment project added ~318,000 cy of sand to the reach. Following that project, an erosional wave moved from east to west along Reach 5, resulting in critical erosion by 2016. Shoal bypassing added volume to the eastern portions of the reach between 2013 and 2014, but this was quickly offset by erosion associated with Hurricane *Matthew in 2016.* The 2018 project added ~909,000 cy of sand (151.6 cy/ft) to Reach 5, but erosion subsequently removed ~823,700 cy (–142.0 cy/ft) (Figure 4.12) between 2018 and August 2025. As of August 2025, the reach contains less than 10% of the 2018 project volume. However, it is important to note that these losses are not evenly distributed. Areas near Beach Club Villas have gained significant volume due to the ongoing shoal attachment, while areas near Beachwood East have been highly erosional for the past several years.

Losses measured since the 2018 project have been particularly high along Beachwood East, especially along approximately 1,000 ft of shoreline. As shoals move ashore at the east end of Reach 5 and at the Wild Dunes Grand Pavilion, a gap in the main shoal off along Beachwood East allows higher waves to pass through. This leads to concentrated wave energy along the section of beach. Based on visual observations of the ongoing shoal bypass event along Reaches 5 and 6, it is probable that a significant change in wave energy along the Reach has caused the recent dramatic erosion along Beachwood East. Volume losses have averaged –21.0 cy/ft between Stations 256 and 262 from September 2024 to August 2025. The western arm of the attaching shoal has migrated west and reduced the gap in the shoals that caused the focused waves. The City sponsored a shoal management event in November 2025 that connected the shoal with the beach, which has expedited the attachment and spreading process.

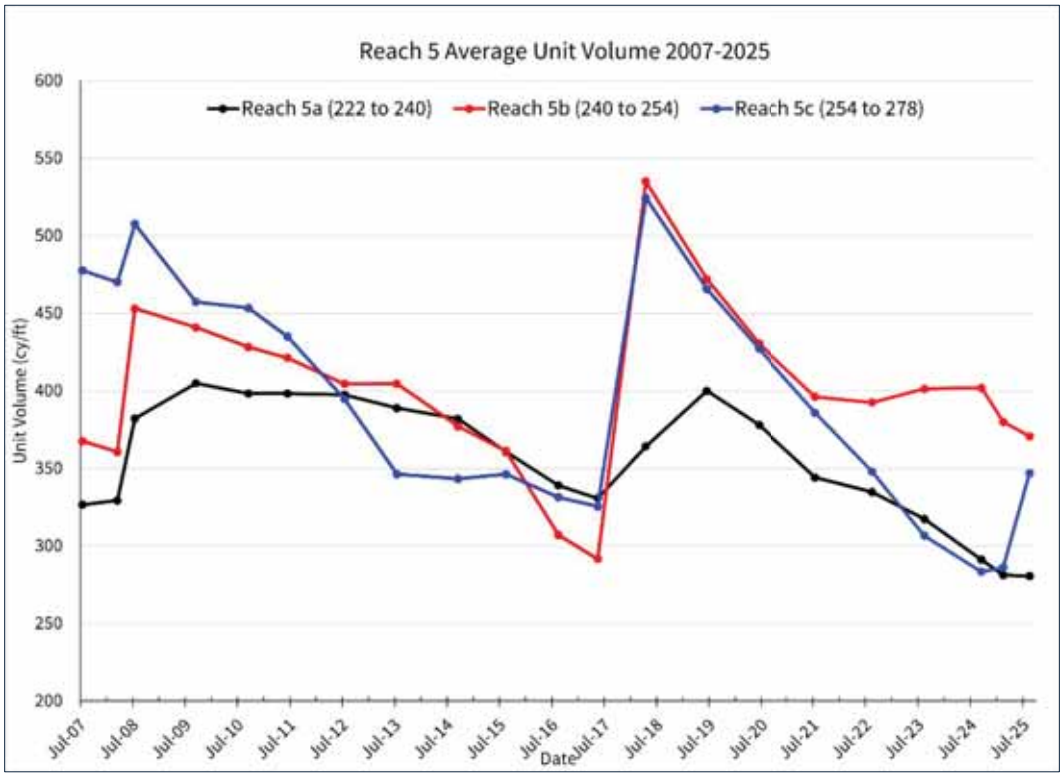


FIGURE 4.12a. Average beach volume in Reach 5 since 2007.

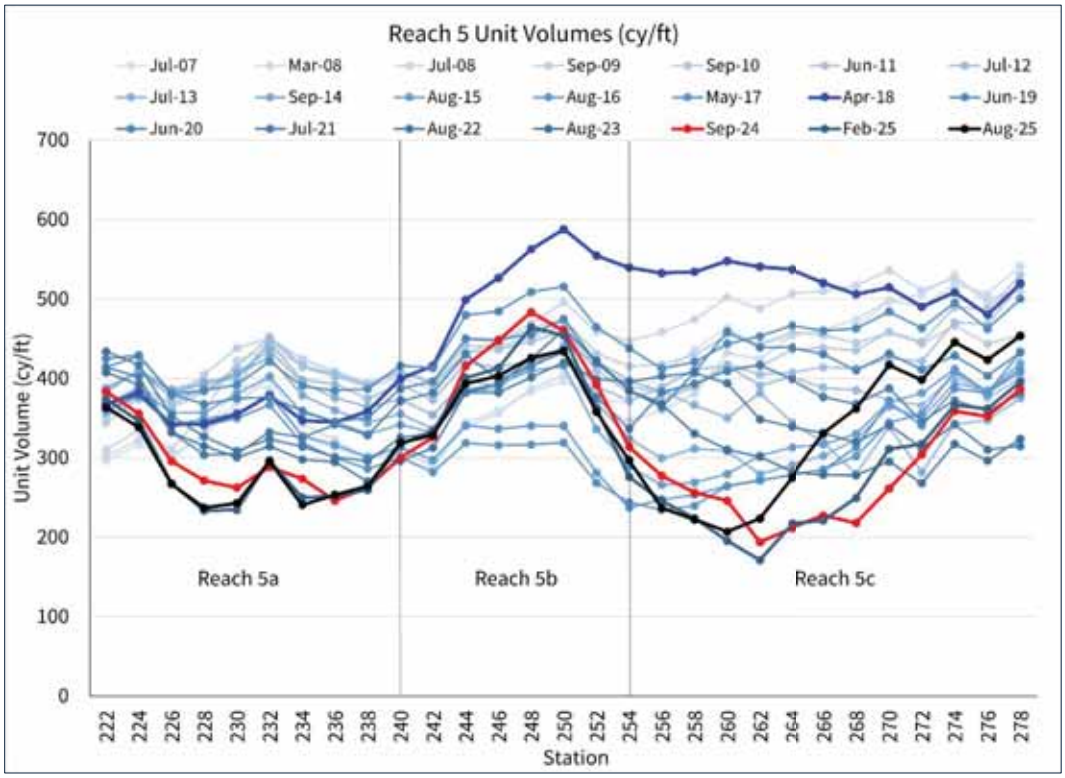


FIGURE 4.12b. Profile unit volumes for each monitoring line in Reach 5.

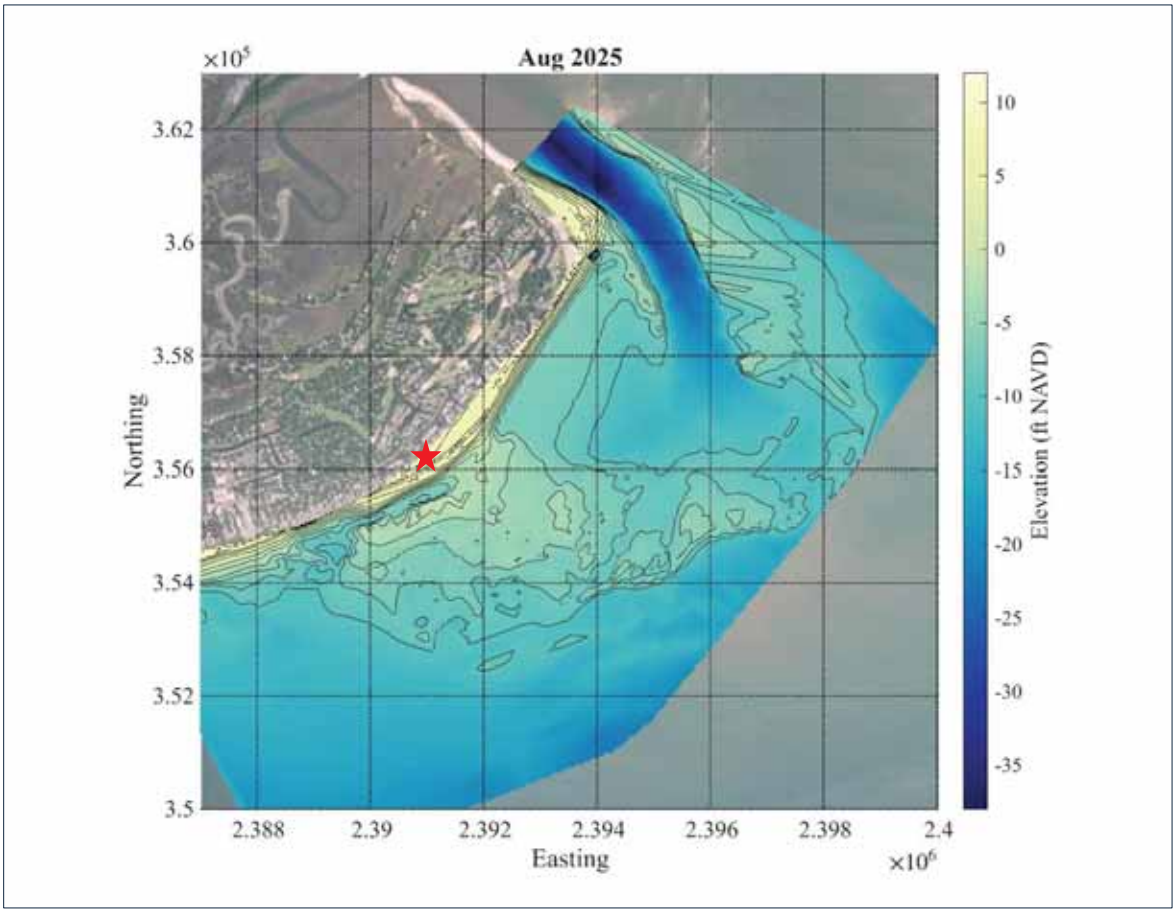


FIGURE 4.13. Shoal attachment in August 2025 with the red star on Beach Club Villas.

Reach 5 eroded ~–44,000 cy (–7.6 cy/ft) from September 2024 to February 2025 and gained ~131,100 cy (22.6 cy/ft) from February 2025 to August 2025. Last year saw some of the lowest levels of erosion since the 2008 project (considering the entire reach), and this year's accretion can be attributed to the shoal attachment happening near Beach Club Villas. Figure 4.13 depicts the shoal located just off Reaches 5 and 6. While the overall reach volume is experiencing accretion due to the shoal attachment, many stations are undergoing erosion. This indicates that certain areas of Reach 5 have not yet benefited from the shoal attachment and remain vulnerable to damage. Stations with the greatest erosion are averaging losses of around ~40.4 cy/ft compared to 2024.

The variability in erosion and accretion rates along Reach 5 is worth mentioning here, as it underlines the range of beach conditions and volume changes along relatively small lengths of beach due to shoal bypass events. Within the reach, changes from 2024 to 2025 along individual profiles ranged from –57.5 cy/ft to +155.5 cy/ft.

Similar to Reach 6, Reach 5 was also broken down into subreaches this year to better evaluate the variability in erosion and accretion in Reach 5. Reach 5a is from around 57th Avenue to 53rd Avenue and experienced erosion during both semi-annual monitoring periods. However, it is important to note that the erosion rate seen from February 2025 to August 2025 is the smallest annualized erosion rate since the subreach experienced accretion in 2019. When projects do occur in the East End, Reach 5a benefits greatly from sand spreading alongshore. Subreach 5b covers the area from 53rd Avenue to Grand Pavilion Boulevard. It is similar to the trends seen in 5a, with erosion seen in both semi-annual monitoring events. The magnitude of erosion was greater than 5a, likely due to the closer proximity to the initial shoal attachment, where it suffered from erosion caused by stage 2 of shoal bypass. Subreach 5c is from Grand Pavilion to the Wild Dunes Property Owners Beach House. 5c is one of the most variable subreaches as it contains areas of high erosion and high accretion. Overall, the subreach experienced accretion of significant magnitudes due to the shoal attachment and spreading near the northern limits of the subreach. Despite this, some areas experienced significant erosion, especially those near Beach Club Villas.

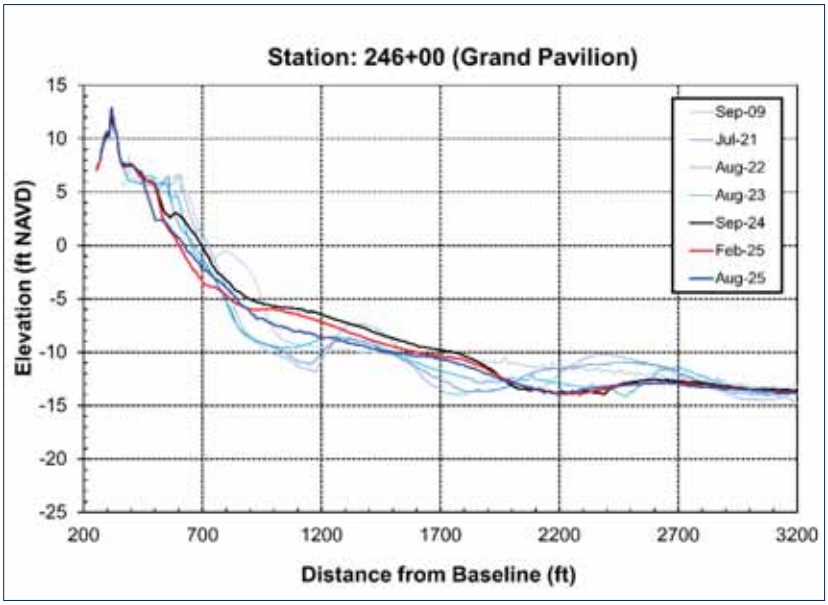
Accretion was measured between Stations 236 and 242 as well as Stations 262 and 278; both areas are located along shoal attachment points, and the accretion along these reaches mostly occurred along the underwater portions (Figs 4.14 and 4.15). Excluding the main shoal attachment from Stations 262 to 278, the whole Reach averages erosion of around ~21.5 cy/ft compared to last year. This erosion will likely continue until the shoal fully attaches sometime in the next year. The City has applied for renourishment permits from SCDES-BCM and USACE. This project is currently scheduled for the Summer of Fall of 2026 and is expected to add around 800,000 cy to Reach 5. The planned fill currently extends from Station 242 to 278 and can be extended to Stations 222 to 280 if necessary.

4.2.4 Summary of East End Changes

Overall, the 2018 project area reaches (5 and 6) lost ~1,584,900 cy (–143.4 cy/ft) of sand from April 2018 to August 2025. This volume equates to an annual loss of ~20.5 cy/ft per year and represents nearly all of the nourishment material placed. Historical erosion rates (pre 2000) along the eastern end of the island have been variable but generally average between 5–10 cy/ft per year (CSE 2007). The recent sharp increase in erosion rates this year is partly due to the phase of shoal attachment process (Fig 2.3). Erosion tends to be most extreme during stage 2 (initial attachment). This is the period when wave refraction and focusing have the greatest effect on the beach. The higher erosion rates that have not only been experienced this year, but in the past 8 years, are likely due to a combination of shoal configuration and storm timing from 2016 through 2025, exacerbated by the rising sea level (discussed in Section 5). CSE has observed higher than typical erosion rates along several beaches in the Charleston area over the same period.

While the magnitude of the erosion has decreased compared to last year, this year's erosion is significant as it leaves certain areas vulnerable to damage from storms. Beach conditions now are similar to those in 2017, signifying the need for a beach nourishment project. As the ongoing shoal bypass event continues and sand begins spreading laterally, some of the losses along these areas should begin to reverse, and significant accretion is anticipated in areas adjacent to the attachment site.

The City's proposed project is scheduled to add around 1,200,00 cy of sandy material, which should build the beach up in this area similarly to the 2018 project. The total fill will depend on beach conditions at the time of construction and may be less than the proposed volume, depending on the volume gained by shoal attachment and available budget.



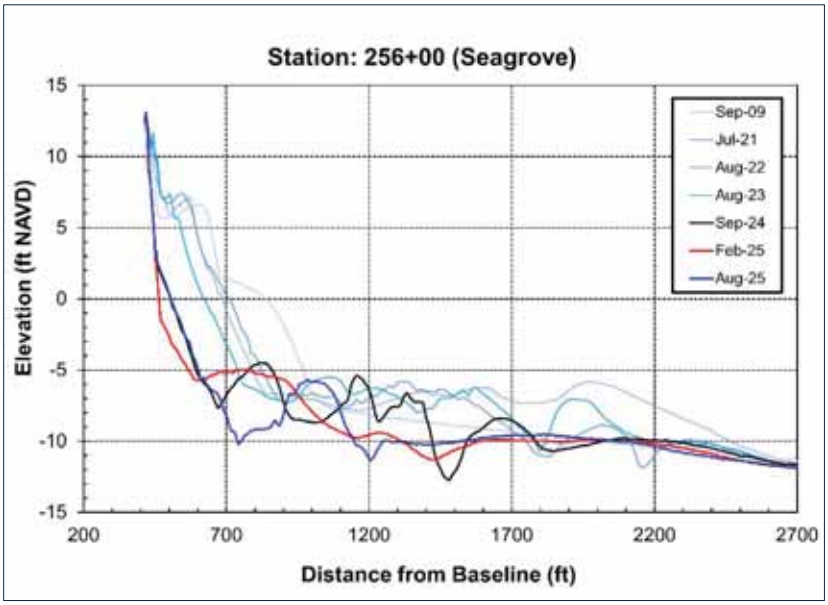


FIGURE 4.14. Reach 5 profiles. Note the distinct bypassing shoal at Station 278+00 migration landward and upward off of Beach Club Villas.

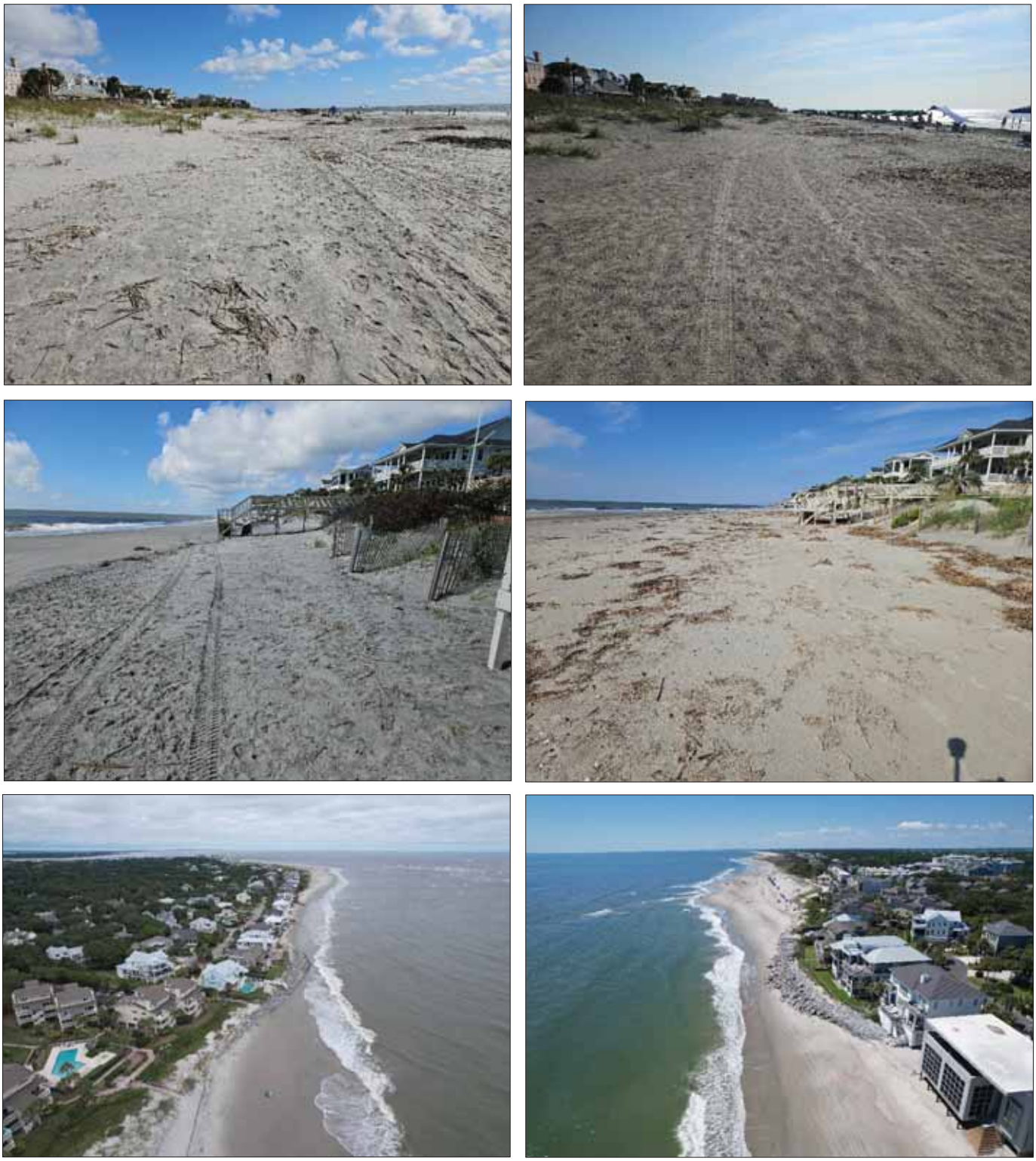


FIGURE 4.15. Ground photos of Reach 6 showing Station 244 in 2024 **[UPPER LEFT]**, Station 244 in 2025 **[UPPER RIGHT]**, Station 272 in 2024 **[MIDDLE LEFT]**, and Station 272 in 2025 **[MIDDLE RIGHT]**. Aerial photo from August 2024 **[BOTTOM LEFT]** and September 2025 **[BOTTOM RIGHT]**.

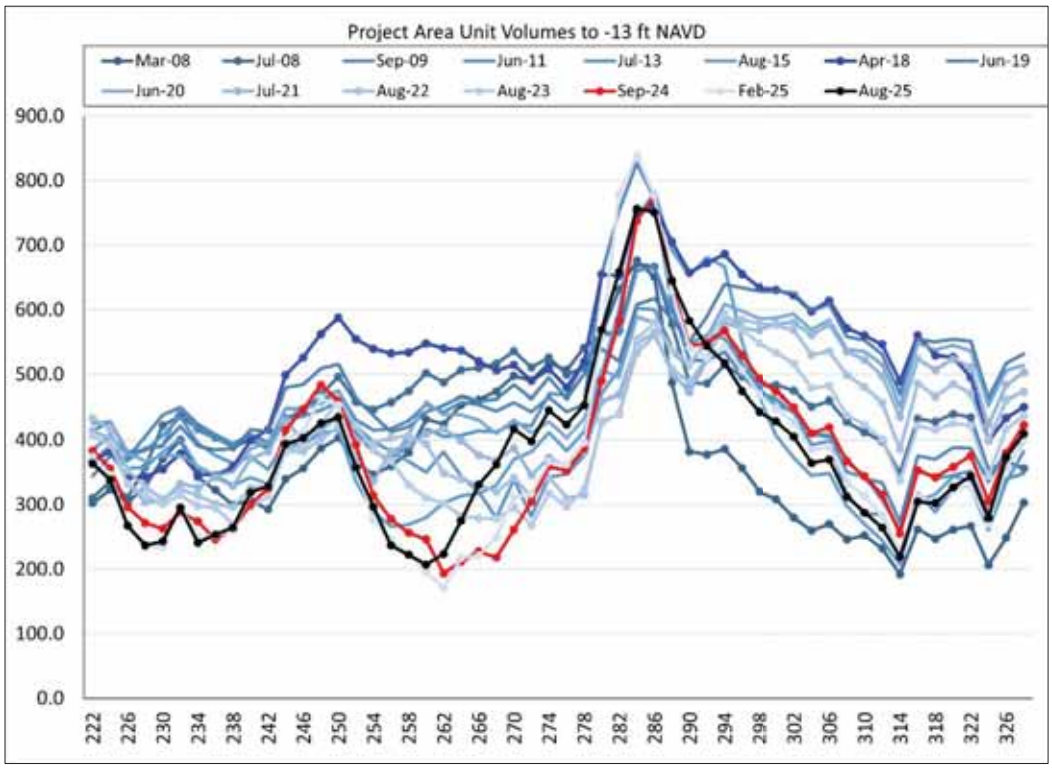


FIGURE 4.16a. Beach width changes along the area spanning the Citadel House to the 18th hole of the Links Course. Note the greater losses around Stations 222–262 and 290–326. Note the extensive accretion present south of the 2018 project area (left side of the image from Stations 262–282).

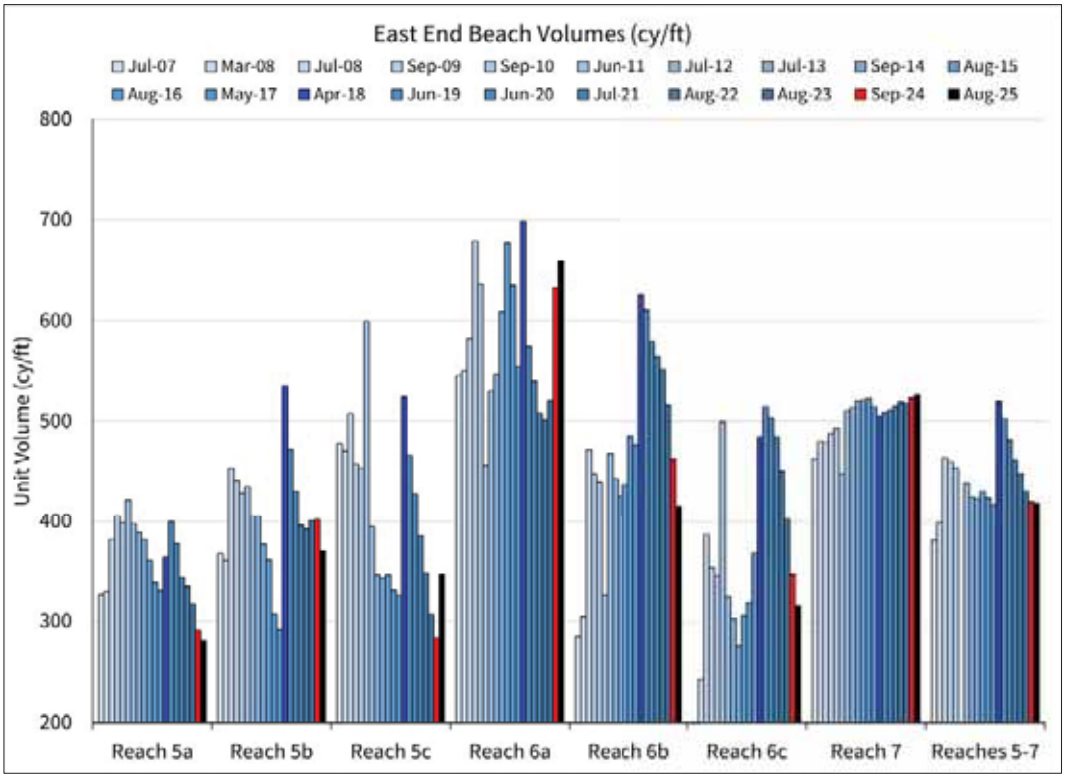


FIGURE 4.16b. The beach volume history of the eastern end of the island since 2007, with dates following nourishment indicated.

Figure 4.17 provides the beach volume history of the eastern end of the island since 2007. The overall erosional trend is evident along Reaches 5 and 6 between nourishment projects, each of which restores sand volumes to maintain a dry beach and protective dune. Sand lost from Reaches 5 and 6 either moves south to provide sediment to the rest of Isle of Palms, or recycles to Dewees Inlet, which will eventually form a shoal and recycle back to the beach (as is currently happening).

Annualized erosion rates from 2018 through 2025 are 125% higher than those observed in the preceding decade (see Fig 4.17). It is likely this increased erosion is due to the relatively high number of impactful storms (both tropical and non-tropical) the Charleston area has experienced since 2016, as well as increased water levels due to ongoing sea level rise (Domingues et al 2018). CSE has observed similar increases in year-to-year erosion rates along several beaches spanning South Carolina and is closely tracking these changes as they affect the projected lifetimes of nourishment projects and related funding cycles in local communities.

Higher erosion rates may necessitate the need to adjust the City's long-term planning strategies, as prior assumptions may no longer apply. Previous historical assumptions have driven the City's long-term plan and if erosion rates do not return to the historical future plans will need to address the additional erosion. This can include additional projects, construction of hard erosion control structures, and other alternatives.

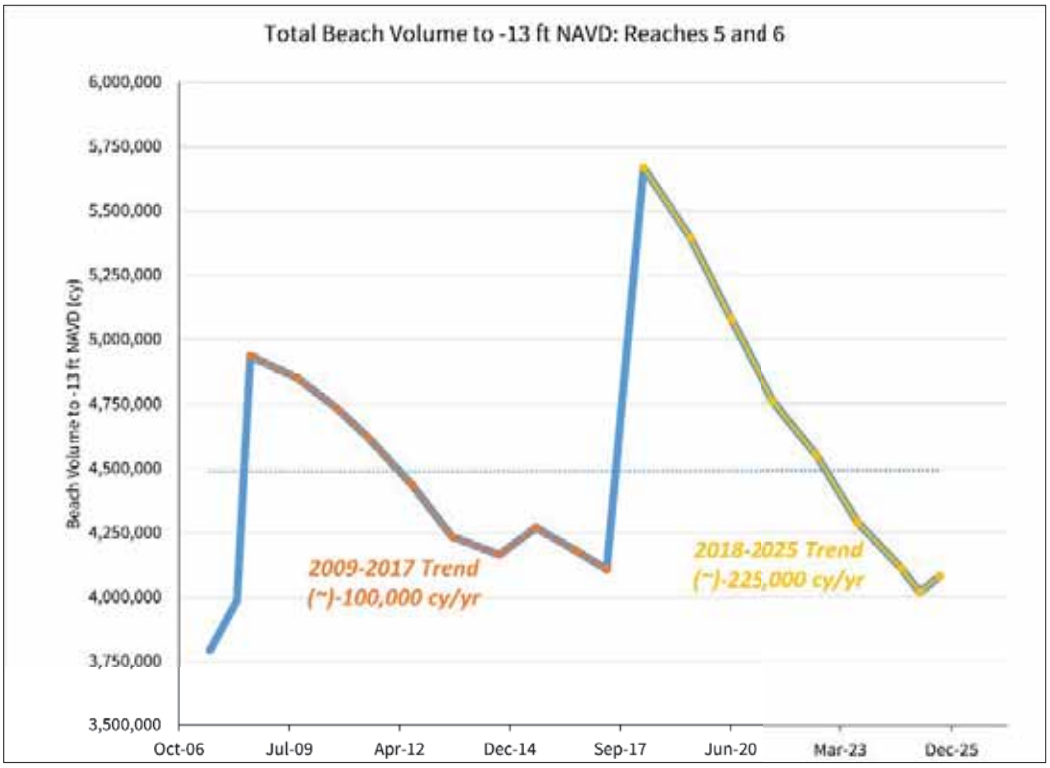


FIGURE 4.17. Total beach volume history of the eastern end of the island since 2007. The graph illustrates the overall erosional trend along Reaches 5 and 6 between nourishment projects.

4.2.5 Reach 4

Reach 4 includes the length of beach between 31st and 53rd Avenues (Stations 140 to 222 – Fig 4.18 and Fig 4.19). This reach is ~7,200 ft long and immediately downdrift of the 2008 and 2018 project area. It is also outside Dewees Inlet's direct influence and maintains a more typical and consistent beach profile shape. By being downdrift of the nourishment area as well as the shoal bypass attachment zone, it receives nourishment sand spreading from the placement area as well as spreading shoal sand. Sand gains have occurred annually along the reach since 2009, excluding 2016, which followed Hurricane *Matthew*'s impact on the Isle of Palms, and 2024–2025, the current monitoring year.

FIGURE 4.18. Baseline stationing along Reach 4 spanning the length of beach between 31st Ave and 53rd Ave.

The reach receives sand eroded from the island's east end, particularly Reaches 5 and 6, with that sand originating from shoal bypass events or nourishment. A significant influx of sand was observed along the reach following the 2018 project, with an accretional wave propagating south. The leading edge of the spreading sand is visible as a span of high accretion relative to adjacent areas. Over time, the magnitude of the accretion wave decreases as sand spreads at uneven rates. The peak in accretion along individual profiles reached ~70 to 80 cy/ft between Stations 214 and 208 (in 2019 and 2020, respectively) but has subsided even showing erosion along most of the reach this year. In the past, accretion from sand moving south from Reaches 5 and 6 led to the creation of a new dune ridge and wide dry-sand beach along the reach (Fig 4.20).

Reach 4 lost ~62,600 cy (–8.7 cy/ft) of sand from September 2024 to February 2025 and lost around ~9,900 cy (–1.4 cy/ft) from February to August 2025. Erosion this year is the first such event since 2016 and is the highest magnitude of loss in the past two decades. Despite this the beach in August 2025 contains nearly 824,000 cy more sand than the 2009 condition, including a net gain of 464,600 cy since 2017. The historical accretion in this area is mostly attributed to sand from Reaches 5 and 6 moving south. In general, areas in the center of mixed-energy barrier islands tend to be more stable with low erosion rates and steadier sand transport away from inlets.

The relatively large swings between accretion and erosion that affect Reaches 5 and 6 are modulated along Reaches 3 and 4. Erosion this year is partially likely the result of an upstream pause in sediment supply as sand from the east moved behind the attaching shoal instead of continuing south, thereby interrupting the sediment transport. This is characteristic of stage 2 of the shoal bypass cycle (Fig 2.3). There has also been recent storm activity which may have moved some material further south along the dominant direction of littoral transport under northeast waves. This year only three stations in this reach stations showed minor accretion, gaining between 3.0 cy/ft and 11.6 cy/ft.

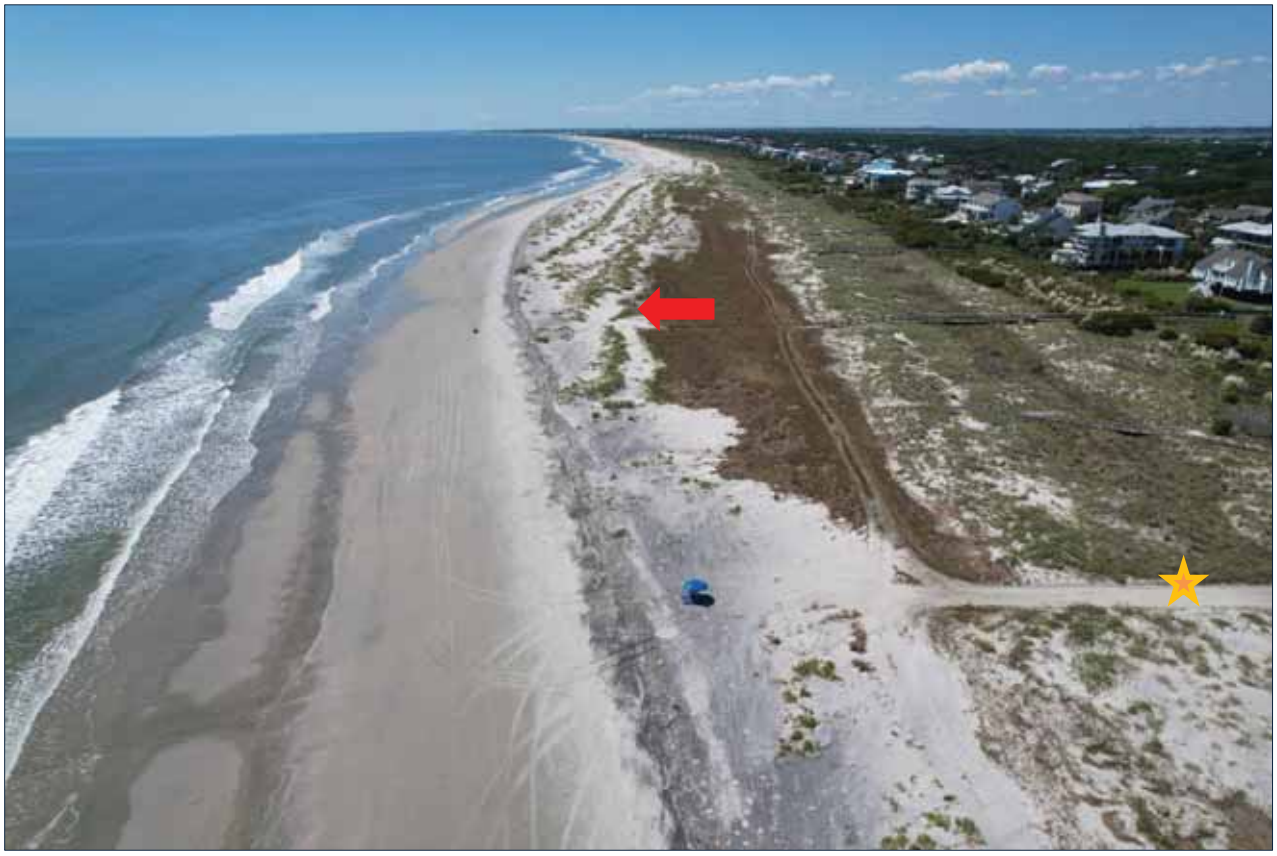
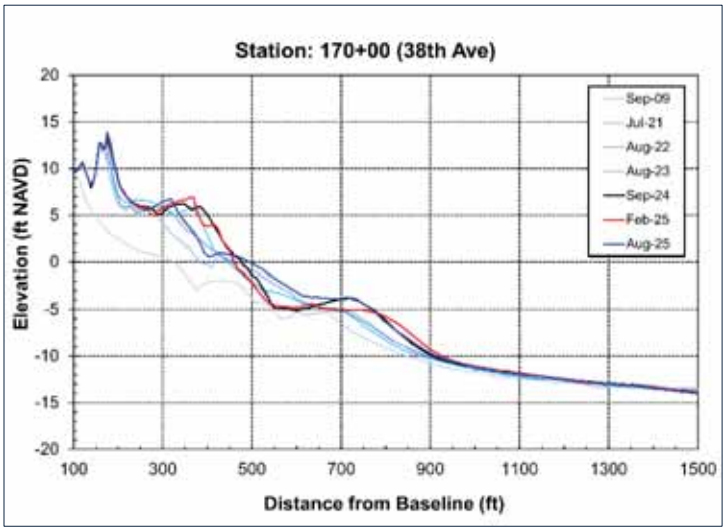
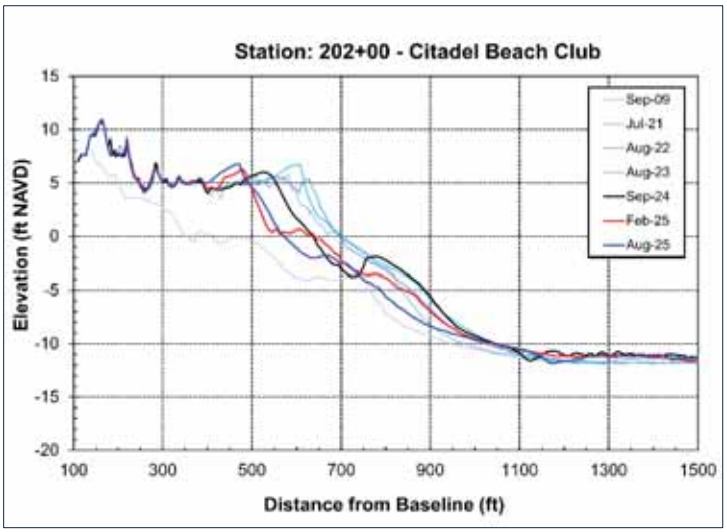


FIGURE 4.19. September 2025 aerial photo of Reach 4 (53rd Avenue is marked by the orange star). By being positioned downdrift of the nourishment area, Reach 4 receives nourishment sand spreading from the placement area as well as spreading shoal sand. This reach has gained sand every year since 2009, except in 2016 and 2025. As the vegetated dunes expand, sheltered locations (such as low-lying areas behind protective dune ridges) will gradually transform into a shrub habitat with larger areas of wax myrtle replacing dune grasses. The 2008 dune line is shown by the red arrow.

The average erosion of all stations is around ~20.4 cy/ft, reflected in the reduction of dry-sand beach widths in this area. After the project in 2018, the dune system and dry beach portion grew considerably due to sediment moving downcoast from the nourishment project. Since then, the dry-sand portion of the beach has been decreasing since 2022 at most stations, and it has further decreased this past year. Despite the recent erosion, beach conditions now are significantly better than in 2009, with an increase of 824,000 cy. This level of accretion is of similar magnitude to many beach nourishment projects conducted along coastal communities in South Carolina and is greater than the proposed volume for the upcoming beach nourishment in Reach 5. This volume is equivalent to a $8.7–13 million nourishment investment. The growth in the dune over the past decade offers substantial storm protection to the homes and infrastructure in this area.

As predicted last year, the accretion rate decreased, and erosion occurred in most of Reach 4. Depending on the pending construction of beach nourishment just north and the ongoing shoal attachment, Reach 4 will experience accretion as eroded fill material shifts south. If the project is delayed, it is likely that the moderate erosional trend of the past twelve months will continue. **Combined with Reach 3, there is a net gain of 1,264,600 cy of sand since monitoring began along the downcoast areas of Isle of Palms (Sea Cabins Pier to 53rd Ave), which is a direct benefit of the 2008 and 2018 nourishment projects.**





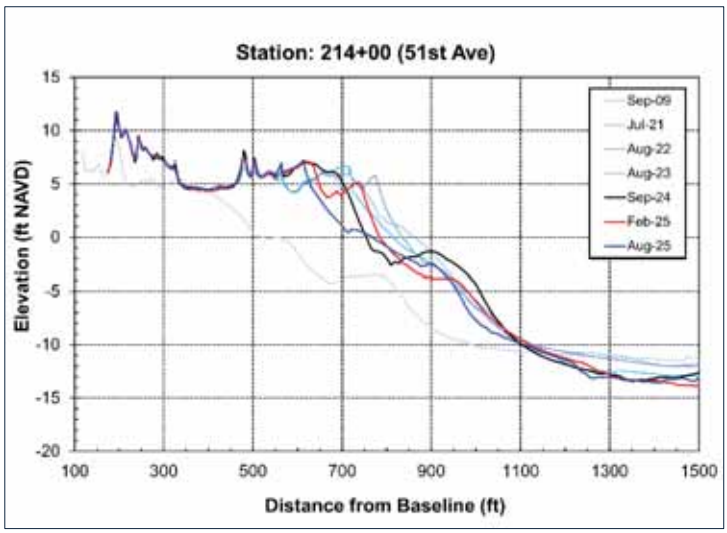


FIGURE 4.20. **[LEFT]** Profiles along Reach 4 show accretion has led to gains of over 300 ft of dry-sand width and formation of new dune ridges. **[RIGHT]** Ground photos from Station 170 **[UPPER]**, Station 202 **[MIDDLE]**, and Station 214 **[LOWER]** in September 2024.

4.2.6 Reach 3

Reach 3 extends 6,000 lf from Beach Access 13, just south of the Sea Cabins Pier, to 31st Avenue (Stations 80 to 140 – Fig 4.21 and Fig 4.22). Like Reach 4, the long-term trend in this area is stable to accretional. Dwellings in the reach are well set back from the beach, generally between 400 ft and 500 ft, except at the western end, where Sand Dune Lane and the county park facilities are set back ~150 ft. The reach has shown periods of erosion and accretion since CSE began island-wide monitoring in 2009, but has generally gained volume. Variations in wave conditions from year to year and temporary changes in sediment supply lead to minor fluctuations in yearly volume change.

FIGURE 4.21. Baseline stationing along Reach 3 spanning the length of beach from the Sea Cabins Pier to 31st Ave.

From September 2024 to February 2025, Reach 3 gained 11,200 cy (1.9 cy/ft) and gained 34,600 (5.77 cy/ft) between February and August 2025. Similar to last year, the northern end of the reach gained volume over the year, with average increases of ~12.8 cy/ft between Stations 110 and 140. Stations 90 and 100 had the only recorded losses in the reach, averaging losses of ~8.1 cy/ft.

Reach 3 is in a similar position to Reach 4 insofar as its location in the center of the island tends to accumulate sand eroded from the nourishment templates in Reaches 5 and 6. Since 2009, the reach has gained ~440,700 cy, of which about half (~211,700 cy) has accumulated since 2017. Profile plots from the reach (Figure 4.23) show that the dune continues to increase in width as it recovers from the series of hurricanes impacting the area from 2015 to 2022. There was a slight flattening of the beach profile in August due to Hurricane *Erin* that brought elevated surf as it passed. It is likely that Reach 3 will continue to accrete sand, especially in the north section, as nourishment volume continues to move south.

FIGURE 4.22. Aerial photo of Reach 3 in September 2025 (24th Ave in the foreground). The long-term trend for Reach 3 is stable to accretional. Dwellings in the reach are generally set back from the beach between 400 ft and 500 ft.

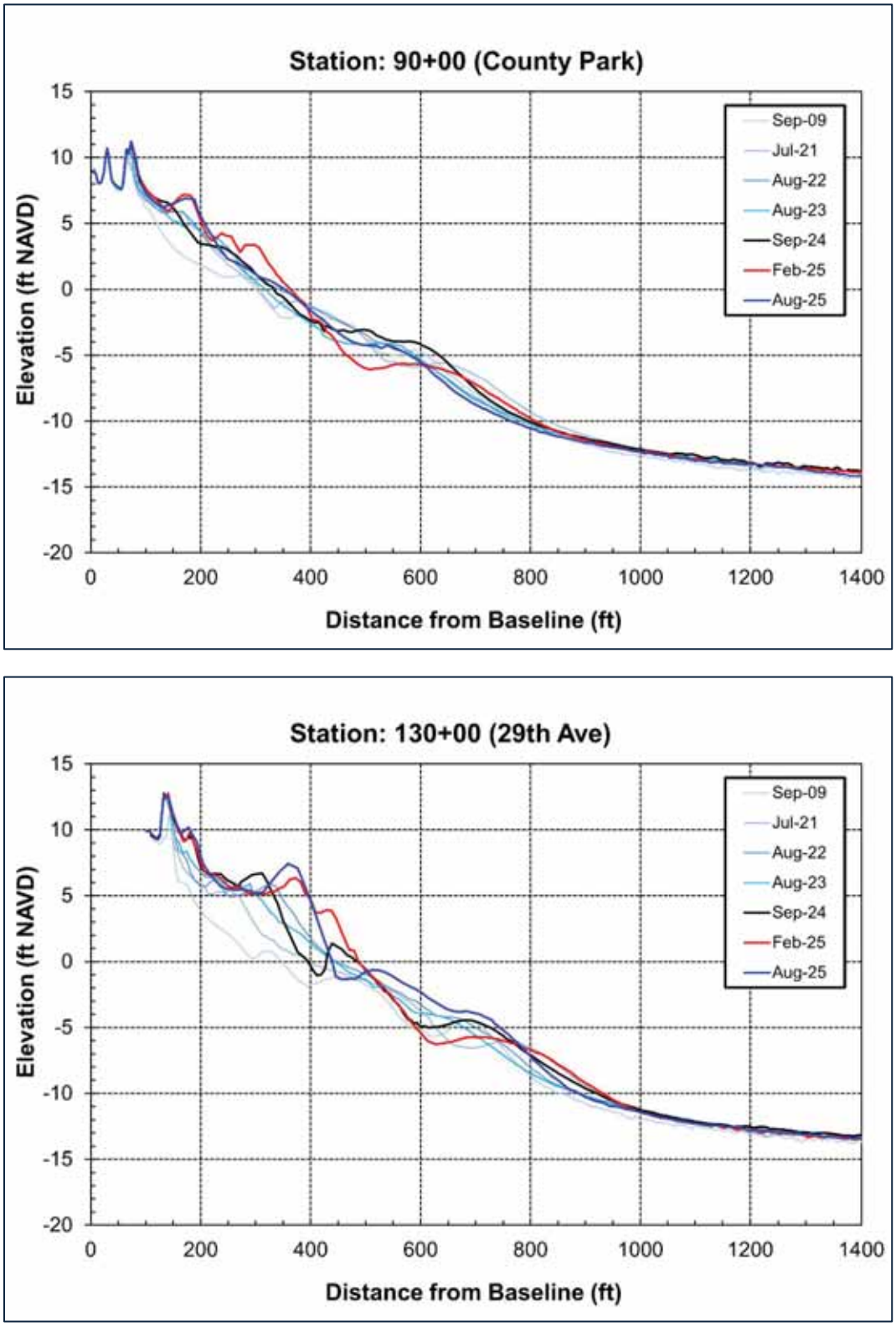


FIGURE 4.23. Example profiles from Reach 3. At Station 90+00, there was a net loss of volume due to movement of the underwater sandbar and a slight decrease in the dry beach portion.

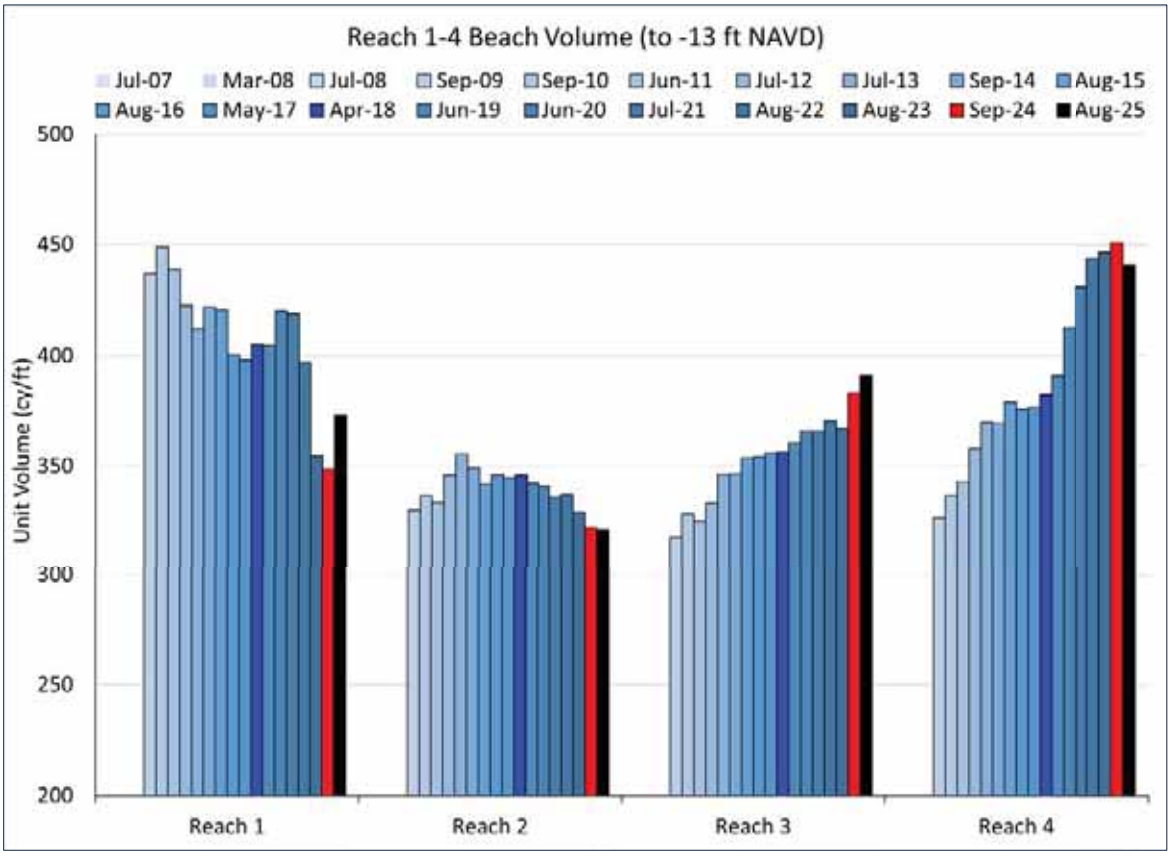


FIGURE 4.24. Reaches 3 and 4 have steadily gained sand since 2007, while Reaches 1 and 2 have experienced more erosion over the last 2–3 years relative to the long-term trends. This recent shift towards erosion in Reaches 1 and 2 is related to the dynamics of Breach Inlet and is addressed later in the report.

4.2.7 Reach 2

Reach 2 spans 4,000 ft between south of 6th Avenue and Beach Access 13 (Stations 40 to 80 – Fig 4.25 and Fig 4.26). It includes the oceanfront commercial area at the eastern end of the reach. Reach 2 shows a shoreline change pattern like Reach 3, with intermittent periods of accretion and erosion and a long-term trend of accretion. Since monitoring began in 2009, Reach 2 has been the most stable reach, with lower magnitude volume changes than all other reaches.

FIGURE 4.25. Baseline stationing along Reach 2 spanning between 6th Avenue and the Sea Cabins Pier.

Year-to-year changes in unit volumes along Reach 2 (Figure 4.24) highlight general trends of accretion and erosion over the past decade. Volume increases and/or relative stability tended to occur from 2007 through the August 2016 survey. From August 2016 through April 2018, changes varied between relatively minor accretion and erosion. However, from 2018 through 2024, erosion has dominated with accelerated losses occurring from August 2022 to September 2024. Between September 2024 and August 2025, the reach lost 4,700 cy (–1.18 cy/yr). However, these losses occurred between September 2024 and February 2024; the reach gained 9,800 cy (2.5 cy/ft) of volume from February 2025 to August 2025.

The minor but consistent changes between accretion and erosion imply that Reach 2 is sensitive to yearly changes in weather patterns impacting short-term sediment supply. This is a contrast to the changes from large-scale inlet dynamics that tend to overwhelm volume changes closer to Breach and Dewees Inlets. The erosion in Reach 2 is consistent across individual profiles, but the long-term trend in the magnitude of losses increases at the southern end of the section. This has resulted in some escarpments seen near the south end of the reach (Fig 4.26). Between 2009 and 2017, Reach 2 gained ~59,700 cy (14.9 cy/ft) of sand, highlighting the stability of the reach at the time. However, since 2017, the reach has lost ~95,300 cy (–25.8 cy/ft). This is likely due to interruptions in sediment supply from further north and an increase in storm erosion.

Aerial photos (Fig 4.27) of Reach 2 show a crescent-shaped beach extending south of the pier. This should be closely monitored in the future, given the shoreline morphology and variable erosion patterns. The building setbacks in Reach 2 are generally less than along Reaches 3–4. Should an erosional period persist, or a major storm impact the area, structures along the front beach or the southern end of the Isle of Palms could become threatened. At a minimum, additional erosion along the south end of the reach will reduce the dry beach width, limiting recreational area.

From 2011 to 2022, Reach 2 remained relatively stable, exhibiting minor net accretion with low-magnitude volumetric change. This trend shifted markedly beginning in 2022. Between 2022 and February 2025, Reach 2 experienced an accelerated and atypical erosion phase, resulting in a net loss of approximately 70,000 cy (−17.5 cy/ft). When annualized and projected over a typical 8-year nourishment cycle, this erosion rate equates to a potential loss of roughly 160,000 cy. Although limited accretion occurred between February and August 2025, the observed gains were minimal and insufficient to offset prior losses if current trends persist. Continuation of erosion at the 2022–2025 magnitude would pose a risk to upland infrastructure and would likely necessitate mitigation through beach nourishment.

Currently, most of Reach 2 (up to Station 86) will be included in the next beach nourishment. The exact fill volume and design template are subject to change depending on beach conditions at the time of construction and results of federal beneficial-use projects, such that fill may not be required in some areas if the beach recovers prior to construction. The total fill volume for the entire southern nourishment area is planned to be up to 800,000 cy.

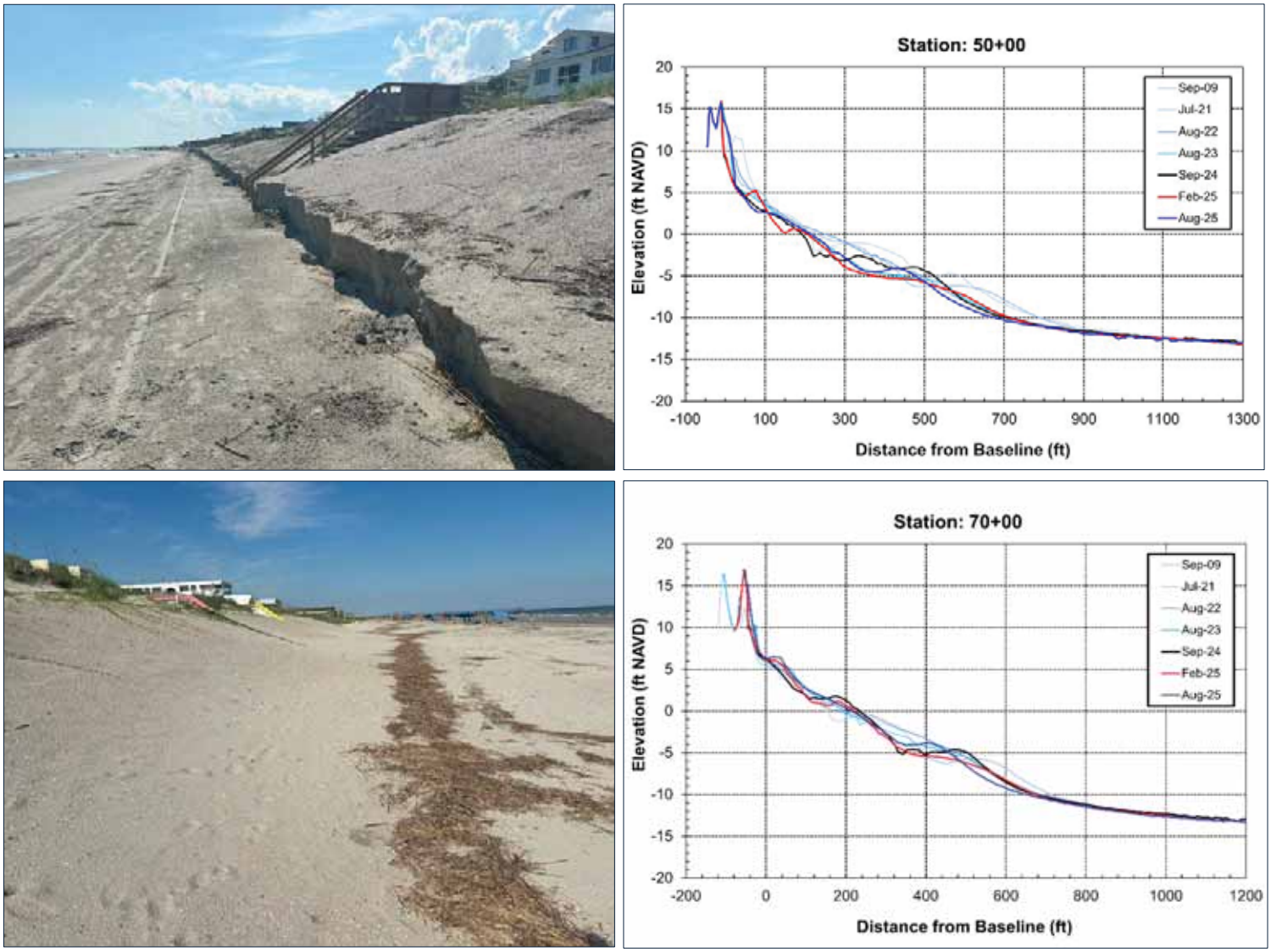


FIGURE 4.26. September 2025 photos of Reach 2. **[UPPER LEFT]** View south from Station 50. **[LOWER LEFT]** View north from Station 70. The top photo highlights the slight escarpment forming at the dune line toward the south of Reach 2 and the bottom photo shows a healthy beach around Station 70.

FIGURE 4.27. Aerial view of Reach 2 in September 2025. Since monitoring began in 2009, Reach 2 has been the most stable reach, typically showing lower magnitudes of volume change compared to the other reaches along Isle of Palms. The arc in the shoreline west of the pier indicates that the structure impacts waves, particularly during winds from the north, thereby modifying sand transport and erosion rates along Reach 2.

4.2.8 Reach 1

Reach 1 encompasses 5,000 lf of beach between Breach Inlet and South of 6th Avenue (Fig 4.28) and is classified as an unstabilized inlet erosion zone due to the dynamic nature of the shoals associated with the inlet delta.

The long-term trend in the reach is accretion, evidenced by a new row of houses built seaward of the original 'beachfront' row in the 1980s, based on historical Google imagery. Sand supply originates from shoal-bypass events at Dewees Inlet and longshore sand transport from northeast to southwest over the length of the Isle of Palms. Excess sand is deposited along the southern spit of the island and in the Breach Inlet ebb-tidal delta. The shoals of Breach Inlet form a salient or bulge in the shoreline, which is a zone of sand trapping, functioning much like a terminal groin. Changes in this area are related to bars from the inlet delta migrating onto the beach, or marginal flood channels moving landward or seaward. Such natural processes lead to rapid changes in the upper beach compared to the central Isle of Palms reaches. Marginal flood channels of Breach Inlet are particularly problematic because they encroach directly on the visible beach if they are forced landward by inlet shoals. Once shoals attach, the shoreline can jump seaward by hundreds of feet.

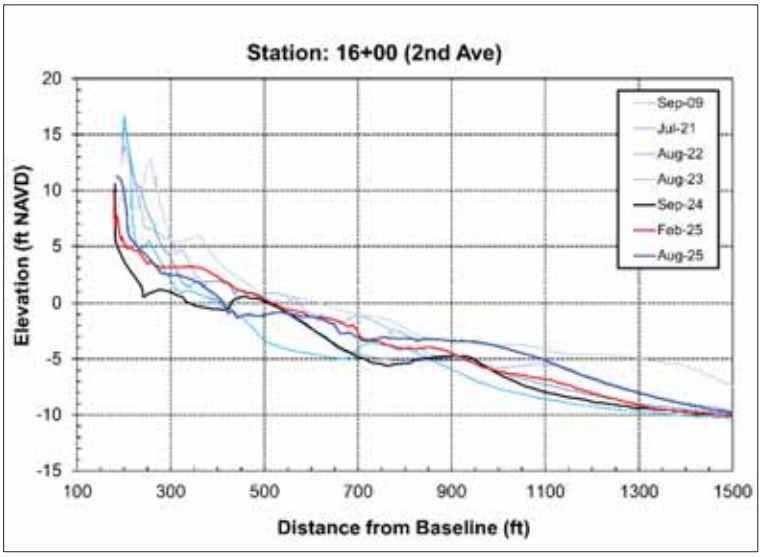
FIGURE 4.28. Baseline stationing along Reach 1, which encompasses the beach between Breach Inlet and 6th Avenue.

Due to its proximity to Breach Inlet and changes in sediment supply from upcoast, Reach 1 experiences variable periods of erosion and accretion, with the mid-term trend showing erosion since 2009 (Fig 4.34). Historically (going back to 1980) Reach 1 has been stable to accretional, with limited erosion and change in the shoreline. Erosion increased significantly from 2021 to 2023 with losses averaging –161,000 cy/yr (32.2 cy/ft). From 2023 to 2024, the erosion rate slowed to ~31,725 cy (6.4 cy/ft). In this past year, Reach 1 has gained a total of ~123,000 cy (24.6 cy/ft) with most of the accretion occurring from February to August 2025 (+~120,600 cy or 24.1 cy/ft), likely due in large part to the USACE nourishment work in the area.

Beach conditions during the year have fluctuated, with sandbags remaining in place along the 100–300 blocks. Some homeowners have elected to reinforce their sandbag lines to provide better storm protection. The recent accretion observed has largely been evident in the low-tide and underwater portions of the beach profile.

Currently, the USACE's "beneficial use project" to place sand along the southern reaches of Isle of Palms is still ongoing. The total plan was to add around 500,000 cy of material to Reaches 1 and 2. Most of the sand that has been placed as of August 2025 has been around the south end of Reach 1. As of September 2025, the project was at Station 16+00, near 2nd Ave. Much of this volume has been placed near mean low water (MLW). Typically, sediment placed in the MLW zone creates bars that dissipate wave energy (a beneficial effect in this case). However, when the nourished sediment contains a high portion of high-grained sediment, which is the case for the USACE dredge spoil sediments, much of the material will shift offshore as it is transported by wave action. The coarse, sandy material tends to eventually move onshore or downcoast into Breach Inlet. While this project has offered some improvement in beach widths, a general erosional trend persists. Photos of the 2025 condition are shown in Figures 4.29 and 4.30.

As discussed before, the magnitude of erosion from 2021 to 2023 was abnormal and represented erosion greater than the combined losses measured in all other monitoring periods (eg – since 2010). To help the homes and beaches in this area, the City is planning to include Reaches 1 and 2 in the next beach nourishment project. This will add approximately up to 800,000 cy to the southern end of the island. The typical fill rates will be 50 cy/ft to 150 cy/ft in Reaches 1 and 2. The project is expected to add more sand than was lost in Reach 1 since 2009 and provide sufficient sand to maintain a healthy beach along the south end for 8–10 years.



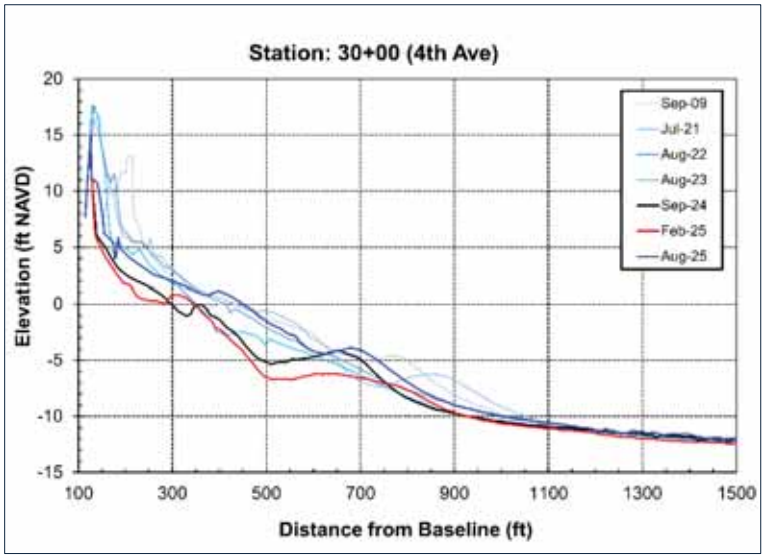


FIGURE 4.29. **[LEFT]** Profile plots for Reach 1 showing a significant loss of the dune area over the past two years. **[TOP RIGHT]** September 2025 aerial photo of Reach 1. **[MIDDLE RIGHT]** Ground photo of Station 16 looking south. **[BOTTOM RIGHT]** Ground photo of Station 30 looking south.

FIGURE 4.30. Ground photo of Station 12 looking east on August 26th, 2025, highlighting the erosion that is affecting the 100 block of Ocean Blvd.

4.2.9 Dewees Inlet Shoal Analysis

For this report, CSE performed an analysis of recent shoal bypass events at Dewees Inlet. The analysis consists of tracking the movement and amount of sand in the shoal attaching to Reaches 5 and 6. To quantify the amount of material present in the shoals the attachment area was broken up to three different zones – Landward, Middle, and Seaward (Figure 4.31).

FIGURE 4.31. Google Earth aerial imagery showing the control areas used to compute volumes relative to offshore condition lacking any bypassing shoal.

This analysis evaluated shoal attachments in 2008, 2012 to 2016, and the recent, ongoing attachment from 2022 to 2025. These shoals have mixed effects on the beach near the attachment area; prior to shoal attachment the area experiences erosion. This dynamic is triggered by sediment accumulating in the lee of the shoal due to a natural breakwater effect, while adjacent areas erode due to wave refraction as bathymetry changes around the incoming shoal. The current shoal contains ~600,000 to 800,000 cy of sand. That volume, combined with the planned beach nourishment project, will bring significant improvements in beach conditions along Reaches 5 and 6 (Tables 4.3 and 4.4).

TABLE 4.3. Yearly change in the Dewees Inlet shoal, annualized, tracks the movement of sand throughout volume boxes.

Yearly Differences in Shoal Volume (cy Annualized)				
Year	**Land**	**Middle**	**Sea**	**Total**
2008-2009	61,643	-67,111	5,954	486
2009-2010	-82,790	-18,052	86,488	-14,354
2010-2011	-190,388	98,465	116,321	24,399
2011-2012	10,650	290,308	-22,421	278,538
2012-2013	202,339	424	-59,594	143,169
2013-2014	155,027	-53,303	-62,005	39,720
2014-2015	57,259	-178,470	-4,997	-126,209
2015-2016	-287,656	-82,533	50,758	-319,432
2016-2017	-201,659	-119,522	-56,202	-377,383
2017-2018	135,561	72,820	82,762	291,143
2018-2019	-95,403	3,058	-12,215	-104,561
2019-2020	-28,912	47,779	-33,692	-14,825
2020-2021	-15,063	-22,758	104,662	66,841
2021-2022	-1,867	218,034	47,663	263,830
2022-2023	119,928	113,526	-52,945	180,509
2023-2024	248,912	-178,491	11,894	82,314
2024-2025	280,790	110,578	-103,298	288,070

TABLE 4.4. Comparison between the absence of a shoal in 2019 and the years after. These quantities estimate the total volume of sand contained in the ongoing shoal attachment and how volume shifts landward through the process.

Shoal Volume Compared to 2019 (No Shoal formation offshore)				
Year	**Land**	**Middle**	**Sea**	**Total**
2019-2020	-29,132	47,727	-33,599	-15,004
2019-2021	-45,180	23,413	78,231	56,465
2019-2022	-47,188	266,489	131,380	350,681
2019-2023	75,489	373,584	81,627	530,699
2019-2024	356,787	172,167	95,051	624,005
2019-2025	480,196	220,504	49,772	750,472

The current shoal bypass event is similar to prior attachments, typically centered around Beach Club Villas and Mariner's Walk. In 2025, the shoal initially attached near Beach Club Villas; however, it differs from prior events with an extension to the south off Dunecrest Lane and Beachwood East (Figure 4.32). This has shifted the zone of maximum erosion under Stage 2 of shoal bypass events (Fig 2.3) to Beachwood East and areas just west. As the shoal nears attachment, it tends to produce a tidal channel in between the shoal and the beach. The channel encroaches on the lower beach and exacerbates erosion until the shoal is attached. When the shoal fully attaches to shore, the southern extension of the shoal should provide some relief to the homeowners in this area.

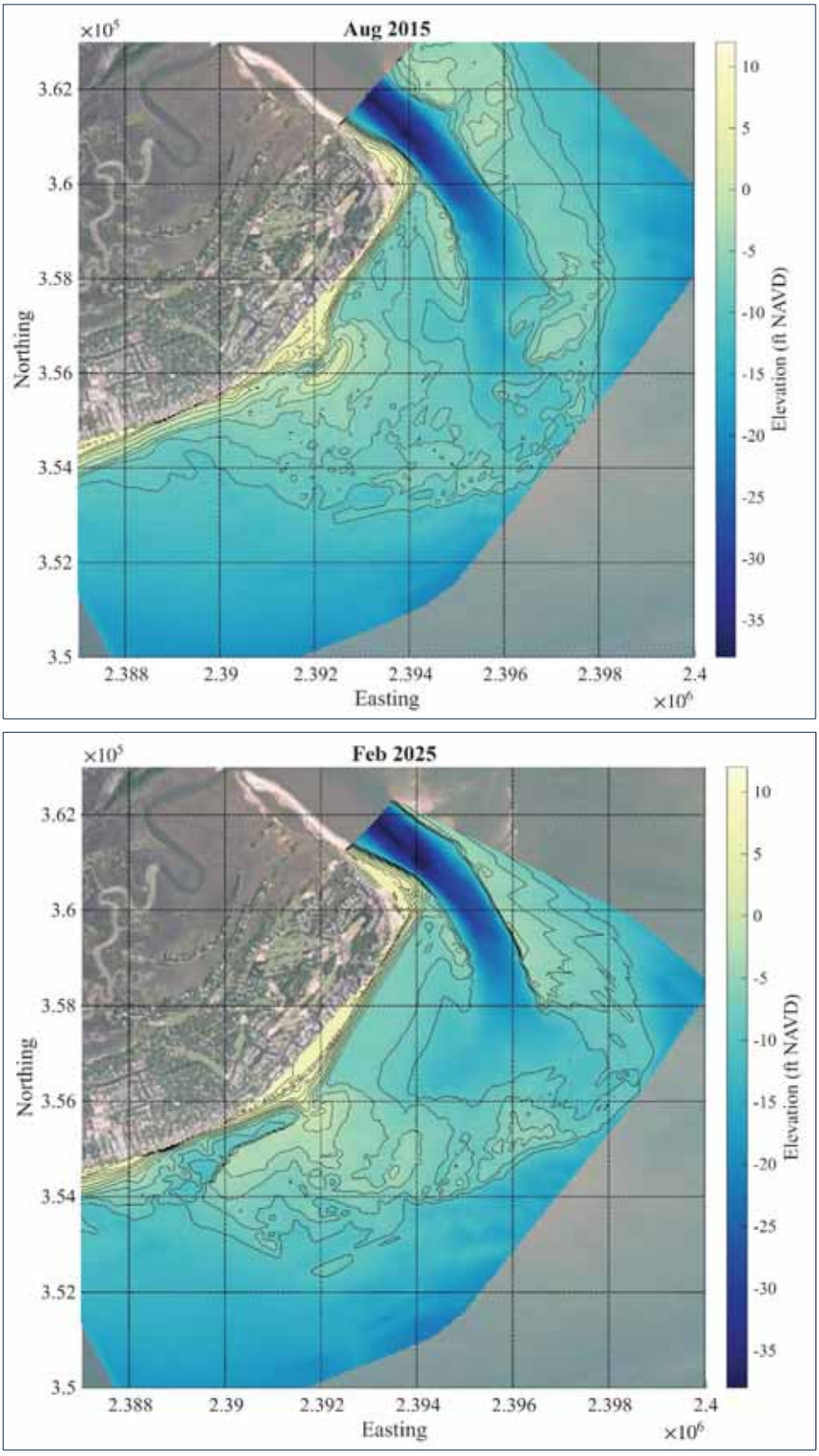


FIGURE 4.32. Shoal Contour Map from August 2015 compared to February 2025. Note the southwesterly extension of the 2025 shoal and associated channel landward of the shoal that is the cause of recent erosion at Beachwood East.

4.2.10 Breach Inlet Shoal Analysis

After the increased rate of erosion in Reach 1 between 2021 and 2023, CSE examined some of the morphology and dynamics of Breach Inlet. As with the analysis conducted at Dewees Inlet, volumetric and contour methods were applied to assess the dynamics of Breach Inlet. This analysis was done to examine whether the erosional trends on the beach are tied to recent changes in Breach Inlet. Historically, the southern end of Isle of Palms has exhibited stability and a slight trend towards accretion. That said, erosion has occurred periodically and is often related to the changes in the channel orientation and shoal development of Breach Inlet. CSE's analysis examines recent erosion events and their connections to shoal growth in Breach Inlet.

Contour maps were used to quantify volume and positional changes in the Breach Inlet ebb tidal delta. This analysis was different than the one used for Dewee's Inlet because it examines the size of the shoal as it grows away from the island versus the amount of material coming toward it in an attachment zone. Due to limitations in data availability for offshore and downcoast portions of the delta, there are limitations in volumetric and contour analysis. CSE has expanded survey coverage in recent years to fully cover Breach Inlet and its shoals. Moreover, CSE's monitoring of Sullivan's Island, which was initiated in 2023, can be used to supplement missing data further downcoast.

There is an observable trend between the growth of the shoal in Breach Inlet and erosion on the beach in Reach 1 (Figure 4.33). Generally, when the offshore shoal gains volume as it extends west towards Sullivans Island, there is accompanying erosion on the beach along Reach 1. This indicates that the delta shoals draw sand off of the shoreline during the extension process that follows a natural delta breach.

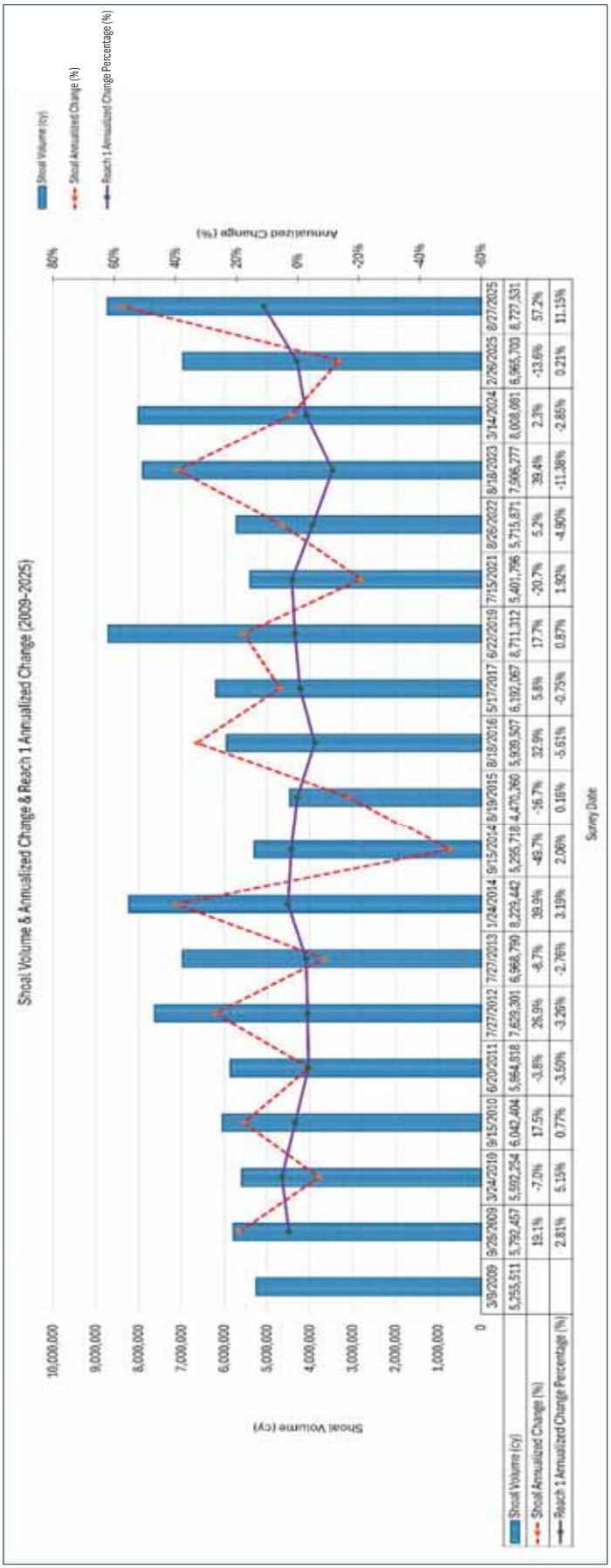


FIGURE 4.33. Bar and line chart showing the relationship between shoal growth and beach erosion. Note how typically when the shoal in Breach Inlet gains volume to a significant rate, the beach in Reach 1 losses volume, the same is vice versa. This does not occur on every instance, but the trendlines depict the possible cause and effect relation between the change in shoal volume and the change in beach volume.

Similar to the shoal migration in Dewees Inlet, bypass events occur in Breach Inlet where shoals form off of Isle of Palms and overextend across Breach Inlet (Hubbard 1977; Hayes 1980; Nelligan 1982). The ebb tidal delta deflects the Breach Inlet channel to the west until its the outer bar breaches, triggering onshore shoal migration onto Sullivan's Ilsland. The cycle of spit growth over extension and breaching impacts the rate at which sand is drawn off Isle of Palms into Breach Inlet. In general, when the shoal grows, there is erosion along Isle of Palms spit. In 2020, the Breach Inlet shoal started to grow significantly, and it may have been a trigger for the high erosion in 2021 to 2023 as it drew sand off the beach to accumulate in the offshore shoal. As of August 2025, the area covered by Breach Inlet shoals is larger than at any point since monitoring began. It is likely that shoal growth is inversely related to beach growth in Reach 1.

Changes in Breach Inlet directly impact the spit changes along the south end of Isle of Palms. These impacts are likely amplified by the trough between the beach and the shoal, which can efficiently remove large quantities of sand from the beach and transport it landward into Breach Inlet. This produces cycles of erosion and accretion in Reach 1. Based on the data collected, the changes in the shoal growth and detachment are not a new trend and have continued throughout monitoring. Aerial imagery shows similar shoal bypassing occurring before monitoring began.

The magnitude of change has been greater over the past couple of years, with the erosion on the beach in Reach 1. In the long term (decades), IOP has had a positive sand budget and, as a result, has accreted. At Dewees Inlet, the combination of shoal bypassing and periodic nourishment projects is likely to keep pace with sea level rise and cyclic erosion trends over the next few decades.

With this area of Reach 1 being highly dynamic, CSE recommends further re-analysis of historical trends. Given the lifetime of barrier islands (centuries to millennia), changes that may seem unlikely along the southern reach of Isle of Palms may be part of a long-term cycle between erosion and accretion around Breach Inlet. Further analysis will be required to investigate this dynamic and determine the likelihood of it persisting indefinitely.

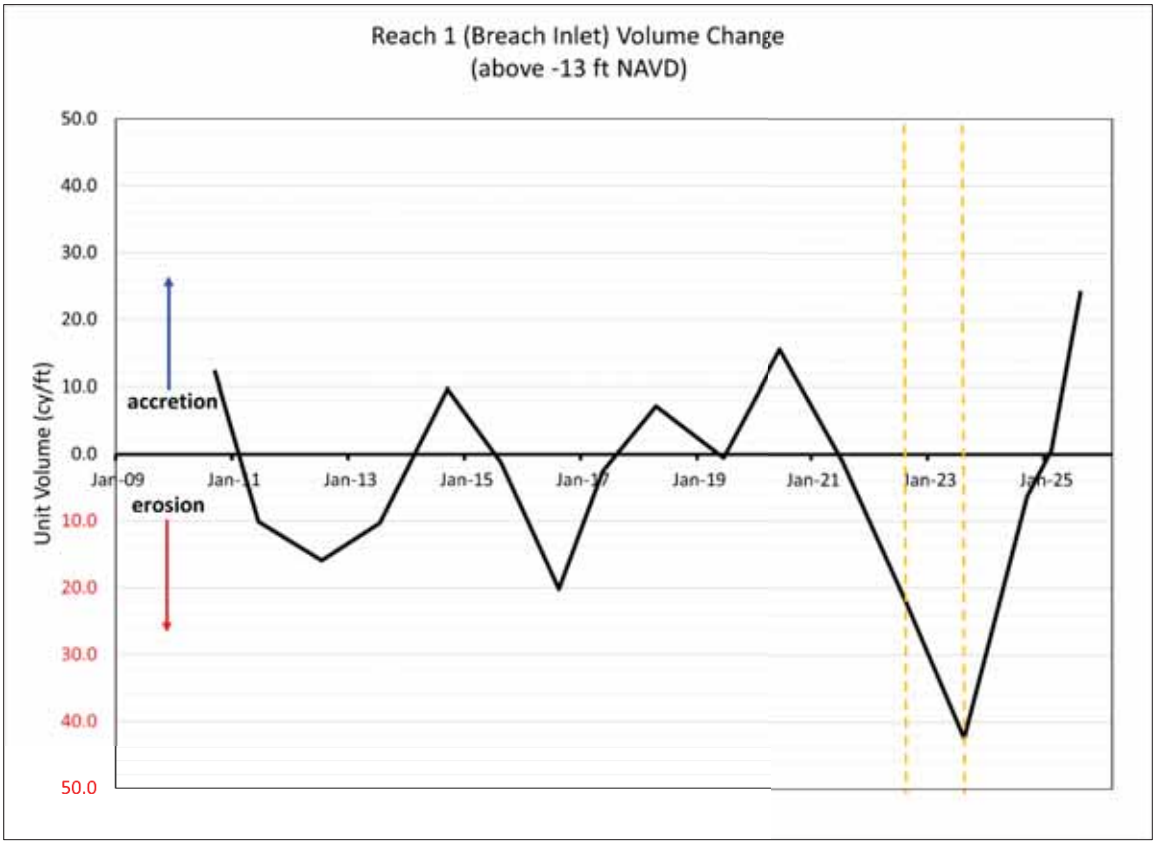


FIGURE 4.34. Breach Inlet unit volume change by year, with dotted orange lines depicting 2022 to 2023, a time period of abnormally high erosion rates**.** Volume changes along Reach 1 are highly cyclical and alternate between periods of moderate erosion and accretion. This is a common dynamic equilibrium around relatively small inlets like Breach Inlet, which tend to experience shoal bypass events at a greater frequency – but generally lower magnitude – than the larger inlet systems like Dewees Inlet at the east end. As the underwater bars and channels of Breach Inlet shift back and forth from the Isle of Palms to Sullivan's side of the system, there are likewise changes in shoreface steepness, wave energy, and beach volumes on either side of the inlet. This is a natural feature of systems such as Breach Inlet and has been well documented in other mixed-energy settings worldwide (Beck and Wang 2019, Nienhuis and Ashton 2016, Gaudiano and Kana 2001, FitzGerald 2000).

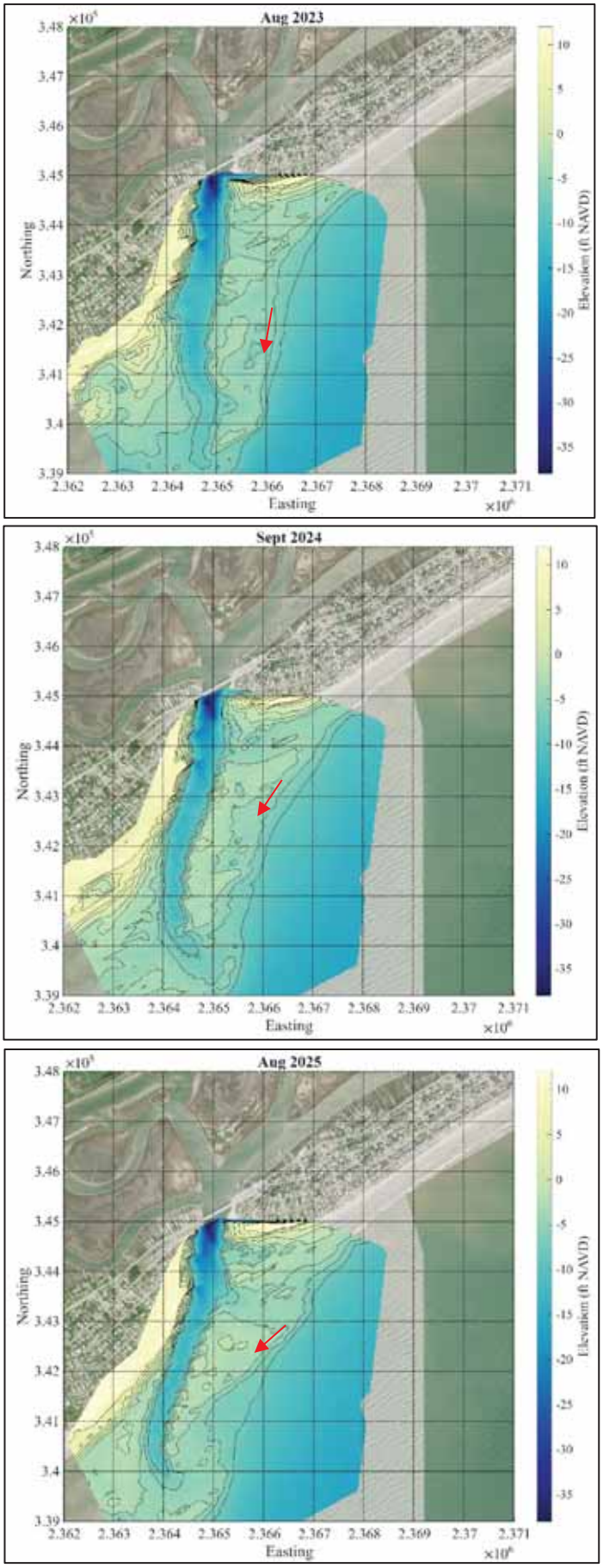


FIGURE 4.35. Breach Inlet contour maps showing the changes in shoal position and size, along with the changes to the inlet channel. With arrows showing the growth of the shoal and its seaward movement toward Sullivans Island.

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5.0 COASTAL RESILIENCY UPDATE

5.1 Weather and Climate Conditions, September 2024 to September 2025

CSE gathered weather and climate data from outside sources (all NOAA-supported) to evaluate observed changes to the beach with respect to environmental conditions. Wind and wave data reported here cover the period from September 2024 to September 2025 (the same as the survey data presented herein). Wind data are compared to historical data covering the period from 1945 to 2025 (Fig 5.1). Real-time and historical hourly wind data from across the United States are aggregated by the Midwestern Regional Climate Center (MRCC), a cooperative program between offices of the National Oceanic and Atmospheric Administration (NOAA) and Purdue University (MRCC 2025, http://mrcc.purdue.edu/). The closest operational station is located at Charleston International Airport (FAA Identifier – CHS) in North Charleston, ~20 miles northwest of Isle of Palms.

The average wind speed and direction from 2010 to 2025 was 14.6 miles per hour (mph) from ~232° (southwest, Fig 5.1). The peak observed wind speed from 2010 to 2025 was a gust to 73.1 mph from ~22° (north) on 30 September 2022 during the passage of Hurricane *Ian*. During this past year, from September 2024 to September 2025, the average wind speed and direction* was 14.7 mph from ~165° (south), and the peak was 43.0 mph from ~189° on September 1st, 2024. According to data from MRCC-NOAA, wind data during the study period were similar to the long-term trends. The proportion of winds from the southeast (90°–180°) and southwest (180°–270°) quadrants represents ~45.0 percent of the total from 1945 to 2025; between September 2024 and September 2025, these have represented ~47.5 percent of the total incoming winds. Northerly winds were consistent with long-term trends, as well.

Wave data are recorded by the National Data Buoy Center (NDBC) Station 41004 ('Edisto'), 41 nautical miles (nm) southeast of Charleston (SC) (NOAA 2025, http://www.ndbc.noaa.gov/station_page.php?station=41004). The average wave height at Station 41004 from September 2024 to September 2025 was ~4.2 ft, with an average dominant wave period of ~7.7 seconds. The maximum observed wave height was ~18.4 ft on 27 September 2024 as Hurricane *Helene* passed the buoy. The average wave direction was ~126° (southeast).

From January 2010 to September 2025, Station 41004 experienced similar wave conditions compared to recent years. Data from Station 41004 has been collected nearly continuously since January 2010, and in the period from then until September 2025, wave height exceeded 10 ft ~208 times per year and 15 ft ~24 times per year. Between September 2024 and September 2025, wave height exceeded 10 ft an average of ~381 times per year and exceeded 15 ft ~12 times per year.

Atmospheric pressure dropped below 1000 millibars (mb) ~88 times per year from 2010 to 2025, and occurred ~16 times from September 2024 to September 2025 (Fig 5.2).

Most Category 1 hurricanes have a central pressure of ~980–990 mb, and many nor'easter-type storms will feature central pressures below 1000 mb. On 5 March 2025, a storm bearing a pressure of 999 millibars traveled up the South Carolina coast, producing gusts of 55 mph in Charleston, but it did not bring elevated sea conditions. Pressure dropped below 1,000 mb one more time on March 10th, 2025, but like the previous event, it did not have dangerous effects. Hurricane *Erin* impacted Isle of Palms in early August 2025 despite not producing low pressure. There were various storms in October 2024 that had similar effects that were also not below the 1000 mb pressure threshold.

Similarly, wave height is an easy parameter to assess the relative intensity of storm events. However, atmospheric pressure and wave height combined are imperfect measures because these are simply proxies for the physical processes that result in beach erosion (eg – a more energetic surf zone with longshore transport in a particular direction occurring in phase with high tide).

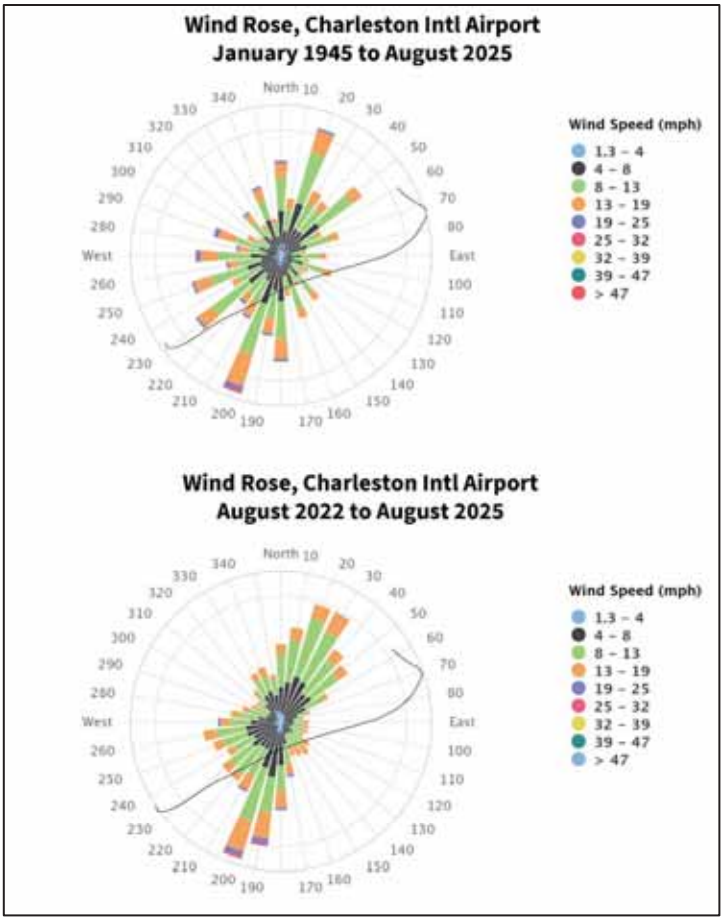


FIGURE 5.1. Wind roses showing the direction and magnitude of winds measured at Charleston International Airport from January 1945 to September 2025 **[UPPER]** and from September 2024 to September 2025 **[LOWER]**.

* *Herein, wind and wave direction is either given in degrees north or in terms of the direction from which it propagates.*

** *The direction from which waves propagate toward NDBC Station 41004.*

The work of erosion is fundamentally a sand transport problem. An increase in erosion indicates more sand is being transported away from a location than is being transported to replace lost volume. Sand transport increases exponentially with current velocity, and wave energy increases by the square of the wave height. So, in tidal channels, a doubling of velocity will result in an eight-fold increase in net transport, while a doubling of wave heights produces a four-fold increase in erosive force. This helps explain why even minor storms can do considerable damage along the coast. A four-foot wave impacting a structure or the foredune will be much more impactful than a normal two-foot wave.

Engineers and scientists use measurements of wave properties like height, wavelength, and speed to estimate the magnitude of energy exerted by a wave striking the beach. The estimate is expressed as 'wave power' in kilowatts per meter of crest length (kW/m). Because sand can migrate either way along a beach, wave power must be adjusted so that waves resulting in southerly transport (ie – north to south) and northerly transport (ie – south to north) can be differentiated. To accomplish this, wave power can be calculated so that northerly transport is measured above zero (positive) while southerly transport is measured below zero (negative). Wave power at Station 41004 is presented in Figure 5.3 with wave height. The larger-magnitude wave power values from September to March represent the passage of cyclonic storms during the fall and winter. In the spring and summer, lower-magnitude positive values tend to dominate.

The most powerful waves from September 2024 to September 2025 exhibited ~9.6 kW/m of wave power in southerly and 7.7 kW/m in northerly directions, with southerly waves occurring more frequently (Fig 5.3). However, the average power of a northerly-directed wave from September 2024 to September 2025 was 1.3 kW/m, while the average southerly-directed wave power was –0.7 kW/m. Calculating the average of all wave power indicates there was a general balance in either direction over the period, which, in theory, should lead to a more stable shoreline. The reason it is not along Isle of Palms is the transformation of waves as they approach shore, refract around inlet shoals, and strike at varying angles to the beach.

These results indicate that most waves at Isle of Palms approach from the south, but the strongest waves approach from the north. Since 2010, a similar pattern has been observed wherein approximately three to four times more total energy is expended moving waves in a northerly direction compared to a southerly direction. However, individual southerly-directed waves are roughly twice as powerful. This result corroborates long-term observations along the Isle of Palms documenting southerly-directed sand transport. It is important to note that Station 41004 is several dozen miles off the coast with slightly different exposure to northerly winds. Thus, the net total wave power exhibited at Station 41004 may be different from the inshore zone off Isle of Palms, but the general trends in long-term wave climate should be similar.

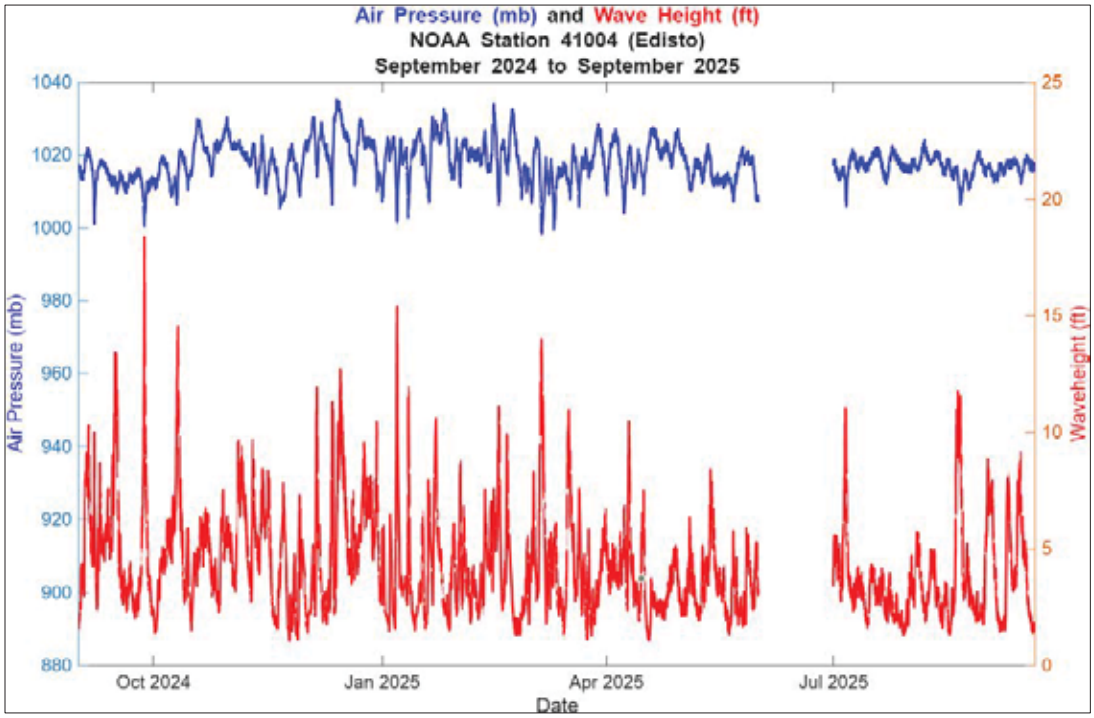


FIGURE 5.2. Atmospheric pressure and wave height at NDBC 41004 from September 2024 to September 2025. Wave heights exceeded 10 ft multiple times during the study period, and atmospheric pressure dropped below 1000 mb during a few low-pressure systems occurring during the winter, spring, and summer months.

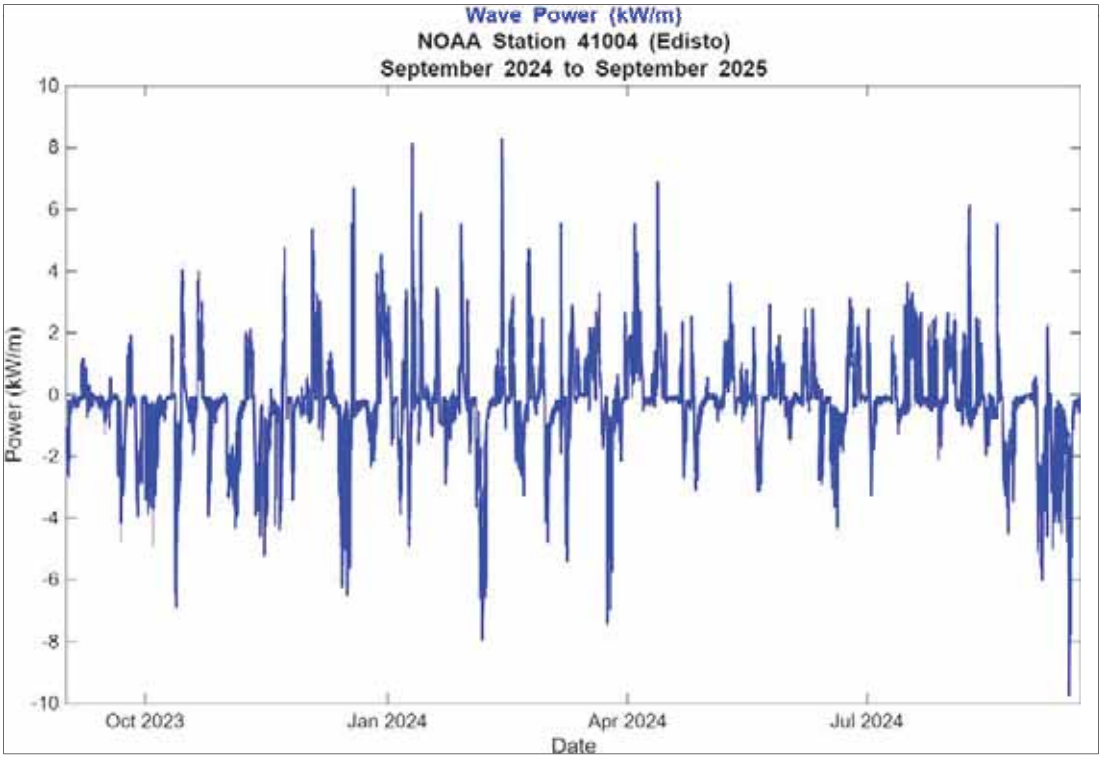


FIGURE 5.3. Wave power (in kW/m) and wave height (in m) for NDBC 41008 from September 2024 to September 2025. Wave power is a useful parameter for determining the relative magnitude and direction of wave energy in an alongshore direction along a beach. Positive values indicate waves move from south to north (ie – northerly transport), while negative values indicate a predominance of north-to-south (ie – southerly) transport.

Wave data are presented in Figures 5.4, 5.5, and 5.6 in the form of a wave rose and histograms. The wave rose illustrates that most of the waves approach IOP from East-Southeast, or roughly normal to the shoreline, along with the magnitude of those waves. The waves shown were transformed to represent the size and direction they would be when they affect the inshore zone of Isle of Palms.

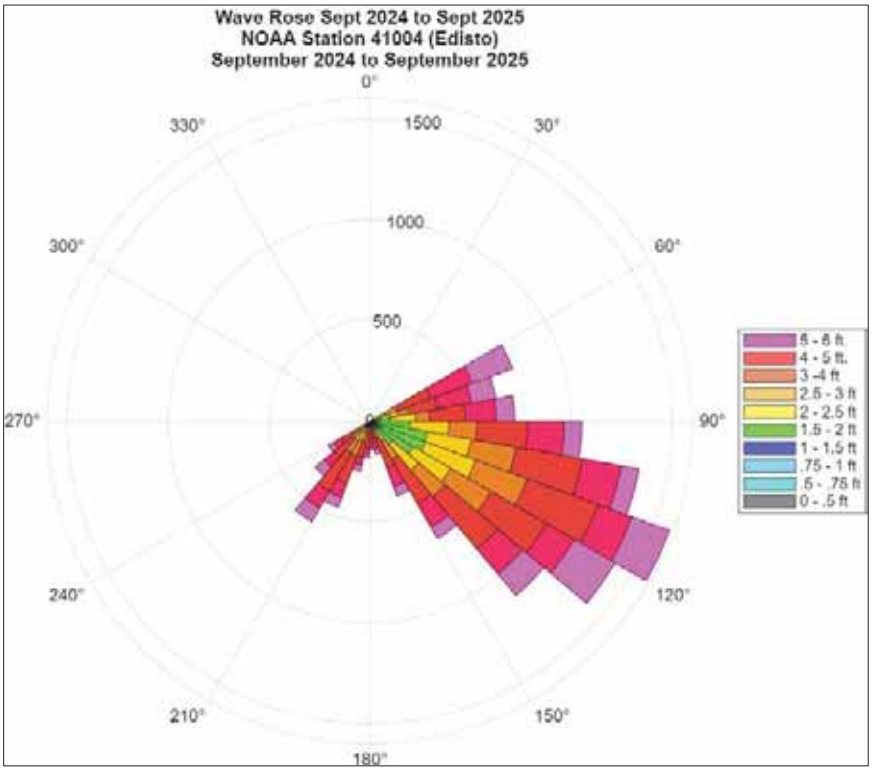


FIGURE 5.4. Wave rose in Isle of Palms from September 2024 to September 2025.

The wave histogram is another tool to visualize the number of waves recorded by the NBDC wave buoy and their heights. A wave histogram records the number of waves recorded that fall into a particular height range. The two wave histograms from NOAA Station 41004, indicate that conditions from September 2024 to September 2025 were generally calmer than September 2023 and September 2024. Both periods were dominated by 2–4 ft waves; however, the 2023–2024 period shows more frequent events exceeding 8 ft, suggesting greater storm activity and higher erosive potential. The reduced occurrence of large waves during 2024–2025, in combination with the shoal attachment and USACE project, has contributed to the decreased erosion rate during in the past year. However, lower wave energy also tends to slow the rate of shoal movement toward shore, thus prolonging Stage 2 conditions of the shoal bypass cycle when focused erosion tends to be worse.

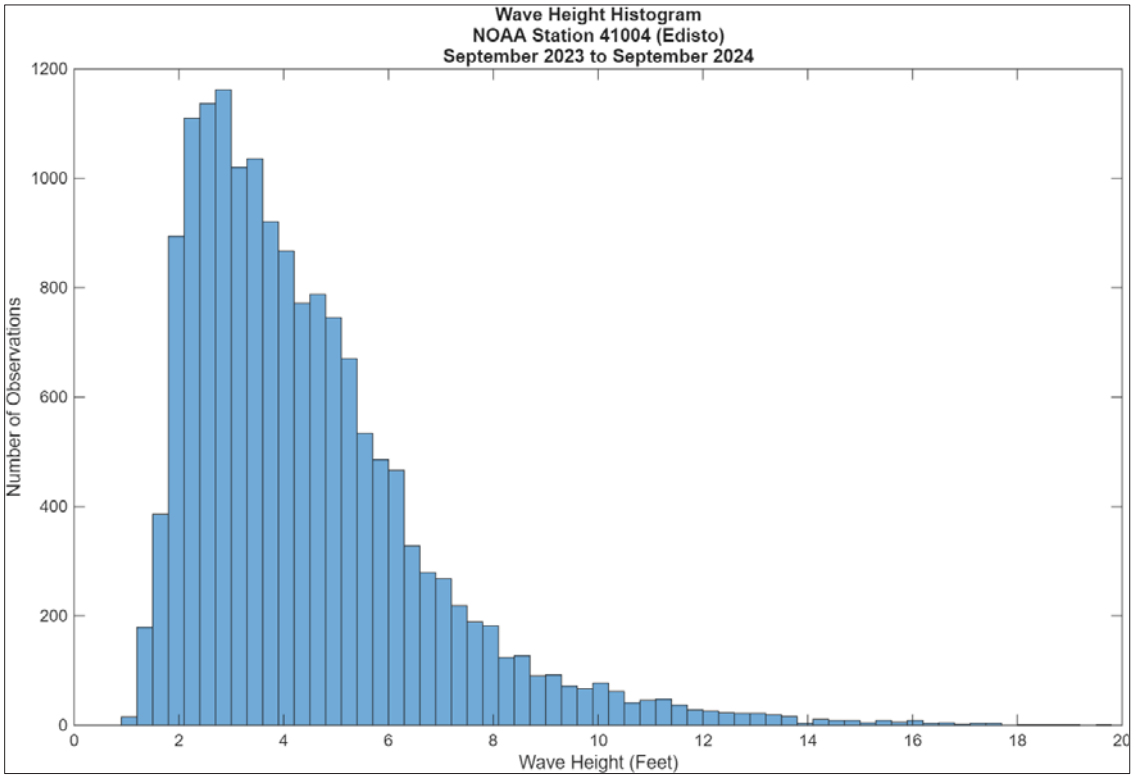


FIGURE 5.5. Wave Histogram in Isle of Palms from September 2023 to September 2045.

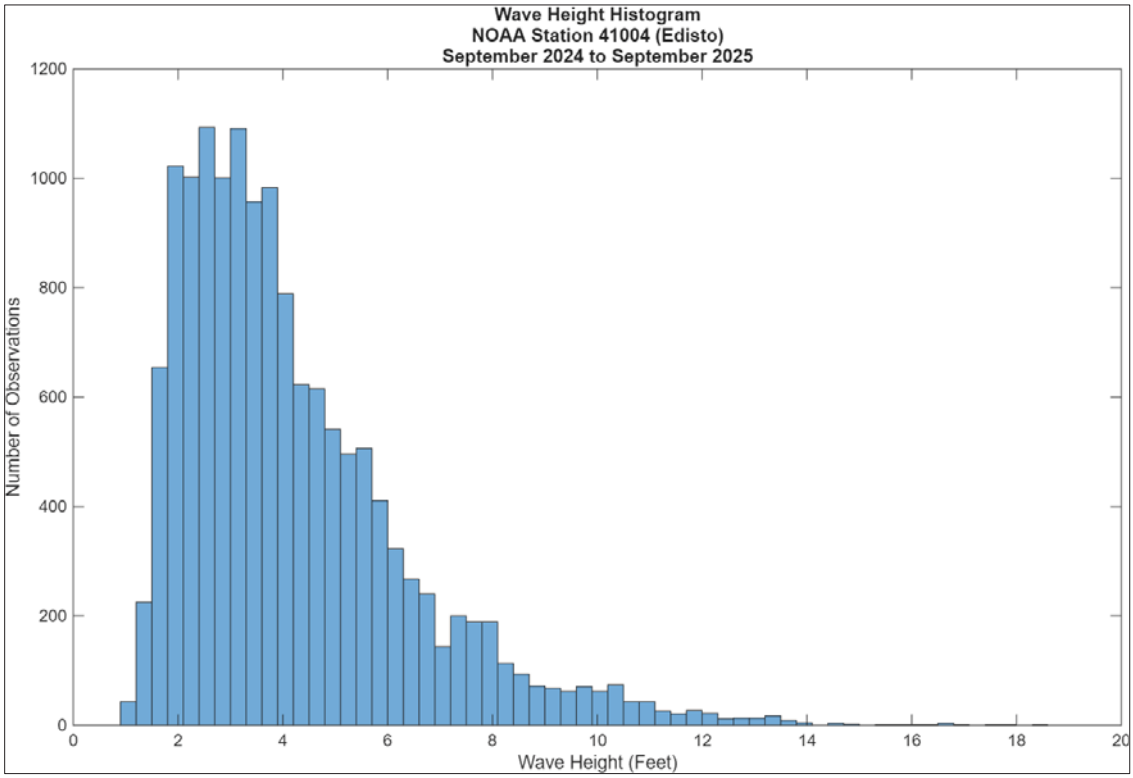


FIGURE 5.6. Wave Histogram in Isle of Palms from September 2024 to September 2025.

5.2 Flood Vulnerability

Regional projections of sea level rise (SLR) through this century within the Southeast US range from ~1 ft to ~10 ft (Sweet et al 2022). These projections are based on modeled values of future CO_2 and other greenhouse gas emissions, shifts in ocean circulation, vertical movements in the Earth's crust, and changes to Earth's gravitational field and rotation. They range from a 'Low' scenario (~1 ft by 2100) to 'Extreme' (~10 ft by 2100), with a 'High' scenario at 8 ft and three 'Intermediate' values averaging ~4 ft (Fig 5.7; NOAA 2021).

For reference, the highest astronomical tide (aka 'King Tide') expected at Isle of Palms would bring water levels ~3 ft above mean sea level (MSL). So, the water levels observed during those King Tide events represent the higher range of projected MSL by ~2060 and the lower-intermediate projected MSL by ~2100 (Fig 5.7).

Relative to 1995–2014 conditions, the likely global mean sea level rise by 2100 is ~1 to 2 ft under the *lowest* emissions scenario. This scenario calls for warming to be held at or below 1.5 °C by 2100 compared to 1900 and for 'net-zero' CO_2 emissions by 2100. 'Net-zero' emissions represent the condition in which removals of atmospheric carbon exceed emissions. The 'intermediate' scenarios are approximately in line with the upper (eg – higher-emitting) end of reduced emissions and project ~3–5 ft of SLR by 2100, while the 'very high' scenario assumes no policy changes and project ~5 to 7 ft of SLR by 2100.

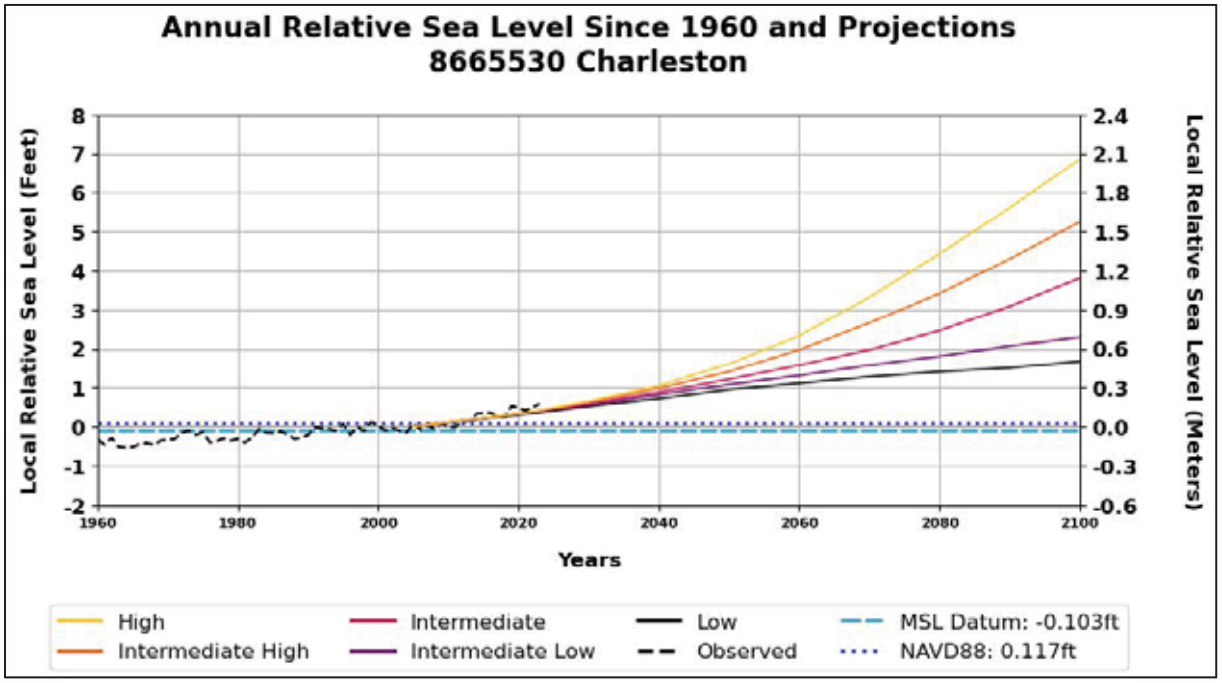


FIGURE 5.7. Projected MSL values under an 'Intermediate' emissions scenario average ~2 ft by 2060, and ~4 ft by 2100 at Charleston Harbor. These projections are global-scale predictions of future water levels (based on emissions) adapted to the Lowcountry by accounting for regional and localized changes in ocean circulation, vertical movement in the ground surface, and other factors. (source: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8665530#tabscenario). Note higher rate of sea level rise for Charleston since 2010 based on observed data (bold dashed line).

Keep in mind that any rise in *mean* sea level in the future is accompanied by a corresponding rise in mean high tide. So, in simple terms, today's high tide level would become a future mean tide level, and a future normal high tide level could be the equivalent of the storm tides the Isle of Palms experienced during hurricanes *Matthew* or *Dorian*.

Coastal communities are becoming more aware of the subtle differences in these impacts as they begin to feel pressure from sunny day 'nuisance' floods (see Sweet et al 2018, Sweet et al 2020, Sweet et al 2022). Such floods will tend to impact low-lying sheltered shorelines, such as causeways over the marsh or creek-front backyards. Just a minor increase in sea level can quickly overtop a road that is barely above normal spring tide levels. On the other hand, locations along the oceanfront generally do not experience nuisance floods the same way. This is because dunes just inland from the beach lie at higher elevations than the mainland-facing 'back side' of barrier islands, where the shoreline transitions more gradually into marsh and creek habitats.

NOAA provides a 'Sea Level Rise Viewer' (SLRV; see https://coast.noaa.gov/digitalcoast/tools/slr.html) to help people identify local variations in flood impacts under different SLR scenarios. This tool allows users to specify water levels and generate inundation maps showing MSL and projected depths in previously dry areas. The NOAA viewer is a handy tool to see which SLR scenarios begin to impact a particular property.

Figure 5.8a, b shows a range of SLR scenarios between 1 ft and 4 ft above mean higher high water (MHHW). MHHW is presently 2.62 ft above 0 ft NAVD at the Charleston Harbor entrance. So, ~2 feet of SLR would bring MSL up to present-day MHHW and likewise move MHHW upwards. These visualizations do not distinguish between MSL and MHWW; however, they indicate the water level at 1, 2, 3, and 4 ft above MHHW. This means the maps show where the highest astronomical tide would flood under these scenarios. It is apparent that with increasing SLR, flooding will be more impactful along the backside of the island.

At present, all properties on the island remain above MHHW. Under a SLR scenario of 1 ft (Fig 5.8), some of the marsh edge along the Intracoastal Waterway, Waterway Island, and the landward side of Wild Dunes would be inundated. Roads could be threatened by nuisance flooding more frequently than at present. This is particularly true for the portions of Waterway Boulevard near holes 6 through 8 of the Harbor Course. This scenario is equivalent to projected MHHW in ~2040 under an 'Intermediate' scenario (see Fig 5.7). A 2-ft increase in MHHW would lead to further marsh creep and periodic inundation of holes 6 through 10 of the Harbor Course (Fig 5.8). Marsh edges behind the Harris Teeter and around Marsh Island Lane and Merritt Boulevard would continue to move inland and upward, and these areas would likely see increased nuisance flooding. According to NOAA

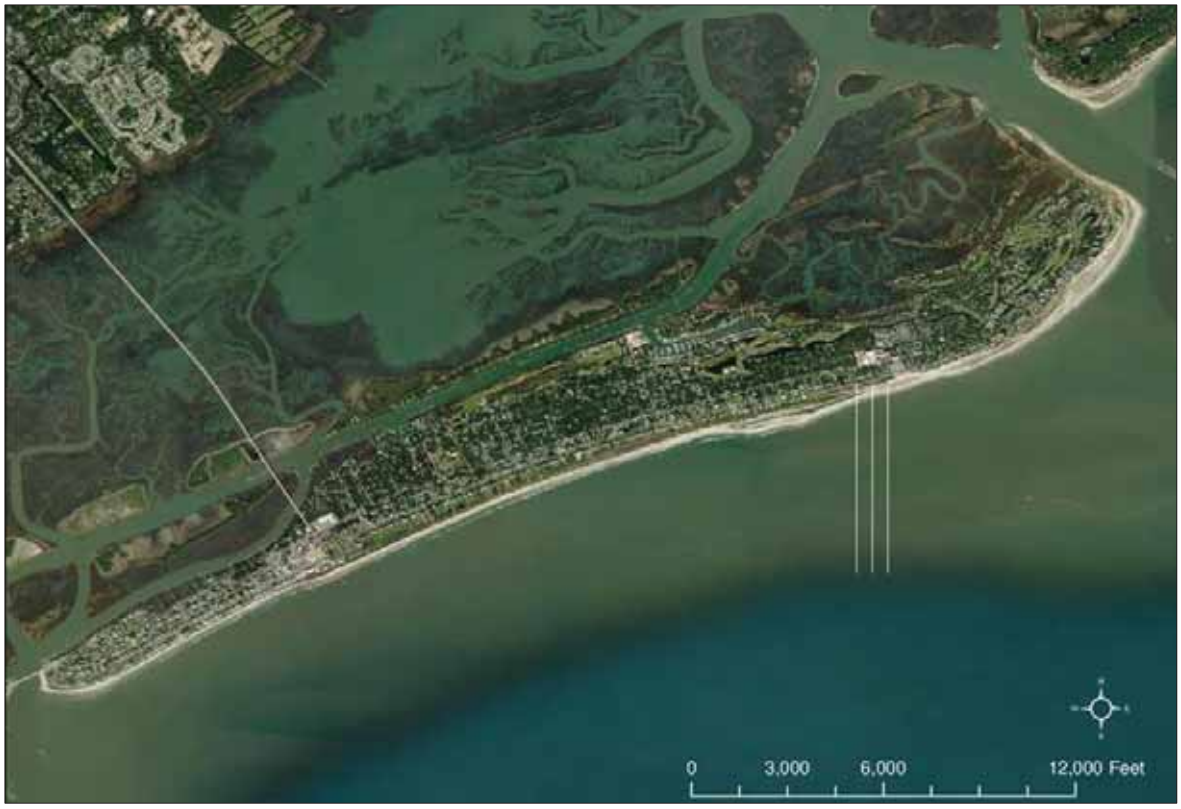
projections under an 'Intermediate' scenario, this increase would occur by ~2070 (see Fig 5.7). Kiawah Island has begun strategic planning to address the impacts of this SLR rate and magnitude (see Town of Kiawah Island 2018).

The SLRV indicates that the most significant changes could occur when MHHW increases from 2 ft to >3 ft above present (Fig 5.8). Many properties would be permanently inundated, particularly along Waterway Boulevard, between 2nd and 6th Ave, behind the Harris Teeter, and along Back Bay Drive in Wild Dunes. With 3 ft of SLR, Palm Boulevard near Hunley Bridge will become permanently inundated. At 4 ft of SLR, a substantial portion of the neighborhood bound by 32nd Ave, Hartnett Boulevard, and 41st Ave would be inundated.

SLR of 3 ft and 4 ft on the oceanfront could trigger a mixture of impacts. If sufficient sand volumes are maintained along the oceanfront, the first one or two rows of beachfront homes would likely remain high and dry even with a 4-ft rise in MHHW. This is because most oceanfront properties are elevated higher than back-barrier buildings to accommodate surge and wave runup. Keep in mind that such properties may be safe from normal conditions but will still be exposed to higher water levels in storms. Houses presently elevated to the 100-yr flood level standard will become more vulnerable to lower return-period storm surges – as frequently as a 30-yr interval – under the likely SLR scenarios in the next 80 years (see Marsooli et al 2019).

A 3-ft increase in MHHW is possible under the 'Intermediate' scenario by ~2090 (see Fig 5.7), whereas a 4-ft SLR under the same scenario is not expected until after 2100. Folly Beach plans to adapt to SLR of 3 ft by ~2060 (see SC Sea Grant 2017). Extensive research is being conducted worldwide to improve future sea-level predictions and ramifications for individual locations. A key finding of the August 2021 IPCC* report is that regardless of any level of reduction in atmospheric CO_2, sea levels will rise through 2100 by at least 2 to 3 ft.

** IPCC – the Intergovernmental Panel on Climate Change was formed by the United Nations to provide regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. The panel currently has 195 members worldwide, with dozens of additional scientists contributing to each report.*



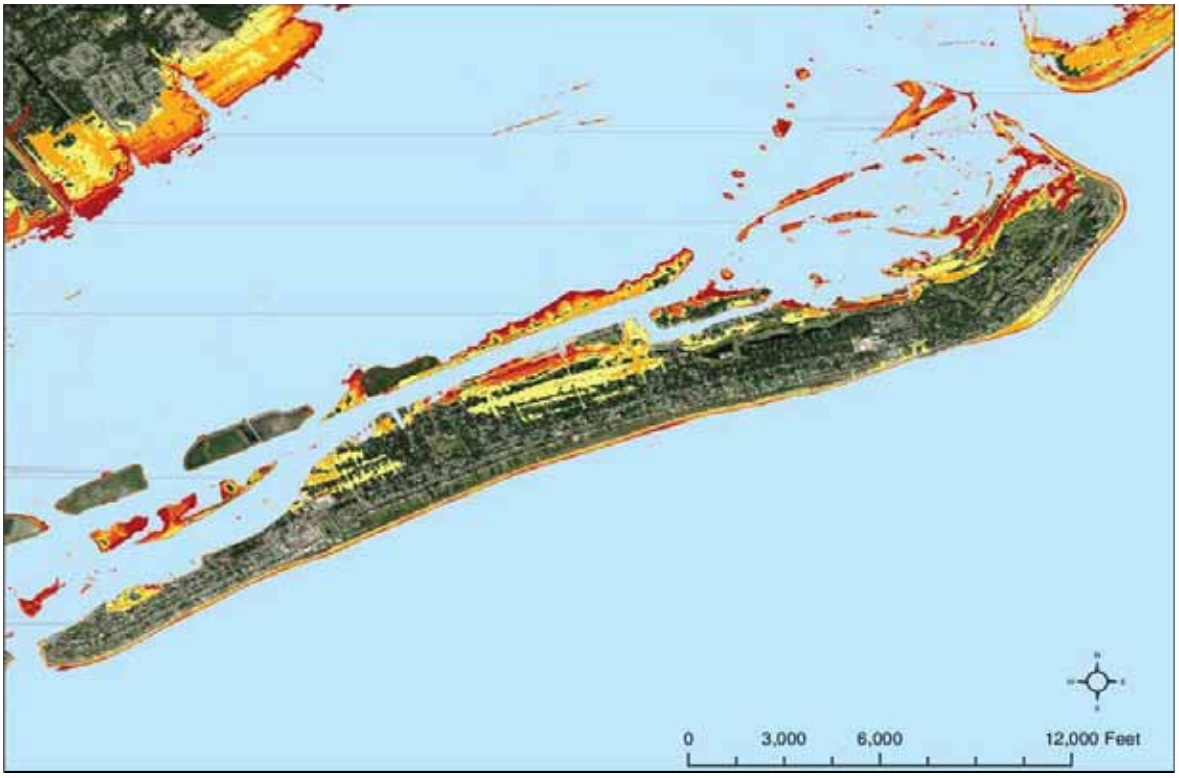


FIGURE 5.8a, b. Sea level inundation models around the Isle of Palms generated using data from NOAA (https://coast.noaa.gov/digitalcoast/tools/slr.html). Shades of yellow, orange, red, and maroon are used to signify SLR of 1, 2, 3, and 4 ft above present-day MHHW.

5.3 Coastal Resilience in the 21st Century

NOAA's Ocean Service defines coastal resiliency as the "ability of a community to 'bounce back' after hazardous events…rather than simply react to impacts" (NOAA 2021). NOAA recommendations for effectively preparing for hazardous situations and improving coastal resiliency include being "informed and prepared" for the impacts of SLR as a community.

As mentioned above, many communities around the nation, the world, and a handful of communities in South Carolina have begun strategic planning initiatives to address the impacts of projected SLR. The impacts of SLR are diverse and extensive, and conditions vary significantly from one community to another. Individualized plans developed at a community level help prepare for these impacts using a variety of tools and adaptation strategies.

Other communities in South Carolina have categorized potential adaptation strategies according to their role and utility in mitigating impacts from future SLR. These include water infrastructure management, uplands management and/or conservation, transportation adaptation, and education/communication. The order of mitigation and adaptation strategies should be timed according to the vulnerability and capabilities of the community in question. Shorter-term goals (eg – 1 to 3 years) are focused on generating plans and recommendations based on a detailed inventory of the vulnerability of upland properties at a parcel scale. Medium- and long-term goals (eg – 3 to 5+ years) include implementing recommendations.

SLRV data indicates flooding along Waterway Boulevard and portions of Wild Dunes will present issues for the entire island by mid-century under 'Intermediate' SLR scenarios (Fig 5.8). Mitigation and adaptation strategies for that vulnerability should target improving drainage following rain events and elevating the road surface above future MHHW. On a longer timescale ('Intermediate' scenarios as projected by the end of the century), developed properties between Hartnett Boulevard and the Harbor Course, as well as near the Exchange Club, will be vulnerable to persistent flooding even during calm weather conditions.

Figure 5.9 illustrates an example of SLR on a barrier island and how it affects both the back bay and oceanfront properties. SLR in the back bay can affect the ability of water to effectively drain out of the island. This can worsen problems with sunny-day flooding that affect low-lying areas, which can lead to a water quality problem. This can lead to the need for long-term projects to strengthen the back bay in the form of bulkheads, stormwater drainage reform, and more. On the oceanfront, storm waves and surge can affect higher up the beach, leading to increased erosion. In areas where beach and dunes are already affected by erosion, property damage can occur.

Figure 5.10 illustrates how the rate of sea level change has varied over time, based on a two-year running average. While short-term fluctuations are evident, the overall trend (red dotted line) indicates that the rate of sea level rise has gradually increased since the mid-20th century. This suggests that, in addition to natural variability, there is a long-term acceleration in sea level rise that may have implications for coastal planning and infrastructure resilience.

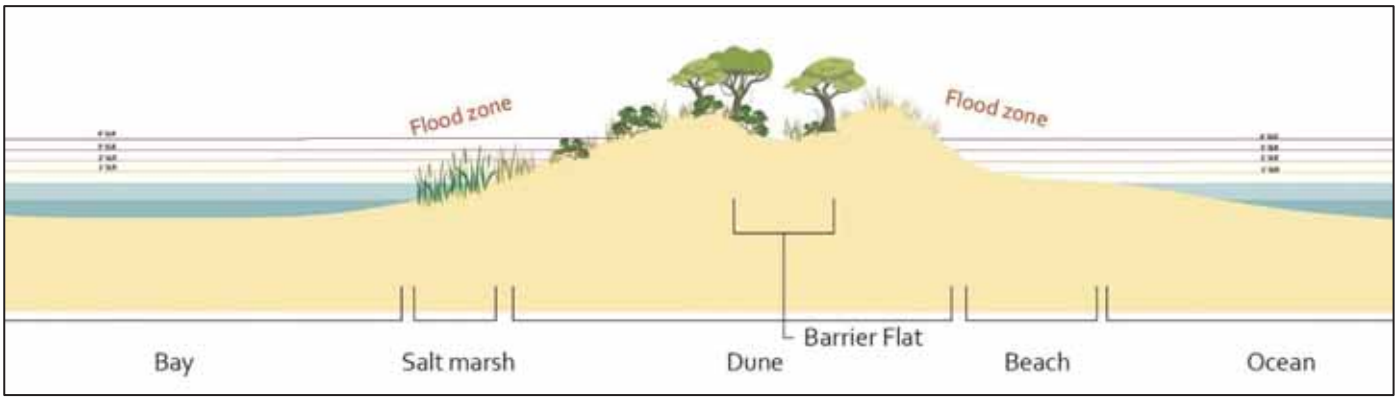


FIGURE 5.9. Example of 1, 2, 3, and 4 ft SLR above MHW on barrier islands.
(Original image: https://creatingattheedge.wordpress.com/wp-content/uploads/2015/06/doorsnedes-barrier-mainland-flood-20150506.jpg).

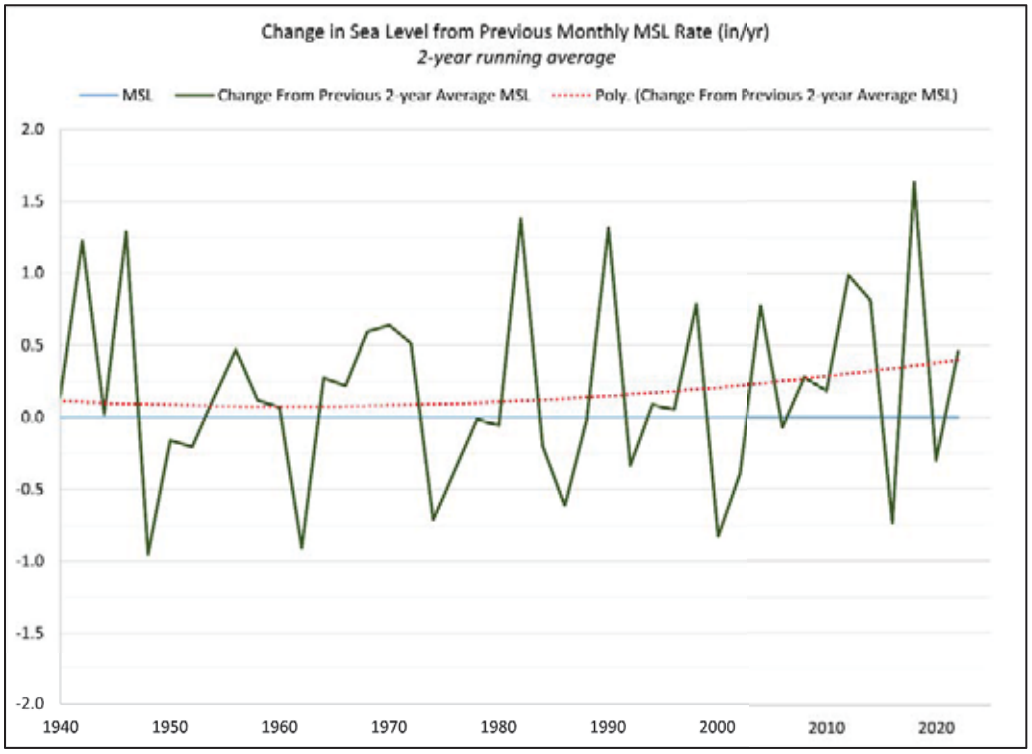


FIGURE 5.10. Change in sea level rate (in/yr) based on a 2-year running average, showing short-term variability and a long-term upward trend since the 1940s.

The City should consider sponsoring a Climate Change and SLR adaptation plan like those developed by Folly Beach and Kiawah Island to improve its coastal resiliency. Adaptation plans are not unlike the Beachfront Management Plans prepared by many communities, although due to the broad array of SLR impacts, they can represent a more interdisciplinary effort. These plans contain recommendations and identify time horizons for specific priorities and goals. More importantly, they inform a community of the hazards presented by SLR and how to prepare adequately before those hazards negatively impact the community.

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6.0 SUMMARY & RECOMMENDATIONS

This report describes beach conditions at Isle of Palms as observed between 2024 and 2025. The beach gained a total of ~71,900 cy (1.2 cy/ft) of sand from September 2024 to August 2024. The 2018 project area lost ~29,000 cy (10.1 cy/ft) over the past year and has lost ~1.58 million cy since project completion. Volume represents ~94% of the 2018 project volume. Since project completion, the project area has seen higher erosion rates compared to the previous post-project monitoring period (2009–2017). From 2009 to 2017, annual losses in Reaches 5 and 6 measured ~100,000 cy/yr, while from 2018 through 2024, they measured ~225,000 cy/yr. The primary results of this latest monitoring effort are 1) that the large shoal at the east end has partially attached and is beginning to spread sand to adjacent areas, 2) erosion hotspots continue to be vulnerable and while some areas have stabilized or will likely in the very near future (south end and along Beachwood East), the area near Ocean Club and the Wild Dunes Links Course is likely to remain in an erosion condition over the next 6 months, and 3) areas eroded over the past several years are vulnerable to further damage and restoration is needed.

There are several dynamics that would drive a multi-year increase in erosion rates, as has been described in the report. First, there has been a relatively high frequency of moderate-strength storms over the same time period. More than a dozen named tropical cyclones, unnamed tropical cyclones, and non-tropical nor'easter-type storms have impacted the Isle of Palms since Hurricane *Matthew* in 2016. The short windows of relatively quiet conditions between these storms are inadequate to allow a full post-storm recovery in the beach and dune system. This collectively results in increased vulnerability to erosional losses during future storm events (Houser and Hamilton 2008).

Second, an ongoing shoal bypass event in Reaches 5 and 6 has triggered rapid, localized erosion around Beachwood East and the Wild Dunes Ocean Club. While more of the shoal is attached to the beach compared to last year, and some portions of the east end are seeing spreading, the natural spreading has not reached all areas. The 600,000 to 800,000 cy that the shoal contains should help the sand-starved area—but it will not be fully attached to the beach for several months at the earliest—will continue to merge with the beach over the next 24 months. Localized areas of erosion may continue to persist, especially at the eastern end of the Wild Dunes area. In the meantime, localized erosional conditions are likely to persist.

Third, sea level rise has accelerated around the Charleston area since 2010, such that year-to-year water level increases from 2010 through 2025 are an order of magnitude higher than those observed from 2000 through 2010. While the increase in water levels does not necessarily trigger beach erosion on its own, increased water levels coincident with a series of storm impacts – noted above – allow storm waves to erode higher on the profile and do more damage than under a scenario with lower water levels.

Finally, Breach Inlet continues to draw sand off Reach 1, leaving some isolated hotspots. Between 2021 and 2024, Reach 1 lost more volume than it had collectively lost since 2010. From February 2025 to Augst 2025, Reach 1 has mostly stabilized compared to years prior when the Breach Inlet shoal was growing significantly. The recovery is due to natural sand transport patterns and the project by the US Army Corps of Engineers. The USACE added a considerable amount of sediment to the low tide portion of parts of Reach 1, but this sand has not made it to the dry beach portion of the heavily eroded area as of August 2025. One reason for the limited benefit so far is the sediment quality, whereby fine-grained material is winnowing from the fill and shifting offshore or into the water column. While the beach has recovered in some areas, the prior losses have left much of the south end vulnerable, and there are isolated hotspots that continue to erode.

With the ongoing shoal bypass event at Dewees Inlet, reduced dune volumes at Breach Inlet, and ever-increasing flood hazards due to sea level rise, the City certainly has a number of active concerns regarding beach (and coastal) planning. To offset the beach erosion, the City is planning a large-scale beach renourishment. This project will be similar to the nourishment that occurred in 2018; however, will also include sand placement along the south end of the island. Scheduled for Summer or the Fall of 2026, or Winter of 2027, the nourishment will add a maximum of 1.7 million cubic yards to Reaches 5 and 6, and 800,000 cy to Reaches 1 and 2.

The planned nourishment is intended not only to address recent erosion but also to enhance the island's natural coastal defenses. The addition of sand will provide a wider dry beach and help absorb wave energy during storm events. It will also add sediment to the littoral system that will spread to unnourished areas. Some of the sand will build up the inshore zone and dissipate storm waves before they can impact the dunes. The offshore serves as the first line of defense during a storm and takes the pressure off the berm and dune.

While this project continues to move forward, issuance of permits and contracts remains months away, and hotspots of erosion – particularly on the inlet-adjacent portions of the island – are likely to persist. CSE recommends the City continue its current efforts to pursue various restoration efforts, including short-, mid-, and long-term plans. This includes continued maintenance of emergency protective measures and planning of projects following the upcoming beach nourishment. The USACE beneficial use project at the south end (if completed to design) will restore some of the sand volume lost over the past three years and should serve as sufficient protection until the upcoming large-scale nourishment is completed. This will offer a sand supply to promote beach recovery; however, the results of the work are still uncertain.

CSE is aware of multiple property owners who are replacing and maintaining their emergency beach management structures, such as sandbags. Presently, the critical erosion hotspots include ~1,200 ft around Ocean Club, ~1,400 ft around Beachwood East, and ~3,200 ft around Seascape Condos. At the north end of the Island CSE expects the shoal at the east end to attach within a year, which will provide sufficient sand to restore some of the eroded areas. Based on shoal analysis there is not enough material to offset all the losses since 2018. CSE also recommends that the City pursue further examination of the long-term changes of Breach Inlet and the effects it has on the homes in Reach 1. The City has committed to increasing the frequency of beach monitoring, which will aid in determining rates of recovery and in planning for future nourishment.

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APPENDIX A

CSE Profiles

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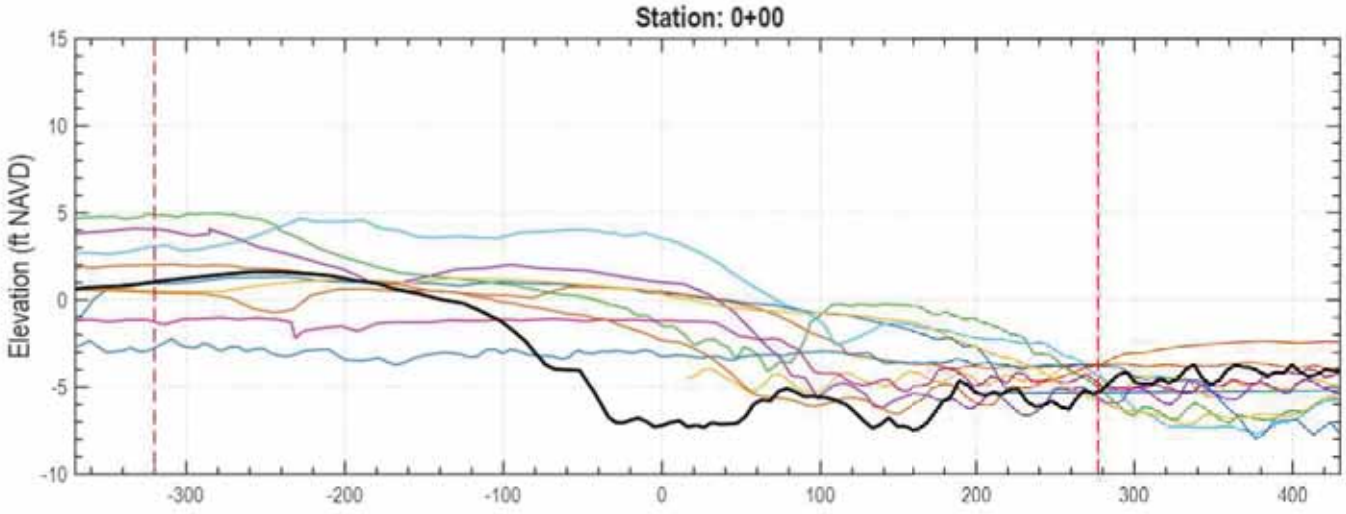

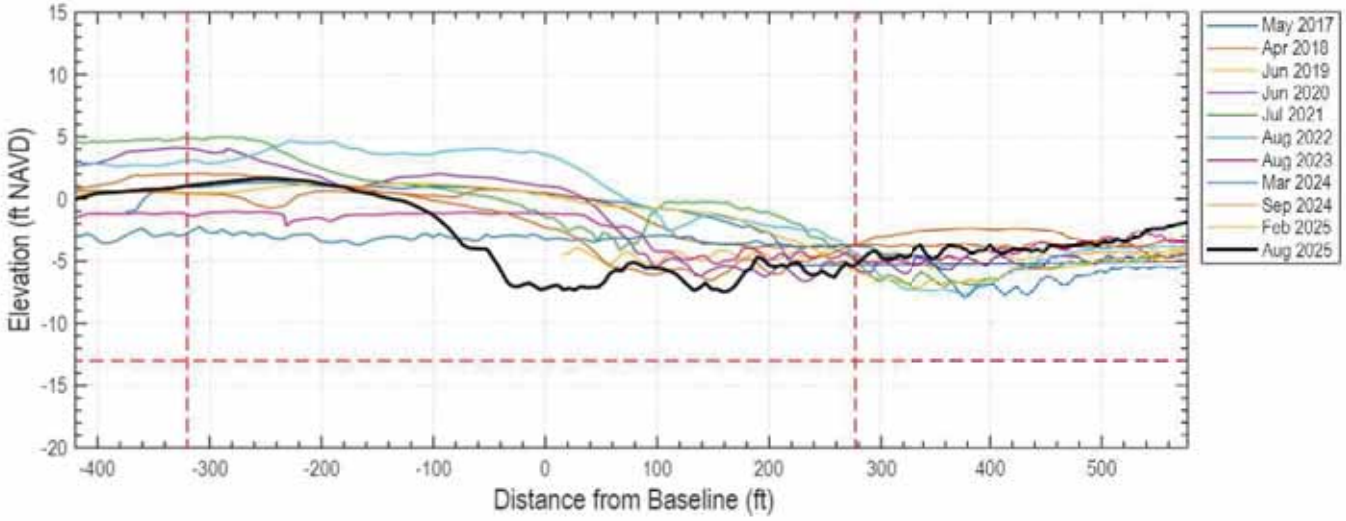

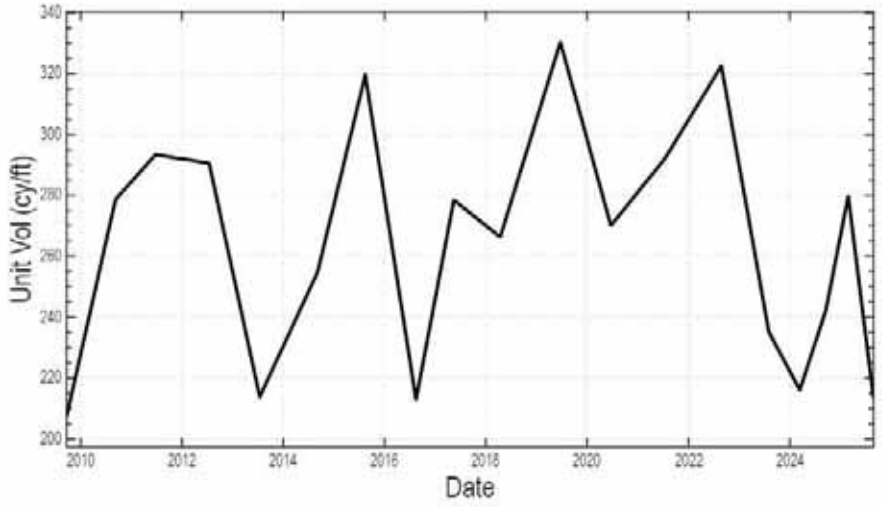

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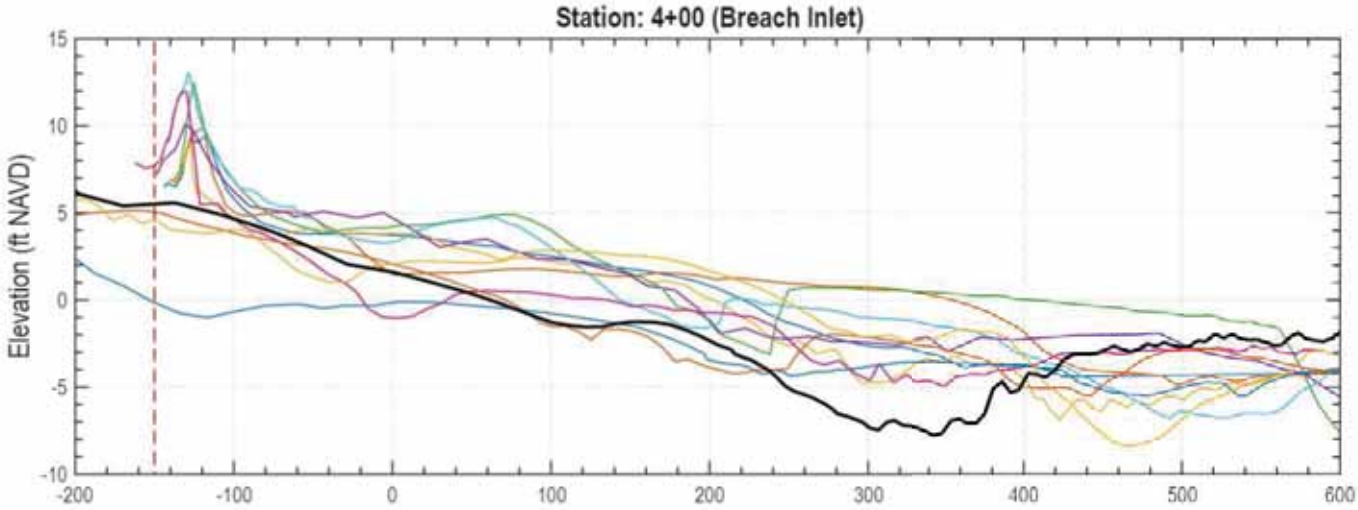

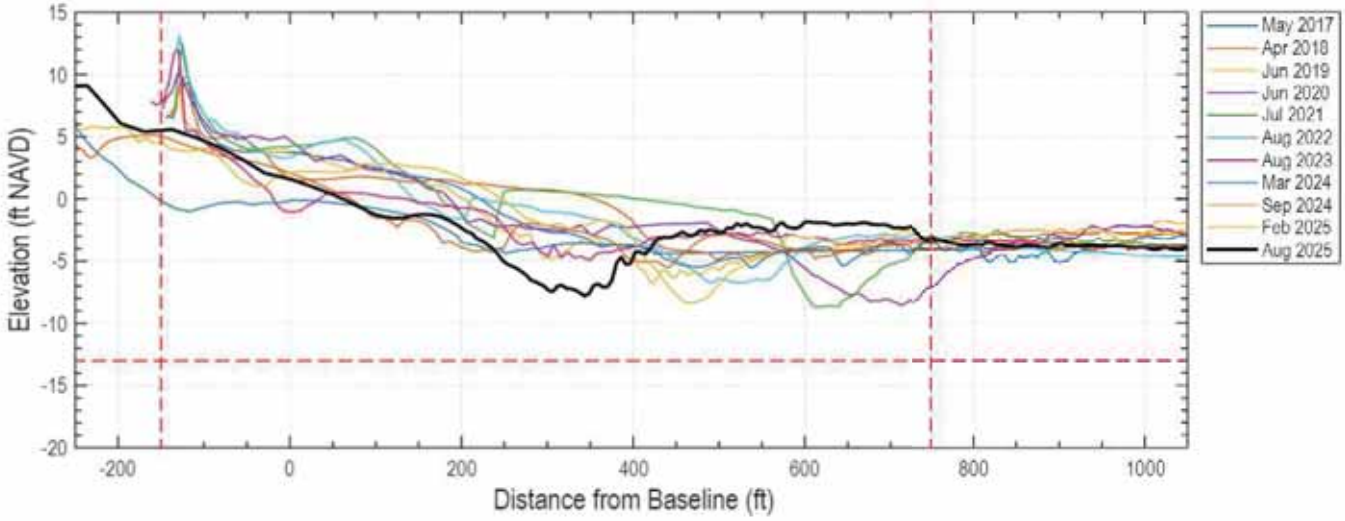

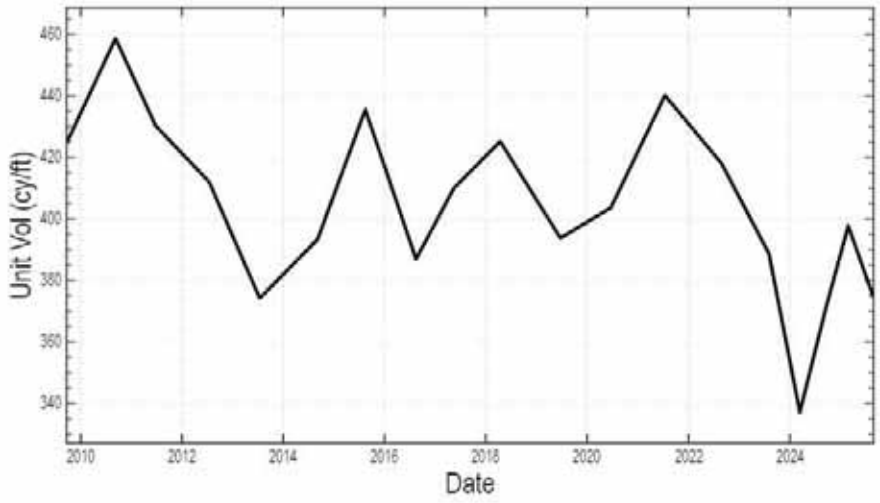

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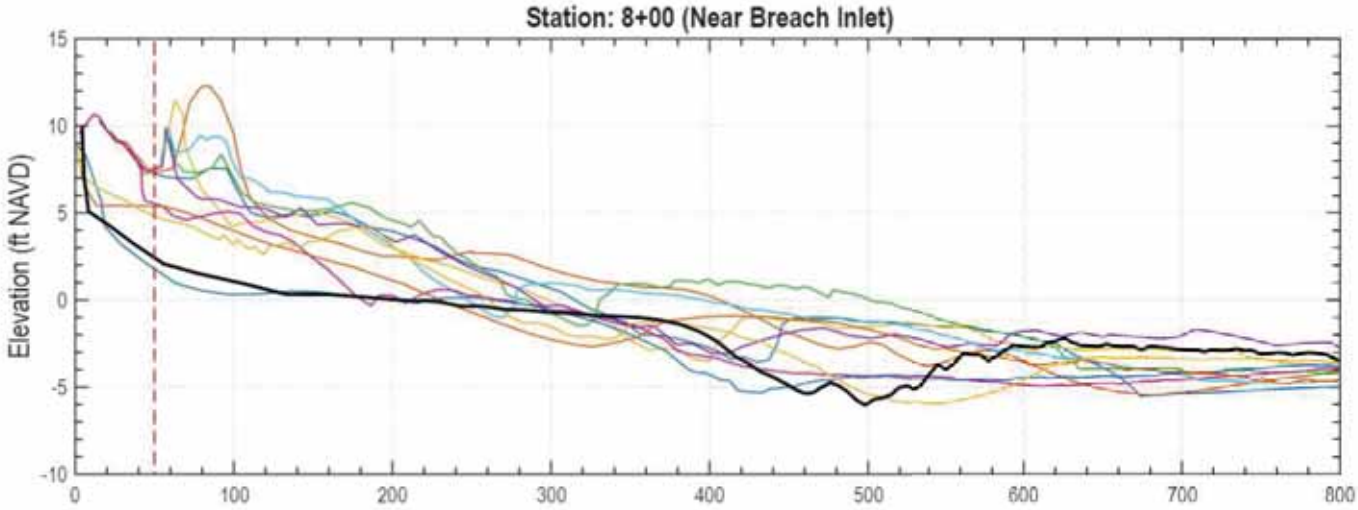

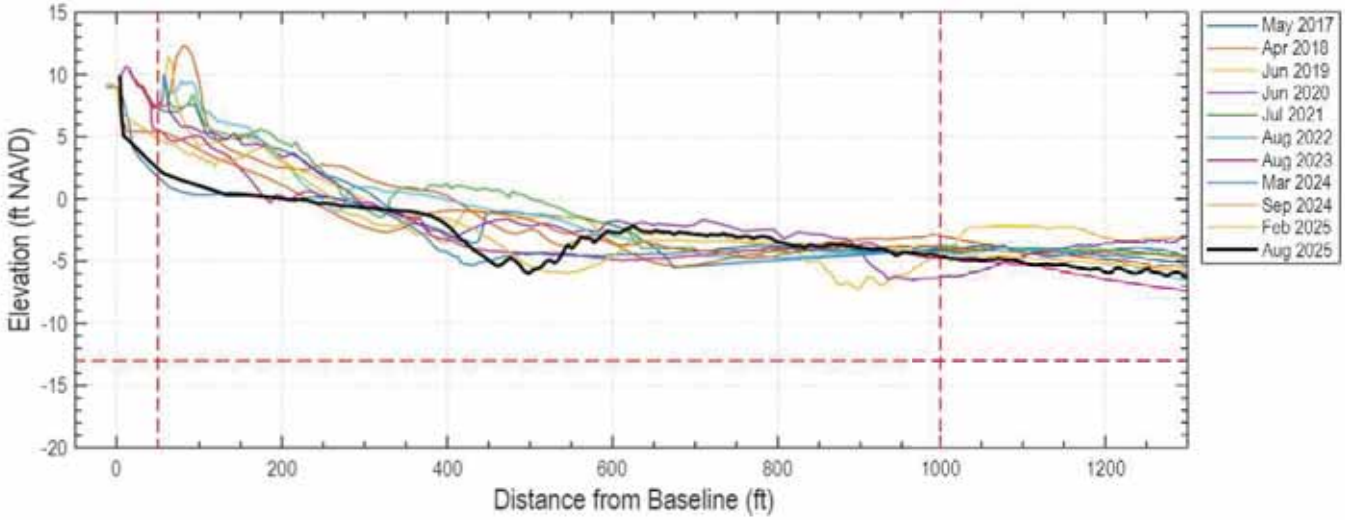

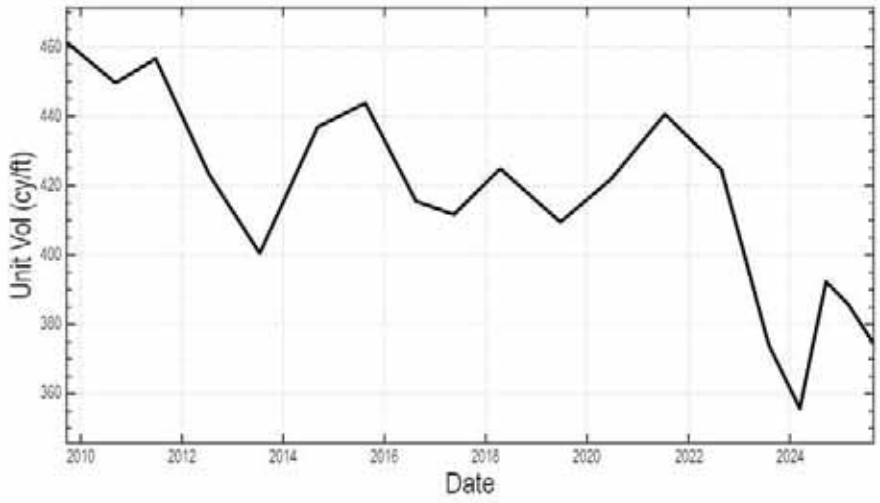

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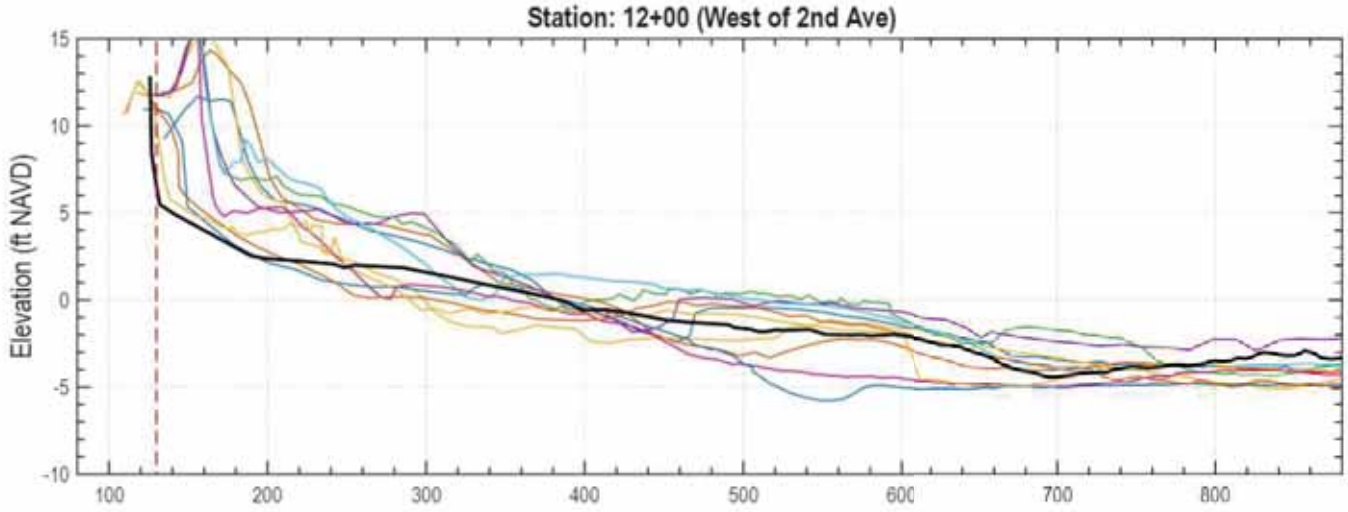

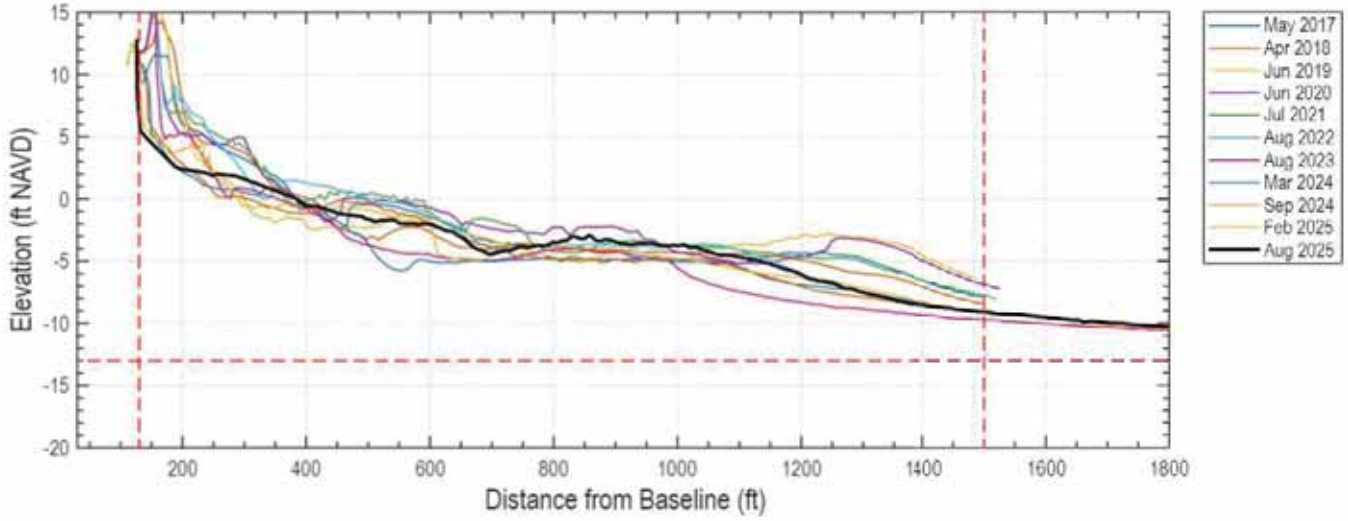

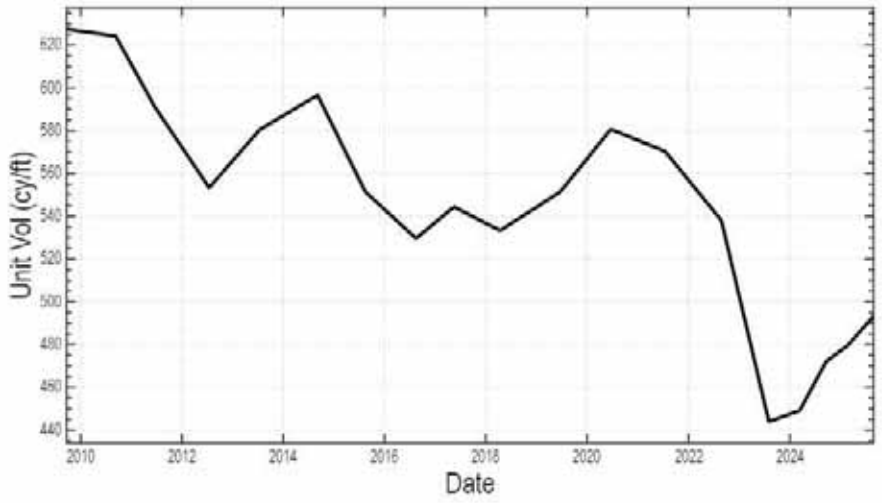

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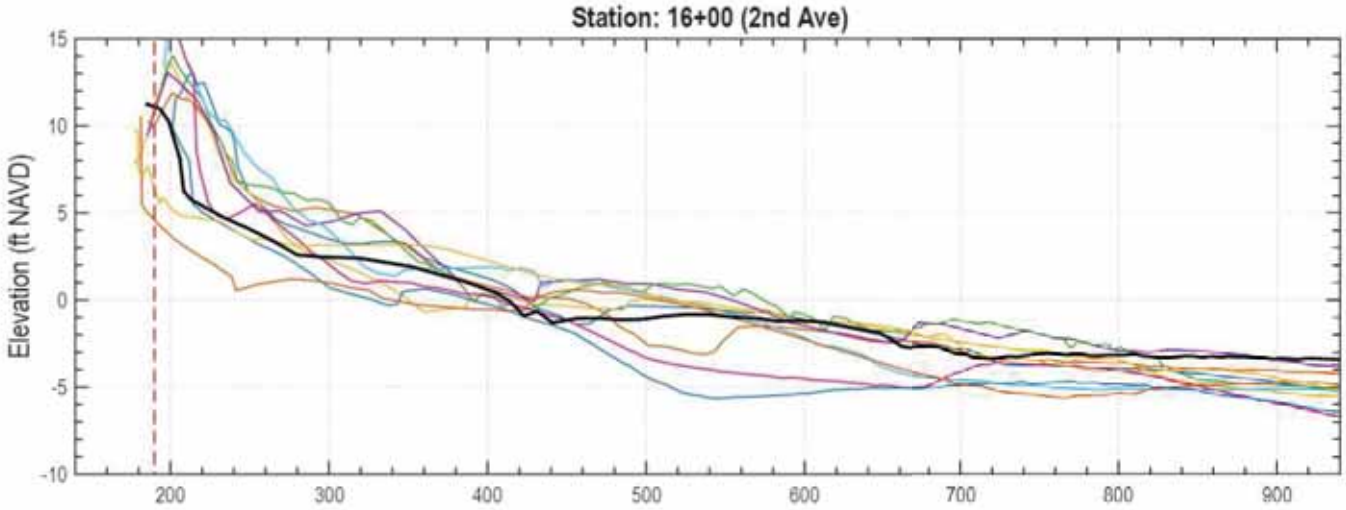

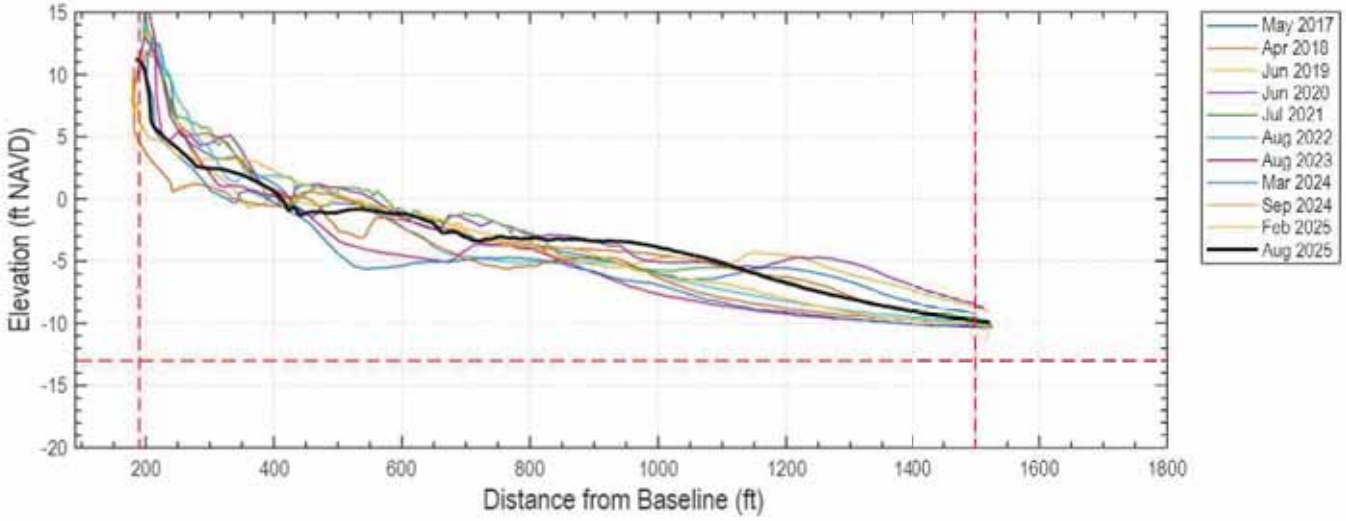

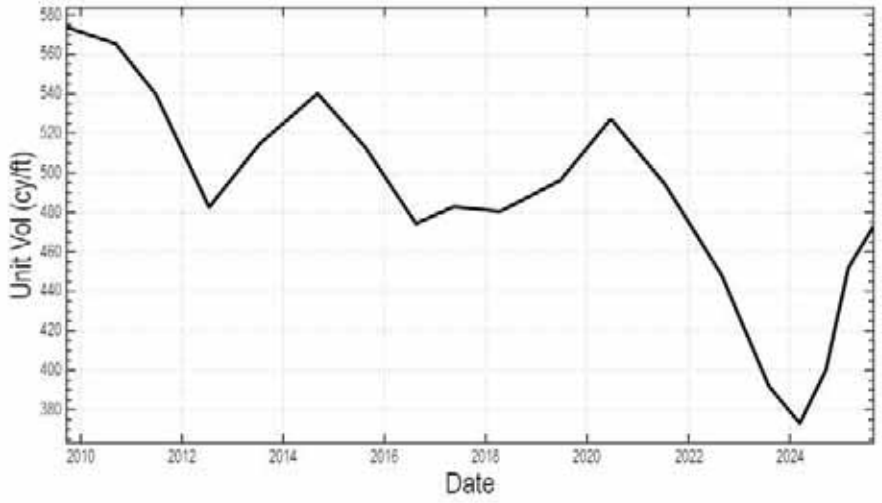

X: 2366942.8
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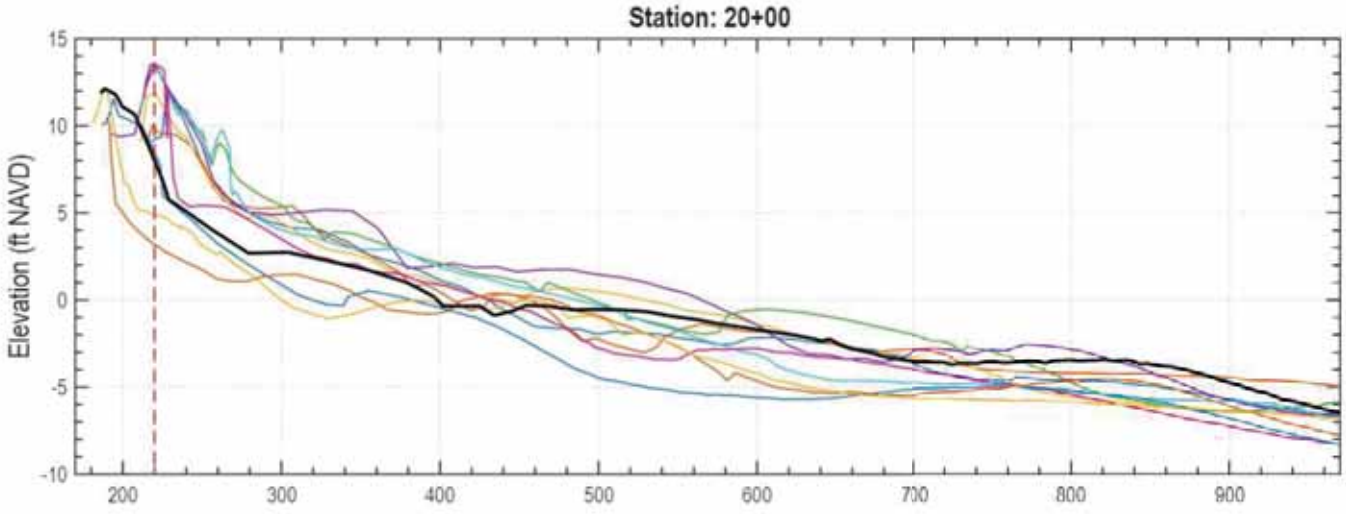

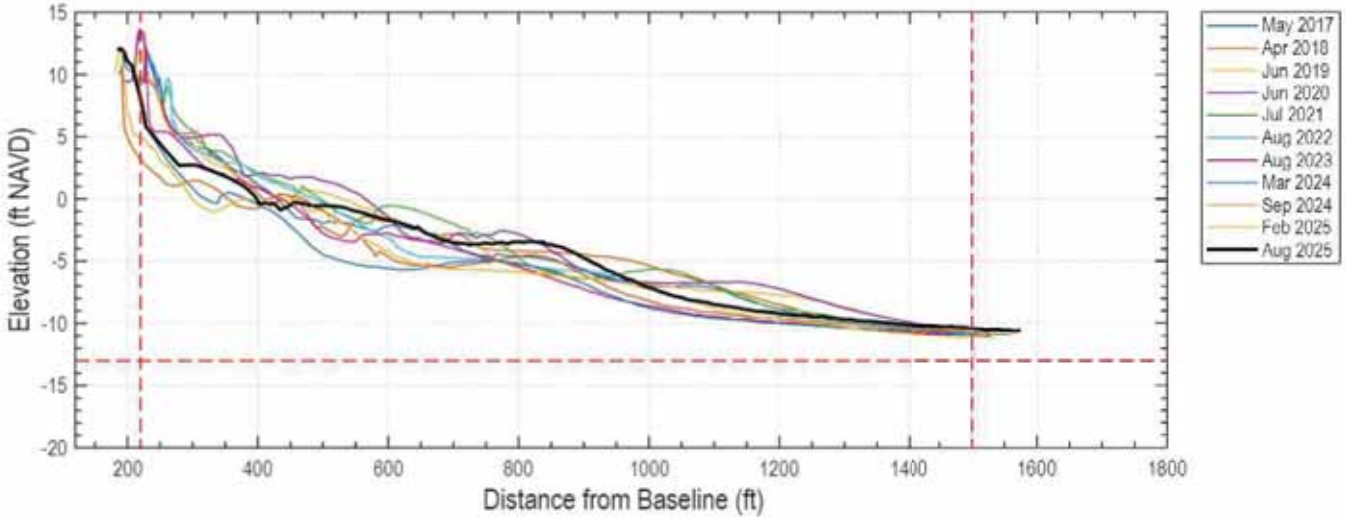

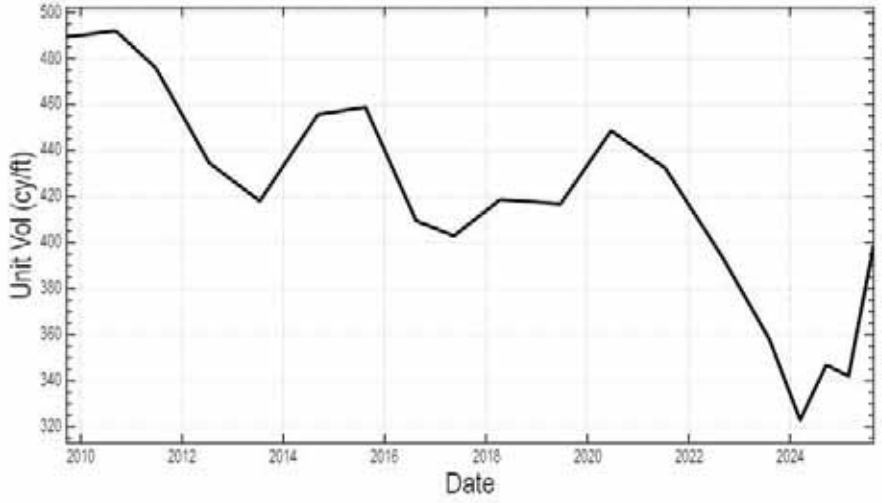

X: 2367291.63
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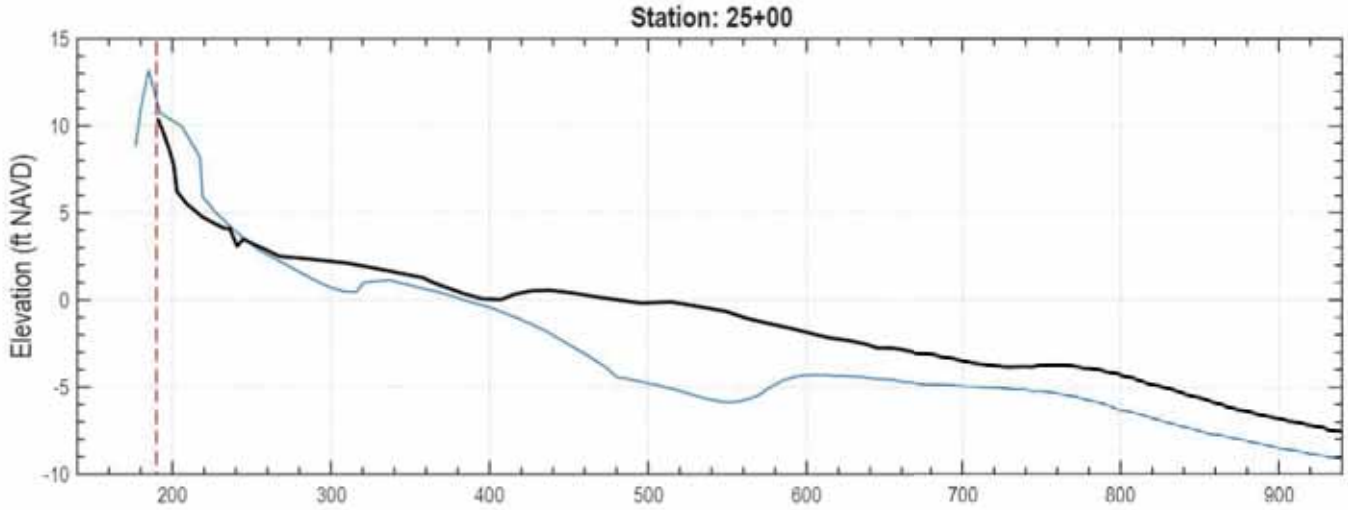

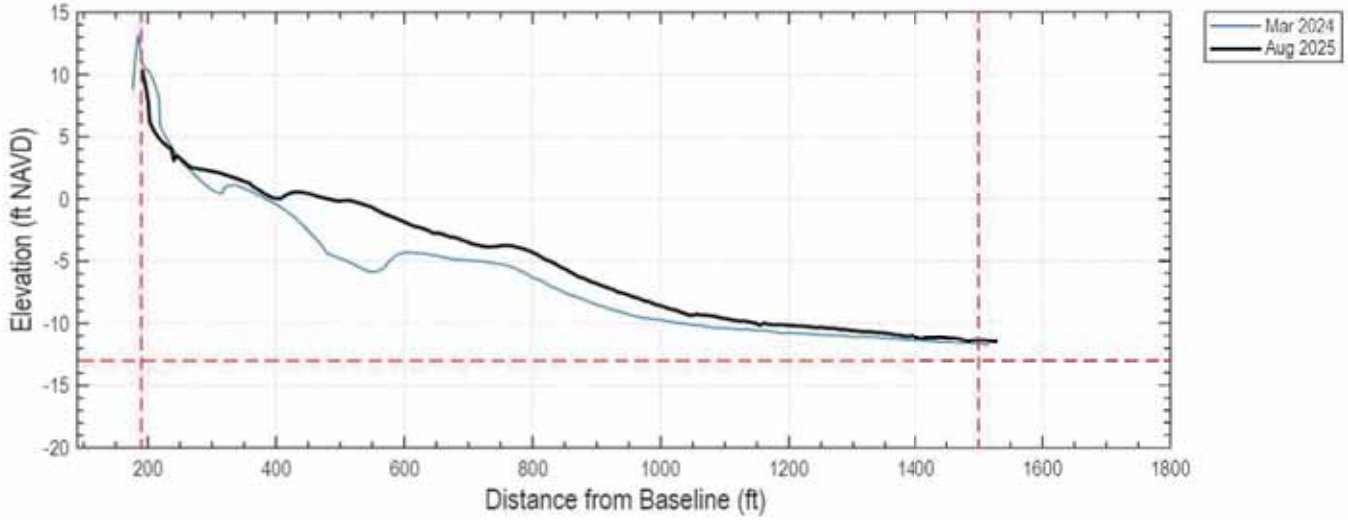

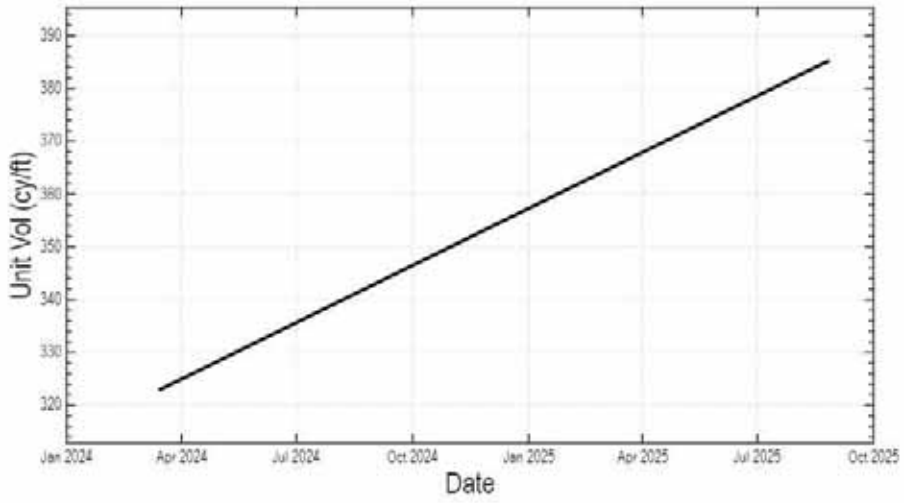

X: 2367727.67
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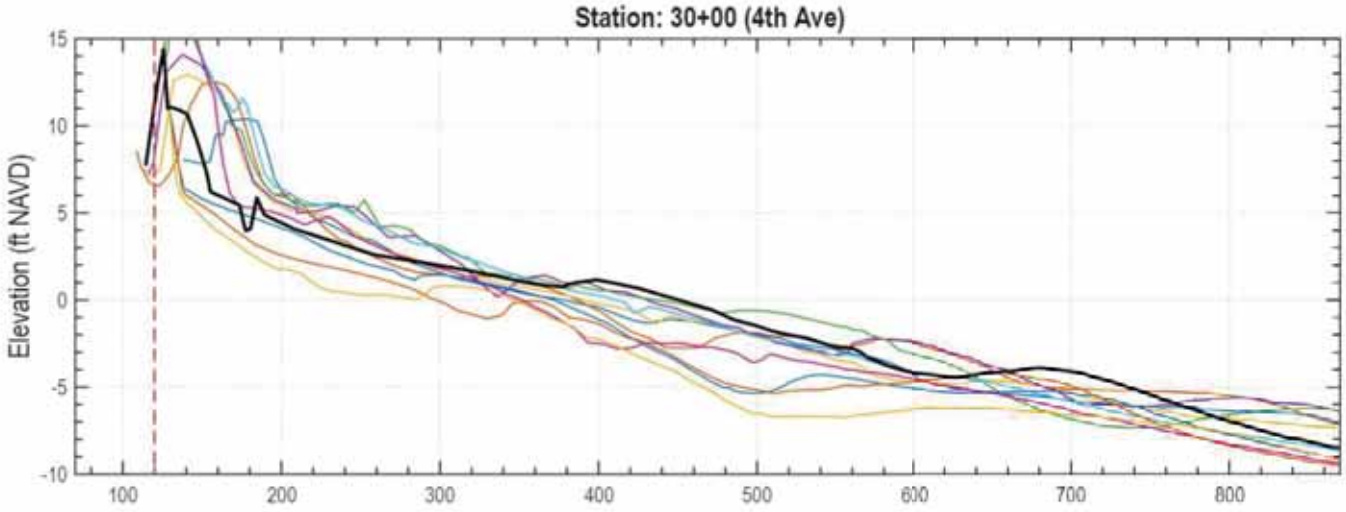

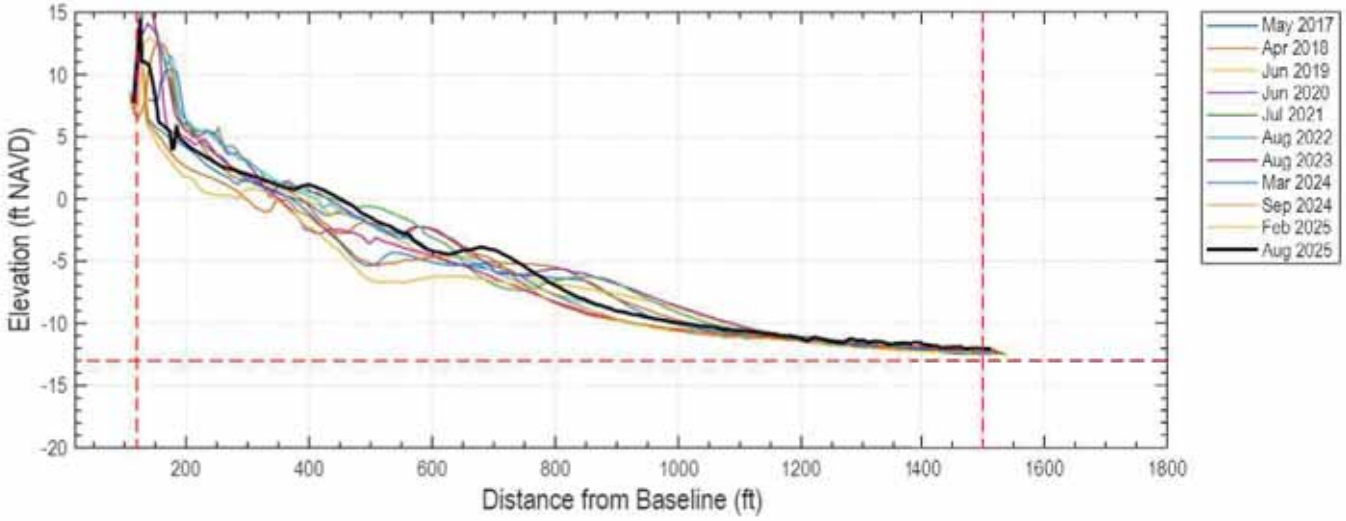

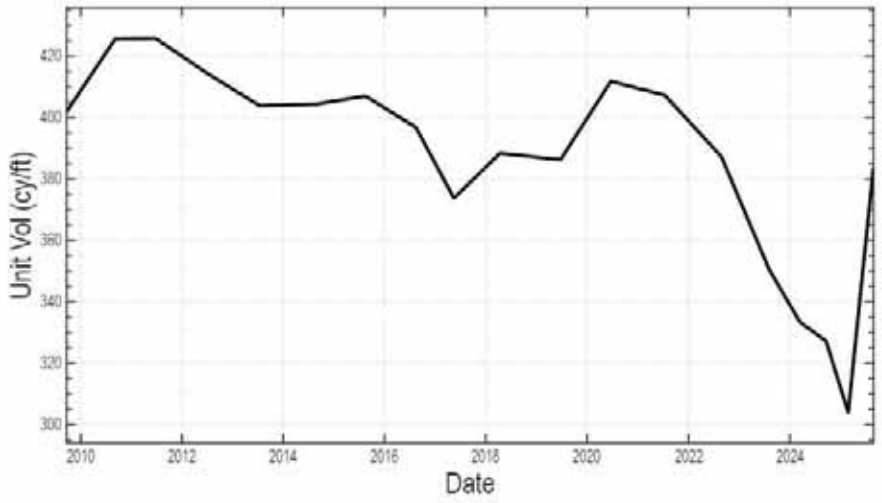

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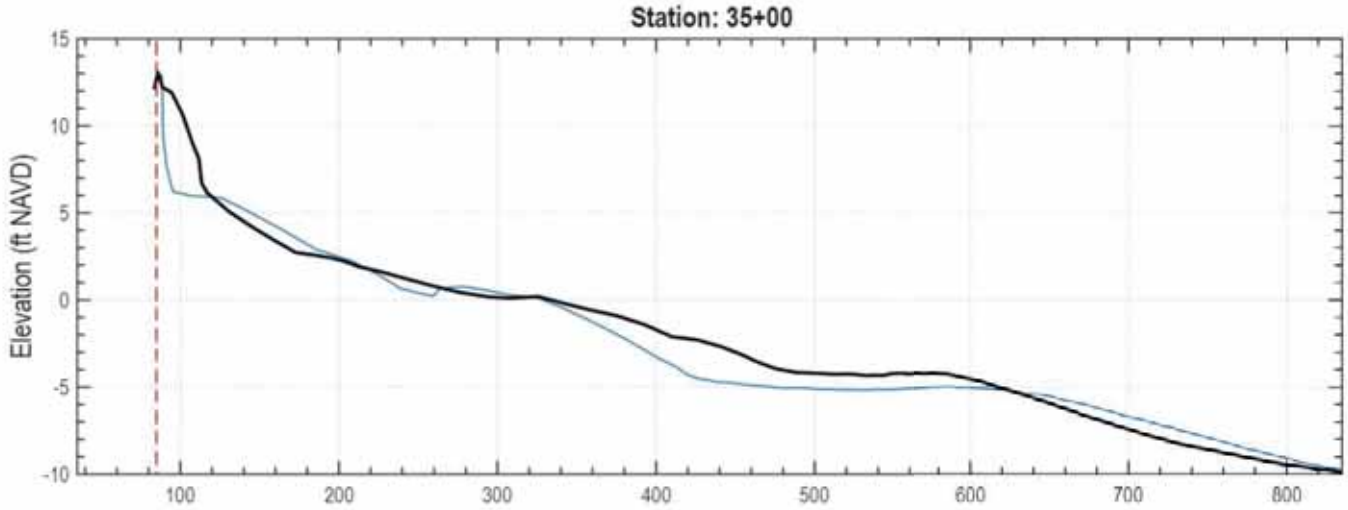

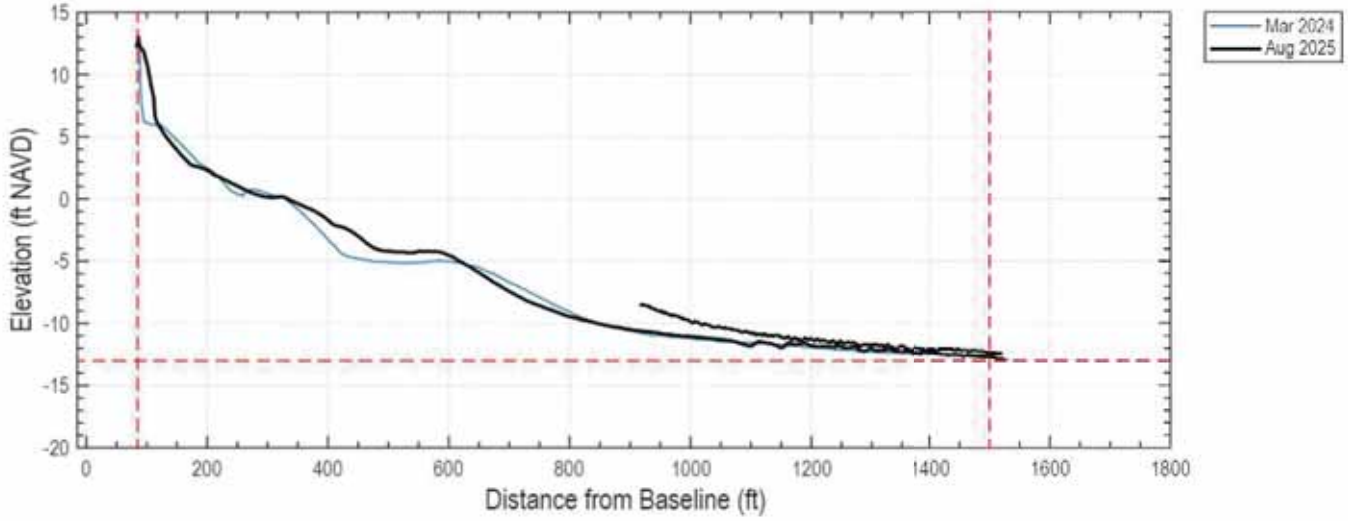

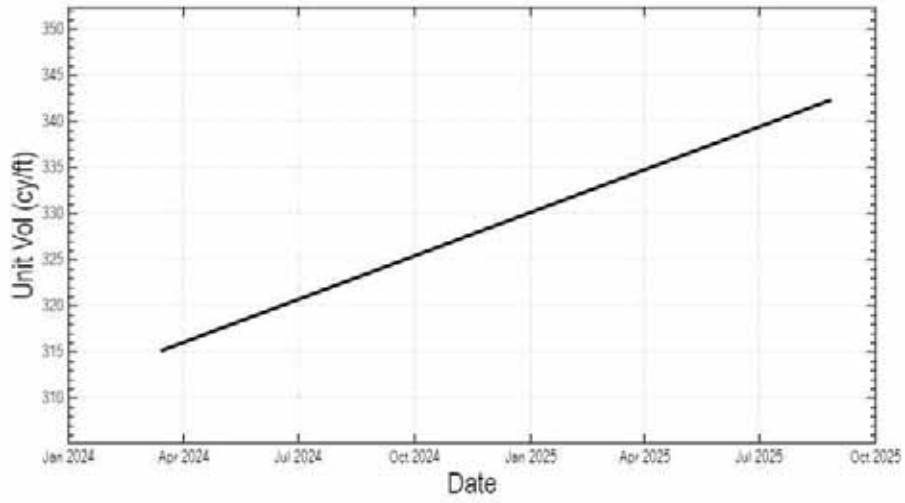

X: 2368599.75
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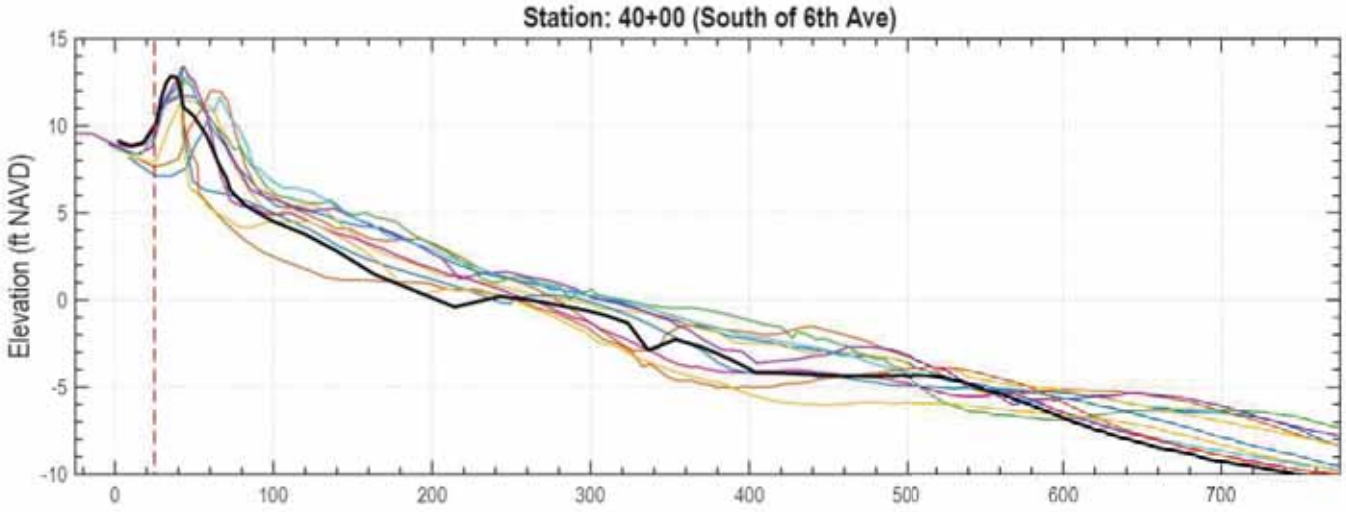

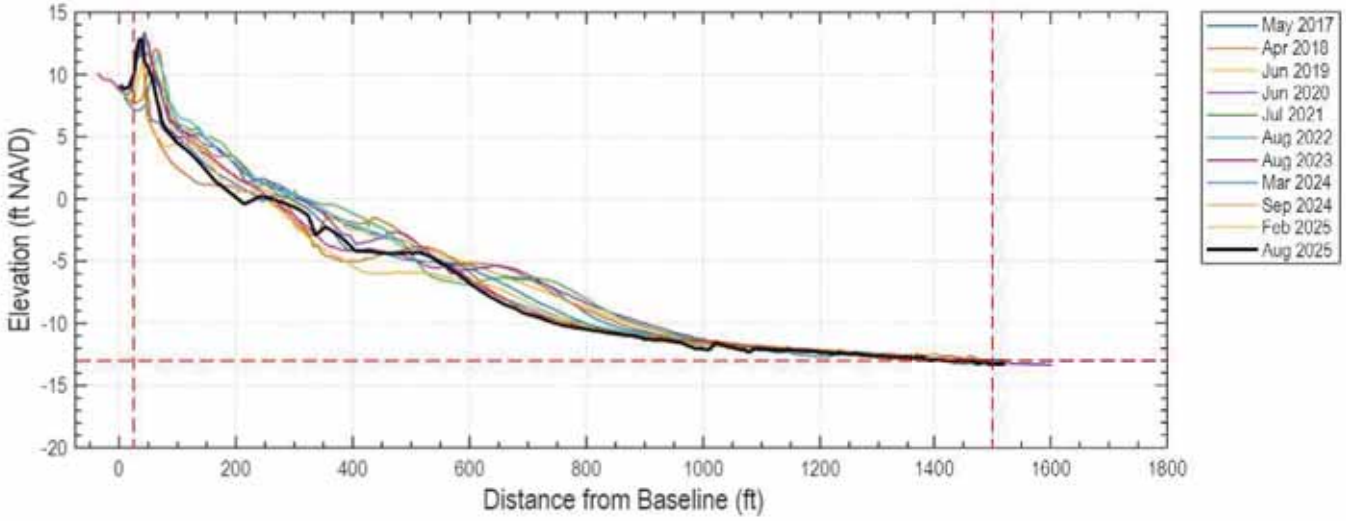

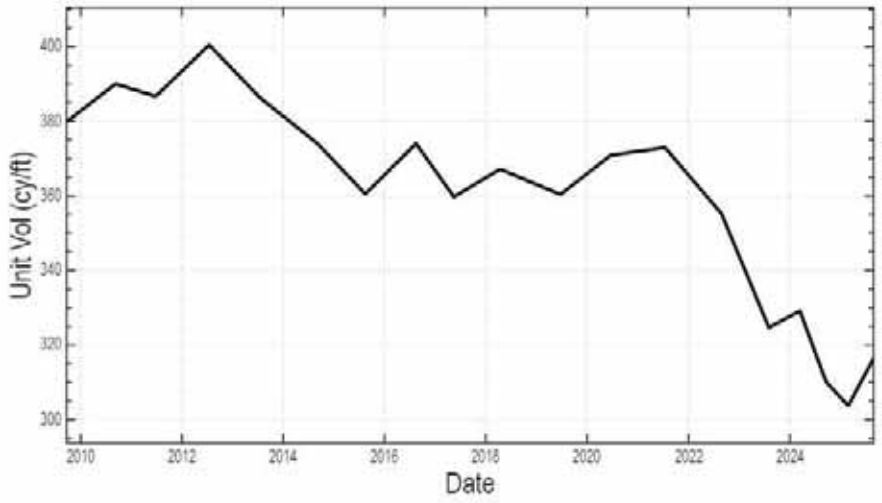

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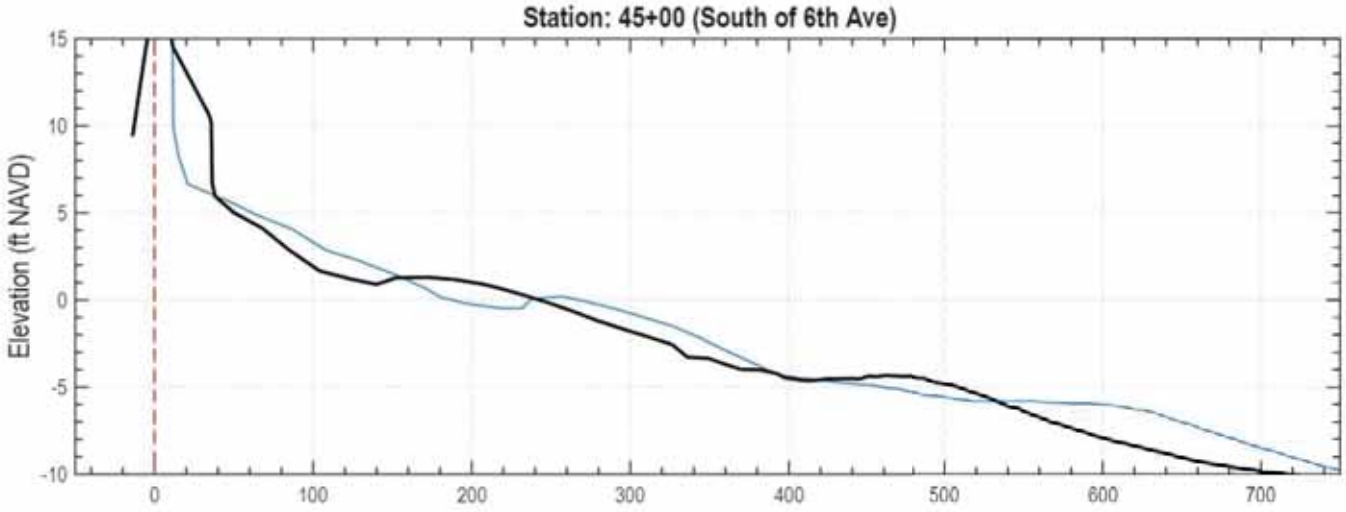

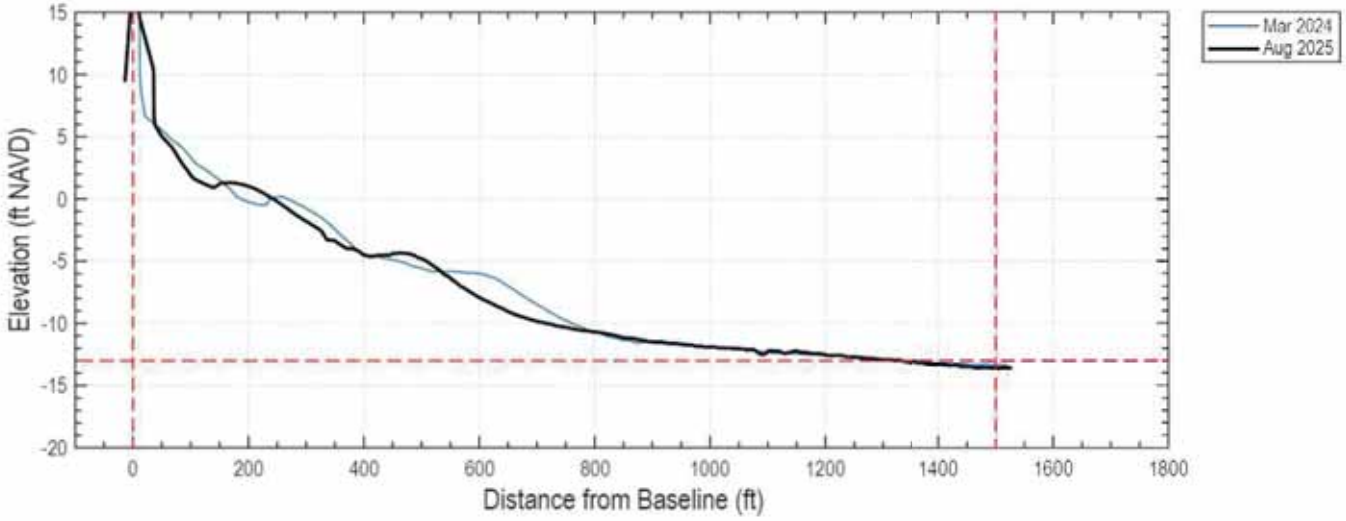

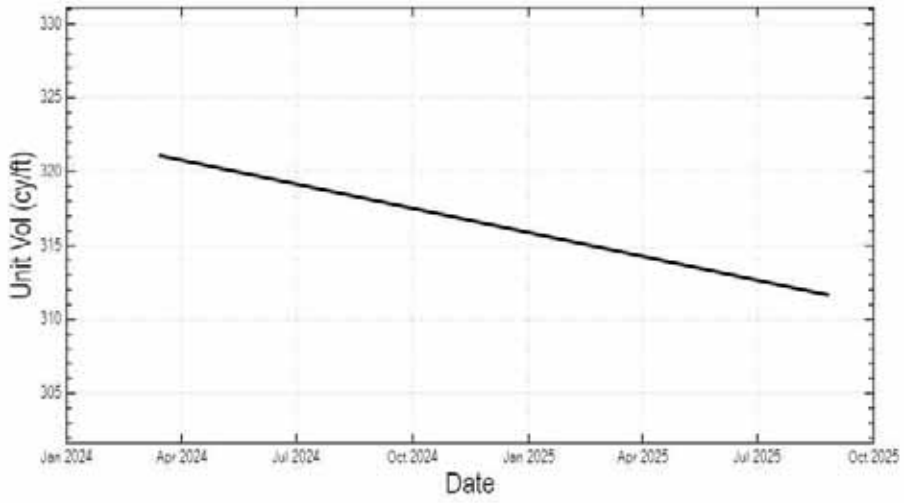

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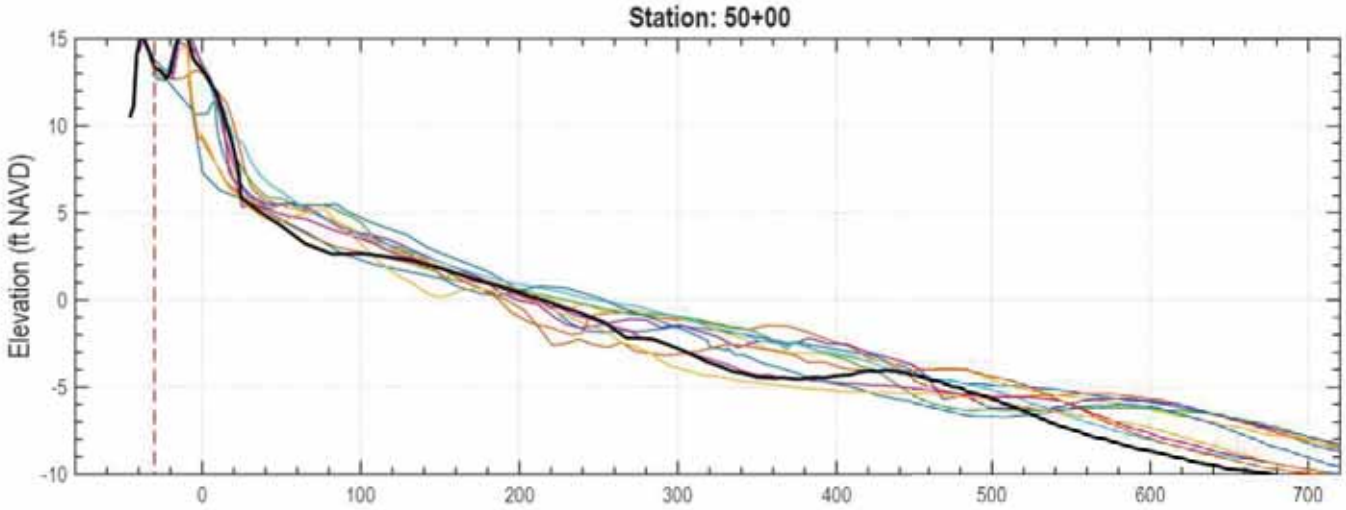

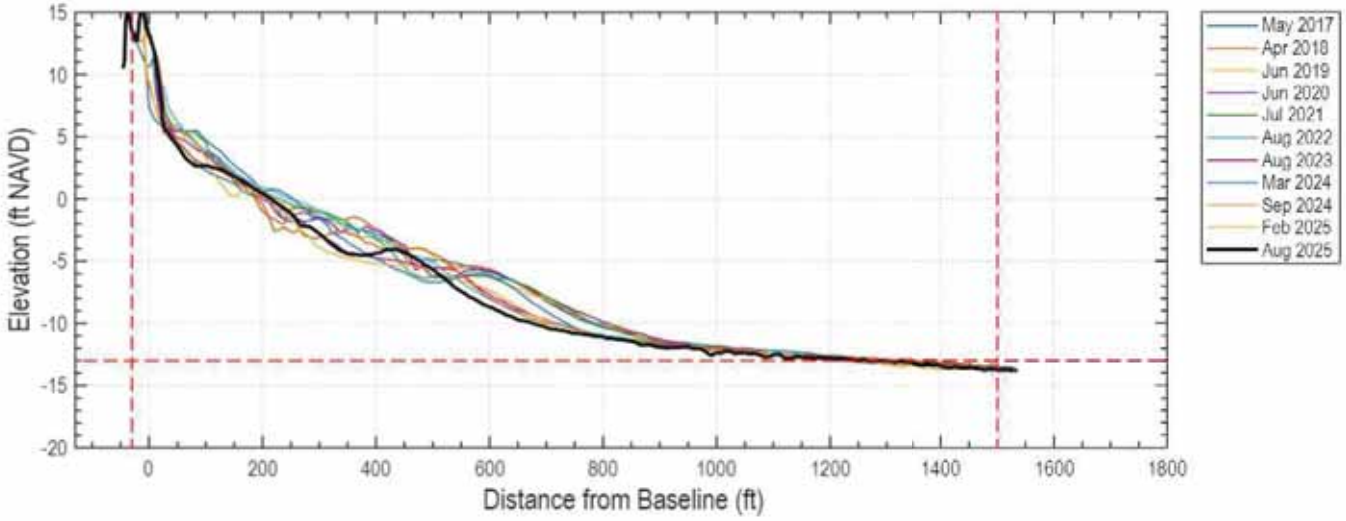

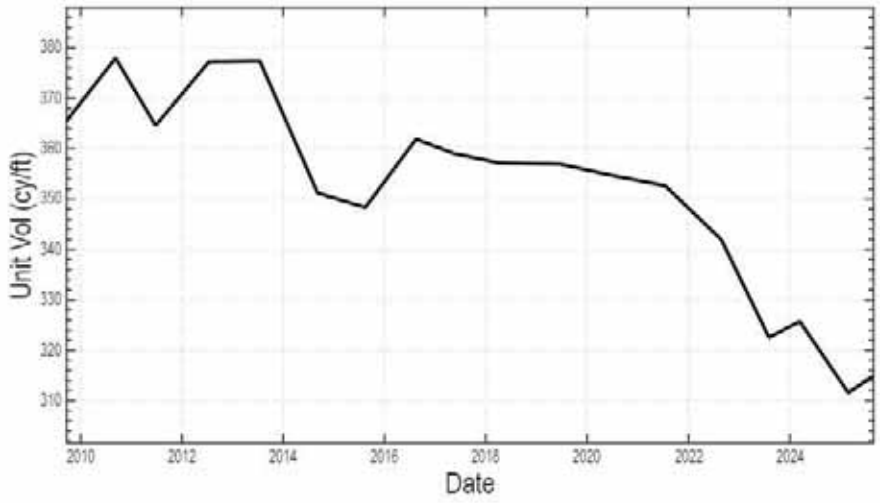

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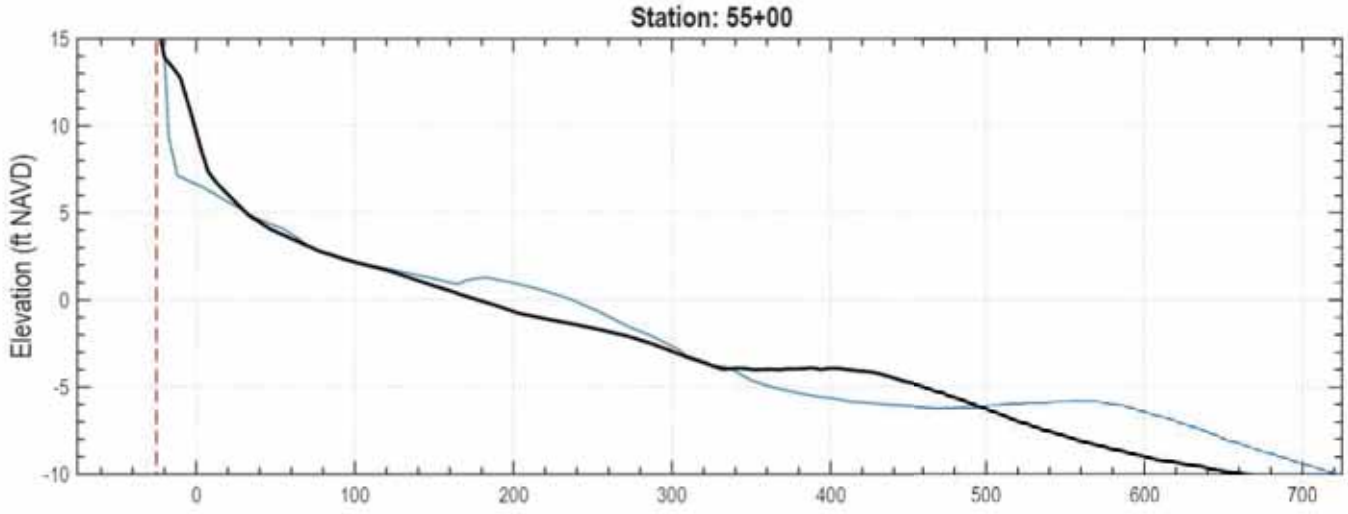

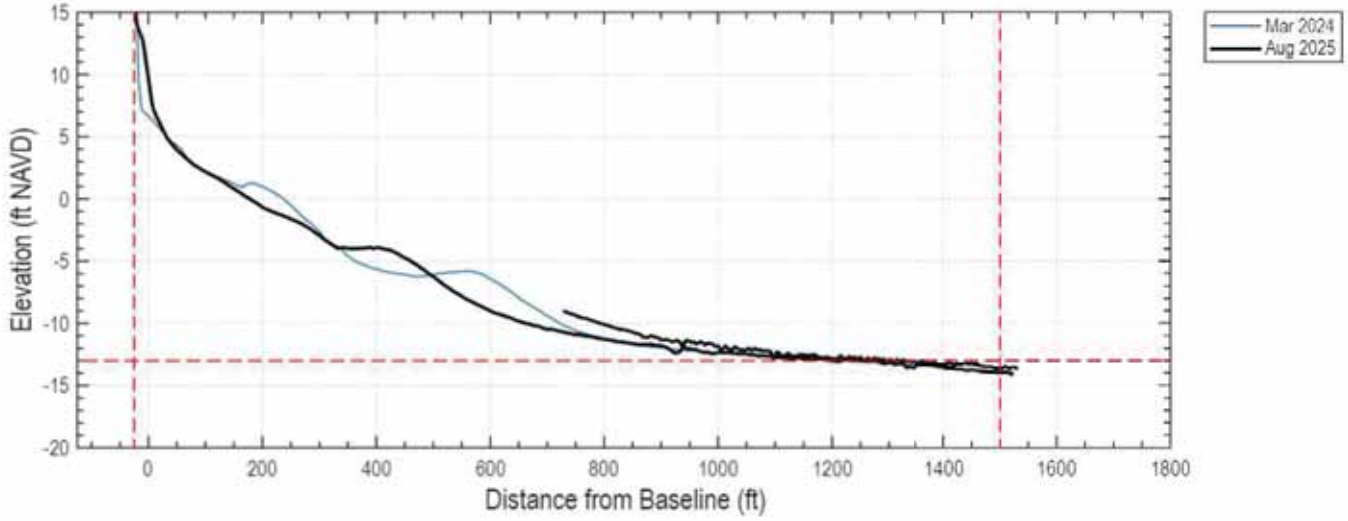

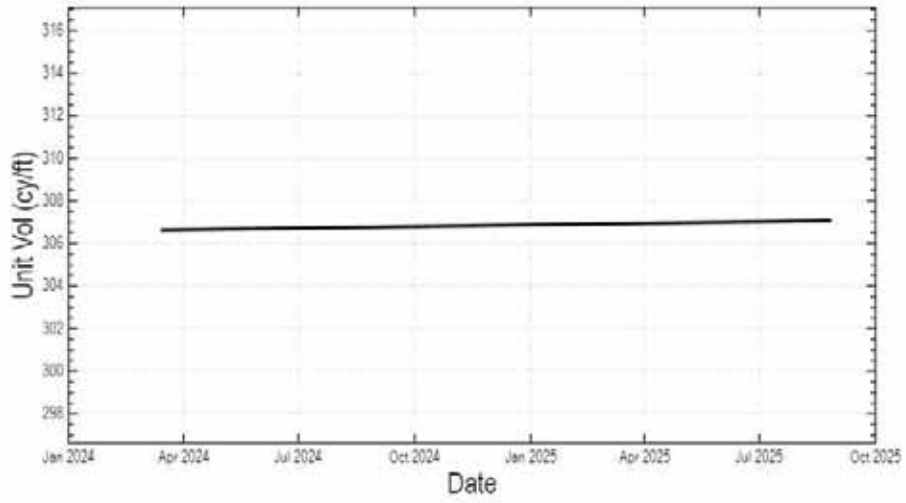

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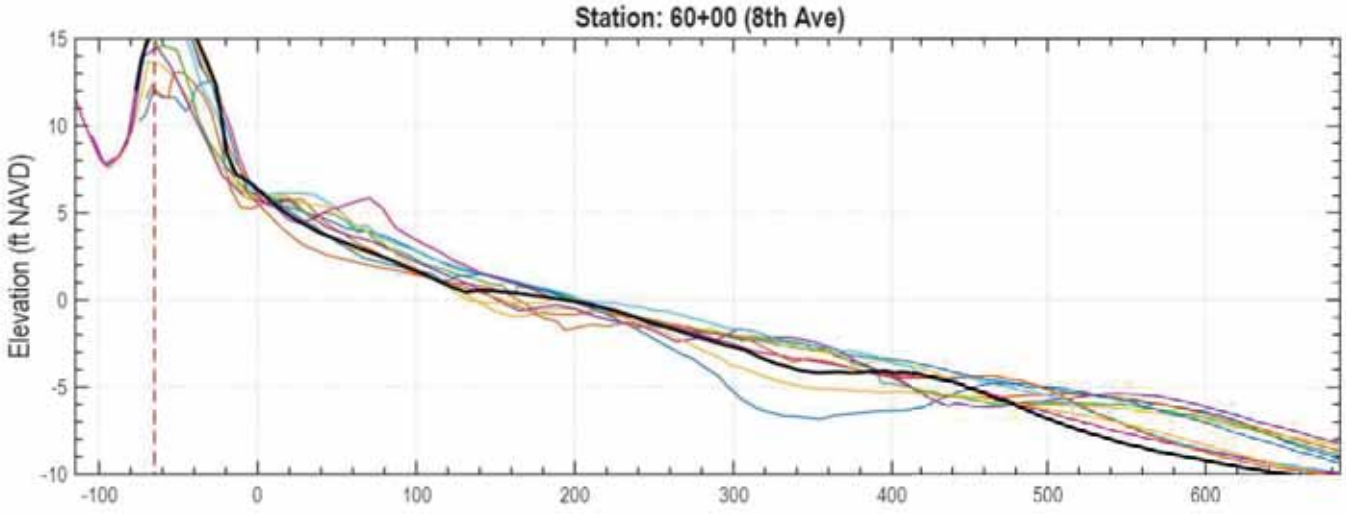

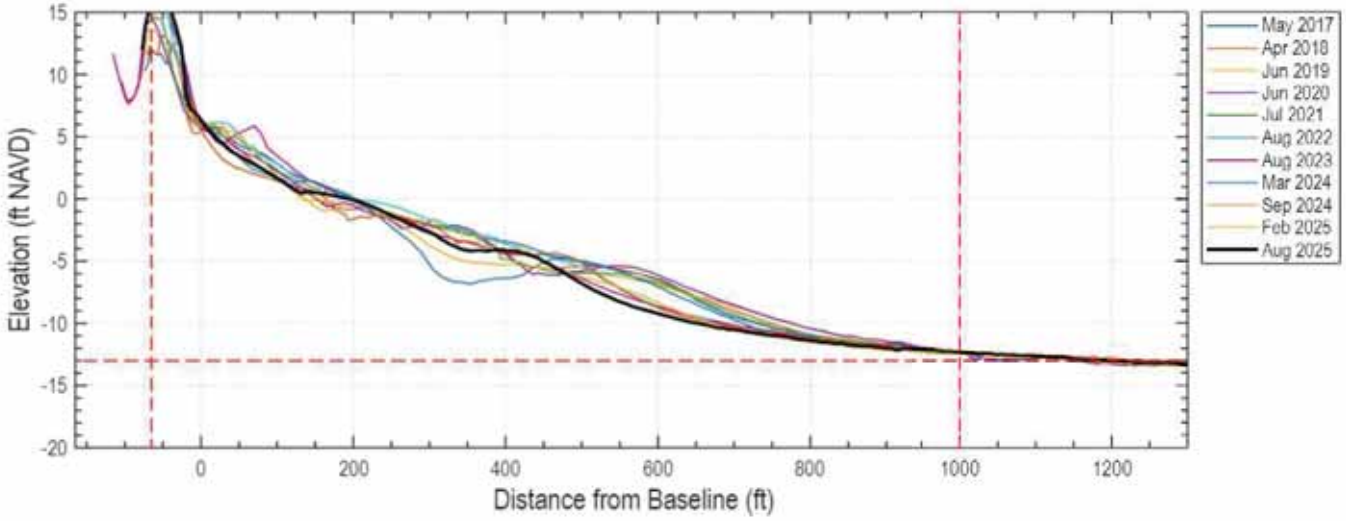

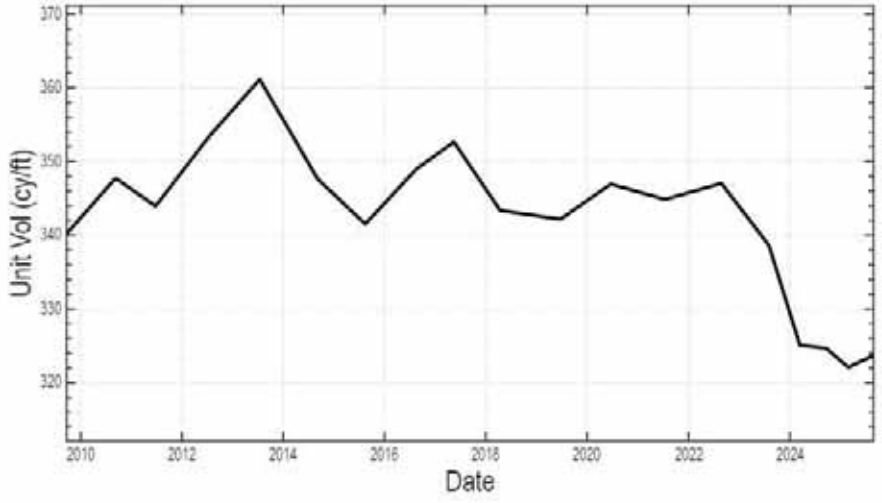

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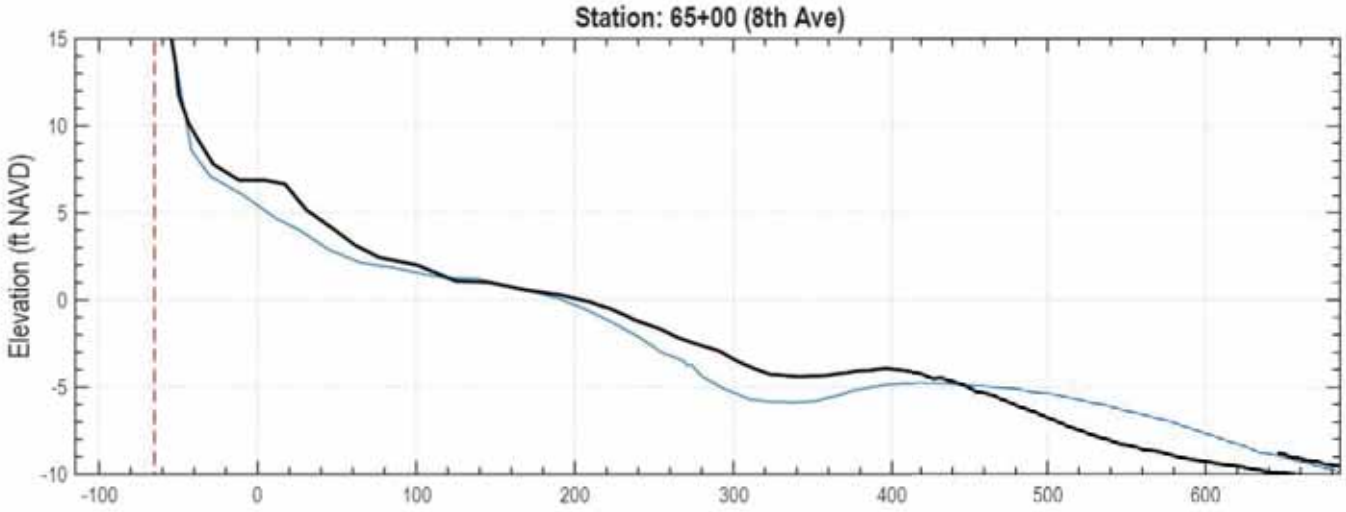

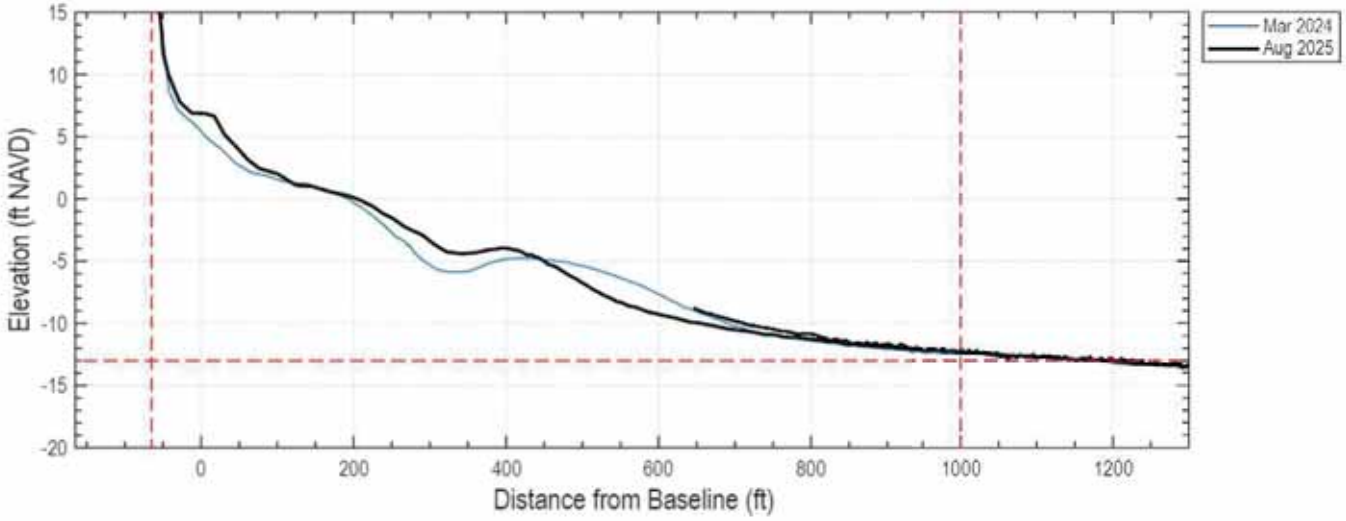

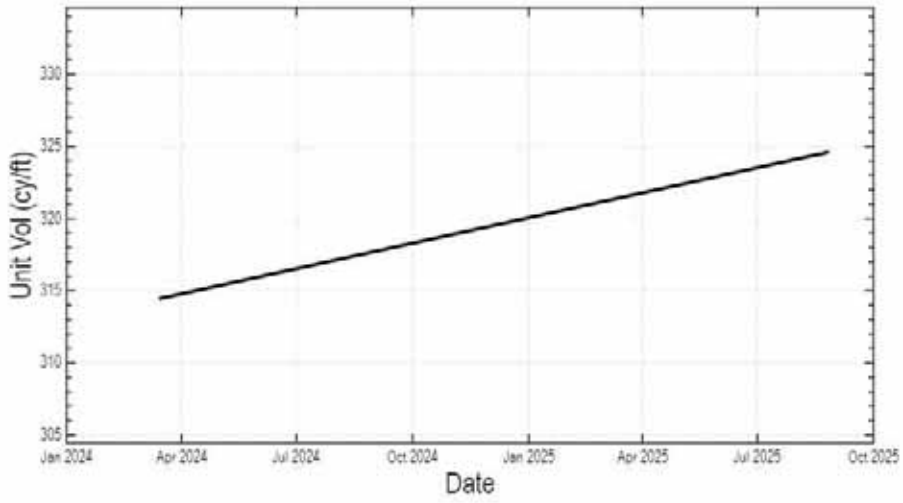

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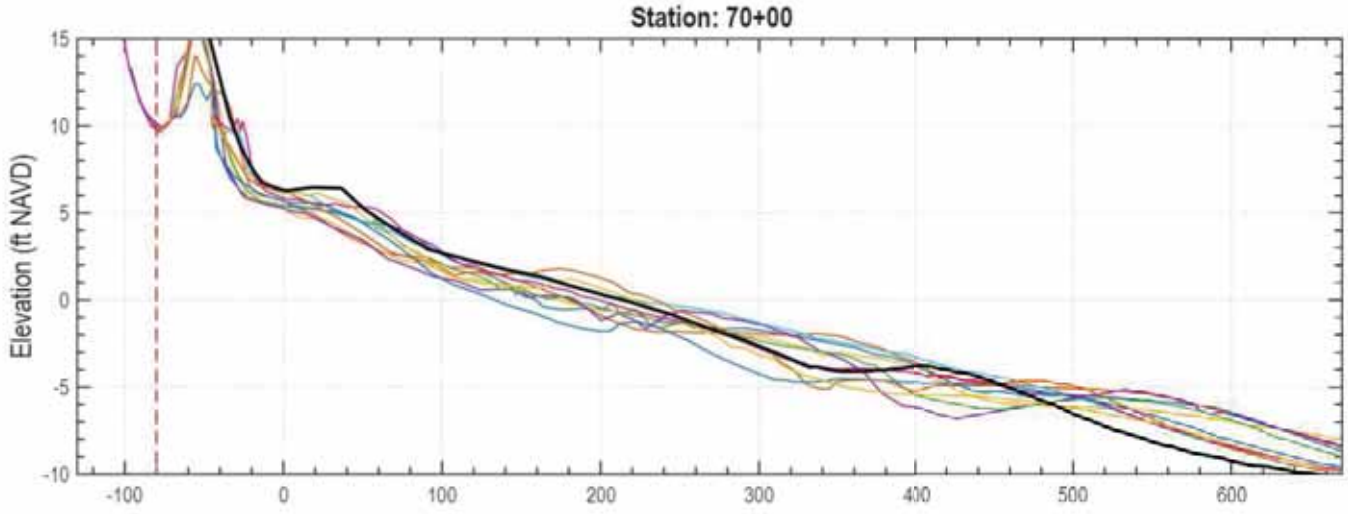

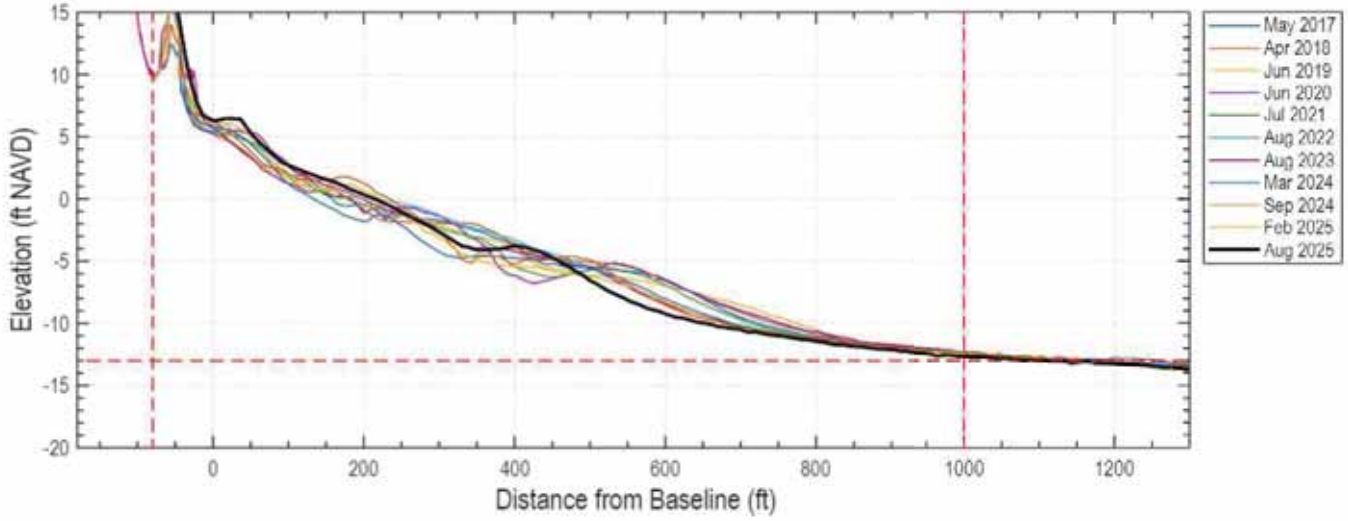

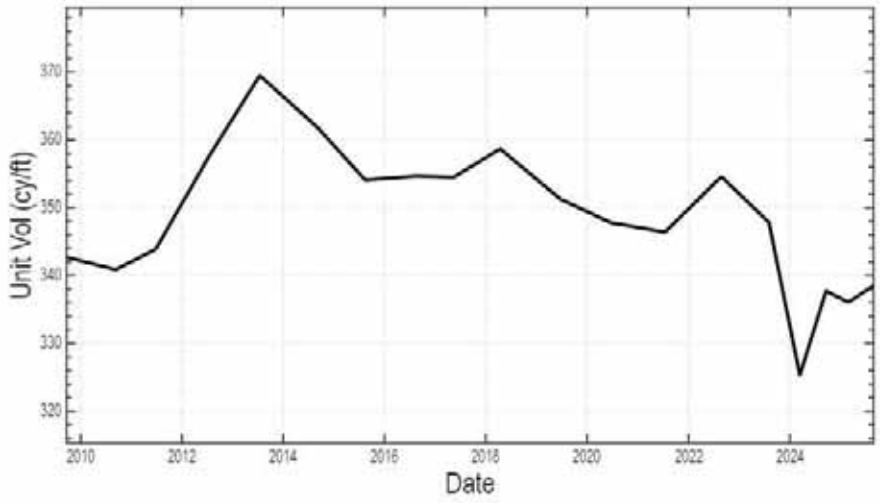

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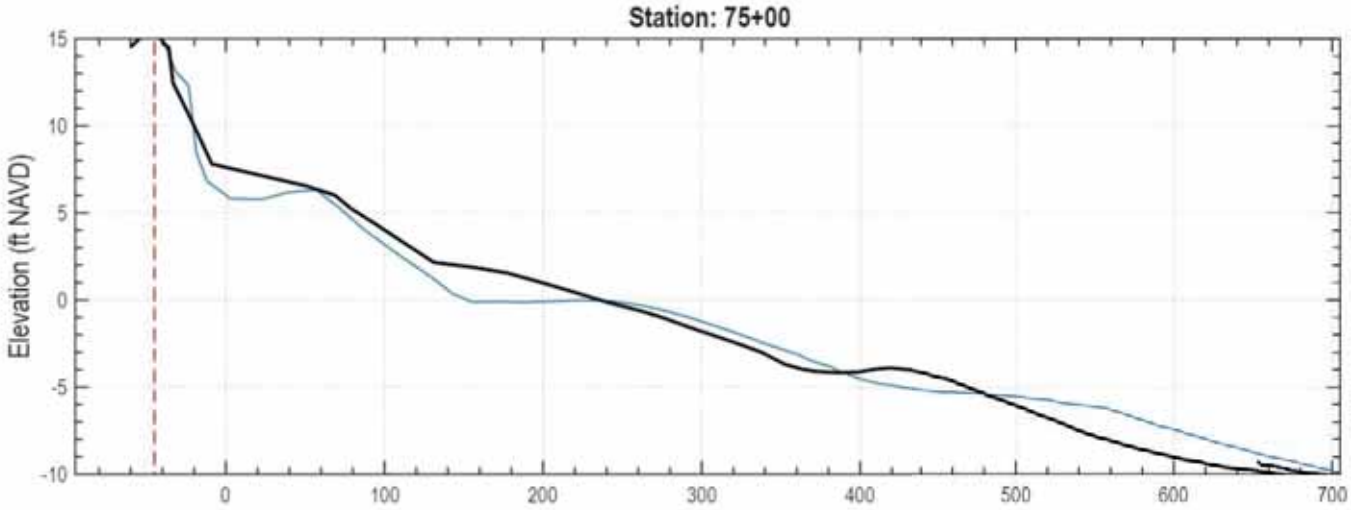

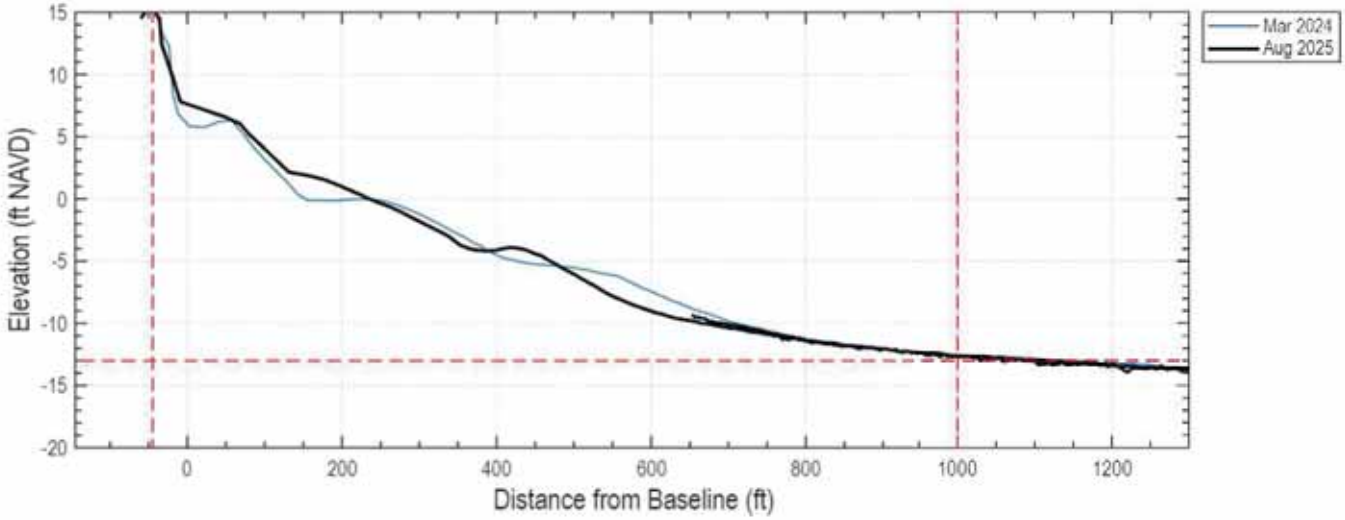

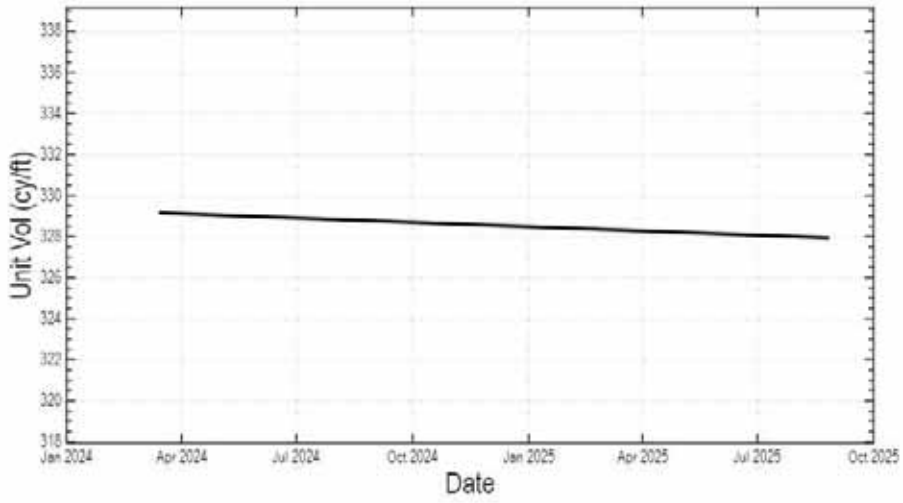

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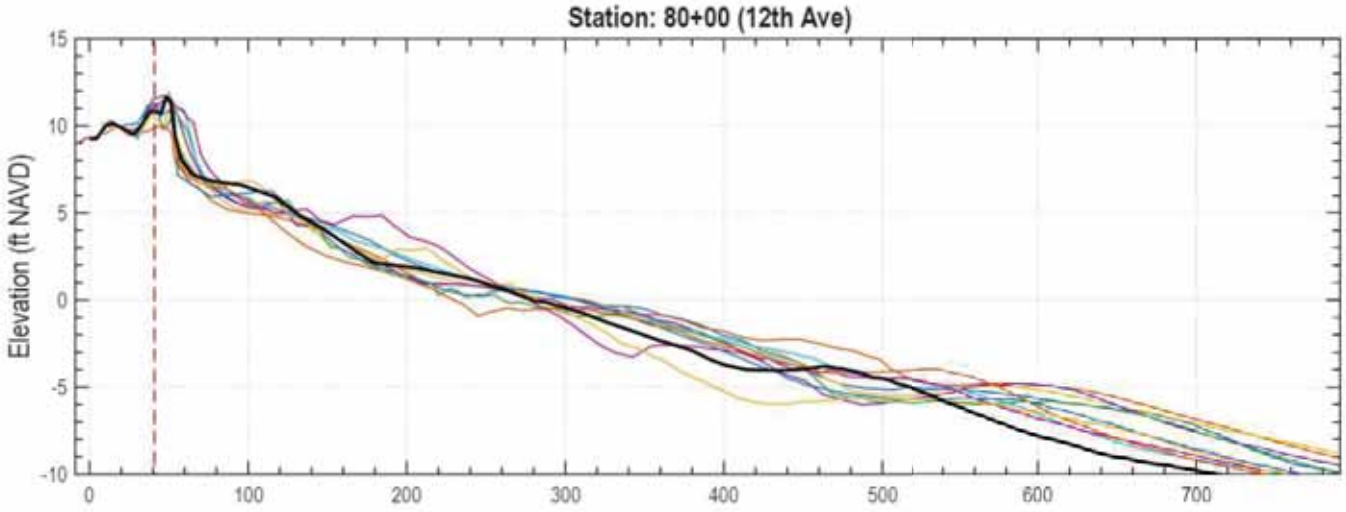

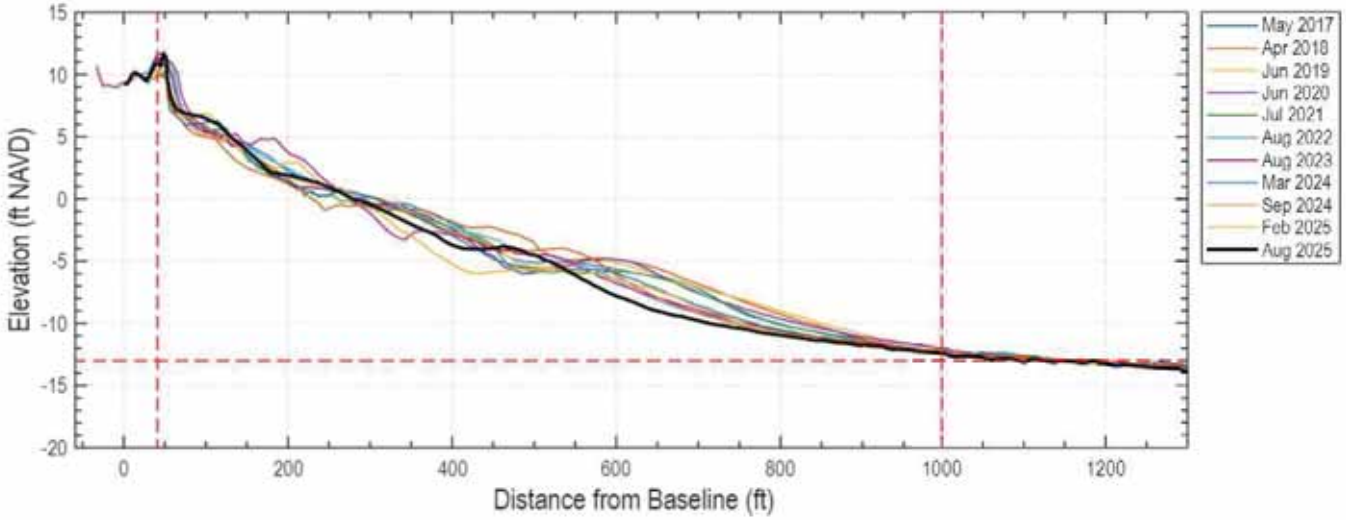

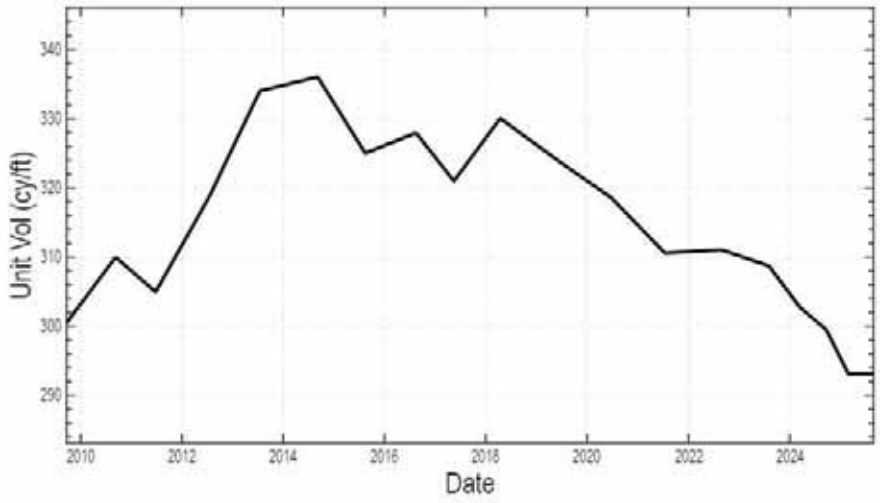

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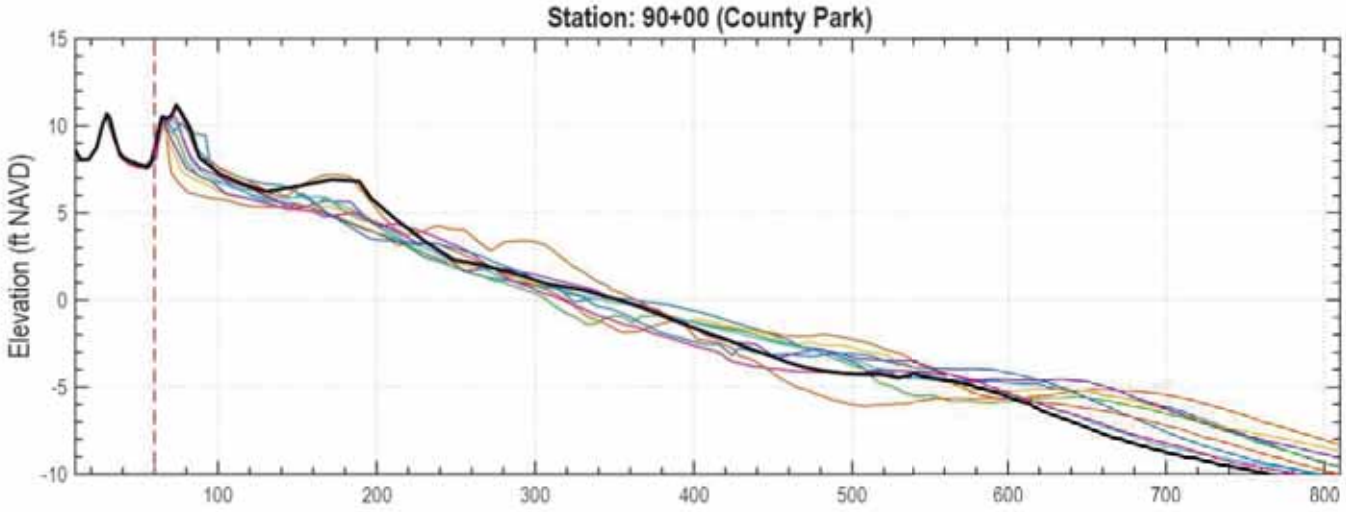

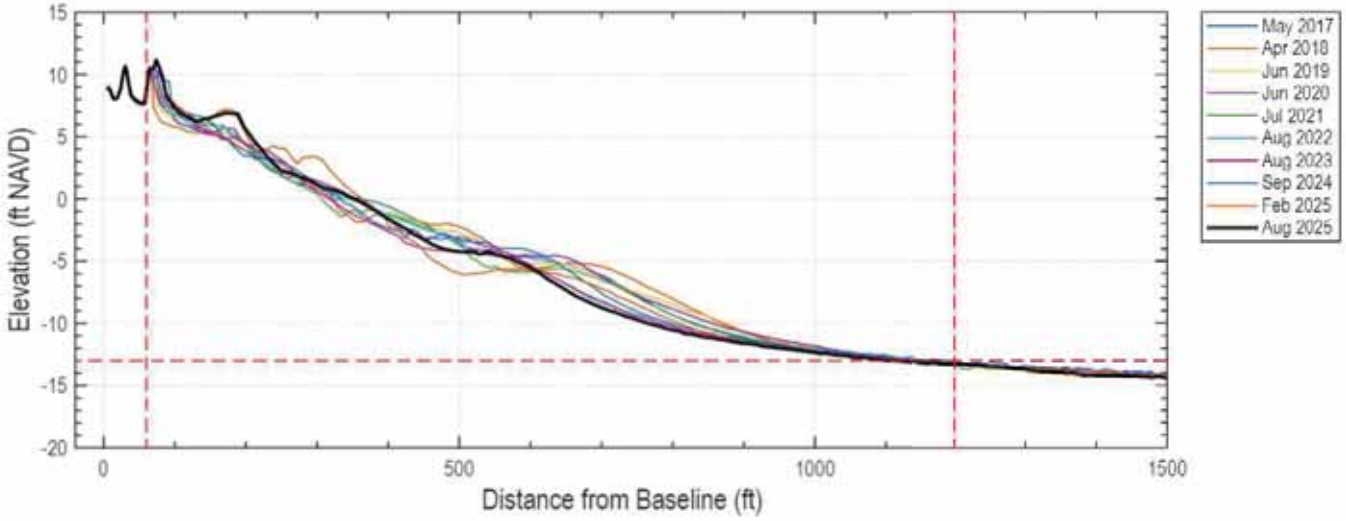

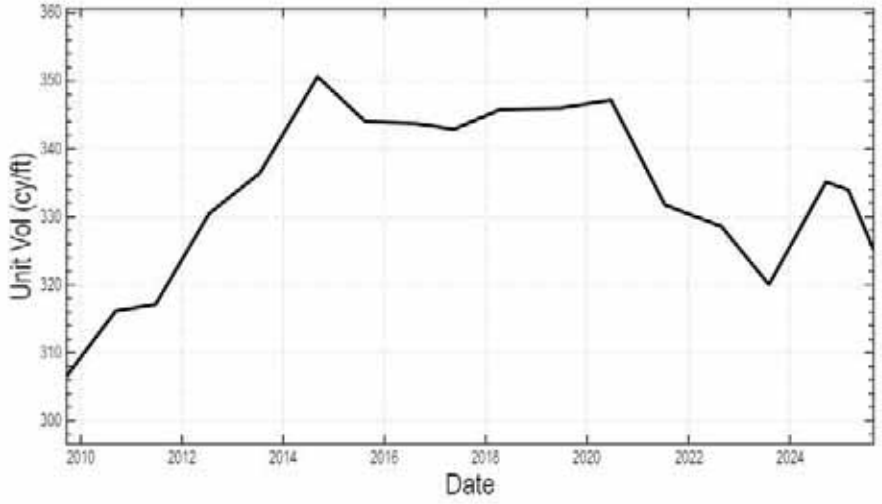

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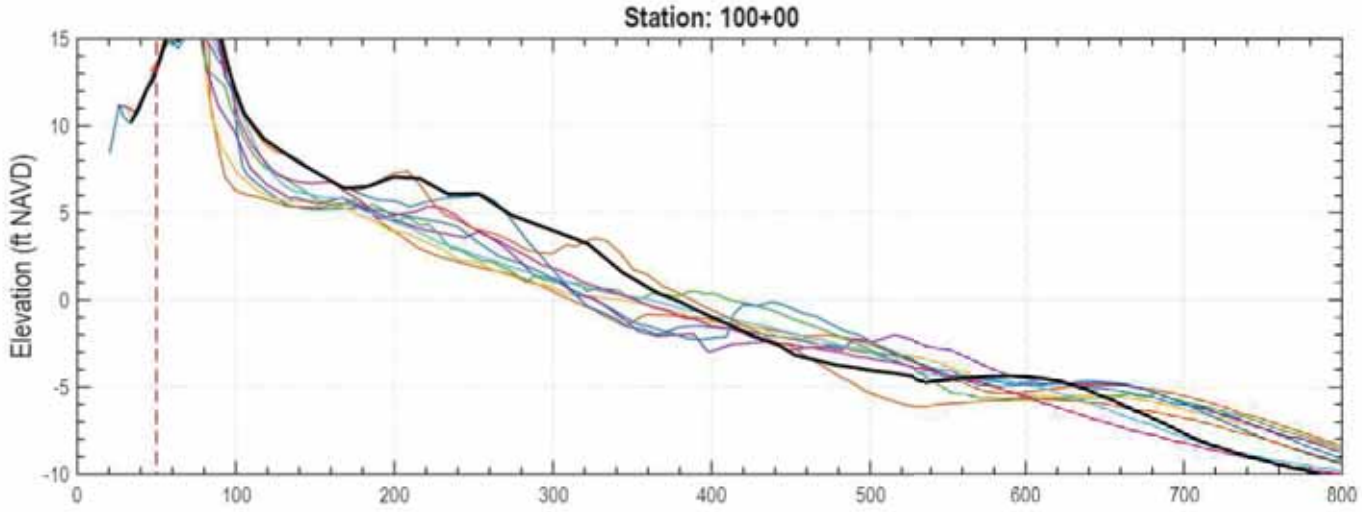

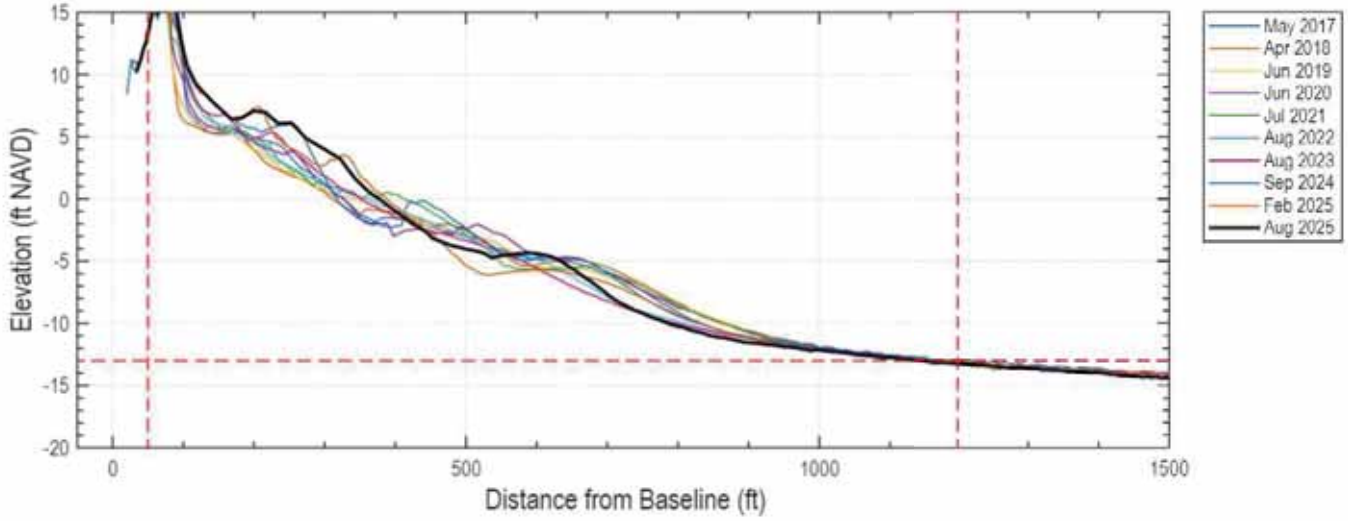

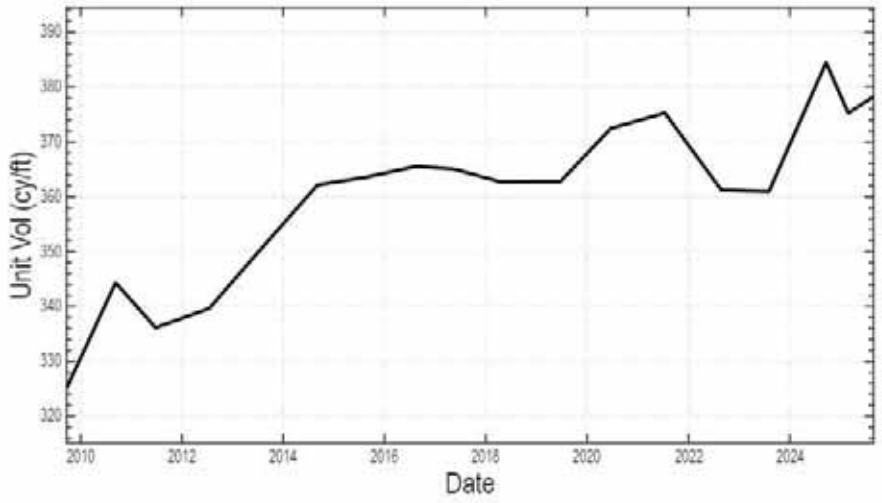

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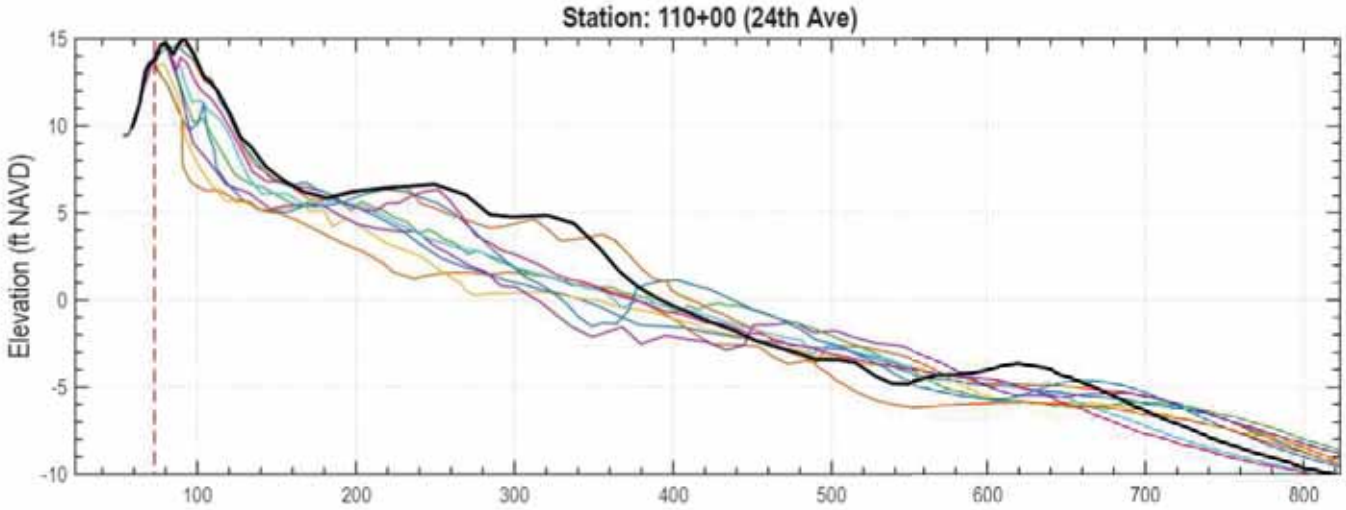

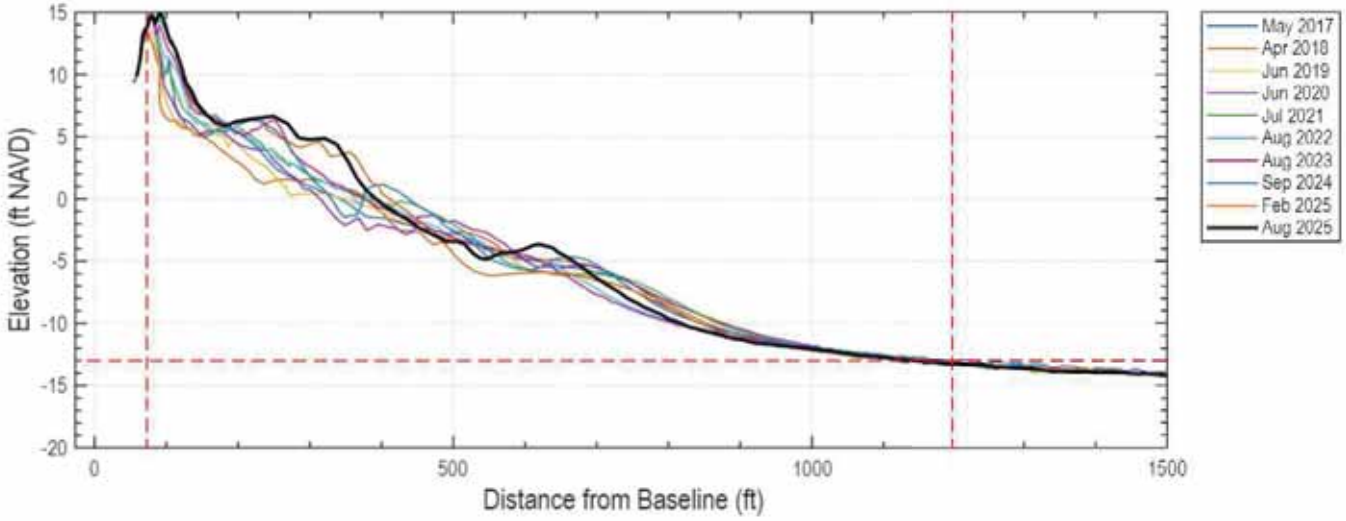

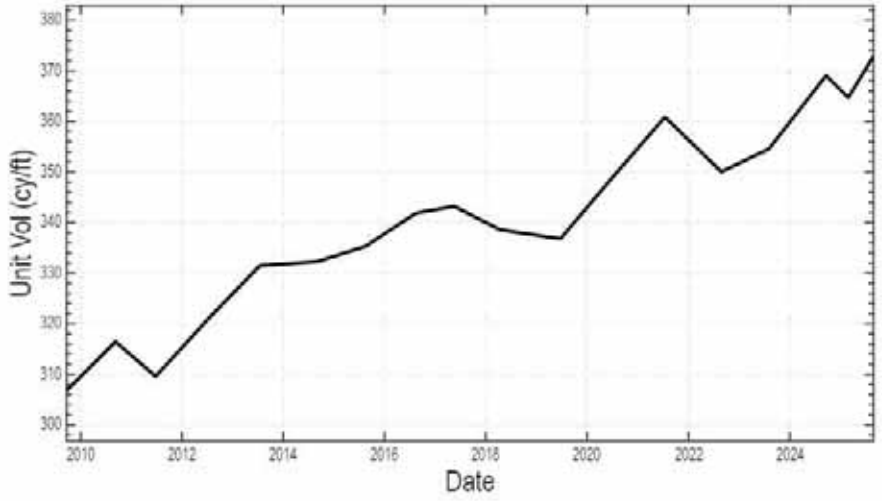

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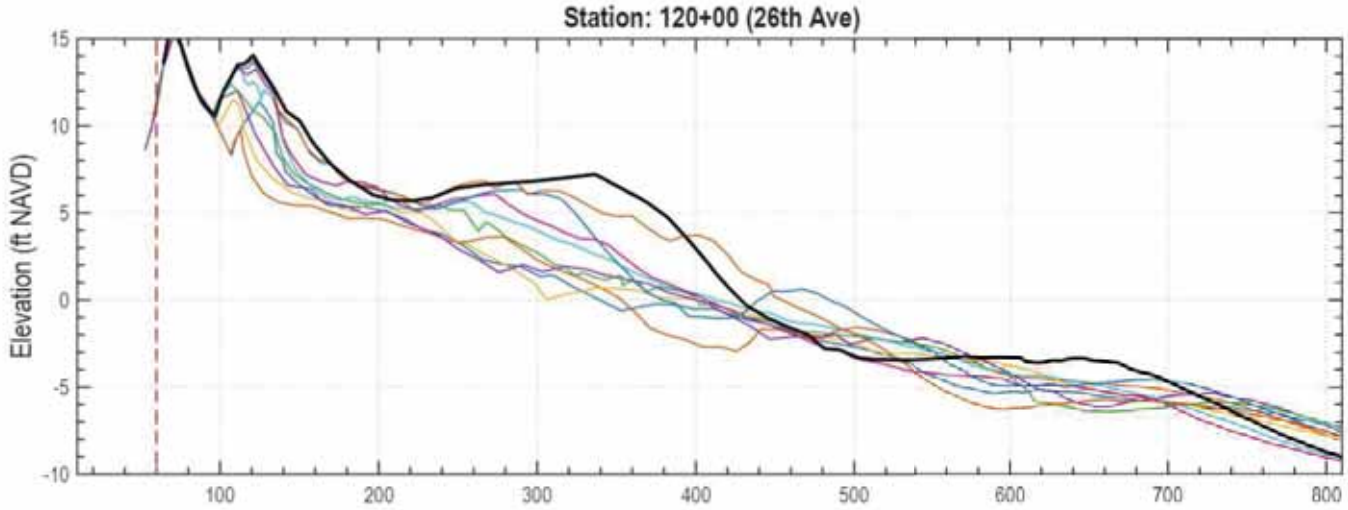

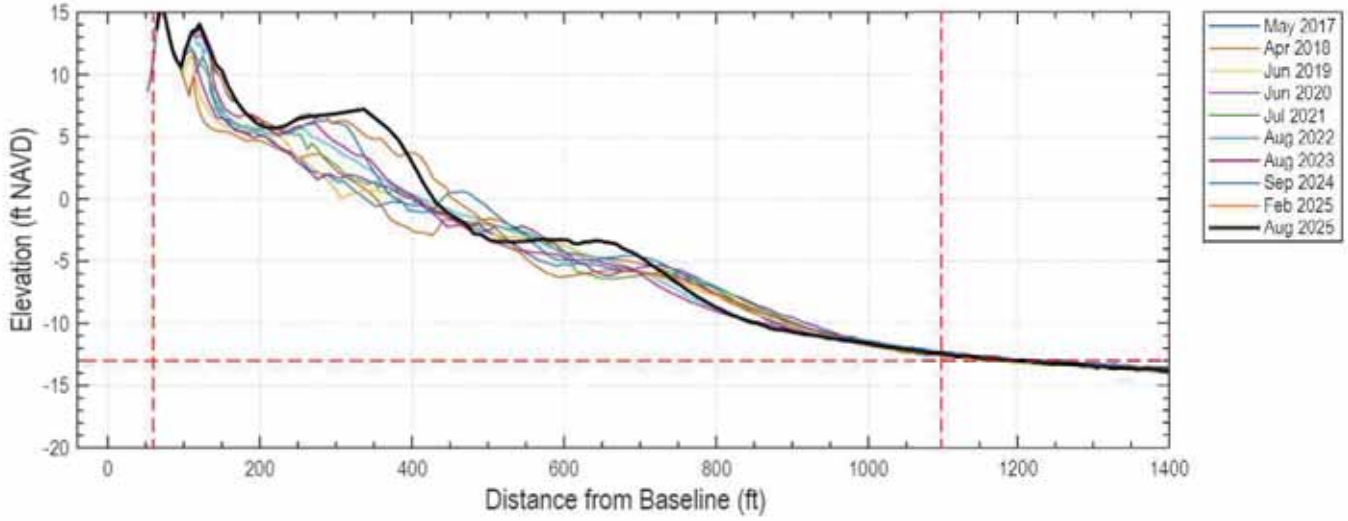

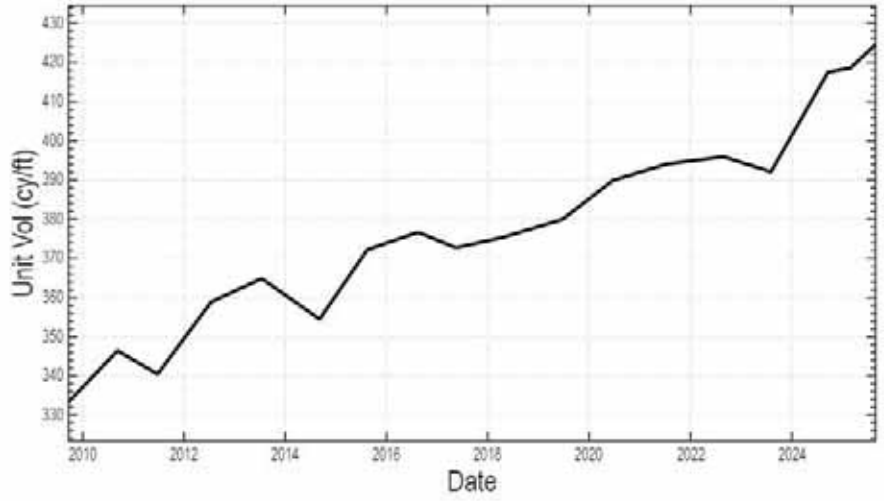

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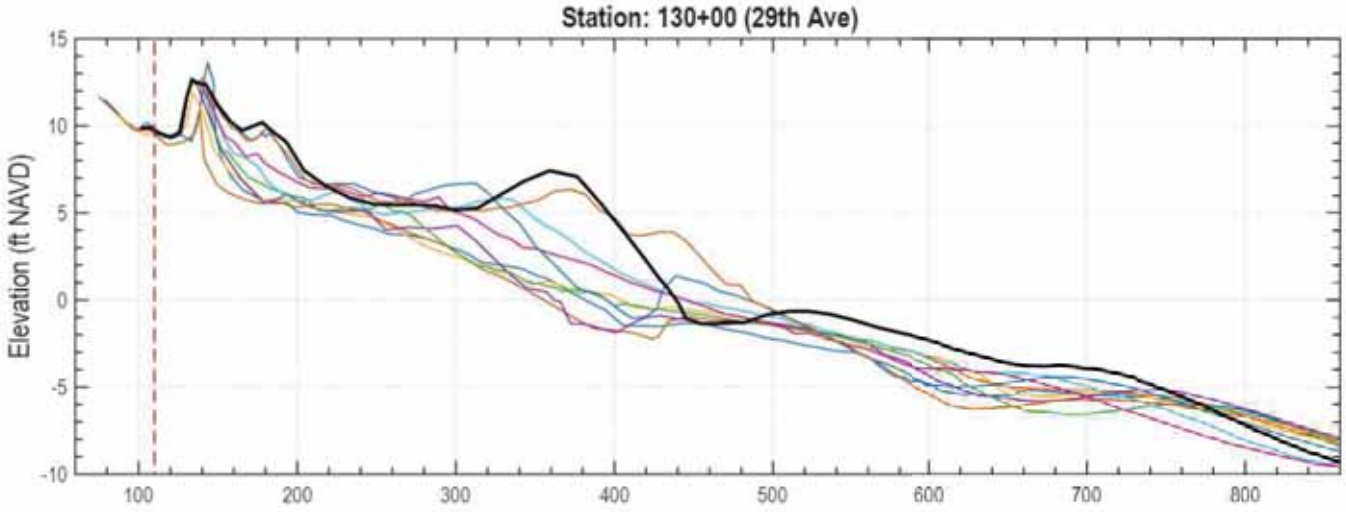
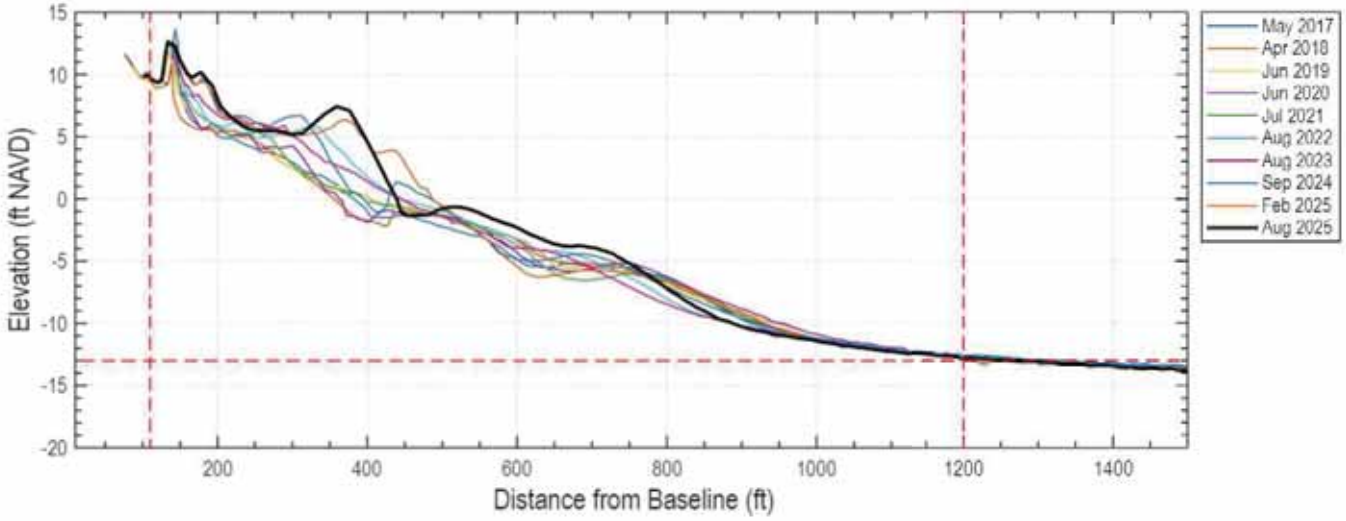
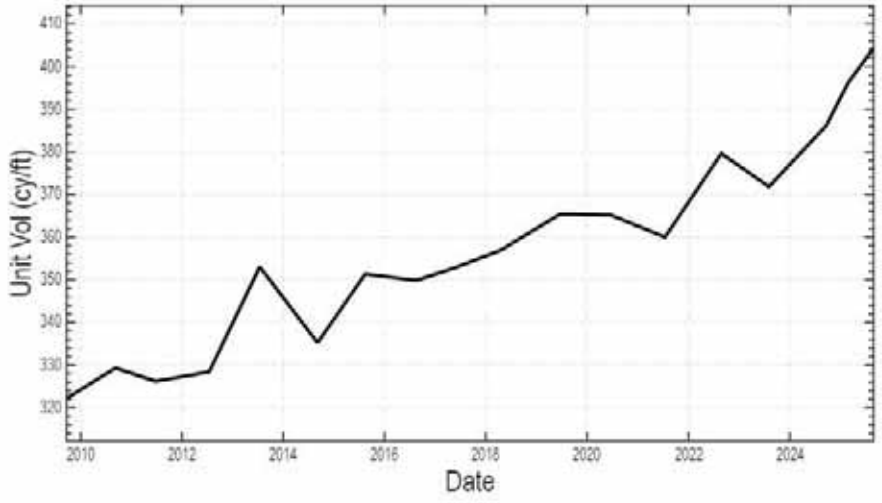
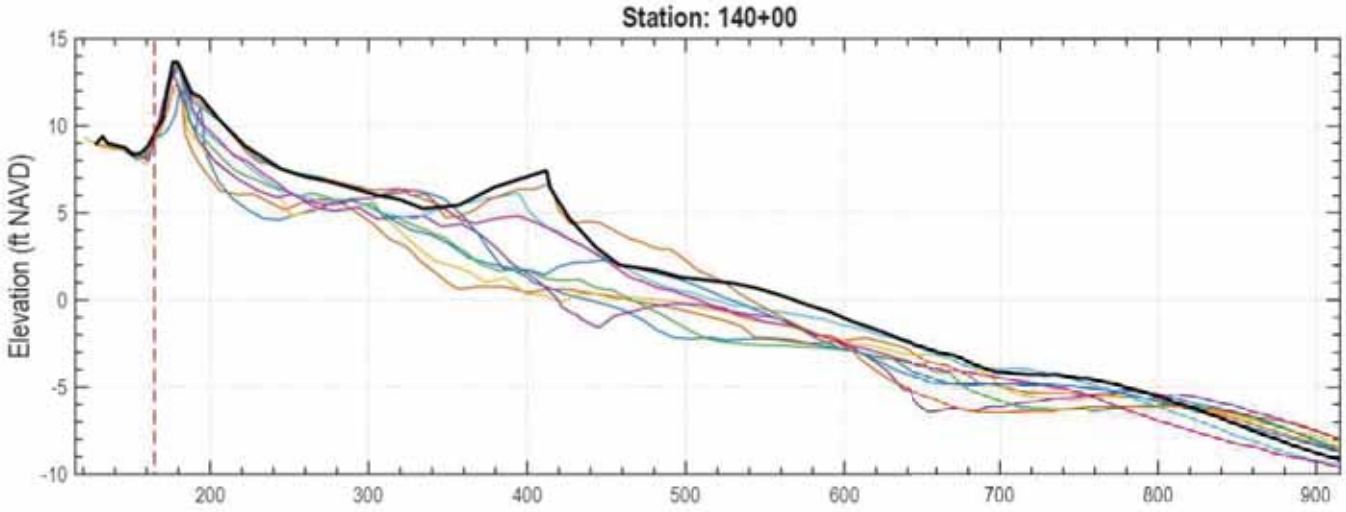
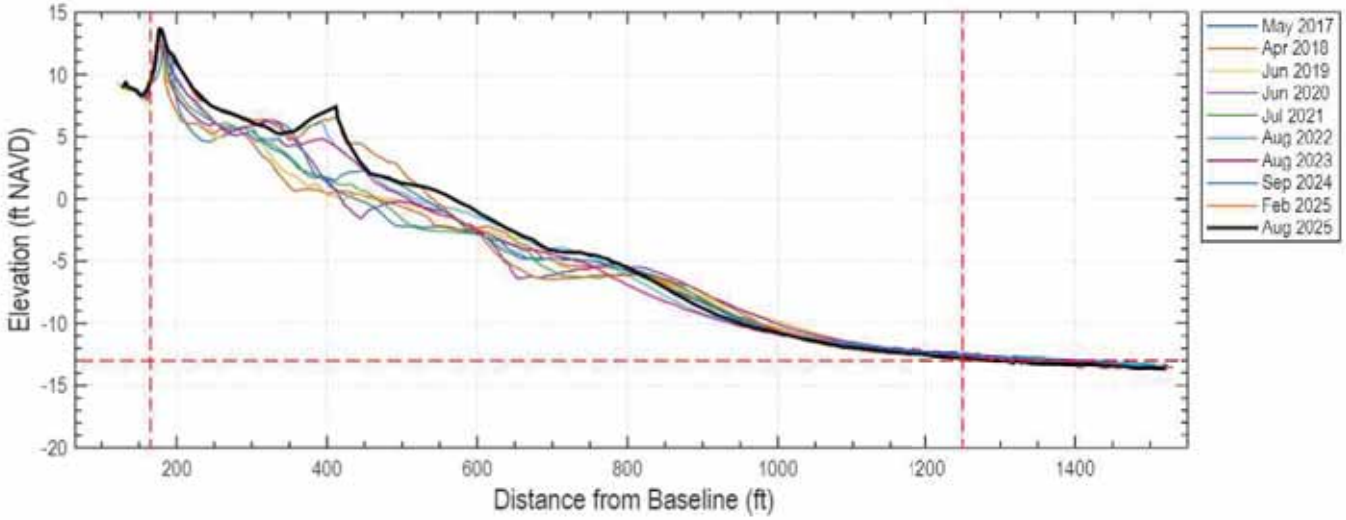


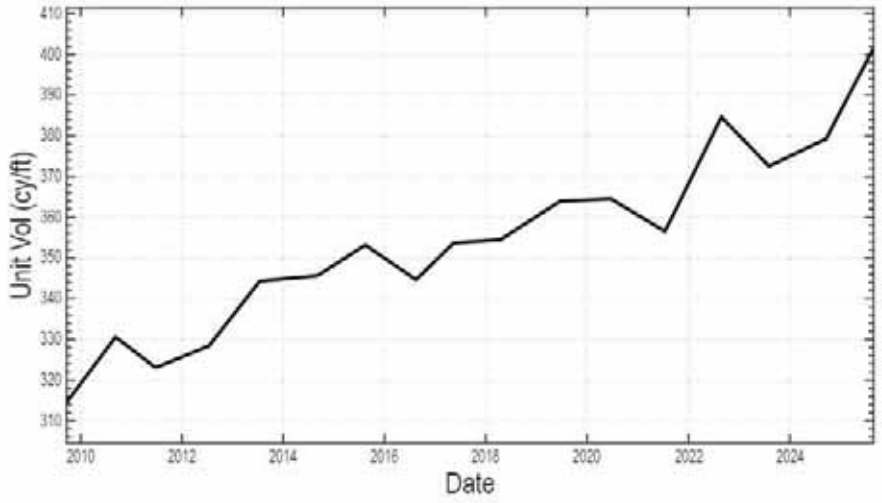




X: 2376884.55
Y: 350823.84

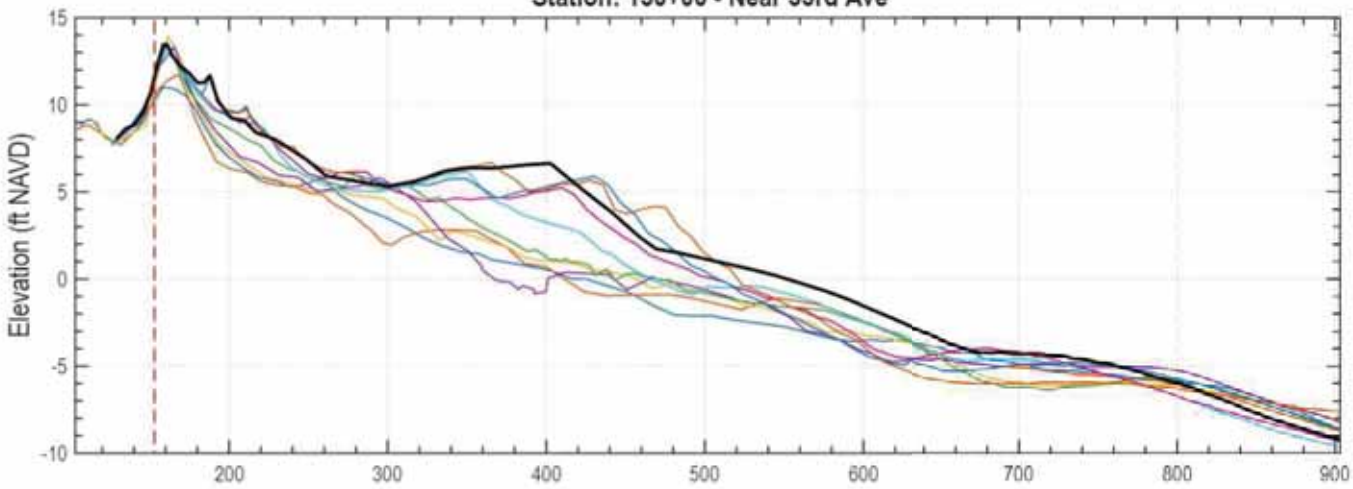


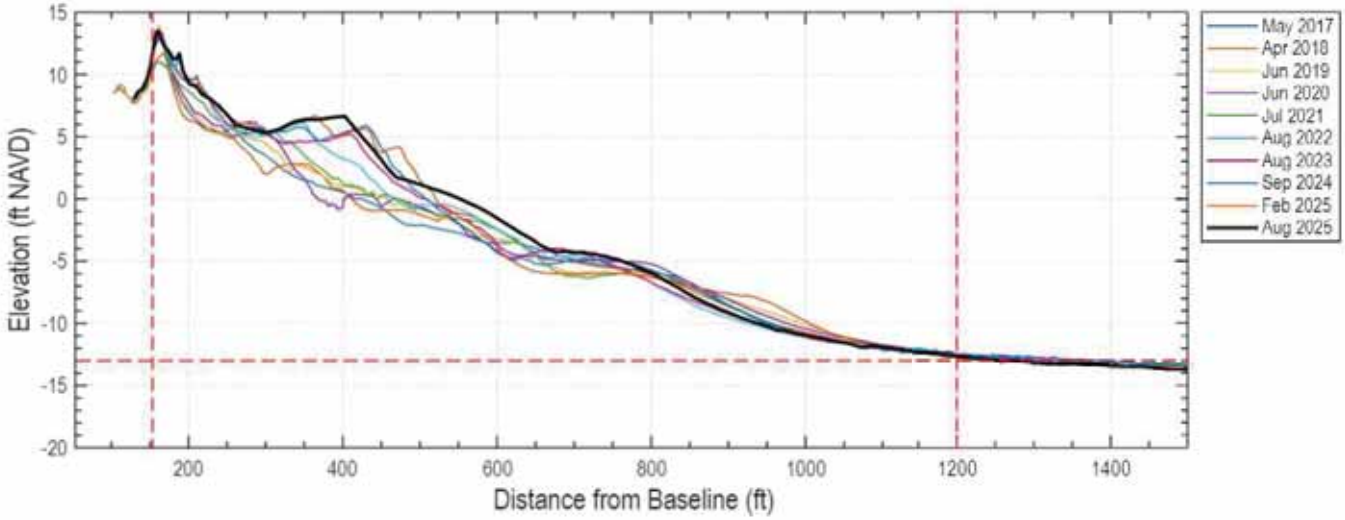


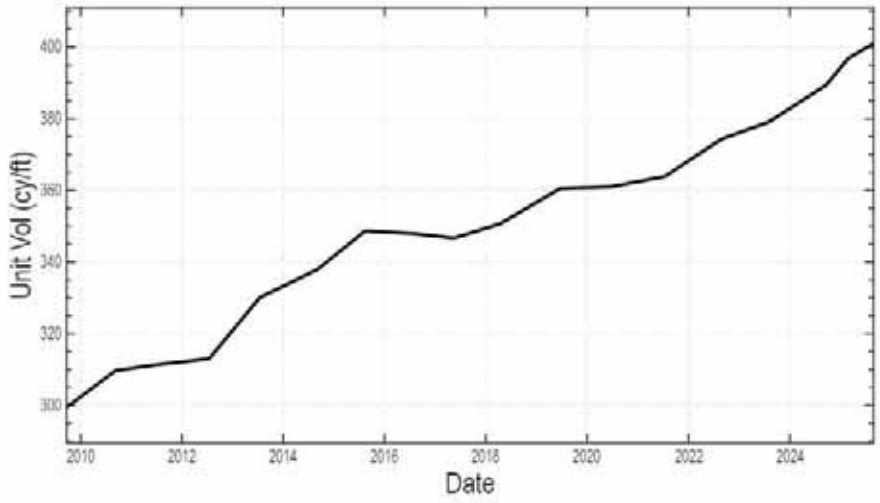


X: 2377756.64
Y: 351313.19

Station: 150+00 - Near 33rd Ave







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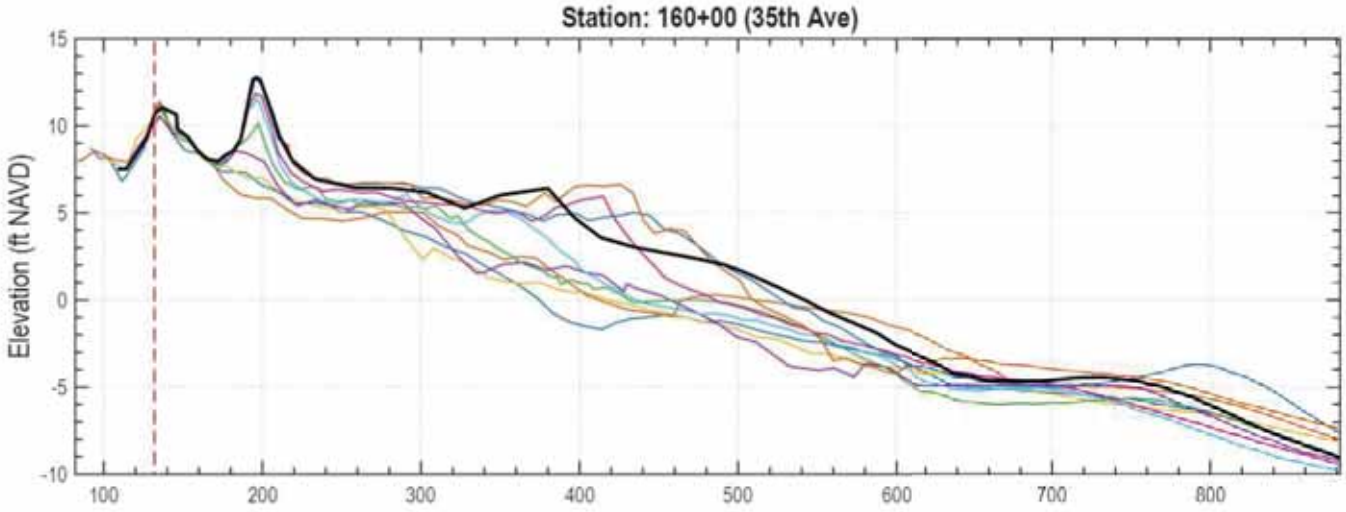

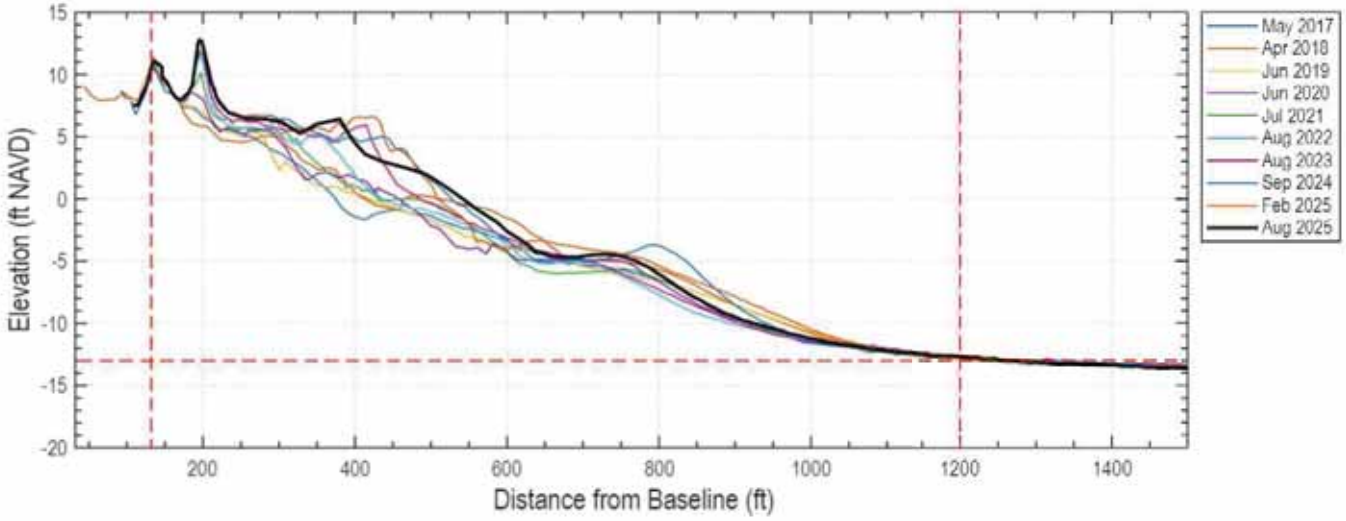

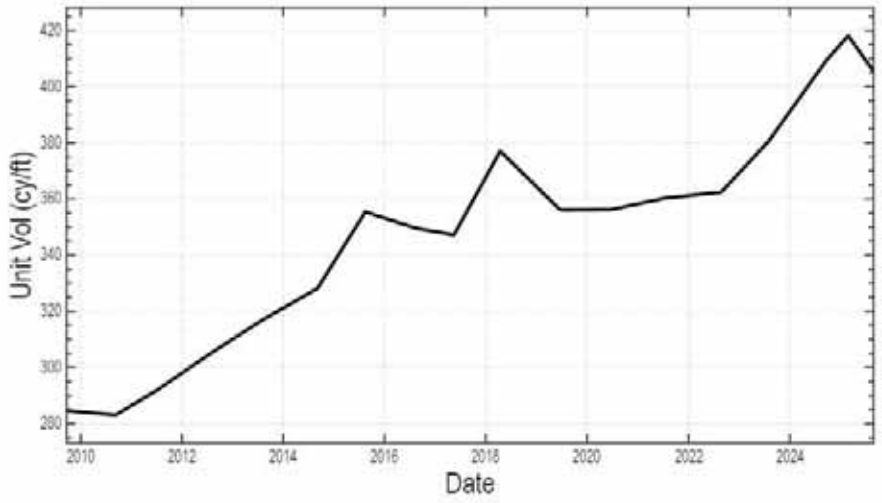

X: 2379610.2
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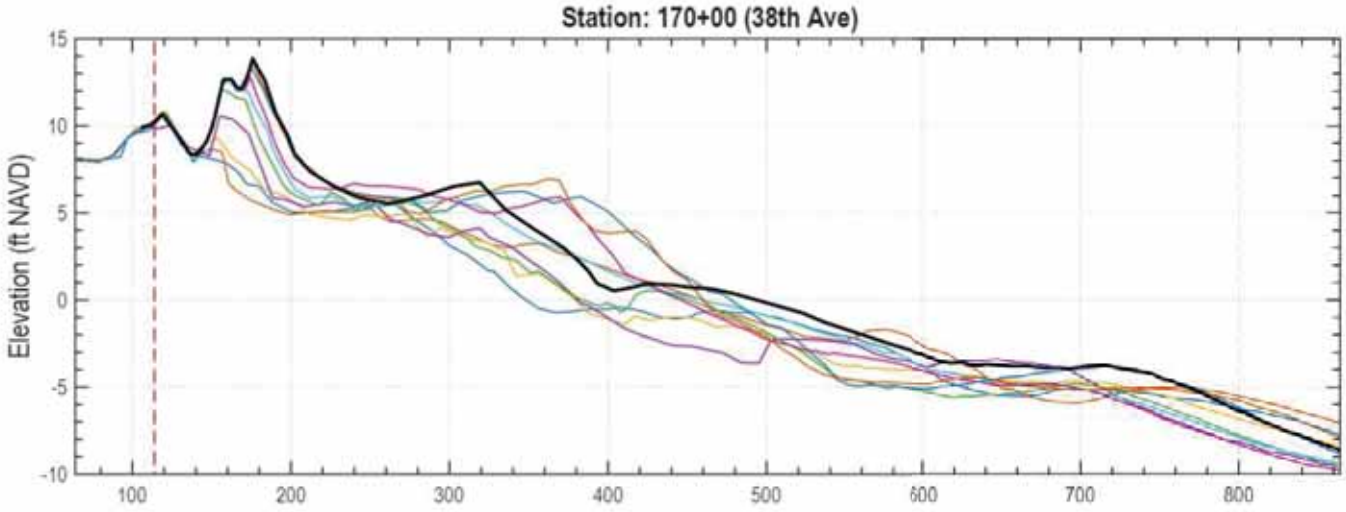
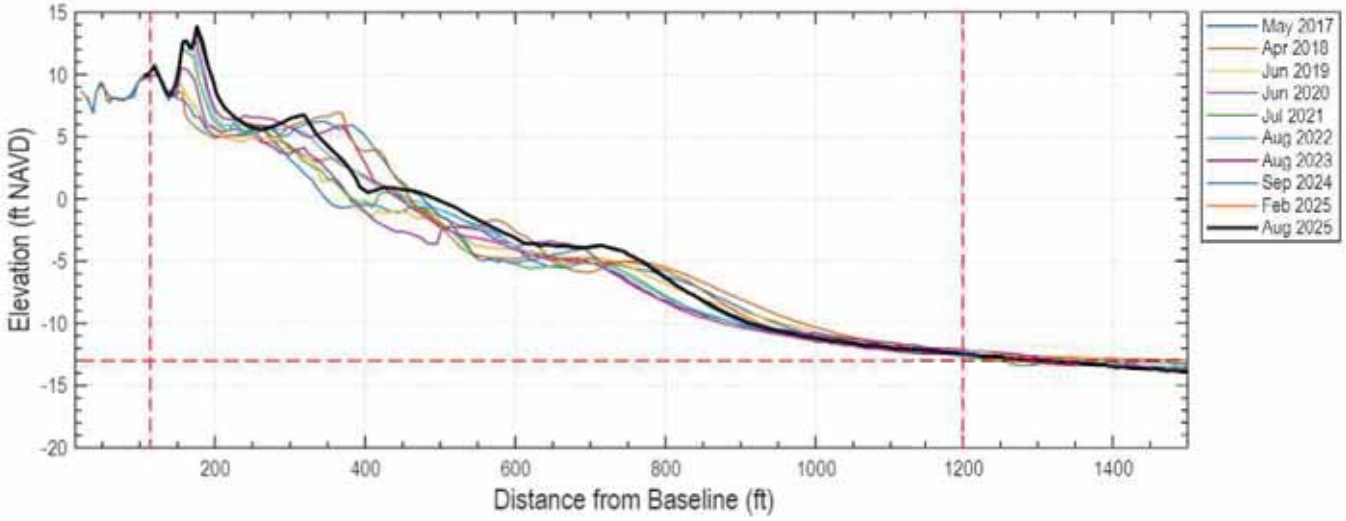
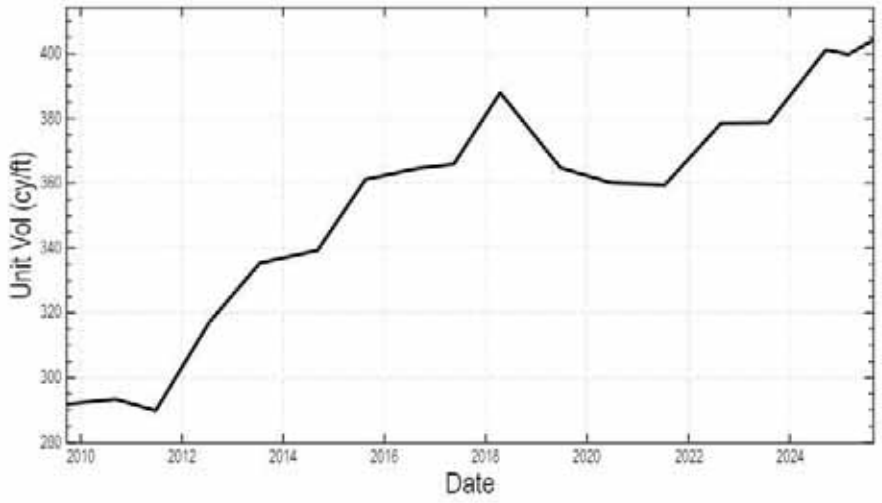
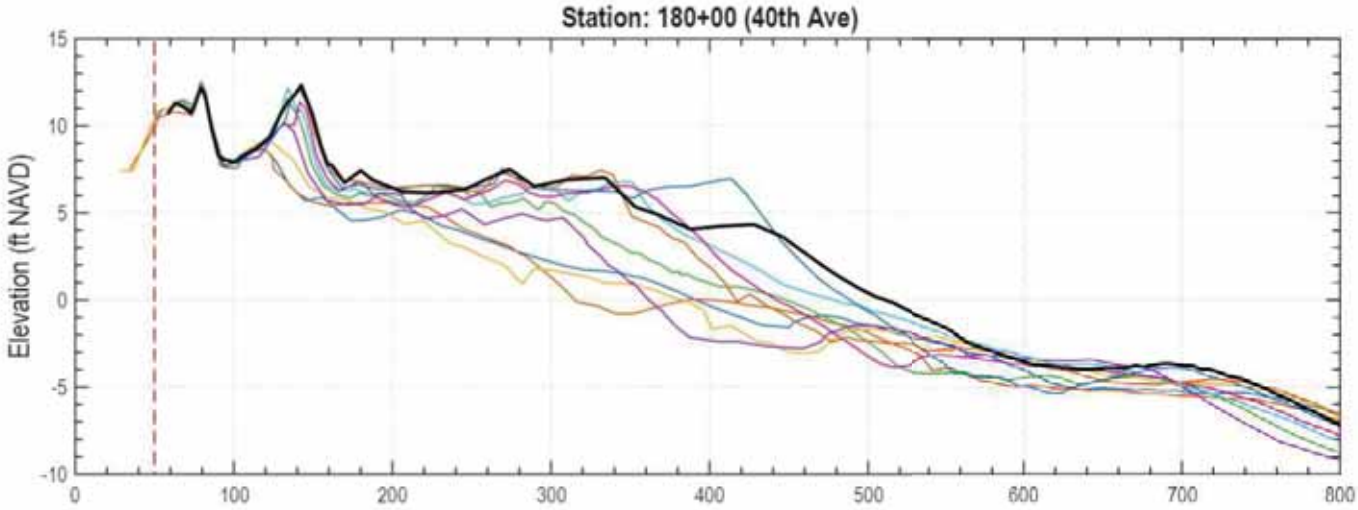
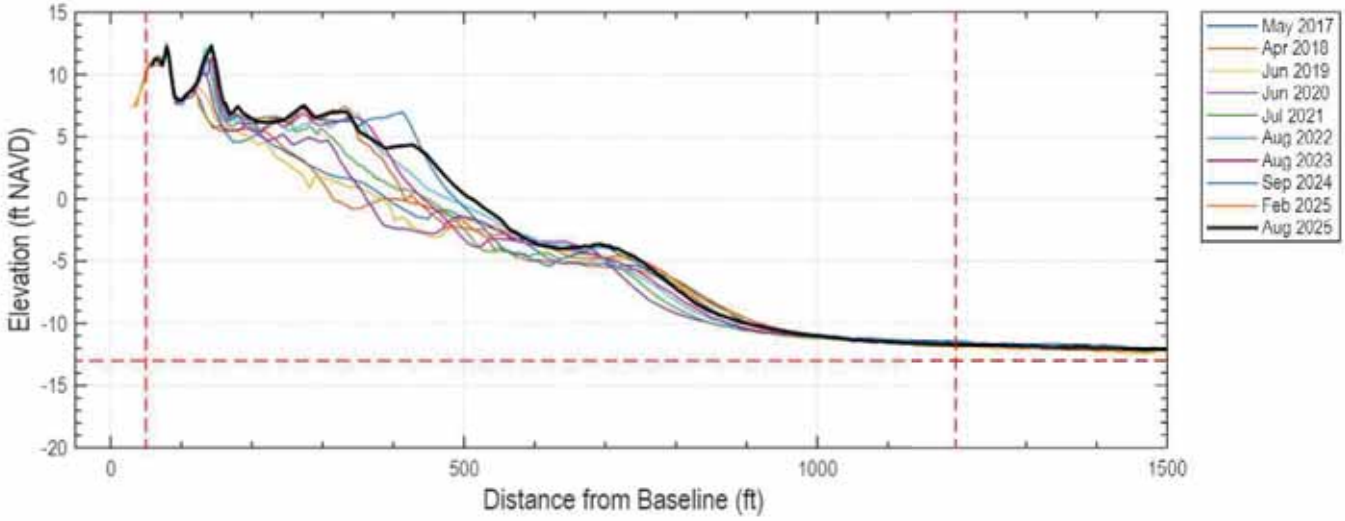


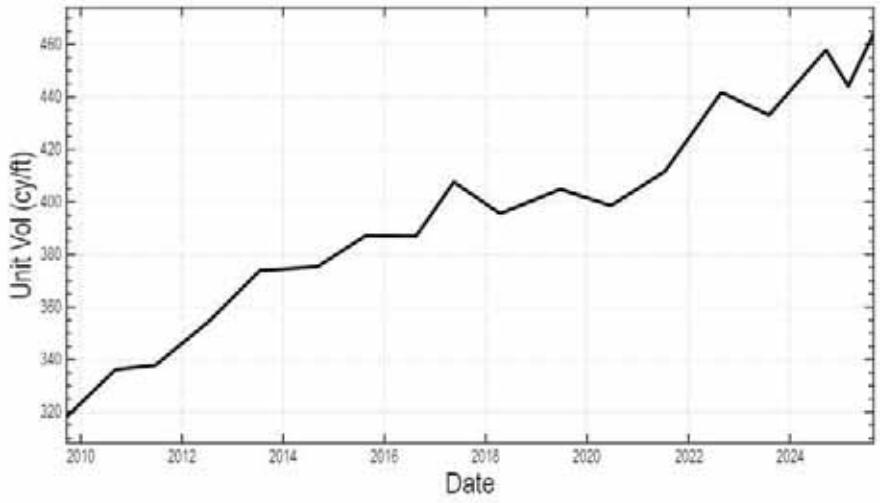




X: 2380546.35
Y: 352408.3







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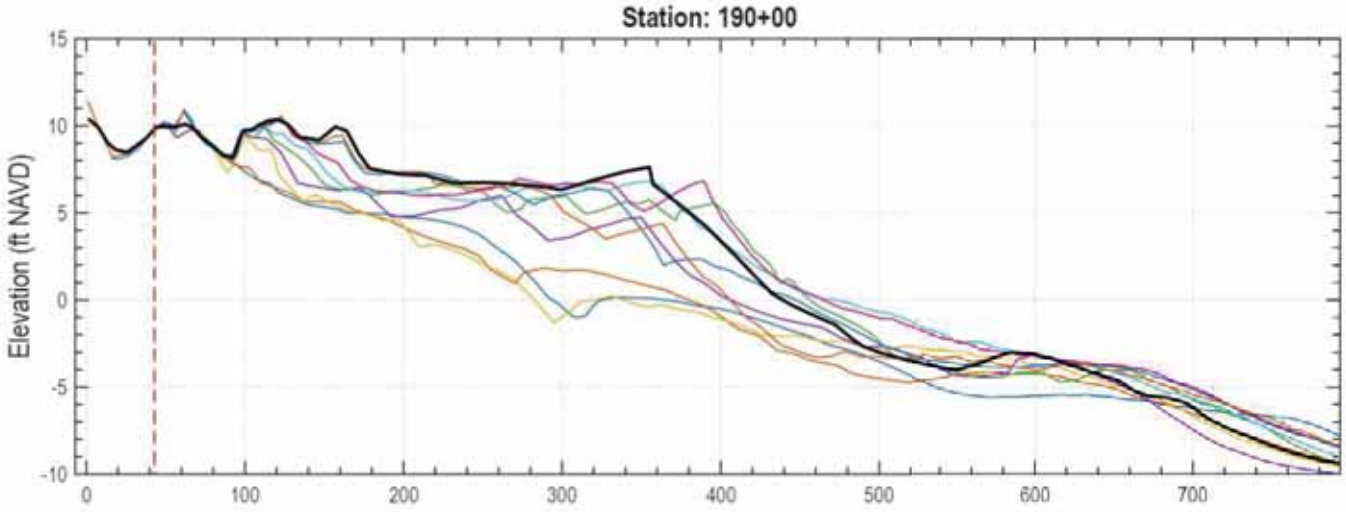

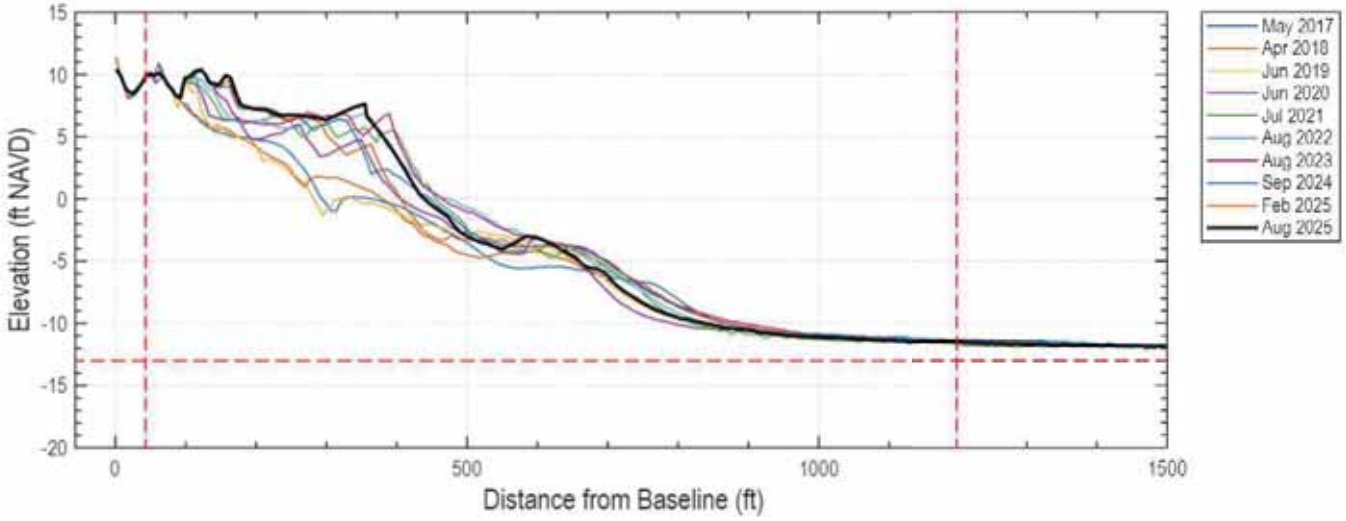

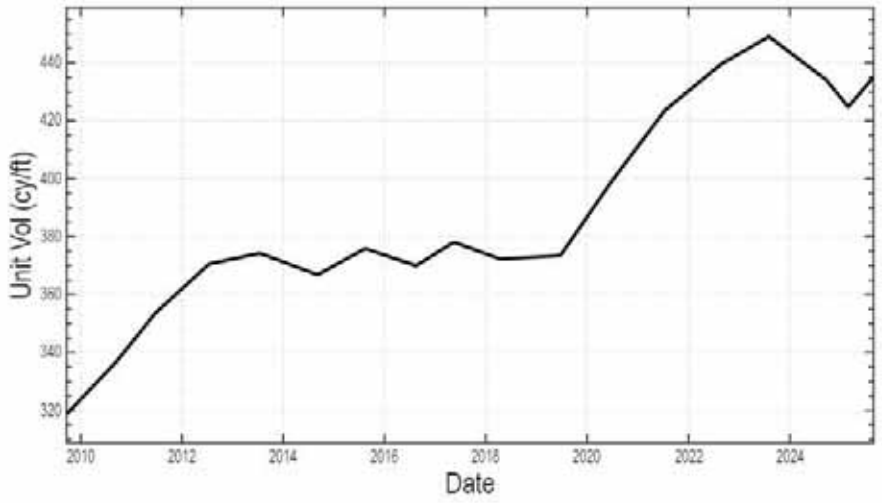

X: 2382418.64
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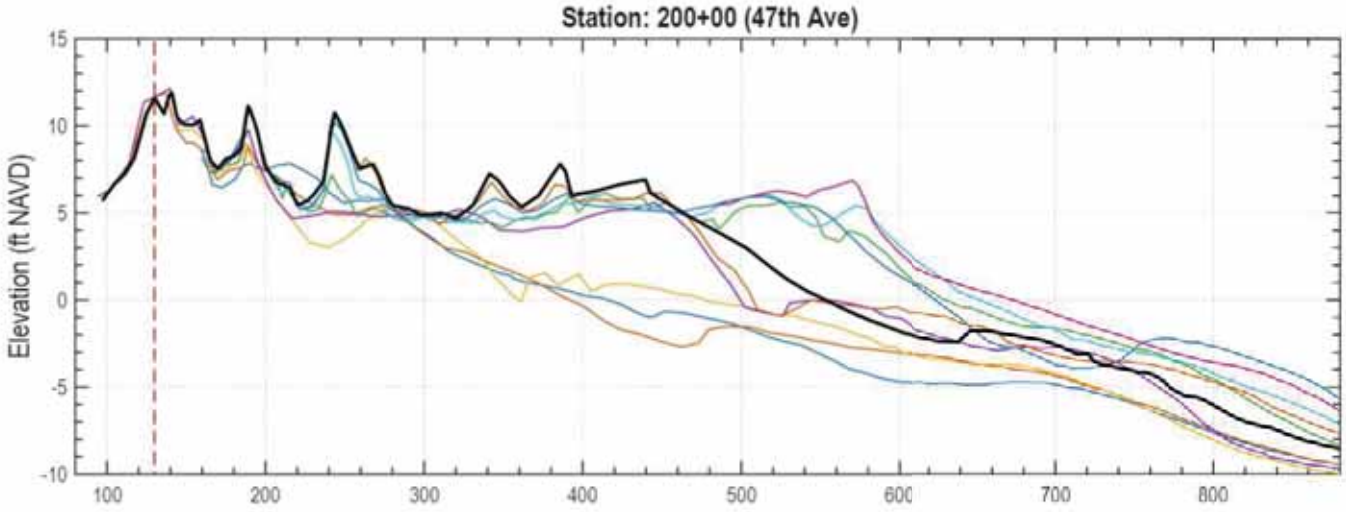

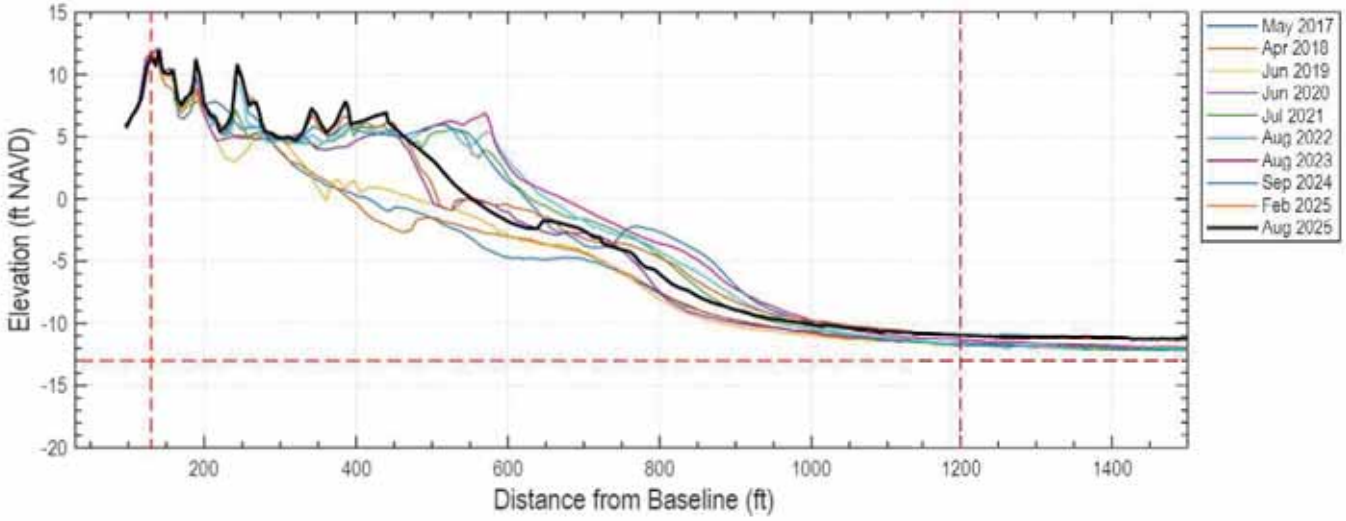

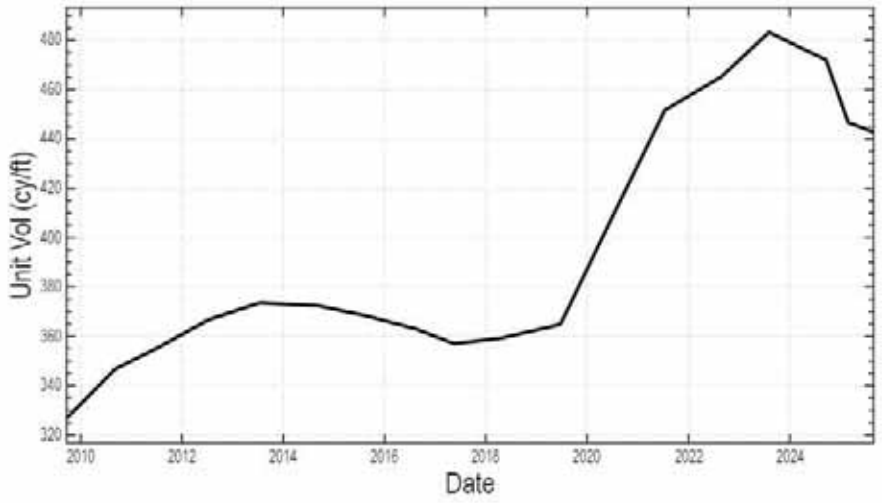

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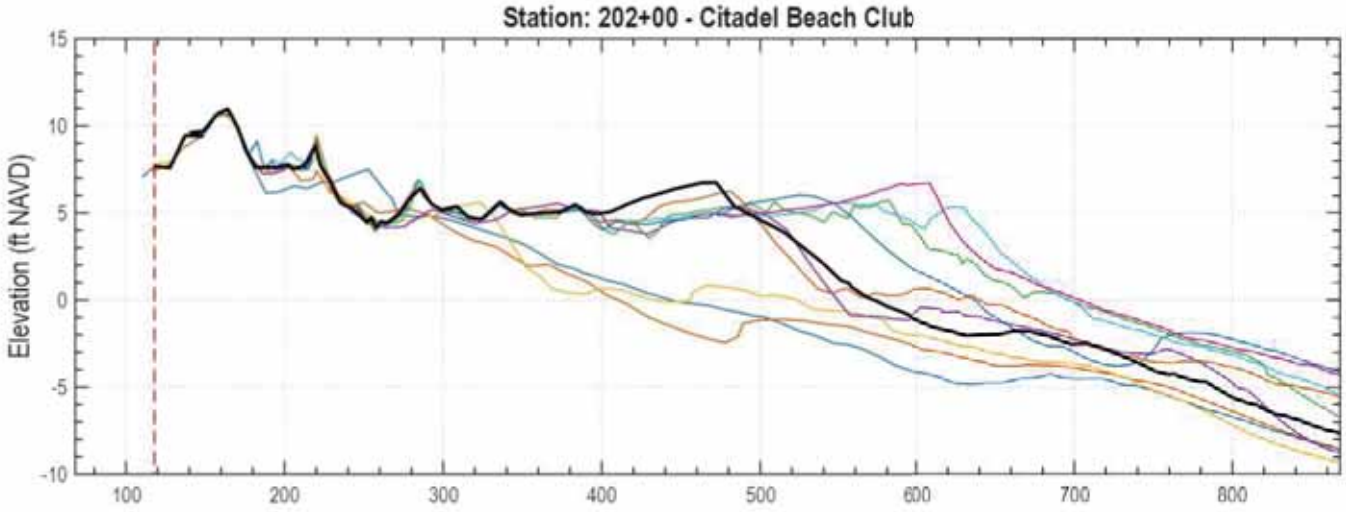

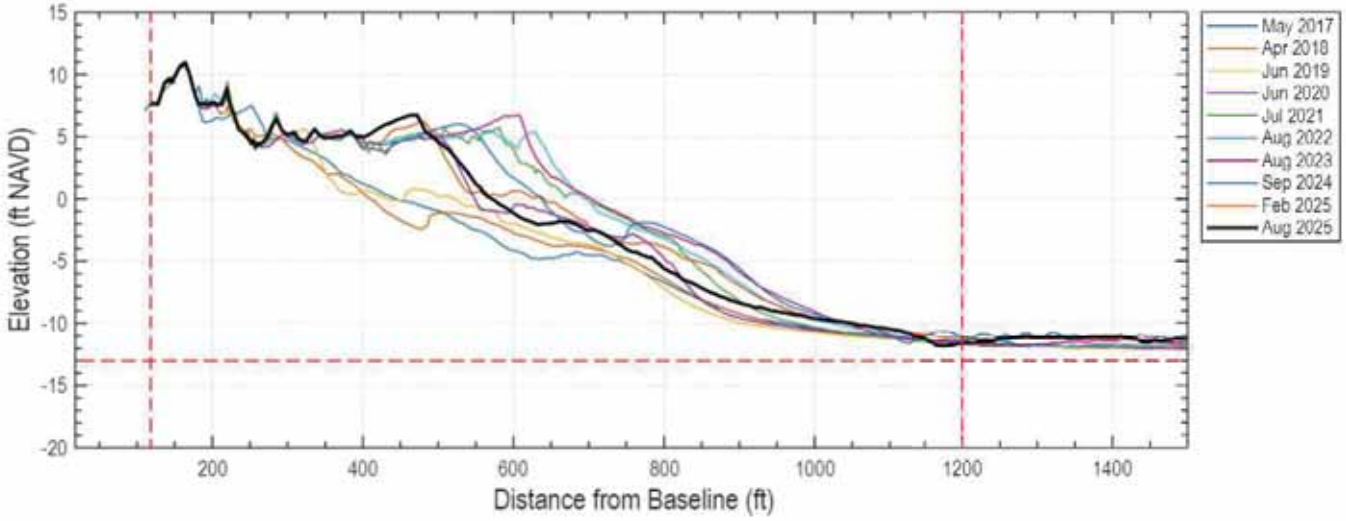

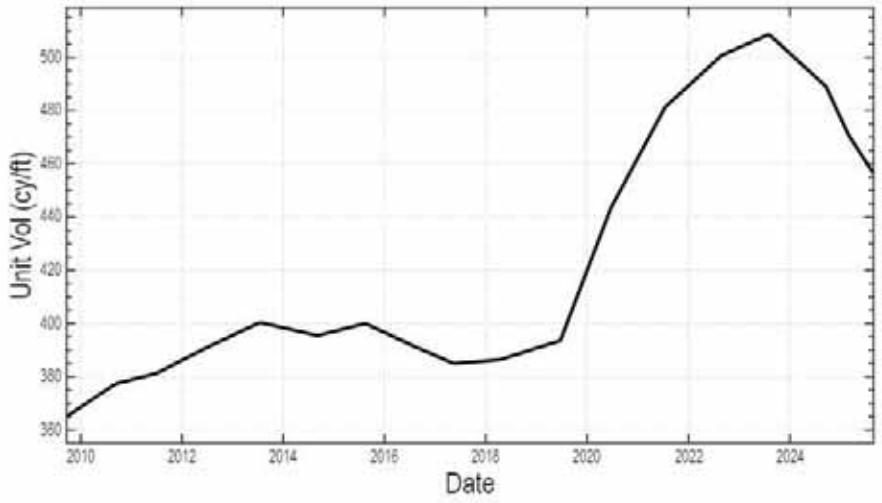

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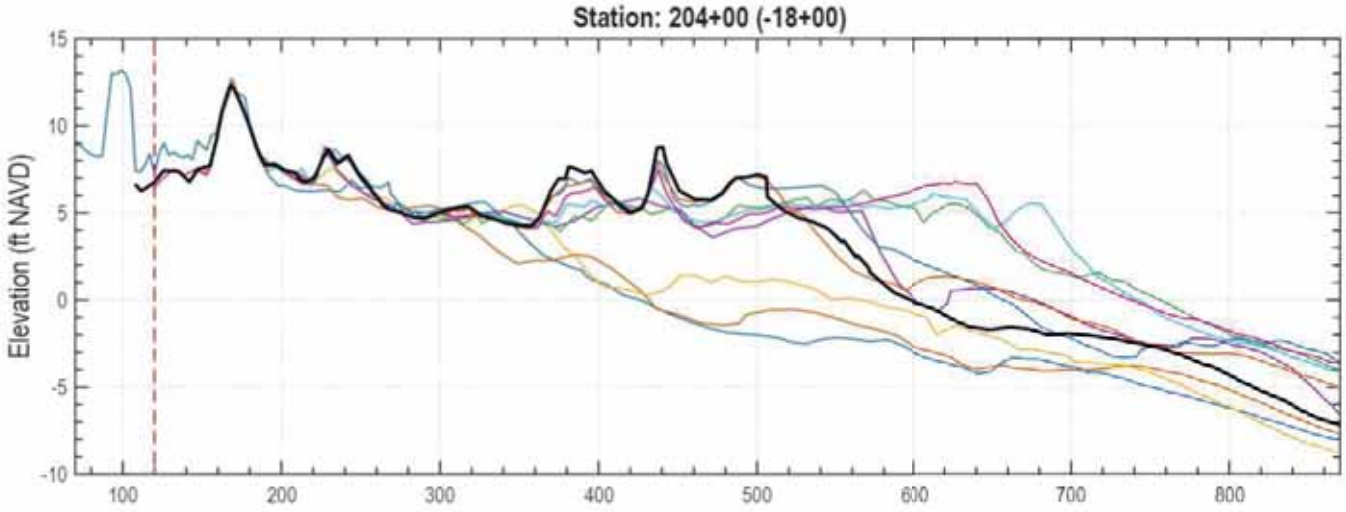
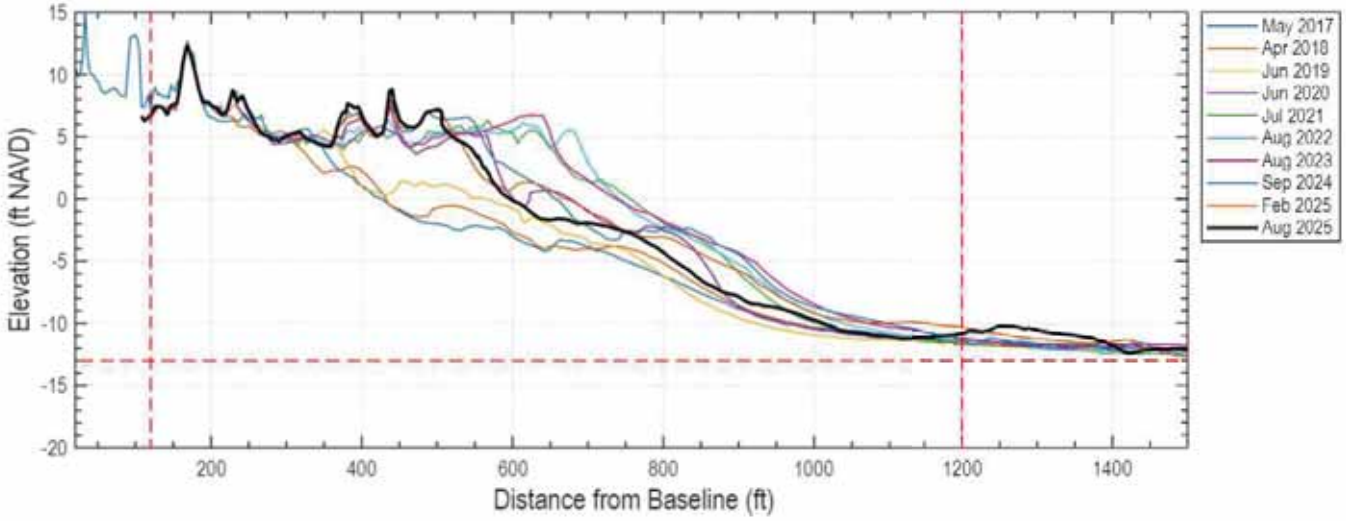
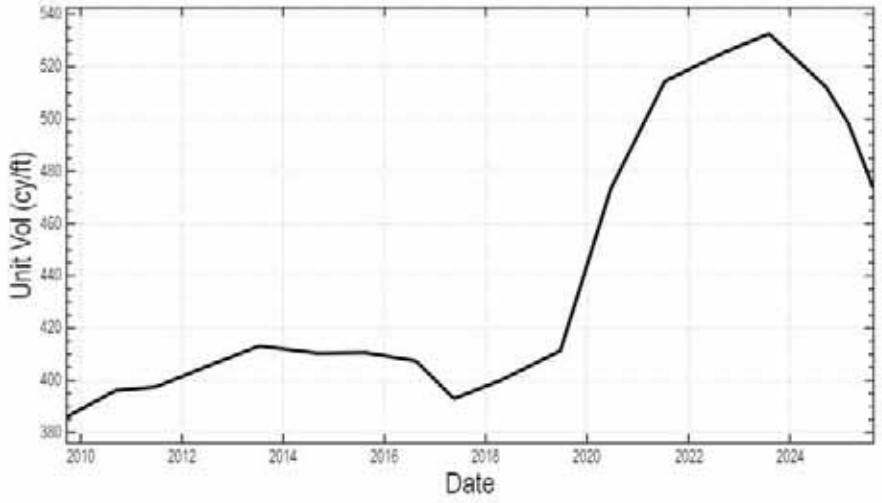
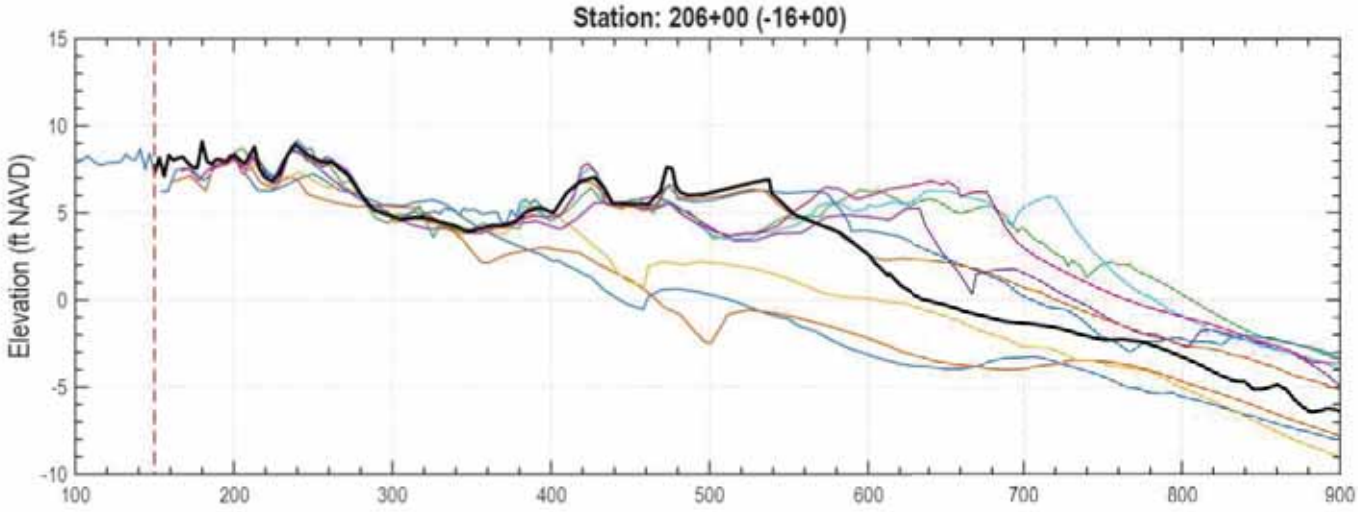
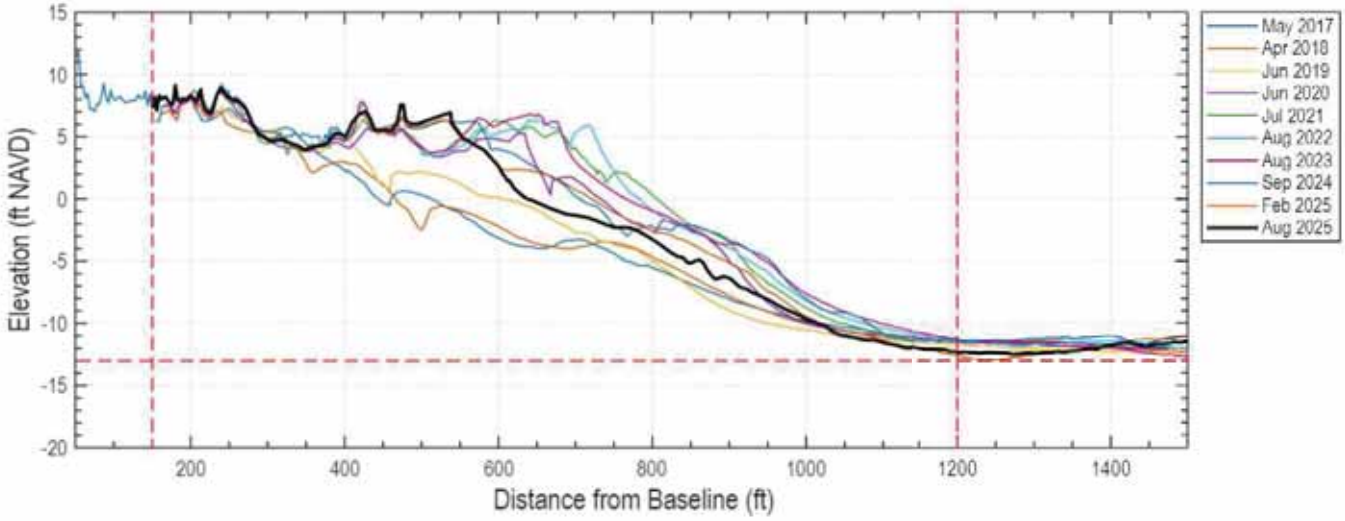


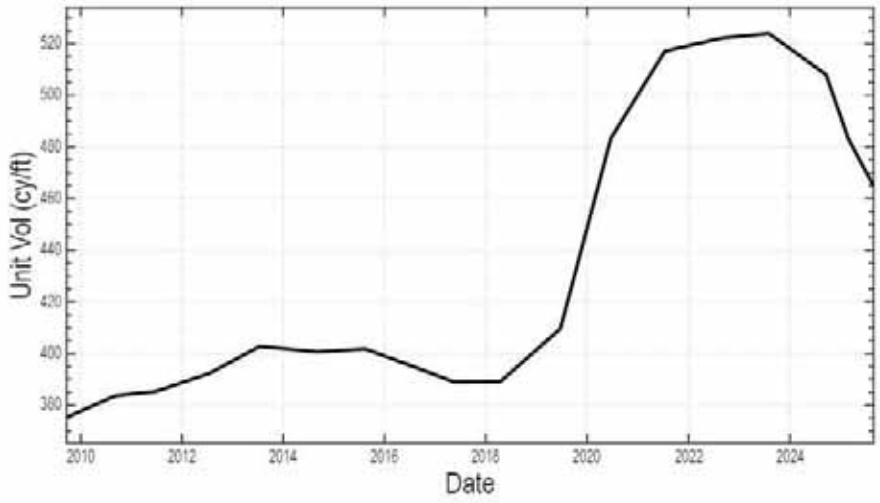




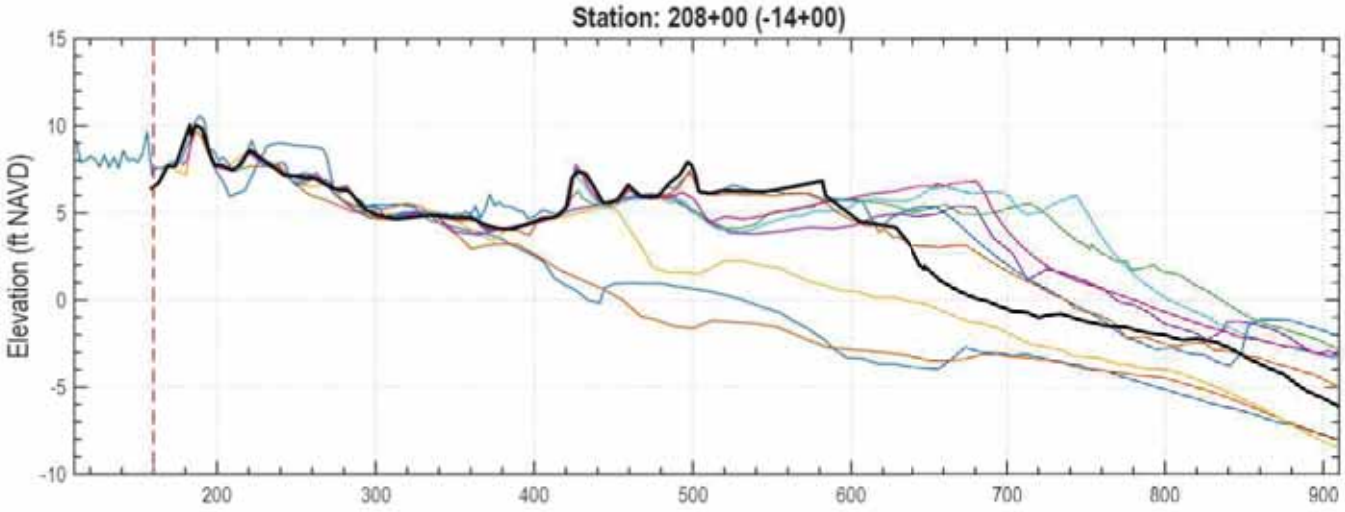
X: 2383731.27
Y: 353598.25

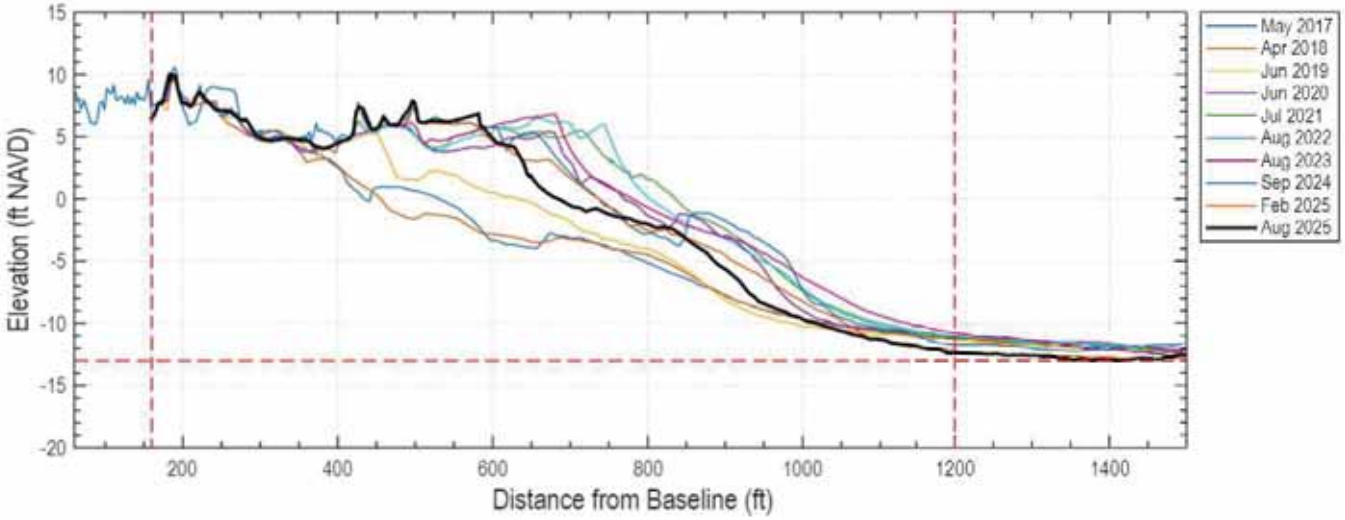


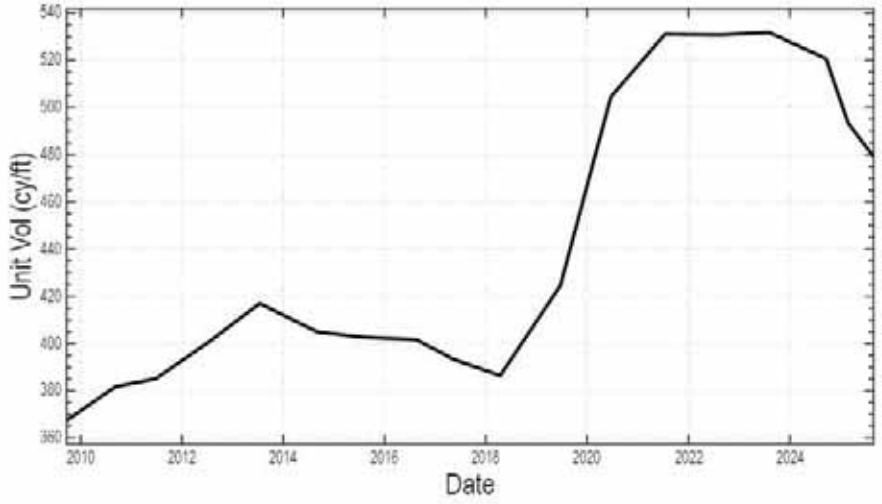




X: 2383919.64
Y: 353665.47







X: 2384108
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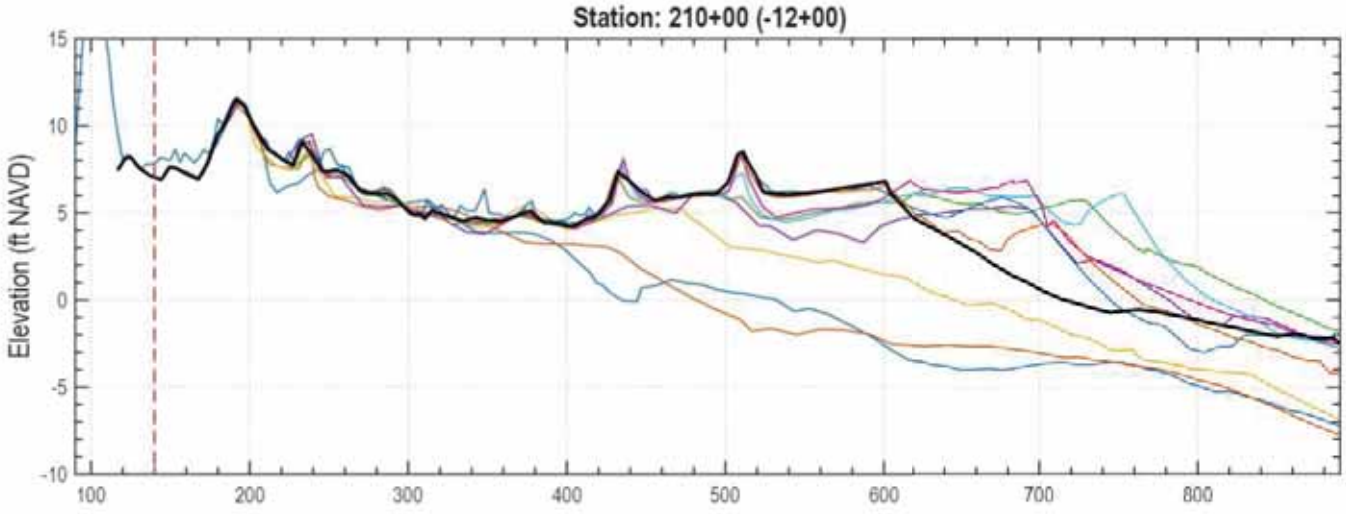
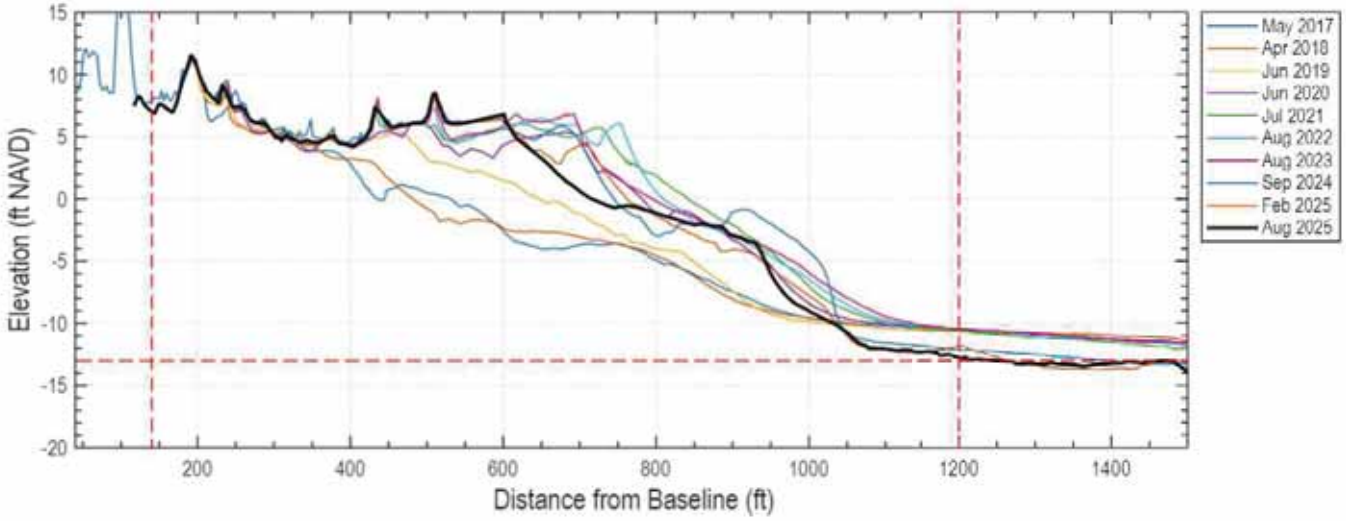
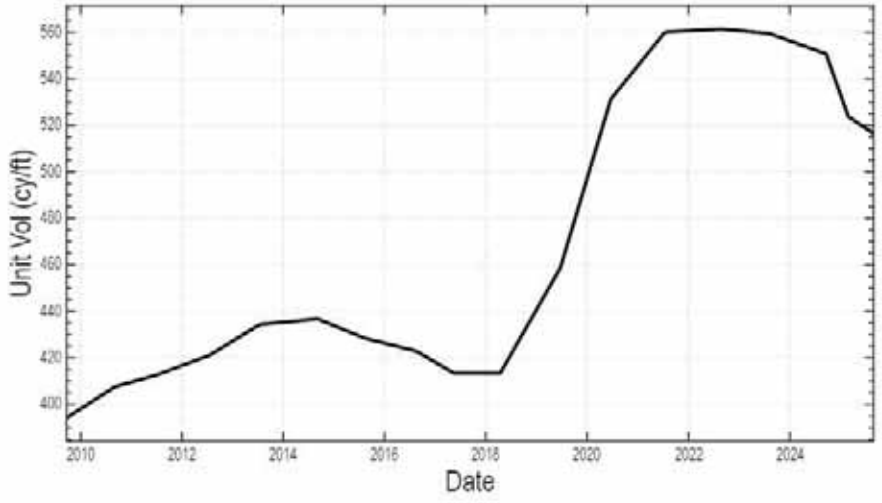
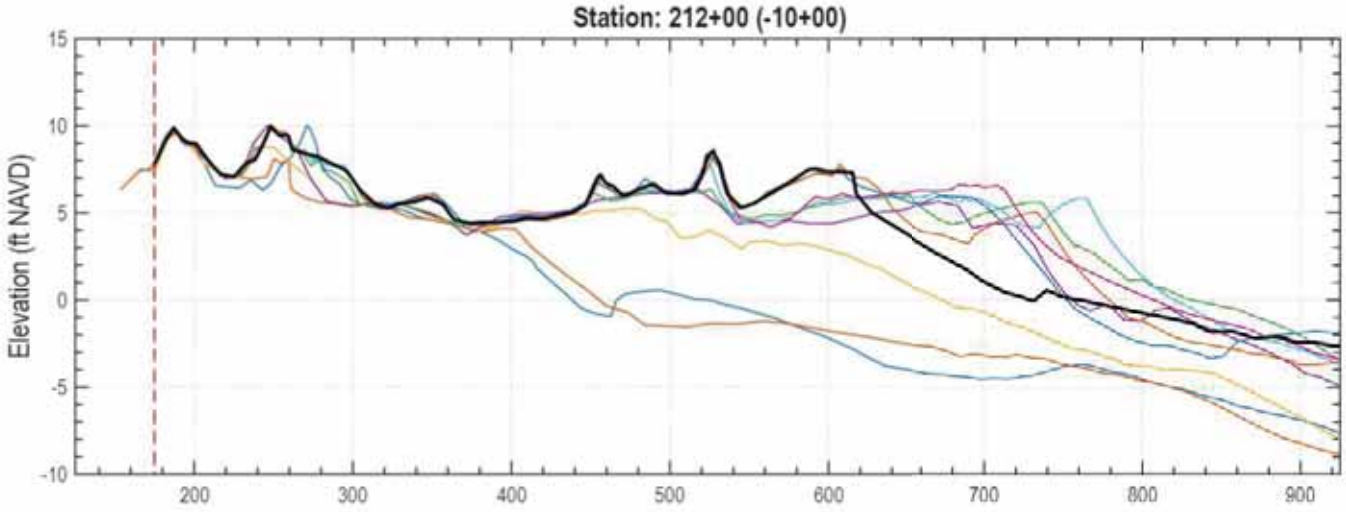
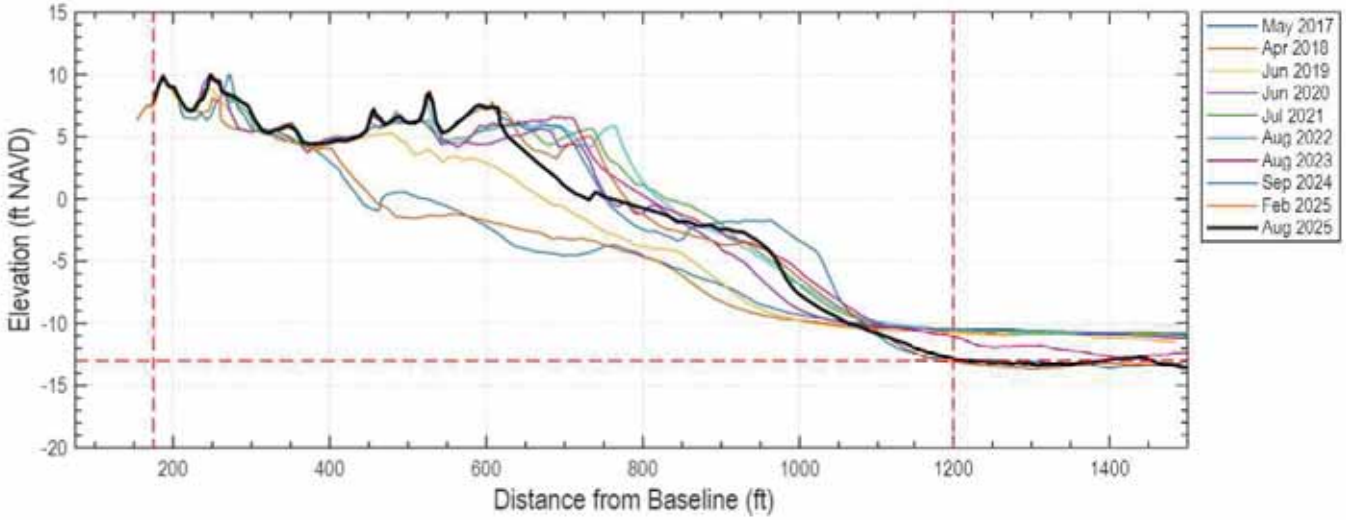


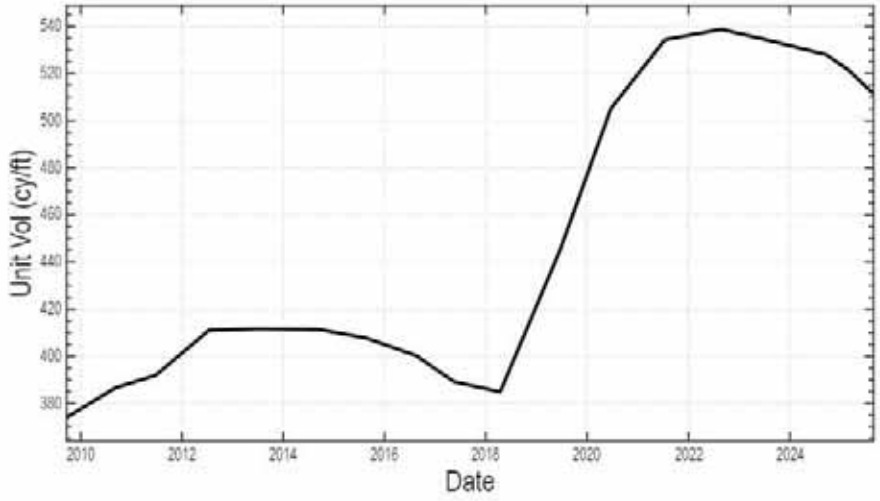




X: 2384296.37
Y: 353799.9







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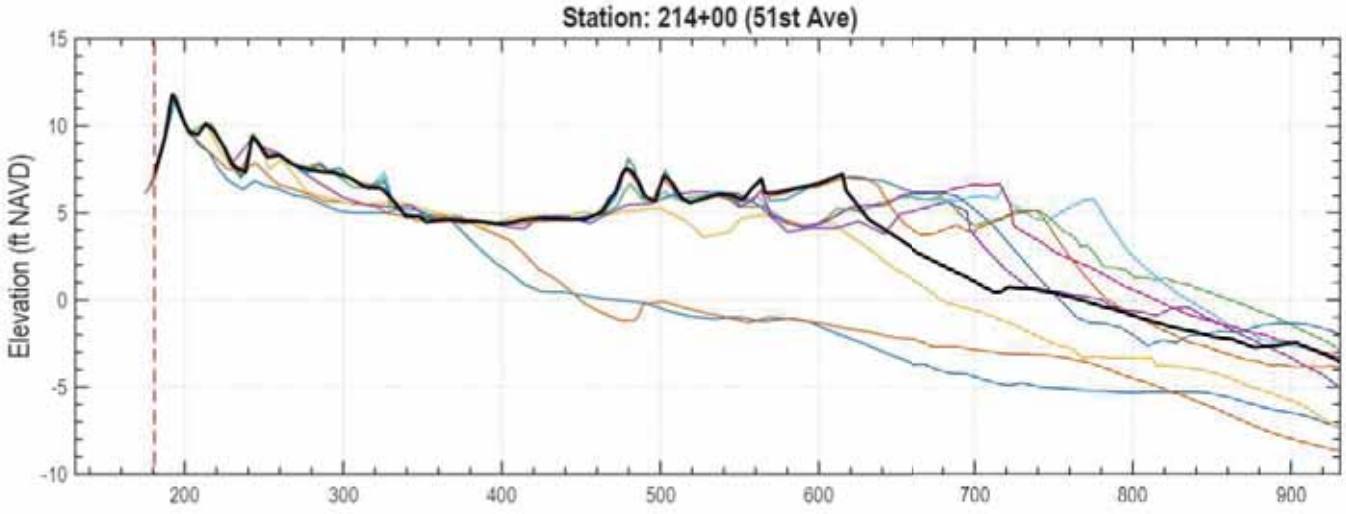
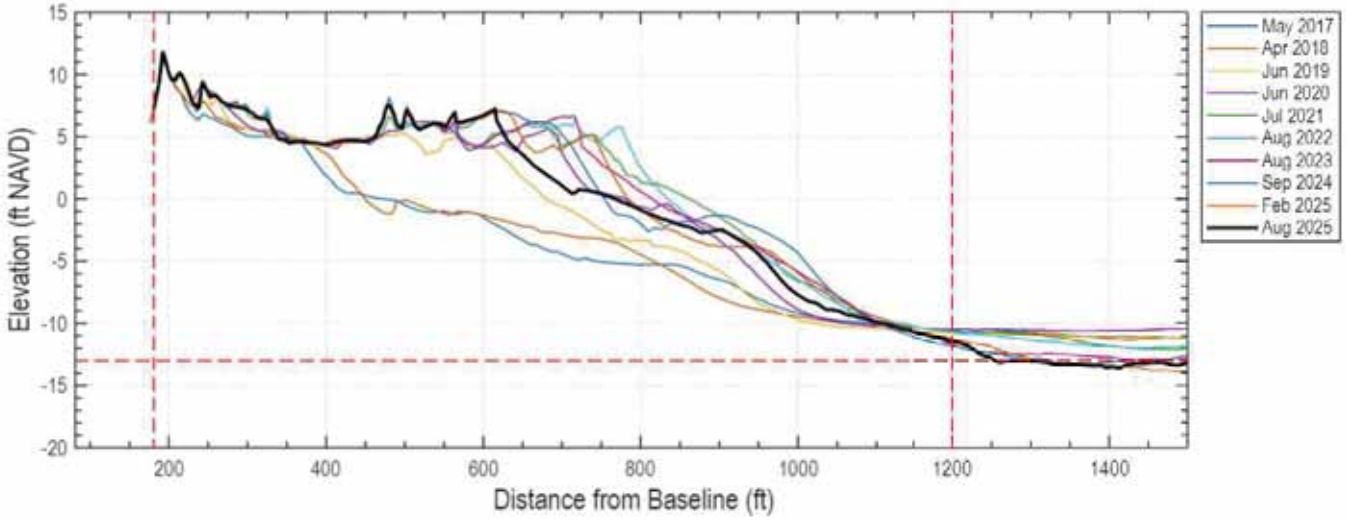
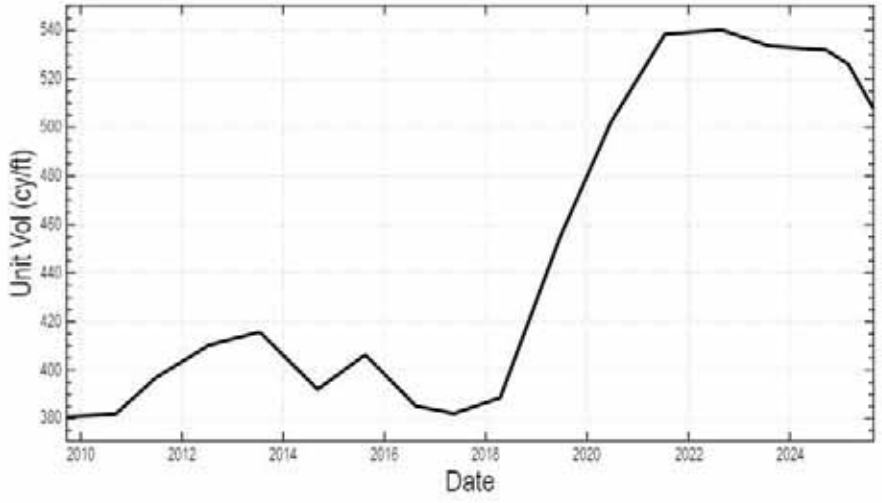
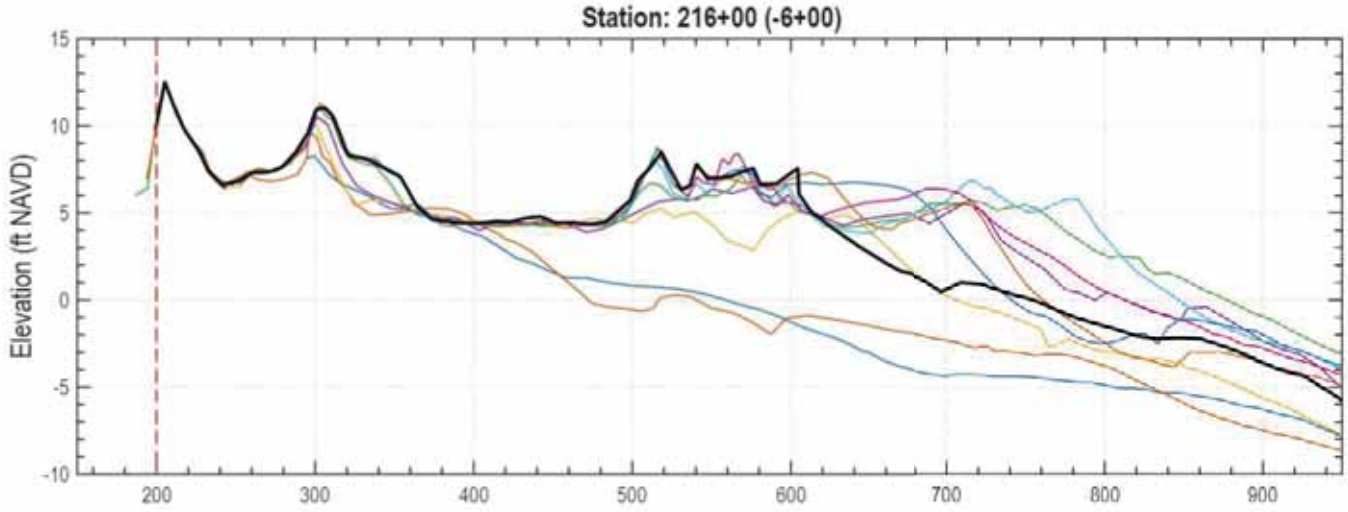
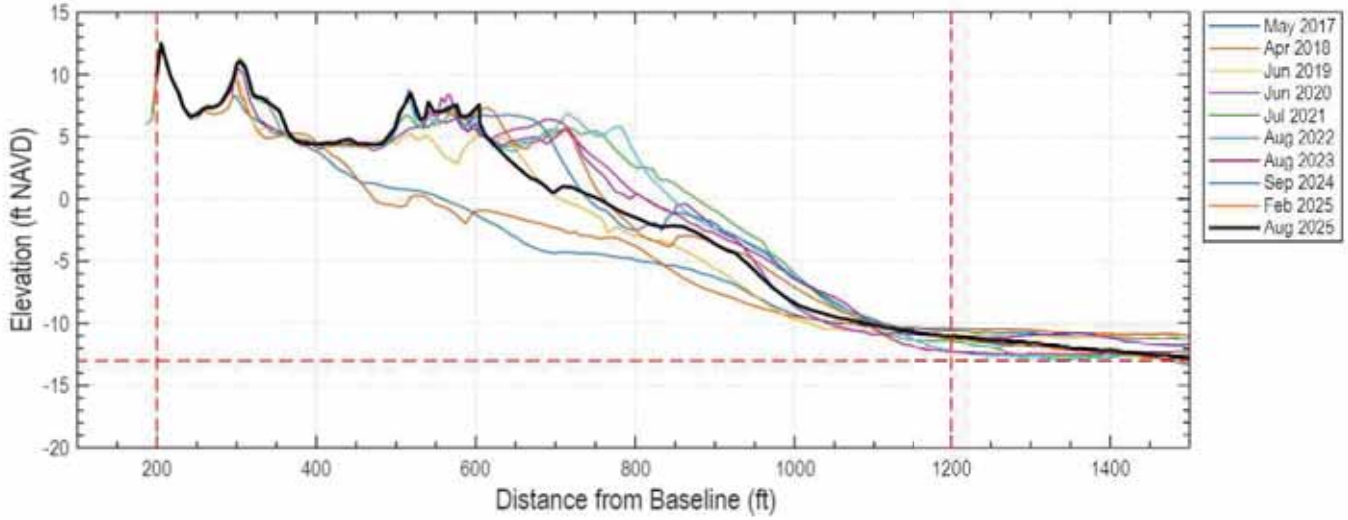


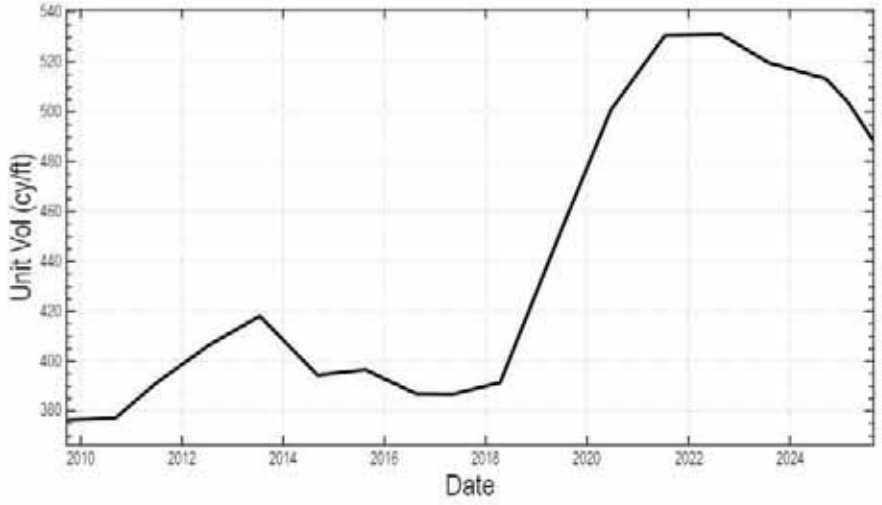




X: 2384673.1
Y: 353934.34







X: 2384861.47
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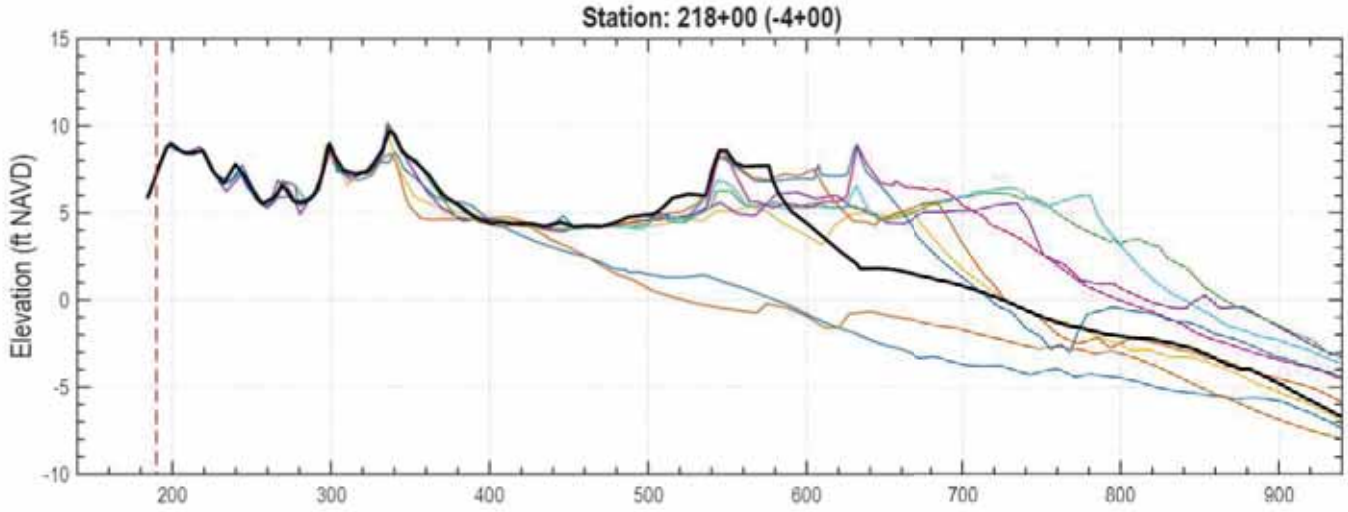

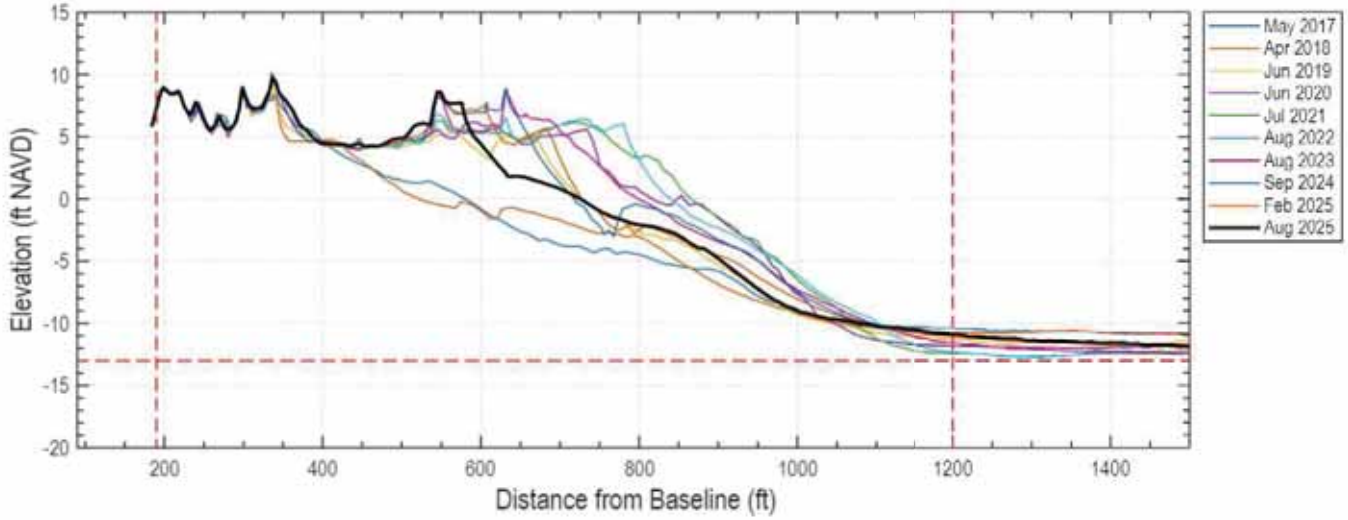

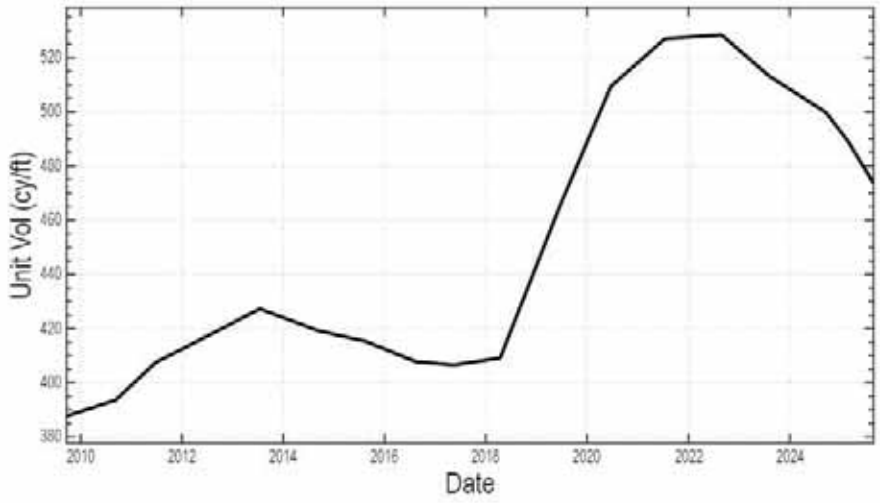

X: 2385049.83
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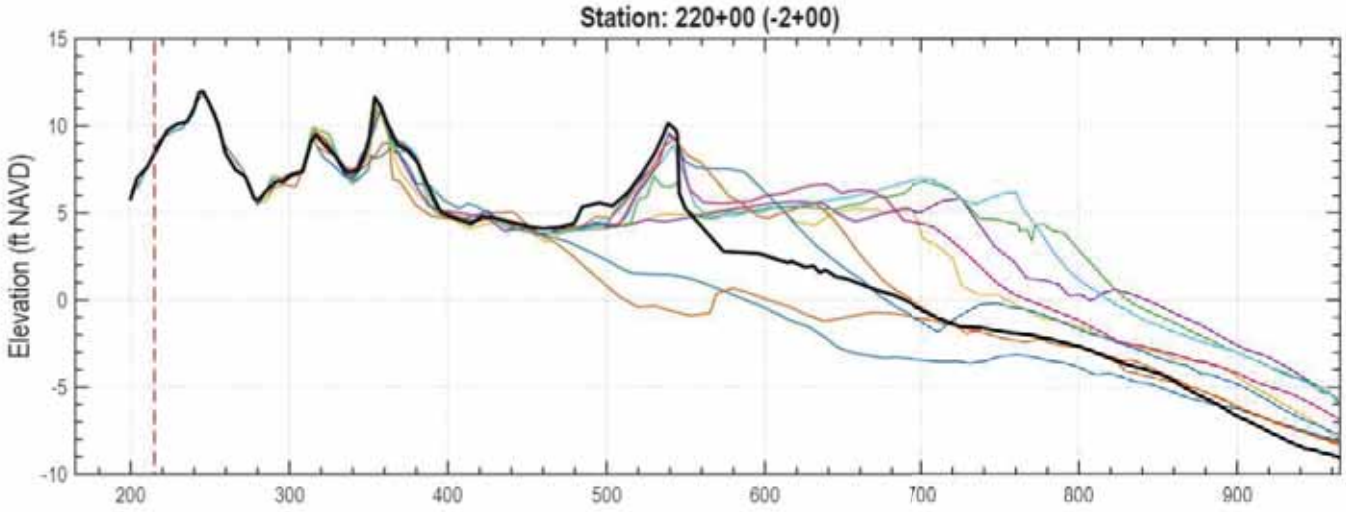
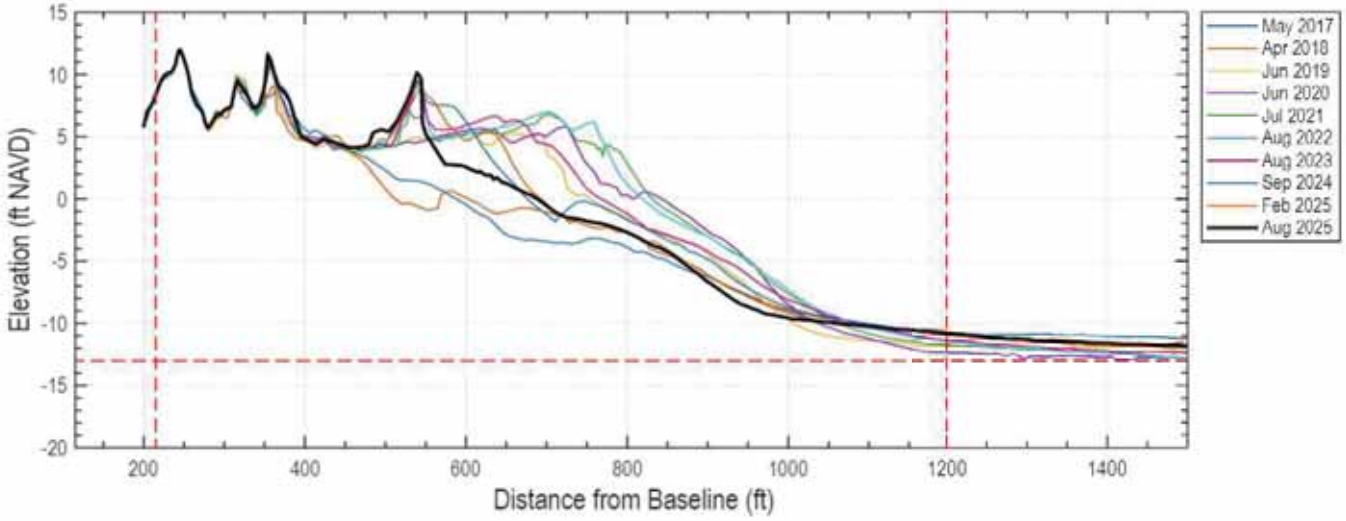
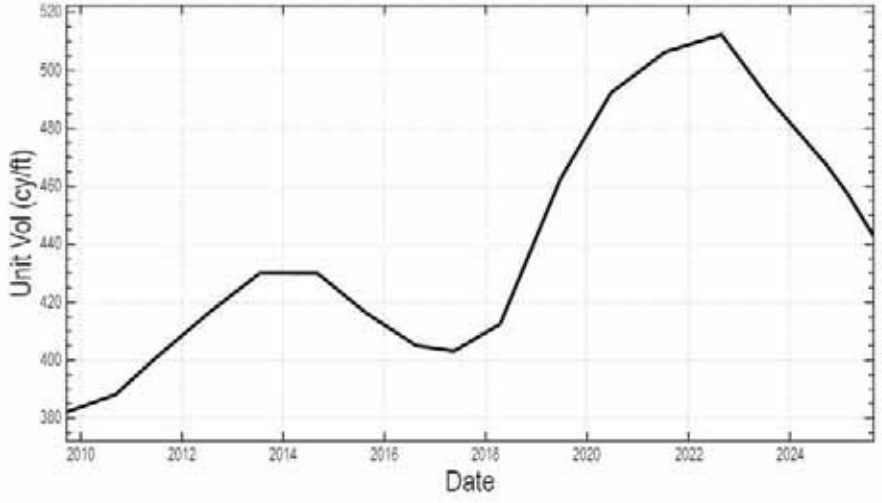
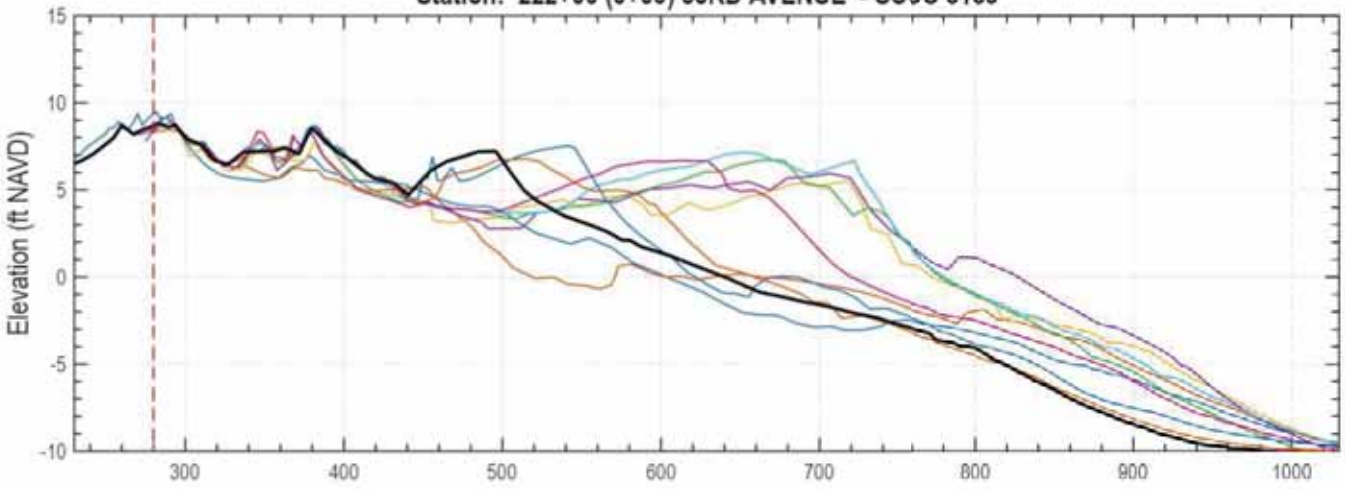


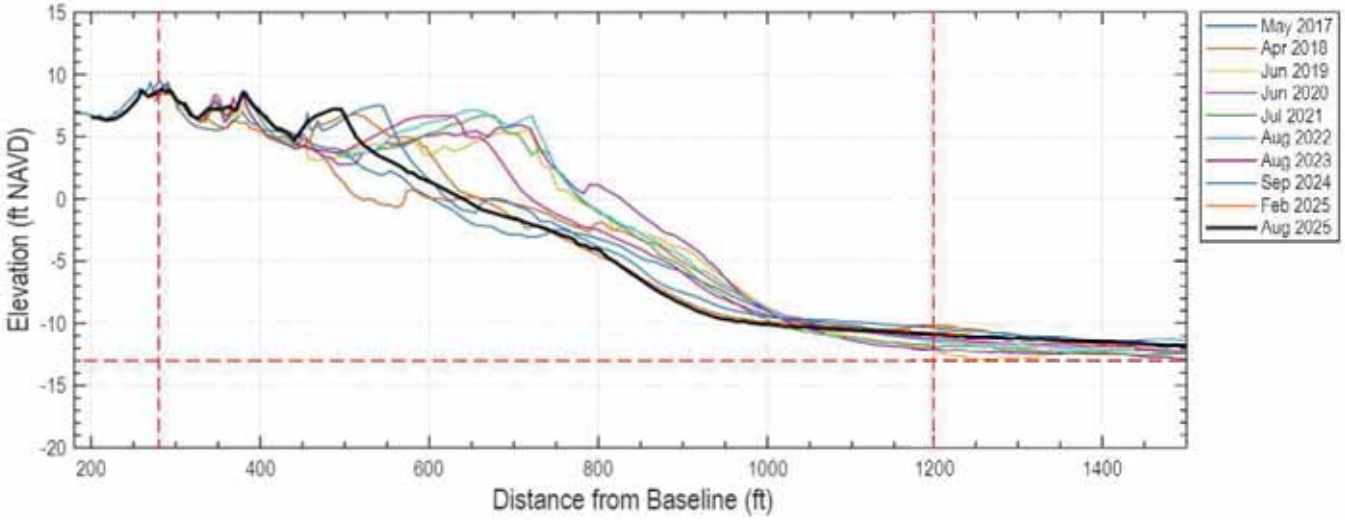


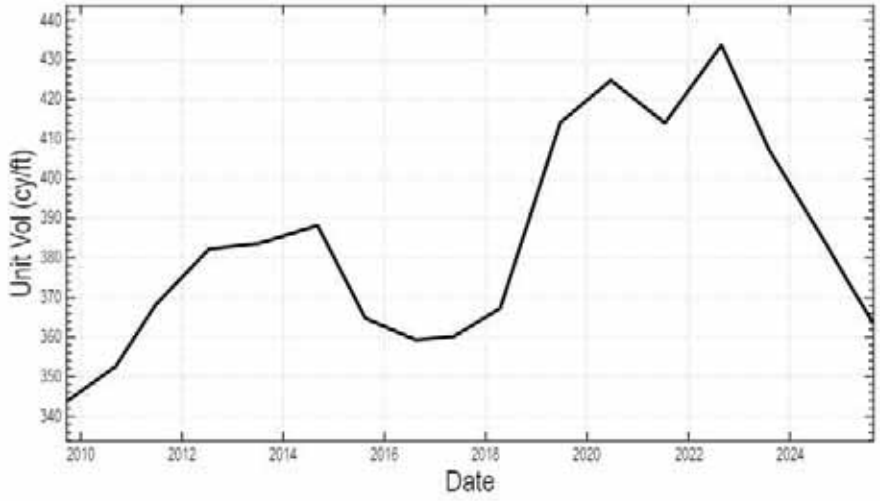


X: 2385238.2
Y: 354135.99

Station: 222+00 (0+00) 53RD AVENUE - SCCC 3159







X: 2385426.56
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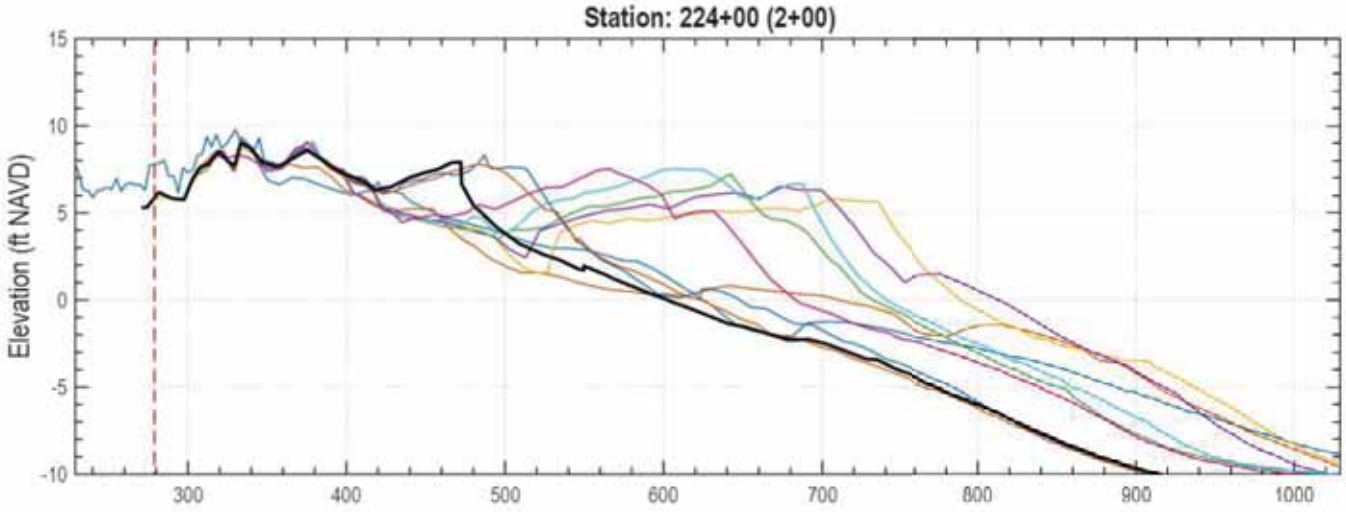

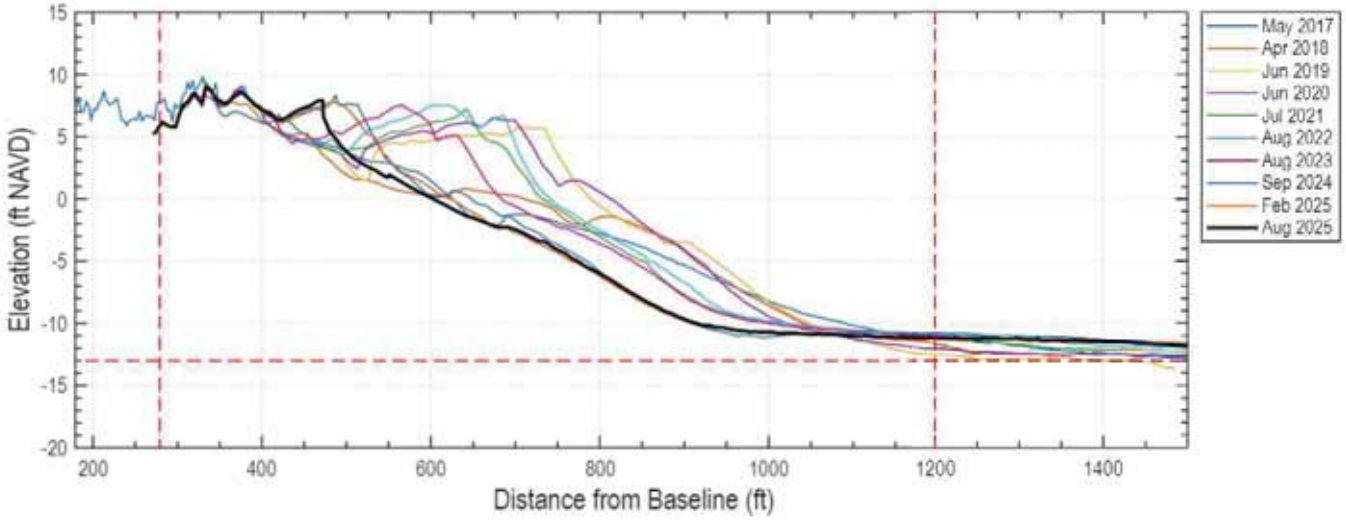

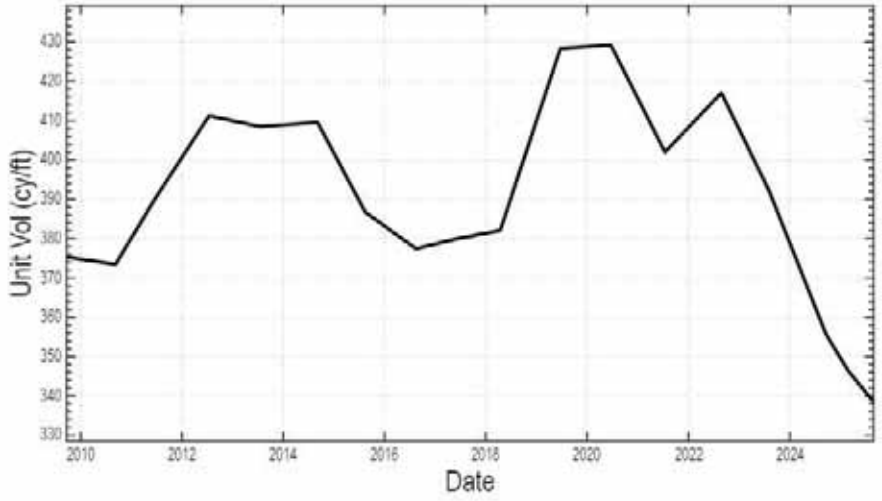

X: 2385613.66
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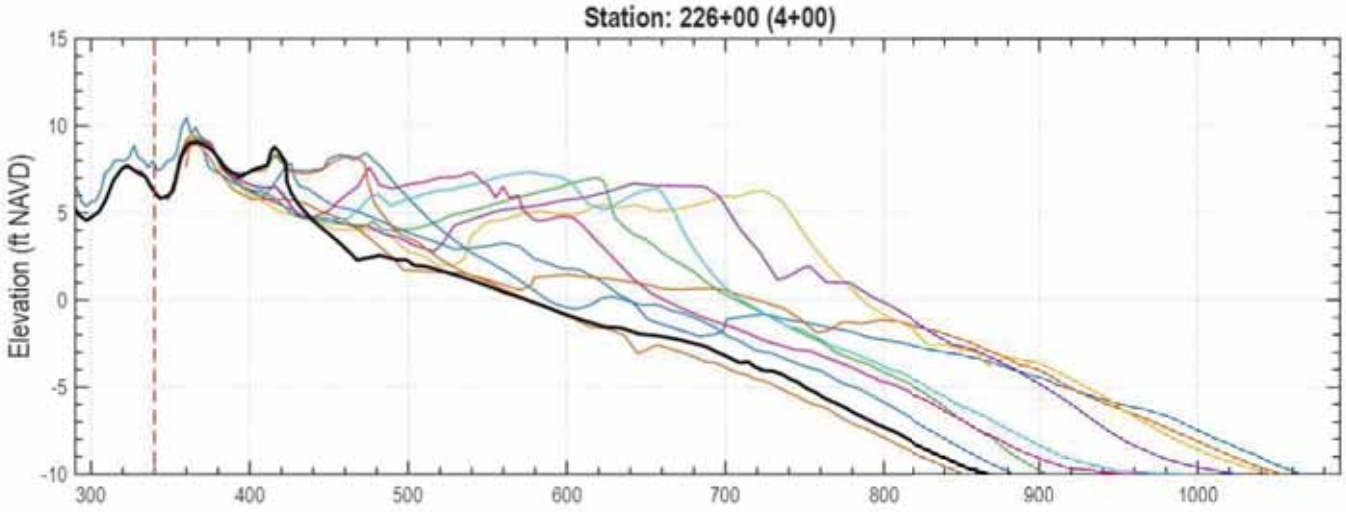
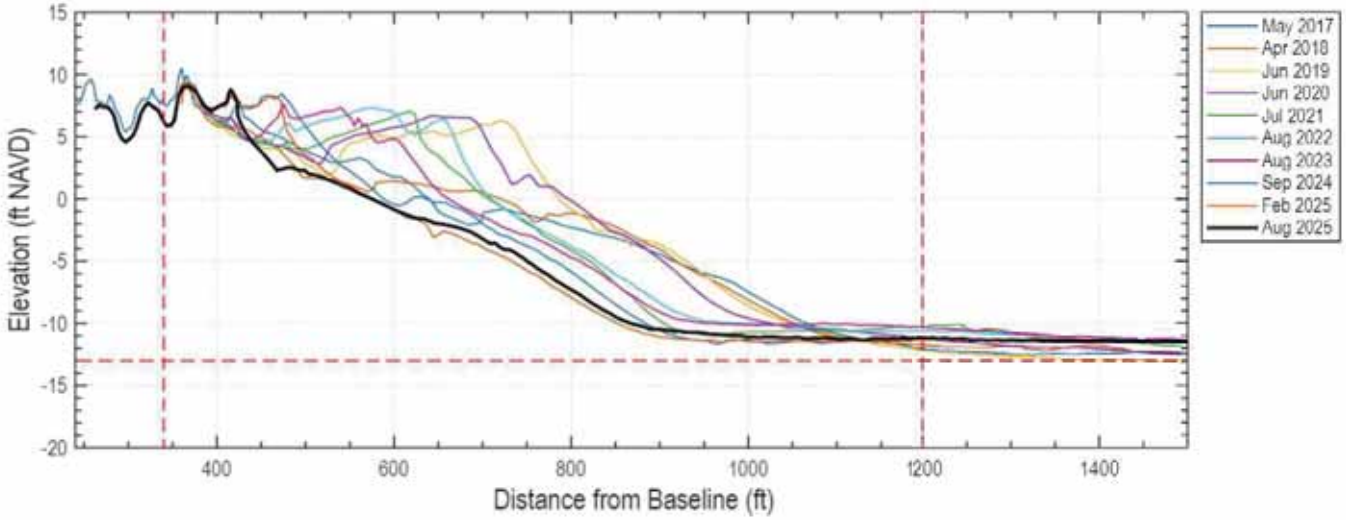
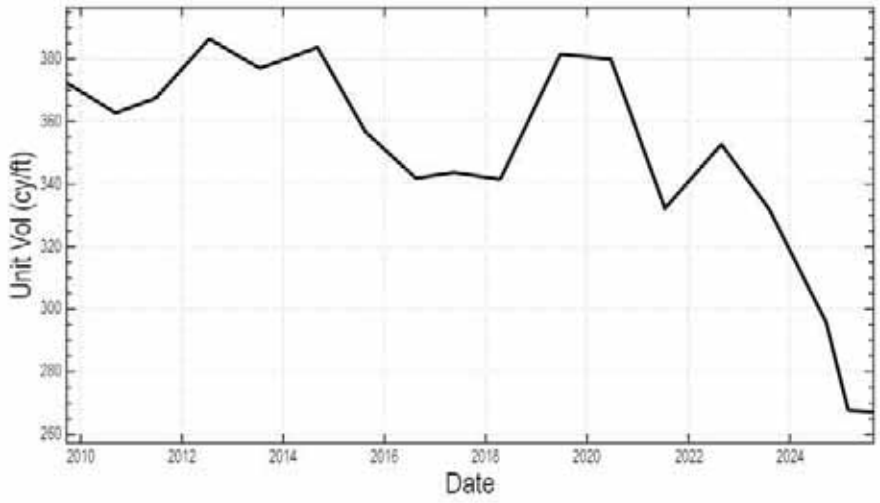
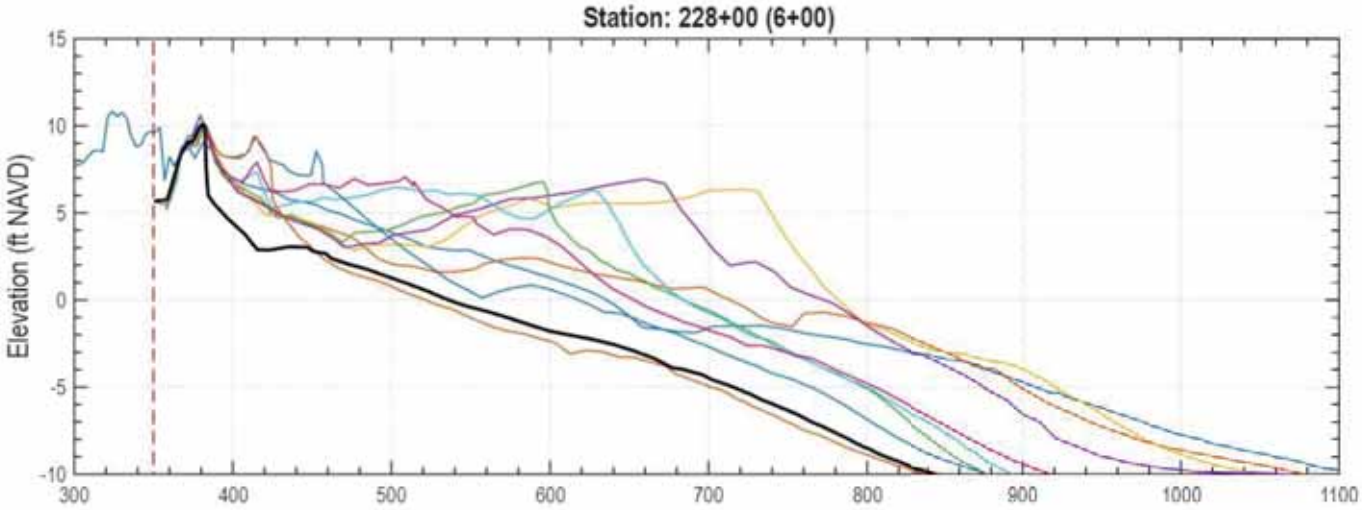
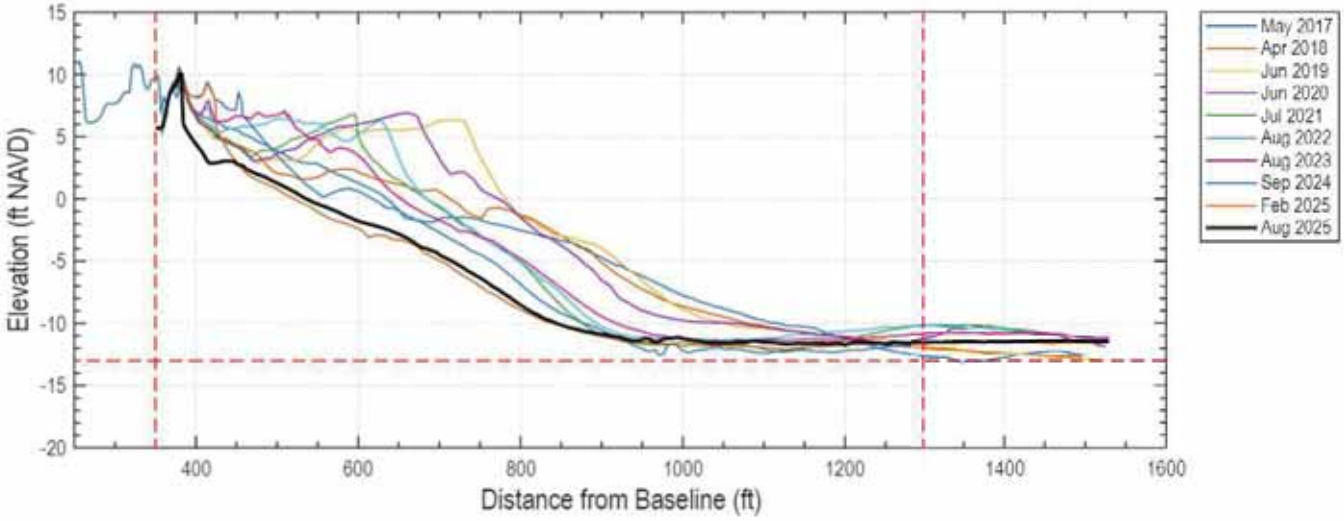


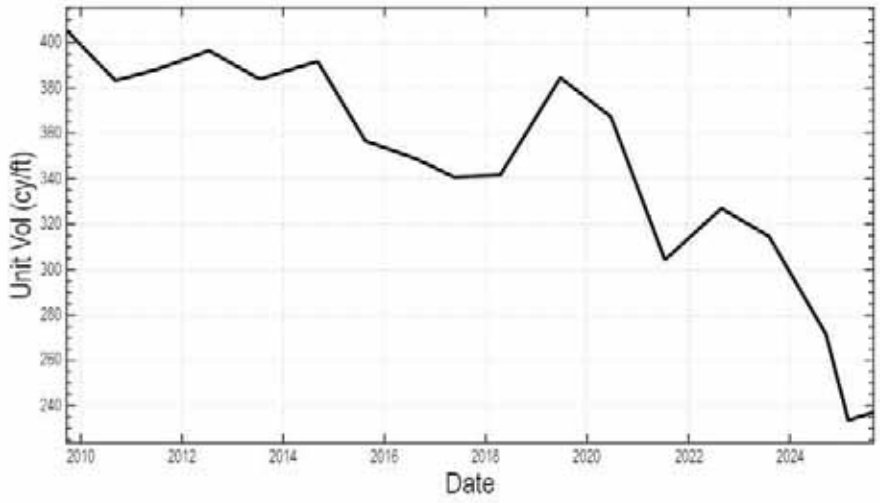




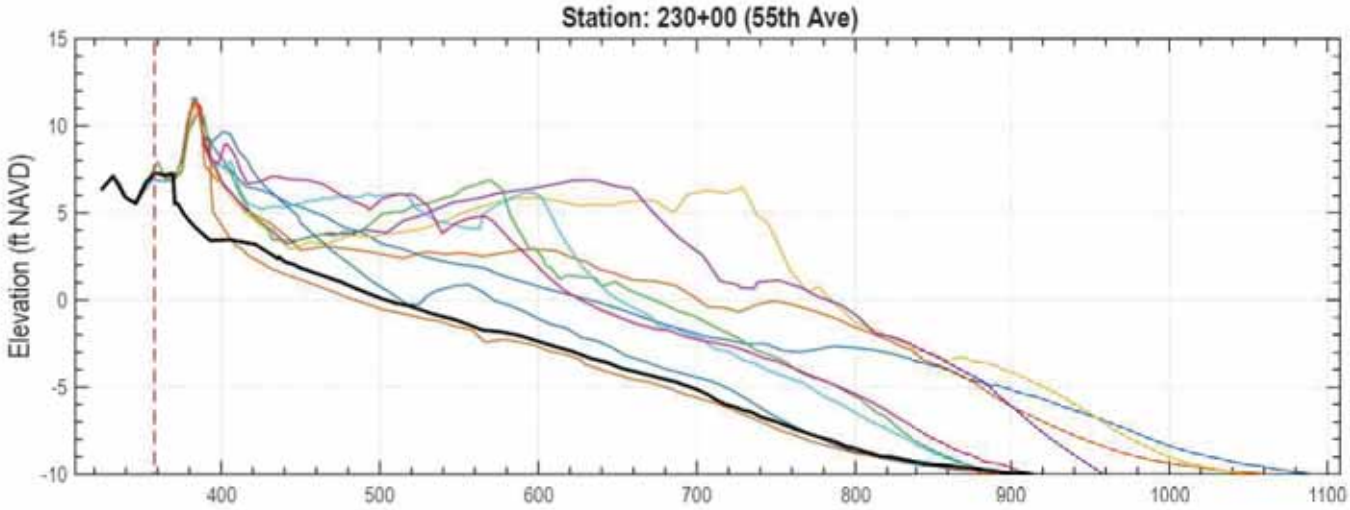
X: 2385800.77
Y: 354344.54

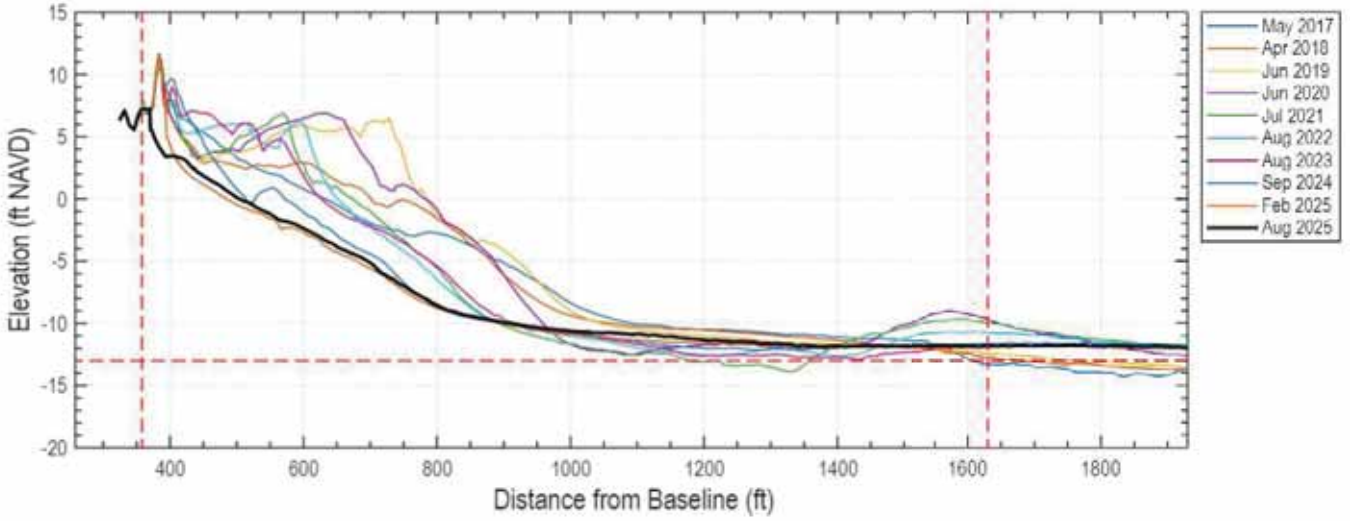


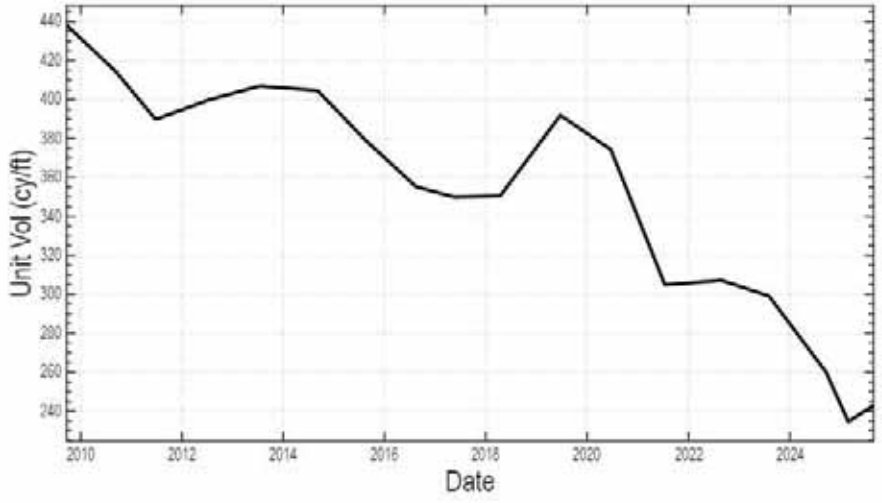




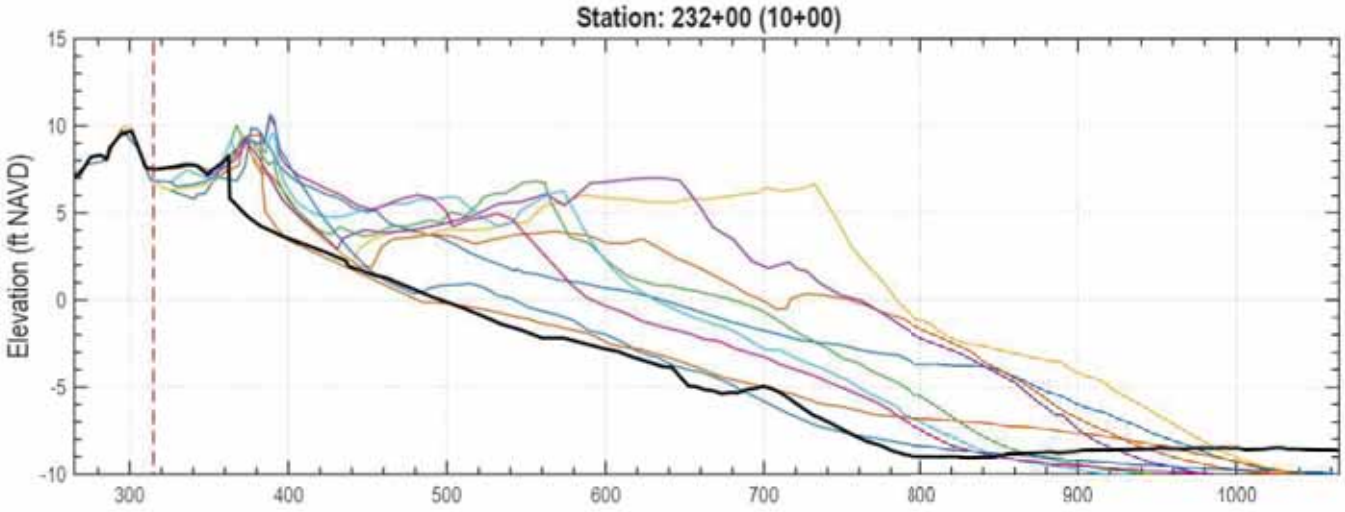
X: 2385987.87
Y: 354415.2

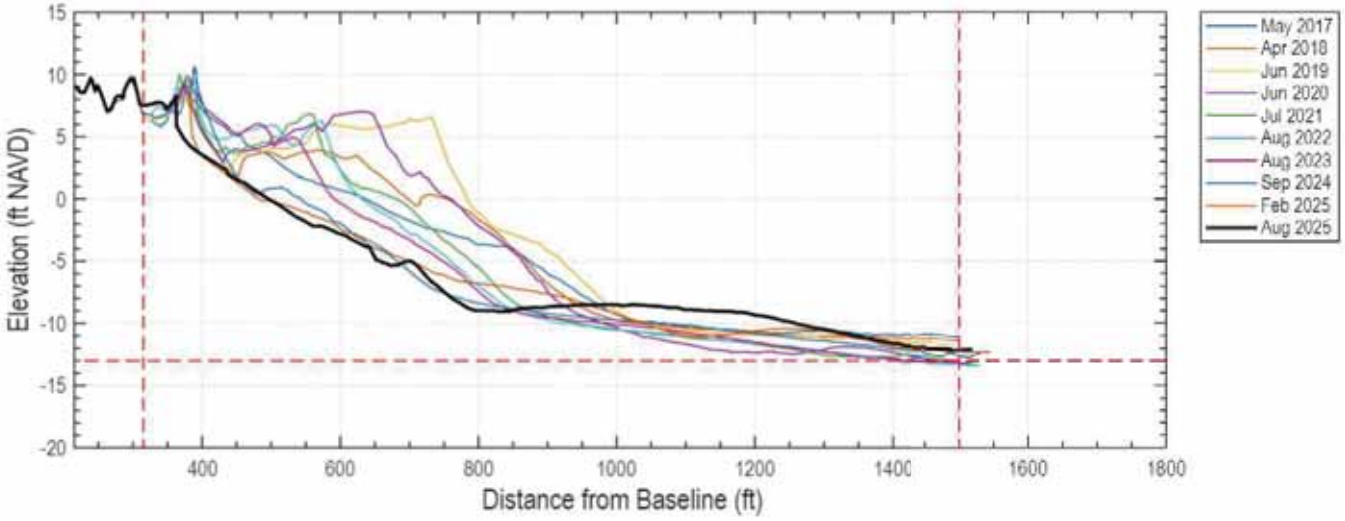


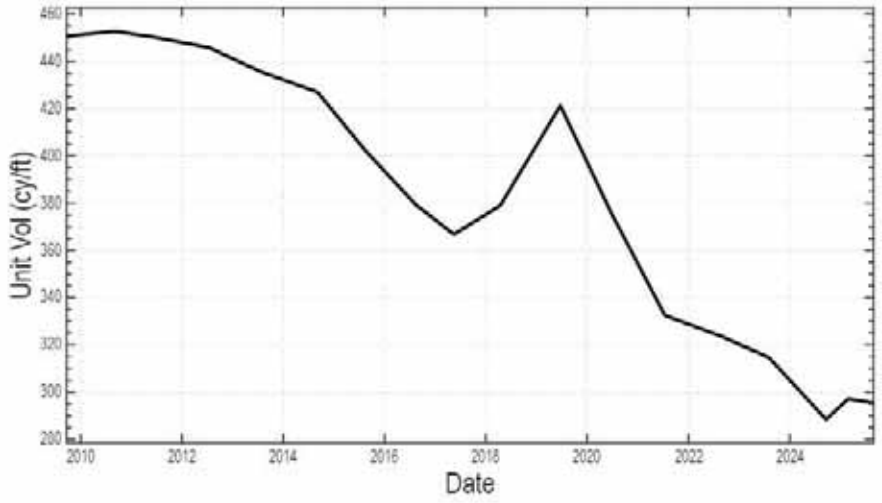




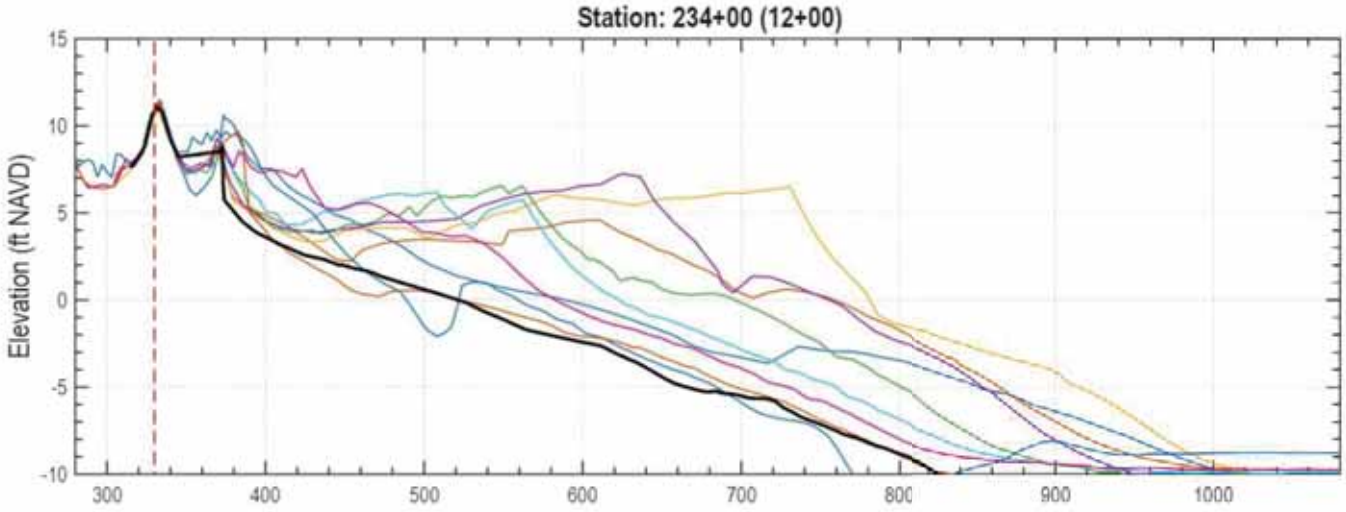
X: 2386174.97
Y: 354485.86

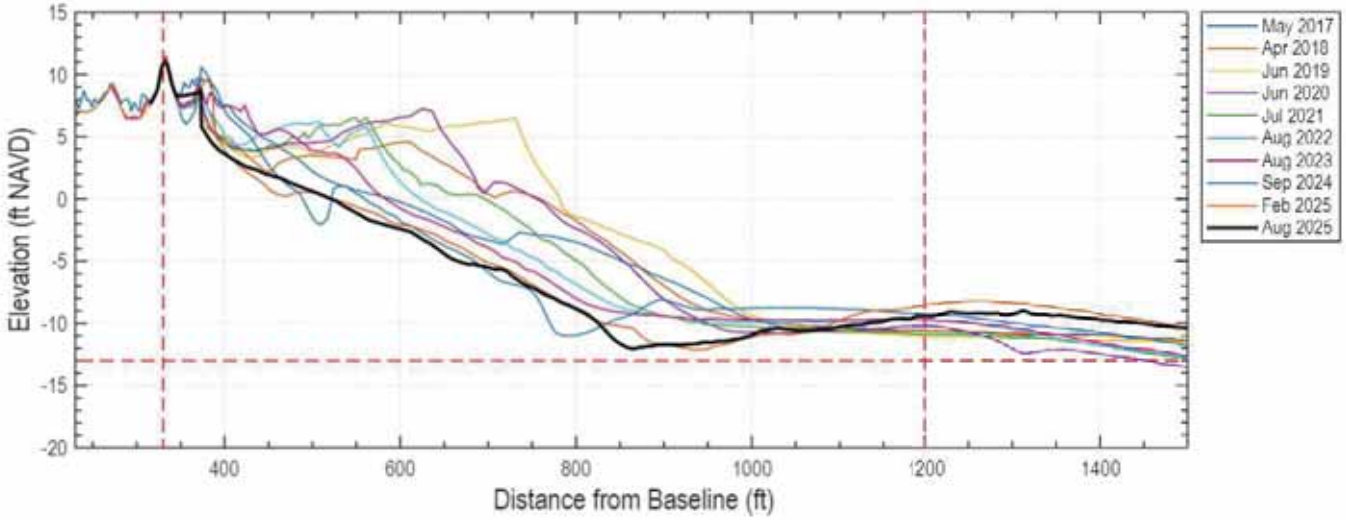


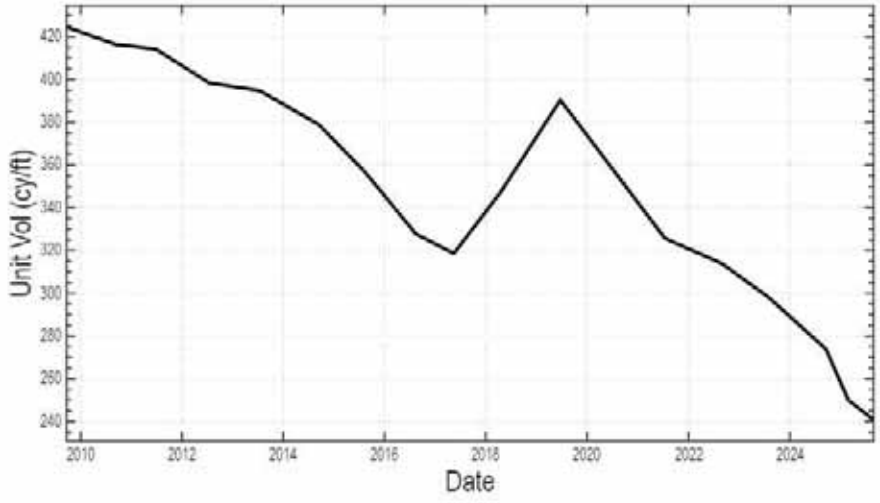




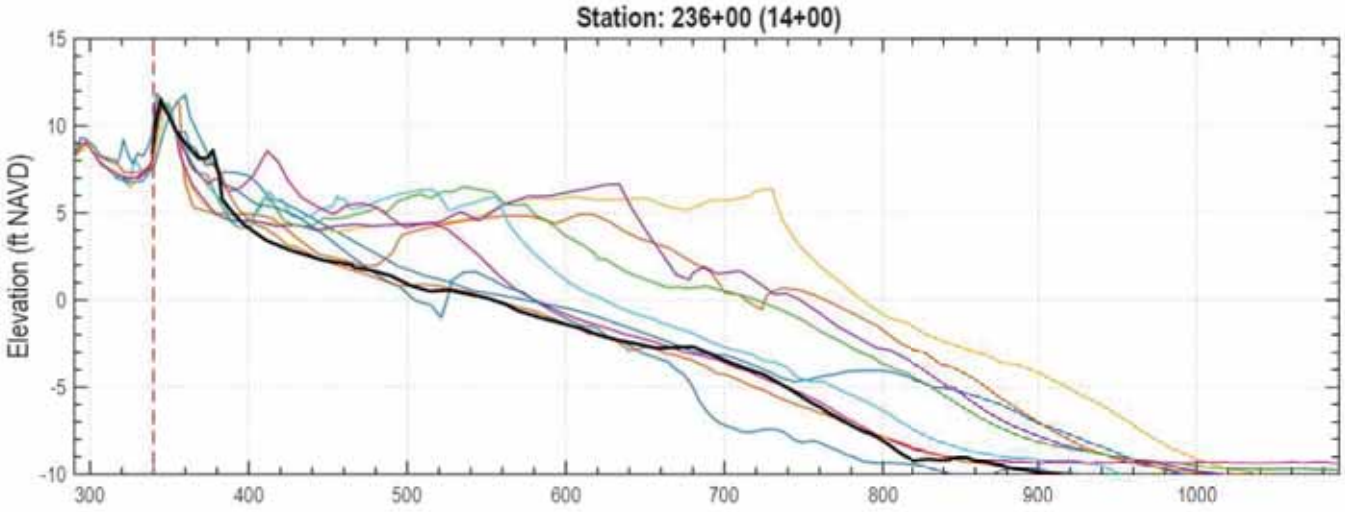
X: 2386362.07
Y: 354556.53

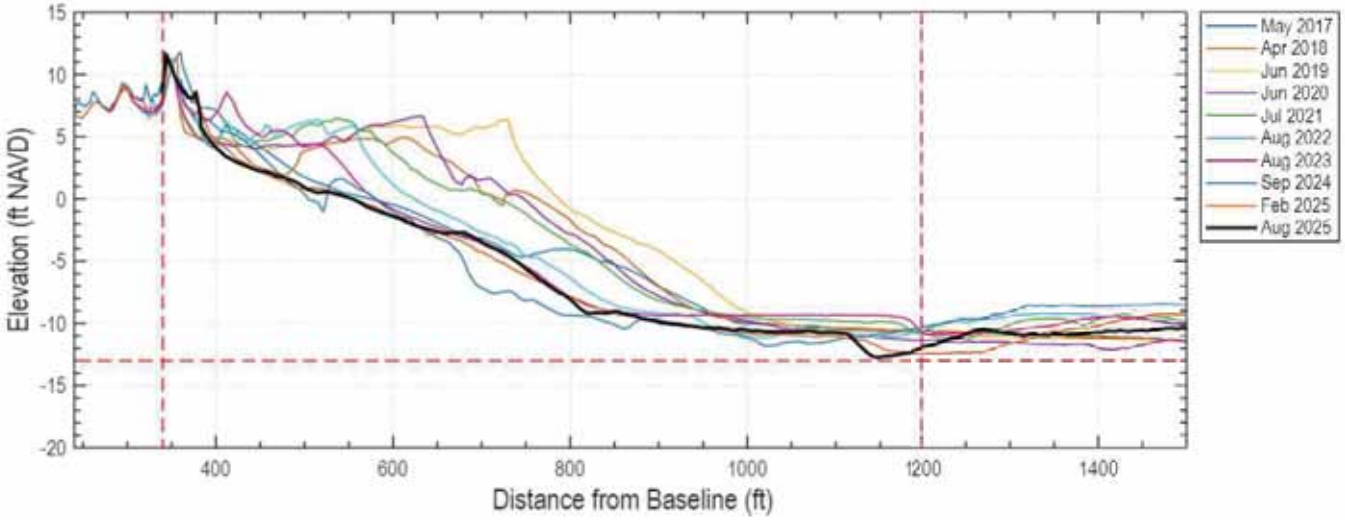


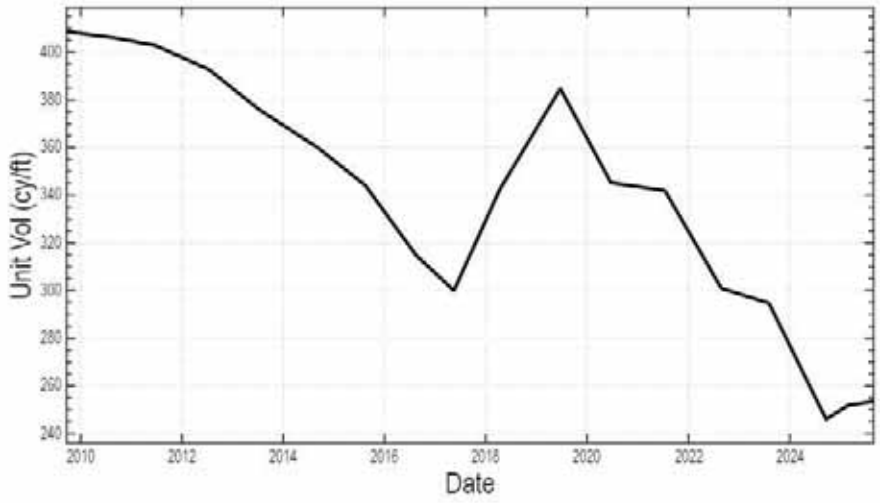




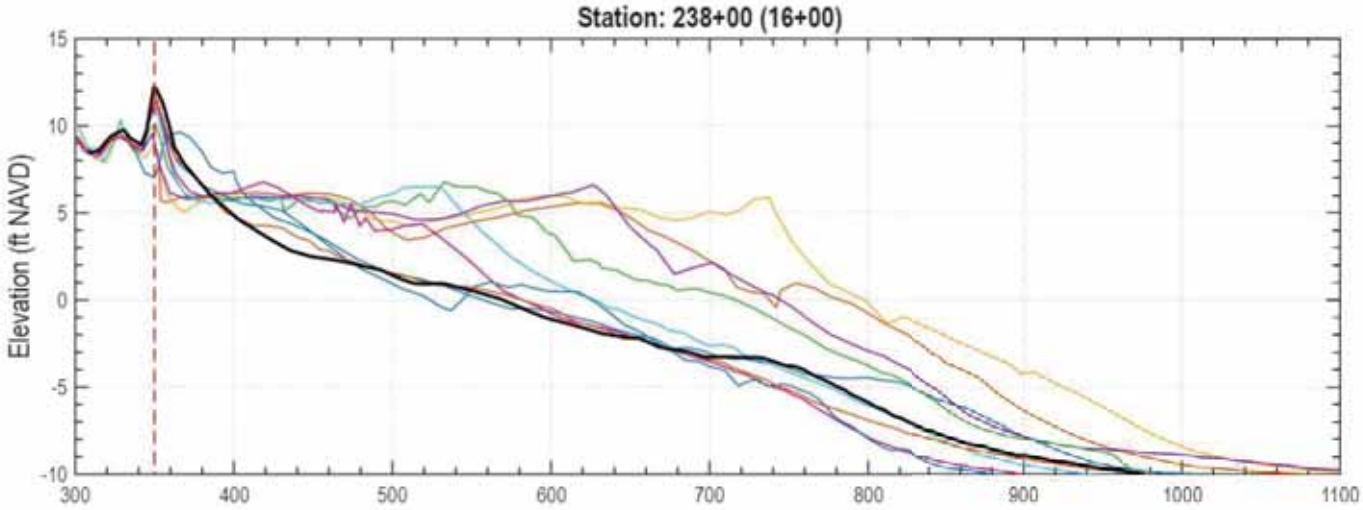
X: 2386549.17
Y: 354627.19

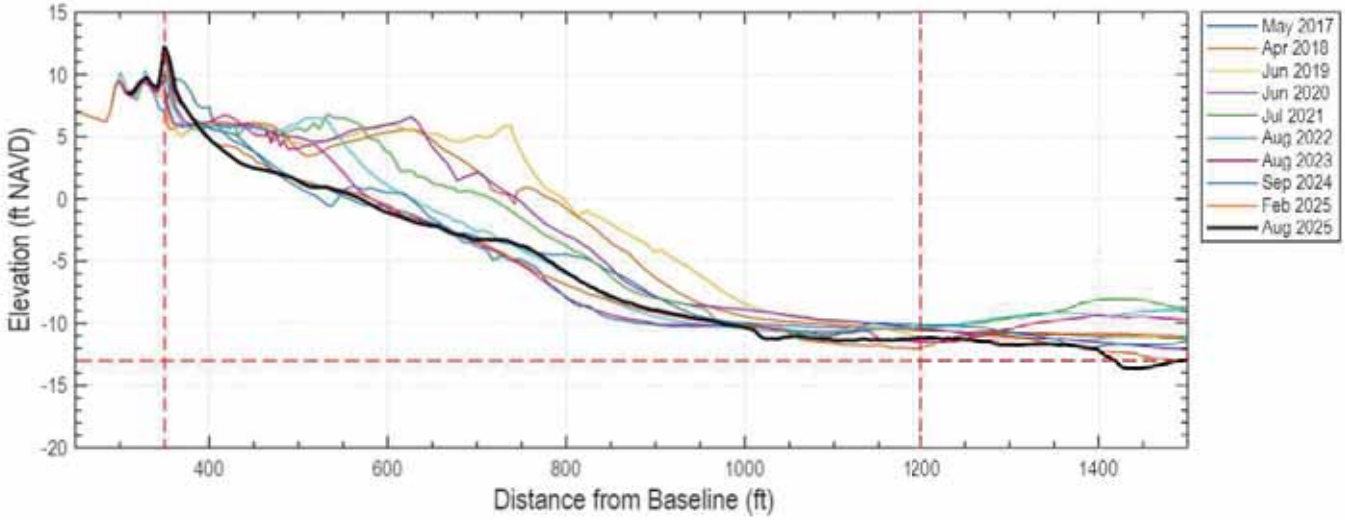


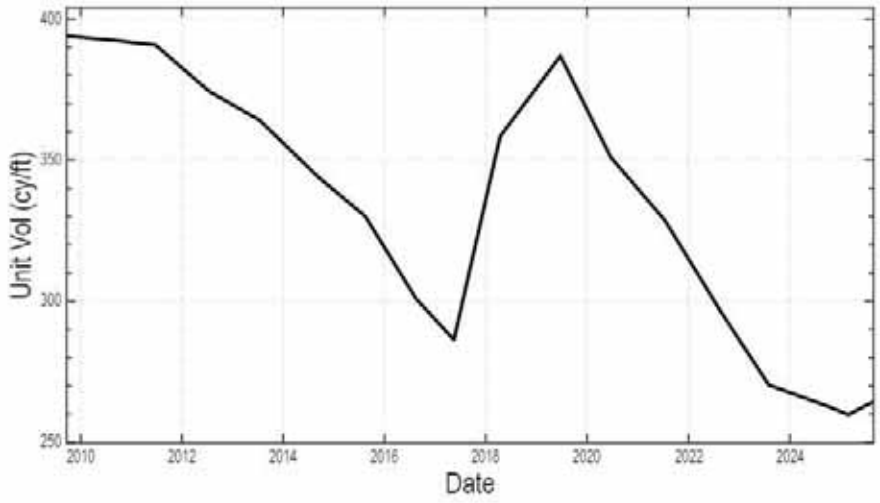




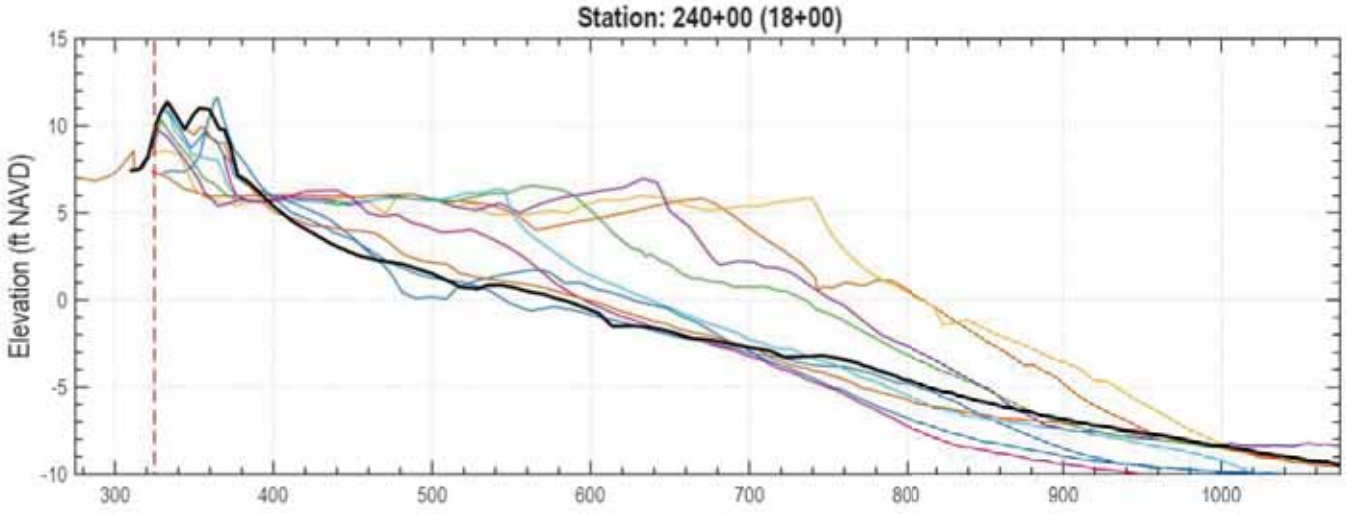
X: 2386736.27
Y: 354697.85

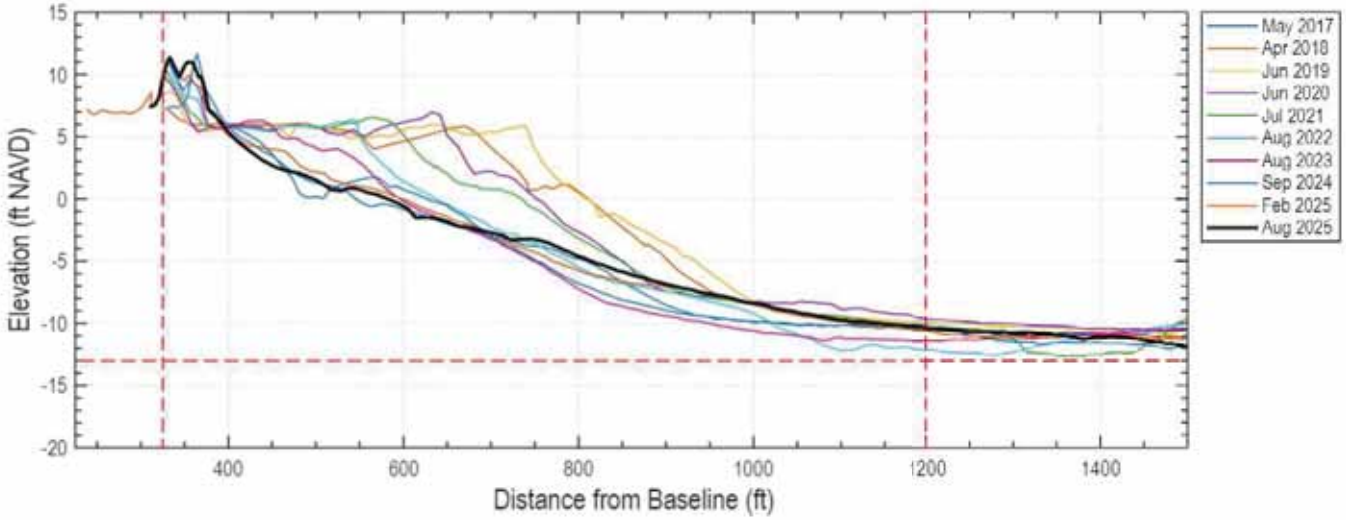


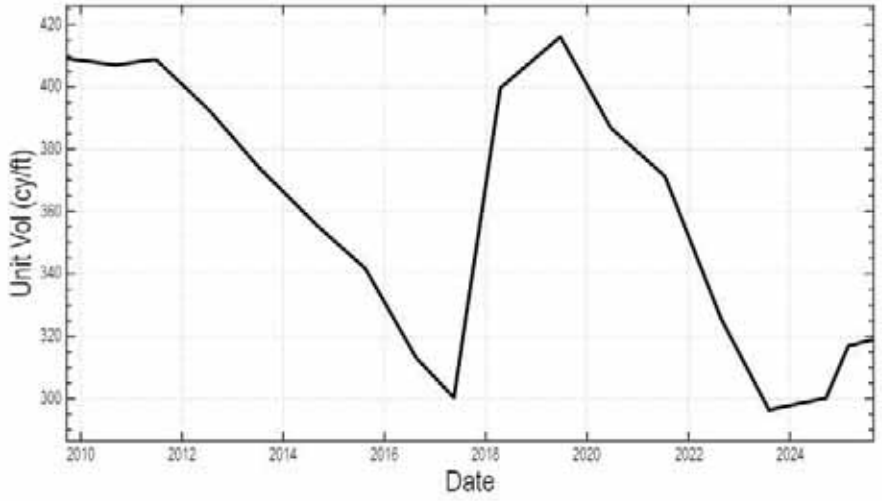




X: 2386923.37
Y: 354768.52

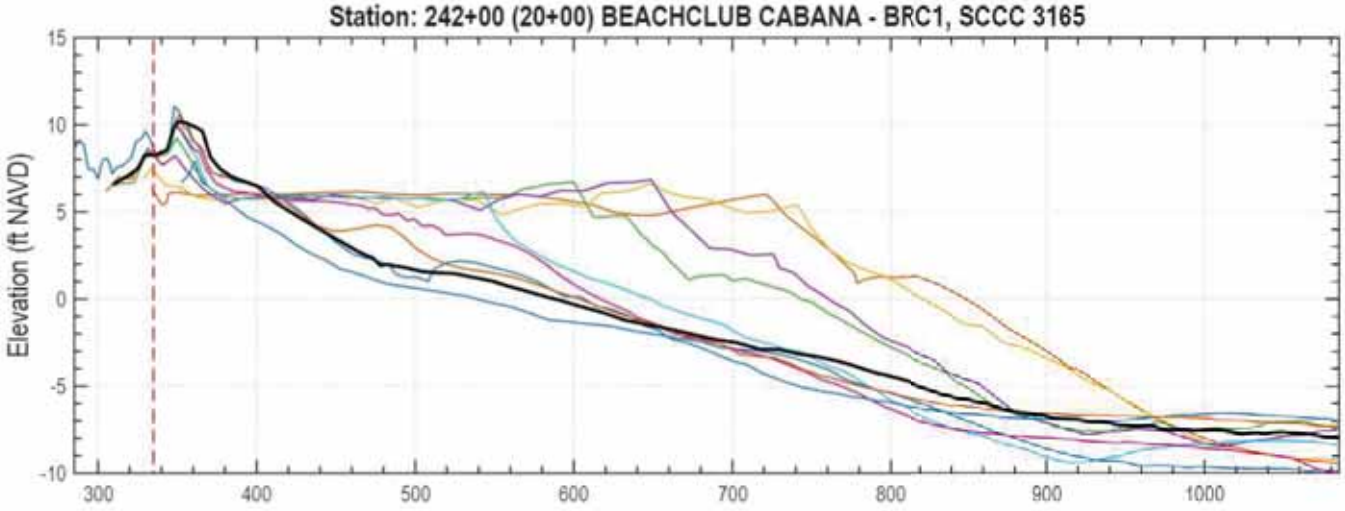


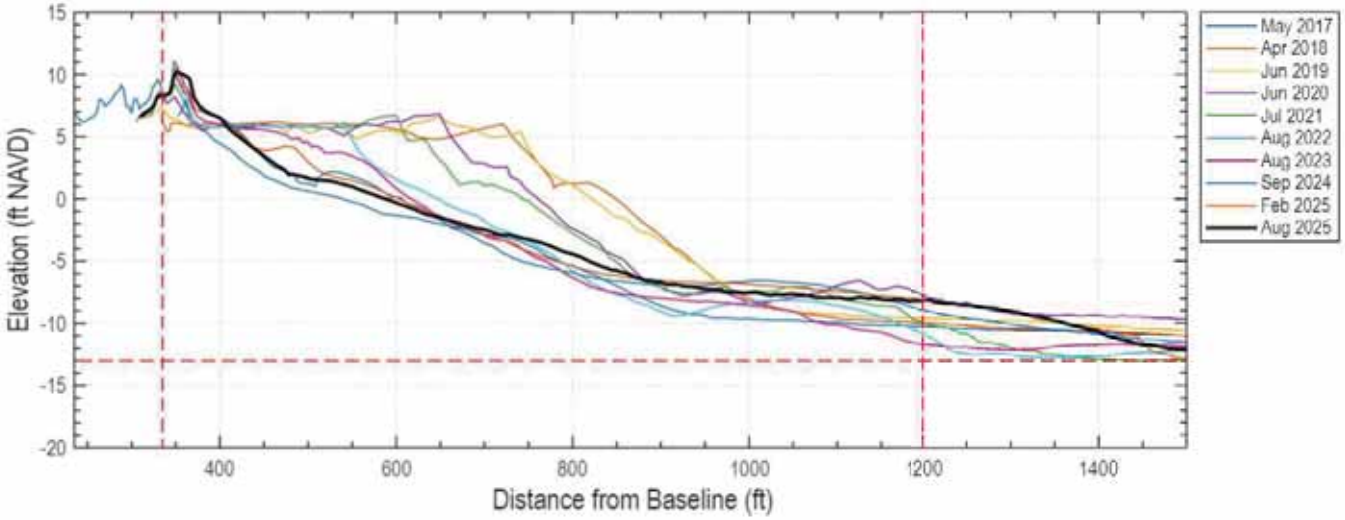


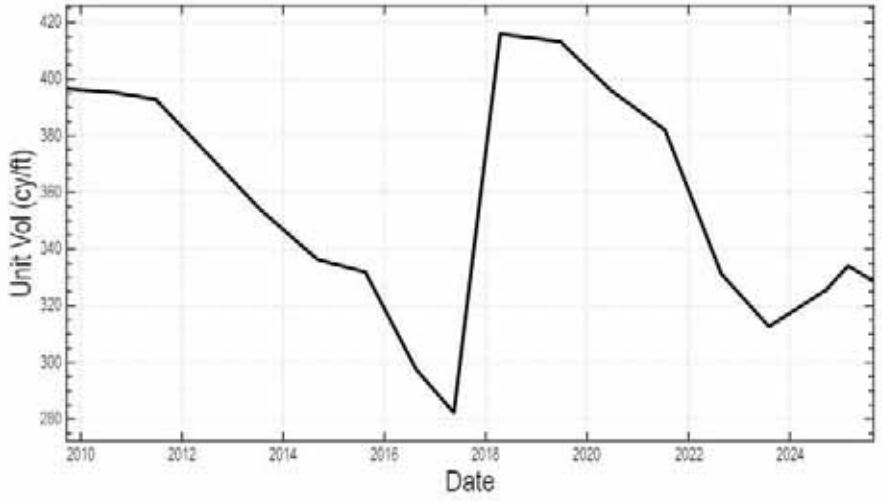


X: 2387110.47
Y: 354839.18

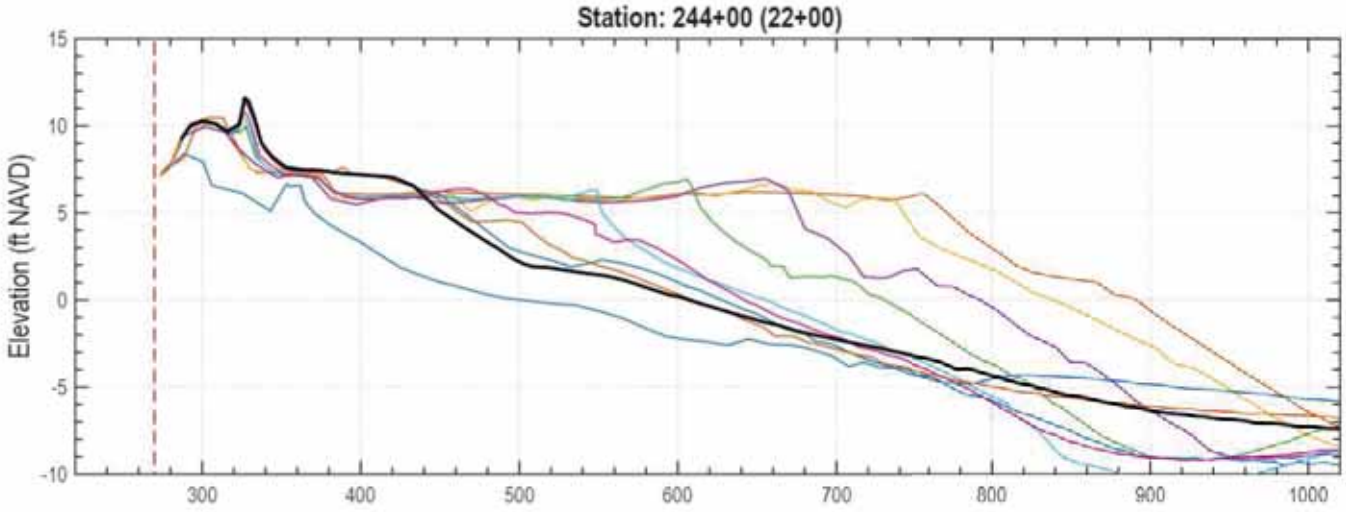
Station: 242+00 (20+00) BEACHCLUB CABANA - BRC1, SCCC 3165

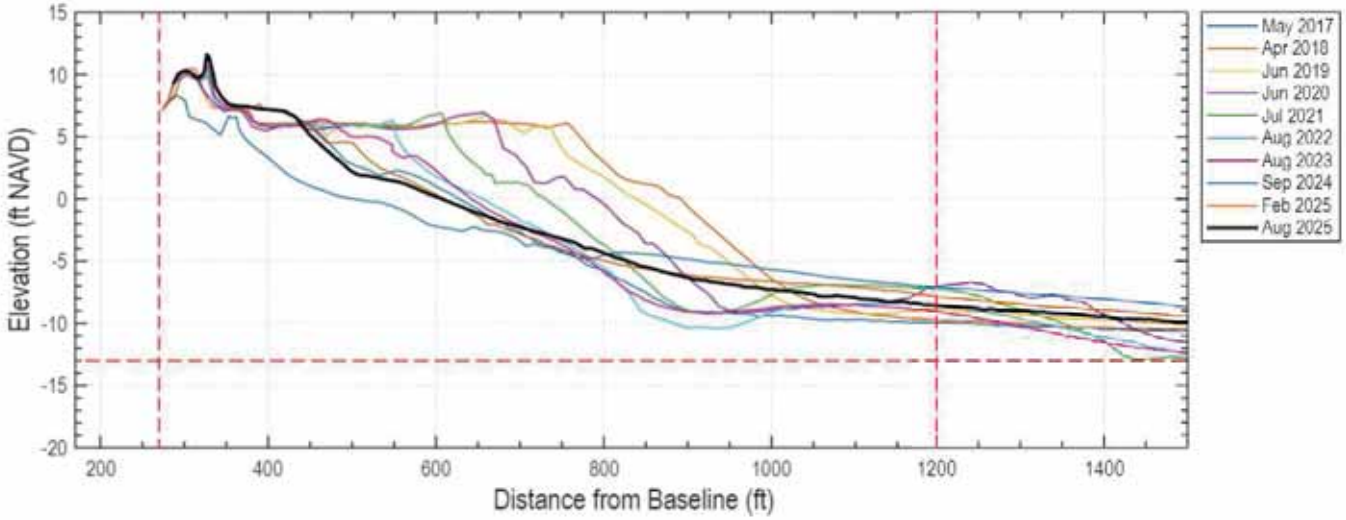


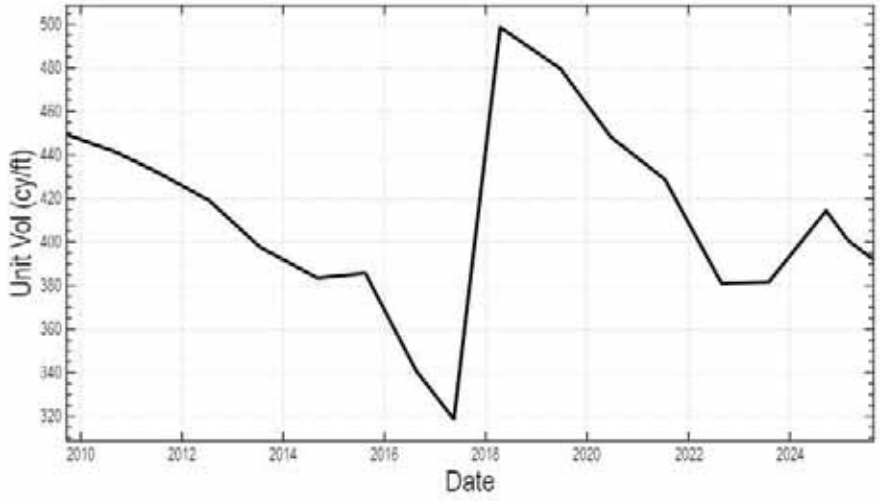




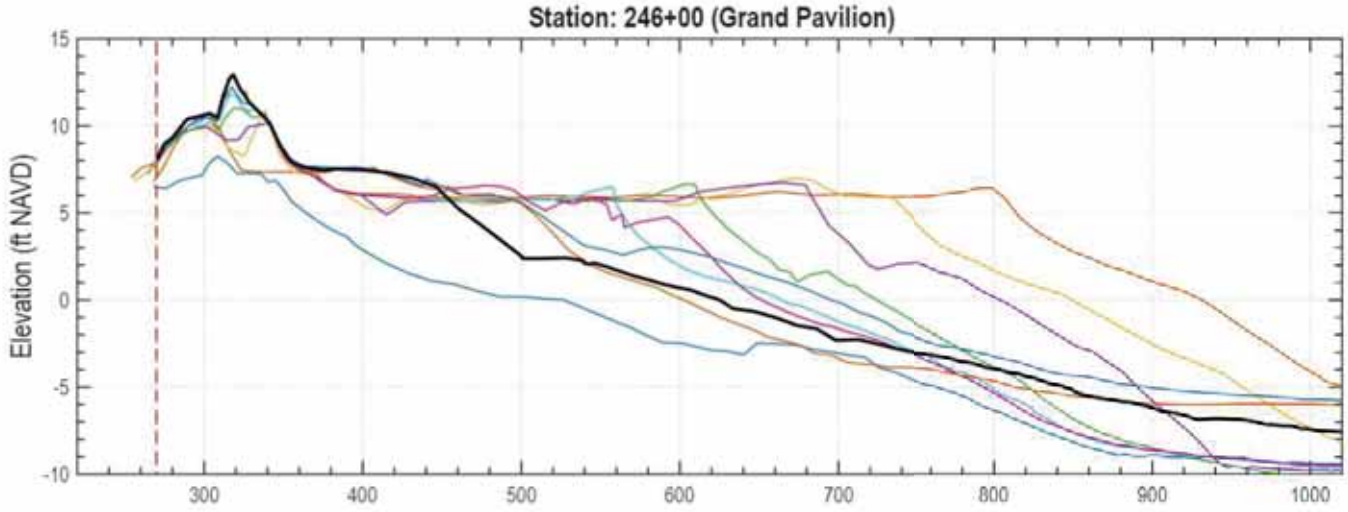
X: 2387297.57
Y: 354909.85

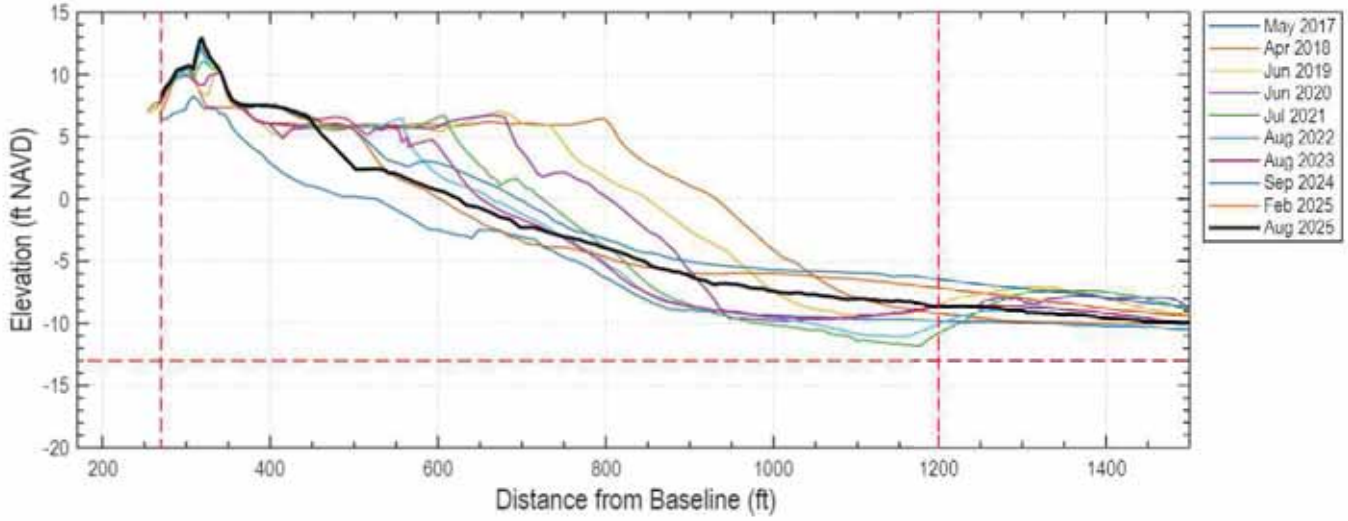


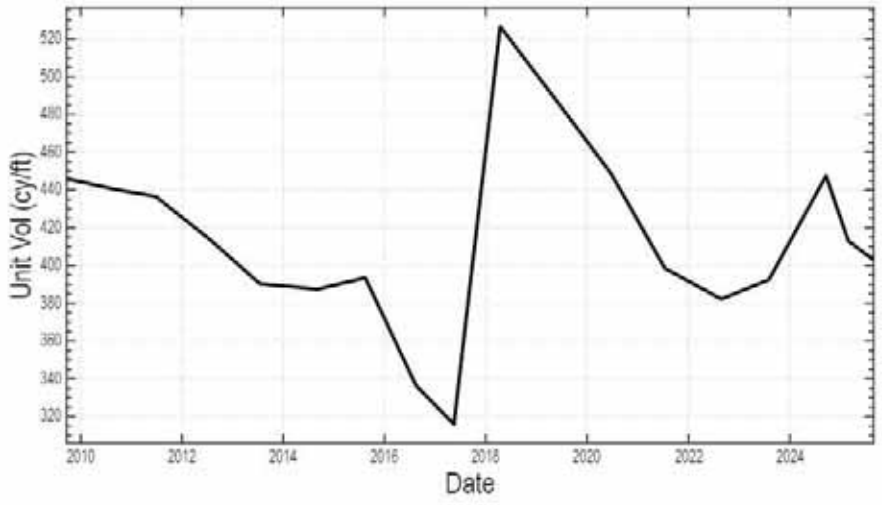




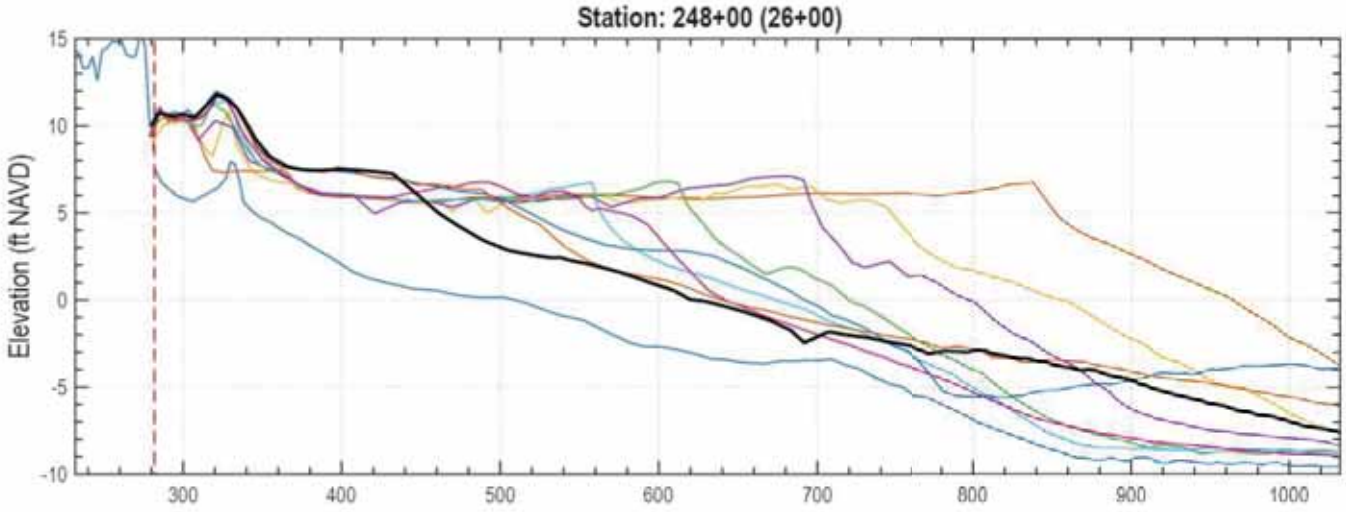
X: 2387484.67
Y: 354980.51

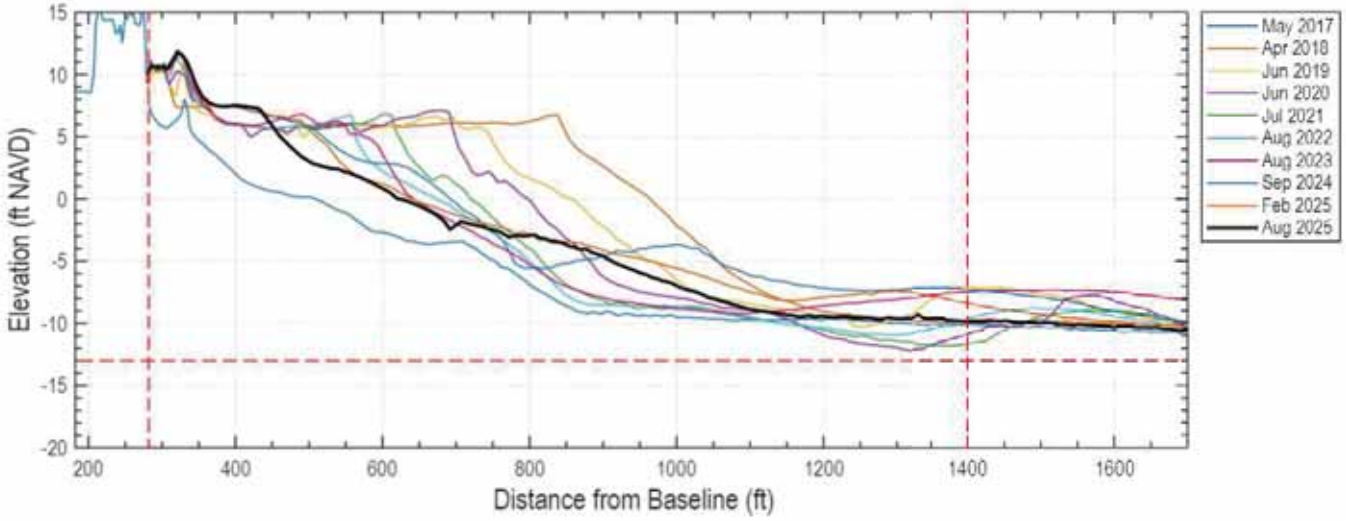


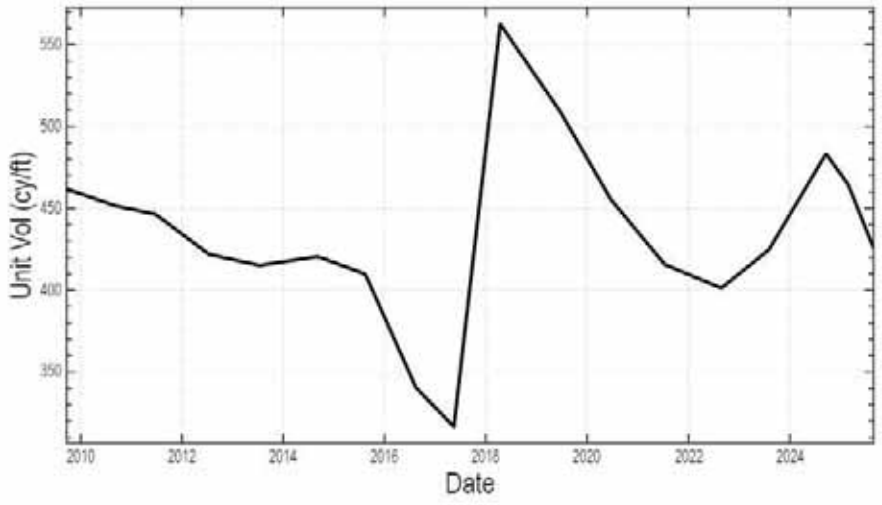




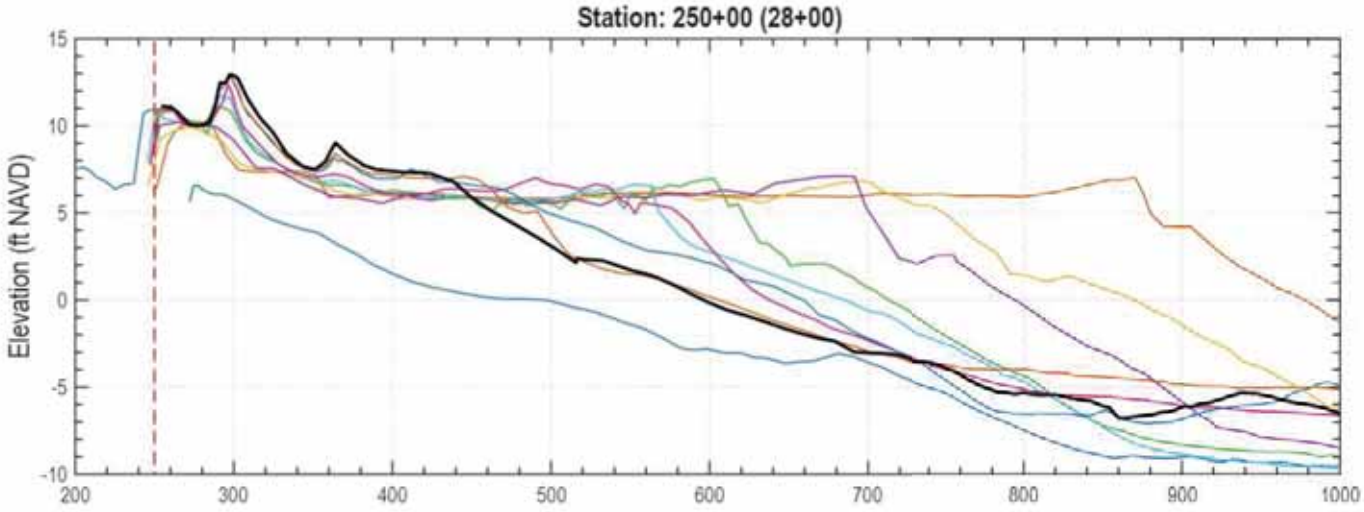
X: 2387671.77
Y: 355051.17

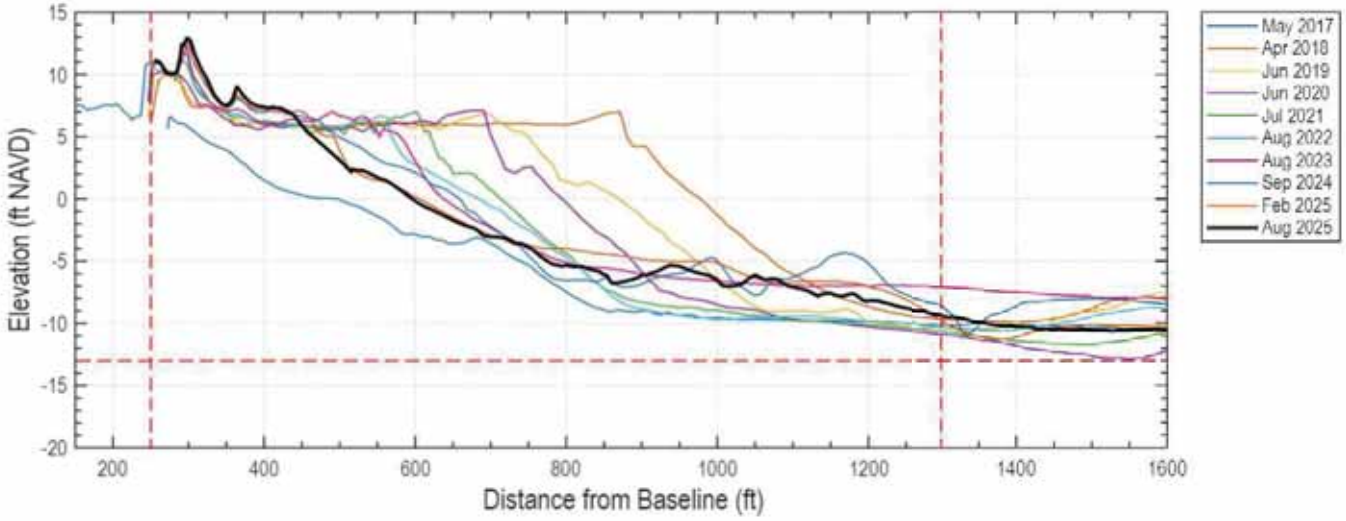


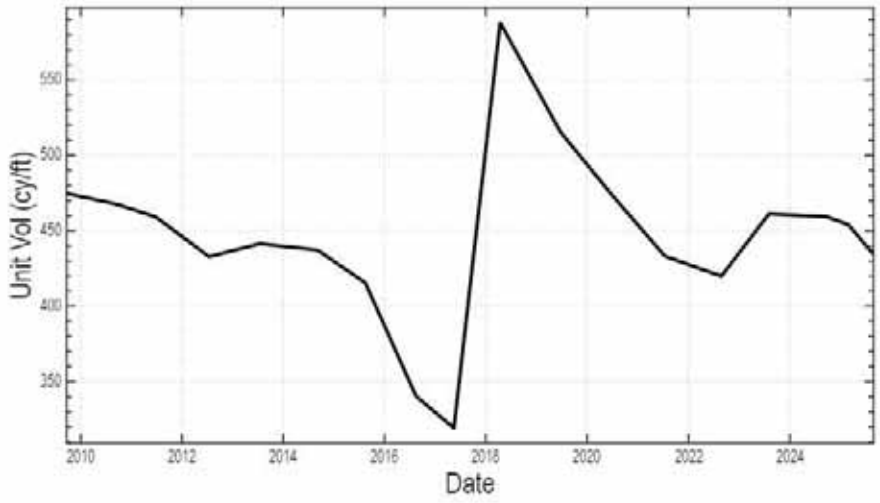




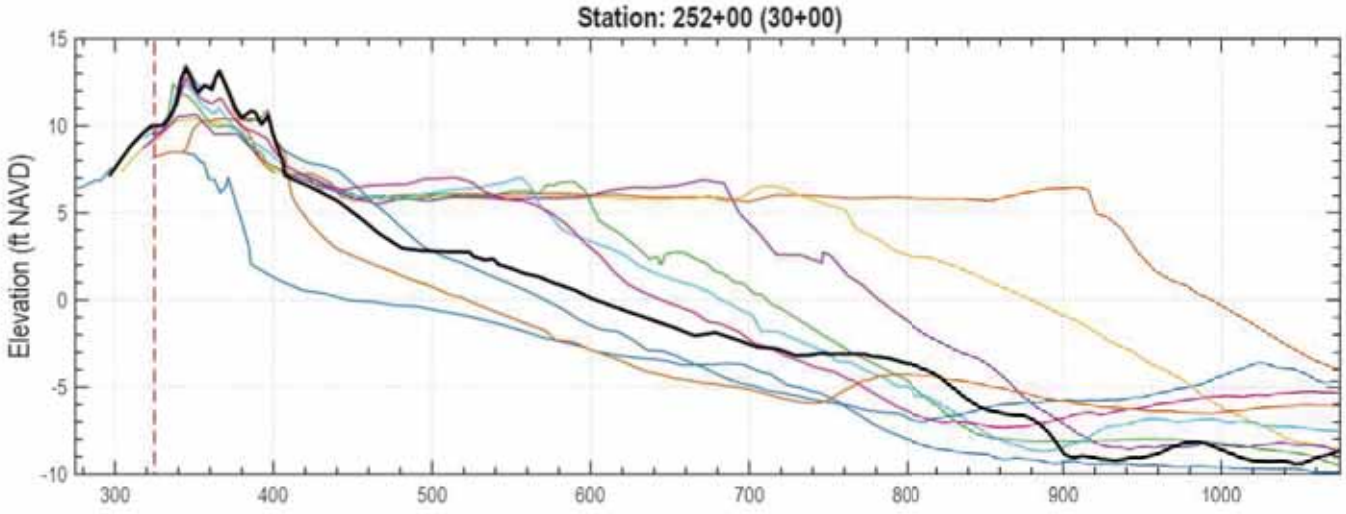
X: 2387858.67
Y: 355121.84

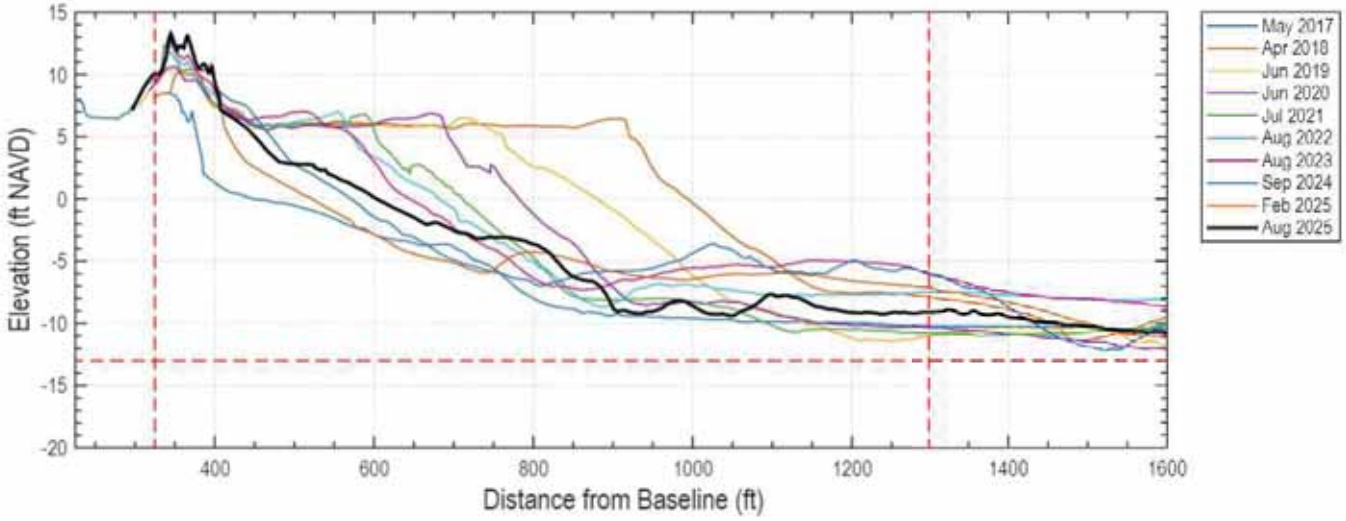


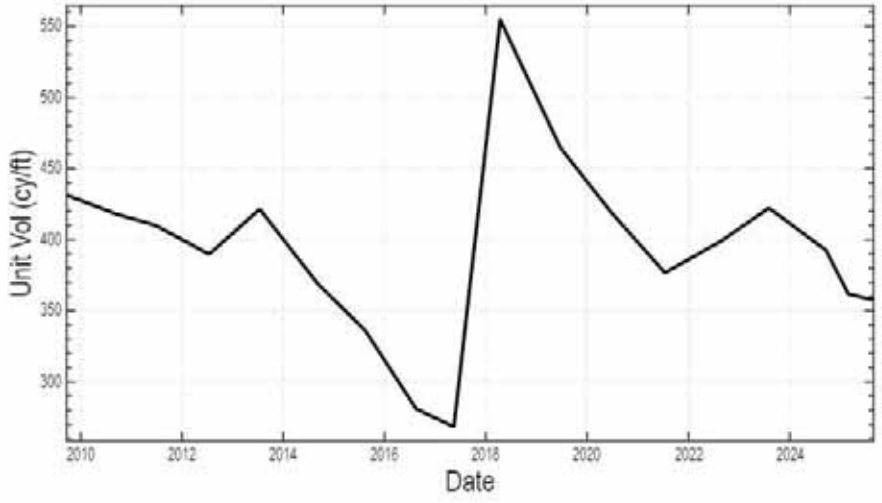




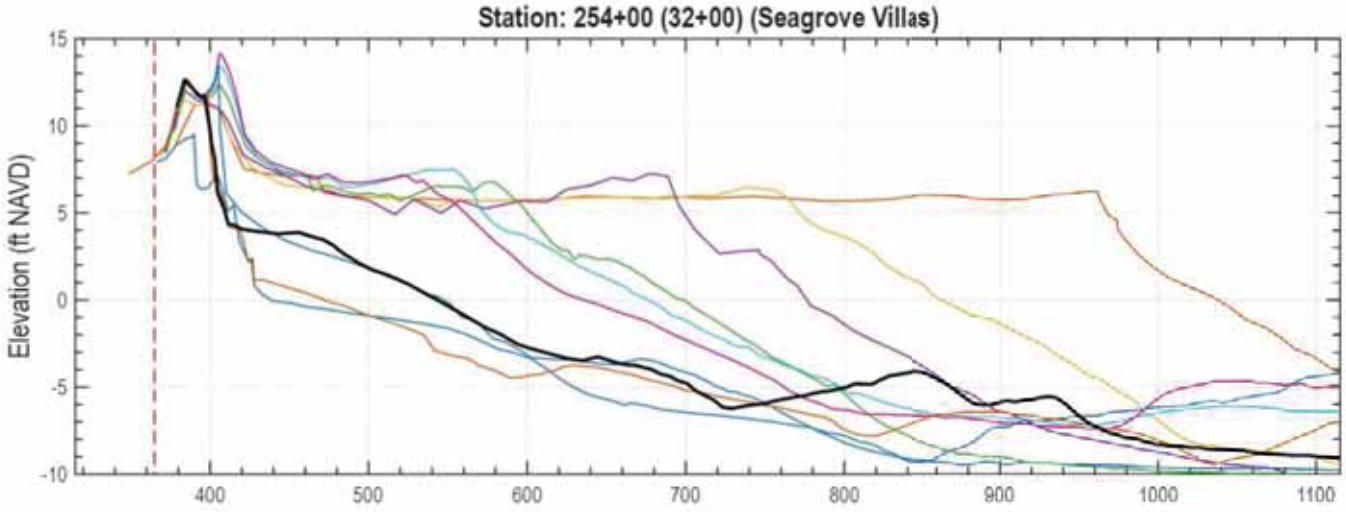
X: 2388045.97
Y: 355192.5

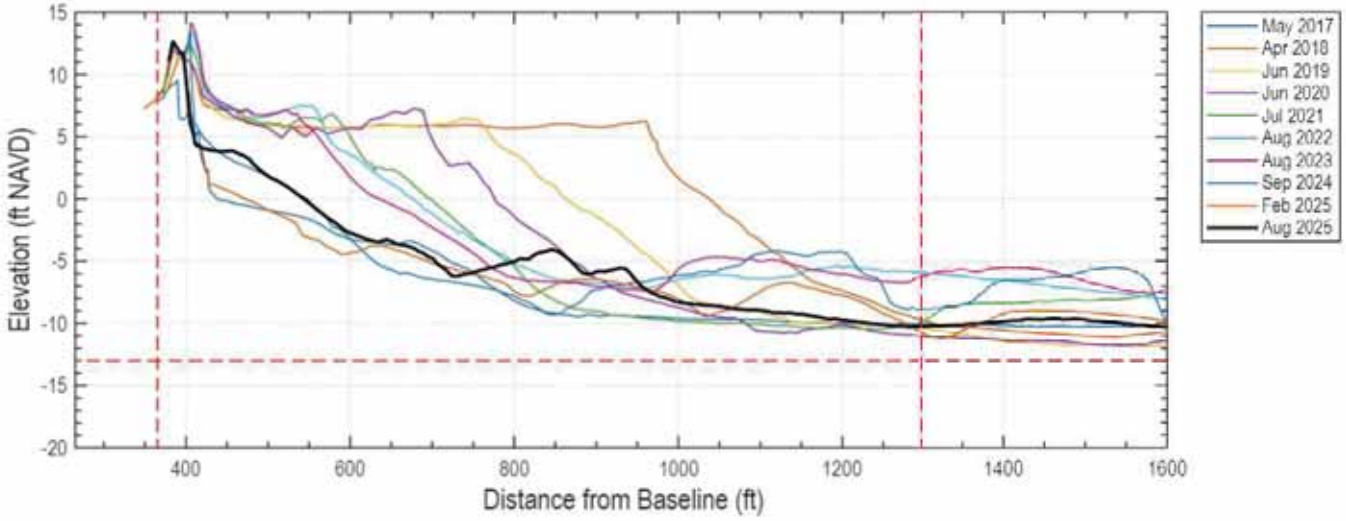


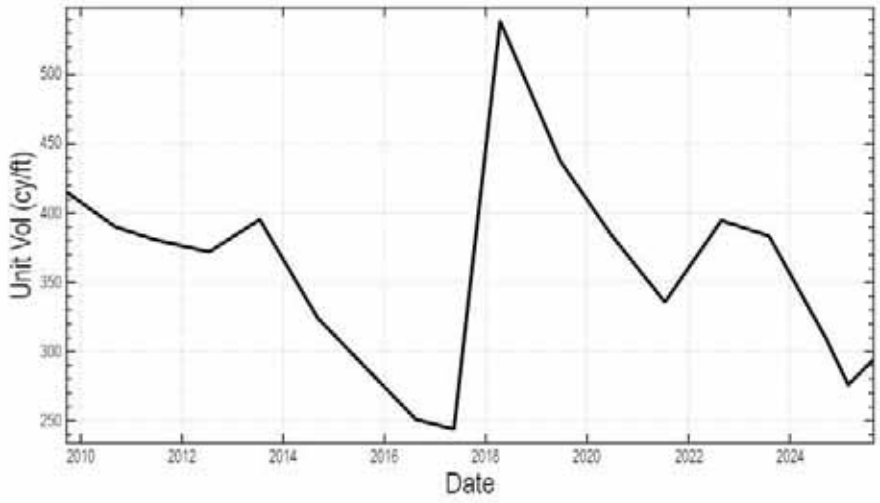




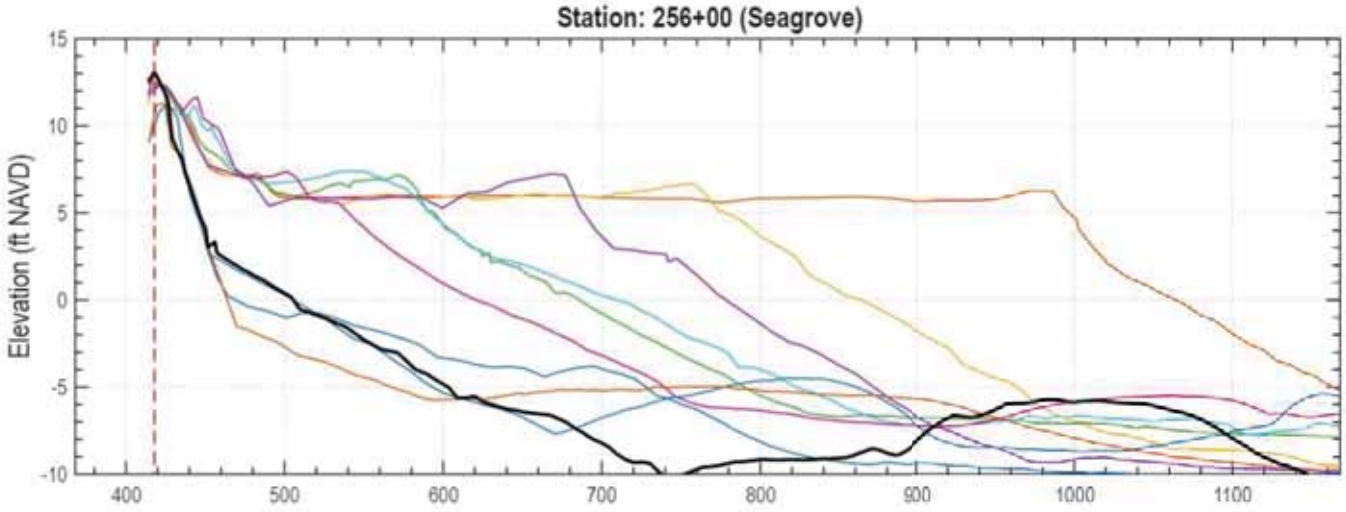
X: 2368233.07
Y: 355263.16

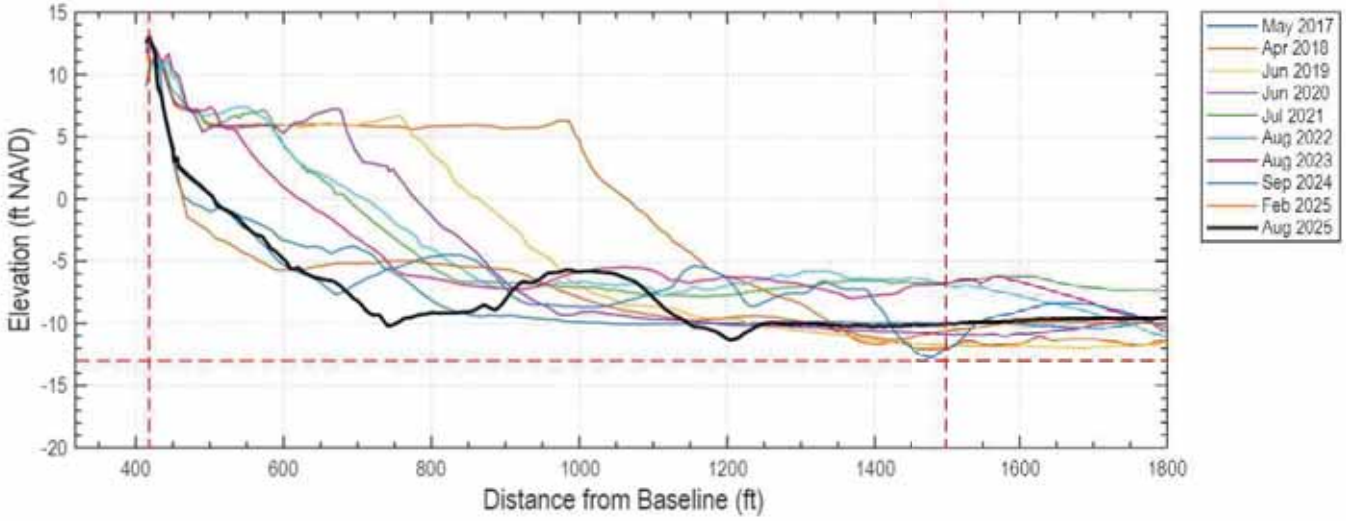


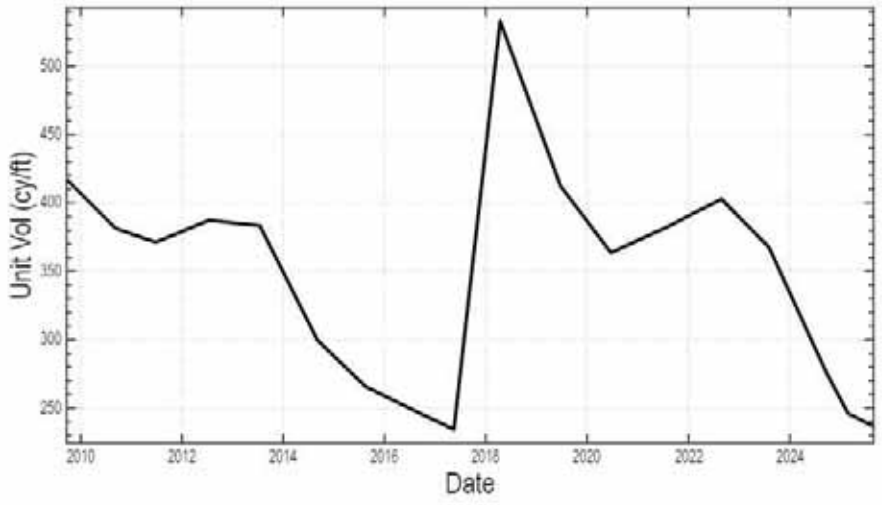




X: 2388420.17
Y: 355333.83

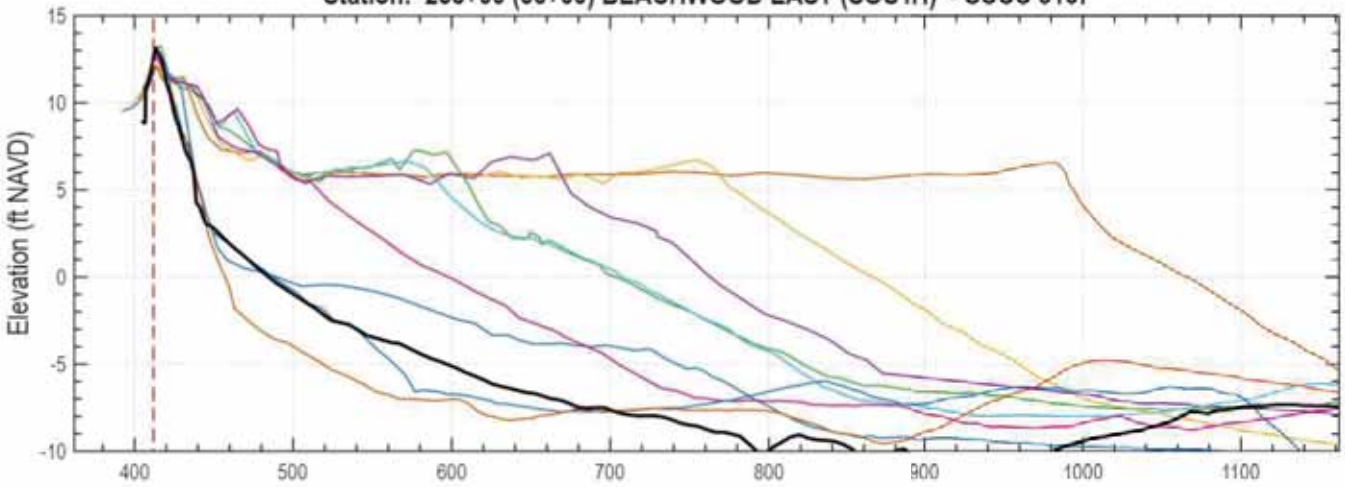


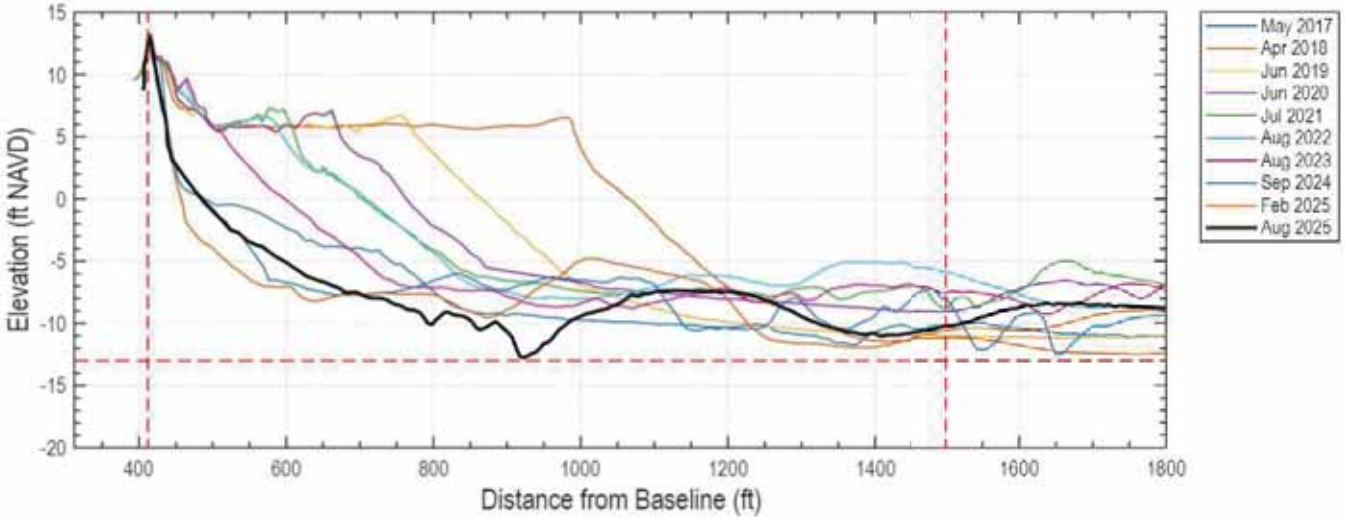


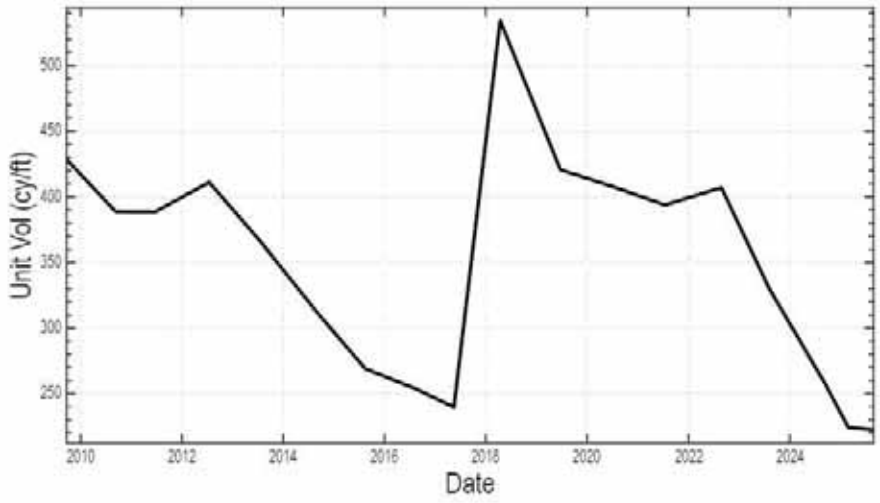


X: 2388607.27
Y: 355404.49

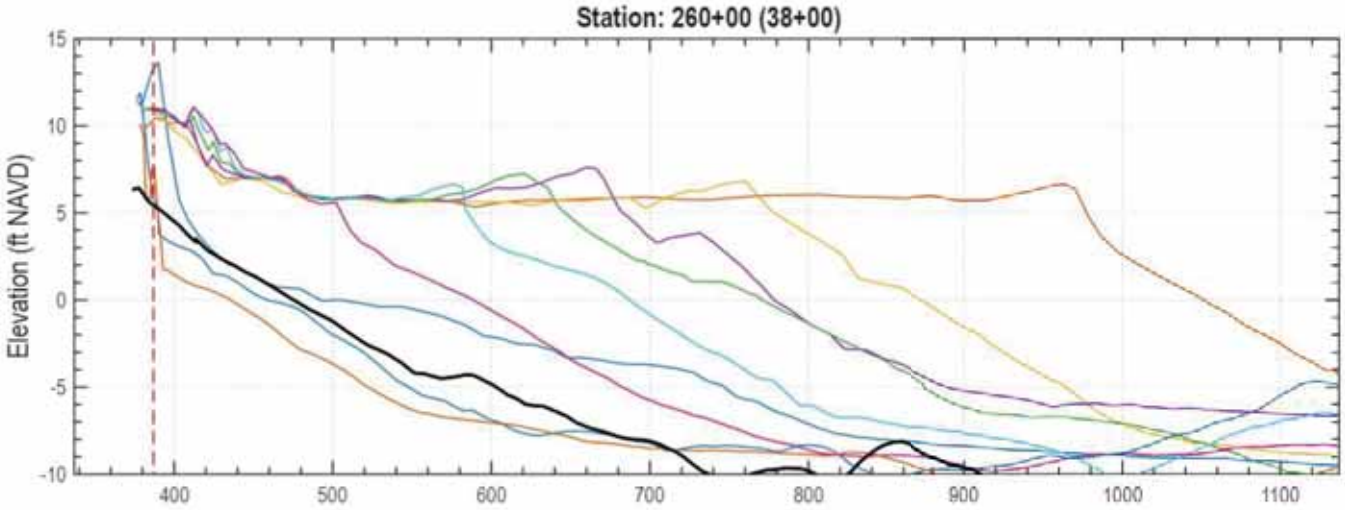
Station: 258+00 (36+00) BEACHWOOD EAST (SOUTH) - SCCC 3167

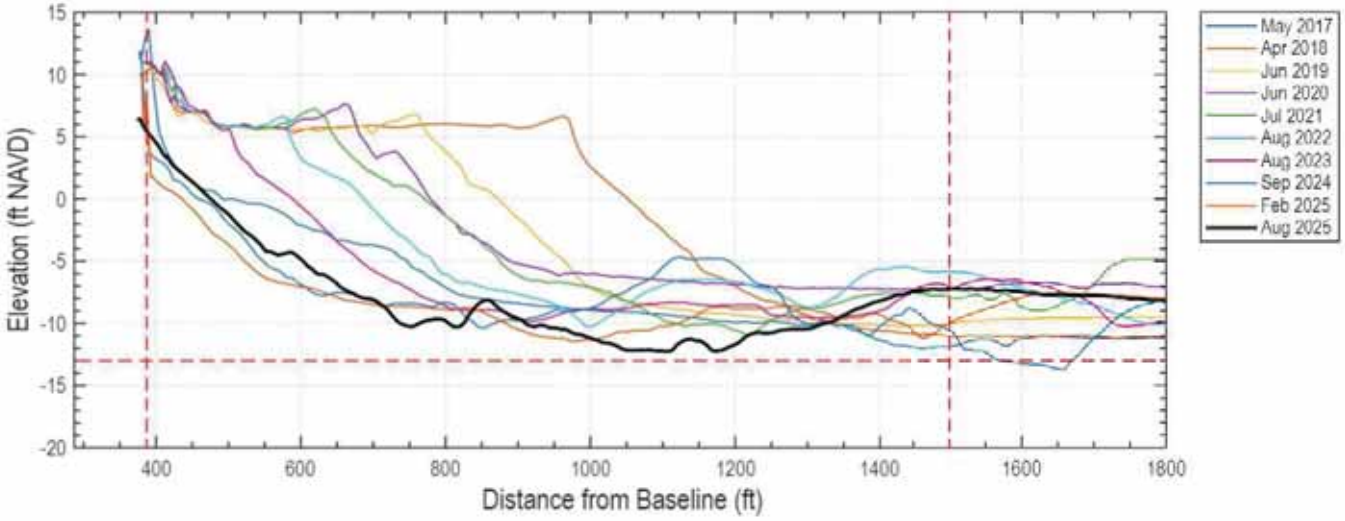


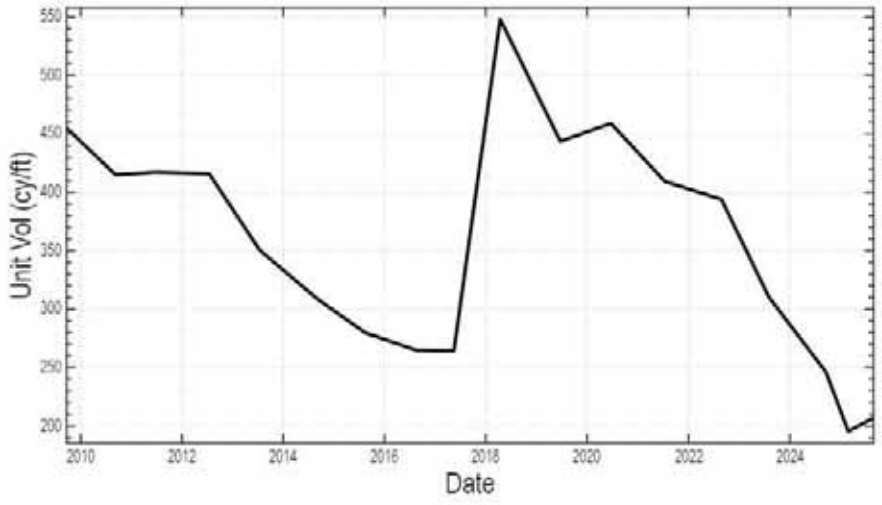




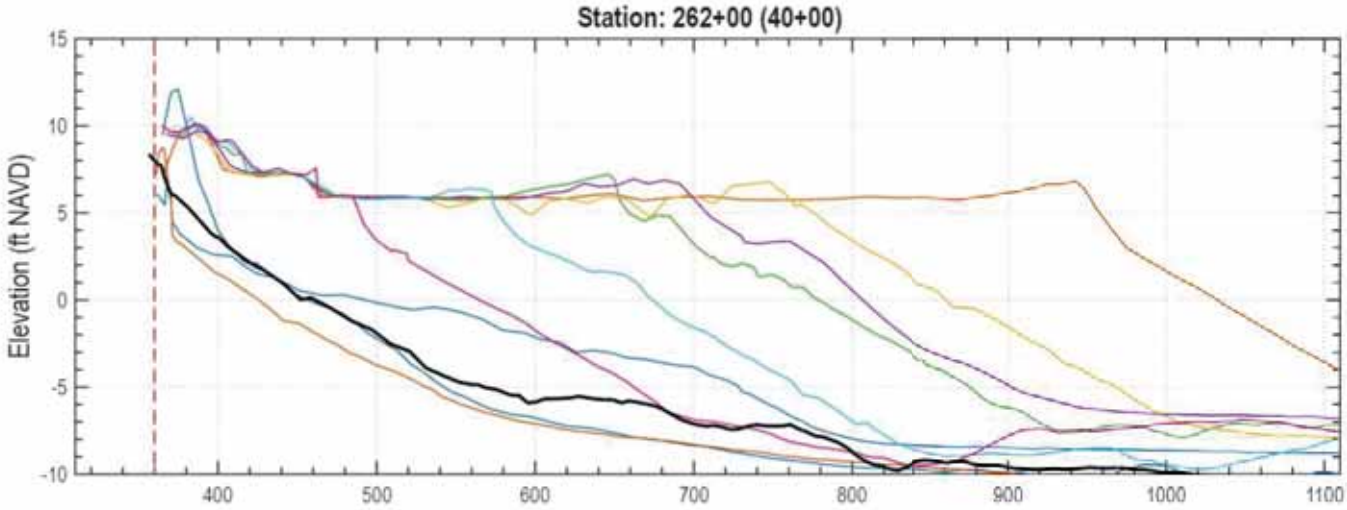
X: 2388794.38
Y: 355475.15

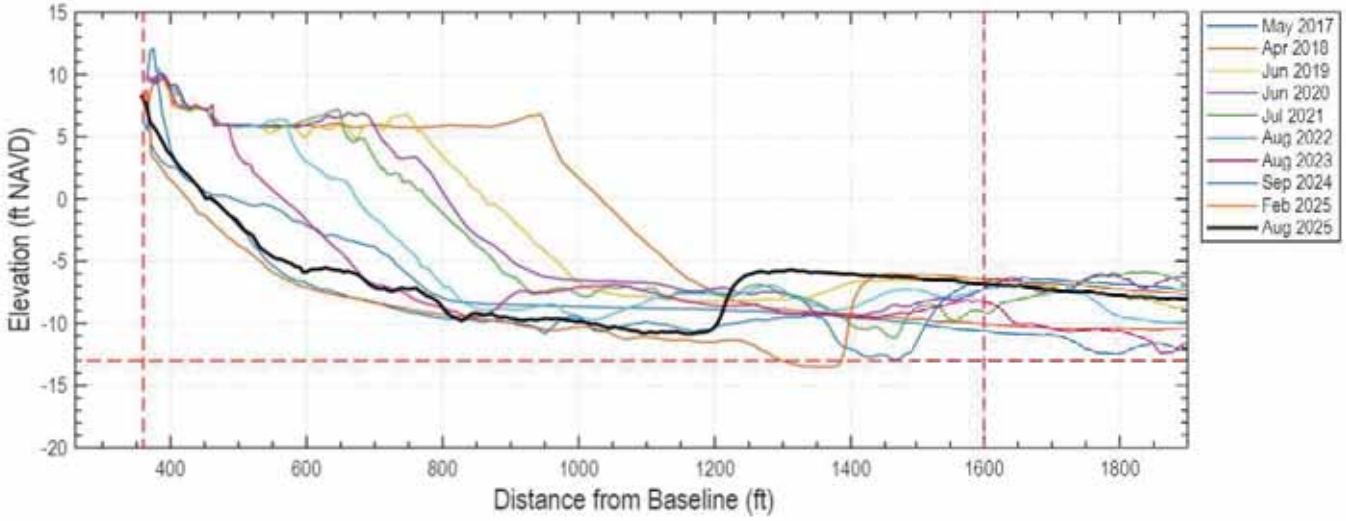


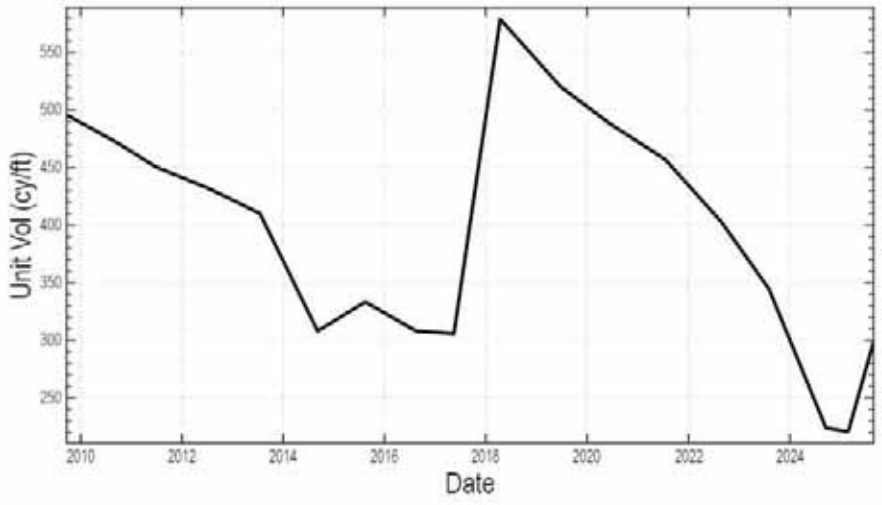




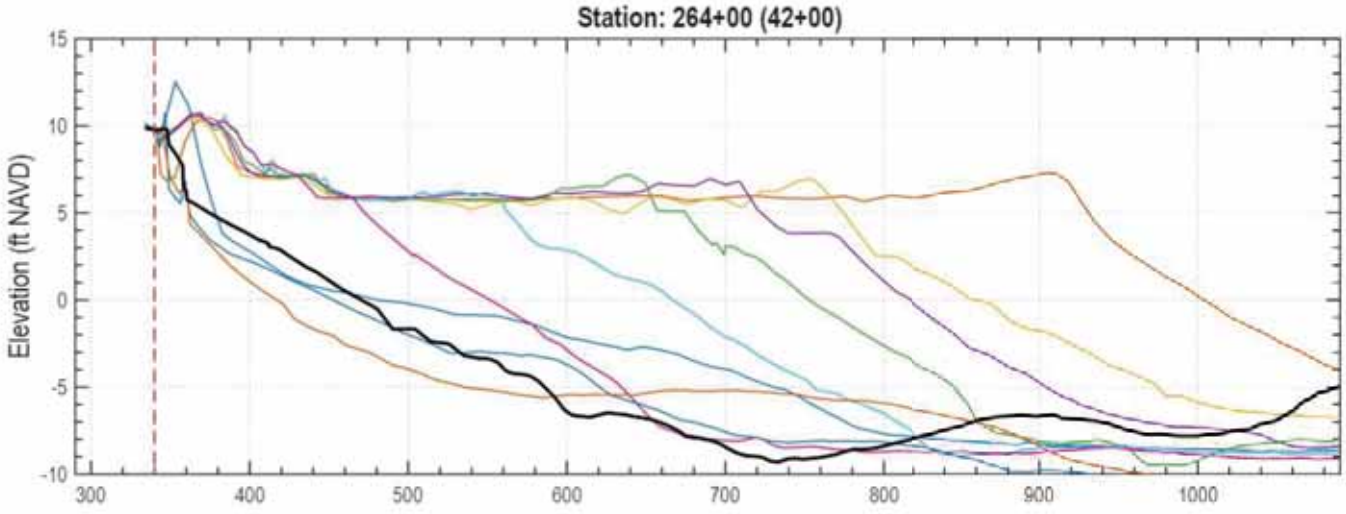
X: 2388981.48
Y: 355545.82

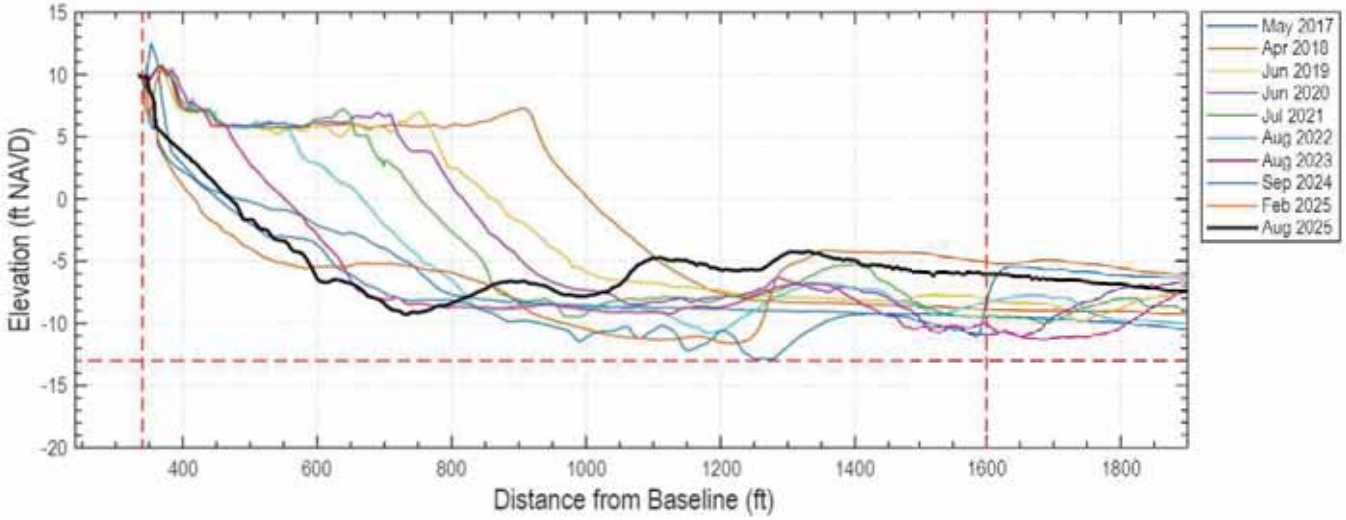


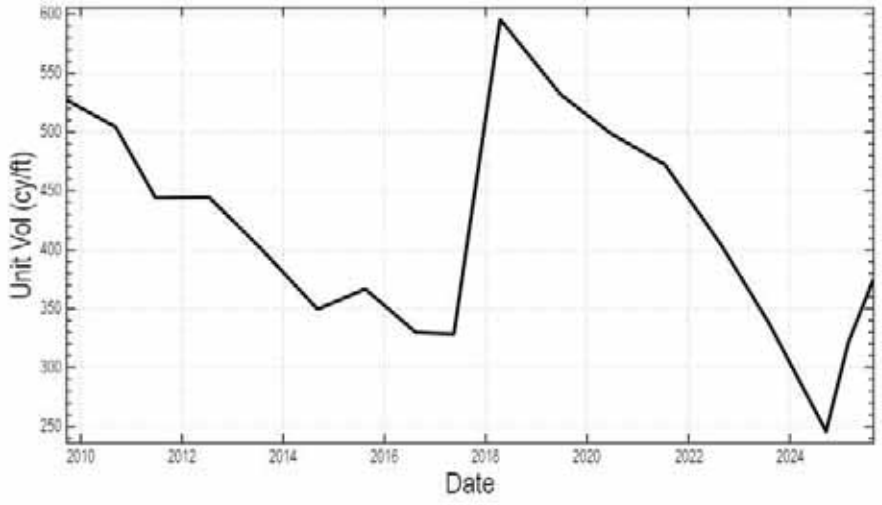




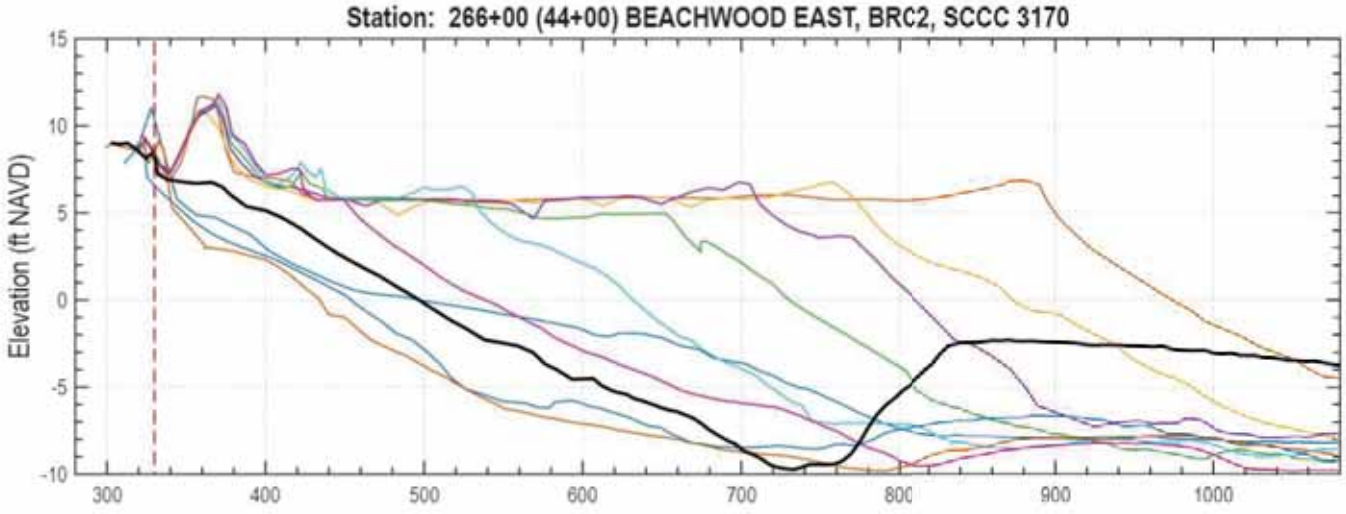
X: 2389168.58
Y: 355616.48

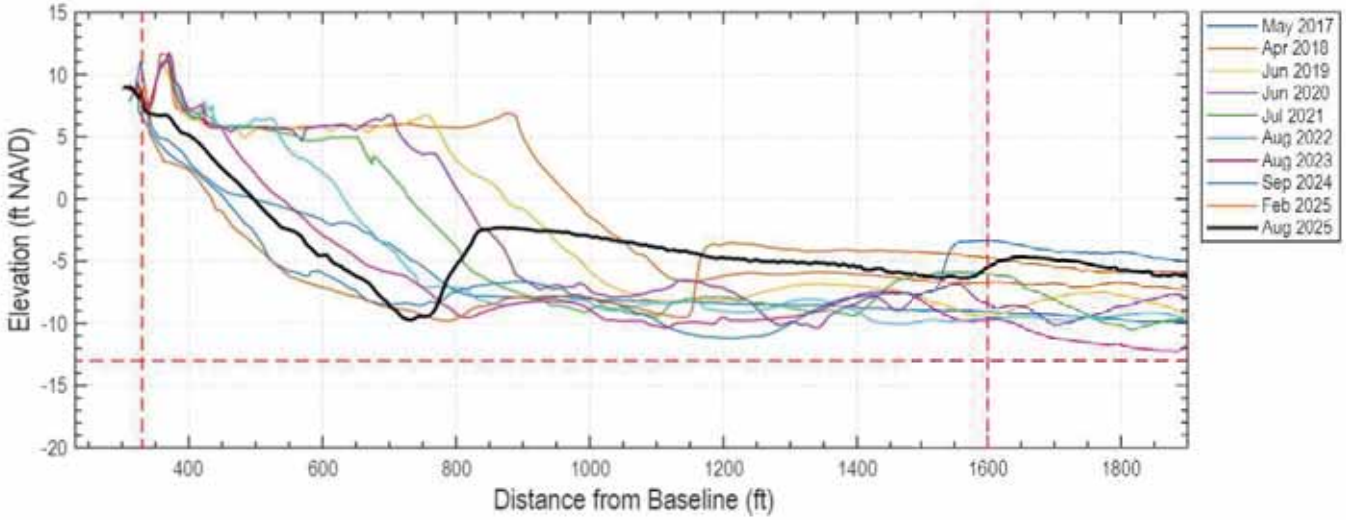


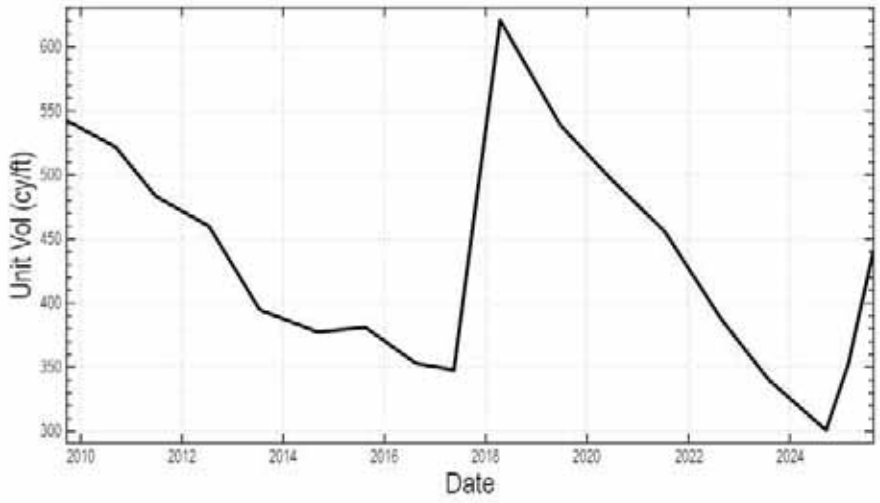




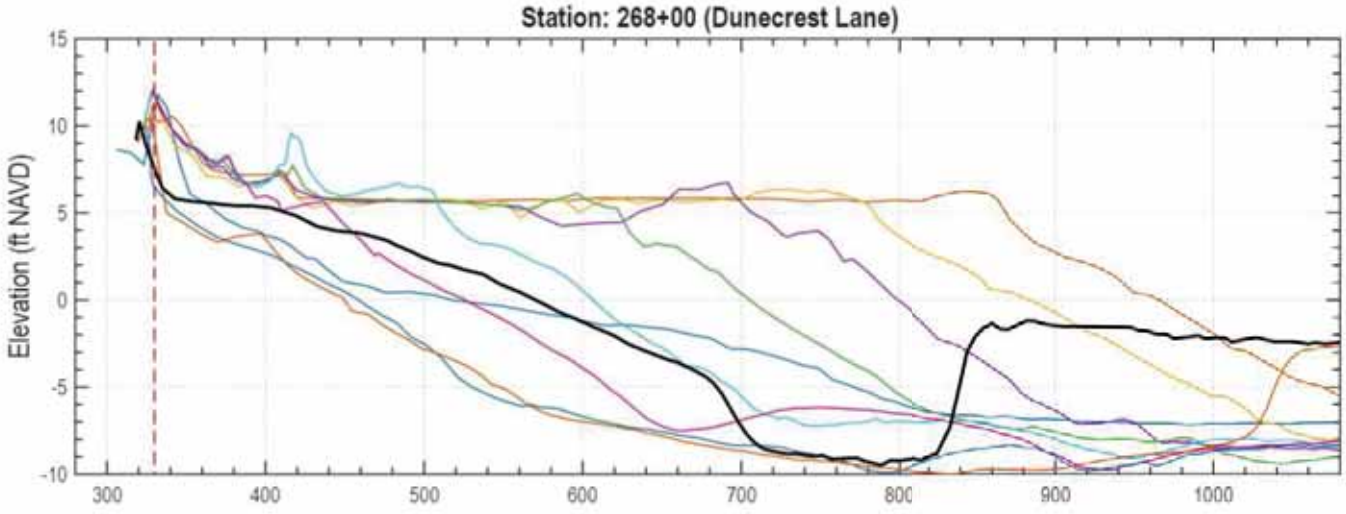
X: 2389355.68
Y: 355687.15

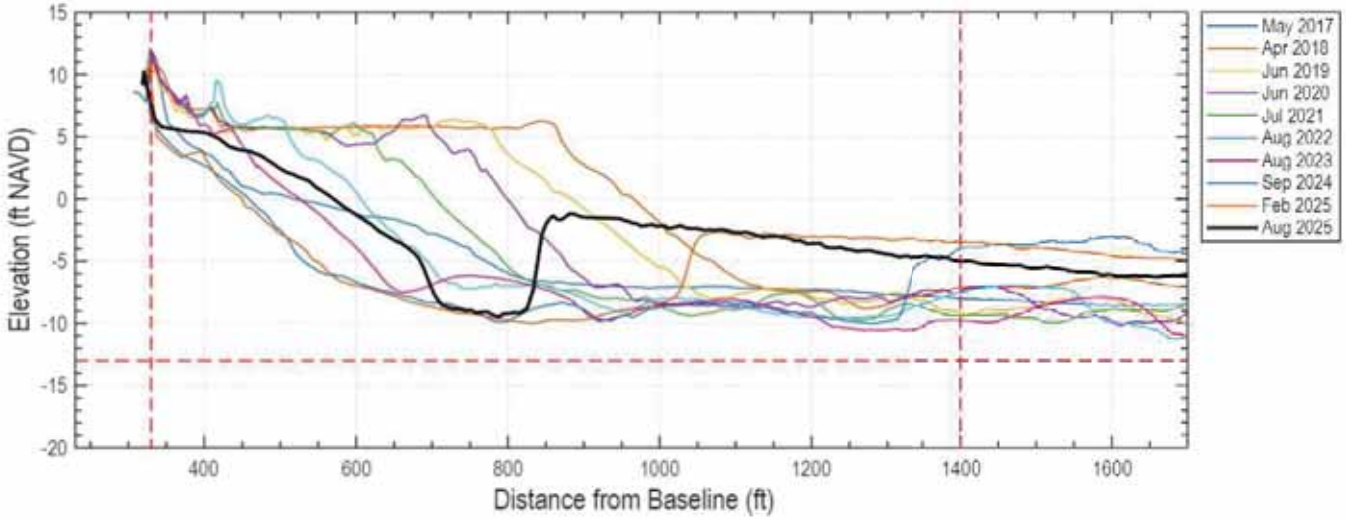


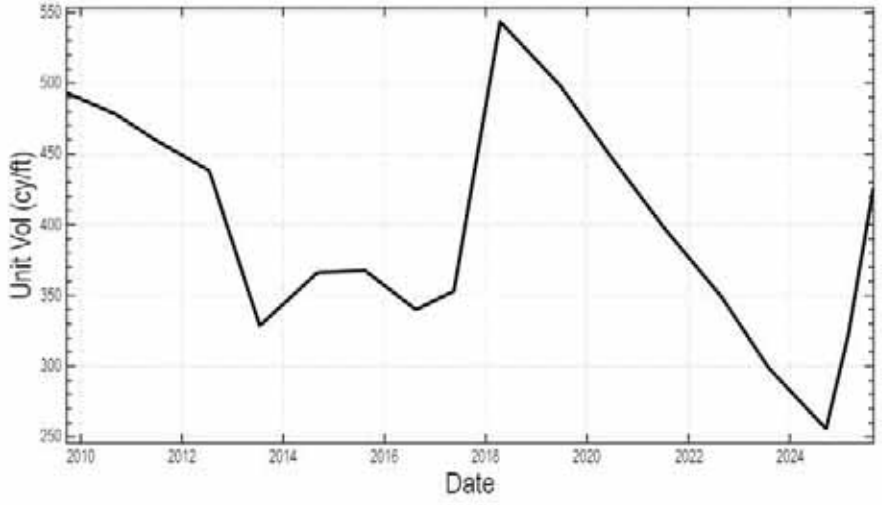




X: 2389542.78
Y: 355757.81







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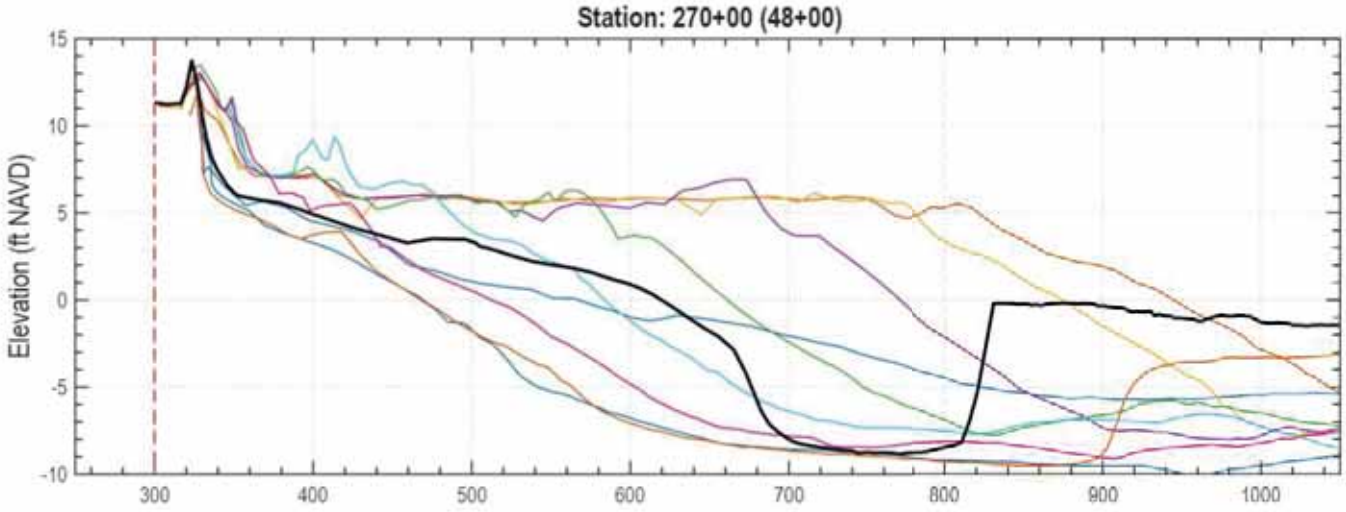

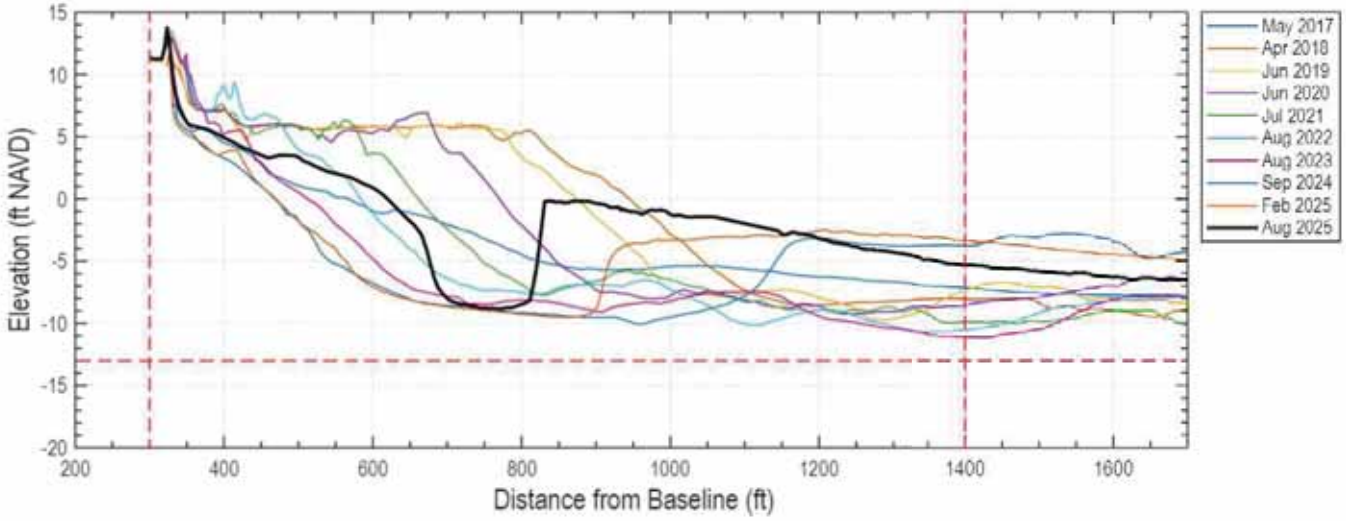

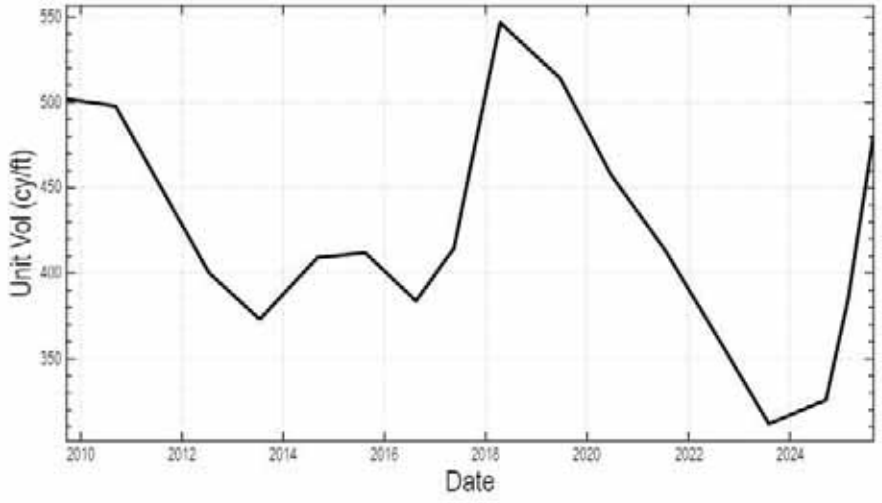

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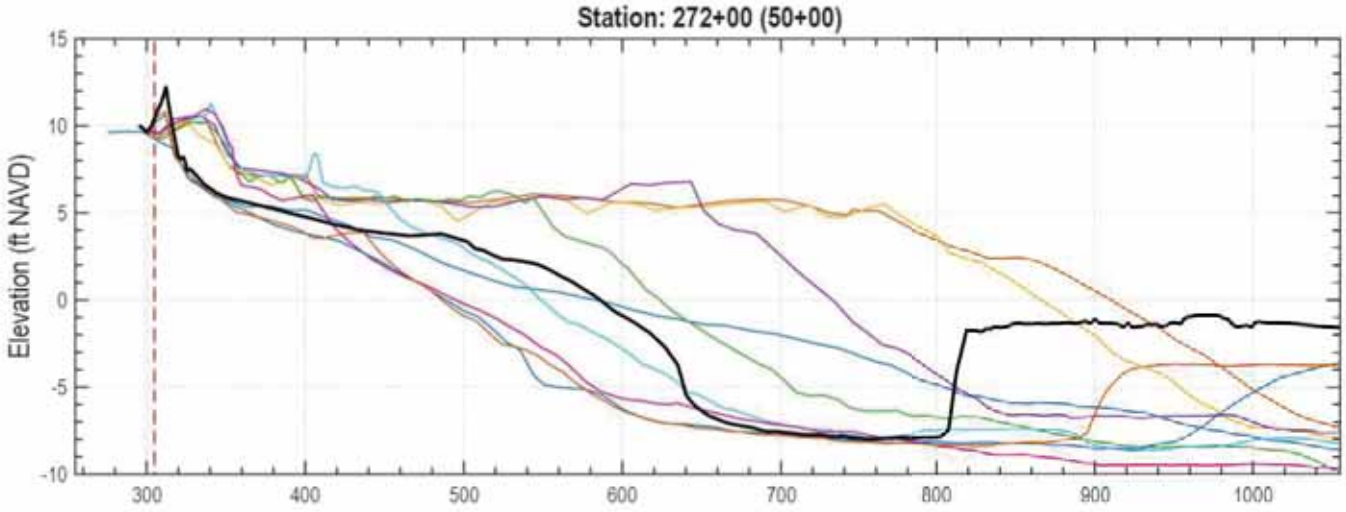

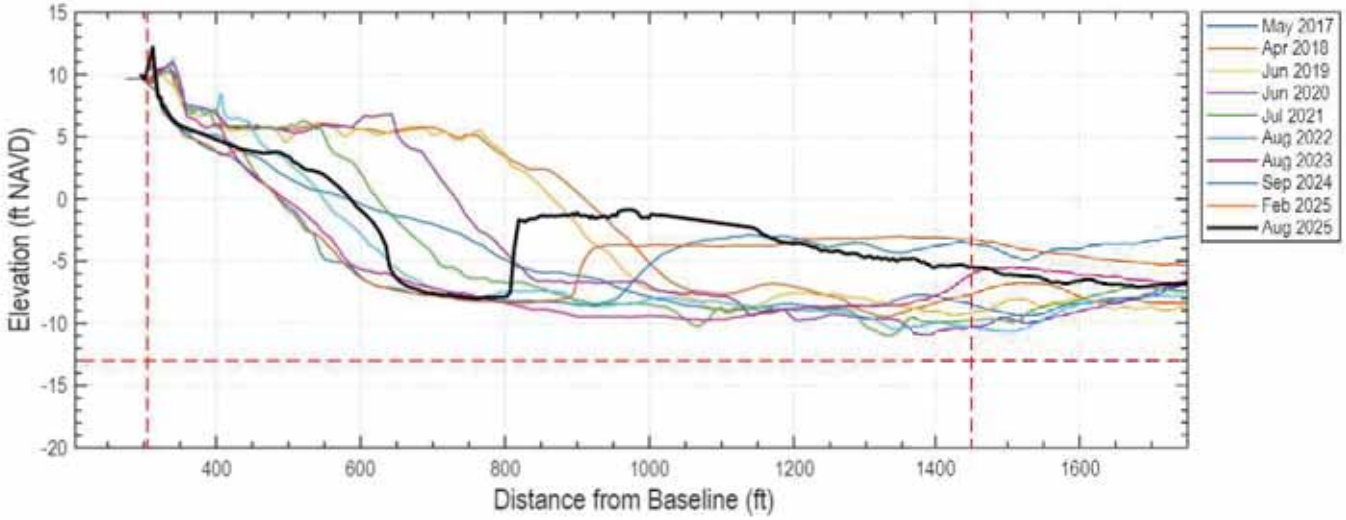

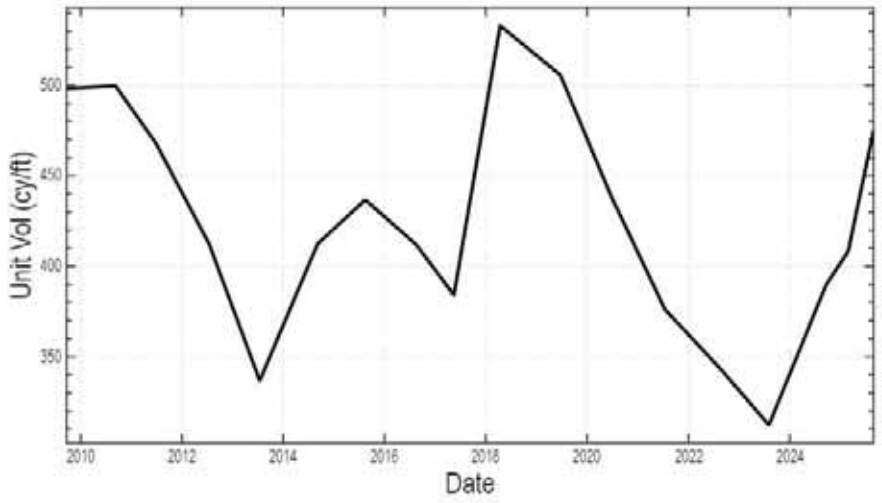

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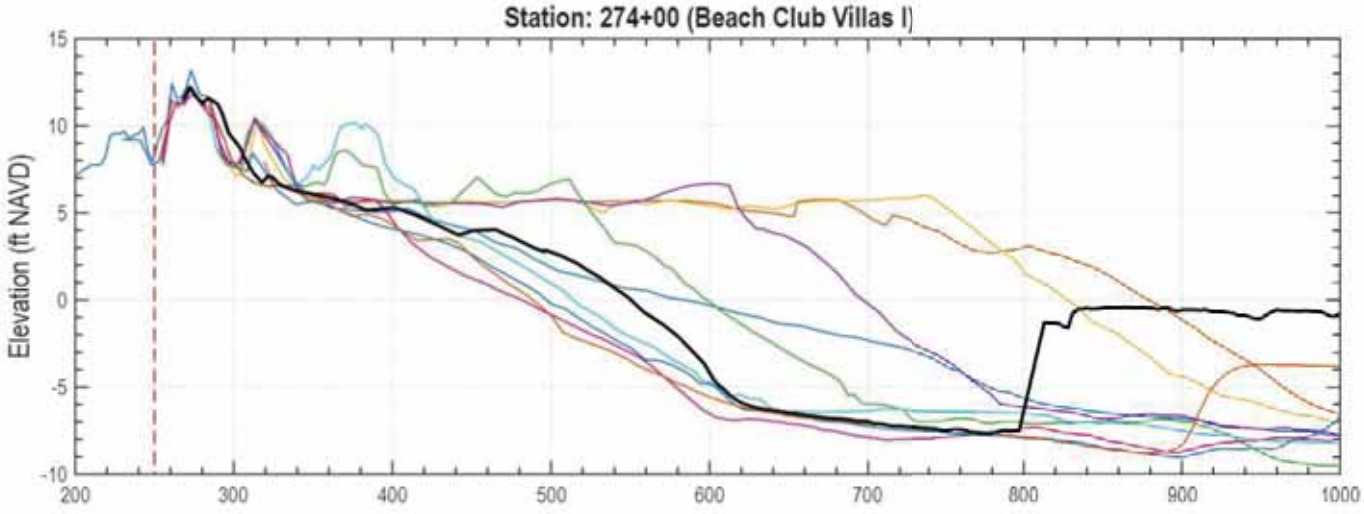

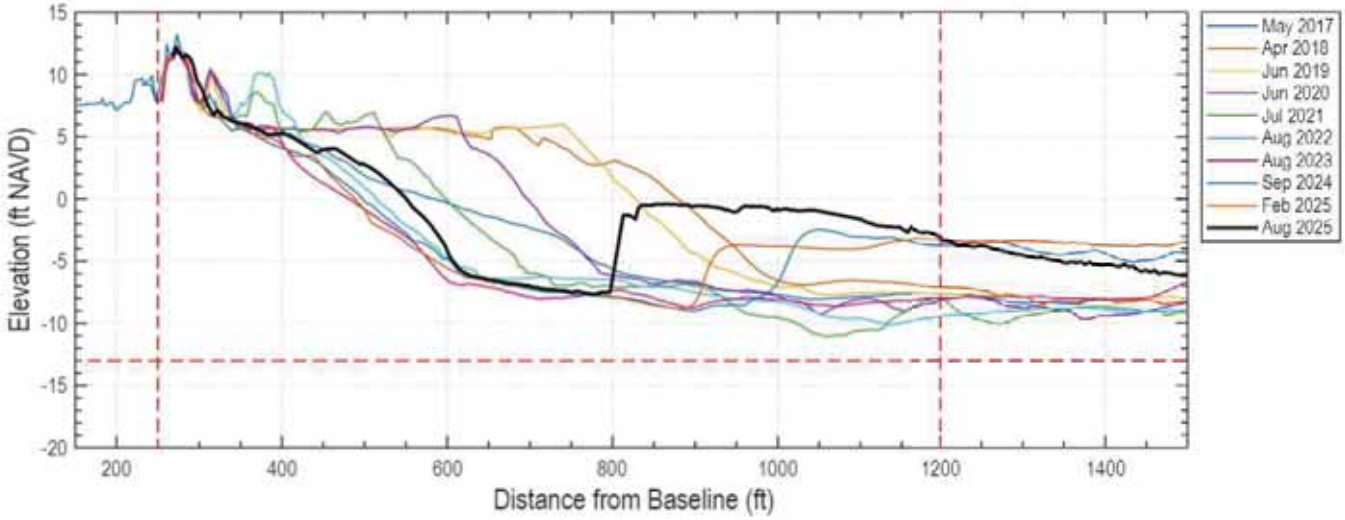

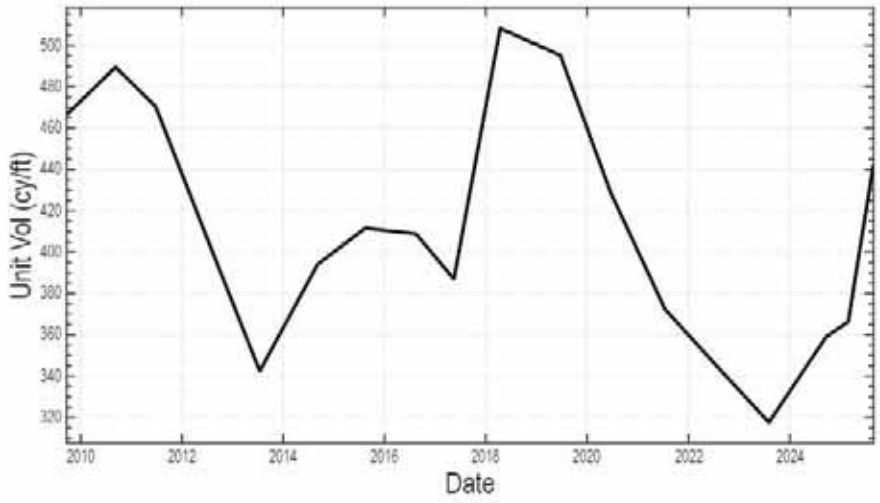

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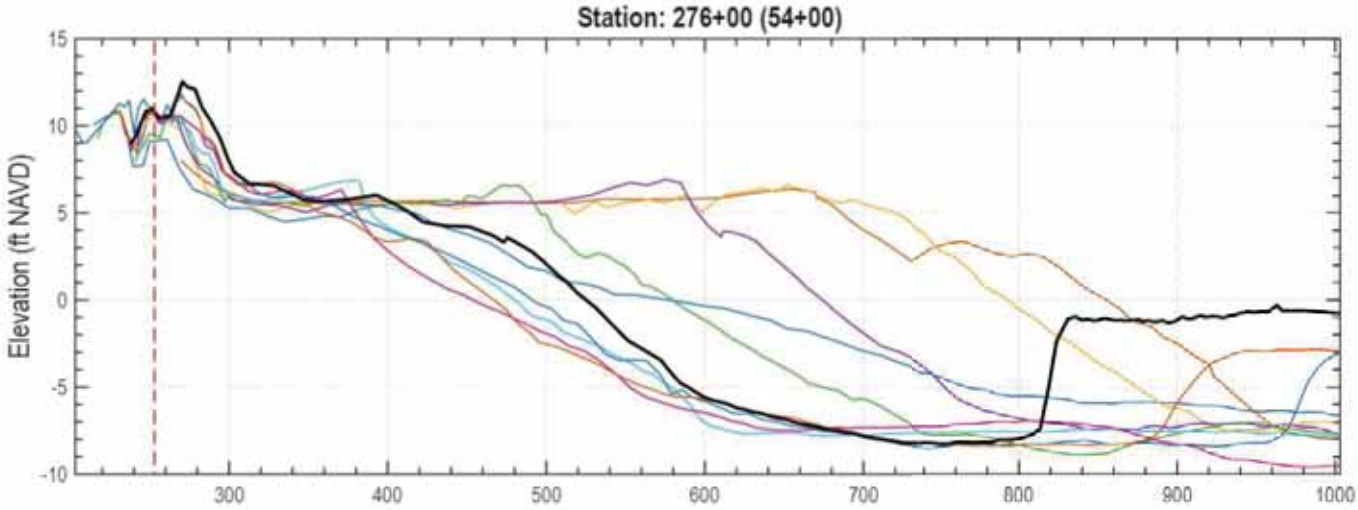

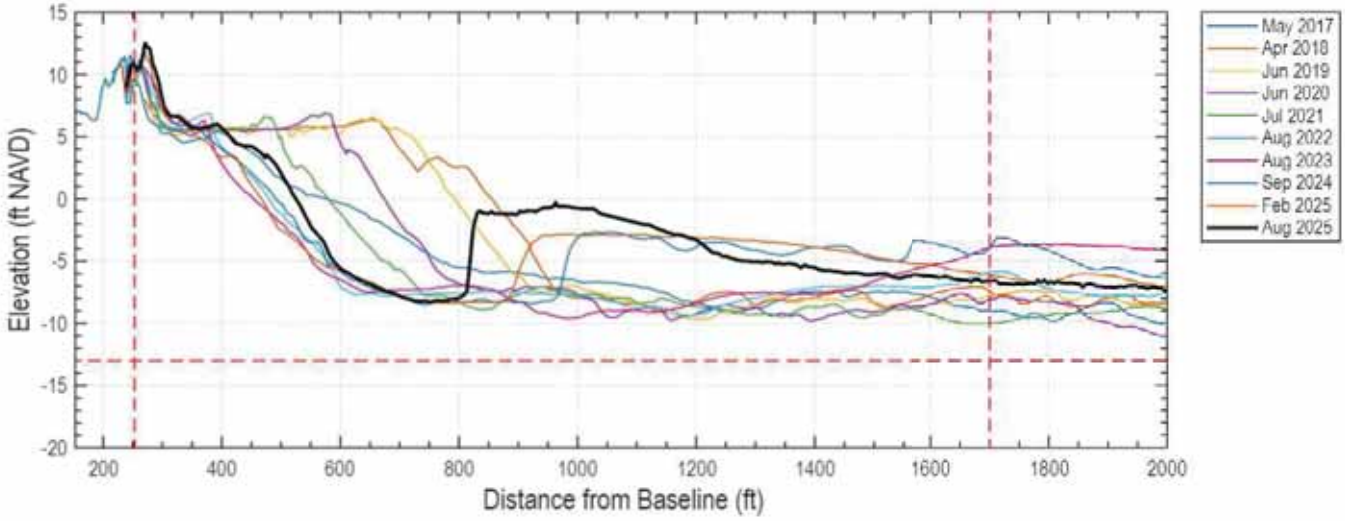

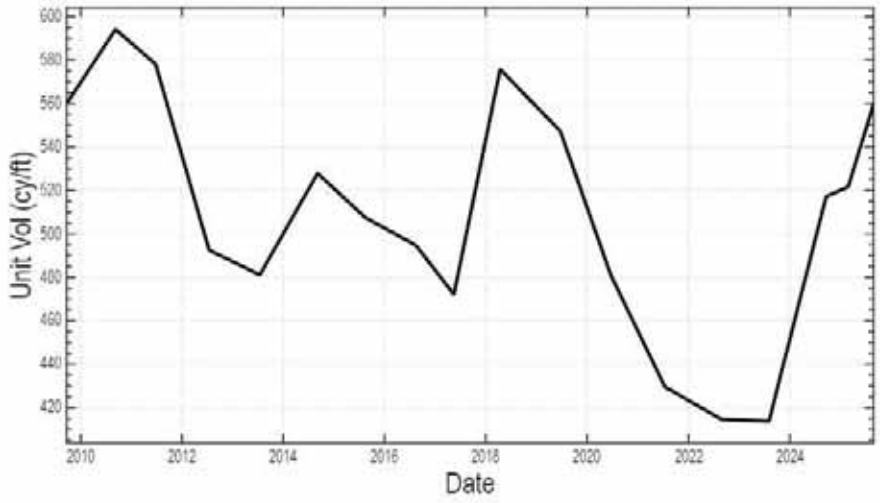

X: 2390478.28
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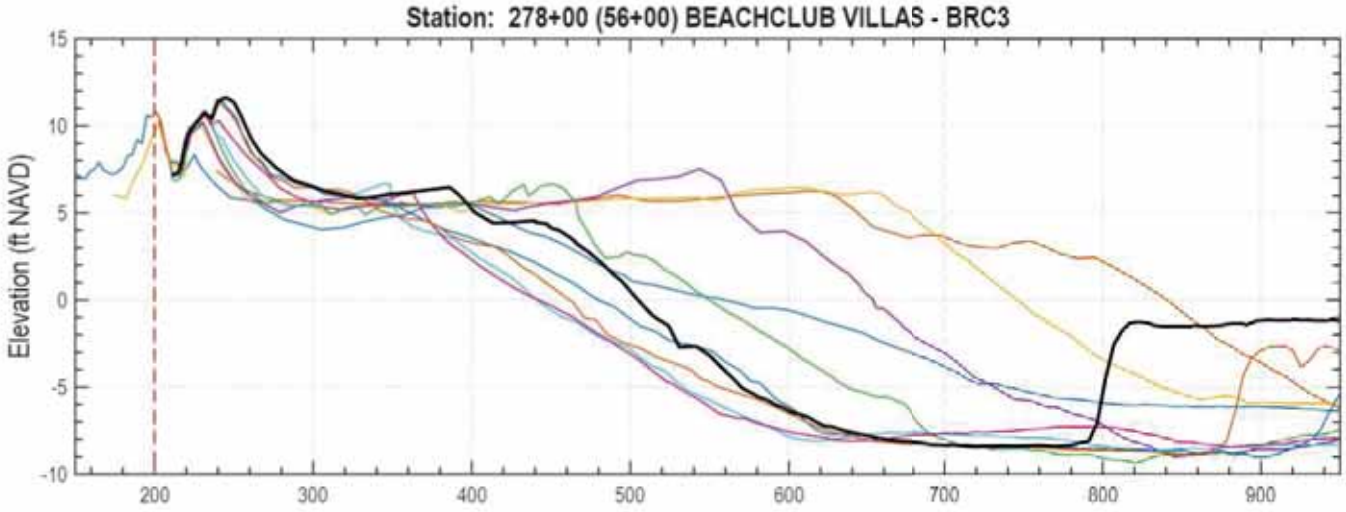

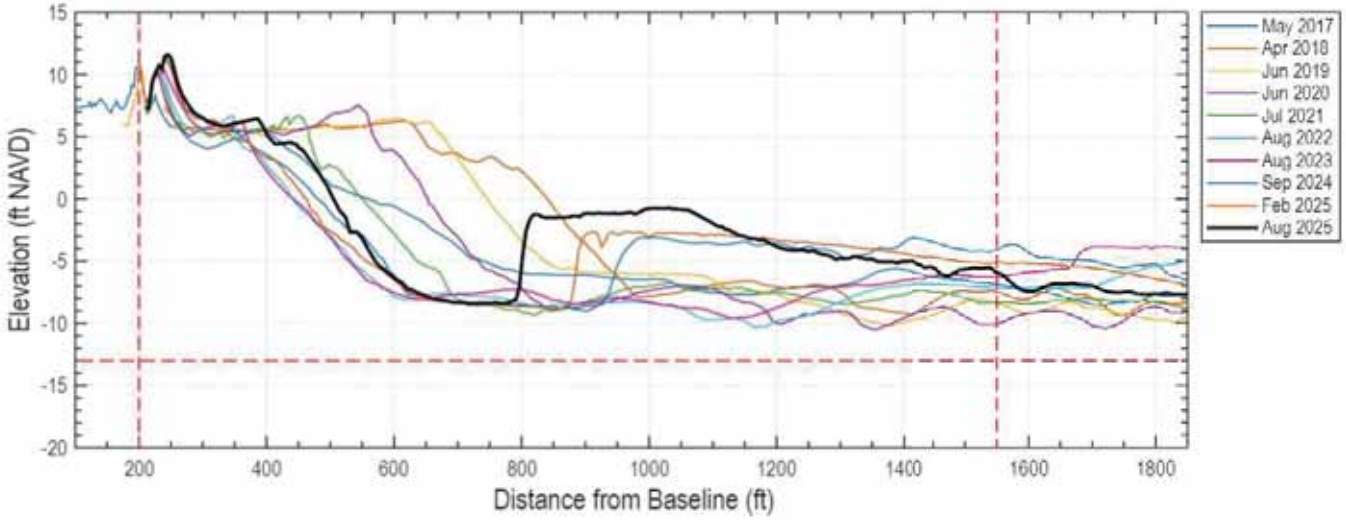

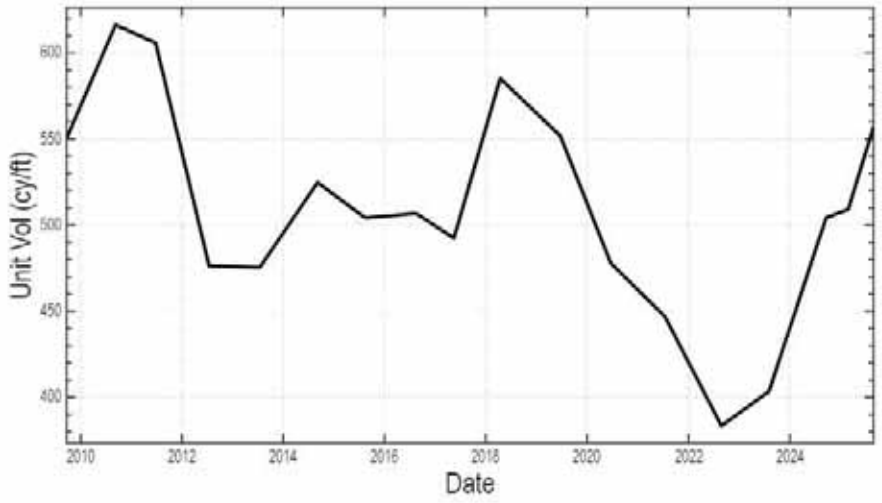

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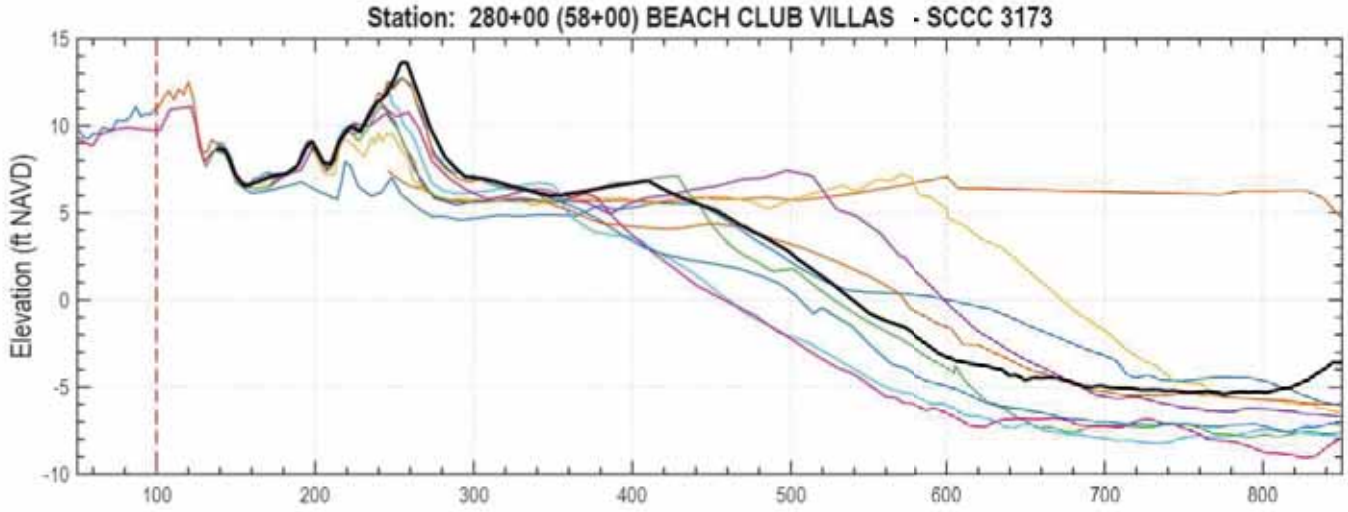

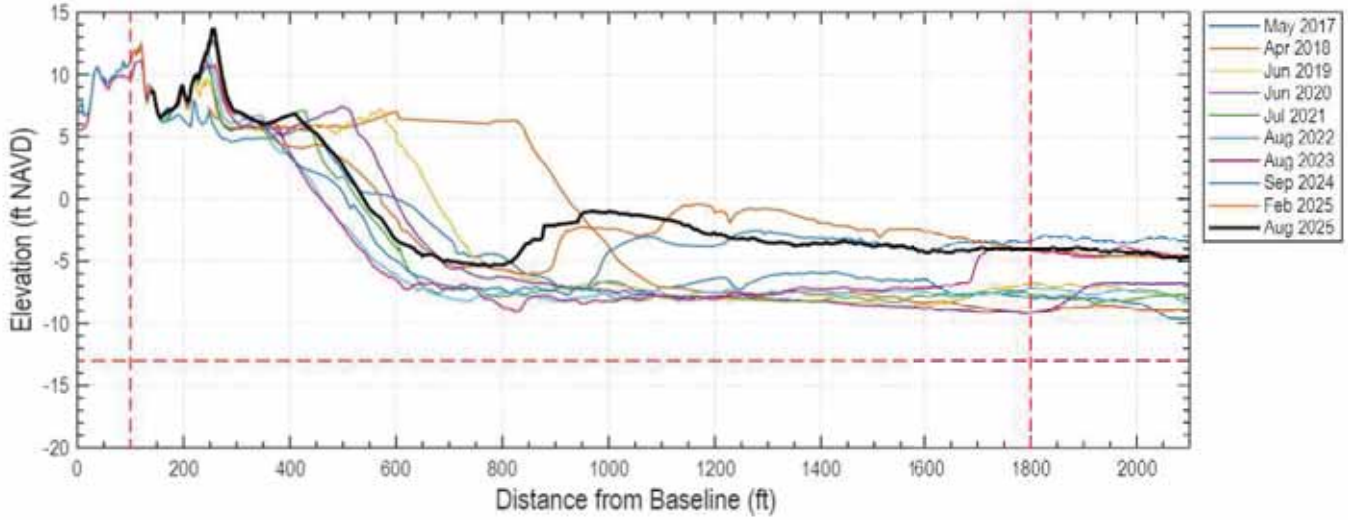

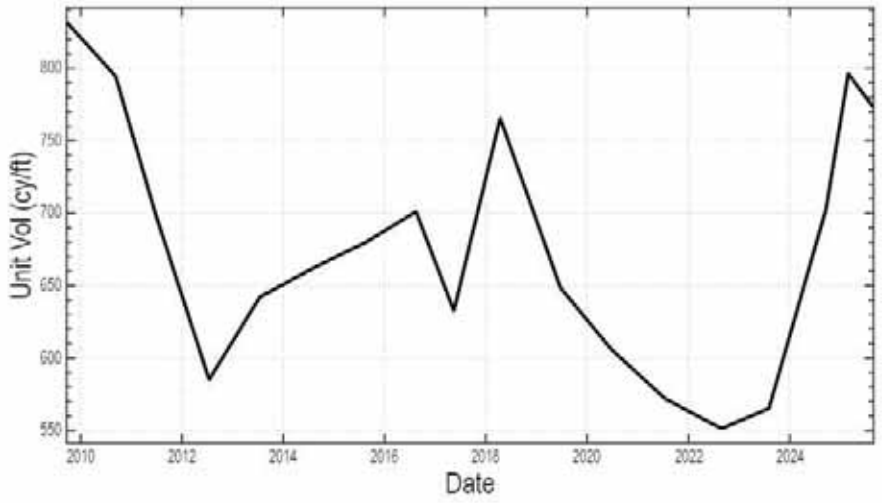

X: 2390849.49
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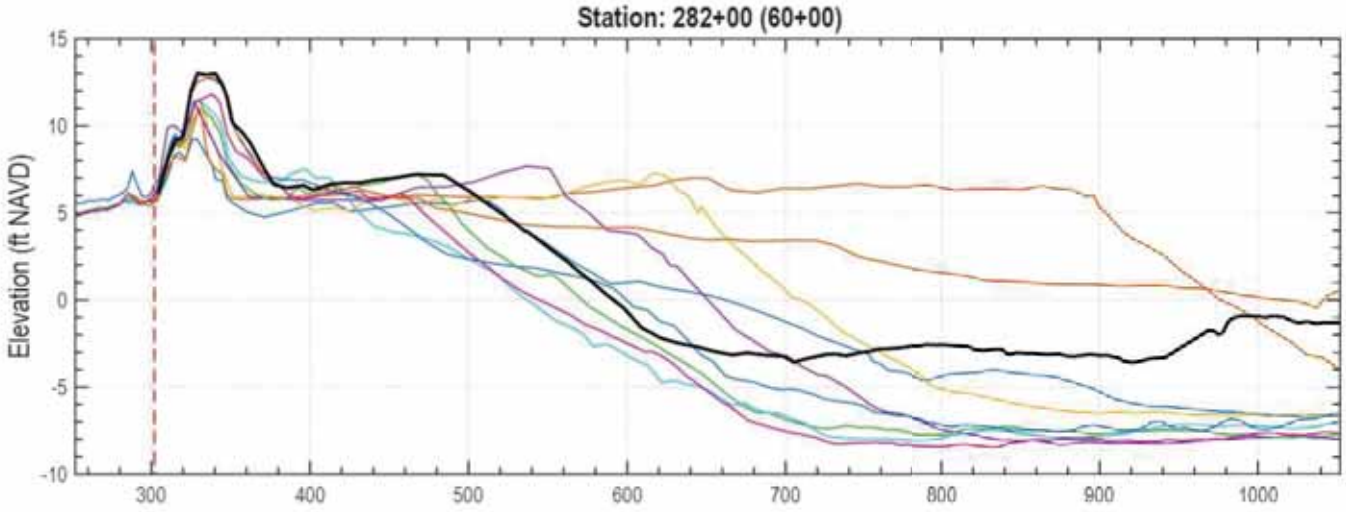

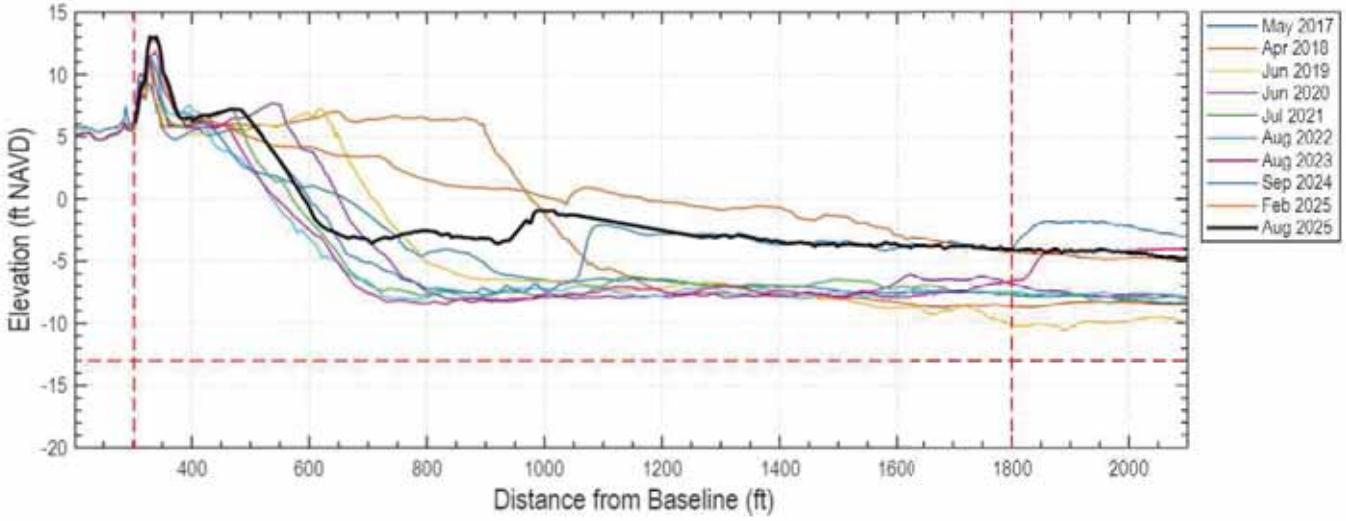

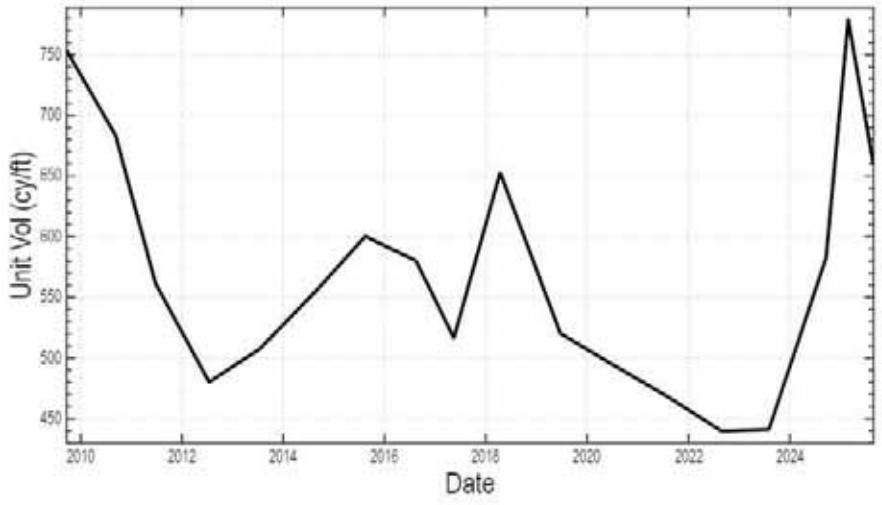

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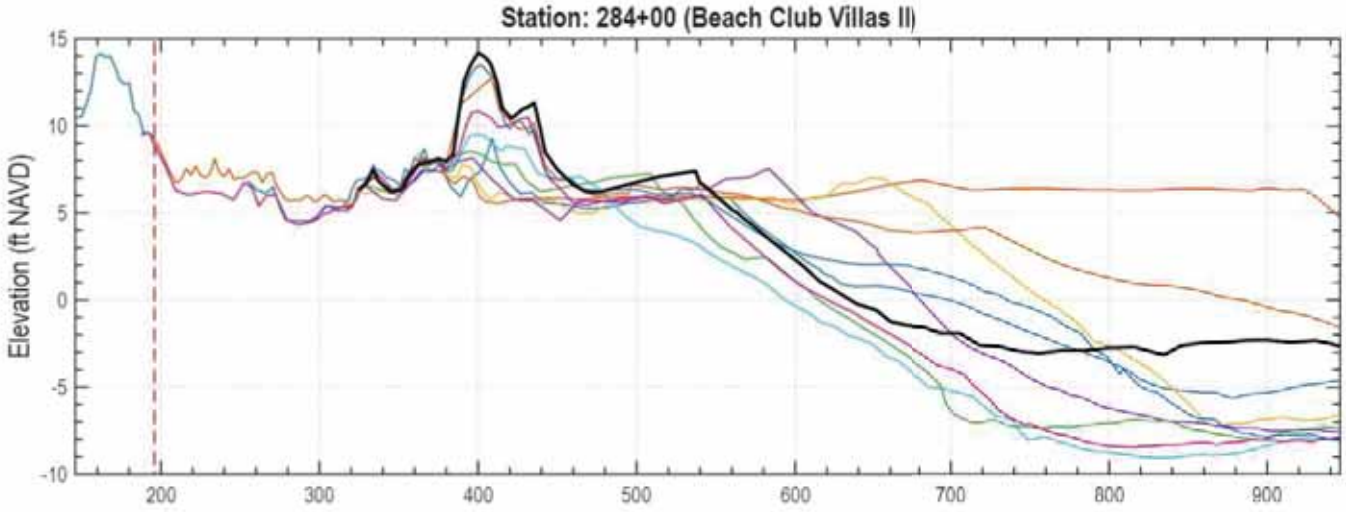

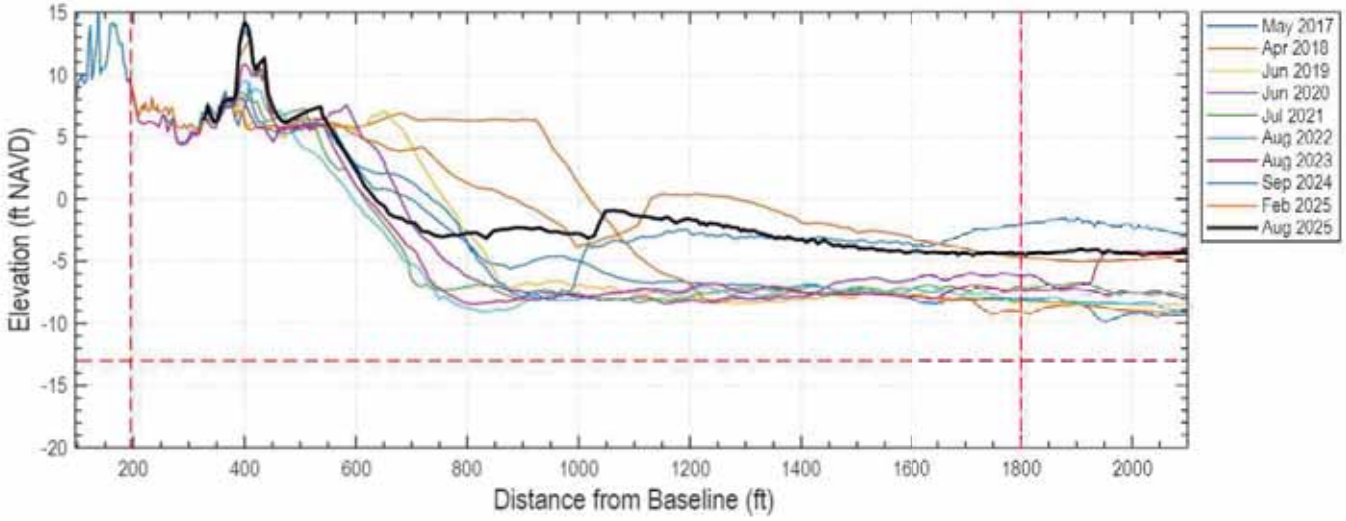

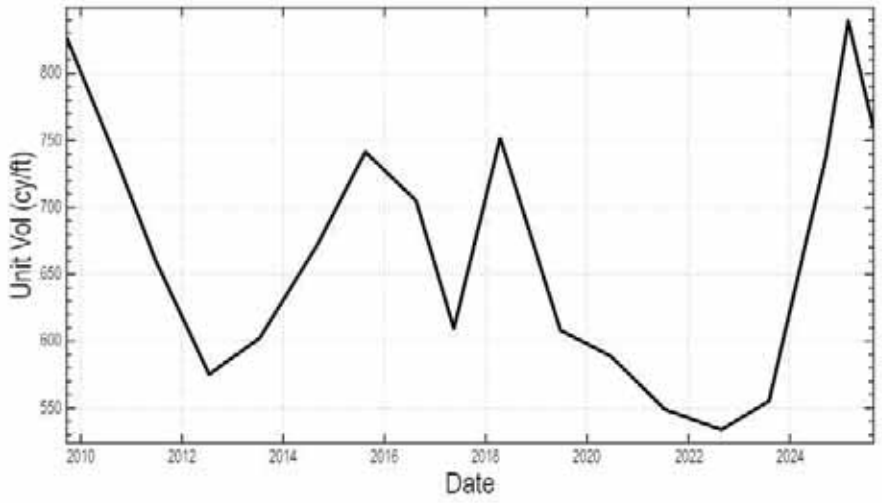

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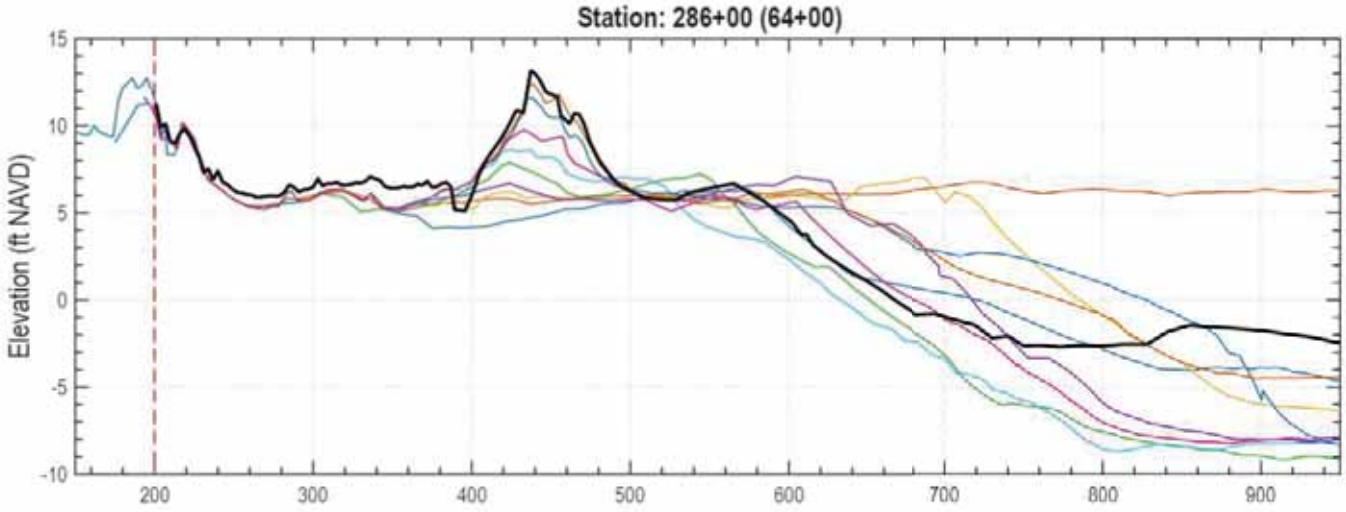

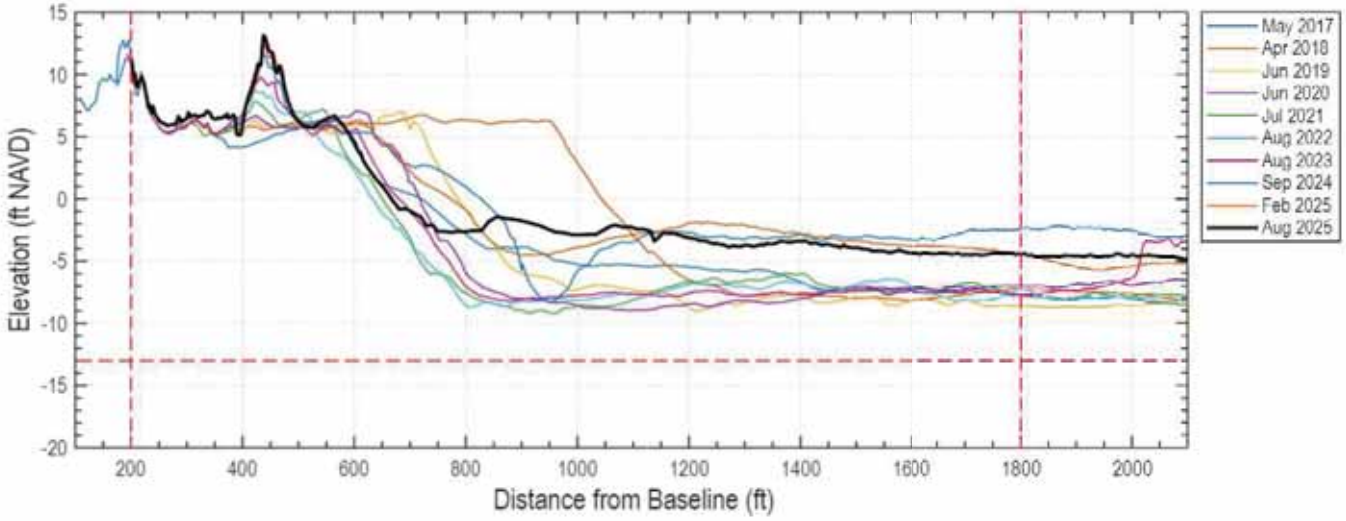

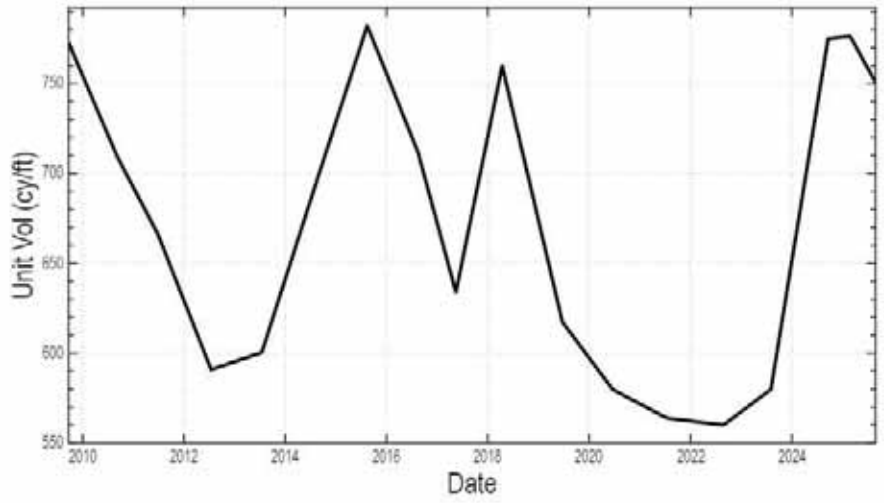

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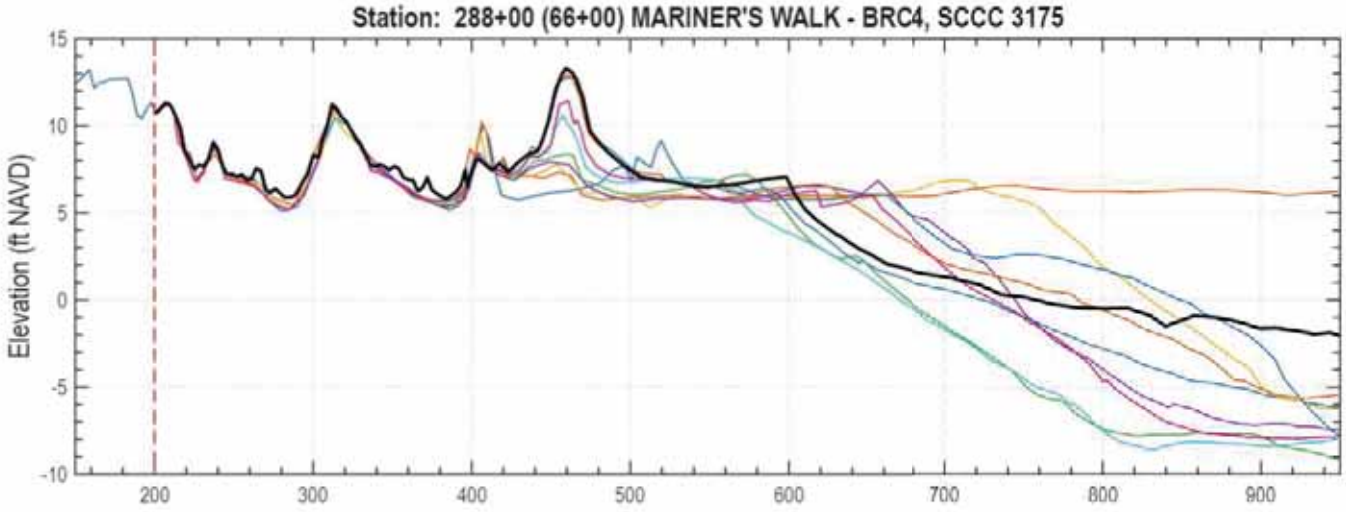

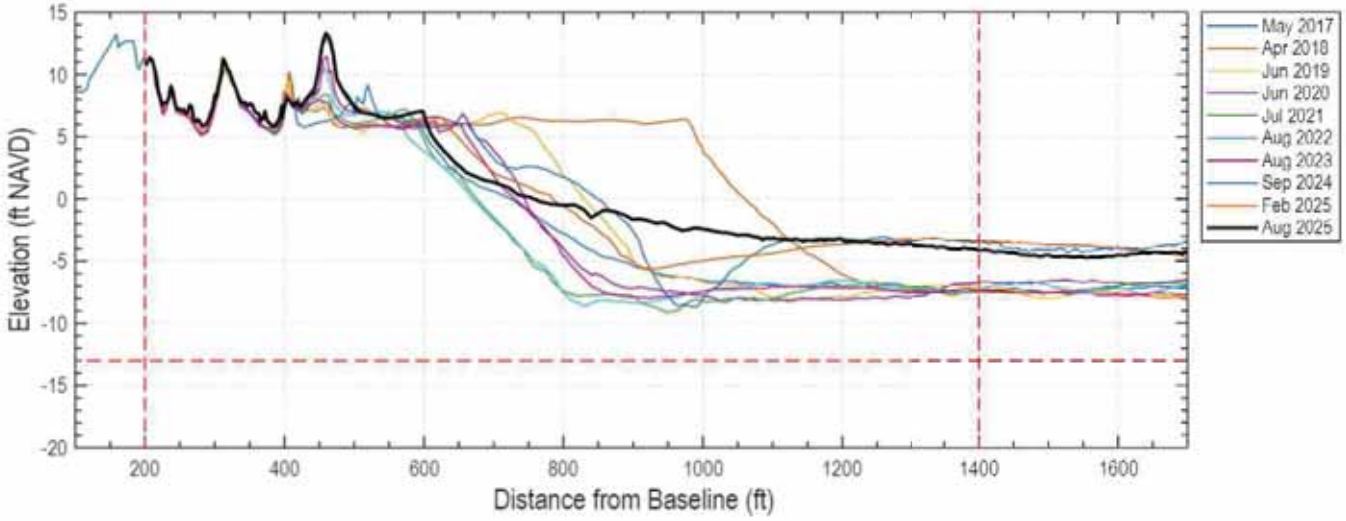

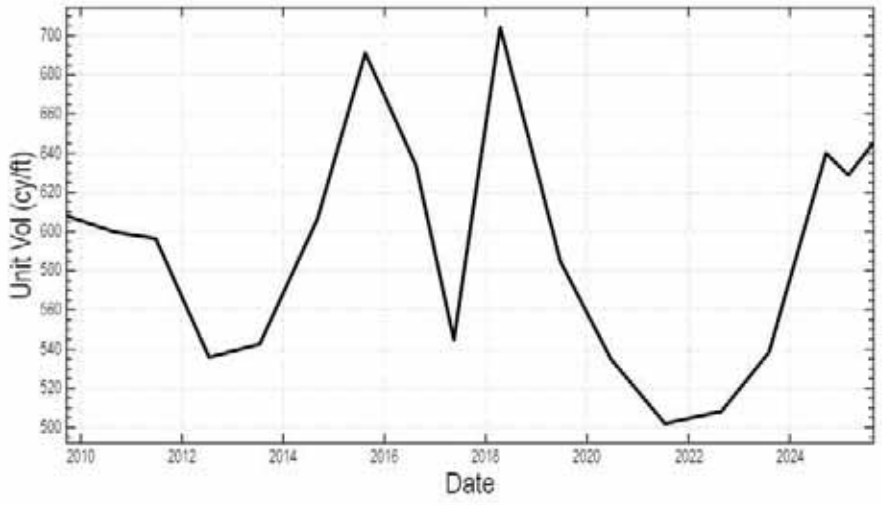

X: 2391346.93
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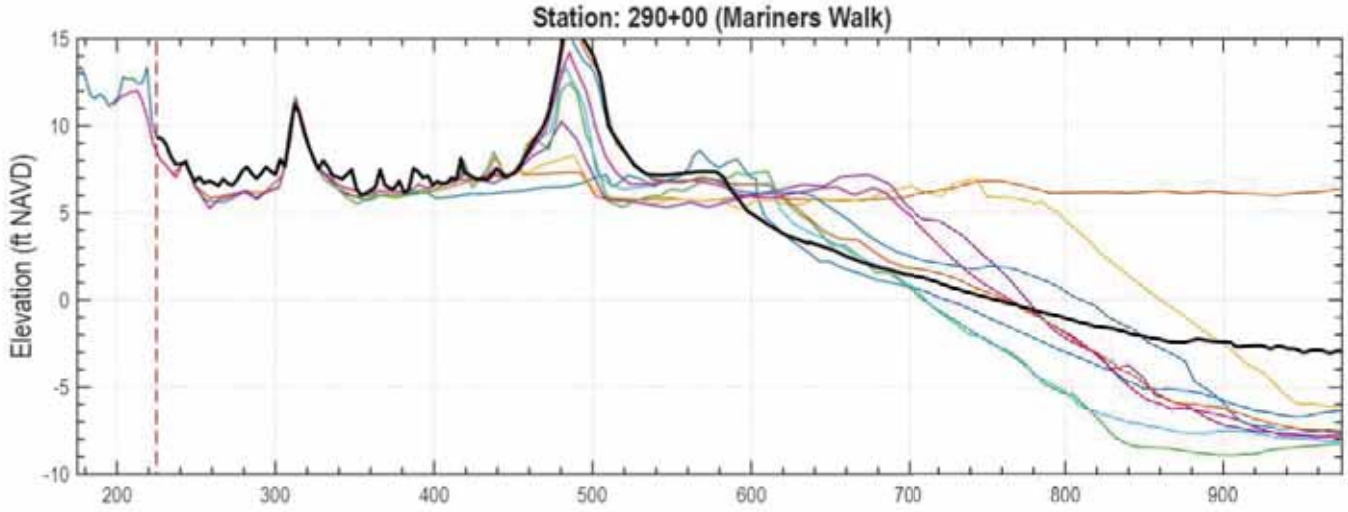

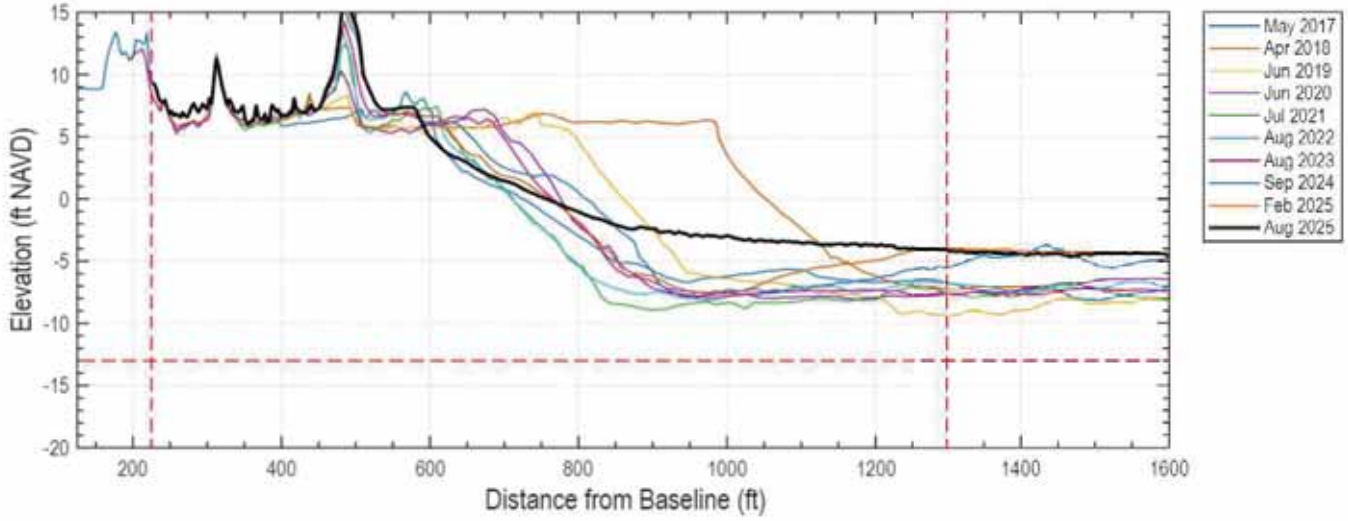

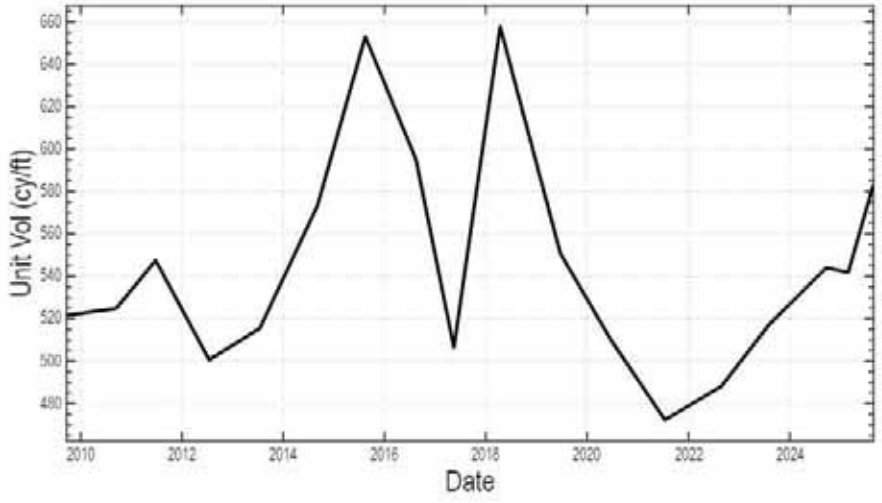

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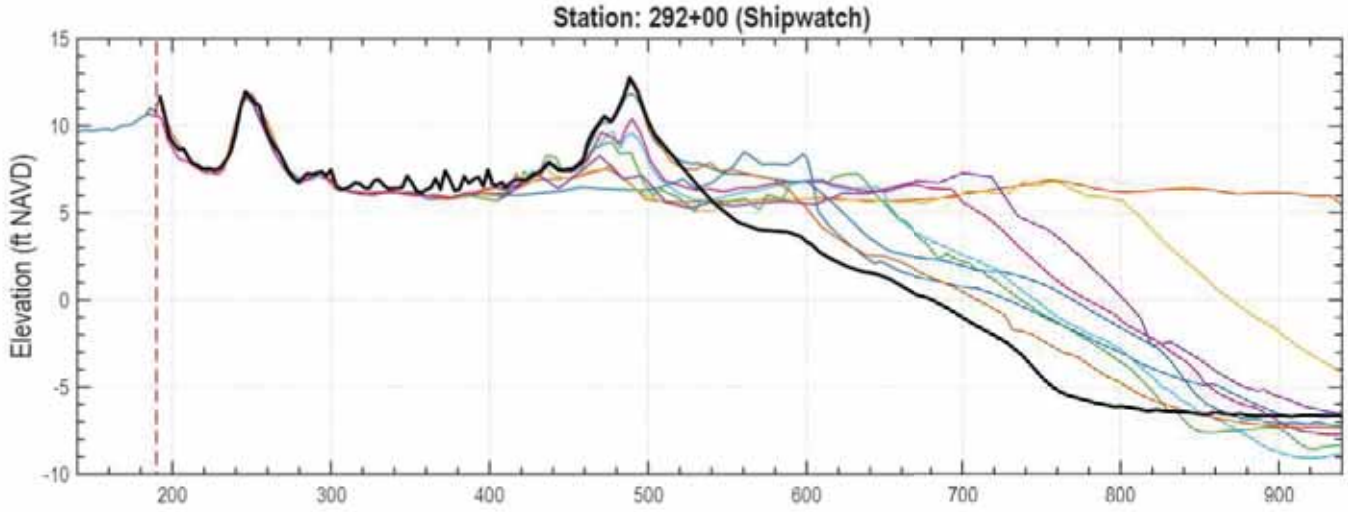

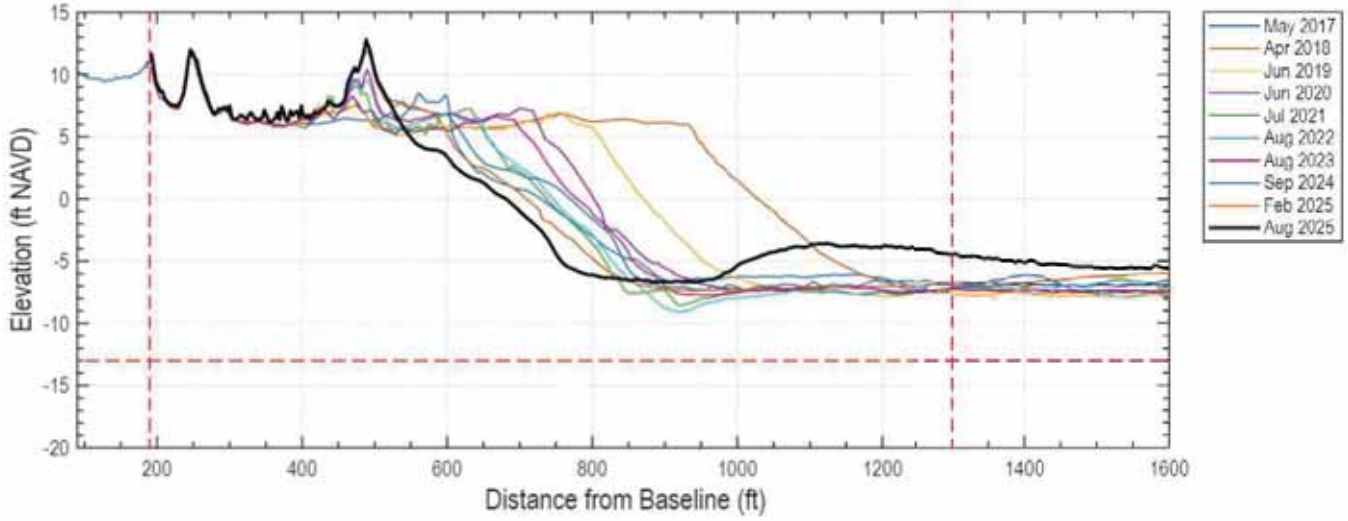

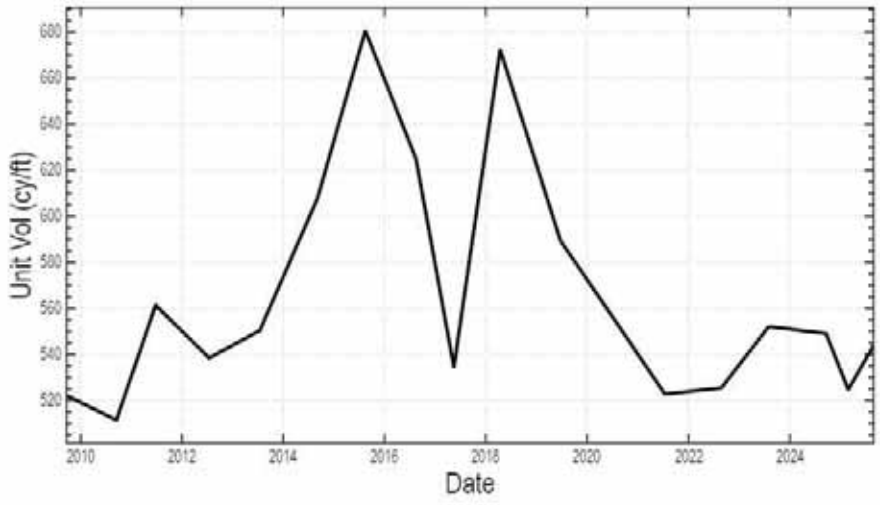

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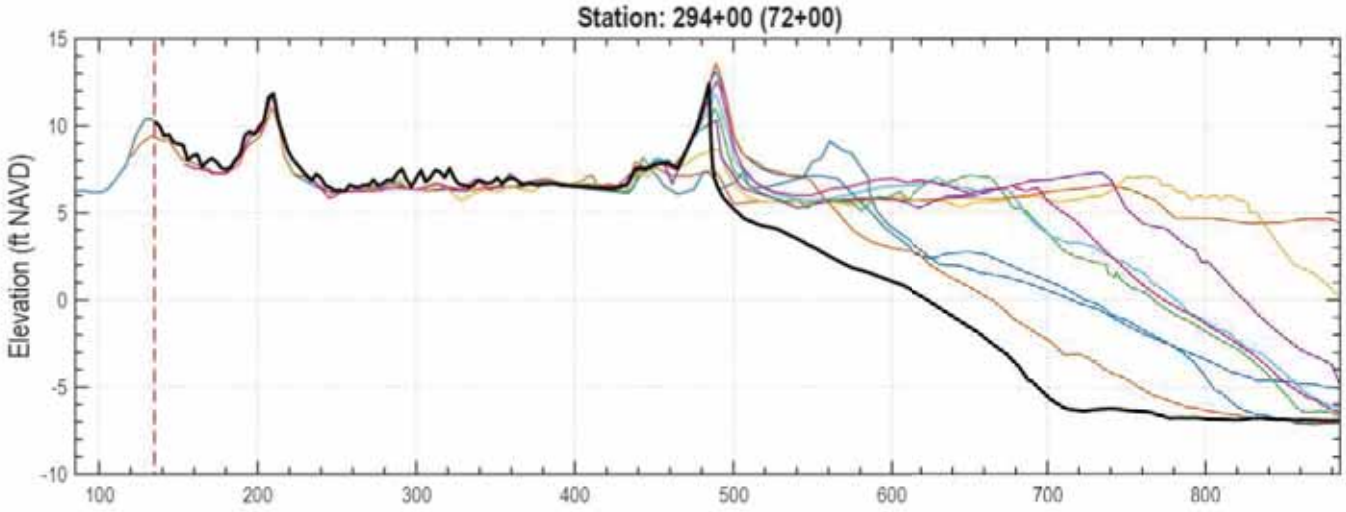

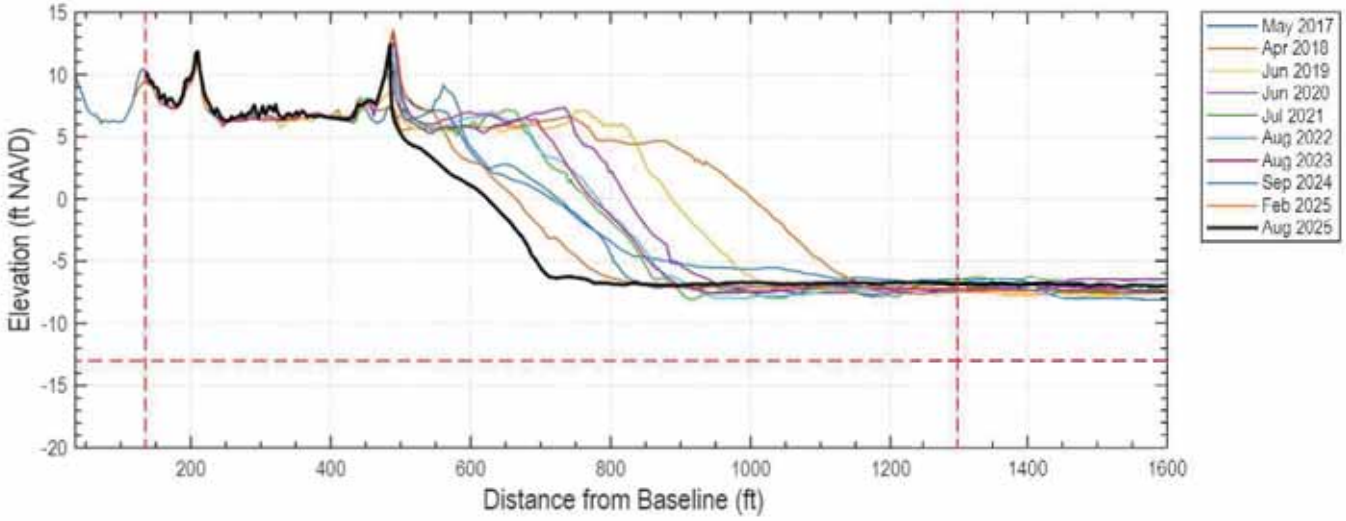

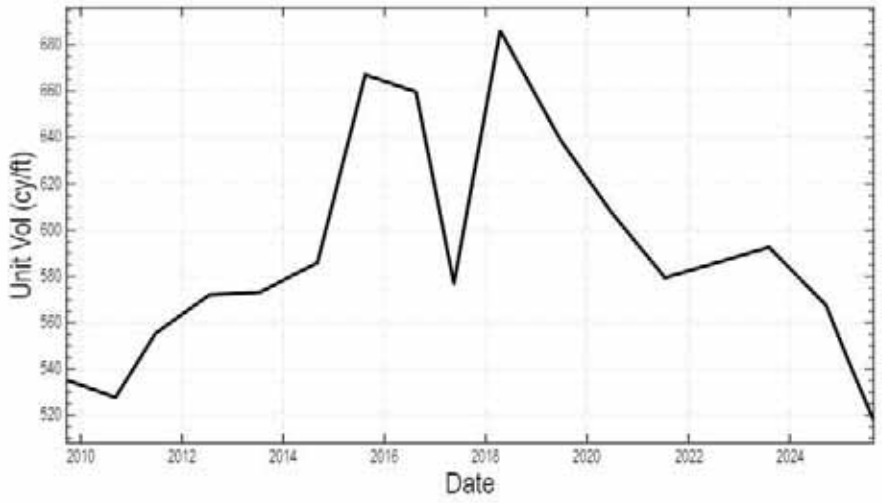

X: 2391720
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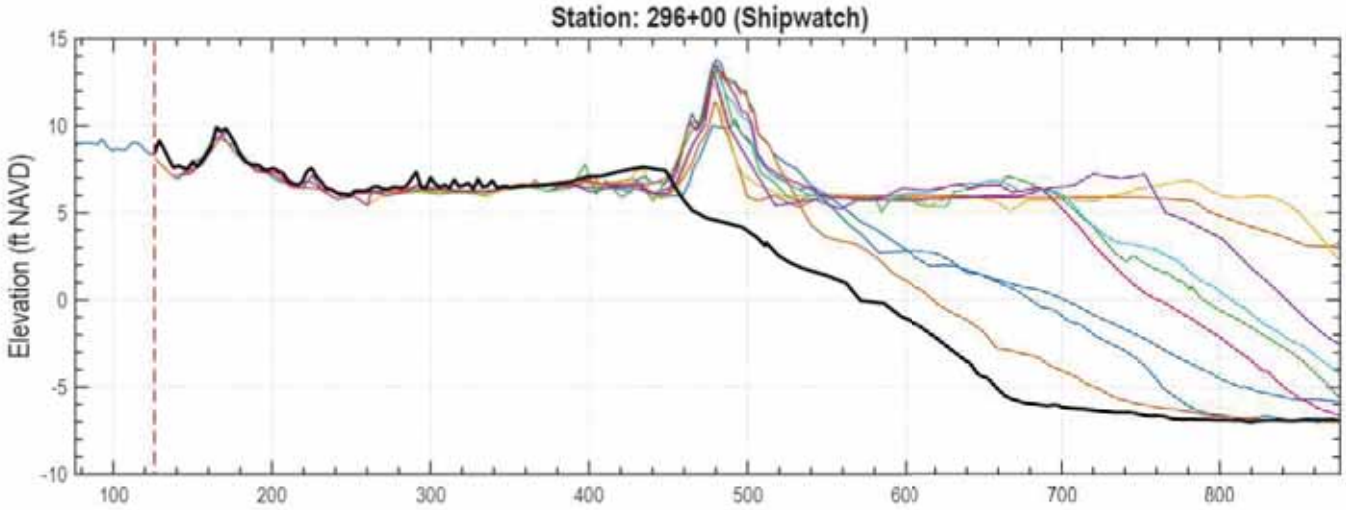

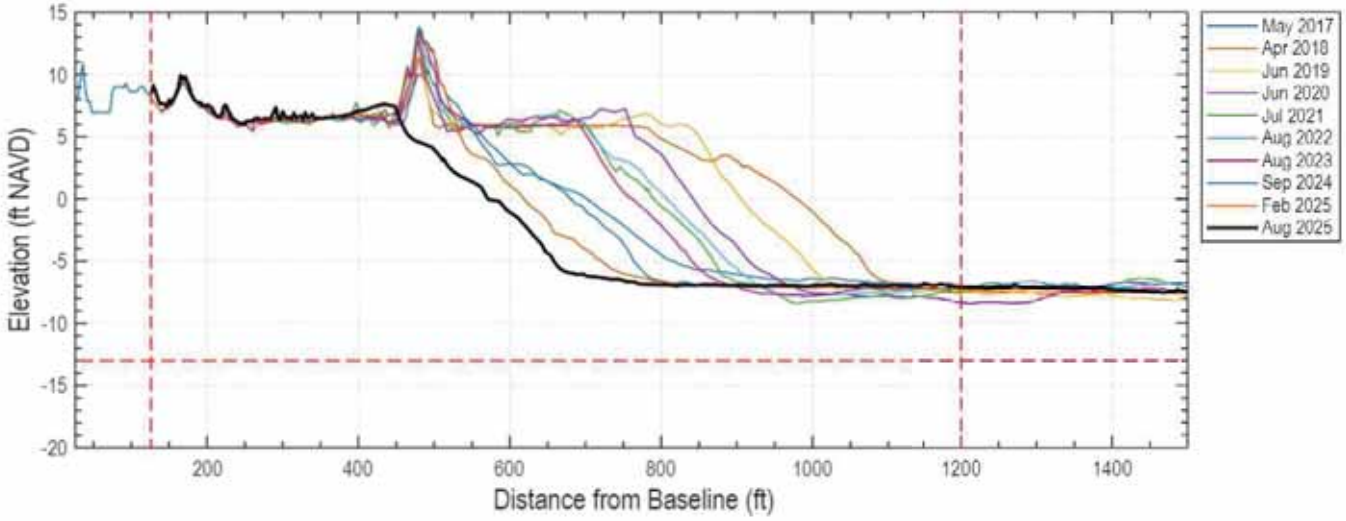

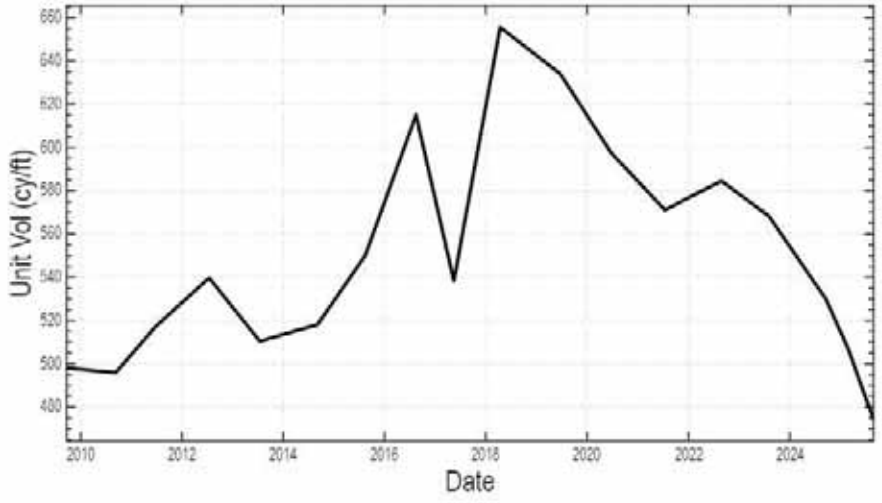

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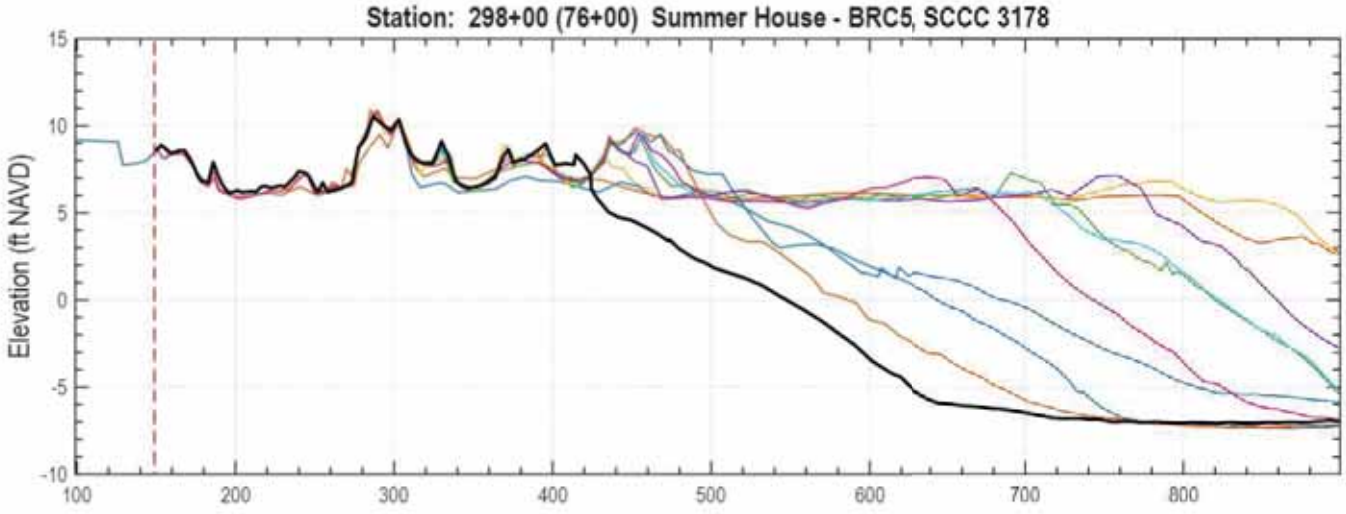

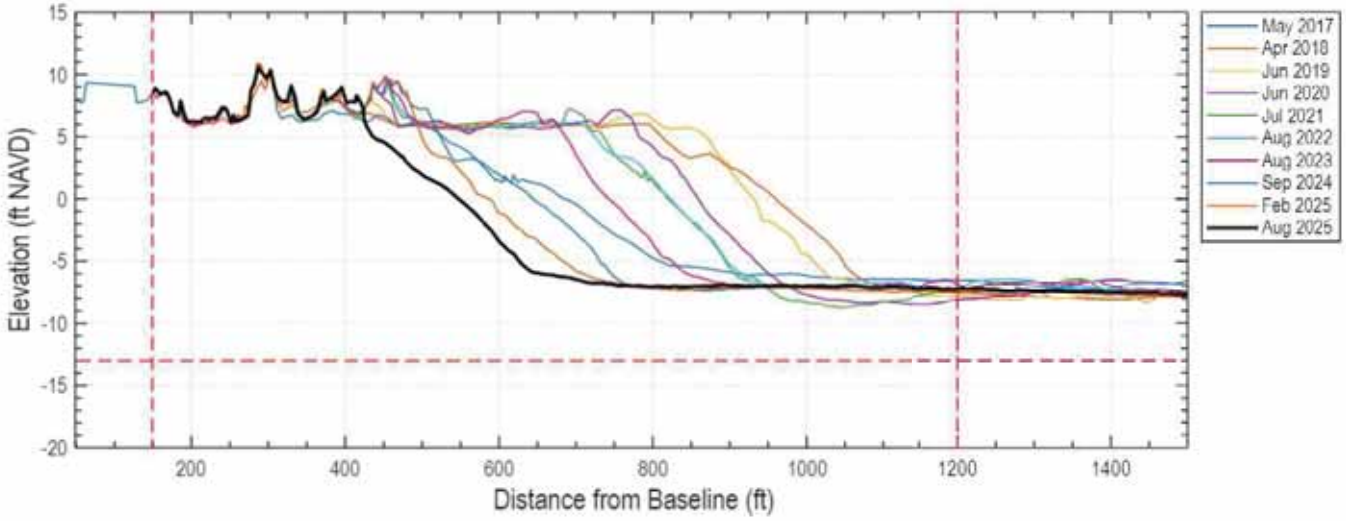

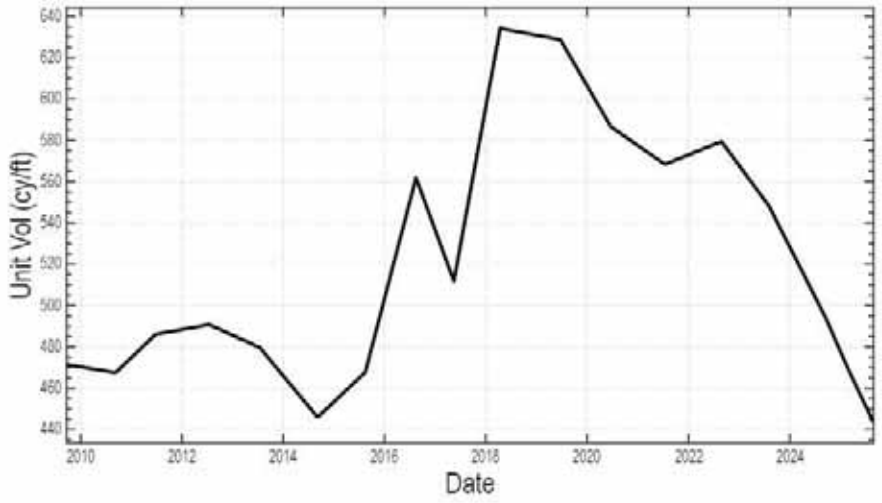

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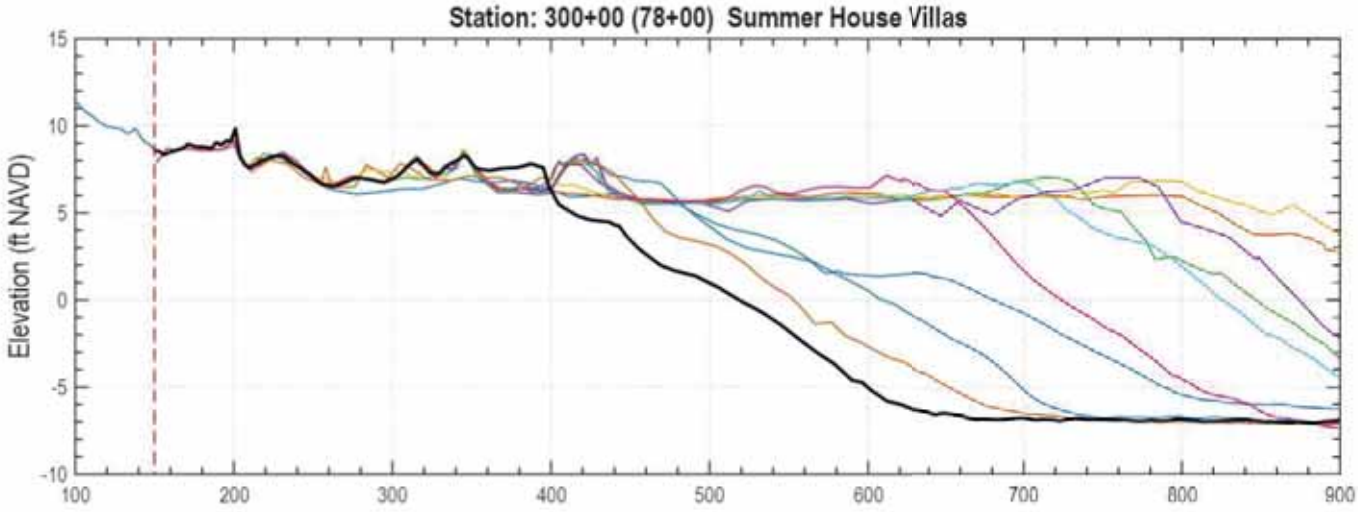

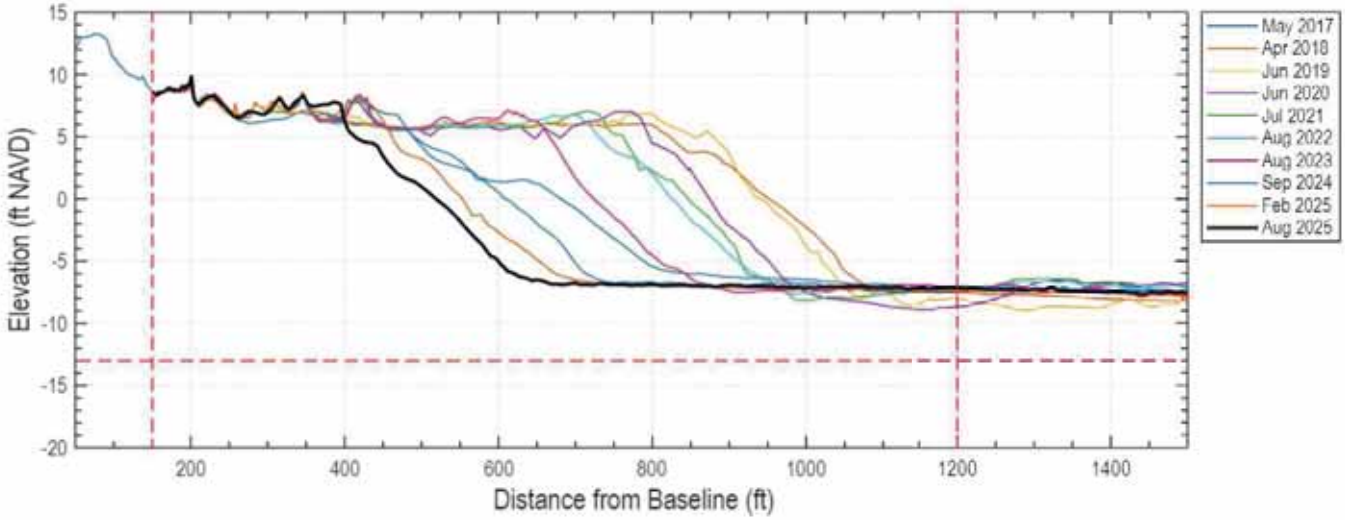

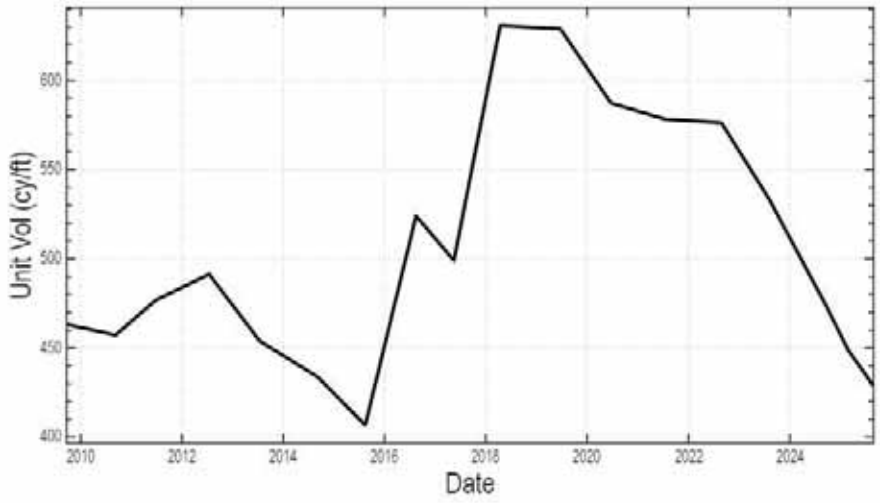

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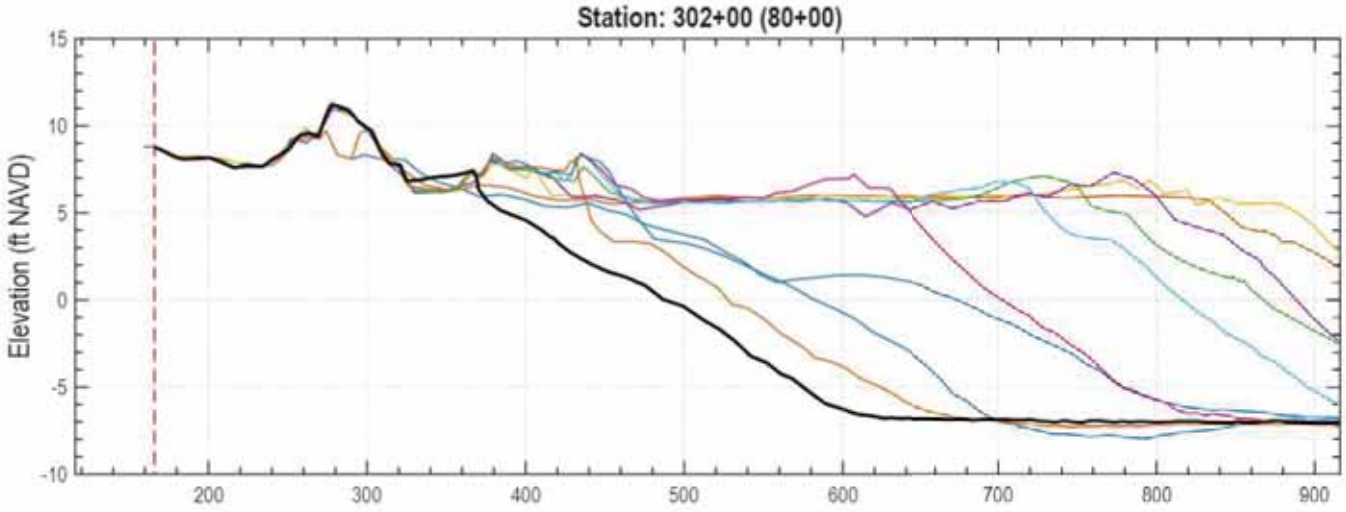

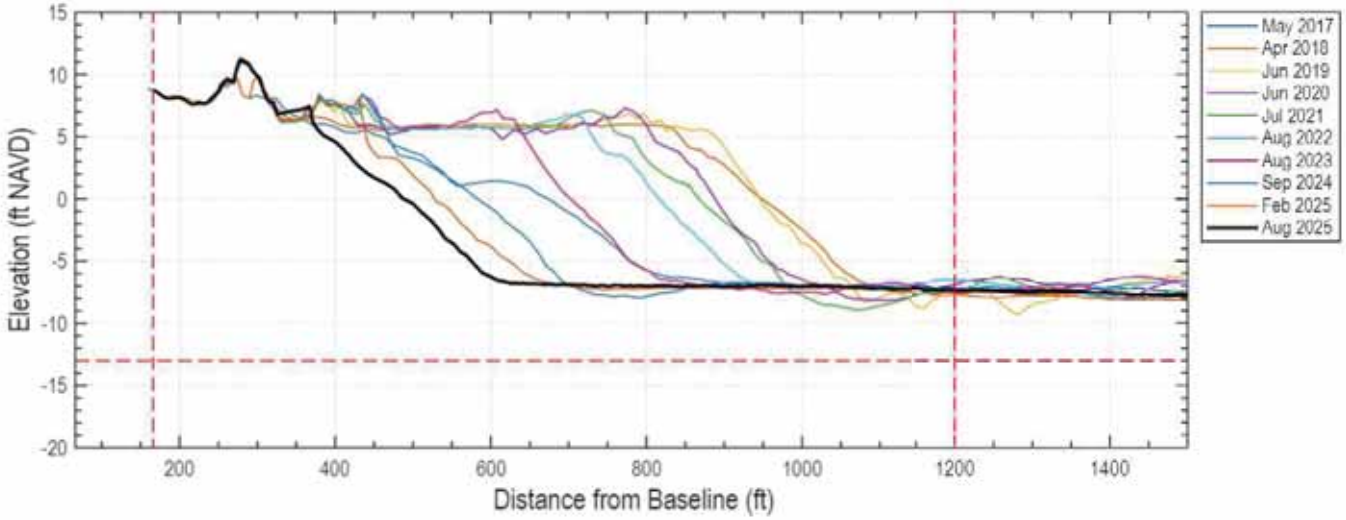

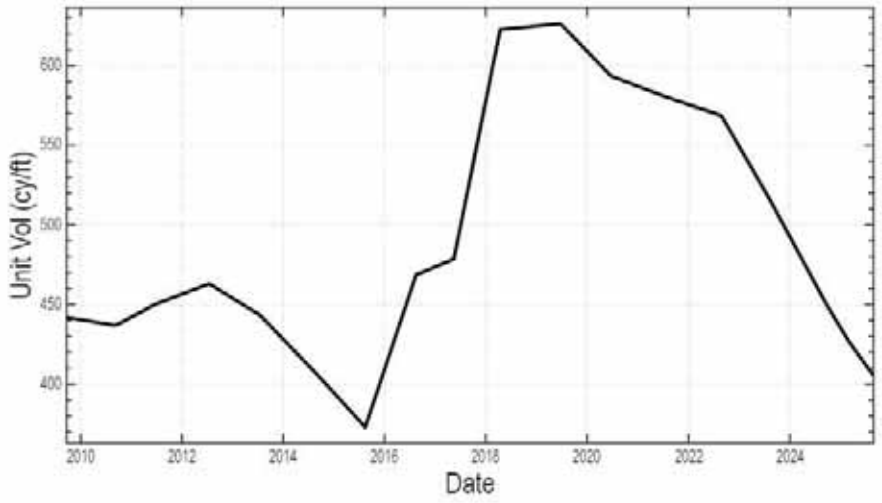

X: 2392217.44
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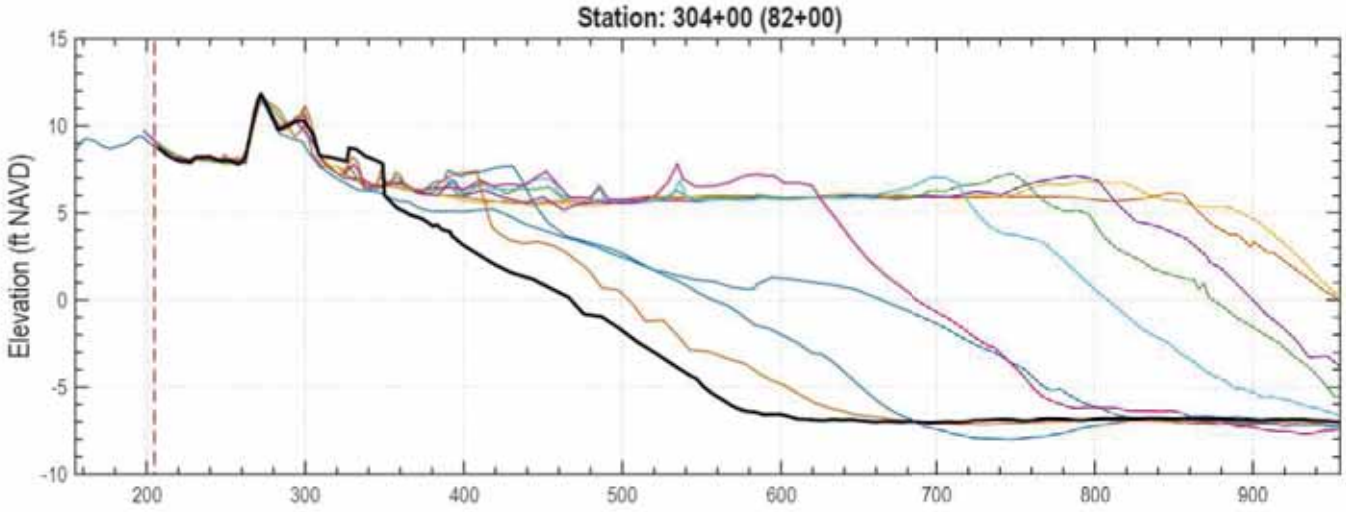

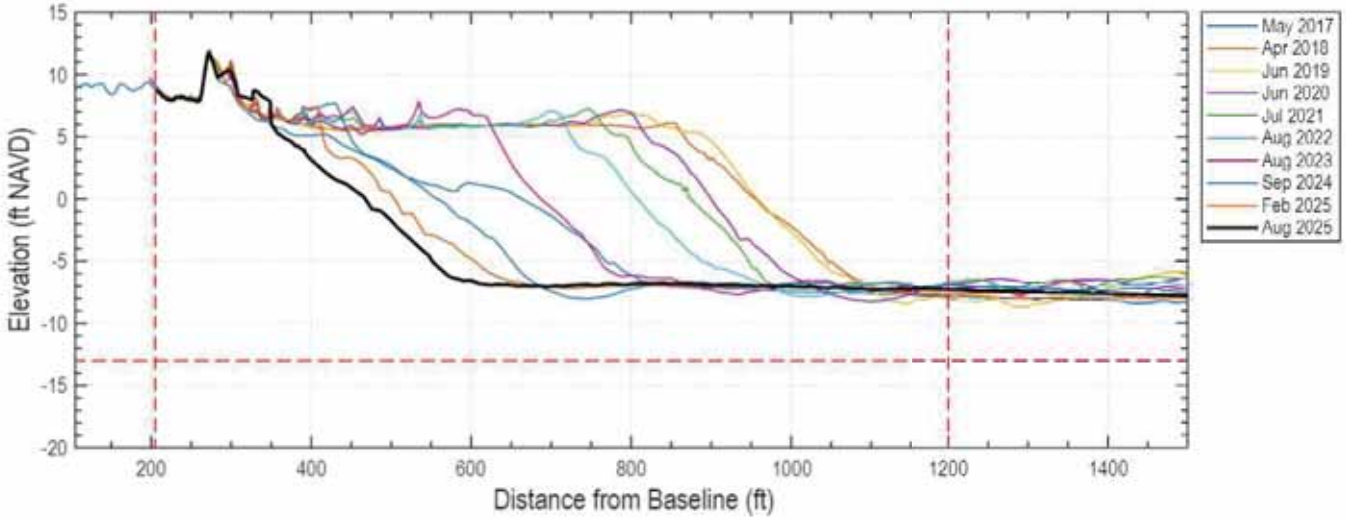

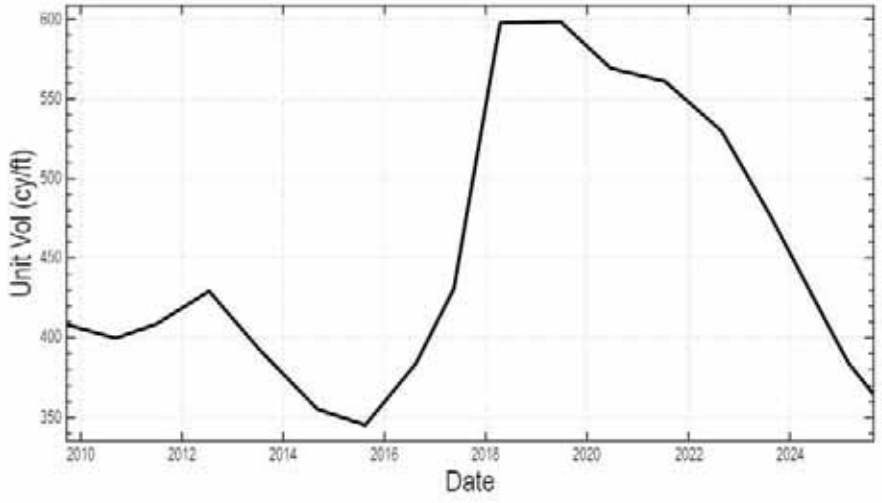

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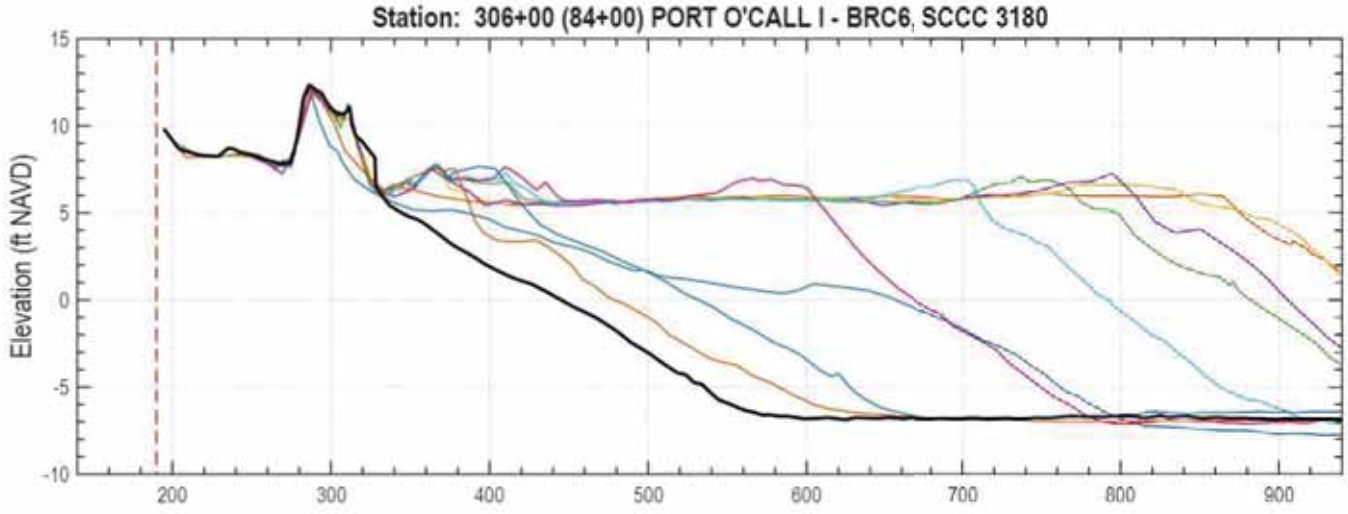

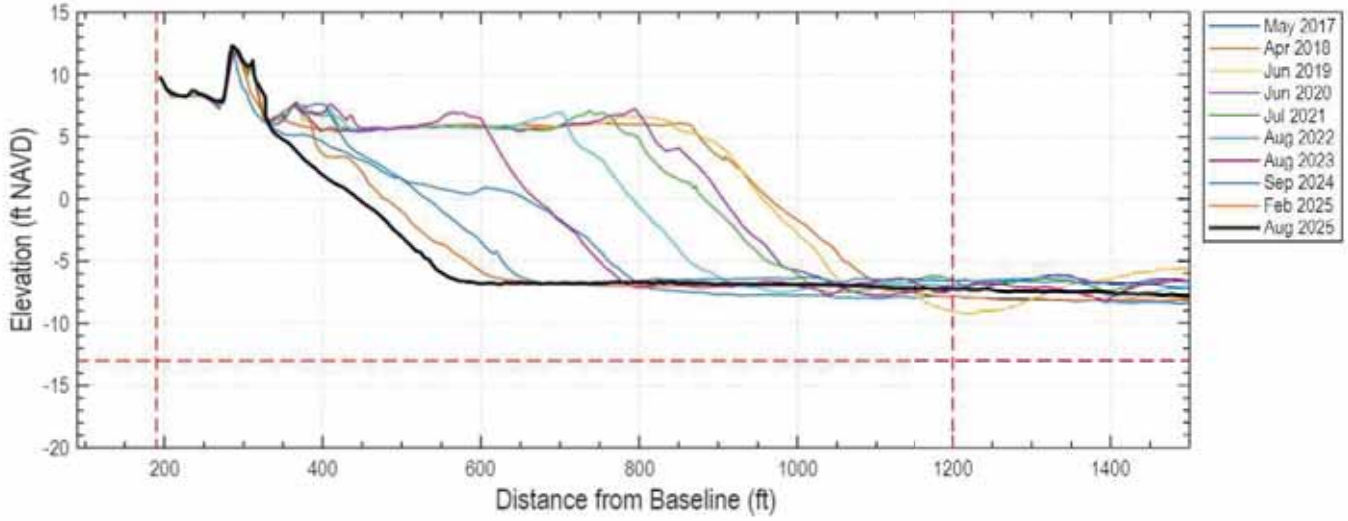

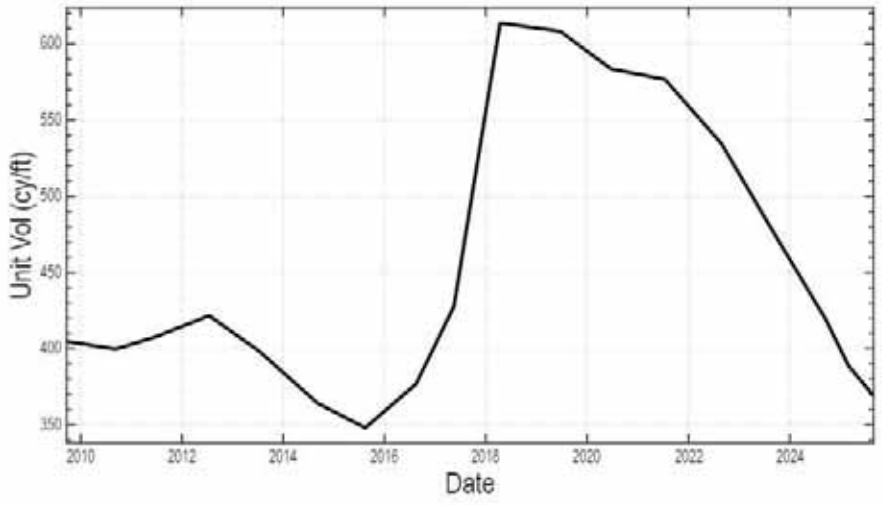

X: 2392466.15
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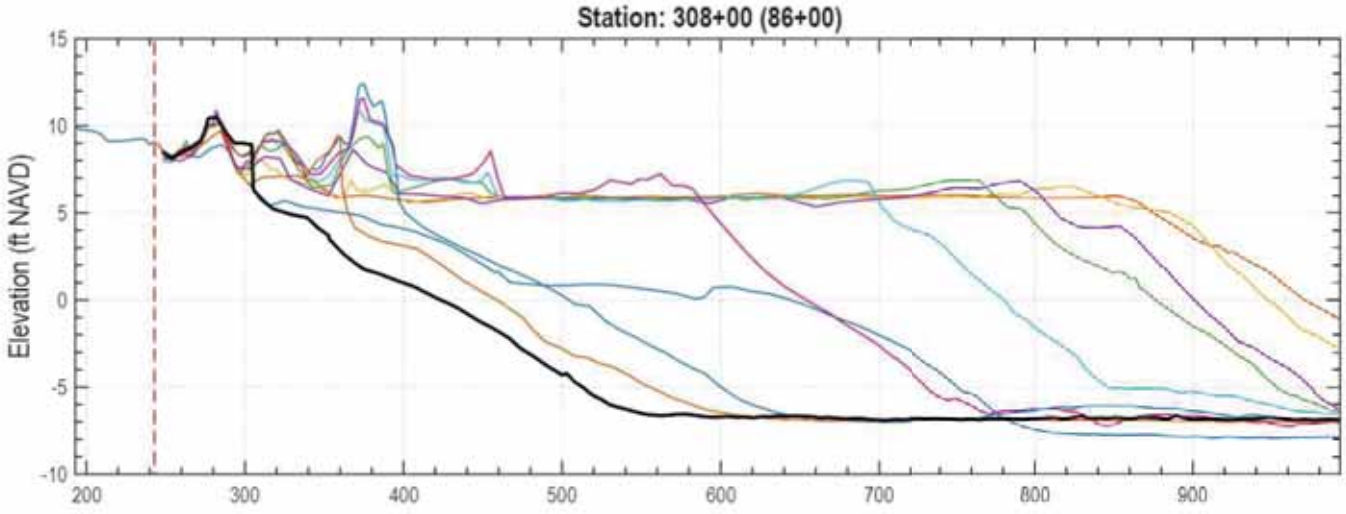

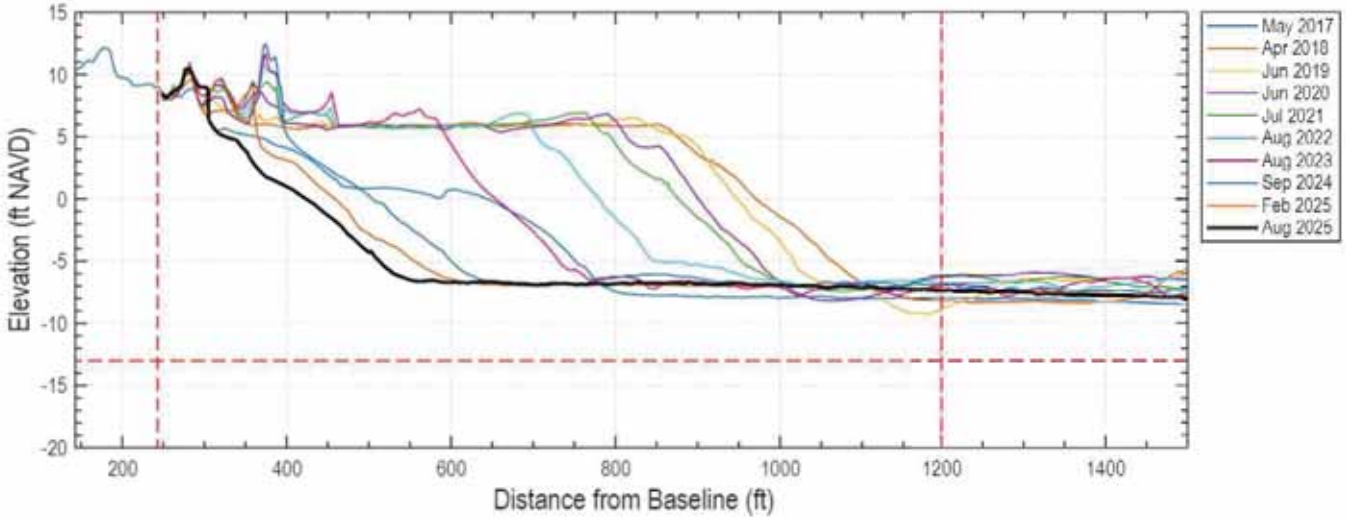

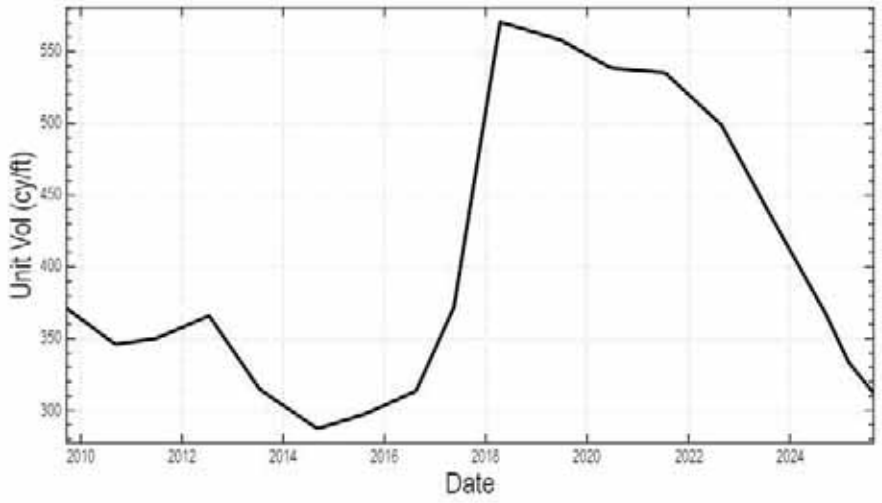

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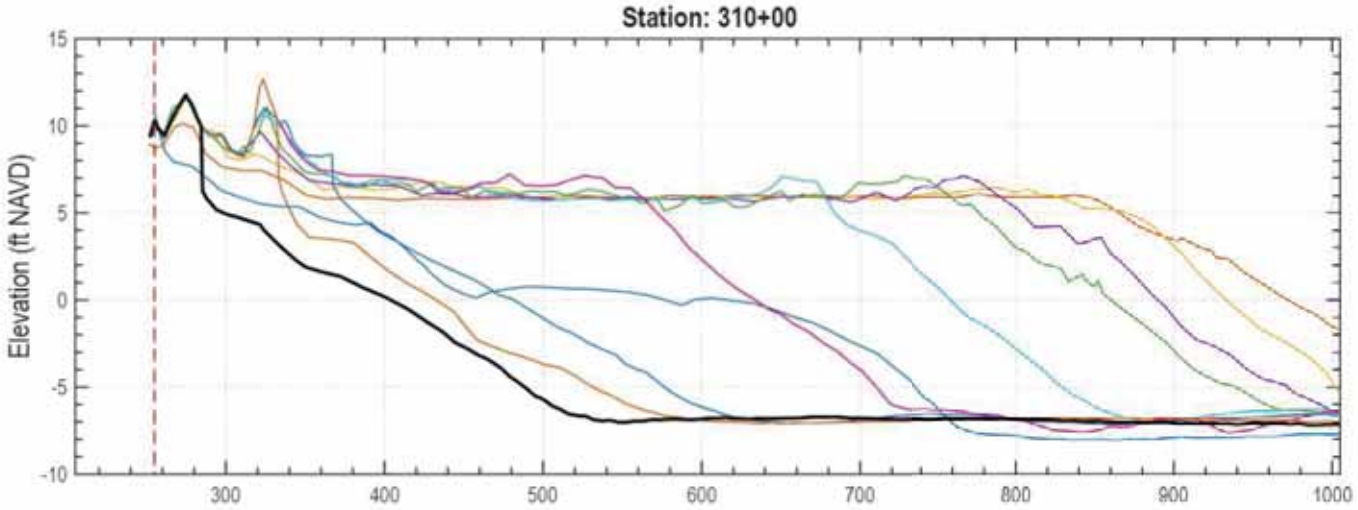

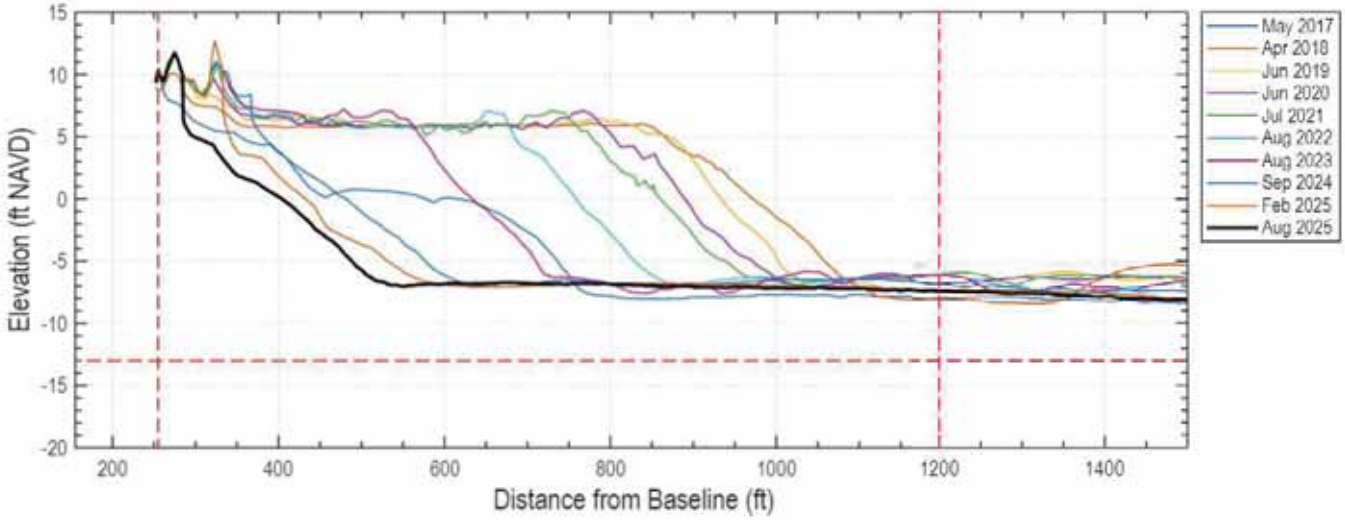

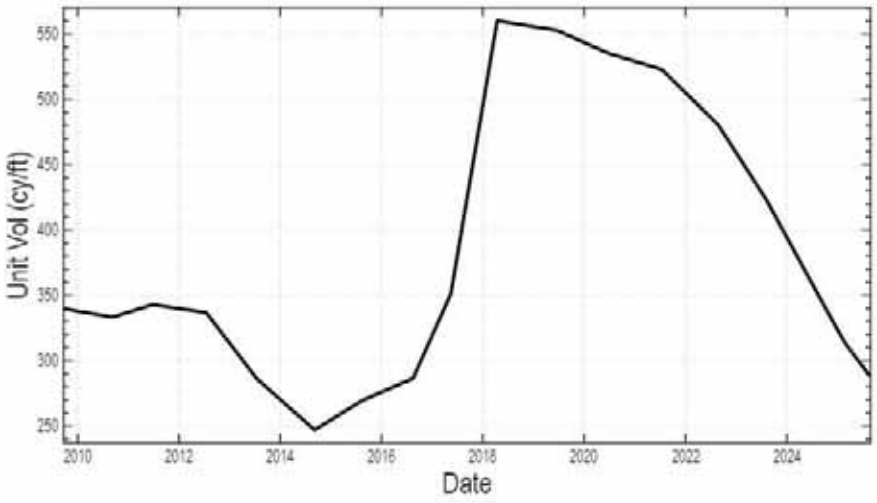

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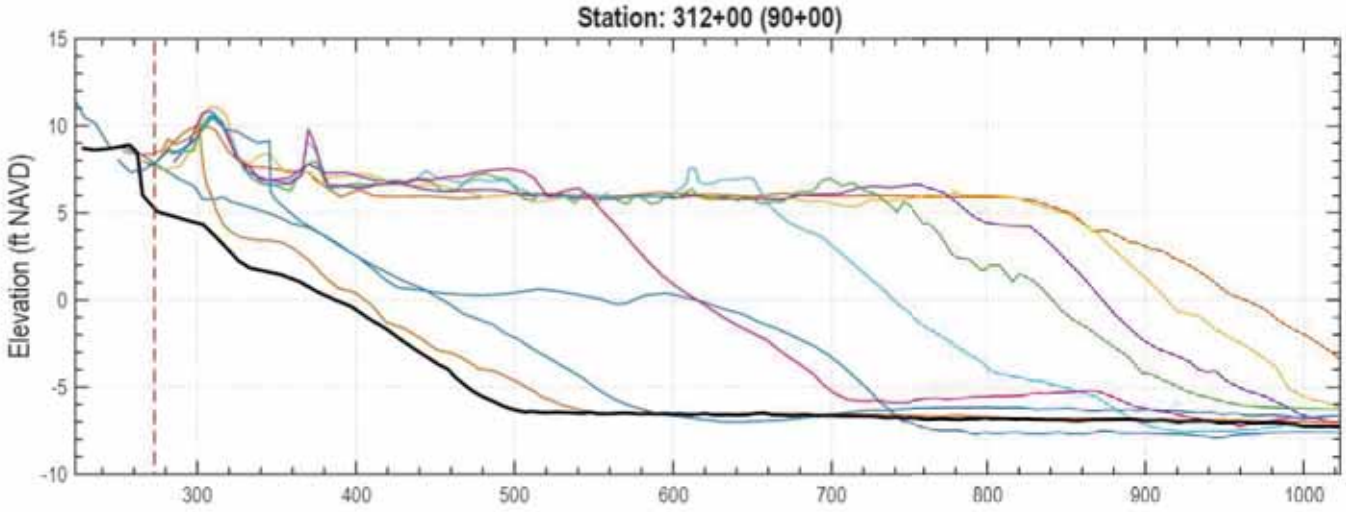

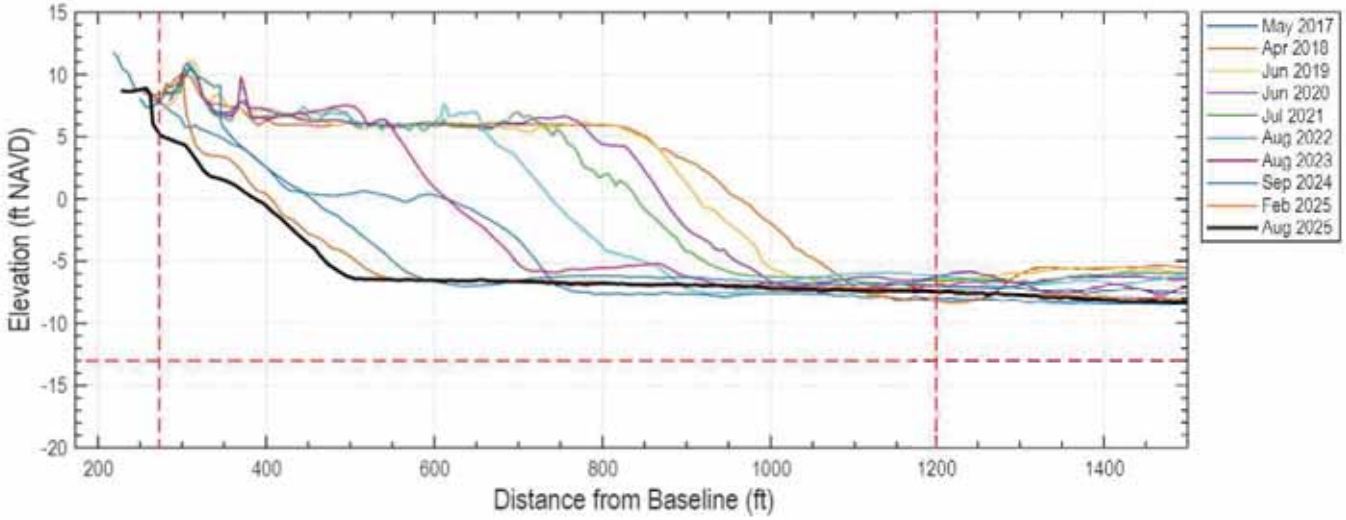

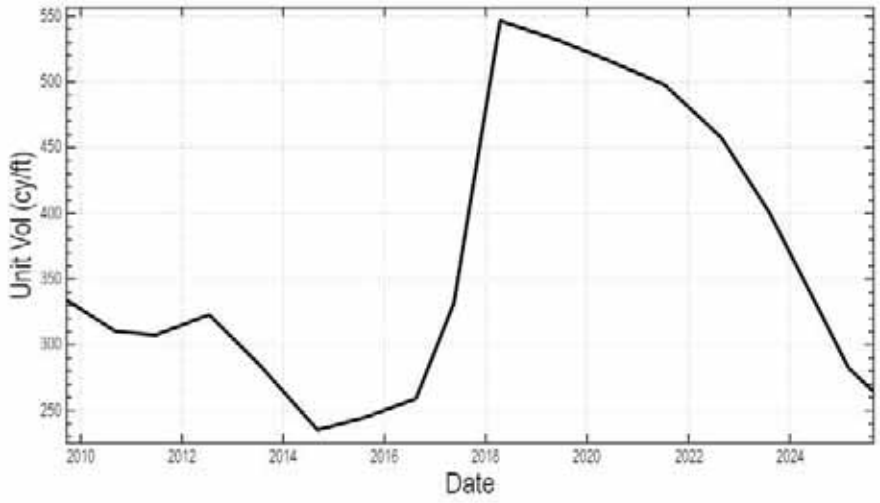

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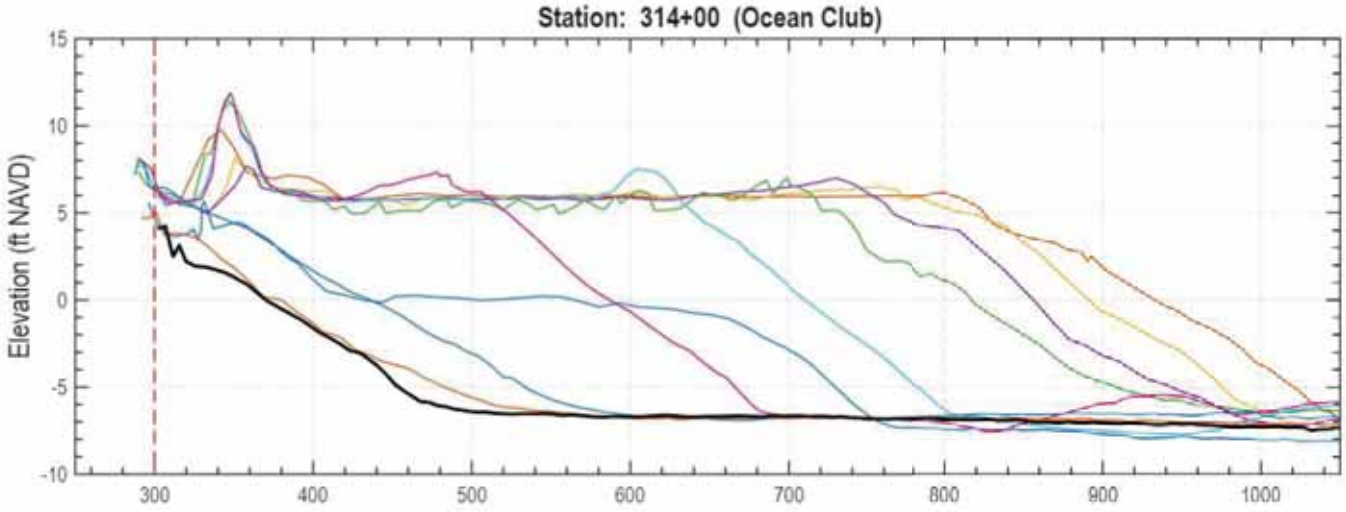

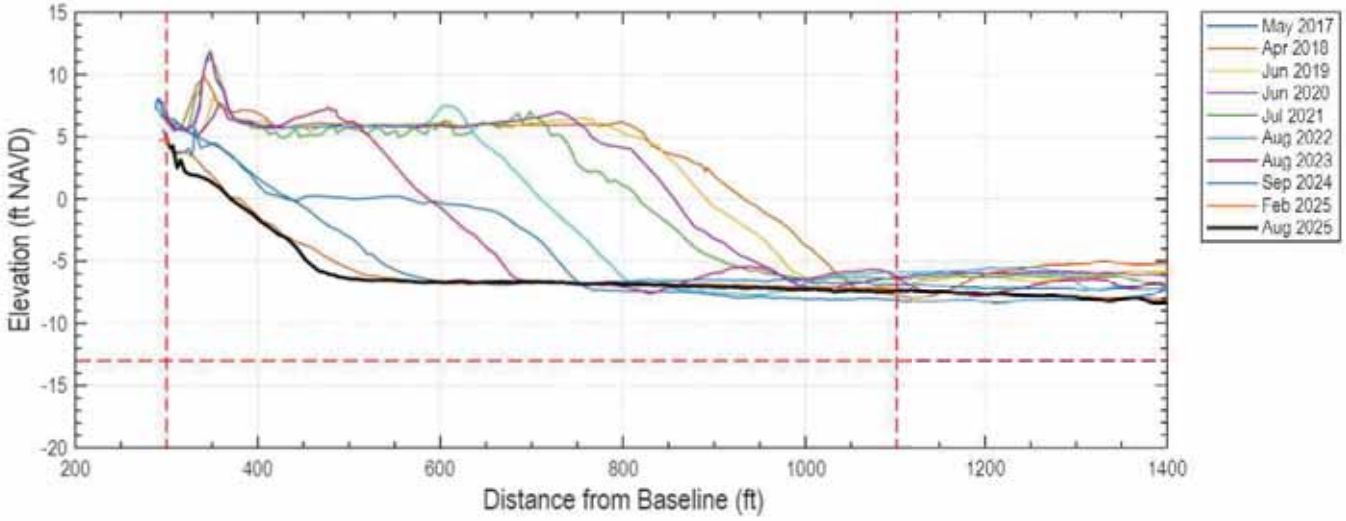

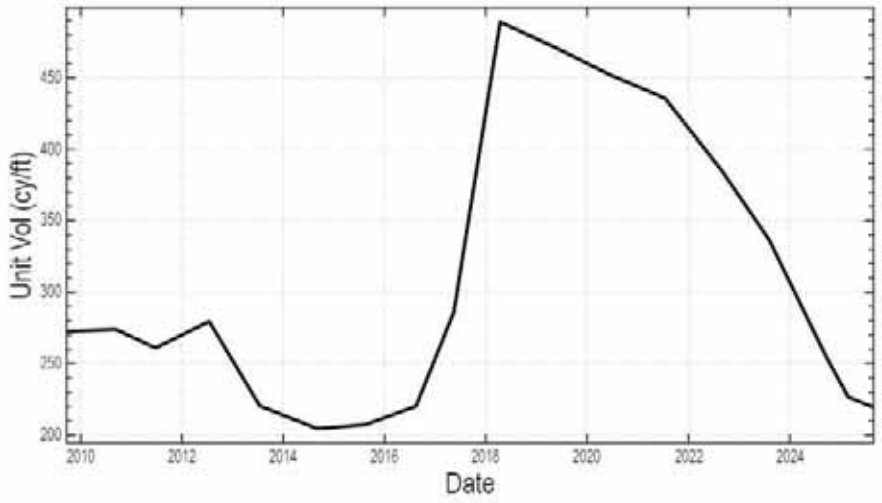

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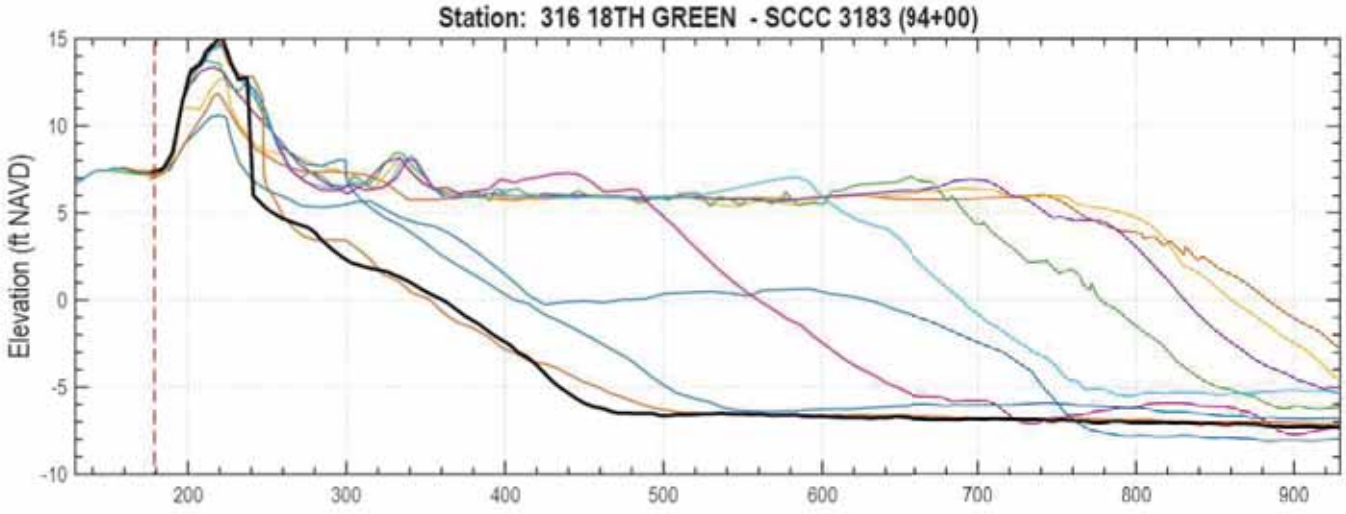

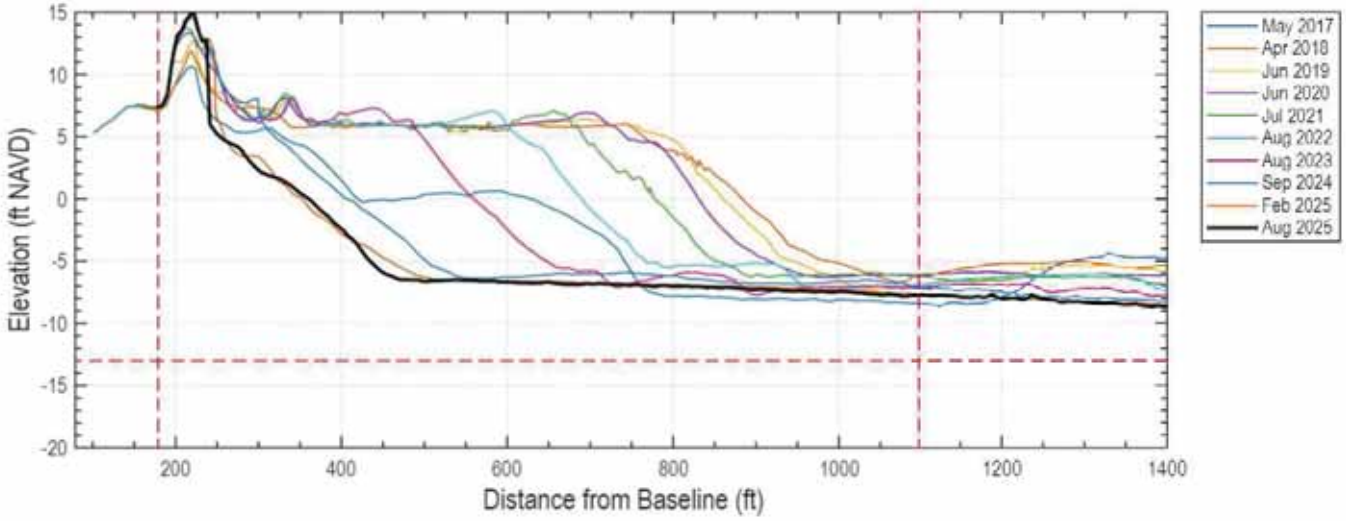

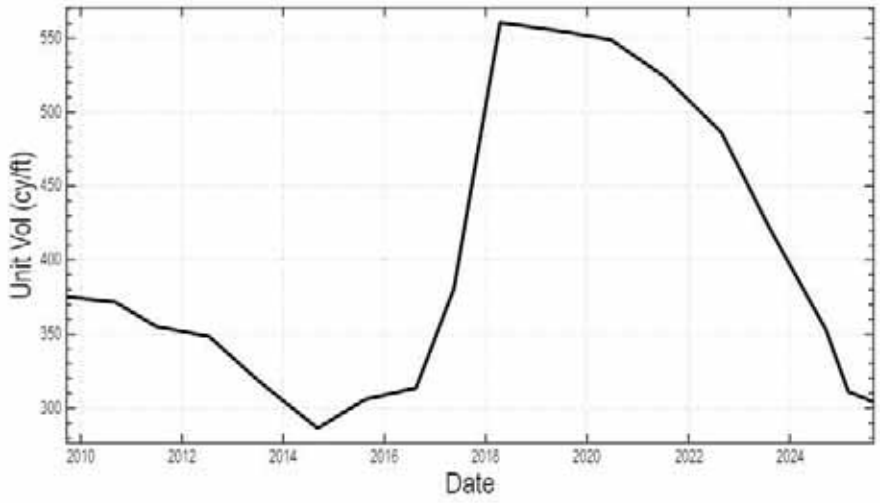

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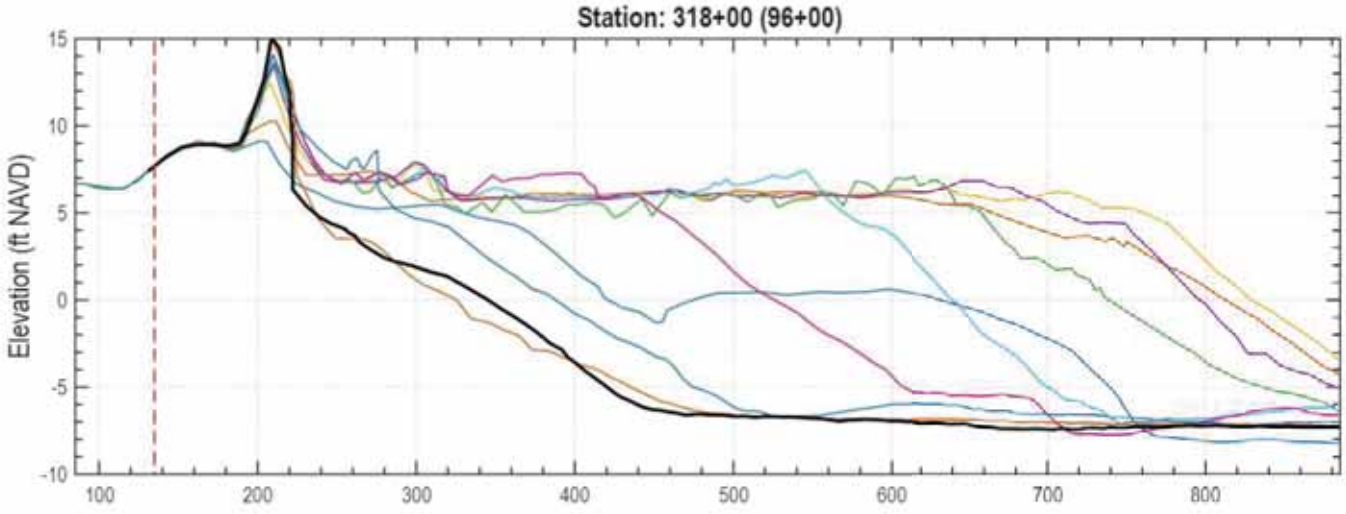

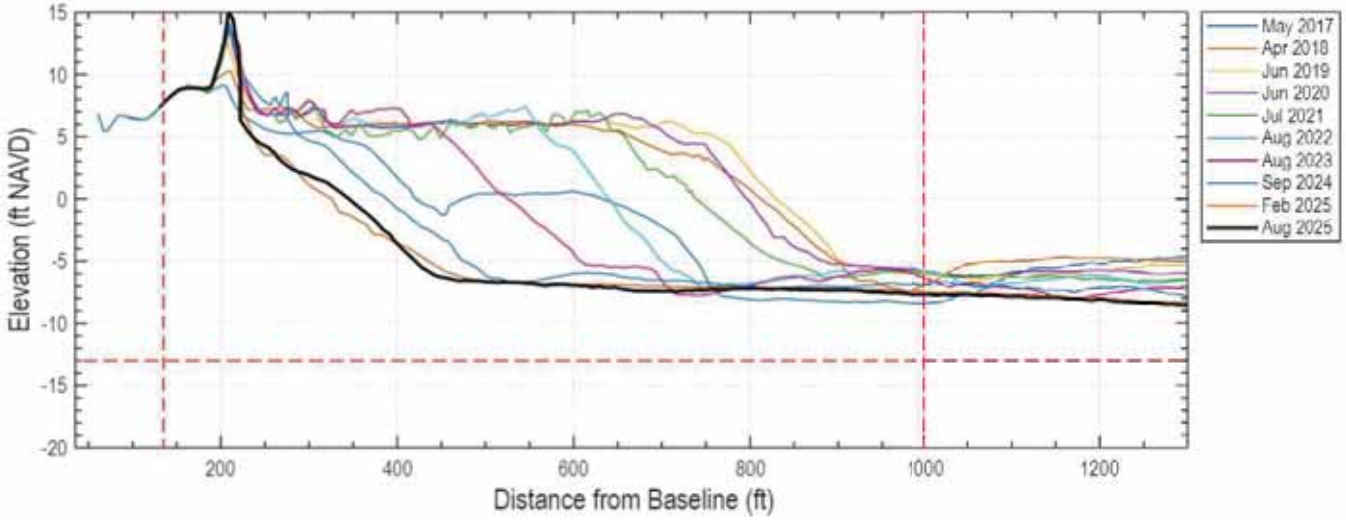

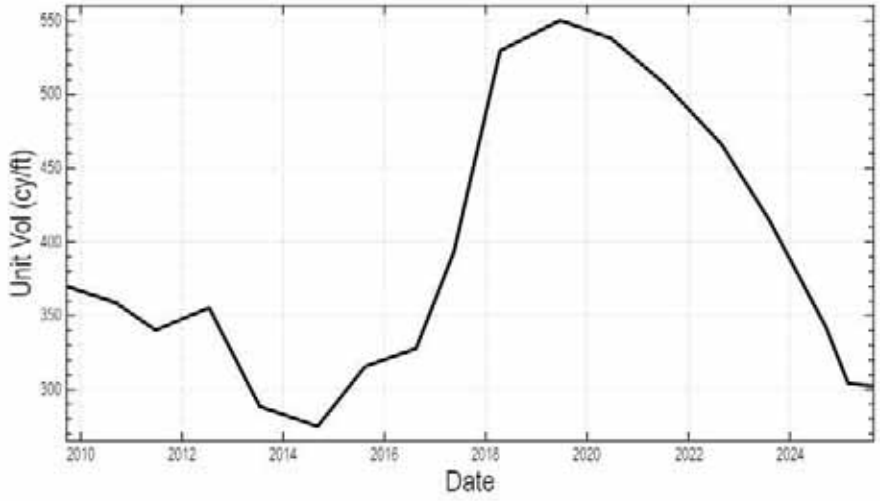

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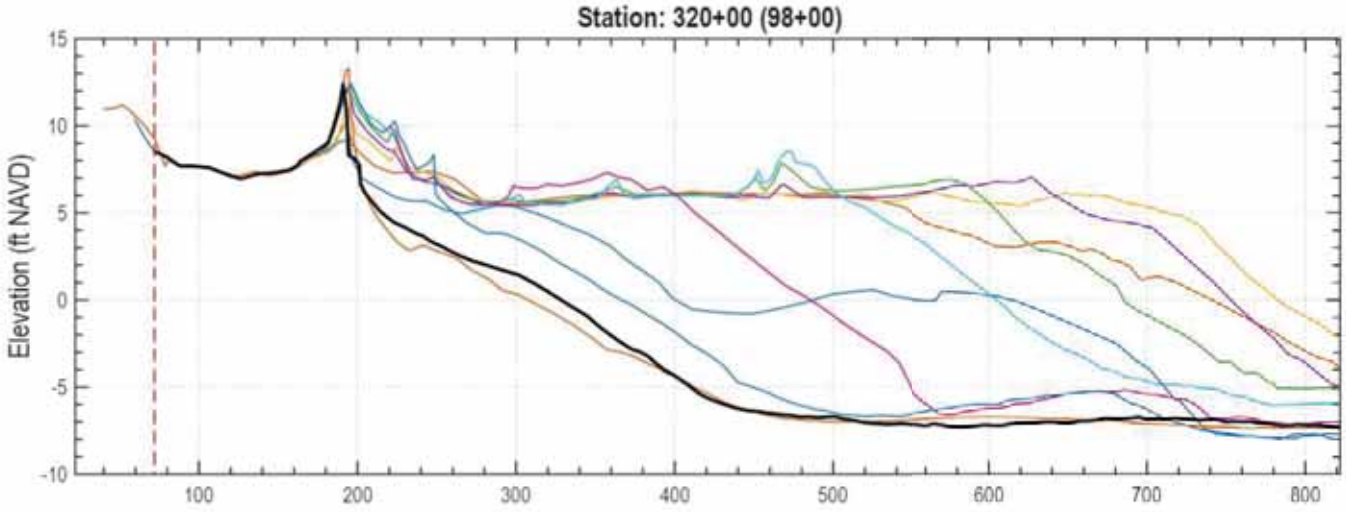

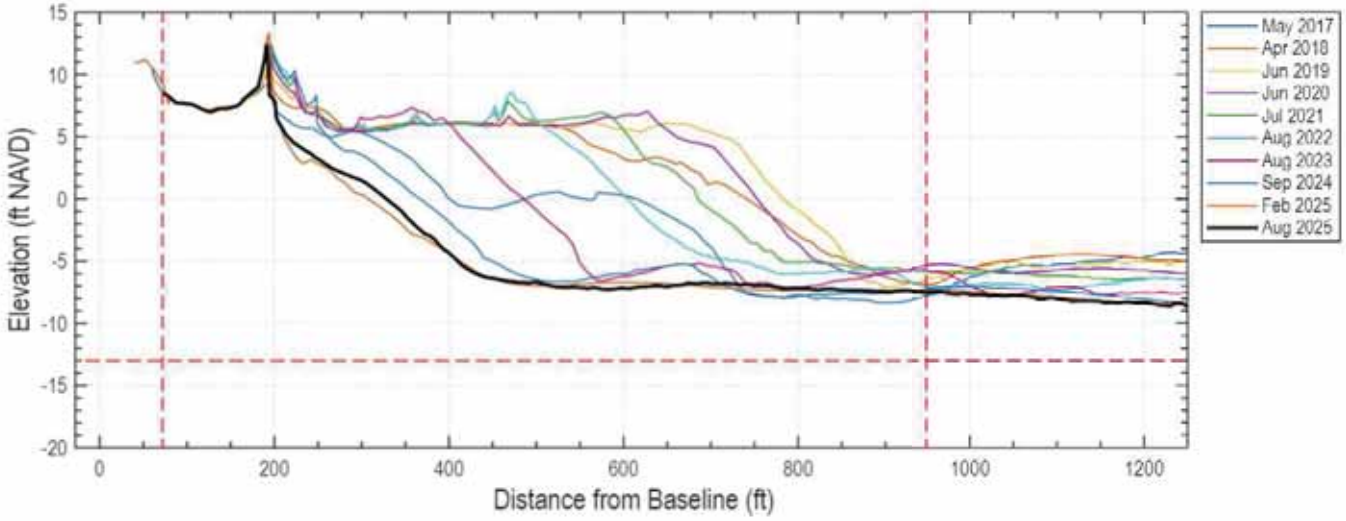

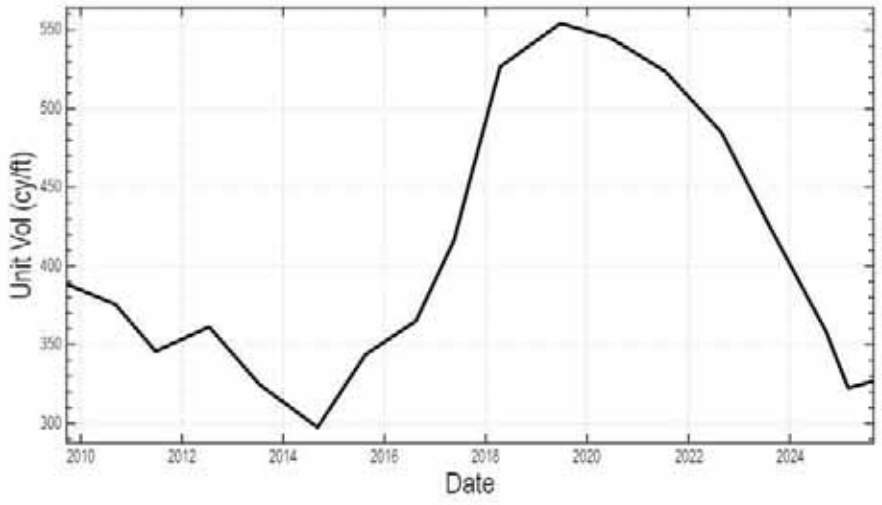

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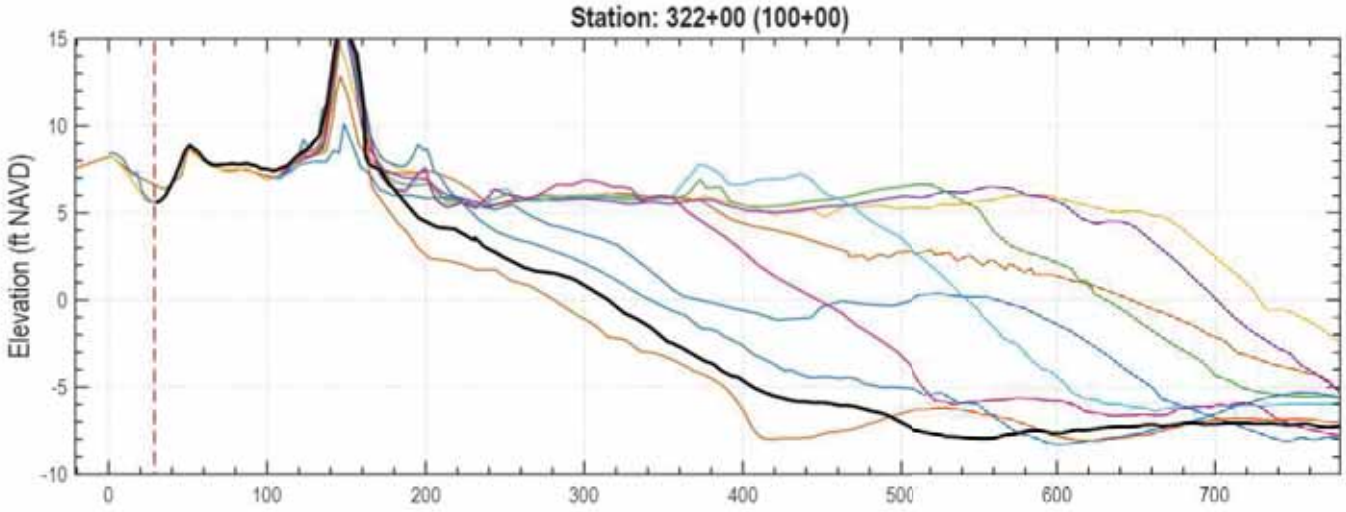

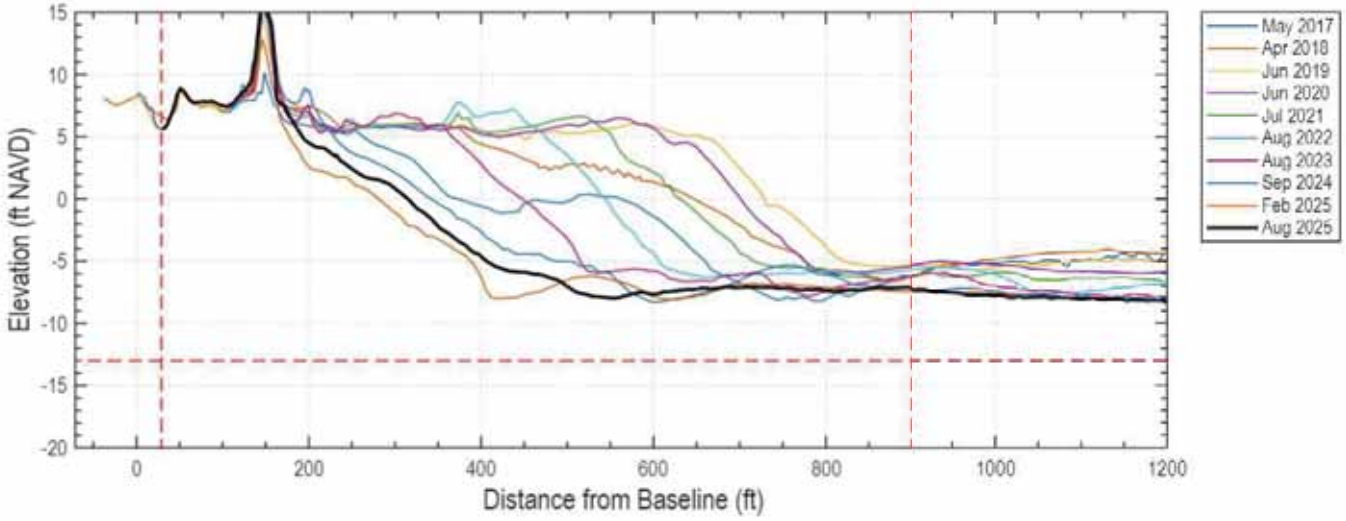

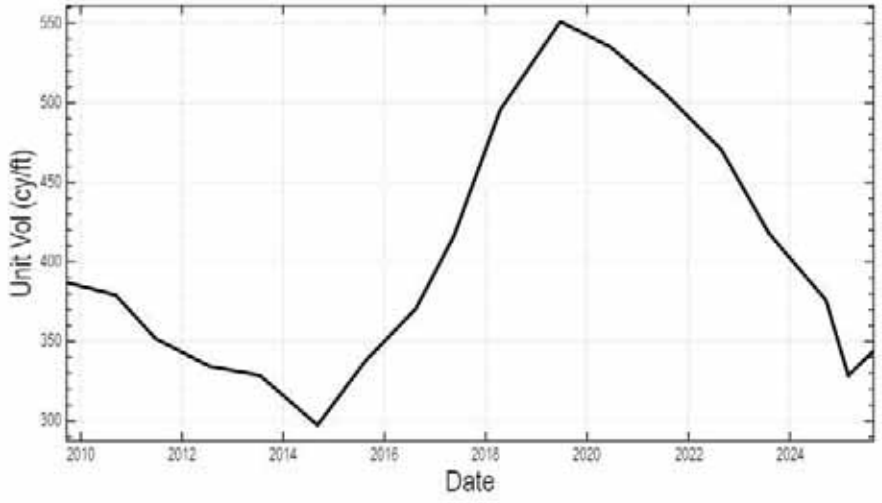

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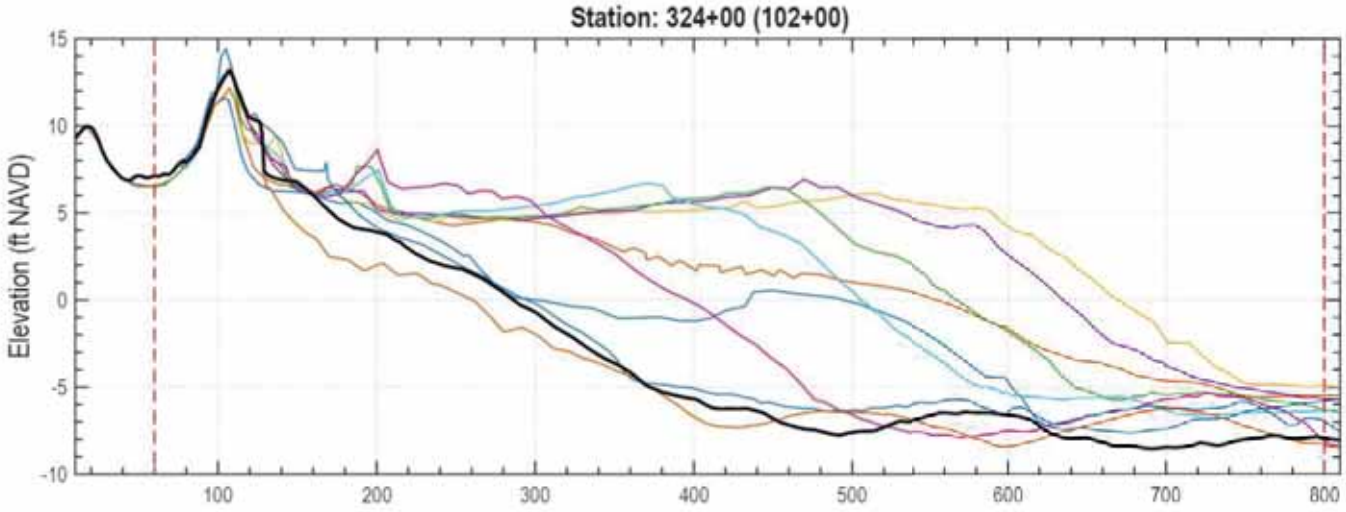

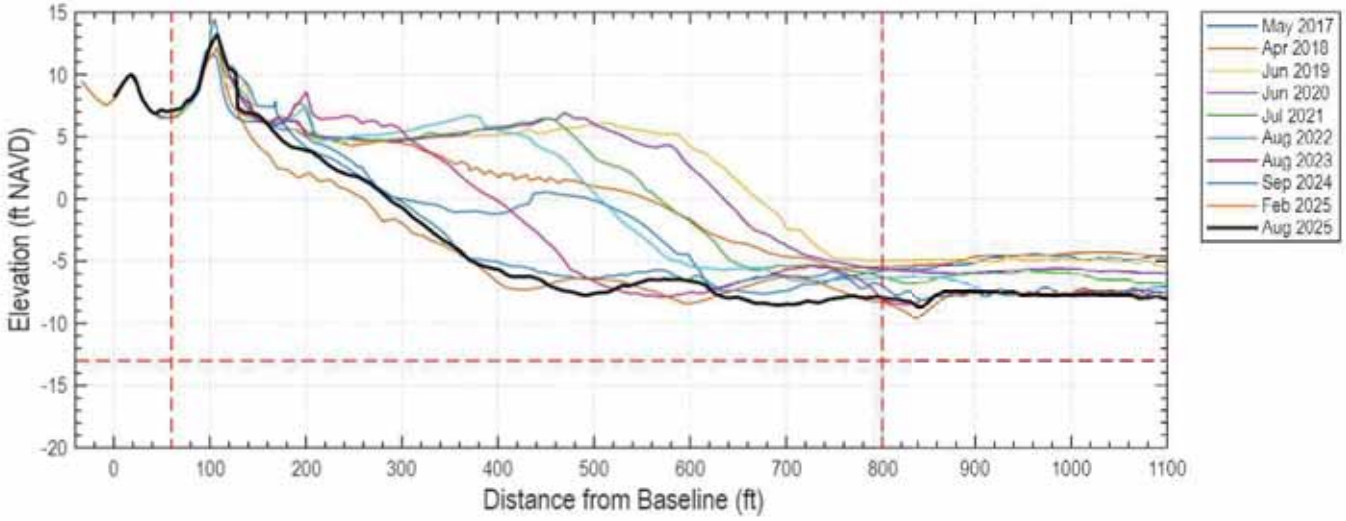

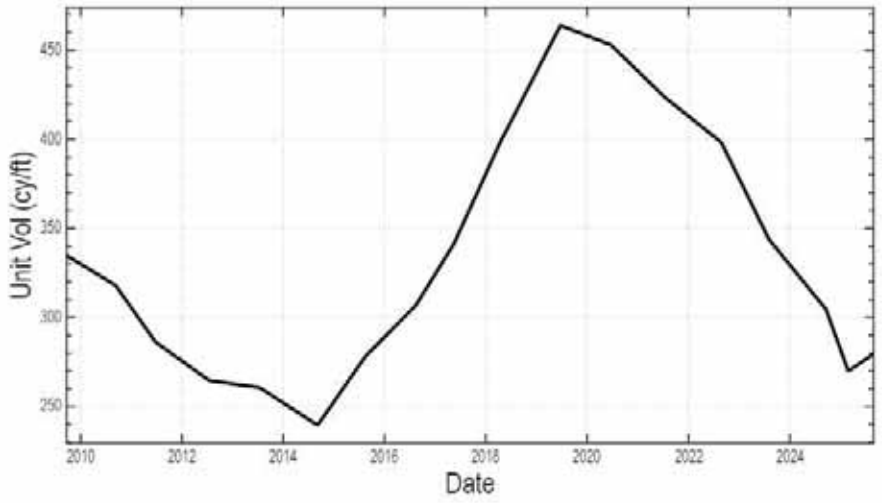

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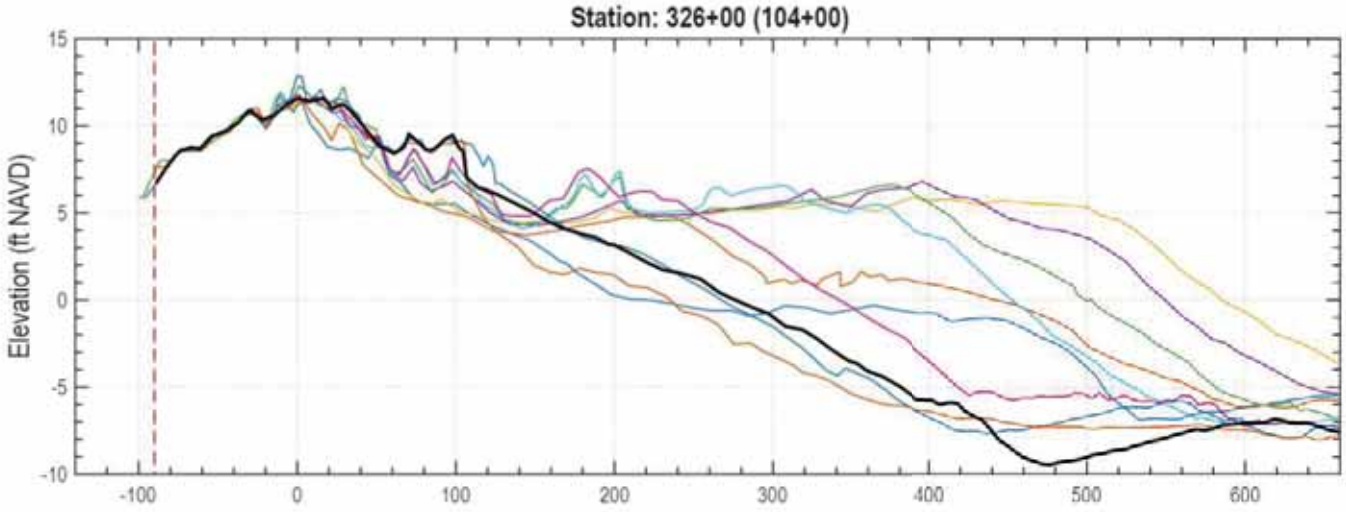

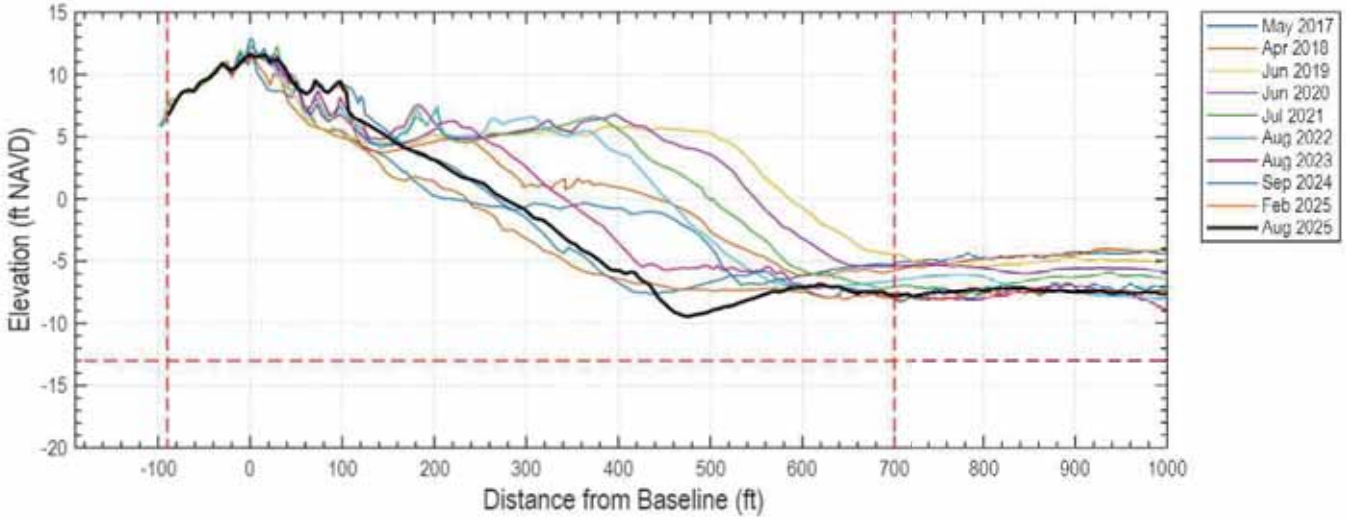

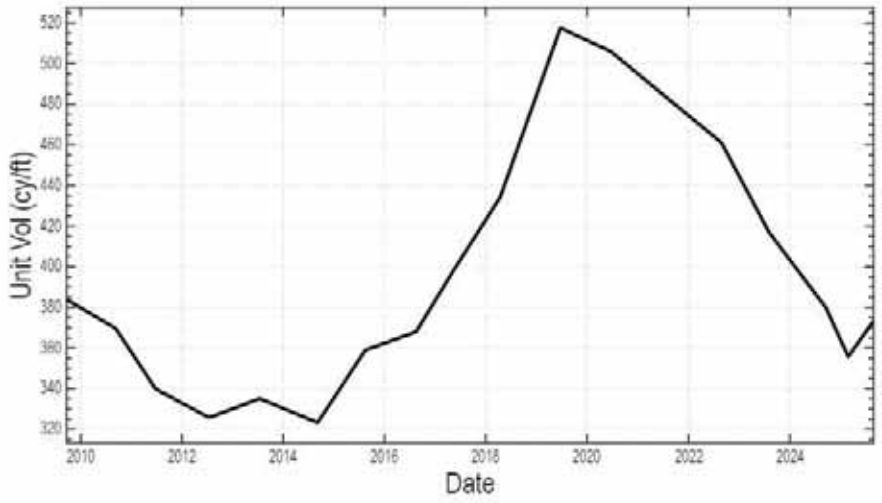

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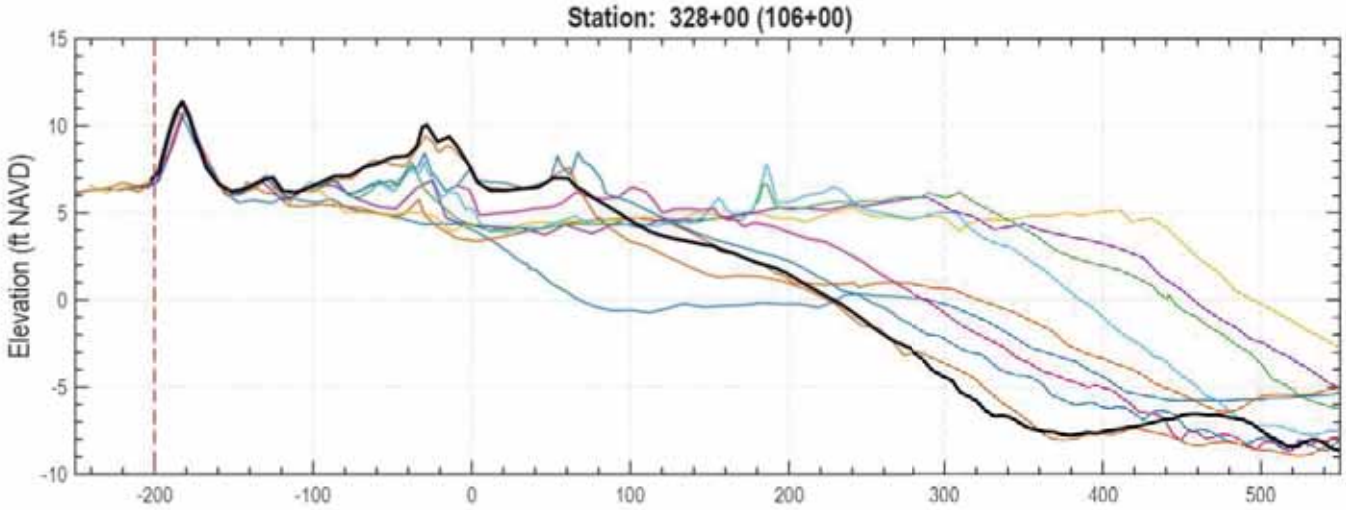

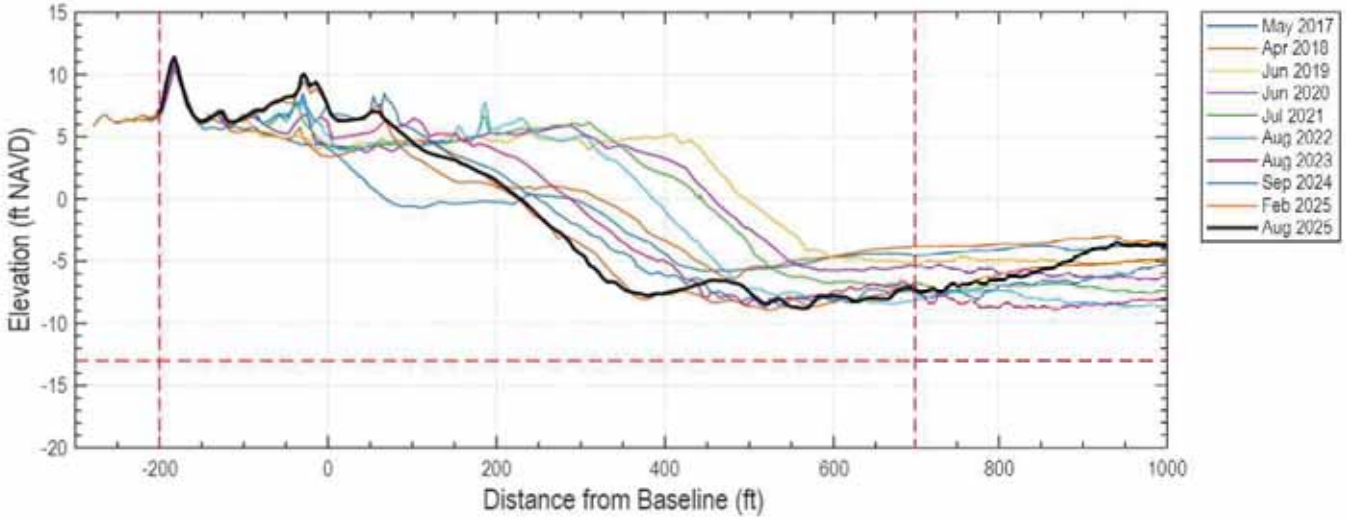

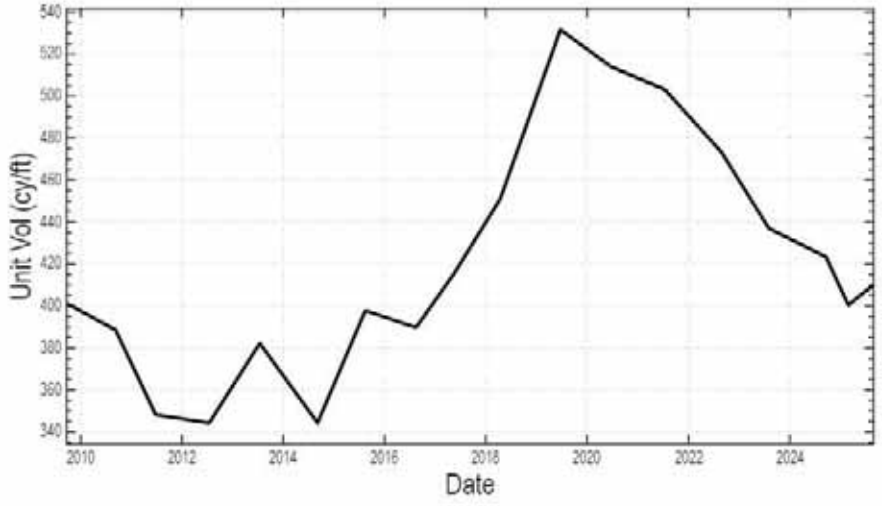

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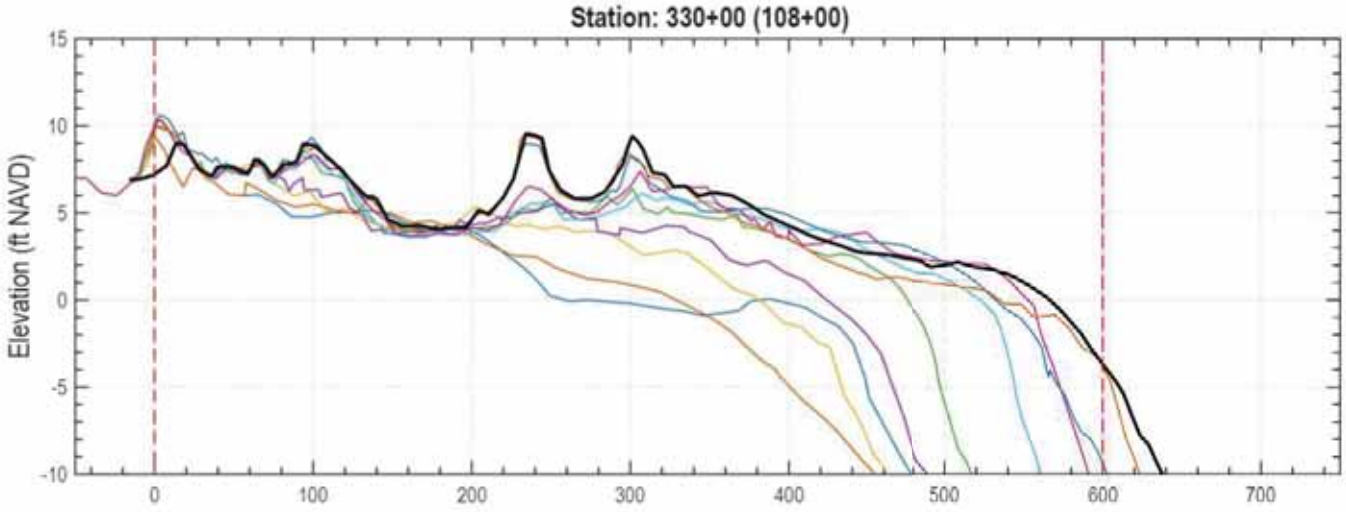

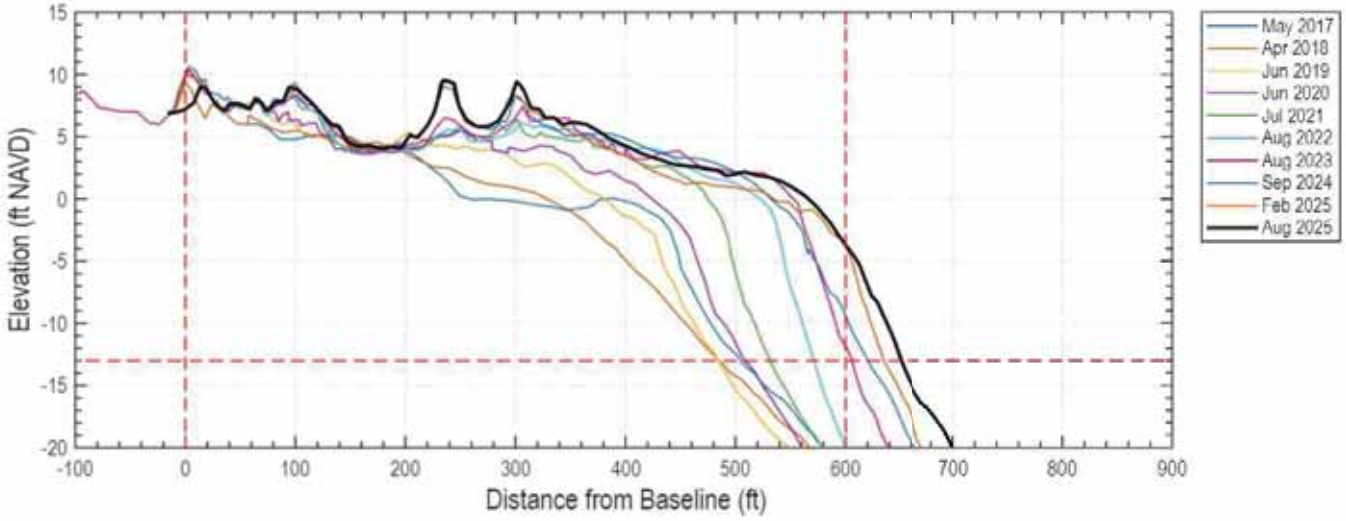

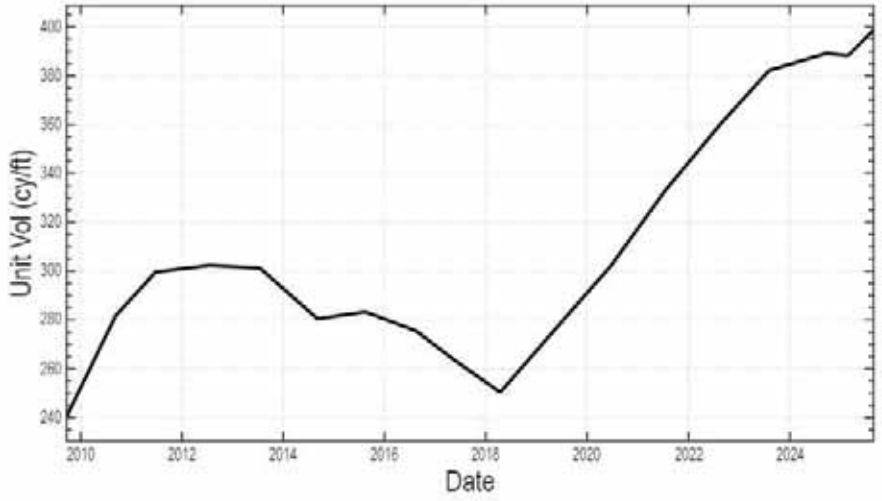

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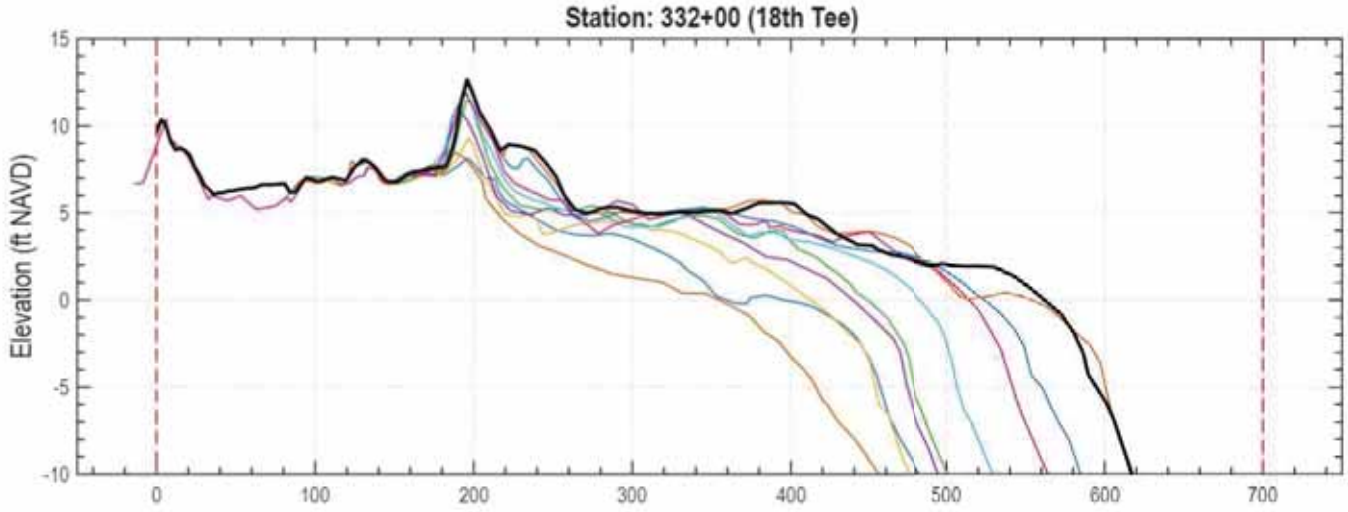

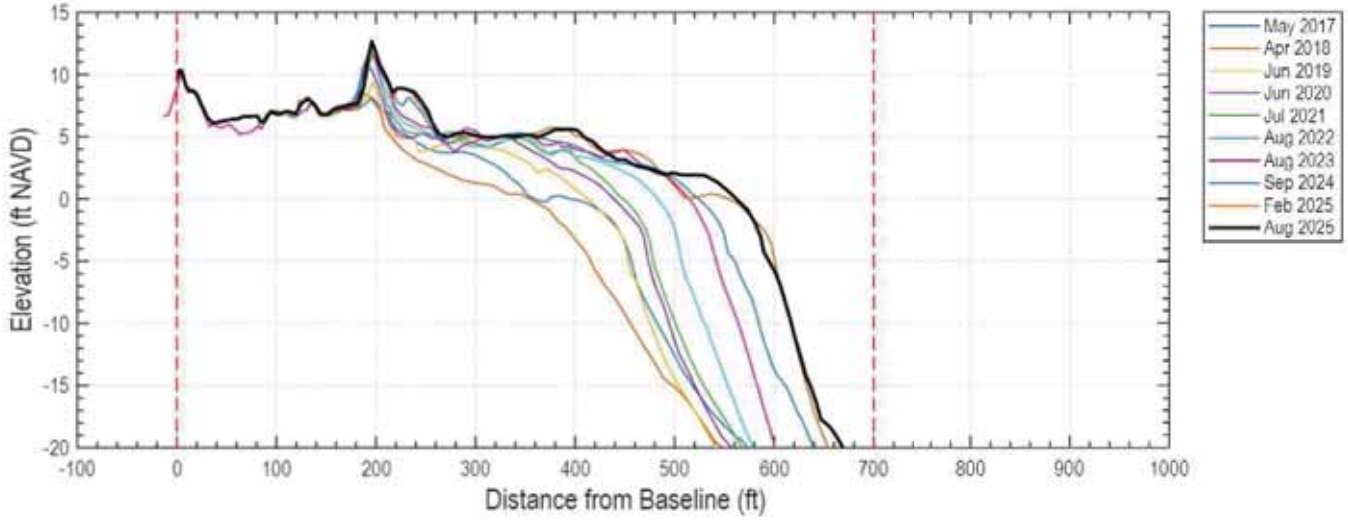

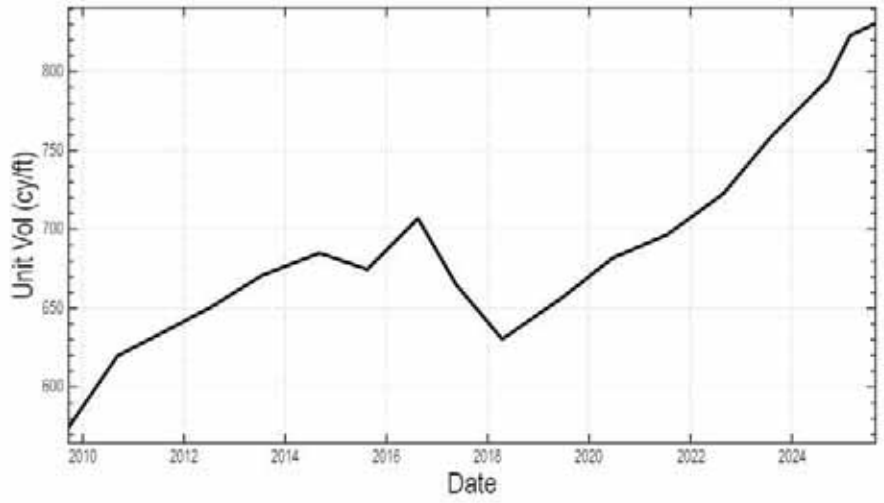

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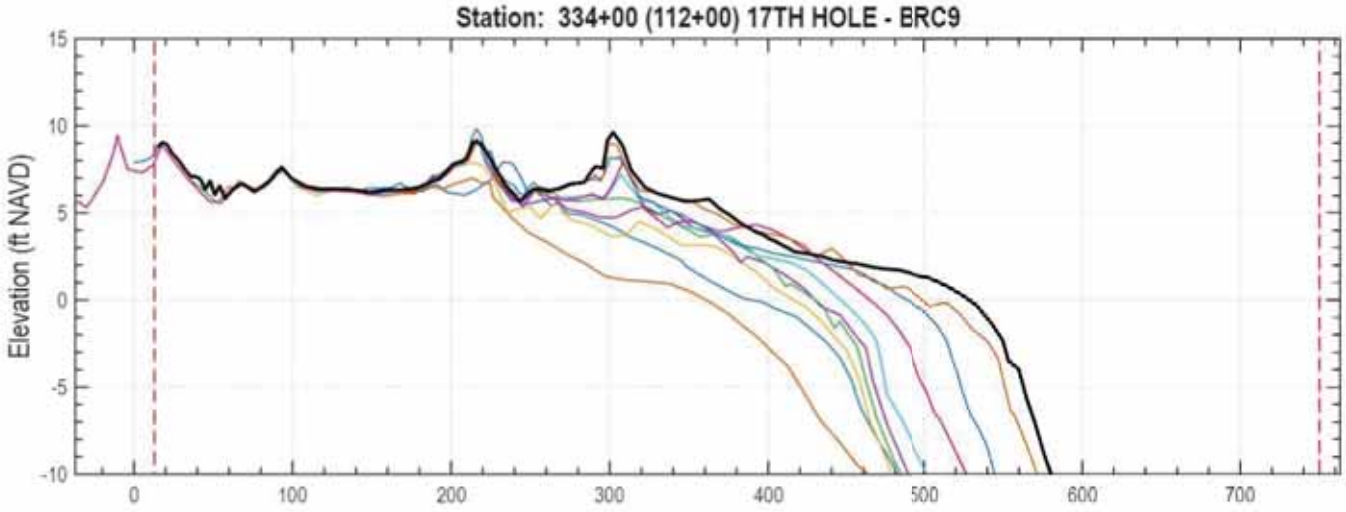

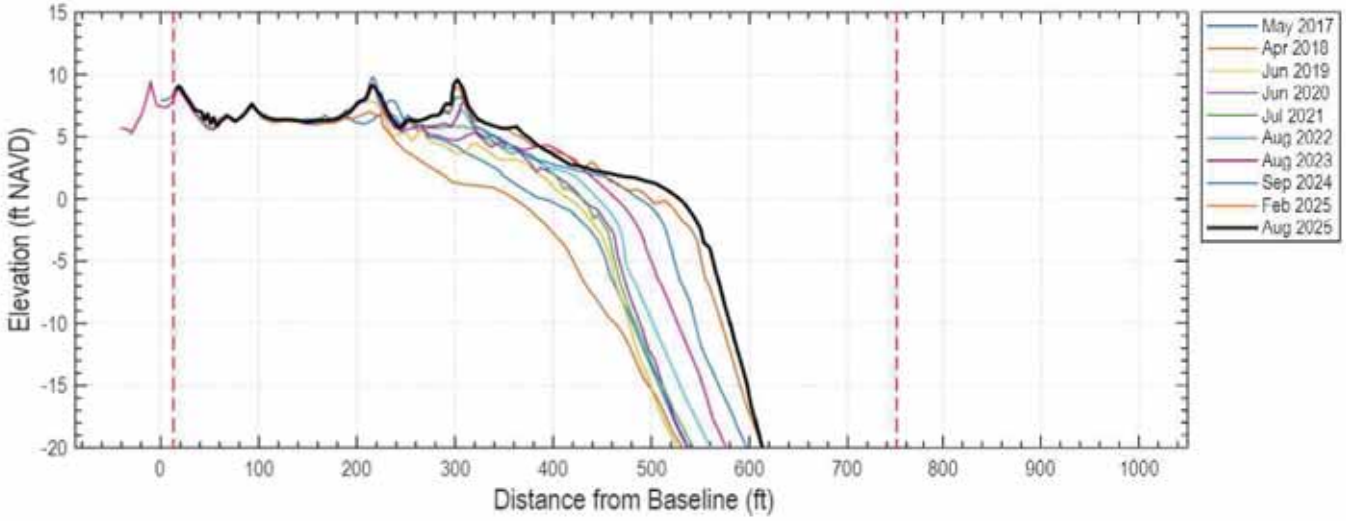

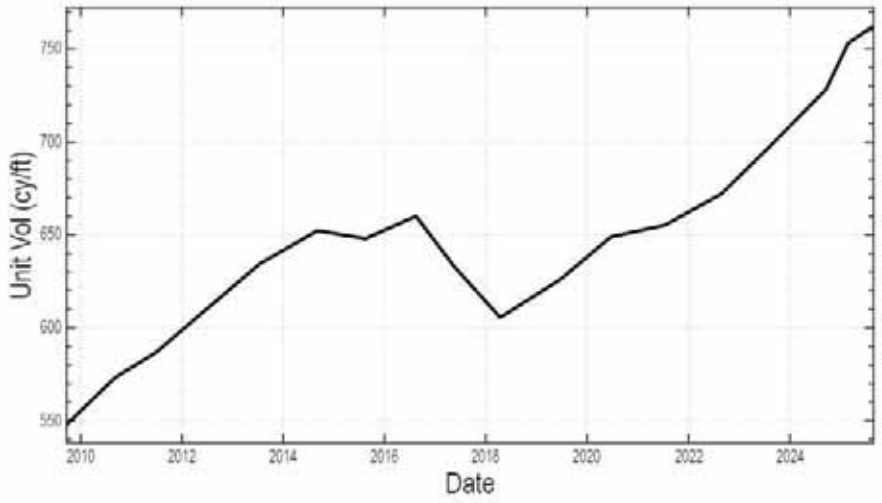

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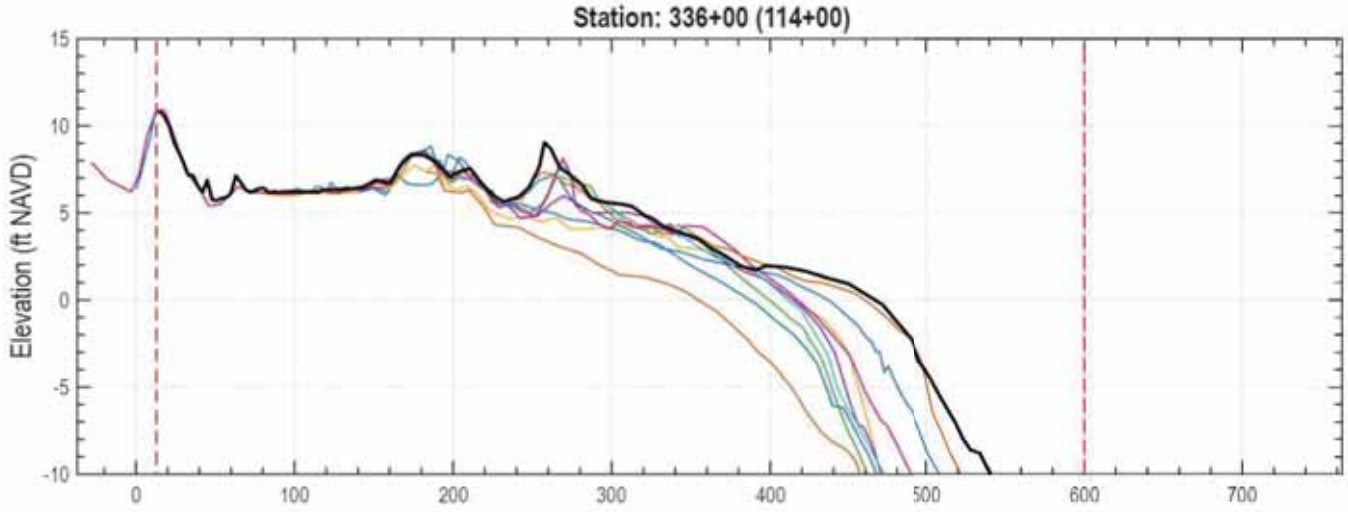

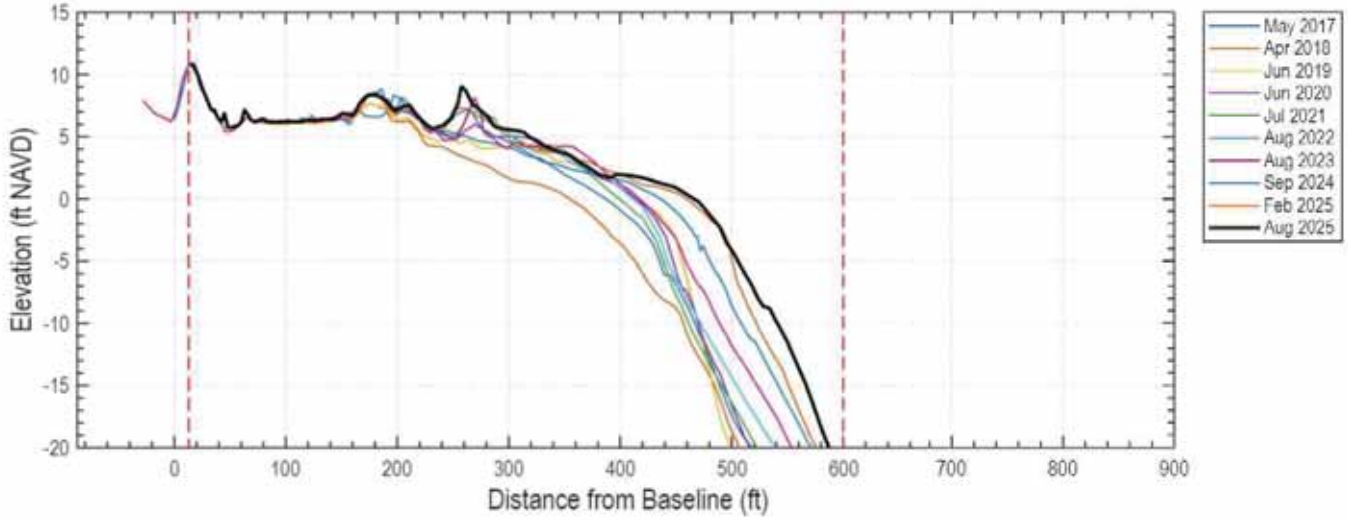

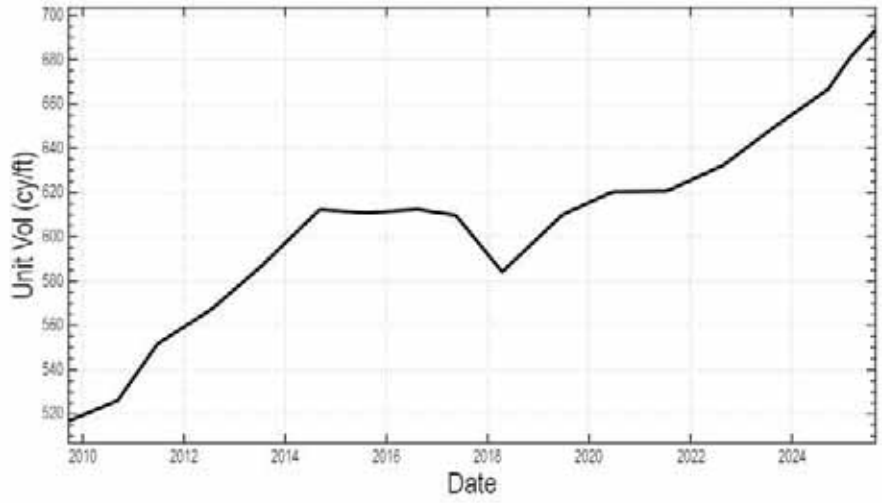

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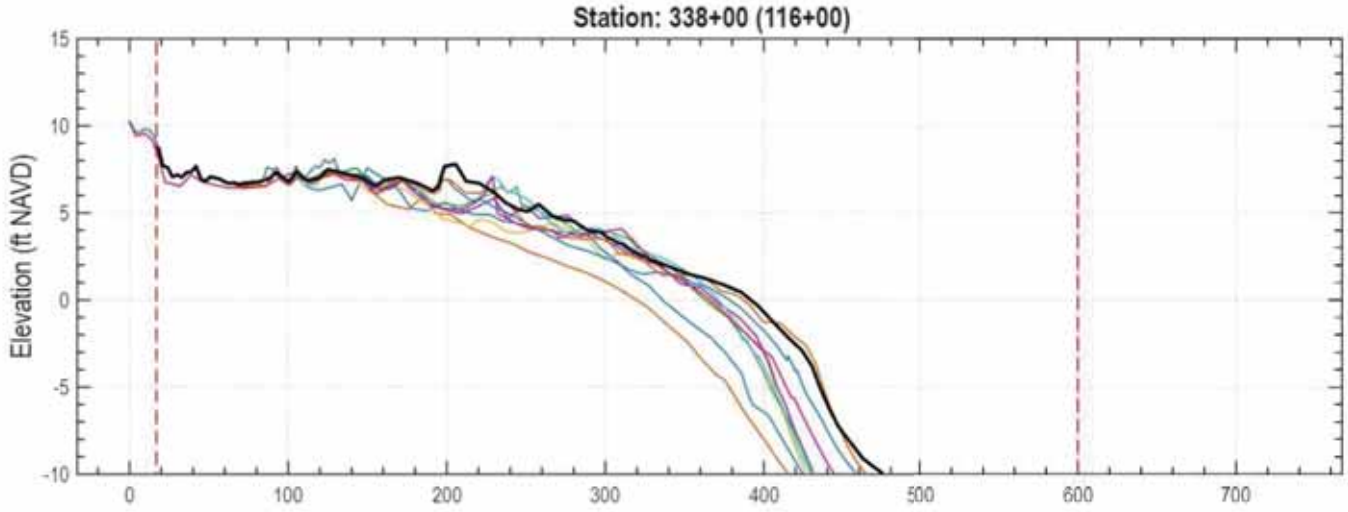

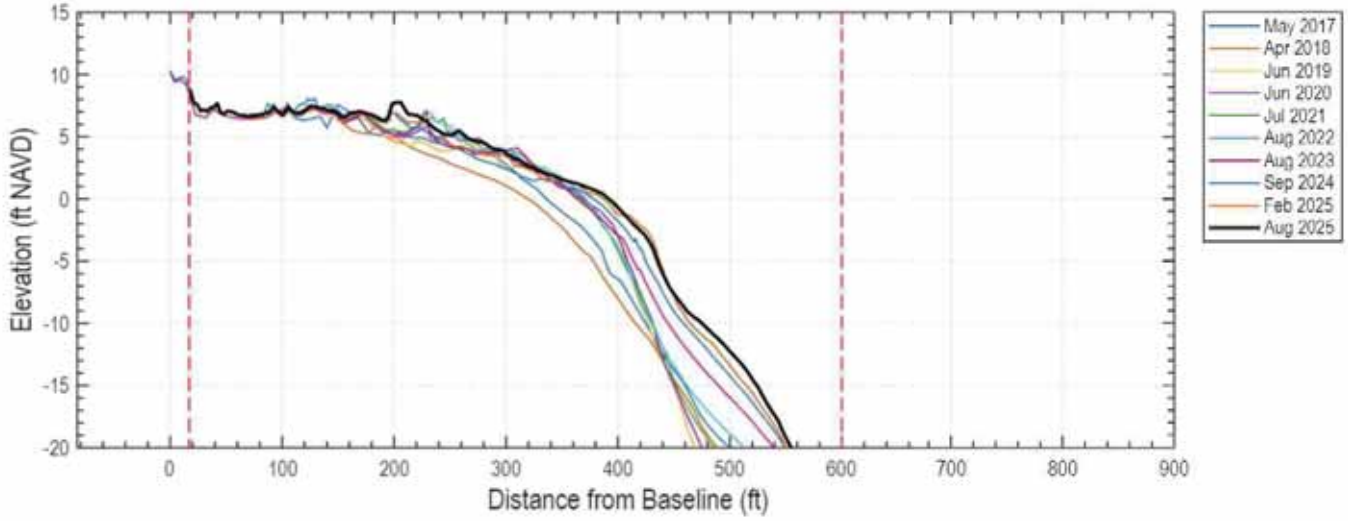

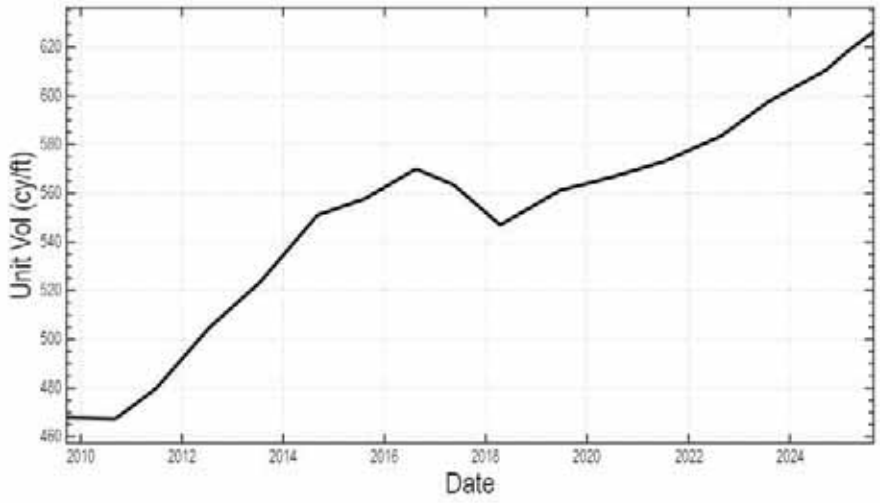

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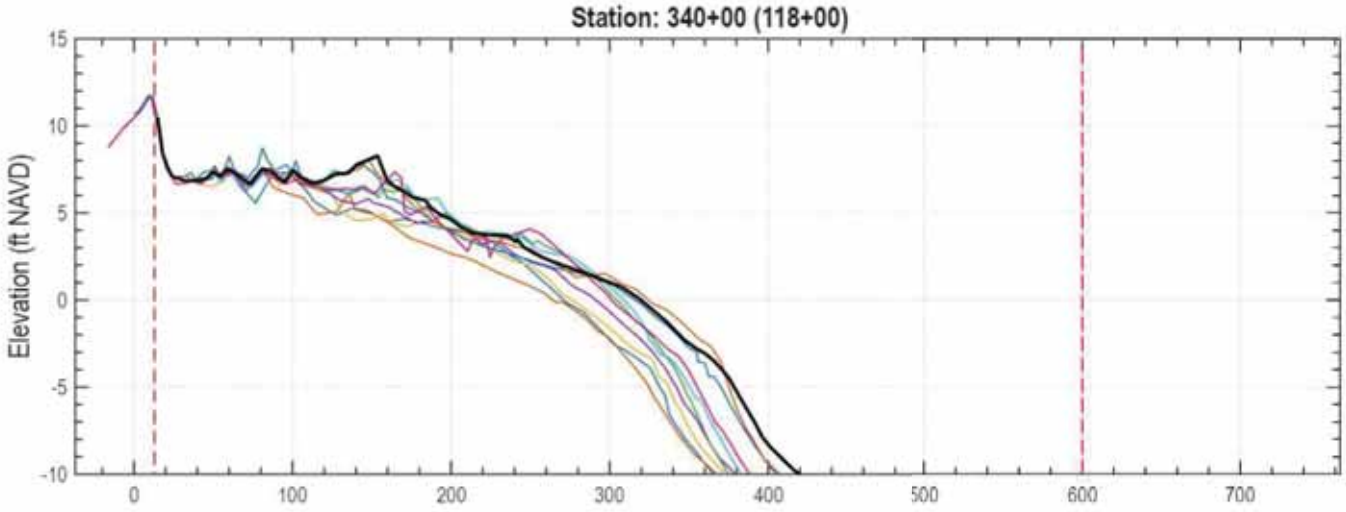

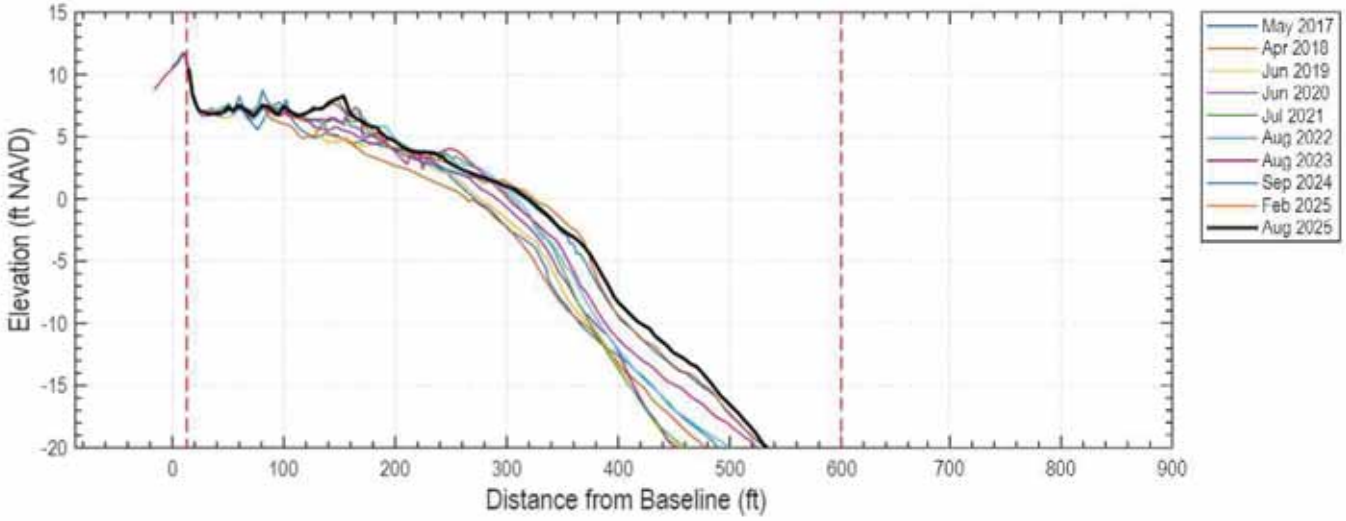

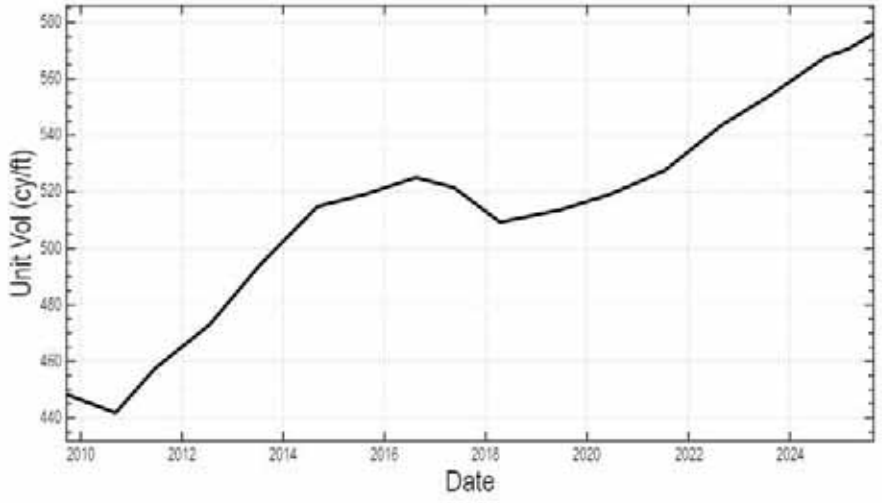

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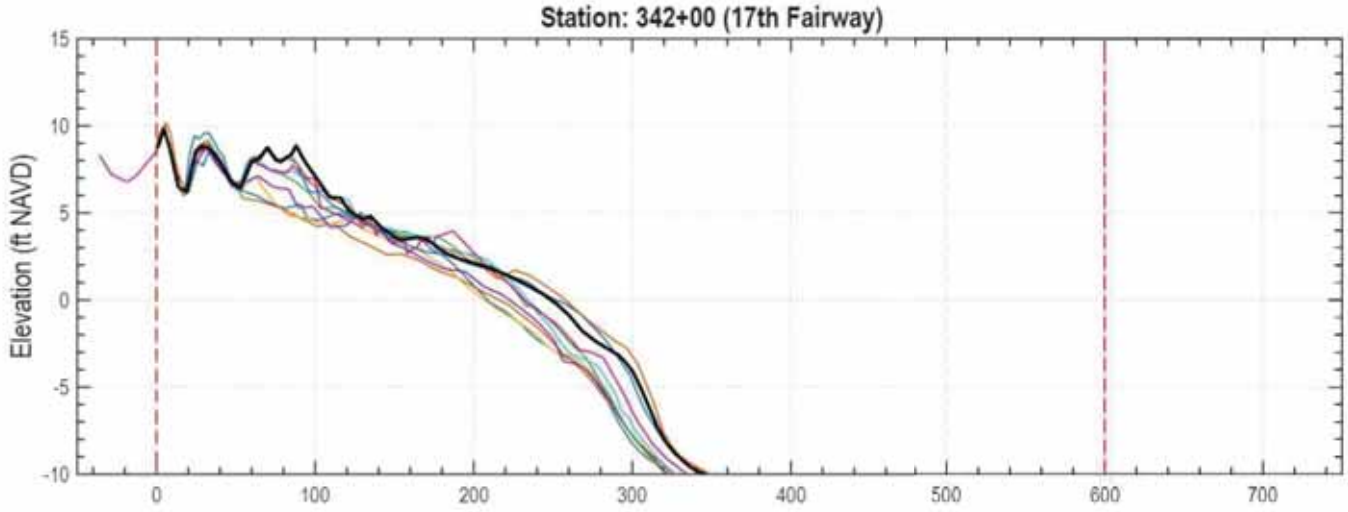

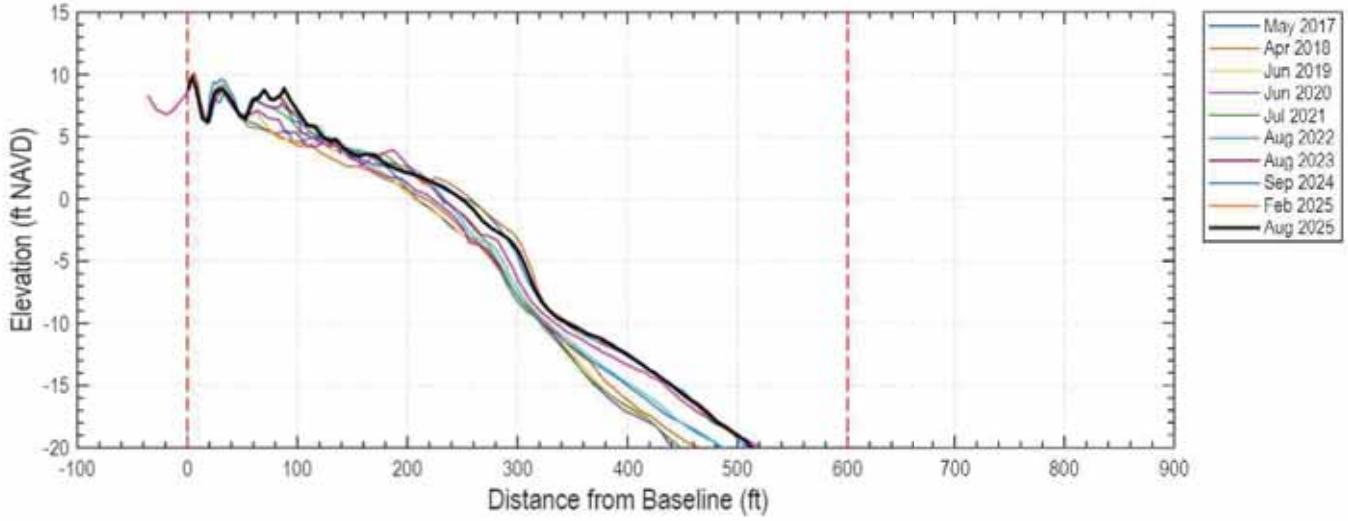

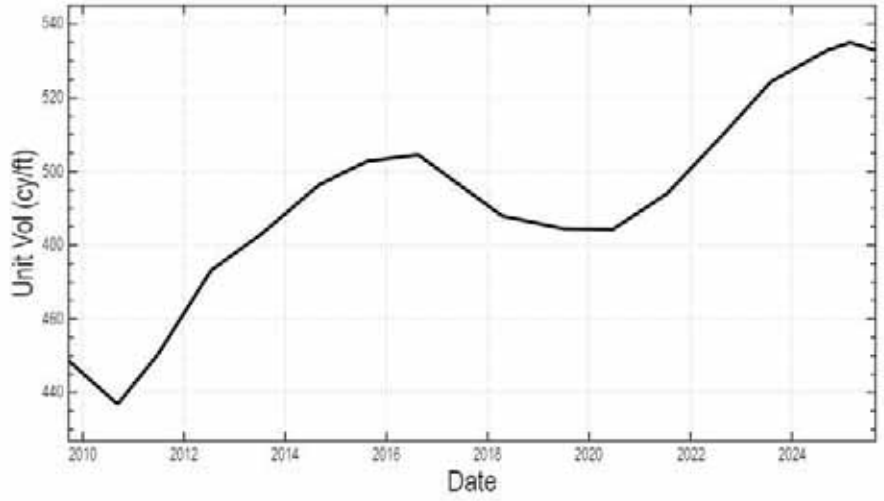

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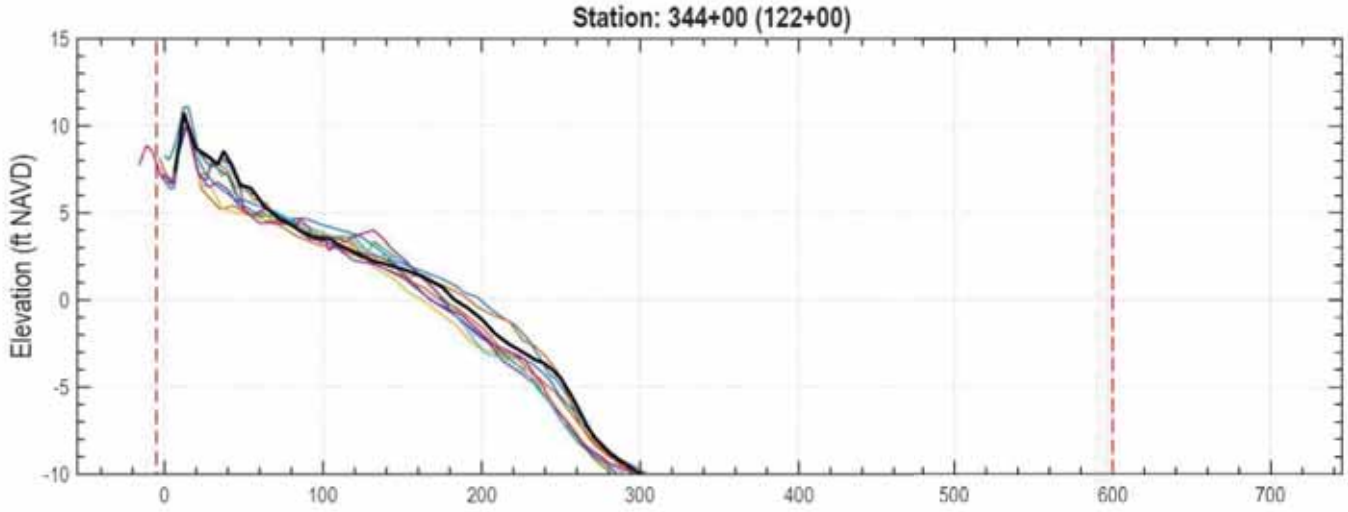

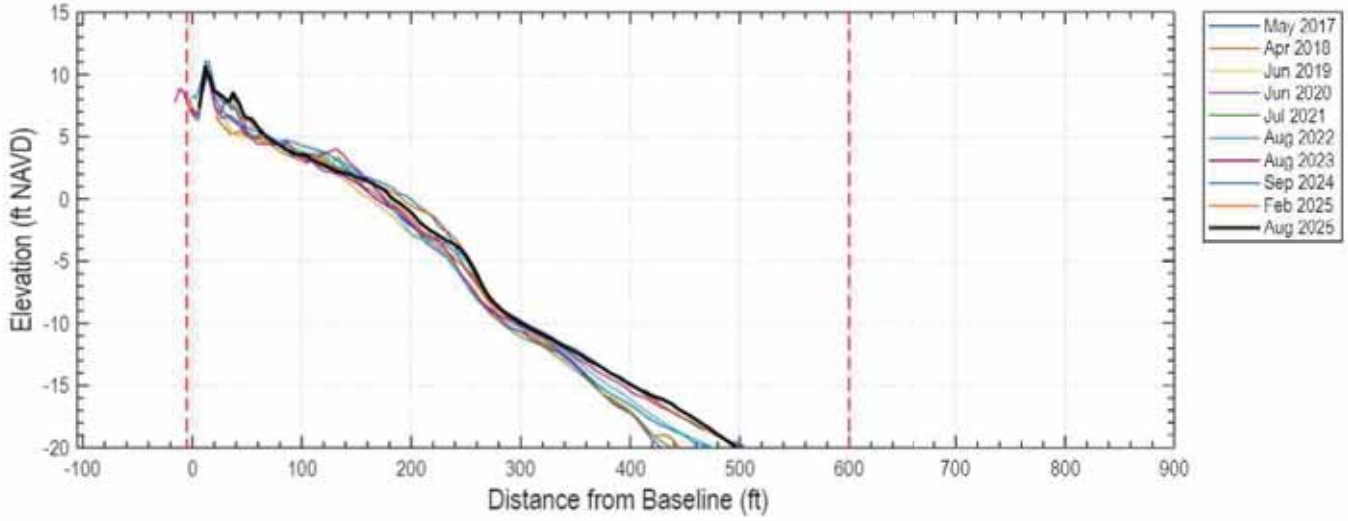

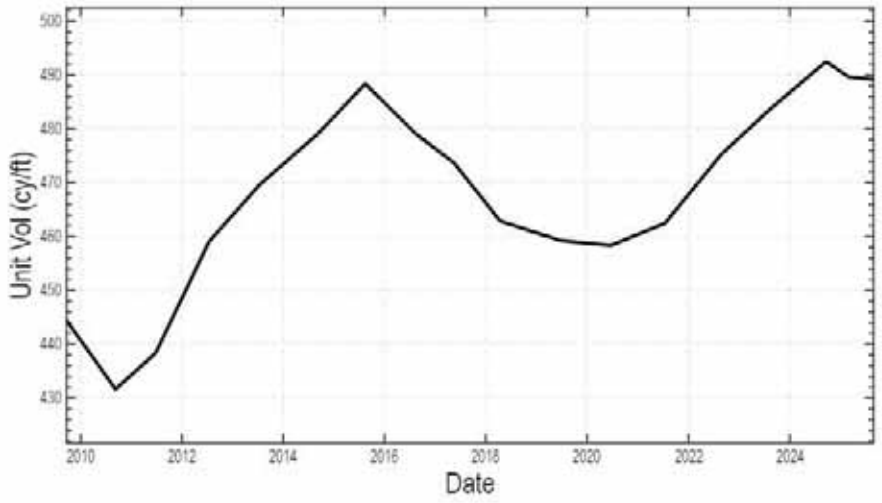

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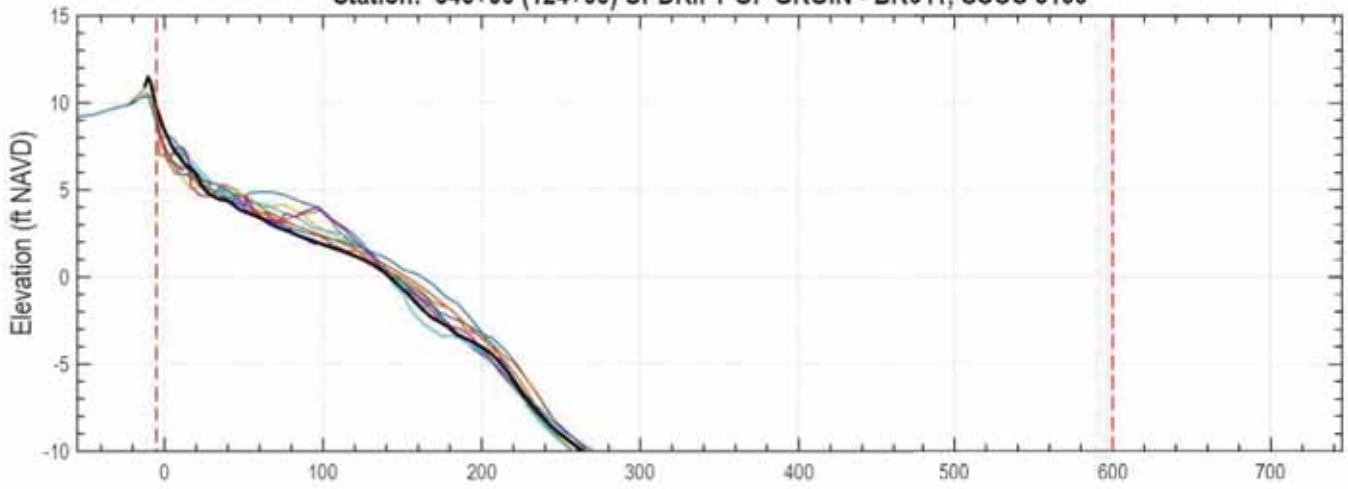
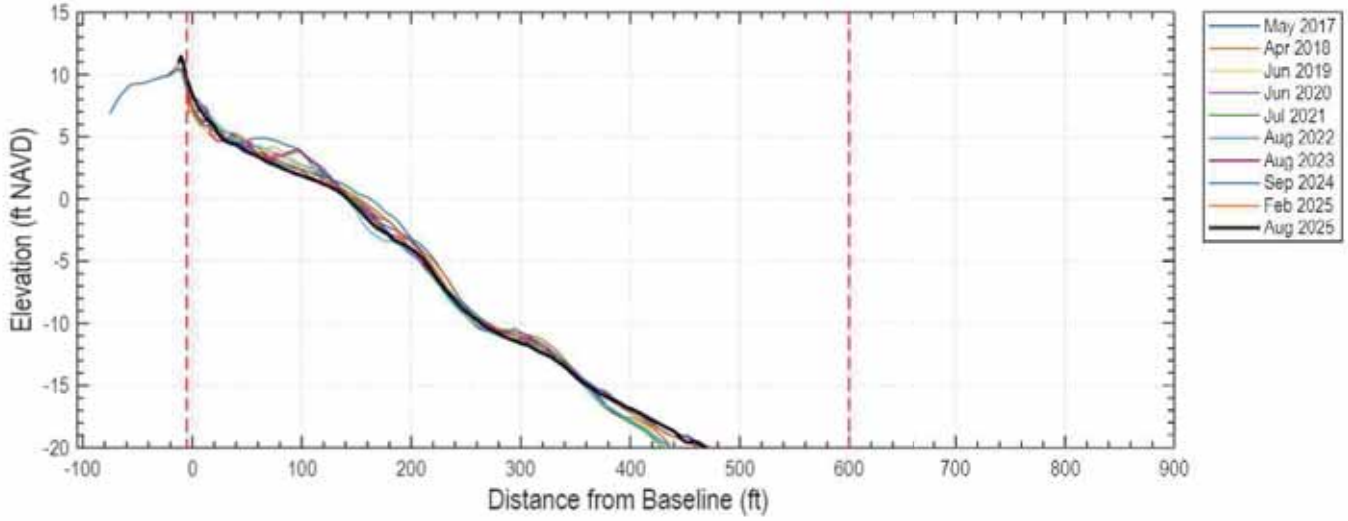
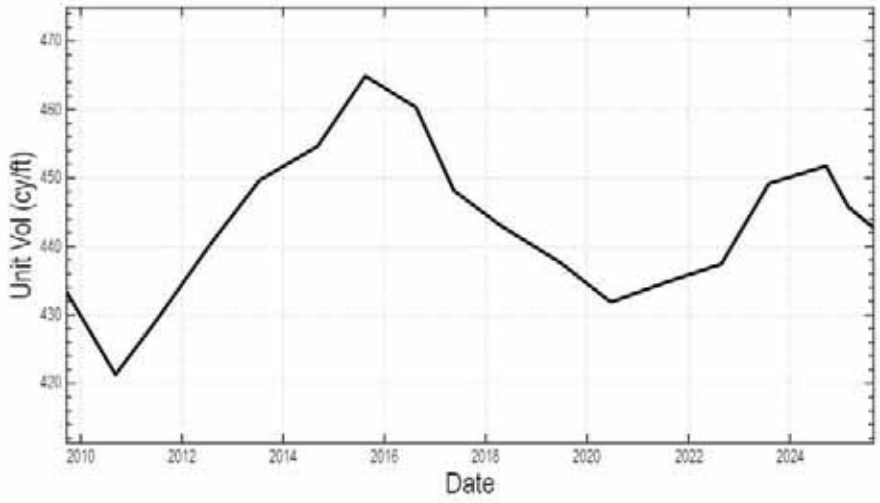
Station: 346+00 (124+00) UPDRIFT OF GROIN - BRC11, SCCC 3190







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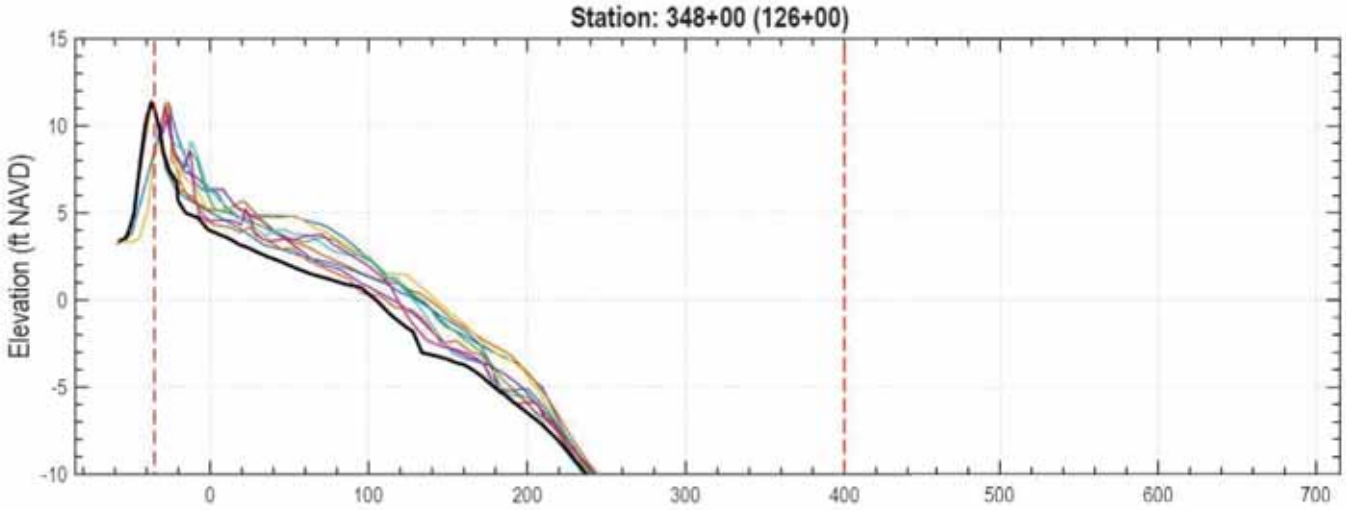

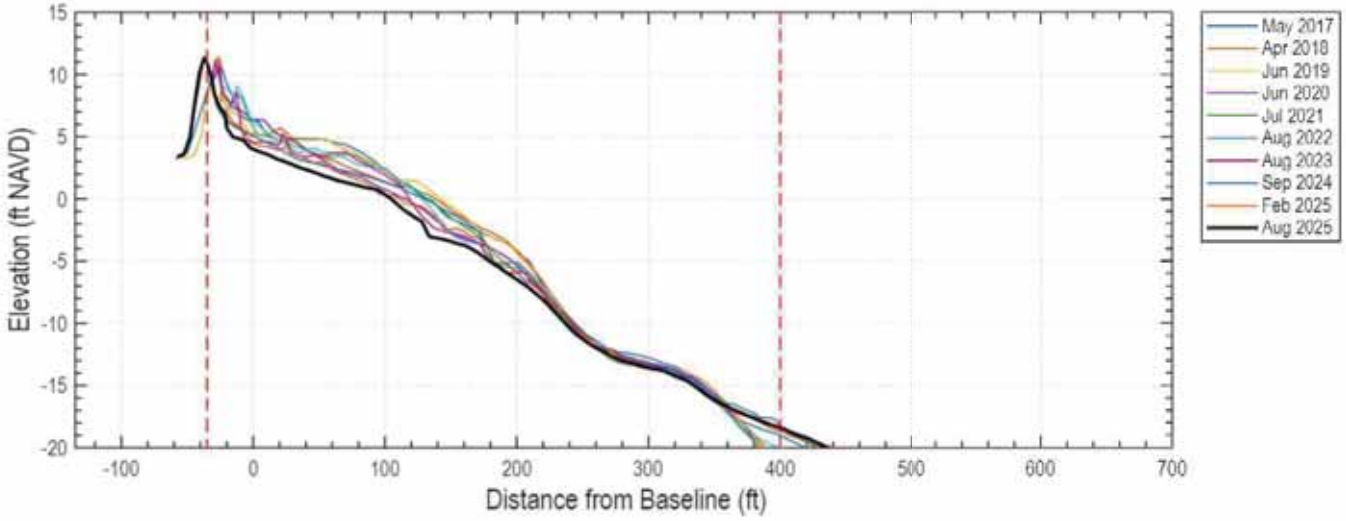

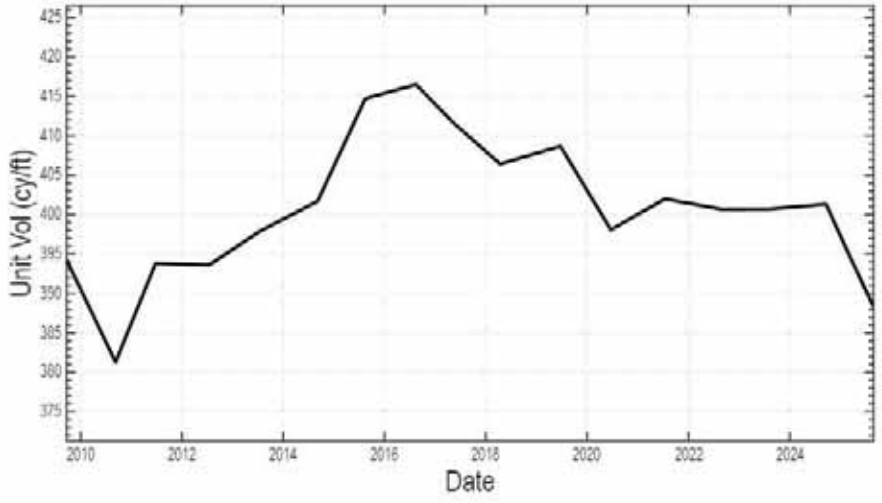

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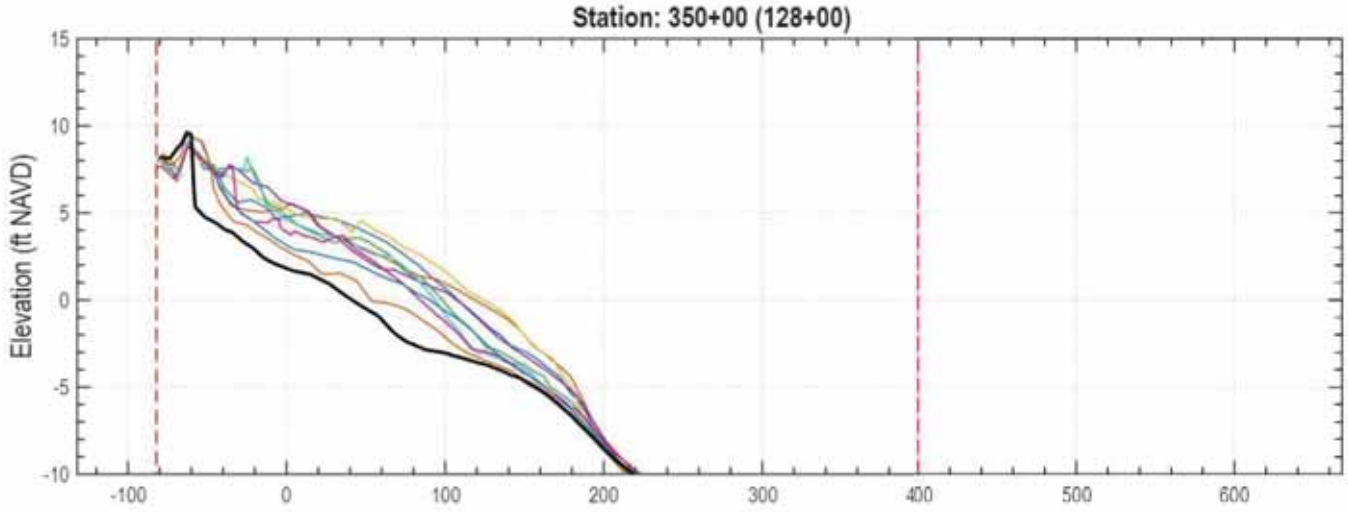

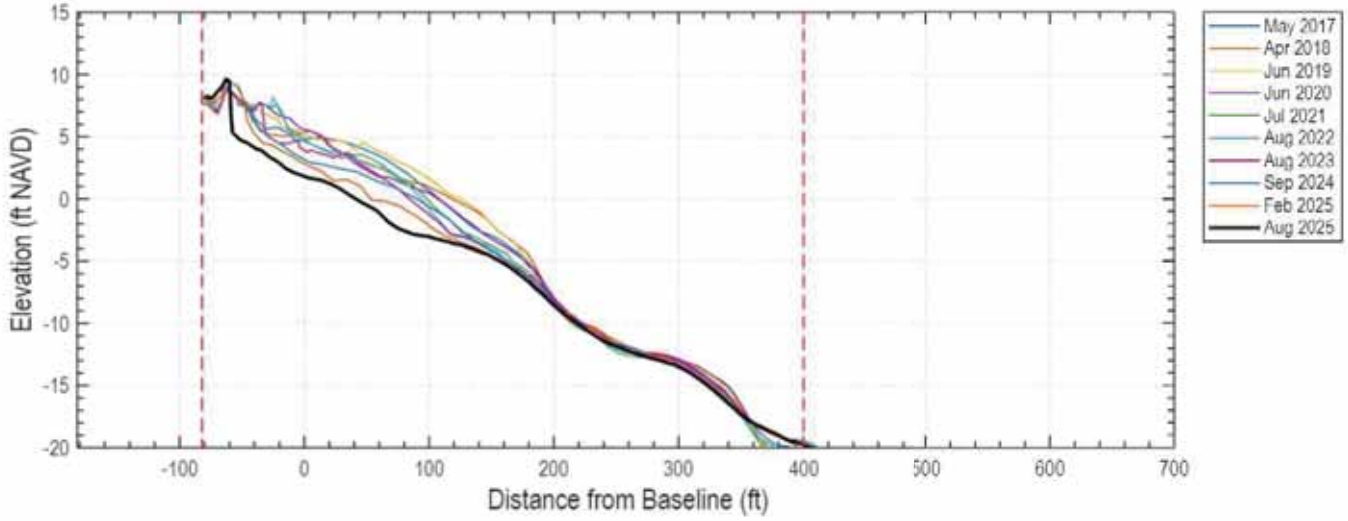

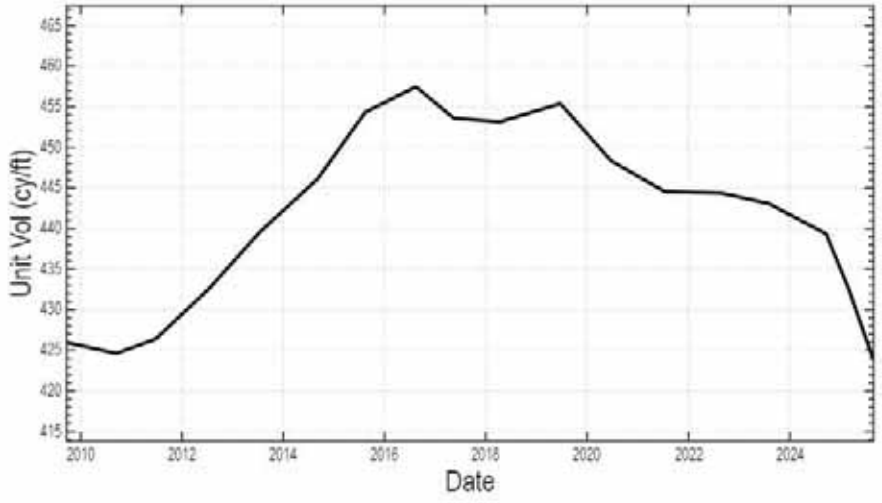

X: 2392201.94
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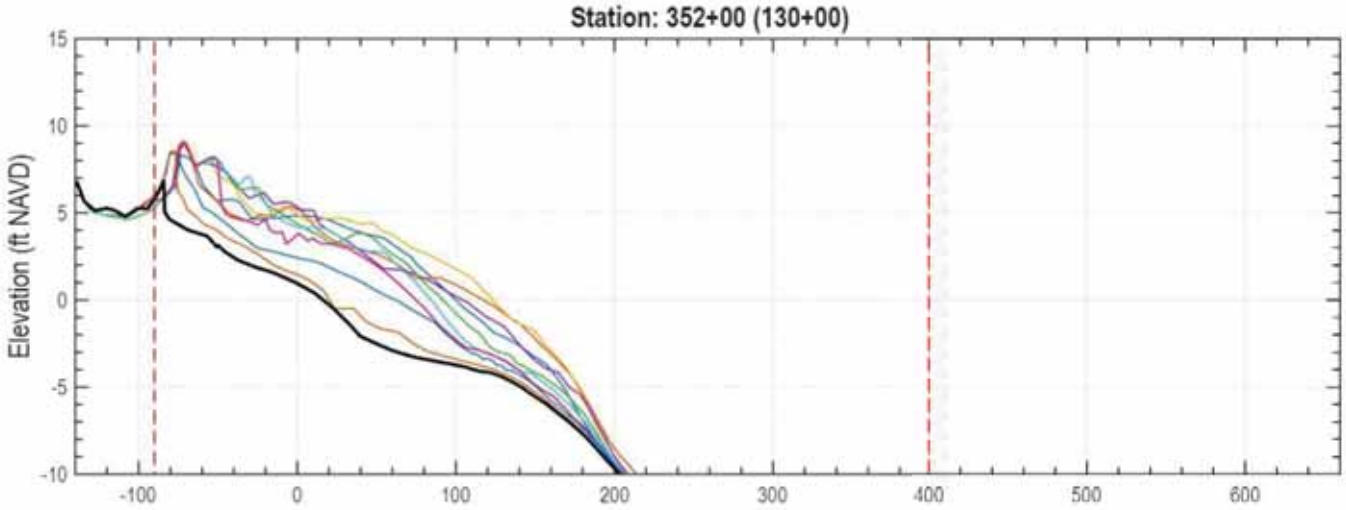

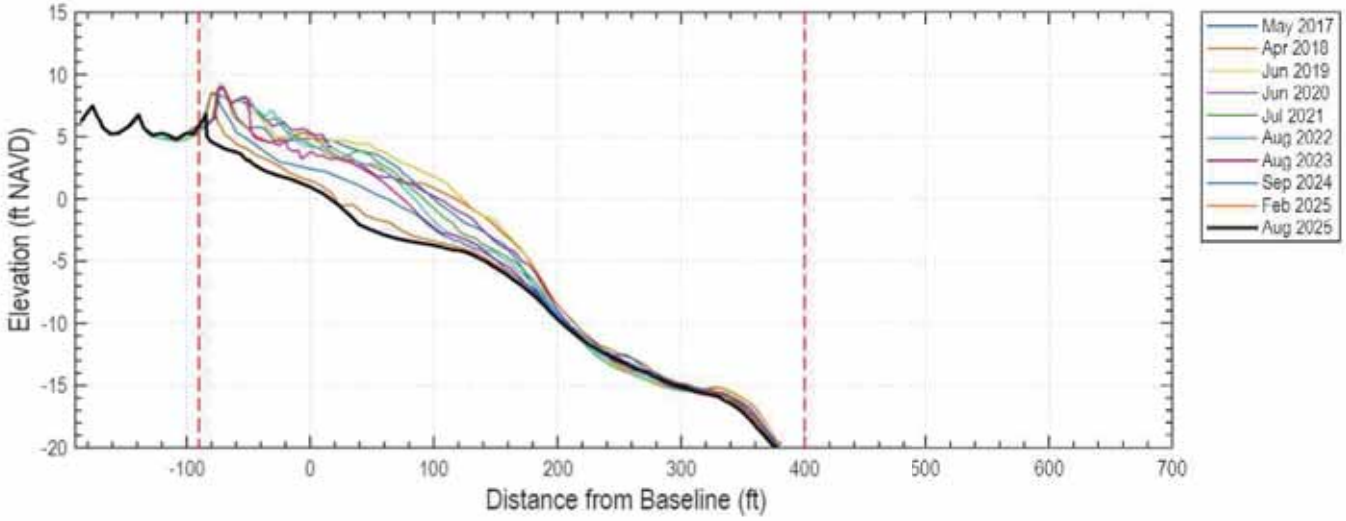

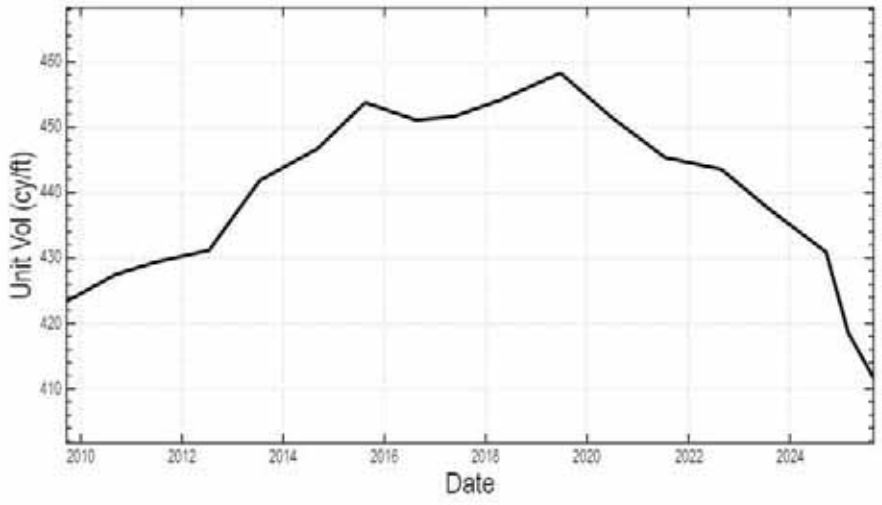

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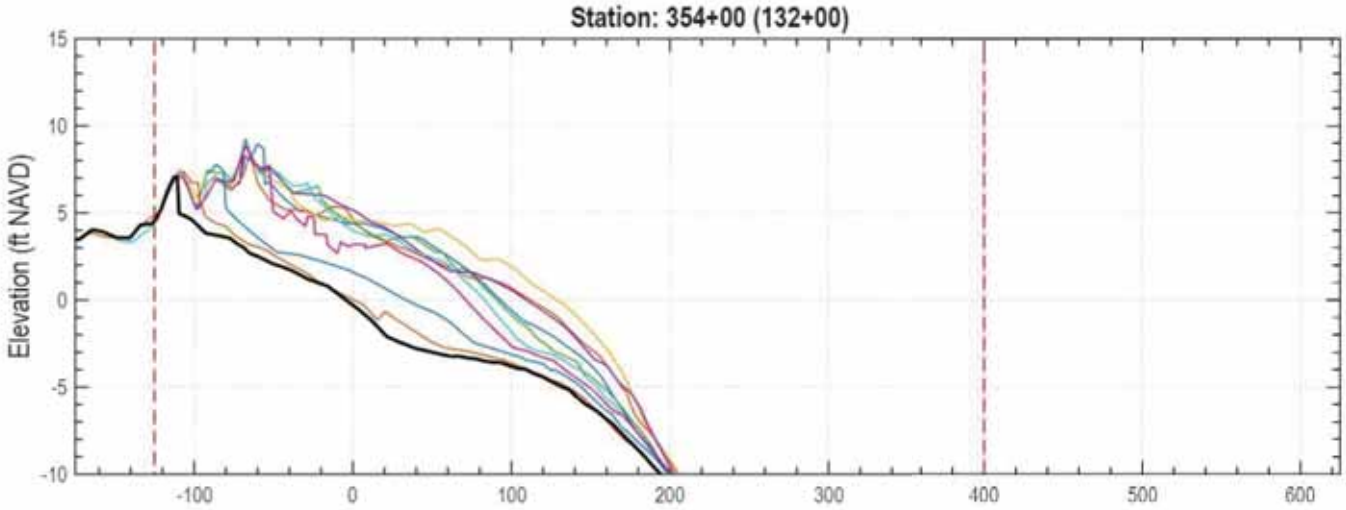

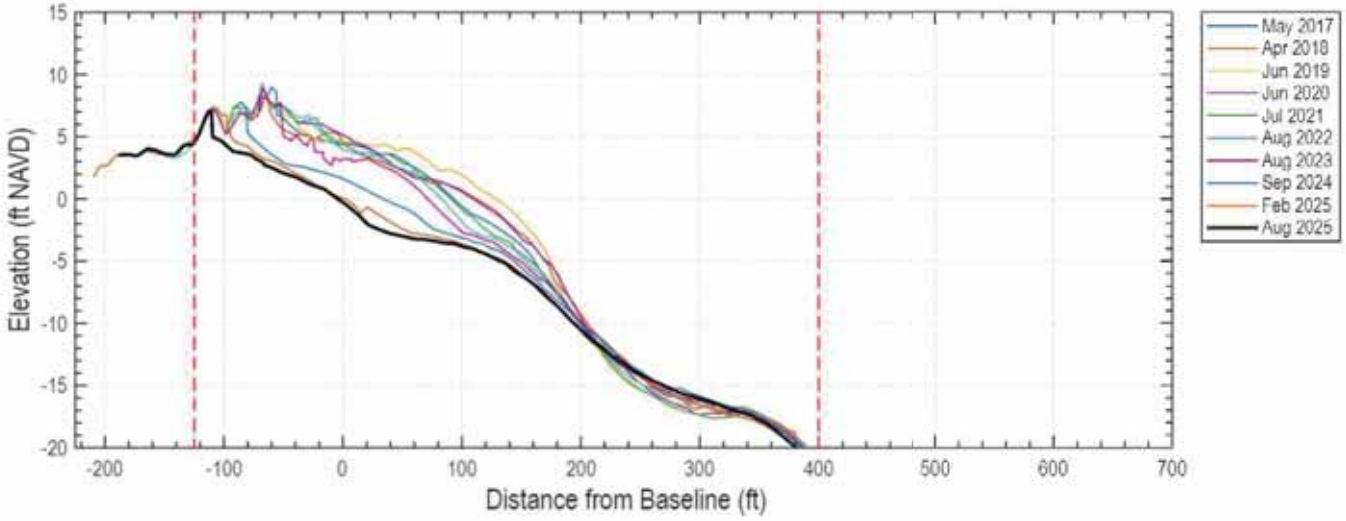

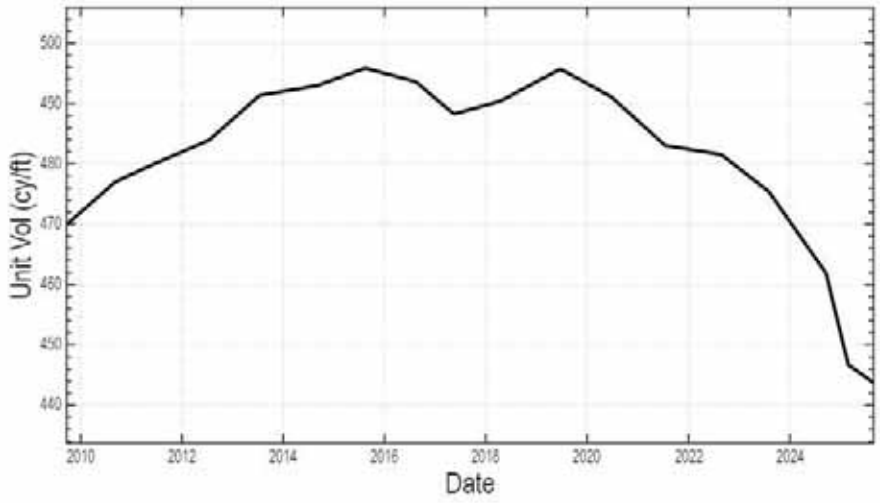

X: 2391905.17
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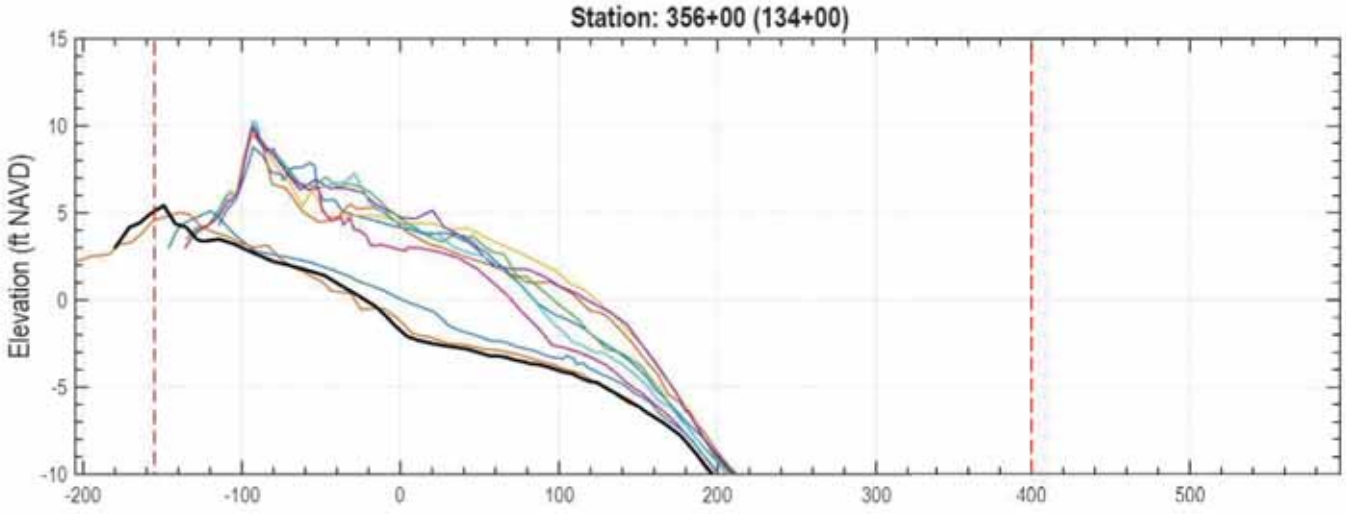

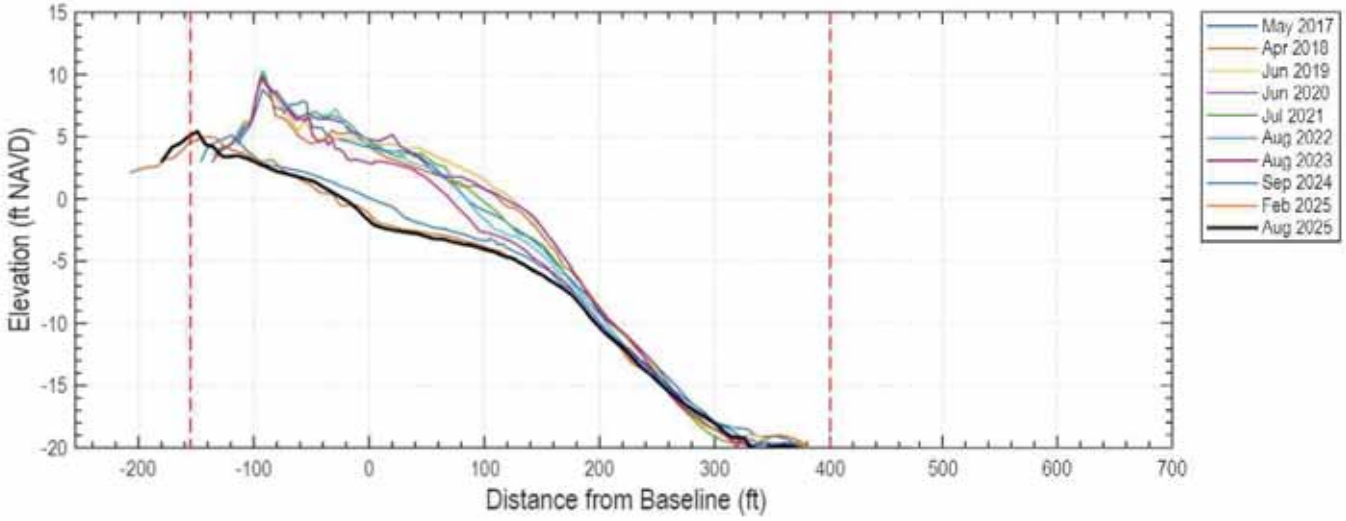

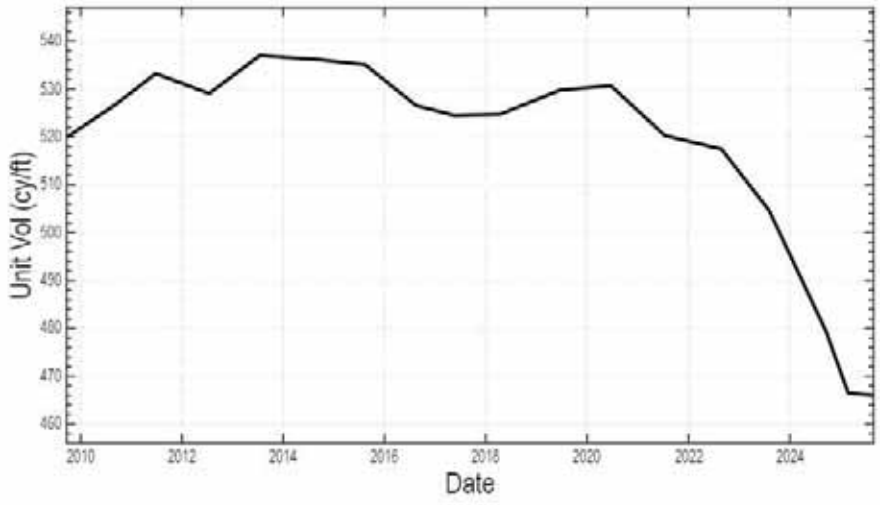

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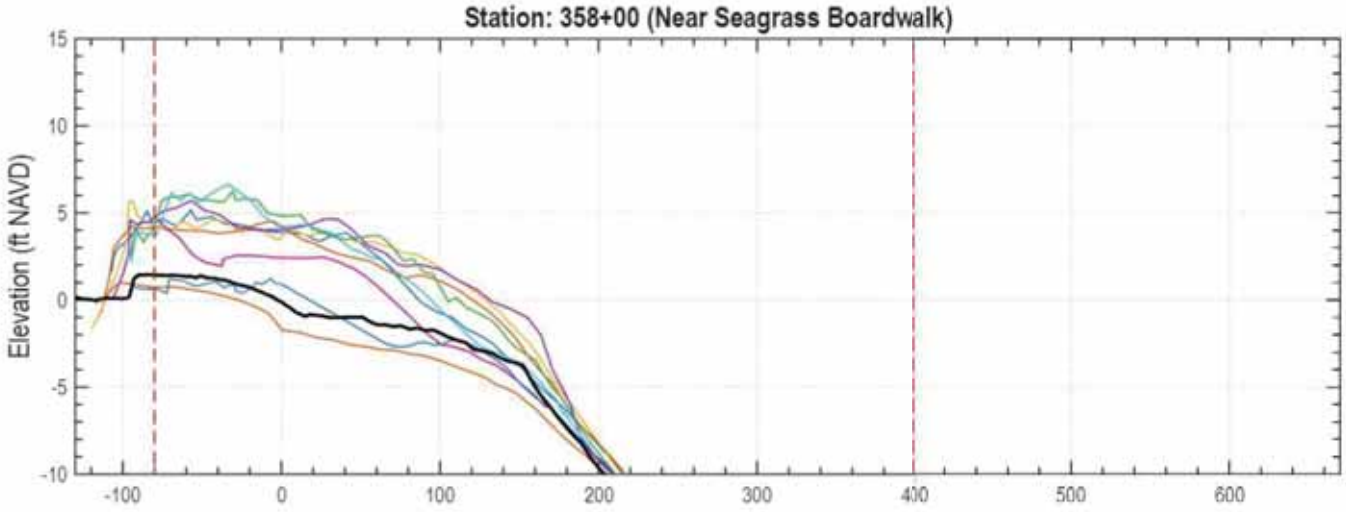

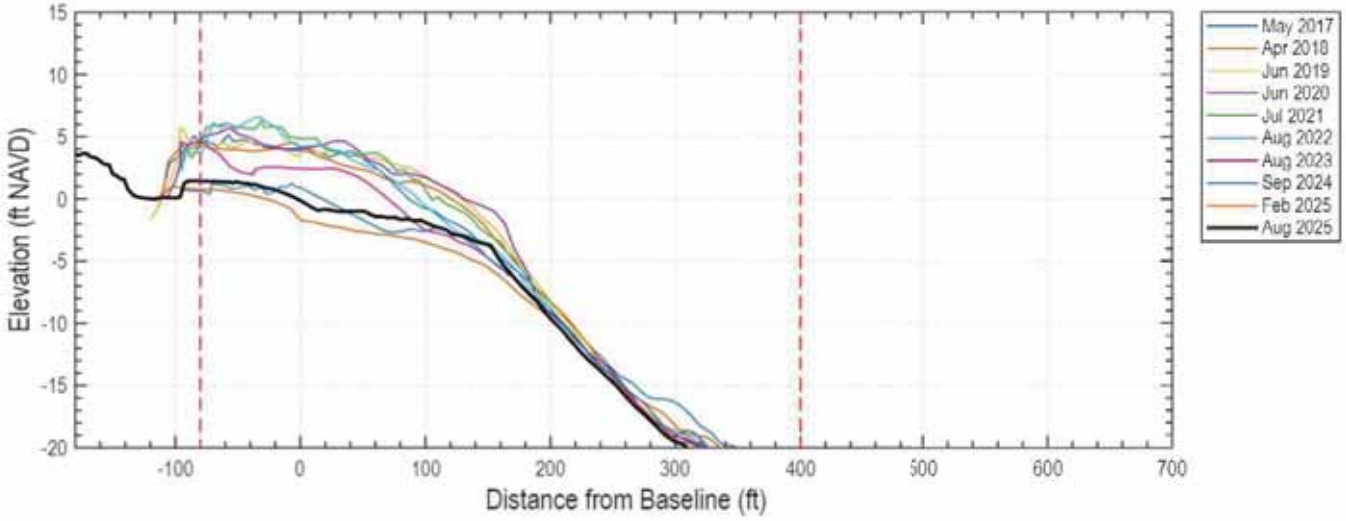

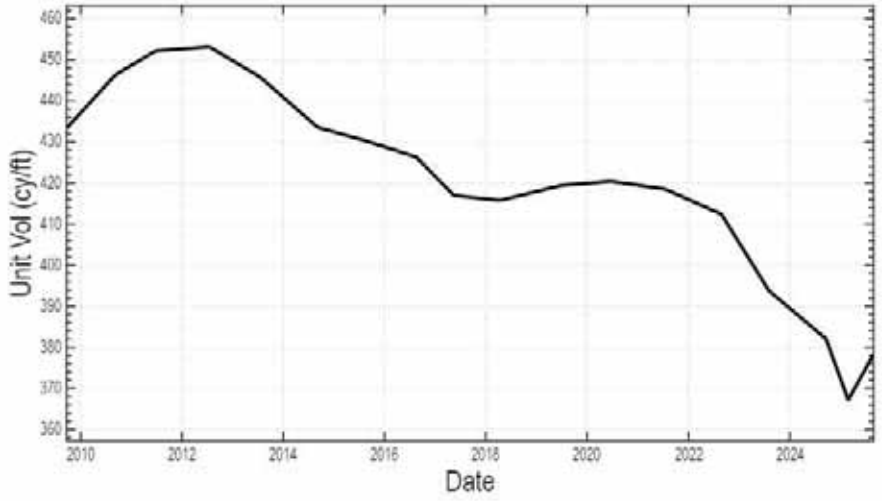

X: 2391608.39
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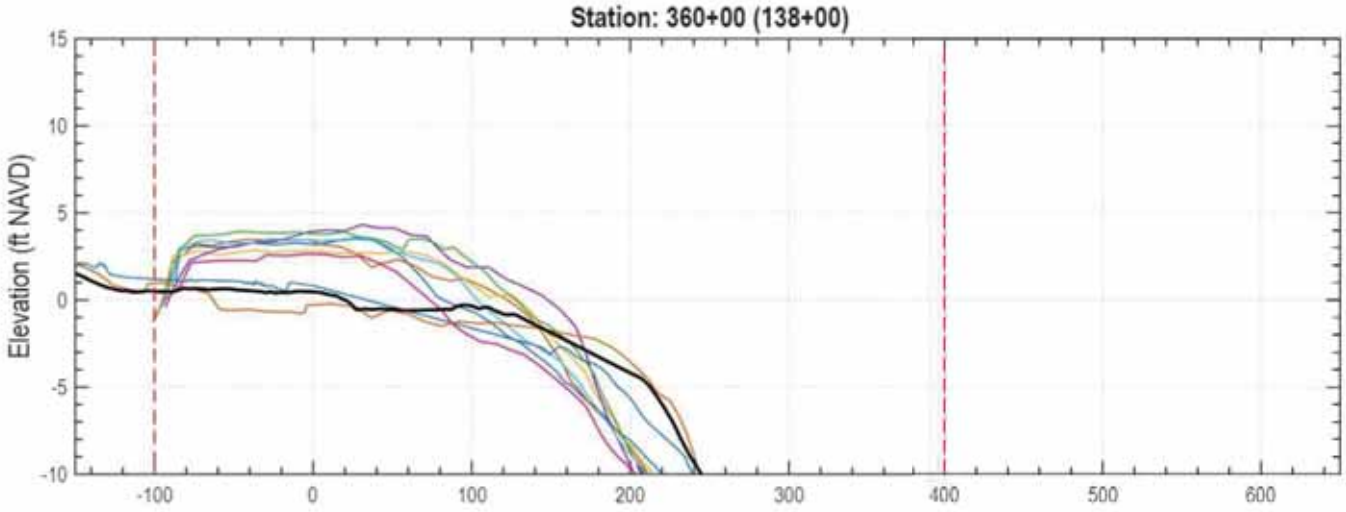

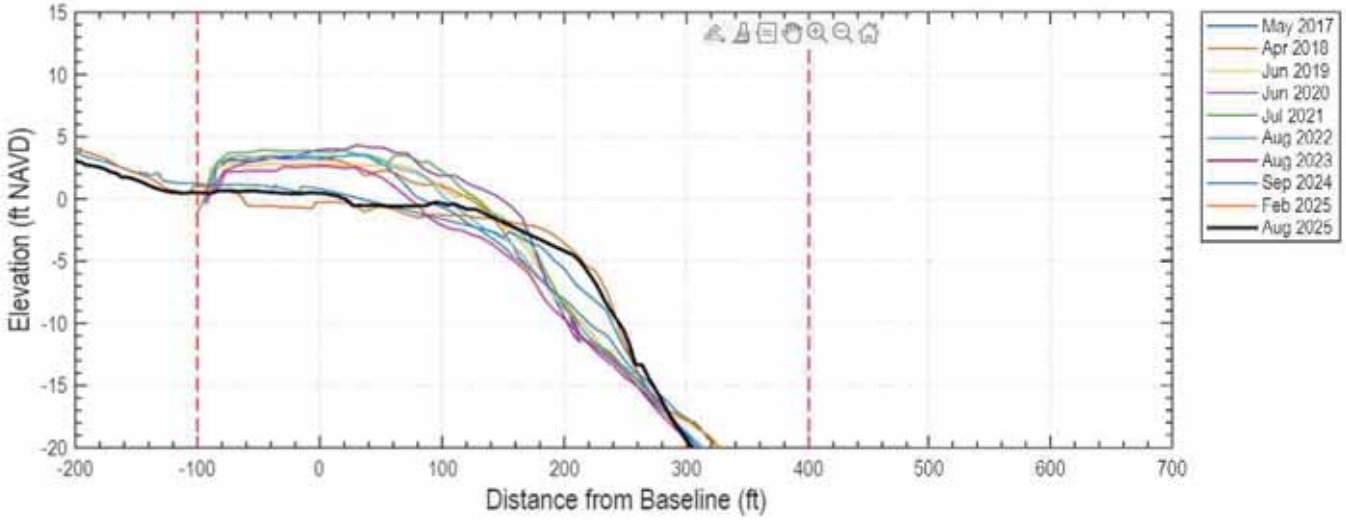

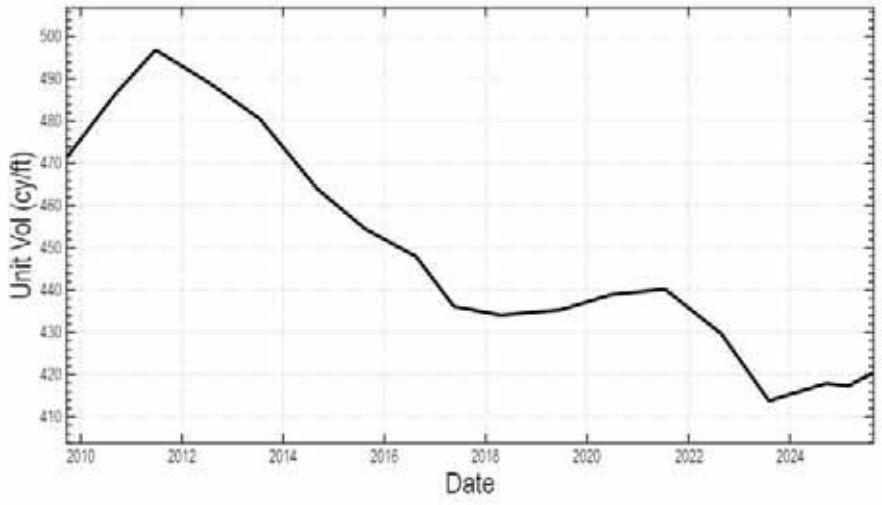

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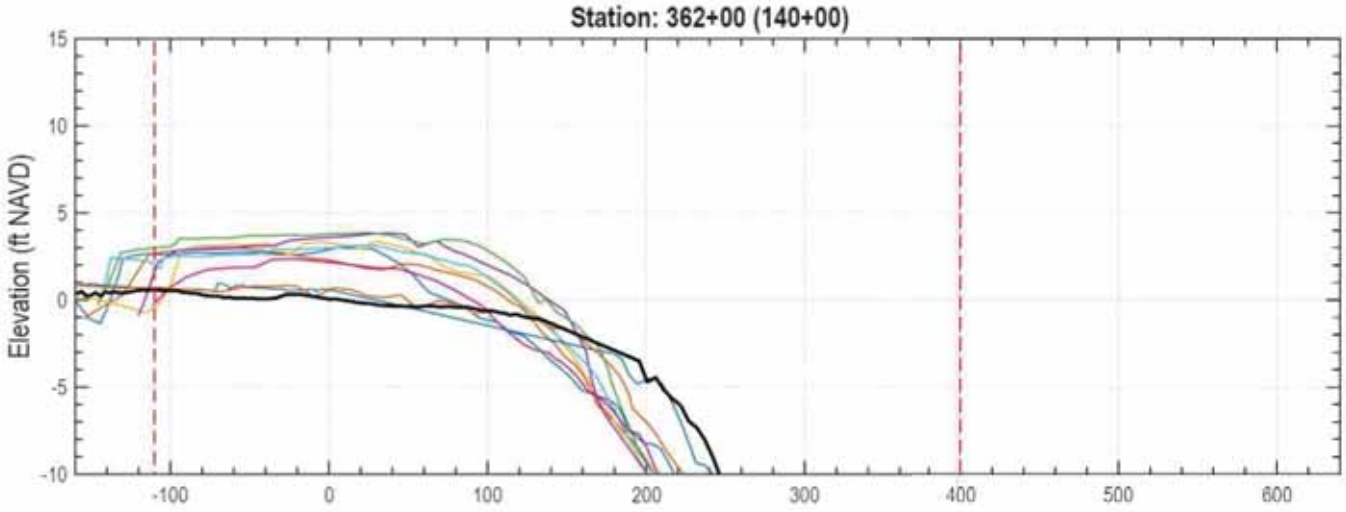

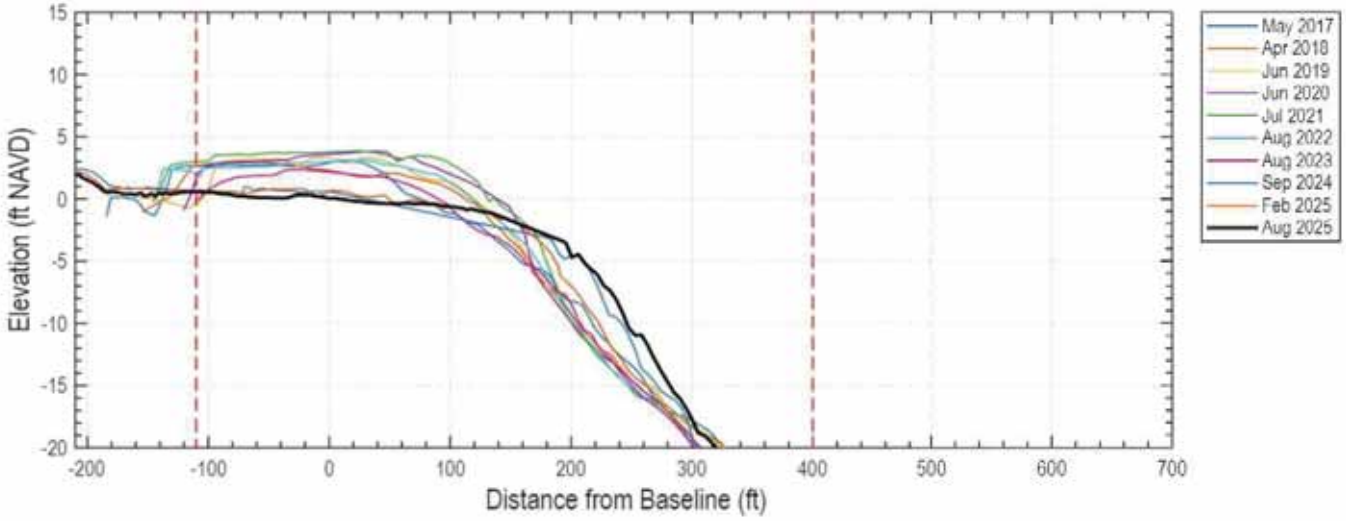

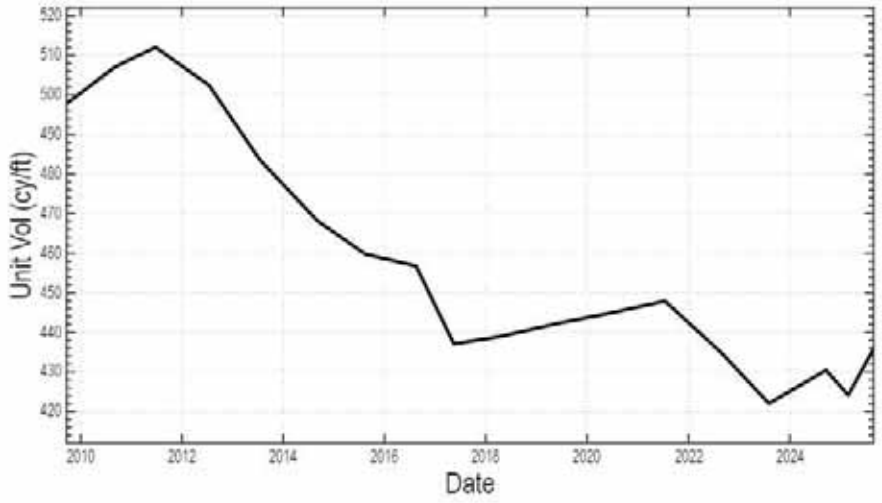

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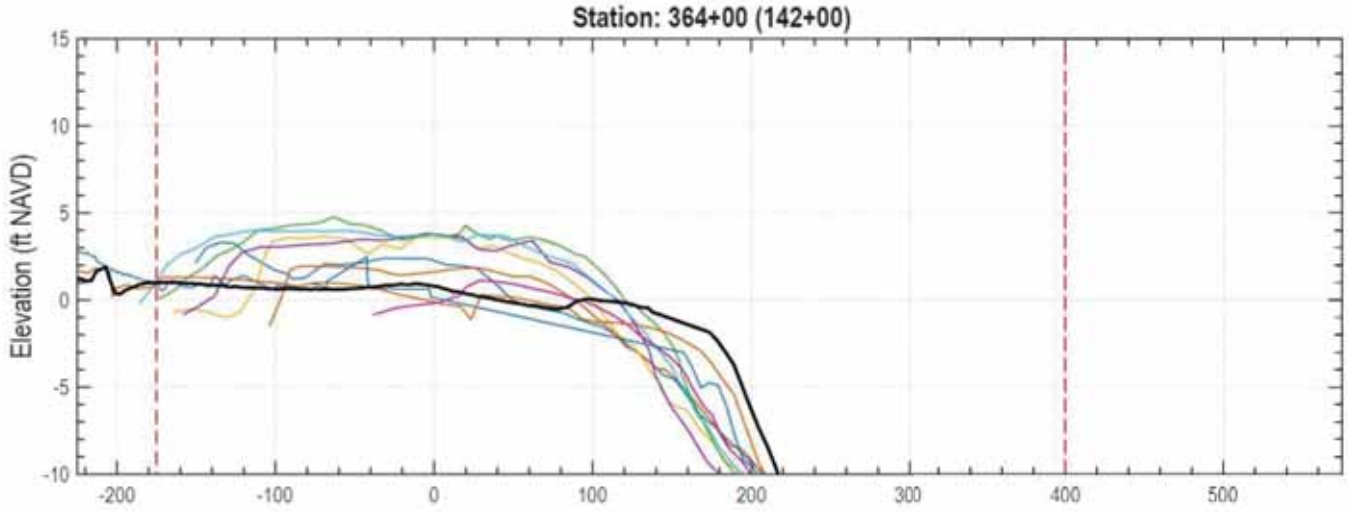

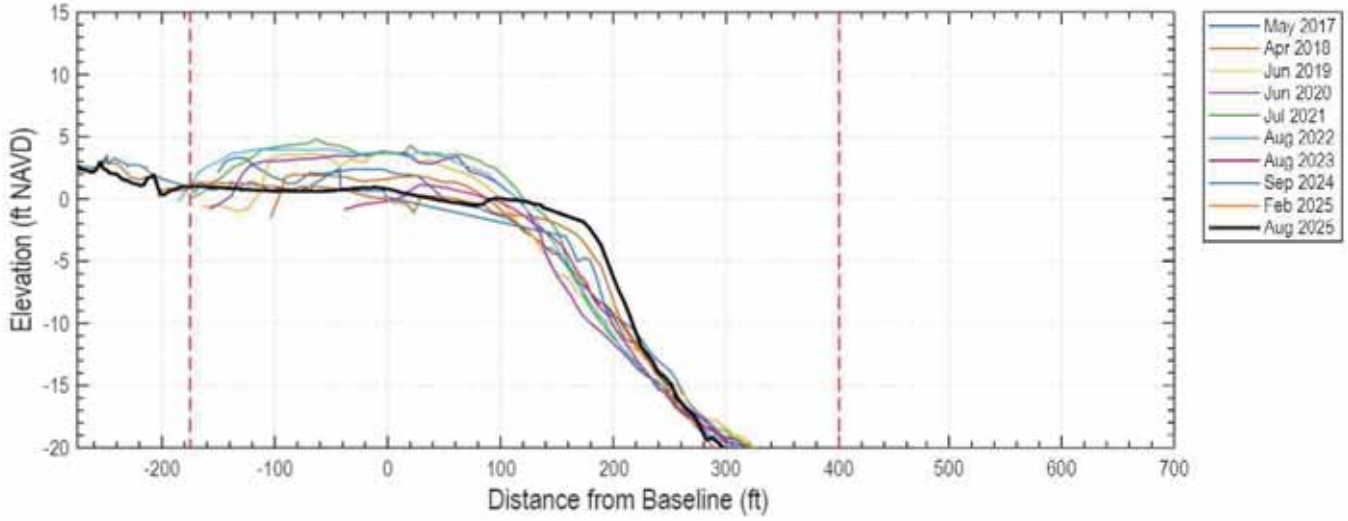

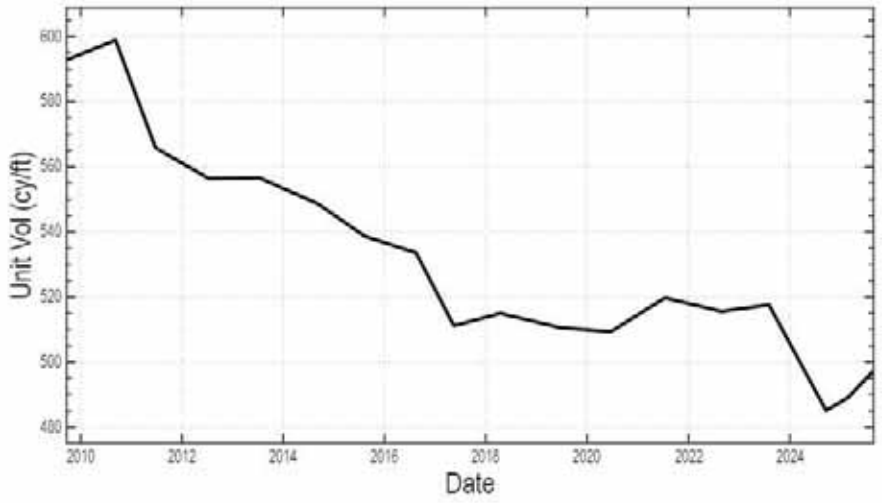

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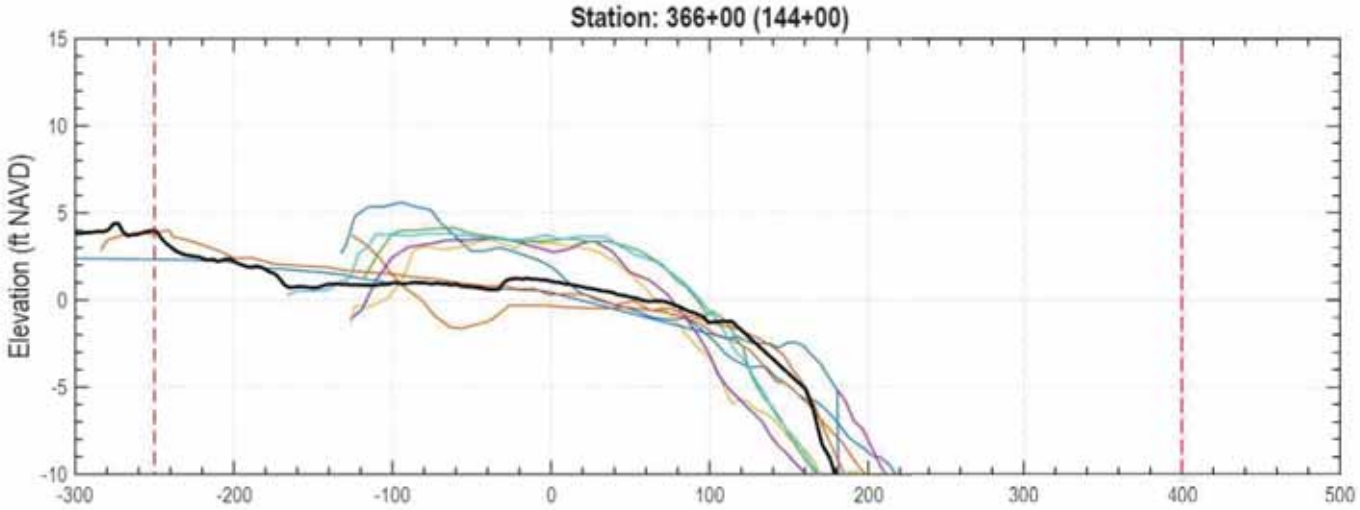

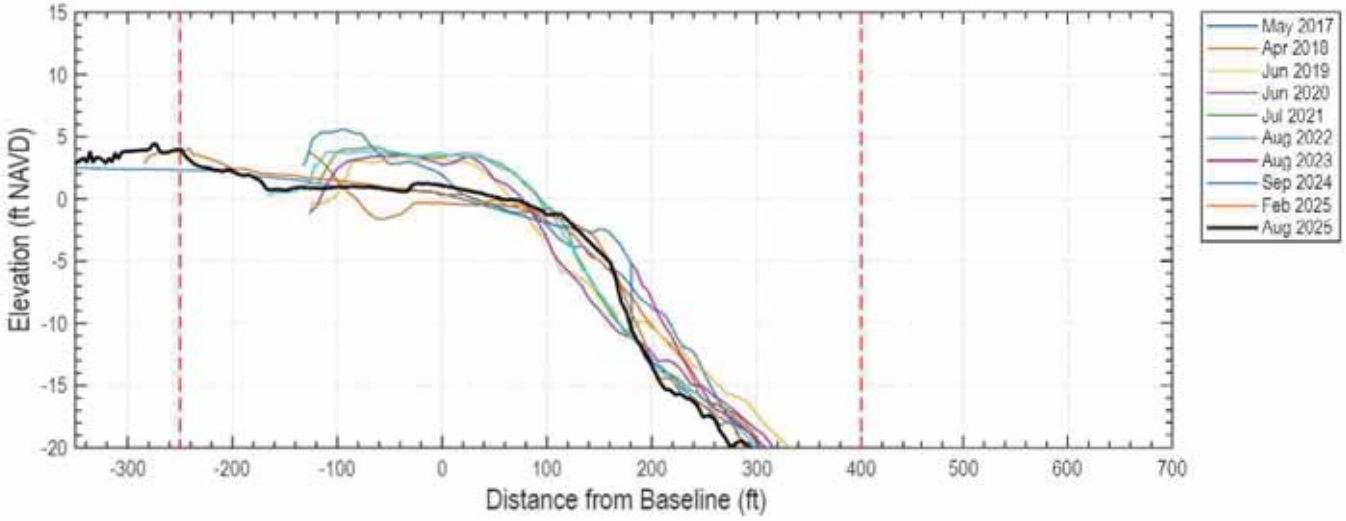

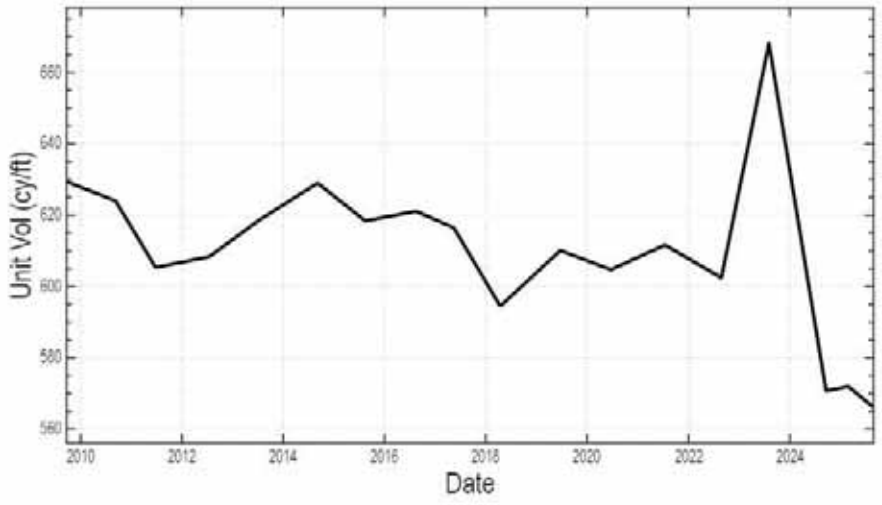

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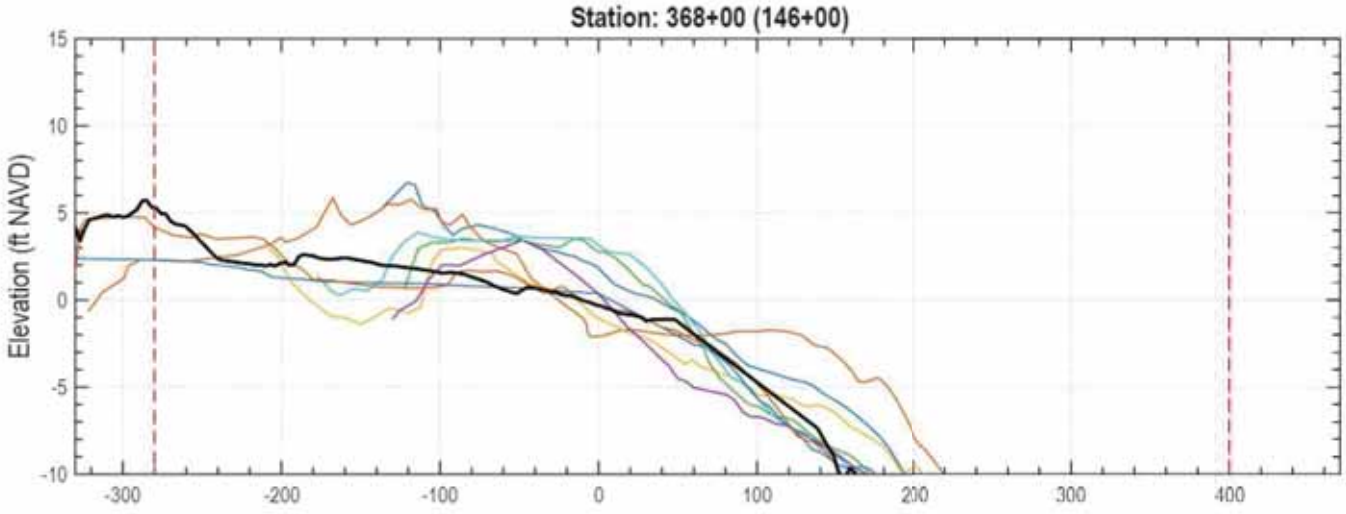

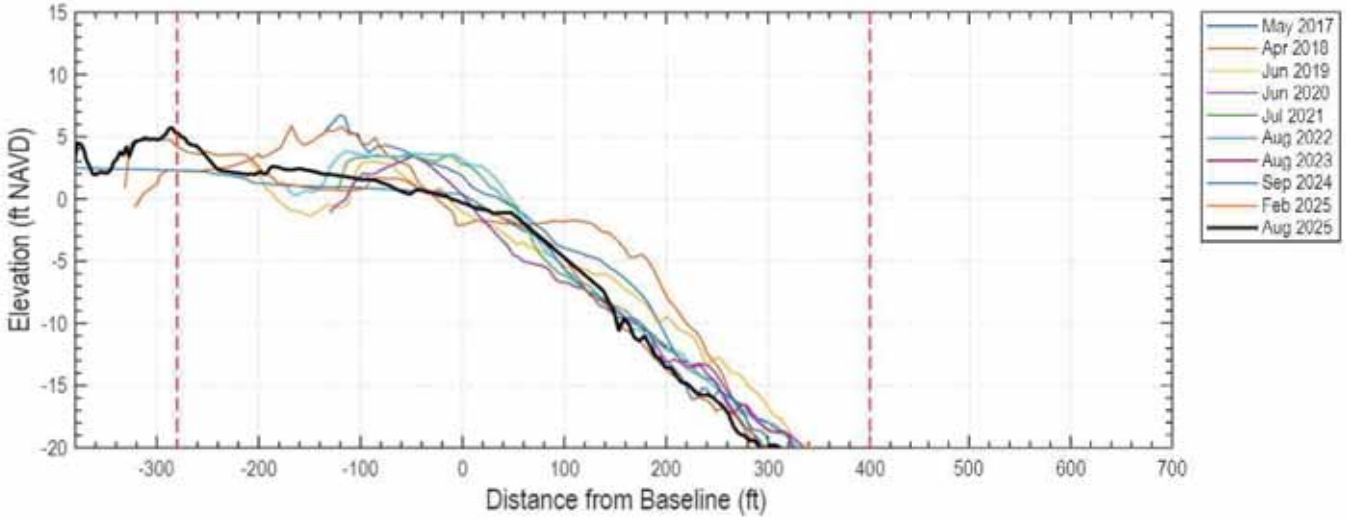

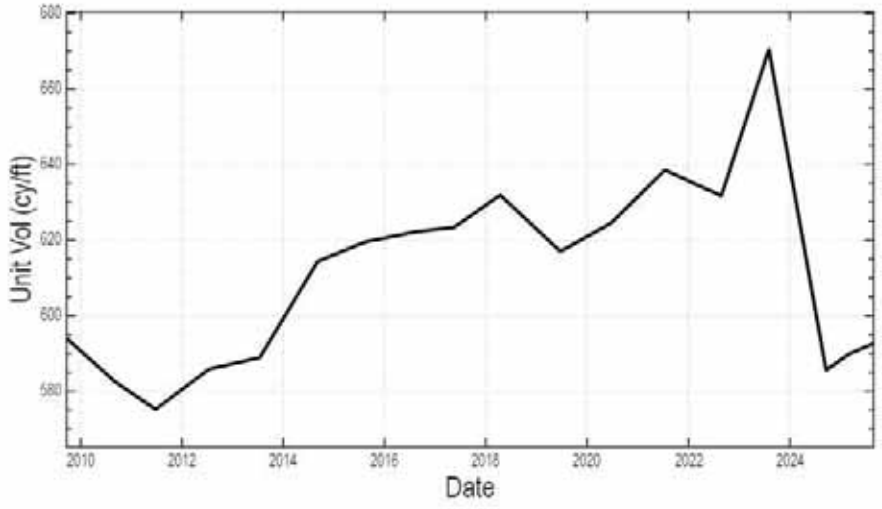

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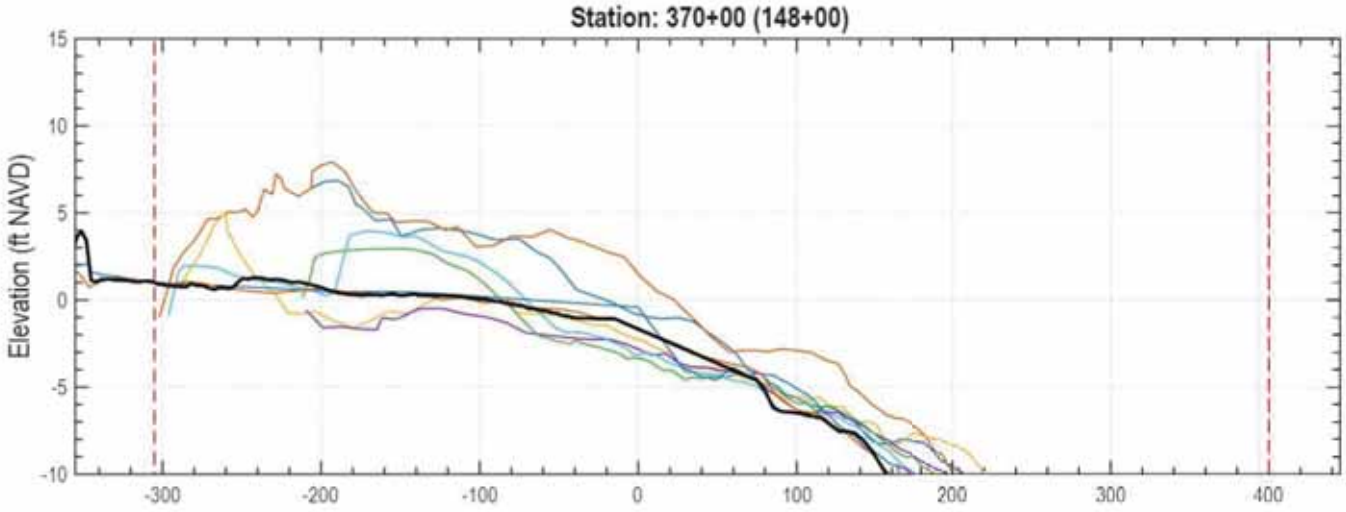

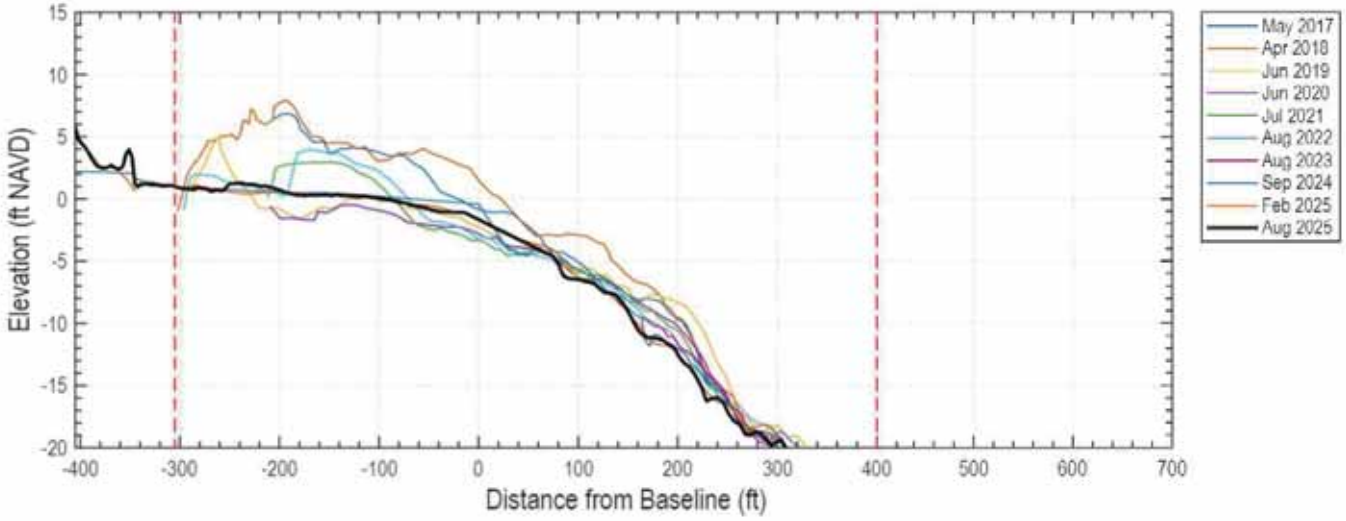

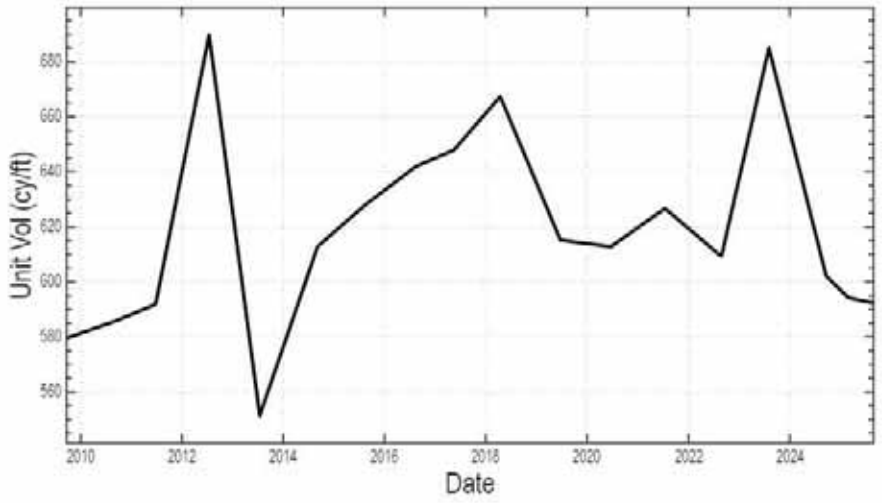

X: 2390718.06
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