COAST & HARBOR ENGINEERING

LS POWER

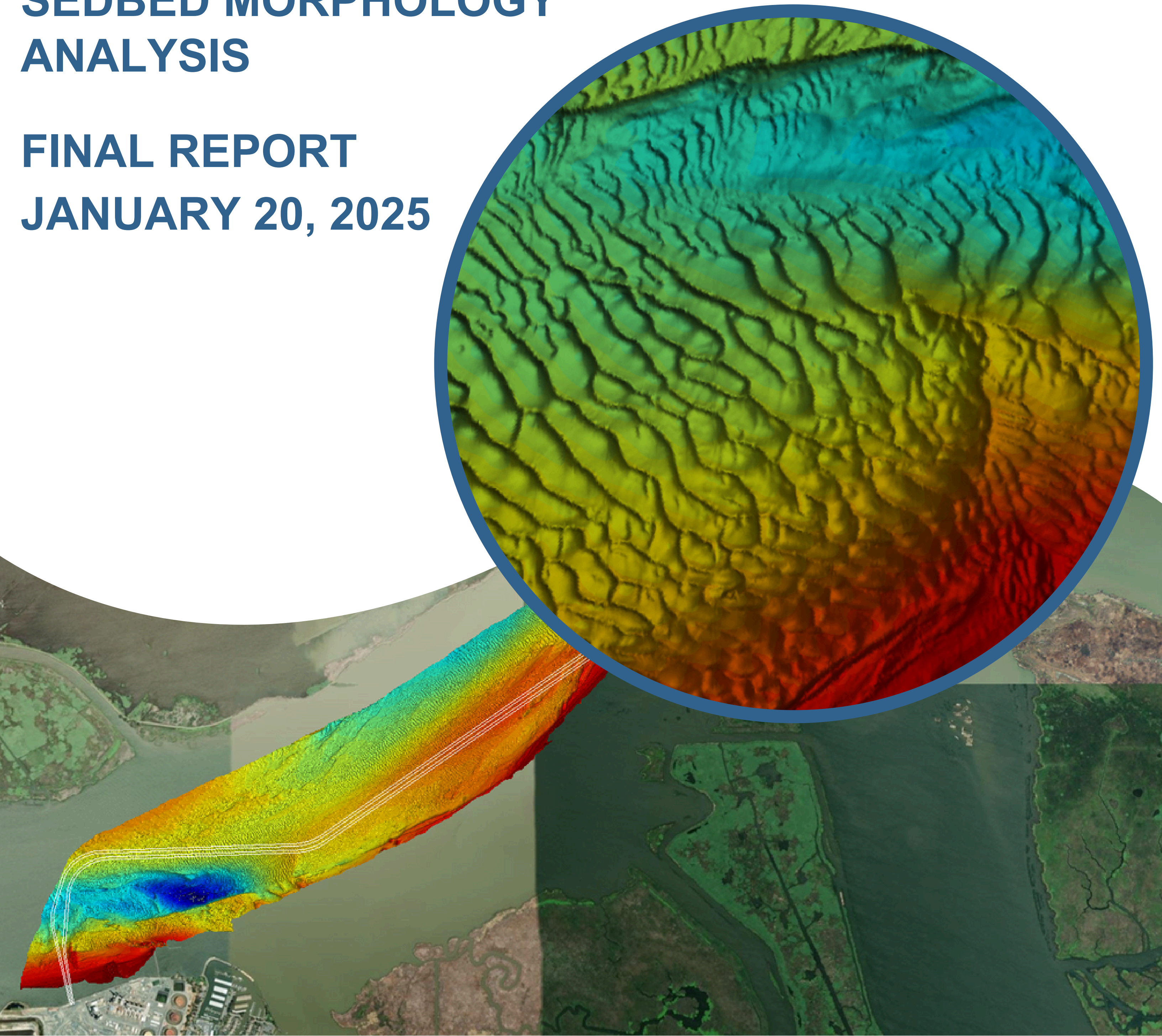
Innovation and Investment in Energy

# COLLINSVILLE TO PITTSBURG SUBMARINE CABLE

## SEDBED MORPHOLOGY ANALYSIS

## FINAL REPORT

## JANUARY 20, 2025



COAST & HARBOR ENGINEERING

Digitally Signed 1/20/2025

# Technical Memo

| | | | |
|---|---|---|---|
| **Project:** | **LS Power Collinsville to Pittsburg Submarine Cable** | | |
| **Project Number:** | 24-051 | **Your Reference:** | N/A |
| **Prepared by:** | Frank Salcedo, PE | **Date:** | January 20, 2025 |
| **Approved by:** | Scott Fenical, PE, BC.CE, BC.PE | | |
| **Subject:** | Seabed Morphology Analysis | | |

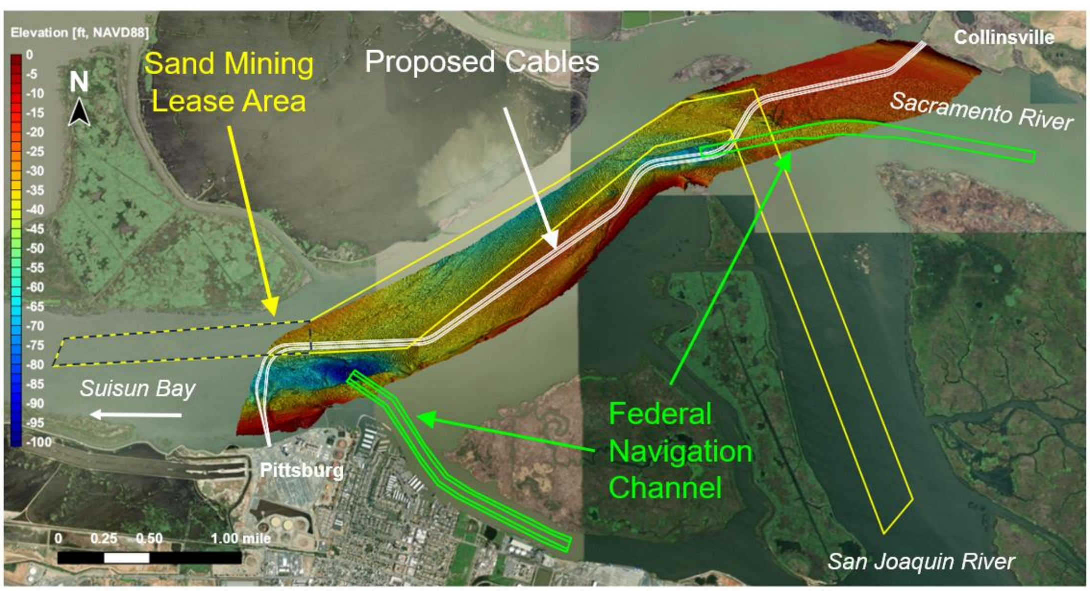
## 1. Introduction

Coast & Harbor Engineering (CHE) analyzed seabed morphology trends on behalf of LS Power Grid California, LLC (LS Power) along four (4) proposed submarine cable routes from Collinsville to Pittsburg, CA. This purpose of the analysis was to evaluate erosion and deposition trends, identify potential future cable exposures, and provide LS Power with guidance regarding appropriate cable burial depths. Figure 1 shows the proposed submarine cable routes. The cable routes are approximately 4.7 miles long and stretch between an area west of Old Town Pittsburg/Pittsburg Marina and Collinsville east of Montezuma Island. The spacing between the cables varies from 50 to 75 feet. The cable routes cross the State of California's Sand Mining Lease Area (7781 East) near the south and north ends of the route, and Federal Navigation Channel boundaries in two locations. The morphology analysis was performed to:

- Evaluate changes in seabed elevation along the proposed submarine cable route;
- Determine potential exposure locations and time before exposures may occur; and
- Quantify active morphology areas (e.g., sand waves) for prescription of seabed morphology allowance contributing to a recommended Depth of Lowering (DOL).

This memo summarizes the methodology, approach, and findings of the morphology assessment. Additional details regarding the analysis approach and results are presented in Appendix A.

**Figure 1: Proposed Submarine Cable Routes**



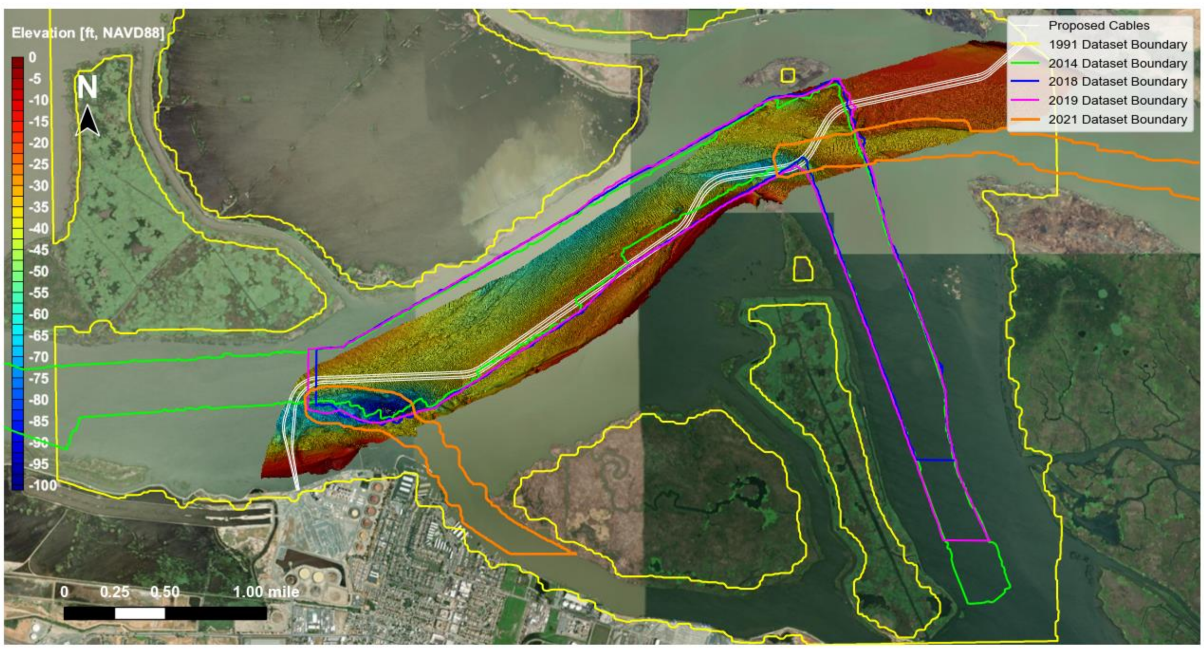
## 2. Bathymetric Survey Data Sources

Historical bathymetric datasets from 1991 to present day were compiled and analyzed, including:

1. 1991 Multibeam (NOAA)
2. 2014 Multibeam (CSU Monterey Bay/USGS)
3. 2018 Multibeam (eTrac)
4. 2019 Multibeam (eTrac)
5. 2011–2024 Navigation Channel Transects (USACE)
6. 2021 Multibeam (USACE)
7. 2023 Multibeam (eTrac)

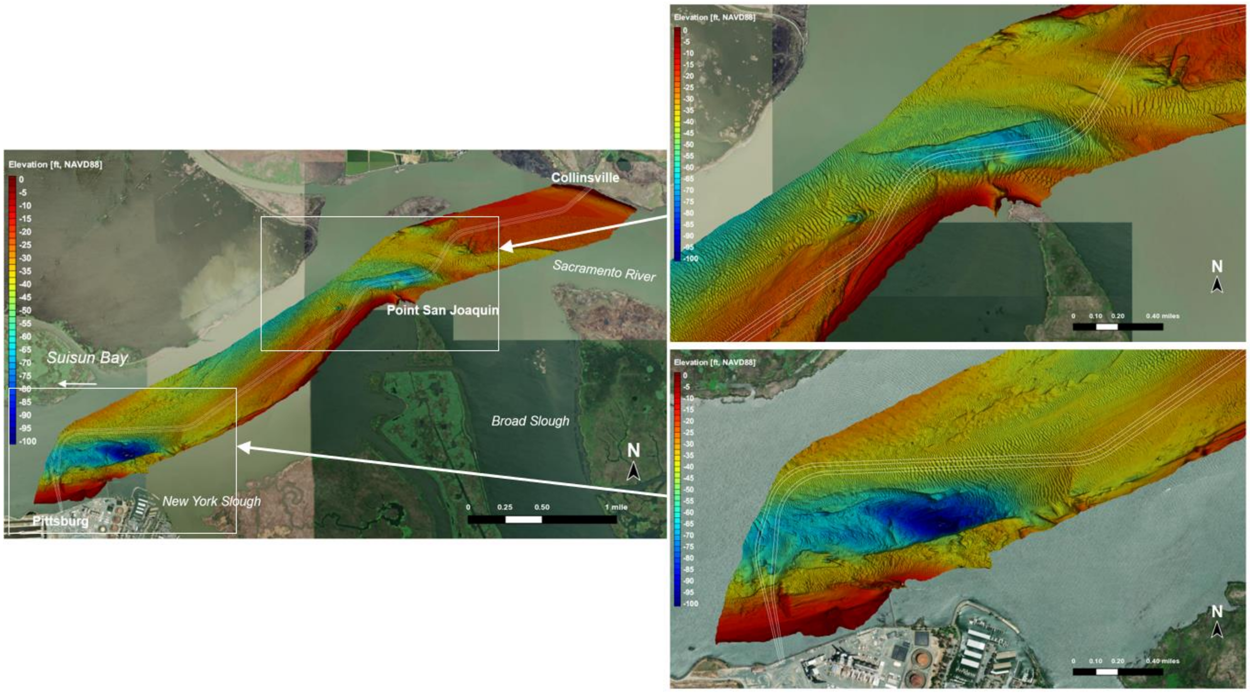
Data extents and resolution varied significantly between the surveys. Figure 2 shows the dataset extents highlighted in different colors for each survey (2023 eTrac survey is shown as the basemap). The 1991 data were excluded due to low resolution. The 2011-2024 USACE navigation channel transects and 2021 multibeam data were excluded due to lack of spatial coverage along the cable routes. Therefore, the 2014, 2018, 2019, and 2023 multibeam surveys were used in the analysis.

### Figure 2: Survey Data Coverage




There are two primary areas with large scour features. The four cables pass by and through two channel confluences as shown in Figure 3. North of Pittsburg, where the Sacramento River merges with New York Slough, scour has occurred to depths greater than 100 feet (NAVD88). Near Point San Joaquin, scour has occurred to depths greater than 70 feet (NAVD88) where the Sacramento River and San Joaquin River meet. In both areas, soil type variability is also evident which likely exacerbates scour of fine sand.

**Figure 3: Large Scour Features Observed in 2023 Multibeam Dataset**




## 3. Elevation Change Analysis

### 3.1 Methodology

The multibeam bathymetric surveys were analyzed to quantify rates of elevation change at the proposed cables and estimate times until potential cable exposure. The analysis was performed in the following three steps:

1. **Simple Analysis (Linear Trends)**: Linear erosion/deposition trends were calculated on a 6-ft grid using linear regression. The analysis result is a map of linear bed change trends. Although this analysis is limited because it neglects possible changing trends or movement of surrounding features, it allowed rapid identification of erosive areas and prediction of potential exposure times.
2. **Changing (Nonlinear) Trends**: Nonlinear elevation regression analysis was performed by fitting nonlinear elevation trends on the same 6-ft grid. This analysis identified that some erosive areas are slowing down and require closer inspection in a transect-based analysis. Similar to the simple linear trend analysis, the nonlinear trend analysis cannot account for horizontal movement of surrounding features and is limited based on the spatial extents of the datasets.
3. **Transect-Based Analysis**: This analysis comprised a more granular inspection of elevation profiles along the proposed cable routes. The transect inspection was intended to identify areas of active change which may not result in exposures (given sufficient burial depth) which could not be identified using elevation change regression analysis.

### 3.2 Simple Analysis (Linear Trends)

Average elevation change rates were computed by fitting a linear regression trendline at each grid point. Figure 4 shows an example of a linear regression trendline for a single location where erosion is occurring. Figure 5 shows a project-wide erosion/deposition rate map generated by repeating the linear regression analysis at each grid point where the survey datasets overlap (two or more surveys). Regions of stronger erosion were identified at the confluences of Sacramento River and merging channels (New York Slough and Broad Slough), and west of Point San Joaquin. While linear trend prediction is reasonable for a small number of surveys, linear trend analysis does not account for areas where scour is slowing down or horizontal scour feature movement.

**Figure 4: Example Linear Regression (Single Grid Point)**

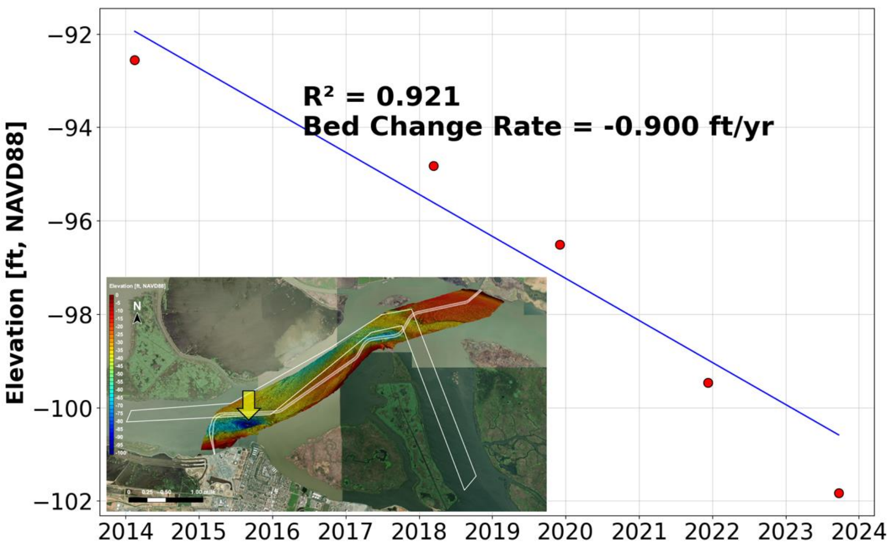
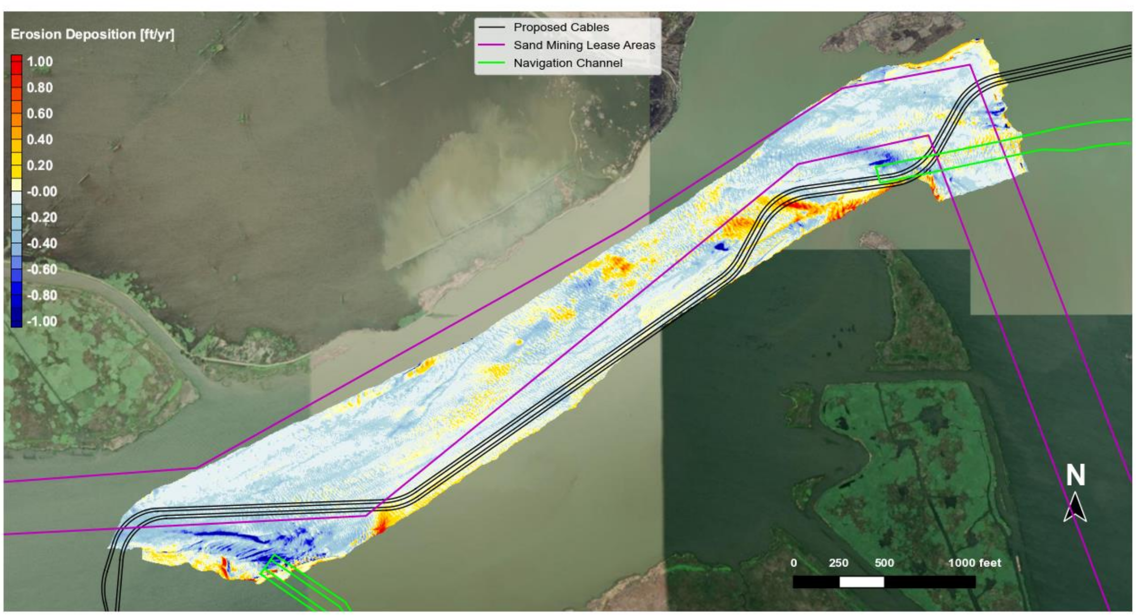


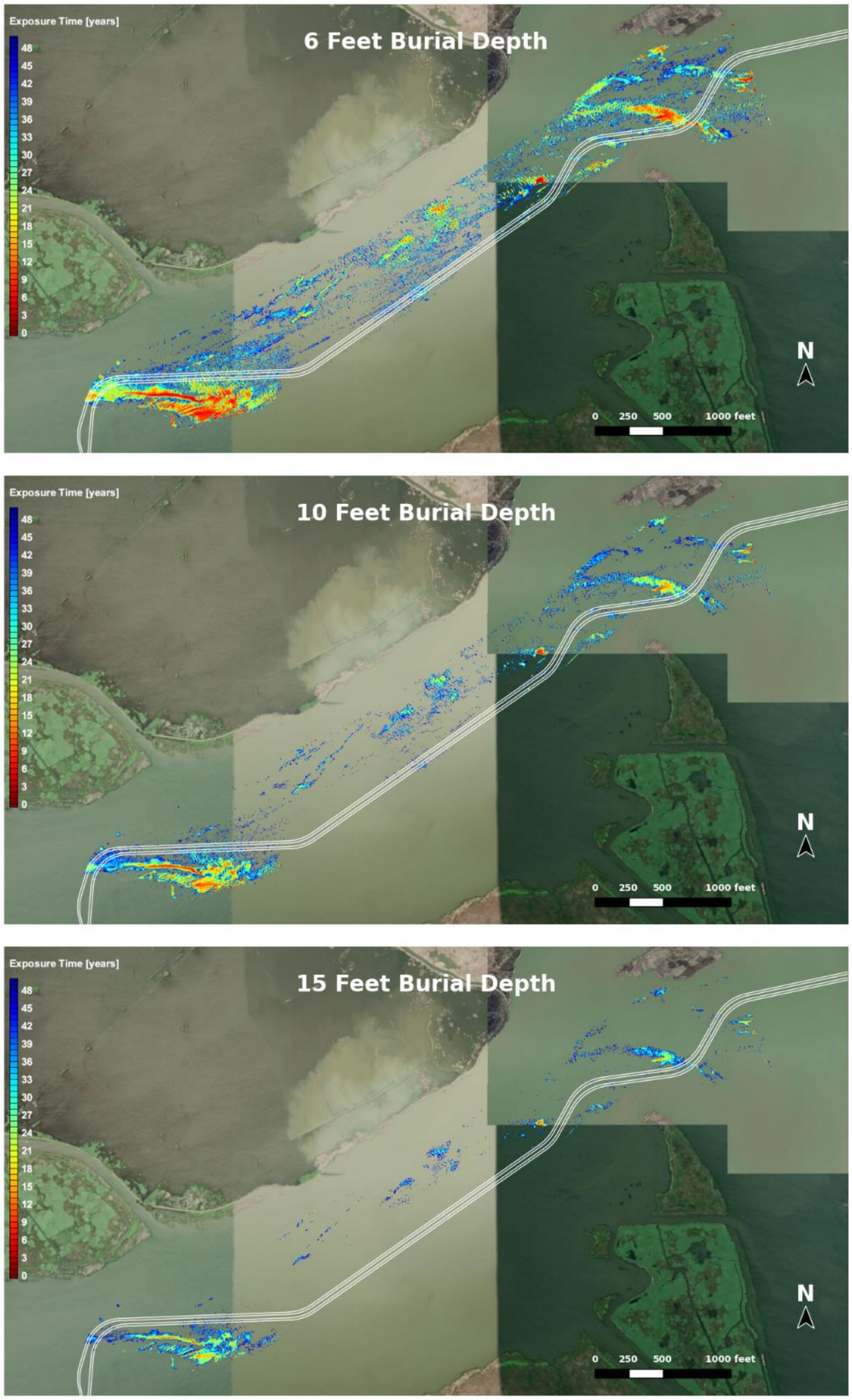

**Figure 5: Erosion/Deposition Rate Map from Linear Regression**



Exposure times were calculated based on the linear trends for 3 assumed (example) initial burial depths: 6 feet, 10 feet, and 15 feet. The exposure time maps are shown in Figure 6. Transparent regions along the cable routes indicate that the exposure time is greater than 50 years. Most of the proposed cable route areas have exposure times larger than 25 years. At larger burial depths (e.g., 15 feet), potential exposure time less than 25 years was only identified in one small area (less than 50 feet) near the deep scour area at the north end of the route.

Appendix A provides additional graphics demonstrating the specific portions of each route which may become exposed and the anticipated exposure times, as well as tables showing percentages of cable routes exposed at different time horizons for different burial depths. The linear trend analysis is a conservative approach that does not account for areas where erosion is slowing down and where exposure times may be greater.

**Figure 6: Exposure Times for 6-ft, 10-ft, and 15-ft Cable Burial Depths**



### 3.3 Changing Trends (Nonlinear)

Erosion trends were also predicted with a nonlinear curve, to account for trends where erosion is slowing down over time. Figure 7 shows an example nonlinear curve fit using historical bathymetry at a single point. Figure 8 shows a map of anticipated exposure times using the nonlinear trend analysis. Results of the analysis mostly indicate longer exposure times than predicted using the linear trend analysis. However, in some areas the nonlinear trend analysis resulted in somewhat shorter to exposure times, due to recent scour acceleration. The nonlinear trend analysis does not account for features moving horizontally, and areas actively eroding which may not result in cable exposure. Transect-based analysis was performed to identify these areas and refine the potential exposure predictions.

**Figure 7: Example Non-linear Erosion Trend**

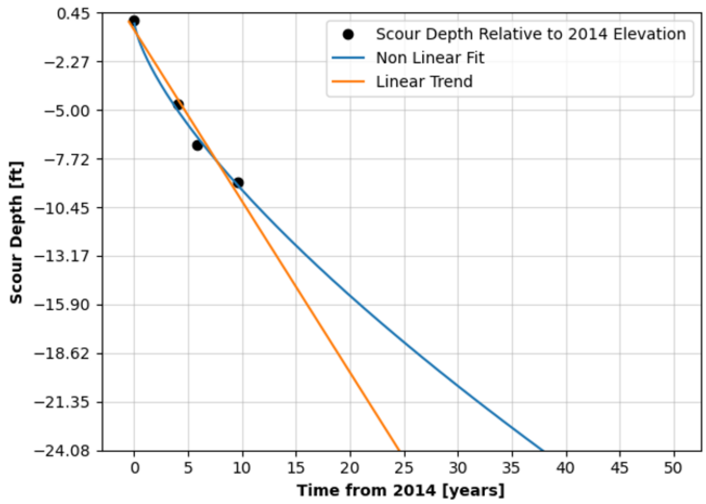
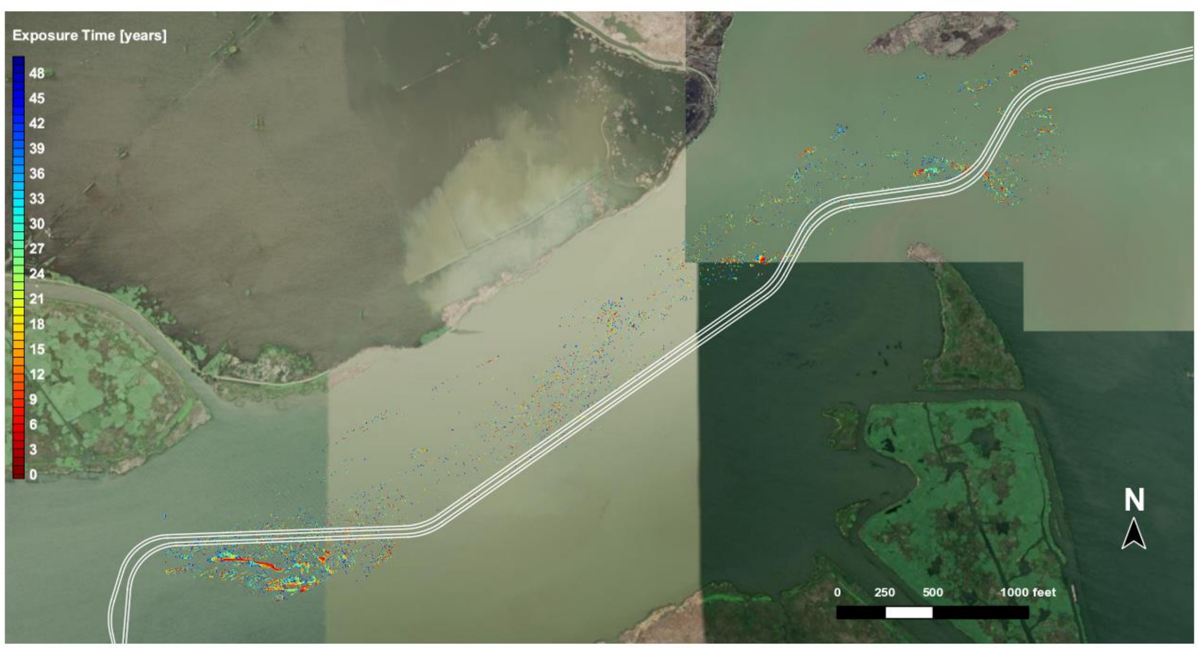


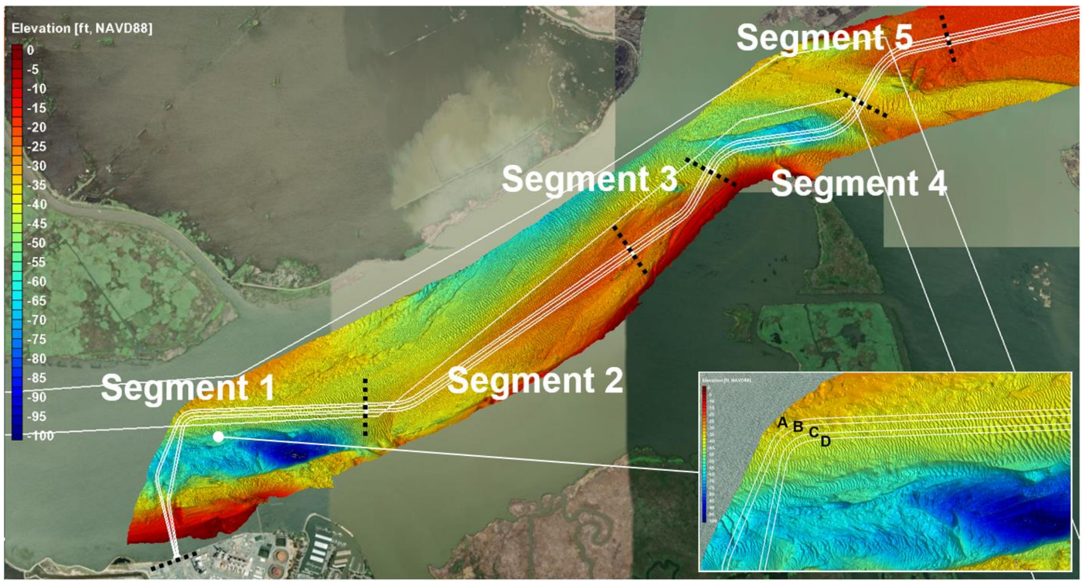

**Figure 8: Exposure Times from Nonlinear Analysis for 15-ft Cable Burial Depth**



### 3.4 Transect Analysis

Transects were plotted to analyze the morphologic trends that the simple linear trend and nonlinear trend analyses cannot identify. The cable alignments were divided into five (5) segments based on similarity in morphologic trends and bedforms. Figure 9 shows the segments and labels assigned to each cable (A-D). The transect analysis covered only regions with data overlap to investigate trends. In this section, select transects are plotted for demonstration purposes. A complete set of cable transects is provided in Appendix A. Transects taken normal to the cable routes are shown in Appendix B.

**Figure 9: Segments for Transect Analysis**

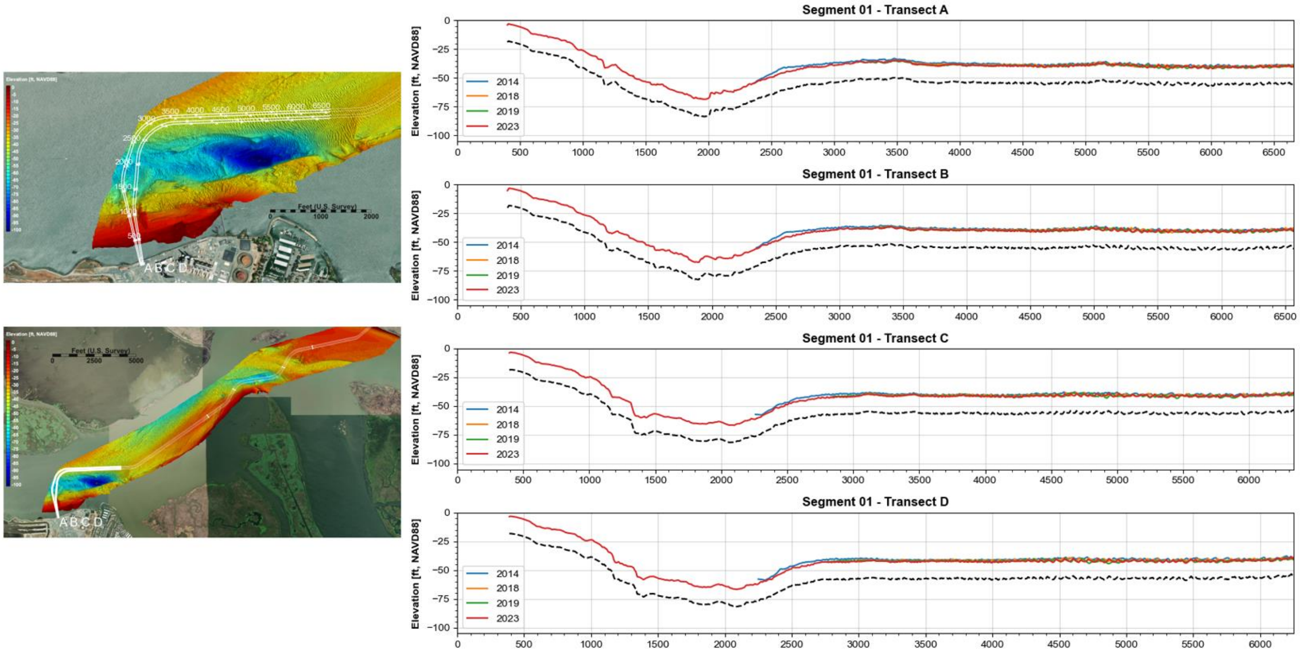



#### 3.4.1 Segment 1

Segment 1 begins near Pittsburgh and extends approximately over 6000 linear feet. Near the segment, is the deepest region near with depths greater than 100 ft (NAVD88) and sand waves (or sand ripples) present in the shallower areas. Strong morphological changes in the large scour area are likely caused by the confluence of flows and variability is soil conditions (stiffer materials adjacent to fine sand). The proposed cables avoid the large scour region by traversing north into the sand mining leasing area. Figure 10 shows elevation transects taken along Segment 1 for each of the four cables.

In all transects (A-D), the data show lateral erosion of a ridge feature (at approximate distance 2000 to 2500 ft) as the cables traverse northwards, west of the deep region. Transect analysis indicates that exposure could potentially be avoided in this area with sufficient burial depth, since the erosion is progressing horizontally (northwards) over the cable. Nevertheless, vertical erosion rate analysis predicts a minimal rate of scour resulting in long exposure times in this area.

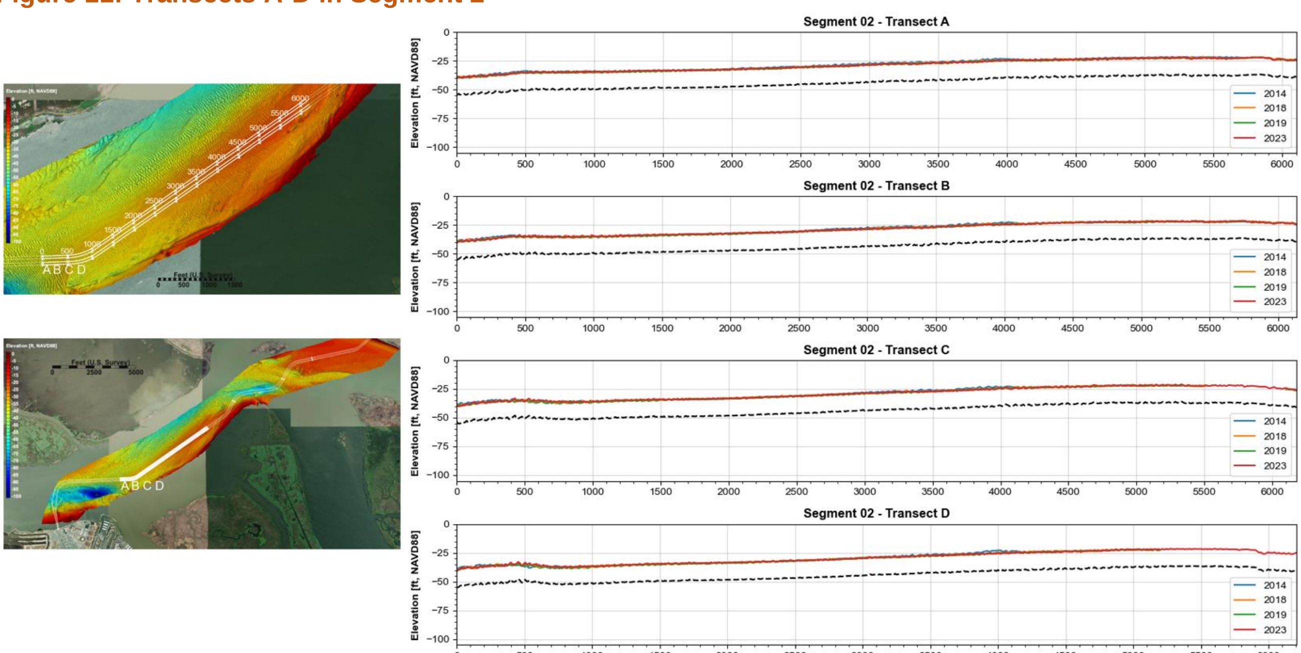
**Figure 10: Transects A-D in Segment 1**




### 3.4.2 Segment 2

Segment 2 is the most stable area of all the cable routes. There are no signs of heavy erosion and no signs of horizontal scour (feature movement) as observed in Segment 1. Segment 2 is primarily a straight segment without channel flows converging and with relatively stable bed elevation. Segment 2 is assumed to be a sandy area based on presence of sand waves throughout. Transects for Segment 2 are shown in Figure 11.

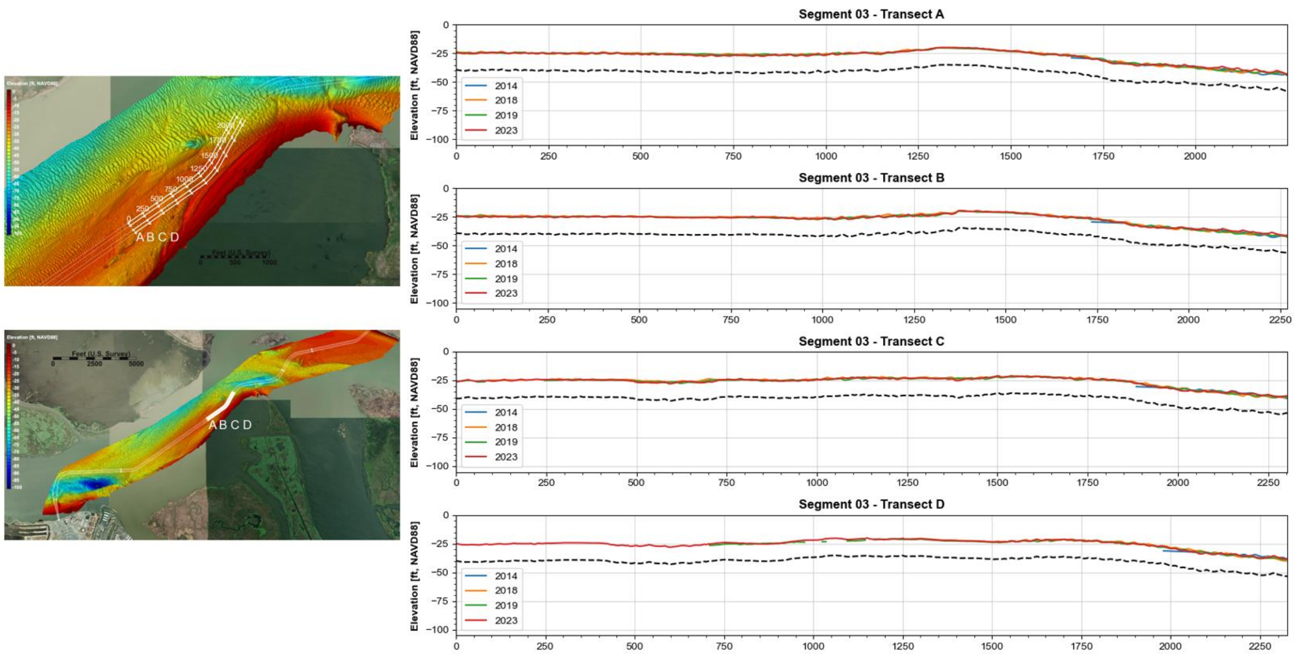
**Figure 11: Transects A-D in Segment 2**



### 3.4.3 Segment 3

Segment 3 is similar to Segment 2 - primarily a stable area with sand waves. However, there is one active scour feature (hole) located directly west of Point San Joaquin, as shown in Figure 12. While the scour of the region is active, analysis shows that this hole is scouring horizontally westward, and this should be no of concern as the cables avoid this scour region.

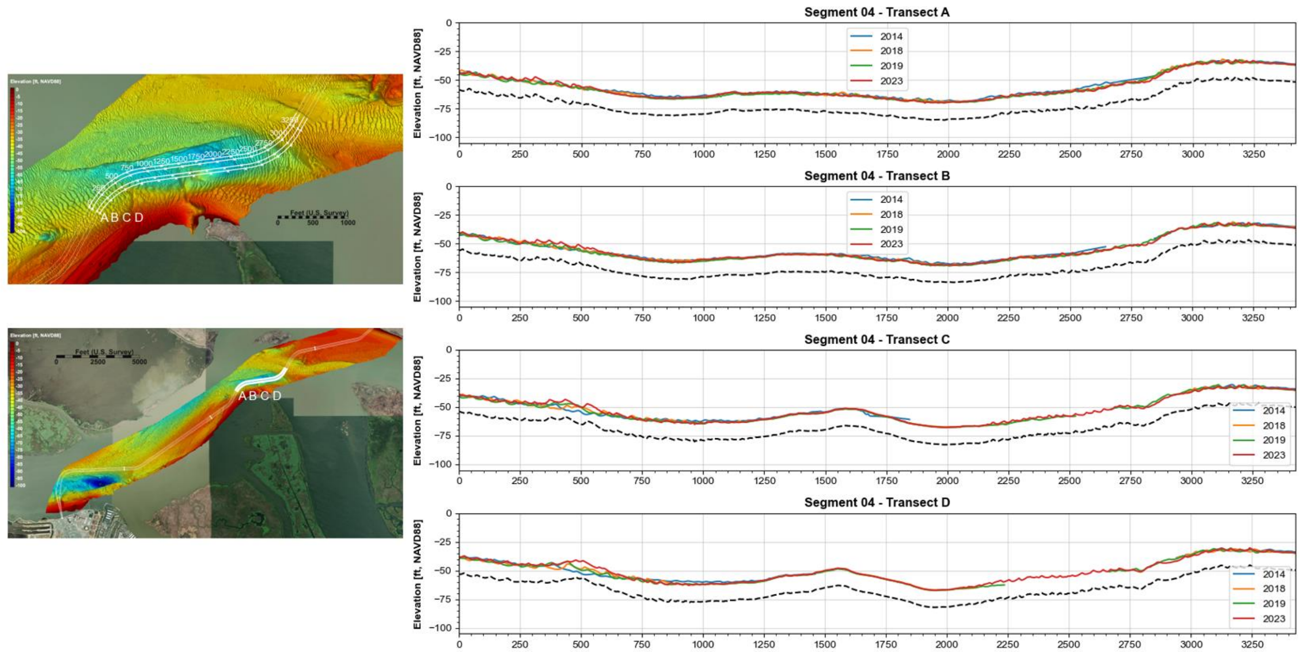
**Figure 12: Transects A-D in Segment 3**




### 3.4.4 Segment 4

Segment 4 includes a deep region along the proposed cables, which was most likely generated by the confluence of channel flows as well as soil variability (presence of more rigid material). Sand waves are present in most areas outside of the deep region. Elevation changes are minimal in most areas along the transects (see Figure 13). The cable routes avoid the ridge along the north edge of the large deep area where erosion is observed. Erosion along this ridge has slowed significantly in recent years.

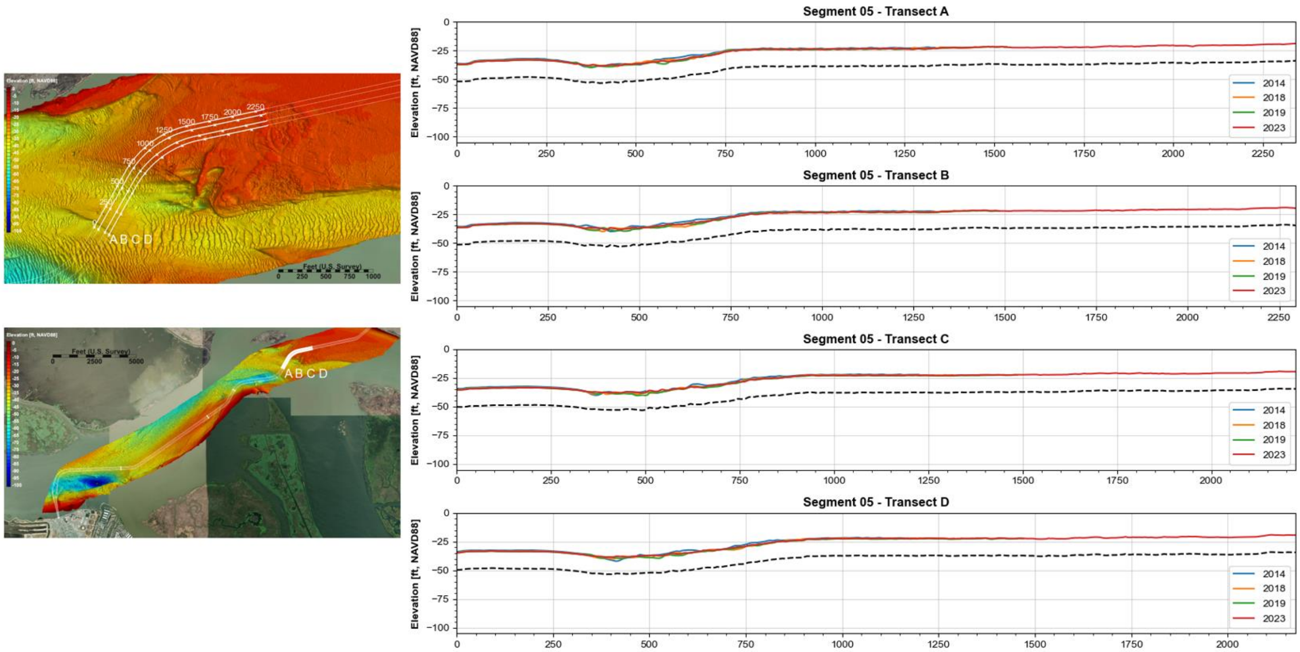
### Figure 13: Transects A-D in Segment 4




### 3.4.5 Segment 5

Figure 14 shows transects taken along Segment 5, which includes the shallower area approaching Collinsville. Segment 5 has relatively large sand waves, but minimal overall scour. Some erosion was observed after 2014 (distance 250 to 750 feet on Transect A), but the erosion appears to be slowing down. It is important to note that the transect analysis of Segment 5 was only performed in areas with data overlap (to investigate trends) and does not include the entire profile within the 2023 dataset. Changes were not analyzed in the remaining northern portion of the route, since only 2023 data were available.

**Figure 14: Transects A-D in Segment 5**




### 3.5 Potential Cable Exposure Summary

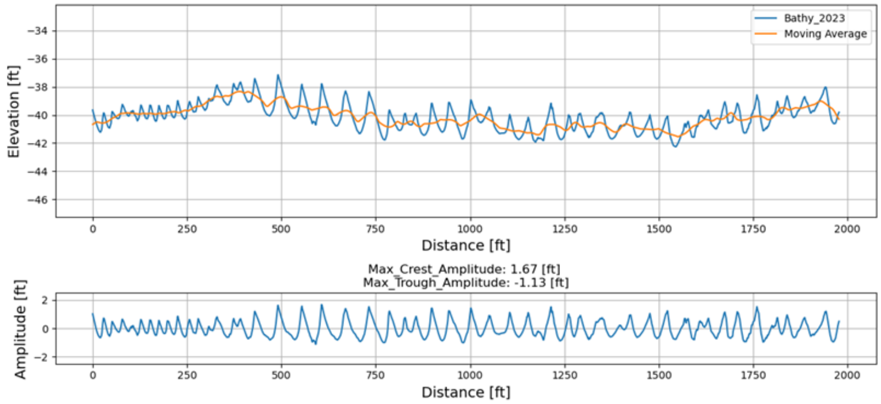
Cable exposures may occur over limited areas within a 25-year period, depending on initial burial depth. The likelihood and extent of potential exposures can be significantly reduced with larger burial depths. Transect-based analysis indicates that 15-ft burial depth may prevent nearly all exposure over the next 25 years. Smaller burial depths (e.g., 6 feet, 10 feet) are likely to result in more areas of exposure and larger distances over which cables are exposed. However, exposures do not necessarily translate into an unacceptable level of overall risk. Overall risk is informed by the anchor risk assessment (CHE 2025).

## 4. Bedform Analysis

Sand wave heights are typically considered in addition to the burial depth required to mitigate anchor risk, in the form of a seabed morphology allowance. The burial depth for acceptable anchor risk and seabed morphology allowance are typically combined to produce a recommended Depth of Lowering (initial target cable burial depth).

Representative sand wave heights were calculated using the 2023 survey. Transects were extracted along the cable routes and analyzed. Larger elevation trends along the transects were removed (filtered out), and the remaining sand wave signal was analyzed. Figure 15 (top) shows an example of this process with the original elevation transect (blue) and larger elevation trend (orange) that was removed to obtain the sand wave signal (bottom). Sand wave heights were calculated from trough to crest.

**Figure 15: Sand Wave Height Calculations**




This analysis process was repeated along each of the proposed cable routes. Portions of the route with similar sand wave patterns and magnitudes were combined for simplicity. Sand wave heights vary within each segment along the route; however, the maximum sand wave height within each area was reported. Figure 16 shows the cable routes with mile markers where representative sand wave heights were taken (top), and sand wave heights calculated along the center cable route (B), as an example (bottom). Sand wave heights range from 0.5 to 3.2 feet.

Maximum sand wave heights were calculated for the cable alignment with the largest sand waves. Figure 17 displays the largest sand wave heights (color coded) throughout the cable alignment as a map. For both Figures 16 and 17, the map shows the cable routes with mile markers with black text on the cable alignment corresponding to mile along the cable starting from Pittsburgh.

The largest sand wave heights were identified in the northeast portion of the route near the Federal channel. These sand wave heights along the route should be considered in combination with burial depths required to mitigate anchor risk.

**Figure 16: Cable Route with Mile Markers (top) and Calculated Sand Wave Heights (bottom)**

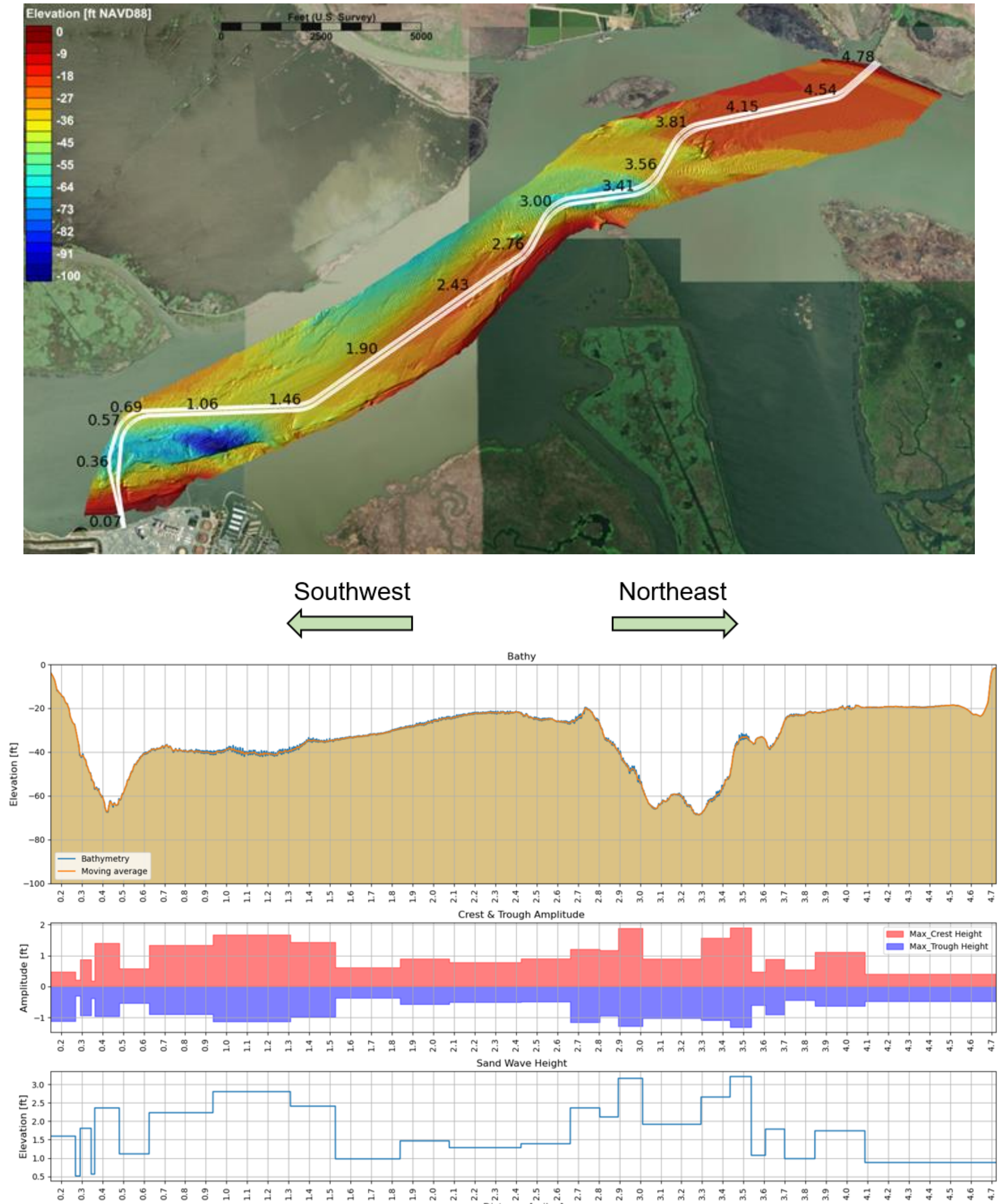
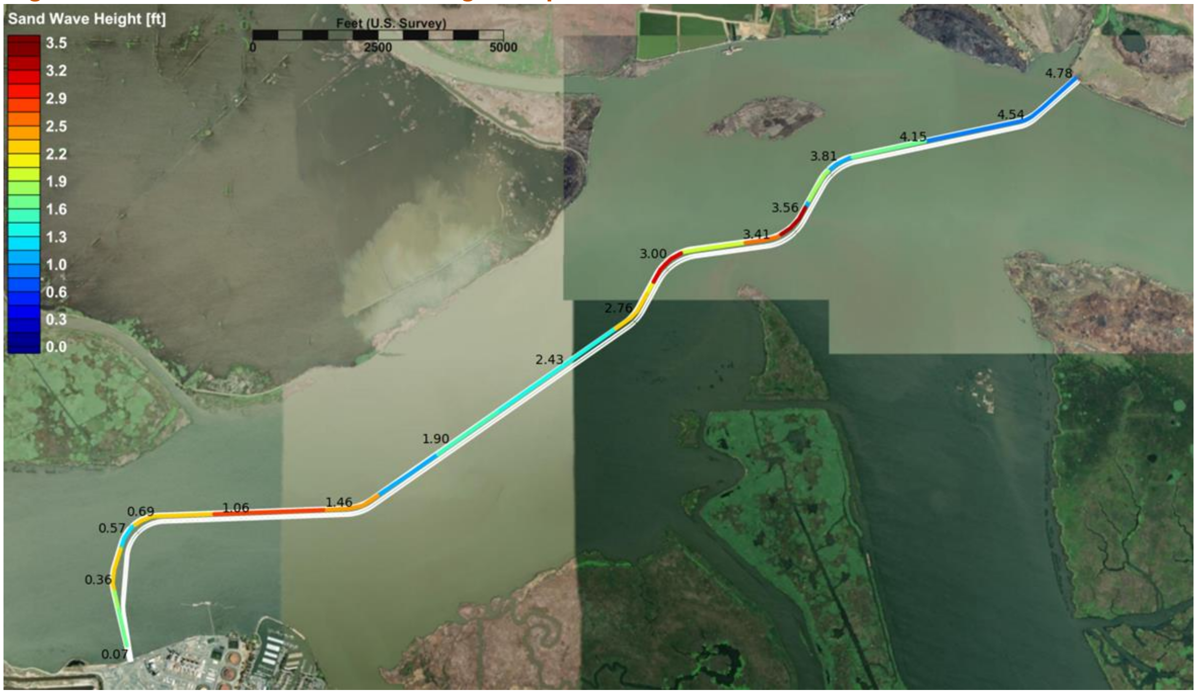


**Figure 17: Maximum Sand Wave Height Map**




## 5. Summary

Seabed morphology was analyzed using multiple different methods and high-resolution bathymetric survey data collected from 2014 to 2023. Results indicate that cable exposures may occur, but the time to exposure and exposure extents depend on the initial cable burial depth. Potential exposures can be significantly reduced with larger cable burial depth. For example, 15 ft burial depth may prevent nearly all exposures over the next 25 years. However, 6 ft or 10 ft burial depths likely result in several additional exposures.

Sand wave heights between 0.5 and 3.2 feet were observed along the route. Typically, sand wave heights are considered a seabed morphology burial depth allowance which is combined with burial depths for acceptable anchor risk, and a recommended Depth of Lowering is calculated.

Limited cable exposures may not result in unacceptable overall risk. The results of the anchor risk assessment (CHE 2025) provide context regarding potential risk associated with exposures, and the influence of different burial depths.

## 6. References

Coast & Harbor Engineering (CHE, 2025). LS Power Collinsville to Pittsburg Submarine Cable - Probabilistic Anchor Risk Analysis.

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eTrac (2019). Multibeam Data Collected in 2019 in Suisun Bay. Data sent electronically via email on June 20th, 2024.

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eTrac (2023b). LS Power Cable Route Survey Report. Marine Geophysical Survey Report Prepared for LS Power. Revision A1.

Kvitek, R. and Iampietro P. (2014). Multibeam Data Collected in 2018 in Suisun Bay. Multibeam Data collected by Sea Floor Mapping Lab. California State University, Monterey Bay.

MarineCadastre.gov. (2024). “Automated Information System (AIS)”. Data available on the World Wide Web accessed 2024. https://marinecadastre.gov/data/.

National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (1991). Descriptive Report for H10342. Data sent electronically via email on June 20th, 2024.

U.S. Army Corp of Engineers (USACE) San Francisco District (2021). Federal Navigation Hydrosurveys.

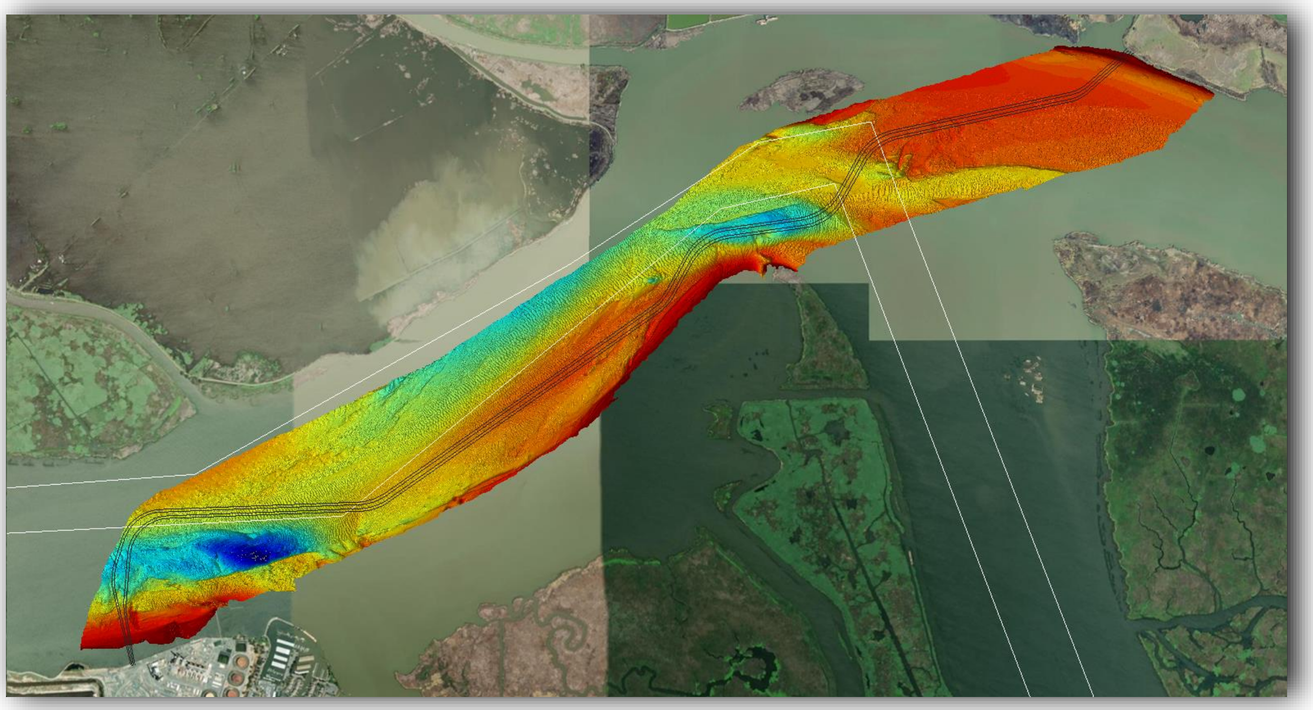
# Appendix A : Morphology Results

# Collinsville to Pittsburg Submarine Cable

Seabed Morphology Analysis

Appendix A – Results Presentation

January 20, 2025



# Collinsville to Pittsburg Submarine Cable

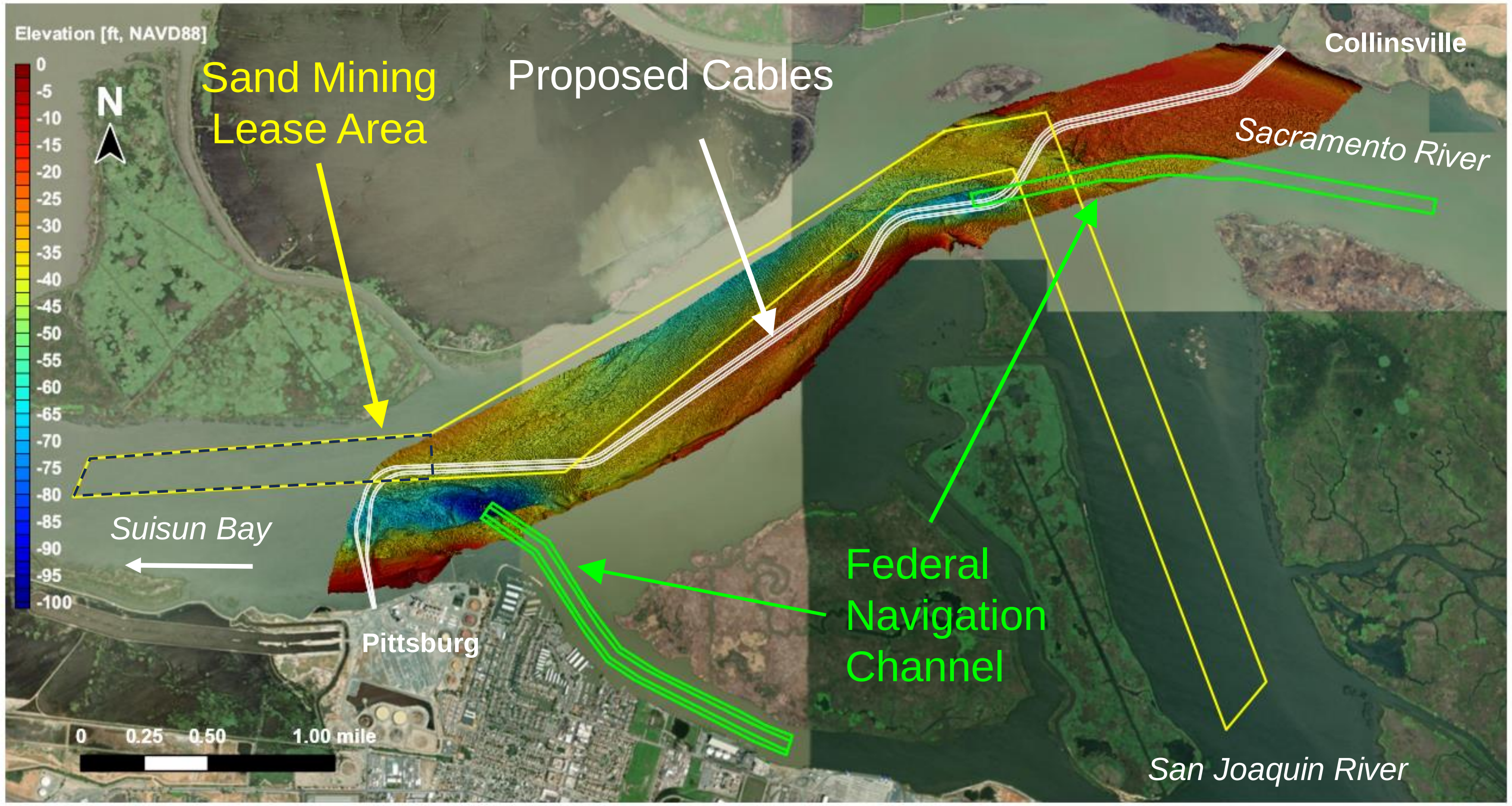
## Seabed Morphology Analysis and Cable Routing

1. Site Setting
2. Bathymetry Datasets
3. Sub-Bottom Data Evaluation
4. General Elevation Change Analysis
5. Potential Exposures
6. Mobility Zone Delineation and Characterization
7. Route Modification

# Collinsville to Pittsburg Submarine Cable

## Site Setting

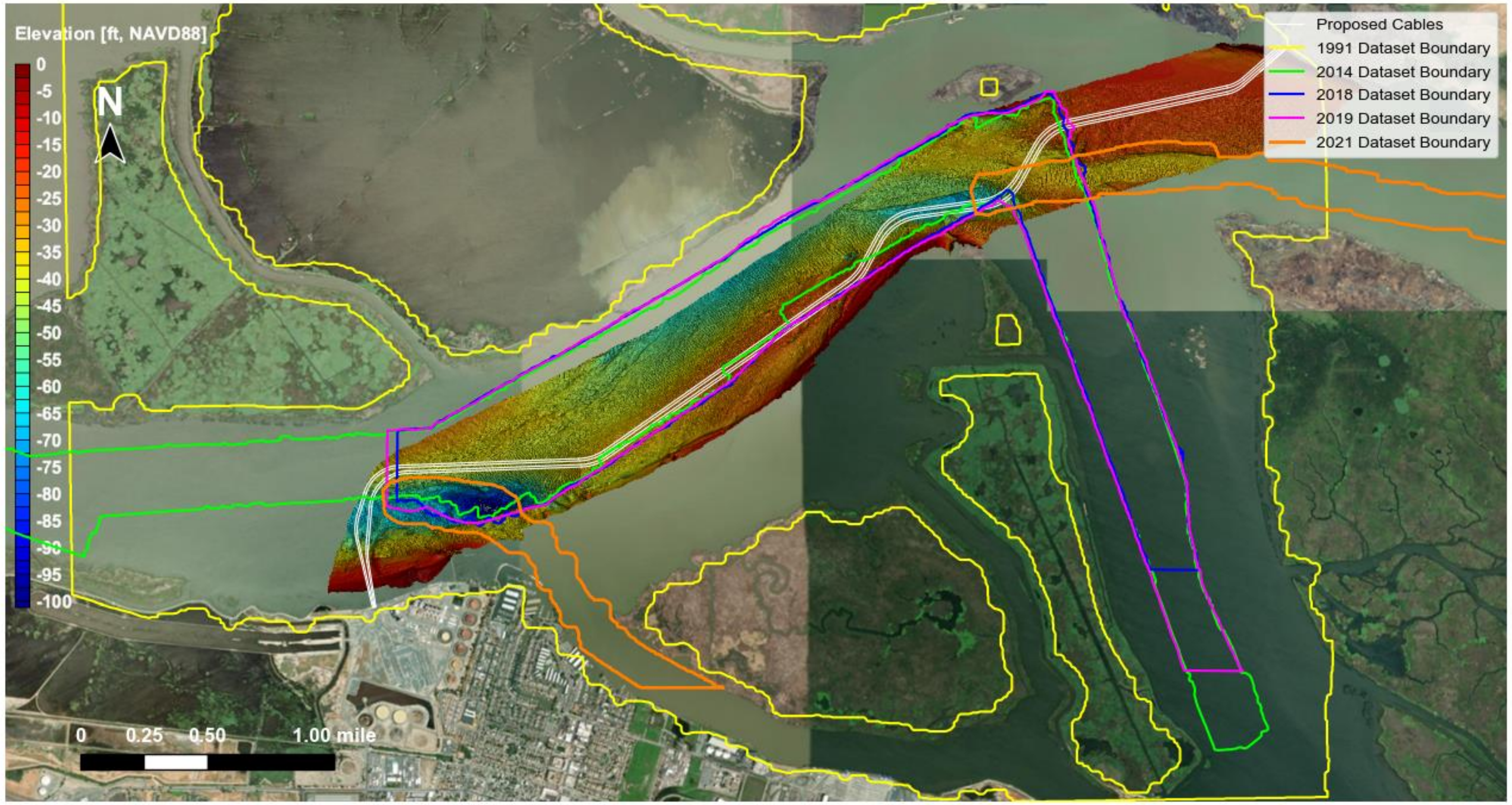
- Four cable routes
- Sand mining area
- Navigation channels



# Bathymetry Compilation

## Available Bathymetry

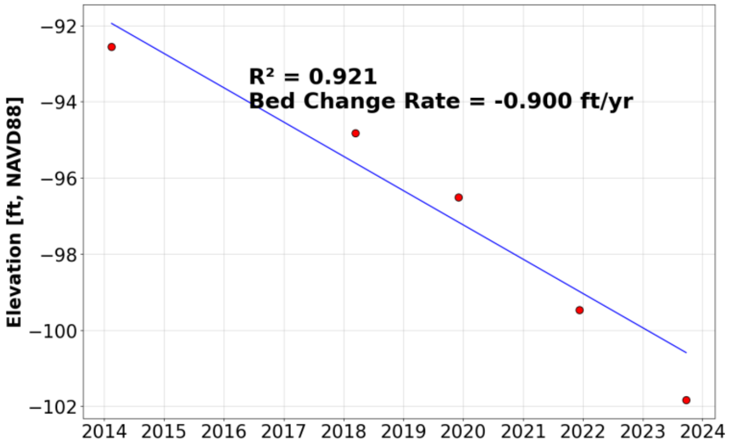
- 1991 NOAA (coarse)
- 2014 USGS
- 2018 eTrac
- 2019 eTrac
- 2021 USACE (channels only)
- 2023 eTrac



# Methodology

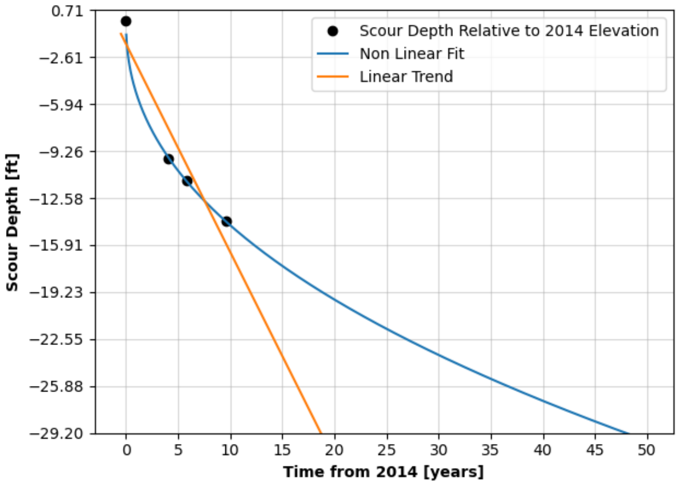
## 3-Step Process

### Step 1 – Simple Analysis



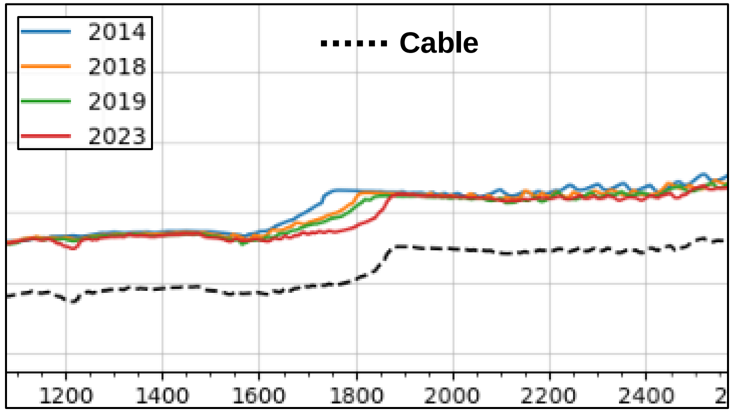

- Quickly and confidently identifies safe zones
- Quantifies time to exposure

### Step 2 – Changing Trends (Nonlinear)




- Identifies some trends where erosion is slowing down (but not stopping)
- Quantifies time to exposure

### Step 3 – Transect Analysis

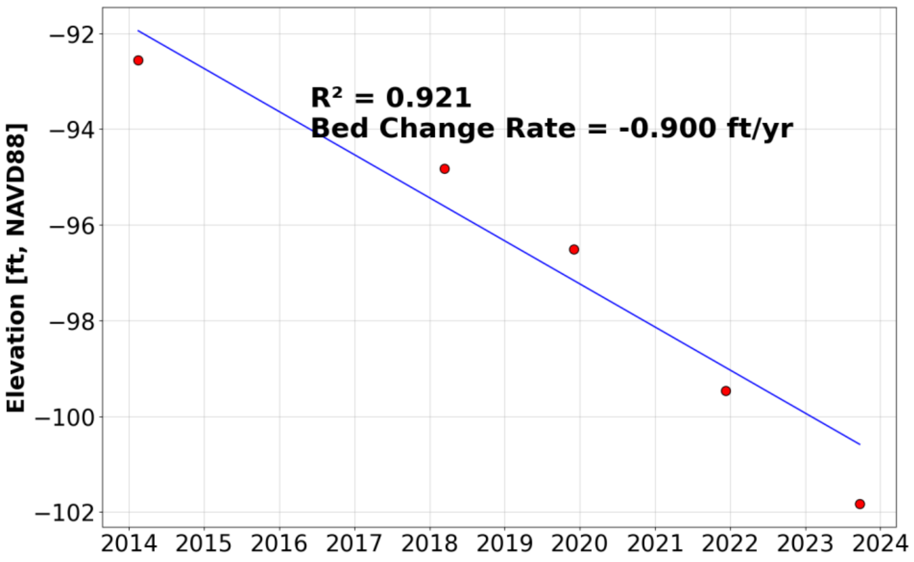



- Identifies some trends where erosion would stop prior to exposure, “horizontal scour”

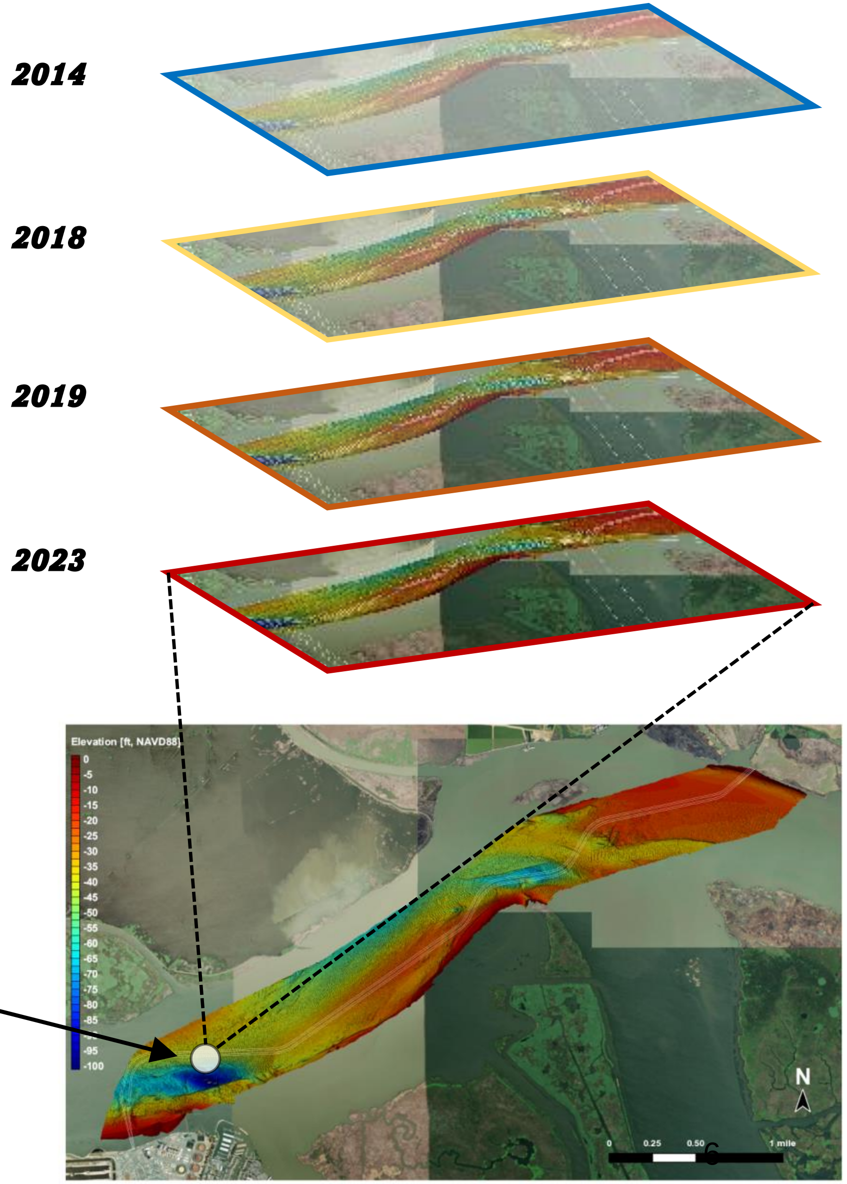
# Erosion/Deposition Trends

## Step 1 – Simple Elevation Change Analysis

- At location where we have data overlap, utilize all survey datapoints to find an “average” change rate.
- This analysis does not account for scour that is slowing down, or features that move horizontally.



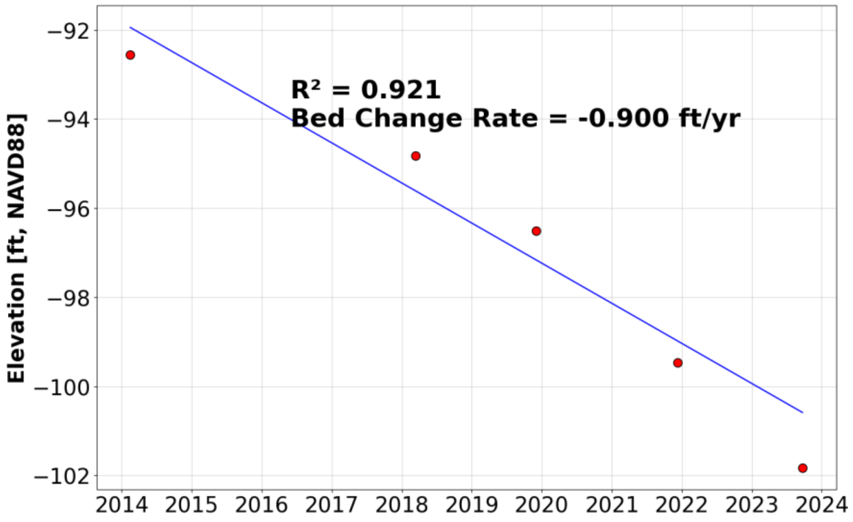

*Note: the example bed change plot is not along the cable route.*

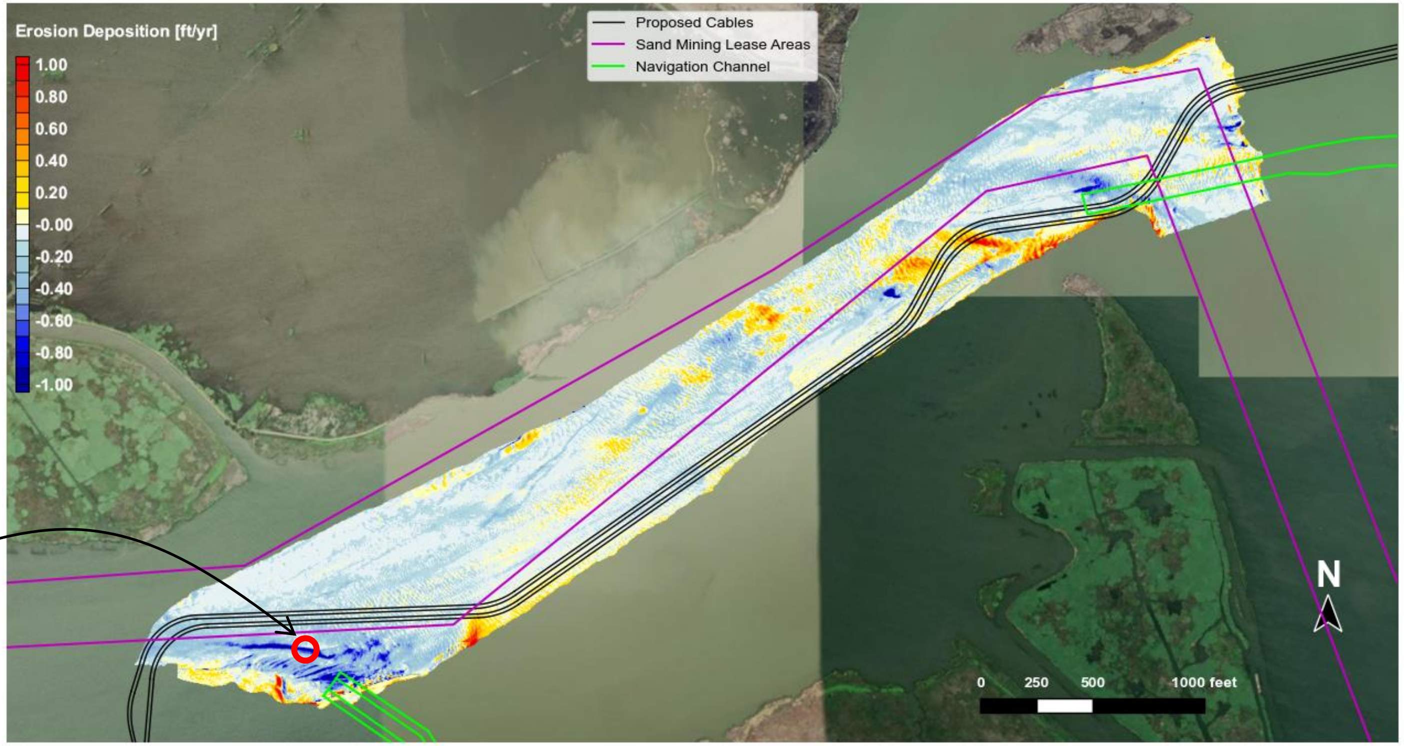


# Erosion/Deposition Trends

## Step 1 – Simple Elevation Change Analysis

- Linear trend fit performed at every grid point with survey overlap
- 1991 data not included (poor resolution)
- 2014-2023 trends differ from 1991-2023 trends



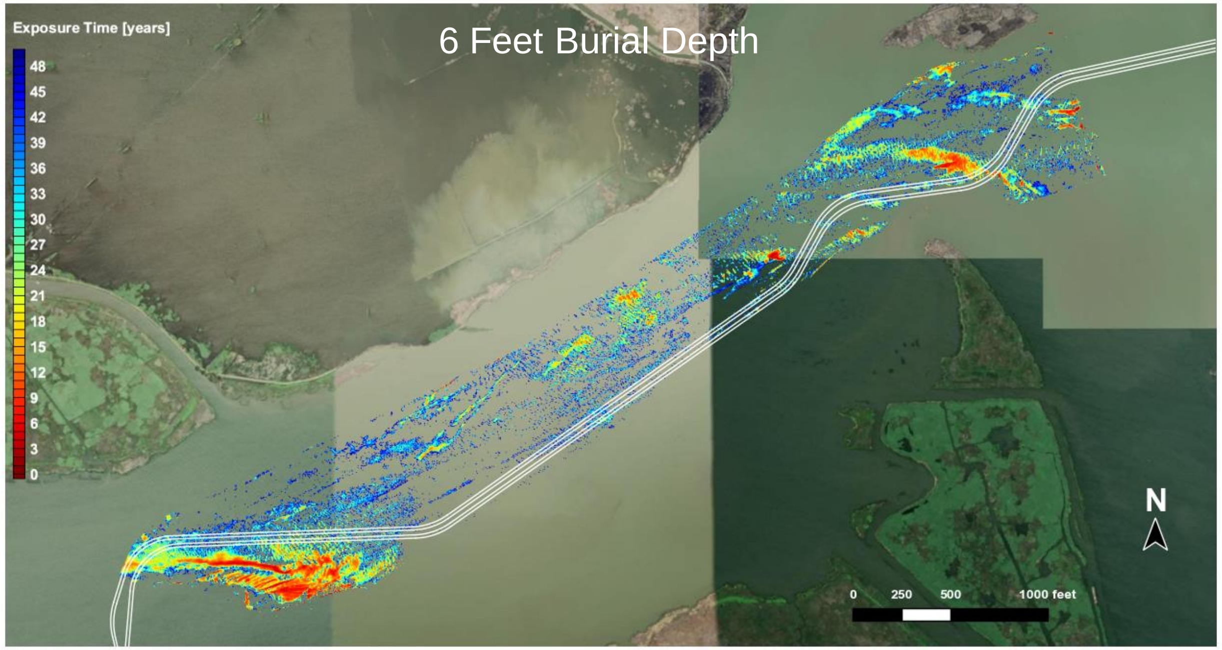



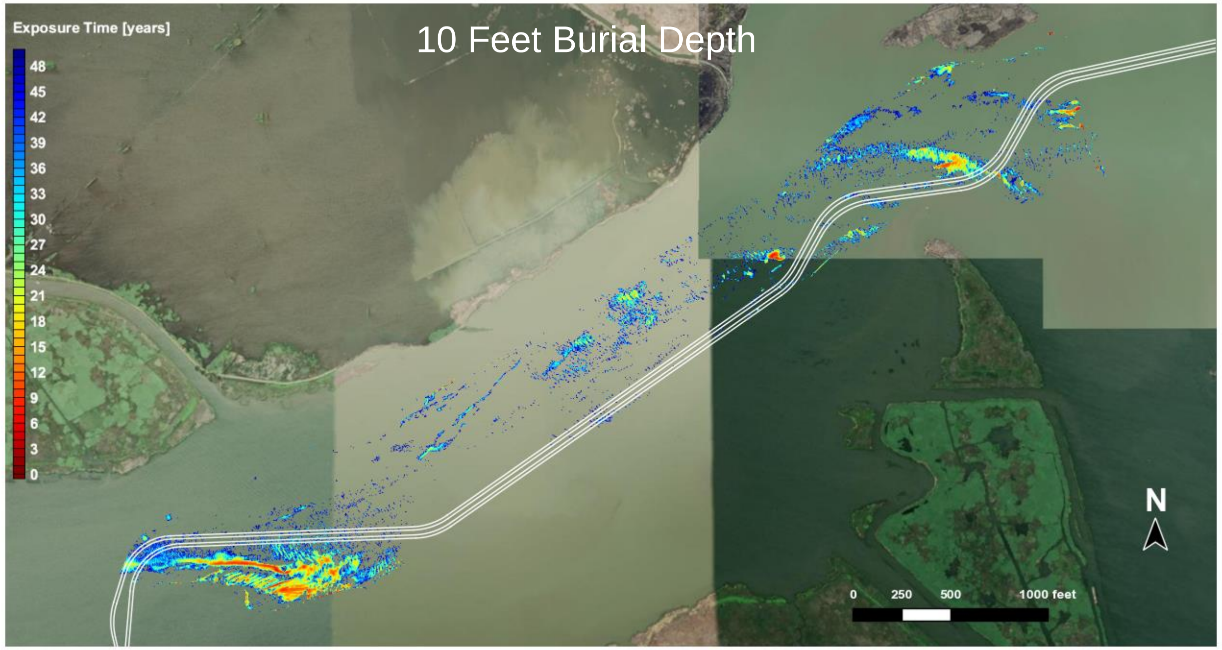

*Note: the example bed change plot is not along the cable route.*

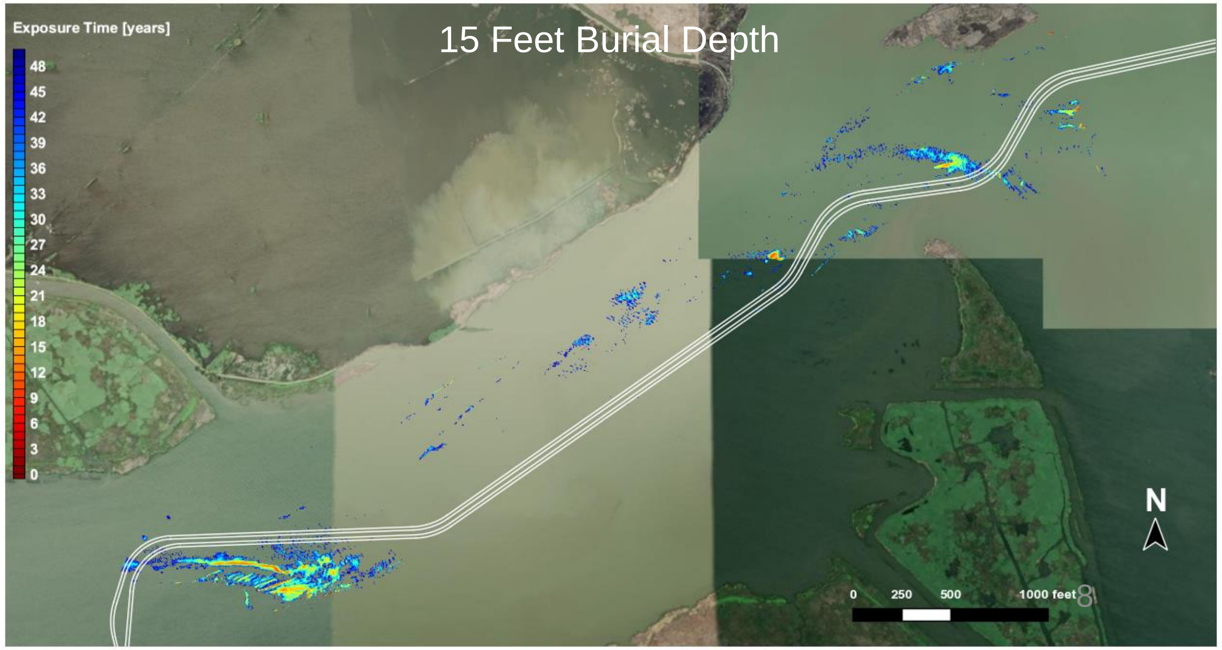
# Exposure Times (Simple Trends)

## Step 1 – Simple Elevation Change Analysis

- Exposure times calculated based on simple trends for 3 initial burial depths (6’, 10’, 15’)



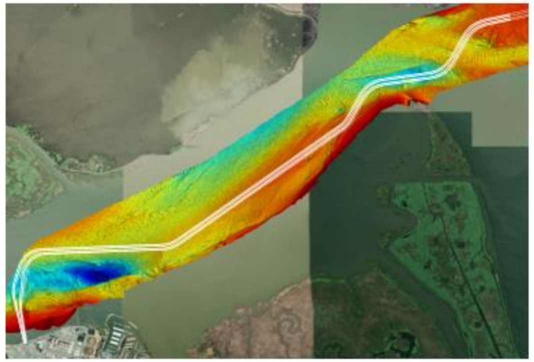



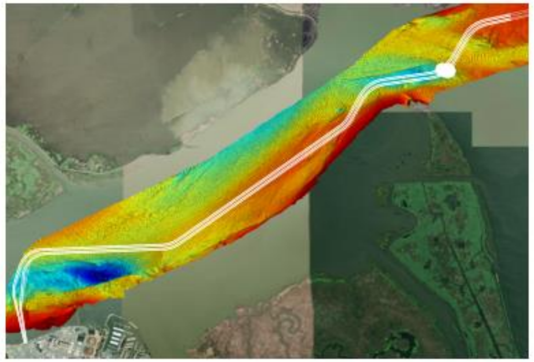
# Exposure Lengths (Simple Trends)

## Burial Depth 6 Feet

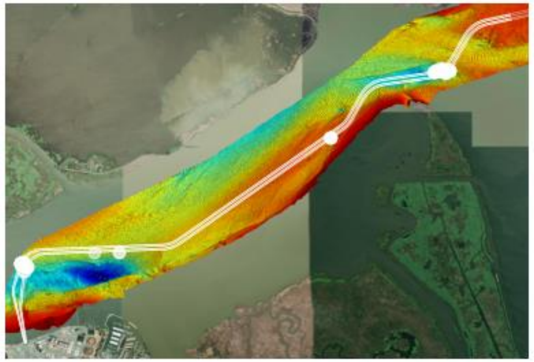
5 Years → 0.00% Exposed



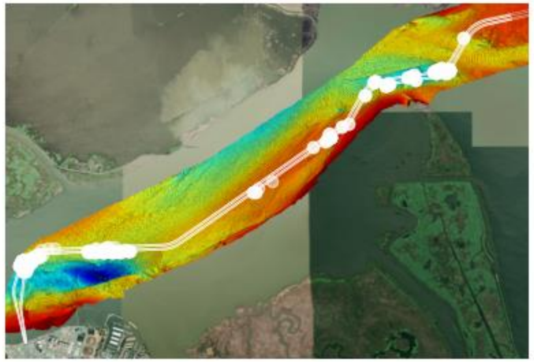
10 Years → 0.21% Exposed



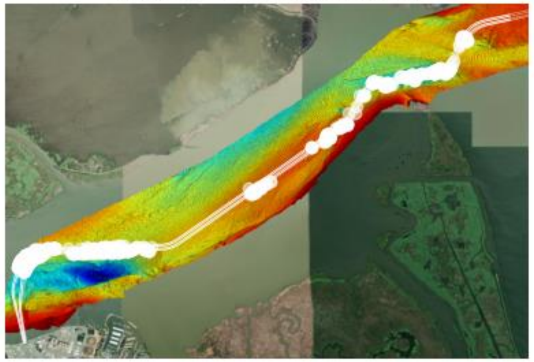
15 Years → 0.87% Exposed



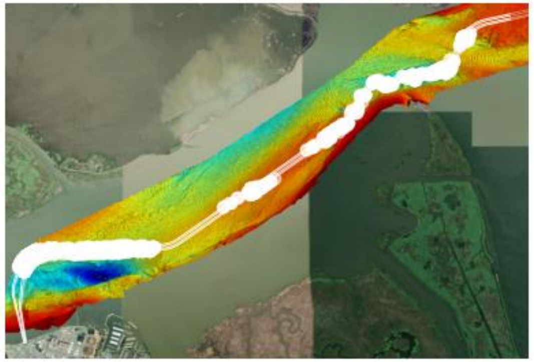
20 Years → 3.57% Exposed



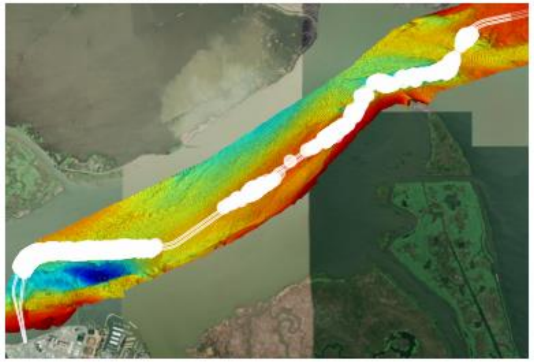
25 Years → 9.05% Exposed



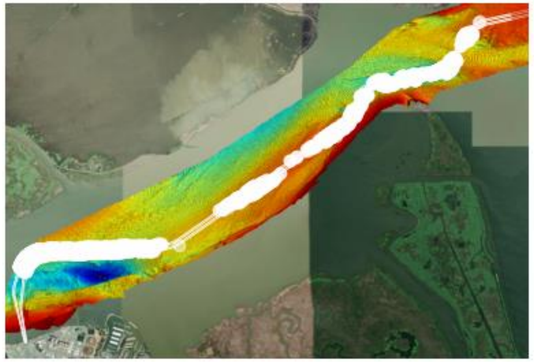
30 Years → 14.76% Exposed



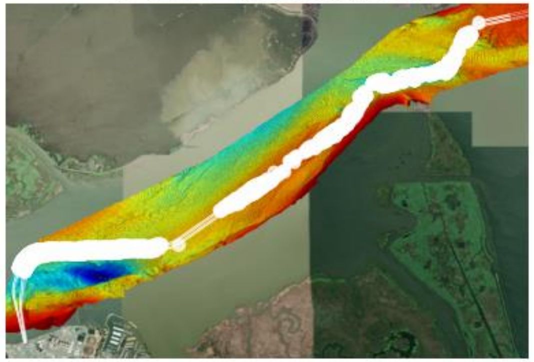
35 Years → 19.65% Exposed



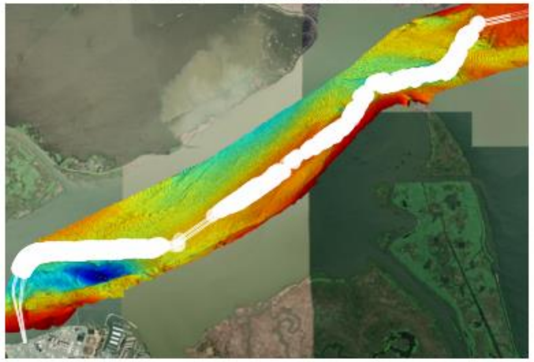
40 Years → 24.37% Exposed



45 Years → 28.72% Exposed



50 Years → 33.82% Exposed



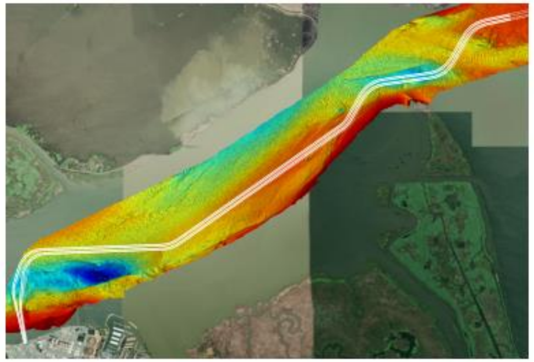
**Percent of Cable Exposed to 6 Feet Burial**

| | 5 yr | 10 yr | 15 yr | 20 yr | 25 yr | 30 yr | 35 yr | 40 yr | 45 yr | 50 yr |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 0.0 | 0.7 | 2.8 | 6.8 | 11.5 | 17.4 | 23.4 | 28.7 | 33.8 |
| B | 0.0 | 0.1 | 0.8 | 2.2 | 4.8 | 8.9 | 14.9 | 21.1 | 26.3 | 30.8 |
| C | 0.0 | 0.2 | 0.9 | 3.1 | 7.8 | 12.8 | 17.6 | 22.4 | 26.9 | 30.4 |
| D | 0.0 | 0.2 | 0.7 | 3.6 | 9.1 | 14.8 | 19.6 | 24.4 | 28.0 | 31.4 |

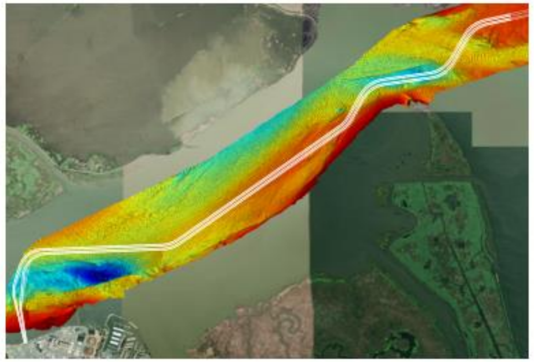
# Exposure Lengths (Simple Trends)

## Burial Depth 10 Feet

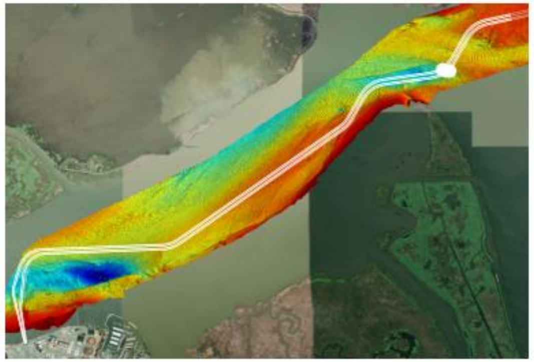
5 Years → 0.00% Exposed



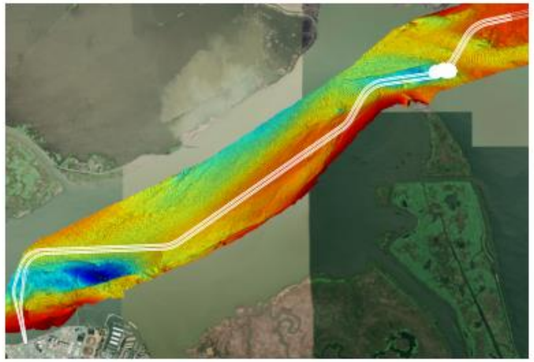
10 Years → 0.00% Exposed



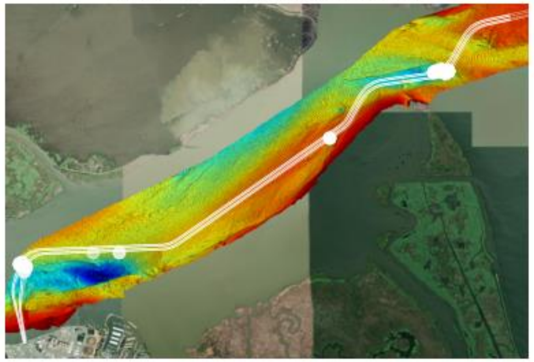
15 Years → 0.13% Exposed



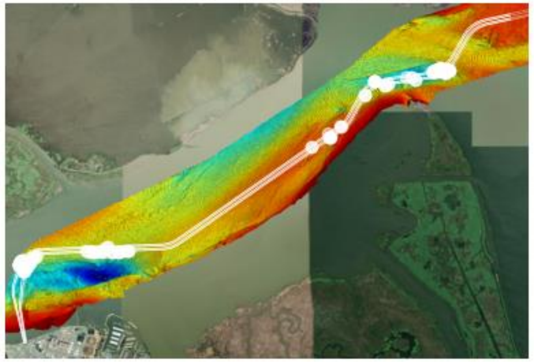
20 Years → 0.39% Exposed



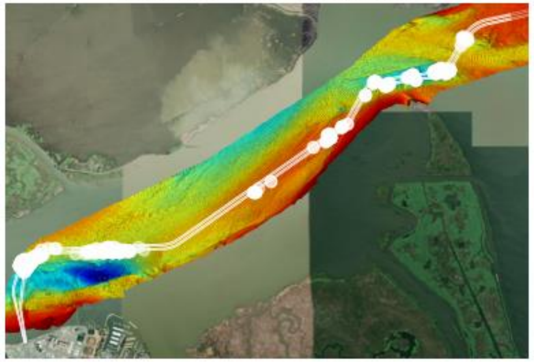
25 Years → 0.87% Exposed



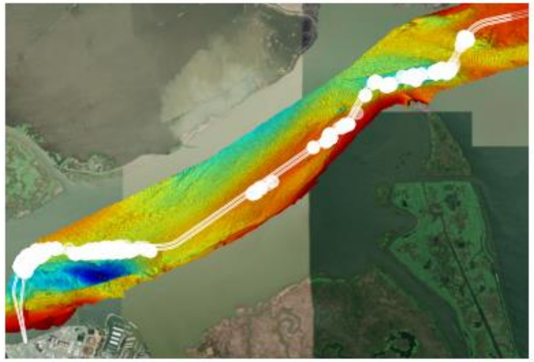
30 Years → 1.93% Exposed



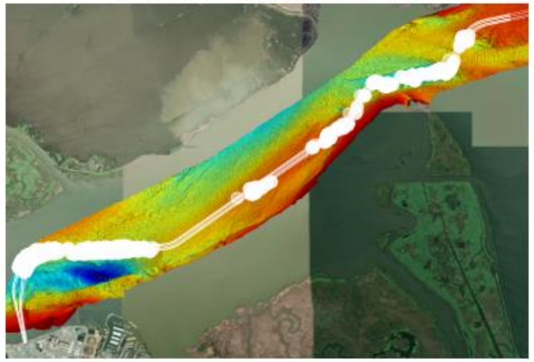
35 Years → 4.56% Exposed



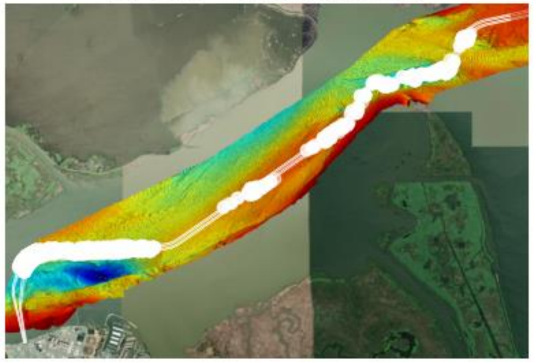
40 Years → 7.87% Exposed



45 Years → 11.45% Exposed



50 Years → 14.76% Exposed



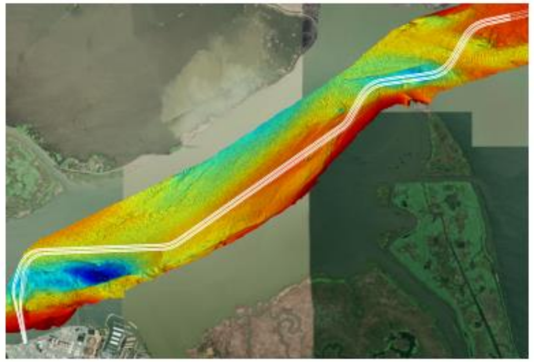
**Percent of Cable Exposed to 10 Feet Burial**

| | 5 yr | 10 yr | 15 yr | 20 yr | 25 yr | 30 yr | 35 yr | 40 yr | 45 yr | 50 yr |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 0.0 | 0.0 | 0.1 | 0.7 | 1.9 | 3.5 | 5.9 | 8.4 | 11.5 |
| B | 0.0 | 0.0 | 0.1 | 0.2 | 0.8 | 1.5 | 2.8 | 4.3 | 6.1 | 8.9 |
| C | 0.0 | 0.0 | 0.1 | 0.4 | 0.9 | 1.5 | 3.9 | 6.9 | 10.0 | 12.8 |
| D | 0.0 | 0.0 | 0.1 | 0.3 | 0.7 | 1.7 | 4.6 | 7.9 | 11.4 | 14.8 |

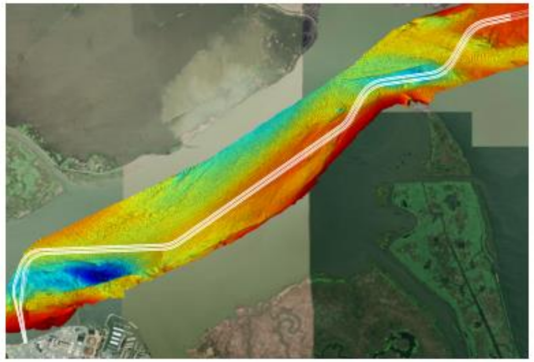
# Exposure Lengths (Simple Trends)

## Burial Depth 15 Feet

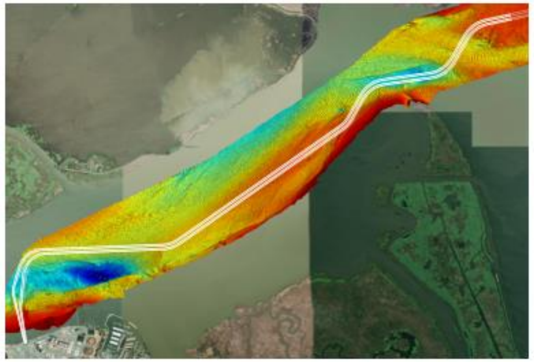
5 Years → 0.00% Exposed



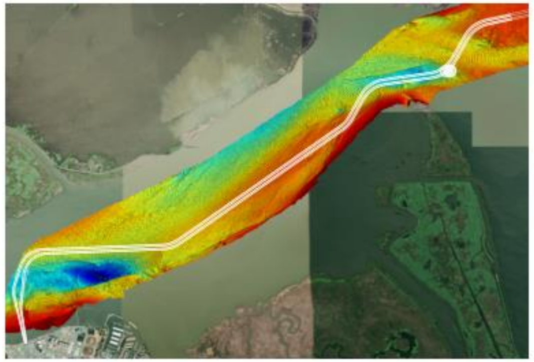
10 Years → 0.00% Exposed



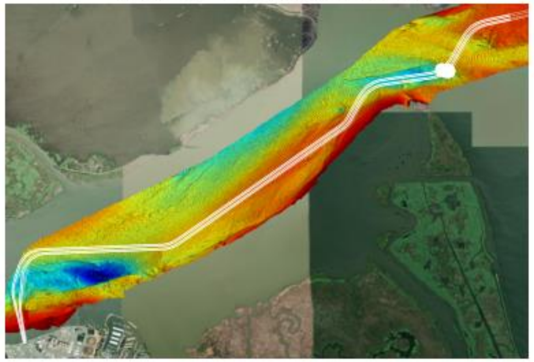
15 Years → 0.00% Exposed



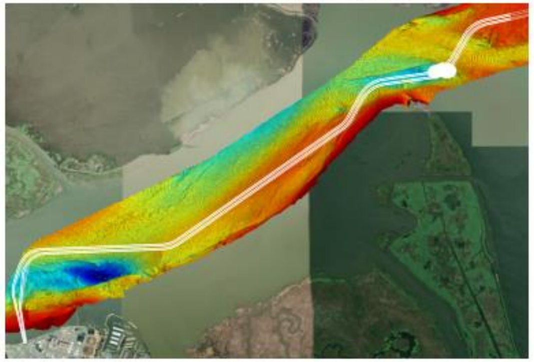
20 Years → 0.07% Exposed



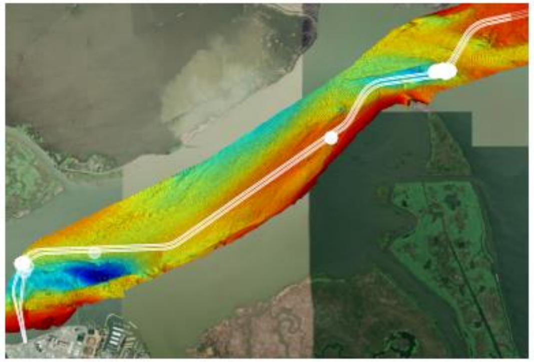
25 Years → 0.21% Exposed



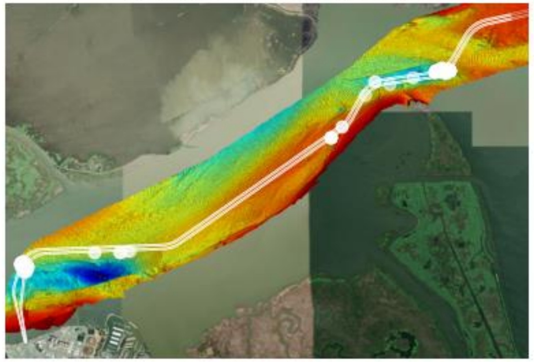
30 Years → 0.39% Exposed



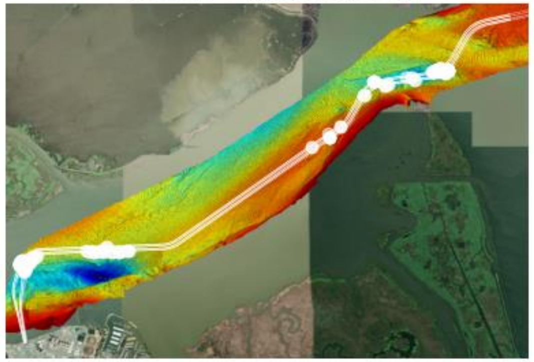
35 Years → 0.75% Exposed



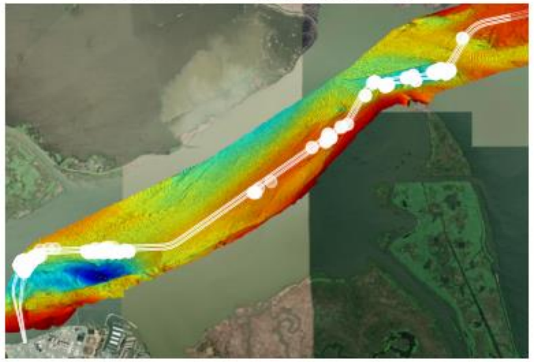
40 Years → 1.13% Exposed



45 Years → 1.93% Exposed



50 Years → 3.57% Exposed



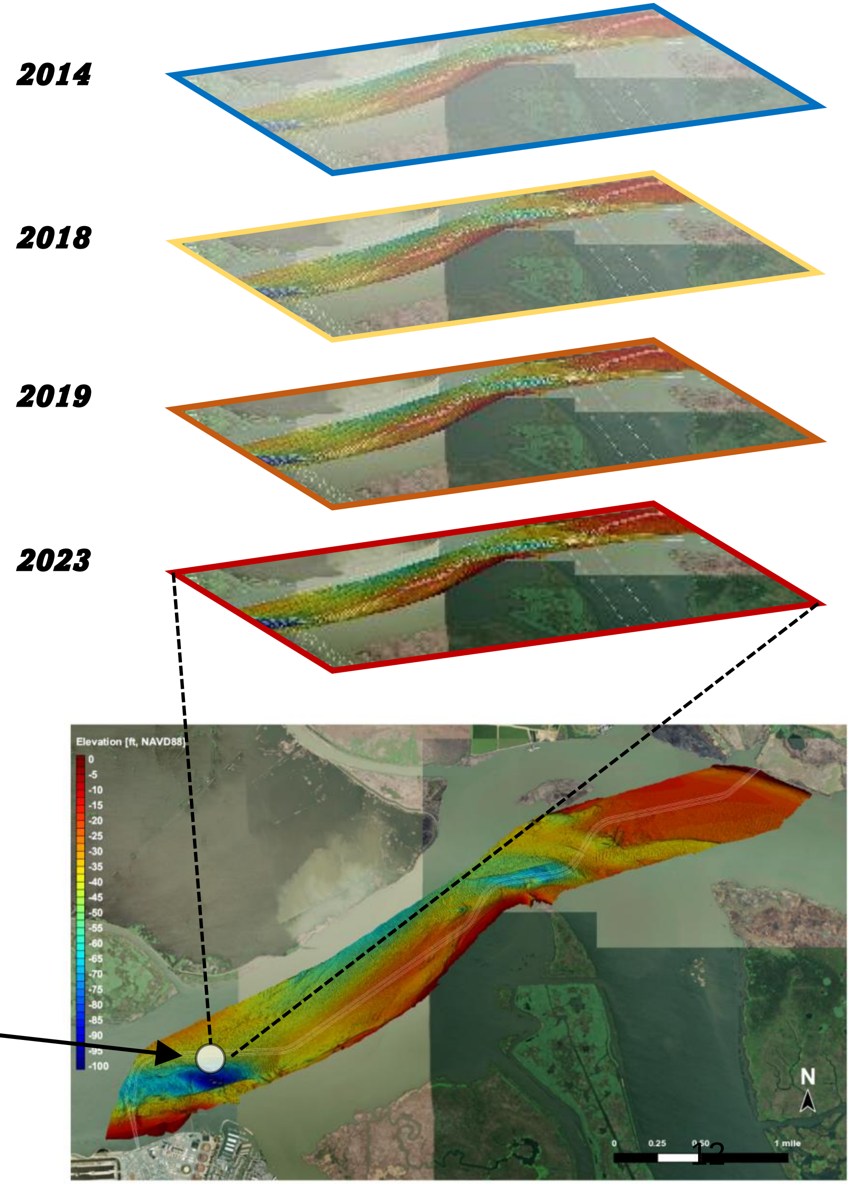
Percent of Cable Exposed to 15 Feet Burial

| | 5 yr | 10 yr | 15 yr | 20 yr | 25 yr | 30 yr | 35 yr | 40 yr | 45 yr | 50 yr |
|---|---|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | 1.1 | 1.9 | 2.8 |
| B | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.5 | 1.1 | 1.5 | 2.2 |
| C | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.4 | 0.7 | 1.0 | 1.5 | 3.1 |
| D | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.9 | 1.7 | 3.6 |

# Erosion/Deposition – Changing Trends

## Step 2 – Changing Trends (Nonlinear)

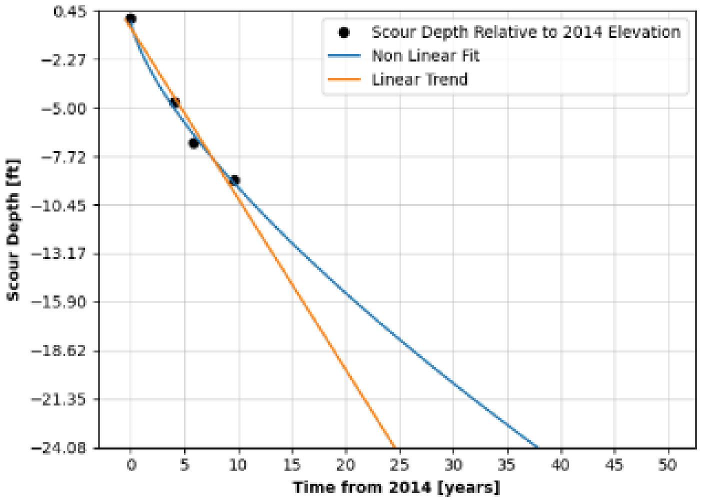
- Erosion trends also predicted with nonlinear curve, to account for erosion slowing down.
- Time to exposure typically increases.
- Still does not predict erosion stopping, i.e. this is still not the whole story – erosion will stop before exposure in some locations.




~24 feet of erosion takes ~25 years

~24 feet of erosion takes ~37 years

*Example only*

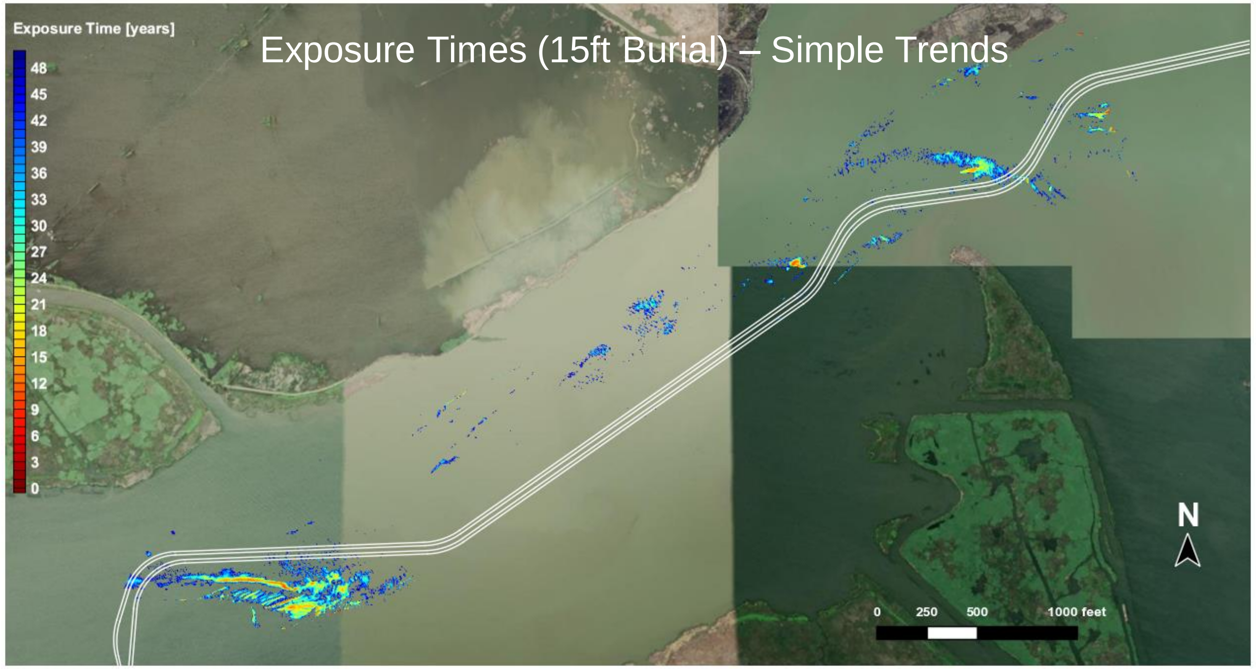


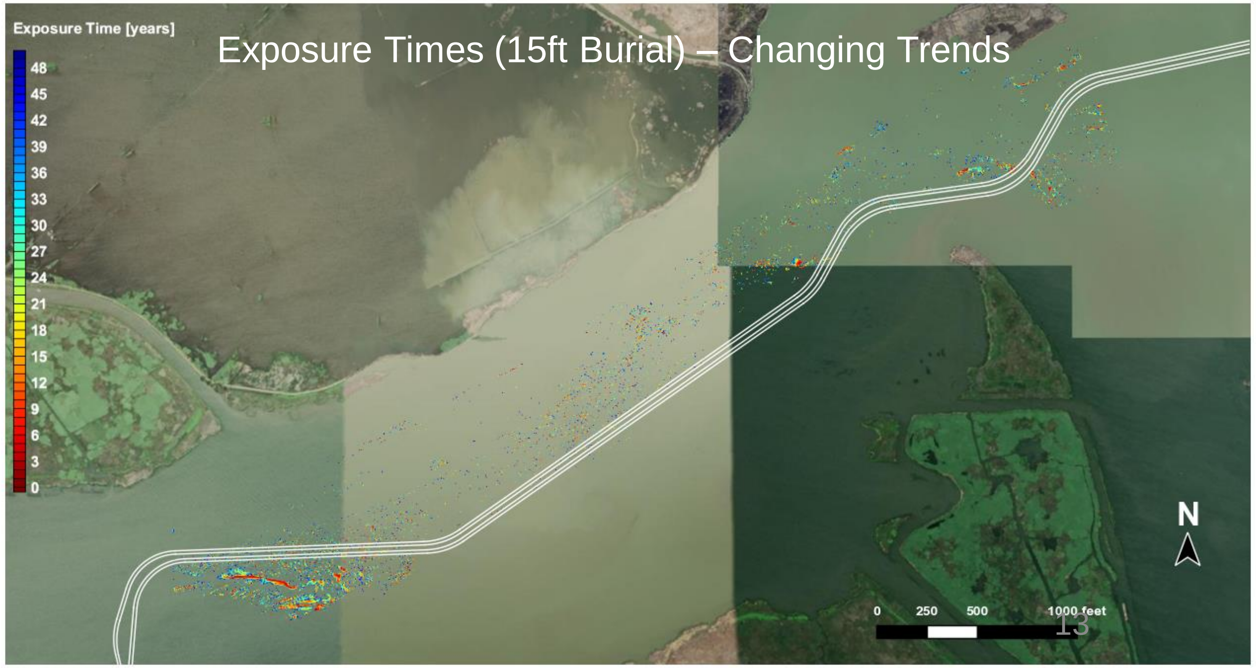

*Note: the example bed change plot is not along the cable route.*

# Exposure Times (Simple vs. Changing Trends)

## Step 2 – Changing Trends (Nonlinear)

- More complex trend shows that exposure areas are reduced in many areas.
- Stronger scour areas still show small areas of exposure in 25 years.
- This approach still neglects horizontal feature movement.

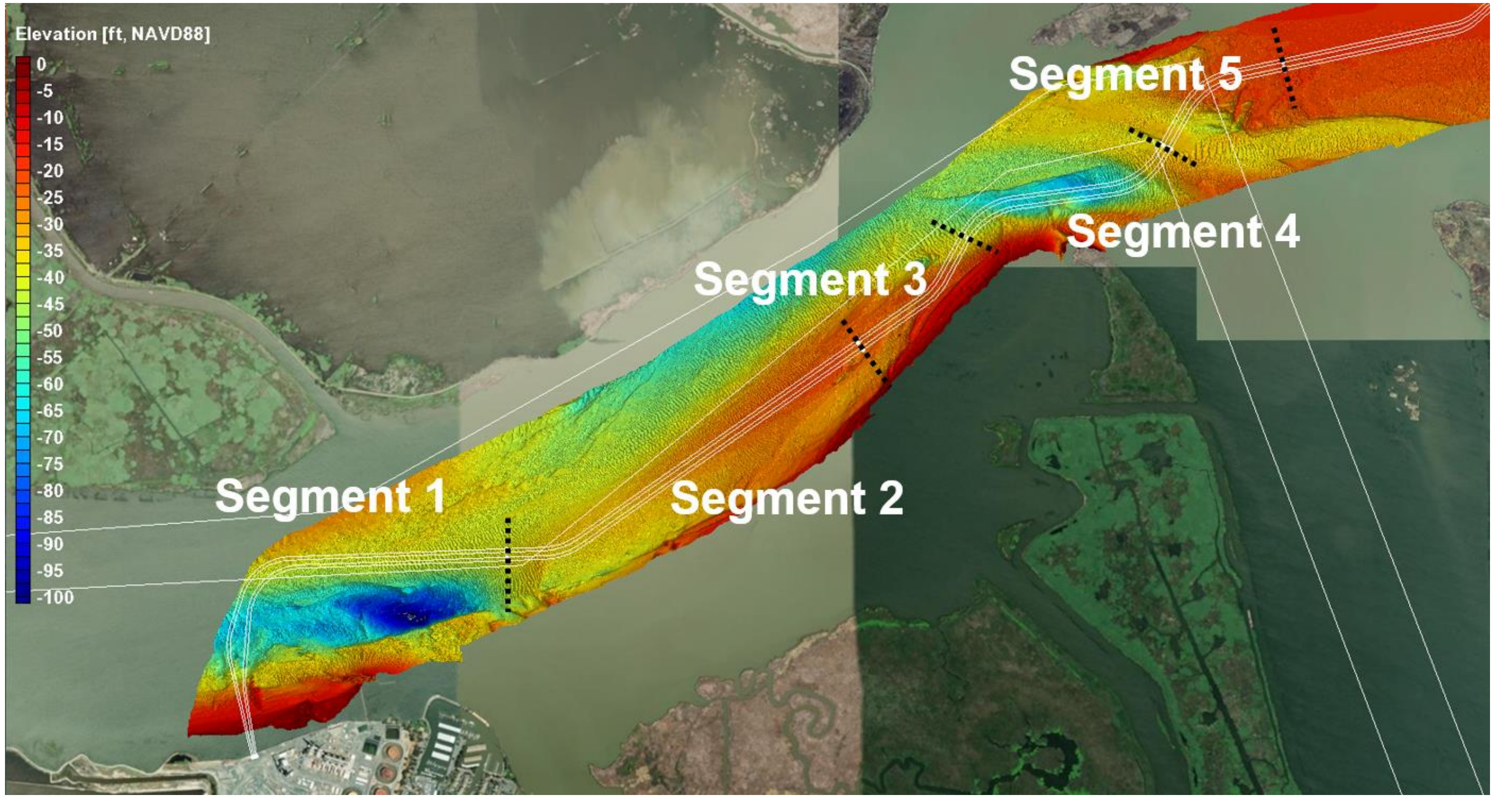


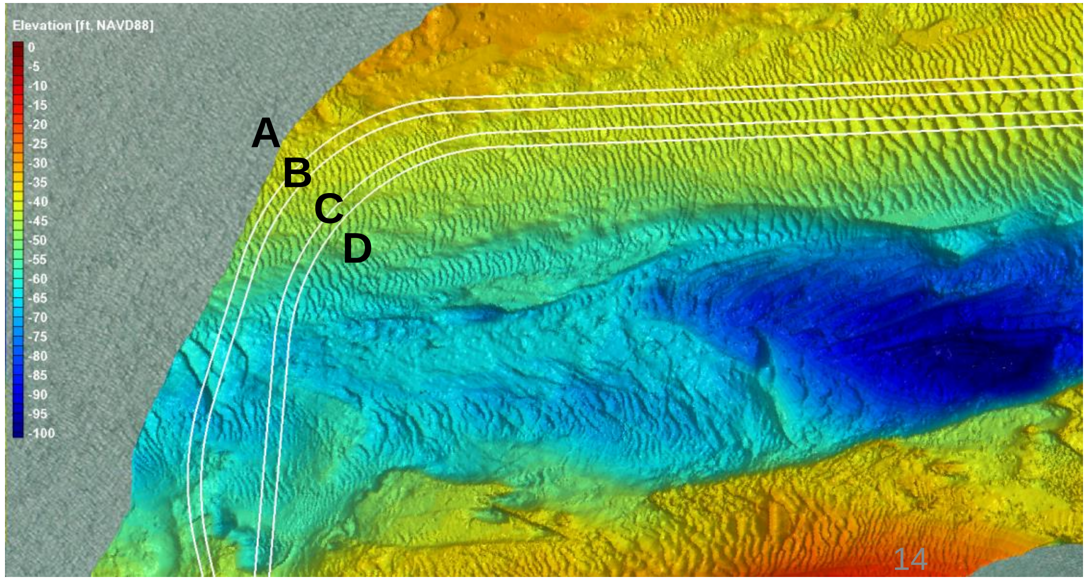
# Transect Analysis

## Trends Observed Along Cable Transects

- Five (5) segments developed based on morphology/bedform observations
- Each segment analyzed to determine trends and likelihood of exposure



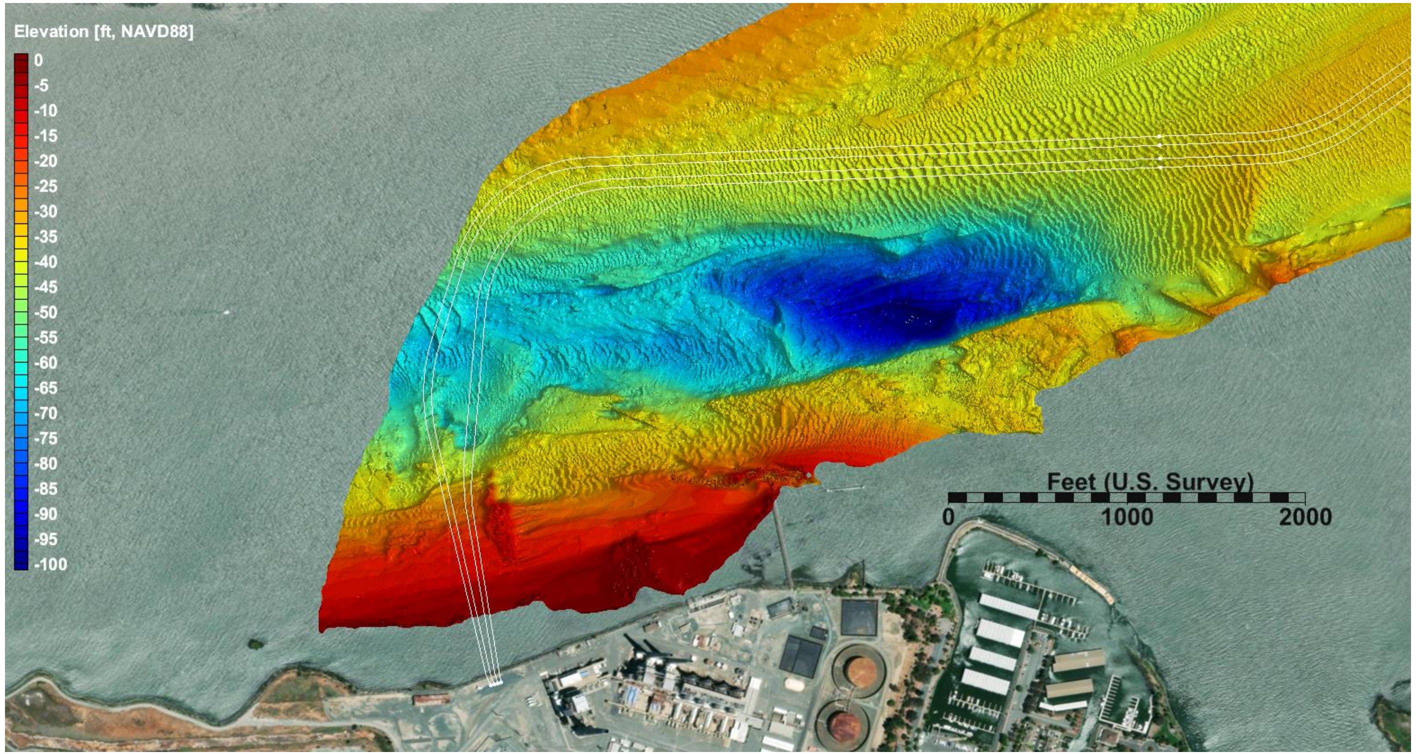

A B C D

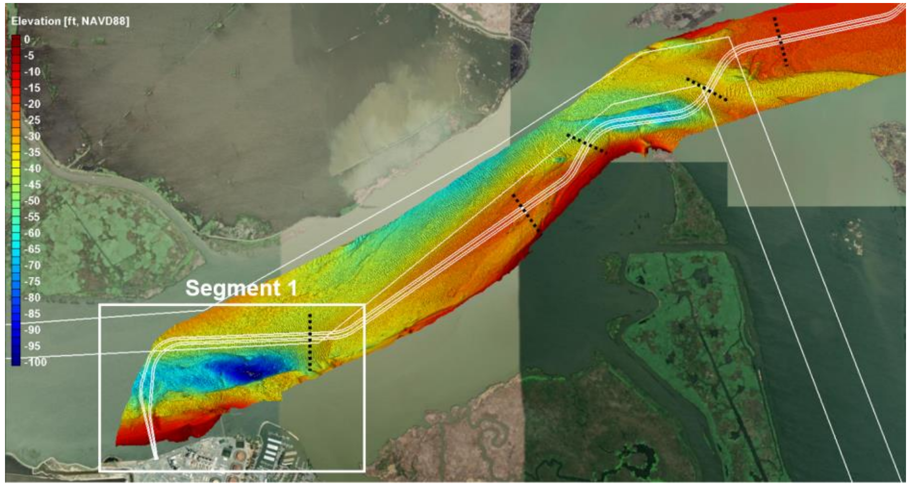


# Transect Analysis

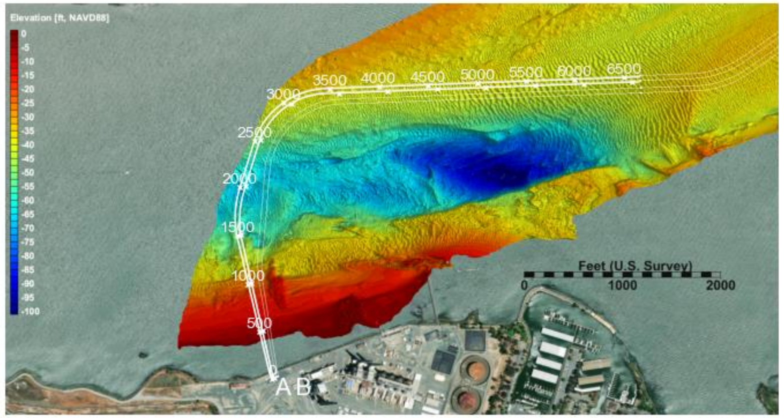
## Transect Analysis for Segment 1

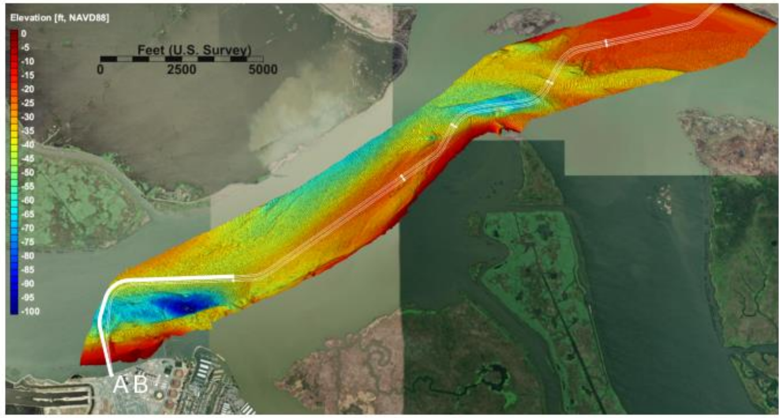
- Confluence of channels and soil variability causing erosion in large scour area
- Cable route avoids deepest region along the proposed cables
- Sand waves present in most areas

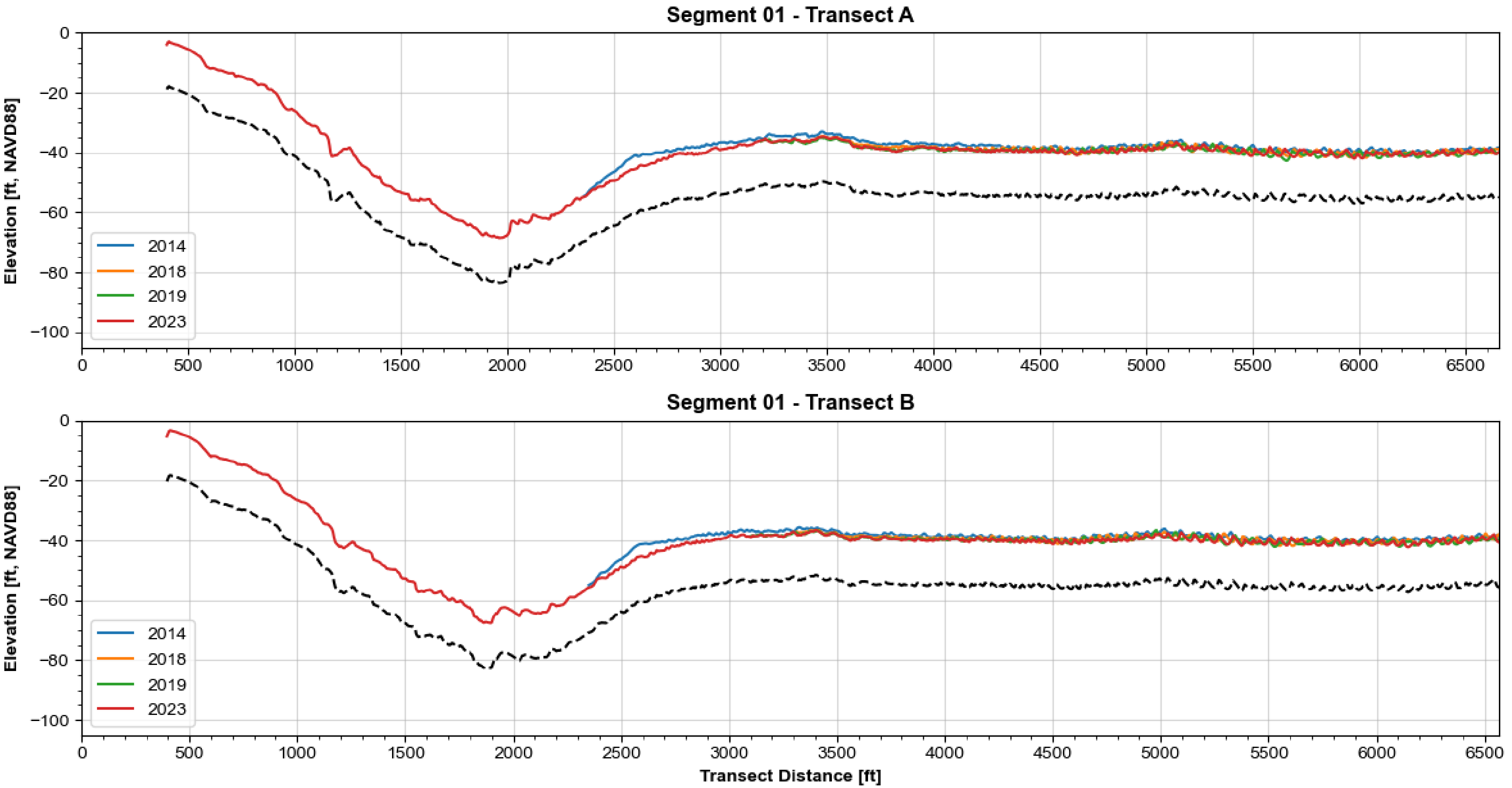


# Transect Analysis

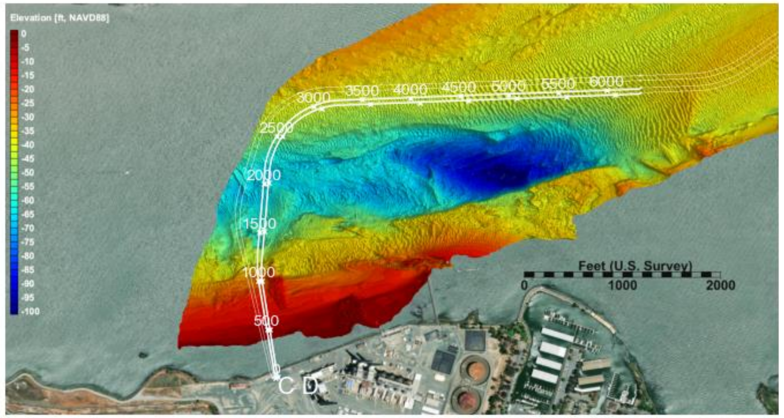


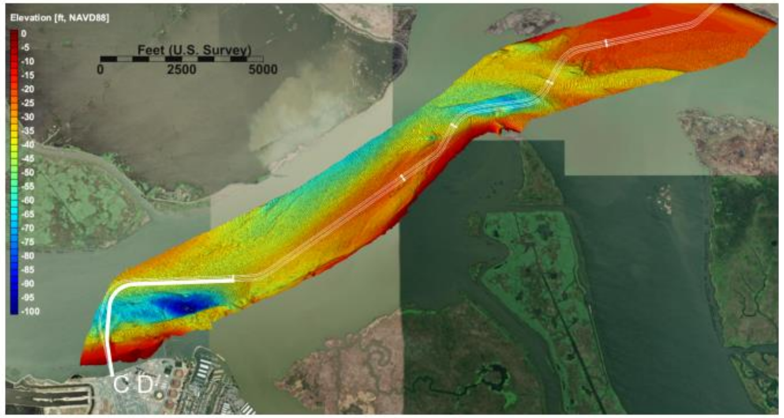



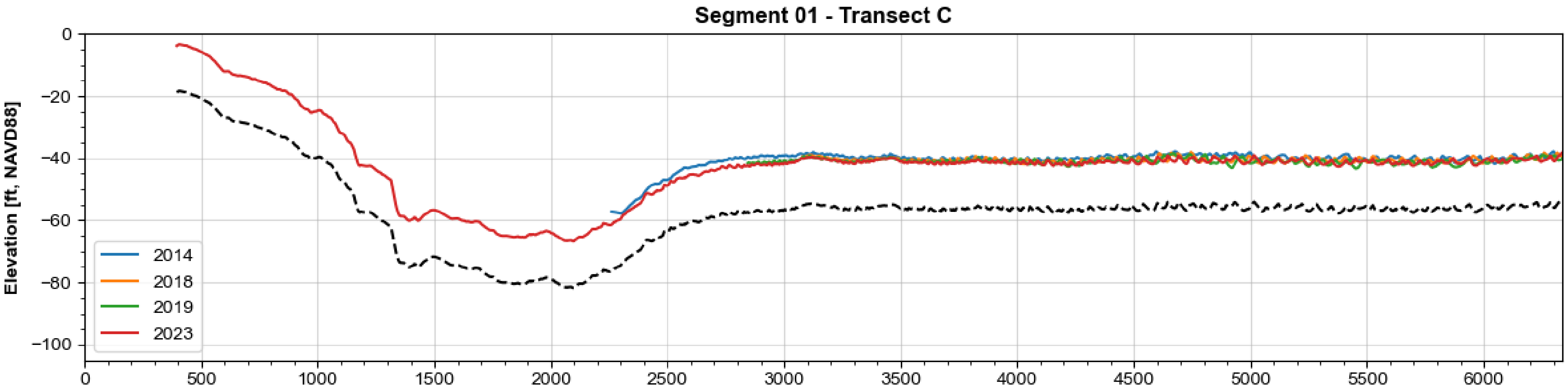



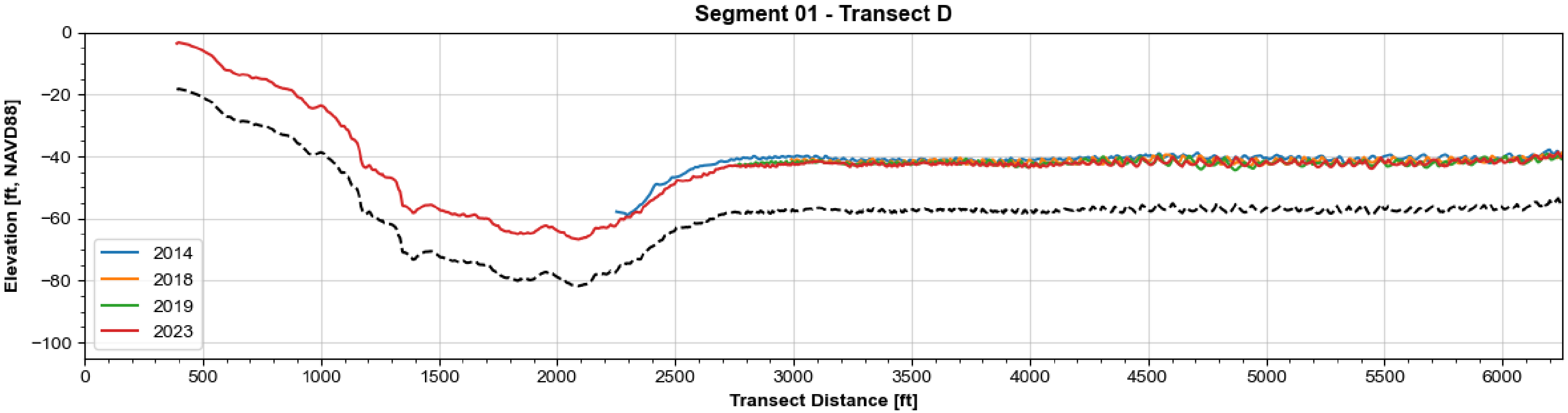

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis



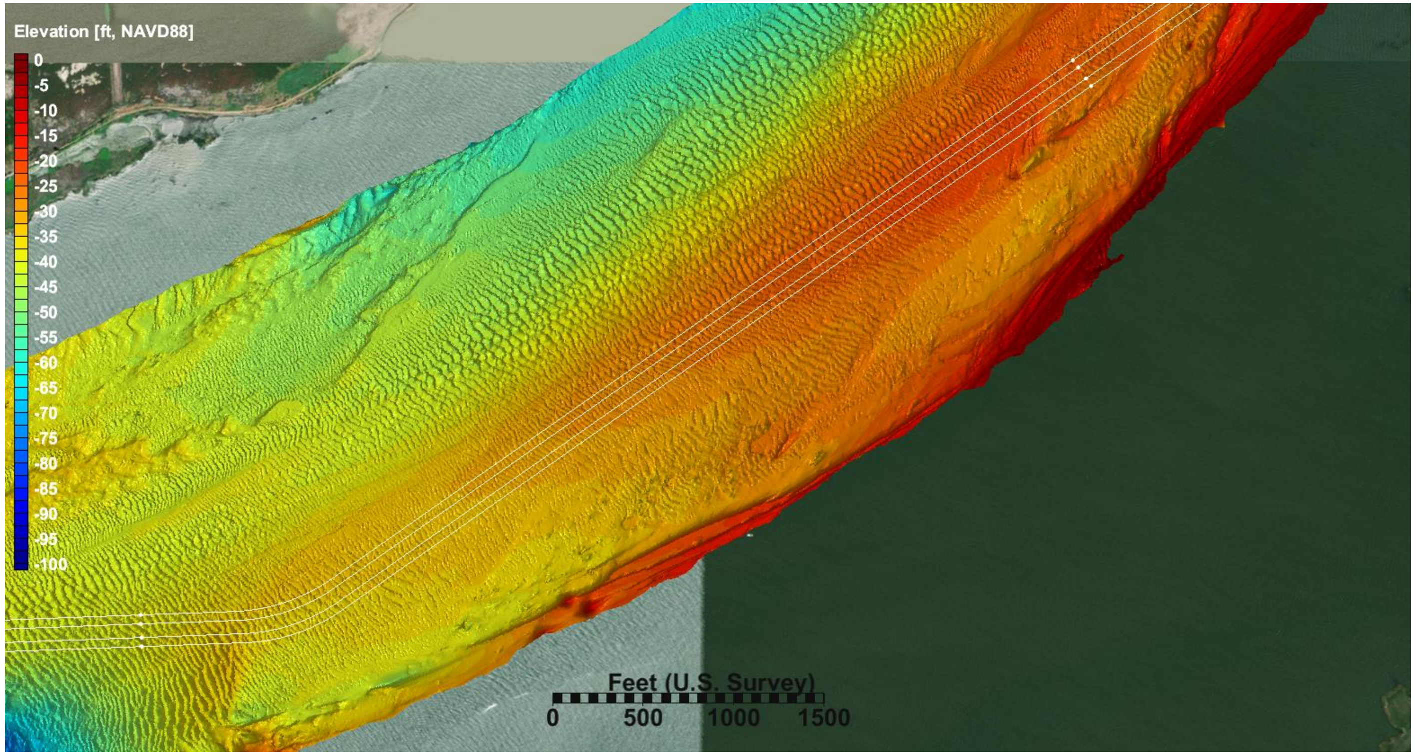



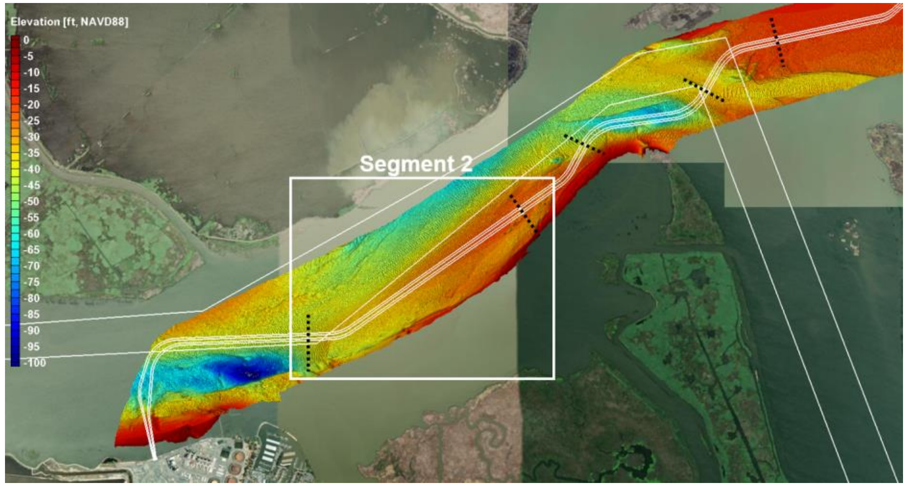

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis

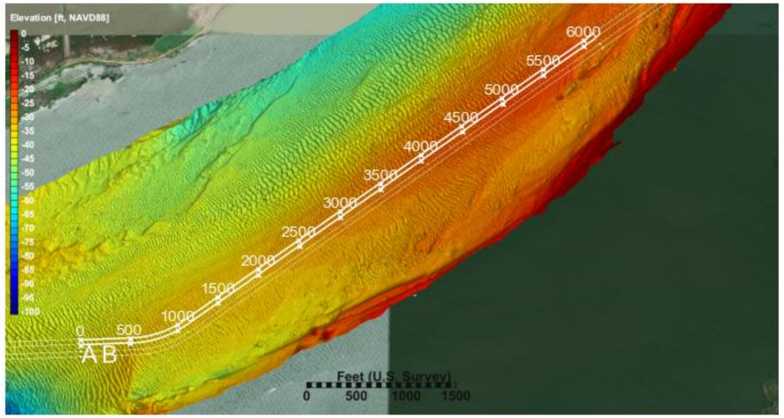
## Transect Analysis for Segment 2

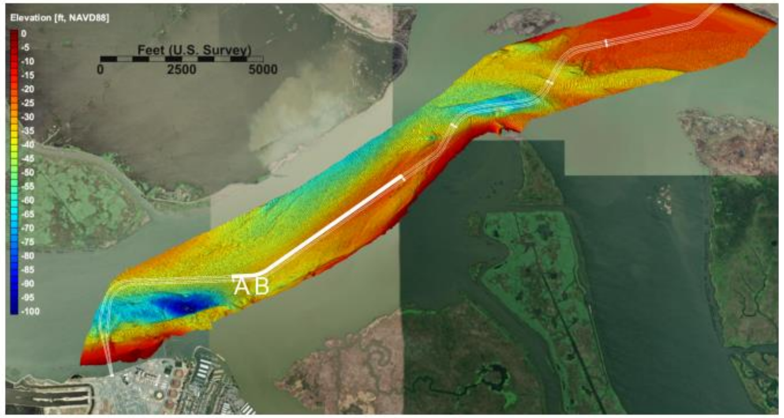
- Sand waves present throughout
- No signs of heavy erosion
- Most stable area of cable routes
- No signs of horizontal scour (feature movement)

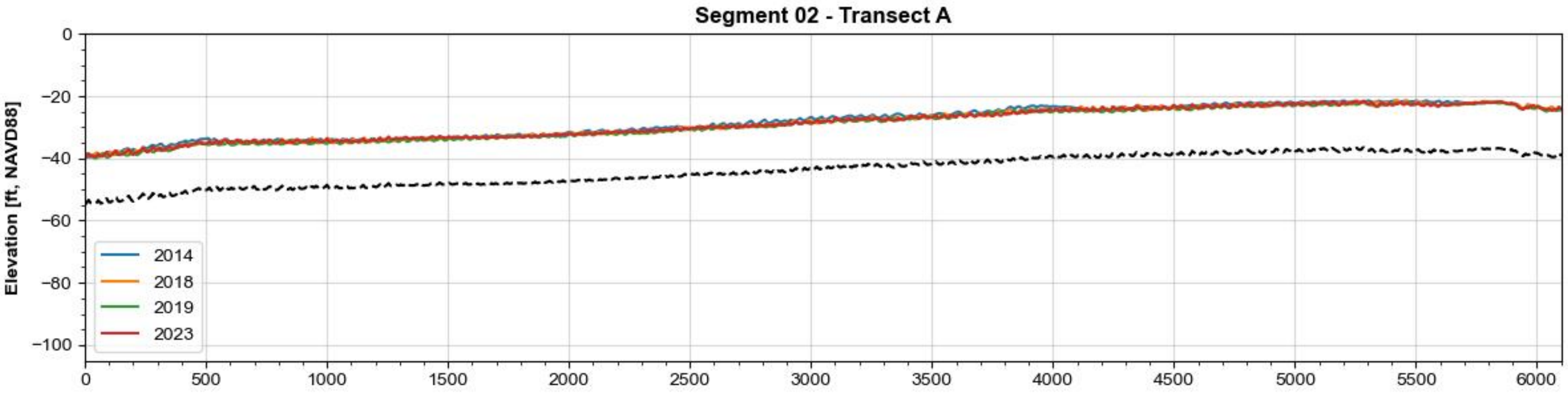


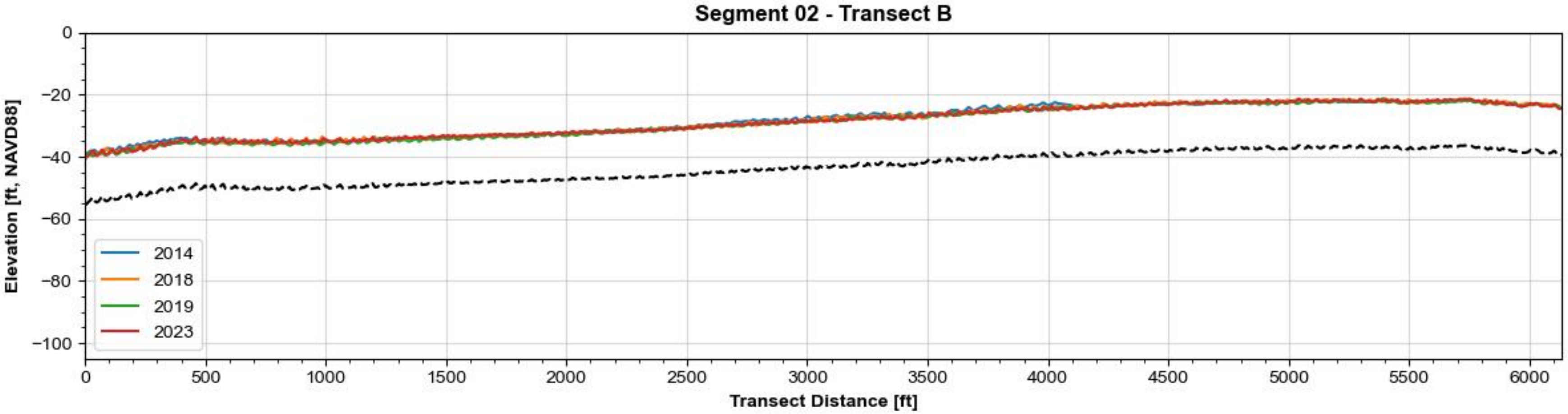



# Transect Analysis



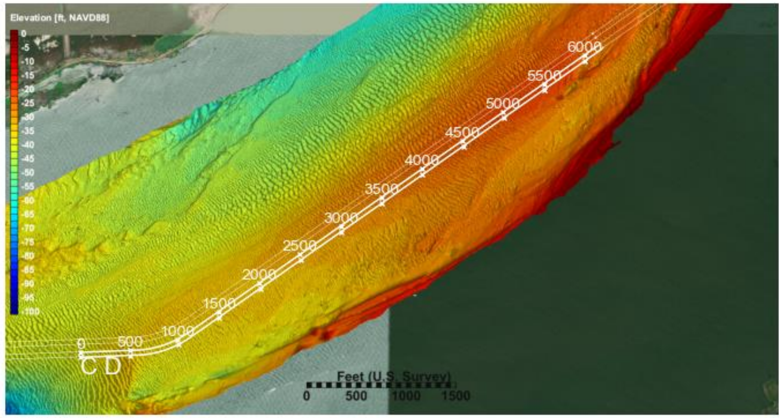



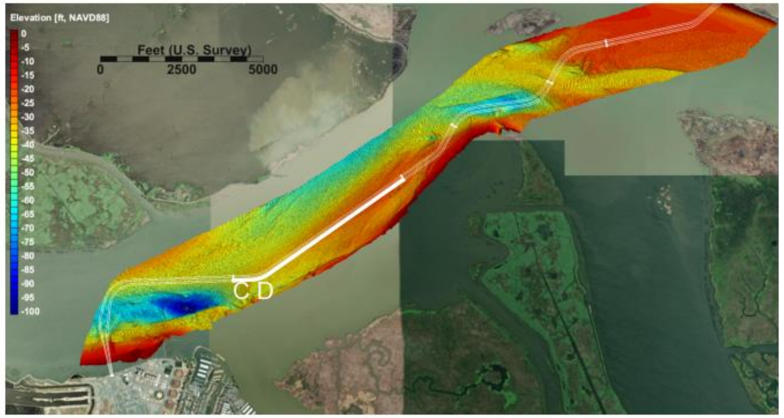



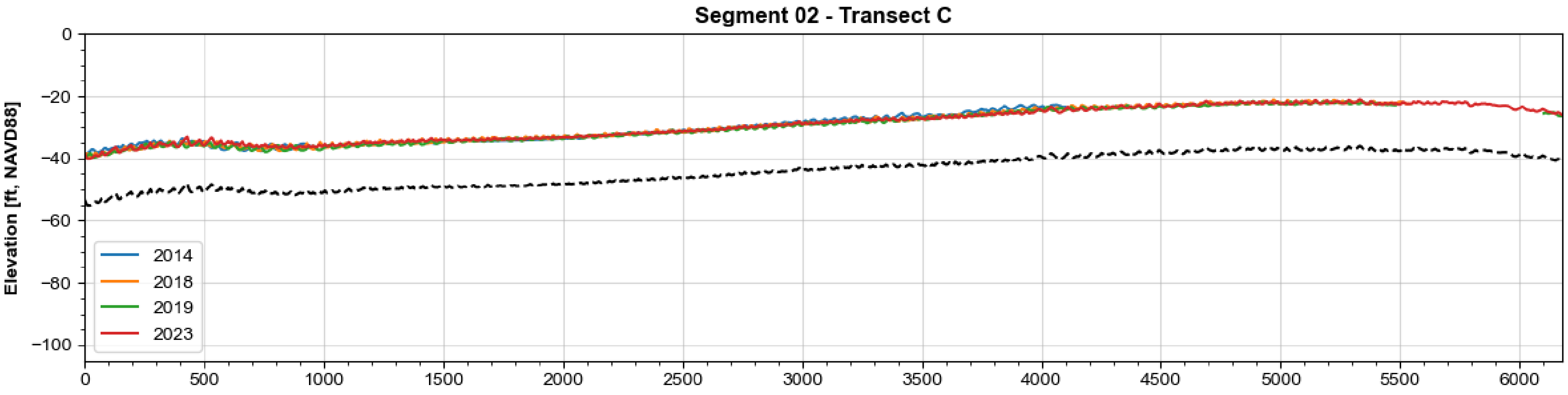



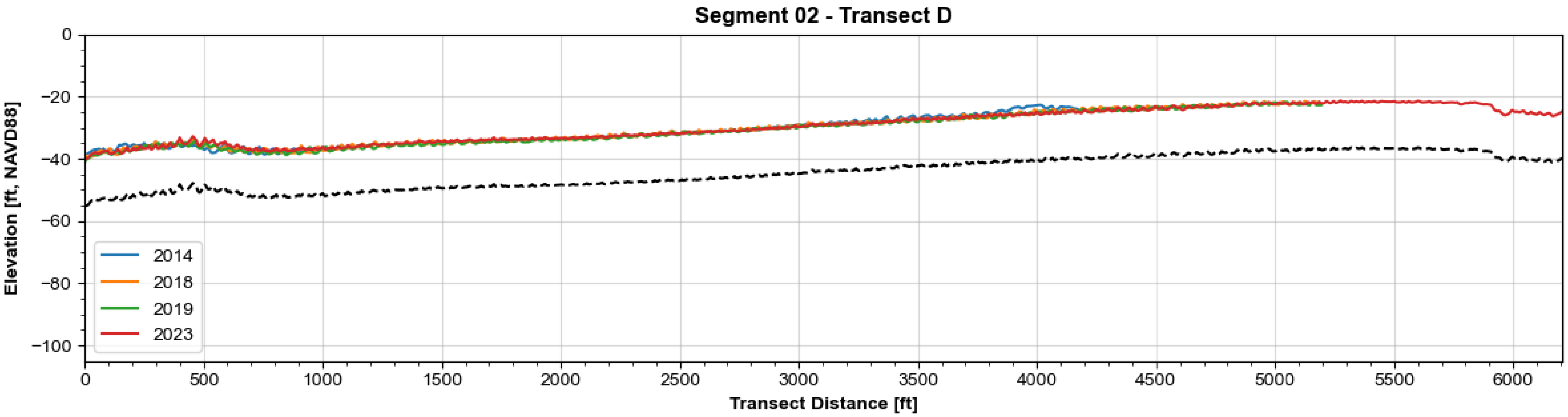

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis



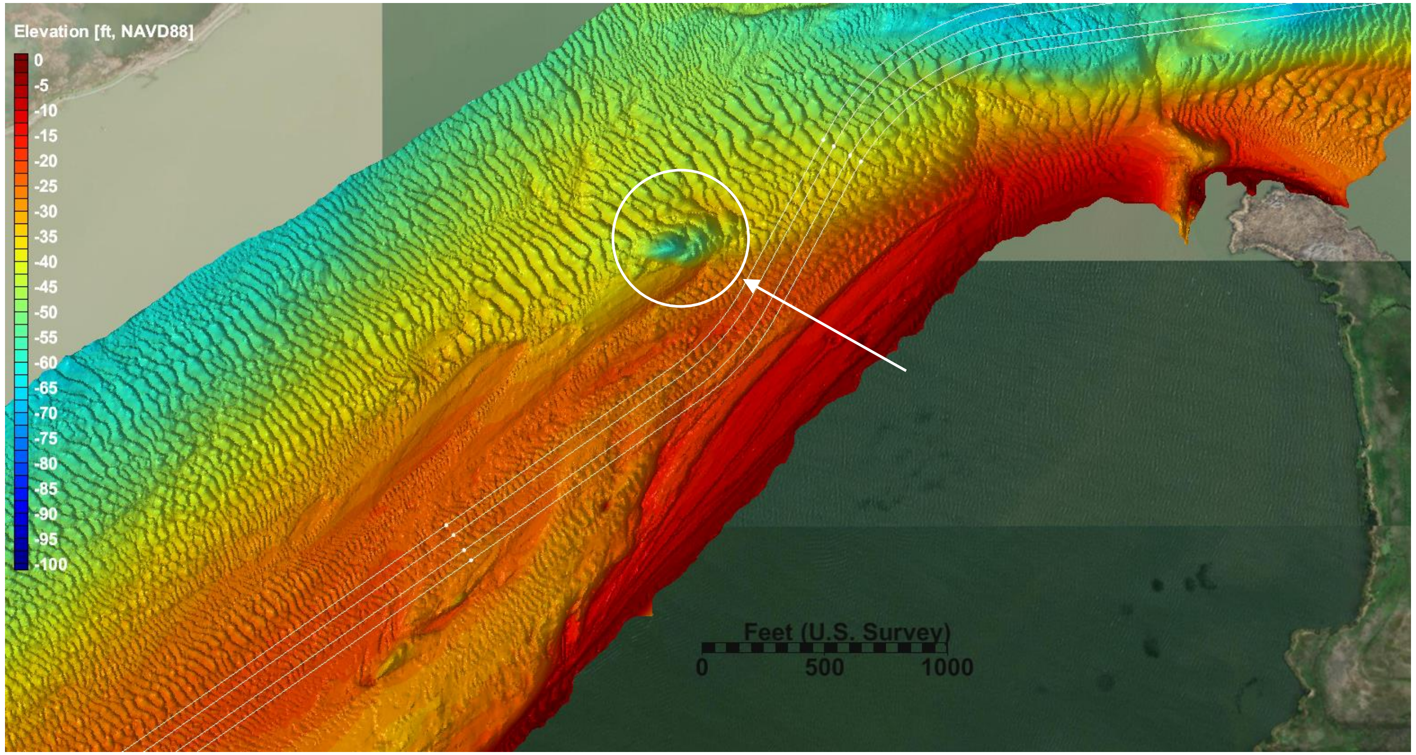



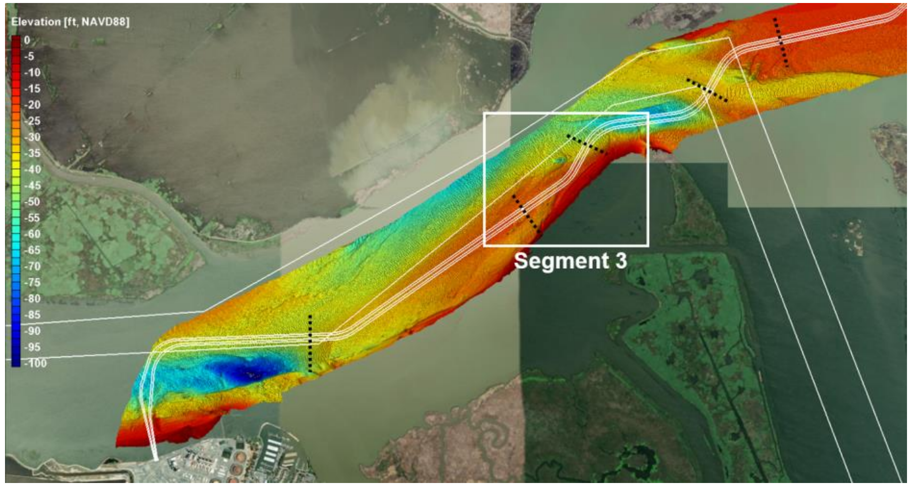

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis

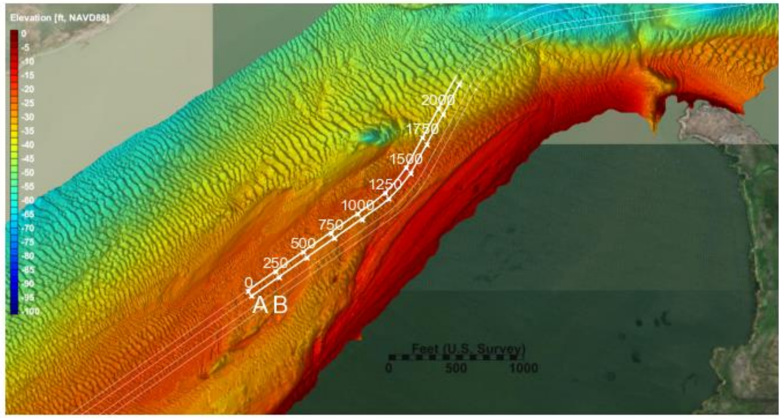
## Transect Analysis for Segment 3

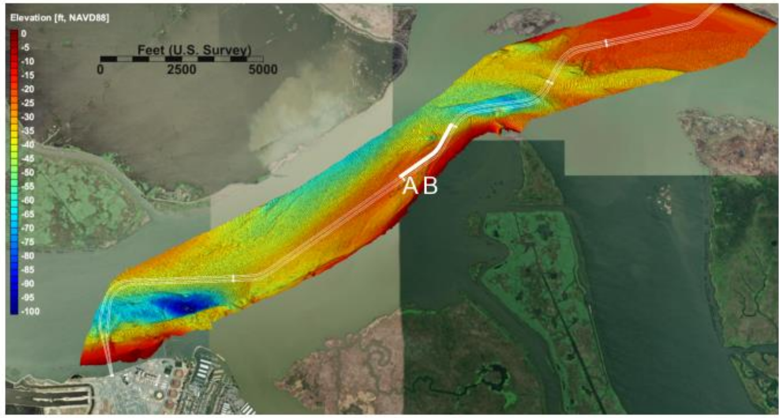
- Sand waves present in most areas
- Mostly a stable area
- Avoids one active scour feature (hole) is present in this area, but not located along cable routes

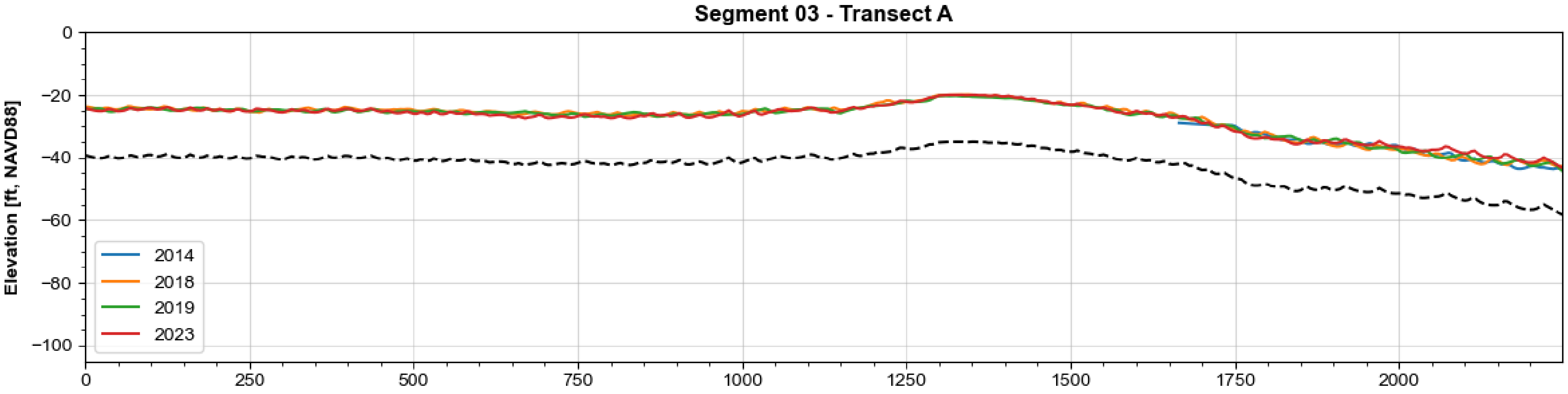


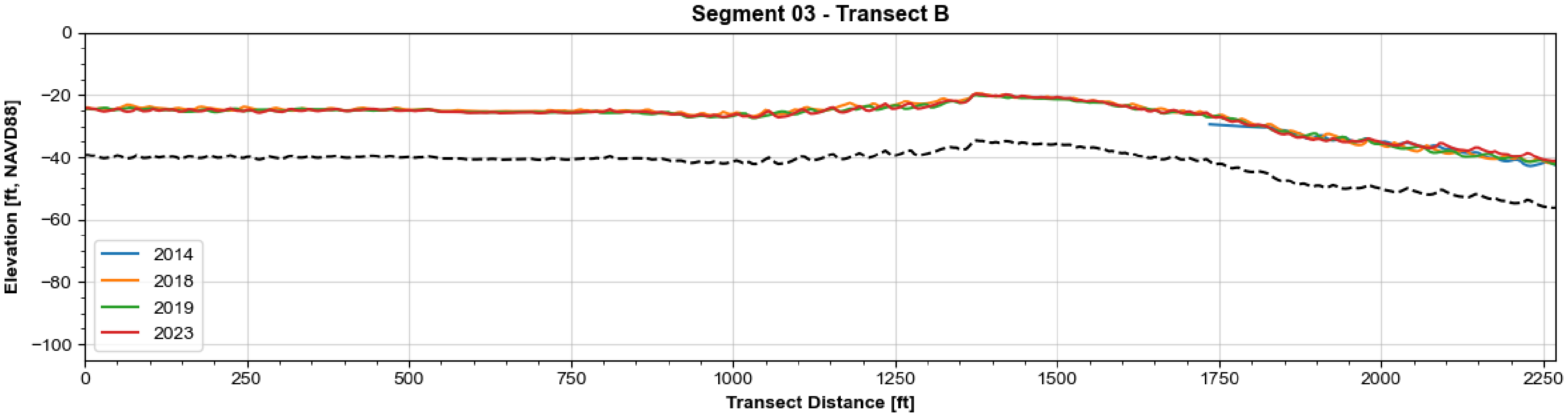



# Transect Analysis



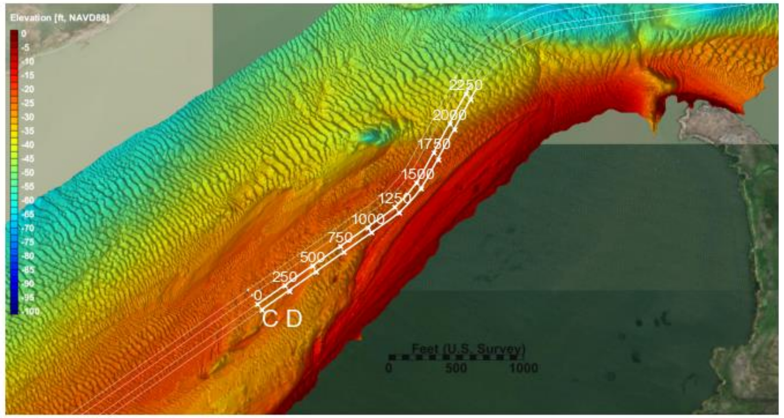



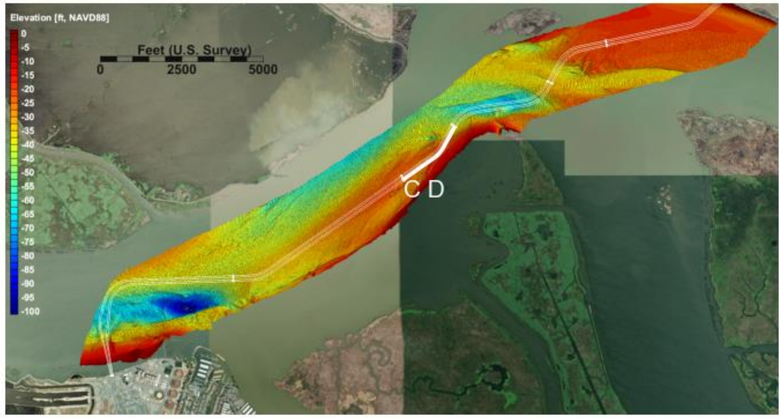



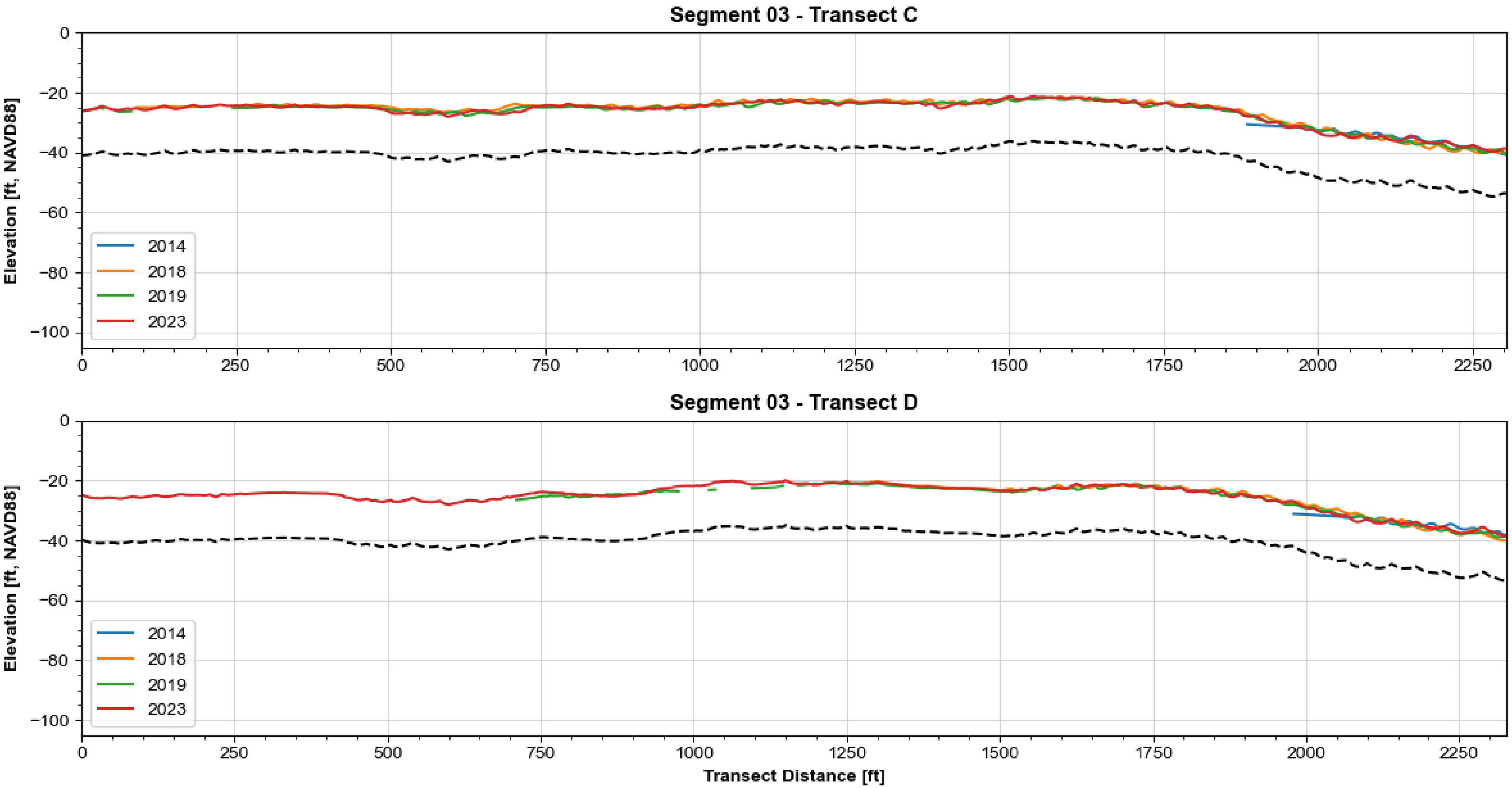




***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis



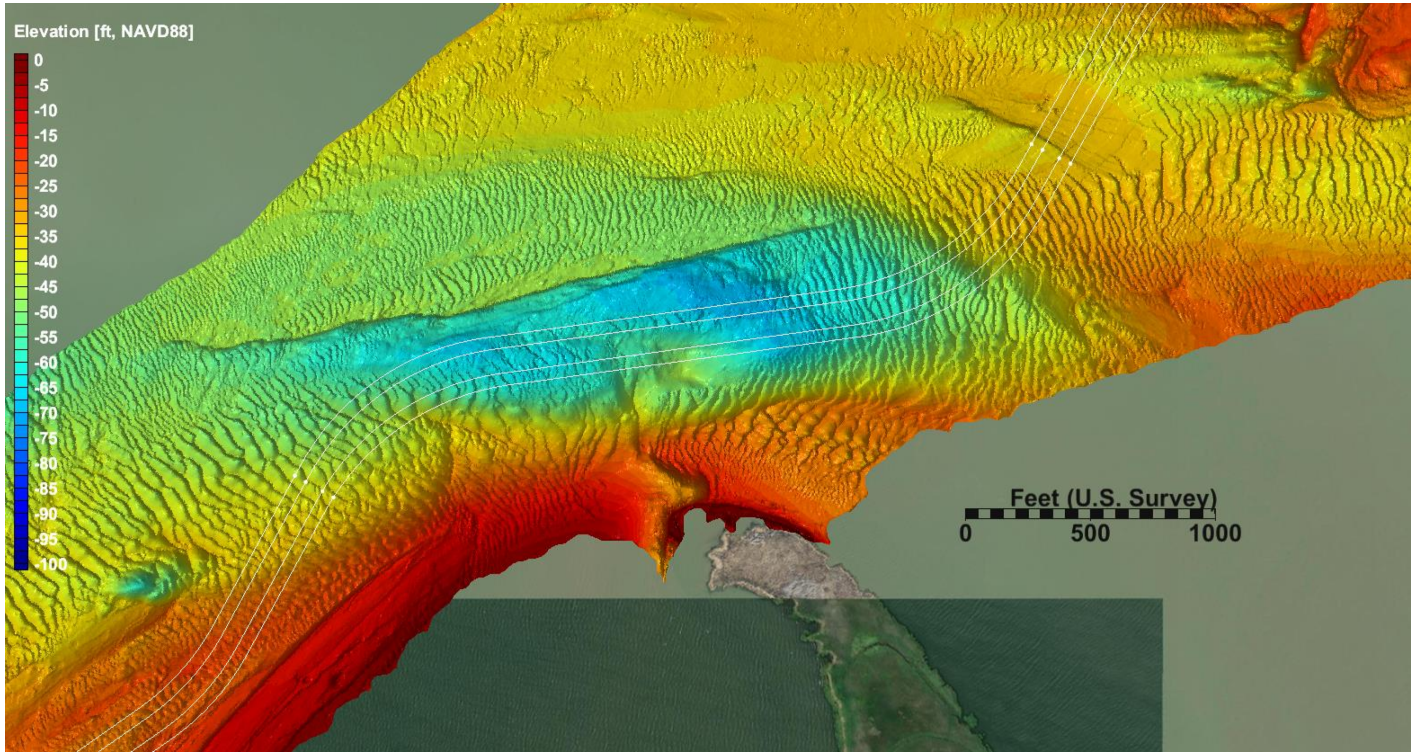



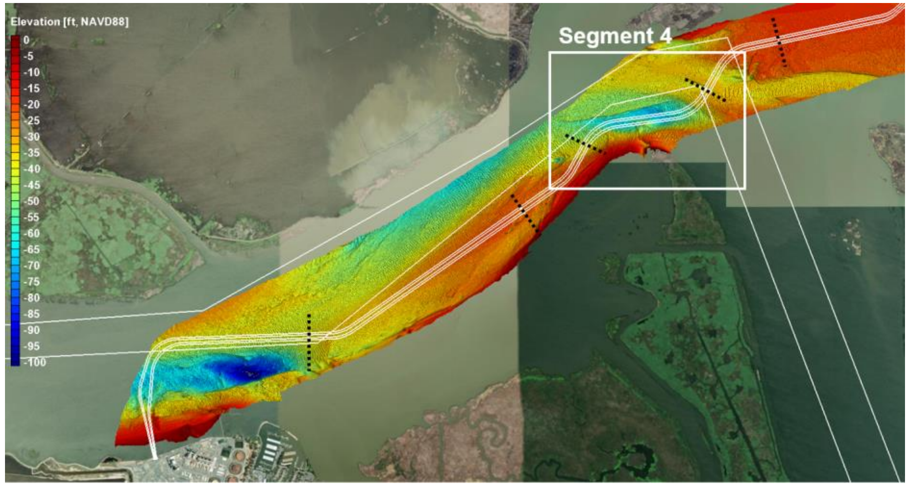

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis

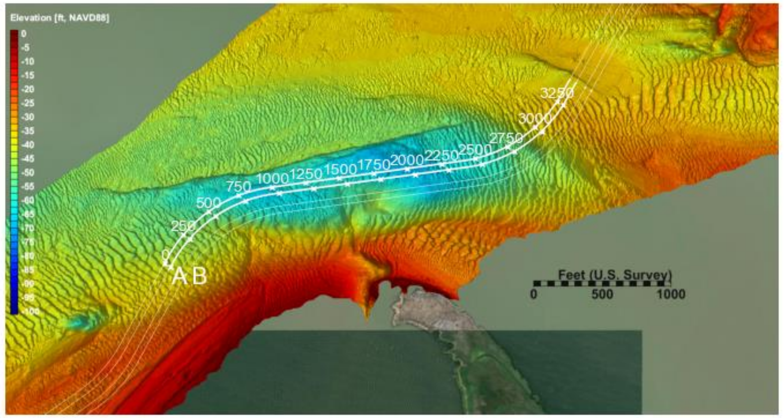
## Transect Analysis for Segment 4

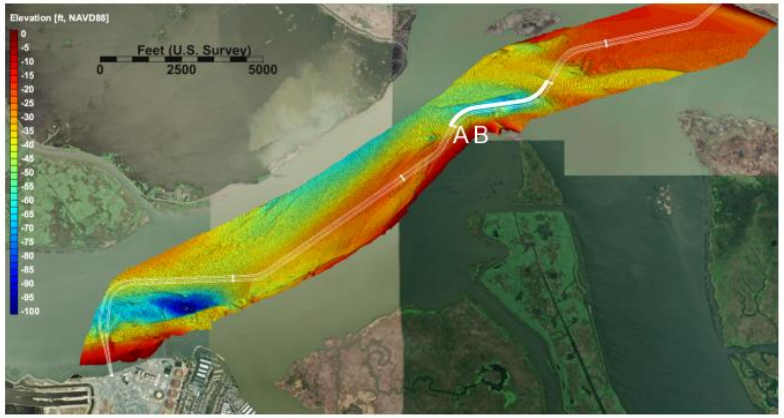
- Deep region along the proposed cables
- Confluence of channels and soil variability causing erosion
- Sand waves present in most areas

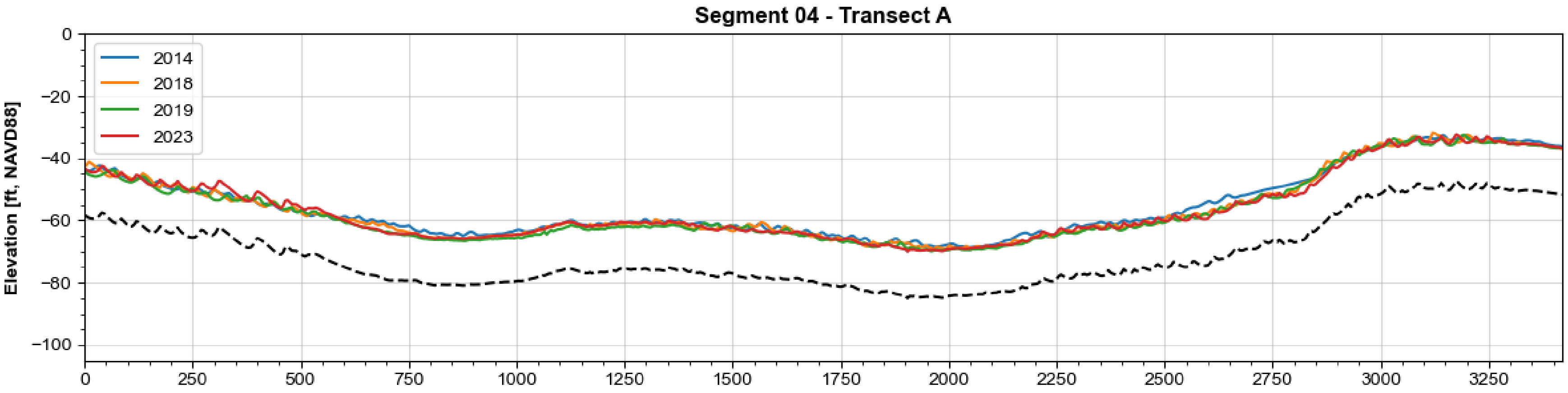


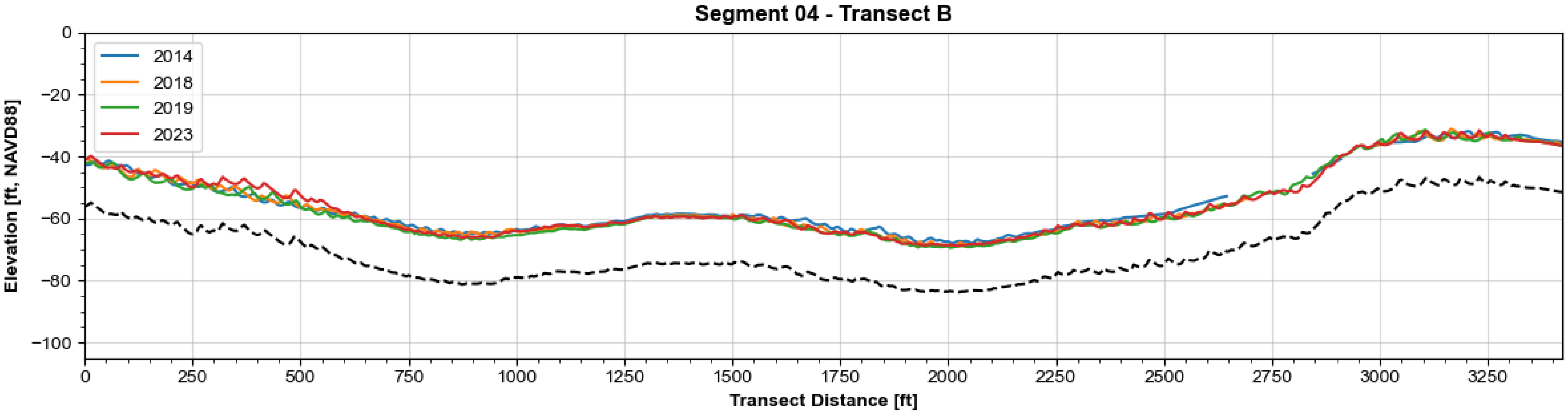



# Transect Analysis



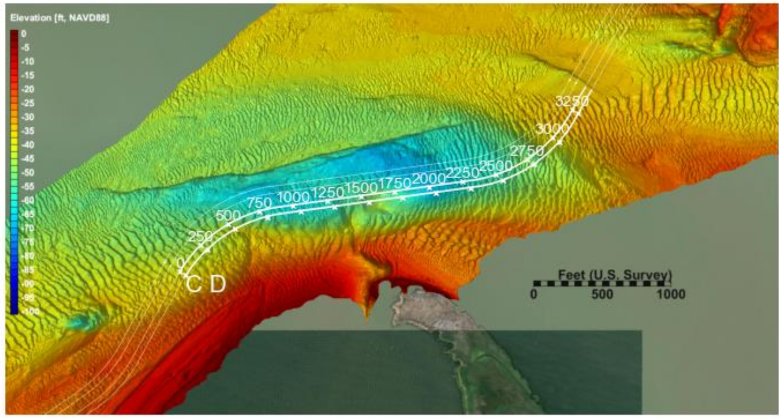



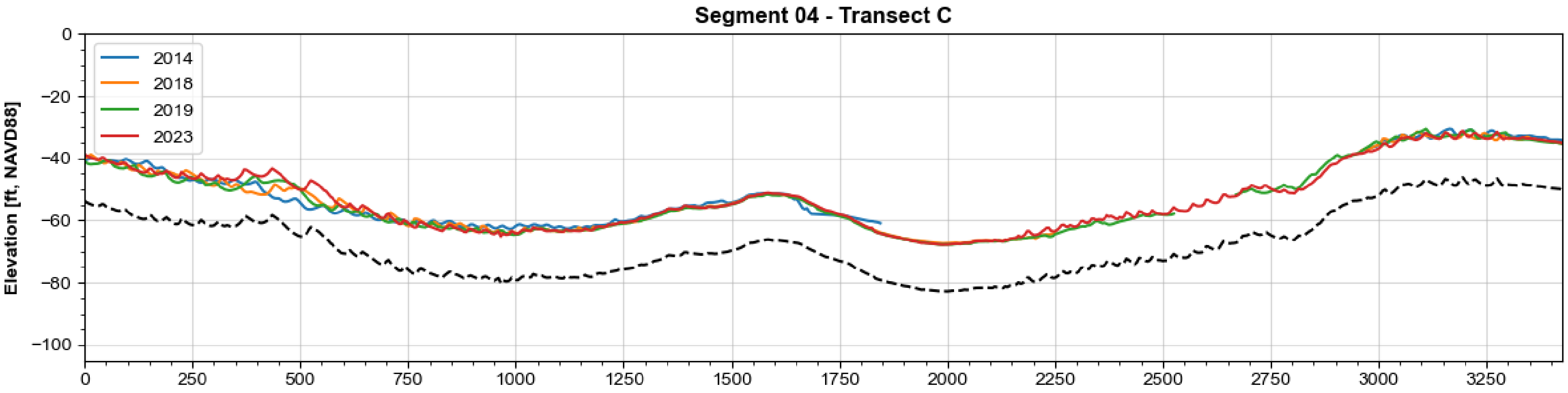



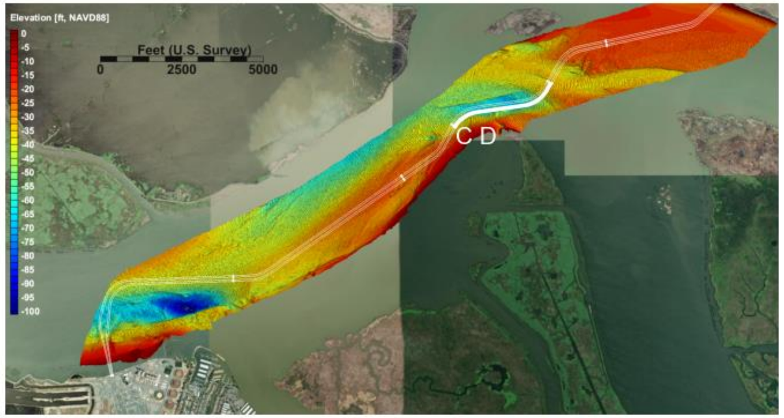



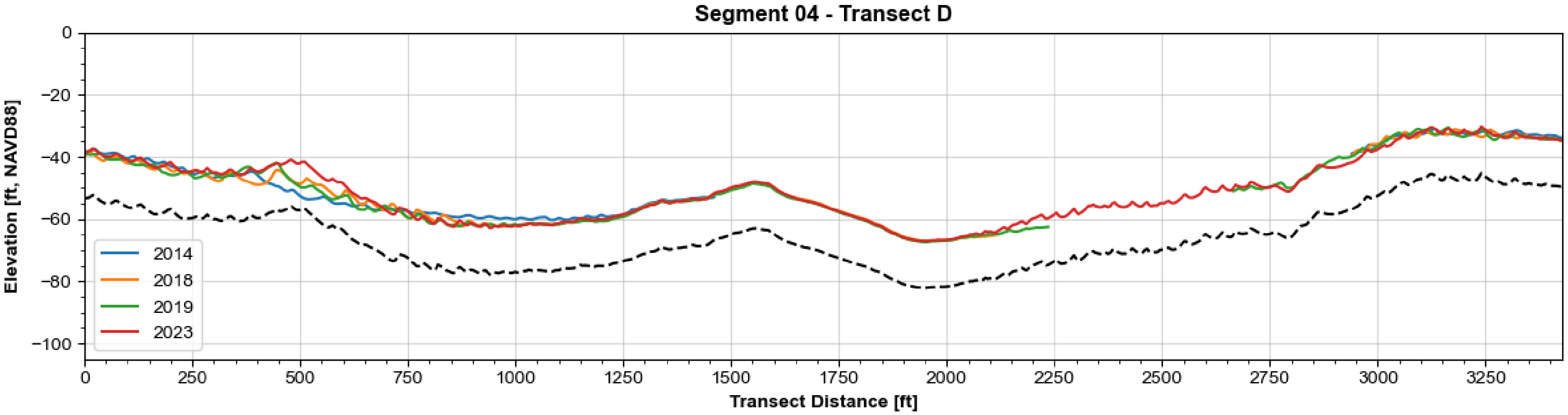

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis



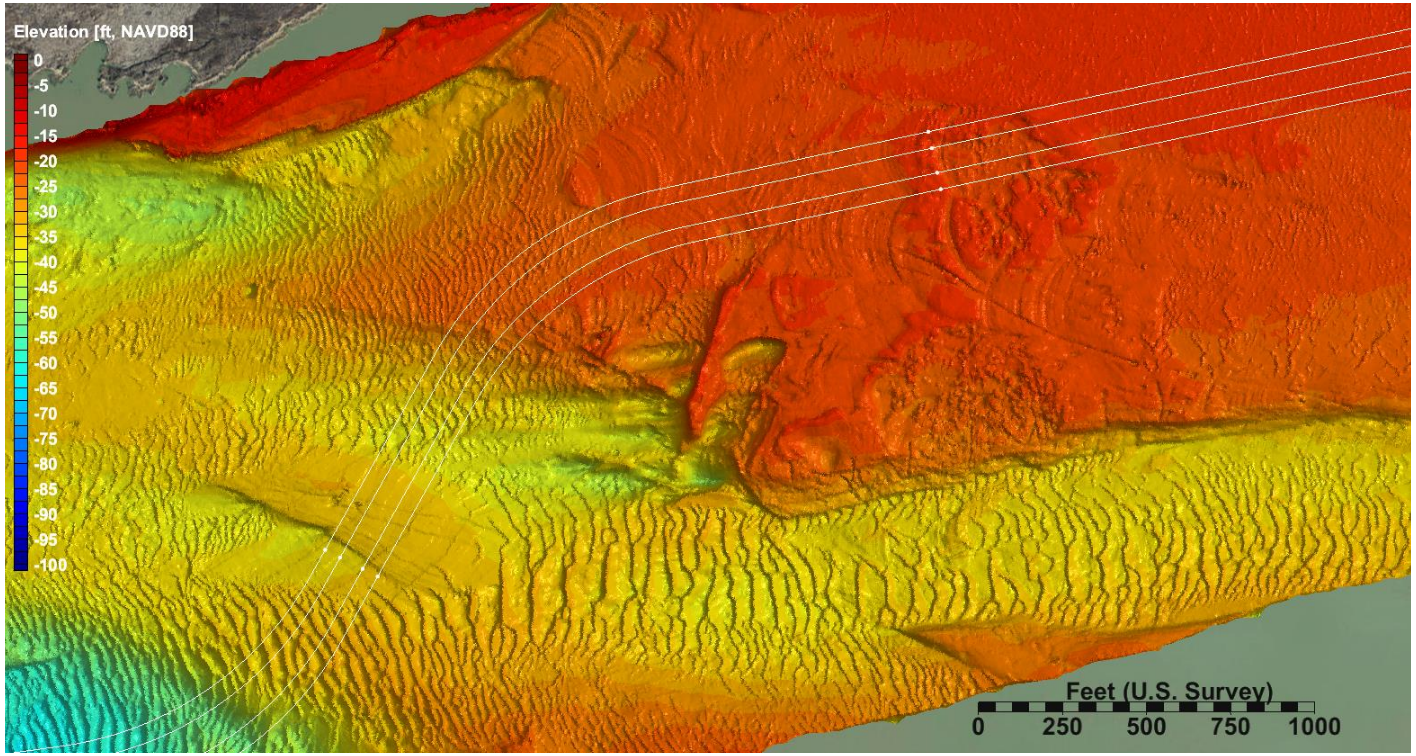



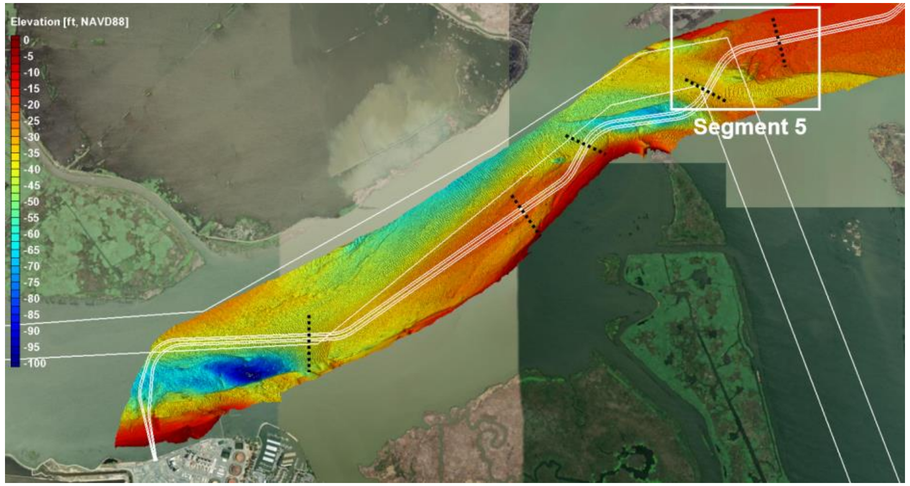

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis

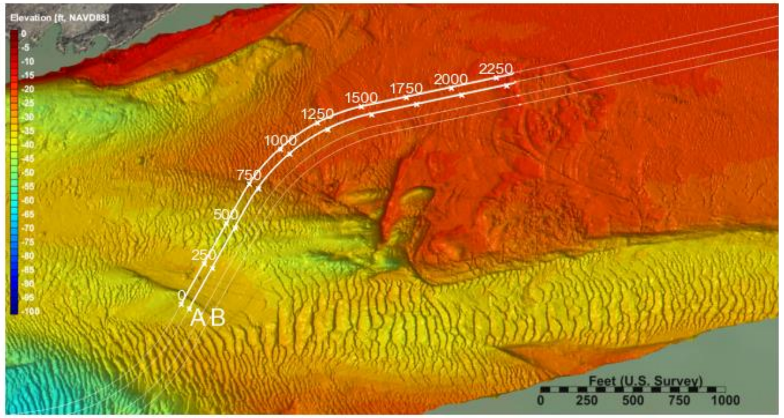
## Transect/Profiles for Segment 5

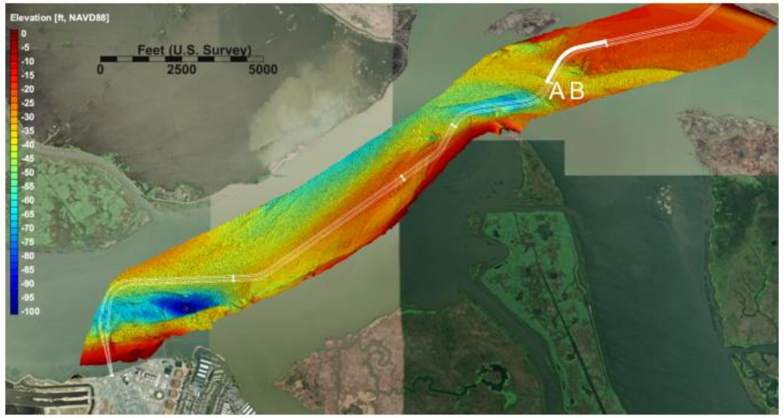
- Sand waves present in some areas
- Minimal scour areas

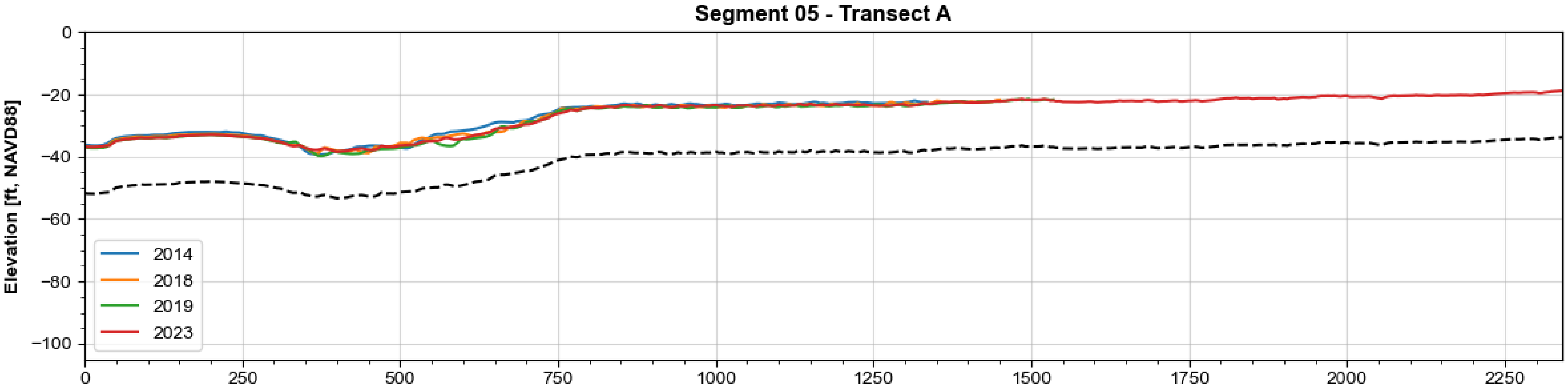


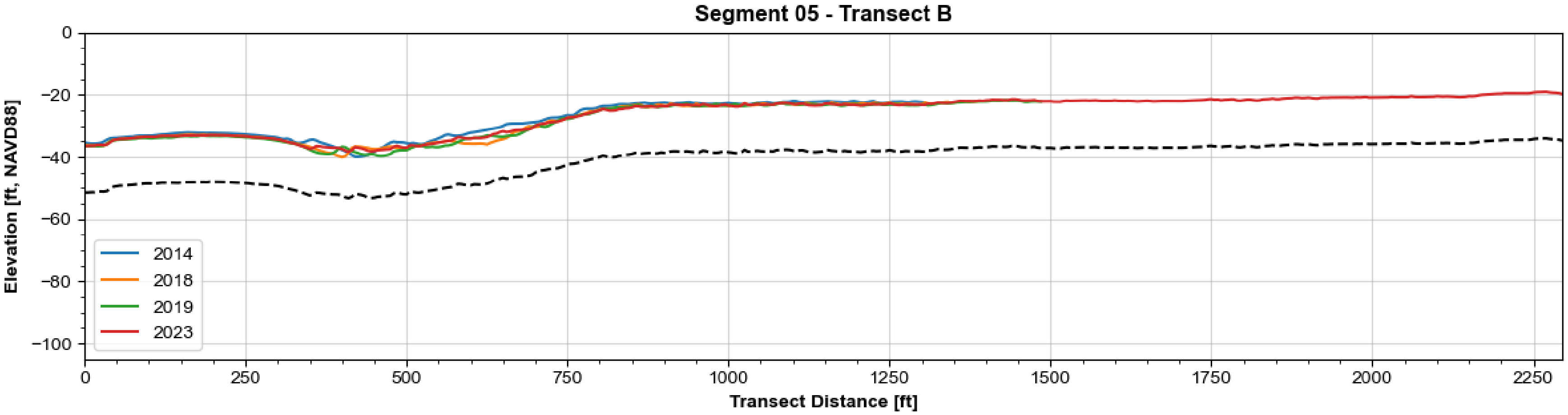



# Transect Analysis



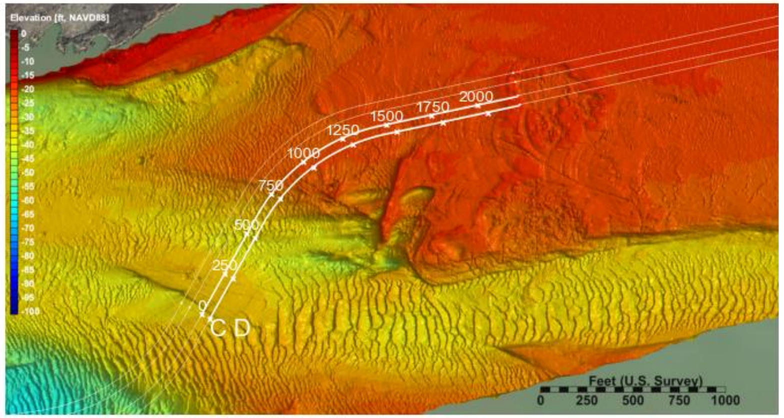



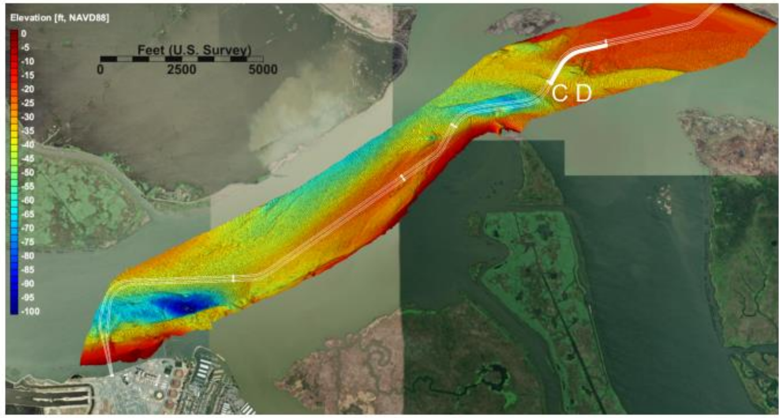



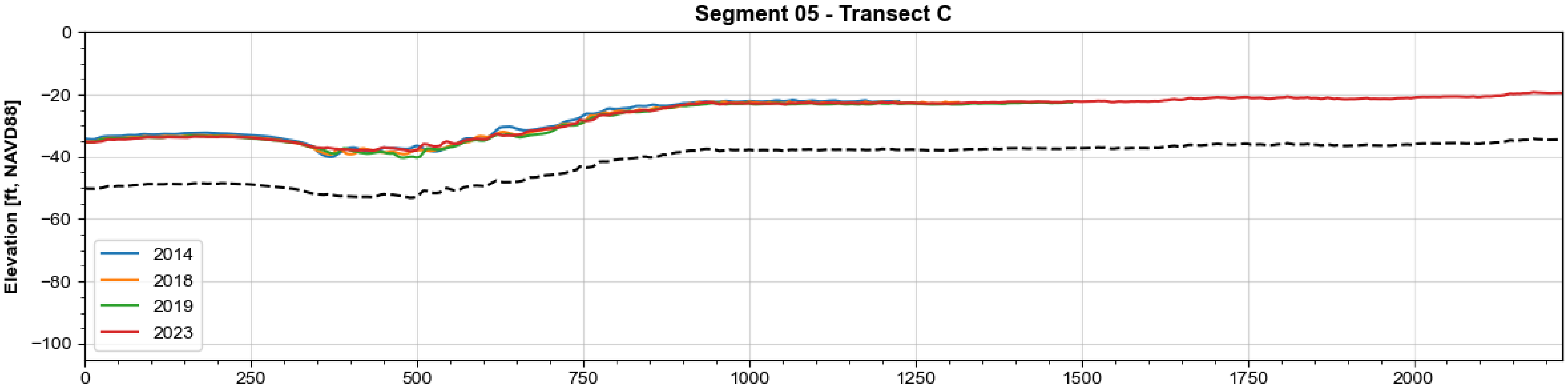



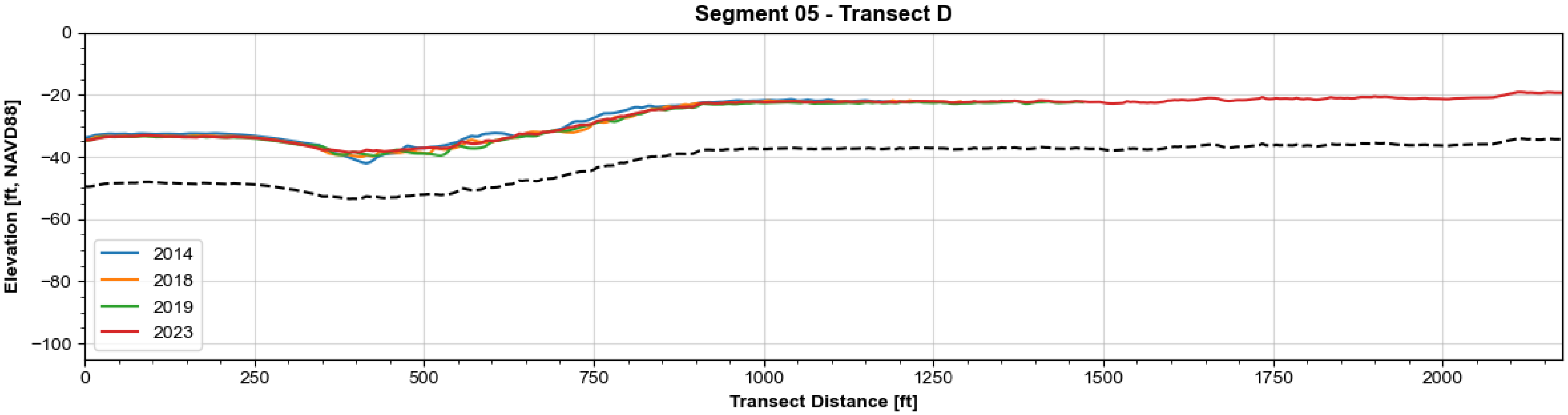

***Note: vertical exaggeration on elevation transect plots***

# Transect Analysis



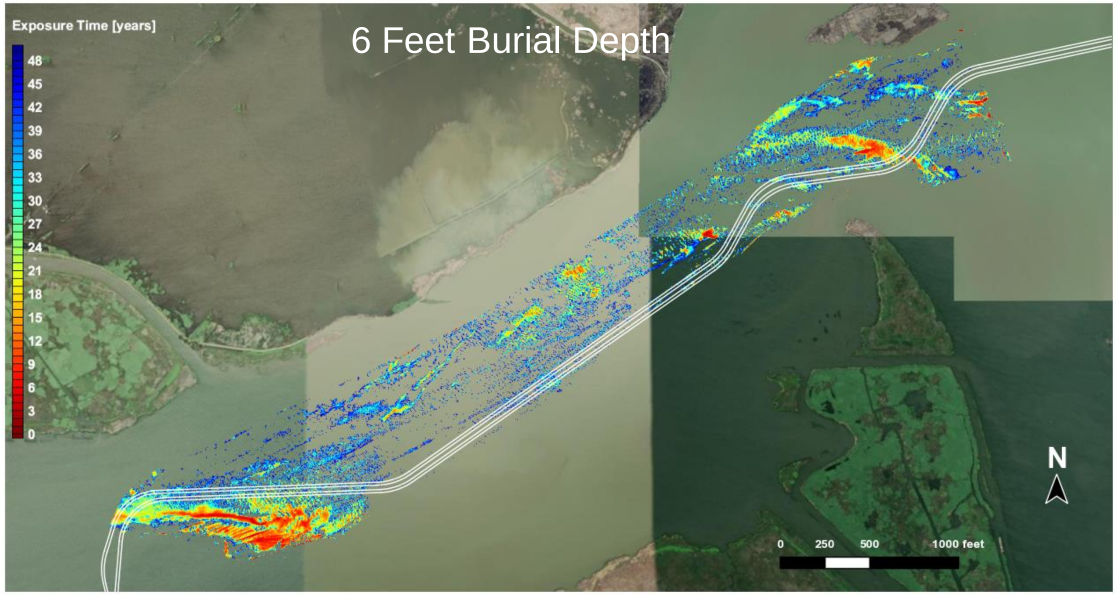



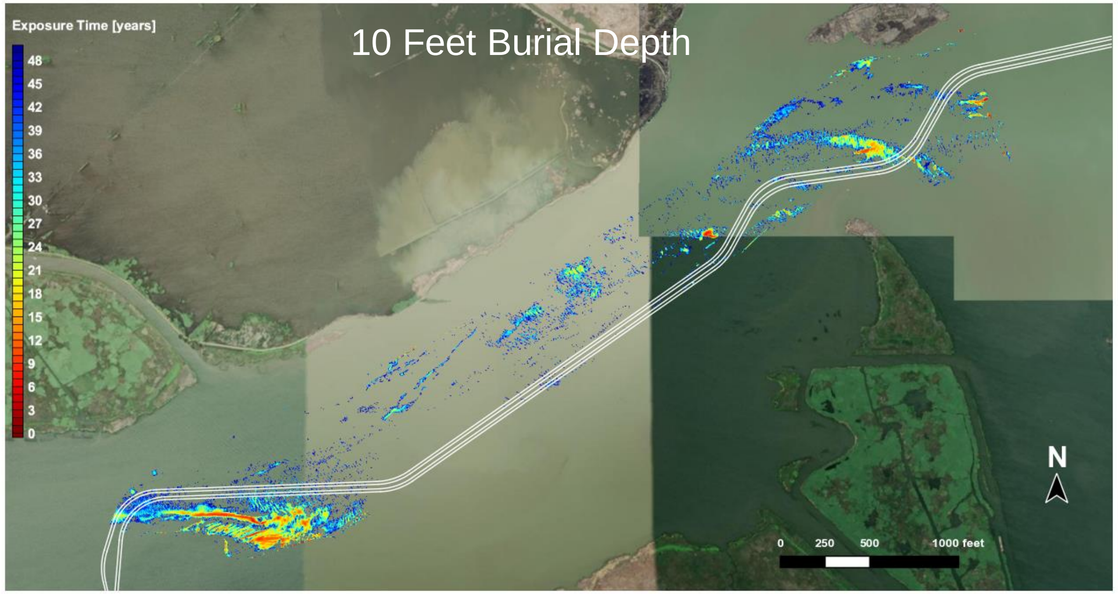



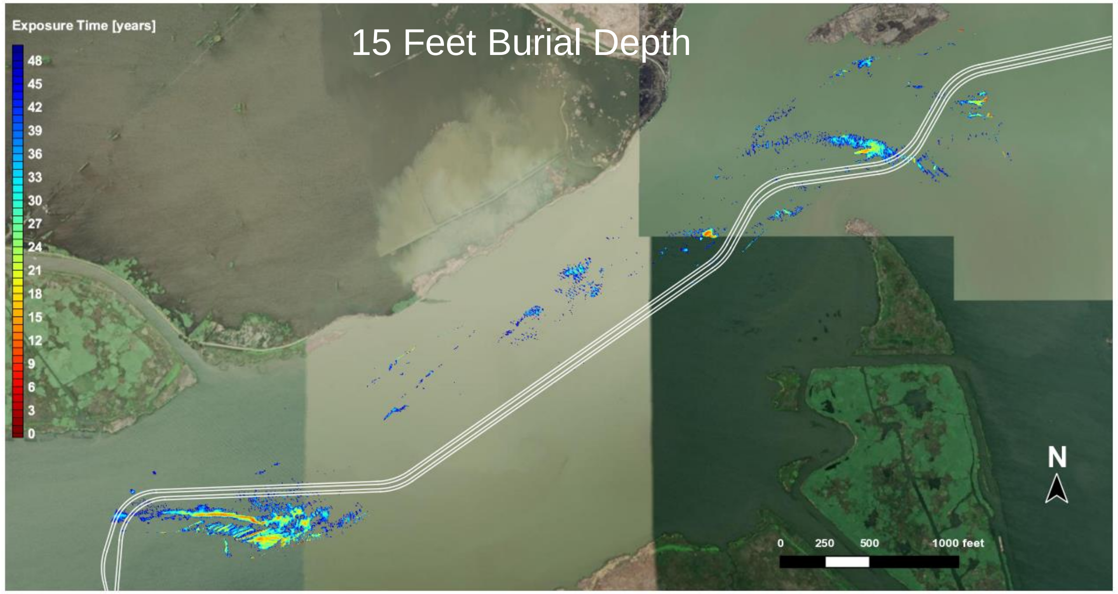

***Note: vertical exaggeration on elevation transect plots***

# Findings – Potential Exposures

- Potential exposures significantly reduced with larger burial depth
- Potential exposures are only predicted over small areas
- 15 ft burial depth likely prevents almost all exposures over 25 years (based on transect analysis)
- 6 ft or 10 ft burial depth likely result in several exposure locations of limited size over 25 years
- Exposures over small areas are not likely to result in higher anchor risk



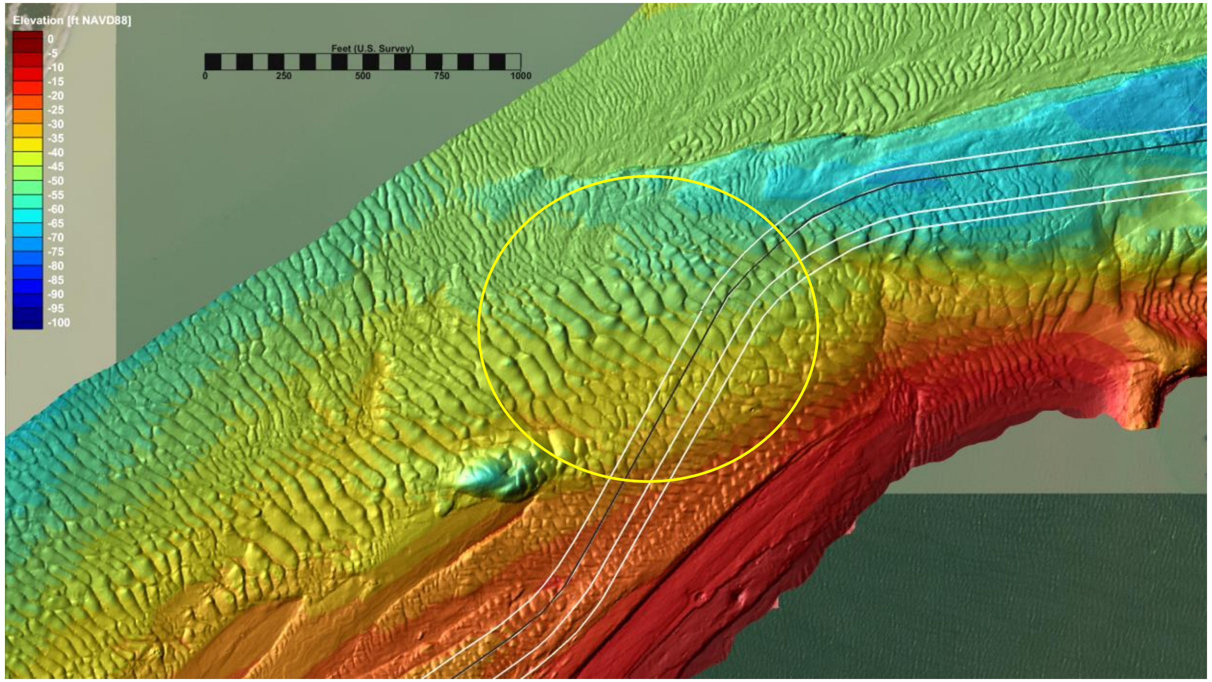



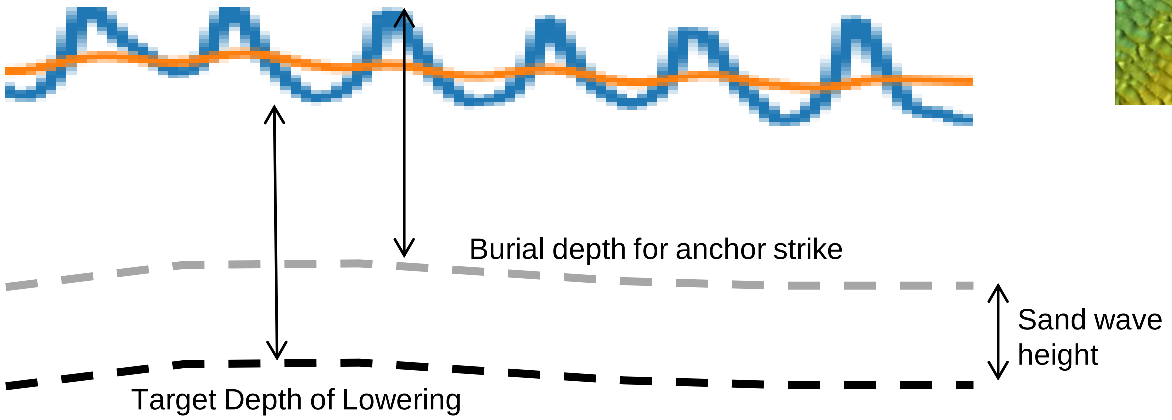



# Bedform Analysis

## Sand Waves

- Sand wave heights are typically added to burial depth to protect against anchor strike

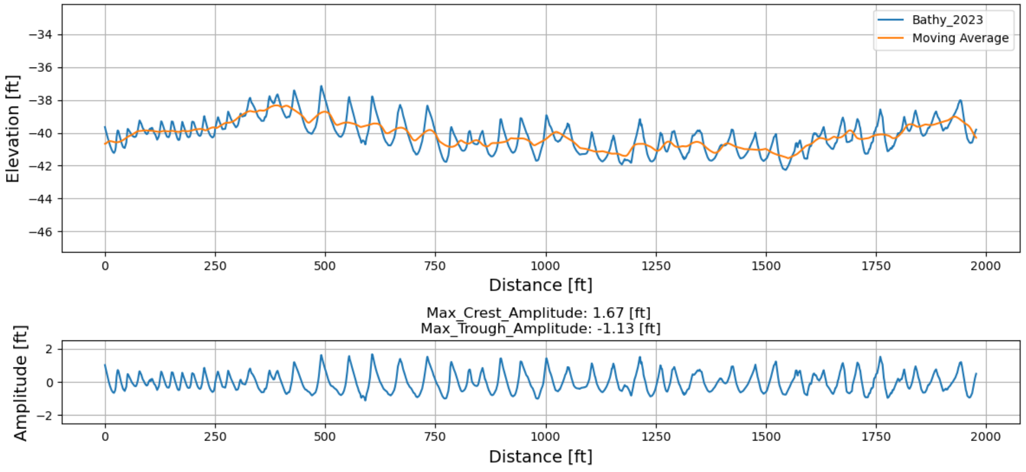


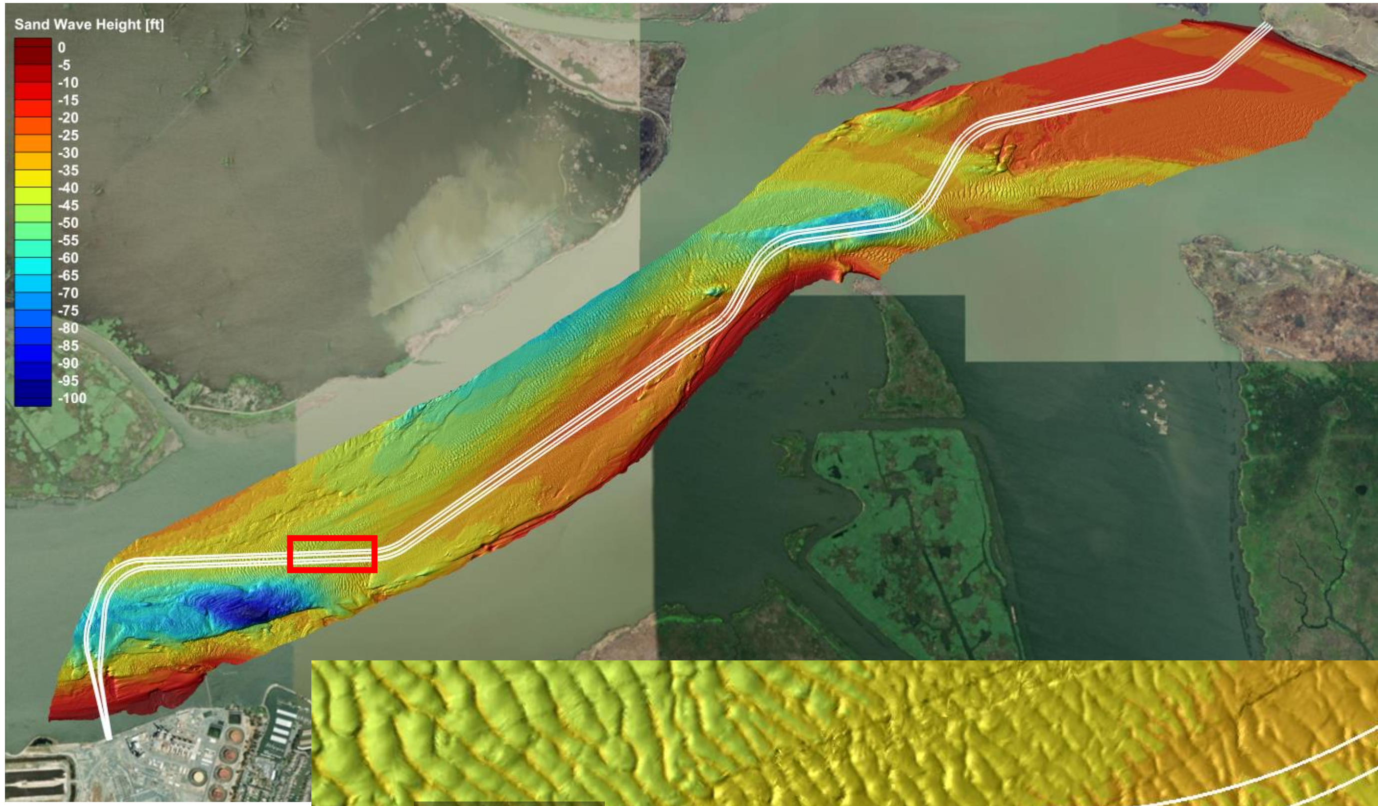



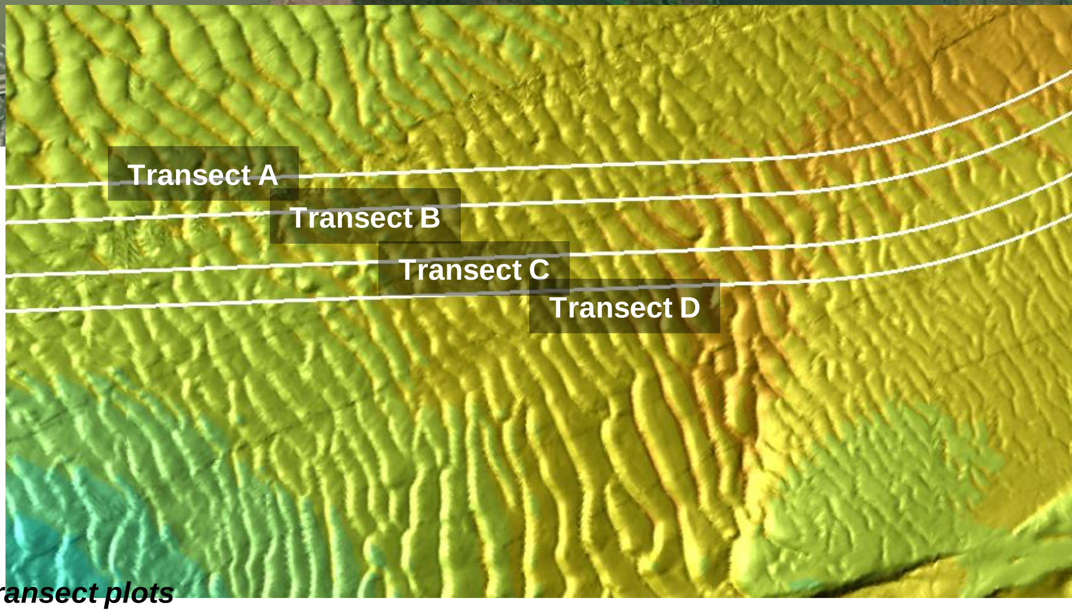
# Bedform Analysis

## Sand Wave Height Calculations

- Transects analyzed
- Larger elevation trends removed
- Sand wave heights calculated along all four cable routes



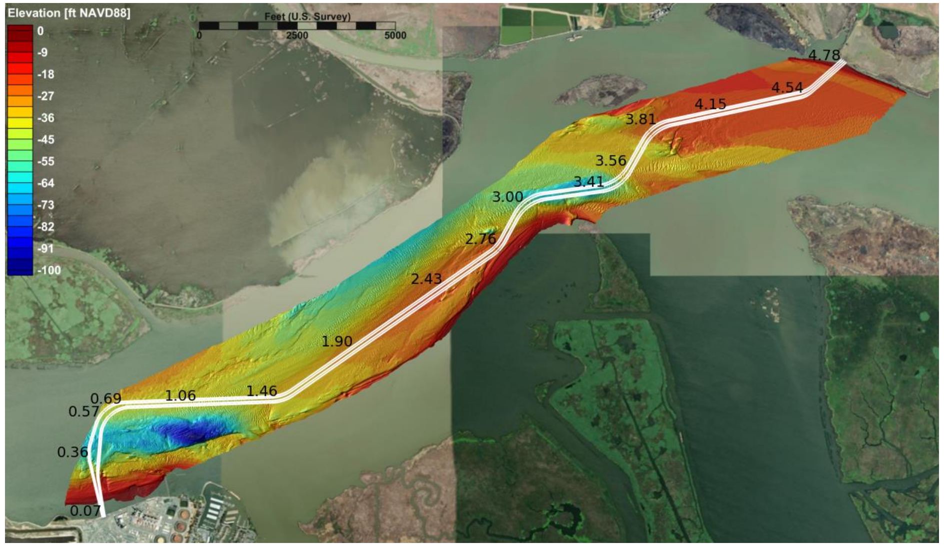




***Note: vertical exaggeration on elevation transect plots***

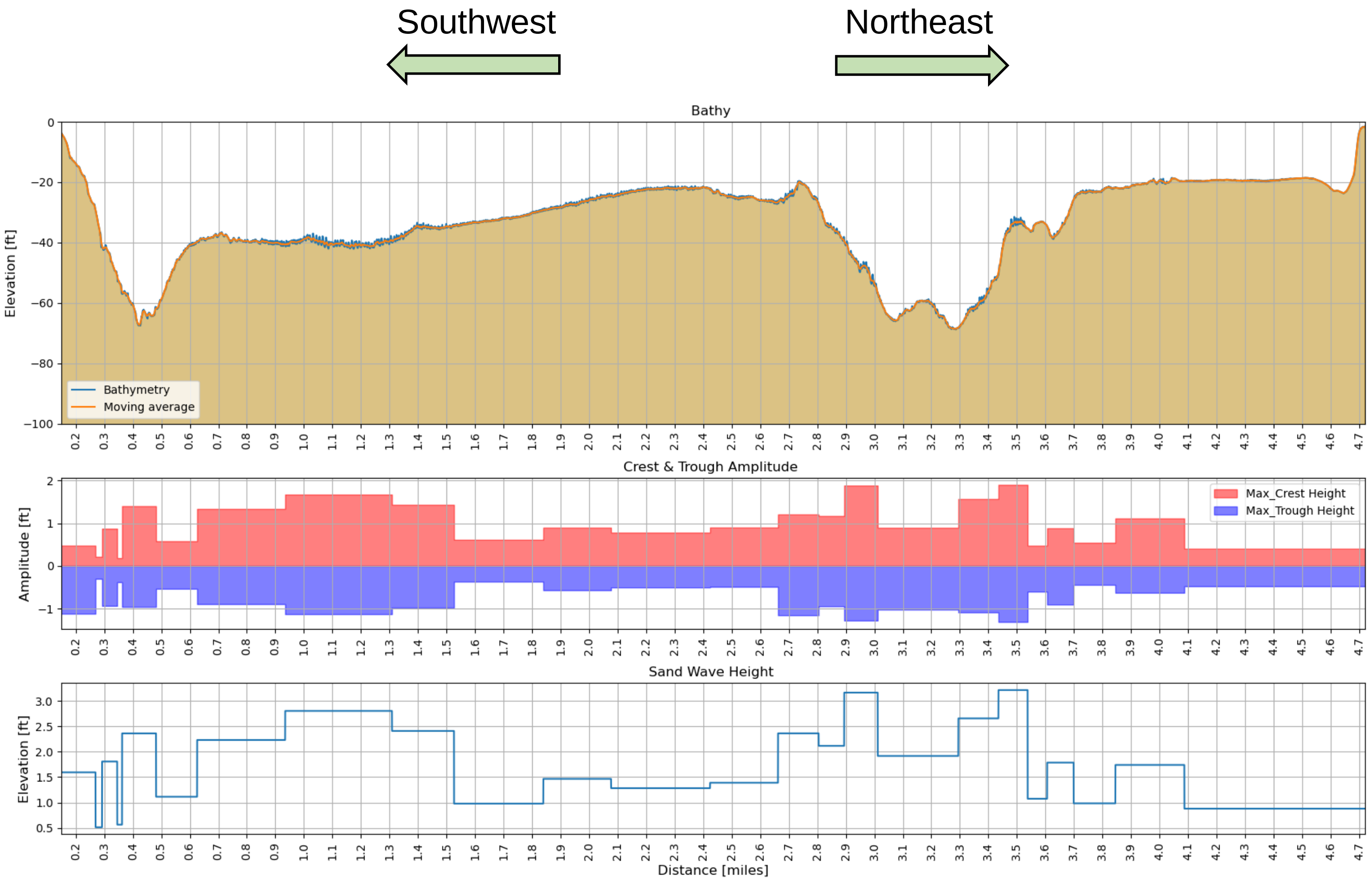
# Bedform Analysis – Transect B (example)

## Sand Wave Height Calculations

- Sand wave heights range from 0.5 to 3.2 feet
- Largest sand waves found at north end near navigation channel




*Numbers shown above represent mile markers where areas with similar sand waves are present*

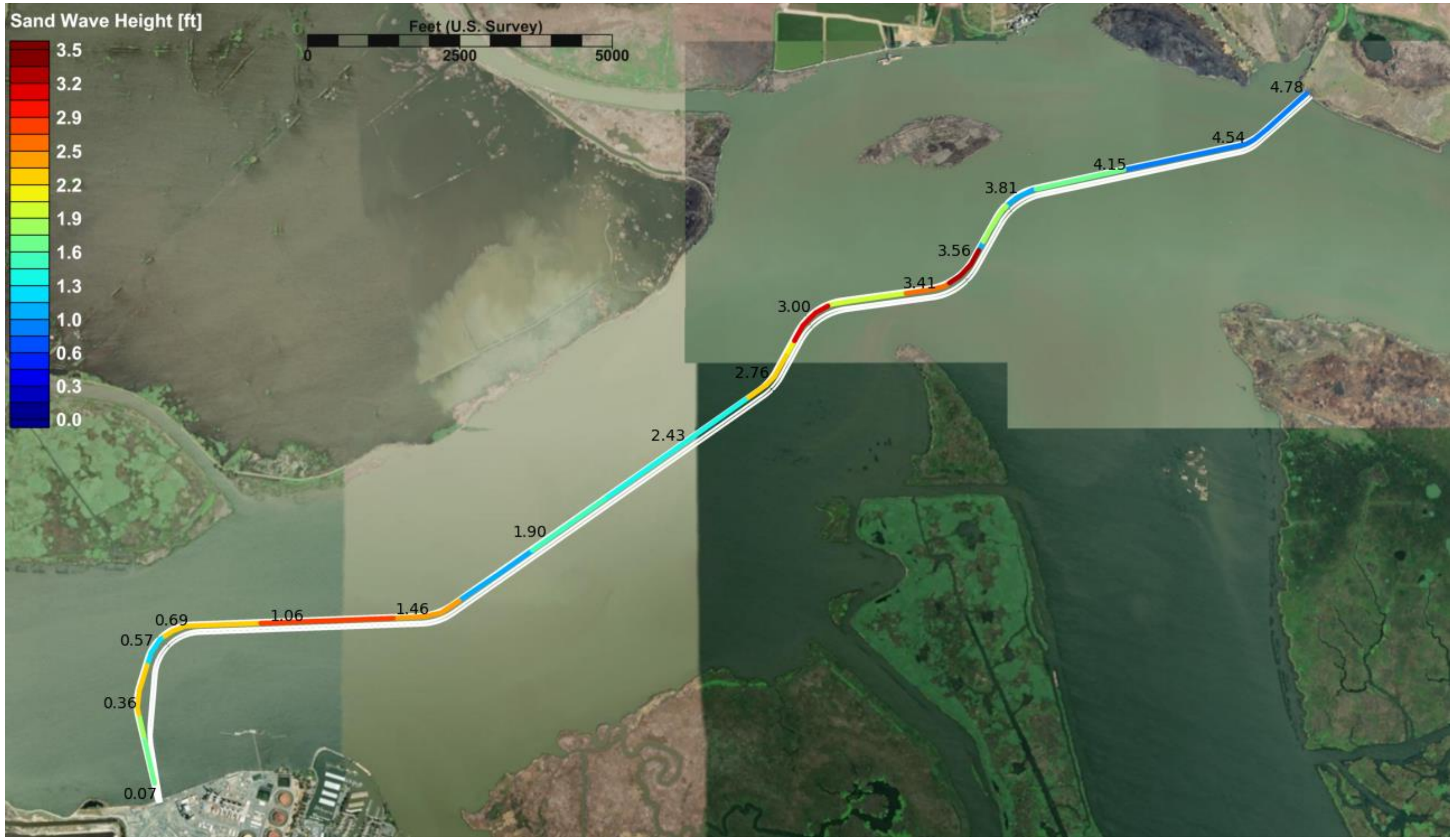



***Note: vertical exaggeration on elevation transect plots***

# Sand Wave Height Map

## Maximum Sand Wave Height Map

- Maximum sand wave heights calculated for Transects B
- Representative sand wave heights developed for use in burial assessment
- Typically, additional burial depth equal to sand wave heights is added to burial depth for anchor strike (Target Depth of Lowering)



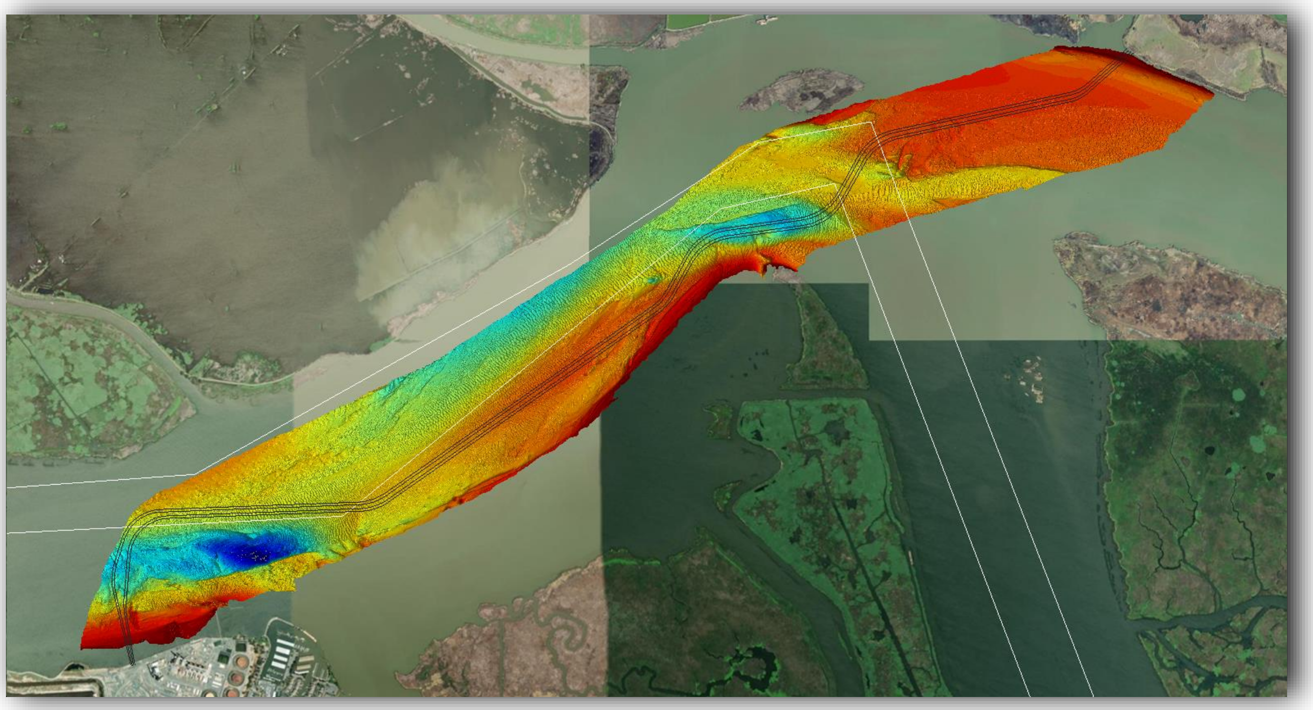

*Numbers shown above represent mile markers where areas with similar sand waves are present*

# Collinsville to Pittsburg Submarine Cable

## Seabed Morphology Analysis

## Appendix A – Results Presentation

January 20, 2025



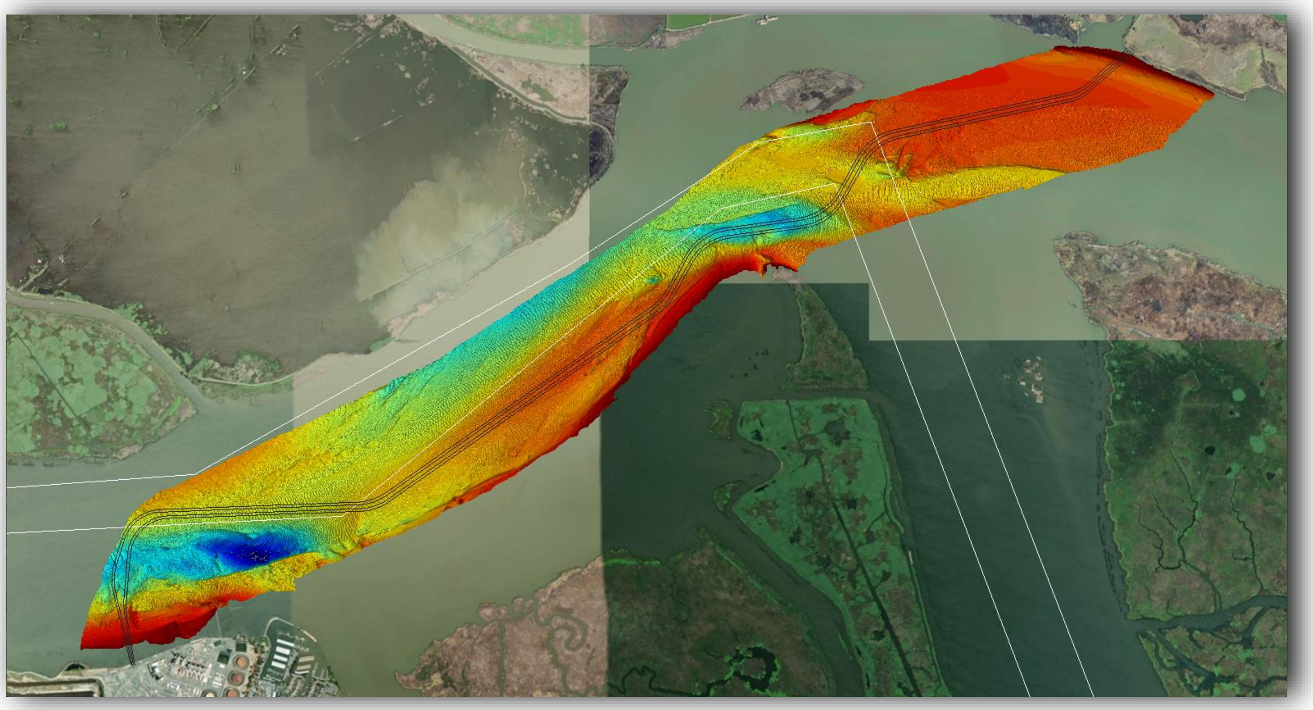
# Appendix B : Supplemental Transects

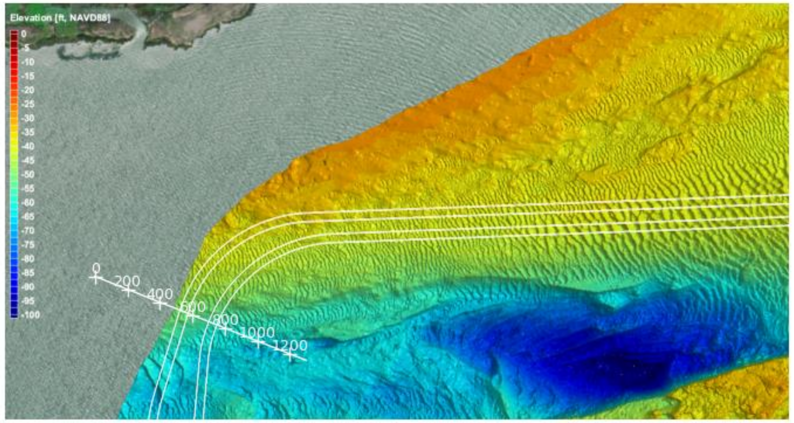
# Collinsville to Pittsburg Submarine Cable

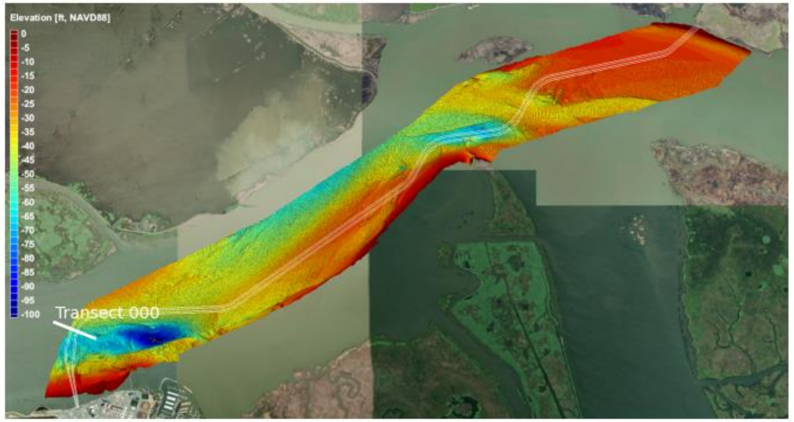
Seabed Morphology Analysis

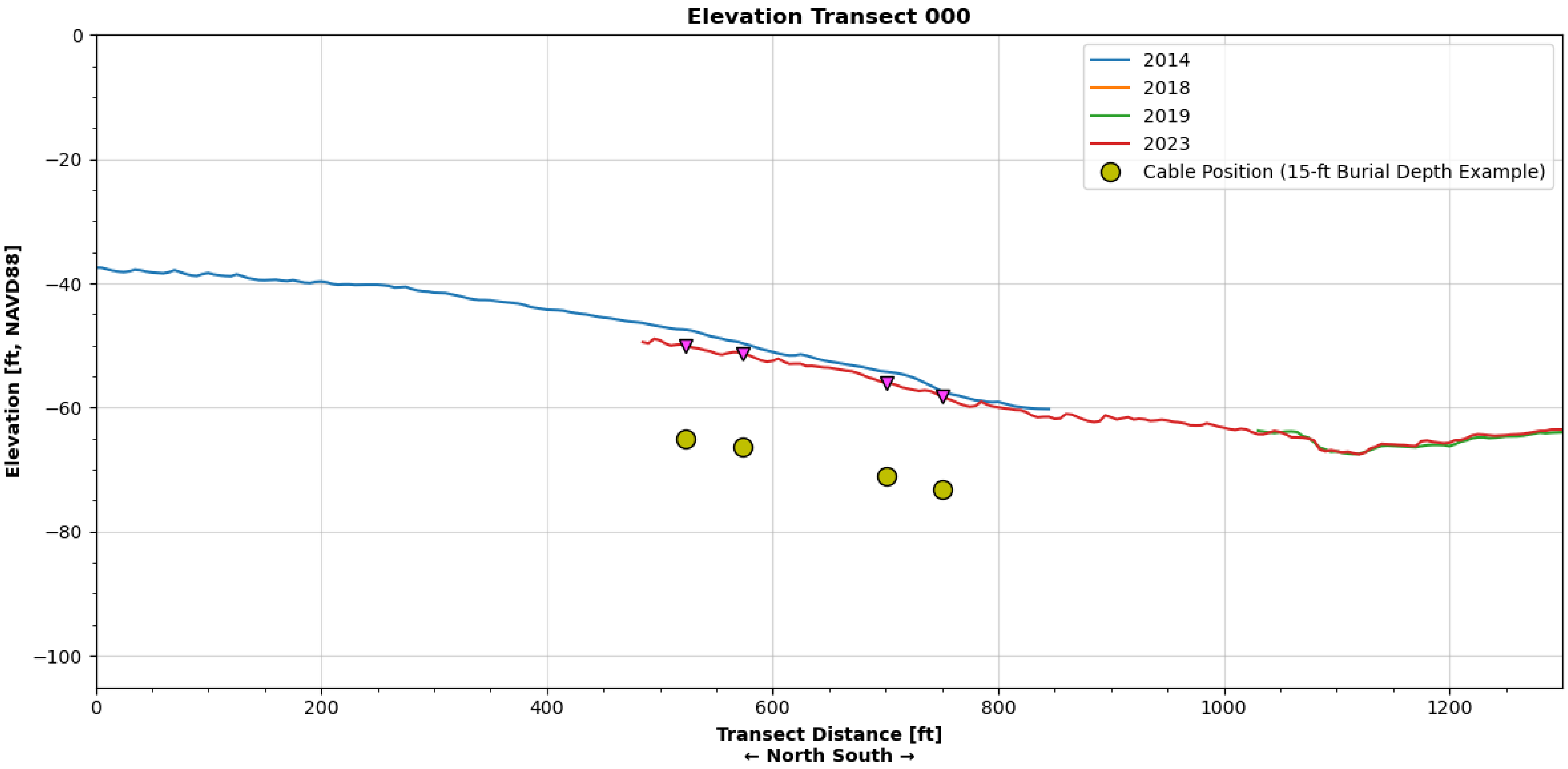
Appendix B - Supplemental Transects

January 20, 2025

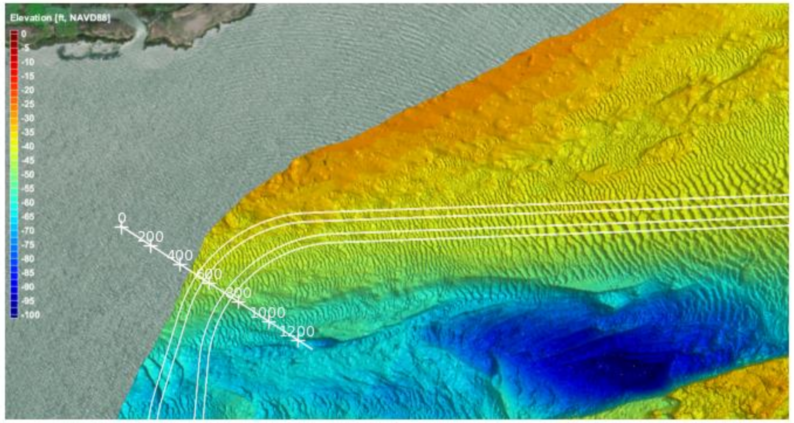


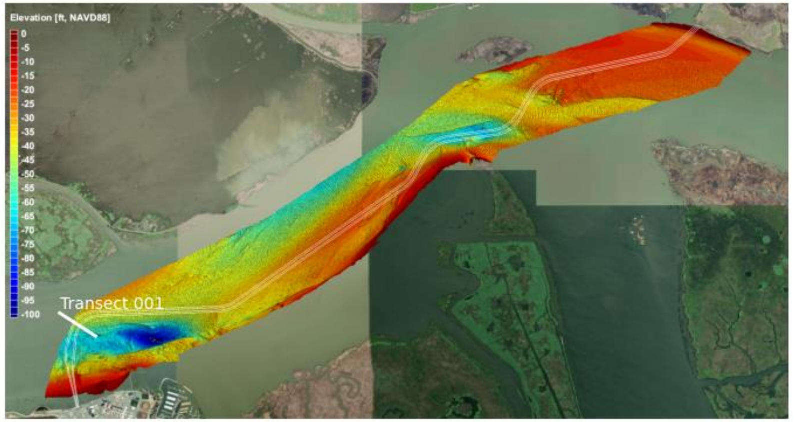


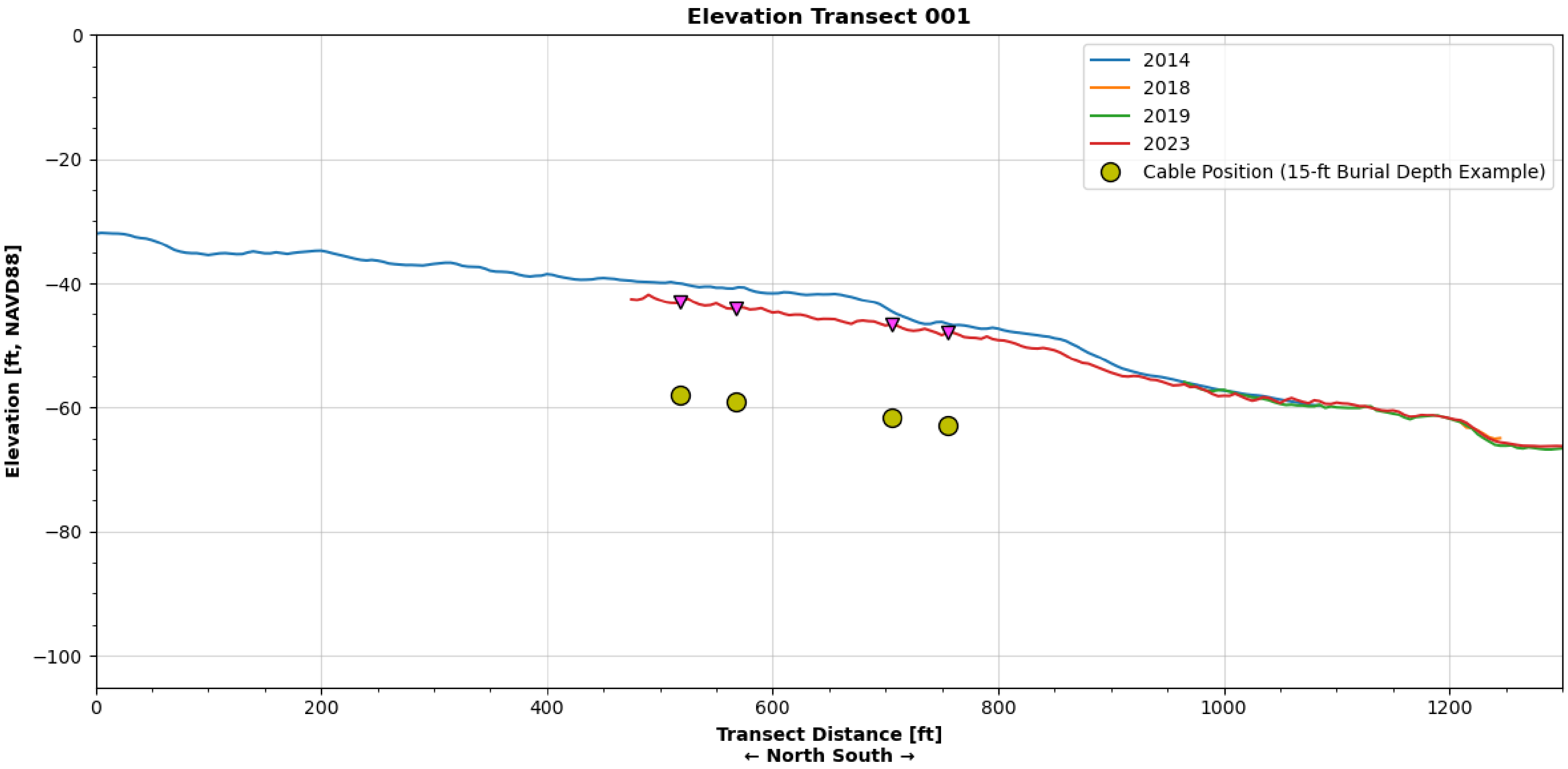




*Note: vertical exaggeration on elevation transect plots*




*Note: vertical exaggeration on elevation transect plots*

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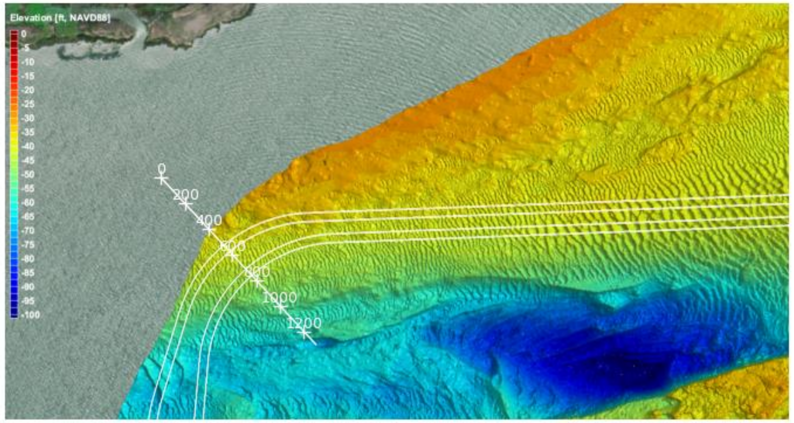


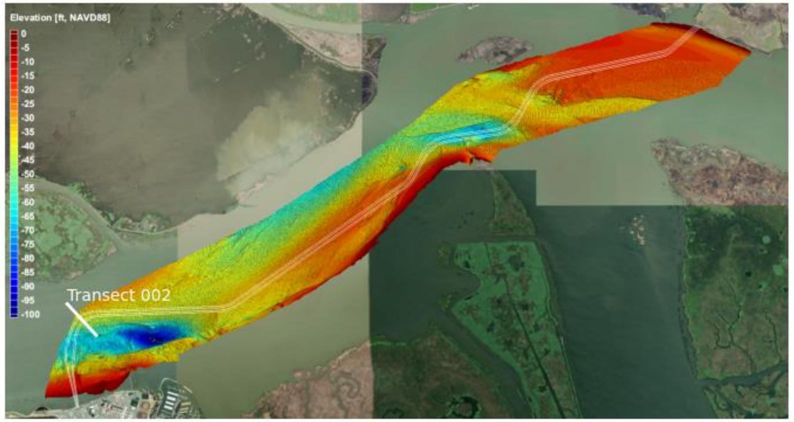


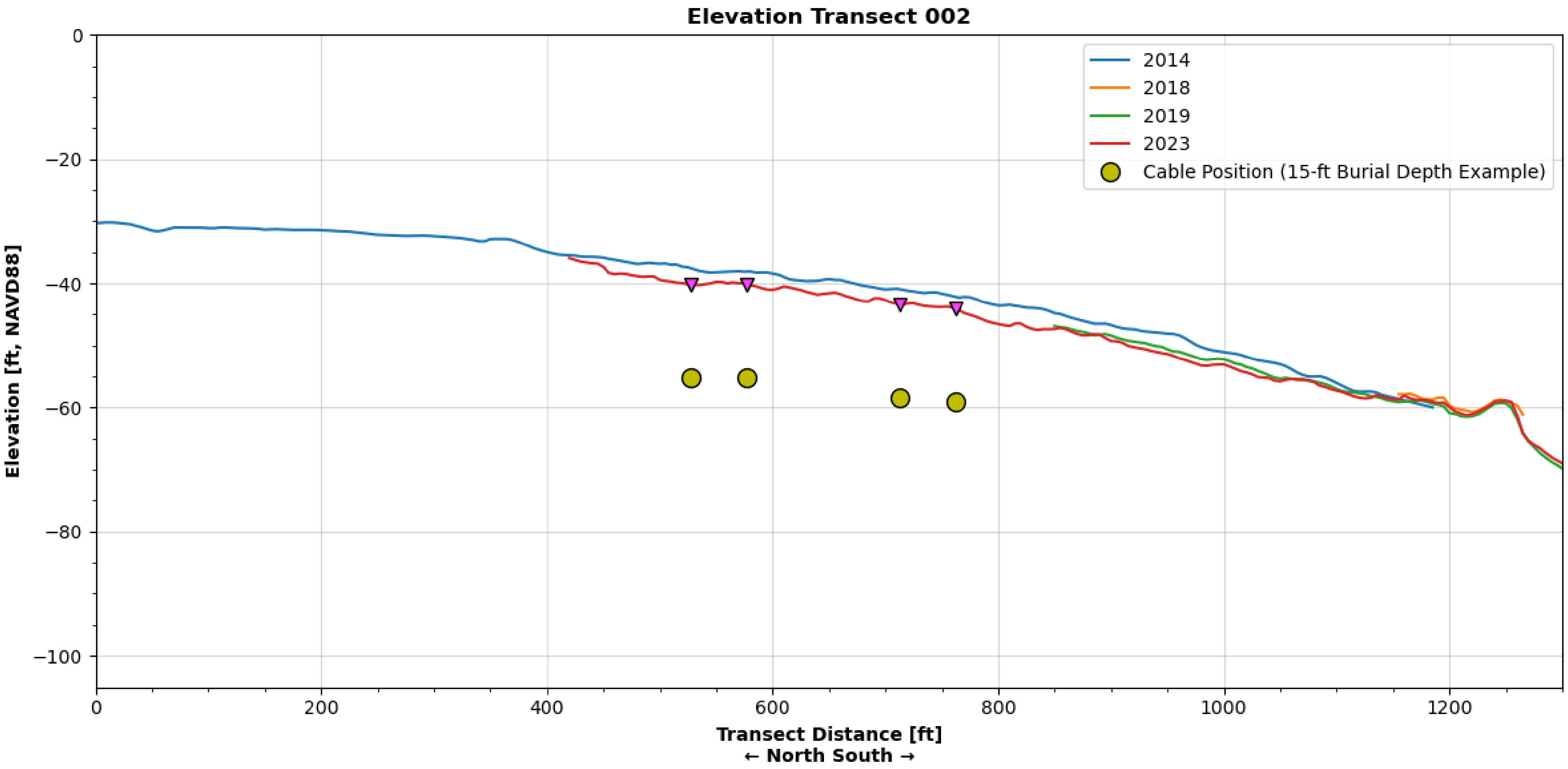


*Note: vertical exaggeration on elevation transect plots*

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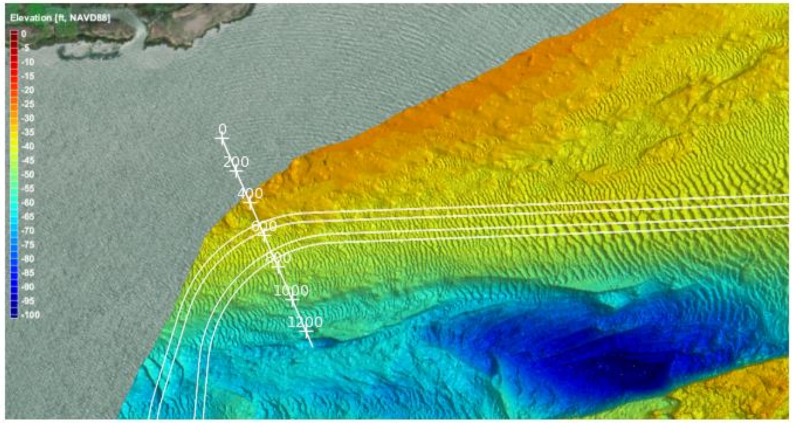
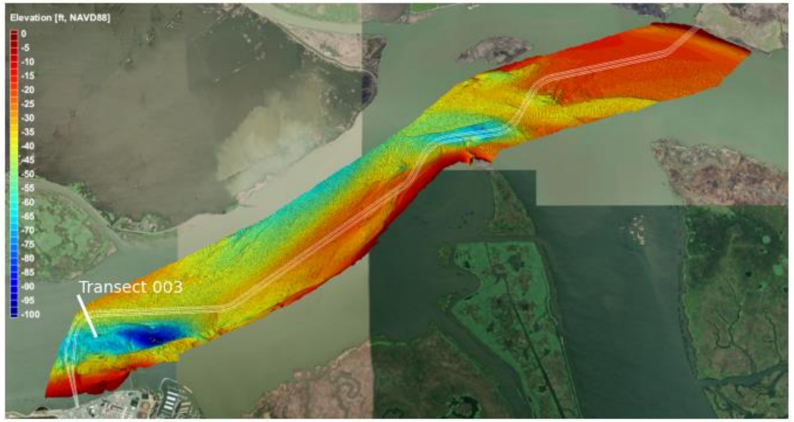
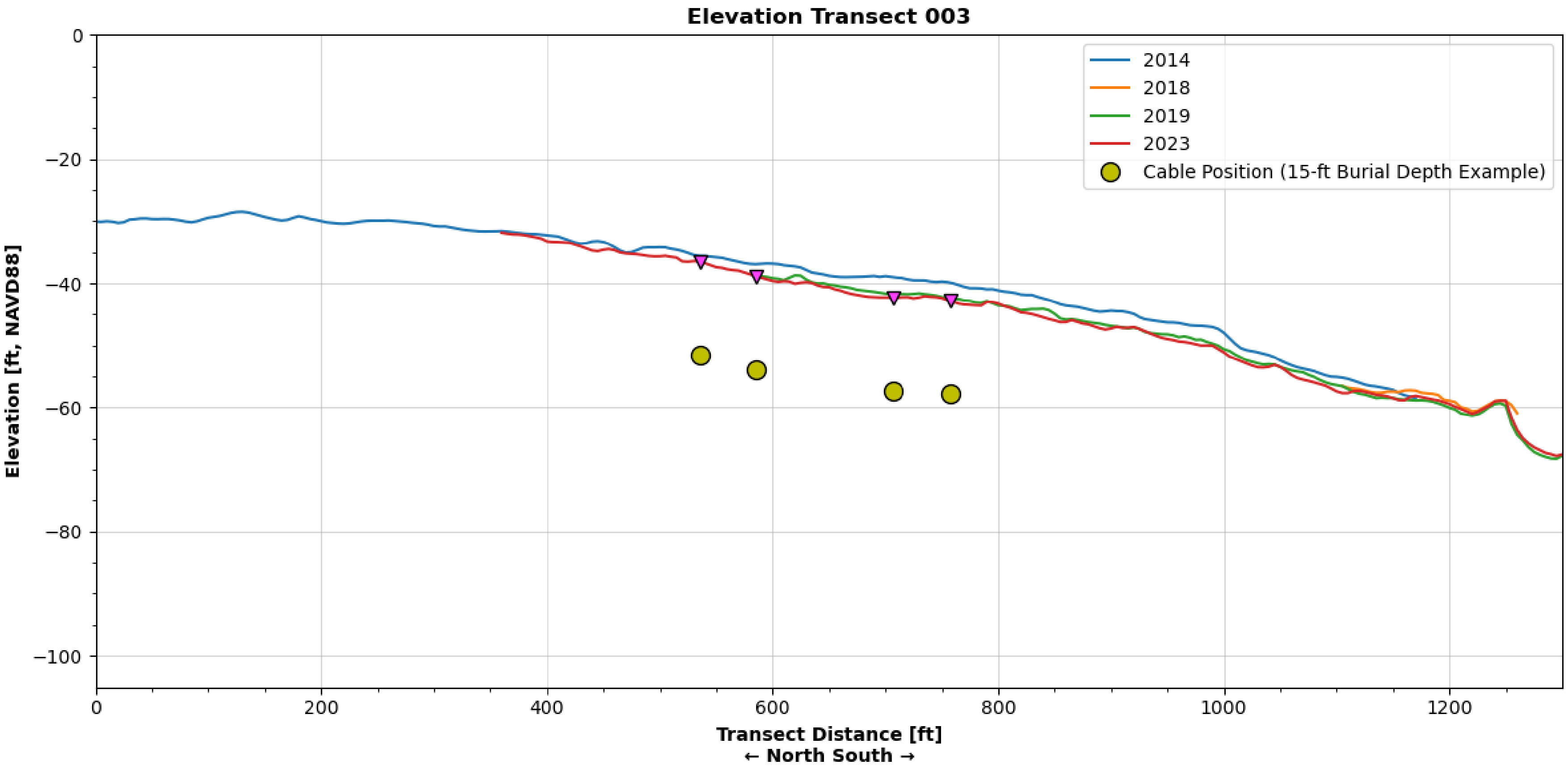
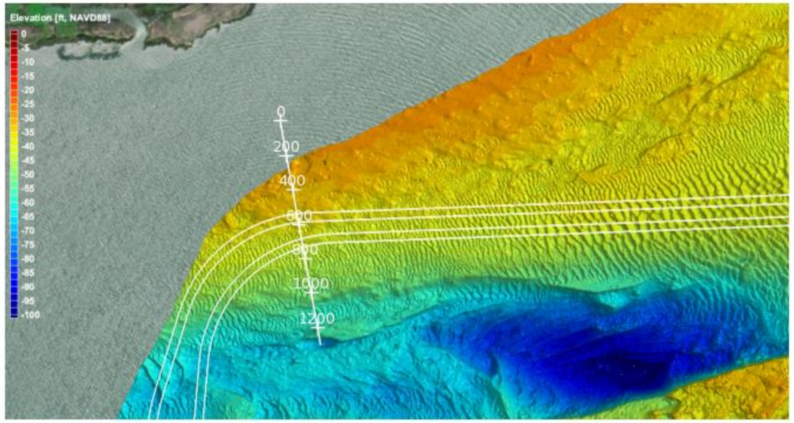
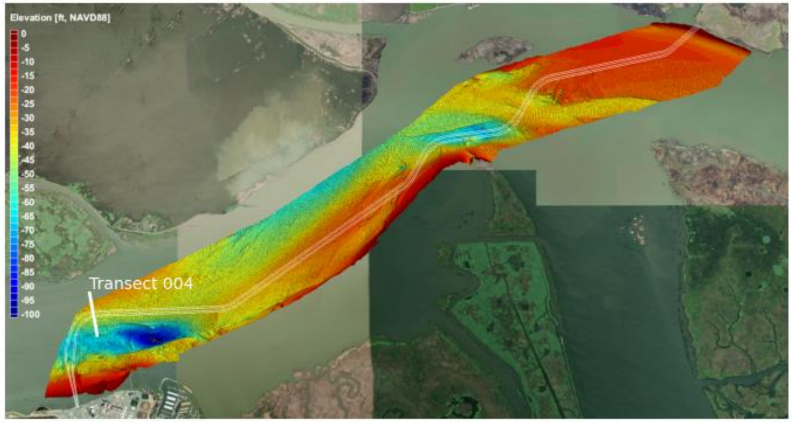


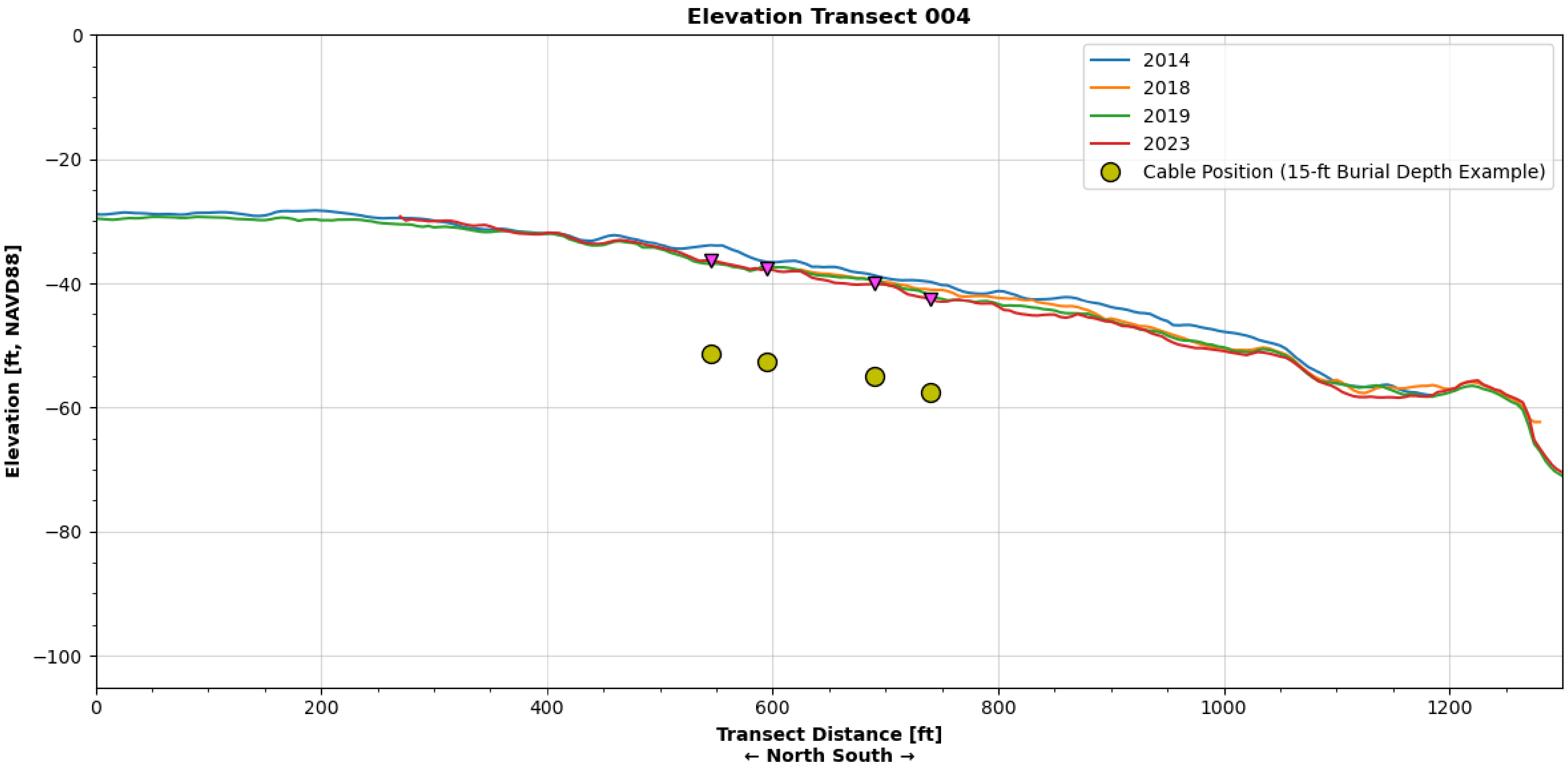



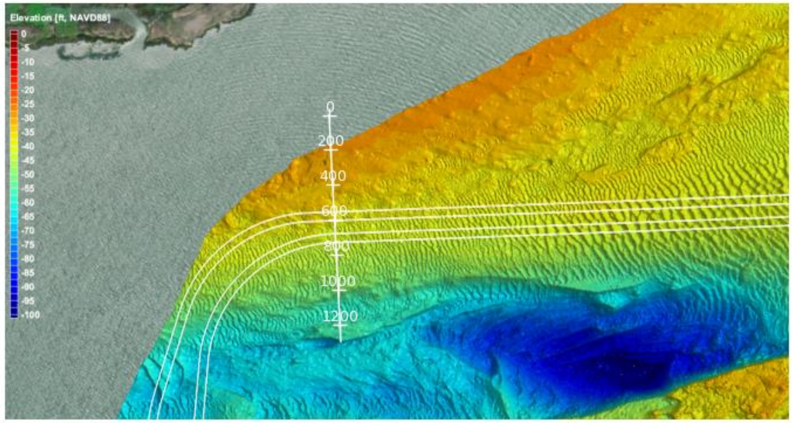

*Note: vertical exaggeration on elevation transect plots*

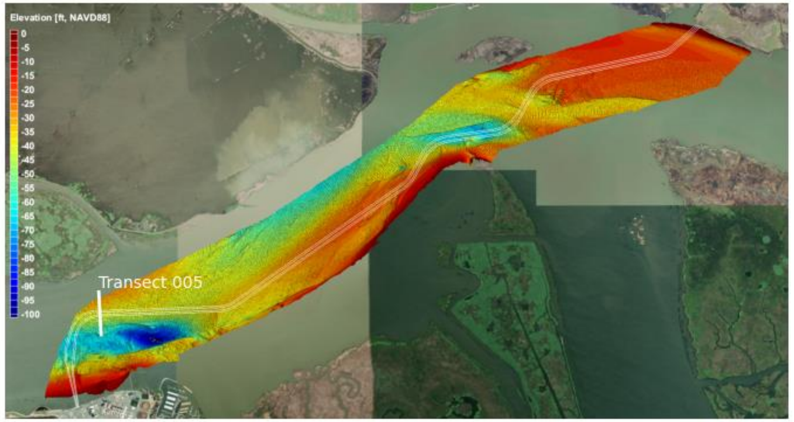


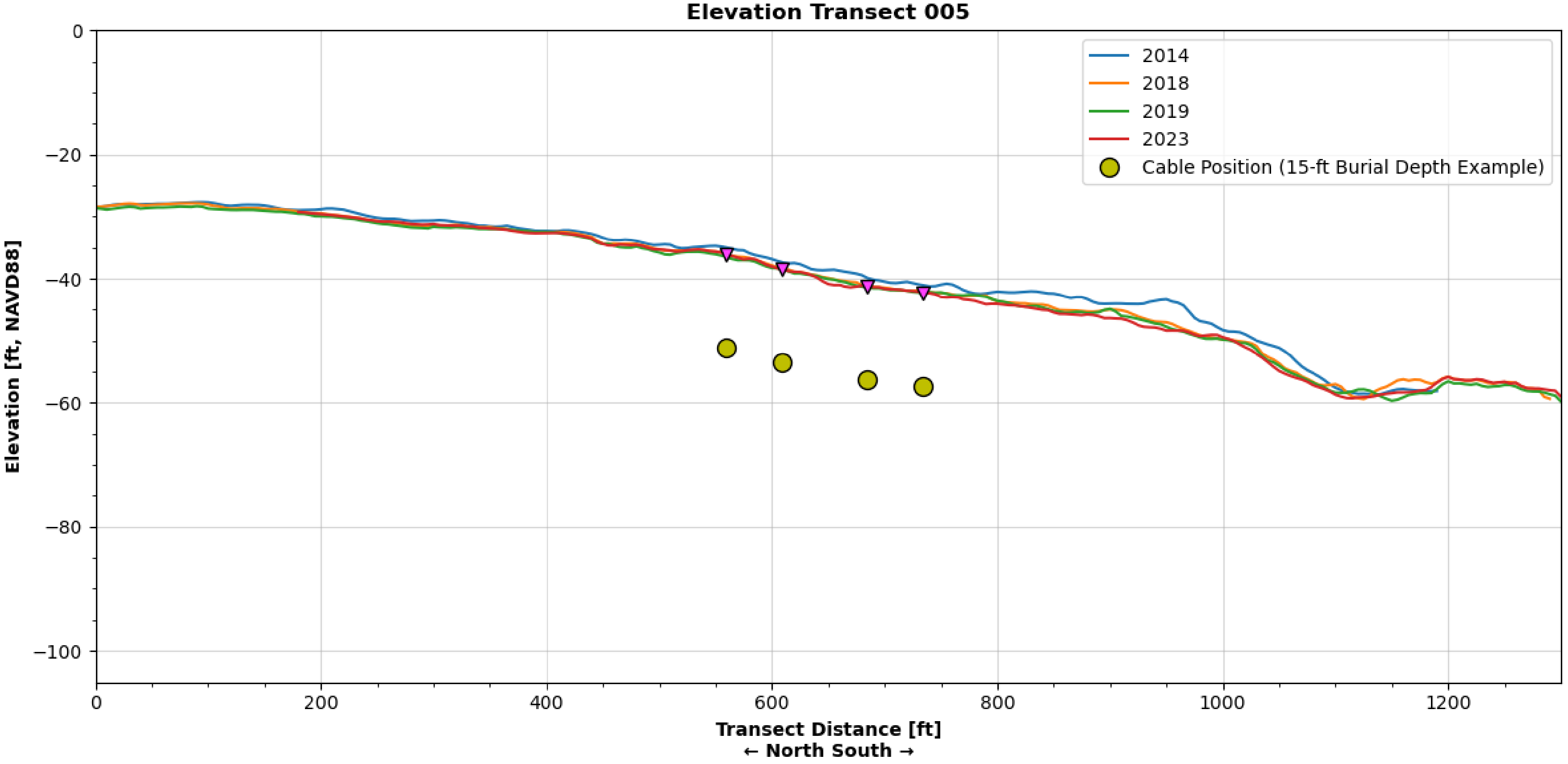




*Note: vertical exaggeration on elevation transect plots*




*Note: vertical exaggeration on elevation transect plots*

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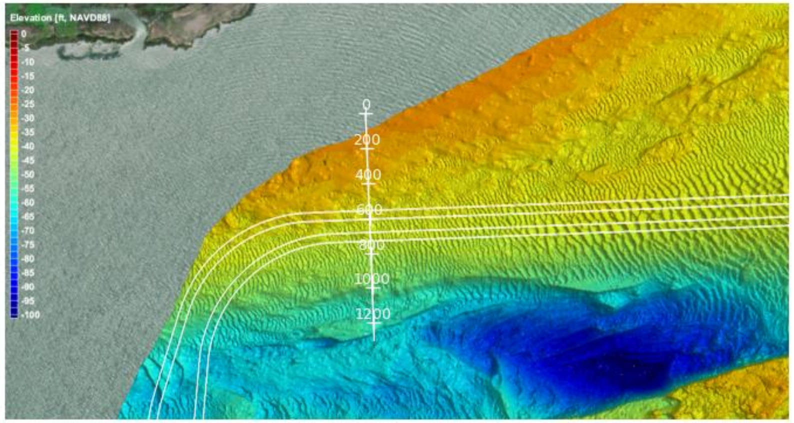
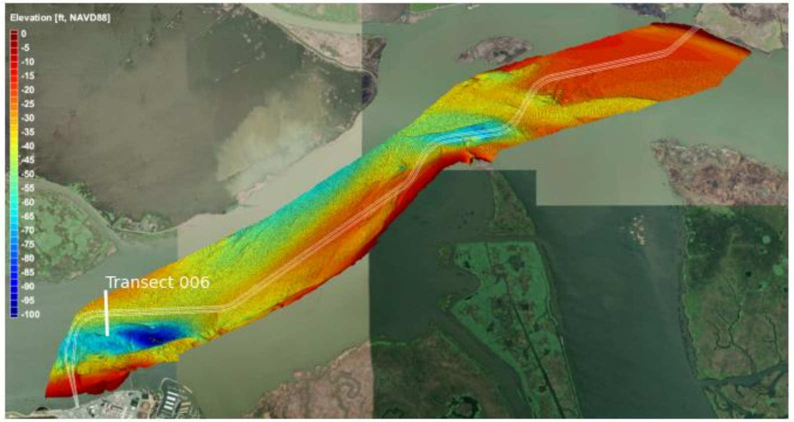
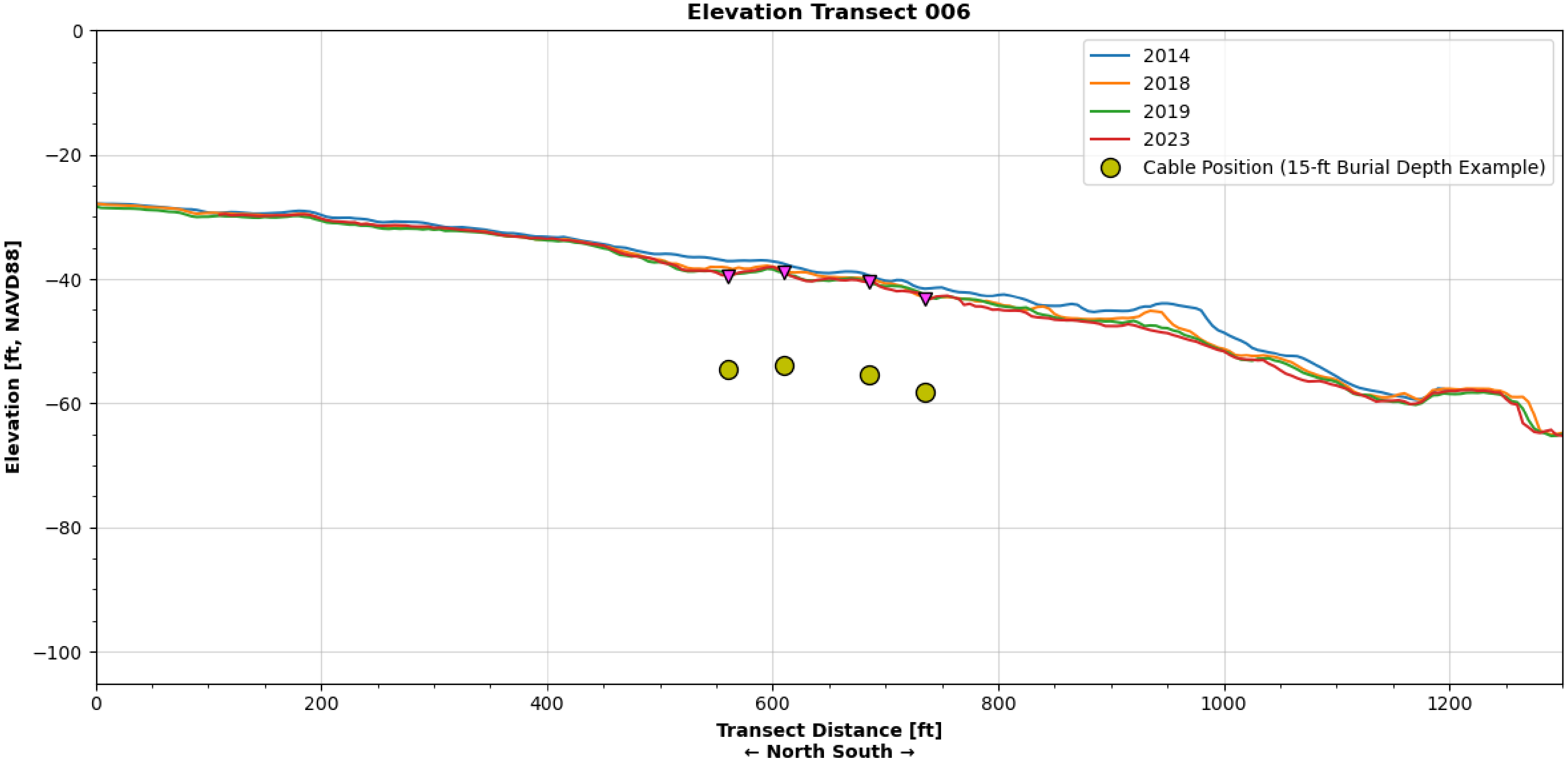
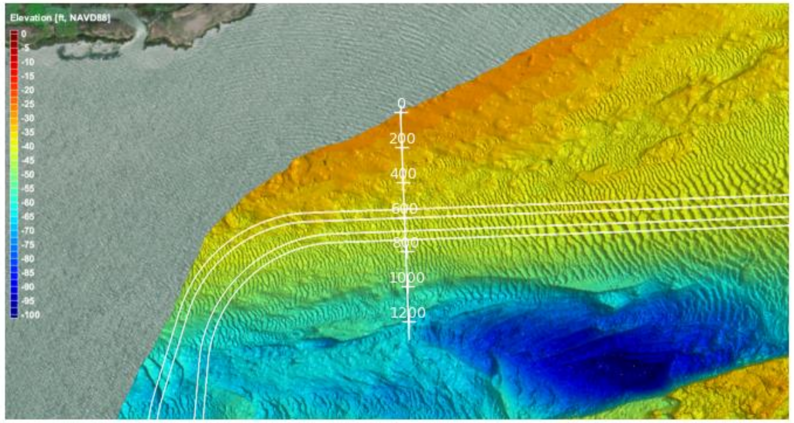
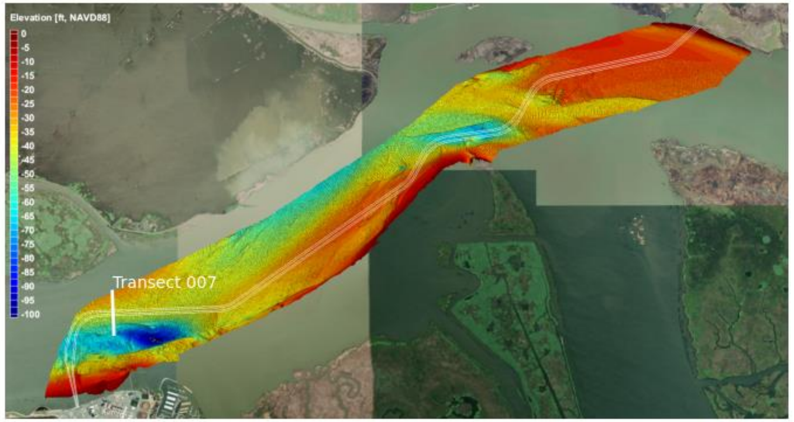


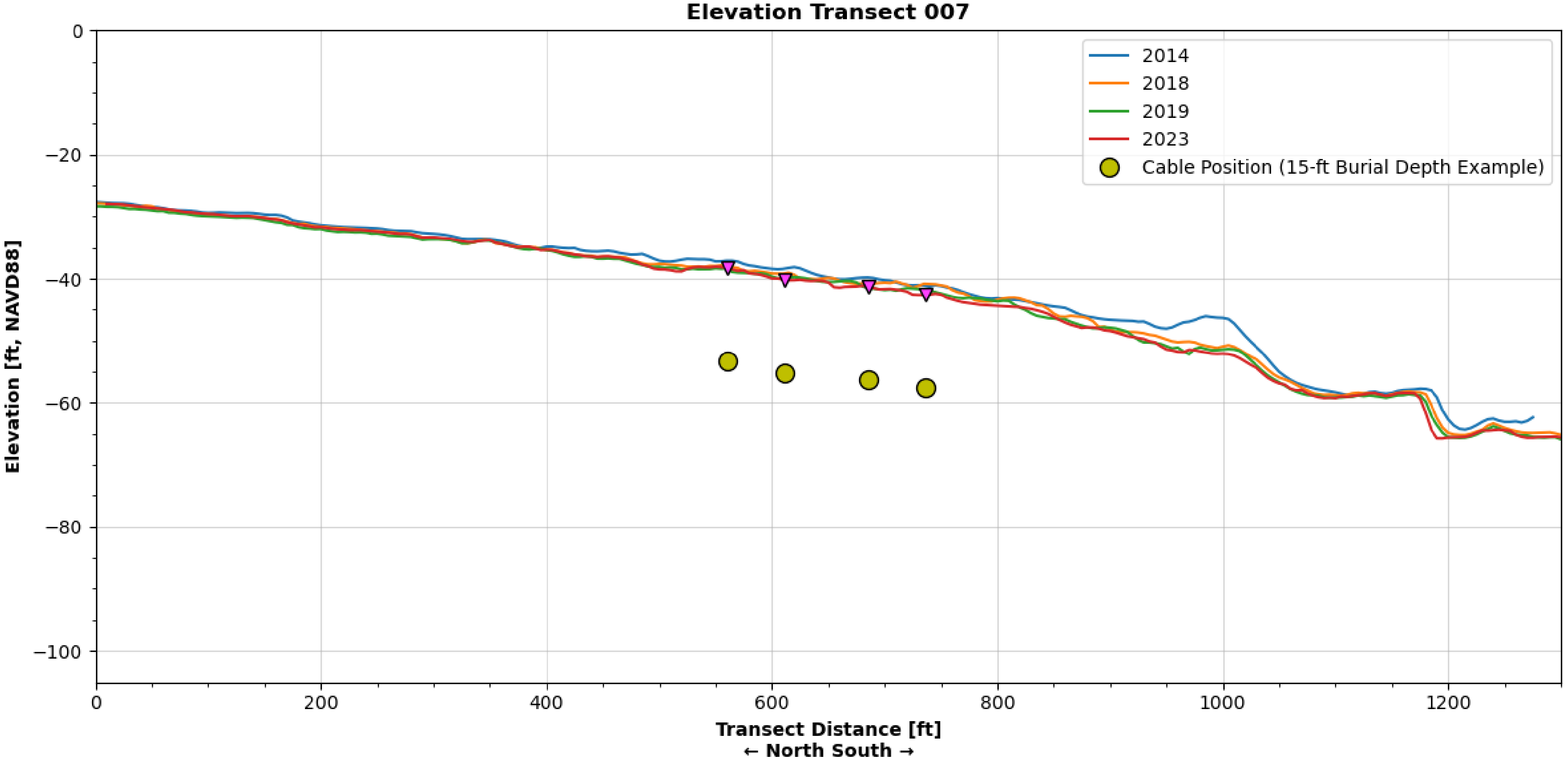




*Note: vertical exaggeration on elevation transect plots*




*Note: vertical exaggeration on elevation transect plots*

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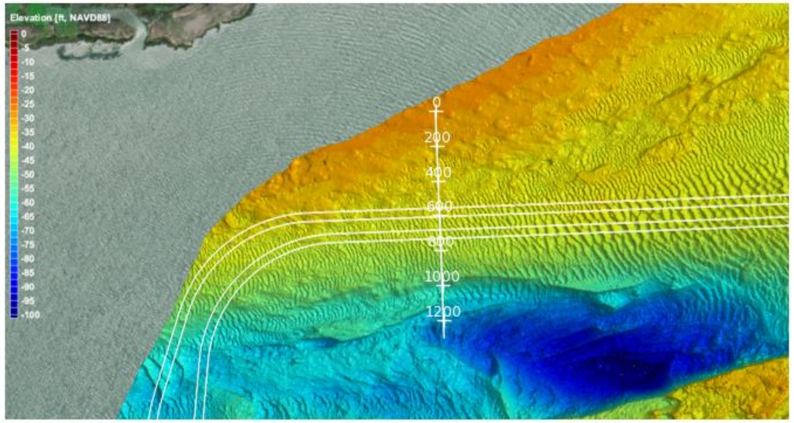


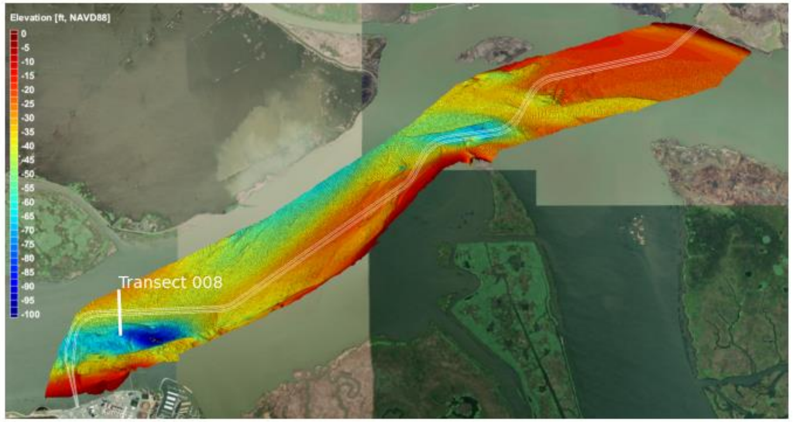


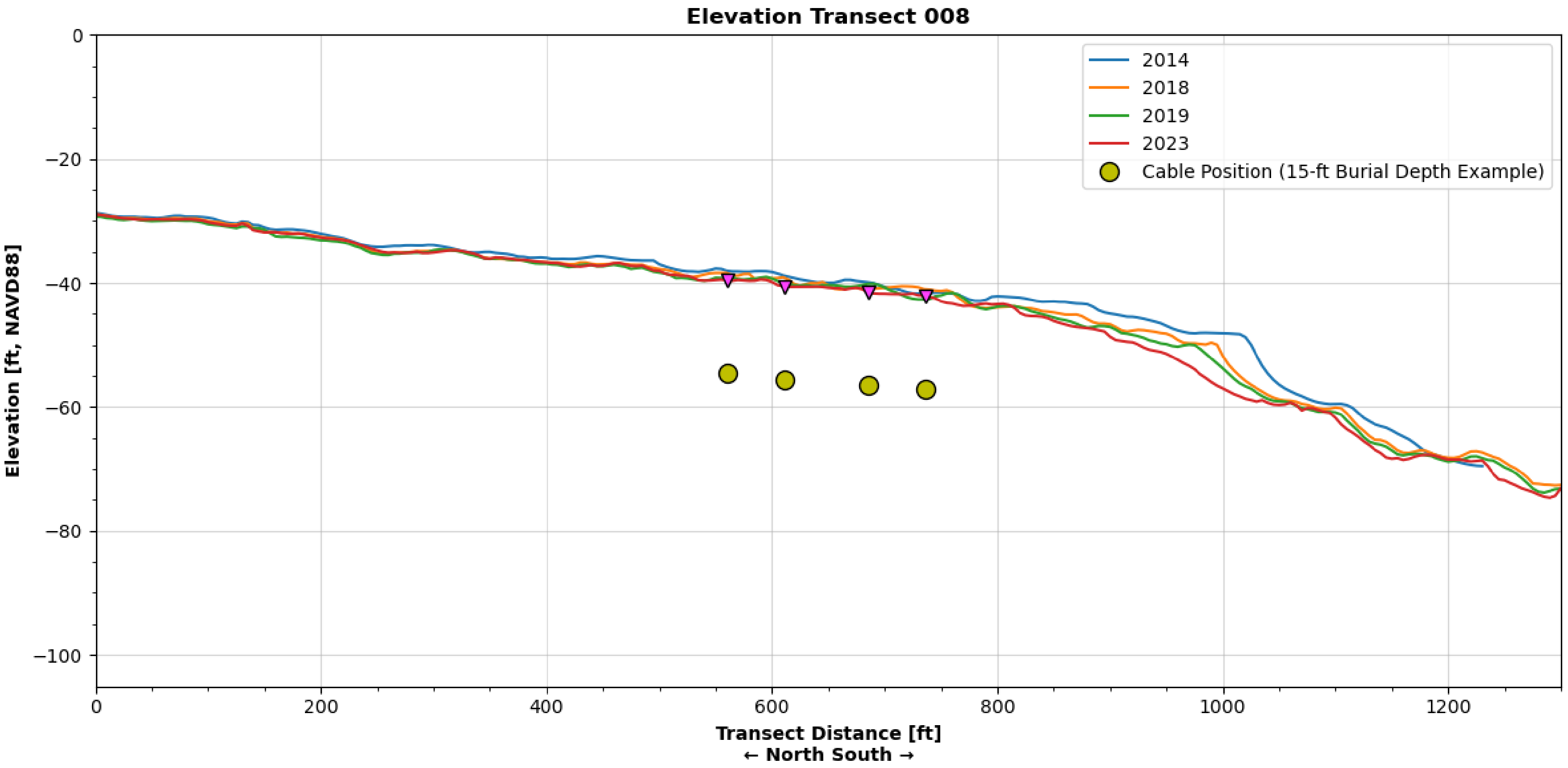


*Note: vertical exaggeration on elevation transect plots*

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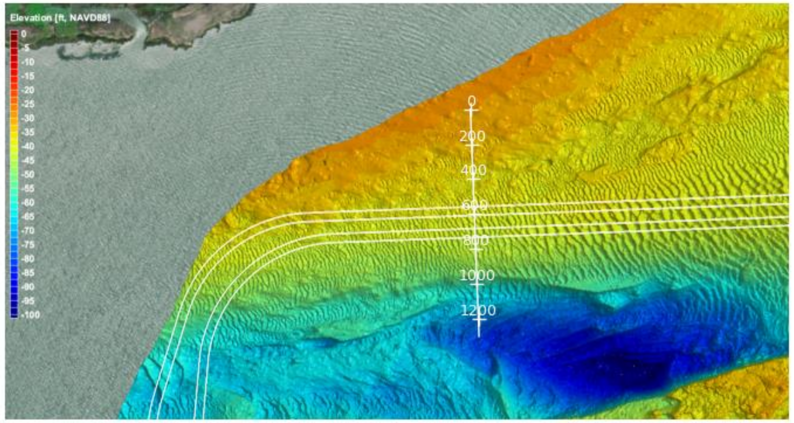


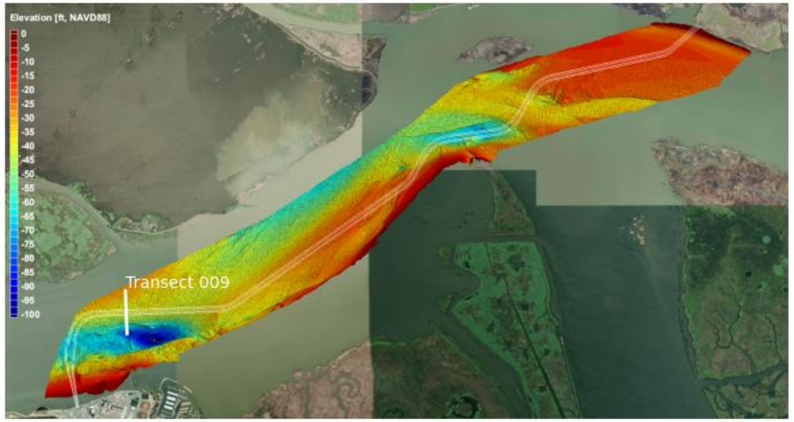


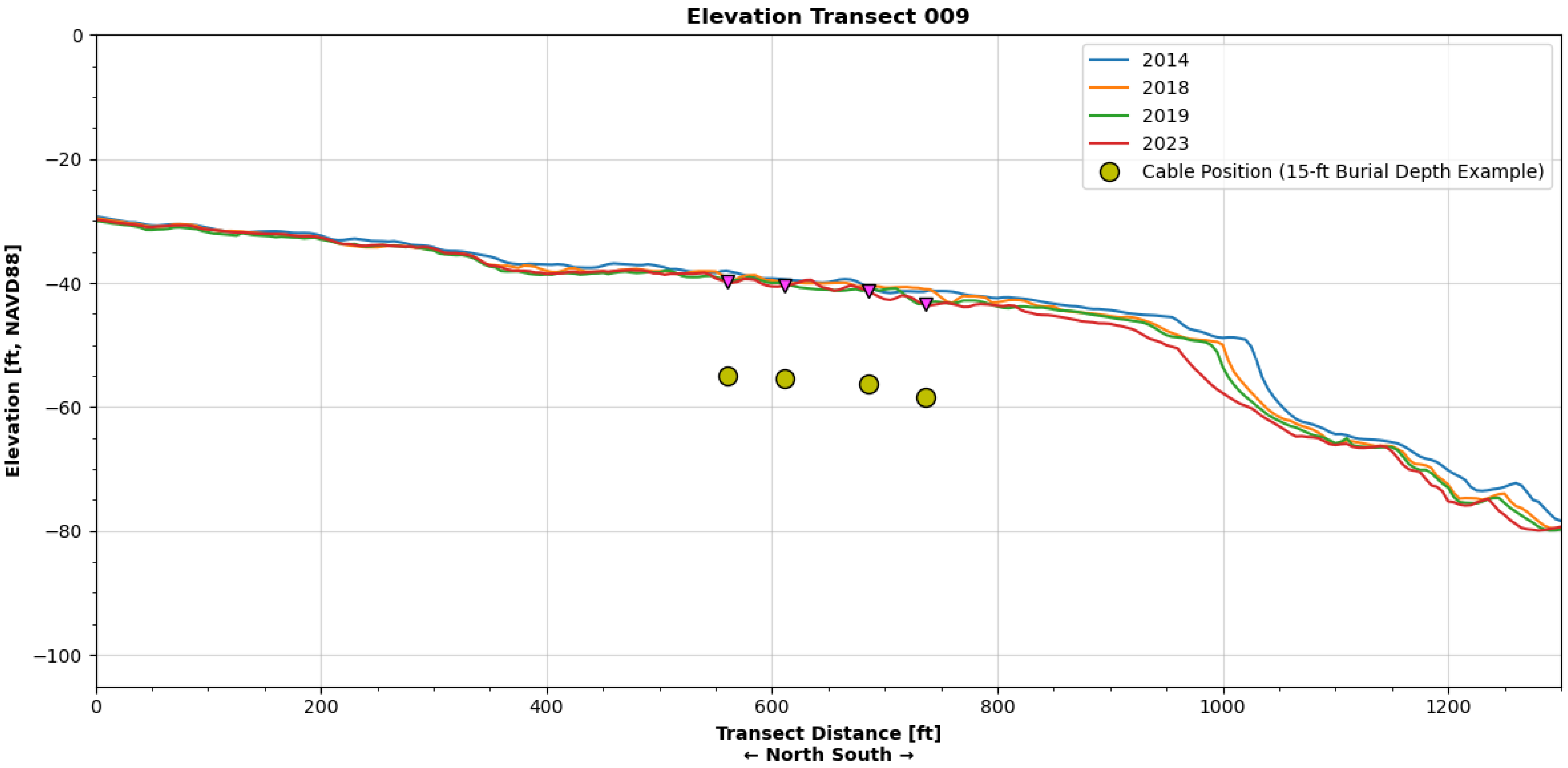


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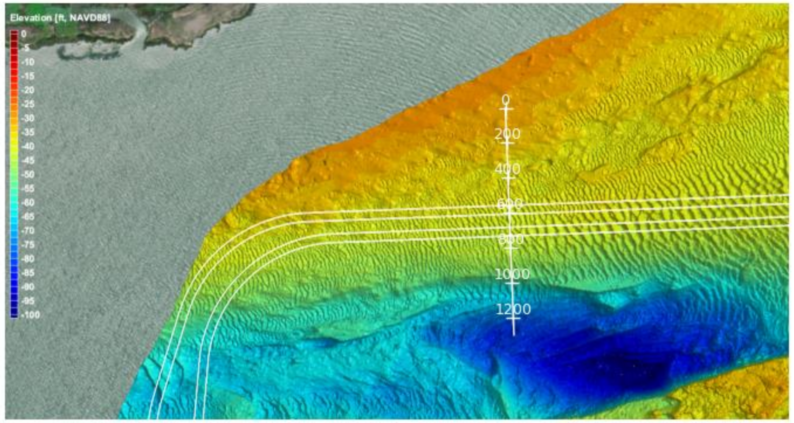


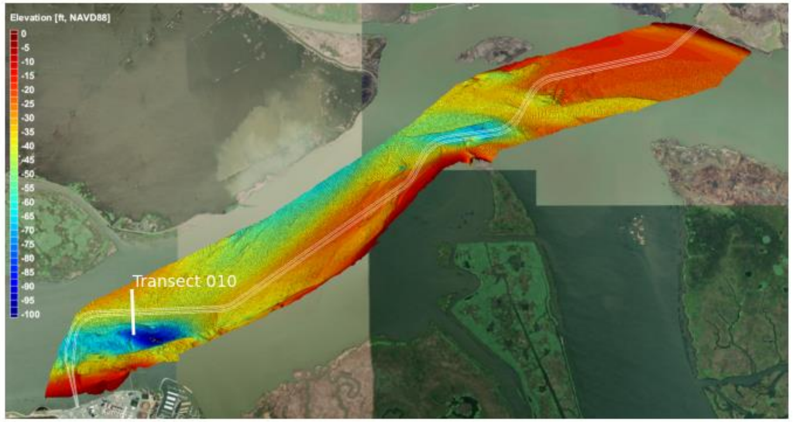


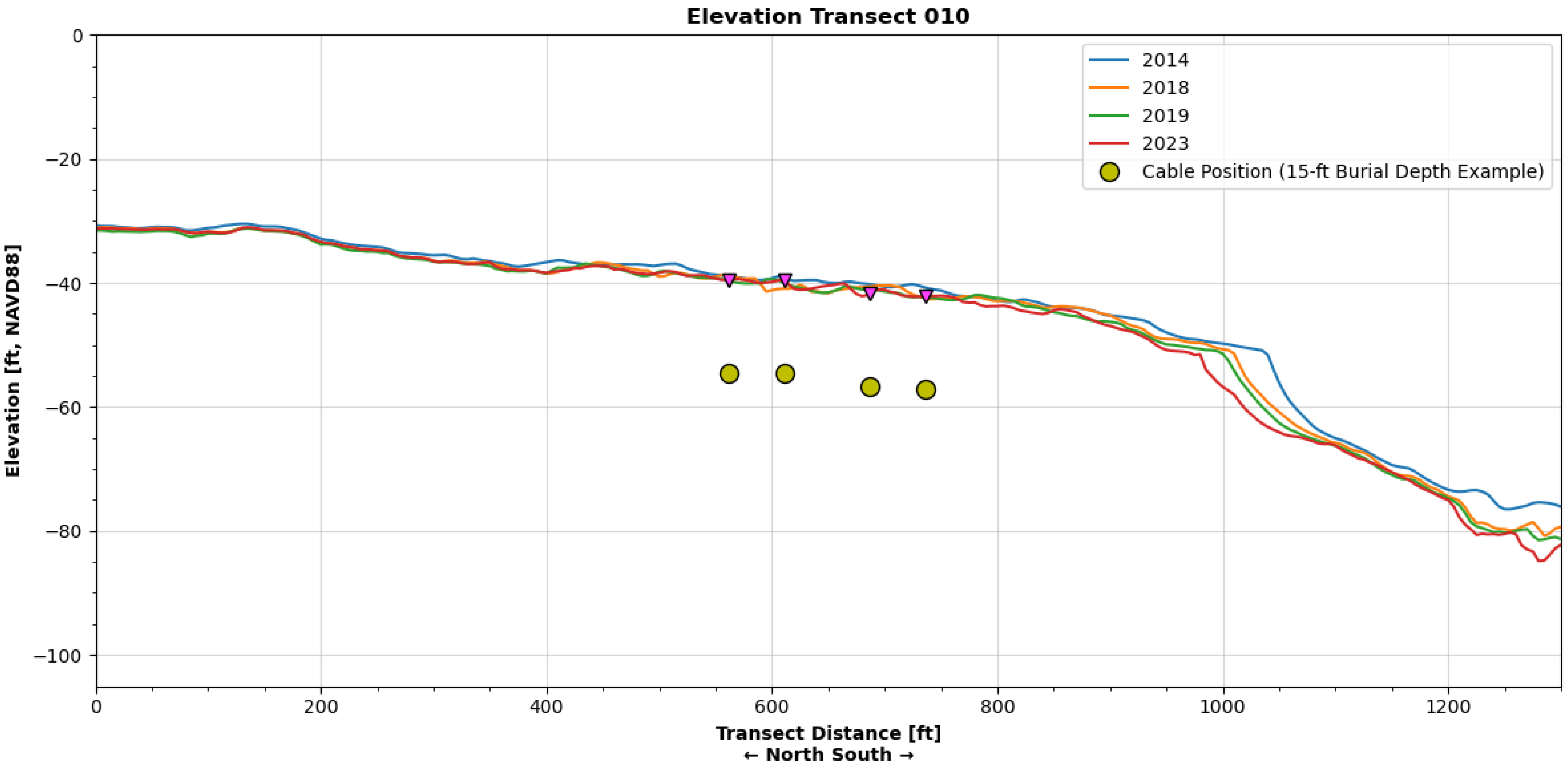


*Note: vertical exaggeration on elevation transect plots*

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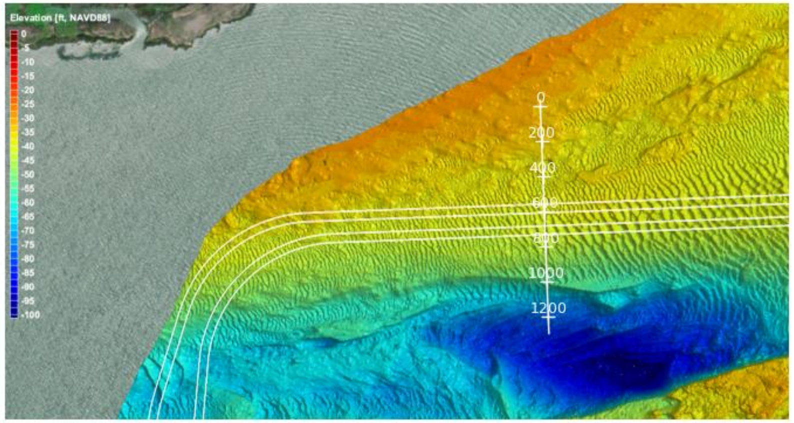
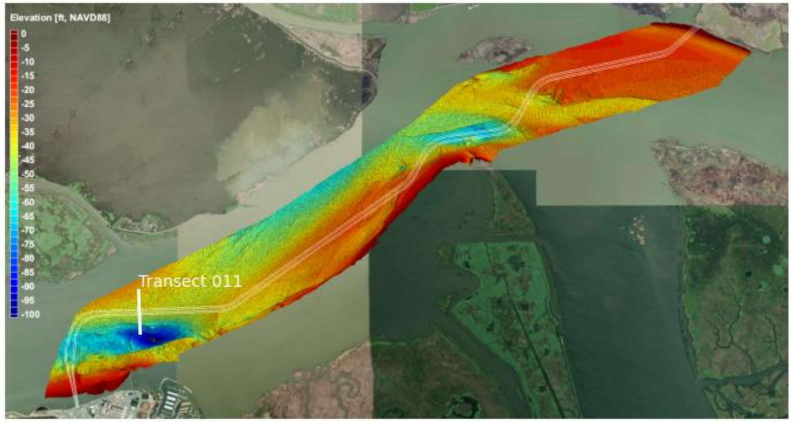
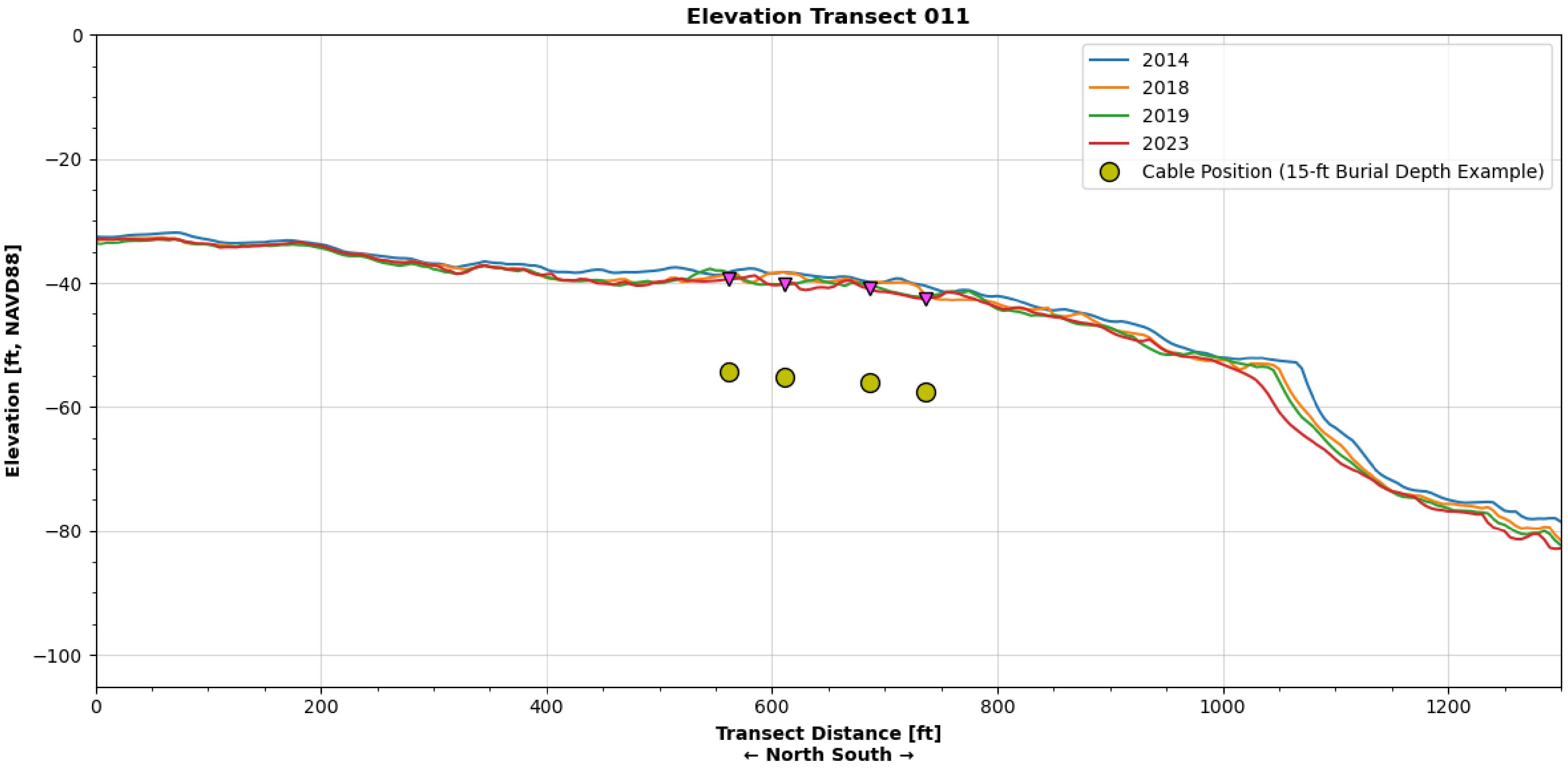
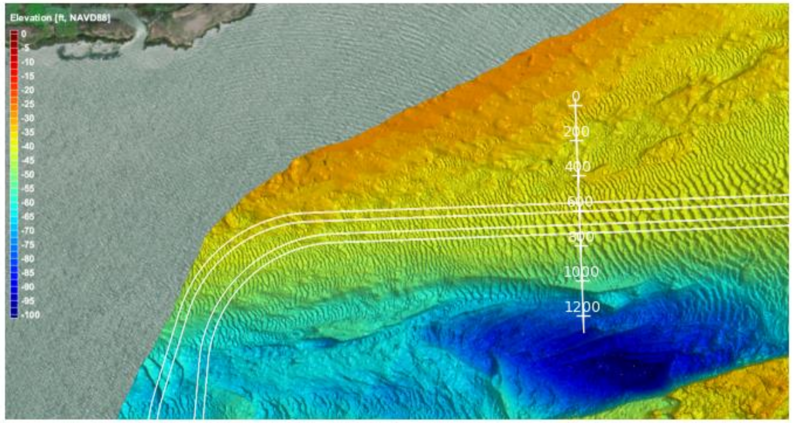
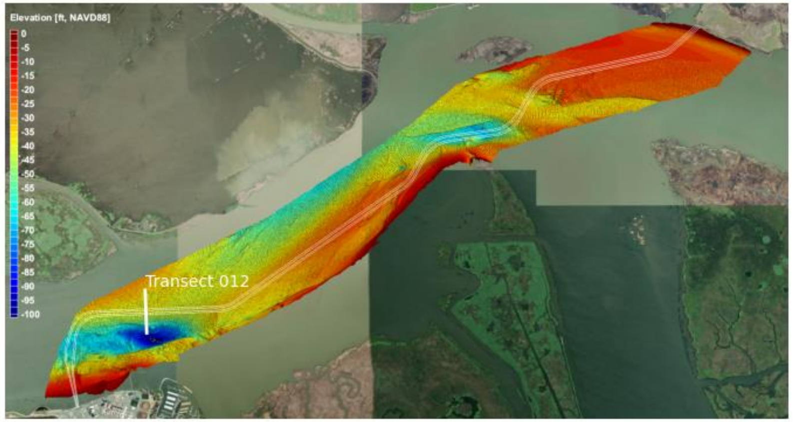


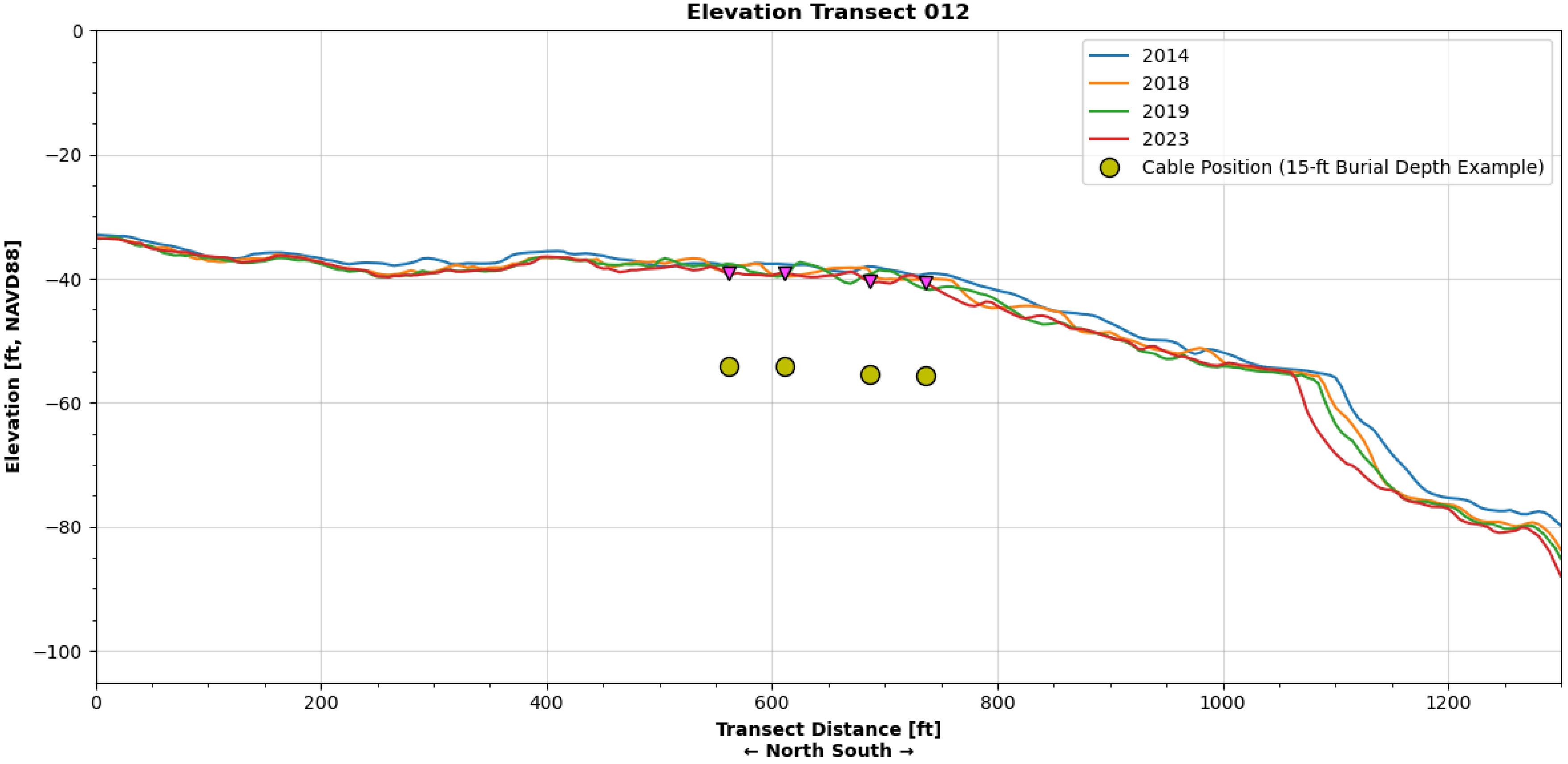




*Note: vertical exaggeration on elevation transect plots*

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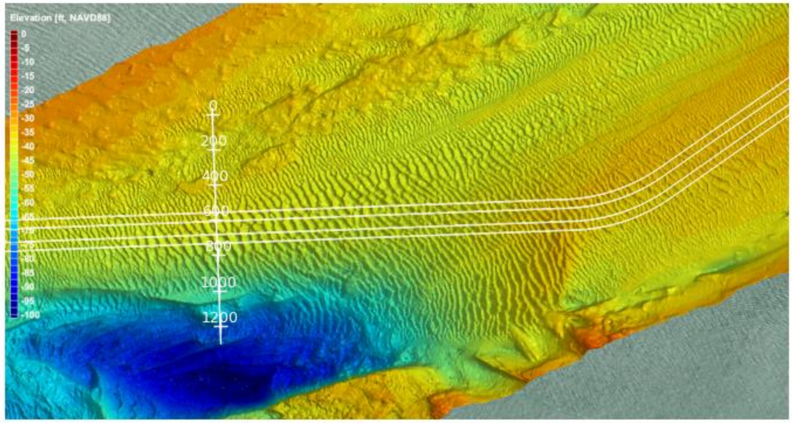


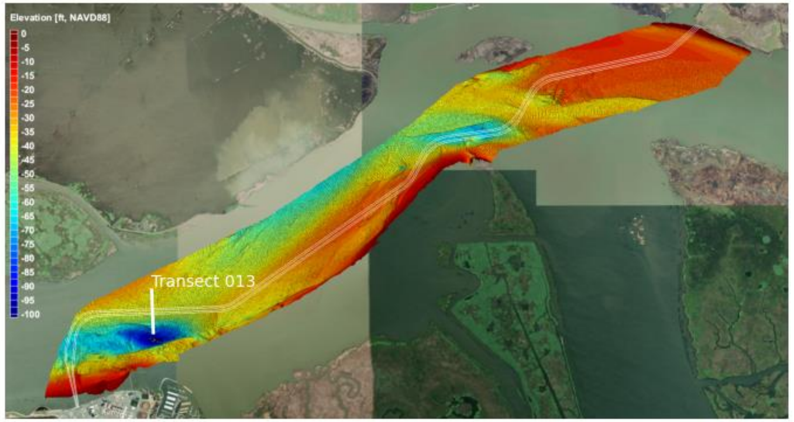


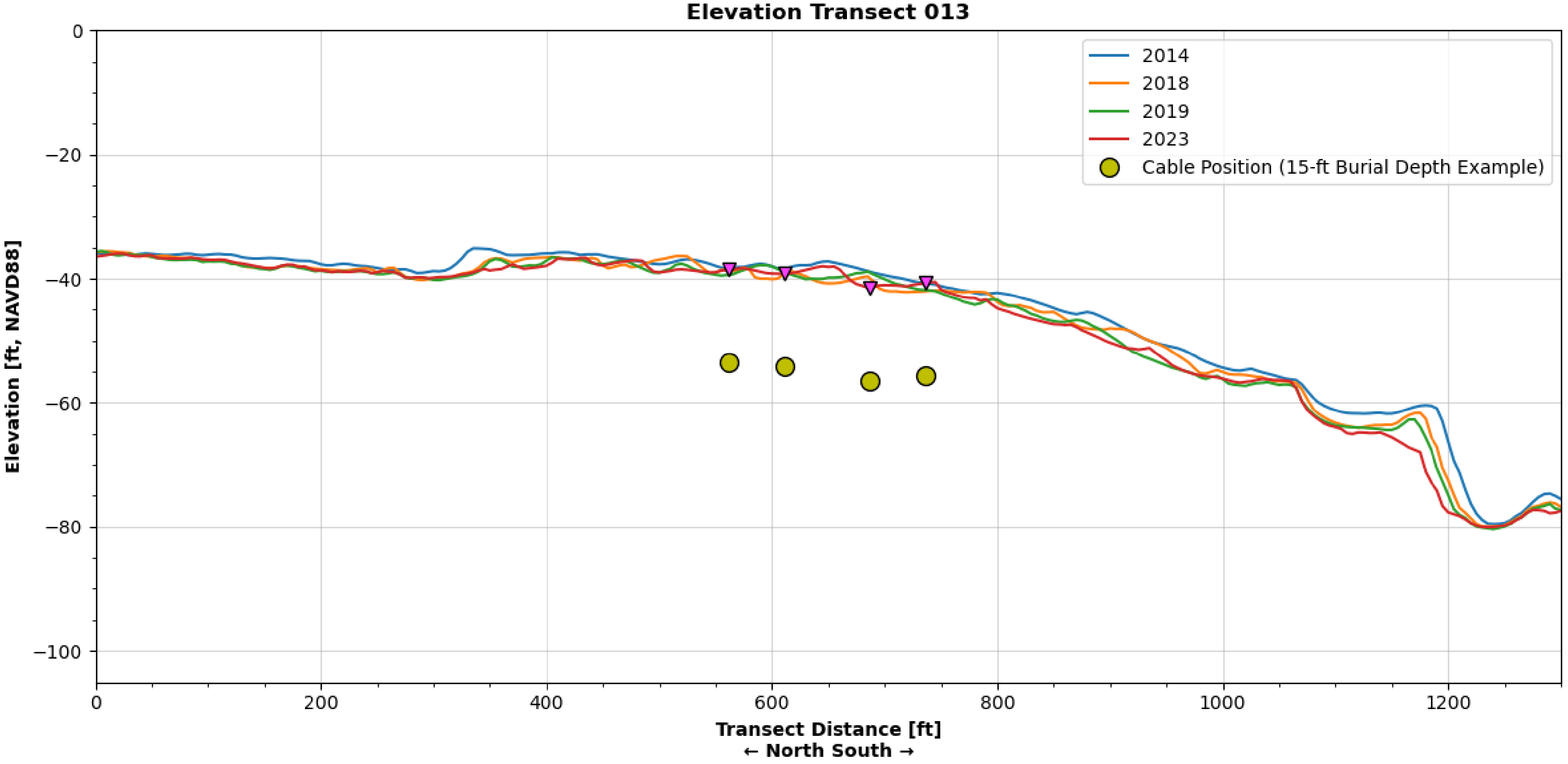


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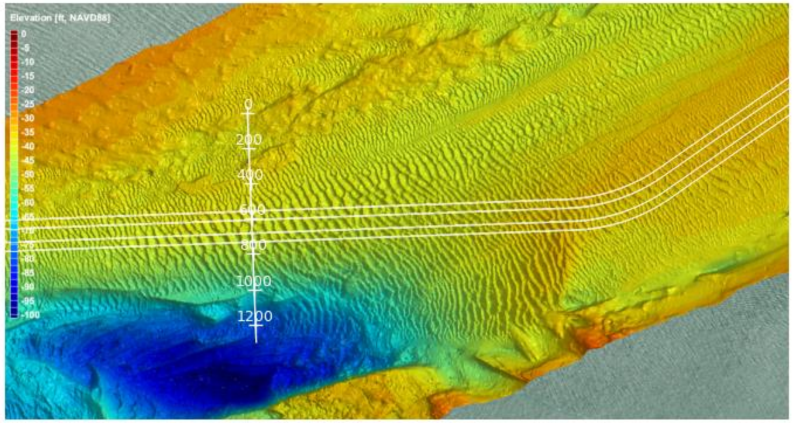


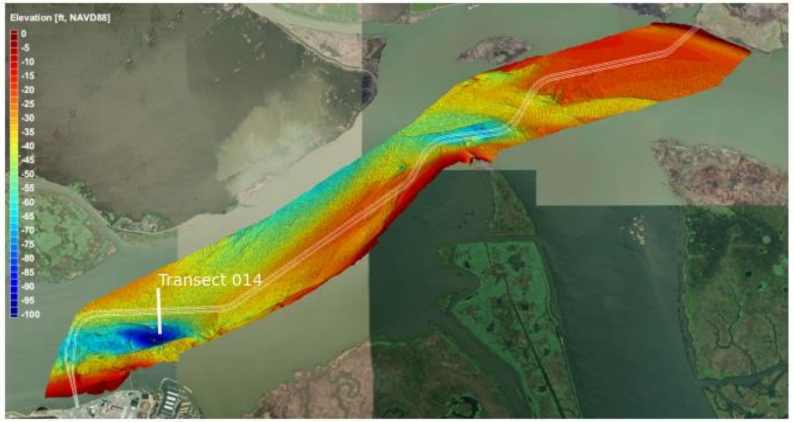


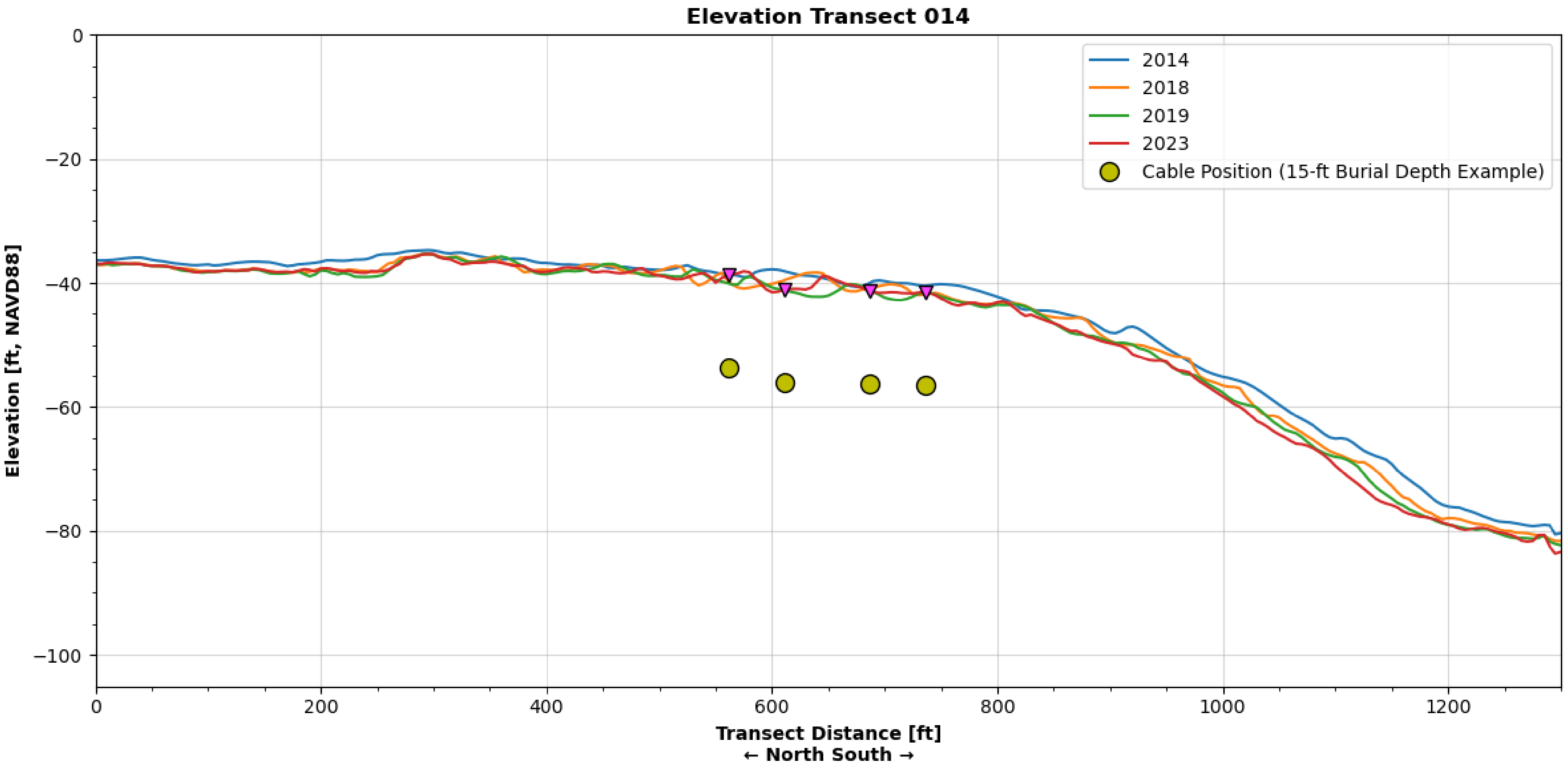


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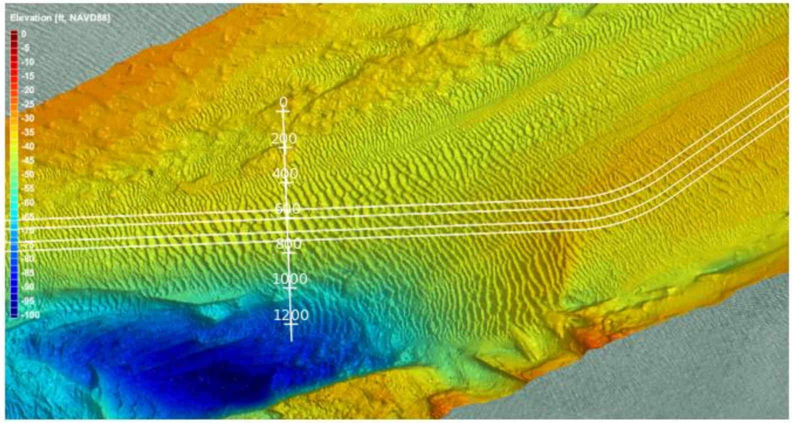

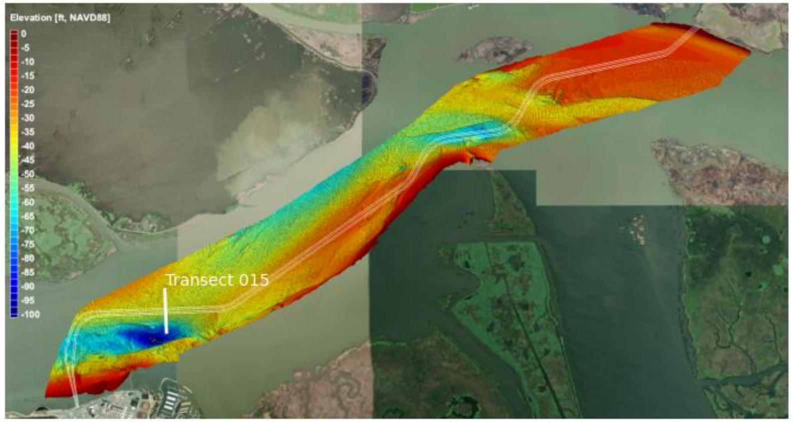


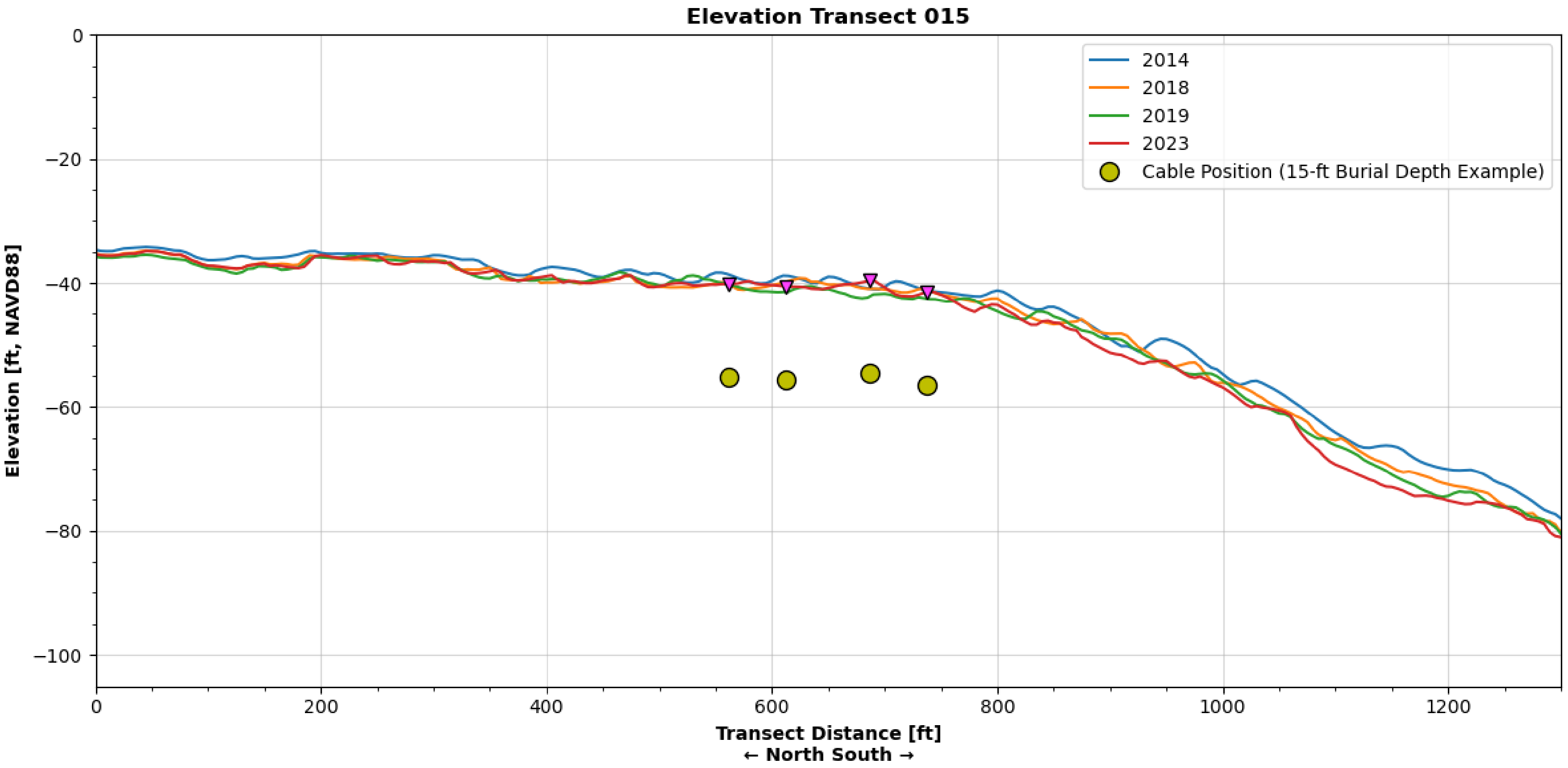


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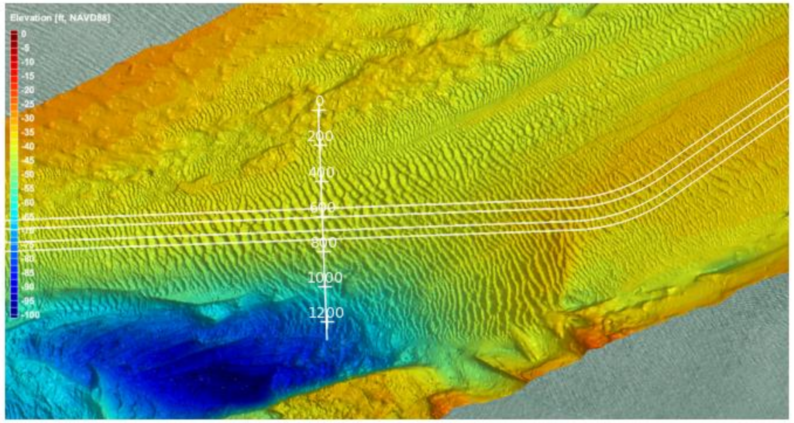

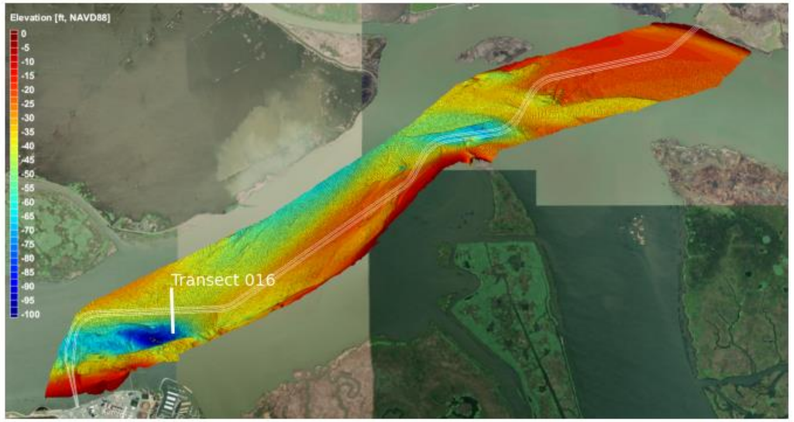


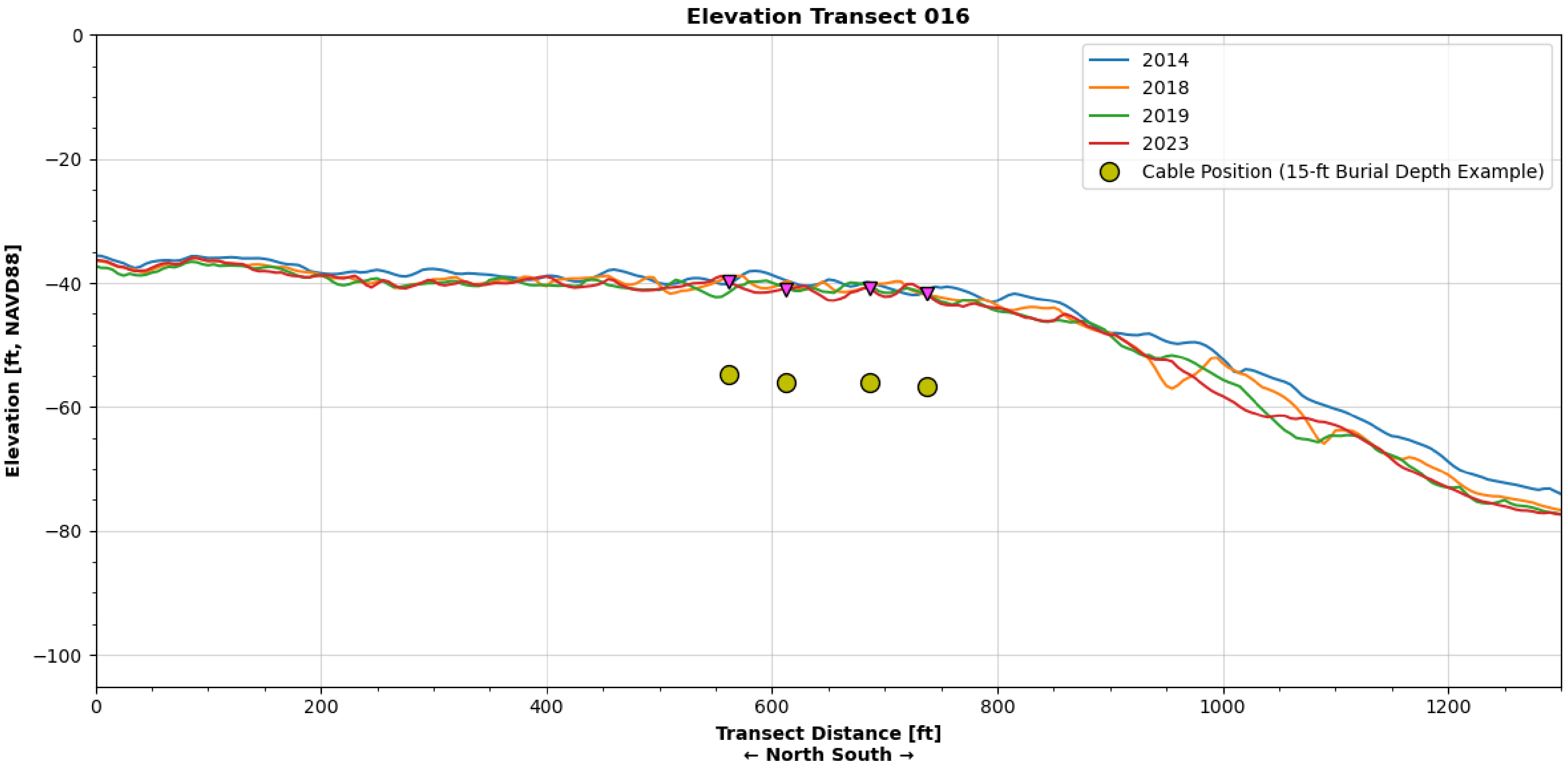


*Note: vertical exaggeration on elevation transect plots*

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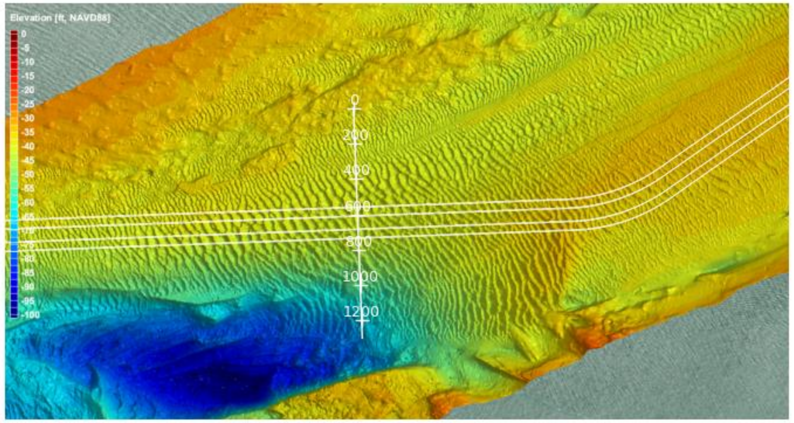


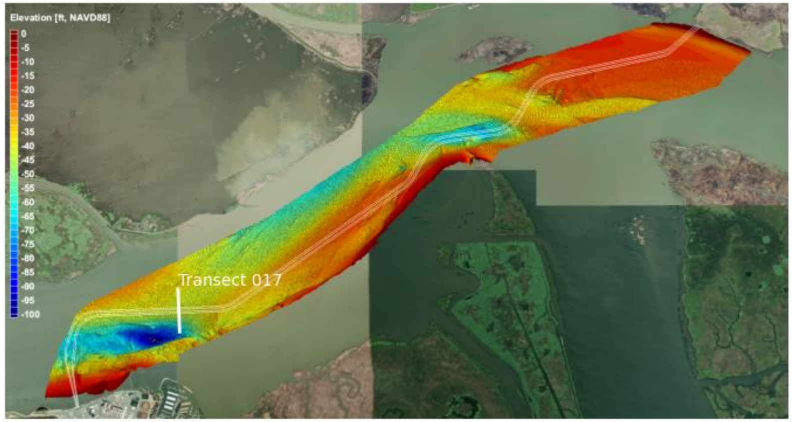


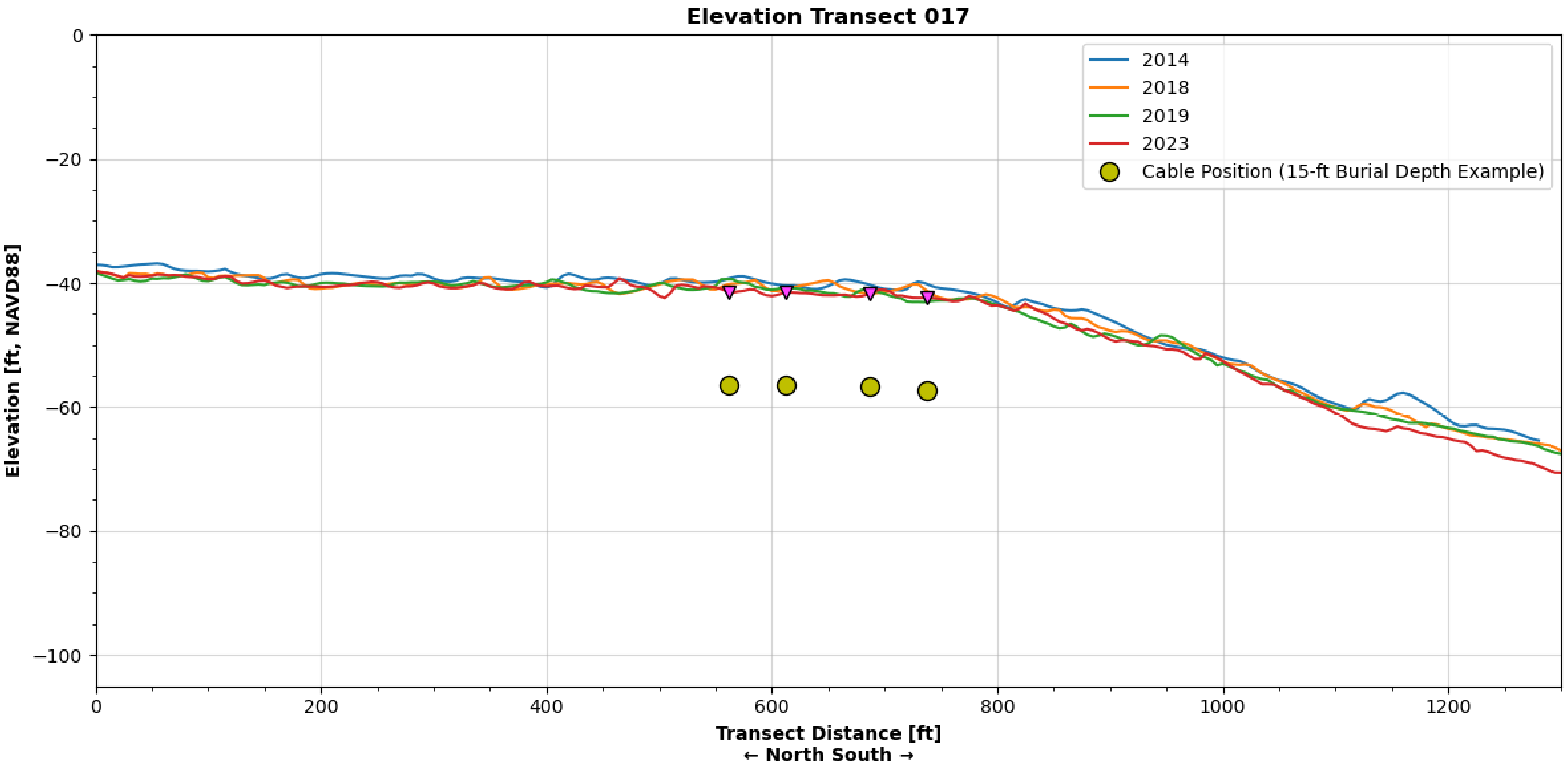


*Note: vertical exaggeration on elevation transect plots*

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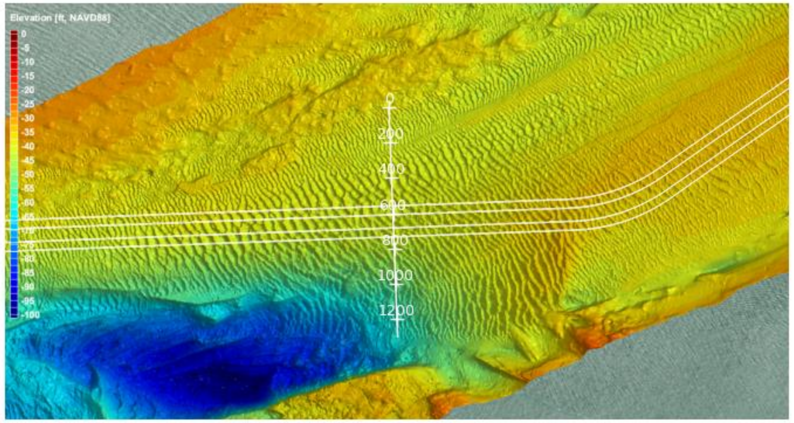


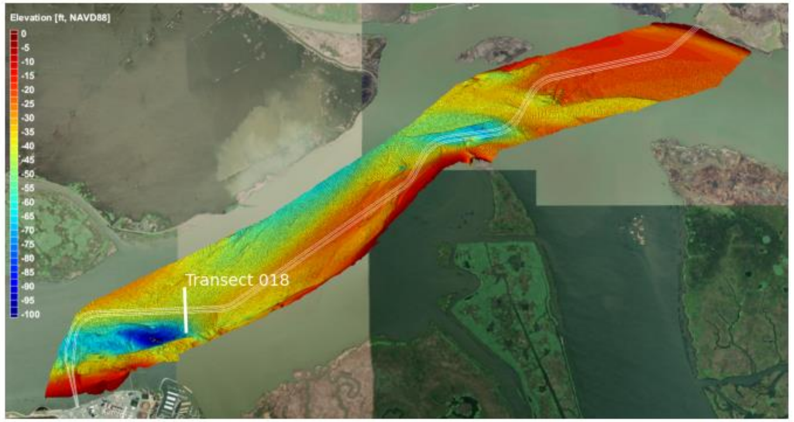


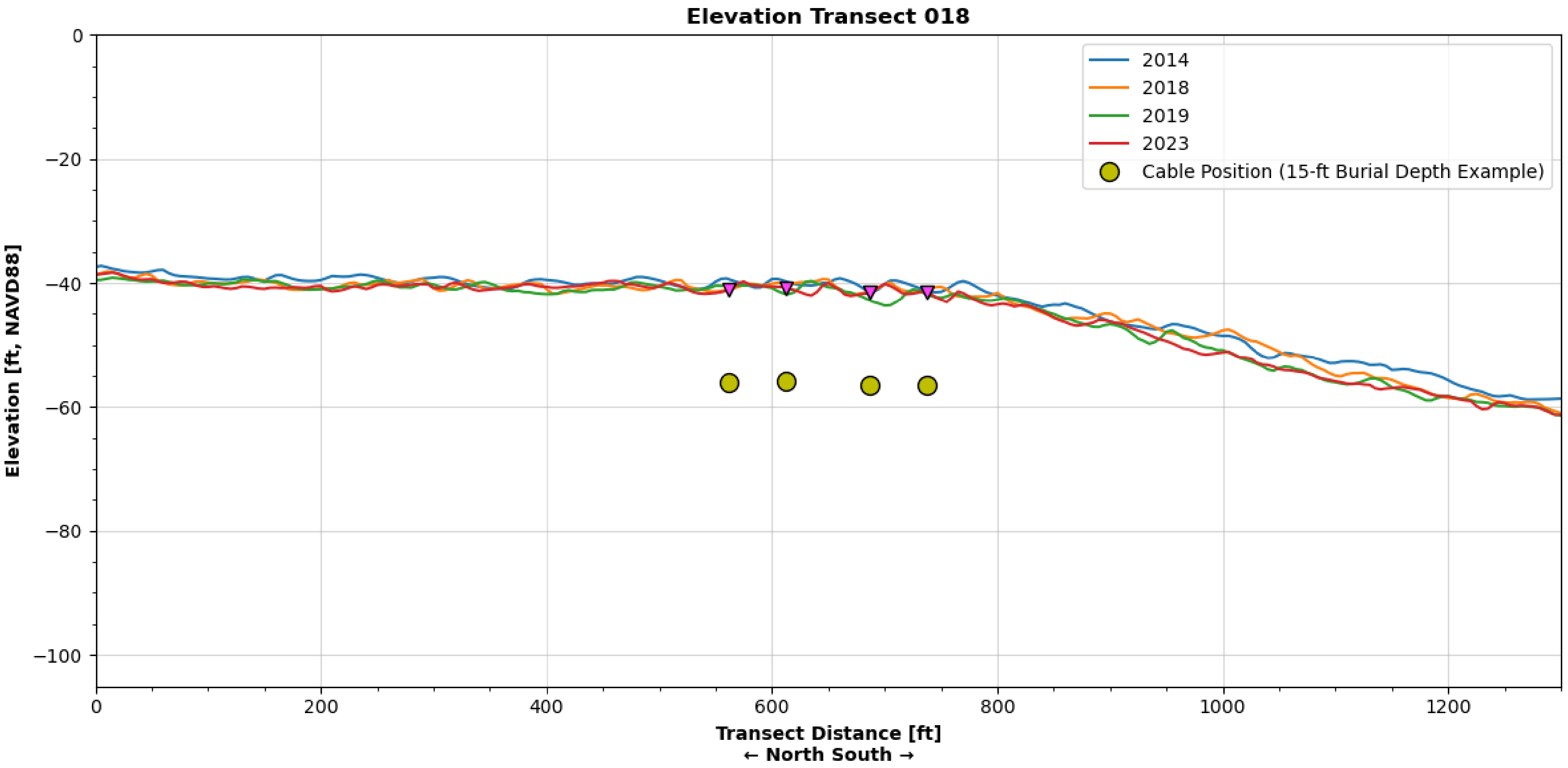


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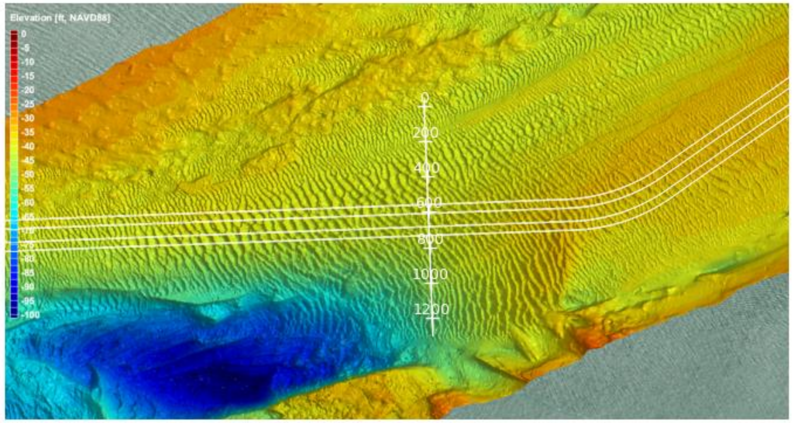


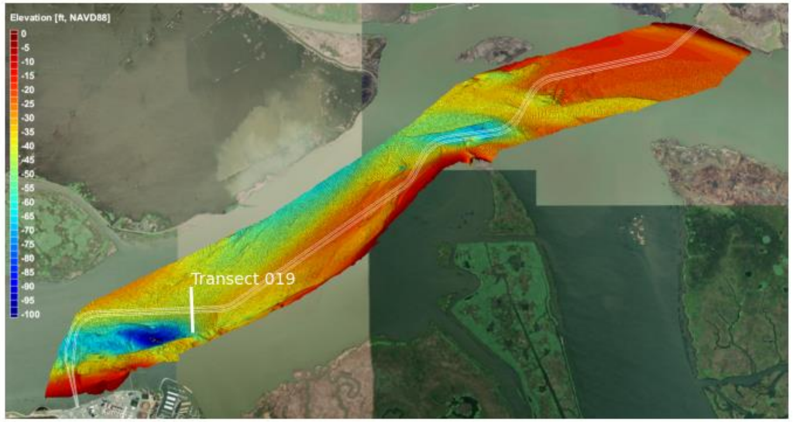


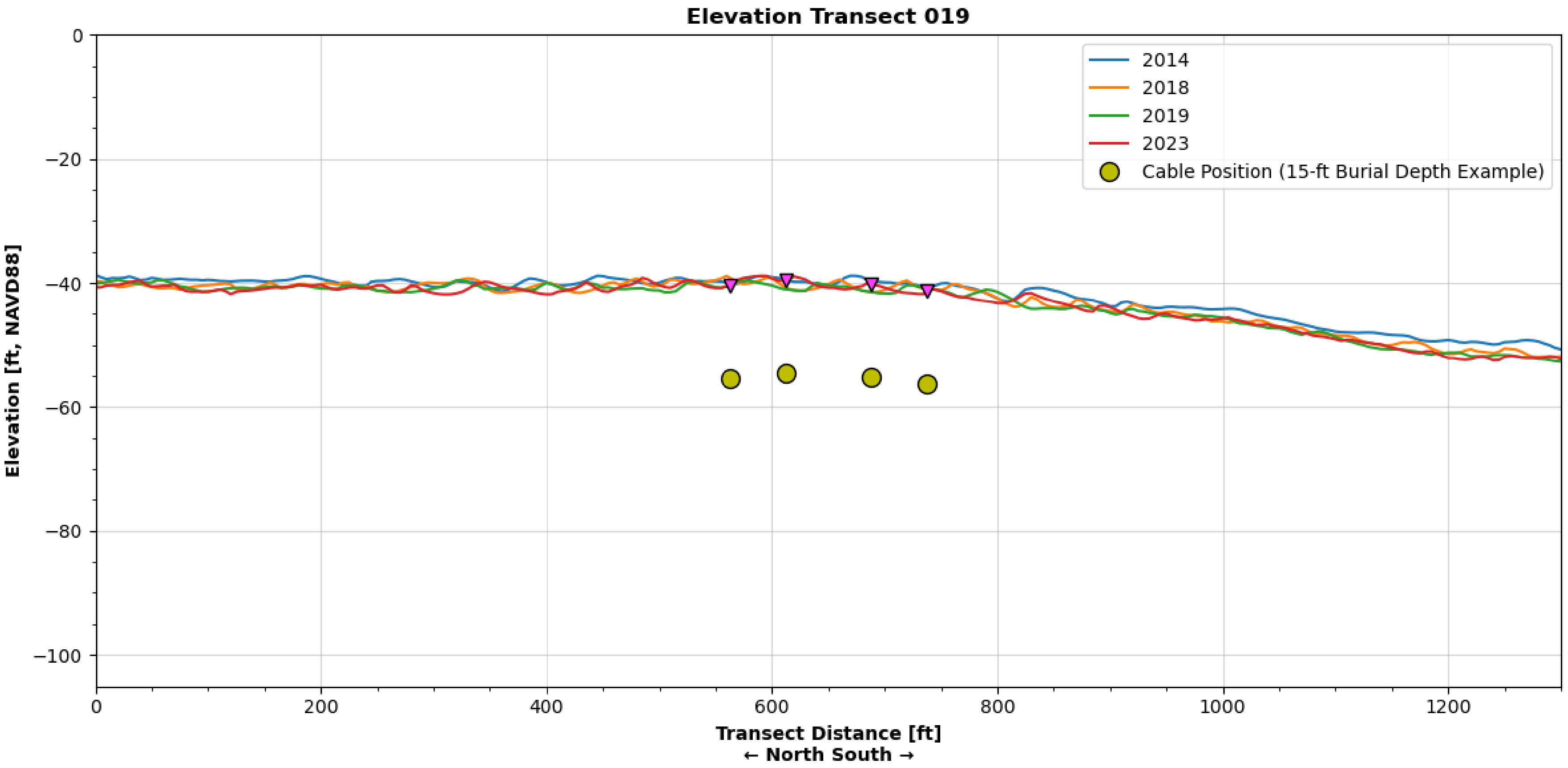


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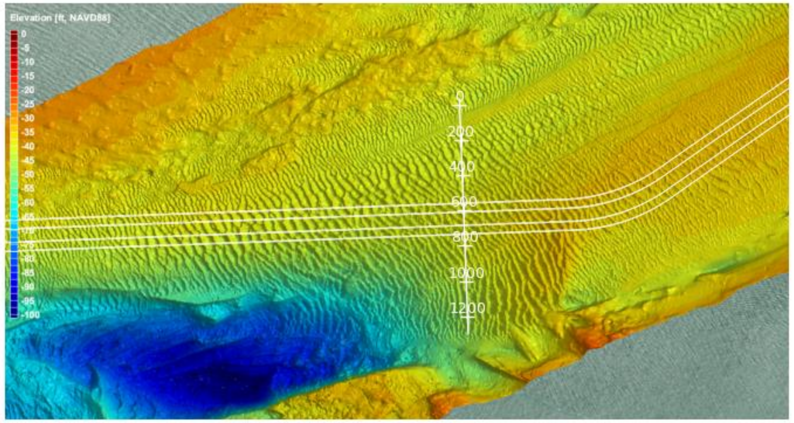


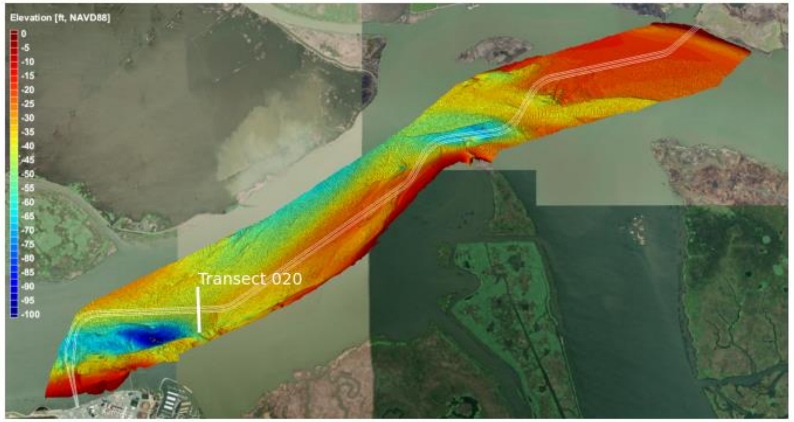


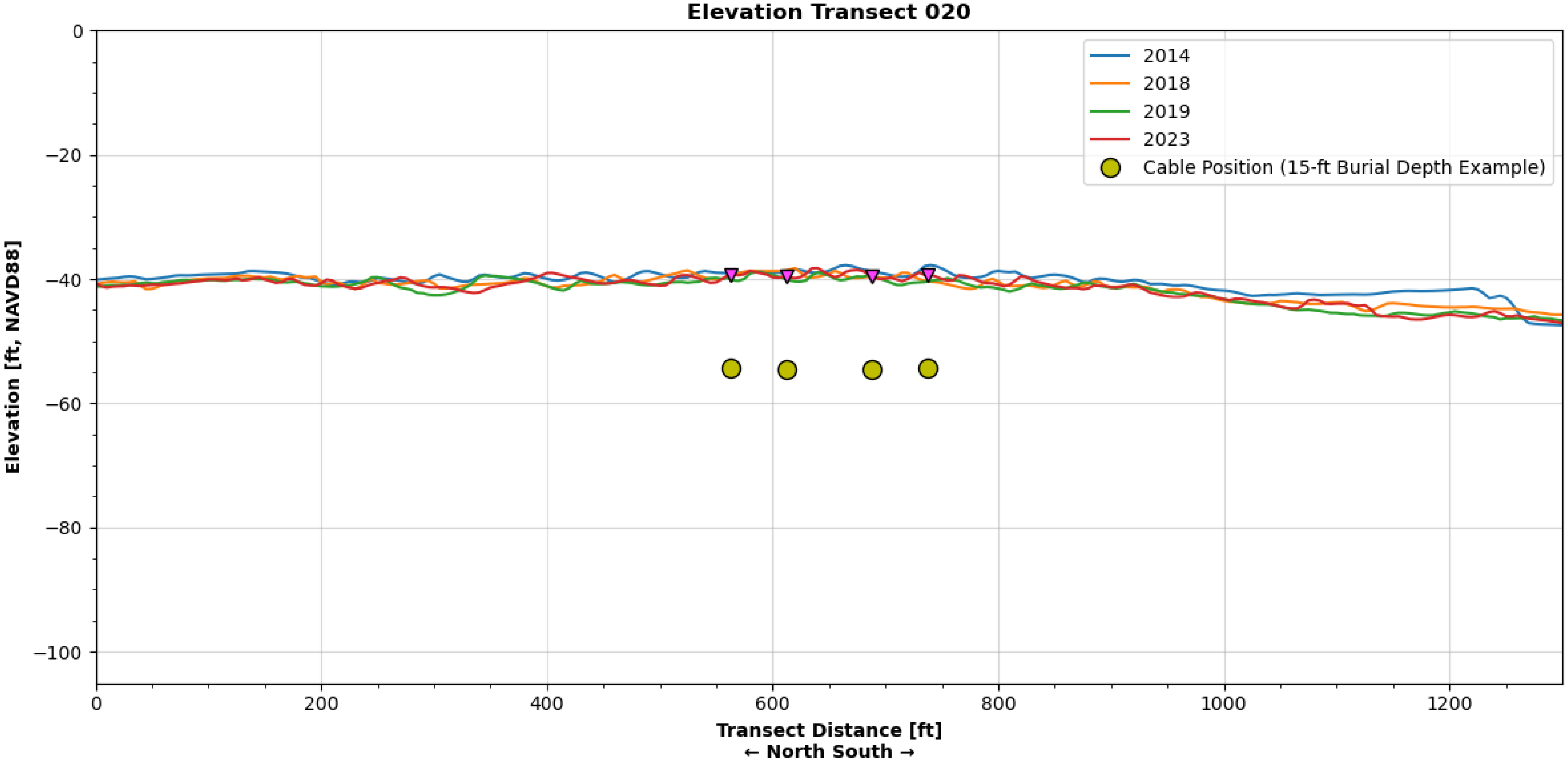


*Note: vertical exaggeration on elevation transect plots*

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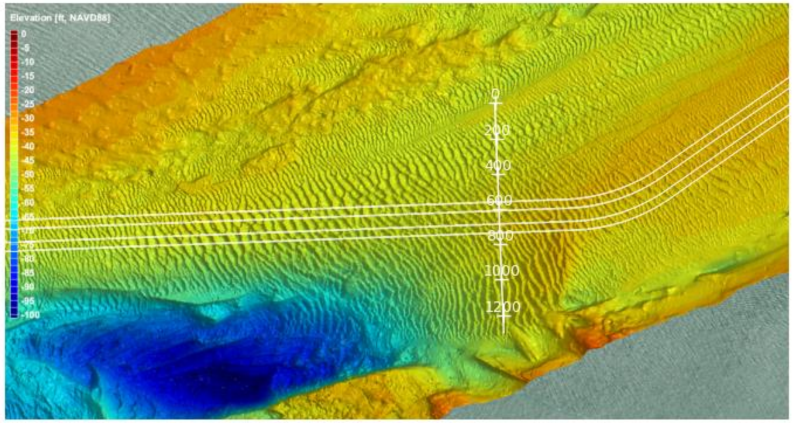


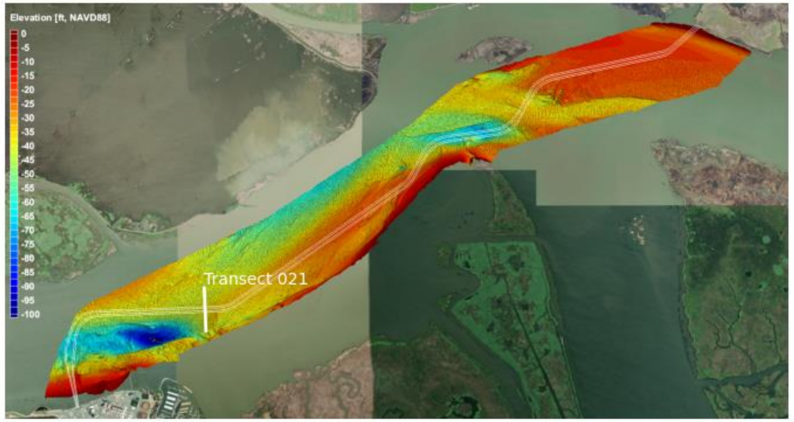


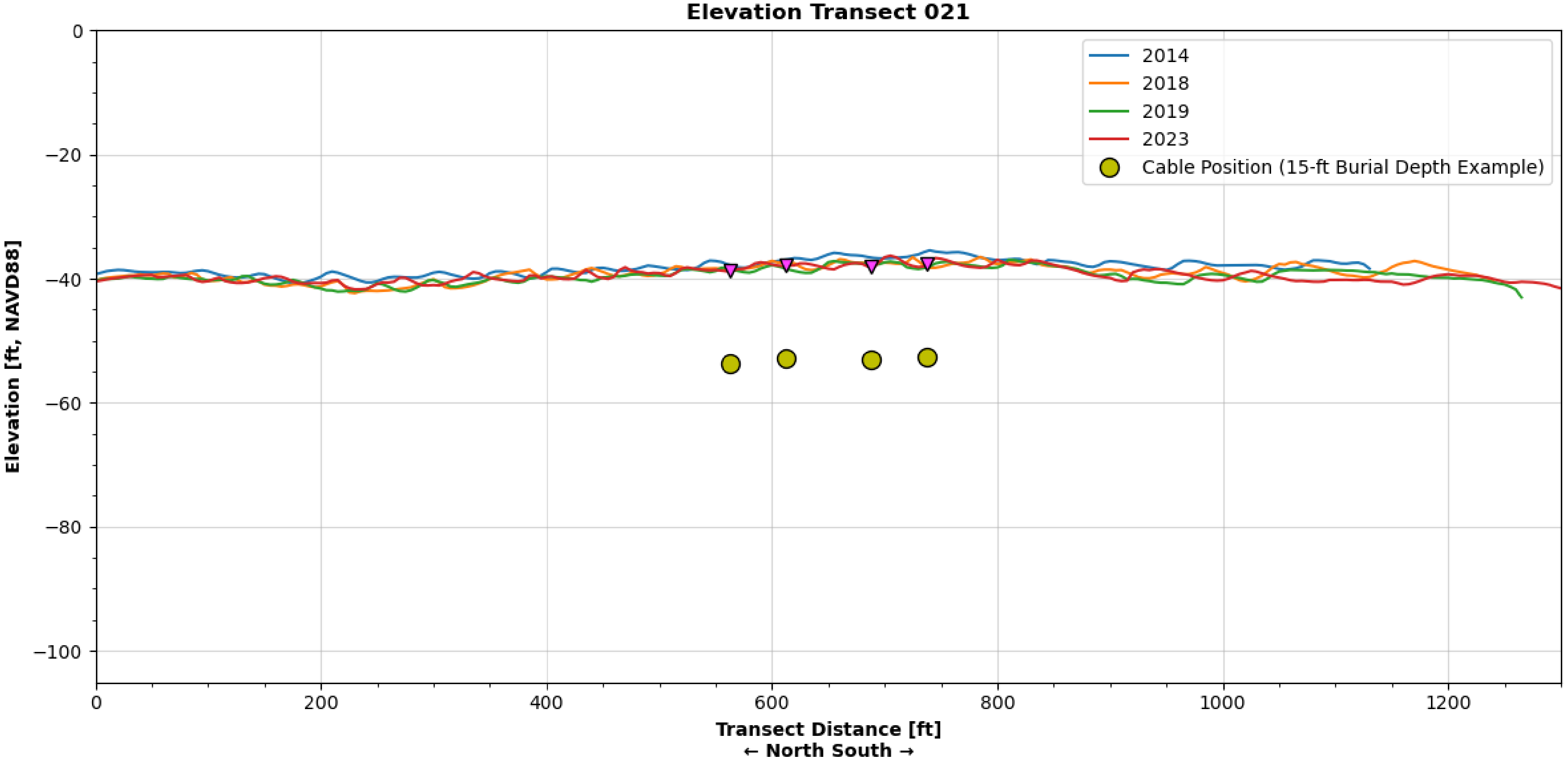


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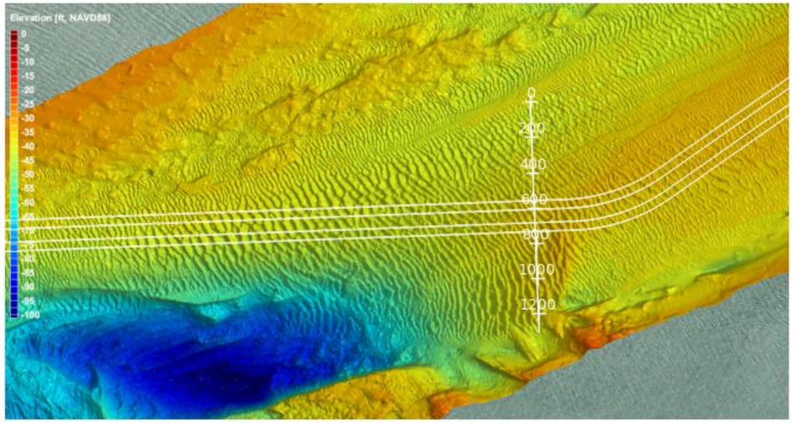


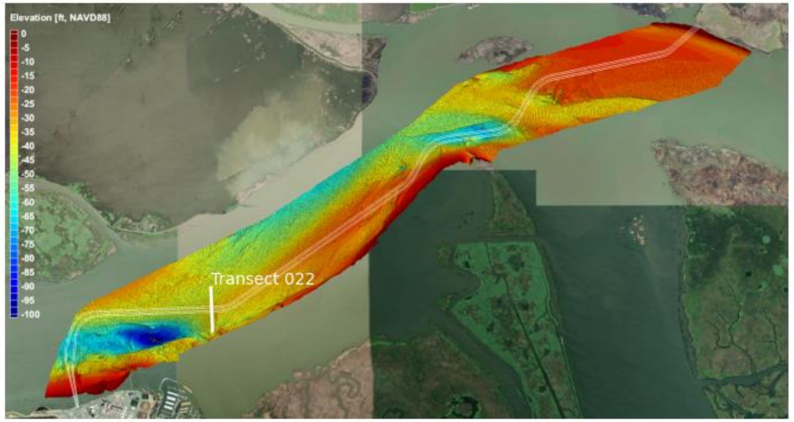


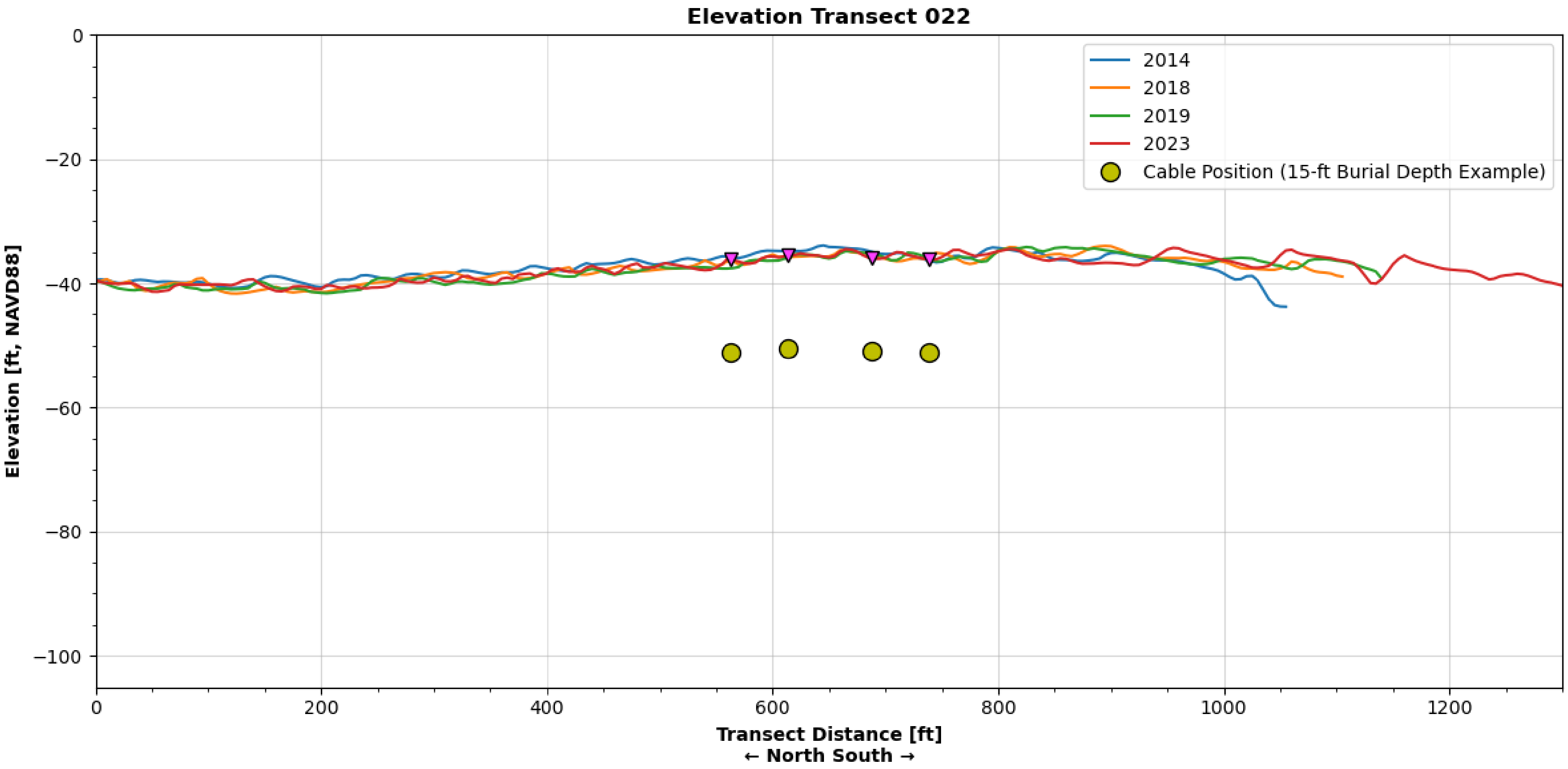


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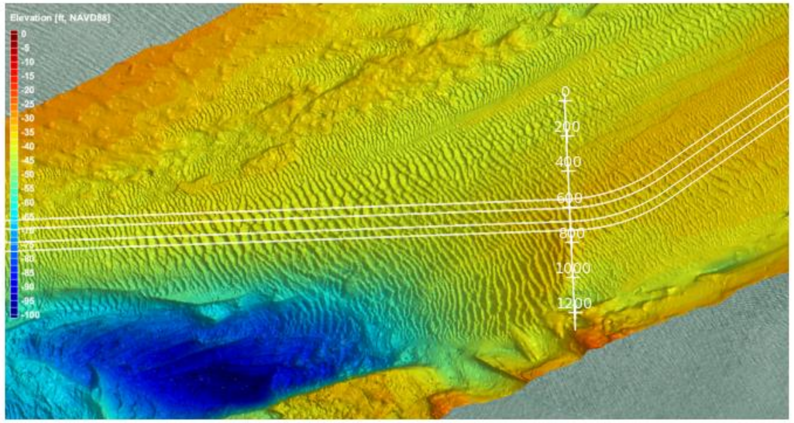


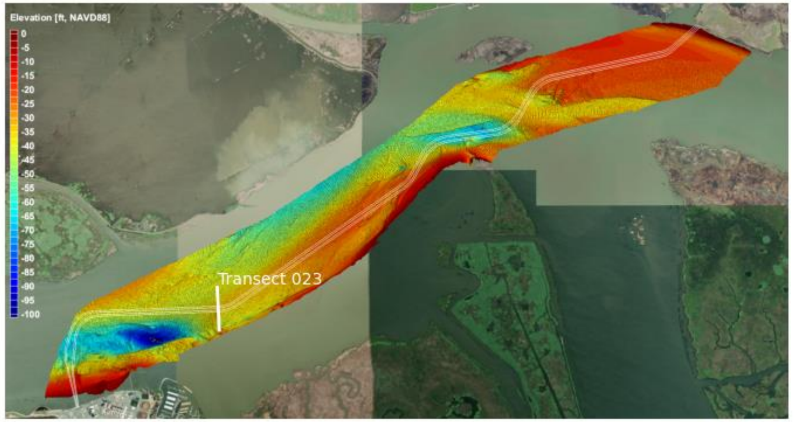


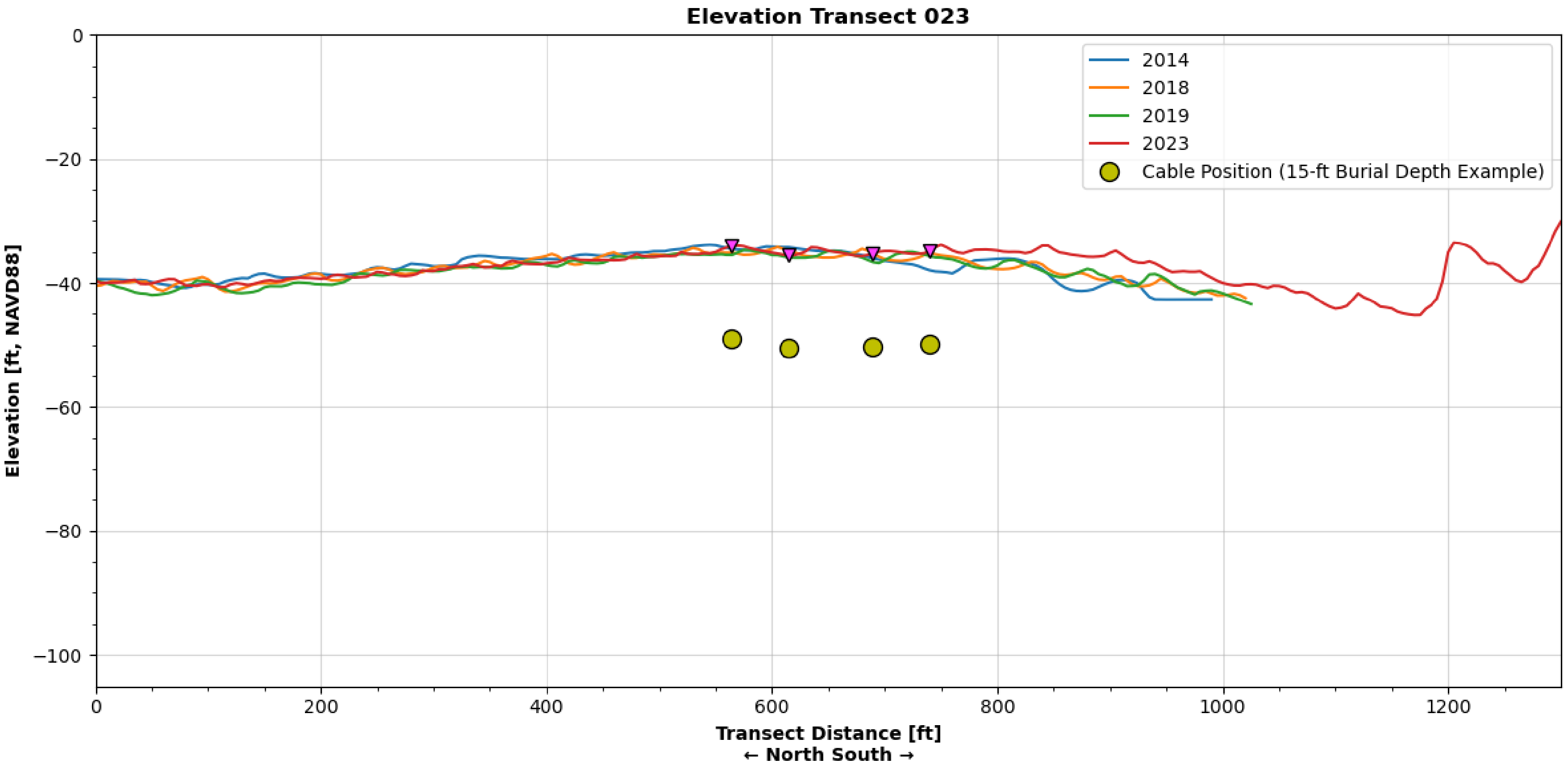


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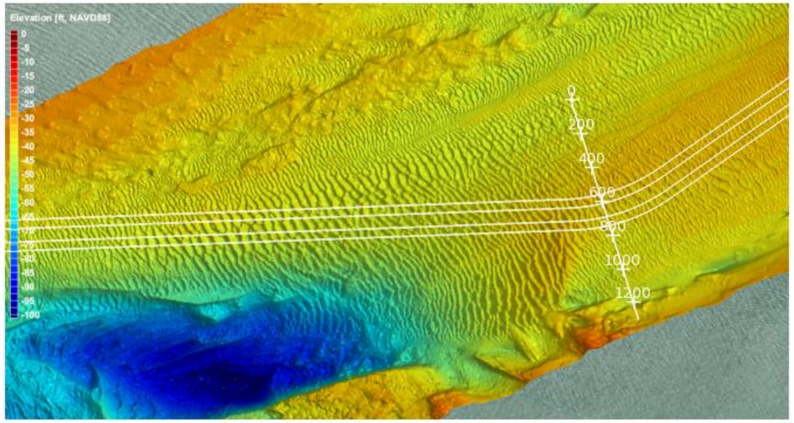


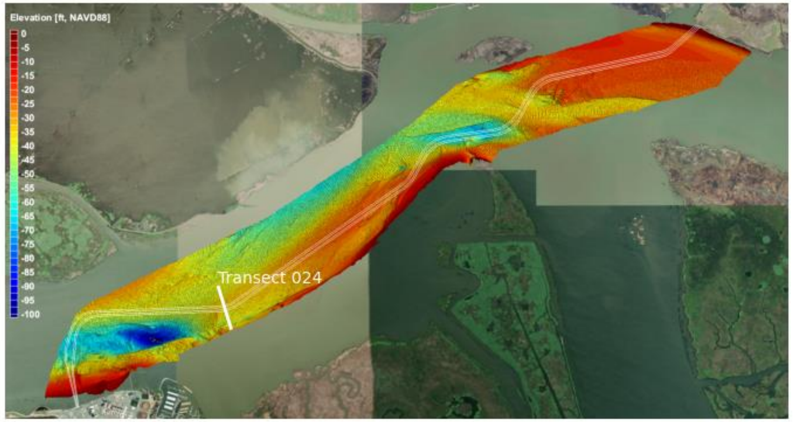


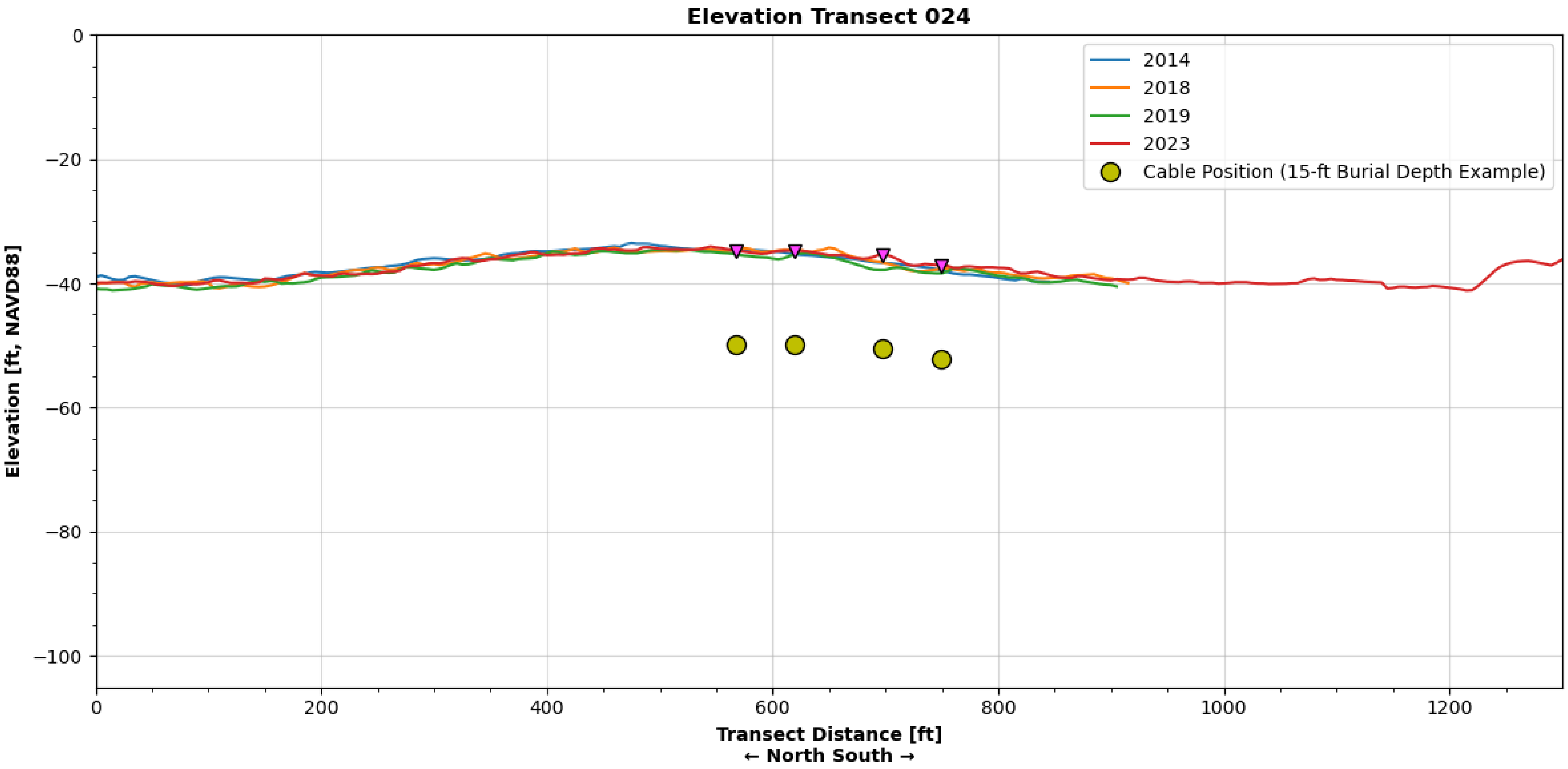


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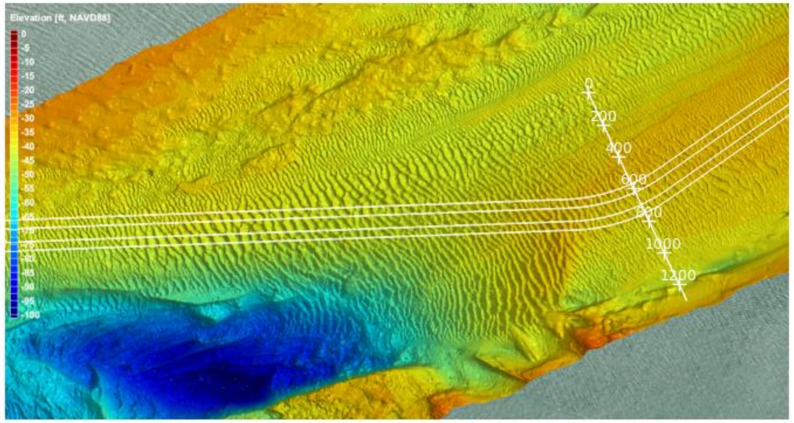

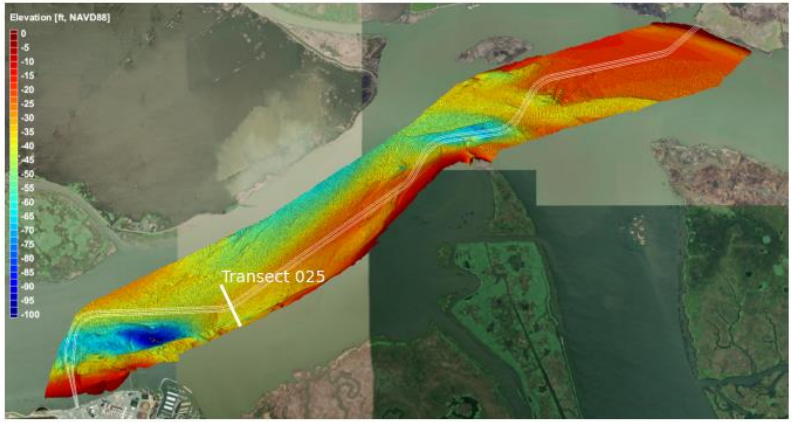


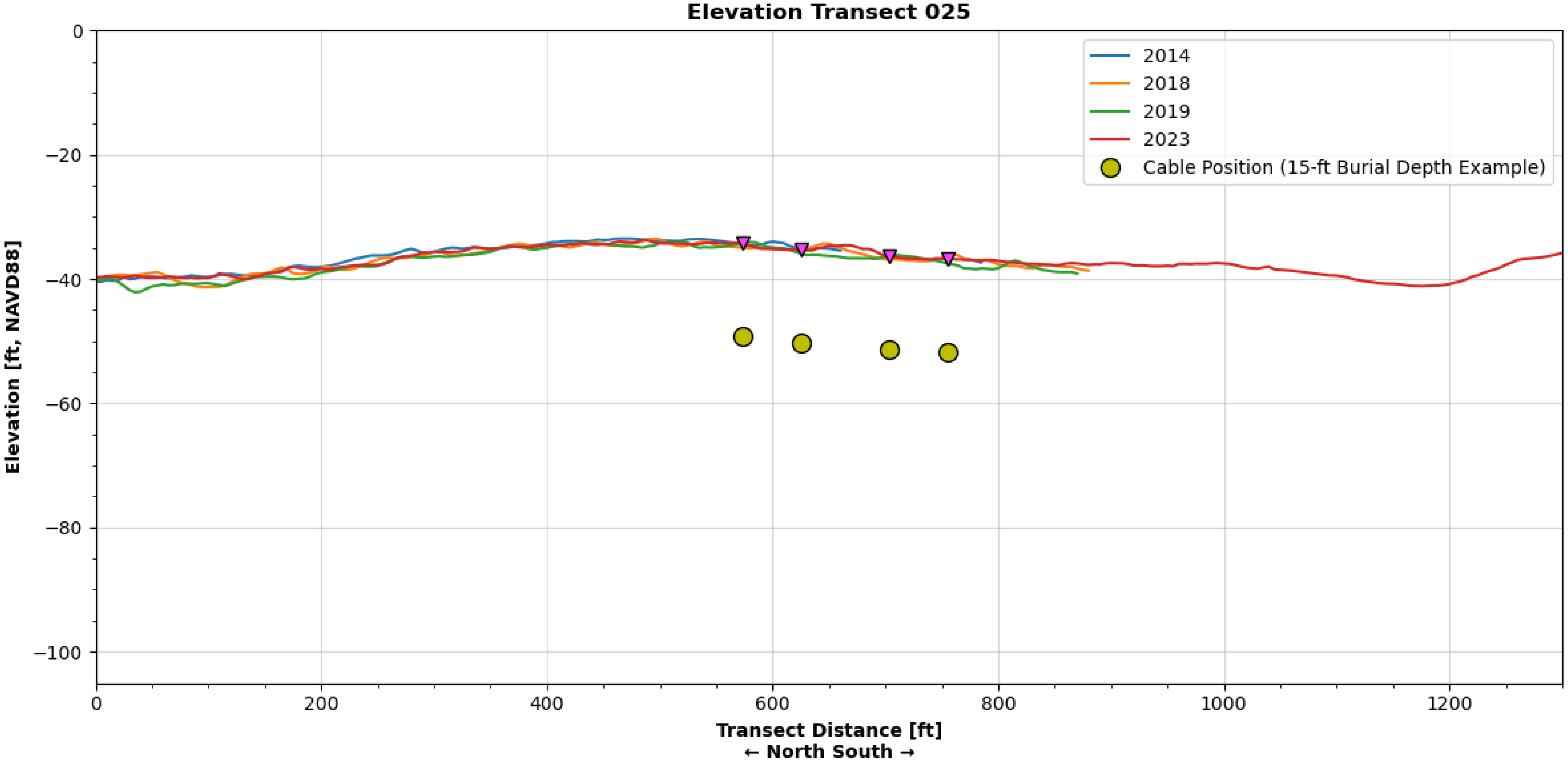


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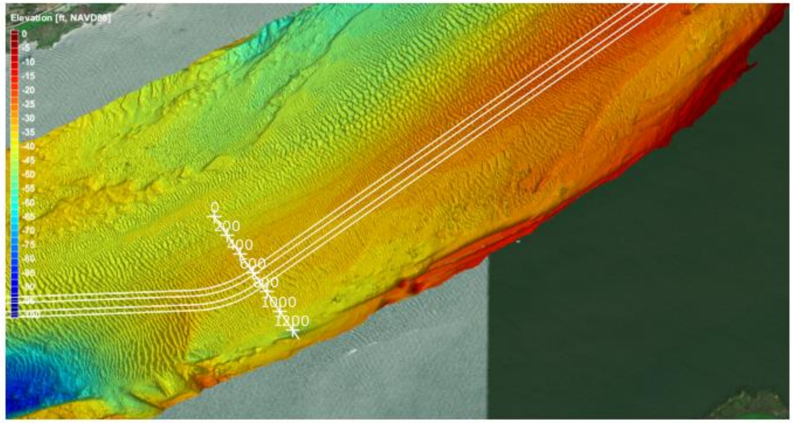

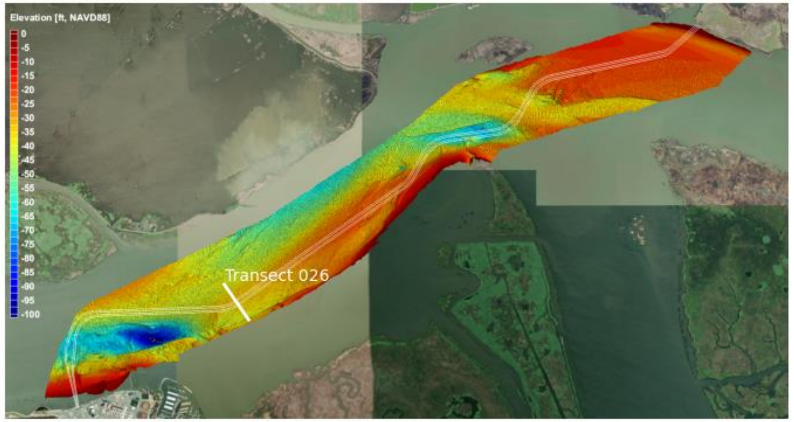


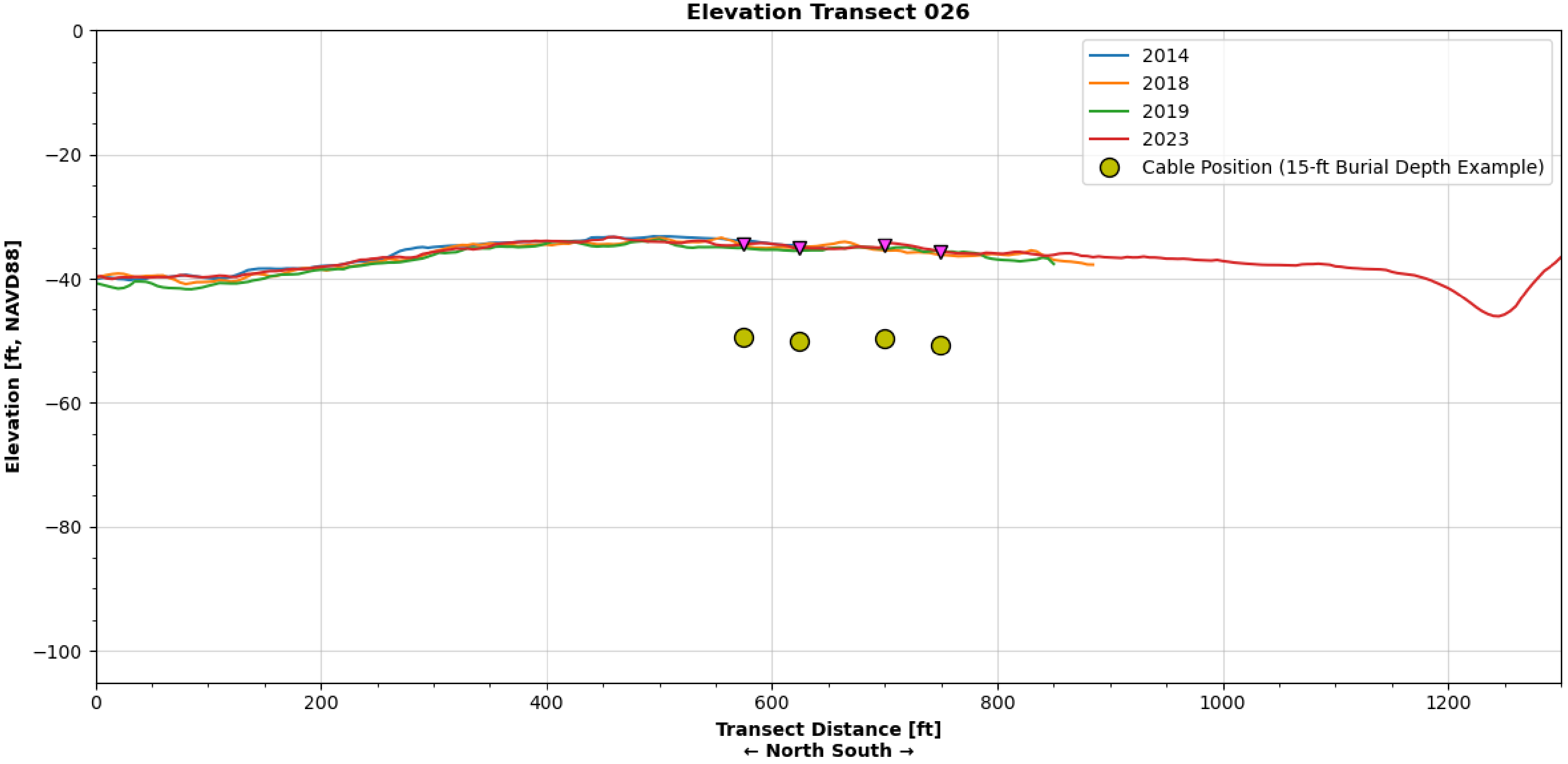


Note: vertical exaggeration on elevation transect plots

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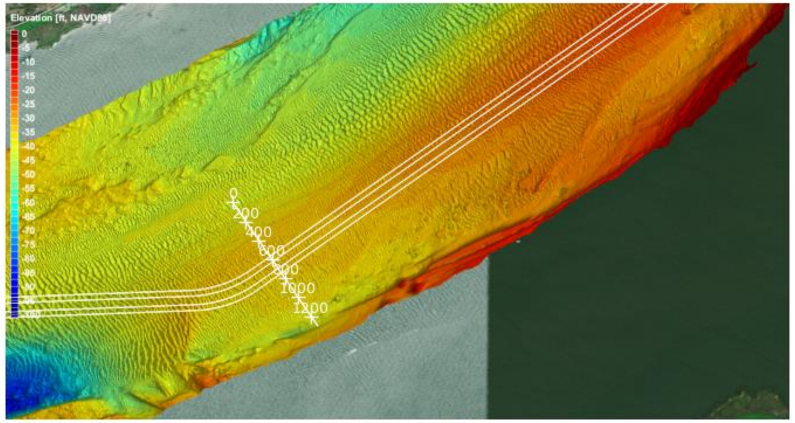


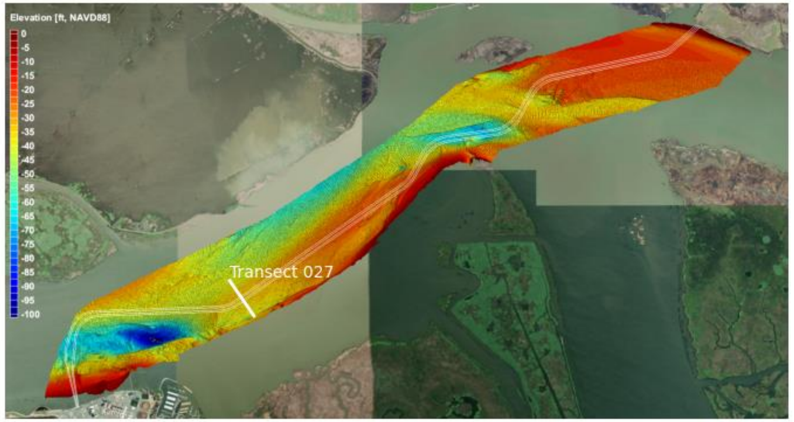


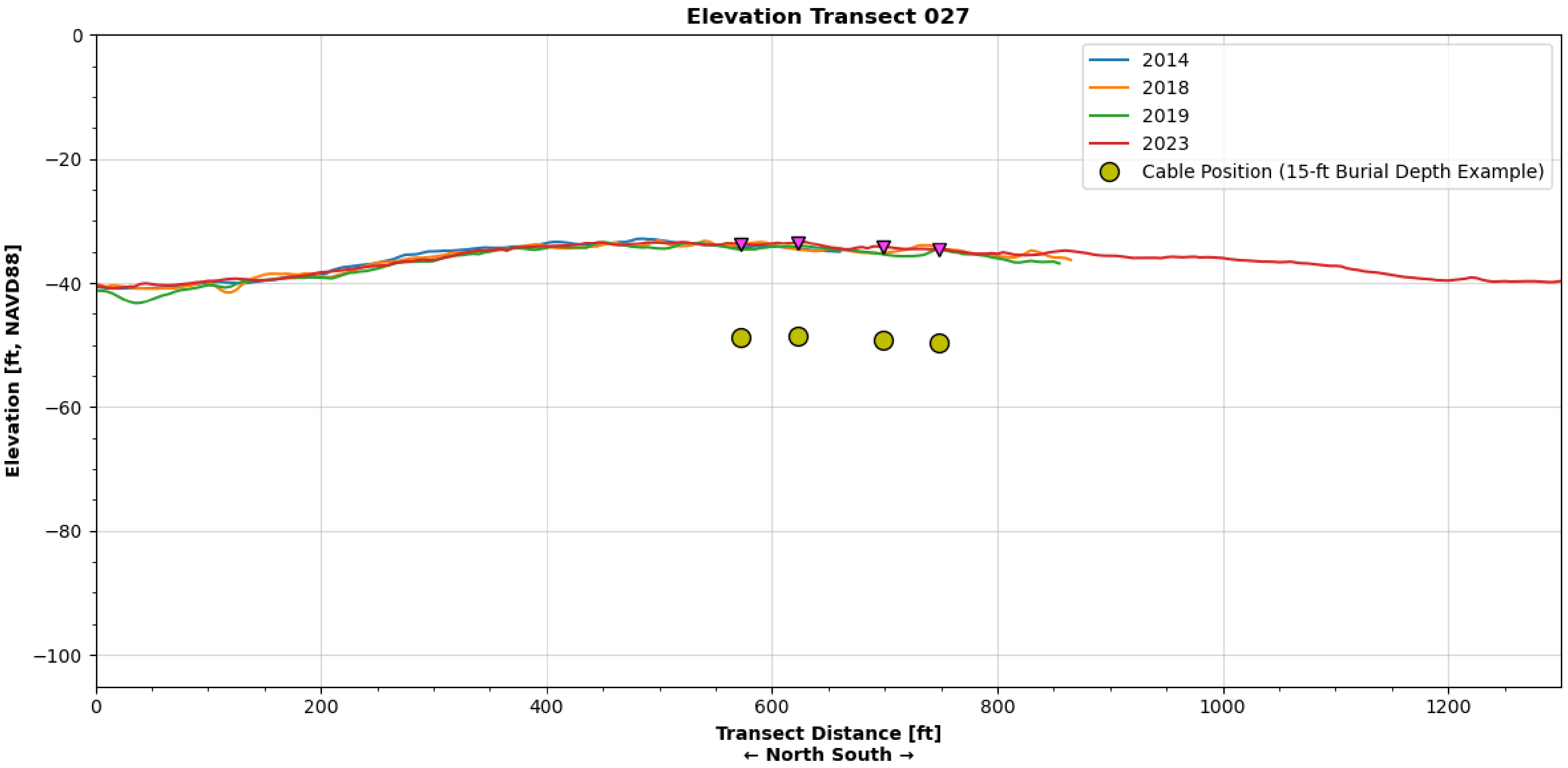


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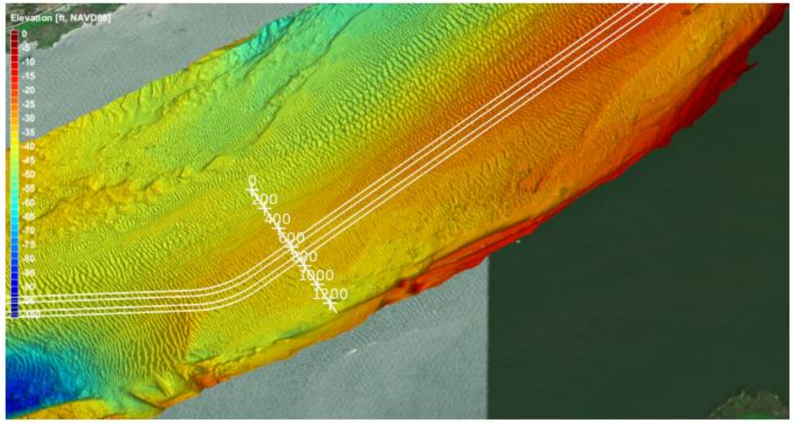


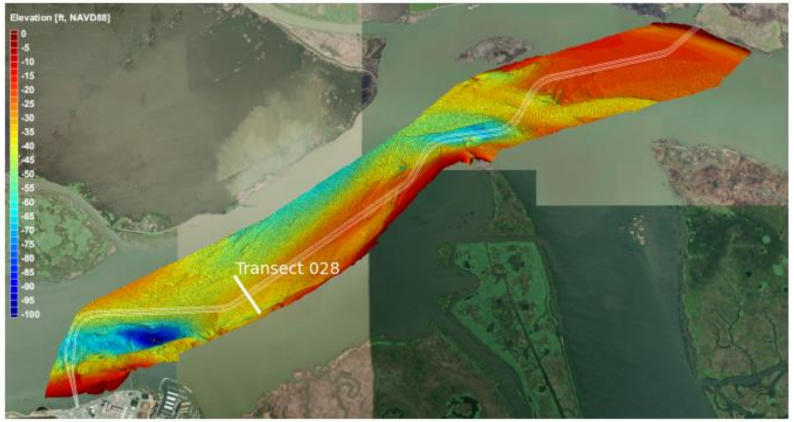


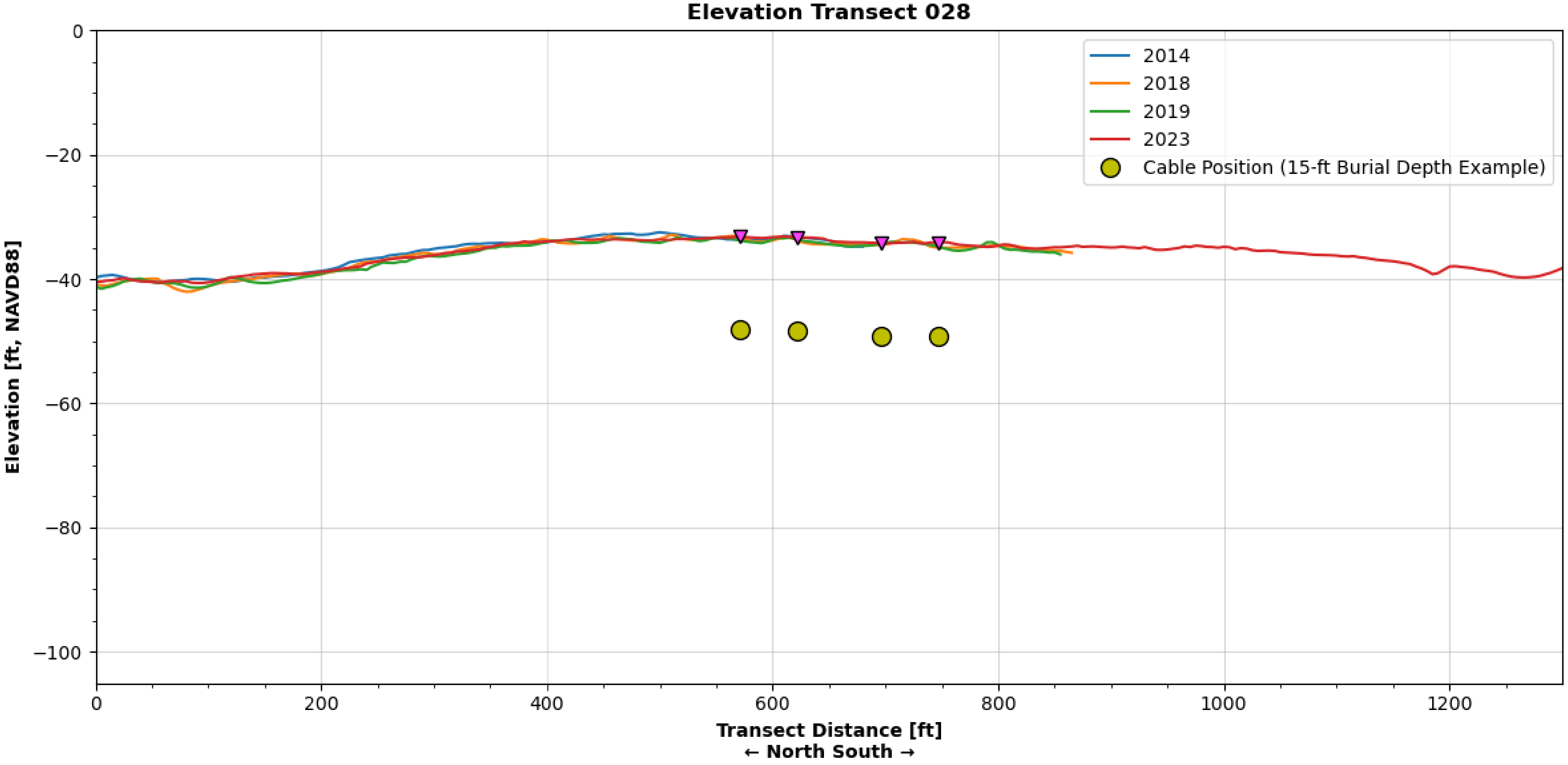


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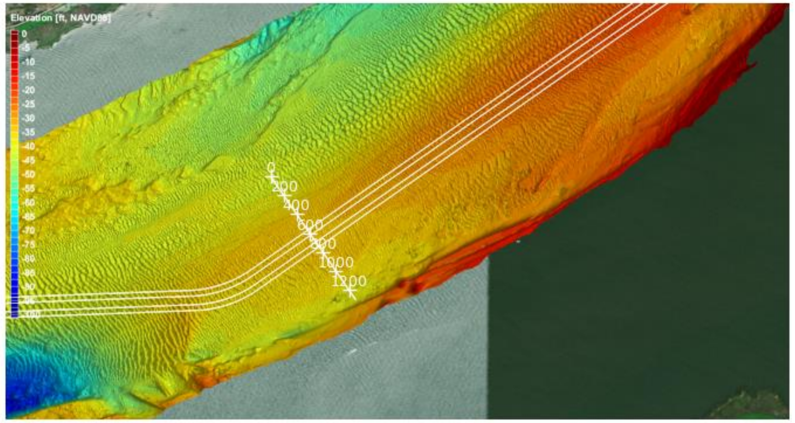


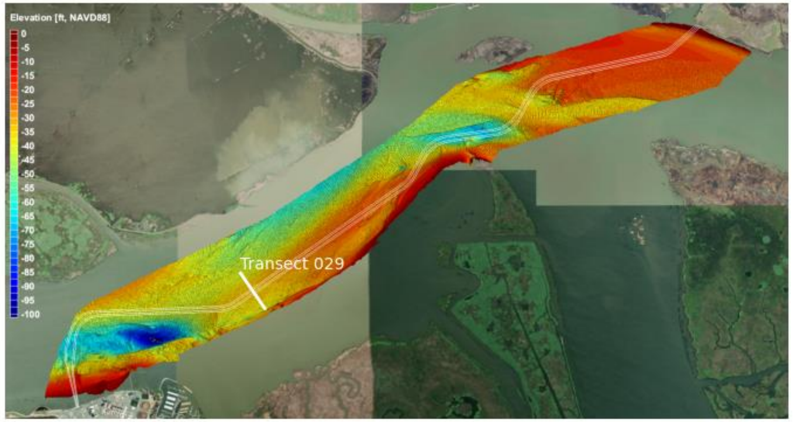


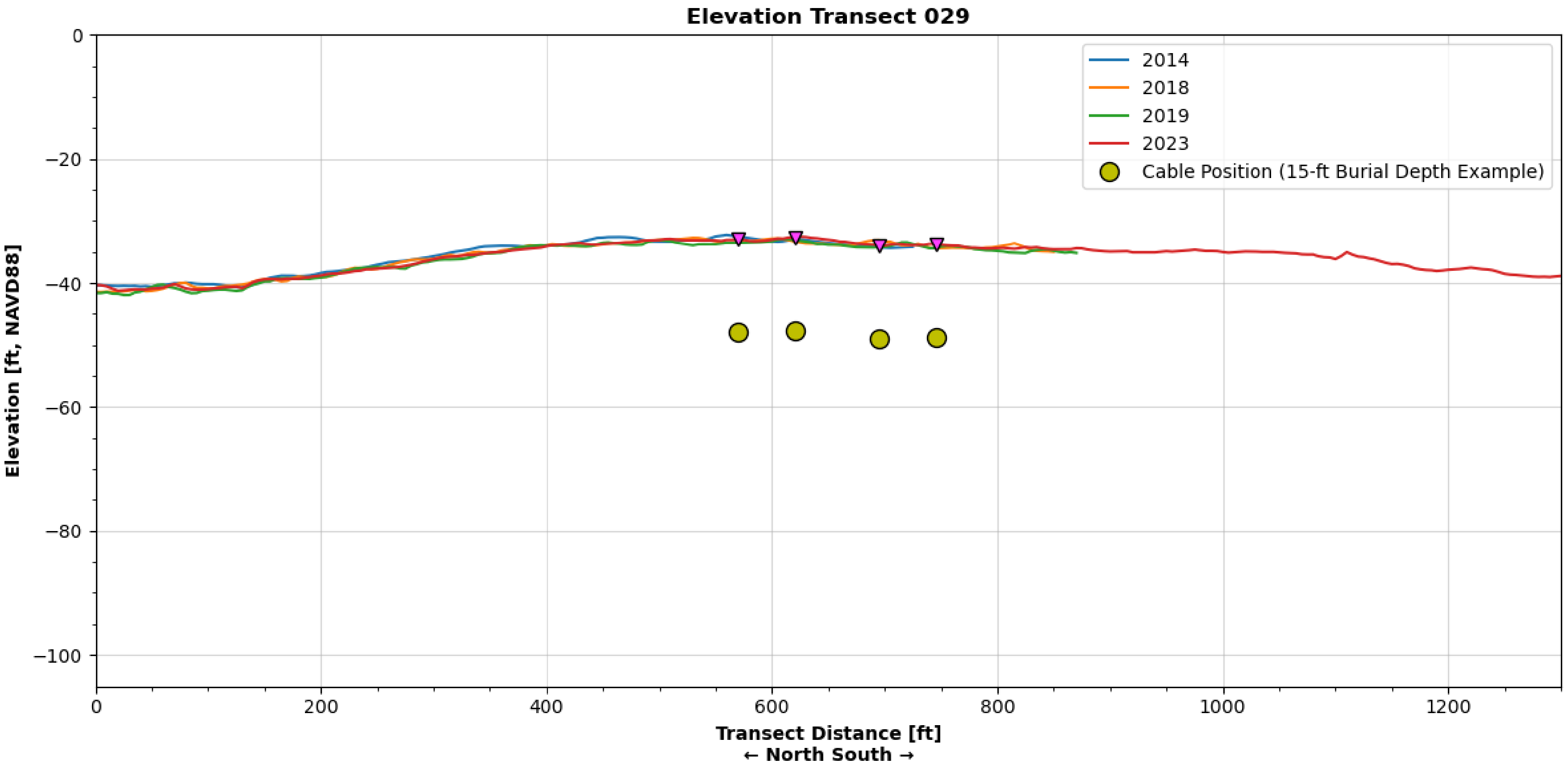


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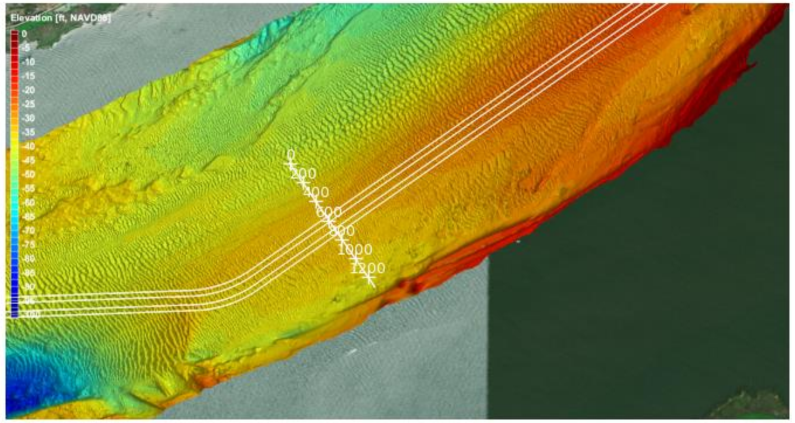

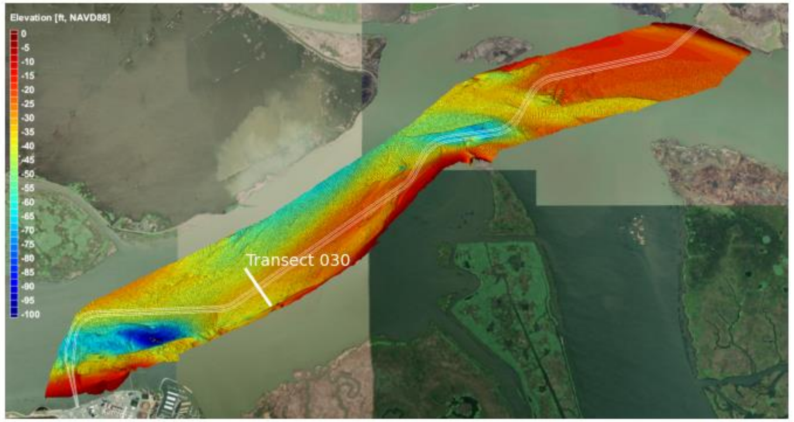


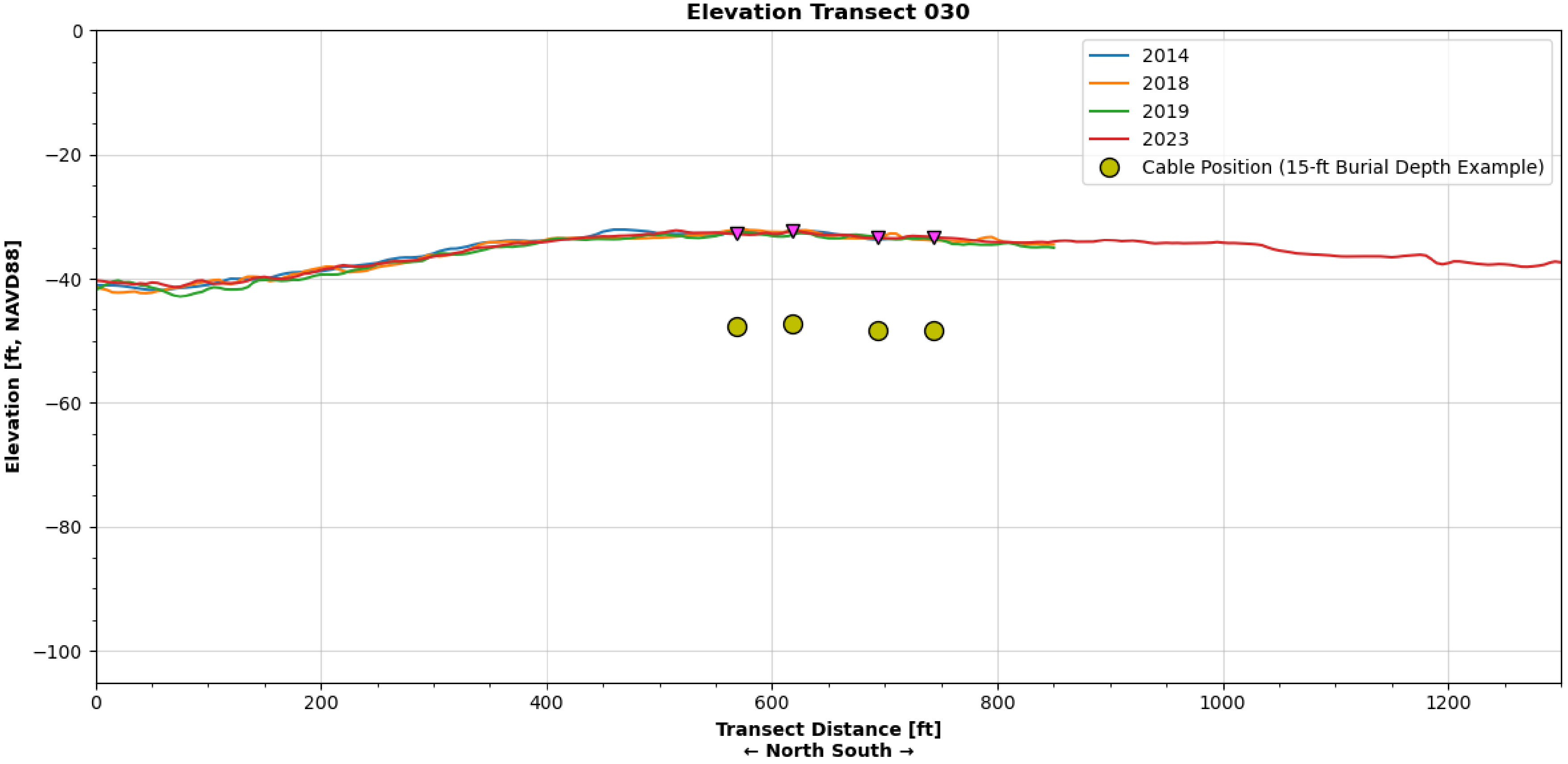


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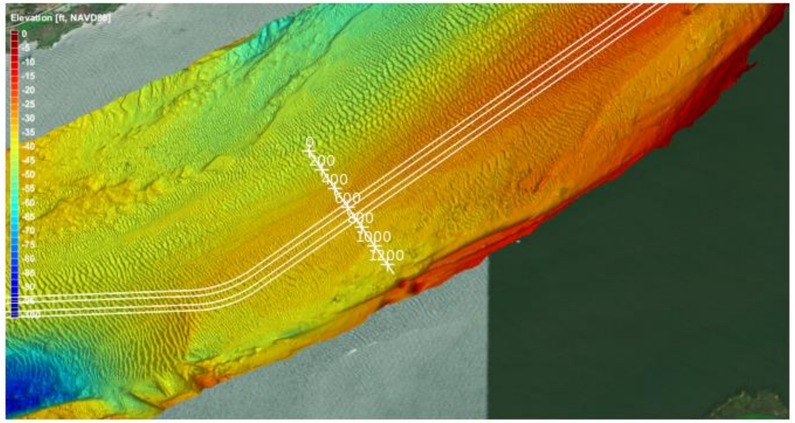

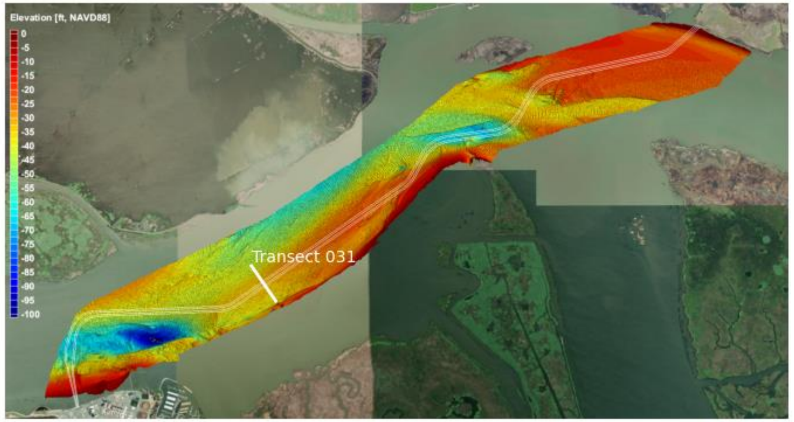


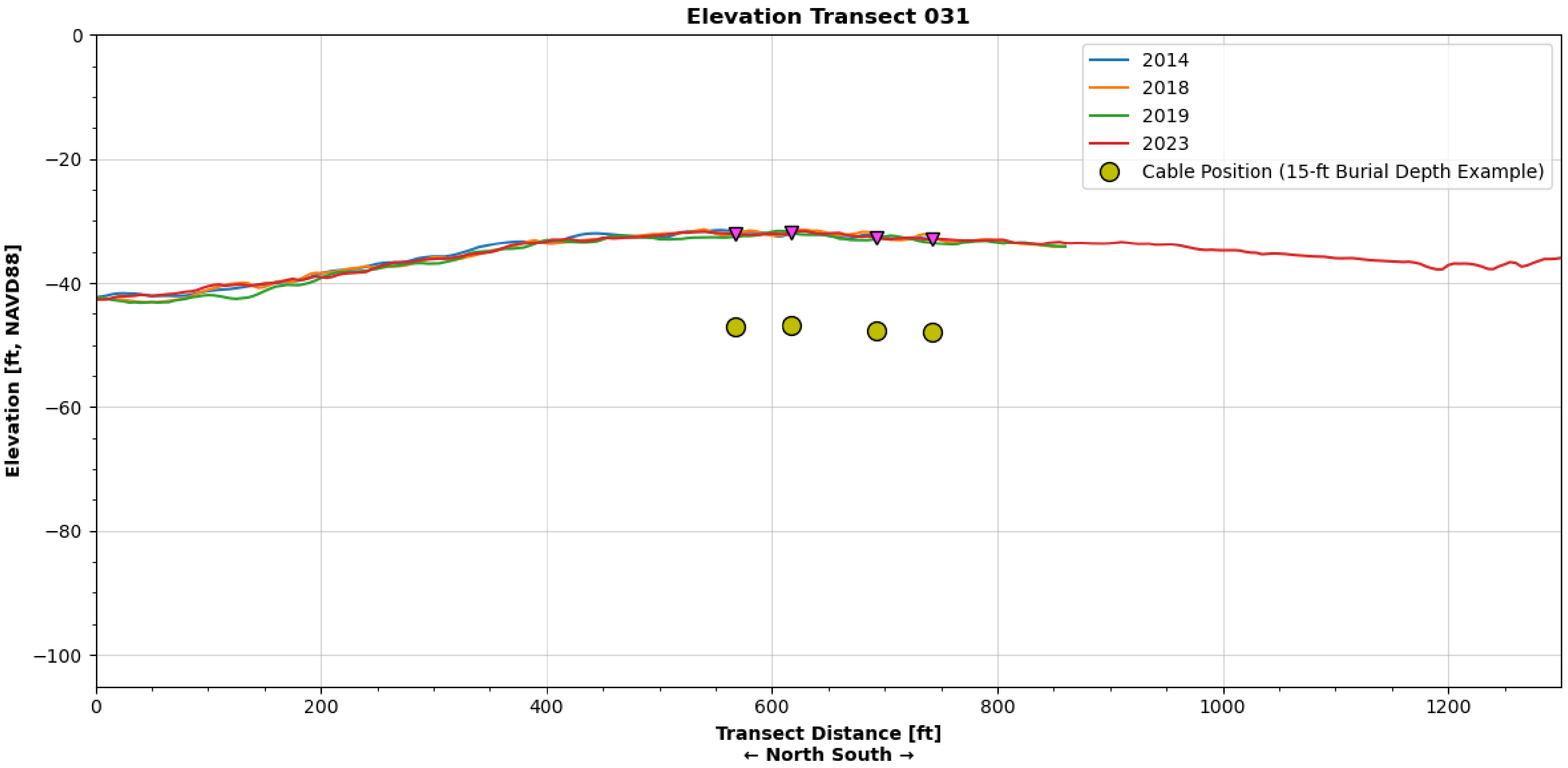


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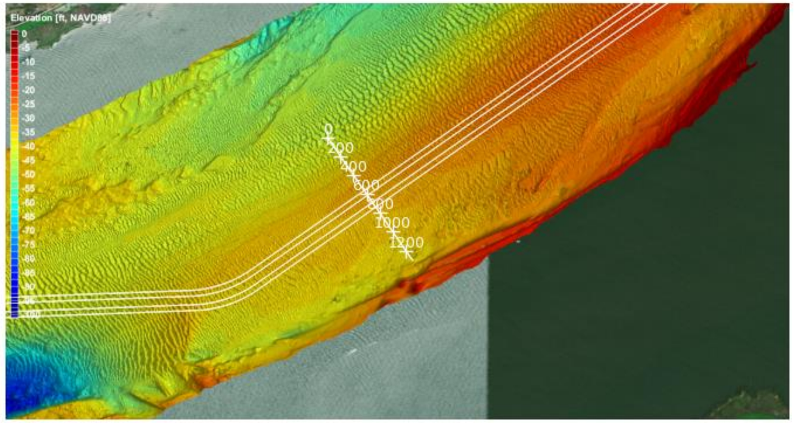

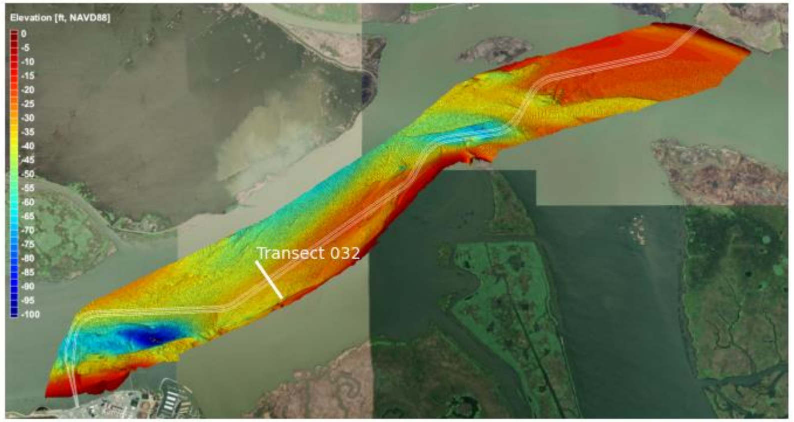


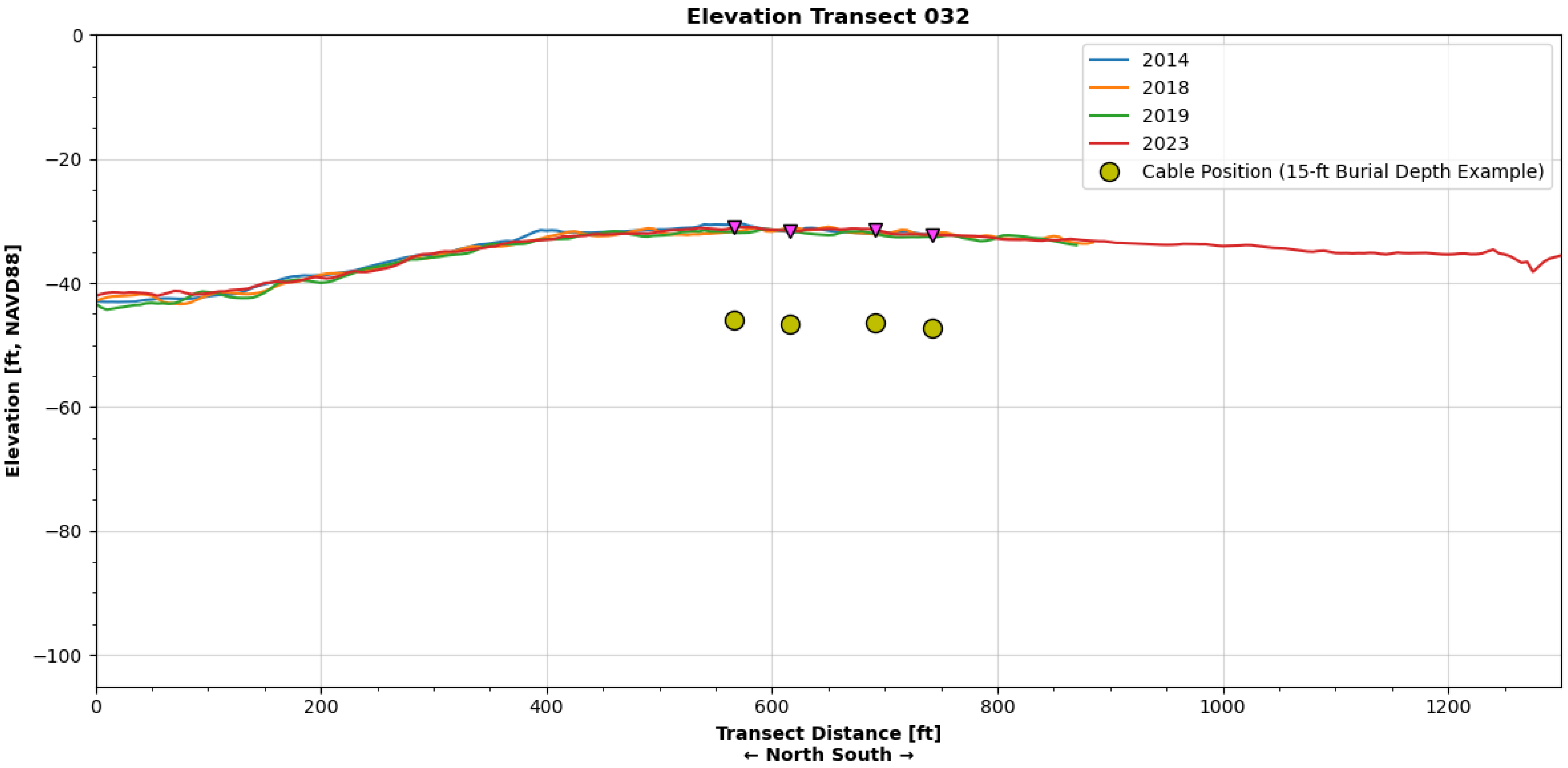


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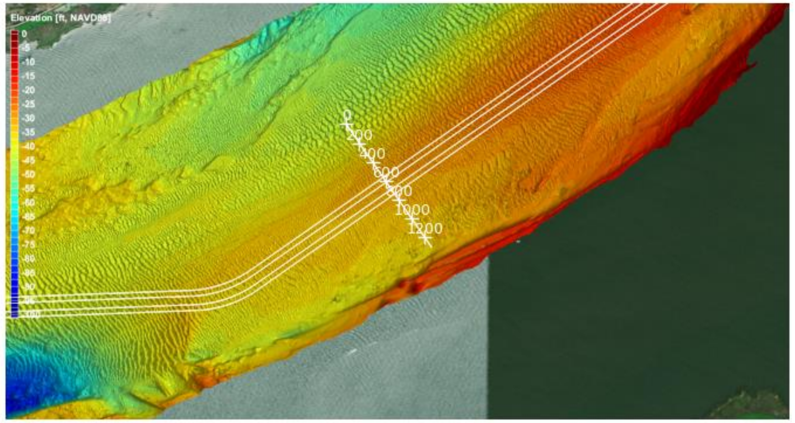


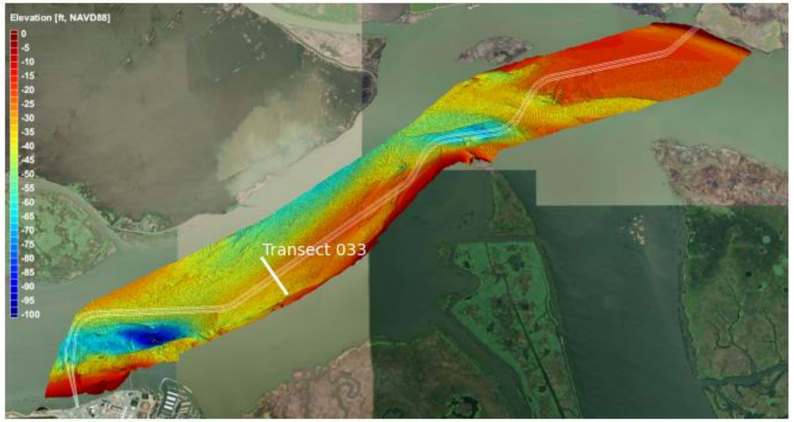


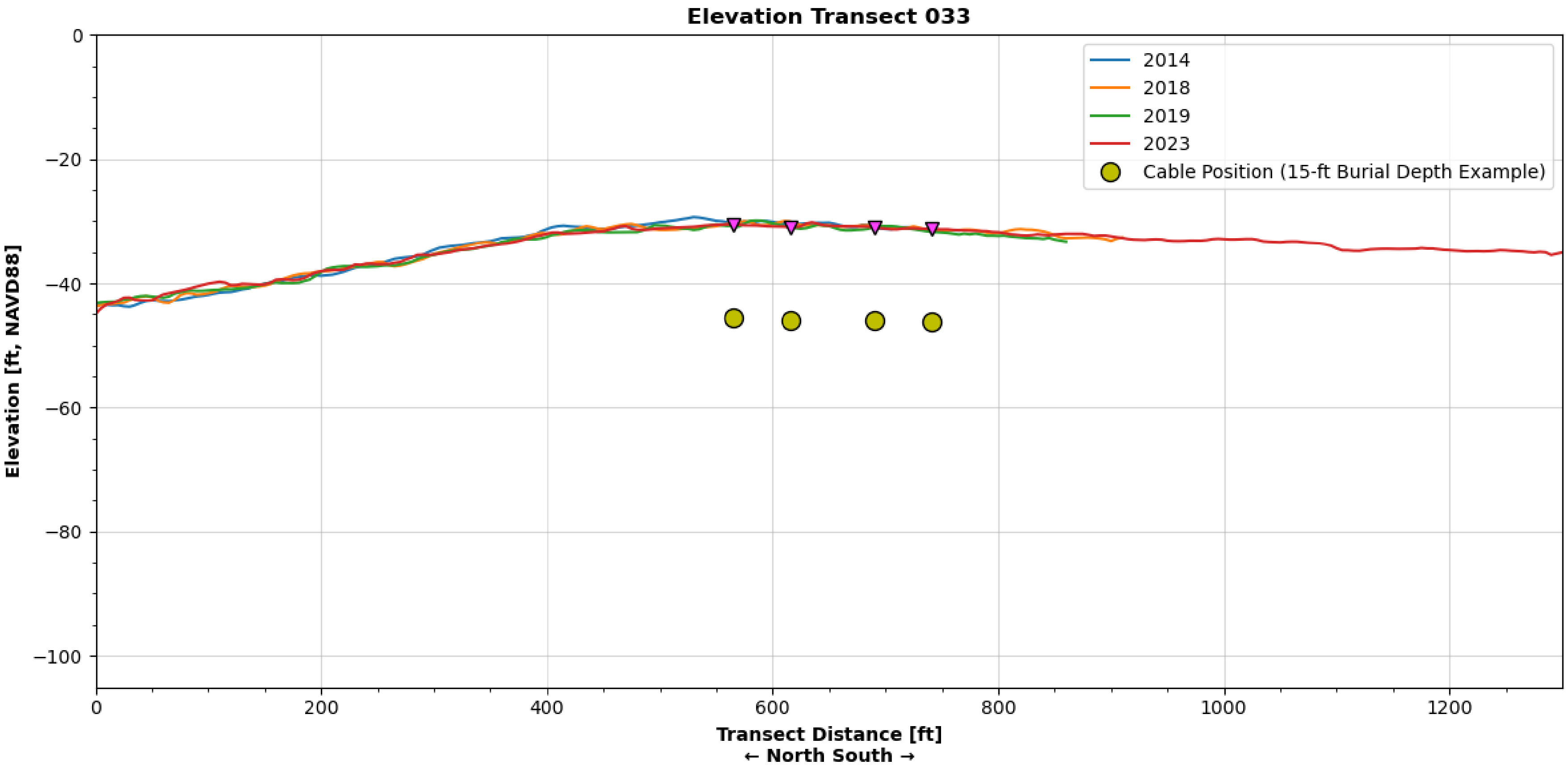


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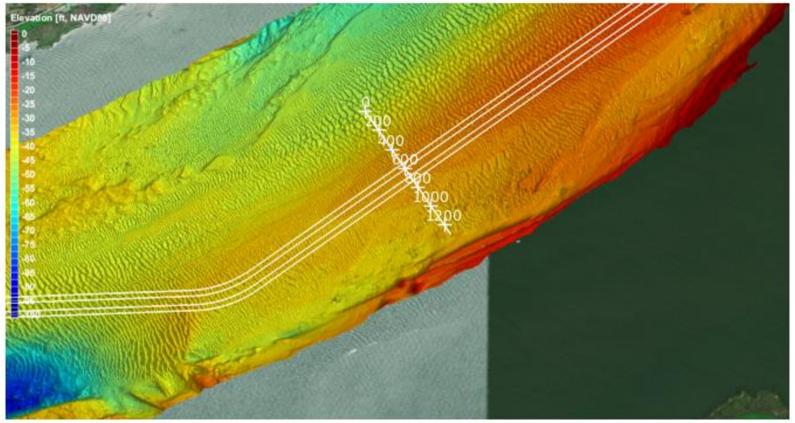


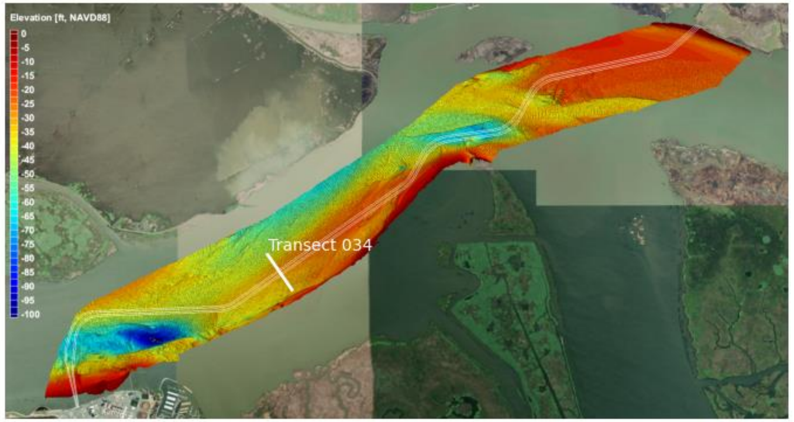


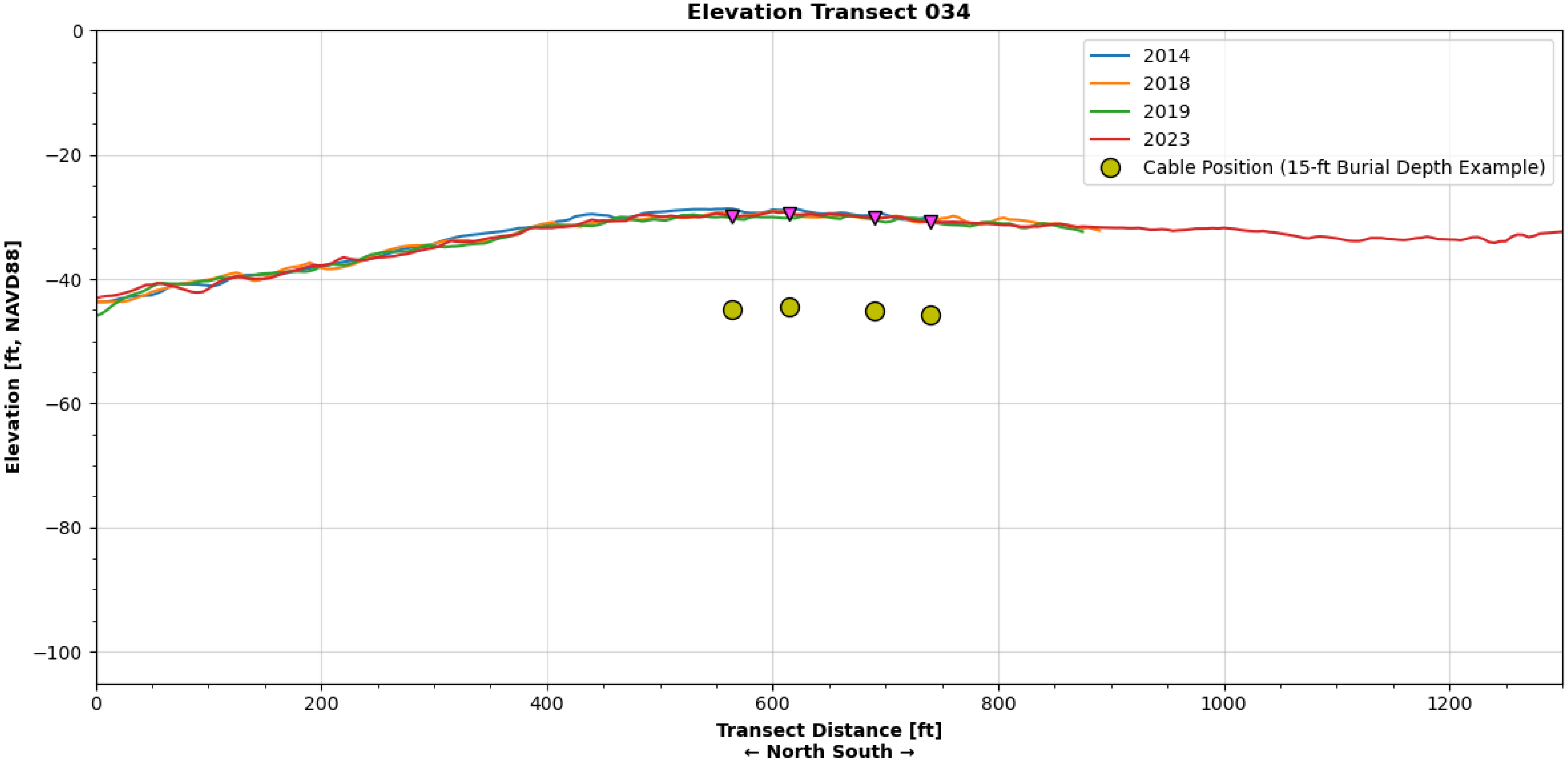


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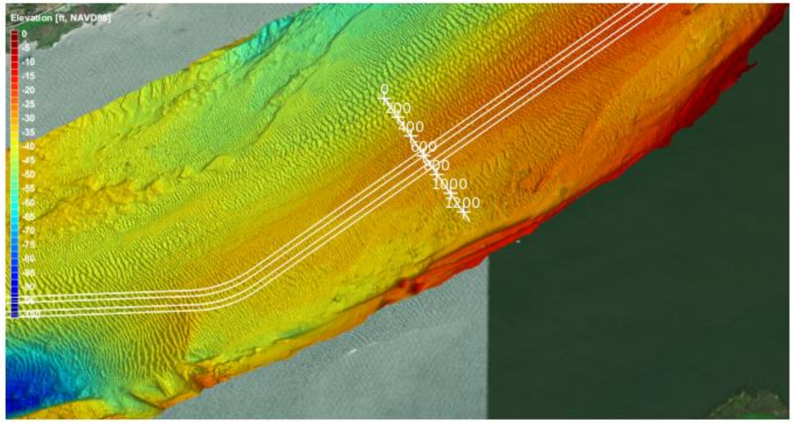

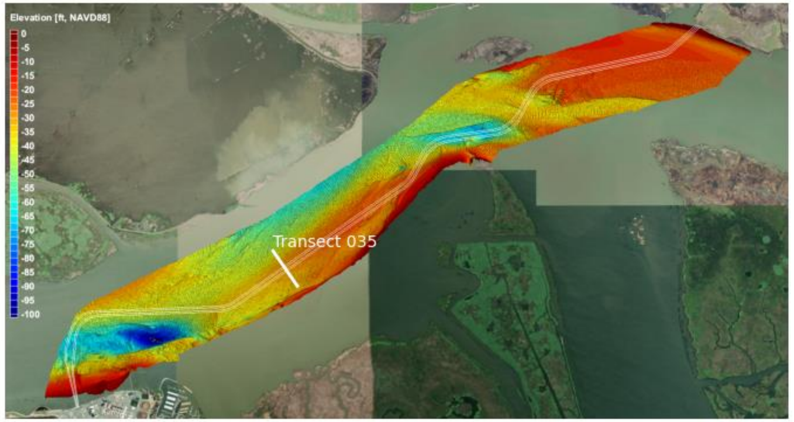


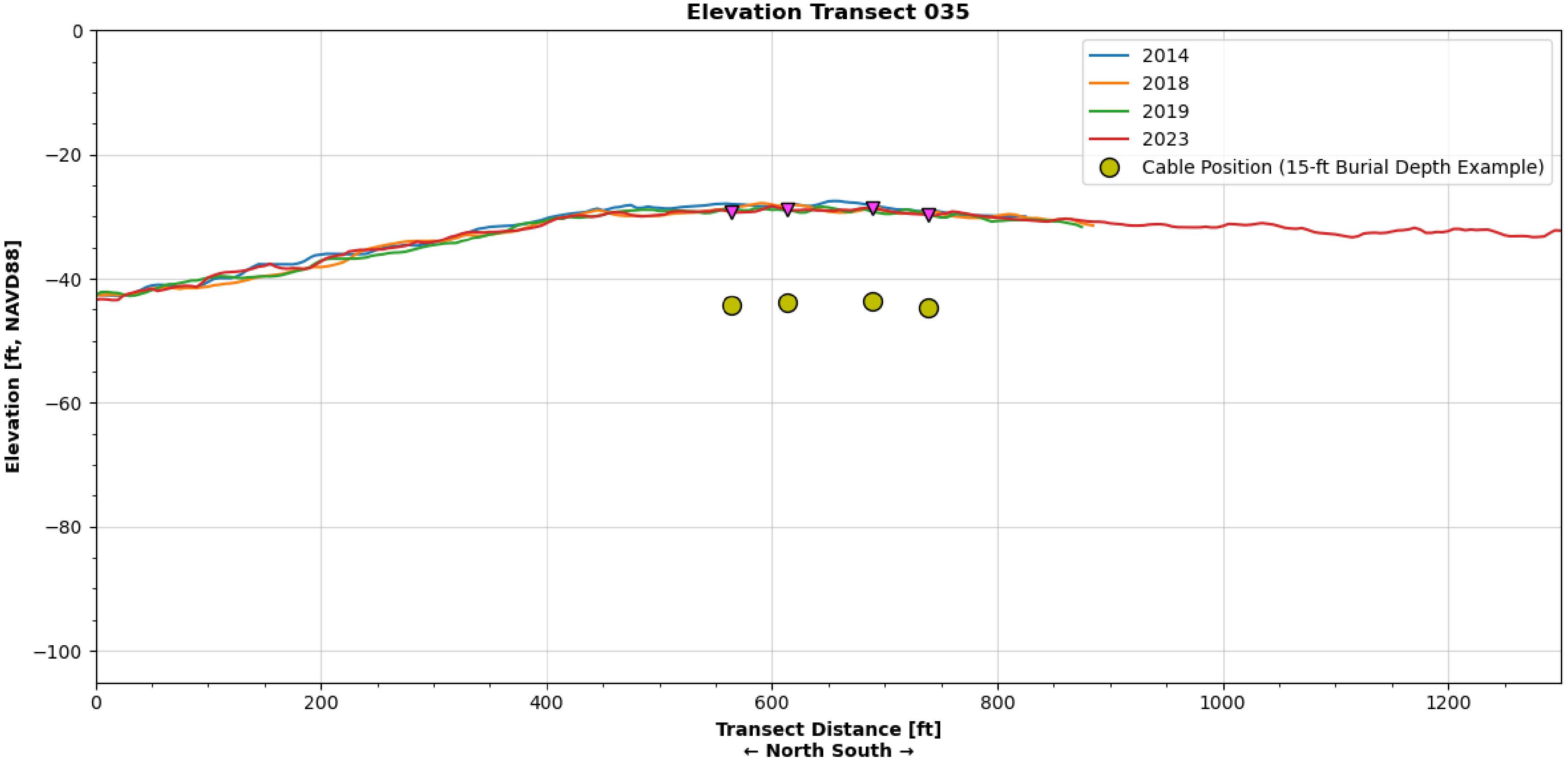


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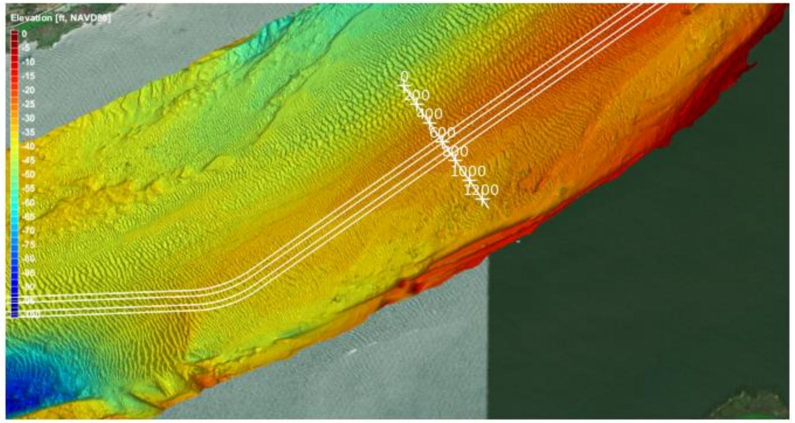
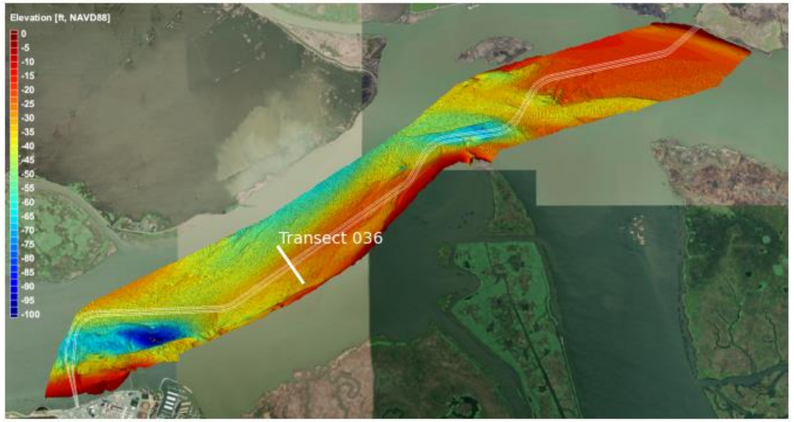
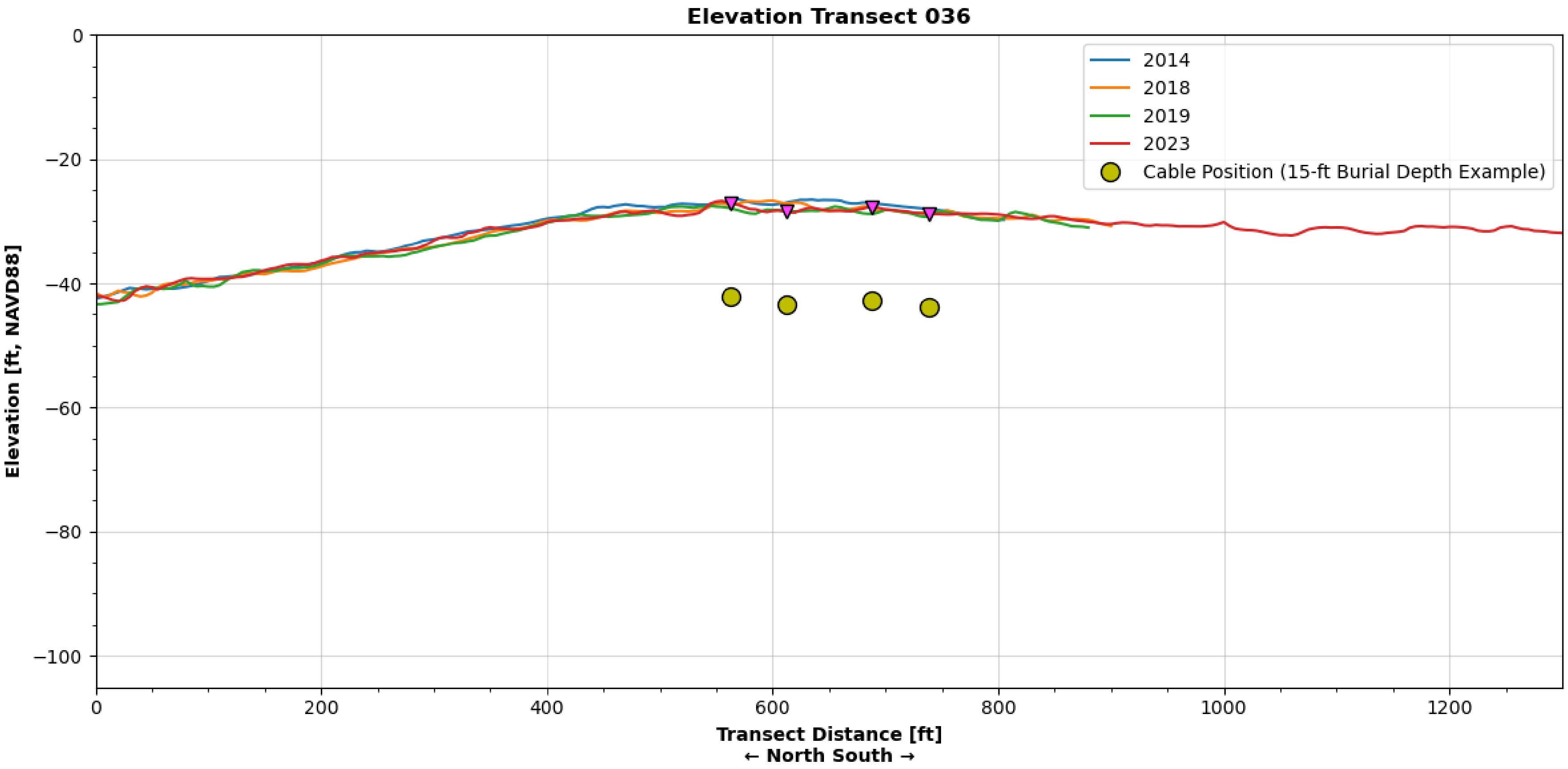
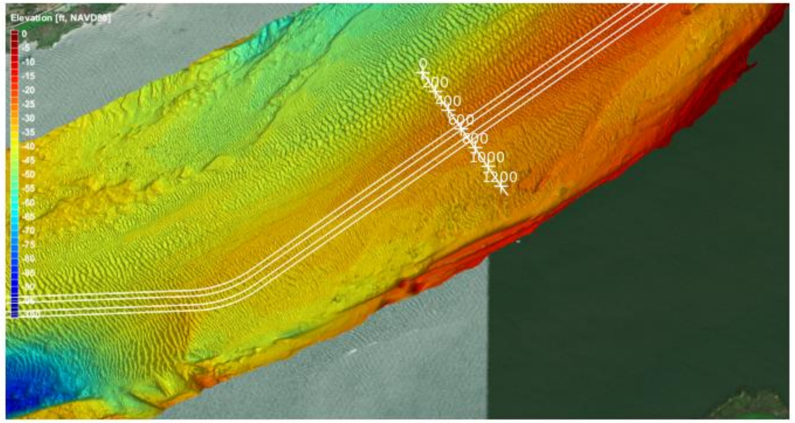
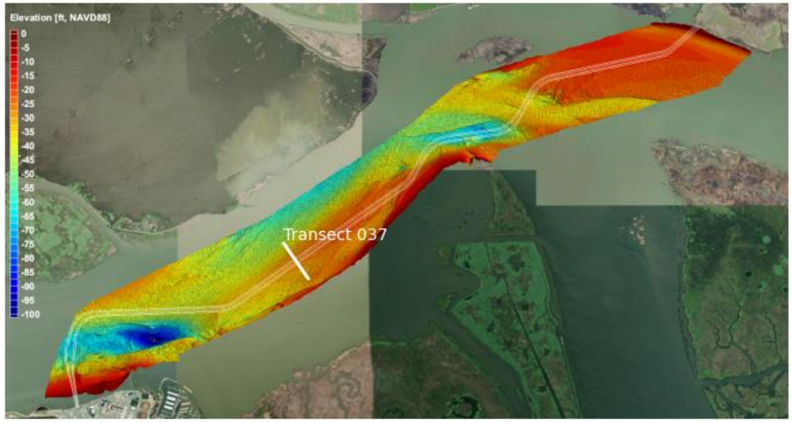


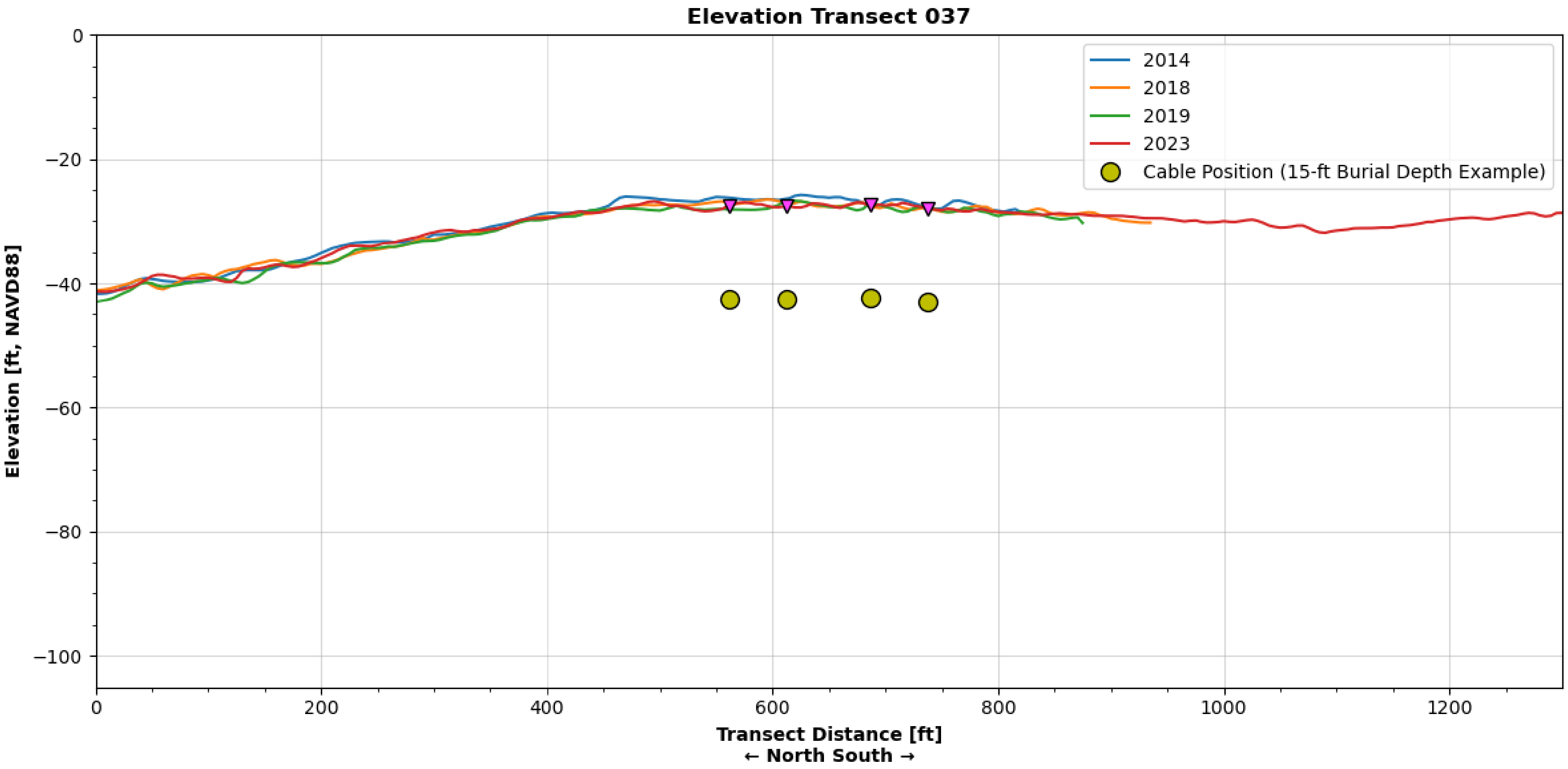



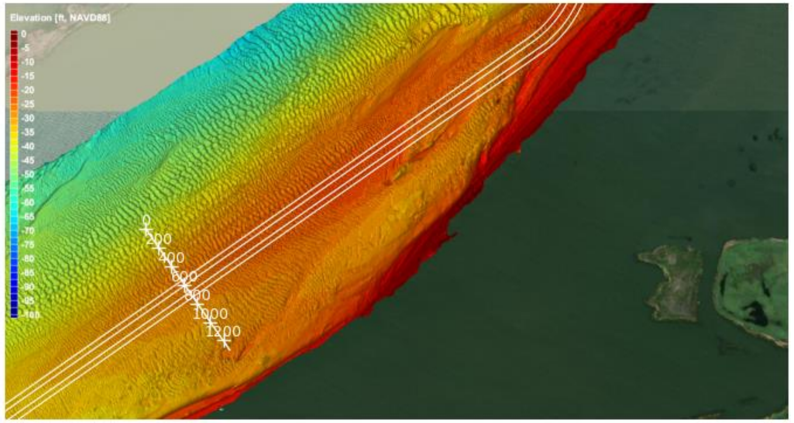

*Note: vertical exaggeration on elevation transect plots*

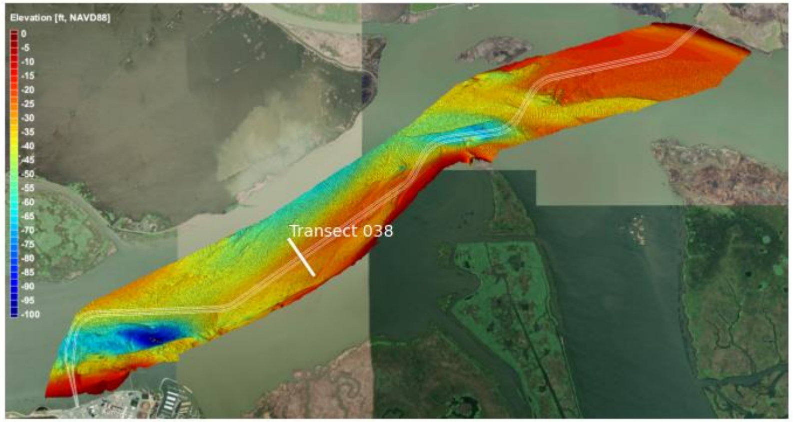


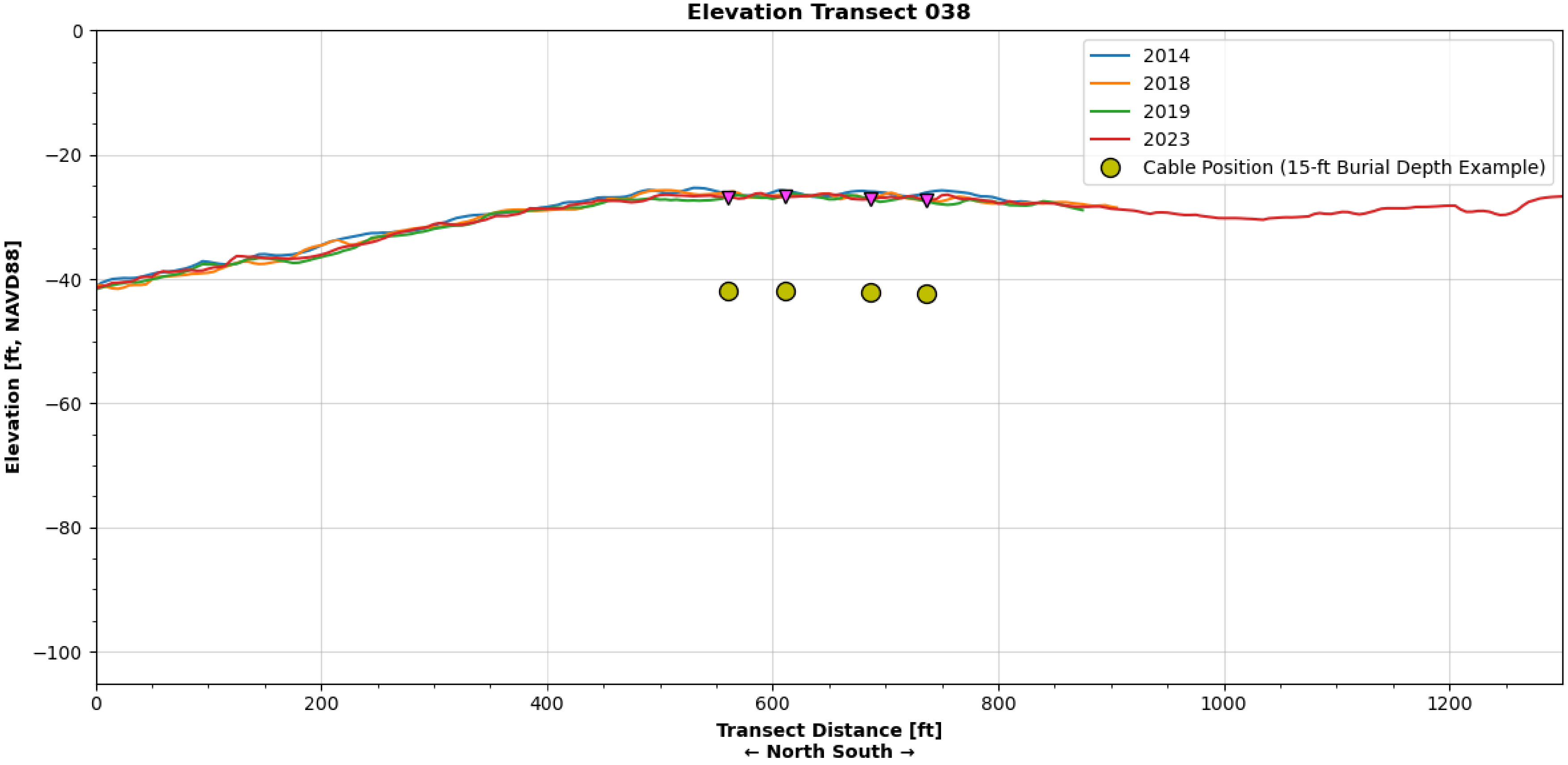



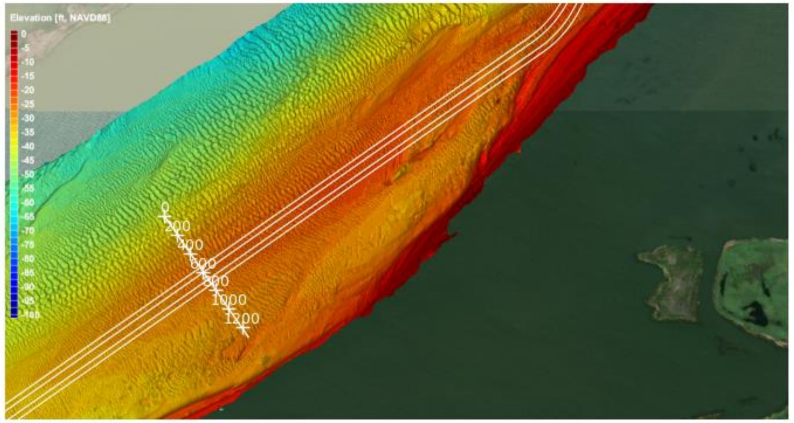

*Note: vertical exaggeration on elevation transect plots*

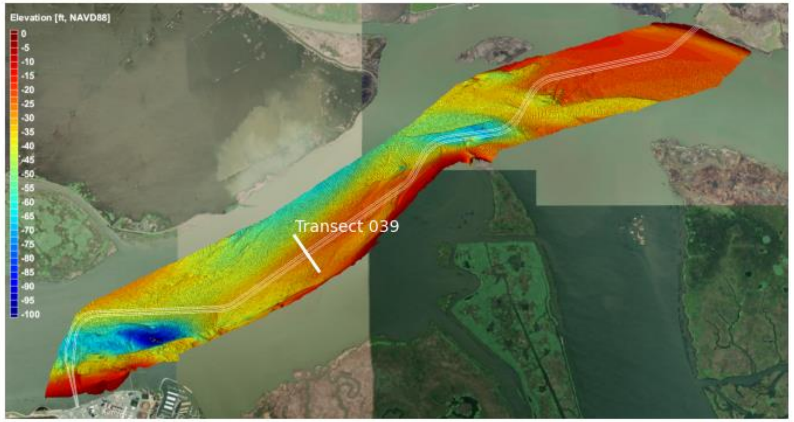


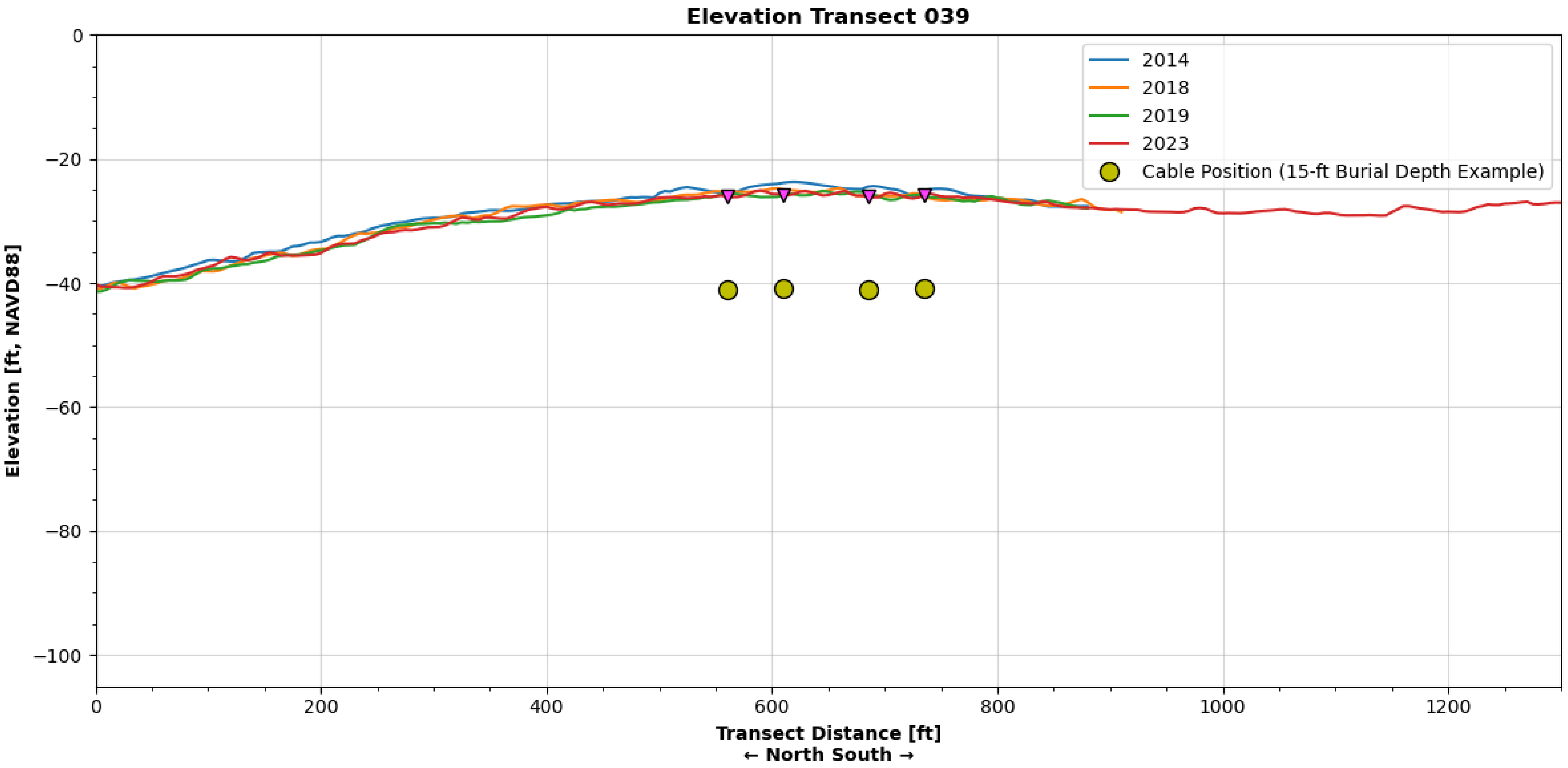



Note: vertical exaggeration on elevation transect plots

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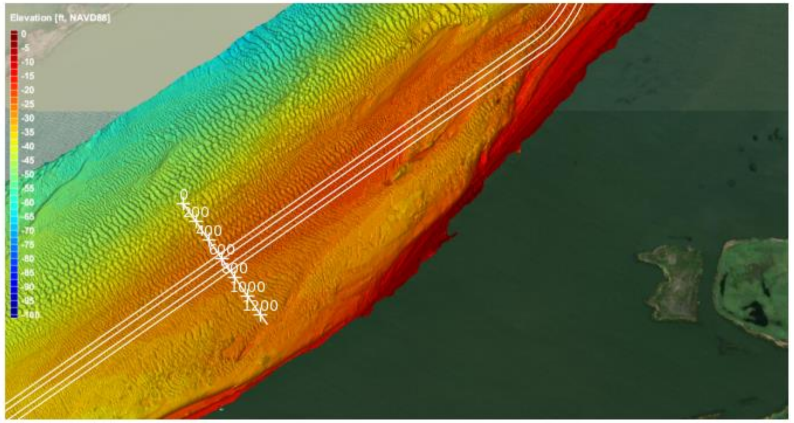

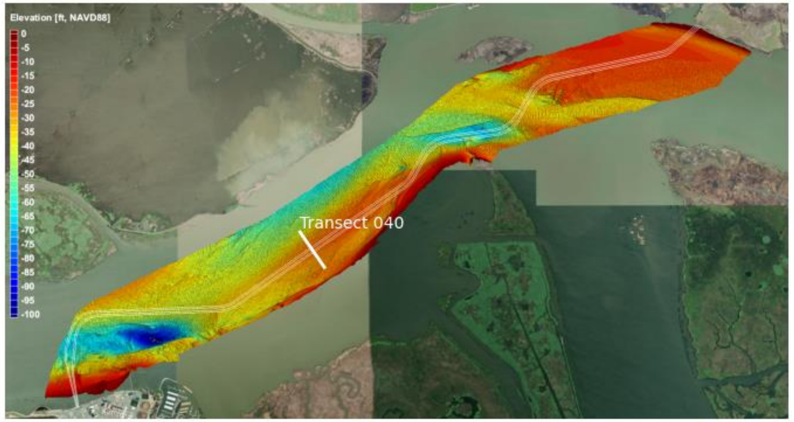


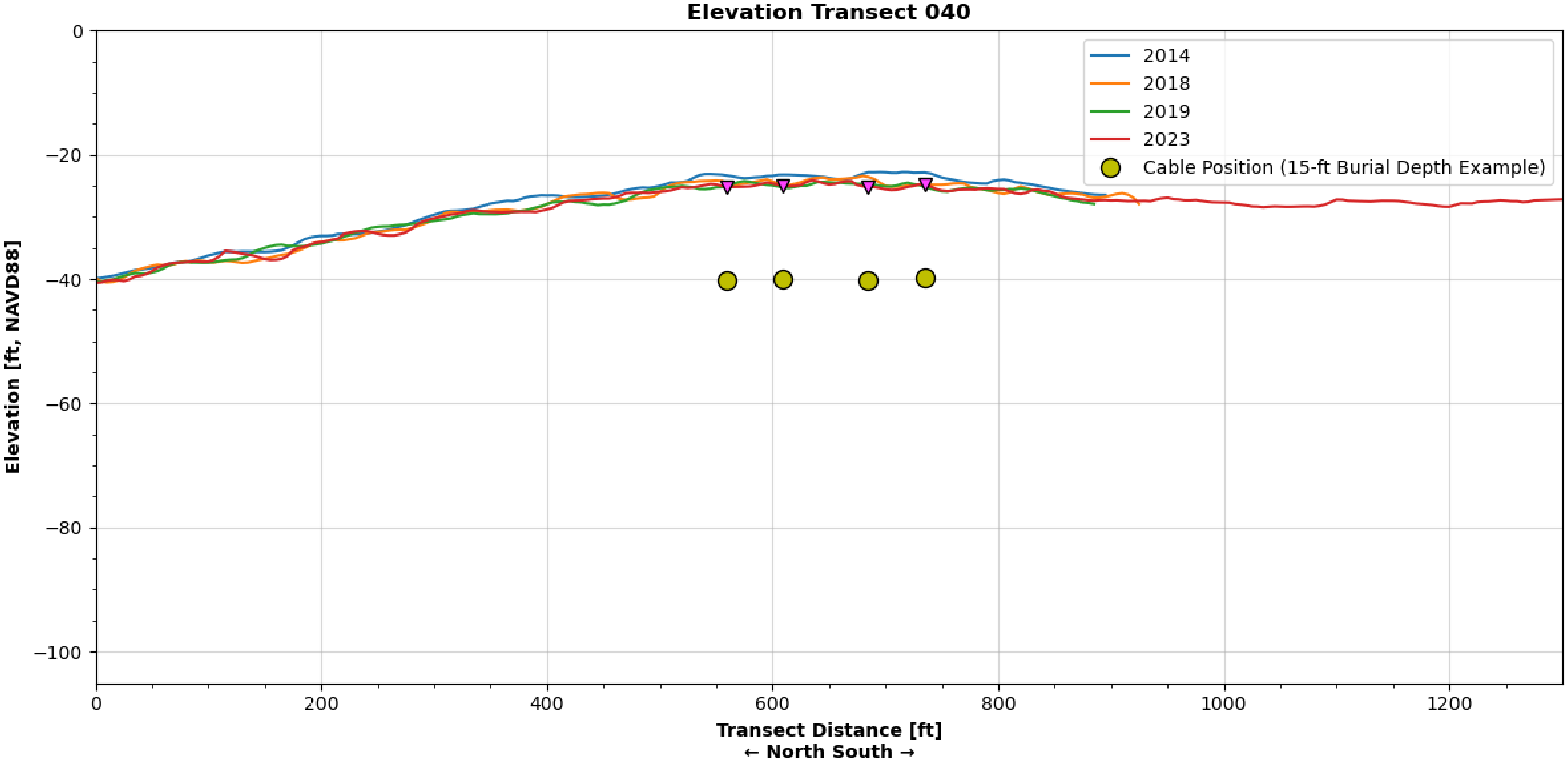


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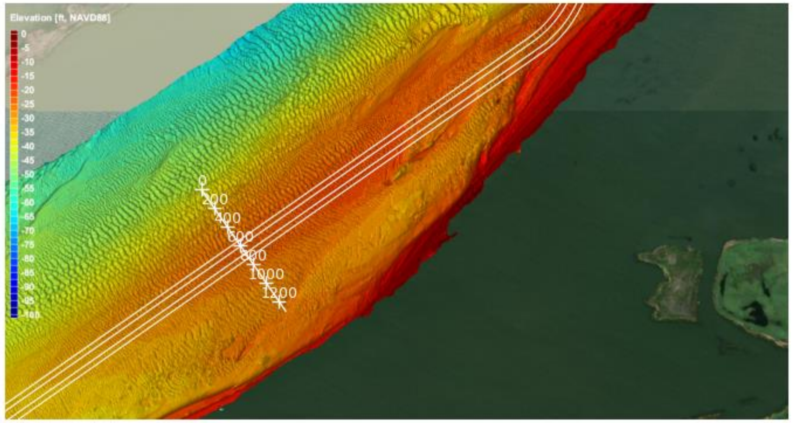

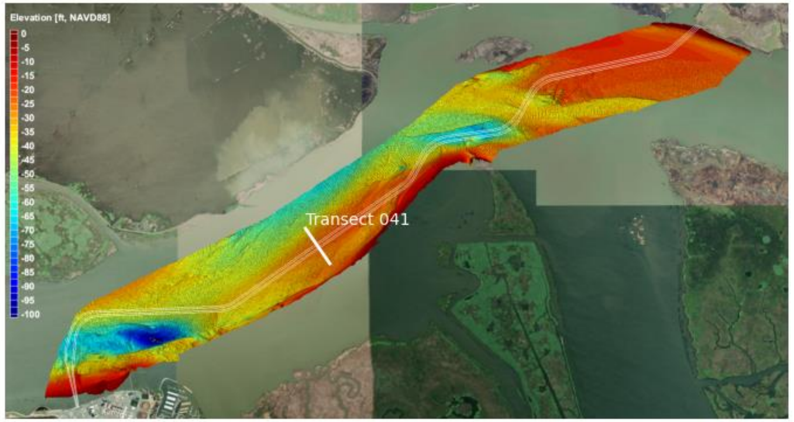


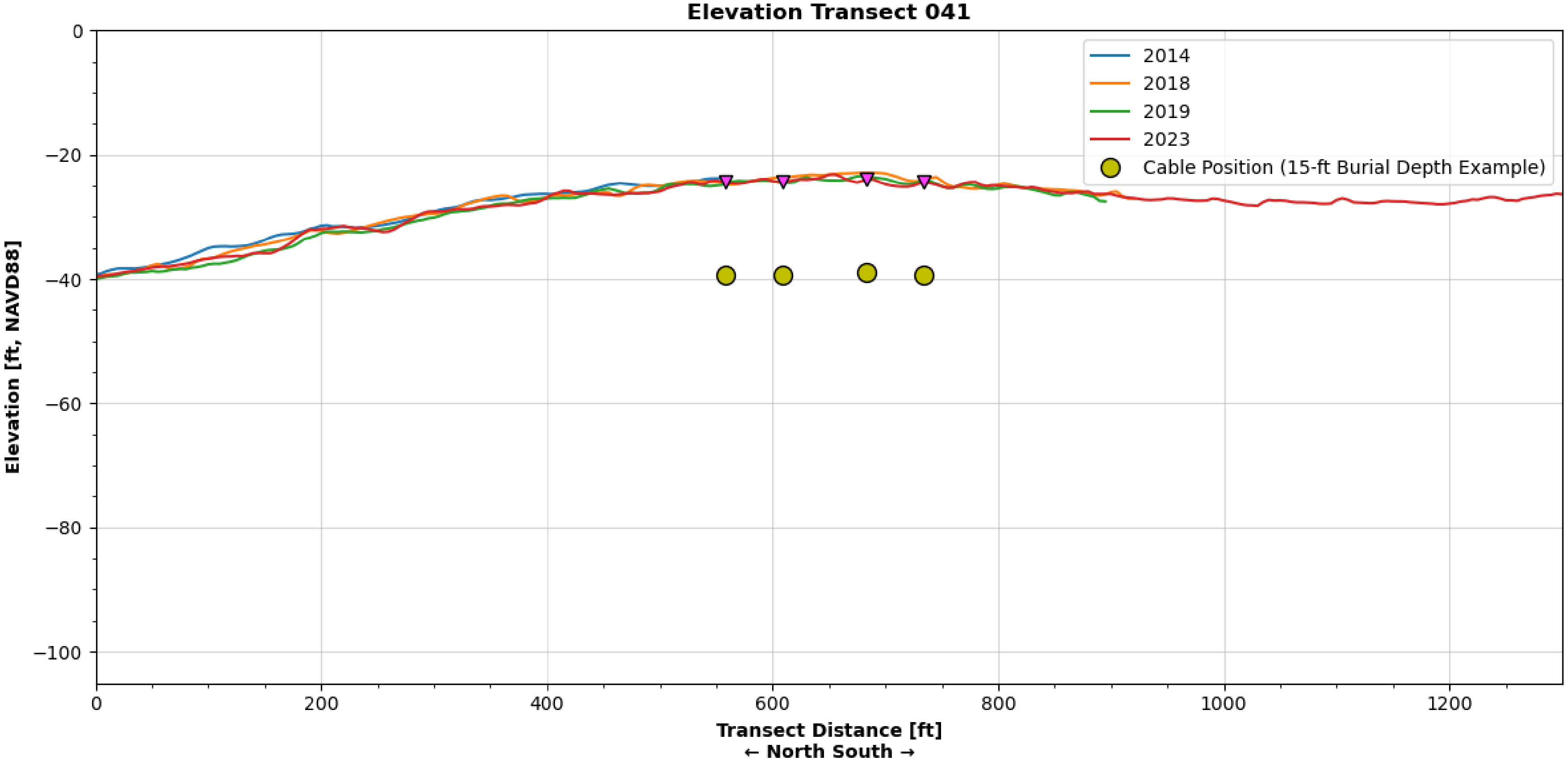


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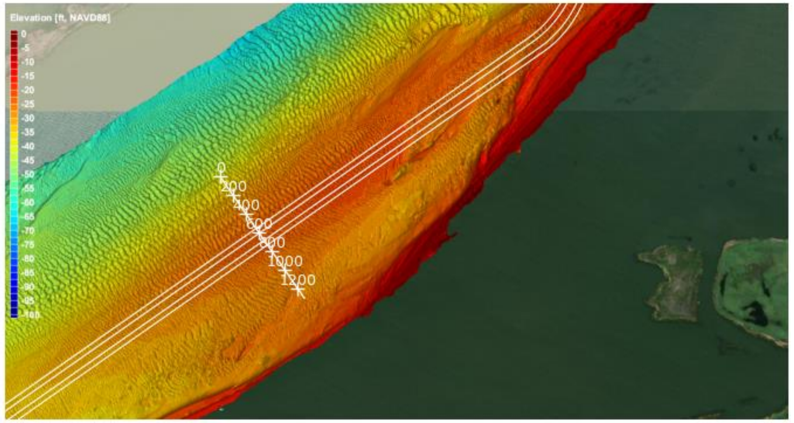
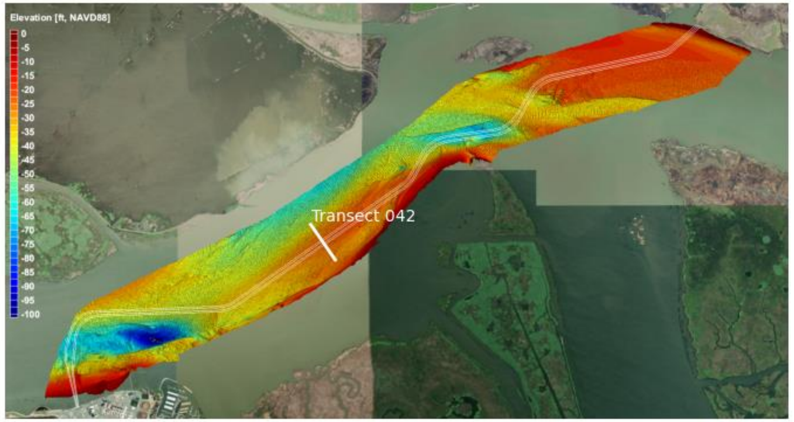
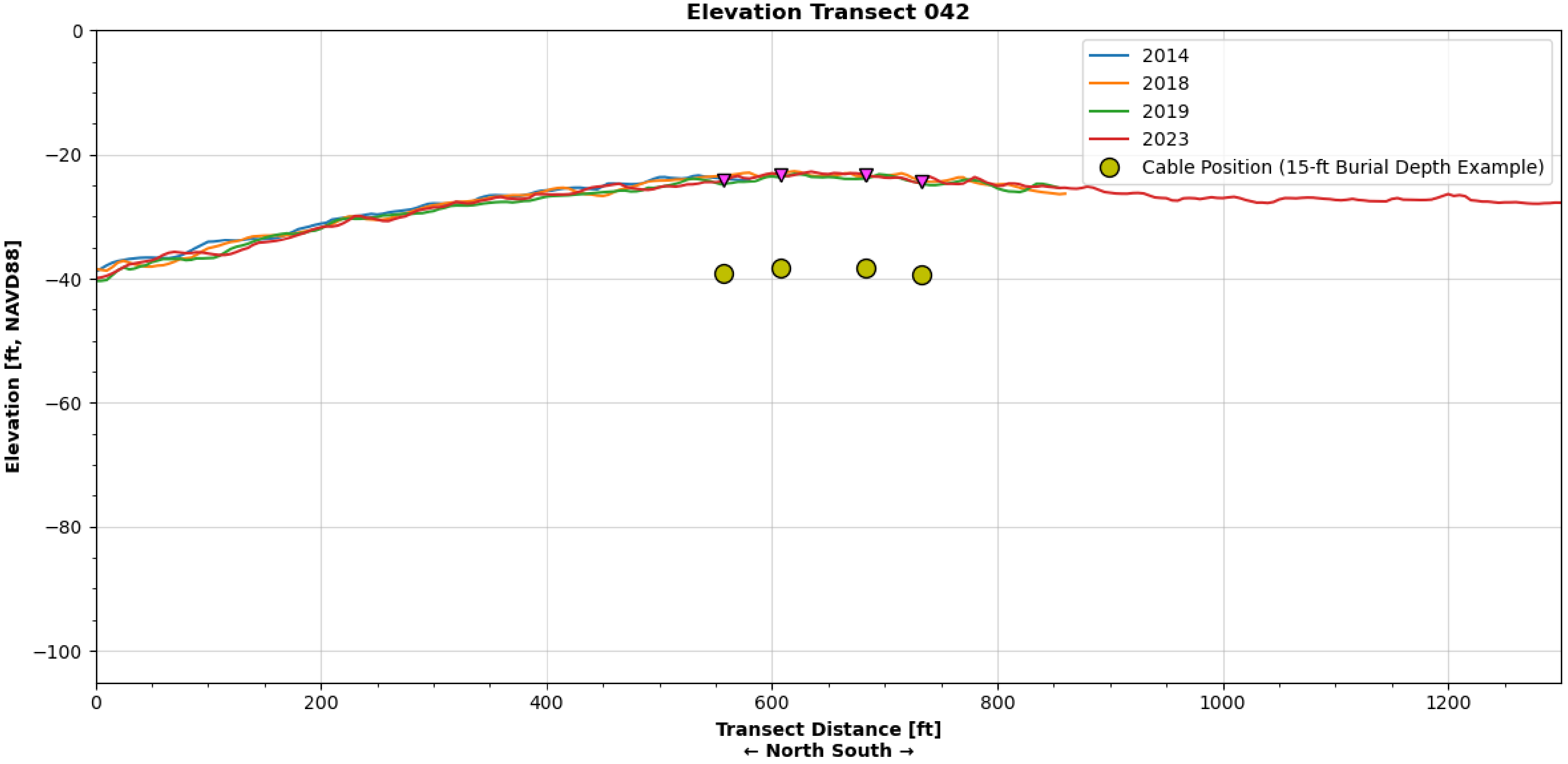
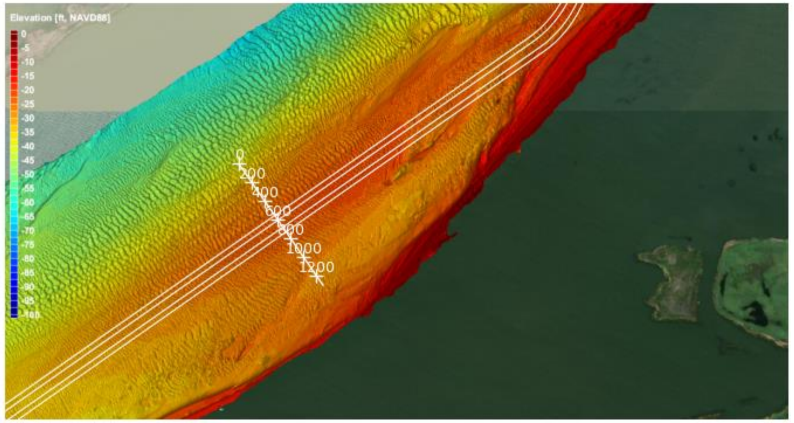
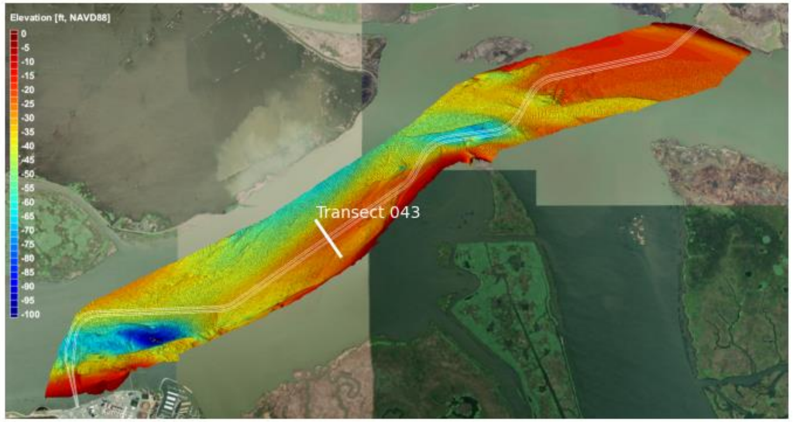


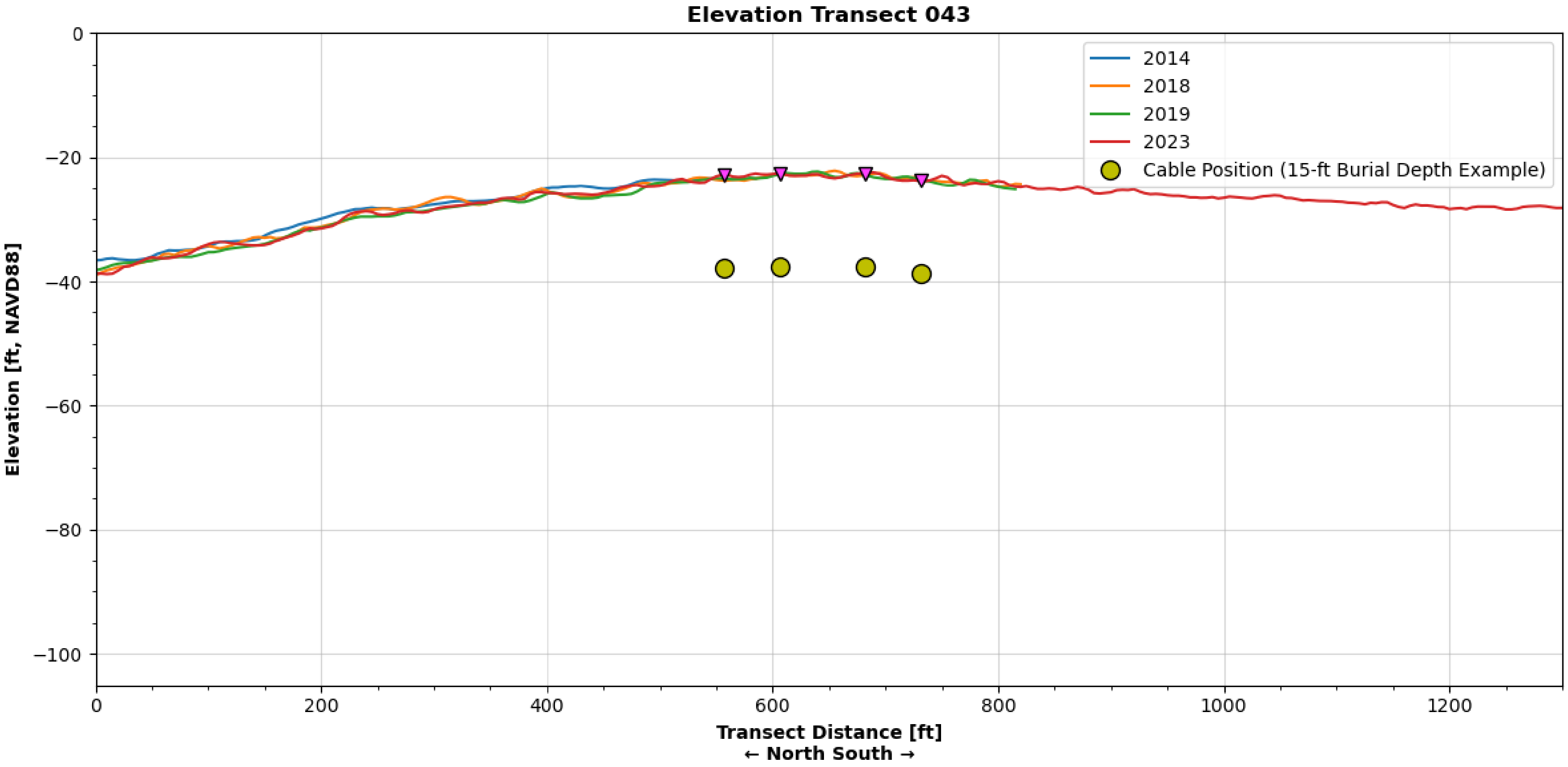



Note: vertical exaggeration on elevation transect plots




*Note: vertical exaggeration on elevation transect plots*

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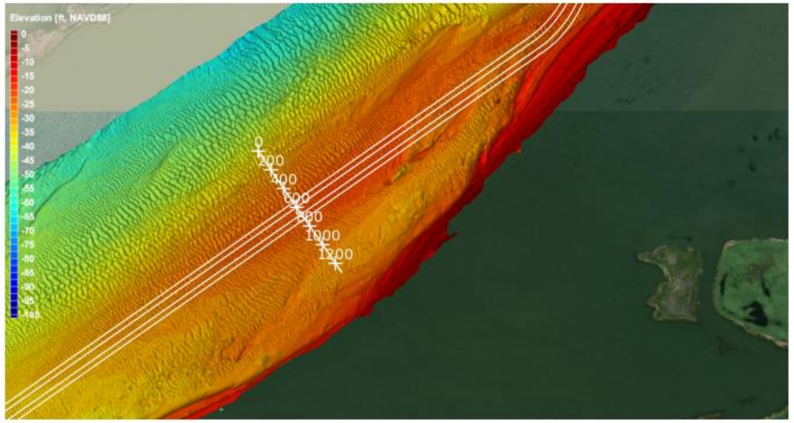

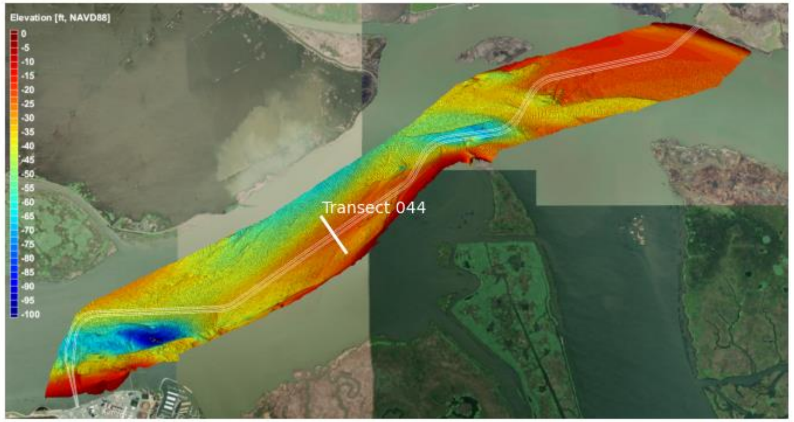


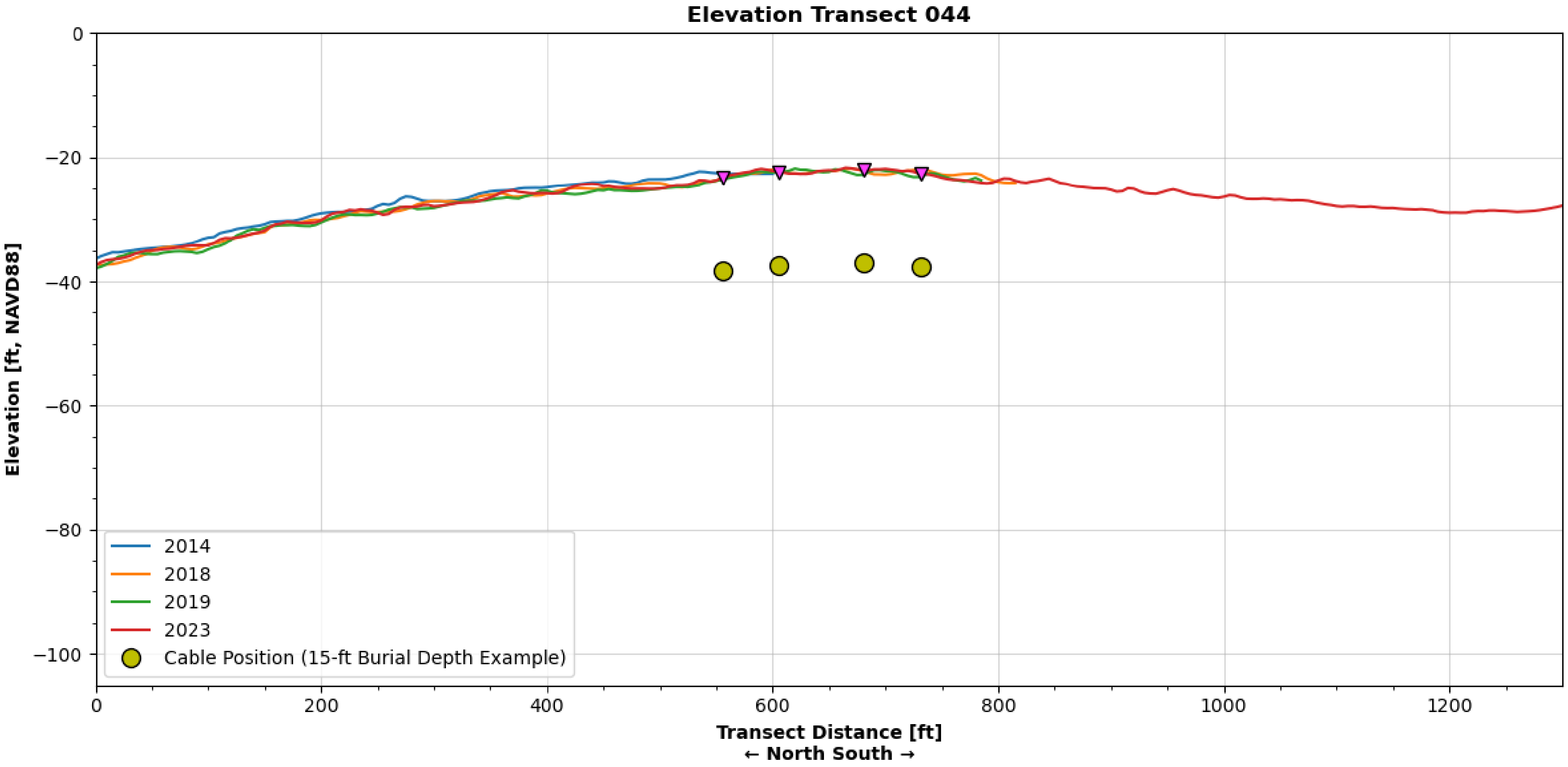


*Note: vertical exaggeration on elevation transect plots*

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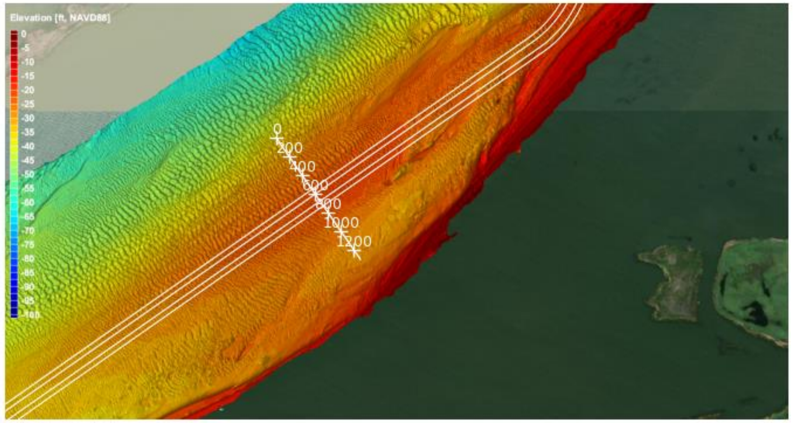
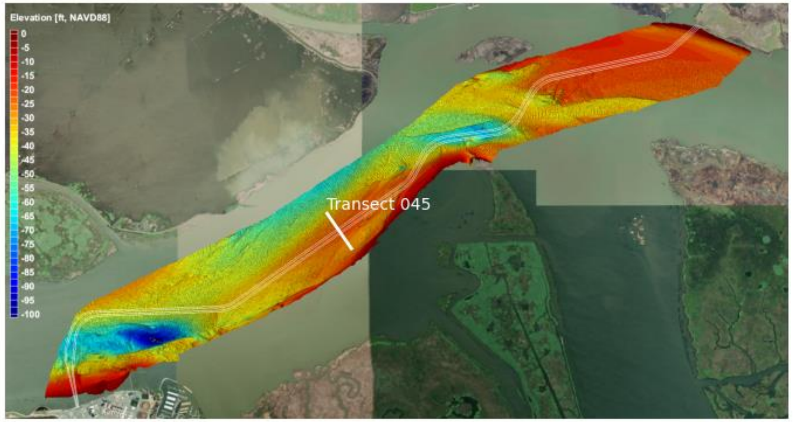
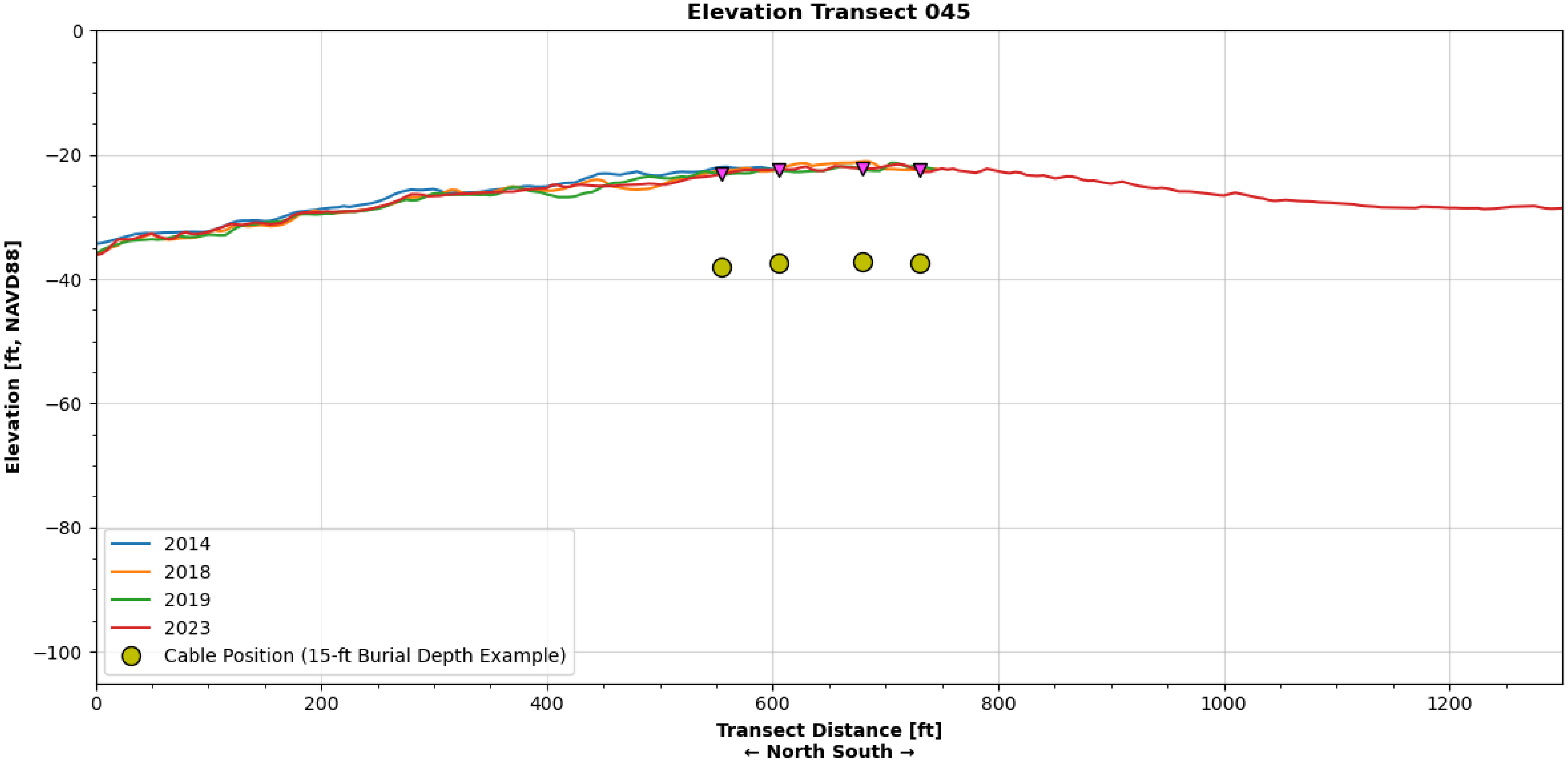
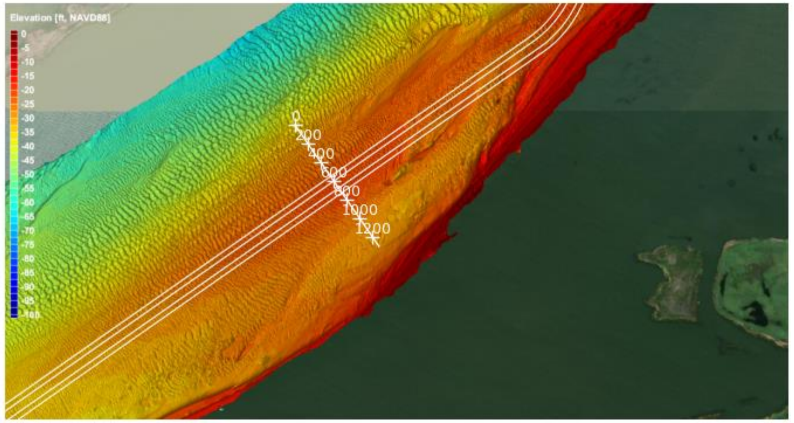
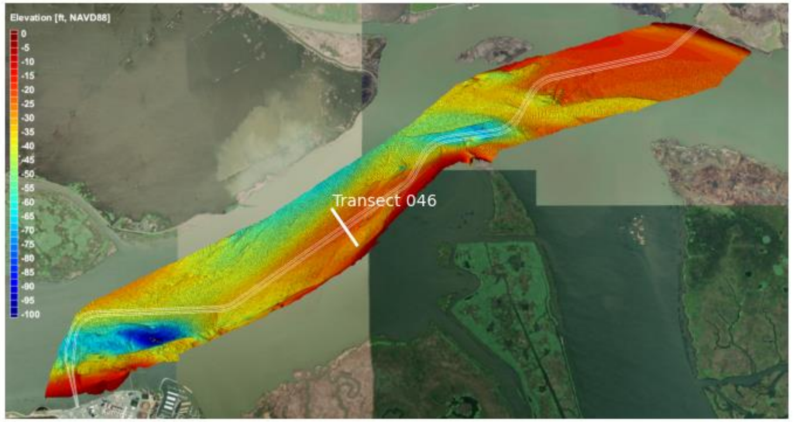


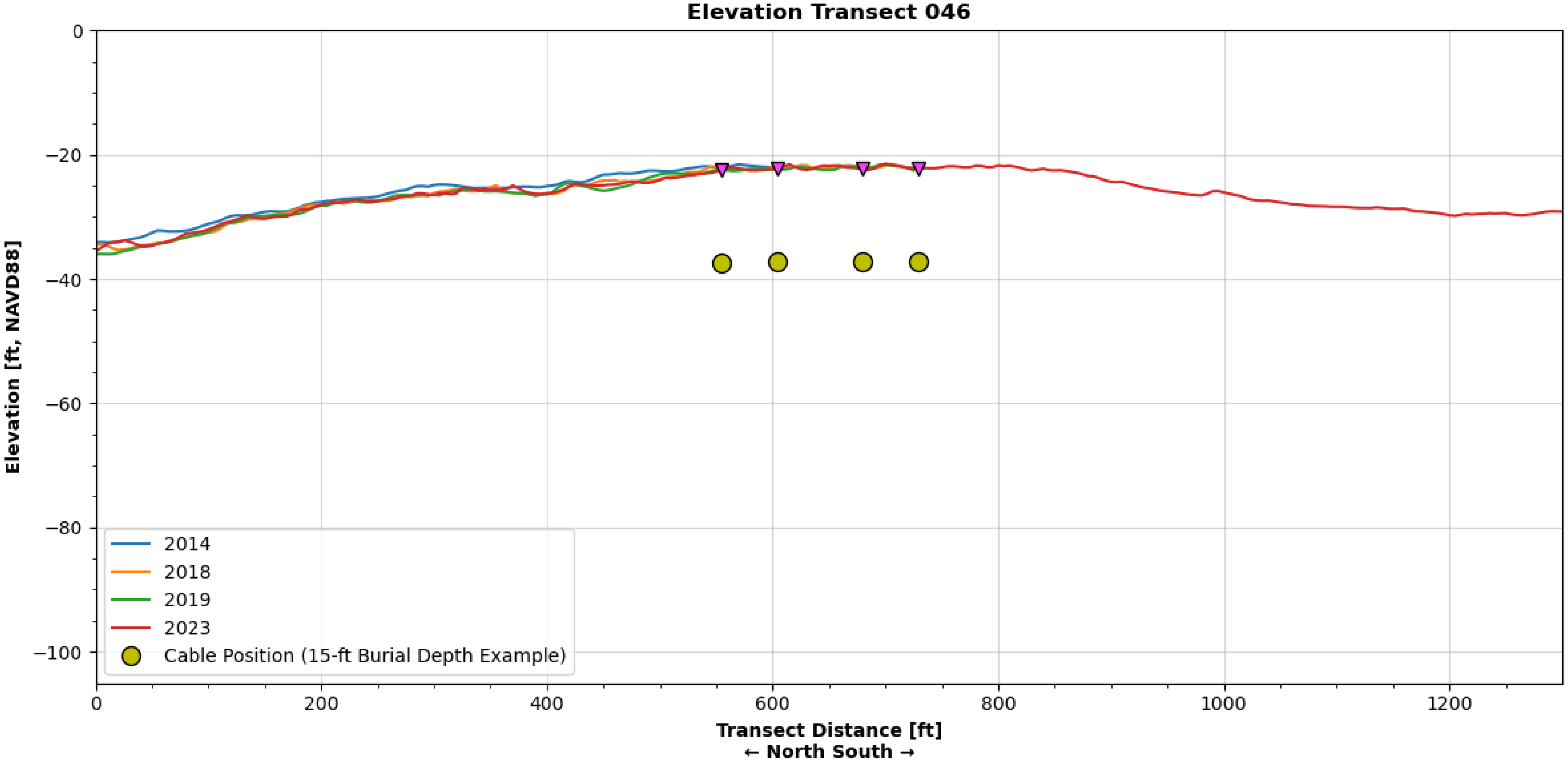



*Note: vertical exaggeration on elevation transect plots*



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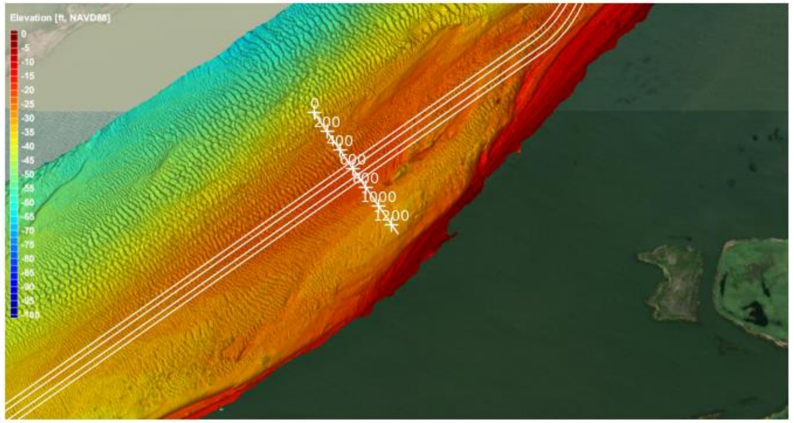

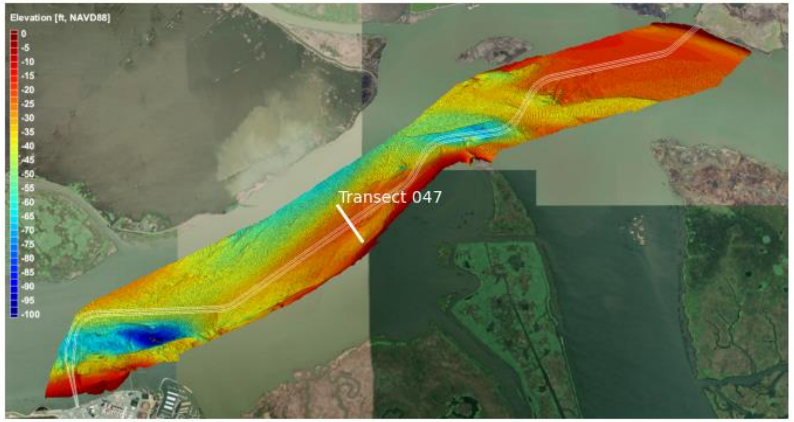


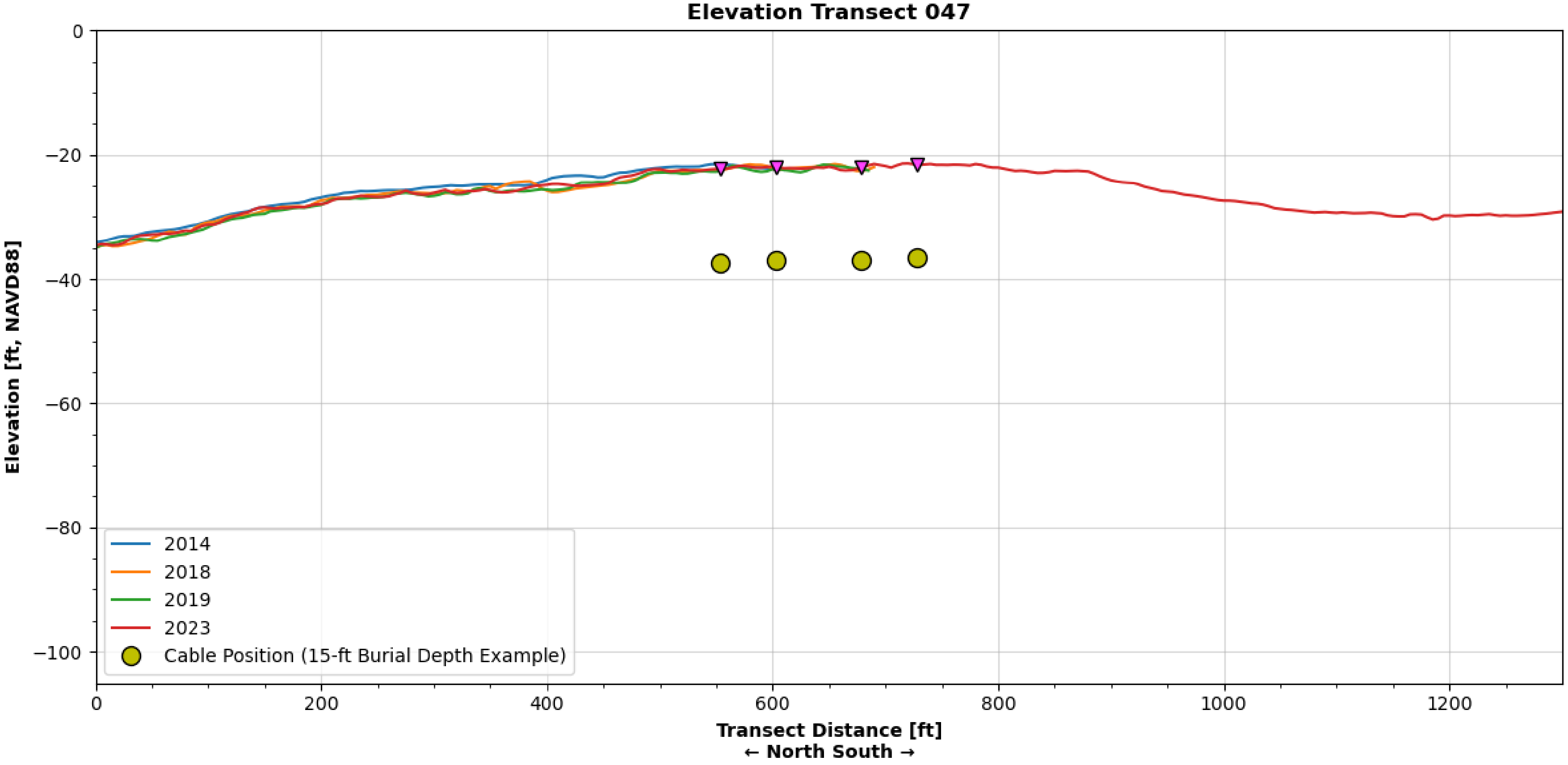


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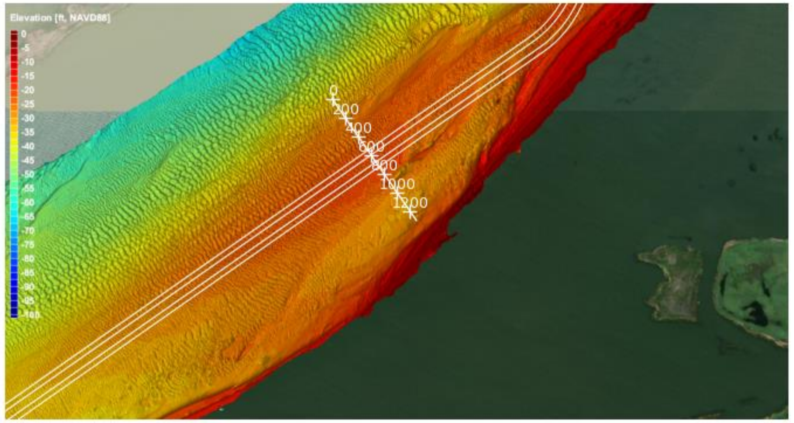


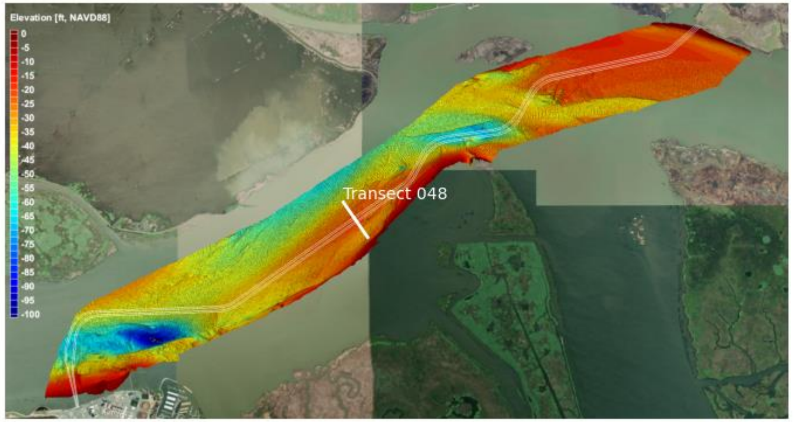


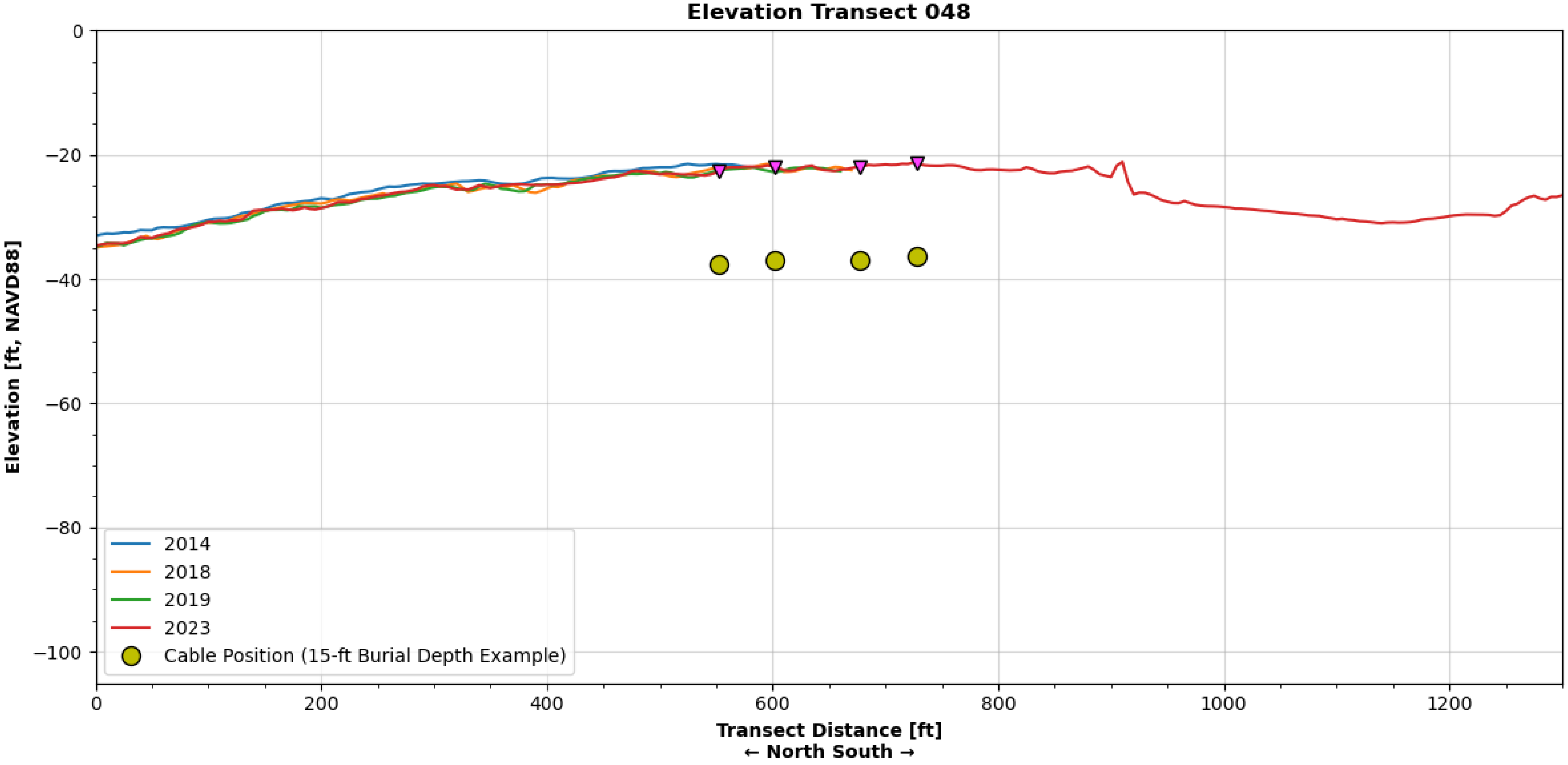


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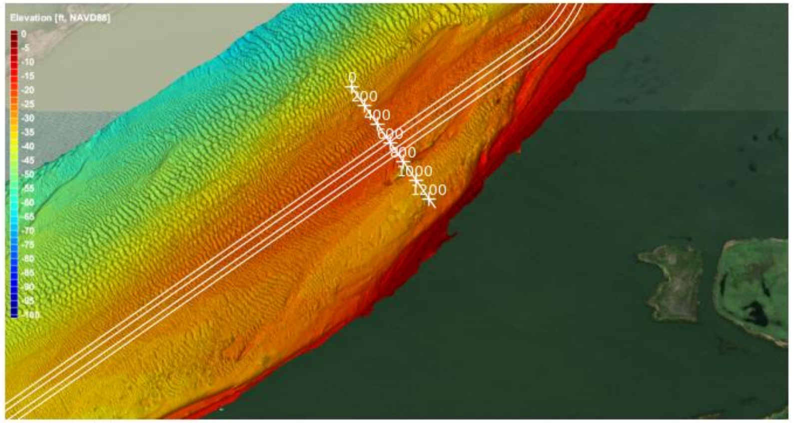


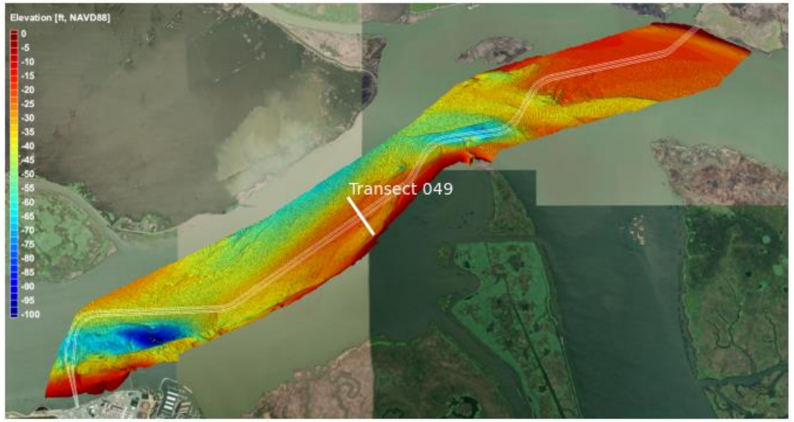


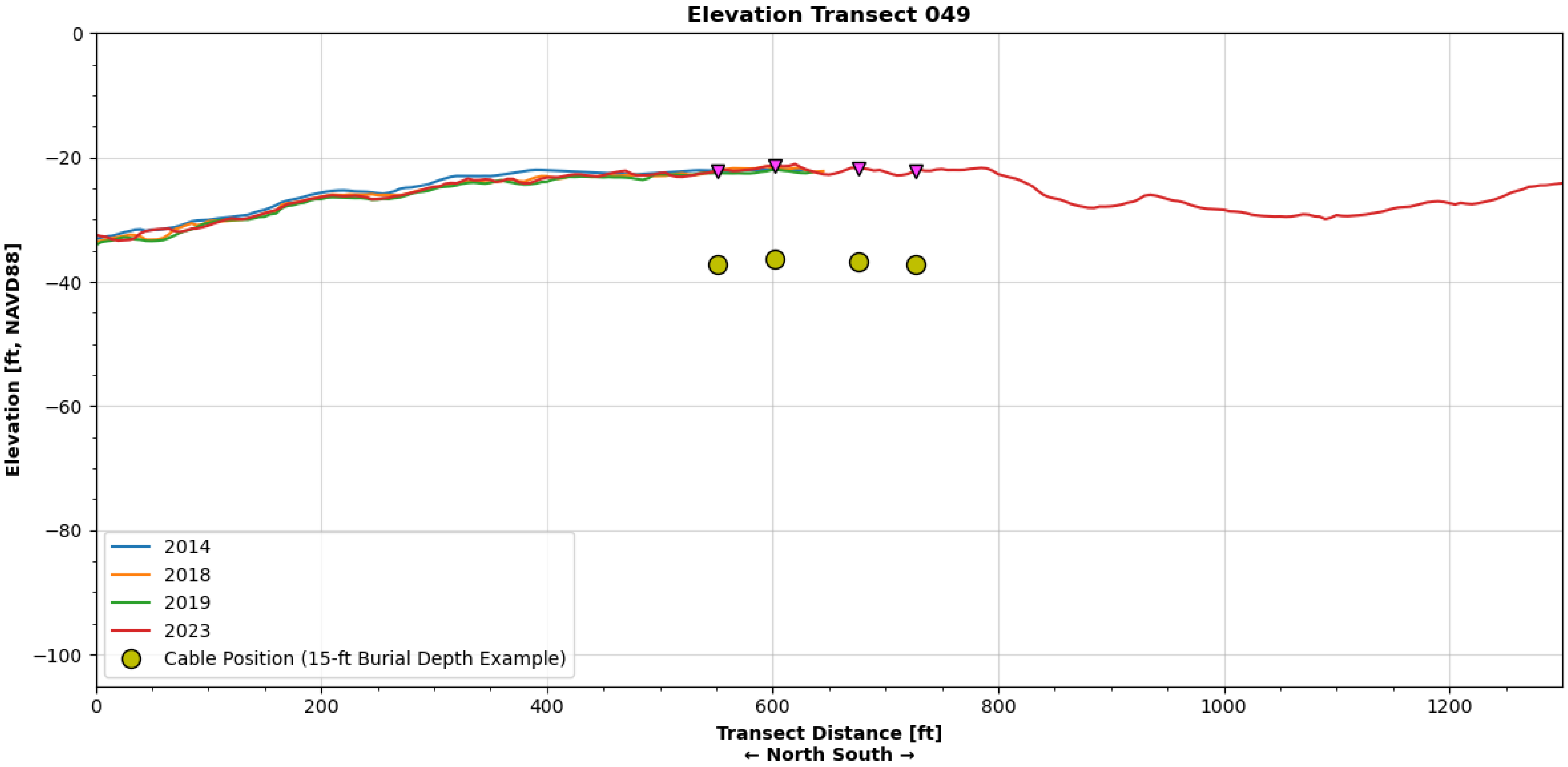


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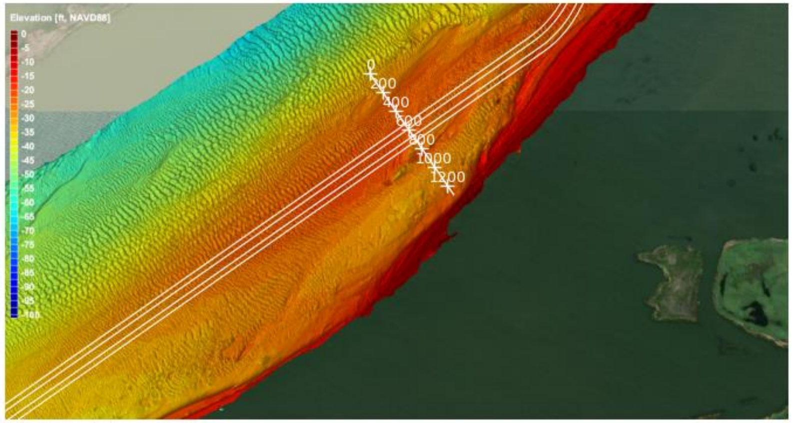


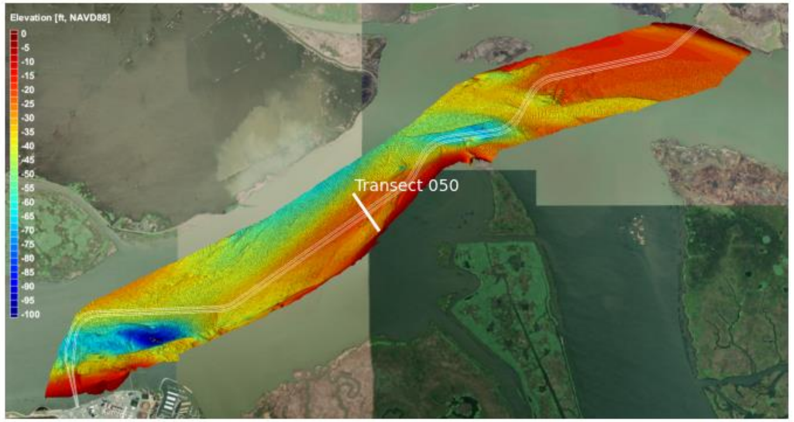


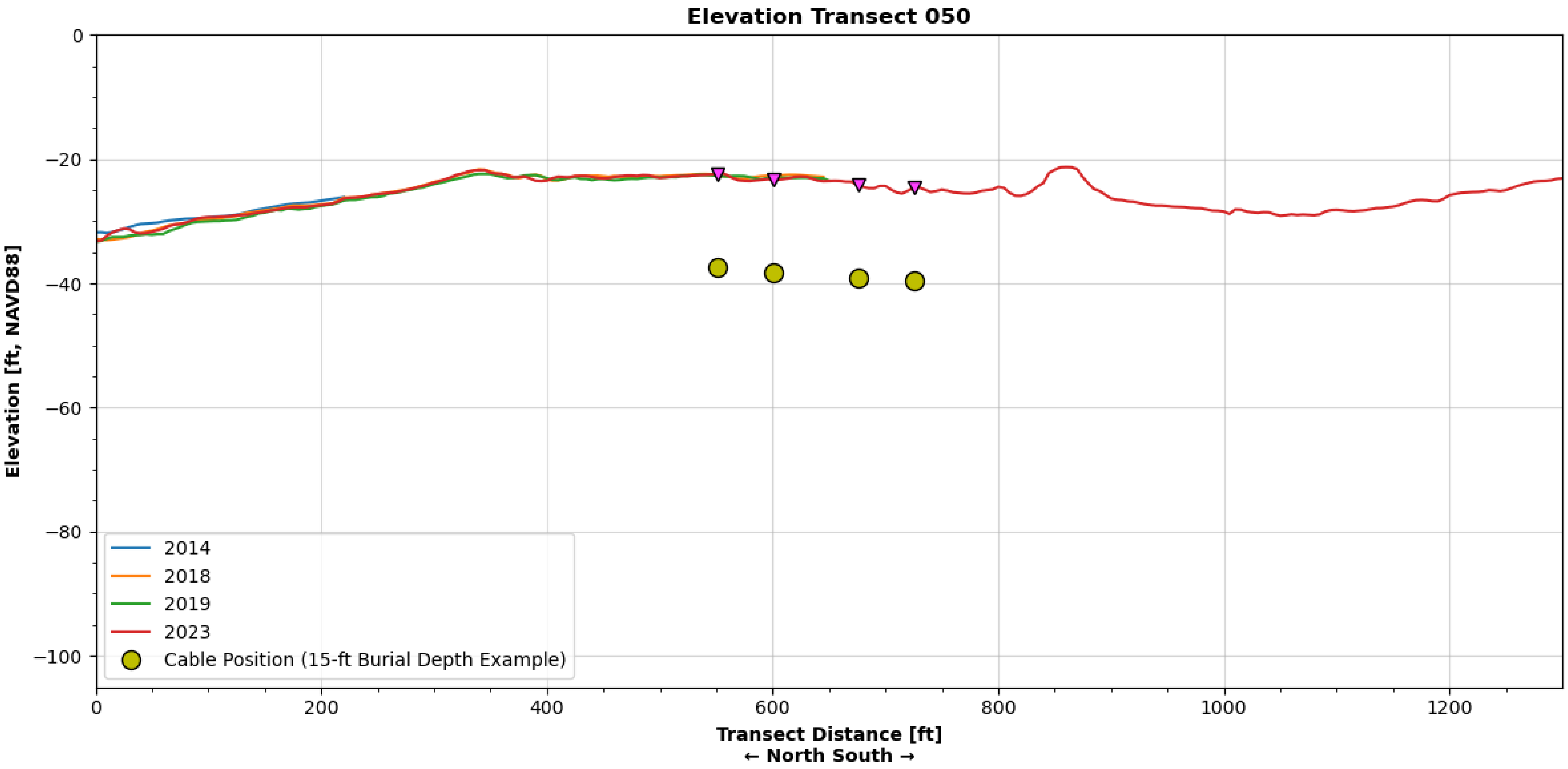


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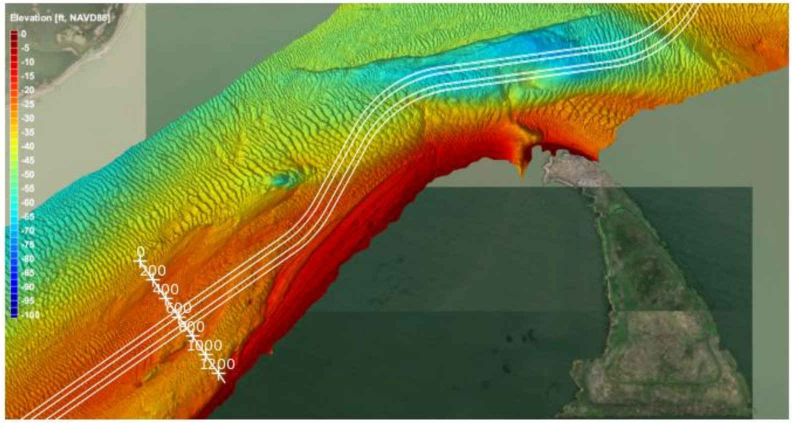

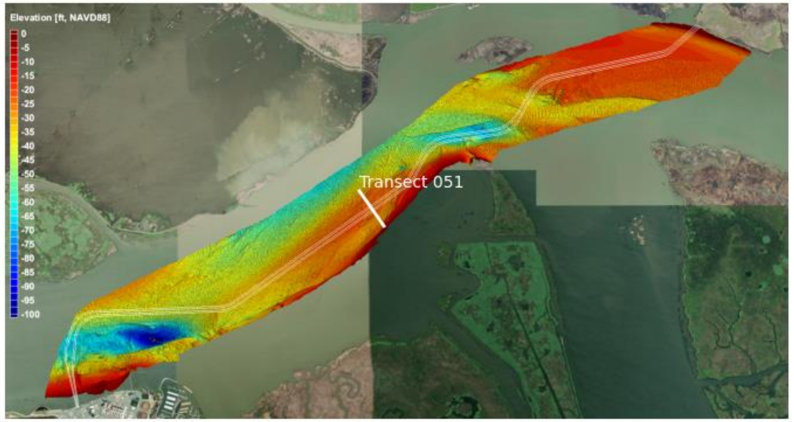


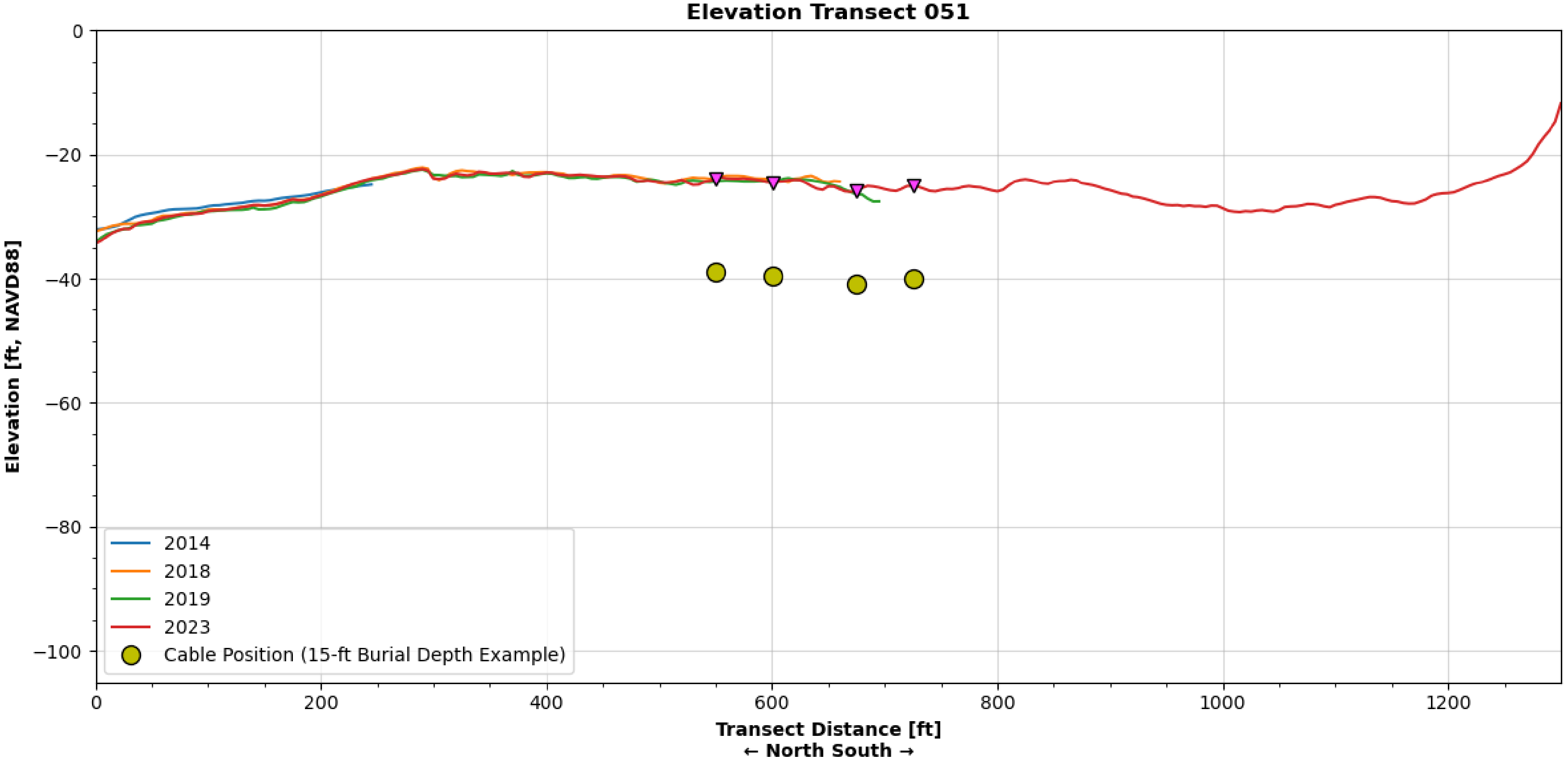


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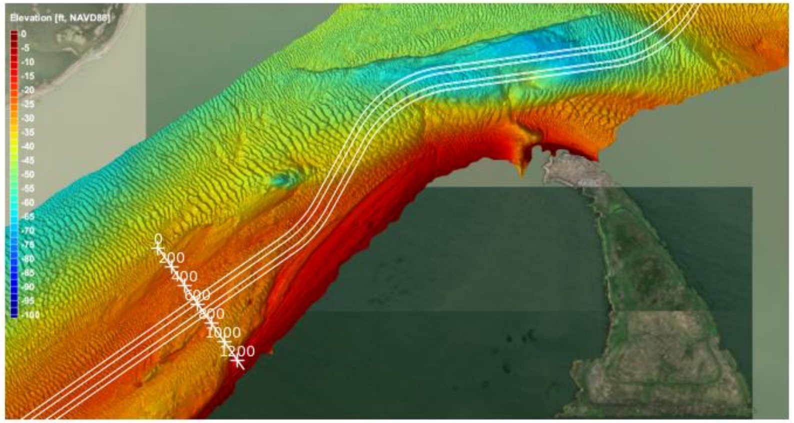


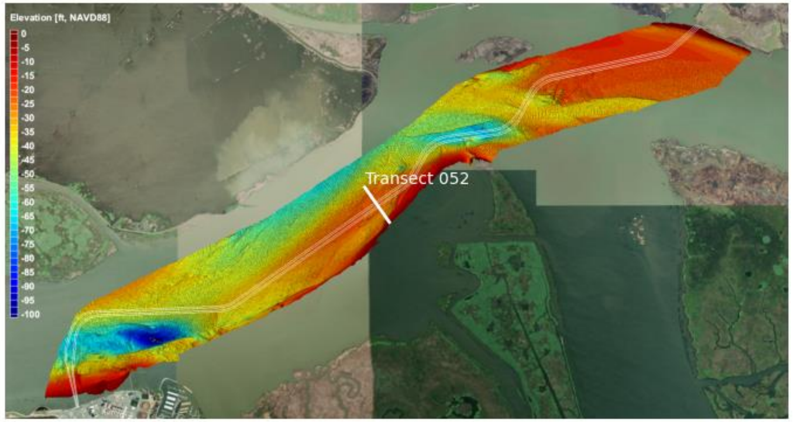


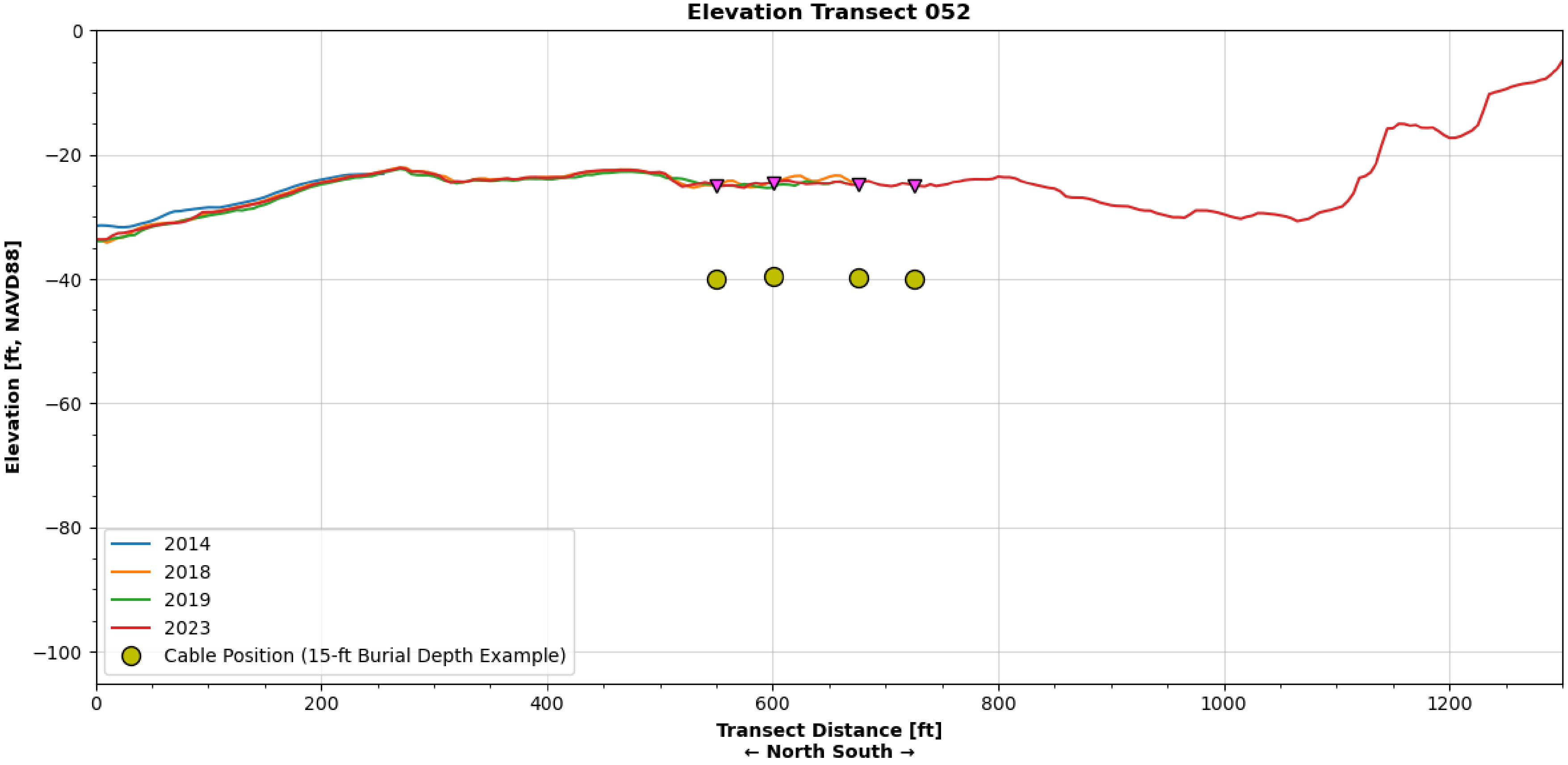


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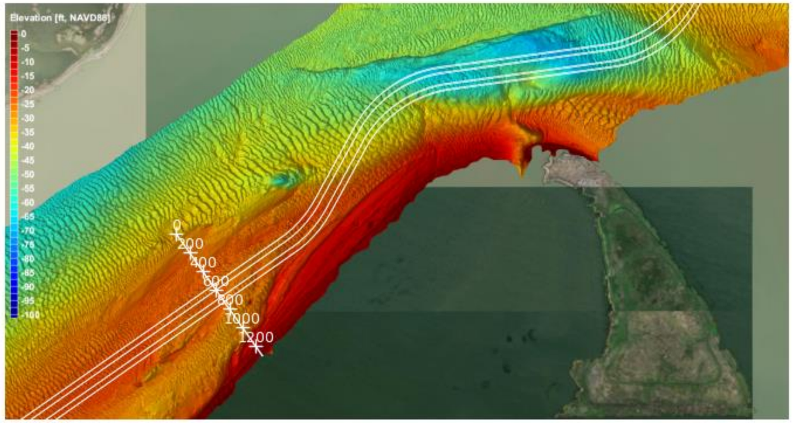


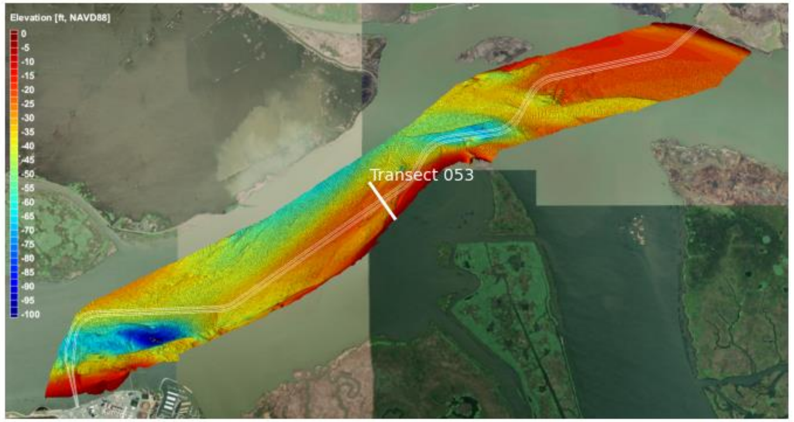


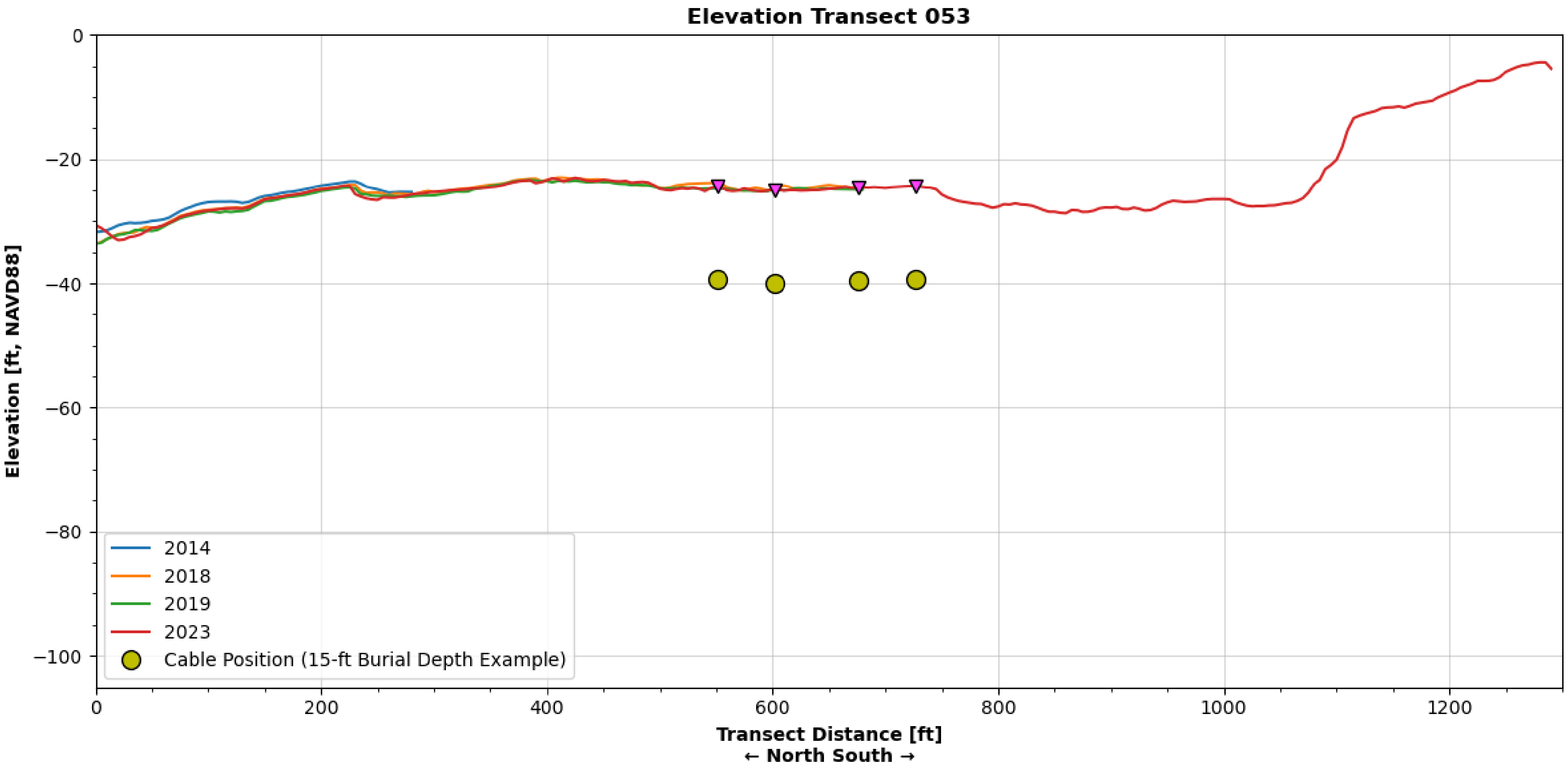


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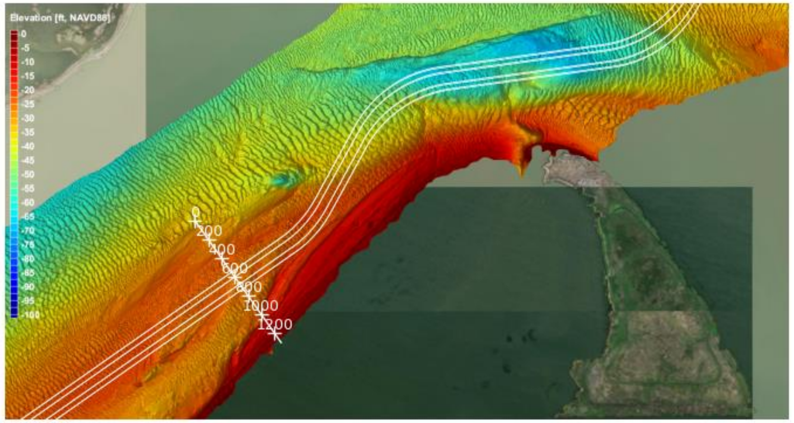


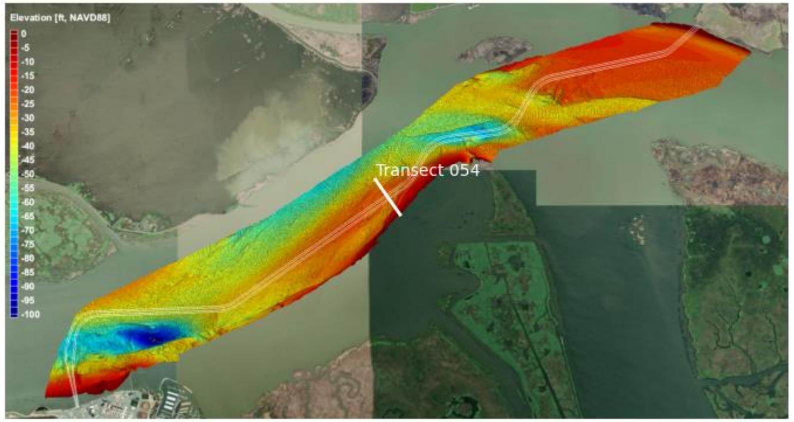


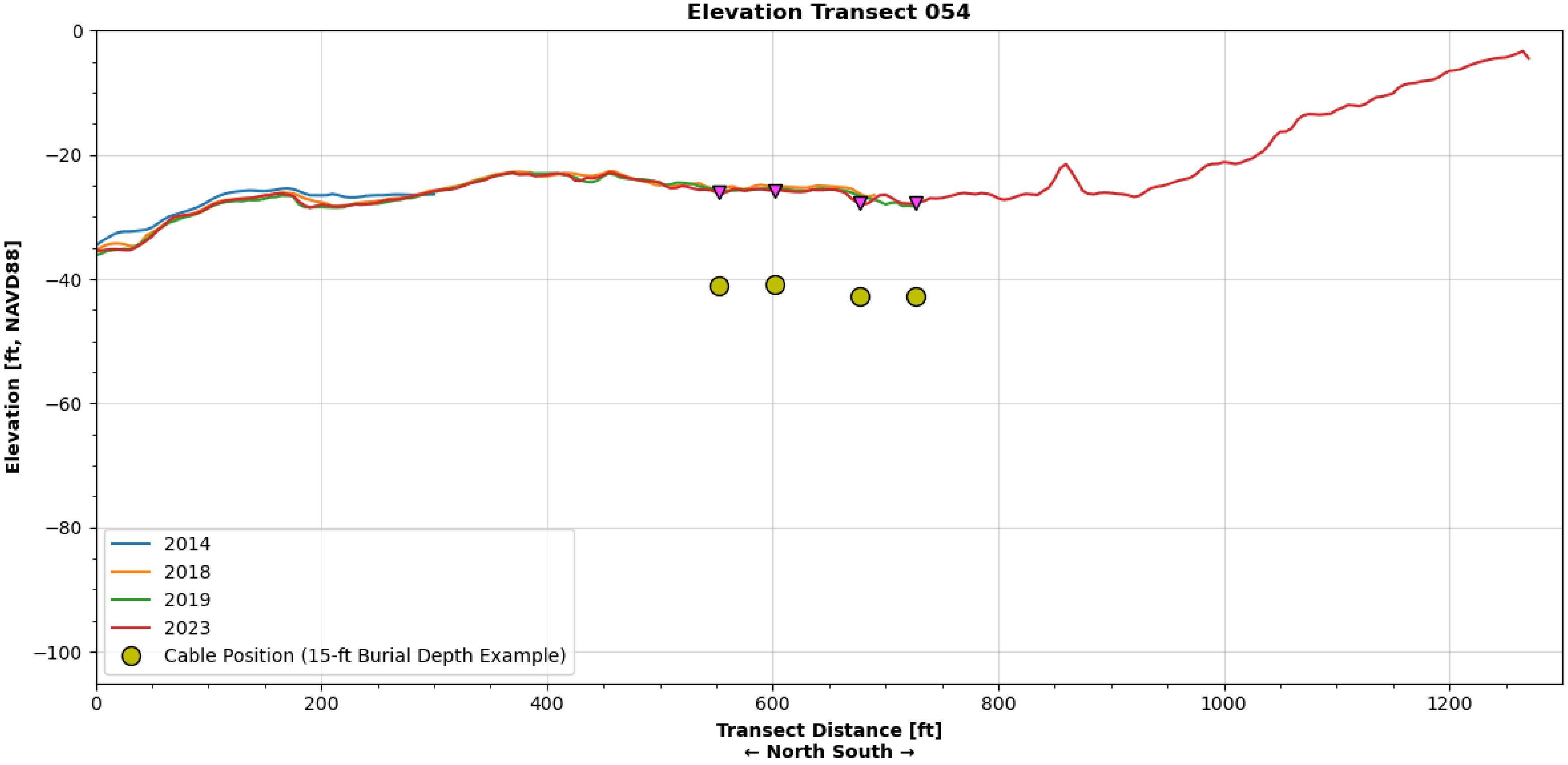


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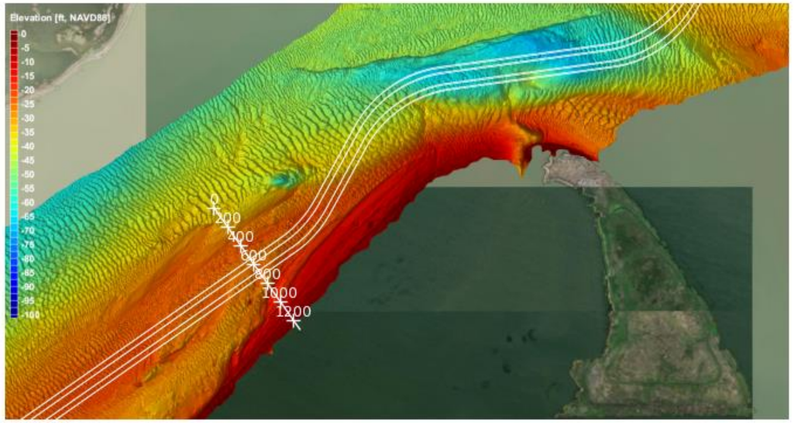


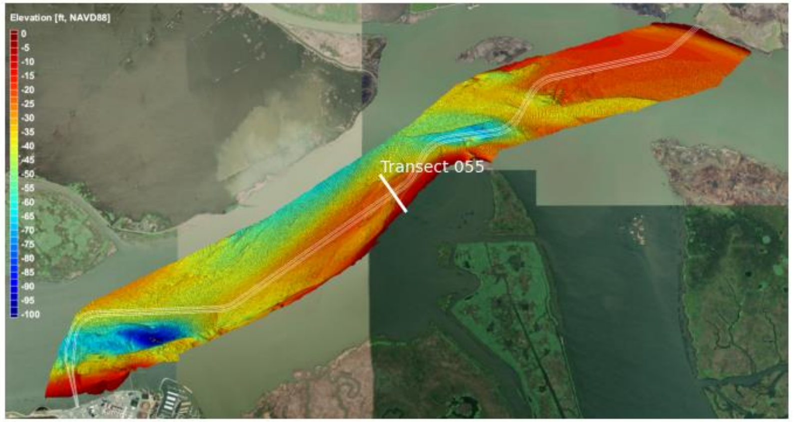


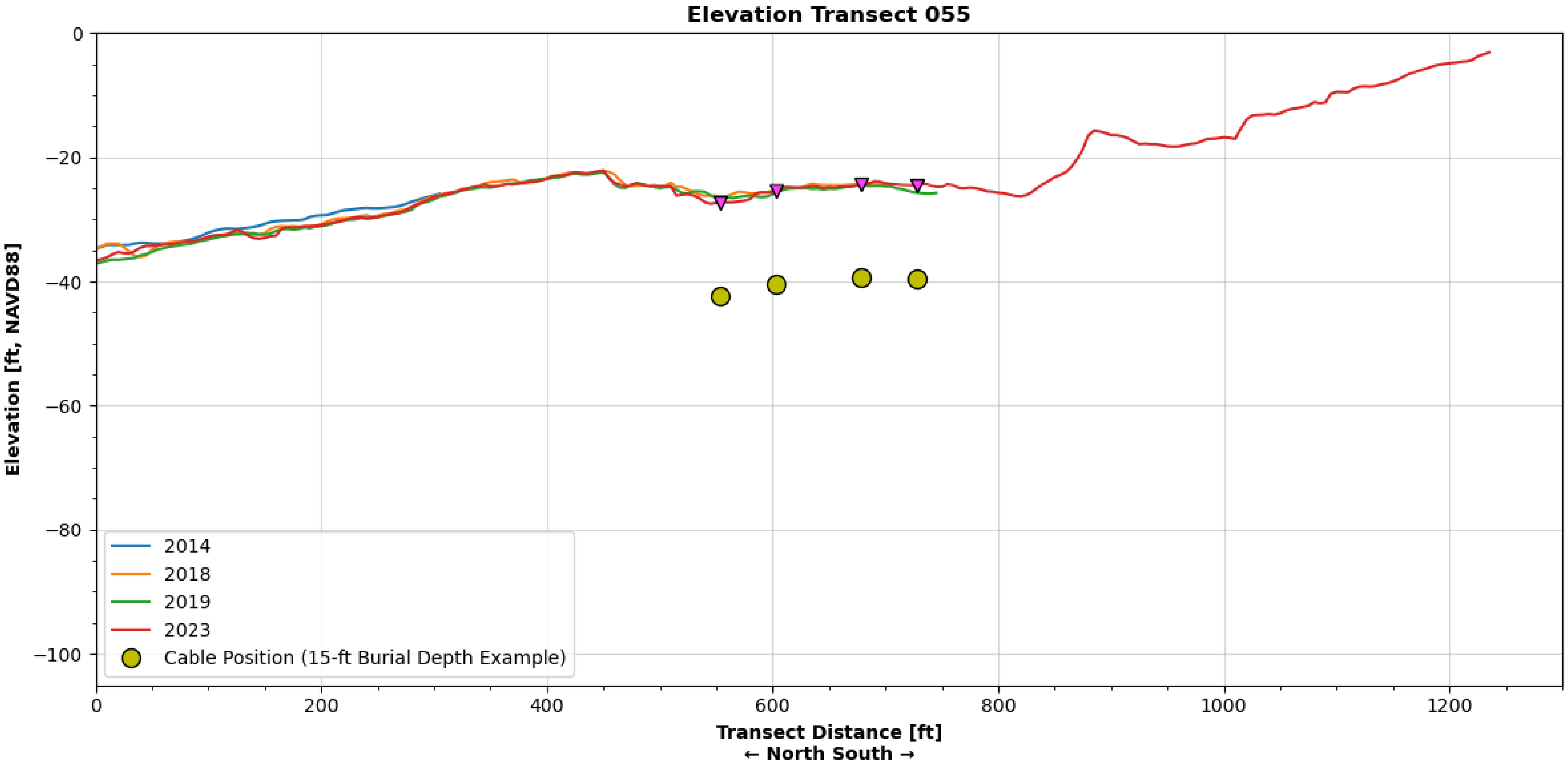


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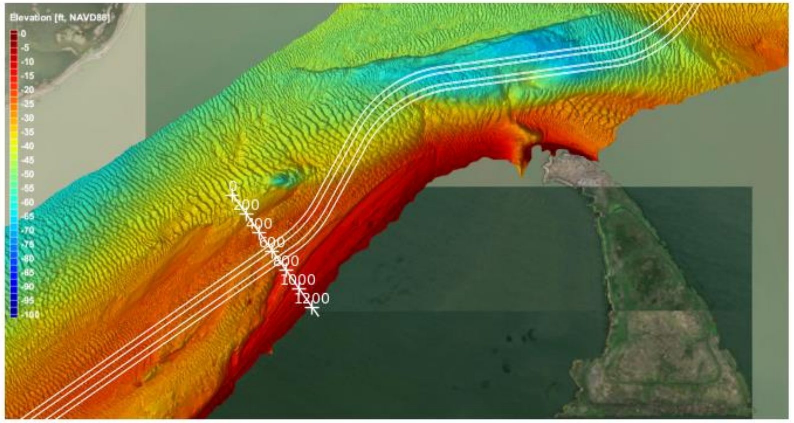


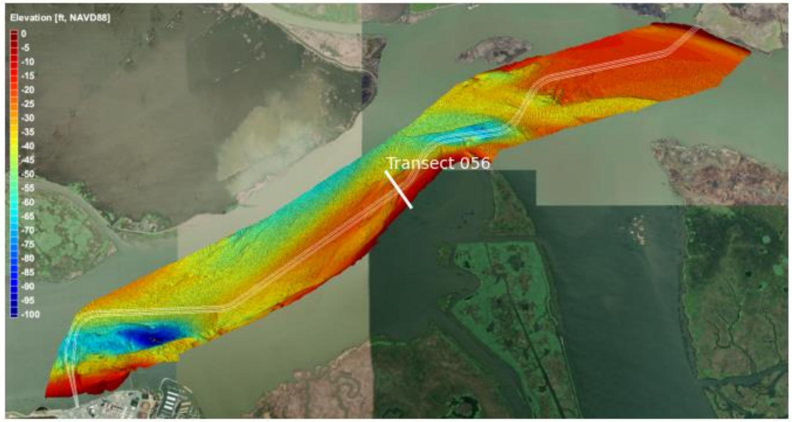


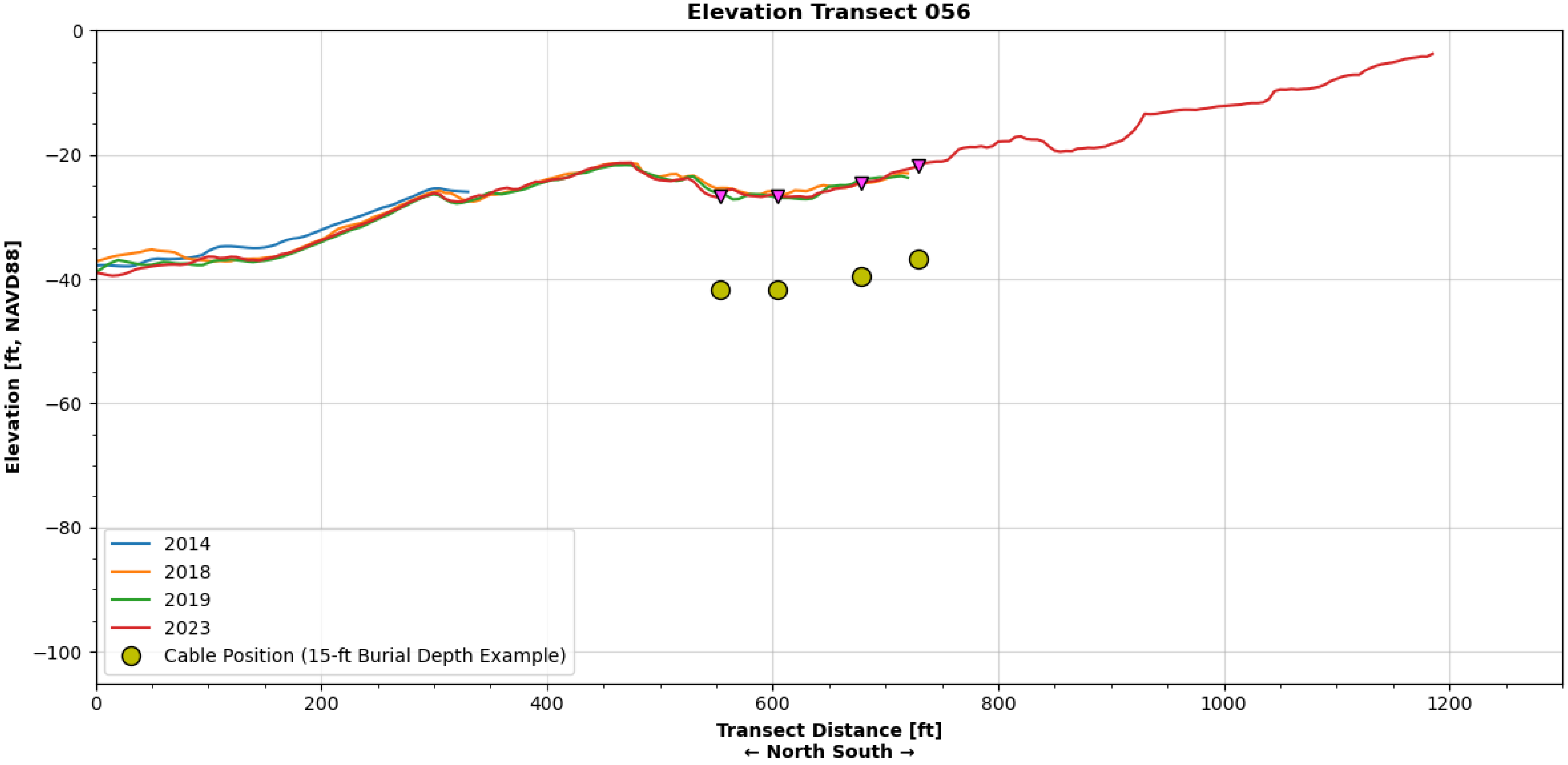


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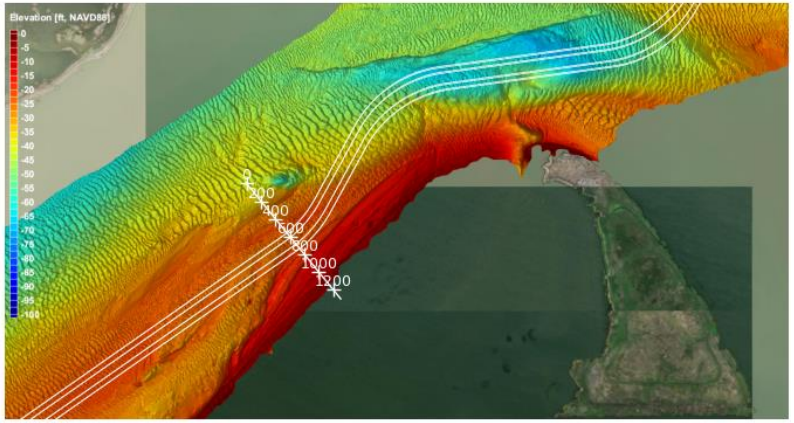


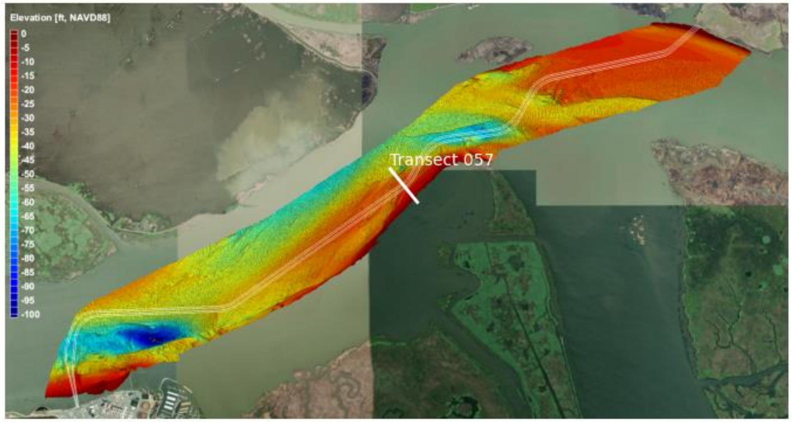


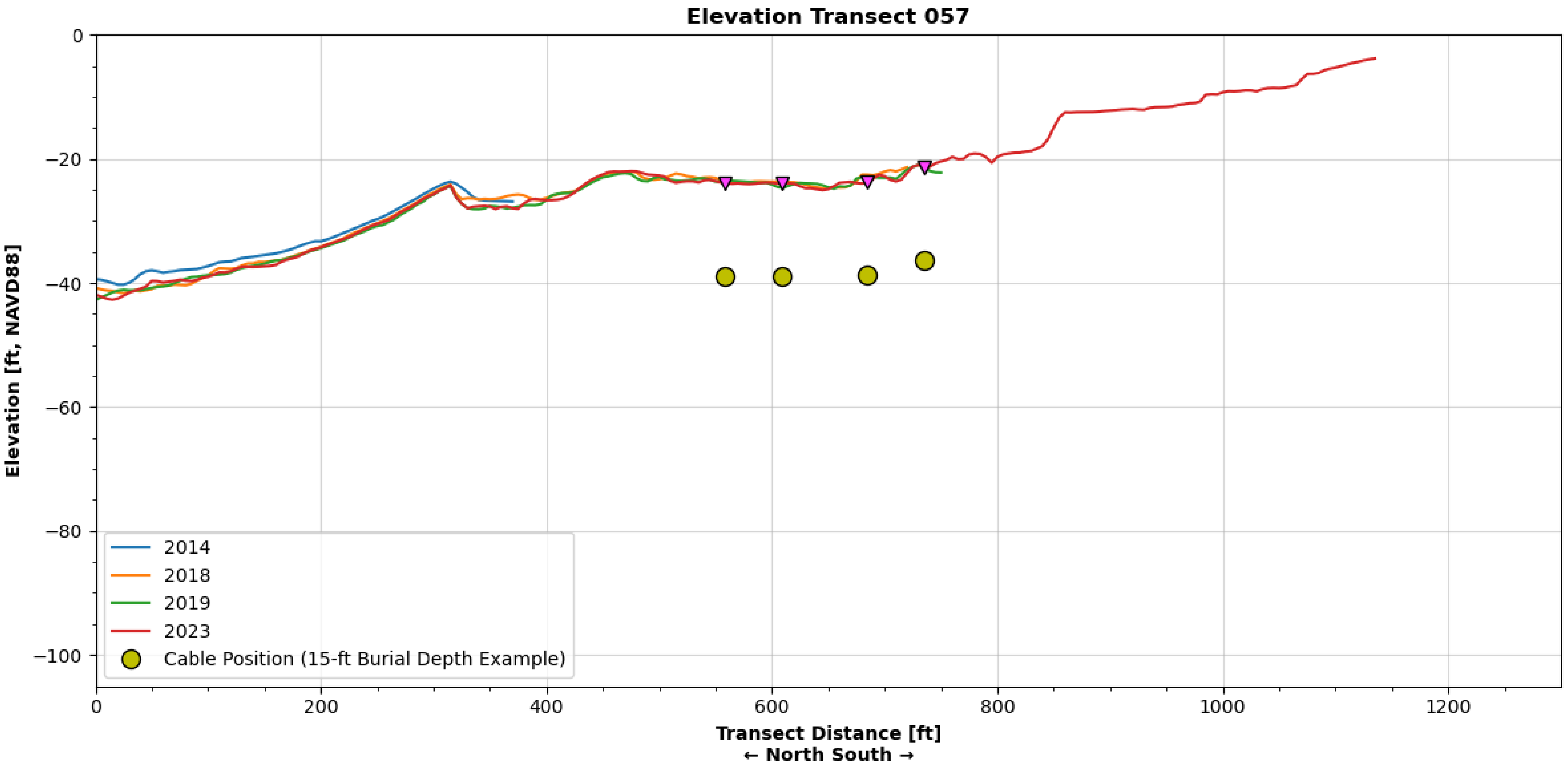


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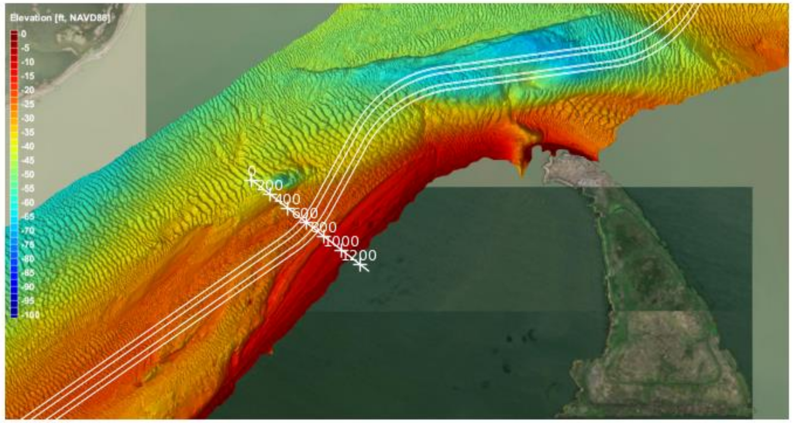


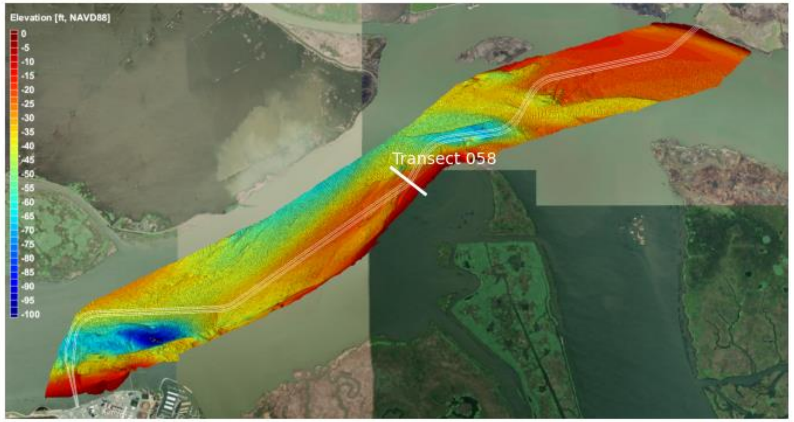


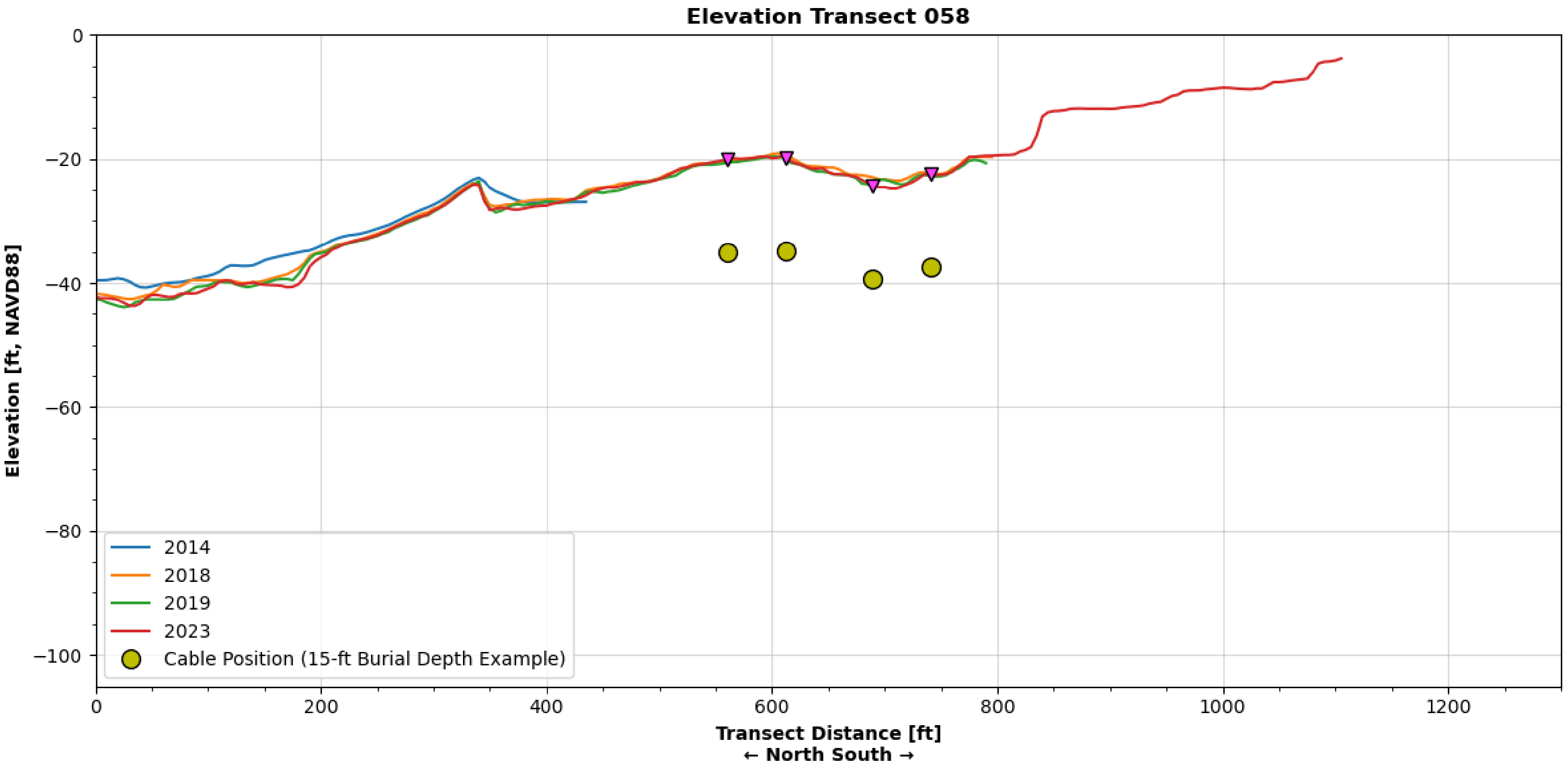


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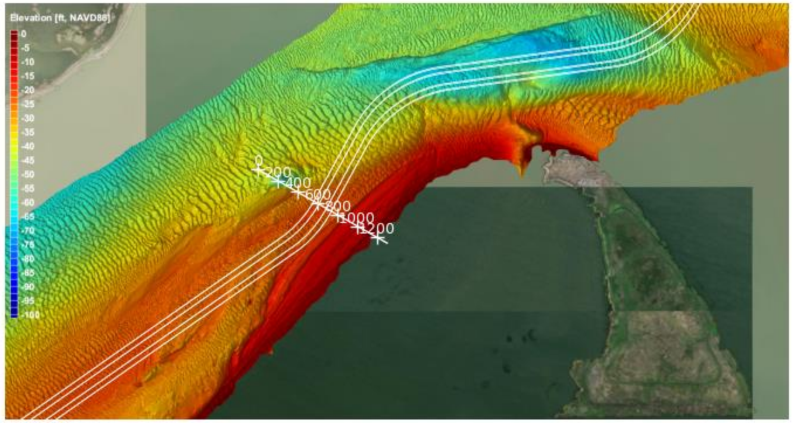

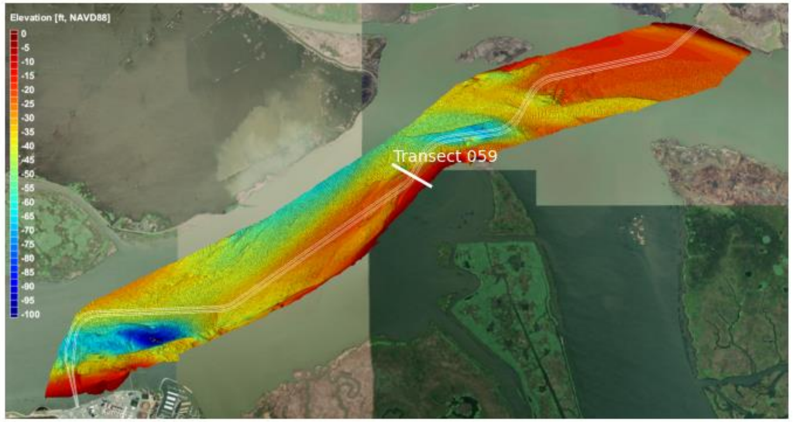


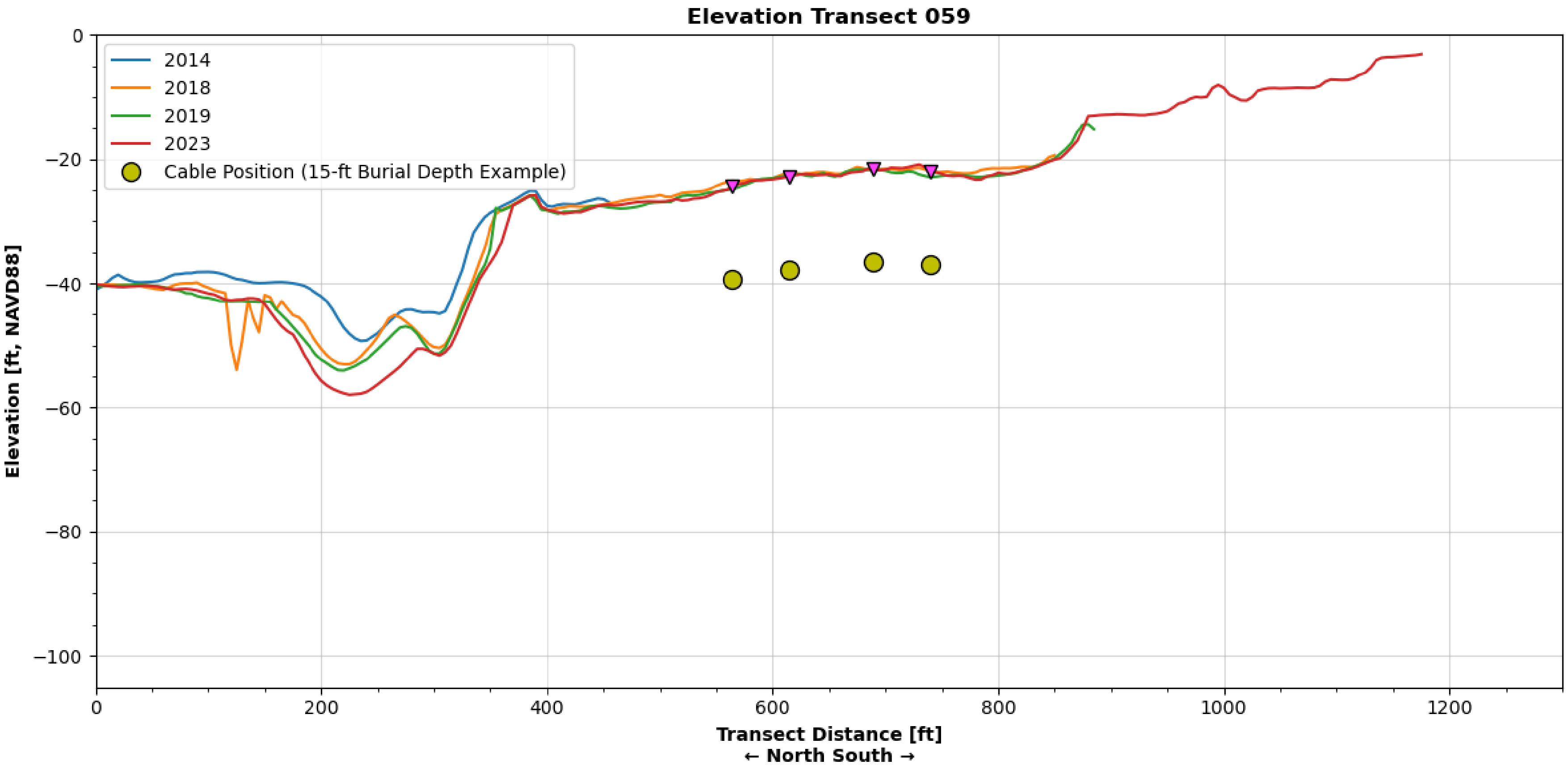


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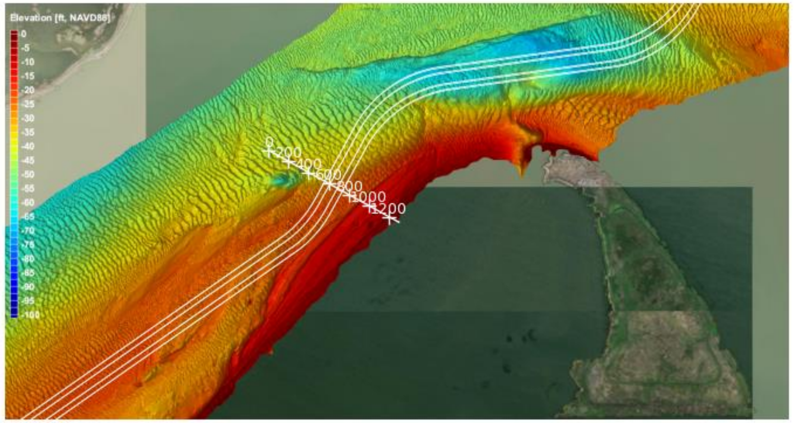


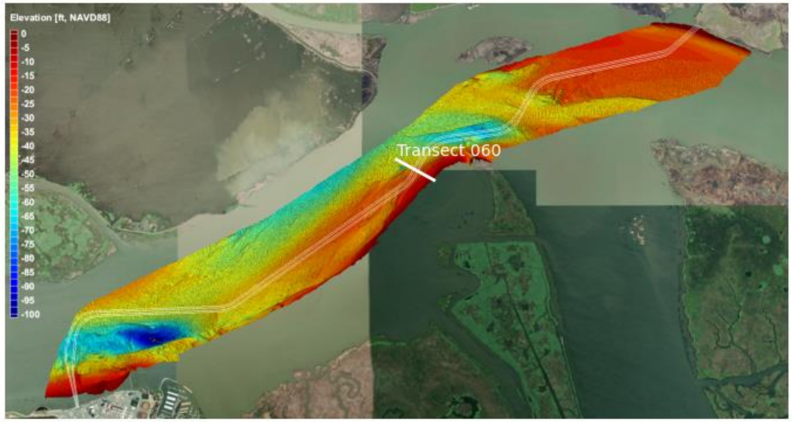


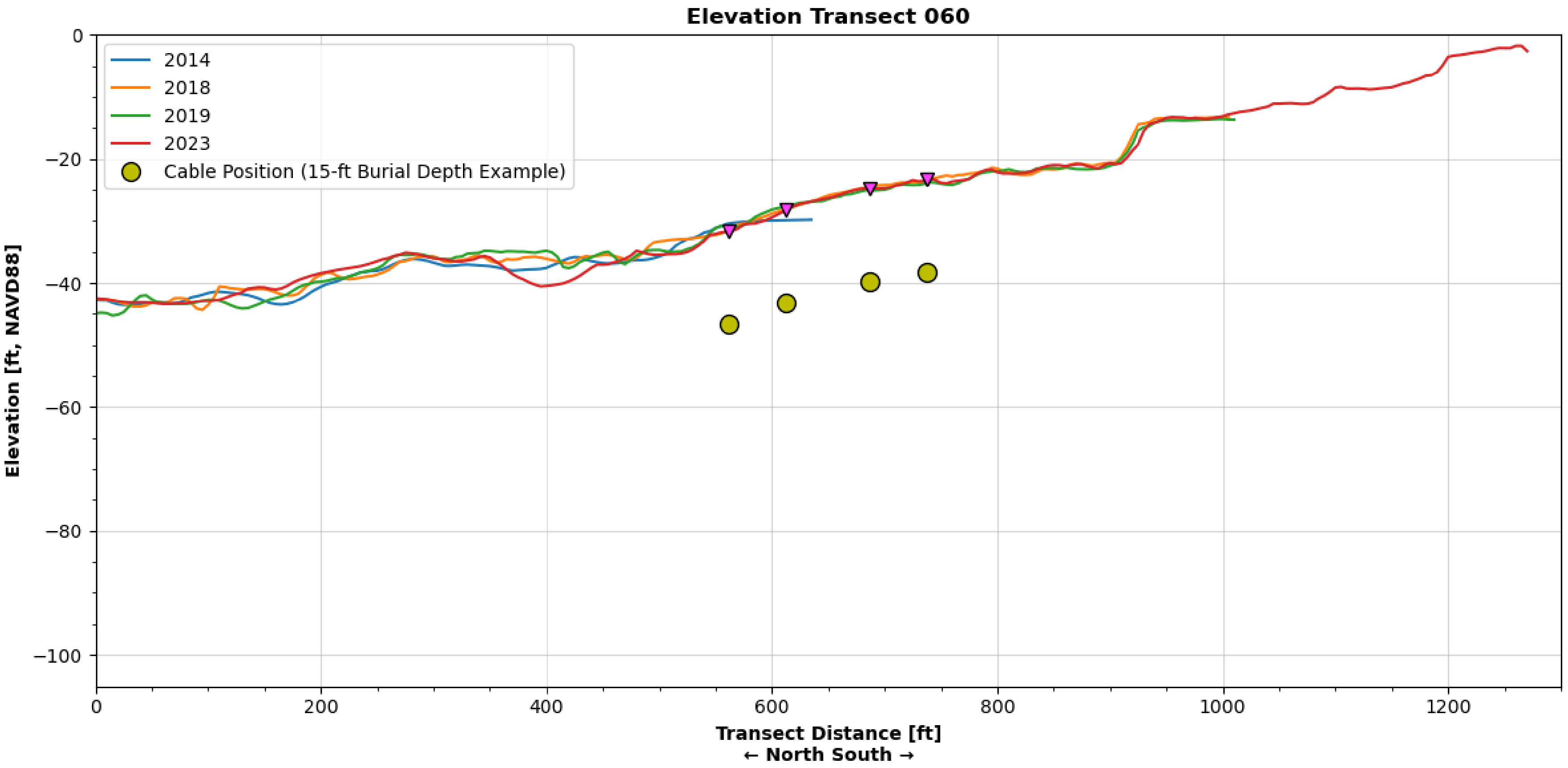


*Note: vertical exaggeration on elevation transect plots*

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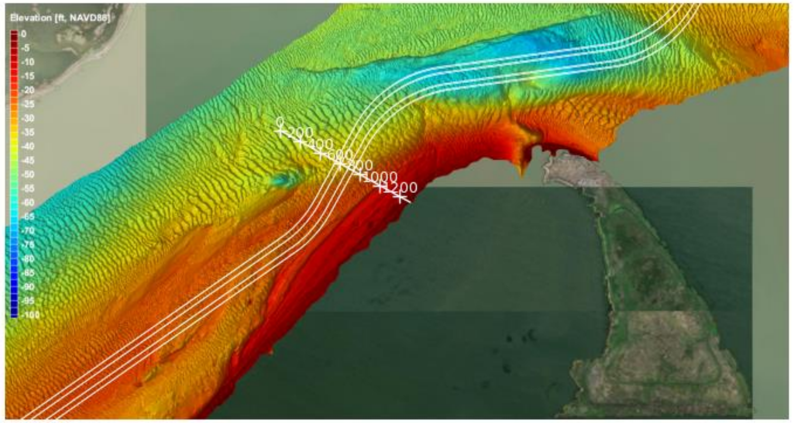


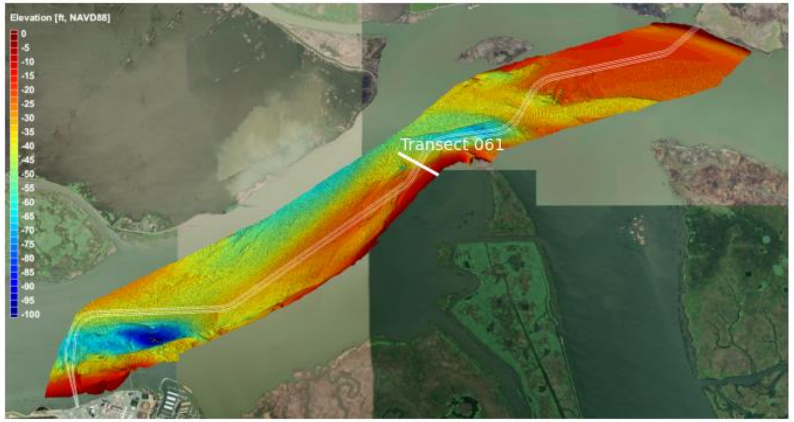


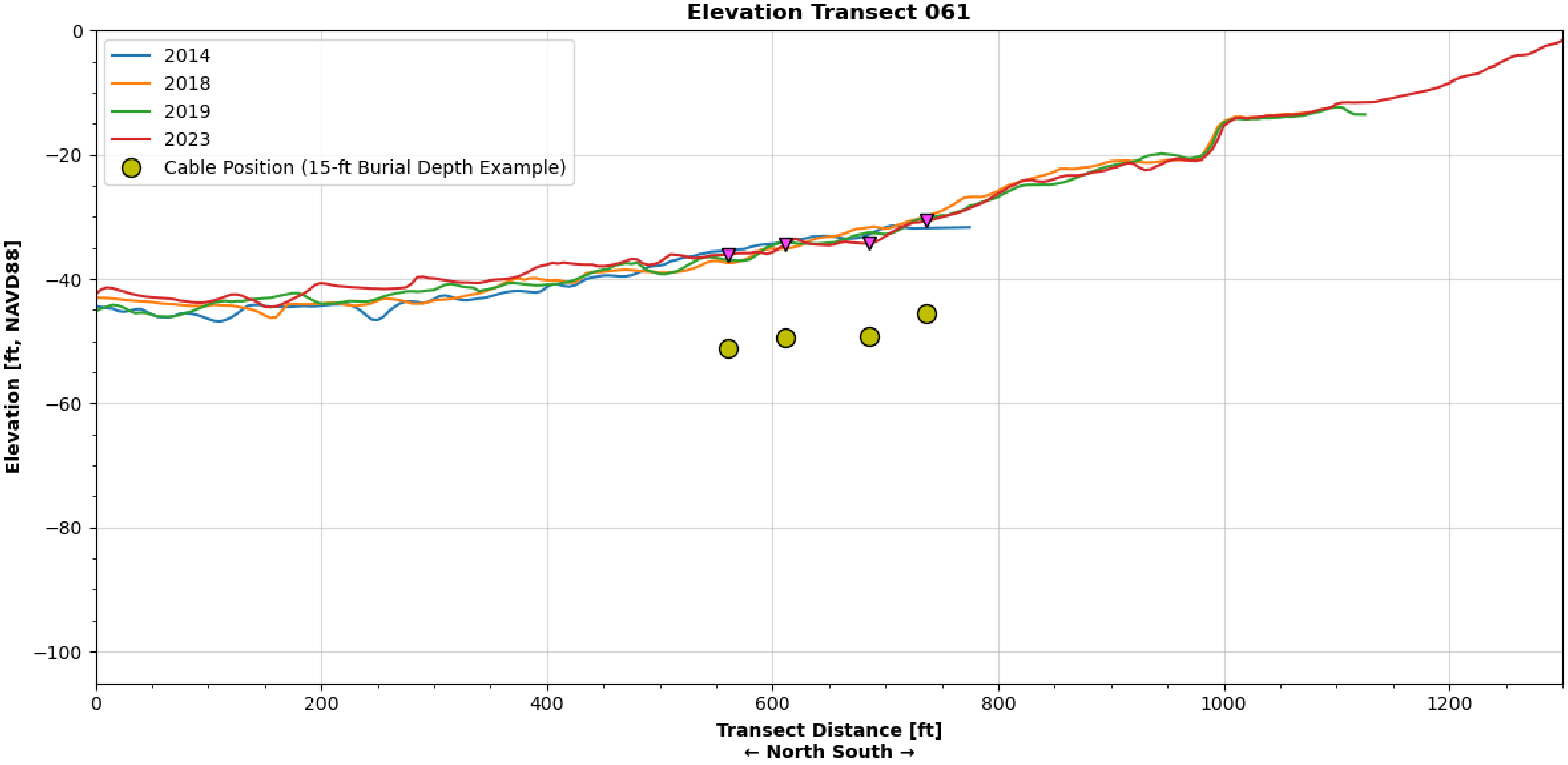


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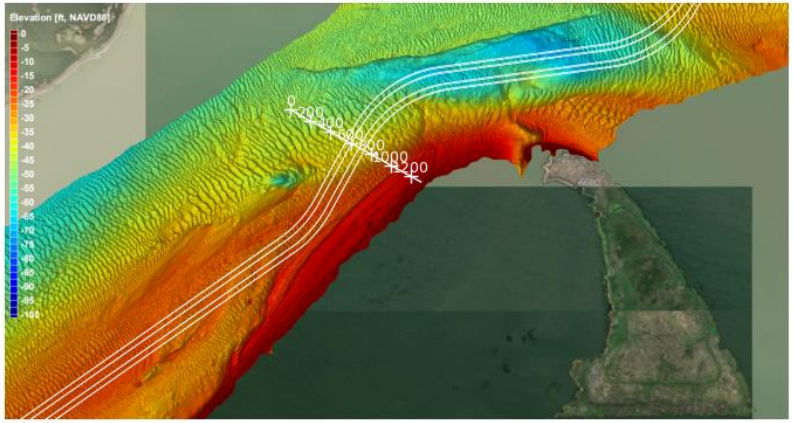


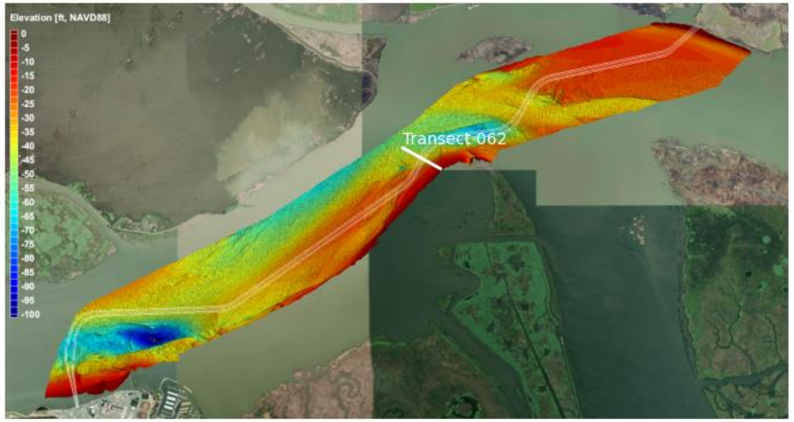


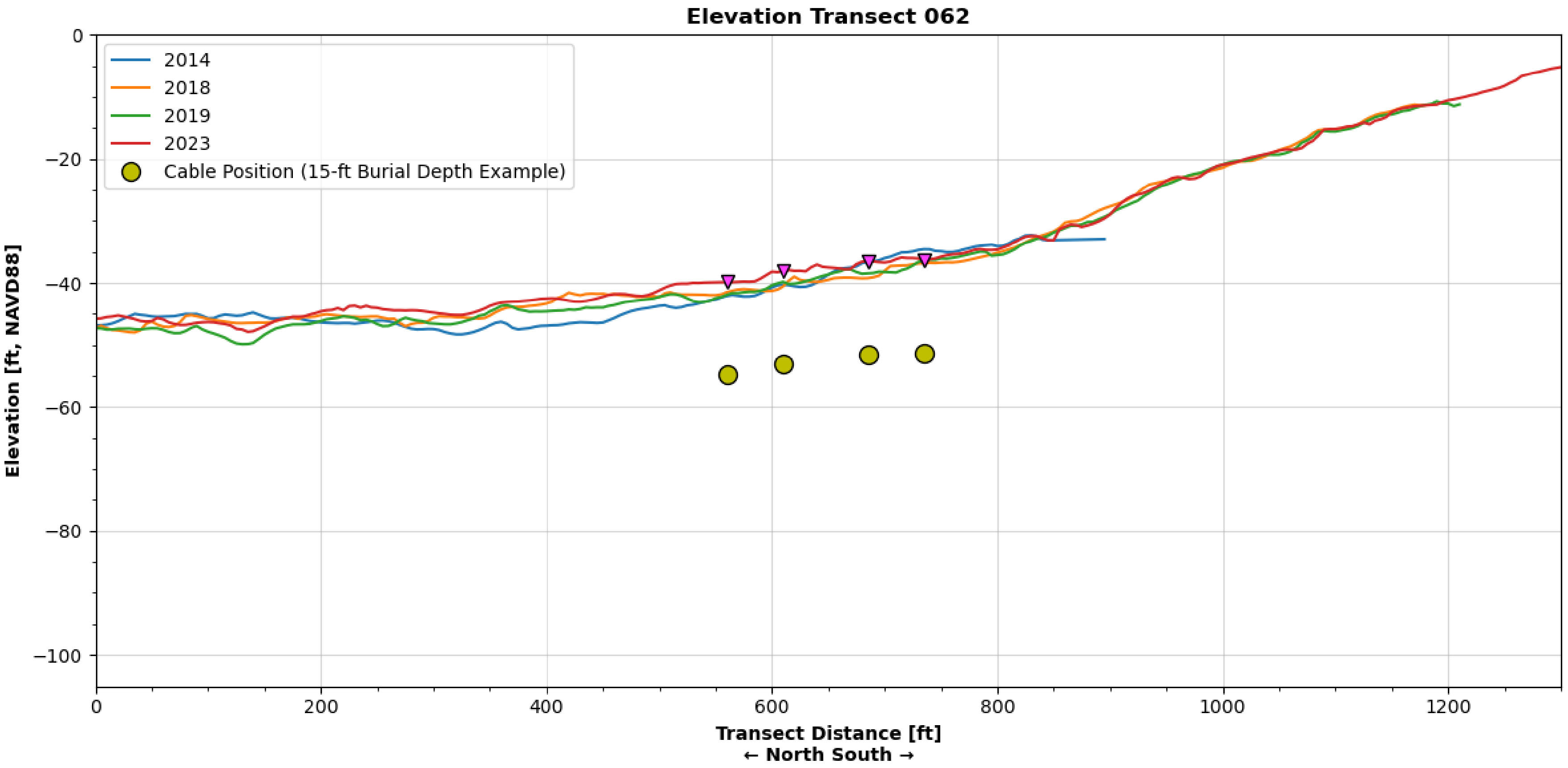


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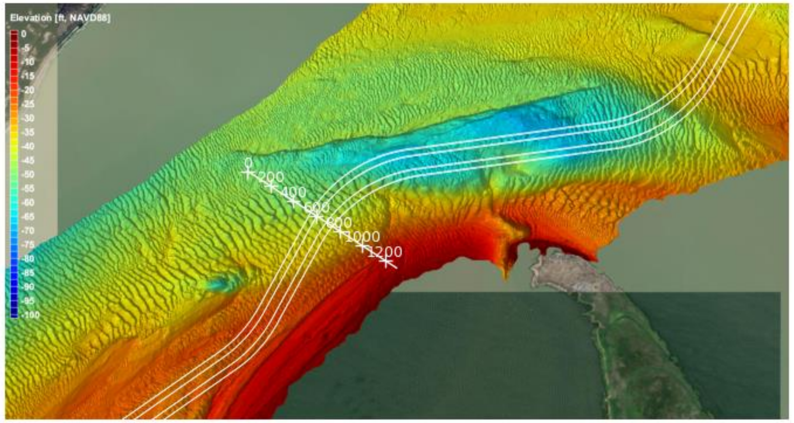


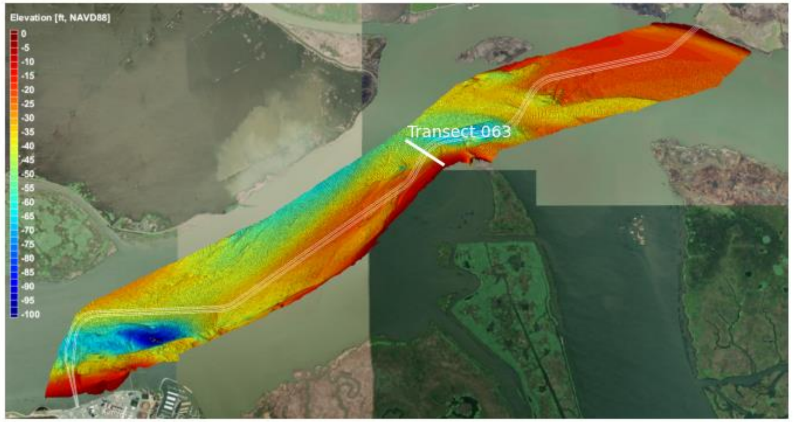


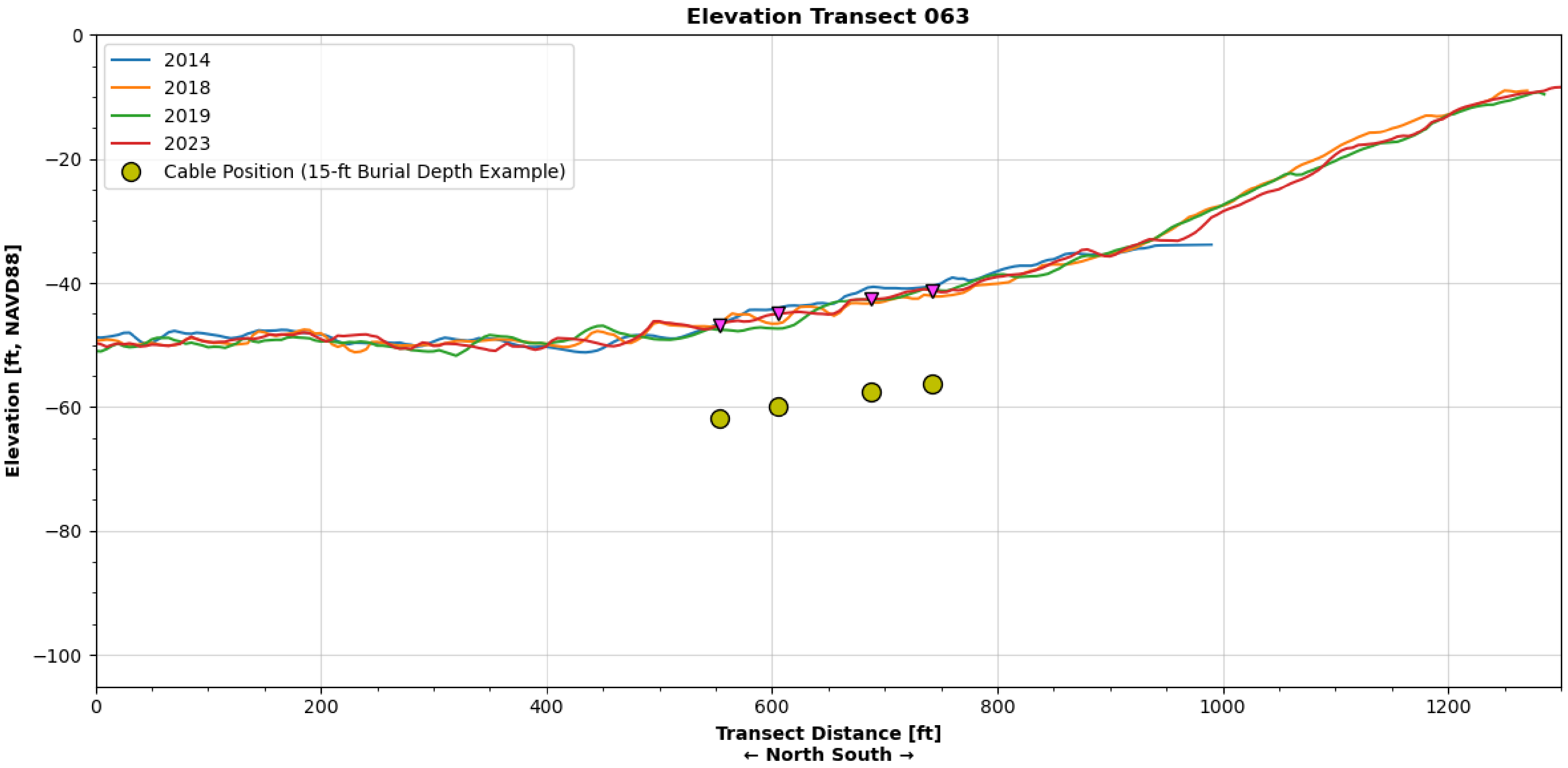


*Note: vertical exaggeration on elevation transect plots*

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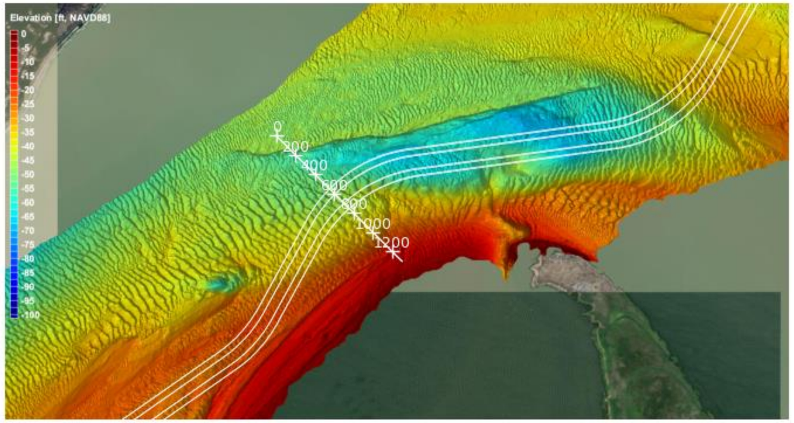


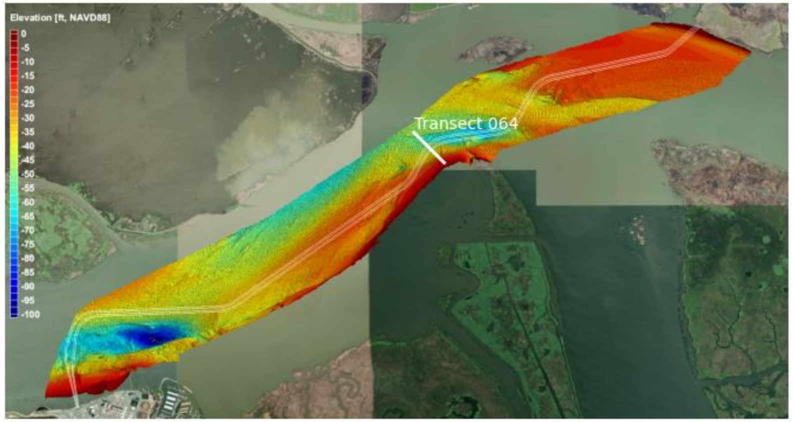


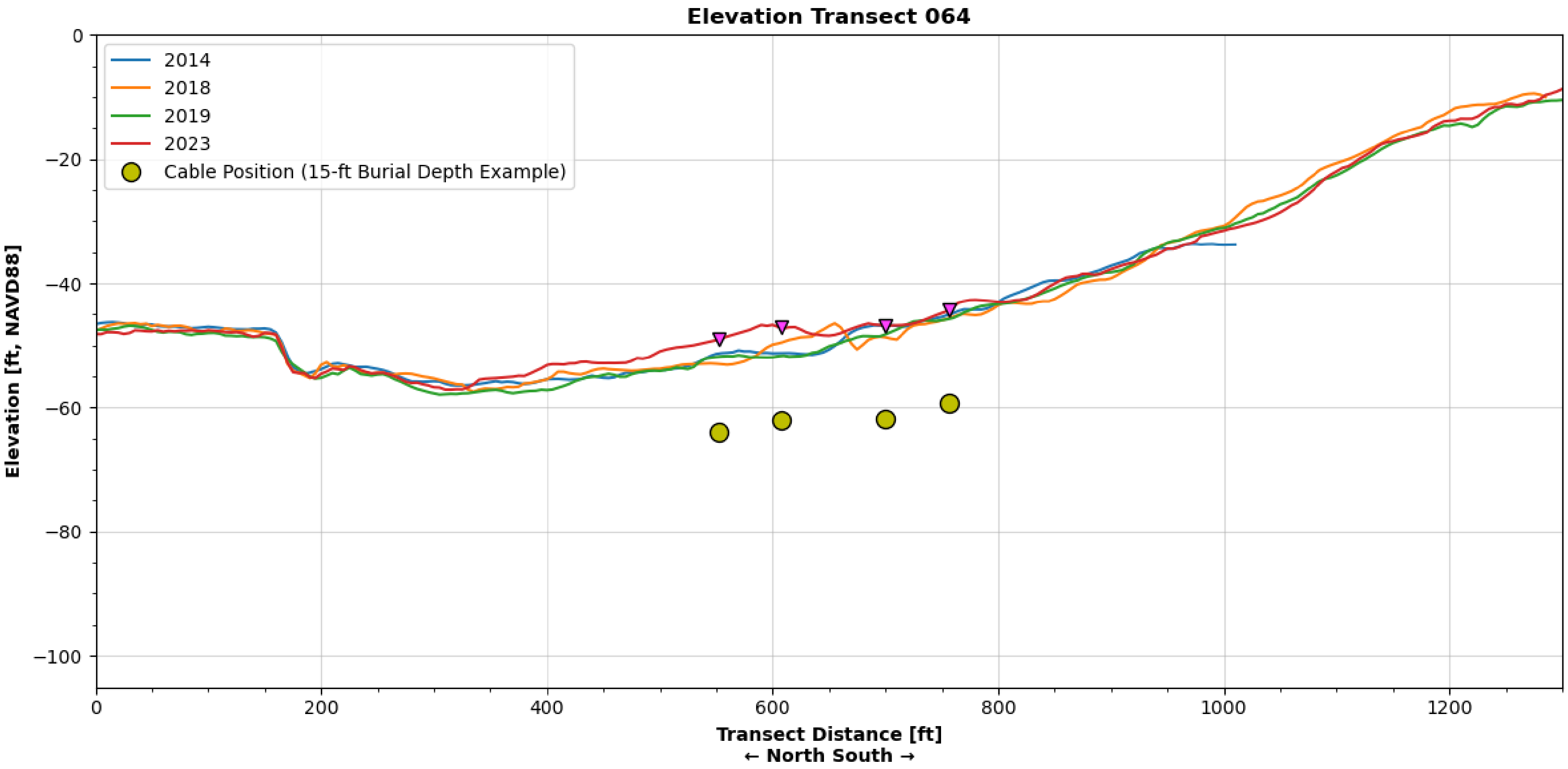


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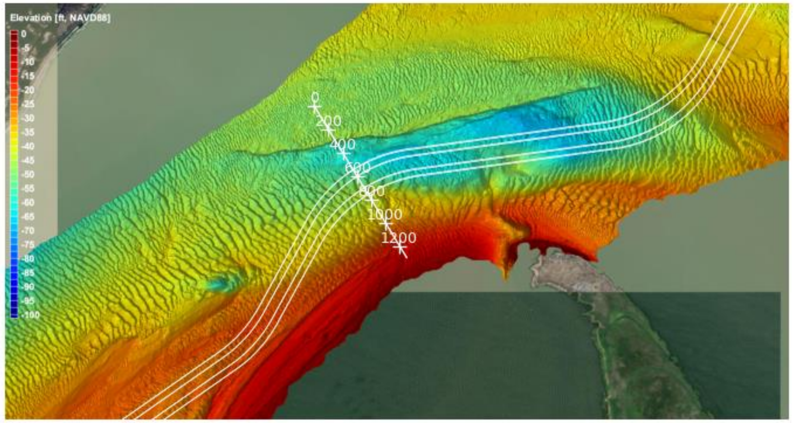

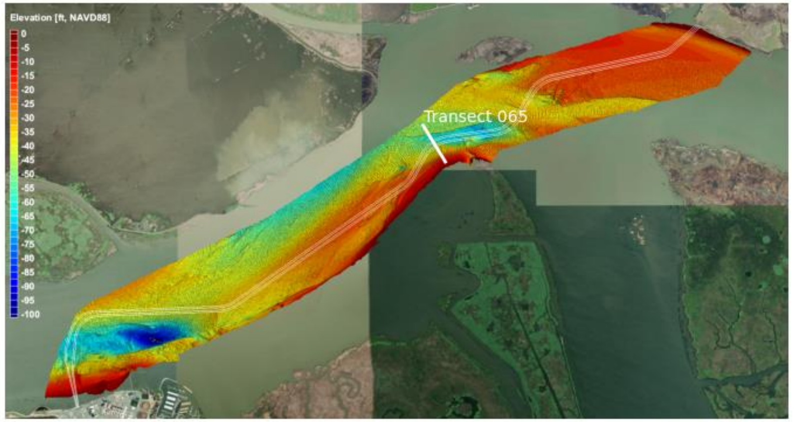


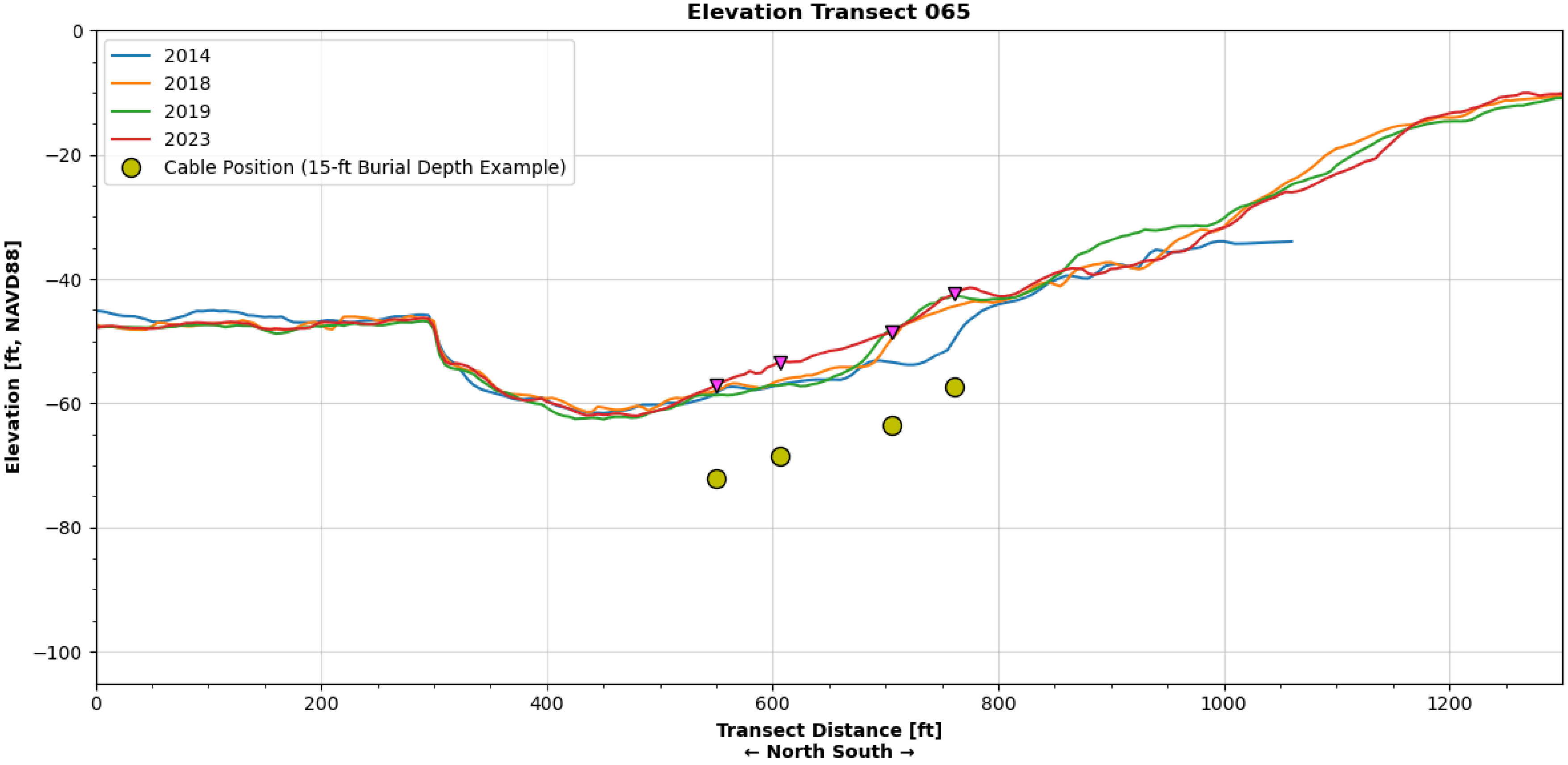


*Note: vertical exaggeration on elevation transect plots*

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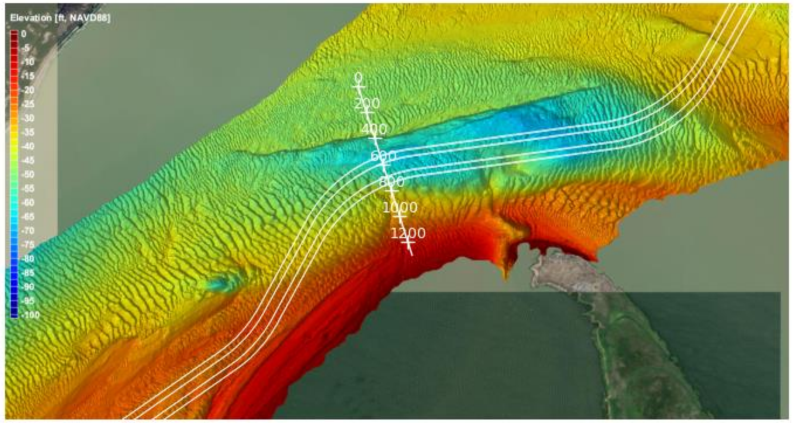


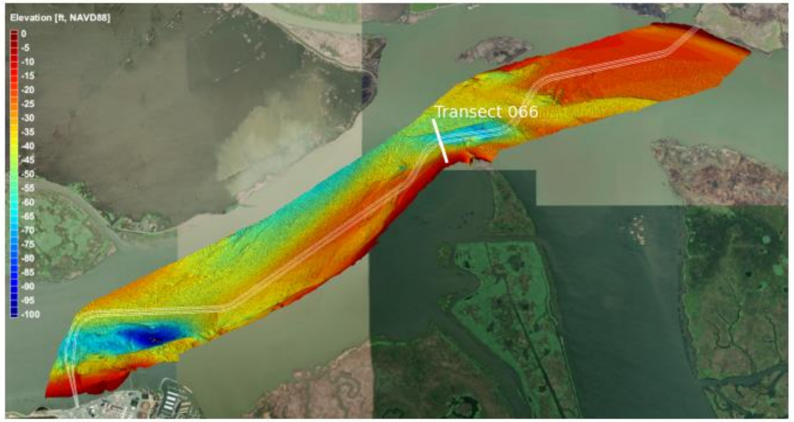


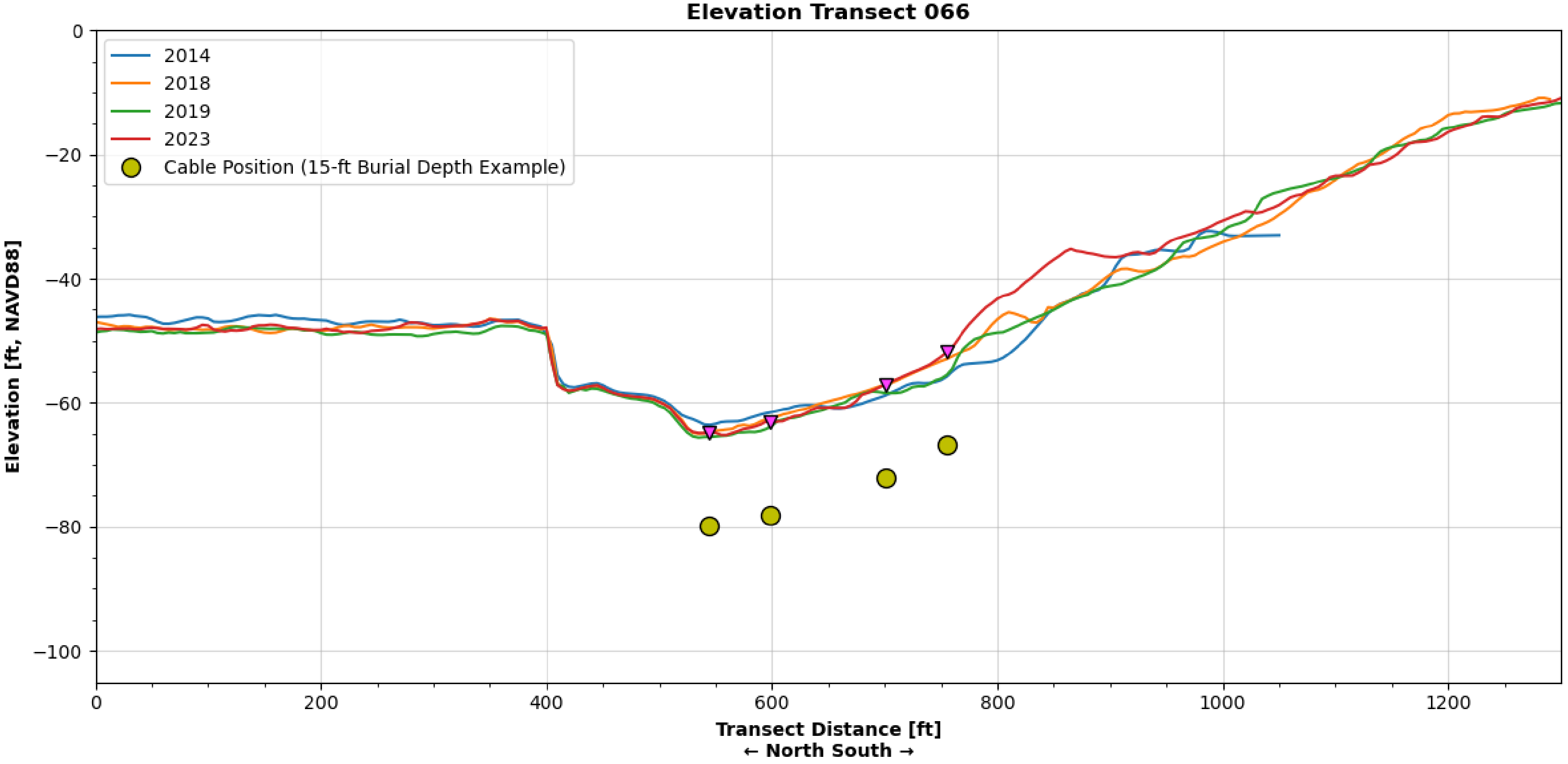


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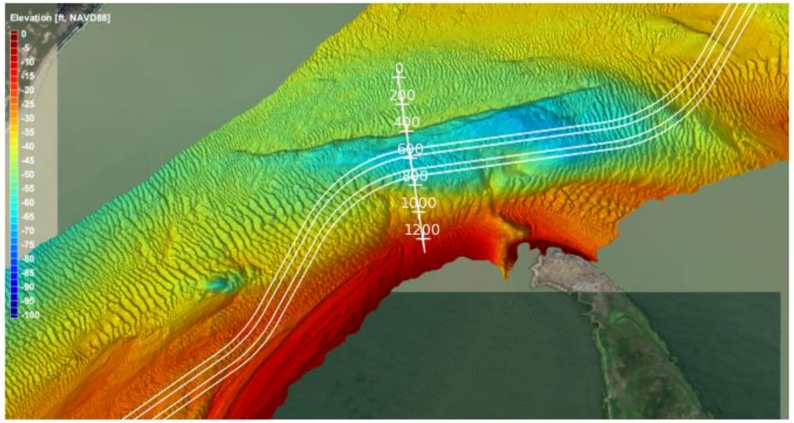

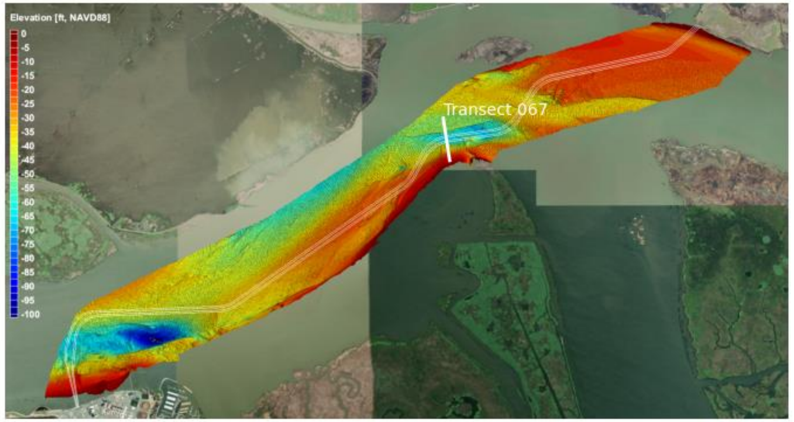


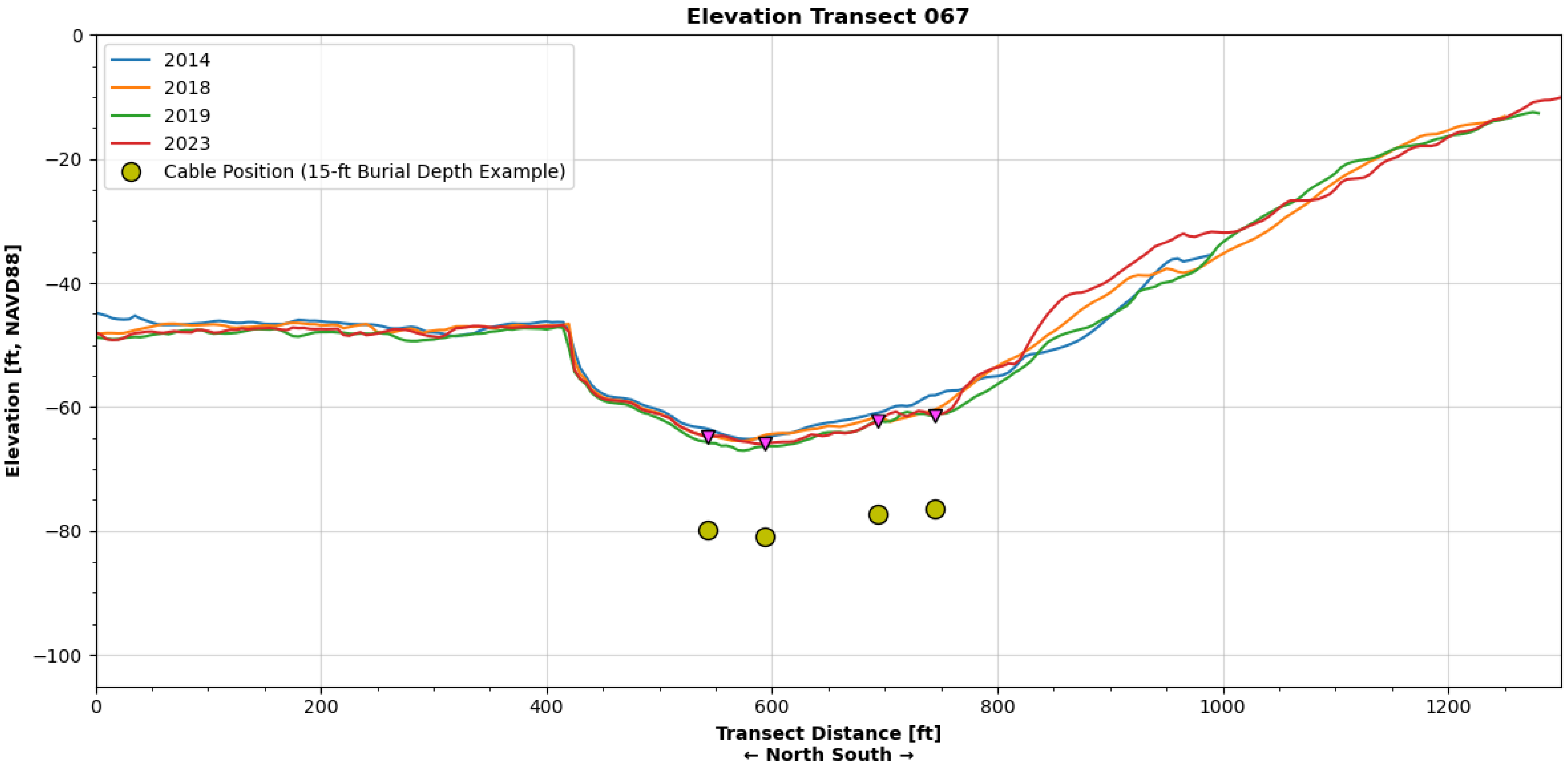


*Note: vertical exaggeration on elevation transect plots*

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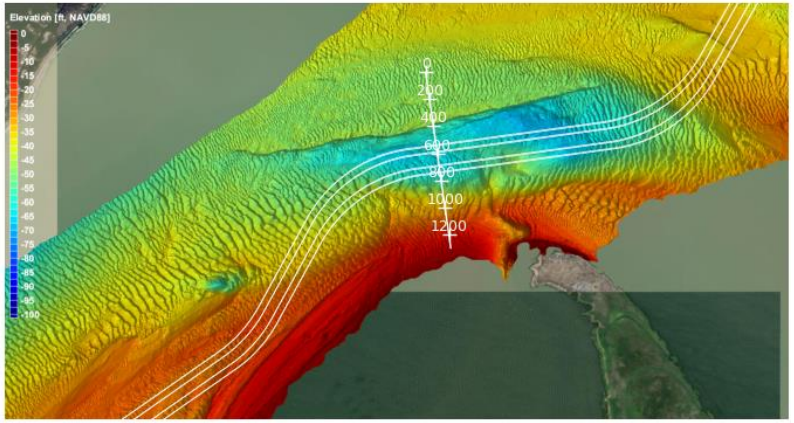


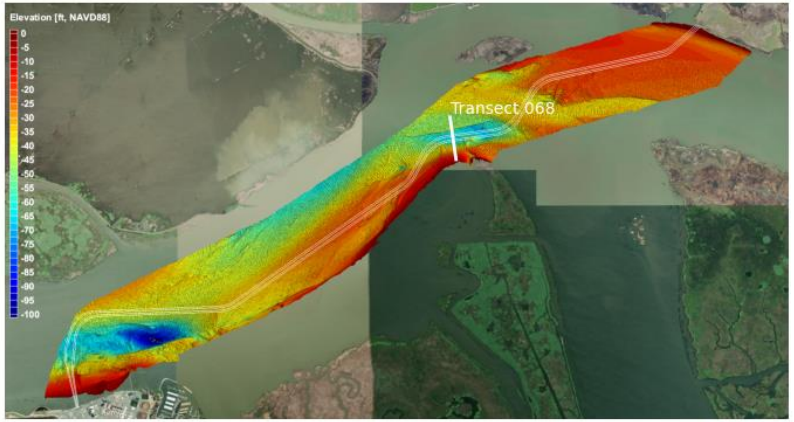


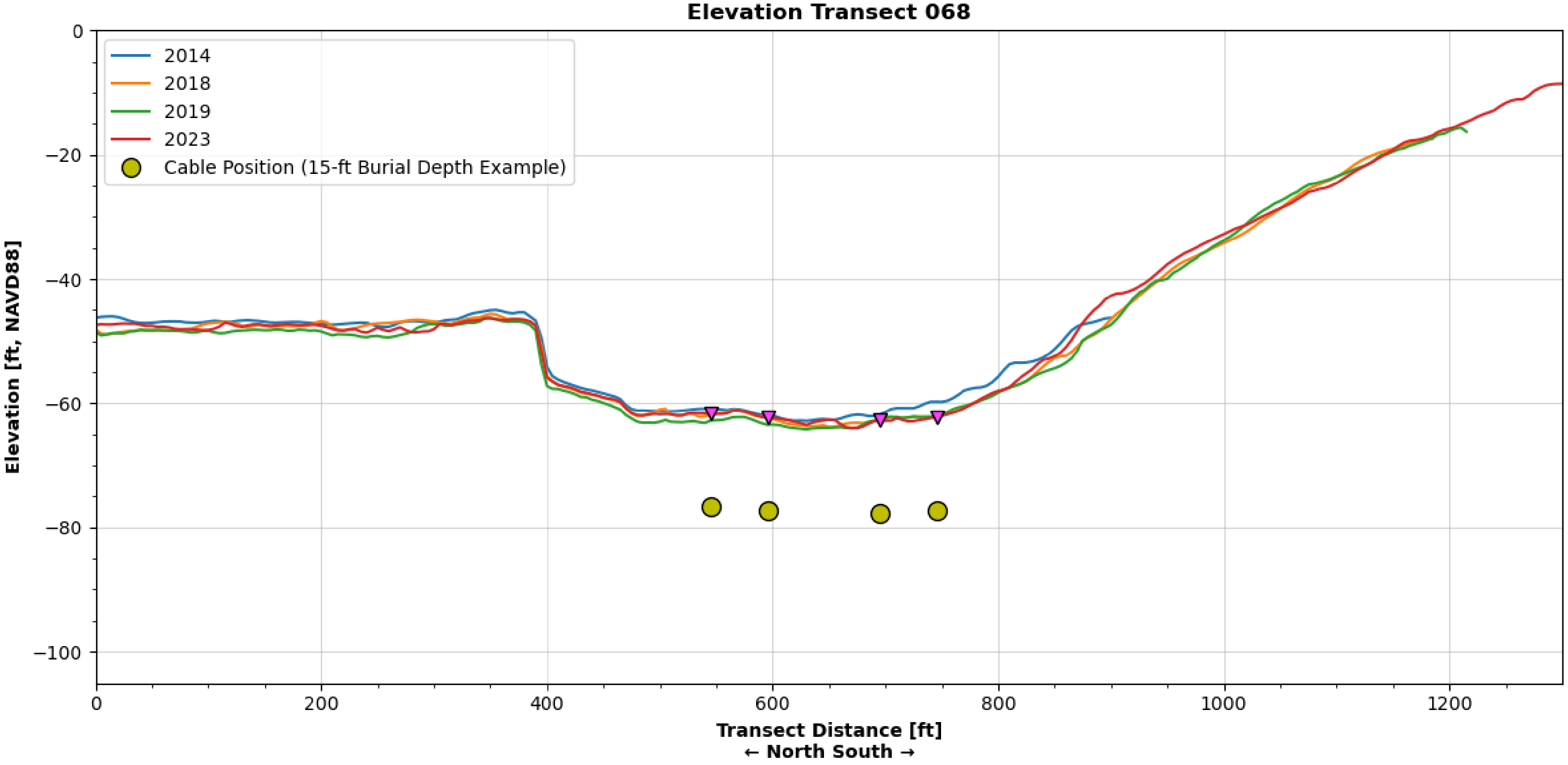


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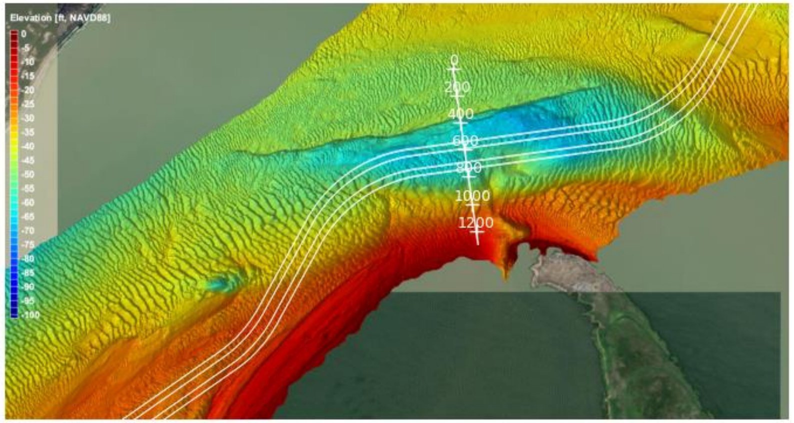


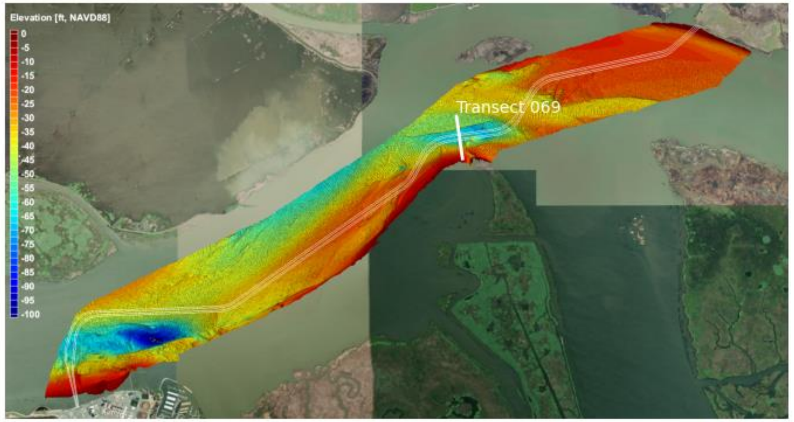


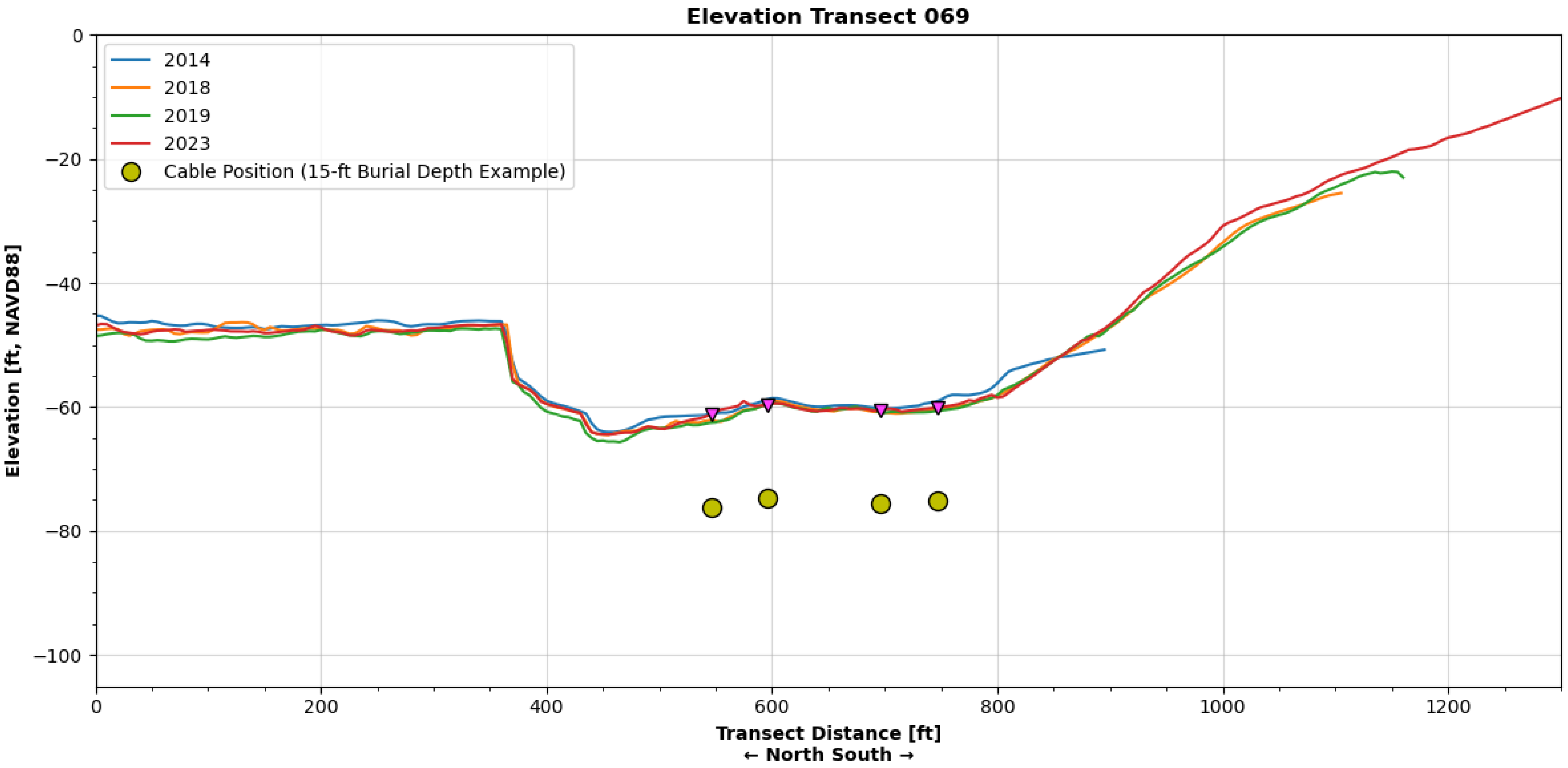


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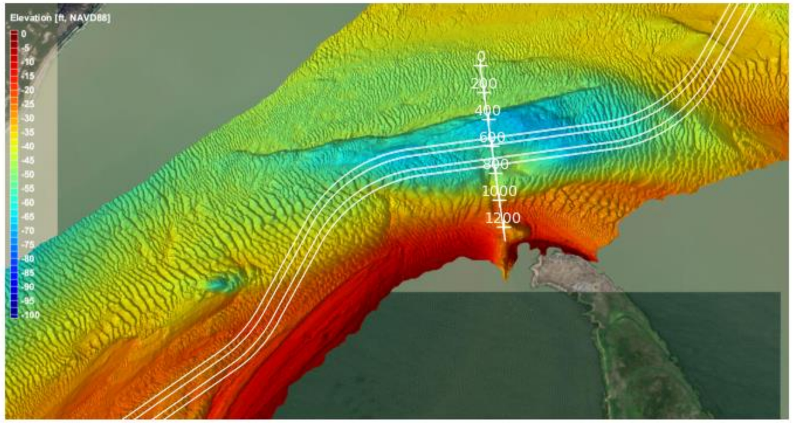


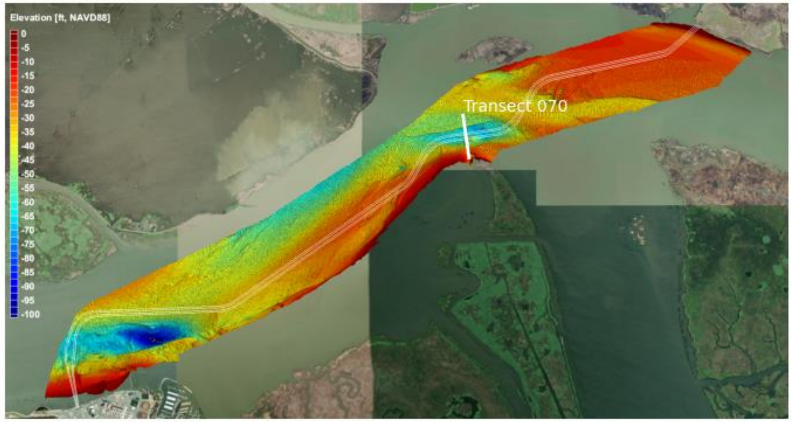


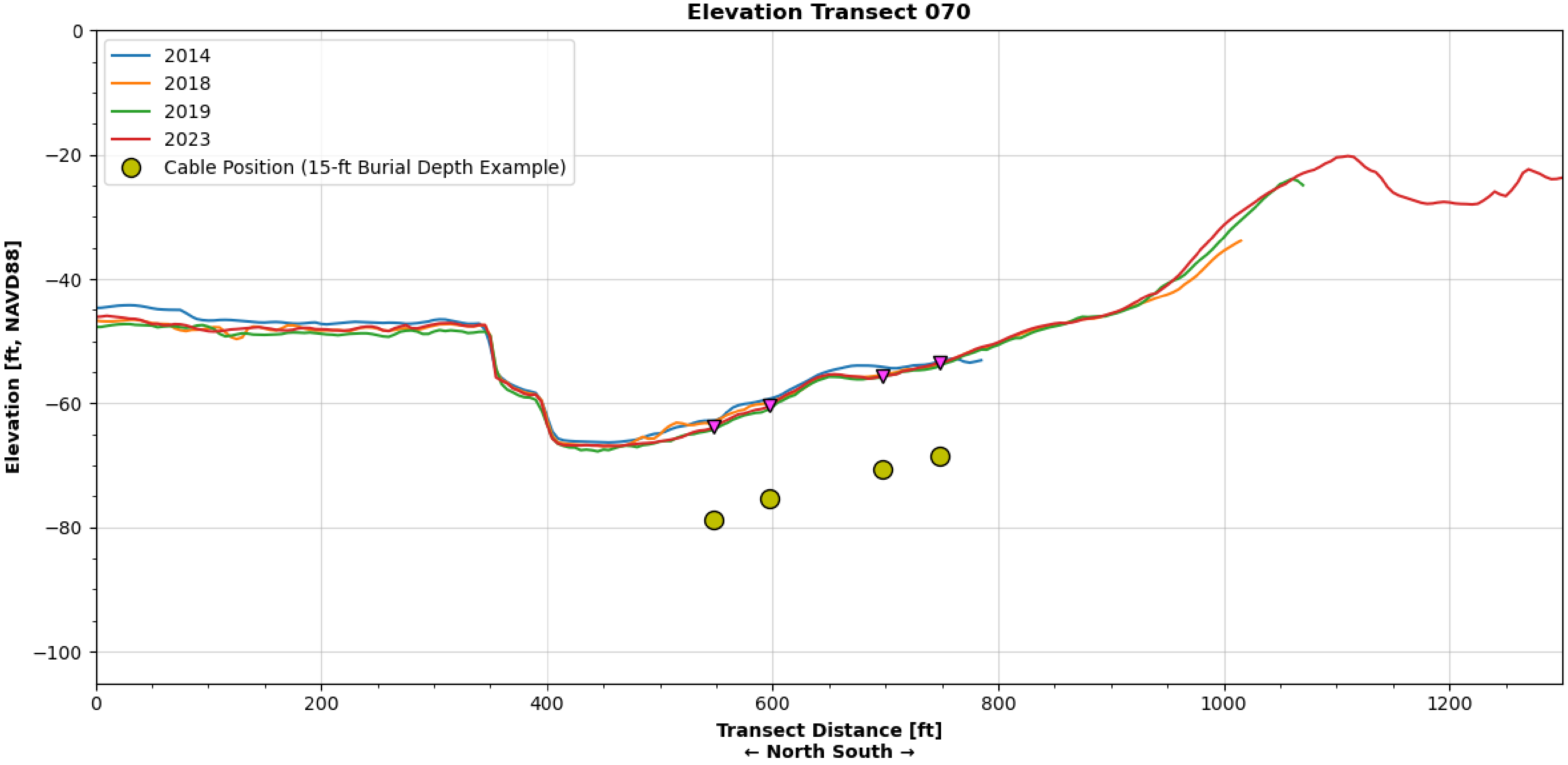


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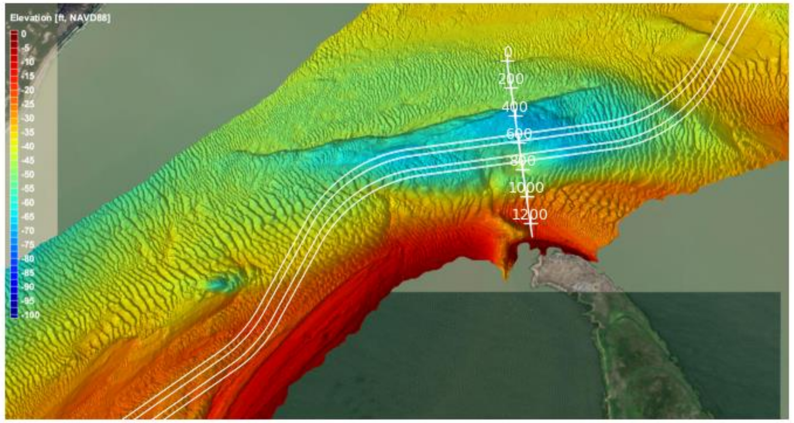


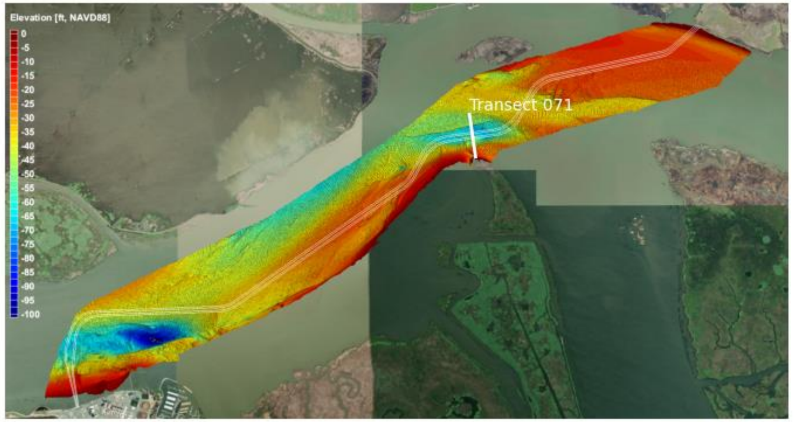


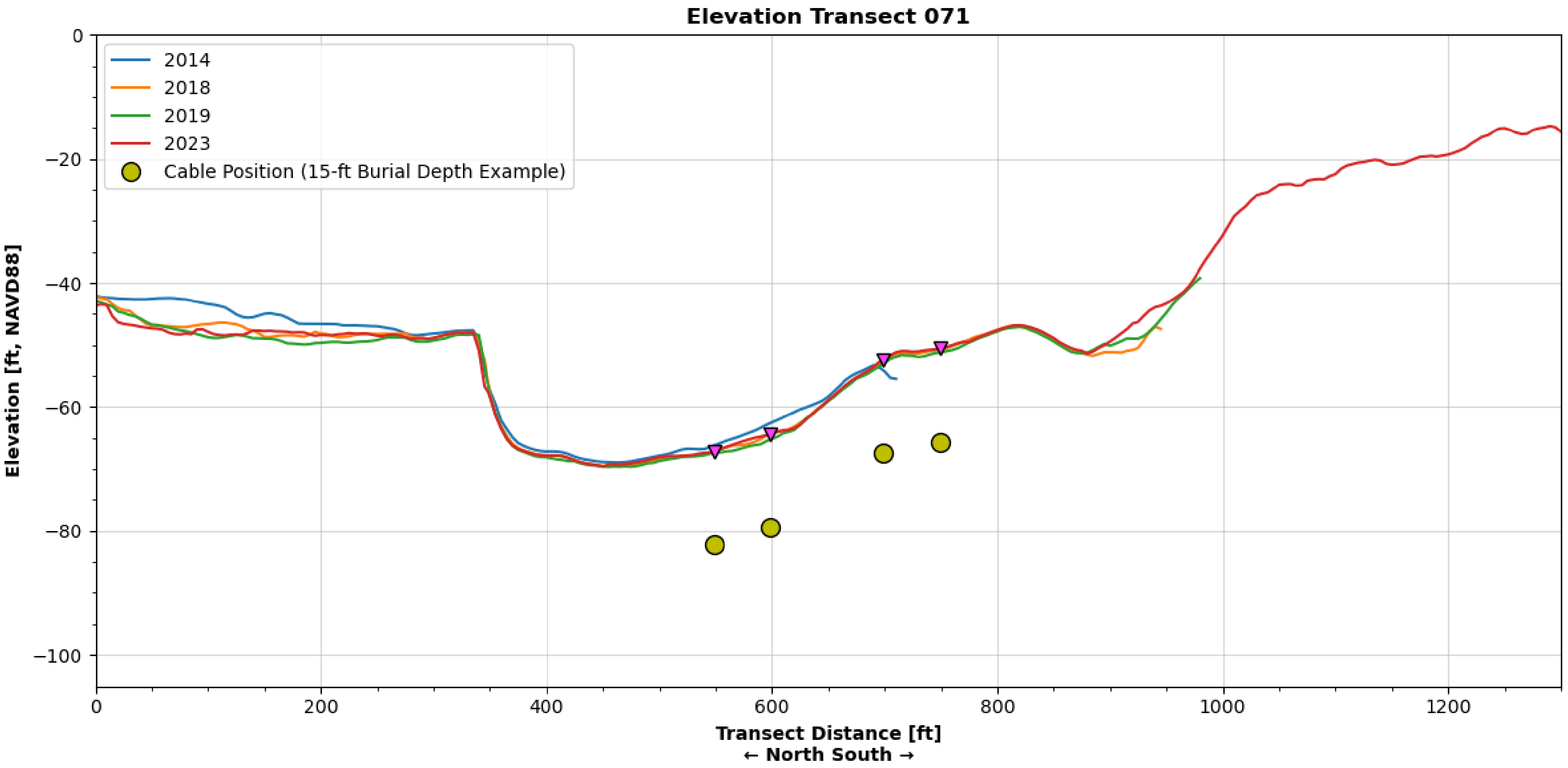


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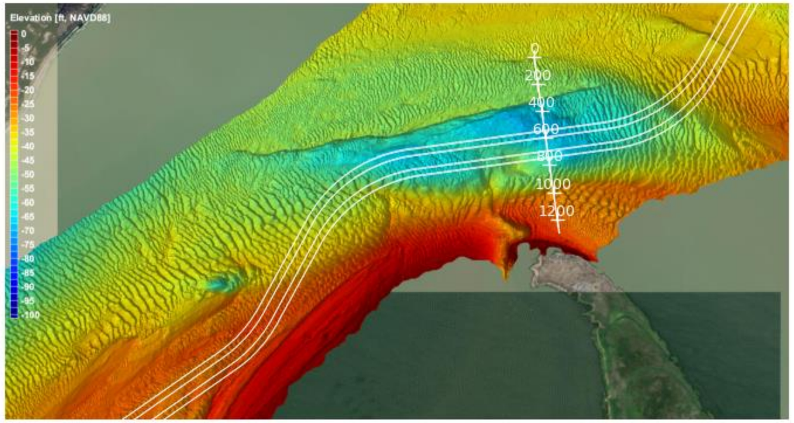


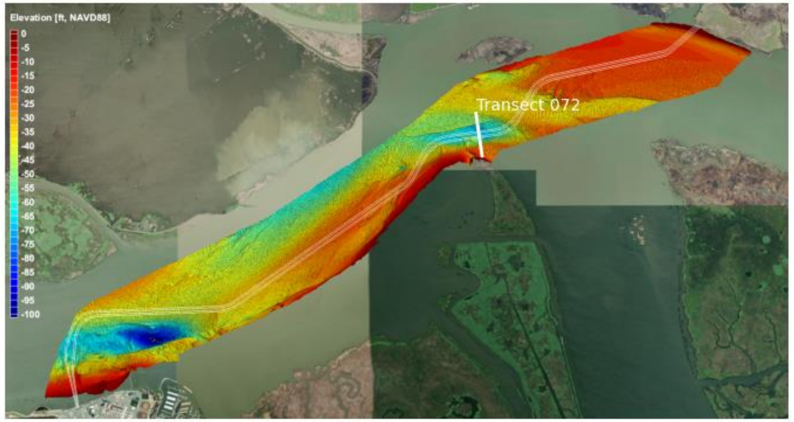


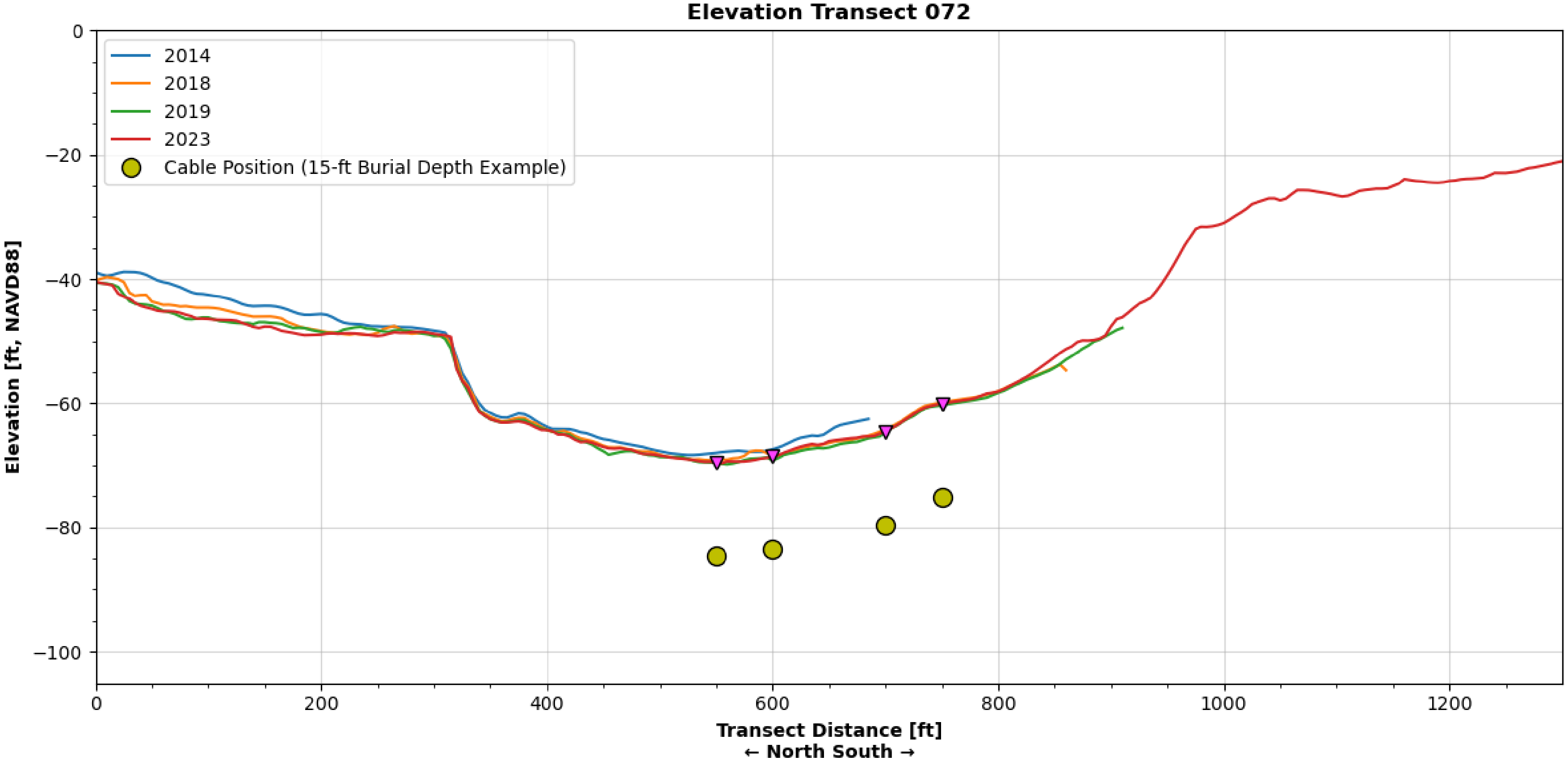


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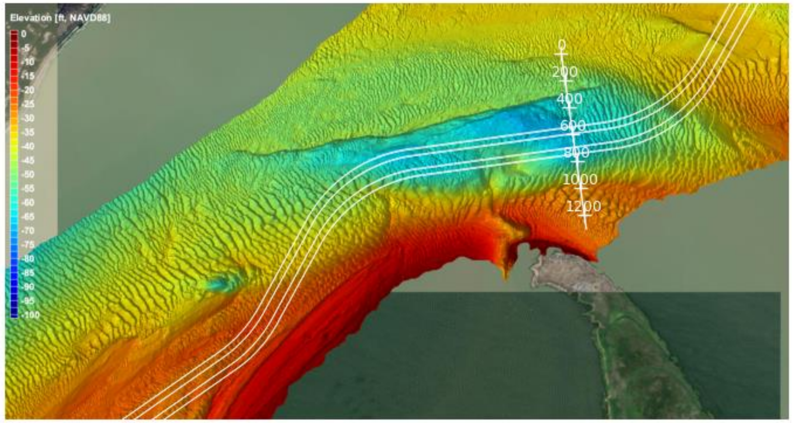


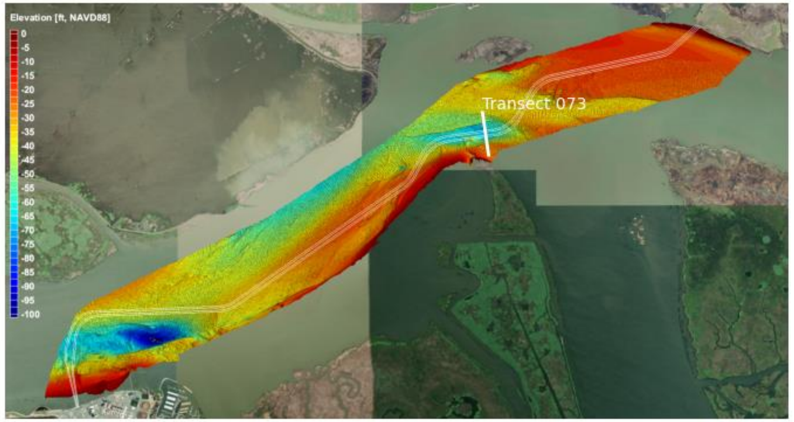


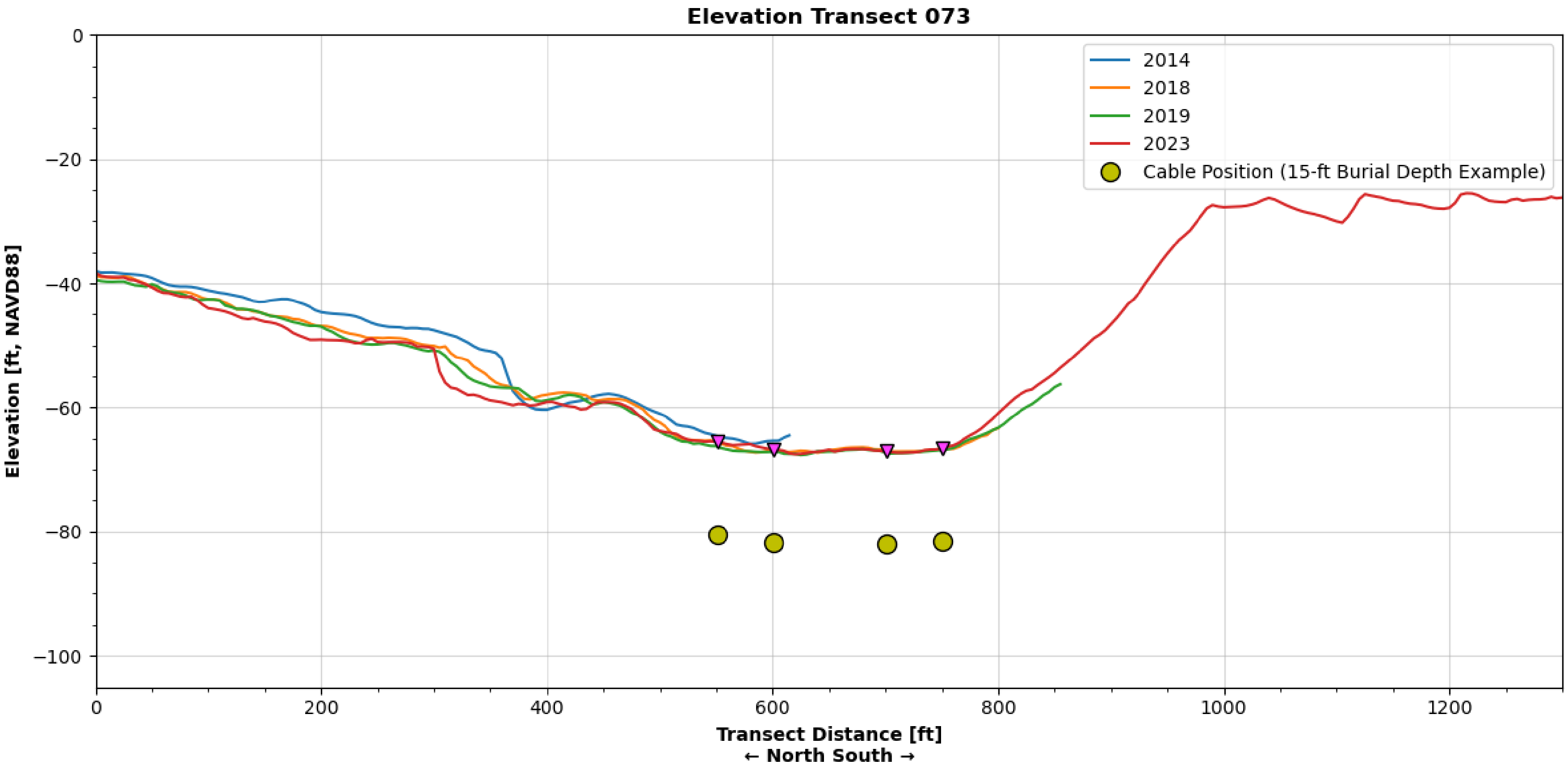


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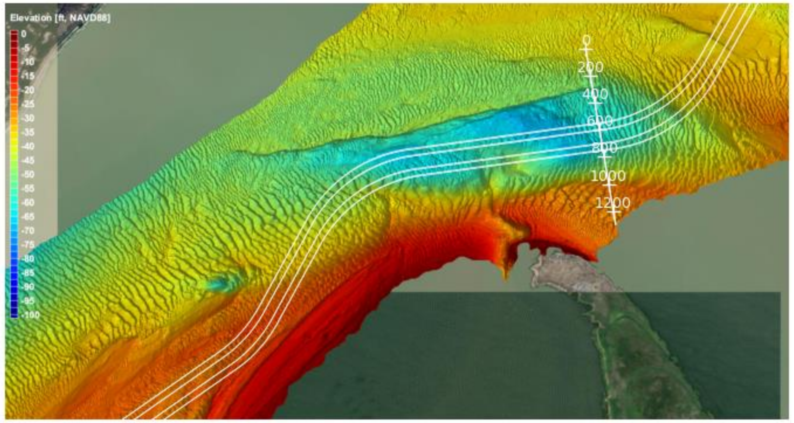


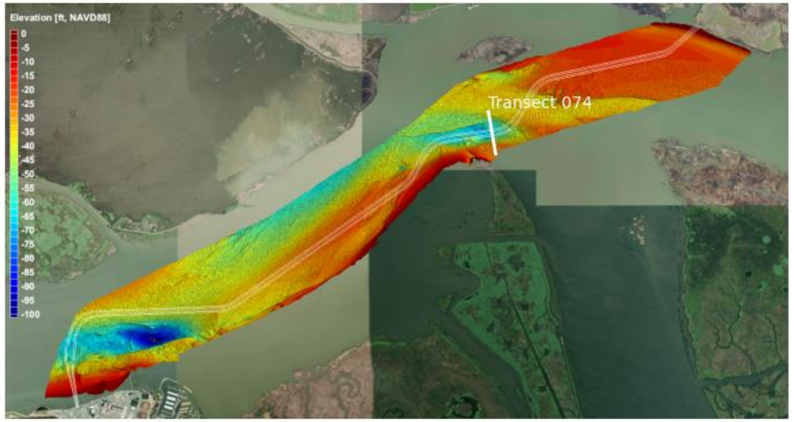


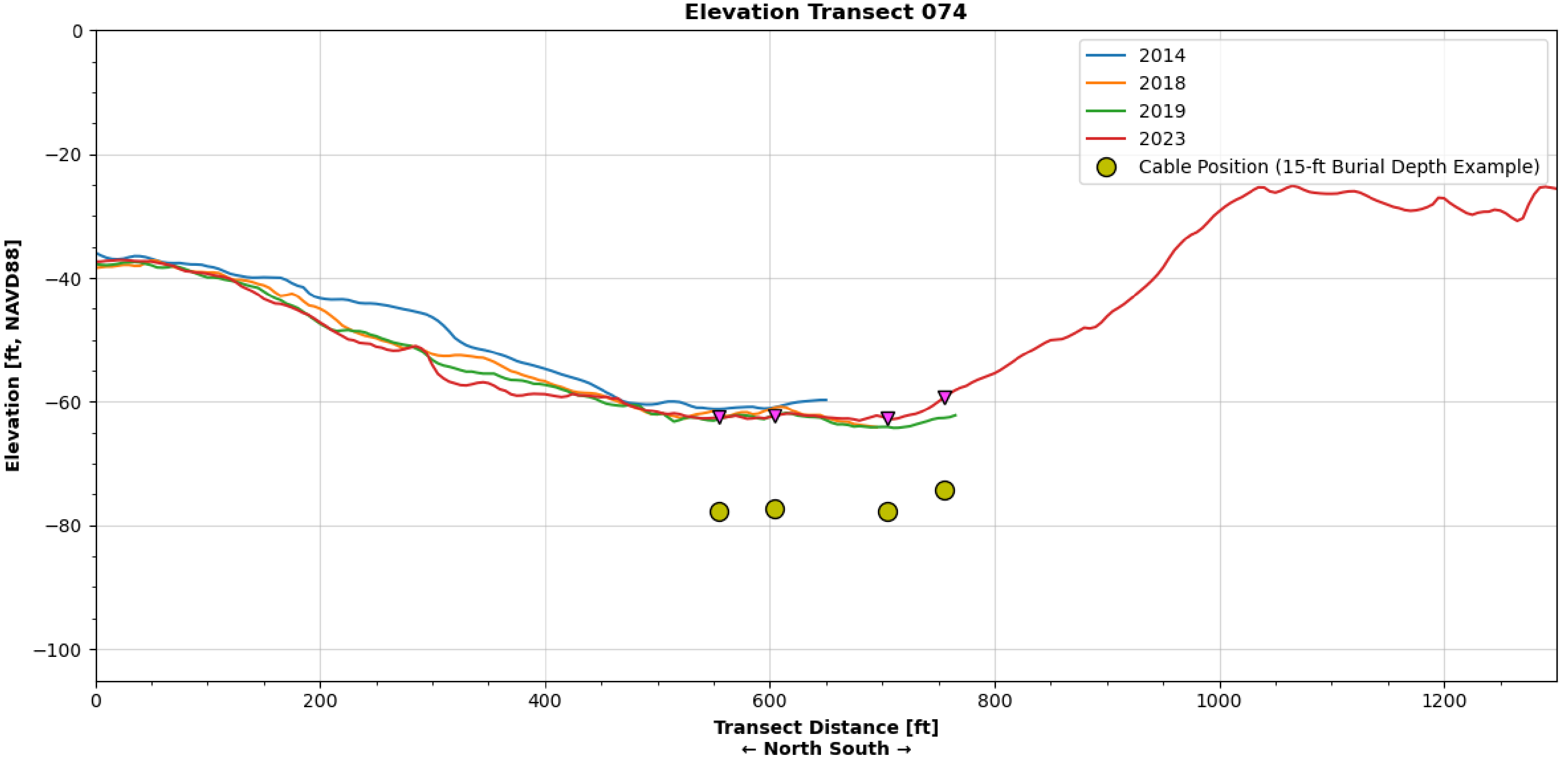


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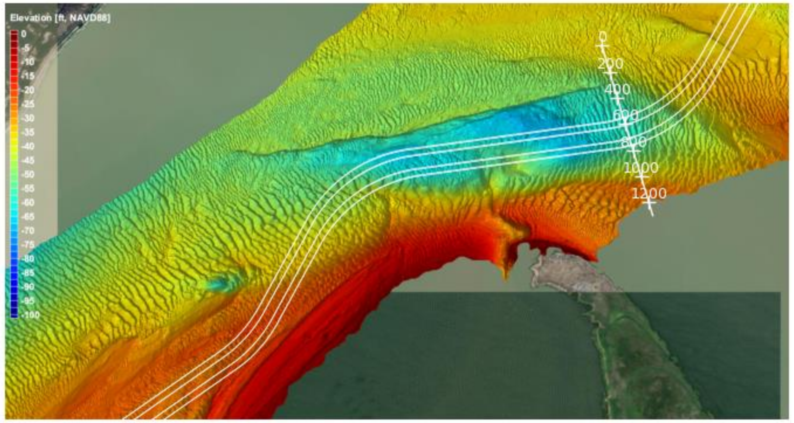


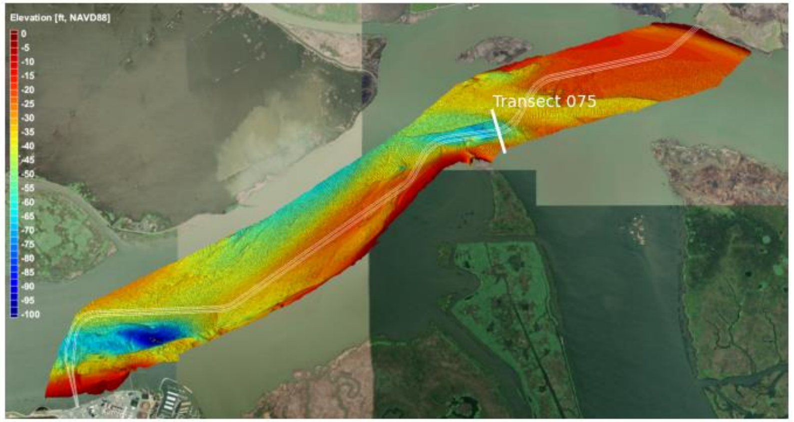


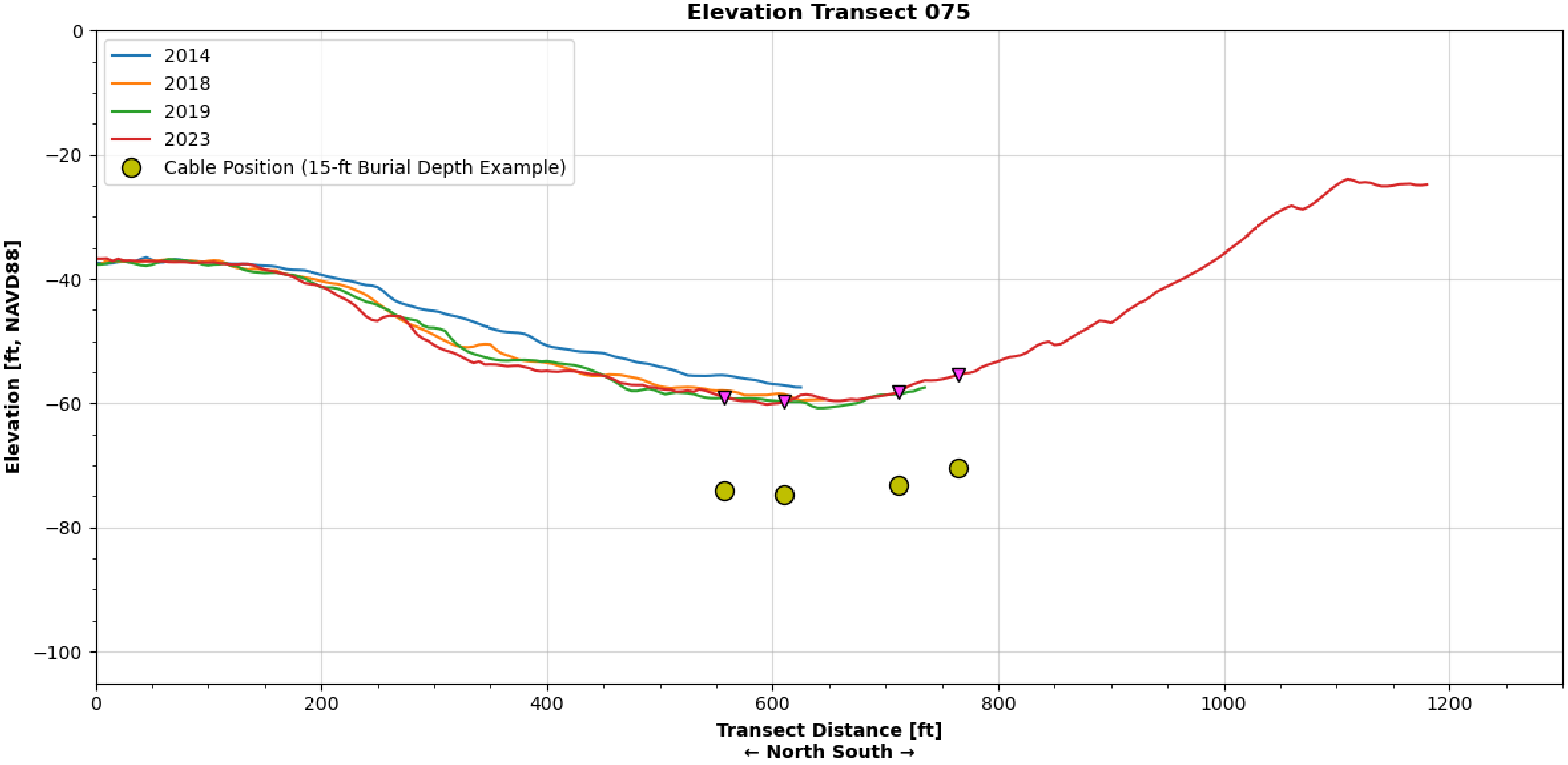


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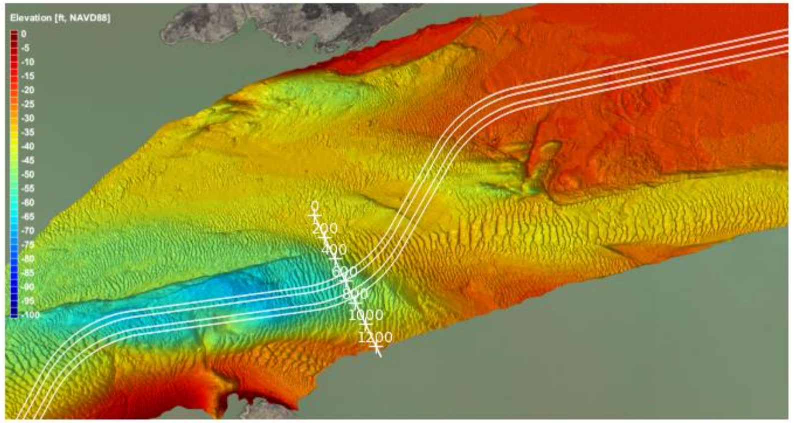


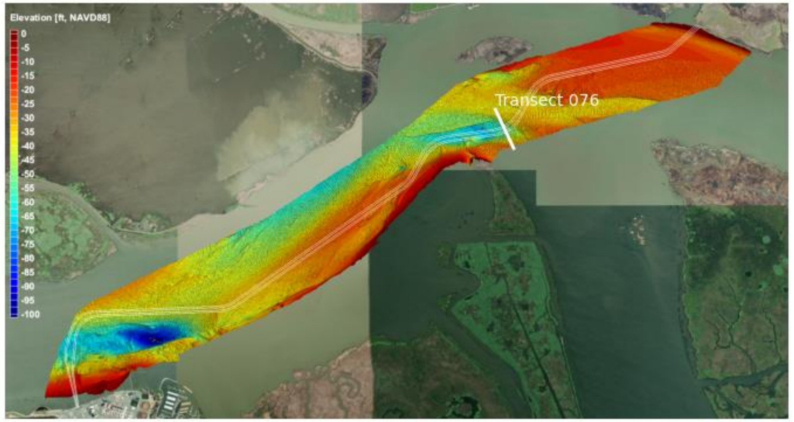


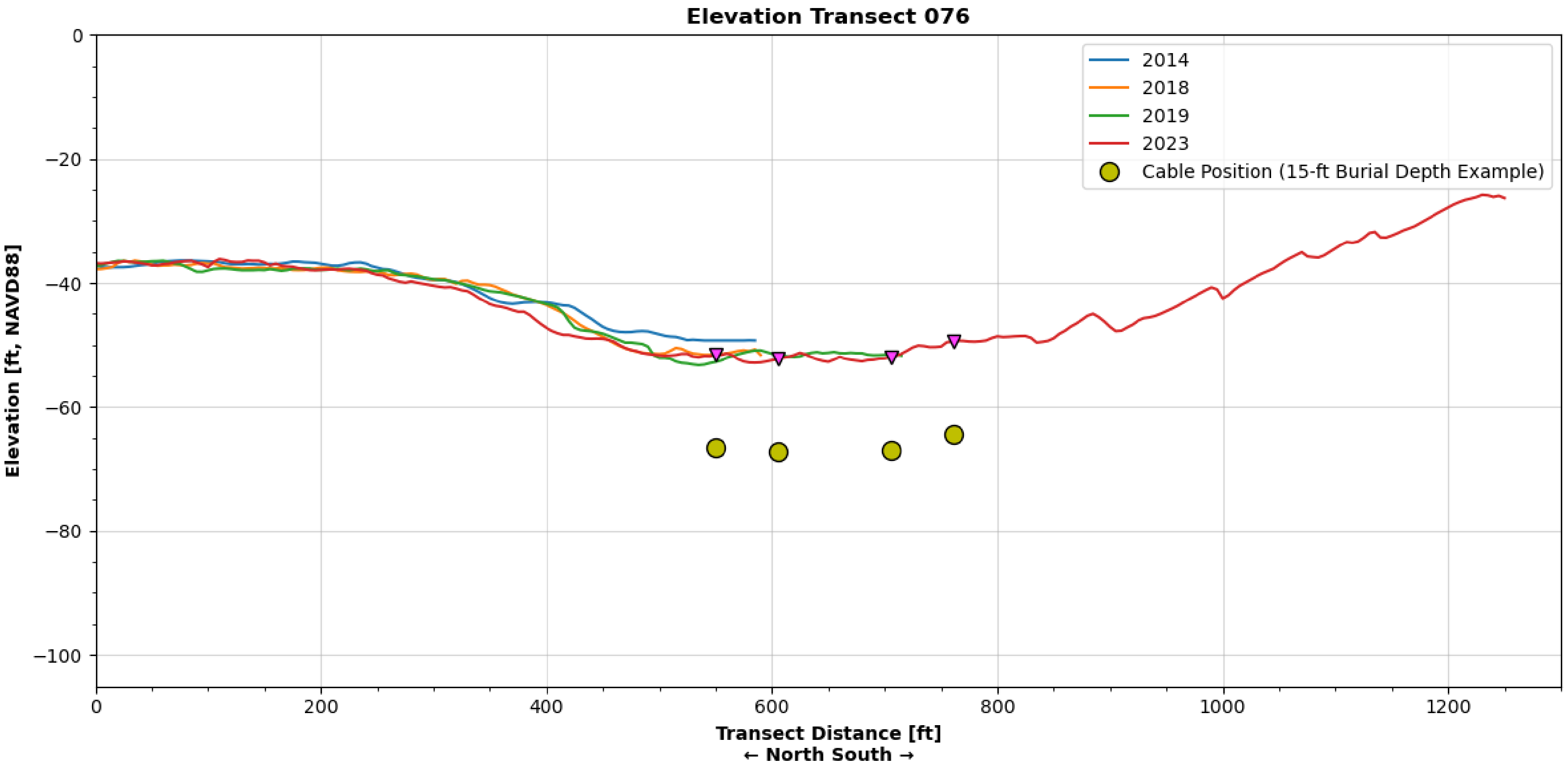


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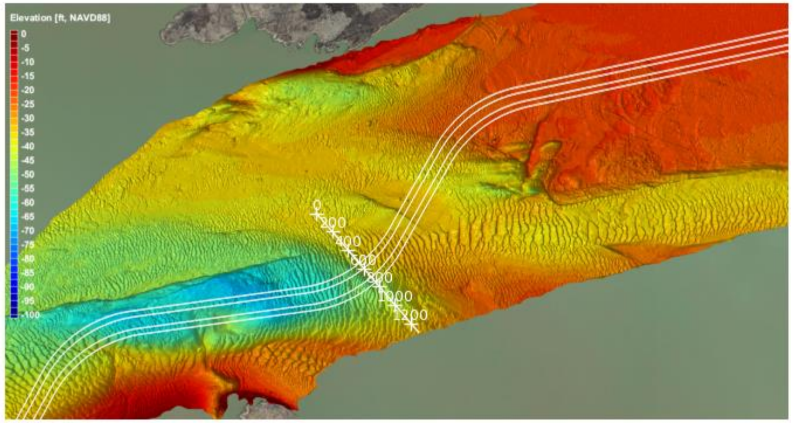


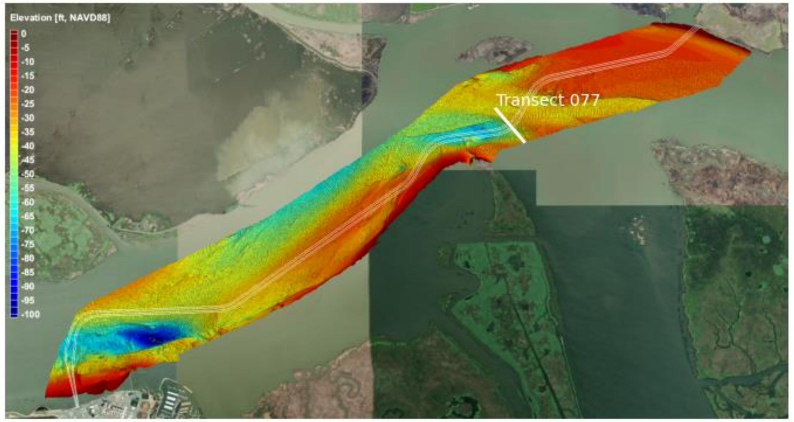


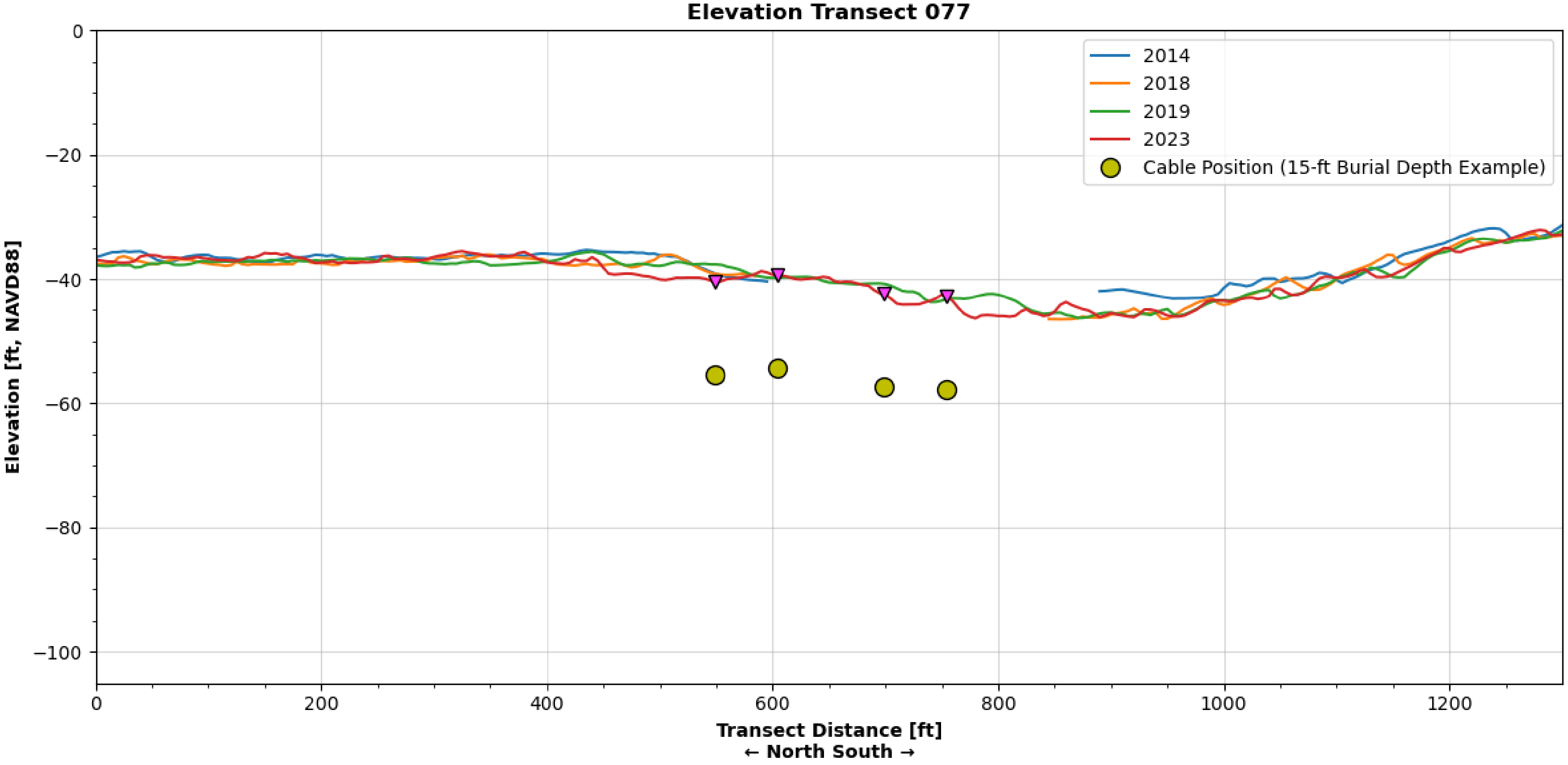


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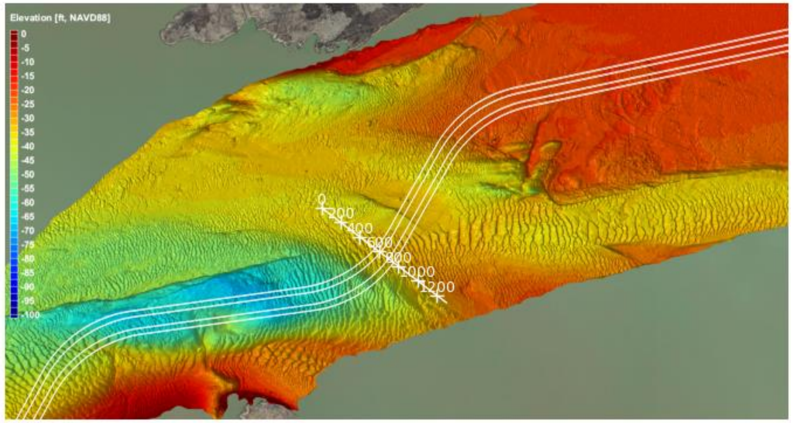


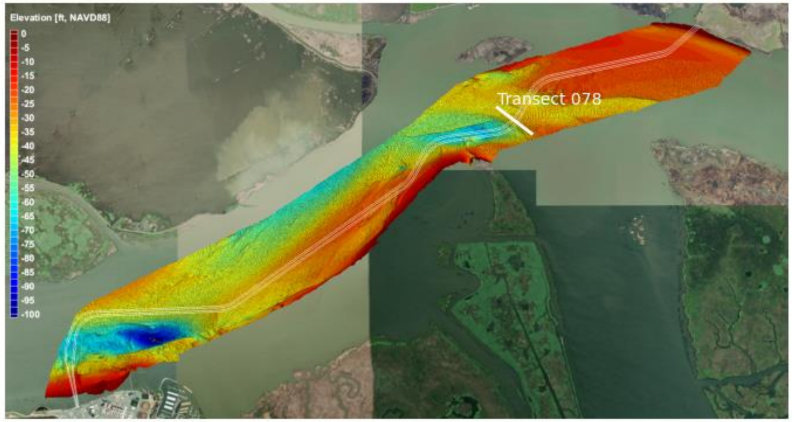


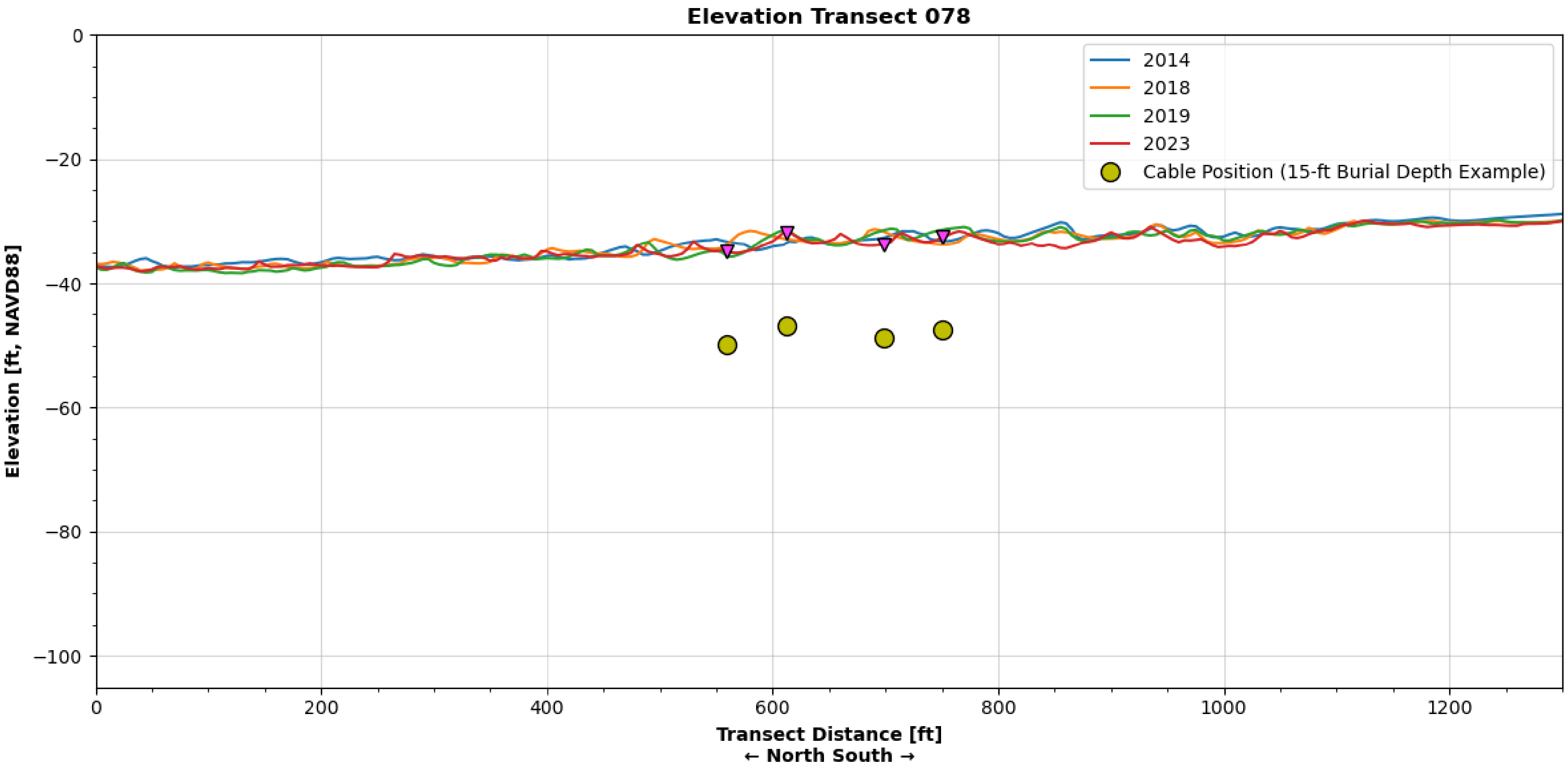


Note: vertical exaggeration on elevation transect plots

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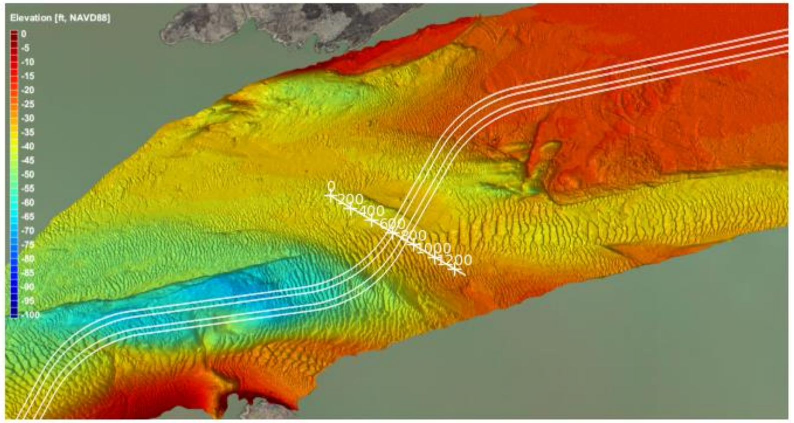

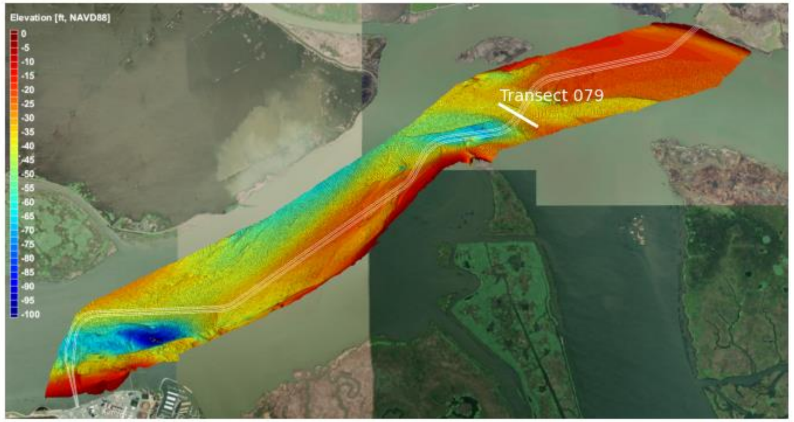


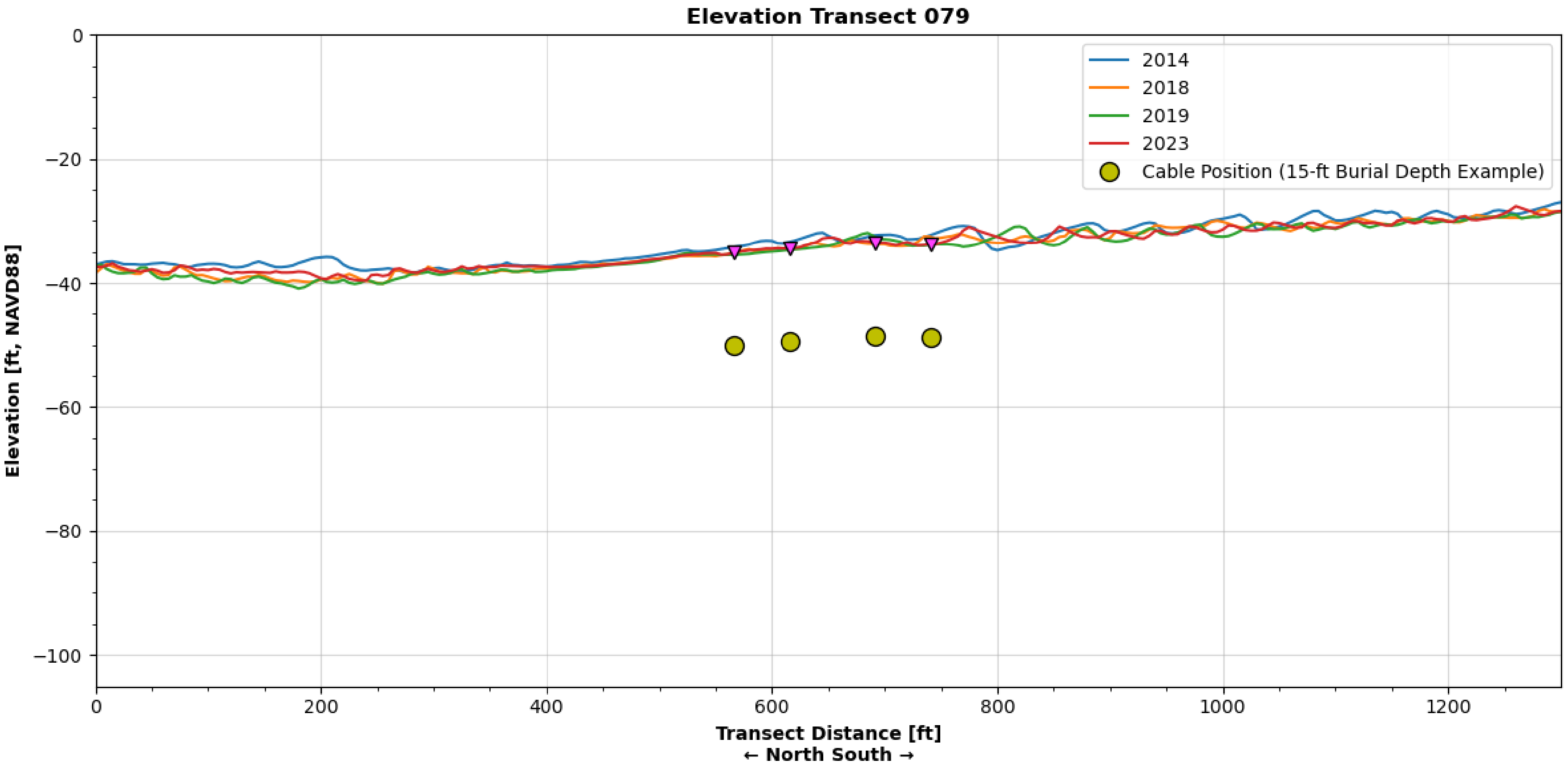


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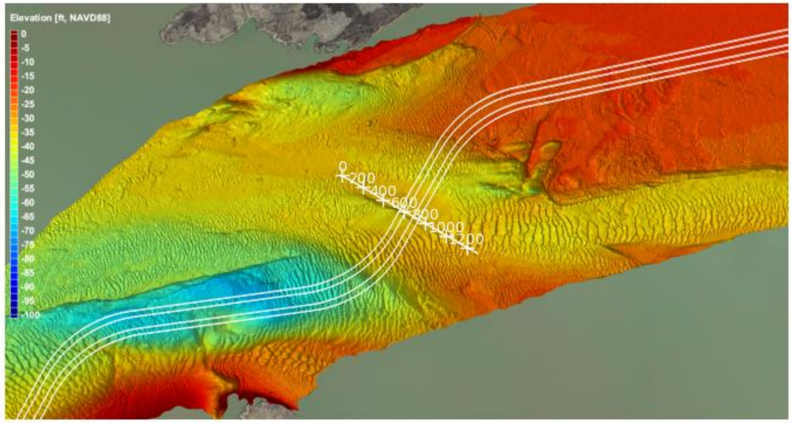


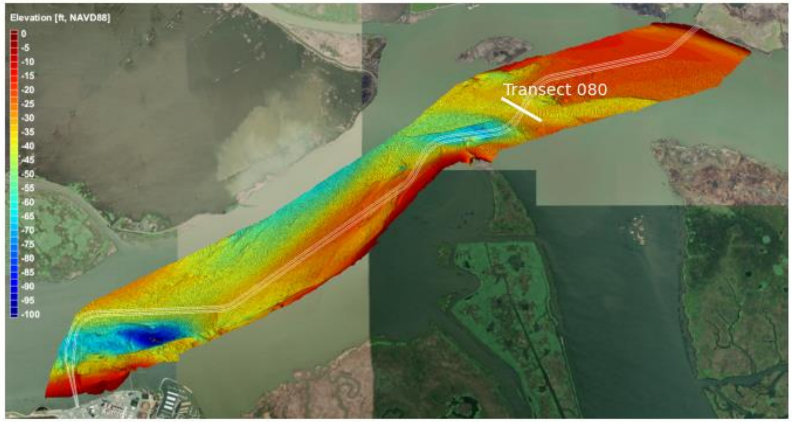


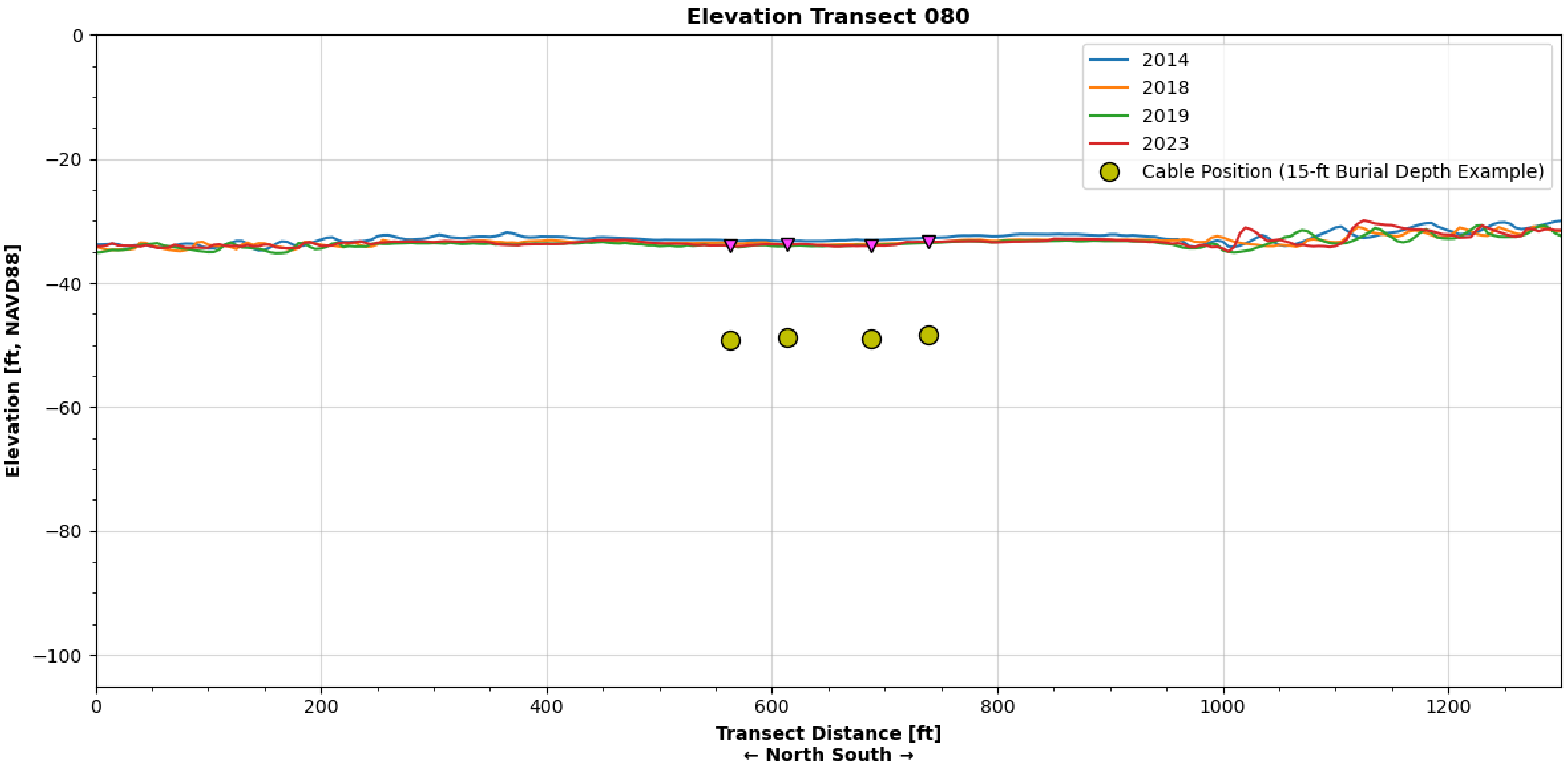


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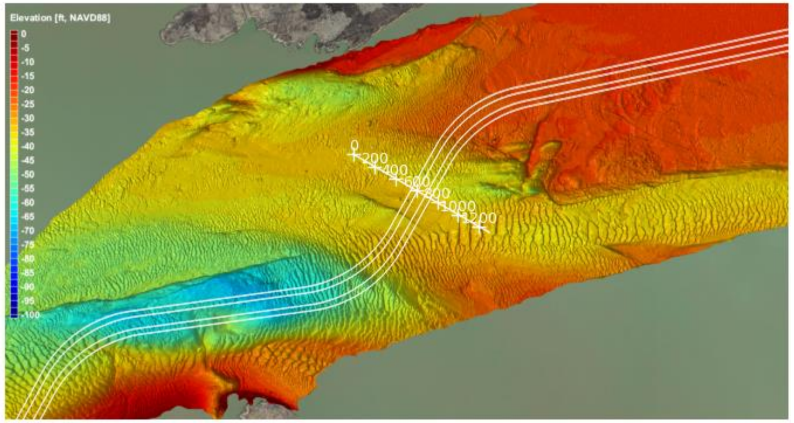


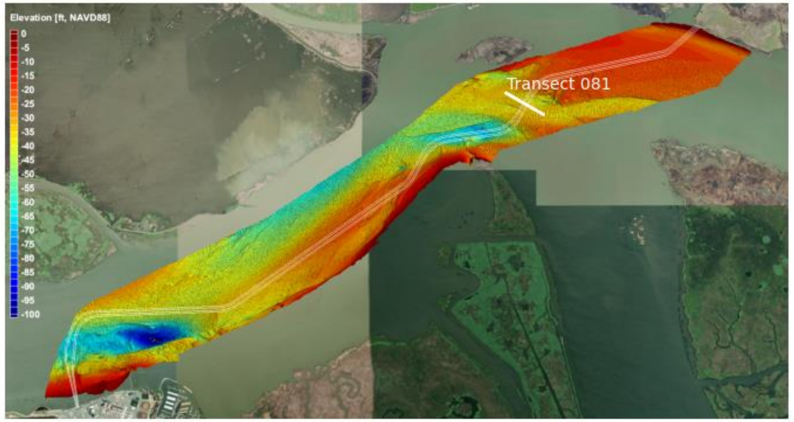


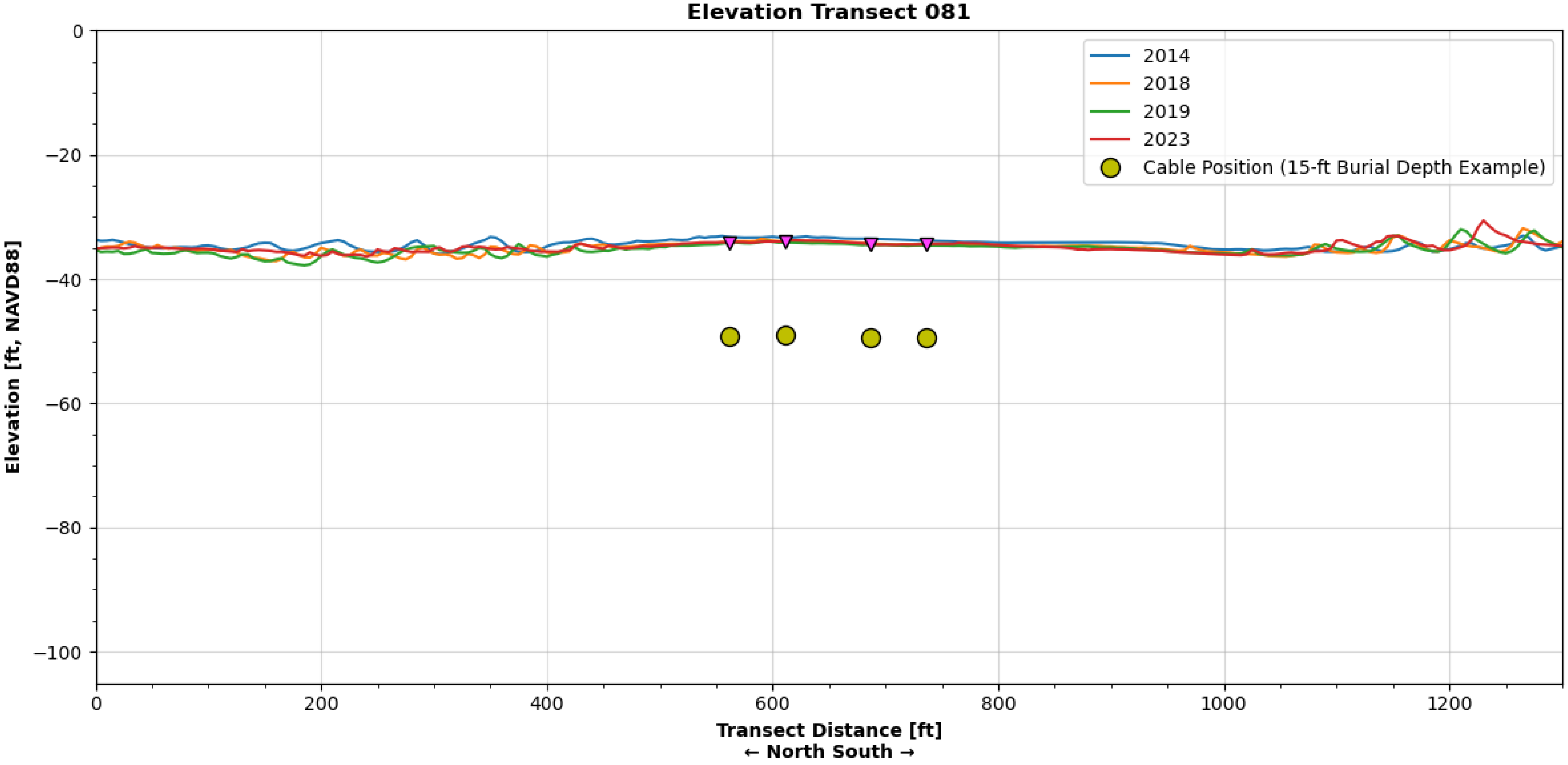


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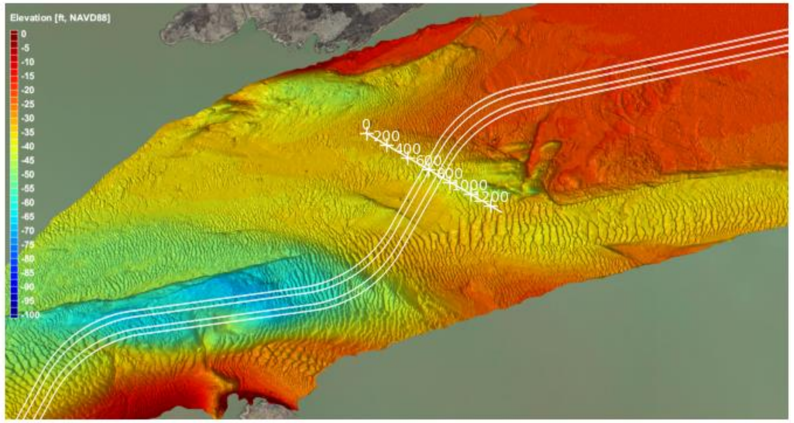


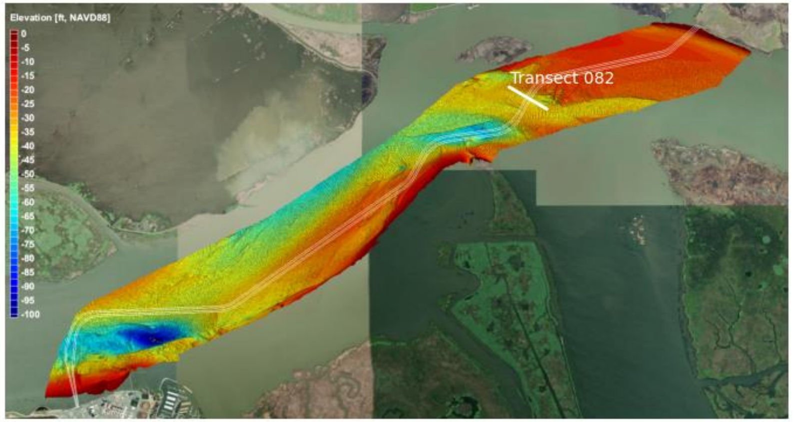


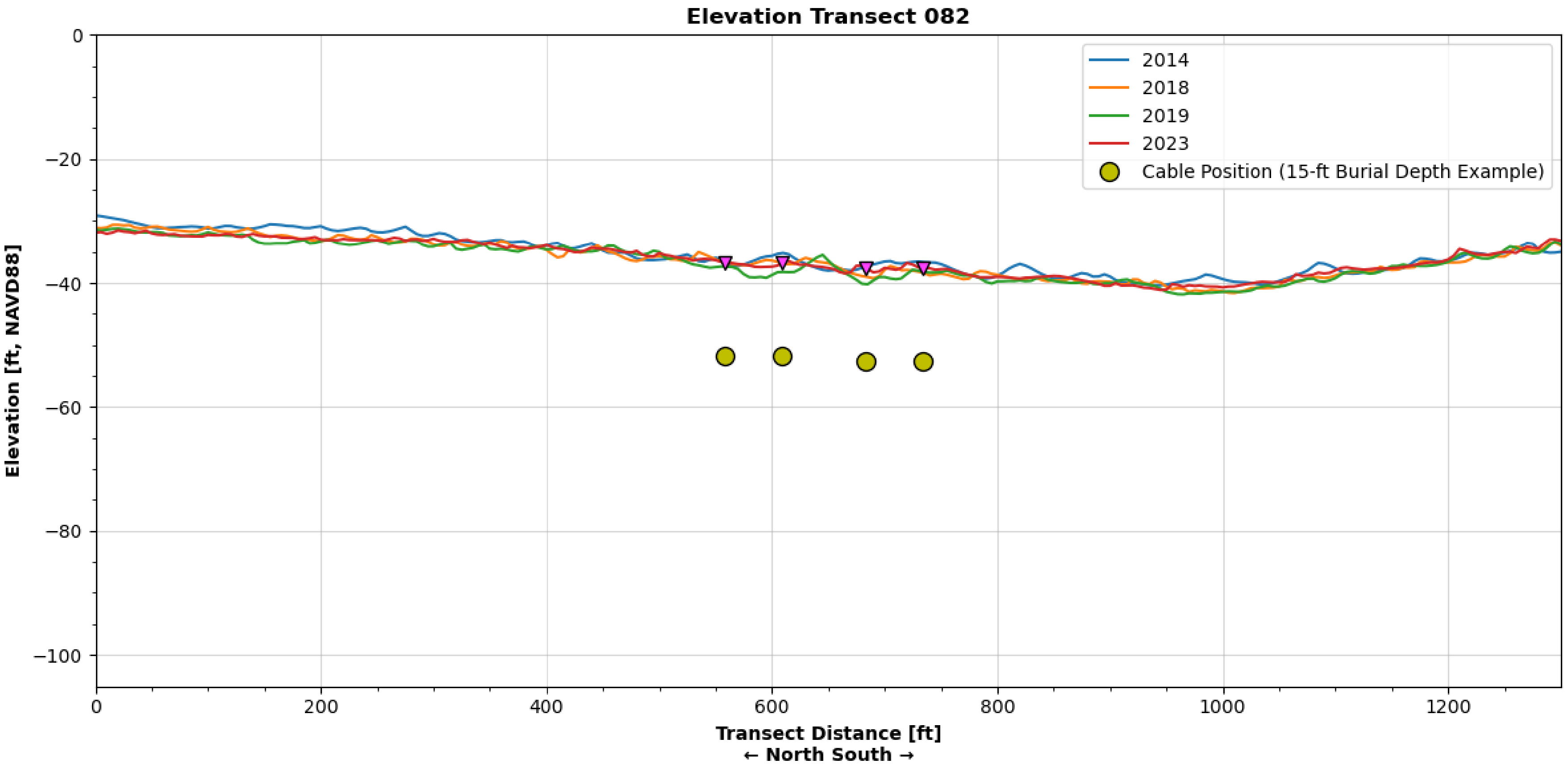


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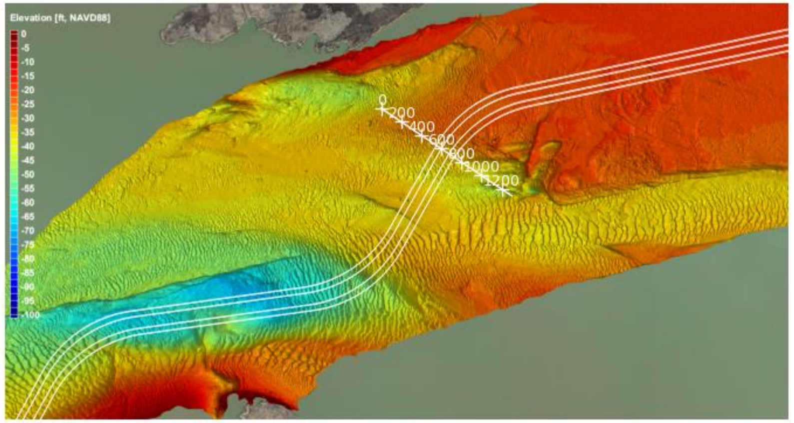


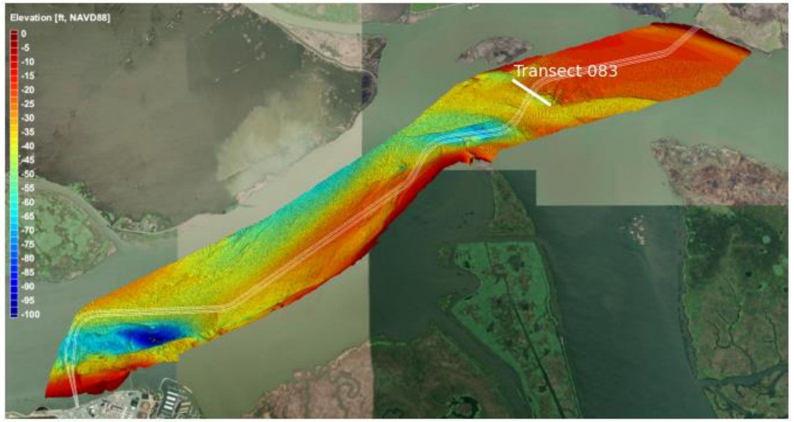


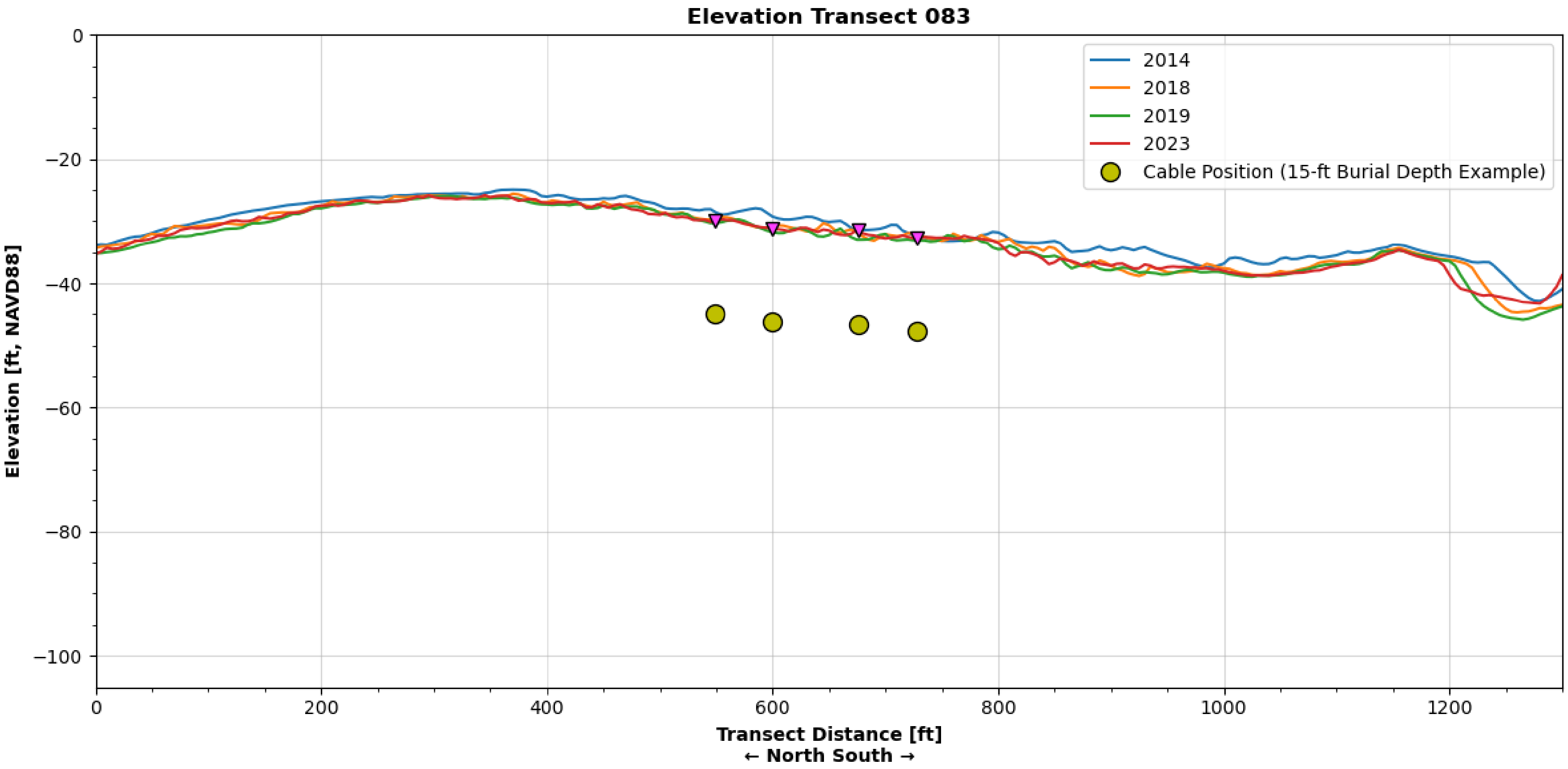


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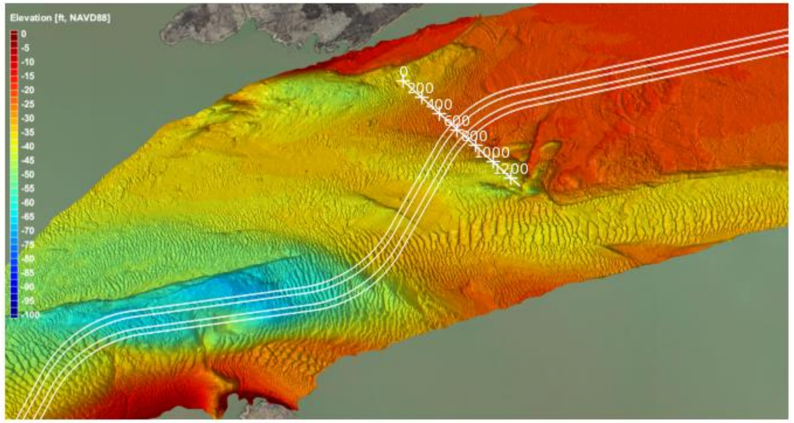
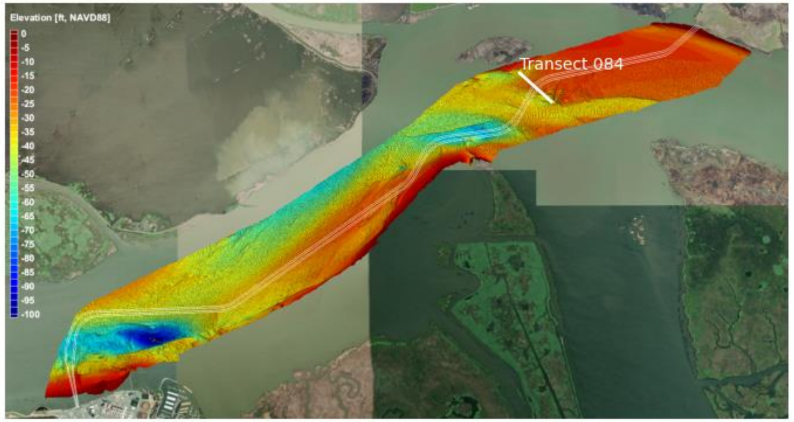
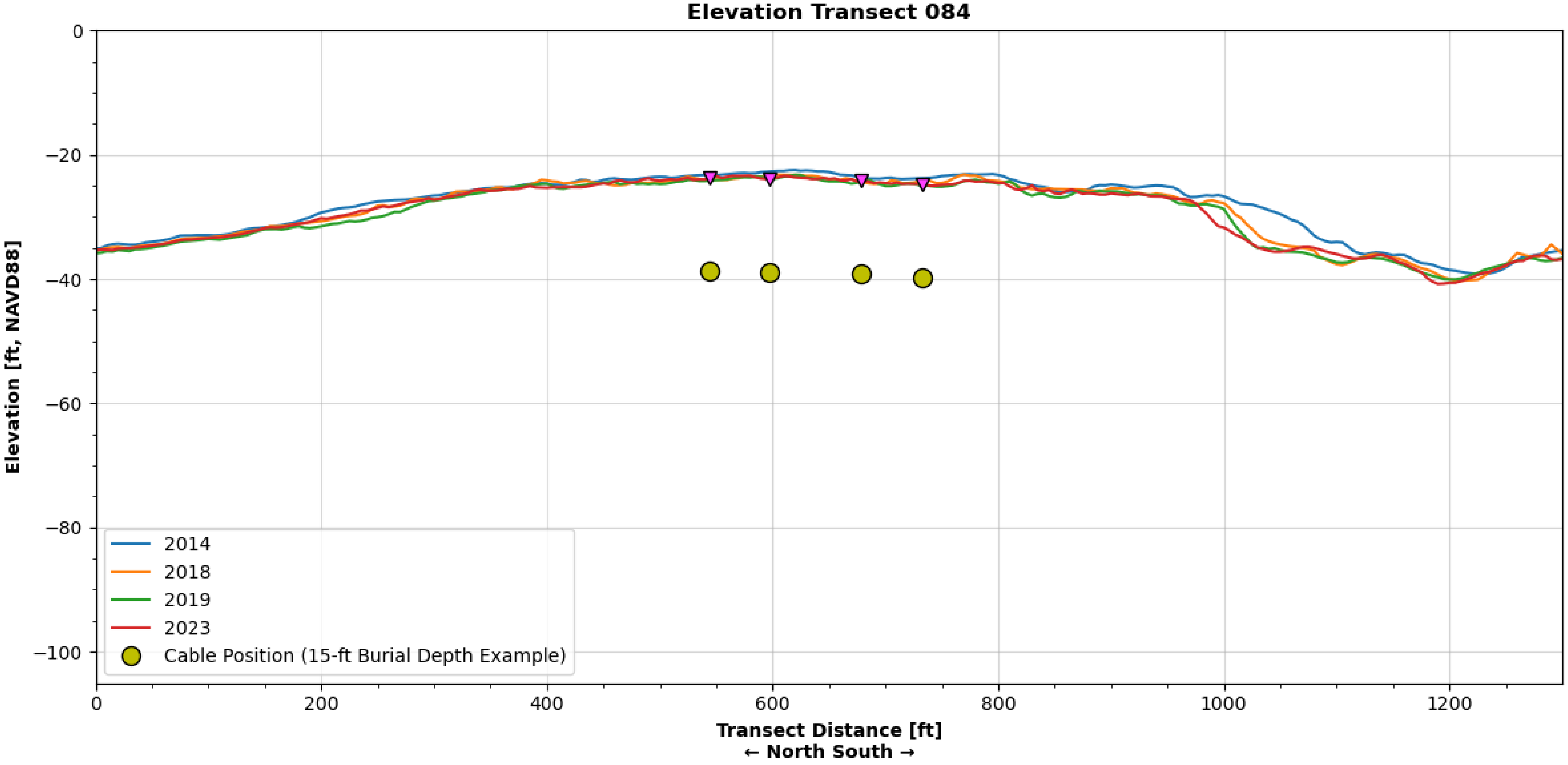
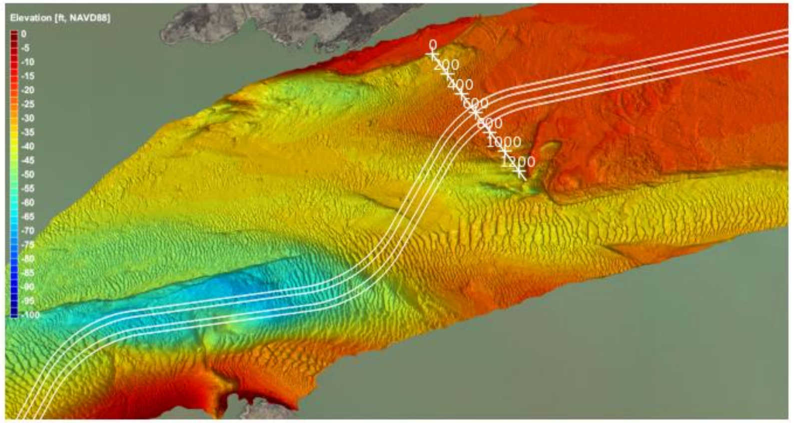
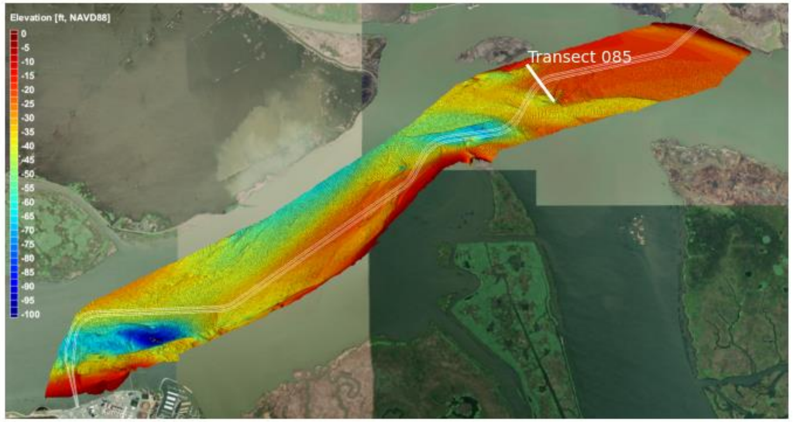


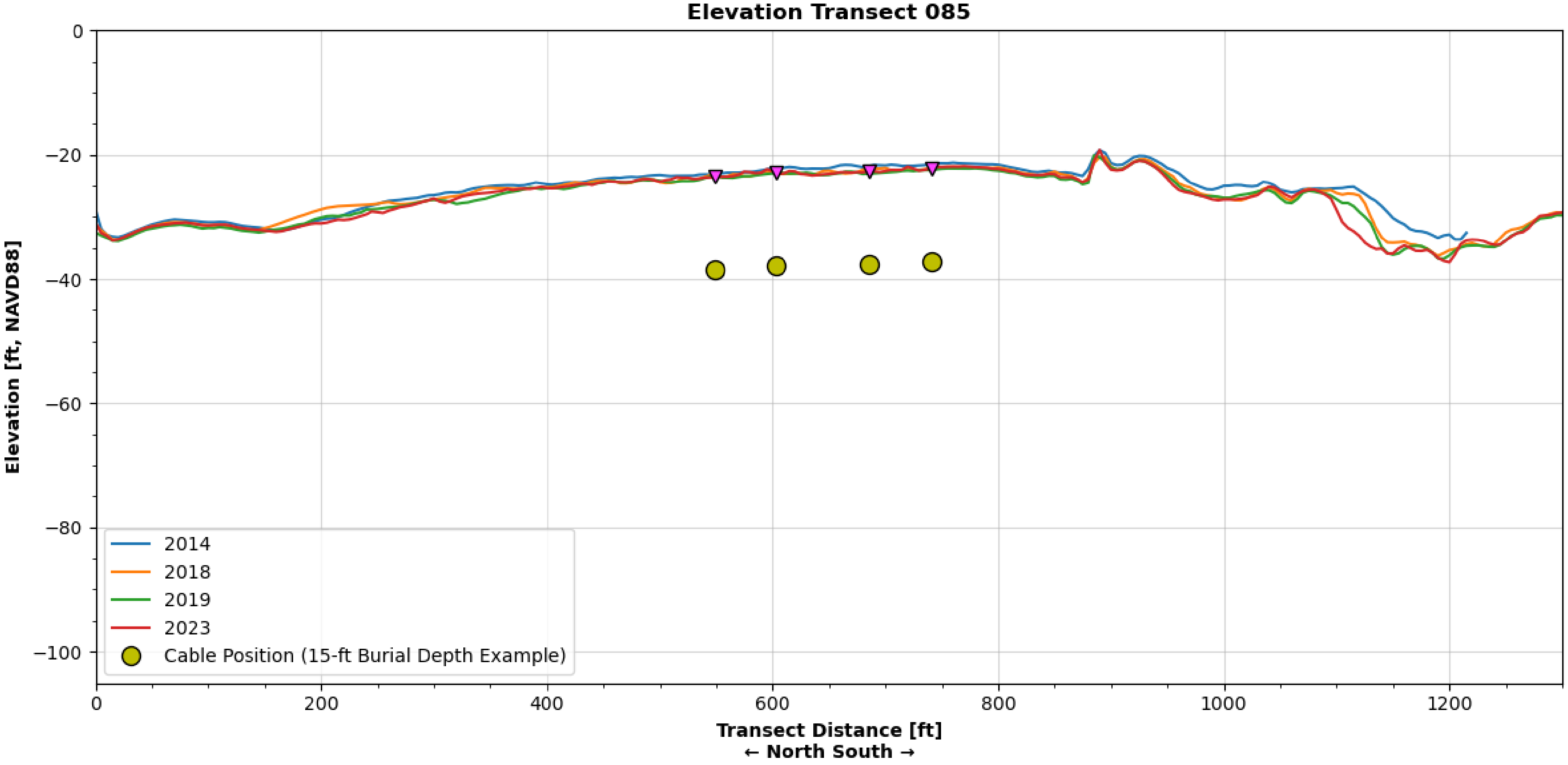



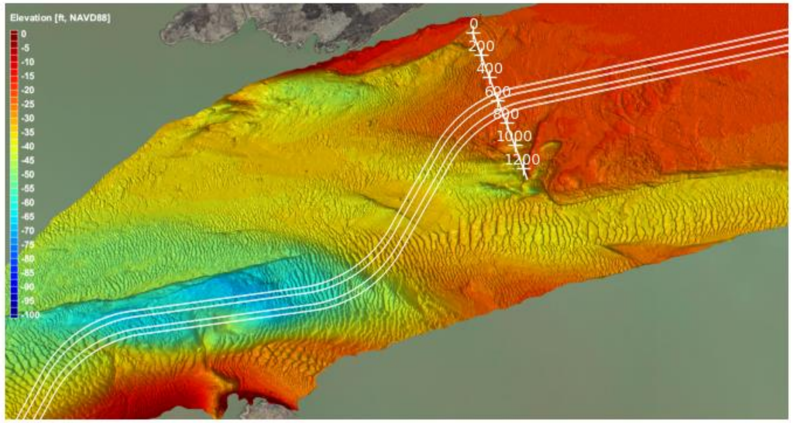

*Note: vertical exaggeration on elevation transect plots*

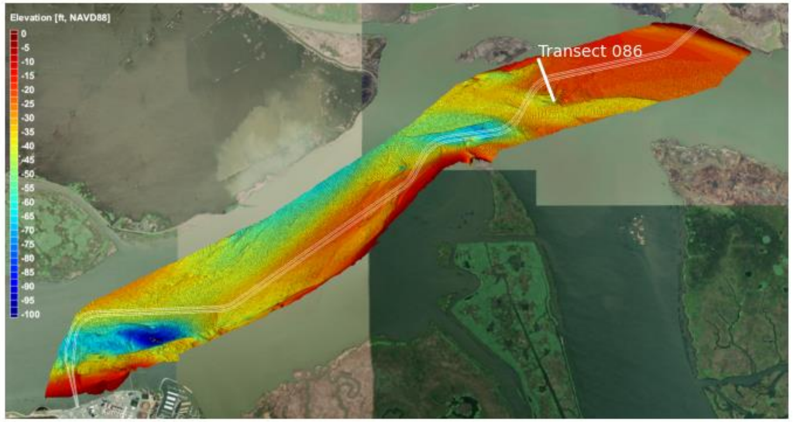


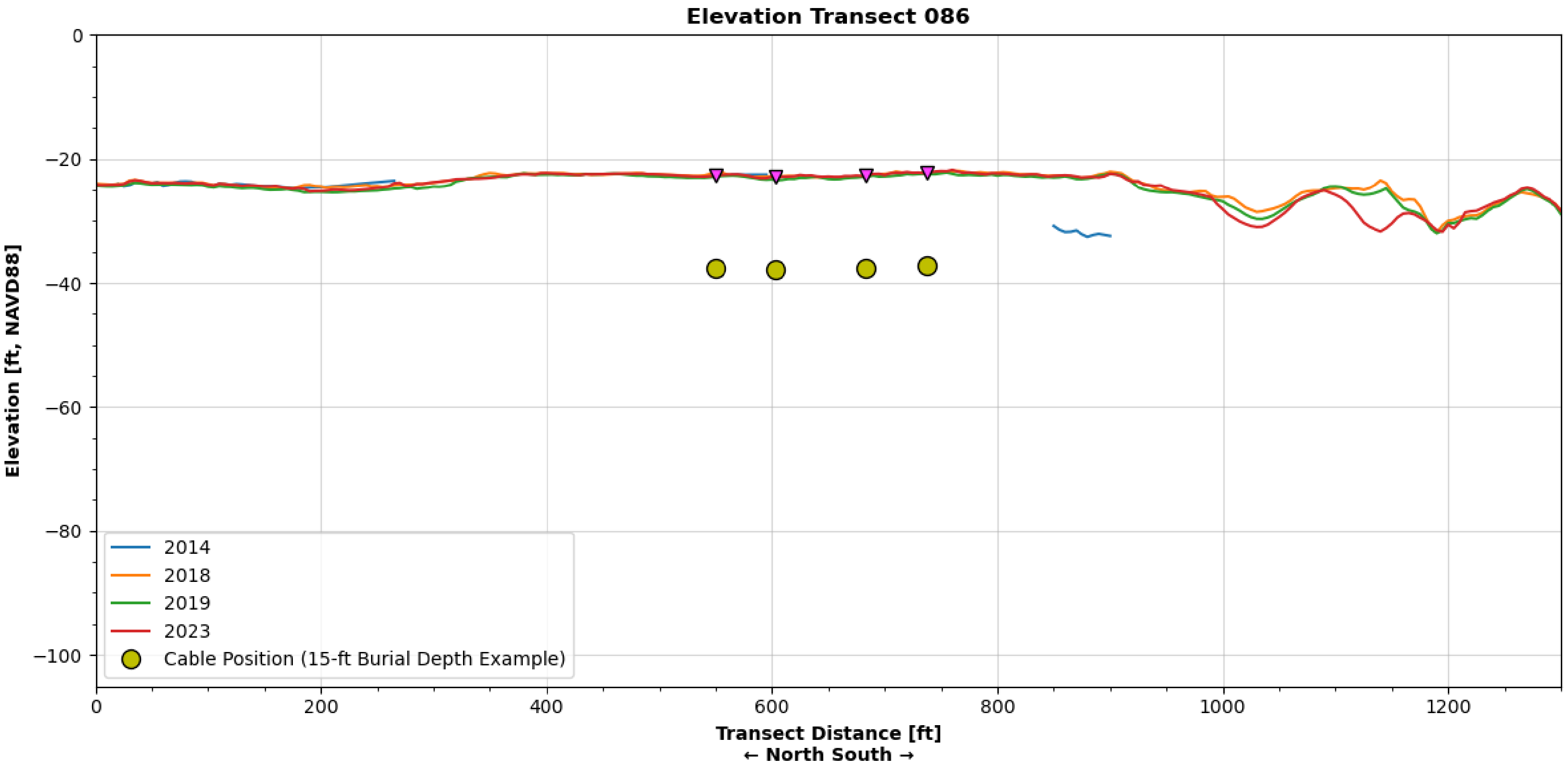



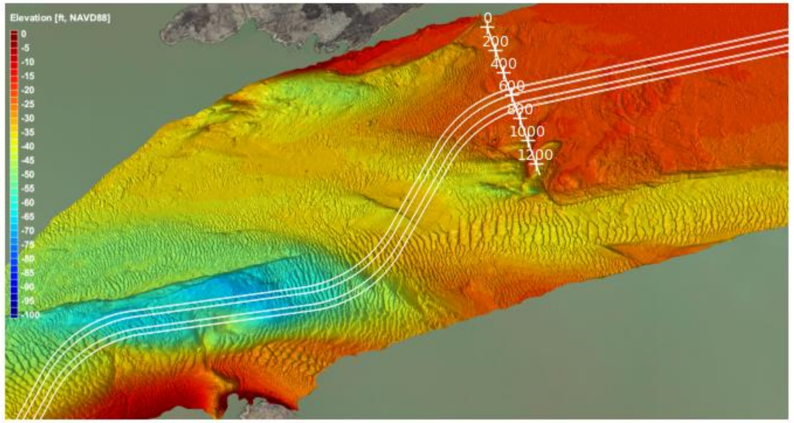

*Note: vertical exaggeration on elevation transect plots*

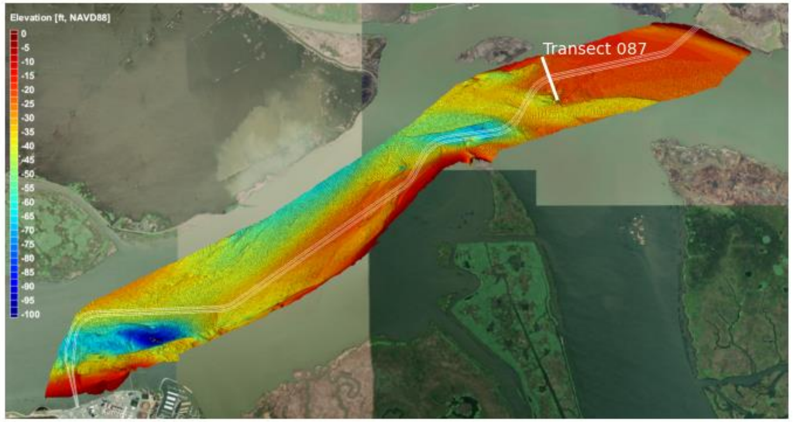


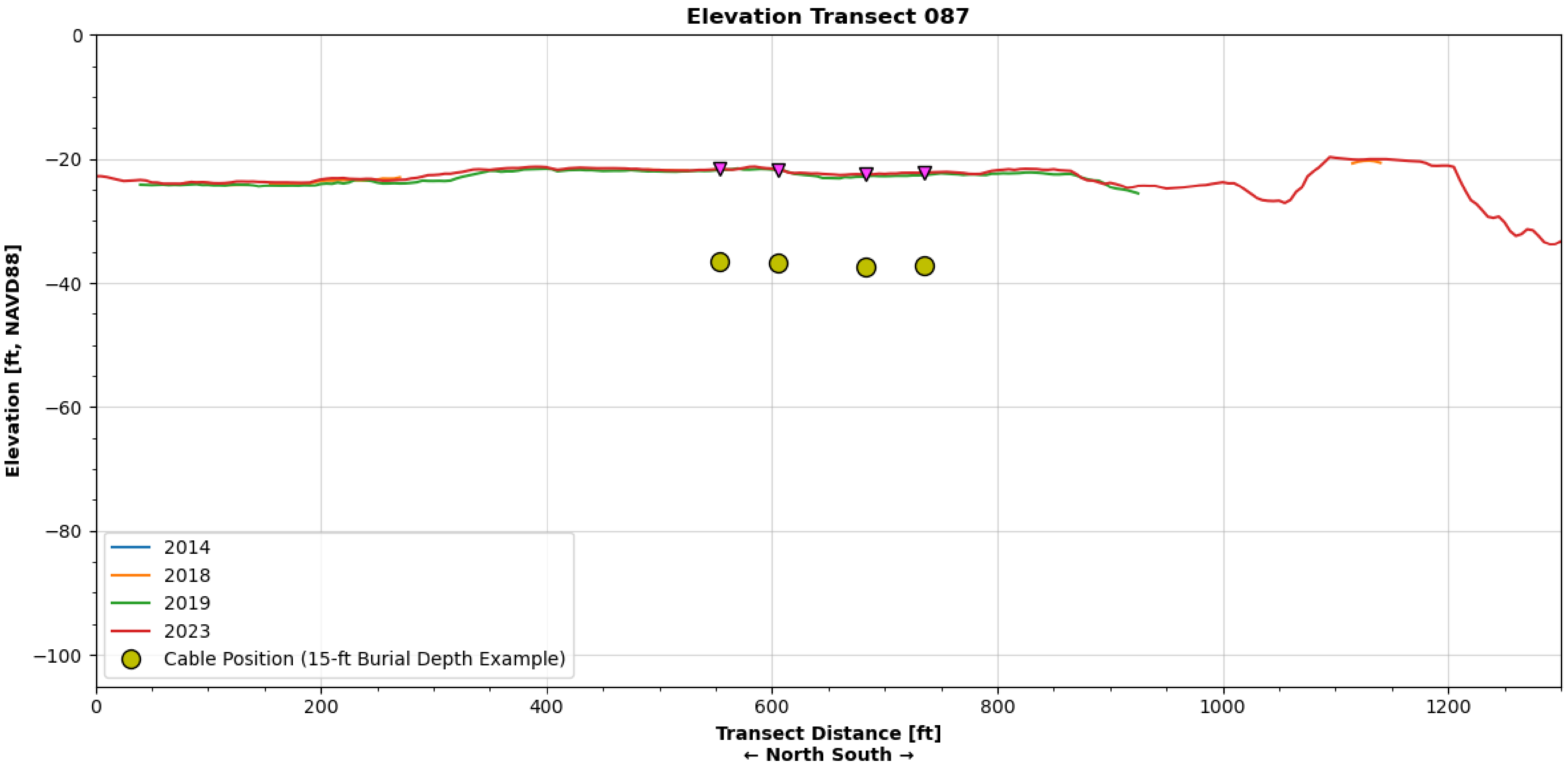




*Note: vertical exaggeration on elevation transect plots*




*Note: vertical exaggeration on elevation transect plots*

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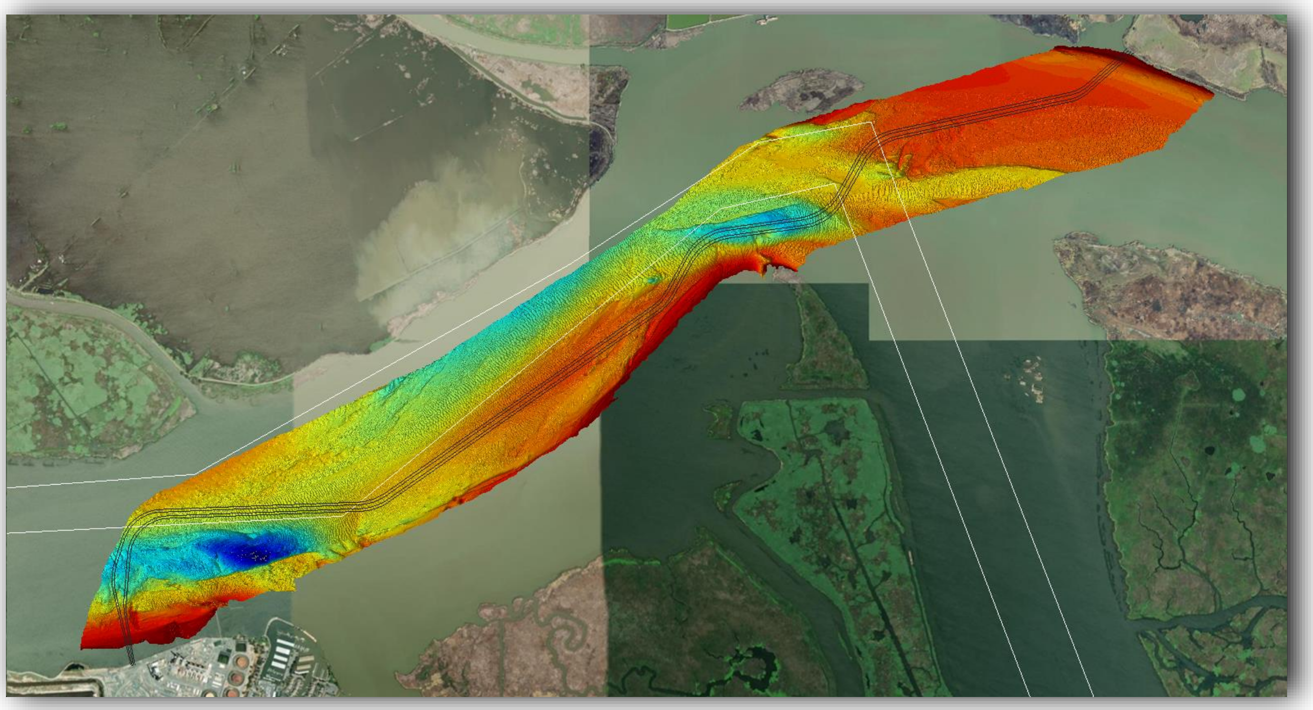
## Seabed Morphology Analysis

## Appendix B - Supplemental Transects



January 20, 2025