Florida Department of Transportation

HOWARD FRANKLAND BRIDGE

Geotechnical Challenges

Presenters

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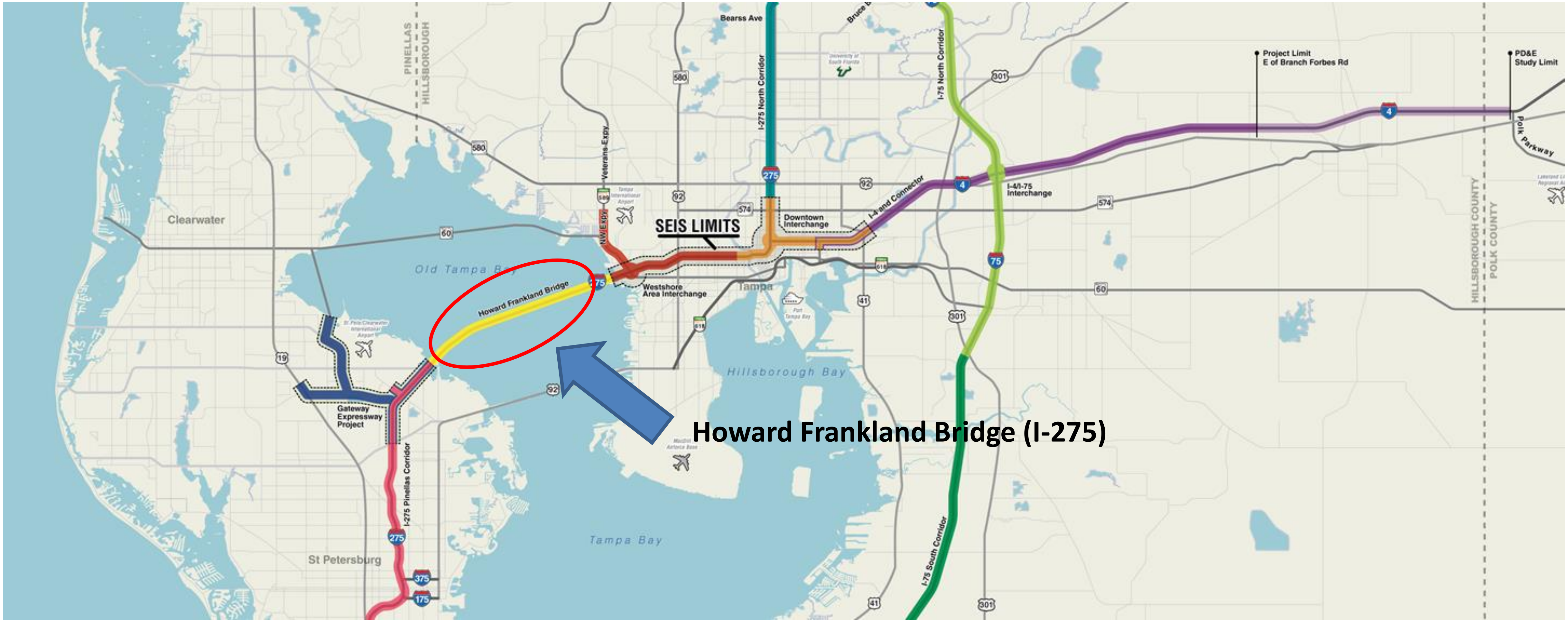
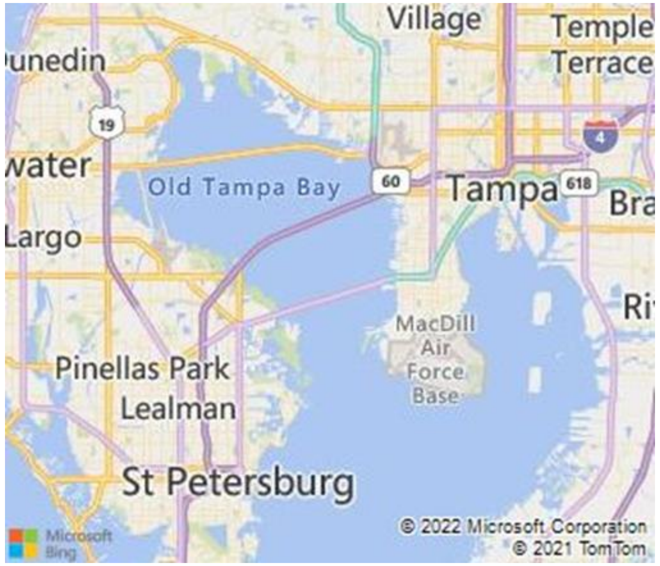


Howard Frankland Bridge (I-275)


Village
Temple Terrace
Dunedin
19
4
water
Old Tampa Bay
60
Tampa
618
Bra
Largo
Ri
MacDill Air Force Base
Pinellas Park
Lealman
St Petersburg
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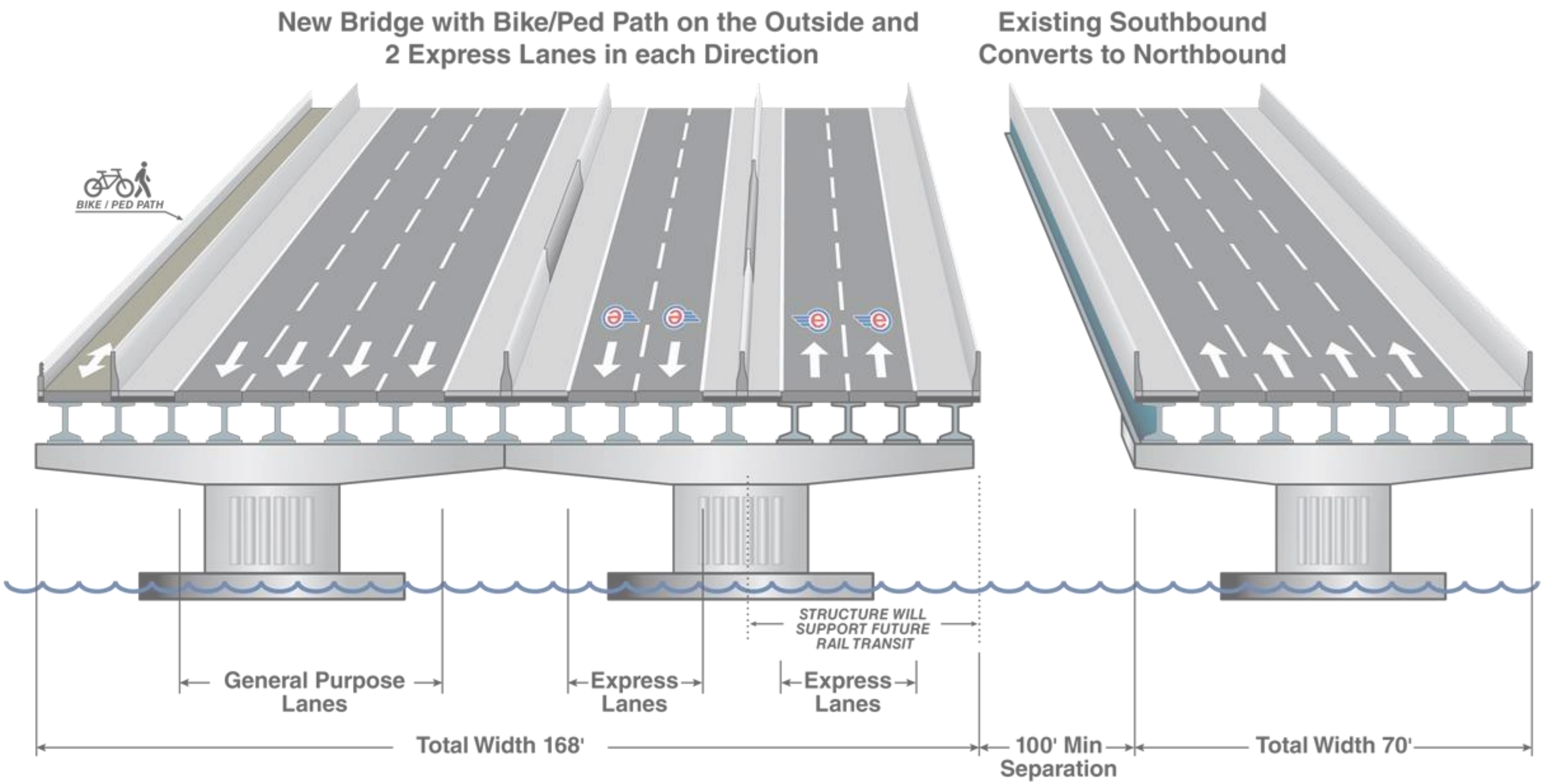
Microsoft Bing


Old Tampa Bay
Spruce St
Cypress St
60
275
Red St
Westshore Blvd
Howard Frankland Bridge
Begin Construction
MM 14.314 (15190 - Pinellas)
End Construction
MM 1.855 (10190 - Hillsborough)
275
Ulmerton Rd
688
275
4th St
St
92


New Bridge with Bike/Ped Path on the Outside and 2 Express Lanes in each Direction
Existing Southbound Converts to Northbound
BIKE / PED PATH
STRUCTURE WILL SUPPORT FUTURE RAIL TRANSIT
General Purpose Lanes
Express Lanes
Express Lanes
Total Width 168'
100' Min Separation
Total Width 70'

CHALLENGES OF DESIGN BUILD OPTION FOR OWNER

- Final Design is Unknown
  - Pier spacing
  - Pile sizes (perhaps even foundation type)
  - Pile “capacity”
- Can Put “Constraints” Due to Geotechnical Conditions but that May Limit the DB Firms Ability to Innovate

CHALLENGES OF DESIGN BUILD OPTION FOR OWNER

- How Much Geotechnical Data to Provide
  – What kind of data
- Need to be “Fair” to Contractor
- Creating a Competitive Atmosphere
  – The larger and more complex the project, fewer firms that can perform the work
  – Innovative Solutions

CHALLENGES OF DESIGN BUILD OPTION FOR OWNER

- Goals of Design Build Geotechnical Information
  - Enough Information to Mitigate Claims for Lack of Data
  - Desire for a Competitive Bid that Balances Risk and Cost Savings
  - If Not Enough Information, Additional Risk May be Built into Bid
  - Avoid Unforeseen Conditions that Could Delay Project or Substandard Construction (e.g. pile splices)

GEOLOGY

- Undifferentiated sediments overlying arcadia formation
  – Sands, Silty Sands, Clayey Sands, and some Clays
- Arcadia Formation (Late Oligocene to Early Miocene)
  – Tampa Member (a.k.a. Tampa Limestone or Tampa Formation)
    - Member consists predominantly of limestone with dolostone (a.k.a. chert), sand and clay in seams within the limestone (Scott, 1988)
    - The Tampa Member and the lower part of the Arcadia Formation form the upper part of the Floridan Aquifer system
    - These limestones are considered karst conditions

EXISTING DATA

- 1960 Bridge
  - Limited Information – Essentially of No Value
- 1990 Bridge
  - Borings
  - Load Tests
  - Pile Driving Records
    - Pile Driving Records Provided Most Widespread Tangible Data
    - Next Slide Shows the Variability Across the Bridge

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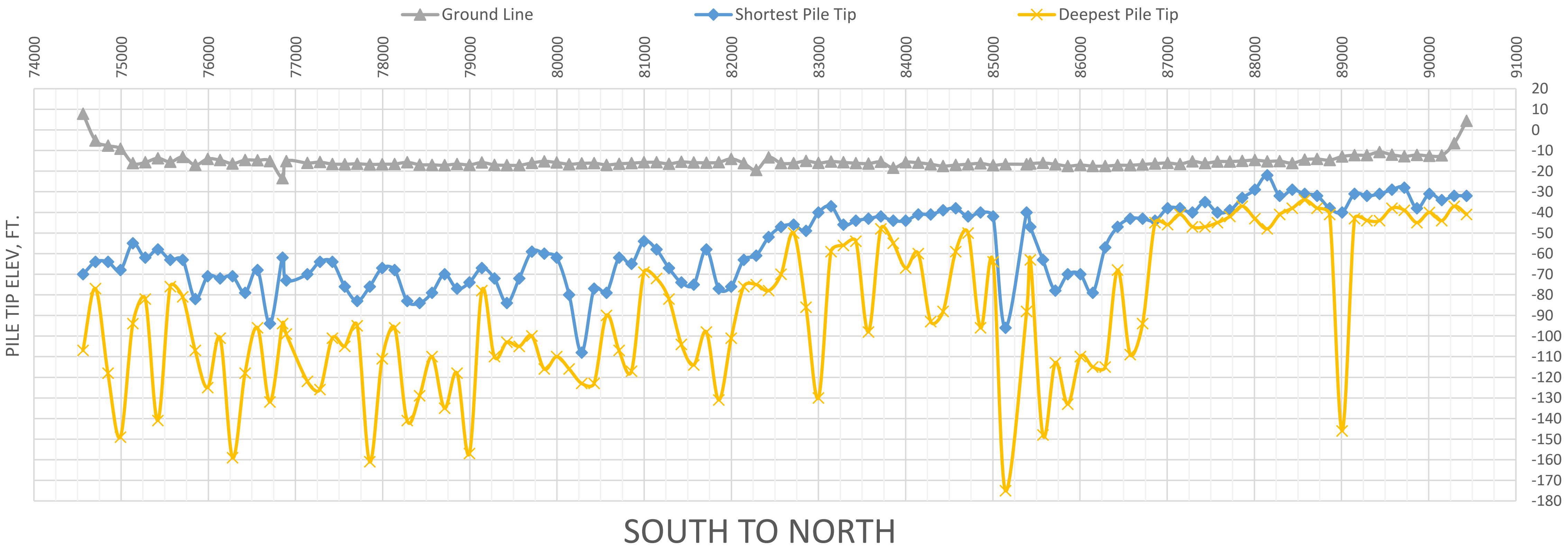
HOWARD FRANKLAND 1990 BRIDGE PILE TIP ELEVATIONS



INVESTIGATION PLAN

- Separate Contract to Provide Prelim. Geotech. for Request for Proposal Dev.
- Average One Boring per 1000 LF of Bridge
- One Boring at Each Main Span Footing
- Borings for Causeway/Seawall Included
- Rock Cores (nominal 4” diameter wireline) for Foundation Alternatives and Scour Analysis
- D_{50} for Scour Analysis in Soils Above Limestone

MARINE SEISMIC REFRACTION

- Case Study to Evaluate the Geophysical Data with the Geotechnical Borings and the Pile Driving
- Advancement in Technology is making the use of Geophysical Applications More Practical in general
  - Includes data collection over water for bridges or other structures

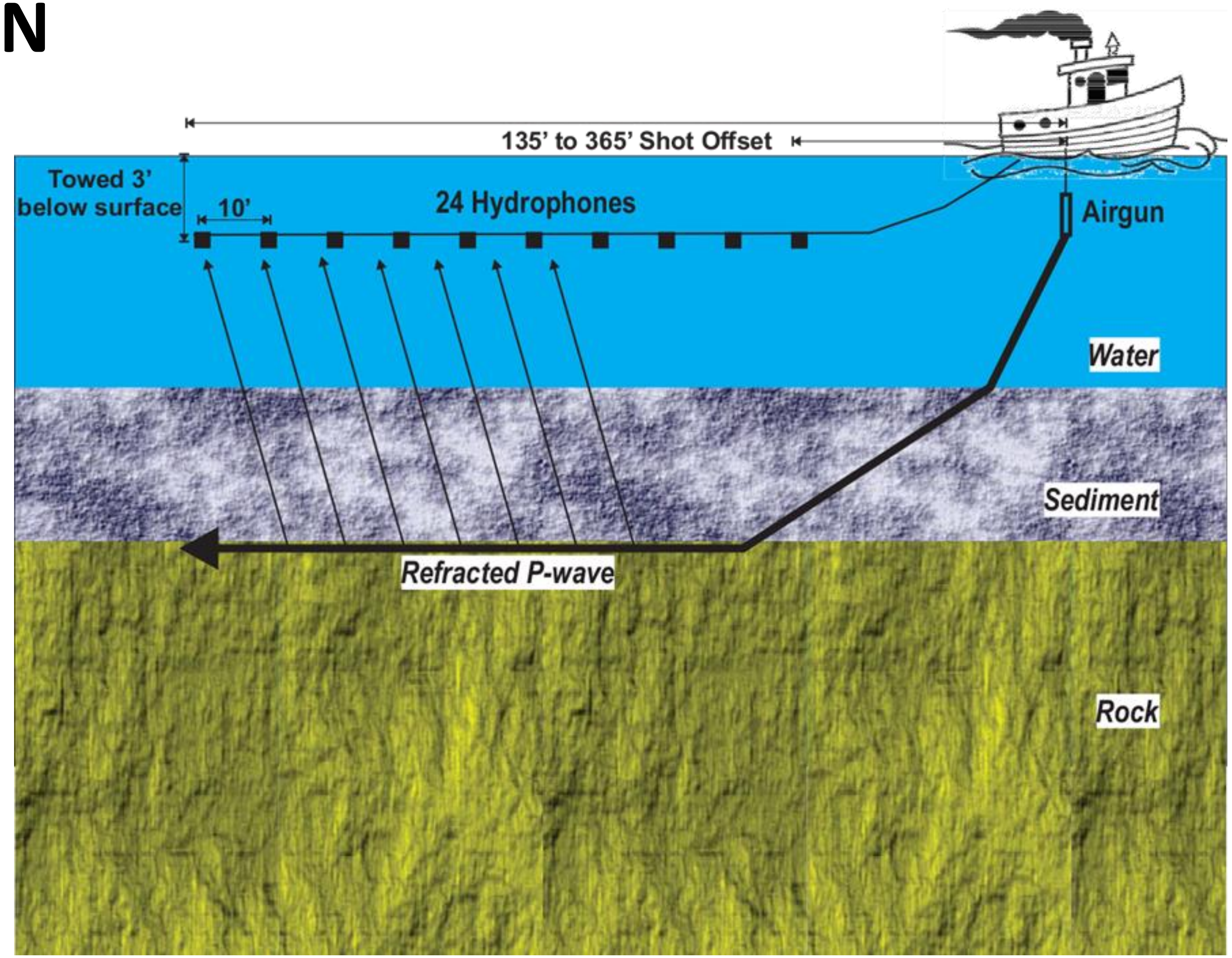
ROCK CORE PHOTOS ILLUSTRATE SOME OF THE VARIABILITY

MARINE SEISMIC REFRACTION

- Used to “fill in” data gaps between borings provided to DB firms
- The method uses “P” waves to reflect off the top of the limestone
  - A limitation to the methodology is that it only gives a top of limestone profile (depth can be an issue)
  - However, our Tampa limestone has a very irregular surface, so it still provided good fill in data
  - Using the “consistency” of the data, permitted use of Order Lengths in some section

MARINE SEISMIC REFRACTION

- 3 Parallel Lines
  - 20,000 Linear Feet
  - 85 Feet apart
- Compression (P-wave) Velocity
  - Tomographic Model
  - Bathymetric Data
- Quality of Data
  - Compared with the Borings & Pile Driving



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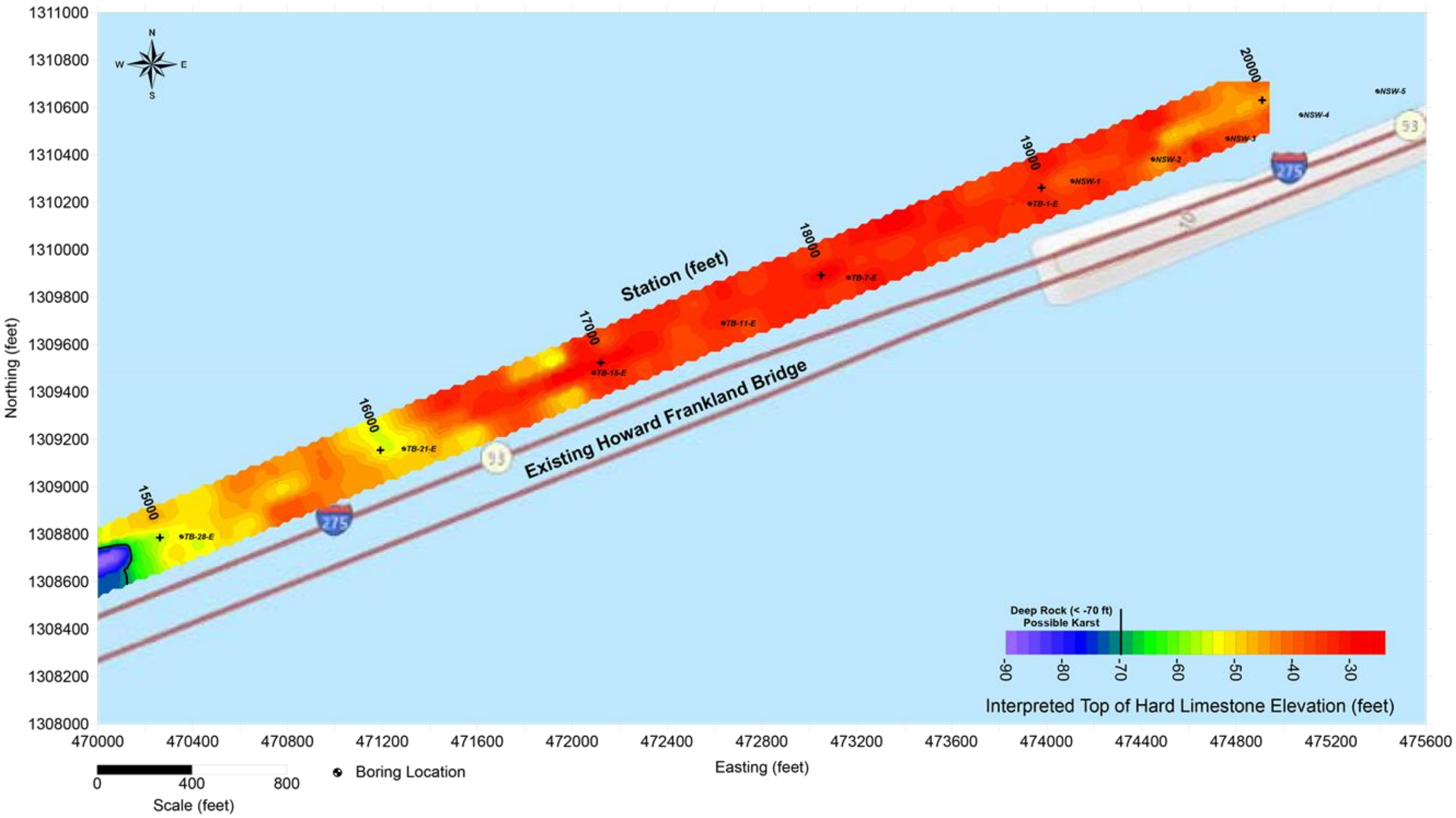
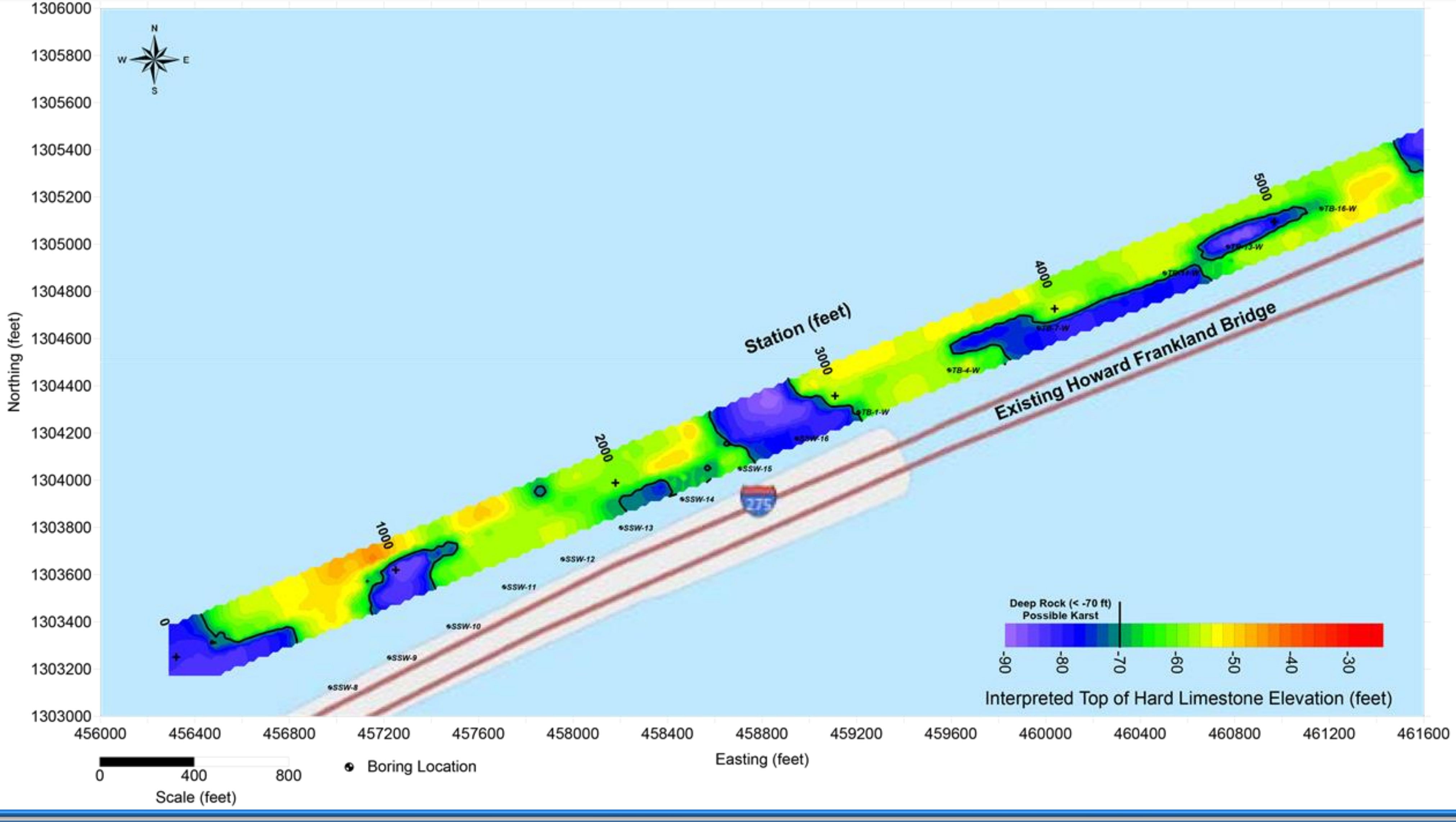
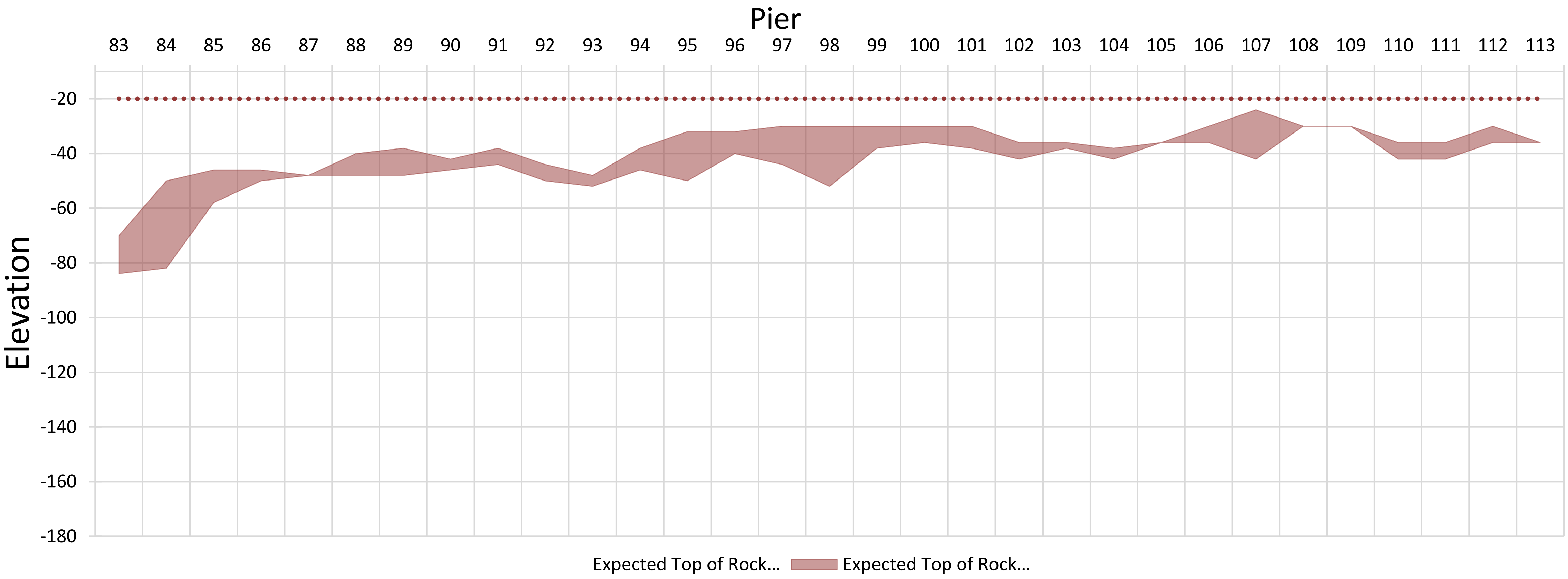




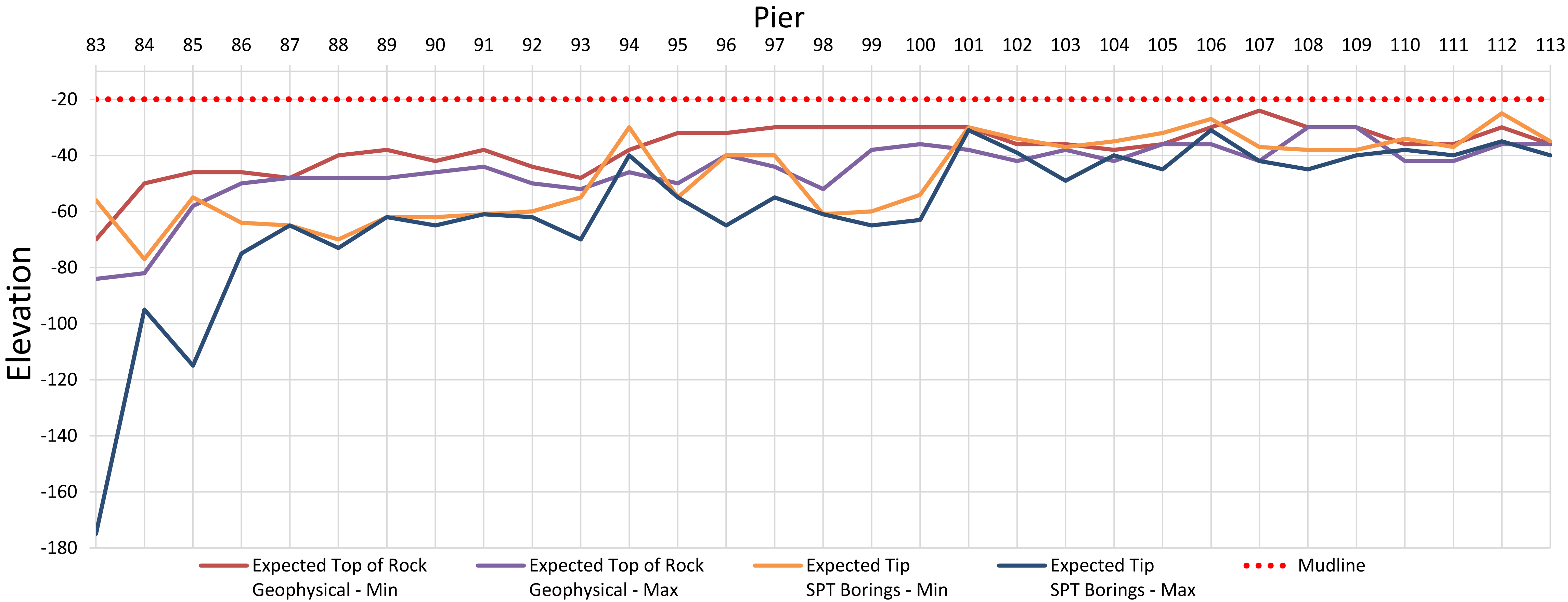
Station (feet)
Existing Howard Frankland Bridge
0
1000
2000
3000
4000
5000
275
N
S
E
W
SSW-8
SSW-9
SSW-10
SSW-11
SSW-12
SSW-13
SSW-14
SSW-15
SSW-16
TB-1-W
TB-4-W
TB-7-W
TB-13-W
TB-16-W
Northing (feet)
1306000
1305800
1305600
1305400
1305200
1305000
1304800
1304600
1304400
1304200
1304000
1303800
1303600
1303400
1303200
1303000
Easting (feet)
456000
456400
456800
457200
457600
458000
458400
458800
459200
459600
460000
460400
460800
461200
461600
Deep Rock (< -70 ft)
Possible Karst
-90
-80
-70
-60
-50
-40
-30
Interpreted Top of Hard Limestone Elevation (feet)
0
400
800
Scale (feet)
Boring Location

North End of Bridge (Toward Tampa and Tampa International)

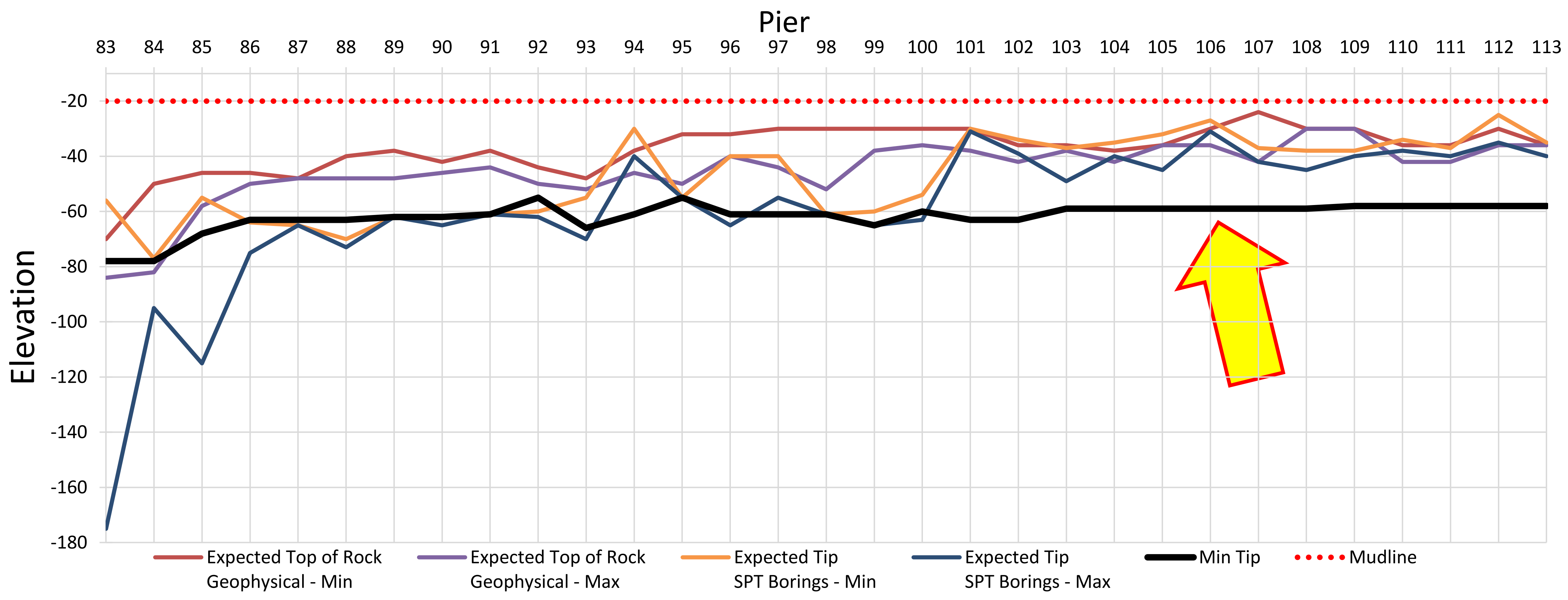
Geophysical Survey Top of Limestone (Pier 84 to 113)



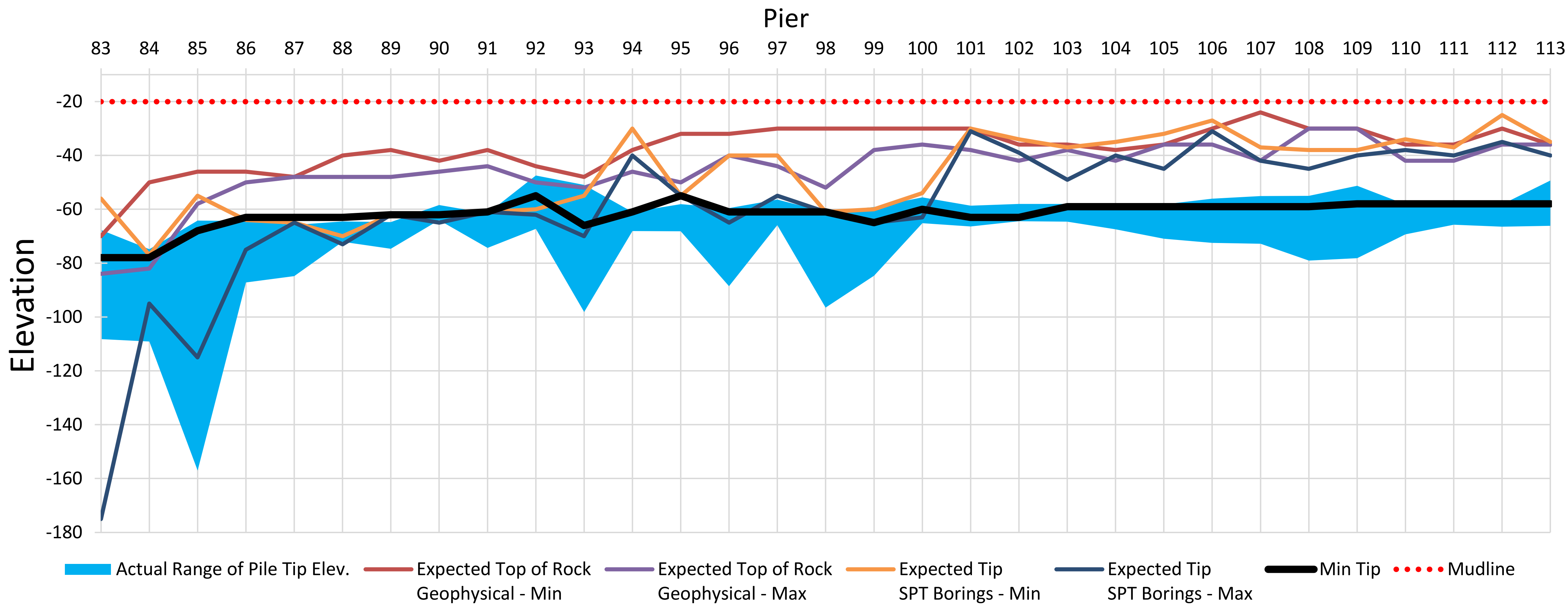
Geophysical Survey vs. Borings



Geophysical Survey vs. Borings (Effect of Minimum Tip)

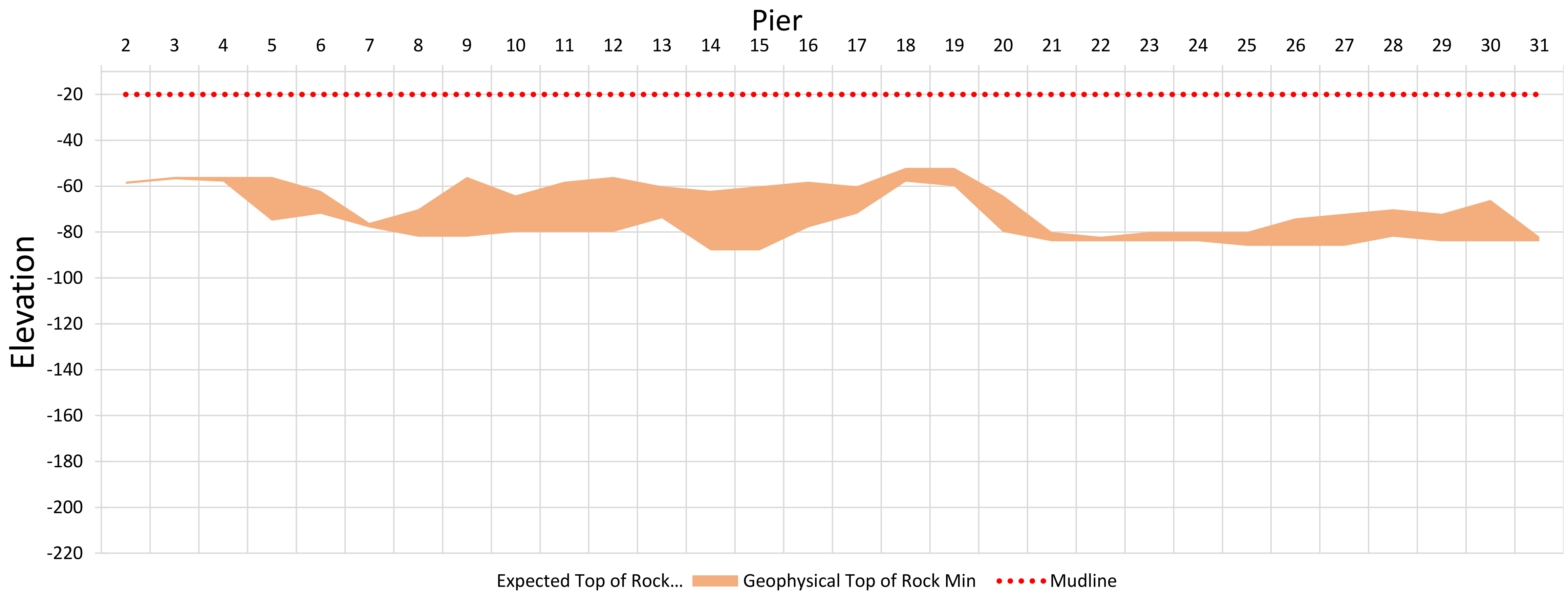


Geophysical Survey vs. Borings vs. Pile Tip Elevation

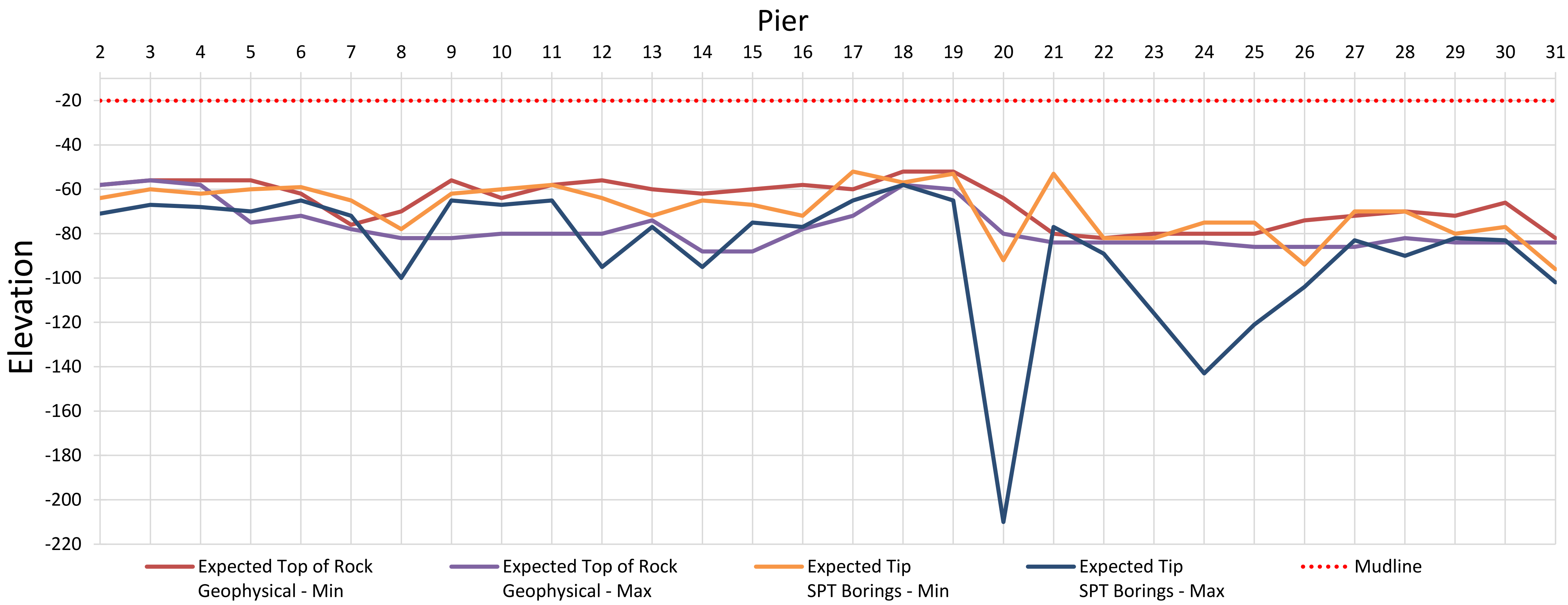


South End of Bridge (Toward Clearwater/St. Petersburg)

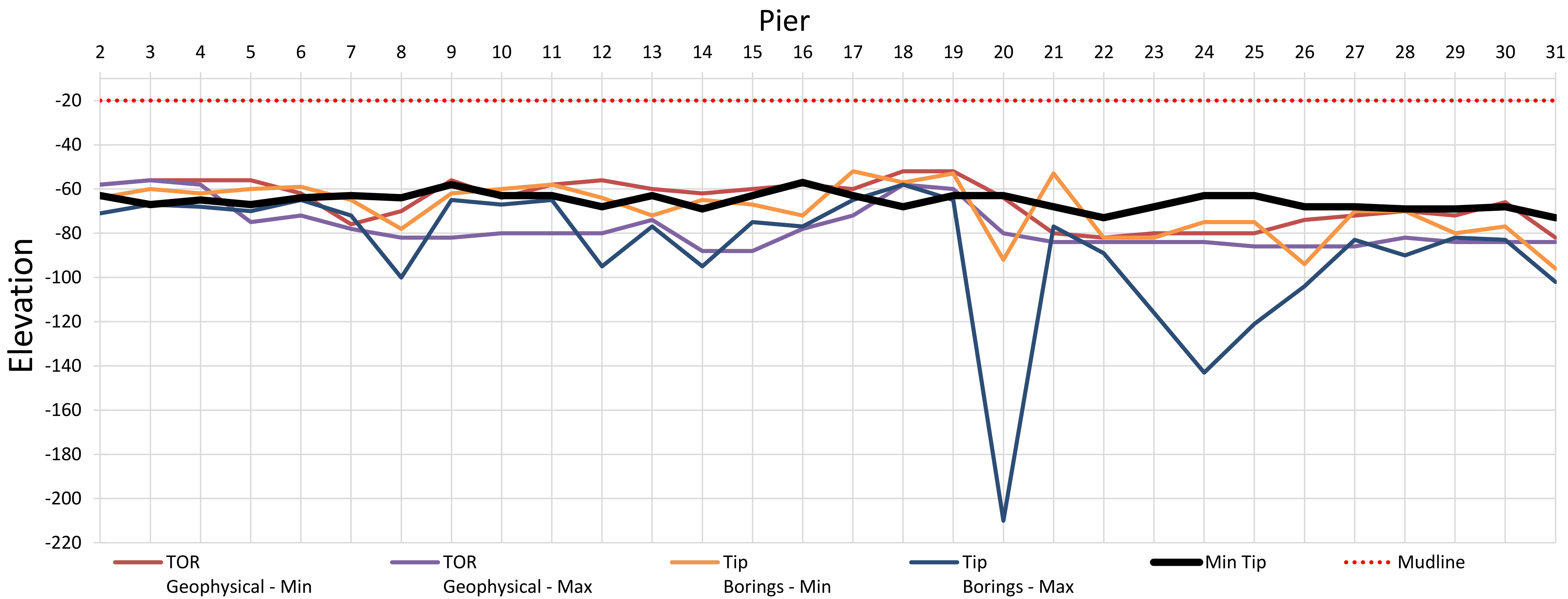
Geophysical Survey Top of Limestone (Pier 2 to 31)



Geophysical Survey vs. SPT Borings



Geophysical Survey vs. Borings (Effect of Minimum Tip)



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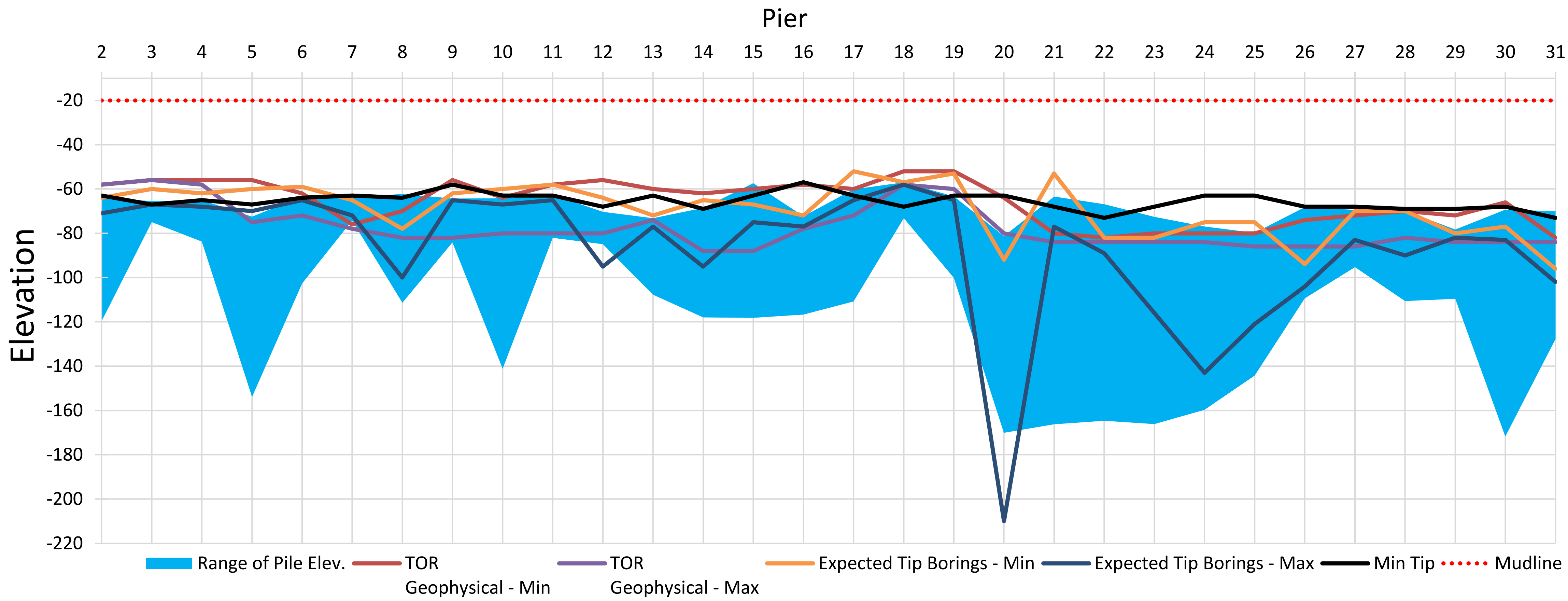
Geophysical Survey vs. Borings vs. Pile Tip Elevation



DURING CONSTRUCTION

- Effect of Minimum Tip Elevations (mostly east end)
  - Though limestone was encountered shallower, the requirements for lateral stability after Scour required Pile Tip Elevations to be deeper than top of limestone
- Allowed Pile Order Lengths vs. Test Pile Program Approach
  - Pile Order Lengths are Faster for Contractor
  - Normal Practice is Test Pile Program
  - Upon Completion of Test Pile Program then Place Order

LESSONS LEARNED

- Marine Geophysical Study Requires a Relatively Long Bridge to be Effective
- Geophysical Works Well to Fill in Top of Limestone
  - Borings were in reasonably good agreement with top of limestone
- Geophysical Work May Not be a Reliable Indication of Pile Tip
  - Design Factors such as Minimum Tip Elevations may control
  - Variability in Limestone Consistency Creates Dramatic Differences in Pile Tip Elevations Within the Same Pier

LESSONS LEARNED

- This Geophysical Work was performed in 2016
- Geophysical Methods are Evolving and Will Continue to Evolve
- Methods such as ERI and MASW would allow a “view” of the materials below the Limestone Surface
  - A deeper “view” could improve the Pile Tip Projections
  - The deeper “view” would show soft zones within the Limestone

Thanks to . . .

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Questions?