Tower B South Stability Study

Detroit-Superior Bridge

CUY-06-1456 (SFN 1800930)
PID 115039

September 20, 2021

Prepared for:
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Introduction

Per the scope of services, ms consultants and our subconsultant S&ME have investigated the stability of Tower B South of the Detroit Super Bridge (CUY-06-1456, SFN 1800930). This tower has been leaning away from the main structure for several years and thus has been a cause for concern as it could eventually collapse. The tower is not a structural element of the bridge since the sidewalk above is supported by floor beams up and down station of the tower. However, it is connected to the bridge as it shares a wall with the main bridge, and the tower's footing is connected to the main bridge's footing.

The focus of this report is to determine alternatives to stabilize the tower to prevent collapse, including estimated construction costs, and to provide a reasonable remaining service life of the tower. We also include alternatives to remove the tower, and to replace the tower in-kind on a deep foundation.

The Detroit Superior Bridge (aka the Veteran's Memorial Bridge) was constructed in 1917 and has had several improvements over the years. Notable is the 1994 rehabilitation, where the top of Tower B was modified to include a new cap and a cold joint separating it from the cantilevered sidewalk above. That same rehabilitation replaced the adjacent floorbeams supporting the main deck. Those details and the location of Tower B is shown in the plan excerpts below (Figures 1-5):

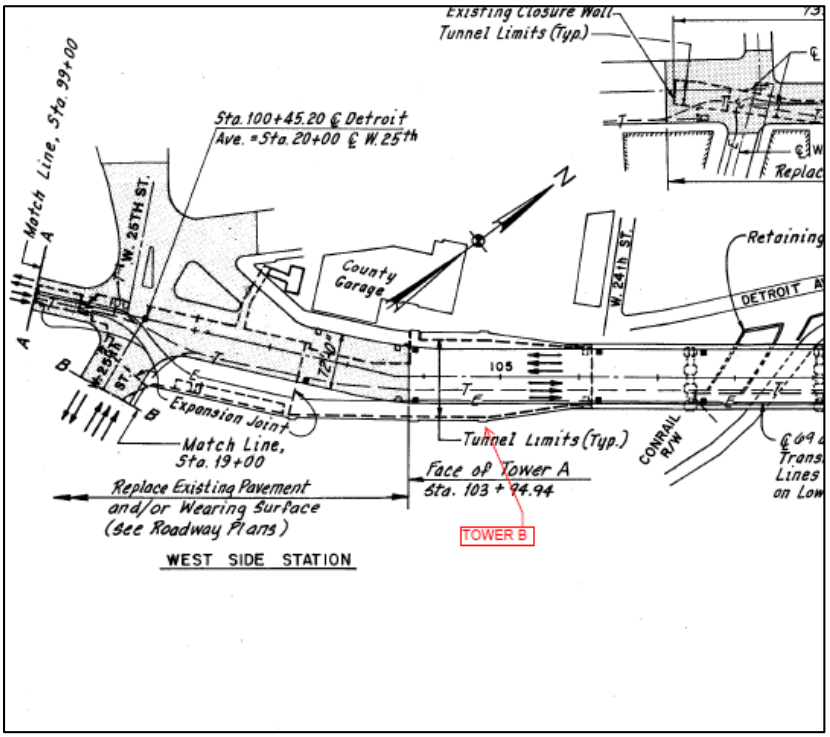


Figure 1- TOWER B LOCATION PLAN (1994)

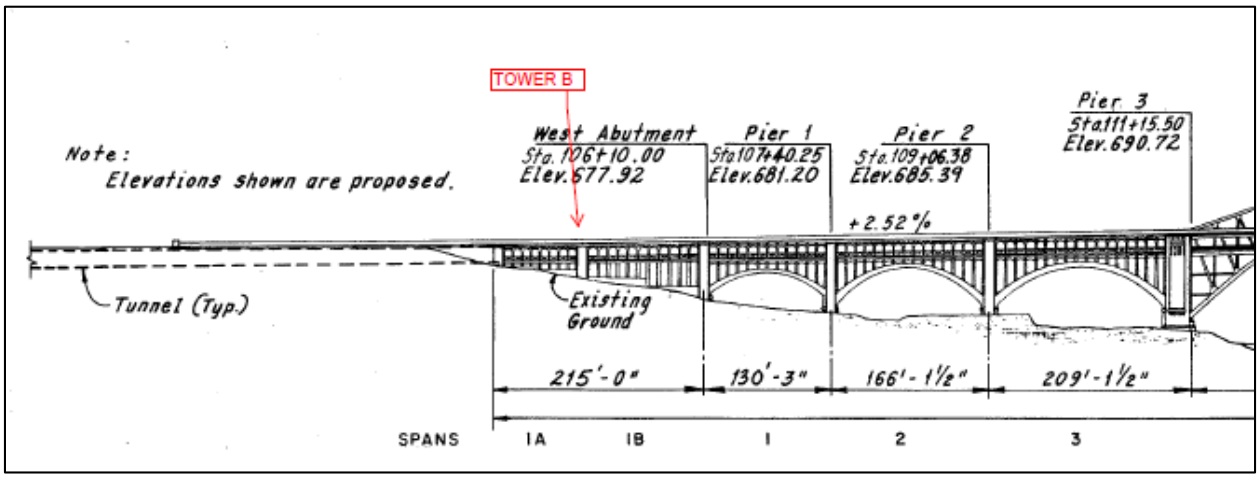


Figure 2 - TOWER B ELEVATION (1994)

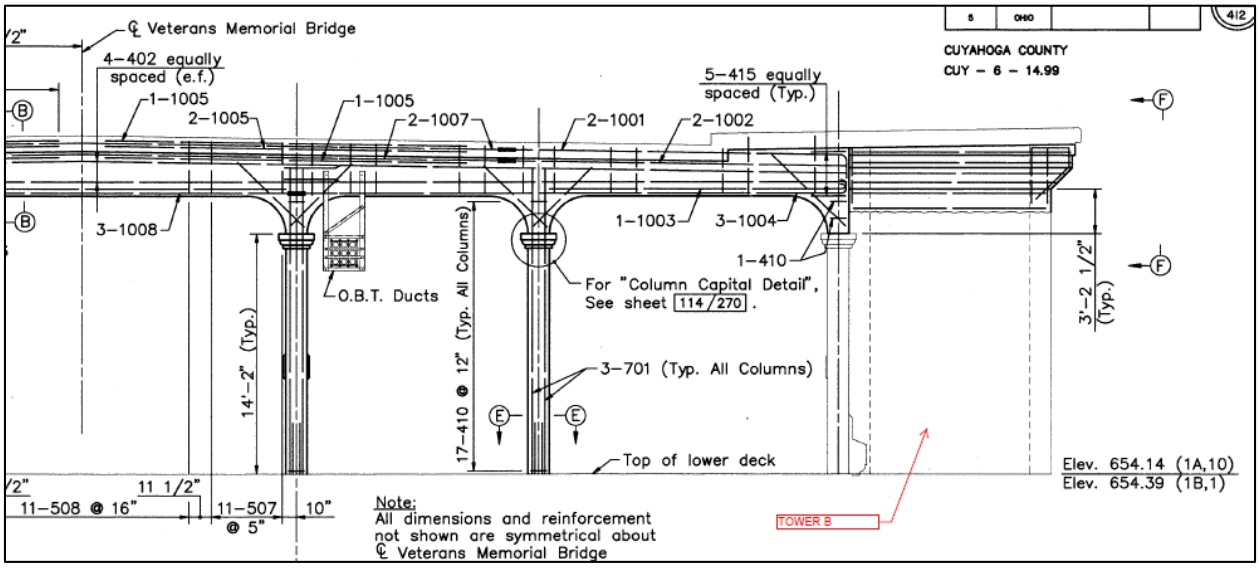


Figure 3 - TOWER B SECTION (1994)

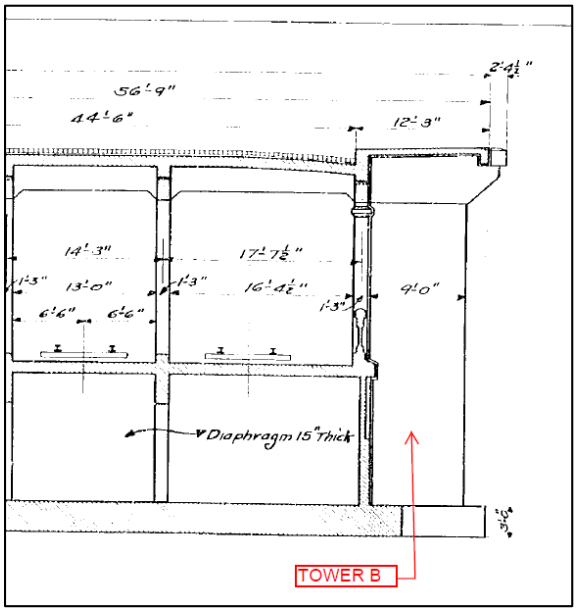


Figure 4 - TOWER B SECTION (1917)

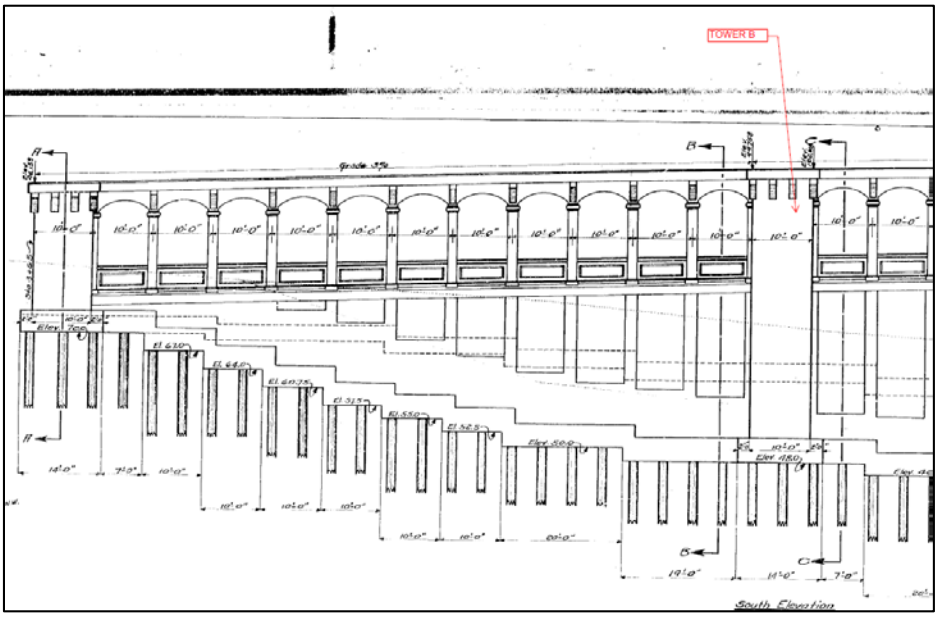


Figure 5 – TOWER B ELEVATION (1917)

As stated, Tower B is a relatively isolated element of the main bridge approach structure, and this relative isolation has allowed it to rotate away from the bridge. It is noted that the tower has a wall which was cast adjacent to the wall of the main structure, and that the footing of the tower is an extension of the main structure's foundation. However, for practical purposes it is considered isolated since the tower's rotation away from the main structure is not compromising the main structure's integrity and ability to function and carry self-weight and live load traffic.

The Tower and adjacent main bridge are founded on the west slope of the Cuyahoga River, which has a long history of deep seated slope movement. This history is discussed in detail in S&ME's report, included in an appendix herein. This immediate area has been dubbed the Irishtown Bend, and is currently being studied for slope stability improvements by the Cleveland-Cuyahoga County Port Authority, to both arrest the overall slope movement and to allow this west side of the river to be utilized for development. A cross section from the 90% plans from the Irishtown Bend project is shown below in Figure 5A. The cross section is coincidentally taken adjacent to Tower B. S&ME has analyzed the slope considering the Irishtown Bend project improvements. When constructed, it will improve the factor of safety of the slope from 1.0 currently to approximately 1.3. It is noted that a factor of safety of 1.5 is required by AASHTO/FHWA to provide for a fully stable slope since the slope supports the bridge.

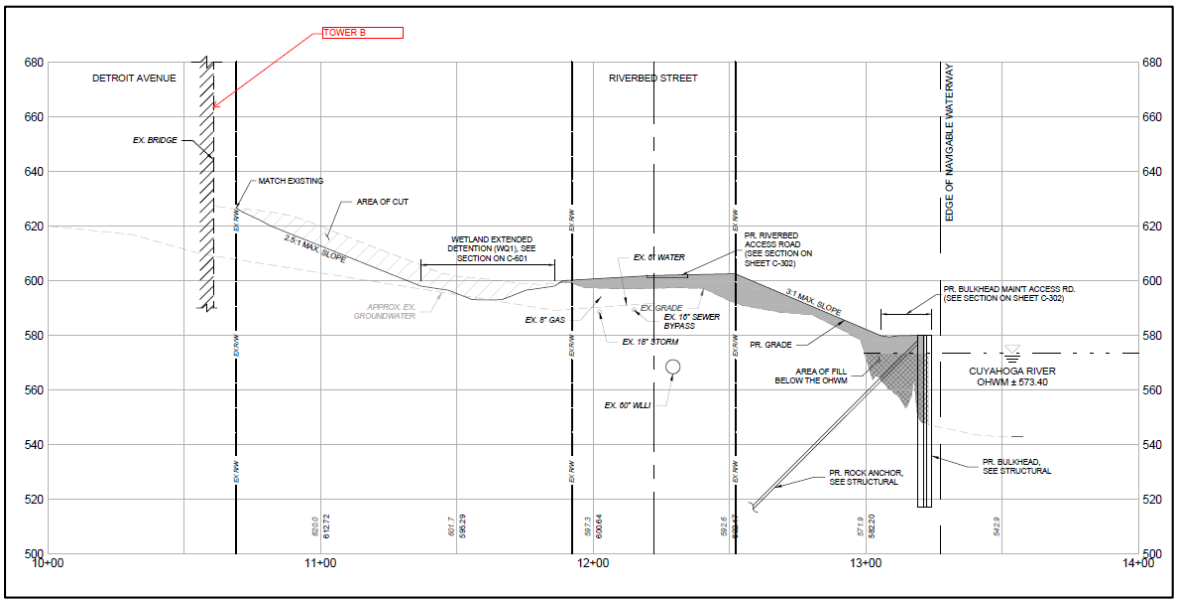


Figure 5A – IRISHTOWN BEND PROJECT - RETAINING WALL AND DEEP FOUNDATION IMPROVMENTS ADJACENT TO TOWER B

From the 1917 original construction plans, it is noted that the tower and the main bridge adjacent to it are supported by piling (see Figure 5). Based on the 1917 drawings, it appears that the piles are concrete, with estimated lengths of 25 to 40 feet, thus it is believed that these piles are friction piles due to the absence of bedrock at the site. These piles are not effective at resisting the slope movements, since the failure plane is located at significant depth (approximately 75 feet below grade).

Scope

As part of this project the ms/S&ME team has been contracted by ODOT D-12 to investigate remediation alternatives to stabilize Tower B from its outward rotation away from the main bridge. As part of this work, the ms/S&ME team has performed the following tasks:

A. Site visits including the exterior of the tower and the interior of the bridge adjacent to the tower.
B. Review of available documentation including plans, soil borings and instrumentation readings including inclinometer and crack measurement data.
C. Coordination with District 12 to refine the scope of services, and with Osborn who is the engineer for the planned Irishtown Bend project
D. Geotechnical slope stability analyses and deep foundation and underpinning concepts
E. Structural investigations and concepts for stabilizing the structure
F. Prepare alternatives to stabilize Tower B, including estimated construction costs.

The sections below summarize the site visits, existing conditions, and proposed alternatives.

Site Visit and Existing Conditions

ms consultants and S&ME performed site visits on 6/23/2021 and 7/20/2021 to view the outside and inside of the tower, respectively. The exterior of the tower is shown in Figure 6 below, which highlights the rotation of the tower away from the main bridge structure. The gap between the main bridge and the tower is approximately 3 inches at the ground level. The photo also shows how the tower is sliding relative to the cantilevered sidewalk above, indicating there is no positive connection to the sidewalk above. Figures 7 and 8 shows the inside of the main bridge, in the cell immediately adjacent to Tower B. The exterior wall of the main bridge is separating from the cellular walls. Tower B is pulling this exterior wall away from the main bridge. This exterior wall of the main bridge extends from the base up to the lower mid-level of the bridge, which is the location of the lower deck which used to support subway/rail lines. Finally, Figure 9 shows the foundation of the main bridge and the crack in that footing. This crack is the assumed location that the footing is rotating about.

Figure 6 – TOWER B (LOOKING UPSTATION) – ROTATION OF TOWER AWAY FROM MAIN STRUCTURE

Figure 7 - INSIDE OF BRIDGE (AT BASE) – CRACKING OF EXTERIOR WALL AT LEFT WHICH IS ADJACENT TO TOWER B INSIDE WALL

Figure 8 - EXTERIOR WALL IN EXTERIOR CELL OF MAIN BRIDGE ADJACENT TO TOWER B - SHOWING CRACKING AND PULLING AWAY OF TOWER B FROM MAIN BRIDGE. THE CEILING IN THIS PHOTO IS THE LOWER LEVEL OF THE MAIN BRIDGE

Figure 9 - FOOTING ADJACENT TO MOUSEHOLE IN EXTERIOR CELL OF MAIN BRIDGE. SHOWING CRACK. THIS IS THE POINT OF ROTATION OF TOWER B.

The following Figures show photos of the upper level, from the lower deck to the top of the tower. Tower B has a vertical opening in this upper level adjacent to the main bridge, and is completely indendent of the main bridge. Tower B has vertical columnar stiffeners which provide structural support at this opening. These columns were installed with the 1994 rehablitation. Figure 10 shows the Tower as it extends up to the underside of the main deck's sidewalk, which is supported by floor beams cantilevered from the main bridge. Figure 11 shows that the main bridge upper deck is separated from the top of the tower. The black markings were bond breaker that allowed for this movement to occur without compromising the upper deck.

Figure 10 – TOWER B AT SEEN FROM THE LOWER DECK, ALSO SHOWING THE MAIN BRIDGE CANTILEVERED FLOOR BEAMS WHICH SUPPORT THE SIDEWALK, INDEPENDENT OF THE TOWER

Figure 11 – TOWER B RECTANUGALAR COLUMNS ADJACENT TO MAIN BRIDGE COLUMNS. ALSO SHOWN IS THE OUTWARD DEFLECTION AT THE BOTTOM OF THE MAIN BRIDGE TOP DECK, AND THE BOND BREAKER AT THE TOP OF THE TOWER B COLUMNS.

The following figures further show the tower at the main bridge deck elevation level. Figure 12 shows the gap at the lower deck relative to the Tower B stiffener columns. As shown in Figure 13, this gap was measured at 7 inches. The gap at the top of the tower underneath the deck was not measured, but is obviously greater.

Figure 12 – TOWER B AT MAIN BRIDGE LOWER DECK LEVEL SHOWING OUTWARD MOVEMENT OF TOWER

Figure 13 – GAP WAS MEASURED AT 7 INCHES JUST ABOVE THE MAIN BRIDGE LOWER DECK

Alternatives Discussion

As agreed upon with ODOT D-12, the following alternatives to stabilize Tower B are presented in this report:

Alternative	Description
1	Remove Tower B
2	Replace Tower B In Kind with Deep Foundation (Micropiles)
3	Laterally Connect Tower B at top with PT Bars Connected to Bridge to Prevent Further Overturning
4	Laterally Connect Tower B at mid-level with Tie Backs drilled into Existing Bridge Foundation
5A	Install Micropiles around Perimeter of Existing Tower B Footing with Positive Connection to footing
5B	Install Drilled Shafts around Perimeter of Existing Tower B Footing with Positive Connection to footing
6	Do Nothing - Assuming Irishtown Bend Project Slope Stability Improvements is Constructed

These alternatives, including estimated costs and assumed life expectancy, are summarized below.

Alternative 1 – Removal of Tower B:

This alternative is a feasible alternative, in that Tower B could be removed without affecting the integrity of the existing bridge. The tower does not provide structural support of the main bridge to carry dead or live load. It only carries its self-weight which is approximately 460 kips. Removal of the tower would actually have a positive impact on the stability of the slope, as it would impart less concentrated dead load on the slope.

The tower would be removed to 1 foot below existing grade. Removal of the tower would require reconstructing the exterior wall of the bridge.

The negative aspect of removing the tower would be that it is an architectural element of the bridge, one that is on the National Historic Register. While the tower is currently obscured by trees, the Irishtown Bend project will likely regrade the slope in this area opening up visually to the future development of the area. In order for the tower to be removed, approval would have to be granted from the Ohio State Historic Preservation Office. This coordination is outside of the scope of this report.

The estimated cost for this alternative is $72,900. The estimated life of this alternative was not considered.

Alternative 2 – Replace Tower B In-Kind with Deep Foundation:

This is also a feasible alternative, and consists of removing the existing tower and its foundation, and replacing it in-kind, however with a deep foundation. The deep foundation would create a stable structure for the reconstructed tower. While this foundation would be designed with piles to bedrock, they would

not mitigate the overall slope movement since the piling would only be localized. Also, the capability of the piling to resist the shear force at the deep failure plane is also unknown, and would require more extensive analysis.

As stated in Alternative 1, the existing exterior wall of the existing bridge adjacent to the tower would also have to be replaced. The proposed deep foundation for this alternative is utilizing micropiles.

We have considered micropiles, HP piles to rock, and drilled shafts, and have considered the presence of the sidewalk overhang approximately 25 feet above ground, as well as an unknown utility adjacent to the tower. Micropiles can be installed with low headroom equipment. These approximately 9.5" diameter piles are drilled in, then a single reinforcing bar is installed, and then the annular space is grouted. There is relatively little disturbance to the adjacent ground. Shorter micropile pieces would can be spliced together thus the work can be done with overhead obstructions. Drilled shafts would require casing and long reinforcing cages (see Alt 5B discussion), and are therefore not a cost effective deep foundation type. HP piles would require a crane with long leads to drive the piles to the necessary depths to reach bedrock. Due to the low headroom restrictions, driven piles are also not a cost effective deep foundation type.

The estimated cost for this alternative is $578,300. The estimated life of this alternative, when coupled with the Irishtown Bend slope remediation project, is 30 years.

Alternative 3 – Laterally Connect Tower B at the top with PT Bars Connected to Main Bridge:

This alternative would anchor Tower B to the existing main bridge, to prevent further rotation/overturning of the tower away from the main bridge. PT Bars could be installed and connect the walls of the tower to the floor beams of the main bridge. Per discussion with D-12, the goal of this alternative is to stabilize the tower from outward rotation only, and not to prevent the tower from settling at the interface of the tower and the main bridge. Since the tower is rotating about the foundation crack which is interior to the main bridge, this seems like a prudent approach as it does not require a structural shear connection.

A concept for this connection is presented in the appendix. The structural connection to the walls of the tower and to the floor beams could be made with doweled in anchors to connect a steel bracket to these elements. A transfer beam would be used to span between floorbeams of the main bridge, and between the walls of the tower. PT bars could then be installed and tightened to resist the future out of balance load that will likely occur as the slope continues to slip. It is noted again that the Irishtown Bend project will install sheet piling and tie backs along the bank of the Cuyahoga River. This system, when installed, will bring the factor of safety of the slope to around 1.3. Thus future slope sliding would be reduced and/or eliminated.

The estimated cost for this alternative is $65,300. The estimated life of this alternative, when coupled with the Irishtown Bend slope remediation project, is 30 years. If the Irishtown Bend project is not completed, the estimated life is 15 years.

Alternative 4 - Laterally Connect Tower B at mid-level with Tie Backs into Existing Bridge Foundation:

This alternative will provide a structural connection to resist overturning of the tower by providing tie backs drilled into the existing bridge foundation and into the soil below. These tie backs would be grouted

and stressed. A similar bracket and transfer beam as proposed in Alternative 3 could be provided. The outside wall of the tower would have to have an opening constructed to allow access to the inside of the tower, and to facilitated the tie back installation. Openings in the inside wall of the tower, as well as in the outside wall of the main bridge and the cellular walls of the main bridge would be needed. The force in these tie backs would be greater than the PT bars proposed in Alternative 3 as they would be angled and also since they are at a lower elevation than Alternative 3, and thus have a reduced moment arm to resist the overturning force.

We had tried to reach out to a tie back contractor to determine the feasibility of this approach. From our perspective it is feasible, but there are several unknowns including the ability to drill the tiebacks into the existing foundation, any impediments which may be encountered including utilities and unknown structures, and actual length of tie back needed. Our cost estimate is therefore inflated for these unknowns.

The estimated cost for this alternative is $99,000. The estimated life of this alternative, when coupled with the Irishtown Bend slope remediation project, is 30 years. If the Irishtown Bend project is not completed, the estimated life is 15 years.

Alternative 5A/5B – Install Micropiles (or Drilled Shafts) around Perimeter of Existing Tower B Footing:

This alternative would install a deep foundation system adjacent to the Tower B footing, with a footing extension to provide a positive connection to the existing tower's foundation. This is a relatively common approach to underpinning a structure to redirect the foundations load to the newly installed deep foundation elements.

We have considered both micropiles and drilled shafts, and have considered the presence of the sidewalk overhang approximately 25 feet above ground, as well as an unknown utility adjacent to the tower. Micropiles (Alternative 5A) can be installed around the three-sided perimeter of the existing footing. These approximately 9.5" diameter piles are drilled in, then a single reinforcing bar is installed, and then the annular space is grouted. There is relatively little disturbance to the adjacent ground. Shorter micropile pieces would can be spliced together thus the work can be done with overhead obstructions.

Drilled shafts (Alternative 5B) for this site would require a long temporary casing to prevent caving in of the shaft through the poorer soils, likely to around 100 feet depth. The casing at this depth would be difficult to extract thus it would have to be left in place. Also a long reinforcing steel cage would be needed, to extend below the active failure plane at around 75 feet below grade. Due to the limited height restrictions, several splices of the cage would be required. For these reasons, we have not considered drilled shafts any further.

To engage the micropiles, a positive connection to the existing footing is required. A reinforced concrete footing extension would be installed to connect the micropiles to the existing footing.

The estimated cost for Alternative 5A is $306,300. The estimated life of this alternative, when coupled with the Irishtown Bend slope remediation project, is 40 years. If the Irishtown Bend project is not completed, the estimated life is 20 years.

Alternative 6 – Do Nothing, Assuming Irishtown Bend Slope Stability Improvements are Constructed:

This alternative comes at no immediate cost to ODOT District 12. The Irishtown Bend project is a real project and will be moving forward. Further, NOACA recently approved significant additional funding for this project. Per discussion with Joseph K. Ferenczy of Osborn on 9/17/2021, the Irishtown Bend slope stabilization project will be constructed starting in 2021.

S&ME has confirmed that the Irishtown Bend project will improve the factor of safety of the slope from 1.0 existing to approximately 1.3 with the construction of the retaining wall and tie backs along the Cuyahoga River, and unloading of the slope by removing soil. These improvements will have a positive effect on the overall slope stability including the portion under the existing bridge and Tower B. Thus ODOT District 12 could consider continued monitoring of the Tower, both before the Irishtown Bend project is constructed and after, to determine if movement slows and or stops. Additional remediation could be considered at that time, and only if needed.

The estimated cost for this alternative is $0.00, however maintenance cost for the Tower, which could include future concrete repair work, would need to be considered. The estimated life of this alternative, when coupled with the Irishtown Bend slope remediation project, is 15 years. If the Irishtown Bend project is not completed, the estimated life is 3-5 years.

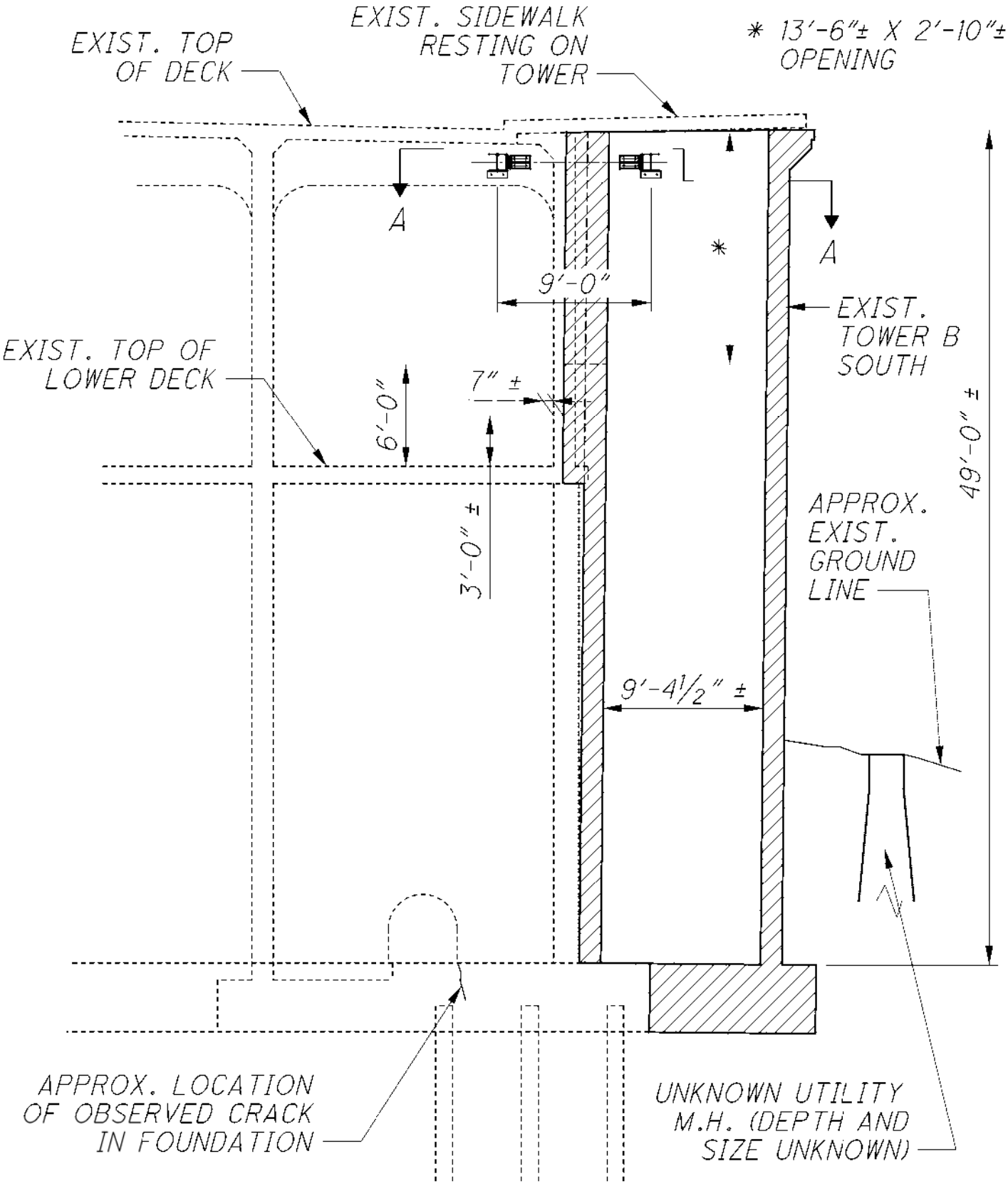
Summary

The following summarizes the alternatives and estimated costs:

Alternative	Description	Cost
1	Remove Tower B	$72,900
2	Replace Tower B In Kind with Deep Foundation	$578,300
3	Laterally Connect Tower B at Top with PT Bars Connected to Bridge to Prevent Further Overturning	$65,300
4	Laterally Connect Tower B at Mid Level with Tie Backs drilled into existing bridge foundation	$99,000
5A	Install Micropiles around Perimeter of Existing Tower B Footing with Positive Connection to Footing	$306,300
5B	Install Drilled Shafts around Perimeter of Existing Tower B Footing with Positive Connection to Footing	N/A
6	Do Nothing - Assuming Irishtown Bend Project, with Slope Stability Improvements Are Constructed	$0

APPENDICES

- SKETCHES FOR ALTERNATIVES 3, 4 AND 5A
- CONSTRUCTION COST ESTIMATES
- DATA REVIEW AND REMEDIATION FEASIBILITY ALTERNATIVES ASSESSMENT (DRAFT)



ELEVATION
(INSIDE TOWER B)

NOTE:

1. FOR VIEW A-A, SEE SHEET 2 OF 2

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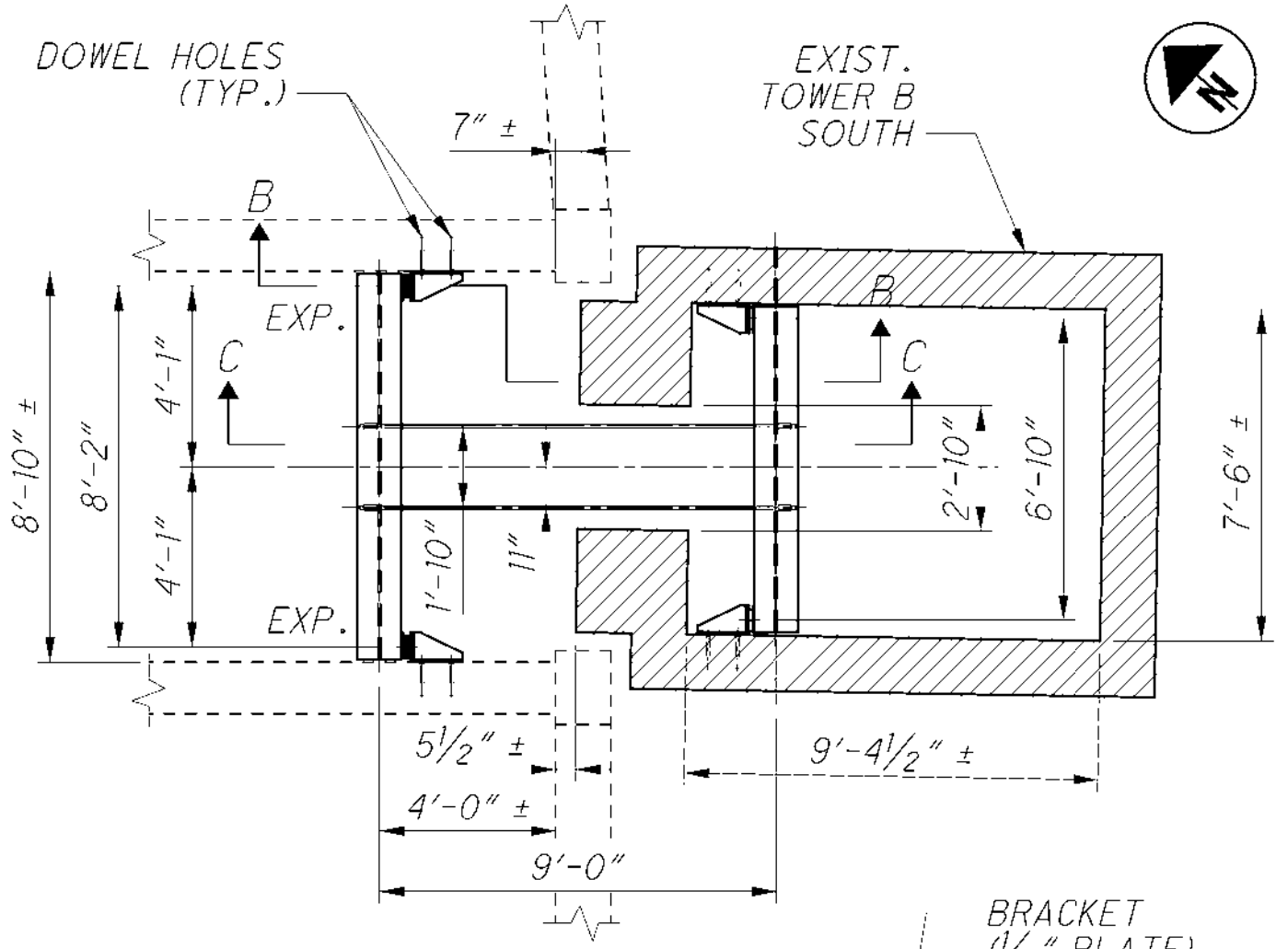
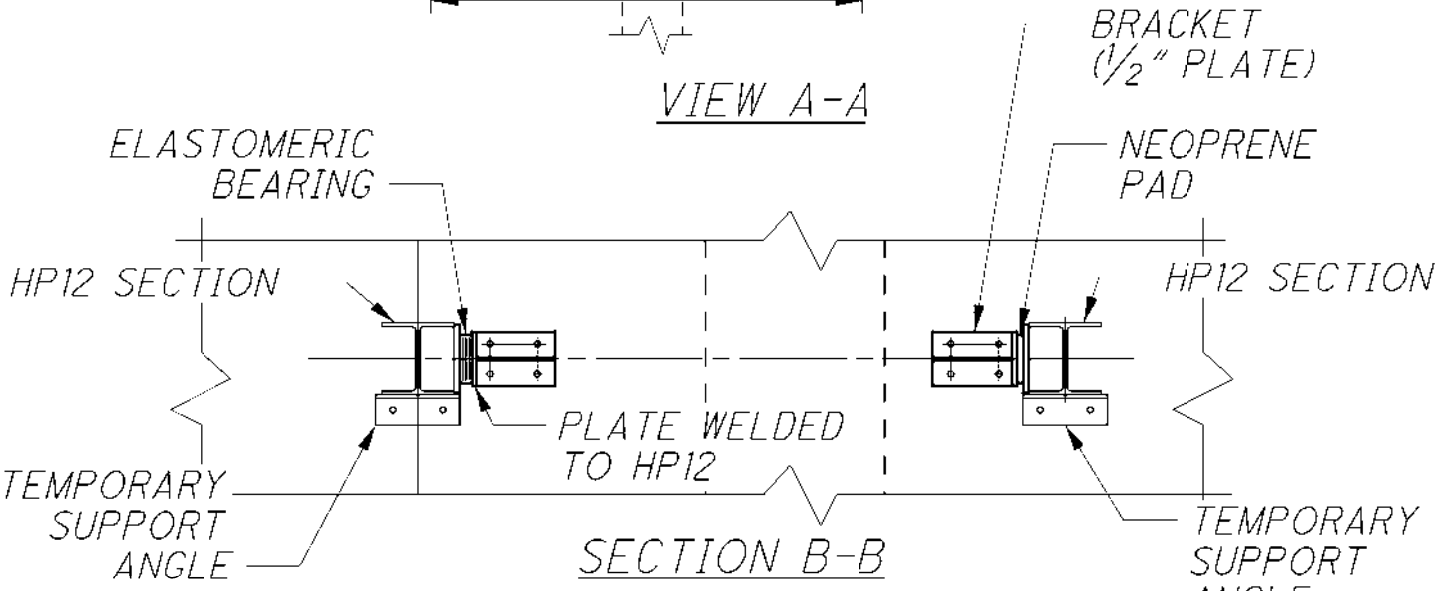
ALTERNATIVE 3



VIEW A-A



SECTION B-B

SECTION C-C

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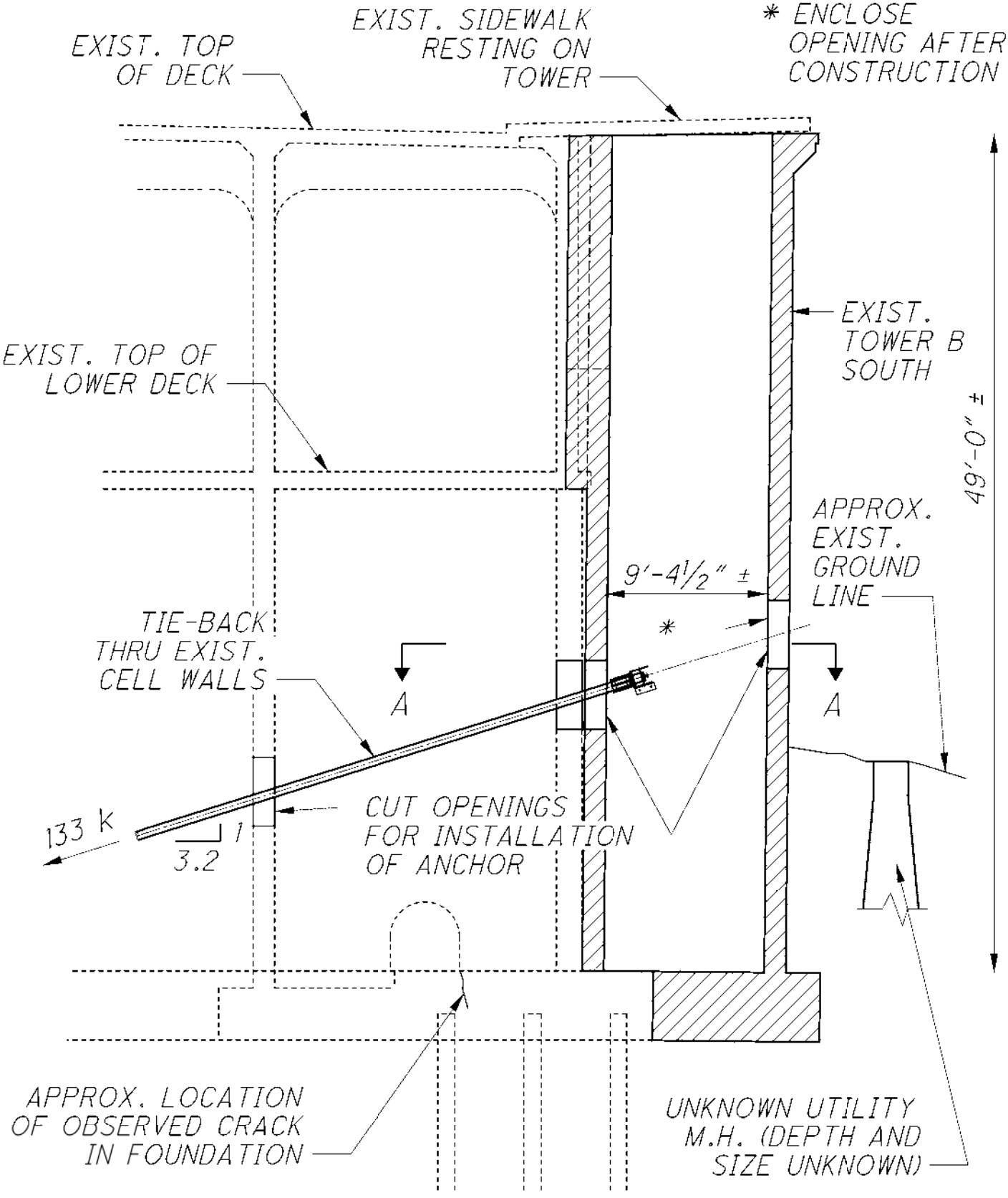
ALTERNATIVE 3



ELEVATION
(INSIDE TOWER B)

NOTE:

1. FOR VIEW A-A, SEE SHEET 2 OF 2

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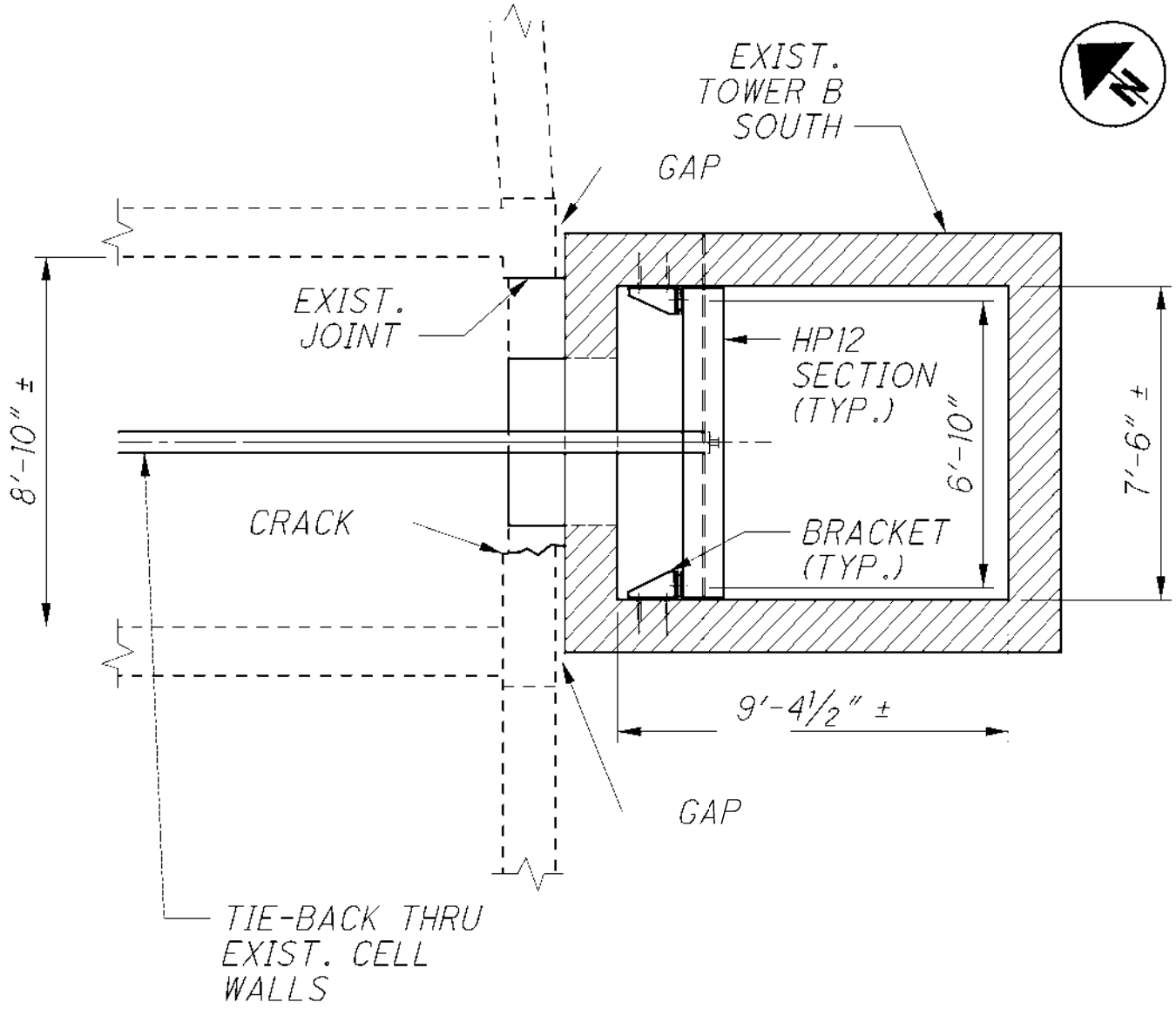
ALTERNATIVE 4



VIEW A-A

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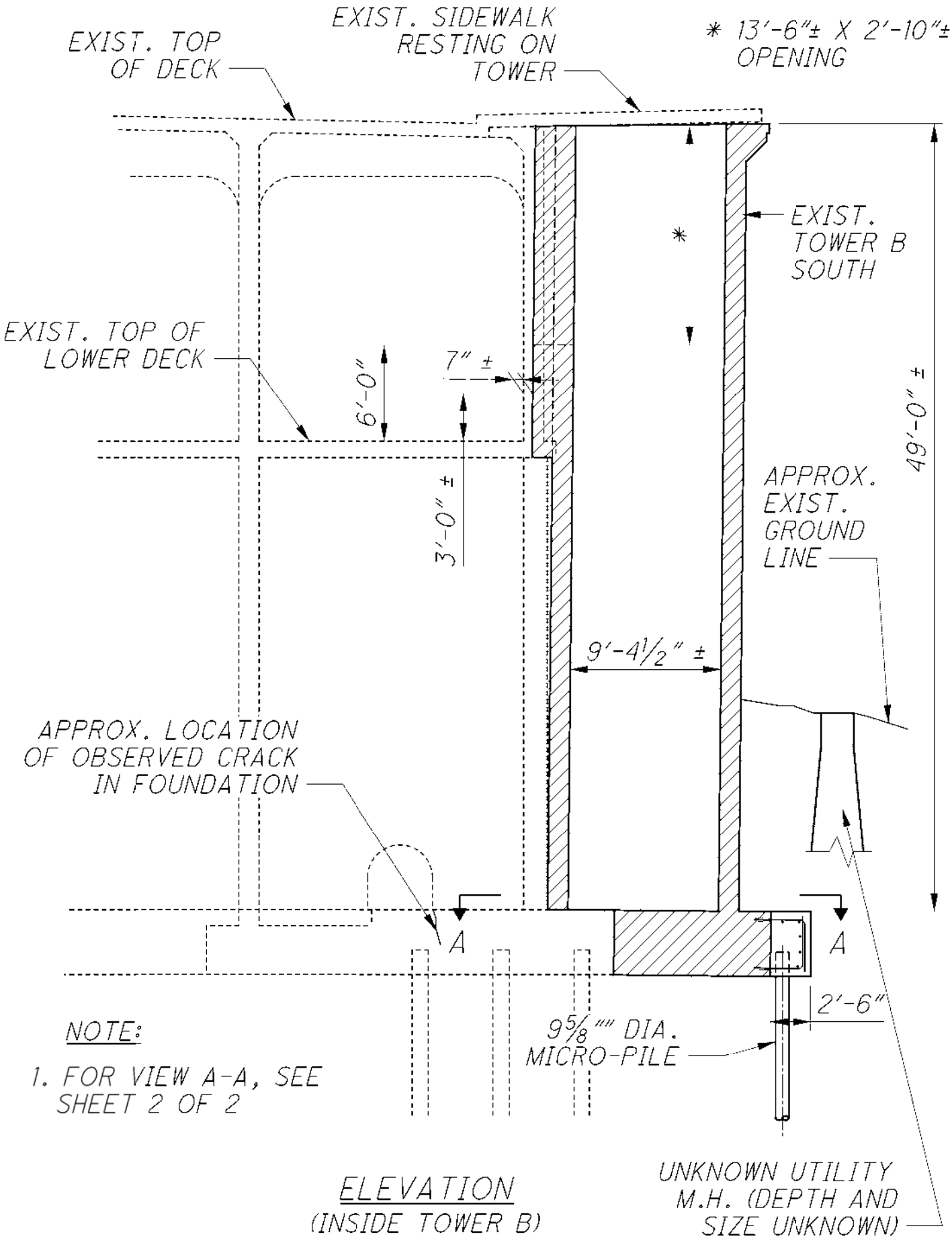
ALTERNATIVE 4



NOTE:

1. FOR VIEW A-A, SEE SHEET 2 OF 2

ELEVATION
(INSIDE TOWER B)

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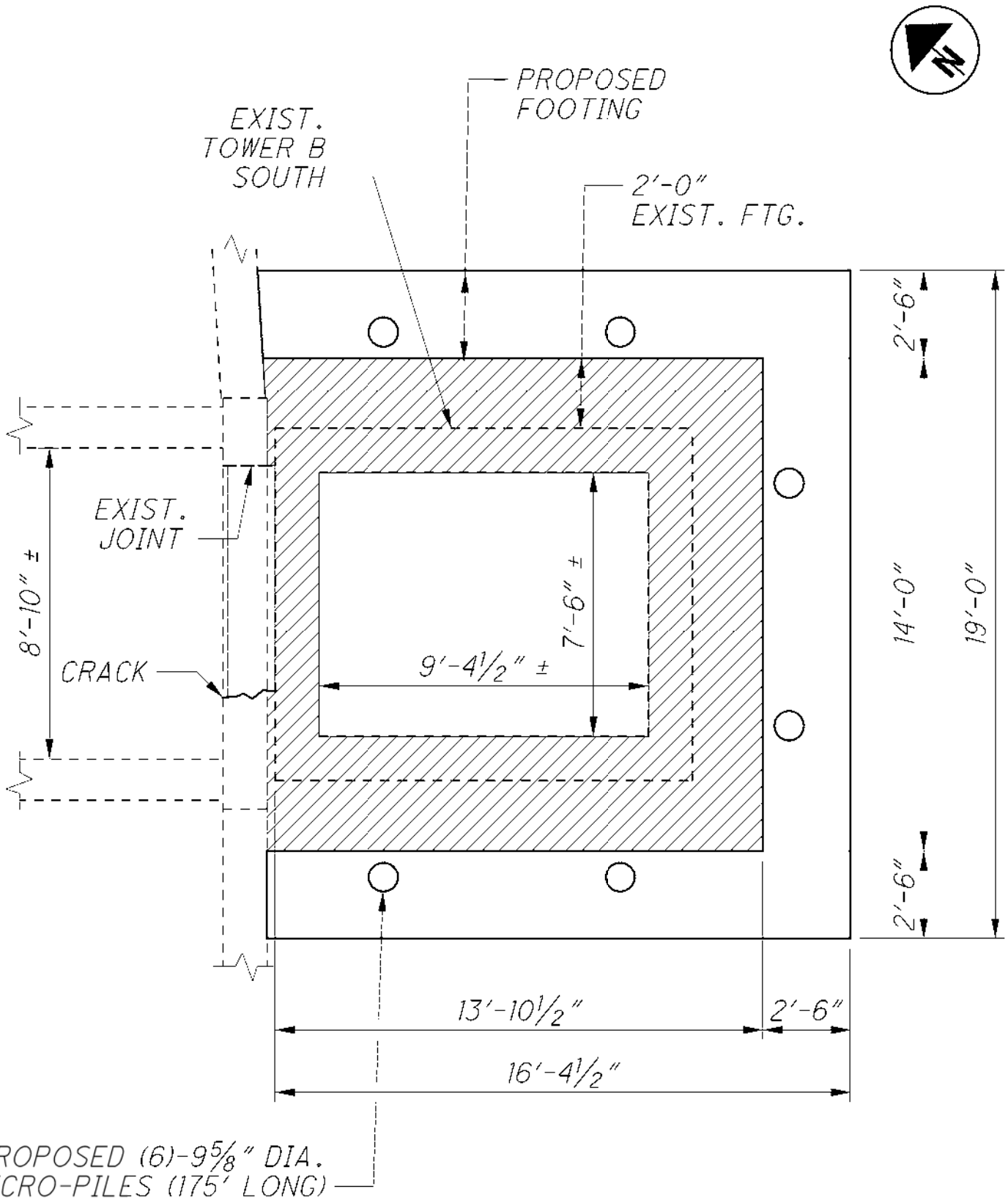
ALTERNATIVE 5A



VIEW A-A

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ALTERNATIVE 5A

ALTERNATIVE 1 - TOWER B REMOVAL						
ITEM	DESCRIPTION	ADDITIONAL DESCRIPTION	QTY	UNITS	UNIT COST	COST
202	PORTIONS OF STRUCTURE REMOVED	Remove Tower Concrete to One Foot Below Grade	73	CY	$500	$36,500
509	EPOXY COATED REINFORCING STEEL	Repair Existing Exterior Wall of Main Bridge	1860	LB	$1.35	$2,511
511	CLASS QCI CONCRETE, PIER		9	CY	$1,000	$9,259
624	MOBILIZATION	-	1	LS	$10,000	$10,000
					Subtotal	$58,270
					25% Contingency	$14,568
					Total	$72,900

ALTERNATIVE 2 - TOWER B REMOVAL AND IN-KIND REPLACEMENT WITH DEEP FOUNDATION						
ITEM	DESCRIPTION	ADDITIONAL DESCRIPTION	QTY	UNITS	UNIT COST	COST
202	PORTIONS OF STRUCTURE REMOVED	Tower Concrete	112	CY	$400	$44,800
202	PORTIONS OF STRUCTURE REMOVED	Foundation Concrete	22	CY	$350	$7,700
503	UNCLASSIFIED EXCAVATION	Includes Shoring	1	LS	$10,000	$10,000
505	PILE DRIVING EQUIPMENT MOBILIATION	For Micropiles	1	LS	$40,000	$40,000
505	MICROPILE TESTING	For Micropiles	1	LS	$25,000	$25,000
507	9 7/8" DIAMETER MICROPILES	6 piles 175 feet long	1050	LF	$120	$126,000
509	EPOXY COATED REINFORCING STEEL	For pier and footing	30820	LB	$1.35	$41,607
511	CLASS QCI CONCRETE, PIER	Includes Footing and Exterior Wall of Main Bridge	154	CY	$1,000	$154,100
512	SEALING OF CONCRETE SURFACES	Epoxy Urethane	136	SY	$25	$3,400
624	MOBILIZATION	-	1	LS	$10,000	$10,000
					Subtotal	$462,607
					25% Contingency	$115,652
					Total	$578,300

ALTERNATIVE 3 - LATERAL CONNECTION OF TOWER B WITH POST-TENSIONING BARS AT TOP						
ITEM	DESCRIPTION	ADDITIONAL DESCRIPTION	QTY	UNITS	UNIT COST	COST
510	DOWEL HOLES WITH NONSHRINK, NONMETALLIC GROUT	For Bracket Connection	16	EACH	$20	$320
513	STRUCTURAL STEEL MEMBERS, LEVEL UF	Brackets and Transfer Beams	2000	LB	$12	$24,000
516	1" ELASTOMERIC BEARING PAD	Transfer Beam Support on Bracket	2	EACH	$400	$800
516	ELASTOMERIC BEARING (6" X 8" X 2.00") WITH INTERNAL LAMINATES (NEOPRENE)	Transfer Beam Support on Bracket	2	EACH	$800	$1,600
519	PATCHING CONCRETE STRUCTURE	For Crack in Abutment Wall	90	SF	$150.00	$13,500
SPECIAL	HIGH STRENGTH POST-TENSIONING THREADBAR	-	2	EACH	$1,000	$2,000
624	MOBILIZATION	-	1	LS	$10,000	$10,000
					Subtotal	$52,220
					25% Contingency	$13,055
					Total	$65,300

ALTERNATIVE 4 - LATERAL CONNECTION OF TOWER B WITH TIE-BACK AT MID LEVEL						
ITEM	DESCRIPTION	ADDITIONAL DESCRIPTION	QTY	UNITS	UNIT COST	COST
202	PORTIONS OF STRUCTURE REMOVED	Openings For Access	3	CY	$750	$2,250
510	DOWEL HOLES WITH NONSHRINK, NONMETALLIC GROUT	For Bracket Connection	8	EACH	$20	$160
509	EPOXY COATED REINFORCING STEEL	Replace Tower B Exterior Wall Access Opening	200	LB	$1.35	$270
511	CLASS QCI CONCRETE, PIER		1	CY	$1,000	$1,000
513	STRUCTURAL STEEL MEMBERS, LEVEL UF	Brackets and Transfer Beams	1500	LB	$12	$18,000
516	1" ELASTOMERIC BEARING PAD	Transfer Beam Support on Bracket	2	EACH	$400	$800
519	PATCHING CONCRETE STRUCTURE	For Crack in Abutment Wall	90	SF	$150.00	$13,500
SPECIAL	POST-TENSIONING TIE-BACK		1	EACH	$15,000	$15,000
624	MOBILIZATION		1	LS	$15,000	$15,000
					Subtotal	$65,980
					50% Contingency	$32,990
					Total	$99,000

ALTERNATIVE 5A - INSTALL PERIMETER FOOTING EXTENSION WITH MICROPILES						
ITEM	DESCRIPTION	ADDITIONAL DESCRIPTION	QTY	UNITS	UNIT COST	COST
503	UNCLASSIFIED EXCAVATION	Includes cofferdams	1	LS	$10,000	$10,000
505	PILE DRIVING EQUIPMENT MOBILIATION	For Micropiles	1	LS	$40,000	$40,000
505	MICROPILE TESTING	For Micropiles	1	LS	$25,000	$25,000
507	9 7/8" DIAMETER MICROPILES	6 piles 175 feet long	1050	LF	$120	$126,000
509	EPOXY COATED REINFORCING STEEL	For Footing Extension	1000	LB	$1.35	$1,350
510	DOWEL HOLES WITH NONSHRINK, NONMETALLIC GROUT	Footing Connection	56	EACH	$20	$1,120
511	CLASS QCI CONCRETE, FOOTING	Footing Extension	18	CY	$1,000	$18,000
519	PATCHING CONCRETE STRUCTURE	For Crack in Abutment Wall	90	SF	$150.00	$13,500
624	MOBILIZATION		1	LS	$10,000	$10,000
					Subtotal	$244,970
					25% Contingency	$61,243
					Total	$306,300

Data Review and Remediation Feasibility Alternatives Assessment (Draft), Rev. #1
Detroit Superior Bridge Tower B South (PID 115039)
Cleveland, Ohio
S&ME Project No. 213051A

PREPARED FOR:

ms consultants, inc.
One Cascade Plaza, Suite 140
Akron, Ohio 44308-1116

PREPARED BY:

S&ME, Inc.
8400 Sweet Valley Drive, Suite 404
Valley View, OH 44125

September 17, 2021

September 17, 2021

ms consultants, inc.
One Cascade Plaza, Suite 140
Akron, Ohio 44308-1116

Attention: Mr. Jonathan Hren

Reference: **Data Review and Remediation Feasibility Alternatives Assessment (Draft), Rev. #1**
VAR-D12/D03-General Engineering Services, Task 12-01
Detroit Superior Bridge Tower B South (PID 115039)
Cleveland, Ohio
S&ME Project No. 213051A

Dear Mr. Hren:

In accordance with our revised proposal dated May 3, 2021, which was authorized on June 16, 2021, by ms consultants, inc. (ms), S&ME, Inc. (S&ME) has completed a review of existing data and prepared a conceptual remediation alternatives assessment to address the observed movement of Tower B South of the Detroit Superior Bridge in Cleveland, Cuyahoga County, Ohio. The location of this project is shown on the Vicinity Map submitted as Plate 1 in Appendix I of this report.

In accordance with our proposal, S&ME is herewith submitting a revised "draft" version of this report to address comments provided by ms on September 16. A final version of this report will be prepared following receipt of all review comments from ODOT District 12 on our draft submission and all necessary information.

We appreciate being given the opportunity to be of service. Please do not hesitate to contact our office if you have any questions concerning this report.

Sincerely,

S&ME, Inc.

Brian K. Sears, P.E.
Senior Engineer / Geotechnical Project Manager

Richard S. Weigand, P.E.
Senior Engineer / Senior Reviewer

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Appendices

1.0 Introduction and Scope of Work

During an April 15, 2021, project scoping meeting between ODOT District 12 (D12), ms consultants, inc. (ms), Euthenics, Inc. (Euthenics) and S&ME, S&ME was informed that settlement/movement has been occurring for more than 10 years at Tower B South of the Detroit Superior Bridge (DSB) in Cleveland, Ohio. ODOT D12 indicated that although Tower B South is not believed to structurally support the bridge or pedestrian sidewalk, it is structurally connected to the main bridge structure. The Detroit Superior Bridge is on the west edge of the Irishtown Bend hillside above the Cuyahoga River which has a well-known history of slope failure movement. ODOT has performed multiple phases of soil drilling and sampling on both sides of the Detroit Superior bridge and within the Irishtown Bend hillside, including inclinometers installed at nine (9) different locations. The inclinometers were installed between November 2012 and December 2013.

At this scoping meeting, ODOT requested that S&ME review the available information regarding the bridge structure, soil borings and instrumentation readings obtained by others, and in conjunction with ms, develop multiple conceptual remediation alternatives to reduce the magnitude and rate of the movement of Tower B South. We understand the scope of this project does NOT include developing an approach for resetting/repositioning Tower B to its original position

2.0 Geology and Observations of the Project

2.1 Geology and Hydrogeology

Various publicly available resources were reviewed to gain an understanding of the site. These resources and a brief summary of the information reviewed are summarized in Table 2-1 below. Additionally, S&ME (then BBC&M Engineering, Inc.) prepared a report for the CUY-90-15.24 project (focusing on the west abutment of the IR 90 Innerbelt Bridge) which included a detailed summary of the geologic history of the Lower Cuyahoga River Valley where the present Superior Bridge site is located. This detailed summary is available upon request.

Table 2-1 Summary of Geologic and Surficial Soil Information

Resource	Summary of Findings
Physiographic Regions of Ohio (ODNR)	The site lies within the Lake Erie Plain Physiographic Region. This region typically consists of Pleistocene-age lacustrine sand, silt, clay, and wave-planed glacial till over Devonian- and Mississippian-age shales and sandstones.
Ground Surface Topography Mapping (Cuyahoga County)	Based on 2006 topographic information provided by Cuyahoga County, the ground surface elevation near the top of the slope east/south of the DSB, near the vacated Cuyahoga Metropolitan Housing Authority building, is El. 670. The slope extends down to the Cuyahoga River which is near EL. 574. The ground surface at the base of Tower B South is near El. 632.
Bedrock Topography Mapping (ODNR)	Bedrock topography mapping suggests the bedrock within the site is between approximately El. 425 and El. 450. Bedrock was encountered in the borings performed on site by others ranging from El. 443.0 to El. 470.5.

Resource	Summary of Findings
Karst Interactive Map Viewer (ODNR)	No known karst features are in the immediate or general vicinity of the project site.
GeoFacts 8: Landslides in Ohio (ODNR)	This map indicates that the project site lies in a region indicated to be subject to severe slope failure.
Surficial Geology Mapping (ODNR)	Indicates the potential for alluvium deposits over interbedded sand and lacustrine deposits atop glacial till and bedrock. Estimated depth to bedrock ranges from approximately 150 feet to 180 feet.
Mines of Ohio Online Mapping Tool (ODNR)	This tool indicates that no known mines are mapped within the project limits or vicinity.
Groundwater Pollution Potential Mapping (ODNR)	Indicates the site lies within a buried valley with a mixture of sand/gravel and silt/clay soil materials overlying bedrock. Depth to water is noted to be from 5 to 15 feet.
Groundwater Resource Potential Mapping (ODNR)	Buried valley containing 200 to 300 feet of fine sand, silt and clay with a very meager (typically) yield ranging from 3 to 10 gallons per minute.

2.2 Available Information

S&ME has been provided with the following information by ODOT D12 regarding this project:

- Boring logs of nine (9) soil borings drilled by PSI on behalf of ODOT in 2012 and 2013. Slope inclinometers were installed in each boring. A summary of the findings from these borings will be provided later in this report.
- Inclinometer plots of inclinometer readings obtained from eight (8) of the borings. Readings were obtained between November 2012 and December 2020. A summary of the findings and conclusions from the inclinometer readings will be provided later in this report.
- Data from two (2) digital tilt meters installed on the inside wall of Tower B North and Tower B South.
- Excerpts of the 2016 Physical Condition Report for the Detroit Superior Bridge, prepared by Pennoni. The excerpts provided (pages 30-31, 59-63) describe various observations of cracks and movement in Tower B.
- A 2020 Physical Condition Report, with a stamped date of January 30, 2021, prepared by Palmer Engineering, Inc.
- A single page PDF titled "Cellular West Approach 1800930" which shows photos of crack monitors, their location on a bridge plan drawing, and of the cracks observed in the lower portion of Tower B. The photos have a date stamp of April 16, 2013.
- An Excel spreadsheet with crack monitoring data for a gauge initially installed at an unknown location within Tower B on May 6, 2006. A new gauge was installed on April 16, 2013, after excessive movement occurred beyond the reading limits of the original gauge. The final reading on the second gauge was taken on May 15, 2019, and this reading was once again outside of gauge limits.

- A 30% Conceptual Plan Set for the Irishtown Bend Stabilization Project. This set of plans is Appendix D of a report titled "Franklin Hill / Irishtown Bend Stabilization and Restoration" dated May 1, 2015, and prepared by Barr and Prevost.
- Various construction drawings for the Detroit Superior Bridge including original plans (dated 1914), additions to the bridge (dated 1945), closure of the rail lines on the 2nd level (dated 1955), rehabilitation plans (dated 1967), bulkhead protection, etc. A total of 958 pages were provided.
- A 90% Construction Plan Set for the Irishtown Bend Stabilization and Rehabilitation Project. This set of plans is dated February 26, 2021, and was prepared by Osborn Engineering.

In addition to the above information provided by ODOT, S&ME has also reviewed historic soil borings and geotechnical reports regarding the following:

- Borings from the RTA/Cleveland Union Terminal (1923)
- W. S. Housel of the University of Michigan (1960) for a landslide/subsidence investigation
- Stilson & Associates, Inc. (1995). It is also noteworthy that this report discusses the findings of four other reports/assessments or explorations of the Irishtown Bend that we have not been able to locate. These missing reports include:
  - HNTB (1966)
  - Neff & Associates (1989 – 1992)
  - Professional Services Industries, Inc. (PSI) (1989 – 1992)
  - Lewin Corporation (1992)
- BBC&M Engineering, Inc., now S&ME, Inc. (1998)
- K. Bradley, M.S. Thesis for Cleveland State University (1999)
- URS Greiner Woodward Clyde (2000)
- BBC&M Engineering, Inc. (now S&ME, Inc.) (2003)
- EDP Consultants, Inc. (2005)
- BBC&M Engineering, Inc. (2006)
- NTH Consultants, Inc. (2006-2007)
- BBC&M Engineering, Inc. (2008)
- Barr and Prevost (2015)
- S&ME, Inc. (2017)
- Mueser Rutledge Consulting Engineers PLLC (2020)

While there have been a significant quantity of investigations and assessments performed for the Irishtown Bend hillside and other adjacent projects, few of these historical resources directly address Tower B of the Detroit Superior Bridge. Accordingly, no summary or further details of these investigations and assessments will be provided in this report except where such information aids our assessment of Tower B and the conceptual recommendations provided in this report.

2.3 Site Reconnaissance

S&ME visited the site on June 22, 2021, to view the exterior of the bridge, Tower B, and the surrounding conditions. S&ME returned to the site on July 20, 2021, in company with representatives from ms and ODOT D12 to view a portion of the interior of the bridge structure, specifically the cells near the foundation of Tower B and

between Tower B and Tower A. Photos taken during our site visits are included as Plates 43 through 47 in Appendix I and are referenced with the descriptions below.

2.3.1 Exterior Observations

- Prior movement of Tower B is evident from the east and west sides of the tower (see Photos 1 and 2).
- Tower B appears to be both moving outward and tilting away from the bridge. At approximately 6 feet above the ground, the displacement between the wall of the bridge and the tower is approximately 2.5 to 3 inches. Near the top of the tower, the approximate displacement is 6 to 8 inches (see photos 1 and 2).
- An erosion channel approximately 2- to 2.5-feet deep has developed within a few feet of the south wall of the bridge (see Photos 1 and 4). This channel parallels the south side of the bridge and tower, eventually turning east and ending at the base of the hillside slope south of the tower.
- All eight (8) inclinometers still capable of being measured were found in the field (see examples in Photos 3 and 4).
- The hillside to the south of the bridge is heavily vegetated, making ground observations of on-going landslide activity difficult to assess.
- Numerous homeless encampments were observed on the hillside or beneath the bridge (between the rear abutment/Tower C and Pier 1).
- No visible evidence of ground movement at the surface was observed in the immediate vicinity of the north side of the bridge.

2.3.2 Interior Observations

- Numerous cracks were observed in the interior and exterior walls and footing inside Tower B, and in the walls and floor of the "cells" between Tower A and Tower B (see Photos 5 through 8).
- Many of the cracks were being monitored by crack measurement devices adhered to the concrete surfaces or by written markings (see Photos 6 and 8).
- On the 2nd level of the bridge, 6 to 8-inch gaps were observed within ruptured portions of the bridge wall attached to and near the top of Tower B (see Photos 9 and 10).

3.0 Exploration

S&ME was not authorized to perform additional soil borings in connection with this project but was requested to conduct our assessment utilizing two (2) historic explorations performed by PSI for ODOT D12 in 2012 and 2013.

The June 2012 PSI exploration consisted of two (2) borings advanced to depths of 157 and 179 feet below existing grade. Boring I-001-0-12 (later renamed to B-002-1-12) was performed immediately adjacent to Tower B South. Boring I-002-0-12 (later renamed to B-002-2-12) was performed directly downslope of Tower B, near the base of the hillside, but not near the river's edge. The borings were terminated after coring10 to 13 feet into shale bedrock. Inclinometers were installed in each of these borings.

The second exploration consisted of eight (8) borings completed in June, July and August 2013. Borings were located adjacent to Tower A North (B-001-0-13), Tower A South (B-001-1-13), Tower B North (B-002-0-13), near the edge of the Cuyahoga River in line with Tower B (B-002-1-13, later renamed to B-002-3-13), Rear Abutment/Tower C North (B-003-0-13), Pier 1 South (B-003-1-13), Pier 2 North (B-004-0-13) and Pier 2 South (B-

004-1-13). These borings were terminated after coring 9.5 to 10 feet into shale bedrock, with inclinometers installed in each boring.

A plan showing the approximate locations of the borings performed during these two (2) exploration programs, along with logs of the borings are included in Appendix I. For simplicity, the boring numbers will be hereafter referred to without the two-digit year designation.

4.0 Findings

4.1 Historic Boring Summary

The conditions encountered in the ten (10) borings performed in 2012 and 2013 by PSI may be described as belonging to five general strata described as follows:

4.1.1 Surface Materials (Pavement or Topsoil)

Asphalt pavement ranging from 3- to 3.5-inches in thickness was encountered in four (4) borings (B-001-0, B-002-0, B-003-0, B-004-0), and was underlain by 9 inches of sand and gravel base material in all of these borings except B-004-0. Topsoil ranging from 2 to 12 inches in thickness was encountered in Borings B-001-1, B-002-2, B-003-1 and B-004-1.

4.1.2 Fill Materials

Fill materials were visually identified and noted in each boring at the surface or beneath the surface materials described above to depths ranging from 3.9 to 32 feet below the existing ground surface (El. 574 to El. 644.5), with an average thickness of approximately 13.5 feet. The fill materials were composed of very-loose to medium-dense (with dense zones in B-003-1 and B-004-1) GRAVEL WITH SAND (A-1-b), COARSE AND FINE SAND (A-3a), SANDY SILT (A-4a), SILT (A-4b) containing zones of soft to stiff SANDY SILT (A-4a), SILT (A-4b), SILT AND CLAY (A-6a). The fill soils contained miscellaneous materials including foundry sand, slag, concrete, brick, cinders, organics (type of organics not specified), and wood fragments.

4.1.3 "Loose/Soft" Alluvial Deposits

Below the fill materials, each boring encountered a layer of generally looser or softer soil to a depth ranging from 37 to 138.5 feet below existing grades (El. 507.5 to El. 557.4). The materials encountered within this stratum may be described as very-loose to medium-dense granular soil consisting of GRAVEL (A-1-a), GRAVEL WITH SAND (A-1-b), FINE SAND (A-3), COARSE AND FINE SAND (A-3a), SANDY SILT (A-4a), SILT (A-4b), and/or very-soft to stiff (with occasional very-stiff or hard zones) cohesive soil comprised of SANDY SILT (A-4a), SILT (A-4b), SILT AND CLAY (A-6a) and SILTY CLAY (A-6b). A total of 12 unconfined compressive strength tests were performed on recovered Shelby tube samples from the borings and the results are summarized below in Table 4-1.

Table 4-1 Summary of Unconfined Compressive Strength Testing on Soil

Boring ID	Depth of UC Test (ft)	Elevation of UC Test	Unconfined Compressive Strength (psf)	Material Type
B-001-0	78.5′ – 80.5′	577.5 – 579.5	3,418	Silt and Clay (A-6a)
B-002-0	58.5′ – 60.5′	596.9 – 598.9	4,343	Silt (A-4b)
B-002-1	56.0′ – 58.0′	573.0 – 575.0	2,311	Silt (A-4b)
B-002-1	71.0′ – 73.0′	558.0 – 560.0	3,090	Silt and Clay (A-6a)
B-002-2	36.0′ – 38.0′	567.0 – 569.0	5,151	Silt (A-4b)
B-002-2	46.0′ – 48.0′	557.0 – 559.0	3,024	Silty Clay (A-6b)
B-002-2	56.0′ – 58.0′	547.0 – 549.0	3,969	Silt and Clay (A-6a)
B-002-3	48.0′ – 50.0′	544.4 – 546.4	3,260	Clay (A-7-6)
B-003-0	108.0′ – 110.0′	545.0 – 547.0	2,951	Silt and Clay (A-6a)
B-003-1	38.5′ – 40.5′	559.2 – 561.2	3,313	Silt and Clay (A-6a)
B-004-1	38.5′ – 40.5′	565.5 – 567.5	1,904	Silt (A-4b)
B-004-1*	73.5′ – 75.0′	531.0 – 532.5	2,620	Clay (A-7-6)

*This sample was obtained from the "dense/hard" stratum described below.

4.1.4 "Dense/Hard" Alluvial Deposits and Glacial Till

Below the loose/soft alluvial deposits, relatively hard or dense materials were encountered to the top of bedrock at depths ranging from 127 to 188 feet below existing grade (El. 443 to El. 470.5). Soils encountered within this stratum were generally cohesive in nature and consisted of very-stiff to hard (with occasional stiff zones) SANDY SILT (A-4a), SILT (A-4b), SILT AND CLAY (A-6a), and CLAY (A-7-6). Within Borings B-002-1, B-002-2 and B-002-3, a 10 to 12.5-foot-thick layer of dense to very-dense GRAVEL (A-1-a), COARSE AND FINE SAND (A-3a) or SANDY SILT (A-4a) was encountered between El. 497.5 and El. 484.5.

4.1.5 Bedrock

Shale bedrock was encountered in each boring with each boring being terminated after coring 9.5 to 13 feet. Bedrock was encountered between El. 443 to El. 470.5 and the bedrock was described as very weak to moderately strong, gray, and slightly to highly weathered. Unconfined compressive strength tests were performed on nine (9) rock core specimens with results ranging from 1,614 to 6,143 psi (average of 3,176_psi) and summarized in Table 4-2.

Table 4-2 Summary of Unconfined Compressive Strength Testing on Rock

Boring ID	Depth of UC Test (ft)	Elevation of UC Test	Unconfined Compressive Strength (psi)
B-001-1	170.0	465.8	6,143
B-002-1	173.3	457.7	2,640
B-002-1	182.3	448.7	2,549
B-002-2	149.8	455.2	3,212
B-002-2	155.5	449.5	5,385
B-002-3	131.0	463.4	2,041
B-003-1	156.0	443.7	3,212
B-004-0	173.0	432.0	1,614
B-004-1	167.0	439.0	1,786

4.1.6 Groundwater Observations

Groundwater markings on the logs indicate that groundwater was encountered in seven (7) of the ten borings, however, in each boring soils layers were described as "wet" even though no groundwater mark is shown on the log. Table 4-3 summarizes the groundwater observations obtained from the boring logs.

Table 4-3 Summary of Groundwater Observations

Boring ID	Free Water During Drilling		End of Drilling		Described as "Wet" During Drilling	
	Depth	Elevation	Depth	Elevation	Depth	Elevation
B-001-0	19.0′	El. 639.0	9.0′*	El. 649.0	--	--
B-001-1	23.5′	El. 612.3	--	--	--	--
B-002-0	28.5′	El. 628.9	28.5′*	El. 628.9	--	--
B-002-1	19.9′	El. 611.1	--	--	--	--
B-002-2	--	--	--	--	0.0′	El. 605.0
B-002-3	13.5′	El. 580.9	--	--	--	--
B-003-0	23.5′	El. 631.5	--	--	--	--
B-003-1	--	--	--	--	6.5′	El. 593.2
B-004-0	11.5′	El. 593.5	23.0′*	El. 582.0	--	--
B-004-1	--	--	--	--	42.5′	El. 563.5

*No notes are included on log to indicate if this water reading was obtained prior to or after coring.

4.2 Summary of Existing Site Data

In addition to the soil boring logs previously described, S&ME has also reviewed additional data provided by ODOT. The following sections provide a summary of this additional information.

4.2.1 Inclinometer Readings

Inclinometers were installed in each of the ten (10) borings previously discussed in Section 3.0. These inclinometers extended to depths ranging from 133.5 to 198.0 feet below the existing ground surface. Inclinometer readings were obtained by ODOT approximately every 12 months between 2012 and 2018, at 3 to 6-month intervals in 2019, and then at an approximate 12-month interval between the December 2019 and November 2020. Incremental and cumulative displacement plots of the 2013 through 2019 inclinometer readings were provided to S&ME by ODOT on April 22, 2021, and August 9, 2021, for readings collected through November 2020. It should be noted, however, that no additional readings have been obtained from the inclinometer installed at Boring B-002-3 since June 2018, when excessive movement in the inclinometer generated concern about the potential loss of or damage to the inclinometer probe. Copies of the inclinometer readings provided by ODOT are included in Appendix II.

The inclinometer plots from Borings B-001-1, B-002-1, B-002-2 and B-002-3 recorded primary slope movement between Elevation 548 and Elevation 566 (depths ranging from 46 to 76 feet below grade). The magnitude of movement was roughly ¾" to 1¾" in Borings B-001-1, B-002-1 and B-002-2, and 6¼" in Boring B-002-3. Each inclinometer also recorded additional ¼" to 1¾" of movement in the uppermost 15 to 30 feet of soils. The movement in this upper zone is often more characterized by a bowing of the inclinometer pipe rather than the abrupt shear surface which characterizes the movement between Elevations 548 and 566. The remainder of the inclinometers recorded little to no distinctive movement.

Table 5-1 summarizes the depth, elevation, and magnitude of movement observed in these four inclinometers. Table 5-2 summarizes the rate of movement along the deeper failure plane which may be used to estimate the life expectancy of deep foundation elements as discussed in Section 5.1. For reference, the mean high-water elevation of the Cuyahoga River at this location is approximately El. 574 with the river bottom near approximately El. 542 to El. 546 (based on plans prepared by Barr and Prevost, 2015).

Table 4-4 Summary of Slope Inclinometer Readings

Boring/Inclinometer	Depth of Movement (ft)	Elevation	Cumulative Movement (in.)
B-001-1	16 – 26	610 – 620	1-½
	70 – 74	562 – 566	¾
B-002-1	15 – 30	601 – 616	1
	76	555	¾
B-002-2	25 – 30	575 – 580	2
	47 – 51	554 – 558	1-¾
B-002-3	15 – 17	577 – 575	8
	46	548	6-¼

Table 4-5 Summary of Measured Rate of Movement Along Deep Failure Plane

Boring/Inclinometer	Maximum Rate of Movement (in./yr)*	Minimum Rate of Movement (in./yr)*	Average Rate of Movement (in./yr)**
B-001-1	0.267	0.0	0.096
B-002-1	0.487	0.0	0.095
B-002-2	0.626	0.0	0.214
B-002-3	1.92	0.0	0.935

* Between two consecutive readings

** Average of all rates of movement between consecutive readings from the initial reading

4.2.2 Crack and Tilt Monitoring

Crack monitoring has been performed in numerous locations inside the bridge structure near the south side of the bridge within the "cells" at and between Tower B and Tower A. Additional crack monitoring has been recorded on the lower level of the bridge. S&ME observed plastic crack monitor gauges along the walls and on the floor during our site visit on July 20, 2021 (see Photos 6 and 8 in Appendix I). Based on observations made during our site visit and the data provided, cracks within the lower "cells" at/by Tower B appeared to have widths ranging from less than 1/8-inch up to approximately 1½-inches.

Crack monitoring records included in the 2020 Bridge Inspection Report prepared by Palmer Engineering, Inc. indicates movement from 1 to 5 mm in the "V" and "H" directions since the gauges were installed at four locations within the cellular construction at/by Tower B in 2007. However, a crack gauge installed at the lower deck of the bridge indicates 11 mm of movement in the "V" direction and 2 mm in the "H" direction. A copy of the available crack monitoring data has been included in Appendix II.

Tilt loggers were installed by PSI in August 2013, on each of the inside walls of Tower B South and Tower B North. Microsoft Excel files were provided to S&ME with the data collected from the tilt loggers. However, this data was recorded in units of "sin(angle)" rather than engineering units (i.e., centimeters or millimeters), and the calibration data and other information required to convert the as-received data into engineering units is not available. Accordingly, no interpretation or commentary can be provided on the data obtained from the tilt loggers.

4.2.3 Bridge/Tower Construction Drawings

The original bridge construction drawings suggest that portions of the bridge foundations near Tower B South were constructed primarily on shallow foundations with 3 to 4-foot-thick footings augmented by three rows of piles installed along the outer edge. The first pile was positioned 2 feet from the edge of the footing with the two remaining piles spaced at 5 feet center-on-center (see Figures 5-1 and 5-2 below). The type and length of the piles at this location of the bridge are unknown. The piles installed at the piers were driven to depths ranging from 25 to 40 feet below the footings and were referred to as "concrete" piles. We anticipate similar type and length of piling was installed along the south edge of the bridge near Tower B South.

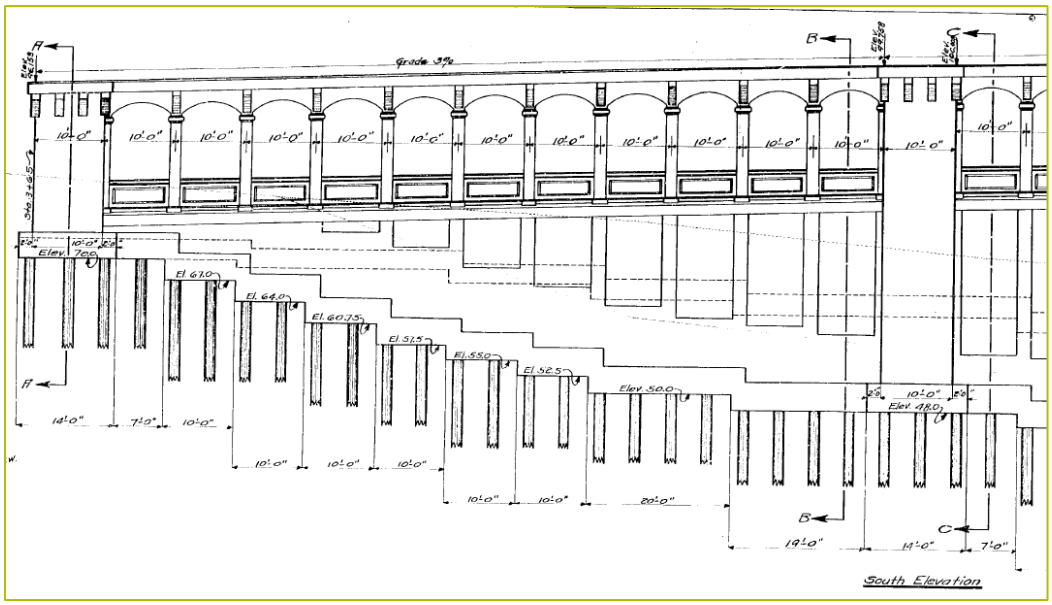


Figure 4-1 Elevation View of South Side of Bridge Between Towers A and B

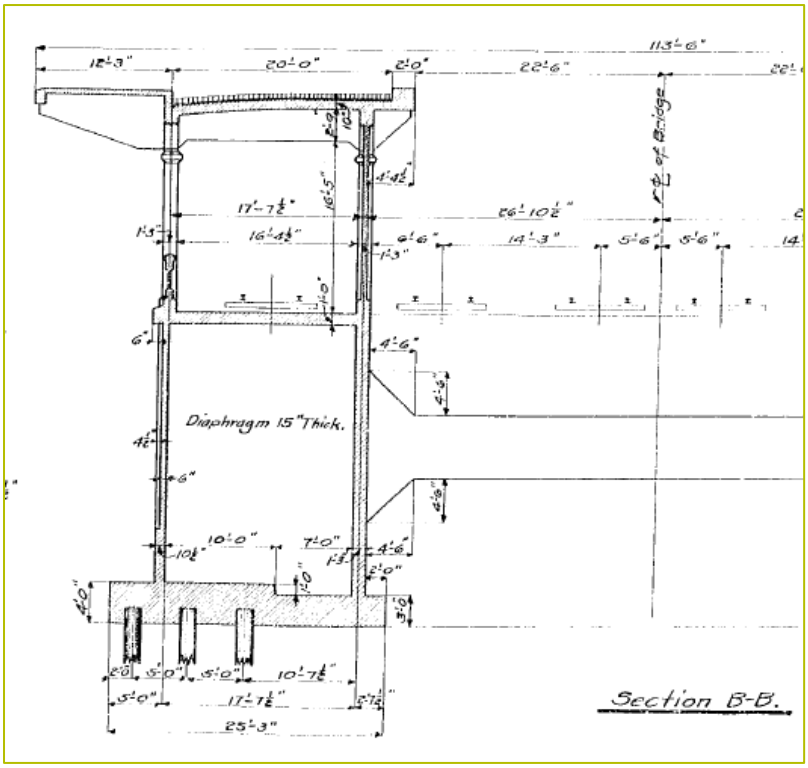


Figure 4-2 Section B-B (Immediately West of Tower B) Showing Pile Spacing

5.0 Conceptual Analyses and Preliminary Discussion

As previously stated, the purpose of this geotechnical assessment is to review the available existing information and identify multiple potential alternatives to stabilize Tower B South. Accordingly, S&ME will now present a summary of the potential remediation alternatives which may be considered for this project.

5.1 Conceptual Remediation Alternatives

In cooperation with ms and ODOT, several conceptual remediation alternatives to address the on-going movement at Tower B South have been identified and are discussed below in Table 5-3. Note that in accordance with our current scope of work, the conceptual alternatives presented below are intended to address potential remediation of the Tower B South structure only and are not intended to address the larger scale slope movements and/or cracking observed away from Tower B. We recognize that a more comprehensive plan is being developed by others to regrade the slope below Tower B and install a deep foundation structural retaining solution at the river's edge to address the larger scale movements known to exist within the Irishtown Bend hillside below this bridge. The timeframe for construction of these improvements is unknown.

Table 5-1 Summary of Potential Conceptual Repair Alternatives

Remediation Alternative	Discussion, Advantages, Disadvantages
Underpin Tower B South with Micropiles	• Install micropiles (9-5/8" diameter) around the perimeter of existing Tower B South and attach the micropiles to the existing foundation of Tower B for axial support • To resist lateral loading from landslide forces, micropiles may need to be socketed into the bedrock located at a depth of 163 feet • Micropiles provide a marginal improvement to overall global factor of safety (see Appendix II) of slope movement • Averaging a rate of approximately 0.10 in./year, and assuming a cumulative lateral displacement of approximately 1 inch could result in "failure" of the micropiles, this potential remediation approach has an estimated functional life of approximately 10 years
Underpin Tower B South with Drilled Shafts	• Install drilled shafts (3' diameter) around the perimeter of existing Tower B South and attach the shafts to the foundation of Tower B for axial support • To resist lateral loading from landslide forces, drilled shafts may need to be socketed into bedrock located at a depth of 163 feet • Improves the overall global factor of safety (see Appendix II) with respect to slope movement, but does not provide a factor of safety exceeding 1.3 • Provided the shafts are designed to resist the landslide forces this potential remediation approach has an estimated functional life of approximately 20 years (assuming the rate of movement or depth of failure plane does not change)
Strengthen Foundation Soil with Deep Soil Mixing	• Accomplished by using augers to mix soil and cement (or other applicable chemical agent) to create a "block" of hardened soil beneath the foundation of the tower • Differing soil types may be anticipated to experience variable strength gain

	• Higher plasticity soil (such as soil classifications A-6b and A-7-6) typically requires a different type of chemical additive (i.e., lime vs. cement) that may make it impractical to perform the mixing when dealing with multiple kinds of additives • Due to the presence of the tower, there may be difficulty in achieving a satisfactory mixing of all soils directly beneath and immediately surrounding the tower • Soils would need to be mixed to a depth below the current failure plane (near a depth of 76 feet) which is near the maximum useful depth for this repair technique • Design and/or installation would likely require assistance from a proprietary contractor • Due to the foregoing concerns, this alternative was deemed not feasible and was not considered in the preliminary opinion of probable costs
Underpin Tower B and/or Strengthen Foundation Soil with Controlled Modulus Columns (CMCs)	• Accomplished by installing vertical or battered "columns" of grouted mixture, usually 12 inches or less in diameter • Due to the presence of the tower, there may be difficulty in achieving a satisfactory placement of the columns directly beneath and immediately surrounding the tower • Soils would need to be mixed to a depth below the current failure plane (near a depth of 76 feet) which may exceed the maximum useful depth for this repair • Design and/or installation would require assistance from a proprietary contractor • Due to the foregoing concerns, this alternative was deemed not feasible and was not considered in the preliminary opinion of probable costs
Remove Tower with No Rebuild	• Consists of removing Tower B South and reconstructing a flat façade roughly matching the original look of the outer walls. • This alternative is only feasible if changes to the structure are approved by SHPO (State Historic Preservation Office) since the bridge is listed as a historic structure
Demolish Tower and Rebuild using Normal Weight or Lightweight Materials	• Remove existing tower and rebuild a new tower of the same dimensions and appearance and supported on deep foundations of either driven piles, micropiles or drilled shafts (driven piles were assumed for the preliminary cost estimate prepared by ms) • Removal of the tower would better facilitate the installation of the deep foundation system being used to support the tower • Replacement structure may consist of normal weight or lightweight materials with the outer façade being constructed to appear the same as the rest of the structure
Connect/Anchor Tower to Bridge Structure	• Connect the existing Tower B to the bridge by one or more levels of PT (post tensioned, or similar) anchors • Will require detailed structural analysis of existing bridge to assess the capability of the existing bridge to support the additional tower load • If the existing tower structure is too heavy to be supported by the bridge, the existing tower may be removed and reconstructed using lightweight materials (additional structural analyses required) • Based on a conference call with ODOT on August 25, 2021, the anchors would not be designed to handle any vertical (shear) loading. The design would include only the horizontal tieback force required to stabilize the structure. If vertical movement (settlement) of the tower is observed and would endanger the anchor design, additional remediation efforts may be required.

5.2 Concpetual Geotechnical Remediation - Stability Analyses

Conceptual level stability analyses were performed to estimate the stability of the existing slope beneath the tower/bridge, and then assess the potential increase in stability that may be available if micropiles and drilled shafts were used to provide additional support to the existing tower structure. Our analyses were performed using the two-dimensional limit-state computer program SLIDE2 (v9.014). The Spencer method was used for the limit equilibrium calculations. The existing ground surface profile was modeled based on the 90% plans prepared by Osborn Engineering (Osborn), dated February 26, 2021, for the Irishtown Bend Stabilization and Rehabilitation Project for the Cuyahoga Count Port Authority. This project includes the regrading of portions of the Irishtown Bend hillside and installation of an anchored bulkhead at the edge of the Cuyahoga River.

Strength parameters used to represent the soil layers were generally obtained from the recent geotechnical analyses and laboratory testing performed by Mueser Rutledge Consulting Engineers PLLC (MRCE), geotechnical consultants for the Osborn team on the aforementioned project. Multiple reports dated February 12, 2020, May 5, 2020, and July 23, 2020, were provided for our review. The strength parameters used in the MRCE analyses were reviewed by S&ME and were accepted as is or modified based on our knowledge of the project site, our experience with similar soils, and the results of our back analysis.

The results of our conceptual level stability analyses are included in Appendix III at the rear of this document. Plate 1 shows the results of our back analysis performed using the anticipated shear strength of the soils and the geometry of the anticipated failure plane based on inclinometer readings from Borings B-002-1, B-002-2 and B-002-3. Plates 2 and 3 show the estimated global factor of safety computed after installing micropiles and drilled shafts, respectively, around the existing Tower B, with the assumption that the failure plane remains at roughly the same depth as previously identified, and also assuming the existing ground surface remains. We note that the installation of micropiles or drilled shafts to axially support Tower B South does not raise the global factor of safety above 1.2 which is less than the factor of safety of 1.5 as required by FHWA and AASHTO for slopes that support or contain a structure.

Plates 4 and 5 of Appendix II show the anticipated slope regrading and anchored bulkhead that is being shown in the plans currently being prepared by Osborn. Plate 4 shows the estimated factor of safety if the failure surface occurs at the same depths included in our back analysis. Plate 5, however, shows the estimated factor of safety if the failure surface is calculated by a different theoretical approach and allowed more “flexibility” with where the failure surface develops. The result of the analyses shown in Plates 4 and 5 indicate that some improvement will be realized by implementation of the design being developed by Osborn. We note that the planned improvements to the slope do not raise the global factor of safety above 1.5 as required by FHWA and AASHTO.

Stability analyses including the micropiles or drilled shafts at Tower B in addition to the work being planned by Osborn were not performed. However, the addition of micropiles or drilled shafts at Tower B would be anticipated to improve the overall factor of safety within the section of slope directly below Tower B when combined with the design being developed by Osborn.

5.3 Preliminary Opinion of Probable Design and Construction Costs

During a conference call with ODOT on August 25, 2021, ms and S&ME were informed that ODOT D12 prefers to proceed with a non-geotechnical solution at the present time due to the significant forces at work within the

slope and the impact on the cost of implementing the repair. However, during a follow up conference call on September 3, 2021, ODOT revised the prior direction given on August 25th to request that preliminary cost information be provided for installing micropiles to the underlying bedrock surface to support the axial loading of the tower to mitigate potential settlement which could cause a vertical shear force to develop within the structural anchors. Accordingly, preliminary costs for a structural anchoring system and micropiles installed to bedrock are to be provided by the design team. Preliminary cost information will be provided in the submission being prepared by ms.

To assist with the preparation of the cost estimate, S&ME contacted a contractor to obtain conceptual level estimates of the cost to install micropiles and which is summarized below.

- Mobilization/De-mobilization ~$40,000
- Testing Program ~ $25,000
- Micropile Installation ~ $120/linear foot
- Estimated Depth of Micropiles ~ 175 feet (approximately 10 feet into bedrock)

In addition to obtaining the costs listed above, S&ME reviewed the publication FHWA-NHI-05-039 "Micropile Design and Construction" which provides guidance for developing cost estimates of micropile installations (see Chapter 10). Utilizing the methodology discussed in Chapter 10, S&ME estimated range of $180 to $220 per linear foot (includes mobilization and testing within the footage rate), which is comparable to the budgetary numbers provided by the contractor.

6.0 Final Considerations

This conceptual report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The preliminary conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop this document. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify this document based on this additional information if necessary.

The discussions and opinions presented in this document are also based on limited data from a field exploration program performed by others. Subsurface conditions can vary widely between explored areas. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

The information presented in this report is conceptual and preliminary in nature and is not intended for use to develop construction plans or drawings. Following selection of a preferred alternative, to be selected by others, additional analysis and design must be performed.

Appendices

Appendix I – Plan of Borings, PSI Borings Logs, Site Photos

Project Location
Cuyahoga County, Ohio

USGS Mapping:
Cleveland North and South USGS Quads

0 2000 4000
GRAPHIC SCALE (IN FEET)

Vicinity Map

Data Review and Remediation Feasibility Alternatives Assessment
Detroit Superior Bridge Tower B South (PID 115039)
Cleveland, Cuyahoga County, Ohio

SCALE:	FIGURE NO.
GRAPHIC	1
DATE:	
09-01-2021	
PROJECT NUMBER	
213051A	

Drawing Path: T:\GEO\Projects\2021\213051_msc_ODOT D12-3 GES_Ohio\213051A_Detroit Superior Bridge Tower B\CAD\Construction\Vicinity Map.dwg

NOTE:
Borings B-001-0-12, B-002-0-12 and B-002-1-13, numbering revised with installation of borings in 2013.

B-002-1-13/B-002-3-13 was abandoned on 6/7/2018.

NOTE: During our site reconnaissance, S&ME observed that Boring B-003-1-13 was shown at the incorrect location on the plan provided by ODOT. The actual (approximate) location is as indicated on this plan.

50
0 100
HORIZONTAL SCALE IN FEET

CUY-6-14.56

DETROIT SUPERIOR BRIDGE INCLINOMETER INSTALLATIONS
BORING LOCATION PLAN

PLATE 2

CALCULATED KJD
CHECKED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 11/13/13 09:03 - C:\DOCUMENTS AND SETTINGS\ALL USERS\DOCUMENTS\PSI GINT\ODOT LOGS\FROM JANET 102413\0142-78

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:	EXPLORATION ID B-001-0-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE	
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 658.0 (MSL) EOB: 198.5 ft.	PAGE 1 OF 4
START: 8/5/13 END: 8/5/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 666028.444 N, 2185925.904 E	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
3 1/2" ASPHALT 9" SAND AND GRAVEL	658.0 657.0																	
LOOSE, BLACK, **GRAVEL AND STONE FRAGMENTS WITH SAND**, FOUNDRY SAND WITH SLAG AND CONCRETE, TRACE TO LITTLE SILT/CLAY, MOIST (FILL)		2.5	1 2 2	5	39	SS-1	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
		5.0 7.5																
		10.0	2 3 2	7	39	SS-2	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
	644.5	12.5																
STIFF, GRAY, **SILT**, TRACE CLAY, TRACE GRAVEL, SOME SAND, MOIST		15.0	4 6 8	19	100	SS-3	-	0	0	34	63	3	NP	NP	NP	17	A-4b (6)	
	639.4	17.5																
LOOSE TO MEDIUM DENSE, BROWN, **FINE SAND**, TRACE TO LITTLE SILT/CLAY, TRACE GRAVEL, WET		20.0	3 4 4	11	100	SS-4	-	0	0	90	- 10 -		NP	NP	NP	28	A-3 (0)	
	634.5	22.5																
MEDIUM STIFF TO VERY STIFF, GRAY, **SILT**, TRACE TO LITTLE CLAY, TRACE SAND AND GRAVEL, MOIST		25.0	4 3 3	8	94	SS-5	-	0	0	0	83	17	26	22	4	22	A-4b (8)	
		27.5																
		30.0	3 5 8	18	89	SS-6	-	-	-	-	-	-	-	-	-	19	A-4b (V)	
		32.5																
		35.0	4 5 7	16	100	SS-7	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		37.5																
		40.0	4 6 7	18	100	SS-8	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		42.5																
		45.0	5 7 10	23	100	SS-9	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		47.5																
			12	46	100	SS-10	-	-	-	-	-	-	-	-	-	19	A-4b (V)	

PLATE 3

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/5/13	END: 8/5/13	PG 2 OF 4	B-001-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 608.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
	606.0	52.5	15 19															
STIFF, GRAY, **SILT AND CLAY**, LITTLE TO SOME SILT, TRACE SAND AND GRAVEL, MOIST		55.0	5 6 6	16	100	SS-11	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		57.5																
	598.0	60.0	4 5 6	15	100	SS-12	-	0	0	0	71	29	34	23	11	23	A-6a (8)	
STIFF TO VERY STIFF, GRAY, **SILT**, LITTLE CLAY, TRACE SAND AND GRAVEL, MOIST		62.5																
		65.0	4 6 7	18	100	SS-13	-	0	0	0	79	21	30	23	7	22	A-4b (8)	
		67.5																
		70.0	6 8 11	26	94	SS-14	-	-	-	-	-	-	-	-	-	20	A-4b (V)	
		72.5																
	583.0	75.0	3 4 6	14	100	SS-15	-	-	-	-	-	-	-	-	-	28	A-4b (V)	
VERY SOFT TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND AND GRAVEL, MOIST		77.5																
** UNCONFINED COMPRESSION = 3,418 @ 78.5' - 80.5'		80.0			100	ST-16	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		82.5																
		85.0	3 4 5	12	89	SS-17	-	0	0	1	39	60	38	23	15	28	A-6a (10)	
		87.5																
		90.0	3 4 3	9	89	SS-18	-	-	-	-	-	-	-	-	-	28	A-6a (V)	
		92.5																
** VERY SOFT SOIL @ 93.5' - 105.0'		95.0	0 0 0	0	44	SS-19	-	0	1	4	46	49	33	21	12	27	A-6a (9)	
		97.5																
		100.0	0 0 0	0	33	SS-20	-	-	-	-	-	-	-	-	-	34	A-6a (V)	
		102.5																

PLATE 4

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/5/13	END: 8/5/13	PG 3 OF 4	B-001-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY SOFT TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND AND GRAVEL, MOIST *(continued)*	554.5	105.0	0 0 0	0	50	SS-21	-	-	-	-	-	-	-	-	-	28	A-6a (V)	
		107.5																
		110.0	4 5 7	16	78	SS-22	-	0	0	0	66	34	32	21	11	23	A-6a (8)	
		112.5																
		115.0	4 6 8	19	100	SS-23	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		117.5																
	538.0	120.0	7 10 13	31	89	SS-24	-	-	-	-	-	-	-	-	-	21	A-6a (V)	
VERY STIFF, GRAY, **SILT**, WITH CLAY, TRACE SAND AND GRAVEL, MOIST		122.5																
		125.0	6 10 14	33	78	SS-25	-	0	0	0	57	43	30	21	9	22	A-4b (8)	
		127.5																
	528.0	130.0	7 11 15	35	83	SS-26	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND AND GRAVEL, MOIST		132.5																
		135.0	6 9 12	28	72	SS-27	-	0	0	0	11	89	37	22	15	26	A-6a (10)	
		137.5																
		140.0	7 10 15	34	67	SS-28	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
		142.5																
		145.0	0 12 7	26	89	SS-29	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
** GRAVEL INCREASES @ 144.5' TO 147.0'		147.5																
		150.0	5 9 14	31	100	SS-30	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		152.5																
** COBBLES @ 152.5'		155.0	12 20 27	64	89	SS-31	-	-	-	-	-	-	-	-	-	18	A-6a (V)	

PLATE 5

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/5/13	END: 8/5/13	PG 4 OF 4	B-001-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND AND GRAVEL, MOIST *(continued)*	500.9	157.5																
		160.0	9 11 15	35	89	SS-32	-	-	-	-	-	-	-	-	-	25	A-6a (V)	
		162.5																
		165.0	14 16 24	54	0	SS-33	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
		167.5																
		170.0	11 18 23	56	67	SS-34	-	-	-	-	-	-	-	-	-	12	A-6a (V)	
		172.5																
		175.0	12 19 27	62	78	SS-35	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
		177.5																
		180.0	15 22 33	75	78	SS-36	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		182.5																
		185.0	14 26 41	91	44	SS-37	-	5	7	7	37	44	32	20	12	14	A-6a (9)	
	470.5	187.5																
SHALE, GRAY, HIGHLY WEATHERED, VERY WEAK.		190.0																
		192.5	42		100	NQ-38											CORE	
		195.0																
	459.5	197.5																
		EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 6

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:	EXPLORATION ID B-001-1-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE	
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 635.8 (MSL) EOB: 178.2 ft.	PAGE 1 OF 4
START: 8/12/13 END: 8/12/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 665949.799 N, 2186031.495 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 635.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
4" TOPSOIL	635.5																	
LOOSE TO MEDIUM DENSE, BROWN AND GRAY, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT AND CLAY, TRACE GRAVEL, SOME RED BRICK, SOME BROKEN CONCRETE, MOIST (FILL)		2.5	5 12 11	31	100	SS-1	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
	626.8	5.0																
LOOSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS**, SOME SAND, TRACE SILT AND CLAY, MOIST TO WET		7.5	8 4 3	9	78	SS-2	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
		10.0					-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
		12.5	1 2 1	4	67	SS-3	-	73	18	6	3	-	NP	NP	NP	4	A-1-a (0)	
		15.0																
		17.5	1 2 2	5	56	SS-4	-	-	-	-	-	-	-	-	-	35	A-1-a (V)	
		20.0																
	611.8	22.5 W																
MEDIUM STIFF TO STIFF, GRAY, **SILT**, LITTLE TO SOME CLAY, TRACE SAND AND GRAVEL, WET		25.0	1 3 6	12	100	SS-5	-	-	-	-	-	-	-	-	-	17	A-1-a (V)	
		27.5					-	-	-	-	-	-	-	-	-	21	A-4b (V)	
		30.0	3 5 6	15	100	SS-6	-	0	1	1	78	20	29	23	6	20	A-4b (8)	
		32.5																
		35.0	3 4 5	12	100	SS-7	-	-	-	-	-	-	-	-	-	19	A-4b (V)	
		37.5																
		40.0	2 3 5	11	100	SS-8	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
		42.5																
		45.0	3 4 5	12	100	SS-9	-	0	0	0	69	31	32	24	8	24	A-4b (8)	
		47.5																
			2	14	100	SS-10	-	-	-	-	-	-	-	-	-	24	A-4b (V)	

PLATE 7

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/12/13	END: 8/12/13	PG 2 OF 4	B-001-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO STIFF, GRAY, **SILT**, LITTLE TO SOME CLAY, TRACE SAND AND GRAVEL, WET *(continued)*	585.8	52.5	5 5															
		55.0	3 4 6	14	100	SS-11	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
		57.5																
		60.0	3 3 3	8	100	SS-12	-	-	-	-	-	-	-	-	-	29	A-4b (V)	
		62.5																
		65.0	4 6 8	19	100	SS-13	-	-	-	-	-	-	-	-	-	25	A-4b (V)	
		67.5																
	565.8	70.0	4 6 7	18	100	SS-14	-	0	0	0	62	38	30	22	8	24	A-4b (8)	
SOFT TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE TO SOME SILT, TRACE SAND AND GRAVEL, MOIST		72.5																
		75.0	2 4 4	11	100	SS-15	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		77.5																
		80.0	0 0 2	3	100	SS-16	-	6	2	5	37	50	35	22	13	25	A-6a (9)	
		82.5																
		85.0	0 4 6	14	100	SS-17	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		87.5																
		90.0	3 5 6	15	67	SS-18	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		92.5																
		95.0	4 6 8	19	83	SS-19	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		97.5																
		100.0			0	ST-20	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
		102.5																

PLATE 8

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/12/13	END: 8/12/13	PG 3 OF 4	B-001-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
SOFT TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE TO SOME SILT, TRACE SAND AND GRAVEL, MOIST *(continued)*	532.3	105.0	7 9 12	28	56	SS-21	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		107.5																
		110.0	6 9 12	28	100	SS-22	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		112.5																
VERY STIFF TO HARD, GRAY, **SANDY SILT**, LITTLE TO SOME CLAY, TRACE GRAVEL, MOIST	522.3	115.0	5 8 13	28	100	SS-23	-	7	6	9	39	39	27	19	8	17	A-4a (8)	
		117.5																
		120.0	6 10 15	34	67	SS-24	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
		122.5																
		125.0	7 12 17	39	67	SS-25	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
		127.5																
		130.0	4 10 16	35	100	SS-26	-	-	-	-	-	-	-	-	-	21	A-4a (V)	
		132.5																
		135.0	12 22 23	61	100	SS-27	-	1	10	3	38	48	30	20	10	20	A-4a (8)	
		137.5																
		140.0	5 11 11	30	100	SS-28	-	-	-	-	-	-	-	-	-	23	A-4a (V)	
		142.5																
		145.0	16 23 31	73	100	SS-29	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
		147.5																
		150.0			-	SS-30	-	9	12	15	40	24	23	16	7	12	A-4a (6)	
		152.5																
		155.0	8 15 22	50	100	SS-31	-	-	-	-	-	-	-	-	-	15	A-4a (V)	

PLATE 9

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/12/13	END: 8/12/13	PG 4 OF 4	B-001-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY STIFF TO HARD, GRAY, **SANDY SILT**, LITTLE TO SOME CLAY, TRACE GRAVEL, MOIST *(continued)*	478.7	157.5																
	475.8	160.0	16 23 29	71	78	SS-32	-	-	-	-	-	-	-	-	-	15	A-4a (V)	
HARD, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, MOIST (TILL)		162.5																
		165.0	16 25 35	81	100	SS-33	-	-	-	-	-	-	-	-	-	15	A-4a (V)	
	467.1	167.5																
SHALE, GRAY, VERY WEAK, MOIST. ** UNCONFINED COMPRESSION = 6,143 @ 170.0'		170.0	50/2"	-	100	SS-34	-	-	-	-	-	-	-	-	-	-	Rock (V)	
		172.5	86		100	NQ-35											CORE	
	457.6	175.0																
		177.5 EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 10

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:	EXPLORATION ID B-002-0-13	
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE		
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 657.4 (MSL) EOB: 198.8 ft.	PAGE 1 OF 4	
START: 7/23/13 END: 7/23/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 666086.277 N, 2185989.688 E		

MATERIAL DESCRIPTION AND NOTES	ELEV. 657.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
3 1/2" ASPHALT	657.1																	
9" SAND AND GRAVEL BASE	656.4																	
VERY LOOSE TO LOOSE, BLACK, **COARSE AND FINE SAND**, TRACE TO LITTLE SILT/CLAY, BRICK, FILL MATERIAL, TRACE GRAVEL, MOIST (FILL) (FOUNDRY SAND)		2.5	1 1 1	3	67	SS-1	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
		5.0																
		7.5	4 3 3	8	61	SS-2	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
		10.0																
LOOSE, BROWN, **SANDY SILT**, TRACE TO LITTLE CLAY, TRACE GRAVEL, ROOTING, WOOD FRAGMENTS, ORGANICS, MOIST (FILL)	646.4	12.5																
	642.4	15.0	4 4 5	12	39	SS-3	-	0	5	46	49	-	NP	NP	NP	15	A-4a (3)	
VERY LOOSE TO LOOSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, TRACE SILT/CLAY, MOIST TO WET		17.5																
		20.0	1 1 1	3	83	SS-4	-	2	48	44	6	-	NP	NP	NP	5	A-1-b (0)	
		22.5																
		25.0	5 5 5	14	72	SS-5	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		27.5																
** WET BELOW 28.5'		30.0	3 5 6	15	67	SS-6	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
		32.5																
	623.4	35.0	4 5 5	14	100	SS-7	-	0	0	9	71	20	24	23	1	18	A-4b (8)	
STIFF TO HARD, GRAY, **SILT**, TRACE CLAY, TRACE SAND AND GRAVEL, MOIST		37.5																
		40.0	4 6 8	19	94	SS-8	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		42.5																
		45.0	8 16 15	42	100	SS-9	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		47.5																
			6	18	100	SS-10	-	-	-	-	-	-	-	-	-	21	A-4b (V)	

PLATE 11

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/23/13	END: 7/23/13	PG 2 OF 4	B-002-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
STIFF TO HARD, GRAY, **SILT**, TRACE CLAY, TRACE SAND AND GRAVEL, MOIST *(continued)*	607.4	52.5	6 7															
		55.0	5 7 6	18	94	SS-11	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		57.5																
** UNCONFINED COMPRESSION = 4,343 PSI @ 58.5' - 60.5'		60.0			100	ST-12	-	-	-	-	-	-	-	-	-	28	A-4b (V)	
		62.5																
		65.0	4 6 8	19	94	SS-13	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
	588.4	67.5																
STIFF TO VERY STIFF, GRAY, **SANDY SILT**, TRACE GRAVEL, WITH CLAY, MOIST		70.0	9 11 12	31	94	SS-14	-	-	-	-	-	-	-	-	-	19	A-4a (V)	
		72.5																
		75.0	4 4 6	14	94	SS-15	-	-	-	-	-	-	-	-	-	25	A-4a (V)	
	577.4	77.5																
STIFF, GRAY, **SILT AND CLAY**, MOIST		80.0	4 6 9	20	100	SS-16	-	0	1	1	49	49	32	22	10	23	A-4a (8)	
	572.4	82.5																
STIFF TO VERY STIFF, GRAY, **SILT**, WITH CLAY, TRACE SAND AND GRAVEL, MOIST		85.0	3 5 6	15	100	SS-17	-	0	0	0	50	50	37	23	14	27	A-6a (10)	
		87.5																
		90.0	4 4 5	12	100	SS-18	-	0	1	0	54	45	29	22	7	27	A-4b (8)	
		92.5																
		95.0	3 5 6	15	100	SS-19	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
		97.5																
		100.0	0 1 5	8	100	SS-20	-	-	-	-	-	-	-	-	-	29	A-4b (V)	
		102.5																

PLATE 12

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/23/13	END: 7/23/13	PG 3 OF 4	B-002-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
STIFF TO VERY STIFF, GRAY, **SILT**, WITH CLAY, TRACE SAND AND GRAVEL, MOIST *(continued)*	553.9	105.0	0 4 6	14	100	SS-21	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		107.5																
		110.0	0 5 6	15	100	SS-22	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		112.5																
		115.0	2 7 9	22	100	SS-23	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
		117.5																
		120.0	6 10 12	30	100	SS-24	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
		122.5																
		125.0	7 10 12	30	100	SS-25	-	0	0	1	61	38	30	22	8	22	A-4b (8)	
		127.5																
		130.0	6 9 11	27	89	SS-26	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		132.5																
		135.0	7 11 14	34	100	SS-27	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		137.5																
VERY STIFF, GRAY, **SANDY SILT**, WITH CLAY, TRACE GRAVEL, MOIST	518.9	140.0	6 10 14	33	78	SS-28	-	7	9	11	41	32	26	19	7	15	A-4a (8)	
		142.5																
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST	513.9	145.0	6 10 16	35	100	SS-29	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		147.5																
		150.0	7 12 17	39	100	SS-30	-	2	6	9	41	42	30	19	11	17	A-6a (V)	
		152.5																
		155.0	10 18 24	57	100	SS-31	-	-	-	-	-	-	-	-	-	17	A-6a (V)	

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/23/13	END: 7/23/13	PG 4 OF 4	B-002-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 500.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST *(continued)*		157.5																
		160.0	7 11 14	34	100	SS-32	-	-	-	-	-	-	34	22	12	22	A-6a (V)	
		162.5																
** SILT @ 163.5' - 165.0'		165.0	6 6 9	20	100	SS-33	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
		167.5																
		170.0	14 19 27	62	100	SS-34	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
		172.5																
		175.0	16 32 49	110	28	SS-35	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
		177.5																
		180.0	13 21 30	69	100	SS-36	-	-	-	-	-	-	-	-	-	14	A-6a (V)	
	473.9	182.5																
HARD, OLIVE, **SANDY SILT**, LITTLE CLAY, LITTLE GRAVEL, MOIST (TILL)		185.0	19 35 37	98	67	SS-37	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
	469.9	187.5																
SHALE, GRAY, VERY WEAK, FINE GRAINED, THIN BEDDED.		190.0	100/4"	-	100	SS-38	-	-	-	-	-	-	-	-	-	-	Rock (V)	
		192.5	0		100	NQ-39											CORE	
		195.0																
	458.6	197.5																
		EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 14

NOTE: BORING RENAMED TO B-002-1-12.

PROJECT: CUY-6-14.56 (0142-612)	DRILLING FIRM / OPERATOR: OTB / C.B.	DRILL RIG: CME-55 OTB	STATION / OFFSET:	EXPLORATION ID I-001	
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: AUTOMATIC HAMMER	ALIGNMENT:		
PID: 77040 BR ID:	DRILLING METHOD: 4.25" HSA / NX	CALIBRATION DATE: 10/12/11	ELEVATION: 631.0 (MSL) EOB: 179.0 ft.	PAGE 1 OF 5	
START: 6/6/12 END: 6/11/12	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 84	LAT / LONG: Not Recorded		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
BROWN/BLACK, **COARSE AND FINE SAND**, SOME RED BRICKS, SOME SILT, TRACE CLAY, LITTLE GRAVEL (FILL), MOIST	631.0	2.5																
		5.0	3 2 1	4	89	SS-1	-	-	-	-	-	-	-	-	-	9	A-3a (V)	
		7.5																
		10.0	7 4 3	10	89	SS-2	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
	618.0	12.5																
VERY LOOSE TO LOOSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, WET		15.0	3 2 2	6	100	SS-3	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		17.5																
	611.0	20.0	3 2 1	4	100	SS-4	-	9	70	17	- 4 -		NP	NP	NP	13	A-1-b (0)	
VERY LOOSE, BROWN, **FINE SAND**, LITTLE SILT, TRACE GRAVEL, WET		22.5																
		25.0	2 1 1	3	100	SS-5	-	7	22	66	- 5 -		NP	NP	NP	21	A-3 (0)	
		27.5																
		30.0	2 1 1	3	100	SS-6	-	-	-	-	-	-	-	-	-	22	A-3 (V)	
	600.0	32.5																
MEDIUM STIFF TO STIFF, GRAY, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, WET		35.0	4 6 7	18	100	SS-7	1.00	-	-	-	-	-	-	-	-	20	A-4b (V)	
		37.5																
			6 7	22	100	SS-8	1.00	-	-	-	-	-	-	-	-	17	A-4b (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:42 - L:\ODOT LOGS\0142-612.GPJ

PLATE 15

NOTE: BORING RENAMED TO B-002-1-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/6/12	END: 6/11/12	PG 2 OF 5	I-001

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO STIFF, GRAY, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, WET *(continued)*	591.0	42.5	9															
		45.0	3 4 7	15	100	SS-9	1.00	0	0	1	81	18	24	20	4	18	A-4b (8)	
		47.5																
		50.0	2 3 4	10	100	SS-10	1.00	-	-	-	-	-	-	-	-	21	A-4b (V)	
		52.5																
		55.0	2 3 4	10	67	SS-11	2.00	-	-	-	-	-	-	-	-	24	A-4b (V)	
** Unconfined Compression = 2,311 psf @ 56.0' - 58.0'		57.5			75	ST-12	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
		60.0	1 2 3	7	100	SS-13	1.00	-	-	-	-	-	-	-	-	23	A-4b (V)	
	568.0	62.5																
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, WET		65.0	3 5 6	15	100	SS-14	0.40	-	-	-	-	-	-	-	-	26	A-6a (V)	
		67.5																
		70.0	2 4 4	11	100	SS-15	0.40	2	3	3	51	41	30	18	12	21	A-6a (9)	
** Unconfined Compression = 3,090 psf @ 71.0' - 73.0'		72.5			100	ST-16	-	-	-	-	-	-	-	-	-	34	A-6a (V)	
		75.0	2 3 4	10	100	SS-17	0.40	-	-	-	-	-	-	-	-	31	A-6a (V)	
		77.5																
		80.0	1 2 4	8	100	SS-18	0.80	-	-	-	-	-	-	-	-	28	A-6a (V)	
		82.5			0	ST-19	-	-	-	-	-	-	-	-	-	-	A-6a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:42 - L:\ODOT LOGS\0142-612.GPJ

PLATE 16

NOTE: BORING RENAMED TO B-002-1-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/6/12	END: 6/11/12	PG 3 OF 5	I-001

MATERIAL DESCRIPTION AND NOTES	ELEV. 548.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, WET *(continued)*		85.0	2 4 4	11	100	SS-20	1.00	-	-	-	-	-	-	-	-	25	A-6a (V)	
		87.5			0	ST-21	-	-	-	-	-	-	-	-	-	-	A-6a (V)	
		90.0	3 4 6	14	100	SS-22	1.00	-	-	-	-	-	-	-	-	26	A-6a (V)	
		92.5																
		95.0	3 6 7	18	100	SS-23	1.00	-	-	-	-	-	-	-	-	23	A-6a (V)	
		97.5																
		100.0	3 5 7	17	100	SS-24	2.00	-	-	-	-	-	-	-	-	24	A-6a (V)	
		102.5																
		105.0	7 13 15	39	100	SS-25	2.50	-	-	-	-	-	-	-	-	22	A-6a (V)	
		107.5																
		110.0	5 9 15	34	67	SS-26	2.50	-	-	-	-	-	-	-	-	23	A-6a (V)	
		112.5																
		115.0	7 12 17	41	100	SS-27	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		117.5																
		120.0	7 11 18	41	100	SS-28	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		122.5																
		125.0	6 12 16	39	83	SS-29	2.00	6	5	6	40	43	29	18	11	18	A-6a (8)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:42 - L:\ODOT LOGS\0142-612.GPJ

PLATE 17

NOTE: BORING RENAMED TO B-002-1-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/6/12	END: 6/11/12	PG 4 OF 5	I-001

MATERIAL DESCRIPTION AND NOTES	ELEV. 505.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, WET *(continued)*		127.5																
		130.0	10 19 25	62	67	SS-30	3.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
	497.0	132.5																
DENSE, GRAY, **FINE SAND**, TO COARSE SAND, LITTLE SILT, TRACE GRAVEL, WET		135.0	20 28 34	87	100	SS-31	-	-	-	-	-	-	-	-	-	20	A-3a (V)	
		137.5																
		140.0	11 13 14	38	89	SS-32	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
		142.5																
		145.0	20 15 13	39	89	SS-33	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
	484.5	147.5																
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, WET		150.0	15 25 41	92	100	SS-34	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		152.5																
		155.0	10 19 37	78	100	SS-35	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		157.5																
		160.0	17 32 42	104	100	SS-36	2.50	31	5	5	37	22	31	19	12	12	A-6a (6)	
	468.0	162.5																
SHALE, GRAY, HIGHLY TO SLIGHTLY WEATHERED, STRONG, FINE GRAINED, THIN BEDDED.		165.0	36 50/5"	-	73	SS-37	-	-	-	-	-	-	-	-	-	11	Rock (V)	
		167.5																

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:42 - L:\ODOT LOGS\0142-612.GPJ

PLATE 18

NOTE: BORING RENAMED TO B-002-1-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/6/12	END: 6/11/12	PG 5 OF 5	I-001

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
SHALE, GRAY, HIGHLY TO SLIGHTLY WEATHERED, STRONG, FINE GRAINED, THIN BEDDED. *(continued)*	462.5		50/2"	-	100	SS-38	-	-	-	-	-	-	-	-	-	11	Rock (V)	
		170.0	63		100	NX-39											CORE	
** Unconfined Compression = 2,640 psi @ 173.3'		172.5																
		175.0	93		100	NX-40											CORE	
	452.0	177.5 EOB																
** Unconfined Compression = 2,549 psi @ 182.3'																		

NOTES: APPROXIMATE BORING ELEVATIONS FROM PROVIDED TOPO MAP

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:43 - L:\ODOT LOGS\0142-612.GPJ

NOTE: BORING RENAMED TO B-002-2-12.

PROJECT: CUY-6-14.56 (0142-612)	DRILLING FIRM / OPERATOR: OTB / C.B.	DRILL RIG: CME-55 OTB	STATION / OFFSET:	EXPLORATION ID I-002	
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: AUTOMATIC HAMMER	ALIGNMENT:		
PID: 77040 BR ID:	DRILLING METHOD: 4.25" HSA / NX	CALIBRATION DATE: 10/12/11	ELEVATION: 605.0 (MSL) EOB: 157.0 ft.	PAGE 1 OF 4	
START: 6/12/12 END: 6/15/12	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 84	LAT / LONG: Not Recorded		

MATERIAL DESCRIPTION AND NOTES	ELEV. 605.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
TOPSOIL	604.8																	
STIFF, BROWN/GRAY, **SILT**, LITTLE SAND, LITTLE GRAVEL, LITTLE CLAY, WET (FILL)	601.1	2.5																
STIFF TO VERY STIFF, GRAY, **SILT**, LITTLE SAND, LITTLE CLAY, TRACE GRAVEL, WET		5.0	2 6 6	17	100	SS-1	-	-	-	-	-	-	-	-	-	25	A-4b (V)	
		7.5																
		10.0	3 4 4	11	100	SS-2	-	2	0	0	83	15	23	20	3	19	A-4b (8)	
		12.5																
		15.0	3 4 4	11	83	SS-3	-	-	-	-	-	-	-	-	-	19	A-4b (V)	
		17.5																
		20.0	4 5 8	18	100	SS-4	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		22.5																
		25.0	1 3 5	11	100	SS-5	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
		27.5																
		30.0	5 8 7	21	100	SS-6	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
		32.5																
		35.0	2 3 3	8	100	SS-7	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
** Unconfined Compression = 5,151 psf @ 36.0' - 38.0'		37.5			100	ST-8	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
			2 4	14	100	SS-9	-	-	-	-	-	-	-	-	-	25	A-4b (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:43 - L:\ODOT LOGS\0142-612.GPJ

PLATE 20

NOTE: BORING RENAMED TO B-002-2-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/12/12	END: 6/15/12	PG 2 OF 4	I-002

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
STIFF TO VERY STIFF, GRAY, **SILT**, LITTLE SAND, LITTLE CLAY, TRACE GRAVEL, WET *(continued)*	565.0	42.5	6															
	561.5																	
MEDIUM STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, WET		45.0	2 4 4	11	100	SS-10	-	5	1	2	30	62	40	24	16	41	A-6b (10)	
** Unconfined Compression = 3,024 psf @ 46.0' to 48.0'		47.5			100	ST-11	-	-	-	-	-	-	-	-	-	27	A-6b (V)	
	555.0	50.0	2 3 4	10	100	SS-12	-	-	-	-	-	-	-	-	-	28	A-6b (V)	
MEDIUM STIFF, TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, WET		52.5																
		55.0	1 3 2	7	100	SS-13	-	9	10	8	32	41	33	21	12	22	A-6a (8)	
** Unconfined Compression = 3,969 psf @ 56.0' to 58.0'		57.5			100	ST-14	-	-	-	-	-	-	-	-	-	21	A-6a (V)	
		60.0	3 5 7	17	100	SS-15	-	-	-	-	-	-	-	-	-	21	A-6a (V)	
		62.5																
		65.0	3 4 6	14	100	SS-16	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		67.5																
		70.0	2 4 7	15	100	SS-17	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		72.5																
		75.0	2 4 6	14	100	SS-18	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		77.5																
		80.0	2 5 5	14	100	SS-19	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		82.5																

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:43 - L:\ODOT LOGS\0142-612.GPJ

PLATE 21

NOTE: BORING RENAMED TO B-002-2-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/12/12	END: 6/15/12	PG 3 OF 4	I-002

MATERIAL DESCRIPTION AND NOTES	ELEV. 522.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF, TO HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, WET *(continued)*		85.0	2 5 7	17	100	SS-20	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
	516.5	87.5																
HARD, GRAY, **SANDY SILT**, LITTLE TO SOME CLAY, TRACE GRAVEL, MOIST TO WET		90.0	6 10 15	35	100	SS-21	-	3	6	9	47	35	26	19	7	17	A-4a (8)	
		92.5																
		95.0	8 12 20	45	89	SS-22	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
		97.5																
		100.0	6 12 14	36	89	SS-23	-	-	-	-	-	-	-	-	-	17	A-4a (V)	
		102.5																
	497.5	105.0	7 14 19	46	89	SS-24	-	-	-	-	-	-	-	-	-	21	A-4a (V)	
DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET		107.5																
		110.0	16 24 27	71	78	SS-25	-	0	8	65	27	-	-	-	-	12	A-3a (V)	
		112.5																
		115.0	21 27 23	70	83	SS-26	-	47	27	6	20	-	-	-	-	11	A-3a (V)	
	487.5	117.5																
HARD, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, MOIST		120.0	23 37 45	115	56	SS-27	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
	485.0	122.5																
HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		125.0	16 26 34	84	100	SS-28	-	-	-	-	-	-	-	-	-	14	A-6a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:43 - L:\ODOT LOGS\0142-612.GPJ

PLATE 22

NOTE: BORING RENAMED TO B-002-2-12.

PID: 77040	BR ID:	PROJECT: CUY-6-14.56 (0142-612)	STATION / OFFSET:	START: 6/12/12	END: 6/15/12	PG 4 OF 4	I-002

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
HARD, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST *(continued)*	479.3	127.5																
	475.0	130.0	14 23 29	73	83	SS-29	-	-	-	-	-	-	-	-	-	14	A-6a (V)	
HARD, GRAY, **SILT**, LITTLE SAND, LITTLE TO SOME CLAY, LITTLE ROCK FRAGMENTS (TILL), MOIST Till		132.5	21 27 38	91	100	SS-30	-	2	5	7	64	22	21	20	1	16	A-4b (8)	
	463.5	135.0																
		137.5	24 33 41	104	78	SS-31	-	-	-	-	-	-	-	-	-	10	A-4b (V)	
SHALE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG, FINE GRAINED, THIN TO MEDIUM BEDDED.		140.0																
		142.5	50/1"	-	100	SS-32	-	-	-	-	-	-	-	-	-	12	Rock (V)	
		145.0	80		100	NX-33											CORE	
** Unconfined Compression = 3,212 psi @ 149.8'		147.5																
		150.0	83		100	NX-34											CORE	
		152.5	83		100	NX-35											CORE	
** Unconfined Compression = 5,385 psi @ 155.5'	448.0	155.0 EOB	100		100	NX-36											CORE	

NOTES: APPROXIMATE BORING ELEVATIONS FROM PROVIDED TOPO MAP

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 6/29/12 10:43 - L:\ODOT LOGS\0142-612.GPJ

PLATE 23

NOTE: BORING RENAMED TO B-002-3-12.

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:	EXPLORATION ID B-002-1-13	
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE		
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 594.4 (MSL) EOB: 138.5 ft.	PAGE 1 OF 3	
START: 7/13/13 END: 7/13/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 665886.392 N, 2186246.280 E		

MATERIAL DESCRIPTION AND NOTES	ELEV. 594.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY LOOSE, BROWN/BLACK, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND AND SILT**, WITH CINDERS, ORGANICS, LITTLE CLAY, MOIST (FILL)		2.5	1 (1, 2)	4	100	SS-1	-	-	-	-	-	-	-	-	-	8	A-2-4 (V)	
		5.0	4 (2, 1)	4	100	SS-2	-	-	-	-	-	-	-	-	-	8	A-2-4 (V)	
		7.5	1 (1, 1)	3	100	SS-3	-	-	-	-	-	-	-	-	-	16	A-2-4 (V)	
	583.9	10.0	2 (1, 2)	4	100	SS-4	-	-	-	-	-	-	-	-	-	14	A-2-4 (V)	
VERY LOOSE, BROWN, **FINE SAND**, LITTLE SILT, TRACE CLAY, LITTLE GRAVEL, MOIST	581.4	12.5	2 (1, 2)	4	100	SS-5	-	10	26	62	-	2 -	NP	NP	NP	12	A-3 (0)	
LOOSE TO MEDIUM DENSE, BROWN TO GRAY, **SILT**, WITH CLAY, TRACE SAND, TRACE GRAVEL, WET	W	15.0	1 (2, 2)	5	100	SS-6	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
** GRAY @ 16.5'		17.5	2 (4, 6)	14	100	SS-7	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
		20.0	6 (9, 9)	24	100	SS-8	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		22.5																
		25.0	3 (4, 5)	12	100	SS-9	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
		27.5																
		30.0	2 (3, 3)	8	100	SS-10	-	0	0	2	57	41	28	18	10	22	A-4b (8)	
		32.5																
		35.0	3 (3, 5)	11	100	SS-11	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
	557.4	37.5																
STIFF, GRAY, **CLAY**, WITH SILT, TRACE SAND, TRACE GRAVEL, WET		40.0	1 (2, 4)	8	100	SS-12	-	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		42.5																
		45.0	0 (4, 4)	11	100	SS-13	-	0	1	2	49	48	46	23	23	24	A-7-6 (14)	
		47.5																
** UNCONFINED COMPRESSION = 3,260 PSF @ 48.0' - 50.0'					-	ST-14	-	-	-	-	-	-	-	-	-	22	A-7-6 (V)	

NOTE: BORING RENAMED TO B-002-3-12.

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/13/13	END: 7/13/13	PG 2 OF 3	B-002-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
STIFF, GRAY, **CLAY**, WITH SILT, TRACE SAND, TRACE GRAVEL, WET *(continued)*	544.4	52.5																
	539.4	55.0	3 4 6	14	100	SS-15	-	-	-	-	-	-	-	-	-	9	A-7-6 (V)	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, WET		57.5																
		60.0	2 4 6	14	100	SS-16	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		62.5																
		65.0	4 7 10	23	100	SS-17	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		67.5																
		70.0	4 6 8	19	100	SS-18	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		72.5																
		75.0	4 6 8	19	100	SS-19	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		77.5																
		80.0	4 7 10	23	100	SS-20	-	0	12	9	40	39	35	21	14	16	A-6a (10)	
		82.5																
		85.0	5 9 12	28	100	SS-21	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		87.5																
		90.0	6 9 14	31	100	SS-22	-	-	-	-	-	-	-	-	-	17	A-6a (V)	
		92.5																
	497.4	95.0	7 11 16	37	100	SS-23	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
DENSE, GRAY, **SANDY SILT**, LITTLE SILT, TRACE CLAY, WET		97.5																
	493.4	100.0	14 14 20	46	100	SS-24	-	0	0	58	36	6	NP	NP	NP	16	A-4a (1)	
DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS**, TRACE GRAVEL, TRACE CLAY, MOIST		102.5																

NOTE: BORING RENAMED TO B-002-3-12.

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/13/13	END: 7/13/13	PG 3 OF 3	B-002-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS**, TRACE GRAVEL, TRACE CLAY, MOIST *(continued)*	490.9	105.0	18 38 34	98	100	SS-25	-	73	16	7	- 4	-	NP	NP	NP	7	A-1-a (0)	
	486.4	107.5																
VERY HARD, GRAY, **SANDY SILT**, LITTLE TO SOME ROCK FRAGMENTS, LITTLE CLAY, WET		110.0	16 25 34	80	100	SS-26	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
		112.5																
		115.0	14 19 30	66	100	SS-27	-	7	13	15	34	31	24	17	7	12	A-4a (6)	
		117.5																
		120.0	10 17 23	54	100	SS-28	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
		122.5																
		125.0	8 16 19	47	100	SS-29	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
	467.4	127.5																
SHALE, GRAY, STRONG, FINE GRAINED, THIN TO THICK BEDDED.		130.0																
** UNCONFINED COMPRESSION = 2,041 PSI @ 131.0'		132.5	83		100	NQ-30											CORE	
		135.0																
	455.9	137.5																
		EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 26

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:	EXPLORATION ID B-003-0-13	
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE		
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 655.0 (MSL) EOB: 198.0 ft.	PAGE 1 OF 4	
START: 8/12/13 END: 8/12/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 666142.484 N, 2186047.131 E		

MATERIAL DESCRIPTION AND NOTES	ELEV. 655.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
3" ASPHALT 9" SAND AND GRAVEL SOFT, BROWN AND BLACK, **SANDY SILT**, TRACE TO LITTLE CLAY, TRACE GRAVEL, ORGANICS, MOIST (FILL)	654.0	2.5	1 2 2	5	67	SS-1	-	-	-	-	-	-	-	-	-	21	A-4a (V)	
		5.0																
		7.5	2 2 2	5	44	SS-2	-	-	-	-	-	-	-	-	-	14	A-4a (V)	
		10.0																
		12.5	2 3 7	14	100	SS-3	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
		15.0																
LOOSE, BLACK, **COARSE AND FINE SAND**, TRACE SILT AND CLAY, TRACE GRAVEL, ORGANICS, MOIST (FILL)	645.0	17.5	2 2 3	7	78	SS-4	-	3	47	29	-	21 -	NP	NP	NP	10	A-1-b (0)	
		20.0																
VERY LOOSE TO LOOSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, LITTLE SILT AND CLAY, MOIST	636.5	22.5	1 1 1	3	100	SS-5	-	-	-	-	-	-	-	-	-	27	A-1-b (V)	
	631.0	W					-	0	0	27	54	19	24	21	3	30	A-4b (8)	
SOFT TO VERY STIFF, BROWN, **SILT**, TRACE TO LITTLE CLAY, TRACE TO LITTLE SAND AND GRAVEL, MOIST TO WET ** GRAVEL LAYER @ 28.5' - 29.0'		25.0																
		27.5	2 1 2	4	72	SS-6	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
		30.0																
		32.5	8 10 12	30	100	SS-7	-	-	-	-	-	-	-	-	-	19	A-4b (V)	
		35.0																
		37.5	3 5 7	16	100	SS-8	-	-	-	-	-	-	-	-	-	17	A-4b (V)	
		40.0																
		42.5	6 5 5	14	83	SS-9	-	-	-	-	-	-	-	-	-	25	A-4b (V)	
		45.0																
		47.5	2	14	100	SS-10	-	0	0	1	88	11	24	24	NP	21	A-4b (8)	

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/12/13	END: 8/12/13	PG 2 OF 4	B-003-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
SOFT TO VERY STIFF, BROWN, **SILT**, TRACE TO LITTLE CLAY, TRACE TO LITTLE SAND AND GRAVEL, MOIST TO WET *(continued)*	605.0	52.5	4 6															
	600.0	55.0	3 4 5	12	100	SS-11	-	0	1	0	72	27	31	24	7	23	A-4b (8)	
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		57.5																
		60.0	2 4 6	14	100	SS-12	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		62.5																
		65.0	3 5 7	16	100	SS-13	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		67.5																
		70.0	4 6 7	18	83	SS-14	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		72.5																
		75.0	2 3 5	11	100	SS-15	-	-	-	-	-	-	-	-	-	26	A-6a (V)	
		77.5																
		80.0	3 4 8	16	100	SS-16	-	-	-	-	-	-	-	-	-	26	A-6a (V)	
		82.5																
		85.0	3 4 6	14	100	SS-17	-	0	0	1	40	59	34	21	13	26	A-6a (9)	
		87.5																
		90.0	3 4 6	14	100	SS-18	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		92.5																
		95.0	3 4 5	12	100	SS-19	-	-	-	-	-	-	-	-	-	29	A-6a (V)	
		97.5																
		100.0	0 1 5	8	100	SS-20	-	-	-	-	-	-	-	-	-	28	A-6a (V)	
		102.5																

PLATE 28

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST *(continued)*	551.4	105.0	0 6 6	16	100	SS-21	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
** UNCONFINED COMPRESSION = 2,951 @ 108.0' - 110.0'	545.0	107.5			92	ST-22	-	-	-	-	-	-	-	-	-	21	A-6a (V)	
VERY STIFF, GRAY, **SILT**, TRACE SAND, TRACE GRAVEL, WITH CLAY, MOIST		110.0																
	537.0	112.5																
VERY STIFF TO HARD, GRAY, **CLAY**, LITTLE TO SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST		115.0	5 8 11	26	78	SS-23	-	0	0	1	66	33	31	21	10	22	A-4b (8)	
		117.5																
		120.0	4 6 9	20	83	SS-24	-	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		122.5																
		125.0	5 8 11	26	83	SS-25	-	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		127.5																
		130.0	5 8 12	27	83	SS-26	-	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		132.5																
		135.0	4 7 10	23	100	SS-27	-	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		137.5																
		140.0	6 10 13	31	89	SS-28	-	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
		142.5																
		145.0	7 11 13	33	0	SS-29	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	
		147.5																
		150.0	7 13 18	42	94	SS-30	-	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		152.5																
	500.0	155.0	11 15 18	45	100	SS-31	-	0	1	0	30	69	42	24	18	25	A-7-6 (12)	
HARD, GRAY, **SANDY SILT**, LITTLE GRAVEL, TRACE TO LITTLE CLAY, MOIST																		

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 8/12/13	END: 8/12/13	PG 4 OF 4	B-003-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
HARD, GRAY, **SANDY SILT**, LITTLE GRAVEL, TRACE TO LITTLE CLAY, MOIST *(continued)*	497.9	157.5																
		160.0	8 12 17	39	72	SS-32	-	-	-	-	-	-	-	-	-	17	A-4a (V)	
		162.5																
		165.0	18 30 32	84	50	SS-33	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
		167.5																
		170.0	14 23 30	72	72	SS-34	-	11	16	16	38	19	22	17	5	10	A-4a (4)	
		172.5																
		175.0	14 24 31	75	78	SS-35	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
		177.5																
	475.0	180.0	16 29 36	88	61	SS-36	-	-	-	-	-	-	-	-	-	7	A-4a (V)	
HARD, GRAY, **SANDY SILT**, (TILL), DAMP		182.5																
		185.0	22 42 50	125	-	SS-37	-	-	-	-	-	-	-	-	-	-	A-4a (V)	
	467.0	187.5																
SHALE, GRAY, HIGHLY WEATHERED.		190.0																
		192.5	0		32	NX-38											CORE	
		195.0																
	457.0	197.5																
		EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 30

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:	EXPLORATION ID B-003-1-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE	
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 599.7 (MSL) EOB: 158.5 ft.	PAGE 1 OF 4
START: 7/18/13 END: 7/18/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 666168.638 N, 2186264.665 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 599.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
6" TOPSOIL	599.2																	
MEDIUM DENSE, BLACK, **COARSE AND FINE SAND**, WITH SILT, TRACE CLAY, TRACE GRAVEL, SOME CINDERS SOME RED BRICKS, LITTLE ORGANICS, MOIST (FILL)	593.2	2.5	13 13 13	35	100	SS-1	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
LOOSE, GRAY, **SILT**, LITTLE CLAY, TRACE GRAVEL, TRACE SAND, WET		5.0																
		7.5	3 3 4	9	100	SS-2	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
** INTERBEDDING OF FINE SAND		10.0																
		12.5	2 2 3	7	100	SS-3	-	0	1	1	78	20	NP	NP	NP	27	A-4b (8)	
		15.0																
		17.5	2 2 2	5	100	SS-4	-	-	-	-	-	-	-	-	-	25	A-4b (V)	
		20.0																
		22.5	3 3 5	11	100	SS-5	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
	572.7	25.0																
MEDIUM STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, WET		27.5	3 5 5	14	100	SS-6	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		30.0																
		32.5	3 5 5	14	100	SS-7	-	0	1	0	50	49	32	20	12	21	A-6a (9)	
		35.0																
		37.5			88	ST-8	-	-	-	-	-	-	-	-	-	20	A-6a (V)	
** UNCONFINED COMPRESSION = 3,313 PSF @ 38.5' - 40.5'		40.0																
		42.5	3 3 4	9	100	SS-9	-	-	-	-	-	-	-	-	-	31	A-6a (V)	
		45.0																
		47.5	1	7	100	SS-10	-	-	-	-	-	-	-	-	-	30	A-6a (V)	

PLATE 31

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/18/13	END: 7/18/13	PG 2 OF 4	B-003-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, WET *(continued)*	549.7	52.5	2 3															
		55.0	1 4 5	12	100	SS-11	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		57.5																
		60.0	3 6 9	20	100	SS-12	-	0	3	3	39	55	33	22	11	21	A-6a (8)	
		62.5																
		65.0	3 6 9	20	100	SS-13	-	-	-	-	-	-	-	-	-	20	A-6a (V)	
		67.5																
		70.0	3 7 9	22	100	SS-14	-	-	-	-	-	-	-	-	-	20	A-6a (V)	
		72.5																
		75.0	4 7 11	24	100	SS-15	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		77.5																
		80.0	5 9 13	30	100	SS-16	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
	516.7	82.5																
VERY STIFF TO HARD, GRAY, **SANDY SILT**, WITH CLAY, TRACE GRAVEL, WET		85.0	7 12 15	37	100	SS-17	-	5	6	10	40	39	27	19	8	16	A-4a (8)	
		87.5																
		90.0	6 11 15	35	100	SS-18	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
		92.5																
		95.0	8 14 20	46	100	SS-19	-	-	-	-	-	-	-	-	-	54	A-4a (V)	
	501.7	97.5																
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, WET		100.0	10 20 30	68	100	SS-20	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
		102.5																

PLATE 32

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/18/13	END: 7/18/13	PG 3 OF 4	B-003-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, WET *(continued)*	496.2	105.0	9 20 25	61	100	SS-21	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		107.5																
		110.0	19 30 35	88	100	SS-22	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
		112.5																
		115.0	19 26 36	84	100	SS-23	-	-	-	-	-	-	-	-	-	9	A-6a (V)	
		117.5																
		120.0	12 21 27	65	100	SS-24	-	7	9	12	33	39	30	18	12	14	A-6a (8)	
		122.5																
	474.7	125.0	12 20 28	65	100	SS-25	-	-	-	-	-	-	-	-	-	9	A-6a (V)	
HARD, GRAY, **SANDY SILT**, SOME TO WITH CLAY, TRACE GRAVEL, WET		127.5																
		130.0	11 19 24	58	100	SS-26	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
** LAYER OF SILT AND CLAY (TILL)		132.5																
		135.0	12 30 39	94	100	SS-27	-	-	-	-	-	-	-	-	-	14	A-4a (V)	
		137.5																
		140.0	24 28 55	113	67	SS-28	-	-	-	-	-	-	-	-	-	12	A-4a (V)	
		142.5																
	452.7	145.0	42 56	-	33	SS-29	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
SHALE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, FINE GRAINED, MEDIUM TO THICK BEDDED.		147.5																
		150.0																
		152.5	90		100	NQ-30											CORE	
		155.0																
** UNCONFINED COMPRESSION = 3,212 PSI @ 156.0'																		

PLATE 33

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/18/13	END: 7/18/13	PG 4 OF 4	B-003-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
	442.6																	
	441.2	157.5 EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 34

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / J. WATTS	DRILL RIG: D-50	STATION / OFFSET:	EXPLORATION ID B-004-0-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE	
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 605.0 (MSL) EOB: 173.6 ft.	PAGE 1 OF 4
START: 6/27/13 END: 6/28/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 77.98	COORD: 666364.951 N, 2186300.732 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 605.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
5.5" ASPHALT	604.6																	
VERY LOOSE TO MEDIUM DENSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, LITTLE RED BRICK, LITTLE ORGANICS, WET (FILL)		2.5	19 9 8	22	100	SS-1	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		5.0	2 2 1	4	100	SS-2	-	31	23	31	-	15 -	NP	NP	NP	10	A-1-b (0)	
	597.0	7.5	1 0 1	1	28	SS-3	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
STIFF, BROWN/GRAY, **SANDY SILT**, LITTLE CLAY, LITTLE GRAVEL, LITTLE ORGANICS, SOME WOOD FRAGMENTS, WET (FILL) ** WOOD FRAGMENTS @ 8.5' TO 10.0'		10.0	1 1 11	16	56	SS-4	-	-	-	-	-	-	-	-	-	45	A-4a (V)	
	592.0	12.5	2 3 3	8	67	SS-5	-	-	-	-	-	-	-	-	-	26	A-4a (V)	
LOOSE, GRAY, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, MOIST		15.0	2 3 5	10	78	SS-6	-	-	-	-	-	-	-	-	-	20	A-4b (V)	
		17.5	3 4 5	12	100	SS-7	-	0	1	4	75	20	NP	NP	NP	20	A-4b (8)	
		20.0	2 3 3	8	100	SS-8	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
		25.0	2 3 5	10	100	SS-9	-	-	-	-	-	-	-	-	-	20	A-4b (V)	
		30.0	2 2 4	8	100	SS-10	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
	570.0	35.0	3 5 7	16	100	SS-11	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
MEDIUM STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, MOIST TO WET		40.0	3 5 6	14	100	SS-12	-	-	-	-	-	-	-	-	-	25	A-6a (V)	
		45.0	2 3 4	9	100	SS-13	-	0	0	0	47	53	34	20	14	29	A-6a (10)	
			5	13	100	SS-14	-	-	-	-	-	-	-	-	-	20	A-6a (V)	

W

PLATE 35

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 6/27/13	END: 6/28/13	PG 2 OF 4	B-004-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 555.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, MOIST TO WET *(continued)*		52.5	6 4															
		55.0	3 2 4	8	100	SS-15	-	-	-	-	-	-	-	-	-	28	A-6a (V)	
		57.5																
		60.0	5 6 8	18	100	SS-16	-	-	-	-	-	-	-	-	-	25	A-6a (V)	
		62.5																
		65.0	5 7 9	21	100	SS-17	-	0	1	2	44	53	35	21	14	22	A-6a (10)	
		67.5																
		70.0	7 10 12	29	28	SS-18	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		72.5																
		75.0	7 9 11	26	100	SS-19	-	-	-	-	-	-	-	-	-	21	A-6a (V)	
		77.5																
		80.0	6 8 10	23	100	SS-20	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		82.5																
		85.0	7 10 13	30	100	SS-21	-	-	-	-	-	-	-	-	-	24	A-6a (V)	
		87.5																
		90.0	8 15 20	45	100	SS-22	-	-	-	-	-	-	-	-	-	15	A-6a (V)	
		92.5																
		95.0	8 12 15	35	100	SS-23	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		97.5																
		100.0	4 9 13	29	100	SS-24	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
		102.5																

PLATE 36

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 6/27/13	END: 6/28/13	PG 3 OF 4	B-004-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
MEDIUM STIFF TO HARD, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, MOIST TO WET *(continued)*	501.5	105.0	4 9 14	30	100	SS-25	-	2	1	2	34	61	35	22	13	21	A-6a (9)	
	498.0	107.5																
VERY STIFF TO HARD, GRAY, **SILT**, LITTLE CLAY, LAYER OF FINE SAND, TRACE GRAVEL, MOIST		110.0	8 13 14	35	100	SS-26	-	-	-	-	-	-	-	-	-	22	A-4b (V)	
	490.0	112.5																
HARD, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, MOIST		115.0	16 16 19	45	83	SS-27	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
		117.5																
		120.0	11 20 25	58	100	SS-28	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
		122.5																
		125.0	12 17 26	56	100	SS-29	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		127.5																
		130.0	8 14 23	48	100	SS-30	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		132.5																
		135.0	22 32 37	90	100	SS-31	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
		137.5																
		140.0	15 25 39	83	100	SS-32	-	8	2	3	25	62	37	22	15	15	A-6a (10)	
		142.5																
		145.0	23 27 40	87	100	SS-33	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		147.5																
	455.0	150.0	21 30 32	81	94	SS-34	-	-	-	-	-	-	-	-	-	17	A-6a (V)	
HARD, GRAY, **SANDY SILT**, LITTLE ROCK FRAGMENTS, LITTLE CLAY, MOIST		152.5																
		155.0	26 38 50	114	100	SS-35	-	-	-	-	-	-	-	-	-	13	A-4a (V)	

PLATE 37

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 6/27/13	END: 6/28/13	PG 4 OF 4	B-004-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
HARD, GRAY, **SANDY SILT**, LITTLE ROCK FRAGMENTS, LITTLE CLAY, MOIST *(continued)*	447.9	157.5																
		160.0	28 35 59	122	100	SS-36	-	-	-	-	-	-	-	-	-	12	A-4a (V)	
	443.0																	
SHALE, GRAY, SLIGHTLY WEATHERED, STRONG, FINE GRAINED, MEDIUM TO THICK BEDDED.		162.5	50/1"	-	100	SS-37	-	-	-	-	-	-	-	-	-	11	Rock (V)	
		165.0																
		167.5	95		95	NQ-38											CORE	
		170.0																
** UNCONFINED COMPRESSION = 1,614 PSI @ 173.0'	431.4	172.5 EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 38

PROJECT: CUY-6-14.56	DRILLING FIRM / OPERATOR: PSI / T. SUCHAN	DRILL RIG: CME 55 ATV	STATION / OFFSET:
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PSI / S.T.	HAMMER: CME AUTOMATIC	ALIGNMENT: DETROIT-SUPERIOR BRIDGE
PID: BR ID:	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 7/10/13	ELEVATION: 606.0 (MSL) EOB: 169.2 ft.
START: 7/9/13 END: 7/9/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 81.4	COORD: 666282.939 N, 2186374.016 E

EXPLORATION ID B-004-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
12" TOPSOIL	606.0																	
	605.0																	
LOOSE TO MEDIUM DENSE, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, LITTLE RED BRICKS, LITTLE CINDERS, TRACE ORGANICS, MOIST (FILL)		2.5	2 3 3	8	78	SS-1	-	-	-	-	-	-	-	-	-	16	A-6a (V)	
		5.0	2 4 2	8	44	SS-2	-	7	7	9	46	31	32	21	11	17	A-6a (8)	
		7.5	4 5 3	11	67	SS-3	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
		10.0	3 3 7	14	67	SS-4	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
	595.5																	
VERY LOOSE TO MEDIUM DENSE, BROWN/GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE CLAY, TRACE SILT, SOME CONCRETE FRAGMENTS, LITTLE RED BRICKS, MOIST (FILL)		12.5	5 5 7	16	56	SS-5	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		15.0	12 26 5	42	56	SS-6	-	-	-	-	-	-	-	-	-	20	A-1-b (V)	
		17.5																
		20.0	5 4 7	15	33	SS-7	-	47	13	17	-	23 -	NP	NP	NP	10	A-1-b (0)	
		22.5																
		25.0	1 1 1	3	25	SS-8	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		27.5																
	574.0	30.0	18 7 3	14	33	SS-9	-	-	-	-	-	-	-	-	-	19	A-1-b (V)	
		32.5																
VERY STIFF, GRAY, **SILT**, SOME TO WITH CLAY, TRACE GRAVEL, TRACE SAND, MOIST TO WET		35.0	6 9 10	26	100	SS-10	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
		37.5																
** UNCONFINED COMPRESSION = 1,904 PSF @ 38.5' - 40.5'		40.0			65	ST-11	-	-	-	-	-	-	-	-	-	19	A-4b (V)	
		42.5																
		45.0	5 7 6	18	100	SS-12	-	0	0	0	69	31	29	22	7	22	A-4b (8)	
		47.5																
			3	19	100	SS-13	-	-	-	-	-	-	-	-	-	25	A-4b (V)	

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/9/13	END: 7/9/13	PG 2 OF 4	B-004-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
VERY STIFF, GRAY, **SILT**, SOME TO WITH CLAY, TRACE GRAVEL, TRACE SAND, MOIST TO WET *(continued)*	556.0	52.5	6 8															
	552.5																	
SOFT TO VERY STIFF, GRAY, **CLAY**, TRACE TO LITTLE SILT, TRACE SAND, TRACE GRAVEL, MOIST TO WET		55.0	4 4 5	12	100	SS-14	-	-	-	-	-	-	-	-	-	31	A-7-6 (V)	
		57.5																
		60.0	0 0 3	4	100	SS-15	-	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
		62.5																
		65.0	0 0 3	4	100	SS-16	-	-	-	-	-	-	-	-	-	29	A-7-6 (V)	
		67.5																
		70.0	0 0 5	7	100	SS-17	-	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
		72.5																
** UNCONFINED COMPRESSION = 2,620 PSF @ 73.5' - 75.0'		75.0			92	ST-18	-	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
		77.5																
		80.0	6 10 13	31	100	SS-19	-	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		82.5																
		85.0	6 9 11	27	100	SS-20	-	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		87.5																
		90.0	4 8 11	26	100	SS-21	-	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		92.5																
		95.0	8 13 18	42	100	SS-22	-	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
	507.5	97.5																
DENSE, GRAY, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, WET		100.0	11 16 21	50	100	SS-23	-	-	-	-	-	-	-	-	-	16	A-4b (V)	
		102.5																

PLATE 40

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/9/13	END: 7/9/13	PG 3 OF 4	B-004-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
DENSE, GRAY, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, WET *(continued)*	502.5	105.0	4 7 11	24	100	SS-24	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
** BOULDER @ 108.0' TO 109.5'		107.5	50/1"	-	100	SS-25	-	-	-	-	-	-	-	-	-	-	A-4b (V)	
		110.0																
		112.5																
** SAND LAYER @ 114.5' TO 116.0'	490.0	115.0	14 17 20	50	100	SS-26	-	0	2	0	81	17	NP	NP	NP	22	A-4b (8)	
HARD, GRAY, **SILT AND CLAY**, TRACE TO LITTLE SAND, LITTLE ROCK FRAGMENTS, MOIST TO WET		117.5																
		120.0	14 25 31	76	100	SS-27	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
		122.5																
		125.0	15 23 26	66	100	SS-28	-	-	-	-	-	-	-	-	-	14	A-6a (V)	
		127.5																
		130.0	12 18 25	58	100	SS-29	-	-	-	-	-	-	-	-	-	17	A-6a (V)	
		132.5																
		135.0	8 13 17	41	67	SS-30	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
		137.5																
		140.0	10 13 20	45	89	SS-31	-	4	2	4	35	55	35	21	14	19	A-6a (10)	
		142.5																
		145.0	11 14 22	49	100	SS-32	-	-	-	-	-	-	-	-	-	22	A-6a (V)	
		147.5																
		150.0	14 27 29	76	28	SS-33	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		152.5																
** SOME ROCK FRAGMENTS AFTER 153.0'		155.0	21 37 59	130	100	SS-34	-	-	-	-	-	-	-	-	-	11	A-6a (V)	

PLATE 41

PID:	BR ID:	PROJECT: CUY-6-14.56	STATION / OFFSET:	START: 7/9/13	END: 7/9/13	PG 4 OF 4	B-004-1-13

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	INCL.
	448.9																	
	447.0	157.5																
SHALE, GRAY, MODERATELY STRONG, FINE GRAINED, MEDIUM BEDDED.			31 50/2"	-	113	SS-35	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		160.0																
		162.5																
		165.0	67		67	NQ-36											CORE	
** UNCONFINED COMPRESSION = 1,786 PSI @ 167.0'		167.5																
	436.8	EOB																

NOTES: NONE

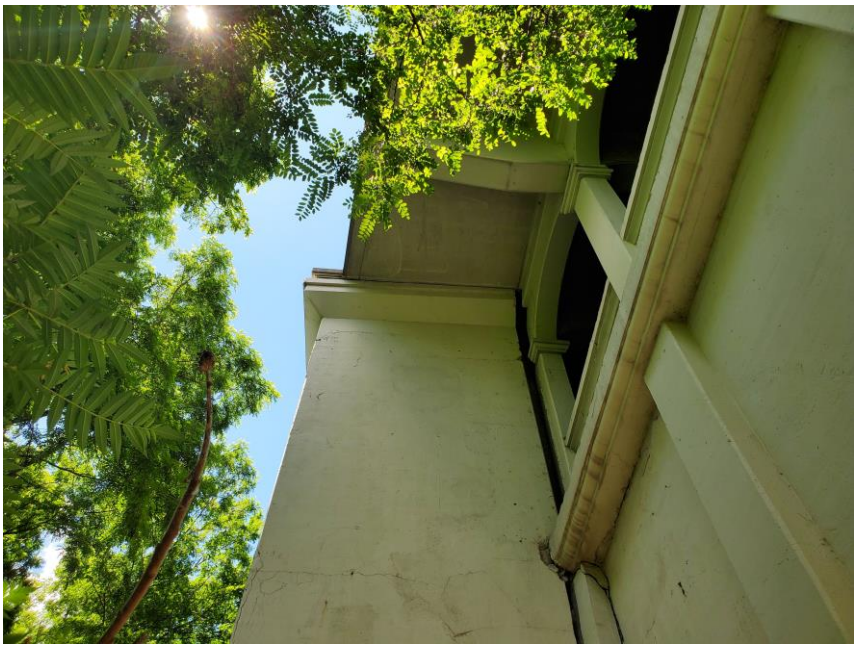
ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

PLATE 42

Date: 6/23/2021

Photographer: BKS

1	**Location / Orientation**	Detroit Superior Bridge, Tower B South, Looking NE
	Remarks	Movement of Tower B South, Inclinometer B-002-1-12



Date: 6/23/2021

Photographer: BKS

2	**Location / Orientation**	Detroit Superior Bridge, Tower B South, Looking SW
	Remarks	Movement of Tower B (upper half)

Date: 6/23/2021

Photographer: BKS

3	**Location / Orientation**	Detroit Superior Bridge, South Side, Looking NE
	Remarks	Inclinometer B-001-1-13

Date: 6/23/2021

Photographer: BKS

4	**Location / Orientation**	Detroit Superior Bridge, South Side, Looking NE
	Remarks	Inclinometer B-002-1-12

Date: 6/23/2021

Photographer: BKS

5	**Location / Orientation**	Detroit Superior Bridge, Inside Tower B, Looking SE
	Remarks	Wall cracking and gaps opening

Date: 6/23/2021

Photographer: BKS

6	**Location / Orientation**	Detroit Superior Bridge, Inside Tower B, Looking NE
	Remarks	Wall cracking with crack gauge monitor

Date: 6/23/2021

Photographer: BKS

7	**Location / Orientation**	Detroit Superior Bridge, Inside Tower B, Looking SE
	Remarks	Crack in footer

Date: 6/23/2021

Photographer: BKS

8	**Location / Orientation**	Detroit Superior Bridge, Inside Tower B
	Remarks	Crack in footer with crack gauge monitor

Date: 6/23/2021

Photographer: BKS

9	**Location / Orientation**	Detroit Superior Bridge, 2nd Level, Looking SE
	Remarks	Outward movement in upper half of tower

Date: 6/23/2021

Photographer: BKS

10	**Location / Orientation**	Detroit Superior Bridge, 2nd Level, Looking SE
	Remarks	Outward movement at top of Tower B

Appendix II – Inclinometer Reading Plots, Crack Monitoring Data

Inclinometer Plots

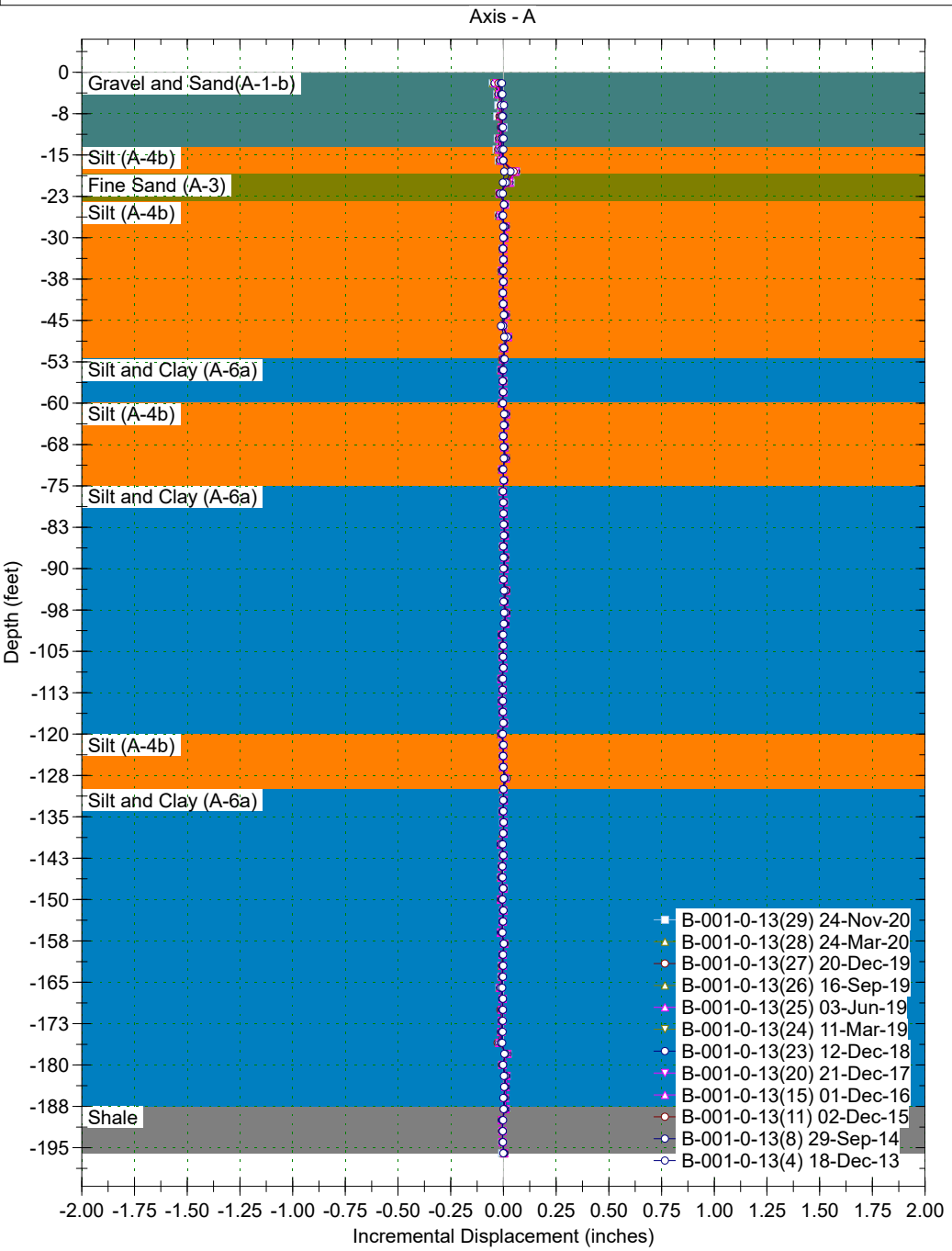
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-001-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666028.444
Easting : 2185925.904
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 196.0 feet
A+ Groove Azimuth : 129° 27' 19"
Base Reading : 2013 Oct 21 15:19
Applied Azimuth : 0.0 degrees



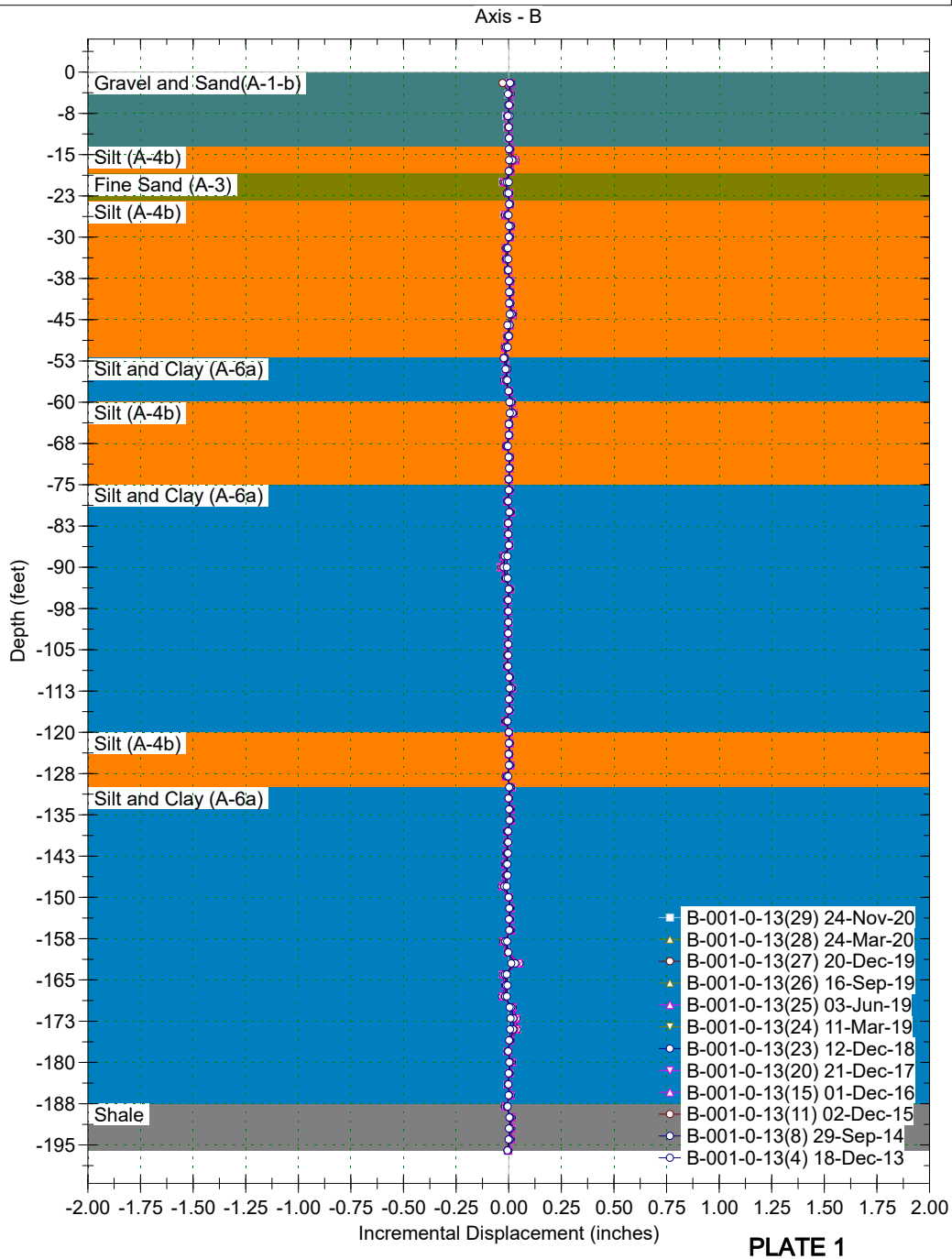


PLATE 1

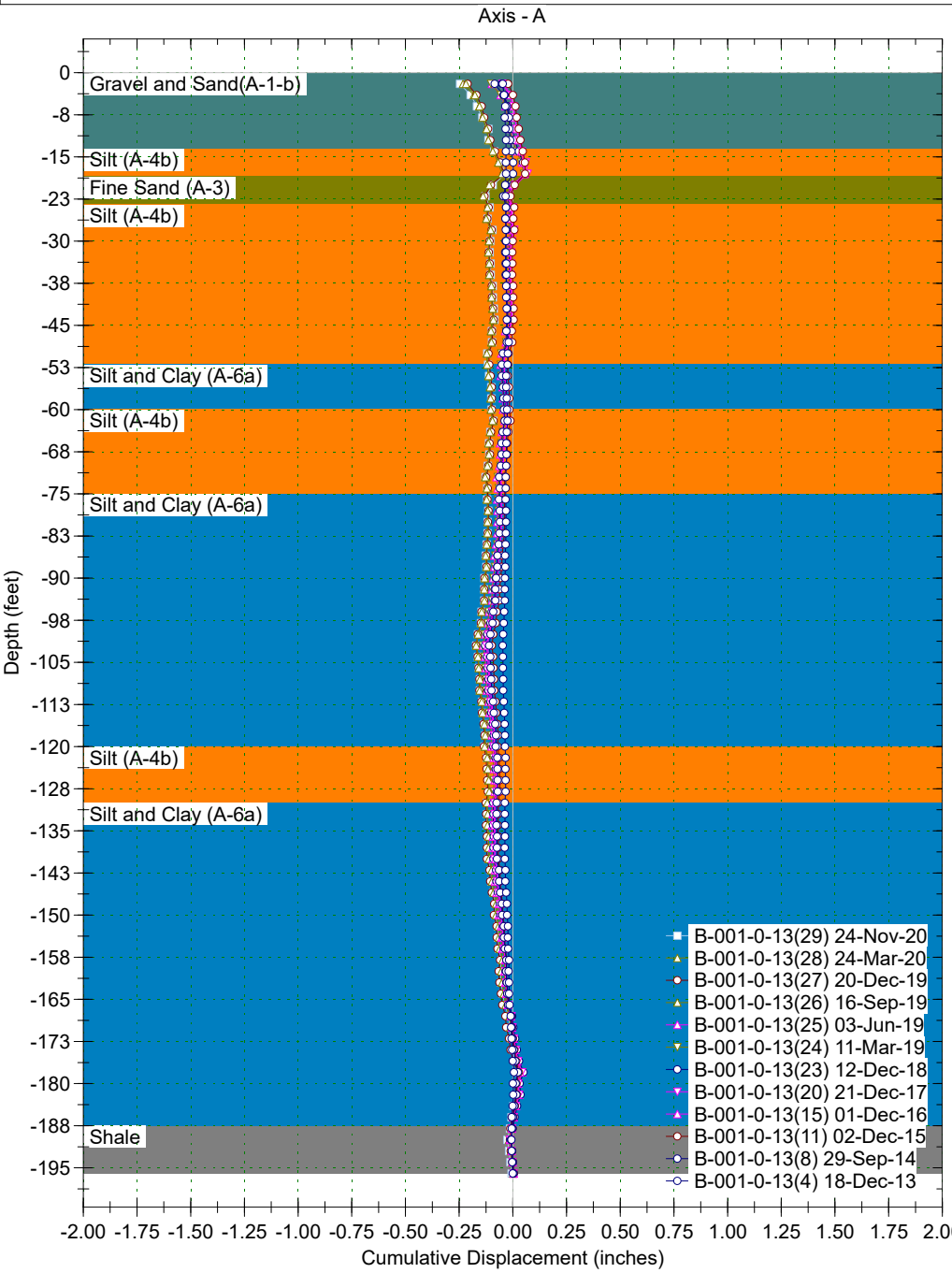
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-001-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666028.444
Easting : 2185925.904
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 196.0 feet
A+ Groove Azimuth : 129° 27' 19"
Base Reading : 2013 Oct 21 15:19
Applied Azimuth : 0.0 degrees



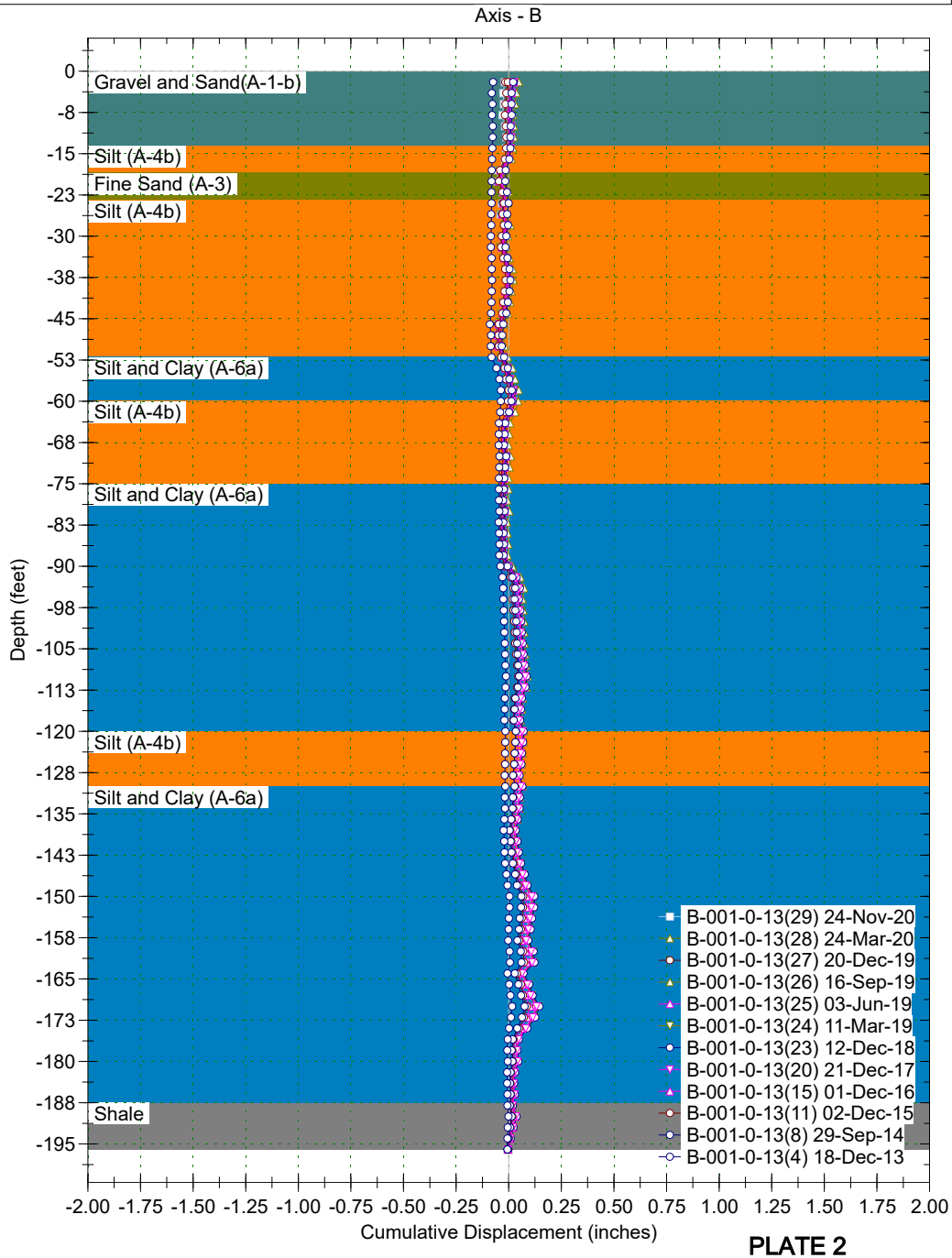


PLATE 2

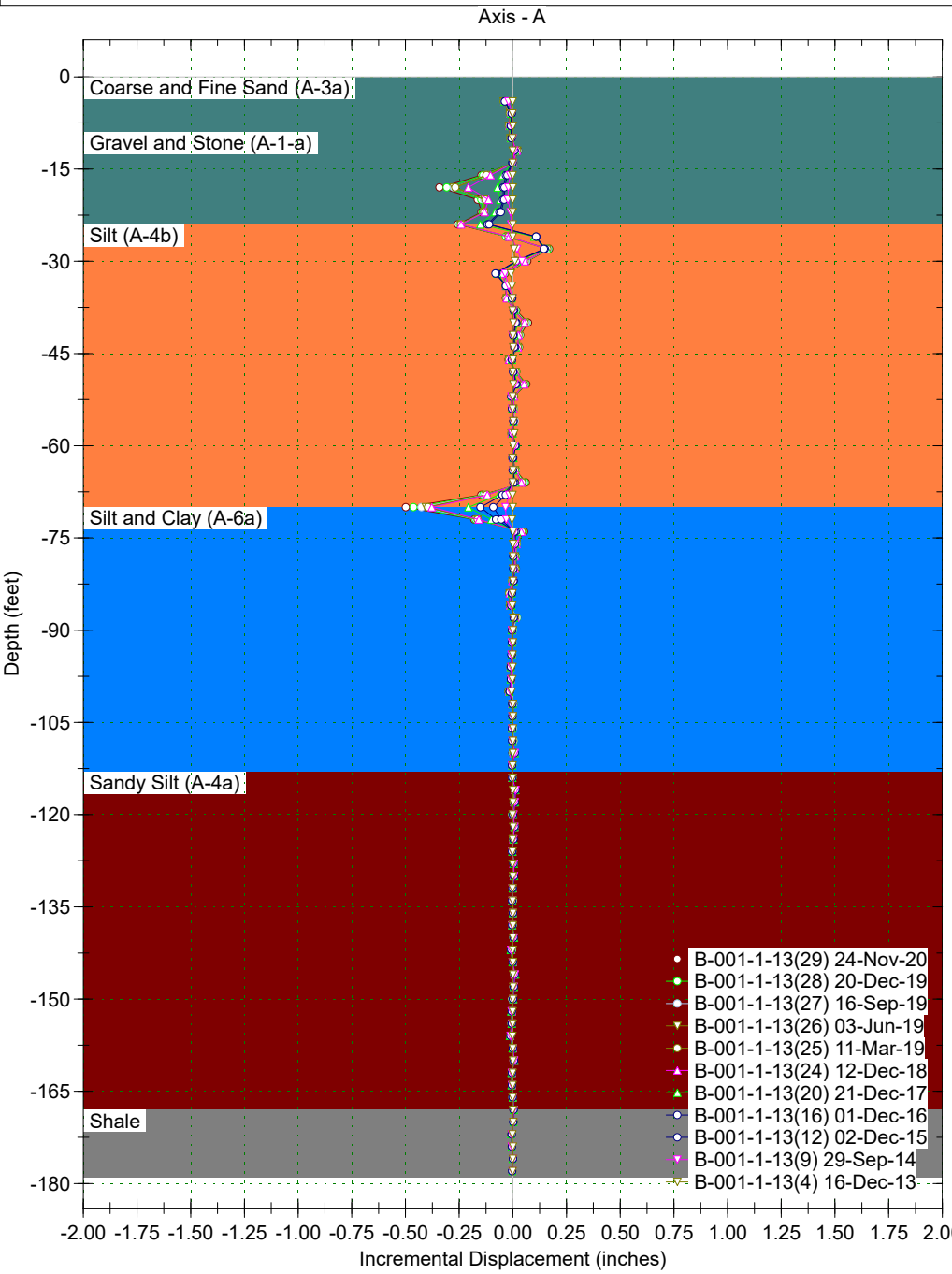
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-001-1-13
Project : Detroit Superior Bridge
Location :
Northing : 665949.799
Easting : 2186031.495
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 178.0 feet
A+ Groove Azimuth : 106° 23' 23"
Base Reading : 2013 Oct 21 13:15
Applied Azimuth : 0.0 degrees



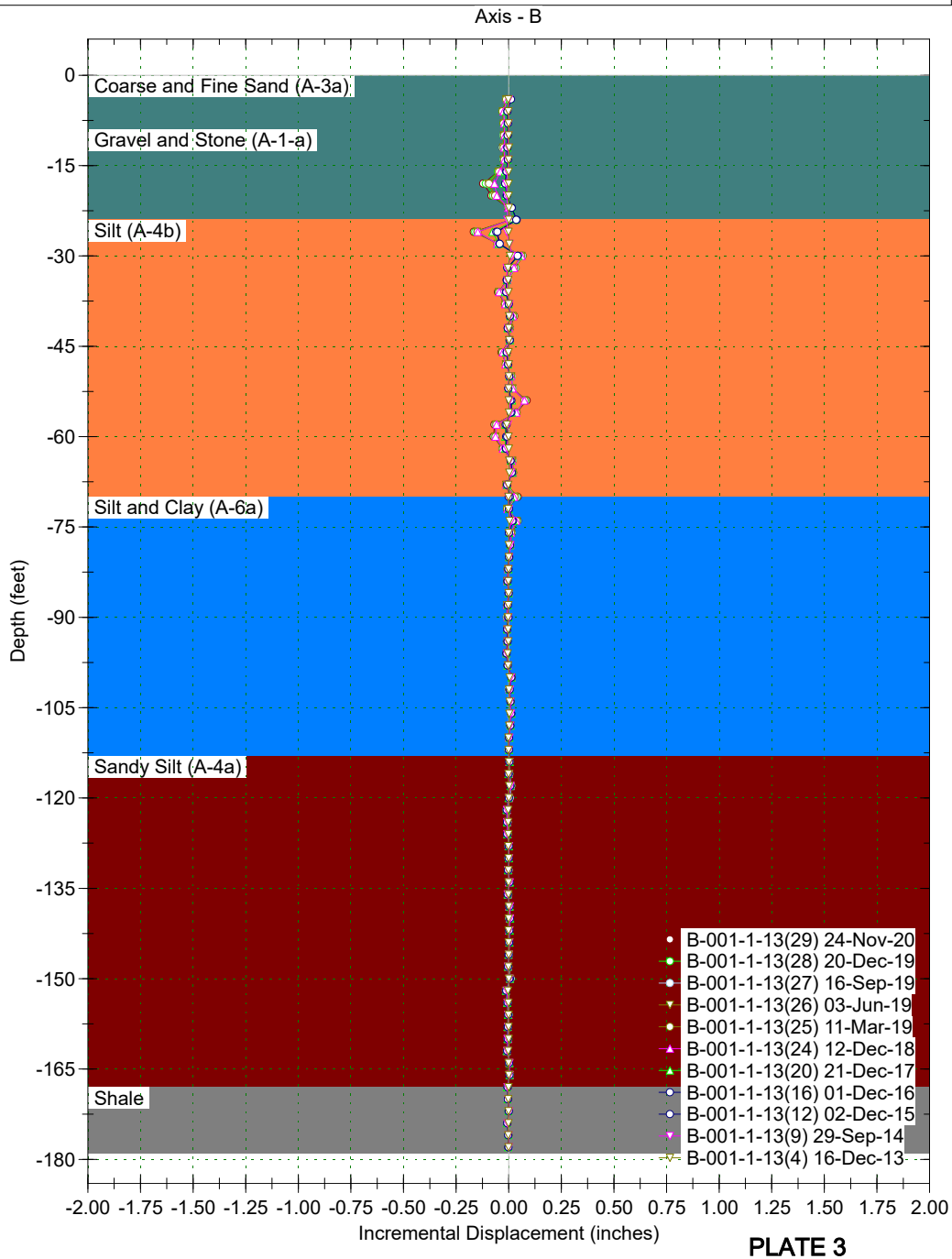


PLATE 3

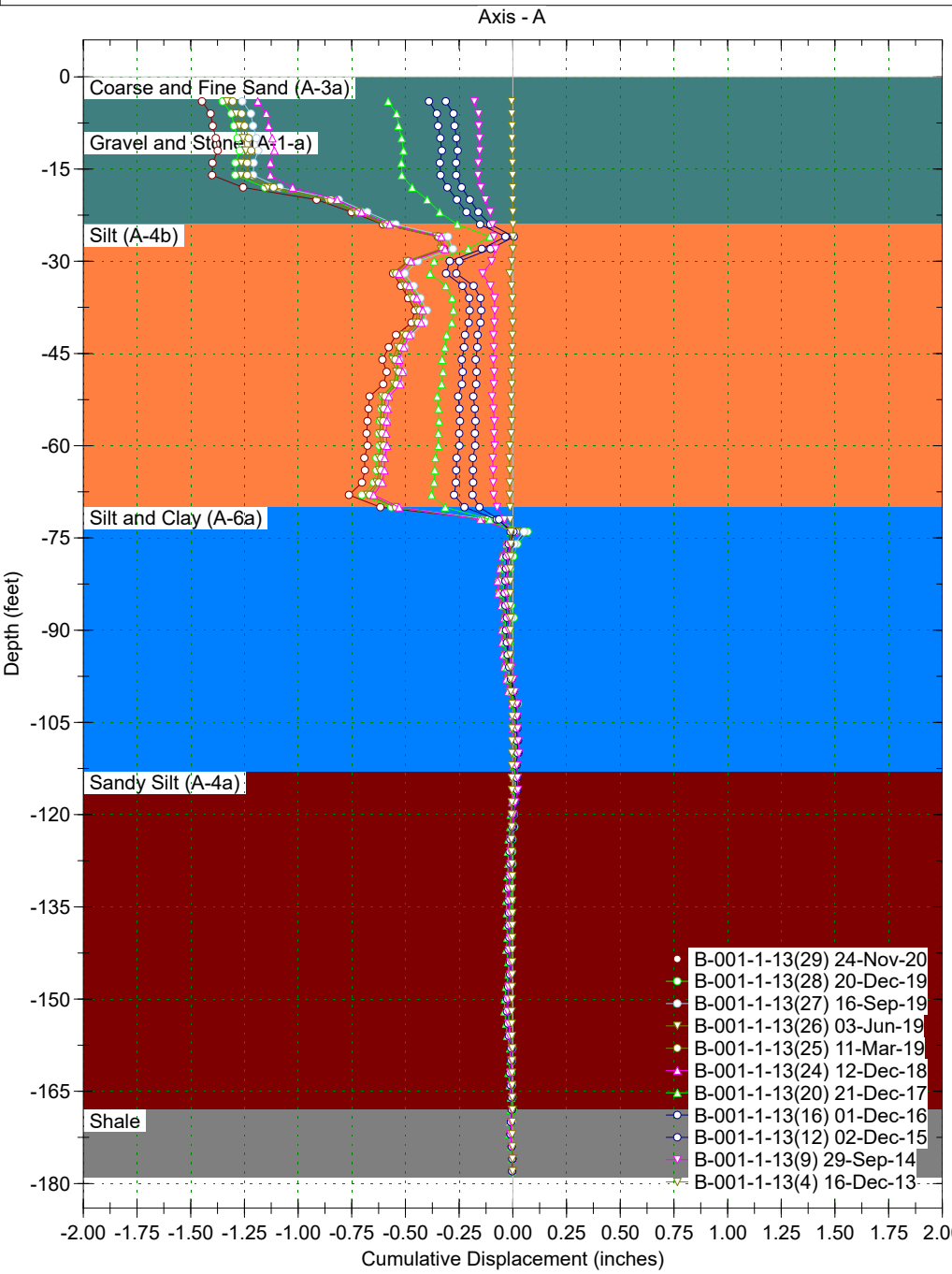
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-001-1-13
Project : Detroit Superior Bridge
Location :
Northing : 665949.799
Easting : 2186031.495
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 178.0 feet
A+ Groove Azimuth : 106° 23' 23"
Base Reading : 2013 Oct 21 13:15
Applied Azimuth : 0.0 degrees



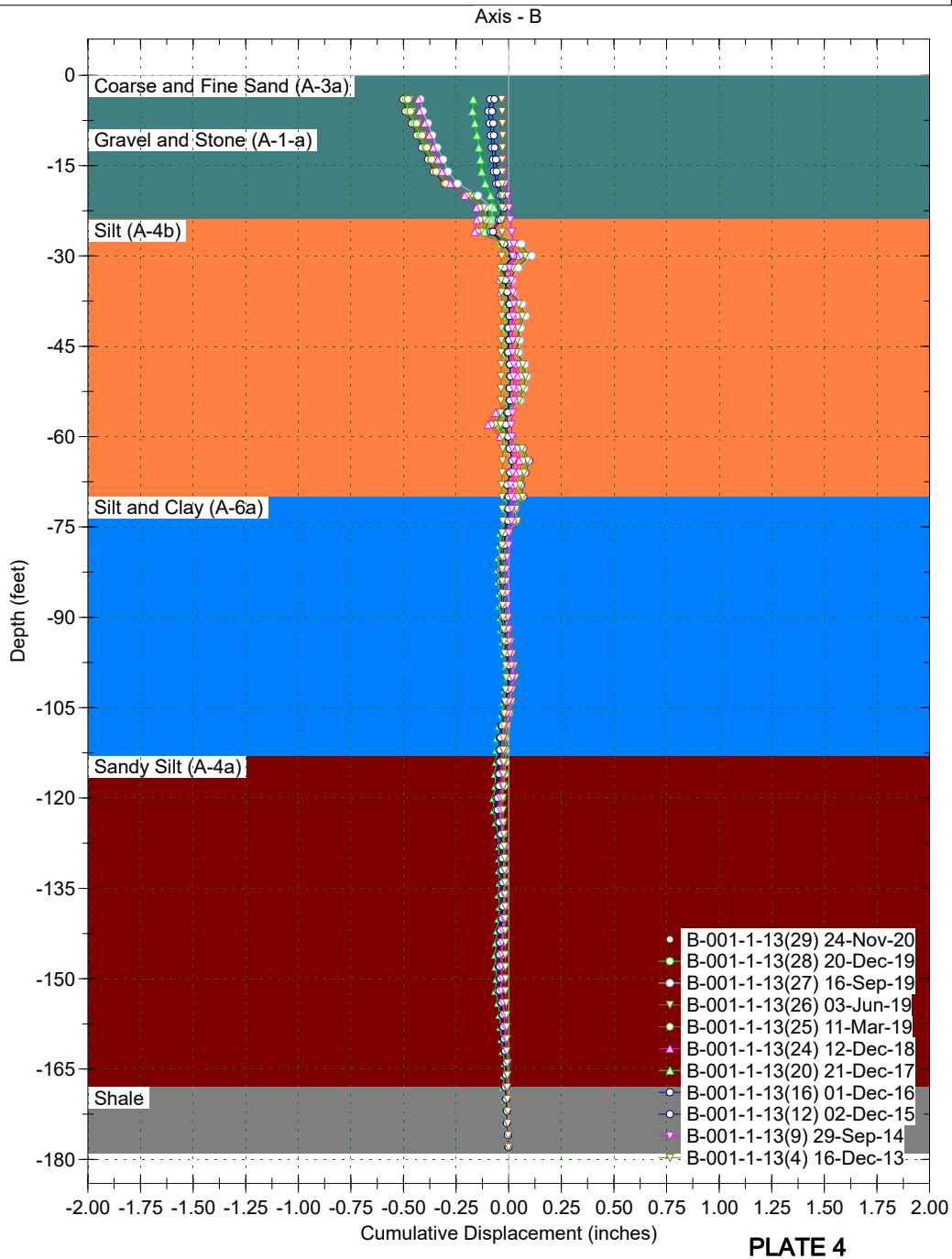


PLATE 4

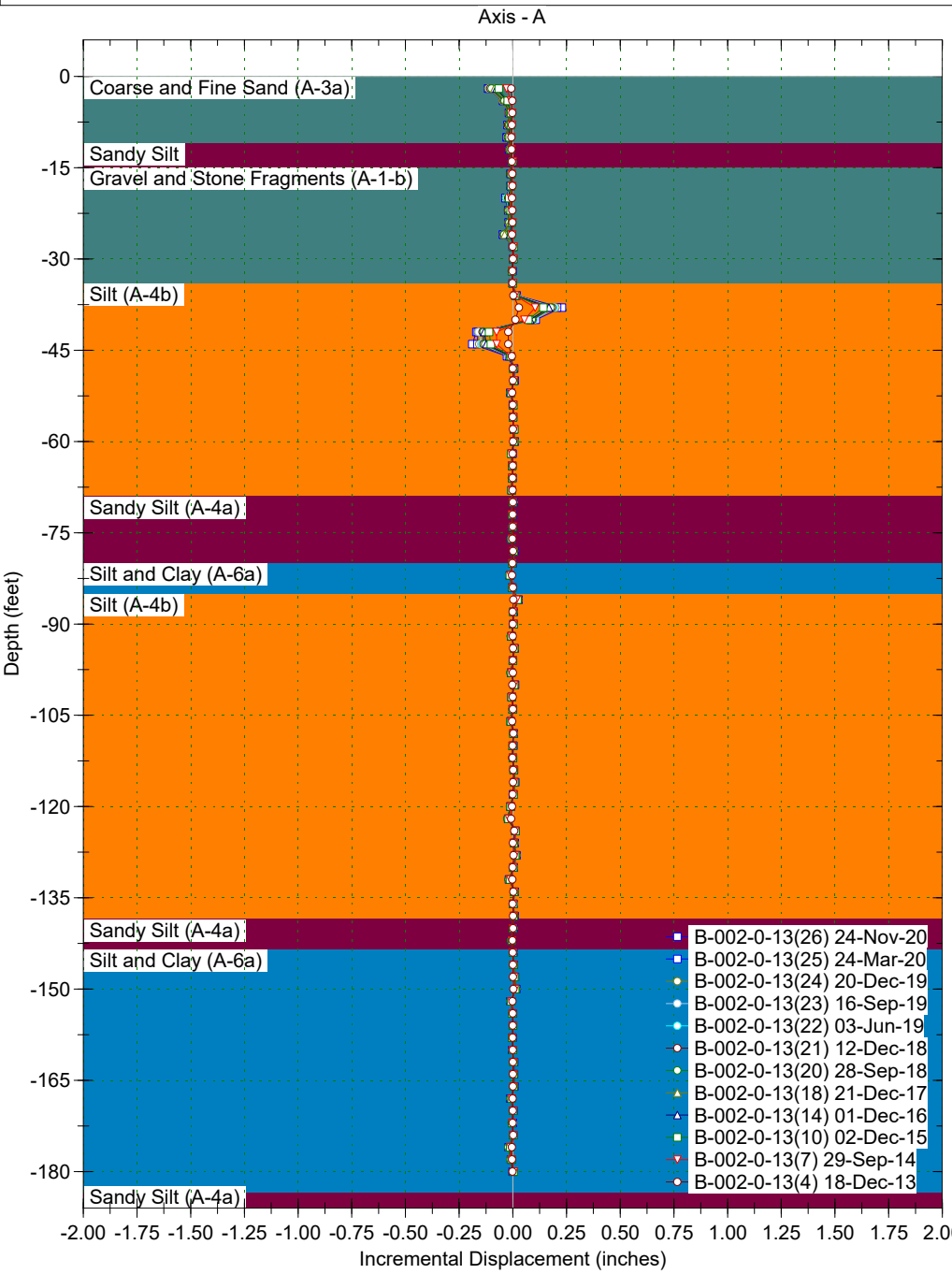
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-002-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666086.277
Easting : 2185989.688
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 180.0 feet
A+ Groove Azimuth : 108° 59' 32"
Base Reading : 2013 Oct 21 14:51
Applied Azimuth : 0.0 degrees



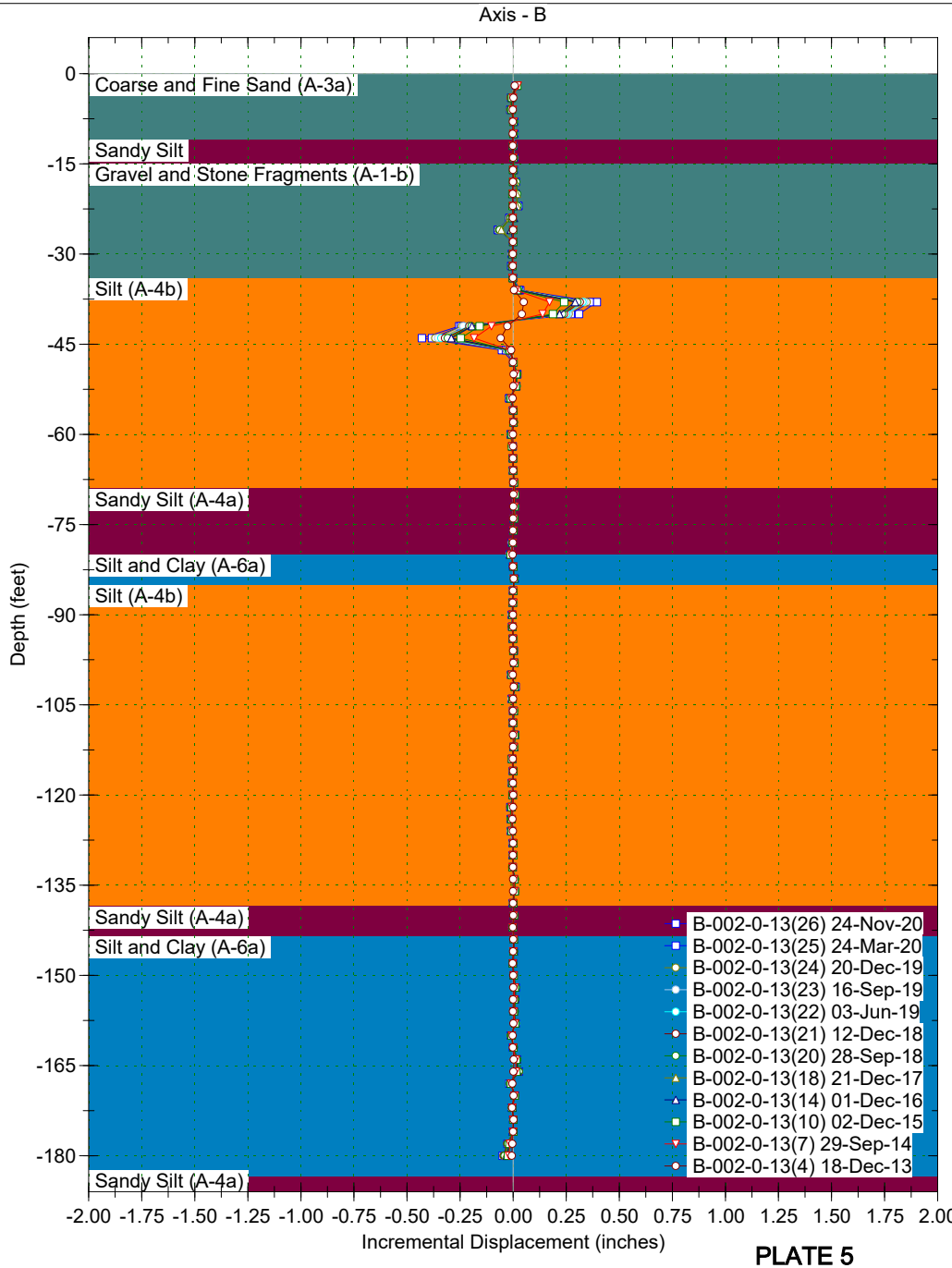


PLATE 5

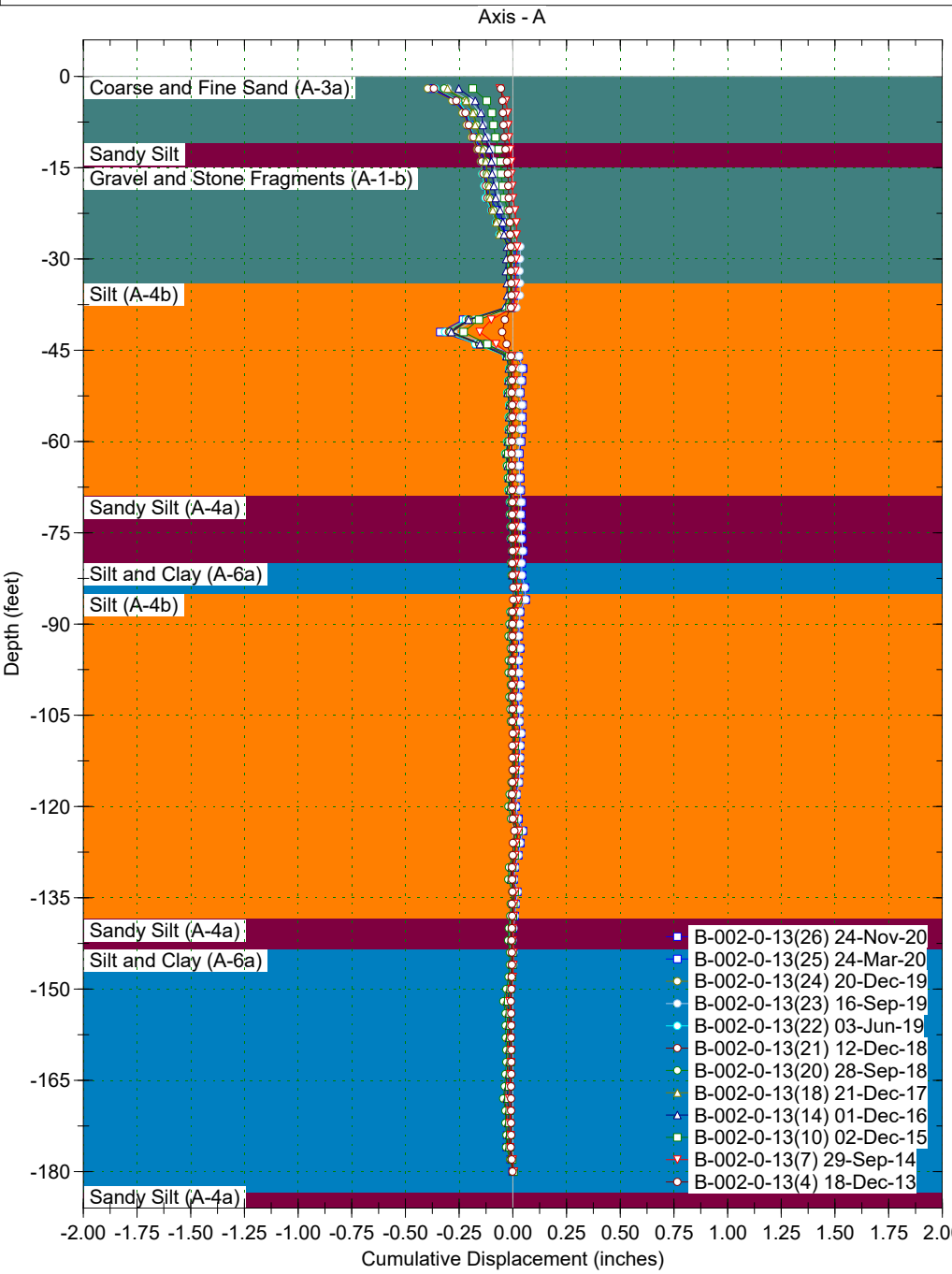
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-002-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666086.277
Easting : 2185989.688
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 180.0 feet
A+ Groove Azimuth : 108° 59' 32"
Base Reading : 2013 Oct 21 14:51
Applied Azimuth : 0.0 degrees



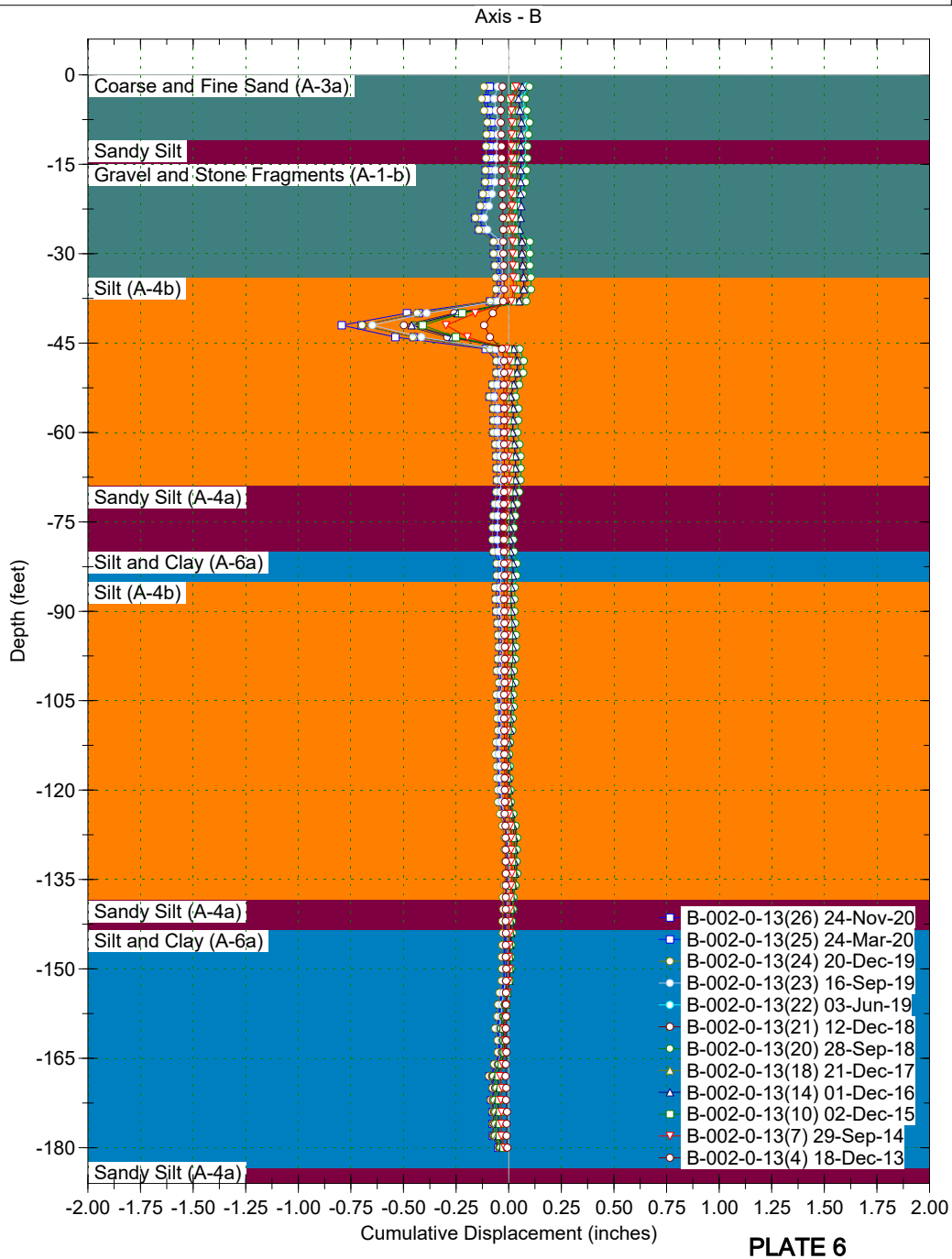


PLATE 6

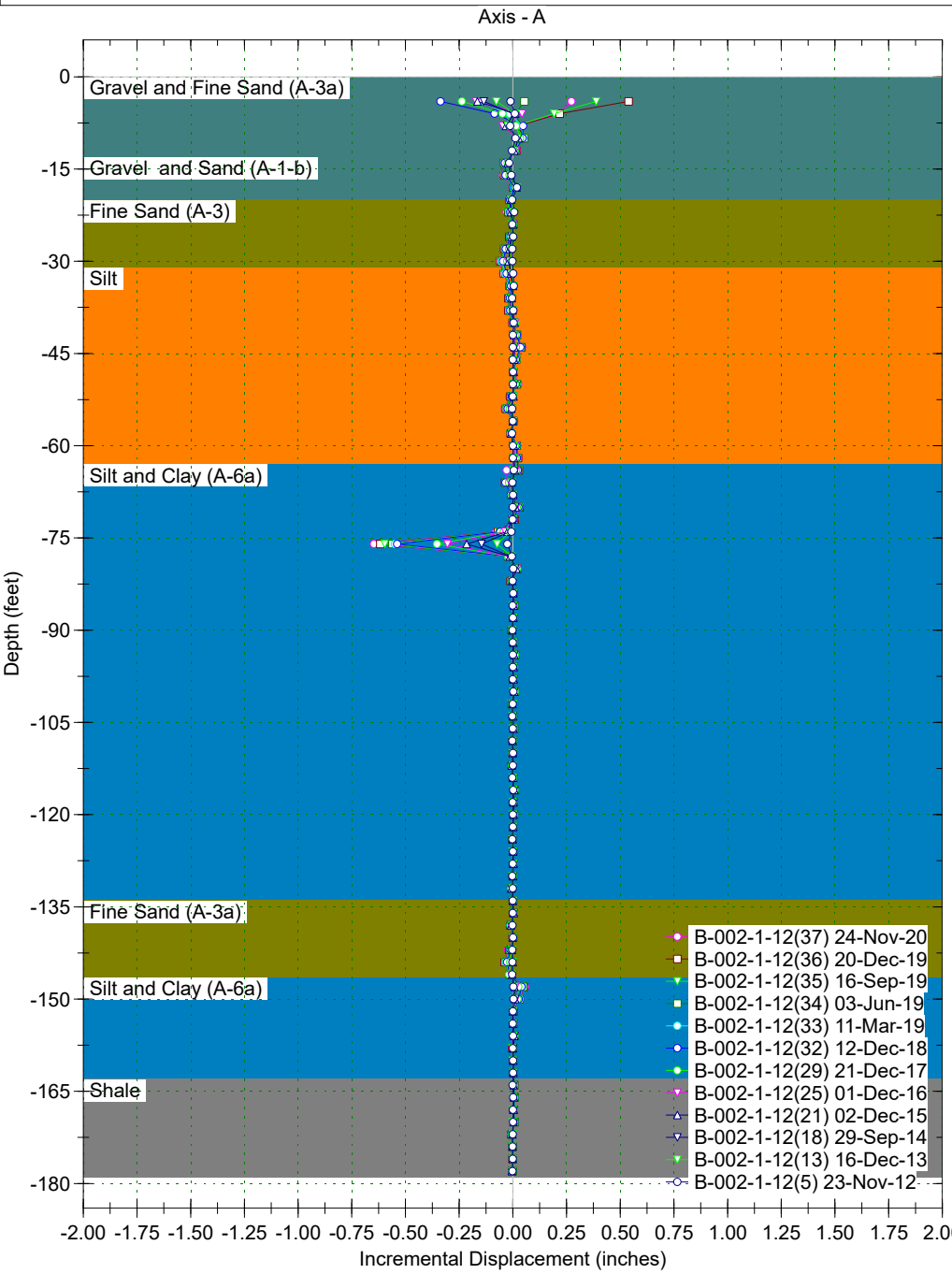
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-002-1-12
Project : Detroit Superior Bridge
Location :
Northing : 665999.036
Easting : 2186079.163
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 178.0 feet
A+ Groove Azimuth : 124° 0' 37"
Base Reading : 2012 Jun 25 10:24
Applied Azimuth : 0.0 degrees



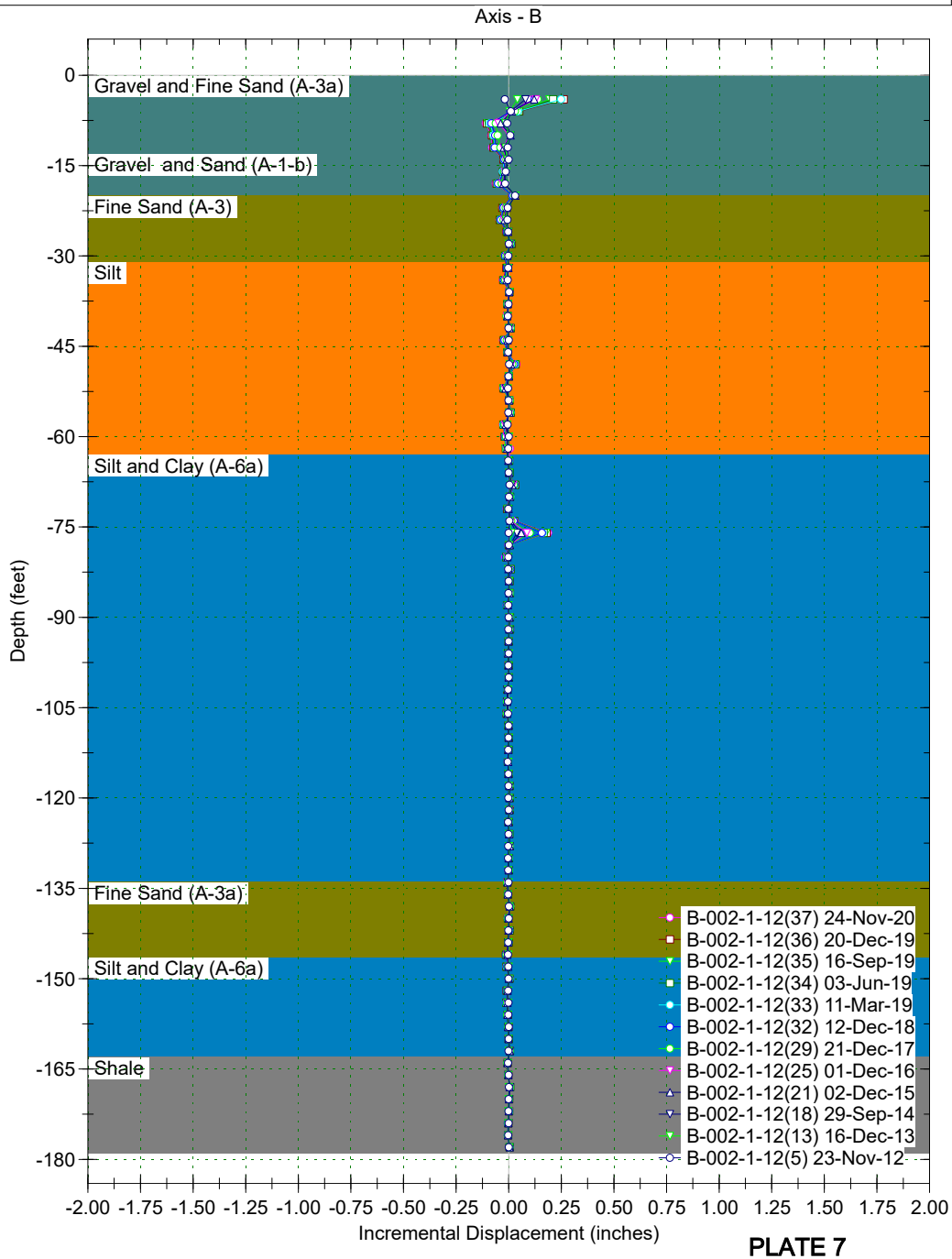


PLATE 7

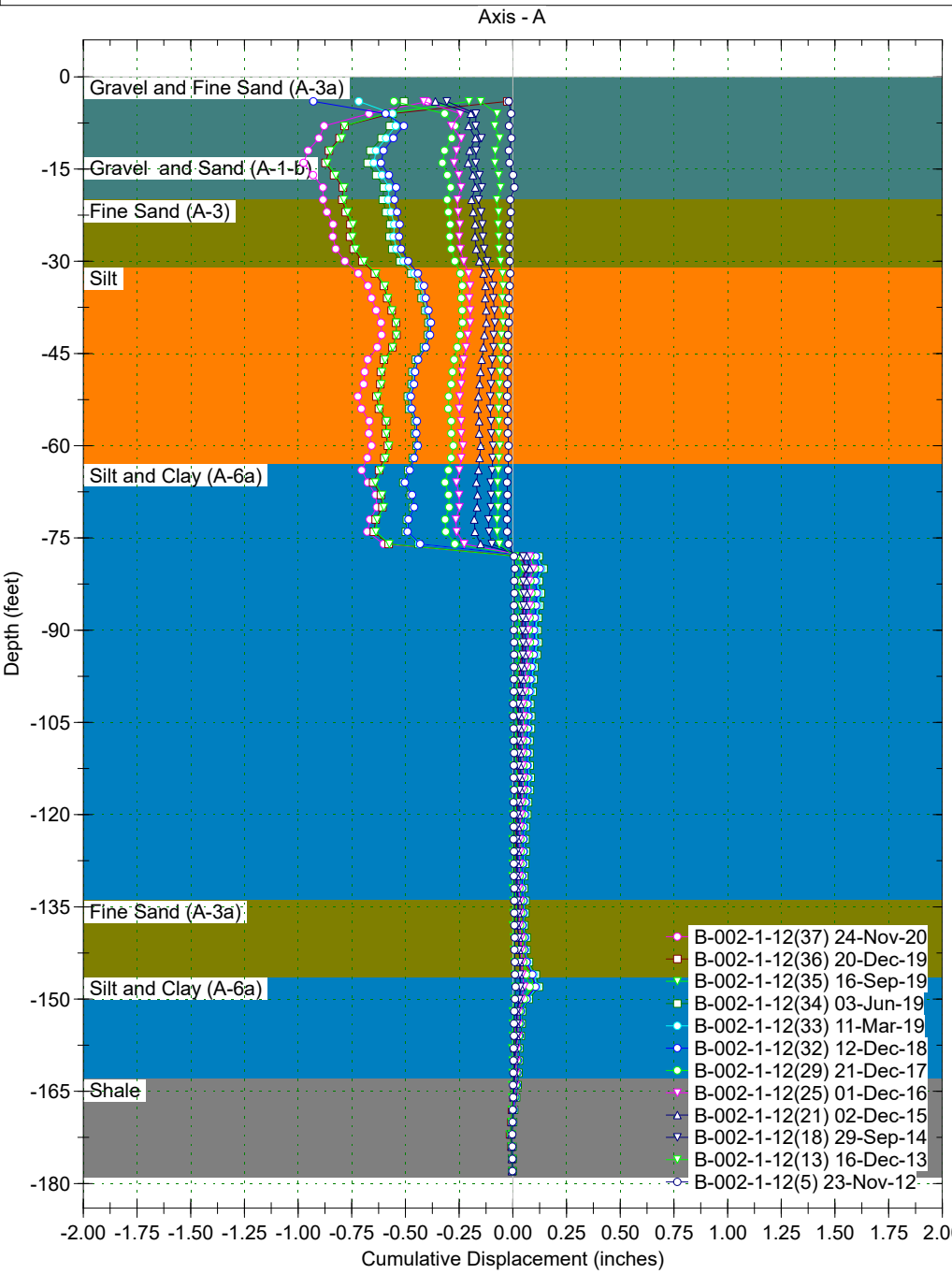
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-002-1-12
Project : Detroit Superior Bridge
Location :
Northing : 665999.036
Easting : 2186079.163
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 178.0 feet
A+ Groove Azimuth : 124° 0' 37"
Base Reading : 2012 Jun 25 10:24
Applied Azimuth : 0.0 degrees



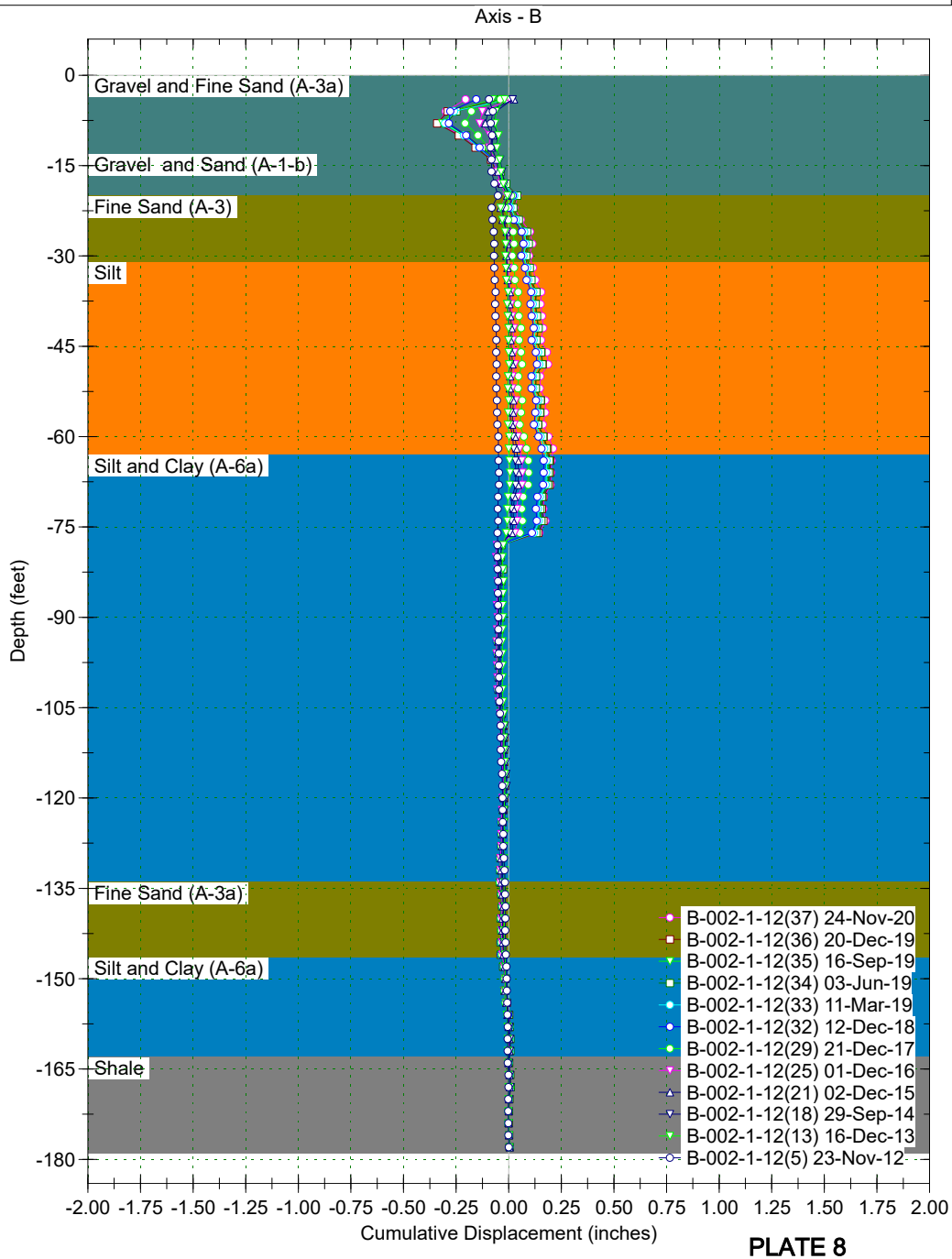


PLATE 8

RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-002-2-12
Project : Detroit Superior Bridge
Location :
Northing : 665959.660
Easting : 2186142.032
Collar :

Spiral Correction : N/A
Collar Elevation : 3.0 feet
Borehole Total Depth : 158.0 feet
A+ Groove Azimuth :
Base Reading : 2012 Jun 25 10:59
Applied Azimuth : 0.0 degrees

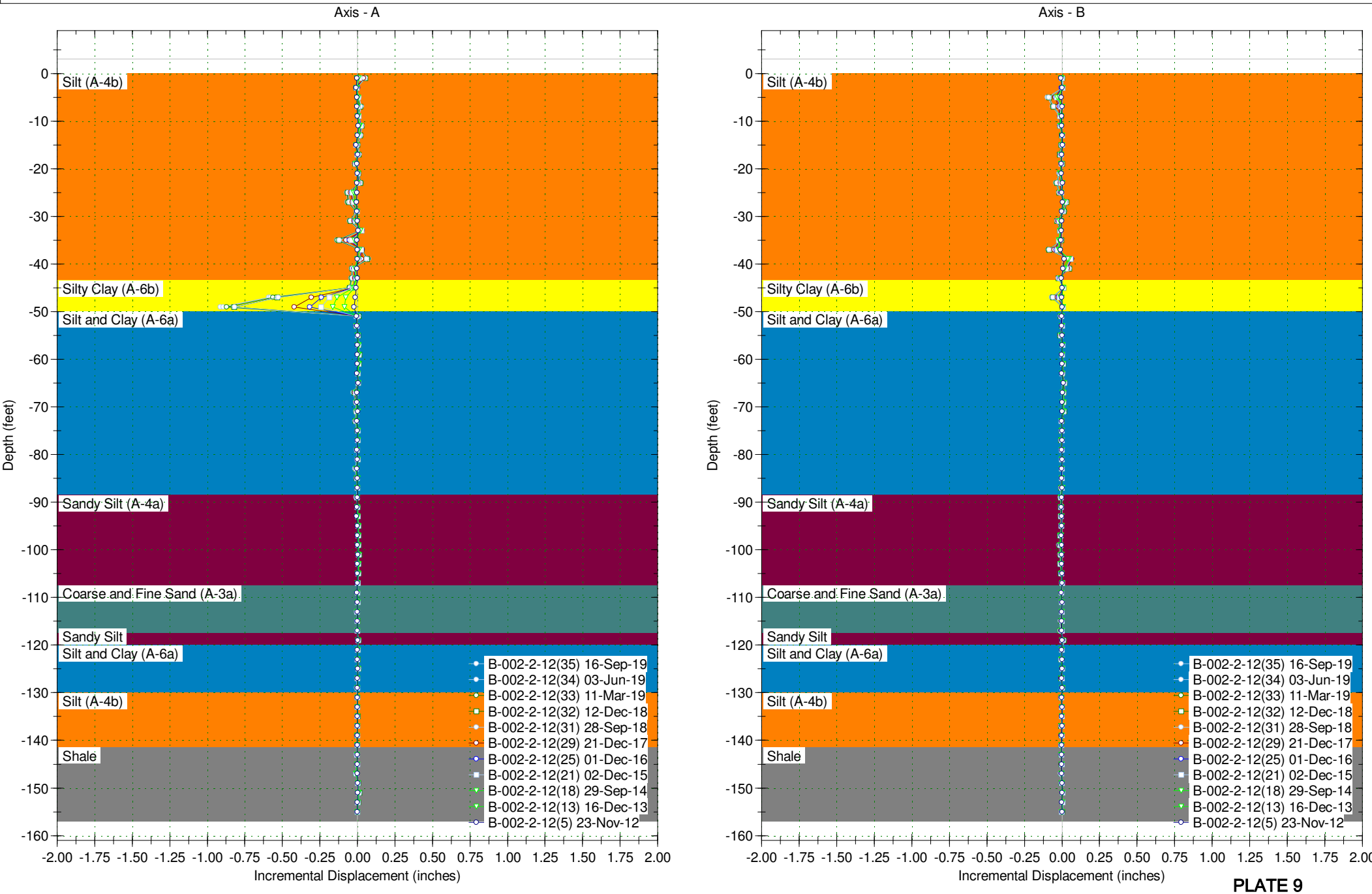


PLATE 9

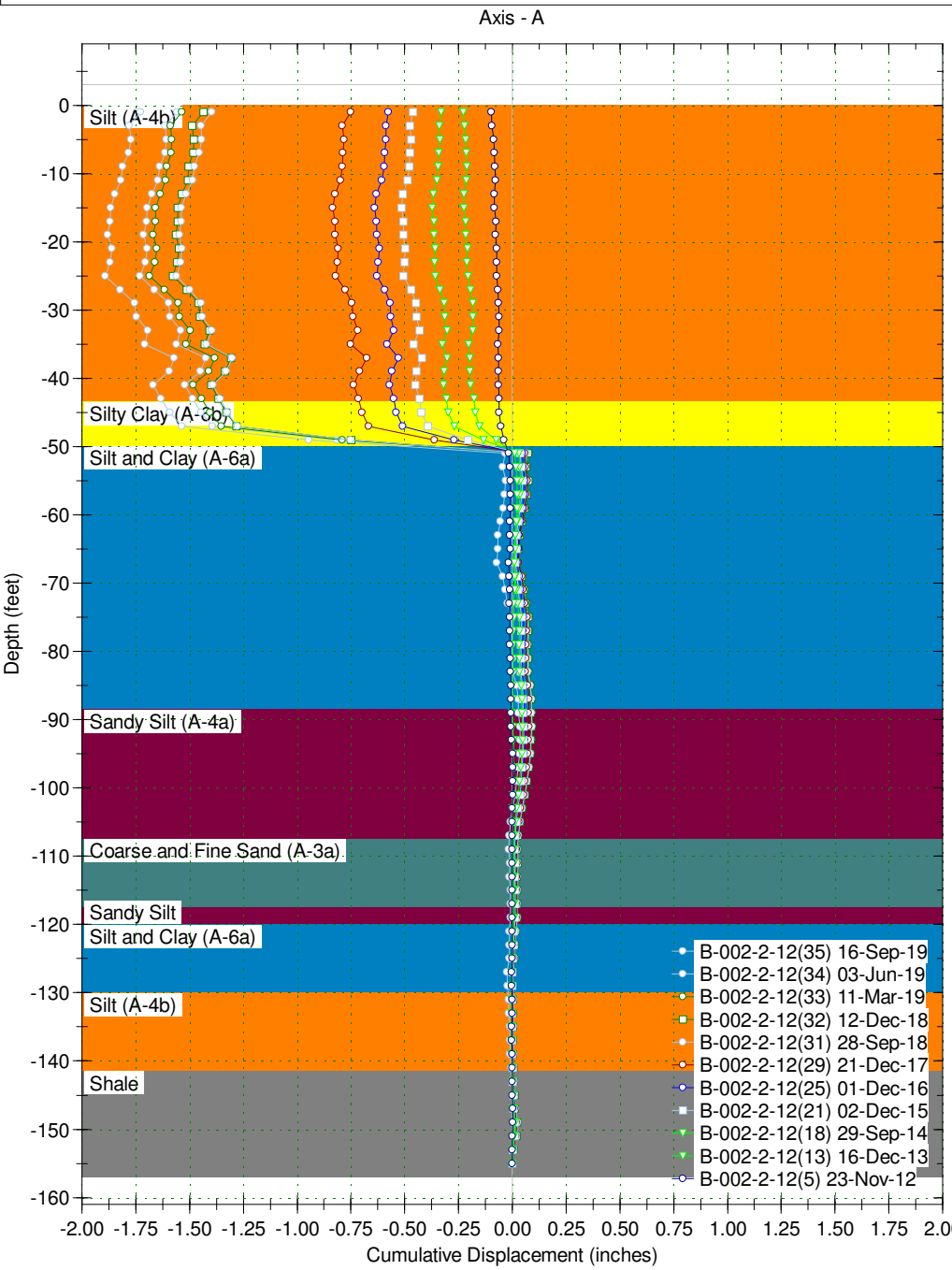
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-002-2-12
Project : Detroit Superior Bridge
Location :
Northing : 665959.660
Easting : 2186142.032
Collar :

Spiral Correction : N/A
Collar Elevation : 3.0 feet
Borehole Total Depth : 158.0 feet
A+ Groove Azimuth :
Base Reading : 2012 Jun 25 10:59
Applied Azimuth : 0.0 degrees



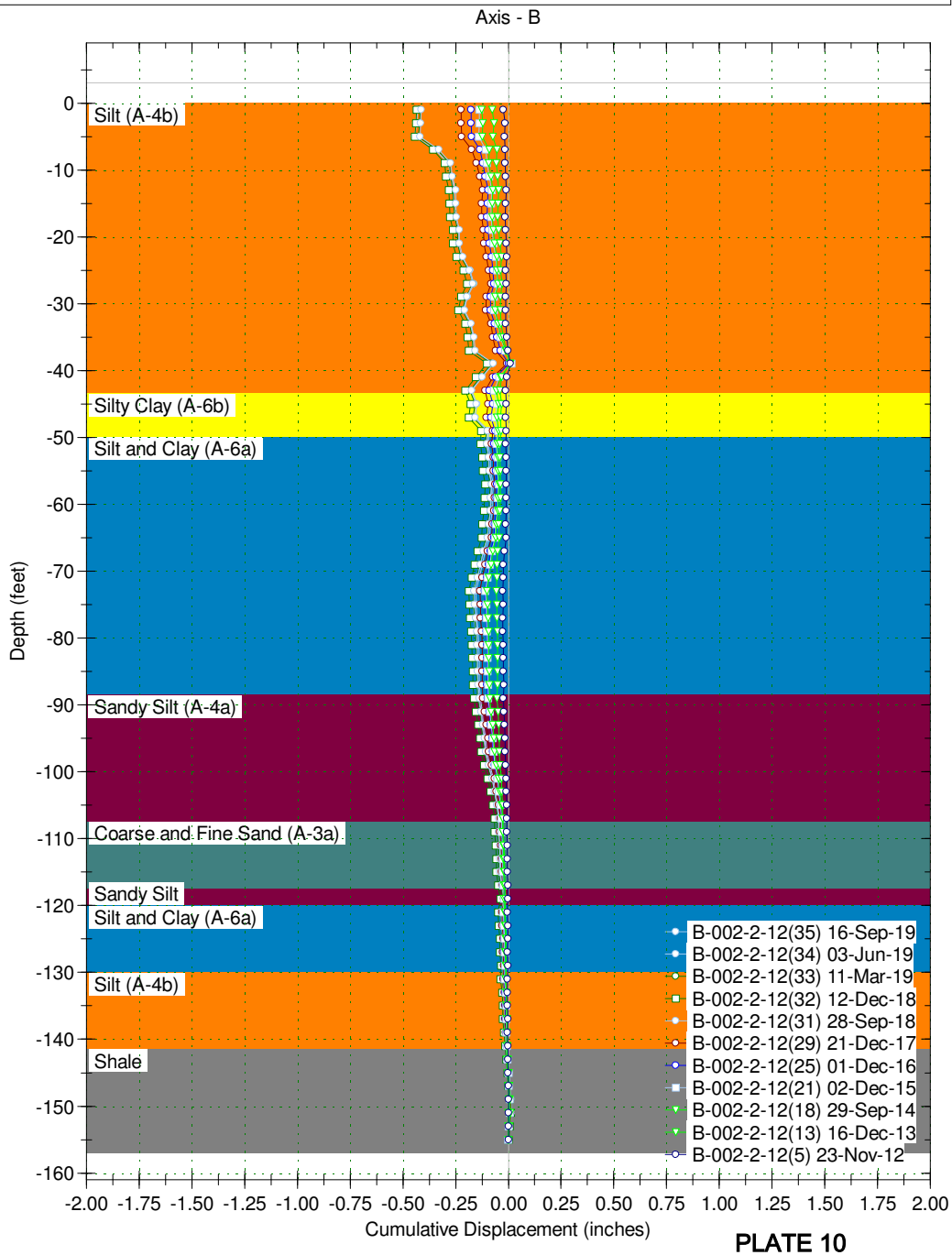


PLATE 10

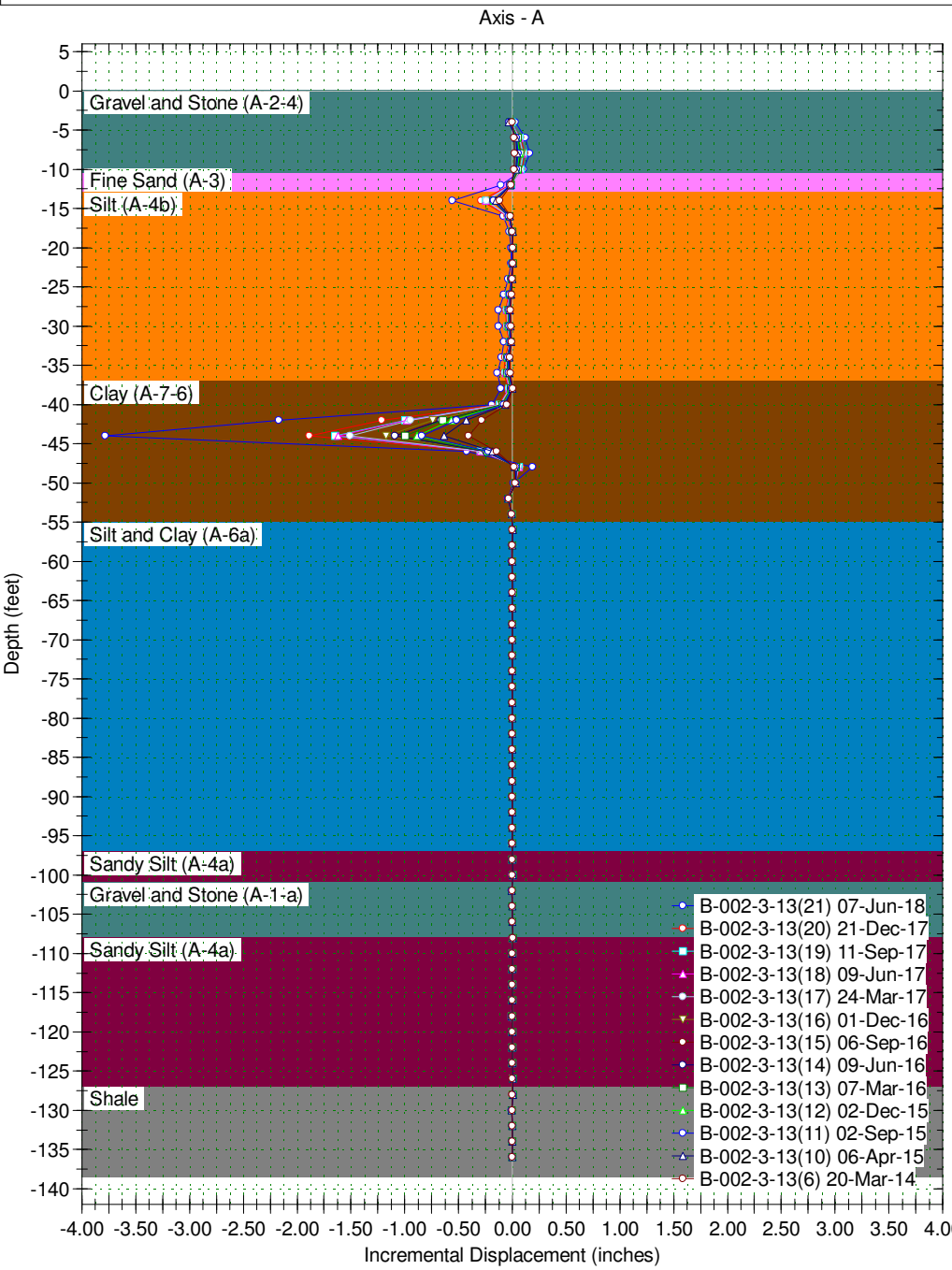
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : B-002-3-13
Project : Detroit Superior Bridge
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 136.0 feet
A+ Groove Azimuth :
Base Reading : 2013 Oct 15 14:34
Applied Azimuth : 0.0 degrees



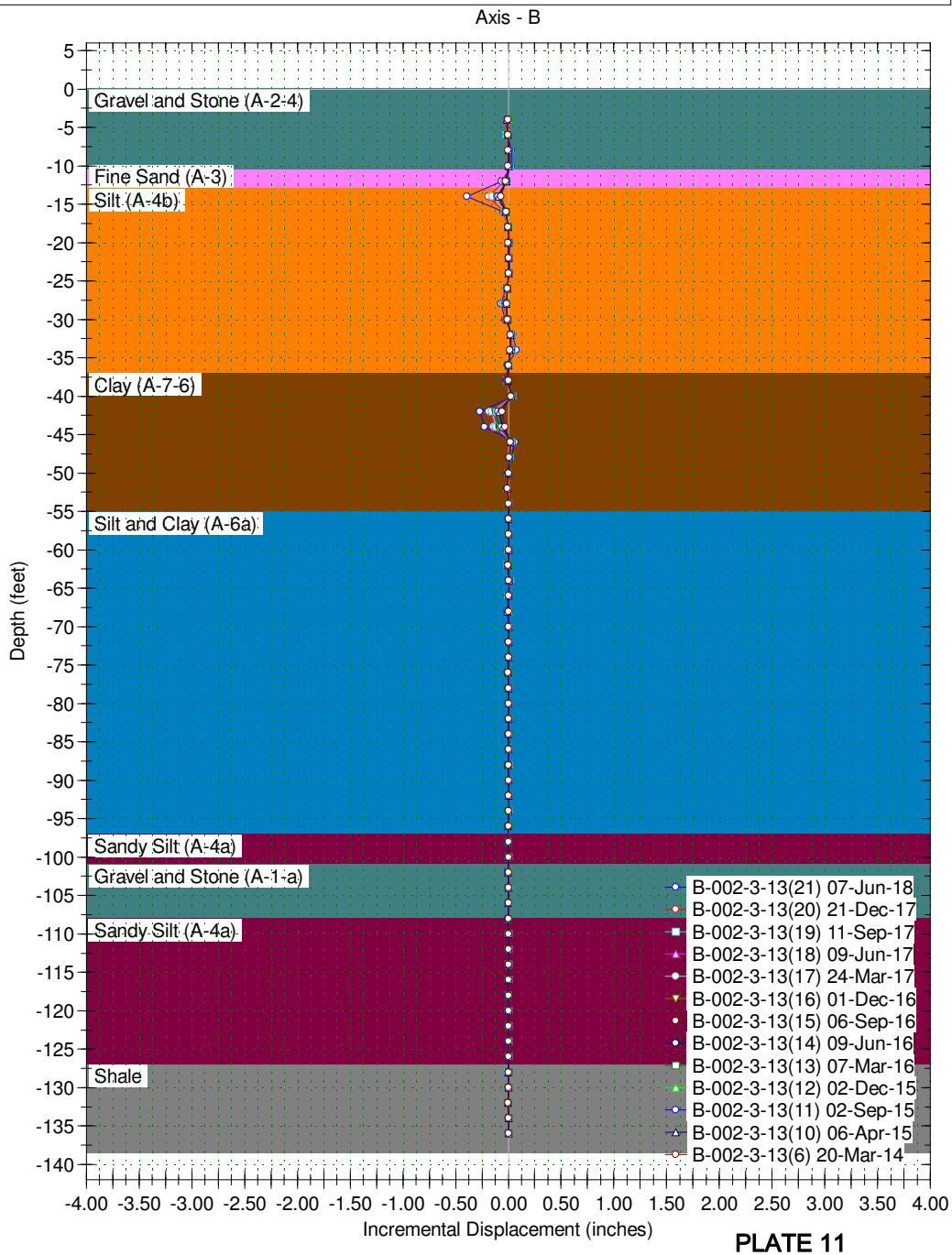


PLATE 11

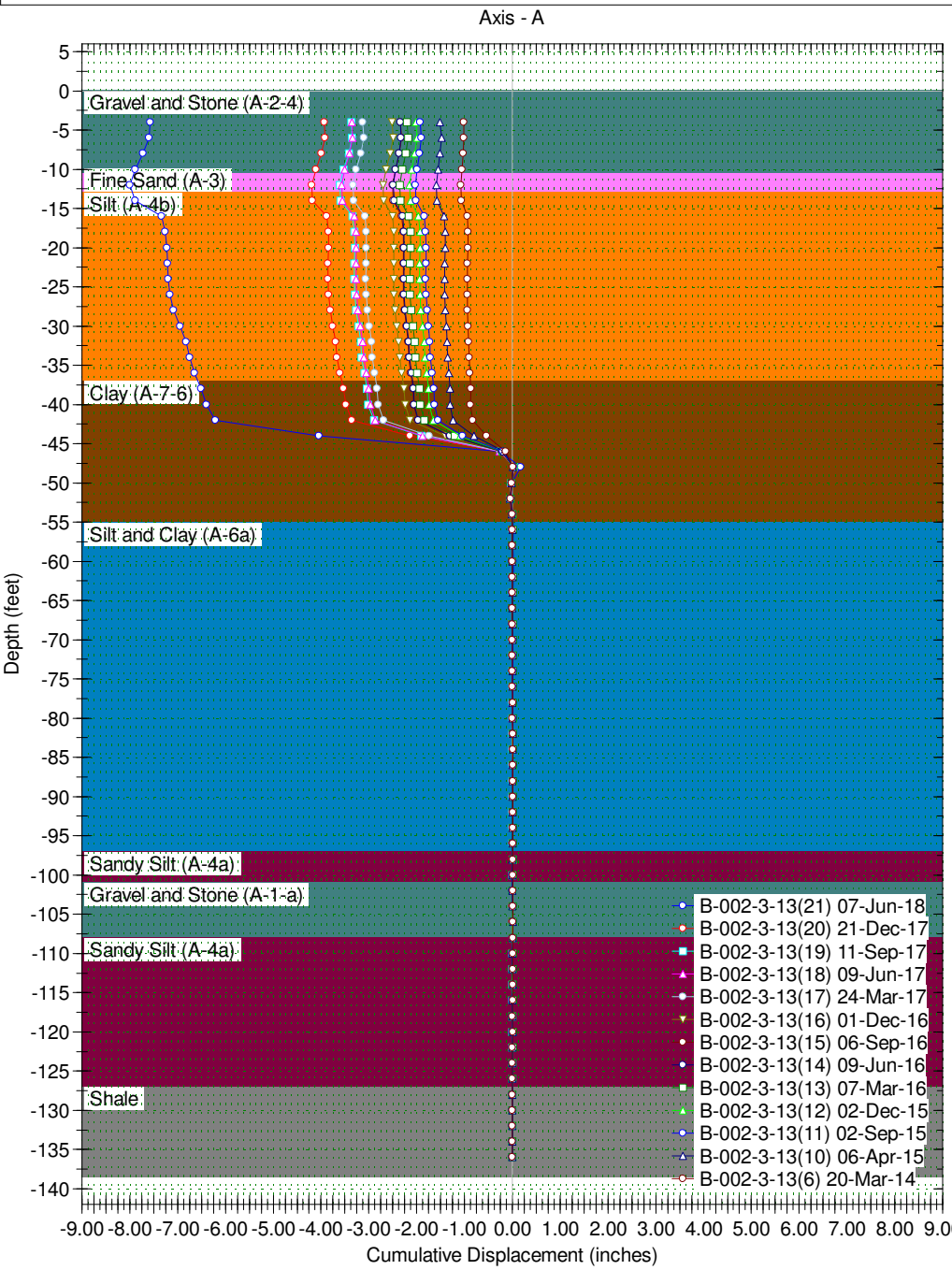
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.47.5

Borehole : B-002-3-13
Project : Detroit Superior Bridge
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 136.0 feet
A+ Groove Azimuth :
Base Reading : 2013 Oct 15 14:34
Applied Azimuth : 0.0 degrees



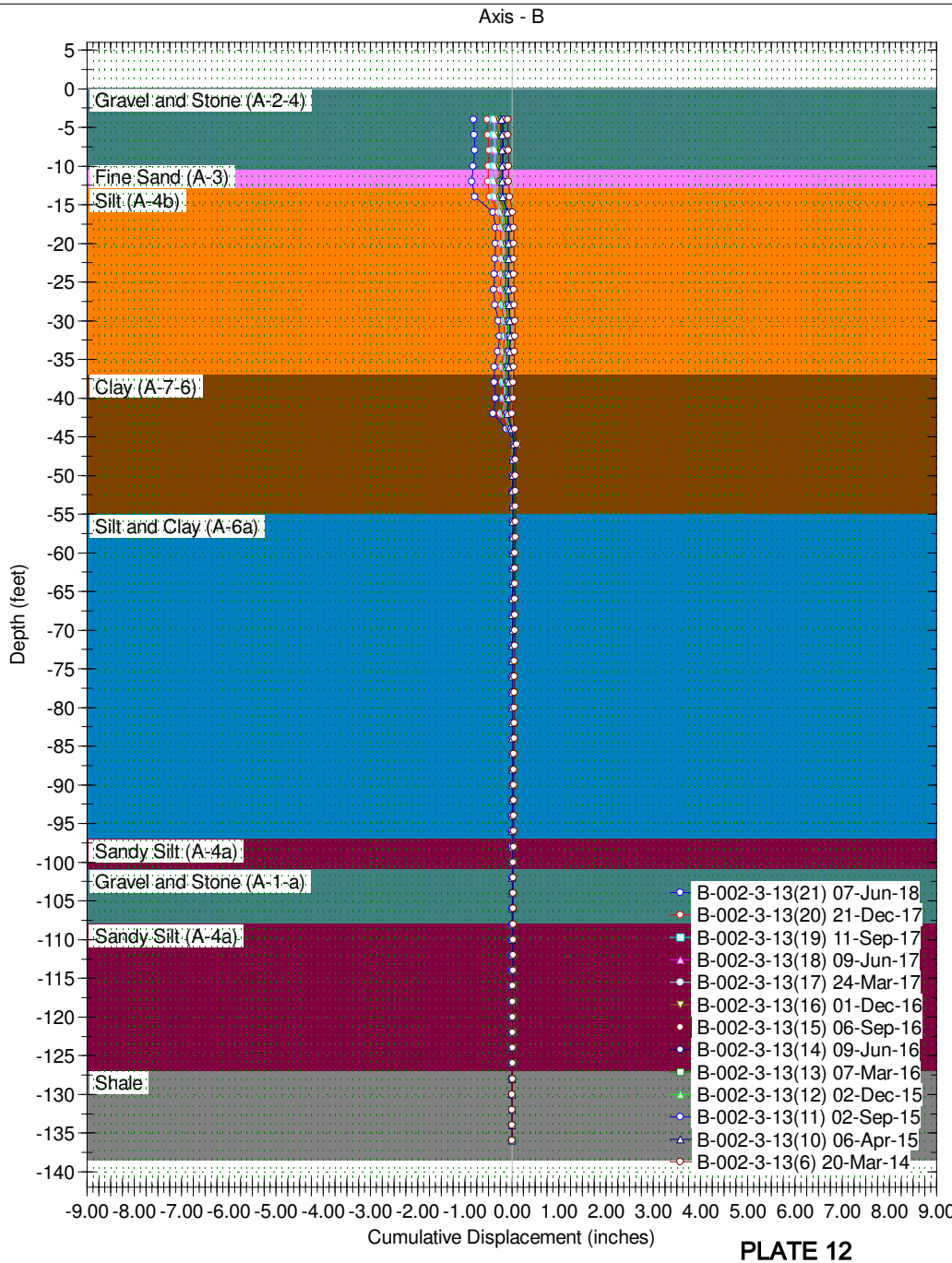


PLATE 12

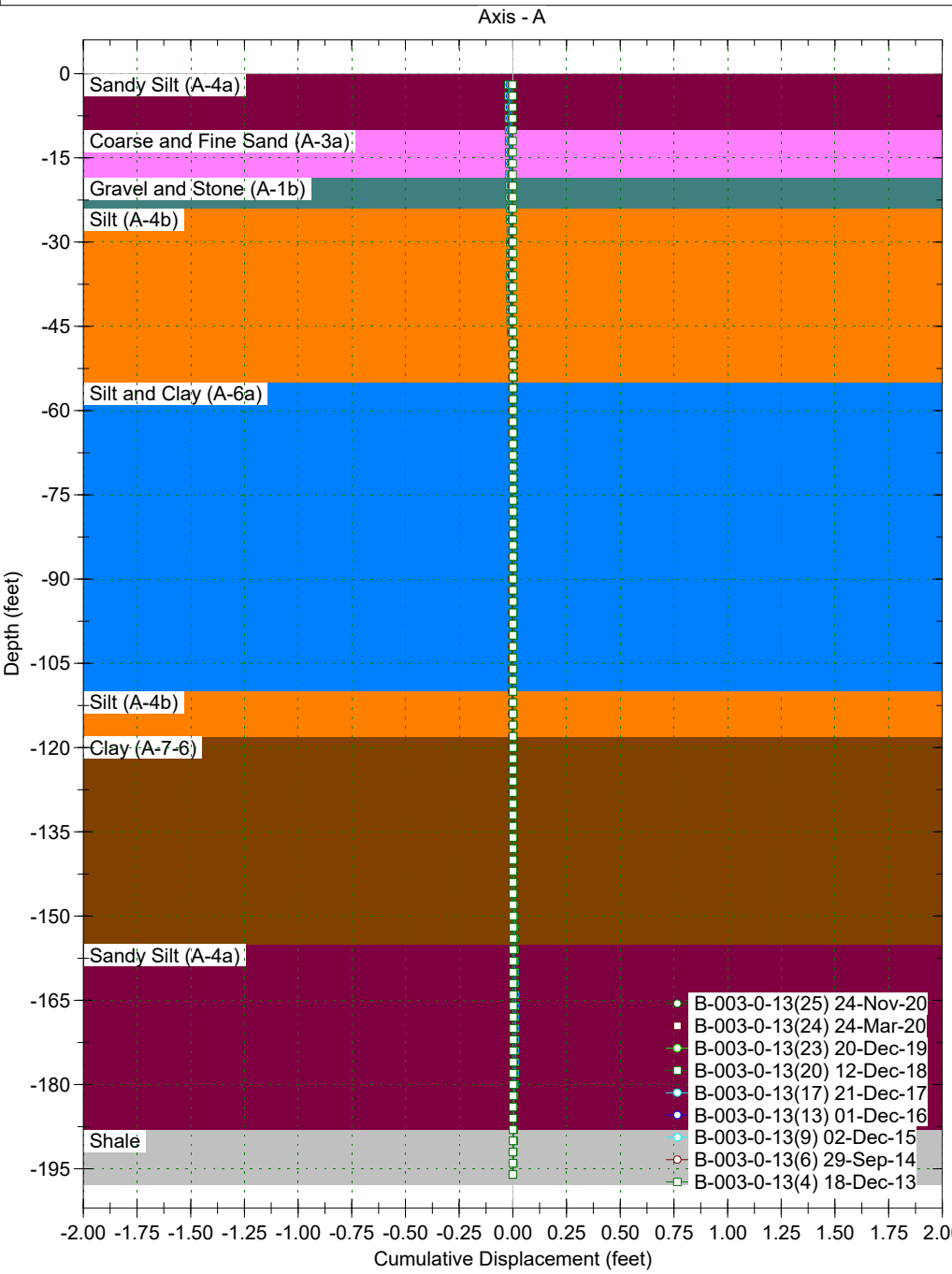
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-003-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666142.484
Easting : 2186047.131
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 196.0 feet
A+ Groove Azimuth : 144° 36' 46"
Base Reading : 2013 Oct 21 14:25
Applied Azimuth : 0.0 degrees



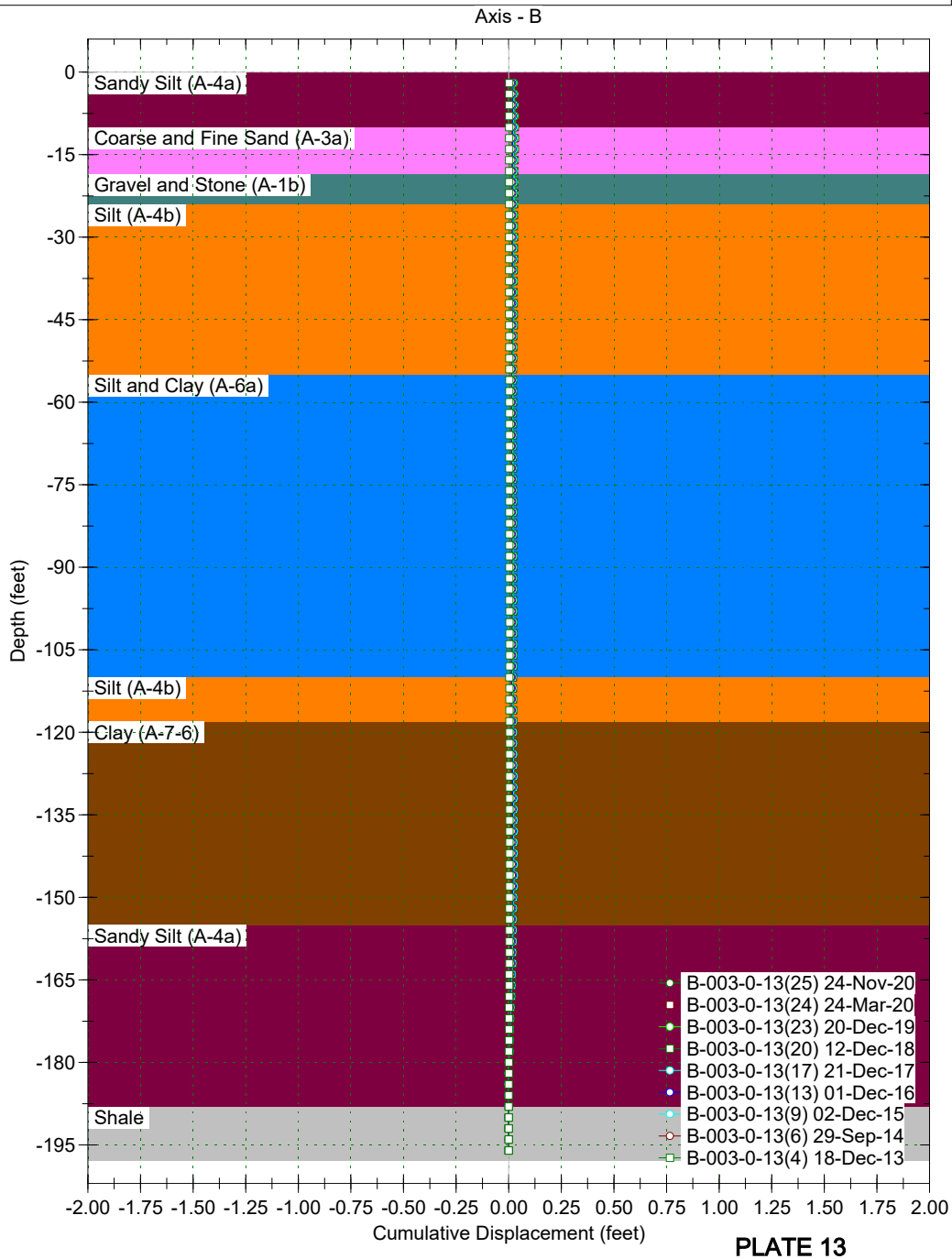


PLATE 13

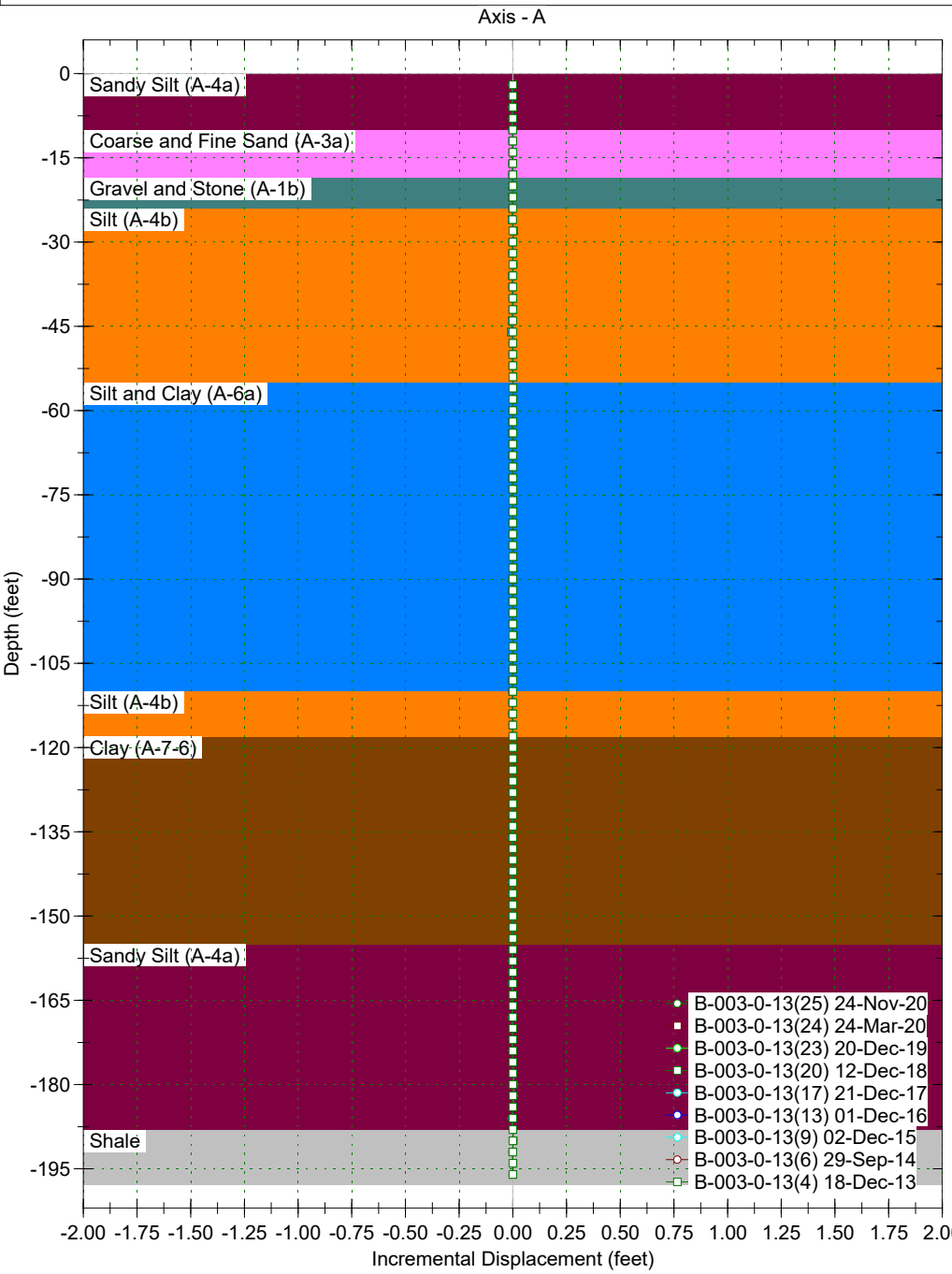
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-003-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666142.484
Easting : 2186047.131
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 196.0 feet
A+ Groove Azimuth : 144° 36' 46"
Base Reading : 2013 Oct 21 14:25
Applied Azimuth : 0.0 degrees



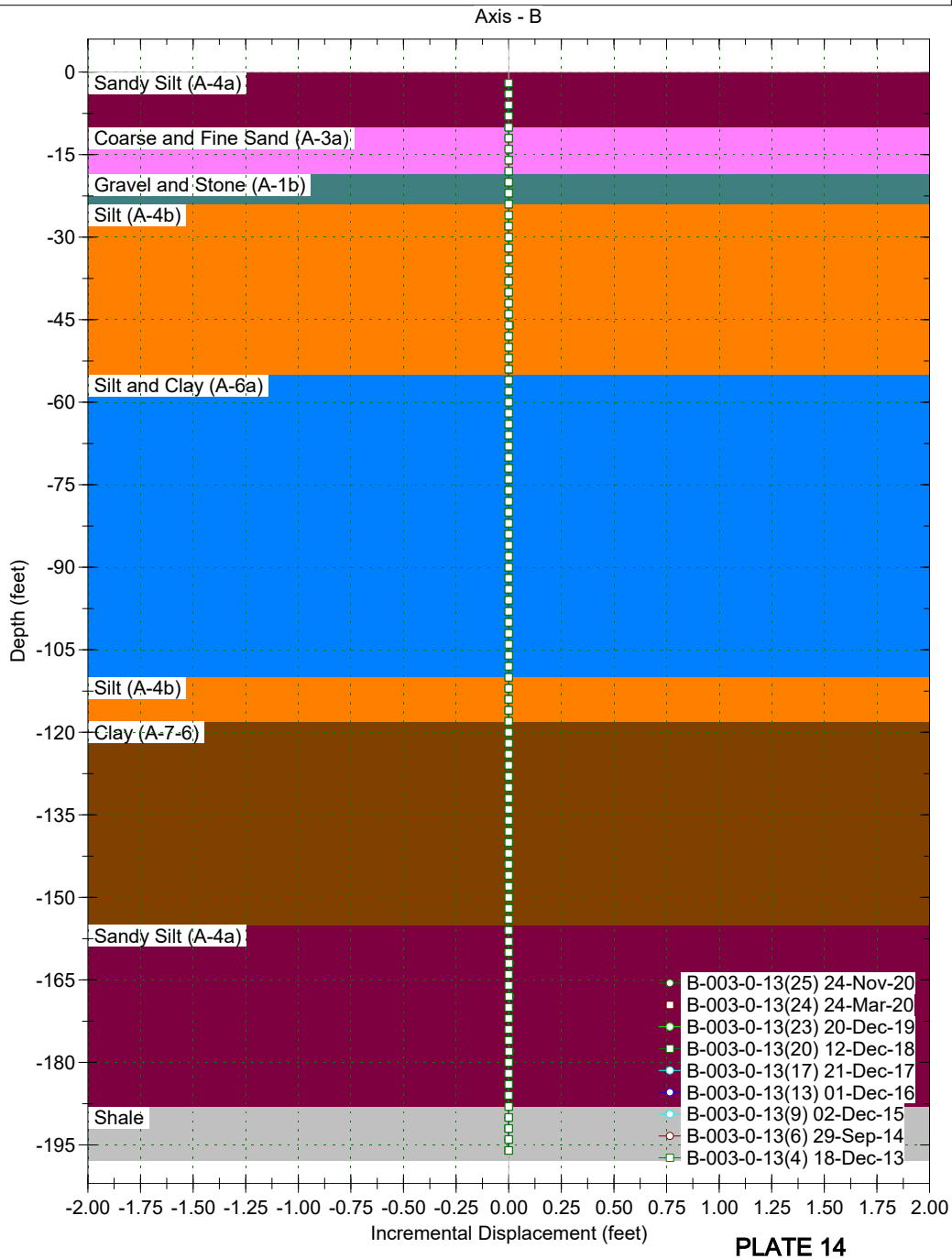


PLATE 14

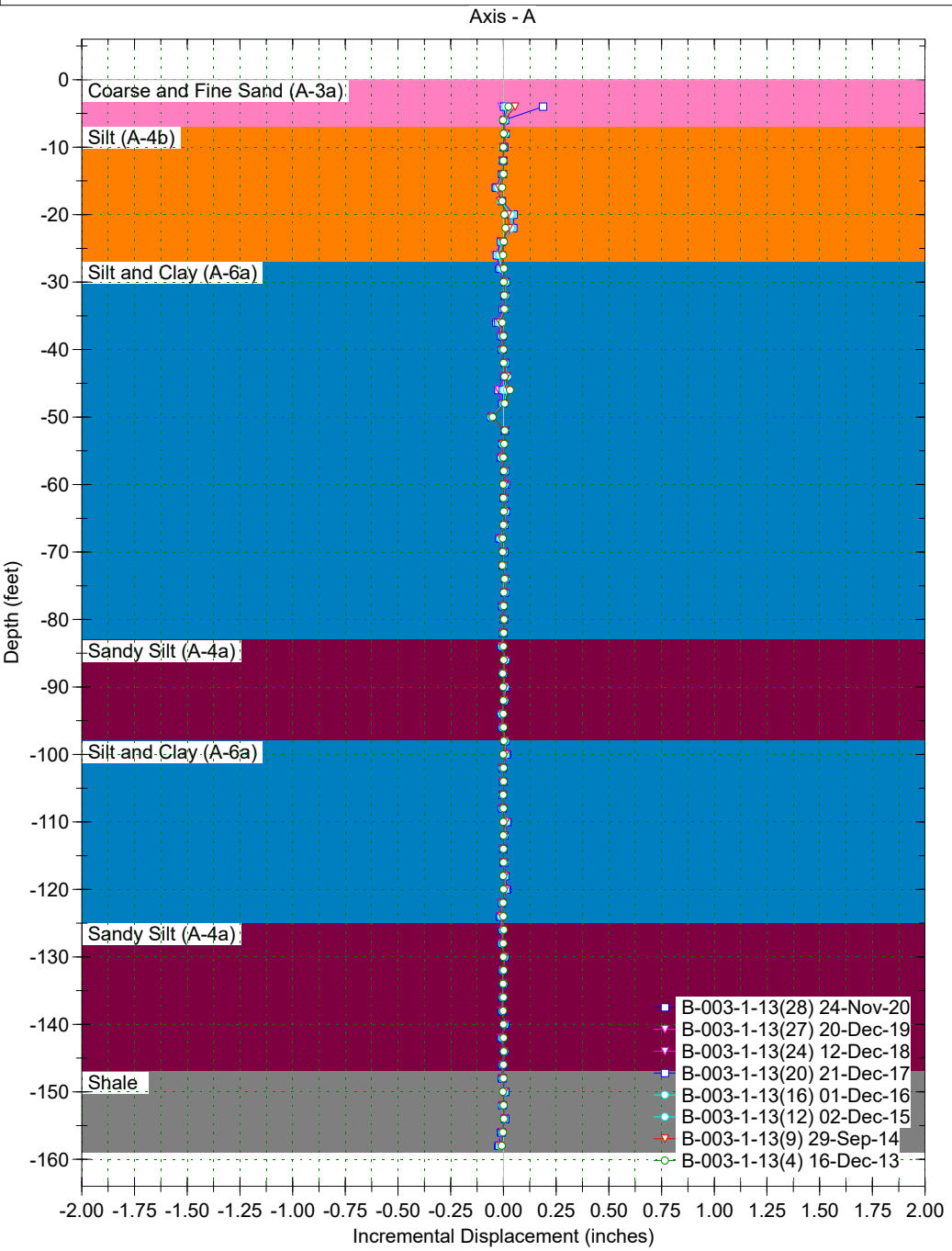
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-003-1-13
Project : Detroit Superior Bridge
Location :
Northing : 666168.638
Easting : 2186264.665
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 158.0 feet
A+ Groove Azimuth : 113° 50' 43"
Base Reading : 2013 Oct 15 15:21
Applied Azimuth : 0.0 degrees



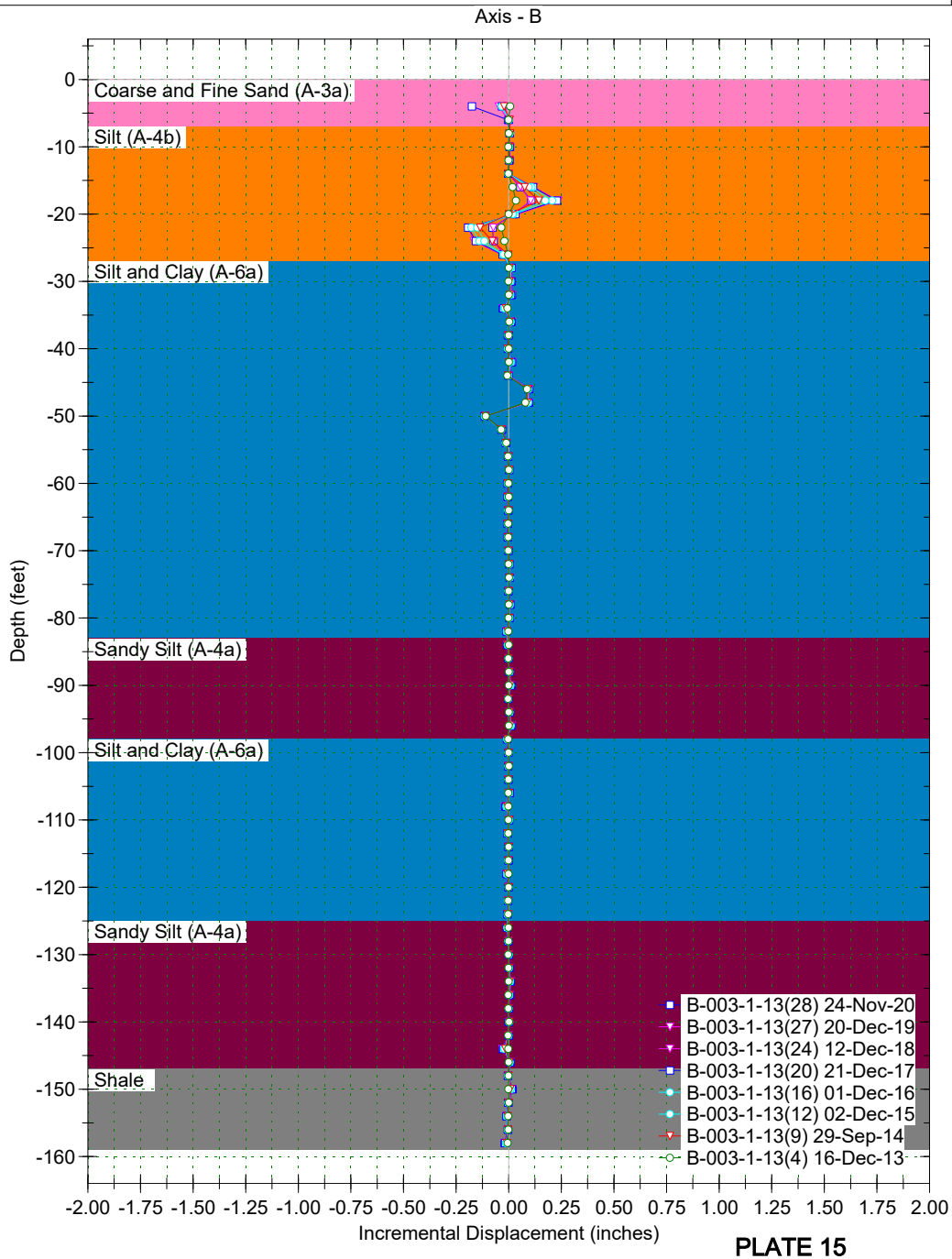


PLATE 15

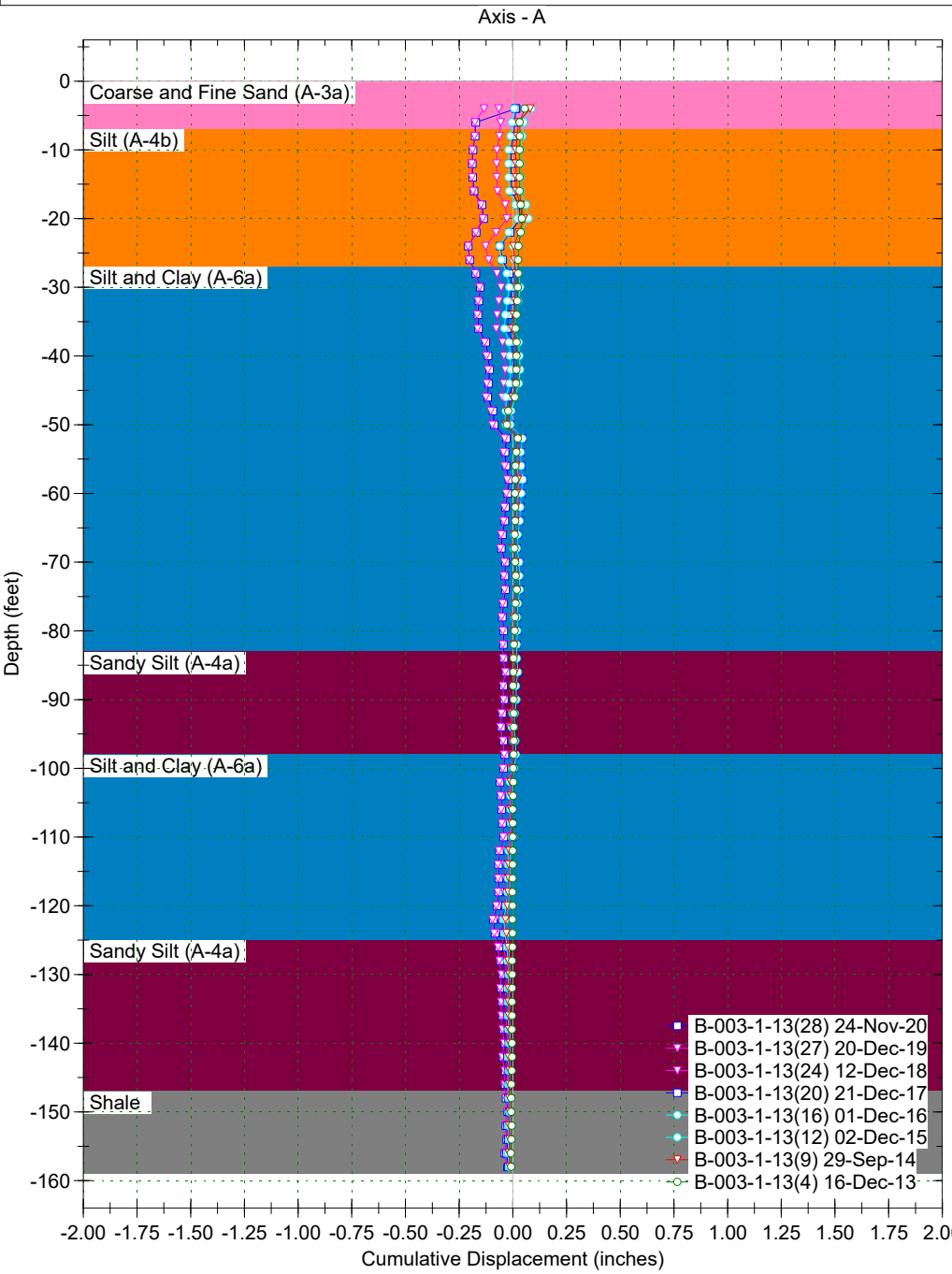
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-003-1-13
Project : Detroit Superior Bridge
Location :
Northing : 666168.638
Easting : 2186264.665
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 158.0 feet
A+ Groove Azimuth : 113° 50' 43"
Base Reading : 2013 Oct 15 15:21
Applied Azimuth : 0.0 degrees



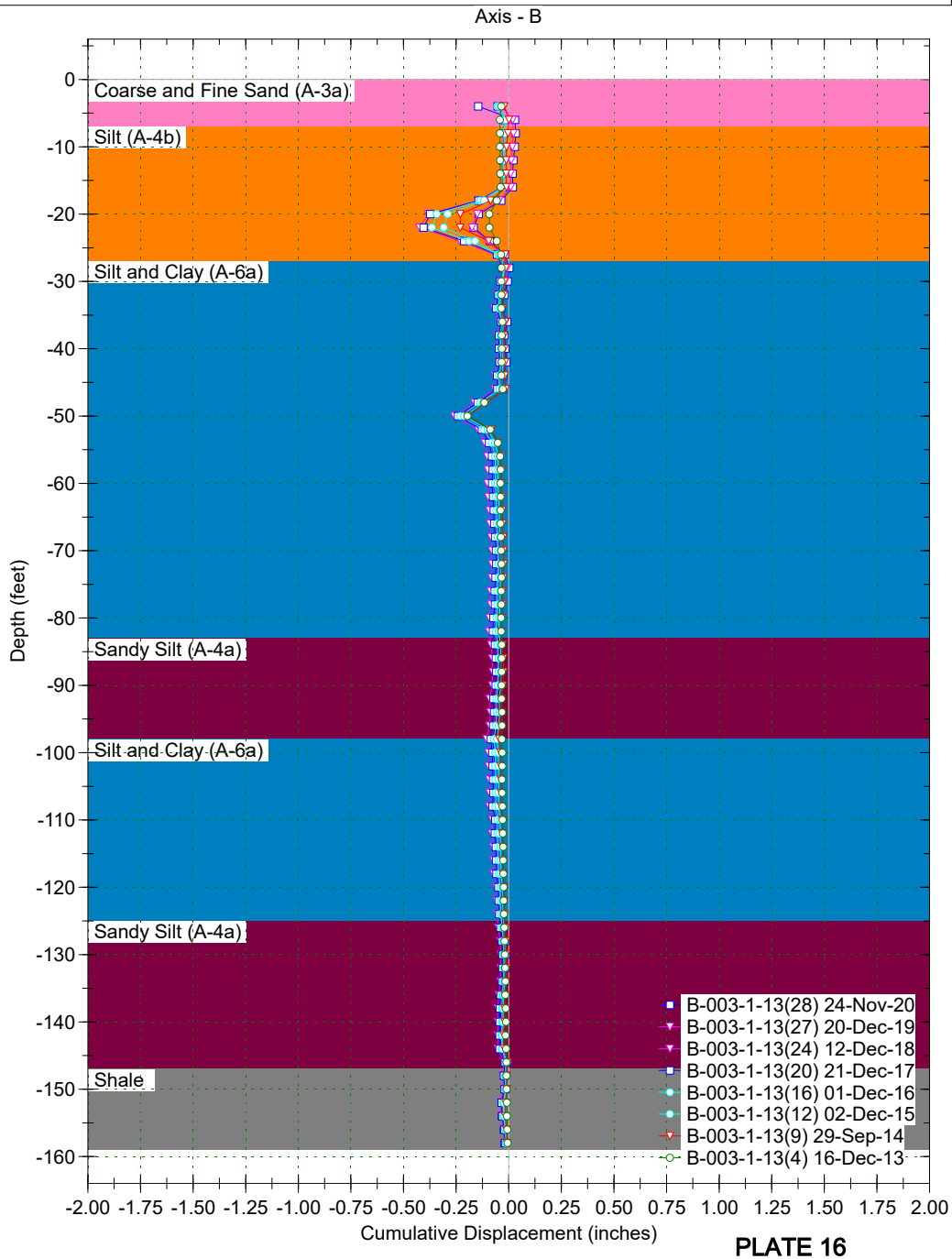


PLATE 16

RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-004-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666364.951
Easting : 2186300.732
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 160.0 feet
A+ Groove Azimuth : 132° 0' 16"
Base Reading : 2013 Oct 15 16:29
Applied Azimuth : 0.0 degrees

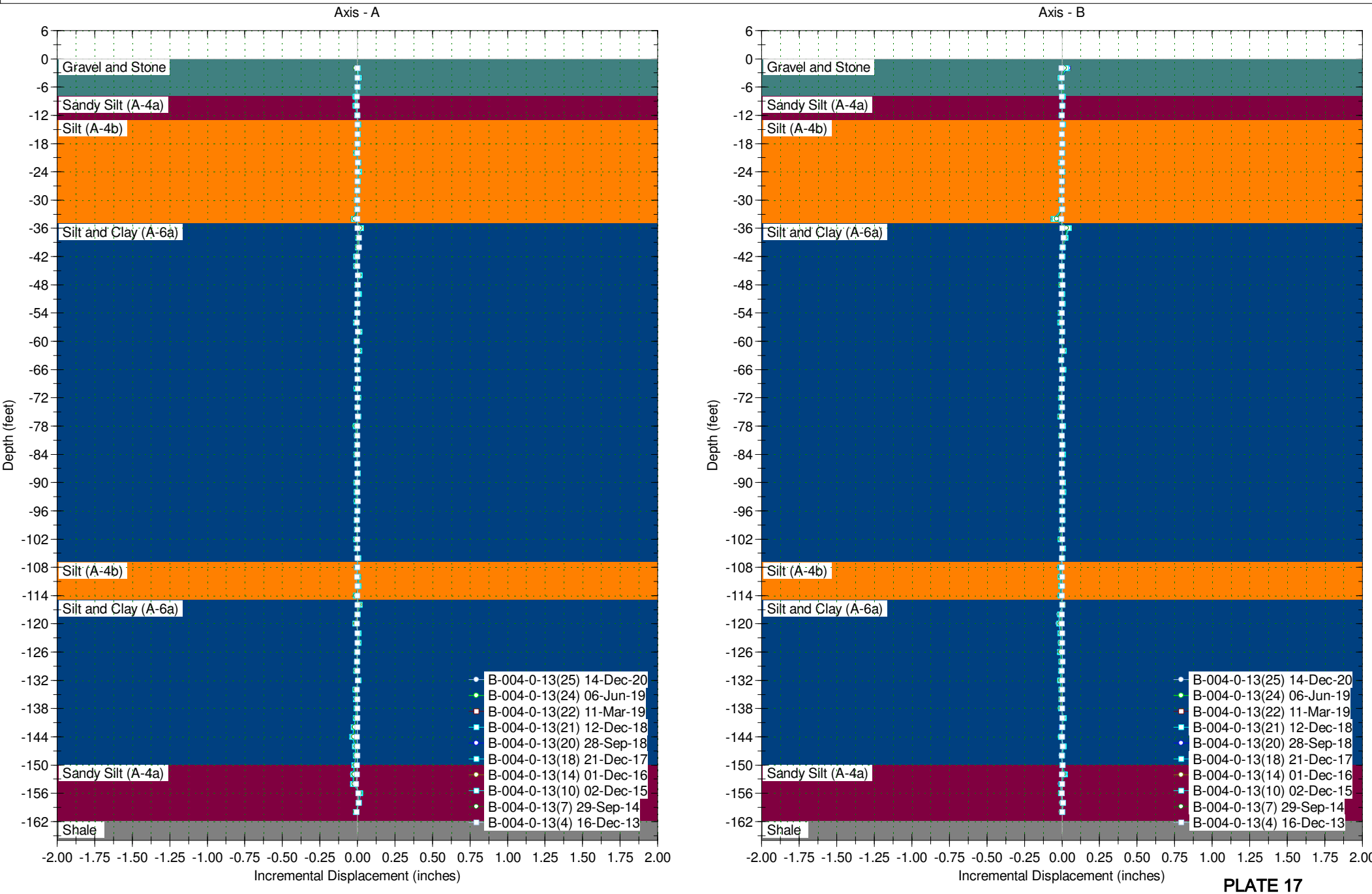


PLATE 17

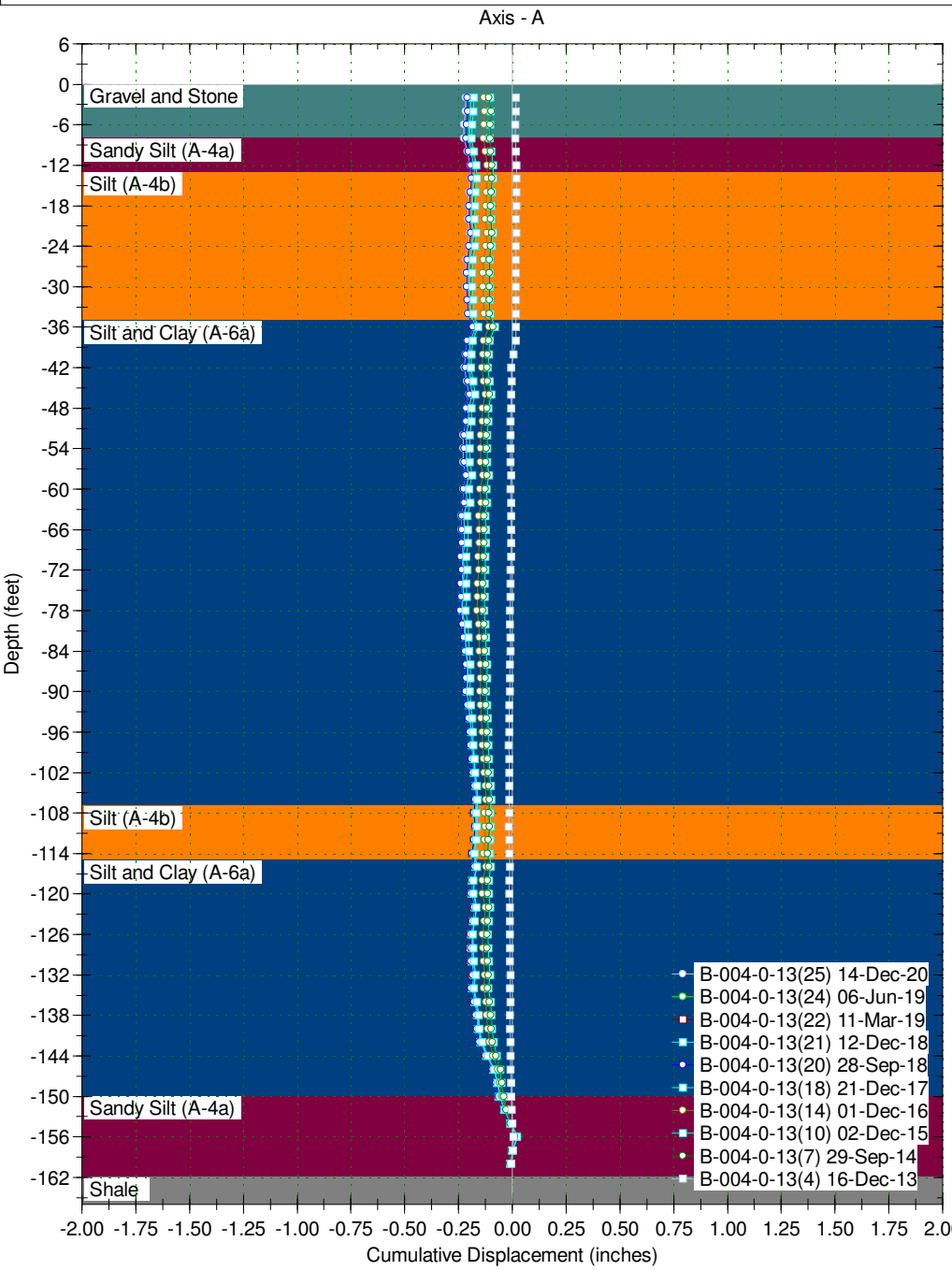
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-004-0-13
Project : Detroit Superior Bridge
Location :
Northing : 666364.951
Easting : 2186300.732
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 160.0 feet
A+ Groove Azimuth : 132° 0' 16"
Base Reading : 2013 Oct 15 16:29
Applied Azimuth : 0.0 degrees



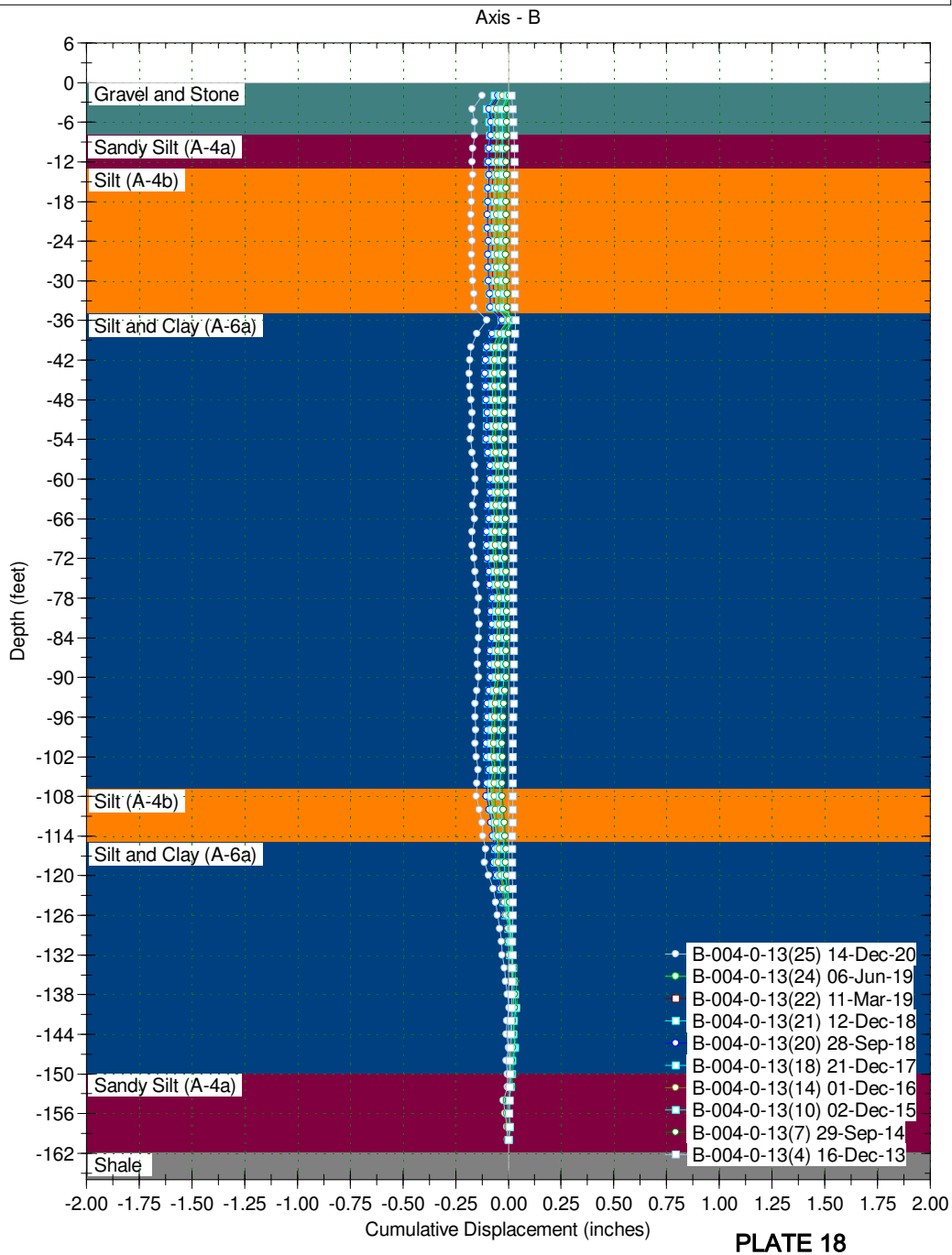


PLATE 18

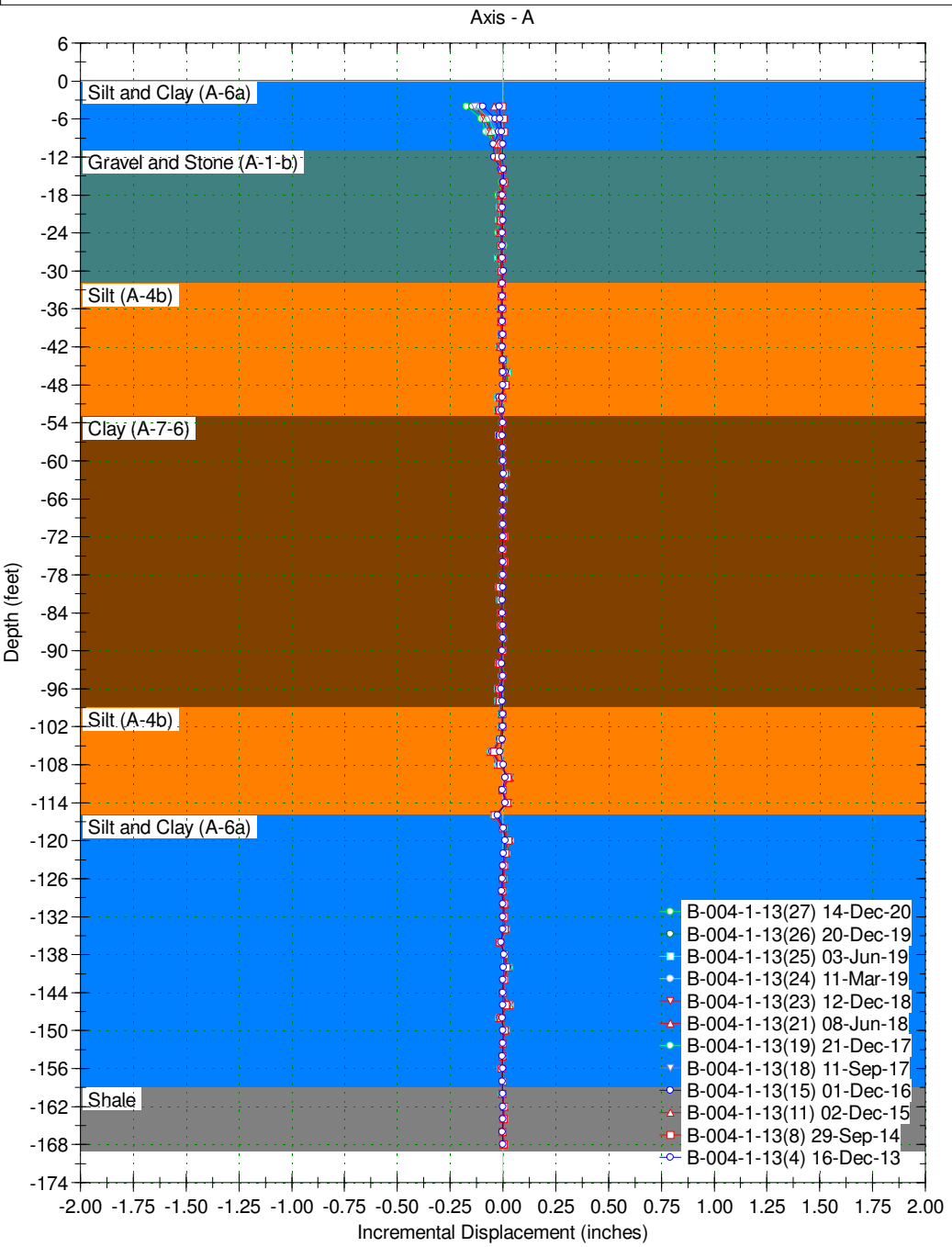
RST Instruments Ltd.

INCREMENTAL DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-004-1-13
Project : Detroit Superior Bridge
Location :
Northing : 666282.939
Easting : 2186374.016
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 168.0 feet
A+ Groove Azimuth : 91° 40' 7"
Base Reading : 2013 Oct 15 15:53
Applied Azimuth : 0.0 degrees



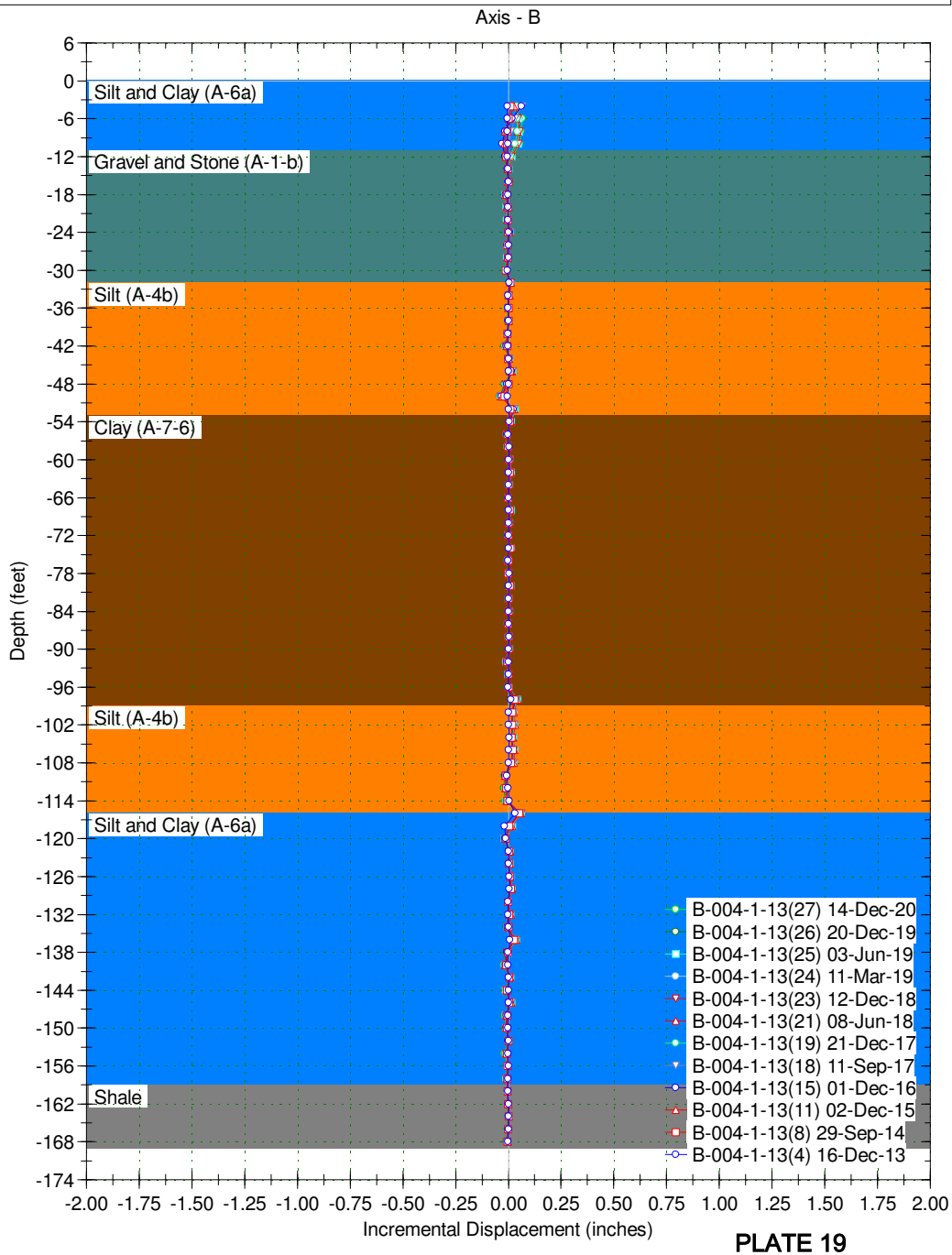


PLATE 19

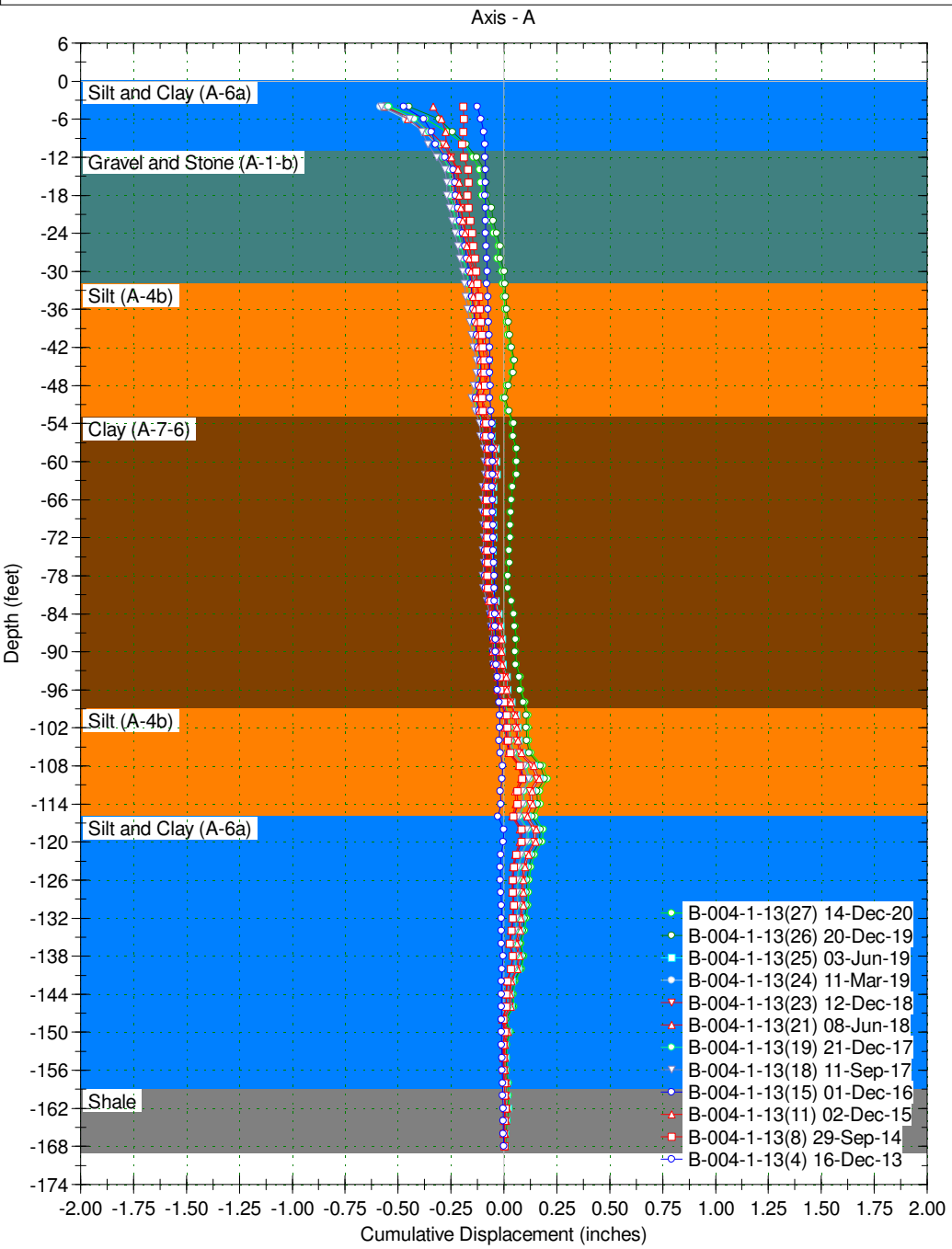
RST Instruments Ltd.

CUMULATIVE DISPLACEMENT

Inclinalysis v. 2.43.1

Borehole : B-004-1-13
Project : Detroit Superior Bridge
Location :
Northing : 666282.939
Easting : 2186374.016
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 feet
Borehole Total Depth : 168.0 feet
A+ Groove Azimuth : 91° 40' 7"
Base Reading : 2013 Oct 15 15:53
Applied Azimuth : 0.0 degrees



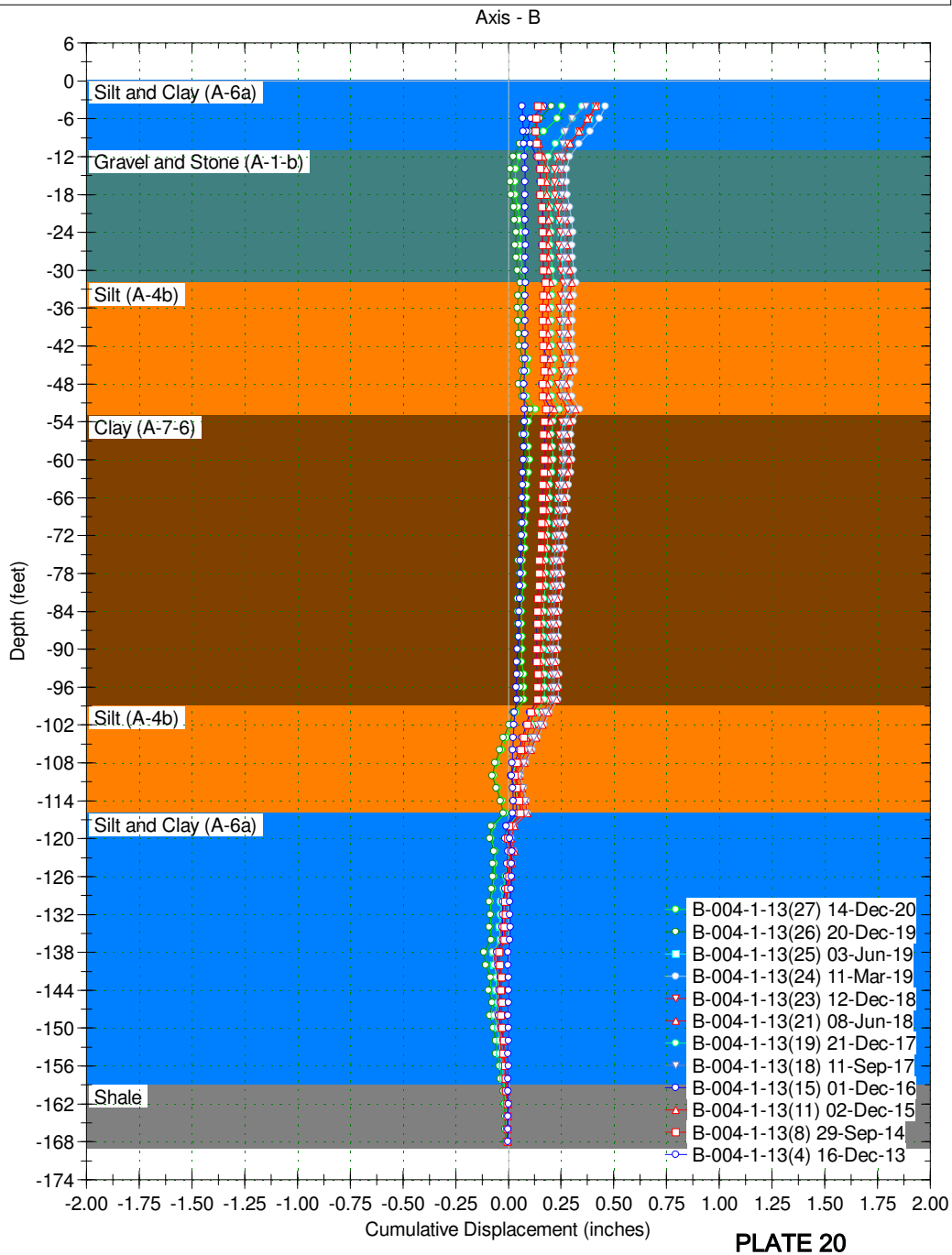


PLATE 20

Excerpts from 2016 Bridge Inspection Report (Pennoni)

Wingwalls (c40)

The abutment wingwalls are in ***Good*** condition. The wingwalls consist of the south wall of the West Station, Spans 1A and 1B, and East Station and the north wall of the East Station.

Element Level Quantities – Wingwalls				
Total Quantity	**CS 1**	**CS 2**	**CS 3**	**CS 4**
12	12			

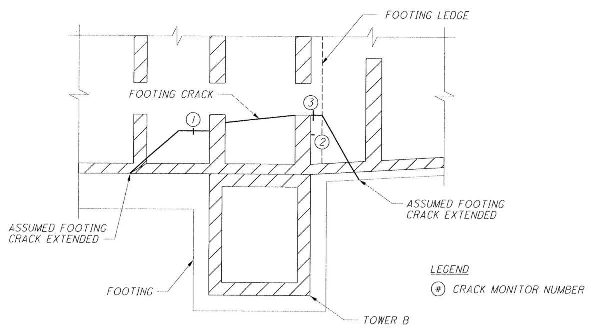
Tower B South

Tower B South has had an active history of movement for at least the past 10 years, but overall, slope movement in this area has been documented for over 50 years. Slope instability was first observed in 1963 with a landslide that came within 15 feet of the bridge.[8]

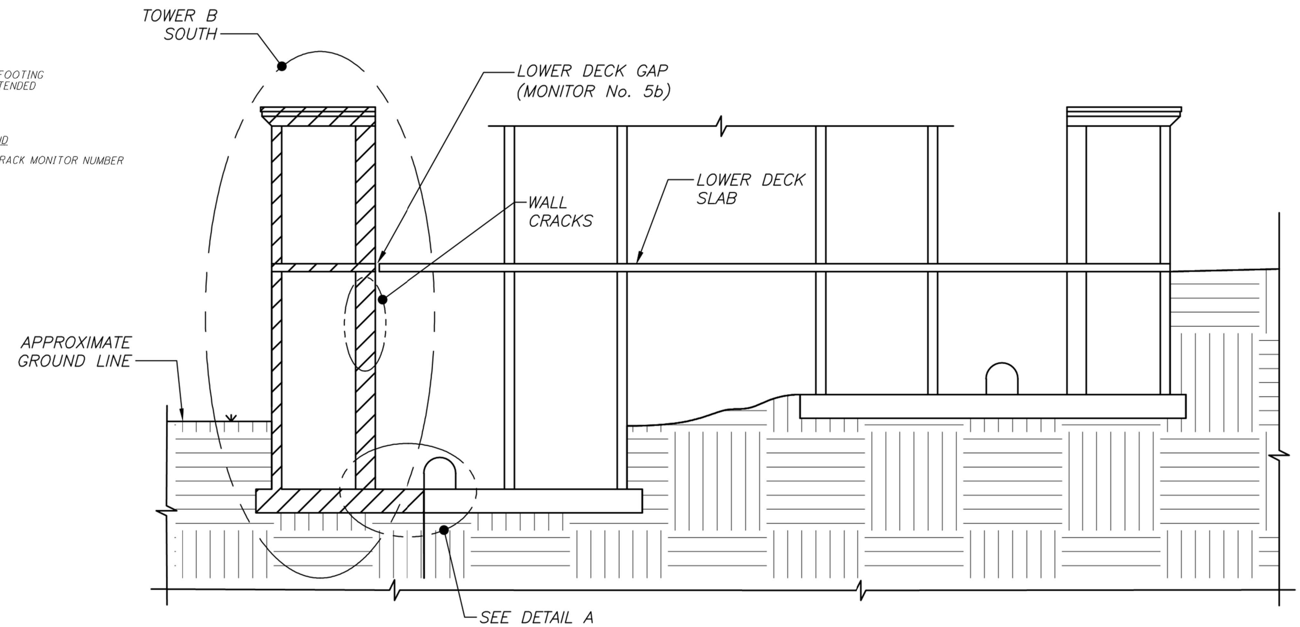
While this current movement likely is a continuation of the movement that resulted in the 1995 rebuilding of the Southeast corner of the West Station, this inspection identified the correct nature of the Tower B movement. Within the cellular construction below, the footing for Tower B and the adjacent approach span wall has cracked and rotated over a length of three panels (**Photo 55**). With identification of this cracked footing, three crack monitors were installed during this inspection's conclusion (**Photo 56**). Crack monitor No. 2 will measure any future drop in the footing elevation. Inspection in the cellular construction verified the construction of the Span 1A, Span 1B and Tower B footings per original plan sheet A2.38. The location and nature of the footing crack, and the placement of the three new crack monitors, is shown in **Figure 6**.

Measurements indicate the tower is leaning approximately $^{1}/_{8}$-inch per foot. The tower has shifted outward and rotated at least six inches (**Photo 57**) while at the lower deck level, the gap between that the upper deck column and face of tower is 4 $^{3}/_{4}$ inches, included the 1-inch original construction space. Also at the top of the tower, the section is spalled and cracked because it is wedged up against the upper deck sidewalk above (**Photo 58**).

[8] *Reconstruction of the Detroit-Superior Bridge Criteria for Design*, Howard, Needles Tammen & Bergendoff, October 1965, p. 12.



PLAN VIEW

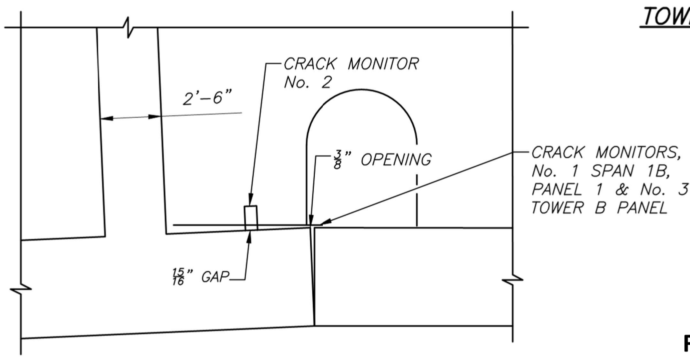


TOWER B SOUTH – EAST ELEVATION

LOOKING WEST
(UPPER DECK FLOOR BEAMS NOT SHOWN FOR CLARITY)

LEGEND

ROTATING PORTION OF TOWER A



DETAIL A

Figure 6 – Location & Orientation of Tower B South Footing Crack.

Photo 55 – Location of Tower B Footing Crack (at Arrow), Looking South in Cellular Construction, Panel 2, Span 1B.

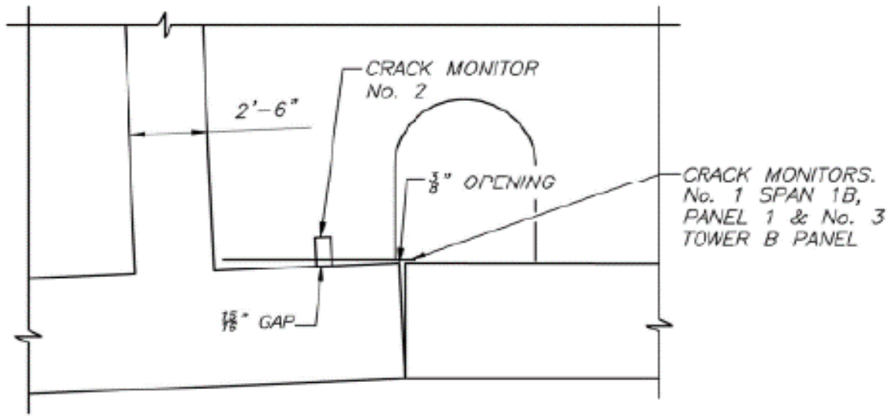
Photo 56 – Tower B Footing Crack (Highlighted with Red Arrows), and Footing Rotation & Drop with Respect to Transverse Wall (at Yellow Arrows), Looking South.

Photo 57 – Tower B Wall Shaft Wedged & Fracturing Against Sidewalk Cantilever.

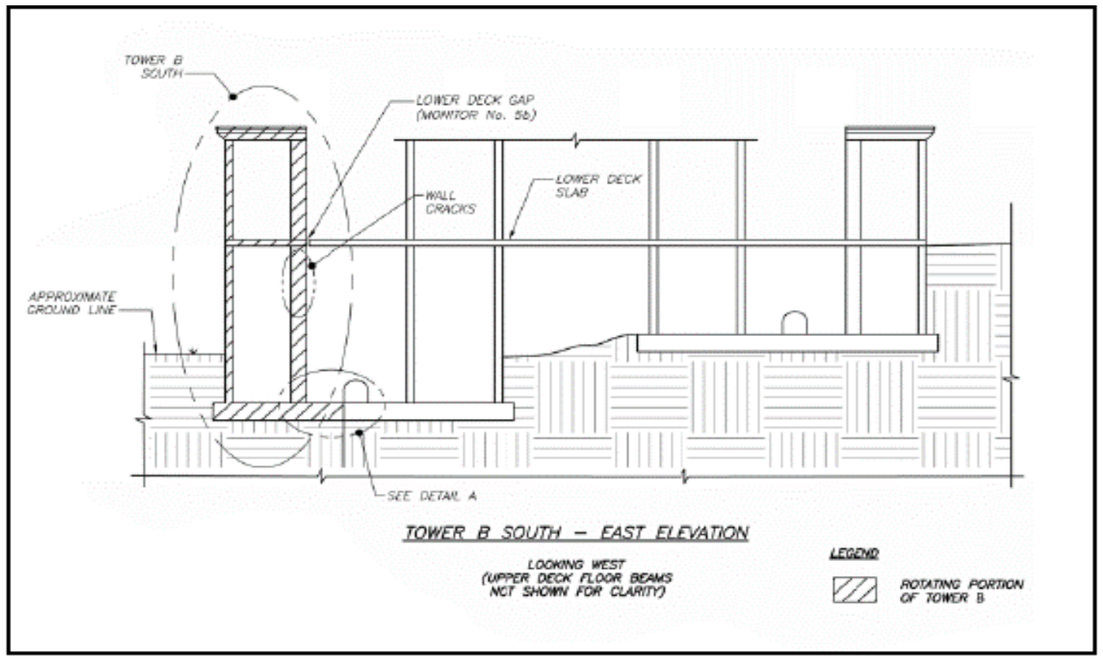
Photo 58 – Four-Inch Movement of Embedded Pipe Between Tower B Wall Shaft & Sidewalk Cantilever Above.

Excerpt from 2020 Bridge Inspection Report (Palmer)

Table 6: Crack Gage Measurements, Span 1A Cellular Construction & Tower B South										
Date	No. 5B Tower B at Lower Deck		No. 1		No. 2		No. 3		No. 4	
	V (mm)	H (mm)	V (mm)	H (mm)	V (mm)	H (mm)	V (mm)	H (mm)	V (mm)	H (mm)
5/17/07	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/16/13	---	---	2.0	1.0	2.5	0.3	0.0	0.0	0.8	0.2
10/3/14	6.0	2.0	2.3	1.0	3.0	0.6	0.0	0.0	0.8	0.2
8/16/15	8.0	2.0	2.8	1.1	4.5	0.8	0.0	0.0	0.9	0.5
9/14/16	11.0	2.0	3.0	1.1	4.8	0.8	0.0	0.0	1.0	0.5
11/27/17										
10/22/18									1.0	1.1
11/18/19					4.8	2.0			1.0	1.3
10/22/20			4.0	1.0	5.0	1.0	0.5	5.0	1.0	1.5

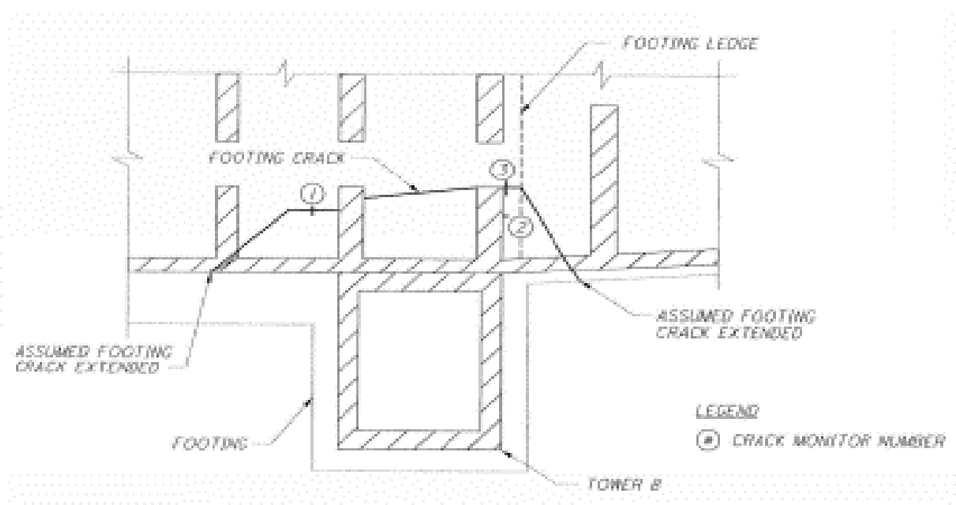


DETAIL A



TOWER B SOUTH – EAST ELEVATION

LOOKING WEST
(UPPER DECK FLOOR BEAMS NOT SHOWN FOR CLARITY)



PLAN VIEW

Tower B Crack Monitor Data

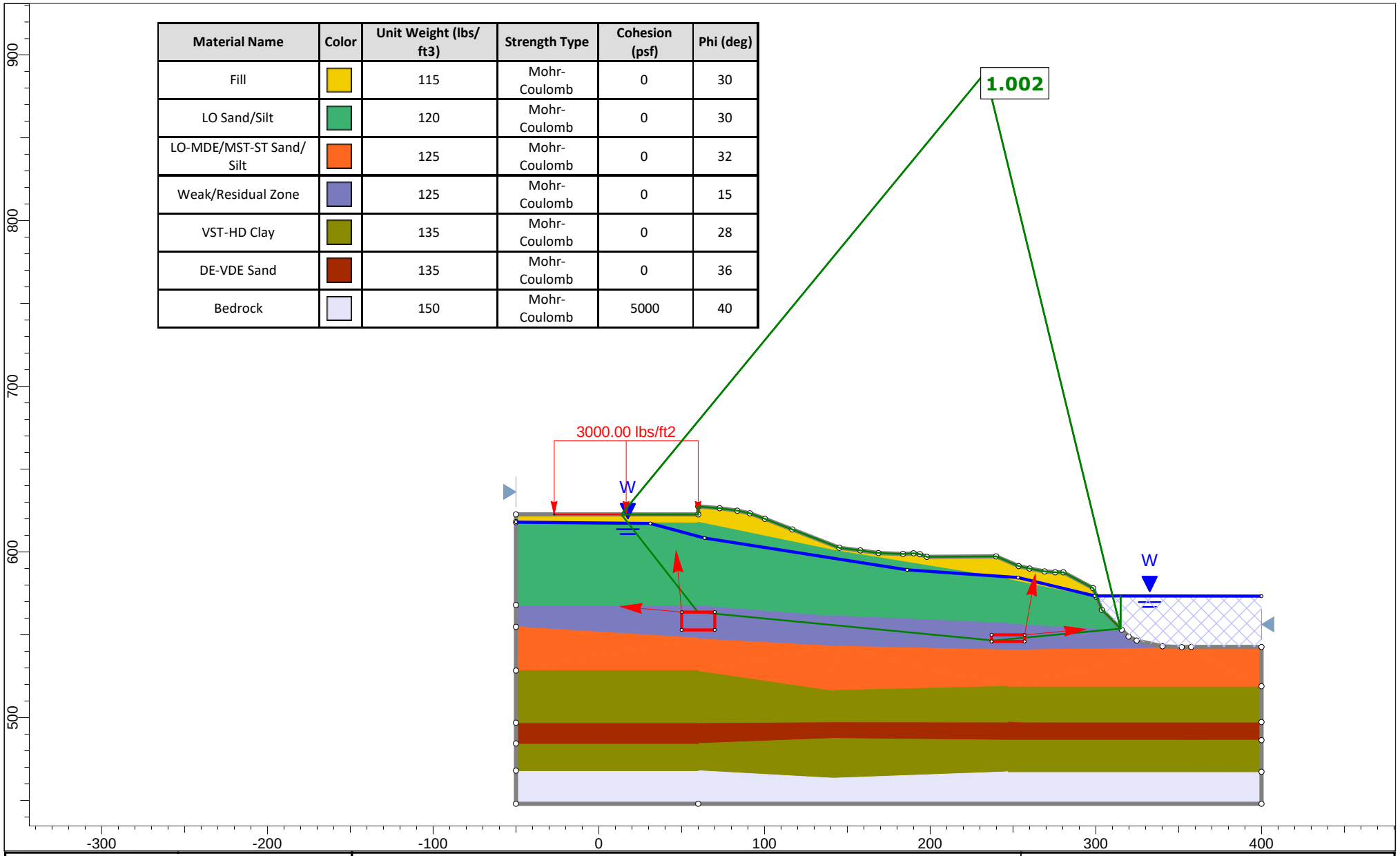
SFN 1800930
CUY-6-1456
TOWER B MOVEMENT

Tower B (south) is being monitored for movement to the south (away) from the west approach structure. There is also rotation, therefore readings are recorded for left and right edges of the tower. Readings are also taken at a crack monitor at the center of the tower. There is historical evidence that there has been issues with the substructure at this location.

Date	Left TransRdg	Center TransRdg	Right TransRdg	Days from Start	Days from Prev.	Rate from Start L	Rate from Start C	Rate from Start R	Rate from Prev L	Rate from Prev C	Rate from Prev R	Right LongRdg	Comments
5/6/2006	0.000	0.000	0.000										gauge intsalled
5/9/2007	NA	0.350	NA	368	368	#VALUE!	0.00095	#VALUE!	#VALUE!	0.0009511	#VALUE!		
1/1/2008	NA	NA	NA	605	237	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!		B&N Inspection
1/1/2009	NA	NA	NA	971	366	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!		B&N Inspection
9/15/2010	3.500	1.380	2.938	1593	622	0.00220	0.00087	0.001844	#VALUE!	#VALUE!	#VALUE!		September
3/28/2011	NA	1.460	NA	1787	194	#VALUE!	0.00082	#VALUE!	#VALUE!	0.0004124	#VALUE!		2011: March: column interface with deck -new concrete spall-see photos
5/9/2011	NA	1.520	NA	1829	42	#VALUE!	0.00083	#VALUE!	#VALUE!	0.0014286	#VALUE!		
9/17/2011	NA	NA	NA	1960	131	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!		
9/21/2012	4.125	1.560	3.500	2330	370	0.00177	0.00067	0.0015021	#VALUE!	#VALUE!	#VALUE!		
1/7/2013	4.250	2.110	NA	2438	108	0.00174	0.00087	#VALUE!	0.0011574	0.0050926	#VALUE!		Monitor off scale. Install New gauge
4/16/2013	4.500	2.125	3.875	2537	99	0.00177	0.00084	0.0015274	0.0025253	0.0001515	#VALUE!		Install New Gauge new 0 will start with 2.125 - NOTE: 1 mm = .039"
9/11/2013	4.500	2.125	3.750	2685	148	0.00168	0.00079	0.0013966	0	0	-0.000845		
1/9/2014	4.625	2.281	3.938	2805	120	0.00165	0.00081	0.0014039	0.0010417	0.0013	0.0015667	6.688	Monitor indicated 3mm longitudinal & 4mm transverse movement.
5/7/2014	4.688	2.281	3.938	2923	118	0.00160	0.00078	0.0013472	0.0005339	0	0	6.688	crack gauge is back to zero in the longitudinal direction.
9/17/2014	4.625	2.281	3.938	3056	133	0.00151	0.00075	0.0012886	-0.000474	0	0	6.625	
1/16/2015	4.719	2.398	4.063	3177	121	0.00149	0.00075	0.0012789	0.0007769	0.0009669	0.0010331	6.656	Center Trans. gauge has moved 7mm transverse & 2mm longitudinal from zero.
5/5/2015	4.656	2.359	4.031	3286	109	0.00142	0.00072	0.0012267	-0.000578	-0.000358	-0.000294	6.594	Center Trans. gauge has moved 6mm transverse & 0mm longitudinal from zero.
1/4/2016	4.813	2.476	4.094	3530	244	0.00136	0.00070	0.0011598	0.0006434	0.0004795	0.0002582	6.688	Center Trans. Gauge has moved 9mm transverse & 2 mm longitudinal from zero.
4/4/2016	4.813	2.476	4.125	3621	91	0.00133	0.00068	0.0011392	0	0	0.0003407	6.594	Center Trans. Gauge has moved 9mm transverse & 1 mm longitudinal from zero.
9/7/2016	4.844	2.156	4.156	3777	156	0.00128	0.00057	0.0011003	0.0001987	-0.002051	0.0001987		KB and MG
1/3/2017	4.875	2.515	4.25	3895	118	0.00125	0.00065	0.0010911	0.0002627	0.0030424	0.0007966	6.688	Center Trans. Gauge has moved 10 mm transverse & 2 mm longitudinal from zero.
1/17/2018	5.188	2.827	4.563	4274	379	0.00121	0.00066	0.0010676	0.0008259	0.0008232	0.0008259	6.719	Center Trans. Gauge has moved 18 mm transverse & 3 mm longitudinal from zero.
5/15/2019	6.063	OFF GAUGE	5.313	4757	483	0.00127	#VALUE!	0.0011169	0.0018116	#VALUE!	0.0015528	6.719	Center Trans. Gauge has moved off the gauge transverse & 0 mm longitudinal from zero.
				-38843	-43600	0.00000	0.00000	0	0.0001391	#VALUE!	0.0001219		
				-38843	0	0.00000	0.00000	0	#DIV/0!	#DIV/0!	#DIV/0!		
				-38843	0	0.00000	0.00000	0	#DIV/0!	#DIV/0!	#DIV/0!		
				-38843	0	0.00000	0.00000	0	#DIV/0!	#DIV/0!	#DIV/0!		

Appendix III – Conceptual Slope Stability Analysis Results

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		115	Mohr-Coulomb	0	30
LO Sand/Silt		120	Mohr-Coulomb	0	30
LO-MDE/MST-ST Sand/ Silt		125	Mohr-Coulomb	0	32
Weak/Residual Zone		125	Mohr-Coulomb	0	15
VST-HD Clay		135	Mohr-Coulomb	0	28
DE-VDE Sand		135	Mohr-Coulomb	0	36
Bedrock		150	Mohr-Coulomb	5000	40



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Project: **Detroit Superior Bridge Tower B South**

Analysis Description: **Existing Conditions (Effective Stress)**

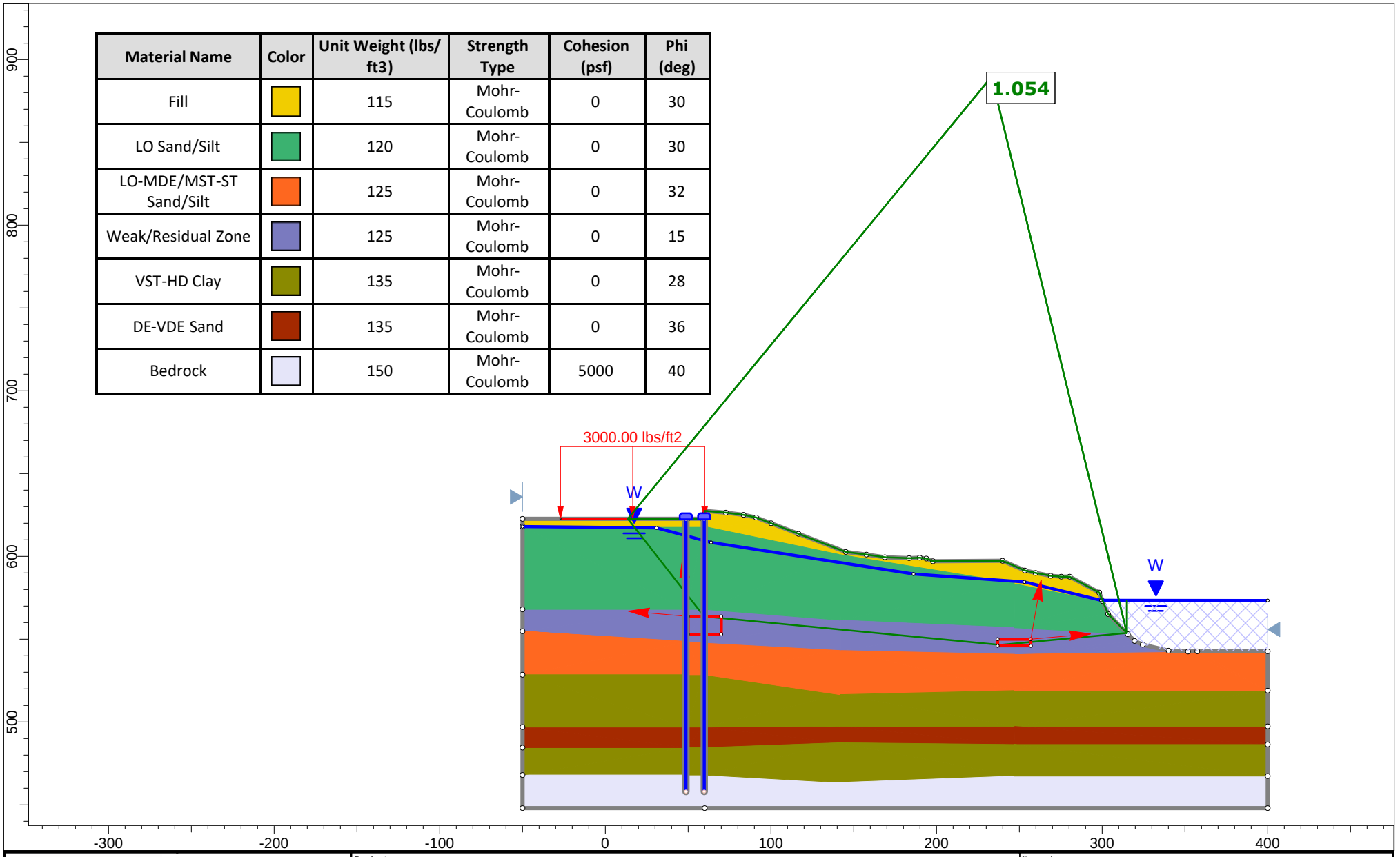
Comments: Surcharge loading from bridge has been assumed.

Date	Date Revised	Drawn by	Checked	Project No.
8/19/2021	8/19/2021 4:34:08 PM	BKS	RSW	213051A

Filepath: T:\GEO\Projects\2021\213051_msc_ODOT D12-3 GES_Ohio\213051A_Detroit Superior Bridge Tower B\Calcs\Slide Analysis\Existing Conditions.slim

PLATE 1

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		115	Mohr-Coulomb	0	30
LO Sand/Silt		120	Mohr-Coulomb	0	30
LO-MDE/MST-ST Sand/Silt		125	Mohr-Coulomb	0	32
Weak/Residual Zone		125	Mohr-Coulomb	0	15
VST-HD Clay		135	Mohr-Coulomb	0	28
DE-VDE Sand		135	Mohr-Coulomb	0	36
Bedrock		150	Mohr-Coulomb	5000	40



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SLIDEINTERPRET 9.014

Project: **Detroit Superior Bridge Tower B South**

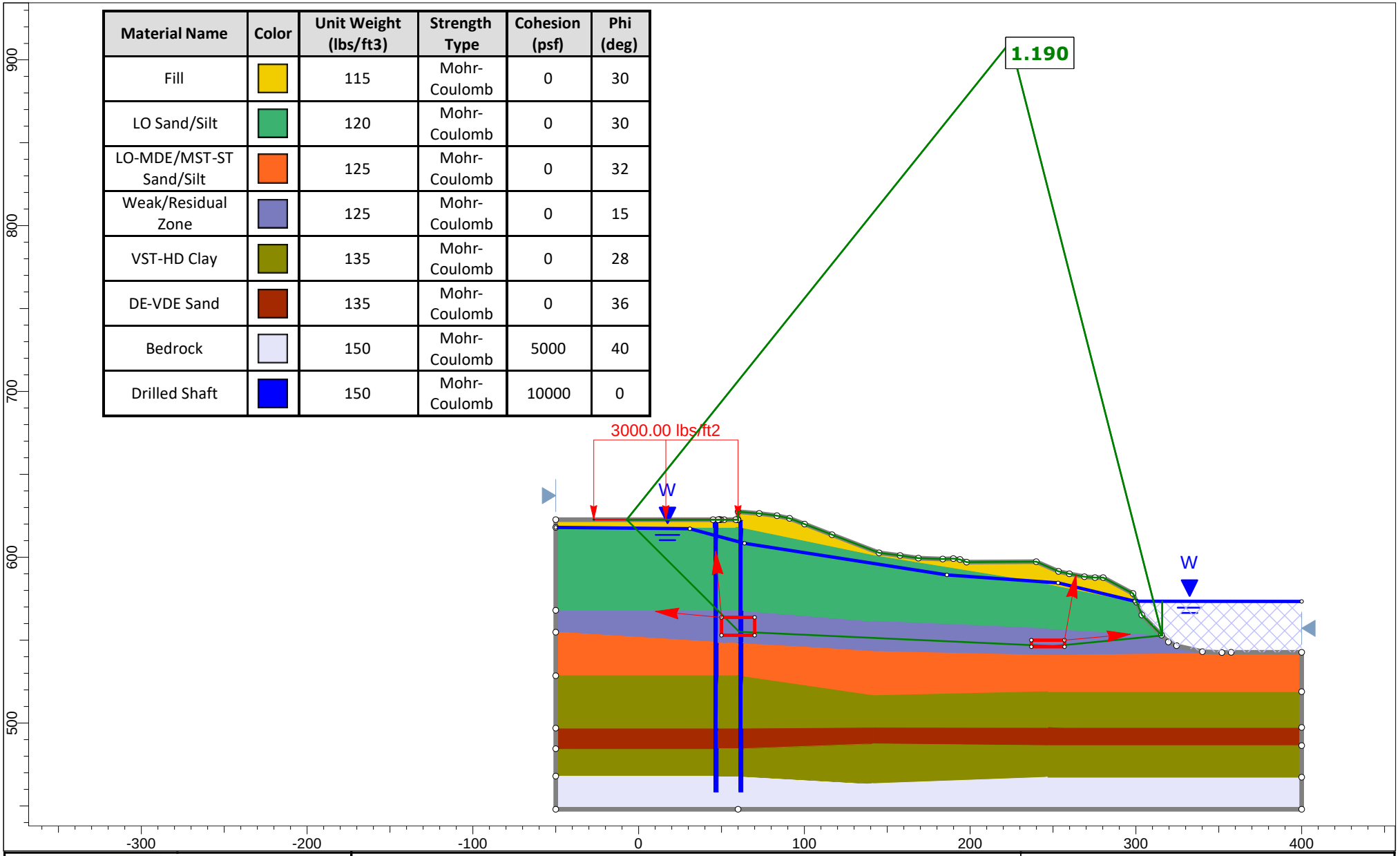
Analysis Description: **Conceptual Repair Alternative #1 - Micropiles**

Comments: Surcharge loading from bridge has been assumed.

Date	Date Revised	Drawn by	Checked	Project No.
8/19/2021	8/19/2021 4:36:26 PM	BKS	RSW	213051A

Filepath: T:\GEO\Projects\2021\213051_msc_ODOT D12-3 GES_Ohio\213051A_Detroit Superior Bridge Tower B\Calcs\Slide Analysis\Repair Alternative #1 - Micropiles.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		115	Mohr-Coulomb	0	30
LO Sand/Silt		120	Mohr-Coulomb	0	30
LO-MDE/MST-ST Sand/Silt		125	Mohr-Coulomb	0	32
Weak/Residual Zone		125	Mohr-Coulomb	0	15
VST-HD Clay		135	Mohr-Coulomb	0	28
DE-VDE Sand		135	Mohr-Coulomb	0	36
Bedrock		150	Mohr-Coulomb	5000	40
Drilled Shaft		150	Mohr-Coulomb	10000	0



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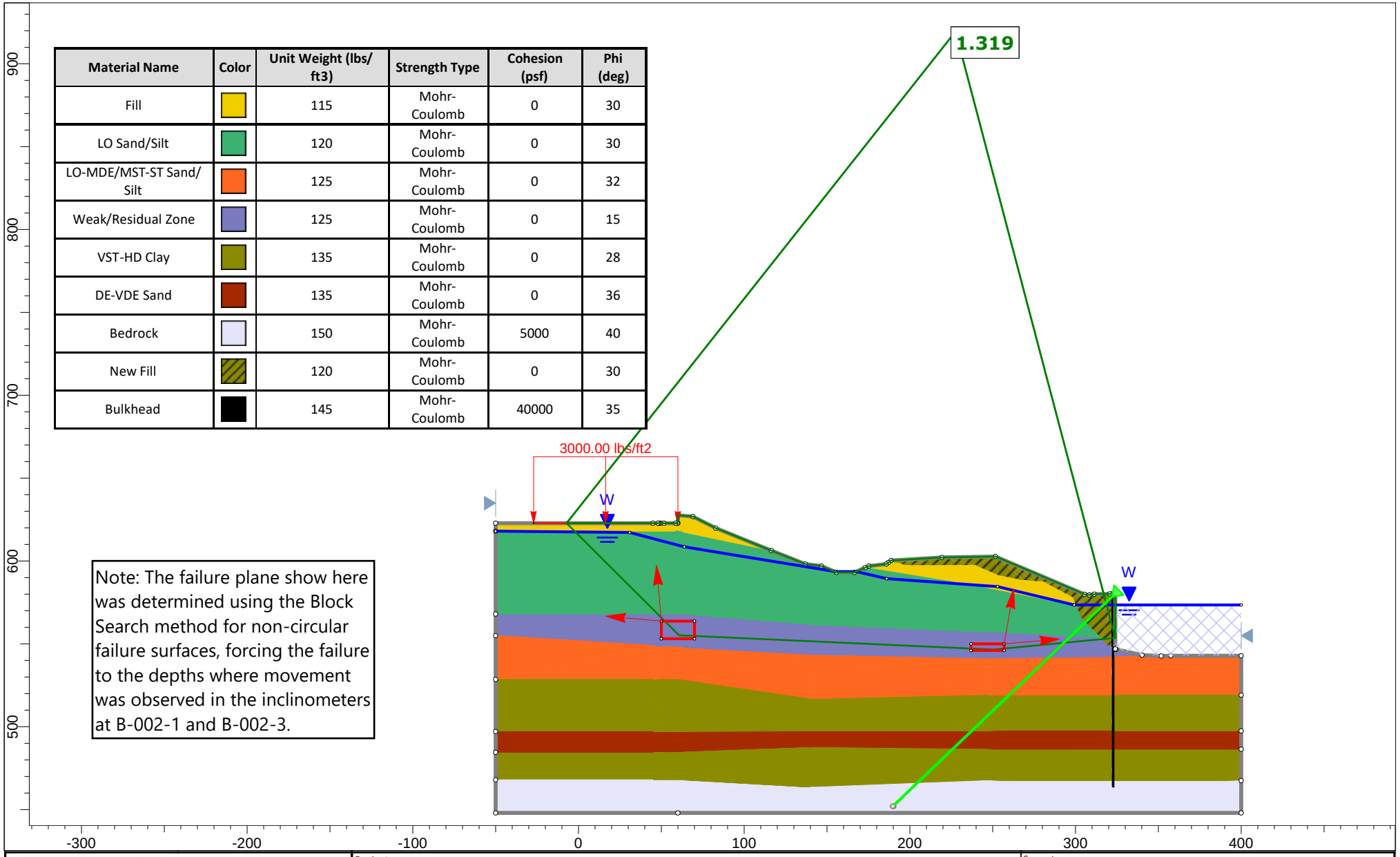
SLIDEINTERPRET 9.014

Project	**Detroit Superior Bridge Tower B South**
Analysis Description	**Conceptual Repair Alternative #2 - Drilled Shafts**
Comments	Surcharge loading from bridge has been assumed.
Date	8/19/2021
Date Revised	8/19/2021 4:39:17 PM
Drawn by	BKS
Checked	RSW
Project No.	213051A
Filepath	T:\GEO\Projects\2021\213051_msc_ODOT D12-3 GES_Ohio\213051A_Detroit Superior Bridge Tower B\Calcs\Slide Analysis\Repair Alternative #2 - Drilled Shafts.slim

PLATE 3

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		115	Mohr-Coulomb	0	30
LO Sand/Silt		120	Mohr-Coulomb	0	30
LO-MDE/MST-ST Sand/ Silt		125	Mohr-Coulomb	0	32
Weak/Residual Zone		125	Mohr-Coulomb	0	15
VST-HD Clay		135	Mohr-Coulomb	0	28
DE-VDE Sand		135	Mohr-Coulomb	0	36
Bedrock		150	Mohr-Coulomb	5000	40
New Fill		120	Mohr-Coulomb	0	30
Bulkhead		145	Mohr-Coulomb	40000	35



Note: The failure plane show here was determined using the Block Search method for non-circular failure surfaces, forcing the failure to the depths where movement was observed in the inclinometers at B-002-1 and B-002-3.

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SLIDEINTERPRET 9.018

Project: **Detroit Superior Bridge Tower B South**

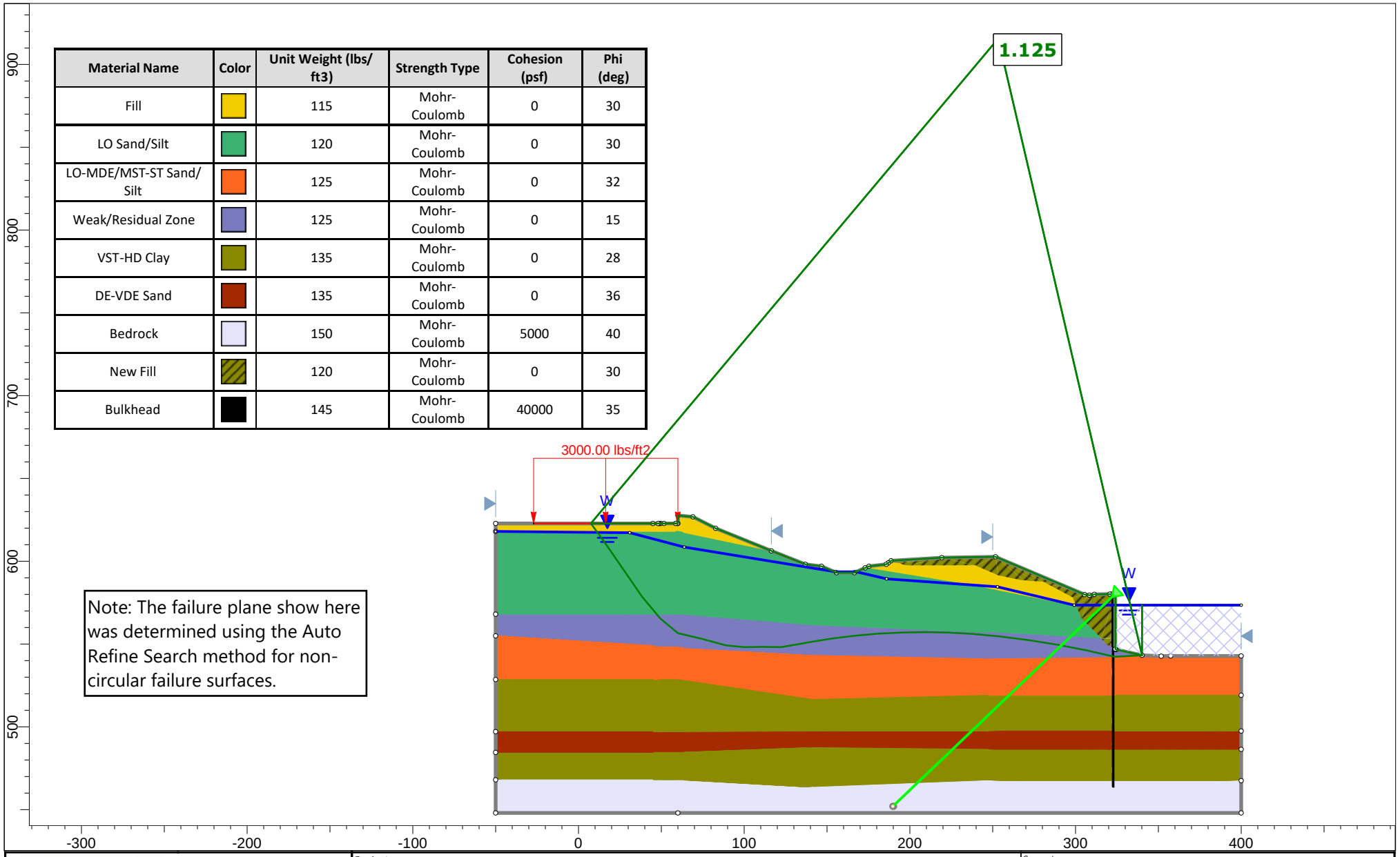
Analysis Description: **Future Condition - Proposed Slope Regrade**

Comments: Surcharge loading from bridge has been assumed.

Date	Date Revised	Drawn by	Checked	Project No.
8/19/2021	8/20/2021 10:20:32 AM	BKS	RSW	213051A

Filepath: T:\GEO\Projects\2021\213051_msc_ODOT D12-3 GES_Ohio\213051A_Detroit Superior Bridge Tower B\Calcs\Slide Analysis\Future Condition - Slope Regrade.slim

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		115	Mohr-Coulomb	0	30
LO Sand/Silt		120	Mohr-Coulomb	0	30
LO-MDE/MST-ST Sand/ Silt		125	Mohr-Coulomb	0	32
Weak/Residual Zone		125	Mohr-Coulomb	0	15
VST-HD Clay		135	Mohr-Coulomb	0	28
DE-VDE Sand		135	Mohr-Coulomb	0	36
Bedrock		150	Mohr-Coulomb	5000	40
New Fill		120	Mohr-Coulomb	0	30
Bulkhead		145	Mohr-Coulomb	40000	35



Note: The failure plane show here was determined using the Auto Refine Search method for non-circular failure surfaces.

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SLIDEINTERPRET 9.018

Project: **Detroit Superior Bridge Tower B South**

Analysis Description: **Future Condition - Proposed Slope Regrade**

Comments: Surcharge loading from bridge has been assumed.

Date	Date Revised	Drawn by	Checked	Project No.
8/19/2021	9/2/2021 6:01:38 AM	BKS	RSW	213051A

Filepath: T:\GEO\Projects\2021\213051_msc_ODOT D12-3 GES_Ohio\213051A_Detroit Superior Bridge Tower B\Calcs\Slide Analysis\Future Condition - Slope Regrade.slim