GEOTECHNICAL ENGINEERING REPORT

SCOTTS CROSSING ROAD PROJECT

TYSONS CORNER, VIRGINIA

VDOT PROJECT NO. 8102-029-065 UPC 103907

Fairfax County Project No. 2G40-020-000 Fund 400-C40011

Prepared for: Fairfax County DOT

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Final

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ECS Project No. 01-21924

Reference: Scotts Crossing Road – Task Order No. 33
(aka Jones Branch Connector)
Tysons Corner, Virginia
VDOT Project No. 8102-029-265 UPC 103907
FCDOT Project No. 2G40-020-000 Fund No. 400-C40011

Dear Mr. Dresser:

ECS Mid-Atlantic, LLC (ECS) is pleased to present this Geotechnical Engineering Report for the above-referenced project. This report represents a final report based on recently developed plans and loads for the three bridges and the retaining walls for the project. The work to complete the final engineering analyses has been provided in accordance with the ECS' proposal No. 44673 dated September 4, 2013 and the NTP issued by FCDOT dated September 6, 2013. Subsequent explorations for various retaining walls and the sound wall were authorized in September 2015.

Project information for Bridge B627 and associated retaining walls have been provided to us by Athavale Lystad and Associates. Project information for Bridges B628 and B629 and associated retaining walls have been provided by Johnson, Mirmiran and Thompson. Project information for Scotts Run retaining walls have been provided by Fairfax County DOT.

This report is based on the final load information for the bridges and bridge and wall layout plans. This report includes changes that reflect the combined VDOT review comments dated March 2, 2016.

The recommendations presented in this report are based on the data collected by ECS for this project. A few borings performed by others for the Express Lanes project were also used in our analyses. Appendix A of this Geotechnical Engineering Report contains boring location plans and estimated subsurface profiles. Appendices B and C present the results of the field investigations and laboratory studies performed by ECS. Various calculations are presented in Appendix D.

We appreciate the opportunity to be of service to you. If you have any questions with regard to the information presented, or if we can be of further assistance to you during construction, please do not hesitate to contact us. We look forward to working with you as your QA/QC representative during construction.

Respectfully,

ECS MID-ATLANTIC, LLC

Michael A. Rayl, P.E.
Senior Engineer

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VP – Chief Engineer

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1.0 INTRODUCTION

The purpose of this investigation and preparation of the geotechnical report is to develop design and construction recommendations for the Scotts Crossing Road Project (aka Jones Branch Connector). The project will link Jones Branch Drive, which is located about 700 feet west of the Capital Beltway, I-495, to Dolley Madison Boulevard, which is located about 1,500 feet east of I-495. The project involves construction of roadways and three bridges; one over I-495 SB lanes, one over the Capital Beltway Express Lanes, and one over I-495 NB.

The scope of the exploration performed for this investigation was developed by Fairfax County with review by VDOT representatives. The scope development considered the proposed design, available existing information, and site access conditions.

ECS previously provided a preliminary report for the project, dated August 19, 2014, that was based on the 30 percent plans, dated January 11, 2013 and titled; *Fairfax County Jones Branch Connector, From: Jones Branch Drive To: Dolley Madison Boulevard (Route 123*). The plans included a subset of drawings, dated the same, and titled; *Bridge and Retaining Wall Plans*.

This final report is based on roadway plans titled *Scotts Crossing Road (Route 8102), From Jones Branch Drive (Route 5062), to: Dolley Madison Boulevard (Route) 123*, dated September 21, 2015. Bridge structural and load information has been provided by two consultants currently working on the project. The plan information received is piecemeal in nature and no updated comprehensive plan set has been provided. Athavale Lystad and Associates provided information for Bridge B627 and Johnson, Mirmiran and Thompson provided information for Bridges B628 and B629.

This investigation was limited to bridges retaining walls, and roadways. The investigation of culverts, stormwater, ponds, or other structures is not part of the scope of services requested. The borings previously performed by ECS in 2013 for the preliminary geotechnical report were used for the analyses of the bridges presented in this final report. . New borings were drilled in 2015 for the sound wall and four retaining walls that were added since the preliminary layout was developed.

2.0 PROJECT DESCRIPTION

A description of the project and the proposed construction is reviewed in the following paragraphs. The review is presented by describing the project from its beginning at the west end and continuing east to the project's end. All station references are based on the proposed center baseline, JBCON, unless otherwise noted. The proposed roadway connection Jones Branch Drive is referred to herein as Jones Branch Connector up to the east side of I-495 NB and as Scotts Crossing Road ahead to the connection with Dolley Madison Boulevard.

2.1 Roadways and Bridges

<u>Jones Branch Connector - Sta 18+22.00 to 22+48.00</u>

The project begins at the east edge of the existing pavement of Jones Branch Drive. This section involves construction of two EB lanes that will be separated from the existing WB lanes by a new raised grassed median. Construction of the EB lanes will be near existing grade to about Sta 19+50. Ahead, the right side widening will require removal of an existing tied back wall that leads to an existing parking structure. The lower section of the existing tied back wall will be replaced with a MSE Wall, RW-001.

New sidewalks will be constructed along both roadway directions. Slopes 4H to 1V will extend up from the EB sidewalk edge to the existing parking garage wall. The existing WB lanes will be widened slightly to accommodate a new right turn lane and the relocation of the sidewalk. This will require minor cuts (< 8 feet high) and fills (< 10 feet high), both having 2H to 1V slopes.

<u>Bridge B627 - Sta 22+48.00 to 25+12.00</u>

Bridge B627 will carry Jones Branch Connector (JBCONN) over the Capital Beltway, I-495 SB. The new structure will carry three lanes in each direction. It will be a 264.0-foot long, two-span, curved-girder structure. Bridge B627 involves construction of a three-lane structure for the eastbound lanes and extension of existing Bridge B658 to the west to carry the two westbound lanes. Both directions will carry a bike lane and sidewalk. A raised concrete median will separate the travel directions. The extension of the westbound lanes is from Sta 22+48 to about Sta 23+50. The new deck will tie into the existing deck of Bridge B658.

The site of the new bridge is currently occupied by an existing single-span, curved girder bridge that crosses I-495-SB and on-ramps to I-495 SB from the EB Dulles Access and Toll Road (DARWS and DTWS). The new bridge will result in widening the existing bridge and lengthening it to the west by constructing a new span. The new span will cross future ramps from Dulles Access Road (DARWS) and from Dulles Toll Road (DTCB).

The existing west abutment of the existing bridge (to be converted into Pier 1 of the new bridge) consists of a continuous wall that is supported by drilled shafts. The top of the shaft elevation (bottom of wall) elevation is +325.0 feet as noted on the as-built plans. The existing wall is supported by 4.0-foot diameter shafts. The tip bearing elevations are not noted on the as-built drawings, but the recommended tip elevation of ECS's 2009 geotechnical report for this bridge was about +287.0 feet. This abutment has wrap-around MSE-type wing walls that will be

removed when the bridge is lengthened to the west. The new pier substructure will be constructed in a similar manner by extending the existing abutment wall to the south and supporting it with 4.0-foot diameter shafts as well. The bottom of new wall (pier cap) elevation will be +325.5 feet.

The existing east abutment (new Abutment B) consists of a stub abutment supported by HP 12x53 piles. The pile layout consists of two rows of staggered piles. The stub abutment is located behind and near the top of an MSE wall that has wrap around wingwalls. The piles have cans within the MSE fill zone. The as-built drawings indicate that the bottom of abutment elevation is +363.0 feet and the pile tip elevations are around +240.0 feet; however, the pile tip elevation is not confirmed. The ECS report cited above recommended a tip elevation of about +302.0 feet.

The new Abutment B extension will also have a bottom elevation of +363.0 feet and be supported by two rows of steel piles. The new front wingwall for Abutment B, Wall RW-002, will be stepped with the front bottom of wall varying from elevation +333.8 to +341.0 feet. The new south wrap-around wall will taper with the height varying from about 33 feet to about 8 feet.

The new Abutment A substructure will be a stub-type structure that sits atop a grade beam supported by two rows of 18-inch diameter augercast piles. The top of pile elevation will be +341.5 feet. Abutment A will have short wrap-around walls that will be auger-cast pile supported. The north and south halves of the abutment will be separated by an isolation joint located between them.

The east side of the bridge crosses existing I-495 SB and Ramp DTWS. Ramp DTWS will be lowered in the future and a retaining wall will be required to separate the ramp from I-495 SB. The design of this wall is outside the scope of work for this report. It will be necessary to excavate below existing grade to construct future Ramps DARWS and DTCB. Retaining walls will be required along both sides of Ramp DARWS to support these future ramps. The design of these walls is outside the scope of this report.

<u>Jones Branch Connector - Sta 25+12.00 to 27+57.06</u>

The section crosses a raised embankment that currently provides access from Jones Branch Connector to the SB Express Lanes. Each direction will have two travel lanes plus a sidewalk. The right side of the widened lane will be supported by the south bend of the Wall RW-002. A raised grassed median will separate the EB and WB directions.

<u>Bridge B628 - Sta 27+57.06 to 28+87.06</u>

Bridge B68 will carry Jones Branch Connector (JBCONN) over Express Lanes SB and Ramp DTWSH (from Dulles Toll Road WB to SB Express (HOT)). This structure involves widening the existing bridge at this location on the south side. The south side of the existing bridge will tie into the new deck of the widened bridge. The widened bridge will carry two lanes in each direction plus turn lanes. The existing bridge currently carries a single EB lane from Jones Branch Connector to the Express Lanes SB and two WB lanes from Express Lanes SB to Jones Branch Connector.

The widened bridge will have two left turn lanes located on the EB side and one left turn lane located on the EB side. The travel directions will be separated by a raised concrete median. It will be a 130-foot long, single-span, skewed, straight-girder structure.

Both abutments will be integral type abutments located behind a MSE wall. Each abutment will be supported by a single row of HP 12x53 steel piles. The planned bottoms of abutment elevations are +364.6 and +363.4 feet at the tie-ins of Abutment A and B, respectively. The planned bottoms of abutment elevations are +362.7 and +361.8 feet at the south ends of Abutments A and B, respectively.

Wall RW-003 will be constructed in front of Abutment A. The north end will connect to existing Wall 7RW-62. The south end will have a short wrap-around end wall. The planned front side top of coping is +364.8 to +366.6 feet and the bottom of wall is elevation +346.0 feet.

Wall RW-004 will be constructed in front of Abutment B. The north end will connect to existing Wall 7RW-64A. The south end will have a short wrap-around end wall. The planned front side top of coping is +365.4 to +363.8 feet and the bottom of wall is elevation +355.5.0 to +340.0 feet on the front side

<u>Jones Branch Connector – 28+87.06 to 30+01.25</u>

The section crosses a raised embankment that currently provides exit points form the NB and SB Express Lanes to Jones Branch Connector. This section will add two turn lanes and two through lanes in the EB direction. Minor filling will be required and it will be retained by the north and south wing walls of Bridges B628 and B229. Fill will be placed to the east of the existing MSE wall supporting the ramp form the NB express lanes, Ramp JBSEW, up to the west abutment of Bridge B629.

<u>Bridge B629 - Sta 301+25 to 34+04.16</u>

Bridge B629 will carry Jones Branch Connector (JBCONN) over the NB Express Lanes (NBH), ramp from NB Express Lanes to Dulles Toll Road WB (DTSWH), Capital Beltway I-495 NB, and Capital One service road. The new structure will carry three lanes in each direction with a right turn lane in the WB direction. It will be a 398.6-foot long, three-span, curved-girder structure.

Abutment A is located at the west end of the bridge and sits about 20 feet in front of and existing wall supporting a ramp to NB Express Lanes. Pier 1 is located in the narrow, grass-covered area between the guardrails lining the right and left shoulders of Ramp DTSWH and I-95 NB, respectively. Pier 2 is located east of the existing sound wall that parallels the right side of I-495 NB. This area is a mound that this is covered with grass and brush. Abutment B is located at the east end of the bridge and sits in the middle of the cul-de-sac located at the west end of Old Spring House Road.

Abutment A is located behind MSE Wall RW-005. The abutment will be supported by a single row of drilled shafts. The bottom of abutment elevations are 362.6 and 361 feet, north and south ends respectively. Piers 1 and 2 consist of a concrete bent supported by columns atop drilled shafts. The Pier 1 top of shaft elevations vary from 341.9 to 344.0 feet, north and south

ends respectively. The Pier 2 top of shaft elevations vary from 341.0 to 340.8 feet, north and south ends respectively. Abutment B is located behind MSE Wall RW-006. The abutment will be supported by a single row of drilled shafts. The bottom of abutment elevations are 347.3 and 345.5 feet, north and south ends respectively.

The existing sound wall located to the right of I-495 NB diverges from being parallel with I-495 to take advantage of a mound in order to reduce wall height. The wall will be removed in the diverged alignment area to accommodate Bridge B629. A new sound wall, SW-011, will be constructed parallel to I-95 along the chord line of the existing wall.

Scotts Crossing Road - Sta 34+04.16 to Sta 37+25

This section is a raised grade section between the two wing walls of Wall RW-006. This section will be constructed along the existing alignment of Old Springhouse Road and will cross the southern end of Spring Gate, part of Capital One Drive and a parking lot located at the north end of a soccer field. The travel directions are separated by a raised grassed median. Each travel direction will have two through lanes and the EB lanes will have two turn lanes. Sidewalks will be provided along each side.

Scotts Crossing Road - Sta 37+25 to 38+25

This section will be an at-grade intersection. A short extension on the north will be provided to the Gates of McLean, an existing condominium complex. The south side of the intersection will connect with the new relocated two-lane Capital One Drive.

Scotts Crossing Road - Sta 38+25 to 41+75

This section will be a near at-grade section; however, fill will be required to develop the south side of the roadway. A MSE type wall, Wall RW-007, is planned from about Sta 38+66 to about Sta 41+16 along the EB shoulder.

Scotts Crossing Road - Sta 41+75 to 42+75

This section will be an at-grade intersection with Old Springhouse Road to the south.

Scotts Crossing Road Sta 42+75 to Sta 47+18.89

This section continues along the alignment of existing Old Springhouse Road to its termination at the existing west pavement edge of Dolley Madison Boulevard. The travel directions will be separated by a raised grassed median. Minor amounts of fill will be added to raise the pavement grade. About 10 feet of fill, placed on a 2H to 1V slope, will be required along the south side of the roadway. An at-grade tie-in to an apartment complex parking lot will be provided at Sta 43+95 in the westbound direction.

Existing skewed, twin box culverts carrying Scott's Run under the existing Old Springhouse Road at Sta 44+50. Widening on the north side in the vicinity of the culvert outlet will require construction of an RW-3 type retaining wall, Wall RW-008 from Sta 40+00 to 43+62. Widening

on the south side in the vicinity of the culvert outlet will require construction of an RW-3 type retaining wall, Wall RW-009 from Sta 44+30 to 45+75.

Capital One Drive - Sta 14+62.47 to 19+05.74

A two-lane road with minor cuts and fills will be constructed form the service road on the west to its intersection with Jones Branch connector at Sta 37+73.80. Planned cuts will be about 10 feet high or less with 2H to 1V slopes. Planned fills will be about 10 feet high or less with 3H to 1V slopes.

Capital One Service Road – Sta 37+88.57 to Sta 46+02.91

A two-lane service road running north to south will be built at the west end of Capitol One Drive. The service road will run under Bridge 2902 to provide fire access to properties to the located north of Jones Branch Connector. It will be constructed close to existing grade in an open area.

2.2 Retaining and Sound Walls

Wall RW-001

This wall will replace the lower half an existing tied back wall located to the right of Jones Branch from about Sta 18+76 to 20+93. This wall is an L-shaped wall. It will provide an access roadway to an existing underground parking structure. RW-001 will be an MSE wall, about 243 feet long, and varying in height from 7 feet to 22 feet. The bottom of the wall will be stepped with elevations increasing from +320.0 feet to +325.0 feet, west to east.

Wall RW-002

This wall is a V-shaped, wrap-around wall for Abutment B of Bridge B627. The wall will be an MSE type wall, about 199 feet long. The top of coping elevation under the bridge is +365.0 feet and the bottom on the wall will be stepped from El. +333.8 to +341+00 feet in this section. The wrap-around section will extend back to Sta 26+88 on the south side The bottom of the wall in the wrap-around section will range in height from about 37 to 9 feet and will slope up from elevation +341.0 feet to about +374.0 feet. The north end of the section of the wall on the under the bridge 627 will tie into Wall 7-RW61, the existing MSE front retaining wall of Bridge B658.

Wall RW-003

Wall RW-003 will be constructed in front of Abutment A. This wall is an L-shaped wall, about 149 feet long. The north end will connect to existing Wall 7RW-62. The planned front side top of coping is +364.8 to +366.6 feet and the bottom of wall is elevation +346.0 feet. The south end will have a short wrap-around end wall. The height of the wrap around wall varies from about 28 to 9 feet and the bottom of the wall will slope up from elevation +346.0 to +358.0 feet.

Wall RW-004

Wall RW-004 will be constructed in front of Abutment B. This wall is an L-shaped wall, about 193 feet long. The north end will connect to existing Wall 7RW-64A. The planned front side top

of coping is +365.4 to +363.8 feet and the bottom of wall is elevation +355.5.0 to +340.0 feet. The south end will have a short wrap-around end wall. The height of the wrap around wall varies in height from about 29 to 10 feet and the bottom of the wall will slope up from elevation +343.5 to +362.0 feet.

Wall RW-004A

This wall will extend existing Wall 7RW-64A to the north. This wall is an L-shaped wall, about 70 feet long. The north end will connect to existing Wall 7RW-64A. The planned front side top of coping is +365.4 feet and the bottom of wall is elevation +330.0 feet. The north end will have a short wrap-around end wall. The height of the wrap around wall varies in height from about 43 to 29 feet and the bottom of the wall will slope up from elevation +330.0 to +342.0 feet.

Wall RW-005

This wall is a U-shaped wall with short wrap-around wings that tie into existing Wall 7-RW65 that supports Ramp JBSEW. This wall will be constructed as part of Abutment A for Bridge B629. The wall will be an MSE type wall, about 260 feet long. The top of coping elevation under the bridge is +365.0 feet and the bottom on the wall will be elevation +341.0 feet. The south wrap around wall varies in height from about 25 to 17 feet and will step up from elevation +341.0 to +353.0 feet. The north wrap around wall varies in height from about 28 to 20 feet and will step up from elevation +341.0 to +353.0 feet.

Wall RW-006

This wall is a horseshoe-shaped, wrap-around wall for Abutment B of Bridge B629. The wall will be an MSE type wall, about 739 feet long. The top of coping elevation under the bridge is +346.5 feet. The bottom on the wall will be about +333.5 feet in the north half of the section and steps down to +331.0 feet at the south end of this section.

The north wing parallels the sidewalk on the north side of Scotts Crossing Road up to about Sta 36+93. The wall height in this section ranges from about 25 feet high to about 4.0 feet high from west to east. The south wing parallels the sidewalk on the south side of Scotts Crossing Road up to about Sta 36+14. The wall height in this section ranges from about 26 feet high to about 5 feet high from west to east.

Wall RW-007

This wall will be a MSE wall. It is located along the south side of the east end of Scotts Crossing Road between Capital One Drive and the Capital One Bank entrance from Sta 39+47 to 42+25. The height of the retaining wall will be about 13 to 18 feet. The base of the wall is stepped with the contours and varies from elevation about +298.0 feet to +304.5 feet.

Wall RW-008

This wall will be an RW-3 type retaining wall, 390 feet long, constructed along the north side of Scotts Crossing Road from Sta 40+00 to 43+90. The wall will have a maximum height of about

8 feet. The bottom of the wall will be stepped down from elevation +309.0 to +302.0 feet, west to east.

Wall RW-009

This wall will be an RW-3 type retaining wall, 45 feet long, constructed along the south side of Scotts Crossing Road from Sta 44+30 to 45+75.. The wall will have a maximum height of about 9 feet. The bottom of the wall will be stepped up from elevation +298.4 to +302.8 feet, west to east.

Wall RW-010

This wall is located along the south side of the entrance to the Spring Gate Condominiums. It replaces the east end of an existing stone wall. It is an RW-3 type retaining wall that varies in height from about 6 to 9 feet high. The bottom elevation of the wall is +321.0 feet.

Sound Wall SW-011

A new section of the existing will be constructed parallel to I-95 along the chord line of the existing wall. It will sit in front of Abutment B of Bridge B628. It will be about 20 feet high, except under the bridge where it will be about 15 feet high. The sound wall will be supported by posts embedded in predrilled holes filled with concrete.

2.3 Typical Sections

Jones Brand Connector / Scotts Crossing Road

Non-bridge sections will typically be constructed as non-superelevated sections with 2 percent cross slopes. The pavement section will consist of surface, intermediate, and bas asphalt courses atop a base of No. 21B graded aggregate. Curbs, VDOT Type CG-2, will be provided along the roadway edges. Some sections will have VDOT type CG-6 curb and gutters. Underdrains, VDOT type UD-4 will be provided under the curbs. VDOT Type UD-2 underdrains will be place under grassed medians. Sidewalks not located adjacent to the curbs, and exceeding 3% slope, will have a VDOT Type UD-3 underdrain.

Typical Section Capital One Service Road

The road will be constructed with a single cross slope of 2%. The pavement section will consist of surface, intermediate, and base asphalt courses atop a base of No. 21B graded aggregate. Curbs, VDOT Type CG-2, will be provided along the left roadway edges VDOT type CG-6 curb and gutters will be constructed along the right pavement edges (low side). Underdrains, VDOT type UD-4 will be provided under the curb and gutters. Sidewalks without underdrains will be constructed along the right curb and gutter.

Typical Section Capital One Drive

This road will be constructed with non-superelevated sections with a center crown and 2% cross slopes. The pavement section will consist of surface, intermediate, and base asphalt courses

atop a base of No. 21B graded aggregate. No curbs, curbs and gutters, underdrains, or sidewalks are planned.

2.4 Bridge Structural and Load Information

Project structure and load information for the bridges was provided to us in the form of emails and drawings from the project civil designers. Athavale Lystad Associates (ALA) provided information for Bridge B627. Johnson, Mirmiran and Thompson (JMT) provided information for Bridges B628 and B629.

2.4.1 Bridge B627

The substructure and load information for Bridge B627, which was provided by ALA, is presented in Table 2.1.

Table 2.1 – Bridge B627 Substructure and Load Information

Substructure	Bottom Elevation	Single Pile/ Shaft Max F_V	Total Substructure Loads[1, 2, 3]				
			F_V	F_L	M_L	F_T	M_T
	feet	kips	kips	ft-kip	ft-kip	kip	ft-kip
Abut A - North Half	341.5	250	3,000	420	3,400		
Abut A - North Half WW	341.5	120	430	210	970		
Abut A - South Half	341.5	230	2,400	350	2,700		
Abut A - South Half WW	341.5	100	400	170	750		
Pier 1	325.5	1,250	4,525	133	18,330	86	3,110
Abutment B[2]	363.0	150	135	6	48		

Notes:

1. All loads are strength loads.
2. Abutment B loads are per pile load.
3. Abutment and wingwall loads are total loads per subsbstructure.
4. F_V = axial load, F_L & M_L = longit. force and moment loads, F_T & M_T = transv. force and moment loads

2.4.2 Bridge B628

The substructure and load information for Bridge B628, which was provided by JMT, is presented in Table 2.2.

Table 2.2 – Bridge B628 Substructure and Load Information

Substructure	El. Bottom of Abutment feet	Max F_V kips
Abutment A - Tie-In	364.6	177
Abutment A - South End	362.7	177
Abutment B - North Tie-In	363.4	171
Abutment B - South End	361.8	171

Notes:

1. All loads are strength loads.
2. Pier loads are per shaft load.
3. F_V = axial load.

No, lateral loads have been provided. JMT indicated that the expected thermal expansion will be 0.05 foot (1.2 inch) at each abutment.

2.4.3 Bridge B629

The substructure and load information for Bridge B628, which was provided by JMT, is presented in Tables 2.3 and 2.4.

Table 2.3 – Bridge B629 Abutment and Pier Substructure and Load Information

Substructure	El. Bottom Abutment feet	Strength / Service[1]					Maximum Single Shaft F_V kips
		F_V kips	F_T kips	F_L kips	M_L ft-kips	M_T ft-kips	
Abutment A - North End	360.4	527 / 386	27 / 35	94 / 71	342 / 205	-	527
Abutment A - South End	359.5	528 / 386	28 / 35	95 / 71	343 / 205	-	527
Abutment B - North End	345.0	603 / 406	18 / 24	95 / 74	254 / 176	-	603
Abutment B - South end	343.6	604 / 406	19 / 24	96 / 74	255 / 176	-	603
Pier 1 North	342.1	1100 / 800	8 / 13	15 / 14	525 / 410	80 / 45	1100
Pier 1 Middle	343.0	1100 / 800	8 / 13	15 / 14	525 / 410	81 / 45	1100
Pier 1 South	343.9	1100 / 800	8 / 13	15 / 14	525 / 410	82 / 45	1100
Pier 2 North	341.1	1100 / 800	8 / 13	15 / 14	525 / 410	83 / 45	1100
Pier 2 Middle	341.0	1100 / 800	8 / 13	15 / 14	525 / 410	84 / 45	1100
Pier 2 South	341.0	110 / 800	8 / 13	15 / 14	525 / 410	85 / 45	1100
Alt. Pier Stength Loading	Varies	1400	17	13	415	110	1400

Notes:

1. All loads are per shaft load.
2. F_V = axial load, F_L & M_L = longit. force and moment loads, F_T & M_T = transv. force and moment loads.
3. Alternative strenth pier loads (trolley loading) are provided as controlling load is not discernable.

3.0 SITE CONDITIONS

3.1 General Description

The Jones Branch Connector Project is located in northeast Fairfax County, Virginia, an area identified as Tysons Corner. The Connector, now identified as Scotts Crossing Road, will link Jones Branch Drive, located west of I-495 in the Westpark Development, to Dolley Madison Boulevard, located east of I-495 in the Westgate Development. A site location plan is included as Drawing 1 in Appendix A.

The overall length of the project is about 0.57 mile long an encounters some remarkable topography, notably in the I-495 area crossing. Three bridges will be constructed in the vicinity of I-495. The west bridge will cross I-495 SB, various ramps, and future ramps to be built. The center bridge will cross the Capital Express Lanes SB. The east bridge will cross the Capital Express Lanes NB, I-495 NB, and future ramps to be built.

As noted, the project will be built in a setting with remarkable topography and complex existing infrastructure. The boring location plans included in Appendix A provide substantial site information.

3.2 Local Site Conditions

As noted above, the boring location plans provide plan information relative to the site conditions. The project plans cited in Section 1.0 contain roadway profiles and cross section drawings. Section 2.0 provides descriptions of particular sections of the project and associated site conditions. The site conditions at the major elements of the project are presented below.

<u>Jones Branch Connector - Sta 18+22.00 to 22+48.00</u>

Construction of the EB lanes will be near existing grade to about Sta 19+50. Ahead, cuts on the south side up to about 18 feet high that extend up to the below grade wall of an existing parking structure will be required in the widened area. These cuts will require the removal of existing tiebacks.

<u>Bridge B627 - Abutment A – Sta 22+48.00</u>

About 20 feet of excavation will be required near the south side of the abutment to reach profile grade. It will be necessary to excavate further below the bridge deck for future ramps I-495 SBCB and DTCB. A gas line is located approximately 16 feet behind the planned location of the new abutment.

<u>Bridge B627 - Abutment B – Sta 25+12.00</u>

Bridge B627 parallels existing Bridge B658 and Abutment B will tie into the existing bridge abutment. The new abutment will be located near the base of an existing embankment that is about 25 feet high and slopes up from I-495 SB lanes. The reinforced zone for the new abutment will abut the existing bridge backfill zone. If the existing wing wall is left in place, the

use of sheeting placed against the existing embankment is not expected to be necessary for construction of the new abutment backfill zone.

Jones Branch Connector - Sta 22+48.00 to 27+57.06

Fil, up to about 15 feet high, will be placed against the existing embankment supporting the ramp to the Express Lanes SB will be required. This fill will be retained by the south wingwall of Wall RW-002.

Bridge B628 - Abutments A & B – Sta 27+57.06 to 28+87.06

This bridge will be constructed adjacent to south side existing Bridge B628 in open air space. The abutments will tie into the existing abutments of Bridge B2242. The reinforced zones for the new abutments will abut the existing bridge backfill zones. If the existing south wing walls of the existing abutments remain in place, the use of sheeting placed against the existing embankments is not expected.

Jones Branch Connector 28+87.06 to 30+01.25

This short section is a raised ramp from Express Lanes NB. The ramp is retained by MSE walls on the west and east sides. Fill, up to about 25 feet high, will be placed from the east wall up to Wall RW-005 that will support the abutment for Bridge B629.

Bridge B629 – Abutment A – Sta 30+01.25

This abutment will be constructed near the middle of a slope that is about 20 feet high.

Bridge B629 – Abutment B – Sta 34+04.16

The abutment location is on flat ground in the middle a cul-de-sac and an approach fill about 25 feet high will be required to reach profile grade.

Scotts Crossing Road - Sta 34+04.16 to 37+25

This section will be a raised grade section situated between the two wing walls of Wall RW-006. The height of the retained fill ranges from about 25 feet on the west end to matching existing grade on the east end. The north half of the roadway will be constructed over existing Scotts Crossing Road. This section will cross the former tee connection to Capitol One Drive that has been recently relocated to the east.

Scotts Crossing Road – Sta 37+25 to Sta 38+25

This area becomes an intersection with Spring Gate Drive on the north that will be relocated about 100 feet to the east and the newly relocated Capitol One Drive to the south.

Scotts Crossing Road - Sta 37+24 to 47+18.69

This section widens the existing Scotts Crossing Road to a full four-lane roadway with turning lanes at the planned intersections of Capital One Drive and Old Springhouse Road. This section crosses over the existing twin box culvert that carries the north-flowing Scotts Run.

4.0 REGIONAL AND SITE GEOLOGY

4.1 Regional Geology

The project is situated in the Upland Section of the Piedmont Physiographic Province that is characterized as being underlain by metamorphic rocks, mainly quartz-rich sericite schist, granite, gneiss, and greenstone. Locally, the site is part of the Mather Gorge formation, a north-south trending formation of early Cambrian to late Proterozoic age. The underlying rock formations consist of sericite schist.

Beneath the surface the residual profile becomes less weathered with depth. The depth to bedrock varies considerably across the site and its depth is not necessarily reflective of the surface topography. Due to highway construction and development in the JBCONN corridor, significant cuts and placement of artificial fill has occurred, particularly in the west half of the corridor.

A transition between the upper residual soil profile and bedrock exists. The materials in this transition zone are less weathered, exhibit relict structure, and often contain rock fragments of varying size. This transition zone is considered to be highly weathered rock (HWR), aka Intermediate Geotechnical Material (IGM). The top of this stratum is defined by materials that exhibit standard penetration resistances greater than 60 bpf. This stratum is quite thick, over 50 feet at some boring locations. None of the borings drilled for this project extended to the base of this stratum and encountered bedrock.

Fairfax County Soil Survey Reports identify the upper soils at the site to be Glenelg and Manor Silt Loams. The soils associated with these soil series generally are low-plasticity SANDY SILTS (ML) with pockets of ELASTIC SLITS (MH) intermixed with SILTY SANDS (SM) and occasional SANDY CLAYS (CL).

4.2 Seismic Design Parameters

AASHTO LRFD 2010 Specifications recommend a 7 percent probability of exceedence in the 75-year design event given a nominal 1,000-year earthquake for design of highway bridges (See Comment 3.10.2.1). Various seismic design parameters for the site are presented in Table 4.1 below.

Table 4.1 – Recommended AASHTO Seismic Design Parameters

AASHTO Seismic Design Parameter	Value	AASHTO Code Reference
Site Class	D	Table 3.10.3.1-1
Seismic Zone	1	Table 3.10.6.1, Tables 3.10.3.2-3, & Eqn 3.10.4.2-6
Peak Ground Acceleration Coef. (PGA)	0.04	Figure 3.10.2.1-1
Spectral Acceleration Coef 0.2 sec (S_s)	0.09	Figure 3.10.2.1-2
Spectral Acceleration Coef 1.0 sec (S_1)	0.03	Figure 3.10.2.1-3

The designer is recommended to review Section 3.10.9.2 for design relative Seismic Zone 1.

5.0 SUBSURFACE CONDITIONS

5.1 Field Exploration

ECS performed sixty-one borings and five pavement cores for this investigation. A boring location plan that illustrates the locations of the borings and pavement cores performed for this investigation is included in Appendix A.

The borings performed for this investigation were performed by Connelly Drilling Associates, Inc. under the full-time observation of a geologist from ECS. The borings were performed in general accordance with ASTM D 1452, Standard Practice for Soil Investigation and Sampling by Auger Borings, and ASTM D 1586, and Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

The borings were advanced by hollow-stem augers with continuous SPT sampling conducted in the upper 10 feet. The borings were generally terminated at the assigned depths. Rock coring was not performed for this investigation as it was expected that adequate design resistance by deep foundations could be achieved without extending the foundations to bear on rock.

The test boring records for this investigation are presented in Appendix B. The 13JB-series represent borings performed by ECS in 2013. The 15RW-, 15SW-, and 15MSE-series borings were performed for various retaining walls by ECS in 2015. Borings 628-1 & -2, 629-3 & -4, and 658-1 were drilled around 2008 by MACTEC.

5.2 Boring Layout

The boring locations were selected by Fairfax County with a review of the plan performed by VDOT. The boring locations were surveyed and staked in the field prior to drilling by NXL Inc., who provided as-staked elevations, coordinates, and latitudes and longitudes of the boring locations.

It was necessary to offset a few borings during the course of the field investigation. If the borings were offset, the approximate distances, differences in elevation and direction were noted and the as-drilled locations were recomputed.

5.3 General Stratigraphic Conditions

Due to the relatively remarkable topography and the significant amount of past earthwork operations in the corridor, broad, general descriptions of subsurface conditions would not be representative of the site stratigraphic conditions at specific structures. However, estimated subsurface profiles are provided in Appendix A for each substructure. The profiles indicate the bottoms of the substructures and the bottom elevations of the front faces of the

associated MSE walls. The profiles and the test boring records in Appendix B should be reviewed for subsurface conditions at specific structures.

Four basic stratigraphic conditions represent the site. General descriptions of these strata are provided below.

Surface Materials

Outside of roadway pavement and shoulder areas, topsoil encountered in the borings generally ranged from about 1 to 4 inches thick and averaged about 3 inches thick. Root mat was not observed in the borings. Pavement thickness measurements are provided in Table 5.2.

Man-Placed Fill

The existing fill appears to consist of a SILTY SANDS (SM) and SANDY SILTS (ML), the source of which appears to be from the original construction in cut areas in the I-495 corridor. The average fill depth, where encountered, is about 5.0 feet. The fill depth varies across the site and ranges from about 1.0 to 13.0 feet.

Residuum

The residuum consists of mostly silty soil types that have been derived from the in-situ weathering of the underlying highly weathered rock and bedrock. The thickness of the residuum is variable, but is typically about 40 feet thick. SPT resistance range from about 10 to 20 bpf in the upper 20 feet and range from about 20 to 40 bpf in the lower 20 feet.

The most common soil type in this stratum is a SANDY SILT (ML) with interspersed layers of occasional sandy ELASTIC SILTs (MH) and SILTY SANDs (SM).

Highly Weathered Rock (HWR)

Highly Weathered Rock, aka Intermediate Geotechnical Material (IGM), represents a residual material as it transitions in depth from soil to rock. These materials typically exhibit relic structure and have SPT values of 60 bpf or greater. The penetration resistance generally increases with depth. The HWR rock typically has SPT values exhibiting 100 blows per foot or less penetration at a depth 20 feet below the HWR surface, although this is variable. Occasional pockets of more weathered soil (SPT values < 60) are present within the HWR layer.

All of the borings were terminated within this stratum and bedrock was not encountered. The thickness of the HWR layer was not determined, but it is quite thick---over 50 feet thick in several borings. It is derived by chemical and physical weathering of the underlying bedrock, a sericite schist.

The HWR stratum consists of non-friable particles, generally noted as SANDY SILT containing schist rock fragments and classified as ML. It also consists of friable material sampled as SILTY SAND containing schist rock fragments and identified by a SM symbol on the test boring records.

It is expected that the HWR layer can be generally excavated by large excavation equipment; however, in confined excavations, or near the bottom of the stratum where SPT values are about 100 blows per 6 inches or less, the excavation process will be more difficult. HWR with SPT values of 100 blows per 6 inches of penetration or less and slate bedrock are expected to require pneumatic hammers or blasting to remove.

5.4 Groundwater

Groundwater was encountered in about half of the borings. The locations where groundwater was observed in the borings are presented in Table 5.1.

Table 5.1 – Locations of Observed Groundwater in Borings

Location	Boring No.	Boring El. ft	GWT Depth ft	Aprox. GWT El. ft
Bridge B627 Abutment A	13JB-04	356.9	73.0	283.9
Bridge B627 Pier 1	658-1	354.9	33.1	321.8
Bridge B627 Pier 1	13JB-06	339.3	58.5	280.8
Bridge B627 Abutment B	13JB-07	340.7	43.0	297.7
Bridge B627 Abutment B	629-4	336.2	33.0*	303.2
Bridge 628 Abutment A	13JB-09	351.4	41.0*	310.4
Bridge 628 Abutment A	628-2	367.0	63.0*	304.0
Bridge 628 Abutment B	13JB-10	338.7	63.0*	275.7
Bridge 628 Abutment B	13JB-11	342.0	40.0*	302.0
Bridge 628 Abutment B	328-1	366.0	68.5*	297.5
Bridge B629 Abutment A	13JB-12	344.8	44.0*	300.8
Bridge B629 Abutment A	13JB-13	344.3	46.0	298.3
Bridge B629 Pier 1	13JB-14	342.7	38.0	304.7
Bridge B629 Pier 1	13JB-15	343.6	32.0	311.6
Bridge B629 Pier 1	13JB-16	344.8	45.0*	299.8
Bridge B629 Pier 2	13JB-18	352.4	61.0*	291.4
Bridge B629 Pier 2	13JB-19	350.3	67.0*	283.3
Bridge B629 Abutment B	13JB-21	335.6	45.0*	290.6
Wall RW-001	15MSE-002	324.9	13.0*	311.9
Wall RW-001	15MSE-004	327.8	14.0*	313.8
Wall RW-007	13JB-33	312.3	11.5	300.8
Wall RW-007	13JB-34	306.5	9.0	297.5
Wall RW-007	13JB-35	309.0	14.0	295.0
Wall RW-008	15RW008-B3	308.9	28.0*	280.9
Wall RW-008	15RW008-B4	307.0	20.2*	286.8
Wall RW-009	15RW009-B2	308.8	5.5*	303.3
Scotts Crossing Road 43+92	13JB-49	305.8	8.0*	297.8

Notes:

1. * indicates GWT observed during drilling. No long-term measurement taken.

All construction planning should be based on the understanding that variations in groundwater conditions will occur. These variations will depend on seasonal conditions, surface runoff, precipitation, construction activities, changes in subsurface conditions, and other factors. High groundwater conditions should be assumed in swales and low-lying areas.

5.5 Pavement Thickness Measurements

The measured thicknesses of asphalt and underlying aggregate base course materials were relatively uniform across the site. The pavement and base course thicknesses at specific locations are indicated on the test boring records and asphalt core photographs presented in Appendix B. Table 5.2 lists the pavement thickness at the locations where it was encountered and the corresponding average thickness of the pavement and base course for the indicated roadways.

Table 5.2 - Summary of Measured Pavement Section Thicknesses

Roadway	Boring No.	Asphalt Concrete in	Base Aggregate in
Ramp to Express Lanes SB	13JB-08	12.0	12.0
Express Lanes SB	13JB-10	12.0	3.0
Express Lanes SB	13JB-11	12.0	4.0
	Average =	**12.0**	**6.3**
Scotts Crossing EB	13JB-25	12.0	12.0
Scotts Crossing 2-lane section	13JB-27	10.0	14.0
Scotts Crossing 2-lane section	13JB-28	12.0	12.0
Scotts Crossing 2-lane section	13JB-29	12.0	12.0
Scotts Crossing 2-lane section	13JB-44	12.0	12.0
Scotts Crossing WB	13JB-45	12.0	12.0
Scotts Crossing WB	13JB-46	12.0	12.0
Scotts Crossing EB	13JB-47	12.0	12.0
Scotts Crossing WB	13JB-48	12.0	12.0
Scotts Crossing EB	13JB-49	12.0	12.0
Scotts Crossing EB	13JB-50	12.0	12.0
Scotts Crossing EB	13JB-51	7.5	12.0
Scotts Crossing WB	13JB-52	9.5	12.0
Springhouse Road	13JB-35	12.0	12.0
Scotts Crossing Cul-de-Sac	13JB-20	12.0	12.0
Scotts Crossing EB	C-04	8.0	12.0
Scotts Crossing WB	C-05	8.0	7.0
Scotts Crossing WB	15RW008-B1	7.0	5.0
Scotts Crossing WB	15RW008-B2	7.0	5.0
Scotts Crossing WB	15RW008-B3	8.0	4.0
Scotts Crossing WB	15RW008-B4	8.0	4.0
Scotts Crossing EB	15RW009-B1	10.0	6.0
Scotts Crossing EB	15RW009-B2	8.0	4.0
Shirley Gate Drive	15RW010-B1	7.0	5.0
	Average =	**10.1**	**9.8**
Jones Branch Connector EB	13JB-02	12.0	12.0
Jones Branch Connector EB	13JB-03	12.0	12.0
Jones Branch Connector WB	13JB-04	11.0	4.0
Jones Branch Connector EB	13JB-05	11.0	4.0
Jones Branch Connector WB	13JB-42	12.0	7.2
Jones Branch Connector WB	13JB-43	9.0	4.0
Jones Branch Connector EB	C-01	10.5	2.0
Jones Branch Connector WB	C-02	11.2	4.0
Jones Branch connector EB	C-03	10.5	4.0
	Average =	**11.0**	**5.9**

Notes:

1. See Test Boring Records for stations of borings.
2. See Boring Location Plans for locations of pavement cores (C -series).

5.6 Potentially Unsuitable Soils

Few potentially unsuitable soils are scattered across the site in relatively limited locations. The potentially unsuitable soils identified herein consist of ELASTIC SILTS (MH) and high moisture content soils. The typical optimum moisture content is about 13 to 14 percent. While it is expected that mass earthwork operations generally result in lowering the moisture content to near optimum levels, some areas could be problematic and require additional moisture adjustments. Borings that have moisture contents greater than 25 percent in the upper 6 feet include: 13JB-04, -09, -09A, -10, -11, -20, -21, -29, and -52 and RW008-B2.

ELASTIC SILTS (MH) are not generally present at elevations near planned profile grades; however, these might occur at locations between borings. These soils should not be used as compacted fills or as subgrade support for roadways.

ELASTIC SILTS were encountered near the planned bottom of reinforced fill or roadway subgrade at the following wall locations:

- Wall RW-003, south half of front wall
- Wall RW-006, south half front wall
- Wall RW-006, east end of north wing wall
- Scotts Run Crossing Sta. 36+25 to 37+15

Where ELASTIC SILTS are encountered within 2 feet of the subgrade levels beneath the reinforced fill zones of MSE walls or the roadway pavement section, these soils will require removal and replacement with suitable fill soils.

Areas of roadway subgrade that contain high moisture content should be proof-rolled to identify soft or yielding zones that are not capable of supporting the roadway. The wet soils not passing proof-roll should be scarified, left in place to dry, and recompacted. If the subgrade passes proof-roll after drying and recompacting, then the subgrade should be considered suitable. If the subgrade does not pass proofroll, then the above steps can be repeated until the subgrade passes proofroll or the soils can be undercut as needed and replaced with suitable fill material as presented in section 8.0 of this report.

Table 5.3 below provides a summary of unsuitable soil locations and type.

Table 5.3 – Locations of Soils Exhibiting High Moisture Contents, Highly Plasticity, and Soft Soils in the Upper 3 Feet

Boring No.	Structure	Roadway Station from	Station to	Moisture Content (≥25 %)	Highly Plastic Soils	Soft Soil (SPT N-value ≤5)
13JB-04	B627 Abut A	22+00	23+00	25.4	Yes	-
13JB-09	B628 Abut A	27+50	28+50	27.7	Yes	-
13JB-09A	RW-0003	27+50	28+50	31.0	Yes	-
13JB-10	B628 Abut B	28+25	29+25	40	-	-
13JB-11	B628 Abut B	28+25	29+25	26.5	-	-
13JB-20	RW-0006	33+60	34+10	38.1	Yes	-
13JB-21	RW-0006	33+75	34+25	34.3	Yes	-
13JB-22	RW-0006	33+85	34+35	30.6	Yes	-
13JB-29	Scotts Run Crossing	36+25	37+15	-	Yes	-
13JB-52	Scotts Run Crossing	46+00	47+00	30.3	-	-
RW0008-B2	RW-008	40+75	40+50	25.5	-	-

6.0 LABORATORY TESTING

6.1 Laboratory Testing Program

Laboratory tests were performed on selected samples for the purpose of characterizing the soils encountered during the geotechnical investigation and to obtain values for engineering analyses. Brief summaries of the test results are presented in the subsequent report sections. A summary of all the laboratory tests performed for this Geotechnical Engineering Report is presented in Appendix C. Individual test reports are also presented in Appendix C. The test boring records contained in Appendix B note the results of the moisture content tests, Atterberg limits tests, and the percent passing No. 200 sieve tests.

6.2 Index Testing

Index testing consisting of Atterberg limits, grain size analysis, and moisture content testing was performed primarily on samples obtained from existing fills and the residuum stratum as most of the earthwork operations will be performed in these strata. As noted in Sections 4.1 and 5.3, the residuum stratum at the site has limited number of soil types, which are generally somewhat similar as they tend to be silty in nature; however, the distribution of specific soil types across the site is generally random. Therefore, summary descriptions presented in Table 6.1 are limited to ranges and average values. Index values at specific locations are noted on the test boring records in Appendix B and the Laboratory Soil Test Summary in Appendix C.

Table 6.1 – Summary of Index Testing

Atterberg Limits						Passing No. 200 sieve		
Min LL	Max LL	Avg LL	Min PI	Max PI	Avg PI	Min %	Max %	Avg %
23	71	45	6	27	13	24	89	63

Notes:
1. Table excludes tests that indicated to be non-plastic (NP)

The average values noted in table 6.1 is likely slightly higher than the real average value as the selection of samples for testing was somewhat biased towards selection of elastic silts for testing as compared to random selection. It is noted that 42 percent of the Atterberg limits tests indicated that the samples tested were non-plastic (NP).

The moisture content of the upper 6 feet of existing fill and residuum was above 25.0 percent in approximately one-sixth of the boring locations. These locations are identified in Section 5.6. It is noted the average optimum moisture content as determined by VTM-1 moisture density testing is 13.3 percent. The moisture contents are generally below the plastic limits, except borings: JB-22, -34, -35, and -50 and RW009-B1 and -B1A.

6.3 VTM-1 Compaction and VTM-8 CBR Testing

Six CBR tests were performed for this project. The results of these tests are summarized in Table 6.2.

Table 6.2 - Compaction Testing and CBR Test Results

Proctor Testing						CBR Test Results		
Min MDD pcf	**Max MDD** pcf	**Avg MDD** pcf	**Min OMC** %	**Max OMC** %	**Avg OMC** %	**Min** %	**Max** %	**Avg** %
103	128	113	11.5	15.7	13.3	4.7	8.0	6.8

Notes:
1. The coefficient of variation for the CBR testing is 0.20 (not including the value = 30.0).
2. The CBR range excludes the one test with a CBR value of 30.0.

For pavement design purposes, all but one CBR test are considered representative. An average CBR of 6.8 is recommended for design. As the coefficient of variation is greater than 0.1, the average CBR value must be reduced by two-thirds, which reduces the design CBR value to 4.56.

7.0 ENGINEERING DESIGN RECOMMENDATIONS

7.1 Bridge B627

Tables 7.1 to 7.4 present the results of analyses and pertinent design information for the substructures of Bridge B627.

Table 7.1 - Bridge B627 Abutment Axial Design Recommendations

Substructure	Pile Type	Factored Resistance kips	Elev. Top of Pile feet	Elev. Pile Tip feet	Pile Length feet
Abutment A - North Half	18-in. Augercast	250	341.5	292.0	49.5
Abut A - North Wingwall	18-in. Augercast	250	341.5	292.0	49.5
Abutment A - South Half	18-in. Augercast	250	341.5	302.0	39.5
Abut A - South Wingwall	18-in. Augercast	250	341.5	302.0	39.5
Abutment B	HP 12x53	180	363.0	313.0	50.0

Notes:

1. Pile length does not include abutment embedment.
2. Cans should be placed over the piles in the Abutment B MSE zone.

Table 7.2 - Bridge B627 Abutment Lateral Design Recommendations

Substructure	Deflect. in	Fixity Depth ft	Max. Moment ft-kip	Max. Mom. Depth feet	Max. Shear kips	Max. Shear Depth feet
Abutment A - North Half	0.24	21.0	153.3	0.0	35.4	0.0
Abut A - North Wingwall	0.24	21.0	145.8	0.0	35.0	0.0
Abutment A - South Half	0.39	22.0	204.2	0.0	32.0	0.0
Abut A South Wingwall	0.17	20.0	113.3	0.0	28.2	0.0
Abutment B	0.57	26.0	70.0	5.0	8.6	10.0

Notes:

1. Augercast pile reinforcement should extend below fixity depth.

Table 7.3 - Bridge B627 Axial Pier 1 Design Recommendations

Substructure	Shaft Type	Factored Resistance kips	Elev. Top of Shaft feet	Elev. Shaft Tip feet	Shaft Length feet
Pier 1 North Three Shafts	48-in. Concrete	1,250	325.5	286.0	39.5
Pier 1 South Two Shafts	48-in. Concrete	1,250	325.5	276.0	49.5

Notes:

1. Shaft length does not include cap embedment.

Table 7.4 - Bridge B627 Lateral Pier 1 Design Recommendations

Substructure	Deflect. in	Fixity Depth ft	Max. Moment ft-kip	Max. Mom. Depth feet	Max. Shear kips	Max. Shear Depth feet
Pier 1 North Three Shafts	0.78	30.0	3,666.7	0.0	200.0	15.0
Pier 2 South Two Shafts	0.70	35.0	3,666.7	0.0	220.0	14.0

7.2 Bridge B628

Tables 7.5 and 7.6 present the results of analyses and pertinent design information for the substructures of Bridge B628.

Table 7.5 - Bridge B628 Abutment Axial Design Recommendations

Substructure	Pile Type	Factored Resistance kips	Elev. Top of Pile feet	Elev. Pile Tip feet	Pile Length feet
Abutment A - North Third[4]	HP 12x53	180	364.3	310.0	54.3
Abutment A - Middle Third	HP 12x53	180	364.0	297.0	67.0
Abutment A - South Third	HP 12x53	180	362.7	308.0	54.7
Abutment B - North Half	HP 12x53	180	363.4	308.5	54.9
Abutment B - South Half	HP 12x53	180	361.8	308.5	53.3

Notes:

1. Pile top elevation represents average bottom of abutment elevation for section noted.
2. Pile length does not include abutment depth.
3. Cans should be placed over the piles in the MSE fill zones.
4. North third covers the trolley section.

Table 7.6 - Bridge B628 Lateral Abutment Design Recommendations

Substructure	Deflect. in	Fixity Depth ft	Max. Moment ft-kip	Max. Mom. Depth feet	Max. Shear kips	Max. Shear Depth feet
Abutment A - North Tie-In	1.20	24.0	110.0	6.8	20.0	0.0
Abutment A - South End	1.20	23.5	110.0	7.0	20.0	0.0
Abutment B - North Tie-In	1.20	26.0	110.0	7.5	20.0	0.0

The abutments were analyzed by applying a trial longitudinal force at the top of the pile that produces about 1.2-inch deflection.

7.3 Bridge B629

Tables 7.7 and 7.8 present the results of analyses and pertinent design information for the substructures of Bridge B629.

Table 7.7 – Bridge B629 Axial Abutment and Pier Design Recommendations

Substructure	Shaft Type	Factored Resistance kips	Elev. Top of Shaft feet	Elev. Shaft Tip feet	Shaft Length feet
Abutment A - North End	4.0-ft Dia.	527	360.4	310.0	50.4
Abutment A - Middle	4.0-ft Dia.	527	361.3	310.0	51.3
Abutment A - South End	4.0-ft Dia.	527	359.5	310.0	49.5
Pier 1 - North End	5.0-ft Dia.	1400	342.1	285.0	57.1
Pier 1 - Middle	5.0-ft Dia.	1100	343.0	285.0	58.0
Pier 1 - South End	5.0-ft Dia.	1100	343.9	285.0	58.9
Pier 2 - North End	5.0-ft Dia.	1400	341.1	277.0	64.1
Pier 2 - Middle	5.0-ft Dia.	1100	341.0	277.0	64.0
Pier 2 - South End	5.0-ft Dia.	1100	341.0	277.0	64.0
Abutment B - North End	4.0-ft Dia.	603	345.0	280.0	65.0
Abutment B - Middle	4.0-ft Dia.	603	345.1	280.0	65.1
Abutment B - South End[1]	4.0-ft Dia.	603	343.3	270.0	73.3

Notes:

1. Extend all shafts in south third of abutment to El. +270.0
2. Shsft Lengths do not include substructure embedment.

Table 7.8 – Bridge B629 Lateral Abutment and Pier Design Recommendations

Substructure	Deflect. in	Fixity Depth ft	Max. Moment ft-kip	Max. Mom. Depth feet	Max. Shear kips	Max. Shear Depth feet
Abutment A - North End	0.25	35.0	916.7	9.0	98.0	0.0
Abutment A - South End	0.25	35.0	916.7	9.0	98.0	0.0
Pier 1 - North End	0.09	43.0	625.0	8.0	37.5	20.0
Pier 1 - North Trolley	0.09	37.0	566.7	10.0	35.0	20.5
Pier 1 - Middle	0.07	47.0	600.0	6.5	36.5	16.5
Pier 1 - South End	0.07	40.0	616.7	7.0	41.0	16.5
Pier 2 - North End	0.08	43.0	620.8	8.0	36.0	18.0
Pier 2 - North Trolley	0.08	44.0	558.3	8.0	32.5	5.0
Pier 2 - Middle	0.07	41.0	600.0	6.0	37.0	17.5
Pier 2 - South End	0.10	45.0	612.5	7.5	36.0	20.5
Abutment B - North End	0.24	39.0	916.7	9.0	97.0	0.0
Abutment B - Middle	0.24	38.0	825.0	9.0	97.0	0.0
Abutment B -South End	0.23	37.0	833.3	9.0	97.0	0.0

It is noted that the lateral analyses of the shafts and piles for the bridges were analyzed using factored loads. The reason for using factored loads is to determine the moment and shear forces required for structural design of the piles and shafts. Since the top deflections using factored loads are expected to be acceptable, further lateral analyses using service loads is not necessary.

7.4 Auger-Cast Pile Foundations

Abutment A of Bridge 627 should be supported on 18-inch diameter auger-cast piles. The piles should be installed with a continuous flight auger. The equipment used should have enough torque and down pressure to reach the required tip elevations. The pile is constructed by pumping grout through the hollow center of the auger stem to the base of the auger. Simultaneous pumping of grout occurs while the auger is withdrawn. Steel reinforcing is placed in the pile immediately after the auger is withdrawn. A minimum pile-to pile spacing of 5.0 feet (>3 times the pile diameter) is recommended.

Prior to production, we recommend that a test pile be load tested to two times the recommended design resistance. The test should be performed in accordance with ASTM D 1143, *Standard Test Methods for Deep Foundations Under Axial Static Compressive Load.* The load test will require the installation of reaction piles, which might encroach the existing gas line. The load test location may be moved to west of the abutment location; however, a boring should be conducted at the test location to evaluate similarity of subsurface conditions at the test location. Additionally, we recommend that all auger cast piles be tested with a pile integrity tester, a device that can detect discontinuities and changes in cross sectional area using pulse echo (sonic) soundings.

The installation of auger-cast piles requires a set of owner-controlled set of specifications for installation and verification of quality during construction. Therefore, it is recommended that a set of special provisions, acceptable to VDOT be developed for the project. The special provision should define all aspects of the work required, the type of equipment to be used, submittal requirements, installation procedures, grout mix design, gout testing, field monitoring, and specific requirements for quality assurance.

We recommend that the following notes be placed on the plans for auger-cast piles:

1. The auger-cast piles shall be constructed in accordance with the *Special Provision for Augercast Piles.*

2. The tips of the augercast piles shall extend to or below the tip elevations noted in Table 7.1.

3. Installation of the reinforcing shall occur immediately upon completion of the auger-cast pile.

4. Prior to demobilizing of auger-cast pile installation equipment, all piles shall be tested with pile integrity testing equipment (sonic echo) and the Geotechnical Engineer shall verify that the piles have been satisfactorily installed.

7.5 Driven Pile Foundations

The required factored resistance for the HP 12x53 piles is 180 kips for Bridges B627 and B628. The piles should be driven to a driving resistance of 277 kips as determined by pile driver analyzer testing (PDA). This required driving resistance is expected to develop as the piles are driven to the approximate tip elevations noted in Tables 7.1 and 7.5. The design factored resistance of 180 kips is based on piles driven to 277 kips and an applied resistance factor of 0.65 for PDA-tested piles. We recommend a minimum of two pile dynamic tests with signal matching analysis be performed for each substructure.

The HP 12x53 piles should be ASTM A709 Grade 50 steel piles equipped with pile points. The piles should have minimum pile-to pile spacings of 3 feet. Piles located within MSE reinforced fill zones should be placed in cans to reduce downdrag loads. Clean, loose sand, with less than 10 per cent fines, should be loosely placed around the piles in the cans.

We recommend that the following notes be placed on the plans for driven piles:

1. All piles should be driven in accordance with VDOT Road and Bridge Specifications (VR&B) Section 403 and applicable VDOT *Special Provision for Dynamic Testing of Friction Piles.*

2. Prior to pile driving, the Contractor shall engage the Geotechnical Engineer to perform wave equation analyses in accordance with VDOT *Special Provision for Wave Equation Analysis* to evaluate the suitability of the contractor-selected hammer and to establish the initial driving criterion. The Contractor shall provide hammer and cushion data for the proposed pile driving equipment. This analysis is required prior to mobilizing the hammer equipment to the site.

3. The Contractor shall engage the Geotechnical Engineer to perform pile driver analyzer testing (PDA) during driving. If the Contractor elects to perform his own PDA testing, the results should be provided to the Geotechnical Engineer the same day the piles are driven. Two PDA tests shall be performed per substructure, one at each end.

4. The piles shall be driven to the *Required Driving Resistance* shown on this sheet. Re-striking the piles is not planned.

5. If the required driving nominal resistance is met and the length of the pile driven is less than 80 percent of the estimated pile length the Geotechnical Engineer shall be contacted.

7.6 Drilled Shaft Foundations

The shaft sizes and estimated lengths are noted in Tables 7.3 and 7.7. The recommended axial design resistances for drilled shafts are based on a resistance available when the tip of the shaft is embedded at least two diameters below the top of the highly weathered rock layer. The

recommended axial design resistance has been developed by static analysis methods in accordance the AASHTO LRFD design procedures.

Normally, confirmation of the static analysis is performed by load testing in the field using the Osterberg (O-CELL) test method. It is noted that the recommended axial design resistances are consistent with the design resistances used for numerous bridges recently constructed for the Capital Beltway Express Lanes project and the Dulles Metrorail Silver Line project. These design resistances were based on limited O-CELL test results conducted at the beginning of these projects. Based on this successful experience, we do not recommend load testing of drilled shafts for this project. Based on the recommended shaft lengths and bearing elevations the average ratio of maximum factored design load (including the factored shaft weight) to the ultimate resistance is about 0.38 (max. is 0.51).

The contractor should install one non-production technique shaft in the vicinity of each substructure supported by drilled shafts. The use of a 3.0-foot diameter technique shaft may be used for technique shafts.

The design of the reinforcement required should be made based on the results of lateral pile analyses presented in Table 7.4 and 7.8.

All drilled shaft inspections should be performed by the Geotechnical Engineer to determine that the shaft is constructed in accordance with the design requirements and the requirements for construction.

The following notes should be included on the project plans:

1. The drilled shafts shall be constructed in accordance with the VDOT *Special Provision for Drilled Shafts.*

2. The drilled shafts shall extend and bear a minimum of two shaft diameters below the top of the Highly Weathered Rock (HWR) surface. The shaft tips shall extend and bear at or below the tip elevations noted in Tables 7.3 and 7.7.

3. The identification of HWR shall be verified in the field during the installation of drilled shafts. The verification process shall consist of:

    - The subsurface conditions encountered in the field during excavation shall be compared to the expected conditions noted in the nearest geotechnical soil test boring record.

    - The auger cuttings shall be visually examined. The field inspector shall monitor all drilling operations and closely examine the drill cuttings for changes in color size, relic structure, and rock fragments. It is expected that drill cuttings from the HWR stratum will contain highly weathered rock fragments.

- The inspector shall monitor the rate of physical advancement (penetration) by the drilling equipment for changes in increased resistance to advancement.

4. The termination elevation of the drilled shafts shall meet the following criteria:

   - The tips shall terminate at or below the tip elevations noted in Table 7.1.

   - The shafts tips shall be embedded at least two diameters into the HWR.

   - The shafts shall extend at least one diameter below the bottom of any discontinuities (non-HWR soil layers) found within the HWR zone, and shall extend at least two diameters below the top of the discontinuous HWR zone for that shaft.

5. All 48-inch and 60-inch shafts shall be equipped with equally spaced four and six crosshole sonic logging (CSL) tubes, respectively. The first two drilled shafts installed shall be CSL tested. If there is any change in drilling technique, the first shaft following the change in technique shall be CSL tested. After the initial CSL tests, 25 percent of the remaining shafts shall be CSL tested. Any shafts with concerns, anomalies, excess concrete take, or problems noted during drilled shaft inspection by the Geotechnical Engineer shall be CSL tested.

6. Prior to concreting, verification of effective cleaning of the bottom of the shafts shall be performed by downhole inspection of dry cased shafts and by soundings of wet shafts.

Shafts may be constructed as dry cased shafts or by using wet polymer slurry methods. Regardless of the method employed, the construction of the shafts and cleaning prior to concrete placement should be performed in accordance with the *Special Provision for Drilled Shafts.*

7.7 Abutment Settlement, Downdrag, and Monitoring Requirements

The piles and shafts supporting the abutments of the bridges (except Abutment A of Bridge B628) will extend up through the retained backfill. Settlement beneath the abutments in excess of about 0.5 inches adds a downdrag load to the piles. The estimate total settlements are expected to range from about 0.5 to 1.5 inches; therefore, some downdrag force is expected for all deep foundations supporting abutments. The settlements are expected to occur within the upper strata, which are fairly thin; consequently, the downdrag is expected to be minor. Accommodation of minor downdrag force has been accounted for in the design of the piles. To eliminate downdrag from being added to the HP piles in the MSE zone, we recommend placing cans around the piles and filling the cans with loose, dry sand. To eliminate downdrag from being added to drilled shafts in the MSE zones of the abutments for Bridge B629, we recommend wrapping the shafts with Yellow Jacket™, which is a prefabricated friction reduction pile sleeve.

7.8 Deep Foundations QA/QC

Construction of deep foundations, i.e. the installation of driven piles, drilled shafts, and augercast piles, should be performed in accordance with existing VDOT special provisions. The Geotechnical Engineer should be retained to review existing special provisions for project-specific needs developed by the structural engineers. General quality assurance and quality control should be performed in accordance with VDOT's *Special Provision for Quality Assurance/Quality Control (QA/QC) for the Construction of Deep Foundation Systems*. This special provision and these recommendations cite related special provisions for QA/QC for deep foundations.

7.9 Retaining Walls

Proposed MSE walls will tie into existing MSE abutment walls or be constructed as wrap-around walls with the front face situated in front of the abutment. Walls RW-002 to RW-006 are associated with new abutment construction. Walls RW-001 and RW-007 will be MSE type wall constructed to retain embankments. Walls RW-008 to -010 will be RW-3 type gravity walls constructed to retain embankments. The results of the retaining wall analyses are presented in Table 7.9.

Table 7.9 - Results of Retaining Wall Analyses

Wall No.	Section Analyzed	Wall Height ft	Factors of Safety					Avg. Applied Bng. Stress psf
			Global		Bearing Capacity	Overturn	Sliding	
			Circular	Block				
RW-001	Sta 12+17	18.5	2.8	2.6	4.90	2.21	1.43	3,865
RW-001	Sta 12+34	22.0	2.1	2.0	4.89	2.13	1.40	4,928
RW-002	Front Wall South Half	34.0	1.9	-	4.12	2.25	1.66	7,871
RW-003	Front Wall Sta 10+50	29.4	1.9	-	1.99	2.19	1.36	6,938
RW-003	Front Wall Sta 11+40	29.4	1.8	-	1.90	2.19	1.36	6,938
RW-004	Front Wall Sta 11+15	39.0	1.6	-	1.55	2.30	1.32	8,887
RW-005	Front Wall Sta 11+00	30.7	1.9	-	3.56	2.21	1.60	7,201
RW-006	Front Sta 13+75	23.7	1.8	-	2.31	2.09	1.29	5,782
RW-006	Front Sta 14+25[5]	24.5	1.7	-	1.82	1.97	1.20	6,133
RW-006	North Bend Sta 12+10	19.2	1.8	1.8	2.18	2.44	1.45	4,210
RW-006	South Bend Sta 15+20	17.0	1.8	1.6	1.84	2.40	1.42	3,762
RW-007	Sta 40+50	16.0	2.1	1.7	2.01	1.87	1.27	4,255
RW-008	Sta 40+20	7.8	1.7	2.1	1.14	1.24	1.31	2,800
RW-008	Sta 43+28	7.4	1.4	2.2	1.19	1.24	1.35	2,640
RW-009	Sta 50+00	9.2	1.9	2.1	1.25	1.63	1.22	2,610
RW-009	Sta 51+20	6.0	1.6	2.1	1.56	1.62	1.45	1,710
RW-010	Sta 10+00	8.9	2.4	2.3	2.76	1.21	1.48	3,220

Notes:

1. Analyses were performend in accordance with LRFD methods
2. Factor of safety for non-global analyses represents represents the ratio of factored resistance to factored load. SF ≥ 1.0 meets the acceptance criteria.
3. Wall height includes wall embedment.
4. Analyzed height of front abutment walls is from profile grade to top of leveling pad.
5. Results are based on lengthened straps
6. The base width of RW-009 should be 0.7H
7. Retaining walls RW-008 and WR-009 are to be constructed either entirely or in part on a slope. A minimum bench of 4.0 feet located in front of the toe of the wall was assumed where walls are to be constructed on slopes. A minimum embedment depth of 2.0 feet should be incorporated for RW-3 walls.

The expected settlements of retaining walls are presented in Table 7.10.

Table 7.10 - Results of Settlement Analysis for Walls

Wall No.	Section Analyzed	Estimated Settlement, in		Monitoring Requirement
		Short Term (A)	Long Term (B)	
RW-001	Sta 12+17	0.10	0.01	None
RW-001	Sta 12+34	0.10	0.01	None
RW-002	Front Wall - South Half	0.27	0.03	None
RW-003	Front Wall Sta 10+50	1.19	0.13	Two-Month Wait period
RW-003	Front Wall Sta 11+40	0.92	0.10	None
RW-004	Front Wall Sta 11+15	1.33	0.15	Two-Month Wait period
RW-005	Front Wall Sta 11+00	0.47	0.05	None
RW-006	Front Sta 13+75	0.84	0.09	None
RW-006	Front Sta 14+25	0.88	0.10	None
RW-006	North Bend Sta 12+10	0.48	0.05	None
RW-006	South Bend Sta 15+20	0.34	0.04	None
RW-007	Sta 40+50	0.17	0.02	None
RW-008	Sta 40+20	0.20	0.03	None
RW-008	Sta 43+28	0.33	0.04	None
RW-009	Sta 50+00	0.09	0.01	None
RW-009	Sta 51+20	0.15	0.02	None
RW-010	Sta 10+00	0.02	0.01	None

Notes:

1. A = immediate + elastic and consolidation within two months of completion.
2. B = residual settlement beyond two months of completion.

Based on the settlements presented in Table 7.10, differential settlement is not expected to be a concern. The settlement data shown in Column A includes immediate and elastic and consolidation settlement that is expected to occur during wall construction and within a period of two months after the full wall height is reached. The residual settlement, Column B includes minor residual elastic settlement and consolidation settlement (beyond two months) and long-term, secondary consolidation up to a period of twenty years.

The locations where the total settlement is expected to exceed 1.0 inch requires settlement monitoring over a period of about two months are noted in Table 7.10. Settlement monitoring readings should be provided to the Geotechnical Engineer. Once the Geotechnical Engineer determines that the remaining long-term settlement is less than 1.0 inch, construction of pavements, grade slabs, and moment slabs can proceed.

7.10 General Wall Design and Construction Recommendations

General wall design and construction recommendations are presented in this section. Additional wall-specific recommendations required as a result of our analyses or by the subsurface conditions are presented in Section 7.12.

7.10.1 MSE Walls

Stability of Existing MSE Abutment Walls During Construction

During the construction of the proposed abutment walls for RW-002, -003, -004, and -005, the excavation for the new reinforcing straps will impact the existing abutment MSE walls at these locations. Specifically, the existing wrap-around MSE wall leveling pad of the abutment walls typically stair-step up in elevation from the face of the existing abutment until it nears the existing supported road grade. The construction of the new/expanded abutment MSE walls will require a horizontal cut to be extended from the abutment face to the end of the reinforcing straps. The resulting excavation would undermine the stepped portion of the existing MSE wrap-around walls or will otherwise create an unfavorable condition for global stability during their construction. These conditions will require sheeting and/or bracing to support the existing MSE wall and potentially the adjacent embankment slopes during construction. The MSE specialty contractor or others will need to design the applicable bracing and shoring to provide adjacent temporary stability during construction.

The following paragraphs provide descriptions of the proposed MSE abutment walls and detail the expected impacts to the existing MSE abutment walls.

Proposed MSE wall RW-002 (Existing wall 7RW-61)

The proposed RW-002 MSE wall is planned to abut the southern side of the existing 7RW-61 MSE wall at Abutment B of Bridge B627. The southern 7RW-61 wrap-around wall turns at an angle of about 122º from the Abutment B face and stair steps up the underlying embankment slope for a length of about 86 feet before the wall meets roadway grade. The RW-002 wall will be approximately 42 feet in height at its tallest point at the face of Abutment B (measured from top of roadway to bottom of leveling pad) with an effective strap length of about 29.5 feet. The construction of the new straps will potentially undermine a segment of the southern wrap-around portion of MSE wall 7RW-61.

Proposed MSE wall RW-003 (Existing wall 7RW-62)

The proposed RW-003 MSE wall is planned to abut the southern side of the existing 7RW-62 MSE wall at Abutment A of Bridge B628. The southern 7RW-62 wrap-around wall turns at an angle of about 60º from the Abutment A face and stair steps up the underlying embankment slope for a length of about 45 feet before the wall nears roadway grade. The RW-003 wall will be approximately 29.4 feet in height at its tallest point at the face of Abutment B (measured from top of roadway to bottom of leveling pad), with an effective strap length of about 20.6 feet. The construction of the new straps will potentially undermine a segment of the southern wrap-around MSE wall of 7RW-62.

Proposed MSE wall RW-004 (Existing wall 7RW-64A)

The proposed RW-004 MSE wall is planned to abut the southern side of the existing 7RW-62 MSE wall at Abutment B of Bridge B628. The southern 7RW-64A wrap-around wall turns at an angle of about 120º from the Abutment A face and extends in line with the Jones Branch Connector roadway for about 11 feet before turning southward along a 47.8-foot radius and eventually running parallel to I-495 (approximately perpendicular to the Jones Branch Connector Roadway). The 7RW-64A southern wrap-around wall extends for a total length of 346 feet and stair steps up the underlying/adjacent embankment slope before the wall nears roadway grade. The RW-004 wall will be approximately 39.0 feet in height at its tallest point at the face of Abutment B (measured from top of roadway to bottom of leveling pad), with an effective strap length of about 20.5 feet. The construction of the new straps will potentially undermine a segment of the southern wrap-around MSE wall of 7RW-64A.

Proposed MSE wall RW-004A (Existing wall 7RW-64A)

The proposed RW-004A MSE wall is planned to abut the northern side of the existing 7RW-62 MSE wall at Abutment B of Bridge B628. The northern 7RW-64A wrap-around wall turns at an angle of about 100º from the Abutment A face and extends in line with the Jones Branch Connector roadway for about 6 feet before turning northward along a 32.8-foot radius and eventually running parallel to I-495 (approximately perpendicular to the Jones Branch Connector Roadway). The 7RW-64A northern wrap-around wall extends for a total length of 363 feet and stair steps down the underlying/adjacent embankment slope before terminating at the beginning of MSE wall 7RW64B. The RW-004A wall will be approximately 43.4 feet in height at its tallest point at the face of Abutment B (measured from top of roadway to bottom of leveling pad), with an effective strap length of about 30.4 feet. The construction of the new straps will potentially undermine a segment of the northern wrap-around MSE wall of 7RW-64A.

Proposed MSE wall RW-005 (Existing wall 7RW-64A)

The proposed RW-005 MSE wall is planned to be constructed at the proposed Abutment A location of Bridge B629. The location of this MSE wall extends from about Sta 11+25 to about Sta. 14+00 of the existing 7RW-65 MSE wall. The proposed RW-005 wall will run parallel with the 7RW-65 wall and will be offset to the east of the existing wall by about 22 feet at the northernmost point of RW-005 to a maximum of about 38 feet at the southern portion of RW-005. The RW-005 wall will be approximately 31.5 feet in height at its tallest point (measured from top of roadway to bottom of leveling pad), with an maximum effective strap length of about 22 feet. The construction of the new straps for RW-005 will will likely cause global instability of the existing wall, and will require either bracing or shoring along this span.

Table 7.11 – Slope Stability of MSE Walls During Construction

Proposed Wall No.	Section Analyzed	Cut Depth next to Adjacent Exist. Wall, ft	Estimated Global Factor of Safety - No Bracing	Estimated Global Factor of Safety - With Bracing*	Estimated Required Embedment Depth for Bracing/Shoring* ft
RW-002	Sta 25+11	12.0	1.1	1.4	3.0
RW-003	Sta 11+49	2.3	<1.3	1.5	Brace to Dredge Depth
RW-004	Sta 11+00	8.9	1.2	1.4	3.5
RW-004A	Sta 10+26	9.5	1.1	1.3	8.0
RW-005	Sta 10+33	9.0	1.2	1.4	5.0
	Sta 12+30	9.0	1.1	1.4	5.0

Notes:

1. Wall cut depth next to adjacent existing walls calculated from bottom of existing wall to top of excavation for
2. Results are based on assumed strap lenghts of 0.7*H of the proposed wall heights.
3. RW-005 at Sta 10+33 is 9.0 feet below the existing MSE wall, but is located about 15.5 feet away from the face of the existing MSE wall, and due to the existing slope in font of the wall, only requires a cut of

*Final requirements to be determined by the shoring contractor

The MSE wall contractor should plan on installing bracing/sheeting to the minimum depths above which provide a minimum Factor of Safety of at least 1.3.

The MSE walls should be designed and constructed in accordance with VDOT's current *Special Provision for Mechanically Stabilized Earth Walls (Concrete Panel Facing)*; VDOT's current standard plan notes, *MSE Retaining Wall - MSE Design Requirements*; and *Chapter 10 of VDOT's Earth Retaining Structures Manual*.

Reinforcement straps for MSE walls should have lengths of L = 0.7*H (minimum length of = 8.0 feet) as noted in Table 7.12, where H = the total of the exposed wall weight to top of leveling pad. For walls located in front of abutments, H = the distance from the roadway profile grade to the top of the leveling pad. .

A minimum embedment depth of 2 feet is recommended for all MSE walls. Additionally, MSE walls should be embedded a depth at least H/10 for abutments. If the slope below the bases of the walls are not relatively flat on a perpendicular projection, the embedment ratio should be H/12 for 3H:1V slopes and H/7 for 2H:1V slopes. The required embedment depths should be shown on the project plans.

The Specialty Contractor should prepare shop drawings for the proposed retaining walls and submit them to the Project Designer for review. The analyses performed for this project include only nominal traffic surcharge loads. If the Specialty Contractor plans to place earth, construction materials, or equipment within a 1H to 1V projection from the base of the wall, the design of the wall by the Specialty Contractor must include these loads. Heavy equipment

should be kept a minimum of 5 feet horizontally from the wall panels. This will require the use of lighter compaction equipment behind the retaining walls.

Slip joints should be used at connections to existing walls and at locations where the backfill is not simultaneously placed. The analyses indicate that the use of slip joints at other specific locations is not needed; however, the Specialty Contractor may elect to include slip joints in his design.

Select backfill placed behind the MSE wall within the reinforced zone shall meet the requirements of VR&B Section 203 and the applicable Special Provision. The compacted reinforced backfill should have a moist density of approximately 100 to 110 pcf and should have a friction angle of at least 34 degrees. Soil material placed behind the reinforced zone should meet the requirements of VR&B Section 303 and have a compacted moist density of 118 pcf and a minimum friction angle of 30 degrees.

The vertical sides of the reinforced fill exposed to natural soil or backfill soils should be protected with a non-woven geotextile that meets the requirements of VR&B Section 245.03(d) and have a minimum weight of 10 oz/yd^2.

To enhance the life of metal reinforcement, an impervious membrane should be placed beneath the surface or pavement section above the first row of reinforcement. The membrane should slope away from the wall panels. A geotextile at the top of the MSE reinforced fill is not required if an impervious membrane is used.

To reduce the possible pull-down effects on the panels or abutments, the MSE backfill should be placed up to a level about 2 inches above the panel and abutment hooks before placing the metal strips on the backfill.

The borings indicate that fairly good foundation conditions are present near the foundation levels of the retaining walls; nevertheless, there could be locations that do not meet the required bearing requirements noted on the project plans. To cover this possibility, VDOT requires the following notes to be placed on the project plans:

> "Prior to construction of the leveling pad and MSE fill, the Geotechnical Engineer of Record (GER) shall verify that the retaining wall is founded on subgrade materials that meet the minimum allowable bearing capacity noted on the wall plan and elevation sheets. If the GER determines that the subgrade is unacceptable for placement of MSE fill, the Contractor shall undercut the subgrade to the limits directed by the GER. Unacceptable materials include, but are not limited to, all fat clays and elastic silts (CH, MH), low plasticity clays and silts (CL, ML) with an unconfined compressive strength of less than 2,000 psf, and other obvious soil types not capable of providing the required foundation support. Undercut materials shall be replaced with Select Backfill Materials, Type 1, Minimum CBR of 30, per VDOT Section 207."

If undercutting is required, the undercutting should extend at least 3 feet beyond the front and heel of the reinforced zones. If groundwater is present during undercutting, a stabilization fabric meeting the requirements of VR&B Section 245.03(d) with a minimum weight of 10 oz/yd^2 should be placed on the bottom and sides of the undercut excavation prior to placing the select fill.

The select fill should be placed in loose lifts not exceeding 8 inches and then compacted. The moisture content of the select fill should be maintained within 20 percent of the optimum moisture content. The select fill should be compacted to 95 percent of the maximum dry density as determined by VTM-1.

7.10.2 RW-3 Type Walls

Retaining Walls RW-008 and RW-009 are to be constructed either entirely or in part on a slope near the toe of the wall. A minimum bench of 4.0 feet will be required for these portions of the wall. The toe slope extending from the bench should be constructed with a maximum (no steeper than) 2H:1V slope. The bearing capacity factors for these wall segments were reduced per Bowles, 5th edition Table 4.7, to account for the bench width, maximum toe slope, and underlying soil strength properties. The resulting analyses require that a minimum embedment depth of 2.0 feet can be used for the RW-3 walls constructed on slopes with a 4-foot bench, except Wall RW-009. The base width of Wall RW-009 should be increased to 0.7H to provide adequate bearing capacity.

Portions of the proposed RW-008 and RW-009 walls are also planned to cross over a Conspan type box culvert which transports Scotts Run under Scotts Run Crossing. Settlement analyses were performed along the alignment of the retaining walls, which did not indicate settlements that would create cause for concern with regards to either differential settlements or unusual stress on the pipe (highest calculated total settlement was about 0.33”). Any potentially loose backfill material present around the Conspan structure should be identified during the QA process during construction and undercut/replaced in accordance with the recommendations in the following paragraphs. Vertical construction joints should be constructed in the retaining walls at the point where the walls cross the Conspan box culvert.

The recommendations in the following paragraphs apply to VDOT RW-3 type concrete gravity retaining walls.

Backfill materials placed against the walls should be relatively free draining soils, such as SM or better or AASHTO A-2-4 soils. Highly plastic materials should be excluded from the wall backfill materials. If highly plastic or soft soils are encountered at the foundation bearing elevations, they should be undercut entirely or a minimum of 2 feet and replaced with compacted fill meeting the requirements of Section 303 of the VDOT Road and Bridge (VR&B) Specifications, Type I Select Fill, Minimum CBR = 30. The select fill should be wrapped entirely with a woven geotextile meeting the VR&B Specification 245.03(d). The undercut should extend a distance of 3 feet beyond the toe and heel of the wall.

The top 2 feet of backfill should consist of a low-permeability soil to minimize the amount of surface water infiltration into the backdrain. On-site clay (CL) soils may be adequate for this criterion, provided that the soil used is not sandy in nature.

The backdrain should be constructed in accordance with VDOT Road and Bridge Standards Detail RW-3. Additionally, we recommend that the gravel backdrain be wrapped in a filtration geotextile meeting the requirement of VR&B, Section 245.03 (c).

The fill placed adjacent to the retaining walls should not be over-compacted. Heavy earthwork equipment should maintain a minimum horizontal distance away from the retaining walls within a 1:1 projection from the bottom of the wall. Lighter compaction equipment should be used close to the retaining wall. To achieve a desirable balance between minimizing excessive pressures against the retaining walls and reducing the settlement of the wall backfill, we recommend that the wall backfill be compacted to 95% of the maximum dry density obtained in accordance with VTM-1. The moisture content should be maintained within 20 percent of the optimum moisture content.

7.10.3 Wall Settlement Monitoring

At locations where the calculated short-term and long-term settlement expected by MSE construction within twenty years of completing the walls is less than 1 inch for abutments and less than 2 inches for roadway walls, monitoring is not required nor is a wait period required prior to construction of approach slabs, pavements, or moment slabs. At locations where the total long-term settlement is greater than these values, but the remaining residual long-term settlement two months after completion is less than 1.0 inch for abutments, and less than 2 inches for roadway walls, a two-month wait period is required at the end of wall construction prior to construction of approach slabs, pavements, or moment slabs. Table 7.10 lists the monitoring requirements for the retaining walls.

If a wait period is required, the contractor may elect to monitor the wall settlement to reduce the wait period. If monitoring is selected, survey readings should be performed bi-weekly during construction thereafter until construction is completed. The GER should review the data and determine that the rate of settlement has stabilized and that the remaining settlement will not exceed the allowable amount prior to discontinuing monitoring.

Survey pins placed for monitoring should be attached to the first row of panels, one per 50 feet in the required areas, but not less than two pins. The pins should be protected from damage by construction activities.

7.11 Specific Wall Design and Construction Recommendations

The embedment depths of the walls should meet the minimum requirements of Table 7.4. Notes should be placed on the plans that indicate the foundation soils have the bearing resistances noted in Table 7.12 below:

Table 7.12 - Recommended Design Criteria for Retaining Walls

Wall No.	Section Analyzed	Min. Required Bearing Resistance psf	Minimum Strap Length ft	Minimum Embedment ft
RW-001	Sta 12+17	3,900	0.7*H	2.0
RW-001	Sta 12+34	5,000	0.7*H	2.0
RW-002	Front Wall South Half	7,900	0.7*H	2.4
RW-003	Front Wall Sta 10+50	7,000	0.7*H	2.0
RW-003	Front Wall Sta 11+40	7,000	0.7*H	2.0
RW-004	Front Wall Sta 11+15	8,900	0.7*H	3.0
RW-005	Front Wall Sta 11+00	7,200	0.7*H	2.4
RW-006	Front Sta 13+75	5,800	0.7*H	2.0
RW-006	Front Sta 14+25	5,200	0.7*H	2.0
RW-006	North Bend Sta 12+10	4,200	0.7*H	2.0
RW-006	South Bend Sta 15+20	3,800	0.7*H	2.0
RW-007	Sta 40+50	4,300	0.7*H	2.0
RW-008	Sta 40+20	2,800	-	2.0
RW-008	Sta 43+28	2,700	-	2.0
RW-009	Sta 50+00	2,800	-	2.0
RW-009	Sta 51+20	1,800	-	2.0
RW-010	Sta 10+61	3,000	-	2.0

Notes:

1. H is the distance from the top of the wall to the top of the leveling pad. For walls located in front of abutments, H = the distance from roadway profile grade to top of leveling pad.
2. The minimum embedment for wing walls embannkment supporting wall is H/20 ≥ 2.0 feet.
3. Minimum embedment for front abutment walls is H/10 ≥ 2.0 feet.

The Specialty Contractor will prepare shop drawings for the MSE walls. The drawings will indicate the expected wall bearing loads for each wall section. These bearing loads are expected to be similar to the minimum required bearing resistances at specific stations noted in Table 7.12. The minimum required bearing resistances noted in Table 7.12 are based on LRFD analysis. The computed bearing stress is typically about 1.5 times higher than in ASD analysis because of factored loadings. It is expected that the Geotechnical Engineer's representative will verify the available foundation resistance by conventional methods. In consideration of the field methods employed, the factored bearing pressure noted on the plans (or shop drawings if prepared) should be reduced by 1.5, or as directed by the Geotechnical Engineer. If the foundation bearing resistance in the field is determined to meet or exceed the reduced bearing

pressure, the bearing resistance should be considered as acceptable for support of the retaining wall.

Wall RW-002

Undercutting soft soils below the zone of MSE reinforced fill to El 328.2, or as determined in the field, and replacement of the undercut materials with Type I select fill should be expected in the vicinity of the south third of the front wall. See detail in Appendix A.

Wall RW-003

Undercutting ELASTIC SILTS 2.0 feet and replacement of the undercut materials with Type I select fill in the MSE reinforce zone should be expected in the vicinity of the south third of the front wall. Settlement monitoring is required.

Wall RW-004

Settlement monitoring is required.

Wall RW-006

Undercutting ELASTIC SILTS 2.0 feet and replacement of the undercut materials with Type I select fill in the MSE reinforced zone should be expected along the majority of the front wall. See detail in Appendix A.

Wall RW-009

The base width of this wall should be 0.7H.

Other Walls

No specific design and construction recommendations are required for these walls.

Undercutting might be required at other locations when poor bearing soils or highly plastic soils are present. Where undercutting is required, the undercutting should extend 3 feet horizontally in front and back of the reinforced zone. To facilitate ease of excavation and compaction, undercutting operations should be performed prior to pile driving.

7.12 Sound Walls

The sound wall will be designed by a Specialty Contractor. Typically, sounds walls are constructed by placing panels between concrete or steel posts. The posts are typically placed in predrilled holes and concreted. The Specialty Contractor will determine the size and depth of the predrilled hole and the horizontal spacing of the posts. Parameter sheets for design of the

posts are presented in as the first two sheets of Appendix D. The Specialty Contractor should expect that site conditions can vary between borings.

7.13 Pavement Design

7.13.1 Design Information

Pavement design has been performed using the traffic data provided in emails from Mr. John Dresser of Fairfax County DOT dated February 11 and 12, 2014.

For all roadways:

The opening year is 2018. The truck percentage is 1.5%. The design requirement is 30 years. The growth rate is expected to be near 1.0%. No heavy trucks are permitted on the I-495 Express Lanes.

Roadway No. 1 - Jones Branch Connector/Scotts Crossing Road

The 2020 and 2040 two-way AADTs are 33,000 and 40,000 vpd. This corresponds to a growth rate of 0.967%, which would make the 2018 year AADT 32,371 vpd. We assumed a 50-50 split between light trucks and heavy trucks and we assumed 0.3% busses. This roadway is classified as an urban primary arterial route. It is a four-lane through roadway with turning lanes.

Roadway No. 2 - Ramp I-495 SB Off-Ramp from I-495 Express Lanes to JBC

The 2040 one-way AADT is 10,125 vpd. We assumed 80% of this traffic for the opening year, which corresponds to a growth rate of 1.012 percent. We assumed a 50-50 split between light trucks and buses. This roadway is classified as an urban interstate route. It is a two-lane through roadway.

Roadway No. 3 - Ramp I-495 SB On-Ramp to I-495 Express Lanes from JBC

The 2040 one-way AADT is 4,425 vpd. We assumed 80% of this traffic for the opening year, which corresponds to a growth rate of 1.012 percent. We assumed a 50-50 split between light trucks and buses. This roadway is classified as an urban interstate route. It is a one-lane through roadway.

Roadway No. 4 - Ramp I-495 NB Off-Ramp from I-495 Express Lanes to JBC

The 2040 one-way AADT is 3,525 vpd. We assumed 80% of this traffic for the opening year, which corresponds to a growth rate of 1.012 percent. We assumed a 50-50 split between light trucks and buses. This roadway is classified as an urban interstate route. It is a two-lane through roadway.

Roadway 5 - Ramp I-495 NB On-Ramp to I-495 Express Lanes from JBC

The 2040 one-way AADT is 8,175 vpd. We assumed 80% of this traffic for the opening year, which corresponds to a growth rate of 1.012 percent. We assumed a 50-50 split between light trucks and buses. This roadway is classified as an urban interstate route. It is a two-lane through roadway.

7.13.2 Existing Pavement Sections

Based on typical sections prepared for the I-495 HOT Lanes project, Drawing 7-2A(23) Jones Branch Connector, Section 7 – Package 2; and Drawing 7-2A(24) Dulles Interchange Ramps, Section 7 - Package 2, the following pavement sections are observed:

Table 7.13 - Existing Pavement Sections

Roadway	Pavement Layer, inch				Structural Nos.	
	SM-12.5E	IM-19.0 D	BM 25.0 A	21B	Actual S_N	S_N Reqd.
Jones Branch Connector	1.5	2.0	7.0	6.0	5.34	4.58
Ramps	2.0	2.0	10.0	6.0	6.88	≤ 4.56

The existing pavement sections for the ramps in the Dulles Interchange cover ramps to and from I-495 as well as I-495 Express Lanes (HOT Lanes) ramps (designated with an H at the end of the ramp identifier).

7.13.3 Pavement Analysis

The pavement analyses were performed in accordance with Chapter 6 of VDOT's Manual of Instruction (MOI). This chapter incorporates the procedures of the 1993 AASHTO Pavement Design Methods. The vehicle ESAL factors listed in the MOI were used in the analysis. An ESAL factor of 1.5 was used for buses as this was the ESAL factor used in the design of pavements for the I-495 Express Lanes project.

A CBR value of 4.56 was based on the average value of five tests performed for the project and reduced by two-thirds.

The required pavement design structural numbers, S_N, are presented in Table 7.14.

Table 7.14 - Required Pavement Structural Number

Roadway	Required Pavement S_N
No. 1 – JBC/Scotts Crossing Road	4.58
No. 2 - 495 SB off from Exp. Lanes to JBC	4.54
No. 3 - 495 SB to Exp. Lanes from JBC	4.00
No. 4 - 495 NB off from Exp. Lanes to JBC	3.76
No. 5 - 495 NB on to Exp. Lanes from JBC	4.38

7.13.4 Pavement Design Recommendations

Based on the given traffic data and the calculated required pavement structural numbers, the pavement sections noted in Table 7.5 would be adequate. For JBCON, it is recommended that the new pavement match the existing pavement in areas that will be widened, from the west end at about Sta 18+00 up to Sta 25+12. The total thickness of new/widened Scotts Crossing Road pavement sections ahead of station 30+01 shall be 16.5 inches with an asphalt thickness of 10.5 inches.

Where ramps are to be widened and for the segment of Scotts Run Crossing between Sta 25+12 to 30+01, we recommend that the pavements be widened with the same pavement section as existing ramps; 14.0 inches of asphalt over 6 inches of 21B. The total asphalt thickness of the new ramps shall also be the same thickness of existing ramps. The recommended pavement sections are summarized in Table 7.15.

Table 7.15 - Recommended Pavement Sections - Through Lanes and HOT Lane Ramps

Roadway	Pavement Layer, inch				S_N
	SM-9.5D	IM-19.0 A	BM 25.0 A	21B	
JBCON Widening up to Sta 25+12	1.5	2.0	7.0	6.0	5.34
Scotts Crossing New Sta 25+12 to 30+01	1.5	2.0	7.0	6.0	5.34
Scotts Crossing New ahead Sta 30+01	1.5	2.0	7.0	6.0	5.34
Ramps - Widened Sections	1.5	2.5	10.0	6.0	6.88
Ramps - New	1.5	2.5	10.0	6.0	6.88

The pavement thickness for the Capitol One Service Road should match the pavement system provided on the Capital One Infrastructure Site Plan. Pavement thicknesses for the Gates of McLean entrance, Spring Gate Drive, and new Gates of McLean parking should match the existing pavement thicknesses for these areas. The Capitol One Infrastructure Site Plan and the as-built drawings for the Gates of McLean were provided to ECS by RK&K and the required pavement systems are summarized in Table 7.16 below.

Table 7.16 - Recommended Pavement Sections - Side Roads/Parking

Roadway	Pavement Layer, inch			S_N
	Surface Pavement	Base Pavement	Aggregate Base	
Capital One Service Road	2.0 SM-9.5A	4.0 BM-25.0	8.0 CTA	4.24
Gates of McLean Entrance/Spring Gate Drive /Parking	1.5 SM-9.5**	2.5 BM-25.0**	6.0 21A	2.48

Notes:

1. The As-built drawings provided SM-2A and BM-2 (pre-2000 VDOT standard) pavement types which correlate to SM-9.5 and BM-25.0 pavement types under current VDOT standards.

For design consistency and continuity of drainage, it is recommended that widened sections of Jones Branch Connector and all ramps be constructed with the same pavement sections as the existing pavement sections.

Underdrains

Jones Branch Connector/ Scotts Crossing Road - All raised medians should be provided with an underdrain, Std. Type UD-2. The outside edges of each the roadways should be provided with an underdrain, Std. type UD-4. All ramps should be provided with an underdrain at the edge of pavement on the low side, Std. Type UD-4.

Existing Pavement Tie-Ins

Saw cuts should be used to tie into existing pavements. The tie-ins should be performed in accordance with Std. Detail WP-2. Minor adjustments to the required pavement sections at the tie-in locations might be required to accommodate variations in the existing pavement thickness.

Milling and Overlays

The eastern end of Scotts Crossing Road will be milled and overlain to save portions of the existing asphalt. The mill and overlay area for the existing pavement to be reused is from about Sta. 44+20 to about Sta. 47+18. To meet the required S_N, the overlays should increase the thickness of the existing asphalt by 1.5 inches. Where SM-9.5D is placed, the minimum and maximum lift thicknesses are 1.0 and 2.0 inches, respectively. If additional thickness is required, a base should be built up first with SM-19.0D, which has a minimum and maximum lift thickness of 2.0 and 3.0 inches, respectively.

Subgrade Stabilization

The roadway subgrades should be prepared in accordance with recommendations of the geotechnical engineering report prepared for the project and applicable VDOT Road and Bridge Specifications. At locations where additional stabilization is needed, at least 4.0 inches of Select Material, Type I with a minimum CBR of 30 should be used. The select material should meet the Requirements of the VDOT Road and Bridge Specifications Section 207.

8.0 GENERAL CONSTRUCTION RECOMMENDATIONS

8.1 Site Preparation

All site preparation and earthwork operations should be performed in accordance with Section 303 of the VDOT Road and Bridge (VR&B) Specifications. All clearing and grubbing operations should follow Section 301 of the VR&B Specifications. All pipes, structures, stumps and root mats should be removed regardless of fill height.

All clearing and grubbing operations should follow Section 301 of the VDOT Road and Bridge Specifications. Installation of the appropriate erosion and sediment (E&S) control devices should be performed in advance of the clearing and grading operations. The project plans should include specific E&S requirements and details that are to be practiced at all times during construction.

Prior to placing new fill, all topsoil, root matter, loose soils, wet soils, frozen ground, or other materials not capable of supporting the embankment should be removed. Prior to filling, we recommend that the surface be scarified and compacted. The ground surface should then be proofrolled with a heavy vehicle, such as a loaded dump truck and observed by the Geotechnical Engineer. Areas that rut, deflect, or pump excessively should be undercut and replaced with compacted fill. The compacted fill should be tested to determine that it meets the requirements stated herein. The use of bridge lifts should be avoided; however, in some circumstances it may be expedient, but only with the approval of the Geotechnical Engineer.

8.2 Fill Material Requirements

All materials to be used as compacted fill should be in compliance with VR& B Section 303 and the recommendations presented herein. Soils used as compacted fills should be free of fibrous organic matter, construction debris, frozen soil, highly plastic soils, and excessively wet soils. The soils should have a liquid limit less than 45 and a plasticity index less than 20. Large rocks or concrete and asphalt fragments should not be used as compacted fill. Rock larger than 2.0 feet maximum dimension should not be used at any embankment level. Rock with maximum dimensions of 8 inches or less may be used up to 1.0 feet below subgrade. Only particles with maximum dimensions of 3 inches or less may be used as backfill within the top 12 inches of roadway subgrade, over culverts, utilities or substructures. Additionally, within 1 foot proximity of culverts, the maximum particle dimension is 2 inches.

If undercutting is required beneath MSE walls and the associated reinforced zone, as described in Section 7.2.3, the replacement materials should consist of Type I select fill that meets the requirements of VR&B Section 207 and has a minimum CBR of 30. Materials used in the reinforced zone behind MSE walls should meet the requirements of VR&B Section 203 and the applicable Special Provision for MSE Walls.

It is recommended that before filling operations begin, representative samples of proposed fill materials (including on-site blended materials) be obtained and sent to the QC laboratory. The samples should be tested for gradation, plasticity (Atterberg limits), maximum dry density, and optimum moisture content. These tests will be required for quality control testing during construction as well as to determine if the proposed materials meet the requirements stated herein.

8.3 Fill Placement and Compaction

We recommend that general fill lifts be limited to a maximum thickness of 8 inches; however, when backfilling over culverts and structures (if any), the maximum lift thickness should be 6 inches. The fill soils should be compacted to 95 percent of the maximum dry density as determined by VTM-1. The upper 2.0 feet beneath pavements should be compacted to 100 percent. The moisture content of the fill soils should be maintained within 20 percent of the optimum moisture content determined by VTM-1.

The fill surface should be sloped adequately during construction to promote surface runoff and to prevent the accumulation of ponded water on the fill. It is good practice to roll the surface with a smooth roller to promote water runoff if rainfall is imminent and at the end of each work day. Frozen soils should be removed before placing new fill or pavement aggregate bases.

It is recommended that the Geotechnical Engineer or his representative observe and document the placement of all fill materials. Density tests should be performed at the frequency required by VDOT's Inspection Manual. Areas that do not meet the specified compaction should be recompacted and retested. Deviations in fill construction or test results that vary with the specifications should be brought to the attention of the Geotechnical Engineer.

8.4 Fill/Cut Slope Protection

The VDOT Road and Bridge Specifications state that non-rock slopes require the establishment of temporary or permanent soil stabilization within fifteen days after final grade is achieved. Soil stabilization is also required for slopes that might not be at grade but will remain undisturbed for longer than sixty days.

In order to reduce erosion and to provide slope protection all cut and fill slopes should be seeded immediately after grading. The most common method of seeding is by hydro-seeding. The hydro-seeder can generally prepare appropriate mixtures of seed, lime, fertilizer, and mulch. Seed types that produce plants that can grow on steep slopes and resist drought conditions should be used. Slopes steeper than 2H to 1V should be further stabilized with erosion control mats, such as VDOT's EC-2 mat.

8.5 Pavements

8.5.1 Subgrade Preparation

Construction of compacted fills and roadway subgrade preparation should be performed as recommended in Sections 8.2 and 8.3 of this report. In addition to meeting the requirements for subgrade fill of Section 8.3 the top 2 feet of subgrade soils should have a minimum CBR value of 4.5. Compaction of the upper 2 feet of roadway subgrade soils must achieve minimum density of 100 percent of the VTM-1 maximum dry density. Additional subgrade preparation requirements are provided by VR&B, Section 305. Prior to placing the aggregate base course, the subgrade should be proofrolled under the observation of the Geotechnical Engineer or his representative.

8.5.2 Pavement Construction

Prior to placing the aggregate base course, the subgrade should be prepared as recommended in Section 8.5.1 of this report.

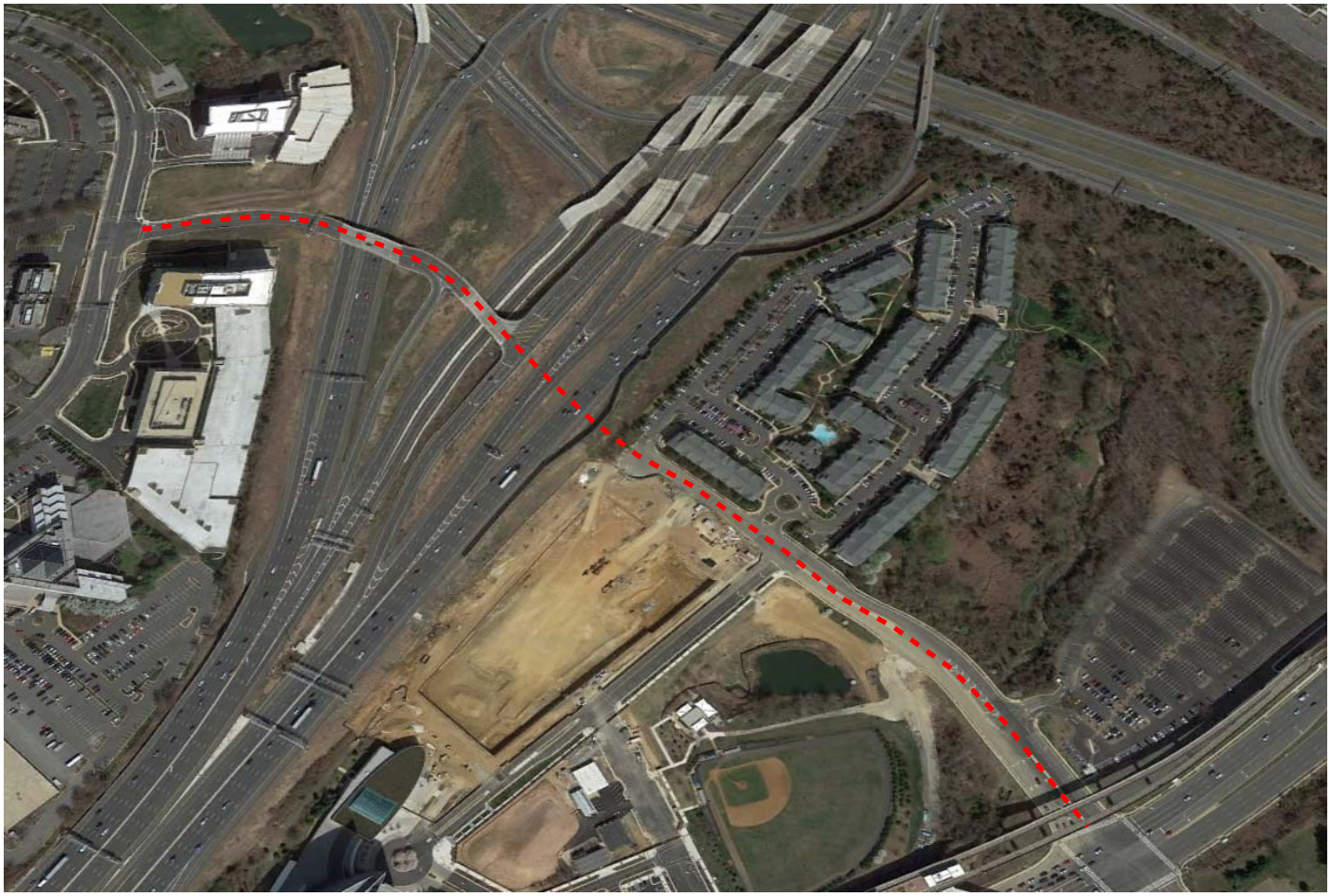
Base course aggregates should meet the material and placement requirements of VR&B Sections 203, 208, and 309. Base course aggregates should be compacted to a minimum of 95% of the VTM-1 maximum dry density and be within 20 percent of the optimum moisture content.

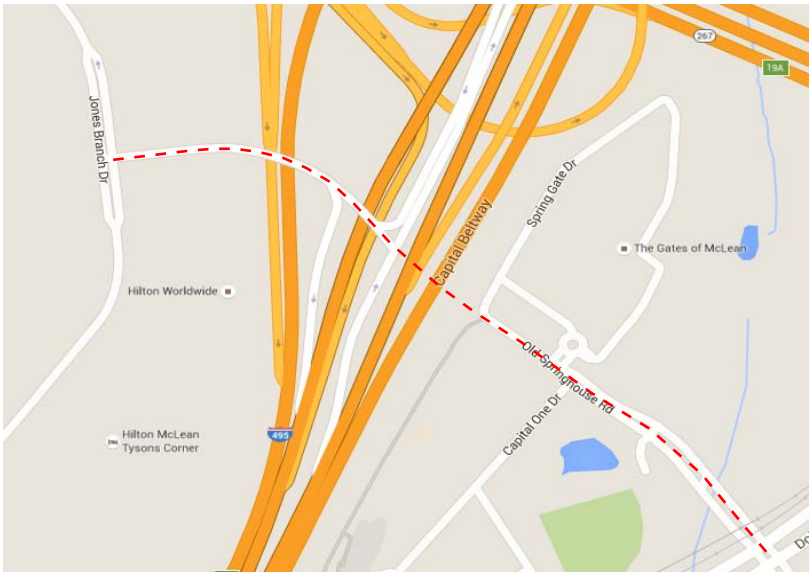
Asphalt pavement materials should be in compliance with the requirements of VR&B Sections 210 and 211. Construction of asphalt pavement sections should be in compliance with VR&B Section 315.

APPENDIX A – FIGURES

Site Location Plan
Boring Location Plans
Bridge Estimated Subsurface Profiles (B627, B628, & B629)
Bridges Plans
- B627 Plan and Profile
- Wall RW-002 Plan and Profile
- Wall RW-002 Undercut Detail
- B628 Plan and Profile
- Walls RW-003 and -004 Plan and Profile
- B629 Plan and Profile
- Walls RW-005 and -006 Plan and Profile

Other Walls
- RW-001 Plan and Profile
- RW-008 Plan and Profile
- RW-009 Plan and Profile
- RW-010 Plan and Profile
- SW-011 Plan and Profile





District:	**Northern virginia**	**SITE LOCATION PLAN**	
County:	**Fairfax**	**Scotts Crossing Road**	
ECS Project No:	**01-22941**		
Date:	**12/31/15**	**VDOT Project No:**	**8102-029-065**
By:	**JCG**	**VDOT UPC No:**	**103907**

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LIMITED ACCESS HIGHWAY

By Resolution of Highway Commission dated October 4, 1956, modified by the Commonwealth Transportation Board on December 13, 2007, and further modified by the Commonwealth Transportation Board on May 20, 2015.

JOHNSON, MIRMIRAN & THOMPSON
Engineering A Brighter Future
13921 Park Center Road Suite 140 Herndon, Virginia 20171

PROJECT MANAGER John Dresser, P.E. (703)877-5812
SURVEYED BY, DATE Rice & Associates (703) 968-3200, 2/4/2015
DESIGN BY Johnson, Mirmiran & Thompson, Inc. (703) 464-7369
SUBSURFACE UTILITY BY, DATE So-Deep, Inc. (703) 361-6005, 8/19/2015

REVISED	STATE	ROUTE	PROJECT	SHEET NO.
	VA.	8102	(FO) 8102 - 029 - 065	3

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

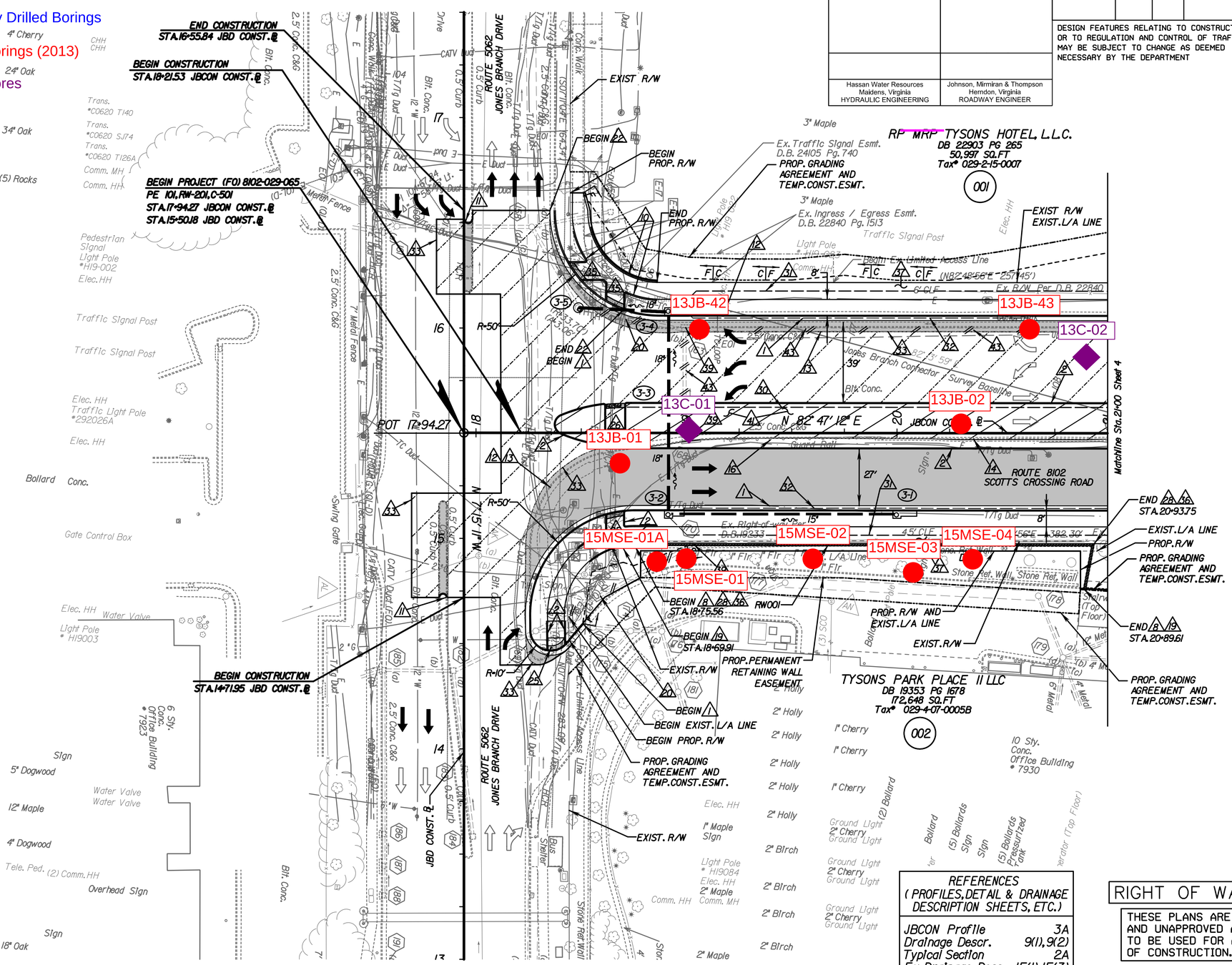
Hassan Water Resources
Maidens, Virginia
HYDRAULIC ENGINEERING

Johnson, Mirmiran & Thompson
Herndon, Virginia
ROADWAY ENGINEER

Approximate Locations of Previously Drilled Borings

Approximate Locations of Current Borings (2013)

Approximate Locations of Asphalt Cores



CONSTRUCTION ITEMS LEGEND

1. STD. CG-6 REQ'D.
2. STD. CG-2 REQ'D.
8. MSE RETAINING WALL
10. STD.CG-3 REQ'D
11. STD.SOLID CONCRETE RAISED MEDIAN STRIP (MS-1A)
12. REMOVE EXIST. SIDEWALK
13. REMOVE EXIST. CURB & GUTTER
14. REMOVE EXIST. CONC. BARRIER
16. REMOVE EXIST. GUARDRAIL
19. REMOVE EXIST.RET.WALL
20. REMOVE EXIST.PIPE
22. STD.CG-7 REQ'D
25. STD. CG-12, TYPE B CURB RAMP
26. STD. CG-12, TYPE MI
28. VDOT BR27C-15 (WITH ARCH.TREATMENT)
30. STD. UD-2 REQ'D.
31. STD. UD-3 REQ'D.
32. STD. UD-4 REQ'D.
33. STD.WP-2 REQ'D
35. STD. CG-12, TYPE C CURB RAMP
36. ORNAMENTAL FENCE (4'-6" MIN.HEIGHT)
37. 8' CONCRETE SIDEWALK
39. REMOVE EXIST.INLET
41. STD.RAISED GRASS MEDIAN STRIP (MS-2)
43. STD.PP-1 REQ'D (ABANDONED IN PLACE)

LEGEND

- C ..... Denotes Construction Limits In Cuts
- F _ _ Denotes Construction Limits In Fills
- Denotes Temporary Easement
- Denotes Permanent Easement
- Denotes Demolition of Pavement
- Denotes Proposed Pavement
- Denotes Mill & Overlay Pavement
- Denotes Future Proposed Pavement
- Grasscrete
- Proposed Directional Arrow
- Existing Directional Arrow

REFERENCES
(PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)

JBCON Profile	3A
Drainage Descr.	9(1), 9(2)
Typical Section	2A
Ex. Drainage Desc.	1F(1)-1F(3)
Curb Ramp Details	2J(1)

RIGHT OF WAY PLANS

THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION.

ROADWAY PLANS

SCALE	PROJECT	SHEET NO.
0 25' 50'	(FO) 8102-029-065	3

9/21/2015

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LIMITED ACCESS HIGHWAY

By Resolution of Highway Commission dated October 4, 1956, modified by the Commonwealth Transportation Board on December 13, 2007, and further modified by the Commonwealth Transportation Board on May 20, 2015.

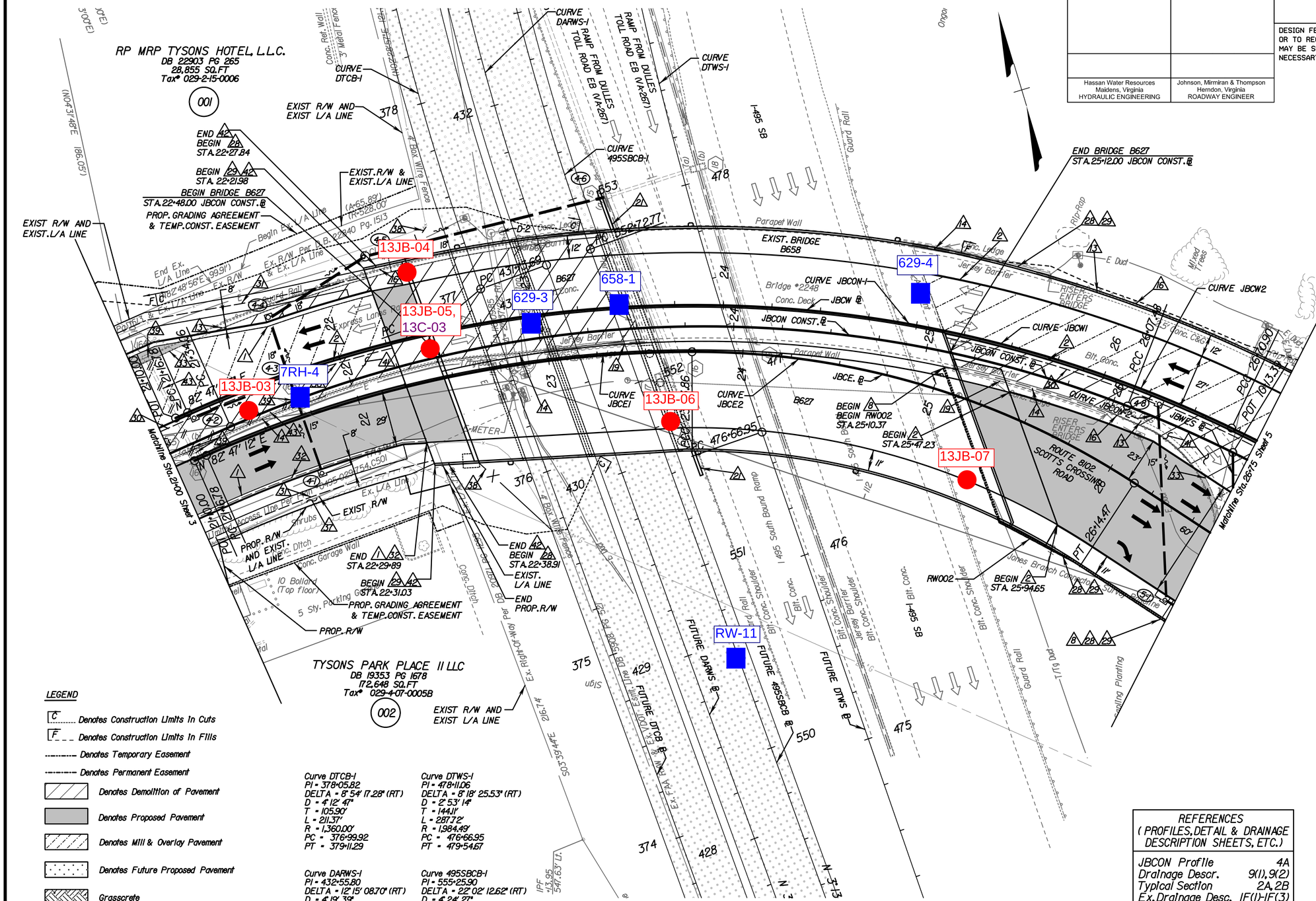
JOHNSON, MIRMIRAN & THOMPSON
Engineering A Brighter Future
13921 Park Center Road Suite 140 Herndon, Virginia 20171

PROJECT MANAGER John Dresser, P.E. (703) 877-5812
SURVEYED BY, DATE Rice & Associates (703) 968-3200, 2/4/2015
DESIGN BY Johnson, Mirmiran & Thompson, Inc. (703) 464-7369
SUBSURFACE UTILITY BY, DATE So-Deep, Inc. (703) 361-6005, 8/19/2015

REVISED	STATE	STATE ROUTE	STATE PROJECT	SHEET NO
	VA.	8102	(FO) 8102 - 029 - 065	4

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

Hassan Water Resources Maidens, Virginia HYDRAULIC ENGINEERING	Johnson, Mirmiran & Thompson Herndon, Virginia ROADWAY ENGINEER



CONSTRUCTION ITEMS LEGEND

1. STD. CG-6 REQ'D.
2. STD. CG-2 REQ'D.
8. MSE RETAINING WALL
13. REMOVE EXIST. CURB & GUTTER
14. REMOVE EXIST. CONC. BARRIER
16. REMOVE EXIST. GUARDRAIL
19. REMOVE EXIST. RET. WALL
21. PIER PROTECTION SYSTEM (BPPS-1)
28. VDOT BR27C-15 (WITH ARCH.TREATMENT)
29. ORNAMENTAL FENCE (8'-4" MIN.HEIGHT)
30. STD. UD-2 REQ'D.
31. STD. UD-3 REQ'D.
32. STD. UD-4 REQ'D.
33. STD.WP-2 REQ'D
37. 8' CONCRETE SIDEWALK
38. STD. FE-B, REQ'D.
39. REMOVE EXIST. INLET
41. STD.RAISED GRASS MEDIAN STRIP (MS-2)
42. 54" BR27C TERMINAL WALL (WITH ARCH.TREATMENT)
43. STD.PP-1 REQ'D (ABANDONED IN PLACE)

LEGEND

- C ..... Denotes Construction Limits In Cuts
- F - - - Denotes Construction Limits In Fills
- ---------- Denotes Temporary Easement
- ---------- Denotes Permanent Easement
- Denotes Demolition of Pavement
- Denotes Proposed Pavement
- Denotes Mill & Overlay Pavement
- Denotes Future Proposed Pavement
- Grasscrete
- Proposed Directional Arrow
- Existing Directional Arrow

REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)	
JBCON Profile	4A
Drainage Descr.	9(1), 9(2)
Typical Section	2A, 2B
Ex. Drainage Desc.	IF(1)-IF(3)

RIGHT OF WAY PLANS

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ROADWAY PLANS

SCALE	PROJECT	SHEET NO.
0 25' 50'	(FO) 8102-029-065	4

9/21/2015

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LIMITED ACCESS HIGHWAY

By Resolution of Highway Commission dated October 4, 1956, modified by the Commonwealth Transportation Board on December 13, 2007, and further modified by the Commonwealth Transportation Board on May 20, 2015.

JOHNSON, MIRMIRAN & THOMPSON
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DESIGN BY Johnson, Mirmiran & Thompson, Inc. (703) 464-7369
SUBSURFACE UTILITY BY, DATE So-Deep, Inc. (703) 361-6005, 8/19/2015

Curve JBCON-2
PI = 26+79.32
DELTA = 11° 55' 21.38" (RT)
D = 8° 19' 40"
T = 71.84'
L = 143.17'
R = 688.00'
PCC = 26+07.48
PT = 27+50.64

Curve JBCW-2
PI = 27+16.63
DELTA = 7° 29' 10.58" (RT)
D = 5° 11' 49"
T = 45.73'
L = 91.33'
R = 698.99'
PCC = 26+70.90
PT = 27+62.23

Curve JBCE-3
PI = 29+56.37
DELTA = 12° 02' 38.93" (LT)
D = 15° 09' 27"
T = 39.88'
L = 79.46'
R = 378.00'
PC = 29+16.49
PT = 29+95.95

Curve JBCON-3
PI = 31+33.18
DELTA = 12° 02' 38.93" (LT)
D = 4° 46' 29"
T = 126.59'
L = 252.25'
R = 1,200.00'
PC = 30+06.59
PT = 32+58.84

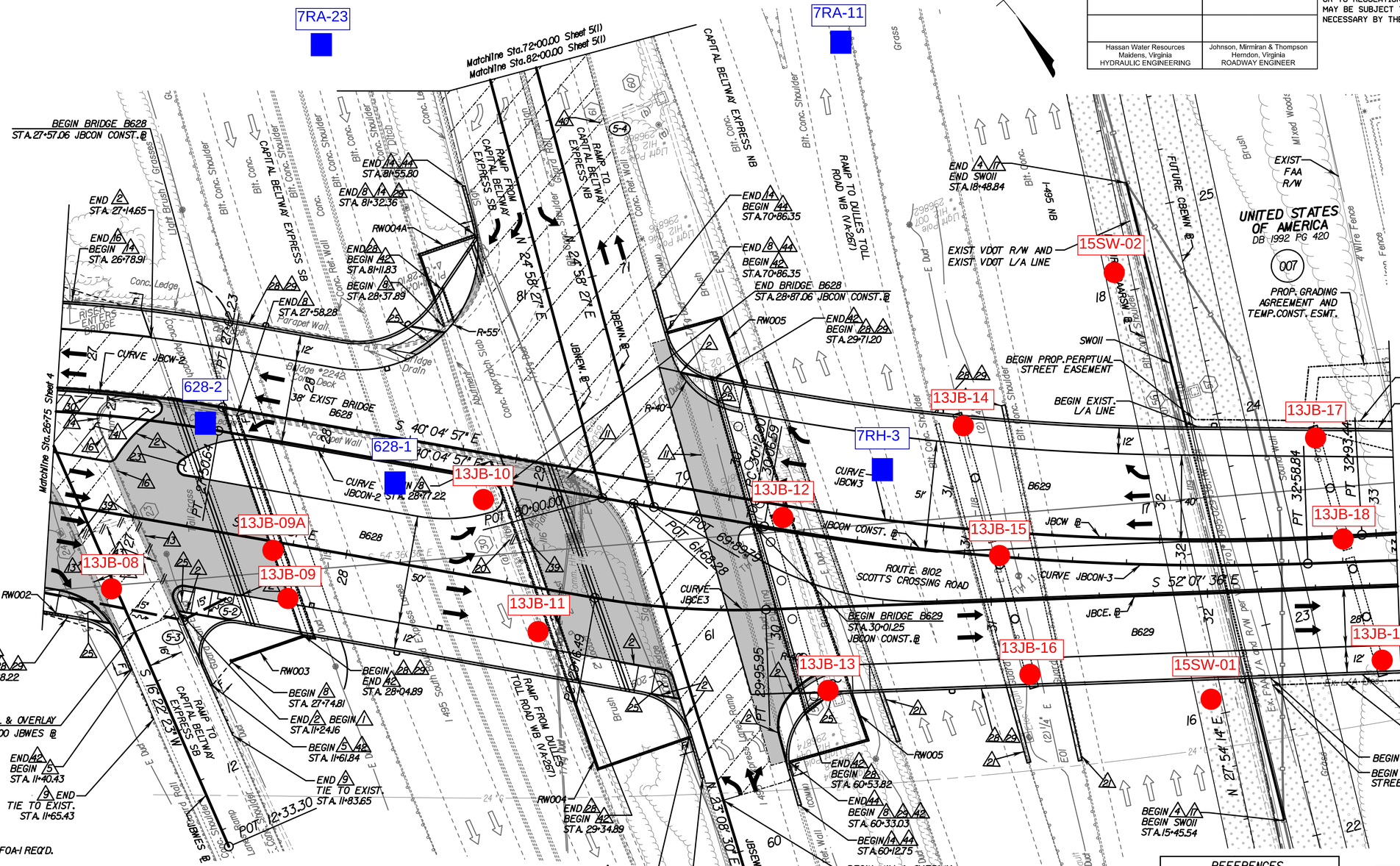
Curve JBCW-3
PI = 31+53.37
DELTA = 13° 26' 16.90" (LT)
D = 4° 46' 29"
T = 141.37'
L = 281.45'
R = 1,200.00'
PC = 30+12.00
PT = 32+93.44

REVISED	STATE	STATE ROUTE	STATE PROJECT	SHEET NO.
	VA.	8102	(F0) 8102 - 029 - 065	5

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

Hassan Water Resources
Maidens, Virginia
HYDRAULIC ENGINEERING

Johnson, Mirmiran & Thompson
Herndon, Virginia
ROADWAY ENGINEER



LEGEND

- Denotes Construction Limits In Cuts
- Denotes Construction Limits In Fills
- Denotes Temporary Easement
- Denotes Permanent Easement
- Denotes Demolition of Pavement
- Denotes Proposed Pavement
- Denotes Mill & Overlay Pavement
- Denotes Future Proposed Pavement
- Grasscrete
- Proposed Directional Arrow
- Existing Directional Arrow

CONSTRUCTION ITEMS LEGEND

- 1 STD. CG-6 REQ'D.
- 2 STD. CG-2 REQ'D.
- 3 STD. HR-1 TYPE III REQ'D.
- 5 STD. GR-FOA-I REQ'D.
- 8 MSE RETAINING WALL
- 9 STD. GR-2, REQ'D
- 13 REMOVE EXIST. CURB & GUTTER
- 14 REMOVE EXIST. CONC. BARRIER
- 16 REMOVE EXIST. GUARDRAIL
- 17 REMOVE EXIST. SOUNDWALL
- 20 REMOVE EXIST. PIPE
- 22 PIER PROTECTION SYSTEM (BPPS-1)
- 25 STD. CG-12, TYPE B CURB RAMP
- 28 VDOT BR27C-15 (WITH ARCH. TREATMENT)
- 29 ORNAMENTAL FENCE (8'-4" MIN. HEIGHT)
- 30 STD. UD-2 REQ'D.
- 39 REMOVE EXIST. INLET
- 40 ADJUST EXIST. INLET
- 41 STD. RAISED GRASS MEDIAN STRIP (MS-2)
- 42 54" BR27C TERMINAL WALL (WITH ARCH. TREATMENT)
- 43 STD. PP-1 REQ'D (ABANDONED IN PLACE)
- 44 TRANSITION 54" BR27C TERMINAL WALL TO MB-7F BARRIER

REFERENCES
(PROFILES, DETAIL & DRAWING DESCRIPTION SHEETS, ETC.)

JBCON Profile	7A
Drainage Descr.	9(1), 9(2)
Typical Section	2B, 2C, 2G
JBSEW Profile	5B
JBEWN Profile	5C
JBNEW Profile	5D
JBWES Profile	5E
Ex. Drainage Desc.	IF(1)-IF(3)
Curb Ramp Details	2J(1), 2J(2)

RIGHT OF WAY PLANS

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ROADWAY PLANS

SCALE	PROJECT	SHEET NO.
0 25' 50'	(F0) 8102-029-065	5

9/21/2015

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LIMITED ACCESS HIGHWAY

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SUBSURFACE UTILITY BY, DATE So-Deep, Inc. (703) 361-6005, 8/19/2015

REVISED	STATE	ROUTE	PROJECT	SHEET NO
	VA.	8102	(F0) 8102 - 029 - 065	6

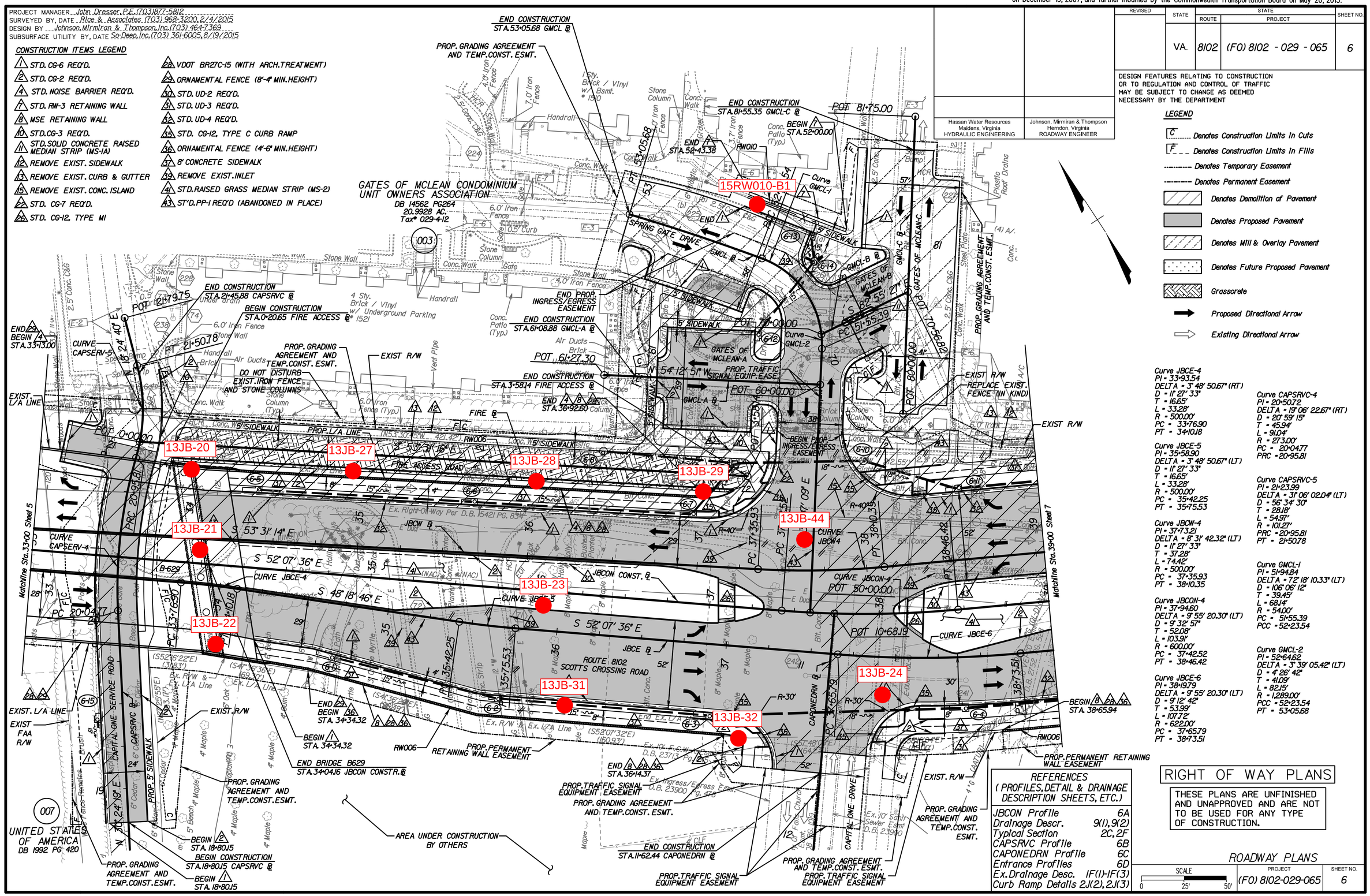
DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

Hassan Water Resources, Maidens, Virginia, HYDRAULIC ENGINEERING

Johnson, Mirmiran & Thompson, Herndon, Virginia, ROADWAY ENGINEER

CONSTRUCTION ITEMS LEGEND

1. STD. CG-6 REQ'D.
2. STD. CG-2 REQ'D.
4. STD. NOISE BARRIER REQ'D.
7. STD. RW-3 RETAINING WALL
8. MSE RETAINING WALL
10. STD. CG-3 REQ'D.
11. STD. SOLID CONCRETE RAISED MEDIAN STRIP (MS-1A)
12. REMOVE EXIST. SIDEWALK
13. REMOVE EXIST. CURB & GUTTER
15. REMOVE EXIST. CONC. ISLAND
22. STD. CG-7 REQ'D.
26. STD. CG-12, TYPE MI
28. VDOT BR27C-15 (WITH ARCH. TREATMENT)
29. ORNAMENTAL FENCE (8'-4" MIN. HEIGHT)
30. STD. UD-2 REQ'D.
31. STD. UD-3 REQ'D.
32. STD. UD-4 REQ'D.
35. STD. CG-12, TYPE C CURB RAMP
36. ORNAMENTAL FENCE (4'-6" MIN. HEIGHT)
37. 8' CONCRETE SIDEWALK
39. REMOVE EXIST. INLET
41. STD. RAISED GRASS MEDIAN STRIP (MS-2)
43. ST'D. PP-1 REQ'D (ABANDONED IN PLACE)



LEGEND

- C — Denotes Construction Limits In Cuts
- F — Denotes Construction Limits In Fills
- Denotes Temporary Easement
- Denotes Permanent Easement
- Denotes Demolition of Pavement
- Denotes Proposed Pavement
- Denotes Mill & Overlay Pavement
- Denotes Future Proposed Pavement
- Grasscrete
- Proposed Directional Arrow
- Existing Directional Arrow

Curve JBCE-4
PI = 33+93.54
DELTA = 3° 48' 50.67" (RT)
D = 11° 27' 33"
T = 16.65'
L = 33.28'
R = 500.00'
PC = 33+76.90
PT = 34+10.18

Curve JBCE-5
PI = 35+58.90
DELTA = 3° 48' 50.67" (LT)
D = 11° 27' 33"
T = 16.65'
L = 33.28'
R = 500.00'
PC = 35+42.25
PT = 35+75.53

Curve JBCW-4
PI = 37+73.21
DELTA = 8° 31' 42.32" (LT)
D = 11° 27' 33"
T = 37.28'
L = 74.42'
R = 500.00'
PC = 37+35.93
PT = 38+10.35

Curve JBCON-4
PI = 37+94.60
DELTA = 9° 55' 20.30" (LT)
D = 9° 32' 57"
T = 52.08'
L = 103.91'
R = 600.00'
PC = 37+42.52
PT = 38+46.42

Curve JBCE-6
PI = 38+19.79
DELTA = 9° 55' 20.30" (LT)
D = 9° 12' 42"
T = 53.99'
L = 107.72'
R = 622.00'
PC = 37+65.79
PT = 38+73.51

Curve CAPSRVC-4
PI = 20+50.72
DELTA = 19° 06' 22.67" (RT)
D = 20° 59' 15"
T = 45.94'
L = 91.04'
R = 273.00'
PC = 20+04.77
PRC = 20+95.81

Curve CAPSRVC-5
PI = 21+23.99
DELTA = 31° 06' 02.04" (LT)
D = 56° 34' 30"
T = 28.18'
L = 54.97'
R = 101.27'
PRC = 20+95.81
PT = 21+50.78

Curve GMCL-1
PI = 51+94.84
DELTA = 7° 18' 10.33" (LT)
D = 106° 06' 12"
T = 39.45'
L = 68.14'
R = 54.00'
PC = 51+55.39
PCC = 52+23.54

Curve GMCL-2
PI = 52+64.62
DELTA = 3° 39' 05.42" (LT)
D = 4° 26' 42"
T = 41.09'
L = 82.15'
R = 1,289.00'
PCC = 52+23.54
PT = 53+05.68

REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)

JBCON Profile	6A
Drainage Descr.	9(1), 9(2)
Typical Section	2C, 2F
CAPSRVC Profile	6B
CAPONEDRN Profile	6C
Entrance Profiles	6D
Ex. Drainage Desc.	1F(1)-1F(3)
Curb Ramp Details	2J(2), 2J(3)

RIGHT OF WAY PLANS

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ROADWAY PLANS

SCALE	PROJECT	SHEET NO.
0 25' 50'	(F0) 8102-029-065	6

9/21/2015

JOHNSON, MIRMIRAN & THOMPSON
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REVISED	STATE	STATE ROUTE	STATE PROJECT	SHEET NO.
	VA.	8102	(F0) 8102 - 029 - 065	7

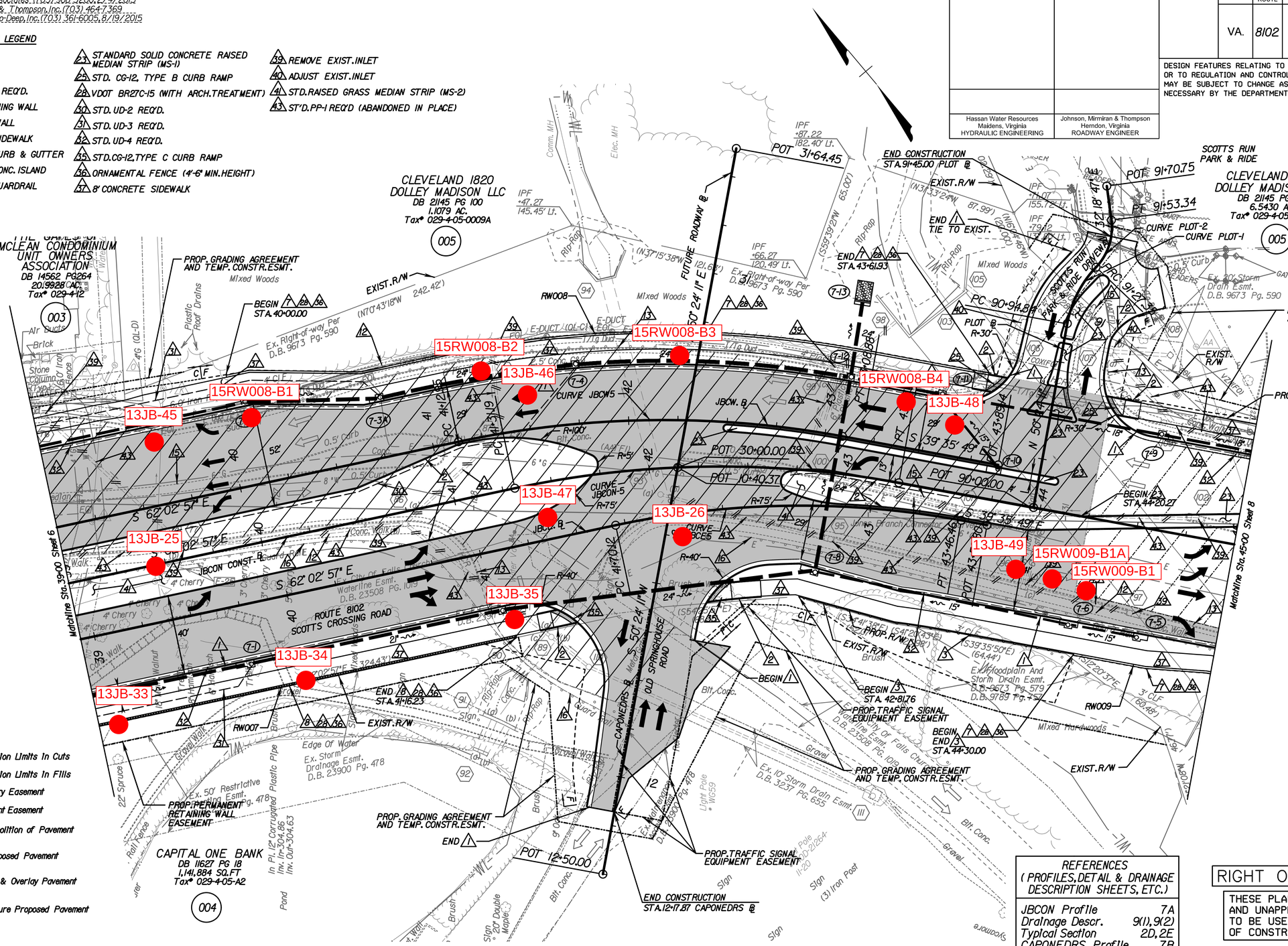
DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

Hassan Water Resources
Maidens, Virginia
HYDRAULIC ENGINEERING

Johnson, Mirmiran & Thompson
Herndon, Virginia
ROADWAY ENGINEER

CONSTRUCTION ITEMS LEGEND

1. STD. CG-6 REQ'D.
2. STD. CG-2 REQ'D.
3. STD. HR-1 TYPE III REQ'D.
7. STD. RW-3 RETAINING WALL
8. MSE RETAINING WALL
12. REMOVE EXIST. SIDEWALK
13. REMOVE EXIST. CURB & GUTTER
15. REMOVE EXIST. CONC. ISLAND
16. REMOVE EXIST. GUARDRAIL
23. STANDARD SOLID CONCRETE RAISED MEDIAN STRIP (MS-1)
25. STD. CG-12, TYPE B CURB RAMP
28. VDOT BR27C-15 (WITH ARCH. TREATMENT)
30. STD. UD-2 REQ'D.
31. STD. UD-3 REQ'D.
32. STD. UD-4 REQ'D.
35. STD. CG-12, TYPE C CURB RAMP
36. ORNAMENTAL FENCE (4'-6' MIN. HEIGHT)
37. 8' CONCRETE SIDEWALK
39. REMOVE EXIST. INLET
40. ADJUST EXIST. INLET
41. STD. RAISED GRASS MEDIAN STRIP (MS-2)
43. ST'D. PP-1 REQ'D (ABANDONED IN PLACE)



Curve PLOT-1
PI = 91+11.57
DELTA = 33° 15' 30.28" (RT)
D = 102° 18' 50"
T = 16.73'
L = 32.51'
R = 56.00'
PC = 90+94.84
PRC = 91+27.35

Curve PLOT-2
PI = 91+41.29
DELTA = 51° 20' 54.19" (LT)
D = 197° 34' 18"
T = 13.94'
L = 25.99'
R = 29.00'
PRC = 91+27.35
PT = 91+53.34

Curve JBCW-5
PI = 42+12.19
DELTA = 22° 27' 07.69" (RT)
D = 11° 27' 33"
T = 99.24'
L = 195.93'
R = 500.00'
PC = 41+12.95
PT = 43+08.88

Curve JBCON-5
PI = 42+30.43
DELTA = 22° 27' 07.69" (RT)
D = 11° 27' 33"
T = 99.24'
L = 195.93'
R = 500.00'
PC = 41+31.19
PT = 43+27.12

Curve JBCE-7
PI = 42+59.44
DELTA = 22° 27' 07.69" (RT)
D = 12° 43' 57"
T = 89.32'
L = 176.34'
R = 450.00'
PC = 41+70.12
PT = 43+46.46

LEGEND

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- Denotes Mill & Overlay Pavement
- Denotes Future Proposed Pavement
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- Proposed Directional Arrow
- Existing Directional Arrow

REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)

JBCON Profile	7A
Drainage Descr.	9(1), 9(2)
Typical Section	2D, 2E
CAPONEDRS Profile	7B
PLOT Profile	7C
Ex. Drainage Desc.	IF(1)-IF(3)
Curb Ramp Details	2J(3)

RIGHT OF WAY PLANS

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ROADWAY PLANS

SCALE	PROJECT	SHEET NO.
0 25' 50'	(F0) 8102-029-065	7

9/21/2015

JOHNSON, MIRMIRAN & THOMPSON
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REVISED	STATE	STATE ROUTE	STATE PROJECT	SHEET NO.
	VA.	8102	(FO) 8102 - 029 - 065	8

DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT

Hassan Water Resources
Maidens, Virginia
HYDRAULIC ENGINEERING

Johnson, Mirmiran & Thompson
Herndon, Virginia
ROADWAY ENGINEER

LEGEND

- C ..... Denotes Construction Limits In Cuts
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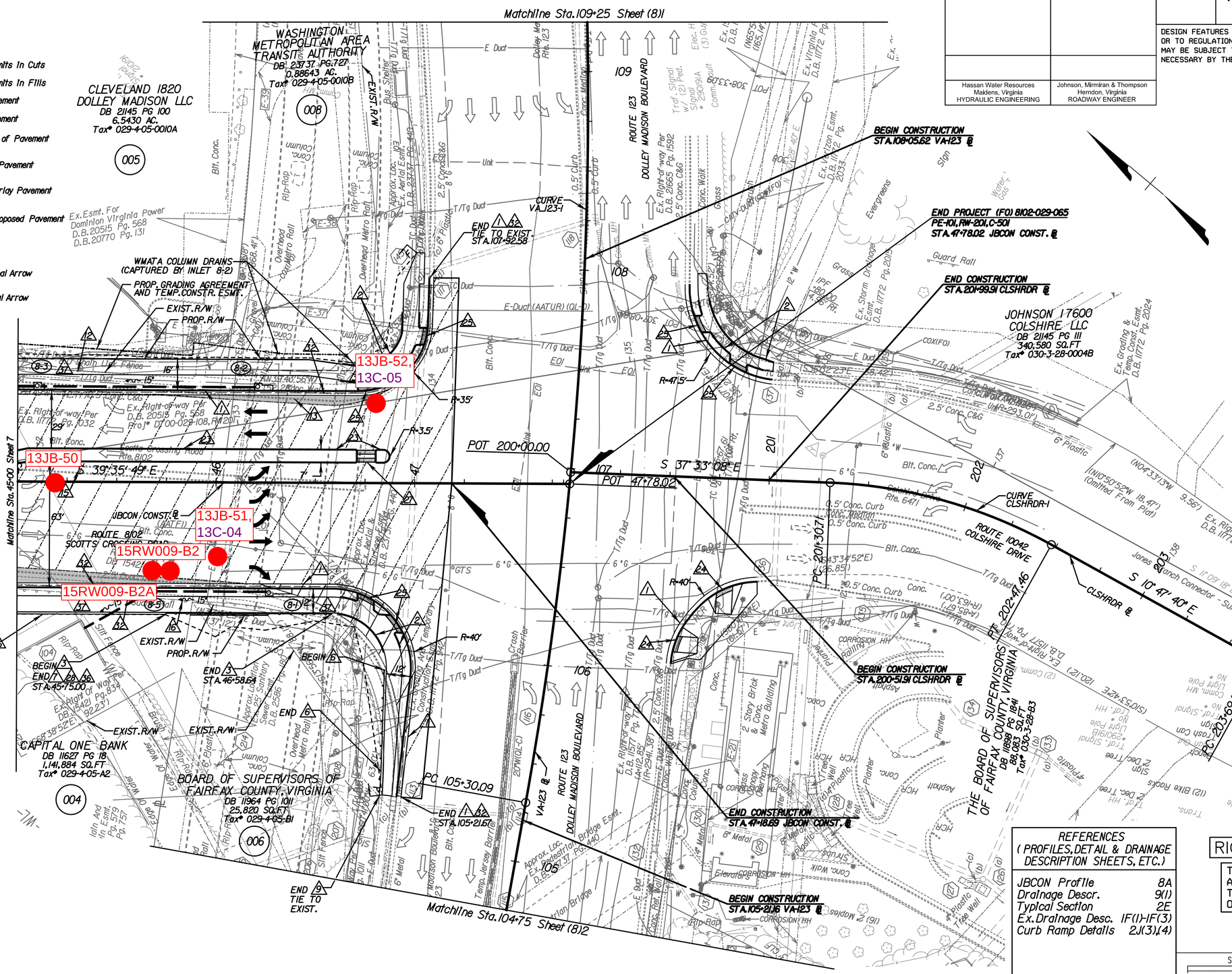

CONSTRUCTION ITEMS LEGEND

1. STD. CG-6 REQ'D.
2. STD. CG-2 REQ'D.
3. STD. HR-1 TYPE III REQ'D.
5. STD. GR-FOA-1 REQ'D.
6. STD. GR-9 REQ'D.
7. STD. RW-3 RETAINING WALL
9. STD. GR-2, REQ'D
12. REMOVE EXIST. SIDEWALK
13. REMOVE EXIST. CURB & GUTTER
15. REMOVE EXIST. CONC. ISLAND
16. REMOVE EXIST. GUARDRAIL
23. STD. SOLID CONCRETE RAISED MEDIAN STRIP (MS-1)
24. STD. CG-12, TYPE A CURB RAMP
25. STD. CG-12, TYPE B CURB RAMP
27. STD. CG-12, TYPE M2
28. VDOT BR27C-15 (WITH ARCH. TREATMENT)
32. STD. UD-4 REQ'D.
36. ORNAMENTAL FENCE (4'-6" MIN. HEIGHT)
37. 8' CONCRETE SIDEWALK

Curve VA_123-1
PI = 108+01.63
DELTA = 15° 27' 48.73" (LT)
D = 2° 51' 53"
T = 271.54'
L = 539.78'
R = 2,000.00'
PC = 105+30.09
PT = 110+69.87

Curve CLSHRDR-1
PI = 201+90.17
DELTA = 26° 45' 28.42" (RT)
D = 22° 55' 06"
T = 59.46'
L = 116.75'
R = 250.00'
PC = 201+30.71
PT = 202+47.46

REFERENCES (PROFILES, DETAIL & DRAINAGE DESCRIPTION SHEETS, ETC.)	
JBCON Profile	8A
Drainage Descr.	9(1)
Typical Section	2E
Ex. Drainage Desc.	1F(1)-1F(3)
Curb Ramp Details	2J(3),(4)

RIGHT OF WAY PLANS

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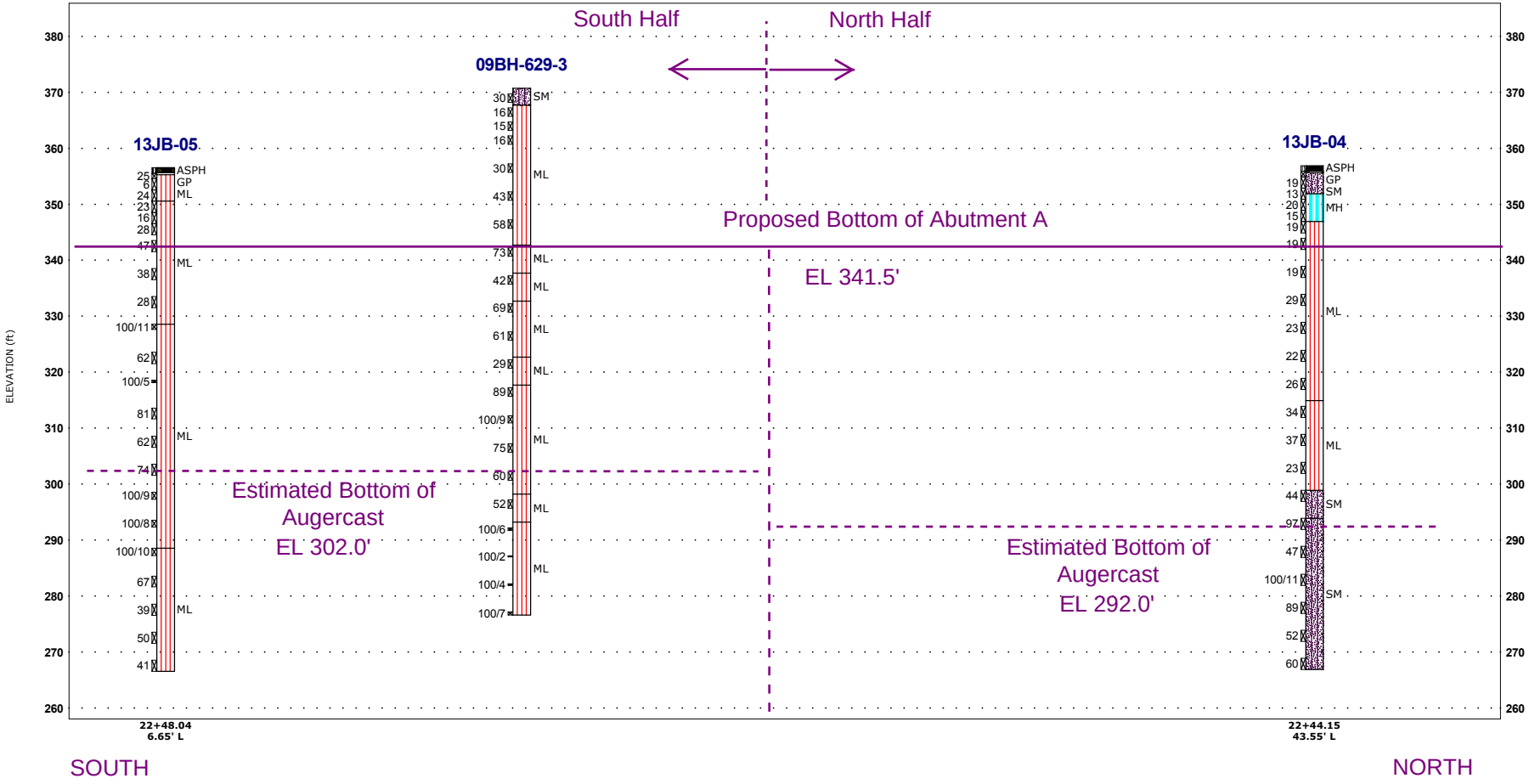
ROADWAY PLANS

SCALE	PROJECT	SHEET NO.
0 25' 50'	(FO) 8102-029-065	8

9/21/2015

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B627 - ABUTMENT A



Notes: See borehole logs for complete data
See Material and Sample Symbols List

The subsurface information shown on the boring logs in these plans was obtained with reasonable care and recorded in good faith solely for use by the Department in establishing design controls for the project. The Department has no reason to suspect that such information is not reasonably accurate as an approximate indication of the subsurface conditions at the sites where the borings were taken. The Department does not in any way warrant or guarantee that such data can be projected as indicative of conditions beyond the limits of the borings shown; and any such projections by bidders are purely interpretive and altogether speculative. Further, the Department does not in any way guarantee, either expressly or by implication, the sufficiency of the information for bid purposes.

The boring logs are made available to bidders in order that they may have access to subsurface data identical to that which is possessed by the Department, and are not intended as a substitute for personal investigation, interpretation and judgment by the bidders.

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

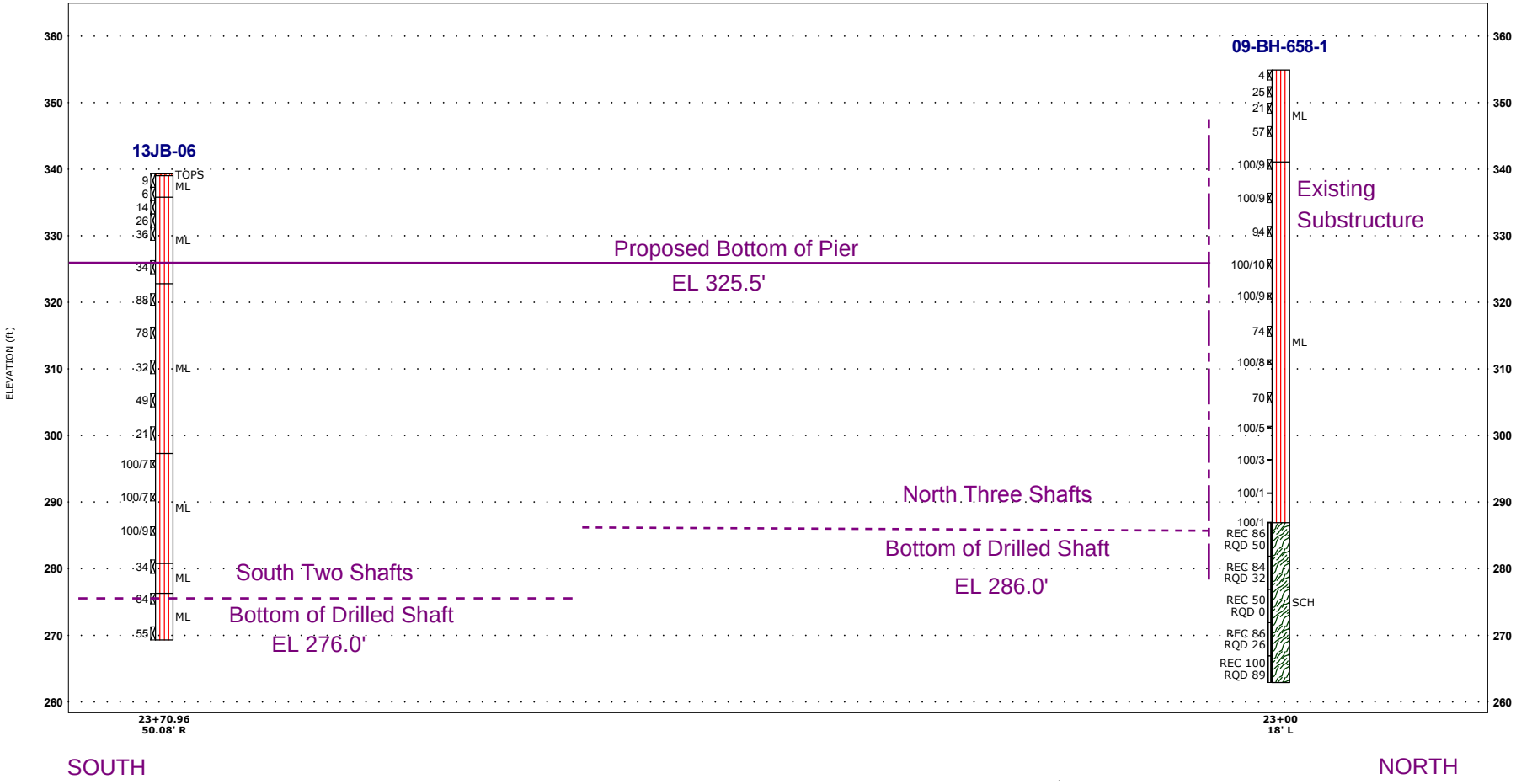
FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

SPT_FBI/CE21504-BCONN_BORING_LOGS_FOR PROFILES ONLY (BH) 830.00301251212/713

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B627 - PIER



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

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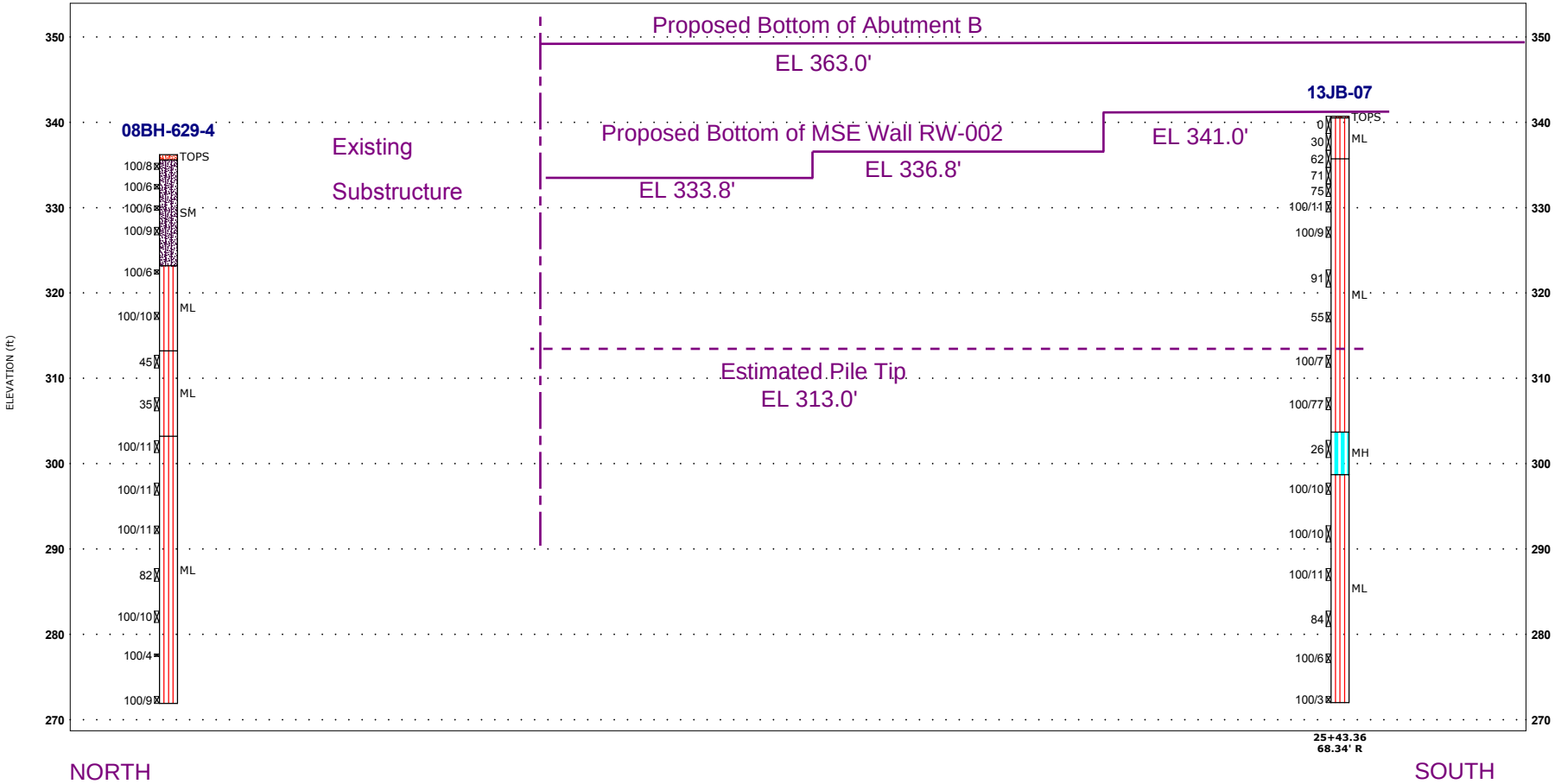
FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B627 - ABUTMENT B



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
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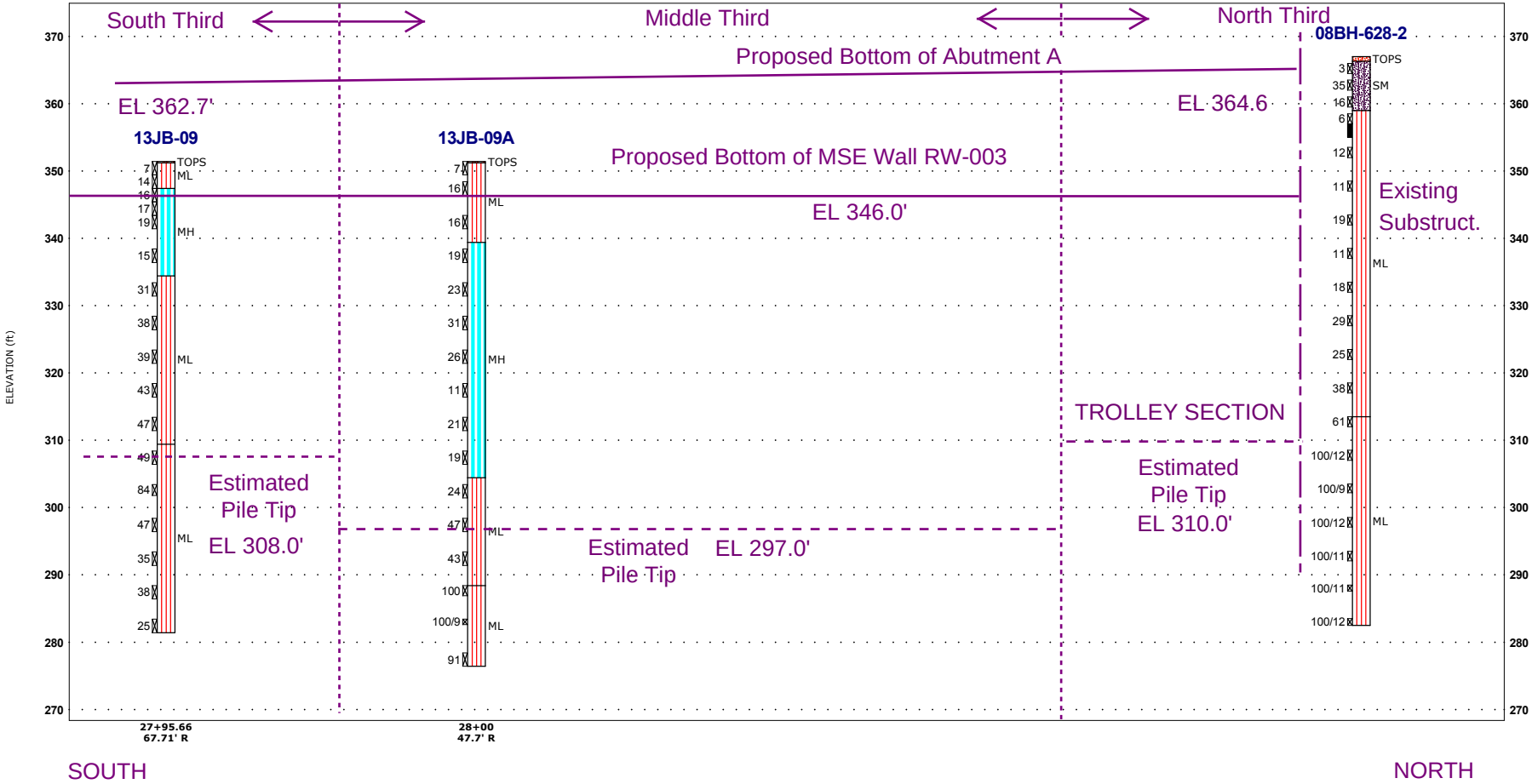
SPT_FBI/CE21504-BCONN_BORING_LOGS_FOR PROFILES ONLY (SPJ 830.003/1/25/12/7/13

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B628 - ABUTMENT A



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

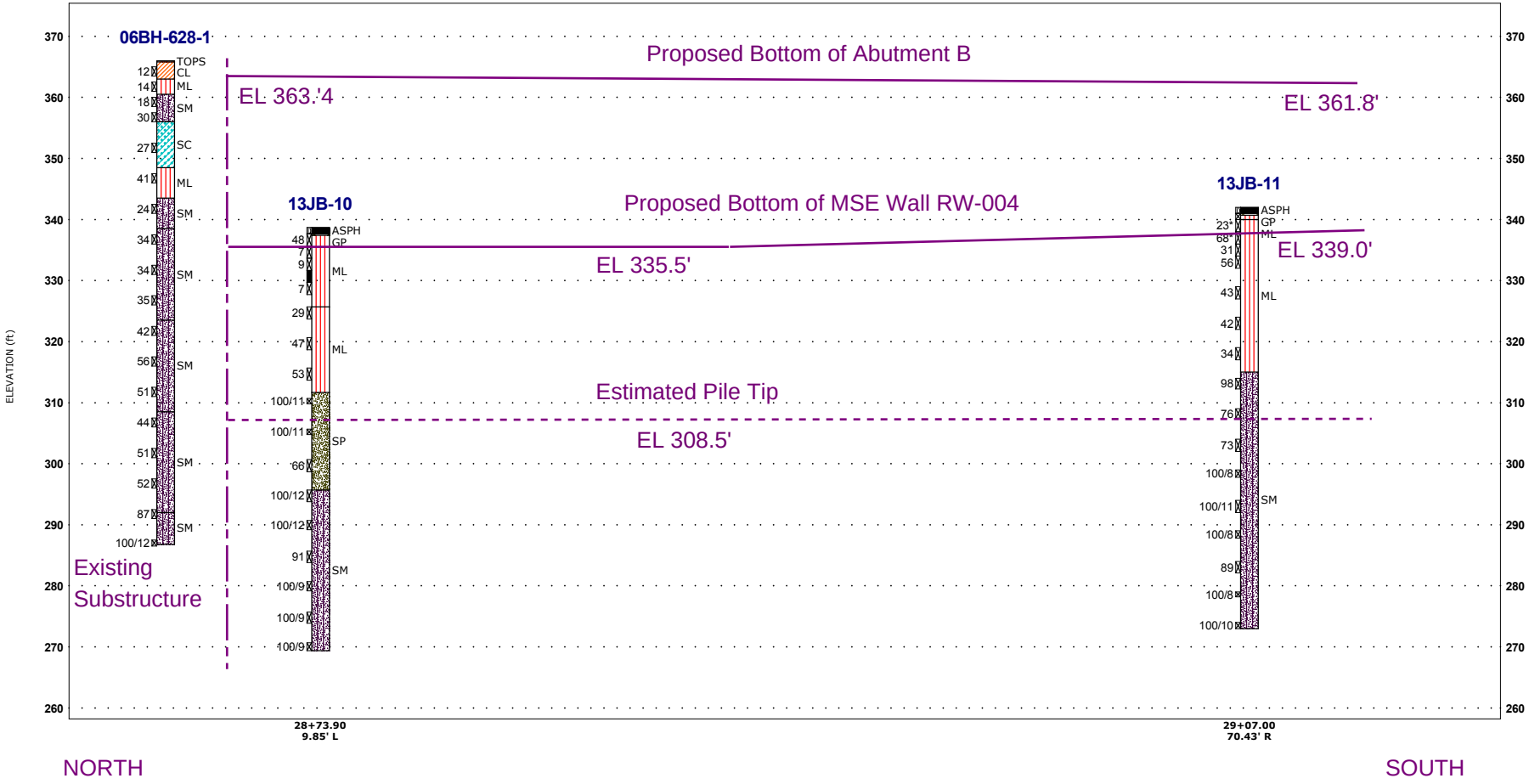
FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

SPT_FBI/CE21604-BCONN_BORING_LOGS_FOR PROFILES ONLY (BP)-830.00301251219713

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B628 - ABUTMENT B



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

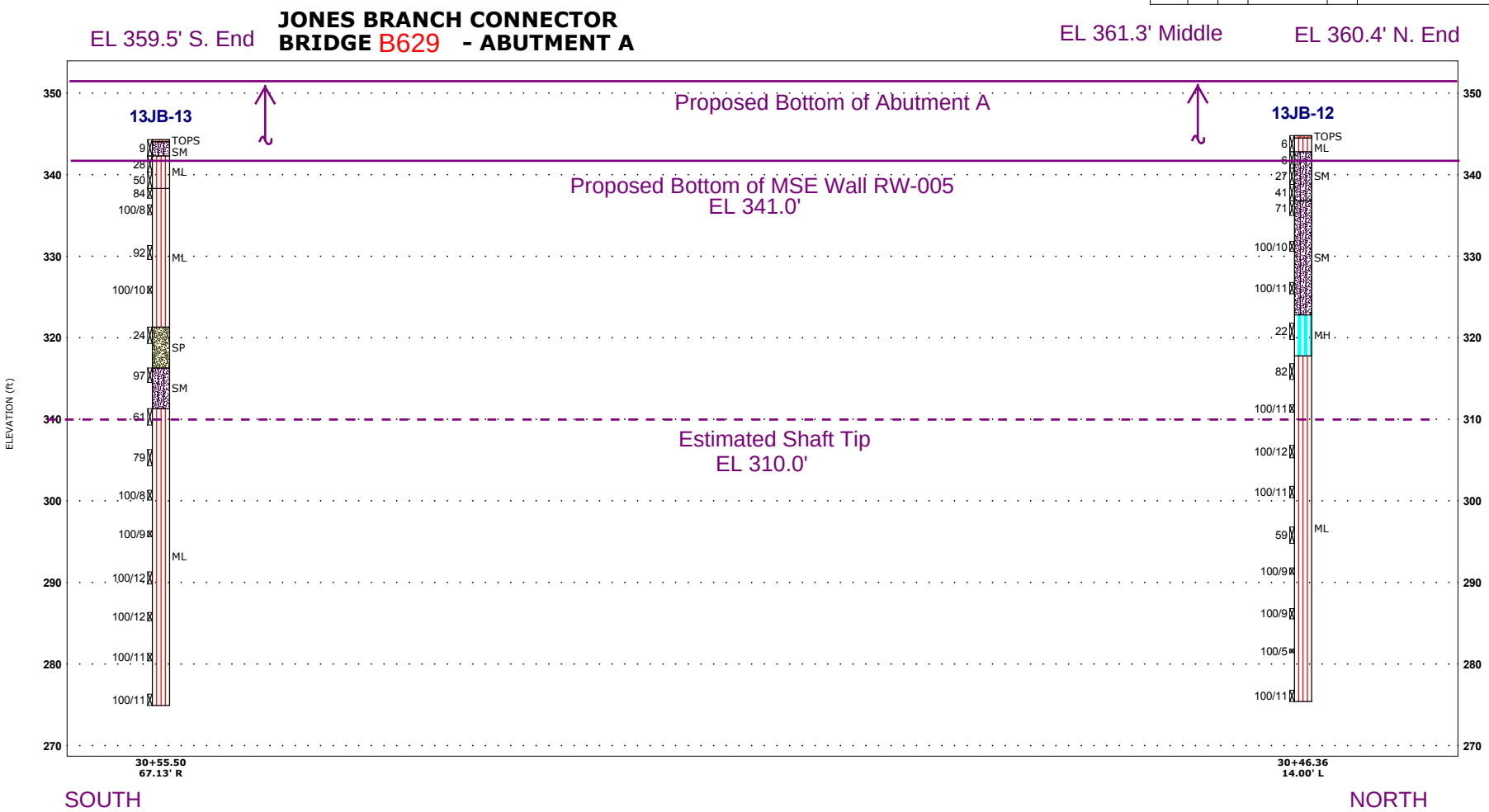
FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

SPT_FBI/CE21504-BCONN_BORING_LOGS_FOR PROFILES ONLY (BH)-B30.003/1/25/12/2713

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR BRIDGE B629 - ABUTMENT A



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
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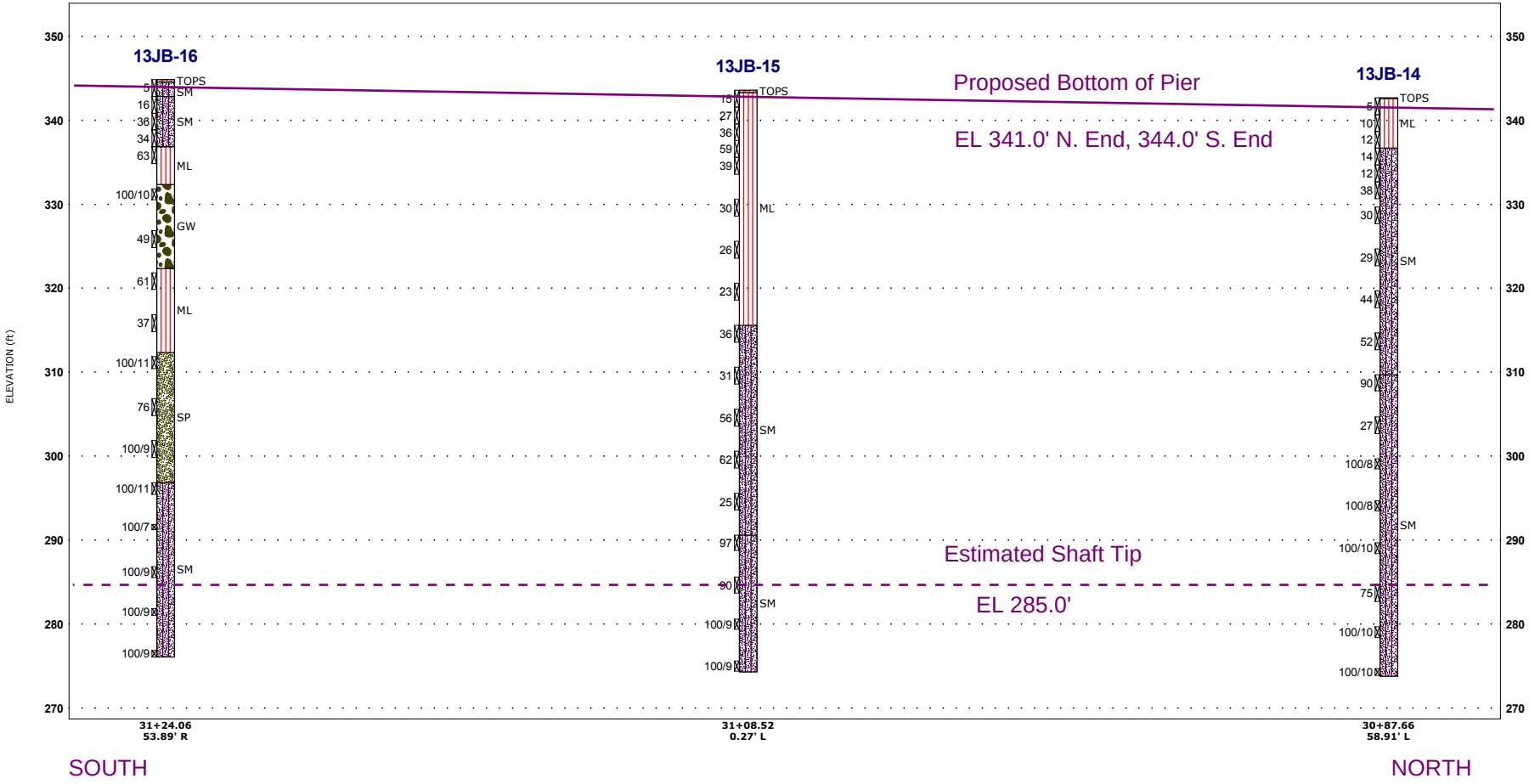
SPT_FBV-CB-21624-B630N_BORING_LOGS_FOR PROFILES ONLY.GPJ 8.30.003.01252 12/9/13

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B629 - PIER 1



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

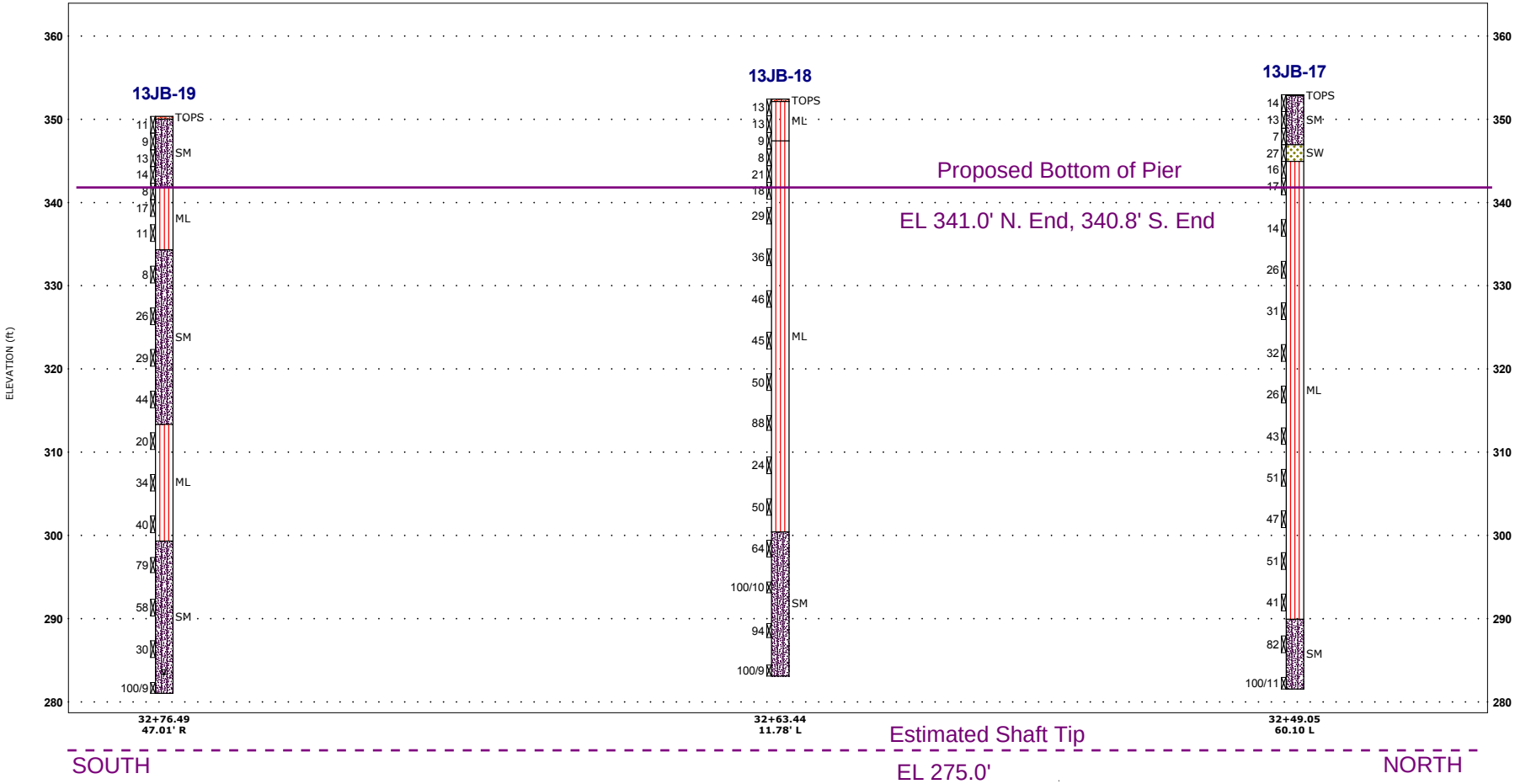
FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

SPT_FBV-CB-21624-BOONN_BORING_LOGS_FOR PROFILES ONLY.GPJ 8.30.003.01252 12/9/13

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B629 - PIER 2



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

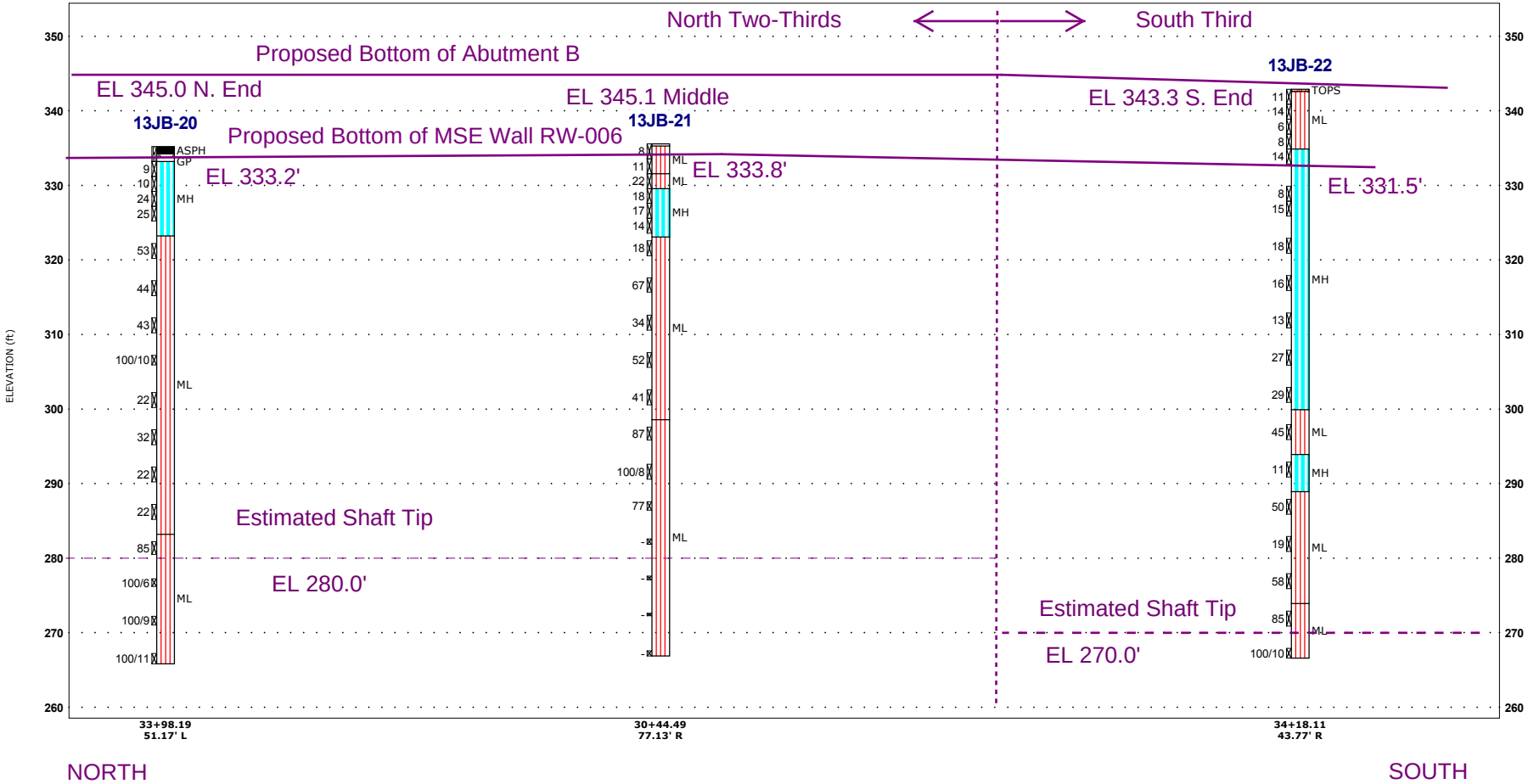
FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

SPT_FBV-CB-21624-BOONN_BORING_LOGS_FOR PROFILES ONLY.GPJ 8.30.03 01:25:12 12/9/13

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.					

JONES BRANCH CONNECTOR
BRIDGE B629 - ABUTMENT B



Notes: See borehole logs for complete data
See Material and Sample Symbols List

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

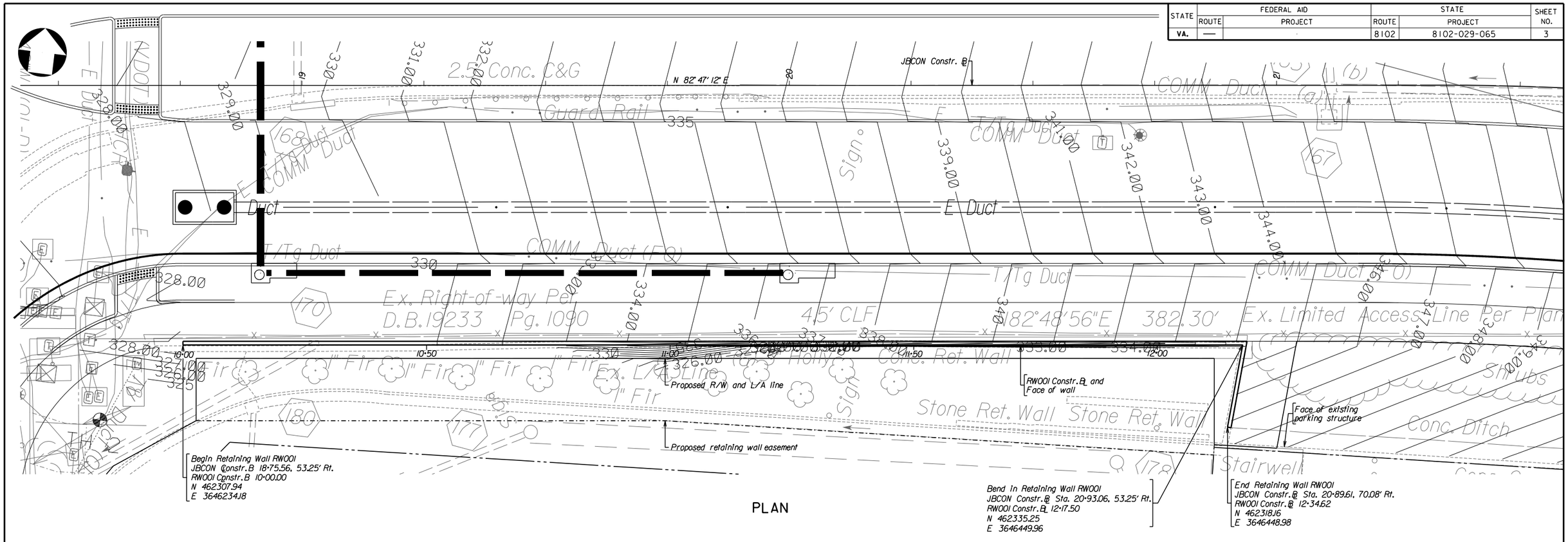
MATERIALS DIVISION

FCDOT No. 2G40-020-000
ENGINEERING GEOLOGY

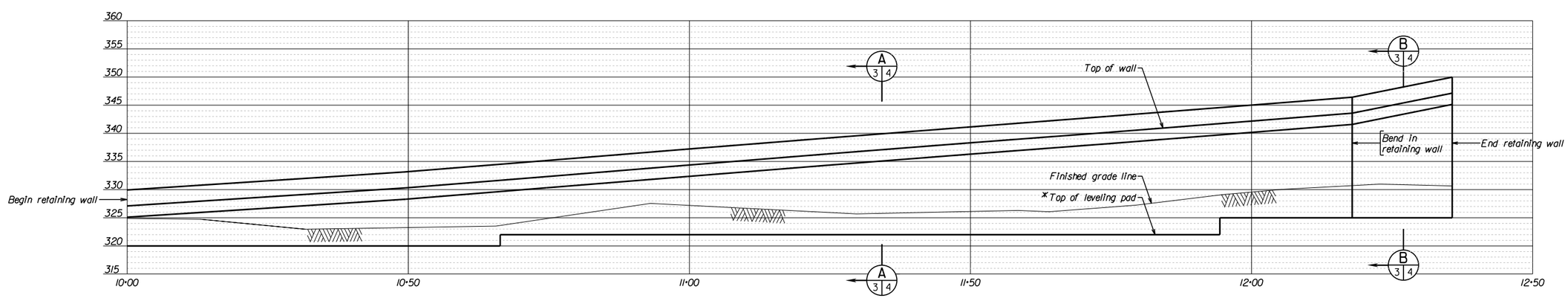
Drilled:	Date	Plan No.	Sheet No.
Logged:			
Checked:			

SPT_FBVCBB-21624-BKONN_BORING_LOGS_FOR PROFILES ONLY.GPJ 8.30.003.01252 12/9/13

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	-	8102	8102-029-065	3



PLAN



RW001_003.dgn

Notes:

Top of wall shall be located parallel to the JBCON proposed grade line.

Finished grade line shall match existing ground line.

* Top of leveling pad shall be located a minimum of 2'-0" below finished grade line.

For additional retaining wall notes, see sheet 4.

PROFILE ALONG RW001 CONSTR. ℄

Scale: 1" = 10"

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

TYSON'S PARK PLACE II
RETAINING WALL RW001
PLAN AND PROFILE

Designed: AAP
Drawn: SRS
Checked: WRA

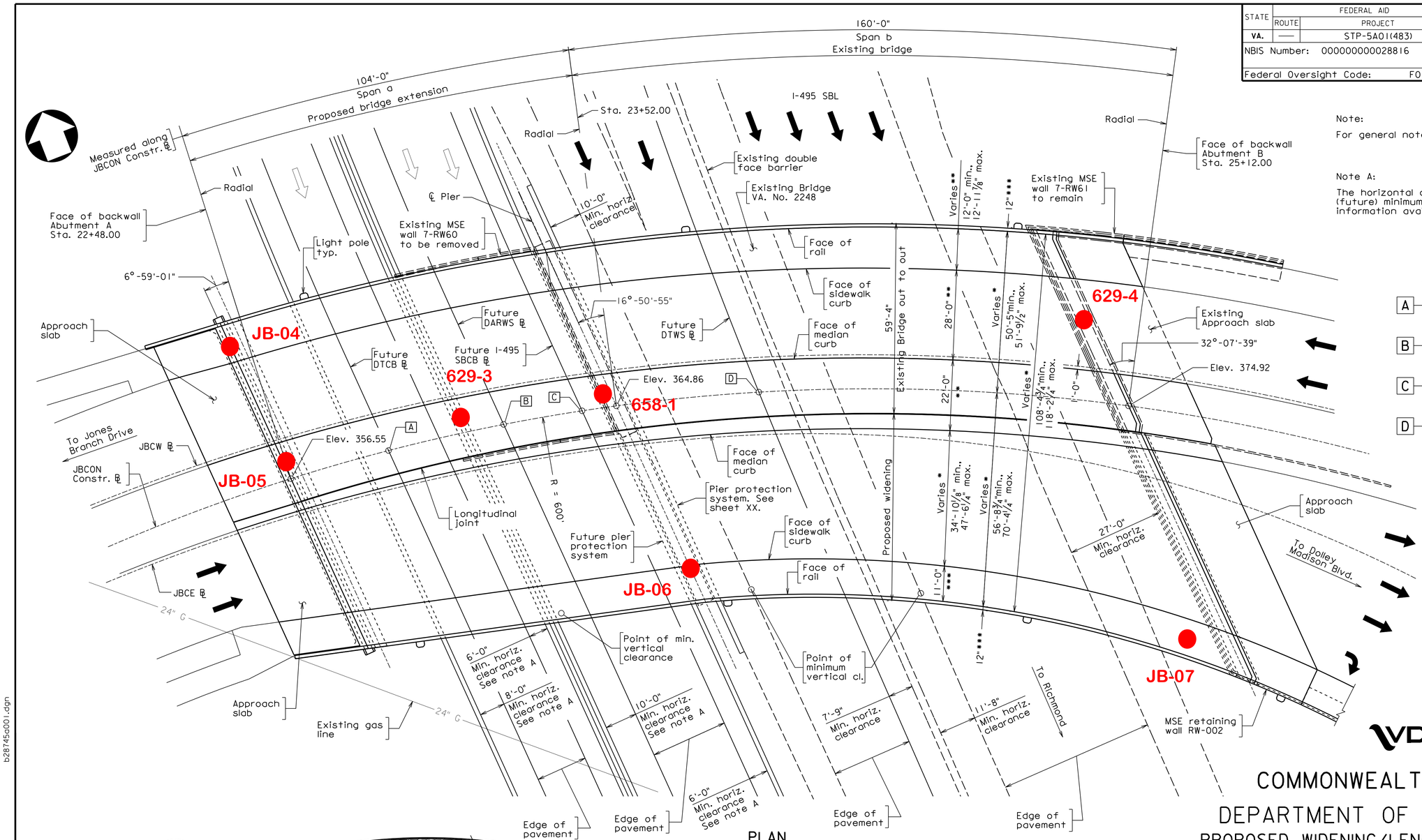
Date	Plan No.	Sheet No.
August 2015	-	3 of 4

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	STP-5A01(483)	—	8102-029-065, B627	1

NBIS Number: 000000000028816 — UPC No. 103907

Federal Oversight Code: F0 — FHWA Construction and Scour Code: X271-SN



PLAN

Note:

For general notes, see sheet 2.

Note A:

The horizontal clearance provided are ultimate (future) minimum horizontal clearances based on information available for the proposed roadway.

Tie stations

A — POC Sta. 22+79.64 JBCON Constr. ℄
POC Sta. 376+69.72 Future DTCB ℄
△ = 9°54'-59" Rt.

B — POC Sta. 23+16.41 JBCON Constr. ℄
POC Sta. 430+76.05 Future DARWS ℄
△ = 13°25'-39" Rt.

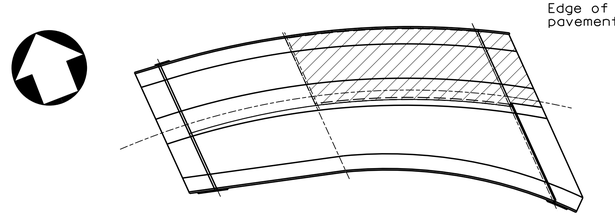
C — POC Sta. 23+41.21 JBCON Constr. ℄
POC Sta. 522+28.87 I-495 Future SBCB ℄
△ = 15°47'-46" Rt.

D — POC Sta. 23+96.59 JBCON Constr. ℄
POC Sta. 477+24.05 Future DTWS ℄
△ = 18°37'-23" Rt.

VDOT

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION
PROPOSED WIDENING/LENGTHENING OF BRIDGE ON

SCOTTS CROSSING ROAD (ROUTE 8102)
SBL I-495, RAMPS DTWS AND DARWS
(AND FUTURE DTCB AND I-495 BCB)
FAIRFAX CO. - 3.02 MI. NORTH OF RTE. I-66
PROJ. 8102-029-065, B627



KEY PLAN
Scale: 1" = 60'-0"

Legend:
- Existing bridge
- Proposed bridge

* Denotes dimension measured normal to JBCON Constr. ℄

** Denotes dimension measured normal to JBCW ℄

*** Denotes dimension measured normal to face of sidewalk curb.

Scale: 1/16" = 1'-0"

No.	Description	Date

REVISIONS

For Table of Revisions, see Sheet 4.

Recommended for Approval: _____ State Structure and Bridge Engineer — Date

Approved: _____ Chief Engineer — Date

Date: January 11, 2016

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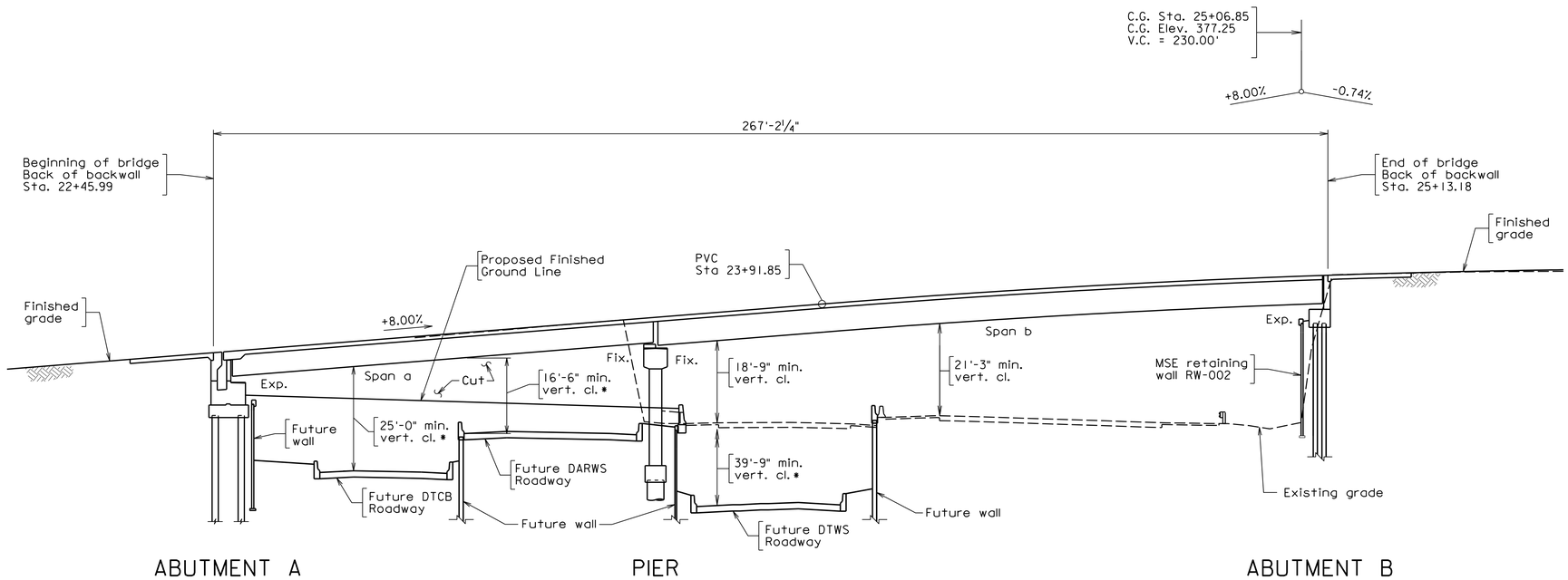
287-45A
Sheet 1 of 101

ATHAVALE, LYSTAD & ASSOC. Inc.
McLean, Virginia
STRUCTURAL ENGINEER

PLANS BY:	Consultant
COORDINATED:	John Dresser
SUPERVISED:	Tewolde Iyob
DESIGNED:	Jacqueline Sansone
DRAWN:	John Elliott
CHECKED:	Daniel Walsh

b28745s001.dgn

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	STP-5A01(483)	—	8102-029-065, B627	2



DEVELOPED SECTION ALONG JBCON CONSTR. ℄

Note:

* The minimum ultimate vertical clearance over the future roadways shall be 16'-6".

DESIGN EXCEPTION(S):

None

GENERAL NOTES:

The original approved sheet, including original signatures, is filed in the VDOT Central Office. Any misuse of electronic files, including scanned signatures, is illegal. Violators will be prosecuted to the full extent of the applicable laws.

Widths: Variable width sidewalk (12'-0" min., 12'-11⅞" max.), 5'-0" bike lane, 23'-0" roadway, 22'-0" median, variable width roadway (29'-10" min., 42'-6¼" max.), 5'-0" bike lane, 11'-0" sidewalk. Overall width varies (108'-4¾" min., 118'-2¼" max.) face-to-face of rails. Includes widening to the south of variable width (56'-7" min., 64'-5½" max.) and extension of 104' Span a.

Span layout: 104'-0" - 160'-0" simple steel plate girder spans.

Capacity: HL-93 loading.

Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2007.

Design: AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2008.

These plans are incomplete unless accompanied by the Supplemental Specifications and Special Provisions included in the contract documents.

Design loading includes 20 psf allowance for construction tolerances and construction methods.

Design loading includes 15 psf allowance for future wearing surface.

The use of prestressed decks panels as stay-in-place forms will not be permitted.

All structural steel, except in bearings and sole plates, shall be ASTM A709 Grade 50W and shall be unpainted except as required by Section 407 of the Specifications. Structural steel in bearings and sole plates shall be ASTM A709 Grade 36 and shall be painted.

Finish paint color shall be brown, 595-20059.

Plate girders shall be curved by cutting the flanges to the proper curvature radius. Heat-curving is not allowed.

The spacing and height of stud shear connectors shall be shown on the shop plans (working drawings).

Concrete in superstructure including deck slab, sidewalks, median and rails shall be Class A4. All other concrete shall be Class A3.

Low permeability concrete shall be used in this project.

All reinforcing steel shall be deformed and shall conform to ASTM A615, Grade 60 except for reinforcing steels noted as CRR (corrosion resistant reinforcing) which shall conform to applicable specifications noted in the Special Provisions. All reinforcing bar dimensions on the detailed drawings are to centers of bars except where otherwise noted and are subject to fabrication and construction tolerances.

Corrosion Resistant Reinforcing (CRR) steels shall conform to one or more of the three Classes listed in the Special Provision. The minimum yield strength shall be: 100 ksi for low carbon/chromium and 60 ksi for stainless clad steel or solid stainless steel. The Class(es) of CRR steel(s) required on this project is/are noted on the plan sheets and in the reinforcing steel schedule. Corrosion Resistant Reinforcing Steel, Class II or Class III may be substituted for Class I. Corrosion Resistant Reinforcing Steel, Class III, may be substituted for Class II.

GENERAL NOTES: (Continued)

Piles at Abutment A shall be 18" diameter auger cast concrete piles having a factored axial reistance of 200 tons per pile. Piles shall be installed to the minimum tip elevation shown on sheet 24.

Drilled shafts for the pier shall provide the axial resistances as shown in the Drilled Shaft Data Table on sheet 47. Drilled shafts shall be installed to the minimum tip elevations shown in the Drilled Shaft Data Table, unless otherwise directed or authorized by the Engineer.

Piers at Abutment B shall be steel H-piles conforming to ASTM A709 grade 50 steel and shall be driven to the required nominal axial resistance. For axial resistance requirements, see the Pile Data Table on sheet 35. All piles shall be driven to or below the minimum tip elevation shown in the Pile Data Table, unless otherwise directed or authorized by the Engineer.

Structural approach slabs are included in the bridge contract.

Bridge no. of existing bridge is 2248. Plan no. is 287-45.

B.M.: see roadway plans.

b28745a002.dgn

ATHAVALE, LYSTAD & ASSOC. Inc.
McLean, Virginia
STRUCTURAL ENGINEER

Scale: 1/16" = 1'-0"

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

ELEVATION AND GENERAL NOTES

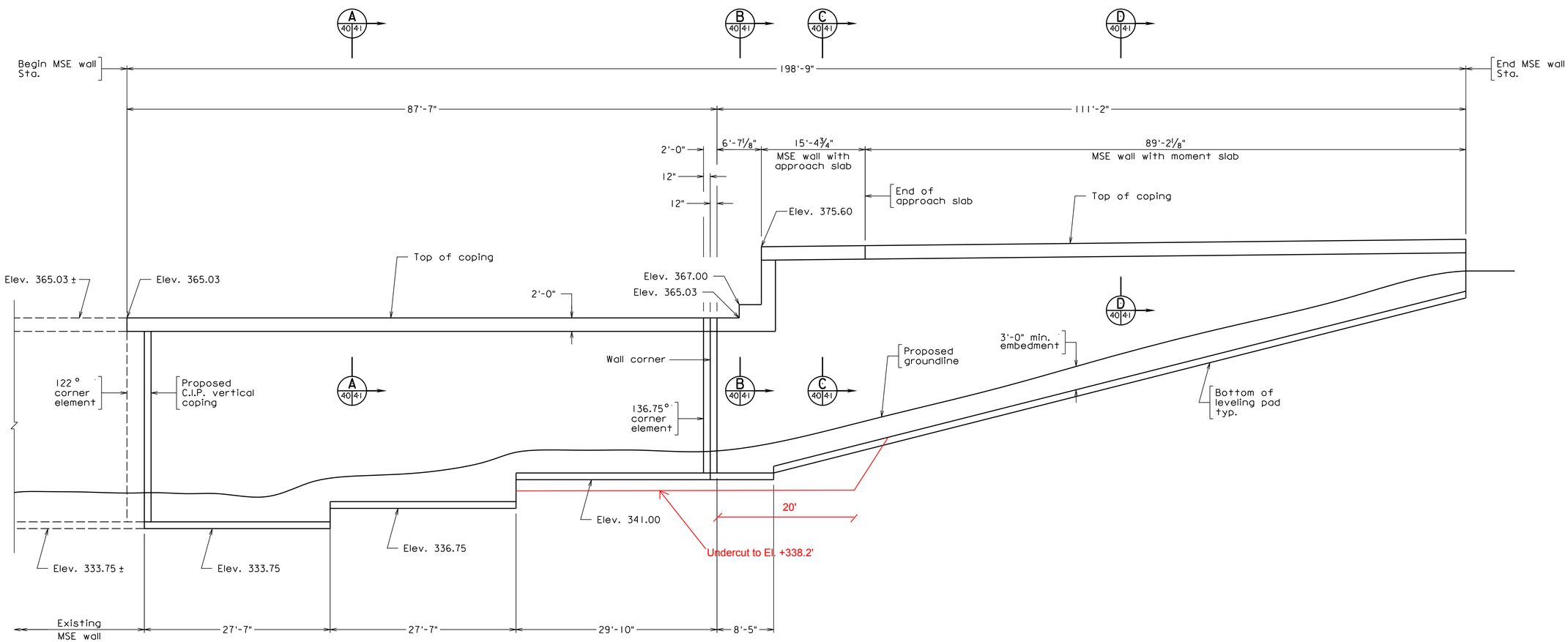
Designed: J.S.
Drawn: D.E.
Checked: K.A.

Date: Jan. 2016

Plan No. 287-45A

Sheet No. 2 of 101

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	—	—	8102-029-065, B627	40



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RW-002

ELEVATION

PRELIMINARY PLANS

THESE PLANS ARE UNFINISHED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION OR ROW ACQUISITION

Scale: 1/8" = 1'-0"

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ATHAVALE, LYSTAD & ASSOC. Inc.
McLean, Virginia
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

ABUTMENT B - MSE WALL ELEVATION

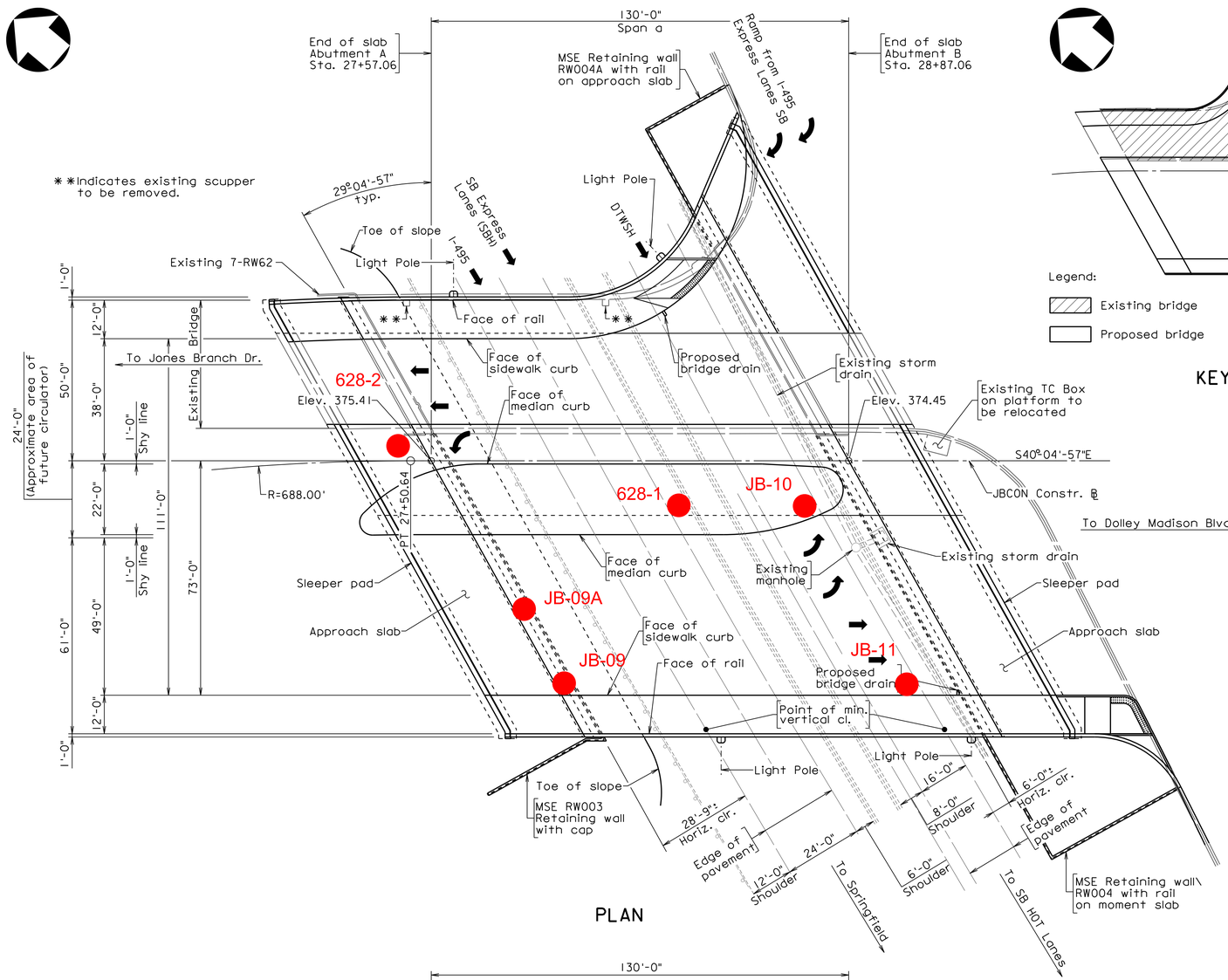
Designed: J.S.
Drawn: D.W.
Checked: D.W.

Date	Plan No.	Sheet No.
Sept. 2015	287-45A	40 of XX

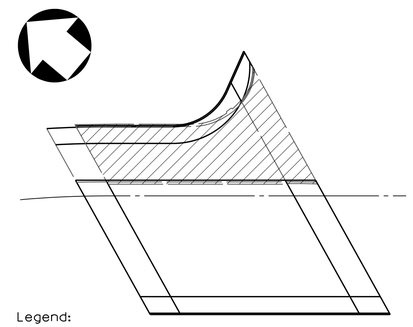
STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	STP-5A01(483)	—	8102-029-065, B628	1

NBIS Number: 000000000028812 — UPC No. 103907

Federal Oversight Code: F0 — FHWA Construction and Scour Code: X271-SN



PLAN

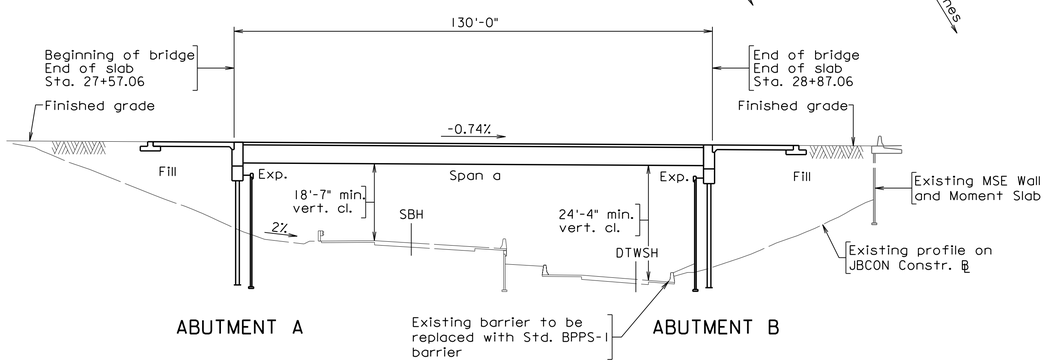


Legend:

Existing bridge

Proposed bridge

KEY PLAN



DEVELOPED SECTION ALONG ℄

Scale: 1" = 20'

DESIGN EXCEPTION(S):

A design waiver for the modified bridge railing will be submitted to VDOT Structure and Bridge Division for approval.

A design waiver for modified deck slab cast wider than 80' without a longitduinal joint will be submitted to VDOT Structure and Bridge Division for approval.

GENERAL NOTES:

The original approved sheet, including original signatures, is filed in the VDOT Central Office. Any misuse of electronic files, including scanned signatures is illegal. Violators will be prosecuted to the full extent of the applicable laws.

Width: 12'-0" sidewalk, 5'-0" bike lane, 34'-0" roadway, 22'-0" median, 45'-0" roadway, 5'-0" bike lane, 12'-0" sidewalk. Over all width varies (136'-0" min., 166'-6 9/16" max.) face-to-face of rails. Includes widening of 1'-1 1/2" to 32'-7 9/16" on left of existing bridge and 96'-4 1/2" on right of existing bridge.

Span layout: 130'-0" steel plate girder span.

Capacity: HL-93 loading.

Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2007.

Design: AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2008.

These plans are incomplete unless accompanied by the Supplemental Specifications and Special Provisions included in the contract documents.

Design loading includes 20 psf allowance for construction tolerances and construction methods.

Design loading includes 15 psf allowance for future wearing surface

All structural steel shall be ASTM A709 Grade 50W and shall be unpainted.

The spacing and height of stud shear connectors shall be shown on the shop plans (working drawings).

Concrete in superstructure, in sidewalks, rails, terminal walls, medians in superstructure and substructure, Class A4; in abutments, Class A3.

Low permeability concrete shall be used in this project.

All reinforcing steel shall be deformed and shall conform to ASTM A615, Grade 60 except for reinforcing steels noted as CRR (corrosion resistant reinforcing) which shall conform to applicable specifications noted in the special provisions. All reinforcing bar dimensions on the detailed drawings are to centers of bars except where otherwise noted and are subject to fabrication and construction tolerances.

Corrosion resistant reinforcing (CRR) steels shall conform to one or more of the three Classes listed in the special provision. The minimum yield strength shall be: 100 ksi for low carbon/chromium and 60 ksi for stainless clad steel or solid stainless steel. The Classes) of CRR steel(s) required on this project is/are noted on the plan sheets and in the reinforcing steel schedule. Corrosion Resistant Reinforcing Steel, Class II or Class III may be substituted for Class I. Corrosion Resistant Reinforcing Steel, Class III, may be substituted for Class II.

General Notes continued on sheet 2.

VDOT

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

PROPOSED BRIDGE WIDENING ON SCOTTS CROSSING ROAD OVER SBH AND DTWSH
FAIRFAX - 3.02 MI. NORTH OF RTE. I-66
PROJ. 8102-029-065, B628

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

No.	Description	Date

REVISIONS

For Table of Revisions, see Sheet 2.

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

PLANS BY:
COORDINATED:
SUPERVISED:
DESIGNED:
DRAWN:
CHECKED:

Recommended for Approval: _____ State Structure and Bridge Engineer — Date

Approved: _____ Chief Engineer — Date

Date: April 2015

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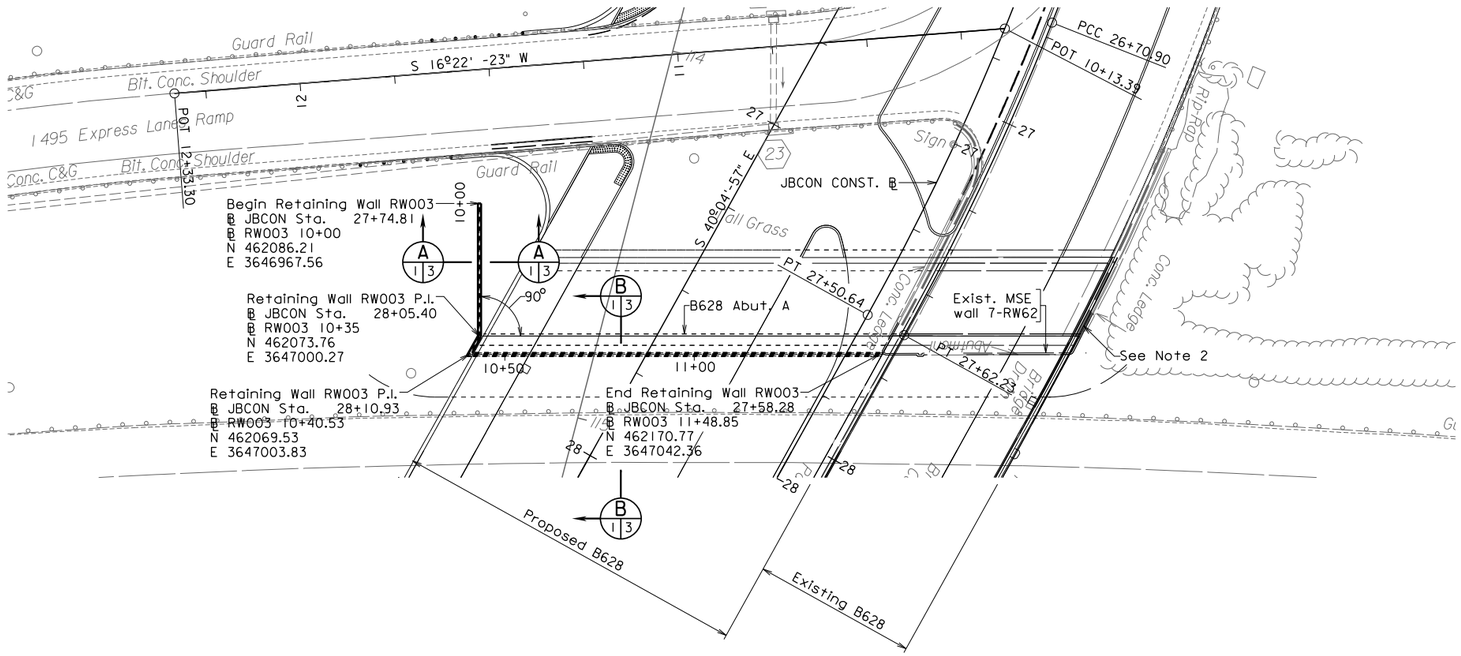
287-57A

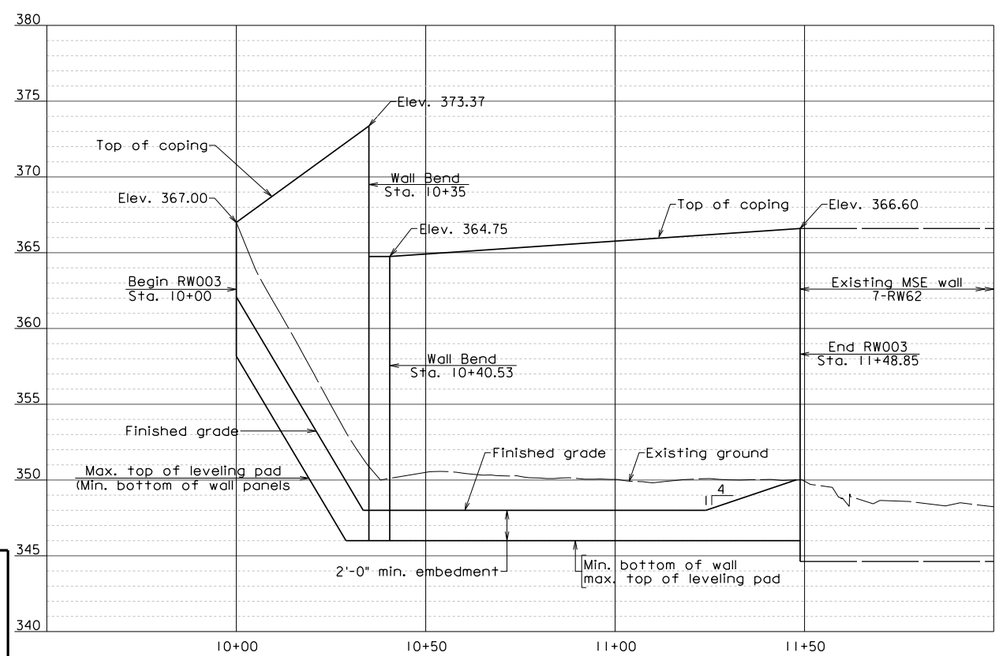
b28757A001.dgn

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	-	-	8102-029-065	1



PLAN

Scale: 1" = 20'



PROFILE ALONG ℄ RW003

Scale: Horizontal 1" = 20'
Vertical 1" = 5'

GENERAL NOTES

Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2007.

Design: AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2008.

These plans are incomplete unless accompanied by the Supplemental Specifications and Special Provisions included in the contract documents.

The minimum design life of MSE wall shall be 100-year.

The maximum allowable foundation bearing pressure shall be xx tons/sq. ft.

The anticipated MSE wall total settlement is xx inches and differential settlement is xx.

For bearing requirements, see the MSE Wall Bearing Resistance Table.

For settlement requirements, see the Estimated Wall Settlement Table.

Vertical slip joints shall be placed in the wall at intervals not to exceed xx ft. between stations xx+xx and xx+xx.

Rustication treatment shall be xxxxxxxxx. Forms and liners shall be approved by the Engineer.

Minimum panel design thickness is 5.5 inches.

The selected wall supplier will submit a detailed design and shop drawings for approval.

All panel types and other related elements shall be detailed on shop drawings.

ESTIMATED WALL SETTLEMENT TABLE

	Monitoring Location	Estimated intermediate settlement at the end of wall constructions (inches)	Estimated total settlement over the life of the wall (inches)	Estimated time for percent settlement to occur (days)				Required waiting period (from wall completion) (days)
				25%	50%	75%	95%	
Abutment A	Wall face	X to X	X	X	X	X	X	X
	Behind wall	X to X	X	X	X	X	X	X

MSE WALL BEARING RESISTANCE DATA TABLE

Support Location	Service Applied base pressure (Settlement=X") (ksf)	Strength Factored bearing resistance ϕ_b = Y (ksf)
Abutment A	X	X

Notes:

1. Base line for MSE Wall (RW003) is located at outside face of wall.
2. Remove existing F-Shape barrier on approach slab and moment slab. Construct new 1'-0" concrete rail with ornamental fence.
3. MSE Wall fill for the reinforced zone shall be crushed aggregate. See VDOT Special Provisions for MSE Walls.

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

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JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW003 PLAN AND PROFILE

Designed: KWZ
Drawn: SRS
Checked: AAP

Date: Dec. 2015

Plan No.

Sheet No. 1 of 4

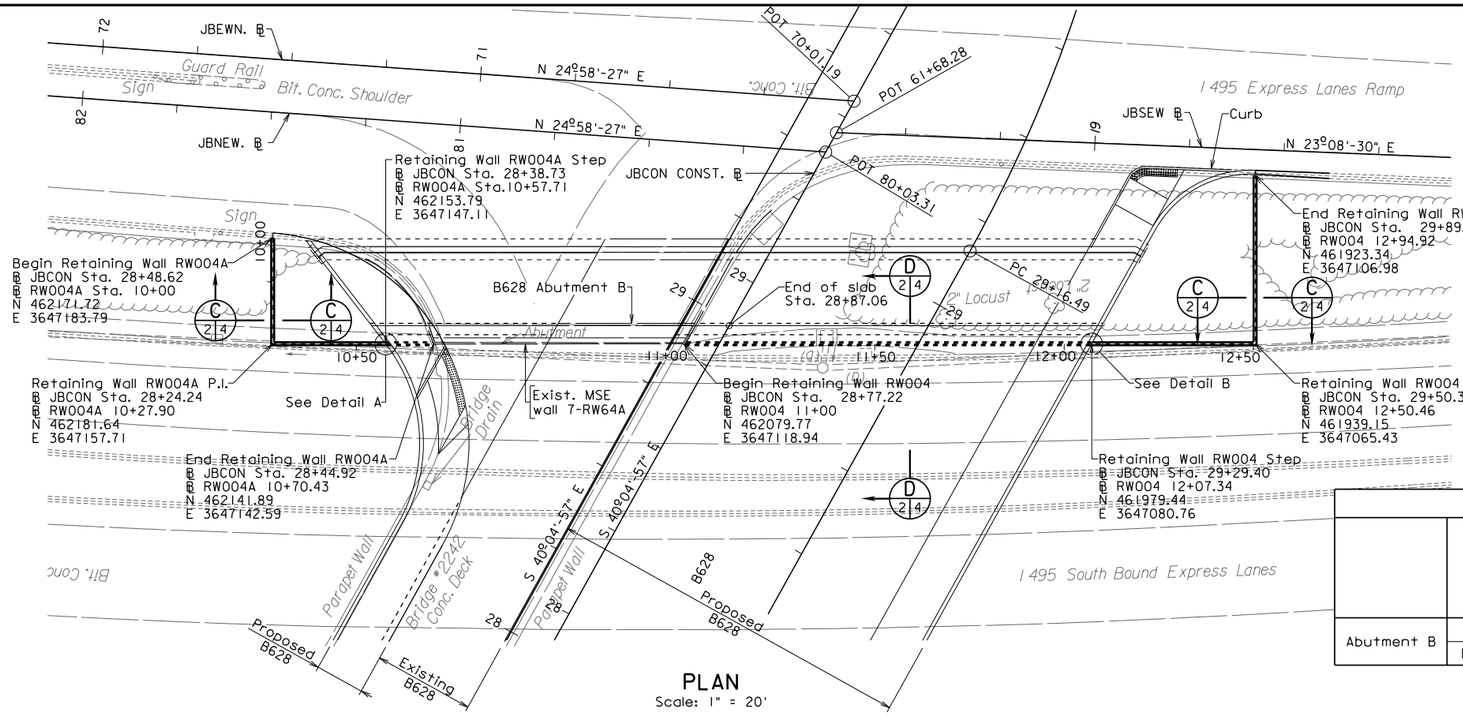
RW003_001.dgn

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—			8102-029-065	1

Notes:

Base line for MSE Wall (RW004 and RW004A) is located at outside face of wall.

See Sheet 4 of 4 for Section C-C and Section D-D.



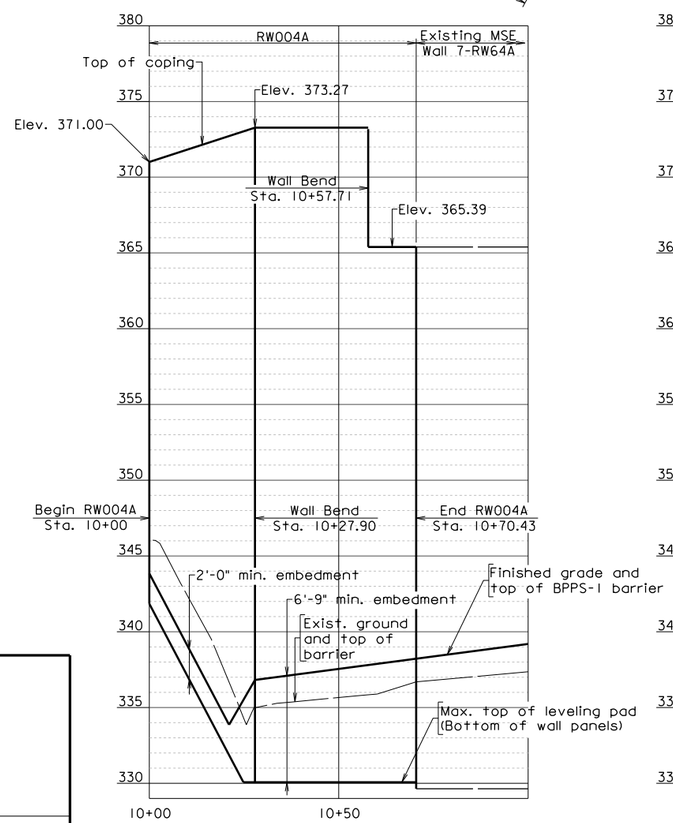
PLAN
Scale: 1" = 20'

ESTIMATED WALL SETTLEMENT TABLE

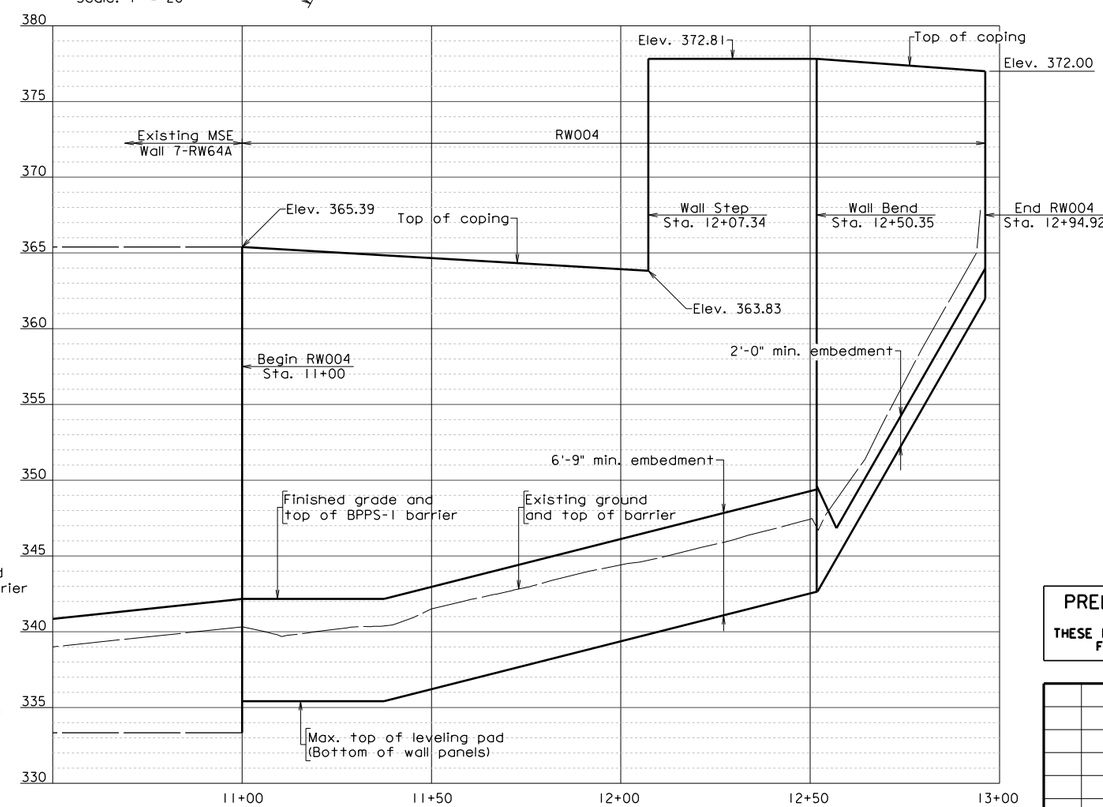
	Monitoring Location	Estimated intermediate settlement at the end of wall constructions (inches)	Estimated total settlement over the life of the wall (inches)	Estimated time for percent settlement to occur (days)				Required waiting period (from wall completion) (days)
				25%	50%	75%	95%	
Abutment B	Wall face	X to X	X	X	X	X	X	X
	Behind wall	X to X	X	X	X	X	X	X

MSE WALL BEARING RESISTANCE DATA TABLE

Support Location	Service Applied base pressure (Settlement=X") (ksf)	Strength Factored bearing resistance ϕ_b = Y (ksf)
Abutment B	X	X



PROFILE ALONG ℄ RW004A
Scale: Horizontal 1" = 20'
Vertical 1" = 5'



PROFILE ALONG ℄ RW004
Scale: Horizontal 1" = 20'
Vertical 1" = 5'

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

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RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW004 AND RW004A PLAN AND PROFILE

Designed: KWZ
Drawn: SRS
Checked: AAP

Date	Plan No.	Sheet No.
Dec. 2015		2 of 4

RW004_4A_001.dgn

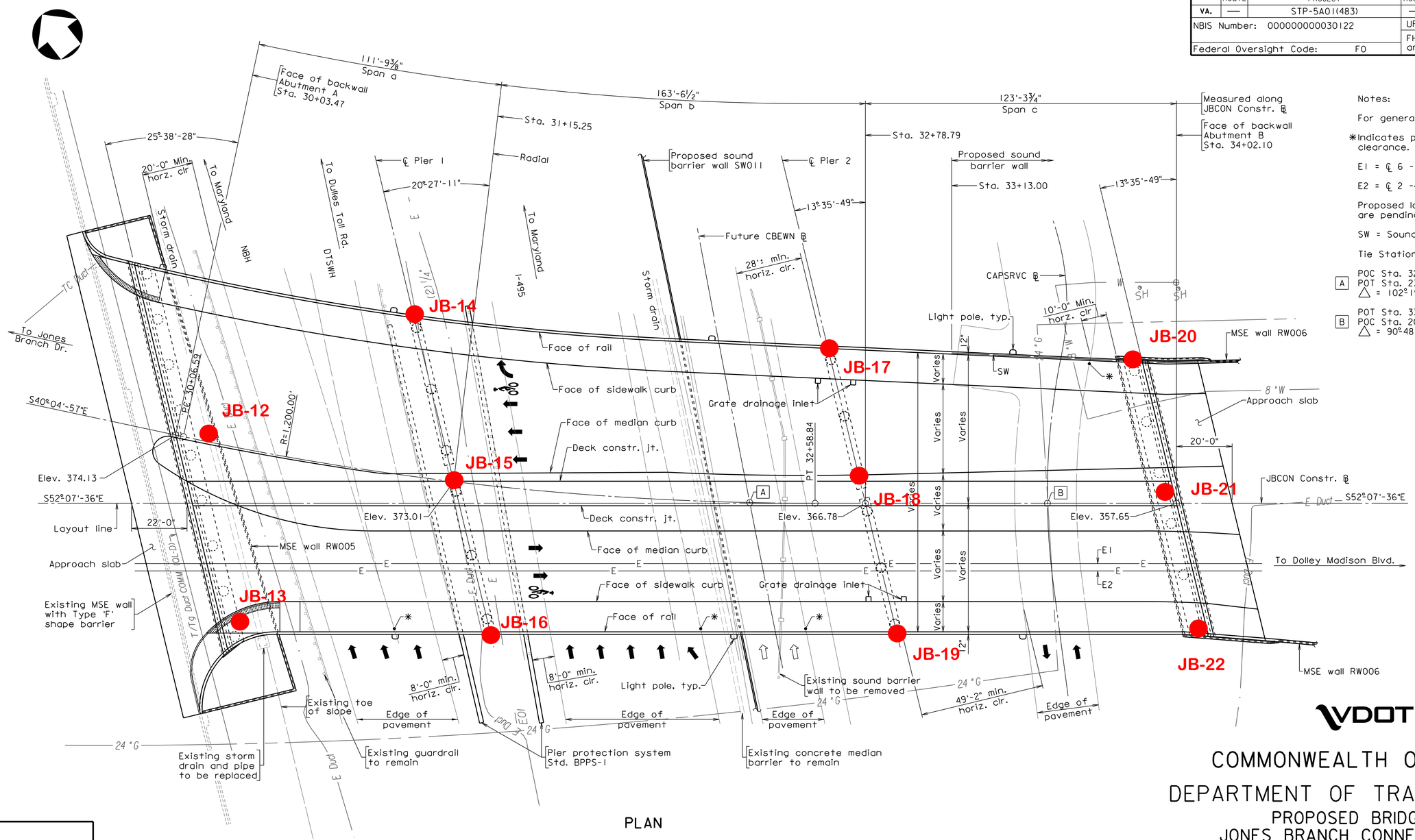
STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—	STP-5A01(483)	—	8102-029-065, B629	1

NBIS Number: 0000000000030122

UPC No. 103907

Federal Oversight Code: FO

FHWA Construction and Scour Code: X271-SN



PLAN

Notes:

For general notes, see Sheet 2.

*Indicates points of minimum vertical clearance.

E1 = ℄ 6 - 8" dia. electric conduits.

E2 = ℄ 2 -4" dia. electric conduits.

Proposed location of electric conduits are pending approval by the Department.

SW = Sound barrier wall.

Tie Stations:

A POC Sta. 32+32.93 JBCON Constr. ℄ = POT Sta. 23+28.35 Future CBEWN ℄ △ = 102°19'-11" Lt.

B POT Sta. 33+50.95 JBCON Constr. ℄ = POC Sta. 20+36.48 CAPSRVC ℄ △ = 90°48'-44" Lt.

VDOT

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

PROPOSED BRIDGE ON
JONES BRANCH CONNECTOR OVER
NBH, DTSWH, I-495N, CBEWN AND
CAPITAL ONE SERVICE ROAD
FAIRFAX CO. - 3.02 MI. NORTH OF RTE. I-66
PROJ. 8102-029-065, B629

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

No.	Description	Date

REVISIONS

For Table of Revisions, see Sheet 2.

Recommended for Approval: _____ State Structure and Bridge Engineer Date

Approved: _____ Chief Engineer Date

297-05

Date: September 2015

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Sheet 1 of 16

Scale: 1" = 20'

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

PLANS BY:	Johnson, Mirmiran & Thompson
COORDINATED:	
SUPERVISED:	Arthelius A. Phaup, III
DESIGNED:	W. R. Asbury
DRAWN:	Spencer R. Sloan
CHECKED:	

b29705001.dgn

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—			8102-029-065, B629	2

INDEX OF SHEETS

Sheet No.	Description
1	Title sheet; Plan
2	Developed Section and General Notes
3	Geometric Layout
4	Abutment A Plan and Elevation
5	Abutment A Plan and Elevation
6	Abutment B Plan and Elevation
7	Abutment A and B Sections
8	Pier 1 Plan, Elevation and Section
9	Pier 1 Plan, Elevation and Section
10	Pier 2 Plan, Elevation and Section
11	Pier 2 Plan, Elevation and Section
12	Span A Transverse Section
13	Span B Transverse Section
14	Span C Transverse Section
15	Framing Plan
16	Design Information For Future Circulator

DESIGN EXCEPTION(S):

A design waiver for deck slabs cast wider than 80' without providing longitudinal joint has been submitted to VDOT Structure and Bridge Division for approval.

GENERAL NOTES:

Width: 11'-9¾" to 12'-1½" sidewalk, 29'-5½" to 51'-0" roadway, 11'-0" to 25'-4½" median, 28'-0" to 45'-9⅞"roadway, 12'-0" to 14'-8⅜" sidewalk Overall width varies 108'-7½" to 143'-0 7/16" face-to-face of rails.

Span layout: 111'-9⅜" - 163'-6½" - 123'-3¾" continuous steel plate girder spans.

Capacity: HL-93 loading.

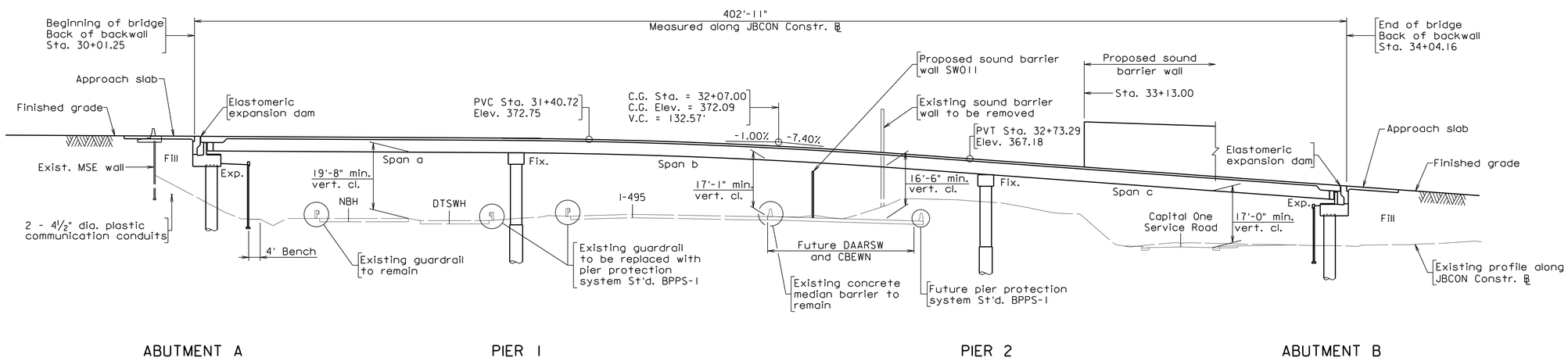
Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2007.

Design: AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2008.

All structural steel, including bearings shall be ASTM A709 Grade 50W and shall be unpainted.



DEVELOPED SECTION ALONG CONSTR. ℄

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PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

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Scale: 1" = 20'

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No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

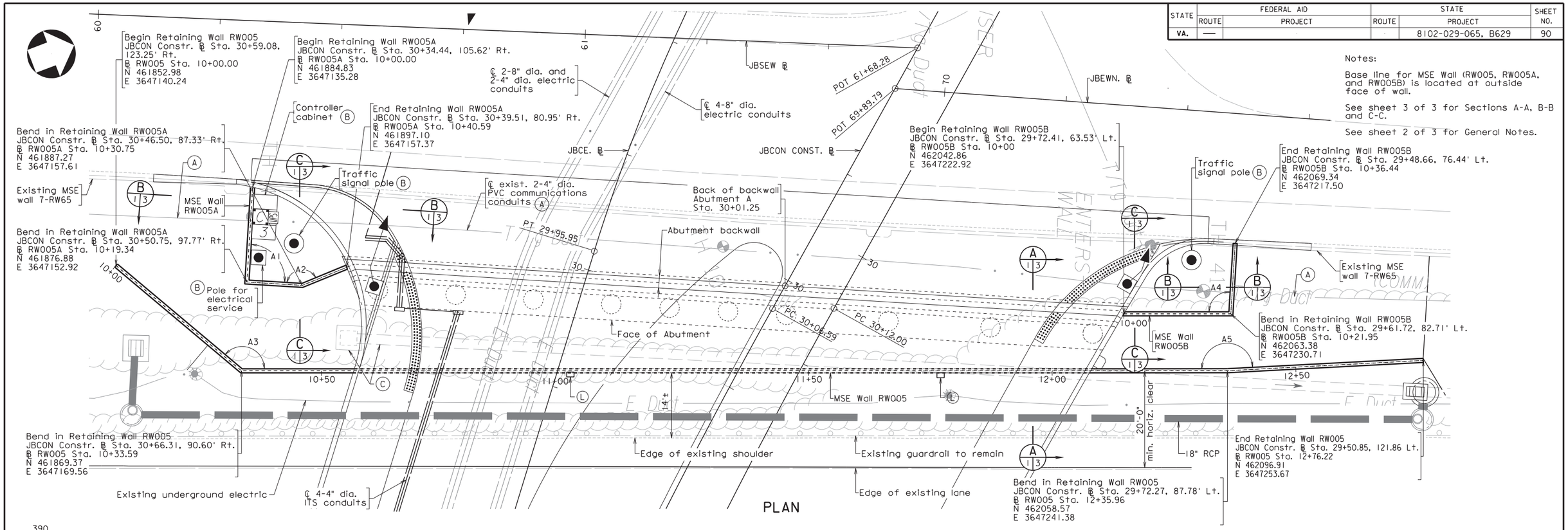
STRUCTURE AND BRIDGE DIVISION

DEVELOPED SECTION AND GENERAL NOTES

Designed: WRA
Drawn: SPS
Checked: AAP

Date	Plan No.	Sheet No.
Sept. 2015	297-05	2 of 16

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—			8102-029-065, B629	90

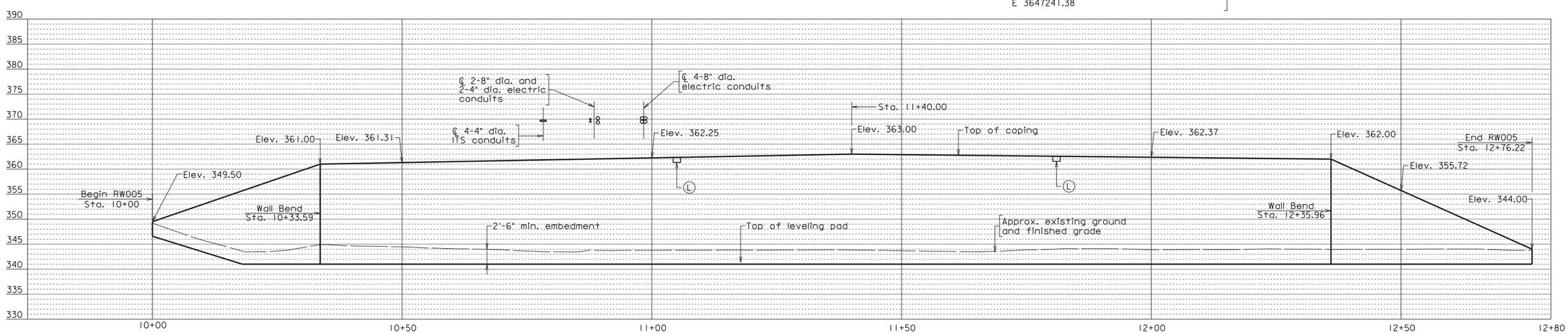


Notes:

Base line for MSE Wall (RW005, RW005A, and RW005B) is located at outside face of wall.

See sheet 3 of 3 for Sections A-A, B-B and C-C.

See sheet 2 of 3 for General Notes.



(A) Contractor to exercise extreme caution to not disturb existing conduit.

(B) See Traffic Signal Plans for additional information. Clearance between controller cabinet foundation and wall panel to be 12" minimum. Signal pole foundations to be constructed prior to wall construction.

(C) Existing inlet and RCP to be removed.

(L) Luminaire attached to coping. See Lighting Plans sheet 11(11) for additional information.

WALL ANGLE:

A1 90° 00'-00"

A2 154° 21'-38"

A3 140° 00'-00"

A4 93° 29'-04"

A5 177° 00'-00"

PROFILE ALONG ℄ RW005

Scale: 1" = 10'

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

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RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW005 PLAN AND PROFILE

Designed: KWZ	Date	Plan No.	Sheet No.
Drawn: SRS	Feb. 2016	297-05	90 of 100
Checked: JAU			

b29T05090.dgn

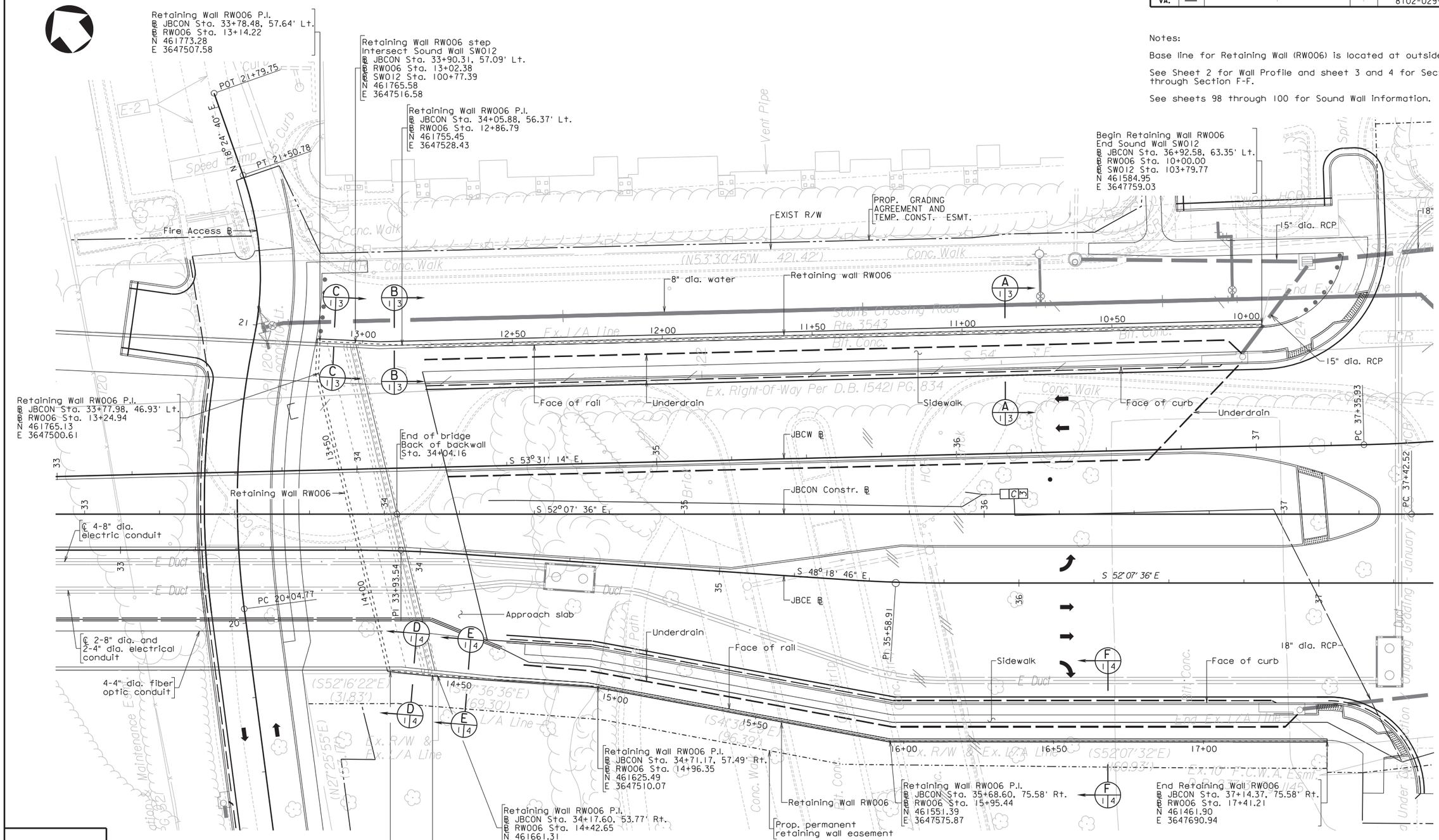
STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—			8102-029-065, B629	93

Notes:

Base line for Retaining Wall (RW006) is located at outside face of wall.

See Sheet 2 for Wall Profile and sheet 3 and 4 for Section A-A through Section F-F.

See sheets 98 through 100 for Sound Wall information.



PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

No.	Description	Date

Revisions

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW006 PLAN

Designed: KWZ
Drawn: SRS
Checked: GMC

Date	Plan No.	Sheet No.
Feb. 2016	297-05	93 of 100

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RICHMOND, VA
STRUCTURAL ENGINEER

Scale: 1/16" = 1'-0"

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STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	—			8102-029-065, B629	94

ESTIMATED WALL SETTLEMENT TABLE

Monitoring Location	Estimated intermediate settlement at the end of wall constructions (inches)	Estimated total settlement over the life of the wall (inches)	Estimated time for percent settlement to occur (days)				Required waiting period (from wall completion) (days)
			25%	50%	75%	95%	
Sta. 12+10	0.48	0.53	10	20	25	30	Not required
Sta. 13+75	0.84	0.94	10	20	25	30	Not required
Sta. 14+25	1.13	1.25	15	25	50	100	60
Sta. 15+20	0.34	0.38	10	20	25	30	Not required

Total settlement is the settlement that occurs due to the placement of the wall between the beginning of wall construction and the end of design wall life. Total settlement also includes secondary consolidation until the end of design wall life.

Intermediate settlement is the settlement that occurs between the beginning of wall construction and the completion of the wall.

The "waiting" period starts when the survey readings at the completion of the wall construction are obtained and shall continue until the required waiting period has been completed and the Geotechnical Engineer of Record reviews the data and confirms that the rate of settlement has stabilized, primary consolidation or elastic settlement is complete and that the remaining long-term settlement will not exceed the allowable amount.

MSE WALL BEARING RESISTANCE DATA TABLE

Support Location	Service Applied base pressure (Settlement=X") (ksf)	Strength Factored bearing resistance ϕ_b = Y (ksf)
Sta. 12+10	3.0	4.2
Sta. 13+75	4.0	5.8
Sta. 14+25	2.5	3.6
Sta. 15+20	2.6	3.8

The wall design shall be based on the lower of the values (either Service Limit or Strength Limit States) given for each Support Location in the table above. The Nominal Bearing Resistance will be verified by the Engineer prior to construction of wall.

GENERAL NOTES

Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2016.

Design: AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2008.

These plans are incomplete unless accompanied by the Supplemental Specifications and Special Provisions included in the contract documents.

The minimum design life of MSE wall shall be 100 years.

For bearing requirements, see the MSE Wall Bearing Resistance Data Table.

For settlement requirements, see the Estimated Wall Settlement Table.

Vertical slip joints shall be placed in the wall at locations where the backfill is not simultaneously placed. Otherwise vertical slip joints are not required.

Prior to wall construction, the foundation shall be compacted with a smooth wheel vibratory roller. The drums of the roller should be ballasted and each pass of the roller should overlap one half the width of the previous pass. The roller shall make at least ten passes over the proposed wall foundation zone. No density test will be required. Any foundation soils found to be unsuitable shall be removed and replaced with select material Type I minimum CBR of 30.

For architectural surface finish and concrete surface coating, refer to Special Provision for Architectural Treatment.

Minimum panel design thickness is 5.5 inches. Thickness of concrete must increase to accommodate any architectural surface finish that may be specified.

An impervious membrane shall be placed below the pavement and just above the first row of soil reinforcement to intercept any flows containing deicing chemicals. The membrane shall be sloped to drain away from the facing to an intercepting longitudinal drain outletted beyond the reinforced soil zone.

A geotextile shall be used as a separator between the reinforced soil zone and the subbase.

Subgrade stabilization fabric shall be placed along the interface between MSE select backfill material and embankment fill, etc.

Corrosion resistant reinforcing steel shall be used in moment slab and shall be the same type of corrosion resistant reinforcing steel specified for pedestrian/roadway barrier.

Corrosion resistant reinforcing steel shall be used in facing panels.

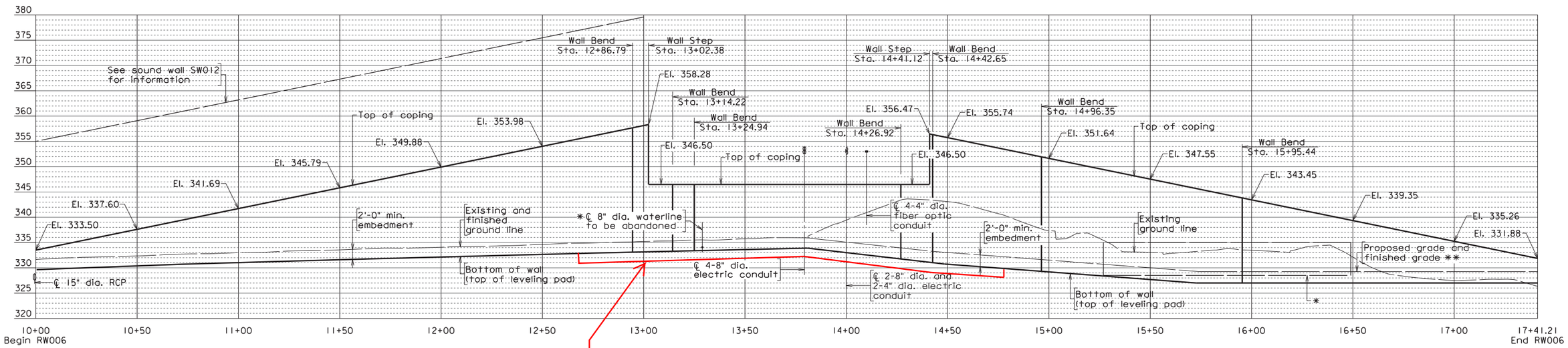
Moment slab shall not be placed until 60 days after wall completion has elapsed.

The selected wall supplier will submit a detailed design and shop drawings for approval.

Provide drainage details such as perforated pipe underdrain and or drainage blanket based upon field conditions.

All panel types and other related elements shall be detailed on shop drawings.

Prior to construction of the leveling pad and MSE fill, the Geotechnical Engineer of Record (GER) shall verify that the retaining wall is founded on subgrade materials that meet the minimum allowable bearing capacity noted on the wall plan and elevation sheets. If the GER determines that the subgrade is unacceptable for placement of MSE fill, the Contractor shall undercut the subgrade to the limits directed by the GER. Unacceptable materials include, but are not limited to, all fat clays and elastic silts (CH, MH), low plasticity clays and silts (CL, ML) with an unconfined compressive strength of less than 2,000 psf, and other obvious soil types not capable of providing the required foundation support. Undercut materials shall be replaced with Select Backfill Materials, Type I, Minimum CBR of 30, per VDOT Section 207.



Undercut 2' to back of MSE wall front straps. Undercut limits of wrap-around walls to be determined in the field.

PROFILE ALONG ℄ RW006

Scale: Horizontal 1" = 25'
Vertical 1" = 10'

PRELIMINARY PLANS

THESE PLANS NOT TO BE USED FOR CONSTRUCTION

Note:

* Contractor to verify that existing utilities have been abandoned or relocated.

** Construction on the Capitol One property will control the proposed grade. Proposed grade is approximated between station 13+75 and 17+41.21. Prior to ordering materials or starting construction, Contractor shall verify proposed grade.

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

As noted

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No.	Description	Date

Revisions

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

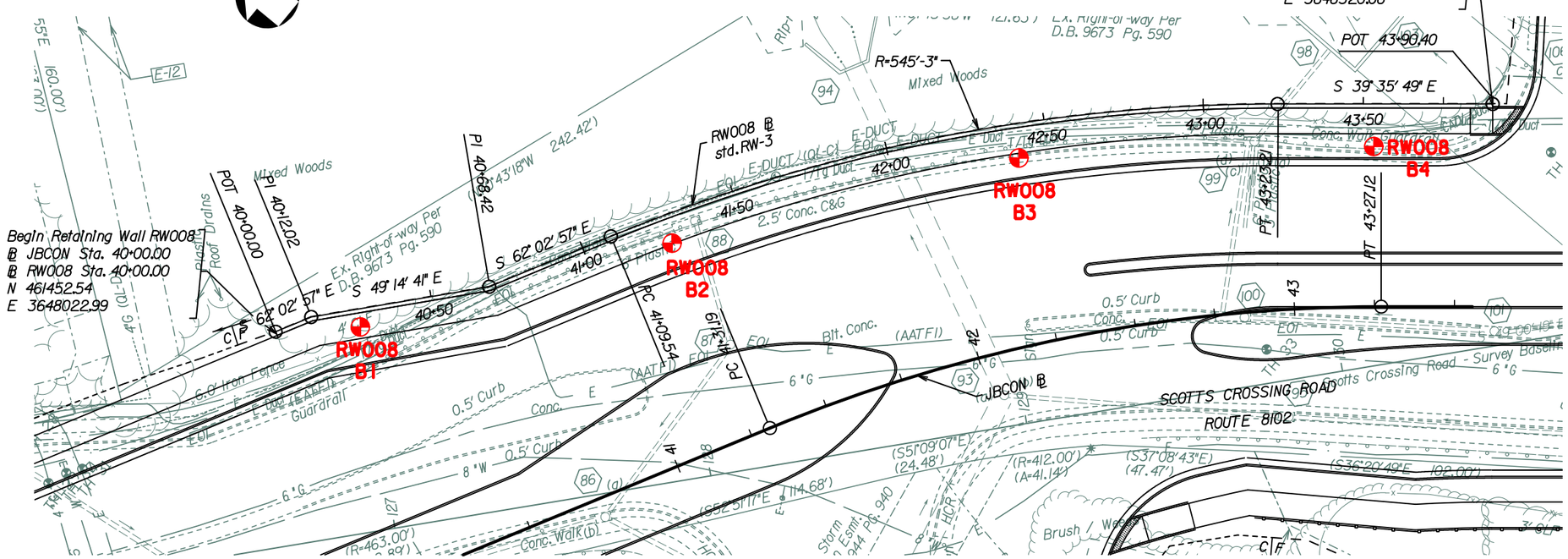
RETAINING WALL RW006 PROFILE AND GENERAL NOTES

Designed: KWZ
Drawn: SRS
Checked: JAV

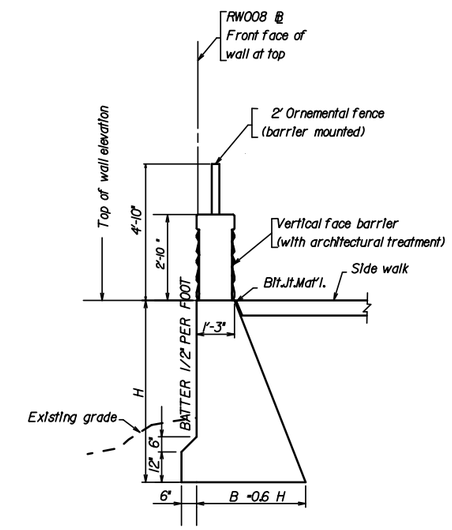
Date	Plan No.	Sheet No.
Feb. 2016	297-05	94 of 100

b29705094.dgn

STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	8102	STP-5A01	8102	8102-029-065	1

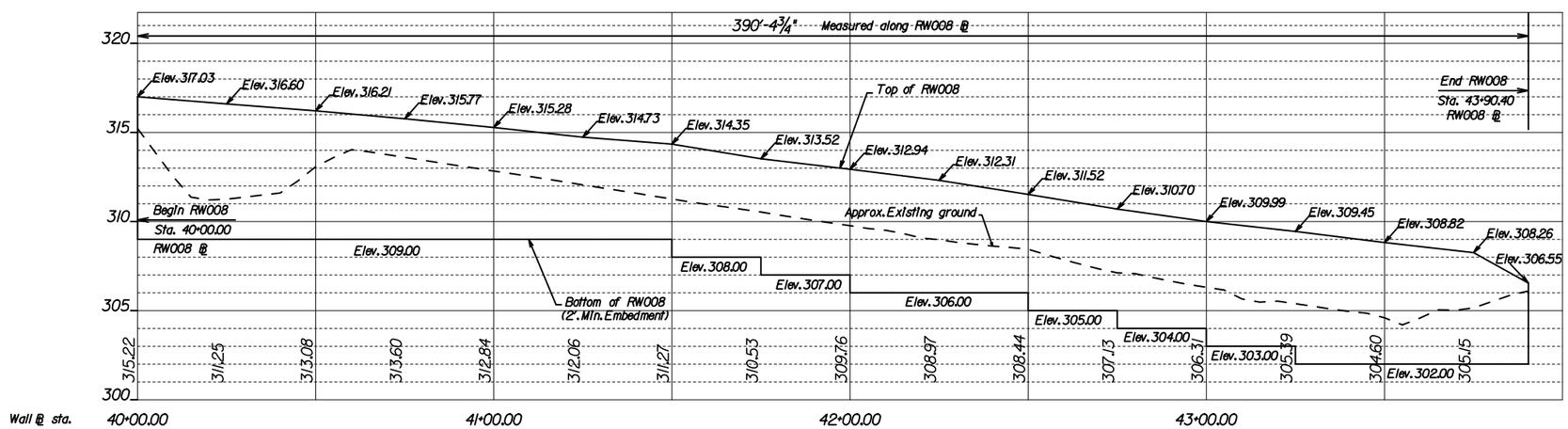


PLAN
Scale: 1" = 20'



NOTE: For additional RW-3 details, see VDOT Road and Bridge Standard manual

TYPICAL RW008 WALL SECTION
Scale: 1/8" = 1'-0"



PROFILE ALONG ℄ RW008
Scale: Horizontal 1" = 20'
Vertical 1" = 4'

RW008 BORING LOCATION TABLE

	BORING STATION	BORING OFFSET	PROJECT COORDINATES NORTH (Y)	PROJECT COORDINATES EAST (X)
RW008-B1	40+25	73' TO 83' LT	461,433.10	3,648,040.98
RW008-B2	41+25	65' LT	461,374.74	3,648,123.22
RW008-B3	42+25	58' LT	461,308.22	3,648,212.76
RW008-B4	43+25	50' LT	461,225.10	3,648,286.17

FIELD INSPECTION PLANS

THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION OR THE ACQUISITION OF RIGHT OF WAY.

d10390TRW008.dgn

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date

Revisions

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW008
PLAN AND PROFILE

Designed: RH
Drawn: RH
Checked:

Date	Plan No.	Sheet No.
June 2015	XXX-XX	1 OF. 1

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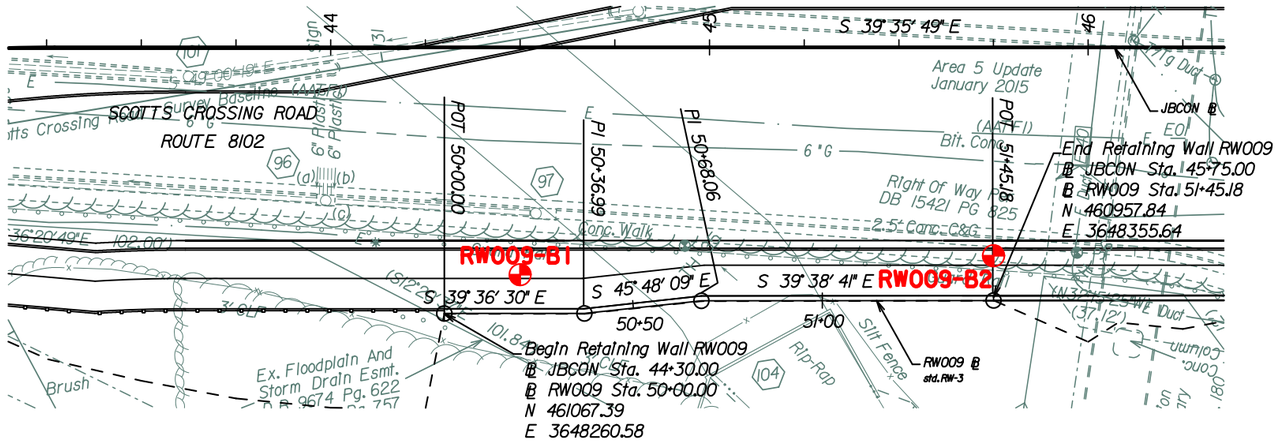
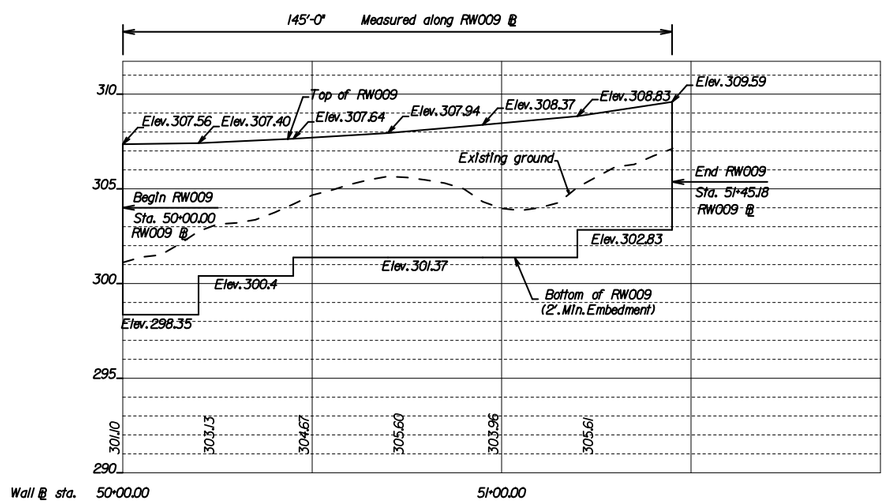
STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	8102	STP-5A01	8102	8102-029-065	1



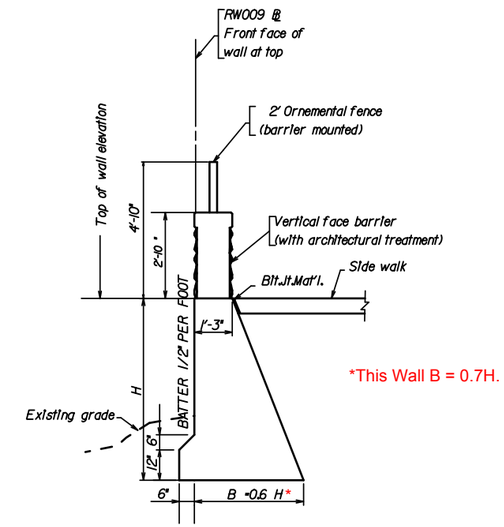
PLAN

Scale: 1" = 20'



PROFILE ALONG ℄ RW009

Scale: Horizontal 1" = 20'
Vertical 1" = 4'



*This Wall B = 0.7H.

NOTE: For additional RW-3 details, see VDOT Road and Bridge Standard manual

TYPICAL RW009 WALL SECTION

Scale: 1/8" = 1'-0"

461,094.00 3,648,284.47

RW009 BORING LOCATION TABLE				
	BORING STATION	BORING OFFSET	PROJECT COORDINATES NORTH (Y)	PROJECT COORDINATES EAST (X)
RW009-B1	44+31	~~60'~~ RT	~~461,058.51~~	~~3,648,281.23~~
RW009-B2	45+75	~~55'~~ RT	~~460,965.38~~	~~3,648,364.75~~

35'

44'

460,968.49 3,648,376.52

FIELD INSPECTION PLANS

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d103907RW009.dgn

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW009 PLAN AND PROFILE

Designed: RH
Drawn: RH
Checked:

Date	Plan No.	Sheet No.
June 2015	XXX-XX	1 OF 1

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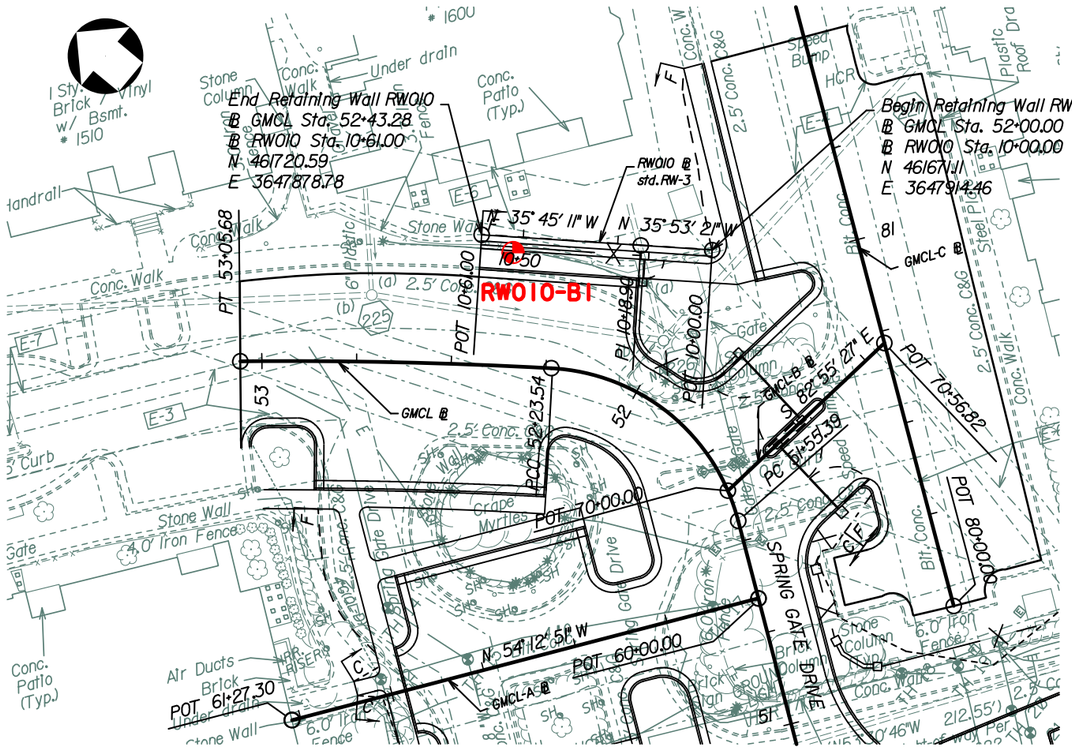
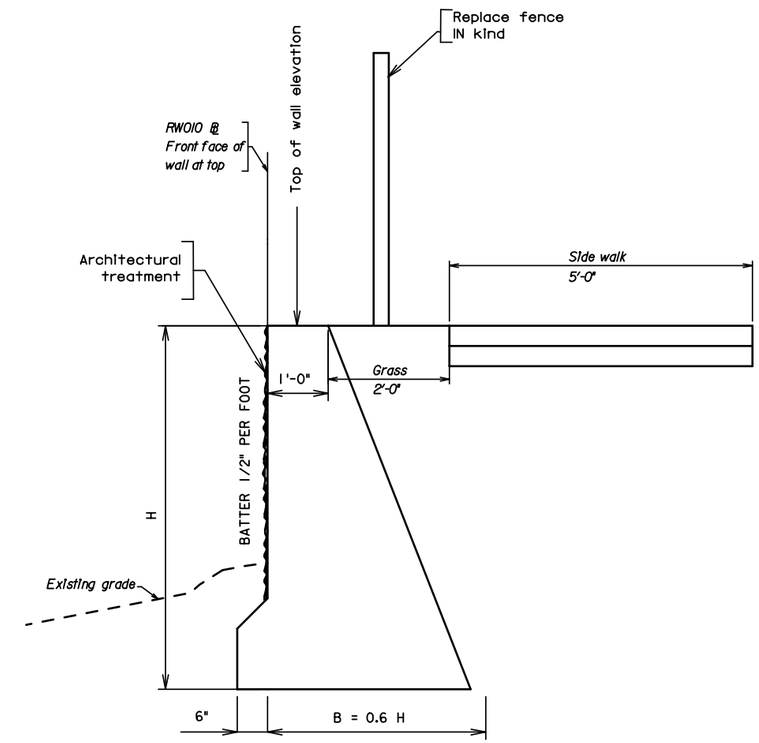
STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	8102	STP-5A01	8102	8102-029-065	1



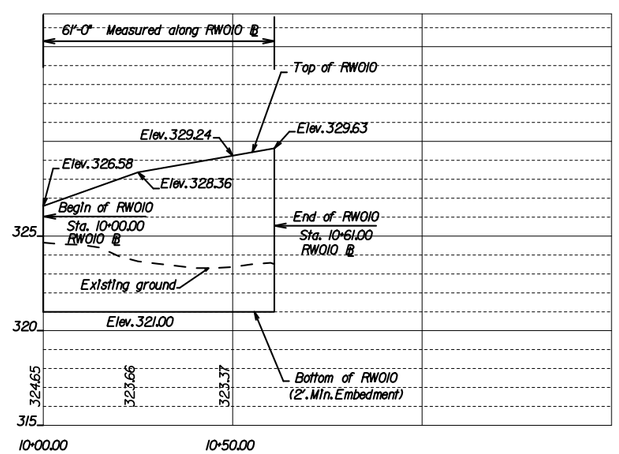
PLAN
Scale: 1" = 20'

RW010 BORING LOCATION TABLE				
	BORING STATION	BORING OFFSET	PROJECT COORDINATES NORTH (Y)	PROJECT COORDINATES EAST (X)
RW010-B1	52+35	30' RT	461,711.21	3,647,880.46



NOTE: For additional RW-3 details, see VDOT Road and Bridge Standard manual

TYPICAL RW010 WALL SECTION
Scale: 3/4" = 1'-0"



PROFILE ALONG ℄ RW010
Scale: Horizontal 1" = 20'
Vertical 1" = 4'

FIELD INSPECTION PLANS

THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION OR THE ACQUISITION OF RIGHT OF WAY.

d10390TRW010.dgn

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

RETAINING WALL RW010 PLAN AND PROFILE

Designed: RH/RMS
Drawn: RH
Checked:

Date	Plan No.	Sheet No.
June 2015	XXX-XX	1 OF 1

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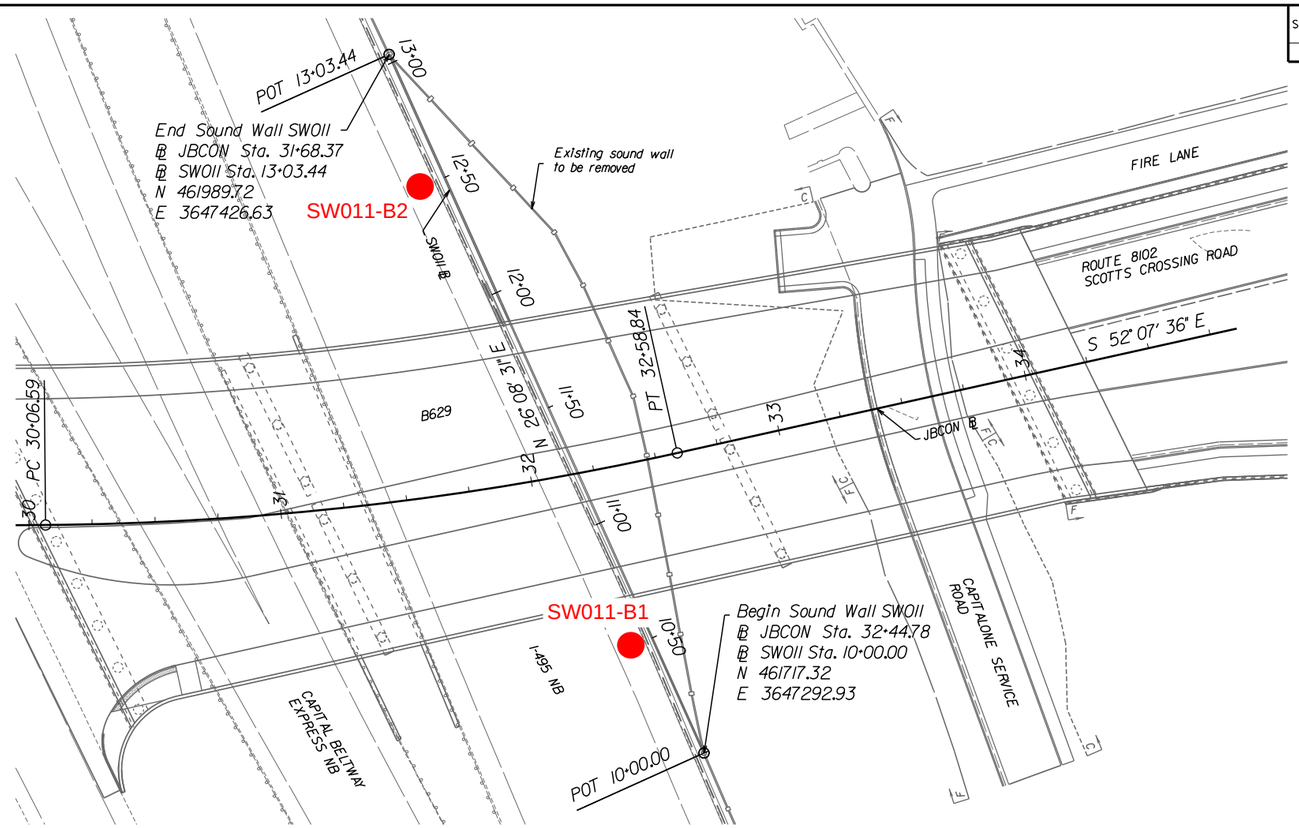
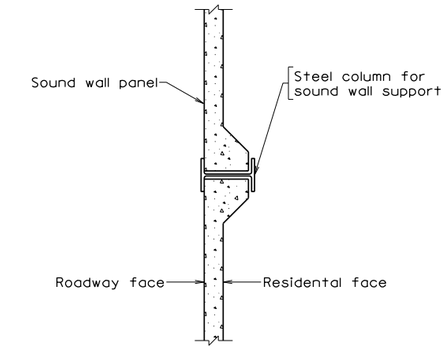
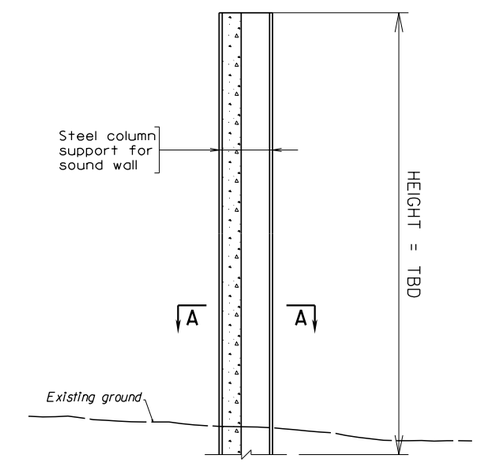
STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
VA.	8102	STP-5A01	8102	8102-029-065	1



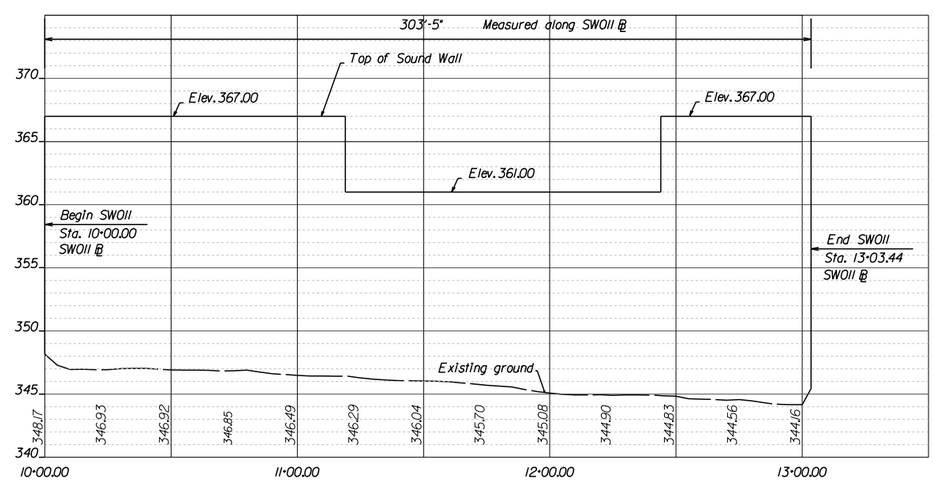
PLAN
Scale: 1" = 30'



SECTION A-A
Scale: 3/4" = 1'-0"



TYPICAL SECTION SW011
Scale: 3/4" = 1'-0"



PROFILE ALONG ℄ SW011
Scale: Horizontal 1" = 30'
Vertical 1" = 6'

FIELD INSPECTION PLANS

THESE PLANS ARE UNFINISHED AND UNAPPROVED AND ARE NOT TO BE USED FOR ANY TYPE OF CONSTRUCTION OR THE ACQUISITION OF RIGHT OF WAY.

d103907SW011.dgn

JOHNSON, MIRMIRAN & THOMPSON
RICHMOND, VA
STRUCTURAL ENGINEER

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE AND BRIDGE DIVISION

SOUND WALL SW011 PLAN AND PROFILE

Designed: RMS/RH
Drawn: RH
Checked:

Date	Plan No.	Sheet No.
June 2015	XXX-XX	1 OF 1

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APPENDIX B – FIELD INVESTIGATION

ECS Key to Field Soil Descriptions
Unified Soil classification System
Material and Sample Symbols Lists
Test Boring Records
Asphalt Core Photographs

ECS KEY TO FIELD SOIL DESCRIPTIONS - VDOT BORING LOGS

The descriptions noted on the boring logs generally conform to the USCS and ASTM D 2487.

DESCRIPTION FORMAT

Geologic origin*, color, primary grain size adjective, secondary component, PRIMARY COMPONENT, with…, or trace..., contains relative density, moisture, expanded terms, SYMBOL

*Such *as Fill, Alluvium, Residuum, IGM*, etc. In Coastal Plain areas, name of formation may be used. Geologic origin is cited only for first sample of geologic type.

SAME

The term SAME is used when the subsequent sample is of the same classification and is similar in nature. Exceptions to the previous description are defined. It is assumed that these exceptions continue to the end of the stratum, unless otherwise noted.

COLOR

- Basic colors
- Mottled, indicates splotches of various colors
- Variegated, indicates thin layers of various colors

SAND AND GRAVEL GRAIN SIZE ADJECTIVES

SIZE:	12"	3"	¾"	¼"	#10	#40	#200
DESCRIPTION:	BOULDER	COBBLE	GRAVEL		SAND		SILT to CLAY
RANGE:			Coarse / Fine	Coarse	Medium	Fine	
EXAMPLE:	basketball	softball	golf ball / marble	pea	sugar	beach sand	flour

SECONDARY AND PRIMARY COMPONENTS (Primary >50% noted in CAPS)

Primary SAND OR GRAVEL

>12% fines	*silty* or *clayey* is the secondary	
5% to 12% fines	add *with silt* or *with clay*	Poorly graded or well-graded is indicated
<5% fines	add *trace silt* or *trace clay*	Poorly graded or well-graded is indicated

Primary SILT OR CLAY

≥ 30% sand or gravel	% sand > % gravel	sandy is the secondary	≥ 15% gravel	add *with gravel*
			<15% gravel	add *trace gravel*
	% gravel > % sand	gravelly is the secondary	≥ 15% sand	add *with sand*
			<15% sand	add *trace sand*
< 30% sand or gravel	≥ 15% to < 30% sand or gravel		add *with sand* or *with gravel*	
	< 15% sand or gravel		add *trace sand* or *trace gravel*	

PLASTICITY OF CLAYS OR SILTS

FAT CLAYS (CH)	A CLAY that can be rolled to 1/16" threads w/o wetting, LL ≥ 50, PI > 6
ELASTIC SILTS (MH)	A SILT that can be rolled to less than 1/8" threads w/o wetting, LL ≥ 50
LEAN CLAY (CL)	A CLAY that can be rolled to 1/8" threads w/o wetting, LL < 50
SILT (ML)	A SILT that breaks before rolled to 1/8" threads w/o wetting, LL < 50
SILTY CLAY (CL-ML)	A mixture of SILT and CLAY with 4 ≤ PI ≤ 7
ORGANIC CLAYS / SILTS (OL, OH)	Sufficient organic matter present to influence the LL determination

CONTAINS

Contains is used to describe non-ASTM components such as rootlets, construction debris, asphalt concrete, etc. *contains slight* is used for occasional particles, *contains* is used for about 10% to 30% particles, *contains heavy concentrations of* is used for > 30% particles

ECS KEY TO FIELD SOIL DESCRIPTIONS - VDOT BORING LOGS

IGM

Friable IGM is described as a soil with ASTM symbol included. Non-friable IGM is described as a highly weathered ROCK NAME; relative density is not included.

MICA

Slightly micaceous is used for a few shiny flakes, *micaceous* is used for common flakes throughout the soil, and *highly micaceous* is used when the predominant constituent is mica.

RELATIVE DENSITY

SANDS AND GRAVELS

SPT	Density description
0 - 3	Very loose
4 - 9	Loose
10 - 29	Medium Dense
30 - 50	Dense
> 50	Very Dense

SILTS AND CLAYS

SPT	Density Description
0 - 1	Very Soft
2 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very Stiff
31 - 60	Hard
> 60	Very Hard

RELICT STRUCTURE

SPT	SOIL APPEARANCE	DESCRIPTION
20 - 60	Visual evidence of rock or mineral structure	DECOMPOSED ROCK
60+	Visual evidence of rock mass structure, rock mass is Discolored, high alteration of rock mineralogy	HIGHLY WEATHERED ROCK
100/2”	Split-spoon refusal (also 50/1”) interpreted as:	ROCK When the parent rock is known, the rock type replaces the word rock

MOISTURE

Dry	Dusty, dry to touch
Moist	Moisture can be felt but not visible
Wet	Water is visible

FILL

Soils interpreted as man-placed that are not natural depositional or weathered soils or soils containing debris, such as asphalt, concrete, tree limbs, are described as *FILL* or *possible FILL*.

MISCELLANEOUS

WOR – Weight of Rods WOH – Weight of Hammer

The boring records include the hammer type used. If the hammer efficiency is known, the efficiency is listed on the boring record. If the efficiency is not listed, the efficiency is assumed to be 80%. In determining N_{60} values the field values should be corrected for efficiency and rod length.

Rod length (feet)	Correction Factor
< 13	0.75
13 - 20	0.85
20 - 30	0.95
30 - 100	1.00

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS
(more than 50% of material is larger than No. 200 sieve size.)

GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)		
		GW	Well-graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)		
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)		
		SW	Well-graded sands, gravelly sands, little or no fines
		SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)		
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures

FINE-GRAINED SOILS
(50% or more of material is smaller than No. 200 sieve size.)

SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

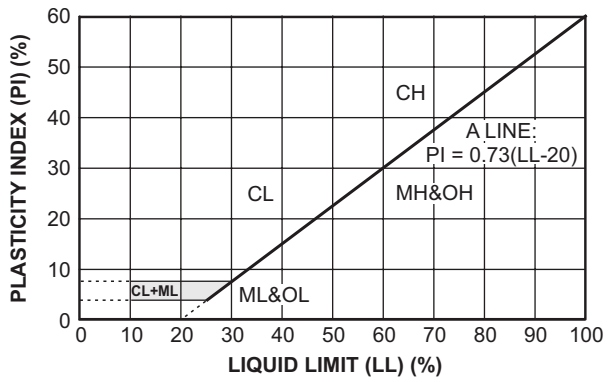
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



MATERIAL AND SAMPLE SYMBOLS LIST

Pavement/Soils

ASPH- ASPHALT PVT
GP - Poorly-graded Gravel
MH - Elastic Silt
SC - Clayey Sand
CH - Fat Clay
GP-GC
MH/CH
SM - Silty Sand
CL - Lean Clay
GP-GM
MH/ML
SP - Poorly-Graded Sand
CL-ML
GW - Well-Graded Gravel
MH/SM
SP-SC
CONC- CONCRETE PVT
GW-GC
ML - Silt
SP-SM
FL -Fill
GW-GM
ML/CL
SW - Well-Graded Sand
GC - Clayey Gravel
GM/GP
ML/GM
SW-SC
GC-GM
GM/ML
ML/SM
GM - Silty Gravel
GM/SM
SW-SM

Sedimentary Rocks

CGL - Conglomerate
SE - Shell Bed
CLST - Cherty Limestone
SHL - Shale
COL - Coal
SLS - Siltstone
MST Mudstone
SST - Sandstone
GWK - Graywacke
SST-SHL - Interbedded Sandstone/Shale
LST - Limestone
SST-SLS - Interbedded Sandstone/Siltstone
UCY - Underclay
SHLS-Shaly Limestone
SHDS Shaly Dolostone
MSH Silty Shale
CHK Chalk
SSHL Sandy Shale

Igneous Rocks

AND - Andesite
BST - Basalt
DBS - Diabase
DRT - Diorite
GBR - Gabbro
GRD - Granodiorite
GRN Granite
POR - Porphyry
RHY - Rhyolite

Metamorphic Rocks

GGE - Gouge
GNS - Gneiss
MYL - Mylonite
PHY - Phyllite
SCH - Schist
SLT - Slate

Misc.

CAV - Cavity
HWR Highly Weathered Rock
BRC - Breccia

Sampling

SPT
Core
Auger
Vane
Undisturbed
Grab
No Recovery
Other

Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

06BH-628-1

STATION: 29+33 OFFSET: 14' R
LATITUDE: 38.928443° N LONGITUDE: 77.213291° W
SURFACE ELEVATION: 366.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 3/17/2006 - 3/17/2006
Drilling Method(s): HSA 2.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: Burgess & Niple
Logger: D Thandaveswara

GROUND WATER
FIRST ENCOUNTERED AT 68.5 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	365	4 7 5			1 2.5						0.0 / 366.0 Grass and TOPSOIL **TOPS**			
2											0.2 / 365.8 Stiff, mottled, yellowish brown and black silty CLAY, with little fine sand and trace of fine gravel, moist **CL**			
4		4 6 9			3.5 5						2.5 / 363.5 Firm, mottled, red to yellowish brown-black silty fine SAND, with little clay, moist **SM**			
6	360	7 7 11			6 7.5						3.0 / 363.0 Stiff, mottled, yellowish brown and blueish gray SILT, with little clay, and little sand-size mica, moist **ML**			
8		6 9 21			8.5 10						5.5 / 360.5 Firm, mottled, yellowish brown and gray fine sand, with some silt, little clay, and trace quartz gravel, moist **SM**			
10	355										10.0 / 356.0 Firm, yellowish brown and black clayey fine SAND, with little mica, moist **SC**			
12														
14		8 11 16			13 14.5									
16	350													
18		10 21 20			18.5 20						17.5 / 348.5 Hard, mottled, red to yellow and brownish gray SILT, with some fine sand, dry **ML**			
20	345													
22														
24		6 10 14			23.5 25									
26	340													
28		9 15 19			28.5 30						27.5 / 338.5 Dense to very dense, mottled yellowish brown, blackish brown and pink silty fine SAND, with little clay, moist **SM**			
30	335													
32														

REMARKS: Rig Type: CME 45C Truck Mount ATV..
Residual schistose structure observed throughout. BL. SBH

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

STATION: 29+33 OFFSET: 14' R
LATITUDE: 38.928443° N LONGITUDE: 77.213291° W
SURFACE ELEVATION: 366.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 3/17/2006 - 3/17/2006
Drilling Method(s): HSA 2.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: Burgess & Niple
Logger: D Thandaveswara

GROUND WATER
FIRST ENCOUNTERED AT 68.5 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA		
		SOIL				ROCK								
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT LL	PLASTICITY INDEX PI	MOISTURE CONTENT (%)
34		13 16 18			33.5–35									
36	330													
38		16 14 21			38.5–40									
40														
42	325													
44		12 19 23			43.5–45						42.5 / 323.5 Dense to very dense, yellowish brown and black silty fine SAND, little clay, moist **SM**			
46	320													
48		21 25 31			48.5–50									
50														
52	315													
54		13 17 34			53.5–55									
56	310													
58		17 19 25			58.5–60						57.5 / 308.5 Dense, gray silty fine SAND, with little clay, dry to moist **SM**			
60														
62	305													
64		20			63.5									

REMARKS: Rig Type: CME 45C Truck Mount ATV..
Residual schistose structure observed throughout. BL. SBH

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Logger: D Thandaveswara

GROUND WATER
FIRST ENCOUNTERED AT 68.5 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		26 25			65									
66	300													
68		17 22 30			68.5 70									
70	295													
72														
74		25 37 50			73.5 75						74.0 / 292.0 Very dense, mottled, yellowish brown and black DECOMPOSED MICA SCHIST, moist to wet **SCH**			
76	290													
78		50 50/2			78.5 79.2						Boring Terminated at 79.2 Feet Below Ground Surface (BGS) on 3/17/2006.			

NOTES:
1. Water level at time of drilling was 68.5' bgs on 3/17/2006.
2. Cave-in depth was 70.0' bgs on 3/17/2006.

REMARKS: Rig Type: CME 45C Truck Mount ATV..
Residual schistose structure observed throughout. BL. SBH

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628 ABUTMENT A

STATION: 27+47 OFFSET: 5' L
LATITUDE: 38.928663° N LONGITUDE: 77.213468° W
SURFACE ELEVATION: 367.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 07/10/2008 - 07/11/2008
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Jim Lawhead
Logger: David Gibbs/F&R

GROUND WATER
FIRST ENCOUNTERED AT 63.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 367.0 8" TOPSOIL **TOPS**				
2	365	2 1 2	53		1 2.5						0.7 / 366.3 Brown red-brown fine to medium silty SAND, trace of quartz gravel, very loose, moist, FILL **FL**			9.3	
4		3 13 22	53		3.5 5						SAME, brown tan, dense			9.8	
6	360	4 6 8	7		6 7.5						SAME, brown, contains rootlets, medium dense			12.5	
8		3 3 3	93		8.5 10						8.0 / 359.0 Brown red-brown SILT with sand, contains mica, firm, moist **ML**			27.7	
												45	10	26.9	73.4
12	355				12						SAME, tan black, stiff				
14		3 5 7	100		13.5 15									21.4	
16	350										SAME, red-brown brown tan				
18		3 4 7	73		18.5 20									27.1	
22	345														
24		10 7 12	13		23.5 25						SAME, trace of quartz gravel, very stiff			14.4	
26	340										SAME, red-brown tan black, no quartz gravel, stiff				
28		3 4 7	100		28.5 30									38.9	
32	335														

REMARKS: Rig Type: CME 55.
Hammer efficiency = 94%.
Dry upon completion of boring on 7/11/2008. Caved depth 8.0' on 7/11/2008. BL. SBH

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628 ABUTMENT A

STATION: 27+47 OFFSET: 5' L
LATITUDE: 38.928663° N LONGITUDE: 77.213468° W
SURFACE ELEVATION: 367.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 07/10/2008 - 07/11/2008
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Jim Lawhead
Logger: David Gibbs/F&R

GROUND WATER
FIRST ENCOUNTERED AT 63.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		6 8 10	100		33.5–35						SAME, very stiff			39.1	
36	330														
38		9 12 17	100		38.5–40									37.6	
40															
42	325														
44		7 10 15	100		43.5–45									39.5	
46	320														
48		10 15 23	73		48.5–50						SAME, relict structure, hard			34.9	
50															
52	315														
54		12 18 43	100		53.5–55						53.5 / 313.5 Red-brown tan black highly weathered SCHIST (recovered as: SILT with sand, contains highly weathered rock fragments and mica, very hard, moist (ML) **SCH**			31.0	
56	310														
58		12 27 73	100		58.5–60										
60															
62	305														
64		32			63.5										

REMARKS: Rig Type: CME 55.
Hammer efficiency = 94%.
Dry upon completion of boring on 7/11/2008. Caved depth 8.0' on 7/11/2008. BL. SBH

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628 ABUTMENT A

STATION: 27+47 OFFSET: 5' L
LATITUDE: 38.928663° N LONGITUDE: 77.213468° W
SURFACE ELEVATION: 367.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 07/10/2008 - 07/11/2008
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Jim Lawhead
Logger: David Gibbs/F&R

GROUND WATER
FIRST ENCOUNTERED AT 63.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		52 48/3	100		64.8										
66															
	300										SAME, tan black red-brown				
68		24 76	100		68.5 69.5										
70															
72	295														
74		15 46 54/5	100		73.5 74.9										
76															
	290														
78		28 72/5	100		78.5 79.4										
80															
82	285														
84		29 71	100		83.5 84.5						Boring terminated at 84.5' on 7/11/2008				

REMARKS: Rig Type: CME 55.
Hammer efficiency = 94%.
Dry upon completion of boring on 7/11/2008. Caved depth 8.0' on 7/11/2008. BL. SBH

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627, ABUTMENT B

08BH-629-4

STATION: 40+05 B.L. JBCON — OFFSET: 21' RT
LATITUDE: 38.929107° N — LONGITUDE: 77.214137° W
SURFACE ELEVATION: 336.2 ft — COORD. DATUM: NAD 83

Date(s) Drilled: 09/22/2008 - 09/23/2008
Drilling Method(s): 3.25" HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Joe Scribellito
Logger: David Gibbs/F&R

GROUND WATER
FIRST ENCOUNTERED AT 33.0 ft DEPTH

FIELD DATA — SOIL: STANDARD PENETRATION TEST HAMMER BLOWS; SOIL RECOVERY (%); SAMPLE LEGEND; SAMPLE INTERVAL. ROCK: CORE RECOVERY (%); ROCK QUALITY DESIGNATION; DIP °: STRATA, JOINTS; STRATA LEGEND. **LAB DATA**: LIQUID LIMIT (LL); PLASTICITY INDEX (PI); MOISTURE CONTENT (%)

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE INTERVAL	FIELD DESCRIPTION OF STRATA
					0.0 / 336.2 7" TOPSOIL **TOPS**
2	335	50 50/2	100	1 1.7	0.6 / 335.6 Red-brown purple highly weathered SCHIST (recovered as: fine to medium silty SAND, trace of gravel, contains highly weathered rock fragments and mica, very dense, moist **SM**
4			100	3.5 4	
6	330		100	6 6.5	SAME, orange gray red-brown
8		74 26/3	100	8.5 9.3	SAME, tan gray red-brown
10					
12	325				
14			100	13.5 14	13.0 / 323.2 Red-brown, brown gray highly weathered SCHIST (recovreed as: sandy SILT, contains highly weathered rock fragments and mica, very hard, moist **ML**
16	320				
18		30 70/4	100	18.5 19.3	SAME, red-brown black orange, trace of quartz gravel
20					
22	315				
24		18 19 26	100	23.5 25	23.0 / 313.2 Tan black red-brown sandy SILT, contains mica, relict structure, hard, moist **ML**
26	310				
28		9 13 22	100	28.5 30	SAME, orange red-brown black with sand
30	305				
32					

REMARKS: Rig Type: CME 55 Track Rig.
Hammer effciency = 75.1%. Water level 37.0' upon completion of boring on 9/23/2008. Caved depth at 42.5' on 9/23/2008.

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627, ABUTMENT B

STATION: 40+05 B.L. JBCON
OFFSET: 21' RT
LATITUDE: 38.929107° N
LONGITUDE: 77.214137° W
SURFACE ELEVATION: 336.2 ft
COORD. DATUM: NAD 83

Date(s) Drilled: 09/22/2008 - 09/23/2008
Drilling Method(s): 3.25" HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Joe Scribellito
Logger: David Gibbs/F&R

GROUND WATER
FIRST ENCOUNTERED AT 33.0 ft DEPTH

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
34		14 28 72/5	100		33.5 34.4						33.0 / 303.2 Orange red-brown black highly weathered SCHIST (recovered as: SILT with sand, contains highly weathered rock fragments and mica, very hard, moist **ML**			
36	300													
38		18 40 60/5	100		38.5 39.4						SAME, red-brown black tan, sandy			
40														
42	295													
44		44 56/5	89		43.5 44.6						SAME, orange red-brown black			
46	290													
48		24 28 54	80		48.5 49						SAME, red-brown orange black			
50														
52	285													
54		100/4	100		53.5 53.8						SAME, red-brown gray black			
56	280													
58														
60											SAME, tan gray orange			
62	275													
64		57			63.5									

REMARKS: Rig Type: CME 55 Track Rig.
Hammer effciency = 75.1%. Water level 37.0' upon completion of boring on 9/23/2008. Caved depth at 42.5' on 9/23/2008.

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627, ABUTMENT B

08BH-629-4

STATION: 40+05 B.L. JBCON
OFFSET: 21' RT
LATITUDE: 38.929107° N
LONGITUDE: 77.214137° W
SURFACE ELEVATION: 336.2 ft
COORD. DATUM: NAD 83

Date(s) Drilled: 09/22/2008 - 09/23/2008
Drilling Method(s): 3.25" HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Joe Scribellito
Logger: David Gibbs/F&R

GROUND WATER
FIRST ENCOUNTERED AT 33.0 ft DEPTH

FIELD DATA											LAB DATA		
		SOIL				ROCK							
								DIP °					
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT (%)
		43/3	100		64.3								

FIELD DESCRIPTION OF STRATA

Boring terminated at 64.3' on 9/23/2008

REMARKS: Rig Type: CME 55 Track Rig.
Hammer effciency = 75.1%. Water level 37.0' upon completion of boring on 9/23/2008. Caved depth at 42.5' on 9/23/2008.

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627, PIER 1

09BH-629-3

STATION: 41+86 B.L. JBCON — OFFSET: 7' RT
LATITUDE: 38.929304° N — LONGITUDE: 77.214789° W
SURFACE ELEVATION: 370.7 ft — COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 01/21/2009 - 01/21/2009
Drilling Method(s): 3.25" HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Cody Haines
Logger: Dan Dunlap/MACTEC

GROUND WATER
NOT ENCOUNTERED DURING DRILLING

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
	370	3 17 13	67		1 – 2.5						0.0 / 370.7 1" TOPSOIL **TOPS**			
2											0.1 / 370.6 Brown fine to coarse silty SAND with gravel, dense, moist **SM**			
4		8 8 8	80		3.5 – 5						3.0 / 367.7 Brown sandy SILT with gravel, very stiff, moist **ML**			
6	365	4 5 10	93		6 – 7.5						SAME, stiff			
8														
10		5 8 8	100		8.5 – 10						SAME, red-brown, trace of gravel, very stiff			
12	360													
14		14 15 15	100		13.5 – 15									
16	355													
18														
20		19 20 23	100		18.5 – 20						SAME, relict structure, hard			
22	350													
24		19 26 32	100		23.5 – 25						SAME, very hard			
26	345													
28											28.0 / 342.7 Red-brown tan highly weathered SCHIST (recovered as: SILT with sand, contains highly weathered rock fragments, very hard, moist **ML**			
30		24 37 36	100		28.5 – 30									
32	340													

REMARKS: Rig Type: CME 55 Track Rig.
Hammer efficiency = 75.1%. Caved depth 58.8' on 1/21/2009. Boring drilled 14.9' N, 36' W of staked location. Latitude and longitude reflect as-drilled location.

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627, PIER 1

STATION: 41+86 B.L. JBCON — OFFSET: 7' RT
LATITUDE: 38.929304° N — LONGITUDE: 77.214789° W
SURFACE ELEVATION: 370.7 ft — COORD. DATUM: NAD 83

Date(s) Drilled: 01/21/2009 - 01/21/2009
Drilling Method(s): 3.25" HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Cody Haines
Logger: Dan Dunlap/MACTEC

GROUND WATER
NOT ENCOUNTERED DURING DRILLING

FIELD DATA — **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
34	335	10 18 24	100		33.5–35						33.0 / 337.7 Orange tan white SILT with sand, contains highly weathered schist rock fragments, hard, moist **ML**			
36														
38	330	18 32 37	100		38.5–40						38.0 / 332.7 Orange tan white highly weathered SCHIST (recovered as: SILT with sand, contains highly weathered rock fragments, very hard, moist **ML**			
40														
42														
44	325	12 25 35	100		43.5–45									
46														
48	320	9 11 18	100		48.5–50						48.0 / 322.7 Red tan gray sandy SILT, contains highly weathered schist rock fragments, very stiff, moist **ML**			
50														
52														
54	315	22 38 53	100		53.5–55						53.0 / 317.7 Red tan gray highly weathered SCHIST (recovered as: sandy SILT, contains highly weathered rock fragments, very hard, moist **ML**			
56														
58	310	29 68 32/3	92		58.5–59.8						SAME, tan, trace of quartz gravel			
60														
62														
64		30			63.5									

REMARKS: Rig Type: CME 55 Track Rig.
Hammer efficiency = 75.1%. Caved depth 58.8' on 1/21/2009. Boring drilled 14.9' N, 36' W of staked location. Latitude and longitude reflect as-drilled location.

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627, PIER 1

09BH-629-3

STATION: 41+86 B.L. JBCON — OFFSET: 7' RT
LATITUDE: 38.929304° N — LONGITUDE: 77.214789° W
SURFACE ELEVATION: 370.7 ft — COORD. DATUM: NAD 83

Date(s) Drilled: 01/21/2009 - 01/21/2009
Drilling Method(s): 3.25" HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: Free State/Cody Haines
Logger: Dan Dunlap/MACTEC

GROUND WATER
NOT ENCOUNTERED DURING DRILLING

FIELD DATA — **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		33 42	100		65									
66	305													
68		10 29 31	87		68.5 70						SAME, tan gray, no quartz gravel			
70	300													
72														
74		17 22 30	100		73.5 75						72.5 / 298.2 Tan white sandy SILT, contains highly weathered schist rock fragments, hard, moist **ML**			
76	295													
78		100	100		78.5 79						77.5 / 293.2 Tan, white weathered SCHIST (recovered as: sandy SILT, contains highly weathered rock fragments, very hard, moist **ML**			
80	290													
82														
84		100/2	100		83.5 83.7						SAME, tan gray white, trace of quartz gravel			
86	285													
88		100/4	67		88.5 88.8						SAME, gray tan			
90	280													
92														
94		80 20/1	100		93.5 94.1						Boring terminated at 94.1' on 1/21/2009			

REMARKS: Rig Type: CME 55 Track Rig.
Hammer efficiency = 75.1%. Caved depth 58.8' on 1/21/2009. Boring drilled 14.9' N, 36' W of staked location. Latitude and longitude reflect as-drilled location.

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627-1, PIER 1

09BH-658-1

STATION: 41+43 B.L. JBCON — OFFSET: 5' RT
LATITUDE: 38.929283° N — LONGITUDE: 77.214640° W
SURFACE ELEVATION: 354.9 ft — COORD. DATUM: NAD 83

Date(s) Drilled: 09/24/2015 - 09/24/2015
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: K. Kersh, Connelly Drilling
Logger: D. Bookbinder

GROUND WATER
- FIRST ENCOUNTERED AT 55.0 ft DEPTH
- STABILIZED AT 33.1 ft AFTER 24 HOURS

FIELD DATA — **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
2	350	1 2 2	40		1.5						0.0 / 354.9 Brown, sandy SILT, contains trace rootlets, soft, moist **ML**			
4		8 12 13	33		2.5 4						2.0 / 352.9 Brown, sandy SILT, exhibits relic rock structure, very stiff, moist **ML**			
6		8 10 11	100		5 6.5									
8														
10	345	20 28 29	87		8.5 10									
12														
14	340	29 55 45/5	100		13.5 15						13.8 / 341.1 Brown, highly weathered SCHIST, moist **HWR**			
16														
18	335	28 52 48/5	100		18.5 20									
20														
22														
24	330	31 46 48	100		23.5 25									
26														
28	325	28 61 39/4	100		28.5 29.8									
30														
32														

REMARKS: Rig Type: VDOT RIG TYPE: CME 55LC.
Hammer effciency = 88.3%. Caved depth at 59.3' on 9/24/2009. BL. JBCON

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627-1, PIER 1

09BH-658-1

STATION: 41+43 B.L. JBCON
OFFSET: 5' RT
LATITUDE: 38.929283° N
LONGITUDE: 77.214640° W
SURFACE ELEVATION: 354.9 ft
COORD. DATUM: NAD 83

Date(s) Drilled: 09/24/2015 - 09/24/2015
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: K. Kersh, Connelly Drilling
Logger: D. Bookbinder

GROUND WATER
- FIRST ENCOUNTERED AT 55.0 ft DEPTH
- STABILIZED AT 33.1 ft AFTER 24 HOURS

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
34	320	48 57/5	100		33.5 34.4									
36														
38		29 35	100		38.5 39									
40	315													
42														
44		63 37/2	100		43.5 44.2									
46	310													
48		27 37 33	100		48.5 49									
50	305													
52														
54		100/5	100		53.5 53.9									
56	300													
58		100/3	100		58.5 58.8									
60	295													
62														
64		50/1	100		63.5									

REMARKS: Rig Type: VDOT RIG TYPE: CME 55LC.
Hammer effciency = 88.3%. Caved depth at 59.3' on 9/24/2009. BL. JBCON

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627-1, PIER 1

STATION: 41+43 B.L. JBCON — OFFSET: 5' RT
LATITUDE: 38.929283° N — LONGITUDE: 77.214640° W
SURFACE ELEVATION: 354.9 ft — COORD. DATUM: NAD 83

Date(s) Drilled: 09/24/2015 - 09/24/2015
Drilling Method(s): 3 1/4" diameter HSA
SPT Method: Automatic Hammer
Other Test(s):
Driller: K. Kersh, Connelly Drilling
Logger: D. Bookbinder

GROUND WATER
- FIRST ENCOUNTERED AT 55.0 ft DEPTH
- STABILIZED AT 33.1 ft AFTER 24 HOURS

FIELD DATA — **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	DIP °: STRATA	DIP °: JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
					63.6									
66	290													
68					67.9						Split-Spoon refusal at 68.0'			
70	285					1720	50				68.1 / 286.8 Moderaely weathered, moderately hard, high jointing, brown, SCHIST, highly weathered 70.4' to 70.7', intensely fractured 70.4' to 70.7', 71.7' to 72.0', 72.7' to 72.8', no recovery 68.0' to 68.7', joint angles 5 to 20 degrees **SCH**			
72					72.9									
74					73						73.0 / 281.9 Moderately weathered, moderately hard, high jointing, brown **SCH**			
76	280					1680	32				SAME, intensely fractured 75.3' to 75.6', 77.2' to 78.0', no recovery 73.0' to 73.8'. joint angles 10 to 25 degrees			
78					78						78.0 / 276.9 Moderately weathered, moderately hard to soft, high jointing, brown, SAME, mud seam 80.5', 81.3', highly weathered 82.2' to 82.3', intensely fractured 82.2', to 82.5', no recovery 78.0' to 80.5', joint angles 5 to 25 degrees			
80	275					1000	0							
82					83						83.0 / 271.9 Highly weathered, moderately hard, high jointing, brown, sAME, mud seam 83.7', 84.0', highly weathered 86.2' to 86.5', 87.2' to 88.0', intensely fractured 86.2' to 88.0', no recovery 83.0' to 83.7', joint angles 10 to 20 degrees			
84	270					1700	26							
86														
88					88						88.0 / 266.9 Moderately weathered, moderately hard, moderate jointing, brown, SAME, highly fractured 91.5' to 92.0', joint angles 10 to 25 degrees			
90	265					2500	89							
92					92						Coring terminated at 92.0' on 9/24/2009			

REMARKS: Rig Type: VDOT RIG TYPE: CME 55LC.
Hammer effciency = 88.3%. Caved depth at 59.3' on 9/24/2009. BL. JBCON

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: JONES BRANCH CONNECTOR ROAD

13JB-01

STATION: 18+71 OFFSET: 13' R
LATITUDE: 38.929159° N LONGITUDE: 77.216306° W
SURFACE ELEVATION: 328.23 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K.HURLEY, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		3 5 10 13	25										2.8	
2		4 6 6 7	79		2						37	7	16.9	46.7
4	325	2 4 5 7	75		4								23.8	
6		4 7 9 10	63		6								16.6	
8	320	2 4 4 7	84		8								22.7	
10		3 6 7 7	100		10								17.2	
12					12									

FIELD DESCRIPTION OF STRATA

0.0 / 328.23
6" AGGREGATE BASE, **GP**

0.5 / 327.73
Fill, Brown, fine, SILTY SAND, medium dense, moist **SM**

SAME, contains rootlets, loose

SAME, medium dense

8.0 / 320.23
Residuum, Brown, SILTY SAND, loose, moist, **SM**

SAME, trace gravel, slightly micaceous, medium dense

Boring terminated at 12'.

REMARKS: Rig Type: CME-45-C-2.
Caved Depth at 6.5'.
Northing(VDOT): 462347.4155
Easting(VDOT): 3646224.89
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: JONES BRANCH CONNECTOR ROAD

13JB-02
PAGE 1 OF 1

STATION: 20+32 OFFSET: 7' L
LATITUDE: 38.929263° N LONGITUDE: 77.215751° W
SURFACE ELEVATION: 339.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.5											0.0 / 339.0			
1.0	338										12" ASPHALT CONCRETE **ASPH**			
1.5											1.0 / 338.0			
2.0		12			2						12" AGGREGATE BASE, **GP**			
2.5		17												
3.0	336	21	96								2.0 / 337.0			9.4
3.5		32									*Residuum*, Tan-brown, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, dense, moist, **SM**			
4.0		11			4									
4.5		20												
5.0	334	29	100											10.3
5.5		71/6												
6.0		26			6						SAME, contains quartz gravel, dense			
6.5		36												
7.0	332	31	100											12.2
7.5		37												
8.0		19			8						SAME, no quartz gravel, dense			
8.5		20												
9.0	330	22	25											12.9
9.5		24												
10.0					10						Boring terminated at 10.0'.			

REMARKS: Rig Type: CME-45-C-2.
Caved Depth at 5.5'.
Northing(VDOT): 462387.4069
Easting(VDOT): 3646382.257

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13JB-02

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: JONES BRANCH CONNECTOR ROAD

13JB-03

STATION: 21+49 OFFSET: 5' L
LATITUDE: 38.929293° N LONGITUDE: 77.215340° W
SURFACE ELEVATION: 348.43 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5	348										0.0 / 348.43 12" ASPHALT **ASPH**				
1.0															
1.5															
2.0					2						1.0 / 347.43 12" AGGREGATE BASE, **GP**				
2.5	346	9 7 7 5	75								2.0 / 346.43 *Residuum*, Red-brown, fine, SILTY SAND, trace gravel, slightly micaceous, medium dense, moist, **SM**	40	7	22.3	44.4
3.0															
3.5															
4.0					4										
4.5	344	9 13 10 10	63								SAME, exhibits relict rock structure			9.6	
5.0															
5.5															
6.0		100/6"	100		6										
6.5	342				6.5						SAME, no trace gravel, very dense			8.2	
7.0															
7.5															
8.0					8										
8.5	340	3 10 63 27/3"	44												
9.0														6.1	
9.5					9.7						Boring terminated at 9.7'.				

REMARKS: Rig Type: CME-45-C-2.
Caved Depth at 5.0'.
Northing(VDOT): 462400.1547
Easting(VDOT): 3646498.966

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-04

STATION: 22+44 OFFSET: 43' L
LATITUDE: 38.929400° N LONGITUDE: 77.214996° W
SURFACE ELEVATION: 356.89 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/14/13 - 10/14/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 73.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
					1						0.0 / 356.89 11" ASPHALT, **ASPH**				
2	355	7 3 9 5 10 13	58		2						0.9 / 355.99 4" AGGREGATE BASE, **GP**			26.6	
4		4 6 7 9	34		4						1.3 / 355.59 *Fill*, Red-brown, fine, SILTY SAND FILL, slightly micaceous, medium dense, moist, **SM**			24.3	
6		6 9 11 14	50		6						5.0 / 351.89 *Residuum*, Red-brown, black, gray, ELASTIC SILT, trace sand, slightly micaceous, exhibits relict rock structure, very stiff, moist, **MH**			25.4	
8	350	5 7 8 11	71		8						SAME, orange-brown, black			22.7	
10		8 8 11 13	79		10							71	21	20.8	89.2
12	345	8 8 11 12	92		12						10.0 / 346.89 Orange-brown, black, SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist, **ML**			6.0	
14		8 8 11 14	100		13 15									20.7	
16	340														
18		8 8 11 14	100		18 20									23.0	
22	335														
24		7 12 17 22	100		23 25									16.1	
26	330														
28		5 9 14 18	100		28 30									19.2	
32	325														

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 49.5'.
Northing(VDOT): 462440.4591
Easting(VDOT): 3646596.322

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

STATION: 22+44 OFFSET: 43' L
LATITUDE: 38.929400° N LONGITUDE: 77.214996° W
SURFACE ELEVATION: 356.89 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/14/13 - 10/14/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 73.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP °: STRATA	ROCK: DIP °: JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		6 9 13 15	100		33–35									21.9	
36	320														
38		4 10 16 20	100		38–40									17.8	
40															
42	315										42.0 / 314.89 Orange-brown, black, SILT with sand, slightly micaceous, exhibits relict rock structure, hard, moist **ML**				
44		8 13 21 23	100		43–45						SAME, hard	46	11	22.6	83.2
46	310														
48		5 15 22 22	100		48–50									21.8	
50															
52	305														
54		2 7 16 22	100		53–55						SAME, very stiff			25.5	
56	300														
58		8 17 27 35	100		58–60						58.0 / 298.89 Brown, gray, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, dense, moist, **SM**			12.4	
60															
62	295														
64		14 36			63						63.0 / 293.89				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 49.5'.
Northing(VDOT): 462440.4591
Easting(VDOT): 3646596.322

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

STATION: 22+44 OFFSET: 43' L
LATITUDE: 38.929400° N LONGITUDE: 77.214996° W
SURFACE ELEVATION: 356.89 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/14/13 - 10/14/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 73.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		61 39/4	100		64.83						*IGM*, Brown, white, fine, SILTY SAND, slightly micaceous, very dense, moist, **SM**			15.8	
66	290														
68		7 14 33 67	100		68 70						SAME, dense			17.4	
70															
72	285														
74		18 52 48/5	100		73 74.41						SAME, very dense			18.0	
76	280														
78		13 32 57 43/3	100		78 79.75									14.6	
80															
82	275														
84		8 20 32 46	100		83 85									21.0	
86	270														
88		15 23 37 57	100		88 90						Boring terminated at 90.0'.			18.9	
90															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 49.5'.
Northing(VDOT): 462440.4591
Easting(VDOT): 3646596.322

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-05

STATION: 22+48 OFFSET: 6' L
LATITUDE: 38.929299° N LONGITUDE: 77.214991° W
SURFACE ELEVATION: 356.54 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 356.54 11" ASPHALT **ASPH** 0.09 / 356.45 4" AGGREGATE BASE, **GP**				
2	355	8 10 15 18	100		1 2									11.1	
		5 6	63								1.25 / 355.29 *Fill*, Red-brown, SANDY SILT FILL, with gravel, stiff, moist, **ML**			20.2	
4		8 11 13 15	50		4						SAME, very stiff SAME, contains asphalt			8.2	
6	350	6 10 13 13	38		6						6.0 / 350.54 *Residuum*, Red-brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist, **ML**			15.1	
8		5 7 9 16	50		8									15.0	
10		9 11 17 20	50		10							39	6	14.8	60.9
12	345				12										
14		8 19 28 36	75		13 15						SAME, hard			12.0	
16	340														
18		11 17 21 33	75		18 20						SAME, very stiff			9.7	
22	335														
24		12 13 15 19	84		23 25						SAME, very stiff			13.1	
26	330														
28		28 72/5	100		28 28.9						28.0 / 328.54 *IGM*, Tan, brown, SANDY SILT, slightly micaceous, very dense, moist, **ML**			9.3	
30															
32	325														

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 37.5'.
Northing(VDOT): 462403.3789
Easting(VDOT): 3646598.127

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-05

STATION: 22+48 OFFSET: 6' L
LATITUDE: 38.929299° N LONGITUDE: 77.214991° W
SURFACE ELEVATION: 356.54 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		19 28 34 47	84		33–35									10.1	
36	320														
38		100/5	100		38–38.4						SAME, quartz rock seam at 38.25'			7.6	
40															
42	315														
44		11 37 44 50/5	100		43–44.9						SAME, contains highly weathered rock fragments			13.0	
46	310														
48		15 25 37 41	100		48–50									14.5	
52	305														
54		13 31 43 57	100		53–55									14.3	
56	300														
58		28 48 52/3	100		58–59.25									13.0	
60															
62	295														
64		20 56	100		63									15.2	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 37.5'.
Northing(VDOT): 462403.3789
Easting(VDOT): 3646598.127

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-05

STATION: 22+48 OFFSET: 6' L
LATITUDE: 38.929299° N LONGITUDE: 77.214991° W
SURFACE ELEVATION: 356.54 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		44/2			64.2										
66	290														
68		34 50 50/4	100		68 – 69.3						68.0 / 288.54 Tan, brown, SILT, with sand, very hard, moist, **ML**	39	9	15.7	82.9
70															
72	285														
74		17 29 38 68/5	100		73 – 74.9									17.6	
76	280														
78		4 13 26 32	100		78 – 80						SAME, hard			17.4	
80															
82	275														
84		10 17 33 52	100		83 – 85									16.5	
86	270														
88		11 16 25 33	100		88 – 90									22.3	
90											Boring terminated at 90.0'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 37.5'.
Northing(VDOT): 462403.3789
Easting(VDOT): 3646598.127

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-06

STATION: 23+70 OFFSET: 50' R
LATITUDE: 38.929088° N LONGITUDE: 77.214618° W
SURFACE ELEVATION: 339.3 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/18/13 - 10/18/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. VIETEN, ECS

GROUND WATER
FIRST ENCOUNTERED AT 59.0 ft DEPTH
STABILIZED AT 58.5 ft

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		12 6 3 5	71							0.0 / 339.3 3" TOPSOIL **TOPS**			21.0	
2		5 3 3 7	50	2						0.3 / 339.0 *Fill*, Red-brown, gray, white, SANDY SILT FILL, contains mica and crushed stone, stiff, moist, **ML** SAME, firm			9.7	
4	335	2 5 9 18	100	4						3.5 / 335.8 *Residuum*, Red-brown, gray, white, fine, SANDY SILT, trace sand, slightly micaceous, stiff, moist, **ML**	NP	NP	13.6	59.7
6		5 11 15 22	50	6						SAME, very stiff			15.1	
8		9 15 21 36	100	8						SAME, red-brown, black, exhibits relict rock structure, hard			26.5	
10	330			10										
12														
14	325	3 9 25 55	100	13 15						SAME, red-brown, gray, no relict rock structure			12.2	
16										16.5 / 322.8 Tan, gray, SILT, trace of sand, slightly micaceous, exhibits relict rock structure, moist, very hard **ML**				
18		23 34 54 45/3	100	18									14.3	
20	320			19.75										
22														
24	315	13 25 53 47/3	100	23 24.75						SAME, tan, gray, black			11.1	
26														
28		13 13 19 28	100	28						SAME, hard			21.1	
30	310			30										
32														

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 60.0'.
Northing(VDOT): 462328.1344
Easting(VDOT): 3646705.405

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-06

STATION: 23+70 OFFSET: 50' R
LATITUDE: 38.929088° N LONGITUDE: 77.214618° W
SURFACE ELEVATION: 339.3 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/18/13 - 10/18/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. VIETEN, ECS

GROUND WATER
FIRST ENCOUNTERED AT 59.0 ft DEPTH
STABILIZED AT 58.5 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	305	11 18 31 45	100		33–35							NP	NP	14.4	57.9
36															
38	300	6 8 13 24	100		38–40						SAME, very stiff			21.0	
40															
42											42.0 / 297.3 *IGM*, Tan, gray, black, fine, SANDY SILT, with sand, slightly micaceous, exhibits relict rock structure, moist, **ML**				
44	295	15 71 30/1	98		43–44.1							NP	NP	8.5	58.5
46															
48	290	11 79 21/1	98		48–49.1									9.2	
50															
52															
54	285	23 40 60/3	104		53–54.2									8.2	
56															
58	280	12 15 19 27	100		58–60						58.5 / 280.8 Red-brown, black, SILT, slightly micaceous, exhibits relict rock structure, hard, moist, **ML**			27.6	
60															
62															
64		19 23	99		63						63.0 / 276.3			13.7	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 60.0'.
Northing(VDOT): 462328.1344
Easting(VDOT): 3646705.405

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-06

STATION: 23+70 OFFSET: 50' R
LATITUDE: 38.929088° N LONGITUDE: 77.214618° W
SURFACE ELEVATION: 339.3 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/18/13 - 10/18/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. VIETEN, ECS

GROUND WATER
FIRST ENCOUNTERED AT 59.0 ft DEPTH
STABILIZED AT 58.5 ft

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	275	61 39/1			64.6						Tan, gray, black, SILT, with sand, slightly micaceous, exhibits relict rock structure, very hard, moist **ML**				
66															
68		17 26 29 45	100		68						SAME, hard	48	15	18.1	76.5
	270														
70					70						Boring terminated at 70.0'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 60.0'.
Northing(VDOT): 462328.1344
Easting(VDOT): 3646705.405

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-07

STATION: 25+43 OFFSET: 68' R
LATITUDE: 38.928867° N LONGITUDE: 77.214149° W
SURFACE ELEVATION: 340.71 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/15/13 - 10/15/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
FIRST ENCOUNTERED AT 43.0 ft DEPTH
DRY AFTER 24 HRS

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	340	WH WH 1 4	29							0.0 / 340.71 2.4" TOPSOIL **TOPS**			16.5	
2		6 12 18 20	100	2						0.2 / 340.51 *Fill*, Orange, brown, SILT FILL, contains quartz gravel and fragments, very soft, moist, **ML**			25.0	
4		16 28 34 49	100	4						SAME, contains asphalt, hard,			12.1	
6	335	10 19 52 48/2	100	6 7.66						5.0 / 335.71 *IGM*, Red, orange, brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist **ML**			38.3	
8		12 22 53 47/5	100	8 9.9							36	10	11.8	58.5
10	330	14 42 58/5	100	10 11.4									16.5	
12		61 57 43/3	100	13 14.2						SAME, red-brown			37.1	
14	325													
16														
18		14 31 60 40	92	18 20									21.3	
20	320													
22		10 18 37 65/5	100	23 24.9						SAME, gray, orange, hard			15.5	
24														
26	315													
28		40 86 41/1	100	28 29.08						SAME, very hard			19.0	
30	310													
32														

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.0'.
Northing(VDOT): 462249.4786
Easting(VDOT): 3646840.01
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

STATION: 25+43 OFFSET: 68' R
LATITUDE: 38.928867° N LONGITUDE: 77.214149° W
SURFACE ELEVATION: 340.71 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/15/13 - 10/15/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
FIRST ENCOUNTERED AT 43.0 ft DEPTH
DRY AFTER 24 HRS

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		15 32 68/5	0		33 – 34.4										
36	305														
38		10 12 14 17	100		38 – 40						37.0 / 303.71 Orange, brown, ELASTIC SILT, with sand, very stiff, moist, **MH** SAME, orange, brown, very stiff	53	14	28.3	78.2
40	300														
42											42.0 / 298.71 Gray, orange, brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist **ML**				
44		14 52 50/4	100		43 – 44.3									17.3	
46	295														
48		9 17 46 54/4	96		48 – 49.9									23.2	
50	290														
52															
54		15 28 72/5	100		53 – 54.4									19.8	
56	285														
58		13 34 50 50/2	100		58 – 59.6									17.7	
60	280														
62															
64		54 87	100		63									11.1	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.0'.
Northing(VDOT): 462249.4786
Easting(VDOT): 3646840.01
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B627

13JB-07

STATION: 25+43 OFFSET: 68' R
LATITUDE: 38.928867° N LONGITUDE: 77.214149° W
SURFACE ELEVATION: 340.71 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/15/13 - 10/15/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
FIRST ENCOUNTERED AT 43.0 ft DEPTH
DRY AFTER 24 HRS

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		13/0			64										
66	275														
68		40 100/3	100		68 68.7									13.3	
											Boring terminated at 68.7'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.0'.
Northing(VDOT): 462249.4786
Easting(VDOT): 3646840.01
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR BRIDGE B627

13JB-08

STATION: 27+19 OFFSET: 94' R
LATITUDE: 38.928537° N LONGITUDE: 77.213799° W
SURFACE ELEVATION: 373.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 373.68 12" ASPHALT **ASPH**				
											1.0 / 372.68 12" AGGREGATE BASE, **GP**				
2	370	3 5 6 7	75		2						2.0 / 371.68 *Fill*, Red-brown, SANDY SILT FILL, trace gravel, slightly micaceous, stiff, moist, **ML**	44	9	21.7	58.3
4		5 5 8 8	75		4						SAME, no gravel, contains wood fragments	43	10	15.3	53.9
6		4 5 5 6	71		6						6.0 / 367.68 *Residuum*, Red-brown, gray, SANDY SILT, trace gravel, slightly micaceous, exhibits relict rock structure, stiff, moist, **ML**			10.5	
8	365	7 8 13 13	79		8						SAME, no gravel, very stiff			10.8	
10					10										
12															
14	360	8 11 14 16	92		13 15						SAME, no mica, no relict rock structure			11.9	
16															
18	355	10 15 18 18	100		18						SAME, hard	NP	NP	12.6	62.6
20					20										
22															
24	350	10 16 18 23	100		23 25						SAME, red-brown, gray, black, slightly micaceous			13.9	
26															
28	345	16 26 33 52	100		28						SAME, with quartz gravel, exhibits relict rock structure			24.4	
30					30										
32		26 27			31						31.0 / 342.68				

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 27.0'.
Northing(VDOT): 462130.8765
Easting(VDOT): 3646941.15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR BRIDGE B627

STATION: 27+19 OFFSET: 94' R
LATITUDE: 38.928537° N LONGITUDE: 77.213799° W
SURFACE ELEVATION: 373.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/9/13 - 10/9/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT LL	PLASTICITY INDEX PI	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		41 59	75		33						*IGM*, Red-brown, gray, black, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			5.0	
34	340														
36															
38	335	18 18 57 43	84		38 40									18.6	
40															
42															
44	330	38 64 36/3"	34		43 44.25									5.4	
46															
48	325	11 21 56 44	100		48 50						SAME, red-brown			16.1	
50											Boring terminated at 50.0'.				

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 27.0'.
Northing(VDOT): 462130.8765
Easting(VDOT): 3646941.15

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-09

STATION: 27+95 OFFSET: 67' R
LATITUDE: 38.928432° N LONGITUDE: 77.213563° W
SURFACE ELEVATION: 351.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/22/13 - 10/22/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 41.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		1 2 5 6	88								0.0 / 351.41 TOPSOIL **TOPS**				
2	350	3 7 7 9	84		2						0.2 / 351.21 *Residuum* Red-brown, SILT, with sand, slightly micaceous, firm, moist, **ML** SAME, red-brown, black, exhibits relict rock structure, stiff			27.4	
4		5 7 9 9	92		4						4.0 / 347.41 Red-brown, ELASTIC SILT, with sand, slightly micaceous, exhibits relict rock structure, very stiff, moist, **MH**			27.7	
6	345	6 8 9 11	100		6							50	11	23.8	70.7
8		4 8 11 15	84		8									26.5	
10					10										
12	340														
14		4 6 9 12	100		13 15						SAME, stiff			11.9	
16	335														
18		10 13 18 27	84		18						17.0 / 334.41 Red-brown, SILT, with sand, slightly micaceous, hard, moist, **ML**			23.8	
20					20										
22	330														
24		9 15 23 32	100		23 25						SAME, red-tan,			14.4	
26	325														
28		11 15 24 30	100		28									13.0	
30					30										
32	320														

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 58.5'.
Northing(VDOT): 462093.5893
Easting(VDOT): 3647008.691

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

STATION: 27+95 OFFSET: 67' R
LATITUDE: 38.928432° N LONGITUDE: 77.213563° W
SURFACE ELEVATION: 351.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/22/13 - 10/22/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 41.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		11 15 28 47	100		33–35									14.7	
36	315														
38		10 20 27 46	100		38–40									18.7	
40															
42	310										42.0 / 309.41 Red-tan, SANDY SILT,slightly micaceous, exhibits relict rock structure, hard, moist, **ML**				
44		9 18 31 50	100		43–45									16.8	61.4
46	305														
48		17 36 48 26/1	100		48–49.6						SAME, very hard			7.1	
50															
52	300														
54		18 23 24 50	100		53–55						SAME, hard				
56	295														
58		12 13 22 25	100		58–60										
60															
62	290														
64		6 13			63										

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 58.5'.
Northing(VDOT): 462093.5893
Easting(VDOT): 3647008.691

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-09

STATION: 27+95 OFFSET: 67' R
LATITUDE: 38.928432° N LONGITUDE: 77.213563° W
SURFACE ELEVATION: 351.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/22/13 - 10/22/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 41.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		25 27	100		65										
66	285														
68		5 10 15 28	100		68						SAME, tan, very stiff				
70					70						Boring terminated at 70.0'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 58.5'.
Northing(VDOT): 462093.5893
Easting(VDOT): 3647008.691

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-09A

STATION: 28+00 OFFSET: 47' R
LATITUDE: 38.928498° N LONGITUDE: 77.213537° W
SURFACE ELEVATION: 351.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/22/13 - 10/22/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		2 2 5 7	100		2								27.3	
2	350													
		5 7 9 11	100		3 5								28.2	
4														
6	345													
8		3 6 10 13	100		8 10								29.0	
10														
12	340													
14		6 9 10 13	84		13 15						53	16	31.0	82.4
16	335													
18		6 10 13 18	100		18 20								29.0	
20														
22	330													
24		8 12 19 25	92		23 25								24.5	
26	325													
28		5 9 17 25	100		28 30								28.4	
30														
32	320													

FIELD DESCRIPTION OF STRATA

0.0 / 351.41
TOPSOIL **TOPS**

0.2 / 351.21
Residuum, Red-brown, black, SANDY SILT, slightly micaceous, firm, moist, **ML**

SAME, red-brown, black, very stiff

12.0 / 339.41
Red-brown, black, ELASTIC SILT, with sand, slightly micaceous, very stiff, moist **MH**

SAME, orange-brown, black

SAME, Red-brown, black, exhibits relict rock structure, hard

SAME, very stiff

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.5'.
Northing(VDOT): 462116.6877
Easting(VDOT): 3646999.123

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-09A

STATION: 28+00 OFFSET: 47' R
LATITUDE: 38.928498° N LONGITUDE: 77.213537° W
SURFACE ELEVATION: 351.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/22/13 - 10/22/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	315	3 4 7 11	75		33–35						SAME, trace sand, stiff	60	15	28.2	85.5
38	310	5 8 13 17	84		38–40						SAME, red-tan, very stiff			22.4	
44	305	3 7 12 19	75		43–45						SAME, red-tan, brown			24.5	
48		24 8 16 24	100		48–50						47.0 / 304.41 Red-tan, brown, SANDY SILT, slightly micaceous, very stiff, moist, **ML** SAME, brown			19.2	
54	300	13 18 29 31	100		53–55						SAME, brown, black, hard			17.7	
60	295	8 18 25 33	100		58–60						SAME, orange-brown, tan			17.5	
64	290	23 25	100		63						63.0 / 288.41			17.8	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.5'.
Northing(VDOT): 462116.6877
Easting(VDOT): 3646999.123

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-09A

STATION: 28+00 OFFSET: 47' R
LATITUDE: 38.928498° N LONGITUDE: 77.213537° W
SURFACE ELEVATION: 351.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/22/13 - 10/22/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		75			64.5						*IGM*, Tan, brown, SANDY SILT, slightly micaceous, contains highly weathered schist rock fragments, very hard, moist, **ML**				
66	285														
68		48 52/3	100		68 68.8						SAME, red-tan, brown			13.2	
70															
72	280														
74		30 38 53 49	100		73 75									10.2	
											Boring terminated at 75.0'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.5'.
Northing(VDOT): 462116.6877
Easting(VDOT): 3646999.123

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-10

STATION: 28+74 OFFSET: 14' L
LATITUDE: 38.928367° N LONGITUDE: 77.213232° W
SURFACE ELEVATION: 338.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/24/13 - 10/24/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Victor V., CDA
Logger: P. MCPARTLAND, ECS

GROUND WATER
FIRST ENCOUNTERED AT 63.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
				1						0.0 / 338.68 12" ASPHALT CONCRETE **ASPH**				
2		32 30 18 10	50	3						1.0 / 337.68 3" AGGREGATE BASE, **GP**			4.0	
4	335	2 4 3 3	34	5						1.3 / 337.38 *Fill*, Red-brown, SANDY SILT FILL, slightly micaceous, hard, moist, **ML**			12.0	
6		3 4 5 4	0	7						SAME, firm SAME, stiff			40.0	
8	330	3 3 4 5	71	9						7.0 / 331.68 Brown, fine to medium, SILTY SAND FILL, with gravel, contains coarse gravel sized granite rock fragments, moist **ML**	43	10	13.4	41.9
10			75	11						9.0 / 329.68 Tan, white, fine to medium, SILTY SAND FILL, slightly micaceous, firm, moist **ML**			15.3	
12														
14	325	10 13 16 25	59	13 15						13.0 / 325.68 *Residuum*, Red-brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist, **ML**			16.4	
16														
18	320	13 22 25 27	100	18 20						SAME, hard			14.6	
22														
24	315	14 22 31 53	100	23 25						SAME, orange-brown, tan			13.6	
26														
28	310	30 70/5	83	28 28.9						27.0 / 311.68 *IGM*, Tan, gray, fine to medium, POORLY-GRADED SAND, trace silt, slightly micaceous, contains quartz gravel fragments, exhibits relict rock structure, very dense, moist, **SP**			9.6	
30														
32														

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 50.0'.
Northing(VDOT): 462070.9819
Easting(VDOT):3647103.34

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

STATION: 28+74 OFFSET: 14' L
LATITUDE: 38.928367° N LONGITUDE: 77.213232° W
SURFACE ELEVATION: 338.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/24/13 - 10/24/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Victor V., CDA
Logger: P. MCPARTLAND, ECS

GROUND WATER
FIRST ENCOUNTERED AT 63.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)	LAB DATA: FINES CONTENT -#200 (%)
34	305	33 67/5	83		33 33.9						SAME, no quartz gravel fragments			8.4	
36															
38	300	18 28 38 45	100		38 40									13.1	
40															
42															
44	295	16 42 66 44/5	79		43 44.9						43.0 / 295.68 Tan, fine to medium, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist **SM**			11.7	
46															
48	290	20 36 64	100		48 49.5									9.3	
50															
52															
54	285	10 33 58 42/5	79		53 54.9						SAME, tan			11.1	
56															
58	280	21 77 33/3	80		58 59.25									10.5	
60															
62															
64	275	41 59/3	100		63 63.7						SAME, tan, brown			18.1	

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 50.0'.
Northing(VDOT): 462070.9819
Easting(VDOT):3647103.34

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-10

STATION: 28+74 OFFSET: 14' L
LATITUDE: 38.928367° N LONGITUDE: 77.213232° W
SURFACE ELEVATION: 338.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/24/13 - 10/24/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Victor V., CDA
Logger: P. MCPARTLAND, ECS

GROUND WATER
FIRST ENCOUNTERED AT 63.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
66															
68	270	14 38 52/3	100		68 69.2									14.8	
70											Boring terminated at 69.3'.				

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 50.0'.
Northing(VDOT): 462070.9819
Easting(VDOT):3647103.34

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-11

STATION: 29+07 OFFSET: 70' R
LATITUDE: 38.928192° N LONGITUDE: 77.213322° W
SURFACE ELEVATION: 342.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/24/13 - 10/24/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 40.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
					1						0.0 / 342.0 12" ASPHALT CONCRETE **ASPH**			20.6	
2	340				2						1.0 / 341.0 4" AGGREGATE BASE, **GP**			25.4	
			0								1.3 / 340.7 *Fill*, Red-brown, gray, SANDY SILT FILL, slightly micaceous, moist, **ML**				
4					4									18.6	
											2.0 / 340.0 *Residuum*, Orange-brown, gray, black SANDY SILT, slightly micaceous, exhibits relict rock structure, moist, **ML**				
6		6 11 20 28			6										
	335		100								SAME, red-brown, brown, black, hard			26.5	
8		8 29 27 40			8										
			100											19.8	
10					10										
12	330														
		7 13 30 39			13										
14			100									NP	NP	19.5	69.4
					15										
16															
	325														
18		11 17 25 40			18						SAME, tan, black				
			100											16.8	
20					20										
22	320														
		5 12 22 42			23						SAME, orange-brown, black				
24			100											34.1	
					25										
26															
	315										27.0 / 315.0 *IGM*, Tan, brown, black, fine to medium, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**				
28		10 28 70 41/3			28										
			100											18.1	
30					29.75										
32															

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 44.0'.
Northing(VDOT): 462007.054100
Easting(VDOT): 3647078.460254
* Hammer malfunction noted between 0'-6'. Blow counts in this area provided for information purposes

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

STATION: 29+07 OFFSET: 70' R
LATITUDE: 38.928192° N LONGITUDE: 77.213322° W
SURFACE ELEVATION: 342.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/24/13 - 10/24/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 40.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		24 36 40	100		33 – 34.5						SAME, tan, white, black, fine			21.3	
36	305														
38		13 29 44 63	100		38 – 40						SAME, brown			13.8	
40 ∇															
42	300														
44		29 80 28/2	100		43 – 44.2						SAME, gray-brown, fine to medium			12.7	
46	295														
48		21 50 60	67		48 – 49.5						SAME, orange-brown, black			17.7	
50															
52	290														
54		21 57 81/3	100		53 – 54.3									19.8	
56	285														
58		29 41 48 52/5	96		58 – 59.9						SAME, brown, tan, orange			18.3	
60															
62	280														
64		34 75/3	100		63 – 63.8						SAME, tan, fine			15.6	

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 44.0'.
Northing(VDOT): 462007.054100
Easting(VDOT): 3647078.460254
* Hammer malfunction noted between 0'-6'. Blow counts in this area provided for information purposes

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B628

13JB-11

STATION: 29+07 OFFSET: 70' R
LATITUDE: 38.928192° N LONGITUDE: 77.213322° W
SURFACE ELEVATION: 342.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/24/13 - 10/24/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 40.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
66	275														
68		44 68	50		68 69						SAME, brown, fine to medium, contains quartz fragments			10.5	
70											Boring terminated at 69.0'.				

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 44.0'.
Northing(VDOT): 462007.054100
Easting(VDOT): 3647078.460254
* Hammer malfunction noted between 0'-6'. Blow counts in this area provided for information purposes

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-12

STATION: 30+16 OFFSET: 3' L
LATITUDE: 38.928106° N LONGITUDE: 77.212839° W
SURFACE ELEVATION: 344.79 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/21/13 - 10/21/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: P. MCPARTLAND, ECS

GROUND WATER
FIRST ENCOUNTERED AT 44.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		2 3 3 3	50								0.0 / 344.79 3" TOPSOIL **TOPS**	40	8	18.2	62.6
2		2 2 4 6	59		2						0.3 / 344.49 *Fill*, Red-brown, SANDY SILT FILL, slightly micaceous, firm, moist, **ML**			19.6	
4	340	3 15 12 20	75		4						2.0 / 342.79 *Residuum*, Red-brown, black, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, contains weathered rock fragments, loose, moist, **SM**			8.6	
6		8 15 26 37	75		6						SAME, medium dense SAME, dense			9.1	
8		9 24 47 52/4	100		8						8.0 / 336.79 *IGM*, Red-brown, black, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			11.1	
10	335				9.8										
12															
14		33 69 31/4	100		13 14.3						SAME, brown			8.7	
16	330														
18		10 34 70/5	100		18 19.4						SAME, red-brown, black			11.3	
20	325														
22											22.0 / 322.79 Red-brown, red, ELASTIC SILT, with sand, slightly micaceous, exhibits relict rock structure, very stiff, moist, **MH**				
24		10 10 12 18	100		23 25							56	12	30.6	78.8
26	320														
28		14 32 50 50	100		28						27.0 / 317.79 Red-brown, red, black, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			11.8	
30	315				30										
32															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 48.0'.
Northing(VDOT): 461977.759343
Easting(VDOT): 3647216.461534
Bulk sample of auger cuttings obtained between 1.0-6.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-12

STATION: 30+16 OFFSET: 3' L
LATITUDE: 38.928106° N LONGITUDE: 77.212839° W
SURFACE ELEVATION: 344.79 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/21/13 - 10/21/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: P. MCPARTLAND, ECS

GROUND WATER
FIRST ENCOUNTERED AT 44.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	310	36 64/5	100		33 – 33.9									12.3	
38	305	27 50 50	100		38 – 39.5									16.8	
44	300	16 29 69/5	100		43 – 44.4									9.7	
48	295	15 17 42 59	100		48 – 50						SAME, hard			12.0	
53	290	38 62/3	94		53 – 53.8						SAME, very hard			12.4	
58	285	21 52 48/3	100		58 – 59.25									12.7	
63		100/5	0		63 – 63.4									40.0	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 48.0'.
Northing(VDOT): 461977.759343
Easting(VDOT): 3647216.461534
Bulk sample of auger cuttings obtained between 1.0-6.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-12

STATION: 30+16 OFFSET: 3' L
LATITUDE: 38.928106° N LONGITUDE: 77.212839° W
SURFACE ELEVATION: 344.79 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/21/13 - 10/21/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: P. MCPARTLAND, ECS

GROUND WATER
FIRST ENCOUNTERED AT 44.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	280														
66															
68		25 29 71/5	24		68						SAME, Red-brown, contains highly weathered rock fragments			9.2	
70	275				69.4						Boring terminated at 69.4'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 48.0'.
Northing(VDOT): 461977.759343
Easting(VDOT): 3647216.461534
Bulk sample of auger cuttings obtained between 1.0-6.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-13

STATION: 30+42 OFFSET: 67' R
LATITUDE: 38.927873° N LONGITUDE: 77.212987° W
SURFACE ELEVATION: 344.3 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/18/13 - 10/18/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. KURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 42.0 ft DEPTH
STABILIZED AT 46.0 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		1 3 6 12	50		2						0.0 / 344.3 3" TOPSOIL **TOPS**			13.6	
2		9 11 17 21	34		4						0.25 / 344.05 *Fill*, Brown, fine, SILTY SAND FILL, contains rootlets, loose, moist, **SM**	NP	NP	9.1	54.8
4	340	8 21 29 32	63		6						2.0 / 342.3 *Residuum*, Red-brown, fine, SANDY SILTY, slightly micaceous, exhibits relict rock structure, medium dense, moist, **ML**			9.0	
6		11 30 54 46/3	98		7.7						SAME, dense				
8		17 69 31/2	100		8 9.2						6.0 / 338.3 *IGM*, Orange, gray, black, SANDY SILT, with quartz gravel, slightly micaceous, exhibits relict rock structure, very dense, **ML**			7.0	
10	335										SAME, orange, gray, black, very dense			9.3	
12															
14	330	14 34 58 42/3	88		13 14.7									8.5	
16															
18	325	21 79/4	100		18 18.8									9.2	
20															
22															
24	320	7 10 14 30	84		23 25						23.0 / 321.3 Red-brown, gray, black, fine, POORLY-GRADED SAND, trace silt, slightly micaceous, exhibits relict rock structure, medium dense, **SP**			19.6	
26															
28	315	23 44 53 47/4	100		28 29.8						28.0 / 316.3 Orange, gray, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, **SM**			12.4	
30															
32															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.0' (augers left in boring over weekend; water level taken with augers in hole, then removed and caved depth recorded).
Northing(VDOT): 461892.207535 Easting(VDOT): 3647175.410588

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-13

STATION: 30+42 OFFSET: 67' R
LATITUDE: 38.927873° N LONGITUDE: 77.212987° W
SURFACE ELEVATION: 344.3 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/18/13 - 10/18/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. KURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 42.0 ft DEPTH
STABILIZED AT 46.0 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											33.0 / 311.3 Brown, black, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist **ML**	NP	NP	10.1	52.7
34	310	10 22 39 61	100		33 35										
36															
38	305	26 35 44 47	100		38 40									10.5	
40															
42															
44	300	20 71 29/2	98		43 44.2						SAME, tan, black			5.7	
46															
48	295	46 54/3	100		48 48.7						SAME, brown			9.3	
50															
52															
54	290	14 86 14/6	67		53 54.5									10.3	
56															
58	285	34 66	100		58 59									8.2	
60															
62															
64		28 72/5	100		63									8.4	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.0' (augers left in boring over weekend; water level taken with augers in hole, then removed and caved depth recorded).
Northing(VDOT): 461892.207535 Easting(VDOT): 3647175.410588

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 30+42 OFFSET: 67' R
LATITUDE: 38.927873° N LONGITUDE: 77.212987° W
SURFACE ELEVATION: 344.3 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/18/13 - 10/18/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. KURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 42.0 ft DEPTH
STABILIZED AT 46.0 ft

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	280				63.9										
66															
68		19 47 53/5	100		68									9.9	
	275				69.4						Boring terminated at 69.4'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 30.0' (augers left in boring over weekend; water level taken with augers in hole, then removed and caved depth recorded).
Northing(VDOT): 461892.207535 Easting(VDOT): 3647175.410588

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-14

STATION: 30+92 OFFSET: 63' L
LATITUDE: 38.928045° N LONGITUDE: 77.212571° W
SURFACE ELEVATION: 342.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/16/13 - 10/16/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 59.0 ft DEPTH
STABILIZED AT 38.0 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		2 2 3 3	71								0.0 / 342.68 1.2" TOPSOIL **TOPS**			20.4	
2	340	3 4 6 7	42		2						0.1 / 342.58 *Residuum*, Red-brown, SILT, with sand, slightly micaceous, exhibits relict rock structure, firm, moist, **ML** SAME, stiff	NP	NP	18.4	72.2
4		4 6 6 7	59		4									17.3	
6		6 7 7 9	46		6						6.0 / 336.68 Red-brown, gray, black, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, medium dense, moist, **SM**			12.5	
8	335	4 5 7 12	75		8									15.1	
10		12 18 20 24	79		10						SAME, dense			10.9	
12	330	10 13 17 19	100		12 13 15									14.2	
14															
16															
18	325	9 13 16 21	100		18 20						SAME, medium dense			18.3	
20															
22	320	18 21 23 29	100		23 25						SAME, brown, black, dense			13.4	
24															
26															
28	315	11 24 28 21	100		28 30									11.9	
30															
32															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 65.0'.
Northing(VDOT): 461956.4731
Easting(VDOT): 3647292.979

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-14

STATION: 30+92 OFFSET: 63' L
LATITUDE: 38.928045° N LONGITUDE: 77.212571° W
SURFACE ELEVATION: 342.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/16/13 - 10/16/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 59.0 ft DEPTH
STABILIZED AT 38.0 ft

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)	LAB DATA: FINES CONTENT -#200 (%)
	310	17 42 48 52/5	100		33 – 34.9						33.0 / 309.68 *IGM*, Orange-brown, gray, black, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			11.1	
34															
36															
38	305	11 11 16 32	100		38 – 40						SAME, medium dense	NP	NP	13.7	47.6
40															
42															
	300	13 65 35/2	100		43 – 44.2						SAME, brown, gray, very dense			10.7	
44															
46															
48	295	18 49 51/2	100		48 – 49.2									10.9	
50															
52															
	290	16 34 66/4	96		53 – 54.3						SAME, black, brown			12.2	
54															
56															
58	285	18 32 43 51	100		58 – 60						SAME, brown			14.4	
60															
62															
	280	18 49	100		63									11.6	
64															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 65.0'.
Northing(VDOT): 461956.4731
Easting(VDOT): 3647292.979

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 30+92 OFFSET: 63' L
LATITUDE: 38.928045° N LONGITUDE: 77.212571° W
SURFACE ELEVATION: 342.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/16/13 - 10/16/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 59.0 ft DEPTH
STABILIZED AT 38.0 ft

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		51/4			64.3										
66															
68	275	60 40/4	100		68 68.8									8.1	
70											Boring terminated at 68.8'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 65.0'.
Northing(VDOT): 461956.4731
Easting(VDOT): 3647292.979

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-15

STATION: 31+15 OFFSET: 0'
LATITUDE: 38.927893° N LONGITUDE: 77.212671° W
SURFACE ELEVATION: 343.58 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/16/13 - 10/16/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 61.0 ft DEPTH
STABILIZED AT 32.0 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		5 5 10 11	84								0.0 / 343.58 3" TOPSOIL **TOPS**			12.0	
2		7 11 16 17	50		2						0.3 / 343.28 *Residuum*, Red-brown, gray, black, SANDY SILT, slightly micaceous, exhibits relict rock structure, stiff, moist, **ML**			15.3	
4	340	7 15 21 23	100		4						SAME, very stiff SAME, hard			9.4	
6		14 21 38 44	75		6									19.1	
8	335	12 17 22 23	100		8									13.6	
10					10										
12															
14	330	6 14 16 20	84		13 15						SAME, very stiff	NP	NP	17.1	60.2
16															
18	325	5 8 18 24	100		18 20									9.2	
20															
22															
24	320	7 8 15 19	50		23 25						SAME, contains quartz gravel fragments			16.0	
26															
28	315	9 17 19 25	100		28 30						28.0 / 315.58 Red-brown, gray, black, fine, SILTY SAND, contains weathered rock fragments, slightly micaceous, exhibits relict rock structure, dense, moist, **SM**			14.3	
32															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 65.0'.
Northing(VDOT): 461900.8827
Easting(VDOT): 3647265.369

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 31+15 OFFSET: 0'
LATITUDE: 38.927893° N LONGITUDE: 77.212671° W
SURFACE ELEVATION: 343.58 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/16/13 - 10/16/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 61.0 ft DEPTH
STABILIZED AT 32.0 ft

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP °: STRATA	ROCK: DIP °: JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	310	8 8 23 31	84		33–35							NP	NP	7.7	35.8
36															
38	305	5 19 37 44	88		38–40						SAME, brown, tan, black, very dense			9.4	
40															
42															
44	300	14 28 34 32	100		43–45									11.7	
46															
48	295	5 10 15 24	100		48–50						SAME, varved brown, gray, pink, no weathered rock fragments, medium dense			23.9	
50															
52															
54	290	18 31 66 34/3	100		53–54.8						53.0 / 290.58 *IGM*, Orange, black, gray, fine, SILTY SAND, contains weathered rock fragments, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			16.6	
56															
58	285	16 42 48 52/5	100		58–59.9						SAME, brown, no weathered rock fragments			10.4	
60															
62															
64	280	23 61	100		63						SAME, fine to medium			9.2	

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 65.0'.
Northing(VDOT): 461900.8827
Easting(VDOT): 3647265.369

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-15

STATION: 31+15 OFFSET: 0'
LATITUDE: 38.927893° N LONGITUDE: 77.212671° W
SURFACE ELEVATION: 343.58 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/16/13 - 10/16/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 61.0 ft DEPTH
STABILIZED AT 32.0 ft

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		39/3			64.2										
66															
68		15			68										
	275	50 50/3	100		69.2									13.3	
70											Boring terminated at 69.2'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 65.0'.
Northing(VDOT): 461900.8827
Easting(VDOT): 3647265.369

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-16

STATION: 31+35 OFFSET: 59' R
LATITUDE: 38.927758° N LONGITUDE: 77.212767° W
SURFACE ELEVATION: 344.84 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/17/13 - 10/17/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: C. EAGEN, ECS

GROUND WATER
FIRST ENCOUNTERED AT 45.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		2 2 3 4	63								0.0 / 344.84 3.6" GRASS and TOPSOIL **TOPS**			16.0	
2		6 8 8 10	67		2						0.3 / 344.54 *Fill*, Red-brown, fine, SILTY SAND FILL, slightly micaceous, contains quartz gravel fragments, loose, moist, **SM**			14.7	
4	340	7 15 21 23	92		4						2.0 / 342.84 *Residuum*, Red-brown, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, medium dense, moist, **SM**	NP	NP	8.8	35.6
6		13 15 19 26	50		6						SAME, dense SAME, fine to medium			11.1	
8		11 28 35 37	100		8						8.0 / 336.84 Brown, gray, SANDY SILT, contains weathered rock fragments, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			7.0	
10	335				10										
12															
14	330	25 37 63/4	100		13 14.3						12.5 / 332.34 White, gray, red, fine to coarse, WELL-GRADED SAND, trace silt, contains quartz rock fragments, very dense, **SW**			3.0	
16															
18		23 22 27 46	100		18						SAME, red-brown, white, gray, dense			8.3	
20	325				20										
22															
24		10 22 39 65	100		23						22.5 / 322.34 Brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			11.1	
	320				25										
26															
28		12 17 20 31	100		28						SAME, hard	NP	NP	20.0	61.3
30	315				30										
32															

REMARKS: Caved Depth at 38.0'.
Northing(VDOT): 461851.1947
Easting(VDOT): 3647238.584

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-16

STATION: 31+35 OFFSET: 59' R
LATITUDE: 38.927758° N LONGITUDE: 77.212767° W
SURFACE ELEVATION: 344.84 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/17/13 - 10/17/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: C. EAGEN, ECS

GROUND WATER
FIRST ENCOUNTERED AT 45.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	310	13 41 59/5	100		33 – 34.4						32.5 / 312.34 *IGM*, Brown, fine, POORLY-GRADED SAND, trace silt, slightly micaceous, exhibits relict rock structure, very dense, moist, **SP**			12.2	
36															
38	305	7 31 45 35	100		38 – 40						SAME, fine to medium, contains weathered rock fragments			11.8	
42															
44	300	16 55 45/3	100		43 – 44.25									10.2	
46															
48	295	16 32 68/5	100		48 – 49.4						48.0 / 296.84 Brown, black, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			11.7	
52															
54	290	70 30/1	100		53 – 53.6									9.4	
56															
58	285	20 40 60/3	100		58 – 59.3						SAME, contains highly weathered rock fragments,			12.5	
62															
64		50 50/3	100		63 – 63.8									7.9	

REMARKS: Caved Depth at 38.0'.
Northing(VDOT): 461851.1947
Easting(VDOT): 3647238.584

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-16
PAGE 3 OF 3

STATION: 31+35 | OFFSET: 59' R
LATITUDE: 38.927758° N | LONGITUDE: 77.212767° W
SURFACE ELEVATION: 344.84 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 10/17/13 - 10/17/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: C. EAGEN, ECS

GROUND WATER
FIRST ENCOUNTERED AT 45.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	280														
66															
68		32 68/3	100		68 68.75						Boring terminated at 68.75'.			7.1	

REMARKS: Caved Depth at 38.0'.
Northing(VDOT): 461851.1947
Easting(VDOT): 3647238.584

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SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-17

STATION: 32+65 OFFSET: 62' L
LATITUDE: 38.927760° N LONGITUDE: 77.212174° W
SURFACE ELEVATION: 352.93 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/7/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		9 7 7 6	25								0.0 / 352.93 1.2" TOPSOIL **TOPS**			6.7	
2	350	5 5 8 7	84		2						0.1 / 352.83 *Fill*, Brown, red-brown,SANDY SILT FILL, contains quartz gravel fragments, medium dense, moist, **SM** SAME, red, no fragments			9.0	
4		3 3 4 6	100		4						SAME, loose			10.3	64.6
6		9 13 14 8	100		6						6.0 / 346.93 *Residuum*, White, red-brown, fine to coarse, WELL-GRADED SAND, trace silt, contains quartz rock fragments, medium dense,			4.4	
8	345	5 7 9 9	25		8						*sample consists almost entirely of quartz rock fragments* ***SW***			8.9	
10		5 8 9 13	50		10						8.0 / 344.93 Red-brown, SANDY SILT, very stiff, moist, **ML** SAME, contains weathered rock fragments, slightly micaceous, exhibits relict rock structure			11.9	
12					12										
14	340														
16		4 6 8 10	100		15 17						SAME, stiff	NP	NP	10.9	53.0
18	335														
20		8 11 15 20	100		20						SAME, red-brown, brown, black, very stiff			11.2	
22					22										
24	330														
26		12 14 17 21	100		25 27						SAME, hard			10.8	
28	325														
30		15 15 17 23	100		30						SAME, red-brown, no weathered rock fragments			19.9	
32															

REMARKS: Boring did not cave prior to backfilling.
Northing(VDOT): 461854.4069
Easting(VDOT): 3647407.334

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 32+65 OFFSET: 62' L
LATITUDE: 38.927760° N LONGITUDE: 77.212174° W
SURFACE ELEVATION: 352.93 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/7/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
					32										
	320														
34															
		8 11 15 18	100		35						SAME, very stiff	NP	NP	22.6	69.7
36					37										
38	315														
40		15 19 24 31	100		40						SAME, hard			21.5	
42					42										
	310														
44															
		15 20 31 41	100		45						SAME, orange-brown, black			18.2	
46					47										
48	305														
50		12 21 26 31	100		50						SAME, tan, black			15.8	
52					52										
	300														
54															
		15 27 24 30	100		55						SAME, brown, tan, black			14.0	
56					57										
58	295														
60		10 18 23 32	50		60									16.1	
62					62										
	290										63.0 / 289.93				
64															

REMARKS: Boring did not cave prior to backfilling.
Northing(VDOT): 461854.4069
Easting(VDOT): 3647407.334

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 32+65 OFFSET: 62' L
LATITUDE: 38.927760° N LONGITUDE: 77.212174° W
SURFACE ELEVATION: 352.93 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/7/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT LL	PLASTICITY INDEX PI	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
66	285	16 29 53 47/3	100		65 – 66.8						*IGM*, Tan, brown, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			13.3	
68															
70		19 32 68/5	71		70 – 71.4									13.1	
											Boring terminated at 71.4'.				

REMARKS: Boring did not cave prior to backfilling.
Northing(VDOT): 461854.4069
Easting(VDOT): 3647407.334

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

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PAGE 1 OF 3

STATION: 32+76 OFFSET: 12' L
LATITUDE: 38.927633° N LONGITUDE: 77.212242° W
SURFACE ELEVATION: 352.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 61.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
									0.0 / 352.41 3.6" TOPSOIL **TOPS**				
		4 6 7 7	71						0.3 / 352.11 *Fill*, Orange, brown, SANDY SILT FILL, stiff, moist, **ML**			7.4	
2	350	5 6 7 9	100	2								9.5	
4		3 4 5 5	100	4								11.0	
6		2 3 5 7	59	6					5.0 / 347.41 *Residuum*, Red-brown, SANDY SILT, slightly micaceous, stiff, moist, **ML** SAME, firm		NP	11.9	61.0
0 8	345	5 10 11 12	100	8					SAME, red-brown, tan, black, exhibits relict rock structure, very stiff			11.6	
10		4 7 11 14	50	10					SAME, red-brown			10.5	
12	340			12									
14		9 13 16 24	88	13 15					SAME, quartz gravel layer encountered from 14.5' to 15'			10.5	
16													
18	335	11 17 19 20	100	18 20					SAME, hard			11.4	
22	330	12 19 27 39	100	23 25								11.0	
26													
28	325	14 22 23 21	100	28 30					SAME, red-brown, black			12.4	
32													

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 42.0'.
Northing(VDOT):461807.6991
Easting(VDOT):3647388.617

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13JB-18

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-18
PAGE 2 OF 3

STATION: 32+76 OFFSET: 12' L
LATITUDE: 38.927633° N LONGITUDE: 77.212242° W
SURFACE ELEVATION: 352.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 61.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB: LIQUID LIMIT (LL)	LAB: PLASTICITY INDEX (PI)	LAB: MOISTURE CONTENT (%)	LAB: FINES CONTENT -#200 (%)
0	320	12 23 27 31	100		33–35								NP	15.9	55.8
34															
36															
38	315	16 37 51 49/3	97		38–39.8						SAME, brown, black, very hard			13.3	
40															
42	310	7 10 14 21	100		43–45						SAME, orange-brown, black, very stiff			22.9	
44															
46															
48	305	14 27 23 41	100		48–50						SAME, brown, black, hard			13.1	
50															
52	300	13 26 38 39	100		53–55						52.0 / 300.41 *IGM*, tan, black, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			14.0	
54															
56															
58	295	21 43 57/4	100		58–59.3									12.2	
60															
62	290	15 27			63						SAME, tan				
64															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 42.0'.
Northing(VDOT):461807.6991
Easting(VDOT):3647388.617

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

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PAGE 3 OF 3

STATION: 32+76 OFFSET: 12' L
LATITUDE: 38.927633° N LONGITUDE: 77.212242° W
SURFACE ELEVATION: 352.41 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/7/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 61.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		67 33/2	88		64.7									12.7	
66															
	285														
68		27 53 47/3	96		68 69.3									12.7	
70											Boring terminated at 69.3'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 42.0'.
Northing(VDOT):461807.6991
Easting(VDOT):3647388.617

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-19

STATION: 32+93 OFFSET: 52' R
LATITUDE: 38.927484° N LONGITUDE: 77.212336° W
SURFACE ELEVATION: 350.33 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 67.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	350	3 5 6 6	25								0.0 / 350.33 3" TOPSOIL **TOPS**			12.5	
2		3 4 5 6	0		2						0.3 / 350.03 *Residuum*, Brown, fine to medium SILTY SAND, slightly micaceous, medium dense, moist, **SM**			13.9	
4		3 5 8 4	13		4						SAME, brown, fine, loose SAME, contains root matter, medium dense			22.3	
6	345	5 6 8 9	59		6						SAME, fine to coarse, no root matter			15.6	
8		1 3 5 7	100		8						8.5 / 341.83 Red-brown, SILT, trace sand, slightly micaceous, firm, moist, **ML**			25.7	89.5
10	340	5 8 9 11	100		10						SAME, very stiff			24.2	
12					12										
14		3 4 7 7	100		13 15						SAME, stiff			27.4	
16	335										16.0 / 334.33 Red-brown, fine, SILTY SAND, slightly micaceous, loose, moist, **SM**				
18		7 4 4 4	100		18									12.2	43.2
20	330				20										
22															
24		11 12 14 13	100		23 25						SAME, medium dense			29.9	
26	325														
28		12 13 16 19	92		28									17.0	
30	320				30										
32															

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 43.0'.
Northing(VDOT): 461753.2739
Easting(VDOT): 3647362.826

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-19

STATION: 32+93 OFFSET: 52' R
LATITUDE: 38.927484° N LONGITUDE: 77.212336° W
SURFACE ELEVATION: 350.33 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 67.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	315	11 20 24 32	100		33–35						SAME, dense			16.6	
36															
38	310	8 8 12 14	100		38–40						37.0 / 313.33 Red-brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist, **ML**			21.0	64.3
40															
42															
44	305	9 14 20 23	100		43–45						SAME, hard			21.5	
46															
48	300	7 16 24 25	100		48–50									12.8	
50															
52	295	25 31 48 52/4	100		53–54.8						51.0 / 299.33 *IGM*, Tan, red, fine, SILTY SAND, slightly micaceous, exhibits relict rock structure, very dense, moist, **SM**			12.4	
54															
56															
58	290	12 22 36 51	100		58–60									12.0	
60															
62															
64		5 10			63										

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 43.0'.
Northing(VDOT): 461753.2739
Easting(VDOT): 3647362.826

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 32+93 OFFSET: 52' R
LATITUDE: 38.927484° N LONGITUDE: 77.212336° W
SURFACE ELEVATION: 350.33 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
FIRST ENCOUNTERED AT 67.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	285	20 27	100		65						SAME, dense			30.6	
66															
68		25 46 54/3	100		68 69.3						SAME, very dense			17.2	
70											Boring terminated at 69.3'.				

REMARKS: Rig Type: CME 55-LC2.
Caved Depth at 43.0'.
Northing(VDOT): 461753.2739
Easting(VDOT): 3647362.826

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-20

STATION: 33+83 OFFSET: 57' L
LATITUDE: 38.927486° N LONGITUDE: 77.211786° W
SURFACE ELEVATION: 335.21 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. KURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	335										0.0 / 335.21 12" ASPHALT CONCRETE **ASPH**				
											1.0 / 334.21 12" AGGREGATE BASE, **GP**				
2		3 4 5 6	84		2						2.0 / 333.21 *Residuum*, Red, SANDY ELASTIC SILT, slightly micaceous, stiff, moist **MH**	52	14	38.1	69.6
4	330	4 4 6 5	79		4									26.1	
6		9 11 13 10	84		6						SAME, very stiff			26.1	
8		8 11 14 21	100		8									26.9	
10	325				10										
12											12.0 / 323.21 Red-brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, hard, moist, **ML**				
14		14 23 30 35	100		13 15									20.8	
16	320														
18		10 20 24 34	100		18						SAME, orange, brown			22.9	
20	315				20										
22															
24		14 20 23 51	100		23 25						SAME, brown, gray			17.7	
26	310														
28		25 67 33/4	100		28 29.3						SAME, red, brown, very hard			12.2	
30	305														
32															

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 59.0'.
Northing(VDOT): 461756.062
Easting(VDOT): 3647519.165
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-20

STATION: 33+83 OFFSET: 57' L
LATITUDE: 38.927486° N LONGITUDE: 77.211786° W
SURFACE ELEVATION: 335.21 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. KURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	300	6 9 13 21	100		33–35						SAME, orange, brown, gray, very stiff	NP	NP	20.6	62.7
38	295	8 14 18 28	100		38–40						SAME, hard			21.1	
44	290	16 9 13 15	100		43–45						SAME, very stiff			27.7	
48	285	6 9 13 17	100		48–50									21.2	
52											52.0 / 283.21 *IGM*, Red-brown, SANDY SILT, fine, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**				
54	280	19 30 55 45/2	100		53–54.7									17.3	
58	275	29 97 3/0	100		58–59									11.0	
64		24 38	83		63									13.7	

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 59.0'.
Northing(VDOT): 461756.062
Easting(VDOT): 3647519.165
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-20

STATION: 33+83 OFFSET: 57' L
LATITUDE: 38.927486° N LONGITUDE: 77.211786° W
SURFACE ELEVATION: 335.21 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. KURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT LL	PLASTICITY INDEX PI	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		62/3			64.2										
	270														
66															
68		34			68										
		51	0											14.8	
		49/5			69.4										
											Boring termianted at 69.4'.				

REMARKS: Rig Type: CME 45-C-2.
Caved Depth at 59.0'.
Northing(VDOT): 461756.062
Easting(VDOT): 3647519.165
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-21

STATION: 33+97 OFFSET: 4' L
LATITUDE: 38.927346° N LONGITUDE: 77.211868° W
SURFACE ELEVATION: 335.58 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/7/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. KURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 45.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	335	3 4 4 6	50								0.0 / 335.58 3.6" TOPSOIL **TOPS**			14.3	
2		7 5 6 5	50		2						0.3 / 335.28 *Fill*, Orange, brown, SANDY SILT FILL, firm, moist, **ML** SAME, stiff			21.2	
4		7 9 13 12	100		4						4.0 / 331.58 *Residuum*, Orange, brown, SILT, with sand, very stiff, moist, **ML**			25.7	
6	330	10 10 8 9	67		6						6.0 / 329.58 Orange, red-brown, ELASTIC SILT, with sand, slightly micaceous, very stiff, moist **MH**			26.9	
8		6 9 8 11	67		8							59	13	27.4	77.9
10	325	4 6 8 9	100		10						SAME, stiff			34.3	
12					12										
14		2 6 12 17	100		13 15						12.5 / 323.08 Orange, red-brown, SILT, with sand, very stiff, moist, **ML**			23.3	
16	320														
18		14 26 41 59/5	105		18 19.9						SAME, very hard			25.7	
20	315														
22															
24		10 14 20 34	100		23 25						SAME, hard			26.9	
26	310														
28		15 21 31 49	100		28						SAME, sandy	46	9	27.4	62.6
30	305				30										
32															

REMARKS: Rig Type: CME 45-C-2.
Boring did not cave prior to backfilling.
Northing(VDOT): 461704.8400
Easting(VDOT): 3647496.5829

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 33+97 OFFSET: 4' L
LATITUDE: 38.927346° N LONGITUDE: 77.211868° W
SURFACE ELEVATION: 335.58 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/7/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. KURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 45.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34		12 17 24 31	100		33–35									29.2	
36	300														
38		8 27 60 40/3	100		38–39.75						37.0 / 298.58 *IGM* Orange, red-brown, black, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist **ML**			17.6	
40	295														
42															
44		34 68 32/2	84		43–45									16.9	
46	290														
48		24 33 44 56/5	100		48–49.16									18.7	
50	285														
52		37 63/3	100		53–53.75									14.5	
54															
56	280														
58		100	100		58–58.5									10.7	
60	275														
62		100/4	100		63–63.3									13.7	
64															

REMARKS: Rig Type: CME 45-C-2.
Boring did not cave prior to backfilling.
Northing(VDOT): 461704.8400
Easting(VDOT): 3647496.5829

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-21

STATION: 33+97 OFFSET: 4' L
LATITUDE: 38.927346° N LONGITUDE: 77.211868° W
SURFACE ELEVATION: 335.58 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/7/13 - 10/7/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. KURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 45.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	270														
66															
68		44 56/3	100		68 68.7									11.7	
											Boring terminated at 68.7'.				
70															

REMARKS: Rig Type: CME 45-C-2.
Boring did not cave prior to backfilling.
Northing(VDOT): 461704.8400
Easting(VDOT): 3647496.5829

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-22

STATION: 34+10 OFFSET: 50' R
LATITUDE: 38.927209° N LONGITUDE: 77.211913° W
SURFACE ELEVATION: 342.89 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		2 4 7 6	85								0.0 / 342.89 3" TOPSOIL **TOPS**			15.7	
2	340	5 7 7 8	84		2						0.3 / 342.59 *Fill*, Tan, brown, SANDY SILT FILL, stiff, moist, **ML**			23.7	
4		2 3 3 4	75		4						SAME, gray, brown, contains quartz gravel and fragments SAME, firm	40	9	19.6	56.0
6		3 4 4 6	75		6									22.2	
8	335	5 7 7 8	100		8						8.0 / 334.89 *Residuum*, Red-brown, ELASTIC SILT, with sand, slightly micaceous,stiff, moist **MH**			24.2	
10					10										
12															
14	330	3 4 4 6	42		13 15						SAME, firm	56	18	17.6	83.2
16		6 7 8 8	34		17						SAME, stiff			29.6	
18	325														
20		5 7 11 12	100		20						SAME, orange, red-brown, very stiff, exhibits relict rock structure			30.6	
22	320				22										
24															
26		4 6 10 11	100		25 27									32.2	
28	315														
30		4 5 8 12	100		30						SAME, stiff	54	21	38.9	75.7
32															

REMARKS: Cave Depth at 37.0'
Northing(VDOT):461654.5053
Easting(VDOT):3647484.5489

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

STATION: 34+10 OFFSET: 50' R
LATITUDE: 38.927209° N LONGITUDE: 77.211913° W
SURFACE ELEVATION: 342.89 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
32															
34	310														
35		5 10 17 19	100		35–37						SAME, very stiff			24.1	
36															
37															
38	305														
40		8 12 17 18	0		40–42									40.0	
42															
43	300										43.0 / 299.89 Gray, brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, hard, moist, **ML**				
44															
45		17 19 26 24	100		45–47									11.7	
46															
47															
48	295														
49											49.0 / 293.89 Gray, brown, ELASTIC SILT, with sand, slightly micaceous, exhibits relict rock structure, stiff, moist **MH**				
50		2 4 7 14	100		50–52							50	14	17.9	78.5
52															
53	290														
54											54.0 / 288.89 Brown, gray, SANDY SILT, slightly micaceous, exhibits relict rock structure, hard, moist, **ML**				
55		9 19 31 50	100		55–57									14.6	
56															
57															
58	285														
60		5 7 12 21	100		60–62						SAME, very stiff			16.8	
62															
63	280														
64															

REMARKS: Cave Depth at 37.0'
Northing(VDOT):461654.5053
Easting(VDOT):3647484.5489

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: BRIDGE B629

13JB-22

STATION: 34+10 OFFSET: 50' R
LATITUDE: 38.927209° N LONGITUDE: 77.211913° W
SURFACE ELEVATION: 342.89 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: I. WHITEHEAD, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
66		9 21 37 60	100		65–67						SAME, hard			10.7	
68	275														
70		18 34 51 70	100		70–72						69.0 / 273.89 *IGM*, Gray, brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			14.9	
72	270														
74															
76		31 51 49/4	77		75–76.3									12.9	
78	265										Boring terminated at 76.3'.				
80															

REMARKS: Cave Depth at 37.0'
Northing(VDOT):461654.5053
Easting(VDOT):3647484.5489

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

13JB-23
PAGE 1 OF 1

STATION: 36+11.71 OFFSET: 17.08' R
LATITUDE: 38.926973° N LONGITUDE: 77.211350° W
SURFACE ELEVATION: 334.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K.HURLEY, ECS

GROUND WATER
GROUND WATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		3 6 8 11	75								0.0 / 334.41 3.6" TOPSOIL **TOPS**			6.4	
2		6 6 6 8	84		2						0.3 / 334.11 *Fill*, Brown, SANDY SILT FILL, contains rootlets, stiff, moist **ML**			15.5	
4	330	5 8 10 10	59		4						2.0 / 332.41 *Residuum*, Red, SANDY SILT, exhibits relict rock structure, stiff, moist **ML**			10.4	
6		11 8 7 10	84		6						SAME, orange, brown, no relict rock structure, very stiff	NP	NP	15.2	62.4
8		6 5 6 11	67		8						SAME, exhibits relict rock structure, stiff			20.3	
10	325				10										
12															
14	320	10 15 13 15	100		13 15						SAME, very stiff			15.1	
16															
18	315	6 8 12 14	92		18 20									16.2	
20															
22															
24	310	10 14 15 23	100		23 25							NP	NP	24.6	57.7
											Boring terminated at 25.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 19.0'
Northing(VDOT): 461571.1069
Easting(VDOT): 3647645.811

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 38+01.89 OFFSET: 44.50' R
LATITUDE: 38.926588° N LONGITUDE: 77.210870° W
SURFACE ELEVATION: 324.34 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/2/13 - 10/2/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUND WATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5	324	4 5 7 6	67		2						0.0 / 324.34 2" TOPSOIL **TOPS**			21.5	
2.5	322	8 12 16 20	67		4						0.2 / 324.14 *Fill*, Orange, brown, SANDY SILT FILL, contains rootlets, slightly micaceous, stiff, moist **ML**	23	7	6.8	24.1
4.5	320	6 9 11 15	84		6						2.0 / 322.34 *Residuum*, Orange, brown, fine to coarse SILTY CLAYEY SAND, with gravel, slightly micaceous, exhibits relict rock structure, medium dense, moist, **SC/SM**			28.0	
6.5	318	8 8 10 13	84		8						SAME, tan			17.5	
8.5	316	20 14 10 13	75		10						SAME, tan, gray			19.9	
10.0											Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 8.0'
Northing(VDOT):461432.5541
Easting(VDOT):3647784.433

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 39+43.14 OFFSET: 3.02' L
LATITUDE: 38.926507° N LONGITUDE: 77.210347° W
SURFACE ELEVATION: 319.23 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5											0.0 / 319.23 12" ASPHALT CONCRETE, ASPH **ASPH**				
1.0															
1.5	318														
2.0		4			2						1.0 / 318.23 12" AGGREGATE BASE, **GP**				
2.5		3													
3.0	316	6	50								2.0 / 317.23 *FILL*, Gray, SANDY SILT FILL, trace gravel, stiff, moist **ML**			22.0	
3.5															
4.0		12	6		4										
4.5		4													
5.0	314	3	50											15.6	
5.5															
6.0		3	3		6										
6.5		1									SAME, firm				
7.0	312	2	29											19.2	55.9
7.5															
8.0		2	2		8										
8.5		2									SAME, soft				
9.0	310	2	67											23.7	
9.5															
10.0			3		10						Boring terminated at 10'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 5.0'
Northing(VDOT):461405.2316
Easting(VDOT):3647933.52

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 42+10.07 OFFSET: 38.13' R
LATITUDE: 38.926050° N LONGITUDE: 77.209623° W
SURFACE ELEVATION: 309.21 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5, 1.0, 1.5, 2.0	308	6, 23, 14, 7	50		2						0.0 / 309.21 *Fill*, Gray, POORLY GRADED SANDY GRAVEL FILL, dense, dry **GP**			2.1	
2.5, 3.0, 3.5, 4.0	306	4, 3, 5, 6	92		4						2.0 / 307.21 Orange, brown, SANDY SILT, slightly micaceous, firm, moist **SM**	NP	NP	24.5	65.3
4.5, 5.0, 5.5, 6.0	304	4, 4, 5, 7	100		6						SAME, brown, stiff **ML**			20.0	
6.5, 7.0, 7.5, 8.0	302	9, 13, 10, 7	59		8						6.0 / 303.21 *Residuum*, Brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist **ML**			6.4	
8.5, 9.0, 9.5, 10.0	300	4, 3, 5, 10	84		10						SAME, firm			20.8	
											Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 8.0'
Northing(VDOT): 461704.8461
Easting(VDOT): 3647596.0466

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

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STATION: 34+91.06 OFFSET: 58.90' L
LATITUDE: 38.927342° N LONGITUDE: 77.211518° W
SURFACE ELEVATION: 334.16 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/2/13 - 10/2/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 334.16 10" ASPHALT CONCRETE **ASPH**				
											0.8 / 333.36 14" AGGREGATE BASE **GP**				
2		4 6 7 10	75		2						2.0 / 332.16 *Residuum*, Red-brown, SANDY SILT, slightly micaceous, stiff, moist, **ML**			13.2	
4	330	4 8 11 10	75		4						SAME, very stiff	NP	NP	13.2	60.2
6		4 6 9 11	54		6									11.3	
8		4 8 5 7	71		8						SAME, stiff, exhibits relict rock structure			18.9	
10	325				10										
12															
14	320	9 18 22 23	100		13 15						SAME, hard			13.1	
16															
18	315	12 13 31 25	100		18 20									15.5	
20															
22															
24	310	5 10 15 17	100		23 25						SAME, orange, borwn, with quartz gravel, very stiff			17.7	
26															
28	305	7 19 29 26	100		28 30						SAME, hard			14.9	
30															
32															

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 27.0'
Northing(VDOT): 461705.77
Easting(VDOT): 3647596.429

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

STATION: 34+91.06 OFFSET: 58.90' L
LATITUDE: 38.927342° N LONGITUDE: 77.211518° W
SURFACE ELEVATION: 334.16 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/2/13 - 10/2/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA											LAB DATA			
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP °: STRATA	ROCK: DIP °: JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
34	300	7 15 19 40	100		33–35									18.0	
36															
38	295	11 21 47 46	100		38–40						38.0 / 296.16 *IGM*, Red-brown, gray, SANDY SILT, with quartz gravel, slightly micaceous, exhibits relict rock structure, very hard, **ML** Boring terminated at 40.0'.			13.1	
40															

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 27.0'
Northing(VDOT): 461705.77
Easting(VDOT): 3647596.429

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

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STATION: 36+02.33 OFFSET: 61.83' L
LATITUDE: 38.927162° N LONGITUDE: 77.211201° W
SURFACE ELEVATION: 333.08 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/2/13 - 10/2/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 333.08 12" ASPHALT CONCRETE **ASPH**				
											1.0 / 332.08 12" AGGREGATE BASE, **GP**				
2	330	12 17 22 23	92		2						2.0 / 331.08 *Residuum*, Red-brown, gray, SANDY SILT, slightly micaceous, exhibits relict rock structure, hard, moist, **ML**	NP	NP	8.5	50.8
4		11 17 20 19	79		4									10.0	
6		15 31 48 51	100		6						6.0 / 327.08 *IGM*, Red-brown, gray, SANDY SILT, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			9.5	
8	325	21 32 38 50	84		8						SAME, orange, brown			9.8	
10					10										
12															
14	320	18 28 44 50	100		13 15									10.7	
16															
18	315	24 54 46/4	100		18 19.33									15.0	
20															
22															
24	310	6 9 23 40	100		23 25						SAME, orange, brown, gray, hard			14.7	
26															
28	305	24 32 43 50	100		28						SAME, very hard			14.8	
30					30						Boring terminated at 30.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 20.0'
Northing(VDOT): 461640.3831
Easting(VDOT): 3647687.2778

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

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STATION: 36+93.90 OFFSET: 65.16' L
LATITUDE: 38.927009° N LONGITUDE: 77.210944° W
SURFACE ELEVATION: 331.65 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/2/13 - 10/2/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 331.65 12" ASPHALT CONCRETE **ASPH**				
											1.0 / 330.65 12" AGGREGATE BASE, **GP**				
2	330	3 4 5 8	79		2						2.0 / 329.65 *Residuum*, Red-brown, ELASTIC SILT, with sand, slightly micaceous, stiff, moist, **MH**	55	12	24.9	79.1
4		7 9 10 9	84		4									11.6	
6	325	7 10 15 17	92		6						5.0 / 326.65 Red-brown SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist, **ML** SAME, orange, brown			11.3	
8		10 14 19 36	84		8									14.1	
10					10						SAME, hard				
12	320														
14		18 28 33 43	100		13 15						12.0 / 319.65 *IGM*, Red-brown, SANDY SILT, contains quartz gravel and fragments, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**			10.3	
16	315														
18		19 24 35 44	100		18						SAME, orange, gray, hard			11.3	
20					20										
22	310														
24		8 14 17 20	100		23 25						SAME, hard			18.4	
											Boring terminated at 25.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 17.0'
Northing(VDOT): 461585.5688
Easting(VDOT): 3647761.179

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

13JB-31
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STATION: 36+29.63 OFFSET: 75.82' R
LATITUDE: 38.926817° N LONGITUDE: 77.211430° W
SURFACE ELEVATION: 332.29 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		2 2 6 8	25		2						0.0 / 332.29 3" TOPSOIL **TOPS**			9.1	
2	330	5 7 8 10	71		4						0.3 / 331.99 *Fill*, Brown, SANDY SILT FILL, contains rootlets, slightly micaceous, firm, moist, **ML**	NP	NP	18.1	64.6
4		5 8 11 12	71		6						2.0 / 330.29 *Residuum*, Red-brown, gray, SANDY SILT, slightly micaceous, exhibits relict rock structure, stiff, moist, **ML** SAME, very stiff			14.8	
6	325	5 8 8 11	75		8									17.1	
8		7 11 16 50/4	93		9.8									20.2	
10															
12	320	38 24 13 16	50		13 15						SAME, contains quartz gravel and fragments, hard			4.3	
14															
16															
18	315	8 8 7 11	71		18 20						SAME, orange, black, sitff	NP	NP	27.1	60.6
20															
22	310	4 7 11 13	13		23 25						SAME, very stiff			23.7	
24											Boring terminated at 25.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 16.5'
Northing(VDOT): 461513.7386
Easting(VDOT): 3647623.901

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL FOR B2902 RAMP

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STATION: 37+22.45 OFFSET: 75.49' R
LATITUDE: 38.926658° N LONGITUDE: 77.211174° W
SURFACE ELEVATION: 325.41 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	325	6 9 11 12	21		2						0.0 / 325.41 3" TOPSOIL **TOPS**			8.2	
2		4 3 3 2	21		4						0.3 / 325.11 *Fill*, Brown, SILTY SAND FILL, contains rootlets, medium dense, moist, **SM** SAME, loose	NP	NP	9.4	49.5
4	320	4 6 8 9	42		6						SAME, orange, contains mica, medium dense			17.4	
6		7 11 13 18	84		8						6.0 / 319.41 *Residuum*, Orange, red-brown, SANDY SILT, slightly micaceous, exhibits relict rock structure, very stiff, moist, **ML**			15.5	
8		9 20 19 9	96		10						SAME, hard			13.8	
10	315														
12															
14		10 38 40 52	92		13 15						SAME, orange, red-brown, gray, very hard			9.5	
16	310														
18		9 19 23 40	100		18 20						SAME, hard			11.6	
20	305														
22															
24		12 15 19 41	100		23 25						SAME, orange, red-brown, black			11.9	
											Boring terminated at 25.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 17.0'
Northing(VDOT): 461457.0177
Easting(VDOT): 3647697.375

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL

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PAGE 1 OF 1

STATION: 39+00.20 OFFSET: 73.84' R
LATITUDE: 38.926379° N LONGITUDE: 77.210609° W
SURFACE ELEVATION: 312.38 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
STABILIZED AT 11.5 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		3 6 9 11	50							0.0 / 312.38 3" TOPSOIL **TOPS**			9.9	
2	310	6 9 11 13	60	2						0.3 / 312.08 *Alluvium*, Brown, tan, SANDY LEAN CLAY, slightly micaceous, stiff, moist, **CL** SAME, very stiff			13.2	
4		6 7 8 8	100	4						SAME, stiff	34	10	17.0	62.3
6		4 8 9 12	75	6						SAME, very stiff			19.7	
8	305	9 16 13 21	21	8						SAME, contains quartz gravel, exhibits relict rock structure			7.5	
10		9 13 17 22	50	10						SAME, brown			12.3	
12	300			12						11.0 / 301.38 *Residuum* Brown, SANDY SILT, with quartz gravel, very stiff, moist, **ML** SAME, no quartz gravel, hard				
14		9 16 24 29	67	13 15									7.0	
16														
18	295	11 14 16 22	100	18						SAME, very stiff			18.7	
20				20										
22	290													
24		31 35 38 42	100	23 25						SAME, very hard			13.9	
										Boring terminated at 25.0'.				

REMARKS: Rig Type: CME 55-LC2.
Cave Depth at 14.0'
Northing(VDOT): 461357.4651
Easting(VDOT): 3647859.562

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL

13JB-34
PAGE 1 OF 1

STATION: 40+08.06 OFFSET: 72.85' R
LATITUDE: 38.926239° N LONGITUDE: 77.210275° W
SURFACE ELEVATION: 306.45 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: J. GARBER, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
STABILIZED AT 9.0 ft

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		7 9 9 9	84								0.0 / 306.45 7.2" TOPSOIL **TOPS**			14.3	
2	305	6 7 7 8	50		2						0.6 / 305.85 *Alluvium*, Red, LEAN CLAY, with sand, slightly micaceous, medium dense, moist, **CL**	43	18	16.1	72.0
4		3 4 6 7	75		4									22.6	
6	300		100		6						6.0 / 300.45 *Residuum*, Red-brown, SANDY SILT, contains mica, moist, **ML**	33	8	27.7	64.4
8		5 6 7 10	25		8						SAME, stiff			24.6	
10		8 13 16 18	100		10						SAME, very stiff			100.0	
12	295				12										
14		8 13 18 15	0		13 15						SAME, hard			21.4	
16	290														
18		15 31 46 49	0		18						18.0 / 288.45 *IGM*, Red-brown, SILT, with sand, contains quartz gravel and fragments, slightly micaceous, exhibits relict rock structure, very hard, moist, **ML**	44	11	15.8	82.8
20					20										
22	285														
24		23 50 50/3	100		23 24.2						23.0 / 283.45 Brown, fine SAND, very dense, moist, **SP**			100.0	
											Boring terminated at 24.2'.				

REMARKS: Rig Type: CME 55-LC2.
Cave Depth at 15.0'
Northing(VDOT): 461307.7861
Easting(VDOT): 3647955.311

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL

13JB-35

STATION: 41+01.5 OFFSET: 55' R
LATITUDE: 38.926125° N LONGITUDE: 77.209936° W
SURFACE ELEVATION: 309.0 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 14.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
											0.0 / 309.0 12" ASPHALT **ASPH**				
											1.0 / 308.0 12" AGGREGATE BASE, **GP**				
2		2 2 3 5	50		2						2.0 / 307.0 *Fill*, Gray, SANDY SILT FILL, trace gravel, firm, moist, **ML**			21.8	
4	305	5 8 8 9	100		4						SAME, brown, contains rootletts, very stiff			22.9	
6		3 3 4 4	100		6						SAME, red-brown, contains quartz fragments, slightly micaceous, firm			26.0	
8	300	2 3 6 20	100		8						SAME, stiff			12.5	
10					10										
12											11.0 / 298.0 *Residuum*, Red-brown, SILT, with sand, slightly micaceous, exhibits relict rock structure, stiff, wet, **ML**				
14 ∇	295	5 5 4 6	100		13 15							38	9	32.5	83.1
											Boring terminated at 15.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 9.0'
Northing(VDOT): 461264.6206
Easting(VDOT): 3648033.4085

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: JONES BRANCH CONNECTOR ROAD

13JB-42

STATION: 19+14.72 OFFSET: 50.84' L
LATITUDE: 38.929345° N LONGITUDE: 77.216179° W
SURFACE ELEVATION: 329.5 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/14/13 - 10/14/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5											0.0 / 329.5 12" ASPHALT **ASPH**				
1.0					1										
1.5	328	5 5	75								1.0 / 328.5 7.2" AGGREGATE BASE, **GP**			3.3	
2.0					2										
2.5		6 4													
3.0			50								1.6 / 327.9 *Fill*, Brown, SANDY SILT FILL, slightly micaceous, firm, moist, **ML**	39	8	21.4	67.7
3.5	326	5 4													
4.0					4										
4.5		5 3													
5.0			25								4.0 / 325.5 *Residuum*, Brown, SANDY SILT, slightly micaceous, firm, moist, **ML**			21.8	
5.5	324	4 3													
6.0					6										
6.5		5 5													
7.0			67								SAME, slightly micaceous, no rootlets			28.9	
7.5	322	3 4													
8.0					8										
8.5		4 6									SAME, red-brown, stiff				
9.0			75											33.3	
9.5	320	6 7													
10.0					10						Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 55-LC2.
Cave Depth at 4.0'
Northing(VDOT): 462415.6106
Easting(VDOT): 3646259.9971

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: JONES BRANCH CONNECTOR ROAD

13JB-43

STATION: 20+70.47 OFFSET: 45.12' L
LATITUDE: 38.929381° N LONGITUDE: 77.215635° W
SURFACE ELEVATION: 341.99 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/14/13 - 10/14/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: K. KERSH, CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.5											0.0 / 341.99			
1.0		6 8	58		1						9" ASPHALT **ASPH**			
1.5														5.4
2.0	340	9 7			2						0.8 / 341.19			
2.5											4" AGGREGATE BASE (GP) **GP**			
3.0		9	75								1.1 / 340.89			9.7
3.5											*Fill*, Brown, red-brown, SANDY SILT FILL, slightly micaceous,			
4.0	338	14 4			4						firm, moist, **ML**			
4.5		7												
5.0		6	67								2.0 / 339.99			8.9
5.5											*Residuum*, Orange, brown, SANDY SILT, slightly micaceous,			
6.0	336	6 6			6						exhibits relict rock structure, very stiff, moist, **ML**			
6.5		7												
7.0		5	17								SAME, stiff			15.8
7.5														
8.0	334	4 2			8						8.0 / 333.99			
8.5		2												
9.0		10	59								Red-brown, SILTY SAND, slightly micaceous, exhibts relict rock			10.8
9.5											structure, medium dense, moist, **SM**			
10.0	332	16			10									

Boring terminated at 10.0'.

REMARKS: Rig Type: CME 55-LC2.
Cave Depth at 5.75'
Northing(VDOT): 462430.9695
Easting(VDOT): 3646414.5624

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 37+53.15 OFFSET: 42.72' L
LATITUDE: 38.926860° N LONGITUDE: 77.210832° W
SURFACE ELEVATION: 328.87 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5											0.0 / 328.87 12" ASPHALT **ASPH**				
1.0	328										1.0 / 327.87 12" AGGREGATE BASE, **GP**				
1.5															
2.0		3			2										
2.5															
3.0	326	4	67								2.0 / 326.87 *FILL*, Red, SANDY SILT FILL, slightly micaceous, firm, moist, **ML**	43	16	18.6	66.7
3.5		4													
4.0		6			4										
4.5		6													
5.0	324	2	42								4.0 / 324.87 Gray, POORLY GRADED GRAVEL FILL, medium dense, moist **GP**			3.5	
5.5		11													
6.0		8			6										
6.5		10													
7.0	322	12	79								6.0 / 322.87 Brown, SANDY SILT FILL, slightly micaceous, very stiff, moist, **ML**			16.2	
7.5		12													
8.0		17			8										
8.5		8													
9.0	320	14	63								8.0 / 320.87 *Residuum*, SANDY SILT, slightly micaceous, exhibts relict rock structure, hard, **ML**			16.7	
9.5		17													
10.0		25			10										

Boring terminated at 10.0'.

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 6.0'
Northing(VDOT): 461532.0136
Easting(VDOT): 3647793.625

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

13JB-45
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STATION: 39+52.98 OFFSET: 55.46' L
LATITUDE: 38.926620° N LONGITUDE: 77.210228° W
SURFACE ELEVATION: 318.67 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.5	318										0.0 / 318.67 12" ASPHALT CONCRETE **ASPH**			
1.0											1.0 / 317.67 12" AGGREGATE BASE, **GP**			
1.5														
2.0		4			2									
2.5	316	5									2.0 / 316.67 *Fill*, Red-brown, SANDY SILT FILL, trace gravel, slightly micaceous, stiff, moist, **ML**			
3.0		5	75											19.7
3.5		6												
4.0		5			4									
4.5	314	4									4.0 / 314.67 *Residuum*, Red, SILTY SAND, slightly micaceous, exhibts relict rock structure, loose, moist, **SM**			
5.0		5	100											18.2
5.5		7												
6.0		4			6									
6.5	312	4									SAME, Brown			
7.0		4	84											33.1
7.5		4												
8.0		4			8						SAME, Red-brown, orange			
8.5	310	4												
9.0		5	100											35.7
9.5		7												
10.0					10						Boring terminated at 10.0'.			

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 8.0'
Northing(VDOT): 461446.9475
Easting(VDOT): 3647966.792

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 41+47.74 OFFSET: 42.44' L
LATITUDE: 38.926329° N LONGITUDE: 77.209646° W
SURFACE ELEVATION: 310.57 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/3/13 - 10/3/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.5	310										0.0 / 310.57 12" ASPHALT CONCRETE **ASPH**			
1.0														
1.5														
2.0					2						1.0 / 309.57 12" AGGREGATE BASE, **GP**			
2.5	308	5 6 7 9	75											
3.0											2.0 / 308.57 *Fill*, Red-brown, SILT FILL, with sand, trace gravel, stiff, moist, **ML**			20.5
3.5														
4.0					4									
4.5	306	6 12 14 12	100								4.0 / 306.57 Red-brown, POORLY GRADED SANDY GRAVEL FILL, with silt, medium dense, moist, **GP**			4.0
5.0														
5.5														
6.0					6									
6.5	304	4 4 6 8	71											
7.0														17.8
7.5											7.0 / 303.57 *Residuum* Gray, SILTY SAND, with gravel, medium dense, moist, **SM**			
8.0					8									
8.5	302	5 8 6 7	100											
9.0														11.3
9.5														
10.0					10						Boring terminated at 10.0'.			

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 8.5'
Northing(VDOT): 461343.2323
Easting(VDOT): 3648133.831

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

13JB-47
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STATION: 41+43.80 OFFSET: 15.42' R
LATITUDE: 38.926198° N LONGITUDE: -77.209761° W
SURFACE ELEVATION: 309.68 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5											0.0 / 309.68 12" ASPHALT CONCRETE **ASPH**				
1.0											1.0 / 308.68 12" AGGREGATE BASE, **GP**				
1.5	308	4			2						2.0 / 307.68 *Fill*, Gray, brown, SANDY SILT FILL, trace gravel, slightly micaceous, firm, moist, **ML**				
2.0		3													
2.5		4	84											17.6	
3.0		5													
3.5	306	3			4										
4.0		4													
4.5		6	100												
5.0		7									SAME, stiff	46	10	24.8	69.2
5.5	304	5			6										
6.0		7													
6.5		7	100											21.7	
7.0		8													
7.5	302	6			8										
8.0		8									SAME, brown, very stiff				
8.5		8	25											12.4	
9.0		10													
9.5	300				10										
10.0											Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 5.0'
Northing(VDOT): 461294.9404
Easting(VDOT): 3648101.72

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 43+51.35 OFFSET: 35.42' L
LATITUDE: 38.925918° N LONGITUDE: 77.209093° W
SURFACE ELEVATION: 306.88 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.0											0.0 / 306.88				
0.5											12" ASPHALT CONCRETE **ASPH**				
1.0	306										1.0 / 305.88				
1.5											12" AGGREGATE BASE, **GP**				
2.0		3 7 9 8	75		2						2.0 / 304.88	39	16	21.0	85.2
2.5	304										*Fill*, Red, LEAN CLAY FILL, trace sand, very stiff, moist, **CL**				
3.0															
3.5															
4.0		6 8 10 11	84		4						SAME, red, gray			20.1	
4.5	302														
5.0															
5.5															
6.0		6 6 5 6	50		6						SAME, with quartz gravel, stiff			18.6	
6.5	300														
7.0															
7.5															
8.0		3 3 4 5	59		8										
8.5	298														
9.0											SAME, firm			21.0	
9.5															
10.0					10						Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 6.0'
Northing(VDOT): 461195.6774
Easting(VDOT): 3648293.3561

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 43+92.22 OFFSET: 27.22' R
LATITUDE: 38.925717° N LONGITUDE: 77.209182° W
SURFACE ELEVATION: 305.8 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
FIRST ENCOUNTERED AT 8.0 ft DEPTH
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.5											0.0 / 305.8 12" ASPHALT CONCRETE **ASPH**			
1.0														
1.5														
2.0	304	3			2						1.0 / 304.8 12" AGGREGATE BASE **GP**			
2.5		5												
3.0		7	34								2.0 / 303.8 *Fill*, Red, SANDY SILT FILL, stiff, moist, **ML**			14.7
3.5	302	8			4									
4.0		6												
4.5		4												
5.0		5	17											10.0
5.5	300	6			6									
6.0		2												
6.5		2												
7.0		12	42											26.4
7.5														
8.0	298	5			8									
8.5		4									8.0 / 297.8 Gray, GRAVELLY SILT FILL, stiff, moist, **ML**			
9.0		4	50											13.9
9.5		5												
10.0	296	4			10						Boring terminated at 10.0'.			

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 4.0'
Northing(VDOT): 461122.3850
Easting(VDOT): 3648268.9277

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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STATION: 44+97.76 OFFSET: 21.66' L
LATITUDE: 38.925558° N LONGITUDE: 77.208827° W
SURFACE ELEVATION: 308.24 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/4/13 - 10/4/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5	308										0.0 / 308.24 12" ASPHALT CONCRETE **ASPH**				
1.0											1.0 / 307.24 12" AGGREGATE BASE, **GP**				
2.0	306	4 4 6 6	75		2						2.0 / 306.24 *Fill*, Red, LEAN CLAY FILL, with sand, slightly micaceous, stiff, moist, **CL**	37	12	23.5	77.9
4.0	304	2 3 5 9	67		4						SAME, red, gray, trace gravel, firm			19.2	
6.0	302	4 5 5 6	84		6						6.0 / 302.24 *Residuum*, SANDY LEAN CLAY, slightly micaceous, stiff, moist, **CL**			21.4	
8.0	300	3 3 4 7	17		8						8.0 / 300.24 SANDY SILT, with gravel, slightly micaceous, firm, moist, **ML**			31.6	
10.0					10						Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 8.0'
Northing(VDOT): 461065.6676
Easting(VDOT): 3648370.7858
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

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PAGE 1 OF 1

STATION: 45+74.00 OFFSET: 36.86' R
LATITUDE: 38.925343° N LONGITUDE: 77.208805° W
SURFACE ELEVATION: 308.69 ft COORD. DATUM: NAD 83

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5	308				0.6						0.0 / 308.69 7.5" ASPHALT CONCRETE **ASPH**				
1.0															
1.5															
2.0					2						0.6 / 308.09 12" AGGREGATE BASE, **GP**				
2.5	306	4 5 5 6	34								1.6 / 307.09 *Fill*, Red-brown, CLAYEY SAND FILL, with gravel, slightly micaceous, medium dense, moist **SC**	39	15	11.1	43.3
3.0															
3.5															
4.0					4										
4.5	304	8 11 29 14	79								SAME, gray, black, dense			9.6	
5.0															
5.5															
6.0					6						SAME, loose				
6.5	302	4 3 4 5	13											15.9	
7.0															
7.5															
8.0					8						8.0 / 300.69 Gray, SANDY SILT FILL, contains wood fragments, firm, moist, **ML**				
8.5	300	3 3 4 4	79											22.3	
9.0															
9.5															
10.0					10						Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 7.0'
Northing(VDOT): 460987.7119
Easting(VDOT): 3648378.0932
Bulk sample of auger cuttings obtained between 2.0-10.0 feet.

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SCOTTS CROSSING RD. ROADWAY

13JB-52
PAGE 1 OF 1

STATION: 46+71.35 OFFSET: 44.48' L
LATITUDE: 38.925247° N LONGITUDE: 77.208384° W
SURFACE ELEVATION: 311.41 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 10/8/13 - 10/8/13
Drilling Method(s): HSA 3.25"
SPT Method: SAFETY
Other Test(s):
Driller: Rob M., CDA
Logger: K. HURLEY, ECS

GROUND WATER
GROUNDWATER NOT ENCOUNTERED
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5					0.8						0.0 / 311.41 9.5" ASPHALT CONCRETE **ASPH**				
1.0															
1.5	310										0.8 / 310.61 12" AGGREGATE BASE, **GP**				
2.0					2										
2.5		5													
3.0		3									1.8 / 309.61 *Fill*, Red-brown, SILT FILL, with sand, stiff, moist, **ML**			24.9	
3.5	308	6	50												
4.0		8			4										
4.5		5													
5.0		4	67									46	13	30.3	80.4
5.5	306	6													
6.0		7			6										
6.5		3													
7.0		6	100											24.4	
7.5	304	6													
8.0		9			8										
8.5		8									SAME, with gravel, very stiff				
9.0		12	100											18.5	
9.5	302	15													
10.0		18			10						Boring terminated at 10.0'.				

REMARKS: Rig Type: CME 45-C-2.
Cave Depth at 7.0'
Northing(VDOT): 460954.3209
Easting(VDOT): 3648498.2964

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL RW001

15MSE-1
PAGE 1 OF 1

STATION: 18+95 OFFSET: 58' R
LATITUDE: 38.929046° N LONGITUDE: 77.216204° W
SURFACE ELEVATION: 323.01 ft COORD. DATUM: NAD 83

Date(s) Drilled: 7/18/15 - 7/18/15
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: R. Wilcher, Connelly
Logger: M. Hospodar, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5		1									0.0 / 323.01 2" TOPSOIL **TOPS**				
1.0	322	1 6 7	35		2									16.4	
1.5											0.2 / 322.81 *Fill*, Orange-brown, fine, SILTY GRAVEL FILL with sand, contains rock fragments, loose, moist **GM**				
2.0		4													
2.5		2 2 2													
3.0	320		80									NP	NP	25.9	34.4
3.5											SAME, contains trace organics				
4.0					4										
4.5											Auger Refusal at 4.5' on concrete. Offset to MSE-1A to continue drilling.				

REMARKS: Rig Type: D-50.
Cave Depth at 4.5'
Northing(VDOT): 462306.672
Easting(VDOT): 3646254.466

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL RW001

15MSE-1A

STATION: 18+82 OFFSET: 61' R
LATITUDE: 38.929034° N LONGITUDE: 77.216248° W
SURFACE ELEVATION: 323.48 ft COORD. DATUM: NAD 83

Date(s) Drilled: 7/18/15 - 7/18/15
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: R. Wilcher, Connelly
Logger: M. Hospodar, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
0.5											0.0 / 323.48 Auger Probe to 4.0'; see MSE-1 for strata description				
1.0															
1.5	322														
2.0															
2.5											Orange-brown, SILTY GRAVEL FILL, moist (observed from auger cuttings)				
3.0															
3.5	320														
4.0		2			4										
4.5		3									4.0 / 319.48				
5.0		11	50								*Fill*, Orange-brown, POORLY GRADED GRAVEL FILL with clay and sand, medium dense, moist **GP-GC**			5.1	7.8
5.5	318	13													
6.0					6						Auger Refusal at 6.0' on concrete				

REMARKS: Rig Type: D-50.
Cave Depth at 6.0'
Northing(VDOT): 462302.187
Easting(VDOT): 3646241.996

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL RW001

15MSE-2

STATION: 19+57 OFFSET: 61' R
LATITUDE: 38.929056° N LONGITUDE: 77.215992° W
SURFACE ELEVATION: 324.85 ft COORD. DATUM: NAD 83

Date(s) Drilled: 7/18/15 - 7/18/15
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: R. Wilcher, Connelly
Logger: M. Hospodar, ECS

GROUND WATER
FIRST ENCOUNTERED AT 13.0 ft DEPTH
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		1 2 2 5	50								0.0 / 324.85 3" TOPSOIL **TOPS**			14.7	
2		2 6 10 17	100		2						0.25 / 324.6 *Fill*, Tan, SANDY SILT FILL, contains rock fragments and trace organics, soft, moist **ML**			17.5	
4	320	5 11 17 21	100		4						2.0 / 322.85 *Residuum*, Tan, SANDY SILT, very stiff, moist **ML**			18.2	
6		20 24 30 40	100		6						SAME, hard	NP	NP	15.5	58.8
8		5 20 34 39	100		8						SAME, contains rock fragments			14.2	
10	315				10										
12															
14	310	6 22 24 31	100		13 15						SAME, slightly micaceous			13.4	
16															
18	305	8 34 50/5	100		18 19.4						18.0 / 306.85 *IGM*, Tan, fine to coarse, SILTY SAND, slightly micaceous, very dense, moist **SM**	NP	NP	2.2	48.1
20															
22															
24	300	8 27 50/5	100		23 24.4						23.0 / 301.85 Tan, SILT, trace sand, slightly micaceous, very hard, moist **ML**			13.7	
26															
28		22 28 38 50/4	100		28 29.8									10.9	
											Boring Terminated at 29.8'				

REMARKS: Rig Type: D-50.
Cave Depth at 28.0'
Northing(VDOT): 462310.907
Easting(VDOT): 3646314.720

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL RW001

15MSE-3
PAGE 1 OF 1

STATION: 20+07 | OFFSET: 66' R
LATITUDE: 38.929062° N | LONGITUDE: 77.215808° W
SURFACE ELEVATION: 325.83 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 7/18/15 - 7/18/15
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: R. Wilcher, Connelly
Logger: M. Hospodar, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
	325	1 10 7 6	75								0.0 / 325.83 3" TOPSOIL **TOPS**			14.6	
2		8 38 50/4	100		2 3.3						0.25 / 325.58 *Fill*, Orange-tan, fine to coarse, SILTY SAND FILL, trace gravel, contains rock fragments, very dense, moist **SM**	NP	NP	8.8	36.9
4		8 23 45 50/4	100		4 5.8						3.0 / 322.83 *IGM*, Orange-tan, SILT, contains quartz fragments, very hard, moist **ML**			10.6	
6	320	26 37 50/5	100		6 7.4						4.0 / 321.83 Orange-tan, fine to coarse, SILTY SAND, trace gravel, contains quartz fragments, very dense, moist **SM**			13.8	
8		32 50/3	75		8 8.8							NP	NP	7.8	45.1
10	315														
12		50/2	100		13 13.2									7.1	
14															
16	310	50/1	100		17 17.1						Auger Refusal at 17.0'			8.7	
18											17.1 / 308.73 Moderately weathered, soft, highly fractured, gray and red-brown variegated, SCHIST; contains mica, chlorite and quartz **SCH**				
20	305					72	20								
22					22.1						SAME, moderately jointed				
24						100	80								
26	300				27.1						Boring Terminated at 27.1'				

REMARKS: Rig Type: D-50.
Cave Depth at 17.0'
Northing(VDOT): 462313.956
Easting(VDOT): 3646366.865

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15MSE-3

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: MSE WALL RW001

15MSE-4

STATION: 20+37 OFFSET: 60' R
LATITUDE: 38.929089° N LONGITUDE: 77.215709° W
SURFACE ELEVATION: 327.82 ft COORD. DATUM: NAD 83

Date(s) Drilled: 7/18/15 - 7/18/15
Drilling Method(s): HSA 3.25"
SPT Method: Automatic Hammer
Other Test(s):
Driller: R. Wilcher, Connelly
Logger: M. Hospodar, ECS

GROUND WATER
FIRST ENCOUNTERED AT 14.0 ft DEPTH
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	FINES CONTENT -#200 (%)
		1 1 1 1	0								0.0 / 327.82 3" TOPSOIL **TOPS**				
2	325	22 7 17 50/4	94		2 3.8						0.25 / 327.57 *Fill*, Gray-tan, SILT FILL with gravel, contains No. 57 stone, soft, moist **ML**			2.2	
4		50/6	100		4 4.5						2.0 / 325.82 *Residuum*, Tan, SANDY SILT, slightly micaceous, contains rock fragments, very stiff, moist **ML**	NP	NP	4.4	31.5
6		50/5	100		6 6.4						4.0 / 323.82 *IGM*, Tan, fine to coarse, SILTY SAND, trace gravel, slightly micaceous, contains rock fragments, very dense, moist **SM**			4.5	
8	320	50/5	100		8 8.4									14.4	
10															
12															
14	315	10 22 50/3	96		13 14.3						13.0 / 314.82 Tan, SANDY SILT, slightly micaceous, contains rock fragments, very hard, moist **ML**			14.5	
16															
18	310	10 27 40 38	100		18 20									16.1	
22	305	27 30 50/4	100		22 23.3							NP	NP	16.5	60.0
24		29 50/4	100		23.5 24.3									16.0	
26															
28	300	18 28 50/5	100		28 29.4									21.3	
30											Boring Terminated at 29.4'				

REMARKS: Rig Type: D-50.
Cave Depth at 27.5'
Northing(VDOT): 462324.220
Easting(VDOT): 3646394.939

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW008

15RW008-B1

STATION: 40+11 | OFFSET: 56' L
LATITUDE: 38.926548° N | LONGITUDE: 77.210040° W
SURFACE ELEVATION: 315.6 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 08/25/2015 - 08/25/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
	315	6 10 10 10	60		1 3						0.0 / 315.6 7" ASPHALT CONCRETE **ASPH** 0.6 / 315.0 5" AGGREGATE BASE **GP**			19.3	
2															
4		4 5 6 4	45		5						1.0 / 314.6 *Fill*, Brown, SILT FILL with sand and gravel, slightly micaceous, very stiff, moist **ML** SAME, stiff			15.3	
6	310	4 4 6 5	63		7						SAME, contains weathered rock fragments			21.8	
8		4 6 5 7	70		9						SAME, Brown and red			16.7	
10	305	4 6 5 8	95		11						9.0 / 306.6 *Residuum*, Red and brown, SANDY ELASTIC SILT, slightly micaceous, stiff, moist **MH**	50	15	27.4	68.6
12															
14		5 4 7 9	40		13 15						SAME, Brown and tan			26.0	
16	300														
18		18 36 50/5	100		18 19.4						17.0 / 298.6 *IGM*, Red and Brown, SILT, trace sand, slightly micaceous, exhibits relict rock structure, very hard, moist **ML**			13.8	
20	295														
22		50/5	100		23 23.4						Boring Terminated at 23.4 feet			11.8	

REMARKS: Rig Type: D-50.
Cave Depth at 18.5'.
Northing (VDOT): 461421.29
Easting (VDOT): 3648020.75

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW008

STATION: 41+25 OFFSET: 59' L
LATITUDE: 38.926411° N LONGITUDE: 77.209698° W
SURFACE ELEVATION: 311.64 ft COORD. DATUM: NAD 83

Date(s) Drilled: 08/25/2015 - 08/25/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
											0.0 / 311.64 7" ASPHALT CONCRETE **ASPH**				
2	310	14 8 3 32	50		1						0.6 / 311.04 5" AGGREGATE BASE **GP**			16.7	
4		28 17 15 14	10		3						1.0 / 310.64 *Fill*, Brown, SILT FILL, trace sand, slightly micaceous, stiff, moist **ML**			25.5	
6	305	10 17 24 20	0		5						SAME, hard				
8		10 8 7 4	35		7						7.0 / 304.64 Brown, fine to medium, SILTY SAND FILL, slightly micaceous, medium dense, moist **SM**			13.7	39.5
10		5 6 5 5	38		9						SAME, contains weathered rock fragments	NP	NP	14.6	
12	300				11										
14		8 7 7 10	13		13						SAME, Brown			12.6	
16	295				15										
18		11 8 7 5	70		18						17.0 / 294.64 *Residuum*, Brown, SILT, trace clay, slightly micaceous, stiff, moist **ML**			32.4	
20					20										
22	290														
24		8 12 14 7	40		23						SAME, Brown and gray, exhibits relict rock structure, very stiff			12.8	
					25						Boring Terminated at 25.0 feet				

REMARKS: Rig Type: D-50.
Cave Depth at 21.8'.
Northing (VDOT): 461372.77
Easting (VDOT): 3648118.614

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW008

15RW008-B3

STATION: 42+16 | OFFSET: 54' L
LATITUDE: 38.926248° N | LONGITUDE: 77.209422° W
SURFACE ELEVATION: 308.93 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 08/25/2015 - 08/25/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
FIRST ENCOUNTERED AT 28.0 ft DEPTH
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
											0.0 / 308.93 8" ASPHALT CONCRETE **ASPH**				
											0.7 / 308.23 4" AGGREGATE BASE **GP**				
2		4 7 9 9	75		1						1.0 / 307.93 *Fill*, Red and brown, LEAN CLAY FILL, trace sand, very stiff, moist **CL**			22.0	
4	305	5 4 3 7	85		3						SAME, firm			21.6	
6		5 5 7 6	85		5						SAME, stiff	39	16	20.8	85.6
8		6 8 16 17	65		7						7.0 / 301.93 Brown, SILT FILL, trace gravel, slightly micaceous, very stiff, moist **ML**			6.8	
10	300	8 9 10 11	75		9						SAME, Brown and gray			17.3	
12					11										
14	295	6 4 3 4	30		13						SAME, firm			15.4	
16					15										
18	290	4 5 7 15	90		18						SAME, Brownish gray, stiff			10.7	
20					20										
22															
24	285	4 8 14 18	0		23						SAME, very stiff				
26		36 24 50/4	0		25 26.3						25.0 / 283.93 *IGM*, Orange and brown, SILT, trace sand, exhibits relict rock structure, very hard, moist **ML**				
28	280	19 50/6	50		28 29									13.8	
											Boring Terminated at 29.0 feet				

REMARKS: Rig Type: D-50.
Cave Depth at 25.5'.
Northing (VDOT): 461314.76
Easting (VDOT): 3648198.01

15RW008-B3

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW008

STATION: 43+25 OFFSET: 32' L
LATITUDE: 38.926019° N LONGITUDE: 77.209170° W
SURFACE ELEVATION: 307.01 ft COORD. DATUM: NAD 83

Date(s) Drilled: 08/25/2015 - 08/25/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
FIRST ENCOUNTERED AT 20.2 ft DEPTH
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS (SOIL)	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%) (ROCK)	ROCK QUALITY DESIGNATION	DIP ° STRATA	DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
											0.0 / 307.01 8" ASPHALT CONCRETE **ASPH**				
2	305	7 5 5 5	45		1						0.7 / 306.31 4" AGGREGATE BASE **GP**			19.9	
4		5 6 8 10	75		3						1.0 / 306.01 *Fill*, Red and brown, SANDY LEAN CLAY FILL, slightly micaceous, stiff, moist **CL**	37	13	22.5	62.1
6		4 6 10 15	75		5						SAME, Brown SAME, Brown and red, very stiff			19.6	
8	300	4 5 4 6	75		7						SAME, stiff			20.4	
10		2 3 2 4	70		9 11						SAME, firm			28.0	
12	295														
14		4 10 24 8	70		13 15						SAME, Black and tan, trace gravel, hard			22.1	
16															
18	290	6 7 8 8	0		18 20										
20 ∇															
22	285										22.0 / 285.01 *Residuum*, Orange and tan, SILT, trace sand, slightly micaceous, hard, moist **ML**				
24		14 14 26 29			23 25									21.5	
											Boring Terminated at 25.0 feet				

REMARKS: Rig Type: D-50.
Cave Depth at 22.0'.
Northing (VDOT): 461232.42
Easting (VDOT): 3648270.89

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW009

15RW009-B1

STATION: 44+31 OFFSET: 35' R
LATITUDE: 38.925618° N LONGITUDE: 77.209107° W
SURFACE ELEVATION: 306.08 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 08/26/2015 - 08/26/2015
Drilling Method(s): HSA 2.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
0.5											0.0 / 306.08 10" ASPHALT CONCRETE **ASPH**				
1.0															
1.5		4			1.3						0.8 / 305.28 6" AGGREGATE BASE **GP**				
2.0	304	5													
2.5		8	50											15.7	
3.0		10			3.3						1.3 / 304.78 *Fill*, Brown and dark gray, SILT FILL, trace sand and gravel, slightly micaceous, stiff, moist **ML**				
3.5		11													
4.0	302	11													
4.5		6	55											16.1	
5.0		9			5.3						3.3 / 302.78 Brown and dark gray, SILT FILL with gravel, trace sand, slightly micaceous, contains weathered rock fragments, very stiff, moist **ML**				
5.5		10													
6.0	300	20										25	7	23.1	66.1
6.5		18	55												
7.0		7			7.3						5.3 / 300.78 Dark red and gray, SANDY SILTY CLAY FILL, trace gravel, slightly micaceous, hard, moist **CL-ML** Auger Refusal at 7.3 feet (Offset to RW009-B1A)				

REMARKS: Rig Type: D-50.
Cave Depth at 7.0'.
Northing (VDOT): 461086.39
Easting (VDOT): 3648290.87

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15RW009-B1

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW009

STATION: 44+20 OFFSET: 34' R
LATITUDE: 38.925639° N LONGITUDE: 77.209129° W
SURFACE ELEVATION: 305.95 ft COORD. DATUM: NAD 83

Date(s) Drilled: 08/26/2015 - 08/26/2015
Drilling Method(s): HSA 2.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
2, 4	305									0.0 / 305.95 Auger Probe to 5.3 feet Brown, SANDY SILT FILL, moist (observed from auger cuttings)				
6	300	3 3 3 4	20	5.3 – 7.3						5.3 / 300.65 *Fill*, Brown, SILT FILL with sand, contains weathered rock fragments, firm, moist **ML**			11.6	
8		2 3 3 6	63	7.3 – 9.3						7.3 / 298.65 Red and brown, LEAN CLAY FILL, trace silt and sand, slighly micaceous, firm, moist **CL**			26.6	
10	295	20 30 7 6	45	9.3 – 11.3						9.3 / 296.65 Black and brown, medium, SILTY SAND FILL with gravel, slightly micaceous, dense, dry **SM**			4.6	
12, 14, 16	290	5 7 10 10	70	13 – 15						12.0 / 293.95 Brown, SILT FILL with sand, slightly micaceous, contains weathered rock fragments, very stiff, moist **ML**			14.5	
18, 20	285	10 13 22 36	20	18 – 20						17.0 / 288.95 Red and brown, SANDY LEAN CLAY FILL, trace gravel, slightly micaceous, hard, moist **CL**	35	14	21.4	67.4
22, 24, 26	280	50/4	100	23 – 23.3						22.0 / 283.95 *IGM*, Light brown and orange, SILT with sand, slightly micaceous, very hard, moist **ML**			4.8	
28		39 50/3	94	28 – 28.8						27.0 / 278.95 Light brown, SILT, trace sand, slightly micaceous, exhibits relict rock structure, very hard, moist **ML** Boring Terminated at 28.8 feet			10.3	

REMARKS: Rig Type: D-50.
Cave Depth at 16.7'.
Northing (VDOT): 461094.00
Easting (VDOT): 3648284.47

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW009

15RW009-B2

STATION: 45+75 | OFFSET: 44' R
LATITUDE: 38.925291° N | LONGITUDE: 77.208812° W
SURFACE ELEVATION: 308.77 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 08/26/2015 - 08/26/2015
Drilling Method(s): HSA 2.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
FIRST ENCOUNTERED AT 5.5 ft DEPTH
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.5	308	3 2 2 1	20		1						0.0 / 308.77 8" ASPHALT CONCRETE **ASPH**			
1.0											0.7 / 308.07 4" AGGREGATE BASE **GP**			4.0
1.5														
2.0														
2.5	306	2 2 1 1	20		3						1.0 / 307.77 Fill, Dark gray, SILTY SAND FILL with gravel, loose, dry **SM**			16.9
3.0														
3.5														
4.0														
4.5	304	2 7 50/0	90		5						3.0 / 305.77 Light brown and light red, SILT FILL, trace sand, slightly micaceous, soft, moist **ML**			19.0
5.0														
5.5					6						5.0 / 303.77 Red and brown, LEAN CLAY FILL with gravel, contains weathered rock fragments, stiff, moist **CL**			
6.0											Auger and Spoon Refusal at 6.0 feet (Offset to RW009-B2A)			

REMARKS: Rig Type: D-50.
Cave Depth at 5.5'.
Northing (VDOT): 460968.49
Easting (VDOT): 3648376.52

15RW009-B2

SPT_LOG:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW009

STATION: 45+70 OFFSET: 44' R
LATITUDE: 38.925303° N LONGITUDE: 77.208822° W
SURFACE ELEVATION: 308.6 ft COORD. DATUM: NAD 83

Date(s) Drilled: 08/26/2015 - 08/26/2015
Drilling Method(s): HSA 2.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: S. Consolvo, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)	
										0.0 / 308.6 Auger Probe to 5.0 feet Red and brown, SANDY SILT FILL, moist (observed from auger cuttings)				
2, 4	305			5										
6		8, 10, 6, 9	20	7						5.0 / 303.6 *Fill*, Red and brown, SILT FILL, trace sand, slightly micaceous, very stiff, moist **ML**			19.2	
8	300	3, 4, 4, 3	35	9						7.0 / 301.6 Grey-brown, SANDY LEAN CLAY FILL, trace gravel, slightly micaceous, firm, moist **CL**	33	13	19.6	51.8
10		3, 4, 3, 2	63	11						SAME, light brown and red, contains weathered rock fragments			28.4	
12, 14	295	2, 3, 6, 8	75	13, 15						SAME, with gravel, stiff	45	21	22.4	63.8
16, 18	290	50/5	100	18, 18.4						17.0 / 291.6 *IGM*, Light brown and gray, SILT, trace clay, slighly micaceous, very hard, moist **ML**			21.5	
20, 22, 24	285	50/5	100	23, 23.4						SAME, no clay, contains weathered rock fragments			3.1	
26, 28		50/2	100	28, 28.2						Boring Terminated at 28.2 feet			2.8	

REMARKS: Rig Type: D-50.
Cave Depth at 19.5'.
Northing (VDOT): 460972.79
Easting (VDOT): 3648373.58

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: RETAINING WALL RW010

15RW010-B1

STATION: 52+34 (GMCL) OFFSET: 19' R
LATITUDE: 38.927341° N LONGITUDE: 77.210543° W
SURFACE ELEVATION: 329.1 ft COORD. DATUM: NAD 83

Date(s) Drilled: 08/26/2015 - 08/26/2015
Drilling Method(s): HSA 2.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: D. Seserko, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
		7 13 10 9	55	1 – 3						0.0 / 329.1 7" ASPHALT CONCRETE **ASPH** 0.6 / 328.5 5" AGGREGATE BASE **GP**			16.4	
2														
4	325	7 12 14 17	50	3 – 5						1.0 / 328.1 *Fill*, Red-brown, SILT FILL, trace sand, very stiff, moist **ML** SAME, red-gray			12.1	
6		14 17 21 26	50	5 – 7						SAME, hard			12.3	
8		24 50/6	100	7 – 8						7.0 / 322.1 *IGM*, Red-gray, SILT, trace sand, exhibits relict rock structure, slightly micaceous, very hard, moist **ML**			11.3	
10	320	8 20 27 37	63	9 – 11						9.0 / 320.1 *Residuum*, Red-orange, SANDY SILT, exhibits relict rock structure, slightly micaceous, hard, moist **ML**	NP	NP	12.2	56.9
12														
14	315	11 28 50/6	73	13 – 14.5						12.0 / 317.1 *IGM*, Red-orange, SILT, trace sand, exhibits relict rock structure, slightly micaceous, very hard, moist **ML**			10.9	
16														
18	310	20 50/6	100	18 – 19						SAME, Orange-gray			9.1	
20														
22		21 50/5	100	23 – 23.9									15.4	
										Boring Terminated at 23.9 feet				

REMARKS: Rig Type: D-50.
Cave Depth at 18.8'.
Northing (VDOT): 461708.23
Easting (VDOT): 3647873.48

15RW010-B1

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SOUND WALL SW011

15SW011-B1

STATION: 32+25 | OFFSET: 71' R
LATITUDE: 38.927525° N | LONGITUDE: 77.212531° W
SURFACE ELEVATION: 346.36 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 08/24/2015 - 08/24/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: D. Seserko, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
											0.0 / 346.36 19" ASPHALT CONCRETE **ASPH**				
2	345	11 16 11 5	35		2						1.6 / 344.76 5" AGGREGATE BASE **GP**				
4		4 4 6 6	85		4						2.0 / 344.36 *Fill*, Brown, SILT FILL with sand and gravel, slightly micaceous, very stiff, moist **ML**			12.1	
6	340	2 3 4 6	75		6						4.0 / 342.36 *Residuum*, Red-brown, SANDY SILT, slightly micaceous, stiff, moist **ML** SAME, firm	42	13	23.8 24.4	68.7
8		2 3 4 5	75		8									28.7	
10	335				10										
12											12.0 / 334.36 Orange and tan, ELASTIC SILT with sand, slightly micaceous, stiff, moist **MH**				
14		4 5 6 9	90		13 15									38.0	
16	330														
18		9 11 16 16	85		18						17.0 / 329.36 Orange and tan, SILT with sand, exhibits relict rock structure, very stiff, moist **ML**			26.0	
20					20										
22	325														
24		9 9 14 18	88		23 25						SAME, Red and brown			23.0	
26	320														
28		6 8 12 14	90		28						27.0 / 319.36 Red, ELASTIC SILT with sand, slightly micaceous, exhibits relict rock structure, very stiff, moist **MH**	54	19	31.3	79.8
30					30										
32	315														

REMARKS: Rig Type: D-50.
Cave Depth at 24.0'.
Northing (VDOT): 461767.23
Easting (VDOT): 3647306.96

15SW011-B1

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SOUND WALL SW011

STATION: 32+25 OFFSET: 71' R
LATITUDE: 38.927525° N LONGITUDE: 77.212531° W
SURFACE ELEVATION: 346.36 ft COORD. DATUM: NAD 83

Date(s) Drilled: 08/24/2015 - 08/24/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: D. Seserko, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA												LAB DATA			
		SOIL				ROCK									
								DIP °							
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
34		4 10 15 21	85		33 35						SAME, Red and gray			23.5	
											Boring Terminated at 35.0 feet				

REMARKS: Rig Type: D-50.
Cave Depth at 24.0'.
Northing (VDOT): 461767.23
Easting (VDOT): 3647306.96

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SOUND WALL SW011

15SW011-B2

STATION: 31+75 | OFFSET: 122' L
LATITUDE: 38.928027° N | LONGITUDE: 77.212209° W
SURFACE ELEVATION: 344.25 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 08/24/2015 - 08/24/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: D. Seserko, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)	
											0.0 / 344.25 18" ASPHALT CONCRETE **ASPH**				
											1.5 / 342.75 6" AGGREGATE BASE **GP**				
2		3 5 7 8	65		2						2.0 / 342.25 *Residuum*, Red and gray, SILT, trace sand, exhibits relict rock structure, slightly micaceous, stiff, moist **ML**			22.4	
4	340	4 7 11 14	63		4						SAME, Red and orange, very stiff			12.1	
6		4 8 10 12	60		6									11.1	
8		7 10 10 11	55		8									11.6	
10	335				10										
12											12.0 / 332.25 Red and orange, ELASTIC SILT with sand, exhibits relict rock structure, slightly micaceous, stiff, moist **MH**				
14	330	4 5 6 8	75		13 15									31.8	
16															
18		9 26 27 28	75		18						17.0 / 327.25 Red and orange, SILT with sand, exhibits relict rock structure, slightly micaceous, hard, moist **ML**				
20	325				20									11.2	
22											22.0 / 322.25 *IGM*, Orange and tan, SILT with sand, slightly micaceous, very hard, moist **ML**				
24	320	38 50/3	94		23 23.8							NP	NP	9.3	81.8
26															
28		50/5	100		28 28.4									8.3	
30	315														
32															

REMARKS: Rig Type: D-50.
Cave Depth at 23.5'.
Northing (VDOT): 461951.34
Easting (VDOT): 3647395.93

15SW011-B2

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15

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Virginia Department of Transportation

PROJECT #: 8102-029-065, B657
LOCATION: I-495 Capital Beltway
STRUCTURE: SOUND WALL SW011

STATION: 31+75 | OFFSET: 122' L
LATITUDE: 38.928027° N | LONGITUDE: 77.212209° W
SURFACE ELEVATION: 344.25 ft | COORD. DATUM: NAD 83

Date(s) Drilled: 08/24/2015 - 08/24/2015
Drilling Method(s): HSA 3.25"
SPT Method: Safety Hammer
Other Test(s):
Driller: Chris, Connelly & Associates
Logger: D. Seserko, ECS

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG-TERM MEASUREMENTS TAKEN

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		50/6	100	☒	33 33.5						Boring Terminated at 33.5 feet			10.0

REMARKS: Rig Type: D-50.
Cave Depth at 23.5'.
Northing (VDOT): 461951.34
Easting (VDOT): 3647395.93

SPT_LOGB:21924-JBCONN_BORING_LOGS_COMPILED.GPJ:8.30.003:012512:12/18/15
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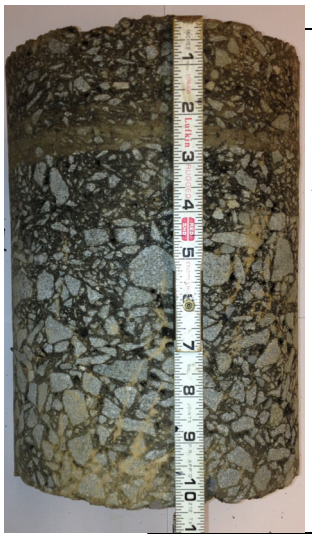
Pavement Core Sample Photographs
C-1 through C-5

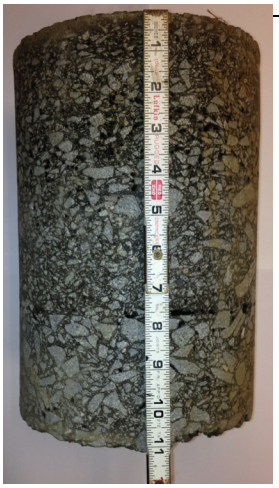
Jones Branch Corridor
ECS Project No. 21924



Asphalt:
10.5 in

(Stone Base: 7 inches)

C-1: *Asphalt measurement taken from the core hole.



Asphalt:
11.25 in

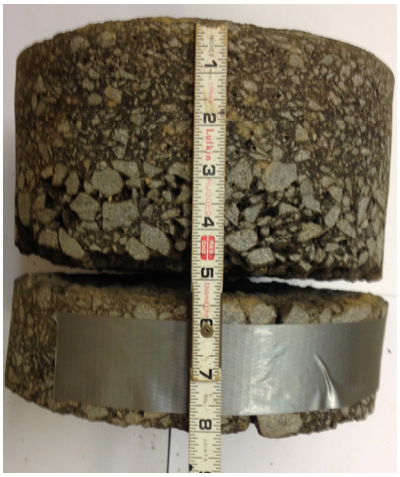
C-2:

(Stone Base: 5 inches)

Asphalt:
10.5 in

(Stone Base: 6 inches)

C-3:



Asphalt:
8 in

(CTA Base)

C-4:

Pavement Core Sample Photographs
C-5

Jones Branch Corridor
ECS Project No. 21924

Asphalt:
8 in

(Stone Base: 7 inches)

C-5:

APPENDIX C - LABORATORY TEST RESULTS

Summary Test Reports
Laboratory Test Reports

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
JB-09A												
	S-1	0.00 - 2.00	27.3									
	S-2	3.00 - 5.00	28.2									
	S-3	8.00 - 10.00	29.0									
	S-4	13.00 - 15.00	31.0	MH	53	37	16	82.4				
	S-5	18.00 - 20.00	29.0									
	S-6	23.00 - 25.00	24.5									
	S-7	28.00 - 30.00	28.4									
	S-8	33.00 - 35.00	28.2	MH	60	45	15	85.5				
	S-9	38.00 - 40.00	22.4									
	S-10	43.00 - 45.00	24.5									
	S-11	48.00 - 50.00	19.2									
	S-12	53.00 - 55.00	17.7									
	S-13	58.00 - 60.00	17.5									
	S-14	63.00 - 64.50	17.8									
	S-15	68.00 - 68.80	13.2									
	S-16	73.00 - 75.00	10.2									
JB-01												
	S-1	0.00 - 2.00	2.8									
	S-2	2.00 - 4.00	16.9	SM	37	30	7	46.7				
	D4S-1	2.00 - 10.00	15.4	ML	43	32	11	56.9	114.1	15.2	8	
	S-3	4.00 - 6.00	23.8									
	S-4	6.00 - 8.00	16.6									
	S-5	8.00 - 10.00	22.7									
	S-6	10.00 - 12.00	17.2									
JB-02												
	S-1	2.00 - 4.00	9.4									
	S-2	4.00 - 6.00	10.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
Project Name: Jones Branch Connector
PM: Michael A. Rayl
PE: Chris Giese
Printed On: Wednesday, December 11, 2013

ECS Mid-Atlantic, LLC
14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-3	6.00 - 8.00	12.2									
	S-4	8.00 - 10.00	12.9									
JB-03												
	S-1	2.00 - 4.00	22.3	SM	40	33	7	44.4				
	S-2	4.00 - 6.00	9.6									
	S-3	6.00 - 6.50	8.2									
	S-4	8.00 - 9.70	6.1									
JB-04												
	S-1	1.00 - 2.00	26.6									
	S-2	2.00 - 4.00	24.3									
	S-3	4.00 - 6.00	25.4									
	S-4	6.00 - 8.00	22.7									
	S-5	8.00 - 10.00	20.8	MH	71	50	21	89.2				
	S-6	10.00 - 12.00	6.0									
	S-7	13.00 - 15.00	20.7									
	S-8	18.00 - 20.00	23.0									
	S-9	23.00 - 25.00	16.1									
	S-10	28.00 - 30.00	19.2									
	S-11	33.00 - 35.00	21.9									
	S-12	38.00 - 40.00	17.8									
	S-13	43.00 - 45.00	22.6	ML	46	35	11	83.2				
	S-14	48.00 - 50.00	21.8									
	S-15	53.00 - 55.00	25.5									
	S-16	58.00 - 60.00	12.4									
	S-17	63.00 - 64.83	15.8									
	S-18	68.00 - 70.00	17.4									
	S-19	73.00 - 74.41	18.0									
	S-20	78.00 - 79.75	14.6									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-21	83.00 - 85.00	21.0									
	S-22	88.00 - 90.00	18.9									
JB-05												
	S-1	1.00 - 2.00	11.1									
	S-2	2.00 - 4.00	20.2									
	S-3	4.00 - 6.00	8.2									
	S-4	6.00 - 8.00	15.1									
	S-5	8.00 - 10.00	15.0									
	S-6	10.00 - 12.00	14.8	ML	39	33	6	60.9				
	S-7	13.00 - 15.00	12.0									
	S-8	18.00 - 20.00	9.7									
	S-9	23.00 - 25.00	13.1									
	S-10	28.00 - 29.90	9.3									
	S-11	33.00 - 35.00	10.1									
	S-12	38.00 - 38.40	7.6									
	S-13	43.00 - 44.90	13.0									
	S-14	48.00 - 50.00	14.5									
	S-15	53.00 - 55.00	14.3									
	S-16	58.00 - 59.25	13.0									
	S-17	63.00 - 64.20	15.2									
	S-18	68.00 - 69.30	15.7	ML	39	30	9	82.9				
	S-19	73.00 - 74.90	17.6									
	S-20	78.00 - 80.00	17.4									
	S-21	83.00 - 85.00	16.5									
	S-22	88.00 - 90.00	22.3									
JB-06												
	S-1	0.00 - 2.00	21.0									
	S-2	2.00 - 4.00	9.7									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-3	4.00 - 6.00	13.6	ML	NP	NP	NP	59.7				
	S-4	6.00 - 8.00	15.1									
	S-5	8.00 - 10.00	26.5									
	S-6	13.00 - 15.00	12.2									
	S-7	18.00 - 19.75	14.3									
	S-8	23.0- - 24.75	11.1									
	S-9	28.00 - 30.00	21.1									
	S-10	33.00 - 35.00	14.4	ML	NP	NP	NP	57.9				
	S-11	38.00 - 40.00	21.0									
	S-12	43.00 - 44.10	8.5	ML	NP	NP	NP	58.5				
	S-13	48.00 - 49.10	9.2									
	S-14	53.00 - 54.20	8.2									
	S-15	58.00 - 60.00	27.6									
	S-16	63.00 - 64.60	13.7									
	S-17	68.00 - 70.00	18.1	ML	48	33	15	76.5				
JB-07												
	S-1	0.00 - 2.00	16.5									
	S-2	2.00 - 4.00	25.0									
	S-3	4.00 - 6.00	12.1									
	S-4	6.00 - 7.66	38.3									
	S-5	8.00 - 9.90	11.8	ML	36	26	10	58.5				
	S-6	10.00 - 11.40	16.5									
	S-7	13.00 - 14.20	37.1									
	S-8	18.00 - 20.00	21.3									
	S-9	23.00 - 24.90	15.5									
	S-10	28.00 - 29.08	19.0									
	S-12	38.00 - 40.00	28.3	MH	53	39	14	78.2				
	S-13	43.00 - 44.30	17.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Phone: (703) 471-8400 Fax: (703) 991-4846

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-14	48.00 - 49.90	23.2									
	S-15	53.00 - 54.40	19.8									
	S-16	58.00 - 59.60	17.7									
	S-17	63.00 - 64.00	11.1									
	S-18	68.00 - 68.70	13.3									
JB-08												
	S-1	2.00 - 4.00	21.7									
	D4S-2	2.00 - 10.00	10.6	ML	44	35	9	58.3	110.8	16.3	7	
	S-2	4.00 - 6.00	15.3	ML	43	33	10	53.9				
	S-3	6.00 - 8.00	10.5									
	S-4	8.00 - 10.00	10.8									
	S-5	13.00 - 15.00	11.9									
	S-6	18.00 - 20.00	12.6	ML	NP	NP	NP	62.6				
	S-7	23.00 - 25.00	13.9									
	S-8	28.00 - 30.00	24.4									
	S-9	31.00 - 33.00	5.0									
	S-10	38.00 - 40.00	18.6									
	S-11	43.00 - 44.25	5.4									
	S-12	48.00 - 50.00	16.1									
JB-09												
	S-2	2.00 - 4.00	27.4									
	S-3	4.00 - 6.00	27.7									
	S-4	6.00 - 8.00	23.8	MH	50	39	11	70.7				
	S-5	8.00 - 10.00	26.5									
	S-6	13.00 - 15.00	11.9									
	S-7	18.00 - 20.00	23.8									
	S-8	23.00 - 25.00	14.4									
	S-9	28.00 - 30.00	13.0									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-10	33.00 - 35.00	14.7									
	S-11	38.00 - 40.00	18.7									
	S-12	43.00 - 45.00	16.8	ML	NP	NP	NP	61.4				
	S-13	48.00 - 49.60	7.1									
	S-14	53.00 - 55.00	17.3									
	S-15	58.00 - 60.00	13.6									
	S-16	63.00 - 65.00	18.3									
	S-17	68.00 - 70.00	25.3									
JB-10												
	S-1	1.00 - 3.00	4.0									
	S-2	3.00 - 5.00	12.0									
	S-3	5.00 - 7.00	40.0									
	S-4	7.00 - 9.00	13.4	GM	43	33	10	41.9				
	S-5	9.00 - 11.00	15.3									
	S-6	13.00 - 15.00	16.4									
	S-7	18.00 - 20.00	14.6									
	S-8	23.00 - 25.00	13.6									
	S-9	28.00 - 28.90	9.6									
	S-10	33.00 - 33.90	8.4									
	S-11	38.00 - 40.00	13.1									
	S-12	43.00 - 44.90	11.7									
	S-13	48.00 - 49.50	9.3									
	S-14	53.00 - 54.90	11.1									
	S-15	58.00 - 59.25	10.5									
	S-16	63.00 - 63.70	18.1									
	S-17	68.00 - 69.20	14.8									
JB-11												
	S-1	1.00 - 2.00	20.6									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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PE: Chris Giese
Printed On: Wednesday, December 11, 2013

ECS Mid-Atlantic, LLC
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Phone: (703) 471-8400 Fax: (703) 991-4846

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-2	2.00 - 4.00	25.4									
	S-3	4.00 - 6.00	18.6									
	S-4	6.00 - 8.00	26.5									
	S-5	8.00 - 10.00	19.8									
	S-6	13.00 - 15.00	19.5	ML	NP	NP	NP	69.4				
	S-7	18.00 - 20.00	16.8									
	S-8	23.00 - 25.00	34.1									
	S-9	28.00 - 29.75	18.1									
	S-10	33.00 - 34.50	21.3									
	S-11	38.00 - 40.00	13.8									
	S-12	43.00 - 44.20	12.7									
	S-13	48.00 - 49.50	17.7									
	S-14	53.00 - 54.30	19.8									
	S-15	58.00 - 59.90	18.3									
	S-16	63.00 - 63.80	15.6									
	S-17	68.00 - 69.00	10.5									
JB-12												
	S-1	0.00 - 2.00	18.2									
	D4S-3	1.00 - 6.00	13.0	ML	40	32	8	62.6	110.7	15.4	6.3	
	S-2	2.00 - 4.00	19.6									
	S-3	4.00 - 6.00	8.6									
	S-4	6.00 - 8.00	9.1									
	S-5	8.00 - 9.80	11.1									
	S-6	13.00 - 14.30	8.7									
	S-7	18.00 - 19.40	11.3									
	S-8	23.00 - 25.00	30.6	MH	56	44	12	78.8				
	S-9	28.00 - 30.00	11.8									
	S-10	33.00 - 33.90	12.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
Project Name: Jones Branch Connector
PM: Michael A. Rayl
PE: Chris Giese
Printed On: Wednesday, December 11, 2013

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-11	38.00 - 39.50	16.8									
	S-12	43.00 - 44.40	9.7									
	S-13	48.00 - 50.00	12.0									
	S-14	53.00 - 53.80	12.4									
	S-15	58.00 - 59.25	12.7									
	S-16	63.00 - 63.40	40.0									
	S-17	68.00 - 69.40	9.2									
JB-13												
	S-1	0.00 - 2.00	13.6									
	S-2	2.00 - 4.00	9.1	ML	NP	NP	NP	54.8				
	S-3	4.00 - 6.00	9.0									
	S-4	6.00 - 7.70	7.0									
	S-5	8.00 - 9.20	9.3									
	S-6	13.00 - 14.70	8.5									
	S-7	18.00 - 18.80	9.2									
	S-8	23.00 - 25.00	19.6									
	S-9	28.00 - 29.80	12.4									
	S-10	33.00 - 35.00	10.1	ML	NP	NP	NP	52.7				
	S-11	38.00 - 40.00	10.5									
	S-12	43.00 - 44.20	5.7									
	S-13	48.00 - 48.70	9.3									
	S-14	53.00 - 54.50	10.3									
	S-15	58.00 - 59.00	8.2									
	S-16	63.00 - 63.90	8.4									
	S-17	68.00 - 69.40	9.9									
JB-14												
	S-1	0.00 - 2.00	20.4									
	S-2	2.00 - 4.00	18.4	ML	NP	NP	NP	72.2				

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-3	4.00 - 6.00	17.3									
	S-4	6.00 - 8.00	12.5									
	S-5	8.00 - 10.00	15.1									
	S-6	10.00 - 12.00	10.9									
	S-7	13.00 - 15.00	14.2									
	S-8	18.00 - 20.00	18.3									
	S-9	23.00 - 25.00	13.4									
	S-10	28.00 - 30.00	11.9									
	S-11	33.00 - 34.90	11.1									
	S-12	38.00 - 40.00	13.7	SM	NP	NP	NP	47.6				
	S-13	43.00 - 44.20	10.7									
	S-14	48.00 - 49.20	10.9									
	S-15	53.00 - 54.30	12.2									
	S-16	58.00 - 60.00	14.4									
	S-17	63.00 - 64.30	11.6									
	S-18	68.00 - 68.80	8.1									
JB-15												
	S-1	0.00 - 2.00	12.0									
	S-2	2.00 - 4.00	15.3									
	S-3	4.00 - 6.00	9.4									
	S-4	6.00 - 8.00	19.1									
	S-5	8.00 - 10.00	13.6									
	S-6	13.00 - 15.00	17.1	ML	NP	NP	NP	60.2				
	S-7	18.00 - 20.00	9.2									
	S-8	23.00 - 25.00	16.0									
	S-9	28.00 - 30.00	14.3									
	S-10	33.00 - 35.00	7.7	SM	NP	NP	NP	35.8				
	S-11	38.00 - 40.00	9.4									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-12	43.00 - 45.00	11.7									
	S-13	48.00 - 50.00	23.9									
	S-14	53.00 - 54.80	16.6									
	S-15	58.00 - 59.90	10.4									
	S-16	63.00 - 64.20	9.2									
	S-17	68.00 - 69.20	13.3									
JB-16												
	S-1	0.00 - 2.00	16.0									
	S-2	2.00 - 4.00	14.7									
	S-3	4.00 - 6.00	8.8	SM	NP	NP	NP	35.6				
	S-4	6.00 - 8.00	11.1									
	S-5	8.00 - 10.00	7.0									
	S-6	13.00 - 14.30	3.0									
	S-7	18.00 - 20.00	8.3									
	S-8	23.00 - 25.00	11.1									
	S-9	28.00 - 30.00	20.0	ML	NP	NP	NP	61.3				
	S-10	33.00 - 34.40	12.2									
	S-11	38.00 - 40.00	11.8									
	S-12	43.00 - 44.25	10.2									
	S-13	48.00 - 49.40	11.7									
	S-14	53.00 - 53.60	9.4									
	S-15	58.00 - 59.30	12.5									
	S-16	63.00 - 63.80	7.9									
	S-17	68.00 - 68.75	7.1									
JB-17												
	S-1	0.00 - 2.00	6.7									
	S-2	2.00 - 4.00	9.0									
	S-3	4.00 - 6.00	10.3	ML	NP	NP	NP	64.6				

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-4	6.00 - 8.00	4.4									
	S-5	8.00 - 10.00	8.9									
	S-6	10.00 - 12.00	11.9									
	S-7	15.00 - 17.00	10.9	ML	NP	NP	NP	53.0				
	S-8	20.00 - 22.00	11.2									
	S-9	25.00 - 27.00	10.8									
	S-10	30.00 - 32.00	19.9									
	S-11	35.00 - 37.00	22.6	ML	NP	NP	NP	69.7				
	S-12	40.00 - 42.00	21.5									
	S-13	45.00 - 47.00	18.2									
	S-14	50.00 - 52.00	15.8									
	S-15	55.00 - 57.00	14.0									
	S-16	60.00 - 62.00	16.1									
	S-17	65.00 - 66.80	13.3									
	S-18	70.00 - 71.40	13.1									
JB-18												
	S-1	0.00 - 2.00	7.4									
	S-2	2.00 - 4.00	9.5									
	S-3	4.00 - 6.00	11.0									
	S-4	6.00 - 8.00	11.9	ML	NP	NP	NP	61.0				
	S-5	8.00 - 10.00	11.6									
	S-6	10.00 - 12.00	10.5									
	S-7	13.00 - 15.00	10.5									
	S-8	18.00 - 20.00	11.4									
	S-9	23.00 - 25.00	11.0									
	S-10	28.00 - 30.00	12.4									
	S-11	33.00 - 35.00	15.9	ML	NP	NP	NP	55.8				
	S-12	38.00 - 39.80	13.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

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Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-13	43.00 - 45.00	22.9									
	S-14	48.00 - 50.00	13.1									
	S-15	53.00 - 55.00	14.0									
	S-16	58.00 - 59.30	12.2									
	S-17	63.00 - 64.70	12.7									
	S-18	68.00 - 69.30	12.7									
JB-19												
	S-1	0.00 - 2.00	12.5									
	S-2	2.00 - 4.00	13.9									
	S-3	4.00 - 6.00	22.3									
	S-4	6.00 - 8.00	15.6									
	S-5	8.00 - 10.00	25.7	ML	47	28	19	89.5				
	S-6	10.00 - 12.00	24.2									
	S-7	13.00 - 15.00	27.4									
	S-8	18.00 - 20.00	12.2	GM	NP	NP	NP	43.2				
	S-9	23.00 - 25.00	29.9									
	S-10	28.00 - 30.00	17.0									
	S-11	33.00 - 35.00	16.6									
	S-12	38.00 - 40.00	21.0	ML	NP	NP	NP	64.3				
	S-13	43.00 - 45.00	21.5									
	S-14	48.00 - 50.00	12.8									
	S-15	53.00 - 54.80	12.4									
	S-16	58.00 - 60.00	12.0									
	S-17	63.00 - 65.00	30.6									
	S-18	68.00 - 69.30	17.2									
JB-20												
	S-1	2.00 - 4.00	38.1									
	D4S-4	2.00 - 10.00	16.8	MH	52	38	14	69.6	103.2	19.7	4.7	

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-2	4.00 - 6.00	26.1	MH	60	44	16	57.5				
	S-3	6.00 - 8.00	26.1									
	S-4	8.00 - 10.00	26.9									
	S-5	13.00 - 15.00	20.8									
	S-6	18.00 - 20.00	22.9									
	S-7	23.00 - 25.00	17.7									
	S-8	28.00 - 29.30	12.2									
	S-9	33.00 - 35.00	20.6	ML	NP	NP	NP	62.7				
	S-10	38.00 - 40.00	21.1									
	S-11	43.00 - 45.00	27.7									
	S-12	48.00 - 50.00	21.2									
	S-13	53.00 - 54.70	17.3									
	S-14	58.00 - 59.00	11.0									
	S-15	63.00 - 64.20	13.7									
	S-16	68.00 - 69.40	14.8									
JB-21												
	S-1	0.00 - 2.00	14.3									
	S-2	2.00 - 4.00	21.2									
	S-3	4.00 - 6.00	25.7									
	S-4	6.00 - 8.00	26.9									
	S-5	8.00 - 10.00	27.4	MH	59	46	13	77.9				
	S-6	10.00 - 12.00	34.3									
	S-7	13.00 - 15.00	23.3									
	S-8	18.00 - 19.90	25.7									
	S-9	23.00 - 25.00	26.9									
	S-10	28.00 - 30.00	27.4	ML	46	37	9	62.6				
	S-11	33.00 - 35.00	29.2									
	S-12	38.00 - 39.75	17.6									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-13	43.00 - 45.00	16.9									
	S-14	48.00 - 49.16	18.7									
	S-15	53.00 - 53.75	14.5									
	S-16	58.00 - 58.50	10.7									
	S-17	63.00 - 63.30	13.7									
	S-18	68.00 - 68.70	11.7									
JB-22												
	S-1	0.00 - 2.00	15.7									
	S-2	2.00 - 4.00	23.7									
	S-3	4.00 - 6.00	19.6	ML	40	31	9	56.0				
	S-4	6.00 - 8.00	22.2									
	S-5	8.00 - 10.00	24.2									
	S-6	13.00 - 15.00	17.6	MH	56	38	18	83.2				
	S-7	15.00 - 17.00	29.6									
	S-8	20.00 - 22.00	30.6									
	S-9	25.00 - 27.00	32.2									
	S-10	30.00 - 32.00	38.9	MH	54	33	21	75.7				
	S-11	35.00 - 37.00	24.1									
	S-12	40.00 - 42.00	40.0									
	S-13	45.00 - 47.00	11.7									
	S-14	50.00 - 52.00	31.3	MH	50	36	14	78.5				
	S-15	55.00 - 57.00	14.6									
	S-16	60.00 - 62.00	16.8									
	S-17	65.00 - 67.00	10.7									
	S-18	70.00 - 72.00	14.9									
	S-19	75.00 - 76.30	12.9									
JB-23												
	S-1	0.00 - 2.00	6.4									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-2	2.00 - 4.00	15.5									
	S-3	4.00 - 6.00	10.4									
	S-4	6.00 - 8.00	15.2	ML	NP	NP	NP	62.4				
	S-5	8.00 - 10.00	20.3									
	S-6	13.00 - 15.00	15.1									
	S-7	18.00 - 20.00	16.2									
	S-8	23.00 - 25.00	24.6	ML	NP	NP	NP	57.7				
JB-24												
	S-1	0.00 - 2.00	21.5									
	S-2	2.00 - 4.00	6.8	SC-SM	23	16	7	24.1				
	S-3	4.00 - 6.00	28.0									
	S-4	6.00 - 8.00	17.5									
	S-5	8.00 - 10.00	19.9									
JB-25												
	S-1	2.00 - 4.00	22.0									
	S-2	4.00 - 6.00	15.6									
	S-3	6.00 - 8.00	19.2	ML	NP	NP	NP	55.9				
	S-4	8.00 - 10.00	23.7									
JB-26												
	S-1	0.00 - 2.00	2.1									
	S-2	2.00 - 4.00	24.5	ML	NP	NP	NP	65.3				
	S-3	4.00 - 6.00	20.0									
	S-4	6.00 - 8.00	6.4									
	S-5	8.00 - 10.00	20.8									
JB-27												
	S-1	2.00 - 4.00	13.2									
	S-2	4.00 - 6.00	13.2	ML	NP	NP	NP	60.2				
	S-3	6.00 - 8.00	11.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-4	8.00 - 10.00	18.9									
	S-5	13.00 - 15.00	13.1									
	S-6	18.00 - 20.00	15.5									
	S-7	23.00 - 25.00	17.7									
	S-8	28.00 - 30.00	14.9									
	S-9	33.00 - 35.00	18.0									
	S-10	38.00 - 40.00	13.1									
JB-28												
	S-1	2.00 - 4.00	8.5	ML	NP	NP	NP	50.8				
	S-2	4.00 - 6.00	10.0									
	S-3	6.00 - 8.00	9.5									
	S-4	8.00 - 10.00	9.8									
	S-5	13.00 - 15.00	10.7									
	S-6	18.00 - 19.33	15.0									
	S-7	23.00 - 25.00	14.7									
	S-9	28.00 - 28.00	40.0									
	S-8	28.00 - 30.00	14.8									
JB-29												
	S-1	2.00 - 4.00	24.9	MH	55	43	12	79.1				
	S-2	4.00 - 6.00	11.6									
	S-3	6.00 - 8.00	11.3									
	S-4	8.00 - 10.00	14.1									
	S-5	13.00 - 15.00	10.3									
	S-6	18.00 - 20.00	11.3									
	S-7	23.00 - 25.00	18.4									
JB-30												
JB-31												
	S-1	0.00 - 2.00	9.1									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
Project Name: Jones Branch Connector
PM: Michael A. Rayl
PE: Chris Giese
Printed On: Wednesday, December 11, 2013

ECS Mid-Atlantic, LLC
14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-2	2.00 - 4.00	18.1	ML	NP	NP	NP	64.6				
	S-3	4.00 - 6.00	14.8									
	S-4	6.00 - 8.00	17.1									
	S-5	8.00 - 9.80	20.2									
	S-6	13.00 - 15.00	4.3									
	S-7	18.00 - 20.00	27.1	ML	NP	NP	NP	60.6				
	S-8	23.00 - 25.00	23.7									
JB-32												
	S-1	0.00 - 2.00	8.2									
	S-2	2.00 - 4.00	9.4	SM	NP	NP	NP	49.5				
	S-3	4.00 - 6.00	17.4									
	S-4	6.00 - 8.00	15.5									
	S-5	8.00 - 10.00	13.8									
	S-6	13.00 - 15.00	9.5									
	S-7	18.00 - 20.00	11.6									
	S-8	23.00 - 25.00	11.9									
JB-33												
	S-1	0.00 - 2.00	9.9									
	S-2	2.00 - 4.00	13.2									
	S-3	4.00 - 6.00	17.0	CL	34	24	10	62.3				
	S-4	6.00 - 8.00	19.7									
	S-5	8.00 - 10.00	7.5									
	S-6	10.00 - 12.00	12.3									
	S-7	13.00 - 15.00	7.0									
	S-8	18.00 - 20.00	18.7									
	S-9	23.00 - 25.00	13.9									
JB-34												
	S-1	0.00 - 20.00	14.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-2	2.00 - 4.00	16.1	CL	43	25	18	72.0				
	S-3	4.00 - 6.00	22.6									
	S-4	6.00 - 8.00	27.7	ML	33	25	8	64.4				
	S-5	8.00 - 10.00	24.6									
	S-7	13.00 - 15.00	21.4									
	S-8	18.00 - 20.00	15.8	ML	44	33	11	82.8				
JB-35												
	S-1	2.00 - 4.00	21.8									
	S-2	4.00 - 6.00	22.9									
	S-3	6.00 - 8.00	26.0									
	S-4	8.00 - 10.00	12.5									
	S-5	13.00 - 15.00	32.5	ML	38	29	9	83.1				
JB-42												
	S-1	1.00 - 2.00	3.3									
	S-2	2.00 - 4.00	21.4	ML	39	31	8	67.7				
	S-3	4.00 - 6.00	21.8									
	S-4	6.00 - 8.00	28.9									
	S-5	8.00 - 10.00	33.3									
JB-43												
	S-1	1.00 - 2.00	5.4									
	S-2	2.00 - 4.00	9.7									
	S-3	4.00 - 6.00	8.9									
	S-4	6.00 - 8.00	15.8									
	S-5	8.00 - 10.00	10.8									
JB-44												
	S-1	2.00 - 4.00	18.6	ML	43	27	16	66.7				
	S-2	4.00 - 6.00	3.5									
	S-3	6.00 - 8.00	16.2									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
Project Name: Jones Branch Connector
PM: Michael A. Rayl
PE: Chris Giese
Printed On: Wednesday, December 11, 2013

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Phone: (703) 471-8400 Fax: (703) 991-4846

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-4	8.00 - 10.00	16.7									
JB-45												
	S-1	2.00 - 4.00	19.7									
	S-2	4.00 - 6.00	18.2									
	S-3	6.00 - 8.00	33.1									
	S-4	8.00 - 10.00	35.7									
JB-46												
	S-1	2.00 - 4.00	20.5									
	S-2	4.00 - 6.00	4.0									
	S-3	6.00 - 8.00	17.8									
	S-4	8.00 - 10.00	11.3									
JB-47												
	S-1	2.00 - 4.00	17.6									
	S-2	4.00 - 6.00	24.8	ML	46	36	10	69.2				
	S-3	6.00 - 8.00	21.7									
	S-4	8.00 - 10.00	12.4									
JB-48												
	S-1	2.00 - 4.00	21.0	CL	39	23	16	85.2				
	S-2	4.00 - 6.00	20.1									
	S-3	6.00 - 8.00	18.6									
	S-4	8.00 - 10.00	21.0									
JB-49												
	S-1	2.00 - 4.00	14.7									
	S-2	4.00 - 6.00	10.0									
	S-3	6.00 - 8.00	26.4									
	S-4	8.00 - 10.00	13.9									
JB-50												
	S-1	2.00 - 4.00	23.5	CL	37	25	12	77.9				

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
Project Name: Jones Branch Connector
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Printed On: Wednesday, December 11, 2013

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Phone: (703) 471-8400 Fax: (703) 991-4846

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	D4S-5	2.00 - 10.00	14.9	CL	42	24	18	58.9	113.8	15.9	8	
	S-2	4.00 - 6.00	19.2									
	S-3	6.00 - 8.00	21.4	CL	46	19	27	60.2				
	S-4	8.00 - 10.00	31.6									
JB-51												
	S-1	2.00 - 4.00	11.1									
	D4S-6	2.00 - 10.00	12.0	SC	39	24	15	43.3	127.8	11.5	30	
	S-2	4.00 - 6.00	9.6									
	S-3	6.00 - 8.00	15.9									
	S-4	8.00 - 10.00	22.3									
JB-52												
	S-1	2.00 - 4.00	24.9									
	S-2	4.00 - 6.00	30.3	ML	46	33	13	80.4				
	S-3	6.00 - 8.00	24.4									
	S-4	8.00 - 10.00	18.5									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924
Project Name: Jones Branch Connector
PM: Michael A. Rayl
PE: Chris Giese
Printed On: Wednesday, December 11, 2013

ECS Mid-Atlantic, LLC
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Engineering Consulting Services Mid-Atlantic, LLC
Chantilly, Virginia

VTM-8 TESTING SUMMARY

Project Name: **Jones Branch**
ECS Project No: 21924
VDOT Proj. No. 8102-029-065

Completed Date: 11/7/13
Performed Date: 11/1/13
Project Engineer: MAR/JCG

Street: Bulk

Summary By: HNT1

Sample No.	Sample Location (Depth)	Soil Description	Classification		Resiliency Factor	Corrected Max. Dry Density(pcf)	Corrected Optimum M/C (%)	Percent Compaction	CBR Soaked	Final Moisture Soaked (%)	Percent Swell
			USCS	AASHTO							
DS4-1	JB-01 (2.0-10.0)	Sandy Silt Trace Mica Yellowish Brown	ML	A-7-5	1.5	114.1	15.2	100.4	8.0	24.1	1.8
DS4-2	JB-08 (2.0-10.0)	Sandy Silt Trace Mica Light Reddish Brown	ML	A-5	1.5	110.8	16.3	100.3	7.0	25.9	2.6
DS4-3	JB-12 (1.0-6.0)	Sandy Silt Trace Mica Reddish Brown	ML	A-4	1.5	110.7	15.4	100.5	6.3	24.6	2.2
DS4-4	JB-20 (2.0-10.0)	Sandy Elastic Silt Trace Mica Reddish Brown	MH	A-7-5	1.5	103.2	19.7	100.3	4.7	30.2	2.9
DS4-5	JB-50 (2.0-10.0)	Sandy Lean Clay Trace Mica Reddish Brown	CL	A-7-6	1.5	113.8	15.9	100.9	8.0	24.3	1.7
DS4-6	JB-51 (2.0-10.0)	Clayey Sand with Gravel Trace Mica Dark Brown	SC	A-6	1.5	127.8	11.5	99.8	30.0	18.3	1.6

Average Laboratory CBR = 10.7

Design CBR Value (VDOT) = 7.1

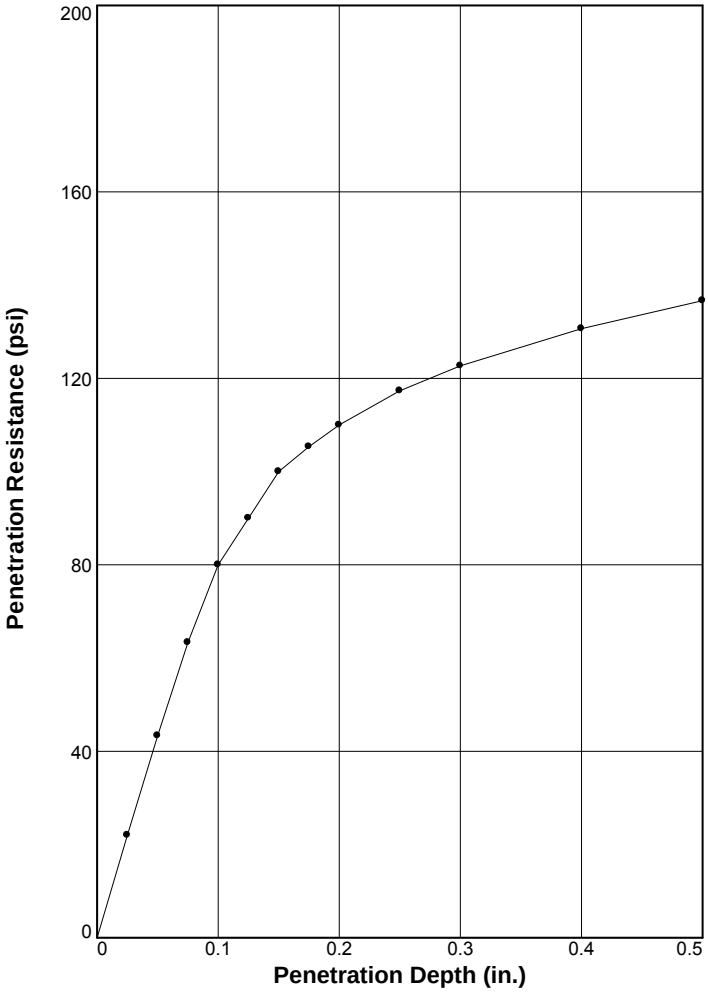
Mica Content = Trace

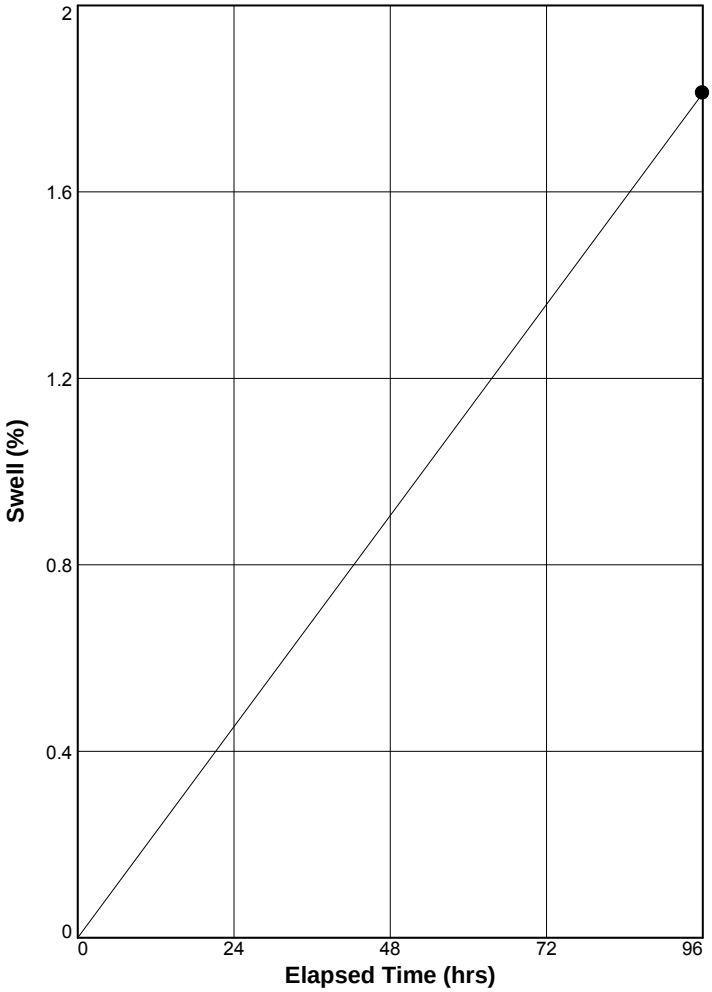
Resiliency Factor = 1.5

Principal Engineer: J. Christopher Giese

J. Chris Giese, P.E.

BEARING RATIO TEST REPORT
VTM-8 (2007)





	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	114.6	100.4	15.4	112.6	98.7	24.1	8.0	7.3	0.000	10	1.8
2 △											
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Sandy Silt Trace Mica Yellowish Brown (18.0% +4)	ML	114.1	15.2	43	11

Project No: 21924

Project: Jones Branch Connector

Source of Sample: JB-01 **Depth:** 2.00-10.00

Sample Number: D4S-1

Date: 10/25/13

ECS Mid-Atlantic, LLC

14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

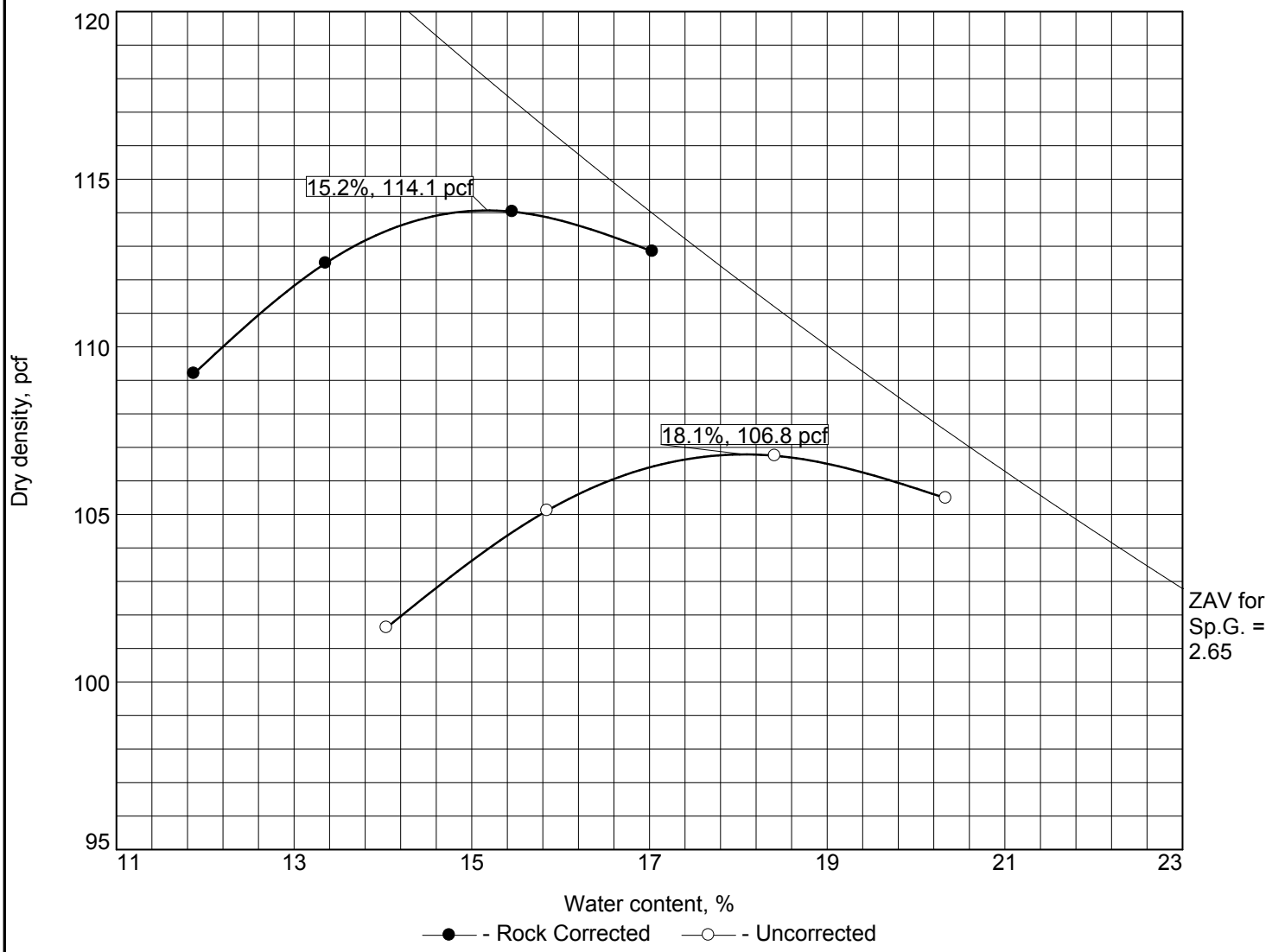
Test Description/Remarks:

Data Entered: 11/7/13

Figure _____

Tested By: DNN **Checked By:** DVT

COMPACTION TEST REPORT For Curve No. S-1



Test specification: Virginia Test Method - 1
AASHTO T 224-01 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
2.00-10.00	ML	A-7-5(5)	15.4	2.65	43	11	18.0	56.9

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 114.1 pcf	106.8 pcf	Sandy Silt Trace Mica Yellowish Brown (18.0% +4)
Optimum moisture = 15.2 %	18.1 %	

Project No. 21924 **Client:** Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Date: 10/25/13
○ **Source of Sample:** JB-01 **Sample Number:** D4S-1

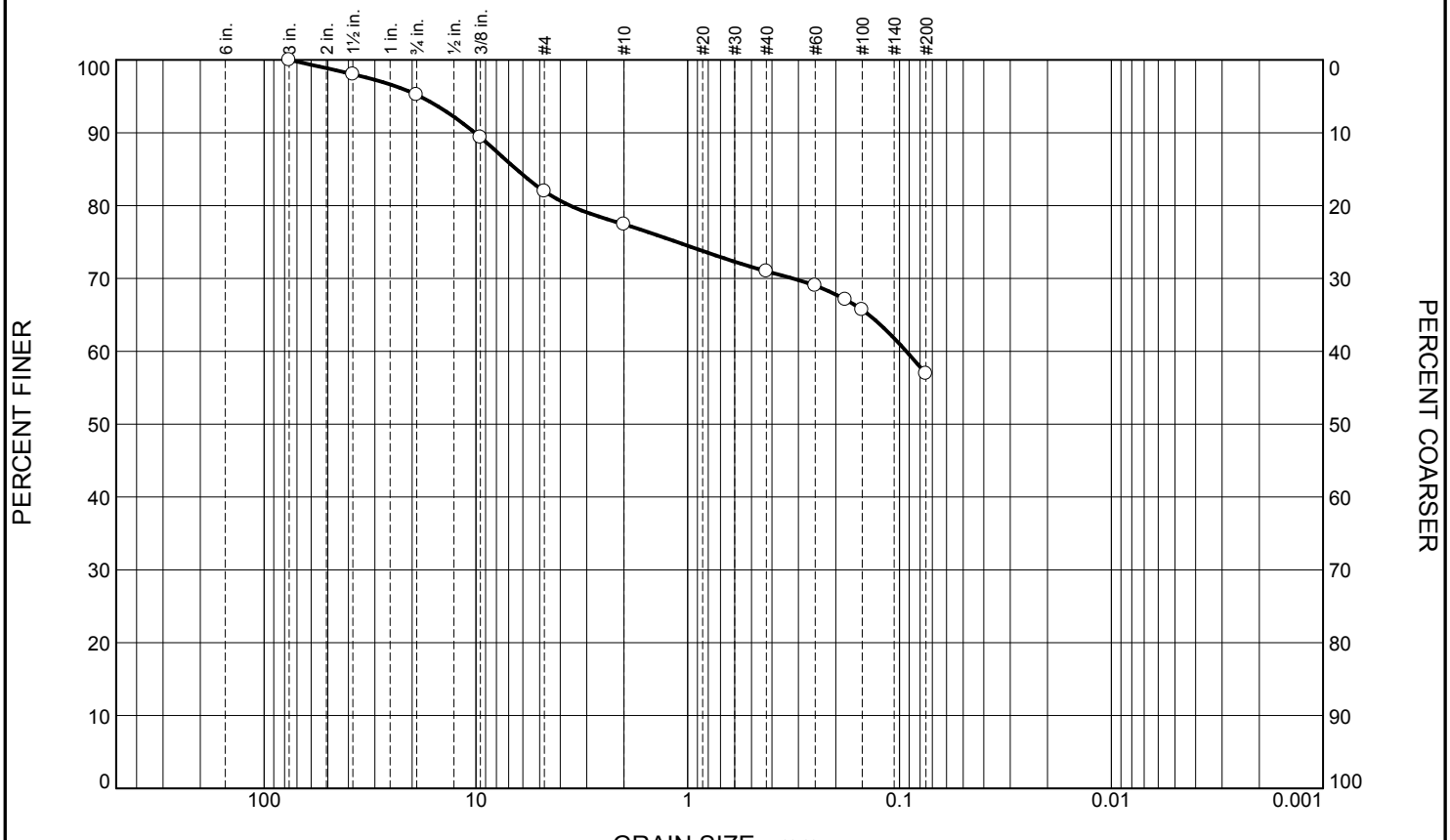
Remarks:
Data Entered: 10/28/13

ECS Mid-Atlantic, LLC
14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

Figure

Tested By: DNN **Checked By:** DVT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.8	13.2	4.6	6.4	14.1	56.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
1.5	98.0		
.75	95.2		
.375	89.4		
#4	82.0		
#10	77.4		
#40	71.0		
#60	69.0		
#80	67.1		
#100	65.7		
#200	56.9		

* (no specification provided)

Material Description

Sandy Silt Trace Mica Yellowish Brown (18.0% +4)

Atterberg Limits

PL= 32 LL= 43 PI= 11

Classification

USCS= ML AASHTO= A-7-5(5)

Remarks

Data Entered: 10/29/13

Source of Sample: JB-01 **Depth:** 2.00-10.00
Sample Number: D4S-1 **Date:** 10/25/13

ECS Mid-Atlantic, LLC
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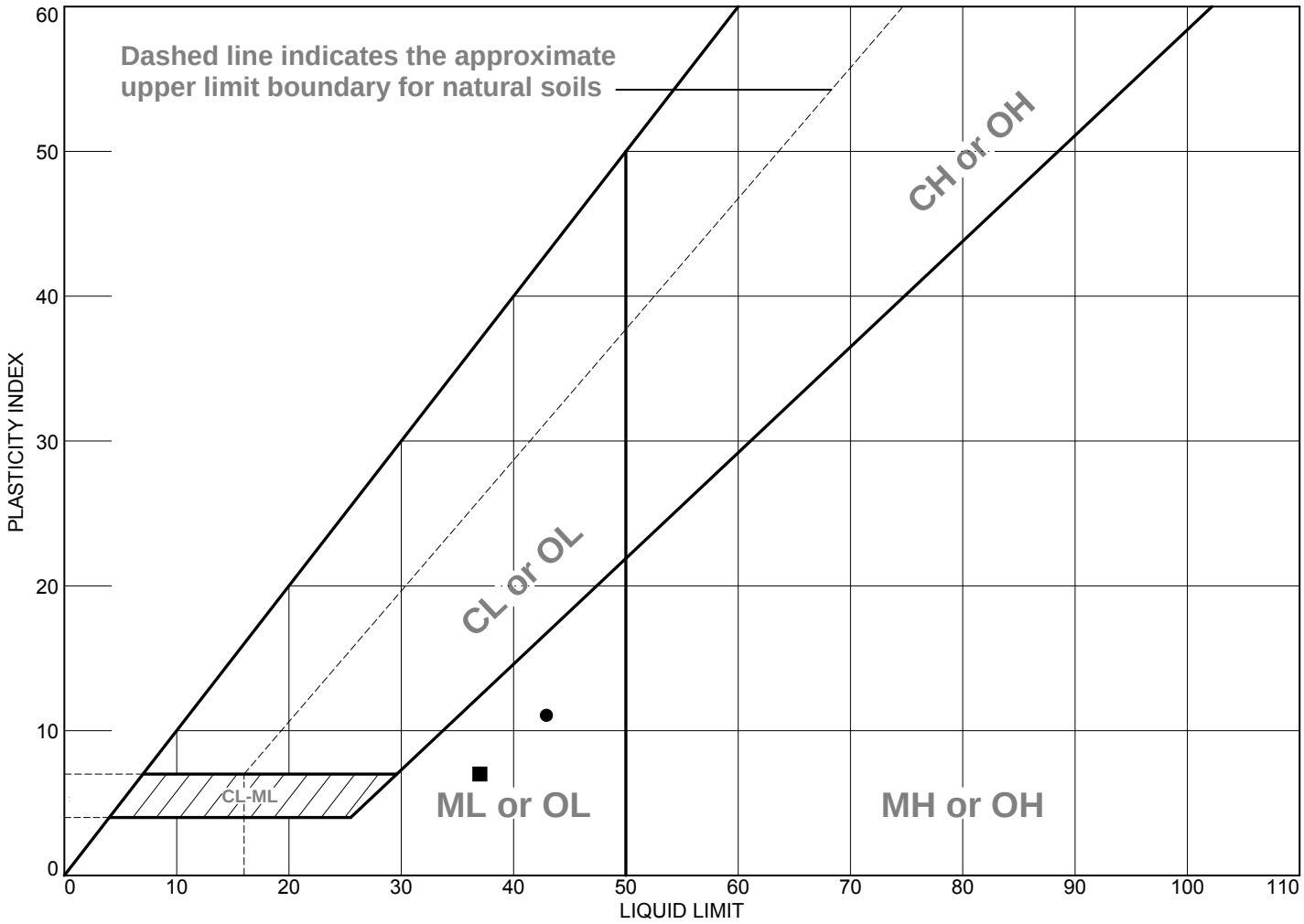
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

Client: Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Project No: 21924 **Figure**

Tested By: DNN **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt Trace Mica Yellowish Brown (18.0% +4)	43	32	11	71.0	56.9	ML
■	Silty Sand Trace Mica Strong Brown (SM)	37	30	7	65.2	46.7	SM

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

●**Source of Sample:** JB-01 **Depth:** 2.00-10.00 **Sample Number:** D4S-1

■**Source of Sample:** JB-01 **Depth:** 2.00-4.00 **Sample Number:** S-2

Remarks:

●Data Entered: 10/29/13

■Data Entered: 11/5/13

ECS Mid-Atlantic, LLC

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Chantilly, VA 20151-3232

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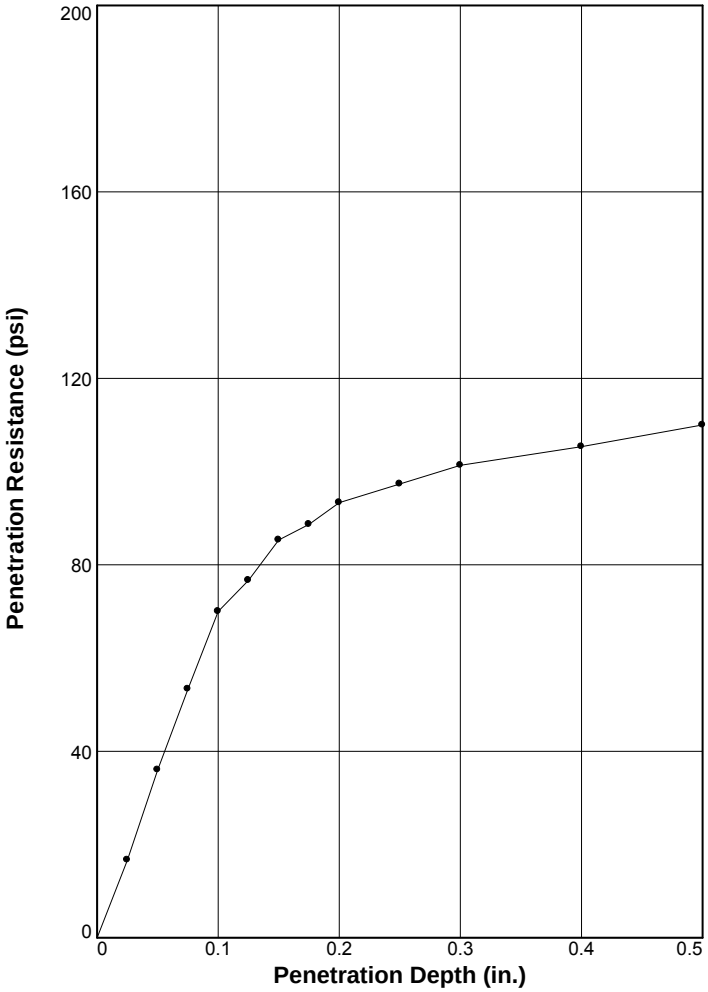
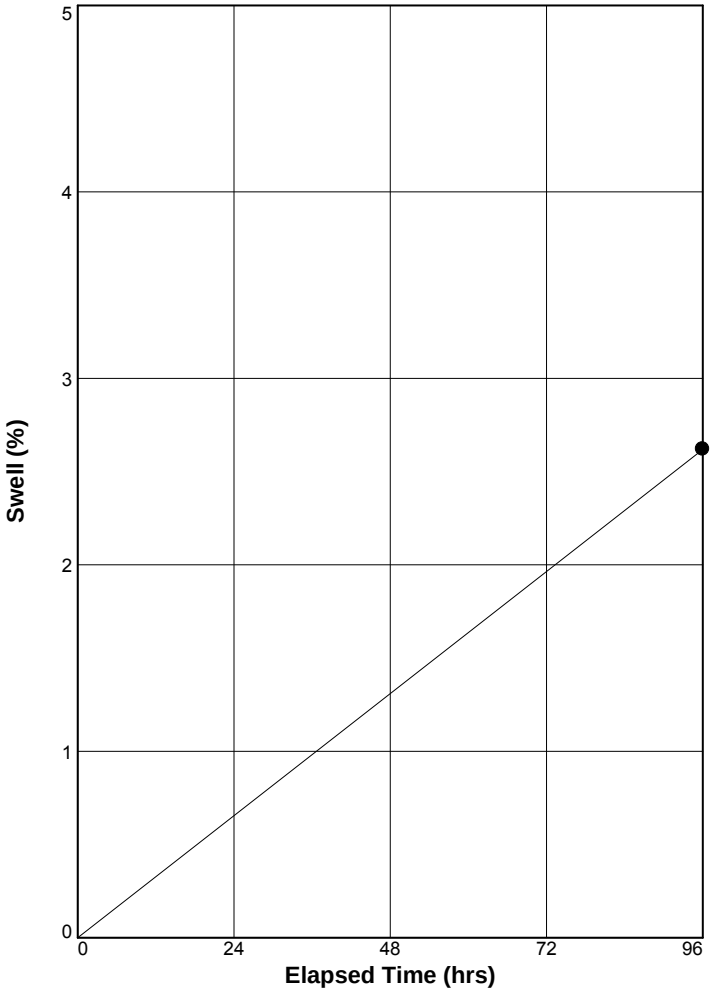
Figure

Tested By: HNT1 **Checked By:** DVT

BEARING RATIO TEST REPORT
VTM-8 (2007)





	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	111.1	100.3	16.7	108.3	97.7	25.9	7.0	6.2	0.000	10	2.6
2 △											
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Sandy Silt Trace Mica Light Reddish Brown (10.1% +4)	ML	110.8	16.3	44	9

Project No: 21924

Project: Jones Branch Connector

Source of Sample: JB-08 **Depth:** 2.00-10.00

Sample Number: D4S-2

Date: 10/25/13

ECS Mid-Atlantic, LLC

14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

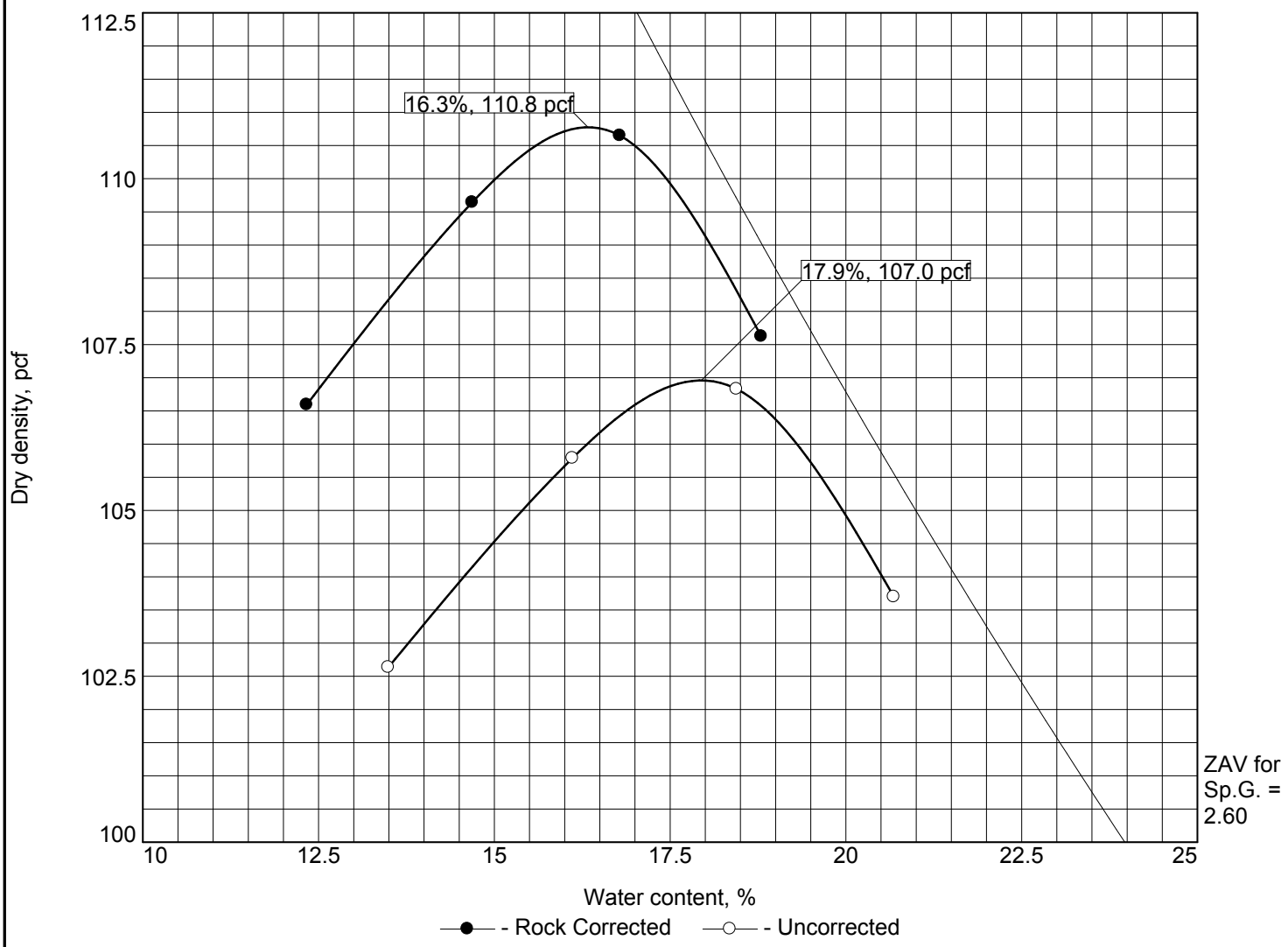
Test Description/Remarks:

Data Entered: 11/7/13

Figure _____

Tested By: DNN **Checked By:** DVT

COMPACTION TEST REPORT For Curve No. S-2



Test specification: Virginia Test Method - 1
AASHTO T 224-01 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
2.00-10.00	ML	A-5(5)	10.6	2.6	44	9	10.1	58.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 110.8 pcf	107.0 pcf	Sandy Silt Trace Mica Light Reddish Brown (10.1% +4)
Optimum moisture = 16.3 %	17.9 %	

Project No. 21924 **Client:** Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Date: 10/25/13
○ **Source of Sample:** JB-08 **Sample Number:** D4S-2

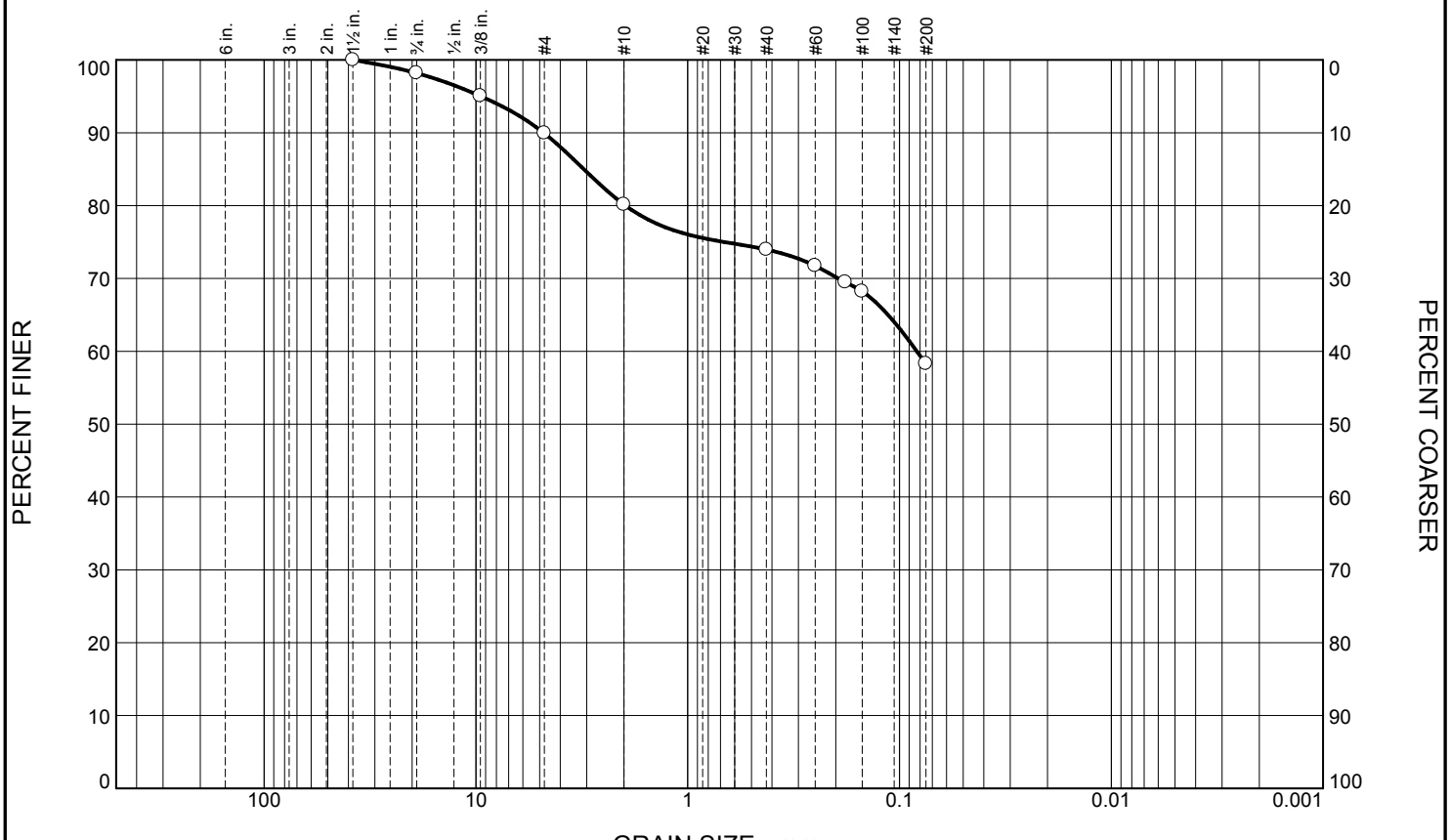
Remarks:
Data Entered: 10/28/13

ECS Mid-Atlantic, LLC
14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400 Fax: (703) 991-4846

Figure

Tested By: DNN **Checked By:** DVT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.8	8.3	9.8	6.1	15.7	58.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
.75	98.2		
.375	95.0		
#4	89.9		
#10	80.1		
#40	74.0		
#60	71.7		
#80	69.5		
#100	68.2		
#200	58.3		

* (no specification provided)

Material Description

Sandy Silt Trace Mica Light Reddish Brown (10.1% +4)

Atterberg Limits

PL= 35 LL= 44 PI= 9

Classification

USCS= ML AASHTO= A-5(5)

Remarks

Data Entered: 10/29/13

Source of Sample: JB-08 **Depth:** 2.00-10.00
Sample Number: D4S-2 **Date:** 10/25/13

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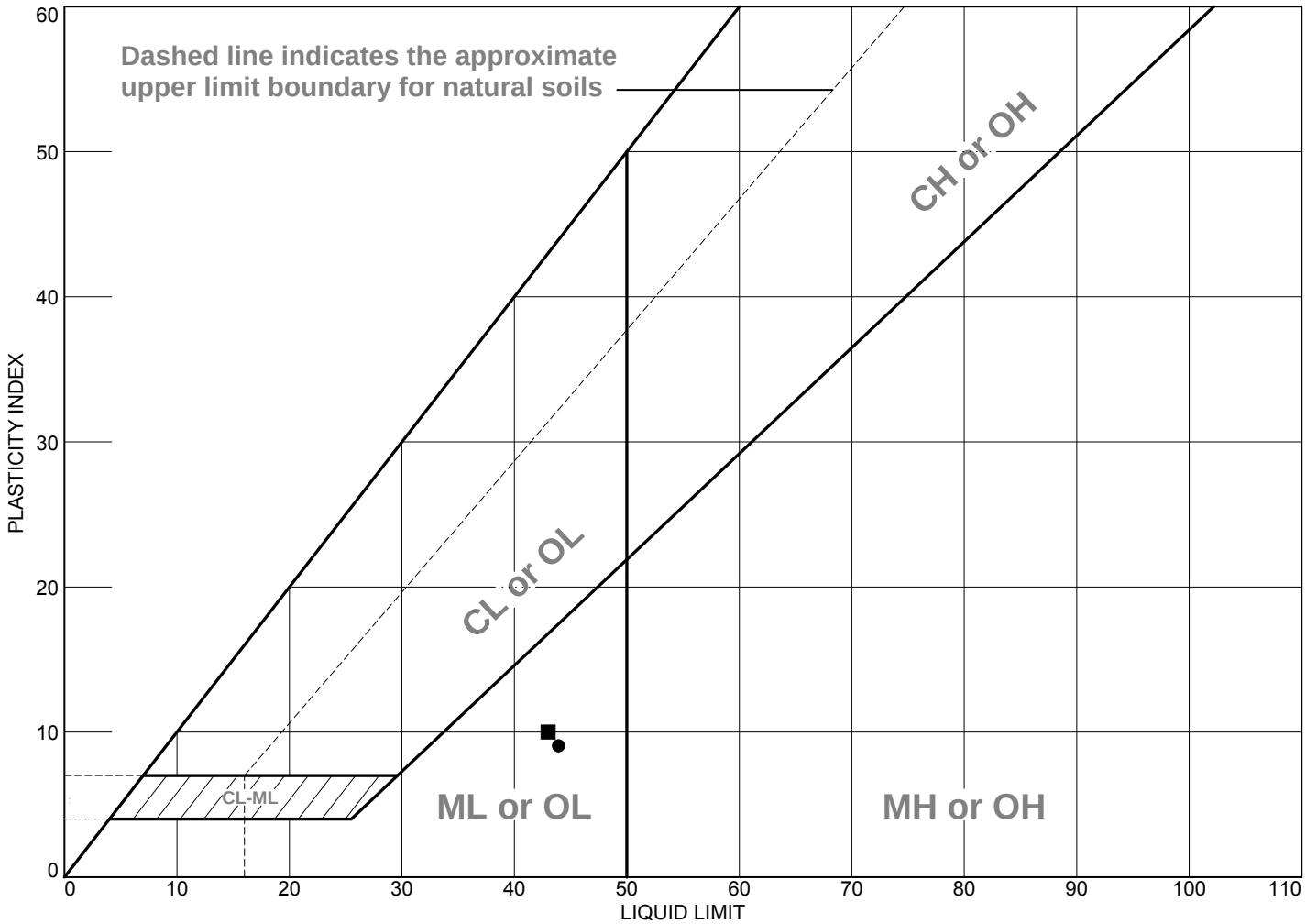
Client: Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Project No: 21924 **Figure**

Tested By: DNN **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt Trace Mica Light Reddish Brown (10.1% +4)	44	35	9	74.0	58.3	ML
■	Sandy Silt Trace Mica Brown (ML)	43	33	10	70.6	53.9	ML
▲	Sandy Silt Trace Mica Strong Brown (ML)	NP	NP	NP	92.8	62.6	ML

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

●**Source of Sample:** JB-08 **Depth:** 2.00-10.00 **Sample Number:** D4S-2

■**Source of Sample:** JB-08 **Depth:** 4.00-4.00 **Sample Number:** S-2

▲**Source of Sample:** JB-08 **Depth:** 18.00-18.00 **Sample Number:** S-6

Remarks:

●Data Entered: 10/29/13

■Data Entered: 11/5/13

▲Data Entered: 11/6/13

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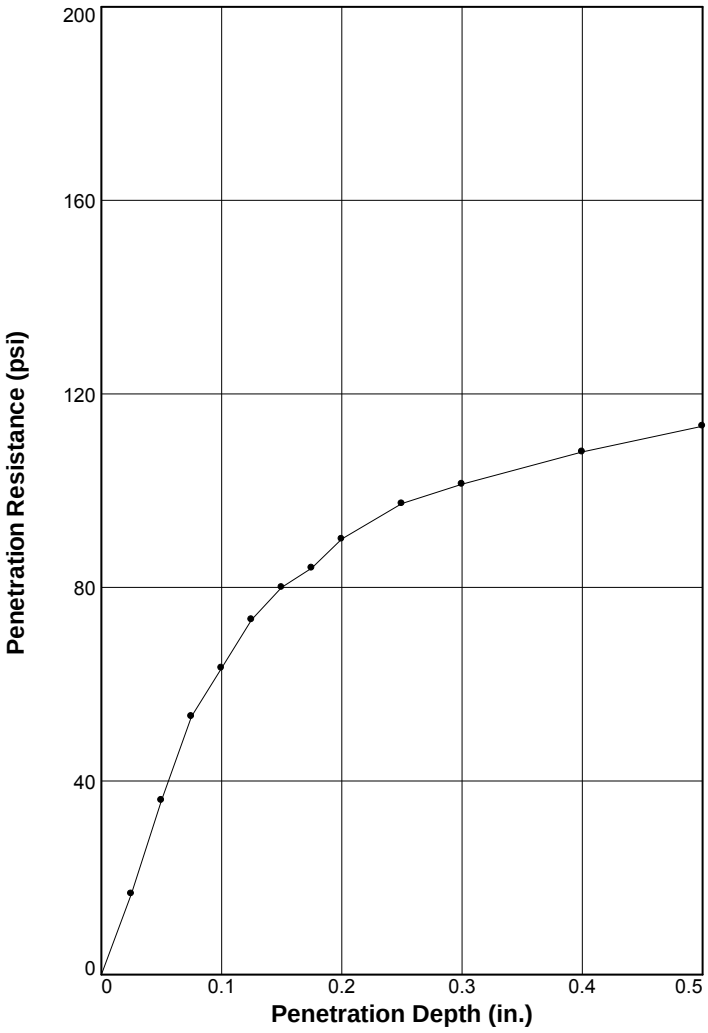
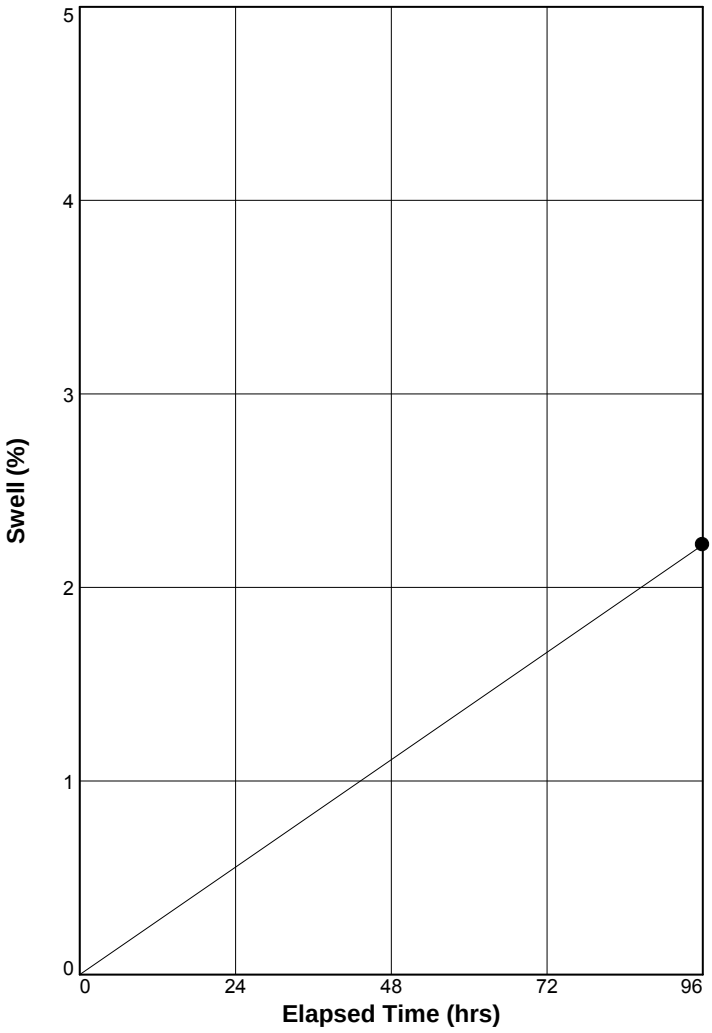
Figure

Tested By: HNT1 **Checked By:** DVT

BEARING RATIO TEST REPORT
VTM-8 (2007)





	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	111.3	100.5	15.8	108.9	98.3	24.6	6.3	6.0	0.000	10	2.2
2 △											
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Sandy Silt Trace Mica Reddish Brown (3.5% +4)	ML	110.7	15.4	40	8

Project No: 21924

Project: Jones Branch Connector

Source of Sample: JB-12 **Depth:** 1.00-6.00

Sample Number: D4S-3

Date: 10/25/13

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Test Description/Remarks:

Data Entered: 11/7/13

Figure _____

COMPACTION TEST REPORT For Curve No. S-3

Test specification: Virginia Test Method - 1

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
1.00-6.00	ML	A-4(5)	13.0	2.6	40	8	3.5	62.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 110.7 pcf Optimum moisture = 15.4 %	Sandy Silt Trace Mica Reddish Brown (3.5% +4)

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

Date: 10/25/13

○ **Source of Sample:** JB-12 **Sample Number:** D4S-3

Remarks:

Data Entered: 10/28/13

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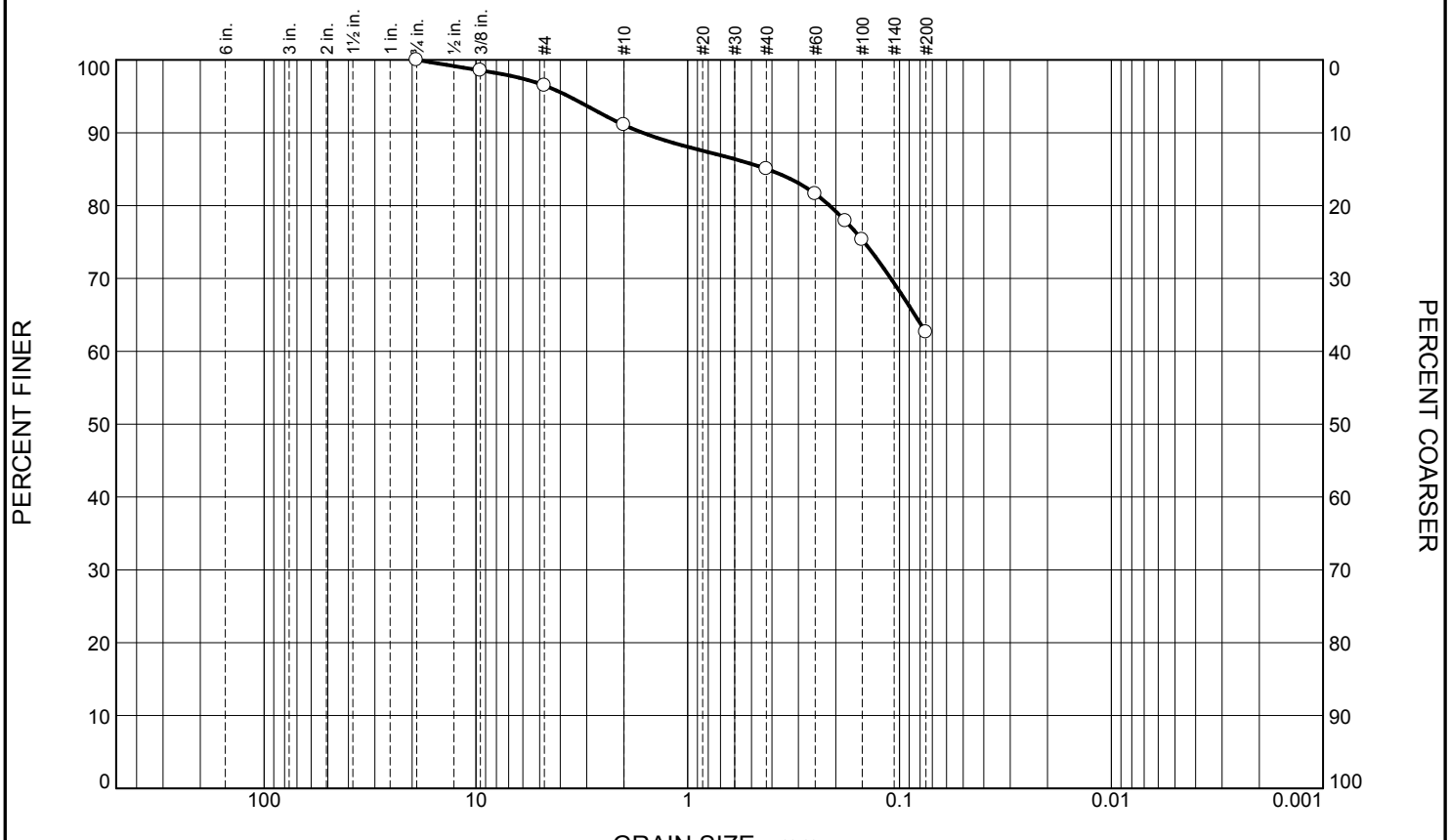
Figure

Tested By: DNN **Checked By:** DVT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.5	5.4	6.1	22.4	62.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.375	98.6		
#4	96.5		
#10	91.1		
#40	85.0		
#60	81.6		
#80	77.9		
#100	75.3		
#200	62.6		

* (no specification provided)

Material Description

Sandy Silt Trace Mica Reddish Brown (3.5% +4)

Atterberg Limits

PL= 32 LL= 40 PI= 8

Classification

USCS= ML AASHTO= A-4(5)

Remarks

Data Entered: 10/29/13

Source of Sample: JB-12 **Depth:** 1.00-6.00
Sample Number: D4S-3 **Date:** 10/25/13

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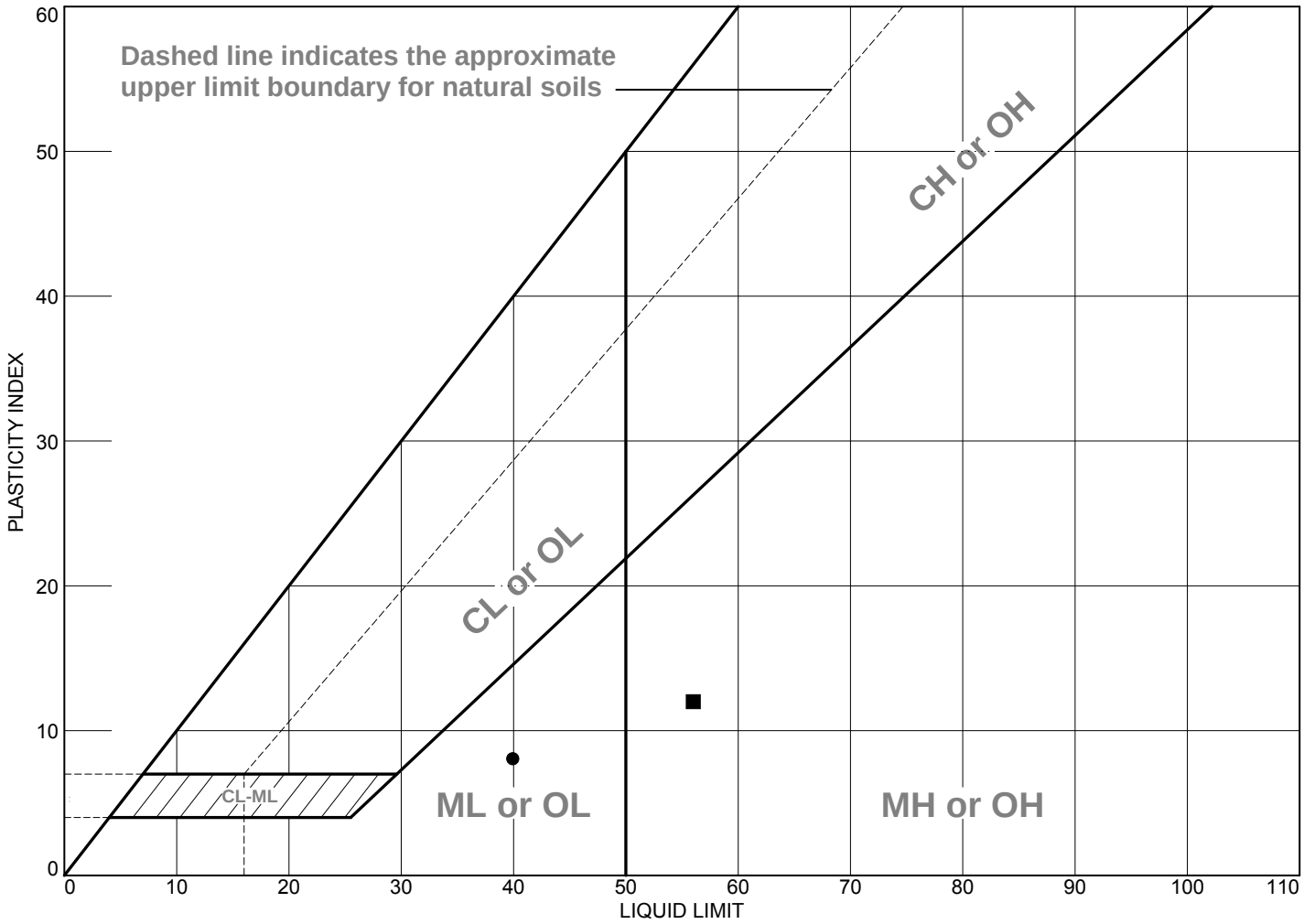
Client: Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Project No: 21924 **Figure**

Tested By: DNN **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt Trace Mica Reddish Brown (3.5% +4)	40	32	8	85.0	62.6	ML
■	Elastic Silt with Sand Trace Mica Reddish Brown (MH)	56	44	12	91.3	78.8	MH

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

●**Source of Sample:** JB-12 **Depth:** 1.00-6.00 **Sample Number:** D4S-3

■**Source of Sample:** JB-12 **Depth:** 23.00-23.00 **Sample Number:** S-8

Remarks:

●Data Entered: 10/29/13

■Data Entered: 11/1/13

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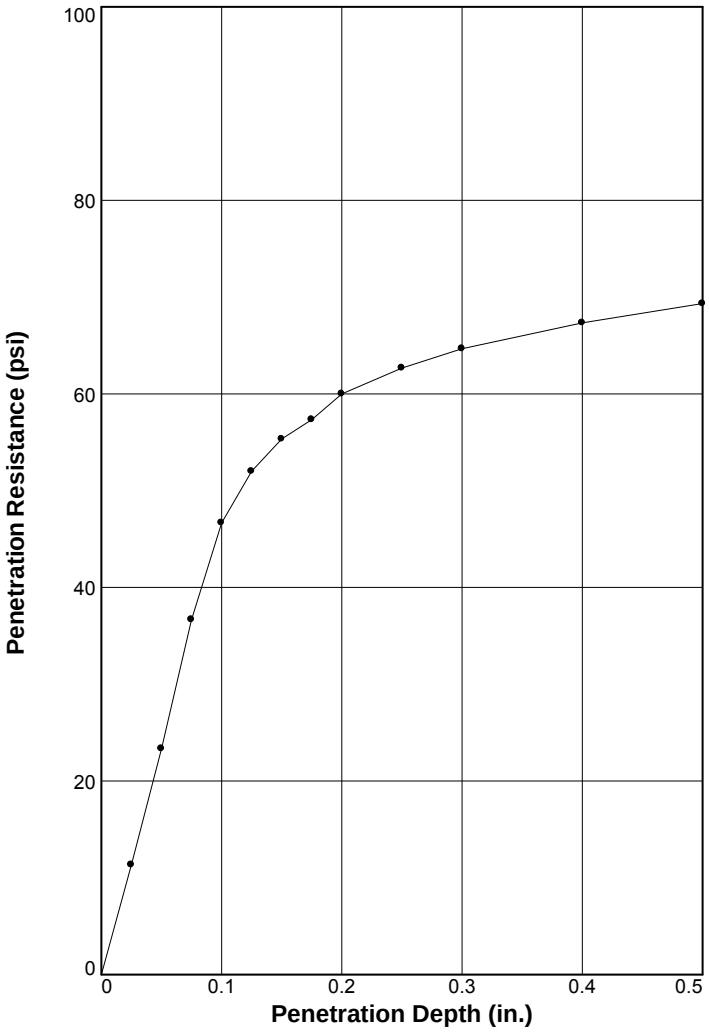
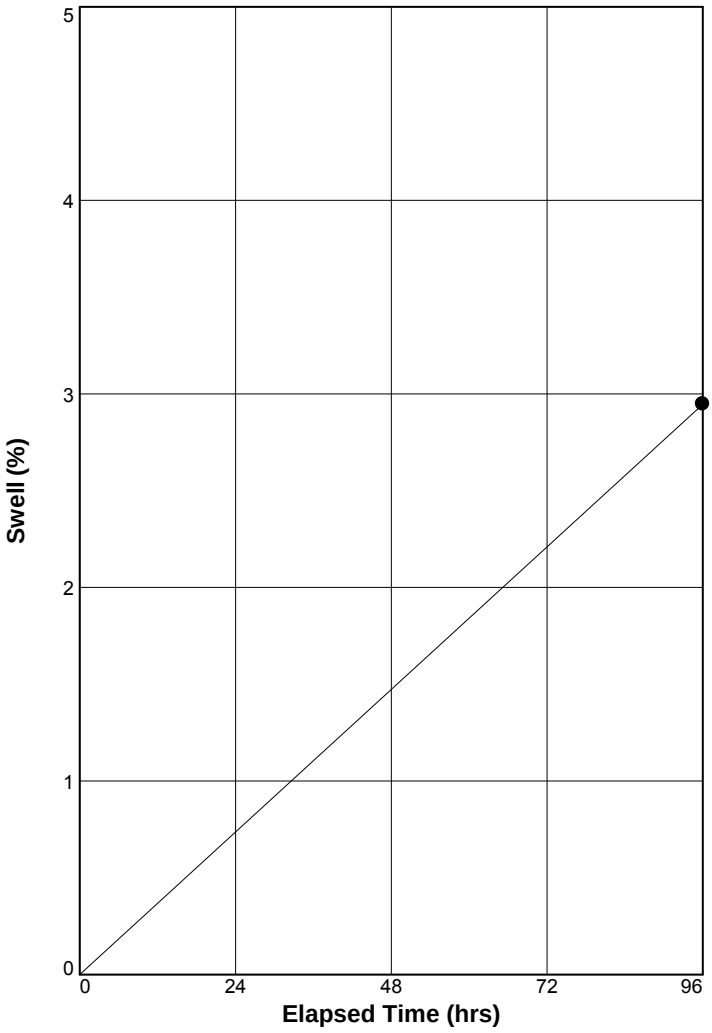
Figure

Tested By: HNT1 **Checked By:** DVT

BEARING RATIO TEST REPORT
VTM-8 (2007)





	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	103.5	100.3	20.0	100.5	97.4	30.2	4.7	4.0	0.000	10	2.9
2 △											
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Sandy Silt Trace Mica Reddish Brown (5.3% +4)	MH	103.2	19.7	52	14

Project No: 21924

Project: Jones Branch Connector

Source of Sample: JB-20 **Depth:** 2.00-10.00

Sample Number: D4S-4

Date: 10/25/13

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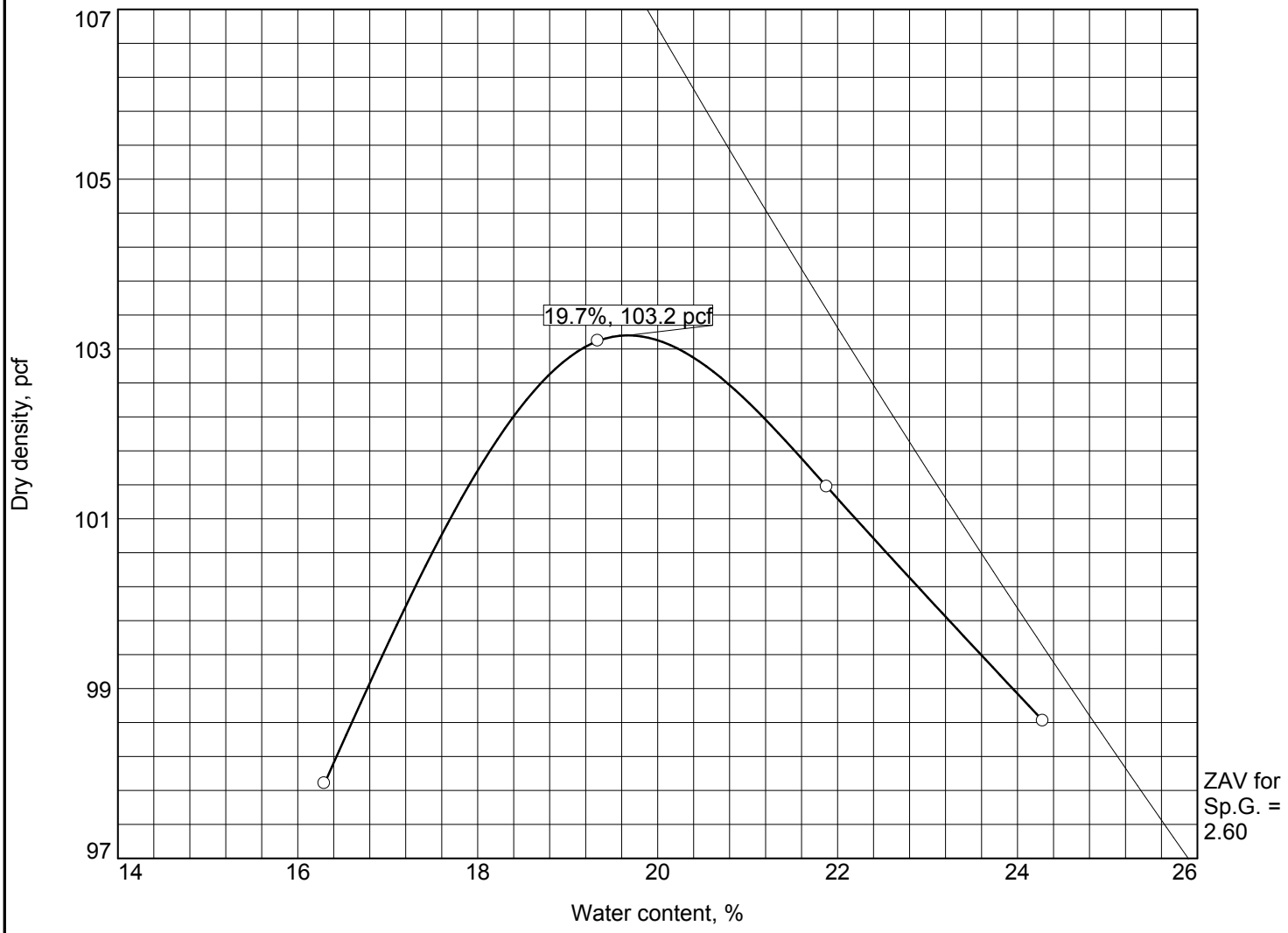
Test Description/Remarks:

Data Entered: 11/7/13

Figure _____

COMPACTION TEST REPORT For Curve No. S-4



Test specification: Virginia Test Method - 1

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
2.00-10.00	MH	A-7-5(11)	16.8	2.6	52	14	5.3	69.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 103.2 pcf Optimum moisture = 19.7 %	Sandy Silt Trace Mica Reddish Brown (5.3% +4)

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

Date: 10/25/13

○ **Source of Sample:** JB-20 **Sample Number:** D4S-4

Remarks:

Data Entered: 10/28/13

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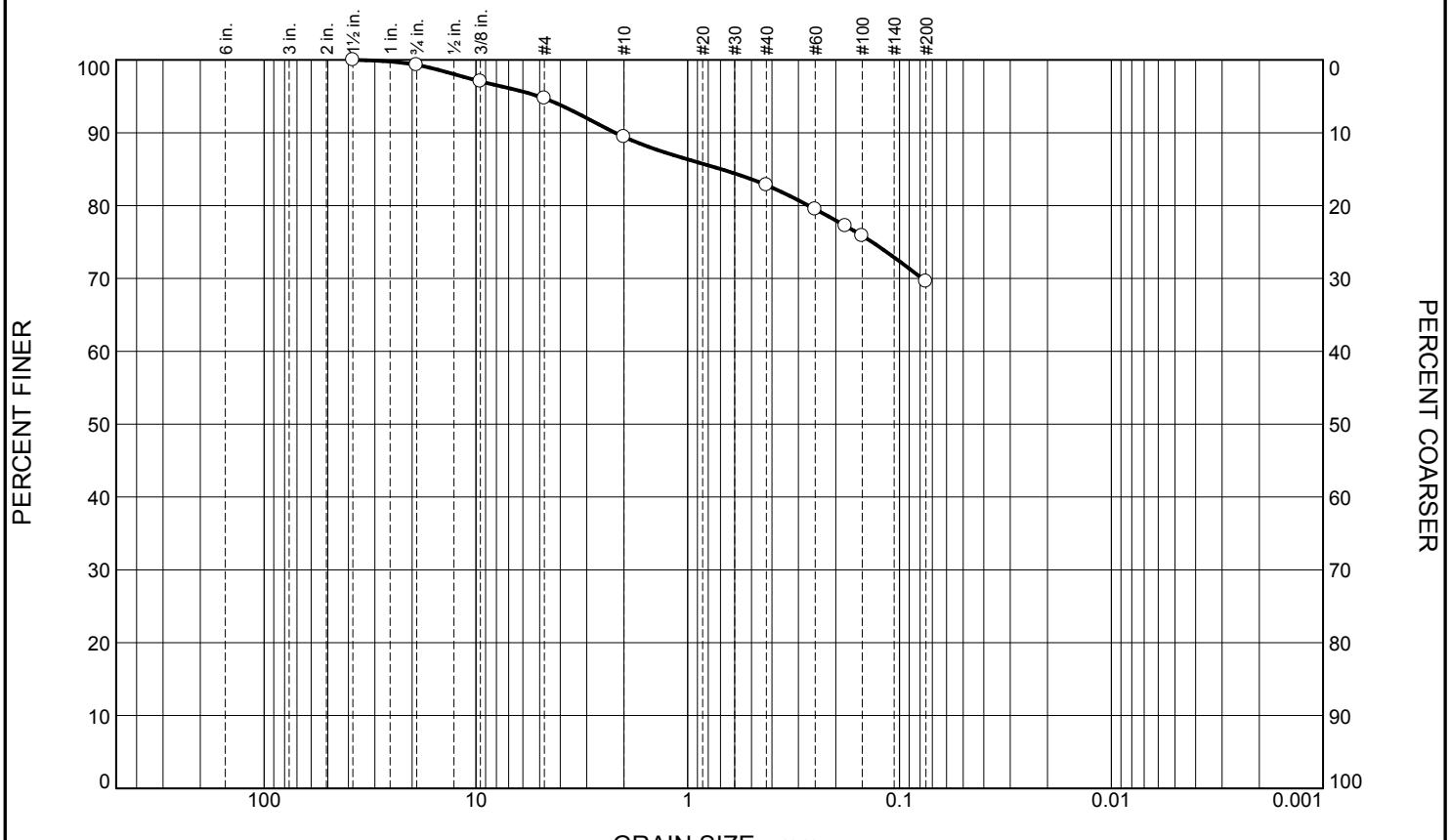
Figure

Tested By: DNN **Checked By:** DVT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.7	4.6	5.3	6.6	13.2	69.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
.75	99.3		
.375	97.0		
#4	94.7		
#10	89.4		
#40	82.8		
#60	79.5		
#80	77.2		
#100	75.9		
#200	69.6		

* (no specification provided)

Material Description

Sandy Silt Trace Mica Reddish Brown (5.3% +4)

Atterberg Limits

PL= 38 LL= 52 PI= 14

Classification

USCS= MH AASHTO= A-7-5(11)

Remarks

Data Entered: 10/29/13

Source of Sample: JB-20 **Depth:** 2.00-10.00
Sample Number: D4S-4 **Date:** 10/25/13

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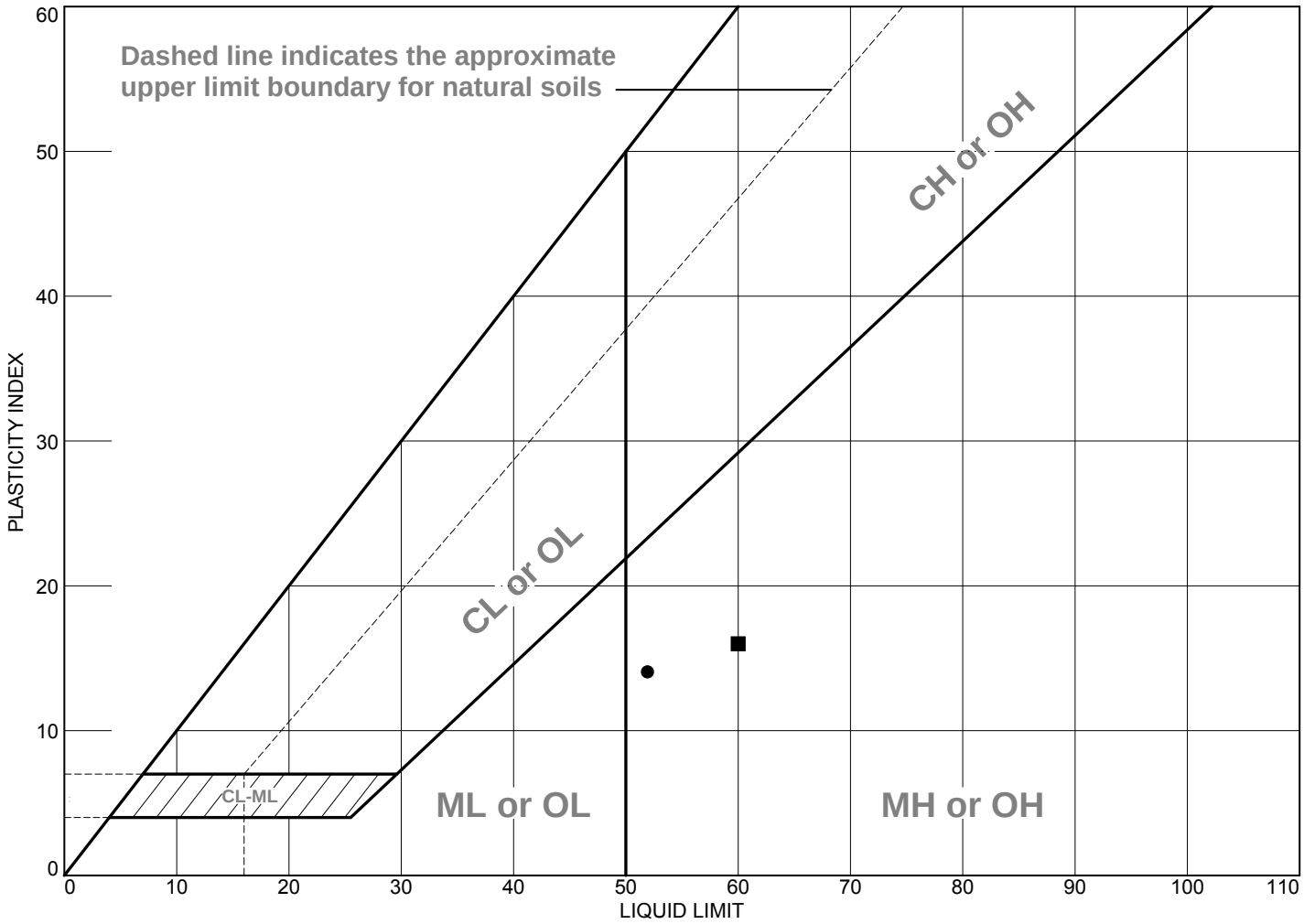
Client: Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Project No: 21924 **Figure**

Tested By: DNN **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt Trace Mica Reddish Brown (5.3% +4)	52	38	14	82.8	69.6	MH
■	Sandy Silt with Gravel Reddish Brown (ML)	60	44	16	67.3	57.5	MH
▲	Sandy Silt Trace Mica Light Yellowish Brown (ML)	NP	NP	NP	90.1	62.7	ML

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

●**Source of Sample:** JB-20 **Depth:** 2.00-10.00 **Sample Number:** D4S-4

■**Source of Sample:** JB-20 **Depth:** 4.00-4.00 **Sample Number:** S-2

▲**Source of Sample:** JB-20 **Depth:** 33.00-33.00 **Sample Number:** S-9

Remarks:

●Data Entered: 10/29/13

■Data Entered: 11/6/13

▲Data Entered: 11/6/13

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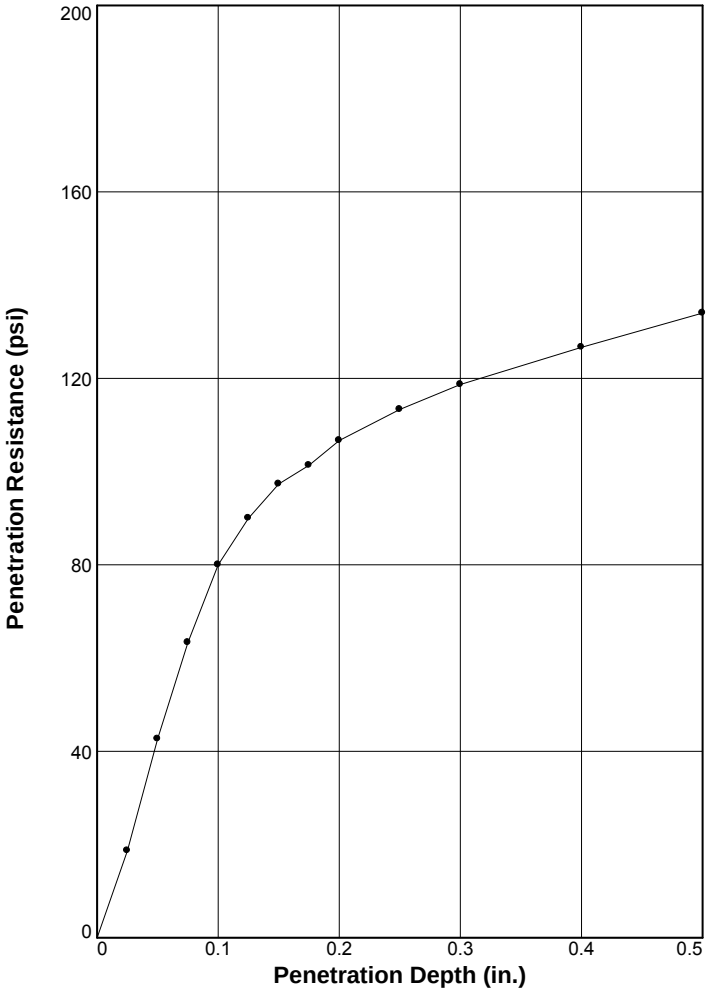
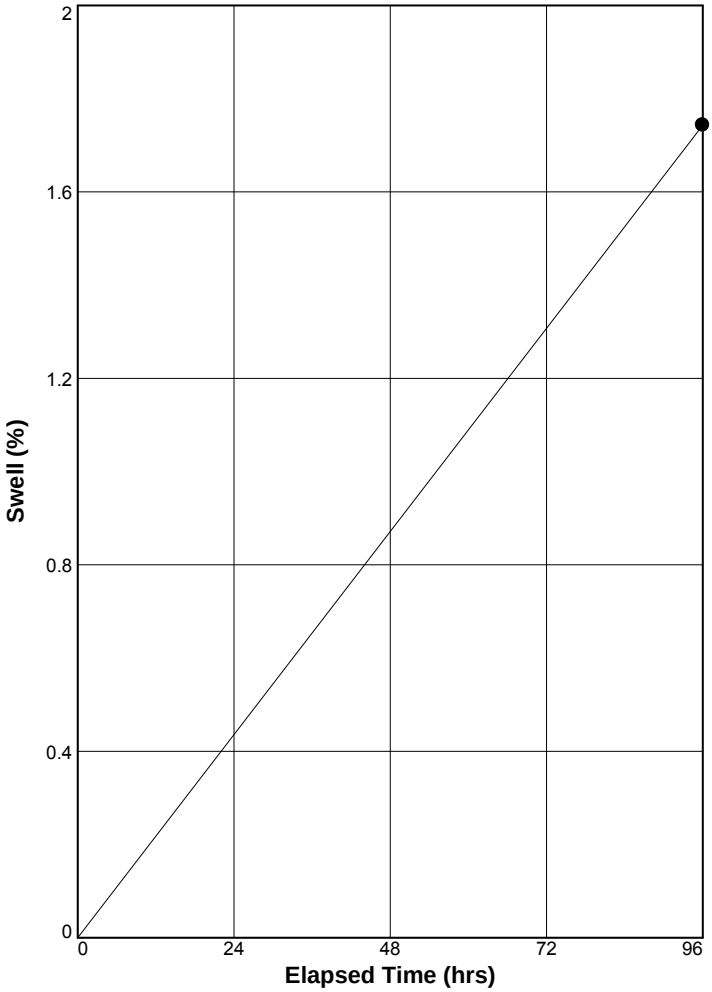
Figure

Tested By: HNT1 **Checked By:** DVT

BEARING RATIO TEST REPORT
VTM-8 (2007)





	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	114.8	100.9	16.0	112.8	99.1	24.3	8.0	7.1	0.000	10	1.7
2 △											
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Sandy Lean Clay Trace Mica Reddish Brown (7.0% +4)	CL	113.8	15.9	42	18

Project No: 21924

Project: Jones Branch Connector

Source of Sample: JB-50 **Depth:** 2.00-10.00

Sample Number: D4S-5

Date: 10/25/13

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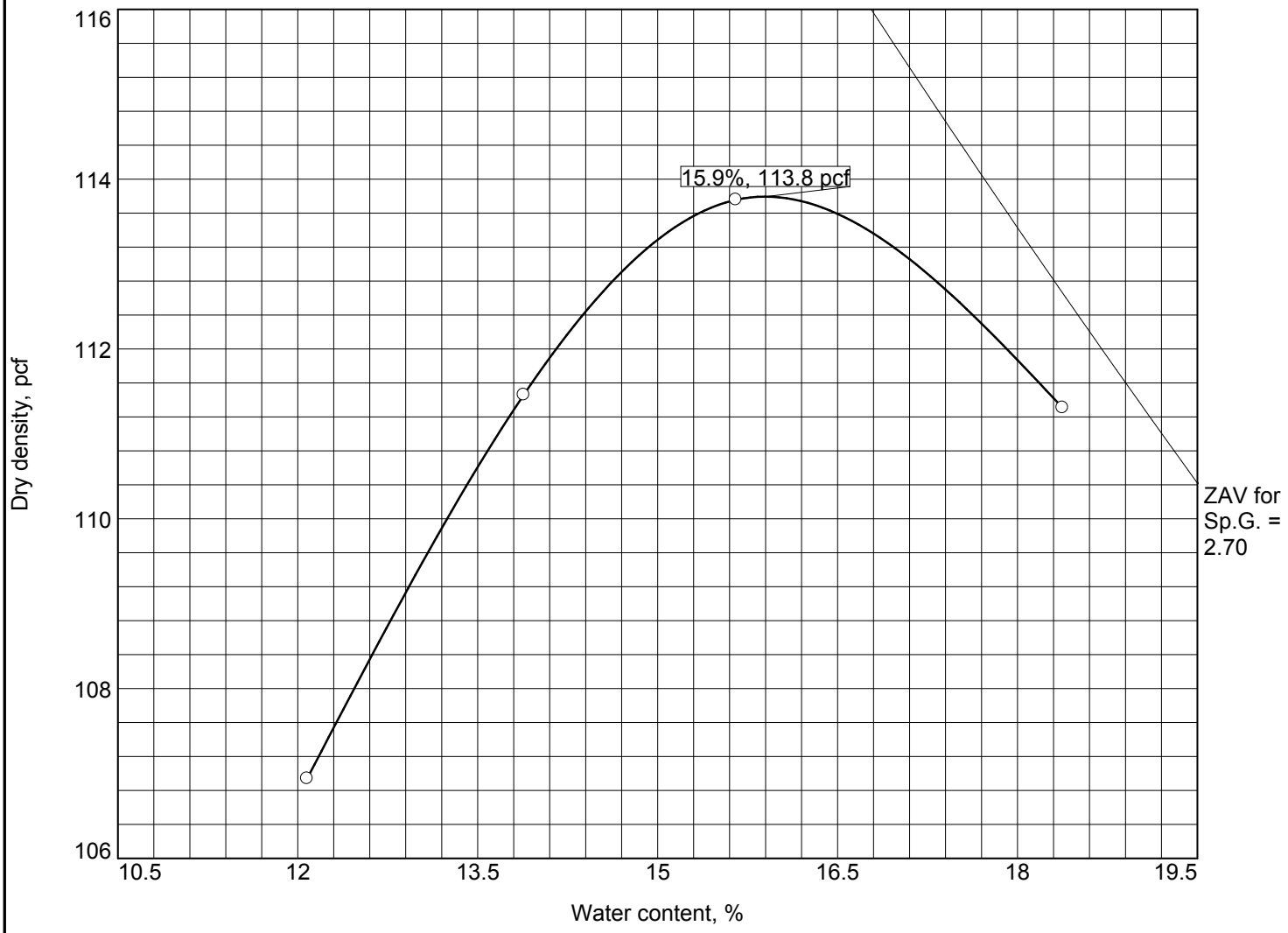
Test Description/Remarks:

Data Entered: 11/7/13

Figure _____

Tested By: DNN **Checked By:** DVT

COMPACTION TEST REPORT For Curve No. S-5



Test specification: Virginia Test Method - 1

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
2.00-10.00	CL	A-7-6(9)	14.9	2.7	42	18	7.0	58.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 113.8 pcf Optimum moisture = 15.9 %	Sandy Lean Clay Trace Mica Reddish Brown (7.0% +4)

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

Date: 10/25/13

○ **Source of Sample:** JB-50 **Sample Number:** D4S-5

Remarks:

Data Entered: 10/28/13

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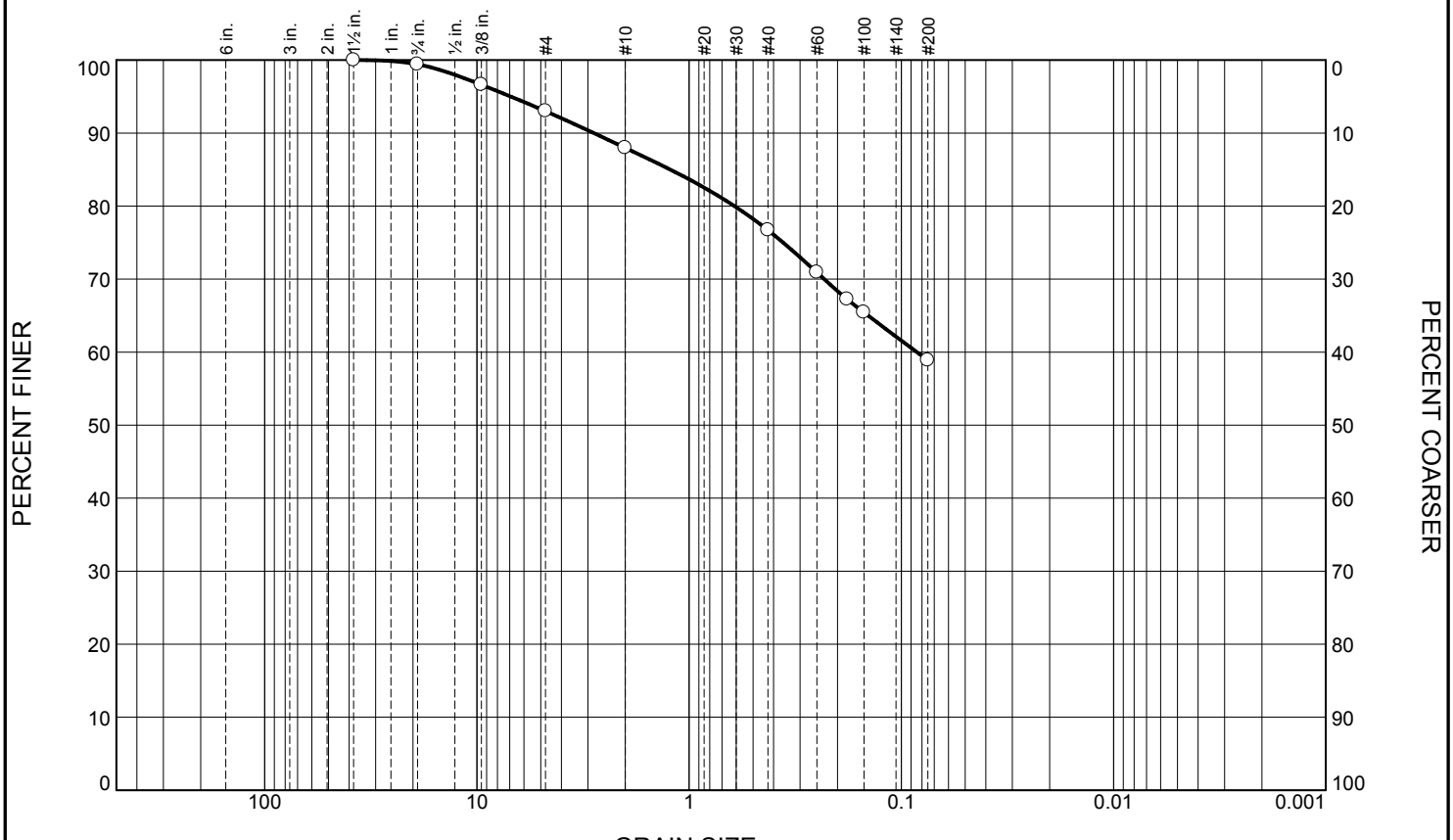
Figure

Tested By: DNN **Checked By:** DVT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.6	6.4	5.0	11.3	17.8	58.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
.75	99.4		
.375	96.6		
#4	93.0		
#10	88.0		
#40	76.7		
#60	70.9		
#80	67.2		
#100	65.4		
#200	58.9		

* (no specification provided)

Material Description

Sandy Lean Clay Trace Mica Reddish Brown (7.0% +4)

Atterberg Limits

PL= 24 LL= 42 PI= 18

Classification

USCS= CL AASHTO= A-7-6(9)

Remarks

Data Entered: 10/29/13

Source of Sample: JB-50 **Depth:** 2.00-10.00
Sample Number: D4S-5 **Date:** 10/25/13

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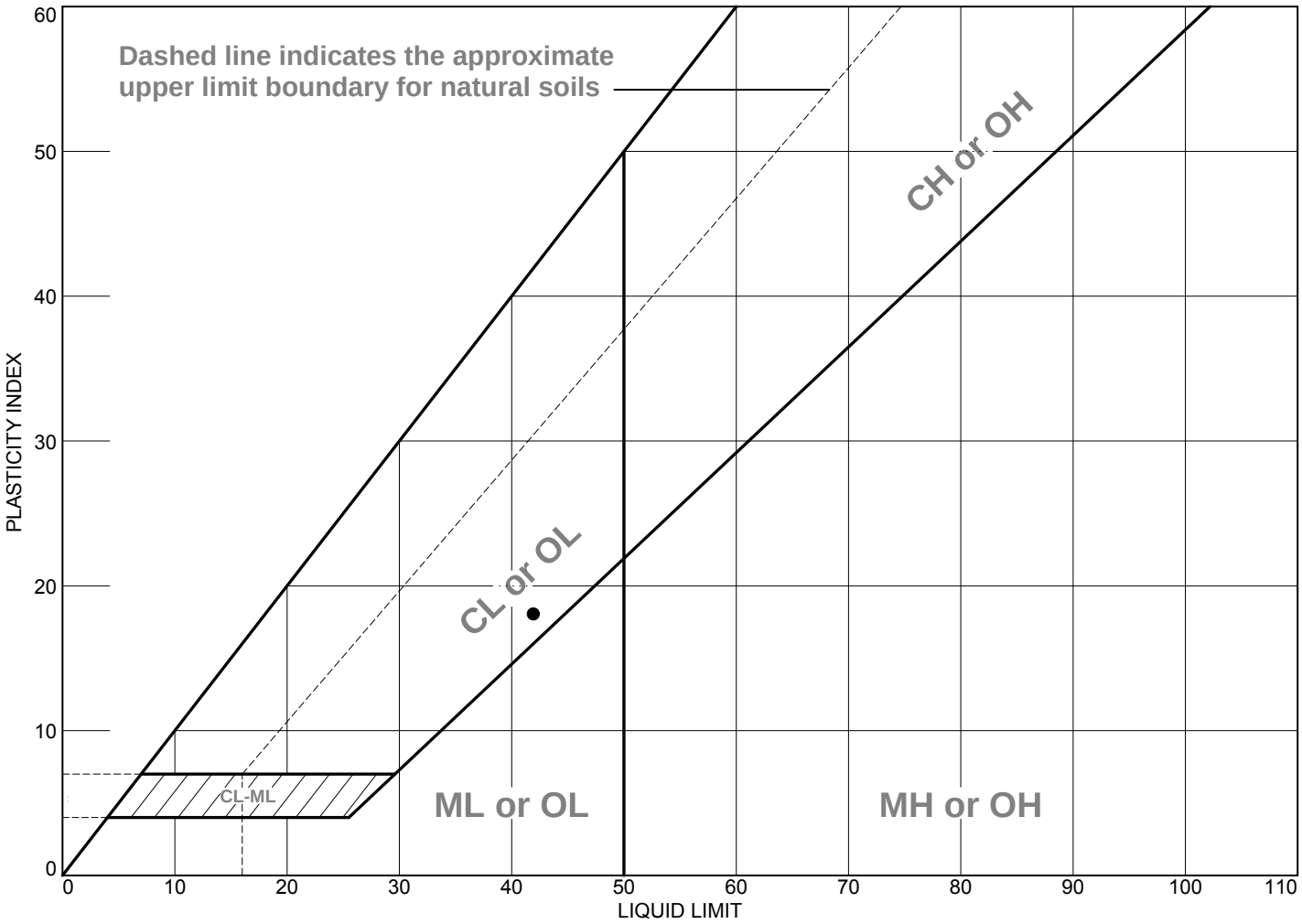
Client: Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Project No: 21924 **Figure**

Tested By: DNN **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Lean Clay Trace Mica Reddish Brown (7.0% +4)	42	24	18	76.7	58.9	CL

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

●**Source of Sample:** JB-50 **Depth:** 2.00-10.00 **Sample Number:** D4S-5

Remarks:

●Data Entered: 10/29/13

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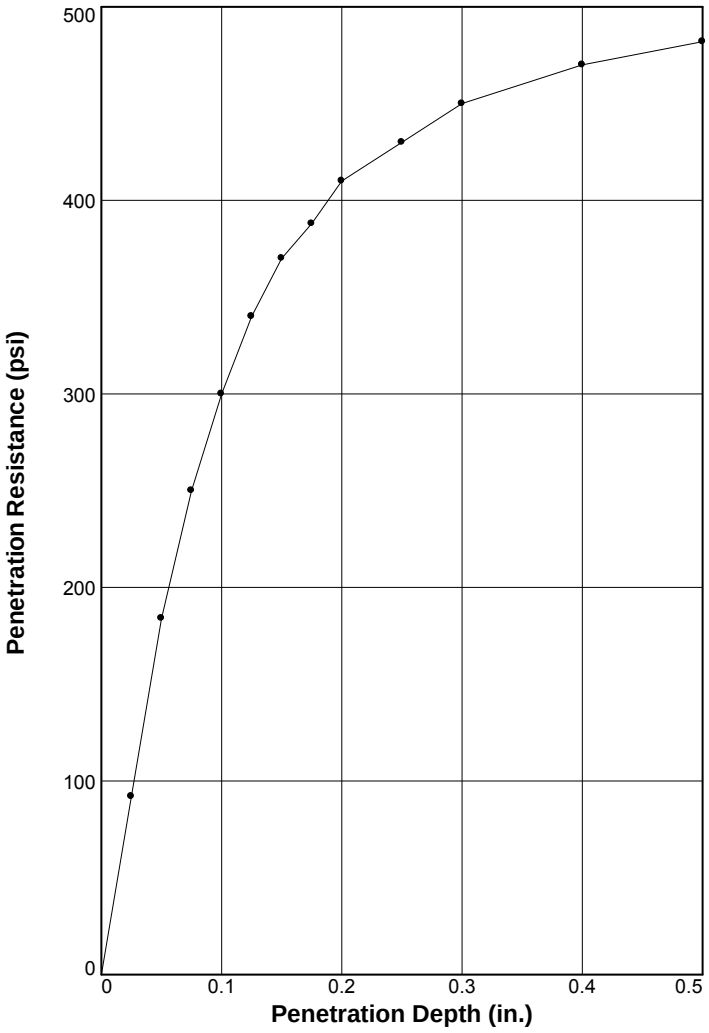
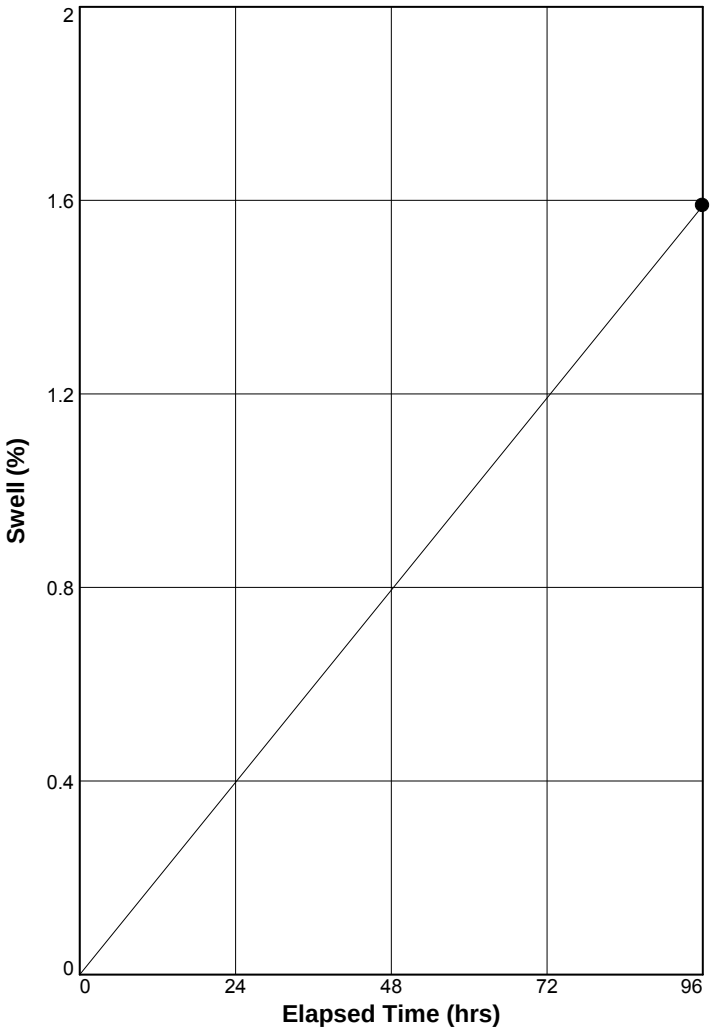
Figure

Tested By: HNT1 **Checked By:** DVT

BEARING RATIO TEST REPORT
VTM-8 (2007)





	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	127.5	99.8	11.8	125.5	98.2	18.3	30.0	27.3	0.000	10	1.6
2 △											
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Clayey Sand with Gravel Trace Mica Dark Brown (21.9% +4)	SC	127.8	11.5	39	15

Project No: 21924

Project: Jones Branch Connector

Source of Sample: JB-51 **Depth:** 2.00-10.00

Sample Number: D4S-6

Date: 10/25/13

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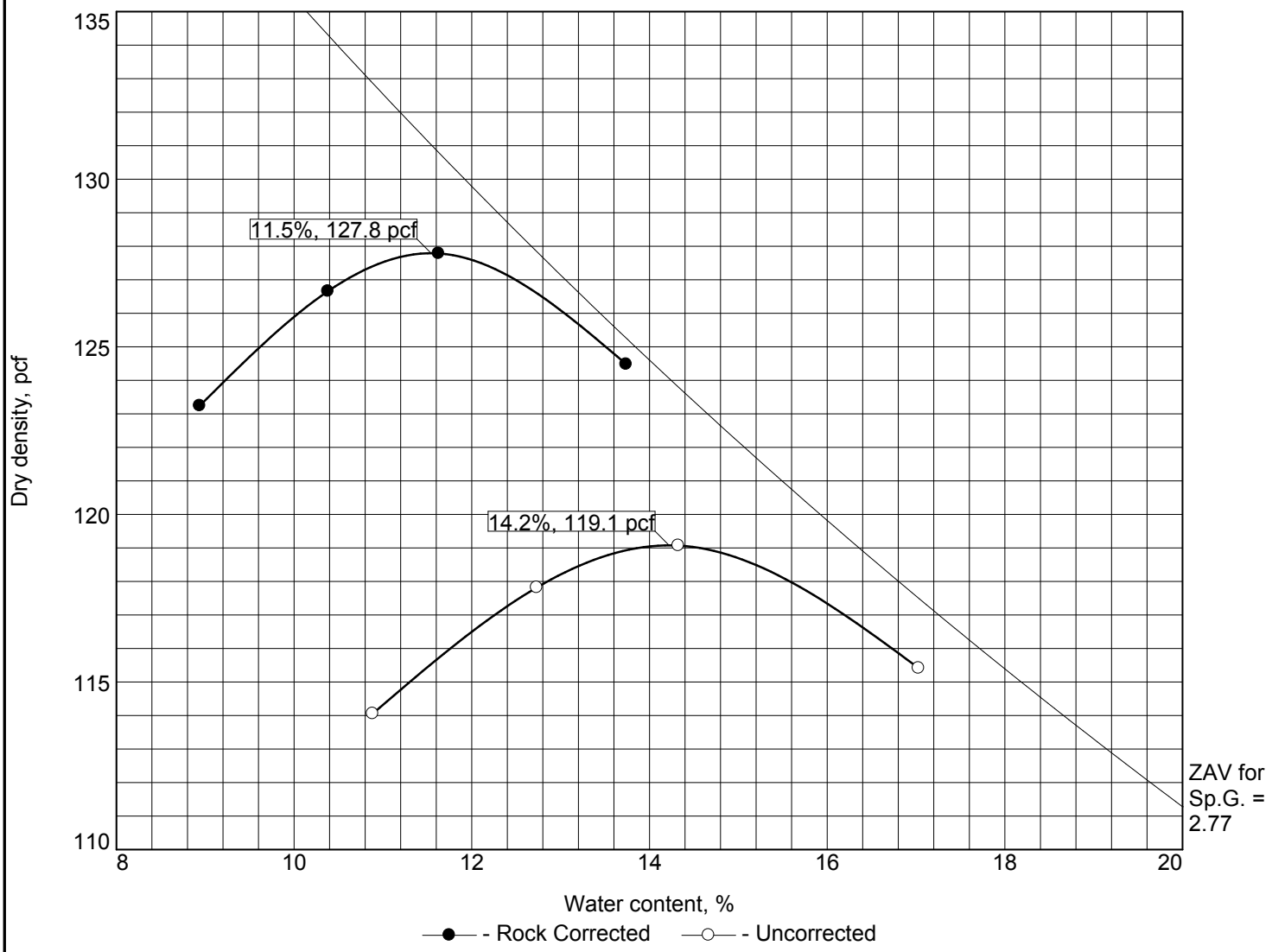
Test Description/Remarks:

Data Entered: 11/7/13

Figure _____

COMPACTION TEST REPORT For Curve No. S-6



Test specification: Virginia Test Method - 1
AASHTO T 224-01 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
2.00-10.00	SC	A-6(3)	12.0	2.77	39	15	21.9	43.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 127.8 pcf	119.1 pcf	Clayey Sand with Gravel Trace Mica Dark Brown (21.9% +4)
Optimum moisture = 11.5 %	14.2 %	

Project No. 21924 **Client:** Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Date: 10/25/13
○ **Source of Sample:** JB-51 **Sample Number:** D4S-6

Remarks:
Data Entered: 10/28/13

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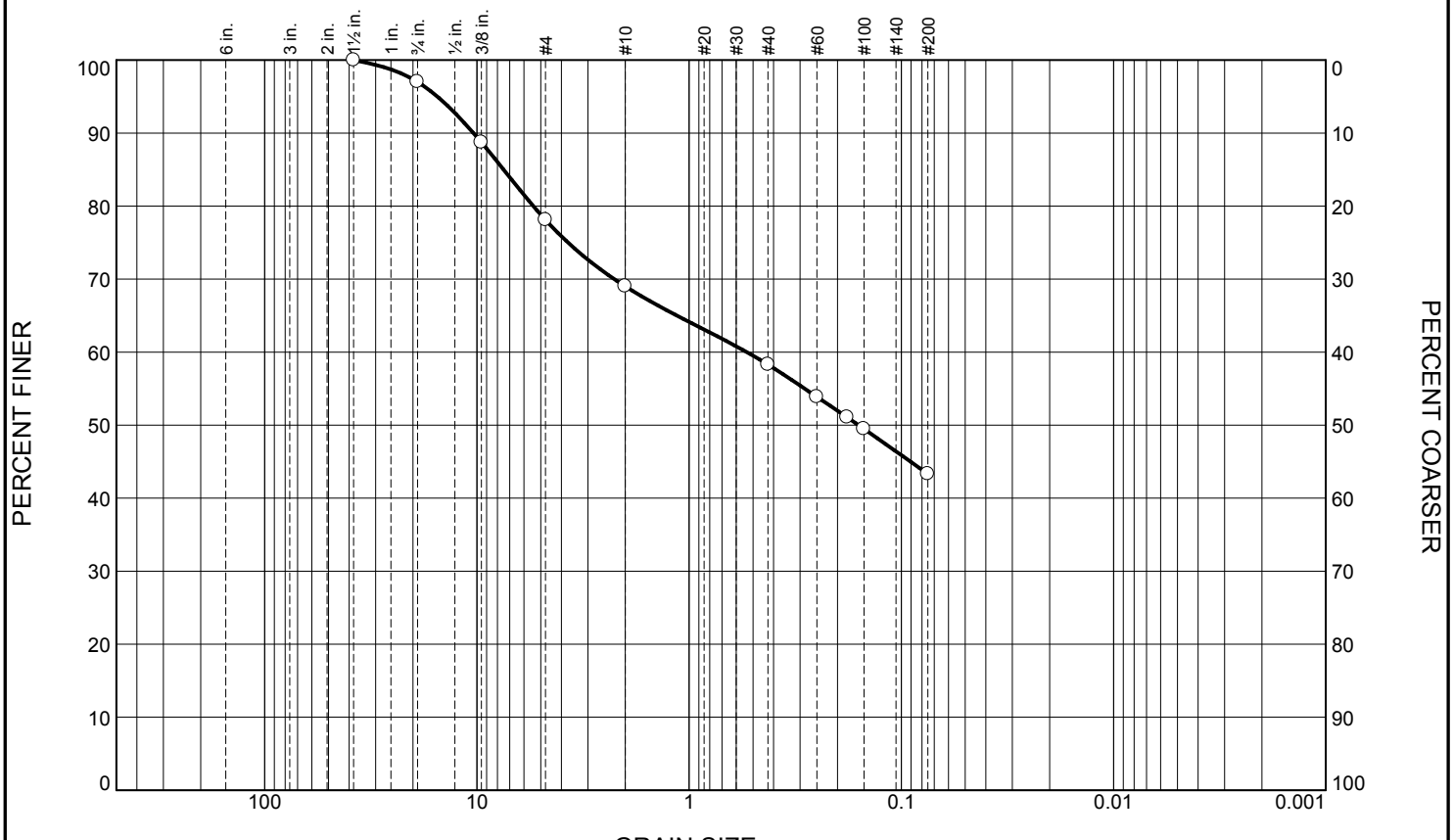
Figure

Tested By: DNN **Checked By:** DVT

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.0	18.9	9.1	10.7	15.0	43.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
.75	97.0		
.375	88.7		
#4	78.1		
#10	69.0		
#40	58.3		
#60	53.9		
#80	51.1		
#100	49.5		
#200	43.3		

* (no specification provided)

Material Description

Clayey Sand with Gravel Trace Mica Dark Brown (21.9% +4)

Atterberg Limits

PL= 24 LL= 39 PI= 15

Classification

USCS= SC AASHTO= A-6(3)

Remarks

Data Entered: 10/29/13

Source of Sample: JB-51 **Depth:** 2.00-10.00
Sample Number: D4S-6 **Date:** 10/25/13

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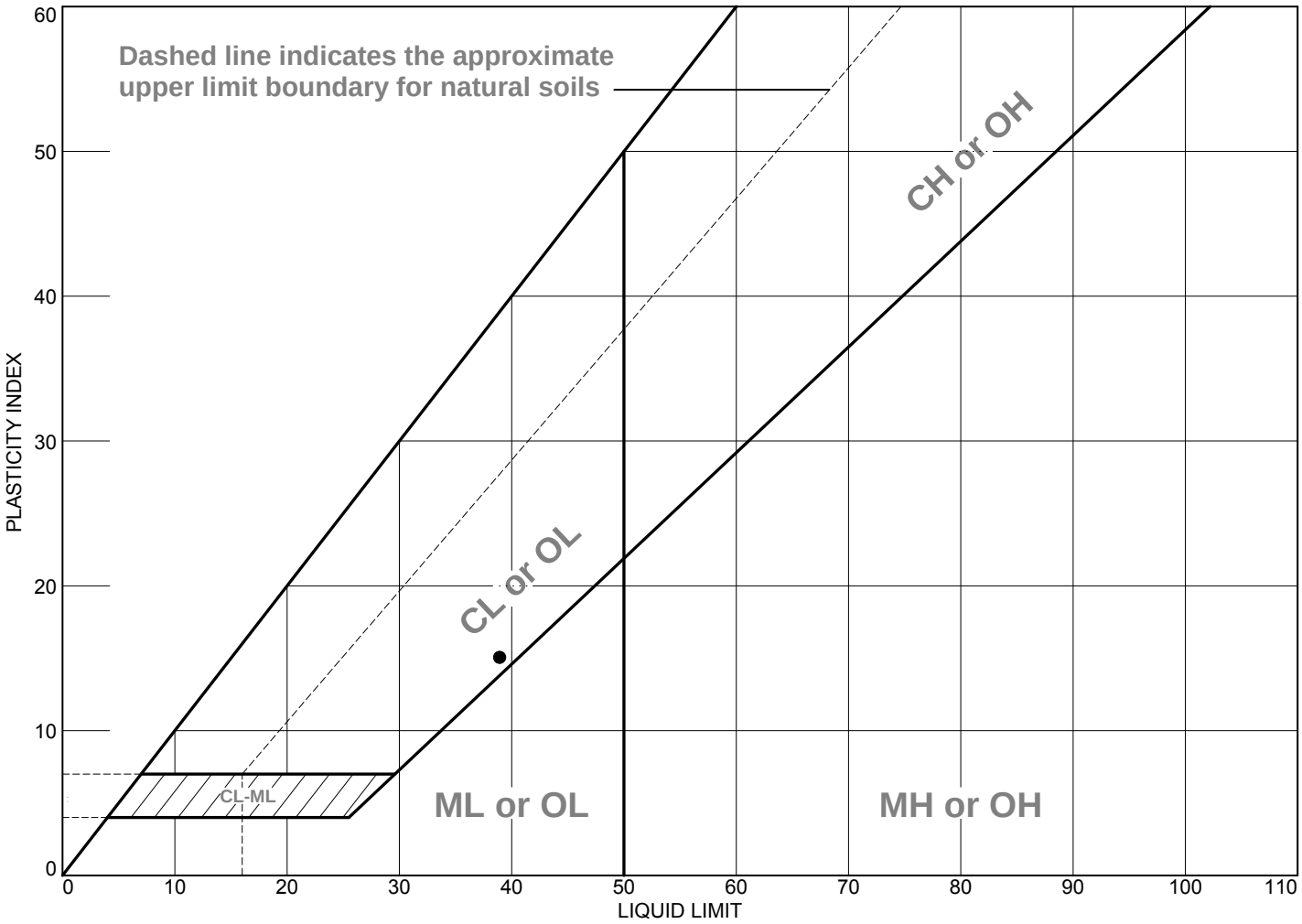
Phone: (703) 471-8400 Fax: (703) 991-4846

Client: Fairfax Co. Department of Transportation
Project: Jones Branch Connector
Project No: 21924 **Figure**

Tested By: DNN **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clayey Sand with Gravel Trace Mica Dark Brown (21.9% +4)	39	24	15	58.3	43.3	SC

Project No. 21924 **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector

●**Source of Sample:** JB-51 **Depth:** 2.00-10.00 **Sample Number:** D4S-6

Remarks:

●Data Entered: 10/29/13

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Figure

Tested By: HNT1 **Checked By:** DVT

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
RW008-B1												
	S-1	1.00 - 3.00	19.3									
	S-2	3.00 - 5.00	15.3									
	S-3	5.00 - 7.00	21.8									
	S-4	7.00 - 9.00	16.7									
	S-5	9.00 - 11.00	27.4	MH	50	35	15	68.6				
	S-6	13.00 - 15.00	26.0									
	S-7	18.00 - 19.42	13.8									
	S-8	23.00 - 23.42	11.8									
RW008-B2												
	S-1	1.00 - 3.00	16.7									
	S-2	3.00 - 5.00	25.5									
	S-4	7.00 - 9.00	13.7	SM	NP	NP	NP	39.5				
	S-5	9.00 - 11.00	14.6									
	S-6	13.00 - 15.00	12.6									
	S-7	18.00 - 20.00	32.4									
	S-8	23.00 - 25.00	12.8									
RW008-B3												
	S-1	1.00 - 3.00	22.0									
	S-2	3.00 - 5.00	21.6									
	S-3	5.00 - 7.00	20.8	CL	39	23	16	85.6				
	S-4	7.00 - 9.00	6.8									
	S-5	9.00 - 11.00	17.3									
	S-6	13.00 - 15.00	15.4									
	S-7	18.00 - 20.00	10.7									
	S-10	28.00 - 29.00	13.8									
RW008-B4												
	S-1	1.00 - 3.00	19.9									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924-A

Project Name: Jones Branch Connector - Additional RW3 Walls

PM: Michael A. Rayl

PE: Chris Giese

Printed On: Friday, October 02, 2015

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-2	3.00 - 5.00	22.5	CL	37	24	13	62.1				
	S-3	5.00 - 7.00	19.6									
	S-4	7.00 - 9.00	20.4									
	S-5	9.00 - 11.00	28.0									
	S-6	13.00 - 15.00	22.1									
	S-8	23.00 - 25.00	21.5									
RW009-B1												
	S-1	1.30 - 3.30	15.7									
	S-2	3.30 - 5.30	16.1									
	S-3	5.30 - 7.30	23.1	CL-ML	25	18	7	66.1				
RW009-B1A												
	S-1	5.30 - 7.30	11.6									
	S-2	7.30 - 9.30	26.6									
	S-3	9.30 - 11.30	4.6									
	S-4	13.00 - 15.00	14.5									
	S-5	18.00 - 20.00	21.4	CL	35	21	14	67.4				
	S-6	23.00 - 23.33	4.8									
	S-7	28.00 - 28.75	10.3									
RW009-B2												
	S-1	1.00 - 3.00	4.0									
	S-2	3.00 - 5.00	16.9									
	S-3	5.00 - 6.00	19.0									
RW009-B2A												
	S-1	5.00 - 7.00	19.2									
	S-2	7.00 - 9.00	19.6	CL	33	20	13	51.8				
	S-3	9.00 - 11.00	28.4									
	S-4	13.00 - 15.00	22.4	CL	45	24	21	63.8				
	S-5	18.00 - 18.42	21.5									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924-A

Project Name: Jones Branch Connector - Additional RW3 Walls

PM: Michael A. Rayl

PE: Chris Giese

Printed On: Friday, October 02, 2015

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Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-6	23.00 - 23.42	3.1									
	S-7	28.00 - 28.17	2.8									
RW010-B1												
	S-1	1.00 - 3.00	16.4									
	S-2	3.00 - 5.00	12.1									
	S-3	5.00 - 7.00	12.3									
	S-4	7.00 - 8.00	11.3									
	S-5	9.00 - 11.00	12.2	ML	NP	NP	NP	56.9				
	S-6	13.00 - 14.50	10.9									
	S-7	18.00 - 19.00	9.1									
	S-8	23.00 - 23.92	15.4									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924-A

Project Name: Jones Branch Connector - Additional RW3 Walls

PM: Michael A. Rayl

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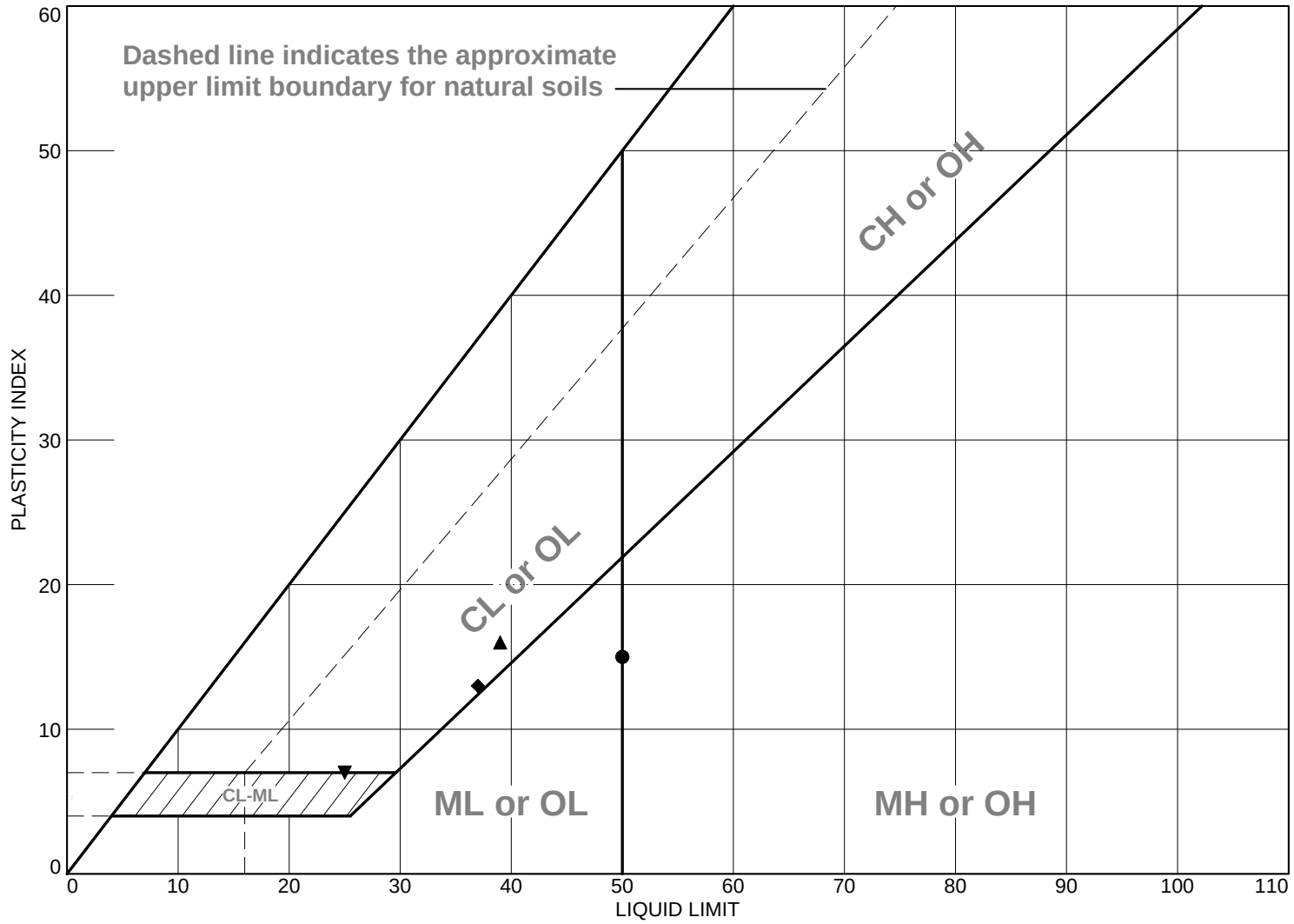
LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Elastic Silt Trace Mica Yellow Light Light Brown (MH)	50	35	15	84.2	68.6	MH
■	Silty Sand Trace Mica Yellowish Light Brown (SM)	NP	NP	NP	70.5	39.5	SM
▲	Lean Clay Reddish Brown (CL)	39	23	16	92.5	85.6	CL
◆	Sandy Lean Clay Trace Mica Strong Brown (CL)	37	24	13	78.9	62.1	CL
▼	Sandy Silty Clay Brown (CL-ML)	25	18	7	75.9	66.1	CL-ML

Project No. 21924-A **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Additional RW3 Walls

● **Source of Sample:** RW008-B1 **Depth:** 9.00-11.00 **Sample Number:** S-5
■ **Source of Sample:** RW008-B2 **Depth:** 7.00-9.00 **Sample Number:** S-4
▲ **Source of Sample:** RW008-B3 **Depth:** 5.00-7.00 **Sample Number:** S-3
◆ **Source of Sample:** RW008-B4 **Depth:** 3.00-5.00 **Sample Number:** S-2
▼ **Source of Sample:** RW009-B1 **Depth:** 5.30-7.30 **Sample Number:** S-3

Remarks:
● Data Entered: 9/2/15
■ Data Entered: 9/2/15
▲ Data Entered: 9/2/15
◆ Data Entered: 9/2/15
▼ Data Entered: 9/1/15

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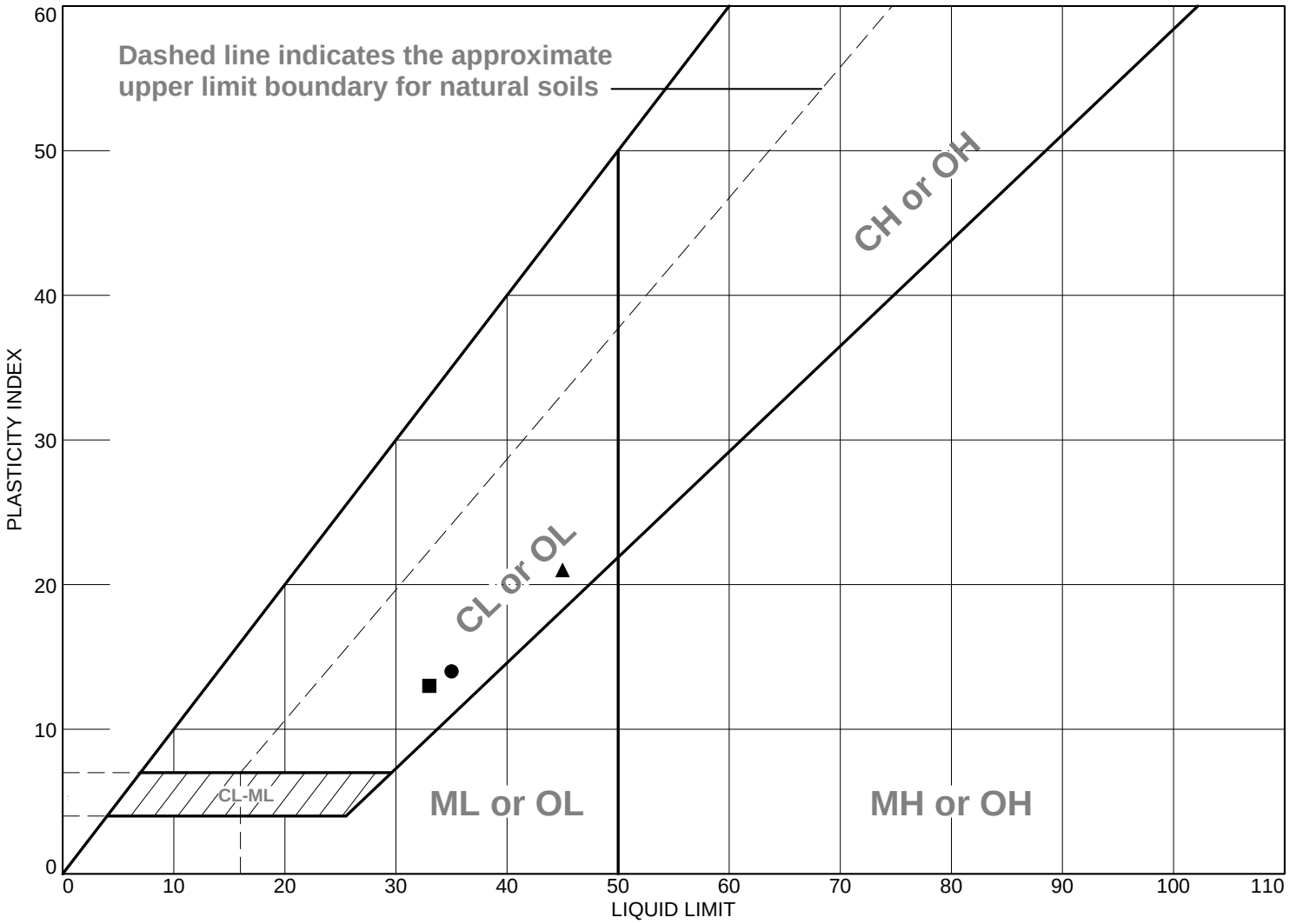
Figure

Tested By: HNT1 **Checked By:** DVT

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Lean Clay Brown (SM)	35	21	14	79.0	67.4	CL
■	Sandy Lean Clay Light Olive Brown (CL)	33	20	13	70.8	51.8	CL
▲	Sandy Lean Clay with Gravel Trace Mica Yellow (CL)	45	24	21	77.9	63.8	CL
◆	Sandy Silt Trace Mica Light Brown (ML)	NP	NP	NP	84.8	56.9	ML

Project No. 21924-A **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Additional RW3 Walls

● **Source:** RW009-B1A **Depth:** 18.00-20.00 **Sample No.:** S-5

■ **Source of Sample:** RW009-B2A **Depth:** 7.00-9.00 **Sample Number:** S-2

▲ **Source:** RW009-B2A **Depth:** 13.00-15.00 **Sample No.:** S-4

◆ **Source of Sample:** RW010-B1 **Depth:** 9.00-11.00 **Sample Number:** S-5

Remarks:

● Data Enter: 9/1/15

■ Data EnteredL: 9/1/15

◆ Data Entered: 9/1/15

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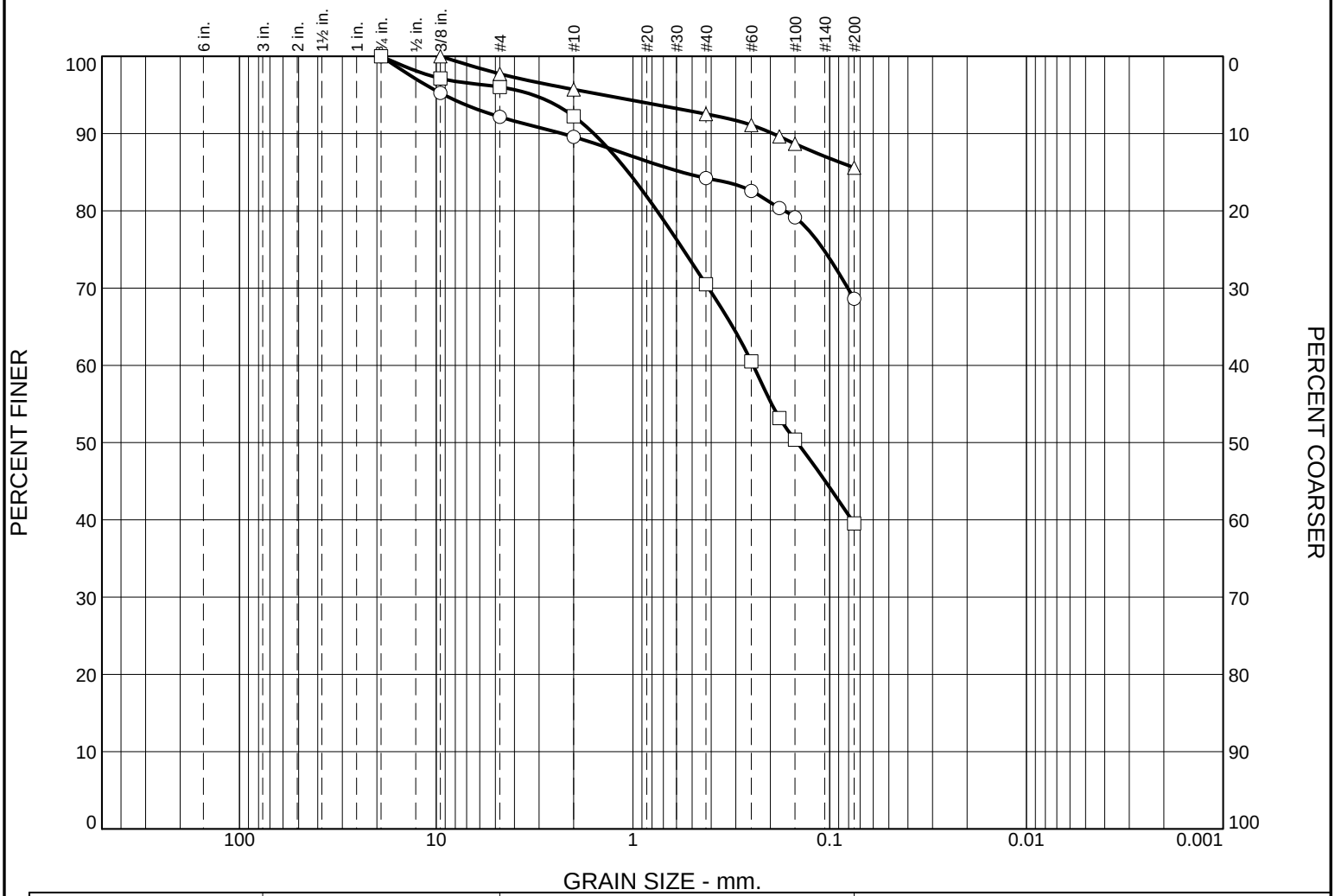
Figure

Tested By: HNT1 **Checked By:** DVT

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	7.8	2.6	5.4	15.6	68.6	
□	0.0	0.0	4.0	3.8	21.7	31.0	39.5	
△	0.0	0.0	2.3	2.0	3.2	6.9	85.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	50	35	0.5641							
□	NP	NP	1.0553	0.2445	0.1461					
△	39	23								

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ Sandy Elastic Silt Trace Mica Yellow Light Light Brown (MH)		MH	27.4
□ Silty Sand Trace Mica Yellowish Light Brown (SM)		SM	13.7
△ Lean Clay Reddish Brown (CL)		CL	20.8

Project No. 21924-A **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Additional RW3 Walls

○ **Source of Sample:** RW008-B1 **Depth:** 9.00-11.00 **Sample Number:** S-5

□ **Source of Sample:** RW008-B2 **Depth:** 7.00-9.00 **Sample Number:** S-4

△ **Source of Sample:** RW008-B3 **Depth:** 5.00-7.00 **Sample Number:** S-3

Remarks:

○ Data Entered: 9/2/15

□ Data Entered: 9/2/15

△ Data Entered: 9/2/15

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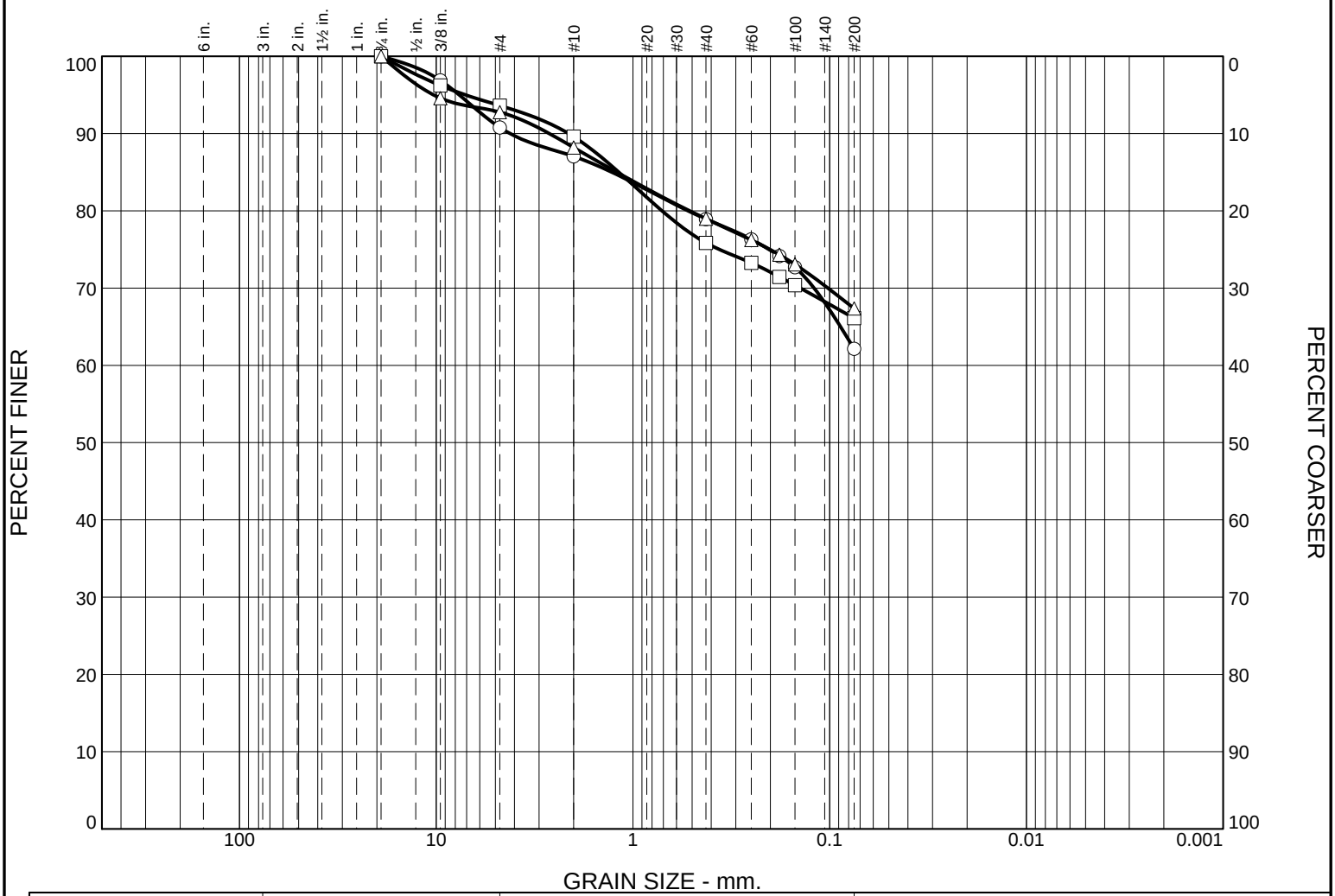
Figure

Tested By: KV **Checked By:** DVT

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	9.2	3.8	8.1	16.8	62.1	
□	0.0	0.0	6.4	4.0	13.7	9.8	66.1	
△	0.0	0.0	7.2	4.6	9.2	11.6	67.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	37	24	1.2788							
□	25	18	1.1794							
△	35	21	1.2064							

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ Sandy Lean Clay Trace Mica Strong Brown (CL)		CL	22.5
□ Sandy Silty Clay Brown (CL-ML)		CL-ML	23.1
△ Sandy Lean Clay Brown (SM)		CL	21.4

Project No. 21924-A **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Additional RW3 Walls

○ **Source of Sample:** RW008-B4 **Depth:** 3.00-5.00 **Sample Number:** S-2

□ **Source of Sample:** RW009-B1 **Depth:** 5.30-7.30 **Sample Number:** S-3

△ **Source of Sample:** RW009-B1A **Depth:** 18.00-20.00 **Sample Number:** S-5

Remarks:

○ Data Entered: 9/2/15

□ Data Entered: 9/1/15

△ Data Entered: 9/1/15

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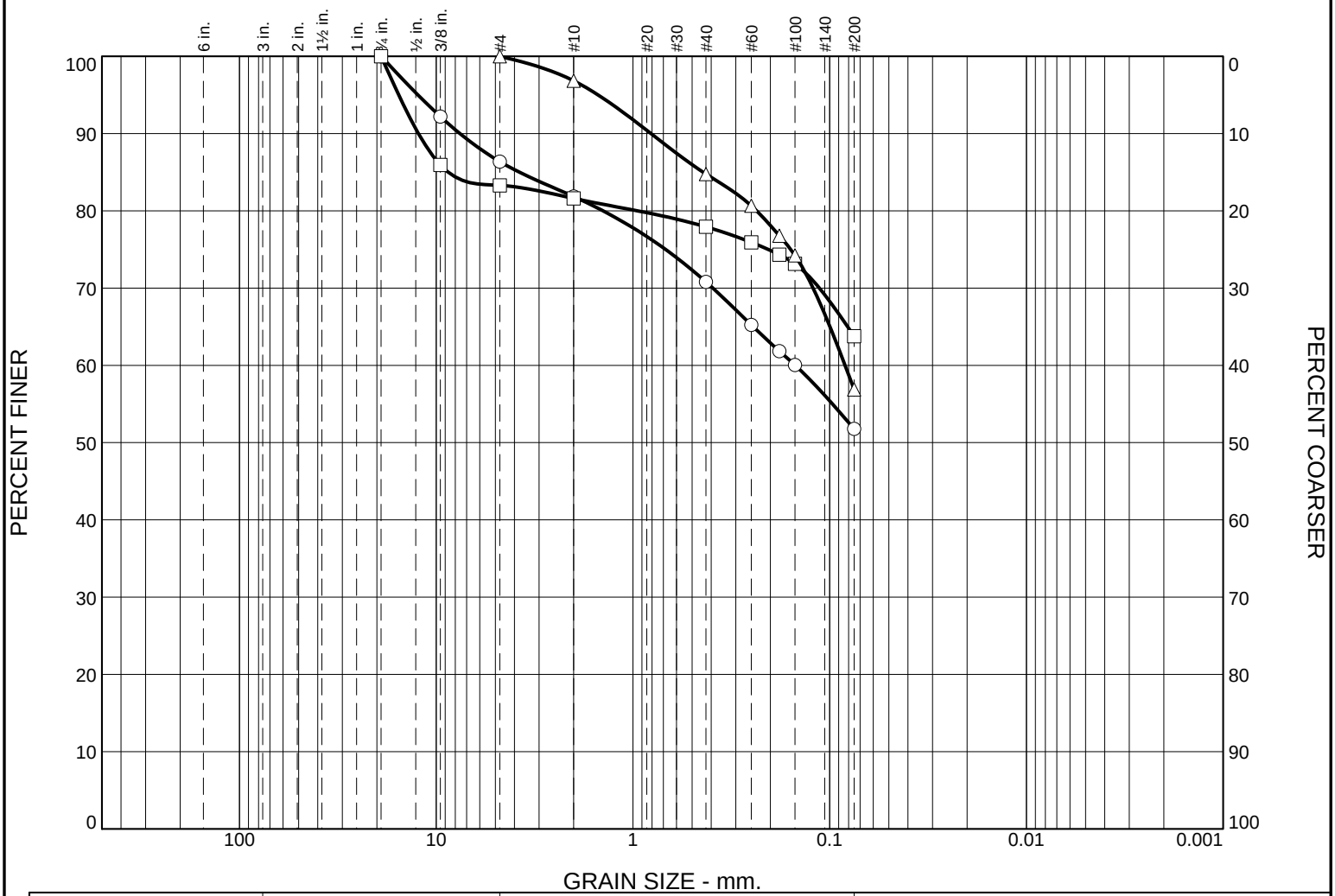
Figure

Tested By: KV **Checked By:** DVT

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	13.6	4.6	11.0	19.0	51.8	
□	0.0	0.0	16.7	1.7	3.7	14.1	63.8	
△	0.0	0.0	0.0	3.2	12.0	27.9	56.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	33	20	3.7777	0.1494						
□	45	24	8.6944							
△	NP	NP	0.4394	0.0834						

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ Sandy Lean Clay Light Olive Brown (CL)		CL	19.6
□ Sandy Lean Clay with Gravel Trace Mica Yellow (CL)		CL	22.4
△ Sandy Silt Trace Mica Light Brown (ML)		ML	12.2

Project No. 21924-A **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Additional RW3 Walls

○ **Source of Sample:** RW009-B2A **Depth:** 7.00-9.00 **Sample Number:** S-2

□ **Source of Sample:** RW009-B2A **Depth:** 13.00-15.00 **Sample Number:** S-4

△ **Source of Sample:** RW010-B1 **Depth:** 9.00-11.00 **Sample Number:** S-5

Remarks:

○ Data Entered: 9/15/15

□ Data Entered: 9/1/15

△ Data Entered: 9/1/15

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Figure

Tested By: KV **Checked By:** DT

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
SW011-B1												
	S-1	2.00 - 4.00	12.1									
	S-2	4.00 - 6.00	23.8									
	S-3	6.00 - 8.00	24.4	ML	42	29	13	68.7				
	S-4	8.00 - 10.00	28.7									
	S-5	13.00 - 15.00	38.0									
	S-6	18.00 - 20.00	26.0									
	S-7	23.00 - 25.00	23.0									
	S-8	28.00 - 30.00	31.3	MH	54	35	19	79.8				
	S-9	33.00 - 35.00	23.5									
SW011-B2												
	S-1	2.00 - 4.00	22.4									
	S-2	4.00 - 6.00	12.1									
	S-3	6.00 - 8.00	11.1									
	S-4	8.00 - 10.00	11.6									
	S-5	13.00 - 15.00	31.8									
	S-6	18.00 - 20.00	11.2									
	S-7	23.00 - 23.75	9.3	ML	NP	NP	NP	81.8				
	S-8	28.00 - 28.42	8.3									
	S-9	33.00 - 33.50	10.0									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 21924-C

Project Name: Jones Branch Connector - Soundwall SW011

PM: Michael A. Rayl

PE: Chris Giese

Printed On: Friday, October 02, 2015

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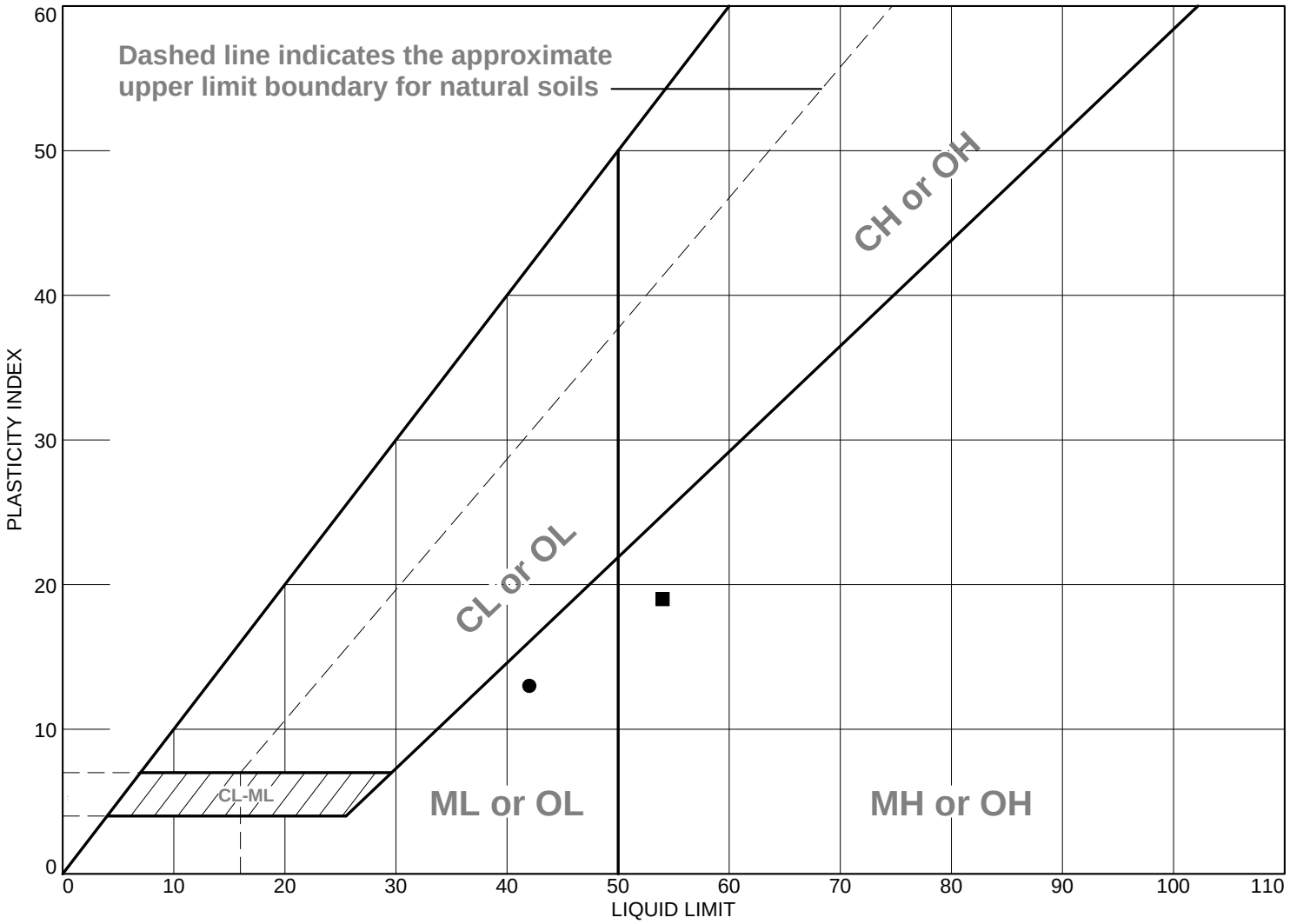
LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sandy Silt Trace Mica Yellow Light Brown (ML)	42	29	13		68.7	ML
■	Elastic Silt with Sand Trace Mica Light Red (MH)	54	35	19		79.8	MH
▲	Silt with Sand Trace Mica Yellowish Light Brown (ML)	NP	NP	NP		81.8	ML

Project No. 21924-C **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Soundwall SW011

● **Source of Sample:** SW011-B1 **Depth:** 6.00-8.00 **Sample Number:** S-3

■ **Source of Sample:** SW011-B1 **Depth:** 28.00-30.00 **Sample Number:** S-8

▲ **Source of Sample:** SW011-B2 **Depth:** 23.00-23.75 **Sample Number:** S-7

Remarks:

● Data Entered: 9/1/15

▲ Data Entered: 9/1/15

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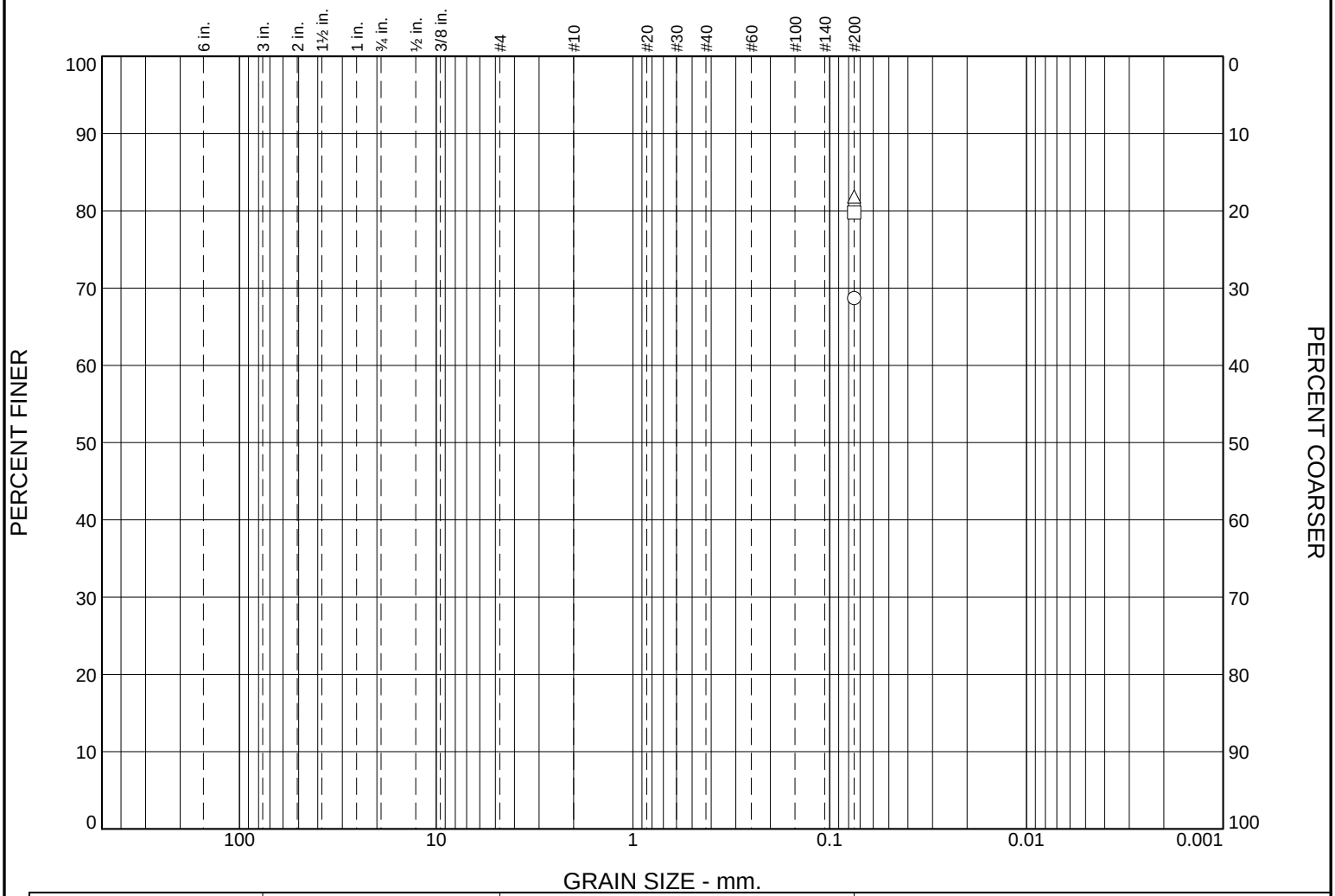
Phone: (703) 471-8400
Fax: (703) 834-5527

Figure

Tested By: HNT1 **Checked By:** DVT

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○							68.7	
□							79.8	
△							81.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	42	29								
□	54	35								
△	NP	NP								

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ Sandy Silt Trace Mica Yellow Light Brown (ML)		ML	24.4
□ Elastic Silt with Sand Trace Mica Light Red (MH)		MH	31.3
△ Silt with Sand Trace Mica Yellowish Light Brown (ML)		ML	9.3

Project No. 21924-C **Client:** Fairfax Co. Department of Transportation

Project: Jones Branch Connector - Soundwall SW011

○ **Source of Sample:** SW011-B1 **Depth:** 6.00-8.00 **Sample Number:** S-3

□ **Source of Sample:** SW011-B1 **Depth:** 28.00-30.00 **Sample Number:** S-8

△ **Source of Sample:** SW011-B2 **Depth:** 23.00-23.75 **Sample Number:** S-7

Remarks:

○ Data Entered: 9/1/15

□ Data Entered: 9/1/15

△ Data Entered: 9/1/15

ECS MID-ATLANTIC, LLC
14026 Thunderbolt Place, Suite 100
Chantilly, VA 20151-3232
Phone: (703) 471-8400
Fax: (703) 834-5527

Figure

Tested By: KV **Checked By:** DVT

APPENDIX D – CALCULATIONS

Soundwalls
- Parameter Sheets

Bridges (Organized per bridge substructure as follows):
- Parameter Sheet
- Driven Pile Analysis, or
- Augercast Pile Analysis, or
- Drilled Shaft Analysis
- GROUP or LPILE Analysis

Retaining Walls (Organized per wall as follows):
- Parameter sheet
- MSE or RW-3 Wall Analysis
- Wall Settlement
- Slope Stability

Pavements
- Input for ESAL Calculations
- Pavement S_N Calculation and Section, per roadway

ECS MID-ATLANTIC, LLC.	Page	1 1
COMPUTATION SHEET	Made By	DJS
Determination of Soundwall Soil Parameters (English Version)	Date	11/4/2015
	Checked By	MAR
LOCATION **SW011** STA **10+50**	Date	11/4/2015

This parameter sheet applies to the wall in the vicinity of the station noted above.

Red values are calculated

Enter Values in Blue

BORING No. **SW011-B1**

Top of Boring Elevation **346.4**

Hammer Efficiency % = **60.0**

Groundwater Elevation = **311.4**

If none, enter bottom of boring.

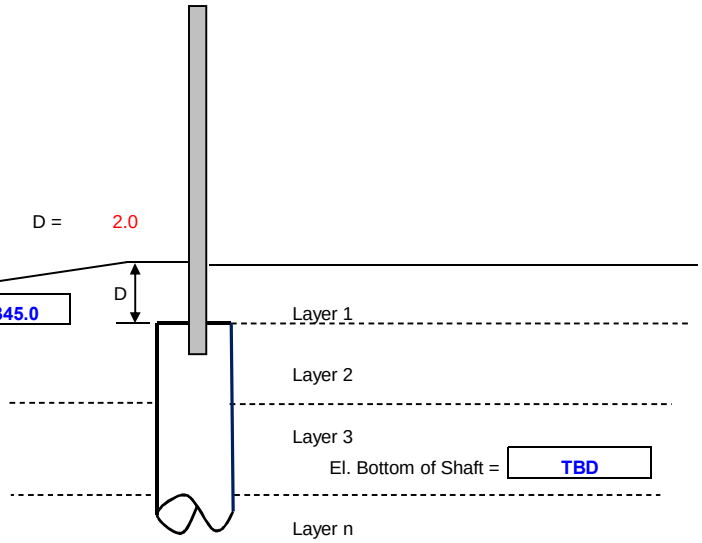
Bench Line

El. Top of Ground = **347.0**

D = 2.0

Bot. Wall El. = **345.0**

(Top Shaft)



El. Bottom of Shaft = **TBD**

R = Rock

CP = Coastal Plain Physiographic Province

CFB = Cupleper Fault Basin

VR = Valley & Ridge

P = Piedmont Physiographic Province

If Layer 1 = Layer 2, split layer. Set a layer at top of shaft.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values (bpf) N1	N2	N3	N4	N5	Avg. N_{60}
1	345.0	2.0	P	II-B	12	estimated				12
2	342.4	2.6	P	II-B	27					27
3	334.4	8.0	P	II-A	10	7	7			8
4	329.4	5.0	P	II-B	11					11
5	319.4	10.0	P	II-B	27	23				25
6	311.4	8.0	P	II-B	20	25				23
7										
8										
9										
10										
11										

ASTM, HWR, R, SF

Layer No.	Γ_{moist}, pcf	Γ_{wet}, pcf	Soil Type	ARCA C, psf	ARCA Φ^o	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	2.0	
2	118.0	125.0	ML	50.0	30.0		2	4.6	
3	95.0	102.0	ML	50.0	28.0		2	12.6	
4	118.0	125.0	MH	50.0	30.0		5	17.6	1375
5	118.0	125.0	ML	50.0	30.0		2	27.6	
6	118.0	125.0	MH	50.0	30.0		5	35.6	2813
7									
8									
9									
10									
11									

Shaded Cells Represent Soils are Below GWT

ECS MID-ATLANTIC, LLC.	Page	1 1
COMPUTATION SHEET	Made By	DJS
Determination of Soundwall Soil Parameters (English Version)	Date	11/4/2015
	Checked By	MAR
LOCATION **SW011** STA **12+50**	Date	11/4/2015

This parameter sheet applies to the wall in the vicinity of the station noted above.

Red values are calculated

Enter Values in Blue

BORING No. **SW011-B2**

Top of Boring Elevation **344.3**

Hammer Efficiency % = **60.0**

Groundwater Elevation = **310.8**

If none, enter bottom of boring.

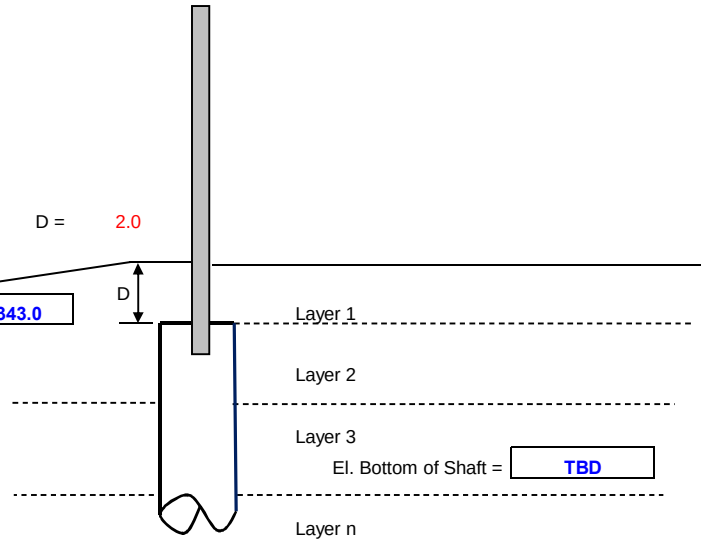
Bench Line

El. Top of Ground = **345.0**

D = 2.0

Bot. Wall El. = **343.0**

(Top Shaft)



El. Bottom of Shaft = **TBD**

R = Rock

CP = Coastal Plain Physiographic Province

CFB = Cupleper Fault Basin

VR = Valley & Ridge

P = Piedmont Physiographic Province

If Layer 1 = Layer 2, split layer. Set a layer at top of shaft.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values (bpf) N1	N2	N3	N4	N5	Avg. N_{60}
1	343.0	2.0	P	II-B	12	estimated				12
2	332.3	10.7	P	II-B	12	18	18	20		17
3	327.3	5.0	P	II-B	11					11
4	322.3	5.0	P	II-C	53					53
5	310.8	11.5	P	III	100	100	100			100
6										
7										
8										
9										
10										
11										

ASTM, HWR, R, SF

Layer No.	Γ_{moist}, pcf	Γ_{wet}, pcf	Soil Type	ARCA C, psf	ARCA Φ^o	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	2.0	
2	118.0	125.0	ML	50.0	30.0		2	12.7	
3	118.0	125.0	MH	50.0	30.0		5	17.7	1375
4	130.0	137.0	ML	50.0	32.0		2	22.7	
5	120.0	128.0	HWR	250.0	34.0		4	34.2	
6									
7									
8									
9									
10									
11									

Shaded Cells Represent Soils are Below GWT

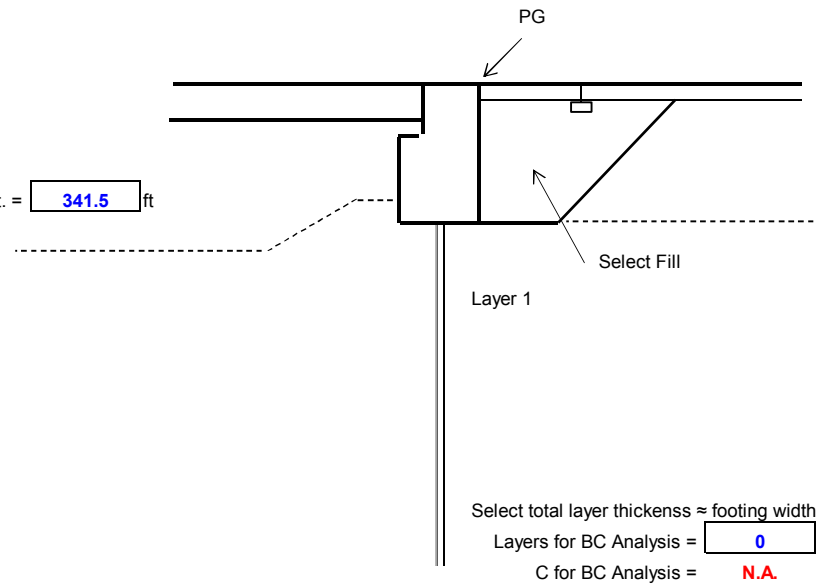
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/1/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 627 Abutment A Enter Values in Blue.	Date 12/1/2015	

Red values are calculated

BORING No. =	JB-04	
Top of Boring El. =	356.9	ft
Profile Grade =	357.1	ft
Top of Layer 1 =	341.5	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	283.9	ft

North Half

Bottom of Abut. = 341.5 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	314.9	26.6	P	II-C	19	29	23	22	26	32
2	298.9	16.0	P	II-C	34	37	23			42
3	293.9	5.0	P	II-C	44					59
4	290.0	3.9	P	II-C	97					100
5	283.9	6.1	P	II-C	47					63
6	266.9	17.0	P	II-C	89	52	60			89
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	130.0	137.0	ML	50.0	32.0		2	26.6	
2	130.0	137.0	ML	50.0	32.0	Y	2	42.6	
3	130.0	137.0	ML	50.0	32.0		2	47.6	
4	120.0	128.0	HWR	250.0	34.0		4	51.5	
5	120.0	128.0	ML	250.0	34.0		2	57.6	
6	120.0	128.0	HWR	250.0	34.0		4	74.6	
7									
8									
9									
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	1/4/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-04	SHAFT NO. North	Date	1/4/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	290	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	345.1	ft	
Top of Shaft	345.1	ft	
Groundwater (Enter bot. shaft if none)	292.0	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	292.0	ft	
Bottom of Shaft	292.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	1.5	ft
Shaft Length	53.1	ft
Shaft Length in Soil or IGM	53.1	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	14.1	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	17.6	kips

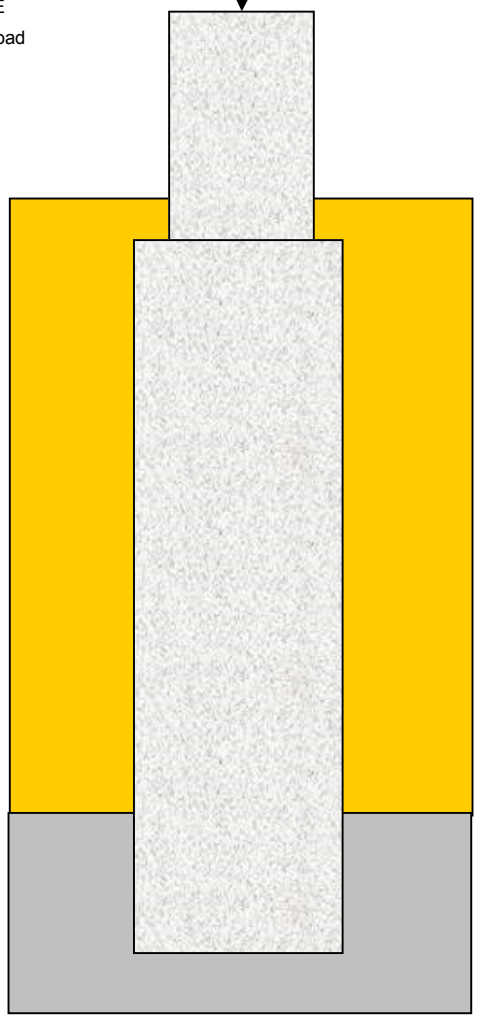
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	80	%
Eff. Wt. of Shaft	14.1	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	345.1
Top of Shaft	345.1
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	292.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				345.1	314.9	30.2	118	25	33	
S2		x				314.9	298.9	16.0	118	34	45	
S3		x				298.9	293.9	5.0	118	44	59	
S4				x		293.9	292.0	1.9	138	97	129	
S5												
S6												

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS					Page	5
						Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0			Date	1/4/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO.	Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-04	SHAFT NO.	North	Date	1/4/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = area shaft — qs = unit side resistance

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1			0.0				
S2			0.0				
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	0

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	30.2	15.1	1.8	1.8	0.00	1.8	33	0.98	1.7	142.3	247	
S2	16.0	38.2	0.9	4.5	0.00	4.5	45	0.67	3.0	75.4	226	
S3	5.0	48.7	0.3	5.7	0.00	5.7	59	0.56	3.2	23.6	76	
S4	1.9	52.2	0.1	6.2	0.00	6.2						
S5												
S6												
			Bot Press.	6.2						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	549	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/4/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-04	SHAFT NO. North	Date	1/4/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	30.2	15.1	118.0	1.78	0.00	1.78	33					
S2	16.0	38.2	118.0	4.51	0.00	4.51	45					
S3	5.0	48.7	118.0	5.75	0.00	5.75	59					
S4	1.9	52.2	138.0	7.20	0.00	7.20	100	47.0	0.98	5.94	8.95	53.2
S5												
S6												
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	53.2

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4	293.9	292.0	292.0	6.2	0.00	6.17	75.8	1.77	134
S5									
S6									
						TOTAL TIP RESISTANCE IN COHESIONLESS IGM			134 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/4/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-04	SHAFT NO. North	Date	1/4/2016

Side and Base Transfer Resistance in Grannular Soils

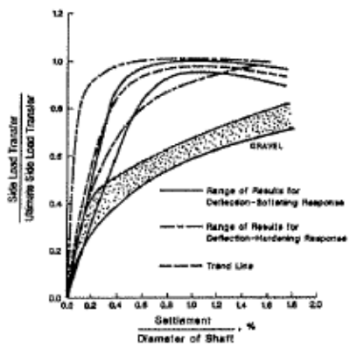


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

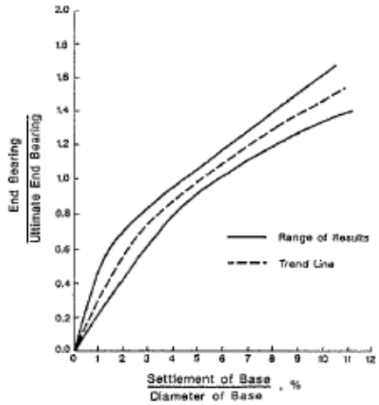


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/4/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-04	SHAFT NO. North	Date	1/4/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 2.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		247.3					
S2		226.2					
S3		75.5					
S4				53.2			
S5							
S6							
Sum	0.0	549.1	0.0	53.2	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	302.0	0.0	31.9	0.0		
L.T. Factor	0.83	0.9	0.8	0.9	0.8	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	271.8	0.0	28.7	0.0	**301**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4				133.9	
S5					
S6					
Sum				133.9	0.0
φ				0.55	0.55
φ * Rs				73.6	0.0
L.T. Factor				0.56	0.81
Rp				41.2	0.0

Sum Rp **41**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	301	Pmax	290	
Rp	41	Wt. Shaft	18	
Σ	342	Σ	308	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B627

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-04

Bridge No.	B627	**Pier No.**	A North	**Bottom of Pile Cap / Top of Shaft El.**	341.5

Project No. 01-21924
By: JCG 1/13/2016
Checked: MAR 1/13/2016

Indicate Analysis Type Required		L/PILE Single Pile/Shaft Free head
		L/PILE Single Pile/Shaft Fixed head
	x	GROUP Fixed Head

			341.5	Top of Ground El.	
Indicate Load Type		Single Pile/Shaft Load	292.0	Tip El.	L inches = 594
	x	Group Load		No. Piles/Shafts for GROUP	
		HP Pile Size			
Pile Size. ft	1.500	f'c	4,000	f'c	
Tranverse Spacing, ft	6.50	Longit. Spacing, ft	6.0		

0.39	P Reducn Factor Long	4.0 B
0.45	P Reducn Factor Trans	4.3 B
0.39	P Reducn Factor Resultant Mom. (based on primary loading only)	

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Max. Fv for Axial Capacity Analysis, kips 400.0

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	3,000.0	kips (lbs)	3,000,000	Fv (FV)	430	kips (lbs)	430,000	Fv (FV)		kips (lbs)	
Fy (FL)	420.00	kips (lbs)	420,000	Fy (FL)	210	kips (lbs)	210,000	Fy (FL)		kips (lbs)	
Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	3,400.00	kip-ft (lb-in)	40,800,000	Mz (ML)	970	kip-ft (lb-in)	11,640,000	Mz (ML)		kip-ft (lb-in)	
Fresultant		kips (lbs)		Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	3,400.00	kip-ft (lb-in)	40,800,000	Mresultant	970	kip-ft (lb-in)	11,640,000	Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 283.9 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	314.9	26.6	ML	P	32	II-C	319	0.07523	32.0		177		
2	298.9	16.0	ML	P	42	II-C	511	0.07523	32.0		232		
3	293.9	5.0	ML	P	59	II-C	571	0.07523	32.0		327		
4	290.0	3.9	HWR	P	100	III	618	0.06944	34.0		554		
5	283.9	6.1	ML	P	63	III	691	0.06944	34.0		349		
6	260.0	23.9	HWR	P	89	III	978	0.03738	34.0		296		
7													
8													
9													
10													
11													

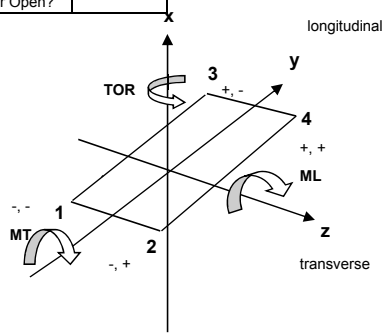
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

M concrete = psi 3,604,997
M Steel = psi 30,000,000

Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64

DETERMINATION OF INPUT RESISTANCE FACTORS FOR GROUP

By:	JCG	1/13/2016
Checked:	MAR	1/13/2016

Projct Name JBCONN B 627 Abutment A North
Project Number
Substructure

Drop down Menus are indicated by shaded boxes
GPOUP Required Input

Pile Shape =	Round		Moment of I =	5,153	in^4	r =	9.00	in
Pile Side/Diameter =	18.0	in	Box End Area =	254.5	in^2	μ =	0.15	
Concrete Area =	254.5	in^2	Circum. Unit Area (per in.) =	72.0	in^2	J =	10,306	in^4
Pile f'c =	4,000	psi	Modulus of E =	3,604,997	psi	G =	1,567,390	psi
Material =	Concrete		HP Steel Area =		in^2	GJ =	1.62E+10	psi
HP Size =								
Rotation Spring =	5	psi (normally use a minimal amount, e.g. 5 psi)						

Analysis Condition = Normal — Use only driven (ultimate) side resistances for the layers appropriate to the analysis condition.

Factored Resistance for Side and End Bearing Pressures 0.65 Use 0.65 for PDA tested piles, otherwise 0.45

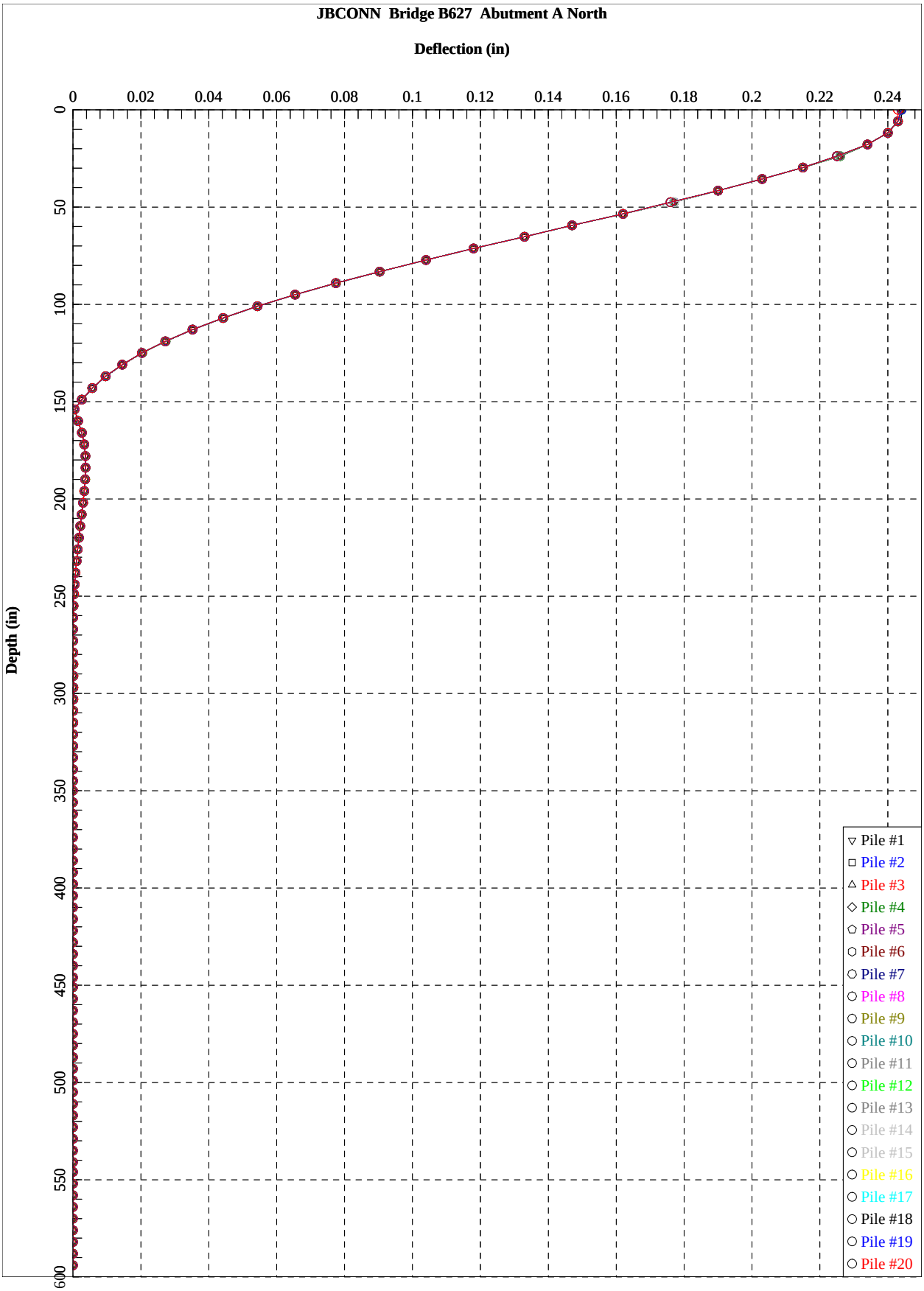
Abut A Unit Side Resistance based on DRIVEN Results

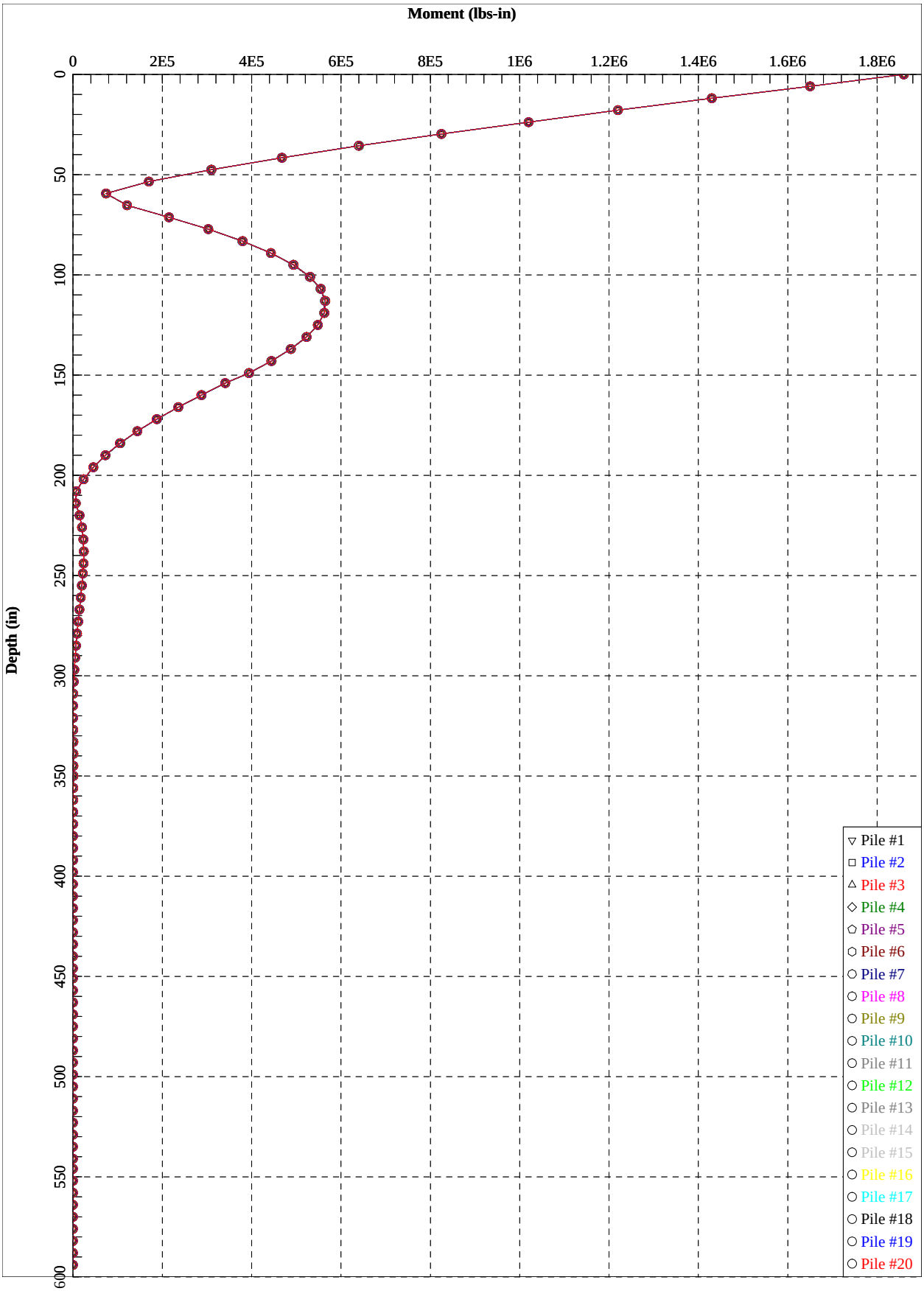
Delete only blue boxes

Layer No.	Layer top (ft)	Layer bot (ft)	Layer top (in)	Layer bot (in)	Side Fr. at Layer Top (kip)	Side Fr. at Layer Bot. (kip)	Unit area (in)	Unit Side Resist (psi)	End Bearing Top (kip)	End Bearing Bottom (kip)	Average End Bearing Top of Layer	Unit End Bearing (psi)
1	0.0	26.6	0.0	319	0.0		22982	0.0				
2	26.6	42.6	319.2	511			13824					
3	42.6	47.6	511.2	571			4320					
4	47.6	51.5	571.2	618			3370					
5	51.5	57.6	618.0	691			5270					
6	57.6	81.5	691.2	978			20650					
7												
8												

From Shaft Analysis	1	1.7	5.90
	2	3	10.42
	3	3.2	11.11
	4	5.9	20.49
	5		0.00
	6		0.00
		From axial	RF = 0.5

77	267.4
From axial	RF = 0.5


JBCONN Bridge B627 Abutment A North
Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8
Pile #9
Pile #10
Pile #11
Pile #12
Pile #13
Pile #14
Pile #15
Pile #16
Pile #17
Pile #18
Pile #19
Pile #20


Moment (lbs-in)
0
2E5
4E5
6E5
8E5
1E6
1.2E6
1.4E6
1.6E6
1.8E6
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8
Pile #9
Pile #10
Pile #11
Pile #12
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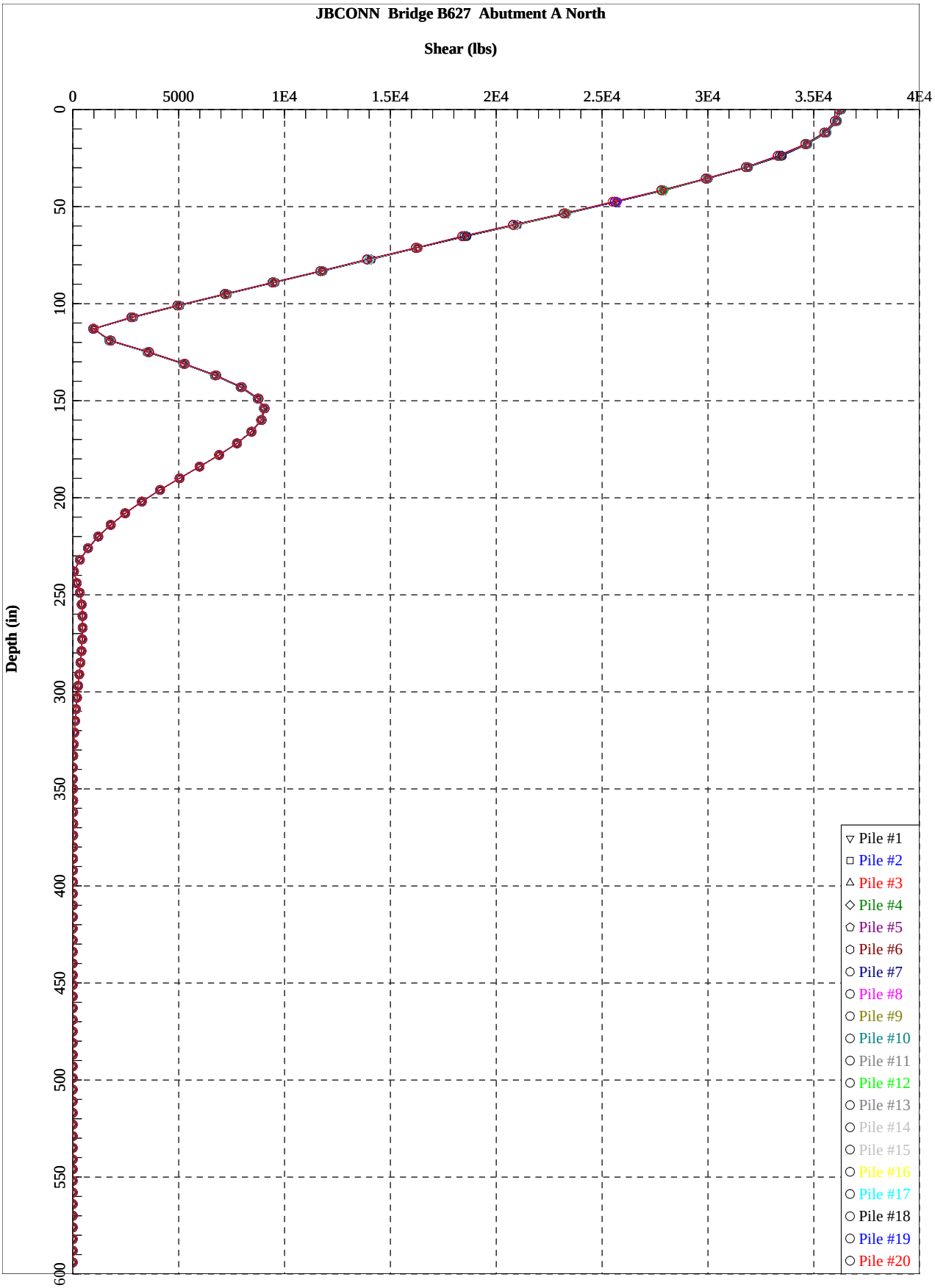
Pile #16
Pile #17
Pile #18
Pile #19
Pile #20


JBCONN Bridge B627 Abutment A North
Shear (lbs)
0
5000
1E4
1.5E4
2E4
2.5E4
3E4
3.5E4
4E4
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8
Pile #9
Pile #10
Pile #11
Pile #12
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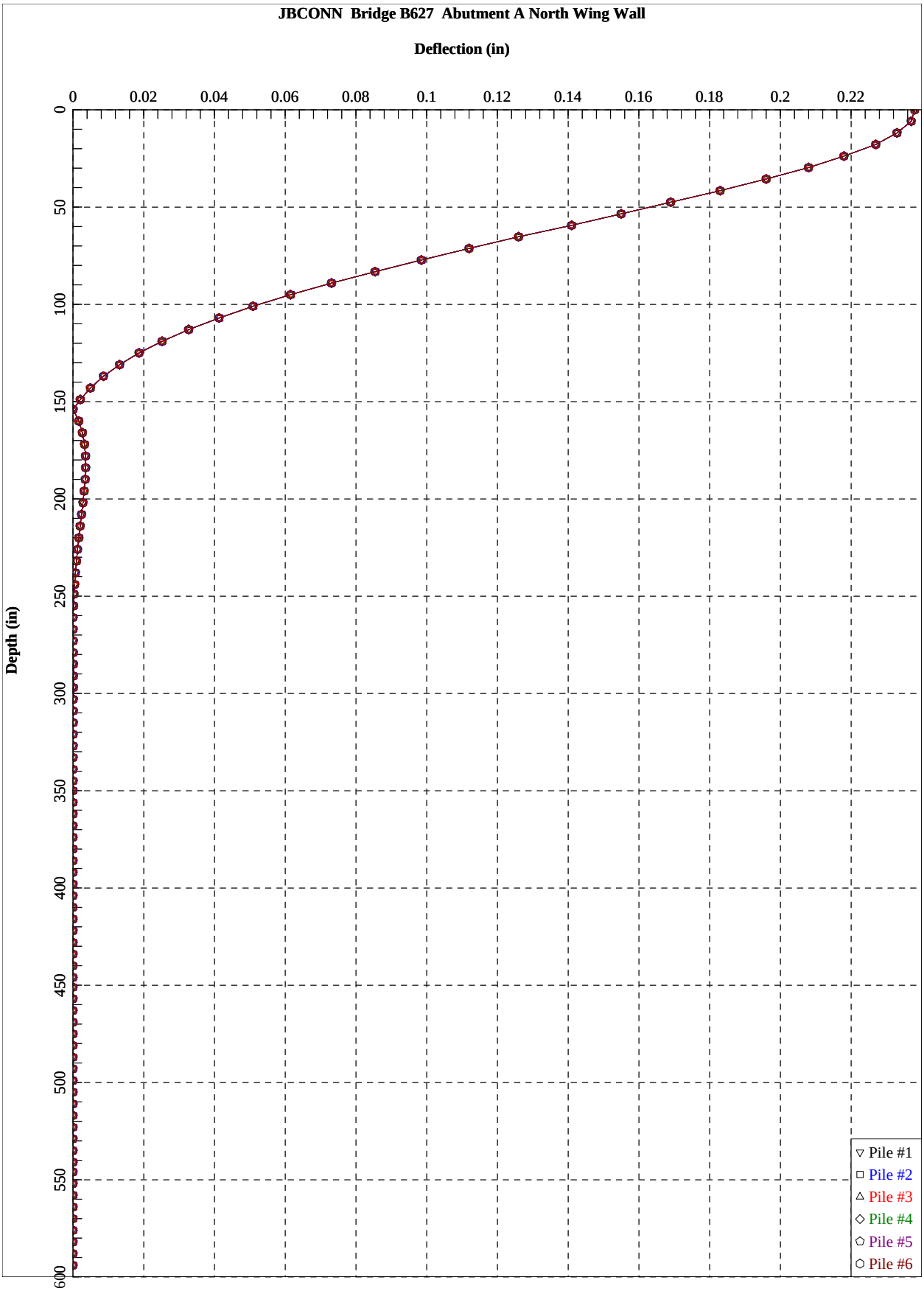
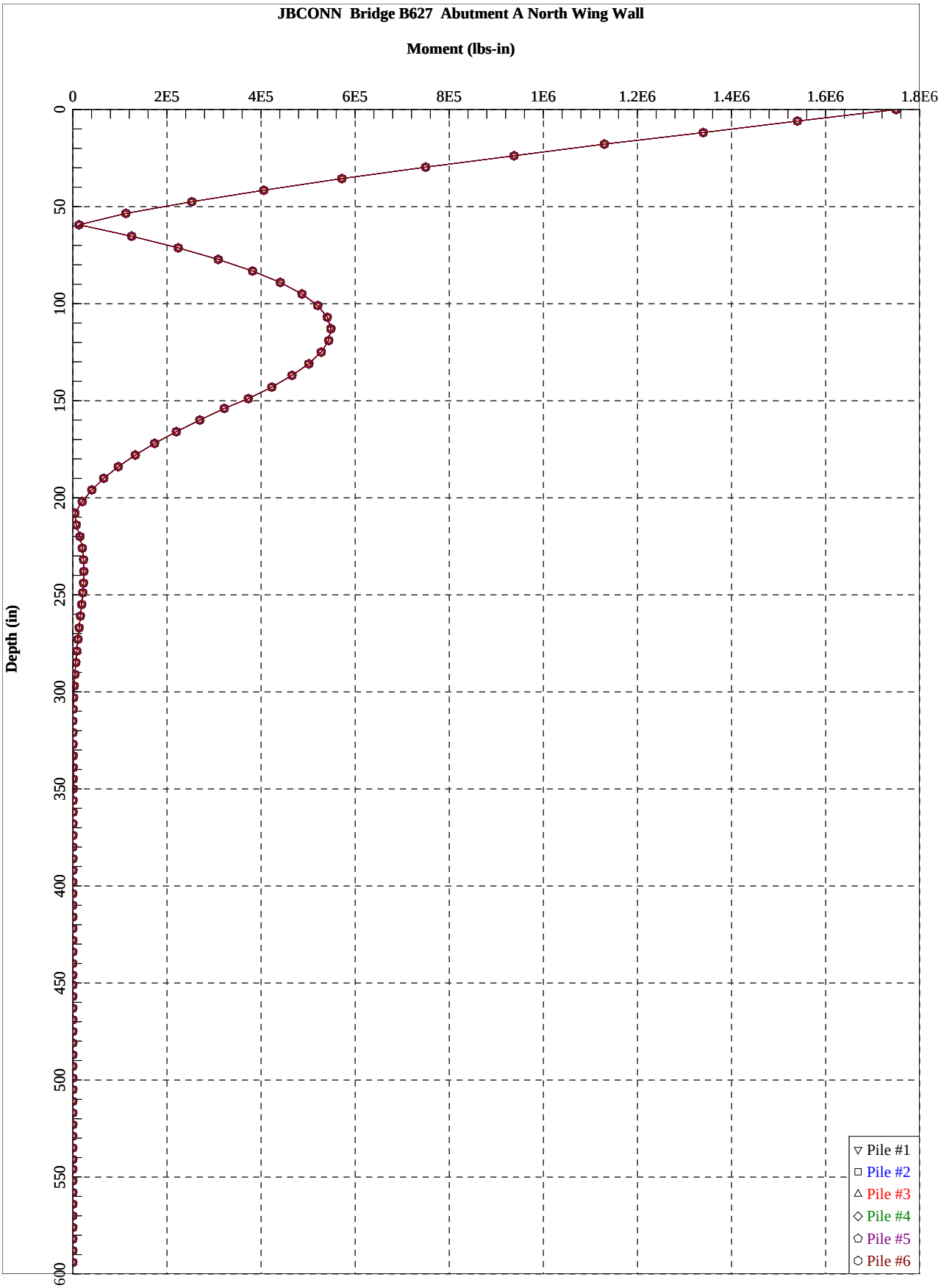
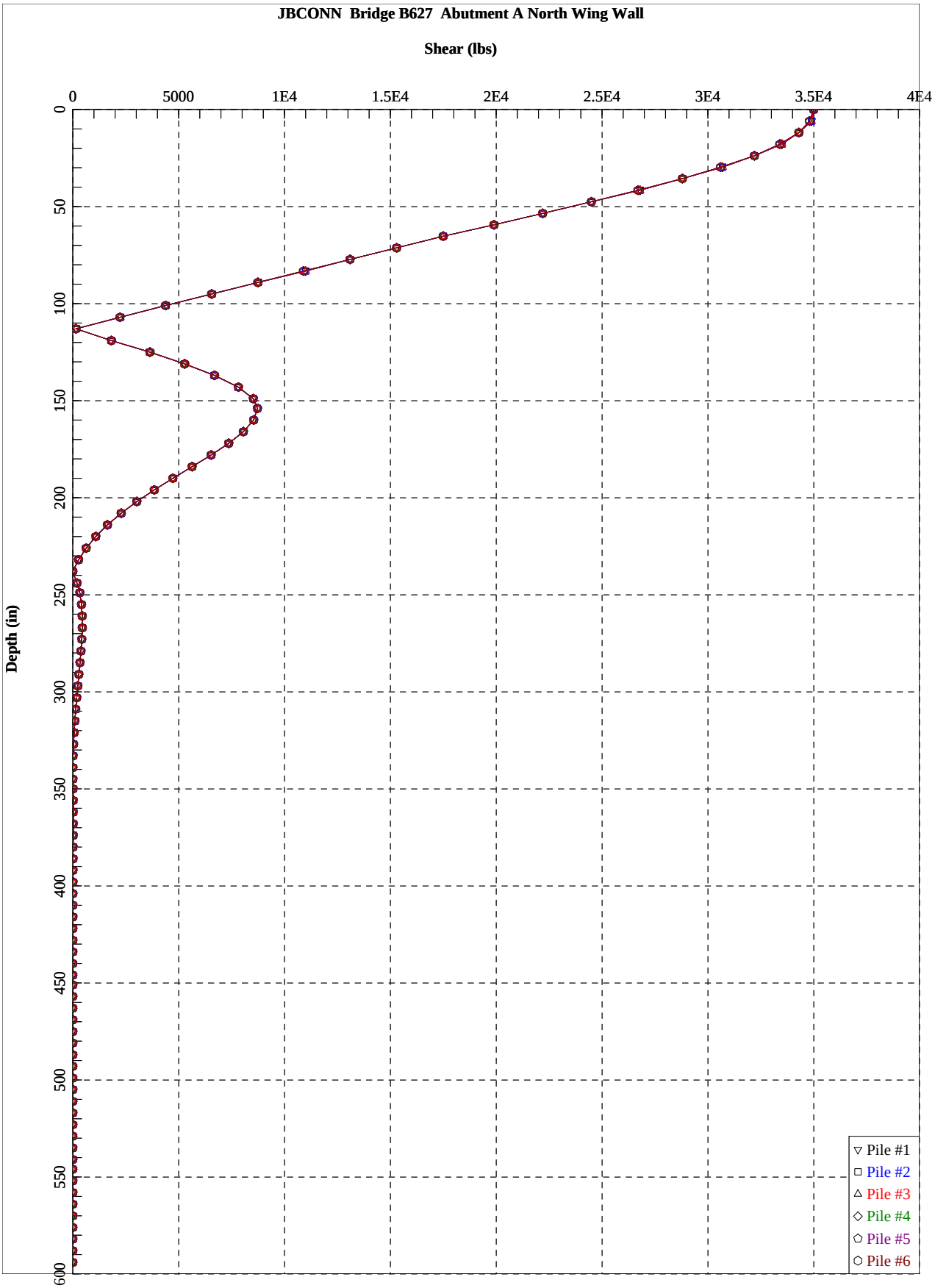
Pile #15
Pile #16
Pile #17
Pile #18
Pile #19
Pile #20


JBCONN Bridge B627 Abutment A North Wing Wall
Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6


JBCONN Bridge B627 Abutment A North Wing Wall
Moment (lbs-in)
0
2E5
4E5
6E5
8E5
1E6
1.2E6
1.4E6
1.6E6
1.8E6
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6


JBCONN Bridge B627 Abutment A North Wing Wall
Shear (lbs)
0
5000
1E4
1.5E4
2E4
2.5E4
3E4
3.5E4
4E4
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6

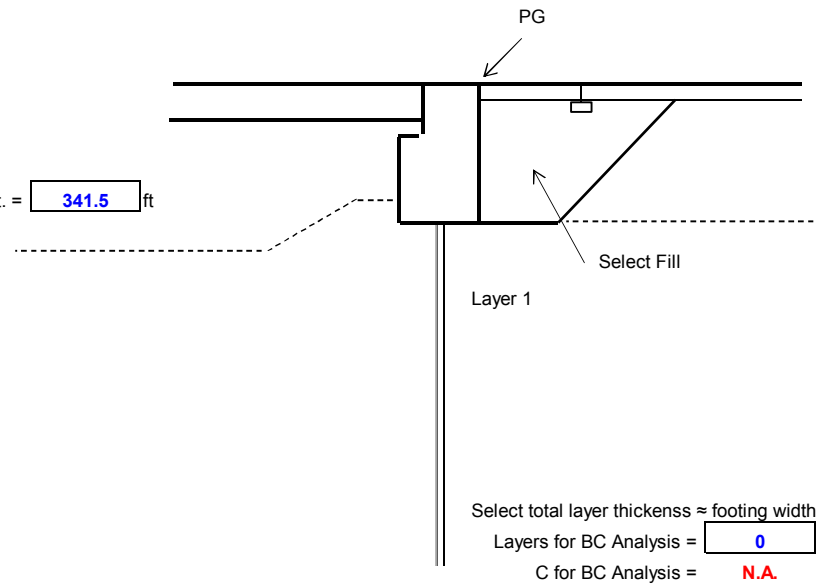
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/1/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 627 Abutment A Enter Values in Blue.	Date 12/1/2015	

Red values are calculated

BORING No. =	JB-05	
Top of Boring El. =	356.5	ft
Profile Grade =	356.2	ft
Top of Layer 1 =	341.5	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	265.0	ft

South Half

Bottom of Abut. = 341.5 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	328.5	13.0	P	II-C	38	28				44
2	310.0	18.5	P	II-C	100	62	100	81		100
3	300.0	74.0	P	II-C	62	74				91
4	285.0	15.0	P	II-C	100	100	100			100
5	266.5	18.5	P	II-C	39	50	41			58
6										
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	130.0	137.0	ML	50.0	32.0		2	13.0	
2	120.0	128.0	HWR	250.0	34.0	Y	2	31.5	
3	120.0	128.0	HWR	250.0	34.0		4	41.5	
4	120.0	128.0	HWR	250.0	34.0		4	56.5	
5	130.0	137.0	ML	50.0	32.0		2	75.0	
6									
7									
8									
9									
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	1/8/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-05	SHAFT NO. South	Date	1/8/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	290	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	345.1	ft	
Top of Shaft	345.1	ft	
Groundwater (Enter bot. shaft if none)	302.0	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	302.0	ft	
Bottom of Shaft	302.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	1.5	ft
Shaft Length	43.1	ft
Shaft Length in Soil or IGM	43.1	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	11.4	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	14.3	kips

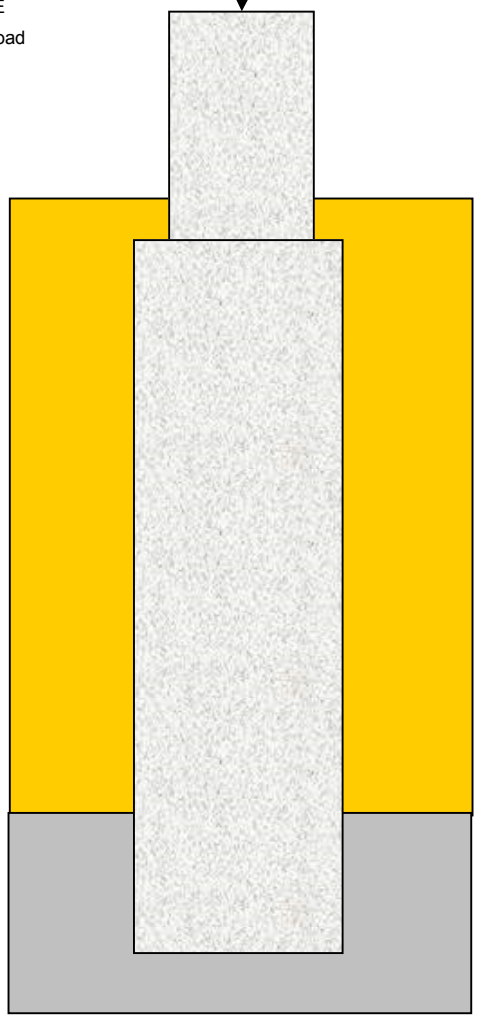
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	80	%
Eff. Wt. of Shaft	11.4	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	345.1
Top of Shaft	345.1
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	302.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				345.1	328.5	16.6	118	33	44	
S2				x		328.5	310.0	18.5	138	86	115	
S3				x		310.0	302.0	8.0	138	68	91	
S4												
S5												
S6												

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing:	Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"	REC ≥ 90	REC < 90
Weathering:	None, Slight, Moderate, Highly		

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	5
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/8/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-05	SHAFT NO. South	Date	1/8/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = area shaft — qs = unit side resistance

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1			0.0				
S2			0.0				
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	0

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	16.6	8.3	1.0	1.0	0.00	1.0	44	1.11	1.1	78.2	85	
S2	18.5	25.9	1.3	3.2	0.00	3.2						
S3	8.0	39.1	0.6	5.1	0.00	5.1						
S4												
S5												
S6												
			Bot Press.	5.1						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	85	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/8/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-05	SHAFT NO. South	Date	1/8/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	16.6	8.3	118.0	0.98	0.00	0.98	44					
S2	18.5	25.9	138.0	3.57	0.00	3.57	100	52.4	1.48	5.20	87.18	453.0
S3	8.0	39.1	138.0	5.40	0.00	5.40	91	48.4	1.10	5.17	37.70	195.0
S4												
S5												
S6												
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	648.0

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2	328.5	310.0							
S3	310.0	302.0	302.0	5.1	0.00	5.06	54.8	1.77	97
S4									
S5									
S6									
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	97 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/8/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-05	SHAFT NO. South	Date	1/8/2016

Side and Base Transfer Resistance in Grannular Soils

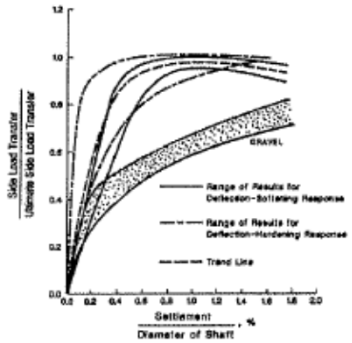


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

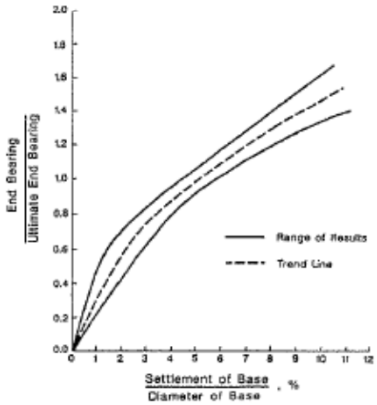


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/8/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-05	SHAFT NO. South	Date	1/8/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 2.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		85.1					
S2				453.0			
S3				195.0			
S4							
S5							
S6							
Sum	0.0	85.1	0.0	648.0	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	46.8	0.0	388.8	0.0		
L.T. Factor	0.83	0.9	0.8	0.9	0.8	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	42.1	0.0	349.9	0.0	**392**	kips

Tip Resistance

Layer No.	Material Description					
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM	
S1						
S2						
S3				96.8		
S4						
S5						
S6						
Sum				96.8	0.0	
φ				0.55	0.55	AASHTO Table 10.5.2.4-1
φ * Rs				53.3	0.0	
L.T. Factor				0.56	0.81	Sum Rp
Rp				29.8	0.0	**30**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	392	Pmax	290	
Rp	30	Wt. Shaft	14	
Σ	422	Σ	304	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B627

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-05

Bridge No.	B627	**Pier No.**	A South	**Bottom of Pile Cap / Top of Shaft El.**	341.5

Project No. 01-21924
By: JCG 1/13/2016
Checked: MAR 1/13/2016

Indicate Analysis Type Required		
		L/PILE Single Pile/Shaft Free head
		L/PILE Single Pile/Shaft Fixed head
	x	GROUP Fixed Head

			341.5	Top of Ground El.	
Indicate Load Type		Single Pile/Shaft Load	302.0	Tip El.	L inches = 474
	x	Group Load	18	No. Piles/Shafts for GROUP	
		HP Pile Size			
Pile Size. ft	1.500	f'c	4,000	f'c	
Tranverse Spacing, ft	12.00	Longit. Spacing, ft	6.0		

0.39	P Reducn Factor Long	4.0 B
1.00	P Reducn Factor Trans	8.0 B
0.39	P Reducn Factor Resultant Mom. (based on primary loading only)	

Max. Fv for Axial Capacity Analysis, kips 400.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	2,400	kips (lbs)	2,400,000	Fv (FV)	400	kips (lbs)	400,000	Fv (FV)		kips (lbs)	
Fy (FL)	350	kips (lbs)	350,000	Fy (FL)	170	kips (lbs)	170,000	Fy (FL)		kips (lbs)	
Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	2,700	kip-ft (lb-in)	32,400,000	Mz (ML)	750	kip-ft (lb-in)	9,000,000	Mz (ML)		kip-ft (lb-in)	
Fresultant		kips (lbs)		Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	2,700.00	kip-ft (lb-in)	32,400,000	Mresultant	750	kip-ft (lb-in)	9,000,000	Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 265.0 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	328.5	13.0	ML	P	44	II-C	156	0.07523	32.0		244		
2	310.0	18.5	HWR	P	100	III	378	0.06944	34.0		554		
3	300.0	10.0	HWR	P	91	III	498	0.06944	34.0		504		
4	285.0	15.0	HWR	P	100	III	678	0.06944	34.0		554		
5													
6													
7													
8													
9													
10													
11													

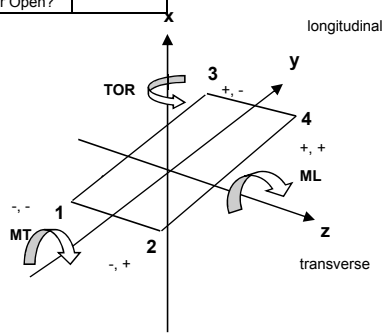
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

M concrete = psi 3,604,997
M Steel = psi 30,000,000

Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64

DETERMINATION OF INPUT RESISTANCE FACTORS FOR GROUP

By:	JCG	1/13/2016
Checked:	MAR	1/13/2016

Projct Name JBCONN B 627 Abutment A South
Project Number
Substructure

Drop down Menus are indicated by shaded boxes
GPOUP Required Input

Pile Shape =	Round		Moment of I =	5,153	in^4	r =	9.00	in
Pile Side/Diameter =	18.0	in	Box End Area =	254.5	in^2	μ =	0.15	
Concrete Area =	254.5	in^2	Circum. Unit Area (per in.) =	72.0	in^2	J =	10,306	in^4
Pile f'c =	4,000	psi	Modulus of E =	3,604,997	psi	G =	1,567,390	psi
Material =	Concrete		HP Steel Area =		in^2	GJ =	1.62E+10	psi
HP Size =								
Rotation Spring =	5	psi (normally use a minimal amount, e.g. 5 psi)						

Analysis Condition = Normal — Use only driven (ultimate) side resistances for the layers appropriate to the analysis condition.

Factored Resistance for Side and End Bearing Pressures 0.65 Use 0.65 for PDA tested piles, otherwise 0.45

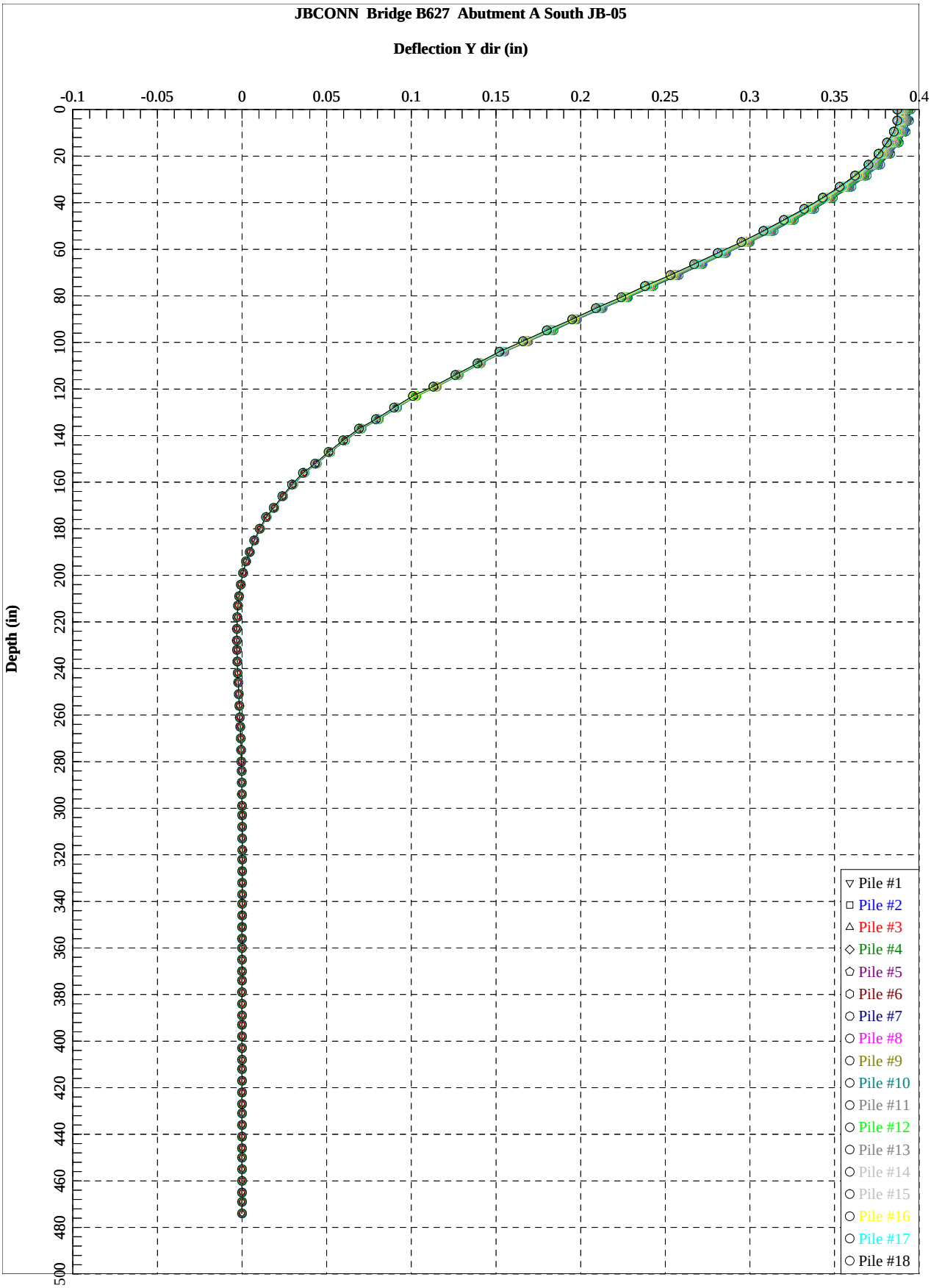
Abut A Unit Side Resistance based on DRIVEN Results

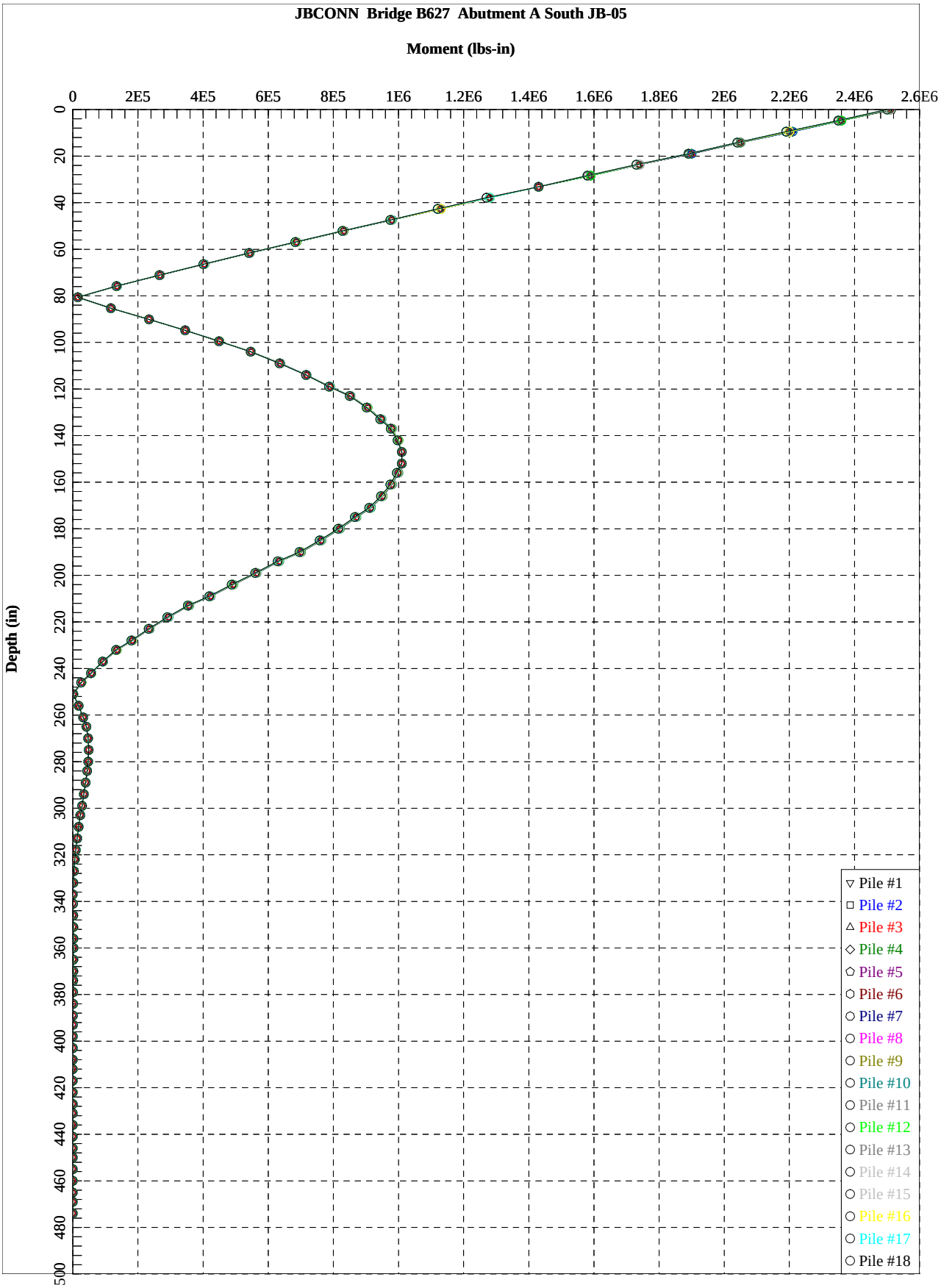
Delete only blue boxes

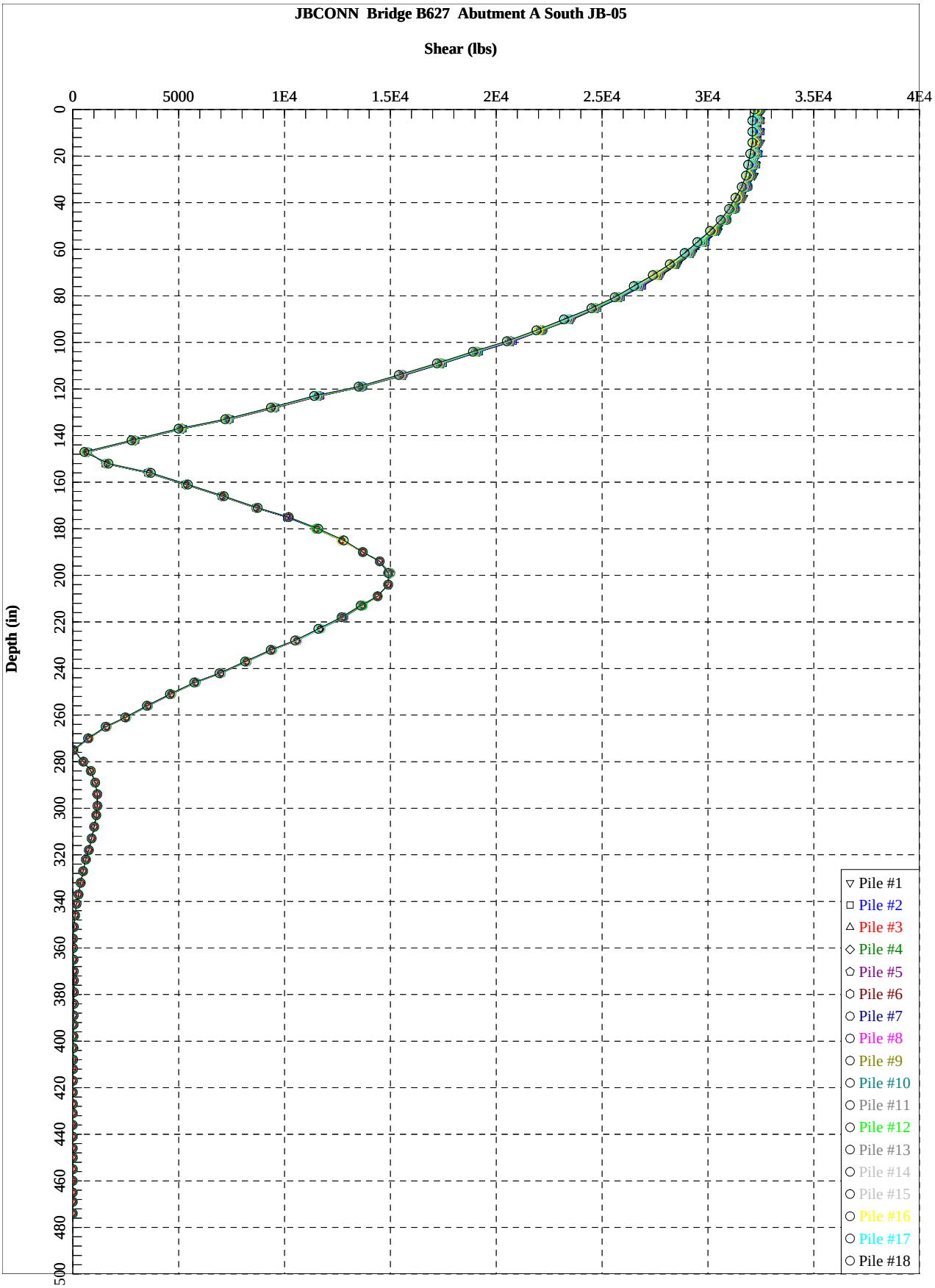
Layer No.	Layer top (ft)	Layer bot (ft)	Layer top (in)	Layer bot (in)	Side Fr. at Layer Top (kip)	Side Fr. at Layer Bot. (kip)	Unit area (in)	Unit Side Resist (psi)	End Bearing Top (kip)	End Bearing Bottom (kip)	Average End Bearing Top of Layer	Unit End Bearing (psi)
1	0.0	13.0	0.0	156	0.0		11232	0.0				
2	13.0	31.5	156.0	378			15984					
3	31.5	41.5	378.0	498			8640					
4	41.5	56.5	498.0	678			12960					
5												
6												
7												
8												

From Shaft Analysis			
	1	1.1	3.82
	2	5.2	18.06
	3	5.2	18.06
	4		0.00
	5		0.00
	6		0.00
		From axial	RF = 0.5

54.8	190.3
From axial	RF = 0.5


JBCONN Bridge B627 Abutment A South JB-05
Deflection Y dir (in)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8
Pile #9
Pile #10
Pile #11
Pile #12
Pile #13
Pile #14
Pile #15
Pile #16
Pile #17
Pile #18


JBCONN Bridge B627 Abutment A South JB-05
Moment (lbs-in)
0
2E5
4E5
6E5
8E5
1E6
1.2E6
1.4E6
1.6E6
1.8E6
2E6
2.2E6
2.4E6
2.6E6
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8
Pile #9
Pile #10
Pile #11
Pile #12
Pile #13
Pile #14
Pile #15
Pile #16
Pile #17
Pile #18


JBCONN Bridge B627 Abutment A South JB-05
Shear (lbs)
0
5000
1E4
1.5E4
2E4
2.5E4
3E4
3.5E4
4E4
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6
Pile #7
Pile #8
Pile #9
Pile #10
Pile #11
Pile #12
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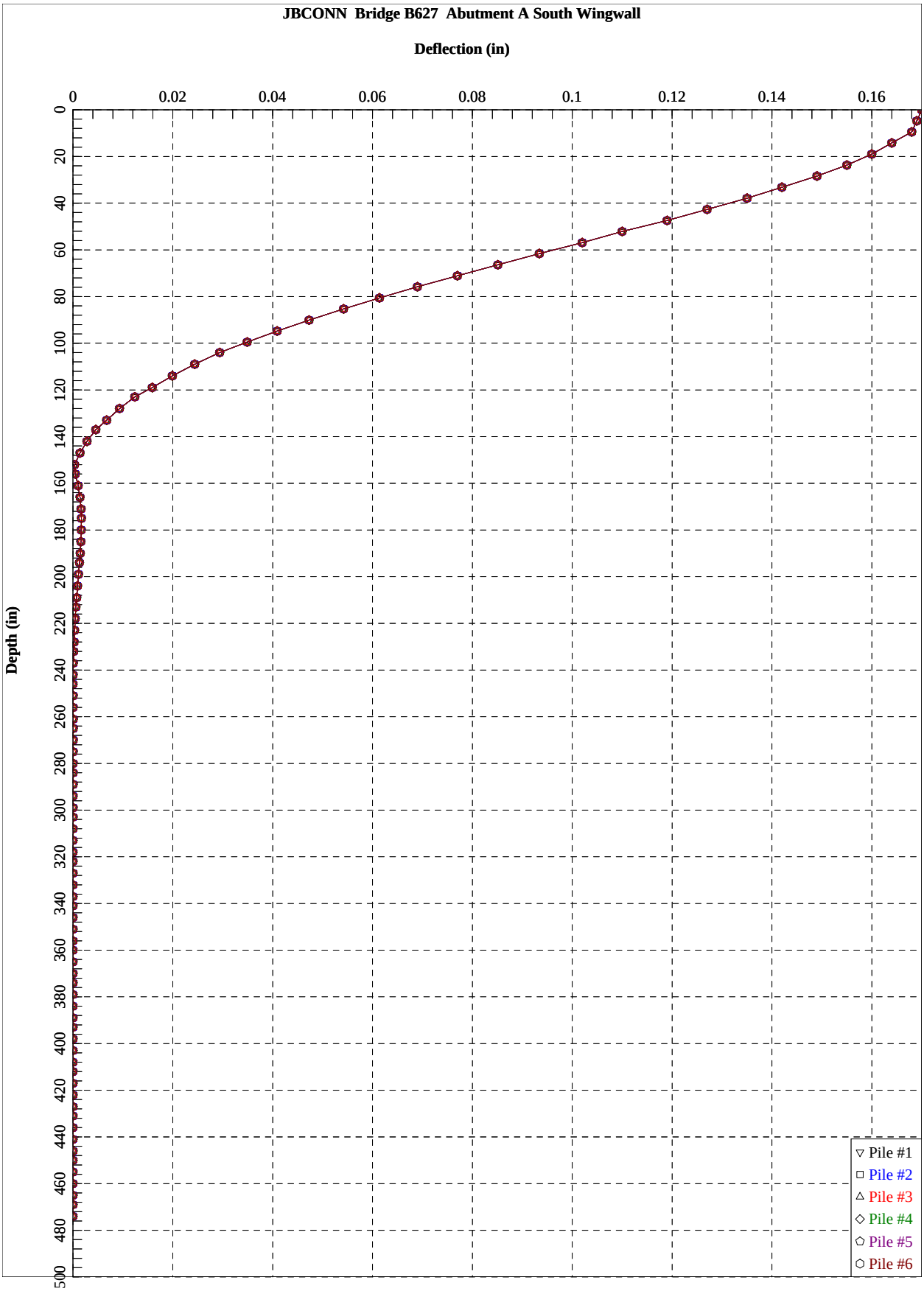
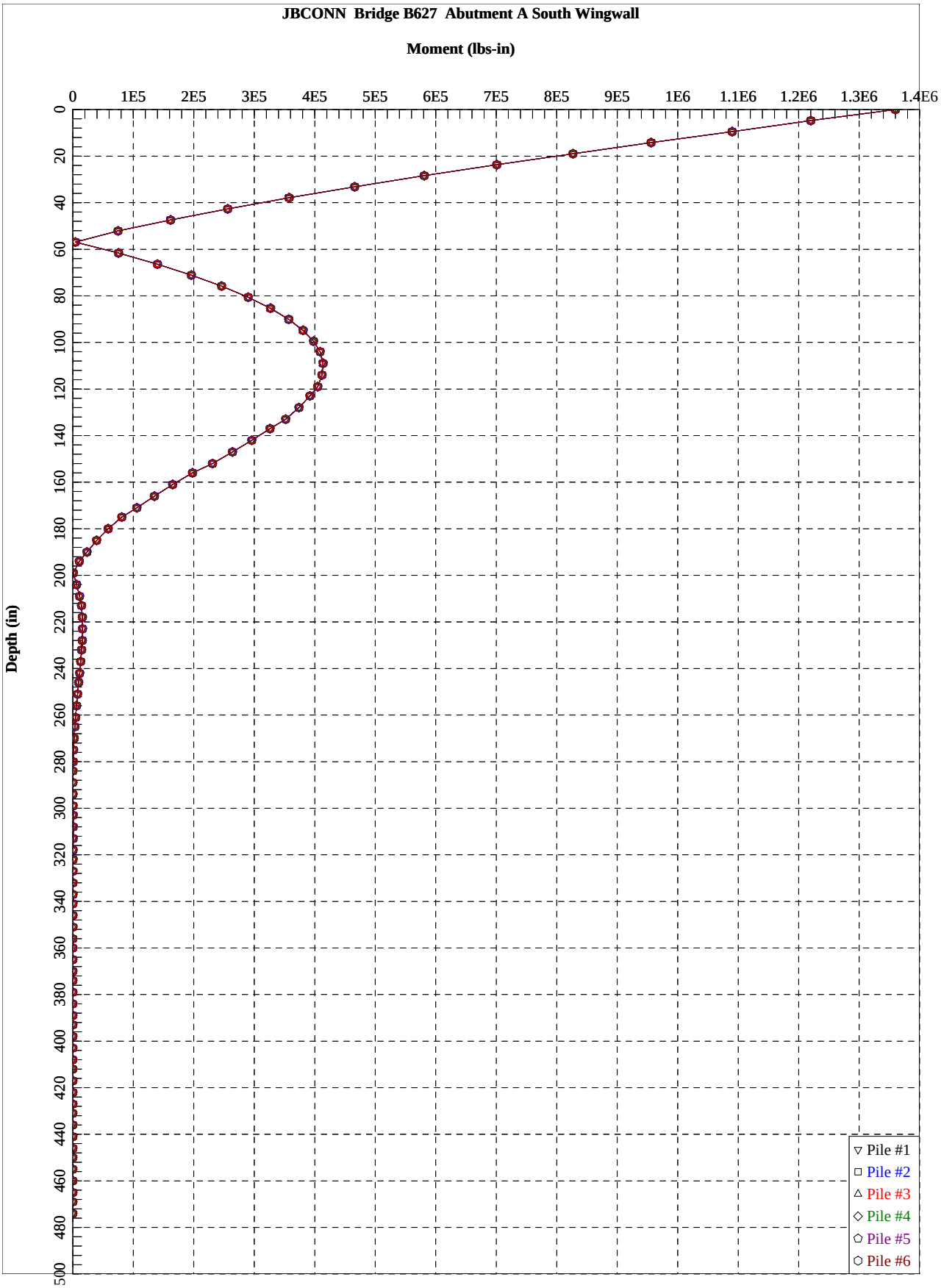
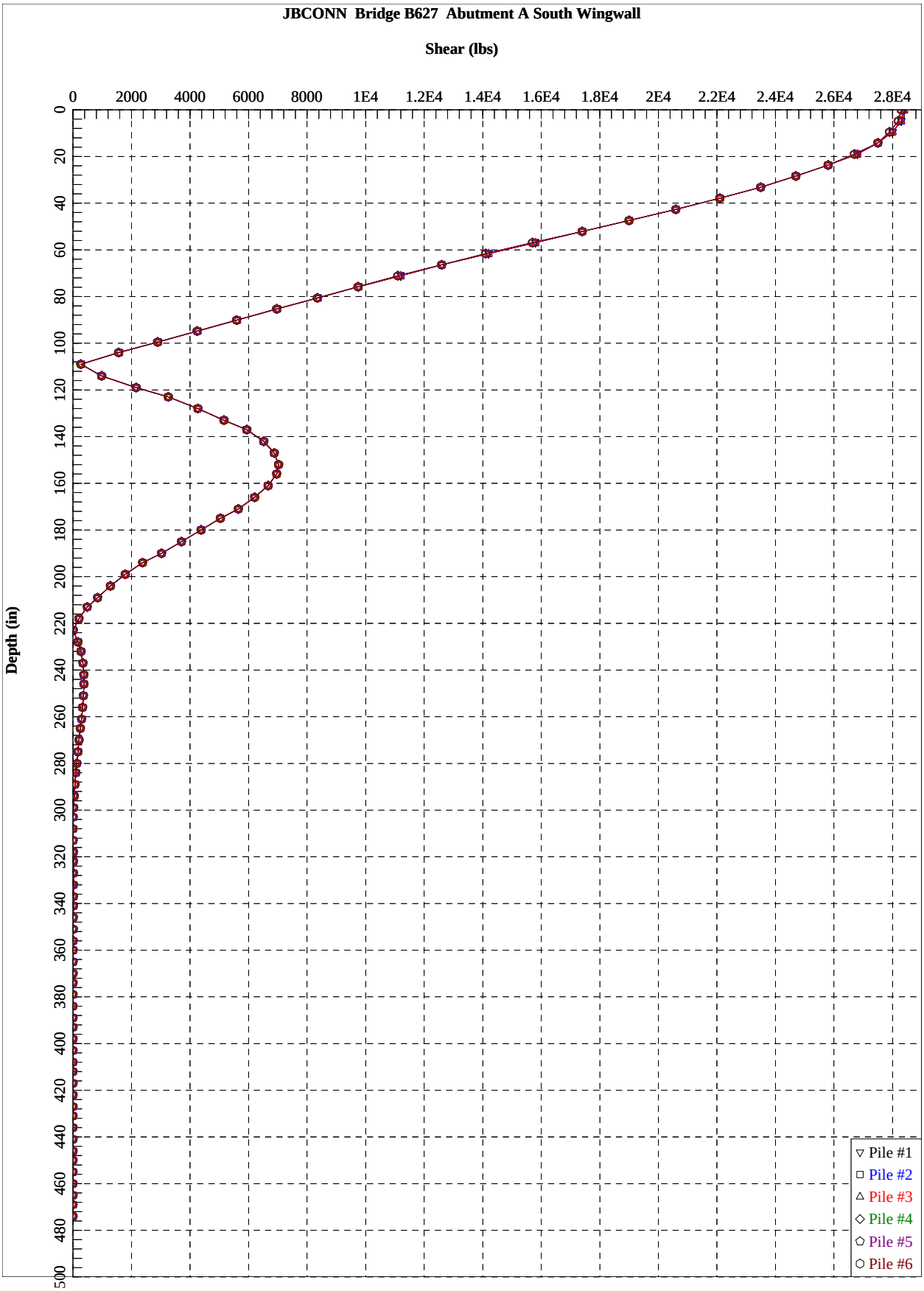
Pile #14
Pile #15
Pile #16
Pile #17
Pile #18


JBCONN Bridge B627 Abutment A South Wingwall
Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6


JBCONN Bridge B627 Abutment A South Wingwall
Moment (lbs-in)
0
1E5
2E5
3E5
4E5
5E5
6E5
7E5
8E5
9E5
1E6
1.1E6
1.2E6
1.3E6
1.4E6
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6

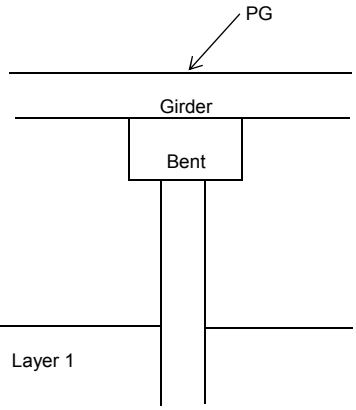

JBCONN Bridge B627 Abutment A South Wingwall
Shear (lbs)
0
2000
4000
6000
8000
1E4
1.2E4
1.4E4
1.6E4
1.8E4
2E4
2.2E4
2.4E4
2.6E4
2.8E4
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5
Pile #6

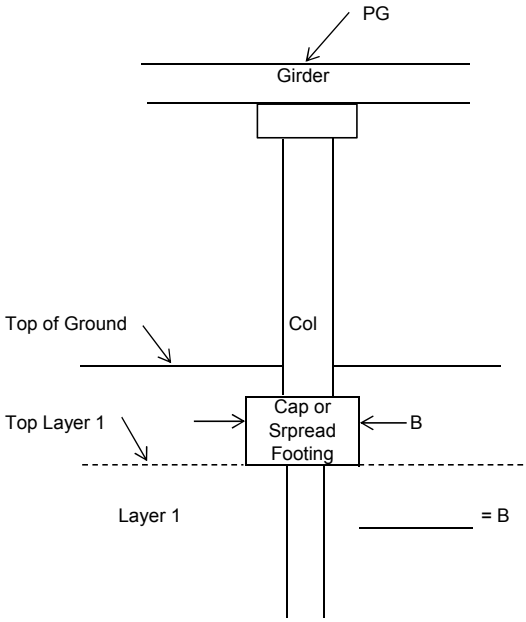
ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	Page 1 of 1	
Determination of Soil Parameters below Piers	Made By	MDY
	Date	12/28/2015
	Checked By	JCG
LOCATION JBCONN Bridge B 627 Pier 1 Enter Values in Blue.	Date	12/28/2015

Red values are calculated

BORING No. =	658-1
Top of Boring El. =	354.9
Profile Grade =	364.6
Top of Layer 1 =	325.5
Top of Ground El. =	325.5
Hammer Efficiency %	80
Groundwater Elevation =	321.8

Bottom of Bent or Cap =	325.5
GW depth below top Layer 1 =	3.7





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

	Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
	1	320.0	5.5	P	II-C	100					100
	2	312.5	7.5	P	II-C	64					85
	3	308.5	4.0	P	II-C	100					100
	4	303.5	5.0	P	II-C	70					93
	5	286.8	16.7	P	II-C	100	100	100	100		100
Poor/Fair	6	266.9	19.9	R	ROCK						
Good	7	262.9	4.0	R	ROCK						
	8										
	9										
	10										
	11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	120.0	128.0	HWR	250.0	34.0		4	5.5	
2	120.0	128.0	HWR	250.0	34.0		4	13.0	
3	120.0	128.0	HWR	250.0	34.0		4	17.0	
4	120.0	128.0	HWR	250.0	34.0		4	22.0	
5	120.0	128.0	HWR	250.0	34.0		4	38.7	
6	145.0	150.0		0.0	37.0			58.6	
7	145.0	150.0		0.0	37.0			62.6	
8									
9									
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	1/13/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	658-1	SHAFT NO. 1	Date	1/13/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,300	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	325.5	ft	
Top of Shaft	325.5	ft	
Groundwater (Enter bot. shaft if none)	321.8	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	286.0	ft	
Bottom of Shaft	286.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	4.0	ft
Shaft Length	39.5	ft
Shaft Length in Soil or IGM	39.5	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	46.4	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	58.0	kips

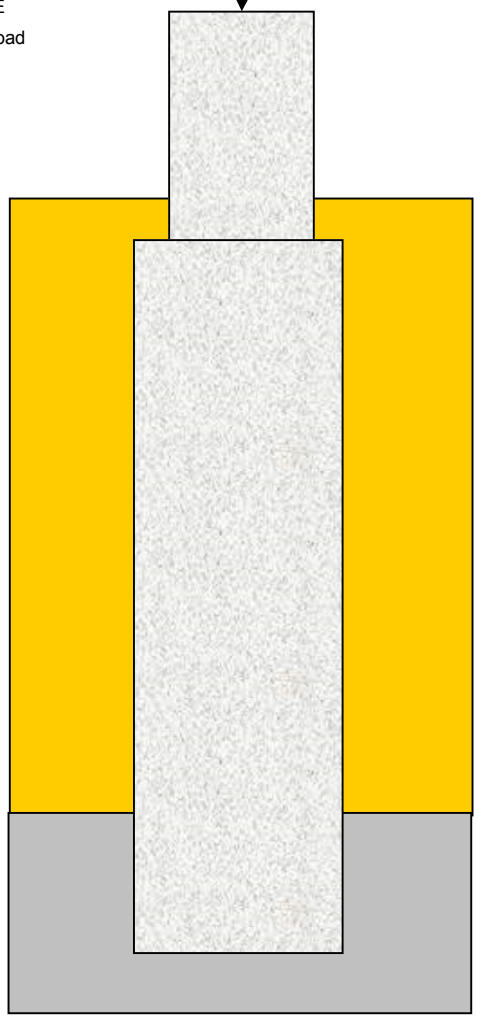
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	80	%
Eff. Wt. of Shaft	46.4	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	325.5
Top of Shaft	325.5
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	286.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1				x		325.5	321.8	3.7	138	100	133	
S2				x		321.8	312.5	9.3	138	64	85	
S3				x		312.5	308.5	4.0	138	100	133	
S4				x		308.5	303.5	5.0	138	70	93	
S5				x		303.5	286.0	17.5	138	100	133	
S6												

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS					Page	5
						Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0			Date	1/13/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO.	Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	658-1	SHAFT NO.	1	Date	1/13/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = area shaft — qs = unit side resistance

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1			0.0				
S2			0.0				
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	0

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	3.7	1.8	0.3	0.3	0.00	0.3						
S2	9.3	8.3	0.6	1.2	0.29	0.9						
S3	4.0	15.0	0.3	2.1	0.71	1.4						
S4	5.0	19.5	0.3	2.7	0.99	1.7						
S5	17.5	30.8	1.2	4.2	1.69	2.6						
S6												
			Bot Press.	4.2						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	0	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/13/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	658-1	SHAFT NO. 1	Date	1/13/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

$ko = (1 - \sin\Phi') * (0.2 * pa * N60 / \sigma'v)^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	3.7	1.8	138.0	0.26	0.00	0.26	100	62.5	10.55	3.60	46.50	167.2
S2	9.3	8.3	138.0	1.15	0.29	0.86	85	58.4	3.58	3.64	116.87	425.1
S3	4.0	15.0	138.0	2.07	0.71	1.36	100	57.9	2.81	4.46	50.27	224.0
S4	5.0	19.5	138.0	2.69	0.99	1.71	93	56.2	2.30	4.34	62.83	272.9
S5	17.5	30.8	138.0	4.24	1.69	2.56	100	54.6	1.83	4.91	219.91	1080.1
S6												
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	2169.2

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

$qp = 0.59 * [N60 * (pa / \sigma'v)]^{0.8} * \sigma'v$ AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1	325.5	321.8							
S2	321.8	312.5							
S3	312.5	308.5							
S4	308.5	303.5							
S5	303.5	286.0	286.0	4.2	2.23	2.01	62.0	12.57	779
S6									
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	779 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/13/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	658-1	SHAFT NO. 1	Date	1/13/2016

Side and Base Transfer Resistance in Grannular Soils

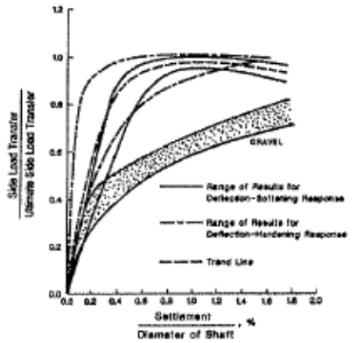


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

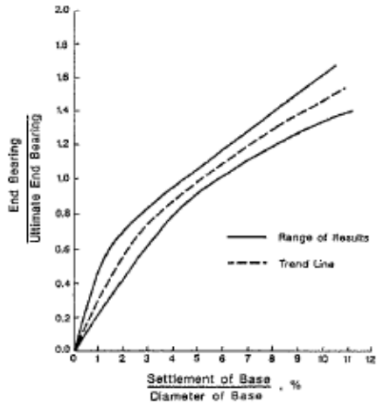


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/13/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	658-1	SHAFT NO. 1	Date	1/13/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1				167.2			
S2				425.1			
S3				224.0			
S4				272.9			
S5				1,080.1			
S6							
Sum	0.0	0.0	0.0	2,169.2	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	0.0	0.0	1301.5	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	0.0	0.0	1262.5	0.0	**1,262**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5				779.3	
S6					
Sum				779.3	0.0
φ				0.55	0.55
φ * Rs				428.6	0.0
L.T. Factor				0.3	0.58
Rp				128.6	0.0

Sum Rp **129**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,262	Pmax	1,300	
Rp	129	Wt. Shaft	58	
Σ	1,391	Σ	1,358	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B627

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. 658-1 New Pier at Tie-In

Bridge No. B627 **Pier No.** Pier 1 **Bottom of Pile Cap / Top of Shaft El.** 325.5

Project No.

By: JCG 1/13/2016

Checked: MAR 1/13/2016

Indicate Analysis Type Required

	L/PILE Single Pile/Shaft Free head
	L/PILE Single Pile/Shaft Fixed head
x	GROUP Fixed Head

325.5 Top of Ground El.

Indicate Load Type

	Single Pile/Shaft Load	286.0	Tip El.
x	Group Load		No. Piles/Shafts for GROUP

L inches = 474

HP Pile Size

Pile Size. ft 4.000 **f'c** 5,000 f'c

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft**

1.00	P Reducn Factor Long	8.0 B
	P Reducn Factor Trans	B
#VALUE!	P Reducn Factor Resultant Mom.	

(based on primary loading only)

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Max. Fv for Axial Capacity Analysis, kips 1,250.0

Include couple effects with Fv Existing Pier Loads New Pier Loads

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	4,525	kips (lbs)	4,525,000	Fv (FV)	1,050	kips (lbs)	1,050,000	Fv (FV)		kips (lbs)	
Fy (FL)	133	kips (lbs)	133,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	86	kips (lbs)	86,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	3,110	kip-ft (lb-in)	37,320,000	My (MT)	675	kip-ft (lb-in)	8,100,000	My (MT)		kip-ft (lb-in)	
Mz (ML)	18,330	kip-ft (lb-in)	219,960,000	Mz (ML)	4,027	kip-ft (lb-in)	48,324,000	Mz (ML)		kip-ft (lb-in)	
Fresultant	158.38	kips (lbs)	158,382	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	18,591.96	kip-ft (lb-in)	223,103,528	Mresultant	4,083	kip-ft (lb-in)	48,998,153	Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 321.8 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	321.8	3.7	HWR	P	100	III	44	0.06944	34.0		554		
2	312.5	9.3	HWR	P	85	III	156	0.03738	34.0		282		
3	308.5	4.0	HWR	P	100	III	204	0.03738	34.0		332		
4	303.5	5.0	HWR	P	93	III	264	0.03738	34.0		309		
5	286.0	17.5	HWR	P	100	III	474	0.03738	34.0		332		
6													
7													
8													
9													
10													
11													

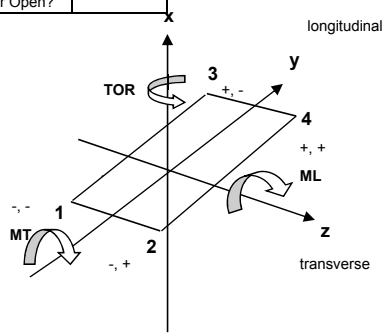
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

M concrete = psi 4,030,509
M Steel = psi 30,000,000

Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64

DETERMINATION OF INPUT RESISTANCE FACTORS FOR GROUP

By:	JCG	1/13/2016
Checked:	MAR	1/13/2016

Projct Name JBCONN B 627 Pier 1
Project Number
Substructure 658-1

Drop down Menus are indicated by shaded boxes
GPOUP Required Input

Pile Shape =	Round		Moment of I =	260,576	in^4	r =	24.00	in
Pile Side/Diameter =	48.0	in	Box End Area =	1809.6	in^2	μ =	0.15	
Concrete Area =	1809.6	in^2	Circum. Unit Area (per in.) =	192.0	in^2	J =	521,153	in^4
Pile f'c =	5,000	psi	Modulus of E =	4,030,509	psi	G =	1,752,395	psi
Material =	Concrete		HP Steel Area =		in^2	GJ =	9.13E+11	psi
HP Size =								
Rotation Spring =	5	psi (normally use a minimal amount, e.g. 5 psi)						

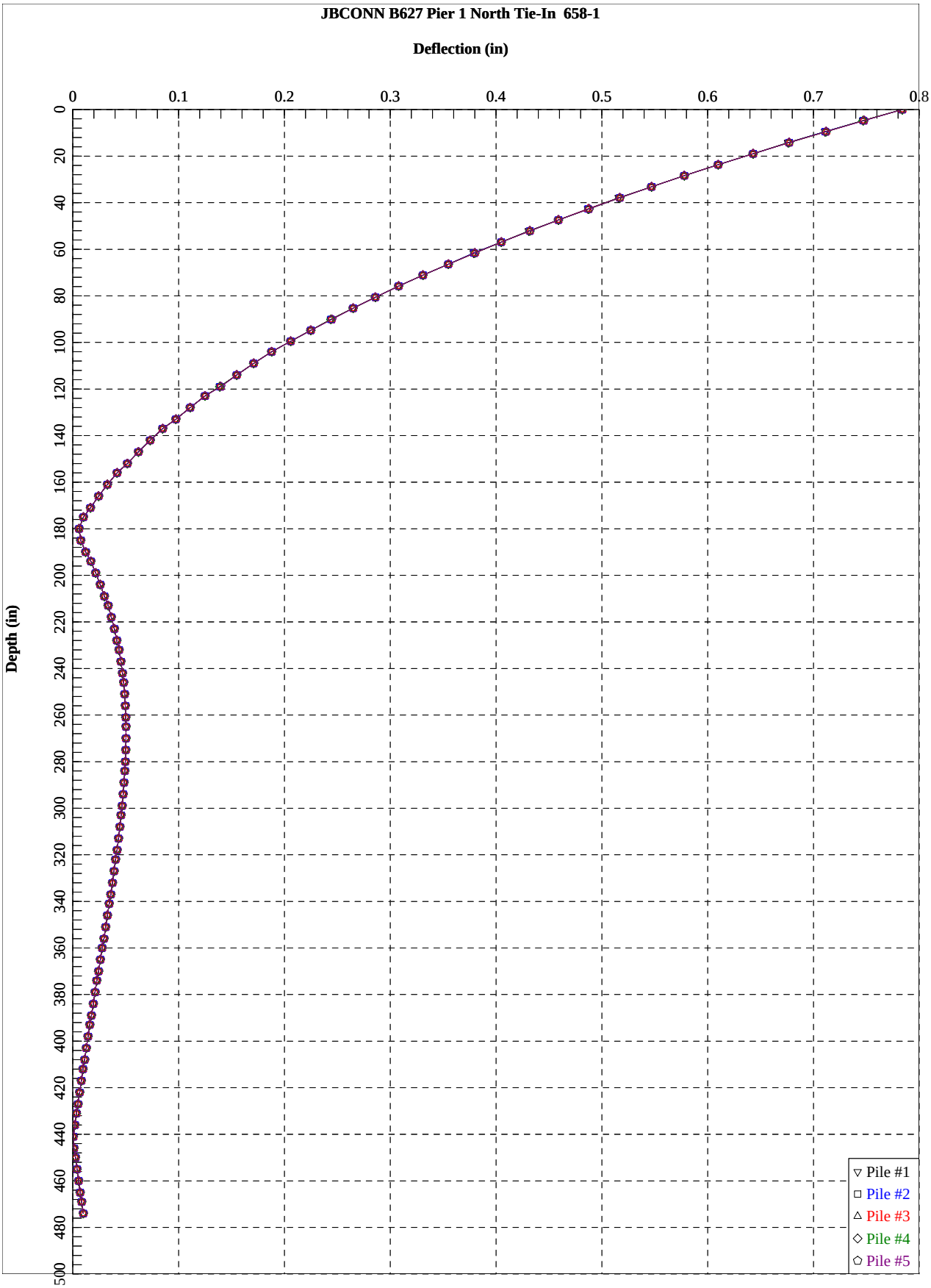
Analysis Condition = Normal — Use only driven (ultimate) side resistances for the layers appropriate to the analysis condition.

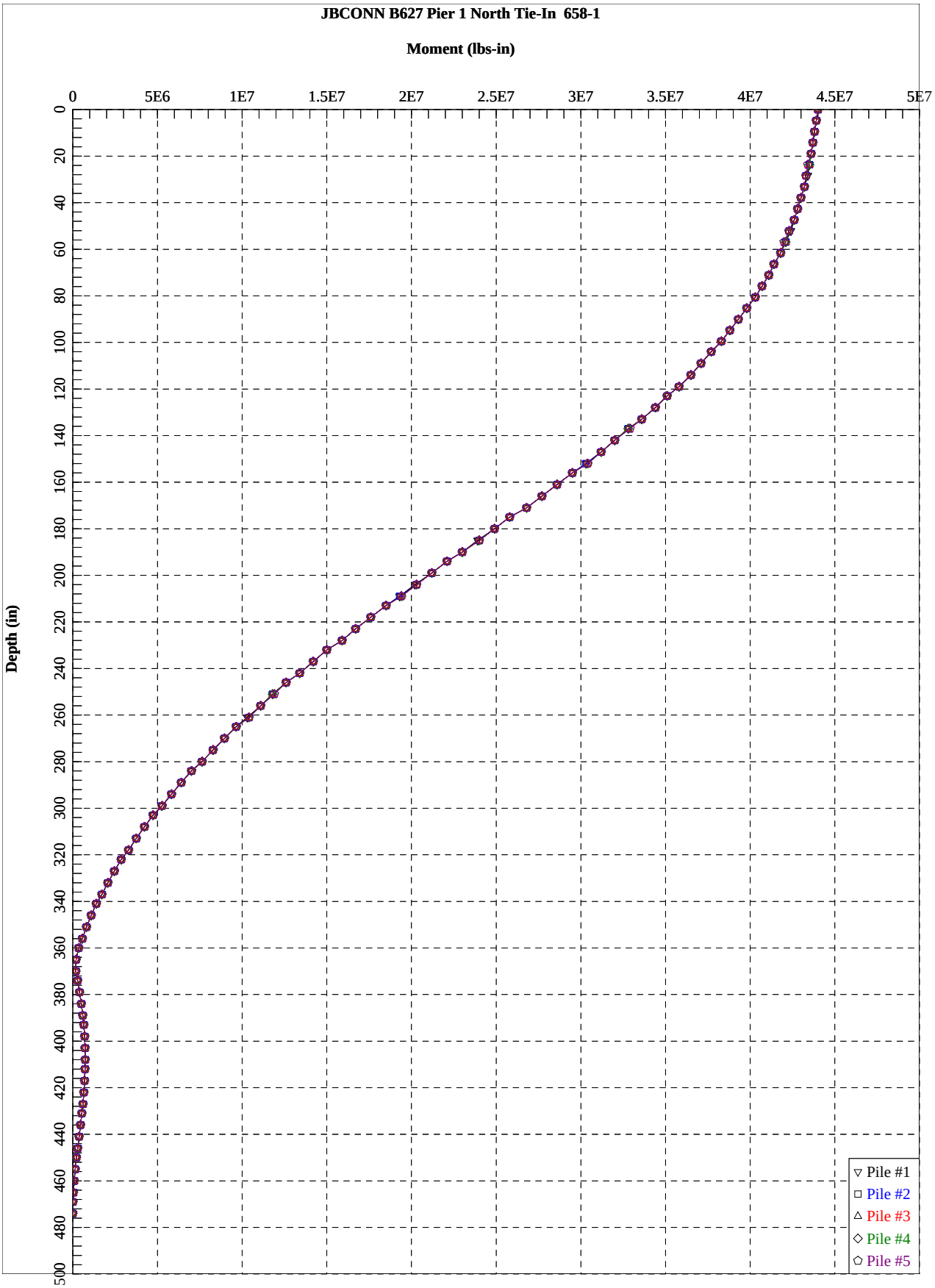
Factored Resistance for Side and End Bearing Pressures: 0.65 — Use 0.65 for PDA tested piles, otherwise 0.45

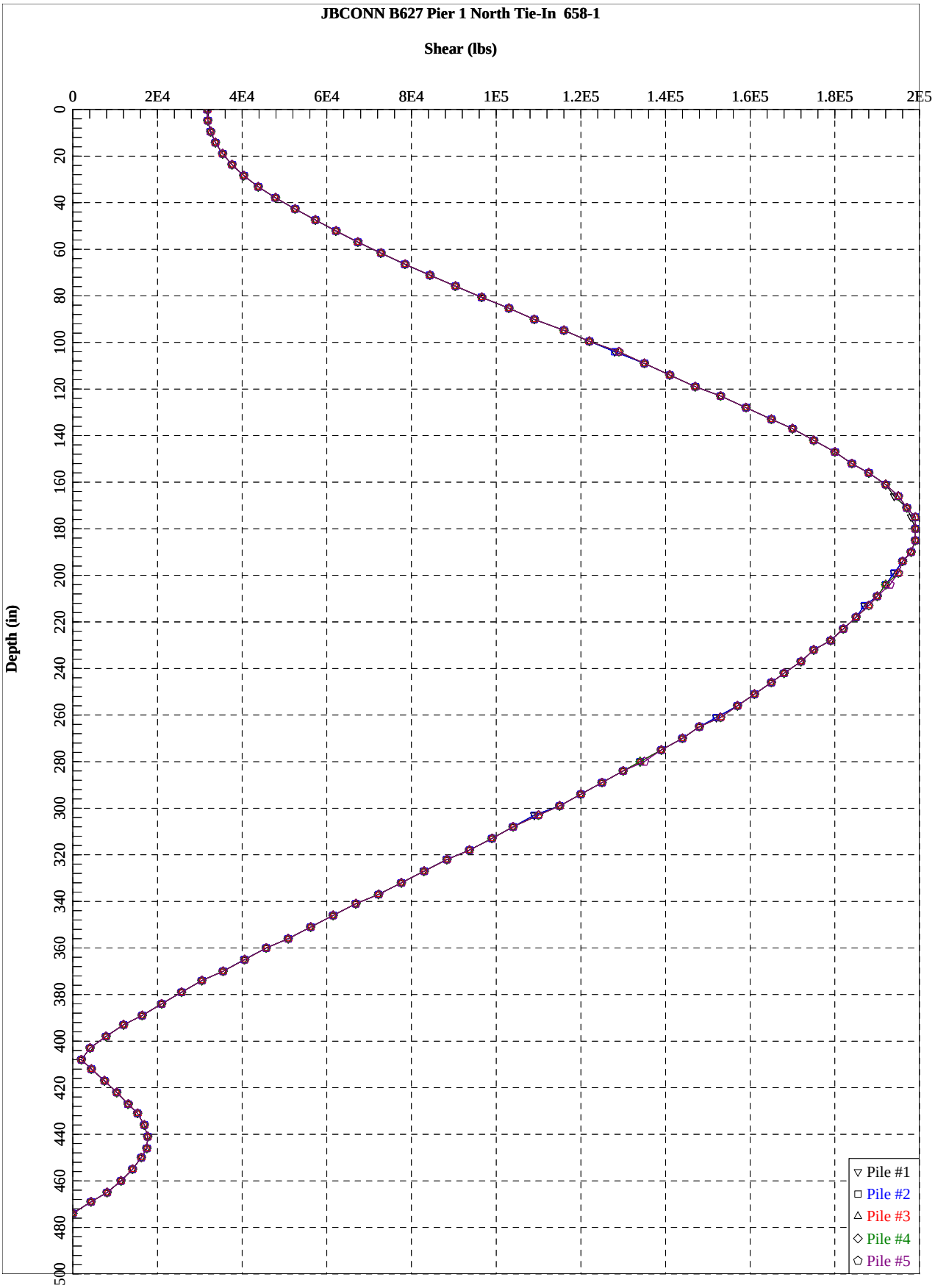
Abut A Unit Side Resistance based on DRIVEN Results

Delete only blue boxes

Layer No.	Layer top (ft)	Layer bot (ft)	Layer top (in)	Layer bot (in)	Side Fr. at Layer Top (kip)	Side Fr. at Layer Bot. (kip)	Unit area (in)	Unit Side Resist (psi)	End Bearing Top (kip)	End Bearing Bottom (kip)	Average End Bearing Top of Layer	Unit End Bearing (psi)
1	0.0	3.7	0.0	44	0.0		8525	0.0				
2	3.7	13.0	44.4	156			21427					
3	13.0	17.0	156.0	204			9216					
4	17.0	22.0	204.0	264			11520					
5	22.0	39.5	264.0	474			40320					
6												
7												
8												
						1	3.6	12.50				
						2	3.64	12.64				
						3	4.46	15.49				
						4	4.34	15.07				
						5	4.89	16.98			61.9	214.9


JBCONN B627 Pier 1 North Tie-In 658-1
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5


JBCONN B627 Pier 1 North Tie-In 658-1
Moment (lbs-in)
0
5E6
1E7
1.5E7
2E7
2.5E7
3E7
3.5E7
4E7
4.5E7
5E7
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5

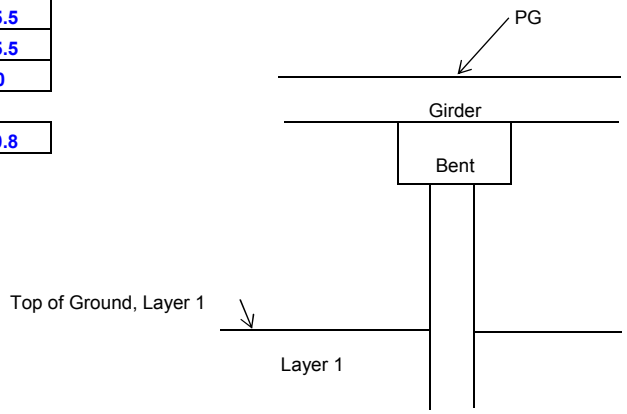

JBCONN B627 Pier 1 North Tie-In 658-1
Shear (lbs)
0
2E4
4E4
6E4
8E4
1E5
1.2E5
1.4E5
1.6E5
1.8E5
2E5
Depth (in)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5

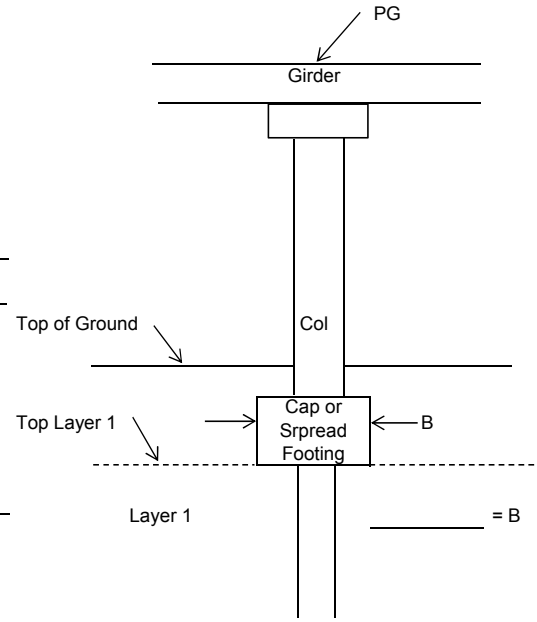
ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	Page 1 of 1	
Determination of Soil Parameters below Piers	Made By	MDY
	Date	12/1/2015
	Checked By	JCG
LOCATION JBCONN Bridge B 627 Pier 1 Enter Values in Blue.	Date	12/1/2015

Red values are calculated

BORING No. =	JB-06
Top of Boring El. =	339.3
Profile Grade =	364.6
Top of Layer 1 =	325.5
Top of Ground El. =	325.5
Hammer Efficiency %	80
Groundwater Elevation =	280.8

Bottom of Bent or Cap =	325.5
GW depth below top Layer 1 =	44.7





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	322.8	2.7	P	II-C	34					45
2	312.5	10.3	P	II-C	88	78				100
3	297.3	15.2	P	II-C	32	49	21			45
4	280.8	16.5	P	II-C	100	100	100			100
5	277.0	3.8	P	II-C	34					45
6	269.3	7.7	P	II-C	84	55				93
7										
8										
9										
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	130.0	137.0	ML	50.0	32.0		2	2.7	
2	120.0	128.0	HWR	250.0	34.0		4	13.0	
3	130.0	137.0	ML	50.0	32.0		2	28.2	
4	120.0	128.0	HWR	250.0	34.0		4	44.7	
5	130.0	137.0	ML	50.0	32.0		2	48.5	
6	120.0	128.0	HWR	250.0	34.0		4	56.2	
7									
8									
9									
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	1/15/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	Fairfax Co.	BORING NO.	JB-06	SHAFT NO. 1	Date	1/15/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,300	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	325.5	ft	
Top of Shaft	325.5	ft	
Groundwater (Enter bot. shaft if none)	280.8	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	282.0	ft	
Bottom of Shaft	276.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	4.0	ft
Shaft Length	49.5	ft
Shaft Length in Soil or IGM	43.5	ft
Shaft Length in Rock	6.0	ft
Bouyant Weight of Shaft	89.5	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	111.9	kips

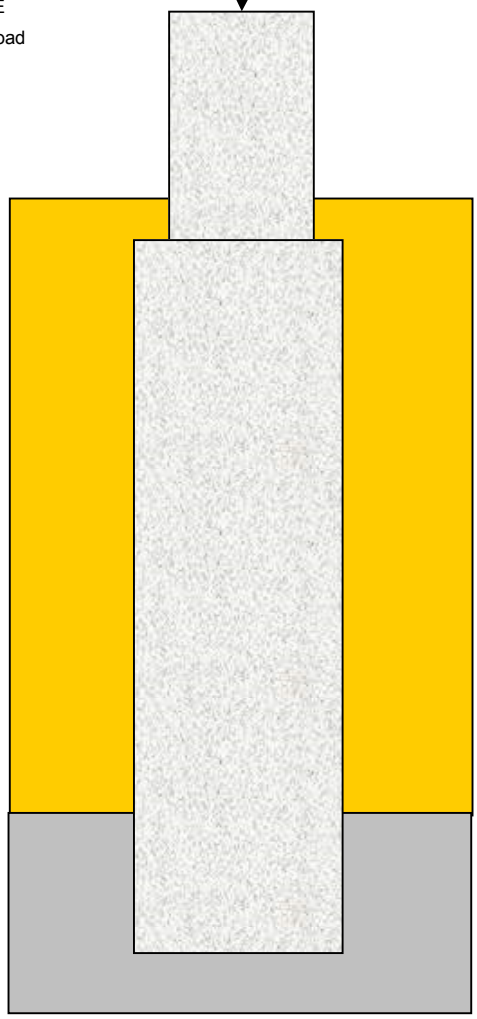
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	80	%
Eff. Wt. of Shaft	89.5	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	325.5
Top of Shaft	325.5
S1 to S6	
Top of Rock	282.0
R1	
R2	
Bot. of Shaft	276.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				325.5	322.8	2.7	118	34	45	
S2				x		322.8	312.5	10.3	138	83	111	
S3		x				312.5	297.3	15.2	118	34	45	
S4				x		297.3	280.8	16.5	138	100	133	
S5		x				280.8	277.0	3.8	118	34	45	
S6				x		277.0	276.0	1.0	138	70	93	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS					Page	5
						Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0			Date	1/15/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO.	Pier 1	Checked By	MAR
PROJECT LOCATION	Fairfax Co.	BORING NO.	JB-06	SHAFT NO.	1	Date	1/15/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = area shaft — qs = unit side resistance

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1			0.0				
S2			0.0				
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	0

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	2.7	1.3	0.2	0.2	0.00	0.2	45	1.34	0.2	33.9	7	
S2	10.3	7.8	0.7	1.0	0.00	1.0						
S3	15.2	20.6	0.9	2.6	0.00	2.6	45	0.89	2.3	191.0	447	
S4	16.5	36.5	1.1	4.7	0.00	4.7						
S5	3.8	46.6	0.2	6.0	0.12	5.9	45	0.58	3.4	47.8	163	
S6	1.0	49.0	0.1	6.3	0.27	6.1						
			Bot Press.	6.3						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	618	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	Fairfax Co.	BORING NO.	JB-06	SHAFT NO. 1	Date	1/15/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

$ko = (1 - \sin\Phi') * (0.2 * pa * N60 / \sigma'v)^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	2.7	1.3	118.0	0.16	0.00	0.16	45					
S2	10.3	7.8	138.0	1.08	0.00	1.08	100	58.9	3.32	4.31	129.43	557.9
S3	15.2	20.6	118.0	2.43	0.00	2.43	45					
S4	16.5	36.5	138.0	5.03	0.00	5.03	100	49.9	1.20	5.53	207.35	1146.6
S5	3.8	46.6	118.0	5.50	0.12	5.38	45					
S6	1.0	49.0	138.0	6.76	0.27	6.49	93	47.2	1.00	5.50	12.57	69.1
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	1773.6

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

$qp = 0.59 * [N60 * (pa / \sigma'v)]^{0.8} * \sigma'v$ AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2	322.8	312.5							
S3									
S4	297.3	280.8							
S5									
S6	277.0	276.0	276.0	6.3	0.30	6.03	58.1	12.57	730
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	730 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
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PROJECT LOCATION	Fairfax Co.	BORING NO.	JB-06	SHAFT NO. 1	Date	1/15/2016

Side and Base Transfer Resistance in Grannular Soils

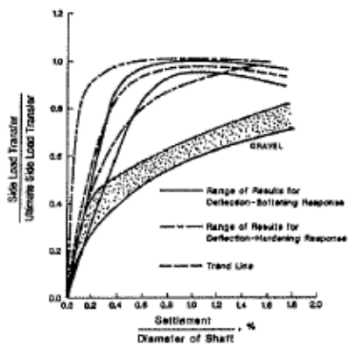


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

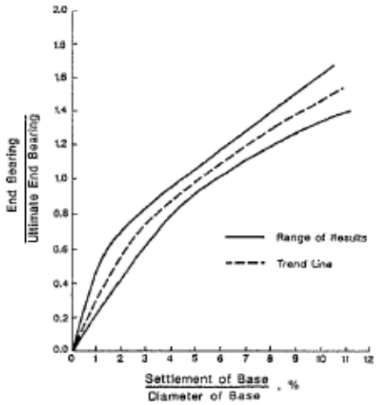


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	1/15/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B627	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	Fairfax Co.	BORING NO.	658-1	SHAFT NO. 1	Date	1/15/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		7.3					
S2				557.9			
S3		446.9					
S4				1,146.6			
S5		163.4					
S6				69.1			
Sum	0.0	617.6	0.0	1,773.6	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	339.7	0.0	1064.1	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	329.5	0.0	1032.2	0.0	**1,362**	kips

Tip Resistance

Layer No.	Material Description					
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM	
S1						
S2						
S3						
S4						
S5						
S6				729.8		
Sum				729.8	0.0	
φ				0.55	0.55	AASHTO Table 10.5.2.4-1
φ * Rs				401.4	0.0	
L.T. Factor				0.3	0.58	Sum Rp
Rp				120.4	0.0	**120**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,362	Pmax	1,300	
Rp	120	Wt. Shaft	112	
Σ	1,482	Σ	1,412	
		FR ≥ RP	**OK**	

See AASHTO Figures 10.8.2.2.2-2 & -4

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B627

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-06

Bridge No.	B627	**Pier No.**	Pier 1	**Bottom of Pile Cap / Top of Shaft El.**	325.5

Project No.
By: JCG 1/13/2016
Checked: MAR 1/13/2016

Indicate Analysis Type Required

	L/PILE Single Pile/Shaft Free head
	L/PILE Single Pile/Shaft Fixed head
x	GROUP Fixed Head

Indicate Load Type

	Single Pile/Shaft Load	276.0	Tip El.
x	Group Load		No. Piles/Shafts for GROUP

Top of Ground El. 325.5

L inches = 594

HP Pile Size

Pile Size. ft 4.000 **f'c** 5,000 **f'c**

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft**

1.00	P Reducn Factor Long	8.0 B
	P Reducn Factor Trans	B
#VALUE!	P Reducn Factor Resultant Mom.	

(based on primary loading only)

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Max. Fv for Axial Capacity Analysis, kips 1,250.0

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	4,525.0	kips (lbs)	4,525,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	133.00	kips (lbs)	133,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	86	kips (lbs)	86,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	3,110	kip-ft (lb-in)	37,320,000	My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	18,330.00	kip-ft (lb-in)	219,960,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	158.38	kips (lbs)	158,382	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	18,591.96	kip-ft (lb-in)	223,103,528	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 280.8 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. — USCS, SF, R, or FR — Enter 15 for compacted fill w/o SPT data, 50 for SF — Max 6.0 — E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	322.8	2.7	ML	P	45	II-C	32	0.07523	32.0		249		
2	312.5	10.3	HWR	P	100	III	156	0.06944	34.0		554		
3	297.3	15.2	ML	P	45	II-C	338	0.07523	32.0		249		
4	280.8	16.5	HWR	P	100	III	536	0.06944	34.0		554		
5	277.0	3.8	ML	P	45	II-C	582	0.04317	32.0		149		
6	275.0	2.0	HWR	P	93	III	606	0.03738	34.0		309		
7													
8													
9													
10													
11													

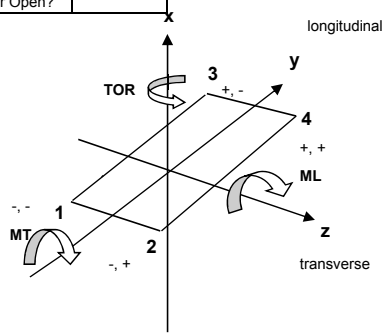
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

M concrete = psi 4,030,509
M Steel = psi 30,000,000

Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72
12-inch sq. Concrete I = 1728

HP 12x53	394	15.6	d= 11.78
HP 14X73	729	21.4	d= 13.64

DETERMINATION OF INPUT RESISTANCE FACTORS FOR GROUP

By:	JCG	1/13/2016
Checked:	MAR	1/13/2016

Projct Name JBCONN B 627 Pier 1
Project Number
Substructure

Drop down Menus are indicated by shaded boxes
GPOUP Required Input

Pile Shape =	Round		Moment of I =	260,576	in^4	r =	24.00	in
Pile Side/Diameter =	48.0	in	Box End Area =	1809.6	in^2	μ =	0.15	
Concrete Area =	1809.6	in^2	Circum. Unit Area (per in.) =	192.0	in^2	J =	521,153	in^4
Pile f'c =	5,000	psi	Modulus of E =	4,030,509	psi	G =	1,752,395	psi
Material =	Concrete		HP Steel Area =		in^2	GJ =	9.13E+11	psi
HP Size =								
Rotation Spring =	5	psi (normally use a minimal amount, e.g. 5 psi)						

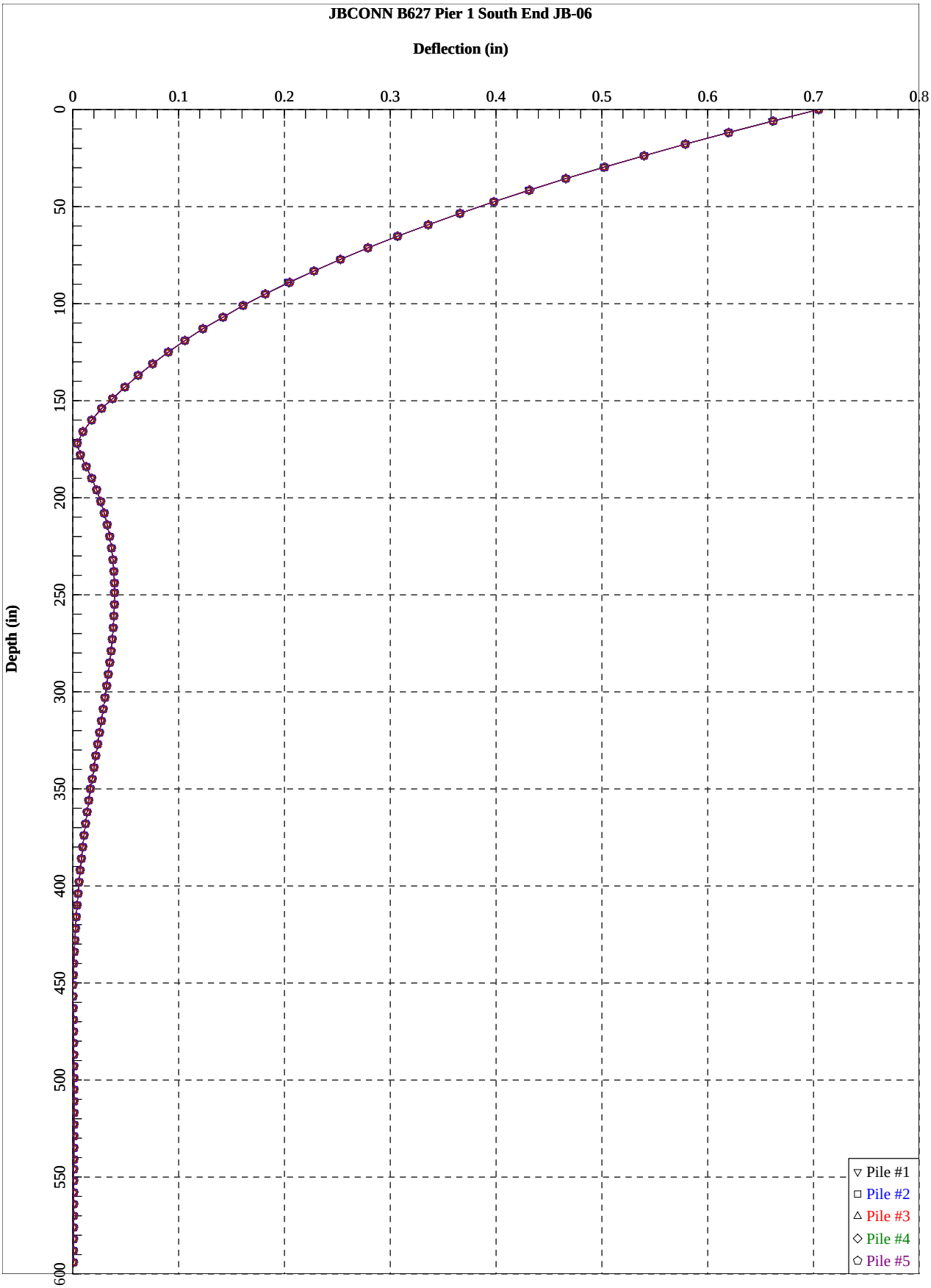
Analysis Condition = Normal — Use only driven (ultimate) side resistances for the layers appropriate to the analysis condition.

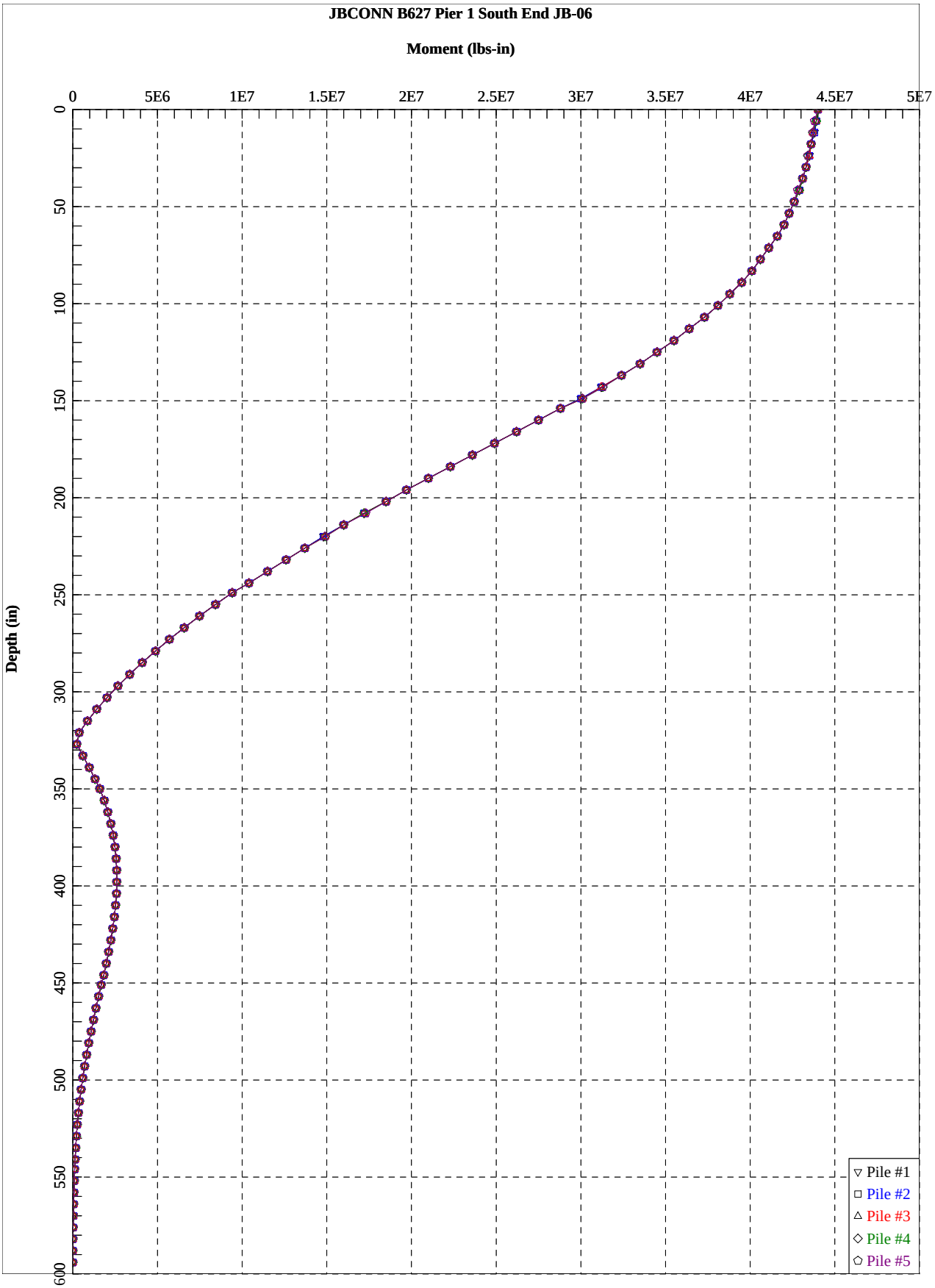
Factored Resistance for Side and End Bearing Pressures: 0.65 — Use 0.65 for PDA tested piles, otherwise 0.45

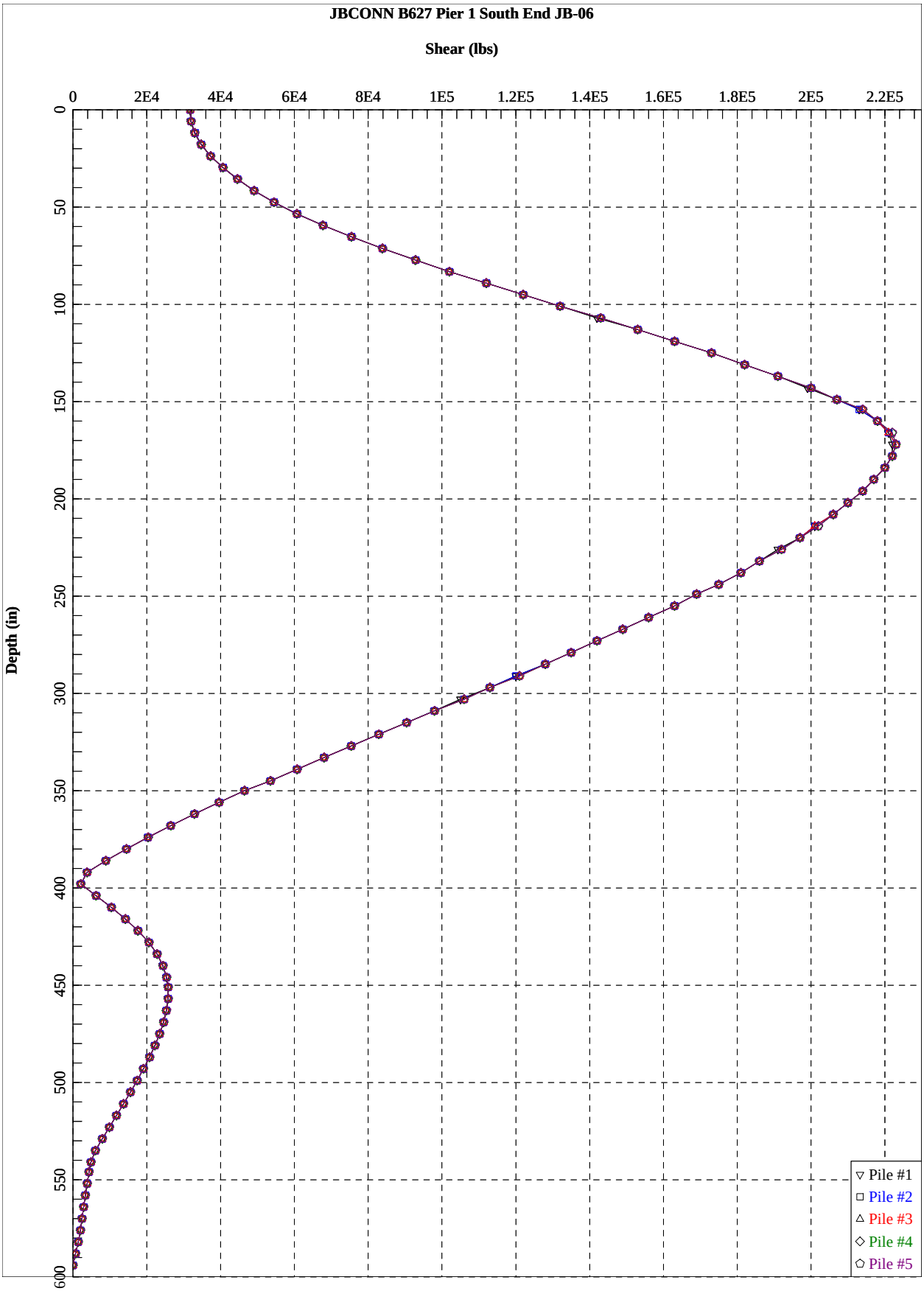
Abut A Unit Side Resistance based on DRIVEN Results

Delete only blue boxes

Layer No.	Layer top (ft)	Layer bot (ft)	Layer top (in)	Layer bot (in)	Side Fr. at Layer Top (kip)	Side Fr. at Layer Bot. (kip)	Unit area (in)	Unit Side Resist (psi)	End Bearing Top (kip)	End Bearing Bottom (kip)	Average End Bearing Top of Layer	Unit End Bearing (psi)
1	0.0	2.7	0.0	32	0.0		6221	0.0				
2	2.7	13.0	32.4	156			23731					
3	13.0	28.2	156.0	338			35021					
4	28.2	44.7	338.4	536			38016					
5	44.7	48.5	536.4	582			8755					
6	48.5	50.5	582.0	606			4608					
7												
8												
						1	0.2	0.69				
						2	4.31	14.97				
						3	2.3	7.99				
						4	5.53	19.20				
						5	3.4	11.81				
						6	5.51	19.13			58.2	202.1
							From axial	RF = 0.5			From axial	RF = 0.5


JBCONN B627 Pier 1 South End JB-06
Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5


JBCONN B627 Pier 1 South End JB-06
Moment (lbs-in)
0
5E6
1E7
1.5E7
2E7
2.5E7
3E7
3.5E7
4E7
4.5E7
5E7
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5


JBCONN B627 Pier 1 South End JB-06
Shear (lbs)
0
2E4
4E4
6E4
8E4
1E5
1.2E5
1.4E5
1.6E5
1.8E5
2E5
2.2E5
Depth (in)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile #1
Pile #2
Pile #3
Pile #4
Pile #5

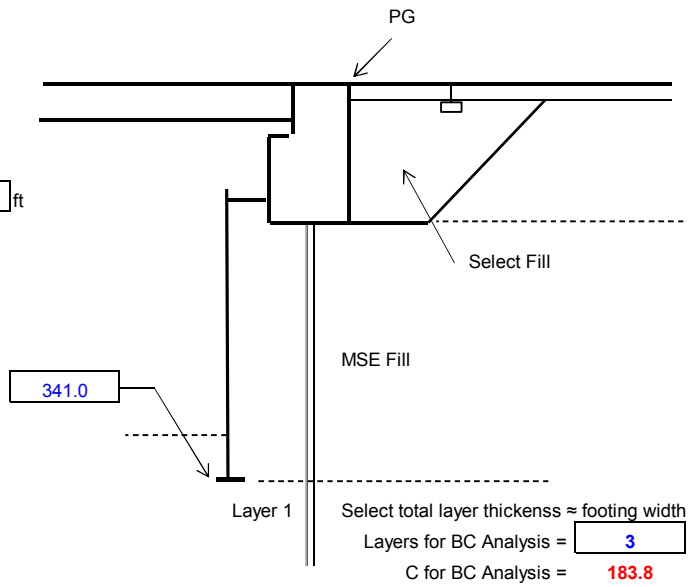
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/28/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 627 Abutment B Enter Values in Blue.	Date 12/28/2015	

Red values are calculated

BORING No. =	JB-07	
Top of Boring El. =	340.7	ft
Profile Grade =	375.0	ft
Top of Layer 1 =	341.0	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	297.7	ft

South Half

Bottom of Abut. = 363.0 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	3
C for BC Analysis =	183.8
Φ for BC analysis =	33.0
Γ for BC Analysis =	121.2

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	338.2	2.8	P	SF	CBR 30					26
2	335.7	2.5	P	II-C	30					40
3	325.0	10.7	P	II-C	62	73	75	100	100	100
4	303.7	21.3	P	II-C	90	53	100	100		100
5	298.7	5.0	P	II-C	26					35
6	290.0	8.7	P	II-C	100	63				100
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

	Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
Undercut	1	118.0	125.0	CBR 30	50.0	30.0		4	2.8	
	2	130.0	137.0	SM	50.0	32.0		2	5.3	
	3	120.0	128.0	HWR	250.0	34.0		4	16.0	
	4	120.0	128.0	HWR	250.0	34.0		4	37.3	
	5	130.0	137.0	ML	50.0	32.0		2	42.3	
	6	120.0	128.0	HWR	250.0	34.0		4	51.0	
	7									
	8									
	9									
	10									
	11									
	12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename:
Project Name: JBCONN B627 Abut B
Project Date: 09/18/2015
Project Client: HNTB
Computed By: Giese
Project Manager: Giese

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	43.30 ft
	- Driving/Restrike	43.30 ft
	- Ultimate:	43.30 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	5.30 ft	0.00%	118.00 pcf	37.6/37.6	Nordlund
2	Cohesionless	10.70 ft	0.00%	120.00 pcf	43.0/43.0	Nordlund
3	Cohesionless	21.30 ft	0.00%	120.00 pcf	41.3/41.3	Nordlund
4	Cohesionless	6.00 ft	0.00%	130.00 pcf	34.5/34.5	Nordlund
5	Cohesionless	7.70 ft	0.00%	120.00 pcf	38.8/38.8	Nordlund

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.59 psf	28.33	N/A	0.00 Kips
5.29 ft	Cohesionless	312.11 psf	28.33	N/A	3.93 Kips
5.31 ft	Cohesionless	626.00 psf	32.38	N/A	3.96 Kips
14.31 ft	Cohesionless	1166.00 psf	32.38	N/A	35.46 Kips
15.99 ft	Cohesionless	1266.80 psf	32.38	N/A	44.57 Kips
16.01 ft	Cohesionless	1910.00 psf	31.11	N/A	44.69 Kips
25.01 ft	Cohesionless	2450.00 psf	31.11	N/A	109.87 Kips
34.01 ft	Cohesionless	2990.00 psf	31.11	N/A	203.78 Kips
37.29 ft	Cohesionless	3186.80 psf	31.11	N/A	245.14 Kips
37.31 ft	Cohesionless	4466.05 psf	25.99	N/A	245.35 Kips
43.29 ft	Cohesionless	4854.75 psf	25.99	N/A	296.04 Kips
43.31 ft	Cohesionless	5245.69 psf	29.23	N/A	296.27 Kips
50.99 ft	Cohesionless	5466.87 psf	29.23	N/A	407.48 Kips

DRIVING - END BEARING

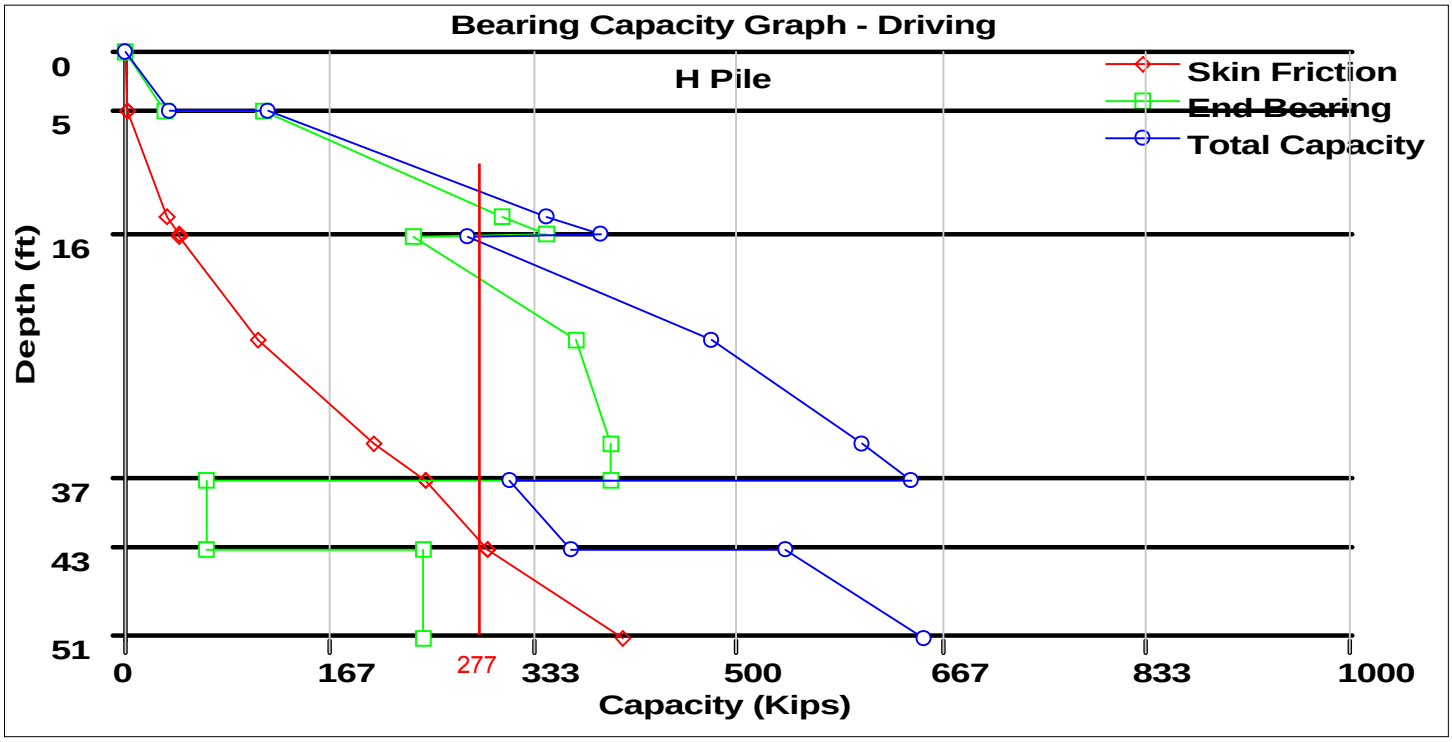
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.18 psf	100.79	181.93 Kips	0.06 Kips
5.29 ft	Cohesionless	624.22 psf	100.79	181.93 Kips	33.81 Kips
5.31 ft	Cohesionless	626.60 psf	307.00	508.20 Kips	113.11 Kips
14.31 ft	Cohesionless	1706.60 psf	307.00	508.20 Kips	308.07 Kips
15.99 ft	Cohesionless	1908.20 psf	307.00	508.20 Kips	344.46 Kips
16.01 ft	Cohesionless	1910.60 psf	214.73	397.34 Kips	235.58 Kips
25.01 ft	Cohesionless	2990.60 psf	214.73	397.34 Kips	368.75 Kips
34.01 ft	Cohesionless	4070.60 psf	214.73	397.34 Kips	397.34 Kips
37.29 ft	Cohesionless	4464.20 psf	214.73	397.34 Kips	397.34 Kips
37.31 ft	Cohesionless	4466.70 psf	59.84	68.03 Kips	68.03 Kips
43.29 ft	Cohesionless	5244.10 psf	59.84	68.03 Kips	68.03 Kips
43.31 ft	Cohesionless	5245.98 psf	130.69	243.28 Kips	243.28 Kips
50.99 ft	Cohesionless	5688.34 psf	130.69	243.28 Kips	243.28 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.06 Kips	0.06 Kips
5.29 ft	3.93 Kips	33.81 Kips	37.74 Kips
5.31 ft	3.96 Kips	113.11 Kips	117.07 Kips
14.31 ft	35.46 Kips	308.07 Kips	343.53 Kips
15.99 ft	44.57 Kips	344.46 Kips	389.03 Kips
16.01 ft	44.69 Kips	235.58 Kips	280.27 Kips
25.01 ft	109.87 Kips	368.75 Kips	478.62 Kips
34.01 ft	203.78 Kips	397.34 Kips	601.11 Kips
37.29 ft	245.14 Kips	397.34 Kips	642.48 Kips
37.31 ft	245.35 Kips	68.03 Kips	313.38 Kips
43.29 ft	296.04 Kips	68.03 Kips	364.07 Kips
43.31 ft	296.27 Kips	243.28 Kips	539.55 Kips
50.99 ft	407.48 Kips	243.28 Kips	650.76 Kips

Filename:

B 627 Abutment B JB-07



LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B627

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-07

Bridge No. B627 **Pier No.** Abut B **Bottom of Pile Cap / Top of Shaft El.** 363.0

Project No.

By: JCG 1/13/2016

Checked: MAR 1/13/2016

Indicate Analysis Type Required

	L/PILE Single Pile/Shaft Free head
	L/PILE Single Pile/Shaft Fixed head
x	GROUP Fixed Head

363.0 Top of Ground El.

Indicate Load Type

x	Single Pile/Shaft Load	313.0	Tip El.
	Group Load	14	No. Piles/Shafts for GROUP

L inches = 600

HP Pile Size HP 12x53

Pile Size. ft 1.000 **f'c** **f'c**

#N/A	P Reducn Factor Long	2.0 B
1.00	P Reducn Factor Trans	8.0 B
#N/A	P Reducn Factor Resultant Mom.	

(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 2.0

Max. Fv for Axial Capacity Analysis, kips 150.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	135.0	kips (lbs)	135,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	6.00	kips (lbs)	6,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	48.00	kip-ft (lb-in)	576,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant		kips (lbs)		Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	48.00	kip-ft (lb-in)	576,000	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 297.7 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in²	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	341.0	22.0	SP	P	5	II-A	264	0.05498	28.0		28		
2	335.7	5.3	SM	P	21	II-B	328	0.06829	30.0		116		
3	325.0	10.7	HWR	P	100	III	456	0.06944	34.0		554		
4	303.7	21.3	HWR	P	100	III	712	0.06944	34.0		554		
5	297.7	6.0	ML	P	35	II-C	784	0.07523	32.0		194		
6	290.0	7.7	HWR	P	100	III	876	0.03738	34.0		332		
7													
8													
9													
10													
11													

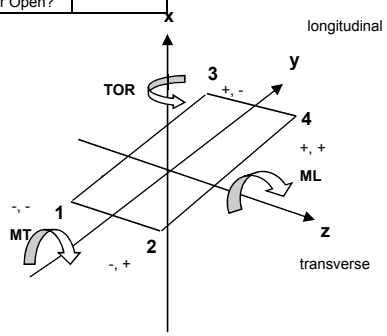
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



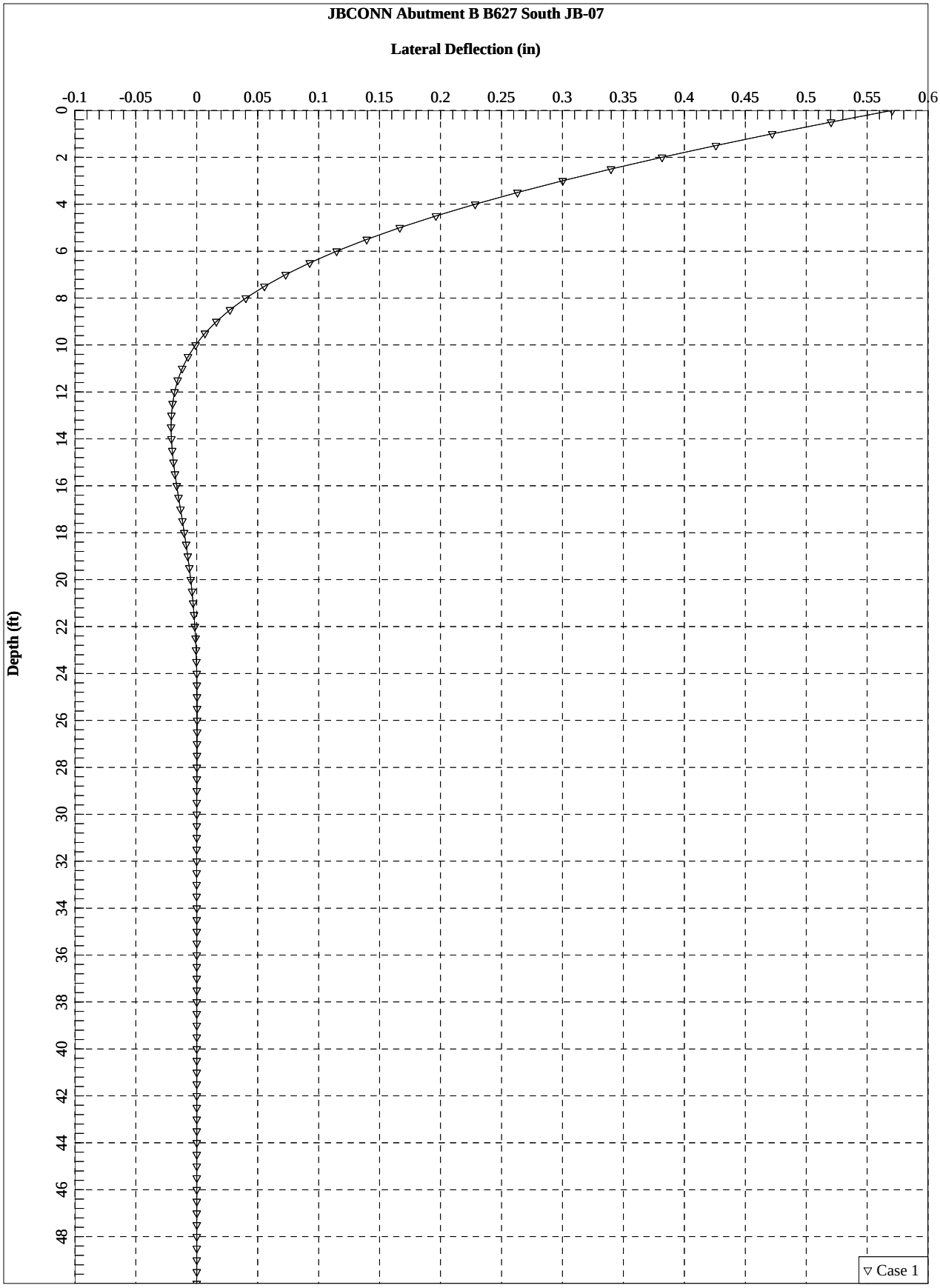
Diameter	Mom. of I. in⁴	Area in²
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

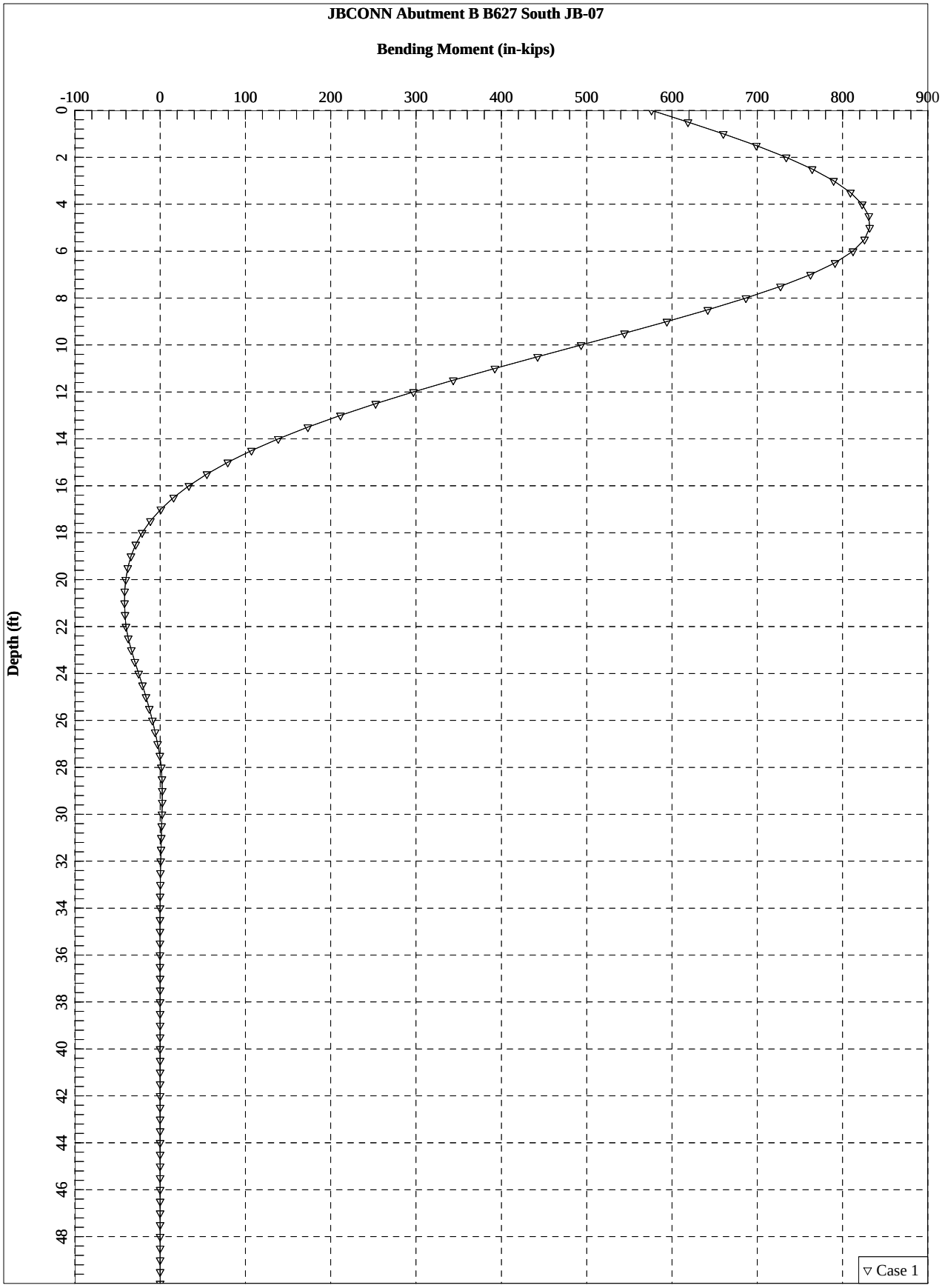
M concrete = psi 0
M Steel = psi 30,000,000

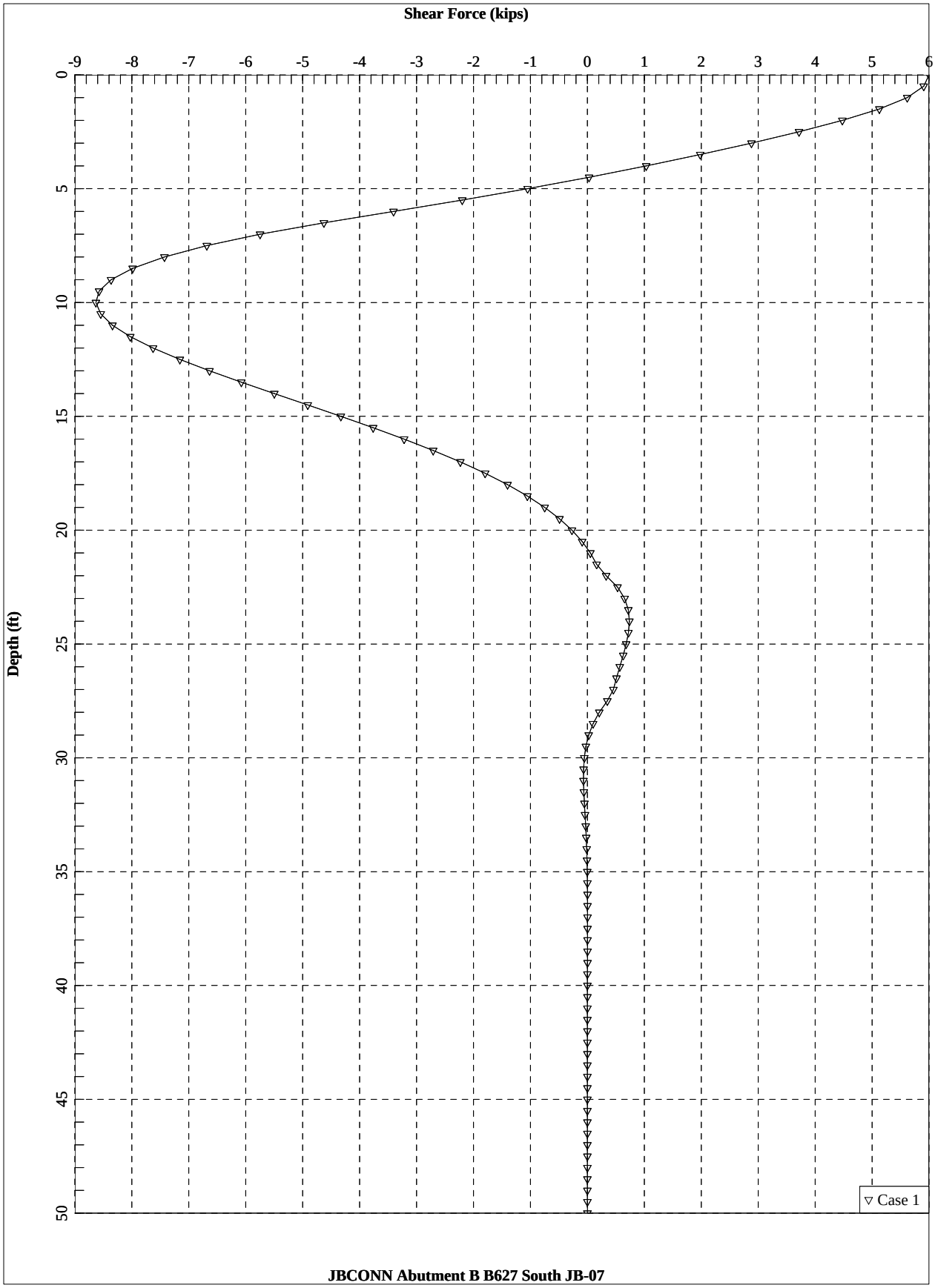
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN Abutment B B627 South JB-07
Lateral Deflection (in)
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
Case 1


JBCONN Abutment B B627 South JB-07
Bending Moment (in-kips)
-100
0
100
200
300
400
500
600
700
800
900
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
Case 1


Shear Force (kips)
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
Case 1
JBCONN Abutment B B627 South JB-07

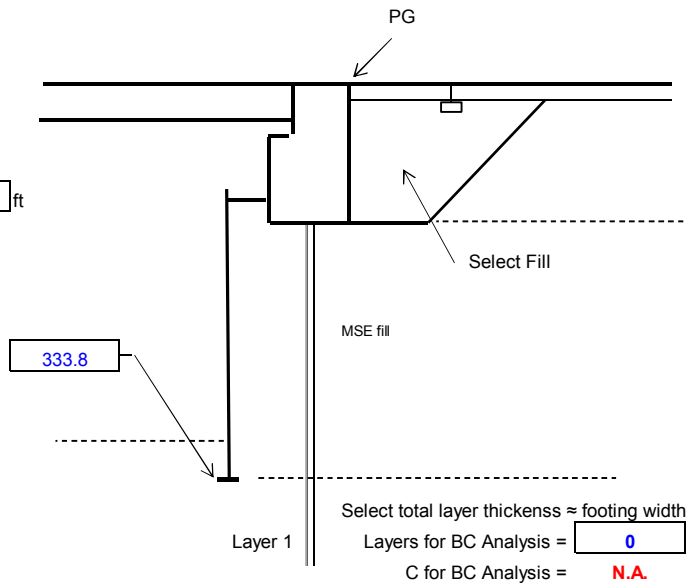
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 1/6/2016	
	Checked By JCG	
LOCATION JBCONN Bridge 627 Abutment B Enter Values in Blue.	Date 1/6/2016	

Red values are calculated

BORING No. =	629-4	
Top of Boring El. =	336.2	ft
Profile Grade =	374.8	ft
Top of Layer 1 =	333.8	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	303.2	ft

North Half

Bottom of Abut. = 363.0 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	323.2	10.6	P	II-C	100	100	100	100		100
2	313.2	10.0	P	II-C	100	100				100
3	303.2	10.0	P	II-C	45	35				53
4	295.0	8.2	P	II-C	100	100				100
5										
6										
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	120.0	128.0	HWR	250.0	34.0		4	10.6	
2	120.0	128.0	HWR	250.0	34.0		4	20.6	
3	130.0	137.0	ML	50.0	32.0		2	30.6	
4	120.0	128.0	HWR	250.0	34.0		4	38.8	
5									
6									
7									
8									
9									
10									
11									
12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename:
Project Name: JBCON B627 Abutt B 629-4 Project Date: 01/06/2016
Project Client:
Computed By: JCG
Project Manager: JCG

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.60 ft
	- Driving/Restrike	30.60 ft
	- Ultimate:	30.60 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	20.60 ft	0.00%	120.00 pcf	43.0/43.0	Nordlund
2	Cohesionless	10.00 ft	0.00%	130.00 pcf	40.2/40.2	Nordlund
3	Cohesionless	8.20 ft	0.00%	128.00 pcf	40.2/40.2	Nordlund

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.60 psf	32.38	N/A	0.00 Kips
9.01 ft	Cohesionless	540.60 psf	32.38	N/A	14.61 Kips
18.01 ft	Cohesionless	1080.60 psf	32.38	N/A	58.39 Kips
20.59 ft	Cohesionless	1235.40 psf	32.38	N/A	76.31 Kips
20.61 ft	Cohesionless	2472.65 psf	30.28	N/A	76.46 Kips
29.61 ft	Cohesionless	3057.65 psf	30.28	N/A	156.83 Kips
30.59 ft	Cohesionless	3121.35 psf	30.28	N/A	167.43 Kips
30.61 ft	Cohesionless	3772.33 psf	30.31	N/A	167.65 Kips
38.79 ft	Cohesionless	4040.63 psf	30.31	N/A	264.21 Kips

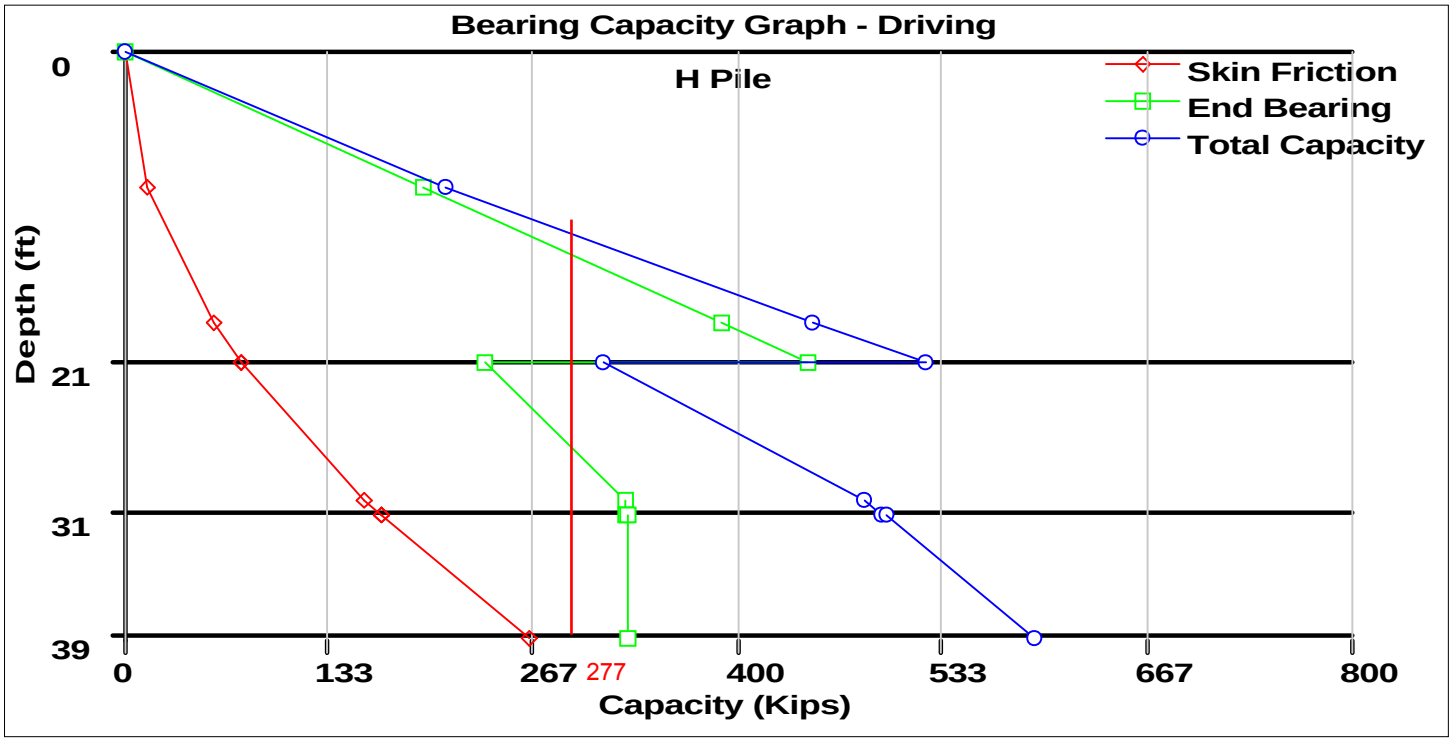
DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.20 psf	307.00	508.20 Kips	0.22 Kips
9.01 ft	Cohesionless	1081.20 psf	307.00	508.20 Kips	195.17 Kips
18.01 ft	Cohesionless	2161.20 psf	307.00	508.20 Kips	390.13 Kips
20.59 ft	Cohesionless	2470.80 psf	307.00	508.20 Kips	446.02 Kips
20.61 ft	Cohesionless	2473.30 psf	168.61	326.41 Kips	235.35 Kips
29.61 ft	Cohesionless	3643.30 psf	168.61	326.41 Kips	326.41 Kips
30.59 ft	Cohesionless	3770.70 psf	168.61	326.41 Kips	326.41 Kips
30.61 ft	Cohesionless	3772.66 psf	170.23	328.90 Kips	328.90 Kips
38.79 ft	Cohesionless	4309.26 psf	170.23	328.90 Kips	328.90 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.22 Kips	0.22 Kips
9.01 ft	14.61 Kips	195.17 Kips	209.79 Kips
18.01 ft	58.39 Kips	390.13 Kips	448.52 Kips
20.59 ft	76.31 Kips	446.02 Kips	522.33 Kips
20.61 ft	76.46 Kips	235.35 Kips	311.81 Kips
29.61 ft	156.83 Kips	326.41 Kips	483.24 Kips
30.59 ft	167.43 Kips	326.41 Kips	493.85 Kips
30.61 ft	167.65 Kips	328.90 Kips	496.55 Kips
38.79 ft	264.21 Kips	328.90 Kips	593.11 Kips

Filename: 627 Abutment B 629-4



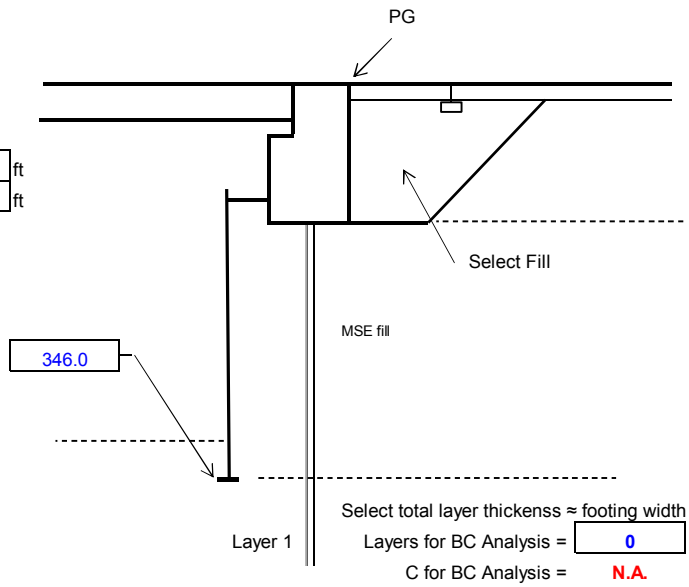
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/8/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment A Enter Values in Blue.	Date 12/8/2015	

Red values are calculated

BORING No. =	628-2	
Top of Boring El. =	367.0	ft
Profile Grade =	375.4	ft
Top of Layer 1 =	346.0	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	304.0	ft

North Tie-In

Top of Wall =	366.6	ft
Bottom of Abut. =	364.6	ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	330.0	16.0	P	II-B	19	11	18			21
2	313.5	16.5	P	II-C	29	25	38			41
3	310.0	3.5	P	II-C	61					81
4	304.0	6.0	P	II-C	100					100
5	280.0	24.0	P	II-C	100	100	100	100		100
6										
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	16.0	
2	130.0	137.0	ML	50.0	32.0		2	32.5	
3	120.0	128.0	ML	250.0	34.0		2	36.0	
4	120.0	128.0	HWR	250.0	34.0		4	42.0	
5	120.0	128.0	HWR	250.0	34.0		4	66.0	
6									
7									
8									
9									
10									
11									
12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename:
Project Name: B628 ABUT A 682-2 Project Date: 11/17/2015
Project Client: JMT
Computed By: GIESE
Project Manager: GIESE

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	42.00 ft
	- Driving/Restrike	42.00 ft
	- Ultimate:	42.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	16.00 ft	0.00%	118.00 pcf	34.8/34.8	Nordlund
2	Cohesionless	16.50 ft	0.00%	130.00 pcf	37.8/37.8	Nordlund
3	Cohesionless	3.50 ft	0.00%	120.00 pcf	40.1/40.1	Nordlund
4	Cohesionless	6.00 ft	0.00%	120.00 pcf	39.5/39.5	Nordlund
5	Cohesionless	24.00 ft	0.00%	128.00 pcf	38.2/38.2	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.59 psf	26.17	N/A	0.00 Kips
9.01 ft	Cohesionless	531.59 psf	26.17	N/A	8.51 Kips
15.99 ft	Cohesionless	943.41 psf	26.17	N/A	26.82 Kips
16.01 ft	Cohesionless	1888.65 psf	28.49	N/A	26.90 Kips
25.01 ft	Cohesionless	2473.65 psf	28.49	N/A	80.98 Kips
32.49 ft	Cohesionless	2959.85 psf	28.49	N/A	145.39 Kips
32.51 ft	Cohesionless	4033.60 psf	30.19	N/A	145.60 Kips
35.99 ft	Cohesionless	4242.40 psf	30.19	N/A	188.66 Kips
36.01 ft	Cohesionless	4453.60 psf	29.74	N/A	188.91 Kips
41.99 ft	Cohesionless	4812.40 psf	29.74	N/A	269.49 Kips
42.01 ft	Cohesionless	5173.33 psf	28.77	N/A	269.76 Kips
51.01 ft	Cohesionless	5468.53 psf	28.77	N/A	393.43 Kips
60.01 ft	Cohesionless	5763.73 psf	28.77	N/A	530.44 Kips
65.99 ft	Cohesionless	5959.87 psf	28.77	N/A	628.87 Kips

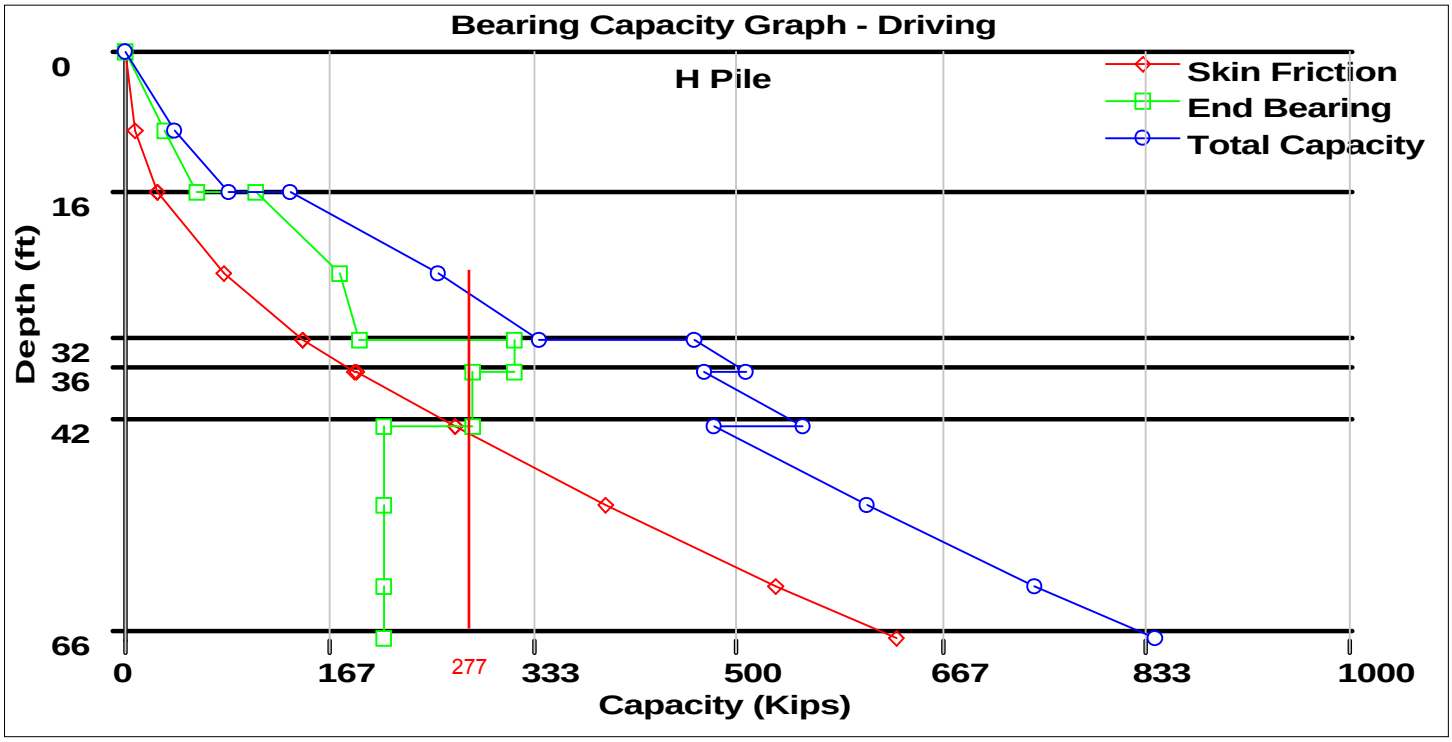
ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.18 psf	61.90	74.32 Kips	0.04 Kips
9.01 ft	Cohesionless	1063.18 psf	61.90	74.32 Kips	33.35 Kips
15.99 ft	Cohesionless	1886.82 psf	61.90	74.32 Kips	59.19 Kips
16.01 ft	Cohesionless	1889.30 psf	106.12	192.74 Kips	108.20 Kips
25.01 ft	Cohesionless	3059.30 psf	106.12	192.74 Kips	175.20 Kips
32.49 ft	Cohesionless	4031.70 psf	106.12	192.74 Kips	192.74 Kips
32.51 ft	Cohesionless	4034.20 psf	163.64	318.78 Kips	318.78 Kips
35.99 ft	Cohesionless	4451.80 psf	163.64	318.78 Kips	318.78 Kips
36.01 ft	Cohesionless	4454.20 psf	147.49	283.35 Kips	283.35 Kips
41.99 ft	Cohesionless	5171.80 psf	147.49	283.35 Kips	283.35 Kips
42.01 ft	Cohesionless	5173.66 psf	115.45	211.71 Kips	211.71 Kips
51.01 ft	Cohesionless	5764.06 psf	115.45	211.71 Kips	211.71 Kips
60.01 ft	Cohesionless	6354.46 psf	115.45	211.71 Kips	211.71 Kips
65.99 ft	Cohesionless	6746.74 psf	115.45	211.71 Kips	211.71 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
9.01 ft	8.51 Kips	33.35 Kips	41.87 Kips
15.99 ft	26.82 Kips	59.19 Kips	86.01 Kips
16.01 ft	26.90 Kips	108.20 Kips	135.09 Kips
25.01 ft	80.98 Kips	175.20 Kips	256.18 Kips
32.49 ft	145.39 Kips	192.74 Kips	338.13 Kips
32.51 ft	145.60 Kips	318.78 Kips	464.39 Kips
35.99 ft	188.66 Kips	318.78 Kips	507.44 Kips
36.01 ft	188.91 Kips	283.35 Kips	472.26 Kips
41.99 ft	269.49 Kips	283.35 Kips	552.84 Kips
42.01 ft	269.76 Kips	211.71 Kips	481.47 Kips
51.01 ft	393.43 Kips	211.71 Kips	605.14 Kips
60.01 ft	530.44 Kips	211.71 Kips	742.15 Kips
65.99 ft	628.87 Kips	211.71 Kips	840.57 Kips

Filename: JB 682-2



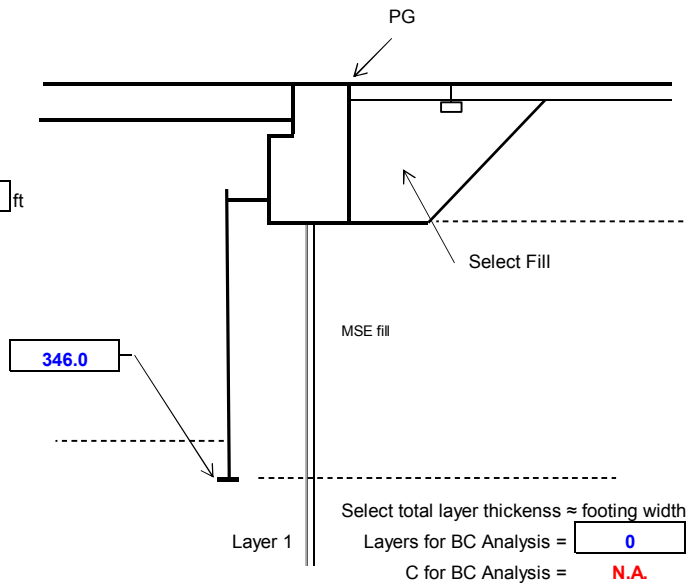
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/8/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment A Enter Values in Blue.	Date 12/8/2015	

Red values are calculated

BORING No. =	JB-09A	
Top of Boring El. =	351.4	ft
Profile Grade =	375.4	ft
Top of Layer 1 =	346.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	276.4	ft

Middle

Bottom of Abut. = 363.7 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	339.4	6.6	P	II-B	16					16
2	330.0	9.4	P	II-B	19	23				21
3	304.4	25.6	P	II-B	31	26	11	21	19	22
4	300.0	4.4	P	II-B	24					24
5	290.0	10.0	P	II-C	41	43				42
6	276.4	13.6	P	II-C	100	100				100
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	6.6	
2	118.0	125.0	MH	50.0	30.0		5	16.0	2625
3	118.0	125.0	MH	50.0	30.0		5	41.6	2700
4	118.0	125.0	ML	50.0	30.0		2	46.0	
5	130.0	137.0	ML	50.0	32.0		2	56.0	
6	120.0	128.0	HWR	250.0	34.0		4	69.6	
7									
8									
9									
10									
11									
12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628DR~2\A609A.DVN
Project Name: B628 ABUT A JB09-A Project Date: 11/17/2015
Project Client: JMT
Computed By: GIESE
Project Manager: GIESE

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	69.60 ft
	- Driving/Restrike	69.60 ft
	- Ultimate:	69.60 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	6.60 ft	0.00%	118.00 pcf	34.6/34.6	Nordlund
2	Cohesionless	9.40 ft	0.00%	118.00 pcf	0.0/0.0	Nordlund
3	Cohesive	25.60 ft	0.00%	118.00 pcf	2700.00 psf	T-79 Steel
4	Cohesionless	4.40 ft	0.00%	118.00 pcf	31.9/35.6	Nordlund
5	Cohesionless	10.00 ft	0.00%	130.00 pcf	34.8/34.8	Nordlund
6	Cohesionless	13.60 ft	0.00%	120.00 pcf	37.1/37.1	Nordlund

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.59 psf	26.07	N/A	0.00 Kips
6.59 ft	Cohesionless	388.81 psf	26.07	N/A	4.51 Kips
6.61 ft	Cohesionless	779.39 psf	0.00	N/A	4.52 Kips
15.61 ft	Cohesionless	1310.39 psf	0.00	N/A	4.52 Kips
15.99 ft	Cohesionless	1332.81 psf	0.00	N/A	4.52 Kips
16.01 ft	Cohesive	N/A	N/A	1011.07 psf	4.56 Kips
25.01 ft	Cohesive	N/A	N/A	1178.44 psf	46.69 Kips
34.01 ft	Cohesive	N/A	N/A	1345.81 psf	100.77 Kips
41.59 ft	Cohesive	N/A	N/A	1460.00 psf	152.88 Kips
41.61 ft	Cohesionless	4909.39 psf	24.05	N/A	153.01 Kips
45.99 ft	Cohesionless	5167.81 psf	24.05	N/A	185.24 Kips
46.01 ft	Cohesionless	5428.65 psf	26.19	N/A	185.42 Kips
55.01 ft	Cohesionless	6013.65 psf	26.19	N/A	281.79 Kips
55.99 ft	Cohesionless	6077.35 psf	26.19	N/A	293.42 Kips
56.01 ft	Cohesionless	6728.60 psf	27.95	N/A	293.69 Kips
65.01 ft	Cohesionless	7268.60 psf	27.95	N/A	442.17 Kips
69.59 ft	Cohesionless	7543.40 psf	27.95	N/A	526.19 Kips

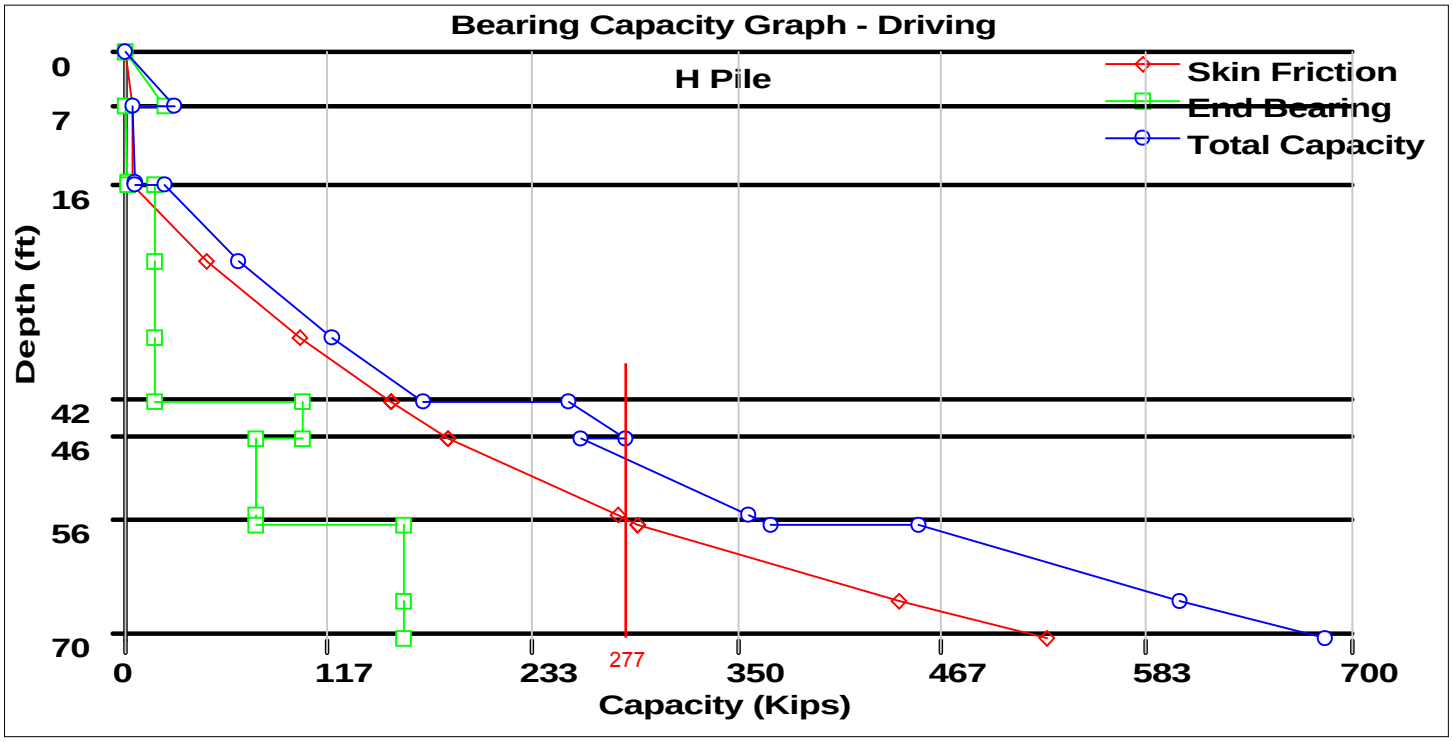
DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.18 psf	60.80	70.95 Kips	0.04 Kips
6.59 ft	Cohesionless	777.62 psf	60.80	70.95 Kips	23.88 Kips
6.61 ft	Cohesionless	779.98 psf	4.80	9.99 Kips	1.02 Kips
15.61 ft	Cohesionless	1841.98 psf	4.80	9.99 Kips	2.42 Kips
15.99 ft	Cohesionless	1886.82 psf	4.80	9.99 Kips	2.48 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	18.23 Kips
25.01 ft	Cohesive	N/A	N/A	N/A	18.23 Kips
34.01 ft	Cohesive	N/A	N/A	N/A	18.23 Kips
41.59 ft	Cohesive	N/A	N/A	N/A	18.23 Kips
41.61 ft	Cohesionless	4909.98 psf	72.52	101.37 Kips	101.37 Kips
45.99 ft	Cohesionless	5426.82 psf	72.52	101.37 Kips	101.37 Kips
46.01 ft	Cohesionless	5429.30 psf	62.09	74.89 Kips	74.89 Kips
55.01 ft	Cohesionless	6599.30 psf	62.09	74.89 Kips	74.89 Kips
55.99 ft	Cohesionless	6726.70 psf	62.09	74.89 Kips	74.89 Kips
56.01 ft	Cohesionless	6729.20 psf	92.80	159.63 Kips	159.63 Kips
65.01 ft	Cohesionless	7809.20 psf	92.80	159.63 Kips	159.63 Kips
69.59 ft	Cohesionless	8358.80 psf	92.80	159.63 Kips	159.63 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
6.59 ft	4.51 Kips	23.88 Kips	28.39 Kips
6.61 ft	4.52 Kips	1.02 Kips	5.55 Kips
15.61 ft	4.52 Kips	2.42 Kips	6.95 Kips
15.99 ft	4.52 Kips	2.48 Kips	7.00 Kips
16.01 ft	4.56 Kips	18.23 Kips	22.79 Kips
25.01 ft	46.69 Kips	18.23 Kips	64.91 Kips
34.01 ft	100.77 Kips	18.23 Kips	119.00 Kips
41.59 ft	152.88 Kips	18.23 Kips	171.11 Kips
41.61 ft	153.01 Kips	101.37 Kips	254.38 Kips
45.99 ft	185.24 Kips	101.37 Kips	286.61 Kips
46.01 ft	185.42 Kips	74.89 Kips	260.31 Kips
55.01 ft	281.79 Kips	74.89 Kips	356.68 Kips
55.99 ft	293.42 Kips	74.89 Kips	368.31 Kips
56.01 ft	293.69 Kips	159.63 Kips	453.32 Kips
65.01 ft	442.17 Kips	159.63 Kips	601.80 Kips
69.59 ft	526.19 Kips	159.63 Kips	685.82 Kips

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628DR~2\A609A.DVN



LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B628

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-09A

Bridge No. B628 **Pier No.** A Middle **Bottom of Pile Cap / Top of Shaft El.** 363.7

Project No. 01-21924
By: JCG 1/4/2016
Checked: MAR 1/4/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

363.7 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 297.0 Tip El. — L inches = 800
- Group Load — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 1.000 f'c 4,000 f'c

1.00 P Reducn Factor Long 8.0 B
P Reducn Factor Trans B
#VALUE! P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 6.50 **Longit. Spacing, ft**

Max. Fv for Axial Capacity Analysis, kips 180.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	180.0	kips (lbs)	180,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant		kips (lbs)		Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 276.4 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	346.0	17.7	SP	P	4	II-A	212	0.05498	28.0		22		
2	339.4	6.6	ML	P	16	II-B	292	0.06829	30.0		89		
3	330.0	9.4	MH	P	21	II-B	404	0.06829		6.00		0.005	
4	304.4	25.6	MH	P	22	II-B	712	0.06829		6.00		0.005	
5	300.0	4.4	ML	P	24	II-B	764	0.06829	30.0		133		
6	290.0	10.0	ML	P	42	II-C	884	0.07523	32.0		232		
7													
8													
9													
10													
11													

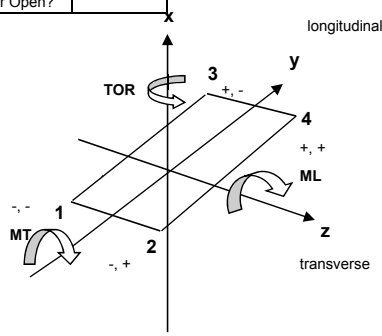
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



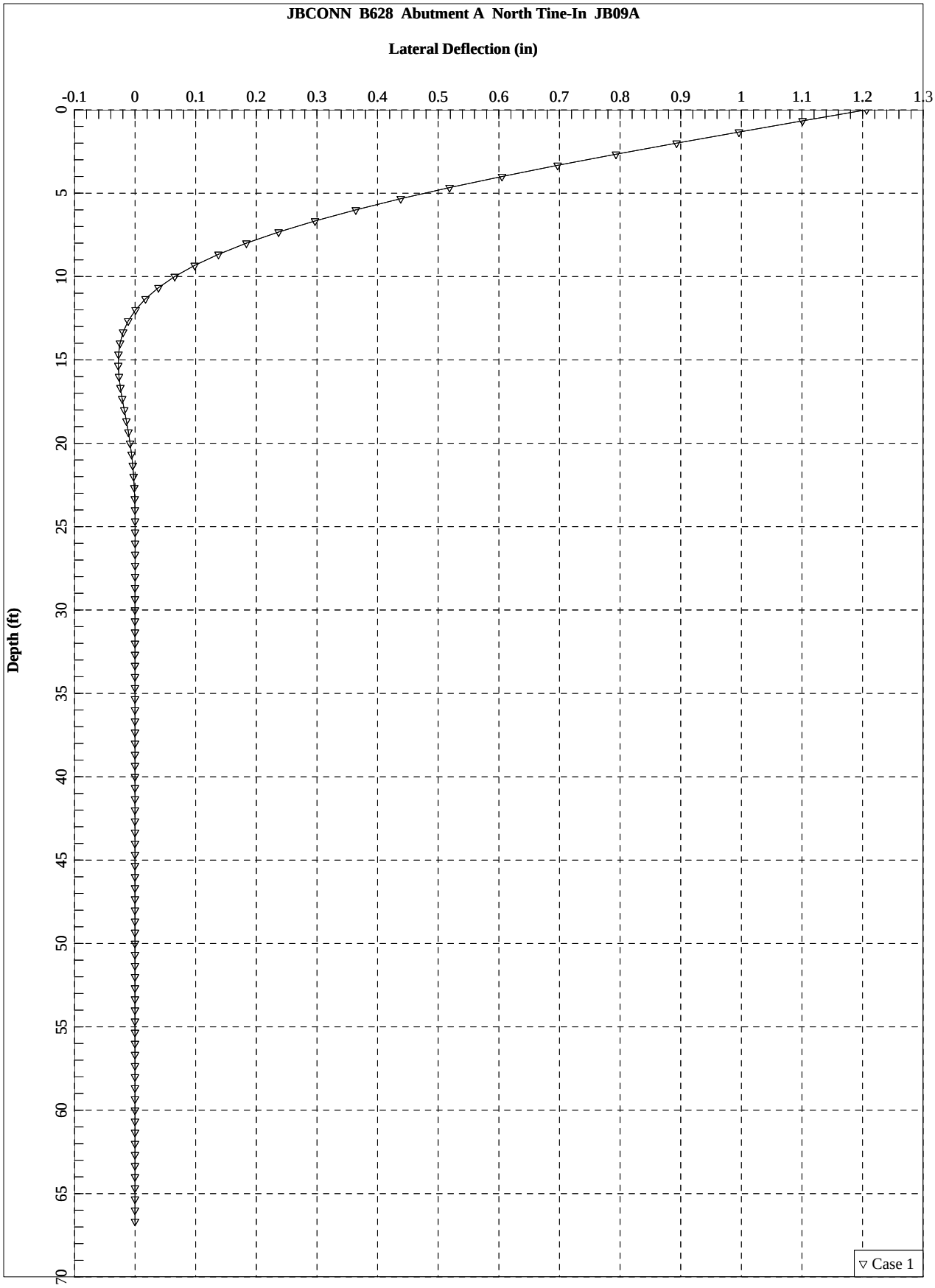
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

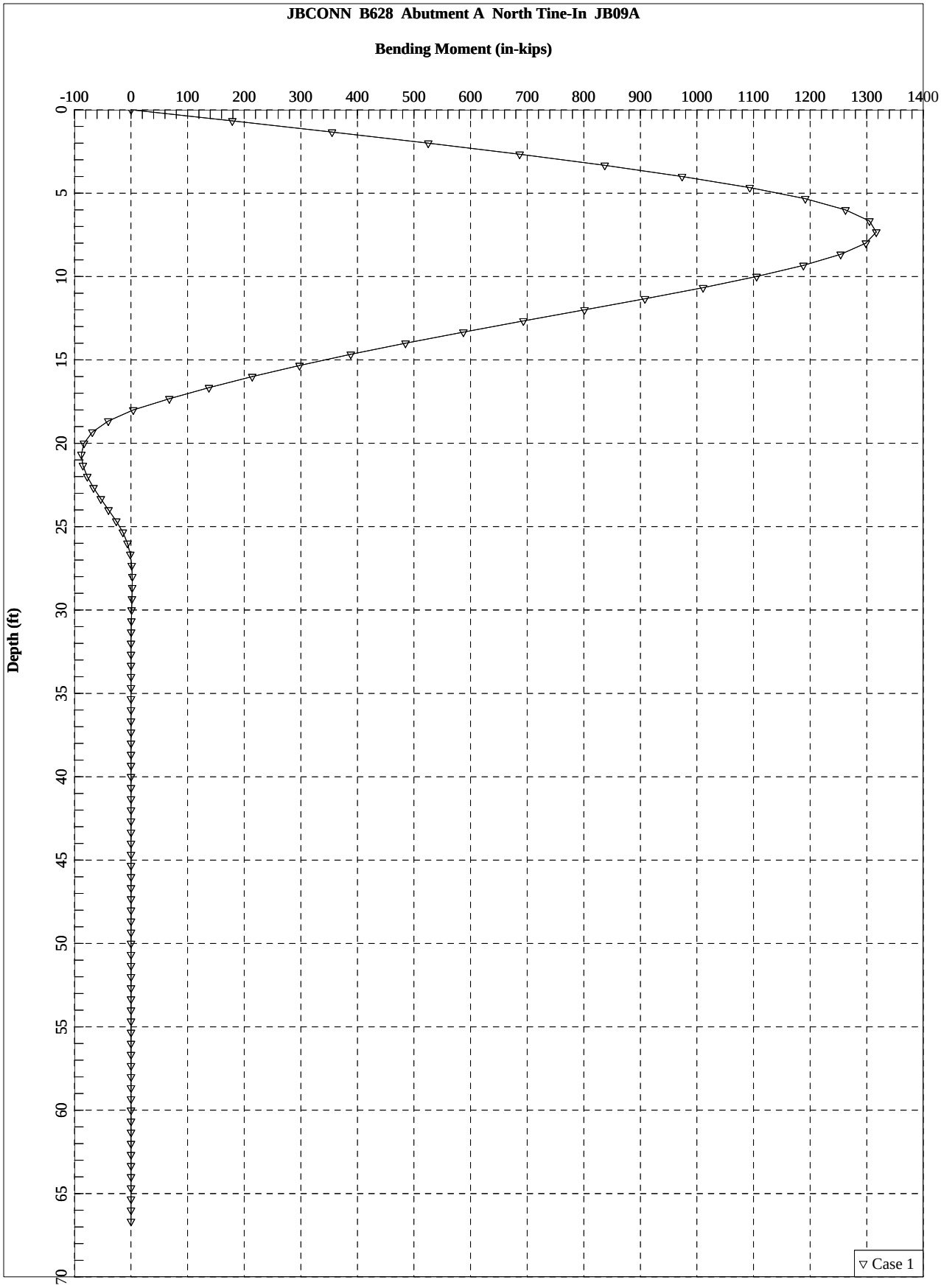
M concrete = psi 3,604,997
M Steel = psi 30,000,000

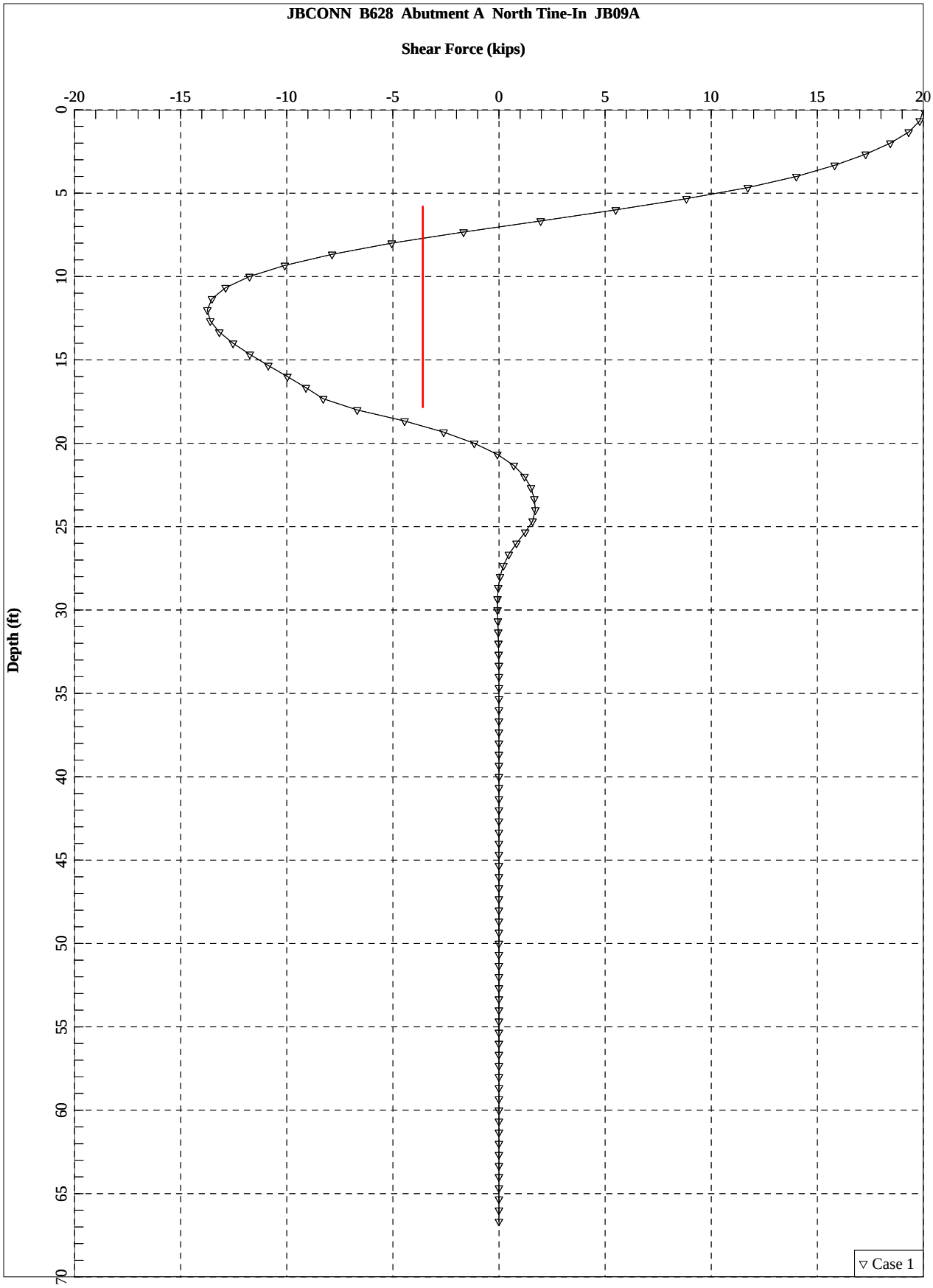
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B628 Abutment A North Tine-In JB09A
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B628 Abutment A North Tine-In JB09A
Bending Moment (in-kips)
-100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B628 Abutment A North Tine-In JB09A
Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

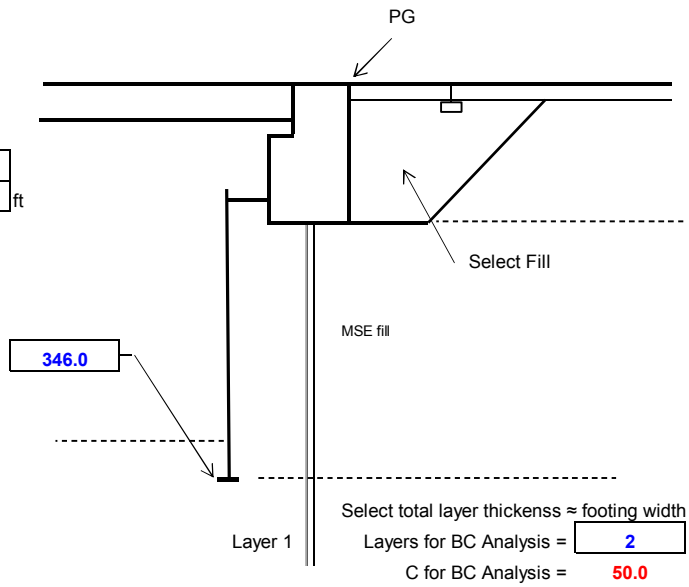
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/8/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment A Enter Values in Blue.	Date 12/8/2015	

Red values are calculated

BORING No. =	JB-09	
Top of Boring El. =	351.4	ft
Profile Grade =	375.4	ft
Top of Layer 1 =	346.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	310.4	ft

South End

Top of Wall =	364.8	
Bottom of Abut. =	362.7	ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	2
C for BC Analysis =	50.0
Φ for BC analysis =	31.1
Γ for BC Analysis =	124.5

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	334.1	11.9	P	II-B	17	19	15			17
2	320.0	14.1	P	II-C	31	38	39			36
3	310.4	9.6	P	II-C	43	47				45
4	305.0	5.4	P	II-C	49					49
5	300.0	5.0	P	II-C	84					84
6	280.0	20.0	P	II-C	47	35	38	25		36
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	MH	50.0	30.0		5	11.9	2125
2	130.0	137.0	ML	50.0	32.0		2	26.0	
3	130.0	137.0	ML	50.0	32.0		2	35.6	
4	130.0	137.0	ML	50.0	32.0		2	41.0	
5	120.0	128.0	HWR	250.0	34.0		4	46.0	
6	130.0	137.0	ML	50.0	32.0		2	66.0	
7									
8									
9									
10									
11									
12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628NE~1\A609.DVN
Project Name: B628 ABUT A JB-09 Project Date: 11/17/2015
Project Client: JMT
Computed By: GIESE
Project Manager: GIESE

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	35.60 ft
	- Driving/Restrike	35.60 ft
	- Ultimate:	35.60 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	11.90 ft	0.00%	118.00 pcf	34.6/34.6	Nordlund
2	Cohesionless	14.10 ft	0.00%	130.00 pcf	34.6/37.5	Nordlund
3	Cohesionless	9.60 ft	0.00%	130.00 pcf	37.5/37.5	Nordlund
4	Cohesionless	5.40 ft	0.00%	137.00 pcf	37.7/37.7	Nordlund
5	Cohesionless	5.00 ft	0.00%	128.00 pcf	39.3/39.3	Nordlund

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.59 psf	26.07	N/A	0.00 Kips
9.01 ft	Cohesionless	531.59 psf	26.07	N/A	8.43 Kips
11.89 ft	Cohesionless	701.51 psf	26.07	N/A	14.69 Kips
11.91 ft	Cohesionless	1404.85 psf	26.07	N/A	14.73 Kips
20.91 ft	Cohesionless	1989.85 psf	26.07	N/A	46.27 Kips
25.99 ft	Cohesionless	2320.05 psf	26.07	N/A	72.25 Kips
26.01 ft	Cohesionless	3237.85 psf	28.23	N/A	72.38 Kips
35.01 ft	Cohesionless	3822.85 psf	28.23	N/A	153.32 Kips
35.59 ft	Cohesionless	3860.55 psf	28.23	N/A	159.38 Kips
35.61 ft	Cohesionless	4485.57 psf	28.36	N/A	159.59 Kips
40.99 ft	Cohesionless	4686.25 psf	28.36	N/A	219.88 Kips
41.01 ft	Cohesionless	4888.37 psf	29.57	N/A	220.13 Kips
45.99 ft	Cohesionless	5051.71 psf	29.57	N/A	289.23 Kips

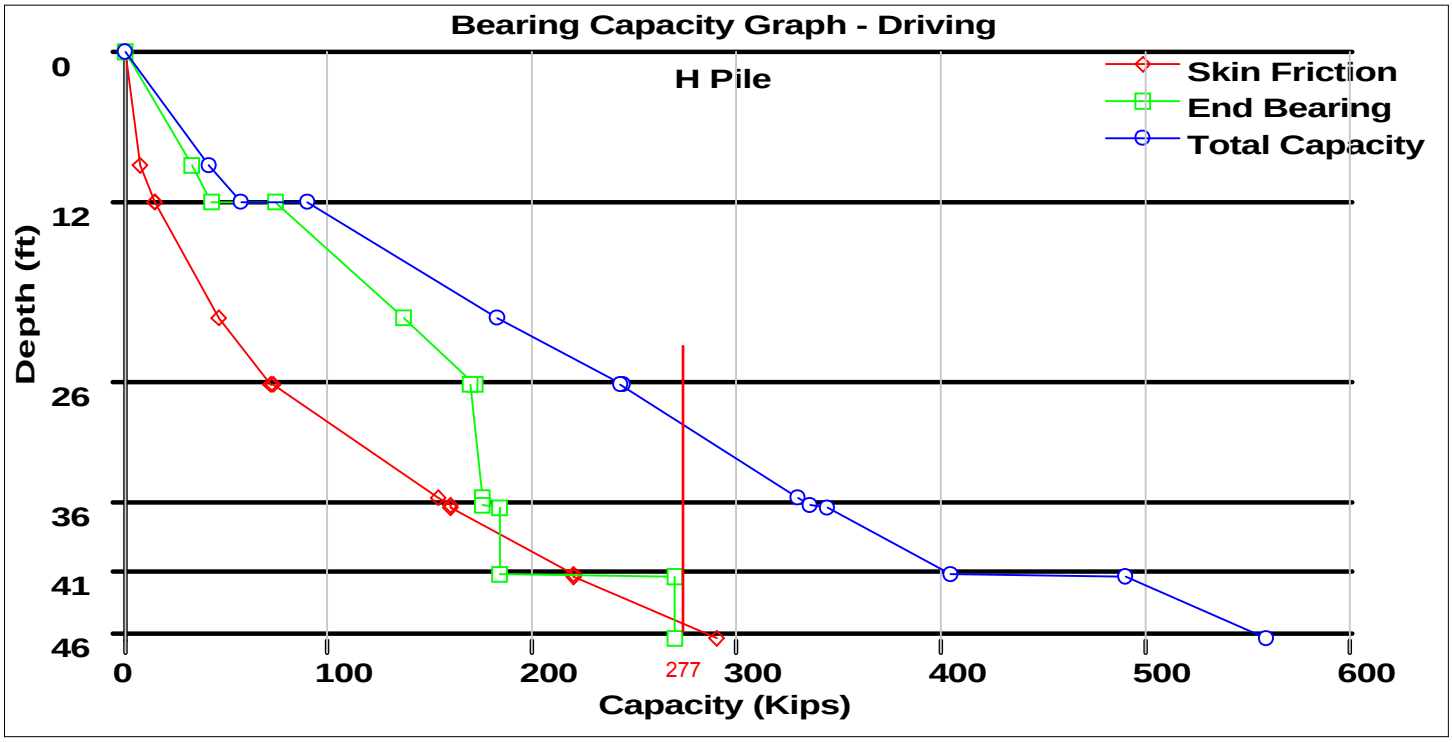
DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.18 psf	60.80	70.95 Kips	0.04 Kips
9.01 ft	Cohesionless	1063.18 psf	60.80	70.95 Kips	32.65 Kips
11.89 ft	Cohesionless	1403.02 psf	60.80	70.95 Kips	43.08 Kips
11.91 ft	Cohesionless	1405.50 psf	98.95	178.19 Kips	74.64 Kips
20.91 ft	Cohesionless	2575.50 psf	98.95	178.19 Kips	136.77 Kips
25.99 ft	Cohesionless	3235.90 psf	98.95	178.19 Kips	171.84 Kips
26.01 ft	Cohesionless	3238.50 psf	97.81	175.66 Kips	169.82 Kips
35.01 ft	Cohesionless	4408.50 psf	97.81	175.66 Kips	175.66 Kips
35.59 ft	Cohesionless	4483.90 psf	97.81	175.66 Kips	175.66 Kips
35.61 ft	Cohesionless	4485.95 psf	101.97	184.32 Kips	184.32 Kips
40.99 ft	Cohesionless	4887.29 psf	101.97	184.32 Kips	184.32 Kips
41.01 ft	Cohesionless	4888.70 psf	141.59	269.29 Kips	269.29 Kips
45.99 ft	Cohesionless	5215.38 psf	141.59	269.29 Kips	269.29 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
9.01 ft	8.43 Kips	32.65 Kips	41.08 Kips
11.89 ft	14.69 Kips	43.08 Kips	57.77 Kips
11.91 ft	14.73 Kips	74.64 Kips	89.37 Kips
20.91 ft	46.27 Kips	136.77 Kips	183.04 Kips
25.99 ft	72.25 Kips	171.84 Kips	244.09 Kips
26.01 ft	72.38 Kips	169.82 Kips	242.20 Kips
35.01 ft	153.32 Kips	175.66 Kips	328.97 Kips
35.59 ft	159.38 Kips	175.66 Kips	335.04 Kips
35.61 ft	159.59 Kips	184.32 Kips	343.92 Kips
40.99 ft	219.88 Kips	184.32 Kips	404.20 Kips
41.01 ft	220.13 Kips	269.29 Kips	489.42 Kips
45.99 ft	289.23 Kips	269.29 Kips	558.52 Kips

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628NE~1\A609.DVN



LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B628

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-09

Bridge No. B628 **Pier No.** A South **Bottom of Pile Cap / Top of Shaft El.** 362.7

Project No. 01-21924
By: JCG 1/4/2016
Checked: MAR 1/4/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

362.7 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 308.0 — Tip El. L inches = 656
- Group Load — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 1.000 f'c 4,000 f'c

1.00 P Reducn Factor Long 8.0 B
P Reducn Factor Trans B
#VALUE! P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 6.50 **Longit. Spacing, ft**

Max. Fv for Axial Capacity Analysis, kips 180.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	180.0	kips (lbs)	180,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant		kips (lbs)		Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 310.4 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	346.0	16.7	SP	P	4	II-A	200	0.05498	28.0		22		
2	334.1	11.9	MH	P	17	II-B	343	0.06829		6.00		0.005	
3	320.0	14.1	ML	P	36	II-C	512	0.07523	32.0		199		
4	310.4	9.6	ML	P	45	II-C	628	0.07523	32.0		249		
5	305.0	5.4	ML	P	49	II-C	692	0.04317	32.0		163		
6													
7													
8													
9													
10													
11													

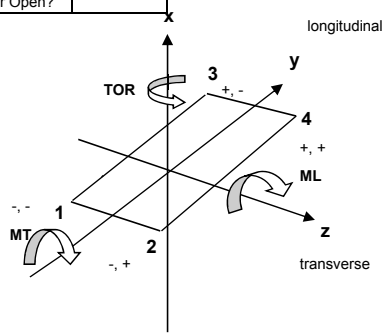
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



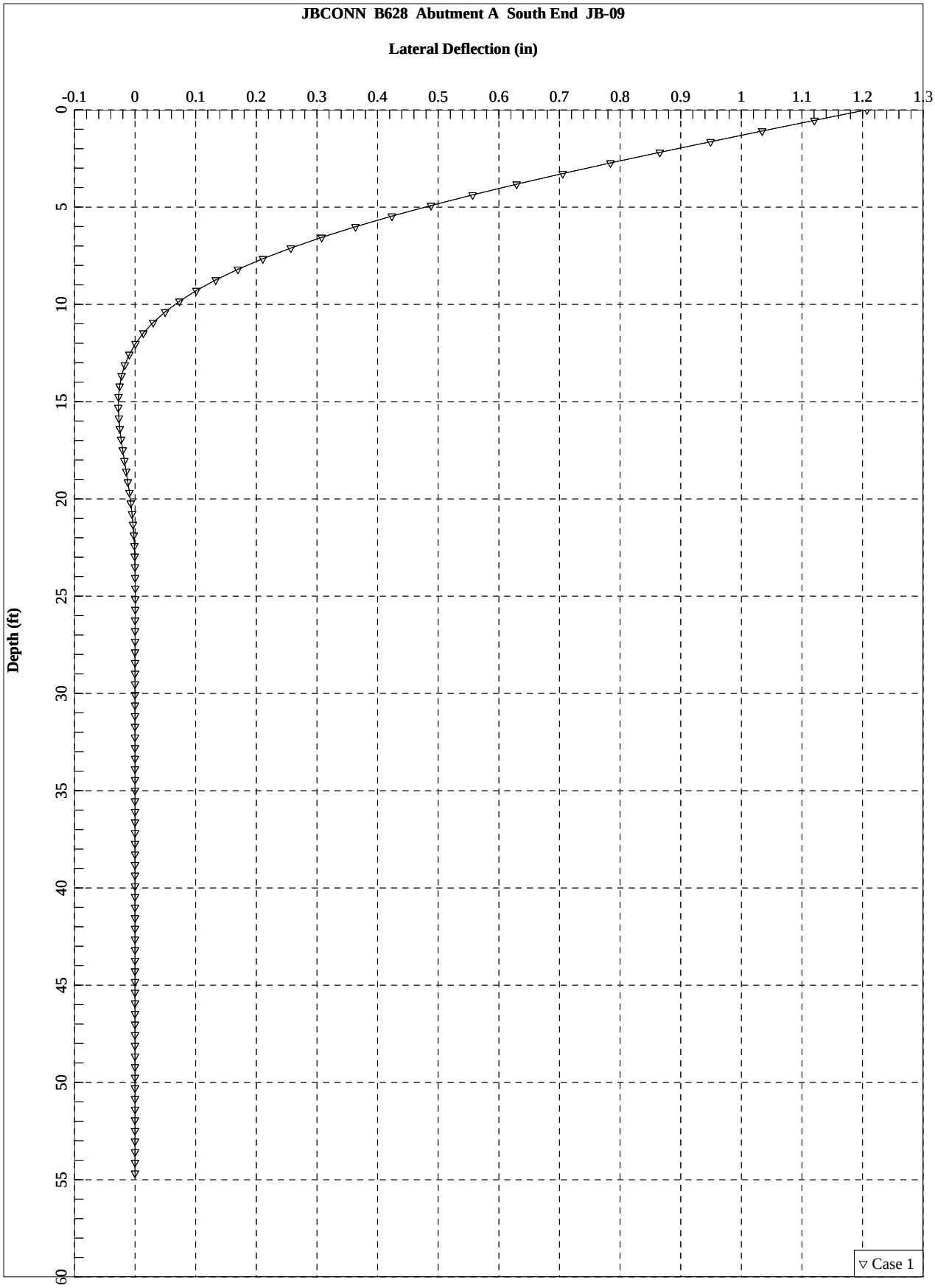
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

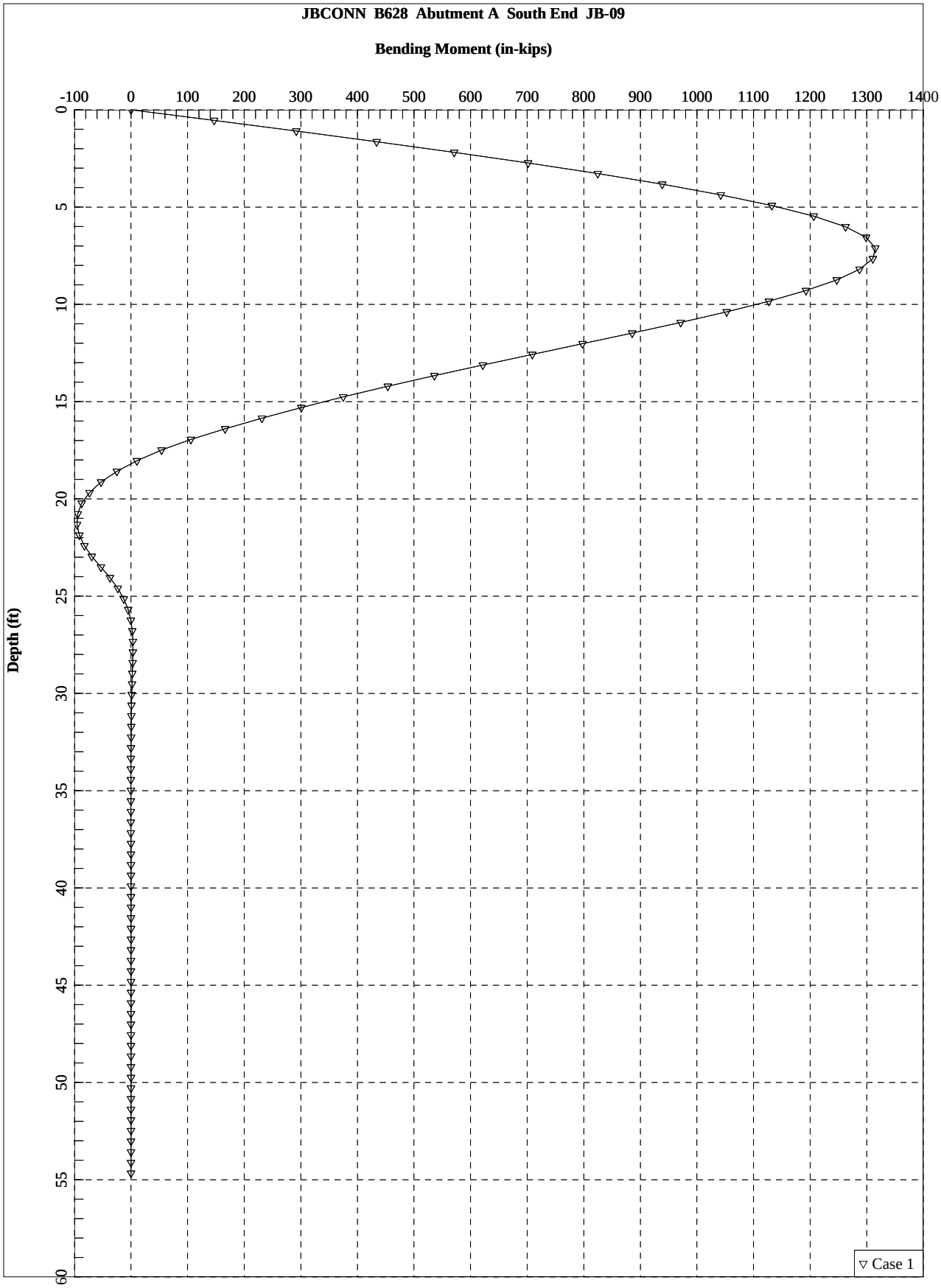
M concrete = psi 3,604,997
M Steel = psi 30,000,000

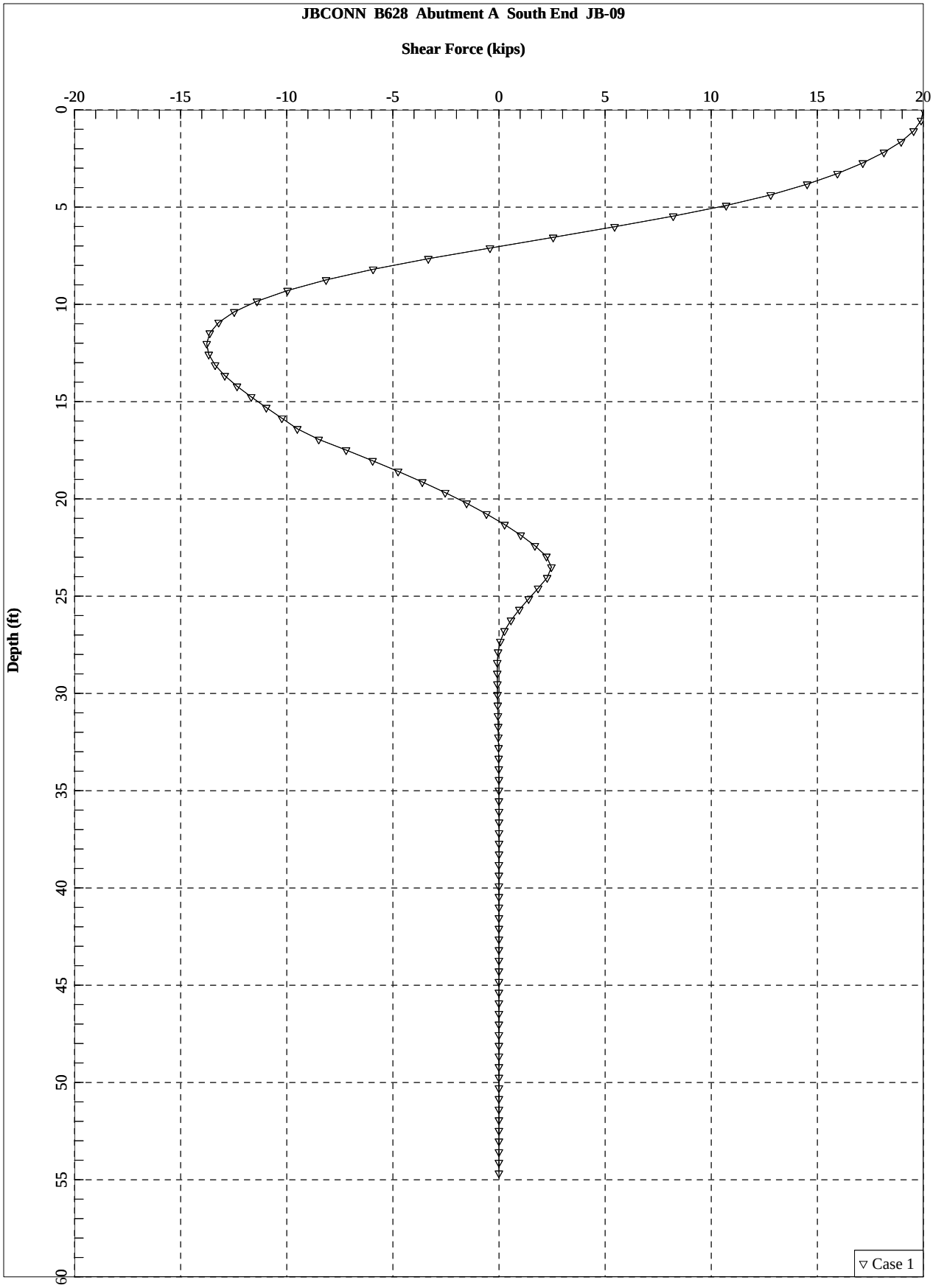
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B628 Abutment A South End JB-09
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN B628 Abutment A South End JB-09
Bending Moment (in-kips)
-100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN B628 Abutment A South End JB-09
Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

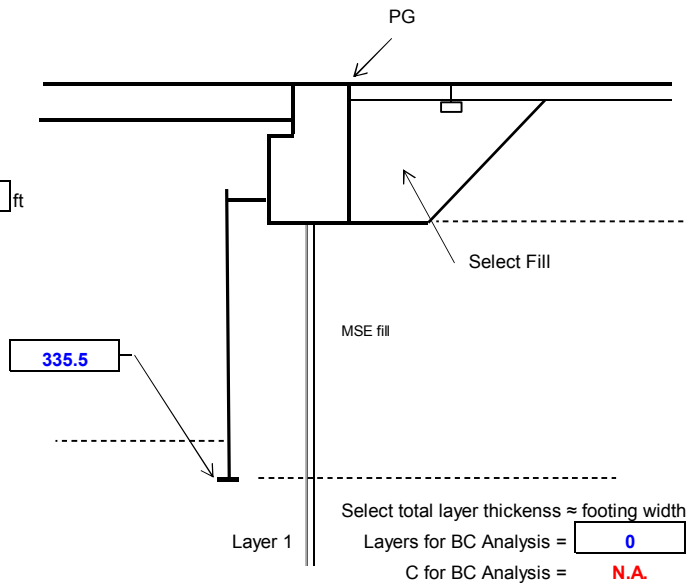
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 1/4/2016	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment B Enter Values in Blue.	Date 1/4/2016	

Red values are calculated

BORING No. =	JB-10	
Top of Boring El. =	338.7	ft
Profile Grade =	374.5	ft
Top of Layer 1 =	335.5	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	275.7	ft

North Tie-In

Bottom of Abut. = 363.4 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	325.7	9.8	P	II-A	7	9	7			8
2	322.0	3.7	P	II-B	29					29
3	311.7	10.3	P	II-C	47	43				45
4	303.0	8.7	P	II-C	100	100				100
5	295.7	7.3	P	II-C	66					66
6	275.7	20.0	P	II-C	100	100	100	100		100
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	95.0	102.0	ML	50.0	28.0		2	9.8	
2	118.0	125.0	ML	50.0	30.0	Y	2	13.5	
3	130.0	137.0	ML	50.0	32.0		2	23.8	
4	120.0	128.0	HWR	250.0	34.0		4	32.5	
5	120.0	128.0	SP	250.0	34.0		3	39.8	
6	120.0	128.0	HWR	250.0	34.0		4	59.8	
7									
8									
9									
10									
11									
12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628DR~1\BJB10.DVN
Project Name: B628 ABUT B JB-10 Project Date: 11/17/2015
Project Client: JMT
Computed By: GIESE
Project Manager: GIESE

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	37.80 ft
	- Driving/Restrike	37.80 ft
	- Ultimate:	37.80 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	9.80 ft	0.00%	95.00 pcf	30.6/30.6	Nordlund
2	Cohesionless	3.70 ft	0.00%	118.00 pcf	37.3/37.3	Nordlund
3	Cohesionless	10.30 ft	0.00%	130.00 pcf	40.3/40.3	Nordlund
4	Cohesionless	8.70 ft	0.00%	120.00 pcf	41.5/41.5	Nordlund
5	Cohesionless	7.30 ft	0.00%	130.00 pcf	39.5/39.5	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.47 psf	23.04	N/A	0.00 Kips
9.01 ft	Cohesionless	427.98 psf	23.04	N/A	4.88 Kips
9.79 ft	Cohesionless	465.02 psf	23.04	N/A	5.76 Kips
9.81 ft	Cohesionless	931.59 psf	28.08	N/A	5.79 Kips
13.49 ft	Cohesionless	1148.71 psf	28.08	N/A	15.55 Kips
13.51 ft	Cohesionless	1368.25 psf	30.32	N/A	15.62 Kips
22.51 ft	Cohesionless	1953.25 psf	30.32	N/A	67.00 Kips
23.79 ft	Cohesionless	2036.45 psf	30.32	N/A	76.80 Kips
23.81 ft	Cohesionless	2707.20 psf	31.29	N/A	76.96 Kips
32.49 ft	Cohesionless	3228.00 psf	31.29	N/A	159.99 Kips
32.51 ft	Cohesionless	3751.25 psf	29.74	N/A	160.21 Kips
37.79 ft	Cohesionless	4094.45 psf	29.74	N/A	220.71 Kips
37.81 ft	Cohesionless	4439.94 psf	29.74	N/A	220.95 Kips
39.79 ft	Cohesionless	4506.86 psf	29.74	N/A	245.92 Kips

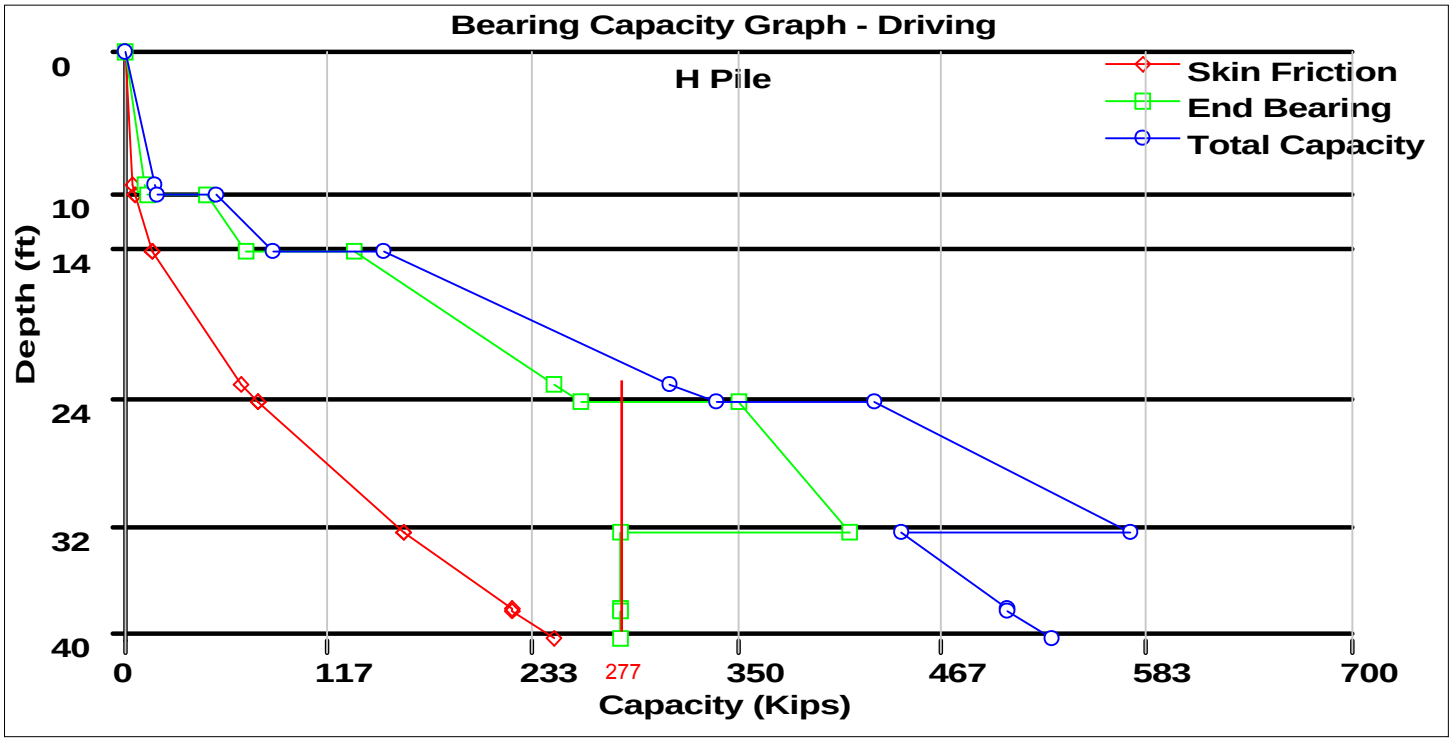
ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.95 psf	33.08	13.25 Kips	0.01 Kips
9.01 ft	Cohesionless	855.95 psf	33.08	13.25 Kips	12.60 Kips
9.79 ft	Cohesionless	930.05 psf	33.08	13.25 Kips	13.25 Kips
9.81 ft	Cohesionless	932.18 psf	95.12	167.06 Kips	47.34 Kips
13.49 ft	Cohesionless	1366.42 psf	95.12	167.06 Kips	69.39 Kips
13.51 ft	Cohesionless	1368.90 psf	170.73	329.66 Kips	132.00 Kips
22.51 ft	Cohesionless	2538.90 psf	170.73	329.66 Kips	244.82 Kips
23.79 ft	Cohesionless	2705.30 psf	170.73	329.66 Kips	260.87 Kips
23.81 ft	Cohesionless	2707.80 psf	224.93	413.74 Kips	351.07 Kips
32.49 ft	Cohesionless	3749.40 psf	224.93	413.74 Kips	413.74 Kips
32.51 ft	Cohesionless	3751.90 psf	147.30	282.90 Kips	282.90 Kips
37.79 ft	Cohesionless	4438.30 psf	147.30	282.90 Kips	282.90 Kips
37.81 ft	Cohesionless	4440.28 psf	147.30	282.90 Kips	282.90 Kips
39.79 ft	Cohesionless	4574.12 psf	147.30	282.90 Kips	282.90 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.01 Kips	0.01 Kips
9.01 ft	4.88 Kips	12.60 Kips	17.48 Kips
9.79 ft	5.76 Kips	13.25 Kips	19.00 Kips
9.81 ft	5.79 Kips	47.34 Kips	53.13 Kips
13.49 ft	15.55 Kips	69.39 Kips	84.94 Kips
13.51 ft	15.62 Kips	132.00 Kips	147.62 Kips
22.51 ft	67.00 Kips	244.82 Kips	311.82 Kips
23.79 ft	76.80 Kips	260.87 Kips	337.67 Kips
23.81 ft	76.96 Kips	351.07 Kips	428.03 Kips
32.49 ft	159.99 Kips	413.74 Kips	573.73 Kips
32.51 ft	160.21 Kips	282.90 Kips	443.11 Kips
37.79 ft	220.71 Kips	282.90 Kips	503.61 Kips
37.81 ft	220.95 Kips	282.90 Kips	503.85 Kips
39.79 ft	245.92 Kips	282.90 Kips	528.82 Kips

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628DR~1\BJB10.DVN



LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B628

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-10

Bridge No. B628 **Pier No.** B North **Bottom of Pile Cap / Top of Shaft El.** 363.4

Project No. 01-21924
By: JCG 1/4/2016
Checked: MAR 1/4/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

335.5 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 308.5 Tip El. L inches = 659
- Group Load — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 1.000 f'c 4,000 f'c

1.00 P Reducn Factor Long 8.0 B
P Reducn Factor Trans B
#VALUE! P Reducn Factor Resultant Mom. (based on primary loading only)

Tranverse Spacing, ft 6.50 **Longit. Spacing, ft**

Max. Fv for Axial Capacity Analysis, kips 180.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	180.0	kips (lbs)	180,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant		kips (lbs)		Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 278.7 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					335						
1	335.5	27.9	SP	P	4	II-A	335	0.05498	28.0		22		
2	325.7	9.8	ML	P	8	II-A	452	0.05498	28.0		44		
3	322.0	3.7	ML	P	29	II-B	497	0.06829	30.0		161		
4	311.7	10.3	ML	P	45	II-C	620	0.07523	32.0		249		
5	303.0	8.7	HWR	P	100	III	725	0.06944	34.0		554		
6	295.7	7.3	SP	P	66	III	812	0.06944	34.0		365		
7													
8													
9													
10													
11													

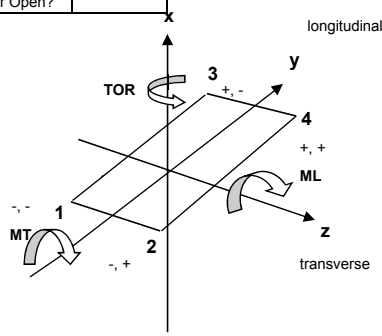
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



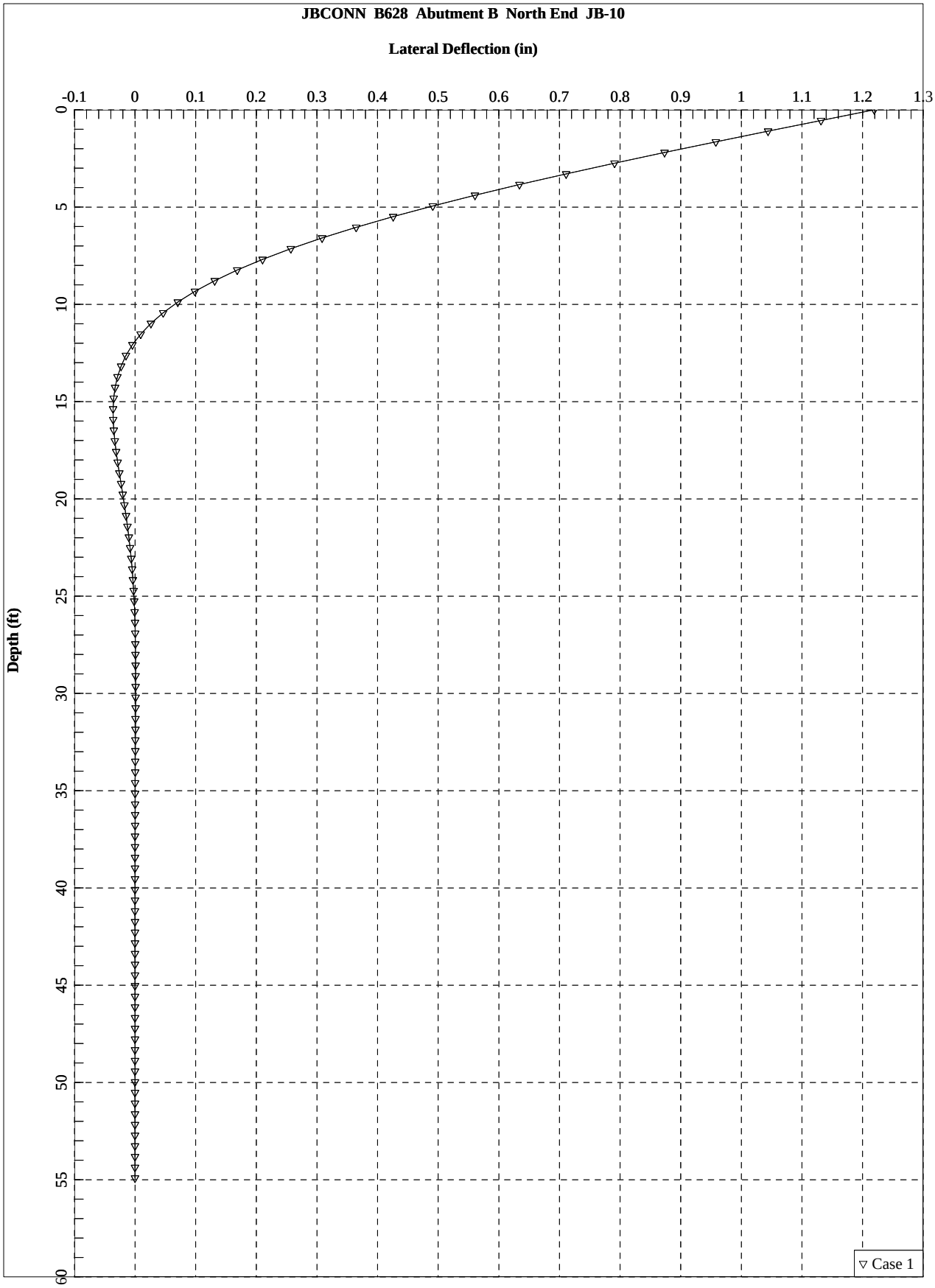
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

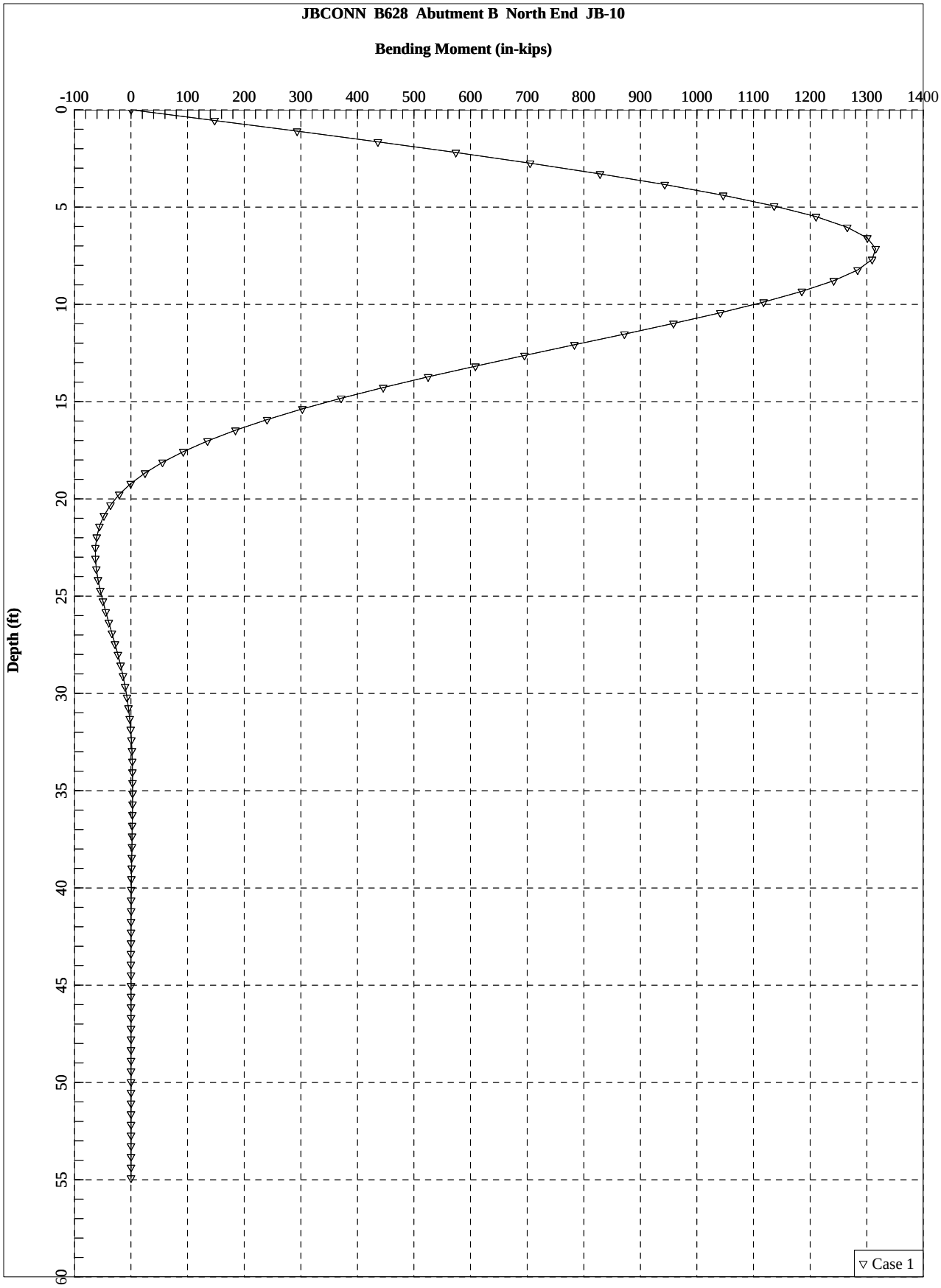
M concrete = psi 3,604,997
M Steel = psi 30,000,000

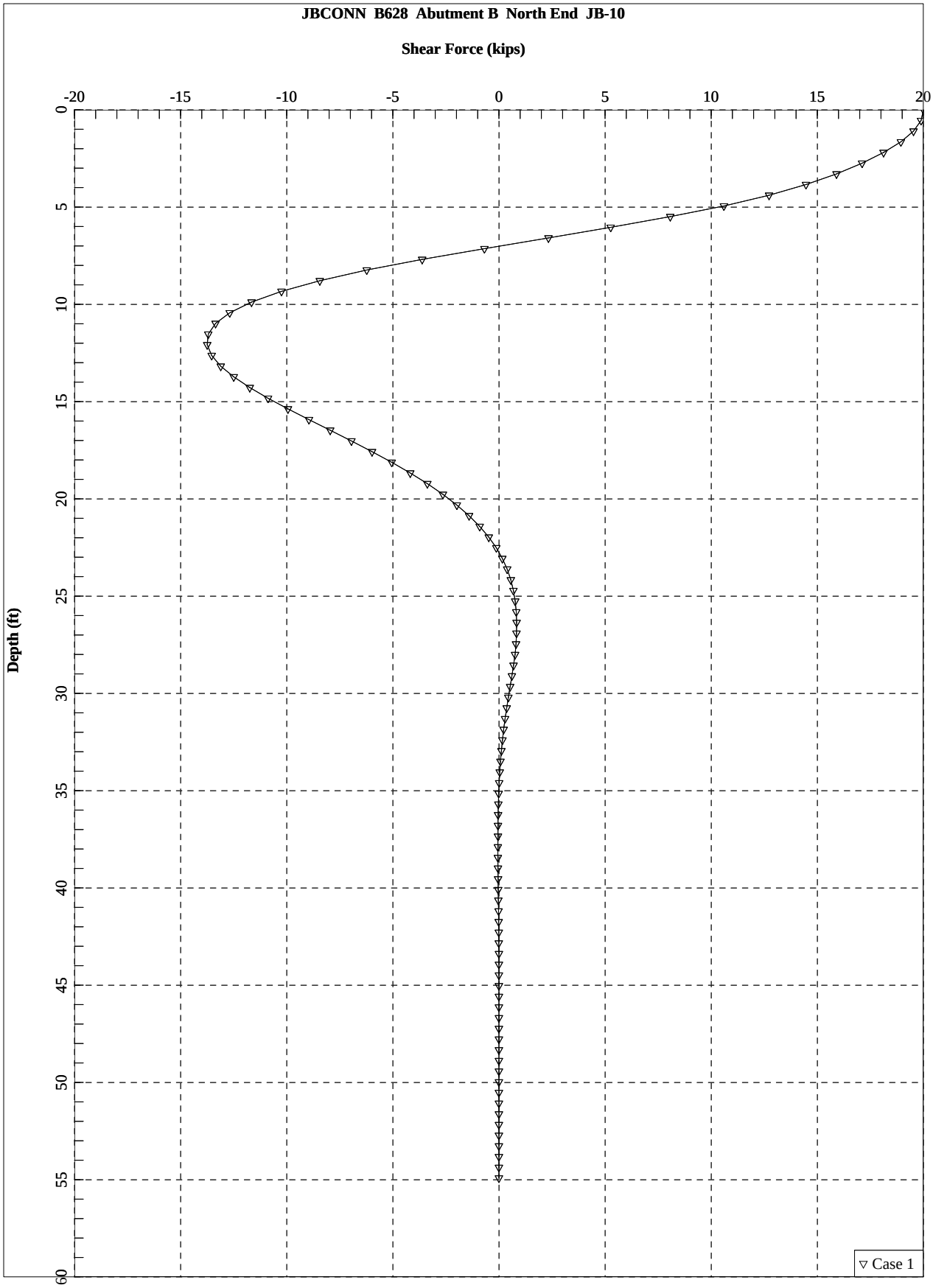
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B628 Abutment B North End JB-10
Lateral Deflection (in)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN B628 Abutment B North End JB-10
Bending Moment (in-kips)
-100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN B628 Abutment B North End JB-10
Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

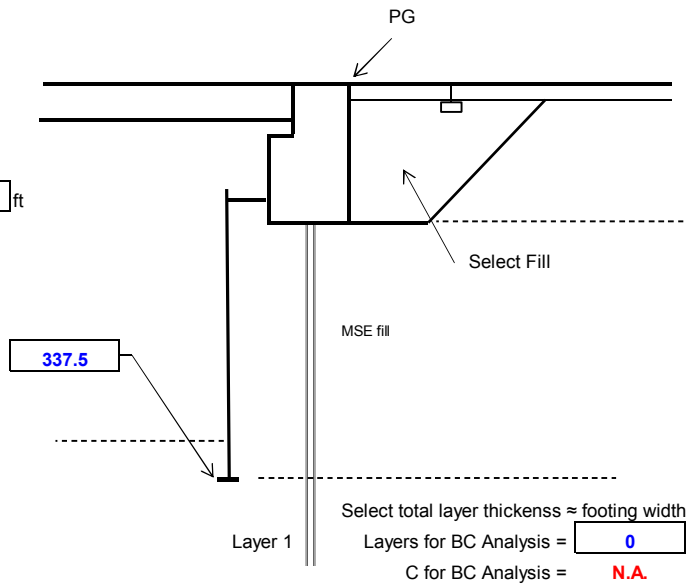
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 1/4/2016	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment B Enter Values in Blue.	Date 1/4/2016	

Red values are calculated

BORING No. =	JB-11	
Top of Boring El. =	342.0	ft
Profile Grade =	374.5	ft
Top of Layer 1 =	337.5	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	302.0	ft

South End

Bottom of Abut. = 361.8 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	334.0	3.5	P	II-C	31					31
2	332.0	2.0	P	II-C	56					56
3	315.0	17.0	P	II-C	43	42	34			40
4	311.0	4.0	P	II-C	100					100
5	302.0	9.0	P	II-C	76	73				75
6	275.0	27.0	P	II-C	100	100	100	89		97
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	130.0	137.0	SM	50.0	32.0		2	3.5	
2	130.0	137.0	HWR	50.0	32.0		4	5.5	
3	130.0	137.0	HWR	50.0	32.0		4	22.5	
4	120.0	128.0	ML	250.0	34.0		2	26.5	
5	120.0	128.0	HWR	250.0	34.0		4	35.5	
6	120.0	128.0		250.0	34.0			62.5	
7									
8									
9									
10									
11									
12									

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\DOCUME~1\XPMUSER\DESKTOP\B628NE~1\BJB11.DVN
Project Name: B628 ABUT B JB-11 Project Date: 11/17/2015
Project Client: JMT
Computed By: GIESE
Project Manager: GIESE

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 0.00 ft
Perimeter Analysis: Box
Tip Analysis: User Area - 0.75 ft^2

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	35.50 ft	
	- Driving/Restrike	35.50 ft	
	- Ultimate:	28.00 ft	Should be 35.5 but we are only using driving.
Ultimate Considerations:	- Local Scour:	0.00 ft	
	- Long Term Scour:	0.00 ft	
	- Soft Soil:	0.00 ft	

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	3.50 ft	0.00%	130.00 pcf	41.7/41.7	Nordlund
2	Cohesionless	2.00 ft	0.00%	130.00 pcf	43.0/43.0	Nordlund
3	Cohesionless	17.00 ft	0.00%	130.00 pcf	39.3/39.3	Nordlund
4	Cohesionless	4.00 ft	0.00%	120.00 pcf	41.1/41.1	Nordlund
5	Cohesionless	9.00 ft	0.00%	128.00 pcf	40.3/40.3	Nordlund

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.65 psf	31.40	N/A	0.00 Kips
3.49 ft	Cohesionless	226.85 psf	31.40	N/A	2.35 Kips
3.51 ft	Cohesionless	455.65 psf	32.38	N/A	2.38 Kips
5.49 ft	Cohesionless	584.35 psf	32.38	N/A	5.85 Kips
5.51 ft	Cohesionless	715.65 psf	29.58	N/A	5.89 Kips
14.51 ft	Cohesionless	1300.65 psf	29.58	N/A	38.11 Kips
22.49 ft	Cohesionless	1819.35 psf	29.58	N/A	90.89 Kips
22.51 ft	Cohesionless	2925.60 psf	30.95	N/A	91.06 Kips
26.49 ft	Cohesionless	3164.40 psf	30.95	N/A	128.20 Kips
26.51 ft	Cohesionless	3405.64 psf	30.32	N/A	128.40 Kips
27.99 ft	Cohesionless	3500.36 psf	30.32	N/A	143.54 Kips
28.01 ft	Cohesionless	3597.64 psf	30.32	N/A	143.75 Kips
35.49 ft	Cohesionless	4076.36 psf	30.32	N/A	232.84 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.30 psf	231.03	423.56 Kips	0.17 Kips
3.49 ft	Cohesionless	453.70 psf	231.03	423.56 Kips	60.56 Kips
3.51 ft	Cohesionless	456.30 psf	307.00	508.20 Kips	82.37 Kips
5.49 ft	Cohesionless	713.70 psf	307.00	508.20 Kips	128.83 Kips
5.51 ft	Cohesionless	716.30 psf	142.05	270.38 Kips	56.46 Kips
14.51 ft	Cohesionless	1886.30 psf	142.05	270.38 Kips	148.68 Kips
22.49 ft	Cohesionless	2923.70 psf	142.05	270.38 Kips	230.45 Kips
22.51 ft	Cohesionless	2926.20 psf	205.99	383.76 Kips	345.00 Kips
26.49 ft	Cohesionless	3403.80 psf	205.99	383.76 Kips	383.76 Kips
26.51 ft	Cohesionless	3406.28 psf	170.65	329.55 Kips	328.31 Kips
27.99 ft	Cohesionless	3595.72 psf	170.65	329.55 Kips	329.55 Kips
28.01 ft	Cohesionless	3598.28 psf	170.65	329.55 Kips	329.55 Kips
35.49 ft	Cohesionless	4555.72 psf	170.65	329.55 Kips	329.55 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.17 Kips	0.17 Kips
3.49 ft	2.35 Kips	60.56 Kips	62.91 Kips
3.51 ft	2.38 Kips	82.37 Kips	84.75 Kips
5.49 ft	5.85 Kips	128.83 Kips	134.69 Kips
5.51 ft	5.89 Kips	56.46 Kips	62.35 Kips
14.51 ft	38.11 Kips	148.68 Kips	186.79 Kips
22.49 ft	90.89 Kips	230.45 Kips	321.35 Kips
22.51 ft	91.06 Kips	345.00 Kips	436.06 Kips
26.49 ft	128.20 Kips	383.76 Kips	511.97 Kips
26.51 ft	128.40 Kips	328.31 Kips	456.71 Kips
27.99 ft	143.54 Kips	329.55 Kips	473.09 Kips
28.01 ft	143.75 Kips	329.55 Kips	473.30 Kips
35.49 ft	232.84 Kips	329.55 Kips	562.39 Kips

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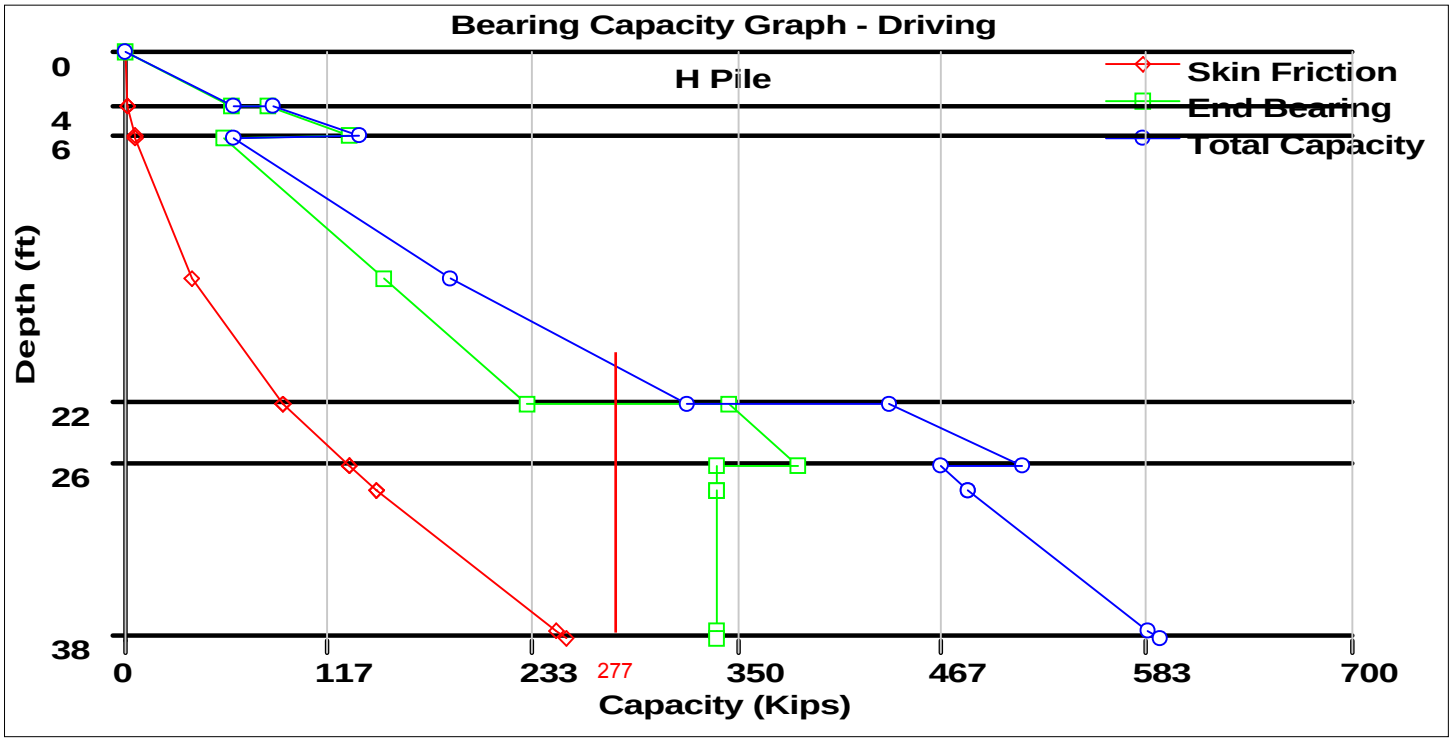


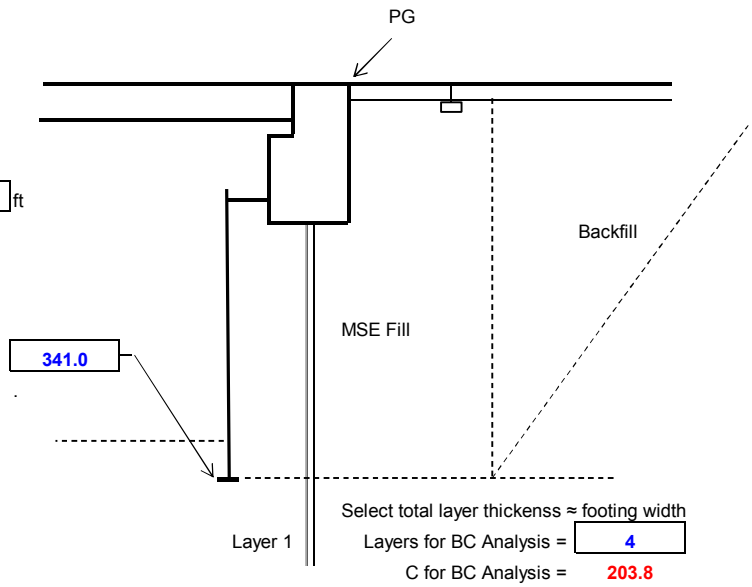
ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 3/17/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment A Enter Values in Blue.	Date 3/17/2016

Red values are calculated

BORING No. =	JB-12	
Top of Boring El. =	344.8	ft
Profile Grade =	374.1	ft
Top of Layer 1 =	341.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	300.8	ft

Middle of Abutment

Bottom of Abut. =	361.3	ft
El. Ground in front of Wall =	343.5	
El. Top of Front Wall =	363.0	
Front Wall Total Height =	22.0	
Front Wall Height from PG to Bot. =	33.1	



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	4
C for BC Analysis =	203.8
Φ for BC analysis =	33.3
Γ for BC Analysis =	120.9

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	338.8	2.2	P	II-B	27					27
2	336.8	2.0	P	II-C	41					41
3	333.0	3.8	P	II-C	71					71
4	322.8	10.2	P	II-C	100	100				100
5	317.8	5.0	P	II-B	22					22
6	300.8	17.0	P	II-C	82	100	100			94
7	298.5	2.3	P	II-C	100					100
8	293.5	5.0	P	II-C	59					59
9	275.4	18.1	P	II-C	100	100	100	100		100
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	SM	50.0	30.0		2	2.2	
2	130.0	137.0	SM	50.0	32.0		2	4.2	
3	120.0	128.0	SM	250.0	34.0		2	8.0	
4	120.0	128.0	HWR	250.0	34.0		4	18.2	
5	118.0	125.0	MH	50.0	30.0		5	23.2	2750
6	120.0	128.0	HWR	250.0	34.0		4	40.2	
7	120.0	128.0	HWR	250.0	34.0		4	42.5	
8	130.0	137.0	ML	50.0	32.0		2	47.5	
9	120.0	128.0	HWR	250.0	34.0		4	65.6	
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-12	SHAFT NO. 1	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	527	kips	Bottom Abutment = 361.3
Service or Scour Load		kips	

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	341.0	ft	
Top of Shaft	341.0	ft	
Groundwater (Enter bot. shaft if none)	300.8	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	310.0	ft	
Bottom of Shaft	310.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	4.0	ft
Shaft Length	31.0	ft
Shaft Length in Soil or IGM	31.0	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	65.6	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	82.1	kips

MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	65.6	kips

Enter new layer at 5' if bottom of clay is > than 5'

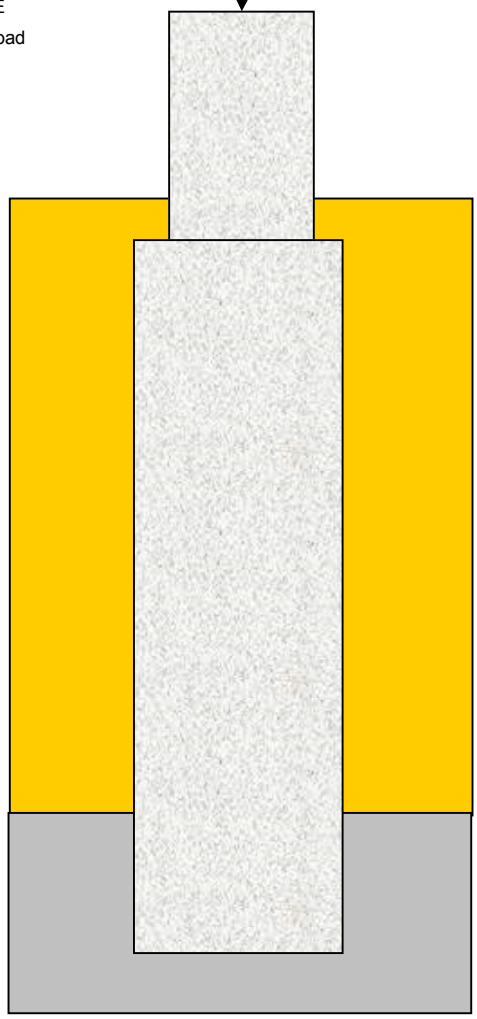
Enter new layer at bottom of downdrag and scour depths

Top of Ground	341.0
Top of Shaft	341.0
Top of Rock	No Rock
Bot. of Shaft	310.0

S1 to S6

R1

R2



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				341.0	338.8	2.2	118	27	27	
S2		x				338.8	336.8	2.0	118	41	41	
S3				x		336.8	333.0	3.8	138	71	71	
S4				x		333.0	322.8	10.2	138	100	100	
S5		x				322.8	317.8	5.0	118	22	22	
S6				x		317.8	310.0	7.8	138	94	94	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

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PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-12	SHAFT NO. 1	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1			0.0				
S2			0.0				
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	0

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	2.2	1.1	0.1	0.1	0.00	0.1	27	1.36	0.2	27.6	5	
S2	2.0	3.2	0.1	0.4	0.00	0.4	41	1.26	0.5	25.1	12	
S3	3.8	6.1	0.3	0.8	0.00	0.8						
S4	10.2	13.1	0.7	1.7	0.00	1.7						
S5	5.0	20.7	0.3	2.7	0.00	2.7	22	0.89	2.4	62.8	152	
S6	7.8	27.1	0.5	3.6	0.00	3.6						
			Bot Press.	3.6						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	168	

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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-12	SHAFT NO. 1	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	2.2	1.1	118.0	0.13	0.00	0.13	27					
S2	2.0	3.2	118.0	0.38	0.00	0.38	41					
S3	3.8	6.1	138.0	0.84	0.00	0.84	71	56.8	3.25	3.08	47.75	147.2
S4	10.2	13.1	138.0	1.81	0.00	1.81	100	56.5	2.30	4.65	128.18	595.9
S5	5.0	20.7	118.0	2.44	0.00	2.44	22					
S6	7.8	27.1	138.0	3.74	0.00	3.74	94	51.5	1.39	4.97	98.02	487.6
										TOTAL SIDE RESISTANCE IN COHESIONLESS IGM		1230.7

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3	336.8	333.0							
S4	333.0	322.8							
S5									
S6	317.8	310.0	310.0	3.6	-0.57	4.13	54.2	12.57	680
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	680 kips

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PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-12	SHAFT NO. 1	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

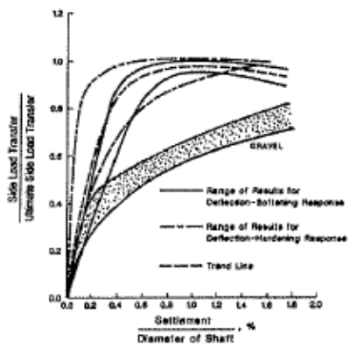

Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

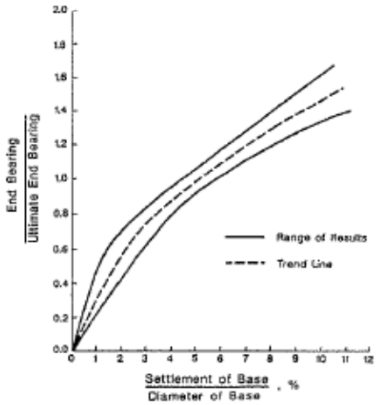

Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-12	SHAFT NO. 1	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		4.9					
S2		11.9					
S3				147.2			
S4				595.9			
S5		151.5					
S6				487.6			
Sum	0.0	168.3	0.0	1,230.7	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	92.6	0.0	738.4	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	89.8	0.0	716.3	0.0	**806**	kips

Tip Resistance

Layer No.	Material Description					
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM	
S1						
S2						
S3						
S4						
S5						
S6				680.5		
Sum				680.5	0.0	
φ				0.55	0.55	
φ * Rs				374.3	0.0	
L.T. Factor				0.3	0.58	Sum Rp
Rp				112.3	0.0	**112**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	806	Pmax	527	
Rp	112	Wt. Shaft	82	22
Σ	918	Σ	609	
		FR ≥ RP	**OK**	

918 > 631

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-12

Bridge No. B629 **Pier No.** A Middle **Bottom of Pile Cap / Top of Shaft El.** 361.3

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

361.3 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 310.0 — Tip El. — L inches = 616
- Group Load — 1 — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 4.000 f'c 5,000 f'c

#N/A	P Reducn Factor Long	0.0	B
0.25	P Reducn Factor Trans	3.0	B
#N/A	P Reducn Factor Resultant Mom.		

(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 527.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	527.0	kips (lbs)	527,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	94.0	kips (lbs)	94,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	27.0	kips (lbs)	27,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	342.0	kip-ft (lb-in)	4,104,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	97.80	kips (lbs)	97,801	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	342.00	kip-ft (lb-in)	4,104,000	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
- CP = Coastal Plain
- P = Piedmont
- CFB = Culpr. Fault Basin
- VR = Valley & Ridge
- R = Rock
- FR = Weak Fract. Rock
- SF = Select Fill

Soil Conditions Water Table El. 300.8 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	341.0	20.3	SF	P	32	Gravel	244	0.07813	32.0		177		
2	338.8	2.2	SM	P	17	II-B	270	0.06829	30.0		94		
3	336.8	2.0	SM	P	41	II-C	294	0.07523	32.0		227		
4	333.0	3.8	SM	P	71	III	340	0.06944	34.0		393		
5	322.8	10.2	HWR	P	100	III	462	0.06944	34.0		554		
6	317.8	5.0	MH	P	22	II-B	522	0.06829		6.00		0.005	
7	310.0	7.8	HWR	P	94	III	616	0.06944	34.0		520		
8													
9													
10													
11													

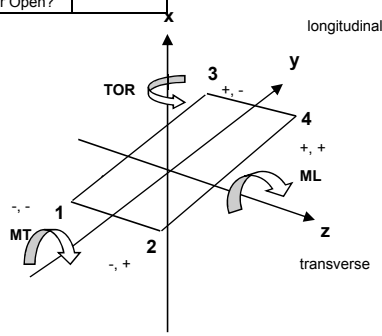
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



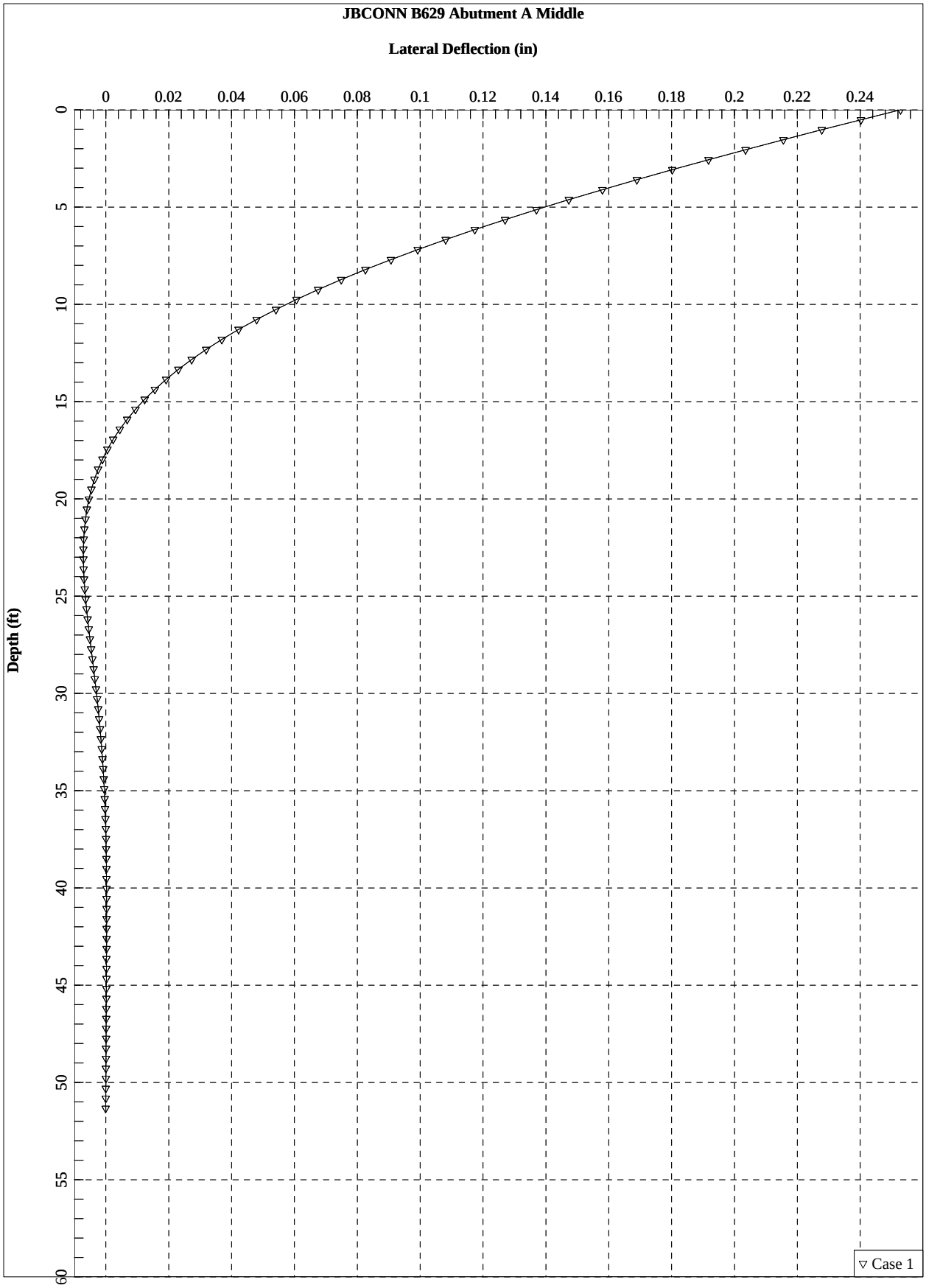
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

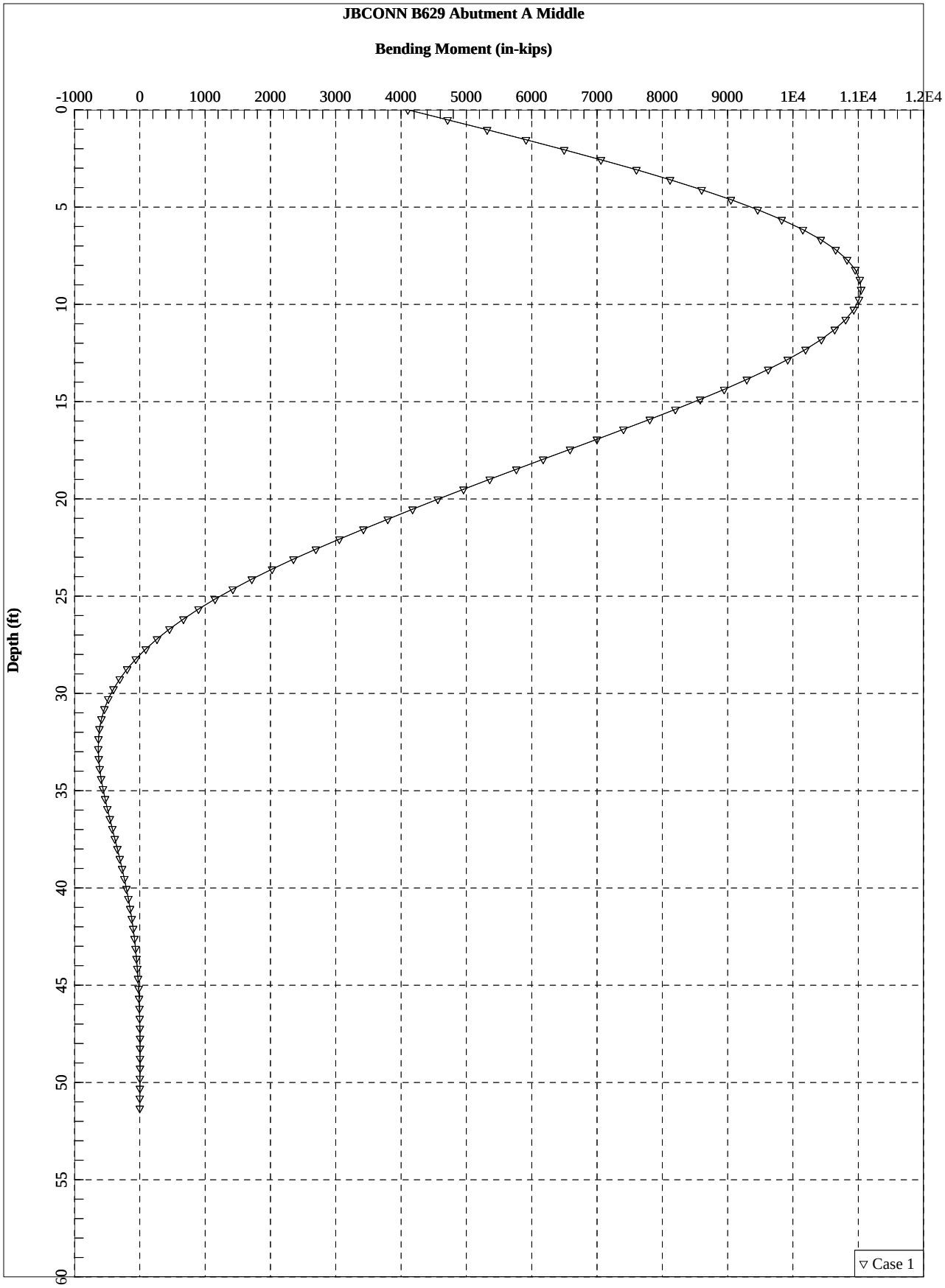
M concrete = psi 4,030,509
M Steel = psi 30,000,000

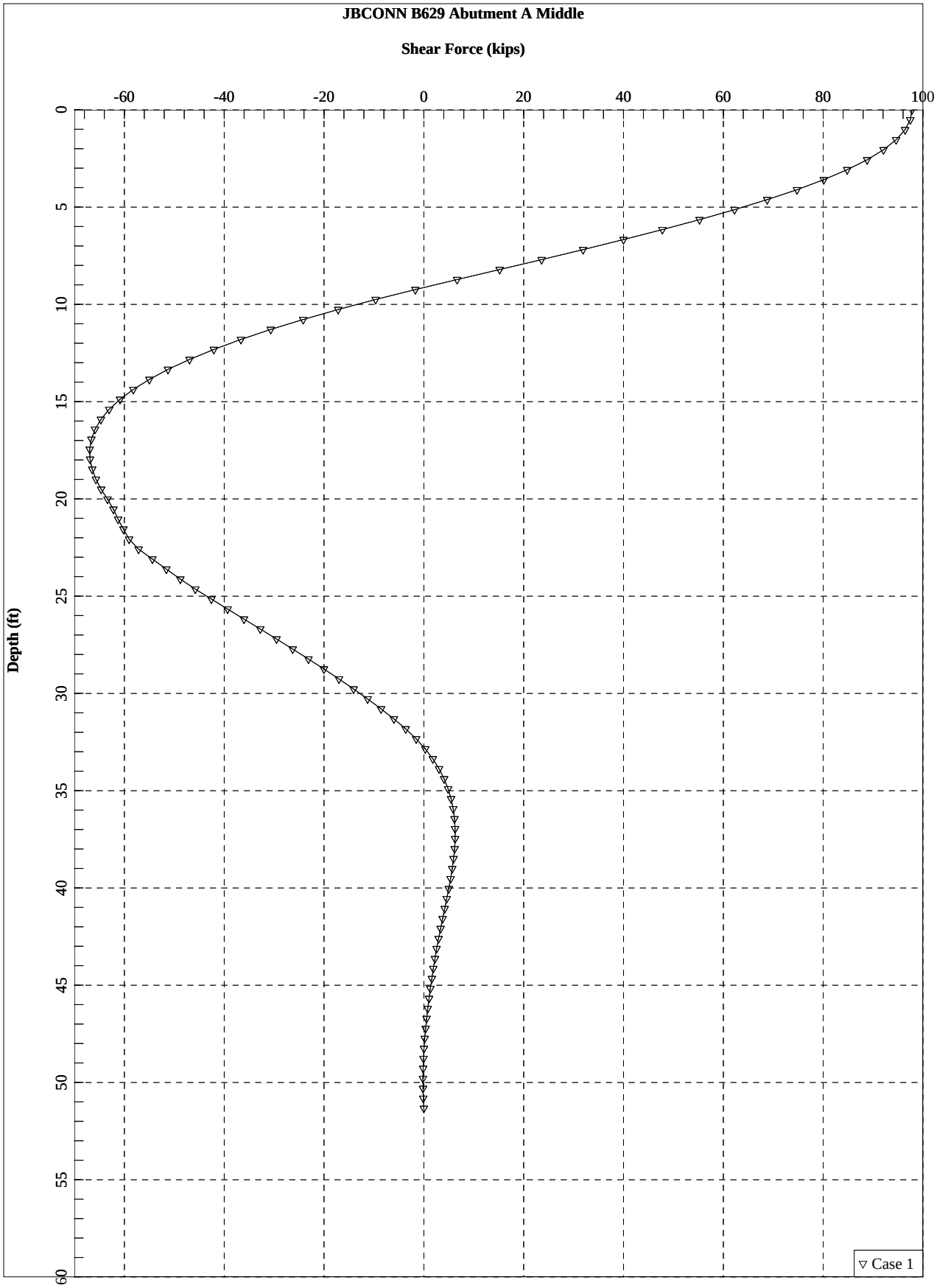
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B629 Abutment A Middle
Lateral Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN B629 Abutment A Middle
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
1E4
1.1E4
1.2E4
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN B629 Abutment A Middle
Shear Force (kips)
-60
-40
-20
0
20
40
60
80
100
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 3/17/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment A Enter Values in Blue.	Date 3/17/2016

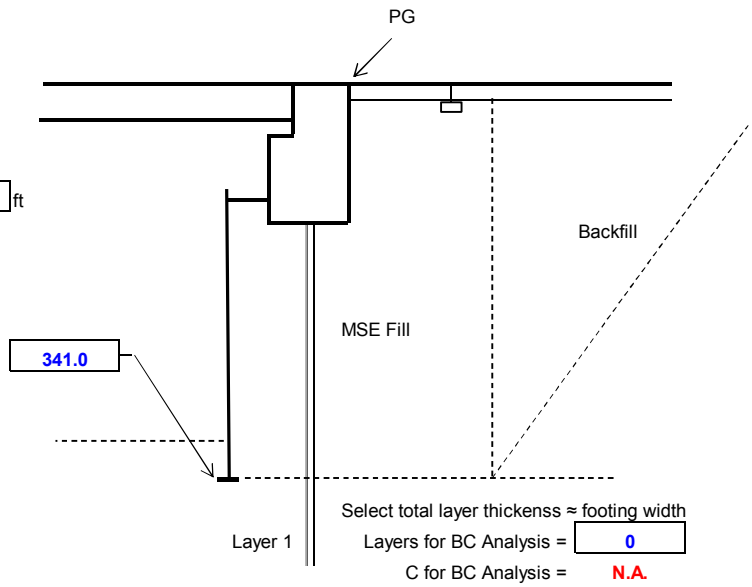
Red values are calculated

BORING No. =	JB-13	
Top of Boring El. =	344.3	ft
Profile Grade =	372.2	ft
Top of Layer 1 =	341.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	298.3	ft

South Abutment End

Bottom of Abut. = 359.5 ft

El. Ground in front of Wall =	343.5
El. Top of Front Wall =	361.3
Front Wall Total Height =	20.3
Front Wall Height from PG to Bot. =	31.2



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	338.3	2.7	P	II-C	28	50				39
2	333.0	5.3	P	II-C	84	100				92
3	328.0	5.0	P	II-C	92					92
4	323.0	5.0	P	II-C	100					100
5	318.0	5.0	P	II-B	24					24
6	313.0	5.0	P	II-C	97					97
7	303.0	10.0	P	II-C	61	79				70
8	298.3	4.7	P	II-C	100					100
9	274.9	23.4	P	II-C	100	100	100	100		100
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	130.0	137.0	ML	50.0	32.0		2	2.7	
2	120.0	128.0	HWR	250.0	34.0		4	8.0	
3	120.0	128.0	HWR	250.0	34.0		4	13.0	
4	120.0	128.0	HWR	250.0	34.0		4	18.0	
5	118.0	125.0	SP	50.0	30.0		3	23.0	
6	120.0	128.0	HWR	250.0	34.0		4	28.0	
7	120.0	128.0	HWR	250.0	34.0		4	38.0	
8	120.0	128.0	HWR	250.0	34.0		4	42.7	
9	120.0	128.0	HWR	250.0	34.0		4	66.1	
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-13	SHAFT NO. 1	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	527	kips	Bottom of Abutment = 359.5
Service or Scour Load		kips	

	ANALYSIS TYPE
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	341.0	ft	
Top of Shaft	341.0	ft	
Groundwater (Enter bot. shaft if none)	298.3	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	310.0	ft	
Bottom of Shaft	310.0	ft	

DRILLED SHAFT INFORMATION

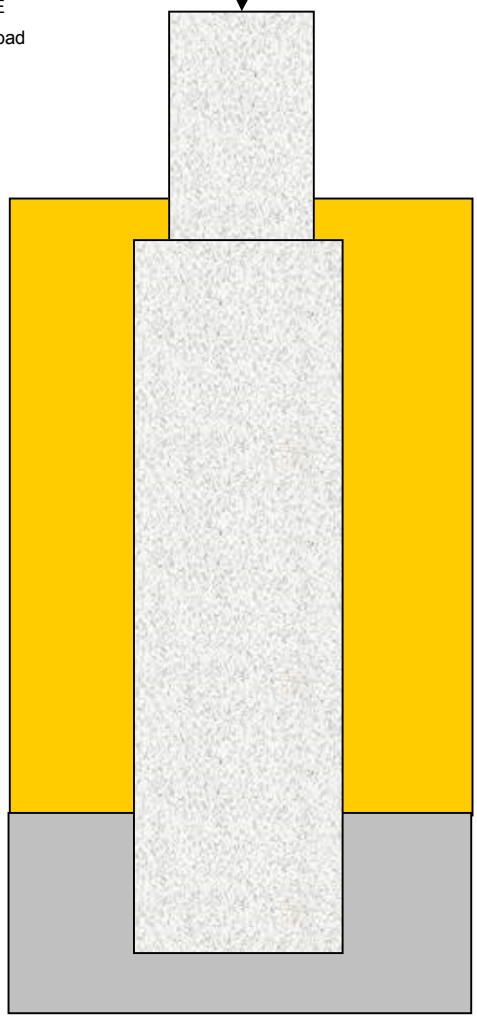
Shaft Lateral Spacing	-	ft	
Shaft Diameter	4.0	ft	
Shaft Length	31.0	ft	
Shaft Length in Soil or IGM	31.0	ft	
Shaft Length in Rock	0.0	ft	
Bouyant Weight of Shaft	67.6	kips	S1 to S6
Factored Shaft Wt. (φ_{DL} = 1.25)	84.5	kips	

MISC INFO

Atmospheric Pressure	2.12	ksf	
Concrete Compressive Strength	5,000	psi	
Unit Weight of Water	0.0624	ksf	
Unit Weight of Concrete	0.15	ksf	
Elastic Modulus of Concrete		ksi	
Downdrag Force Elevation	-	ft	Top of Rock
Scour Depth Elevation	-	ft	No Rock
Top of Shaft for Scour		ft	
Hammer Efficiency	60	%	R1
Eff. Wt. of Shaft	67.6	kips	R2
			Bot. of Shaft
	Enter new layer at 5' if bottom of clay is > than 5'		310.0

Top of Ground: 341.0

Top of Shaft: 341.0



SOIL AND IGM LAYER DATA Enter new layer at bottom of downdrag and scour depths

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				341.0	338.3	2.7	118	39	39	
S2				x		338.3	328.0	10.3	138	92	92	
S3				x		328.0	323.0	5.0	138	100	100	
S4		x				323.0	318.0	5.0	118	24	24	
S5				x		318.0	313.0	5.0	138	97	97	
S6				x		313.0	310.0	3.0	138	70	70	

ROCK DATA qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90 | REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-13	SHAFT NO. 1	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	2.7	1.3	118.0	0.16	0.00	0.16	39					
S2	10.3	7.8	138.0	1.08	0.00	1.08	92	58.2	3.16	4.01	129.43	519.1
S3	5.0	15.5	138.0	2.14	0.00	2.14	100	55.6	2.06	4.77	62.83	299.9
S4	5.0	20.5	118.0	2.42	0.00	2.42	24					
S5	5.0	25.5	138.0	3.52	0.00	3.52	97	52.2	1.46	5.05	62.83	317.5
S6	3.0	29.5	138.0	4.07	0.00	4.07	70	48.0	1.12	3.96	37.70	149.3
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	1285.8

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2	338.3	328.0							
S3	328.0	323.0							
S4									
S5	318.0	313.0							
S6	313.0	310.0	310.0	3.9	-0.73	4.65	43.8	12.57	550
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	550 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-13	SHAFT NO. 1	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs — As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu — qu = unconfined compressive strength of intact IGM, ksf — O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 — FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

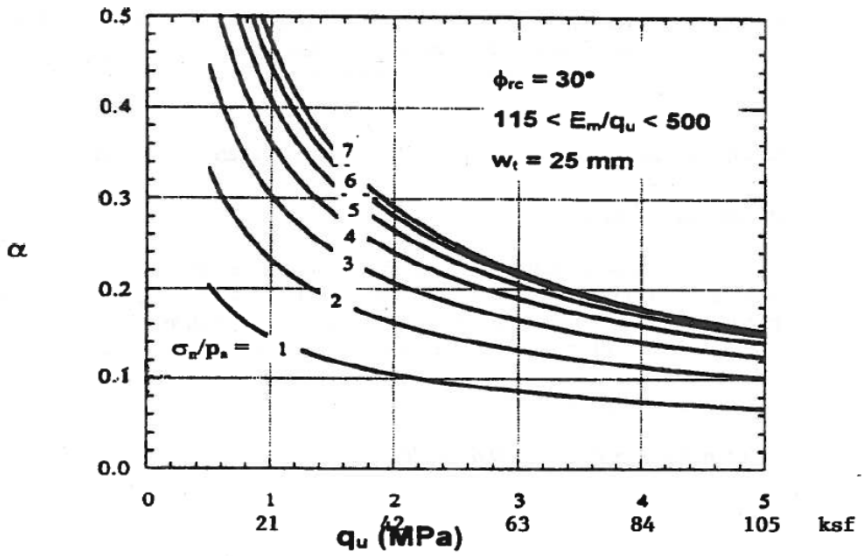


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	2.7	1.3	0.1	0.06					
S2	10.3	7.8	0.8	0.36					
S3	5.0	15.5	1.5	0.71					
S4	5.0	20.5	2.0	0.94					
S5	5.0	25.5	2.5	1.17		0.16			
S6	3.0	29.5	2.9	1.36					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-13	SHAFT NO. 1	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

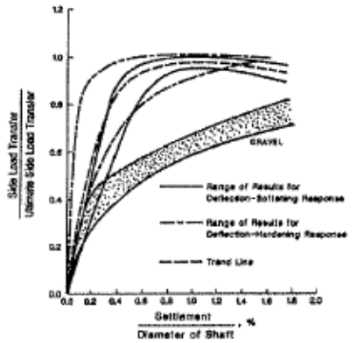


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

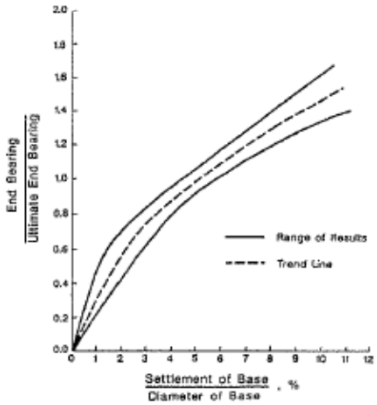


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment A	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-13	SHAFT NO. 1	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		7.3					
S2				519.1			
S3				299.9			
S4		152.2					
S5				317.5			
S6				149.3			
Sum	0.0	159.4	0.0	1,285.8	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	87.7	0.0	771.5	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	85.1	0.0	748.3	0.0	**833**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				550.4	
Sum				550.4	0.0
φ				0.55	0.55
φ * Rs				302.7	0.0
L.T. Factor				0.3	0.58
Rp				90.8	0.0

Sum Rp **91**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt. MSE Zone
Rs	833	Pmax	527	
Rp	91	Wt. Shaft	85	20
Σ	924	Σ	612	
		FR ≥ RP	**OK**	

924 > 629

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-13

Bridge No. B629 **Pier No.** A South **Bottom of Pile Cap / Top of Shaft El.** 359.5

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

359.5 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 310.0 — Tip El. — L inches = 594
- Group Load — 1 — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 4.000 f'c 5,000 f'c 0.25

#N/A P Reducn Factor Long 0.0 B
0.25 P Reducn Factor Trans 3.0 B
#N/A P Reducn Factor Resultant Mom. (based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 527.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	527	kips (lbs)	527,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	94.00	kips (lbs)	94,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	27.0	kips (lbs)	27,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	342	kip-ft (lb-in)	4,104,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	97.80	kips (lbs)	97,801	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	342.00	kip-ft (lb-in)	4,104,000	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 298.3 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in²	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	341.0	18.5	SF	P	32	Gravel	222	0.07813	32.0		177		
2	338.3	2.7	ML	P	39	II-C	254	0.07523	32.0		216		
3	333.0	5.3	HWR	P	92	III	318	0.06944	34.0		509		
4	328.0	5.0	HWR	P	92	III	378	0.06944	34.0		509		
5	323.0	5.0	HWR	P	100	III	438	0.06944	34.0		554		
6	318.0	5.0	sp	P	24	II-B	498	0.06829	30.0		133		
7	313.0	5.0	HWR	P	97	III	558	0.06944	34.0		537		
8	310.0	3.0	HWR	P	70	III	594	0.06944	34.0		387		
9													
10													
11													

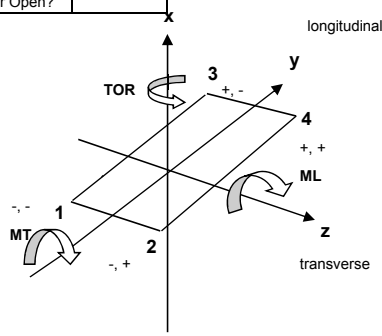
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



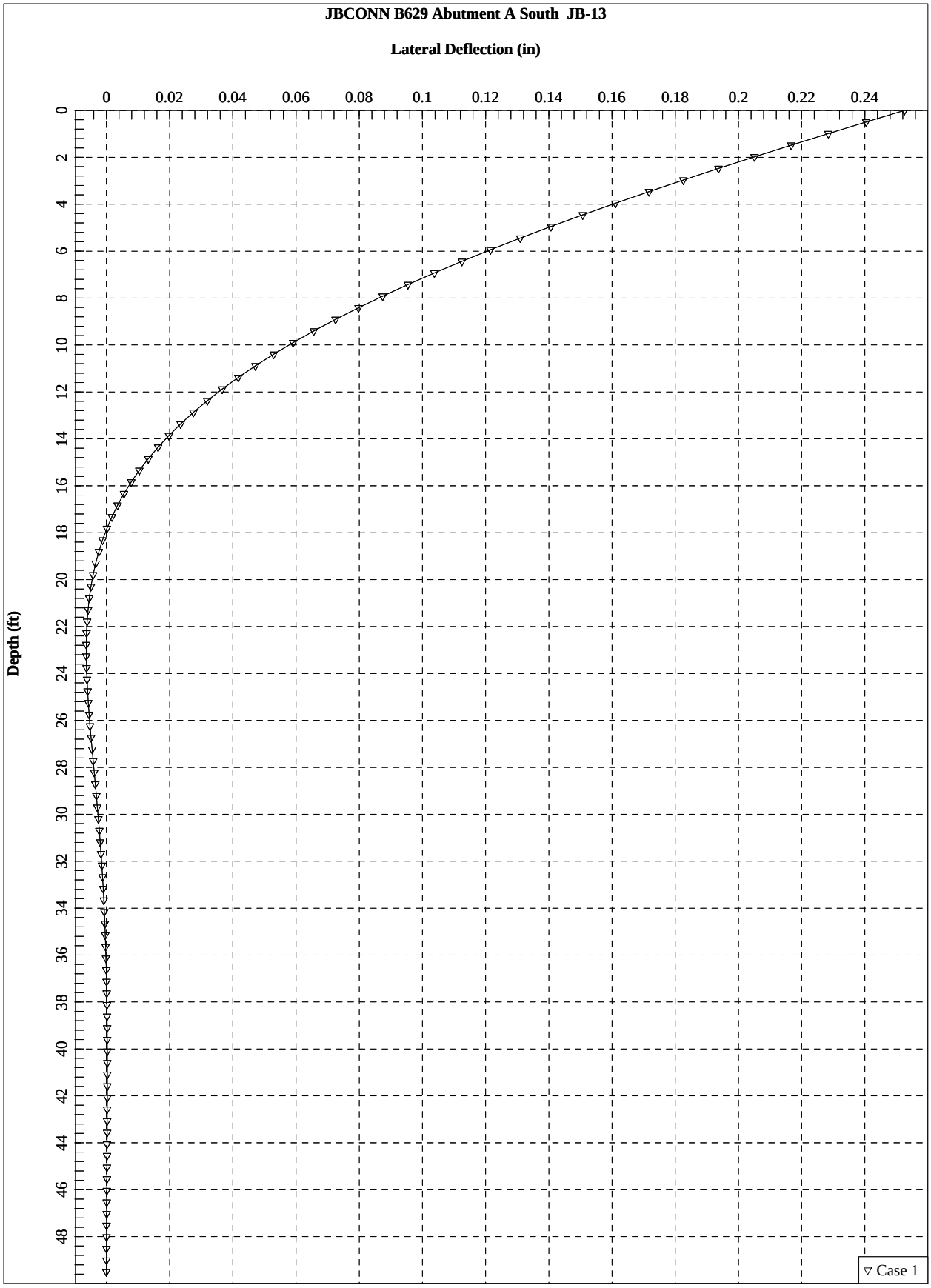
Diameter	Mom. of I. in⁴	Area in²
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

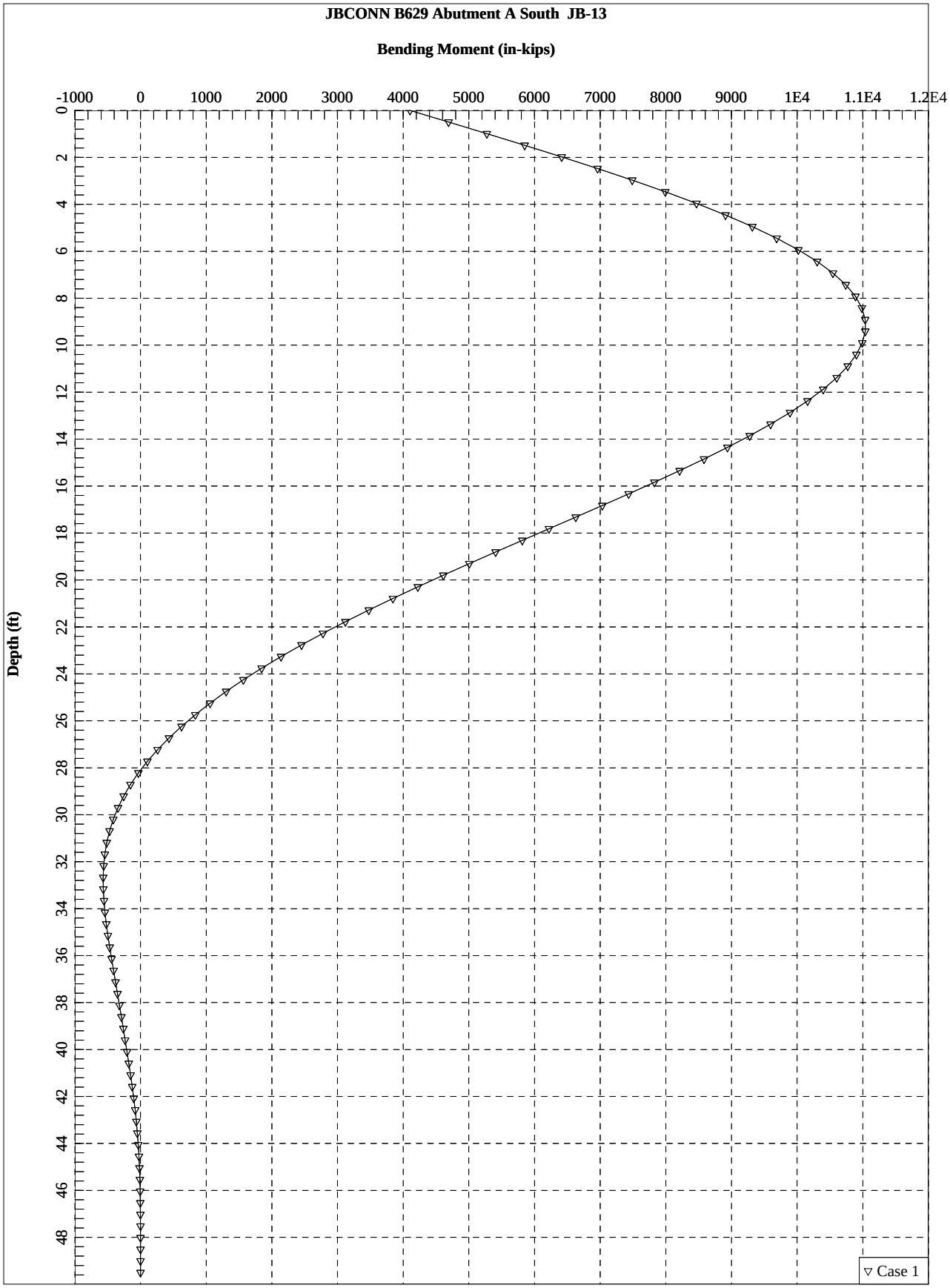
M concrete = psi 4,030,509
M Steel = psi 30,000,000

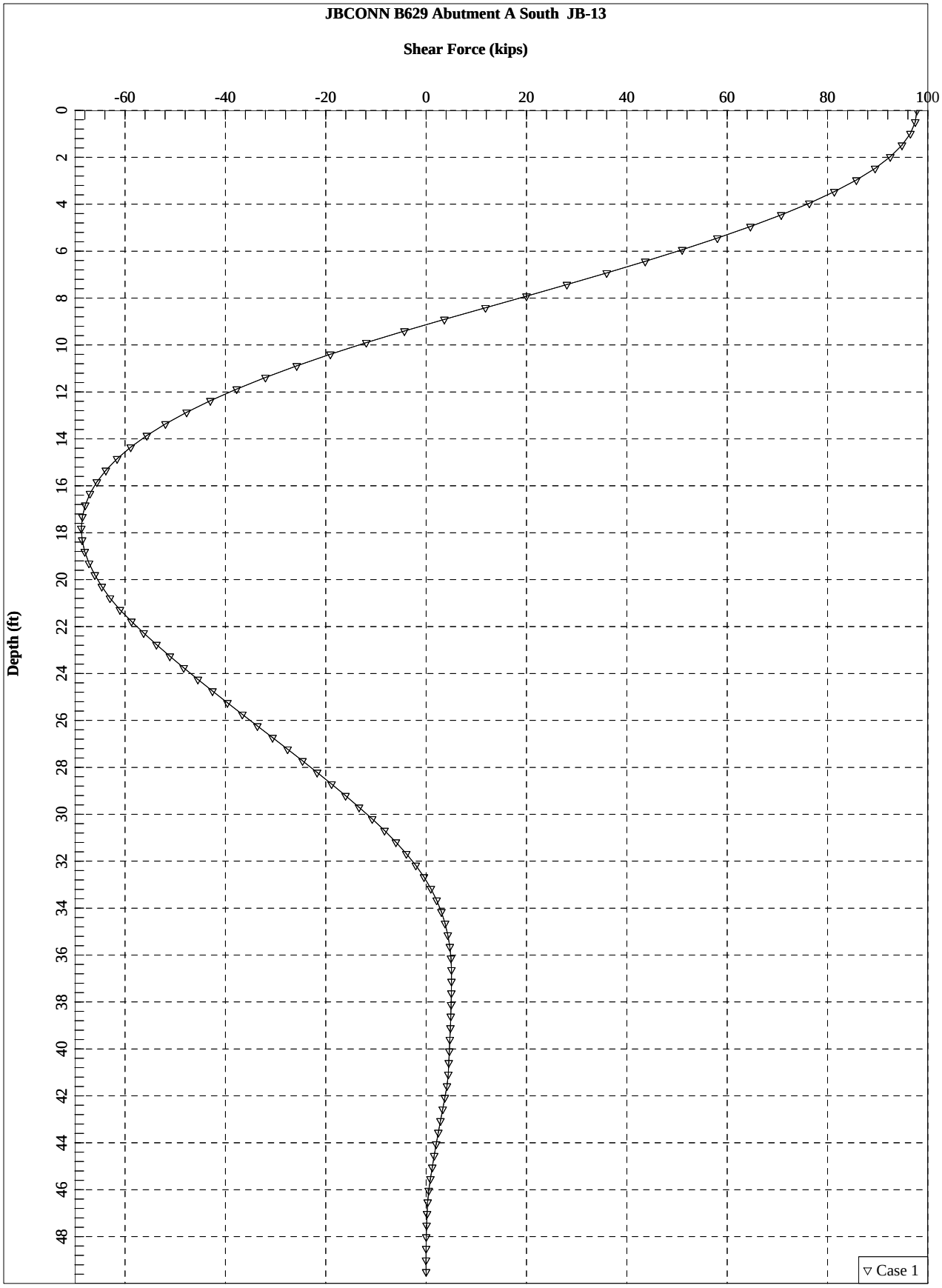
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B629 Abutment A South JB-13
Lateral Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
Case 1


JBCONN B629 Abutment A South JB-13
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
1E4
1.1E4
1.2E4
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
Case 1

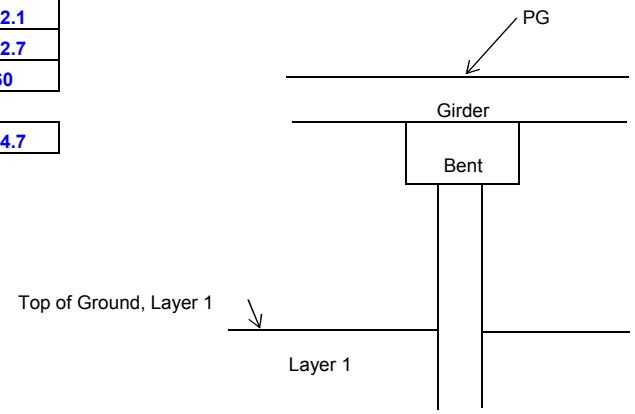

JBCONN B629 Abutment A South JB-13
Shear Force (kips)
-60
-40
-20
0
20
40
60
80
100
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
Case 1

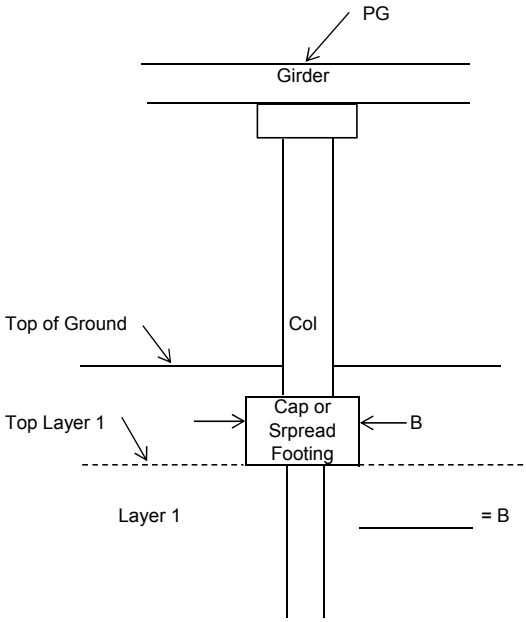
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By	MDY
Determination of Soil Parameters below Piers	Date	3/17/2016
	Checked By	JCG
LOCATION JBCONN Bridge B 629 — Pier 1 — Enter Values in Blue.	Date	3/17/2016

Red values are calculated

	North
BORING No. =	JB-14
Top of Boring El. =	342.7
Profile Grade =	373.0
Top of Layer 1 =	342.1
Top of Ground El. =	342.7
Hammer Efficiency %	60
Groundwater Elevation =	304.7

Bottom of Bent or Cap =	342.1
GW depth below top Layer 1 =	37.4





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	336.7	5.4	P	II-A	5	10	12			9
2	332.7	4.0	P	II-B	14	12				13
3	321.0	11.7	P	II-C	38	30	29			32
4	312.0	9.0	P	II-C	44	52				48
5	304.7	7.3	P	II-C	90					90
6	300.0	4.7	P	II-B	27					27
7	286.0	14.0	P	II-C	100	100	100			100
8	281.0	5.0	P	II-C	75					75
9	273.9	7.1	P	II-C	100	100				100
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	95.0	102.0	ML	50.0	28.0		2	5.4	
2	118.0	125.0	SM	50.0	30.0		2	9.4	
3	130.0	137.0	SM	50.0	32.0		2	21.1	
4	130.0	137.0	SM	50.0	32.0		2	30.1	
5	120.0	128.0	HWR	250.0	34.0		4	37.4	
6	118.0	125.0	SM	50.0	30.0		2	42.1	
7	120.0	128.0	HWR	250.0	34.0		4	56.1	
8	120.0	128.0	HWR	250.0	34.0		4	61.1	
9	120.0	128.0	HWR	250.0	34.0		4	68.2	
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-14	SHAFT NO. North	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,400	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	342.1	ft	
Top of Shaft	342.1	ft	
Groundwater (Enter bot. shaft if none)	304.7	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	285.0	ft	
Bottom of Shaft	285.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	5.0	ft
Shaft Length	57.1	ft
Shaft Length in Soil or IGM	57.1	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	144.0	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	180.0	kips

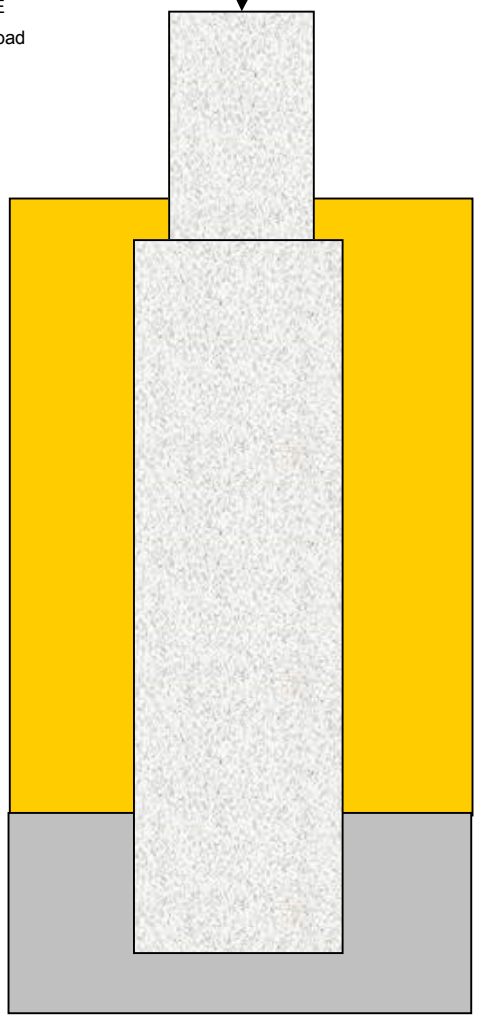
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	144.0	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	
342.1	
Top of Shaft	
342.1	
S1 to S6	
Top of Rock	
No Rock	
R1	
R2	
Bot. of Shaft	
285.0	



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				342.1	336.7	5.4	118	11	9	
S2		x				336.7	332.7	4.0	118	13	13	
S3		x				332.7	312.0	20.7	118	40	40	
S4				x		312.0	304.7	7.3	138	90	90	
S5		x				304.7	300.0	4.7	118	27	27	
S6				x		300.0	285.0	15.0	138	100	100	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-14	SHAFT NO. North	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	5.4	2.7	118.0	0.32	0.00	0.32	9					
S2	4.0	7.4	118.0	0.87	0.00	0.87	13					
S3	20.7	19.8	118.0	2.33	0.00	2.33	40					
S4	7.3	33.8	138.0	4.66	0.00	4.66	90	49.5	1.19	5.00	114.67	573.0
S5	4.7	39.8	118.0	4.69	0.15	4.54	27					
S6	15.0	49.6	138.0	6.84	0.76	6.08	100	48.4	1.08	5.74	235.62	1352.0
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	1925.1

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4	312.0	304.7							
S5									
S6	300.0	285.0	285.0	6.1	1.23	4.92	58.9	19.63	1,157
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	1,157 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-14	SHAFT NO. North	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu qu = unconfined compressive strength of intact IGM, ksf O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

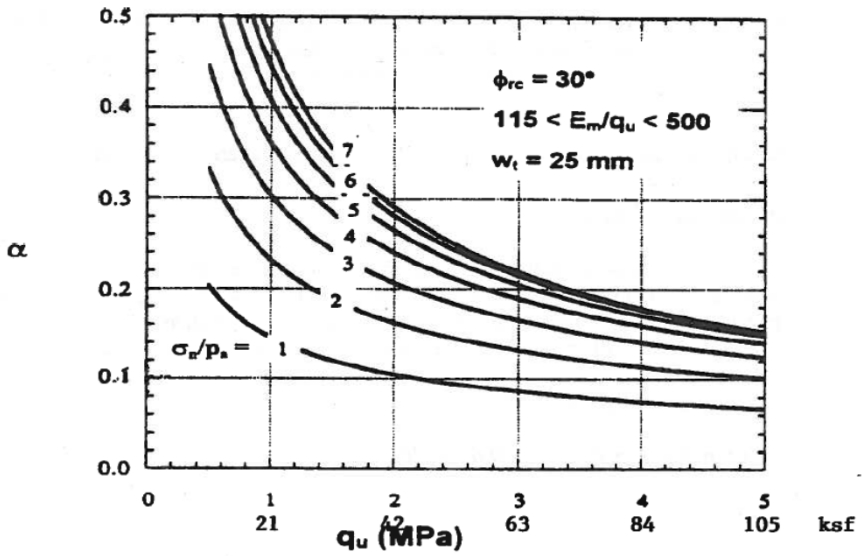


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	5.4	2.7	0.3	0.12					
S2	4.0	7.4	0.7	0.34					
S3	20.7	19.8	1.9	0.91					
S4	7.3	33.8	3.3	1.55					
S5	4.7	39.8	3.9	1.83		0.16			
S6	15.0	49.6	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

Side and Base Resistance Transfer in Cohesive Soils

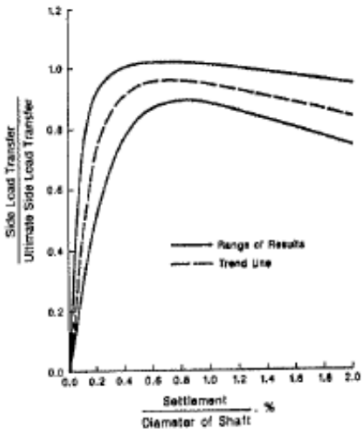


Figure 10.8.2.2.2-1 Normalized Load Transfer in Side Resistance versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

The curves in Figures 10.8.2.2.2-1 and 10.8.2.2.2-3 also show the settlements at which the side resistance is mobilized. The shaft skin friction R_s is typically fully mobilized at displacements of 0.2 percent to 0.8 percent of the shaft diameter for shafts in cohesive soils. For shafts in cohesionless soils, this value is 0.1 percent to 1.0 percent.

	REV 1	REV 6
	x	y
	0.0	0.00
	0.1	0.28
	0.2	0.55
	0.3	0.83
	0.4	0.86
	0.5	0.89
	0.6	0.95
	0.8	0.95
	1.0	0.93
	1.2	0.91
	1.5	0.85
	2.0	0.83

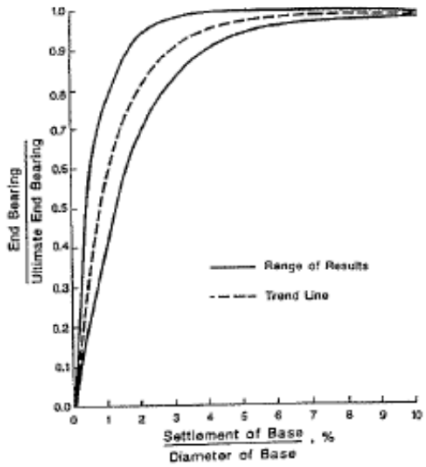


Figure 10.8.2.2.2-2—Normalized Load Transfer in End Bearing versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.09
0.2	0.17
0.3	0.25
0.4	0.31
0.5	0.36
0.6	0.42
0.8	0.5
1.0	0.58
1.3	0.65
1.6	0.72
2.0	0.81
3.0	0.90
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-14	SHAFT NO. North	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 0.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		20.7					
S2		53.9					
S3		682.0					
S4				573.0			
S5		224.7					
S6				1,352.0			
Sum	0.0	981.3	0.0	1,925.1	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	539.7	0.0	1155.0	0.0		
L.T. Factor	0.95	0.96	0.59	0.96	1.0	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	518.1	0.0	1108.8	0.0	**1,627**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				1157.0	
Sum				1157.0	0.0
φ				0.55	0.55
φ * Rs				636.4	0.0
L.T. Factor				0.2	0.5
Rp				127.3	0.0

Sum Rp **127**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,627	Pmax	1,400	
Rp	127	Wt. Shaft	180	
Σ	1,754	Σ	1,580	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

Input Required Noted in Blue | Red Values Are Calculated

North under trolley

Boring No. JB-14

Bridge No. B629 **Pier No.** P1 North **Bottom of Pile Cap / Top of Shaft El.** 342.1

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

342.1 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 285.0 — Tip El. — L inches = 685
- Group Load — 1 — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 5.000 — f'c 5,000 — f'c

#N/A P Reducn Factor Long 0.0 B
#N/A P Reducn Factor Trans 2.4 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 1,400.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	1,100	kips (lbs)	1,100,000	Fv (FV)	1,400	kips (lbs)	1,400,000	Fv (FV)		kips (lbs)	
Fy (FL)	15.00	kips (lbs)	15,000	Fy (FL)	13.0	kips (lbs)	13,000	Fy (FL)		kips (lbs)	
Fz (FT)	7.5	kips (lbs)	7,500	Fz (FT)	17.0	kips (lbs)	17,000	Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	80	kip-ft (lb-in)	960,000	My (MT)	110	kip-ft (lb-in)	1,320,000	My (MT)		kip-ft (lb-in)	
Mz (ML)	525	kip-ft (lb-in)	6,300,000	Mz (ML)	415	kip-ft (lb-in)	4,980,000	Mz (ML)		kip-ft (lb-in)	
Fresultant	16.77	kips (lbs)	16,771	Fresultant	21.40	kips (lbs)	21,401	Fresultant		kips (lbs)	
Mresultant	531.06	kip-ft (lb-in)	6,372,723	Mresultant	429	kip-ft (lb-in)	5,151,970	Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 304.7 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR — Enter 15 for compacted fill w/o SPT data, 50 for SF — Max 6.0 — E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in²	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	336.7	5.4	ML	P	9	II-A	65	0.05498	28.0		50		
2	332.7	4.0	SM	P	13	II-B	113	0.06829	30.0		72		
3	321.0	11.7	SM	P	32	II-C	253	0.07523	32.0		177		
4	312.0	9.0	SM	P	48	II-C	361	0.07523	32.0		266		
5	304.7	7.3	HWR	P	90	III	449	0.06944	34.0		498		
6	300.0	4.7	SM	P	27	II-B	505	0.03623	30.0		90		
7	285.0	15.0	HWR	P	100	III	685	0.03738	34.0		332		
8													
9													
10													
11													

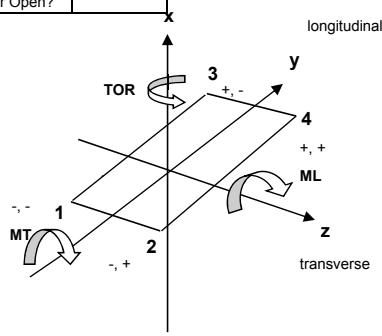
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



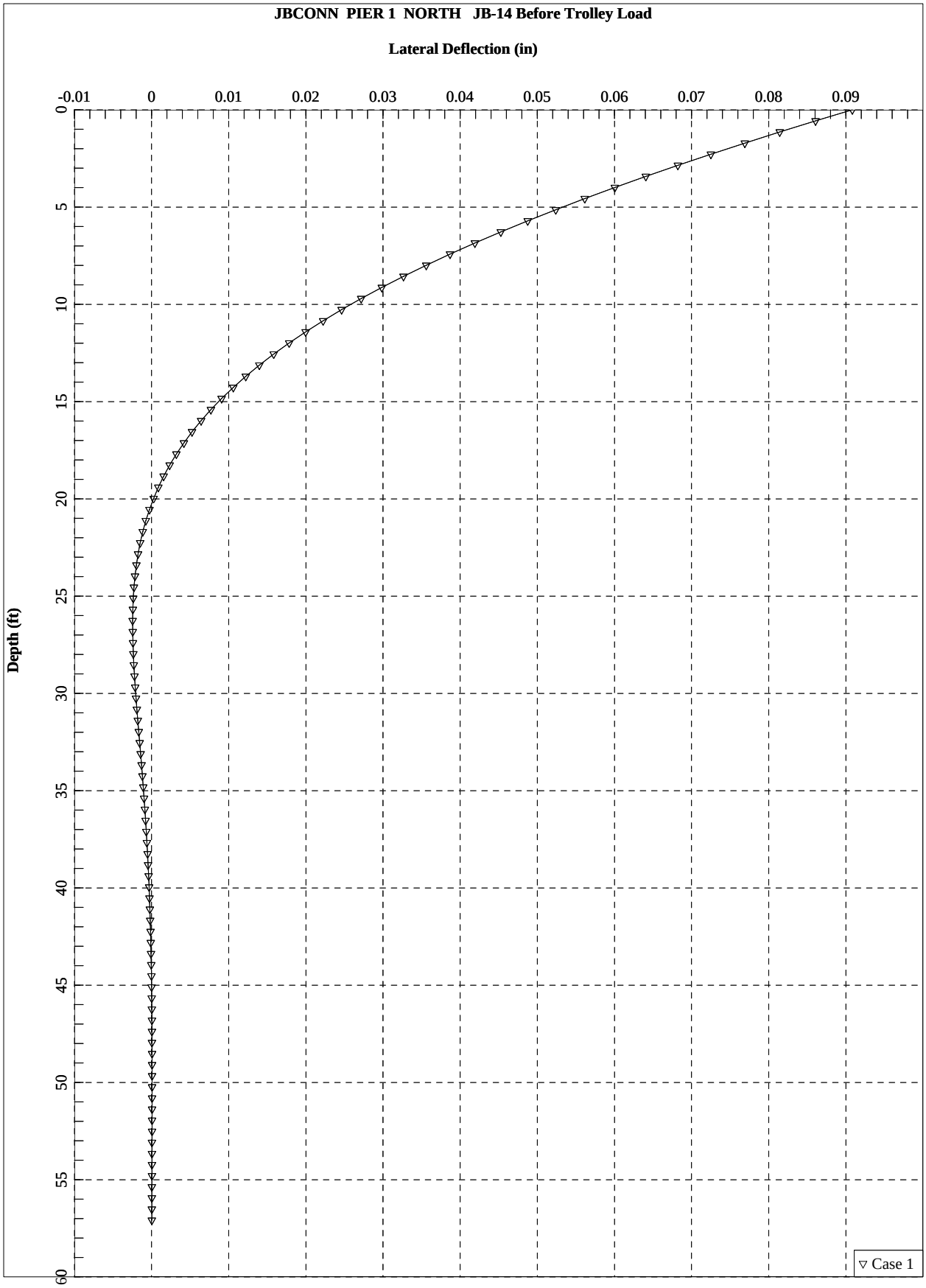
Diameter	Mom. of I. in⁴	Area in²
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

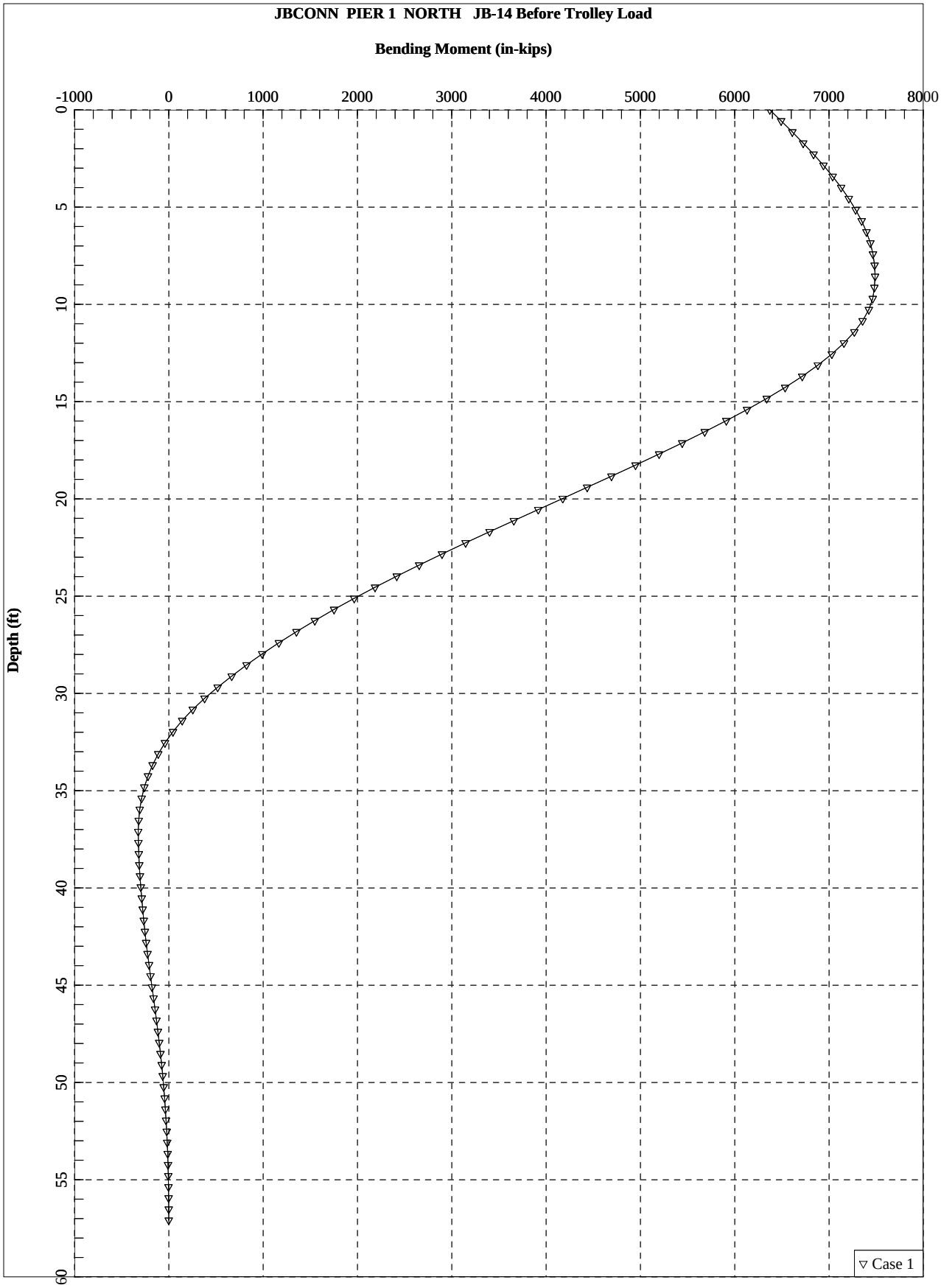
M concrete = psi 4,030,509
M Steel = psi 30,000,000

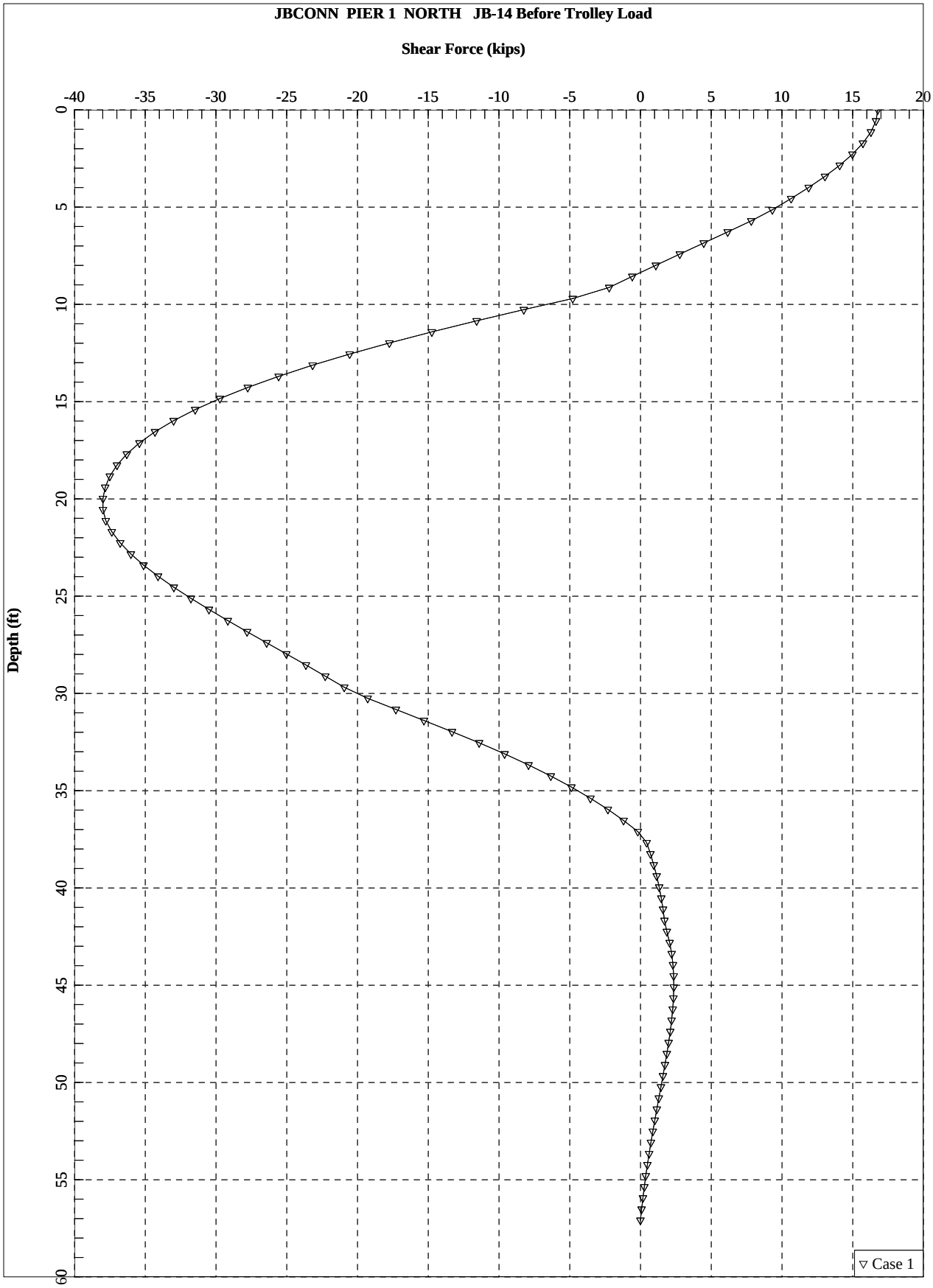
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

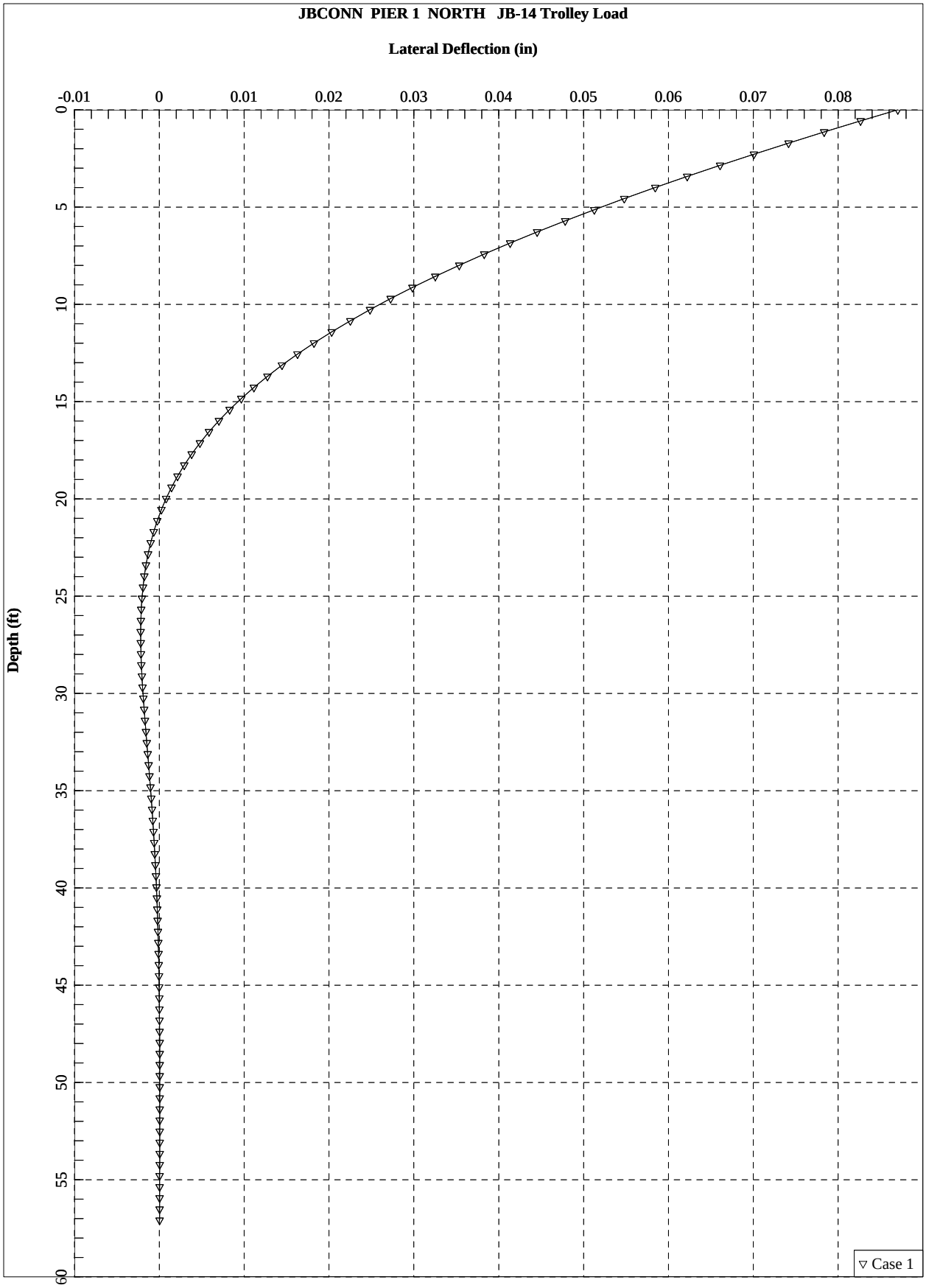
PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

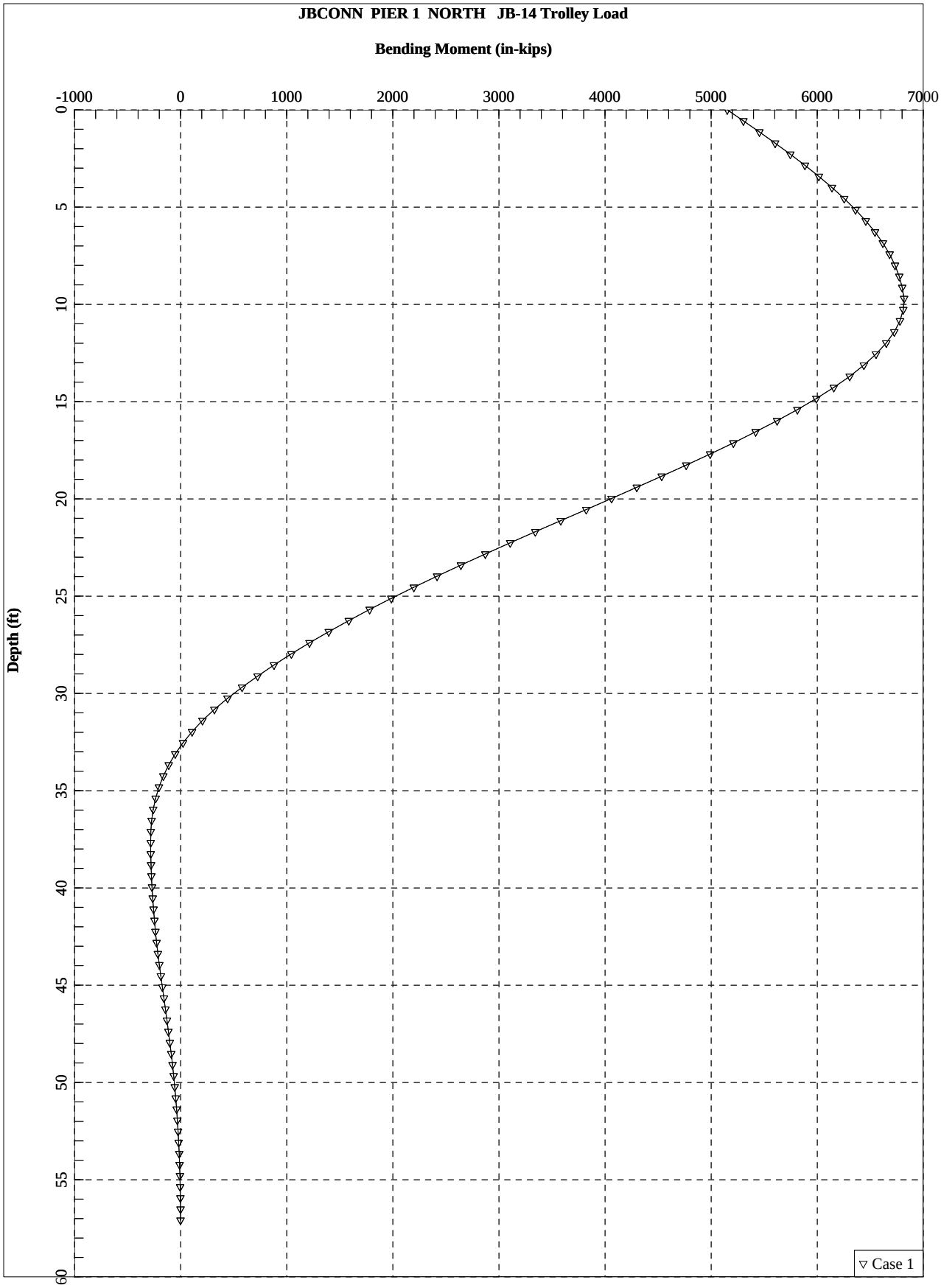
HP 10x42 211 12.4 d = 9.72 — HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 — HP 14X73 729 21.4 d= 13.64

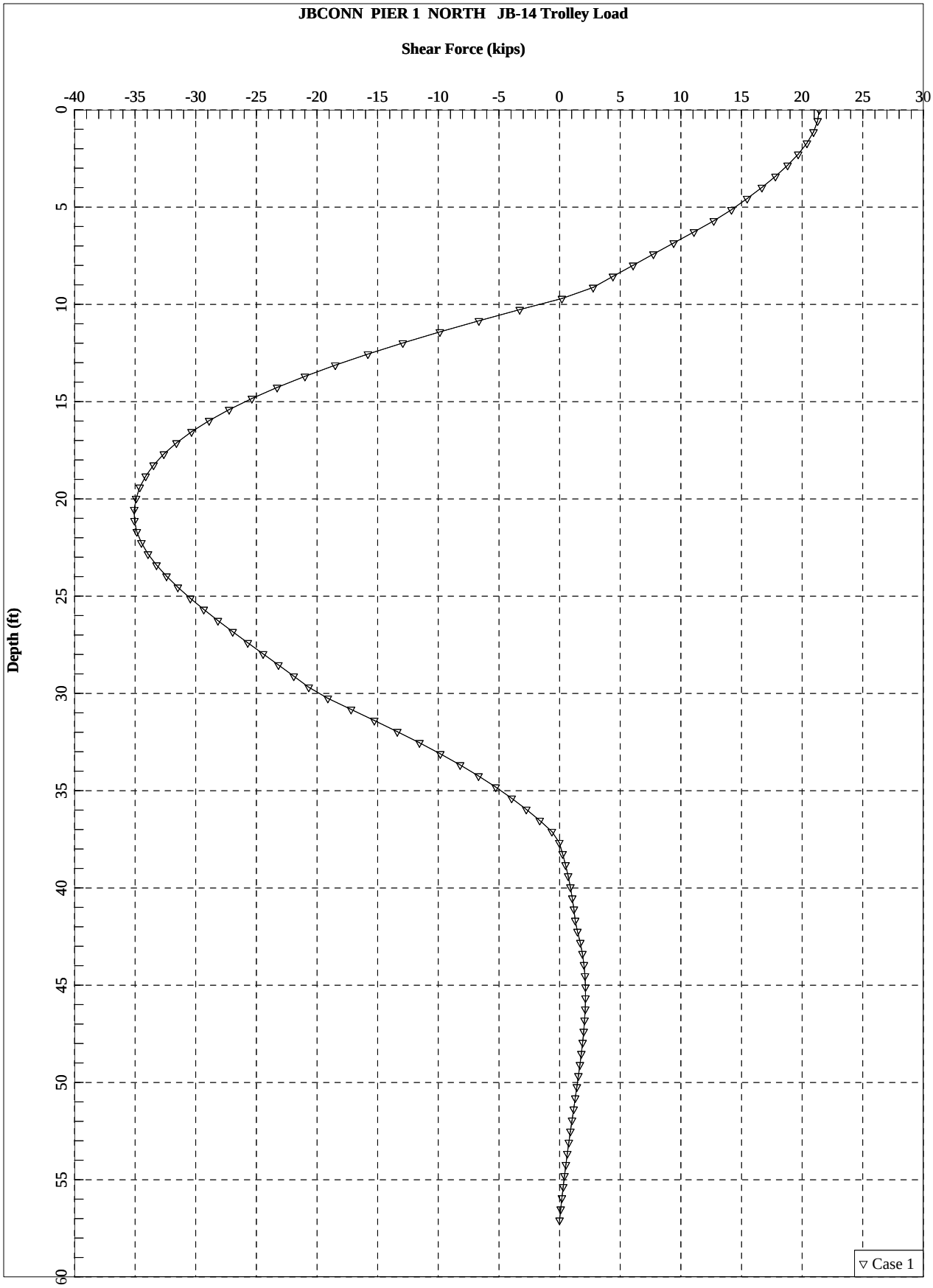

JBCONN PIER 1 NORTH JB-14 Before Trolley Load
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN PIER 1 NORTH JB-14 Before Trolley Load
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN PIER 1 NORTH JB-14 Before Trolley Load
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN PIER 1 NORTH JB-14 Trolley Load
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN PIER 1 NORTH JB-14 Trolley Load
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

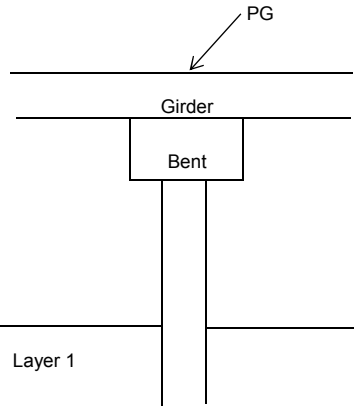

JBCONN PIER 1 NORTH JB-14 Trolley Load
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

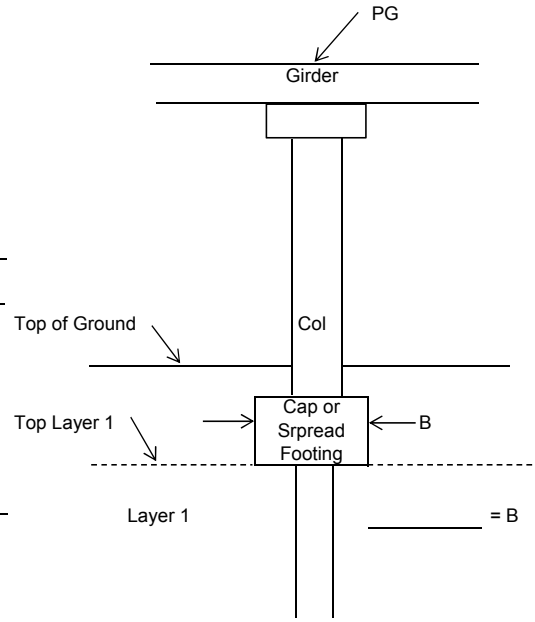
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By	MDY
Determination of Soil Parameters below Piers	Date	3/17/2016
	Checked By	JCG
LOCATION JBCONN Bridge B 629 — Pier 1 — Enter Values in Blue.	Date	3/17/2016

Red values are calculated

	Middle
BORING No. =	JB-15
Top of Boring El. =	343.6
Profile Grade =	373.0
Top of Layer 1 =	342.9
Top of Ground El. =	343.6
Hammer Efficiency %	60
Groundwater Elevation =	311.6

Bottom of Bent or Cap =	342.9
GW depth below top Layer 1 =	31.3





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	337.6	5.3	P	II-B	15	27	36			26
2	327.0	10.6	P	II-C	59	39	30			43
3	317.0	10.0	P	II-B	26	23				25
4	311.6	5.4	P	II-C	38					38
5	307.0	4.6	P	II-C	31					31
6	292.0	15.0	P	II-C	56	62	25			48
7	274.4	17.6	P	II-C	97	92	100	100		97
8										
9										
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	5.3	
2	130.0	137.0	ML	50.0	32.0		2	15.9	
3	118.0	125.0	ML	50.0	30.0		2	25.9	
4	130.0	137.0	SM	50.0	32.0		2	31.3	
5	130.0	137.0	SM	50.0	32.0		2	35.9	
6	130.0	137.0	SM	50.0	32.0		2	50.9	
7	120.0	128.0	HWR	250.0	34.0		4	68.5	
8									
9									
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-15	SHAFT NO. Middle	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,100	kips
Service or Scour Load		kips

ANALYSIS TYPE

x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	343.0	ft	
Top of Shaft	343.0	ft	
Groundwater (Enter bot. shaft if none)	311.6	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	285.0	ft	
Bottom of Shaft	285.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	5.0	ft
Shaft Length	58.0	ft
Shaft Length in Soil or IGM	58.0	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	138.2	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	172.8	kips

MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	138.2	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground 343.0

Top of Shaft 343.0

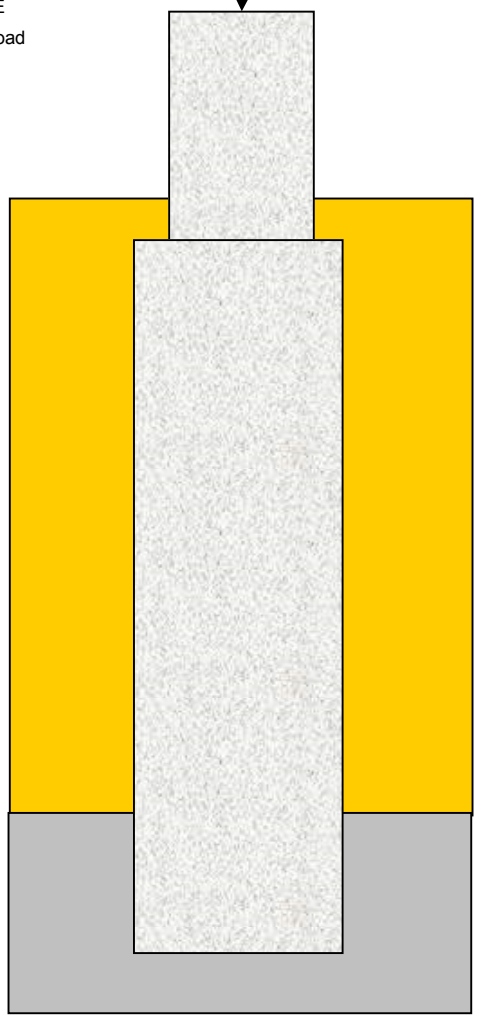
S1 to S6

Top of Rock No Rock

R1

R2

Bot. of Shaft 285.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				343.0	337.6	5.4	118	26	26	
S2		x				337.6	327.0	10.6	118	43	43	
S3		x				327.0	317.0	10.0	118	25	25	
S4		x				317.0	307.0	10.0	118	35	35	
S5		x				307.0	292.0	15.0	118	48	48	
S6				x		292.0	285.0	7.0	138	97	97	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-15	SHAFT NO. Middle	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	5.4	2.7	118.0	0.32	0.00	0.32	26					
S2	10.6	10.7	118.0	1.26	0.00	1.26	43					
S3	10.0	21.0	118.0	2.48	0.00	2.48	25					
S4	10.0	31.0	118.0	3.66	0.00	3.66	35					
S5	15.0	43.5	118.0	5.13	0.76	4.38	48					
S6	7.0	54.5	138.0	7.52	1.44	6.08	97	48.1	1.06	5.60	109.96	615.5
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	615.5

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4									
S5									
S6	292.0	285.0	285.0	6.5	1.66	4.84	57.3	19.63	1,126
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	1,126 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-15	SHAFT NO. Middle	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu qu = unconfined compressive strength of intact IGM, ksf O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

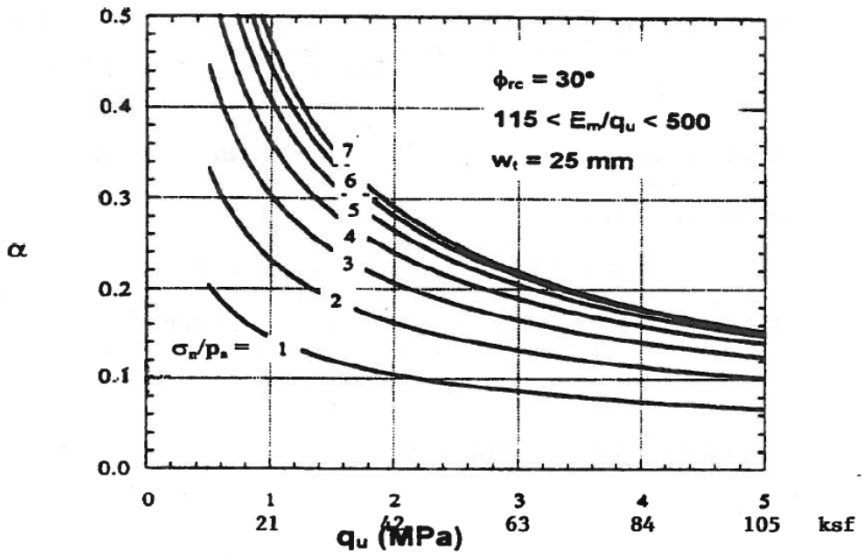


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	5.4	2.7	0.3	0.12					
S2	10.6	10.7	1.0	0.49					
S3	10.0	21.0	2.0	0.97					
S4	10.0	31.0	3.0	1.43					
S5	15.0	43.5	3.9	1.84		0.16			
S6	7.0	54.5	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-15	SHAFT NO. Middle	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

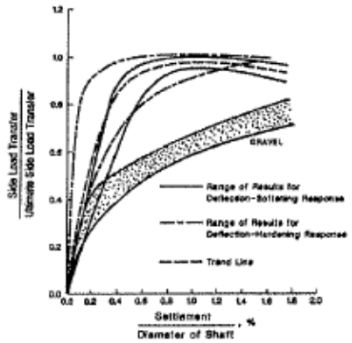


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

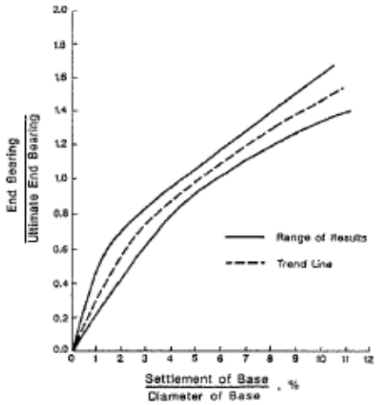


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-15	SHAFT NO. Middle	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 0.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		34.5					
S2		222.5					
S3		343.1					
S4		430.0					
S5		628.8					
S6				615.5			
Sum	0.0	1658.9	0.0	615.5	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	912.4	0.0	369.3	0.0		
L.T. Factor	0.95	0.96	0.59	0.96	1.0	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	875.9	0.0	354.5	0.0	**1,230**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				1125.5	
Sum				1125.5	0.0
φ				0.55	0.55
φ * Rs				619.0	0.0
L.T. Factor				0.2	0.5
Rp				123.8	0.0

Sum Rp **124**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,230	Pmax	1,100	
Rp	124	Wt. Shaft	173	
Σ	1,354	Σ	1,273	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-15

Bridge No. B629 **Pier No.** P1 Middle **Bottom of Pile Cap / Top of Shaft El.** 343.0

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

343.0 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 285.0 Tip El. — L inches = 696
- Group Load — 1 No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 5.000 f'c 5,000 f'c

#N/A P Reducn Factor Long 0.0 B
#N/A P Reducn Factor Trans 2.4 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 1,100.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	1,100	kips (lbs)	1,100,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	15.00	kips (lbs)	15,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	7.5	kips (lbs)	7,500	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	80	kip-ft (lb-in)	960,000	My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	525	kip-ft (lb-in)	6,300,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	16.77	kips (lbs)	16,771	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	531.06	kip-ft (lb-in)	6,372,723	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 311.6 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in²	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	337.6	5.4	ML	P	26	II-B	65	0.06829	30.0		144		
2	327.0	10.6	ML	P	43	II-C	192	0.07523	32.0		238		
3	311.6	15.4	ML	P	29	II-B	377	0.06829	30.0		161		
4	307.0	4.6	SM	P	31	II-C	432	0.04317	32.0		103		
5	292.0	15.0	SM	P	48	II-C	612	0.04317	32.0		159		
6	285.0	7.0	HWR	P	97	III	696	0.03738	34.0		322		
7													
8													
9													
10													
11													

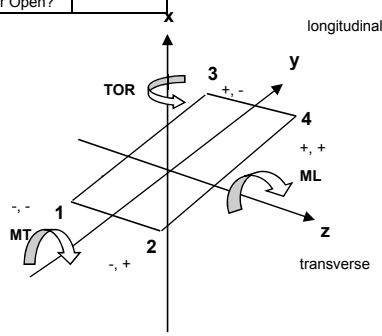
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



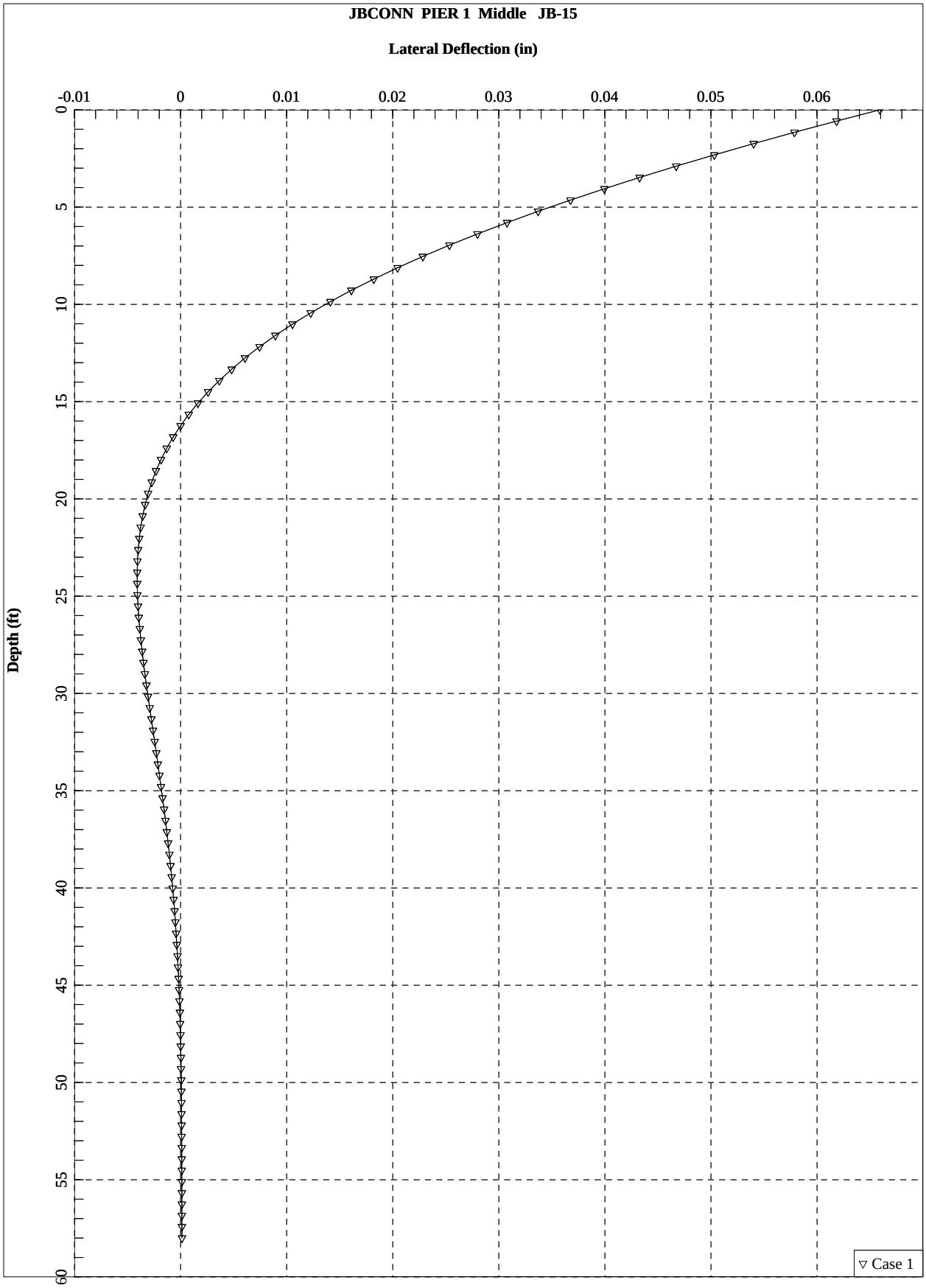
Diameter	Mom. of I. in⁴	Area in²
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

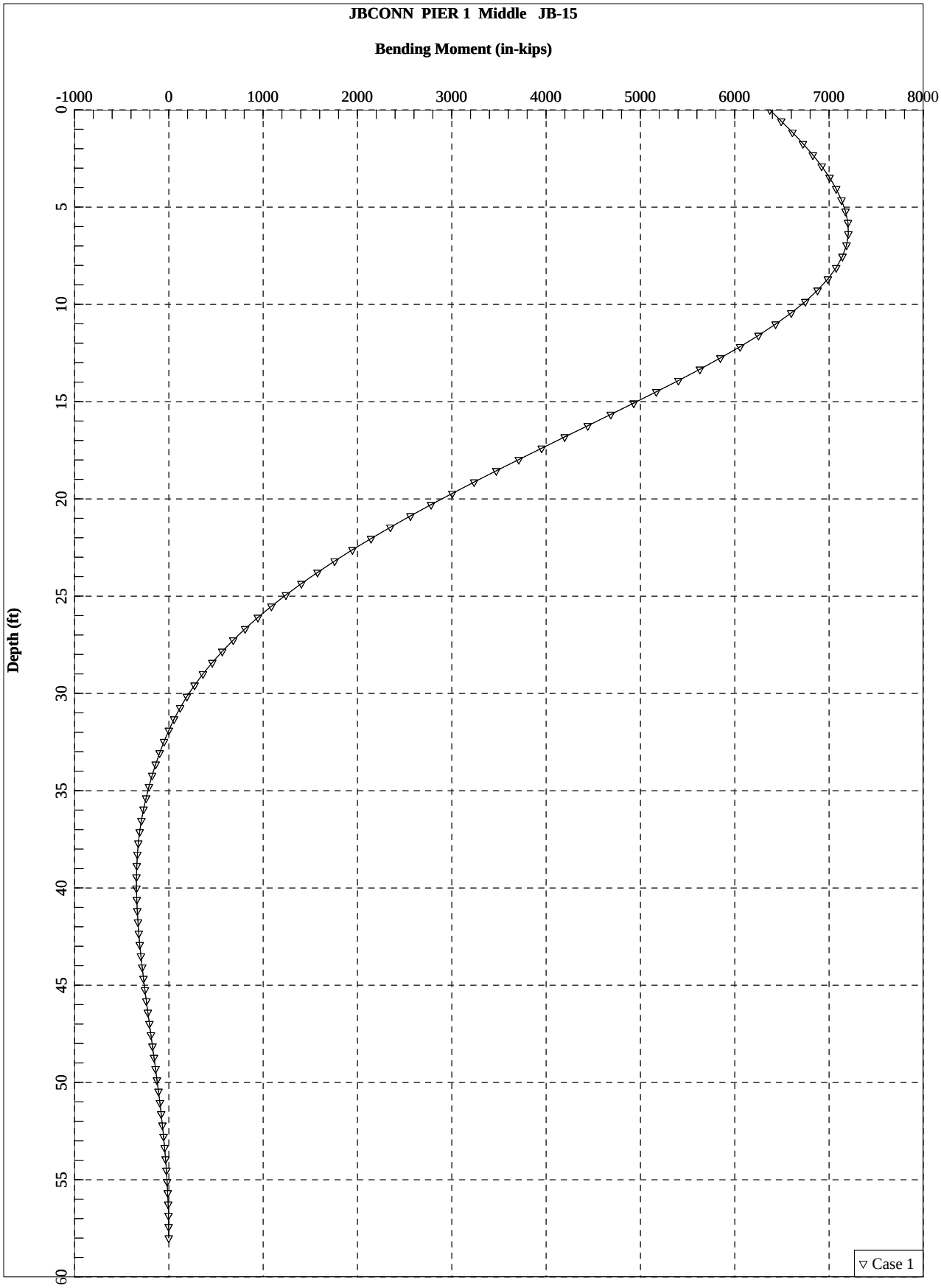
M concrete = psi 4,030,509
M Steel = psi 30,000,000

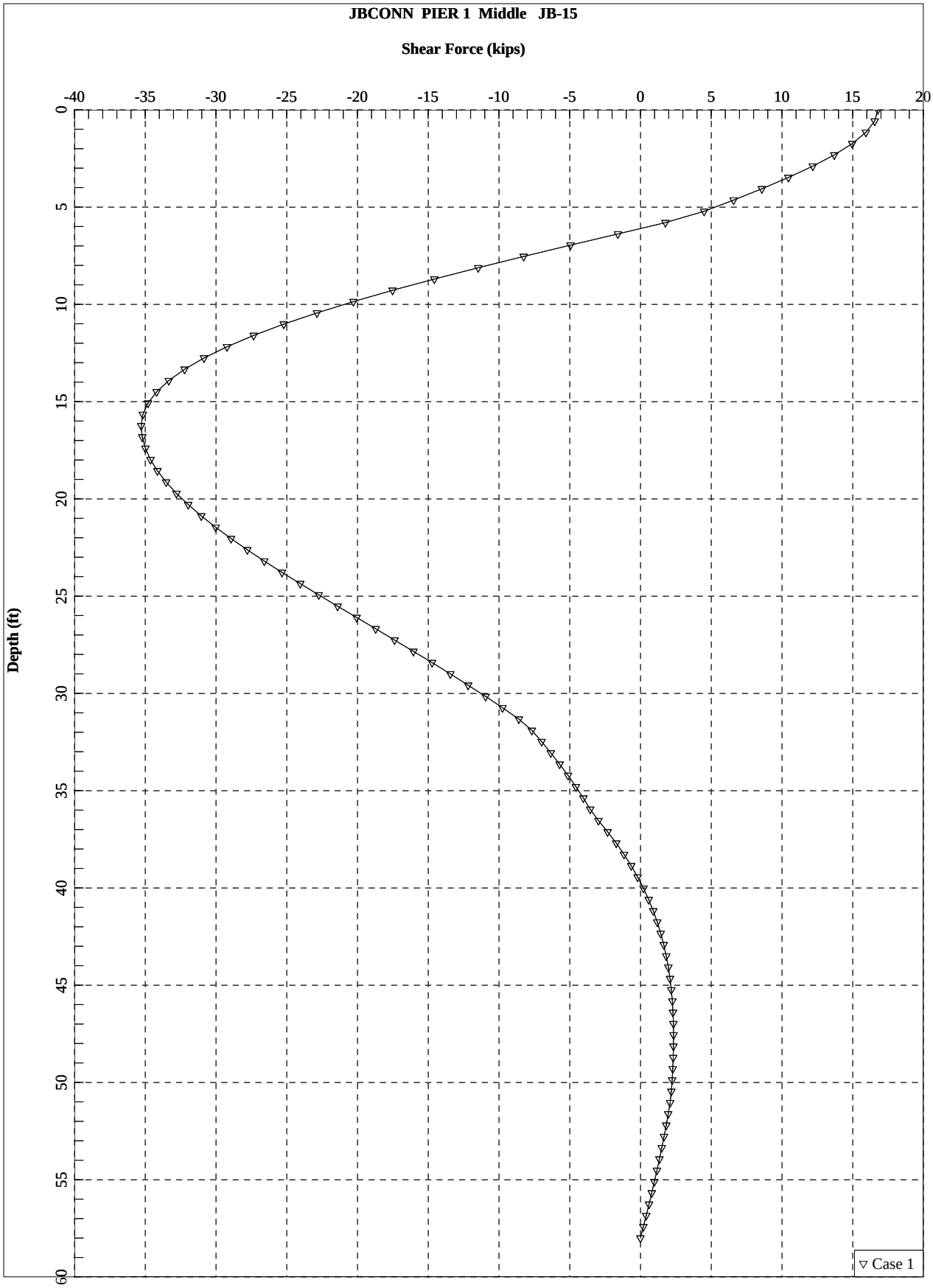
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN PIER 1 Middle JB-15
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN PIER 1 Middle JB-15
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

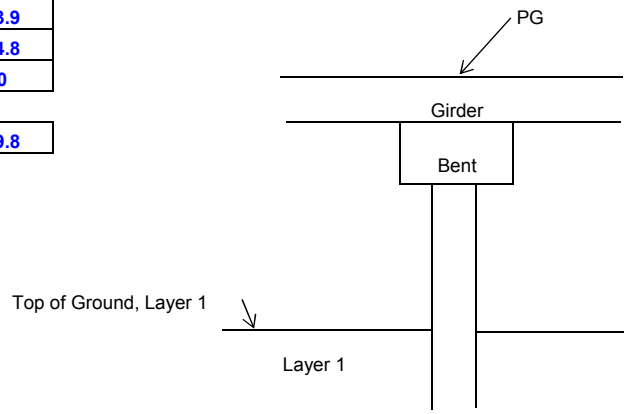

JBCONN PIER 1 Middle JB-15
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

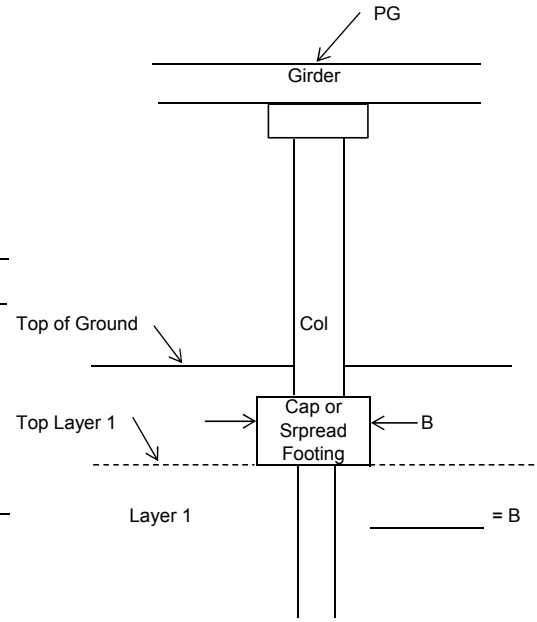
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 3/17/2016	
	Checked By JCG	
LOCATION JBCONN Bridge B 629 Pier 1 Enter Values in Blue.	Date 3/17/2016	

Red values are calculated

	South
BORING No. =	JB-16
Top of Boring El. =	344.8
Profile Grade =	373.0
Top of Layer 1 =	343.9
Top of Ground El. =	344.8
Hammer Efficiency %	60
Groundwater Elevation =	299.8

Bottom of Bent or Cap =	343.9
GW depth below top Layer 1 =	44.1





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	342.4	1.5	P	II-A	5					5
2	336.8	5.6	P	II-B	16	36	34			29
3	333.0	3.8	P	II-C	63					63
4	323.0	10.0	P	II-C	100	49				75
5	313.0	10.0	P	II-C	61	37				49
6	308.0	5.0	P	II-C	100					100
7	303.0	5.0	P	II-C	76					76
8	299.8	3.2	P	II-C	100					100
9	276.0	23.8	P	II-C	100	100	100	100	100	100
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	95.0	102.0	SM	50.0	28.0		2	1.5	
2	118.0	125.0	SM	50.0	30.0		2	7.1	
3	120.0	128.0	ML	250.0	34.0		2	10.9	
4	120.0	128.0	SP	250.0	34.0		3	20.9	
5	130.0	137.0	ML	50.0	32.0		2	30.9	
6	120.0	128.0	SP	250.0	34.0		3	35.9	
7	120.0	128.0	HWR	250.0	34.0		4	40.9	
8	120.0	128.0	HWR	250.0	34.0		4	44.1	
9	120.0	128.0	HWR	250.0	34.0		4	67.9	
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-16	SHAFT NO. South	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,100	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	343.9	ft	
Top of Shaft	343.9	ft	
Groundwater (Enter bot. shaft if none)	299.8	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	285.0	ft	
Bottom of Shaft	285.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	5.0	ft
Shaft Length	58.9	ft
Shaft Length in Soil or IGM	58.9	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	155.3	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	194.2	kips

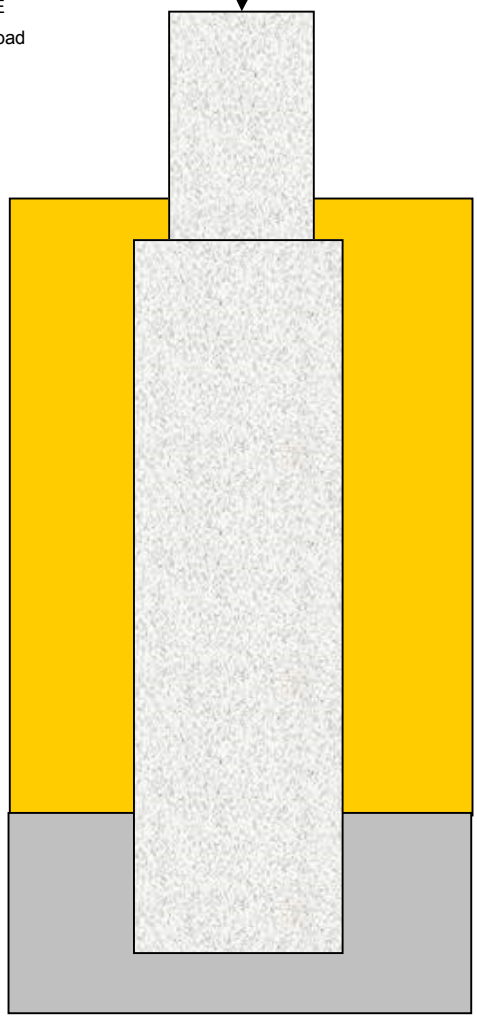
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	155.3	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	343.9
Top of Shaft	343.9
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	285.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				343.9	336.8	7.1	118	29	29	
S2		x				336.8	313.0	23.8	118	62	62	
S3				x		313.0	308.0	5.0	138	100	100	
S4				x		308.0	303.0	5.0	138	76	76	
S5				x		303.0	299.8	3.2	138	100	100	
S6				x		299.8	285.0	14.8	138	100	100	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-16	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	7.1	3.5	118.0	0.42	0.00	0.42	29					
S2	23.8	19.0	118.0	2.24	0.00	2.24	62					
S3	5.0	33.4	138.0	4.61	0.00	4.61	100	50.5	1.26	5.44	78.54	427.3
S4	5.0	38.4	138.0	5.30	0.00	5.30	76	46.8	1.01	4.47	78.54	351.0
S5	3.2	42.5	138.0	5.87	0.00	5.87	100	48.7	1.10	5.70	50.27	286.3
S6	14.8	51.5	138.0	7.11	0.46	6.65	100	47.7	1.03	5.84	232.48	1358.1
										TOTAL SIDE RESISTANCE IN COHESIONLESS IGM		2422.7

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3	313.0	308.0							
S4	308.0	303.0							
S5	303.0	299.8							
S6	299.8	285.0	285.0	6.5	0.92	5.57	60.4	19.63	1,186
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	1,186 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-16	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs — As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu — qu = unconfined compressive strength of intact IGM, ksf — O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 — FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

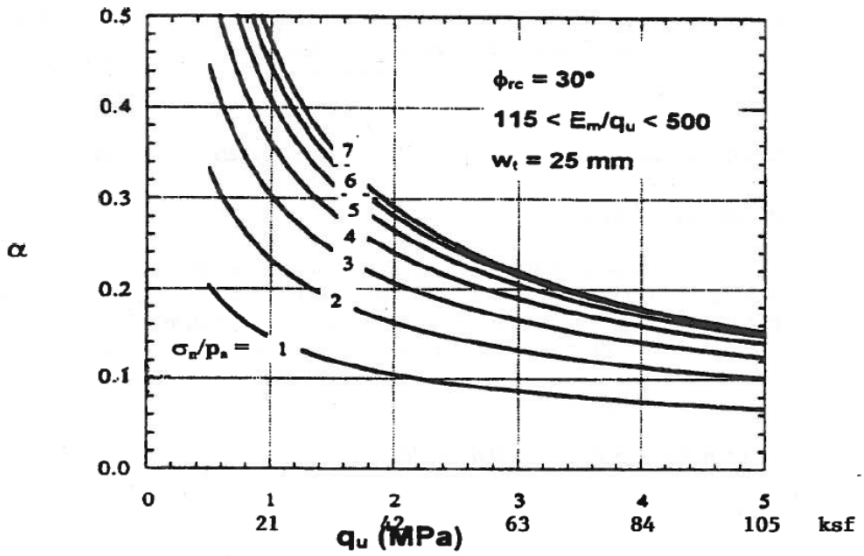


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	7.1	3.5	0.3	0.16					
S2	23.8	19.0	1.9	0.87					
S3	5.0	33.4	3.3	1.54					
S4	5.0	38.4	3.7	1.77					
S5	3.2	42.5	3.9	1.84		0.16			
S6	14.8	51.5	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-16	SHAFT NO. South	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

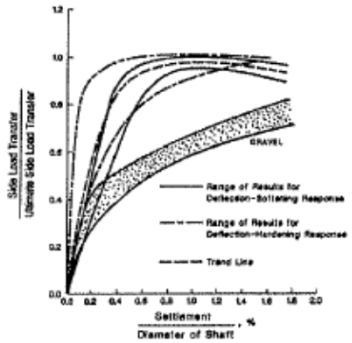


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

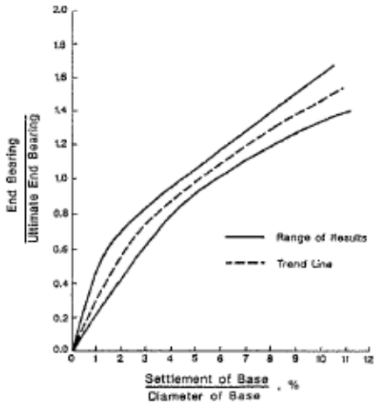


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 1	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-16	SHAFT NO. South	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 0.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		58.2					
S2		764.0					
S3				427.3			
S4				351.0			
S5				286.3			
S6				1,358.1			
Sum	0.0	822.2	0.0	2,422.7	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	452.2	0.0	1453.6	0.0		
L.T. Factor	0.95	0.96	0.59	0.96	1.0	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	434.1	0.0	1395.5	0.0	**1,830**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				1185.9	
Sum				1185.9	0.0
φ				0.55	0.55
φ * Rs				652.2	0.0
L.T. Factor				0.2	0.5
Rp				130.4	0.0

Sum Rp **130**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,830	Pmax	1,100	
Rp	130	Wt. Shaft	194	
Σ	1,960	Σ	1,294	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-16

Bridge No. B629 **Pier No.** P1 South **Bottom of Pile Cap / Top of Shaft El.** 343.9

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

343.9 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 285.0 — Tip El. — L inches = 707
- Group Load — 1 — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 5.000 f'c 5,000 f'c

#N/A P Reducn Factor Long 0.0 B
#N/A P Reducn Factor Trans 2.4 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 1,100.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	1,100	kips (lbs)	1,100,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	15.00	kips (lbs)	15,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	7.5	kips (lbs)	7,500	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	80	kip-ft (lb-in)	960,000	My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	525	kip-ft (lb-in)	6,300,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	16.77	kips (lbs)	16,771	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	531.06	kip-ft (lb-in)	6,372,723	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 299.8 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in²	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	342.4	1.5	SM	P	5	II-A	18	0.05498	28.0		28		
2	336.8	5.6	SM	P	29	II-B	85	0.06829	30.0		161		
3	333.0	3.8	ML	P	63	III	131	0.06944	34.0		349		
4	323.0	10.0	SP	P	75	III	251	0.06944	34.0		415		
5	313.0	10.0	ML	P	49	II-C	371	0.07523	32.0		271		
6	308.0	5.0	SP	P	100	III	431	0.06944	34.0		554		
7	303.0	5.0	HWR	P	76	III	491	0.06944	34.0		421		
8	299.8	3.2	HWR	P	100	III	529	0.06944	34.0		554		
9	285.0	14.8	HWR	P	100	III	707	0.03738	34.0		332		
10													
11													

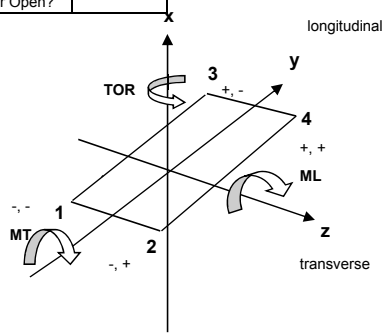
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



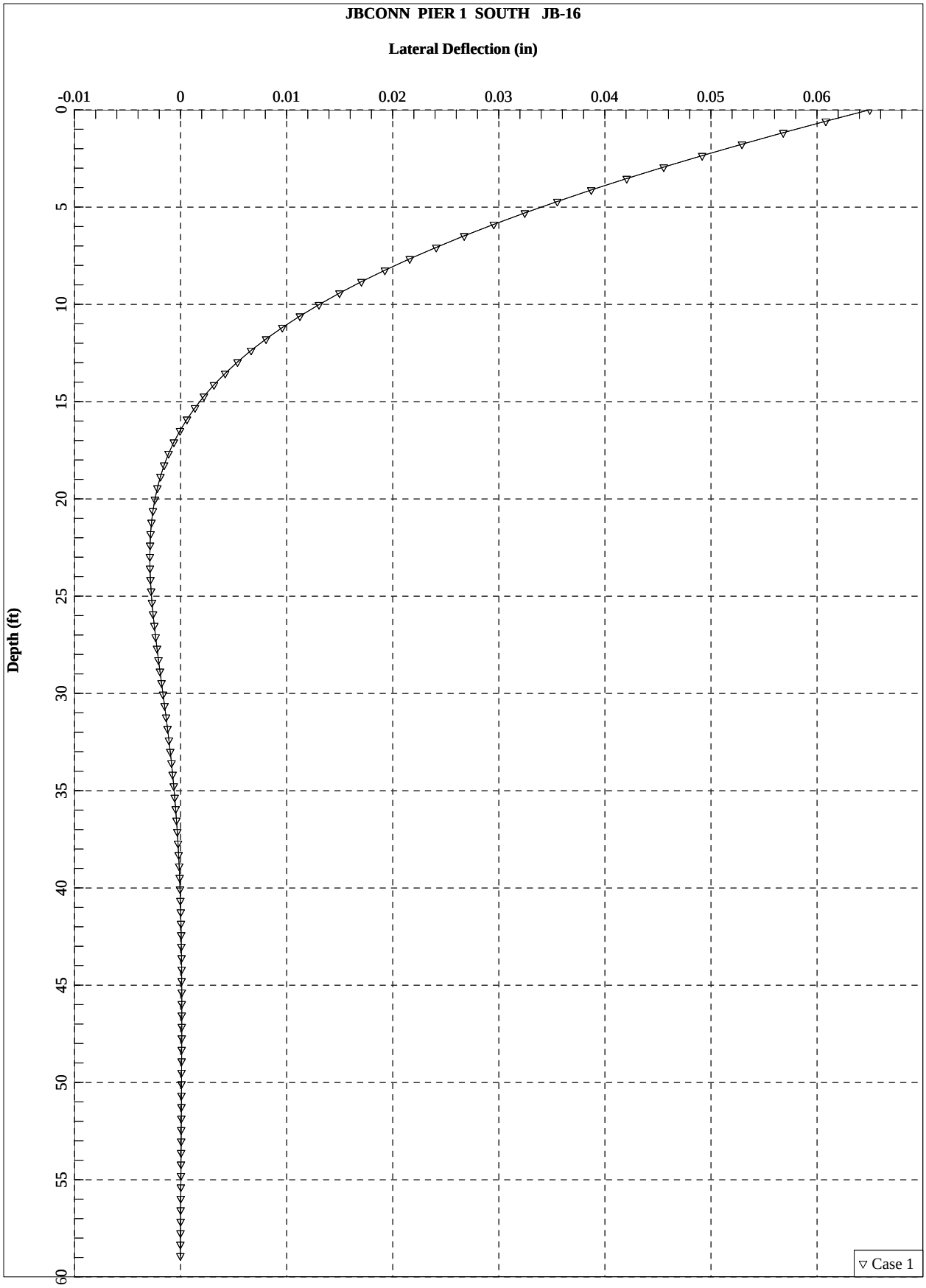
Diameter	Mom. of I. in⁴	Area in²
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

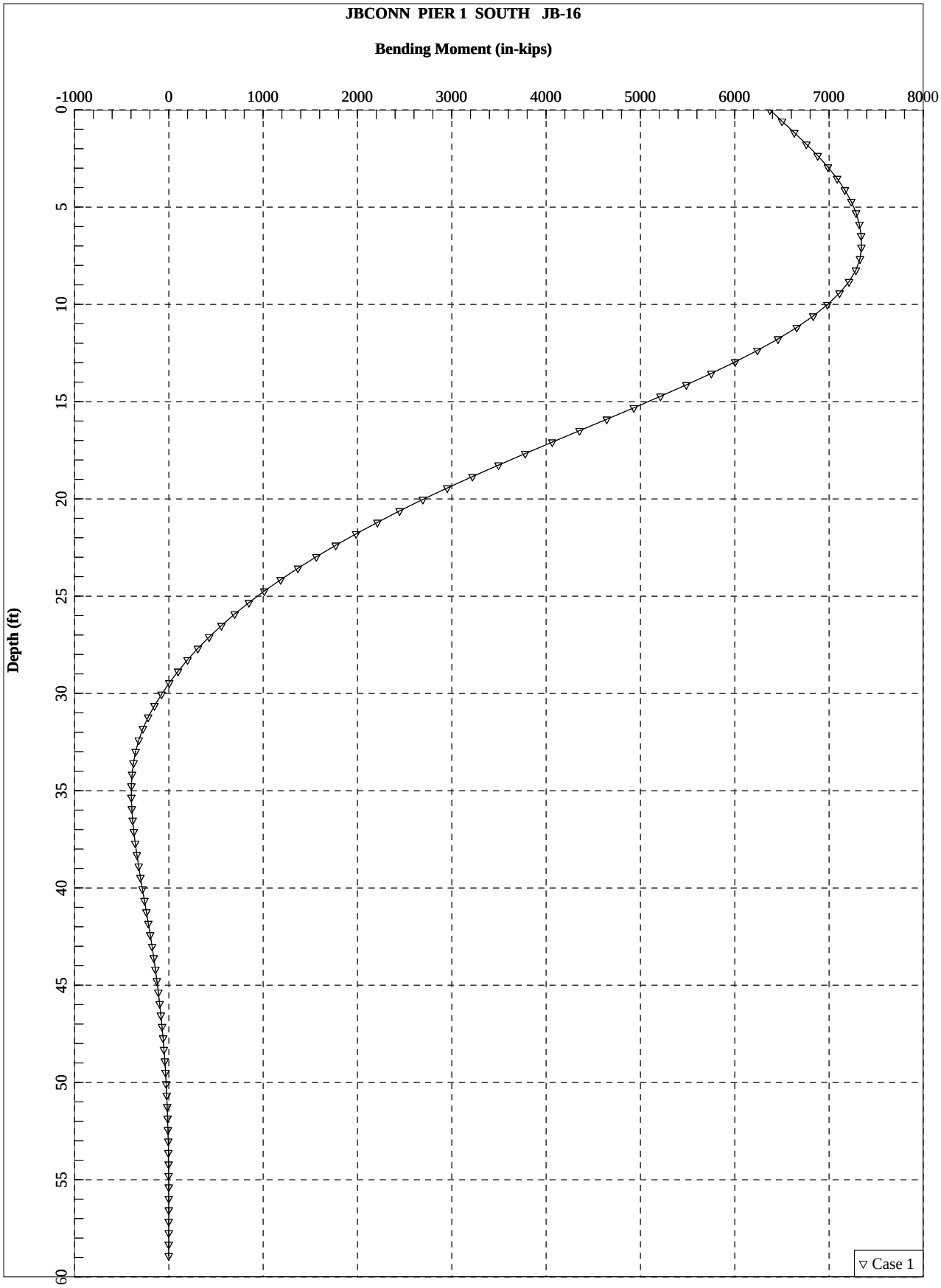
M concrete = psi 4,030,509
M Steel = psi 30,000,000

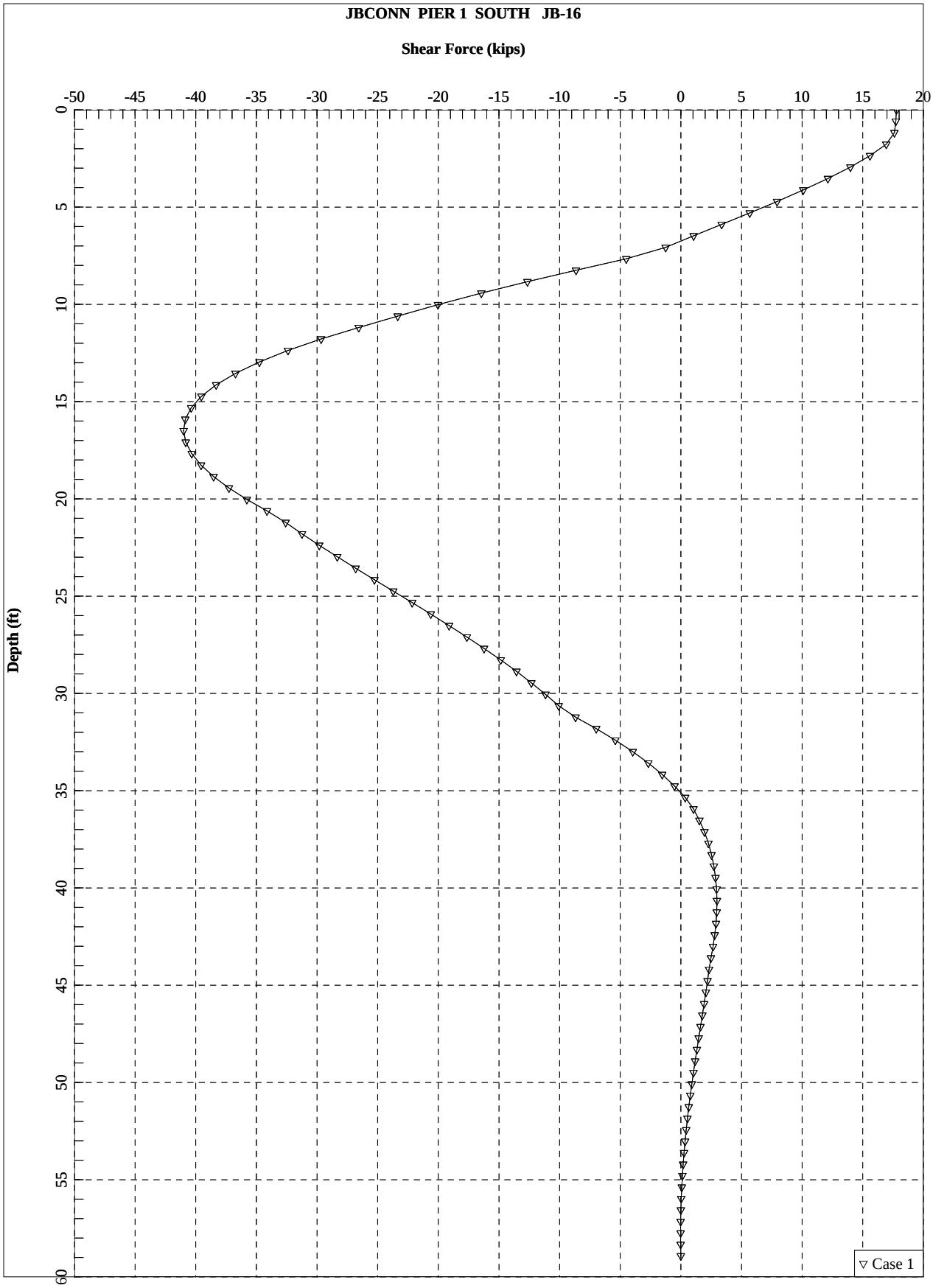
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN PIER 1 SOUTH JB-16
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1


JBCONN PIER 1 SOUTH JB-16
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

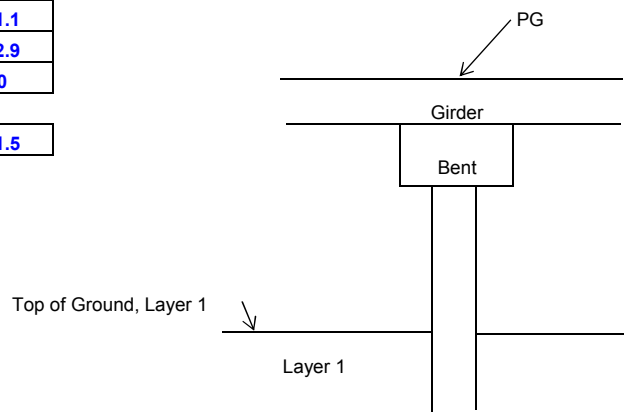

JBCONN PIER 1 SOUTH JB-16
Shear Force (kips)
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1

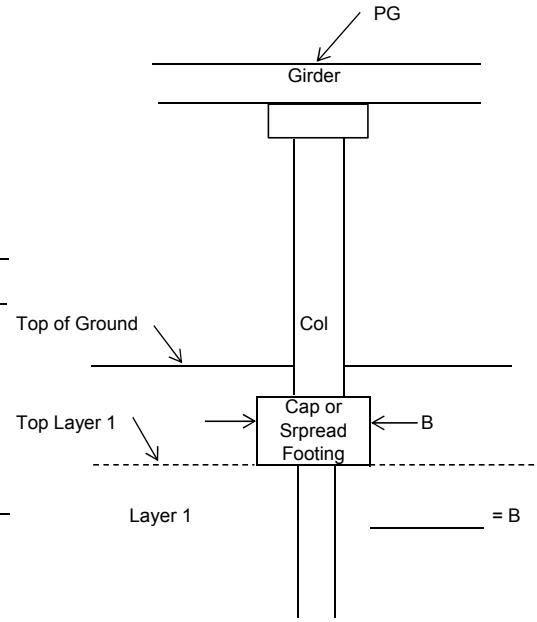
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 3/17/2016	
	Checked By JCG	
LOCATION JBCONN Bridge B 629 Pier 2 Enter Values in Blue.	Date 3/17/2016	

Red values are calculated

	North
BORING No. =	JB-17
Top of Boring El. =	352.9
Profile Grade =	366.8
Top of Layer 1 =	341.1
Top of Ground El. =	352.9
Hammer Efficiency %	60
Groundwater Elevation =	281.5

Bottom of Bent or Cap =	341.1
GW depth below top Layer 1 =	59.6





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	334.0	7.1	P	II-B	14					14
2	314.0	20.0	P	II-B	26	31	32	26		29
3	290.0	24.0	P	II-C	43	51	47	51	41	47
4	281.5	8.5	P	II-C	82	100				91
5										
6										
7										
8										
9										
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	7.1	
2	118.0	125.0	ML	50.0	30.0		2	27.1	
3	130.0	137.0	ML	50.0	32.0		2	51.1	
4	120.0	128.0	HWR	250.0	34.0		4	59.6	
5									
6									
7									
8									
9									
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-17	SHAFT NO. North	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,400	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	341.1	ft	
Top of Shaft	341.1	ft	
Groundwater (Enter bot. shaft if none)	281.5	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	277.0	ft	
Bottom of Shaft	277.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	5.0	ft
Shaft Length	64.1	ft
Shaft Length in Soil or IGM	64.1	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	183.3	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	229.1	kips

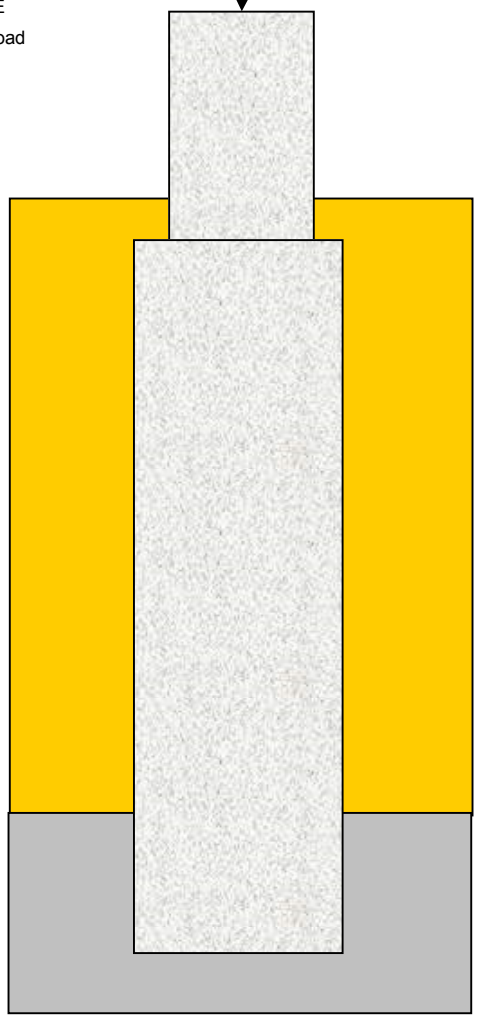
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	183.3	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	341.1
Top of Shaft	341.1
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	277.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		X				341.1	334.0	7.1	118	14	14	
S2		X				334.0	314.0	20.0	118	29	29	
S3		X				314.0	290.0	24.0	118	47	47	
S4				X		290.0	277.0	13.0	138	91	91	
S5												
S6												

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-17	SHAFT NO. North	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	7.1	3.6	118.0	0.42	0.00	0.42	14					
S2	20.0	17.1	118.0	2.02	0.00	2.02	29					
S3	24.0	39.1	118.0	4.61	0.00	4.61	47					
S4	13.0	57.6	138.0	7.95	0.00	7.95	91	45.3	0.89	5.63	204.20	1150.4
S5												
S6												
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	1150.4

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4	290.0	277.0	277.0	6.9	0.28	6.65	58.0	19.63	1,139
S5									
S6									
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	1,139 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-17	SHAFT NO. North	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu qu = unconfined compressive strength of intact IGM, ksf O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

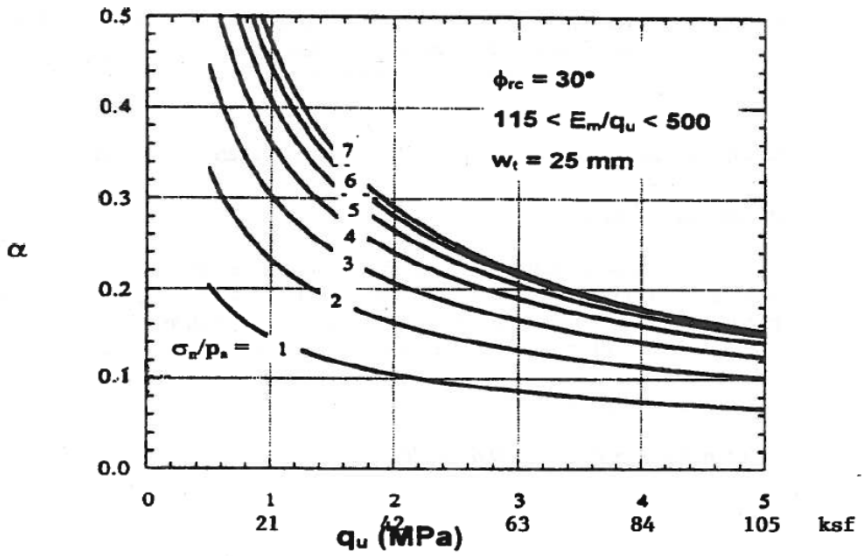


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	7.1	3.6	0.3	0.16					
S2	20.0	17.1	1.7	0.79					
S3	24.0	39.1	3.8	1.80					
S4	13.0	57.6	3.9	1.84					
S5						0.16			
S6									
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-17	SHAFT NO. North	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

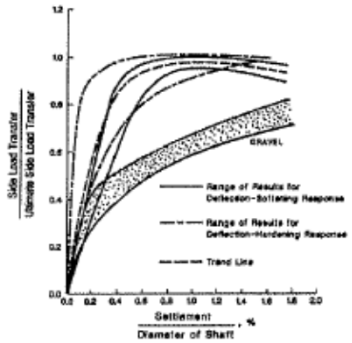


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

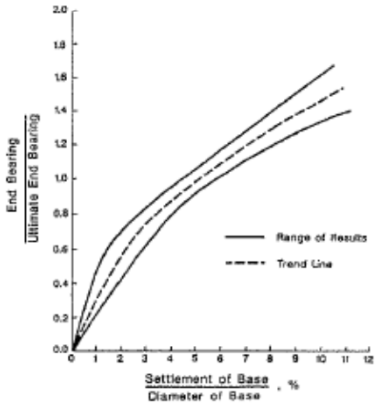


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-17	SHAFT NO. North	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 0.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		54.3					
S2		597.0					
S3		1,140.8					
S4				1,150.4			
S5							
S6							
Sum	0.0	1792.0	0.0	1,150.4	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	985.6	0.0	690.3	0.0		
L.T. Factor	0.95	0.96	0.59	0.96	1.0	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	946.2	0.0	662.7	0.0	**1,609**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4				1139.5	
S5					
S6					
Sum				1139.5	0.0
φ				0.55	0.55
φ * Rs				626.7	0.0
L.T. Factor				0.2	0.5
Rp				125.3	0.0

Sum Rp **125**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,609	Pmax	1,400	
Rp	125	Wt. Shaft	229	
Σ	1,734	Σ	1,629	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN

Input Required Noted in Blue Red Values Are Calculated

Boring No. J B-17

Bridge No. B629 **Pier No.** Pier 2 Nor **Bottom of Pile Cap / Top of Shaft El.** 341.1

Project No. 01-2194
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- [ ] L/PILE Single Pile/Shaft Free head
- [ ] L/PILE Single Pile/Shaft Fixed head
- [x] GROUP Fixed Head

Indicate Load Type
- [ ] Single Pile/Shaft Load
- [x] Group Load

Top of Ground El. 341.1
Tip El. 277.0 L inches = 769
No. Piles/Shafts for GROUP
HP Pile Size
f'c 5,000 f'c 1.00
Pile Size. ft 5.000
Tranverse Spacing, ft Longit. Spacing, ft 0.0

#N/A P Reducn Factor Long 0.0 B
1.00 P Reducn Factor Trans 8.0 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Max. Fv for Axial Capacity Analysis, kips 1,400.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	1,100	kips (lbs)	1,100,000	Fv (FV)	1,400	kips (lbs)	1,400,000	Fv (FV)		kips (lbs)	
Fy (FL)	15.0	kips (lbs)	15,000	Fy (FL)	13.0	kips (lbs)	13,000	Fy (FL)		kips (lbs)	
Fz (FT)	7.5	kips (lbs)	7,500	Fz (FT)	17.0	kips (lbs)	17,000	Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	80	kip-ft (lb-in)	960,000	My (MT)	110	kip-ft (lb-in)	1,320,000	My (MT)		kip-ft (lb-in)	
Mz (ML)	525	kip-ft (lb-in)	6,300,000	Mz (ML)	415	kip-ft (lb-in)	4,980,000	Mz (ML)		kip-ft (lb-in)	
Fresultant	16.77	kips (lbs)	16,771	Fresultant	21.40	kips (lbs)	21,401	Fresultant		kips (lbs)	
Mresultant	531.06	kip-ft (lb-in)	6,372,723	Mresultant	429	kip-ft (lb-in)	5,151,970	Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 281.5 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	334.0	7.1	ML	P	14	II-B	85	0.06829	30.0		77		
2	314.0	20.0	ML	P	29	II-B	325	0.06829	30.0		161		
3	290.0	24.0	ML	P	47	II-C	613	0.07523	32.0		260		
4	281.5	8.5	HWR	P	91	III	715	0.06944	34.0		504		
5	277.0	4.5	HWR	P	100	III	769	0.03738	34.0		332		
6													
7													
8													
9													
10													
11													

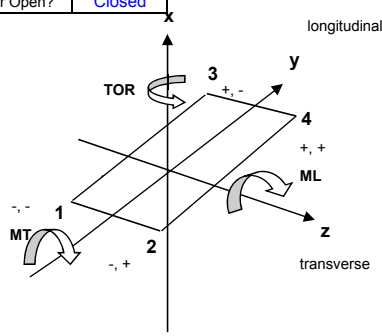
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =		Cohes, psi	
For FR in GROUP	Eir	13,652	pci	qc =	9229	psi	RQD =	10	Cohes, psi	4,615
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =		k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi				

Rock Type	Gneiss	Joints R Closed or Open?	
		Joints FRClosed or Open?	Closed

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



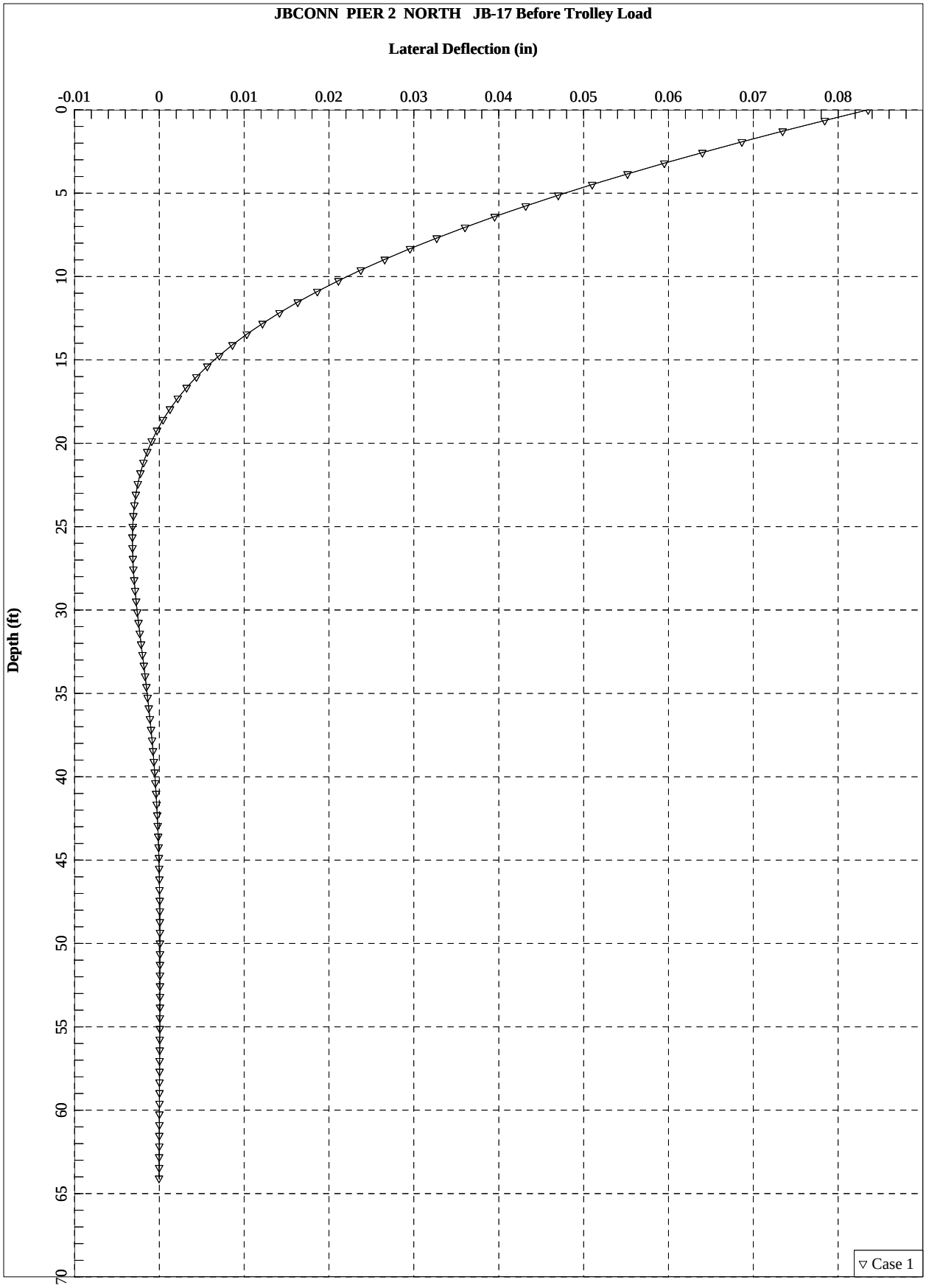
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

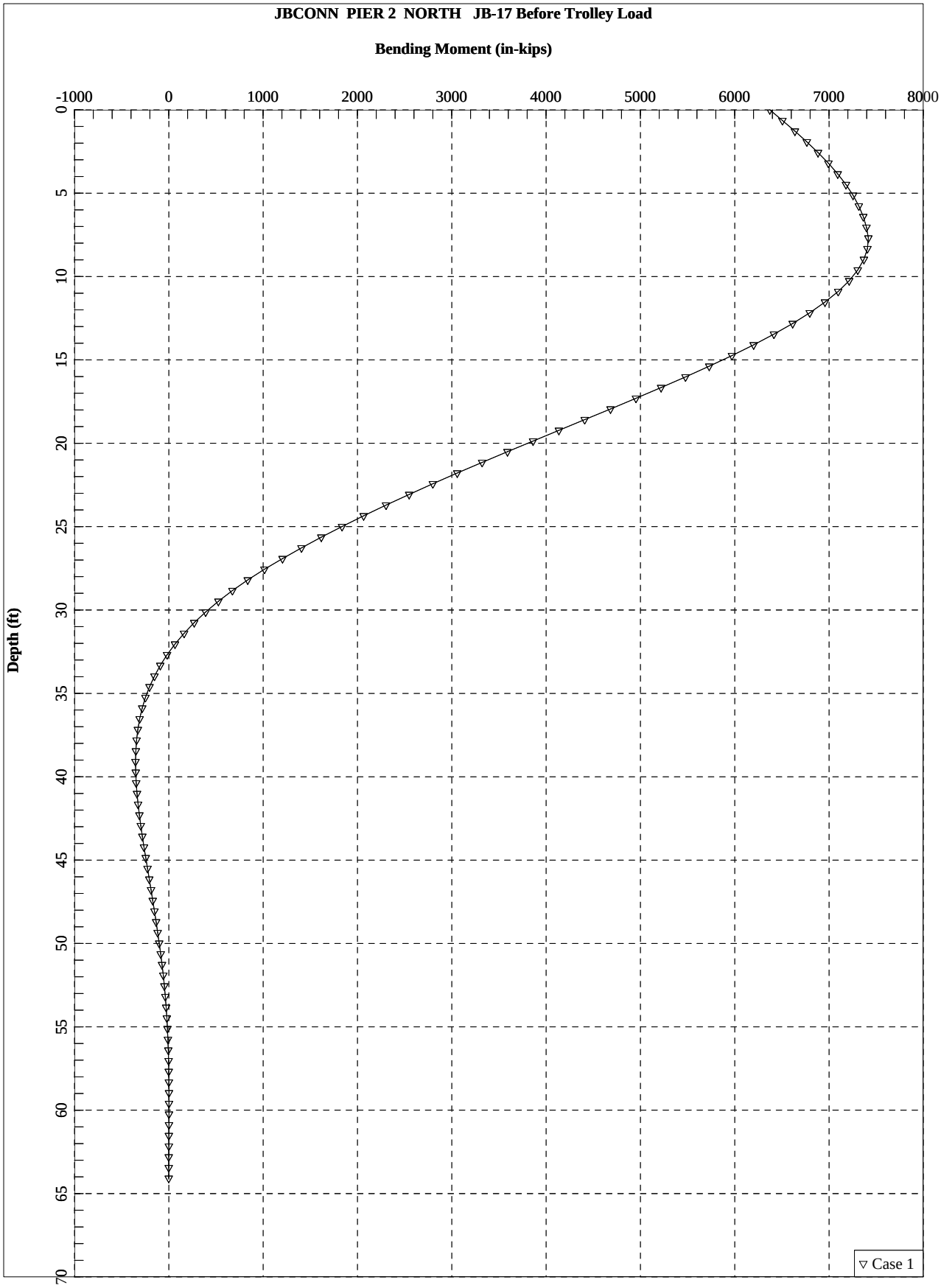
M concrete = psi 4,030,509
M Steel = psi 30,000,000

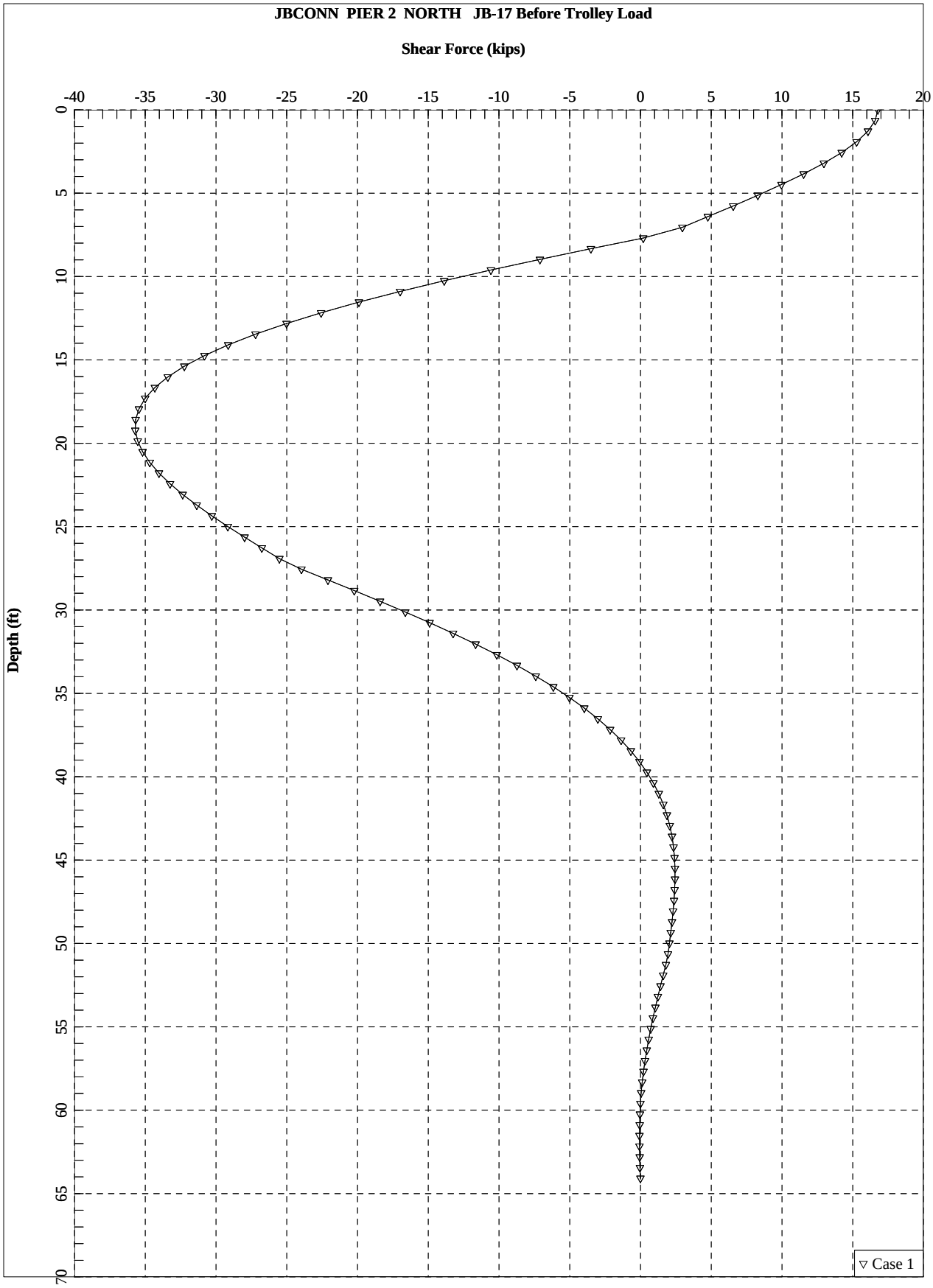
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

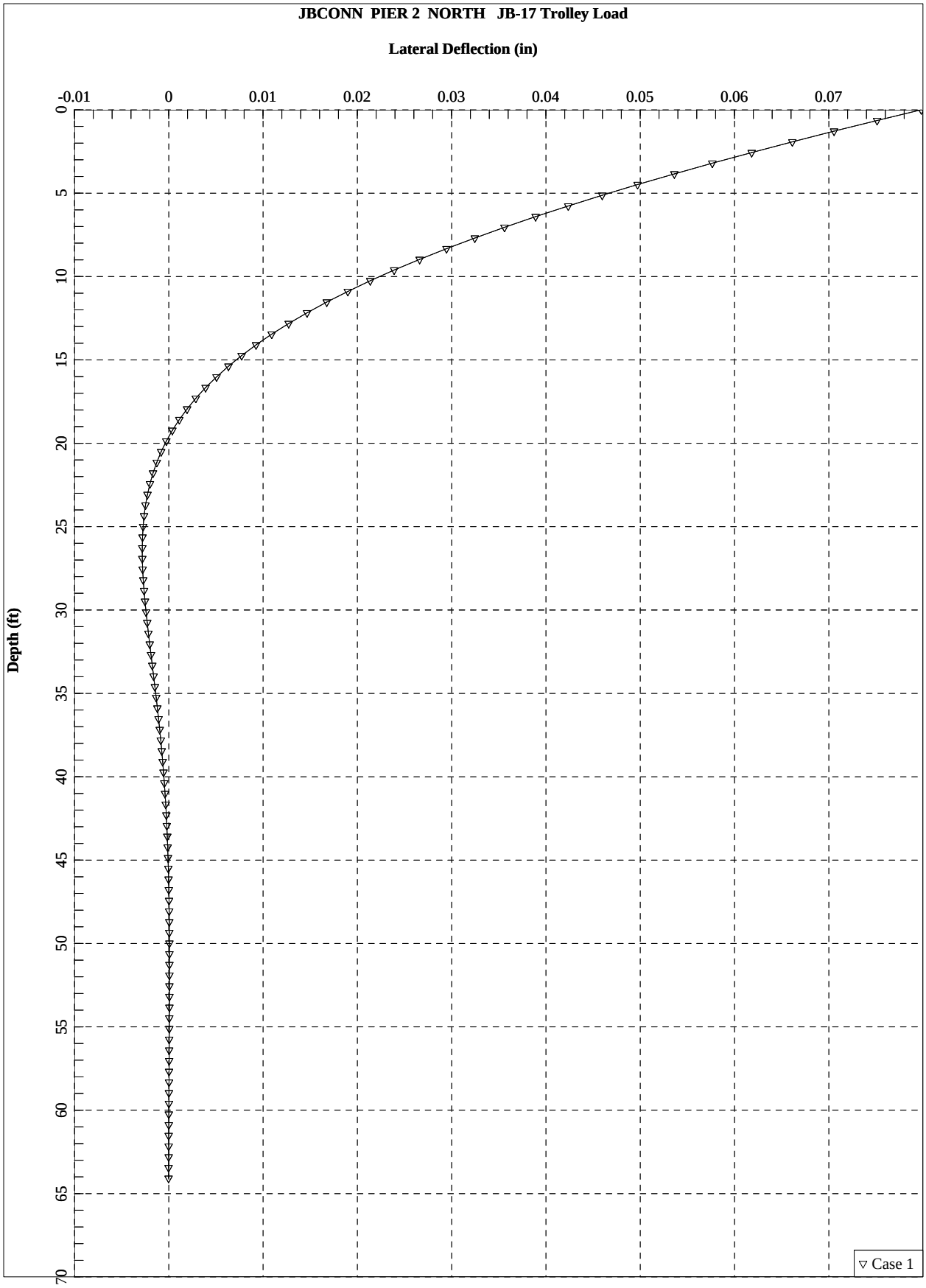
PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

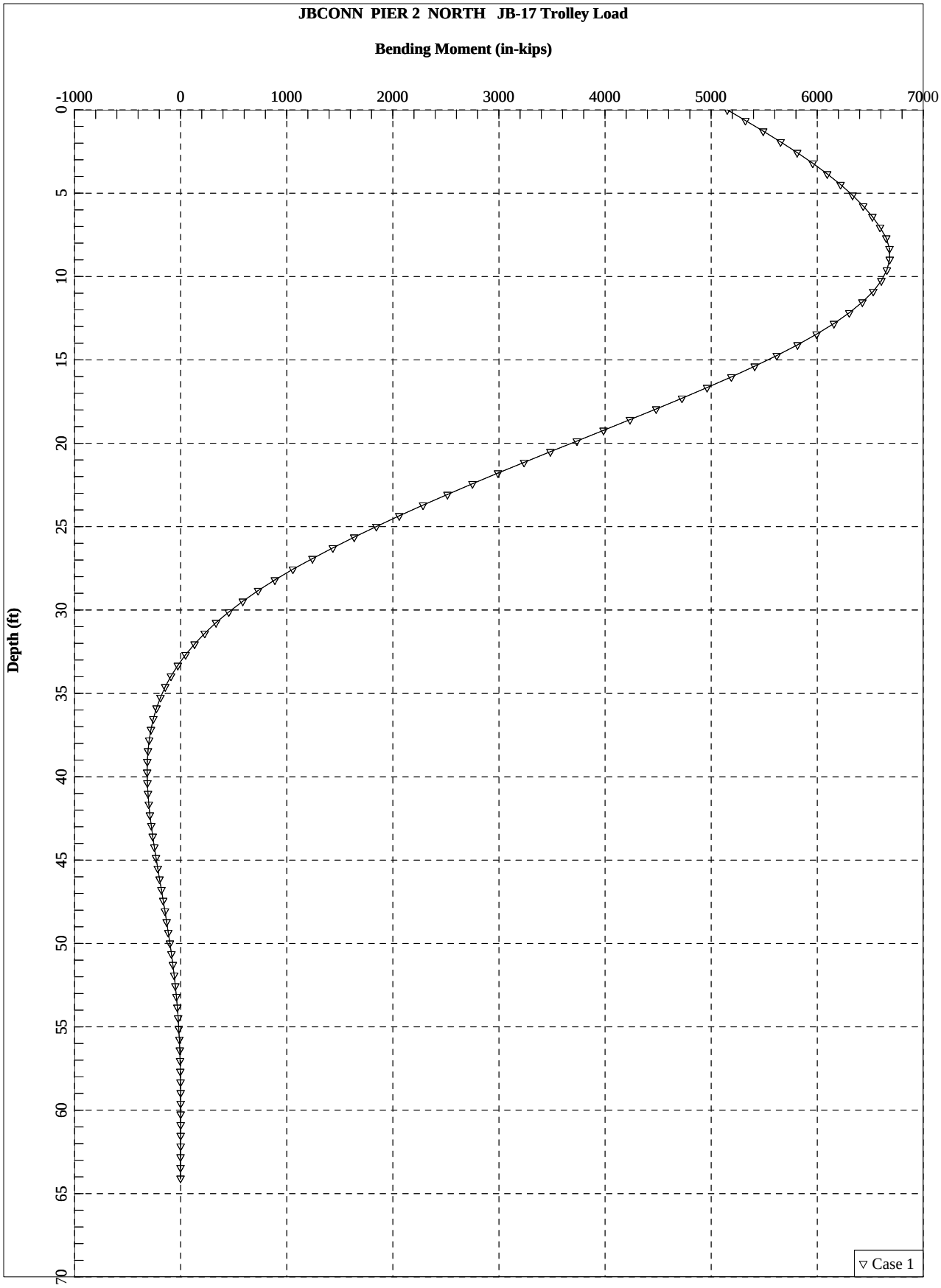
HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64

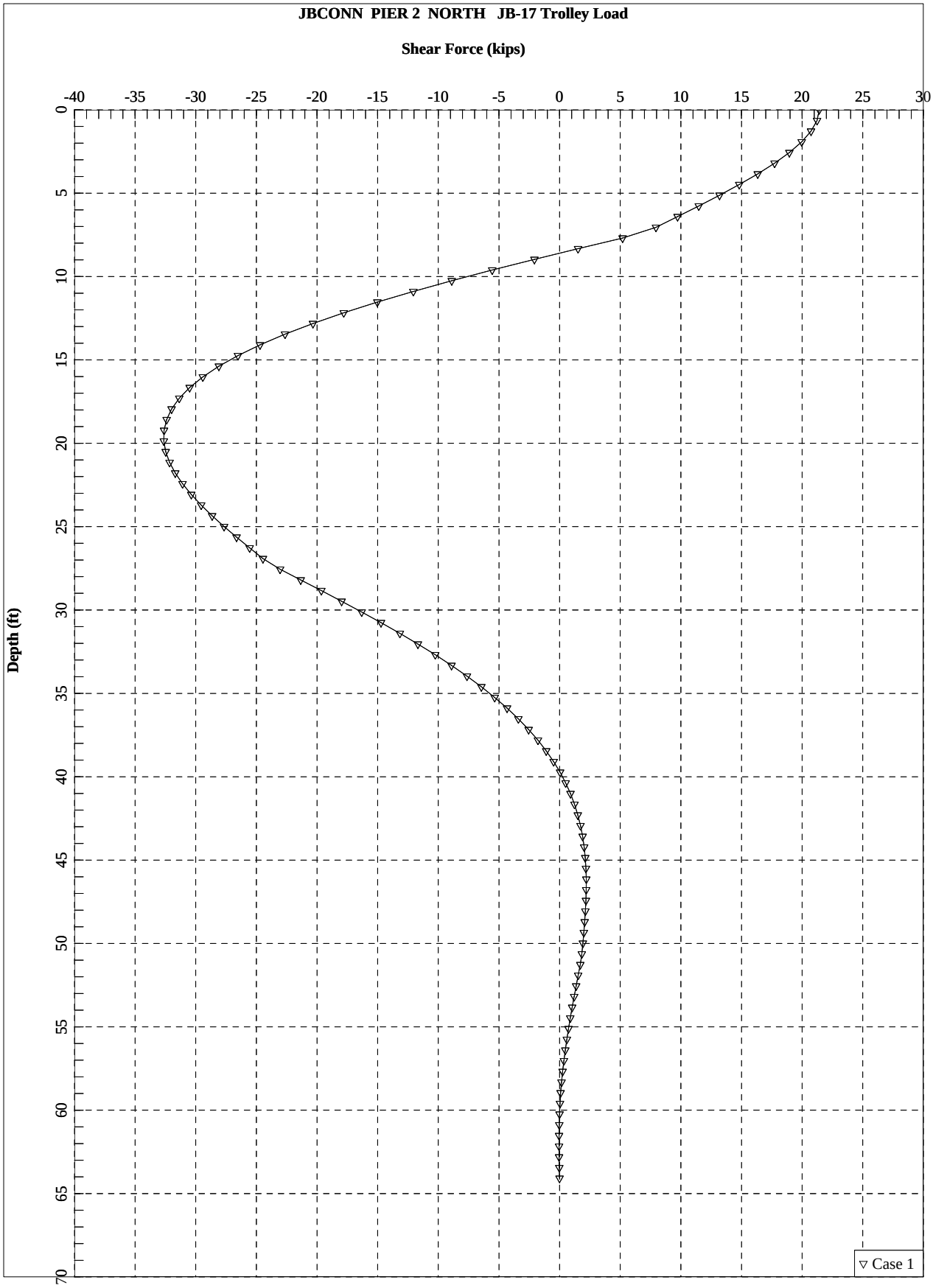

JBCONN PIER 2 NORTH JB-17 Before Trolley Load
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN PIER 2 NORTH JB-17 Before Trolley Load
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN PIER 2 NORTH JB-17 Before Trolley Load
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
▽ Case 1


JBCONN PIER 2 NORTH JB-17 Trolley Load
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN PIER 2 NORTH JB-17 Trolley Load
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

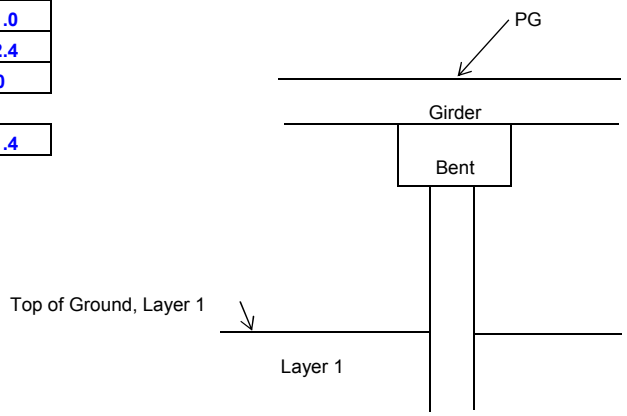

JBCONN PIER 2 NORTH JB-17 Trolley Load
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
25
30
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

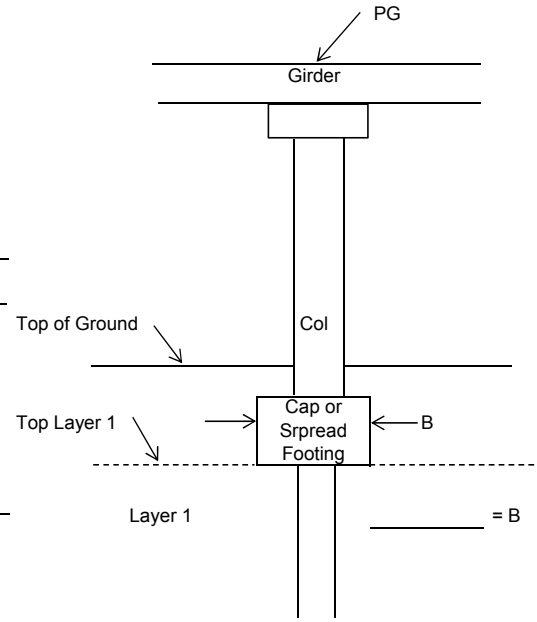
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 3/17/2016	
	Checked By JCG	
LOCATION JBCONN Bridge B 629 Pier 2 Enter Values in Blue.	Date 3/17/2016	

Red values are calculated

	Middle
BORING No. =	JB-18
Top of Boring El. =	352.4
Profile Grade =	366.8
Top of Layer 1 =	341.0
Top of Ground El. =	352.4
Hammer Efficiency %	60
Groundwater Elevation =	291.4

Bottom of Bent or Cap =	341.0
GW depth below top Layer 1 =	49.6





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	331.0	10.0	P	II-B	18	29	36			28
2	316.0	15.0	P	II-C	46	45	50			47
3	311.0	5.0	P	II-C	88					88
4	306.0	5.0	P	II-B	24					24
5	296.0	10.0	P	II-C	50	64				57
6	291.4	4.6	P	II-C	100					100
7	283.1	8.3	P	II-C	94	100				97
8										
9										
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	10.0	
2	130.0	137.0	ML	50.0	32.0		2	25.0	
3	120.0	128.0	HWR	250.0	34.0		4	30.0	
4	118.0	125.0	ML	50.0	30.0		2	35.0	
5	130.0	137.0	SM	50.0	32.0		2	45.0	
6	120.0	128.0	HWR	250.0	34.0		4	49.6	
7	120.0	128.0	HWR	250.0	34.0		4	57.9	
8									
9									
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-18	SHAFT NO. Middle	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,100	kips
Service or Scour Load		kips

ANALYSIS TYPE

x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	341.0	ft	
Top of Shaft	341.0	ft	
Groundwater (Enter bot. shaft if none)	291.4	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	277.0	ft	
Bottom of Shaft	277.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	5.0	ft
Shaft Length	64.0	ft
Shaft Length in Soil or IGM	64.0	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	170.9	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	213.6	kips

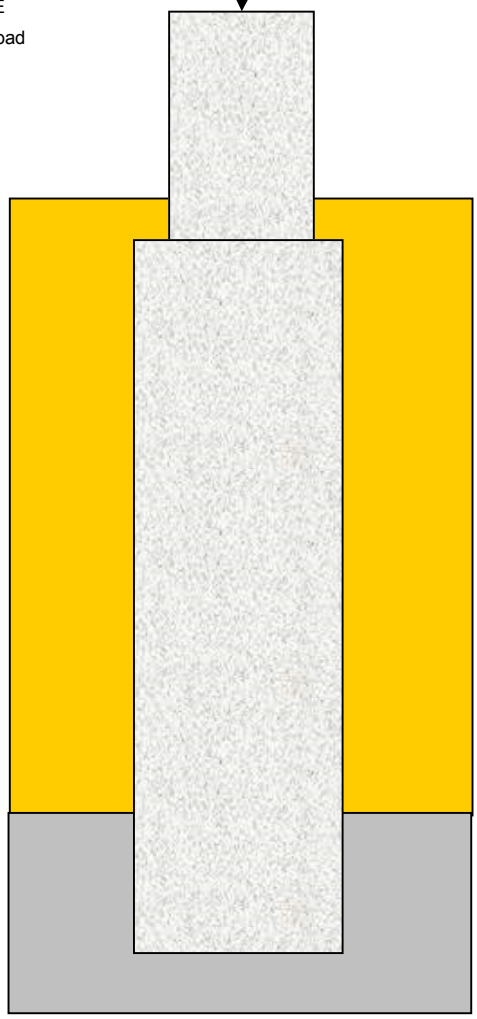
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	170.9	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	341.0
Top of Shaft	341.0
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	277.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				341.0	316.0	25.0	118	38	38	
S2		x				316.0	311.0	5.0	118	88	88	
S3				x		311.0	306.0	5.0	138	24	24	
S4		x				306.0	296.0	10.0	118	57	57	
S5				x		296.0	291.4	4.6	138	100	100	
S6				x		291.4	277.0	14.4	138	97	97	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-18	SHAFT NO. Middle	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	25.0	12.5	118.0	1.48	0.00	1.48	38					
S2	5.0	27.5	118.0	3.25	0.00	3.25	88					
S3	5.0	32.5	138.0	4.49	0.00	4.49	24	37.0	0.65	1.79	78.54	140.7
S4	10.0	40.0	118.0	4.72	0.00	4.72	57					
S5	4.6	47.3	138.0	6.53	0.00	6.53	100	47.8	1.04	5.82	72.26	420.6
S6	14.4	56.8	138.0	7.84	0.45	7.39	97	46.5	0.95	5.83	226.19	1318.7
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	1880.0

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3	311.0	306.0							
S4									
S5	296.0	291.4							
S6	291.4	277.0	277.0	7.0	0.90	6.14	60.1	19.63	1,180
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	1,180 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-18	SHAFT NO. Middle	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu qu = unconfined compressive strength of intact IGM, ksf O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

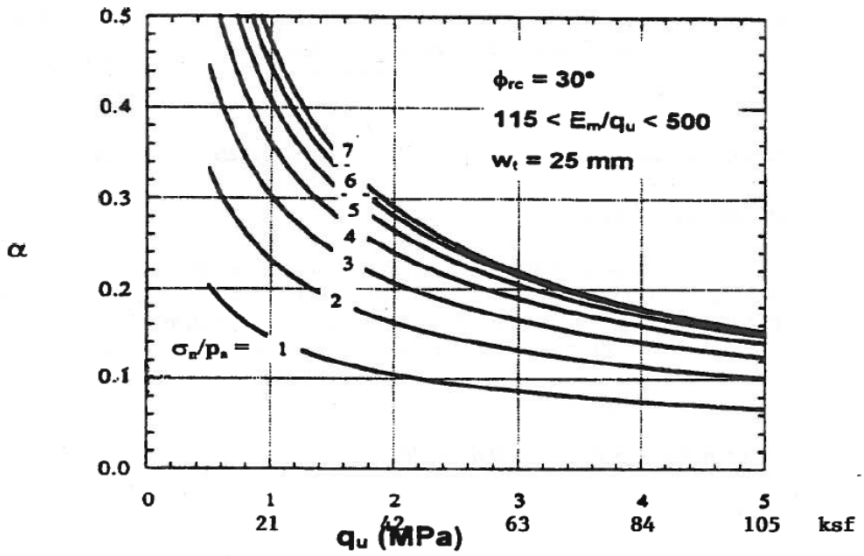

Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	25.0	12.5	1.2	0.57					
S2	5.0	27.5	2.7	1.26					
S3	5.0	32.5	3.2	1.49					
S4	10.0	40.0	3.9	1.84					
S5	4.6	47.3	3.9	1.84		0.16			
S6	14.4	56.8	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-18	SHAFT NO. Middle	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

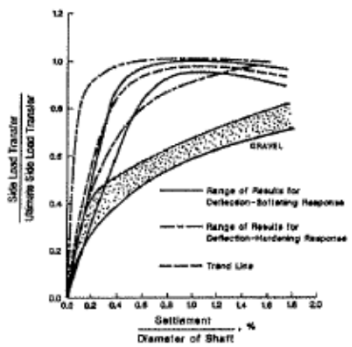


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

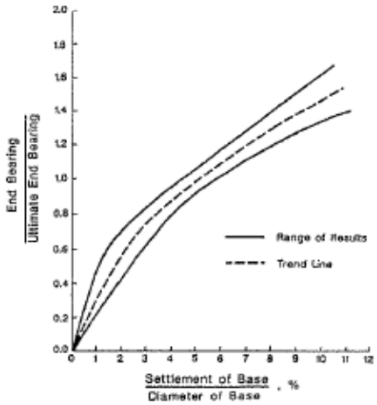


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-18	SHAFT NO. Middle	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 0.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		592.4					
S2		201.9					
S3				140.7			
S4		489.2					
S5				420.6			
S6				1,318.7			
Sum	0.0	1283.5	0.0	1,880.0	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	705.9	0.0	1128.0	0.0		
L.T. Factor	0.95	0.96	0.59	0.96	1.0	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	677.7	0.0	1082.9	0.0	**1,761**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				1180.3	
Sum				1180.3	0.0
φ				0.55	0.55
φ * Rs				649.2	0.0
L.T. Factor				0.2	0.5
Rp				129.8	0.0

Sum Rp **130**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,761	Pmax	1,100	
Rp	130	Wt. Shaft	214	
Σ	1,890	Σ	1,314	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-18

Bridge No. B629 **Pier No.** P2 Middle **Bottom of Pile Cap / Top of Shaft El.** 341.0

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

341.0 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 277.0 Tip El. — L inches = 768
- Group Load — 1 No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 5.000 f'c 5,000 f'c

#N/A P Reducn Factor Long 0.0 B
#N/A P Reducn Factor Trans 2.4 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Max. Fv for Axial Capacity Analysis, kips 1,100.0

Include couple effects with Fv

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	1,100	kips (lbs)	1,100,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	15.00	kips (lbs)	15,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	7.5	kips (lbs)	7,500	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	80	kip-ft (lb-in)	960,000	My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	525	kip-ft (lb-in)	6,300,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	16.77	kips (lbs)	16,771	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	531.06	kip-ft (lb-in)	6,372,723	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 291.4 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	331.0	10.0		P	28	II-B	120	0.06829	30.0		155		
2	316.0	15.0		P	47	II-C	300	0.07523	32.0		260		
3	311.0	5.0		P	88	III	360	0.06944	34.0		487		
4	306.0	5.0		P	24	II-B	420	0.06829	30.0		133		
5	296.0	10.0		P	57	II-C	540	0.07523	32.0		315		
6	291.4	4.6		P	100	III	595	0.06944	34.0		554		
7	277.0	14.4		P	97	III	768	0.03738	34.0		322		
8													
9													
10													
11													

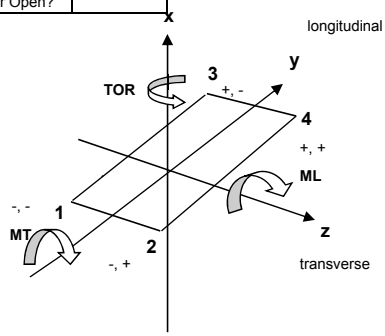
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



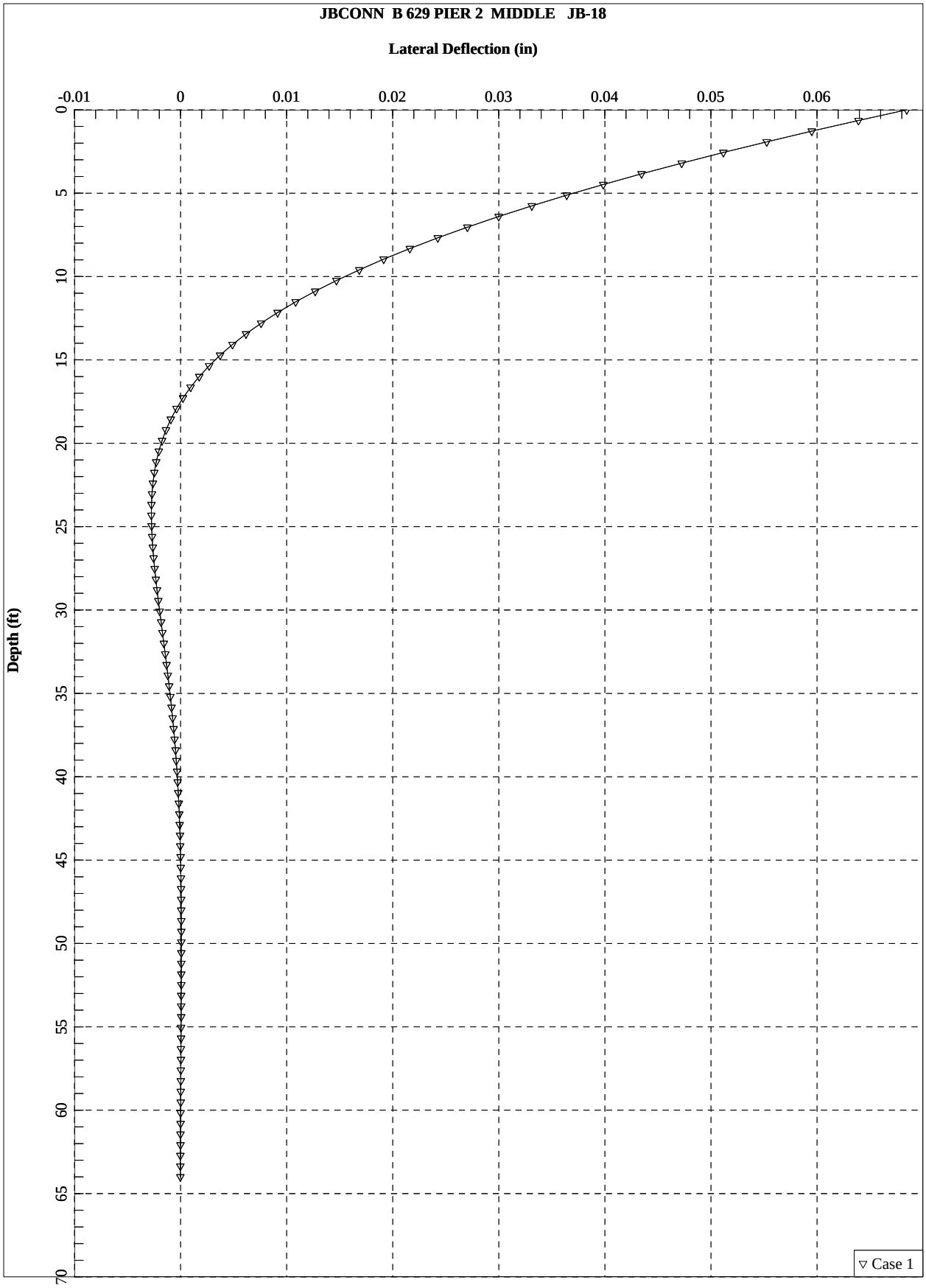
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

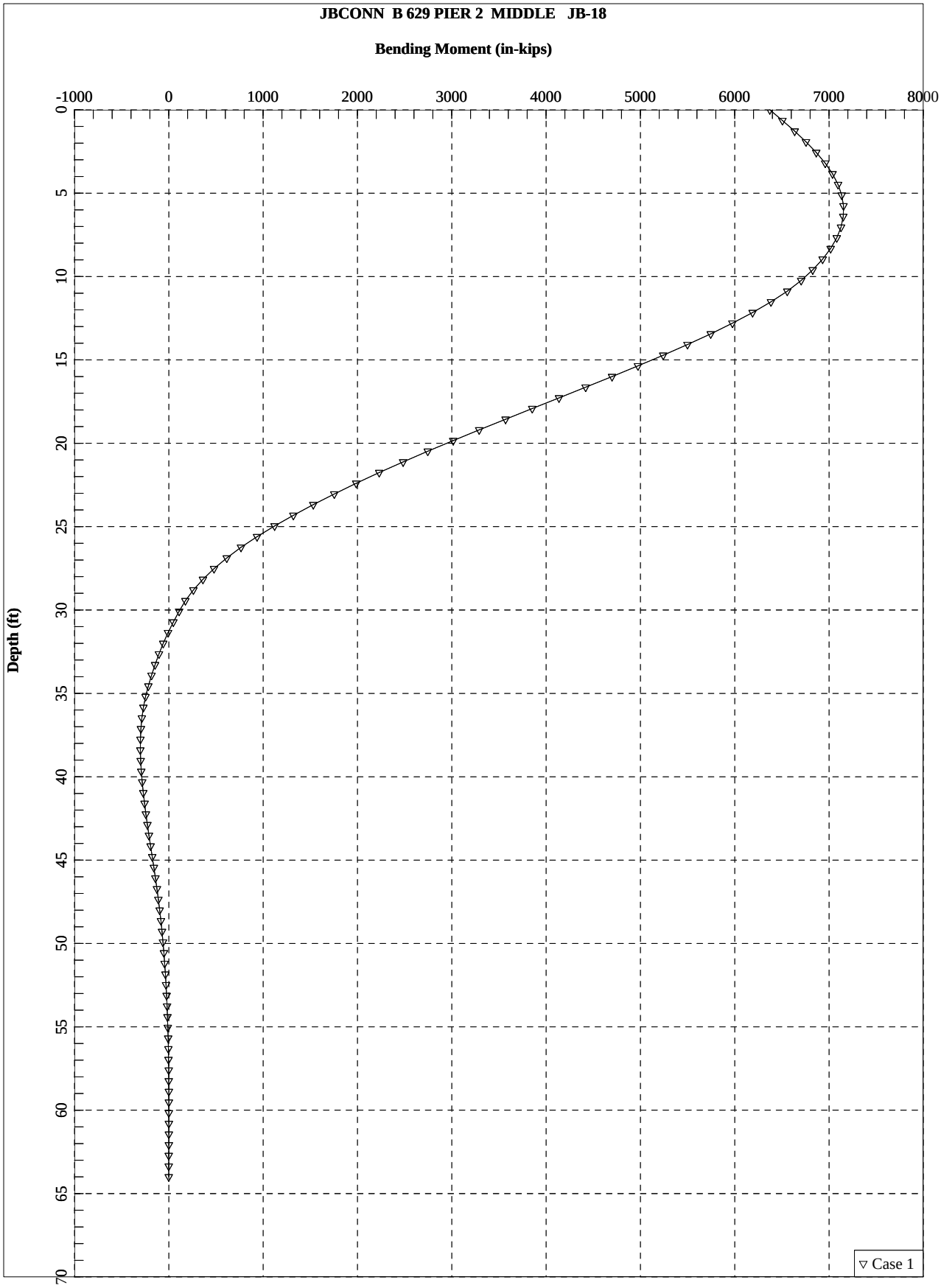
M concrete = psi 4,030,509
M Steel = psi 30,000,000

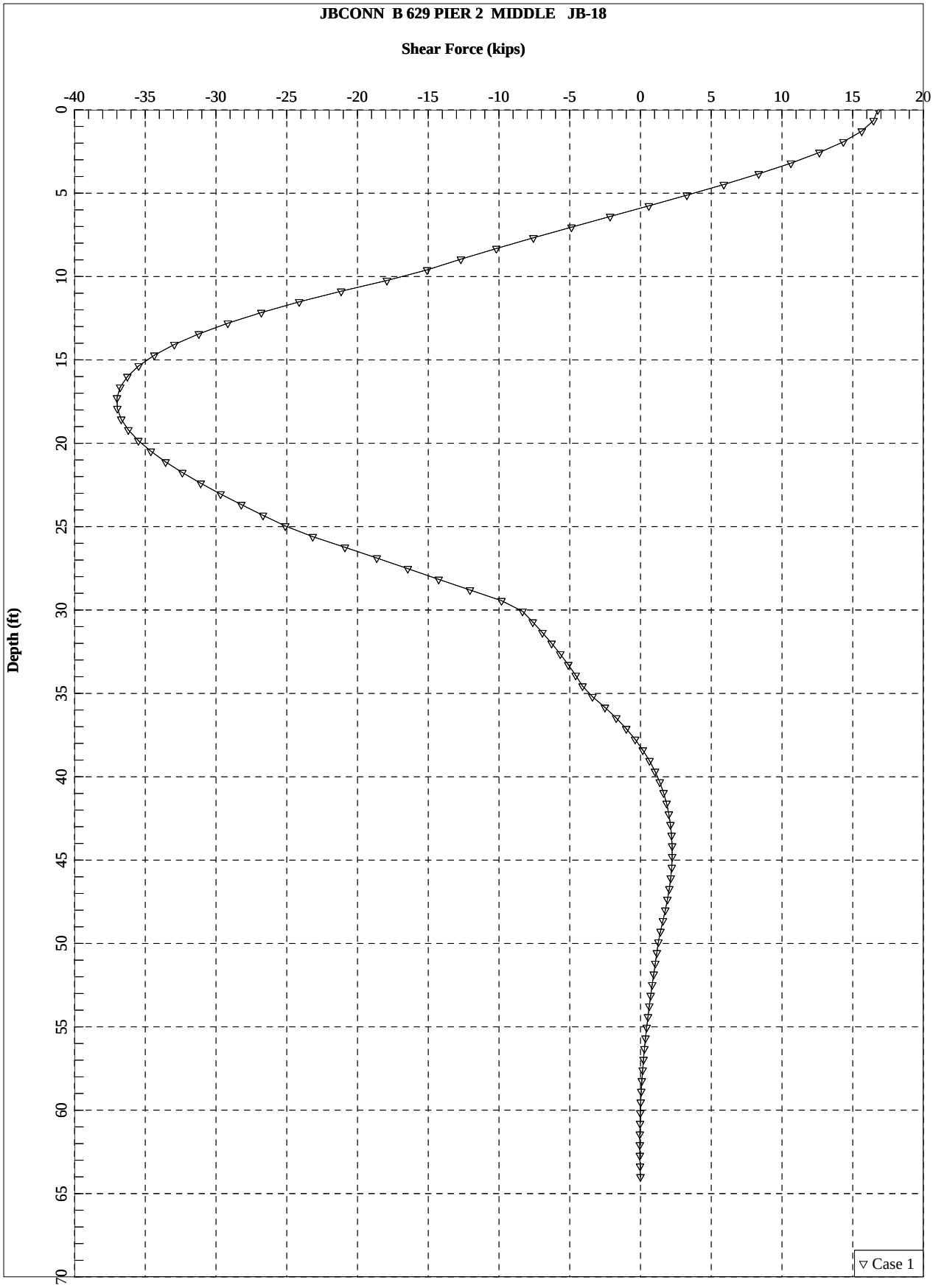
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B 629 PIER 2 MIDDLE JB-18
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B 629 PIER 2 MIDDLE JB-18
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

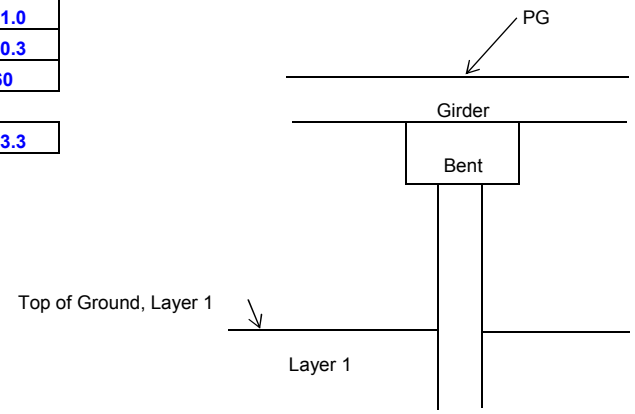

JBCONN B 629 PIER 2 MIDDLE JB-18
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

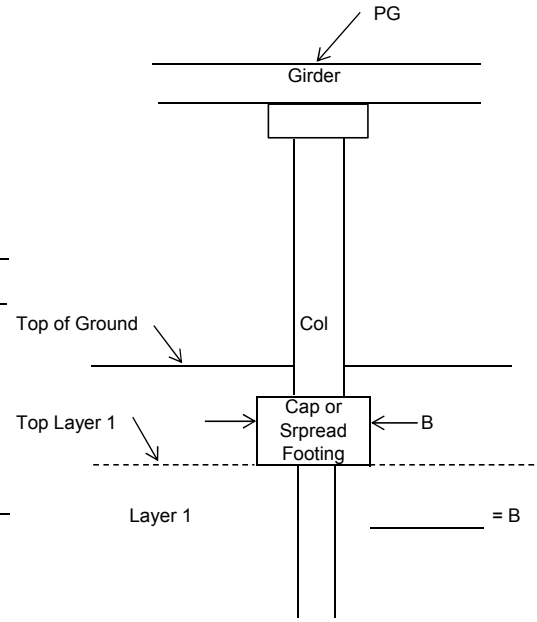
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By	MAR
Determination of Soil Parameters below Piers	Date	3/17/2016
	Checked By	JCG
LOCATION JBCONN Bridge B 629 Pier 2 Enter Values in Blue.	Date	3/17/2016

Red values are calculated

	South
BORING No. =	JB-19
Top of Boring El. =	350.3
Profile Grade =	366.8
Top of Layer 1 =	341.0
Top of Ground El. =	350.3
Hammer Efficiency %	60
Groundwater Elevation =	283.3

Bottom of Bent or Cap =	341.0
GW depth below top Layer 1 =	57.7





R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	328.5	12.5	P	II-B	17	11	8			12
2	314.0	14.5	P	II-C	26	29	44			33
3	309.0	5.0	P	II-B	20					20
4	299.0	10.0	P	II-C	34	40				37
5	294.0	5.0	P	II-C	79					79
6	283.3	10.7	P	II-C	58	30				44
7	281.0	2.3	P	II-C	100					100
8										
9										
10										
11										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	12.5	
2	130.0	137.0	SM	50.0	32.0		2	27.0	
3	118.0	125.0	ML	50.0	30.0		2	32.0	
4	130.0	137.0	ML	50.0	32.0		2	42.0	
5	120.0	128.0	HWR	250.0	34.0		4	47.0	
6	130.0	137.0	SM	50.0	32.0		2	57.7	
7	120.0	128.0	HWR	250.0	34.0		4	60.0	
8									
9									
10									
11									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-19	SHAFT NO. South	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	1,100	kips
Service or Scour Load		kips

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	341.0	ft	
Top of Shaft	341.0	ft	
Groundwater (Enter bot. shaft if none)	283.3	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	277.0	ft	
Bottom of Shaft	277.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	5.0	ft
Shaft Length	64.0	ft
Shaft Length in Soil or IGM	64.0	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	180.8	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	226.0	kips

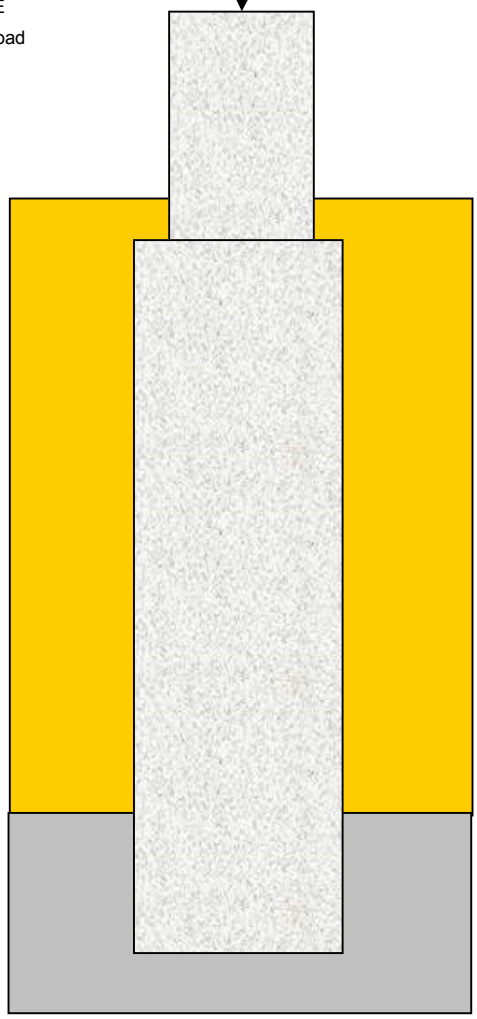
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	180.8	kips

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths

Top of Ground	341.0
Top of Shaft	341.0
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	277.0



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1		x				341.0	328.5	12.5	118	12	12	
S2		x				328.5	309.0	19.5	118	26	26	
S3		x				309.0	299.0	10.0	118	37	37	
S4				x		299.0	294.0	5.0	138	79	79	
S5		x				294.0	283.3	10.7	118	44	44	
S6				x		283.3	277.0	6.3	138	100	100	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-19	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	12.5	6.3	118.0	0.74	0.00	0.74	12					
S2	19.5	22.3	118.0	2.63	0.00	2.63	26					
S3	10.0	37.0	118.0	4.37	0.00	4.37	37					
S4	5.0	44.5	138.0	6.14	0.00	6.14	79	46.0	0.95	4.76	78.54	373.7
S5	10.7	52.4	118.0	6.18	0.00	6.18	44					
S6	6.3	60.9	138.0	8.40	0.20	8.20	100	45.9	0.92	6.11	98.96	604.6
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	978.3

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4	299.0	294.0							
S5									
S6	283.3	277.0	277.0	7.3	0.39	6.95	63.1	19.63	1,240
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	1,240 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-19	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs — As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu — qu = unconfined compressive strength of intact IGM, ksf — O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 — FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

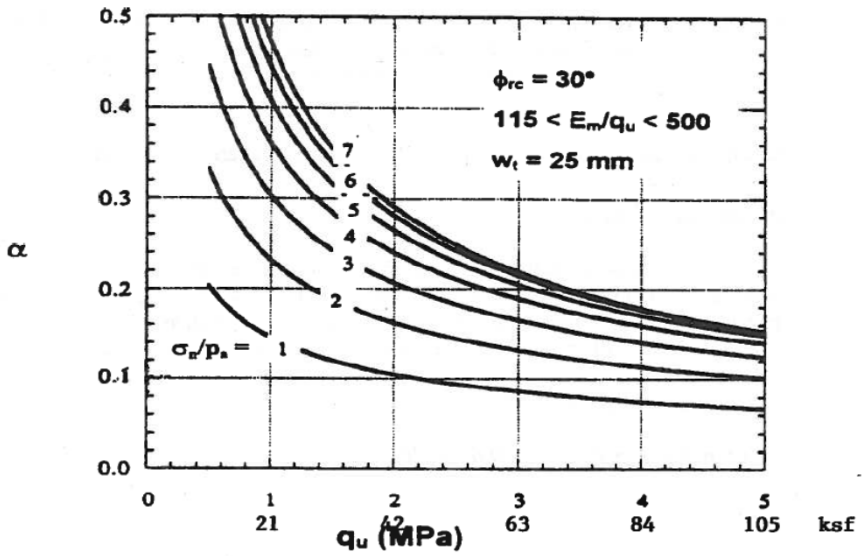


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	12.5	6.3	0.6	0.29					
S2	19.5	22.3	2.2	1.02					
S3	10.0	37.0	3.6	1.70					
S4	5.0	44.5	3.9	1.84					
S5	10.7	52.4	3.9	1.84		0.16			
S6	6.3	60.9	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-19	SHAFT NO. South	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

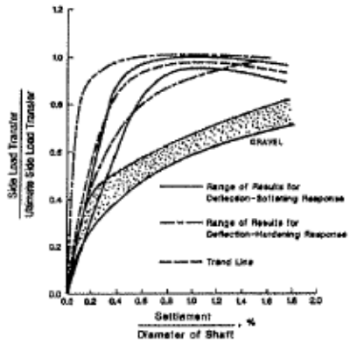


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

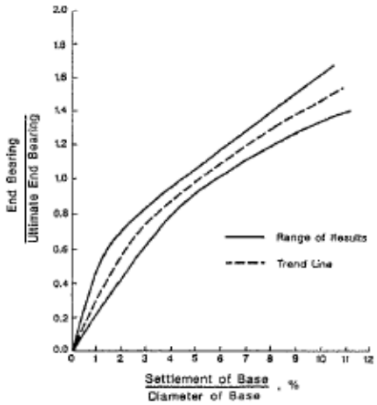


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Pier 2	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-19	SHAFT NO. South	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 0.8 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1		134.7					
S2		694.2					
S3		465.5					
S4				373.7			
S5		552.0					
S6				604.6			
Sum	0.0	1846.5	0.0	978.3	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	0.0	1015.5	0.0	587.0	0.0		
L.T. Factor	0.95	0.96	0.59	0.96	1.0	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	0.0	974.9	0.0	563.5	0.0	**1,538**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				1239.8	
Sum				1239.8	0.0
φ				0.55	0.55
φ * Rs				681.9	0.0
L.T. Factor				0.2	0.5
Rp				136.4	0.0

Sum Rp **136**

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,538	Pmax	1,100	
Rp	136	Wt. Shaft	226	
Σ	1,675	Σ	1,326	
		FR ≥ RP	**OK**	

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-19

Bridge No. B629 **Pier No.** P2 South **Bottom of Pile Cap / Top of Shaft El.** 341.0

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

341.0 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 277.0 Tip El. — L inches = 768
- Group Load — 1 No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 5.000 f'c 5,000 f'c

#N/A P Reducn Factor Long 0.0 B
#N/A P Reducn Factor Trans 2.4 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 1,100.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	1,100	kips (lbs)	1,100,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	15.0	kips (lbs)	15,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	7.5	kips (lbs)	7,500	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)	80	kip-ft (lb-in)	960,000	My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	525	kip-ft (lb-in)	6,300,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	16.77	kips (lbs)	16,771	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	531.06	kip-ft (lb-in)	6,372,723	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 283.3 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	328.5	12.5		P	12	II-B	150	0.06829	30.0		66		
2	314.0	14.5		P	33	II-C	324	0.07523	32.0		183		
3	309.0	5.0		P	20	II-B	384	0.06829	30.0		111		
4	299.0	10.0		P	37	II-C	504	0.07523	32.0		205		
5	294.0	5.0		P	79	III	564	0.06944	34.0		437		
6	283.3	10.7		P	44	II-C	692	0.07523	32.0		244		
7	277.0	6.3		P	100	III	768	0.03738	34.0		332		
8													
9													
10													
11													

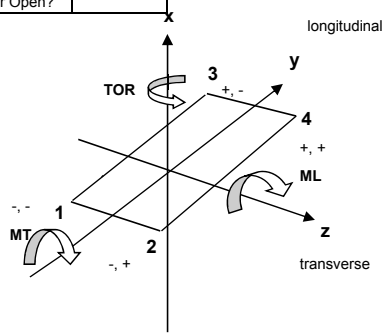
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



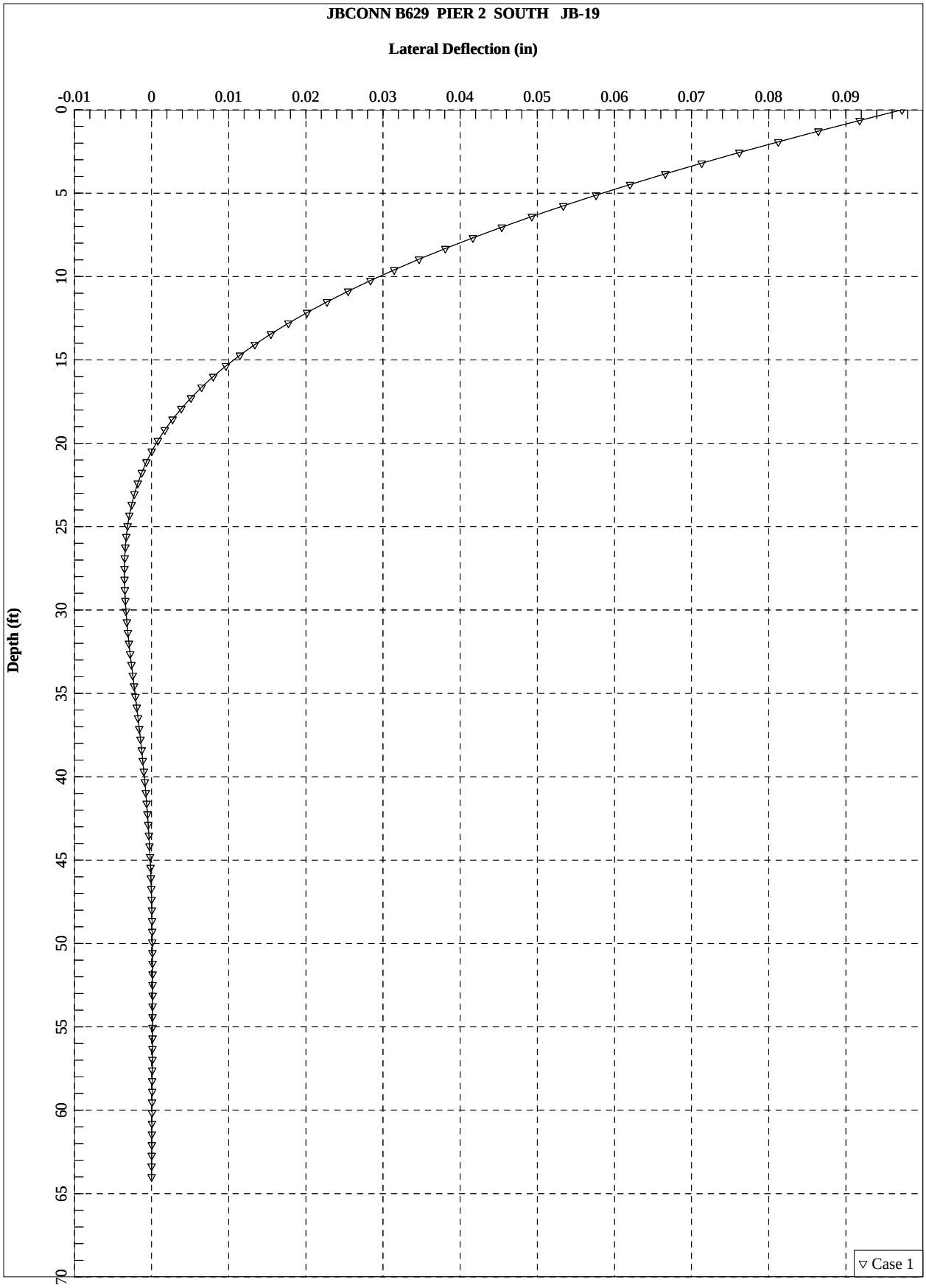
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

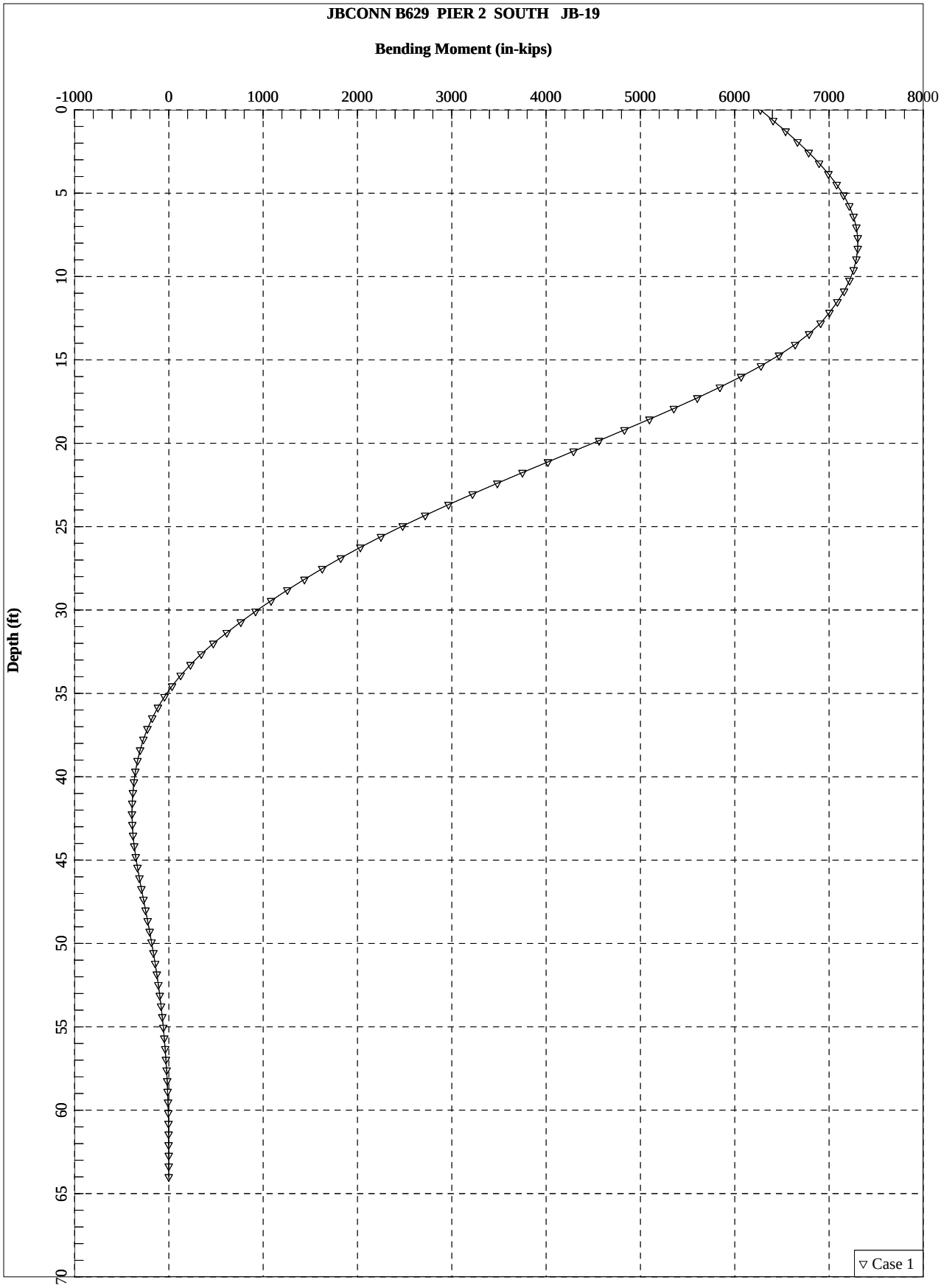
M concrete = psi 4,030,509
M Steel = psi 30,000,000

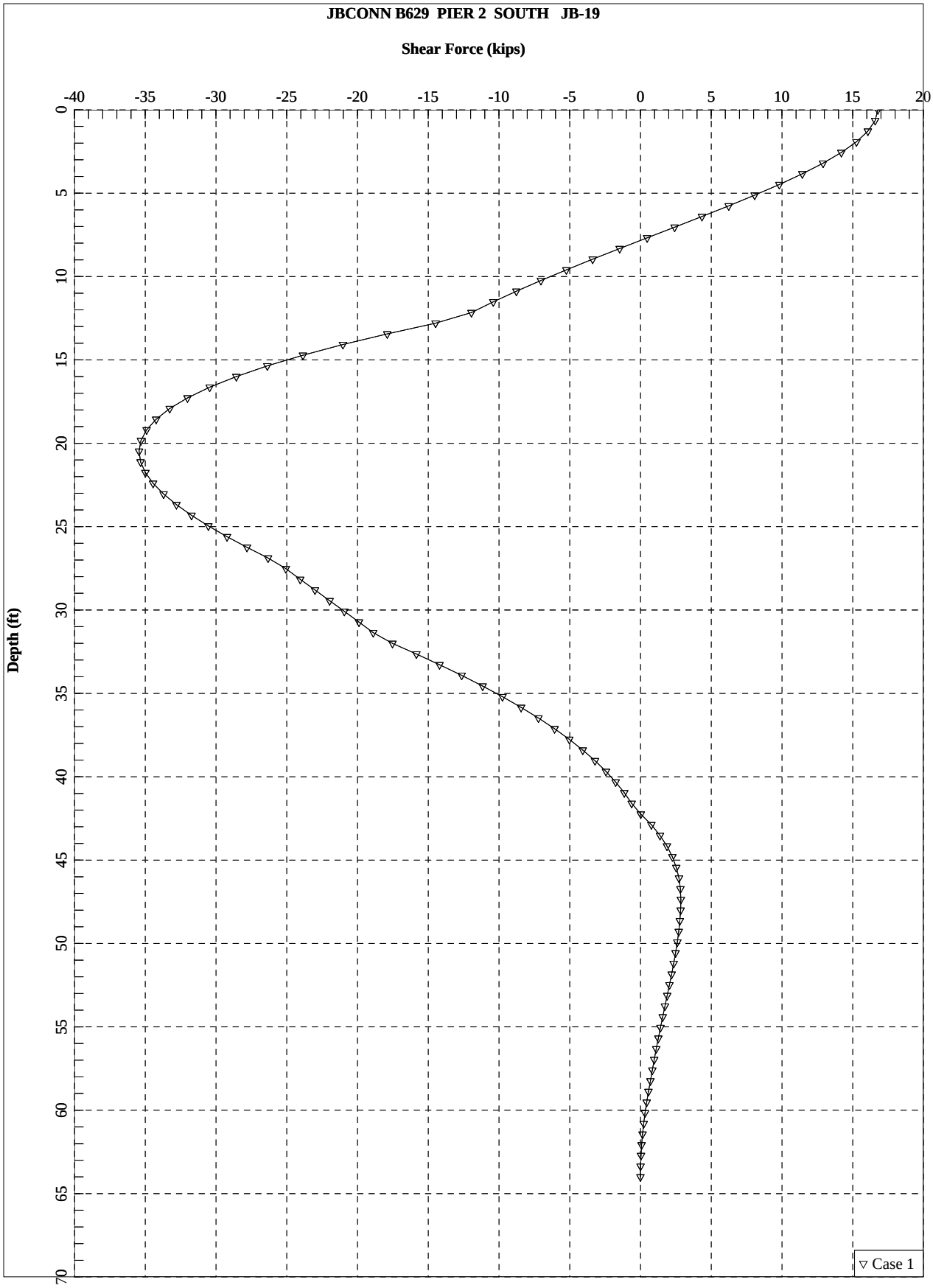
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B629 PIER 2 SOUTH JB-19
Lateral Deflection (in)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B629 PIER 2 SOUTH JB-19
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B629 PIER 2 SOUTH JB-19
Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
20
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 3/17/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment B Enter Values in Blue.	Date 3/17/2016

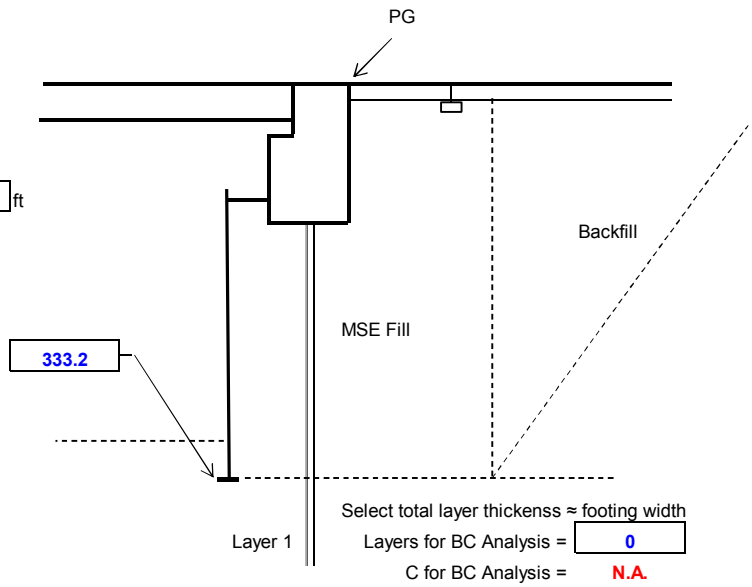
Red values are calculated

BORING No. =	JB-20	
Top of Boring El. =	335.2	ft
Profile Grade =	357.7	ft
Top of Layer 1 =	333.2	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	265.8	ft

North Abutment End

Bottom of Abut. = 345.0 ft

El. Ground in front of Wall =	335.2
El. Top of Front Wall =	346.5
Front Wall Total Height =	13.3
Front Wall Height from PG to Bot. =	24.5



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	329.0	4.2	P	II-A	9	10				10
2	323.2	5.8	P	II-B	24	25				25
3	308.5	14.7	P	II-C	53	44	43			47
4	304.0	4.5	P	II-C	100					100
5	283.2	20.8	P	II-B	22	32	22	22		25
6	265.8	17.4	P	II-C	85	100	100	100		96
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	95.0	102.0	MH	50.0	28.0		5	4.2	1188
2	118.0	125.0	MH	50.0	30.0		5	10.0	3063
3	130.0	137.0	ML	50.0	32.0		2	24.7	
4	120.0	128.0	HWR	250.0	34.0		4	29.2	
5	118.0	125.0	ML	50.0	30.0		2	50.0	
6	120.0	128.0	HWR	250.0	34.0		4	67.4	
7									
8									
9									
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO. North	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	603	kips
Service or Scour Load		kips

Bottom of Abutment = 345.0

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	333.2	ft	
Top of Shaft	333.2	ft	
Groundwater (Enter bot. shaft if none)	265.8	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	285.0	ft	
Bottom of Shaft	285.0	ft	

Top of Ground	333.2
Top of Shaft	333.2
Top of Rock	No Rock
Bot. of Shaft	285.0

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	4.0	ft
Shaft Length	48.2	ft
Shaft Length in Soil or IGM	48.2	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	105.9	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	132.4	kips

S1 to S6

MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%

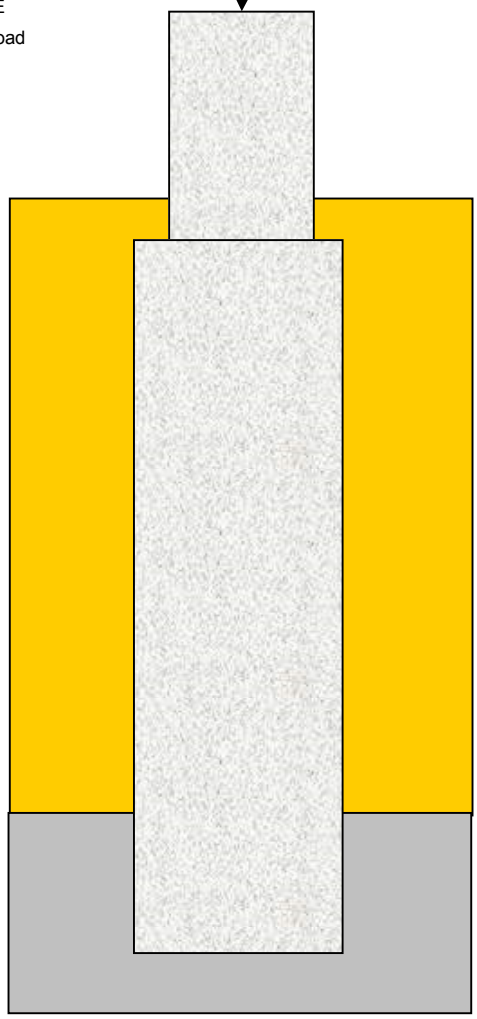
R1

Eff. Wt. of Shaft 105.9 kips

R2

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths



SOIL AND IGM LAYER DATA

Layer No.	Material Description					Top	Bottom	t	Unit Wt	N	N60	qu
	Coh	Sandy	Gravelly	GranIGM	CohIGM	ft	ft	ft	pcf	blows	blows	ksf
S1	x					333.2	329.0	4.2	110	10	10	2.1
S2	x					329.0	323.2	5.8	110	25	25	5.3
S3		x				323.2	308.5	14.7	118	47	47	
S4				x		308.5	304.0	4.5	138	100	100	
S5		x				304.0	283.2	20.8	118	25	25	
S6				x		283.2	280.0	3.2	138	96	96	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing Closed	Jointing Open	Jointing Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS					Page	5
						Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO.	Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO.	North	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = area shaft — qs = unit side resistance

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1	1.1	0.00	0.0	0.0	4.2	52.8	0.0
S2	2.6	1.24	0.6	1.4	5.8	72.9	105.2
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	105

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	4.2	2.1	0.2	0.2	0.00	0.2						
S2	5.8	7.1	0.3	0.8	0.00	0.8						
S3	14.7	17.4	0.9	2.0	0.00	2.0	47	0.94	1.8	184.7	341	
S4	4.5	27.0	0.3	3.1	0.00	3.1						
S5	20.8	39.6	1.2	4.7	0.00	4.7	25	0.65	3.0	261.4	796	
S6	3.2	51.6	0.2	6.1	0.00	6.1						
			Bot Press.	6.1					TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL		1,137	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	6
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO. North	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	4.2	2.1	110.0	0.23	0.00	0.23	10					
S2	5.8	7.1	110.0	0.78	0.00	0.78	25					
S3	14.7	17.4	118.0	2.05	0.00	2.05	47					
S4	4.5	27.0	138.0	3.72	0.00	3.72	100	52.1	1.44	5.23	56.55	296.0
S5	20.8	39.6	118.0	4.67	0.00	4.67	25					
S6	3.2	51.6	138.0	7.12	0.00	7.12	96	46.7	0.97	5.74	40.21	230.7
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	526.6

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4	308.5	304.0							
S5									
S6	283.2	280.0							
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	8
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO. North	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu qu = unconfined compressive strength of intact IGM, ksf O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

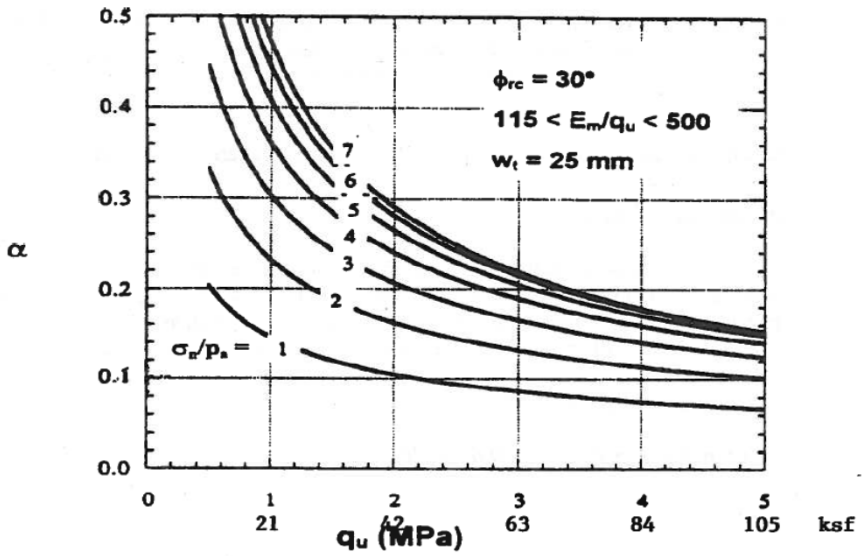


Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	4.2	2.1	0.2	0.10					
S2	5.8	7.1	0.7	0.33					
S3	14.7	17.4	1.7	0.80					
S4	4.5	27.0	2.6	1.24					
S5	20.8	39.6	3.9	1.82		0.16			
S6	3.2	51.6	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO. North	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

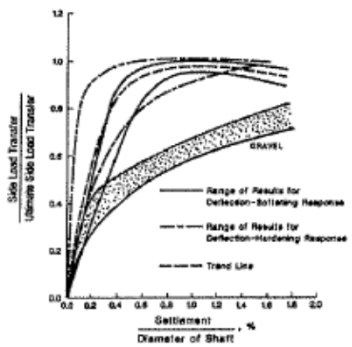


Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

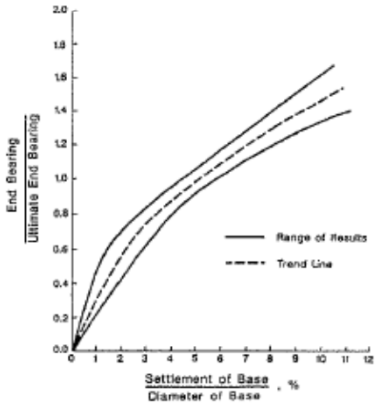


Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	10
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO. North	Date	3/17/2016

Side and Base Resistance Transfer in Cohesive Soils

The curves in Figures 10.8.2.2.2-1 and 10.8.2.2.2-3 also show the settlements at which the side resistance is mobilized. The shaft skin friction R_s is typically fully mobilized at displacements of 0.2 percent to 0.8 percent of the shaft diameter for shafts in cohesive soils. For shafts in cohesionless soils, this value is 0.1 percent to 1.0 percent.

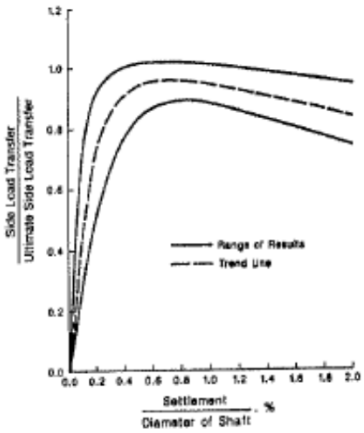


Figure 10.8.2.2.2-1 Normalized Load Transfer in Side Resistance versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

	REV 1	REV 6
	x	y
	0.0	0.00
	0.1	0.28
	0.2	0.55
	0.3	0.83
	0.4	0.86
	0.5	0.89
	0.6	0.95
	0.8	0.95
	1.0	0.93
	1.2	0.91
	1.5	0.85
	2.0	0.83

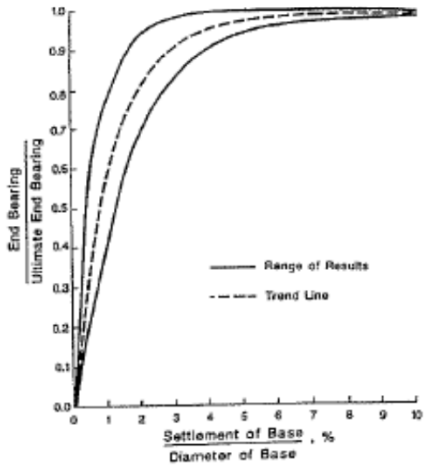


Figure 10.8.2.2.2-2—Normalized Load Transfer in End Bearing versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.09
0.2	0.17
0.3	0.25
0.4	0.31
0.5	0.36
0.6	0.42
0.8	0.5
1.0	0.58
1.3	0.65
1.6	0.72
2.0	0.81
3.0	0.90
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-20	SHAFT NO. North	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1	0.0						
S2	105.2						
S3		340.8					
S4				296.0			
S5		796.2					
S6				230.7			
Sum	105.2	1136.9	0.0	526.6	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	47.4	625.3	0.0	316.0	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	44.0	606.6	0.0	306.5	0.0	**957**	kips

Tip Resistance

Layer No.	Material Description					
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM	
S1						
S2						
S3						
S4						
S5						
S6						
Sum				0.0	0.0	
φ				0.55	0.55	AASHTO Table 10.5.2.4-1
φ * Rs				0.0	0.0	
L.T. Factor				0.3	0.58	Sum Rp
Rp				0.0	0.0	**0**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	957	Pmax	603	
Rp	0	Wt. Shaft	132	24
Σ	957	Σ	735	
		FR ≥ RP	**OK**	

957 > 759

See AASHTO Figures 10.8.2.2.2-2 & -4

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-20

Bridge No. B629 **Pier No.** B North **Bottom of Pile Cap / Top of Shaft El.** 345.0

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

345.0 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 285.0 Tip El. — L inches = 720
- Group Load — 1 No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 4.000 f'c 5,000 f'c

#N/A P Reducn Factor Long 0.0 B
0.25 P Reducn Factor Trans 3.0 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 603.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	603.0	kips (lbs)	603,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	95.0	kips (lbs)	95,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	18.0	kips (lbs)	18,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	254	kip-ft (lb-in)	3,048,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	96.69	kips (lbs)	96,690	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	254.00	kip-ft (lb-in)	3,048,000	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 265.8 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	333.2	11.8	SF	P	32	Gravel	142	0.07813	32.0		177		
2	329.0	4.2	MH	P	10	II-A	192	0.05498		6.00		0.0075	
3	323.2	5.8	MH	P	25	II-B	262	0.06829		6.00		0.005	
4	308.5	14.7	ML	P	47	II-C	438	0.07523	32.0		260		
5	304.0	4.5	HWR	P	100	III	492	0.06944	34.0		554		
6	283.2	20.8	ML	P	25	II-B	742	0.06829	30.0		138		
7	265.8	17.4	HWR	P	96	III	950	0.06944	34.0		531		
8													
9													
10													
11													

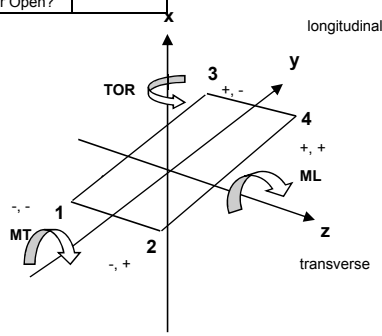
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



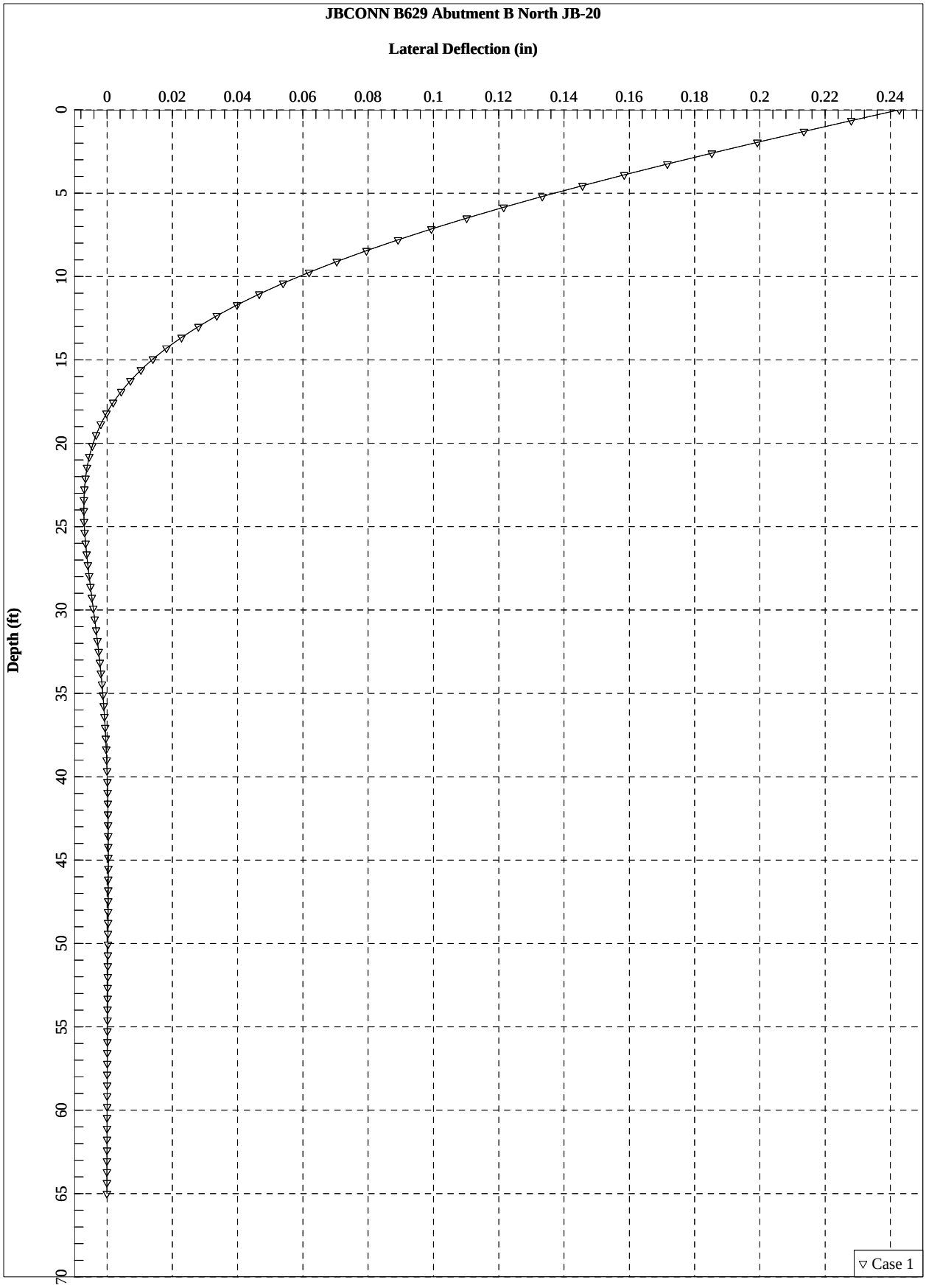
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

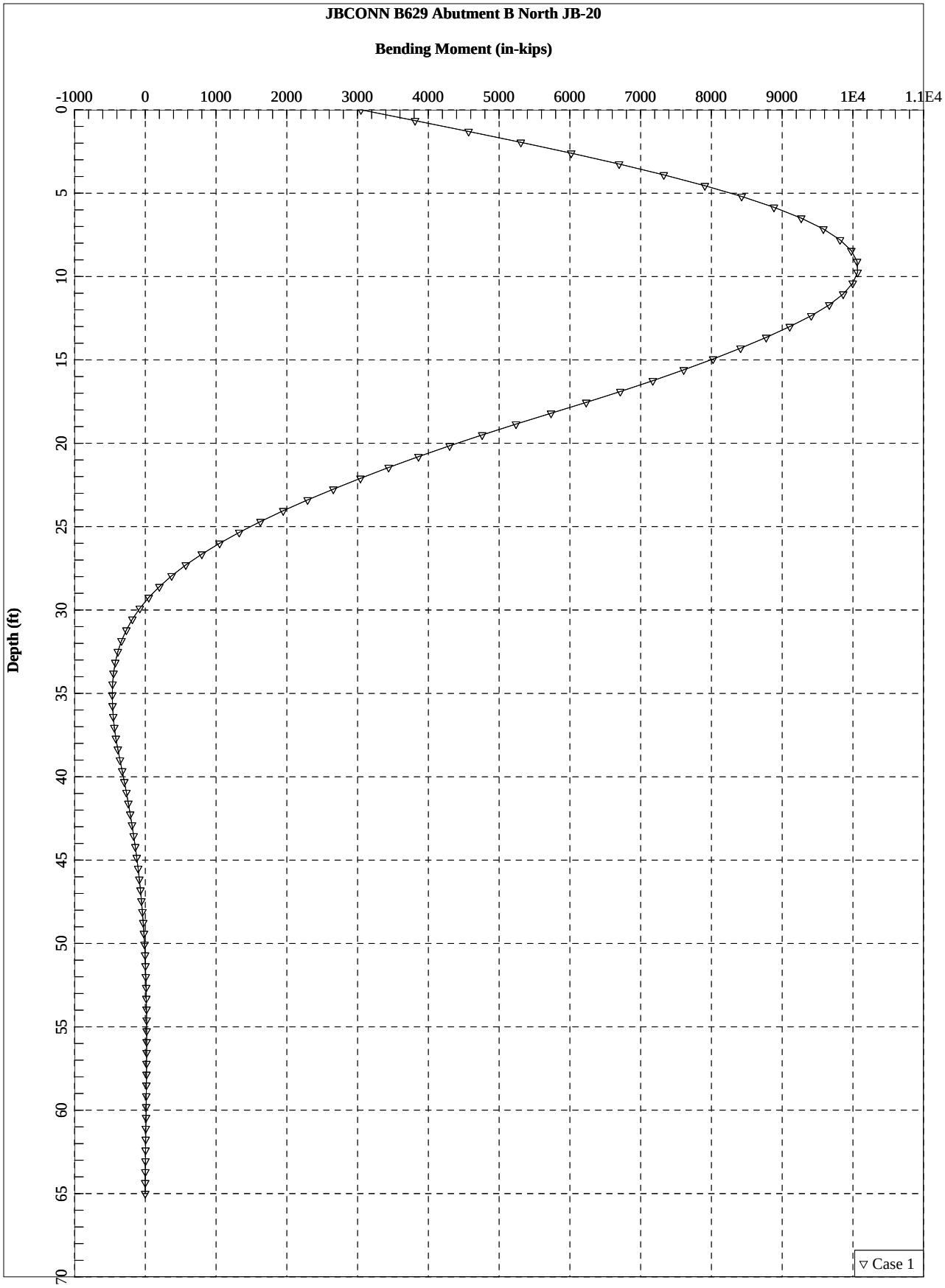
M concrete = psi 4,030,509
M Steel = psi 30,000,000

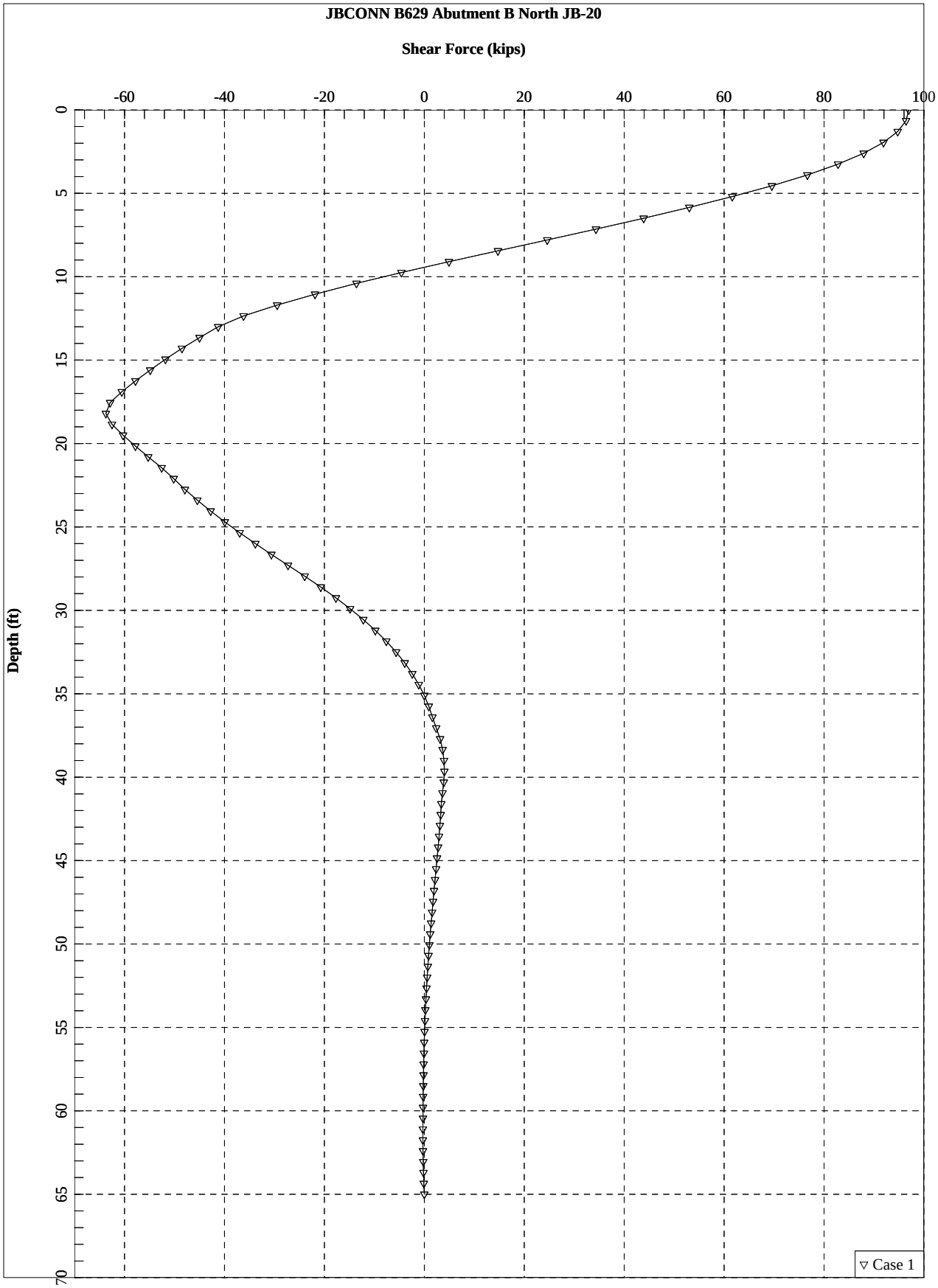
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B629 Abutment B North JB-20
Lateral Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B629 Abutment B North JB-20
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
1E4
1.1E4
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B629 Abutment B North JB-20
Shear Force (kips)
-60
-40
-20
0
20
40
60
80
100
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 3/17/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment B Enter Values in Blue.	Date 3/17/2016

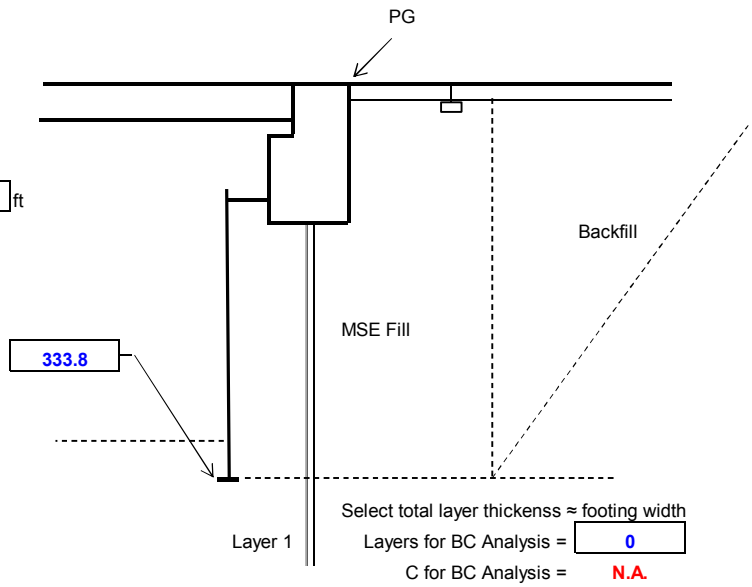
Red values are calculated

BORING No. =	JB-21	
Top of Boring El. =	335.6	ft
Profile Grade =	357.7	ft
Top of Layer 1 =	333.8	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	290.6	ft

Middle Abutment

Bottom of Abut. = 345.1 ft

El. Ground in front of Wall =	335.8
El. Top of Front Wall =	346.5
Front Wall Total Height =	12.7
Front Wall Height from PG to Bot. =	23.9



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	329.6	4.2	P	II-B	11	22				17
2	323.1	6.5	P	II-B	18	17	14			16
3	319.0	4.1	P	II-B	18					18
4	298.6	20.4	P	II-C	67	34	52	41		49
5	294.0	4.6	P	II-C	87					87
6	290.6	3.4	P	II-C	100					100
7	285.0	5.6	P	II-C	77					77
8	266.9	18.1	P	II-C	100	100	100	100		100
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	4.2	
2	118.0	125.0	MH	50.0	30.0		5	10.7	2042
3	118.0	125.0	ML	50.0	30.0		2	14.8	
4	130.0	137.0	ML	50.0	32.0		2	35.2	
5	120.0	128.0	HWR	250.0	34.0		4	39.8	
6	120.0	128.0	HWR	250.0	34.0		4	43.2	
7	120.0	128.0	HWR	250.0	34.0		4	48.8	
8	120.0	128.0	HWR	250.0	34.0		4	66.9	
9									
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-21	SHAFT NO. Middle	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	603	kips	Bottom of Abutment = 345.1
Service or Scour Load		kips	

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	333.8	ft	
Top of Shaft	333.8	ft	
Groundwater (Enter bot. shaft if none)	290.6	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	280.0	ft	
Bottom of Shaft	280.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	4.0	ft
Shaft Length	53.8	ft
Shaft Length in Soil or IGM	53.8	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	93.1	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	116.4	kips

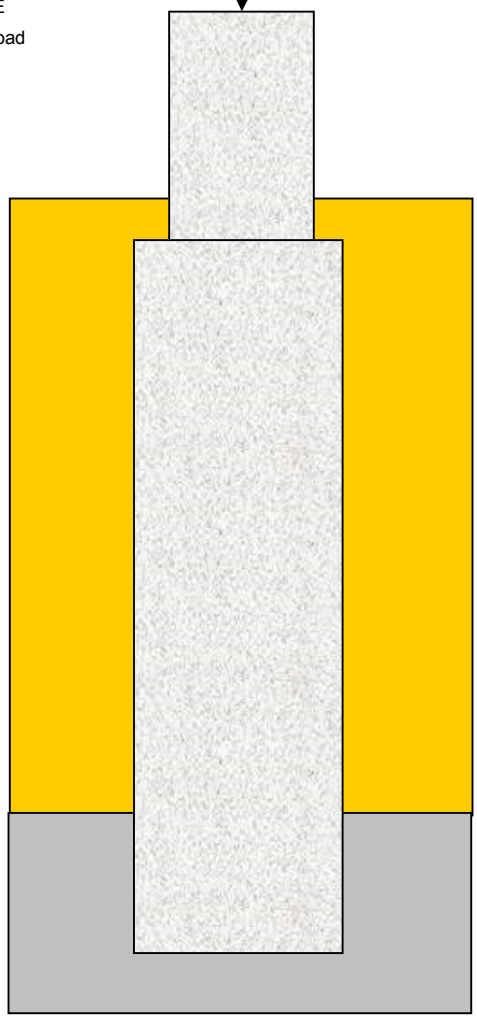
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	93.1	kips

Top of Ground	333.8
Top of Shaft	333.8
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	280.0

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1	x					333.8	323.1	10.7	110	17	17	3.6
S2		x				323.1	319.0	4.1	118	18	18	
S3		x				319.0	298.6	20.4	118	49	49	
S4				x		298.6	290.6	8.0	138	93	93	
S5				x		290.6	285.0	5.6	138	77	77	
S6				x		285.0	280.0	5.0	138	100	100	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

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					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-21	SHAFT NO. Middle	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = area shaft; qs = unit side resistance

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1	1.8	0.84	0.6	1.0	10.7	134.5	132.0
S2			0.0				
S3			0.0				
S4			0.0				
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	132

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	10.7	5.3	0.6	0.6	0.00	0.6						
S2	4.1	12.8	0.2	1.4	0.00	1.4	18	1.02	1.4	51.5	74	
S3	20.4	25.0	1.2	2.9	0.00	2.9	49	0.83	2.4	256.4	606	
S4	8.0	39.2	0.6	4.6	0.00	4.6						
S5	5.6	46.0	0.4	5.6	0.17	5.4						
S6	5.0	51.3	0.3	6.3	0.51	5.8						
			Bot Press.	6.3						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	680	

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SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

$ko = (1 - \sin\Phi') * (0.2 * pa * N60 / \sigma'v)^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	10.7	5.3	110.0	0.59	0.00	0.59	17					
S2	4.1	12.8	118.0	1.50	0.00	1.50	18					
S3	20.4	25.0	118.0	2.95	0.00	2.95	49					
S4	8.0	39.2	138.0	5.41	0.00	5.41	93	48.6	1.11	5.28	100.53	531.3
S5	5.6	46.0	138.0	6.35	0.17	6.17	77	45.7	0.94	4.67	70.37	328.5
S6	5.0	51.3	138.0	7.08	0.51	6.57	100	47.8	1.03	5.83	62.83	366.2
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	1226.0

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

$qp = 0.59 * [N60 * (pa / \sigma'v)]^{0.8} * \sigma'v$ AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4	298.6	290.6							
S5	290.6	285.0							
S6	285.0	280.0	280.0	6.3	0.66	5.63	60.5	12.57	761
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	761 kips

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SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs — As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu — qu = unconfined compressive strength of intact IGM, ksf — O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 — FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

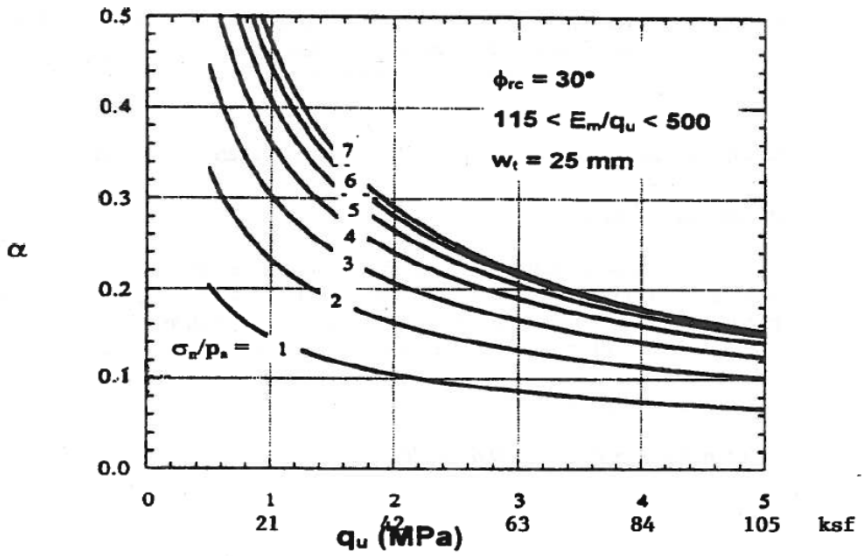

Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	10.7	5.3	0.5	0.25					
S2	4.1	12.8	1.2	0.59					
S3	20.4	25.0	2.4	1.15					
S4	8.0	39.2	3.8	1.80					
S5	5.6	46.0	3.9	1.84		0.16			
S6	5.0	51.3	3.9	1.84					
						TOTAL SIDE RESISTANCE IN COHESIVE IGM			0 kips

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Side and Base Transfer Resistance in Grannular Soils

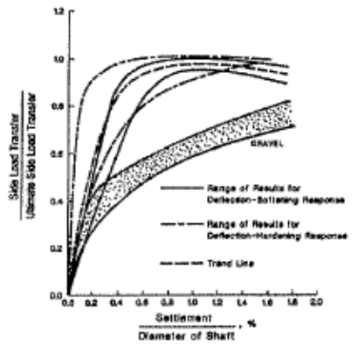

Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

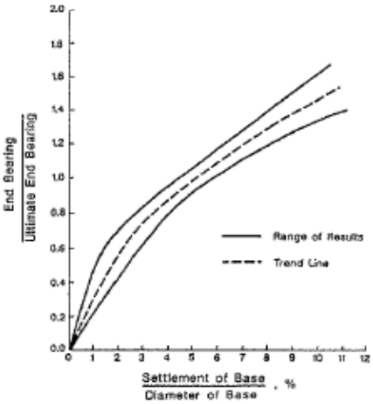

Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

Side and Base Resistance Transfer in Cohesive Soils

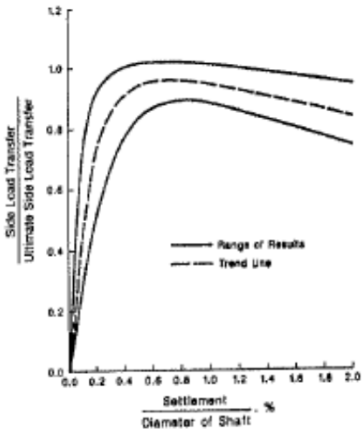

Figure 10.8.2.2.2-1 Normalized Load Transfer in Side Resistance versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

The curves in Figures 10.8.2.2.2-1 and 10.8.2.2.2-3 also show the settlements at which the side resistance is mobilized. The shaft skin friction R_s is typically fully mobilized at displacements of 0.2 percent to 0.8 percent of the shaft diameter for shafts in cohesive soils. For shafts in cohesionless soils, this value is 0.1 percent to 1.0 percent.

	REV 1	REV 6
	x	y
	0.0	0.00
	0.1	0.28
	0.2	0.55
	0.3	0.83
	0.4	0.86
	0.5	0.89
	0.6	0.95
	0.8	0.95
	1.0	0.93
	1.2	0.91
	1.5	0.85
	2.0	0.83

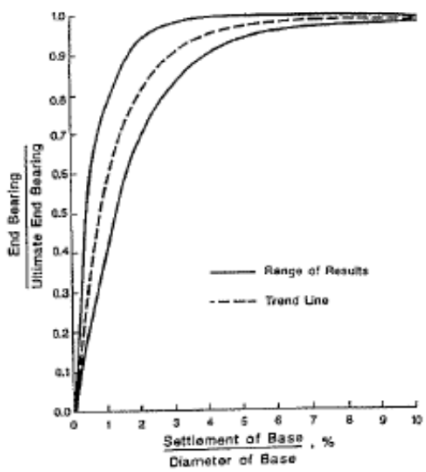

Figure 10.8.2.2.2-2—Normalized Load Transfer in End Bearing versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.09
0.2	0.17
0.3	0.25
0.4	0.31
0.5	0.36
0.6	0.42
0.8	0.5
1.0	0.58
1.3	0.65
1.6	0.72
2.0	0.81
3.0	0.90
5.0	0.98

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SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1	132.0						
S2		74.4					
S3		605.8					
S4				531.3			
S5				328.5			
S6				366.2			
Sum	132.0	680.2	0.0	1,226.0	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	59.4	374.1	0.0	735.6	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	55.2	362.9	0.0	713.5	0.0	**1,132**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				760.7	
Sum				760.7	0.0
φ				0.55	0.55
φ * Rs				418.4	0.0
L.T. Factor				0.3	0.58
Rp				125.5	0.0

Sum Rp **126**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	1,132	Pmax	603	
Rp	126	Wt. Shaft	116	21
Σ	1,257	Σ	719	
		FR ≥ RP	**OK**	

1257 > 740

AASHTO Table 10.5.2.4-1

See AASHTO Figures 10.8.2.2.2-2 & -4

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

ECS LLC MID-ATLANTIC

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-21

Bridge No. B629 **Pier No.** B Middle **Bottom of Pile Cap / Top of Shaft El.** 345.1

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

345.1 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 280.0 — Tip El. — L inches = 781
- Group Load — 1 — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 4.000 f'c 5,000 f'c 0.25

#N/A P Reducn Factor Long 0.0 B
0.25 P Reducn Factor Trans 3.0 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 603.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	603	kips (lbs)	603,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	95.00	kips (lbs)	95,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	18.0	kips (lbs)	18,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	254	kip-ft (lb-in)	3,048,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	96.69	kips (lbs)	96,690	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	254.00	kip-ft (lb-in)	3,048,000	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 290.6 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. USCS, SF, R, or FR Enter 15 for compacted fill w/o SPT data, 50 for SF Max 6.0 E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}	
Surface	ft	ft					0						
1	333.8	11.3	SF	P	32	Gravel	136	0.07813	32.0		177		
2	329.6	4.2	ML	P	17	II-B	186	0.06829	30.0		94		
3	323.1	6.5	MH	P	16	II-B	264	0.06829		6.00		0.005	
4	319.0	4.1	ML	P	18	II-B	313	0.06829	30.0		100		
5	298.6	20.4	ML	P	49	II-C	558	0.07523	32.0		271		
6	294.0	4.6	HWR	P	87	III	613	0.06944	34.0		482		
7	290.6	3.4	HWR	P	100	III	654	0.06944	34.0		554		
8	285.0	5.6	HWR	P	77	III	721	0.03738	34.0		256		
9	280.0	5.0	HWR	P	100	III	781	0.03738	34.0		332		
10													
11													

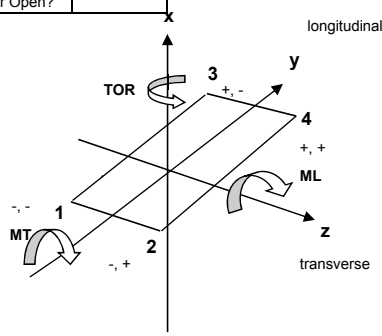
In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion. Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For FR in GROUP	Eir		pci	qc =		psi	RQD =	Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er		psi	qc =		psi ≤ 1000	RQD =	k_rm	0.0005
For Rock (strong rock) in LPILE, enter				qc =		psi			

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



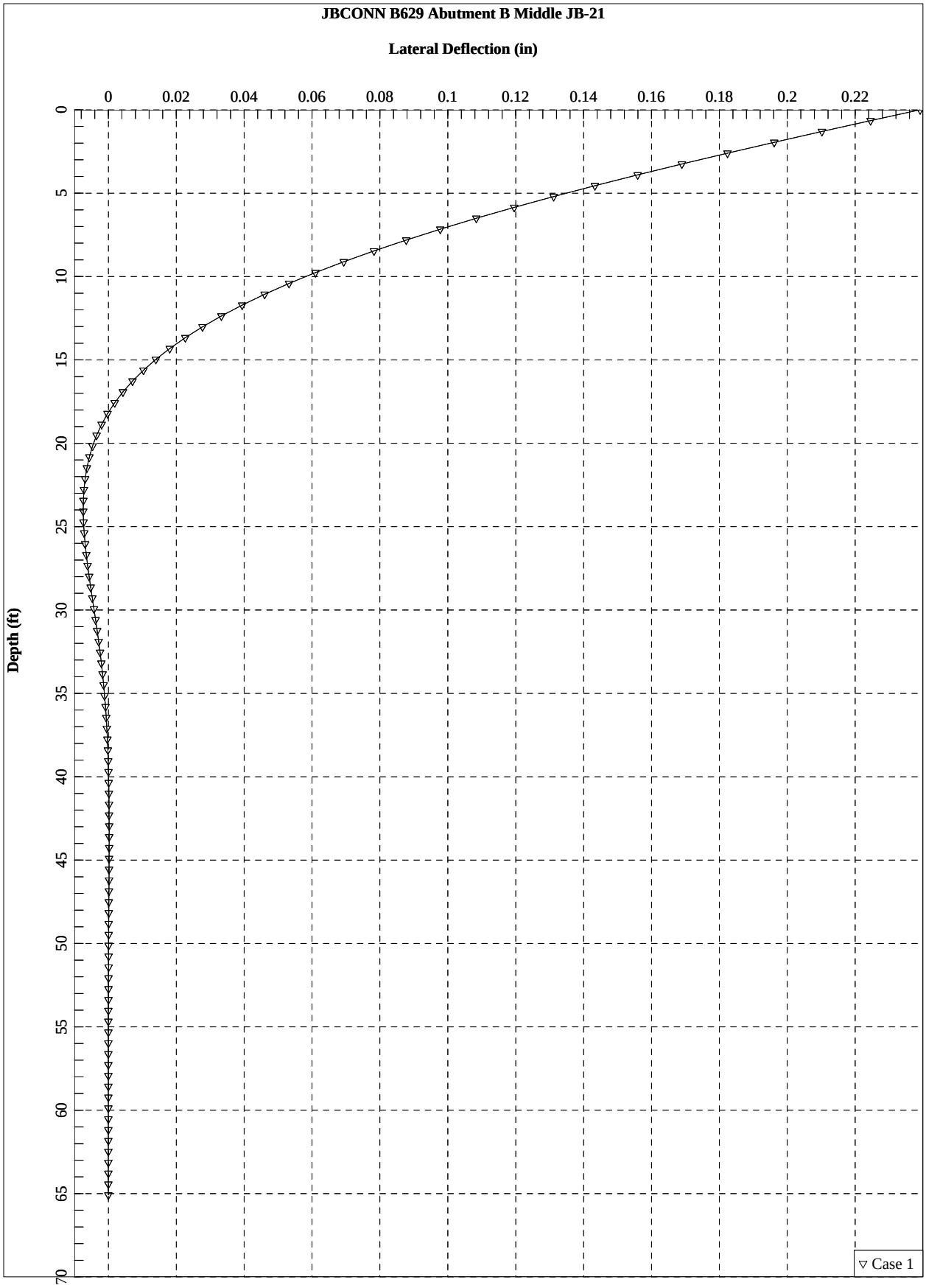
Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

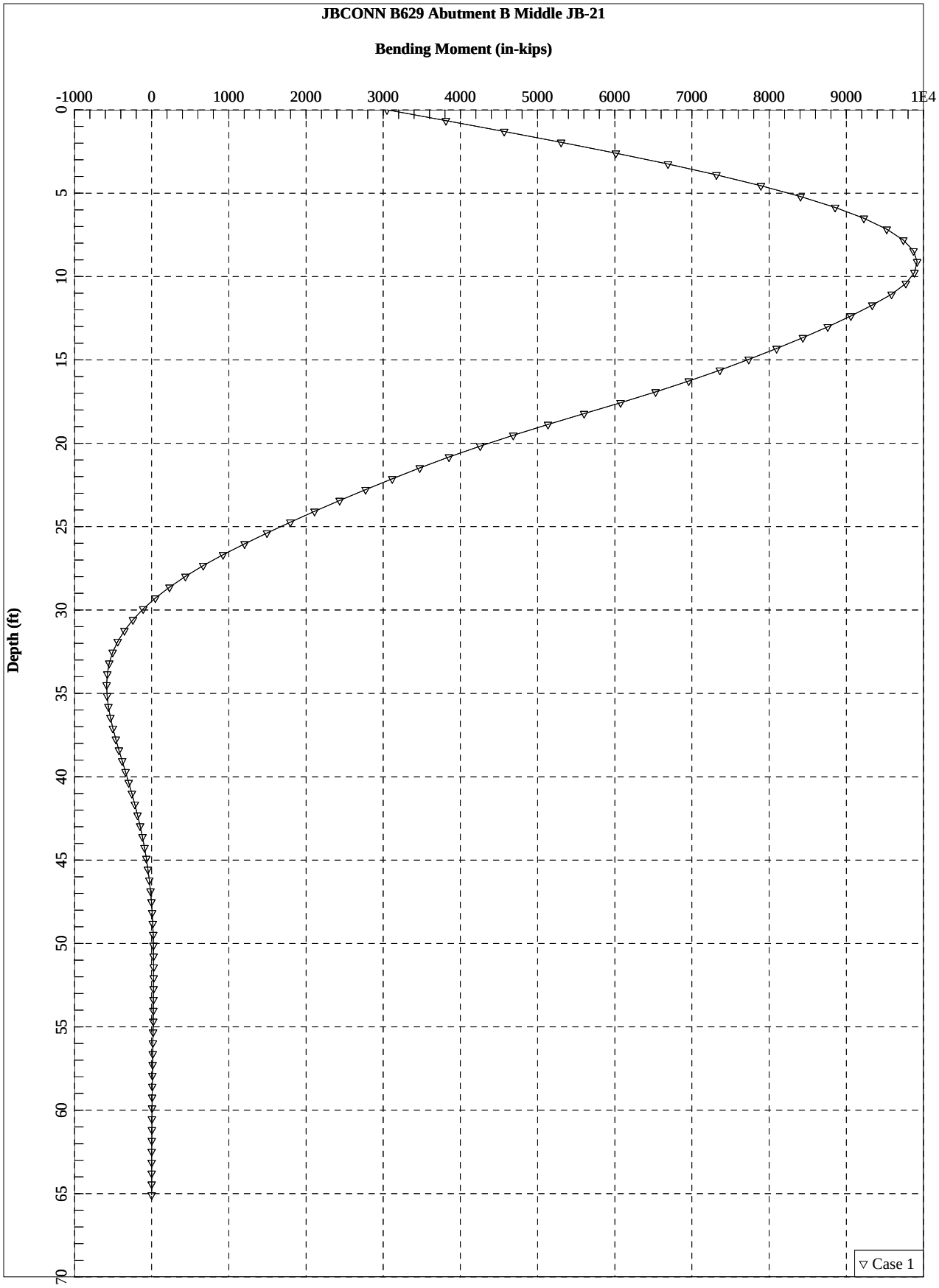
M concrete = psi 4,030,509
M Steel = psi 30,000,000

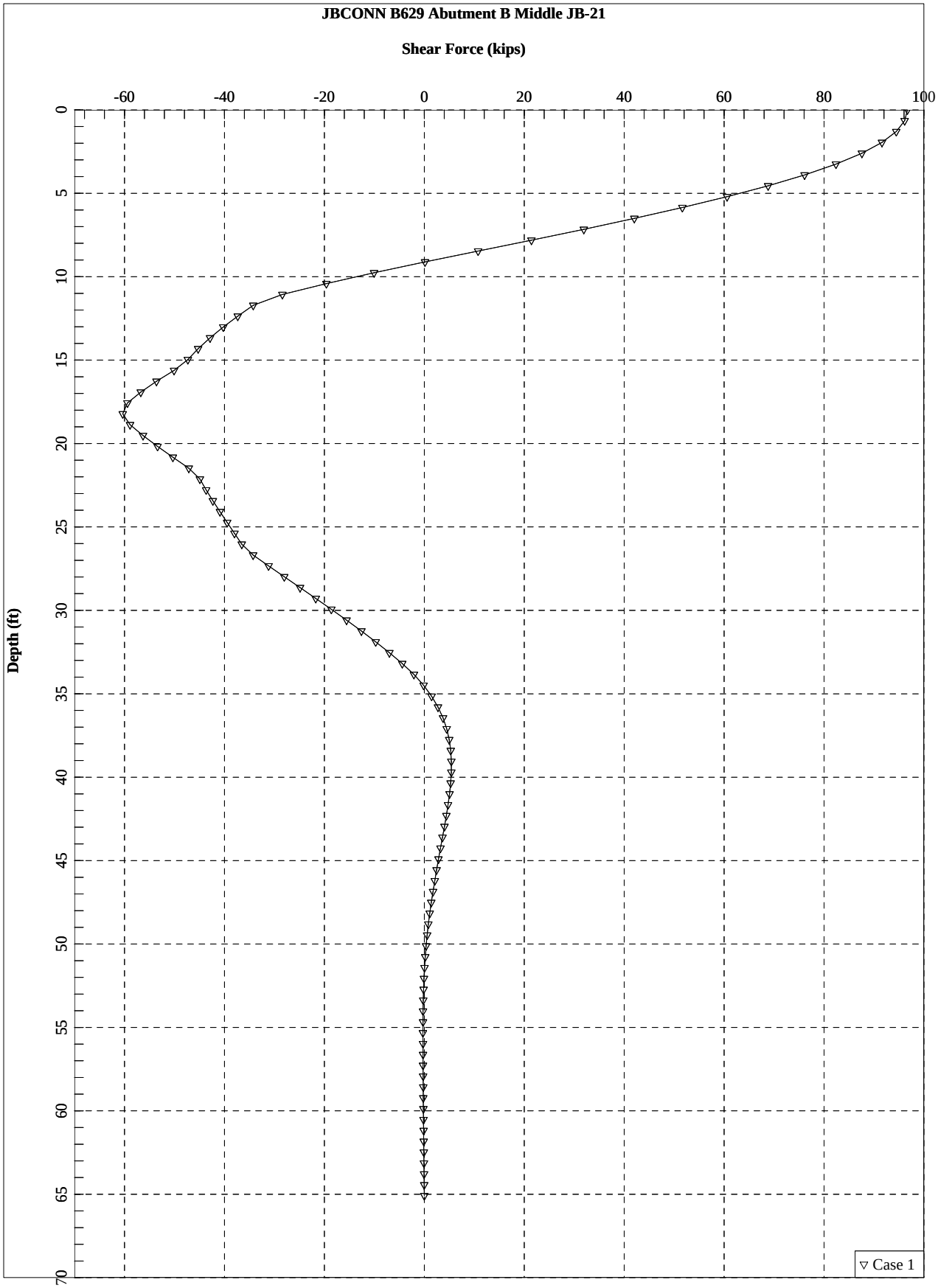
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72 HP 12x53 394 15.6 d= 11.78
12-inch sq. Concrete I = 1728 HP 14X73 729 21.4 d= 13.64


JBCONN B629 Abutment B Middle JB-21
Lateral Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B629 Abutment B Middle JB-21
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
1E4
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1


JBCONN B629 Abutment B Middle JB-21
Shear Force (kips)
-60
-40
-20
0
20
40
60
80
100
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Case 1

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 3/17/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment B Enter Values in Blue.	Date 3/17/2016

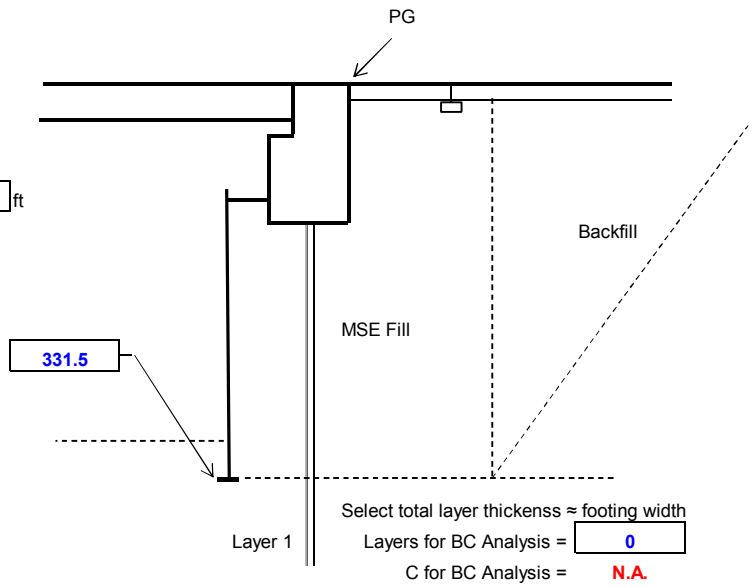
Red values are calculated

BORING No. =	JB-22	
Top of Boring El. =	342.9	ft
Profile Grade =	356.0	ft
Top of Layer 1 =	331.5	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	266.6	ft

South Abutment End

Bottom of Abut. = 343.3 ft

El. Ground in front of Wall =	333.5
El. Top of Front Wall =	346.5
Front Wall Total Height =	15.0
Front Wall Height from PG to Bot. =	24.5



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	319.0	12.5	P	II-B	8	15	18	18		15
2	310.0	9.0	P	II-B	16	13				15
3	300.0	10.0	P	II-B	27	29				28
4	294.0	6.0	P	II-C	45					45
5	289.0	5.0	P	II-B	11					11
6	274.0	15.0	P	II-C	50	19	58			42
7	266.6	7.4	P	II-C	85	100				93
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	MH	50.0	30.0		5	12.5	1844
2	118.0	125.0	MH	50.0	30.0		5	21.5	1813
3	118.0	125.0	MH	50.0	30.0		5	31.5	3500
4	130.0	137.0	ML	50.0	32.0		2	37.5	
5	118.0	125.0	MH	50.0	30.0		5	42.5	1375
6	130.0	137.0	ML	50.0	32.0		2	57.5	
7	120.0	128.0	HWR	250.0	34.0		4	64.9	
8									
9									
10									
11									
12									

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	1
					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.			Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-22	SHAFT NO. South	Date	3/17/2016

REV 6

LOAD DATA

Maximum Factored Axial Load	603	kips	Bottom of Abutment = 343.3
Service or Scour Load		kips	

ANALYSIS TYPE	
x	Max. Factored Load
	Service Load
	Scour El.

ELEVATION DATA

Top of Ground	331.5	ft	
Top of Shaft	331.5	ft	
Groundwater (Enter bot. shaft if none)	266.6	ft	Enter shaft bot, if none
Bottom of Permanent Casing		ft	
Top of Rock or Bot. Shaft in IGM	270.0	ft	
Bottom of Shaft	270.0	ft	

DRILLED SHAFT INFORMATION

Shaft Lateral Spacing	-	ft
Shaft Diameter	4.0	ft
Shaft Length	61.5	ft
Shaft Length in Soil or IGM	61.5	ft
Shaft Length in Rock	0.0	ft
Bouyant Weight of Shaft	118.6	kips
Factored Shaft Wt. (φ_{DL} = 1.25)	148.2	kips

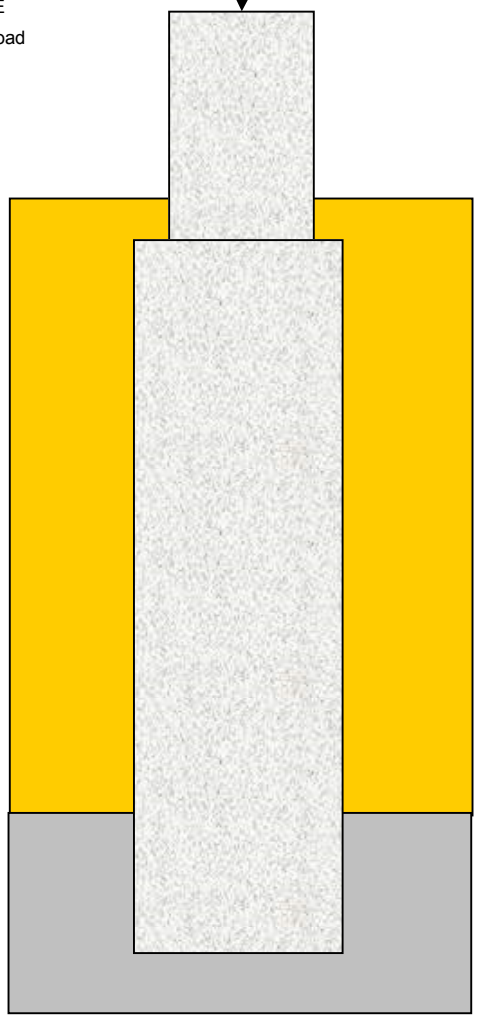
MISC INFO

Atmospheric Pressure	2.12	ksf
Concrete Compressive Strength	5,000	psi
Unit Weight of Water	0.0624	ksf
Unit Weight of Concrete	0.15	ksf
Elastic Modulus of Concrete		ksi
Downdrag Force Elevation	-	ft
Scour Depth Elevation	-	ft
Top of Shaft for Scour		ft
Hammer Efficiency	60	%
Eff. Wt. of Shaft	118.6	kips

Top of Ground	331.5
Top of Shaft	331.5
S1 to S6	
Top of Rock	No Rock
R1	
R2	
Bot. of Shaft	270.0

Enter new layer at 5' if bottom of clay is > than 5'

Enter new layer at bottom of downdrag and scour depths



SOIL AND IGM LAYER DATA

Layer No.	Material Description: Coh	Sandy	Gravelly	GranIGM	CohIGM	Top ft	Bottom ft	t ft	Unit Wt pcf	N blows	N60 blows	qu ksf
S1	x					331.5	310.0	21.5	110	15	15	3.2
S2		x				310.0	300.0	10.0	118	28	28	
S3		x				300.0	294.0	6.0	118	45	45	
S4	x					294.0	289.0	5.0	110	11	11	2.3
S5		x				289.0	274.0	15.0	118	42	42	
S6				x		274.0	270.0	4.0	138	93	93	

ROCK DATA

qu = unconfined compressive strength

Layer No.	Rock Type	Top ft	Bottom ft	t ft	qu ksf	Jointing: Closed	Open	Spacing, ft	Weathering	RQD	REC
R1				0.0							
R2		0.0		0.0							

Spacing: Wide > 10', Slight 3' - 10', Moderate 1' - 3', High 2" - 1', Intense <2"

Weathering: None, Slight, Moderate, Highly

REC ≥ 90	REC < 90

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					Made By	J.C. Giese
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-22	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOIL Use for CL, CH, MH, ML with trace sand and LL ≥ 45 REV 6

Rs = As * qs — As = area shaft — AASHTO10.8.3.5.1b-1

qs = α * Su — α = adhesion factor — Su or c = 0.5 * qu

α = 0.55 for (Su/pa) ≤ 1.5 — AASHTO10.8.3.5.1b-2

α = 0.55 - 0.1 * (Su/pa - 1.5) for 1.5 ≤ (Su/pa) ≤ 2.5 — AASHTO10.8.3.5.1b-3

Su = undrained shear strength

Note: t = 0 if bot of stratum ≤ 5.0'

Layer	Su ksf	Su/pa	α	qs ksf	t ft	As sf	Rs kips
S1	1.6	0.74	0.6	0.9	21.5	270.2	234.0
S2			0.0				
S3			0.0				
S4	1.2	0.54	0.6	0.6	15.0	188.5	120
S5			0.0				
S6			0.0				
						TOTAL SIDE RESISTANCE IN COHESIVE SOIL	354

Type	Default Unit Wt, pcf
Coh	110.0
CohIGM	135.0
GranIGM	138.0
Gravelly	120.0
Sandy	118.0

SIDE RESISTANCE IN SAND/GRAVEL N60 ≤ 50 (COHESIONLESS SOIL) Use for all sandy sandy and gravely soils

qs = β * σ'v ≤ 4.0 ksf — AASHTO 10.8.3.5.2.b-1

β = Load transfer coefficient

σ'v = Vertical effective stress at midpoint of layer

Sandy Soils

N60 ≥ 15 β = 1.5 - 0.135 * $z^{0.5}$ — AASHTO 10.8.3.5.2.b-2

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

Gravelly Soils

N60 ≥ 15 β = 2.0 - 0.06 * $z^{0.75}$ — AASHTO 10.8.3.5.2.b-4

N60 < 15 β = N60/15 * (1.5 - 0.135 * $z^{0.5}$) — AASHTO 10.8.3.5.2.b-3

z = depth from top of ground

Layer	t ft	Ground to Midpoint, ft	Half Layer Press. ksf	σv ksf	σw ksf	σ'v ksf	N60	β	qs ksf	As sf	Rs Sandy kip	Rs Gravelly kip
S1	21.5	10.8	1.2	1.2	0.00	1.2						
S2	10.0	26.5	0.6	3.0	0.00	3.0	28	0.81	2.4	125.7	299	
S3	6.0	34.5	0.4	3.9	0.00	3.9	45	0.71	2.8	75.4	208	
S4	5.0	40.0	0.3	4.5	0.00	4.5						
S5	15.0	50.0	0.9	5.7	0.00	5.7	42	0.55	3.1	188.5	585	
S6	4.0	59.5	0.3	6.8	0.00	6.8						
			Bot Press.	6.8						TOTAL SIDE RESISTANCE IN COHESIONLESS SOIL	1,092	

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					Made By	J.C. Giese
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PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-22	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN SANDY/GRAVELLY SOILS N60 > 50 (COHESIONLESS IGM) **Use for all sandy and gravelly soil and most HWR** REV 6

Rs = As * qs

As = area shaft

qs = unit side resistance

qs = σ'v * Ko * tanΦ' O'Neil and Resse 1999, Eqn. 11.26

σ'v = vertical effective stress at midpoint of layer

Φ' = angle of internal friction

Ko = coefficient of at-rest earth pressure

Φ' = {[N60 / (12.3+ (20.3 * σ'v / pa)]0.34} O'Neil and Resse 1999, Eqn. 11.26

ko = (1 - sinΦ') * (0.2 * pa * N60 / σ'v)$^{\sin\Phi}$ O'Neil and Resse 1999, Eqn. 11.26

N60 is limited to 100 bpf

Layer	t ft	Top Grd. To Midpoint, ft	Unit Wt pcf	σv ksf	σw ksf	σ'v ksf	N60	Φ' deg	Ko	qs ksf	As sf	Rs kip
S1	21.5	10.8	110.0	1.18	0.00	1.18	15					
S2	10.0	26.5	118.0	3.13	0.00	3.13	28					
S3	6.0	34.5	118.0	4.07	0.00	4.07	45					
S4	5.0	40.0	110.0	4.40	0.00	4.40	11					
S5	15.0	50.0	118.0	5.90	0.00	5.90	42					
S6	4.0	59.5	138.0	8.21	0.00	8.21	93	45.2	0.88	5.77	50.27	290.2
											TOTAL SIDE RESISTANCE IN COHESIONLESS IGM	290.2

TIP RESISTANCE IN SANDY/GRAVELLY SOILS N > 50 (COHESIONLESS IGM) Use of sandy soils, grannular IGM, and weak rock, RQD < 20%

Rp = As * qp

As = area shaft

qp = unit tip resistance

qp = 0.59 * [N60 * (pa / σ'v)]$^{0.8}$ * σ'v AASHTO 10.8.3.5.2c

pa = 2.12 ksf

σ'v = vertical effective stress at shaft tip

Layer	Top IGM, ft	Botom IGM, ft	Tip El. ft	σv bot ksf	σw ksf	σ'v	qp ksf	Ap sf	Rp kip
S1									
S2									
S3									
S4									
S5									
S6	274.0	270.0	270.0	6.8	-0.21	7.06	59.8	12.57	751
								TOTAL TIP RESISTANCE IN COHESIONLESS IGM	751 kips

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					Made By	J.C. Giese
PROJECT NAME	JBCONN	VDOT PROJECT NO.	0		Date	3/17/2016
ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-22	SHAFT NO. South	Date	3/17/2016

SIDE RESISTANCE IN COHESIVE SOILS N > 50 (COHESIVE IGM) **Use for HWR derrived from argilacious rocks, e.g. mudstone, clay shales, etc.**

REV 6

Rs = As * qs — As = area shaft, sf

qs = unit side resistance, ksf

qs = α * φ * qu — qu = unconfined compressive strength of intact IGM, ksf — O'Neil and Resse 1999, Eqn. 11.21

N60 is limited to 300 bpf based on Fig. 11.5 qu = 0.21 N* N60 = 150 ksf± for N = 300 — FHWA-IF-99-025

φ = joint effect factor from FHWA Table 11.4 = 0.45 based on RQD = 20%

(assume RQD = 20% for weathered rock modelled as cohesive IGM)

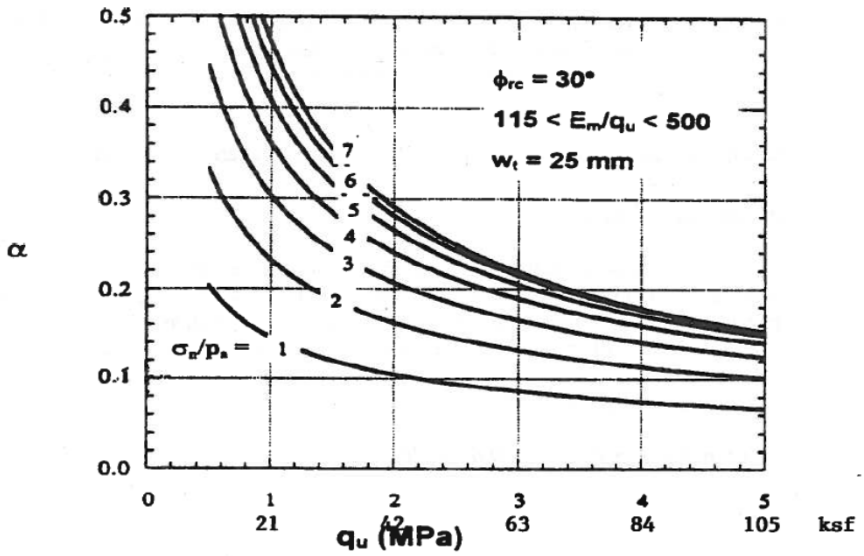

Figure 11.5. Factor α for cohesive IGM's

σn = 0.65 * δc * z, ksf z ≤ 40 ft

σn = fluid weitght of concrete at middle of layer

δc = unit weight of concrete, kcf

Layer	t ft	Top Shaft to Midpoint, ft	σn ksf	σn/Pa	qu ksf	α	qs ksf	As sf	Rs kip
S1	21.5	10.8	1.0	0.49					
S2	10.0	26.5	2.6	1.22					
S3	6.0	34.5	3.4	1.59					
S4	5.0	40.0	3.9	1.84					
S5	15.0	50.0	3.9	1.84		0.16			
S6	4.0	59.5	3.9	1.84					
								TOTAL SIDE RESISTANCE IN COHESIVE IGM	0 kips

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	9
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ECS PROJECT NO.	01-21924	BRIDGE NO.	B629	PIER NO. Abutment B	Checked By	MAR
PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-22	SHAFT NO. South	Date	3/17/2016

Side and Base Transfer Resistance in Grannular Soils

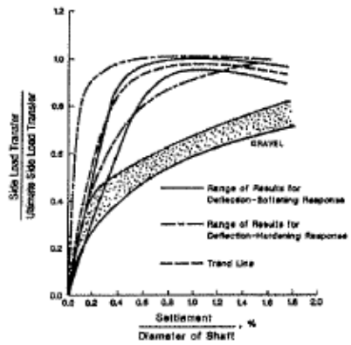

Figure 10.8.2.2.2-3—Normalized Load Transfer in Side Resistance versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

The deflection-softening response typically applies to cemented or partially cemented soils, or other soils that exhibit brittle behavior, having low residual shear strengths at larger deformations. Note that the trend line for sands is a reasonable approximation for either the deflection-softening or deflection-hardening response.

Sandy x	Sandy y	Gravelly y
0.0	0.00	0.00
0.1	0.24	0.20
0.2	0.47	0.35
0.3	0.70	0.40
0.4	0.85	0.46
0.5	0.90	0.51
0.6	0.94	0.55
0.8	0.96	0.59
1.0	0.97	0.64
1.2	1.00	0.68
1.5	0.95	0.72
2.0	0.90	0.80
5.0	0.75	

REV 6

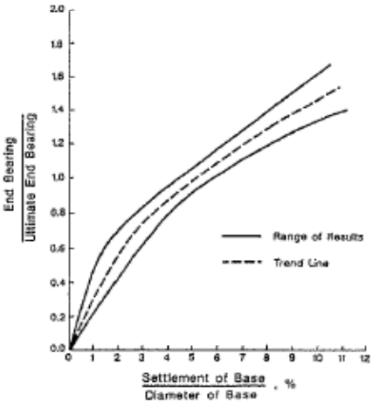

Figure 10.8.2.2.2-4—Normalized Load Transfer in End Bearing versus Settlement in Cohesionless Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.04
0.2	0.07
0.3	0.10
0.6	0.20
1.0	0.30
1.3	0.38
1.6	0.47
2.0	0.56
3.0	0.73
5.0	0.98

Side and Base Resistance Transfer in Cohesive Soils

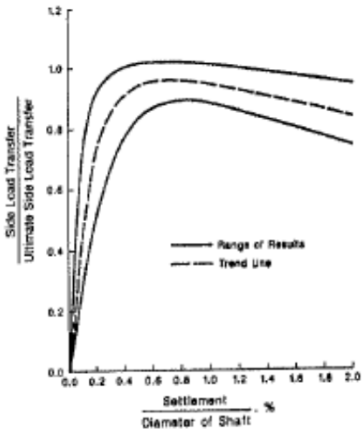

Figure 10.8.2.2.2-1 Normalized Load Transfer in Side Resistance versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

The curves in Figures 10.8.2.2.2-1 and 10.8.2.2.2-3 also show the settlements at which the side resistance is mobilized. The shaft skin friction R_s is typically fully mobilized at displacements of 0.2 percent to 0.8 percent of the shaft diameter for shafts in cohesive soils. For shafts in cohesionless soils, this value is 0.1 percent to 1.0 percent.

	REV 1	REV 6
	x	y
	0.0	0.00
	0.1	0.28
	0.2	0.55
	0.3	0.83
	0.4	0.86
	0.5	0.89
	0.6	0.95
	0.8	0.95
	1.0	0.93
	1.2	0.91
	1.5	0.85
	2.0	0.83

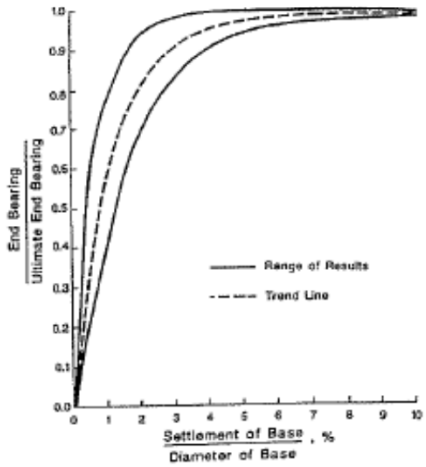

Figure 10.8.2.2.2-2—Normalized Load Transfer in End Bearing versus Settlement in Cohesive Soils (from O'Neill and Reese, 1999)

x	y
0.0	0.00
0.1	0.09
0.2	0.17
0.3	0.25
0.4	0.31
0.5	0.36
0.6	0.42
0.8	0.5
1.0	0.58
1.3	0.65
1.6	0.72
2.0	0.81
3.0	0.90
5.0	0.98

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	AASHTO DRILLED SHAFT ANALYSIS				Page	12
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PROJECT LOCATION	FairfaxCo.	BORING NO.	JB-22	SHAFT NO. South	Date	3/17/2016

SUMMARY OF RESISTANCES WHEN BEARING IN IGM REV 6

Assumed Settlement 0.50 in 1.0 Δ/B

Side Resistances

Layer No.	Material Description						
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM		
S1	234.0						
S2		298.9					
S3		207.9					
S4	119.7						
S5		584.8					
S6				290.2			
Sum	353.8	1091.6	0.0	290.2	0.0		
φ	0.45	0.55	0.55	0.6	0.6		AASHTO Table 10.5.2.4-1
φ * Rs	159.2	600.4	0.0	174.1	0.0		
L.T. Factor	0.93	0.97	0.64	0.97	0.9	Sum Rs	See AASHTO Figures 10.8.2.2.2-1 & -3
qs	148.1	582.3	0.0	168.9	0.0	**899**	kips

Tip Resistance

Layer No.	Material Description				
	Cohesive	Sandy	Gravelly	Gran. IGM	Coh. IGM
S1					
S2					
S3					
S4					
S5					
S6				751.1	
Sum				751.1	0.0
φ				0.55	0.55
φ * Rs				413.1	0.0
L.T. Factor				0.3	0.58
Rp				123.9	0.0

Sum Rp **124**

Strength Resistance Check when Bearing in IGM

R	Fact. Resis. kips	Load Type	Fact. Load kips	Shaft Wt, MSE Zone
Rs	899	Pmax	603	
Rp	124	Wt. Shaft	148	22
Σ	1,023	Σ	751	
		FR ≥ RP	**OK**	

AASHTO Table 10.5.2.4-1 1023 > 773

See AASHTO Figures 10.8.2.2.2-2 & -4

FHWA-10-NHI-10-016 Figure 12=30

LPILE/GROUP DATA INPUT FORM

Project Name JBCONN B629

Input Required Noted in Blue Red Values Are Calculated

Boring No. JB-22

Bridge No. B629 **Pier No.** B South **Bottom of Pile Cap / Top of Shaft El.** 343.3

Project No. 01-21924
By: JCG 3/17/2016
Checked: MAR 3/17/2016

Indicate Analysis Type Required
- x — L/PILE Single Pile/Shaft Free head
- L/PILE Single Pile/Shaft Fixed head
- GROUP Fixed Head

343.3 Top of Ground El.

Indicate Load Type
- x — Single Pile/Shaft Load — 270.0 — Tip El. — L inches = 880
- Group Load — 1 — No. Piles/Shafts for GROUP

HP Pile Size

Pile Size. ft 4.000 f'c 5,000 f'c 0.25

#N/A P Reducn Factor Long 0.0 B
0.25 P Reducn Factor Trans 3.0 B
#N/A P Reducn Factor Resultant Mom.
(based on primary loading only)

Tranverse Spacing, ft 12.00 **Longit. Spacing, ft** 0.0

Max. Fv for Axial Capacity Analysis, kips 603.0

Include couple effects with Fv

Include secondary/tertiary loads when it is not readily apparent which load group is the dominant load group.

Load Conditions (Primary)				Load Conditions (Secondary)				Load Conditions (Tertiary)			
Fv (FV)	603	kips (lbs)	603,000	Fv (FV)		kips (lbs)		Fv (FV)		kips (lbs)	
Fy (FL)	95.00	kips (lbs)	95,000	Fy (FL)		kips (lbs)		Fy (FL)		kips (lbs)	
Fz (FT)	18.0	kips (lbs)	18,000	Fz (FT)		kips (lbs)		Fz (FT)		kips (lbs)	
Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)		Mv (torsion)		kip-ft (lb-in)	
My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)		My (MT)		kip-ft (lb-in)	
Mz (ML)	254	kip-ft (lb-in)	3,048,000	Mz (ML)		kip-ft (lb-in)		Mz (ML)		kip-ft (lb-in)	
Fresultant	96.69	kips (lbs)	96,690	Fresultant		kips (lbs)		Fresultant		kips (lbs)	
Mresultant	254.00	kip-ft (lb-in)	3,048,000	Mresultant		kip-ft (lb-in)		Mresultant		kip-ft (lb-in)	

Province Notes:
CP = Coastal Plain
P = Piedmont
CFB = Culpr. Fault Basin
VR = Valley & Ridge
R = Rock
FR = Weak Fract. Rock
SF = Select Fill

Soil Conditions Water Table El. 266.6 ft

LPILE / GROUP INPUT PARAMETERS

Enter stratum at bot. of water table El. — USCS, SF, R, or FR — Enter 15 for compacted fill w/o SPT data, 50 for SF — Max 6.0 — E_{50} required for CL, CH, & MH

Layer No.	El. Bottom of Layer	Layer Thickness	Soil Type	Province	Avg. N_{60}	Substrat.	Depth inches	Density pci	Φ°	Cohesion p/in^2	Modulus pci	E_{50}
Surface	ft	ft					0					
1	331.5	11.8	SF	P	32	Gravel	142	0.07813	32.0		177	
2	319.0	12.5	MH	P	15	II-B	292	0.06829		6.00		0.005
3	310.0	9.0	MH	P	15	II-B	400	0.06829		6.00		0.005
4	300.0	10.0	MH	P	28	II-B	520	0.06829		6.00		0.005
5	294.0	6.0	ML	P	45	II-C	592	0.07523	32.0		249	
6	289.0	5.0	MH	P	11	II-B	652	0.06829		6.00		0.006
7	274.0	15.0	ML	P	42	II-C	832	0.07523	32.0		232	
8	270.0	4.0	HWR	P	93	III	880	0.06944	34.0		515	
9												
10												
11												

In GROUP, for rock strength, enter phi = 0 and 0.5 * the unconf. compressive strength for cohesion.

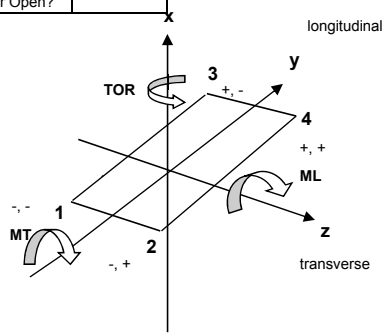
Colored boxes below are FR and Rock parameters reqd. for input.

For Rock in GROUP	Eir	pci	qc =	psi	RQD =		Cohes, psi	0
For FR in GROUP	Eir	pci	qc =	psi	RQD =		Cohes, psi	0
For Fractured Rock (weak rock) in LPILE, enter	Er	psi	qc =	psi ≤ 1000	RQD =		k_rm	0.0005
For Rock (strong rock) in LPILE, enter			qc =	psi				

Rock Type		Joints R Closed or Open?	
		Joints FRClosed or Open?	

Pile Coordinates

Pile No.	Coordinate	Coordinate
1		
2		
3		
4		



Diameter	Mom. of I. in^4	Area in^2
2.0	16,286	452
2.5	39,761	706.86
3.0	82,448	1,018
3.5	152,745	1,385
4.0	260,577	1,810
4.5	417,394	2,290
5.0	636,174	2,827
5.5	931,422	3,421
6.0	1,319,170	4,072
7.0	2,443,926	5,542
8.0	4,169,230	7,238

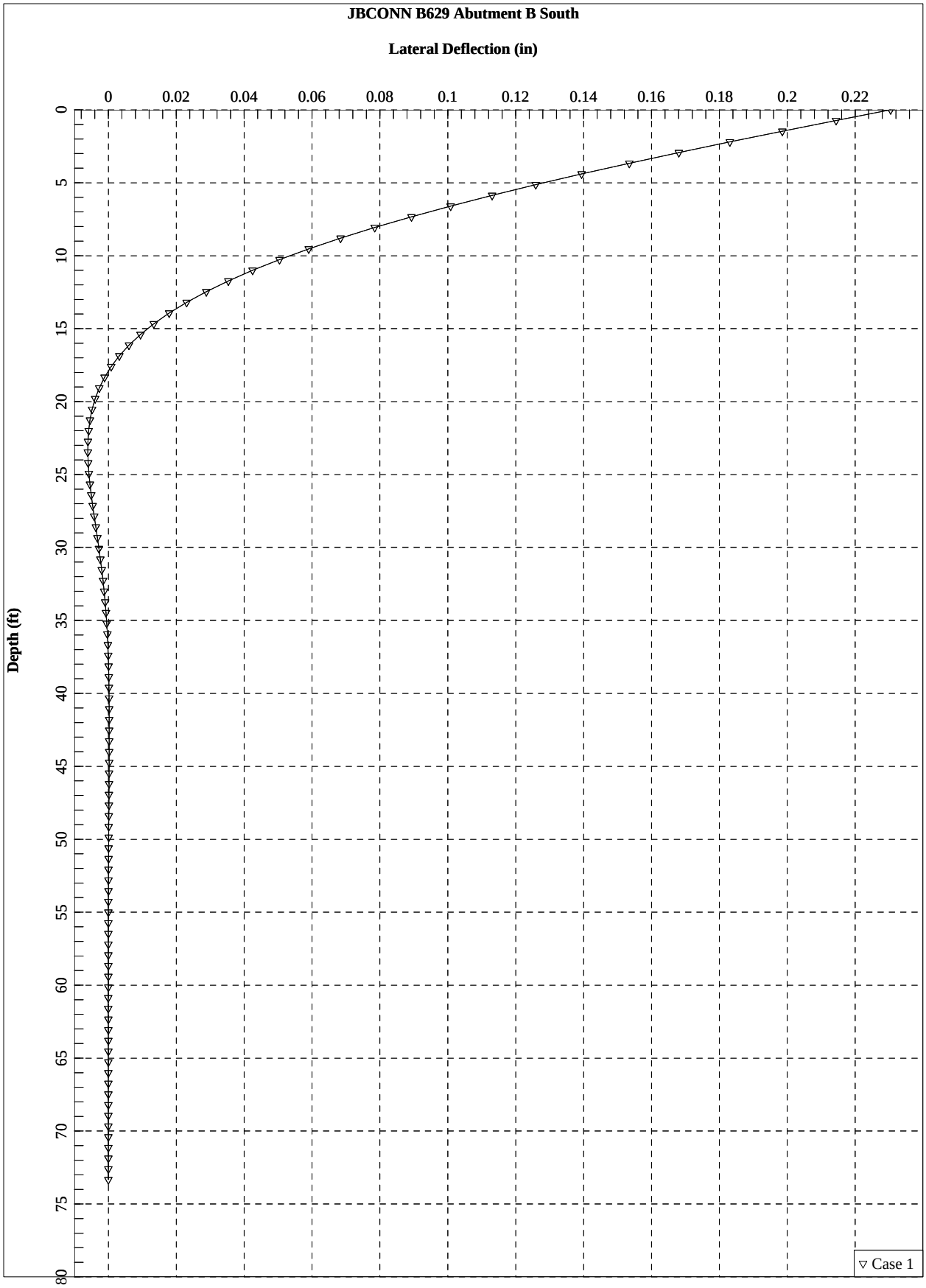
M concrete = psi 4,030,509
M Steel = psi 30,000,000

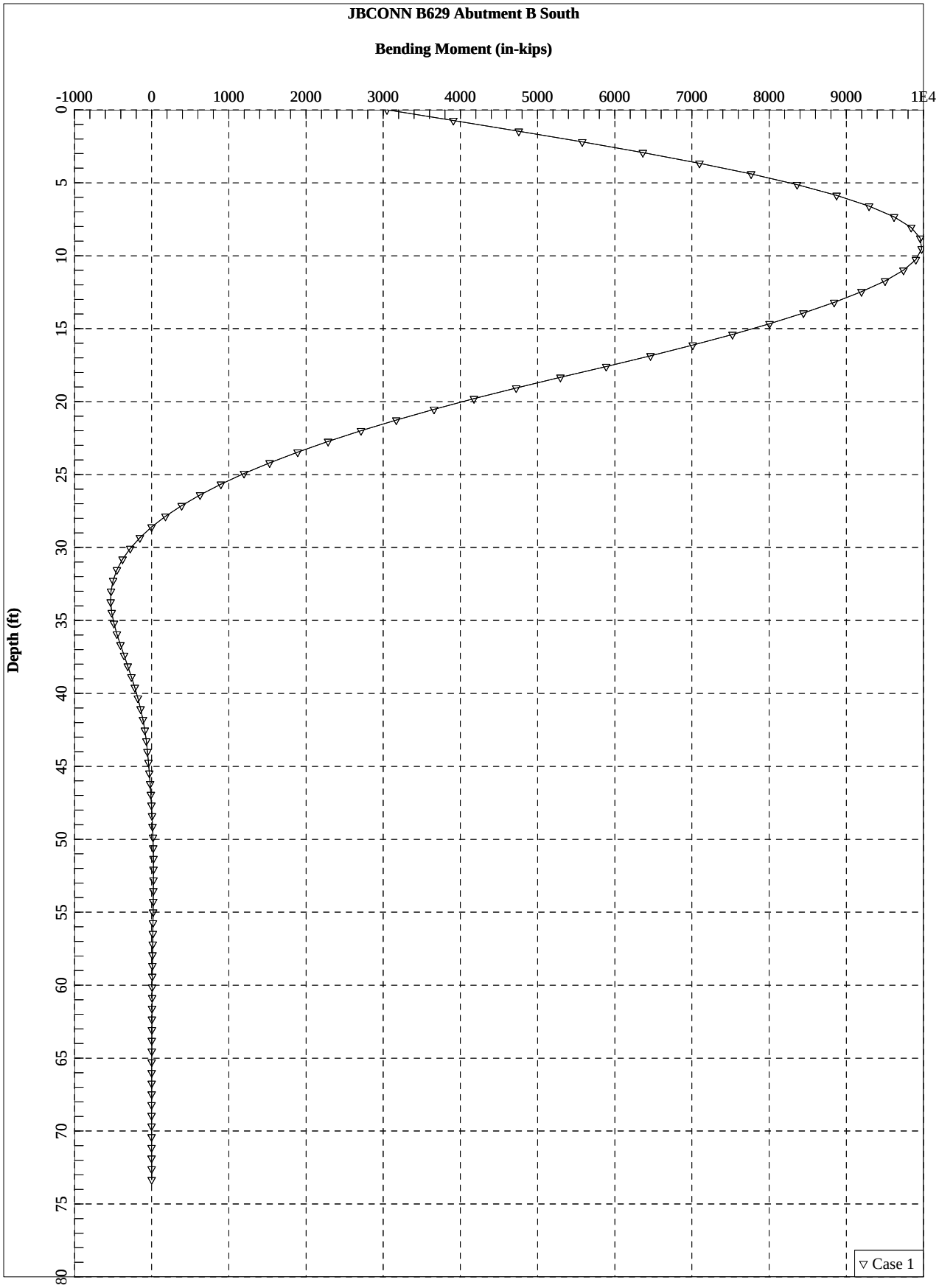
Shaft Spacing * D	P Reduction Factor
3.0	0.25
4.0	0.40
6.0	0.70
8.0	1.00

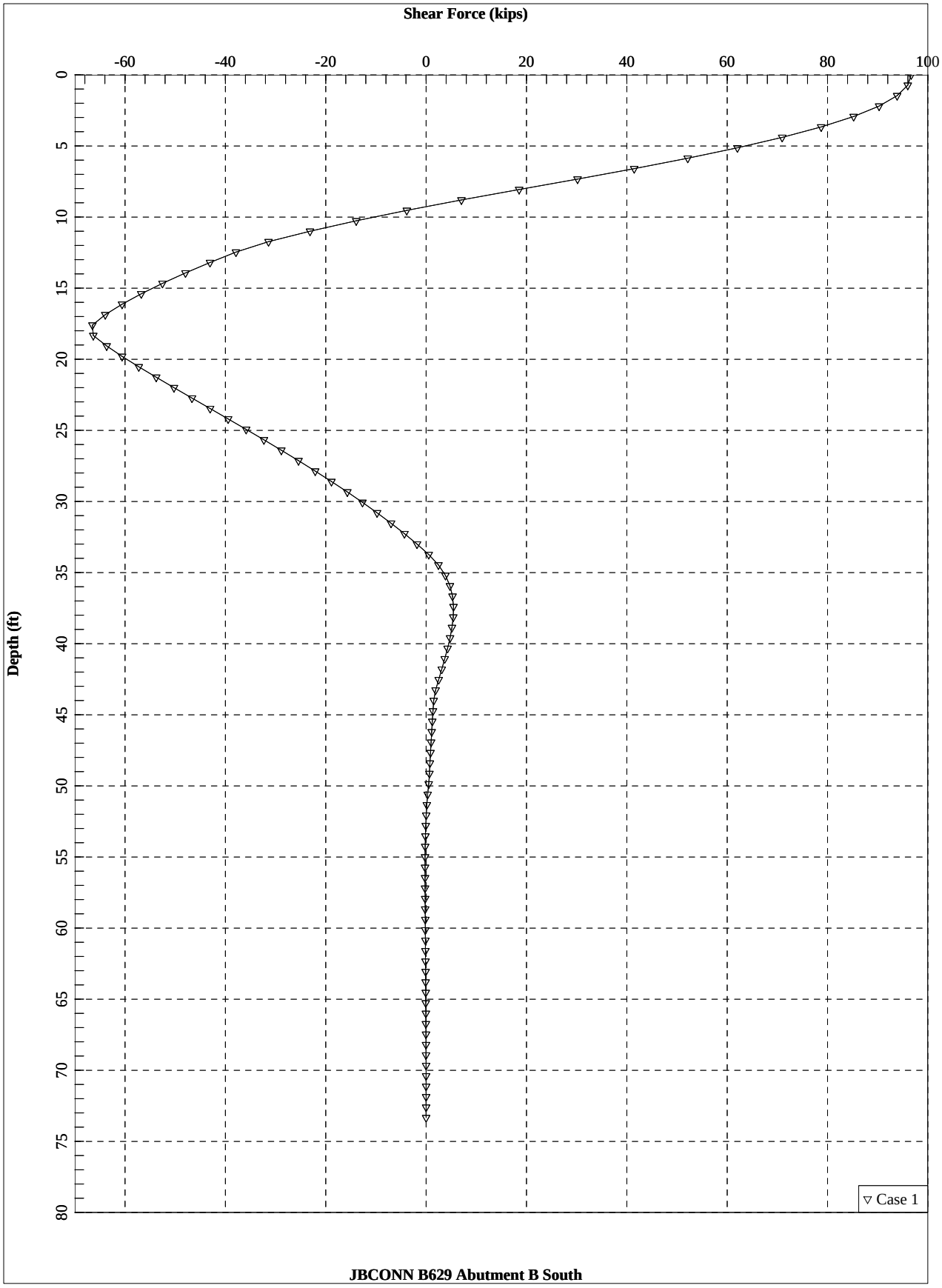
PY reduction for Resultant #NAME?
Transverse Ratio (Secondary): #NAME?

HP 10x42 211 12.4 d = 9.72
12-inch sq. Concrete I = 1728

HP 12x53 394 15.6 d= 11.78
HP 14X73 729 21.4 d= 13.64


JBCONN B629 Abutment B South
Lateral Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Case 1


JBCONN B629 Abutment B South
Bending Moment (in-kips)
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
1E4
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Case 1


Shear Force (kips)
-60
-40
-20
0
20
40
60
80
100
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
▽ Case 1
JBCONN B629 Abutment B South

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	Page 1 of 1	
Determination of MSE Soil Parameters for Analysis (English Version)	Made By DJS3	
	Date 11/4/2015	
	Checked By JCG	
LOCATION Wall No. RW001 STA 12+17.50 Enter Values in Blue.	Date 11/4/2015	

BORING No. 15MSE-4

Top of Boring Elevation 327.8

Red values are calculated

Profile Grade = 343.5

Top Wall El. = 343.5 EL.

Hammer Efficiency 80 %

Top Coping El. = 343.5

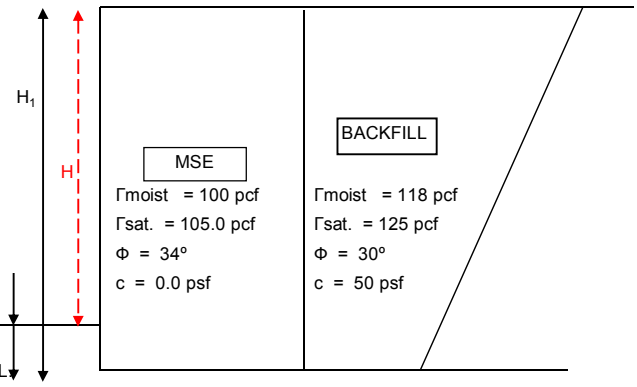
H for MSEW = 13.0

H_1 for stability & settlement analyses = 18.5

Groundwater Elevation = 313.8

Top of Ground = 330.5 5.5 D

Bot. Wall El. = 325.0 EL.



No. Layers for BC Analysis 2 (~0.7H)

Φ° for BC analysis = 33.8

C psf for BC Analysis = 226

C P = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

Layer 1

Layer 2

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	Avg. N_{60}
1	323.8	1.2	P	II-C	24				32
2	314.8	9.0	P	III	100	100	100		100
3	313.8	1.0	P	III	100				100
4	298.4	15.4	P	III	67	100	100	100	100
5									
6									
7									
8									
9									
10									
11									
12									

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	ARCA C, psf	ARCA Φ°	CL w/ sand & gravel ?	Soil No.	Depth to Bot. from Bot. of Wall ft.	
1	130.0	137.0	ML	50.0	32.0		2	1.2	
2	120.0	128.0	HWR	250.0	34.0		4	10.2	
3	120.0	128.0	HWR	250.0	34.0		4	11.2	
4	120.0	128.0	HWR	250.0	34.0		4	26.6	
5									
6									
7									
8									
9									
10									
11									
12									

Project Name: Jones Branch Conn **Wall ID & Station:** RW001 STA 12+17.50
Project No. 21924

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.100
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.130

By: DJS3 **Date:** 12/22/15
Checked: JCG **Date:** 12/22/15

ANALYSIS EXT. LOAD: Surcharge 0.14 ksf; LRFD LIVE LOAD 0.08; LRFD DEAD LOAD 0.00; AASHTO SURCHARGE 0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ, based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = 0.7*H' ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														162						0.142	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.1	226	33.8	18.5	7.224	24.994	13.0	2.0	0.33	46.1	140.9	3.06	0.62	15.0	0.6	2.16	1.84	3578	282	2698	0.00	35.17	38.62	9.26	29920	11.09	YES	YES	YES	YES	
LRFD																				0.226	e/L												YES	
LRFD	Sliding and OT			0.1	226	33.8	18.5	10.960	25.771	13.0	2.0	0.33	70.2	155.1	2.21	0.62	15.0	0.6	1.43	2.93	5151		3865	0.00	35.17	38.62	8.84	18814	4.87	YES	YES	YES	YES	
LRFD	Bearing Capacity								34.156					221.2				Xo	4.42	2.06														
Soil Type	Description			USCS		Layer	Thickness ft	Midpoint ft	Type	SPT					Phi deg	Φ * d	Φ, C depth deg	C psf	c*d	0.159	e/L		1.433	Ratio LRFD/ ASD										
1	Clays			CL		1	1.2		2	32					32.0	38.4	1.2	50	60															
2	Sitls, sandy silts, silty and clayey sands			ML, SM, SC		2	9.0		4	100					34.0	306.0	9	250	2250															
3	clean sands w/ little gravel			SW, SP		3										0.0	0		0															
4	Sandy gravels & gravels, highly weathered rock			HWR, GP, GW		4																												
5	Overconsloidated higly plastic soils			CH, MH		5																												
						6																												
						7																												
	Bottom Layer for Φ consideration in BC =					8																												
															Phi for BC analysis =		33.8	C for BC analysis =	226															

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall coping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade minus Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Do not use for SP or GP at base.
7. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

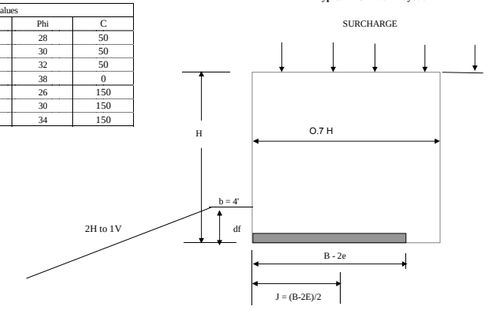
B = 0.7H for normal situations, min = 2.4 m

Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values				
	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φ°	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls				Page 1 of 1 Made By DJS3 Date 12/22/2015 Checked By JCG Date 12/22/2015
LOCATION	RW001	STA 12+17.50	BL	Enter Values in Blue.	

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. 15MSE-4

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	1.2	32	2	0.0	1.2
2	9.0	100	4	1.2	10.2
3	1.0	100	4	10.2	11.2
4	15.4	100	4	11.2	26.6
5					
6					
7					
8					
9					
10					
11					
12					

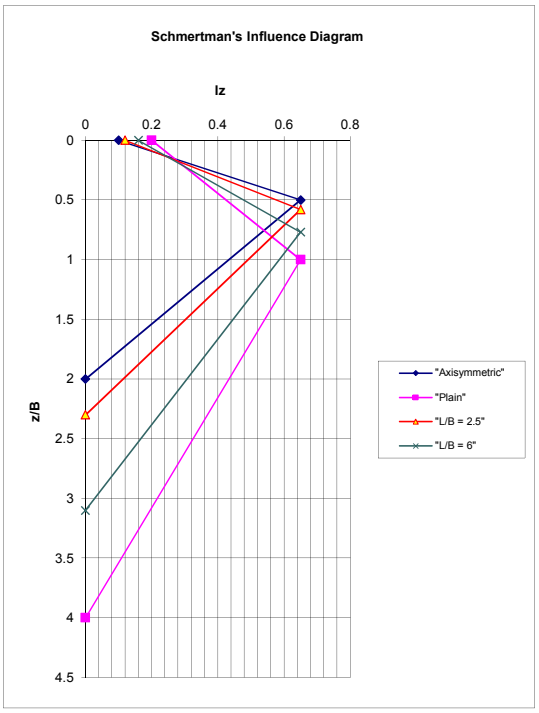
Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	2,698	Avg. Foundation Pressure From MSEW
Γ, pcf	130.0	Bearing Soil Density
B, ft	9.3	Foundation Width (effective B-2e)
L, ft	217	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,698	
L/B	23.28	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR
If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

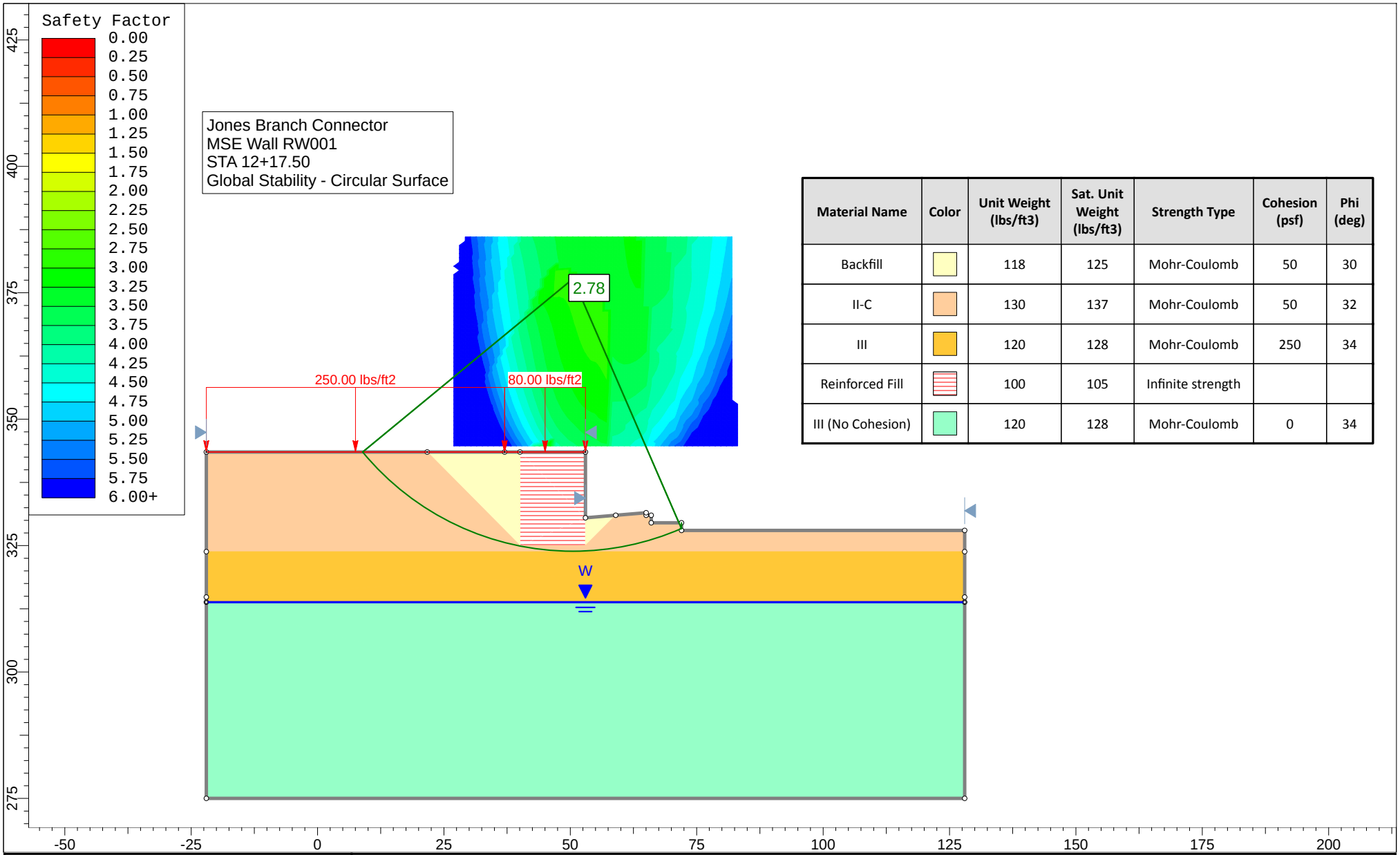
Δ, in	0.07	**Immediate Settlement** (up to end of monitoring period)		
	0.01	Post-Construction Settlement, in.	0.20	year
Δ, in	0.08	**Total Settlement**	1.00	year

Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.10730	0.22824	4	1,217,280	0.01	0.01	0.08	0.08
3	0.32189	0.36472	4	3,804,000	0.01	0.01	0.07	0.07
5	0.53648	0.50120	4	3,804,000	0.01	0.01	0.06	0.06
7	0.75107	0.63768	4	3,804,000	0.01	0.01	0.06	0.06
9	0.96567	0.59561	4	3,804,000	0.01	0.01	0.05	0.05
11	1.18026	0.53595	4	3,804,000	0.01	0.01	0.04	0.04
13	1.39485	0.47629	4	3,804,000	0.01	0.01	0.03	0.03
15	1.60944	0.41664	4	3,804,000	0.01	0.01	0.02	0.02
17	1.82403	0.35698	4	3,804,000	0.01	0.01	0.02	0.02
19	2.03863	0.29732	4	3,804,000	0.01	0.00	0.01	0.01
21	2.25322	0.23767	4	3,804,000	0.00	0.00	0.01	0.01
23	2.46781	0.17801	4	3,804,000	0.00	0.00	0.01	0.01
25	2.68240	0.11835	4	3,804,000	0.00	0.00	0.00	0.00
27	2.89700	0.05870	4	3,804,000	0.00	0.00	0.00	0.00
29	3.11159	0.00000						
31	3.32618	0.00000						
33	3.54077	0.00000						
35	3.75536	0.00000						
37	3.96996	0.00000						
39	4.18455	0.00000						
41	4.39914	0.00000						
43	4.61373	0.00000						
45	4.82833	0.00000						
47	5.04292	0.00000						
49	5.25751	0.00000						
51	5.47210	0.00000						
53	5.68670	0.00000						
55	5.90129	0.00000						
57	6.11588	0.00000						
59	6.33047	0.00000						
61	6.54506	0.00000						
61	6.54506	0.00000						
63	6.75966	0.00000						
65	6.97425	0.00000						
67	7.18884	0.00000						
69	7.40343	0.00000						
71	7.61803	0.00000						
73	7.83262	0.00000						
75	8.04721	0.00000						
77	8.26180	0.00000						
			ΣΔ, in. (Uncorrected)		0.09			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

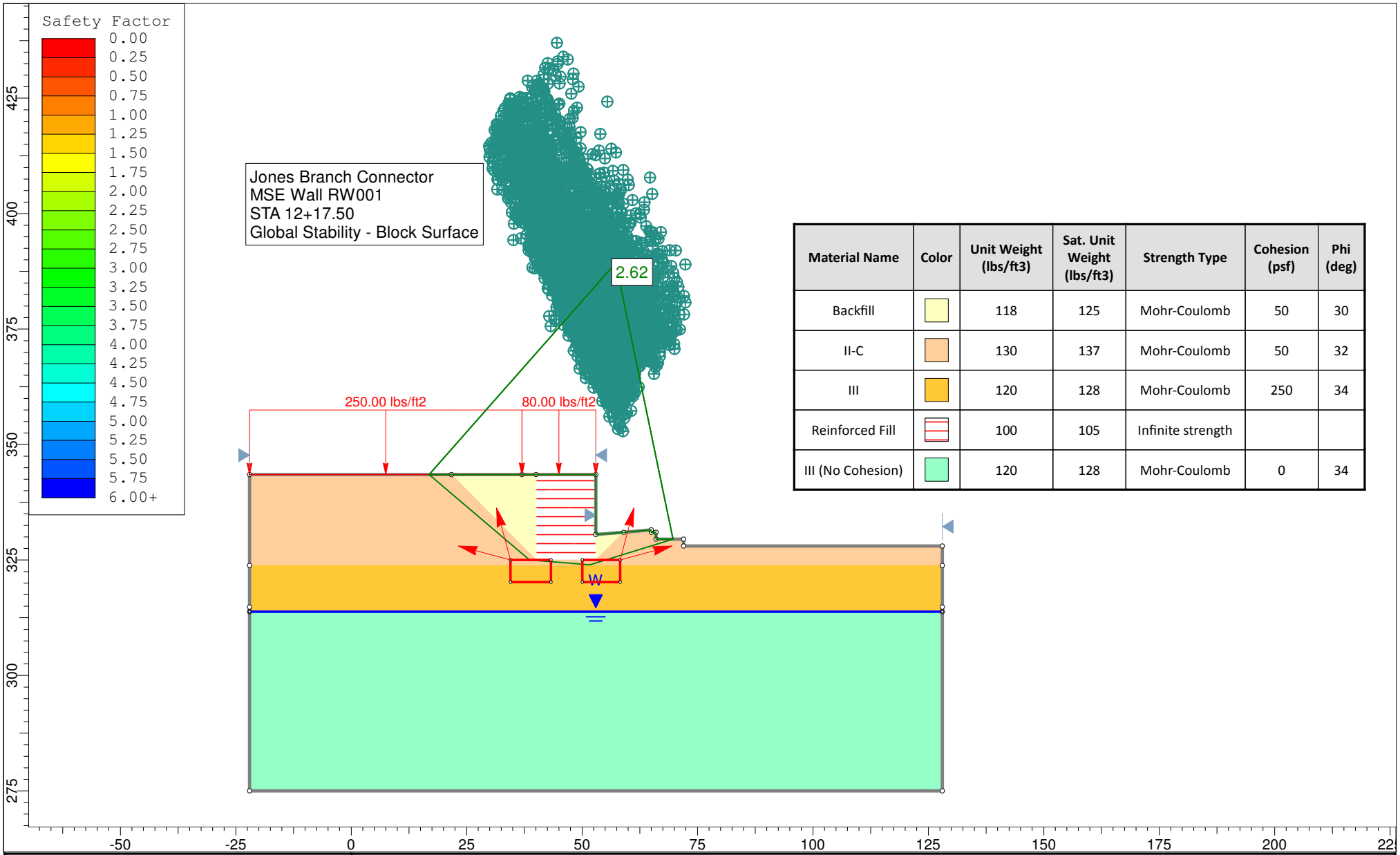
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	125	Mohr-Coulomb	50	30
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Reinforced Fill		100	105	Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.036

Project	JBCONN MSE Wall RW001		
Analysis Description	STA 12+17.50		
Drawn By DJS3	*Scale* 1:315	*Company* ECS	
Date 10/15/2015		*File Name* rw001 sta 12+17_Frev_80 psf.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	125	Mohr-Coulomb	50	30
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Reinforced Fill		100	105	Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

Project	JBCONN MSE Wall RW001		
Analysis Description	STA 12+17.50		
Drawn By	DJS3	Scale 1:345	Company ECS
Date	10/15/2015		File Name rw001 sta 12+17_Frev_80 psf_Block.slim

SLIDEINTERPRET 6.036

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	Page 1 of 1 Made By DJS3	
Determination of MSE Soil Parameters for Analysis (English Version)	Date 11/4/2015 Checked By JCG	
LOCATION Wall No. RW001 STA 12+34.62 Enter Values in Blue.	Date 10/20/2015	

Red values are calculated

BORING No. 15MSE-4

Top of Boring Elevation 327.8

Profile Grade = 347.0

Top Wall El. = 347.0 EL.

Hammer Efficiency 80 %

Top Coping El. = 347

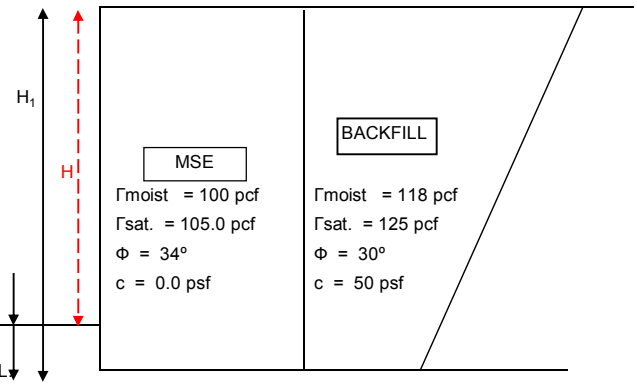
H for MSEW = 16.5

H_1 for stability & settlement analyses = 22.0

Groundwater Elevation = 313.8

Top of Ground = 330.5 5.5 D

Bot. Wall El. = 325.0 EL.



No. Layers for BC Analysis 2 (~0.7H)

Φ° for BC analysis = 33.8

C psf for BC Analysis = 226

C P = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

Layer 1

Layer 2

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	Avg. N_{60}
1	323.8	1.2	P	II-C	24				32
2	314.8	9.0	P	III	100	100	100		100
3	313.8	1.0	P	III	100				100
4	298.4	15.4	P	III	67	100	100	100	100
5									
6									
7									
8									
9									
10									
11									
12									

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	ARCA C, psf	ARCA Φ°	CL w/ sand & gravel ?	Soil No.	Depth to Bot. from Bot. of Wall ft.	
1	130.0	137.0	ML	50.0	32.0		2	1.2	
2	120.0	128.0	HWR	250.0	34.0		4	10.2	
3	120.0	128.0	HWR	250.0	34.0		4	11.2	
4	120.0	128.0	HWR	250.0	34.0		4	26.6	
5									
6									
7									
8									
9									
10									
11									
12									

SOIL DATA

REINFORCED SOIL

Unit weight, γ	100.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	118.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	130.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{equiv.}$	33.8 °
Equivalent cohesion, $c_{equiv.}$	226.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3544 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): N_c = 41.43 N_γ= 39.81

SEISMICITY

Not Applicable

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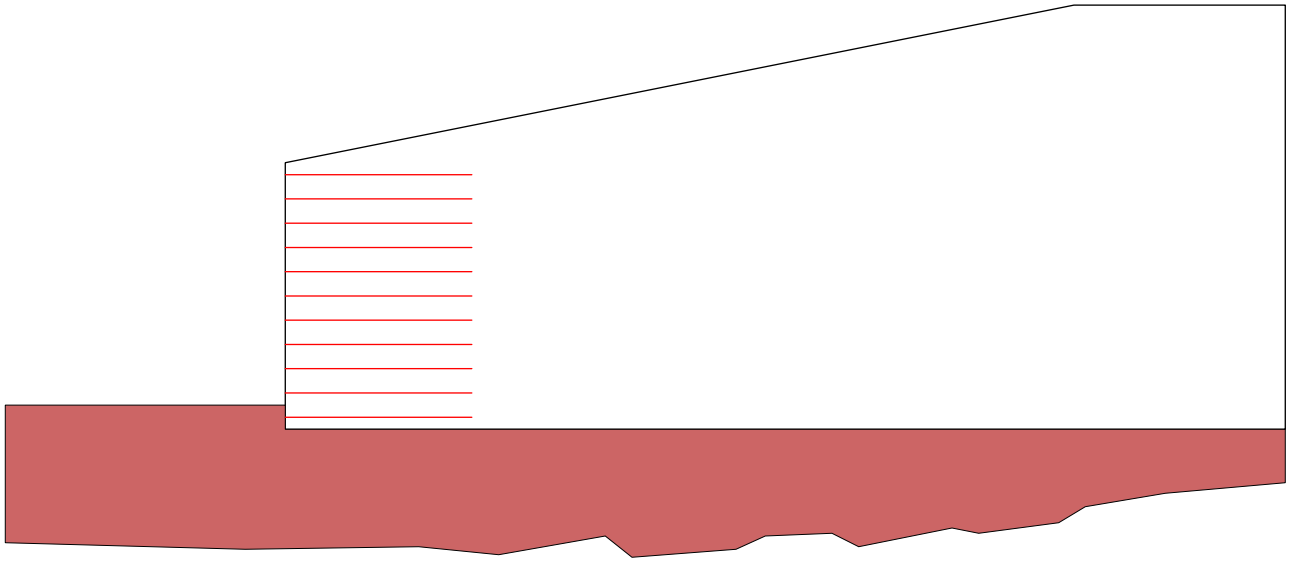
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	22.00	[ft]	{ Embedded depth is E = 2.00 ft, and height above top of finished bottom grade is H = 20.00 ft }
Batter, ω	0.0	[deg]	
Backslope, β	11.3	[deg]	
Backslope rise	13.0	[ft]	Broken back equivalent angle, I = 11.30° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E
Uniformly distributed dead load is 0.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 4.89, factor bearing load = 4928 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.399, Eccentricity, e/L = 0.2037, CDR-overturning = 2.13

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	1.00	15.40	1	N/A	2.02	2.24	2.241	1.213	1.441	0.1859	---
2	3.00	15.40	1	N/A	2.17	2.41	2.410	1.172	1.554	0.1522	---
3	5.00	15.40	1	N/A	2.30	2.56	2.559	1.217	1.688	0.1210	---
4	7.00	15.40	1	N/A	2.50	2.78	2.775	1.237	1.844	0.0922	---
5	9.00	15.40	1	N/A	2.76	3.07	3.068	1.229	2.035	0.0658	---
6	11.00	15.40	1	N/A	3.08	3.42	3.422	1.179	2.272	0.0416	---
7	13.00	15.40	1	N/A	3.51	3.90	3.905	1.205	2.575	0.0192	---
8	15.00	15.40	1	N/A	4.18	4.64	4.641	1.289	2.975	-0.0019	---
9	17.00	15.40	1	N/A	5.31	5.90	5.898	1.394	3.520	-0.0234	---
10	19.00	15.40	1	N/A	7.47	8.30	8.302	1.533	4.285	-0.0497	---
11	21.00	15.40	1	N/A	12.96	14.40	14.403	1.766	5.293	-0.0999	---

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ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, Fs = 11.03, Meyerhof stress = 3472 lb/ft².
Foundation Interface: Direct sliding, Fs = 2.031, Eccentricity, e/L = 0.1369, Fs-overturning = 3.01

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	Fs-overall [pullout resistance]	Fs-overall [connection break]	Fs-overall [metal strip strength]	Metal strip strength Fs	Pullout resistance Fs	Direct sliding Fs	Eccentricity e/L	Product name
1	1.00	15.40	1	N/A	3.63	4.03	4.033	1.819	2.094	0.1244	---
2	3.00	15.40	1	N/A	3.90	4.34	4.338	1.757	2.264	0.1006	---
3	5.00	15.40	1	N/A	4.15	4.61	4.607	1.825	2.465	0.0785	---
4	7.00	15.40	1	N/A	4.50	5.00	4.995	1.855	2.699	0.0581	---
5	9.00	15.40	1	N/A	4.97	5.52	5.522	1.843	2.984	0.0392	---
6	11.00	15.40	1	N/A	5.54	6.16	6.160	1.768	3.340	0.0217	---
7	13.00	15.40	1	N/A	6.33	7.03	7.028	1.807	3.795	0.0052	---
8	15.00	15.40	1	N/A	7.52	8.35	8.354	1.933	4.395	-0.0110	---
9	17.00	15.40	1	N/A	9.56	10.62	10.617	2.091	5.212	-0.0285	---
10	19.00	15.40	1	N/A	13.45	14.94	14.943	2.300	6.361	-0.0519	---
11	21.00	15.40	1	N/A	23.33	25.93	25.926	2.649	7.872	-0.1003	---

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	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls				Page 1 of 1 Made By DJS3 Date 12/22/2015 Checked By JCG Date 12/22/2015
LOCATION	RW001	STA 12+34.62	BL	Enter Values in Blue.	

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. 15MSE-4

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	1.2	32	2	0.0	1.2
2	9.0	100	4	1.2	10.2
3	1.0	100	4	10.2	11.2
4	15.4	100	4	11.2	26.6
5					
6					
7					
8					
9					
10					
11					
12					

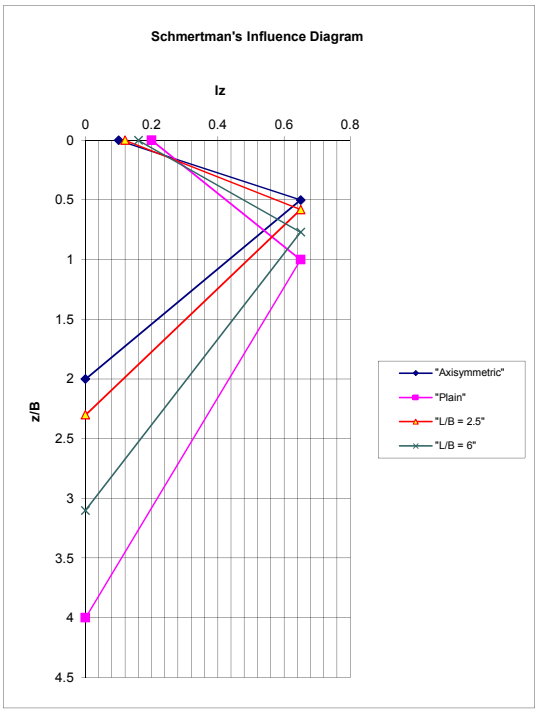
Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	3,472	Avg. Foundation Pressure From MSEW
Γ, pcf	130.0	Bearing Soil Density
B, ft	11.2	Foundation Width (effective B-2e)
L, ft	17	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	3,472	
L/B	1.52	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR
If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

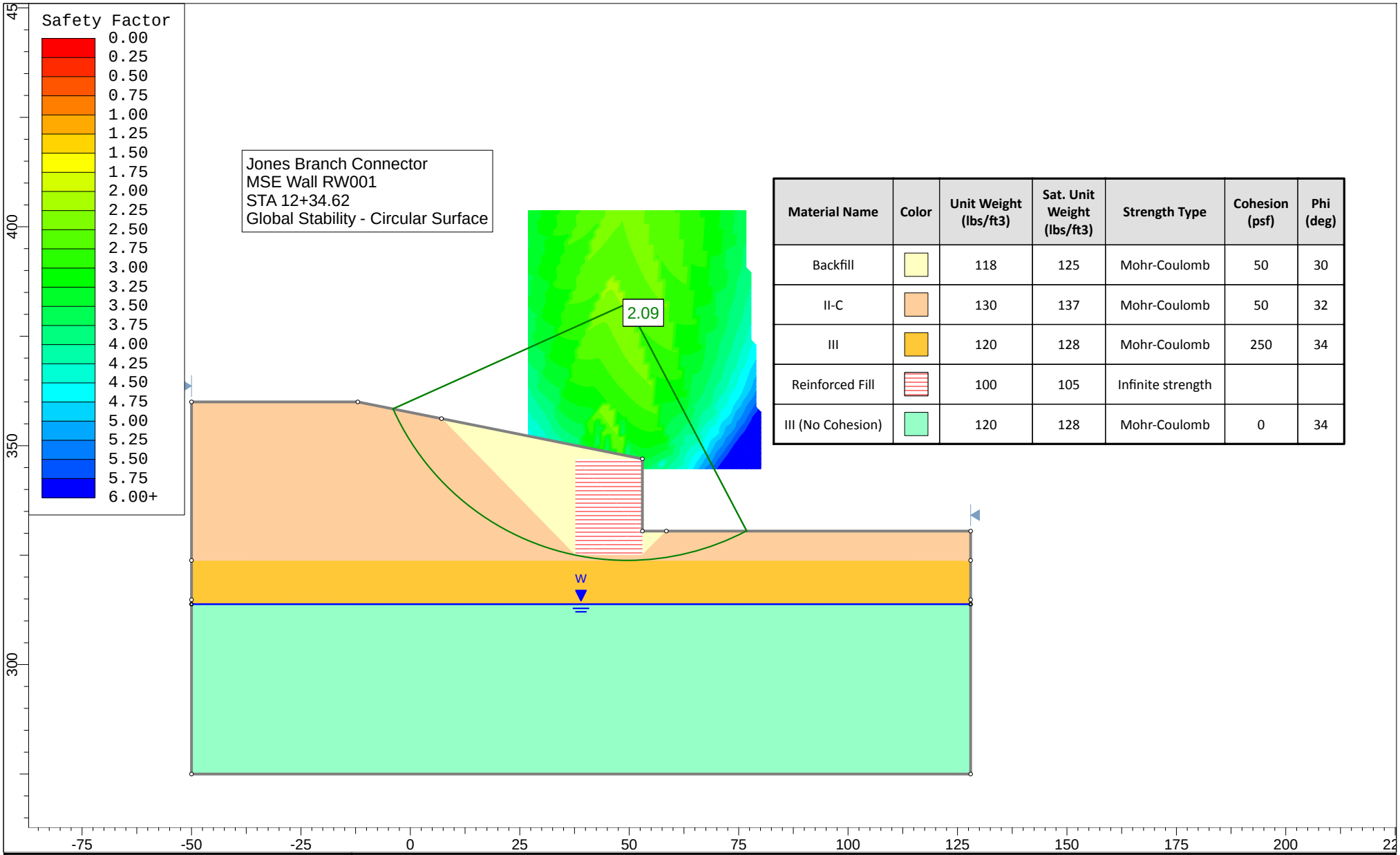
Δ, in	0.10	**Immediate Settlement** (up to end of monitoring period)		
	0.01	Post-Construction Settlement, in.	0.20	year
Δ, in	0.11	**Total Settlement**	1.00	year

Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.08945	0.20175	4	1,025,280	0.02	0.01	0.11	0.11
3	0.26834	0.36526	4	3,204,000	0.01	0.01	0.09	0.09
5	0.44723	0.52877	4	3,204,000	0.01	0.01	0.08	0.08
7	0.62612	0.63289	4	3,204,000	0.02	0.01	0.07	0.07
9	0.80501	0.56652	4	3,204,000	0.01	0.01	0.06	0.06
11	0.98390	0.50015	4	3,204,000	0.01	0.01	0.05	0.05
13	1.16279	0.43378	4	3,204,000	0.01	0.01	0.04	0.04
15	1.34168	0.36742	4	3,204,000	0.01	0.01	0.03	0.03
17	1.52057	0.30105	4	3,204,000	0.01	0.01	0.02	0.02
19	1.69946	0.23468	4	3,204,000	0.01	0.01	0.01	0.01
21	1.87835	0.16831	4	3,204,000	0.00	0.00	0.01	0.01
23	2.05725	0.10194	4	3,204,000	0.00	0.00	0.00	0.00
25	2.23614	0.03557	4	3,204,000	0.00	0.00	0.00	0.00
27	2.41503	0.00000						
29	2.59392	0.00000						
31	2.77281	0.00000						
33	2.95170	0.00000						
35	3.13059	0.00000						
37	3.30948	0.00000						
39	3.48837	0.00000						
41	3.66726	0.00000						
43	3.84615	0.00000						
45	4.02504	0.00000						
47	4.20394	0.00000						
49	4.38283	0.00000						
51	4.56172	0.00000						
53	4.74061	0.00000						
55	4.91950	0.00000						
57	5.09839	0.00000						
59	5.27728	0.00000						
61	5.45617	0.00000						
61	5.45617	0.00000						
63	5.63506	0.00000						
65	5.81395	0.00000						
67	5.99284	0.00000						
69	6.17174	0.00000						
71	6.35063	0.00000						
73	6.52952	0.00000						
75	6.70841	0.00000						
77	6.88730	0.00000						
			ΣΔ, in. (Uncorrected)		0.13			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

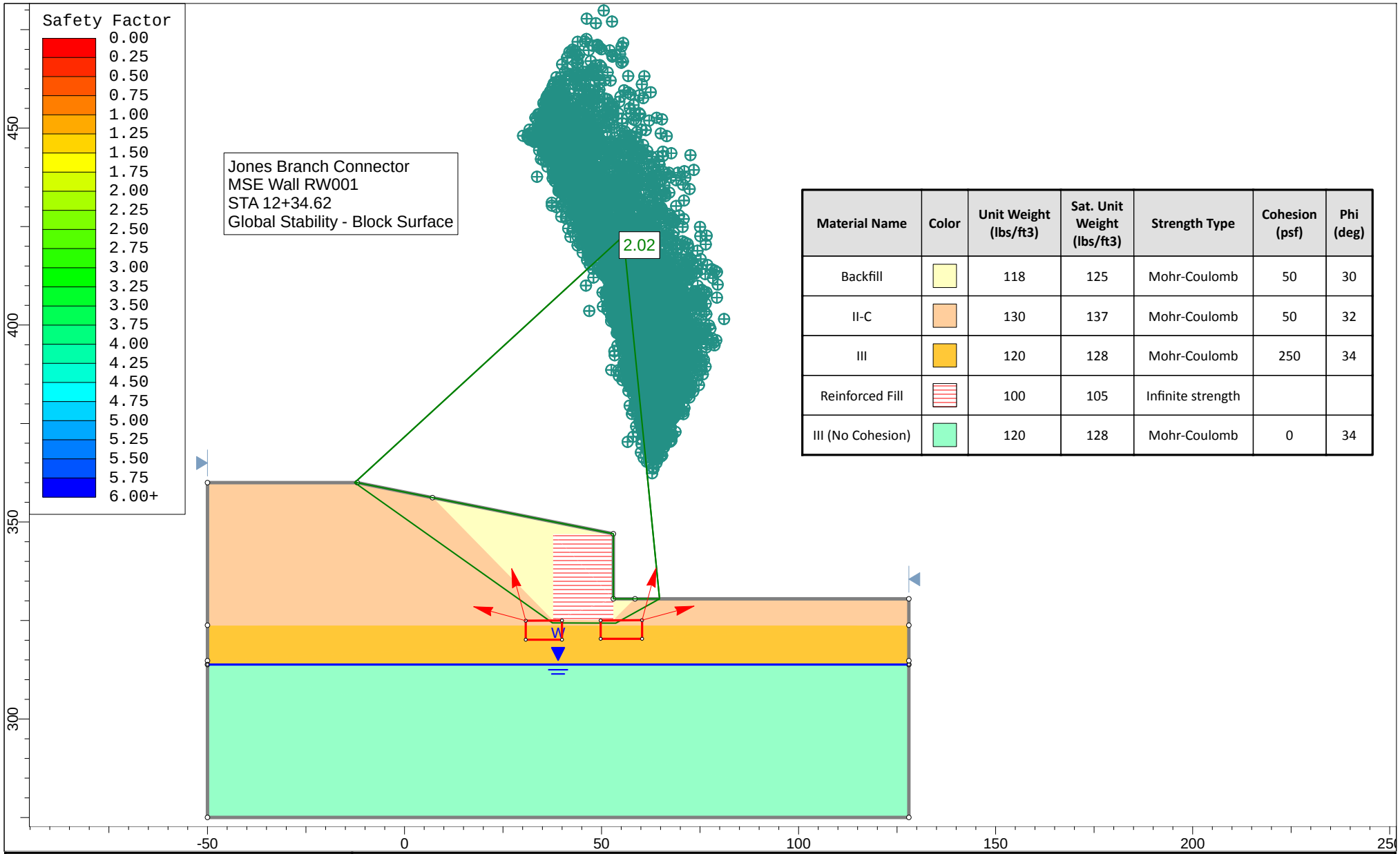
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	125	Mohr-Coulomb	50	30
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Reinforced Fill		100	105	Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.035

Project	JBCONN MSE Wall RW001		
Analysis Description	STA 12+34.62		
Drawn By DJS3	*Scale* 1:364	*Company* ECS	
Date 10/15/2015		*File Name* rw001 sta 12+34_Frev.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	125	Mohr-Coulomb	50	30
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Reinforced Fill		100	105	Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.035

Project	JBCONN MSE Wall RW001		
Analysis Description	STA 12+34.62		
Drawn By DJS3	*Scale* 1:404	*Company* ECS	
Date 10/15/2015		*File Name* rw001 sta 12+34_Frev_Block.slim	

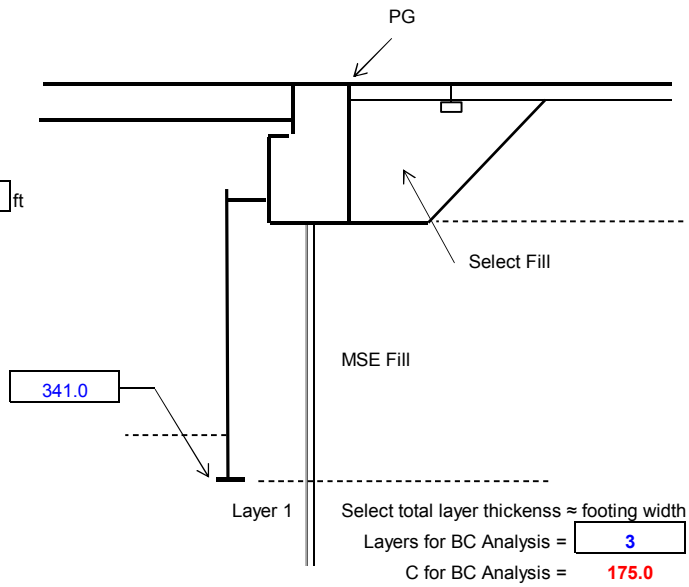
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 1/11/2016	
	Checked By JCG	
LOCATION JBCONN Bridge 627 Abutment B Enter Values in Blue.	Date 1/11/2016	

Red values are calculated

BORING No. =	JB-07	
Top of Boring El. =	340.7	ft
Profile Grade =	375.0	ft
Top of Layer 1 =	341.0	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	297.7	ft

South Half

Bottom of Abut. = 363.0 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	3
C for BC Analysis =	175.0
Φ for BC analysis =	34.2
Γ for BC Analysis =	124.2

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	338.2	2.8	SF	SF	CBR 30					26
2	335.7	2.5	P	II-C	30					40
3	325.0	10.7	P	II-C	62	73	75	100	100	100
4	303.7	21.3	P	II-C	90	53	100	100		100
5	298.7	5.0	P	II-C	26					35
6	290.0	8.7	P	II-C	100	63				100
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

	Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
Undercut	1	135.0	142.0	SF	0.0	37.0		2	2.8	
	2	130.0	137.0	SM	50.0	32.0		2	5.3	
	3	120.0	128.0	HWR	250.0	34.0		4	16.0	
	4	120.0	128.0	HWR	250.0	34.0		4	37.3	
	5	130.0	137.0	ML	50.0	32.0		2	42.3	
	6	120.0	128.0	HWR	250.0	34.0		4	51.0	
	7									
	8									
	9									
	10									
	11									
	12									

Wall 2 - South

Project Name: JBCONN Front Wall **Wall ID & Station:** Abutment B RW-002
Project No. 21924 Boring JB-07

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.125

By: JCG Date: 12/22/15
Checked: MAR Date: 12/22/15

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ, based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														1130						0.135	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	175	34.2	34.0	25.568	94.962	23.8	3.0	0.33	305.8	1059.2	3.46	0.75	67.1	4.2	2.79	3.22	7229	751	5470	0.00	41.04	42.14	17.36	51897	9.49	YES	YES	YES	YES
LRFD																				0.222	e/L												
LRFD	Sliding and OT			0.11	175	34.2	34.0	39.060	99.425	23.8	3.0	0.33	470.8	1059.2	2.25	0.68	60.5	4.2	1.66	5.29	10473		7871	0.00	41.04	42.14	16.59	32450	4.12	YES	YES	YES	YES
LRFD	Bearing Capacity								130.579					1553.9				Xo	8.29	3.61													
Soil Type	Description			USCS		Layer	Thickness ft	Midpoint ft	Type	SPT					Phi deg	Φ * d	Φ, C depth deg	C psf	c*d	0.151	e/L		1.439	Ratio LRFD/ ASD										
1	Clays			CL		1	2.8		4	25					37.0	103.6	2.8	0	0															
2	Sitls, sandy silts, silty and clayey sands			ML, SM, SC		2	2.5		2	40					32.0	80.0	2.5	50	125															
3	clean sands w/ little gravel			SW, SP, GW		3	10.7		4	100					34.0	363.8	10.7	250	2675															
4	Sandy gravels & gravels, highly weathered rock			HWR, GP, GW		4																												
5	Overconsloidated higly plastic soils			CH, MH		5																												
						6																												
						7																												
						8																												
															Phi for BC analysis =		34.2	C for BC analysis =	175															

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

B = 0.7H for normal situations, min = 2.4 m

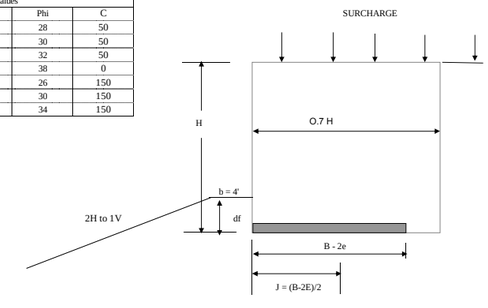
Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values

	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1
	Determination of Settlement below Walls	Made By MAR Date 1/11/2016 Checked By JCG
LOCATION JBCONN RW-002	STA Rt. Corner (Abut. B) BL Bridge 627 Enter Values in Blue.	Date 1/11/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-07

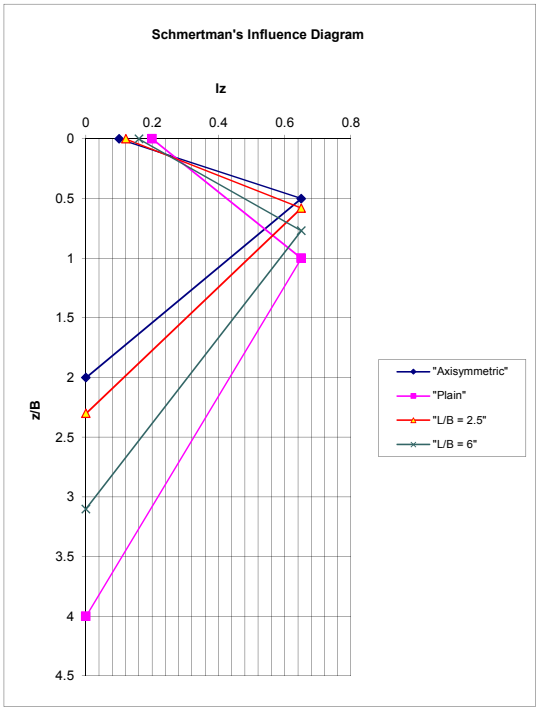
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To	
1	2.8	25	4	0.0	2.8	CBR 30
2	2.5	40	2	2.8	5.3	
3	10.7	100	4	5.3	16.0	
4	21.3	100	4	16.0	37.3	
5	6.0	35	2	37.3	43.3	
6	7.7	100	4	43.3	51.0	
7						
8						
9						
10						
11						
12						

Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	5,470	Avg. Foundation Pressure From MSEW
Γ, pcf	125.0	Bearing Soil Density
B, ft	17.4	Foundation Width (effective B-2e)
L, ft	60	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	5,470	
L/B	3.46	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.27	**Immediate Settlement** (up to end of monitoring period)		
	0.03	Post-Construction Settlement, in.	0.20	year
Δ, in	0.30	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.05760	0.17265	4	801,000	0.03
3	0.17281	0.27795	2	747,600	0.05
5	0.28802	0.38325	4	3,204,000	0.02
7	0.40323	0.48855	4	3,204,000	0.02
9	0.51843	0.59385	4	3,204,000	0.02
11	0.63364	0.63010	4	3,204,000	0.03
13	0.74885	0.58736	4	3,204,000	0.02
15	0.86406	0.54462	4	3,204,000	0.02
17	0.97926	0.50187	4	3,204,000	0.02
19	1.09447	0.45913	4	3,204,000	0.02
21	1.20968	0.41639	4	3,204,000	0.02
23	1.32488	0.37365	4	3,204,000	0.02
25	1.44009	0.33091	4	3,204,000	0.01
27	1.55530	0.28816	4	3,204,000	0.01
29	1.67051	0.24542	4	3,204,000	0.01
31	1.78571	0.20268	4	3,204,000	0.01
33	1.90092	0.15994	4	3,204,000	0.01
35	2.01613	0.11720	4	3,204,000	0.00
37	2.13134	0.07445	2	654,150	0.01
39	2.24654	0.03171	2	654,150	0.01
41	2.36175	0.00000			
43	2.47696	0.00000			
45	2.59217	0.00000			
47	2.70737	0.00000			
49	2.82258	0.00000			
51	2.93779	0.00000			
53	3.05300	0.00000			
55	3.16820	0.00000			
57	3.28341	0.00000			
59	3.39862	0.00000			
61	3.51382	0.00000			
61	3.51382	0.00000			
63	3.62903	0.00000			
65	3.74424	0.00000			
67	3.85945	0.00000			
69	3.97465	0.00000			
71	4.08986	0.00000			
73	4.20507	0.00000			
75	4.32028	0.00000			
77	4.43548	0.00000			
			ΣΔ, in. (Uncorrected)		0.36



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

Wall 2 - South

JBCONN B627 Abutment B Boring JB-07

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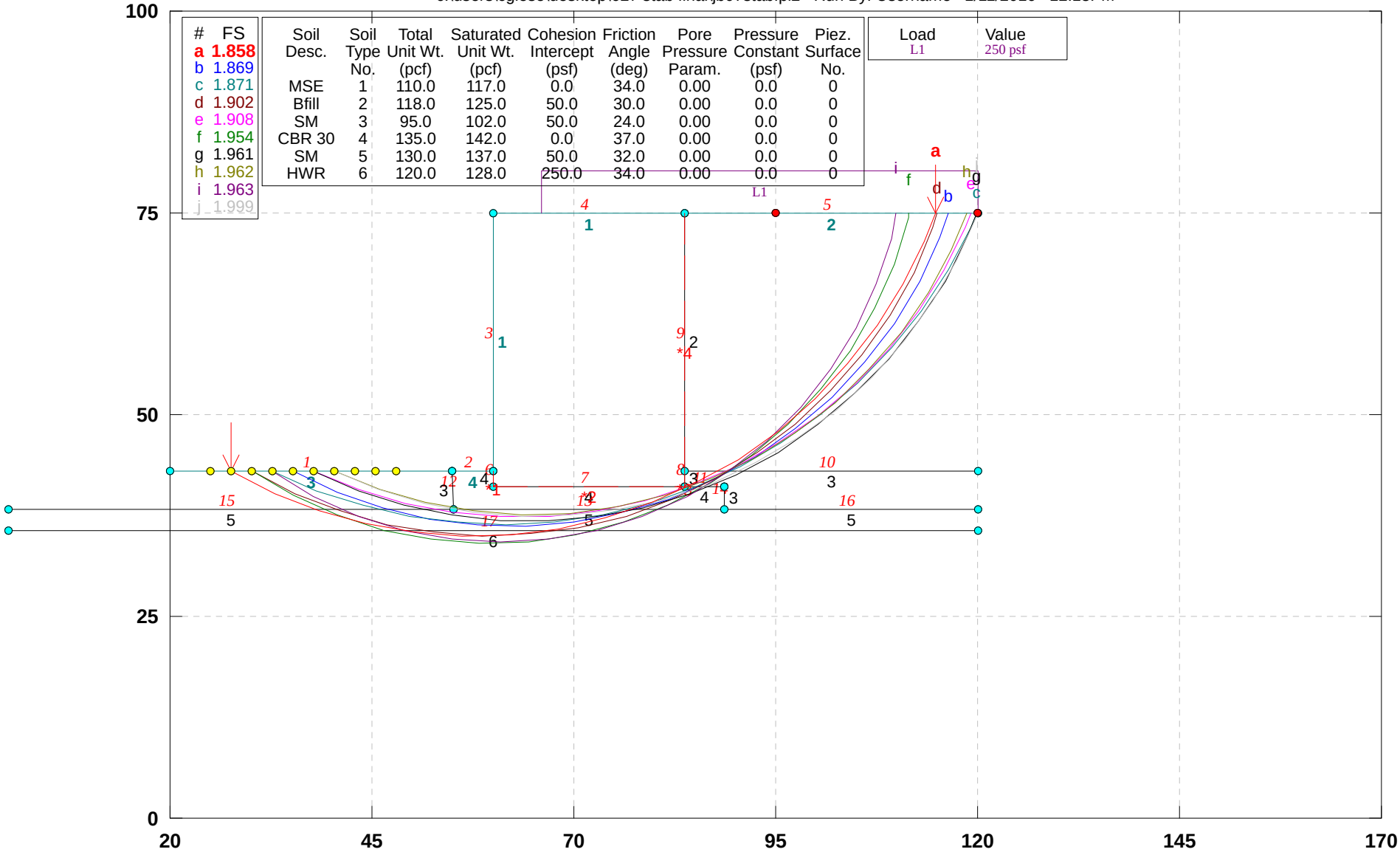

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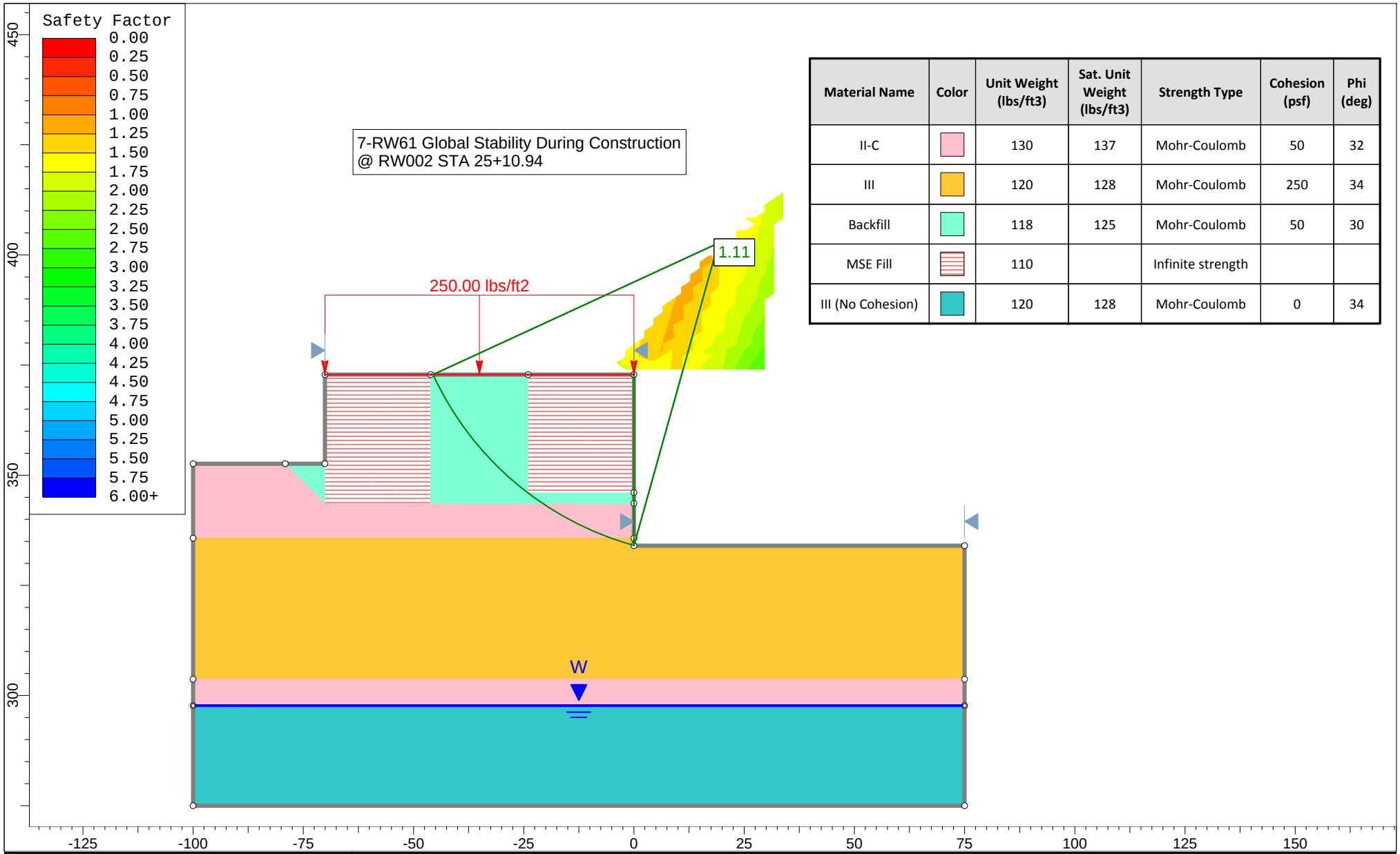
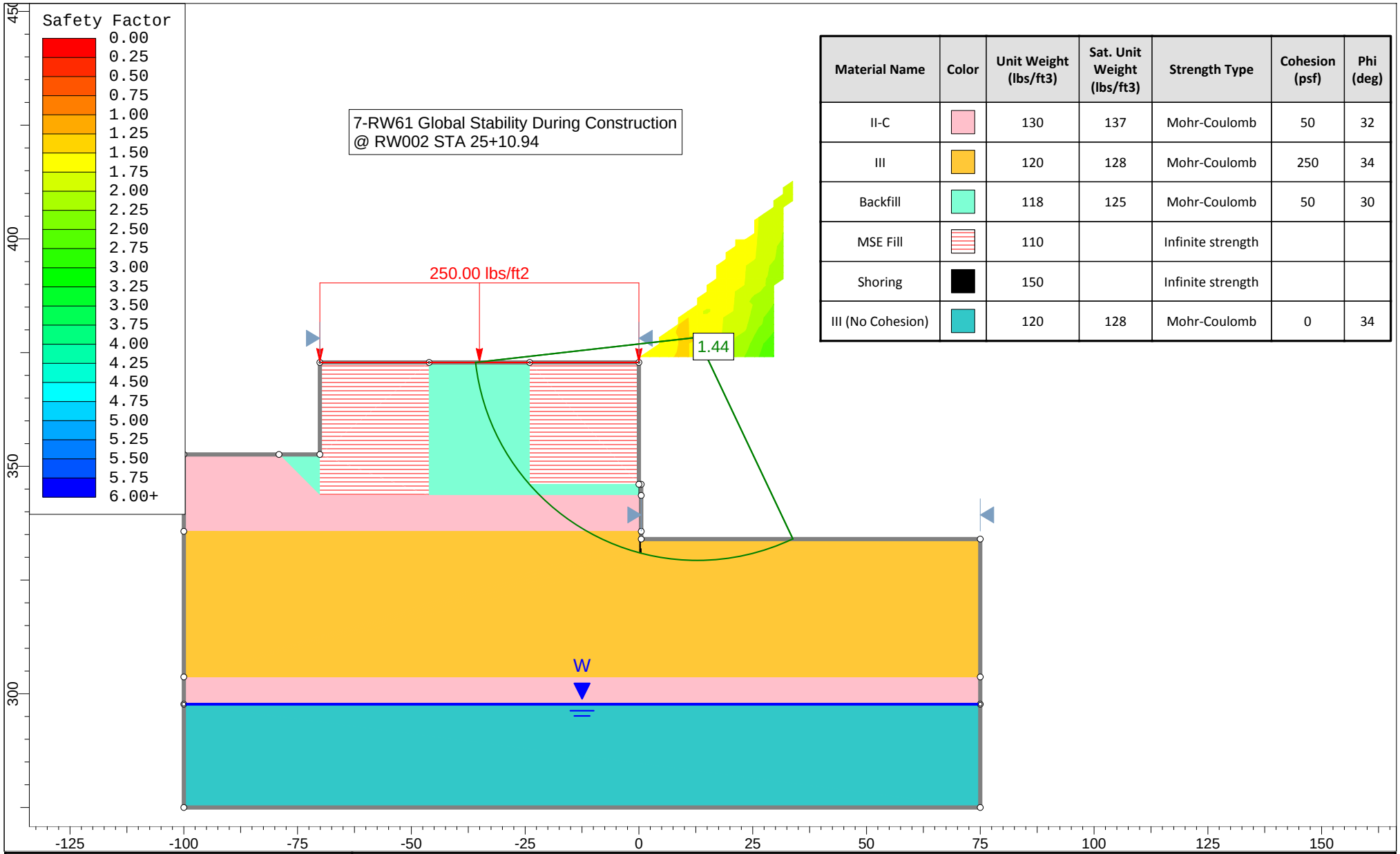
Safety Factors Are Calculated By The Modified Bishop Method



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Backfill		118	125	Mohr-Coulomb	50	30
MSE Fill		110		Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW002 STA 25+11		
Drawn By	DJS3	*Scale* 1:361	*Company* ECS
Date	3/10/2016, 2:37:06 PM		*File Name* RW002 STA 25+11.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Backfill		118	125	Mohr-Coulomb	50	30
MSE Fill		110		Infinite strength		
Shoring		150		Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW002 STA 25+11		
Drawn By DJS3	*Scale* 1:350	*Company* ECS	
Date 3/10/2016, 2:37:06 PM		*File Name* RW002 STA 25+11 with Shoring.slim	

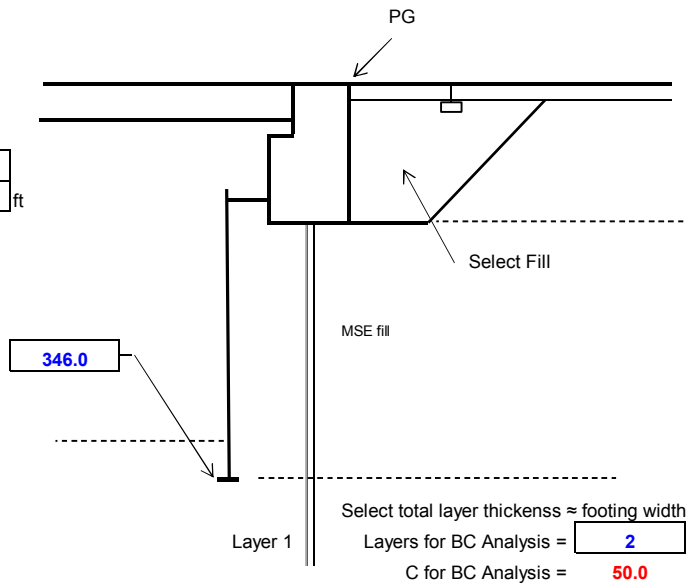
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/8/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment A Enter Values in Blue.	Date 12/8/2015	

Red values are calculated

BORING No. =	JB-09	
Top of Boring El. =	351.4	ft
Profile Grade =	375.4	ft
Top of Layer 1 =	346.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	310.4	ft

South End

Top of Wall =	364.8	
Bottom of Abut. =	362.7	ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	2
C for BC Analysis =	50.0
Φ for BC analysis =	31.1
Γ for BC Analysis =	124.5

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	334.1	11.9	P	II-B	17	19	15			17
2	320.0	14.1	P	II-C	31	38	39			36
3	310.4	9.6	P	II-C	43	47				45
4	305.0	5.4	P	II-C	49					49
5	300.0	5.0	P	II-C	84					84
6	280.0	20.0	P	II-C	47	35	38	25		36
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	MH	50.0	30.0		5	11.9	2125
2	130.0	137.0	ML	50.0	32.0		2	26.0	
3	130.0	137.0	ML	50.0	32.0		2	35.6	
4	130.0	137.0	ML	50.0	32.0		2	41.0	
5	120.0	128.0	HWR	250.0	34.0		4	46.0	
6	130.0	137.0	ML	50.0	32.0		2	66.0	
7									
8									
9									
10									
11									
12									

Wall 3 -10+50

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-003 Sta 10+50
Project No. 21924 Boring JB-09

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.124

By: JCG Date: 1/12/16
Checked: MAR Date: 1/12/16

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														738						0.137	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	50	30.7	29.4	19.449	71.701	20.6	2.0	0.33	202.6	684.9	3.38	0.58	38.4	1.0	2.03	2.83	6354	614	4803	0.00	22.39	30.13	14.93	22229	4.63	YES	YES	YES	YES	
LRFD																				0.228	e/L													
LRFD	Sliding and OT			0.11	50	30.7	29.4	29.786	75.559	20.6	2.0	0.33	312.9	684.9	2.19	0.59	39.5	1.0	1.36	4.70	9236		6938	0.00	22.39	30.13	14.25	13836	1.99	YES	YES	YES	YES	
LRFD	Bearing Capacity								98.854					1017.2				Xo	7.12	3.17														
																				0.154	e/L		1.444	Ratio LRFD/ ASD										

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT					Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	11.9		2	17					30.0	357.0	11.9	50	595
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	6.1		2	36					32.0	195.2	6.1	50	305
3	clean sands w/ little gravel	SW, SP, GW		3													
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4													
5	Overconsloidated higly plastic soils	CH, MH		5													
				6													
				7													
	Bottom Layer for Φ consideration in BC =		2	8													
													Phi for BC analysis =		30.7	C for BC analysis =	50

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

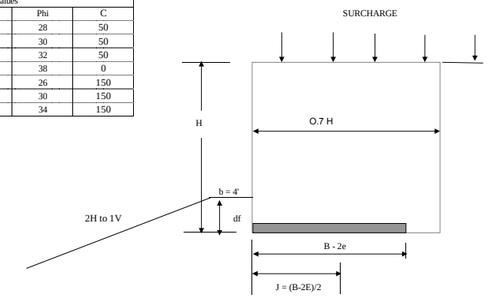
B = 0.7H for normal situations, min = 2.4 m

Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values				
	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls	Page 1 of 1 Made By MAR Date 1/14/2016 Checked By JCG Date 1/14/2016
LOCATION JBCONN RW-003	STA 10+50 (Abut. A) BL	Enter Values in Blue.

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-09

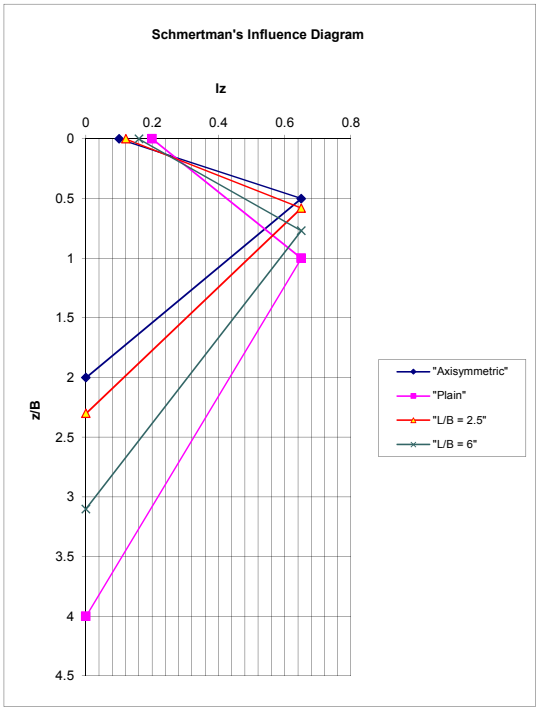
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	11.9	17	5	0.0	11.9
2	14.1	36	2	11.9	26.0
3	9.6	45	2	26.0	35.6
4	5.4	49	2	35.6	41.0
5	5.0	84	4	41.0	46.0
6					
7					
8					
9					
10					
11					
12					

Z, ft	4.00	Height of Existing Ground Above Bottom of Wall
Po, psf	4,803	Avg. Foundation Pressure From MSEW
Γ, pcf	118.0	Bearing Soil Density
B, ft	23.7	Foundation Width (effective B-2e)
L, ft	80	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	4,331	
L/B	3.38	
C1	0.95	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	1.19	**Immediate Settlement** (up to end of monitoring period)		
	0.13	Post-Construction Settlement, in.	0.20	year
Δ, in	1.33	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.04219	0.15857	5	249,645	0.07
3	0.12658	0.23570	5	249,645	0.10
5	0.21097	0.31283	5	249,645	0.13
7	0.29536	0.38996	5	249,645	0.16
9	0.37975	0.46709	5	249,645	0.19
11	0.46414	0.54422	2	672,840	0.08
13	0.54852	0.62135	2	672,840	0.10
15	0.63291	0.63037	2	672,840	0.10
17	0.71730	0.59906	2	672,840	0.09
19	0.80169	0.56775	2	672,840	0.09
21	0.88608	0.53645	2	672,840	0.08
23	0.97046	0.50514	2	672,840	0.08
25	1.05485	0.47383	2	672,840	0.07
27	1.13924	0.44252	2	841,050	0.05
29	1.22363	0.41121	2	841,050	0.05
31	1.30802	0.37991	2	841,050	0.05
33	1.39241	0.34860	2	841,050	0.04
35	1.47679	0.31729	2	915,810	0.04
37	1.56118	0.28598	2	915,810	0.03
39	1.64557	0.25467	2	915,810	0.03
41	1.72996	0.22337	4	2,691,360	0.01
43	1.81435	0.19206	4	2,691,360	0.01
45	1.89873	0.16075	4	2,691,360	0.01
47	1.98312	0.12944	4	2,691,360	0.00
49	2.06751	0.09813	4	2,691,360	0.00
51	2.15190	0.06683	4	2,691,360	0.00
53	2.23629	0.03552	4	2,691,360	0.00
55	2.32068	0.00421	4	2,691,360	0.00
57	2.40506	0.00000			
59	2.48945	0.00000			
61	2.57384	0.00000			
61	2.57384	0.00000			
63	2.65823	0.00000			
65	2.74262	0.00000			
67	2.82700	0.00000			
69	2.91139	0.00000			
71	2.99578	0.00000			
73	3.08017	0.00000			
75	3.16456	0.00000			
77	3.24895	0.00000			
			ΣΔ, in. (Uncorrected)		1.67



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

JBCONN B628 Abutment A Wall RW-003 STA 10+50

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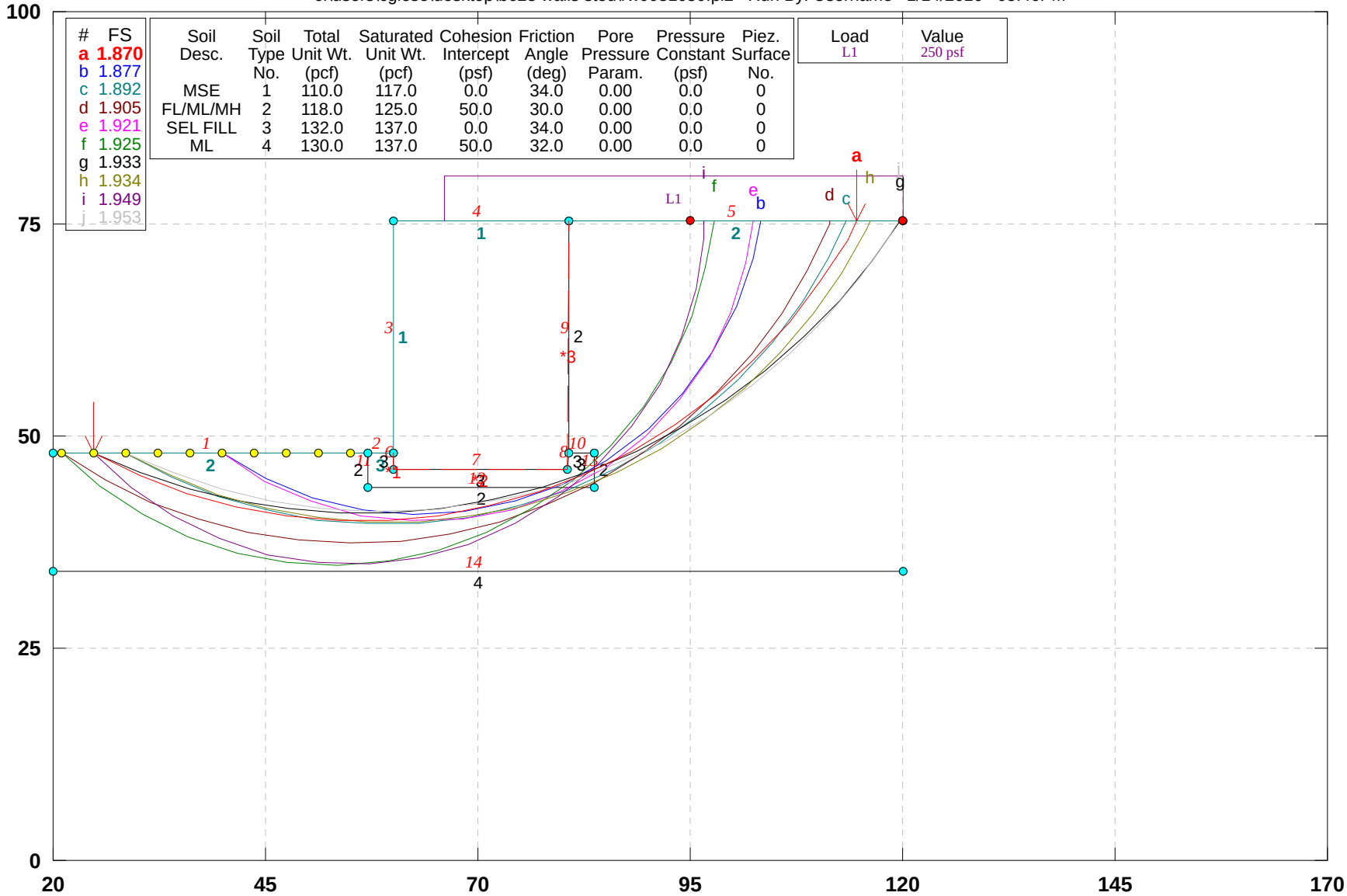


GSTABL7 v.2 FSmin=1.870

Safety Factors Are Calculated By The Modified Bishop Method

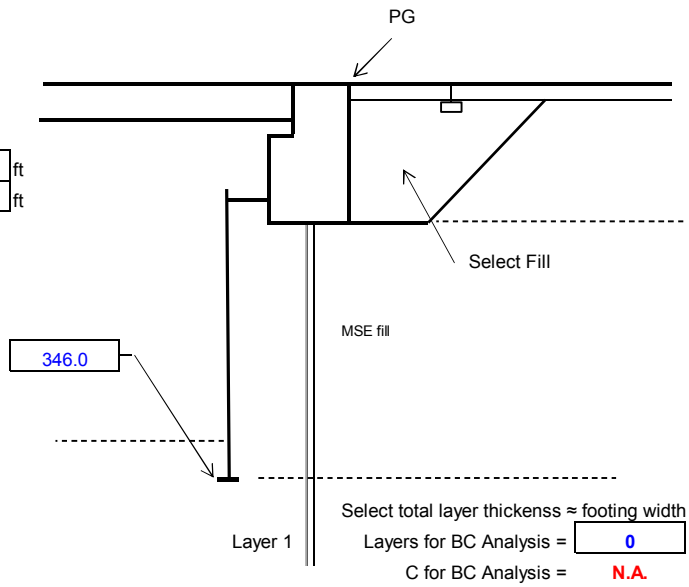
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 12/8/2015	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment A Enter Values in Blue.	Date 12/8/2015	

Red values are calculated

BORING No. =	628-2	
Top of Boring El. =	367.0	ft
Profile Grade =	375.4	ft
Top of Layer 1 =	346.0	ft
Hammer Efficiency =	80	%
Groundwater Elevation =	304.0	ft

North Tie-In

Top of Wall =	366.6	ft
Bottom of Abut. =	364.6	ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	330.0	16.0	P	II-B	19	11	18			21
2	313.5	16.5	P	II-C	29	25	38			41
3	310.0	3.5	P	II-C	61					81
4	304.0	6.0	P	II-C	100					100
5	280.0	24.0	P	II-C	100	100	100	100		100
6										
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	16.0	
2	130.0	137.0	ML	50.0	32.0		2	32.5	
3	120.0	128.0	ML	250.0	34.0		2	36.0	
4	120.0	128.0	HWR	250.0	34.0		4	42.0	
5	120.0	128.0	HWR	250.0	34.0		4	66.0	
6									
7									
8									
9									
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-003 Sta 11+40
Project No. 21924 Boring 682-2

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.118

By: JCG Date: 12/8/15
Checked: MAR Date: 12/8/15

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	*FS AGAINST OVERTURNING* Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	*FACTOR OF SAFETY AGAINST SLIDING* For Sands at base of Wall Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall Force Resisting Sliding kip	Total F.S.	*FACTOR OF SAFETY AGAINST BEARING CAPACITY* Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	*CHECKS* FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														738						0.137	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	50	30.0	29.4	19.449	71.701	20.6	2.0	0.33	202.6	684.9	3.38	0.58	38.4	1.0	2.03	2.83	6354	614	4803	0.00	22.39	30.13	14.93	21227	4.42	YES	YES	YES	YES	
LRFD																				0.228	e/L													
LRFD	Sliding and OT			0.11	50	30.0	29.4	29.786	75.559	20.6	2.0	0.33	312.9	684.9	2.19	0.58	38.4	1.0	1.32	4.70	9236		6938	0.00	22.39	30.13	14.25	13214	1.90	YES	YES	YES	YES	
LRFD	Bearing Capacity								98.854					1017.2				Xo	7.12	3.17														
																				0.154	e/L		1.444	Ratio LRFD/ ASD										

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT				Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	16.0		2	21				30.0	480.0	16	50	800
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2												0
3	clean sands w/ little gravel	SW, SP, GW		3												
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4												
5	Overconsloidated higly plastic soils	CH, MH		5												
				6												
				7												
	Bottom Layer for Φ consideration in BC =		2	8												
												Phi for BC analysis =		30.0	C for BC analysis =	50

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

B = 0.7H for normal situations, min = 2.4 m

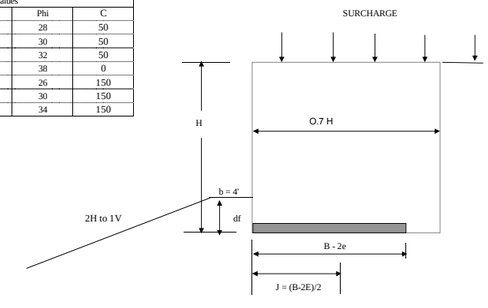
Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values

	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls	Page 1 of 1 Made By MAR Date 12/2/2015 Checked By JCG Date 12/2/2015
LOCATION	JBCONN RW-003 STA 11+40 (Abut. A) BL	Enter Values in Blue.

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. 628-2

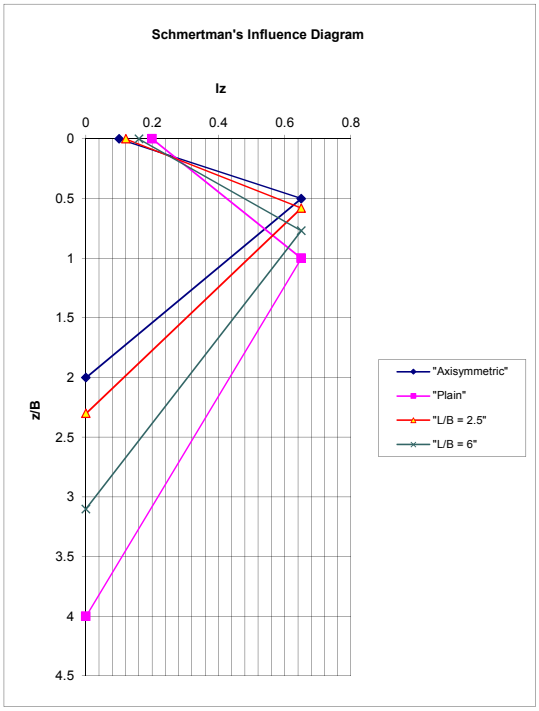
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	16.0	21	2	0.0	16.0
2	16.5	41	2	16.0	32.5
3	3.5	81	2	32.5	36.0
4	6.0	100	4	36.0	42.0
5	24.0	100	4	42.0	66.0
6					
7					
8					
9					
10					
11					
12					

Z, ft	4.00	Height of Existing Ground Above Bottom of Wall
Po, psf	4,803	Avg. Foundation Pressure From MSEW
Γ, pcf	118.0	Bearing Soil Density
B, ft	14.9	Foundation Width (effective B-2e)
L, ft	55	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	4,331	
L/B	3.68	
C1	0.95	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.92	**Immediate Settlement** (up to end of monitoring period)		
	0.10	Post-Construction Settlement, in.	0.20	year
Δ, in	1.02	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.06693	0.18118	2	392,490	0.05
3	0.20080	0.30353	2	392,490	0.08
5	0.33467	0.42589	2	392,490	0.11
7	0.46854	0.54825	2	392,490	0.15
9	0.60241	0.64169	2	392,490	0.17
11	0.73628	0.59202	2	392,490	0.16
13	0.87015	0.54236	2	392,490	0.14
15	1.00402	0.49269	2	392,490	0.13
17	1.13788	0.44302	2	766,290	0.06
19	1.27175	0.39336	2	766,290	0.05
21	1.40562	0.34369	2	766,290	0.05
23	1.53949	0.29403	2	766,290	0.04
25	1.67336	0.24436	2	766,290	0.03
27	1.80723	0.19470	2	766,290	0.03
29	1.94110	0.14503	2	766,290	0.02
31	2.07497	0.09537	2	766,290	0.01
33	2.20884	0.04570	2	1,513,890	0.00
35	2.34270	0.00000			
37	2.47657	0.00000			
39	2.61044	0.00000			
41	2.74431	0.00000			
43	2.87818	0.00000			
45	3.01205	0.00000			
47	3.14592	0.00000			
49	3.27979	0.00000			
51	3.41365	0.00000			
53	3.54752	0.00000			
55	3.68139	0.00000			
57	3.81526	0.00000			
59	3.94913	0.00000			
61	4.08300	0.00000			
61	4.08300	0.00000			
63	4.21687	0.00000			
65	4.35074	0.00000			
67	4.48461	0.00000			
69	4.61847	0.00000			
71	4.75234	0.00000			
73	4.88621	0.00000			
75	5.02008	0.00000			
77	5.15395	0.00000			
			ΣΔ, in. (Uncorrected)		1.28



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

JBCONN B628 Abutment A Wall RW-003 Sta 11+40

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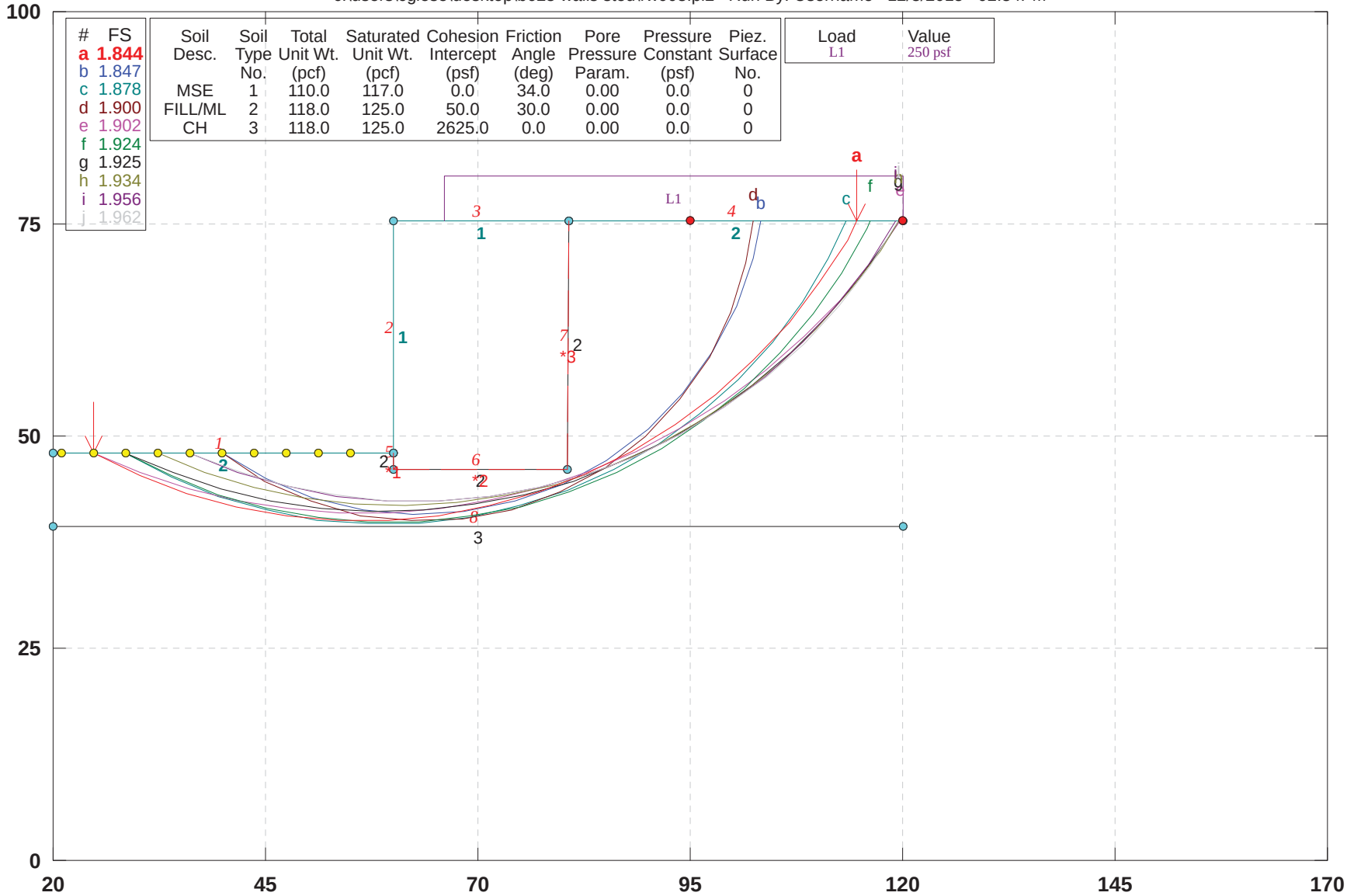


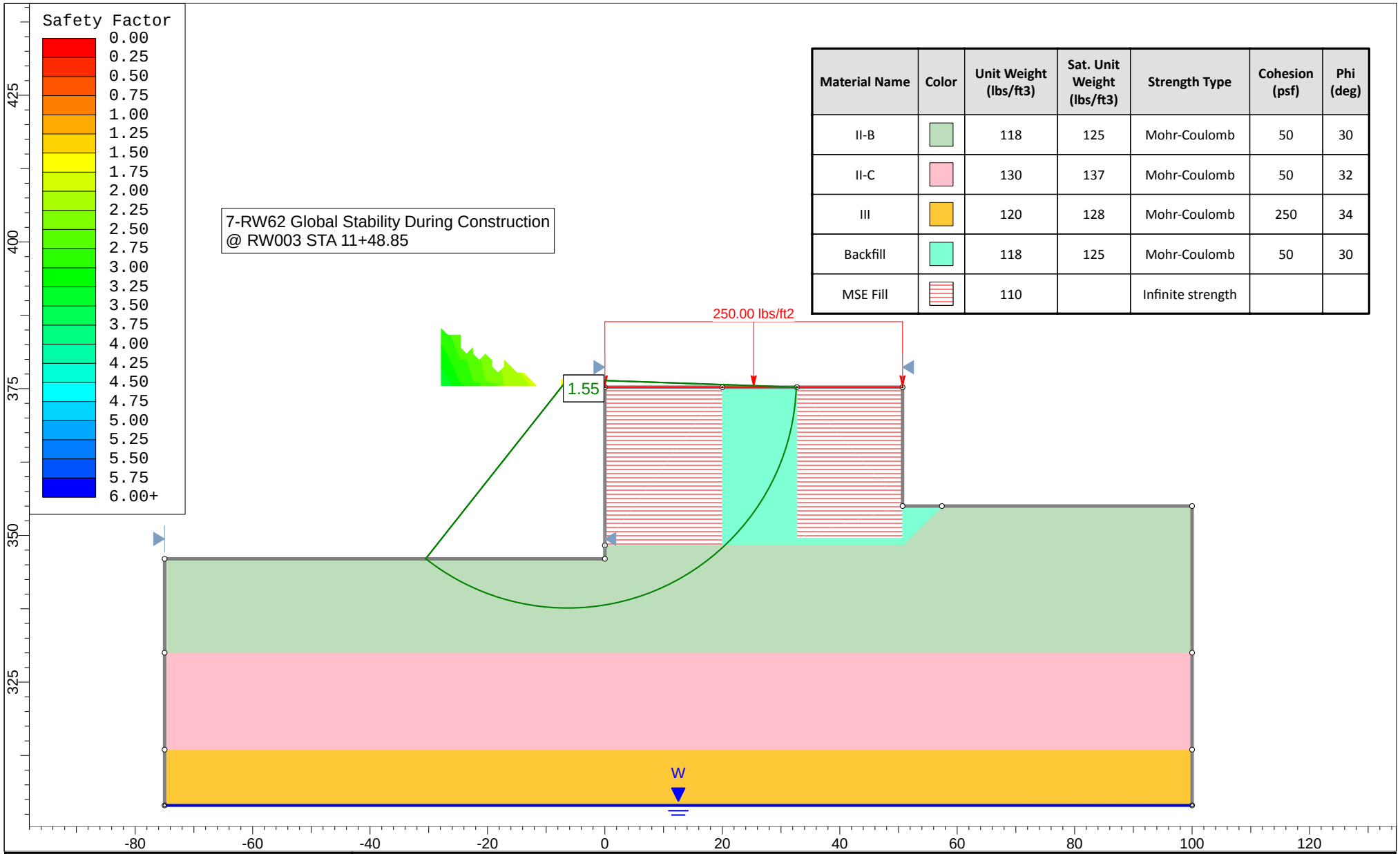
#	FS
a	1.844
b	1.847
c	1.878
d	1.900
e	1.902
f	1.924
g	1.925
h	1.934
i	1.956
j	1.962

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
MSE	1	110.0	117.0	0.0	34.0	0.00	0.0	0
FILL/ML	2	118.0	125.0	50.0	30.0	0.00	0.0	0
CH	3	118.0	125.0	2625.0	0.0	0.00	0.0	0

Load	Value
L1	250 psf

GSTABL7 v.2 FSmin=1.844

Safety Factors Are Calculated By The Modified Bishop Method



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-B		118	125	Mohr-Coulomb	50	30
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Backfill		118	125	Mohr-Coulomb	50	30
MSE Fill		110		Infinite strength		

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW003 STA 11+49		
Drawn By DJS3	*Scale* 1:271	*Company* ECS	
Date 3/10/2016, 2:37:06 PM		*File Name* RW003 STA 11+49.slim	

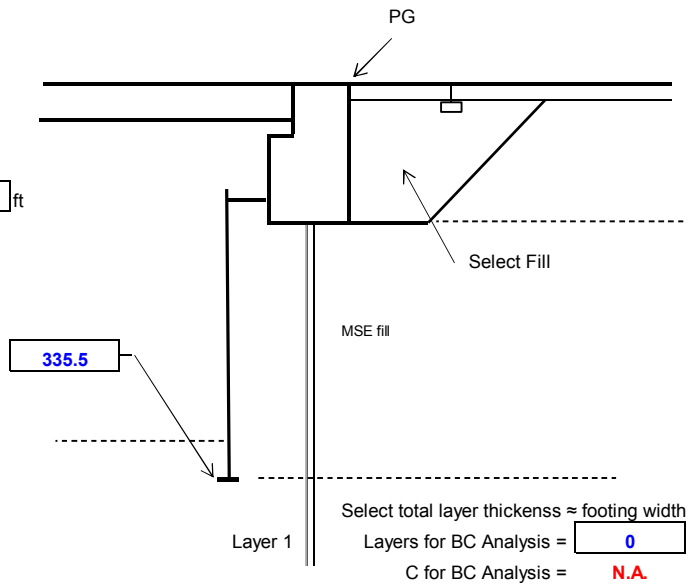
ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By MAR	
Determination of Soil Parameters below Piers	Date 1/4/2016	
	Checked By JCG	
LOCATION JBCONN Bridge 628 Abutment B Enter Values in Blue.	Date 1/4/2016	

Red values are calculated

BORING No. =	JB-10	
Top of Boring El. =	338.7	ft
Profile Grade =	374.5	ft
Top of Layer 1 =	335.5	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	275.7	ft

North Tie-In

Bottom of Abut. = 363.4 ft



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	325.7	9.8	P	II-A	7	9	7			8
2	322.0	3.7	P	II-B	29					29
3	311.7	10.3	P	II-C	47	43				45
4	303.0	8.7	P	II-C	100	100				100
5	295.7	7.3	P	II-C	66					66
6	275.7	20.0	P	II-C	100	100	100	100		100
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	95.0	102.0	ML	50.0	28.0		2	9.8	
2	118.0	125.0	ML	50.0	30.0	Y	2	13.5	
3	130.0	137.0	ML	50.0	32.0		2	23.8	
4	120.0	128.0	HWR	250.0	34.0		4	32.5	
5	120.0	128.0	SP	250.0	34.0		3	39.8	
6	120.0	128.0	HWR	250.0	34.0		4	59.8	
7									
8									
9									
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-004 Sta 11+15
Project No. 21924 Boring JB-10

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.107

By: JCG Date: 12/8/15
Checked: MAR Date: 12/8/15

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														1692						0.134	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	50	29.2	39.0	33.163	123.942	27.3	3.0	0.33	452.2	1598.6	3.53	0.53	62.3	1.4	1.92	3.65	8181	899	6196	0.00	19.33	27.85	20.00	22075	3.56	YES	YES	YES	YES
LRFD																				0.217	e/L												
LRFD	Sliding and OT			0.11	50	29.2	39.0	50.557	129.061	27.3	3.0	0.33	694.2	1598.6	2.30	0.56	65.3	1.4	1.32	5.93	11818		8887	0.00	19.33	27.85	19.14	13766	1.55	YES	YES	YES	YES
LRFD	Bearing Capacity								170.052					2321.2				Xo	9.57	4.08													

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT					Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	9.8		2						28.0	274.4	9.8	50	490
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	13.5		2						30.0	405.0	13.5	50	675
3	clean sands w/ little gravel	SW, SP, GW		3													
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4													
5	Overconsloidated higly plastic soils	CH, MH		5													
				6													
				7													
	Bottom Layer for Φ consideration in BC =		2	8													
													Phi for BC analysis =		29.2	C for BC analysis =	50

																				0.150	e/L		1.434	Ratio LRFD/ ASD										

NOTES: 1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

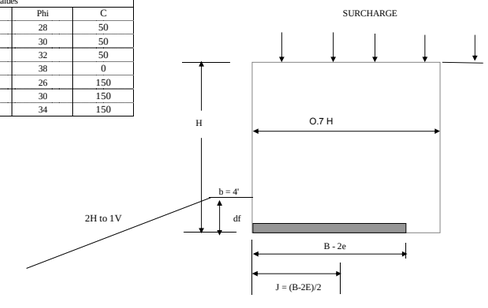
B = 0.7H for normal situations, min = 2.4 m

Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values				
	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1	
	Determination of Settlement below Walls	Made By MAR	
		Date 1/12/2016	
		Checked By JCG	
LOCATION JBCONN RW-004	STA 11+15 (Abut. B) BL	Enter Values in Blue.	Date 1/12/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-10

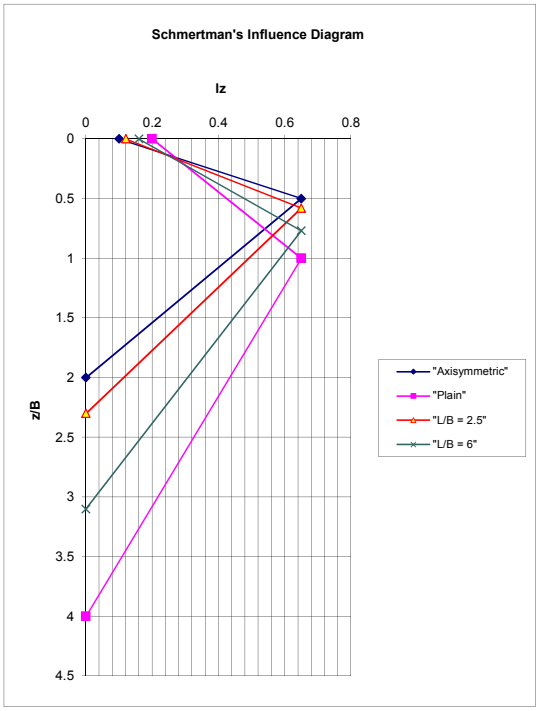
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	9.8	8	2	0.0	9.8
2	3.7	29	2	9.8	13.5
3	10.3	45	2	13.5	23.8
4	8.7	100	4	23.8	32.5
5	7.3	56	3	32.5	39.8
6					
7					
8					
9					
10					
11					
12					

Z, ft	4.50	Height of Existing Ground Above Bottom of Wall
Po, psf	6,196	Avg. Foundation Pressure From MSEW
Γ, pcf	107.0	Bearing Soil Density
B, ft	20.0	Foundation Width (effective B-2e)
L, ft	100	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	5,715	
L/B	5.00	
C1	0.96	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	1.33	**Immediate Settlement** (up to end of monitoring period)		
	0.15	Post-Construction Settlement, in.	0.20	year
Δ, in	1.48	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.05000	0.19180	2	177,520	0.15
3	0.15000	0.25540	2	177,520	0.20
5	0.25000	0.31900	2	177,520	0.25
7	0.35000	0.38260	2	177,520	0.30
9	0.45000	0.44620	2	643,510	0.10
11	0.55000	0.50980	2	643,510	0.11
13	0.65000	0.57340	2	998,550	0.08
15	0.75000	0.63700	2	998,550	0.09
17	0.85000	0.62776	2	998,550	0.09
19	0.95000	0.59996	2	998,550	0.08
21	1.05000	0.57216	2	998,550	0.08
23	1.15000	0.54436	4	3,804,000	0.02
25	1.25000	0.51656	4	3,804,000	0.02
27	1.35000	0.48876	4	3,804,000	0.02
29	1.45000	0.46096	4	3,804,000	0.02
31	1.55000	0.43316	4	3,804,000	0.02
33	1.65000	0.40536	3	1,775,200	0.03
35	1.75000	0.37756	3	1,775,200	0.03
37	1.85000	0.34976	3	1,775,200	0.03
39	1.95000	0.32196	3	1,775,200	0.02
41	2.05000	0.29416	3	1,775,200	0.02
43	2.15000	0.26636	3	1,775,200	0.02
45	2.25000	0.23856	3	1,775,200	0.02
47	2.35000	0.21076	3	1,775,200	0.02
49	2.45000	0.18296	3	1,775,200	0.01
51	2.55000	0.15516	3	1,775,200	0.01
53	2.65000	0.12736	3	1,775,200	0.01
55	2.75000	0.09956	3	1,775,200	0.01
57	2.85000	0.07176	3	1,775,200	0.01
59	2.95000	0.04396	3	1,775,200	0.00
61	3.05000	0.01616	3	1,775,200	0.00
61	3.05000	0.01616	3	1,775,200	0.00
63	3.15000	0.00000			
65	3.25000	0.00000			
67	3.35000	0.00000			
69	3.45000	0.00000			
71	3.55000	0.00000			
73	3.65000	0.00000			
75	3.75000	0.00000			
77	3.85000	0.00000			
			ΣΔ, in. (Uncorrected)		1.84

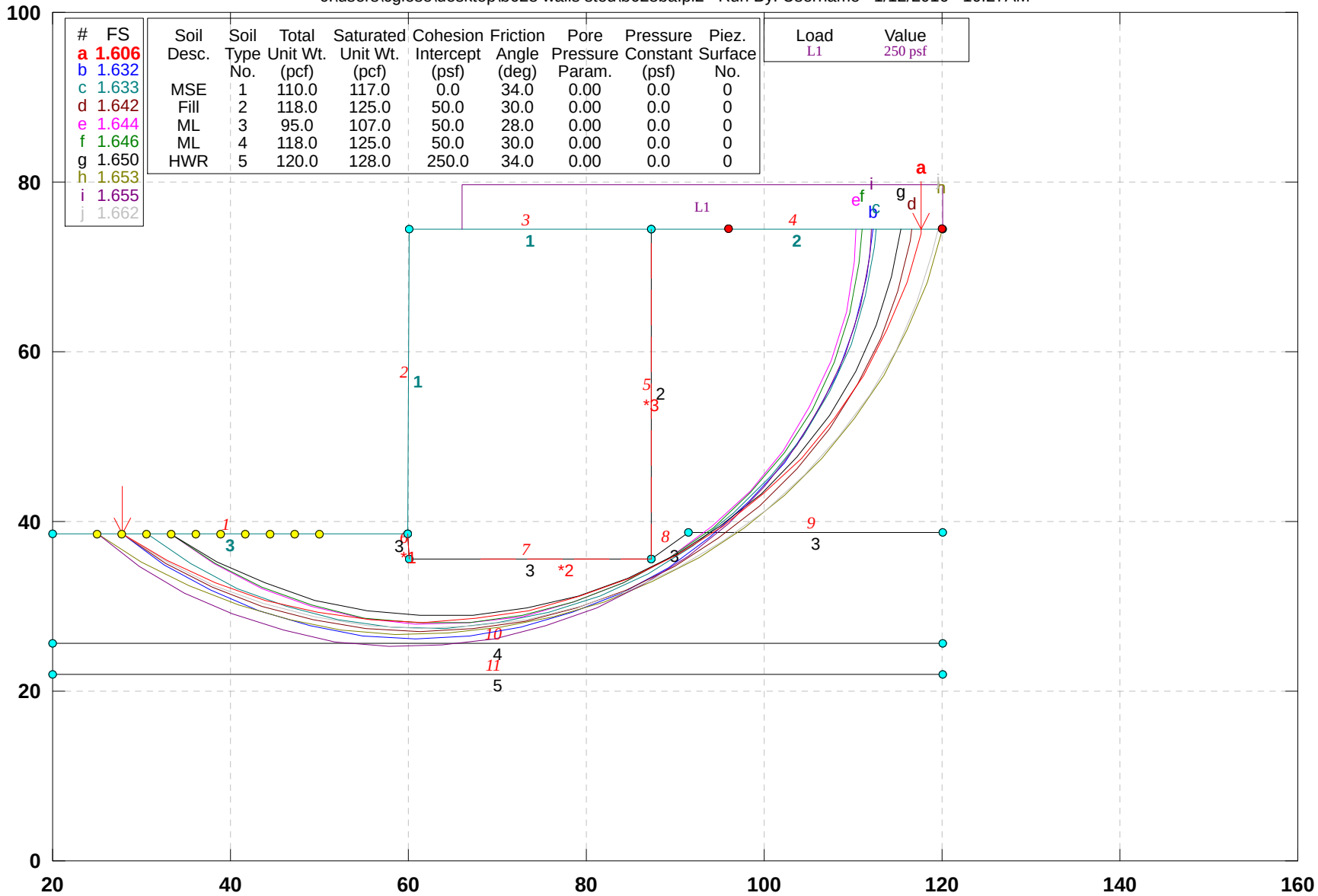


Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

JBCONN B628 Abutment B Wall RW-004 Sta 11+15

c:\users\cgiese\desktop\b628 walls sted\b628ba.pl2 Run By: Username 1/12/2016 10:27AM



#	FS
a	1.606
b	1.632
c	1.633
d	1.642
e	1.644
f	1.646
g	1.650
h	1.653
i	1.655
j	1.662

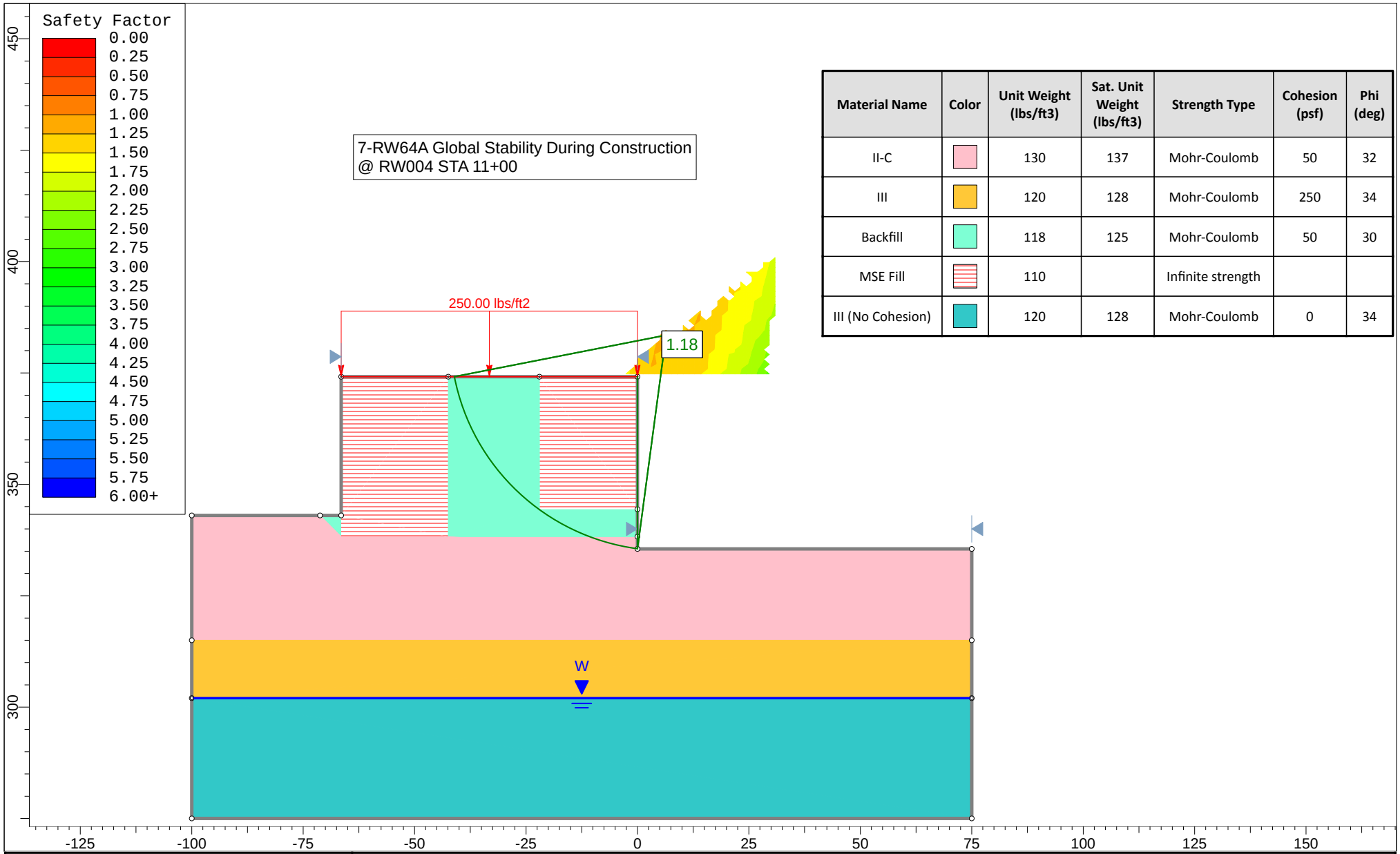
Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
MSE	1	110.0	117.0	0.0	34.0	0.00	0.0	0
Fill	2	118.0	125.0	50.0	30.0	0.00	0.0	0
ML	3	95.0	107.0	50.0	28.0	0.00	0.0	0
ML	4	118.0	125.0	50.0	30.0	0.00	0.0	0
HWR	5	120.0	128.0	250.0	34.0	0.00	0.0	0

Load	Value
L1	250 psf

GSTABL7 v.2 FSmin=1.606

Safety Factors Are Calculated By The Modified Bishop Method

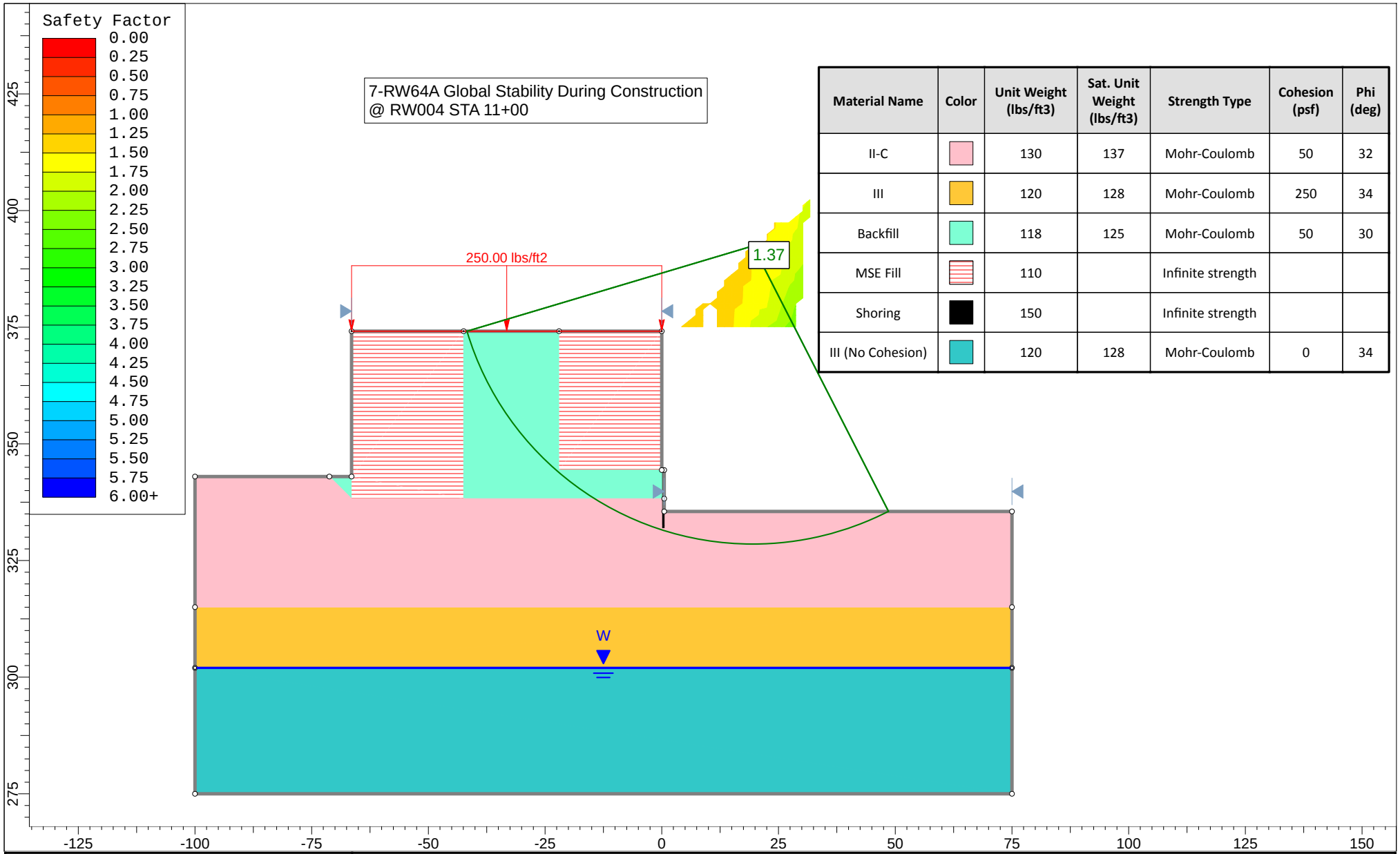
GSTABL7



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Backfill		118	125	Mohr-Coulomb	50	30
MSE Fill		110		Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.036

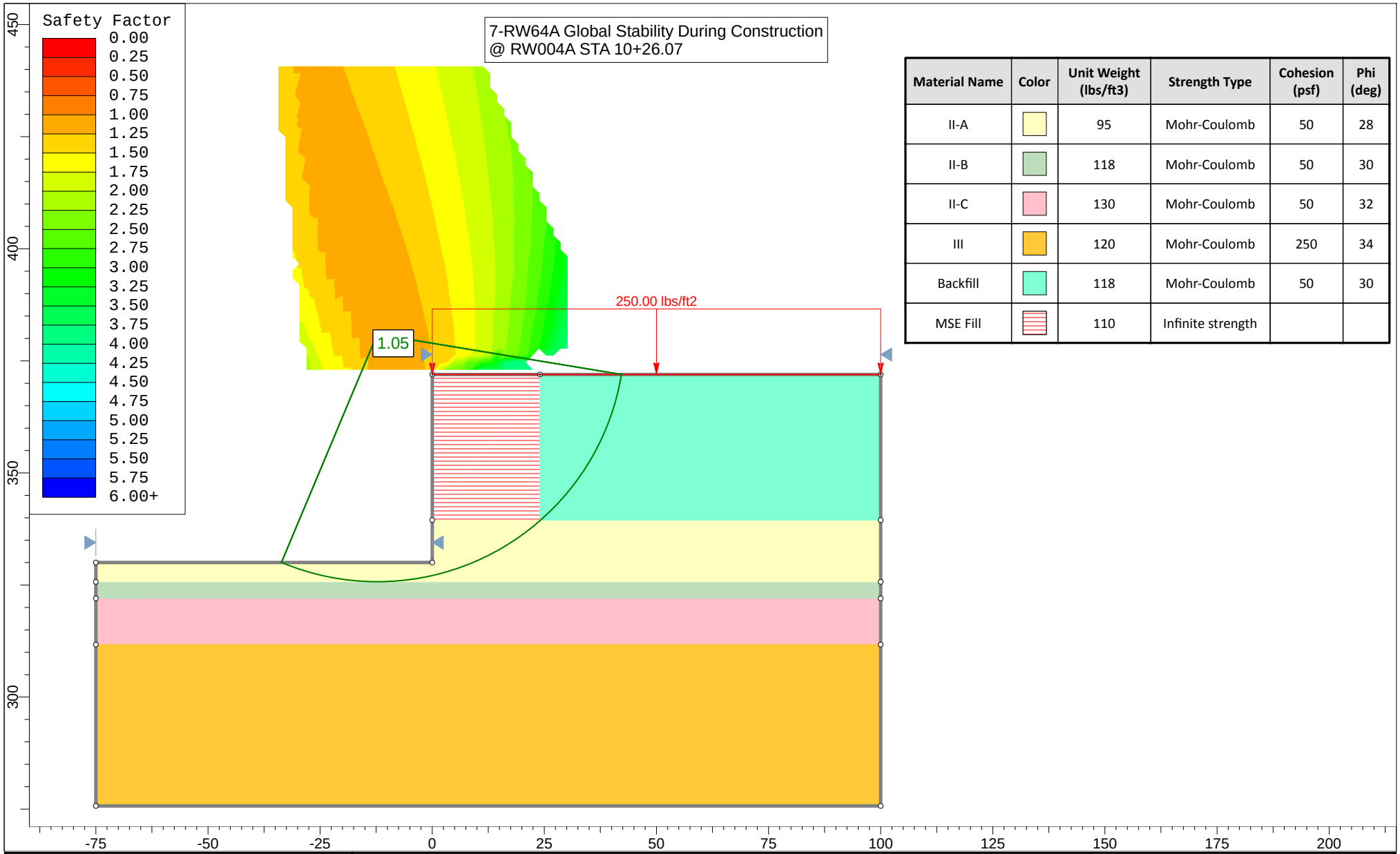
Project	JBCONN		
Analysis Description	RW004 STA 11+00		
Drawn By	DJS3	*Scale* 1:357	*Company* ECS
Date	3/10/2016, 2:37:06 PM		*File Name* RW004 STA 11+00.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-C		130	137	Mohr-Coulomb	50	32
III		120	128	Mohr-Coulomb	250	34
Backfill		118	125	Mohr-Coulomb	50	30
MSE Fill		110		Infinite strength		
Shoring		150		Infinite strength		
III (No Cohesion)		120	128	Mohr-Coulomb	0	34

SLIDEINTERPRET 6.036

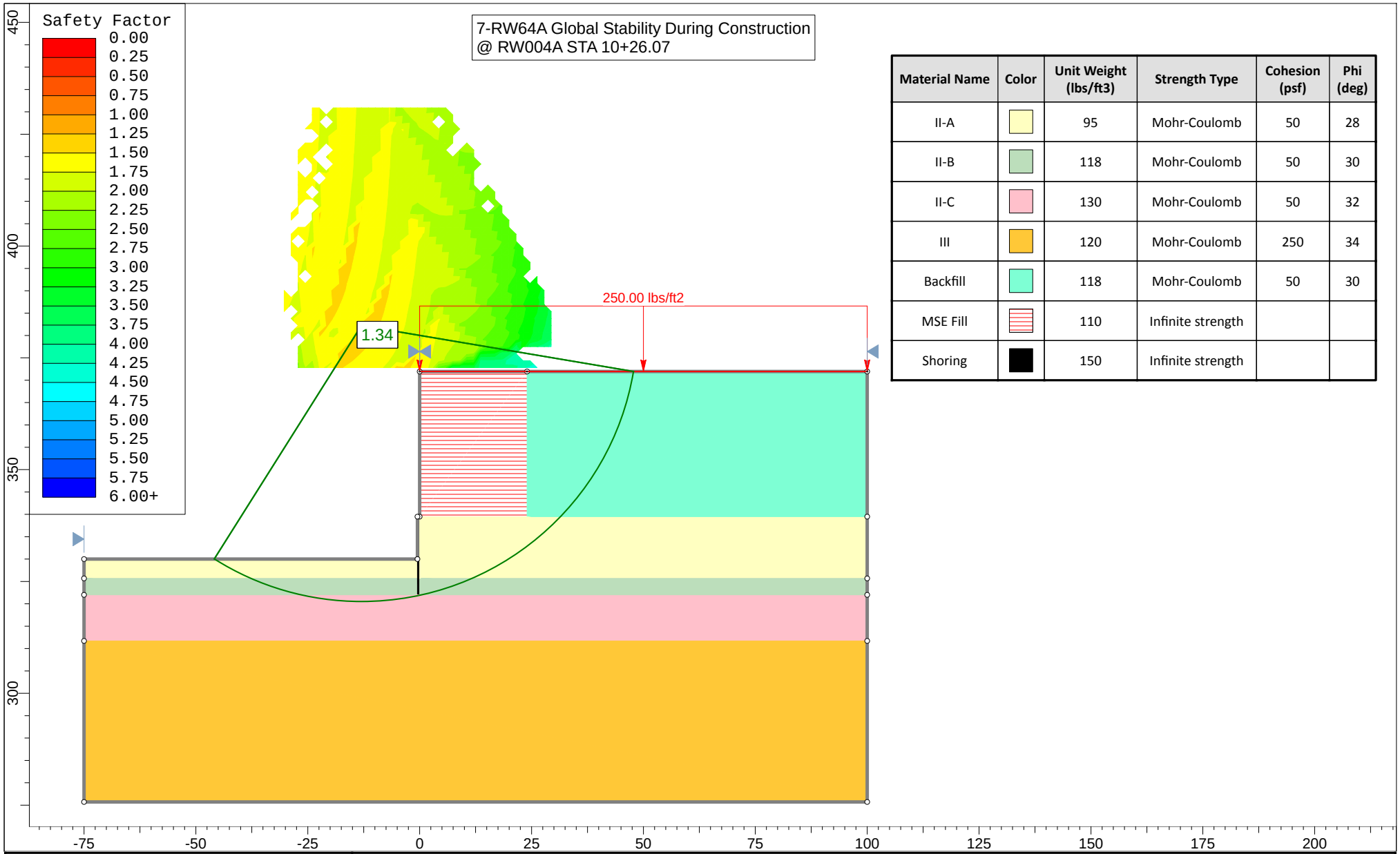
Project	JBCONN		
Analysis Description	RW004 STA 11+00		
Drawn By	DJS3	*Scale* 1:341	*Company* ECS
Date	3/10/2016, 2:37:06 PM		*File Name* RW004 STA 11+00 with Shoring.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-A		95	Mohr-Coulomb	50	28
II-B		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34
Backfill		118	Mohr-Coulomb	50	30
MSE Fill		110	Infinite strength		

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW004A STA 10+26		
Drawn By DJS3	*Scale* 1:355	*Company* ECS	
Date 3/10/2016, 2:37:06 PM		*File Name* RW004A STA 10+26.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
II-A		95	Mohr-Coulomb	50	28
II-B		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34
Backfill		118	Mohr-Coulomb	50	30
MSE Fill		110	Infinite strength		
Shoring		150	Infinite strength		

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW004A STA 10+26		
Drawn By DJS3	*Scale* 1:356	*Company* ECS	
Date 3/10/2016, 2:37:06 PM		*File Name* RW004A STA 10+26 with Shoring.slim	

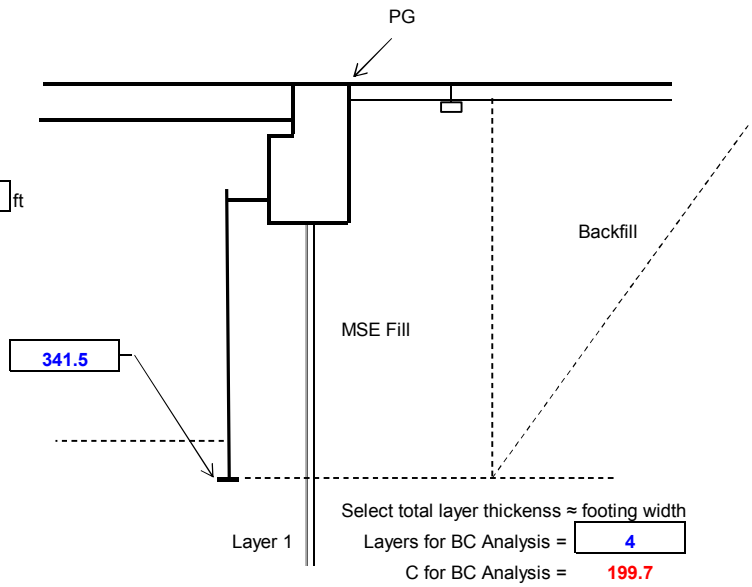
ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 1/6/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment A Enter Values in Blue.	Date 1/6/2016

Red values are calculated

BORING No. =	JB-12	
Top of Boring El. =	344.8	ft
Profile Grade =	374.1	ft
Top of Layer 1 =	341.5	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	300.8	ft

Middle of Abutment

Bottom of Abut. =	362.1	ft
El. Ground in front of Wall =	343.5	
El. Top of Front Wall =	365.0	
Front Wall Total Height =	23.5	
Front Wall Height from PG to Bot. =	32.6	



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	4
C for BC Analysis =	199.7
Φ for BC analysis =	33.2
Γ for BC Analysis =	120.8

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	338.8	2.7	P	II-B	17					17
2	336.8	2.0	P	II-C	41					41
3	333.0	3.8	P	II-C	71					71
4	322.8	10.2	P	II-C	100	100				100
5	317.8	5.0	P	II-B	22					22
6	300.8	17.0	P	II-C	82	100	100			94
7	298.5	2.3	P	II-C	100					100
8	293.5	5.0	P	II-C	59					59
9	275.4	18.1	P	II-C	100	100	100	100		100
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	SM	50.0	30.0		2	2.7	
2	130.0	137.0	SM	50.0	32.0		2	4.7	
3	120.0	128.0	SM	250.0	34.0		2	8.5	
4	120.0	128.0	HWR	250.0	34.0		4	18.7	
5	118.0	125.0	MH	50.0	30.0		5	23.7	2750
6	120.0	128.0	HWR	250.0	34.0		4	40.7	
7	120.0	128.0	HWR	250.0	34.0		4	43.0	
8	130.0	137.0	ML	50.0	32.0		2	48.0	
9	120.0	128.0	HWR	250.0	34.0		4	66.1	
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-005 Sta 11+00
Project No. 21924 Boring JB-12

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.121

By: JCG Date: 1/11/16
Checked: MAR Date: 1/11/16

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														838						0.137	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	200	33.2	30.7	21.094	77.944	21.5	2.0	0.33	229.0	779.8	3.41	0.58	41.9	4.3	2.19	2.94	6602	652	4992	0.00	35.17	38.62	15.62	40935	8.20	YES	YES	YES	YES	
LRFD																				0.227	e/L													
LRFD	Sliding and OT			0.11	200	33.2	30.7	32.281	81.974	21.5	2.0	0.33	353.2	779.8	2.21	0.65	47.5	4.3	1.60	4.87	9586		7201	0.00	35.17	38.62	14.91	25633	3.56	YES	YES	YES	YES	
LRFD	Bearing Capacity								107.374					1153.7				Xo	7.46	3.29														
																				0.153	e/L		1.443	Ratio LRFD/ ASD										

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT				Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	2.7		2	17				30.0	81.0	2.7	50	135
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	2.0		2	41				32.0	64.0	2	50	100
3	clean sands w/ little gravel	SW, SP, GW		3	3.8		2	71				34.0	129.2	3.8	250	950
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4	10.2		4	100				34.0	346.8	10.2	250	2550
5	Overconsloidated higly plastic soils	CH, MH		5												
				6												
				7												
	Bottom Layer for Φ consideration in BC =		4	8												
												Phi for BC analysis =		33.2	C for BC analysis =	200

NOTES: 1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

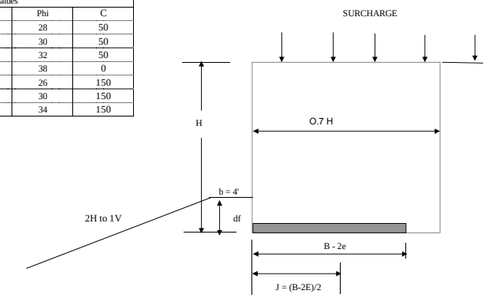
B = 0.7H for normal situations, min = 2.4 m

Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values				
	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1	
	Determination of Settlement below Walls	Made By MAR	
		Date 1/11/2016	
		Checked By JCG	
LOCATION JBCONN RW-005	STA 11+00 (Abut. A) BL	Enter Values in Blue.	Date 1/11/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-12

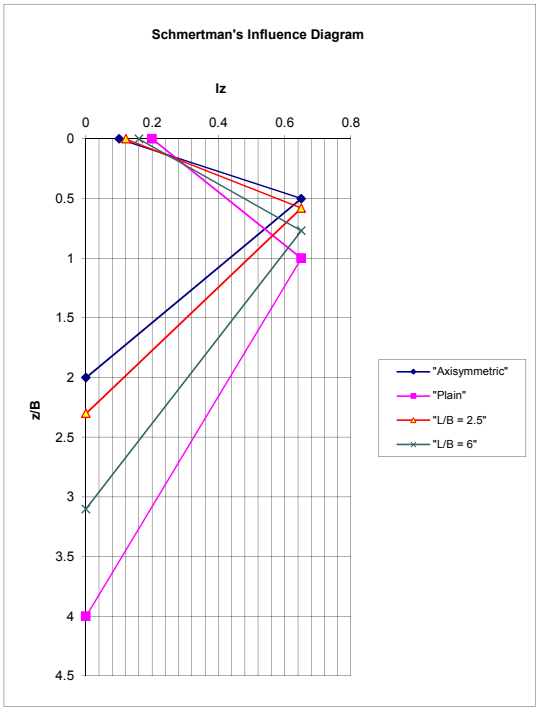
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	2.7	17	2	0.0	2.7
2	2.0	41	2	2.7	4.7
3	3.8	71	2	4.7	8.5
4	10.2	100	4	8.5	18.7
5	5.0	22	5	18.7	23.7
6	17.0	94	4	23.7	40.7
7					
8					
9					
10					
11					
12					

Z, ft	3.30	Height of Existing Ground Above Bottom of Wall
Po, psf	4,992	Avg. Foundation Pressure From MSEW
Γ, pcf	118.0	Bearing Soil Density
B, ft	16.6	Foundation Width (effective B-2e)
L, ft	100	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	4,603	
L/B	6.02	
C1	0.96	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.47	**Immediate Settlement** (up to end of monitoring period)		
	0.05	Post-Construction Settlement, in.	0.20	year
Δ, in	0.52	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.06017	0.19827	2	377,230	0.06
3	0.18051	0.27480	2	909,790	0.03
5	0.30084	0.35134	2	1,575,490	0.02
7	0.42118	0.42787	2	1,575,490	0.03
9	0.54152	0.50440	4	3,804,000	0.01
11	0.66185	0.58094	4	3,804,000	0.02
13	0.78219	0.64661	4	3,804,000	0.02
15	0.90253	0.61316	4	3,804,000	0.02
17	1.02286	0.57970	4	3,804,000	0.02
19	1.14320	0.54625	5	383,570	0.16
21	1.26354	0.51280	5	383,570	0.15
23	1.38387	0.47934	4	3,575,760	0.01
25	1.50421	0.44589	4	3,575,760	0.01
27	1.62455	0.41244	4	3,575,760	0.01
29	1.74489	0.37898	4	3,575,760	0.01
31	1.86522	0.34553	4	3,575,760	0.01
33	1.98556	0.31207	4	3,575,760	0.01
35	2.10590	0.27862	4	3,575,760	0.01
37	2.22623	0.24517	4	3,575,760	0.01
39	2.34657	0.21171	4	3,575,760	0.01
41	2.46691	0.17826	4	3,575,760	0.01
43	2.58724	0.14481	4	3,575,760	0.00
45	2.70758	0.11135	4	3,575,760	0.00
47	2.82792	0.07790	4	3,575,760	0.00
49	2.94826	0.04445	4	3,575,760	0.00
51	3.06859	0.01099	4	3,575,760	0.00
53	3.18893	0.00000			
55	3.30927	0.00000			
57	3.42960	0.00000			
59	3.54994	0.00000			
61	3.67028	0.00000			
61	3.67028	0.00000			
63	3.79061	0.00000			
65	3.91095	0.00000			
67	4.03129	0.00000			
69	4.15162	0.00000			
71	4.27196	0.00000			
73	4.39230	0.00000			
75	4.51264	0.00000			
77	4.63297	0.00000			
			ΣΔ, in. (Uncorrected)		0.65



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

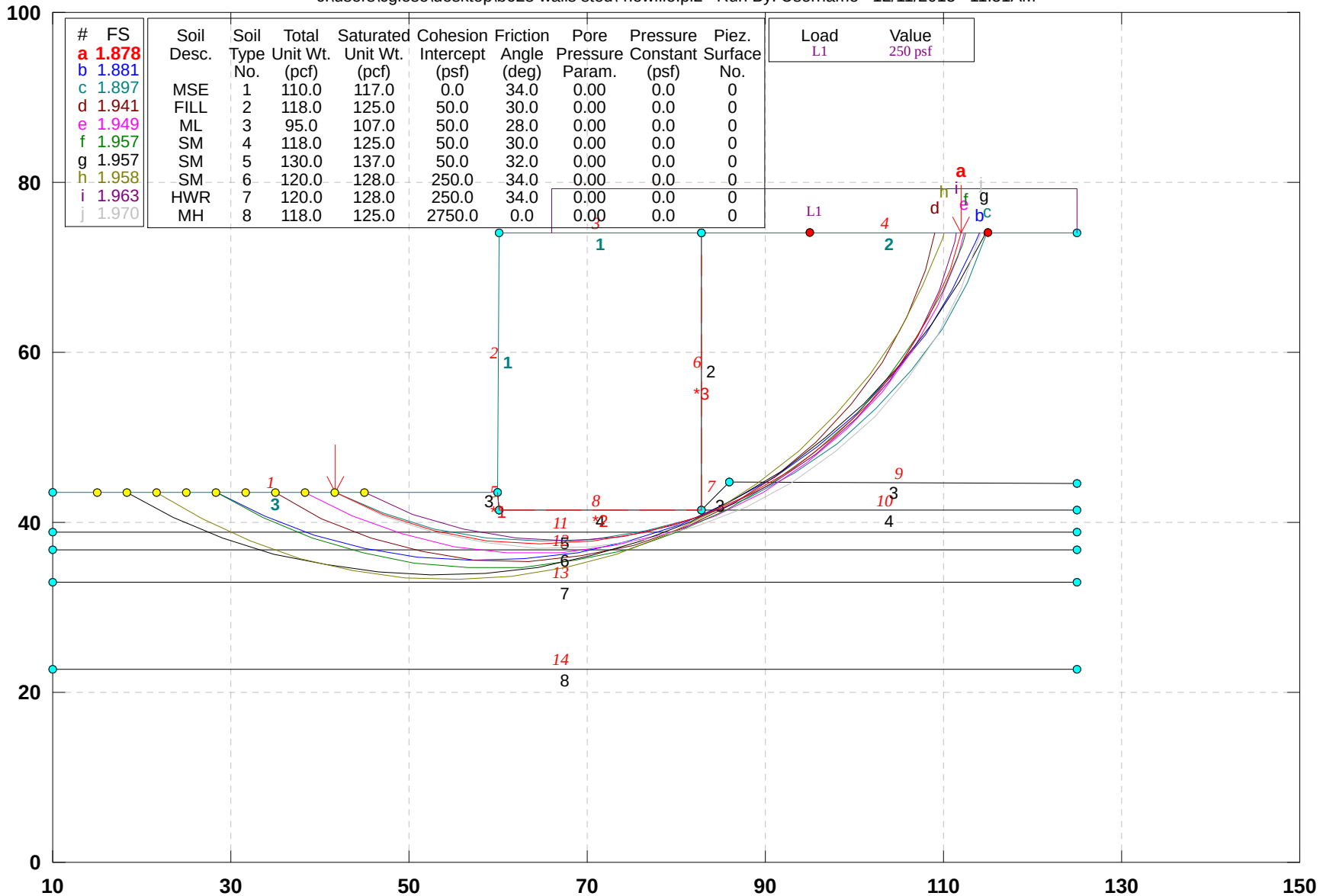
JBCONN WALL RW-005 11+00

c:\users\cgiese\desktop\b628 walls sted\-newfile.pl2 Run By: Username 12/11/2015 11:51AM

#	FS
a	1.878
b	1.881
c	1.897
d	1.941
e	1.949
f	1.957
g	1.957
h	1.958
i	1.963
j	1.970

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
MSE	1	110.0	117.0	0.0	34.0	0.00	0.0	0
FILL	2	118.0	125.0	50.0	30.0	0.00	0.0	0
ML	3	95.0	107.0	50.0	28.0	0.00	0.0	0
SM	4	118.0	125.0	50.0	30.0	0.00	0.0	0
SM	5	130.0	137.0	50.0	32.0	0.00	0.0	0
SM	6	120.0	128.0	250.0	34.0	0.00	0.0	0
HWR	7	120.0	128.0	250.0	34.0	0.00	0.0	0
MH	8	118.0	125.0	2750.0	0.0	0.00	0.0	0

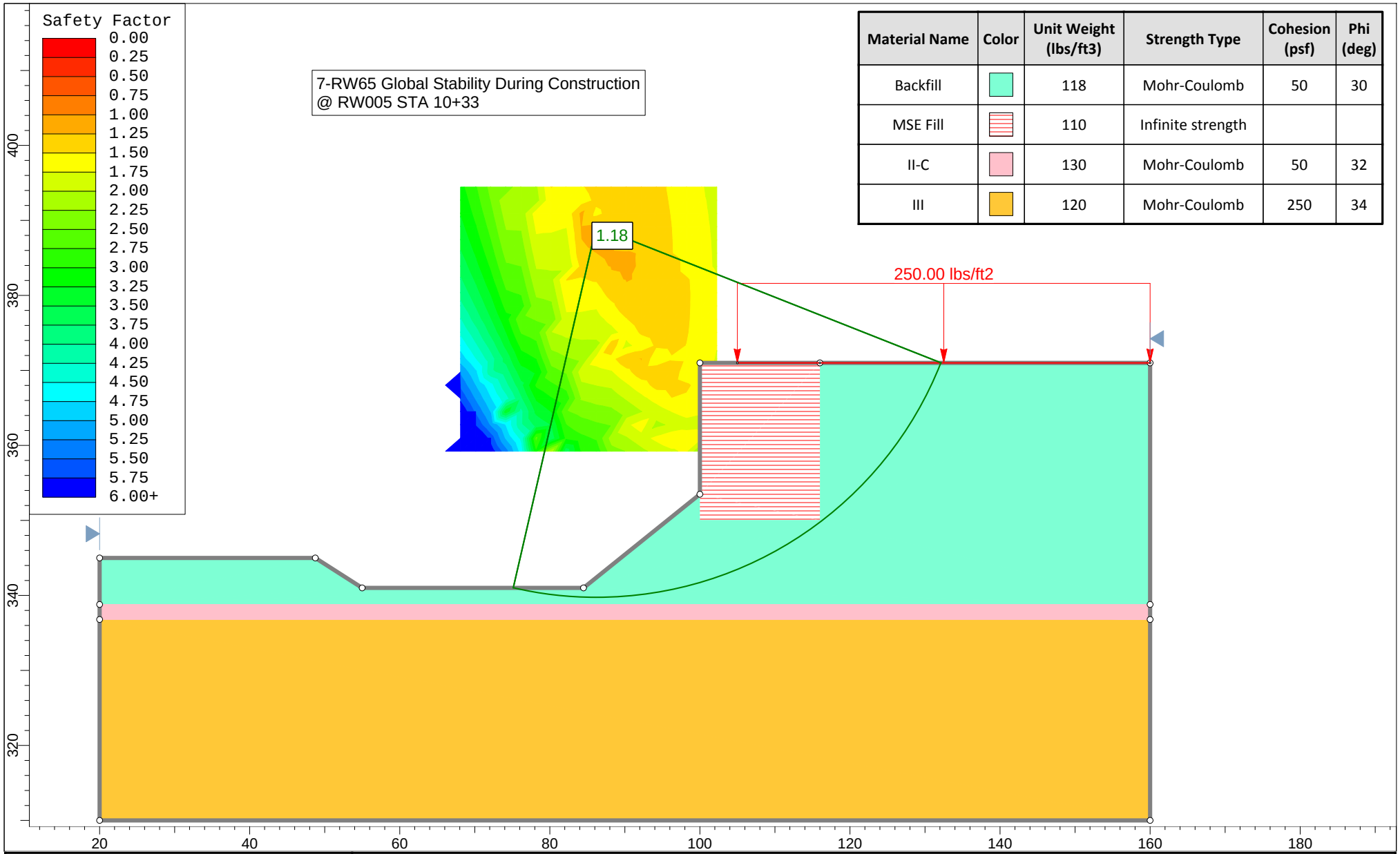
Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=1.878

Safety Factors Are Calculated By The Modified Bishop Method

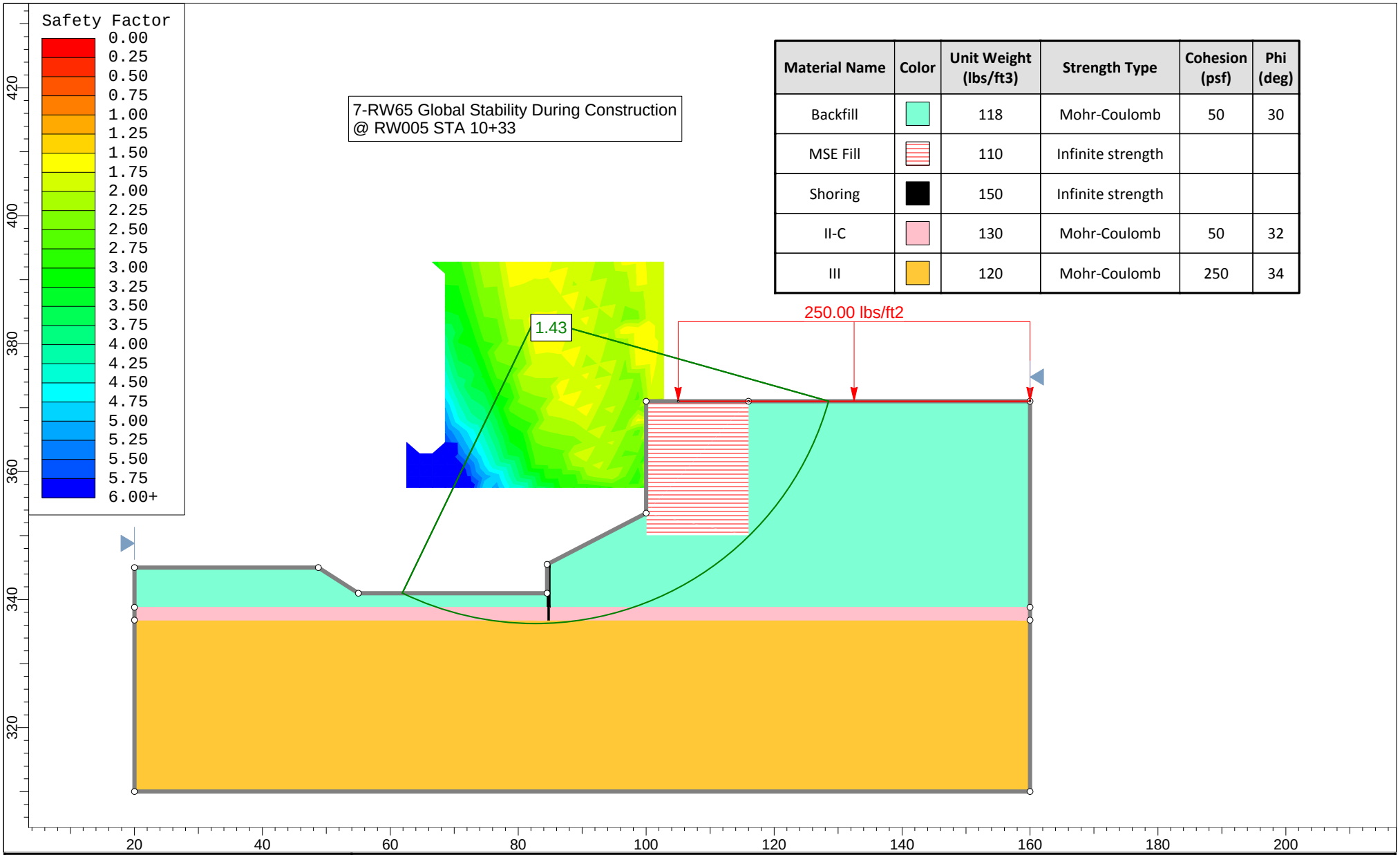
GSTABL7



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
MSE Fill		110	Infinite strength		
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34

SLIDEINTERPRET 6.036

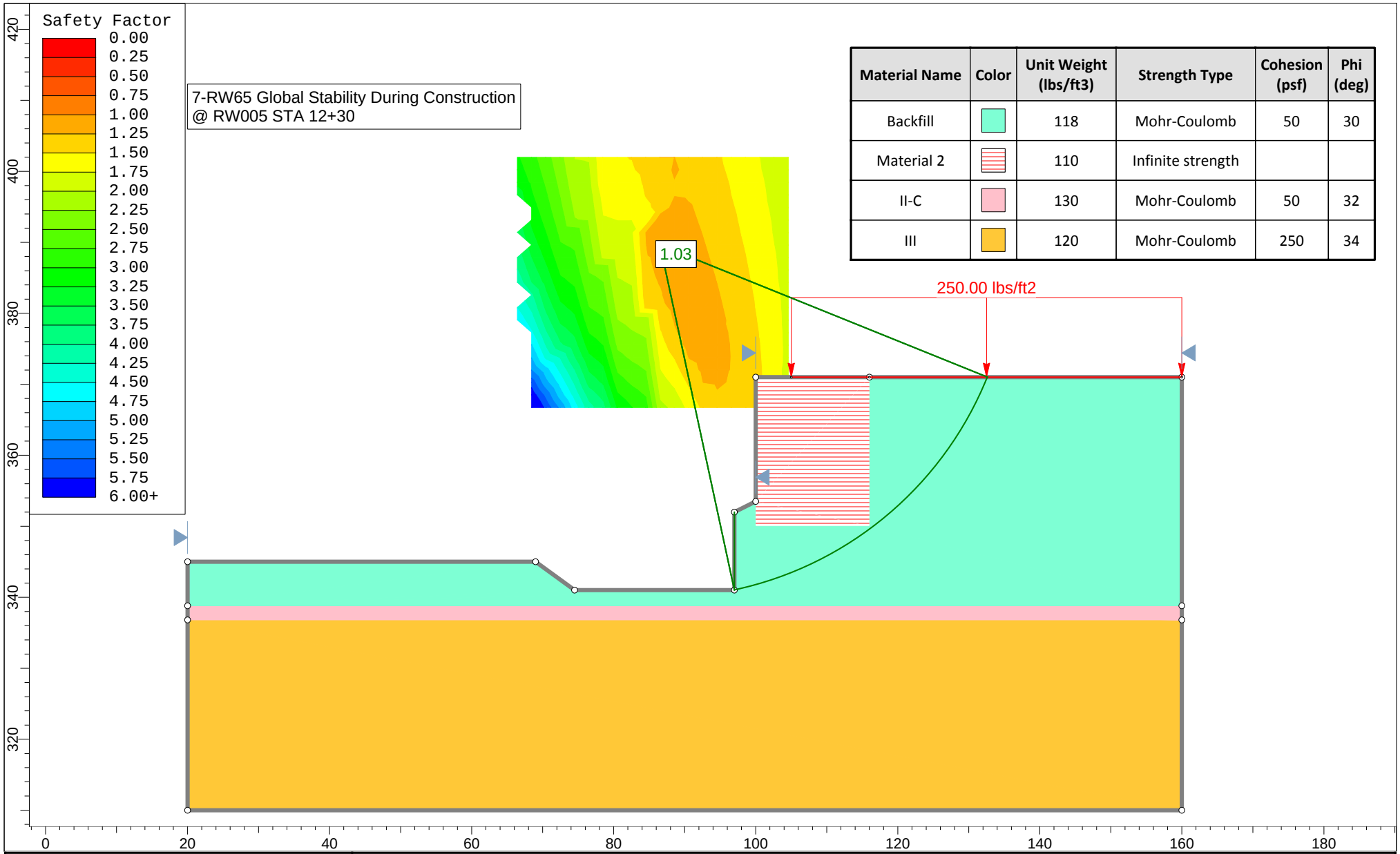
Project	JBCONN		
Analysis Description	RW005 STA 10+33		
Drawn By MAR	*Scale* 1:212	*Company* ECS	
Date 3/14/16		*File Name* RW005 - Sta 10+33_Sloped.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
MSE Fill		110	Infinite strength		
Shoring		150	Infinite strength		
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34

SLIDEINTERPRET 6.036

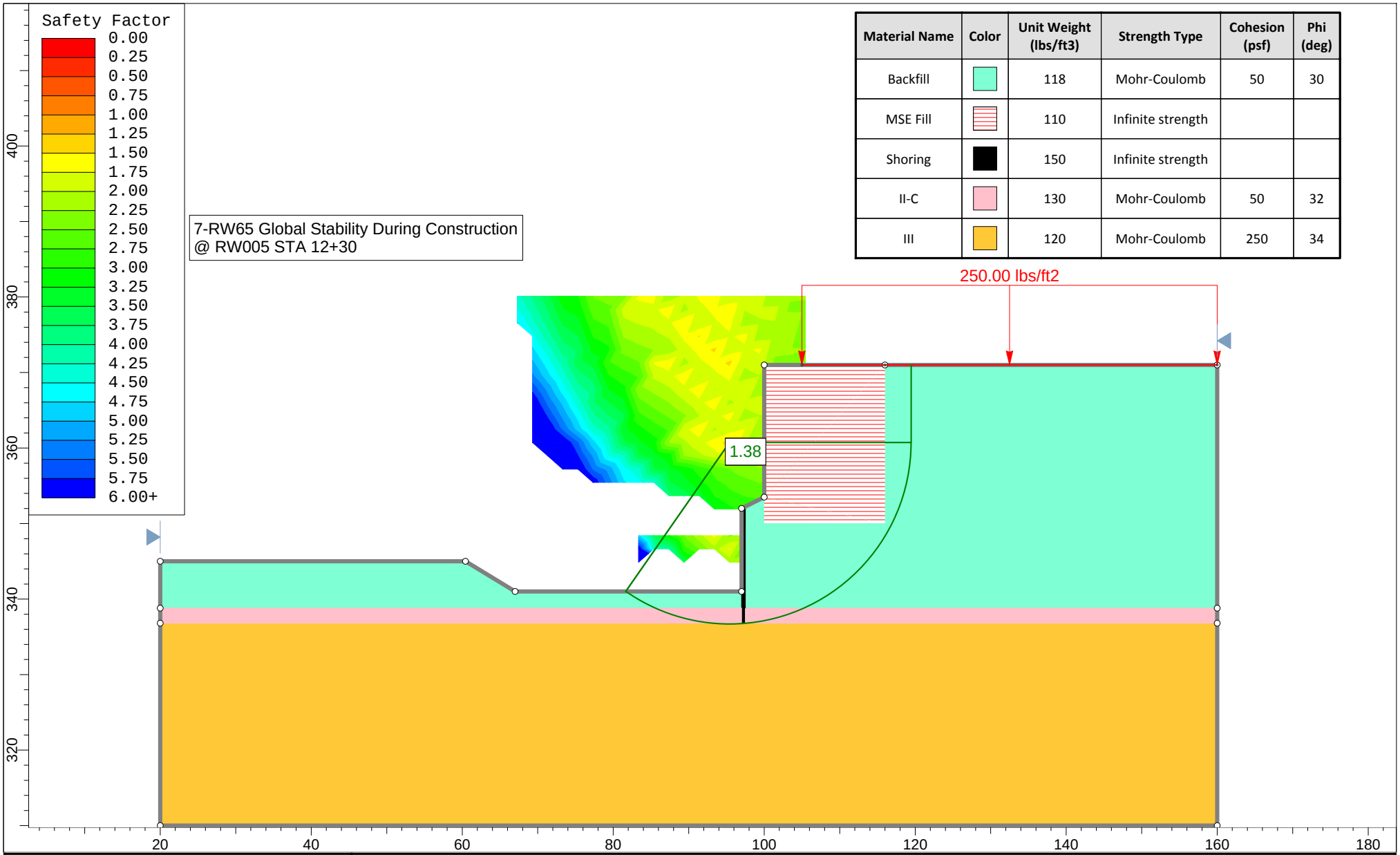
Project	JBCONN		
Analysis Description	RW005 STA 10+33		
Drawn By MAR	*Scale* 1:249	*Company* ECS	
Date 3/14/16		*File Name* RW005 - Sta 10+33_Embeded Sheet Pile.sli	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
Material 2		110	Infinite strength		
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW005 STA 12+30		
Drawn By MAR	*Scale* 1:224	*Company* ECS	
Date 3/14/16		*File Name* RW005 - Sta 12+30.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
MSE Fill		110	Infinite strength		
Shoring		150	Infinite strength		
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34

SLIDEINTERPRET 6.036

Project	JBCONN		
Analysis Description	RW005 STA 12+30		
Drawn By MAR	*Scale* 1:211	*Company* ECS	
Date 3/14/16		*File Name* RW005 - Sta 12+30_Embeded Sheet Pile.slim	

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 1/7/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment B Enter Values in Blue.	Date 1/7/2016

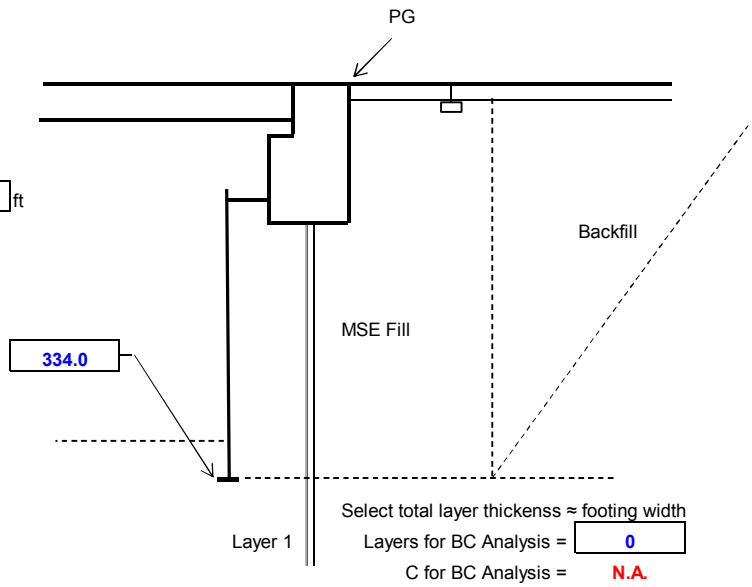
Red values are calculated

BORING No. =	JB-21	
Top of Boring El. =	335.6	ft
Profile Grade =	357.7	ft
Top of Layer 1 =	334.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	290.6	ft

Middle Abutment

Bottom of Abut. = 346.4 ft

El. Ground in front of Wall =	336.0
El. Top of Front Wall =	348.2
Front Wall Total Height =	14.2
Front Wall Height from PG to Bot. =	23.7



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	329.6	4.4	P	II-B	11	22				17
2	323.1	6.5	P	II-B	18	17	14			16
3	319.0	4.1	P	II-B	18					18
4	298.6	20.4	P	II-C	67	34	52	41		49
5	294.0	4.6	P	II-C	87					87
6	290.6	3.4	P	II-C	100					100
7	285.0	5.6	P	II-C	77					77
8	266.9	18.1	P	II-C	100	100	100	100		100
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	4.4	
2	118.0	125.0	MH	50.0	30.0		5	10.9	2042
3	118.0	125.0	ML	50.0	30.0		2	15.0	
4	130.0	137.0	ML	50.0	32.0		2	35.4	
5	120.0	128.0	HWR	250.0	34.0		4	40.0	
6	120.0	128.0	HWR	250.0	34.0		4	43.4	
7	120.0	128.0	HWR	250.0	34.0		4	49.0	
8	120.0	128.0	HWR	250.0	34.0		4	67.1	
9									
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-006 Sta 13+75
Project No. 21924 Boring JB-21

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.150

By: JCG Date: 1/12/16
Checked: MAR Date: 1/12/16

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	*FS AGAINST OVERTURNING* Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	*FACTOR OF SAFETY AGAINST SLIDING* For Sands at base of Wall Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall Force Resisting Sliding kip	Total F.S.	*FACTOR OF SAFETY AGAINST BEARING CAPACITY* Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	*CHECKS* FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														393						0.141	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	50	30.0	23.7	13.022	47.398	16.6	2.0	0.33	110.7	358.8	3.24	0.58	25.0	0.8	1.98	2.33	5270	444	3976	0.00	22.39	30.13	11.92	21523	5.41	YES	YES	YES	YES	
LRFD																				0.240	e/L													
LRFD	Sliding and OT			0.11	50	30.0	23.7	20.026	50.508	16.6	2.0	0.33	171.9	358.8	2.09	0.58	25.0	0.8	1.29	3.97	7703		5782	0.00	22.39	30.13	11.35	13372	2.31	YES	YES	YES	YES	
LRFD	Bearing Capacity								65.646					544.5				Xo	5.68	2.62														
																				0.158	e/L		1.454	Ratio LRFD/ ASD										

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT				Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	4.4		5	17				30.0	132.0	4.4	50	220
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	6.5		2	16				30.0	195.0	6.5	50	325
3	clean sands w/ little gravel	SW, SP, GW		3	4.1		2	18				30.0	123.0	4.1	50	205
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4												
5	Overconsloidated higly plastic soils	CH, MH		5												
				6												
				7												
	Bottom Layer for Φ consideration in BC =		3	8												
												Phi for BC analysis =		30.0	C for BC analysis =	50

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

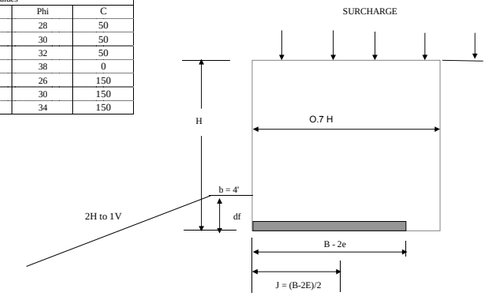
B = 0.7H for normal situations, min = 2.4 m

Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values				
	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1
	Determination of Settlement below Walls	Made By MAR Date 1/12/2016 Checked By JCG
LOCATION JBCONN RW-006	STA 13+75 (Abut. B) BL	Enter Values in Blue. Date 1/12/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-21

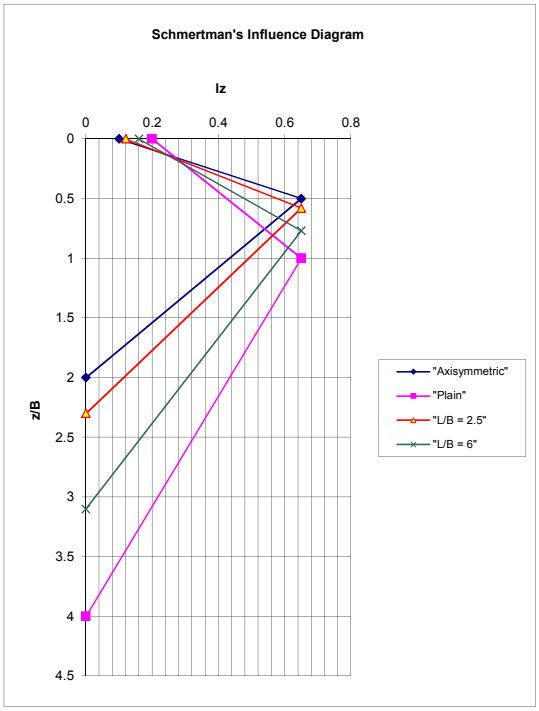
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	4.4	17	2	0.0	4.4
2	6.5	16	5	4.4	10.9
3	4.1	18	2	10.9	15.0
4	20.4	49	2	15.0	35.4
5	4.6	87	4	35.4	40.0
6	3.4	100	4	40.0	43.4
7	5.6	77	4	43.4	49.0
8					
9					
10					
11					
12					

Z, ft	2.00	Height of Existing Ground Above Bottom of Wall
Po, psf	3,976	Avg. Foundation Pressure From MSEW
Γ, pcf	121.0	Bearing Soil Density
B, ft	11.9	Foundation Width (effective B-2e)
L, ft	100	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	3,734	
L/B	8.40	
C1	0.97	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.84	**Immediate Settlement** (up to end of monitoring period)		
	0.09	Post-Construction Settlement, in.	0.20	year
Δ, in	0.94	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.08403	0.21345	2	377,230	0.05
3	0.25210	0.32034	2	377,230	0.08
5	0.42017	0.42723	5	278,960	0.14
7	0.58824	0.53412	5	278,960	0.17
9	0.75630	0.64101	5	278,960	0.21
11	0.92437	0.60709	2	399,420	0.14
13	1.09244	0.56036	2	399,420	0.13
15	1.26050	0.51364	2	1,087,310	0.04
17	1.42857	0.46692	2	1,087,310	0.04
19	1.59664	0.42019	2	1,087,310	0.03
21	1.76471	0.37347	2	1,087,310	0.03
23	1.93277	0.32675	2	1,087,310	0.03
25	2.10084	0.28003	2	1,087,310	0.02
27	2.26891	0.23330	2	1,087,310	0.02
29	2.43697	0.18658	2	1,087,310	0.02
31	2.60504	0.13986	2	1,087,310	0.01
33	2.77311	0.09314	2	1,087,310	0.01
35	2.94118	0.04641	4	3,309,480	0.00
37	3.10924	0.00000			
39	3.27731	0.00000			
41	3.44538	0.00000			
43	3.61345	0.00000			
45	3.78151	0.00000			
47	3.94958	0.00000			
49	4.11765	0.00000			
51	4.28571	0.00000			
53	4.45378	0.00000			
55	4.62185	0.00000			
57	4.78992	0.00000			
59	4.95798	0.00000			
61	5.12605	0.00000			
61	5.12605	0.00000			
63	5.29412	0.00000			
65	5.46218	0.00000			
67	5.63025	0.00000			
69	5.79832	0.00000			
71	5.96639	0.00000			
73	6.13445	0.00000			
75	6.30252	0.00000			
77	6.47059	0.00000			
			ΣΔ, in. (Uncorrected)		1.15



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

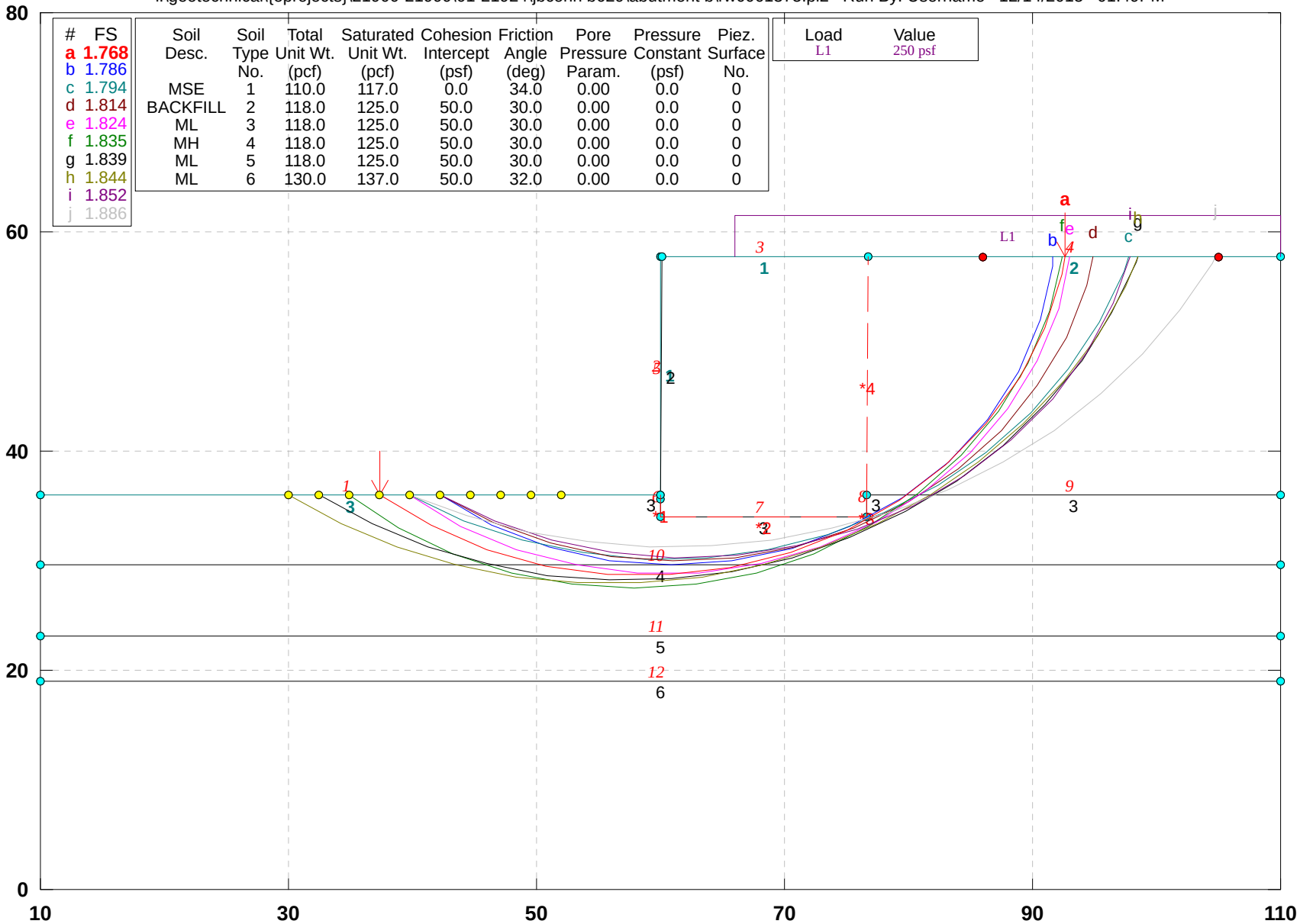
JBCONN RW-006 Sta 13+75

i:\geotechnical\{eprojects}\21900-21999\01-21924\jbconn b629\abutment b\rw0061375.pl2 Run By: Username 12/14/2015 01:49PM

#	FS
a	1.768
b	1.786
c	1.794
d	1.814
e	1.824
f	1.835
g	1.839
h	1.844
i	1.852
j	1.886

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
MSE	1	110.0	117.0	0.0	34.0	0.00	0.0	0
BACKFILL	2	118.0	125.0	50.0	30.0	0.00	0.0	0
ML	3	118.0	125.0	50.0	30.0	0.00	0.0	0
MH	4	118.0	125.0	50.0	30.0	0.00	0.0	0
ML	5	118.0	125.0	50.0	30.0	0.00	0.0	0
ML	6	130.0	137.0	50.0	32.0	0.00	0.0	0

Load	Value
L1	250 psf



GSTABL7 v.2 FSmin=1.768

Safety Factors Are Calculated By The Modified Bishop Method

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 3/17/2016
	Checked By JCG
LOCATION JBCONN Bridge 629 Abutment B Enter Values in Blue.	Date 3/17/2016

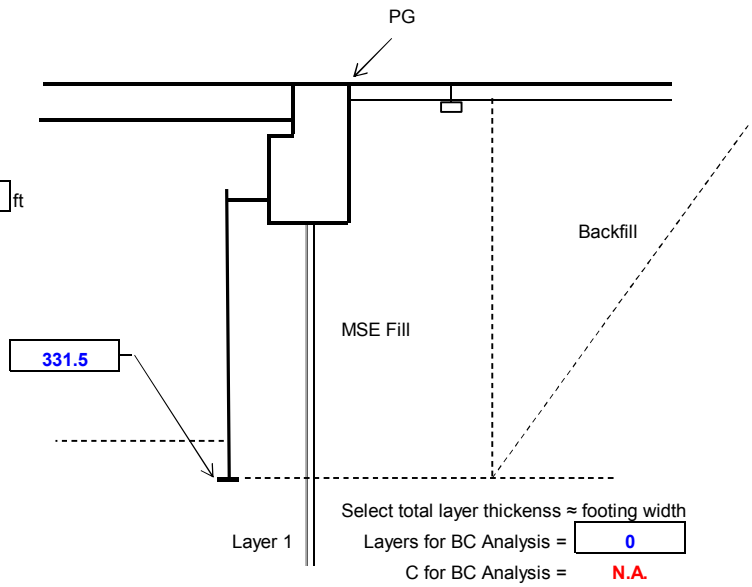
Red values are calculated

BORING No. =	JB-22	
Top of Boring El. =	342.9	ft
Profile Grade =	356.0	ft
Top of Layer 1 =	331.5	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	266.6	ft

South Abutment End

Bottom of Abut. = 343.3 ft

El. Ground in front of Wall =	333.5
El. Top of Front Wall =	346.5
Front Wall Total Height =	15.0
Front Wall Height from PG to Bot. =	24.5



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Layers for BC Analysis =	0
C for BC Analysis =	N.A.
Φ for BC analysis =	N.A.
Γ for BC Analysis =	N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	319.0	12.5	P	II-B	8	15	18	18		15
2	310.0	9.0	P	II-B	16	13				15
3	300.0	10.0	P	II-B	27	29				28
4	294.0	6.0	P	II-C	45					45
5	289.0	5.0	P	II-B	11					11
6	274.0	15.0	P	II-C	50	19	58			42
7	266.6	7.4	P	II-C	85	100				93
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	MH	50.0	30.0		5	12.5	1844
2	118.0	125.0	MH	50.0	30.0		5	21.5	1813
3	118.0	125.0	MH	50.0	30.0		5	31.5	3500
4	130.0	137.0	ML	50.0	32.0		2	37.5	
5	118.0	125.0	MH	50.0	30.0		5	42.5	1375
6	130.0	137.0	ML	50.0	32.0		2	57.5	
7	120.0	128.0	HWR	250.0	34.0		4	64.9	
8									
9									
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-006 Sta 14+25
Project No. 21924 Boring JB-22

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.150

By: JCG **Date:** 3/17/16
Checked: MAR **Date:** 3/17/16

ANALYSIS EXT. LOAD Surcharge 0.44 ksf
LRFD LIVE LOAD 0.25 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE
0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														406						0.150	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	42	29.0	24.5	13.847	48.887	16.6	2.0	0.33	121.4	371.3	3.06	0.67	30.2	0.7	2.23	2.48	5589	301	4203	0.00	19.33	27.85	11.63	18022	4.29	YES	YES	YES	YES
LRFD																				0.254	e/L												
LRFD	Sliding and OT			0.11	42	29.0	24.5	21.280	52.000	16.6	2.0	0.33	188.4	371.3	1.97	0.55	24.8	0.7	1.20	4.21	8177		6133	0.00	19.33	27.85	11.03	11148	1.82	YES	YES	YES	WARNING: CHECK ECCENTRICITY
LRFD	Bearing Capacity								67.657					561.6				Xo	5.52	2.78													

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT				Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	2.0		3	15				34.0	68.0	2	0	0
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	10.0		5	14				28.0	280.0	10	50	500
3	clean sands w/ little gravel	SW, SP, GW		3												
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4												
5	Overconsloidated higly plastic soils	CH, MH		5												
				6												
				7												
	Bottom Layer for Φ consideration in BC =		2	8												
												Phi for BC analysis =		29.0	C for BC analysis =	42

Eccentricity e	Toe Bearing Stress	Heel Bearing Stress	Avg Bearing Stress	Surcharge Coefficient Nq	Friction Coefficent Ng	Cohesion Coefficient Nc	Effective B B'=B-2e	Ultimate Bearing Capacity	FSbc
0.168	e/L		1.459	Ratio LRFD/ ASD					

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

B = 0.7H for normal situations, min = 2.4 m

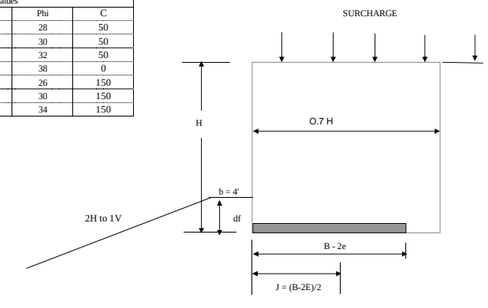
Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values

	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

ECS MID-ATLANTIC, LLC COMPUTATION SHEET		Page 1 of 1	
Determination of Settlement below Walls		Made By MAR	
		Date 3/17/2016	
		Checked By JCG	
LOCATION JBCONN RW-006	STA 14+25 (Abut. B) BL	Enter Values in Blue.	Date 3/17/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-22

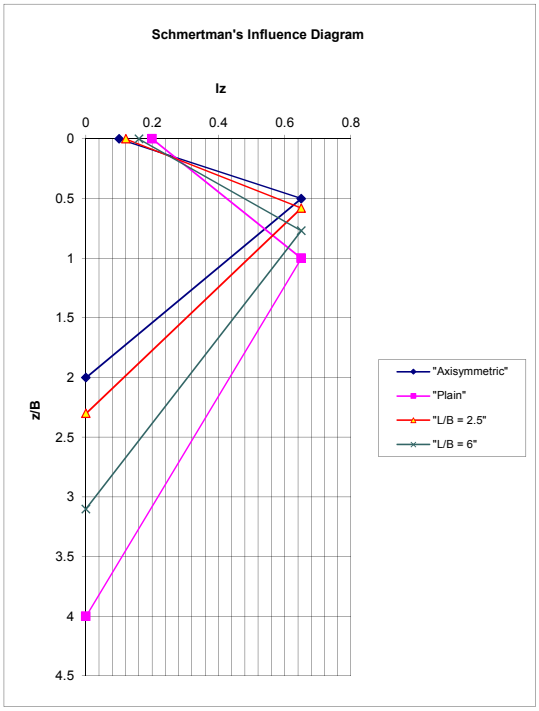
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	2.0	14	3	0.0	2.0
2	18.0	15	5	2.0	20.0
3	9.0	15	5	20.0	29.0
4	10.0	28	5	29.0	39.0
5	6.0	45	2	39.0	45.0
6	5.0	11	5	45.0	50.0
7	15.0	42	2	50.0	65.0
8	7.4	93	4	65.0	72.4
9					
10					
11					
12					

Z, ft	11.5	Height of Existing Ground Above Bottom of Wall
Po, psf	4,203	Avg. Foundation Pressure From MSEW
Γ, pcf	121.0	Bearing Soil Density
B, ft	11.6	Foundation Width (effective B-2e)
L, ft	100	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,812	
L/B	8.62	
C1	0.75	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.88	**Immediate Settlement** (up to end of monitoring period)		
	0.10	Post-Construction Settlement, in.	0.20	year
Δ, in	0.97	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.08621	0.21483	3	443,800	0.03
3	0.25862	0.32448	5	261,525	0.08
5	0.43103	0.43414	5	261,525	0.11
7	0.60345	0.54379	5	261,525	0.14
9	0.77586	0.64837	5	261,525	0.17
11	0.94828	0.60044	5	261,525	0.15
13	1.12069	0.55251	5	261,525	0.14
15	1.29310	0.50458	5	261,525	0.13
17	1.46552	0.45665	5	261,525	0.12
19	1.63793	0.40872	5	261,525	0.11
21	1.81034	0.36078	5	261,525	0.09
23	1.98276	0.31285	5	261,525	0.08
25	2.15517	0.26492	5	261,525	0.07
27	2.32759	0.21699	5	261,525	0.06
29	2.50000	0.16906	5	488,180	0.02
31	2.67241	0.12113	5	488,180	0.02
33	2.84483	0.07320	5	488,180	0.01
35	3.01724	0.02527	5	488,180	0.00
37	3.18966	0.00000			
39	3.36207	0.00000			
41	3.53448	0.00000			
43	3.70690	0.00000			
45	3.87931	0.00000			
47	4.05172	0.00000			
49	4.22414	0.00000			
51	4.39655	0.00000			
53	4.56897	0.00000			
55	4.74138	0.00000			
57	4.91379	0.00000			
59	5.08621	0.00000			
61	5.25862	0.00000			
61	5.25862	0.00000			
63	5.43103	0.00000			
65	5.60345	0.00000			
67	5.77586	0.00000			
69	5.94828	0.00000			
71	6.12069	0.00000			
73	6.29310	0.00000			
75	6.46552	0.00000			
77	6.63793	0.00000			
			ΣΔ, in. (Uncorrected)		1.54



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

JBCON Wall 6 Sta 14+25 extended straps

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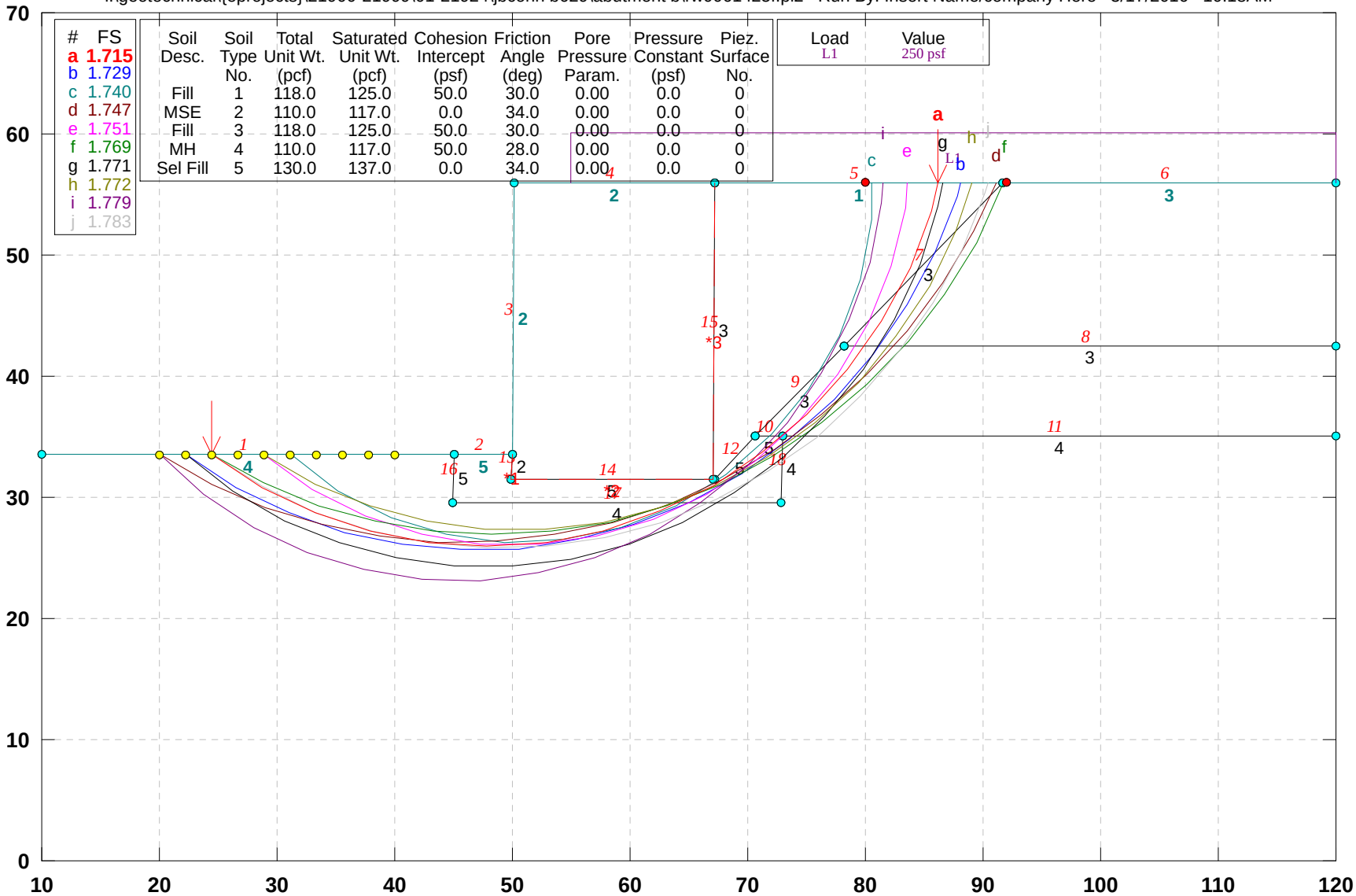


#	FS
a	1.715
b	1.729
c	1.740
d	1.747
e	1.751
f	1.769
g	1.771
h	1.772
i	1.779
j	1.783

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Fill	1	118.0	125.0	50.0	30.0	0.00	0.0	0
MSE	2	110.0	117.0	0.0	34.0	0.00	0.0	0
Fill	3	118.0	125.0	50.0	30.0	0.00	0.0	0
MH	4	110.0	117.0	50.0	28.0	0.00	0.0	0
Sel Fill	5	130.0	137.0	0.0	34.0	0.00	0.0	0

Load	Value
L1	250 psf

GSTABL7 v.2 FSmin=1.715

Safety Factors Are Calculated By The Modified Bishop Method

ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 12/22/2015
	Checked By JCG
LOCATION RW-006 Sta 12+10 North Wing Enter Values in Blue.	Date 12/22/2015

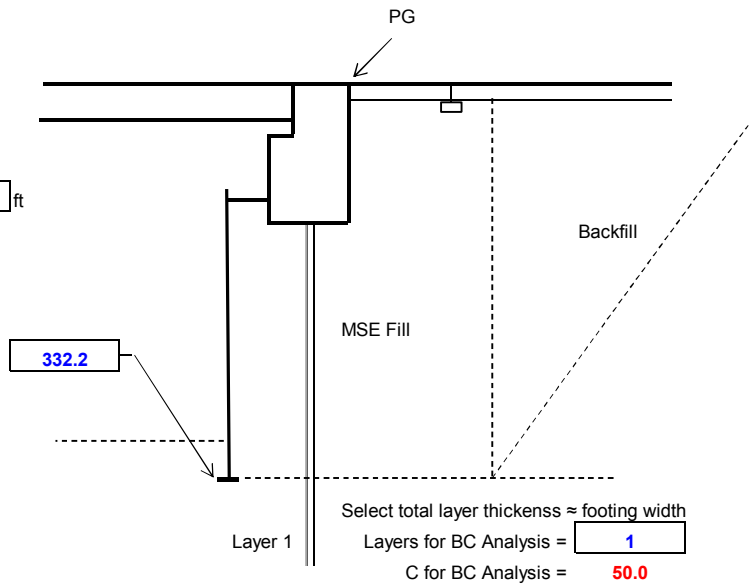
Red values are calculated

BORING No. =	JB-27	
Top of Boring El. =	334.2	ft
Profile Grade =	351.4	ft
Top of Layer 1 =	332.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	294.2	ft

South Abutment End

Bottom of Abut. = ft

El. Ground in front of Wall =	334.2
El. Top of Front Wall =	
Front Wall Total Height =	
Front Wall Height from PG to Bot. =	19.2



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	1
C for BC Analysis =	50.0
Φ for BC analysis =	30.0
Γ for BC Analysis =	118.0

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	322.0	10.0	P	II-B	13	19	15	13		15
2	308.0	14.0	P	II-C	40	34	25			33
3	297.0	11.0	P	II-C	48	34				41
4	294.2	2.8	P	II-C	68					68
5										
6										
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	118.0	125.0	ML	50.0	30.0		2	10.0	
2	130.0	137.0	ML	50.0	32.0		2	24.0	
3	130.0	137.0	ML	50.0	32.0		2	35.0	
4	120.0	128.0	HWR	250.0	34.0		4	37.8	
5									
6									
7									
8									
9									
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-006 Sta 12+10
Project No. 21924 Boring JB-27

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.118

By: JCG **Date:** 12/22/15
Checked: MAR **Date:** 12/22/15

ANALYSIS EXT. LOAD Surcharge 0.14 ksf
LRFD LIVE LOAD 0.08 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE 0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														198						0.130	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	50	30.0	19.2	7.762	29.460	13.4	2.0	0.33	51.3	175.4	3.42	0.58	16.4	0.7	2.20	1.74	3896	488	2959	0.00	22.39	30.13	9.96	14658	4.95	YES	YES	YES	YES	
LRFD																				0.205	e/L													
LRFD	Sliding and OT			0.11	50	30.0	19.2	11.771	30.267	13.4	2.0	0.33	78.2	190.7	2.44	0.58	16.4	0.7	1.45	2.75	5589		4210	0.00	22.39	30.13	9.55	9179	2.18	YES	YES	YES	YES	
LRFD	Bearing Capacity								40.202					270.2				Xo	4.77	1.95														
																				0.145	e/L		1.423	Ratio LRFD/ ASD										

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT					Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	10.0		2	15					30.0	300.0	10	50	500
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2													
3	clean sands w/ little gravel	SW, SP, GW		3													
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4													
5	Overconsloidated higly plastic soils	CH, MH		5													
				6													
				7													
	Bottom Layer for Φ consideration in BC =		1	8													
													Phi for BC analysis =		30.0	C for BC analysis =	50

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

B = 0.7H for normal situations, min = 2.4 m

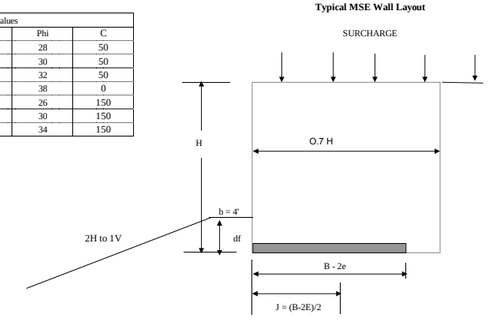
Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values

	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls			Page 1 of 1 Made By MAR Date 12/22/2015 Checked By JCG Date 12/22/2015
LOCATION JBCONN RW-006	STA 12+10	BL	Enter Values in Blue.

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-27

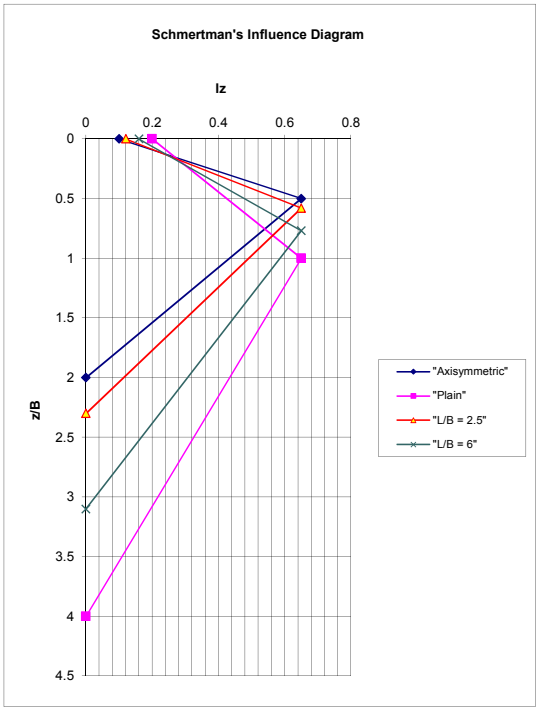
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	10.0	15	2	0.0	10.0
2	14.0	33	2	10.0	24.0
3	11.0	41	2	24.0	35.0
4	2.8	68	5	35.0	37.8
5					
6					
7					
8					
9					
10					
11					
12					

Z, ft	3.00	Height of Existing Ground Above Bottom of Wall
Po, psf	2,959	Avg. Foundation Pressure From MSEW
Γ, pcf	118.0	Bearing Soil Density
B, ft	9.9	Foundation Width (effective B-2e)
L, ft	100	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,605	
L/B	10.10	
C1	0.93	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.48	**Immediate Settlement** (up to end of monitoring period)		
	0.05	Post-Construction Settlement, in.	0.20	year
Δ, in	0.53	**Total Settlement**	1.00	year

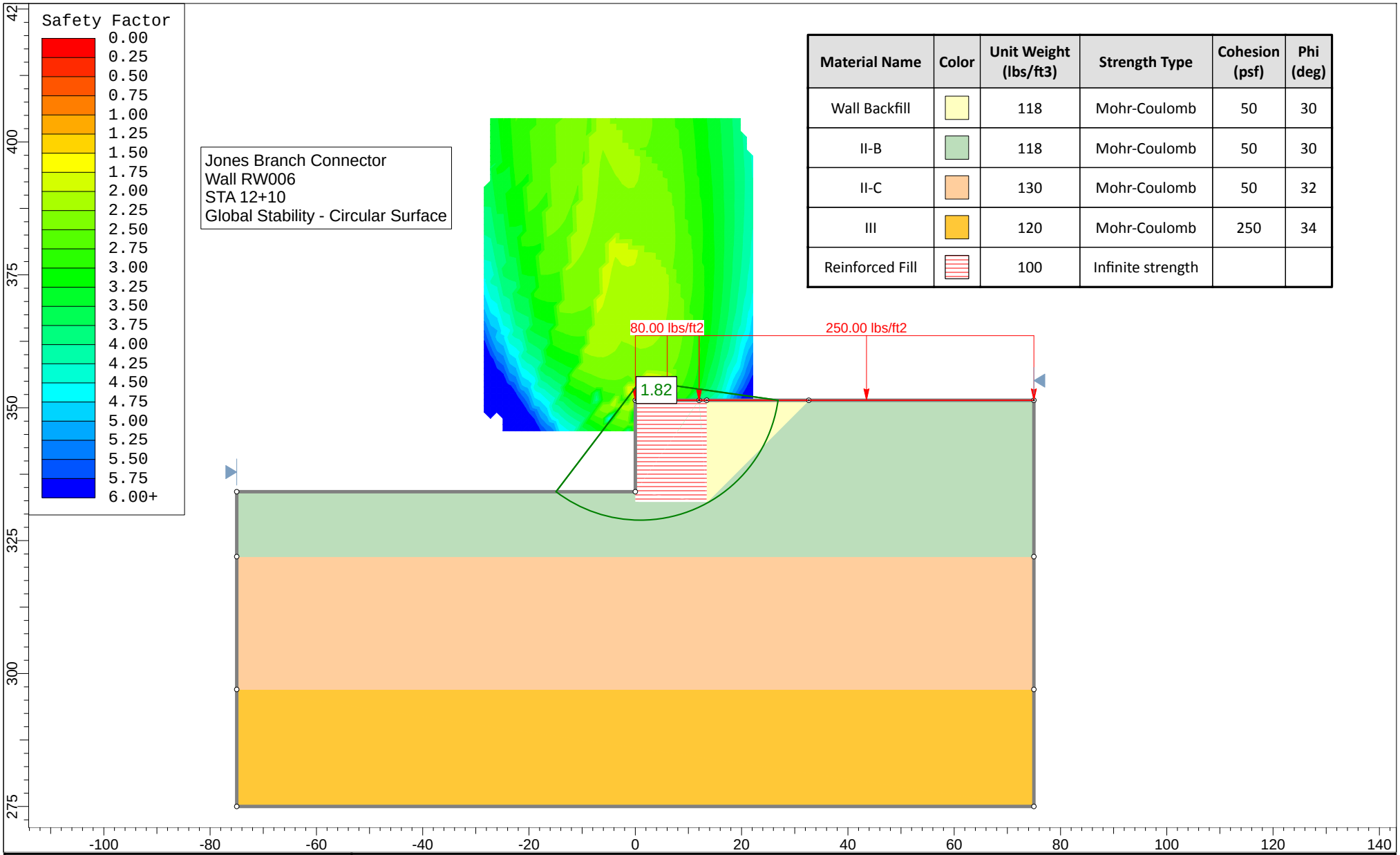
If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.10101	0.22424	2	332,850	0.04
3	0.30303	0.35273	2	332,850	0.07
5	0.50505	0.48121	2	332,850	0.09
7	0.70707	0.60970	2	332,850	0.11
9	0.90909	0.61133	2	332,850	0.11
11	1.11111	0.55517	2	732,270	0.05
13	1.31313	0.49901	2	732,270	0.04
15	1.51515	0.44285	2	732,270	0.04
17	1.71717	0.38669	2	732,270	0.03
19	1.91919	0.33052	2	732,270	0.03
21	2.12121	0.27436	2	732,270	0.02
23	2.32323	0.21820	2	732,270	0.02
25	2.52525	0.16204	2	909,790	0.01
27	2.72727	0.10588	2	909,790	0.01
29	2.92929	0.04972	2	909,790	0.00
31	3.13131	0.00000			
33	3.33333	0.00000			
35	3.53535	0.00000			
37	3.73737	0.00000			
39	3.93939	0.00000			
41	4.14141	0.00000			
43	4.34343	0.00000			
45	4.54545	0.00000			
47	4.74747	0.00000			
49	4.94949	0.00000			
51	5.15152	0.00000			
53	5.35354	0.00000			
55	5.55556	0.00000			
57	5.75758	0.00000			
59	5.95960	0.00000			
61	6.16162	0.00000			
61	6.16162	0.00000			
63	6.36364	0.00000			
65	6.56566	0.00000			
67	6.76768	0.00000			
69	6.96970	0.00000			
71	7.17172	0.00000			
73	7.37374	0.00000			
75	7.57576	0.00000			
77	7.77778	0.00000			
			ΣΔ, in. (Uncorrected)		0.68



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

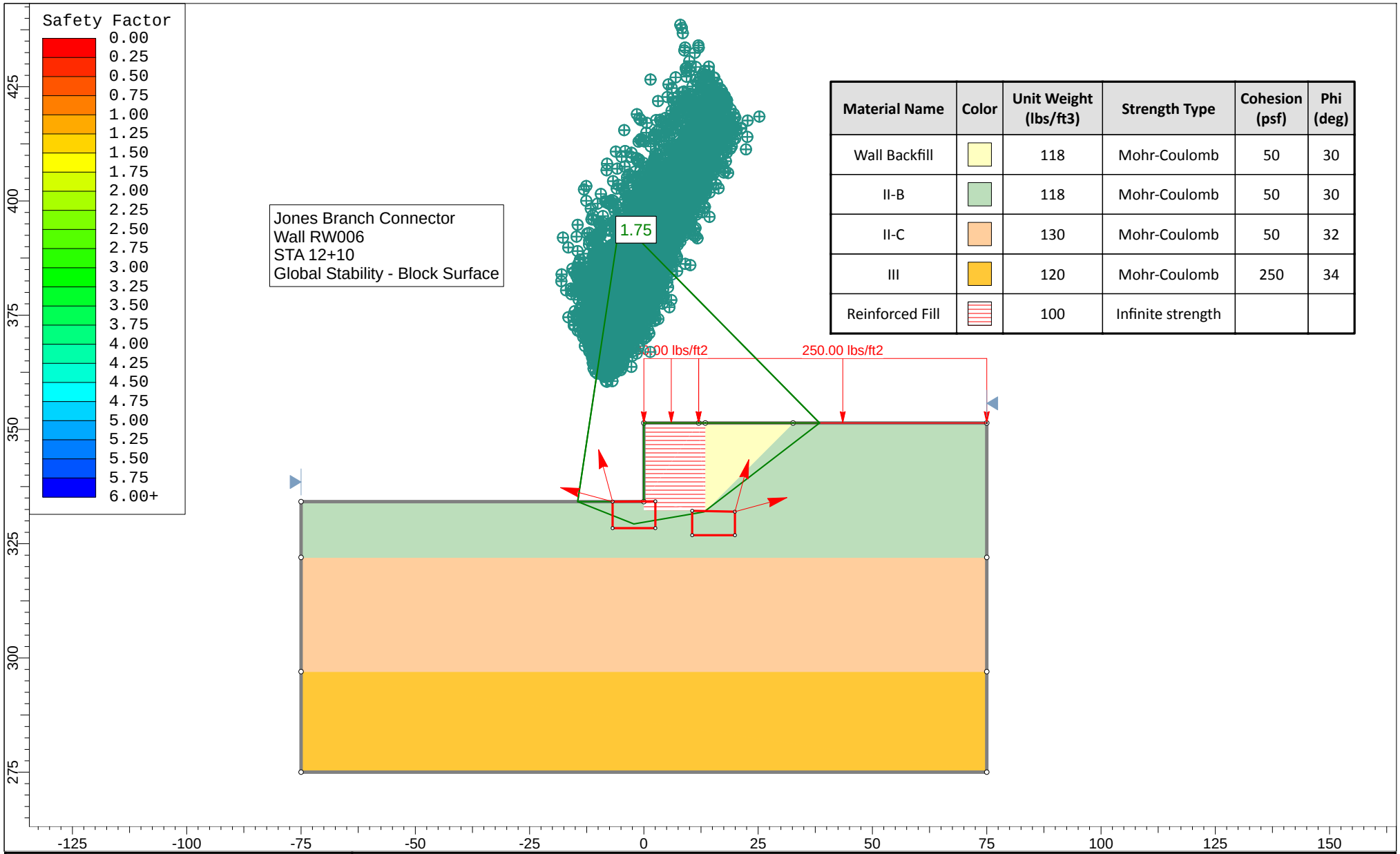
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Wall Backfill		118	Mohr-Coulomb	50	30
II-B		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34
Reinforced Fill		100	Infinite strength		

SLIDEINTERPRET 6.036

Project	Jones Branch Connector		
Analysis Description	Wall RW006 STA 12+10		
Drawn By DJS	*Scale* 1:300	*Company* ECS	
Date 12/22/2015		*File Name* RW006 STA 12+10_Circular.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Wall Backfill		118	Mohr-Coulomb	50	30
II-B		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34
Reinforced Fill		100	Infinite strength		

SLIDEINTERPRET 6.036

Project	Jones Branch Connector		
Analysis Description	Wall RW006 STA 12+10		
Drawn By DJS	*Scale* 1:348	*Company* ECS	
Date 12/22/2015		*File Name* RW006 STA 12+10_Block.slim	

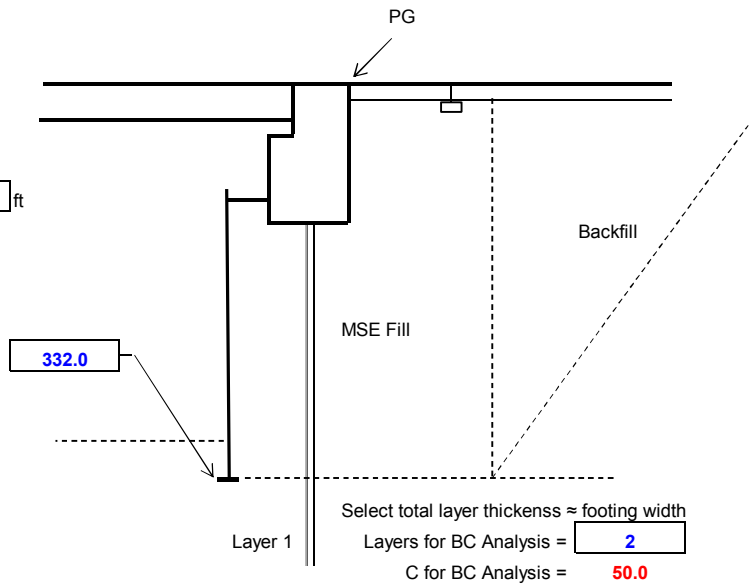
ECS MID-ATLANTIC, LLC.	Page 1 of 1
COMPUTATION SHEET	Made By MAR
Determination of Soil Parameters below Abutments	Date 12/22/2015
	Checked By JCG
LOCATION RW-006 Sta 15+20 South Wing Enter Values in Blue.	Date 12/22/2015

Red values are calculated

BORING No. =	JB-31	
Top of Boring El. =	332.0	ft
Profile Grade =	349.0	ft
Top of Layer 1 =	332.0	ft
Hammer Efficiency =	60	%
Groundwater Elevation =	307.3	ft

Bottom of Abut. = ft

El. Ground in front of Wall =	333.0
El. Top of Front Wall =	
Front Wall Total Height =	
Front Wall Height from PG to Bot. =	17.0



R = Rock
SF = Select Fill
CFB = Culpeper Fault Basin
CP = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province
VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1
Enter a bottom of layer at elevation of water table.

Select total layer thickness ≈ footing width

Layers for BC Analysis =	2
C for BC Analysis =	50.0
Φ for BC analysis =	29.6
Γ for BC Analysis =	112.9

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}
1	330.3	1.7	P	II-A	8					8
2	324.3	6.0	P	II-B	15	29	16			20
3	316.0	8.3	P	II-C	27	37				32
4	307.3	8.7	P	II-B	15	18				17
5										
6										
7										
8										
9										
10										
11										
12										

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth from Top Layer 1, ft.	Cohesion for DRIVEN psf
1	95.0	102.0	ML	50.0	28.0		2	1.7	
2	118.0	125.0	ML	50.0	30.0		2	7.7	
3	130.0	137.0	ML	50.0	32.0		2	16.0	
4	118.0	125.0	ML	50.0	30.0		2	24.7	
5									
6									
7									
8									
9									
10									
11									
12									

Project Name: JBCONN Front Wall **Wall ID & Station:** Wall RW-006 Sta 15+20
Project No. 21924 Boring JB-31

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.114

By: JCG Date: 12/22/15
Checked: MAR Date: 12/22/15

ANALYSIS EXT. LOAD Surcharge 0.14 ksf
LRFD LIVE LOAD 0.08 LRFD DEAD LOAD 0.00 AASHTO SURCHARGE 0.25

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{soil}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficient Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
														138						0.131	e/L			Not Allowed by AASHTO										
ASD	See Below for Soil Type & N Values			0.11	50	29.6	17.0	6.137	23.205	11.9	2.0	0.33	36.1	120.4	3.34	0.53	11.8	0.6	2.02	1.55	3478	422	2639	0.00	19.33	27.85	8.79	11070	4.19	YES	YES	YES	YES	
LRFD																				0.208	e/L													
LRFD	Sliding and OT			0.11	50	29.6	17.0	9.319	23.919	11.9	2.0	0.33	55.1	132.4	2.40	0.57	12.6	0.6	1.42	2.47	4997		3762	0.00	19.33	27.85	8.43	6934	1.84	YES	YES	YES	YES	
LRFD	Bearing Capacity								31.708					188.7				Xo	4.21	1.74														
																				0.146	e/L		1.426	Ratio LRFD/ ASD										

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT					Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	1.7		2	8					28.0	47.6	1.7	50	85
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	6.0		2	20					30.0	180.0	6	50	300
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4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4													
5	Overconsloidated higly plastic soils	CH, MH		5													
				6													
				7													
	Bottom Layer for Φ consideration in BC =		2	8													
													Phi for BC analysis =		29.6	C for BC analysis =	50

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

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B = 0.7H for normal situations, min = 2.4 m

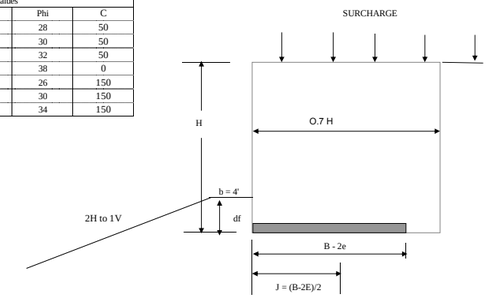
Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values

	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φº	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1	
	Determination of Settlement below Walls	Made By MAR	
		Date 12/22/2015	
		Checked By JCG	
LOCATION JBCONN RW-006	STA 15+20 BL	Enter Values in Blue.	Date 12/22/2015

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-31

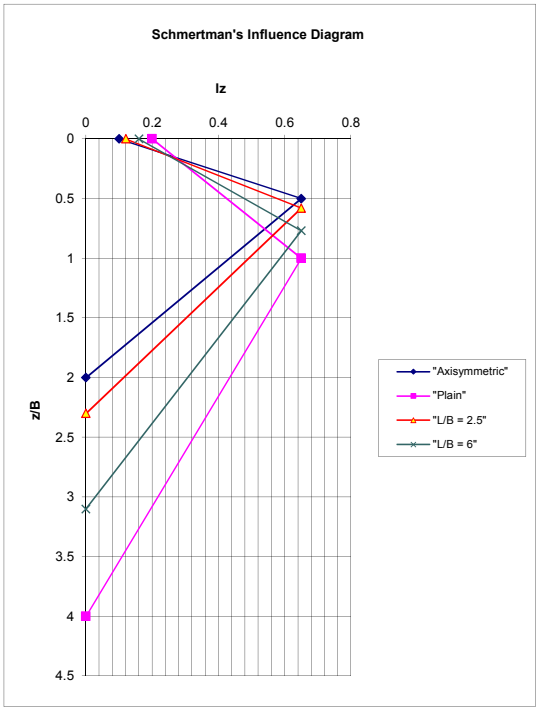
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	1.7	8	2	0.0	1.7
2	6.0	20	2	1.7	7.7
3	8.3	32	2	7.7	16.0
4	8.7	17	2	16.0	24.7
5					
6					
7					
8					
9					
10					
11					
12					

Z, ft	3.00	Height of Existing Ground Above Bottom of Wall
Po, psf	2,639	Avg. Foundation Pressure From MSEW
Γ, pcf	113.0	Bearing Soil Density
B, ft	8.8	Foundation Width (effective B-2e)
L, ft	100	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,300	
L/B	11.36	
C1	0.93	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.34	**Immediate Settlement** (up to end of monitoring period)		
	0.04	Post-Construction Settlement, in.	0.20	year
Δ, in	0.38	**Total Settlement**	1.00	year

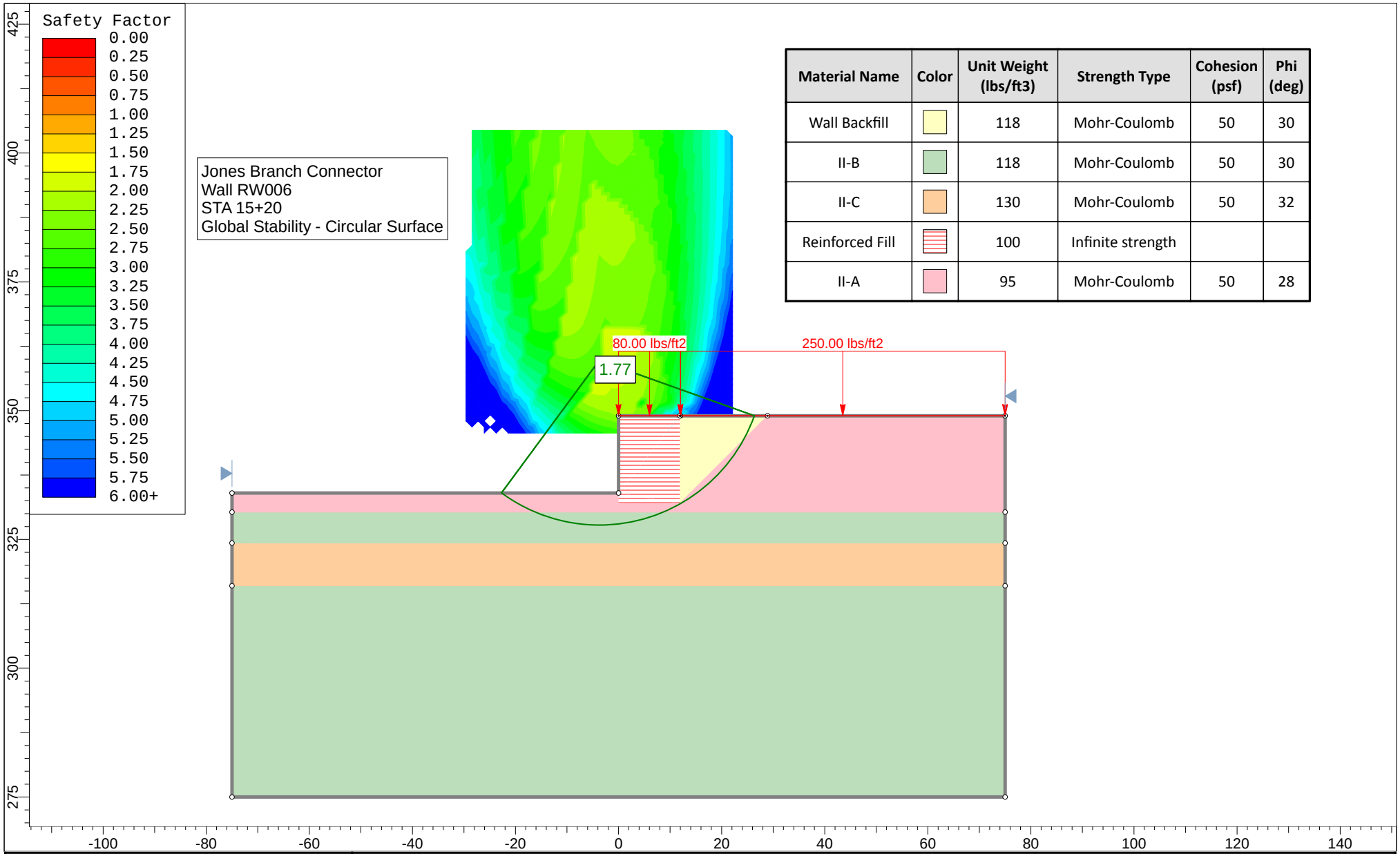
If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.11364	0.23227	2	443,800	0.03
3	0.34091	0.37682	2	443,800	0.05
5	0.56818	0.52136	2	443,800	0.06
7	0.79545	0.64292	2	710,080	0.05
9	1.02273	0.57974	2	710,080	0.05
11	1.25000	0.51656	2	710,080	0.04
13	1.47727	0.45338	2	710,080	0.04
15	1.70455	0.39020	2	710,080	0.03
17	1.93182	0.32701	2	377,230	0.05
19	2.15909	0.26383	2	377,230	0.04
21	2.38636	0.20065	2	377,230	0.03
23	2.61364	0.13747	2	377,230	0.02
25	2.84091	0.07429	2	377,230	0.01
27	3.06818	0.01111	2	377,230	0.00
29	3.29545	0.00000			
31	3.52273	0.00000			
33	3.75000	0.00000			
35	3.97727	0.00000			
37	4.20455	0.00000			
39	4.43182	0.00000			
41	4.65909	0.00000			
43	4.88636	0.00000			
45	5.11364	0.00000			
47	5.34091	0.00000			
49	5.56818	0.00000			
51	5.79545	0.00000			
53	6.02273	0.00000			
55	6.25000	0.00000			
57	6.47727	0.00000			
59	6.70455	0.00000			
61	6.93182	0.00000			
61	6.93182	0.00000			
63	7.15909	0.00000			
65	7.38636	0.00000			
67	7.61364	0.00000			
69	7.84091	0.00000			
71	8.06818	0.00000			
73	8.29545	0.00000			
75	8.52273	0.00000			
77	8.75000	0.00000			
			ΣΔ, in. (Uncorrected)		0.49



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

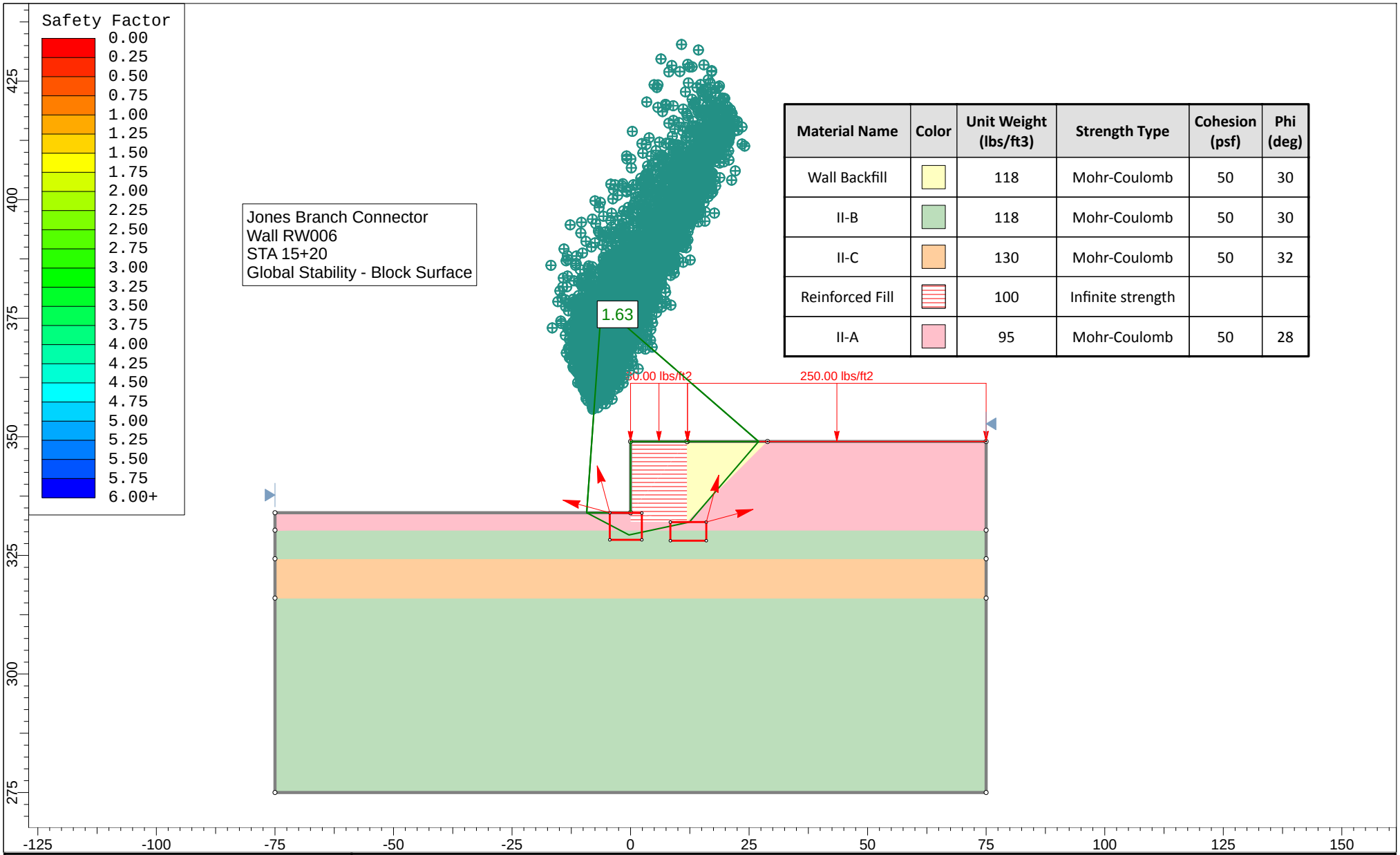
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Wall Backfill		118	Mohr-Coulomb	50	30
II-B		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
Reinforced Fill		100	Infinite strength		
II-A		95	Mohr-Coulomb	50	28

SLIDEINTERPRET 6.036

Project	Jones Branch Connector		
Analysis Description	Wall RW006 STA 15+20		
Drawn By DJS	*Scale* 1:309	*Company* ECS	
Date 12/22/2015		*File Name* RW006 STA 15+20_Circular.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Wall Backfill		118	Mohr-Coulomb	50	30
II-B		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
Reinforced Fill		100	Infinite strength		
II-A		95	Mohr-Coulomb	50	28

SLIDEINTERPRET 6.036

Project	Jones Branch Connector		
Analysis Description	Wall RW006 STA 15+20		
Drawn By DJS	*Scale* 1:336	*Company* ECS	
Date 12/22/2015		*File Name* RW006 STA 15+20_Block.slim	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	Page 1 of 1 Made By JCG	
Determination of MSE Soil Parameters for Analysis (English Version)	Date 12/21/2015 Checked By MAR	
LOCATION Scotts Crossing Raod Wall RW-007 STA 40+50 Enter Values in Blue.	Date	

Subsurface conditions within this range are assumed to correspond to the depth below existing grade, not the stratum elevations.

BORING No. JB-34
Top of Boring Elevation 306.5

Red values are calculated

Profile Grade = 316.0
Top Wall El. = 316.0 EL.

Hammer Efficiency 80%

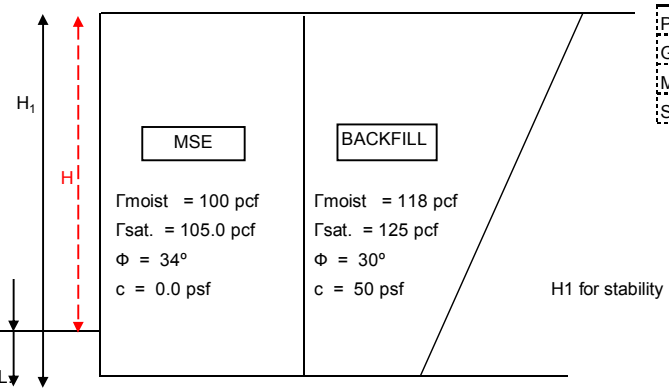
H for MSEW = 14.0

H_1 for stability & settlement analyses = 16.0

Groundwater Elevation = 297.5

Top of Ground = 302.0 2.0 D

Bot. Wall El. = 300.0 EL.



Analysis Checklist

Type	Princip Init.
Parameters	
Global	
MSEW	
Settlement	

No. Layers for BC Analysis 2 (~0.7H)
Φ° for BC analysis = 31.4
C psf for BC Analysis = 50
C P = Coastal Plain Physiographic Province
P = Piedmont Physiographic Province

Layer 1

Layer 2

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	Avg. N_{60}
1	296.5	3.5	P	II-B	13				17
2	288.5	8.0	P	II-C	29	31			40
3	283.5	5.0	P	III	77				100
4									
5									
6									
7									
8									
9									
10									
11									
12									

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	ARCA C, psf	ARCA Φ°	CL w/ sand & gravel ?	Soil No.	Depth to Bot. from Bot. footing, ft.	
1	118.0	125.0	ML	50.0	30.0		2	3.5	
2	130.0	137.0	ML	50.0	32.0		2	11.5	
3	120.0	128.0	HWR	250.0	34.0		4	16.5	
4									
5									
6									
7									
8									
9									
10									
11									
12									

Project Name: JBCON Wall 7 **Wall ID & Station:** 16 feet high
Project No. 21924

STABILITY CALCULATIONS FOR MECHANICALLY-STABILIZED EARTH WALLS

Flat : 1 Slope Below

NO Water Table at Toe of Wall?

BACKFILL and Base MATERIAL

α (deg) 0
MSE Fill ϕ (deg) 34.0
Backfill (deg) 30.0
MSE Fill (kcf) 0.110
Backfill Density (kcf) 0.118
Base Soil Density (kcf) 0.118

By: JCG Date: 8/19/14
Checked: MAR Date: 8/19/14

ANALYSIS EXT. LOAD: Surcharge 0.44 ksf; LRFD LIVE LOAD 0.25; LRFD DEAD LOAD 0.00; AASHTO SURCHARGE 0.25

STRUCTURE	SOIL DESCRIPTION	USCS SOIL TYPE	Typical N-Value within a depth B below footing	UNIT WEIGHT, γ_{tot}[1] MSE Backfill kcf	COHESION, C[7] psf	Design ϕ, based on SPT correl.[6] at foundation deg	MSE Wall Height H[2] ft	Active Soil Force P Plus surcharge AASHTO only kip	Weight of Soil Mass per foot, W Plus Ext Load kip	Effective Base of MSE B = H'/7 ft	Depth of Embedmt. D_f[3] ft	Active Earth Pressure Coefficnt. Ka
ASD	See Below for Soil Type & N Values			0.11	50	31.4	16.0	6.368	22.512	11.2	2.0	0.33
LRFD												
LRFD	Sliding and OT			0.11	50	31.4	16.0	9.885	24.612	11.2	2.0	0.33
LRFD	Bearing Capacity								31.511			

STRUCTURE	FS AGAINST OVERTURNING: Mo Plus Ext. Load ft-kip	Mr =(B/2)*W ft-kip	F.S.overturn =Mr/Mo	FACTOR OF SAFETY AGAINST SLIDING: For Sands at base of Wall: Tan ϕ	Force Resisting Sliding kip	For Clays at Base of Wall: Force Resisting Sliding kip	Total F.S.	FACTOR OF SAFETY AGAINST BEARING CAPACITY: Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficent Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	CHECKS: FSot ASD > 2 LRFD > 1 ?	FSslid ASD 1.5 LRFD > 1 ?	FSbc ASD > 2.5 LRFD > 1 ?	Eccentricity ASD e < B/6 LRFD e/L < 0.25 ?
		126						0.149	e/L			Not Allowed by AASHTO									
ASD	37.5	110.4	2.94	0.58	11.4	0.6	1.88	1.67	3805	215	2862	0.00	25.98	32.66	7.87	13691	4.78	YES	YES	YES	YES
LRFD								0.267	e/L												
LRFD	58.9	110.4	1.87	0.61	12.0	0.6	1.27	2.99	5633		4225	0.00	25.98	32.66	7.46	8492	2.01	YES	YES	YES	WARNING: CHECK ECCENTRICITY
LRFD		176.5				Xo	3.73	1.87													

Soil Type	Description	USCS		Layer	Thickness ft	Midpoint ft	Type	SPT				Phi deg	Φ * d	Φ, C depth deg	C psf	c*d
1	Clays	CL		1	3.5							30.0	105.0	3.5	50	175
2	Sitls, sandy silts, silty and clayey sands	ML, SM, SC		2	8.0							32.0	256.0	8	50	400
3	clean sands w/ little gravel	SW, SP, GW		3									0.0	0		0
4	Sandy gravels & gravels, highly weathered rock	HWR, GP, GW		4												
5	Overconsloidated higly plastic soils	CH, MH		5												
				6												
				7												
	Bottom Layer for Φ consideration in BC =			8	3											
												Phi for BC analysis =		31.4	C for BC analysis =	50

Soil Type	Eccentricity e ft	Toe Bearing Stress q_{toe} psf	Heel Bearing Stress q_{heel} psf	Avg Bearing Stress W/(L-2e) psf	Surcharge Coefficent Nq Meyerhoff	Friction Coefficent Ng Meyerhoff	Cohesion Coefficient Nc Meyerhoff	Effective B B'=B-2e ft	Ultimate Bearing Capacity qult psf	FSbc =qult/qavg	FSot	FSslid	FSbc	Eccentricity
1	135	0.53	lz =0.6											
2	276	0.60												
3														
4														
5														
6														
7														
8														
	0.167	e/L		1.476	Ratio LRFD/ ASD									
	Es, ksf	Δ in												
		1.13												
		0.2828459												

NOTES:
1. Unit Weights determined from Table below
2. H given in specs as Top of MSE wall caping minus Top of Leveling Pad.
3. D_f given in specs as Finish grade in Top of Leveling Pad.
4. All walls considered to have a surcharge load simulating traffic load at top of the wall.
5. Ø = f(Soil Type, N); see formulae below.
6. Typical soil conditions for I-95 Interchange area assumed for walls with insufficient boring data, i.e, N=18 bpf and soil is an SC type.
7. Do not use for SP or GP at base.
8. Assumes level backfill.

ANALYSIS OF MSE RETAINING WALLS

Surcharge for traffic is normally equal to a 0.6 m high fill above wall.

Average stress is computed over a distance = B - 2e.

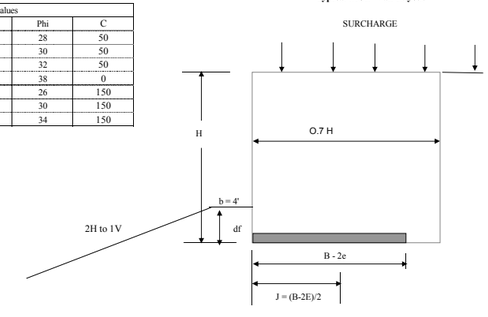
B = 0.7H for normal situations, min = 2.4 m

Surcharge for traffic normally is 250 psf (12 KPa) or 0.6 m of fill

Df is typically 2 feet (0.6m) See Requirements.

VDOT Exhibit N Values				
	Γ_{dry}	Γ_{wet}	Phi	C
II-A	95	102	28	50
II-B	118	125	30	50
II-C	130	137	32	50
III	120	128	38	0
T-I	105	112	26	150
T-II	115	122	30	150
T-III	125	132	34	150

Typical MSE Wall Layout



Φ°	2 to 1 Ng	3 to 1 Ng	Flat Ng	2 to 1 Nc	3 to 1 Nc	Flat Nc
26	7.51	9.12	12.53	17.83	18.41	22.25
27	8.22	10.49	14.46	18.86	20.77	23.93
28	8.99	12.07	16.71	19.89	21.95	25.79
29	9.85	13.89	19.33	20.92	23.13	27.85
30	10.80	15.99	22.39	21.95	24.31	30.13
31	11.84	18.4	25.98	24.71	27.53	32.66
32	13.00	21.18	30.20	27.47	30.75	35.47
33	14.27	24.39	35.17	30.23	33.97	38.62
34	15.68	28.08	41.04	32.99	37.19	42.14
35	17.25	32.33	48.00	35.75	40.41	46.10
36	18.98	37.23	56.27	38.51	43.63	50.56
37	20.89	42.88	66.14	41.27	46.85	55.60
38	23.02	49.39	77.97	44.03	50.07	61.32
39	25.38	56.89	92.17	46.79	53.29	67.83
40	27.99	65.54	109.32	49.55	56.51	75.27

Ng Values from AASHTO Figure 4.4.7.1.1.B

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1	
	Determination of Settlement below Walls	Made By MAR	
		Date 1/15/2016	
		Checked By JCG	
LOCATION JBCONN RW-007	STA 40+50 BL	Enter Values in Blue.	Date 1/15/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settltment after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. JB-34

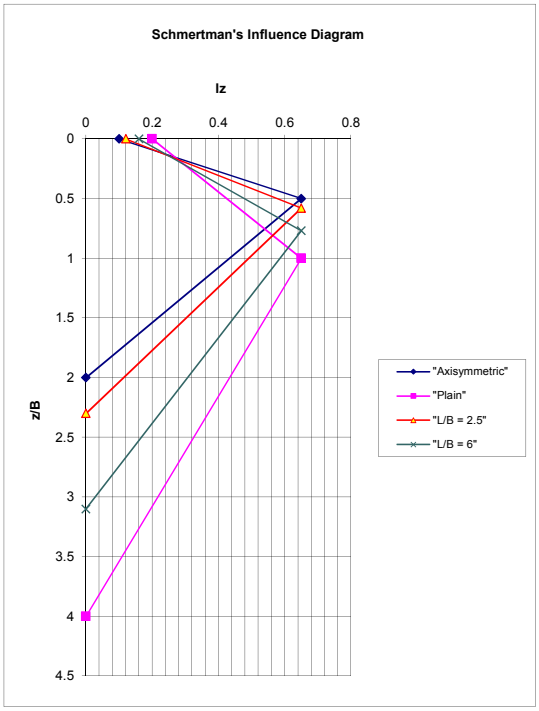
Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	To
1	2.5	17	2	0.0	2.5
2	8.0	40	2	2.5	10.5
3	5.0	100	4	10.5	15.5
4					
5					
6					
7					
8					
9					
10					
11					
12					

Z, ft	3.00	Height of Existing Ground Above Bottom of Wall
Po, psf	2,683	Avg. Foundation Pressure From MSEW
Γ, pcf	118.0	Bearing Soil Density
B, ft	14.1	Foundation Width (effective B-2e)
L, ft	50	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,329	
L/B	3.55	
C1	0.92	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Δ, in	0.17	**Immediate Settlement** (up to end of monitoring period)		
	0.02	Post-Construction Settlement, in.	0.20	year
Δ, in	0.19	**Total Settlement**	1.00	year

If L/B < 4, use red modified influence diagram.
If L/B > 4, use green modified influence diagram.

Depth ft	z/B	Iz	Soil Type	Es psf	Δ in.
1	0.07092	0.18482	2	317,730	0.03
3	0.21277	0.31447	2	747,600	0.02
5	0.35461	0.44411	2	747,600	0.03
7	0.49645	0.57376	2	747,600	0.04
9	0.63830	0.62837	2	747,600	0.05
11	0.78014	0.57575	4	3,204,000	0.01
13	0.92199	0.52312	4	3,204,000	0.01
15	1.06383	0.47050	4	3,204,000	0.01
17	1.20567	0.41788	4	3,204,000	0.01
19	1.34752	0.36525	4	3,204,000	0.01
21	1.48936	0.31263	4	3,204,000	0.01
23	1.63121	0.26000	4	3,204,000	0.00
25	1.77305	0.20738	4	3,204,000	0.00
27	1.91489	0.15475	4	3,204,000	0.00
29	2.05674	0.10213	4	3,204,000	0.00
31	2.19858	0.04951	4	3,204,000	0.00
33	2.34043	0.00000			
35	2.48227	0.00000			
37	2.62411	0.00000			
39	2.76596	0.00000			
41	2.90780	0.00000			
43	3.04965	0.00000			
45	3.19149	0.00000			
47	3.33333	0.00000			
49	3.47518	0.00000			
51	3.61702	0.00000			
53	3.75887	0.00000			
55	3.90071	0.00000			
57	4.04255	0.00000			
59	4.18440	0.00000			
61	4.32624	0.00000			
61	4.32624	0.00000			
63	4.46809	0.00000			
65	4.60993	0.00000			
67	4.75177	0.00000			
69	4.89362	0.00000			
71	5.03546	0.00000			
73	5.17730	0.00000			
75	5.31915	0.00000			
77	5.46099	0.00000			
			ΣΔ, in. (Uncorrected)		0.24



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

JBCON Wall No. 7

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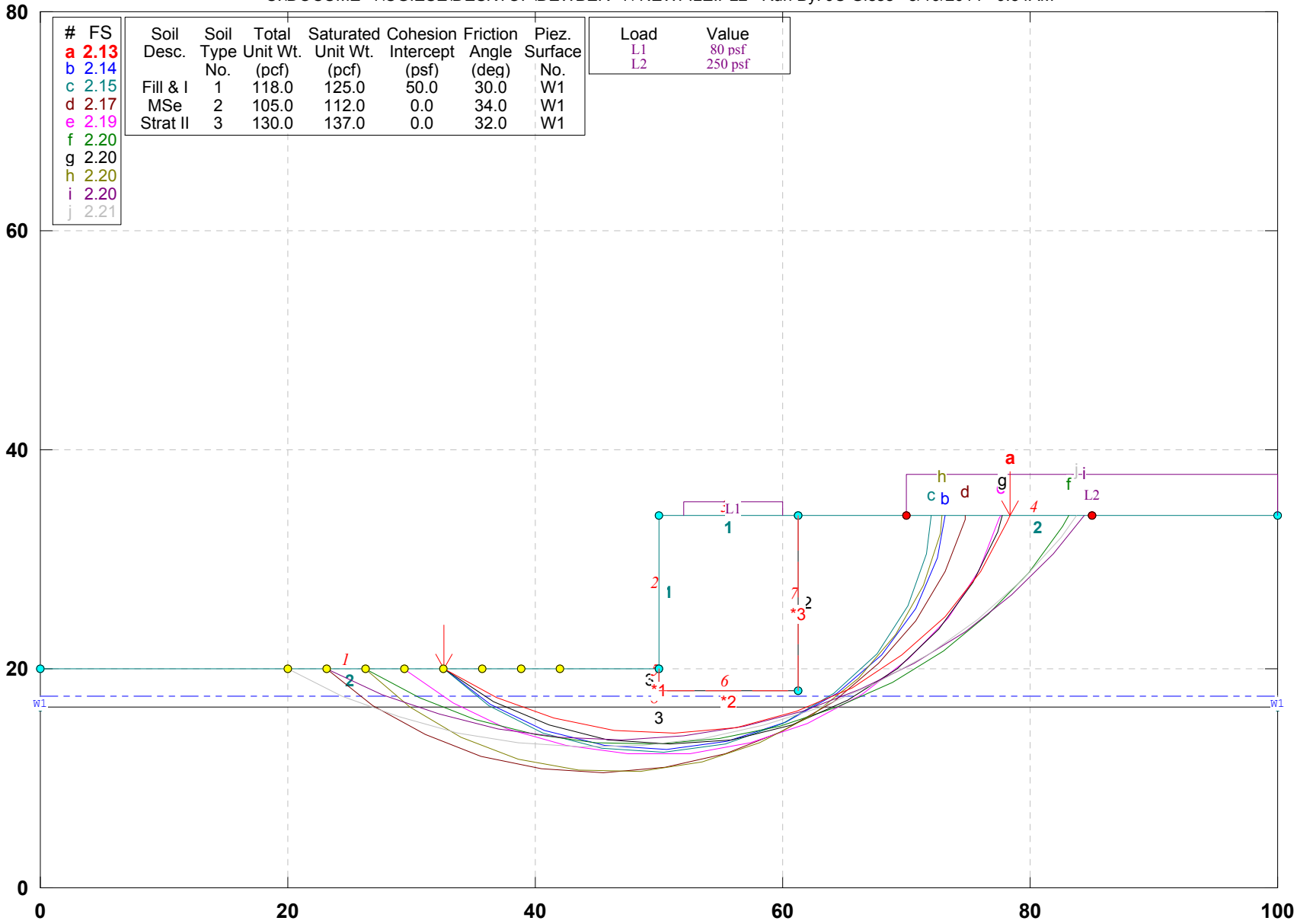
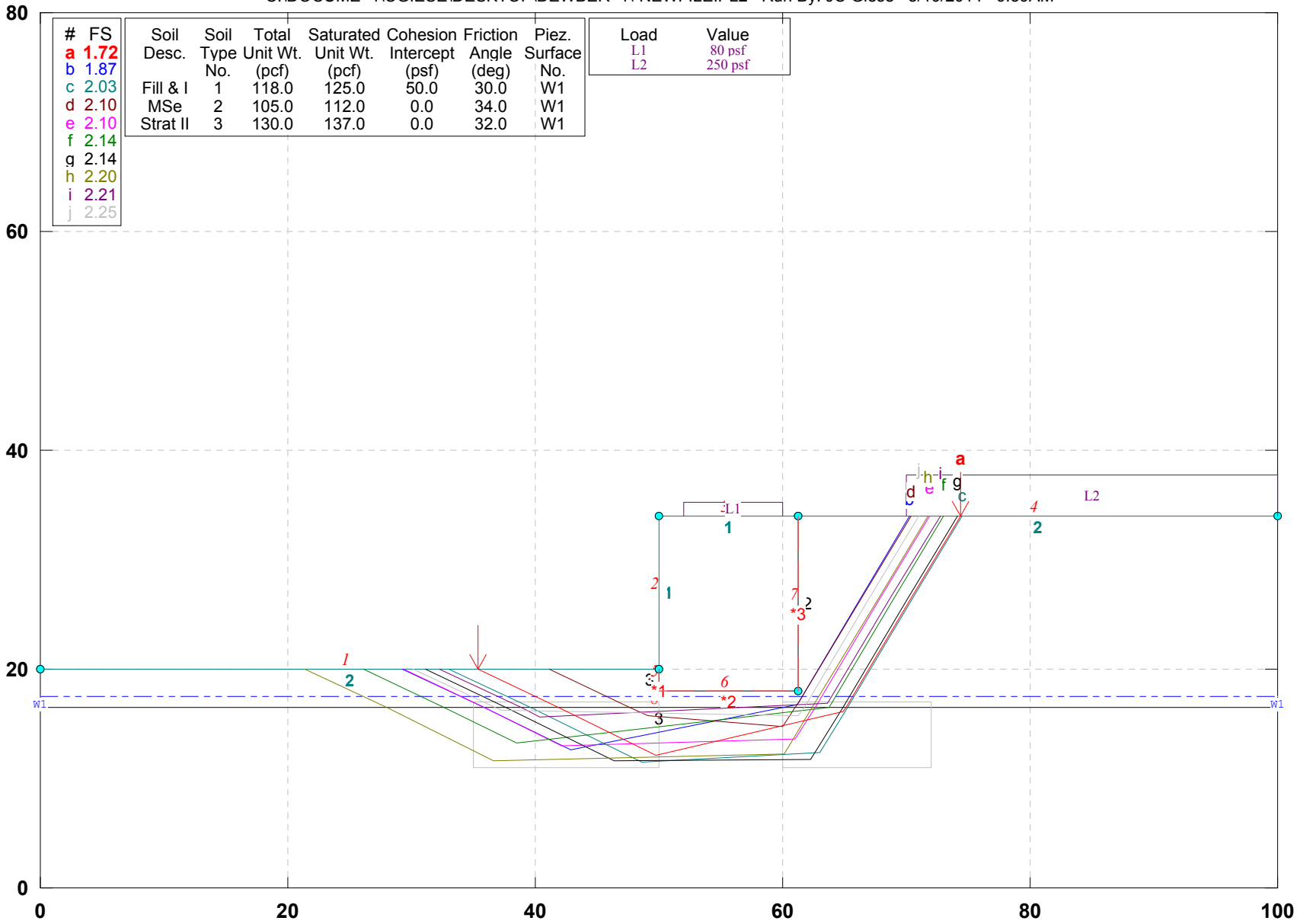


GSTABL7 FSmin=2.13

Safety Factors Are Calculated By The Modified Bishop Method

JBCON Wall No. 7

C:\DOCUME~1\CGIESE\DESKTOP\DEWBER~1\-NEWFILE.PL2 Run By: JC Giese 8/19/2014 9:39AM



GSTABL7 FSmin=1.72

Safety Factors Are Calculated By The Simplified Janbu Method

ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By DJS	
Determination of Soil Parameters below Gravity Walls	Date 3/15/2016	
	Checked By JCG	
LOCATION RW008 STA 40+20	Date 3/15/2016	

Reference: VDOT Soil Design Parameters for Sound Barrier Walls, Retaining Walls, and Non-Critical Slopes, April, 2011

Red values are calculated

Enter Values in Blue

BORING No. RW008-B1

Top of Boring Elevation 315.6

Hammer Efficiency = 60 %

(Use 80% for automatic if eff. Is not provided)

Top Wall El. = 316.8

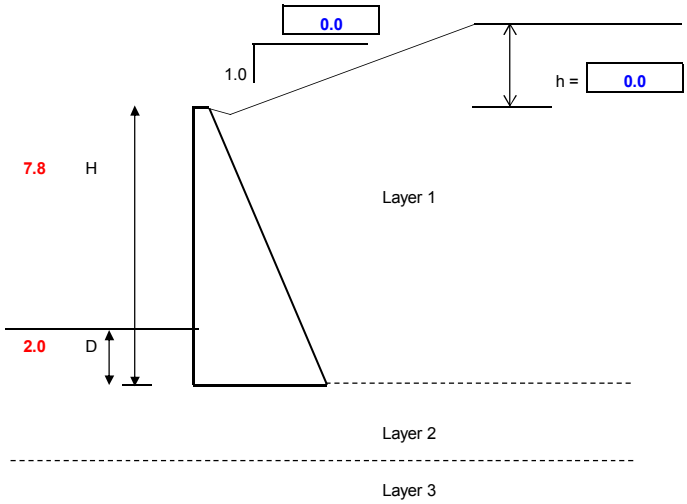
Groundwater Elevation = 292.2

(Enter bottom of boring if dry)

Bench Line

Top of Ground = 311.0

Bot. Wall El. = 309.0



SR = Strong Rock

WR = Weak Rock

SF = Select Fill (CBR 30)

CFB = Culpeper Fault Basin

CP = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1

Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Bot. Layer No. for BC Analysis = 0

C for BC Analysis = N.A.

Φ for BC analysis = N.A.

Γ for BC Analysis = N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}	RQD
1	309.0	7.8	P	II-B	20	11	10			14	
2	306.6	2.4	P	II-B	11					11	
3	298.6	8.0	P	II-B	11	11				11	
4	292.2	6.4	P	III	100	100				100	
5											
6											
7											
8											
9											
10											
11											
12											

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth below FTG ft	Cohesion for DRIVEN or SHAFT psf	MidPoint ft	Half Layer Press psf	Midpoint Pressure psf
1	118.0	125.0	ML	50.0	30.0		2	0.0		1.0	118	118
2	118.0	125.0	ML	50.0	30.0		2	2.4		1.2	142	378
3	118.0	125.0	MH	50.0	30.0		5	10.4	1375	6.4	472	991
4	120.0	128.0	HWR	250.0	34.0		4	16.8		13.6	210	1673
5												
6												
7												
8												
9												
10												
11												
12												

ANALYSIS OF GRAVITY RETAINING WALLS

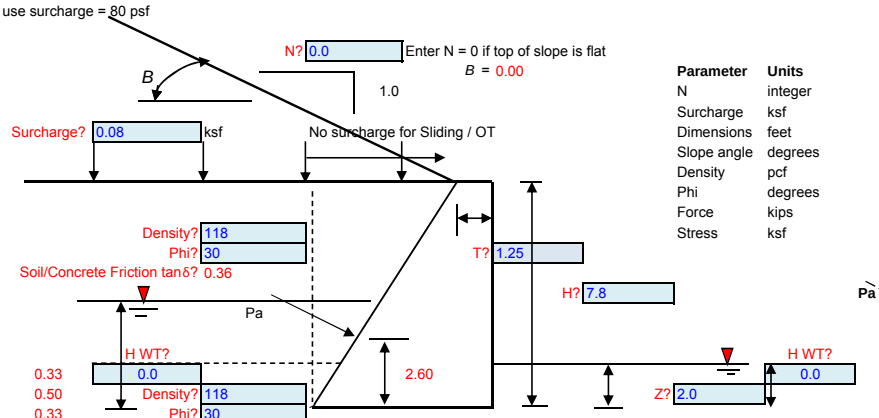
Gravity Wall with Surcharge

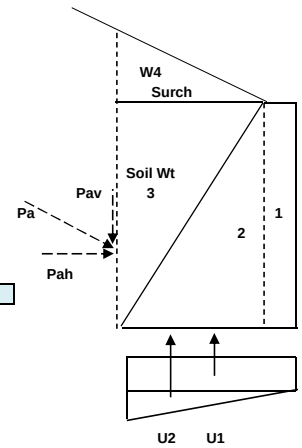
Project	JBCONN	By	DJS3
Job No.	21924	Date	3/15/2016
Analysis	RW008 STA 40+20	Checked	JCG
		Date	3/15/2016

Enter Prompts in Blue-Colored Boxes.
Red Values are calculated.
For traffic, use surcharge = 250 psf
For sidewalks, use surcharge = 80 psf

N? 0.0 Enter N = 0 if top of slope is flat
B = 0.00

Parameter	Units
N	integer
Surcharge	ksf
Dimensions	feet
Slope angle	degrees
Density	pcf
Phi	degrees
Force	kips
Stress	ksf





Ka1 =	0.33	0.0	
Ko1 =	0.50		
Ka2 =	0.33		
Kp2 =	3.00		
Nq =	12.52		
Nc =	19.96		
Ng =	13.30		

	LRFD Force ASD	LRFD Force Service	LRFD Force Strength	Lever Arm	LRFD Moment ASD	LRFD Moment Service	LRFD Moment Strength
W1 =	1.46	1.32	1.83	0.63	0.91	0.82	1.14
W2 =	2.01	1.81	2.51	2.39	4.80	4.32	6.00
W3 =	0.57	0.57	0.78	3.55	2.04	2.04	2.75
W4 =	0.00	0.00	0.00	3.55	0.00	0.00	0.00
Pav =	0.00	0.00	0.00	4.68	0.00	0.00	0.00
Surchv =	0.27	0.00	0.48	2.97	0.81	0.00	1.42
Sum W =	4.32	3.70	5.59				
U1=	0.00	0.00	0.00	2.34	0.00	0.00	0.00
U2=	0.00	0.00	0.00	3.12	0.00	0.00	0.00
Pah =	1.20	1.79	1.79	2.60	-3.11	-4.67	-4.67
Psurchh =	0.21	0.36	0.36	3.90	-0.81	-1.42	-1.42
Pp =	-0.71	-0.53	-0.53	0.67	0.47	0.35	0.35
				Sum M =	5.12		5.59 k-ft
				Xo =	1.19		1.00 ft
				e =	1.15		1.34 ft
				e/B =	0.25		0.29

From Std Detail RW-3

H	T
3.0	1.0
4.0	1.0
5.0	1.0
6.0	1.0
7.0	1.0
8.0	1.0
9.0	1.0
10.0	1.0
11.0	1.1
12.0	1.2
13.0	1.3
14.0	1.5
15.0	1.6
16.0	1.6
17.0	1.6
18.0	1.6
19.0	1.6

Sliding			
Sum Slide =	0.70	1.63	kip
Sum Resist =	2.33	2.13	kip
FS Slide =	**3.35**	**1.31**	
	≥ 1.5?	≥ 1.0?	
	OK	OK	

Overturning			
Sum OT =	3.92	6.09	k-ft
Sum Resist =	8.23	7.54	k-ft
FS OT =	**2.10**	**1.24**	
	≥ 2.0?	≥ 1.0?	
	OK	OK	

Bearing			
Qmax =	2.44	3.75	ksf
Qavg =	1.82	2.80	ksf
Qult dry =	4.82 ksf	3.19	ksf
Qult wet =	2.27 ksf	1.52	ksf
FS BC dry =	**2.64**	**1.14**	
FS BC wet =	**1.25**	**0.54**	
	≥ 2.5?	≥ 1.0?	
	OK	OK	

1.54 Ratio Qavg LRFD/ASD

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1
		Made By DJS3
	Determination of Settlement below Walls	Date 3/15/2016
		Checked By JCG
LOCATION RW008	STA 40+20 BL	Enter Values in Blue. Date 3/15/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settlement after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. RW008-B1

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	2.4	11	2	0.0	2.4
2	8.0	11	5	2.4	10.4
3	6.4	100	4	10.4	16.8
4					
5					
6					
7					
8					
9					
10					
11					
12					

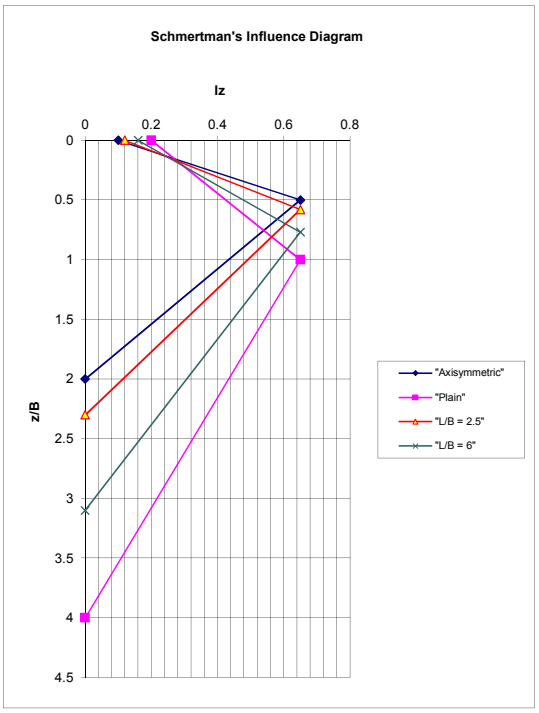
Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	1,820	Avg. Foundation Pressure From Calcs
Γ, pcf	118.0	Bearing Soil Density
B, ft	2.4	Foundation Width (effective B-2e)
L, ft	390	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	1,820	
L/B	162.50	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR
If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

Δ, in	0.20	**Immediate Settlement** (up to end of monitoring period)		
	0.02	Post-Construction Settlement, in.	0.20	year
Δ, in	0.23	**Total Settlement**	1.00	year

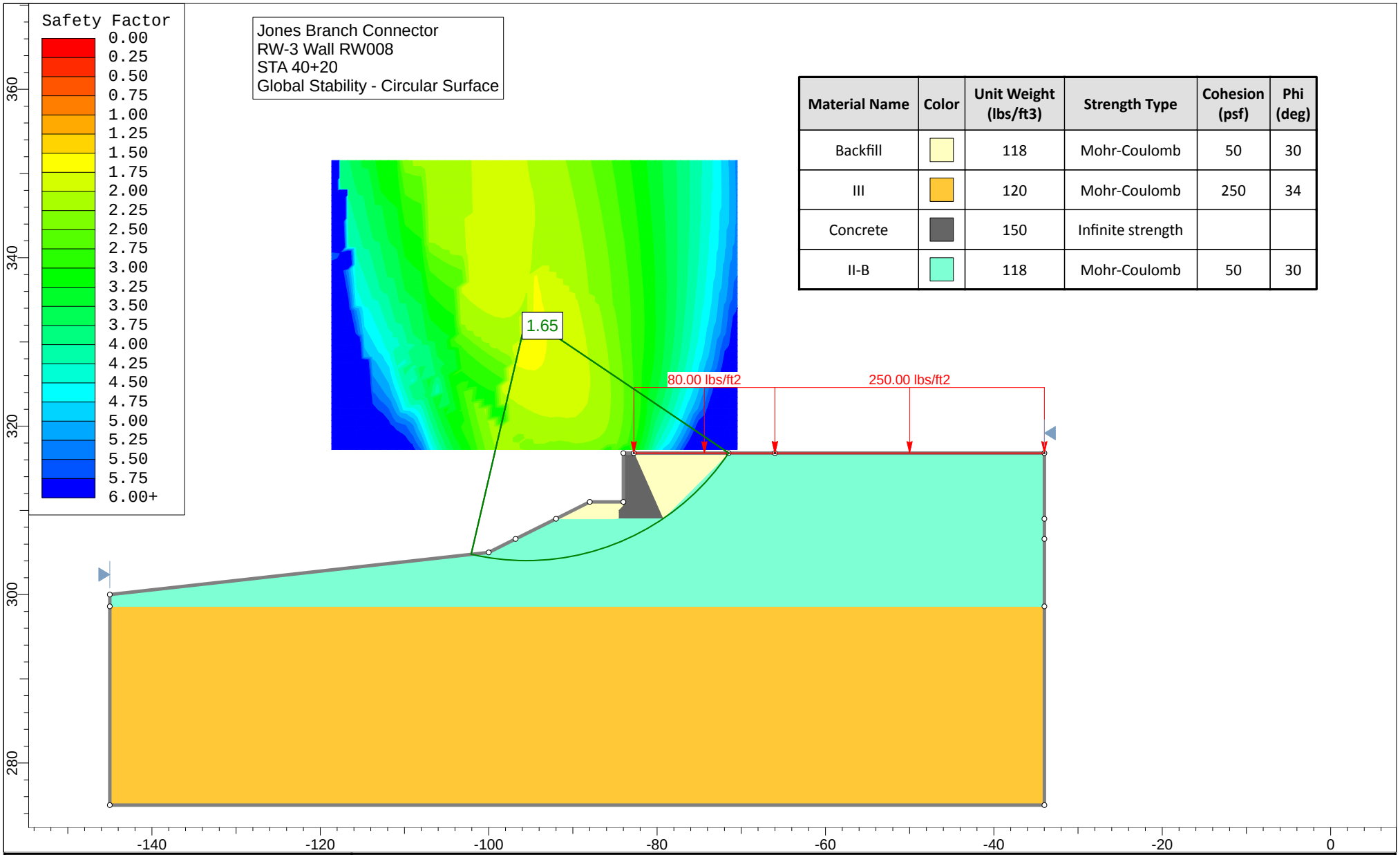
Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.41667	0.42500	2	244,090	0.08	0.06	0.23	0.23
3	1.25000	0.51656	5	191,785	0.12	0.10	0.16	0.16
5	2.08333	0.28489	5	191,785	0.06	0.05	0.06	0.06
7	2.91667	0.05323	5	191,785	0.01	0.01	0.01	0.01
9	3.75000	0.00000						
11	4.58333	0.00000						
13	5.41667	0.00000						
15	6.25000	0.00000						
17	7.08333	0.00000						
19	7.91667	0.00000						
21	8.75000	0.00000						
23	9.58333	0.00000						
25	10.41667	0.00000						
27	11.25000	0.00000						
29	12.08333	0.00000						
31	12.91667	0.00000						
33	13.75000	0.00000						
35	14.58333	0.00000						
37	15.41667	0.00000						
39	16.25000	0.00000						
41	17.08333	0.00000						
43	17.91667	0.00000						
45	18.75000	0.00000						
47	19.58333	0.00000						
49	20.41667	0.00000						
51	21.25000	0.00000						
53	22.08333	0.00000						
55	22.91667	0.00000						
57	23.75000	0.00000						
59	24.58333	0.00000						
61	25.41667	0.00000						
61	25.41667	0.00000						
63	26.25000	0.00000						
65	27.08333	0.00000						
67	27.91667	0.00000						
69	28.75000	0.00000						
71	29.58333	0.00000						
73	30.41667	0.00000						
75	31.25000	0.00000						
77	32.08333	0.00000						
			ΣΔ, in. (Uncorrected)		0.27			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

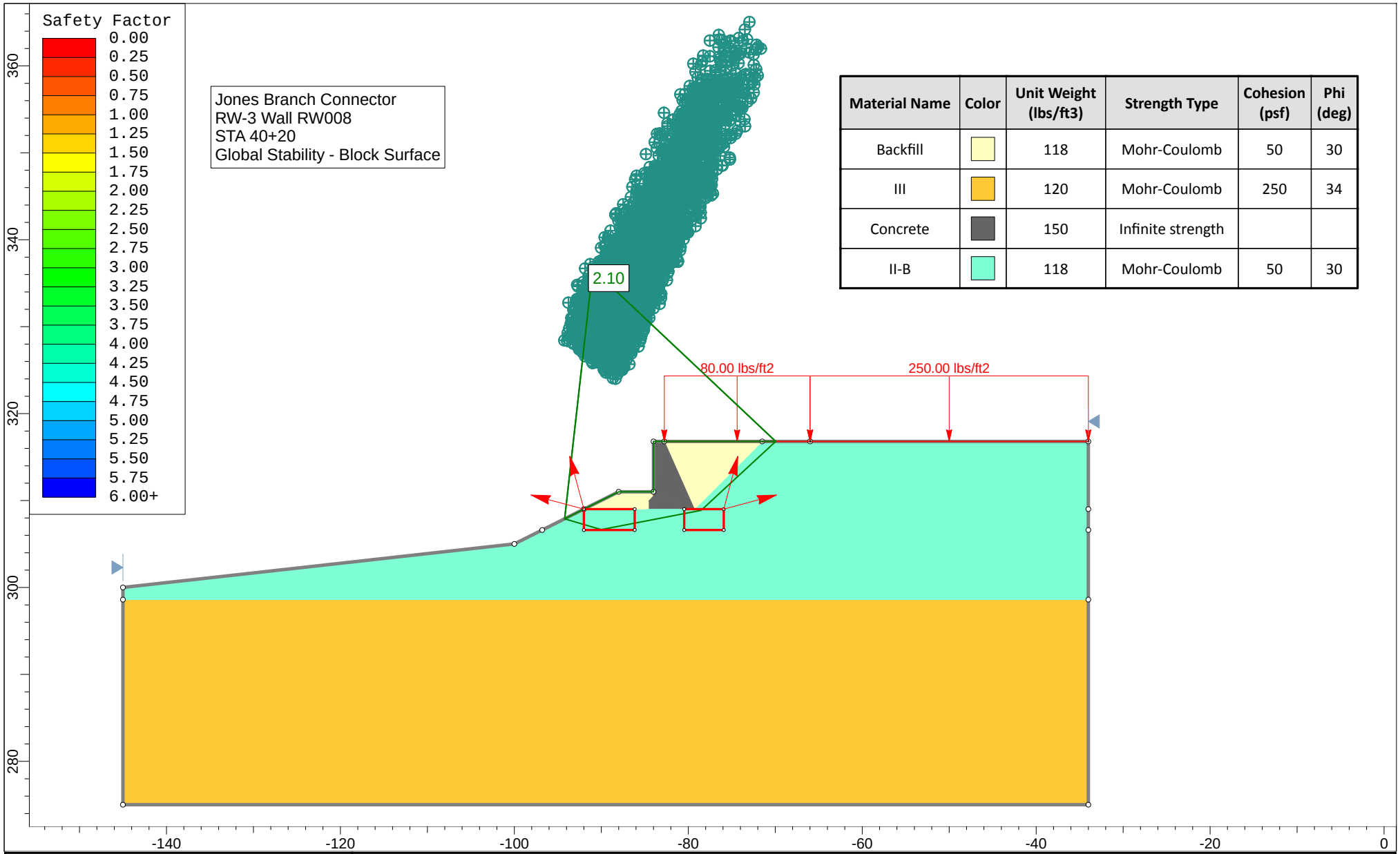
Jones Branch Connector
RW-3 Wall RW008
STA 40+20
Global Stability - Circular Surface



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		
II-B		118	Mohr-Coulomb	50	30

Project	JBCONN RW-3 RW008		
Analysis Description	STA 40+20		
Drawn By	DJS3	Scale 1:189	Company ECS
Date	9/30/15		File Name RW008 RW3 STA 40+20_benched.slim

SLIDEINTERPRET 6.036



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		
II-B		118	Mohr-Coulomb	50	30

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW008		
Analysis Description	STA 40+20		
Drawn By DJS3	*Scale* 1:183	*Company* ECS	
Date 9/30/15		*File Name* RW008 RW3 STA 40+20_benched_Block.slim	

ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By DJS	
Determination of Soil Parameters below Gravity Walls	Date 3/15/2016	
	Checked By JCG	
LOCATION RW008 STA 43+28	Date 3/15/2016	

Reference: VDOT Soil Design Parameters for Sound Barrier Walls, Retaining Walls, and Non-Critical Slopes, April, 2011

Red values are calculated

Enter Values in Blue

BORING No. RW008-B4

Top of Boring Elevation 307.0

Hammer Efficiency = 60 %

(Use 80% for automatic if eff. Is not provided)

Top Wall El. = 309.4

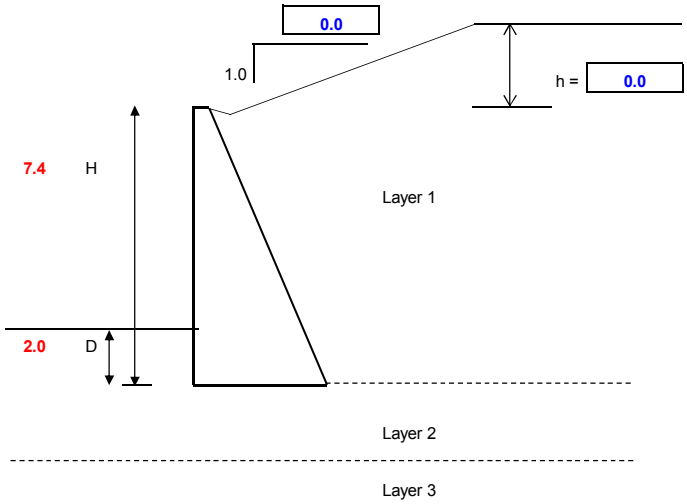
Groundwater Elevation = 286.8

(Enter bottom of boring if dry)

Bench Line

Top of Ground = 304.0

Bot. Wall El. = 302.0



SR = Strong Rock

WR = Weak Rock

SF = Select Fill (CBR 30)

CFB = Culpeper Fault Basin

CP = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1

Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Bot. Layer No. for BC Analysis = 0

C for BC Analysis = N.A.

Φ for BC analysis = N.A.

Γ for BC Analysis = N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}	RQD
1	302.0	7.4	P	II-B	10	14				12	
2	300.0	2.0	P	II-B	16					16	
3	295.0	5.0	P	II-A	9	5				7	
4	286.8	8.2	P	II-B	34	15				25	
5	285.0	1.8	P	II-B	15					15	
6	282.0	3.0	P	II-C	40					40	
7											
8											
9											
10											
11											
12											

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth below FTG ft	Cohesion for DRIVEN or SHAFT psf	MidPoint ft	Half Layer Press psf	Midpoint Pressure psf
1	118.0	125.0	CL	50.0	30.0		1	0.0	900	1.0	118	118
2	118.0	125.0	CL	50.0	30.0		1	2.0	1200	1.0	118	354
3	95.0	102.0	CL	50.0	28.0		1	7.0	525	4.5	238	710
4	118.0	125.0	CL	50.0	30.0		1	15.2	1838	11.1	257	1204
5	118.0	125.0	CL	50.0	30.0		1	17.0	1125	16.1	56	1517
6	130.0	137.0	ML	50.0	32.0		2	20.0		18.5	112	1685
7												
8												
9												
10												
11												
12												

ANALYSIS OF GRAVITY RETAINING WALLS

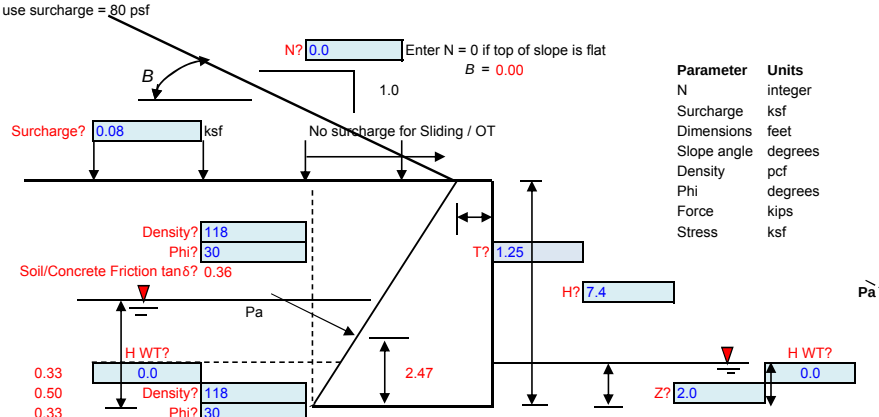
Gravity Wall with Surcharge

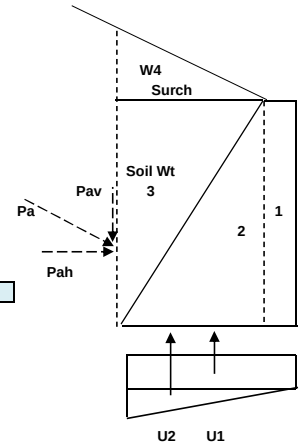
Project	JBCONN	By	DJS3
Job No.	21924	Date	3/15/2016
Analysis	RW008 STA 43+28	Checked	JCG
		Date	3/15/2016

Enter Prompts in Blue-Colored Boxes.
Red Values are calculated.
For traffic, use surcharge = 250 psf
For sidewalks, use surcharge = 80 psf

N? 0.0 Enter N = 0 if top of slope is flat
B = 0.00

Parameter	Units
N	integer
Surcharge	ksf
Dimensions	feet
Slope angle	degrees
Density	pcf
Phi	degrees
Force	kips
Stress	ksf





Ka1 =	0.33	0.0	
Ko1 =	0.50		
Ka2 =	0.33		
Kp2 =	3.00		
Nq =	12.52		
Nc =	19.96		
Ng =	13.30		

	LRFD Force ASD	LRFD Force Service	LRFD Force Strength	Lever Arm	LRFD Moment ASD	LRFD Moment Service	LRFD Moment Strength
W1 =	1.39	1.25	1.73	0.63	0.87	0.78	1.08
W2 =	1.77	1.59	2.21	2.31	4.10	3.69	5.12
W3 =	0.51	0.51	0.68	3.39	1.72	1.72	2.32
W4 =	0.00	0.00	0.00	3.39	0.00	0.00	0.00
Pav =	0.00	0.00	0.00	4.44	0.00	0.00	0.00
Surchv =	0.26	0.00	0.45	2.85	0.73	0.00	1.27
Sum W =	3.92	3.35	5.08				
U1=	0.00	0.00	0.00	2.22	0.00	0.00	0.00
U2=	0.00	0.00	0.00	2.96	0.00	0.00	0.00
Pah =	1.08	1.62	1.62	2.47	-2.66	-3.99	-3.99
Psurchh =	0.20	0.35	0.35	3.70	-0.73	-1.28	-1.28
Pp =	-0.71	-0.53	-0.53	0.67	0.47	0.35	0.35
				Sum M =	4.49		4.88 k-ft
				Xo =	1.15		0.96 ft
				e =	1.07		1.26 ft
				e/B =	0.24		0.28

From Std Detail RW-3

H	T
3.0	1.0
4.0	1.0
5.0	1.0
6.0	1.0
7.0	1.0
8.0	1.0
9.0	1.0
10.0	1.0
11.0	1.1
12.0	1.2
13.0	1.3
14.0	1.5
15.0	1.6
16.0	1.6
17.0	1.6
18.0	1.6
19.0	1.6

	Sliding		
Sum Slide =	0.57	1.43	kip
Sum Resist =	2.12	1.93	kip
FS Slide =	**3.74**	**1.35**	
	≥ 1.5?	≥ 1.0?	
	OK	OK	

	Overturning		
Sum OT =	3.39	5.26	k-ft
Sum Resist =	7.15	6.54	k-ft
FS OT =	**2.11**	**1.24**	
	≥ 2.0?	≥ 1.0?	
	OK	OK	

	Bearing			
Qmax =	2.29		3.54	ksf
Qavg =	1.71		2.64	ksf
Qult dry =	4.75	ksf	3.13	ksf
Qult wet =	2.24	ksf	1.49	ksf
FS BC dry =	**2.78**		**1.19**	
FS BC wet =	**1.31**		**0.56**	
	≥ 2.5?		≥ 1.0?	
	OK		OK	

1.54 Ratio Qavg LRFD/ASD

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET	Page 1 of 1
		Made By DJS3
	Determination of Settlement below Walls	Date 3/15/2016
		Checked By JCG
LOCATION RW008	STA 43+28 BL	Enter Values in Blue. Date 3/15/2016

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settlement after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. RW008-B4

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	2.0	16	1	0.0	2.0
2	5.0	7	1	2.0	7.0
3	8.2	25	1	7.0	15.2
4	1.8	15	1	15.2	17.0
5	3.0	40	2	17.0	20.0
6					
7					
8					
9					
10					
11					
12					

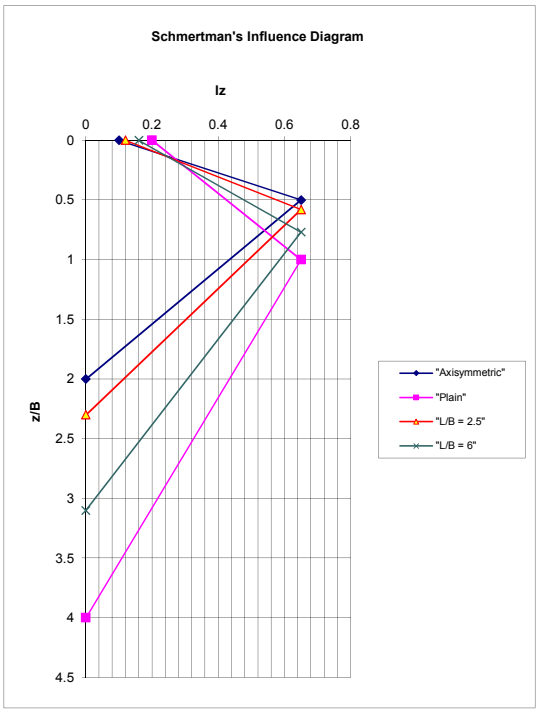
Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	1,710	Avg. Foundation Pressure From Calcs
Γ, pcf	118.0	Bearing Soil Density
B, ft	2.3	Foundation Width (effective B-2e)
L, ft	390	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	1,710	
L/B	172.57	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR
If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

Δ, in	0.33	**Immediate Settlement** (up to end of monitoring period)		
	0.04	Post-Construction Settlement, in.	0.20	year
Δ, in	0.36	**Total Settlement**	1.00	year

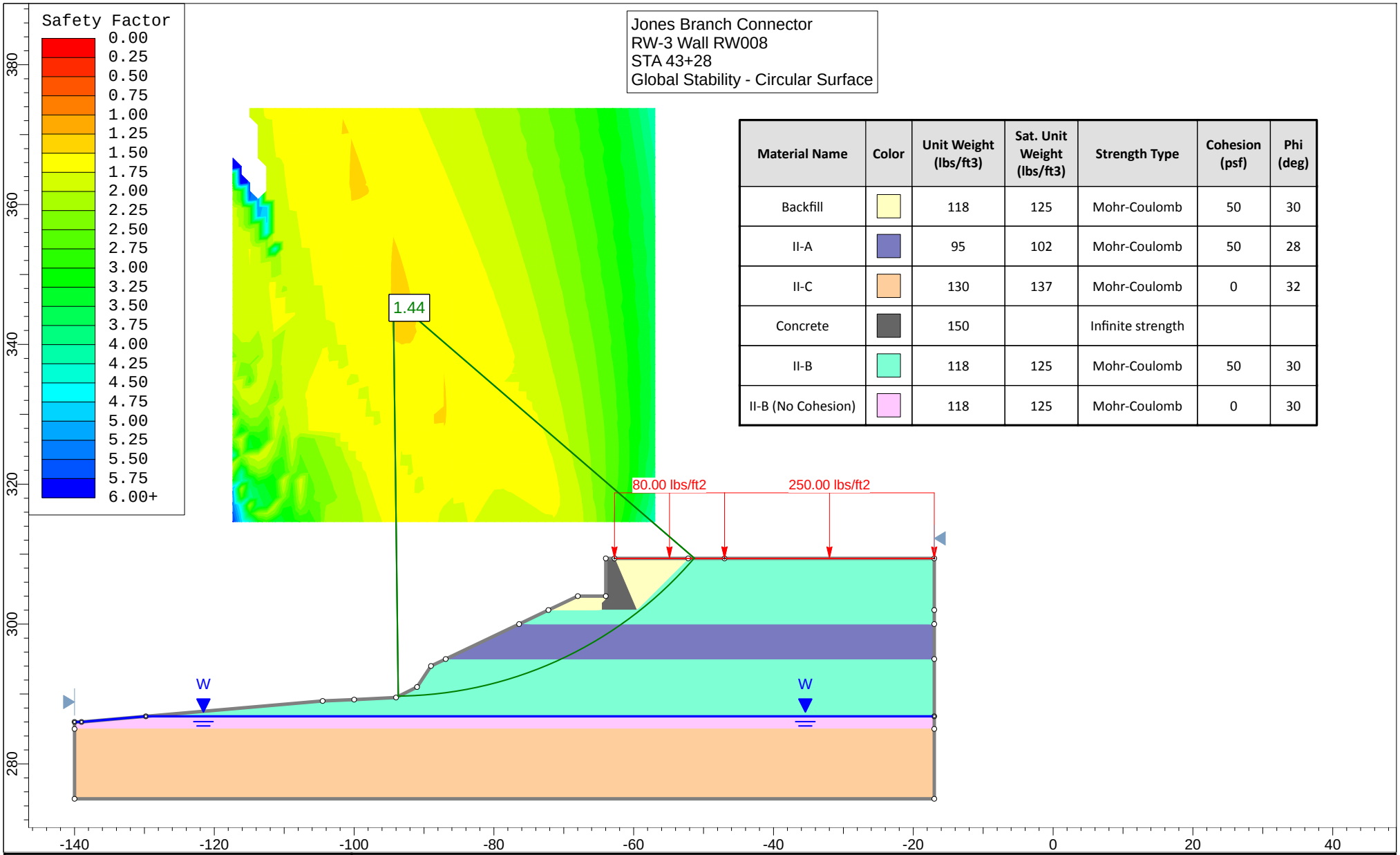
Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.44248	0.44142	1	202,880	0.09	0.08	0.36	0.36
3	1.32743	0.49503	1	88,760	0.23	0.19	0.29	0.29
5	2.21239	0.24902	1	88,760	0.12	0.10	0.10	0.10
7	3.09735	0.00300	1	317,000	0.00	0.00	0.00	0.00
9	3.98230	0.00000						
11	4.86726	0.00000						
13	5.75221	0.00000						
15	6.63717	0.00000						
17	7.52212	0.00000						
19	8.40708	0.00000						
21	9.29204	0.00000						
23	10.17699	0.00000						
25	11.06195	0.00000						
27	11.94690	0.00000						
29	12.83186	0.00000						
31	13.71681	0.00000						
33	14.60177	0.00000						
35	15.48673	0.00000						
37	16.37168	0.00000						
39	17.25664	0.00000						
41	18.14159	0.00000						
43	19.02655	0.00000						
45	19.91150	0.00000						
47	20.79646	0.00000						
49	21.68142	0.00000						
51	22.56637	0.00000						
53	23.45133	0.00000						
55	24.33628	0.00000						
57	25.22124	0.00000						
59	26.10619	0.00000						
61	26.99115	0.00000						
61	26.99115	0.00000						
63	27.87611	0.00000						
65	28.76106	0.00000						
67	29.64602	0.00000						
69	30.53097	0.00000						
71	31.41593	0.00000						
73	32.30088	0.00000						
75	33.18584	0.00000						
77	34.07080	0.00000						
			ΣΔ, in. (Uncorrected)		0.43			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

Es = qc/N * N * 2000 (psf)

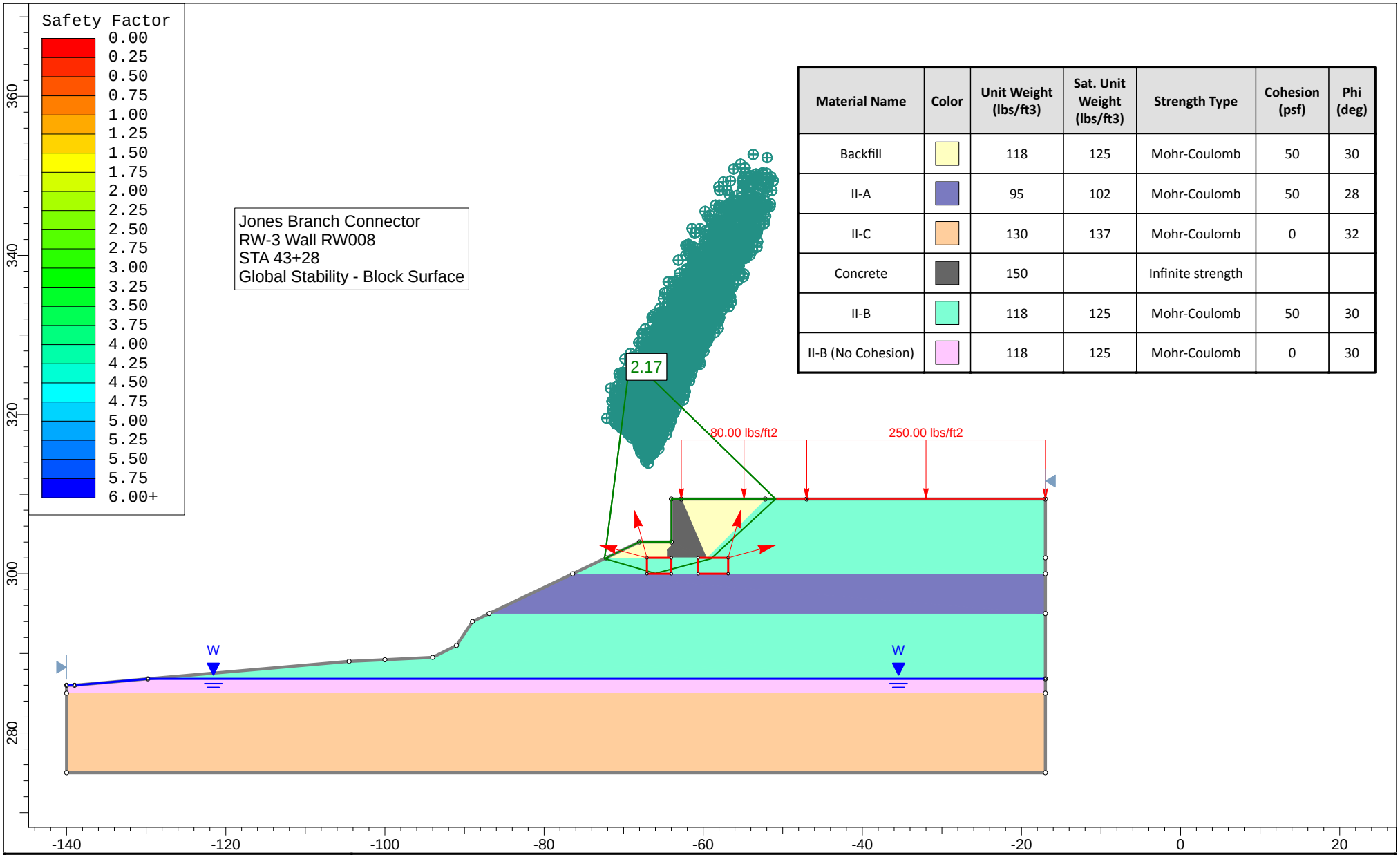
Jones Branch Connector
RW-3 Wall RW008
STA 43+28
Global Stability - Circular Surface



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	125	Mohr-Coulomb	50	30
II-A		95	102	Mohr-Coulomb	50	28
II-C		130	137	Mohr-Coulomb	0	32
Concrete		150		Infinite strength		
II-B		118	125	Mohr-Coulomb	50	30
II-B (No Cohesion)		118	125	Mohr-Coulomb	0	30

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW008		
Analysis Description	STA 43+28		
Drawn By	DJS3	Scale 1:228	Company ECS
Date	9/30/15		File Name RW008 RW3 STA 43+28_benched.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	125	Mohr-Coulomb	50	30
II-A		95	102	Mohr-Coulomb	50	28
II-C		130	137	Mohr-Coulomb	0	32
Concrete		150		Infinite strength		
II-B		118	125	Mohr-Coulomb	50	30
II-B (No Cohesion)		118	125	Mohr-Coulomb	0	30

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW008		
Analysis Description	STA 43+28		
Drawn By DJS3	*Scale* 1:200	*Company* ECS	
Date 9/30/15		*File Name* RW008 RW3 STA 43+28_benched_Block.slim	

ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By DJS	
Determination of Soil Parameters below Gravity Walls	Date 4/22/2016	
	Checked By JCG	
LOCATION RW009 STA 50+00	Date 4/22/2016	

Reference: VDOT Soil Design Parameters for Sound Barrier Walls, Retaining Walls, and Non-Critical Slopes, April, 2011

Red values are calculated

Enter Values in Blue

BORING No. RW009-B1-B1A

Top of Boring Elevation 306.0

Hammer Efficiency = 60 %

(Use 80% for automatic if eff. Is not provided)

Top Wall El. = 307.6

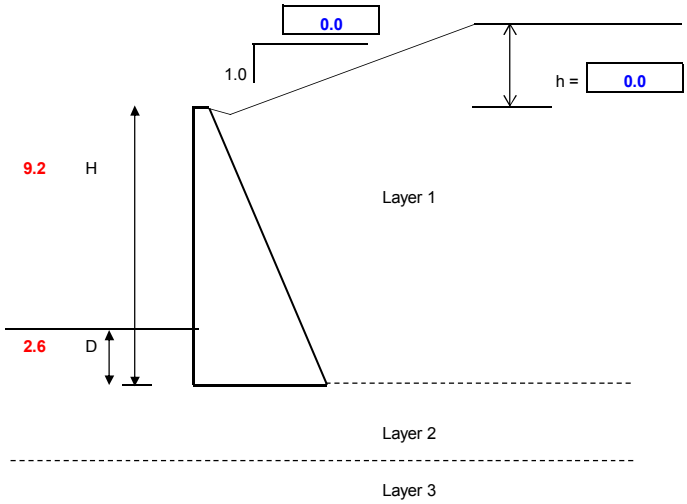
Groundwater Elevation = 277.2

(Enter bottom of boring if dry)

Bench Line

Top of Ground = 301.0

Bot. Wall El. = 298.4



SR = Strong Rock

WR = Weak Rock

SF = Select Fill (CBR 30)

CFB = Culpeper Fault Basin

CP = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1

Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Bot. Layer No. for BC Analysis = 0

C for BC Analysis = N.A.

Φ for BC analysis = N.A.

Γ for BC Analysis = N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}	RQD
1	298.4	9.2	P	II-B	13	17	6			12	
2	296.7	1.7	P	II-A	6					6	
3	284.0	12.7	P	II-B	37	17	35			30	
4	277.2	6.8	P	III	100	100				100	
5											
6											
7											
8											
9											
10											
11											
12											

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth below FTG ft	Cohesion for DRIVEN or SHAFT psf	MidPoint ft	Half Layer Press psf	Midpoint Pressure psf
1	118.0	125.0	ML	50.0	30.0		2	0.0		1.3	153	153
2	95.0	102.0	CL	50.0	28.0		1	1.7	450	0.8	81	388
3	118.0	125.0	CL	50.0	30.0	Y	2	14.4		8.0	749	1218
4	120.0	128.0	HWR	250.0	34.0		4	21.2		17.8	223	2190
5												
6												
7												
8												
9												
10												
11												
12												

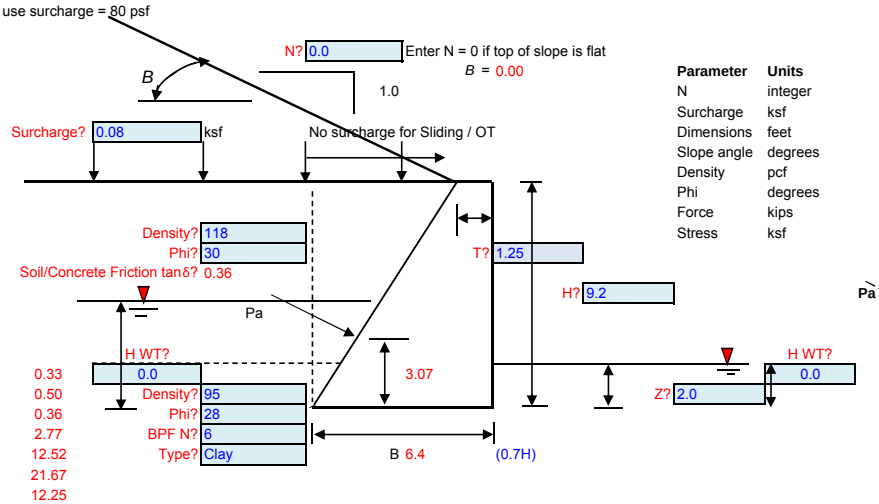
ANALYSIS OF GRAVITY RETAINING WALLS

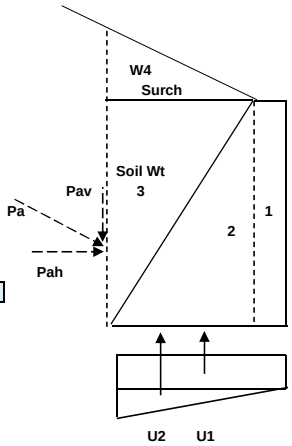
Gravity Wall with Surcharge

Project	JBCONN	By	DJS3
Job No.	21924	Date	3/15/2016
Analysis	RW009 STA 50+00	Checked	JCG
		Date	3/15/2016

Enter Prompts in Blue-Colored Boxes.
Red Values are calculated.
For traffic, use surcharge = 250 psf
For sidewalks, use surcharge = 80 psf

Parameter	Units
N	integer
Surcharge	ksf
Dimensions	feet
Slope angle	degrees
Density	pcf
Phi	degrees
Force	kips
Stress	ksf





	LRFD Force ASD	LRFD Force Service	LRFD Force Strength	Lever Arm	LRFD Moment ASD	LRFD Moment Service	LRFD Moment Strength
W1 =	1.73	1.55	2.16	0.63	1.08	0.97	1.35
W2 =	3.58	3.22	4.48	2.98	10.67	9.60	13.34
W3 =	1.03	1.03	1.38	4.73	4.85	4.85	6.54
W4 =	0.00	0.00	0.00	4.73	0.00	0.00	0.00
Pav =	0.00	0.00	0.00	6.44	0.00	0.00	0.00
Surchv =	0.42	0.00	0.73	3.85	1.60	0.00	2.79
Sum W =	6.75	5.80	8.74				
U1=	0.00	0.00	0.00	3.22	0.00	0.00	0.00
U2=	0.00	0.00	0.00	4.29	0.00	0.00	0.00
Pah =	1.66	2.50	2.50	3.07	-5.11	-7.66	-7.66
Psurchh =	0.25	0.43	0.43	4.60	-1.13	-1.98	-1.98
Pp =	-0.53	-0.39	-0.39	0.67	0.35	0.26	0.26
				Sum M =	12.31		14.65 k-ft
				Xo =	1.82		1.68 ft
				e =	1.40		1.54 ft
				e/B =	0.22		0.24

From Std Detail RW-3

H	T
3.0	1.0
4.0	1.0
5.0	1.0
6.0	1.0
7.0	1.0
8.0	1.0
9.0	1.0
10.0	1.0
11.0	1.1
12.0	1.2
13.0	1.3
14.0	1.5
15.0	1.6
16.0	1.6
17.0	1.6
18.0	1.6
19.0	1.6

	Sliding		
Sum Slide =	1.38	2.53	kip
Sum Resist =	3.37	3.08	kip
FS Slide =	**2.43**	**1.22**	
	≥ 1.5?	≥ 1.0?	
	OK	OK	

	Overturning		
Sum OT =	6.23	9.63	k-ft
Sum Resist =	16.95	15.68	k-ft
FS OT =	**2.72**	**1.63**	
	≥ 2.0?	≥ 1.0?	
	OK	OK	

	Bearing			
Qmax =	2.48		3.50	ksf
Qavg =	1.85		2.61	ksf
Qult dry =	4.50	ksf	3.26	ksf
Qult wet =	1.55	ksf	1.13	ksf
FS BC dry =	**2.44**		**1.25**	
FS BC wet =	**0.84**		**0.43**	
	≥ 2.5?		≥ 1.0?	
	Check		OK	

1.41 Ratio Qavg LRFD/ASD

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls				Page 1 of 1 Made By DJS3 Date 3/16/2016 Checked By JCG Date 3/16/2016
LOCATION	RW009	STA 50+00	BL	Enter Values in Blue.	

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settlement after a specified time period. It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. RW009-B1-B1A

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	1.3	6	1	0.0	1.3
2	12.7	30	2	1.3	14.0
3	6.8	100	4	14.0	20.8
4					
5					
6					
7					
8					
9					
10					
11					
12					

Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	2,120	Avg. Foundation Pressure From Calcs
Γ, pcf	95.0	Bearing Soil Density
B, ft	3.0	Foundation Width (effective B-2e)
L, ft	145	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,120	
L/B	48.33	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

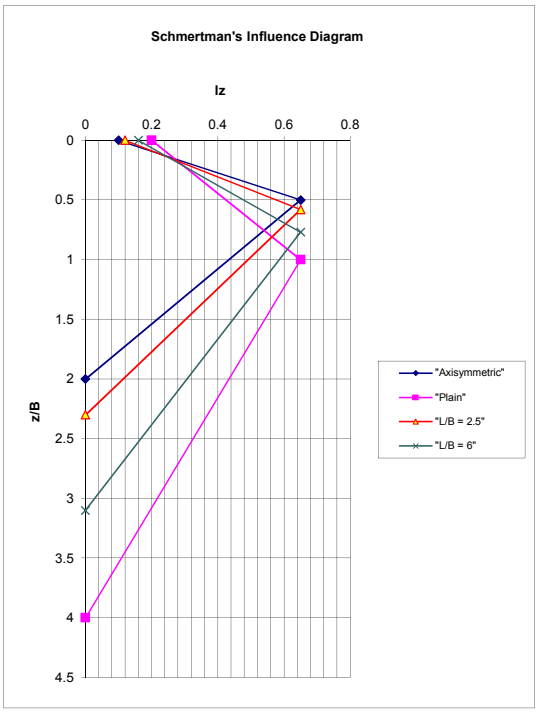
Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR

If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

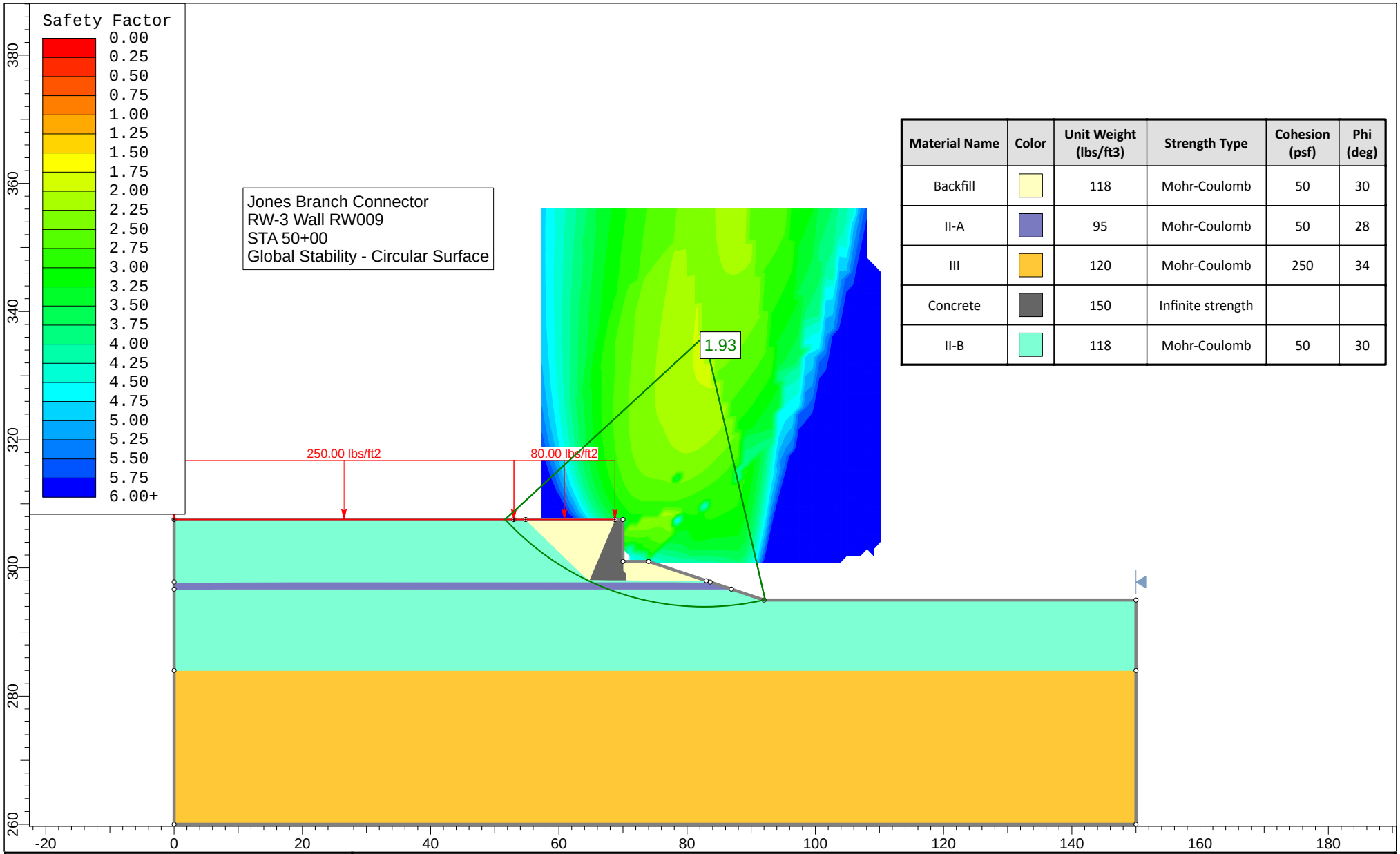
Δ, in	0.09	**Immediate Settlement** (up to end of monitoring period)		
	0.01	Post-Construction Settlement, in.	0.20	year
Δ, in	0.10	**Total Settlement**	1.00	year

Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.33333	0.37200	2	665,700	0.03	0.02	0.10	0.10
3	1.00000	0.58606	2	665,700	0.04	0.04	0.08	0.08
5	1.66667	0.40073	2	665,700	0.03	0.03	0.04	0.04
7	2.33333	0.21539	2	665,700	0.02	0.01	0.02	0.02
9	3.00000	0.03006	2	665,700	0.00	0.00	0.00	0.00
11	3.66667	0.00000						
13	4.33333	0.00000						
15	5.00000	0.00000						
17	5.66667	0.00000						
19	6.33333	0.00000						
21	7.00000	0.00000						
23	7.66667	0.00000						
25	8.33333	0.00000						
27	9.00000	0.00000						
29	9.66667	0.00000						
31	10.33333	0.00000						
33	11.00000	0.00000						
35	11.66667	0.00000						
37	12.33333	0.00000						
39	13.00000	0.00000						
41	13.66667	0.00000						
43	14.33333	0.00000						
45	15.00000	0.00000						
47	15.66667	0.00000						
49	16.33333	0.00000						
51	17.00000	0.00000						
53	17.66667	0.00000						
55	18.33333	0.00000						
57	19.00000	0.00000						
59	19.66667	0.00000						
61	20.33333	0.00000						
61	20.33333	0.00000						
63	21.00000	0.00000						
65	21.66667	0.00000						
67	22.33333	0.00000						
69	23.00000	0.00000						
71	23.66667	0.00000						
73	24.33333	0.00000						
75	25.00000	0.00000						
77	25.66667	0.00000						
			ΣΔ, in. (Uncorrected)		0.12			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

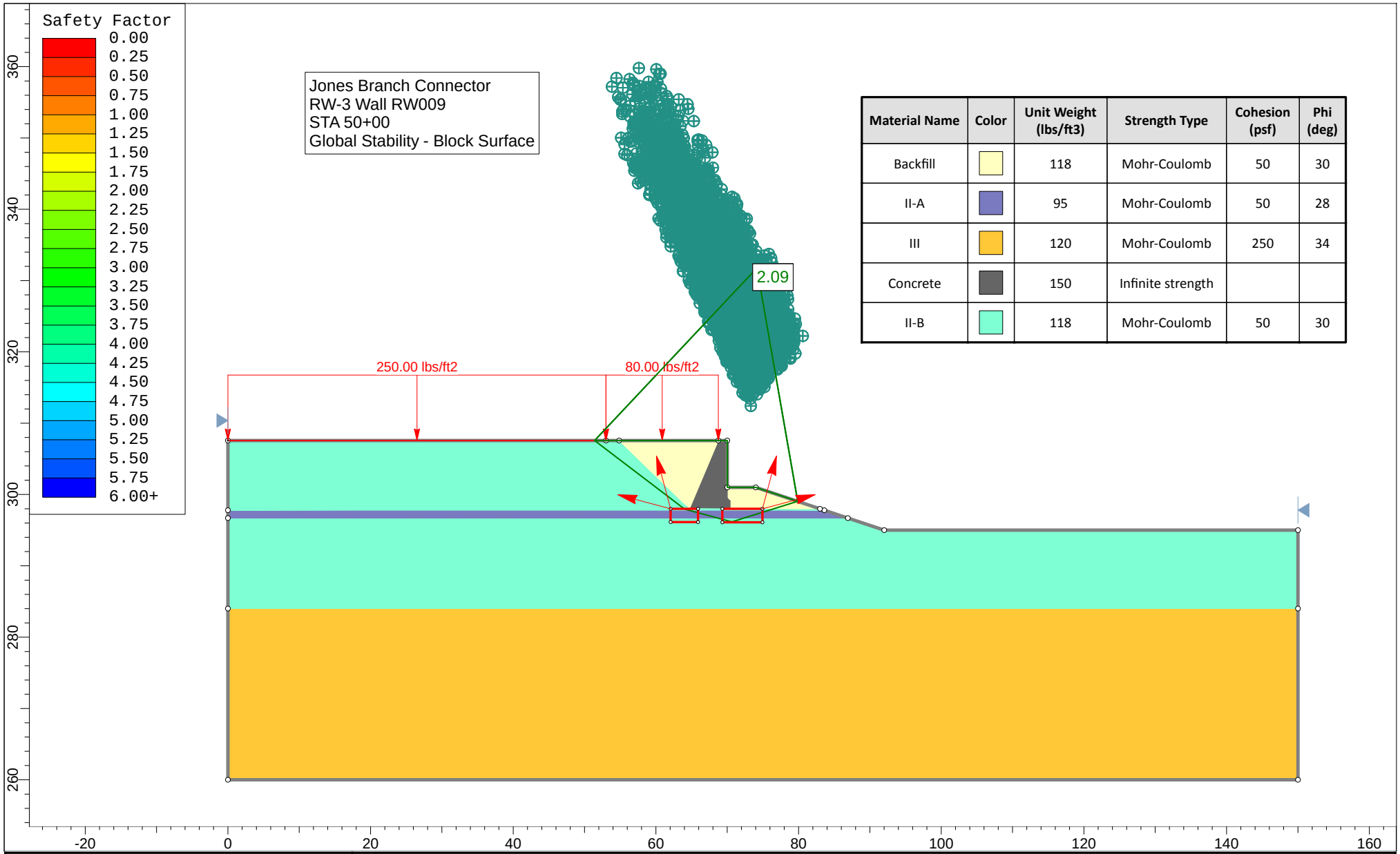
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
II-A		95	Mohr-Coulomb	50	28
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		
II-B		118	Mohr-Coulomb	50	30

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW009		
Analysis Description	STA 50+00		
Drawn By DJS3	*Scale* 1:248	*Company* ECS	
Date 9/30/15		*File Name* RW009 RW3 STA 50+00_benched.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
II-A		95	Mohr-Coulomb	50	28
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		
II-B		118	Mohr-Coulomb	50	30

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW009		
Analysis Description	STA 50+00		
Drawn By DJS3	*Scale* 1:223	*Company* ECS	
Date 9/30/15		*File Name* RW009 RW3 STA 50+00_benched_Block.slim	

ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By DJS	
Determination of Soil Parameters below Gravity Walls	Date 3/16/2016	
	Checked By JCG	
LOCATION RW009 STA 51+20	Date 3/16/2016	

Reference: VDOT Soil Design Parameters for Sound Barrier Walls, Retaining Walls, and Non-Critical Slopes, April, 2011

Red values are calculated

Enter Values in Blue

BORING No. RW009-B2-B2A

Top of Boring Elevation 308.6

Hammer Efficiency = 60 %

(Use 80% for automatic if eff. Is not provided)

Top Wall El. = 308.8

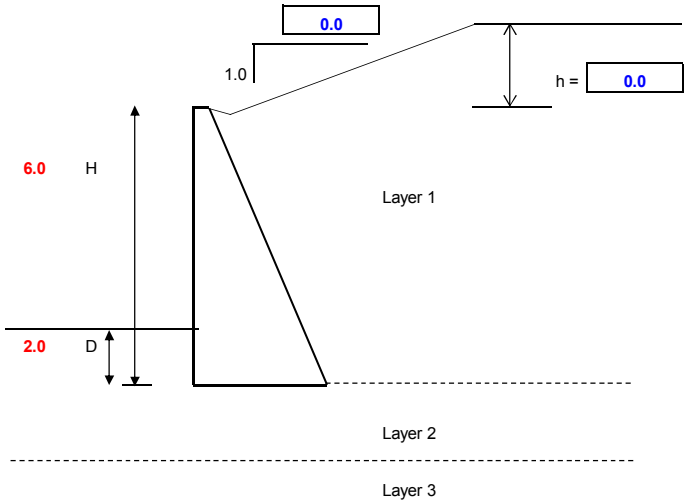
Groundwater Elevation = 280.4

(Enter bottom of boring if dry)

Bench Line

Top of Ground = 304.8

Bot. Wall El. = 302.8



SR = Strong Rock

WR = Weak Rock

SF = Select Fill (CBR 30)

CFB = Culpeper Fault Basin

CP = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1

Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Bot. Layer No. for BC Analysis = 0

C for BC Analysis = N.A.

Φ for BC analysis = N.A.

Γ for BC Analysis = N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}	RQD
1	302.8	6.0	P	II-A	4	3	16			8	
2	291.6	11.2	P	II-A	8	7	9			8	
3	280.4	11.2	P	III	100	100	100			100	
4											
5											
6											
7											
8											
9											
10											
11											
12											

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth below FTG ft	Cohesion for DRIVEN or SHAFT psf	MidPoint ft	Half Layer Press psf	Midpoint Pressure psf
1	95.0	102.0	ML	50.0	28.0		2	0.0		1.0	95	95
2	95.0	102.0	CL	50.0	28.0	Y	2	11.2		5.6	532	722
3	120.0	128.0	HWR	250.0	34.0		4	22.4		16.8	367	1621
4												
5												
6												
7												
8												
9												
10												
11												
12												

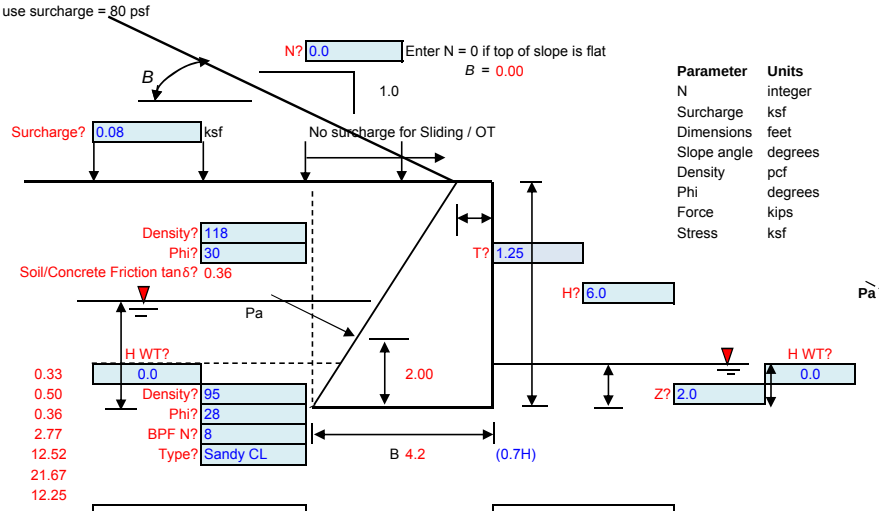
ANALYSIS OF GRAVITY RETAINING WALLS

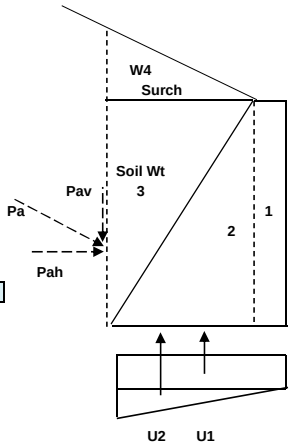
Gravity Wall with Surcharge

Project	JBCONN	By	DJS3
Job No.	21924	Date	3/15/2016
Analysis	RW009 STA 51+20	Checked	JCG
		Date	3/15/2016

Enter Prompts in Blue-Colored Boxes.
Red Values are calculated.
For traffic, use surcharge = 250 psf
For sidewalks, use surcharge = 80 psf

Parameter	Units
N	integer
Surcharge	ksf
Dimensions	feet
Slope angle	degrees
Density	pcf
Phi	degrees
Force	kips
Stress	ksf





Ka1 =	0.33	Density?	95		
Ko1 =	0.50	Phi?	28		
Ka2 =	0.36	BPF N?	8		
Kp2 =	2.77	Type?	Sandy CL		
Nq =	12.52				
Nc =	21.67				
Ng =	12.25				

	LRFD Force ASD	LRFD Force Service	LRFD Force Strength	Lever Arm	LRFD Moment ASD	LRFD Moment Service	LRFD Moment Strength	
W1 =	1.13	1.01	1.41	0.63	0.70	0.63	0.88	
W2 =	1.33	1.19	1.66	2.23	2.96	2.67	3.71	
W3 =	0.38	0.38	0.51	3.23	1.23	1.23	1.66	
W4 =	0.00	0.00	0.00	3.23	0.00	0.00	0.00	
Pav =	0.00	0.00	0.00	4.20	0.00	0.00	0.00	
Surchv =	0.24	0.00	0.41	2.73	0.64	0.00	1.13	
Sum W =	3.07	2.59	3.99					
U1=	0.00	0.00	0.00	2.10	0.00	0.00	0.00	
U2=	0.00	0.00	0.00	2.80	0.00	0.00	0.00	
Pah =	0.71	1.06	1.06	2.00	-1.42	-2.12	-2.12	
Psurchh =	0.16	0.28	0.28	3.00	-0.48	-0.84	-0.84	
Pp =	-0.53	-0.39	-0.39	0.67	0.35	0.26	0.26	
				Sum M =	3.99		4.66	k-ft
				Xo =	1.30		1.17	ft
				e =	0.80		0.93	ft
				e/B =	0.19		0.22	

From Std Detail RW-3

H	T
3.0	1.0
4.0	1.0
5.0	1.0
6.0	1.0
7.0	1.0
8.0	1.0
9.0	1.0
10.0	1.0
11.0	1.1
12.0	1.2
13.0	1.3
14.0	1.5
15.0	1.6
16.0	1.6
17.0	1.6
18.0	1.6
19.0	1.6

Sliding			
Sum Slide =	0.34	0.95	kip
Sum Resist =	1.51	1.38	kip
FS Slide =	**4.41**	**1.45**	
	≥ 1.5?	≥ 1.0?	
	OK	OK	

Overturning			
Sum OT =	1.90	2.96	k-ft
Sum Resist =	5.25	4.79	k-ft
FS OT =	**2.77**	**1.62**	
	≥ 2.0?	≥ 1.0?	
	OK	OK	

Bearing				
Qmax =	1.58		2.29	ksf
Qavg =	1.18		1.71	ksf
Qult dry =	3.89	ksf	2.67	ksf
Qult wet =	1.34	ksf	0.93	ksf
FS BC dry =	**3.30**		**1.56**	
FS BC wet =	**1.13**		**0.54**	
	≥ 2.5?		≥ 1.0?	
	OK		OK	

1.45	Ratio Qavg LRFD/ASD

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls				Page 1 of 1 Made By DJS3 Date 3/16/2016 Checked By JCG Date 3/16/2016
LOCATION	RW009	STA 51+20	BL	Enter Values in Blue.	

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settlement after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. RW009-B2-B2A

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	11.2	8	2	0.0	11.2
2	11.2	100	4	11.2	22.4
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

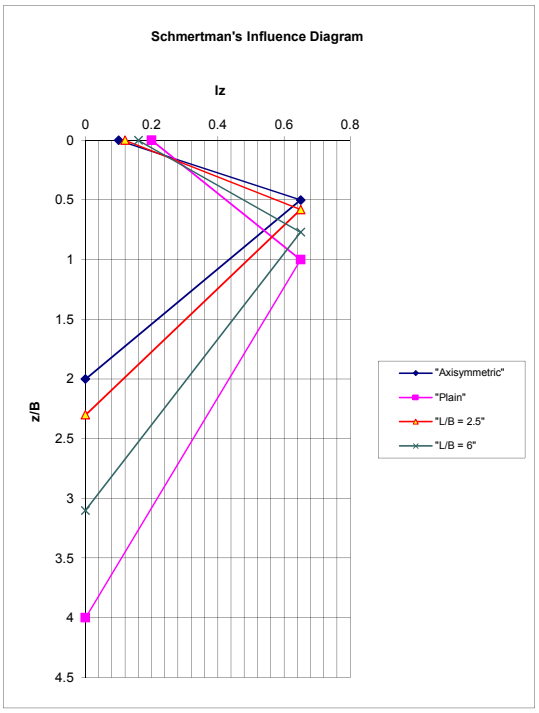
Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	1,360	Avg. Foundation Pressure From Calcs
Γ, pcf	95.0	Bearing Soil Density
B, ft	2.0	Foundation Width (effective B-2e)
L, ft	145	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	1,360	
L/B	73.98	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR
If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

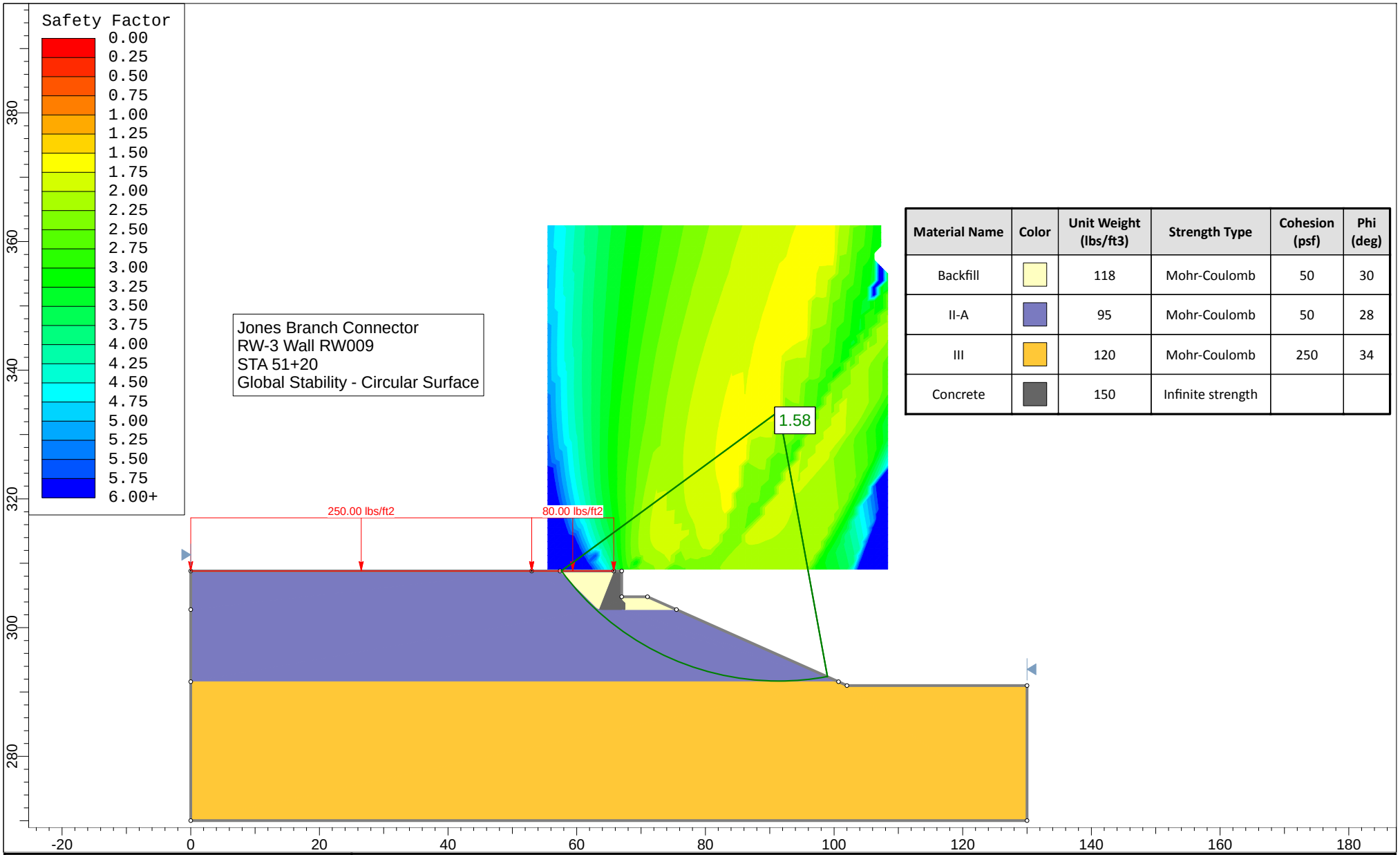
Δ, in	0.15	**Immediate Settlement** (up to end of monitoring period)		
	0.02	Post-Construction Settlement, in.	0.20	year
Δ, in	0.17	**Total Settlement**	1.00	year

Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.51020	0.48449	2	177,520	0.09	0.07	0.17	0.17
3	1.53061	0.43855	2	177,520	0.08	0.07	0.09	0.09
5	2.55102	0.15488	2	177,520	0.03	0.02	0.02	0.02
7	3.57143	0.00000						
9	4.59184	0.00000						
11	5.61224	0.00000						
13	6.63265	0.00000						
15	7.65306	0.00000						
17	8.67347	0.00000						
19	9.69388	0.00000						
21	10.71429	0.00000						
23	11.73469	0.00000						
25	12.75510	0.00000						
27	13.77551	0.00000						
29	14.79592	0.00000						
31	15.81633	0.00000						
33	16.83673	0.00000						
35	17.85714	0.00000						
37	18.87755	0.00000						
39	19.89796	0.00000						
41	20.91837	0.00000						
43	21.93878	0.00000						
45	22.95918	0.00000						
47	23.97959	0.00000						
49	25.00000	0.00000						
51	26.02041	0.00000						
53	27.04082	0.00000						
55	28.06122	0.00000						
57	29.08163	0.00000						
59	30.10204	0.00000						
61	31.12245	0.00000						
61	31.12245	0.00000						
63	32.14286	0.00000						
65	33.16327	0.00000						
67	34.18367	0.00000						
69	35.20408	0.00000						
71	36.22449	0.00000						
73	37.24490	0.00000						
75	38.26531	0.00000						
77	39.28571	0.00000						
			ΣΔ, in. (Uncorrected)		0.20			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

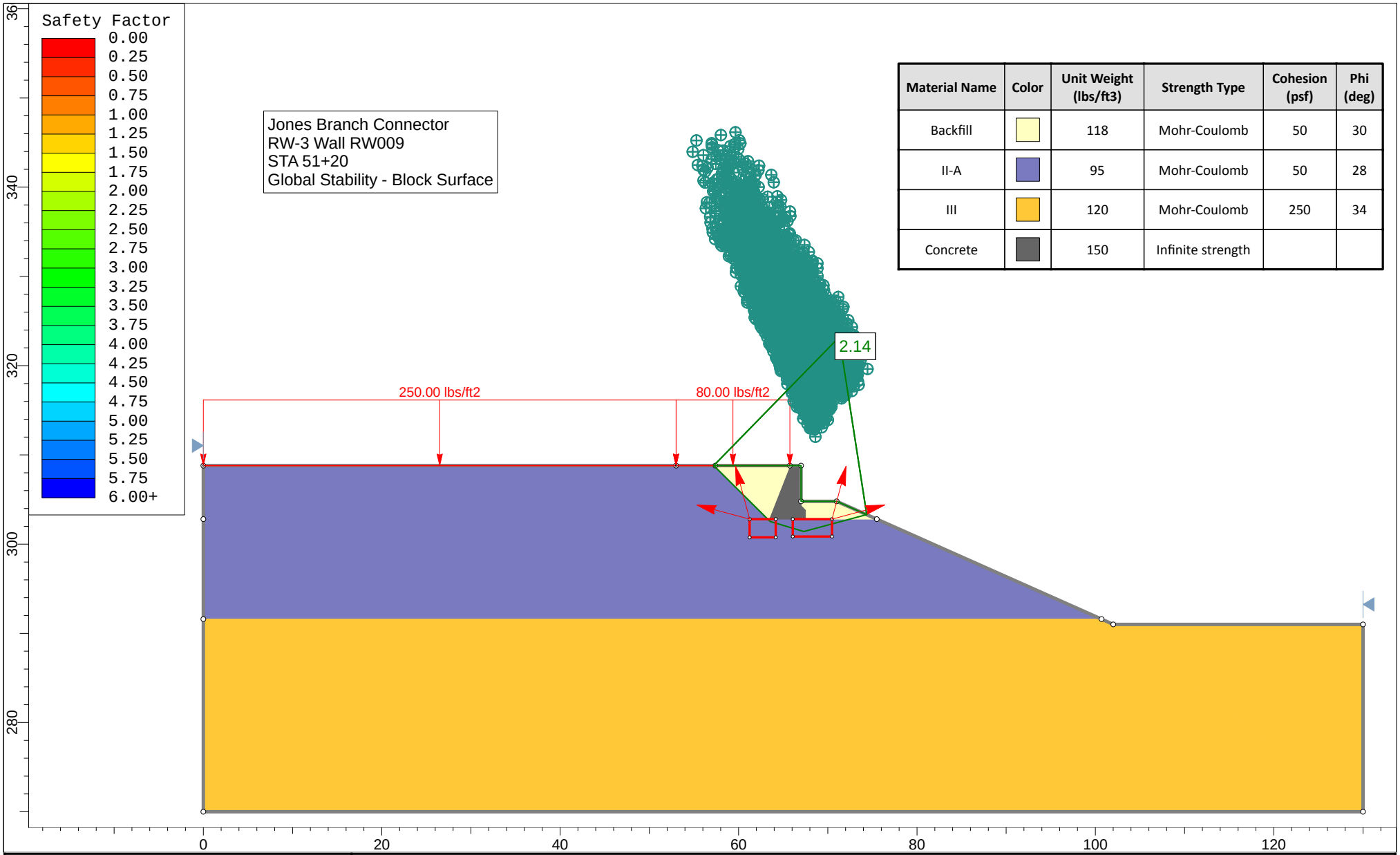
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
II-A		95	Mohr-Coulomb	50	28
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW009		
Analysis Description	STA 51+20		
Drawn By	DJS3	Scale 1:247	Company ECS
Date	9/30/15		File Name RW009 RW3 STA 51+20_benched.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
II-A		95	Mohr-Coulomb	50	28
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW009		
Analysis Description	STA 51+20		
Drawn By DJS3	*Scale* 1:178	*Company* ECS	
Date 9/30/15		*File Name* RW009 RW3 STA 51+20_benched_Block.slim	

ECS MID-ATLANTIC, LLC.	Page 1 of 1	
COMPUTATION SHEET	Made By DJS	
Determination of Soil Parameters below Gravity Walls	Date 3/17/2016	
	Checked By JCG	
LOCATION RW010 STA 10+00	Date 3/17/2016	

Reference: VDOT Soil Design Parameters for Sound Barrier Walls, Retaining Walls, and Non-Critical Slopes, April, 2011

Red values are calculated

Enter Values in Blue

BORING No. RW010-B1

Top of Boring Elevation 329.1

Hammer Efficiency = 60 %

(Use 80% for automatic if eff. Is not provided)

Top Wall El. = 329.9

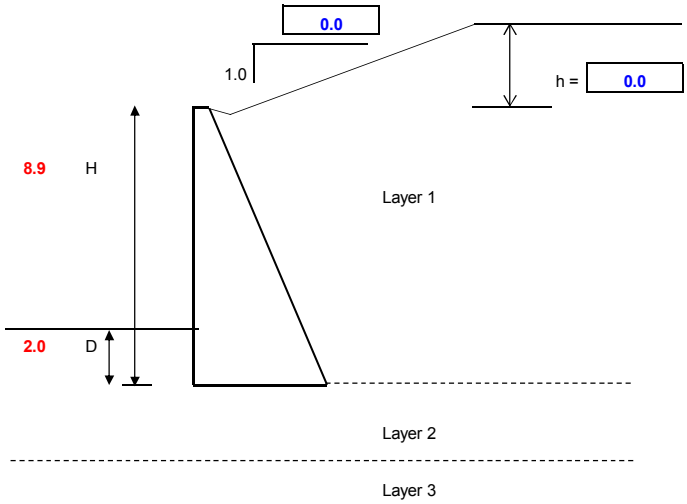
Groundwater Elevation = 305.2

(Enter bottom of boring if dry)

Bench Line

Top of Ground = 323.0

Bot. Wall El. = 321.0



SR = Strong Rock

WR = Weak Rock

SF = Select Fill (CBR 30)

CFB = Culpeper Fault Basin

CP = Coastal Plain Physiographic Province

P = Piedmont Physiographic Province

VR = Valley and Ridge

For compacted fill, Enter Province and 12 blows for N1

Enter a bottom of layer at elevation of water table.

Select total layer thickenss ≈ footing width

Bot. Layer No. for BC Analysis = 0

C for BC Analysis = N.A.

Φ for BC analysis = N.A.

Γ for BC Analysis = N.A.

Layer No.	El. Bottom of Layer ft	Layer Thickness ft	Province	Substratum	Field N Values N1	N2	N3	N4	N5	Avg. N_{60}	RQD
1	321.0	8.9	P	II-B	23	26	38			29	
2	320.1	0.9	P	III	100					100	
3	317.1	3.0	P	II-C	47					47	
4	305.2	11.9	P	III	100	100	100			100	
5											
6											
7											
8											
9											
10											
11											
12											

Highlighted area indicates layer is below water table.

Layer No.	Γ_{moist}, pcf	Γ_{sat}, pcf	Soil Type	C, psf	Φ°	CL w/ sand & gravel ?	Soil No.	Depth below FTG ft	Cohesion for DRIVEN or SHAFT psf	MidPoint ft	Half Layer Press psf	Midpoint Pressure psf
1	118.0	125.0	ML	50.0	30.0		2	0.0		1.0	118	118
2	120.0	128.0	HWR	250.0	34.0		4	0.9		0.4	54	290
3	130.0	137.0	ML	50.0	32.0		2	3.9		2.4	195	539
4	120.0	128.0	HWR	250.0	34.0		4	15.8		9.8	390	1124
5												
6												
7												
8												
9												
10												
11												
12												

ANALYSIS OF GRAVITY RETAINING WALLS

Gravity Wall with Surcharge

Project	JBCONN	By	DJS3
Job No.	21924	Date	3/16/2016
Analysis	RW010 STA 10+00	Checked	JCG
		Date	3/16/2016

Enter Prompts in Blue-Colored Boxes.
Red Values are calculated.
For traffic, use surcharge = 250 psf
For sidewalks, use surcharge = 80 psf

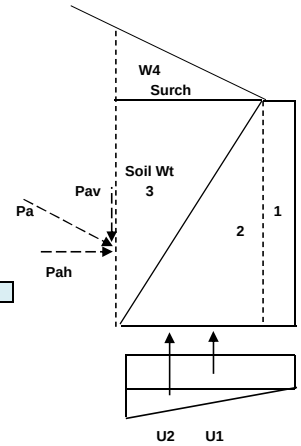
N? 0.0 Enter N = 0 if top of slope is flat
B = 0.00
1.0

Surcharge? 0.08 ksf
No surcharge for Sliding / OT

Density? 118
Phi? 30
Soil/Concrete Friction tanδ? 0.36

T? 1.00
H? 8.9
Pa
H WT? 0.0
2.97
H WT? 0.0
Z? 2.0
B 5.3

Parameter	Units
N	integer
Surcharge	ksf
Dimensions	feet
Slope angle	degrees
Density	pcf
Phi	degrees
Force	kips
Stress	ksf



Ka1 =	0.33	Density?	120
Ko1 =	0.50	Phi?	34
Ka2 =	0.28	BPF N?	100
Kp2 =	3.54	Type?	Silt
Nq =	29.44		
Nc =	42.17		
Ng =	38.36		

	LRFD Force ASD	LRFD Force Service	LRFD Force Strength	Lever Arm	LRFD Moment ASD	LRFD Moment Service	LRFD Moment Strength
W1 =	1.34	1.20	1.67	0.50	0.67	0.60	0.83
W2 =	2.90	2.61	3.62	2.45	7.09	6.38	8.86
W3 =	0.83	0.83	1.12	3.91	3.24	3.24	4.38
W4 =	0.00	0.00	0.00	3.91	0.00	0.00	0.00
Pav =	0.00	0.00	0.00	5.34	0.00	0.00	0.00
Surchv =	0.35	0.00	0.61	3.17	1.10	0.00	1.93
Sum W =	5.41	4.64	7.02				
U1=	0.00	0.00	0.00	2.67	0.00	0.00	0.00
U2=	0.00	0.00	0.00	3.56	0.00	0.00	0.00
Pah =	1.56	2.34	2.34	2.97	-4.62	-6.93	-6.93
Psurchh =	0.24	0.42	0.42	4.45	-1.06	-1.85	-1.85
Pp =	-0.85	-0.64	-0.64	0.67	0.57	0.42	0.42
				Sum M =	6.99		7.64 k-ft
				Xo =	1.29		1.09 ft
				e =	1.38		1.58 ft
				e/B =	0.26		0.30

From Std Detail RW-3

H	T
3.0	1.0
4.0	1.0
5.0	1.0
6.0	1.0
7.0	1.0
8.0	1.0
9.0	1.0
10.0	1.0
11.0	1.1
12.0	1.2
13.0	1.3
14.0	1.5
15.0	1.6
16.0	1.6
17.0	1.6
18.0	1.6
19.0	1.6

	Sliding		
Sum Slide =	0.95	2.12	kip
Sum Resist =	3.41	3.13	kip
FS Slide =	**3.61**	**1.48**	
	≥ 1.5?	≥ 1.0?	
	OK	OK	

	Overturning		
Sum OT =	5.68	8.78	k-ft
Sum Resist =	11.56	10.65	k-ft
FS OT =	**2.04**	**1.21**	
	≥ 2.0?	≥ 1.0?	
	OK	OK	

	Bearing			
Qmax =	2.81		4.32	ksf
Qavg =	2.09		3.22	ksf
Qult dry =	13.01	ksf	8.90	ksf
Qult wet =	6.25	ksf	4.30	ksf
FS BC dry =	**6.21**		**2.76**	
FS BC wet =	**2.98**		**1.33**	
	≥ 2.5?		≥ 1.0?	
	OK		OK	

1.54 Ratio Qavg LRFD/ASD

	ECS MID-ATLANTIC, LLC COMPUTATION SHEET Determination of Settlement below Walls				Page 1 of 1 Made By DJS3 Date 3/17/2016 Checked By JCG Date 3/17/2016
LOCATION	RW010	STA 10+00	BL	Enter Values in Blue.	

This sheet calculates simple elastic Δ of sands, HWR, silts, and sandy clays. It assumes 100% settlement in one year and calculates creep settlement after a specified time period.
It is generally based on Schmertman's 1976 method of analysis. For settlement of soft clays, additional analyses based onconsolidation theory is required.

Boring No. RW010-B1

Layer No.	Layer t ft.	N_{60}	Soil Type	Depths, ft From	Depths, ft To
1	0.9	100	4	0.0	0.9
2	3.0	47	2	0.9	3.9
3	11.9	100	4	3.9	15.8
4					
5					
6					
7					
8					
9					
10					
11					
12					

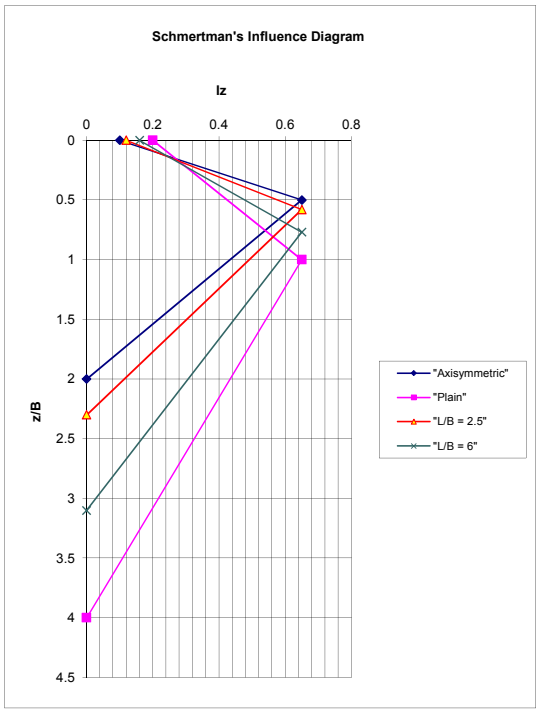
Z, ft	0.00	Height of Existing Ground Above Bottom of Wall
Po, psf	2,090	Avg. Foundation Pressure From Calcs
Γ, pcf	120.0	Bearing Soil Density
B, ft	2.5	Foundation Width (effective B-2e)
L, ft	61	Approximate Wall Length
To, year	0.20	Monitoring period
T, year	1.00	Time to complete creep sands
Dr, ft		Depth to Bedrock
Δp, psf	2,090	
L/B	24.02	
C1	1.00	Embedment Correction Factor
C2	1.14	Creep Correction Factor (sands) after mon. period
C3	1.00	Rock Depth Correction Factor
C4	0.60	Martin's Corr. Fact. (norm 0.6, use 1.0 for fill with debris)

Pile Settlement = 0.00 in

If L/B < 4, use red modified influence diagram. 0.5 for piles in HWR
If L/B > 4, use green modified influence diagram. 0.1 for piles on Rock

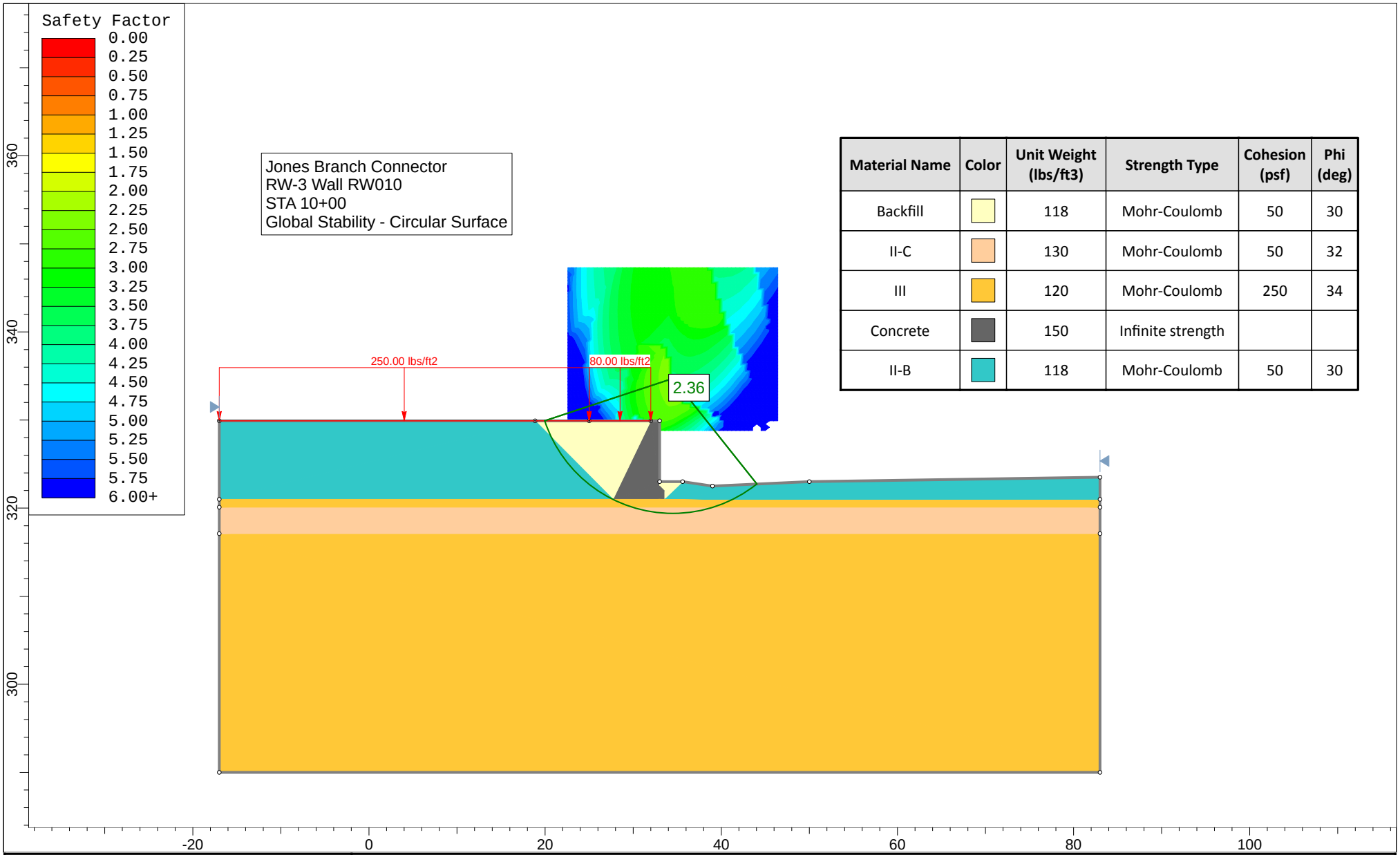
Δ, in	0.02	**Immediate Settlement** (up to end of monitoring period)		
	0.00	Post-Construction Settlement, in.	0.20	year
Δ, in	0.03	**Total Settlement**	1.00	year

Depth ft	z/B	Iz	Soil Type	Es psf	Δ Uncorr. in.	Prorated Δ in.	Σ Δ in	Δ less Pile Δ in.
1	0.39370	0.41039	2	1,042,930	0.02	0.02	0.03	0.03
3	1.18110	0.53571	4	3,804,000	0.01	0.01	0.01	0.01
5	1.96850	0.31682	4	3,804,000	0.00	0.00	0.00	0.00
7	2.75591	0.09792	4	3,804,000	0.00	0.00	0.00	0.00
9	3.54331	0.00000						
11	4.33071	0.00000						
13	5.11811	0.00000						
15	5.90551	0.00000						
17	6.69291	0.00000						
19	7.48031	0.00000						
21	8.26772	0.00000						
23	9.05512	0.00000						
25	9.84252	0.00000						
27	10.62992	0.00000						
29	11.41732	0.00000						
31	12.20472	0.00000						
33	12.99213	0.00000						
35	13.77953	0.00000						
37	14.56693	0.00000						
39	15.35433	0.00000						
41	16.14173	0.00000						
43	16.92913	0.00000						
45	17.71654	0.00000						
47	18.50394	0.00000						
49	19.29134	0.00000						
51	20.07874	0.00000						
53	20.86614	0.00000						
55	21.65354	0.00000						
57	22.44094	0.00000						
59	23.22835	0.00000						
61	24.01575	0.00000						
61	24.01575	0.00000						
63	24.80315	0.00000						
65	25.59055	0.00000						
67	26.37795	0.00000						
69	27.16535	0.00000						
71	27.95276	0.00000						
73	28.74016	0.00000						
75	29.52756	0.00000						
77	30.31496	0.00000						
			ΣΔ, in. (Uncorrected)		0.03			



Soil Type	qc/N, tsf	USCS
1	2.0	CL
2	3.5	ML, SM, SC
3	5.0	SW, SP, GW, GP
4	6.0	HWR
5	2.8	MH, CH

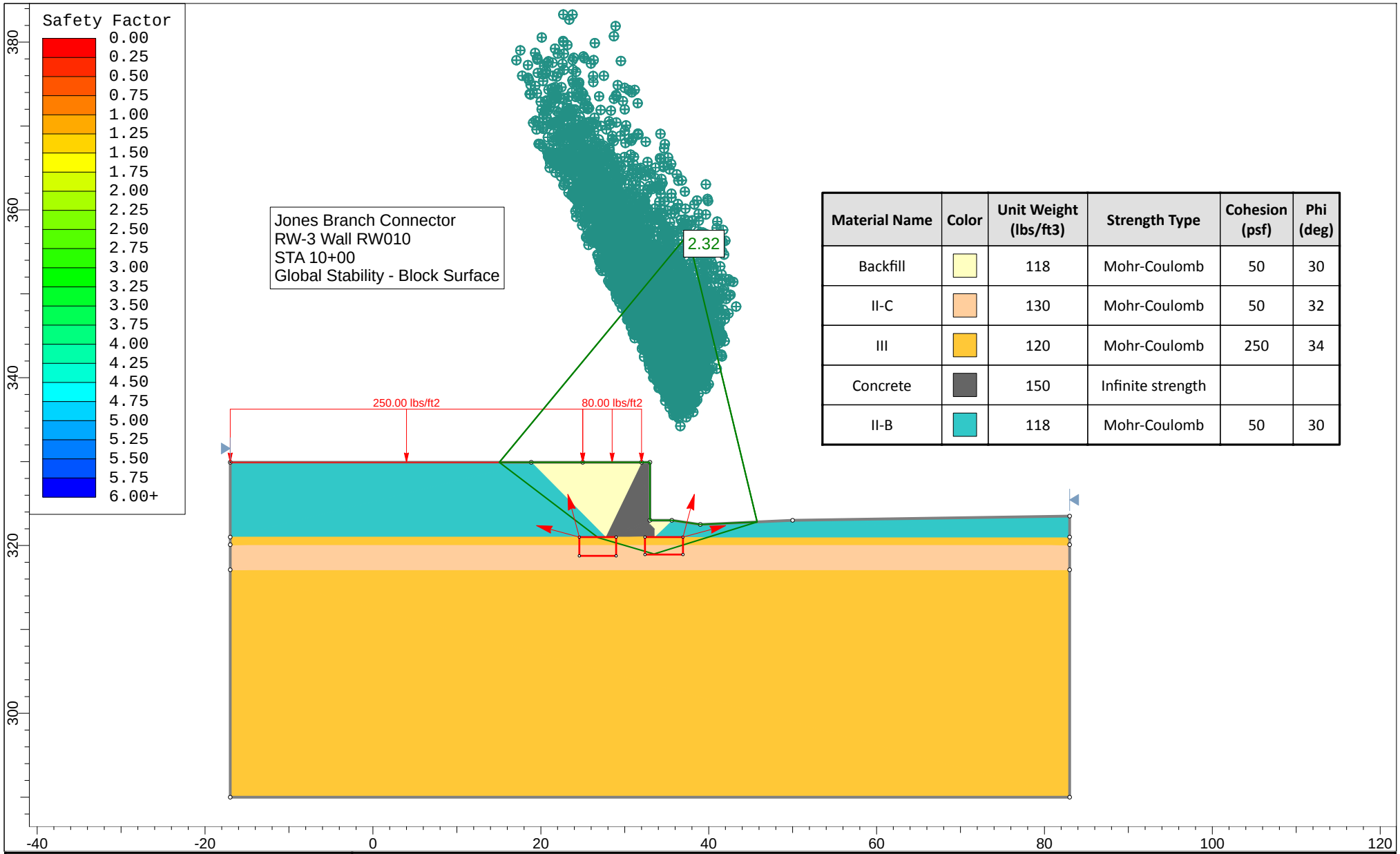
Es = qc/N * N * 2000 (psf)



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		
II-B		118	Mohr-Coulomb	50	30

Project	JBCONN RW-3 RW010		
Analysis Description	STA 10+00		
Drawn By	DJS3	Scale 1:181	Company ECS
Date	9/30/15		File Name RW010 RW3 STA 10+00_Frev.slim

SLIDEINTERPRET 6.036



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Backfill		118	Mohr-Coulomb	50	30
II-C		130	Mohr-Coulomb	50	32
III		120	Mohr-Coulomb	250	34
Concrete		150	Infinite strength		
II-B		118	Mohr-Coulomb	50	30

SLIDEINTERPRET 6.036

Project	JBCONN RW-3 RW010		
Analysis Description	STA 10+00		
Drawn By DJS3	*Scale* 1:190	*Company* ECS	
Date 9/30/15		*File Name* RW010 RW3 STA 10+00_Frev_Block.slim	

ECS MID-ATLANTIC, LLC. COMPUTATION SHEET	Page	1 of 1
	Made By	JCG
Determination of Values for ESAL Calculation	Date	2/9/2014
	Checked By	MAR
Location Jones Branch Connector — Enter Values in Blue	Date	2/12/2014

Red values are calculated

ESAL Factors	Asphalt	Concrete
Cars	0.0002	0.0003
Light Truks	0.46	0.59
Heavy Trucks	1.05	1.59
Buses	1.50	2.00

x	Asphalt Design	No. Lanes	Lane Factor
	Concrete Design	1	1.0
		2	0.9
4.56	Design CBR	3	0.7

Base Year	Base Year ADT[1]	Open to Traffic Year	Future Traffic Year	Future Traff. Year ADT[2]	Required Dgn. Years	Growth Rate %	Directional Distrib %	Percent Light Trucks	Percent Heavy Trucks	Percent Buses	No. Lanes Dgn. Dirtn.	ESALs
Jones Branch Connector												
	32371	2018	x= 33000/1.009665^2									
2020	33000	2018	2040	40000	30	0.9665						
2018	32371	2018	2040	40000	30	0.9665	50	0.6	0.6	0.3	2	2,531,520
Ramp I-495 SB Off Ramp from I-495 Express Lanes to JBC												
2018	8100	2018	2040	10125	30	1.0195	100	0.75		0.75	2	1,382,883
Ramp I-495 SB On Ramp to I-495 Express Lanes from JBC												
2018	3540	2018	2040	4425	30	1.0195	100	0.75		0.75	1	671,523
Ramp I-495 NB Off Ramp from I-495 Express Lanes to JBC												
2018	2820	2018	2040	3525	30	1.0195	100	0.75		0.75	2	481,448
Ramp I-495 NB On Ramp to I-495 Express Lanes from JBC												
2018	6540	2018	2040	8175	30	1.0195	100	0.75		0.75	2	1,116,550

Notes:

1. Base year traffic data was not provided, other than JBC, and is assumed to be 80% of year 2040.
2. Two-way traffic (unless a one-way direction)

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 1-Jones Branch Connector **Project No.** 21924

Location Tysons Corner **By:** MAR **Date:** 8/6/2014
Checked: JCG **Date:** 8/7/2014

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of ESALs

			ESAL Factor	
Traffic in Design Direction	16185.5	ADT		
Percent Cars	98.5	%	0.0002	
Percent Heavy Trucks	0.6	%	1.05	
Percent Light Trucks	0.6	%	0.46	
Percent Buses	0.3	%	1.50	
Growth Rate	0.9665	%		
Design Years	30	years	LDF	
No. Lanes per Direction	2		90	%
Cumulative EASLs			2,531,520	

Determination of Design CBR

Test No.	CBR Value	
1	8.0	Enter 2 or more values
2	7.0	
3	6.3	
4	4.7	
5	8.0	
6		
7		
8		
9		
10		
11		
12		
Mean	6.80	
Cv	0.20	
Design CBR	4.56	

Determination of S_N

Enter Yes for in Box for Appropriate Classification

Highway Classification	Urban	Rural	Reliability	Serv. Init.	Serv. Term.
Interstate					
Divided Primary Route	Yes		90	4.2	2.9
Undivided Primary Route					
High-Volume Secondary Route					
Farm to Market Secondary Route					
Residential/Subdivision Street					

Enter Sand, ML, or CL

Soil Type	ML
Mr	6,834
Standard Deviation	0.49
Drainage Coefficient	1.0

std dev	reliability	S_N	psi
0.49	90	4.58	1.3

eq. hidden

To Determine S_N
Click Tools
Click Goal Seek

Set Cell to:	A47
To Value:	6.40338
By Changing Cell:	C45

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 1-Jones Branch Connector **Project No.** 21924

Location Tysons Corner **By:** JCG **Date:** 8/6/2014

Checked: JCG **Date:** 8/7/2014

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	1.50	0.44	0.66
Intermediate Mix Asphalt	IM-19.0	2.00	0.44	0.88
Base Mix Asphalt	BM-25.0	7.00	0.44	3.08
Graded Aggregate Base	21B	6.00	0.12	0.72
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	5.34
			Required S_N	4.58
			OK?	OK

Enter Type

		Min. Thickness, in
Asphalt Surface Mix	SM-9.0	0.75
Asphalt Surface Mix	SM-9.5	1.25
Asphalt Surface Mix	SM-12.5	1.50
Asphalt Surface Mix	SMA-9.5	1.25
Asphalt Surface Mix	SMA-12.5	1.50
Asphalt Surface Mix	SMA-19.0	2.00
Asphalt Intermediate Mix	IM-19.0	2.00
Asphalt Base Mix	BM-25.0	2.50
Asphalt Base Mix	BM-37.5	3.00
Graded Aggreg Base	21A	4.00
Graded Aggreg Base	21B	4.00
Cement-Treated Aggregate	CTA	6.00
Soil Cement	SC	6.00
Lime-Treated Soil	LTC	6.00
Open Graded Drainage Layer	OGDL	4.00
Gravel	GV	4.00

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project	**2-495 SB Off Ramp from EL to JBC**	**Project No.**	**21924**
Location	**Tysons Corner**	**By:**	**DJS3**
		Date:	3/14/2016
		Checked:	**MAR**
		Date:	3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of ESALs

			ESAL Factor	
Traffic in Design Direction	**8100**	ADT		
Percent Cars	**98.5**	%	0.0002	
Percent Heavy Trucks	**0**	%	1.05	
Percent Light Trucks	**0.75**	%	0.46	
Percent Buses	**0.75**	%	1.50	
Growth Rate	**1.0195**	%		
Design Years	**30**	years	LDF	
No. Lanes per Direction	**2**		90	%
Cumulative EASLs			**1,382,893**	

Determination of Design CBR

Test No.	CBR Value	
1	**8.0**	Enter 2 or more values
2	**7.0**	
3	**6.3**	
4	**4.7**	
5	**8.0**	
6		
7		
8		
9		
10		
11		
12		
Mean	6.80	
Cv	0.20	
Design CBR	**4.56**	

Determination of S_N

Enter Yes for in Box for Appropriate Classification

Highway Classification	Urban	Rural	Reliability	Serv. Init.	Serv. Term.
Interstate	**Yes**		95	4.2	3
Divided Primary Route					
Undivided Primary Route					
High-Volume Secondary Route					
Farm to Market Secondary Route					
Residential/Subdivision Street					

Enter Sand, ML, or CL

Soil Type	**ML**
Mr	6,834
Standard Deviation	0.49
Drainage Coefficient	1.0

std dev	reliability	S_N	psi
0.49	95	**4.54**	1.2

eq. hidden

To Determine S_N

Click Tools

Click Goal Seek

Set Cell to:	A47
To Value:	6.14079
By Changing Cell:	C45

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 2-495 SB Off Ramp from EL to JBC **Project No.** 21924

Location Tysons Corner **By:** DJS3 **Date:** 3/14/2016

Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	1.50	0.44	0.66
Intermediate Mix Asphalt	IM-19.0	2.50	0.44	1.10
Base Mix Asphalt	BM-25.0	10.00	0.44	4.40
Graded Aggregate Base	21B	6.00	0.12	0.72
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	6.88
			Required S_N	4.54
			OK?	OK

Enter Type

		Min. Thickness, in
Asphalt Surface Mix	SM-9.0	0.75
Asphalt Surface Mix	SM-9.5	1.25
Asphalt Surface Mix	SM-12.5	1.50
Asphalt Surface Mix	SMA-9.5	1.25
Asphalt Surface Mix	SMA-12.5	1.50
Asphalt Surface Mix	SMA-19.0	2.00
Asphalt Intermediate Mix	IM-19.0	2.00
Asphalt Base Mix	BM-25.0	2.50
Asphalt Base Mix	BM-37.5	3.00
Graded Aggreg Base	21A	4.00
Graded Aggreg Base	21B	4.00
Cement-Treated Aggregate	CTA	6.00
Soil Cement	SC	6.00
Lime-Treated Soil	LTC	6.00
Open Graded Drainage Layer	OGDL	4.00
Gravel	GV	4.00

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 3-495 SB On Ramp from EL from JBC **Project No.** 21924

Location Tysons Corner **By:** DJS3 **Date:** 3/14/2016

Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of ESALs

			ESAL Factor	
Traffic in Design Direction	3540	ADT		
Percent Cars	98.5	%	0.0002	
Percent Heavy Trucks	0	%	1.05	
Percent Light Trucks	0.75	%	0.46	
Percent Buses	0.75	%	1.50	
Growth Rate	1.0195	%		
Design Years	30	years	LDF	
No. Lanes per Direction	1		100	%
Cumulative EASLs			671,528	

Determination of Design CBR

Test No.	CBR Value	
1	8.0	Enter 2 or more values
2	7.0	
3	6.3	
4	4.7	
5	8.0	
6		
7		
8		
9		
10		
11		
12		
Mean	6.80	
Cv	0.20	
Design CBR	4.56	

Determination of S_N

Enter Yes for in Box for Appropriate Classification

Highway Classification	Urban	Rural	Reliability	Serv. Init.	Serv. Term.
Interstate	Yes		95	4.2	3
Divided Primary Route					
Undivided Primary Route					
High-Volume Secondary Route					
Farm to Market Secondary Route					
Residential/Subdivision Street					

Enter Sand, ML, or CL

Soil Type	ML
Mr	6,834
Standard Deviation	0.49
Drainage Coefficient	1.0

std dev	reliability	S_N	psi
0.49	95	4.00	1.2

eq. hidden

To Determine S_N

Click Tools

Click Goal Seek

Set Cell to:	A47
To Value:	5.82706
By Changing Cell:	C45

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 3-495 SB On Ramp from EL from JBC **Project No.** 21924

Location Tysons Corner **By:** DJS3 **Date:** 3/14/2016
Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	1.50	0.44	0.66
Intermediate Mix Asphalt	IM-19.0	2.50	0.44	1.10
Base Mix Asphalt	BM-25.0	10.00	0.44	4.40
Graded Aggregate Base	21B	6.00	0.12	0.72
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	6.88
			Required S_N	4.00
			OK?	OK

Enter Type

		Min. Thickness, in
Asphalt Surface Mix	SM-9.0	0.75
Asphalt Surface Mix	SM-9.5	1.25
Asphalt Surface Mix	SM-12.5	1.50
Asphalt Surface Mix	SMA-9.5	1.25
Asphalt Surface Mix	SMA-12.5	1.50
Asphalt Surface Mix	SMA-19.0	2.00
Asphalt Intermediate Mix	IM-19.0	2.00
Asphalt Base Mix	BM-25.0	2.50
Asphalt Base Mix	BM-37.5	3.00
Graded Aggreg Base	21A	4.00
Graded Aggreg Base	21B	4.00
Cement-Treated Aggregate	CTA	6.00
Soil Cement	SC	6.00
Lime-Treated Soil	LTC	6.00
Open Graded Drainage Layer	OGDL	4.00
Gravel	GV	4.00

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project	**4-495 NB Off Ramp from EL to JBC**	**Project No.**	**21924**
Location	**Tysons Corner**	**By:**	**DJS3**
		Date:	3/14/2016
		Checked:	**MAR**
		Date:	3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of ESALs

			ESAL Factor	
Traffic in Design Direction	**2820**	ADT		
Percent Cars	**98.5**	%	0.0002	
Percent Heavy Trucks	**0**	%	1.05	
Percent Light Trucks	**0.75**	%	0.46	
Percent Buses	**0.75**	%	1.50	
Growth Rate	**1.0195**	%		
Design Years	**30**	years	LDF	
No. Lanes per Direction	**2**		90	%
Cumulative EASLs			**481,452**	

Determination of Design CBR

Test No.	CBR Value	
1	**8.0**	Enter 2 or more values
2	**7.0**	
3	**6.3**	
4	**4.7**	
5	**8.0**	
6		
7		
8		
9		
10		
11		
12		
Mean	6.80	
Cv	0.20	
Design CBR	**4.56**	

Determination of S_N

Enter Yes for in Box for Appropriate Classification

Highway Classification	Urban	Rural	Reliability	Serv. Init.	Serv. Term.
Interstate	**Yes**		95	4.2	3
Divided Primary Route					
Undivided Primary Route					
High-Volume Secondary Route					
Farm to Market Secondary Route					
Residential/Subdivision Street					

Enter Sand, ML, or CL

Soil Type	**ML**
Mr	6,834
Standard Deviation	0.49
Drainage Coefficient	1.0

std dev	reliability	S_N	psi
0.49	95	**3.76**	1.2

To Determine S_N

Click Tools	
Click Goal Seek	
Set Cell to:	A47
To Value:	5.68255
By Changing Cell:	C45

[ ] eq. hidden

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 4-495 NB Off Ramp from EL to JBC **Project No.** 21924

Location Tysons Corner **By:** DJS3 **Date:** 3/14/2016
Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	1.50	0.44	0.66
Intermediate Mix Asphalt	IM-19.0	2.50	0.44	1.10
Base Mix Asphalt	BM-25.0	10.00	0.44	4.40
Graded Aggregate Base	21B	6.00	0.12	0.72
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	6.88
			Required S_N	3.76
			OK?	OK

Enter Type

		Min. Thickness, in
Asphalt Surface Mix	SM-9.0	0.75
Asphalt Surface Mix	SM-9.5	1.25
Asphalt Surface Mix	SM-12.5	1.50
Asphalt Surface Mix	SMA-9.5	1.25
Asphalt Surface Mix	SMA-12.5	1.50
Asphalt Surface Mix	SMA-19.0	2.00
Asphalt Intermediate Mix	IM-19.0	2.00
Asphalt Base Mix	BM-25.0	2.50
Asphalt Base Mix	BM-37.5	3.00
Graded Aggreg Base	21A	4.00
Graded Aggreg Base	21B	4.00
Cement-Treated Aggregate	CTA	6.00
Soil Cement	SC	6.00
Lime-Treated Soil	LTC	6.00
Open Graded Drainage Layer	OGDL	4.00
Gravel	GV	4.00

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project	**5-495 NB On to EL to JBC**	**Project No.**	**21924**
Location	**Tysons Corner**	**By:**	**DJS3**
		Date:	3/14/2016
		Checked:	**MAR**
		Date:	3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of ESALs

			ESAL Factor	
Traffic in Design Direction	**6540**	ADT		
Percent Cars	**98.5**	%	0.0002	
Percent Heavy Trucks	**0**	%	1.05	
Percent Light Trucks	**0.75**	%	0.46	
Percent Buses	**0.75**	%	1.50	
Growth Rate	**1.0195**	%		
Design Years	**30**	years	LDF	
No. Lanes per Direction	**2**		90	%
Cumulative EASLs			**1,116,558**	

Determination of Design CBR

Test No.	CBR Value	
1	**8.0**	Enter 2 or more values
2	**7.0**	
3	**6.3**	
4	**4.7**	
5	**8.0**	
6		
7		
8		
9		
10		
11		
12		
Mean	6.80	
Cv	0.20	
Design CBR	**4.56**	

Determination of S_N

Enter Yes for in Box for Appropriate Classification

Highway Classification	Urban	Rural	Reliability	Serv. Init.	Serv. Term.
Interstate	**Yes**		95	4.2	3
Divided Primary Route					
Undivided Primary Route					
High-Volume Secondary Route					
Farm to Market Secondary Route					
Residential/Subdivision Street					

Enter Sand, ML, or CL

Soil Type	**ML**
Mr	6,834
Standard Deviation	0.49
Drainage Coefficient	1.0

std dev	reliability	S_N	psi
0.49	95	**4.38**	1.2

eq. hidden

To Determine S_N

Click Tools

Click Goal Seek

Set Cell to:	A47
To Value:	6.04788
By Changing Cell:	C45

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project 5-495 NB On to EL to JBC **Project No.** 21924

Location Tysons Corner **By:** DJS3 **Date:** 3/14/2016

Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	1.50	0.44	0.66
Intermediate Mix Asphalt	IM-19.0	2.50	0.44	1.10
Base Mix Asphalt	BM-25.0	10.00	0.44	4.40
Graded Aggregate Base	21B	6.00	0.12	0.72
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	6.88
			Required S_N	4.38
			OK?	OK

Enter Type

		Min. Thickness, in
Asphalt Surface Mix	SM-9.0	0.75
Asphalt Surface Mix	SM-9.5	1.25
Asphalt Surface Mix	SM-12.5	1.50
Asphalt Surface Mix	SMA-9.5	1.25
Asphalt Surface Mix	SMA-12.5	1.50
Asphalt Surface Mix	SMA-19.0	2.00
Asphalt Intermediate Mix	IM-19.0	2.00
Asphalt Base Mix	BM-25.0	2.50
Asphalt Base Mix	BM-37.5	3.00
Graded Aggreg Base	21A	4.00
Graded Aggreg Base	21B	4.00
Cement-Treated Aggregate	CTA	6.00
Soil Cement	SC	6.00
Lime-Treated Soil	LTC	6.00
Open Graded Drainage Layer	OGDL	4.00
Gravel	GV	4.00

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project JBCONN **Project No.** 01:21924

Location Capital One Dr./Gates of McLean Access Rd. **By:** DJS3 **Date:** 3/14/2016
Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	2.00	0.44	0.88
Intermediate Mix Asphalt	BM-25.0	4.00	0.44	1.76
Base Mix Asphalt	CTA	8.00	0.20	1.60
Graded Aggregate Base				
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	4.24

Enter Type

		Min. Thickness, in
Asphalt Surface Mix	SM-9.0	0.75
Asphalt Surface Mix	SM-9.5	1.25
Asphalt Surface Mix	SM-12.5	1.50
Asphalt Surface Mix	SMA-9.5	1.25
Asphalt Surface Mix	SMA-12.5	1.50
Asphalt Surface Mix	SMA-19.0	2.00
Asphalt Intermediate Mix	IM-19.0	2.00
Asphalt Base Mix	BM-25.0	2.50
Asphalt Base Mix	BM-37.5	3.00
Graded Aggreg Base	21A	4.00
Graded Aggreg Base	21B	4.00
Cement-Treated Aggregate	CTA	6.00
Soil Cement	SC	6.00
Lime-Treated Soil	LTC	6.00
Open Graded Drainage Layer	OGDL	4.00
Gravel	GV	4.00

Note: Per MOI, BM-25.0 coef = 0.44 (formerly 0.40)

1993 AASHTO PAVEMENT DESIGN METHOD - VDOT MODIFIED 2003

Project JBCONN **Project No.** 01:21924

Location Gates of McLean **By:** DJS3 **Date:** 3/14/2016

Checked: MAR **Date:** 3/14/2016

Enter Input Values in Blue. **Calculated Values Are Noted in Red.**

Determination of Pavement Section

Layer	Type	Thickness, in	Coef.	S_N
Surface Mix Asphalt	SM-9.5	1.50	0.44	0.66
Intermediate Mix Asphalt	BM-25.0	2.50	0.44	1.10
Base Mix Asphalt	21A	6.00	0.12	0.72
Graded Aggregate Base				
CTA or Lime-Treated Soil				
Other				
Other				
			ΣS_N	2.48

Enter Type

		Min. Thickness, in	
Asphalt Surface Mix	SM-9.0	0.75	
Asphalt Surface Mix	SM-9.5	1.25	(SM-2 Historic Designation)
Asphalt Surface Mix	SM-12.5	1.50	(SM-2 Historic Designation)
Asphalt Surface Mix	SMA-9.5	1.25	
Asphalt Surface Mix	SMA-12.5	1.50	
Asphalt Surface Mix	SMA-19.0	2.00	
Asphalt Intermediate Mix	IM-19.0	2.00	
Asphalt Base Mix	BM-25.0	2.50	(BM-2 Historic Designation)
Asphalt Base Mix	BM-37.5	3.00	
Graded Aggreg Base	21A	4.00	
Graded Aggreg Base	21B	4.00	
Cement-Treated Aggregate	CTA	6.00	
Soil Cement	SC	6.00	
Lime-Treated Soil	LTC	6.00	
Open Graded Drainage Layer	OGDL	4.00	
Gravel	GV	4.00	

Note: Per MOI, BM-25.0 coef = 0.44 (formerly 0.40)