AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Mark Sargent, Structures Project Manager

LAR CCB

From: Laura Ripley, E.I., Geotechnical Engineer via Christopher C. Benda, P.E., Soils and Foundations Engineer

Date: January 28th, 2013

Subject: Irasburg STP CULV(30) – Geotechnical Recommendations

1.0 INTRODUCTION

We have completed our geological and geotechnical investigation for the proposed project on VT Route 58 in Irasburg, VT; containing both Bridge No. 6 and Bridge No. 7. It was requested by the Structures Section to assess the precast box culvert and wingwall for geotechnical feasibility, as the project is currently in the alternative evaluation phase. Contained herin are the results of our geotechnical analysis and design recommendations as determined, according to 2012 AASHTO LRFD Bridge Design Specifications.

2.0 FIELD INVESTIGATION

The field investigation was conducted between October 9th and October 12th, 2012. Two standard penetration borings were drilled at each bridge location to determine the subsurface profile in order to aid in design and construction. The samples were sent to GeoTesting Express of Acton, MA to complete the testing, while the State Soils Laboratory was temporarily decommissioned for a facility relocation. A summary of the boring location and ground surface elevations can be found in Table 2.1. The values for Northings and Eastings are based on the Vermont State Plane Grid Coordinate System NAD 83.

Table 2.1 Boring Locations and Elevations

Boring Number	Substructure	Easting (ft)	Northing(ft)	Invert Elevation (ft)
B-101	Br. 6 – NW- Inlet	1691783.85	843693.56	837.0
B-102	Br. 6 – SE - Outlet	1691807.52	843671.01	837.0
B-103	Br. 7 – NW - Outlet	1699907.54	840357.40	792.0
B-104	Br. 7 – SE - Inlet	1699936.75	840341.66	792.0

During the boring operations, split spoon samples and SPT tests were taken at five foot intervals to a depth of 15 feet and then continuously for another 30 to 35 feet for the all borings. Where cohesive soils were identified in the field, undisturbed Shelby Tube samples were retrieved in order to properly assess the soil properties. Bedrock was not encountered in any of the borings. For each boring, soil samples were visually identified in and SPT blow counts were recorded on the boring logs.

3.0 FIELD AND LABORATORY TESTING

The standard penetration resistance of the in-situ soil is determined by the number of blows required to drive a 2 inch OD split barrel sampler into the soil with a 140 pound hammer dropped from a height of 30 inches, in accordance with procedures specified in AASHTO T206. During the standard penetration test (SPT), the sampler is driven for a total length of 2 feet, while counting the blows for each 6 inch increment. The SPT N-value, which is defined as the sum of the number of blows required to drive the sampler through the second and third increments, is commonly used with established correlations to estimate a number of soil parameters, particularly the shear strength and density of cohesionless soils. The N-values provided on the boring logs are raw values and have not been corrected for energy, borehole diameter, rod length or overburden pressure. The VT Agency of Transportation has determined a hammer correction value, C_E, to account for the efficiency of the SPT hammer on the drill rig. For this project a CME 45C Skid Rig was used, with a hammer energy correction factor of 1.33. This value, included on the boring logs, was used in calculations to determine soil parameters. Laboratory tests were conducted on all samples to evaluate grain size, moisture content, and percent finer than No. 200 sieve. This testing was conducted on all of the soil samples and results can be found on the attached boring logs.

4.0 SOIL PROFILE

Review of the SPT results, lab data, and borings revealed the following information pertaining to the soil strata at the location of the proposed bridge locations:

4.1 Bridge No. 6 NW Inlet (B-101)

The ground surface elevation was noted in the field at approximately EL 832, and the groundwater level was not recorded. Bedrock was not encountered during boring operations.

Depth (below GSE)	Soil Type
0.0 – 27.0 feet	Medium Dense Gravelly Silty Sand
27.0 – 37.0 feet	Loose Silt
37.0 – 50.0 feet	Soft Silty Clay

4.2 Bridge No. 6 SE Outlet (B-102)

The ground surface elevation was noted in the field at approximately EL 832, and the groundwater level was not recorded. Bedrock was not encountered during boring operations.

Depth (below GSE)	Soil Type
0.0 – 29.0 feet	Loose Gravelly Silty Sand
29.0 – 50.0 feet	Medium Dense Silty Clay

4.3 Bridge No. 7 NW Outlet (B-103)

The ground surface elevation was noted in the field at approximately EL 787, and the groundwater level was not recorded. Bedrock was not encountered during boring operations.

Depth (below GSE)	Soil Type
0.0 – 13.0 feet	Medium Dense Gravelly Sand
13.0 – 34.0 feet	Very Loose Clayey Silt
34.0 – 45.0 feet	Medium Dense Gravelly Sand

4.4 Bridge No. 7 SE Inlet (B-104)

The ground surface elevation was noted in the field at approximately EL 787, and the groundwater level was not recorded. Bedrock was not encountered during boring operations.

Depth (below GSE)	Soil Type
0.0 – 16.0 feet	Medium Dense Silty Gravelly Sand
16.0 – 29.0 feet	Very Loose Clayey Silt
29.0 – 44.4 feet	Medium Dense Silty Sand

Due to same day drilling mobilization and demobilization for each hole, no groundwater measurements were taken. As a result, it was assumed the water level in the stream was equal to the water table used in analysis.

5.0 ANALYSIS

5.1 Shallow Foundation Analysis

AASHTO's LRFD Bridge Design Specifications Manual (2012) was used as the reference for settlement and bearing resistance equations. Section 10.6.3.1.2 contains the equation used for bearing resistance. Neither depth nor load inclination factors were used in analysis as they were not considered pertinent. Hough's Method, used to calculate settlement in normally consolidated cohesionless soils, is found in section 10.6.2.4.2. The specifics for the inlet/outlet and wingwalls follow this section.

The groundwater surface elevation was not determined during field investigations. The elevation was assumed to be located at the existing stream level in both cases. As per section 10.5.5.1 of the 2012 AASHTO LRFD Bridge Design Specifications, a resistance factor of 1.0 should be applied to the unfactored bearing resistance for use in service limit state design. Service limit state designs include, but are not limited to, settlement and scour. Section 10.5.5.2.2 specifies that a resistance factor of 0.45 should be applied to the unfactored bearing resistance for use in strength limit state design for spread footings on rock and soil.

Strength limit state design includes, but is not limited to, checks for bearing resistance, sliding and constructability. Potential for overturning is limited by controlling the location of the resultant of the reaction forces (eccentricity). Eccentricity, e, shall be limited as follows:

Foundations on soil: $|e| < b/4$
Foundations on rock: $|e| < 3b/8$

Eccentricity should be considered for settlement and bearing resistance design of spread footings by using effective footing widths based on AASHTO Section 10.6.1.3. All footing widths presented in this report are effective footing widths.

5.2 Inlet and Outlet

The culvert inlet and outlet were assessed based upon existing conditions and assumed design dimensions for the preliminary analysis.

5.2.1 Bridge No. 6

Based on the profile and empirical relationships with SPT values from the silt bearing stratum, it was determined the soil had a friction angle (φ) of 30° and a density (γ) of 95 lbs/ft^3. One conservative soil profile was used throughout the analysis, due to the similarity of composition and blow counts recorded in the field for Boring B-101 and B-102. Dimensions for embedment and box width were assumed based upon existing conditions, and should they alter greatly further analysis should be conducted. For a box with a nominal width of 8 feet (96 in) the maximum factored bearing resistance calculated for an embedment of 15 feet will be sufficient to account for factored bearing pressures up to 10 ksf.

Found in Figure 5.1 are the settlement values for a footing width of 8 feet. Due to the granular nature of the soils, settlement is expected to occur during or immediately after construction.

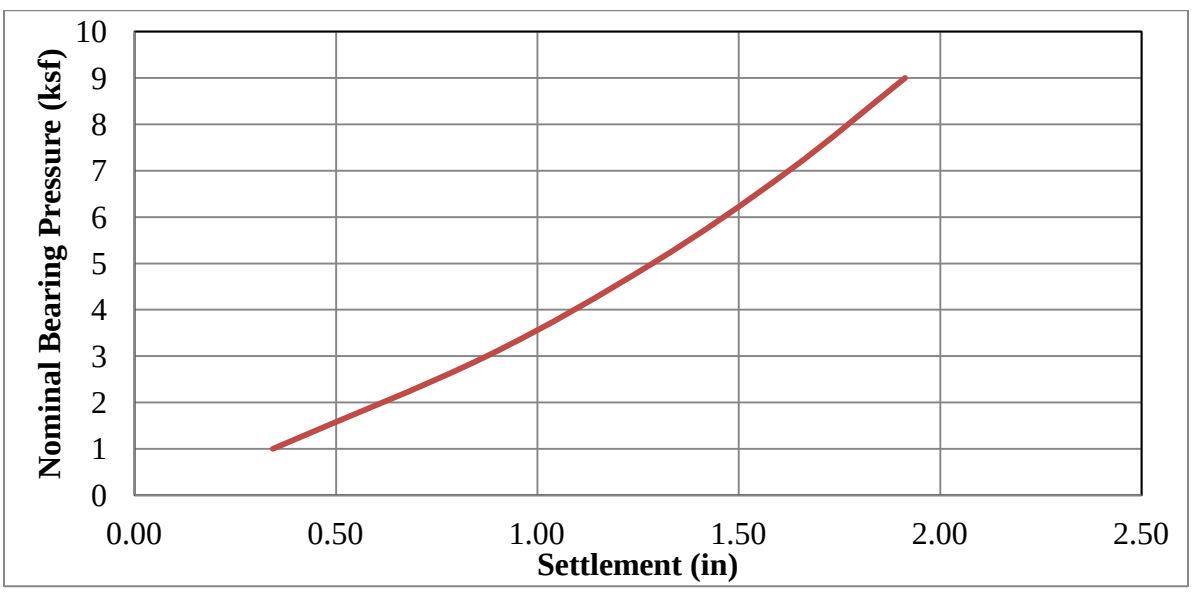


Figure 5.1. Settlement vs. Nominal Bearing Pressure for Br. 6 Inlet and Outlet

5.2.2 Bridge No. 7

Based on the profile and empirical relationships with SPT values from the clayey silt bearing stratum, it was determined the soil had a friction angle (φ) of 28° and a density (γ) of 96 lbs/ft^3. One conservative soil profile was used throughout the analysis, due to the similarity of composition and blow counts recorded in the field for Borings B-103 and B-104. Dimensions for embedment and box width were assumed based upon existing conditions, and should they alter greatly, further analysis should be conducted. For a box with a nominal width of 8 feet (96 in) the maximum factored bearing resistance calculated for an embedment of 16 feet will be sufficient to account for factored bearing pressures up to 10 ksf.

Found in Figure 5.2 are the settlement values for a footing width of 8 feet. Due to the granular nature of the soils, settlement is expected to occur during or immediately after construction.

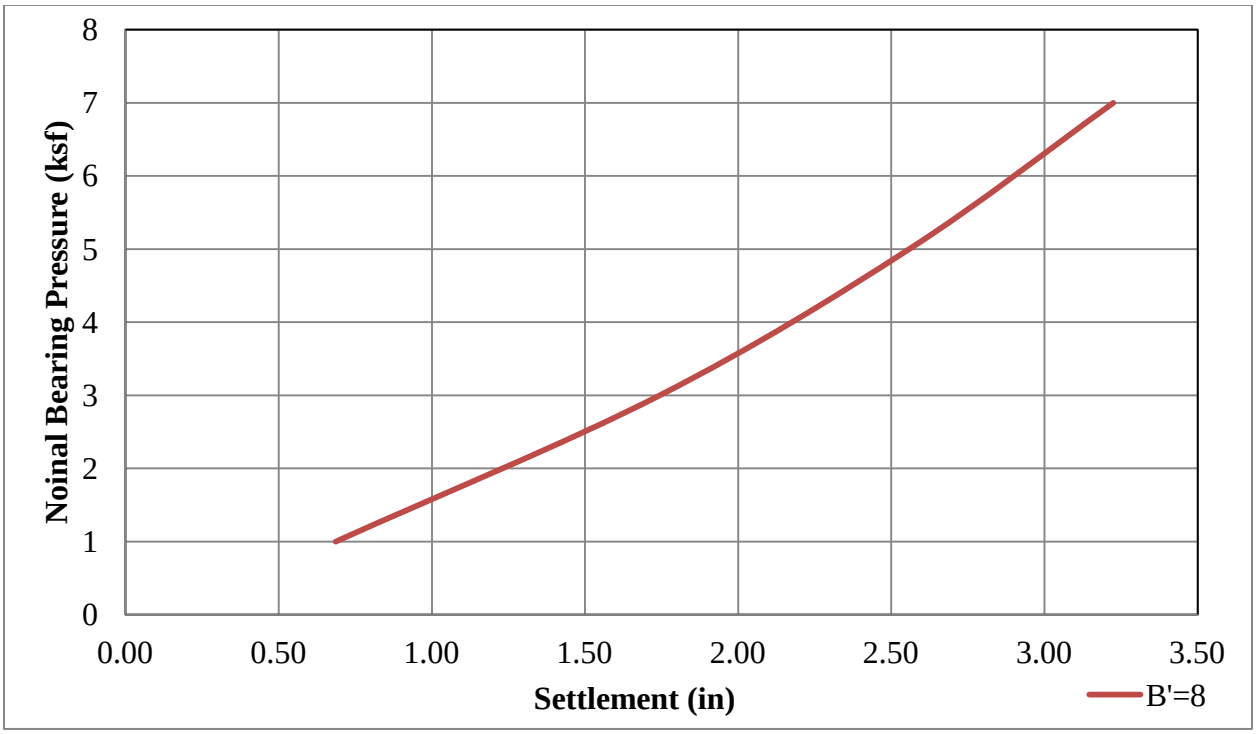


Figure 5.2. Settlement vs. Nominal Bearing Pressure for Br. 7 Inlet and Outlet

5.3 Wingwalls

The wingwalls were assumed to have a length of 15 feet for the preliminary analysis. The same soil profiles that were assumed in the inlet and outlet analysis were used here, in order to ensure consistency between both analyses. The embedment was assumed to be a value of 4 feet below the bottom of the box. Figures 5.3 and 5.6 display the minimum effective footing width per maximum bearing resistance, factored due to LRFD strength and service limit states for Bridge No. 6 and No. 7, respectively.

5.3.1 Bridge No. 6

For effective footing widths of 4, 6, and 8 feet, the maximum factored bearing resistances for the strength or service limit states are 1.9, 2.6, and 3.3 ksf, respectively.

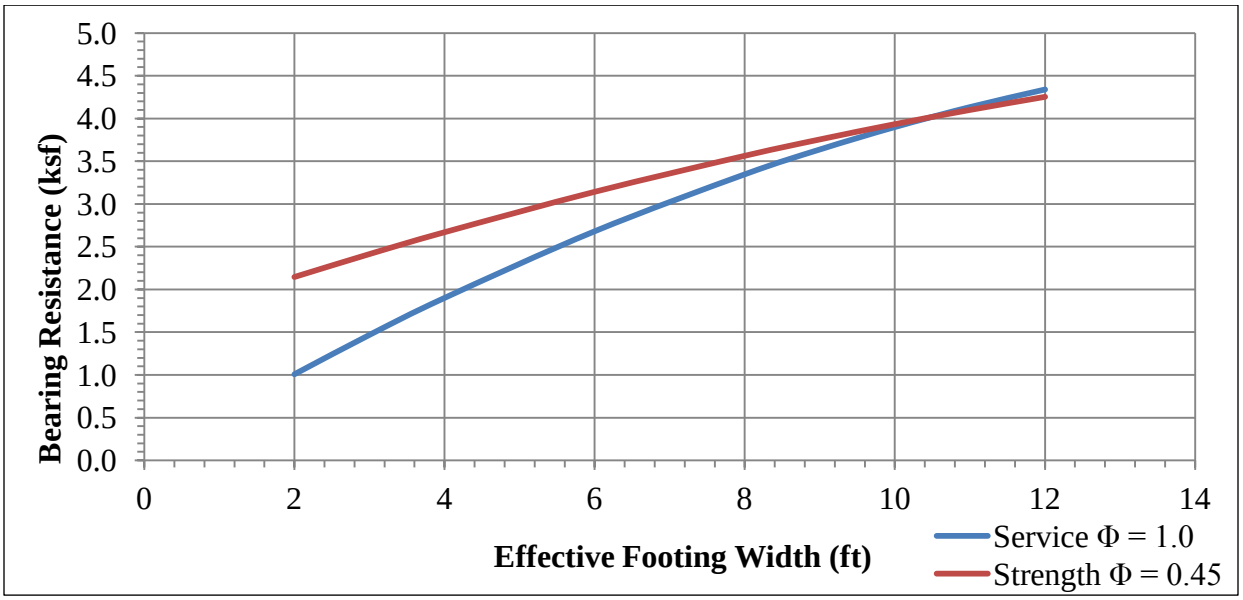


Figure 5.3. *Effective* Footing Width vs. Bearing Resistance for Br. 6 Wingwalls

Soil settlement values were calculated for various footing widths based on the nominal bearing pressure. Found in Figure 5.4 are the settlement values for effective footing widths of 2 to 10 feet for the wingwalls. Due to the granular nature of the foundation soils, settlement is expected to occur during or immediately after construction. Figure 5.5 displays the bearing pressure expected for various effective footing widths based on 1-inch of settlement.

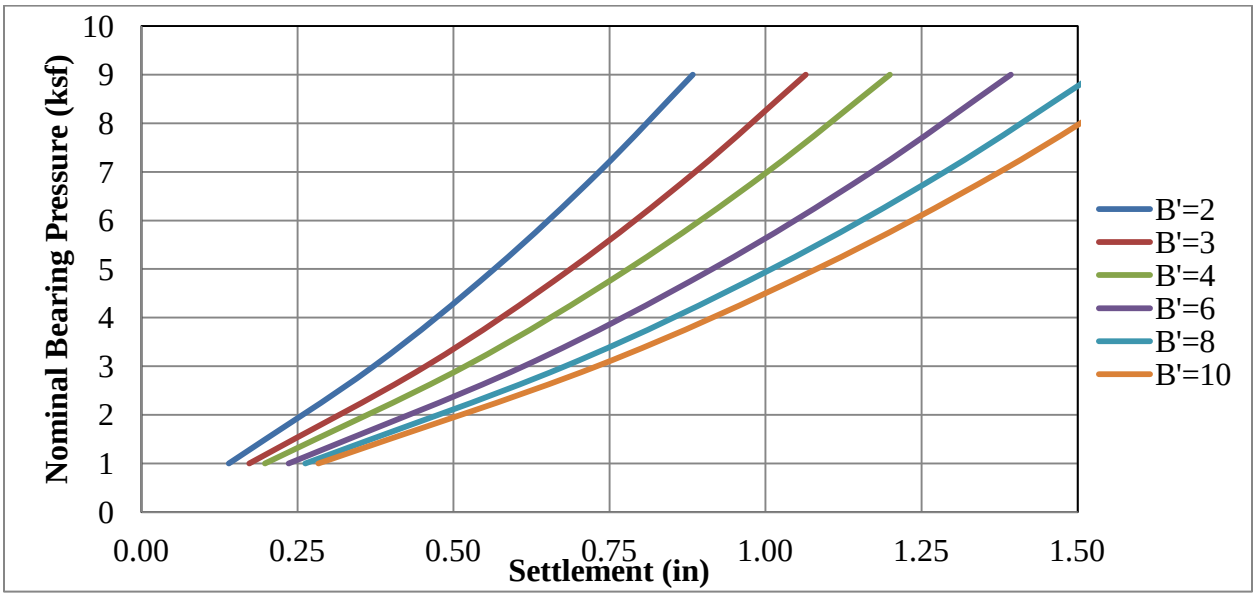


Figure 5.4. Settlement vs. Nominal Bearing Pressure for Br. 6 Wingwalls

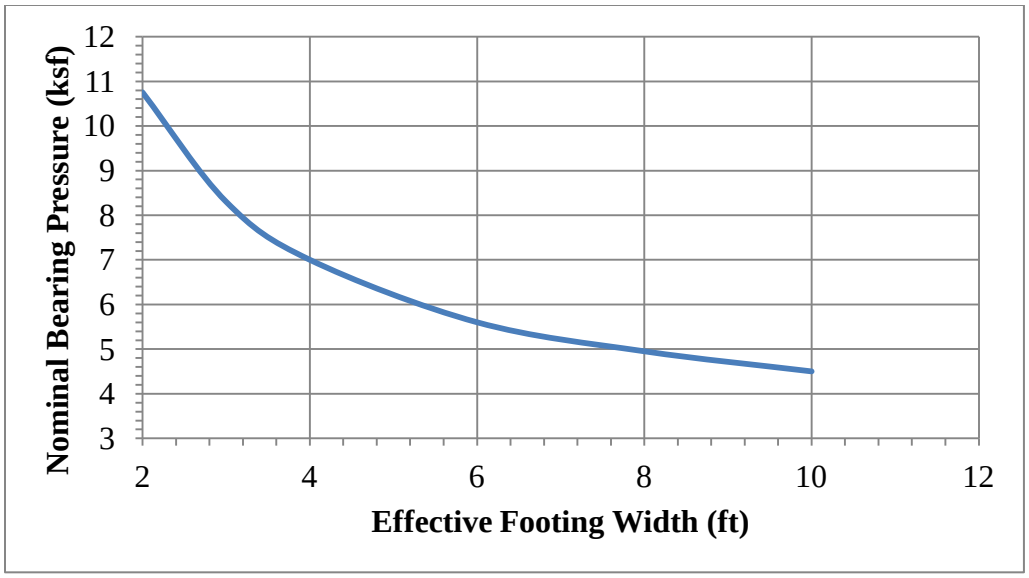


Figure 5.5. Br. 6 Nominal Bearing Pressure vs. *Effective* Footing Width for 1-inch of Settlement

5.3.2 Bridge No. 7

For effective footing widths of 4, 6, and 8 feet, the maximum factored bearing resistances for the strength or service limit states are 1.4, 2.0, and 2.5 ksf, respectively.

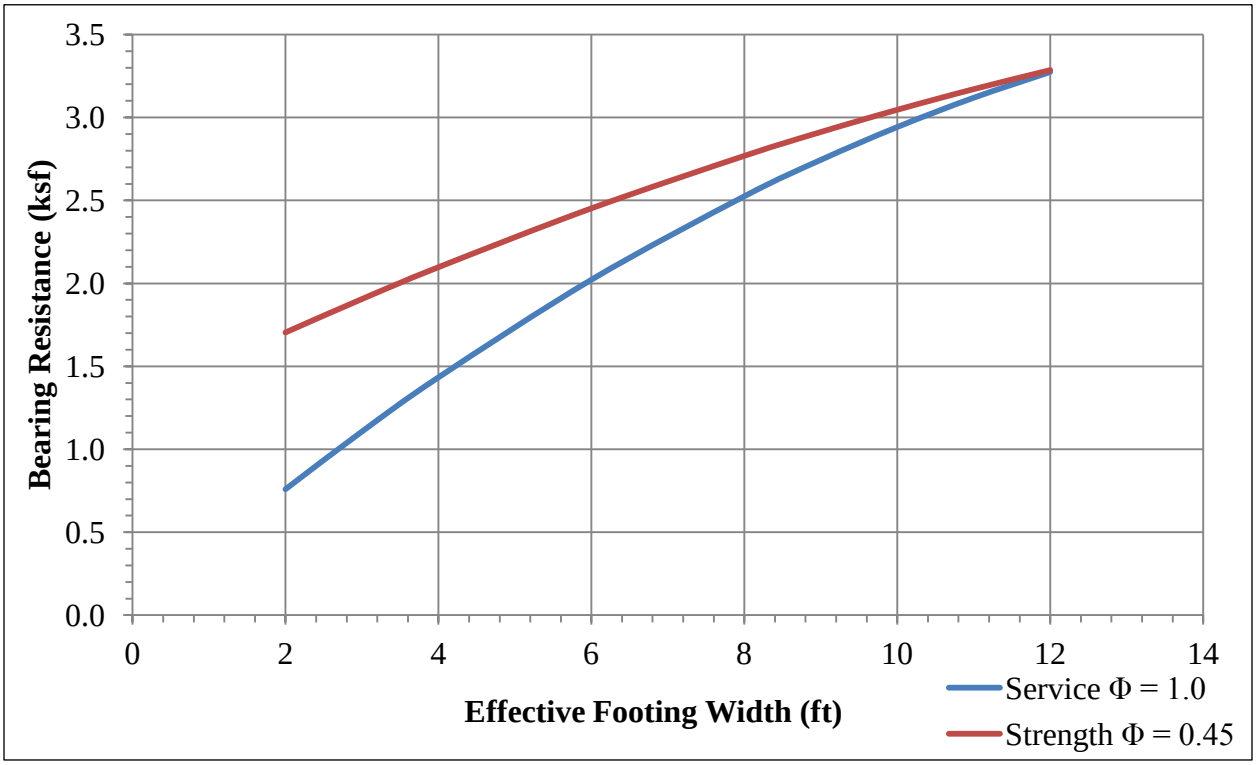


Figure 5.6. *Effective* Footing Width vs. Bearing Resistance for Br. 7 Wingwalls

Soil settlement values were calculated for various footing widths based on the nominal bearing pressure. Found in Figure 5.7 are the settlement values for effective footing widths of 2 to 10 feet for the wingwalls. Due to the granular nature of the foundation soils, settlement is expected to occur during or immediately after construction. Figure 5.8 displays the bearing pressure expected for various effective footing widths based on 1-inch of settlement.

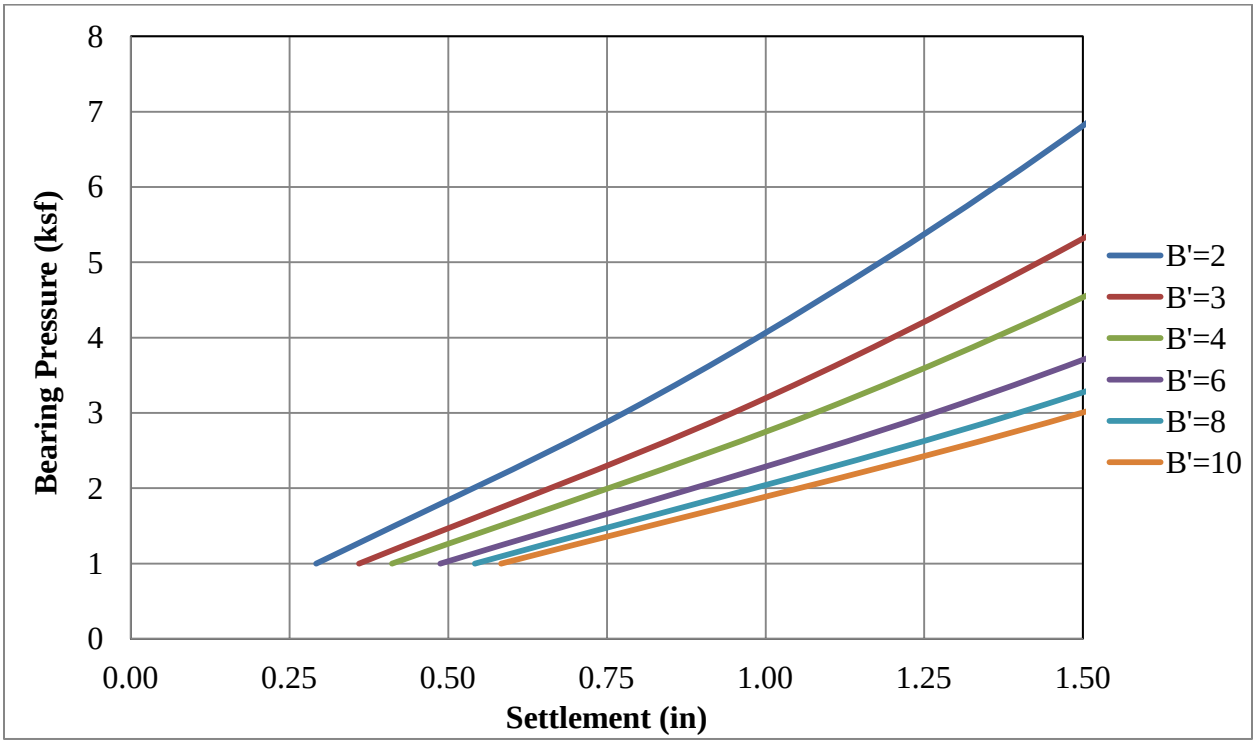


Figure 5.7. Settlement vs. Nominal Bearing Pressure for Br. 7 Wingwalls

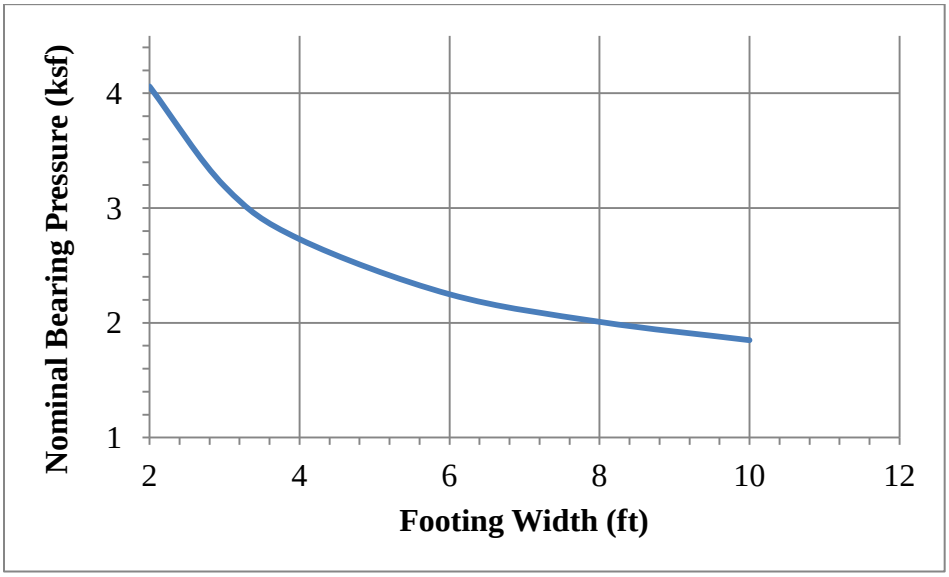


Figure 5.8. Br. 7 Nominal Bearing Pressure vs. *Effective* Footing Width for 1-inch of Settlement

6.0 RECOMMENDATIONS

Shallow foundations appear to be feasible at both Bridge No. 6 and No. 7. Layers of soft or loose material were encountered under the wingwall footings below 27 feet on Bridge No. 6 and from 13 to 34 feet on Bridge No. 7. If the proposed spread footing recommendations do not meet structural requirements for the bridge, alternative foundations or excavation of loose material replaced with granular backfill for structures is recommended.

Factored bearing resistances were calculated for various footing widths of the wingwalls and can be found in Figures 5.3 and 5.6. The settlement is expected to occur during or immediately after construction. These calculations are based on the geometric and geotechnical assumptions outlined in Sections 2.1 and 2.2. Sections 10.5.2 and 10.5.3 of AASHTO outline all design states relevant to spread footing design and their respective resistance factors. Eccentricity should be considered for settlement and bearing resistance design of spread footings by using effective footing widths based on AASHTO Section 10.6.1.3. Table 6.1 shows the appropriate resistance factors for various design states.

Table 6.1. Summary of resistance factors

Design State	Resistance Factor, φ
Settlement	1.0
Scour	1.0
Bearing Resistance	0.45
Sliding	0.80

6.1 Construction Considerations

6.1.1 Cofferdams/Temporary Earthwork Support: The Contractor should be reminded that Section 208.07 of VTrans' *2006 Standard Specifications for Construction* indicates that "The Contractor shall prepare detailed plans and a schedule of its operation for each cofferdam specified in the Contract. The design and structural details of the cofferdam shall be signed, stamped, and dated by a Professional Engineer (Structural or Civil)."

6.1.2 Construction Dewatering: The bottom of foundation elevation for the spread footing are estimated to be at EL 832 and 787 for Bridge No. 6 and No. 7 respectively, with an expected water table at or above this elevation. Therefore, temporary construction dewatering may be required to construct the foundation. Temporary dewatering will also be necessary to limit disturbance to and maintain the integrity of the bearing surface.

Temporary dewatering can likely be accomplished by open pumping from shallow sumps, temporary ditches, and trenches within and around the excavation limits. Sumps should be provided with filters suitable to prevent pumping of fine-grained soil particles. The water trapped by the temporary dewatering controls should be discharged to settling basins or an approved filter "sock" so that the fine particles

suspended in the discharge have adequate time to "settle out" prior to discharge. All effluent, or discharge, should comply with all applicable permits and regulations.

6.1.3 Subgrade Preparation: The subgrade shall be compacted until it is able to provide a firm and stable condition. Wet subgrade soils shall be proofrolled without vibration. Areas exhibiting excessive weaving, soft, or unstable soils should be excavated and replaced with compacted Granular Backfill for Structures (VTrans' pay item 204.30) in the area of the abutments and Granular Borrow (VTrans' pay item 203.32) in the embankments. In areas of steep terrain, the subgrade should be stripped, benched, and proofrolled to provide a level surface on which to place fill.

6.1.4 Placement and Compaction of Soils: Fills should be placed systematically in horizontal layers not more than 12 inches in thickness, prior to compaction. Cobbles larger than 8 inches should be removed from the fill prior to placement. Compaction equipment should preferably consist of large, self-propelled vibratory rollers. Where hand-guided equipment (such as a small vibratory plate compactor) is used, the loose lift thickness shall not exceed 6 inches. Cobbles larger than 4 inches should be removed from the fill prior to placement.

General embankment fills should be compacted to a dry density of at least 90% of the maximum dry density determined in accordance with AASHTO T-99. Granular Backfill for Structures, or other select materials placed within the roadway base section shall be compacted to a dry density equal to 95% of the maximum dry density as determined in accordance with AASHTO T-99.

6.2 Design Parameters: Table 6.2 highlights the geotechnical design parameters of the foundation bearing soil as well as regularly specified aggregates. These values should be used when designing the substructure units. It is recommended that values of K_o be used for calculating earth pressures where the structure is not allowed to deflect longitudinally, away from or into the retained soil mass. Values for K_a should be utilized for an active earth pressure condition where the structure is moving away from the soil mass and K_p where the structure is moving toward the soil mass. The design earth pressure coefficients are based on horizontal surfaces (non-sloping and backfill) and a vertical wall face.

Table 6.2. Engineering Properties of Construction Materials

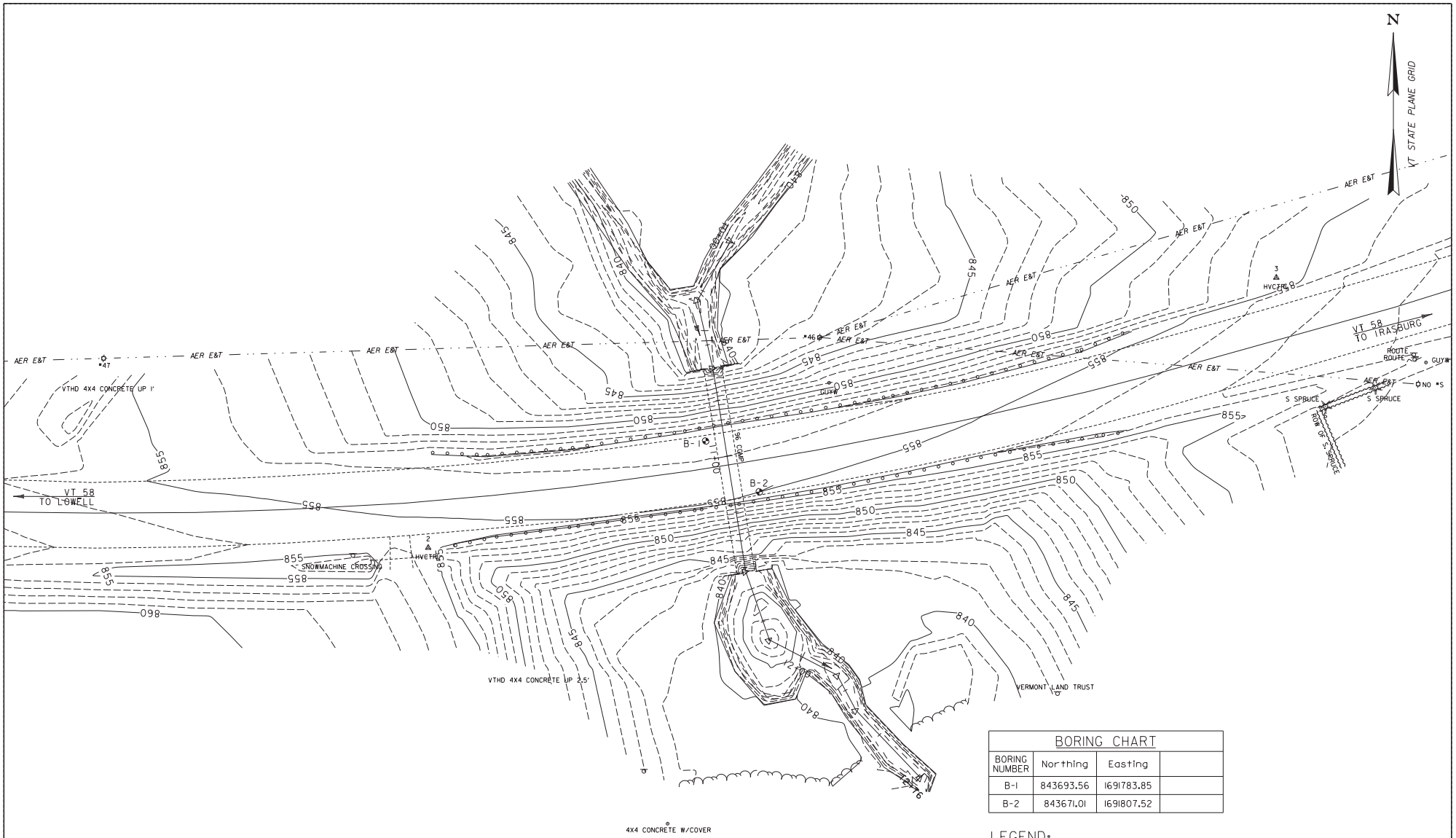
	703.01A - Granular Borrow	**704.08 - Granular Backfill for Structures**	**In-Situ Loose Silt (Br. 6)**	**In-Situ Very Loose ClSi (Br. 7)**
Density (lb/ft^3):	130	140	95	96
Internal Friction Angle, φ (degrees)	32	35	30	28
Coefficient of Friction, f				
- concrete cast against soil:	0.50	0.55	0.31	0.32
- sand against formed concrete	0.40	0.45	0.25	0.25
Active Earth Pressure Coefficient, K_a:	0.31	0.27	0.33	0.36
Passive Earth Pressure Coefficient, K_p:	3.22	3.69	3.00	2.77
At-Rest Earth Pressure Coefficient, K_o:	0.47	0.43	0.50	0.53

7.0 CONCLUSION

If any further analysis is needed or you would like to discuss this report, please contact us at (802) 828-2561. Computer generated boring logs are attached and available in the *M:\Projects\11c266\MaterialsResearch* folder.

Attachments: Boring Logs (4 pages)
Boring Location Plan (2 pages)

cc: Electronic Read File/WEA
Project File/CCB
LAR



BORING CHART			
BORING NUMBER	Northing	Easting	
B-1	843693.56	1691783.85	
B-2	843671.01	1691807.52	

LEGEND:

AUGER BORING

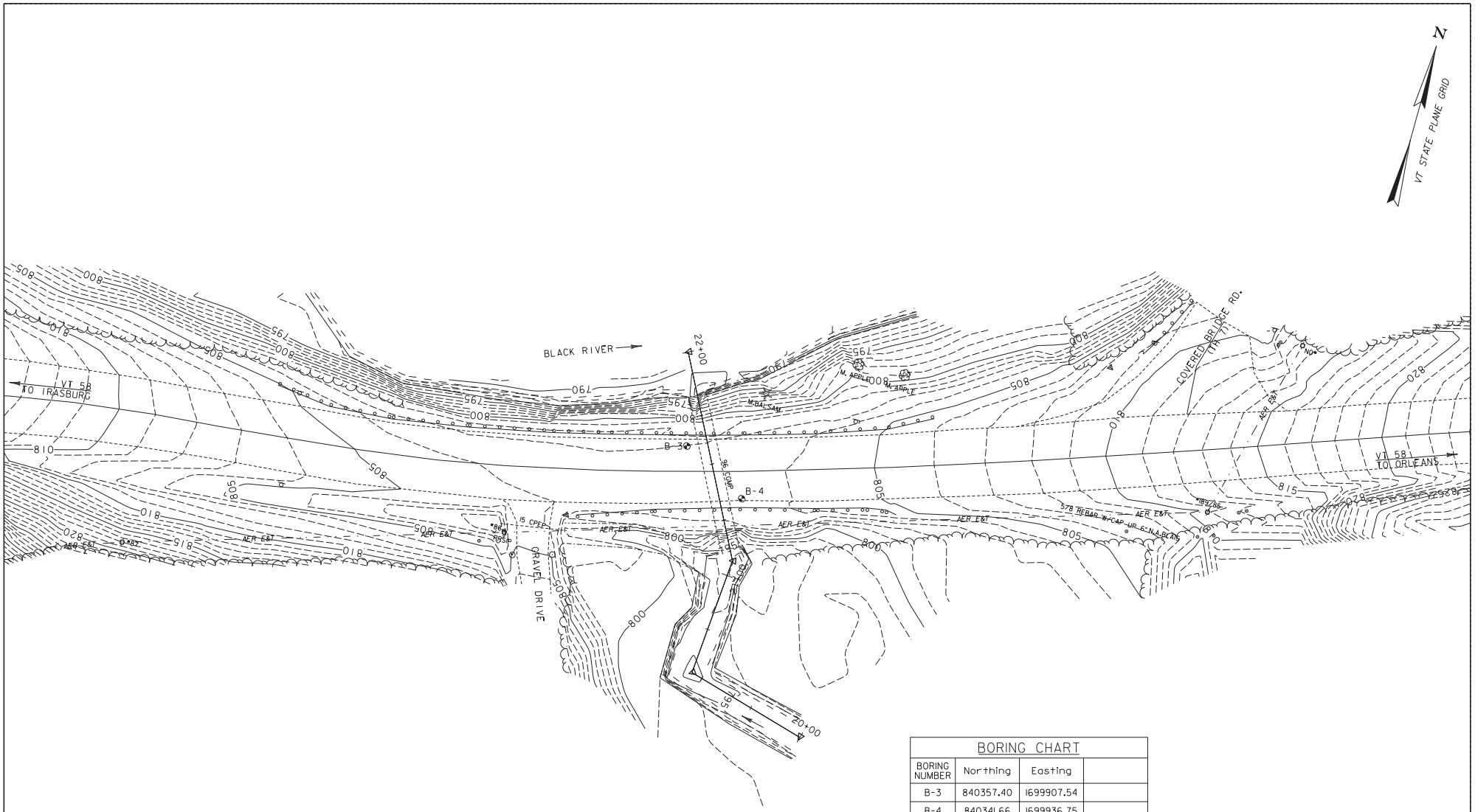
0 20 40
SCALE

Stantec

BRIDGE 6 BORING LAYOUT SHEET

PROJECT NAME: IRASBURG
PROJECT NUMBER: SIP CULV (30)

FILE NAME: ...\z08c194sht_lay_br6.dgn PLOT DATE: 6/6/2012
PROJECT LEADER: DRAWN BY:
DESIGNED BY: CHECKED BY:
PLAN BRIDGE 6 SHEET OF



BORING CHART			
BORING NUMBER	Northing	Easting	
B-3	840357.40	1699907.54	
B-4	840341.66	1699936.75	

LEGEND:

AUGER BORING

0 20 40
SCALE

Stantec

BRIDGE 7 BORING LAYOUT SHEET

PROJECT NAME: IRASBURG
PROJECT NUMBER: SIP CULV (30)

FILE NAME: ...\z08cl94sht_lay_br7.dgn PLOT DATE: 6/5/2012
PROJECT LEADER: DRAWN BY:
DESIGNED BY: CHECKED BY:
PLAN BRIDGE 7 SHEET OF

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
SUBSURFACE INFORMATION

BORING LOG

IRASBURG
STP CULV(30)
VT-58 BR-6&7

Boring No.: **B-101**
Page No.: 1 of 1
Pin No.: 11C266
Checked By: LAR

Boring Crew: GARROW, JUDKINS
Date Started: 10/11/12 Date Finished: 10/11/12
VTSPG NAD83: N 843693.56 ft E 1691783.85 ft
Station: Offset:
Ground Elevation:

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_F = 1.33

Groundwater Observations

Date	Depth (ft)	Notes
10/11/12	15.0	Bedstream Bottom

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %	LL %	PI %
		Asphalt Pavement, 0.0 ft - 0.8 ft							
		A-4, SiSa, brn, Moist, Rec. = 1.0 ft	7-3-3-3 (6)	15.4	12.4	44.2	43.4		
10		Visual Description:, SiGrSa, brn, Moist, Rec. = 0.8 ft	22-13-13-7 (26)						
		Visual Description:, GrSa, brn, Moist, Rec. = 0.8 ft	3-2-5-4 (7)						
		Field Note:, No Recovery, Stone in sampler.	7-6-4-2 (10)						
20		A-2-4, SiSa, Dk/brn, MTW, Rec. = 0.9 ft	4-2-1-1 (3)	42.1	0.5	64.7	34.8		
		Visual Description:, SiSa, Dk/brn, MTW, Rec. = 1.5 ft	1-2-1-2 (3)						
		Visual Description:, SiSa, yellow, MTW, Rec. = 0.1 ft	7-5-8-8 (13)						
		Field Note:, No Recovery	11-8-8-8 (16)						
		A-4, Si, gry, Wet, Rec. = 0.9 ft	7-5-3-4 (8)	26.5		17.3	82.7		
30		Visual Description:, Si, gry, MTW, Rec. = 1.4 ft	2-3-2-2 (5)						
		A-4, Si, gry, MTW, Rec. = 1.4 ft	2-3-5-5 (8)	26.0		17.0	83.0		
		Visual Description:, Si, gry, MTW, Rec. = 1.2 ft	2-3-4-6 (7)						
		A-4, Si, gry, MTW, Rec. = 1.5 ft	3-3-4-5 (7)	24.7		1.6	98.4	23	6
		Visual Description:, Si with little clay, gry, MTW, Rec. = 1.6 ft	3-3-3-4 (6)						
40		Field Note:, No Recovery in Shelby Tube							
		Visual Description:, SiCl, gry, Moist, Rec. = 1.8 ft	3-3-4-6 (7)						
		A-6, SiCl, gry, MTW, Rec. = 1.5 ft	4-5-7-6 (12)	26.5		0.8	99.2	29	11
		Visual Description:, SiCl, gry, MTW, Rec. = 1.8 ft	3-4-6-6 (10)						
		Visual Description:, SiCl, gry, MTW, Rec. = 1.6 ft	5-4-4-6 (8)						
50		Hole stopped @ 50.0 ft							

Remarks:
15.0 feet to bed of stream.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
SUBSURFACE INFORMATION

BORING LOG

IRASBURG
STP CULV(30)
VT-58 BR-6&7

Boring No.: **B-102**
Page No.: 1 of 1
Pin No.: 11C266
Checked By: LAR

Boring Crew: GARROW, JUDKINS
Date Started: 10/12/12 Date Finished: 10/12/12
VTSPG NAD83: N 843671.01 ft E 1691807.52 ft
Station: Offset:
Ground Elevation:

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_F = 1.33

Groundwater Observations

Date	Depth (ft)	Notes

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %	LL %	PI %
		Asphalt Pavement, 0.0 ft - 0.8 ft							
		Visual Description:, SaGr, brn, Moist, Rec. = 0.6 ft	8-8-8-7 (16)						
10		Visual Description:, Broken Rock pieces, gry, Moist, Rec. = 0.1 ft	14-R@6.0"						
		Field Note:, Boulder							
		Visual Description:, GrSa, brn, MTW, Rec. = 0.4 ft	4-4-3-3 (7)						
		Field Note:, No Recovery, Stone in sampler.	4-3-2-4 (5)						
20		Visual Description:, One stone with little sand, gry, Moist, Rec. = 0.1 ft	3-4-3-4 (7)						
		A-2-4, GrSiSa, Dk/gry, MTW, Rec. = 0.7 ft	4-6-5-2 (11)	17.6	26.1	40.2	33.7		
		Visual Description:, GrSiSa, gry, MTW, Rec. = 0.8 ft	4-4-4-3 (8)						
		A-4, SaSi, gry, Wet, Rec. = 1.1 ft	2-2-4-4 (6)	26.5	0.4	43.7	55.9		
		Visual Description:, SiSa, gry, Wet, Rec. = 1.5 ft	2-4-4-4 (8)						
30		A-4, ClSi, gry, Moist, Rec. = 1.7 ft	4-5-5-5 (10)	22.9		3.2	96.8	25	8
		Visual Description:, ClSi, gry, MTW, Rec. = 1.3 ft	2-5-4-6 (9)						
		A-6, SiCl, gry, MTW, Rec. = 1.8 ft	2-4-3-3 (7)	26.3		1.0	99.0	30	11
		Visual Description:, ClSi, gry, MTW, Rec. = 1.4 ft	2-4-5-5 (9)						
		A-4, ClSi, gry, MTW, Rec. = 1.4 ft	3-3-6-6 (9)	24.4		16.6	83.4	23	8
40		Visual Description:, ClSi, gry, MTW, Rec. = 1.4 ft	2-4-6-5 (10)						
		A-4, ClSi, gry, MTW, Rec. = 1.6 ft	4-5-6-4 (11)	23.1		13.3	86.7	24	10
		Visual Description:, SiCl, gry, MTW, Rec. = 1.4 ft	3-6-9-12 (15)						
		A-6, SiCl, gry, MTW, Rec. = 1.6 ft	4-8-10-12 (18)	24.1		5.5	94.5	34	14
		Visual Description:, SiCl, gry, MTW, Rec. = 1.6 ft	4-8-12-16 (20)						
50		Hole stopped @ 50.0 ft							

Remarks:
15.0 feet to bed of stream.

Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
SUBSURFACE INFORMATION

BORING LOG

IRASBURG
STP CULV(30)
VT-58 BR-6&7

Boring No.: **B-103**
Page No.: 1 of 1
Pin No.: 11C266
Checked By: LAR

Boring Crew: GARROW, JUDKINS
Date Started: 10/10/12 Date Finished: 10/10/12
VTSPG NAD83: N 840357.40 ft E 1699907.54 ft
Station: Offset:
Ground Elevation:

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_F = 1.33

Groundwater Observations

Date	Depth (ft)	Notes

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %	LL %	PI %
		Asphalt Pavement, 0.0 ft - 0.6 ft							
		Visual Description:, Sa with little Gravel, gry, Moist, Rec. = 0.6 ft	5-4-4-4 (8)						
10		Field Note:, Boulders & Cobbles							
		Field Note:, No Recovery, gry, Moist, Appears to be Silt.	2-1-2-2 (3)						
		A-6, SiCl, gry, MTW, Rec. = 1.5 ft	(WH)	35.1	0.6	3.0	96.4	33	11
20		ClSi Shelby Tube, gry, MTW, Rec. = 0.8 ft, 19.0 ft - 21.0 ft							
		A-4, ClSi, gry, MTW, Rec. = 1.7 ft	(6)	24.2	1.4	16.5	82.1	26	8
		A-4, Si, gry, MTW, Rec. = 1.1 ft	(2)	22.4		12.9	87.1	20	5
		Visual Description:, GrSaSi, gry, Wet, Rec. = 0.2 ft	(2)						
		A-6, SiCl, gry, Wet, Rec. = 0.3 ft	(2)	19.1				34	18
30		Visual Description:, ClSi, gry, Wet, Rec. = 0.7 ft	(WH)						
		A-4, SaClSi, gry, Wet, Rec. = 1.7 ft	(WH)	31.5		20.0	80.0	23	9
		Visual Description:, SaClSi, gry, Wet, Rec. = 0.6 ft	1-3-5-5 (8)						
		A-2-4, Sa, gry, MTW, Rec. = 1.7 ft	4-3-3-4 (6)	16.9	5.3	77.5	17.2		
		A-1-b, GrSa, gry, MTW, Rec. = 0.6 ft	8-4-5-6 (9)						
40		A-1-b, GrSa, gry, MTW, Rec. = 0.5 ft	8-7-9-11 (16)	10.1	21.8	69.7	8.5		
		Visual Description:, Sa, gry, MTW, Rec. = 1.1 ft	14-11-11-11 (22)						
		A-2-4, Sa, gry, MTW, Rec. = 1.1 ft	6-6-10-10 (16)	13.5	7.9	78.3	13.8		
		Hole stopped @ 45.0 ft							
50		Remarks: Top of river bed is 16.0 feet below ground surface.							

Notes:
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STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH SECTION
SUBSURFACE INFORMATION

BORING LOG

IRASBURG
STP CULV(30)
VT-58 BR-6&7

Boring No.: **B-104**
Page No.: 1 of 1
Pin No.: 11C266
Checked By: LAR

Boring Crew: GARROW, WHITLOCK
Date Started: 10/09/12 Date Finished: 10/09/12
VTSPG NAD83: N 840341.66 ft E 1699936.75 ft
Station: Offset:
Ground Elevation:

	Casing	Sampler
Type:	WB	SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb.
Hammer Fall:	N.A.	30 in.
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_F = 1.33

Groundwater Observations

Date	Depth (ft)	Notes

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %	LL %	PI %
		Field Note:, Asphalt Pavement							
5		Visual Description:, SiSaGr, brn, Wet, Rec. = 0.5 ft	8-5-5-4 (10)						
		Field Note:, Boulder							
10		Visual Description:, SiGrSa, brn, Moist, Rec. = 1.2 ft	7-4-5-7 (9)						
15		Field Note:, No Recovery, Appears to be Sandy Silt.	2-1-2-2 (3)						
		A-4, ClSi, gry, Moist, Rec. = 1.1 ft	1-2-2-2 (4)	31.2	11.2	12.3	76.5	31	10
20		A-4, ClSi, gry, Moist, Rec. = 1.0 ft	1-1-2-3 (3)	26.1	4.2	8.2	87.6	29	10
		SaSi Shelby Tube, gry, Moist, Rec. = 1.1 ft, 21.0 ft - 23.0 ft, Tested Non-Plastic.		15.3					
		A-4, SaClSi, gry, Moist, Rec. = 1.8 ft	(2)	22.6	11.6	21.4	67.0	22	8
25		A-4, SaGrSi with some Clay, gry, Wet, Rec. = 1.5 ft	(WH)	19.3	27.4	21.5	51.1	24	9
		A-4, ClSi, gry, Wet, Rec. = 1.4 ft	(2)	21.5	2.6	11.6	85.8	20	7
30		A-4, SaSi, gry, MTW, Rec. = 1.4 ft	6-5-7-11 (12)	14.1	2.4	41.1	56.5		
		Visual Description:, GrSaSi, gry, MTW, Rec. = 1.0 ft	8-7-7-10 (14)						
		Visual Description:, SiSa, gry, Wet, Rec. = 1.3 ft	2-3-5-7 (8)						
35		A-4, SiSa, gry, Moist, Rec. = 1.4 ft	17-26-26-30 (52)	13.0		59.2	40.8		
		Visual Description:, SiSa, gry, Moist, Rec. = 1.5 ft	18-30-39-R (69)						
40		A-4, SiSa, gry, Moist, Rec. = 0.9 ft	32-R (R)	13.3		55.0	45.0		
		A-4, SiSa, gry, Moist, Rec. = 1.7 ft	13-32-37-R (69)			60.1	39.9		
		Visual Description:, SiSa, gry, Moist, Rec. = 1.3 ft	31-36-R (R)						
45		Hole stopped @ 44.4 ft							

Notes:
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