FRA-71-14.36 PHASE 6R RETAINING WALL E4 PID NO. 105588 FRANKLIN COUNTY, OHIO

STRUCTURE FOUNDATION EXPLORATION REPORT (REV. 1)

Prepared For: ms consultants, inc. 2221 Schrock Road Columbus, OH 43229-1547

Prepared By: Resource International, Inc. 6350 Presidential Gateway Columbus, Ohio 43231

Rii Project No. W-13-072

July 2019

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June 22, 2015 (Revised July 19, 2019)

Mr. Gary Gardner, P.E. ms consultants, inc. 2221 Schrock Road Columbus, OH 43229-1547

Re: Structure Foundation Exploration Report (Rev. 1) FRA-71-14.36 Phase 6R Retaining Wall E4 PID No. 105588 Rii Project No. W-13-072

Mr. Gardner:

Resource International, Inc. (Rii) is pleased to submit this revised structure foundation exploration report for the above referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This report includes recommendations for the design and construction of proposed Retaining Wall E4 as part of the FRA-71-14.36 Phase 6R project in Columbus, Ohio.

We sincerely appreciate the opportunity to be of service to you on this project. If you have any questions regarding the structure foundation exploration or this report, please contact us.

Sincerely,

RESOURCE INTERNATIONAL, INC.

Brian R. Trenner, P.E. Director – Geotechnical Programming

tt P. Cri

Jonathan P. Sterenberg, P.E. Director – Geotechnical Planning

Enclosure: Structure Foundation Exploration Report (Rev. 1)

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EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a structure foundation exploration for the design and construction of the proposed Retaining Wall E4. Based on proposed plan information provided by the Rii, Retaining Wall E4 will support Ramp D7 between the FRA-70-1358L bridge structure over CSX and Norfolk Southern railroads and the FRA-70-1373B bridge structure over Short Street, and will provide the required grade separation such that graded embankments can be utilized up to the existing Mound Street alignment. For the final wall configuration, the wall begins at Sta. 7007+00 (BL Ramp D7) and extends east to Sta. 7007+66 (BL Ramp D7), where the wall wraps around the rear abutment of the proposed FRA-70-1373B structure, and continues back to the west along the north side of Ramp D7 to Sta. 7000+14 (BL Ramp D7), where the wall wraps around the forward abutment of the proposed FRA-70-1358L structure and ends at Sta. 7000+69 (BL Ramp D7). However, for the FRA-71-14.36 project, the wall will only be partially constructed and will end at Sta. 17005+55 (BL Transition Ramp D7), where Ramp D7 will merge with the existing I-70 westbound. The total wall length for Retaining Wall E4 for the final build, including the portion of the wall that crosses in front of the abutments of the proposed bridge structures, is approximately 1,007 lineal feet, and the total length between the abutments of the two crossings is approximately 750 feet. It is understood that a mechanically stabilized earth (MSE) wall is being considered as the preferred wall type for Retaining Wall E4.

Exploration and Findings

Between February 4 and May 13, 2014, five (5) borings, designated as B-018-2-13, B-020-4-13, B-114-7-13, B-114-8-13 and B-114-9-13, were drilled to completion depths ranging from 82.0 to 94.7 feet below the existing ground surface. In addition to the borings performed by Rii as part of the current exploration, one (1) boring, designated as B-017-2-09, was advanced to a completion depth of 54.8 feet below the existing ground surface by DLZ as part of the FRA-70-8.93 preliminary exploration. The project boring locations are shown on the boring plan provided in Appendix I of the full report.

Boring B-017-2-09 was drilled through the existing pavement of Mound Street and encountered 2.0 inches of asphalt overlying 9.0 inches of concrete followed by 3.0 inches of aggregate base. The remaining borings were drilled in the grass area between I-70 and Mound Street and encountered 2.0 to 6.0 inches of topsoil at the ground surface, as identified by the significant presence of vegetation and organic material.

Beneath the surface materials in borings B-017-2-09, B-018-2-13, B-020-4-13, B-114-8-13 and B-114-9-13, material identified as existing fill was encountered extending to depths ranging from 5.5 to 14.5 feet below the existing ground surface, which corresponds to elevations ranging from 699.5 to 708.5 feet msl. The fill material consisted of dark brown, black and brown gravel with sand, gravel with sand and silt, sandy silt, silt and clay and silty clay (ODOT A-1-b, A-2-4, A-4a, A-6a, A-6b). The fill materials contained



trash and debris, including organic material, root fibers, cinders, plastic, coal, brick and slag fragments throughout.

Underlying the surficial materials and existing fill, where encountered, natural granular soils were encountered overlying cohesive material. The granular soils were generally described as brown, gray and dark brown gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay and coarse and fine sand (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a). The cohesive soils were generally described as gray, brown and dark brown sandy silt, silt and clay, silty clay and clay (ODOT A-4a, A-6a, A-6b, A-7-6).

Top of bedrock was encountered in borings B-018-2-13, B-020-4-13, B-114-7-13, B-114-8-13 and B-114-9-13 at depths ranging from 58.8 to 64.9 feet below the existing ground surface, which corresponds to elevations ranging from 648.4 to 656.9 feet msl. The upper portion of the bedrock consists of weathered shale which was able to be augered to competent shale and claystone bedrock in borings B-020-4-13, B-114-8-13 and B-114-9-13 and competent limestone bedrock in borings B-018-2-13 and B-114-7-13. The cored bedrock consists of shale and claystone, which was encountered in borings B-020-4-13, B-114-8-13 and B-114-9-13 at an elevation of 639.3, 647.0 and 649.0 feet msl, respectively, overly limestone bedrock, which was encountered in all of the borings at elevations ranging from 629.0 fee msl in boring B-114-9-13 to 641.2 feet msl in boring B-018-2-13.

Analyses and Recommendations

Design details of the proposed retaining wall were provided by the Rii design team and ms consultants. It is understood that Retaining Wall E4 is proposed to be a MSE wall type that will support Ramp D7 between the FRA-70-1358L and FRA-70-1373B bridge structures. The wall will support the roadway along Ramp D7 between the FRA-70-1358L and FRA-70-1373B bridge structures, and will wrap around in front of the forward abutment of the proposed FRA-70-1358L bridge structure at the west end of the wall alignment and to the rear abutment of the FRA-70-1373B bridge structure at the east end of the wall alignment. The total wall length for Retaining Wall E4, including the portions of the wall that cross in front of the abutments of the proposed bridge structures, is approximately 1,007 lineal feet, and the total length between the abutments of the two bridges, from Sta. 402+02 to 409+52 (BL Wall E4), is approximately 750 feet.

MSE Wall Recommendations

Based on the proposed plan and profile information, the proposed retaining wall will have a maximum height of 27.7 feet, as measured from the top of the leveling pad to the top of the coping, at the east end of the alignment where it connects to the rear abutment of the FRA-70-1373B structure. The wall will step up along the proposed embankment as the wall continues west, with a minimum wall height of approximately 8.7 feet at Sta. 405+20 (BL Wall E4), and will step back down the proposed embankment to a maximum wall height of 42.1 feet where it connects to the forward abutment of the FRA-70-1358L



structure. Fill heights up to approximately 30 feet fill will be required to bring the existing grade up to the proposed bottom of wall elevation along the wall alignment.

Material identified as existing fill or possible fill consisting of loose to medium dense gravel with sand, gravel with sand and silt (ODOT A-1-b, A-2-4) and stiff to very stiff sandy silt, silt and clay and silty clay (ODOT A-4a, A-6a, A-6b), which contained trash and debris, including organic material, root fibers, cinders, plastic, coal, brick and slag fragments, was encountered at the existing grade within the area outside of the existing I-70 embankment. These unsuitable soils extend to a depths ranging from 5.5 to 14.3 feet below the existing ground surface grade (EI. 699.5 to 706.0 feet msl). As noted in Section 5.1 of the full report, it is understood that ground improvement techniques will be implemented within the entire footprint of Wall E4 and the proposed embankment in areas outside of the existing I-70 embankment. As this is a proprietary design, the analysis for this wall considers the existing fill material will remain in place and will not be stabilized.

MSE wall foundations bearing on existing fill material or granular embankment, placed and compacted in accordance with ODOT Item 203, may be proportioned for a factored bearing resistance as indicated in the following table. A geotechnical resistance factor of $\varphi_b=0.65$ was considered in calculating the factored bearing resistance at the strength limit state.

From Station ¹	To Station ¹	Wall Height Analyzed	Backslope Behind Wall in	Minimum Required Reinforcement	Strengt	esistance at h Limit ³ sf)	Strength Limit Equivalent Bearing
		(feet) Analysis		Length ² (feet)	Nominal	Factored ⁴	Pressure ⁵ (ksf)
402+02	404+75	27.7	Level	19.4 (0.70H)	3.47	2.26	6.63
404+75	407+00	15.1	Level	10.6 (0.70H ≥ 8.0)	13.76	5.19 ⁽⁵⁾	4.01
407+00	409+50	42.1	Level	29.5 (0.70H)	5.41	3.52	9.64

Retaining Wall E4 MSE Wall Design Parameters

1. Stationing referenced to the baseline of Retaining Wall E4.

2. The required foundation width is expressed as a percentage of the wall height, H.

3. A geotechnical resistance factor of $\varphi_b=0.65$ was considered in calculating the factored bearing resistance at the strength limit state.

4. The strength limit equivalent bearing pressure is the uniformly distributed pressure asserted by the wall over an effective base width based on the eccentricity of the wall system at the strength limit state.

5. The factored bearing resistance includes a reduction factor applied to the nominal resistance to account for the fore slope in front of the wall per Section 10.6.3.1.2c of the 2018 AASHTO LRFD BDM.



The settlement analysis for the section of the wall alignment where the wall steps up the proposed embankment fill was performed considering the equivalent bearing pressure at the bottom of the MSW wall at the service limit state, as well as the weight of the embankment fill below the proposed bottom of wall elevation. Results of the settlement analysis are tabulated in Table 9. Total settlements ranging from 7.70 to 15.59 inches at the center of the reinforced soil mass and 4.76 to 8.38 inches at the facing of the wall are anticipated along the alignment of Retaining Wall E4. Based on the results of the analysis, 90 percent of the total settlement is anticipated to occur over a period of approximately 8 to 100 days.

Based on the results of the external and global stability analysis performed for the MSE wall, sliding under undrained conditions as well as bearing and global stability under both drained and undrained conditions were not satisfied at a strap length equal to 0.7 times the wall height. Increasing the width of the wall up to 1.3 times the wall height still did not satisfy all of the external and global stability requirements.

Consideration was given to over excavating the existing fill and unsuitable soils and replacing it with granular embankment; however, given the depth and extent of this material along the alignment of the wall, this a very expensive and uneconomical option. Therefore, it is recommended that ground improvement techniques be implemented to increase the strength of the soil mass and reduce settlement potential within existing fill and underlying compressible material. Additional considerations for the ground improvement design, including required performance criteria, are provided in Section 5.1.8 of the full report.

Please note that this executive summary does not contain all the information presented in the report. The unabridged subsurface exploration report should be read in its entirety to obtain a more complete understanding of the information presented.



1.0 INTRODUCTION

The overall purpose of this project is to provide detailed subsurface information and recommendations for the design and construction of the FRA-70/71-13.10/14.36 (Projects 6A/6R) project in Columbus, Ohio. The projects represent the central portion of FRA-70-8.93 (PID 77369) I-70/71 south innerbelt improvements project, which includes all improvements along I-70 westbound from the I-71/SR-315 interchange to Front Street and along I-71 southbound from I-70 to Greenlawn Avenue. The FRA-71-14.36 (Project 6R) phase will consist of all work associated with the reconfiguration and construction of I-71 southbound from downtown (Front Street) to Greenlawn Avenue, including Ramps C3, D6 and D7. This project includes the construction of two (2) new bridge structures, one (1) for I-71 southbound over Short Street, NS/CXS Railroad and the Scioto River (FRA-71-1503L) and one (1) for Ramp D7 over Short Street (FRA-70-1373B), as well as the construction of five (5) new retaining walls (Walls E4, E5, E7, W2 and W5) to accommodate the new configuration.

This report is a presentation of the structure foundation exploration performed for the design and construction of the proposed Retaining Wall E4, as shown on the vicinity map and boring plan presented in Appendix I. Based on proposed plan information provided by the Rii design team, Retaining Wall E4 will support Ramp D7 between the FRA-70-1358L bridge structure over CSX and Norfolk Southern railroads and the FRA-70-1373B bridge structure over Short Street, and will provide the required grade separation such that graded embankments can be utilized up to the existing Mound Street alignment. The proposed Ramp D7 will be a two-lane ramp that will carry traffic from Mound Street to I-70 westbound. For the final wall configuration, the wall begins at Sta. 7007+00 (BL Ramp D7) and extends east to Sta. 7007+66 (BL Ramp D7), where the wall wraps around the rear abutment of the proposed FRA-70-1373B structure, and continues back to the west along the north side of Ramp D7 to Sta. 7000+14 (BL Ramp D7), where the wall wraps around the forward abutment of the proposed FRA-70-1358L structure and ends at Sta. 7000+69 (BL Ramp D7). However, for the FRA-71-14.36 project, the wall will only be partially constructed and will end at Sta. 17005+55 (BL Transition Ramp D7), where Ramp D7 will merge with the existing I-70 westbound. The total wall length for Retaining Wall E4 for the final build, including the portion of the wall that crosses in front of the abutments of the proposed bridge structures, is approximately 1,007 lineal feet, and the total length between the abutments of the two crossings is approximately 750 feet. Please note that the recommendations for the portion of the retaining wall where it crosses in front of the forward abutment of the FRA-70-1358L structure and the rear abutment of the FRA-70-1373B structure have been provided in the respective bridge structure foundation exploration reports, which are presented under separate covers. Additionally, this report provides recommendations for the final alignment and configuration of Retaining **Wall E4.** The wall heights along the portion of the wall alignment that is considered for this exploration report will range from 9.2 feet at Sta. 405+20 (BL Wall E4) to 42.1 feet at Sta. 409+30 (BL Wall E4). It is understood that a mechanically stabilized earth (MSE) wall is being considered as the preferred wall type for Retaining Wall E4.



2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 Site Geology

Both the Illinoian and Wisconsinan glaciers advanced over two-thirds of the State of Ohio, leaving behind glacial features such as moraines, kame deposits, lacustrine deposits and outwash terraces. The glacial and non-glacial regions comprise five physiographic sections based on geological age, depositional process and geomorphic occurrence (physical features or landforms). The project area lies within the Columbus Lowland District of the Till Plains Section. This area is characterized by flat to gently rolling ground moraine deposits from the Late Wisconsinan age. The site topography exhibits moderate to high relief. The ground moraine deposits are composed primarily of silty loam till (Darby, Bellefontaine, Centerburg, Grand Lake, Arcanum, Knightstown Tills), with smaller alluvium and outwash deposits bordering the Scioto River, its tributaries and floodplain areas. A ground moraine is the sheet of debris left after the steady retreat of glacial ice. The debris left behind ranges in composition from clay size particles to boulders (including silt, sand, and gravel). Outwash deposits consist of undifferentiated sand and gravel deposited by meltwater in front of glacial ice, and often occurs as valley terraces or low plains. Alluvium and alluvial terrace deposits range in composition from silty clay size particles to cobbles, usually deposited in present and former floodplain areas.

According to the bedrock geology and topography maps obtained from the Ohio Department of Natural Resources (ODNR), the underlying bedrock consists predominantly of the Middle to Lower Devonian-aged Columbus Limestone. This formation is further subdivided into two members in the central portion of the state, known as the Delhi and Bellepoint Members. The Delhi Member consists of light gray, finely to coarsely crystalline, irregularly bedded, fossiliferous limestone. The Bellepoint Member consists of variable brown, finely crystalline, massively bedded limy dolomite. Both of these members contain chert nodules. Just east of the Scioto River, the underlying bedrock consists of the Upper Devonian Ohio Shale Formation overlying the Middle Devonian-aged Delaware Limestone Formation. The Ohio Shale formation consists of brownish black to greenish gray, thinly bedded, fissile, carbonaceous shale. The Delaware Limestone consists of bluish gray, thin to medium bedded dolomitic limestone with nodules and layers of chert. Regionally, the bedrock surface forms a broad valley aligned roughly north-to-south beneath the Scioto River. According to bedrock topography mapping, the elevation of the bedrock surface ranges from approximately 600 feet mean sea level (msl) in the valley to approximately 625 feet msl near the project limits. Within boring B-020-5-13 performed for this current project, shale and mudstone bedrock was encountered beginning at a depth of 76.6 feet below the existing ground surface, which corresponds to an elevation of 656.8 feet msl.



2.2 Existing Conditions

The proposed Retaining Wall E4 structure will be situated along the south side of the existing Mound Street, west of Short Street, east of the railroads and north of the existing I-70 westbound. Mound Street in the vicinity of the proposed structure is an asphalt paved roadway that narrows from three lanes down to two to the west and ends at a cul-de-sac within the Miranova complex. The existing I-70 westbound in the vicinity of the structure is a four-lane, asphalt paved roadway that is aligned east-to-west. The existing I-70 roadway profile grade is elevated approximately 18 feet above the adjacent grade. There is an existing tennis court at the southwest corner of the intersection of Mound Street and Short Street. The terrain along both roadways and the surrounding area is relatively flat-lying, with dense vegetation covering the existing embankment slope that supports I-70 westbound. The area between the I-70 embankment and Mound Street is grass covered with sparse vegetation.

3.0 EXPLORATION

Between February 4 and May 13, 2014, five (5) borings, designated as B-018-2-13, B-020-4-13, B-114-7-13, B-114-8-13 and B-114-9-13, were drilled to completion depths ranging from 82.0 to 94.7 feet below the existing ground surface. In addition to the borings performed by Rii as part of the current exploration, one (1) boring, designated as B-017-2-09, was performed DLZ in the vicinity of the wall alignment as part of the FRA-70-8.93 preliminary exploration, and the findings were published in the report dated March 18, 2010. The boring was advanced to a completion depth of 54.8 feet below the existing ground surface. The project boring locations are shown on the boring plan provided in Appendix I of this report and summarized in Table 1.

Boring Number	Reference Alignment	Station	Offset	Latitude	Longitude	Ground Elevation (feet msl)	Boring Depth (feet)
B-017-2-09	BL I-70 WB	169+62.30	117.3' Lt.	39.953797580	-83.006927454	713.0	54.8
B-018-2-13	BL I-70 WB	168+63.72	22.9' Lt.	39.953512324	-83.007250705	715.7	84.5
B-020-4-13	BL Ramp D7	7007+11.61	12.0' Rt.	39.954037298	-83.005708660	714.0	94.7
B-114-7-13	BL I-71 SB	271+12.84	28.4' Rt.	39.953781634	-83.006602443	713.3	84.0
B-114-8-13	BL I-71 SB	273+13.25	16.5' Lt.	39.953893690	-83.005886092	714.0	82.0
B-114-9-13	BL I-71 SB	275+07.50	4.7' Rt.	39.953788084	-83.005201418	714.0	90.0

Table 1. Test Boring Summary

The locations for the current exploration borings performed by Rii were determined and located in the field by Rii representatives. Rii utilized a handheld GPS unit to obtain geographic latitude and longitude coordinates of the boring locations. Ground surface elevations at the boring locations were interpolated using topographic mapping information provided by ms consultants.



The borings performed by Rii for the current exploration were drilled using a truck or an all-terrain vehicle (ATV) mounted rotary drilling machine, utilizing a 3.25 or 4.25-inch inside diameter, hollow-stem auger to advance the holes. Standard penetration test (SPT) and split spoon were performed in the borings at 2.5-foot intervals to a depth of 30.0 feet, and at 5.0-foot intervals thereafter to the boring termination depth or top of bedrock. The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted using a 140-pound hammer falling 30.0 inches to drive a 2.0-inch outside diameter split spoon sampler 18.0 inches. Rii utilized a calibrated automatic drop hammer to generate consistent energy transfer to the sampler. Driving resistance is recorded on the boring logs in terms of blow per 6.0-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot (N). Standard penetration blow counts aid in determining soil properties applicable in foundation system design. Measured blow count (N) values are corrected to an equivalent (60%) energy ratio, N₆₀, by the following equation. Both values are represented on boring logs in Appendix III.

$$N_{60} = N_m^*(ER/60)$$

Where:

 N_m = measured N value

ER = drill rod energy ratio, expressed as a percent, for the system used

The hammers for the Mobile B-53 and CME 750 drill rigs operated by Rii were calibrated on April 26, 2013, and have drill rod energy ratios of 77.7 and 82.6 percent, respectively. The hammer for the CME-75 truck rig operated by DLZ has a drill rod energy ratio of 62.0 percent.

During drilling for the borings performed by Rii, field logs were prepared by Rii personnel showing the encountered subsurface conditions. Soil samples obtained from the drilling operation were preserved and sealed in glass jars and delivered to the soil laboratory. In the laboratory, the soil samples were visually classified and select samples were tested, as noted in Table 2.

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	ASTM D 2216	102
Plastic and Liquid Limits	AASHTO T89, T90	34
Gradation – Sieve/Hydrometer	AASHTO T88	35
Unconfined Compressive Strength of Intact Rock	ASTM D7012	7
Point Load Strength Index of Rock Specimens	ASTM D 5731	1

Table 2. Laboratory Test Schedule



The tests performed are necessary to classify existing soil according to the Ohio Department of Transportation (ODOT) classification system and to estimate engineering properties of importance in determining foundation design and construction recommendations. Results of the laboratory testing are presented on the boring logs in Appendix III and in Appendix IV. A description of the soil terms used throughout this report is presented in Appendix II.

Hand penetrometer readings, which provide a rough estimate of the unconfined compressive strength of the soil, were reported on the boring logs in units of tons per square foot (tsf) and were utilized to classify the consistency of the cohesive soil in each layer. An indirect estimate of the unconfined compressive strength of the cohesive split spoon samples can also be made from a correlation with the blow counts (N₆₀). Please note that split spoon samples are considered to be disturbed and the laboratory determination of their shear strengths may vary from undisturbed conditions.

The depth to bedrock in borings B-018-2-13, B-020-4-13, B-114-7-13, B-114-8-13 and B-114-9-13 was determined by split spoon sampler refusal. Split spoon sampler refusal is defined as exceeding 50 blows from the hammer with less than 6.0 inches of penetration by the split spoon sampler. Where borings were extended into the bedrock, an NQ or HQ-sized double-tube diamond bit core barrel (utilizing wire line equipment) was used to core the bedrock. Coring produced 1.85 or 2.5-inch diameter cores, respectively, from which the type of rock and geological characteristics were determined.

Rock cores were logged in the field and visually classified in the laboratory. They were analyzed to identify the type of rock, color, mineral content, bedding planes and other geological and mechanical features of interest in this project. The Rock Quality Designation (RQD) for each rock core run was calculated according to the following equation:

 $RQD = \frac{\sum \text{segments equal to or longer than 4.0 inches}}{\text{core run length}} \times 100$

4.0 FINDINGS

Interpreted engineering logs have been prepared based on the field logs, visual examination of samples and laboratory test results. Classification follows the current version of the ODOT Specifications for Geotechnical Explorations (SGE) at the time the exploration borings were performed. The following is a summary of what was found in the test borings performed as part of the preliminary engineering phase and current exploration and what is represented on the boring logs.



4.1 Surface Materials

Boring B-017-2-09 was drilled through the existing pavement of Mound Street and encountered 2.0 inches of asphalt overlying 9.0 inches of concrete followed by 3.0 inches of aggregate base. The remaining borings were drilled in the grass area between I-70 and Mound Street and encountered 2.0 to 6.0 inches of topsoil at the ground surface, as identified by the significant presence of vegetation and organic material.

4.2 Subsurface Soils

Beneath the surface materials in borings B-017-2-09, B-018-2-13, B-020-4-13, B-114-8-13 and B-114-9-13, material identified as existing fill was encountered extending to depths ranging from 5.5 to 14.5 feet below the existing ground surface, which corresponds to elevations ranging from 699.5 to 708.5 feet msl. The fill material consisted of dark brown, black and brown gravel with sand, gravel with sand and silt, sandy silt, silt and clay and silty clay (ODOT A-1-b, A-2-4, A-4a, A-6a, A-6b). The fill materials contained trash and debris, including organic material, root fibers, cinders, plastic, coal, brick and slag fragments throughout.

Underlying the surficial materials and existing fill, where encountered, natural granular soils were encountered overlying cohesive material. The granular soils were generally described as brown, gray and dark brown gravel, gravel with sand, gravel with sand and silt, gravel with sand, silt and clay and coarse and fine sand (ODOT A-1-a, A-1-b, A-2-4, A-2-6, A-3a). The cohesive soils were generally described as gray, brown and dark brown sandy silt, silt and clay, silty clay and clay (ODOT A-4a, A-6a, A-6b, A-7-6).

The relative density of granular soils is primarily derived from SPT blow counts (N₆₀). Based on the SPT blow counts obtained, the granular soil encountered ranged from very loose (N₆₀ < 5 blows per foot [bpf]) to very dense (N₆₀ > 50 bpf). Overall blow counts recorded from the SPT sampling ranged from 4 bpf to split spoon sampler refusal. The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soil encountered ranged from soft (0.25 < HP \leq 0.5 tsf) to hard (HP > 4.0 tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.5 to over 4.5 tsf (limit of instrument).

Natural moisture contents of the soil samples tested ranged from 3 to 30 percent. The natural moisture content of the cohesive soil samples tested for plasticity index ranged from 7 percent below to 10 percent above their corresponding plastic limits. In general, the soil exhibited natural moisture contents considered to be moderately below to significantly above optimum moisture levels.



4.3 Bedrock

Bedrock was encountered in the borings as presented in Table 3.

Boring	Ground Surface	Top of	Bedrock	Top of Be	drock Core				
Number	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)				
B-018-2-13	715.7	58.8	656.9	74.5	641.2				
B-020-4-13	714.0	64.4	649.6	74.7	639.3				
B-114-7-13	713.3	64.9	648.4	74.0	639.3				
B-114-8-13	714.0	63.5	650.5	67.0	647.0				
B-114-9-13	714.0	59.0	655.0	65.0	649.0				

Table 3. Top of Bedrock Elevations

Top of bedrock was encountered in borings B-018-2-13, B-020-4-13, B-114-7-13, B-114-8-13 and B-114-9-13 at depths ranging from 58.8 to 64.9 feet below the existing ground surface, which corresponds to elevations ranging from 648.4 to 656.9 feet msl. The upper portion of the bedrock consists of weathered shale which was able to be augered to competent shale and claystone bedrock in borings B-020-4-13, B-114-8-13 and B-114-9-13 and competent limestone bedrock in borings B-018-2-13 and B-114-7-13. The cored bedrock consists of shale and claystone, which was encountered in borings B-020-4-13, B-114-8-13 and B-114-9-13 at an elevation of 639.3, 647.0 and 649.0 feet msl, respectively, overly limestone bedrock, which was encountered in all of the borings at elevations ranging from 629.0 fee msl in boring B-114-9-13 to 641.2 feet msl in boring B-018-2-13.

The claystone is described as dark gray, slightly weathered, very weak to weak, thinly laminated to thin bedded, calcareous and fractured to highly fractured with tight to open, slickensided to rough apertures. The shale is described as dark gray, slightly weathered, very weak to weak, thinly laminated to thin bedded, calcareous, argillaceous, fissile, pyritic and moderately to highly fractured with narrow to open, slickensided to slightly rough apertures. The limestone is described as gray and dark gray, unweathered to slightly weathered, moderately strong to very strong, thin to very thick bedded, calcareous, argillaceous, dolomitic, cherty, pyritic, fossiliferous and slightly to highly fractured with narrow to open, slightly rough to rough apertures.

The percent recovery, RQD values and unconfined compressive strengths of the bedrock core runs are summarized in Table 4.



Boring	Core No.	Elevation (feet msl)	Recovery (%)	RQD (%)	Unconfined Compressive Strength					
B-018-2-13	RC-1	641.2 to 636.2	100	72	q _u @ 78.5' = 10,153 psi					
D-010-2-13	RC-2	636.2 to 631.2	100	87	N/A					
	RC-1	639.3 to 634.3	92	75	N/A					
B 020 4 42	RC-2	634.3 to 629.3	100	100	N/A					
B-020-4-13	RC-3	629.3 to 624.3	95	90	q _u @ 86.5' = 13,130 psi					
	RC-4	624.3 to 619.3	95	85	q _u @ 90.7' = 16,178 psi					
B-114-7-13	RC-1	639.3 to 634.3	92	48	q _u @ 75.1' = 8,488 psi					
D-114-7-13	RC-2	634.3 to 629.3	83	52	q _u @ 81.5' = 9,141 psi					
	RC-1	647.0 to 642.0	82	19	N/A					
B-114-8-13	RC-2	642.0 to 637.0	97	12	q _u @ 74.8' = 92 psi					
	RC-3	637.0 to 632.0	98	92	q _u @ 78.4' = 12,567 psi					
	RC-1	649.0 to 644.0	33	26	N/A					
	RC-2	644.0 to 639.0	88	58	N/A					
B-114-9-13	RC-3	639.0 to 634.0	100	83	q _u @ 75.7' = 338 psi ¹					
	RC-4	634.0 to 629.0	93	90	N/A					
	RC-5	629.0 to 624.0	93	89	N/A					

Table 4. Rock Core Summary

1. Indicates unconfined compressive strength determined from point load testing.

It should be noted that bedrock experiences mechanical breaks during the drilling and coring processes. Rii attempted to account for fresh, manmade breaks during tabulation of the RQD analysis. The quality of the claystone and shale bedrock, according to the RQD values, ranged from very poor (RQD $\leq 25\%$) to excellent (90% < RQD $\leq 100\%$), and the quality of the limestone bedrock ranged from poor (25% < RQD $\leq 50\%$) excellent (90% < RQD $\leq 100\%$).



4.4 Groundwater

Groundwater was encountered in the borings as presented in Table 5.

Boring	Ground	Ground Initial Groundwater			mpletion
Number	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-017-2-09	713.0	16.5	696.5	N/A ¹	N/A
B-018-2-13	715.7	25.0	689.7	N/A ¹	N/A
B-020-4-13	714.0	18.5	695.5	N/A ¹	N/A
B-114-7-13	713.3	17.0	698.3	N/A ¹	N/A
B-114-8-13	714.0	18.5	695.5	N/A ¹	N/A
B-114-9-13	714.0	23.0	691.0	N/A ¹	N/A

Table 5. Groundwater

1. The groundwater level at completion could not be obtained due to the addition of mud as a drilling fluid and water during the rock coring process.

Groundwater was encountered initially during drilling in all six borings at depths ranging from 16.5 to 25.0 feet below the existing ground surface, which corresponds to elevations ranging from 689.7 to 689.3 feet msl. The groundwater levels at the completion of drilling could not be measured due to the addition of water or mud to counteract heaving sands as well as water as a circulating fluid during the rock coring process. Please note that short-term water level readings, especially in cohesive soils, are not necessarily an accurate indication of the actual groundwater level. In addition, groundwater levels or the presence of groundwater are considered to be dependent on seasonal fluctuations in precipitation.

A more comprehensive description of what was encountered during the drilling process may be found on the boring logs in Appendix III.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the subsurface exploration programs has been used to determine the foundation support capabilities and the settlement potential for the soil encountered at the site. These parameters have been used to provide guidelines for the design of foundation systems for the subject structure, as well as the construction specifications related to the placement of foundation systems and general earthwork recommendations, which are discussed in the following paragraphs.



Design details of the proposed retaining wall were provided by the Rii design team and ms consultants. It is understood that Retaining Wall E4 is proposed to be a MSE wall type that will support Ramp D7 between the FRA-70-1358L and FRA-70-1373B bridge structures. The wall will support the roadway along Ramp D7 between the FRA-70-1373B and FRA-70-1373B bridge structures, and will wrap around in front of the forward abutment of the proposed FRA-70-1358L bridge structure at the west end of the wall alignment and to the rear abutment of the FRA-70-1373B bridge structure at the east end of the wall alignment. The total wall length for Retaining Wall E4, including the portions of the wall that cross in front of the abutments of the proposed bridge structures, is approximately 1,007 lineal feet, and the total length between the abutments of the two bridges, from Sta. 402+02 to 409+52 (BL Wall E4), is approximately 750 feet. Based on the proposed plan and profile information, wall heights along the portion of the wall alignment that is considered for this exploration report will range from 9.2 feet at Sta. 405+20 (BL Wall E4) to 42.1 feet at Sta. 409+30 (BL Wall E4).

5.1 MSE Wall Recommendations

It is understood that a MSE retaining wall is being considered for use in supporting the proposed Ramp D7 alignment. MSE walls are constructed on earthen foundations at a minimum depth of 3.0 feet below grade, as defined by the top of the leveling pad to the ground surface located 4.0 feet from the face of the wall. Per Section 204.6.2.1 of the 2007 ODOT BDM, the height of the MSE wall is defined as the elevation difference between the top of coping and the top of the leveling pad. However, it is noted that the reinforced soil mass only extends from the foundation bearing elevation (top of leveling pad) to the roadway subgrade elevation. The width of the MSE wall foundation (B) is defined by the length of the reinforced soil mass. Per the Section 204.6.2.1 of the 2007 ODOT BDM and Supplemental Specification (SS) 840, the minimum length of the reinforced soil mass is equal to 70 percent of the height of the MSE wall or 8.0 feet whichever is greater. A non-structural bearing leveling pad consisting of a minimum of 6.0-inches of unreinforced concrete should be placed at the base of the wall foundation.

Based on the proposed plan and profile information, the proposed retaining wall will have a maximum height of 27.7 feet, as measured from the top of the leveling pad to the top of the coping, at the east end of the alignment where it connects to the rear abutment of the FRA-70-1373B structure. The wall will step up along the proposed embankment as the wall continues west, with a minimum wall height of approximately 8.7 feet at Sta. 405+20 (BL Wall E4), and will step back down the proposed embankment to a maximum wall height of 42.1 feet where it connects to the forward abutment of the FRA-70-1358L structure. Fill heights up to approximately 30 feet fill will be required to bring the existing grade up to the proposed bottom of wall elevation along the wall alignment. For the analysis, the foundation width was set at 70 percent of the maximum wall height and the foundation width was increased, if required, until external and global stability requirements were satisfied.



Per Section 840.06.D of ODOT SS 840, the foundation subgrade should be inspected to verify that the subsurface conditions are the same as those anticipated in this report. Material identified as existing fill or possible fill containing soft soils and organic matter was encountered at the proposed bearing elevation in borings B-017-2-09, B-018-2-13, B-020-4-13, B-114-8-13 and B-114-9-13. The unsuitable material extends to a depth of 13.5 feet below existing grade in boring B-017-2-09 (El. 699.5 feet msl), 14.3 feet below existing grade in boring B-018-2-13 (El. 701.4 feet msl), 8.0 feet below existing grade in boring B-020-4-13 (El. 706.0 feet msl), 5.5 feet below existing grade in boring B-114-8-13 (El. 708.5 feet msl) and 8.0 feet below existing grade in boring B-114-9-13 (El. 706.0 feet msl). The fill material consisted of loose to medium dense gravel with sand, gravel with sand and silt (ODOT A-1-b, A-2-4) and stiff to very stiff sandy silt, silt and clay and silty clay (ODOT A-4a, A-6a, A-6b), which contained trash and debris, including organic material, root fibers, cinders, plastic, coal, brick and slag fragments. In addition, stiff to hard silt and clay, silty clay, clay (ODOT A-6a, A-6b, A-7-6) and very loose to loose gravel with sand and silt and coarse and fine sand (ODOT A-2-6, A-3a) was encountered at the ground surface in boring B-114-7-13 and below the existing fill in the borings noted above, which extend to elevations ranging from 694.5 to 701.4 feet msl. Given the low blow counts obtained within the existing fill material and cohesive soil deposits, as well as the presence of organics and debris within the existing fill, these soils are not considered suitable for foundation support for a wall of this size. Consideration was given to over excavation and replacement of the existing fill material and underlying compressible soils, but given the depth of over excavation required, this option is not considered economically feasible.

A study was performed by GPD GROUP as part of the FRA-70-12.68 Project 4R (PID 105523), dated March 2, 2018, to investigate the use of ground improvement techniques (stone columns/rigid inclusions) as well as the use of lightweight fill consisting of cellular concrete to control settlement within the fill material and meet strength requirements. Analyses for both alternatives were provided in the report, as well as a cost comparison between the two alternatives. Based on the results of the study, it was understood that ground improvement techniques will be a cheaper option for that wall. It is anticipated that similar results would be obtained for this wall.

The ground improvement techniques, which will consist of stone columns or rigid inclusions, will increase the bearing resistance of the existing fill and cohesive soil deposits and also reduce settlement potential. The improved soils should also result in an increase of the shear strength within these soils, which in turn will improve the global stability of the wall/embankment system. It is recommended that the ground improvement elements be installed within the entire footprint of Wall E4 and the proposed embankment in areas outside of the existing I-70 embankment. The design of such a system is proprietary and beyond the scope of this investigation. Based on discussions with the ODOT Office of Geotechnical Engineering (OGE), the analysis for the wall was performed assuming that the existing fill and unsuitable soils will remain in place and not be stabilized. Additional considerations for the ground improvement design, including required performance criteria, are provided in Section 5.1.8.



Per ODOT SS 840, following foundation subgrade inspection and acceptance, a minimum of 12.0 inches of ODOT Item 703.16.C, Granular Material Type C, should be placed and compacted in accordance with ODOT Item 204.07.

Since the wall is located within an existing floodplain, the analysis was performed using the design groundwater level at the ground surface elevation.

5.1.1 Strength Parameters Utilized in External and Global Stability Analyses

The shear strength parameters utilized in the external and global stability analyses for the MSE walls at the abutments are provided in Table 6.

Material Type	γ (pcf)	φ' ⁽¹⁾ (°)	<i>c</i> ' ⁽²⁾ (psf)	S _u ⁽³⁾ (psf)
MSE Wall Backfill (Select Granular Fill)	120	34	0	N/A
Item 203 Granular Embankment (Retained Soil and Proposed Embankment)	120	32	0	N/A
Ex. Fill: Stiff to Very Stiff Sandy Silt, Silt and Clay, Silty Clay (ODOT A-4a, A-6a, A-6b)	120	25 to 27	0	625 to 1,875
Ex. Fill: Loose to Medium Dense Gravel with Sand and Silt (ODOT A-2-4)	120	26	0	N/A
Loose to Medium Dense Granular Soils (ODOT A-1-a, A-1-b, A-2-4)	120 to 125	32 to 39	0	N/A
Dense to Very Dense Granular Soils (ODOT A-1-a, A-1-b)	130 to 135	39 to 43	0	N/A
Very Stiff Silt and Clay (ODOT A-6a)	125	27	0	4,500
Hard Silty Clay (ODOT A-6b)	125 to 130	26 to 28	50 to 100	4,375 to 8,000
Very Stiff to Hard Clay (ODOT A-7-6)	120 to 130	25 to 26	0 to 100	1,750 to 8,000

Table 6. Shear Strength Parameters Utilized in Stability Analyses

1. Per Figure 7-45, Section 7.6.9 of FHWA GEC 5 for cohesive soils and Table 10.4.6.2.4-1 of the 2018 AASHTO LRFS BDS for granular soils.

2. Estimated based on overconsolidated nature of soil.

3. $S_u = 125(N_{60})$, Terzaghi and Peck (1967).



Shear strength parameters for the reinforced soil backfill are provided in ODOT SS 840. Per SS 840, the select granular backfill in the reinforced zone must meet the shear strength requirements provided in Table 6. Based on the design plans provided by the Rii design team and ms consultants, it is understood that Item 203 granular embankment will be utilized where any new embankment will be placed below the wall and behind the reinforced soil backfill along the wall alignment. Therefore, the shear strength parameters for the retained fill will be modeled using a friction angle of 32 degrees since granular embankment is being specified, instead of using the shear strength parameters provided in ODOT SS 840.

The shear strength parameters for the natural soils were assigned using correlations provided in FHWA Geotechnical Engineering Circular (GEC) No. 5 (FHWA-NHI-16-072) Evaluation of Soil and Rock Properties and based on past experience in the vicinity of the site with projects performed in similar subsurface profiles. However, the friction angle for the existing fill that consisted of medium dense gravel with sand and silt was conservatively assigned since there no records of the material origin or how it was placed.

5.1.2 Bearing Stability

Material identified as existing fill or possible fill consisting of loose to medium dense gravel with sand, gravel with sand and silt (ODOT A-1-b, A-2-4) and stiff to very stiff sandy silt, silt and clay and silty clay (ODOT A-4a, A-6a, A-6b), which contained trash and debris, including organic material, root fibers, cinders, plastic, coal, brick and slag fragments, was encountered at the existing grade within the area outside of the existing I-70 embankment. These unsuitable soils extend to a depths ranging from 5.5 to 14.3 feet below the existing ground surface grade (EI. 699.5 to 706.0 feet msl). As noted in Section 5.1, it is understood that ground improvement techniques will be implemented within the entire footprint of Wall E4 and the proposed embankment in areas outside of the existing I-70 embankment. As this is a proprietary design, the analysis for this wall considers the existing fill material will remain in place and will not be stabilized. MSE wall foundations bearing on existing fill material or granular embankment, placed and compacted in accordance with ODOT Item 203, may be proportioned for a factored bearing resistance as indicated in Table 7. A geotechnical resistance factor of $\varphi_b=0.65$ was considered in calculating the factored bearing resistance at the strength limit state.



From Station ¹	To Station ¹	Wall Height Analyzed	Backslope Behind Wall in	Minimum Required Reinforcement	Streng	esistance at th Limit sf)	Strength Limit Equivalent Bearing
		(feet)	Analysis	Length ² (feet)	Nominal	Factored ³	Pressure ⁴ (ksf)
402+02	404+75	27.7	Level	19.4 (0.70H)	3.47	2.26	6.63
404+75	407+00	15.1	Level	10.6 (0.70H ≥ 8.0)	13.76	5.19 ⁽⁵⁾	4.01
407+00	409+50	42.1	Level	29.5 (0.70H)	5.41	3.52	9.64

Table 7. Retaining Wall E4 MSE Wall Design Parameters

1. Stationing referenced to the baseline of Retaining Wall E4.

2. The required foundation width is expressed as a percentage of the wall height, H.

3. A geotechnical resistance factor of $\varphi_b=0.65$ was considered in calculating the factored bearing resistance at the strength limit state.

4. The strength limit equivalent bearing pressure is the uniformly distributed pressure asserted by the wall over an effective base width based on the eccentricity of the wall system at the strength limit state.

5. The factored bearing resistance includes a reduction factor applied to the nominal resistance to account for the fore slope in front of the wall per Section 10.6.3.1.2c of the 2018 AASHTO LRFD BDM.

For analysis of the wall section between Sta. 404+75 and 407+00, the calculated factored bearing resistance includes a reduction factor applied to the nominal resistance to account for the fore slope in front of the wall per Section 10.6.3.1.2c of the 2018 AASHTO LRFD BDM.

Rii performed a verification of the bearing pressure exerted on the subgrade material for the specified wall heights indicated in Table 7. Based on the minimum length of reinforced soil mass presented, the factored equivalent bearing pressure exerted below the wall <u>will</u> <u>exceed</u> the factored bearing resistance at the strength limit state, considering the wall will bear on the existing fill material and unsuitable soils.

5.1.3 Settlement Evaluation

The compressibility parameters utilized in the settlement analyses of the proposed MSE wall are provided in Table 8.



Table 6. Compressibility Farameters Otilized in Settlement Analysis									
Material Type	γ (pcf)	LL (%)	$C_c^{(1)}$	$C_{r}^{(2)}$	e _o ⁽³⁾	C _v ⁽⁴⁾ (ft²/yr)	N60	C' ⁽⁵⁾	
Ex. Fill: Stiff to Hard Sandy Silt (ODOT A-4a)	115 to 120	21 to 32	0.099 to 0.198	0.015 to 0.030	0.436 to 0.522	1,000	N/A	N/A	
Ex. Fill: Stiff Silt and Clay (ODOT A-6a)	115	32	0.198	0.030	0.522	600	N/A	N/A	
Ex. Fill: Stiff to Very Stiff Silty Clay (ODOT A-6b)	120	40	0.270	0.041	0.585	300	N/A	N/A	
Ex. Fill: Very Loose to Medium Dense Granular Soils (ODOT A-1-b, A-2-4)	120	N/A	N/A	N/A	N/A	N/A	13 to 18	73 to 117	
Very Loose to Medium Dense Granular Soils (ODOT A-1-a, A-1-b, A-2-6, A-3a)	115 to 125	N/A	N/A	N/A	N/A	N/A	5 to 30	47 to 113	
Dense to Very Dense Granular Soils (ODOT A-1-a, A-1-b, A-3a)	130 to 135	N/A	N/A	N/A	N/A	N/A	34 to 100	121 to 379	
Hard Sandy Silt (ODOT A-4a)	130	25	0.135	0.014	0.467	1,000	N/A	N/A	
Soft to Very Stiff Silt and Clay (ODOT A-6a)	125	33 to 35	0.207 to 0.225	0.031 to 0.023	0.530 to 0.546	600	N/A	N/A	
Stiff to Hard Silty Clay (ODOT A-6b)	115 to 130	31 to 40	0.189 to 0.270	0.019 to 0.038	0.514 to 0.585	300	N/A	N/A	
Very Stiff to Hard Clay (ODOT A-7-6)	125 to 130	41 to 48	0.279 to 0.342	0.014 to 0.034	0.593 to 0.647	150	N/A	N/A	

 Table 8. Compressibility Parameters Utilized in Settlement Analysis

1. Per Table 6-9, Section 6.14.1 of FHWA GEC 5.

2. Estimated at 10% of C_c for natural soils and 15% C_c for existing fill per Section 8.11 of Holtz and Kovacs (1981).

3. Per Table 8-2 of Holtz and Kovacs (1981).

4. Per Figure 6-37, Section 6.14.2 of FHWA GEC 5.

5. Per Figure 10.6.2.4.2-1 of 2018 AASHTO LRFD BDS.

The settlement analysis for the section of the wall alignment where the wall steps up the proposed embankment fill was performed considering the equivalent bearing pressure at the bottom of the MSE wall at the service limit state as well as the weight of the embankment fill below the proposed bottom of wall elevation. Results of the settlement analysis are tabulated in Table 9. Total settlements ranging from 7.70 to 15.59 inches at the center of the reinforced soil mass and 4.76 to 8.38 inches at the facing of the wall are anticipated along the alignment of Retaining Wall E4. Based on the results of the analysis, 90 percent of the total settlement is anticipated to occur over the time periods shown in Table 9. Please note that the consolidation settlement and time rate of consolidation are based on estimates using correlated compressibility parameters provided in Table 8 for the underlying soils. Actual settlement and time rate of consolidation should be determined by monitoring the settlement of the wall using settlement platforms.



From	Service Limit To Bearing		Total Settler (incl	Time for 90%	
Station ¹	Station ¹	Pressure ² (ksf)	Center of Wall Mass	Facing of Wall	Consolidation (Days)
402+02	404+75	4.64 to 5.05	7.70 to 10.46	4.76 to 5.18	8 to 23
404+75	407+00	5.21 to 5.59	15.45 to 15.59	8.00 to 8.38	90 to 100
407+00	409+50	6.27 to 6.80	9.06 to 12.07	5.79 to 7.60	55 to 100

 Table 9. Retaining Wall E4 MSE Wall Settlement Values

1. Stationing referenced to the baseline of Retaining Wall E4.

2. The service limit bearing pressure includes the equivalent bearing pressure from the MSE wall at the service limit state as well as the weight of the embankment fill below the proposed bottom of wall elevation.

Per Section 204.6.2.1 of the 2019 ODOT BDM, "the maximum allowable differential settlement in the longitudinal direction (regardless of the size of panels) is one (1) percent." Given the amount of settlement anticipated at the facing along the wall alignment, as well as the presence of existing fill material that may vary significantly over the footprint of the wall and proposed embankment fill, differential settlement greater than 1/100 may occur if the fill material is not stabilized or over excavated and replaced with embankment fill. If either the total or differential settlement values predicted present an issue with respect to the deformation tolerances that the wall can withstand, then measures should be taken to minimize the amount of settlement that will occur. This can be achieved by preloading the site and consolidating the underlying soils prior to constructing the walls. If preloading the site is not a desired option, then consideration could be given to ground improvement through the use of stone columns. Settlement calculations are provided in Appendix V.

5.1.4 Eccentricity (Overturning Stability)

The resistance of the MSE wall to overturning will be dependent on the on the location of the resultant force at the bottom of the wall due to the overturning and resisting moments acting on the wall. For MSE walls, overturning stability is determined by calculating the eccentricity of the resultant force from the midpoint of the base of the wall and comparing this value to a limiting eccentricity value. Per Section 11.10.5.5 of the 2018 AASHTO LRFD BDS, for foundations bearing on soil, the location of the resultant of the reaction forces shall be within the middle two-thirds ($^{2}/_{3}$) of the base width. Therefore, the limiting eccentricity is one-third ($^{1}/_{3}$) of the base width of the wall. Rii performed a verification of the eccentricity of the resultant force for the specified wall heights indicated in Table 7. Based on the minimum length of reinforced soil mass presented in Table 7 and utilizing the soil parameters listed in Section 5.1.1 for the retained embankment material, the calculated eccentricity of the resultant force **will not exceed** the limiting eccentricity at the strength limit state.



5.1.5 Sliding Stability

The resistance of the MSE wall to sliding was evaluated per Section 11.10.5.3 of the 2018 AASHTO LRFD BDS. For drained conditions, the sliding resistance is determined by multiplying a coefficient of sliding friction "f" times the total vertical force at the base of the wall. The coefficient of sliding friction is determined based on the limiting friction angle between the foundation soil and the reinforced soil backfill. Based on the soil parameters listed in Section 5.1.1 for the foundation and reinforced soil backfill, a coefficient of sliding friction of 0.47 to 0.62 was utilized for design. For undrained conditions, the sliding resistance is taken as the limiting value between the undrained shear strength of the bearing soil and half of the vertical stress applied by the wall multiplied by the width of the MSE wall. Based on the soil parameters listed in Section 5.1.1, the undrained shear strength of the existing fill material is estimated to be 625 to 1,000 psf.

A geotechnical resistance factor of φ_{τ} =1.0 was considered in calculating the factored shear resistance between the reinforced backfill material and foundation soil for sliding. Based on the minimum length of reinforced soil mass presented in Table 7 and utilizing the soil parameters listed in Section 5.1.1 for the retained embankment material, the resultant horizontal forces on the back of the MSE wall <u>will not exceed</u> the factored shear resistance at the strength limit state for drained conditions, but <u>will exceed</u> the factored shear resistance at the strength limit state for undrained conditions.

5.1.6 Overall (Global) Stability

A slope stability analysis was performed to check the global stability of the wall. As per the 2018 AASHTO LRFD BDS, safety against soil failure shall be evaluated at the service limit state by assuming the reinforced soil mass to be a rigid body. Soil parameters utilized in the global stability analyses are presented in Section 5.1.1. For the global stability condition, it was considered that the failure plane will not cross through the reinforced soil mass. The computer software program Slide 2018 manufactured by Rocscience Inc. was utilized to perform the analyses.

Per Section 11.6.2.3 of the 2018 AASHTO LRFD BDS, overall (global) stability for MSE walls that are not integrated with or supporting structural foundations or elements, global stability is satisfied if the product of the factor of safety from the slope stability output multiplied by the resistance factor φ =0.75 is greater than 1.0. Therefore, global stability is satisfied when a minimum factor of safety of 1.3 is obtained. For an MSE wall designed with the minimum strap lengths listed in Table 7, the resulting factor of safety under drained conditions (long-term stability) and undrained conditions (short-term stability) was less than 1.3.



5.1.7 Final MSE Wall Considerations

Based on the results of the external and global stability analysis performed for the MSE wall, sliding under undrained conditions as well as bearing and global stability under both drained and undrained conditions were not satisfied at a strap length equal to 0.7 times the wall height. Increasing the width of the wall up to 1.3 times the wall height still did not satisfy all of the external and global stability requirements. Calculations for external (bearing and sliding resistance and limiting eccentricity) and overall (global) stability of the MSE wall are provided in Appendix V.

As noted in Section 5.1, consideration was given to over excavating the existing fill and unsuitable soils and replacing it with granular embankment; however, given the depth and extent of this material along the alignment of the wall, this a very expensive and uneconomical option. Therefore, it is recommended that ground improvement techniques be implemented to increase the strength of the soil mass and reduce settlement potential within existing fill and underlying compressible material. Additional considerations for the ground improvement design, including required performance criteria, are provided in Section 5.1.8 below.

5.1.8 Ground Improvement Considerations

The design of the ground improvement should result in the improved soil matrix meeting the design criteria for bearing resistance and compressibility for the MSE wall. The improved soil matrix will need to provide a factored bearing resistance greater than or equal to the factored bearing pressure at the strength limit state of 6.63 to 9.64 ksf. Additionally, the improved soil matrix will need to limit settlement to the required maximum differential settlement of 1/100 along the wall facing and to tolerable limits for maximum settlement of the wall based on the wall manufacturer's specifications or for constructability of the roadway. In the absence of specific settlement from the wall manufacturer, the ground improvement design should limit total settlement of the tembankment and back of the reinforced soil mass to 5.0 inches, and total settlement at the facing of the wall to 2.5 inches.

As noted above, total settlements of approximately 7.7 to 15.5 inches at the center of the reinforced soil mass and 4.75 to 8.4 inches at the facing of the wall are anticipated along the alignment of Retaining Wall E4, based on service limit bearing pressures ranging from 4.64 to 6.80 ksf, without stabilization of the existing fill and unsuitable soils. About 70 to 90 percent of the estimated settlement is occurring within these upper layers. Therefore, it is recommended that the ground improvement elements be extended through the existing fill layers and any underlying compressive (cohesive) layers. Based on the conditions encountered, the ground improvement elements should be extended to an approximate elevation of 695 to 700 feet msl. Additionally, it is recommended that ground improvement elements be located along the length of the leveling pad, where the leveling pad is bearing on new fill with a thickness less than two (2) times the width of the pad, if



concentrated loads will be imparted along the pad to ensure that differential settlement does not occur.

5.2 Lateral Earth Pressure

For the soil types encountered in the borings, the "in-situ" unit weight (γ), cohesion (c), effective angle of friction (ϕ '), and lateral earth pressure coefficients for at-rest conditions (k_o), active conditions (k_a), and passive conditions (k_p) have been estimated and are provided in Table 10 and Table 11.

						<u></u>
Soil Type	γ (pcf) ¹	c (psf)	φ	<i>k</i> a	k _o	k_p
Soft to Stiff Cohesive Soil	115	1,000	0°	N/A	N/A	N/A
Very Stiff to Hard Cohesive Soil	125	3,000	0°	N/A	N/A	N/A
Very Loose to Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense Granular Soil	125	0	32°	0.27	0.47	6.82
Dense to Very Dense Granular Soil	130	0	36°	0.23	0.41	9.09
Compacted Cohesive Engineered Fill	120	2,000	0°	N/A	N/A	N/A
Compacted Granular Engineered Fill	120	0	32°	0.27	0.47	6.82

 Table 10. Estimated Undrained (Short-term) Soil Parameters for Design

1. When below groundwater table, use effective unit weight, $\gamma' = \gamma - 62.4$ pcf and add hydrostatic water pressure.

Table 11.	Estimated Drained	(Lona-term) Soil Parameters	for Desian
			/	ioi Dooigii

Soil Type	γ (pcf) ¹	c (psf)	φ'	ka	k.	k _p
Soft to Stiff Cohesive Soil	115	0	26°	0.35	0.56	4.53
Very Stiff to Hard Cohesive Soil	125	0	28°	0.32	0.53	5.07
Very Loose to Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense Granular Soil	125	0	32°	0.27	0.47	6.82
Dense to Very Dense Granular Soil	130	0	36°	0.23	0.41	9.09
Compacted Cohesive Engineered Fill	120	0	30°	0.30	0.50	5.58
Compacted Granular Engineered Fill	120	0	32°	0.27	0.47	6.82

1. When below groundwater table, use effective unit weight, $\gamma' = \gamma - 62.4$ pcf and add hydrostatic water pressure.



These parameters are considered appropriate for the design of all subsurface structures and any excavation support systems. Subsurface structures (where the top of the structure is restrained from movement) should be designed based on at-rest conditions (k_o) . For proposed temporary retaining structures (where the top of the structure is allowed to move), earth pressure distributions should be based on active (k_a) and passive (k_p) conditions. The values in this table have been estimated from correlation charts based on minimum standards specified for compacted engineered fill materials. These recommendations do not take into consideration the effect of any surcharge loading or a sloped ground surface (a flat surface is considered). Earth pressures on excavation support systems will be dependent on the type of sheeting and method of bracing or anchorage.

5.3 Construction Considerations

All site work shall conform to local codes and to the latest ODOT Construction and Materials Specifications (CMS), including that all excavation and embankment preparation and construction should follow ODOT Item 200 (Earthwork).

5.3.1 Excavation Considerations

All excavations should be shored / braced or laid back at a safe angle in accordance to Occupational Safety and Health Administration (OSHA) guidelines. During excavation, if slopes cannot be laid back to OSHA Standards due to adjacent structures or other obstructions, temporary shoring may be required. The following table should be utilized as a general guide for implementing OSHA guidelines when estimating excavation back slopes at the various boring locations. Actual excavation back slopes must be field verified by qualified personnel at the time of excavation in strict accordance with OSHA guidelines.

Soil	Maximum Back Slope	Notes			
Soft to Medium Stiff Cohesive	1.5 : 1.0	Above Ground Water Table and No Seepage			
Stiff Cohesive	1.0 : 1.0	Above Ground Water Table and No Seepage			
Very Stiff to Hard Cohesive	0.75 : 1.0	Above Ground Water Table and No Seepage			
All Granular & Cohesive Soil Below Ground Water Table or with Seepage	1.5 : 1.0	None			

Table 12. Excavation Back Slopes



5.3.2 Groundwater Considerations

Based on the groundwater observations made during drilling, little to no groundwater seepage is anticipated during construction. However, where/if groundwater is encountered, proper groundwater control should be employed and maintained to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or "boiling" condition where soft silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36 inches below the deepest excavation. Any seepage or groundwater encountered at this site should be able to be controlled by pumping from temporary sumps. Additional measures may be required depending on seasonal fluctuations of the groundwater level. Note that determining and maintaining actual groundwater levels during construction is the responsibility of the contractor.

6.0 LIMITATIONS OF STUDY

The above recommendations are predicated upon construction inspection by a qualified soil technician under the direct supervision of a professional geotechnical engineer. Adequate testing and inspection during construction are considered necessary to assure an adequate foundation system and are part of these recommendations.

The recommendations for this project were developed utilizing soil and bedrock information obtained from the test borings that were made at the proposed site for the current investigation. Resource International is not responsible for the data, conclusions, opinions or recommendations made by others during previous investigations at this site. At this time we would like to point out that soil borings only depict the soil and bedrock conditions at the specific locations and time at which they were made. The conditions at other locations on the site may differ from those occurring at the boring locations.

The conclusions and recommendations herein have been based upon the available soil and bedrock information and the design details furnished by a representative of the owner of the proposed project. Any revision in the plans for the proposed construction from those anticipated in this report should be brought to the attention of the geotechnical engineer to determine whether any changes in the foundation or earthwork recommendations are necessary. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the geotechnical engineer.

The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater or surface water within or beyond the site studied. Any statements in this report or on the test boring logs regarding odors, staining of soils or other unusual conditions observed are strictly for the information of our client.

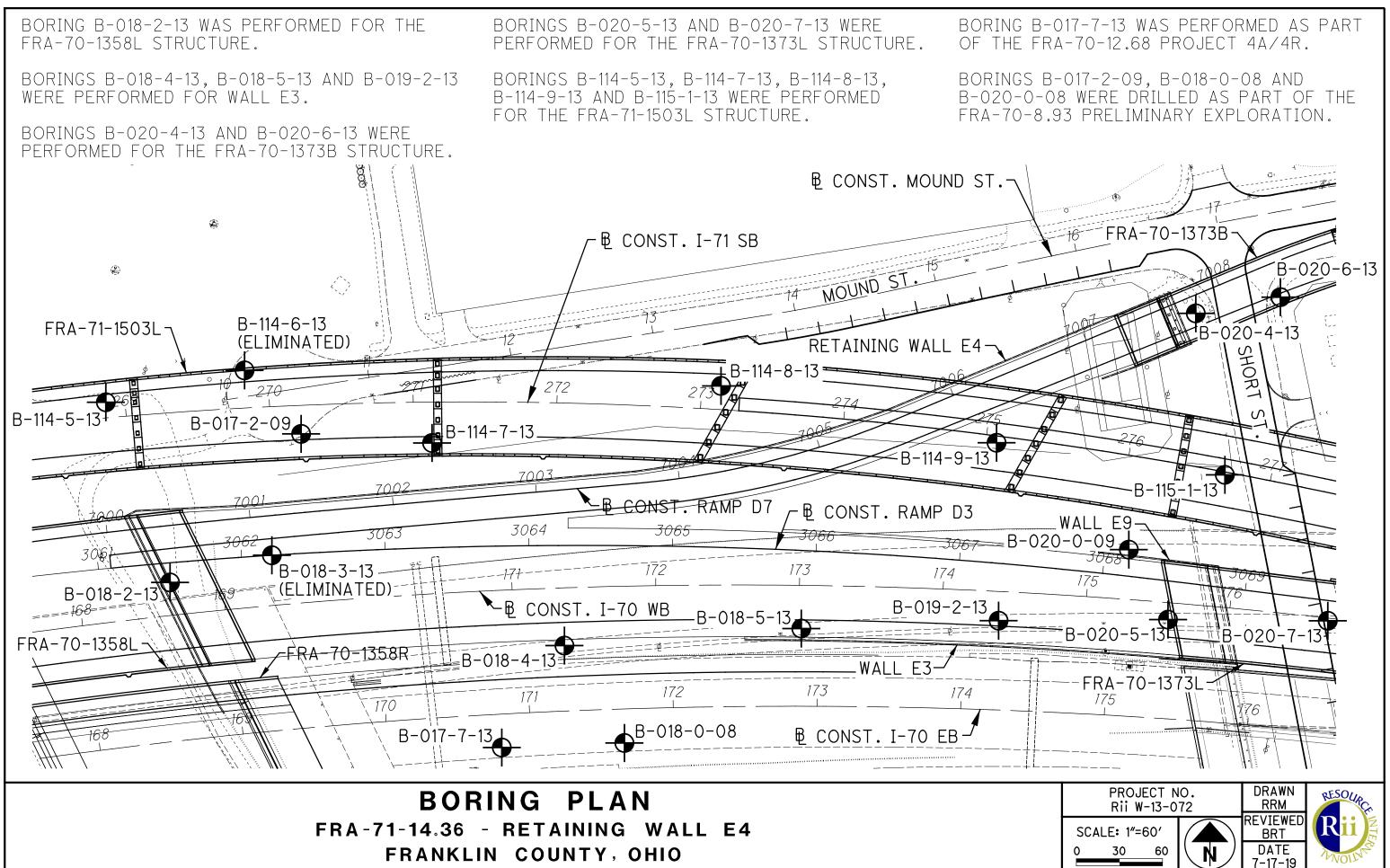


Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. Resource International is not responsible for the conclusions, opinions or recommendations made by others based upon the data included.



APPENDIX I

VICINITY MAP AND BORING PLAN



APPENDIX II

DESCRIPTION OF SOIL TERMS

DESCRIPTION OF SOIL TERMS

The following terminology was used to describe soils throughout this report and is generally adapted from ASTM 2487/2488 and ODOT Specifications for Geotechnical Explorations.

Granular Soils - The relative compactness of granular soils is described as: ODOT A-1, A-2, A-3, A-4 (non-plastic) or USCS GW, GP, GM, GC, SW, SP, SM, SC, ML (non-plastic)

Description	Blows per foot – SPT (N_{60})		
Very Loose	Below		5
Loose	5	-	10
Medium Dense	11	-	30
Dense	31	-	50
Very Dense	Over		50

<u>Cohesive Soils</u> - The relative consistency of cohesive soils is described as: ODOT A-4, A-5, A-6, A-7, A-8 or USCS ML, CL, OL, MH, CH, OH, PT

Description	<u>Blows per foot – SPT (N₆₀)</u>			
Very Soft	Below		2	
Soft	2	-	4	
Medium Stiff	5	-	8	
Stiff	9	-	15	
Very Stiff	16	-	30	
Hard	Over		30	

Gradation - The following size-related denominations are used to describe soils:

<u>Soil Fra</u> Boulders Cobbles	3	USCS Size Larger than 12" 12" to 3"	ODOT Size Larger than 12" 12" to 3"
Gravel	coarse	3" to ¾"	3" to 3⁄4"
	fine	3⁄4" to 4.75 mm (3⁄4" to #4 Sieve)	3⁄4" to 2.0 mm (3⁄4" to #10 Sieve)
Sand	coarse	4.75 mm to 2.0 mm (#4 to #10 Sieve)	2.0 mm to 0.42 mm (#10 to #40 Sieve)
	medium	2.0 mm to 0.42 mm (#10 to #40 Sieve)	-
	fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt		0.074 mm to 0.005 mm (#200 to 0.005 mm)	0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay		Smaller than 0.005 mm	Smaller than 0.005 mm

Modifiers of Components - Modifiers of components are as follows:

Term		Range	
Trace	0%	-	10%
Little	10%	-	20%
Some	20%	-	35%
And	35%	-	50%

Moisture Table - The following moisture-related denominations are used to describe cohesive soils:

<u>Term</u>	Range - USCS
Dry	0% to 10%
Damp	>2% below Plastic Limit
Moist	2% below to 2% above Plastic Limit
Very Moist	>2% above Plastic Limit
Wet	³ Liquid Limit

Organic Content – The following terms are used to describe organic soils:

<u>Term</u>	Organic Content (%)
Slightly organic	2-4
Moderately organic	4-10
Highly organic	>10

Bedrock – The following terms are used to describe bedrock hardness:

Term		Blows per for	ot – SP	T (N)
Very Soft		Below		50
Soft		50/5"	_	50/6"
Medium Hard		50/3"	_	50/4"
Hard		50/1"	_	50/2"
Very Hard	50/0"			

Unconfined						
Co	mp	ressio	n (†	tsf)		
		UCS	≤	0.25		
0.25	<	UCS	≤	0.5		
0.5	<	UCS	≤	1.0		
1.0	<	UCS	≤	2.0		
2.0	<	UCS	≤	4.0		
		UCS	>	4.0		

Well below Plastic Limit Below Plastic Limit Above PL to 3% below LL

Range - ODOT

3% below LL to above LL

DESCRIPTION OF ROCK TERMS

The following terminology was used to describe the rock throughout this report and is generally adapted from ASTM D5878.

Weathering – Describes the degree of weathering of the rock mass:

<u> </u>	
<u>Description</u>	Field Parameter
Unweathered	No evidence of any chemical or mechanical alteration of the rock mass. Mineral crystals have a
	right appearance with no discoloration. Fractures show little or not staining on surfaces.
Slightly Weathered	Slight discoloration of the rock surface with minor alterations along discontinuities. Less than 10%
0	of the rock volume presents alteration.
Moderately Weathered	Portions of the rock mass are discolored as evident by a dull appearance. Surfaces may have a
-	pitted appearance with weathering "halos" evident. Isolated zones of varying rock strengths due to
	alteration may be present. 10 to 15% of the rock volume presents alterations.
Highly Weathered	Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered
5 ,	rock may be present and some areas of severely weathered materials may be present.
Severely Weathered	Majority of the rock mass reduced to a soil-like state with relic rock structure discernable. Zones of
	more resistant rock may be present but the material can generally be molded and crumbled by
	hand pressures.

<u>Strength of Bedrock</u> – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak Slightly Strong	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure. Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

Bedding Thickness – Description of bedding thickness as the average perpendicular distances between bedding surfaces:

Description	Thickness
Very Thick	Greater than 36 inches
Thick	18 to 36 inches
Medium	10 to 18 inches
Thin	2 to 10 inches
Very Thin	0.4 to 2 inches
Laminated	0.1 to 0.4 inches
Thinly Laminated	Less than 0.1 inches

Fracturing – Describes the degree and condition of fracturing (fault, joint, or shear):

Degree of Fracturing

Description	Spacing
Unfractured	Greater than 10 feet
Intact	3 to 10 feet
Slightly Fractured	1 to 3 feet
Moderately Fractured	

Condition of Fractures Aperature Width

Description Width Greater than 0.2 inches Open 0.05 to 0.2 inches Narrow Less than 0.05 inches Tight

Surface Roughness

Description	<u>Criteria</u>
Very Rough	Near vertical steps and ridges occur on surface
Slightly Rough	Asperities on the surfaces distinguishable
Slickensided	Surface has smooth, glassy finish, evidence of
	Striations

RQD – Rock Quality Designation:

Rock Index Property Classification
Very Poor
Poor
Fair
Good
Very Good



CLASSIFICATION OF SOILS Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart. The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classif AASHTO		LL ₀ /LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
°000 °0000	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
			A-1-b		50 Max.	25 Max.		6 Max.	0	
FS	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand		A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
<u>8:0 8:8</u> 9 <u>.005</u> 6:0:06	Gravel and/or Stone Fragments with Sand and Silt	A-:				35 Max.	40 Max. 41 Min.	10 Max.	0	
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6 A-2-7				35 Max.	40 Max. 41 Min.	11 Min.	4	
	Sandy Silt	A-4	A-4a	76 Min.	5	36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
+ + + + + + + + + + + + + + + + + + +	silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
Elastic Clay		A-7-5		76 Min.		36 Min.	41 Min.	≨LL-30	20	
	Clay		7-6	76 Min.	e.	36 Min.	41 Min.	>LL-30	20	
+ + + + + + + +	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-85	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6
	Sod and Topsoil Pavement or Base	-	CLASS trolled escribe	SIFIED BY	VISUAL	INSPEC Bouldery			W-	at, S-Sedimentary Woody F-Fibrous Loamy & etc

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

APPENDIX III

PROJECT BORING LOGS:

B-017-2-09, B-018-2-13, B-020-4-13 and B-114-7-13 through B-114-9-13

BORING LOGS

Definitions of Abbreviations

- AS=Auger sampleGI=Group index as determined from the Ohio Department of Transportation classification systemHP=Unconfined compressive strength as determined by a hand penetrometer (tons per square foot)
- LL_o = Oven-dried liquid limit as determined by ASTM D4318. Per ASTM D2487, if LL_o/LL is less than 75 percent, soil is classified as "organic".
- LOI = Percent organic content (by weight) as determined by ASTM D2974 (loss on ignition test)
- PID = Photo-ionization detector reading (parts per million)
- QR = Unconfined compressive strength of intact rock core sample as determined by ASTM D2938 (pounds per square inch)
- QU = Unconfined compressive strength of soil sample as determined by ASTM D2166 (pounds per square foot)
- RC = Rock core sample
- REC = Ratio of total length of recovered soil or rock to the total sample length, expressed as a percentage
- RQD = Rock quality designation estimate of the degree of jointing or fracture in a rock mass, expressed as a percentage:

 \sum segments equal to or longer than 4.0 inches x100

core run length

- S = Sulfate content (parts per million)
- SPT = Standard penetration test blow counts, per ASTM D1586. Driving resistance recorded in terms of blows per 6-inch interval while letting a 140-pound hammer free fall 30 inches to drive a 2-inch outer diameter (O.D.) split spoon sampler a total of 18 inches. The second and third intervals are added to obtain the number of blows per foot (N_m).
- N_{60} = Measured blow counts corrected to an equivalent (60 percent) energy ratio (ER) by the following equation: $N_{60} = N_m^*(ER/60)$
- SS = Split spoon sample
- 2S = For instances of no recovery from standard SS interval, a 2.5 inch O.D. split spoon is driven the full length of the standard SS interval plus an additional 6.0 inches to obtain a representative sample. Only the final 6.0 inches of sample is retained. Blow counts from 2S sampling are not correlated with N₆₀ values.
- 3S = Same as 2S, but using a 3.0 inch O.D. split spoon sampler.
- TR = Top of rock
- W = Initial water level measured during drilling
- ▼ = Water level measured at completion of drilling

Classification Test Data

Gradation (as defined on Description of Soil Terms):

GR	=	% Gravel
SA	=	% Sand
SI	=	% Silt
CL	=	% Clay

Atterberg Limits:

LL	=	Liquid limit
PL	=	Plastic limit
ΡI	=	Plasticity Index

WC = Water content (%)

DLZ Ohio, Inc.	* 6121 Huntley Road,	Columbus, Ohio 43229 *	(614) 888-0040
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Client:	: ms c	onsu	Itants	6			Project: FRA-70-8.93								Job	No.()221	-100	4.01		
LOG C	DF: Bo	oring	B-01	7-2-0)9	Lo	cation: Sta. 169+62.3, 117.3' LT., BL I-70 WB			Da	te	Drii	lled	1:9/2	23/20	009					
Depth (ft)	Elev. (ft) 713.0	Blows per 6"	Recovery	Sam, No		Hand Penetro- meter (tsf)	WATER OBSERVATIONS: Water seepage at: 16.5' Water level at completion: 17.0' (prior to adding water) 45.5' (includes drilling water) DESCRIPTION	Graphic Log	Aggregate	C. Sand	M. Sand	F. Sand	Si	lay	Natu Blows	ural M PL ⊢	loistu	ire Co	RATIC ontent lon-Pla	, % -' LL	۲
<u>1.2</u> – – 3.5 [–]	711.8	3 4 4	10	1		1.0	Asphalt Concrete - 2" Portland Cement Concrete - 9" Aggregate Base - 3" FILL: Stiff brown SANDY SILT (A-4a), little gravel; moist.														
5	-	3 6 7	5	2		-	some fine to coarse sand, trace to little silt; damp.														
<u>6.0</u> -	707.0	4 3 5	13	3		2.0	FILL: Stiff brown SANDY SILT (A-4a), trace to little gravel; damp to moist. @ 6.0'-7.5', contains few brick fragments.		10	12		19	40	19			· · · · · · · · · · · · · · · · · · ·				
<u>10</u>	-	3 2 3	13	4		1.0															
- - 13.5	699.5	2 3 7	13	5		1.0	@ 11.0'-12.5', little to some gravel;								(+ + +) (+ + +)						
	-	3 3 2	12	6			Loose brown COARSE TO FINE SAND (A-3a), some silt, little gravel; moist to wet.	••••	15	17		42	2	6							
- 18.5	694.5	1 2 2	18	7			•	••••													
		7 9 11	18	8			Medium dense brown GRAVEL WITH SAND, SILT, AND CLAY (A-2-6); wet.														— — — —
23.5	689.5	18 36 44	14	9			· <i>L</i>														11
-	688.0	16 24 40	18	10			very dense brown GRAVEL (A-1-a), some line to coalse		65	18		8	9		N P 						 66

Client:	ms c	onsu	Itants	5			Project: FRA-70-8.93								Job	No. 02	221-10	04.01	
LOG C	DF: Bo	ring	B-01	7-2-0	9	Loc	cation: Sta. 169+62.3, 117.3' LT., BL I-70 WB			Da	ate	Dril	llea	: 9/	/23/20	09			
Depth (ft)	Elev. (ft) 688.0	Blows per 6"	Recovery	Sam, No		Hand Penetro- meter (tsf)	WATER OBSERVATIONS: Water seepage at: 16.5' Water level at completion: 17.0' (prior to adding water) 45.5' (includes drilling water) DESCRIPTION	Graphic Log	% Aggregate	Sand	Sand	% F. Sand			Natu F Blows	ral Mo PL ⊢— per foo	isture (Content	DN (N60) , % - ● LL stic - NP 40
	000.0	P	-	7	-		Very dense brown GRAVEL (A-1-a), some fine to coarse	°0	0	G.	0、	0	0、	0					40
-		38 44 33	11	11			sand, trace silt; wet.	02											
		19 34 33	11	12				00 02 00											 6 (
<u>32.0</u>	681.0	9					Soft to medium stiff gray SILT AND CLAY (A-6a), trace to little fine to coarse sand, trace gravel; moist.												
- <u>35</u> -		12 14	12	13		0.5			7	1		1	41	50					
37.0	676.0	11					Very stiff gray SILTY CLAY (A-6b); trace to little fine to coarse sand; damp to moist.												
<u>40</u> - -		8 24	14	14		2.75													
- <u>45</u> -		8 9 14	18	15		2.75			9	7		6	34	44					
-							@ 48.5'-50.0', possible decomposed shale.												
- 50	663.0	24 36 40	18	16		3.75			-										

Client	: ms c	onsu	Itants	;			Project: FRA-70-8.93							Jo	b Nc	022	21-10	04.01	
LOG	DF: Bo	oring	B-0 1	7-2-0)9	Lo	cation: Sta. 169+62.3, 117.3' LT., BL I-70 WB			Da	te L	Drille	ed: 9	9/23/2	2009				
Depth (ft)	Elev. (ft) 663.0	Blows per 6"	Recovery	Sam No		Hand Penetro- meter (tsf)	WATER OBSERVATIONS: Water seepage at: 16.5' Water level at completion: 17.0' (prior to adding water) 45.5' (includes drilling water) DESCRIPTION	Graphic Log	gregate		pue	% F. Sand		Na	tural PL	Mois	sture (Non-Plas	% - • LL
- - - 54.8	658.2	22 39 50/4		17		2.5	Very stiff gray SILTY CLAY (A-6b); trace to little fine to coarse sand; damp to moist. @ 53.5'-54.8', possible decomposed shale.												
<u> </u>							Bottom of Boring - 54.8'												

6	PROJECT: FRA-70-13.10 - PHASE 6A DRILLING F TYPE: STRUCTURE SAMPLING	FIRM / LC	OGGER:	RII / K.S.	НАМІ	L RIG: MER:	(CME-750 (SI CME AUTO	MATIC	,	ALIG	NMEN			BL	I-70 V			EXPLOF	8-2-
	PID: <u>89464</u> BR ID: <u>FRA-70-1358L</u> DRILLING N START: 2/10/14 END: 2/13/14 SAMPLING			4.25" HSA / HQ SPT / RC			ON DA ATIO ('		4/26/13 82.6			ATION LONC	N:	715.7				8 007251	4.5 ft.	P/ 1 (
	MATERIAL DESCRIPTION AND NOTES	E	ELEV. 715.7					SAMPLE		-	RAD		N (%) CL		ERBE		WC	ODOT CLASS (GI)	HC SEA
0	0.5' - TOPSOIL (6.0")	N N	715.2				(()											1L
C V	FILL: LOOSE TO MEDIUM DENSE, BROWN TO BLACK GRAVEL WITH SAND AND SILT, LITTLE CLAY, MOIST TO WET. -TRASH, DEBRIS, PLASTIC, CINDERS AND ROOT				4 3	10	67	SS-1	-	-	-	-	-	-	-	-	-	12	A-2-4 (V)	
	IBERS PRESENT THROUGHOUT		710.2	-4 -3 - 5	5 8	18	72	SS-2	-	26	25	17	22	10	NP	NP	NP	28	A-2-4 (0)	
	TIL: STIFF TO VERY STIFF, BROWN SILTY CLAY , SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. -TRACE CINDERS AND BRICK FRAGMENTS PRESENT				7 8	21	83	SS-3	2.25	-	-	-	-	-	-	-	-	26	A-6b (V)	
	HROUGHOUT			- 8 - - 9 - 4	4 3	10	61	SS-4	1.75	-	-	-	-	-	-	-	-	23	A-6b (V)	-7 V - 7 V
	ILL: STIFF TO VERY STIFF, BROWN TO DARK BROWN ANDY SILT, SOME CLAY, TRACE FINE GRAVEL, DAMP. -TRACE CINDERS PRESENT IN SS-5	7	705.2	10 116 12	6 8	19	78	SS-5	2.75	9	16	8	39	28	28	19	9	16	A-4a (6)	
	IEDIUM DENSE TO DENSE, BROWN GRAVEL WITH	7	701.4	-13 - $-14 - 3$	3	11	11	SS-6	1.50	-	-	-	-	-	-	-	-	18 11	A-4a (V) A-1-b (V)	
	AND, TRACE CLAY, TRACE SILT, DAMP TO MOIST. -TRACE ROCK FRAGMENTS PRESENT IN SS-6B			- 15 - 16 - 16 - 5	9	22	72	SS-7	-	- 42		- 13	-		- NP			9	A-1-b (V)	
				- 17 - - 18 - - 7	7	22	12	33-7	-	42	57	13	1	7				9	A-1-0 (0)	
	DENSE TO VERY DENSE, GRAY GRAVEL , SOME		695.2	- 19 - 1 - 20	19	39	78	SS-8	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
	COARSE TO VERT DENSE, GRAT GRAVEL, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST.			- 22	1 25 28	73	56	SS-9	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
				-2324 - 1524 - 1525 -	5 20 23	59	83	SS-10	-	54	29	6	6	5	NP	NP	NP	8	A-1-a (0)	
	-IRON STAINING PRESENT IN SS-11			- 26 - 2! - 27 -	5 21 15	50	78	SS-11	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
	-LIMESTONE FRAGMENTS PRESENT THROUGHOUT			- 28 - - 29 - ²³	3	50		00.40												
		Pool		- 23	20 23	59	83	SS-12	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	1:

MATERIAL DESCRIPTION	ELEV.		SPT/		REC	SAMPLE	HP	Ċ	RAD	ATIO)N (%))	ATT	ERBE	ERG		ODOT
AND NOTES	685.7	DEPTHS	RQD	N ₆₀	(%)	ID	(tsf)				SI	CL	LL	PL	PI	WC	CLASS (GI)
DENSE TO VERY DENSE, GRAY GRAVEL , SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP TO MOIST. (same as above) -COBBLES PRESENT @ 31.0'			-														
c	°0°	34 - 34 - 35 -	48 15	45	56	SS-13	-	-	-	-	-	-	-	-	-	8	A-1-a (V)
e e e e e e e e e e e e e e e e e e e		- 36 -															
-INTRODUCED MUD @ 35.0'	678.7	- 37 -	-														
/ERY STIFF TO HARD, GRAY CLAY , SOME SILT, TRACE FINE GRAVEL, TRACE COARSE SAND, DRY TO DAMP.		- 38 -	-														
		39 - - 40 -	9 18	37	39	SS-14	3.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)
		- 	-														
		- 42 - - - 43 -	-														
		- 44 - - - 45 -	5 8 11	26	78	SS-15	3.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)
		- 46 - - 47 - - 47 - - 48 -	-														
		- 	8 11 13	33	72	SS-16	4.00	1	1	0	20	78	45	26	19	22	A-7-6 (13)
		- 	-														
		53 - - 54 -	8 11	36	83	SS-17	4.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)
		55 - 56 -	15 														
	656.9	- 57 - 58 -	-														
HALE : GRAY, HIGHLY WEATHERED, VERY WEAK.	656.9		-		100/	SS-18	~ <u>4.5+</u> ⁄						-				A-7-6 (V)
		61 -	- 1														

MATERIAL DESCRIPTION	ELEV.	DEDTUO	SPT/		REC	SAMPLE	HP	Ģ	RAD	ΑΤΙΟ	N (%) (ATT	ERBE	RG		ODOT
AND NOTES	653.6	DEPTHS	RQD	N ₆₀	(%)	ID	(tsf)		CS		SI	CL	LL	PL	PI	WC	CLASS (GI)
LE : GRAY, HIGHLY WEATHERED, VERY WEAK.		- 63 - - 64 - - 65 - - 66 - - 67 -	- 12 50/5" - - -	-	91	SS-19	-	-	-	-	-	-	-	-	-	11	Rock (V)
		- 68 - - 69 - - 70 - - 71 - - 72 - - 73 -	-	-	100	SS-20	-	-	-	-	-	-	-	-	-	11	Rock (V)
			30 50/2"_/-	-	100	SS-21	-	-	-	-	-	-	-	-	-	13	Rock (V)
AUGER REFUSAL @ 74.5'		- 75 - - 76 - - 77 - - 78 - - 79 -			100	RC-1											CORE
	631.2	- 80 - - 81 - - 82 - - 83 - - 83 - - 84 -	87		100	RC-2											CORE

Rii PROJE		STRUC		S	SAMPLING	6 FIRM	OPERATO	:RII / \$	J.B./T.F. S.B./S.M.	HAI	MMER:		BILE B-53 (AUTOMA	TIC		ALIG	MEN	IT:		BL R	+77.61 Ramp E	7			RATIO 20-4-1 PA
PID:	89464 : 3/5/1		FRA-70-1373 : 3/11/14		orilling Sampling			3.25" HSA SPT /			librat Ergy f			1/26/13 77.7		ELEV. LAT /			714.0) <u> </u>			.7 ft.	10
			SCRIPTION				ELEV. 714.0	DEPT	шe	SPT/ RQD			SAMPLE ID			RAD		_	/	ATTE	ERBEI	RG		ODOT CLASS (GI)	HC SE/
0.2' - TOPSOIL	(2.0")	_	-		/		713.8/	-				(()											\mathbb{X}
FILL: STIFF, DA COARSE TO FI					IST.				- 1 - - 2 - - 3 -	3 2 1	4	44	SS-1	1.25	-	-	-	-	-	-	-	-	25	A-6a (V)	
-TRACE ORGA	NICS AN	D WOOD	FIBERS PRE	ESEN	T IN				- 4 - - 5 -	1 1 2	4	72	SS-2	1.25	14	14	16	31	25	32	18	14	28	A-6a (6)	-
							706.0			3 3 3	8	72	SS-3	2.50	-	-	-	-	-	-	-	-	25	A-6a (V)	
ERY STIFF TO INE SAND, TR				ILT, TI	RACE				- 8 - - 9 - - 10 -	3 5 6	14	72	SS-4	3.50	1	0	5	53	41	48	20	28	29	A-7-6 (17)	
							704.0		- 11 - - 11 - - 12 -	4 5 6	14	100	SS-5	3.75	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
.OOSE, BROW CLAY, MOIST T		L WITH SA	and and sil	_T , TR	ACE		701.0		- 13 - - 14 - - 15 -	WOH 2 2	5	56	SS-6	-	-	-	-	-	-	-	-	-	20	A-2-4 (V)	
							696.0	w	- 16 - - 17 -	2 2 5	9	44	SS-7	-	33	17	16	25	9	NP	NP	۱P	17	A-2-4 (0)	
MEDIUM DENS VITH SAND , LIT VET.					AVEL		090.0	W	- 18 - - 19 - - 20 -	4 6 11	22	33	SS-8	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
-INTRODUCE) MUD @	21.0'							- 21 - - 21 - - 22 -	6 12 15	35	100	SS-9	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
									- 23 24	8 12 18	39	78	SS-10	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
-COBBLES PR	ESENT T	HROUGH	OUT						- 25 - - 26 - - 27 -	21 18 12	39	33	SS-11	-	61	15	8	10	6	NP	NP I	۱P	8	A-1-b (0)	
									- 28	12															Ŵ
									- 29 -	4 4	12	33	SS-12	_	-	_	_	-	-	_	-	-	22	A-1-b (V)	

MATERIAL DESCRIPTION	ELEV.	DEDTUO	SPT/	N	REC	SAMPLE	HP	0	GRAD	ΑΤΙΟ)N (%)	ATT	ERBE	RG		ODOT
AND NOTES	684.0	DEPTHS	RQD	N ₆₀	(%)	ID	(tsf)	GR		FS	<u> </u>	CL	LL	PL	PI	WC	CLASS (GI)
EDIUM DENSE TO DENSE, BROWN TO GRAY GRAVEL ITH SAND , LITTLE SILT, TRACE CLAY, MOIST TO ET. (same as above) EDIUM DENSE, GRAY GRAVEL , SOME COARSE TO NE SAND, TRACE SILT, TRACE CLAY, MOIST.	682.0	- 31 - - 32 - - 33 -															
		- 34 -	1 1 17	23	44	SS-13	-	62	22	5	7	4	NP	NP	NP	11	A-1-a (0)
	677.0	35 36 															
ERY DENSE, GRAY GRAVEL , LITTLE COARSE TO FINE		- 37															
		39 - 40 -	8 20 25	58	67	SS-14	-	-	-	-	-	-	-	-	-	10	A-1-a (V)
		41 42															
		43 - 44	18 26 27	69	83	SS-15	-	_	-	_	-	_	-	-	-	10	A-1-a (V)
		45 46	27														
		47 48															
		- 49 - - 50 -	8 31 50	105	72	SS-16	-	83	10	3	3	1	NP	NP	NP	9	A-1-a (0)
		- 53 - - 54 -	50 _50/3"	-	100	SS-17	-	-	-	-	-	-	-	-	-	12	A-1-a (V)
AUGER REFUSAL ON BOULDER @ 55.5'; SWITCHED TO	d	- 55 - - 55 - - 56 -															
ARD, GRAY SILTY CLAY , TRACE COARSE TO FINE	° 657.0	- 57 - - 57 - - 58 -															
		- 59 - - 60 -	10 27 35	80	42	SS-18	4.5+	7	4	4	41	44	40	19	21	14	A-6b (12)
		61															

MATERIAL DESCRIPTION	ELEV.			SPT/	NI	REC	SAMPLE	HP	(GRAD	ATIC)N (%	5)	ATT	ERBE	RG		ODOT	
AND NOTES	651.9	DEP1	HS	RQD	N ₆₀	(%)	ID	(tsf)	GR	CS	FS	SI	CL	LL	PL	ΡI	WC	CLASS (GI)	s
HARD, GRAY SILTY CLAY , TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP. <i>(same as above)</i>			- 63 -	31 50/5"		91	SS-19	4.5+	_	_				_	_		16	A-6b (V)	
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.	649.6	TR	64 65 66	50/5"	-	91	33-19	4.5+	-	-	-	-	-	-	-	-	10	A-0D (V)	
			- 67 - - 68 - - 69 - - 70 -	50/5"	-	100	SS-20	-	-	-		-	_		-	-	19	Rock (V)	
			- 71 - - 72 - - 73 -	-															
	639.3		_ 74 _	50/5"	-	20	SS-21		-	-	-	-		-	-	-	23	Rock (V)	
SHALE : DARK GRAY, SLIGHTLY WEATHERED, WEAK, /ERY THIN TO THIN BEDDED, ARGILLACEOUS, MODERATELY FRACTURED, NARROW APERTURES, SLICKENSIDED TO SLIGHTLY ROUGH; RQD 66%, REC 199%.	635.6		75 - 76 - 77 - 78 -	75		92	RC-1											CORE	XIINXIINX
CLAYSTONE : DARK GRAY, SLIGHTLY WEATHERED, /ERY WEAK, THIN BEDDED, CALCAREOUS, FRACTURED, TIGHT APERTURES, SLICKENSIDED TO	<u> 035.0</u>	-	- 79 - - 80 -																
SLIGHTLY ROUGH; RQD 100%, REC 100%. -SHALE SEAM PRESENT FROM 79.7' TO 80.7'			- 81 - 82 -	100		100	RC-2											CORE	
-PYRITIC FROM 80.7' TO 83.7' IMESTONE : DARK BROWNISH GRAY,	630.3		- 83 - - - 84 -			100												OORE	
JNWEATHERED, MODERATELY STRONG TO STRONG, THIN TO MEDIUM BEDDED, CHERTY, DOLOMITIC, MODERATELY TO SLIGHTLY FRACTURED, NARROW TO DPEN APERTURES, SLIGHTLY ROUGH; RQD 87%, REC 15%.			- 85 - - 86 -																TXV/TX
-QU @ 86.5' = 13,130 PSI			87 - - - 88 - - - 89 - -	90		95	RC-3											CORE	TXV/TXV
-QU @ 90.7' = 16,178 PSI			- 90 - - - 91 - - - 92 -	85		95	RC-4											CORE	TXV//XV
			- 93 -			-													

PID:	89464	BR ID:	FRA-70)-1373B	PROJE	CT:	FRA-70	-13.10 - I	PHASE 64	4	S	ΤΑΤΙΟ	N / O	FFSE	T: 7	/007+7	77.61	/ 12.0) RT		STAF	RT: 3	3/5/14	4 El	ND:	3/11	/14 F	PG 4 0	F4 B-	020-4-
		M	ATERIA	L DESCI	RIPTION	I			ELEV		DEPT	гне	S	PT/ QD	NI		SAM	PLE	HP		GRAD	ΟΑΤΙΟ	ON (%	6)	AT	TER	BERG	6	ODOT	HO
			AN	ID NOTE	S				619.7		DEP	пэ	R	QD	N ₆₀	(%)	ID)	(tsf)	GR	CS	FS	SI	CL	LL	PL	L PI	WC	CLASS (0	³⁾ SEAI
									<u>619.3</u>	┍┷┎	OB	<u> </u>	-																	\times
									ידיי		10 5																			
	ES: SEEF																													
NL	JDONMEN	T METHO	ds, mate	Erials, Q	UANTITIE	ES: PU	IMPED 1	88 LBS (CEMENT	/ 50 LB	S BEN	TONITE	E POW	DER /	40 GA	AL WAT	ER													

PROJECT:		STRUCT		SAM	ILLING FIRM	/ LOGGEF	R:RII	RII / J.B. / T.F./K.S	HAI	ILL RIG MMER:		CME-750 (SI CME AUTO	MATIC	;	ALIG	NMEN		-	Bl	+12.8 _ I-71 \$	SB			4-7-1
	9464 2/4/14	BR ID: END:	FRA-71-1503L 2/14/14		ILLING METH MPLING MET		4.25" HS SPT			LIBRAT ERGY F			4/26/13 82.6	3	ELEV		N:	713.3				8 006602	34.0 ft.	PA 1 0
51AKI		_		0		ELEV.			SPT/			SAMPLE			GRAD			5)		ERBI		.000002	ODOT	HO
		ND NOT				713.3	DEF		RQD		(%)	ID	(tsf)	-		FS	· · ·	·	LL	-	-	WC	CLASS (GI)	SEA
0.2' - TOPSOIL (2.0						713.1																		7LV
VERY STIFF, BROV GRAVEL, SOME CO -ROCK FRAGMEN	OARSE	O FINE	SAND, DAMP) .				- 1 - - - 2 -	5 7 30	51	83	SS-1	3.25	32	14	13	22	19	33	19	14	12	A-6a (2)	- 1 > r - 1 > r - 1 > r
		02.11.11						- 3 -	0															72
-IRON STAINING	PRESEN	IT IN SS-	-2			707.8		- 4 - - - 5 -	9 11 4	21	61	SS-2	3.00	-	-	-	-	-	-	-	-	11	A-6a (V)	72
VERY STIFF, BRO SAND, TRACE FIN				INE		-	-	6	1															
		,						- 7 -	4 4	11	44	SS-3	3.00	2	0	8	43	47	41	20	21	22	A-7-6 (13) 17 - 1 L
-IRON STAINING	PRESEN		UGHOUT					- 8	3 5	18	67	SS-4	3.25	-	_	-	_	_	-	_	_	25	A-7-6 (V)	
								- 10 -	8														- (*)	- 7 L 7 Z
								11 - 12	8 9 9	25	89	SS-5	2.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
OOSE, BROWN G		NITH SA	ND. SILT. AND		Y E	700.3	-	- 13 -																47
-COBBLES PRES			, 0, ,					- 14 -	3 3 3	8	94	SS-6	-	30	19	21	12	18	34	17	17	14	A-2-6 (1)	
MEDIUM DENSE T			/N GRAVEL, L		E	697.8 (w																	1 1 1
COARSE TO FINE MOIST.							W	16 17	5 9 <u>13</u>	30	56	SS-7	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
						0		- 18 - - - 19 -	6															- 7 L - 7 X
					0000	0		- 20 -	8	22	67	SS-8	-	-	-	-	-	-	-	-	-	12	A-1-a (V)	$\begin{vmatrix} 1 \\ 7 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\$
-ROCK FRAGMEN	ITS PRE	SENT TH	HROUGHOUT		00			21 22	7 8 _	21	78	SS-9	-	-	-	-	-	-	-	-	-	11	A-1-a (V)	
								- 23 -	7															
								- 24 -	8 10 <u>12</u>	30	72	SS-10	-	69	12	6	8	5	NP	NP	NP	14	A-1-a (0)	
					0	0		25	7															
						685.3		- 27 -	10 18	39	83	SS-11	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	1 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
/ERY DENSE, BRO FINE SAND, TRAC				E TO		0	1	- 28	41	-	60	SS-12	_	_			_	-	_	-		8	A-1a (V)	
INL SAND, IRAU		NVAVEL,	WOI31.		0	5		_ 29 _	50/4"	-	00	33-12	-	-	-	-	-	-	-	-	-	0	A-18(V)	- 4 >

MATERIAL DESCRIPTION	ELEV.	DEDTUO	SPT/		REC	SAMPLE	HP	(RAD	ATIC)N (%)	ATT	ERB	ERG		ODOT
AND NOTES	683.3	DEPTHS	RQD	N ₆₀	(%)	ID	(tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	CLASS (GI)
ERY DENSE, BROWN GRAVEL , LITTLE COARSE TO INE SAND, TRACE FINE GRAVEL, MOIST. (same as bove) ERY DENSE, GRAY GRAVEL WITH SAND , LITTLE SILT,	\d	- 31 - - 32 - 															-
RACE CLAY, DAMP.			33 21 19	55	56	SS-13	-	58	17	8	10	7	18	14	4	8	A-1-b (0)
	676.3	- 35 - - 36 -															
IEDIUM DENSE, GRAY GRAVEL WITH SAND, LITTLE		- 37 - - 38 -	6														
-COBBLES PRESENT @ 40.0'		- 39 - - 40 -	6 9	21	33	SS-14	-	-	-	-	-	-	-	-	-	14	A-1-b (V)
ARD, BROWN TO GRAY SILTY CLAY , TRACE COARSE	671.3	41 42 															
O FINE SAND, TRACE FINE GRAVEL, MOIST.		- 43 - - - 44 -	14 14	41	72	SS-15	4.50	4	1	3	46	46	31	15	16	20	A-6b (10)
		- 45 - - 46 - - 47 -	16														
		- 48 - - 49 -	11 11 11	30	83	SS-16	4.25	-	-	-	-	_	-	-	-	19	A-6b (V)
	661.3	- 50 - - 51 -															
ARD, GRAY CLAY , SOME TO "AND" SILT, TRACE TO ITTLE FINE GRAVEL, TRACE COARSE TO FINE SAND, AMP.		52 53 53	21														
-ROCK FRAGMENTS PRESENT IN SS-17		54 - 55 -	32 50/3"	-	100	SS-17	-	9	3	3	38	47	41	18	23	14	A-7-6 (13)
			31 50/5"	-	100	SS-18	-	-	-	-	-	-	-	-	-	15	A-7-6 (V)
		60 - 61															

PID: 89464	BR ID:	FRA-71-	1503L	PROJECT	:F	RA-70-1	3.10 - P	HASE 6A		STATION	/ OFFS	ET:	<u> 271+</u> 1	2.84 / 28.	4 RT		STAR	T: _2	/4/14	EN	D: _2	/14/1	4 P	G 3 O	= 3 B-11	4-7-13
	M	ATERIAL	DESCR	IPTION				ELEV.			SPT/		REC	SAMPLE	HP	0	RAD	ATIC)N (%)	ATT	ERB	ERG		ODOT	HOLE
		ANL	NOTES	6				651.2	DEF	PTHS	RQD	N ₆₀	(%)	ID	(tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	CLASS (GI)	SEALE
HARD, GRA LITTLE FINE DAMP. (same	GRAVEL	., TRACE						040.4		- 63 - 64 -	21 21	-	59	SS-19	-	15	0	1	32	52	50	24	26	17	A-7-6 (16)	
SHALE : GRA	AY, HIGH	LY WEA	THERE	D, VERY V	VEAK.			648.4	TR-		50/5" 															
										69 - 70 - 71 -	18 24 <u>50/3</u> "	-	67	SS-20	-	-	-	-	-	-	-	-	-	12	Rock (V)	
								639.3		- - - - - 73 - - - 74 -	-															
LIMESTONE SLIGHTLY W VERY THICK ARGILLACEO JOINTED, MO APERATURE -QU @ 75.1	EATHER BEDDEL DUS, CAL DDERATI	RED, STR D, CALC/ LCITE VE ELY TO I GH; RQD	ONG TO AREOUS EINS, CH HIGHLY	D VERY S 3, DOLOM IERT INCI FRACTUR	TRON 11TIC, LUSIO	NS,				- - 75 - - 76 - - 77 - - 77 - - 78 - - 79 -	48		92	RC-1											CORE	
-QU @ 81.5	' = 9,141	PSI						629.3	ЕОВ	- - 80 - - 81 - - 82 - - 83 - - 83 - - 84-	- 52		83	RC-2											CORE	
NOTES: SEEF				'; ground'																						
		DS, MATER	RIALS, QU	JANTITIES:	PUMF	PED 188	BLBS C	EMENT 10	00 LBS BE	NTONITE 7	'0 GALLO	NS WA	ATER; C	OMPACTE	D WITH	I THE	AUGE	R 30	0 LBS	BEN ⁻	TONIT	E CH	IPS AI	ND SO	IL CUTTINGS	5

		3.10 - PHASE 6A JCTURE	SAMPLIN	G FIRM	OPERATO		rii / J.K. II / S.B.		ILL RIG MMER:		BILE B-53 (AUTOMA		400)	STAT ALIGN					+13.25 I-71 S			EXPLO B-1	14-8
PID:		FRA-71-1503L				3.25" HS/						4/26/13		ELEV			714.0					2.0 ft.	- F
START:		ND: <u>3/13/14</u>	SAMPLIN	GMEI		SPT /		SPT/	ERGY F		SAMPLE	77.7 HP		LAT /)		53894 ERBE		005886	ODOT	_ <u> </u>
	AND N				714.0	DEP	THS	RQD	N ₆₀	(%)	ID	(tsf)		CS		SI	/			PI	wc	CLASS (GI)) SE
0.3' - TOPSOIL (3.0	,			<u>/</u>]]]	713.7																		\mathbb{X}
FILL: VERY STIFF T SILT, SOME FINE G								7 8 8	21	50	SS-1	4.50	-	-	-	-	-	-	-	-	14	A-4a (V)	
							- 3 -	6 7	21	61	SS-2	3.00	21	22	14	25	18	32	22	10	17	A-4a (2)	-8
STIFF TO VERY ST					708.5		- 5 -	9									_						-
CLAY, LITTLE COAL GRAVEL, MOIST.							- 6	3 2 1	4	33	SS-3	1.75	-	-	-	-	-	-	-	-	24	A-6b (V)	
							- 8 -	5									-						\mathbb{R}
							- 9 - - 10 -	5 8	17	50	SS-4	2.25	-	-	-	-	-	-	-	-	21	A-6b (V)	
							- 11 -	2 3	9	89	SS-5	1.25	1	2	12	36	49	38	16	22	22	A-6b (13	
							_ 13 _	4															
					698.5		14 15	4 4 4	10	72	SS-6	1.25	-	-	-	-	-	-	-	-	22	A-6b (V)	
MEDIUM DENSE TO COARSE TO FINE S				00	0 '	W	- 16 -	14 16	34	72	SS-7	_	64	13	9	10	4	20	19	1	10	A-1-a (0)	
MOIST.				00		w	17 18	10							-		·						
					S		19 20	8 7 8	19	83	SS-8	-	-	-	-	-	-	-	-	-	11	A-1-a (V))
AEDIUM DENSE TO					693.5		20 - 21 - 21 -	4															\rightarrow
NOIST.	, INAUL OIL	LI, INACE CLAT	,				- 22 -	8 16	31	56	SS-9	-	35	42	9	10	4	NP	NP	NP	16	A-1-b (0)	'
-COBBLES PRESE	ENT THROUG	HOUT					- 23	12 16	44	72	SS-10	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
-INTRODUCED MU	JD @ 25.0'						- 25 -	18															
					686.0		27 -	5 3 8	14	33	SS-11	-	-	-	-	-	-	-	-	-	30	A-1-b (V))
ERY DENSE, BRO INE SAND, TRACE					q		- 28 - - - 29 -	19 27	71	72	SS-12		63	18	7	9	3		NP		12	A-1-a (0)	

	A-70-13.10 - PHASE 6A					3.25 / 16.							_		PG 2 C	
MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD		REC (%)	SAMPLE ID	HP (tsf)		GRAD		N (%) si			RBER(_	ODOT H CLASS (GI) SE
VERY DENSE, BROWN GRAVEL , SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DRY TO MOI (same as above)	.T	- 31 32			(70)			UIT	00	10		UL				
-COBBLES PRESENT THROUGHOUT	O O	- 33 -	50/5"	-	20	SS-13	-	-	-	-	-	-	-		3	A-1-a (V)
	$\circ \bigcirc \langle$		50/5"	-	_20_			-	-	-	-	-	-			A-1-a (V)
	000	- 36 -														
IARD, GRAY SILTY CLAY, TRACE COARSE TO FINE	<u>677.0</u>	- 37 -														
SAND, TRACE FINE GRAVEL, MOIST.		- 38 -														
		- 39 -	5 6 8	18	33	SS-14	4.25	3	2	2	38	55	36	18 18	21	A-6b (11)
		40 														
IEDIUM DENSE, GRAY GRAVEL, SOME COARSE TO	672.0	- 42 -														
INE SAND, TRACE SILT, MOIST.		- 43	4												-	
	la∩d 669.2		8	18	100	SS-15	-	-	-	-	-	-			14	A-1-a (V)
/ERY STIFF TO HARD, BROWN CLAY , SOME SILT, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL DAMP.	,	- 45 - - 46 -	-				3.50/	<u> </u>	<u> </u>		-	-				A-7-6 (V)
		- 47														
		- 48 - - 49 -	8 10	30	67	SS-16	3 50	15	11	10	30	34	42 2	20 22	18	A-7-6 (11)
		50	13		01	00-10	0.00			10						
		- 51 -														
		- 52														
		- 54 -	6 42 50/5"	-	65	SS-17	4.5+	-	-	-	-	-	-		12	A-7-6 (V)
												\uparrow				
		- 57 -														
		- 58 -	10													
		59 - - 60	10 49 <u>50/3"</u>	-	100	SS-18	4.5+	-	-	-	-	-	-		15	A-7-6 (V)
		- 61														
			1													

PID: <u>89464</u>	BR ID: FRA-71-1503L		13.10 - P	HASE 6A	S	TATION		=1:	_	3.25 / 16.			STAR							330	F3 B-114
	MATERIAL DESC AND NOTES			ELEV. 651.9	DEP	THS	SPT/ RQD	N ₆₀	REC (%)	SAMPLE ID	HP (tsf)		CS CS	-	(· · ·) CL	ATT LL	ERBE PL	ERG	WC	ODOT CLASS (GI)
						- 63 -			(70)												
SHALE : GRA	AY, HIGHLY WEATHEREI AUGER REFUSAL @				—TR	64	37 _50/4"	-	100	SS-19	-	-	-	-	-	-	-	-	-	15	Rock (V)
VEAK TO W ARGILLACEC JARROW TC SLIGHTLY RC -0.5' CLAYS	K GRAY, SLIGHTLY WE EAK, THINLY LAMINATE DUS, FRACTURED TO HI O OPEN APERTURES, SL OUGH; RQD 19%, REC 8 TONE SEAM @ 67.7' NE SEAMS PRESENT FR	ATHERED, VERY D TO LAMINATED, GHLY FRACTURED, ICKENSIDED TO 2%.				- 67 - - 68 - - 69 - - 70 - - 71 -	19		82	RC-1											CORE
/ERY WEAK /ERY THIN	: DARK GRAY, SLIGHTL TO WEAK, THINLY LAM BEDDED, FRACTURED T O, OPEN APERTURES, R ' = 92 PSI	INATED BEDDING TO		637.0		- 72 - - 73 - - 74 - - 75 - - 76 -	12		97	RC-2											CORE
THICK BEDD JOINTED, SL NARROW TC RQD 92%, RE	: GRAY, UNWEATHEREL ED, CALCAREOUS, CHE IGHTLY FRACTURED TO OPEN APERTURES, SL EC 98%. ' = 12,567 PSI	RTY, PYRITIC, FRACTURED,		632.0		- 77 - - 78 - - 79 - - 80 - - 81 -	92		98	RC-3											CORE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT 50 LBS BENTONITE 40 GALLONS WATER AND SOIL CUTTINGS

PROJECT: TYPE:		STRUC			SAN	/IPLING	FIRM	OPERATO	:F	RII / T.F. RII / B.Z.	HA	MMER:		BILE B-53 (AUTOMA	ATIC			NMEN	IT:		BL	+07.50 I-71 SE	В			14-9-
	39464 5/9/14		FRA-71-1): 5/13			lling M Ipling			3.25" HS SPT			LIBRAT			4/26/13 77.7		ELEV			714.0) E 53788		9 005201	0.0 ft.	1 (
	MATE		SCRIPTIO					ELEV. 714.0		THS	SPT/	N		SAMPLE ID			RAD	ATIO		/	ATTE	RBE	RG	wc	ODOT CLASS (GI)	
0.4' - TOPSOIL (4.		/				_		71 <u>4.0</u>		L	_		(70)			0.1			0.	01						
FILL: LOOSE TO M GRAVEL WITH SAN MOIST. -ROOT FIBERS P	ND AND	SILT, TR	RACE CLA							- 1 - - 2 - - 3 -	2 9 9	23	33	SS-1	-	56	15	10	13	6	-	-	-	8	A-2-4 (V)	
-BRICK FRAGME	NTS PF	RESENTI	IN SS-2 A	ND SS	S-3					- - 4 - - 5 -	3 4	12	33	SS-2	-	60	10	7	15	8	33	23	10	23	A-2-4 (0)	-
-CINDERS PRESI	ENT IN	SS-3						706.0		- 6 - - 7 -	2 2 2	5	67	SS-3	-	-	-	-	-	-	-	-	-	28	A-2-4 (V)	
STIFF, DARK BRO INE SAND, MOIS		TY CLAY	, TRACE	COAR	RSE T	0				- 8 - - - 9 - - - 10 -	1 2	8	67	SS-4	1.75	-	-	-	-	-	-	-	-	29	A-6b (V)	
										- 10 - - - 11 - - - 12 -	2	9	89	SS-5	2.00	0	1	7	53	39	37	20	17	22	A-6b (11)	
-COBBLE PRESE							• • •	701.0		- 13 -	-	<u>'</u>														-
MEDIUM DENSE T SAND, LITTLE SILT							$\circ \bigcirc \circ$			- 14 -	2	14	44	SS-6		_	_		_	_	_	_	_			-))
-LARGE PIECE O	F ROC	K RECOV	/ERED IN	SS-6						- 15 - -		,		00-0				_	_			_				-)
										- 16 - - - 17 -	E .	16	61	SS-7	-	49	11	17	19	4	NP	NP	NP	11	A-1-b (0)	
-COBBLES PRES	ENT TH	IROUGH	OUT							18 - 19 -	16 14	40	67	SS-8	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
										20 - 21 -	-															
									w	- 22 -	4	14	61	SS-9	-	33	31	16	14	6	26	20	6	18	A-1-b (0)	
											21 17	48	0	SS-10	-	-	_	-	-	-	_	-	-	-		-
								688.5		- 25 - -	20 15	-	100	3S-10A	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	Ŵ
/EDIUM DENSE T .ITTLE COARSE T CLAY, MOIST.										- 26 - - - 27 -	12 9	23	44	SS-11	-	82	10	3	4	1	NP	NP	NP	10	A-1-a (V)	
							000			- 28 -																
										- 29 -	16 21	54	39	SS-12	-	_	-	_	_	_	_	_	_	9	A-1-a (V)	, 1 ()

PID: 89464 BR ID:	FRA-71-1503L	PROJECT:	FRA-70-13.	10 - PHASE 6A	S	TATION /				07.50 / 4.7										G 2 OI	F3 B-114-
	MATERIAL DESCI			ELEV.	DEP	гнз	SPT/	N ₆₀		SAMPLE			RAD		<u> </u>			ERBE			
MEDIUM DENSE TO LITTLE COARSE TO CLAY, MOIST. (sam -INTRODUCED MU VERY DENSE, BRO) FINE SAND, TRA e as above) ID @ 30.0'	ROWN GRAV ACE SILT, TRA	ACÉ	684.0 682.0		- 31 - - 32 -	RQD	60	(%)	ID	(tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	CLASS (GI) SE
ITTLE FINE GRAVE			WET.			- 33 -	30		100	00.40		4.4	10	F 4	45	_				24	A 25 (0)
						- 34 - - 35 -	30 _ <u>50/3"</u> _	-	100	SS-13	-	11	18	51	15	5	NP	NP	NP	24	A-3a (0)
				677.0		- 36 -															
iard, brown San Gravel, Damp.	NDY SILT, LITTLE	CLAY, TRACE	EFINE			- 38 -			100											10	
						39 40	50/5"	-	100	SS-14	4.50	-	-	-	-	-	_	_	-	_10_	A-4a (V)
				672.0		41															
ERY DENSE, GRA		ine sand, Lit	TTLE			- 42 - - 43 -	47														
						- 44 - - 45 -	17 19 20	51	67	SS-15	-	-	-	-	-	-	-	-	-	13	A-3a (V)
				667.0		46 -															
ERY STIFF TO HA	RD, GRAY CLAY , SAND, MOIST.	SOME SILT, 1	TRACE			- 47 - - 48 -															
						- 49 - - 50 -	2 9 12	27	72	SS-16	3.50	0	1	2	28	69	42	19	23	21	A-7-6 (14)
			-			- 51															
						52 53															
			- - - - - - - - - - - 			- 54 -	9 11 16	35	78	SS-17	4.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)
			- - - - -			- 56 -															
			- - - - - -	655.0		- 57 - - 58 -															
HALE : GRAY, HIG			K -	655.0	TR	- 59 -	18 50/4"	-	100	SS-18	4.5+	-	-	-	-	-	-	-	-	<u>22</u> 10	A-7-6 (V) Rock (V)
INALE . GRAT, FIIG	HEI WLAINERE	U, VENT VVEA	νι ν .			60 -								\square				\square			
						- 61															

MATERIAL DESCRIPTION	E	ELEV.	DEDT	110	SPT/	N	REC	SAMPLE	HP	Ģ	RAD	ATIC)N (%)	ATT	ERBE	RG		ODOT	HC
AND NOTES	6	651.9	DEPT	HS	RQD	N ₆₀	(%)	ID	(tsf)	GR	CS	FS	SI	CL	LL	PL	ΡI	WC	CLASS (GI)	SEA
SHALE : GRAY, HIGHLY WEATHERED, VERY WEAK.																				\mathbb{K}
same as above)	巨司			- 63 -																
				- ₆₄ -	50/5"	-	100		-	-	-			-	-	-	-	16	Rock (V)	48
AUGER REFUSAL @ 65.0'		649.0			-															
SHALE : DARK GRAY, SLIGHTLY WEATHERED, VERY				65																
VEAK TO WEAK, VERY THIN TO THIN BEDDED,	E			- 66 -																\otimes
CALCAREOUS, FISSILE, PYRITIC, MODERATELY RACTURED TO FRACTURED, NARROW TO OPEN				67 -																
APERTURES, SLIGHTLY ROUGH; RQD 64%, REC 79%.					26		33	RC-1											CORE	
-ARGILLACEOUS FROM 65.6' TO 75.0'	E			68 -																
				- 69 -																
				- 70 -																$-\mathbb{N}$
-0.3' LIMESTONE SEAM @ 71.5'				- 71 -																
3				- 72 -																×
				- 73 -	58		88	RC-2											CORE	
				- 74 -																
				- 75 -																-K
				- 76 -																\otimes
	F																			
				- 77 -			100	DO 3												\otimes
				- 78 -	83		100	RC-3											CORE	
																				\otimes
-ARGILLACEOUS FROM 78.6' TO 85.0'				- 79 -																
-POINT LOAD STRENGTH @ 78.8' TO 81.3' -MEAN QU = 176 PSI	E			- 80 -																\rightarrow
-MEAN Q0 - 170 - 51				- 81 -																
				82 -	90		93	RC-4											CORE	
				- 83 -															OORE	
				- 84 -																
		529.0			-															\otimes
IMESTONE : GRAY, UNWEATHERED, VERY STRONG,	<u> </u>			- 85 -																-186
MEDIUM TO THICK BEDDED, CALCAREOUS, DOLOMITIC,				- 86 -																
PYRITIC, MODERATELY FRACTURED TO FRACTURED, DPEN APERTURES, SLIGHTLY ROUGH; RQD 89%, REC	<u><u> </u></u>			- 87 -																
3%.					89		93	RC-5											CORE	
				- 88 -																
				- 89 -																
	<u> </u>	624.0	—ЕОВ																	\otimes
			LOD	30-																
IOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 23.0' \BANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 18																				

APPENDIX IV

LABORATORY TEST RESULTS



Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949 9885 Rockside Road 4480 La Cleveland, OH 44125 Cincinn Phone (216) 573-0955 Phone I

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

 ve
 Project:
 FRA-70-13.10 - Project 6A

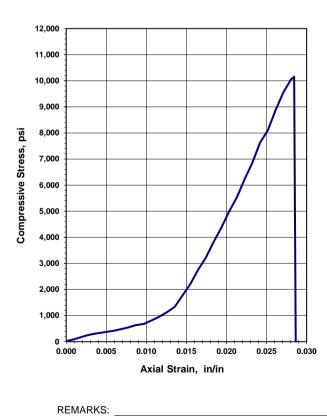
 12
 Project No.:
 W-13-072

 8
 Date of Testing:
 2/13/2014

Test Performed by: J.H./T.K.

Rock Description: Gray Limestone

Boring No.:	B-018-2-13	Average Length:	5.169 in
Sample No:	RC-1	Average Diameter:	2.4 in
Depth (ft):	78.5	Length to diameter ratio:	2.154
Moisture condition:	As received	Cross Sectional Area:	4.522 in ²
Rate of Loading:	78.5 lbs/sec	Failure Load:	45,920 lbs
Testing Time:	585 sec	Axial Strain at Failure:	0.0284 in/in
(1	Rate 2-15 minutes to failure)	Stress:	10,153 psi



Unconfined Compression Test







Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949 9885 Rockside Road 4480 L Cleveland, OH 44125 Cincinn Phone (216) 573-0955 Phone

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

 Project:
 FRA-70-13.10 - Project 6A

 Project No.:
 W-13-072

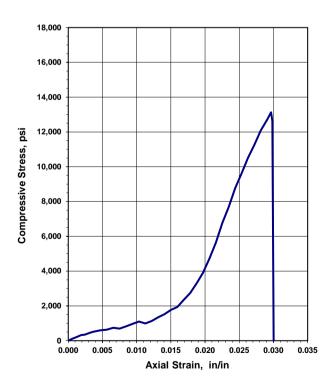
 98
 Date of Testing:

 4/1/2014

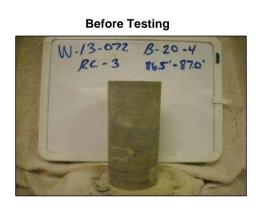
Test Performed by: K.R./T.K.

Rock Description: Limestone

	B-20-4	Average Leng	th:	5.329 in
	RC-3	Average Diamet	er:	2.477 in
	86.5	Length to diameter rate	tio:	2.151
ŀ	As received	Cross Sectional Are	ea:	4.816 in ²
1	14.2 lbs/sec	Failure Los	ad:	63,240 lbs
	554 sec	Axial Strain at Failu	re:	0.0296 in/in
(Rate	2-15 minutes to failure)	Stre	ss:	13,126 psi



Unconfined Compression Test



After Failure





Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949

 9885 Rockside Road
 4480 I

 Cleveland, OH 44125
 Cincin

 Phone (216) 573-0955
 Phone

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

 ve
 Project:
 FRA-70-13.10 - Project 6A

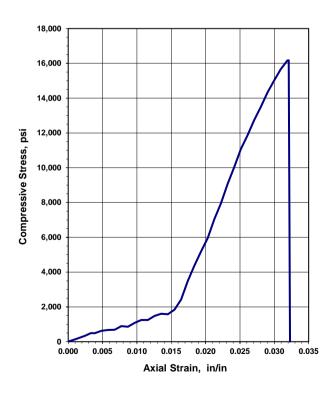
 42
 Project No.:
 W-13-072

 98
 Date of Testing:
 4/1/2014

Test Performed by: K.R./T.K.

Rock Description: Limestone

Boring No.:	B-20-4	Average Length:	5.173 in
Sample No:	RC-4	Average Diameter:	2.47 in
Depth (ft):	90.7	Length to diameter ratio:	2.094
Moisture condition:	As received	Cross Sectional Area:	4.789 in ²
Rate of Loading:	124.0 lbs/sec	Failure Load:	77,480 lbs
Testing Time:	625 sec	Axial Strain at Failure:	0.0321 in/in
(F	Rate 2-15 minutes to failure)	Stress:	16,173 psi



REMARKS:

Unconfined Compression Test



After Failure





Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949 9885 Rockside Road 4480 L Cleveland, OH 44125 Cincinn Phone (216) 573-0955 Phone

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

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 Project:
 FRA-70-13.10 - Project 6A

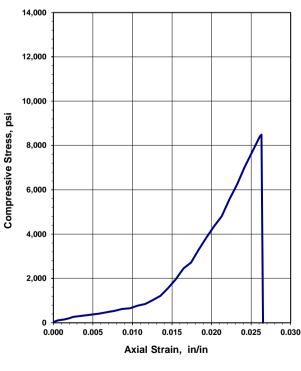
 42
 Project No.:
 W-13-072

 98
 Date of Testing:
 2/20/2014

Test Performed by: K.R./T.K.

Rock Description: Gray Limestone

Boring No.:	B-114-7-13	Average Length:	5.169 in
Sample No:	RC-1	Average Diameter:	2.4 in
Depth (ft):	75.1	Length to diameter ratio:	2.154
Moisture condition:	As received	Cross Sectional Area:	4.522 in ²
Rate of Loading:	67.1 lbs/sec	Failure Load:	38,390 lbs
Testing Time:	572 sec	Axial Strain at Failure:	0.0263 in/in
	(Rate 2-15 minutes to failure)	Stress:	8,488 psi



Unconfined Compression Test







Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949

9885 Rockside Road Cleveland, OH 44125 Phone (216) 573-0955

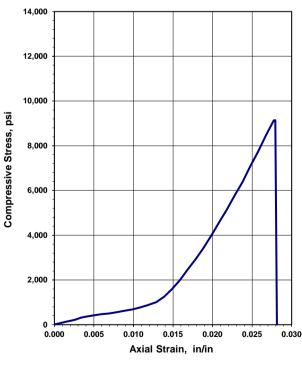
4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

Project: FRA-70-13.10 - Project 6A Project No.: W-13-072 Date of Testing: 2/20/2014

Test Performed by: K.R./T.K.

Rock Description: Gray Limestone

5.047 in	Average Length:	B-114-7-13	Boring No.:
2.397 in	Average Diameter:	RC-2	Sample No:
2.106	Length to diameter ratio:	81.5	Depth (ft):
4.510 in ²	Cross Sectional Area:	As received	Moisture condition:
41,240 lbs	Failure Load:	59.8 lbs/sec	Rate of Loading:
0.0279 in/in	Axial Strain at Failure:	690 sec	Testing Time:
9,141 psi	Stress:	Rate 2-15 minutes to failure)	(F



Unconfined Compression Test

W-13-072 B-114-7-13



82.1



Before Testing



Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949

 9885 Rockside Road
 4480

 Cleveland, OH 44125
 Cincir

 Phone (216) 573-0955
 Phone

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

 ve
 Project:
 FRA-70-13.10 - Project 6A

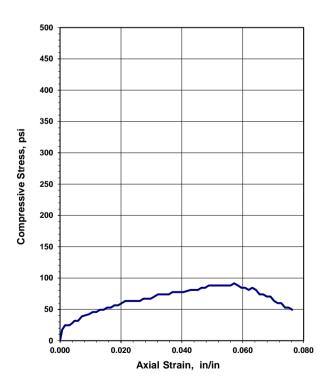
 42
 Project No.:
 W-13-072

 98
 Date of Testing:
 3/17/2014

Test Performed by: K.R./T.K.

Rock Description: Gray Claystone

4.197 in	Average Length:	B-114-8-13	Boring No.:
1.901 in	Average Diameter:	RC-2	Sample No:
2.208	Length to diameter ratio:	74.8	Depth (ft):
2.837 in ²	Cross Sectional Area:	As received	Moisture condition:
260 lbs	Failure Load:	0.3 lbs/sec	Rate of Loading:
0.0572 in/in	Axial Strain at Failure:	821 sec	Testing Time:
92 psi	Stress:	ate 2-15 minutes to failure)	(F



REMARKS:

Unconfined Compression Test

Before Testing W-13-072 B-114-8-13 RC-2 74.8-75-1



After Failure





Engineering Consultants

Unconfined Compressive Strength of Intact Rock Core Specimens (ASTM D 7012-04)

6350 Presidential Gatew. Columbus, OH 43231 Phone (614) 823-4949

9885 Rockside Road 4480 Cleveland, OH 44125 Cincir Phone (216) 573-0955 Phone

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

 Project:
 FRA-70-13.10 - Project 6A

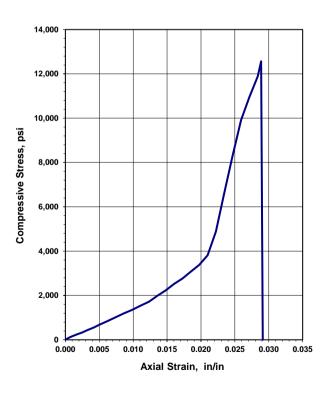
 Project No.:
 W-13-072

 98
 Date of Testing:
 4/1/2014

Test Performed by: K.R./T.K.

Rock Description: Limestone

4.053 in	Average Length:	B-114-8-13	Boring No.:
1.869 in	Average Diameter:	RC-3	Sample No:
2.169	Length to diameter ratio:	78.4	Depth (ft):
2.742 in ²	Cross Sectional Area:	As received	Moisture condition:
34,470 lbs	Failure Load:	127.7 lbs/sec	Rate of Loading:
0.0289 in/in	Axial Strain at Failure:	270 sec	Testing Time:
12,567 psi	Stress:	Rate 2-15 minutes to failure)	(F



Unconfined Compression Test



After Failure





Engineering Consultants

6350 Presidential Gatew. Columbus, OH 43231

Phone (614) 823-4949

9885 Rockside Road Cleveland, OH 44125

Phone (216) 573-0955

4480 Lake Forest Drive Cincinnati, Ohio 45242 Phone (513) 769-6998

Point Load Strength Index of Rock Specimens (ASTM D 5731-08)

Project: FRA-70-13.10 - PHASE 6A

Project No.: W-13-072

Date of Testing: 6/19/2014

Test Performed by: E.M.

Rock Description: SHALE

Boring No.:	B-114-9-13
Sample No:	RC-3 / RC-4
Moisture condition:	As received

Test Apparatus:	Forney-LA 0080
Serial Number:	A125/AZ/0014
Date of Calibration:	8/12/2013

la₍₅₀₎

Sample No.	Test Type	Depth (ft)	Width (mm)	Diameter (mm)	Load (N)	D _e ² (mm ²)	D _e (mm)	F	ls (MPa)	ls ₍₅₀₎ (MPa)	σ _c (MPa)
1	a⊥	78.8'-81.3'	36.1	46.9	330	2,159	46.5	0.97	0.15	0.15	3.52
2	a⊥	78.8'-81.3'	33.5	50.5	35	2,157	46.4	0.97	0.02	0.02	0.37
3	a⊥	78.8'-81.3'	33.4	47.8	25	2,032	45.1	0.95	0.01	0.01	0.28
4	a⊥	78.8'-81.3'	35.1	47.9	330	2,143	46.3	0.97	0.15	0.15	3.54
5	a⊥	78.8'-81.3'	35.1	47.9	310	1,808	42.5	0.93	0.17	0.16	3.94
									STATISTICS		
Specific Spe	cimen Shap	e:	Estimated U	naxial Comp	ression, σ_c =	K*ls		Mean Is ₍₅₀₎ ⊥ Mean Is ₍₅₀₎ ∥			a (14 psi)

Specific Specimen Shape:

d = diametrical

a = axial

b = block

i = irregular lump

 \perp = perpendicular to bedding plane

= parallel to bedding plane

Remarks:

K = 23 *Per Table 1 of ASTM D5731 Mean $\sigma_c =$ 2.33 MPa (338 psi)

APPENDIX V

MSE WALL CALCULATIONS



JOB	FRA-70-13.	10	NO.	W-13-072
SHEET NO.	1		OF	6
CALCULATED E	BY B	RT	DATE	7/12/2019
CHECKED BY	J	PS	DATE	7/12/2019
Retaining W	all E4 - Sta.	402+02 t	o 404+7	5

	в>	$\sigma_{\!LS}^{}=$ 250 ps	sf		
 _			Proposed Top	$\frac{1}{1}$ of Wall El. =	742.2
	*	X		xxx	
	MSE Backfill	Retained Soil:			
	γ_{BF} = 120 pcf φ_{BF} = 34 °	ODOT Item 203 Eml	bankment		
	Reinforcement _∕ Straps	γ_{RS} = 120 φ_{RS} = 30 °	$c_{RS} = 0$ psf		
Proposed Bottom of Wall		$(S_u)_{RS}$ = 2	000 psf		
Bearing Soil: Ex. Fill: Stiff A-6a, A-6b and Loc	ose to Medium Dense A-2-4 γ	φ_{BS} = 120 pcf φ_{BS} = 26 °	$c_{BS} = 0$ psf $(S_u)_{BS}$		714.5
ISE Wall Dimensions and Retained		Bearing Soil Prop			
ISE Wall Height, (H) =	27.7 ft	Bearing Soil Unit We	າດຕົ້າການການກໍ່ກ່າວກໍ່ກໍາການການການການອູ້ການການ		120 pc
ISE Wall Width (Reinforcement Length),		Bearing Soil Friction			<u>26</u> °
1SE Wall Length, $(L) =$	750 ft	Bearing Soil Drained			0 ps
ive Surcharge Load, $(\sigma_{LS}) =$	250 psf	Bearing Soil Undrain		$\left[\left(S_{u}\right)_{BS}\right] =$	625 ps
Retained Soil Unit Weight, $(\gamma_{RS}) =$	<u>120</u> pcf	Embedment Depth, (4.0 ft
Retained Soil Friction Angle, $(\varphi_{RS}) =$	<u>30</u> °	Depth to Grounwater		$(D_W) =$	0.0 ft
Retained Soil Drained Cohesion ¹ , (c_{BS}) =	0 psf	LRFD Load Facto			
Retained Soil Undrained Shear Strength, [EV	EH LS		
Retained Soil Active Earth Pressure Coeff	ດແຕ່ມອຸການແຕ່ມອຸການແຕ່ຜູ້ແຕ່ມານຜູ້ ແມ່ນ ອິການແຫລ່ງແຫຼ່ມແຫຼ່ມຜູ້ແຫຼ	Strength la 1.00	1.50 1.75	(AASHTO LRFD E	
1SE Backfill Unit Weight, $(\gamma_{BF}) =$	120 pcf 34 °	Strength Ib 1.35	1.50 1.75 }-	3.4.1-1 and 3.4.1 Earth Press	
ISE Backfill Friction Angle, (φ _{BF}) = Check Sliding (Loading Case - Stren Sliding Force:	ngth Ia) - AASHTO LRFD BDM	Service I 1.00			
	$P_{H} = P_{EH} + P_{LS_{h}}$	<u>A Section 11.10.5.3</u>		= 20.51	kip/ft
Check Sliding (Loading Case - Stren	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$	<u>A Section 11.10.5.3</u> $a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27)$.7 ft)²(0.297)(1.5)	= 20.51	kip/ft
Check Sliding (Loading Case - Stren	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$	$\frac{A \text{ Section 11.10.5.3}}{a \gamma_{EH}} = \frac{1}{2}(120 \text{ pcf})(27)(120 p$.7 ft)²(0.297)(1.5) ft)(0.297)(1.75)		
Check Sliding (Loading Case - Stren	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$	<u>A Section 11.10.5.3</u> $a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27)$.7 ft)²(0.297)(1.5) ft)(0.297)(1.75)		
Check Sliding (Loading Case - Stren	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$	$\frac{A \text{ Section 11.10.5.3}}{a \gamma_{EH}} = \frac{1}{2}(120 \text{ pcf})(27)(120 p$.7 ft)²(0.297)(1.5) ft)(0.297)(1.75)		
Check Sliding (Loading Case - Stren	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$	$\frac{A \text{ Section 11.10.5.3}}{a \gamma_{EH}} = \frac{1}{2}(120 \text{ pcf})(27)(120 p$.7 ft)²(0.297)(1.5) ft)(0.297)(1.75)		
Check Sliding (Loading Case - Stren Sliding Force: PLSh PLSh Check Sliding Resistance - Drained Nominal Sliding Resistance:	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \frac{1}{2} \gamma_{RS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$ $R_{\tau} = P_{EV} \cdot \tan \delta$	$\frac{A \text{ Section 11.10.5.3}}{a \gamma_{EH}} = \frac{1}{2}(120 \text{ pcf})(27)(120 p$.7 ft)²(0.297)(1.5) ft)(0.297)(1.75) 4.11 kip/ft		
Check Sliding (Loading Case - Stren Sliding Force:	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \frac{1}{2} \gamma_{RS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$ $R_{\tau} = P_{EV} \cdot \tan \delta$	A Section 11.10.5.3 $_{a} \gamma_{EH} = \gamma_{2}(120 \text{ pcf})(27)$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ f})$ $\gamma_{FV} = (120 \text{ pcf})(27.7 \text{ f})$.7 ft)²(0.297)(1.5) ft)(0.297)(1.75) 4.11 kip/ft		kip/ft
Check Sliding (Loading Case - Stren Sliding Force: PLSh PLSh P P Check Sliding Resistance - Drained Nominal Sliding Resistance: P	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$ $Condition$ $R_{\tau} = P_{EV} \cdot \tan \delta$ $P_{EV} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \le t)$	A Section 11.10.5.3 $_{a} \gamma_{EH} = \gamma_{2}(120 \text{ pcf})(27)$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ f})$ $\gamma_{FV} = (120 \text{ pcf})(27.7 \text{ f})$	7 ft)²(0.297)(1.5) ft)(0.297)(1.75) 4.11 kip/ft 7 ft)(19.4 ft)(1.00)	= 3.6 = 64.49	kip/ft kip/ft
Check Sliding (Loading Case - Stren Sliding Force: PLSh PLSh Check Sliding Resistance - Drained Nominal Sliding Resistance:	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$ $Condition$ $R_{\tau} = P_{EV} \cdot \tan \delta$ $P_{EV} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \le t)$	A Section 11.10.5.3 ^a $\gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27)$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ f})$ $\rho/\text{ft} + 3.6 \text{ kip/ft} = 2$ $\gamma_{EV} = (120 \text{ pcf})(27.7 \text{ f})$ an φ_{BF}) ϕ_{BF}) $\phi_{S} \le \tan(34) \longrightarrow 0.49 \le 100$	7 ft)²(0.297)(1.5) ft)(0.297)(1.75) 4.11 kip/ft 7 ft)(19.4 ft)(1.00)	= 3.6 = 64.49	kip/ft kip/ft
Check Sliding (Loading Case - Stren Sliding Force: PLSh PLSh P P Check Sliding Resistance - Drained Nominal Sliding Resistance: P	$P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 20.51 \text{ kip}$ $Condition$ $R_{\tau} = P_{EV} \cdot \tan \delta$ $P_{EV} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \le \tan \delta)$ $R_{\tau} = (64.49 \text{ kip/ft})(0.49)$	A Section 11.10.5.3 $a \gamma_{EH} = \gamma_2(120 \text{ pcf})(27)$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ f})$ p/ft + 3.6 kip/ft = 2 $\gamma_{EV} = (120 \text{ pcf})(27.7 \text{ f})$ $\gamma_{EV} = (120 \text{ pcf})(27.7 \text{ f})$ an φ_{BF}) $p_{S} \le \tan(34) \longrightarrow 0.49 \le 100$ $p_{S} = 31.60 \text{ kip/ft}$	7 ft)²(0.297)(1.5) ft)(0.297)(1.75) 4.11 kip/ft 7 ft)(19.4 ft)(1.00)	= 3.6 = 64.49	kip/ft kip/ft



RESOURCE INTERNATIONAL, INC. 6350 PRESIDENTIAL GATEWAY COLUMBUS, OHIO 43231 PHONE: (614) 823-4949 FAX: (614) 823-4990

job F	RA-70-13.10	NO.	W-13-072
SHEET NO.	2	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wal	I E4 - Sta, 402+02 t	o 404+7	75

MSE Wall Dimensions and Retained Soil Para	<u>meters</u>	Bearing Sc	oil Propertie	<u>s:</u>		
MSE Wall Height, (<i>H</i>) =	27.7 ft	Bearing Soil	Unit Weight,	$(\gamma_{BS}) =$		120 pcf
MSE Wall Width (Reinforcement Length), (B) =	19.4 ft	Bearing Soil	Friction Angle	$e, (\varphi_{BS}) =$		26 °
MSE Wall Length, (L) =	750 ft	າເອັດການກາງການການອົງການການການການການກົງການການການ	Drained Coh) =	0 psf
Live Surcharge Load, $(\sigma_{LS}) =$	250 psf	Bearing Soil	Undrained SI	near Streng	$[(s_u)_{BS}] =$	é
Retained Soil Unit Weight, (γ_{RS}) =	120 pcf	Embedment	Depth, (D_f) =	•		4.0 ft
Retained Soil Friction Angle, (φ_{RS}) =	30 °	Depth to Gro	ounwater (Bel	ow Bot. of	Wall), (D_W)	= 0.0 ft
Retained Soil Drained Cohesion, $(c_{BS}) =$	0 psf	LRFD Load	d Factors			
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000 psf		EV EH	LS		
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength la	1.00 1.5) 1.75) (AASHTI	0 LRFD BDM Tables
MSE Backfill Unit Weight, (γ_{BF}) =	120 pcf	Strength Ib	1.35 1.5) 1.75	- 3.4.1-1	and 3.4.1-2 - Active
MSE Backfill Friction Angle, (φ_{BF}) =	<u>34</u> °	Service I	1.00 1.0	0 1.00	J	arth Pressure)
Check Sliding (Loading Case - Strength Ia) - A		DM Section 11.10.5	.3 (Continued)			
Check Sliding Resistance - Undrained Conditi						
	$\left(\left(S_{u}\right)_{BS}\leq q_{s}\right).$					
	$\left(S_{u}\right)_{BS} = 0.63$					
	$a = \sigma_v / -$	(3.32 ksf) / 2 =	1.66 4	sf		
	$y_s - /2 =$	(0.02 10)/2 =	1.00 K	J I		
		,				
$(\sum_{n} (S_n)_{ns} \leq q_s)$	$\sigma = P_{EV}/$	/ 	t) / (19.4 ft)	=	3.32 ksf	
R _z	_= (0.63 ksf ≤ 1.	.66 ksf)(19.4 ft) =				
		.66 ksf)(19.4 ft) =	12.13 k			
	ng Resistance - L	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k <u>m</u>	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k <u>m</u>	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
/erify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \leq R_ au \cdot \phi_ au \longrightarrow$ 24.11 kip/ft ≤ (*	ng Resistance - L 12.13 kip/ft)(1.0) =	66 ksf)(19.4 ft) = <u>Jndrained Conditio</u>	12.13 k	ip/ft	12.13 kip/ft	



јов Б	RA-70-13.10	NO.	W-13-072
SHEET NO.	3	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wall	F4 - Sta, 402+02 t	o 404+7	75

WWW.RESOURCEIN	TERATIONAL.COM		
MSE Wall Dimensions and Retained Soil Para		Bearing Soil Properties:	
MSE Wall Height, (H) =	27.7 ft	Bearing Soil Unit Weight, $(\gamma_{BS}) =$	120 pcf
MSE Wall Width (Reinforcement Length), (B) =	<u>19.4</u> ft	Bearing Soil Friction Angle, (φ_{BS}) =	26 °
MSE Wall Length, (L) =	750 ft	Bearing Soil Drained Cohesion, $(c_{BS}) =$	0 psf
Live Surcharge Load, $(\sigma_{LS}) =$	250 psf	Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}] =$	625 psf
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment Depth, (D_f) =	4.0 ft
Retained Soil Friction Angle, $(\varphi_{RS}) =$	<u>30</u> °	Depth to Grounwater (Below Bot. of Wall), $(D_W) =$	0.0 ft
Retained Soil Drained Cohesion, $(c_{RS}) =$	0 psf	LRFD Load Factors	
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$	2000 psf	EV EH LS	
Retained Soil Active Earth Pressure Coeff., $(K_a) =$	0.297	Strength la 1.00 1.50 1.75 ¬	
MSE Backfill Unit Weight, $(\gamma_{BF}) =$	120 pcf	Strength Ib 1.35 1.50 1.75 (AASHTO LRFL Strength Ib 1.35 1.50 1.75 - 3.4.1-1 and 3.4	
MSE Backfill Friction Angle, (φ_{BF}) =	34 °	Service I 1.00 1.00 1.00 <i>Earth Pre</i>	
Check Eccentricity (Loading Case - Strength	la) - AASHTO LRFI	D BDM Section 11.10.5.5	
	$B_{2} - x_{o}$		
	/ 2		
P_{EV}	M = M		
$P_{LS_{h_{r}}}$	$=\frac{I V I E V - I V I H}{I}$	= (625.55 kip·ft/ft - 239.17 kip·ft/ft) / (64.49 kip/ft) =	5.99 ft
P_{EH}	P_{EV}		
	M_{EV} = 625.5	5 kip·ft/ft ¬	
$x_o \leftarrow \leftrightarrow e$	$M_{\mu} = 239.1$	7 kip·ft/ft ~ Defined below	
	$M_H = 239.1$ $P_{EV} = 64.49$	9 kin/ft	
$\downarrow B_2 \rightarrow \downarrow$	- <i>EV</i> - 01.10		
	? = (19.4 ft)/2 - 5	.99 ft = 3.71 ft	
	, — (10.+ n//2 0		
Resisting Moment, M_{EV} : M_{EV}	$=P_{EV}(x_1)$		
$\mathbf{Resisting Moment, } M_{EV}. \qquad \mathbf{M}_{EV}$	$-I_{EV}(x_1)$		
P_{I}	$_{EV} = \gamma_{BF} \cdot H \cdot B$	$P \cdot \gamma_{EV} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.00) = 64.49$	kip/ft
P_{EV}	P /		
\mathbf{x}_{1}	$a_1 = \frac{D}{2} = (1)$	9.4 ft) / 2 = 9.70 ft	
	, –		
	$M_{_{FV}} = (64.4)$	l9 kip/ft)(9.70 ft) = 625.55 kip⋅ft/ft	
$ \cdot x_1 > $	27		
Overturning Moment, M_H : M_H	$=P_{EH}\left(x_{2}\right) +H$	$P_{ra}(x_{2})$	
121 1			
			kip/ft
	$\zeta_{H} = \frac{1}{2} \gamma_{RS} H^2 K$	$\zeta_a \gamma_{EH} = \frac{1}{2} (120 \text{ pcf})(27.7 \text{ ft})^2 (0.297)(1.5) = 20.51$	kip/ft
	$\zeta_{H} = \frac{1}{2} \gamma_{RS} H^2 K$	$\zeta_a \gamma_{EH} = \frac{1}{2} (120 \text{ pcf})(27.7 \text{ ft})^2 (0.297)(1.5) = 20.51$	
$P_{LS_{h}} = P_{LS_{h}} P_{LS_{$	$S_{H} = \frac{V_{2}\gamma_{RS}H^{2}K}{\sigma_{LS}HK_{a}\gamma}$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ ft}$	kip/ft kip/ft
$P_{LS_{h}} = P_{LS_{h}} P_{LS_{$	$S_{H} = \frac{V_{2}\gamma_{RS}H^{2}K}{\sigma_{LS}HK_{a}\gamma}$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ ft}$	
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{V_{2}\gamma_{RS}H^{2}K}{\sigma_{LS}} = \sigma_{LS}HK_{a}\gamma$ $S_{h} = \frac{\sigma_{LS}HK_{a}\gamma}{\sigma_{LS}} = \frac{H}{3} = (2)$	$X_a \gamma_{EH} = \frac{\gamma_2(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5)}{(2.297)(1.5)} = 20.51$ $Y_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6$ 7.7 ft / 3 = 9.23 ft	
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{V_{2}\gamma_{RS}H^{2}K}{\sigma_{LS}} = \sigma_{LS}HK_{a}\gamma$ $S_{h} = \frac{\sigma_{LS}HK_{a}\gamma}{\sigma_{LS}} = \frac{H}{3} = (2)$	$X_a \gamma_{EH} = \frac{\gamma_2(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5)}{(2.297)(1.5)} = 20.51$ $Y_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6$ 7.7 ft / 3 = 9.23 ft	
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{V_{2}\gamma_{RS}H^{2}K}{\sigma_{LS}} = \sigma_{LS}HK_{a}\gamma$ $S_{h} = \frac{\sigma_{LS}HK_{a}\gamma}{\sigma_{LS}} = \frac{H}{3} = (2)$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ ft}$	
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{1}{2} \gamma_{RS} H^{2} K$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{1}{3} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2}$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ Jt}$ 7.7 ft) / 3 = 9.23 ft 7.7 ft) / 2 = 13.85 ft	cip/ft
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{1}{2} \gamma_{RS} H^{2} K$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{1}{3} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2}$	$X_a \gamma_{EH} = \frac{\gamma_2(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5)}{(2.297)(1.5)} = 20.51$ $Y_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6$ 7.7 ft / 3 = 9.23 ft	cip/ft
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{1}{2} \gamma_{RS} H^{2} K$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{1}{3} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2}$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ Jt}$ 7.7 ft) / 3 = 9.23 ft 7.7 ft) / 2 = 13.85 ft	cip/ft
$P_{LS_{h}} = P_{LS_{h}} = P_{$	$S_{H} = \frac{1}{2} \gamma_{RS} H^{2} K$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{1}{3} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2}$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ Jt}$ 7.7 ft) / 3 = 9.23 ft 7.7 ft) / 2 = 13.85 ft	cip/ft
$P_{LS_h} = P_{LS_h} P_{LS_h}$	$S_{H} = \frac{1}{2} \gamma_{RS} H^{2} K$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{1}{3} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2} = \frac{1}{2}$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ Jt}$ 7.7 ft) / 3 = 9.23 ft 7.7 ft) / 2 = 13.85 ft	cip/ft
$P_{LS_h} = P_{LS_h} = P_L$ x_{2} $Check Eccentricity$	$S_{H} = \frac{1}{2} \gamma_{RS} H^{2} K$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $2 = \frac{H}{3} = (2)$ $3 = \frac{H}{2} = (2)$ $M_{H} = (20.5)$	$\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^2(0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ Jt}$ 7.7 ft) / 3 = 9.23 ft 7.7 ft) / 2 = 13.85 ft	cip/ft
$P_{LS_{h}} = P_{LS_{h}} = P_{$	$S_{H} = \frac{V_{2} \gamma_{RS} H^{2} K}{\sigma_{LS} H \sigma_{LS} H K_{a} \gamma}$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{H}{3} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$	$\zeta_{a} \gamma_{EH} = \frac{1}{2} (120 \text{ pcf})(27.7 \text{ ft})^{2} (0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ H}$ 7.7 ft / 3 = 9.23 ft 7.7 ft / 2 = 13.85 ft 51 kip/ft)(9.23 ft) + (3.6 kip/ft)(13.85 ft) = 239.17 H	cip/ft
$P_{LS_{h}} = P_{LS_{h}} = P_{$	$S_{H} = \frac{V_{2} \gamma_{RS} H^{2} K}{\sigma_{LS} H \sigma_{LS} H K_{a} \gamma}$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{H}{3} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$	$\zeta_{a} \gamma_{EH} = \frac{1}{2} (120 \text{ pcf})(27.7 \text{ ft})^{2} (0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ H}$ 7.7 ft / 3 = 9.23 ft 7.7 ft / 2 = 13.85 ft 51 kip/ft)(9.23 ft) + (3.6 kip/ft)(13.85 ft) = 239.17 H	cip/ft
$P_{LS_h} = P_{LS_h} = P_L$ x_{2} $Check Eccentricity$	$S_{H} = \frac{V_{2} \gamma_{RS} H^{2} K}{\sigma_{LS} H \sigma_{LS} H K_{a} \gamma}$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{H}{3} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$	$\zeta_{a} \gamma_{EH} = \frac{1}{2} (120 \text{ pcf})(27.7 \text{ ft})^{2} (0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ H}$ 7.7 ft / 3 = 9.23 ft 7.7 ft / 2 = 13.85 ft 51 kip/ft)(9.23 ft) + (3.6 kip/ft)(13.85 ft) = 239.17 H	cip/ft
$P_{LS_{h}} = P_{LS_{h}} = P_{$	$S_{H} = \frac{V_{2} \gamma_{RS} H^{2} K}{\sigma_{LS} H \sigma_{LS} H K_{a} \gamma}$ $S_{h} = \sigma_{LS} H K_{a} \gamma$ $S_{h} = \frac{H}{3} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$ $M_{H} = \frac{1}{2} = \frac{1}{2}$	$\zeta_{a} \gamma_{EH} = \frac{1}{2} (120 \text{ pcf})(27.7 \text{ ft})^{2} (0.297)(1.5) = 20.51$ $\gamma_{LS} = (250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75) = 3.6 \text{ H}$ 7.7 ft / 3 = 9.23 ft 7.7 ft / 2 = 13.85 ft 51 kip/ft)(9.23 ft) + (3.6 kip/ft)(13.85 ft) = 239.17 H	cip/ft



јов Г	RA-70-13.10	NO.	W-13-072
SHEET NO.	4	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wall	F4 - Sta, 402+02 t	o 404+7	7 5

MSE Wall Height, $(H) = 27.7 \text{ ft}$ MSE Wall Width (Reinforcement Length), $(B) = 19.4 \text{ ft}$ Bearing Soil Drained Cohesion, $(c_{BS}) = 26^{\circ}$ MSE Wall Length, $(L) = 750 \text{ ft}$ Bearing Soil Drained Cohesion, $(c_{BS}) = 0 \text{ pr}$ ive Surcharge Load, $(\sigma_{LS}) = 250 \text{ psf}$ Bearing Soil Undrained Shear Strength, $[(S_u)_{BS}] = 250 \text{ psf}$ Bearing Soil Undrained Shear Strength, $[(S_u)_{BS}] = 625 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_u)_{BS}] = 625 \text{ psf}$ Retained Soil Drained Cohesion, $(c_{BS}) = 0.297 \text{ psf}$ Retained Soil Active Earth Pressure Coeff., $(K_u) = 0.297 \text{ strength lb} 1.35 1.50 1.75 \text{ strength lb} 1.440 ft \text{ starth Pressure}$ Check Bearing Capacity (Loading Case - Strength lb) - AASHTO LRFD BDM Section 11.10.54 P_{LS_u} P_{LS_u} P_{LS_h} P_{EH} $e = B_2 - x_o = (19.4 \text{ ft} - 2(2.5 \text{ ft}) = 14.40 \text{ ft}$ $M_w - M_w$				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $			Bearing Soil Properties:	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		······		
$\begin{aligned} & \text{detained Soil Unit Weight, } (y_{R}) = \underbrace{250 \text{ psf}}_{120 \text{ pcf}} & \text{Bearing Soil Unit Weight, } (y_{R}) = \underbrace{225 \text{ psf}}_{120 \text{ pcf}} & \text{Embedment Depth, } (D_{r}) = \underbrace{225 \text{ psf}}_{0.0 \text{ ft}} & \text{Embedment Depth, } (D_{r}) = \underbrace{225 \text{ psf}}_{0.0 \text{ ft}} & \text{Depth to Groumwater (Below Bot. of Wall), } (D_{R}) = \underbrace{200 \text{ psf}}_{0.0 \text{ ft}} & \underbrace{180 \text{ psf}}_{0.0 \text{ ft}} & 180 \text{ $				
$ \begin{array}{c} \begin{array}{c} \begin{array}{c} 120 \text{ pcf} \\ \hline 100 \text{ 1.00} \\ \hline 1.00 \text{ 1.00} \\ \hline 1.00 \\ \hline 1.00$				
$\begin{array}{c} \begin{array}{c} \frac{30}{10} \cdot \\ 30$		<u>-</u>		
$\begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} $				
$\begin{array}{c} \begin{array}{c} \begin{array}{c} \hline \\ \text{Retained Soil Undrained Shear Strength, [(S_{k})_{KS}] = \\ \hline \\ \hline \\ \text{Retained Soil Active Earth Pressure Cost, (K_{k})_{KS} = \\ \hline \\ \hline \\ \hline \\ \text{Retained Soil Active Earth Pressure Cost, (K_{k})_{KS} = \\ \hline \\ \hline \\ \hline \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \\ \hline \\ \begin{array}{c} \begin{array}{c} \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \\ \hline \\ \begin{array}{c} \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \\ \hline \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \\ \begin{array}{c} \\ \\ \end{array} \end{array} \end{array} \end{array} \right) = \\ \begin{array}{c} \begin{array}{c} \begin{array}{c} \\ \begin{array}{c} \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \\ \end{array} \end{array} \end{array} \right) = \\ \begin{array}{c} \begin{array}{c} \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \end{array} \right) = \\ \begin{array}{c} \begin{array}{c} \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \end{array} \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \\ \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \\ \ \\ \ \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \hline \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \\ \ \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \ \\ \text{Ret Beackfill Friction Angle, } (e_{arr}) = \\ \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \ \\ \ \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \ \ \\ \ \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \ \\ \ \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \\ \ \end{array} \end{array} \\ \begin{array}{c} \ \\ \ \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \ \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \end{array} \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \end{array} \\ \end{array} \end{array} \\ \end{array} \end{array} \\ \end{array} \end{array} \end{array} \\ \end{array} \end{array} \\ \end{array} \\ \begin{array}{c} \end{array} \end{array} \end{array} \end{array} \\ \end{array} \end{array} \\ $			n de la maise de la companya de la c	<u>σ</u> π
$\begin{array}{c} \text{detailed Soil Active Earth Pressure Coeff.} (K_{x}) = \boxed{0.297} & \text{Strength Ib} 1.00 1.50 1.75 \\ \text{ASE Backfill Unit Weight,} (y_{w}) = \underbrace{0.234^{\circ}} & \text{Strength Ib} 1.35 1.50 1.75 \\ \text{Strength ID} 1.30 1.00 1.00 1.00 1.00 1.00 1.00 \\ \text{Strength ID} 1.35 1.50 1.75 \\ \text{Strength ID} 1.35 1.50 1.75 \\ \text{Strength ID} 1.30 1.00 1.00 1.00 \\ \text{Strength ID} 1.30 1.00 1.00 \\ \text{Strength ID} 1.00 1.00 1.00 \\ \text{Strength ID} 1.00 1.00 1.00 \\ \text{Strength ID} 1.00 \\ Stre$				
$\begin{array}{c} \frac{120}{34} \mbox{pcd} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$				
$\begin{aligned} &\text{ASE Backfill Friction Angle, } (\varphi_{BF}) = \underbrace{\frac{34}{24}} & \text{Service I} 1.00 1.00 1.00 \end{bmatrix} \underbrace{\text{Derth Presum}} \\ &\text{Priss} \\$		·····	(AASHIO LRFD BDM I	
Check Bearing Capacity (Loading Case - Strength lb) - AASHTO LRFD BDM Section 11.10.5.4 $P_{LS} = \frac{P_{L}}{P_{EV}} = \frac{P_{L}}{P_{LS}} = \frac{P_{L}}{P_{EV}} = \frac{P_{LS}}{P_{EV}} = \frac{P_{LS}}{P_{EV}} = \frac{P_{LS}}{P_{EV}} = \frac{P_{LS}}{P_{EV}} = \frac{P_{LS}}{P_{LS}} = \frac{P_{LS}}{P_{EV}} = \frac{P_{LS}}{P_{LS}} = \frac{P_{LS}}{$			Farth Pressure)	
$\begin{array}{c} P_{LS} \\ q_{eq} = P_{V/B}^{\prime}, \\ B^{\prime} = B - 2e = 19.4 \ \text{ft} - 2(2.5 \ \text{ft}) = 14.40 \ \text{ft} \\ B^{\prime} = B - 2e = 19.4 \ \text{ft} - 2(2.5 \ \text{ft}) = 14.40 \ \text{ft} \\ R^{\prime} = B_{2}^{\prime} - x_{o} = (19.4 \ \text{ft})/2 - 7.2 \ \text{ft} = 2.50 \ \text{ft} \\ x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (92.6.77 \ \text{kip} \ \text{ft/ft} - 239.15 \ \text{kip} \ \text{ft/ft})/95.54 \ \text{kip/ft} = 7.2 \ \text{ft} = \frac{B_{2}^{\prime} - x_{o}}{P_{V}} = (92.554 \ \text{kip/ft})/(14.4 \ \text{ft}) = 6.63 \ \text{ksf} \\ M_{V} = P_{EV}(x_{1}) + P_{LS}(x_{1}) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_{1}) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_{1}) \\ M_{V} = [(120 \ \text{pcf})(27.7 \ \text{ft})(19.4 \ \text{ft})(1.35)(9.7 \ \text{ft}) + [(250 \ \text{psf})(19.4 \ \text{ft})(1.75)](9.7 \ \text{ft}) = 926.77 \ \text{kip} \ \text{ft/ft} \\ M_{H} = P_{EH}(x_{2}) + P_{LS}(x_{3}) = (\sqrt{2} \gamma_{RS} H^{2} K_{A} \gamma_{EH})(x_{2}) + (\sigma_{LS} H K_{A} \gamma_{LS})(x_{3}) \\ M_{H} = [\frac{1}{2}(120 \ \text{pcf})(27.7 \ \text{ft})(9.297)(1.5)](9.23 \ \text{ft}) + [(250 \ \text{psf})(27.7 \ \text{ft})(0.297)(1.75)](13.85 \ \text{ft}) = 239.15 \ \text{kip} \ \text{ft/ft} \\ P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ P_{V} = (120 \ \text{pcf})(27.7 \ \text{ft})(19.4 \ \text{ft})(1.35) + (250 \ \text{psf})(19.4 \ \text{ft})(1.75) = 95.54 \ \text{kip/ft} \\ \hline \begin{array}{c} P_{CK} \text{Bearing Resistance - Drained Condition} \\ \text{kominal Bearing Resistance - Drained Condition} \\ kominal Bearing Resi$		<u> </u>		
$\begin{array}{c} P_{LS} \\ q_{eq} = P_{r}'_{B'} \\ R' \\ P_{EV} \\ P_{EV} \\ P_{LS} \\ P_{EV} \\ P_{LS} \\ P_{EH} \\ P_{EH} \\ P_{EH} \\ P_{EF} \\ P_{EH} \\ P_{EH} \\ P_{E} \\$	Check Bearing Canacity (Loading Case - Stron	ath lh) - AASHTO I	RED BDM Section 11 10 5 4	
$\begin{array}{c} \begin{array}{c} \begin{array}{c} & & & & & & & & & & & & & & & & & & &$				
$\begin{array}{c c} & B^{+} = B - 2e = 19.4 \mathrm{ft} - 2(2.5 \mathrm{ft}) = 14.40 \mathrm{ft} \\ & B^{+} = B - 2e = 19.4 \mathrm{ft} - 2(2.5 \mathrm{ft}) = 14.40 \mathrm{ft} \\ & R + 14.40$		א /		
$\begin{array}{c c} & B^{+} = B - 2e = 19.4 \mathrm{ft} - 2(2.5 \mathrm{ft}) = 14.40 \mathrm{ft} \\ & B^{+} = B - 2e = 19.4 \mathrm{ft} - 2(2.5 \mathrm{ft}) = 14.40 \mathrm{ft} \\ & R + 14.40$	a =			
$\begin{split} & \prod_{x_{o}} P_{EH} = B_{2}' - x_{o} = (19.4 \text{ ft})/2 - 7.2 \text{ ft} = 2.50 \text{ ft} \\ & x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip ft/ft} - 239.15 \text{ kip/ttf})/95.54 \text{ kip/ft} = 7.2 \\ & x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip ft/ft} - 239.15 \text{ kip/ttf})/95.54 \text{ kip/ft} = 7.2 \\ & M_{V} - M_{H} = (926.77 \text{ kip ft/ft} - 239.15 \text{ kip/ttf})/95.54 \text{ kip/ft} = 7.2 \\ & M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_{1}) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_{1}) \\ & M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) = 6.63 \text{ ksf} \\ & M_{H} = P_{EH}(x_{2}) + P_{LS_{v}}(x_{3}) = (\gamma_{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3}) \\ & M_{H} = [\gamma_{c}(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.2 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.28 \text{ ft}) = 239.15 \text{ kip-ft/ft} \\ & P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ & P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft} \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ $		/ B		
$\begin{split} & \prod_{x_{o}} P_{EH} = B_{2}' - x_{o} = (19.4 \text{ ft})/2 - 7.2 \text{ ft} = 2.50 \text{ ft} \\ & x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip ft/ft} - 239.15 \text{ kip/ttf})/95.54 \text{ kip/ft} = 7.2 \\ & x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip ft/ft} - 239.15 \text{ kip/ttf})/95.54 \text{ kip/ft} = 7.2 \\ & M_{V} - M_{H} = (926.77 \text{ kip ft/ft} - 239.15 \text{ kip/ttf})/95.54 \text{ kip/ft} = 7.2 \\ & M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_{1}) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_{1}) \\ & M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) = 6.63 \text{ ksf} \\ & M_{H} = P_{EH}(x_{2}) + P_{LS_{v}}(x_{3}) = (\gamma_{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3}) \\ & M_{H} = [\gamma_{c}(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.2 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.28 \text{ ft}) = 239.15 \text{ kip-ft/ft} \\ & P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ & P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft} \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ & \\ $	r P_{EV} R'	$B - 2\rho = 19$	4 ft - 2(2.5 ft) = 14.40 ft	
$x_{o} = \frac{M_{V} - M_{H}}{P_{r}} = (926.77 \text{ kip-ft/ft} - 239.15 \text{ kip-ft/ft}) / 95.54 \text{ kip/ft} = 7.2$ $x_{o} = \frac{M_{V} - M_{H}}{P_{r}} = (926.77 \text{ kip-ft/ft} - 239.15 \text{ kip-ft/ft}) / 95.54 \text{ kip/ft} = 7.2$ $M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} + H + B + \gamma_{EV})(x_{1}) + (\sigma_{LS} + B + \gamma_{LS})(x_{1})$ $M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) = 926.77 \text{ kip-ft/ft}$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{u}}(x_{3}) = (\frac{1}{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3})$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})(2.97)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) = 239.15 \text{ kip-ft/ft}$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ 2heck Bearing Resistance - Drained Condition Nominal Bearing Resistance: $q_{n} = CN_{cm} + \gamma D_{f}N_{qm}C_{wq} + \frac{1}{2}\gamma BN_{m}C_{wy}$ $N_{cm} = N_{v}s_{v}\dot{t}_{v} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{y} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{y} = 12.44$ $N_{c} = 12.25 \qquad N_{q} = 11.009 \qquad s_{y} = 0.092 \qquad s_{y} = 0.001 \times 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = 1.000 (\text{Assumed})$ $i_{c} = 1.000 (\text{Assumed}) \qquad 1.003 \qquad C_{wy} = 0.001 \times 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = 1.201 \qquad 1.000 (\text{Assumed})$	\uparrow^3 P_{LS_h} P_{LS_h}	J <u>2</u> C 19		
$x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip-ft/ft} - 239.15 \text{ kip-ft/ft}) / 95.54 \text{ kip/ft} = 7.2$ $x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip-ft/ft} - 239.15 \text{ kip-ft/ft}) / 95.54 \text{ kip/ft} = 7.2$ $M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} + H + B + \gamma_{EV})(x_{1}) + (\sigma_{LS} + B + \gamma_{LS})(x_{1})$ $M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) = 926.77 \text{ kip-ft/ft}$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{v}}(x_{3}) = (\frac{1}{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3})$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})(20.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) = 239.15 \text{ kip-ft/ft}$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} + H + B + \gamma_{EV} + \sigma_{LS} + B + \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} + H + B + \gamma_{EV} + \sigma_{LS} + B + \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = N_{v}s_{v}\dot{c}\dot{c} = 22.47 \qquad N_{qm} = N_{q}s_{q}d_{q}\dot{d}_{q} = 12.95 \qquad N_{ym} = N_{y}s_{y}\dot{b}_{y} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{y} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{y} = 10.09 \qquad s_{y} = 0.992 \qquad s_{y} = 1.000 (\text{Assumed}) \qquad 1.083 \qquad C_{wy} = 0.00 \text{ t} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = i_{q} = 1.000 (\text{Assumed}) \qquad 1.083 \qquad C_{wy} = 0.00 \text{ t} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = i_{q} = 1.000 (\text{Assumed}) \qquad C_{wq} = 0.00 \text{ t} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = i_{q} = 0.00 \text{ t} < 1.00 \text{ (Assumed})$		a = B/2 - x =	: (19.4 ft) / 2 - 7.2 ft = 2.50 ft	
$x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip-ft/ft} - 239.15 \text{ kip-ft/ft}) / 95.54 \text{ kip/ft} = 7.2$ $x_{o} = \frac{M_{V} - M_{H}}{P_{V}} = (926.77 \text{ kip-ft/ft} - 239.15 \text{ kip-ft/ft}) / 95.54 \text{ kip/ft} = 7.2$ $M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} + H + B + \gamma_{EV})(x_{1}) + (\sigma_{LS} + B + \gamma_{LS})(x_{1})$ $M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) = 926.77 \text{ kip-ft/ft}$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{v}}(x_{3}) = (\frac{1}{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3})$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})(20.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) = 239.15 \text{ kip-ft/ft}$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = P_{EV} + P_{LS} = 22.47 \qquad N_{qm} = N_{q}S_{q}d_{q}i_{q} = 12.95 \qquad N_{ym} = N_{y}S_{y}i_{y} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{y} = 12.64$ $S_{c} = 1(104 \text{ ft})(1.85/22.25) \qquad S_{q} = 1.009 \qquad S_{y} = 0.992$ $= 1.010 \qquad d_{q} = 1+2an(2^{2})(1-ain(2^{2$		12 ∞		
$\begin{aligned} & A_{c} = A_{cq} = (95.54 \text{ kip/ft}) / (14.4 \text{ ft}) = 6.63 \text{ ksf} \\ & M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_{1}) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_{1}) \\ & M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) = 926.77 \text{ kip-ft/ft} \\ & M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) = (\gamma_{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3}) \\ & M_{H} = [\gamma_{2}(120 \text{ pcf})(27.7 \text{ ft})^{2}(0.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) = 239.15 \text{ kip-ft/ft} \\ & P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ & P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft} \end{aligned}$		$c = \frac{M_V - M_H}{M_V - M_H}$	= (926.77 kip·ft/ft - 239.15 kip·ft/ft) / 95 54 kip/ft =	7.2
$\begin{array}{c} P_{eq} = (95.54 \text{ kip/ft}) / (14.4 \text{ ft}) = 6.63 \text{ ksf} \\ \hline M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_{1}) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_{1}) \\ \hline M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) = 926.77 \text{ kip-ft/ft} \\ \hline M_{H} = P_{EH}(x_{2}) + P_{LS_{u}}(x_{3}) = (\gamma_{2}\gamma_{RS}H^{2}K_{a}\gamma_{EH})(x_{2}) + (\sigma_{LS}HK_{a}\gamma_{LS})(x_{3}) \\ \hline M_{H} = [\gamma_{c}(120 \text{ pcf})(27.7 \text{ ft})^{2}(0.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) = 239.15 \text{ kip-ft/ft} \\ \hline P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ \hline P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft} \\ \hline \text{Check Bearing Resistance:} q_{n} = cN_{cm} + \gamma D_{f}N_{qm}C_{wq} + \gamma_{2}\gamma BN_{jm}C_{wy} \\ \hline N_{cm} = N_{c}S_{c}i_{c} = 22.47 \qquad N_{qm} = N_{q}S_{q}d_{q}i_{q} = 12.95 \qquad N_{jm} = N_{y}S_{y}i_{y} = 12.44 \\ \hline N_{c} = 22.25 \\ S_{c} = 1 \cdot (14.4 \text{ ft}750 \text{ ft})(11.85/22.25) \qquad S_{q} = 1.009 \\ = 1.010 \qquad d_{q} = 1 \cdot 21an(2e^{3})[1 \cdot 1an(2e^{3})]^{1}an^{-1}(4.0 \text{ ft})(4.4 \text{ ft}) = i_{y} = 1.000 \text{ (Assumed)} \\ i_{c} = 1.000 \text{ (Assumed)} \qquad 1.083 \qquad C_{wy} = 0.01 \times 4.0 \text{ ft} = 0.500 \\ \hline \end{array}$	$\hat{x}_{o} \leftarrow \Rightarrow$	P_V		_
$\begin{aligned} &\leftarrow B' \rightarrow i \qquad \qquad$				
$M_{V} = B_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) = (\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV})(x_{1}) + (\sigma_{LS} \cdot B \cdot \gamma_{LS})(x_{1})$ $M_{V} = [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) = 926.77 \text{ kip-ft/ft}$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{v}}(x_{3}) = (\sqrt{2} \gamma_{RS} H^{2} K_{a} \gamma_{EH})(x_{2}) + (\sigma_{LS} H K_{a} \gamma_{LS})(x_{3})$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^{2}(0.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) = 239.15 \text{ kip-ft/ft}$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ Check Bearing Resistance - Drained Condition Nominal Bearing Resistance: $q_{n} = cN_{cm} + \gamma D_{f}N_{qm}C_{wq} + \frac{1}{2}\gamma BN_{jm}C_{wy}$ $N_{cm} = N_{c}s_{c}i_{c} = 22.47 \qquad N_{qm} = N_{q}s_{q}d_{q}i_{q} = 12.95 \qquad N_{jm} = N_{y}s_{y}i_{y} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{y} = 12.54 \qquad s_{y} = 0.992 = 1.010 \qquad d_{q} = 1+2\tan(26')(1-\sin(26'))(1-\sin$		= (95.54 kin/ft)	(144ft) = 6.63 ksf	
$\begin{split} M_{V} &= [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) &= 926.77 \text{ kip-ft/ft} \\ M_{H} &= P_{EH}(x_{2}) + P_{LS_{b}}(x_{3}) = \left(\frac{1}{2}2\gamma_{RS}H^{2}K_{a}\gamma_{EH}\right)(x_{2}) + \left(\sigma_{LS}HK_{a}\gamma_{LS}\right)(x_{3}) \\ M_{H} &= [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^{2}(0.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) &= 239.15 \text{ kip-ft/ft} \\ P_{V} &= P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ P_{V} &= (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) &= 95.54 \text{ kip/ft} \\ \end{split}$ Check Bearing Resistance: $q_{n} &= cN_{cm} + \gamma D_{f} N_{qm} C_{wq} + \frac{1}{2}\gamma \beta N_{pm} C_{w\gamma} \\ N_{cm} &= N_{c}s_{c}i_{c} &= 22.47 \qquad N_{qm} = N_{q}s_{q}d_{q}i_{q} &= 12.95 \qquad N_{pm} = N_{y}s_{y}i_{y} &= 12.44 \\ N_{c} &= 22.25 \qquad N_{q} &= 11.85 \qquad N_{y} &= 12.54 \\ s_{c} &= 1 + (14.4 \text{ ft}750 \text{ ft})(11.85/22.25) \qquad s_{q} &= 1.009 \qquad s_{y} &= 0.092 \\ &= 1.010 \qquad d_{q} &= 1 + 2an(26^{\circ})(1 - \sin(26^{\circ}))(1 - \sin^{\circ}(4.0 \text{ ft})(4.4 \text{ ft}) & i_{y} &= 0.00 \text{ ft} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} &= 1.000 \ (Assumed) \\ c_{wq} &= 0.0 \text{ ft} < 4.0 \text{ ft} &= 0.500 \\ \end{cases}$	Yeq 9′ →			
$\begin{split} M_{V} &= [(120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35)](9.7 \text{ ft}) + [(250 \text{ psf})(19.4 \text{ ft})(1.75)](9.7 \text{ ft}) &= 926.77 \text{ kip-ft/ft} \\ M_{H} &= P_{EH}(x_{2}) + P_{LS_{b}}(x_{3}) = \left(\frac{1}{2}2\gamma_{RS}H^{2}K_{a}\gamma_{EH}\right)(x_{2}) + \left(\sigma_{LS}HK_{a}\gamma_{LS}\right)(x_{3}) \\ M_{H} &= [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^{2}(0.297)(1.5)](9.23 \text{ ft}) + [(250 \text{ psf})(27.7 \text{ ft})(0.297)(1.75)](13.85 \text{ ft}) &= 239.15 \text{ kip-ft/ft} \\ P_{V} &= P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ P_{V} &= (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) &= 95.54 \text{ kip/ft} \\ \end{split}$ Check Bearing Resistance: $q_{n} &= cN_{cm} + \gamma D_{f} N_{qm} C_{wq} + \frac{1}{2}\gamma \beta N_{pm} C_{w\gamma} \\ N_{cm} &= N_{c}s_{c}i_{c} &= 22.47 \qquad N_{qm} = N_{q}s_{q}d_{q}i_{q} &= 12.95 \qquad N_{pm} = N_{y}s_{y}i_{y} &= 12.44 \\ N_{c} &= 22.25 \qquad N_{q} &= 11.85 \qquad N_{y} &= 12.54 \\ s_{c} &= 1 + (14.4 \text{ ft}750 \text{ ft})(11.85/22.25) \qquad s_{q} &= 1.009 \qquad s_{y} &= 0.092 \\ &= 1.010 \qquad d_{q} &= 1 + 2an(26^{\circ})(1 - \sin(26^{\circ}))(1 - \sin^{\circ}(4.0 \text{ ft})(4.4 \text{ ft}) & i_{y} &= 0.00 \text{ ft} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} &= 1.000 \ (Assumed) \\ c_{wq} &= 0.0 \text{ ft} < 4.0 \text{ ft} &= 0.500 \\ \end{cases}$	M - P(r) + P(r) - (r + P)	$I \cdot R \cdot \gamma (\gamma)$	$(\sigma \cdot B \cdot \gamma)(r)$	
$P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV} + \sigma_{LS} \cdot B \cdot \gamma_{LS}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ $P_{V} = N_{V} S_{V} i_{V} = 12.44 \text{ kip/ft}$ $P_{cm} = N_{c} S_{c} i_{c} = 22.47 \qquad N_{qm} = N_{q} S_{q} d_{q} i_{q} = 12.95 \qquad N_{\gamma m} = N_{\gamma} S_{\gamma} i_{\gamma} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad N_{\gamma} = 12.54 \text{ s}_{\gamma} = 0.992 \text{ i}_{\gamma} = 1.010 \text{ d}_{q} = 1+2\tan(26^{\circ})(1-\sin(26^{\circ}))(1-\pi^{-1}(4.0 \text{ ft})4.4 \text{ ft}) = 1.000 \text{ (Assumed)}$ $I_{c} = 1.000 \text{ (Assumed)} \qquad I_{083} \qquad C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$				
$P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ Check Bearing Resistance - Drained Condition Nominal Bearing Resistance: $q_{n} = cN_{cm} + \gamma D_{f}N_{qm}C_{wq} + \frac{1}{2}\gamma BN_{\gamma m}C_{w\gamma}$ $N_{cm} = N_{c}s_{c}i_{c} = 22.47 \qquad N_{qm} = N_{q}s_{q}d_{q}i_{q} = 12.95 \qquad N_{\gamma m} = N_{\gamma}s_{\gamma}i_{\gamma} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad s_{q} = 1.009 \qquad s_{q} = 11.85 \qquad s_{q} = 1.009 \qquad s_{q} = 11.244 \qquad N_{q} $	$M_{H} = [\frac{1}{2}(120 \text{ pcf})(27.7 \text{ ft})^{2}(0.297)(1.5))$](9.23 ft) + [(250 ps	f)(27.7 ft)(0.297)(1.75)](13.85 ft) = 239.15 kip·ft/ft	
$P_{V} = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) + (250 \text{ psf})(19.4 \text{ ft})(1.75) = 95.54 \text{ kip/ft}$ Check Bearing Resistance - Drained Condition Nominal Bearing Resistance: $q_{n} = cN_{cm} + \gamma D_{f}N_{qm}C_{wq} + \frac{1}{2}\gamma BN_{\gamma m}C_{w\gamma}$ $N_{cm} = N_{c}s_{c}i_{c} = 22.47 \qquad N_{qm} = N_{q}s_{q}d_{q}i_{q} = 12.95 \qquad N_{\gamma m} = N_{\gamma}s_{\gamma}i_{\gamma} = 12.44$ $N_{c} = 22.25 \qquad N_{q} = 11.85 \qquad S_{c} = 1+(14.4 \text{ ft/750 ft})(11.85/22.25) \qquad S_{q} = 1.009 \qquad S_{q} = 1.009 \qquad S_{q} = 1.009 \qquad S_{q} = 1.009 \qquad S_{q} = 1.010 \qquad S_{q} = 1.283 \qquad S_{q} = 1.009 \qquad S_{q} = 1.083 \qquad C_{w\gamma} = 0.0 \text{ ft} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = 1.000 \text{ (Assumed)} \qquad C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$	$P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$	$+\sigma_{LS}\cdot B\cdot \gamma_{LS}$		
$\begin{array}{llllllllllllllllllllllllllllllllllll$				
Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{\gamma m} C_{w\gamma}$ $N_{cm} = N_c s_c i_c = 22.47$ $N_{qm} = N_q s_q d_q i_q = 12.95$ $N_{\gamma} = N_{\gamma} s_{\gamma} i_{\gamma} = 12.44$ $N_c = 22.25$ $s_c = 1+(14.4 \text{ ft/750 ft})(11.85/22.25)$ = 1.010 $i_c = 1.000$ (Assumed) $i_c = 1.000$ (Assumed) $i_q = 1.000$ (Assumed) $C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$	$P_V = (120 \text{ pcf})(27.7 \text{ ft})(19.4 \text{ ft})(1.35) +$	(250 psf)(19.4 ft)(1.	75) = 95.54 kip/ft	
Jominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{\gamma m} C_{w\gamma}$ $N_{cm} = N_c s_c i_c$ = 22.47 $N_c = 22.25$ $N_q = 11.85$ $s_c = 1.010$ $s_q = 1.009$ $i_c = 1.000$ (Assumed) 1.083 $i_q = 1.000$ (Assumed) $c_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft}$				
$N_{cm} = N_c S_c i_c = 22.47$ $N_{qm} = N_q S_q d_q i_q = 12.95$ $N_{\gamma m} = N_{\gamma} S_{\gamma} i_{\gamma} = 12.44$ $N_c = 22.25$ $S_c = 1+(14.4 \text{ ft}/750 \text{ ft})(11.85/22.25)$ $= 1.010$ $i_c = 1.000 \text{ (Assumed)}$ $i_c = 1.000 \text{ (Assumed)}$ $N_q = 11.85$ $S_q = 1.009$ $d_q = 1+2\tan(26^\circ)[1-\sin(26^\circ)]^2\tan^{-1}(4.0 \text{ ft}/14.4 \text{ ft})$ $I.083$ $i_q = 1.000 \text{ (Assumed)}$ $C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$	Check Bearing Resistance - Drained Condition			
$N_{cm} = N_c S_c i_c = 22.47$ $N_{qm} = N_q S_q d_q i_q = 12.95$ $N_{\gamma m} = N_{\gamma} S_{\gamma} i_{\gamma} = 12.44$ $N_c = 22.25$ $S_c = 1+(14.4 \text{ ft}/750 \text{ ft})(11.85/22.25)$ $= 1.010$ $i_c = 1.000 \text{ (Assumed)}$ $i_c = 1.000 \text{ (Assumed)}$ $N_q = 11.85$ $S_q = 1.009$ $d_q = 1+2\tan(26^\circ)[1-\sin(26^\circ)]^2\tan^{-1}(4.0 \text{ ft}/14.4 \text{ ft})$ $I.083$ $i_q = 1.000 \text{ (Assumed)}$ $C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$	leminal Proving Projector $\alpha - \alpha N^{T}$	wDNC -	1/2RN C	
$N_{c} = 22.25$ $S_{c} = 1+(14.4 \text{ ft}/750 \text{ ft})(11.85/22.25)$ $= 1.010$ $i_{c} = 1.000 \text{ (Assumed)}$ $i_{q} = 1.000 \text{ (Assumed)}$ $C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$ $N_{\gamma} = 12.54$ $S_{\gamma} = 0.992$ $i_{\gamma} = 1.000 \text{ (Assumed)}$ $C_{w\gamma} = 0.0 \text{ ft} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = 0.500$	Nominal bearing resistance: $q_n = c_{IN} c_m + c_{IN}$	$f^{IV}_{f} m^{U}_{qm} m^{U}_{wq} +$	$72 I D I V_{m} C_{WY}$	
$N_{c} = 22.25$ $S_{c} = 1+(14.4 \text{ ft}/750 \text{ ft})(11.85/22.25)$ $= 1.010$ $i_{c} = 1.000 \text{ (Assumed)}$ $i_{q} = 1.000 \text{ (Assumed)}$ $C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$ $N_{\gamma} = 12.54$ $S_{\gamma} = 0.992$ $i_{\gamma} = 1.000 \text{ (Assumed)}$ $C_{w\gamma} = 0.0 \text{ ft} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = 0.500$	N = N s i = 2247	V = N c d i	= 12.95 $N = N \le i = 12.44$	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$1 cm - 1 cSc^{\prime}c - 2c.\tau l$	$qm = 1 q^{3} q^{\alpha} q^{l} q^{l}$	γ	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$N_{a} = 22.25$	$N_a = 11.85$	N = 12 54	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				
$i_c = 1.000$ (Assumed) $i_q = 1.000$ (Assumed) $C_{wq} = 0.0 \text{ ft} < 1.5(14.4 \text{ ft}) + 4.0 \text{ ft} = 0.500$				
$i_q = 1.000$ (Assumed) $C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$		ด้านการที่การการด้านการการการการการการการการการการการการการก		0
$C_{wq} = 0.0 \text{ ft} > 4.0 \text{ ft} = 0.500$	r c (rosulla)			υ.
$q_n = (0 \text{ psf})(22.473) + (120 \text{ pcf})(4.0 \text{ ft})(12.949)(0.500) + \frac{1}{2}(120 \text{ pcf})(14.4 \text{ ft})(12.440)(0.500) = 8.48 \text{ ksf}$				
\mathbf{T}_{n} (-per/(q = (0 psf)(22 473) + (120 pcf)(4 0 ft)(1)	$(2.949)(0.500) + \frac{1}{6}$	120 pcf)(14.4 ft)(12.440)(0.500) = 8.48 ksf	
	1 <i>n</i> (* For (*	,(
Verify Equivalent Pressure Less Than Factored Bearing Resistance Use $\varphi_b = 0.65$ (Per AASHTO LRFD BDM Table 11.5)				



јов F	RA-70-13.10	NO.	W-13-072
SHEET NO.	5	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wall	F4 - Sta, 402+02 t	o 404+7	'5

WWW.RESOURCEIN				
MSE Wall Dimensions and Retained Soil Par	ameters	Bearing Soil Pro	oerties:	
MSE Wall Height, (<i>H</i>) =	27.7 ft	Bearing Soil Unit W		120 pcf
MSE Wall Width (Reinforcement Length), (B) =	<u>19.4</u> ft	Bearing Soil Friction		26 °
MSE Wall Length, $(L) =$	750 ft	Bearing Soil Draine	.	0 psf
Live Surcharge Load, $(\sigma_{LS}) =$			ned Shear Strength, [Sannan éann an Sannan S
	250 psf			
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment Depth,	านการที่สาวทางการการการการความการขึ้นการการ	4.0 ft
Retained Soil Friction Angle, (φ_{RS}) =	<u>30</u> °		er (Below Bot. of Wall), $(D_W) = 0.0$ ft
Retained Soil Drained Cohesion, (c_{BS}) =	<u>0</u> psf	LRFD Load Facto		
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$	<u>2000</u> psf	EV	EH LS	
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength Ia 1.00	ך 1.50 1.75	(AASHTO LRFD BDM Tables
MSE Backfill Unit Weight, (γ_{BF}) =	<u>120</u> pcf	Strength Ib 1.35	1.50 1.75 -	3.4.1-1 and 3.4.1-2 - Active Earth Pressure)
MSE Backfill Friction Angle, $(\varphi_{BF}) =$	<u>34</u> °	Service I 1.00	1.00 1.00 🖵	
Check Bearing Capacity (Loading Case - Stre		RFD BDM Section 11.	10.5.4 (Continued)	
Check Bearing Resistance - Undrained Cond	lition			
Nominal Bearing Resistance: $q_n = cN_{cm}$	$+ \gamma D_f N_{qm} C_{wq} +$	$\frac{V_2}{\gamma BN_{m}}C_{w\gamma}$		
$N_{cm} = N_c s_c i_c = 5.160$	$N_{qm} = N_q s_q d_q i_q$	= 1.000	$N_{\gamma m} = N_{\gamma} s_{\gamma} i_{\gamma}$	= 0.000
N _c = 5.140	N_q = 1.000		$N_{\gamma} = 0.000$	
$S_c = 1+(14.4 \text{ ft/}[(5)(750 \text{ ft})]) = 1.004$	$s_q = 1.000$		$s_{\gamma} = 1.000$	
$i_c = 1.000$ (Assumed))[1-sin(0°)]²tan⁻¹(4.0 ft/14.4 ft)	$i_{\gamma} = 1.000$	(Assumed)
	1.000			1.5(14.4 ft) + 4.0 ft = 0.1
$q_n = (625 \text{ psf})(5.160) + (120 \text{ pcf})(4.0$		p ft = 0.500 120 pcf)(14.4 ft)(0.000)(3.47 ksf
/erify Equivalent Pressure Less Than Factor	$C_{wq} = 0.0 \text{ ft} > 4.0$ $f(t)(1.000)(0.500) + \frac{1}{2}(-1)$ red Bearing Resistance	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
	$C_{wq} = 0.0 \text{ ft} > 4.0$ $f(t)(1.000)(0.500) + \frac{1}{2}(-1)$ red Bearing Resistance	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>		
Verify Equivalent Pressure Less Than Factor	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 6.63$ ksf	$C_{wq} = 0.0 \text{ ft} > 4.0$ $ft)(1.000)(0.500) + \frac{1}{2}(1000)$ ft = (3.47 ksf)(0.65) = 2.0	oft = 0.500 120 pcf)(14.4 ft)(0.000)(<u>Ce</u>	(0.500) =	



JOB	FRA-70-13.10	NO.	W-13-072
SHEET NO.	6	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wa	II F4 - Sta 402+02 t	o 404+7	' 5

	Retained Soil Param	<u>neters</u>	Bearing Soil	Properties:								
MSE Wall Height, (<i>H</i>) =		27.7 ft	Bearing Soil Ur	nit Weight, $(\gamma_{BS}) =$		120 pc						
MSE Wall Width (Reinforcemen	1t Length), (<i>B</i>) =	19.4 ft	Bearing Soil Friction Angle, (φ_{BS}) =									
MSE Wall Length, (L) =		750 ft	Bearing Soil Dr	rained Cohesion, (c_{BS}) =	0 ps						
Live Surcharge Load, (σ_{LS}) =		250 psf	Bearing Soil Ur	ndrained Shear Streng	gth, $[(s_u)_{BS}] =$	625 pst						
Retained Soil Unit Weight, (γ_{RS})) =	120 pcf	Embedment De			4.0 ft						
Retained Soil Friction Angle, (φ_{I}		30 °		water (Below Bot. of	Wall), $(D_W) =$	0.0 ft						
Retained Soil Drained Cohesion		0 psf	LRFD Load F									
Retained Soil Undrained Shear	an a	2000 psf		EV EH LS								
Retained Soil Active Earth Press		0.297	Strength la 1	.00 1.50 1.75) (AASHTO LRFD							
MSE Backfill Unit Weight, (γ_{BF})		120 pcf		.35 1.50 1.75	- 3.4.1-1 and 3.4.	1-2 - Active						
MSE Backfill Friction Angle, (φ_{BP})		34 °	ທະວັດການການອື່ນການການການກັບການການການສຳມານກ	.00 1.00 1.00	Earth Pres							
Settlement Analysis (Loadii P_{LS_v}	ng Case - Service I) $q_{eq} = I$		DM Section 11.10.	4.1								
	9 eģ —	· / B'										
	∠_ <i>p</i>	B - 2e = 19.4	l ft - 2(2.23 ft) =	14.94 ft								
<u> </u>	$P_{LS_h} P_{EH} e^{B'}$	R/		<u>-</u>								
$R \downarrow$	<u> </u>	$e = \frac{B}{2} - x_o =$	(19.4 ft) / 2 - 7.4	7 ft = 2.23	ft							
					··· / 22.04.1-:/#	7 47						
		$\kappa_o = \frac{M_V - M_H}{P_v}$	= (טוע.סס גוף)	יft/ft - 154.סט אוף ועיו	t) / 69.34 кірлі —	- 7.47						
$x_o \leftrightarrow \Rightarrow e$		- V										
$\leftarrow B_2 \rightarrow$	~											
en al fair an	u	= (69.34 kip/ft) /	(14.94 ft) =	4.64 ksf								
$ \begin{array}{l} \overleftarrow{\leftarrow} B' \rightarrow \end{array} \\ M_{V} = P_{EV}(x_{1}) + P_{L} \\ M_{V} = [(120 \text{ pcf})(x_{1}) + P_{L}] \\ M_{H} = P_{EH}(x_{2}) + P_{L} \end{array} $	$L_{S_v}(x_1) = (\gamma_{BF} \cdot H_{27.7 \text{ ft}})(19.4 \text{ ft})(1.00)]$	$(H \cdot B \cdot \gamma_{EV})(x_1) +$](9.7 ft) + [(250 psf)(7	$-\left(\sigma_{LS}\cdot B\cdot\gamma_{LS} ight)$ 19.4 ft)(1.00)](9.7 ft	(x_1) t) = 672.56	kip·ft/ft							
$M_{V} = [(120 \text{ pcf})(3)]$ $M_{H} = P_{EH}(x_{2}) + P_{L}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})]$ $P_{V} = P_{EV} + P_{LS} = 0$ $P_{V} = (120 \text{ pcf})(27)$	$L_{S_{v}}(x_{1}) = (\gamma_{BF} \cdot H)$ $(27.7 \text{ ft})(19.4 \text{ ft})(1.00)]$ $L_{S_{h}}(x_{3}) = (\frac{1}{2}\gamma_{RS})$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ $7.7 \text{ ft})(19.4 \text{ ft})(1.00) + 1$	$H \cdot B \cdot \gamma_{EV}(x_1) + [(250 \text{ psf})(x_1) + [(250 \text{ psf})(x_2) + B^2 K_a \gamma_{EH})(x_2) + 0)](9.23 \text{ ft}) + [(250 \text{ psf}) + \sigma_{LS} \cdot B \cdot \gamma_{LS})(250 \text{ psf})(19.4 \text{ ft})(1.00)](10.4 \text{ ft})(1.00)$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 19.4 ft)(1.00)](9.7 ft) + ($\sigma_{LS}HK_a\gamma_{LS}$ f)(27.7 ft)(0.297)(1. 00) = 69.34	(x_1) t) = 672.56 (x_3)	kip·ft/ft 154.69 kip·ft							
$M_{V} = [(120 \text{ pcf})(X_{H} = P_{EH}(x_{2}) + P_{L})$ $M_{H} = P_{EH}(x_{2}) + P_{L}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})$ $P_{V} = P_{EV} + P_{LS} = p_{V}$ $P_{V} = (120 \text{ pcf})(27)$ Settlement, Time Rate of Co	$\chi_{S_{V}}(x_{1}) = (\gamma_{BF} \cdot H)$ $(27.7 \text{ ft})(19.4 \text{ ft})(1.00)$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $(27.7 \text{ ft})(19.4 \text{ ft})(1.00) + 10$	$H \cdot B \cdot \gamma_{EV}(x_1) + [(250 \text{ psf})(x_1) + [(250 \text{ psf})(x_2) + B^2 K_a \gamma_{EH})(x_2) + 0)](9.23 \text{ ft}) + [(250 \text{ psf}) + \sigma_{LS} \cdot B \cdot \gamma_{LS})(250 \text{ psf})(19.4 \text{ ft})(1.00)](10.4 \text{ ft})(1.00)$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 19.4 ft)(1.00)](9.7 ft) + ($\sigma_{LS}HK_a\gamma_{LS}$ f)(27.7 ft)(0.297)(1. 00) = 69.34	$)(x_1)$ = 672.56 $)(x_3)$ 00)](13.85 ft) = kip/ft	154.69 kip-ft							
$M_{V} = [(120 \text{ pcf})(X_{H} = P_{EH}(x_{2}) + P_{L})$ $M_{H} = P_{EH}(x_{2}) + P_{L}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})$ $P_{V} = P_{EV} + P_{LS} = p_{V}$ $P_{V} = (120 \text{ pcf})(27)$ Settlement, Time Rate of Co	$L_{S_{v}}(x_{1}) = (\gamma_{BF} \cdot H)$ $(27.7 \text{ ft})(19.4 \text{ ft})(1.00)]$ $L_{S_{h}}(x_{3}) = (\frac{1}{2}\gamma_{RS})$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ $7.7 \text{ ft})(19.4 \text{ ft})(1.00) + 1$	$H \cdot B \cdot \gamma_{EV}(x_1) + [(250 \text{ psf})(x_1) + [(250 \text{ psf})(x_2) + B^2 K_a \gamma_{EH})(x_2) + 0)](9.23 \text{ ft}) + [(250 \text{ psf}) + \sigma_{LS} \cdot B \cdot \gamma_{LS})(250 \text{ psf})(19.4 \text{ ft})(1.00)](10.4 \text{ ft})(1.00)$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 19.4 ft)(1.00)](9.7 ft) + ($\sigma_{LS}HK_a\gamma_{LS}$ f)(27.7 ft)(0.297)(1. 00) = 69.34	(x_1) t) = 672.56 (x_3) 00)](13.85 ft) =	154.69 kip-ft							
$M_{V} = [(120 \text{ pcf})(X_{H} = P_{EH}(x_{2}) + P_{L})$ $M_{H} = P_{EH}(x_{2}) + P_{L}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})$ $P_{V} = P_{EV} + P_{LS} = p_{V}$ $P_{V} = (120 \text{ pcf})(27)$ Settlement, Time Rate of Co	$\sum_{L_{S_v}} (x_1) = (\gamma_{BF} \cdot H)$ $\sum_{L_{S_v}} (x_3) = (\gamma_2 \gamma_{RS} H)$ $\sum_{L_{S_h}} (x_3) = (\gamma_2 \gamma_{RS} H)$ $\sum_{L_{S_h}}$	$H \cdot B \cdot \gamma_{EV}(x_{1}) + [(250 \text{ psf})(x_{1}) + [(250 \text{ psf})(x_{2}) + (250 \text{ psf})(x_{$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ $19.4 \text{ ft}(1.00)](9.7 \text{ ft})$ $+ (\sigma_{LS} H K_a \gamma_{LS})$ $f)(27.7 \text{ ft})(0.297)(1.00) = 69.34$ $1100 = 69.34$ $1100 = 69.34$	$)(x_1)$ t) = 672.56 $)(x_3)$ 00)](13.85 ft) = kip/ft Distance Between Borings Along Wall	154.69 kip-ft							
$M_{V} = [(120 \text{ pcf})(X_{H} = P_{EH}(x_{2}) + P_{L})$ $M_{H} = P_{EH}(x_{2}) + P_{L}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})$ $P_{V} = P_{EV} + P_{LS} = p_{V}$ $P_{V} = (120 \text{ pcf})(27)$ Settlement, Time Rate of Comparison of Comp	$\sum_{S_{V}} (x_{1}) = (\gamma_{BF} \cdot H)$ $\sum_{S_{h}} (x_{3}) = (\gamma_{2} \gamma_{RS})$ $\sum_{S_{h}} (x_{3}) = (\gamma_{2} \gamma_{RS})$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ $7.7 \text{ ft})(19.4 \text{ ft})(1.00) + \frac{1}{2}$ $\frac{1}{2}$ 1	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](9.7 \text{ ft}) + [(250 \text{ psf})(7) + (250 \text{ psf})(7) + (250 \text{ psf})(7) + (250 \text{ psf}) + (250 \text{ psf}) + (250 \text{ psf}) + (250 \text{ psf})(19.4 \text{ ft})(1.0)$ $(250 \text{ psf})(19.4 \text{ ft})(1.0) + (250 \text{ psf})(19.4 \text{ ft})(1.0) + (250 \text{ psf})(19.4 \text{ ft})(1.0)$ $(250 \text{ psf})(19.4 \text{ ft})(1.0) + (250 \text{ psf})(19.4 \text{ ft})(1.0)$ $(250 \text{ psf})(19.4 \text{ ft})(1.0) + (250 \text{ psf})(19.4 \text{ ft})(10.4 \text{ ft})(1$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 19.4 ft)(1.00)](9.7 ft + ($\sigma_{LS}HK_a\gamma_{LS}$ f)(27.7 ft)(0.297)(1. 00) = 69.34 tt: Time for 90% Consolidation 23 days 8 days	$)(x_1)$ t) = 672.56 $)(x_3)$ 00)](13.85 ft) = kip/ft Distance Between Borings Along Wall	154.69 kip-ft							
$M_{V} = [(120 \text{ pcf})(3)]$ $M_{H} = P_{EH}(x_{2}) + P_{L}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})]$ $P_{V} = P_{EV} + P_{LS} = 0$ $P_{V} = (120 \text{ pcf})(27)$ Settlement, Time Rate of Co	$\sum_{L_{S_v}} (x_1) = (\gamma_{BF} \cdot H)$ $\sum_{L_{S_v}} (x_3) = (\gamma_2 \gamma_{RS} H)$ $\sum_{L_{S_h}} (x_3) = (\gamma_2 \gamma_{RS} H)$ $\sum_{L_{S_h}}$	$H \cdot B \cdot \gamma_{EV}(x_{1}) + [(250 \text{ psf})(x_{1}) + [(250 \text{ psf})(x_{2}) + (250 \text{ psf})(x_{$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS}$ $19.4 \text{ ft})(1.00)](9.7 \text{ ft}$ $+ (\sigma_{LS}HK_a\gamma_{LS}$ $f)(27.7 \text{ ft})(0.297)(1.$ $00) = 69.34$ 112 12	$)(x_{1}) = 672.56$ $)(x_{3}) =$ $(x_{3}) =$	154.69 kip-ft							
$M_{V} = [(120 \text{ pcf})(3)]$ $M_{H} = P_{EH}(x_{2}) + P_{L}(x_{2}) + P_{L}(x_{2}$	$L_{S_{v}}(x_{1}) = (\gamma_{BF} \cdot H)$ $(27.7 \text{ ft})(19.4 \text{ ft})(1.00)$ $D_{LS_{h}}(x_{3}) = (\frac{1}{2}\gamma_{RS})$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ $7.7 \text{ ft})(19.4 \text{ ft})(1.00) + \frac{1}{2}$ $One of Reinforced Soil Mass$ 10.464 in 7.697 in	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](9.7 \text{ ft}) + [(250 \text{ psf})(7) + [(250 \text{ psf})(7) + (250 \text{ psf})(7) + (250 \text{ psf}) + (250 \text{ psf}) + (250 \text{ psf}) + (250 \text{ psf}) + (250 \text{ psf})(19.4 \text{ ft})(1.0)$ $(250 \text{ psf})(19.4 \text{ ft})(1.0)$ $fferential Settlement at Wall Facing = 5.175 in = 4.758 in = 5.175 in = 4.758 in = 5.175 in = 5.$	$- (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 19.4 ft)(1.00)](9.7 ft + ($\sigma_{LS}HK_a\gamma_{LS}$ f)(27.7 ft)(0.297)(1. 00) = 69.34 tt: Time for 90% Consolidation 23 days 8 days	$)(x_1)$ t) = 672.56 $)(x_3)$ 00)](13.85 ft) = kip/ft Distance Between Borings Along Wall Facing 160 ft	154.69 kip-ft							
$M_{V} = [(120 \text{ pcf})(3)]$ $M_{H} = P_{EH}(x_{2}) + P_{L}(x_{2}) + P_{L}(x_{2}$	$\sum_{L_{S_{V}}} (x_{1}) = (\gamma_{BF} \cdot H)$ $(27.7 \text{ ft})(19.4 \text{ ft})(1.00)$ $\sum_{L_{S_{h}}} (x_{3}) = (\frac{1}{2} \gamma_{RS} H)$ $(27.7 \text{ ft})^{2}(0.297)(1.00)$ $\gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$ $7.7 \text{ ft})(19.4 \text{ ft})(1.00) +$ onsolidation and Dif Total Settlement at Conter of Reinforced Soli Mass 10.464 in 7.697 in 15.594 in	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](9.7 \text{ ft}) + [(250 \text{ psf})(7)](9.7 \text{ ft}) + [(250 \text{ psf})(7)](9.23 \text{ ft}) + [(250 \text{ psf})](9.23 \text{ ft}) + [(250 \text{ psf})](9.23 \text{ ft}) + [(250 \text{ psf})](19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(1.0)](9.23 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(19.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(10.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(10.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(10.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(10.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(10.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} (250 \text{ psf})(10.4 \text{ ft})(10.0 \text{ ft}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} ($	$= (\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 19.4 ft)(1.00)](9.7 ft $+ (\sigma_{LS} H K_a \gamma_{LS})$ f)(27.7 ft)(0.297)(1. 00) = 69.34 it: Time for 90% Consolidation 23 days 8 days 90 days	$)(x_1)$ t) = 672.56 $)(x_3)$ 00)](13.85 ft) = kip/ft Distance Between Borings Along Wall Facing 160 ft 175 ft	154.69 kip-ft Differential Settlement Along Wall Facing 1/4600 1/650							

Boring B-020-4-13

H=	27.7	ft	Total wall height
B'=	14.9	ft	Effective footing width due to eccentricity
D _w =	0.0	ft	Depth below bottom of footing
q _e =	4,640	psf	Equivalent bearing pressure at bottom of wall

Tatal	Settlement	+	Contor
TOTAL	Settlement	. ai	Center

																Total Settlement at Center of Reinforced Soil Mass Total Settlement at					tlement at Fa	icing of Wall							
Layer	Soil Class.	Soil Type		Depth ft)	Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	l ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)
	A-6a	С	0.0	2.5	2.5	1.3	115	288	144	66	2,066	32	0.198	0.030	0.522				0.08	0.998	4,631	4,697	0.189	2.268	0.500	2,319	2,385	0.093	1.120
1	A-6a	С	2.5	5.0	2.5	3.8	115	575	431	197	2,197	32	0.198	0.030	0.522				0.25	0.959	4,449	4,646	0.157	1.882	0.497	2,305	2,503	0.069	0.833
	A-6a	С	5.0	8.0	3.0	6.5	115	920	748	342	2,342	32	0.198	0.030	0.522				0.44	0.859	3,984	4,326	0.153	1.835	0.486	2,254	2,596	0.066	0.796
2	A-7-6	С	8.0	10.5	2.5	9.3	120	1,220	1,070	493	2,493	48	0.342	0.034	0.647				0.62	0.743	3,446	3,939	0.140	1.676	0.466	2,161	2,654	0.051	0.608
2	A-7-6	С	10.5	13.0	2.5	11.8	120	1,520	1,370	637	2,637	48	0.342	0.034	0.647				0.79	0.648	3,005	3,642	0.105	1.258	0.442	2,052	2,689	0.036	0.437
3	A-2-6	G	13.0	15.5	2.5	14.3	120	1,820	1,670	781	2,781					7	9	56	0.96	0.568	2,636	3,417	0.029	0.346	0.416	1,931	2,711	0.024	0.292
5	A-2-6	G	15.5	18.0	2.5	16.8	120	2,120	1,970	925	2,925					7	9	55	1.12	0.503	2,333	3,258	0.025	0.298	0.389	1,807	2,732	0.021	0.256
1	A-1-b	G	18.0	23.0	5.0	20.5	130	2,770	2,445	1,166	5,166					34	40	131	1.38	0.426	1,978	3,144	0.016	0.197	0.351	1,631	2,796	0.014	0.174
4	A-1-b	G	23.0	28.0	5.0	25.5	130	3,420	3,095	1,504	5,504					34	37	121	1.71	0.352	1,635	3,139	0.013	0.158	0.307	1,424	2,928	0.012	0.143
5	A-1-a	G	28.0	37.0	9.0	32.5	125	4,545	3,983	1,955	5,955					18	18	71	2.18	0.282	1,309	3,263	0.028	0.341	0.257	1,194	3,149	0.026	0.317
6	A-1-a	G	37.0	47.0	10.0	42.0	135	5,895	5,220	2,599	6,599					88	80	331	2.82	0.221	1,027	3,626	0.004	0.052	0.209	969	3,568	0.004	0.050
0	A-1-a	G	47.0	57.0	10.0	52.0	135	7,245	6,570	3,325	7,325					88	73	286	3.49	0.180	835	4,160	0.003	0.041	0.173	803	4,128	0.003	0.039
7	A-6b	С	57.0	64.5	7.5	60.8	130	8,220	7,733	3,942	7,942	40	0.270	0.027	0.585				4.08	0.155	717	4,659	0.009	0.111	0.150	697	4,639	0.009	0.108
1. $\sigma_p' = \sigma_v$	_{′o} '+σ _{m;} Estima	te σ_m of 2,00	00 psf in exis	sting fill mate	erial and 4,00	00 psf (modera	ately overco	onsolidated) f	or natural so	il deposits; F	Ref. Table 11	.2, Coduto 2	003								Total	Settlement:		10.464 in		Total	Settlement:		5.175 in

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. e_o = (C_c/1.15)+0.35; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_o/(1+e_o)](H)\log(\sigma_{vt}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_{vt}'/\sigma_{p'})$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. S_c = H(1/C')log($\sigma_{v'}/\sigma_{vo}$); Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Calculated By:	BRT	Date:	7/18/2019
Checked By:	JPS	Date:	7/18/2019

Boring B-020-4-13

27.7	ft	Total wall height
14.9	ft	Effective footing width due to eccentricity
0.0	ft	Depth below bottom of footing
4,640	psf	Equivalent bearing pressure at bottom of wall
	14.9 0.0	14.9 ft 0.0 ft

	A-6a	A-7-6	A-6b		
c _v =	600	150	300	ft²/yr	Coefficient of consolitation
t =	23	23	23	days	Time following completion of construction
H _{dr} =	5.5	5.5	7.5	ft	Length of longest drainage path considered
$T_v =$	1.250	0.312	0.336		Time factor
U =	96	63	65	%	Degree of consolidation

(S_c)_t = 4.640 in Settlement complete at 90% of primary consolidation

																							Total Se	ttlement at f	Facing of Wall	Settlement Complete at 90% of Primary Consolidation		
Layer	Soil Type	Soil Type	Layer (1	•	Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	l ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	Layer Settlement (in)	(S _c) _t ⁽¹¹⁾ (in)	Layer Settlement (in)	
	A-6a	С	0.0	2.5	2.5	1.3	115	288	144	66	2,066	32	0.198	0.030	0.522				0.08	0.500	2,319	2,385	0.093	1.120		1.075		
1	A-6a	С	2.5	5.0	2.5	3.8	115	575	431	197	2,197	32	0.198	0.030	0.522				0.25	0.497	2,305	2,503	0.069	0.833	2.750	0.800	2.640	
	A-6a	С	5.0	8.0	3.0	6.5	115	920	748	342	2,342	32	0.198	0.030	0.522				0.44	0.486	2,254	2,596	0.066	0.796		0.764		
2	A-7-6	С	8.0	10.5	2.5	9.3	120	1,220	1,070	493	2,493	48	0.342	0.034	0.647				0.62	0.466	2,161	2,654	0.051	0.608	1.045	0.383	0.658	
2	A-7-6	С	10.5	13.0	2.5	11.8	120	1,520	1,370	637	2,637	48	0.342	0.034	0.647				0.79	0.442	2,052	2,689	0.036	0.437	1.043	0.275	0.030	
3	A-2-6	G	13.0	15.5	2.5	14.3	120	1,820	1,670	781	4,781					7	9	56	0.96	0.416	1,931	2,711	0.024	0.292	0.548	0.292	0.548	
5	A-2-6	G	15.5	18.0	2.5	16.8	120	2,120	1,970	925	4,925					7	9	55	1.12	0.389	1,807	2,732	0.021	0.256	0.540	0.256	0.040	
4	A-1-b	G	18.0	23.0	5.0	20.5	130	2,770	2,445	1,166	5,166					34	40	131	1.38	0.351	1,631	2,796	0.014	0.174	0.317	0.174	0.317	
-	A-1-b	G	23.0	28.0	5.0	25.5	130	3,420	3,095	1,504	5,504					34	37	121	1.71	0.307	1,424	2,928	0.012	0.143	0.017	0.143	0.017	
5	A-1-a	G	28.0	37.0	9.0	32.5	125	4,545	3,983	1,955	5,955					18	18	71	2.18	0.257	1,194	3,149	0.026	0.317	0.317	0.317	0.317	
6	A-1-a	G	37.0	47.0	10.0	42.0	135	5,895	5,220	2,599	6,599					88	80	331	2.82	0.209	969	3,568	0.004	0.050	0.089	0.050	0.089	
0	A-1-a	G	47.0	57.0	10.0	52.0	135	7,245	6,570	3,325	7,325					88	73	286	3.49	0.173	803	4,128	0.003	0.039	0.003	0.039	0.009	
7	A-6b	С	57.0	64.5	7.5	60.8	130	8,220	7,733	3,942	7,942	40	0.270	0.027	0.585				4.08	0.150	697	4,639	0.009	0.108	0.108	0.070	0.070	

1. σ_p' = σ_{vo}'+σ_m Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. C_r = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_p')]$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By:	BRT	Date:	07/18/2019
Checked By:	JPS	Date:	07/18/2019

Settlement Remaining After Hold Period: 0.535 in

Boring B-114-9-13

g grade
nkment
11
1

Layer	Soil Class.	Soil Type	,	⁻ Depth ft)	Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	I ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)
	A-2-4	G	0.0	2.0	2.0	1.0	125	250	125	63	2,063					13	26	88	0.03	1.000	5,050	5,112
1	A-2-4	G	2.0	4.0	2.0	3.0	125	500	375	188	2,188					13	23	82	0.09	0.998	5,038	5,225
1	A-2-4	G	4.0	6.0	2.0	5.0	125	750	625	313	2,313					13	21	77	0.15	0.989	4,996	5,309
	A-2-4	G	6.0	8.0	2.0	7.0	125	1,000	875	438	2,438					13	20	73	0.21	0.973	4,916	5,354
0	A-6b	С	8.0	10.5	2.5	9.3	115	1,288	1,144	567	2,567	37	0.243	0.036	0.561				0.28	0.946	4,779	5,345
2	A-6b	С	10.5	13.0	2.5	11.8	115	1,575	1,431	698	2,698	37	0.243	0.036	0.561				0.36	0.907	4,580	5,278
	A-1-b	G	13.0	15.5	2.5	14.3	125	1,888	1,731	842	4,842					16	21	76	0.43	0.861	4,350	5,192
2	A-1-b	G	15.5	18.0	2.5	16.8	125	2,200	2,044	999	4,999					16	20	74	0.51	0.813	4,108	5,107
3	A-1-b	G	18.0	20.5	2.5	19.3	125	2,513	2,356	1,155	5,155					16	19	72	0.58	0.766	3,867	5,022
	A-1-b	G	20.5	23.0	2.5	21.8	125	2,825	2,669	1,312	5,312					16	18	71	0.66	0.720	3,634	4,946
	A-1-a	G	23.0	27.5	4.5	25.3	130	3,410	3,118	1,542	5,542					41	45	148	0.77	0.660	3,333	4,875
4	A-1-a	G	27.5	32.0	4.5	29.8	130	3,995	3,703	1,846	5,846					41	42	138	0.90	0.592	2,992	4,838
5	A-3a	G	32.0	37.0	5.0	34.5	135	4,670	4,333	2,180	6,180					100	97	338	1.05	0.532	2,686	4,865
6	A-4a	С	37.0	42.0	5.0	39.5	130	5,320	4,995	2,530	6,530	25	0.135	0.014	0.467				1.20	0.478	2,416	4,946
7	A-3a	G	42.0	47.0	5.0	44.5	135	5,995	5,658	2,881	6,881					51	45	125	1.35	0.434	2,190	5,070
	A-7-6	С	47.0	51.0	4.0	49.0	125	6,495	6,245	3,187	7,187	42	0.288	0.029	0.600				1.48	0.399	2,017	5,204
8	A-7-6	C	51.0	55.0	4.0	53.0	125	6,995	6,745	3.438	7,438	42	0.288	0.029	0.600				1.61	0.373	1,883	5,321
-	A-7-6	C	55.0	59.0	4.0	57.0	125	7,495	7,245	3,688	7,688	42	0.288	0.029	0.600				1.73	0.349	1,765	5,453
L		-	00.0					,	7,210	,	,			0.020	0.000		1	I		0.010	.,. 00	3,100

1. $\sigma_p' = \sigma_{vo}' + \sigma_{m_c}$ Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. C_r = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{p'})$ for $\sigma_{vo}' < \sigma_{p}' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. $S_c = H(1/C')log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Calculated By:	BRT	Date:	7/18/2019
Checked By:	JPS	Date:	7/18/2019

Total S	Settlement at	Center of Re	einforced So	il Mass		Total Sett	lement at Fa	cing of Wall	
I ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	l ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)
1.000	5,050	5,112	0.043	0.520	0.500	2,525	2,588	0.037	0.440
0.998	5,038	5,225	0.035	0.425	0.500	2,524	2,712	0.028	0.341
0.989	4,996	5,309	0.032	0.385	0.499	2,521	2,834	0.025	0.300
0.973	4,916	5,354	0.030	0.355	0.498	2,515	2,953	0.023	0.271
0.946	4,779	5,345	0.162	1.947	0.496	2,503	3,070	0.069	0.823
0.907	4,580	5,278	0.148	1.772	0.492	2,483	3,181	0.062	0.745
0.861	4,350	5,192	0.026	0.313	0.486	2,455	3,297	0.020	0.235
0.813	4,108	5,107	0.024	0.288	0.479	2,419	3,417	0.018	0.217
0.766	3,867	5,022	0.022	0.266	0.470	2,376	3,531	0.017	0.202
0.720	3,634	4,946	0.020	0.244	0.461	2,327	3,638	0.016	0.188
0.660	3,333	4,875	0.015	0.183	0.446	2,251	3,793	0.012	0.143
0.592	2,992	4,838	0.014	0.163	0.425	2,145	3,991	0.011	0.131
0.532	2,686	4,865	0.005	0.062	0.402	2,030	4,209	0.004	0.051
0.478	2,416	4,946	0.013	0.161	0.378	1,910	4,440	0.011	0.135
0.434	2,190	5,070	0.010	0.118	0.355	1,795	4,676	0.008	0.101
0.399	2,017	5,204	0.015	0.184	0.336	1,698	4,885	0.013	0.160
0.373	1,883	5,321	0.014	0.164	0.320	1,616	5,054	0.012	0.145
0.349	1,765	5,453	0.012	0.147	0.305	1,541	5,229	0.011	0.131
	Total	Settlement:		7.697 in		Total	Settlement:		4.758 in

Boring B-114-9-13

H _{Embank} =	13.0	ft	Height of embankment below wall to existing grade		A-6b	A-4a	A-7-6		
H _{Wall} =	20.0	ft	Wall height	c _v =	300	1000	150	ft²/yr	Coefficient of consolitation
B=	33.0	ft	Width equal to total height of wall and embankment	t =	8	8	8	days	Time following completion of construction
D _w =	0.0	ft	Depth below bottom of embankment	H _{dr} =	2.5	2.5	12	ft	Length of longest drainage path considered
q _{Embank} =	1,560	psf	Pressure due to embankment fill below wall	T _v =	1.052	3.507	0.023		Time factor
q _{Wall} =	3,490	psf	Equivalent bearing pressure at bottom of wall	U =	94	100	17	%	Degree of consolidation
q _e =	5,050	psf	Total pressure at bottom of embankment						
				(S _c) _t =	4.302	in	Settlement	complete	at 90% of primary consolidation

																							Total Se	ettlement at	Facing of Wall		mplete at 90% of consolidation
Layer	Soil Type	Soil Type	,	r Depth (ft)	Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	Layer Settlement (in)	(S _c) _t ⁽¹¹⁾ (in)	Layer Settlement (in)
	A-2-4	G	0.0	2.0	2.0	1.0	125	250	125	63	2,063					13	26	88	0.05	0.500	2,525	2,588	0.037	0.440		0.440	
1	A-2-4	G	2.0	4.0	2.0	3.0	125	500	375	188	2,188					13	23	82	0.15	0.500	2,524	2,712	0.028	0.341	1.351	0.341	1.351
	A-2-4	G	4.0	6.0	2.0	5.0	125	750	625	313	2,313					13	21	77	0.25	0.499	2,521	2,834	0.025	0.300	1.001	0.300	1.551
	A-2-4	G	6.0	8.0	2.0	7.0	125	1,000	875	438	2,438					13	20	73	0.35	0.498	2,515	2,953	0.023	0.271		0.271	
2	A-6b	С	8.0	10.5	2.5	9.3	115	1,288	1,144	567	2,567	37	0.243	0.036	0.561				0.46	0.496	2,503	3,070	0.069	0.823	1.568	0.773	1.474
	A-6b	С	10.5	13.0	2.5	11.8	115	1,575	1,431	698	2,698	37	0.243	0.036	0.561				0.59	0.492	2,483	3,181	0.062	0.745		0.701	
	A-1-b	G	13.0	15.5	2.5	14.3	125	1,888	1,731	842	4,842					16	21	76	0.71	0.486	2,455	3,297	0.020	0.235	-	0.235	4
3	A-1-b	G	15.5	18.0	2.5	16.8	125	2,200	2,044	999	4,999					16	20	74	0.84	0.479	2,419	3,417	0.018	0.217	0.842	0.217	0.842
	A-1-b	G	18.0	20.5	2.5	19.3	125	2,513	2,356	1,155	5,155					16	19	72	0.96	0.470	2,376	3,531	0.017	0.202		0.202	4
	A-1-b	G	20.5	23.0	2.5	21.8	125	2,825	2,669	1,312	5,312					16	18	71	1.09	0.461	2,327	3,638	0.016	0.188		0.188	
4	A-1-a	G	23.0	27.5	4.5	25.3	130	3,410	3,118	1,542	5,542					41	45	148	1.26	0.446	2,251	3,793	0.012	0.143	0.274	0.143	0.274
E	A-1-a A-3a	G	27.5 32.0	32.0 37.0	4.5 5.0	29.8 34.5	130 135	3,995 4,670	3,703 4,333	1,846 2,180	5,846 6,180					41 100	42 97	138 338	1.49 1.73	0.425	2,145 2,030	3,991 4,209	0.011	0.131	0.051	0.131	0.051
5	A-sa A-4a	C	37.0	42.0	5.0	34.5 39.5	135	5,320	4,333	2,180	6,180	25	0.135	0.014	0.467	100	97	330	1.73	0.402	2,030	4,209	0.004	0.051	0.051	0.051	0.031
7	A-4a A-3a	G	42.0	42.0	5.0	39.5 44.5	130	5,320	4,995 5,658	2,530	6,881	20	0.155	0.014	0.407	51	45	125	2.23	0.378	1,910	4,440	0.011	0.135	0.135	0.135	0.135
· ·	A-3a A-7-6	C C	42.0	51.0	4.0	44.5	135	6,495	6,245	3,187	7,187	42	0.288	0.029	0.600	51	40	125	2.23	0.335	1,795	4,885	0.008	0.101	0.101	0.101	0.101
8	A-7-6	c	51.0	55.0	4.0	53.0	125	6,995	6,745	3,438	7,438	42	0.288	0.029	0.600				2.45	0.320	1,616	5,054	0.013	0.100	0.436	0.027	0.074
Ŭ	A-7-6	C C	55.0	59.0	4.0	57.0	125	7,495	7,245	3,688	7,688	42	0.288	0.029	0.600				2.85	0.320	1,541	5,034	0.012	0.143	0.400	0.023	0.074

1. $\sigma_p' = \sigma_{vo'} + \sigma_{m}$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_0 = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

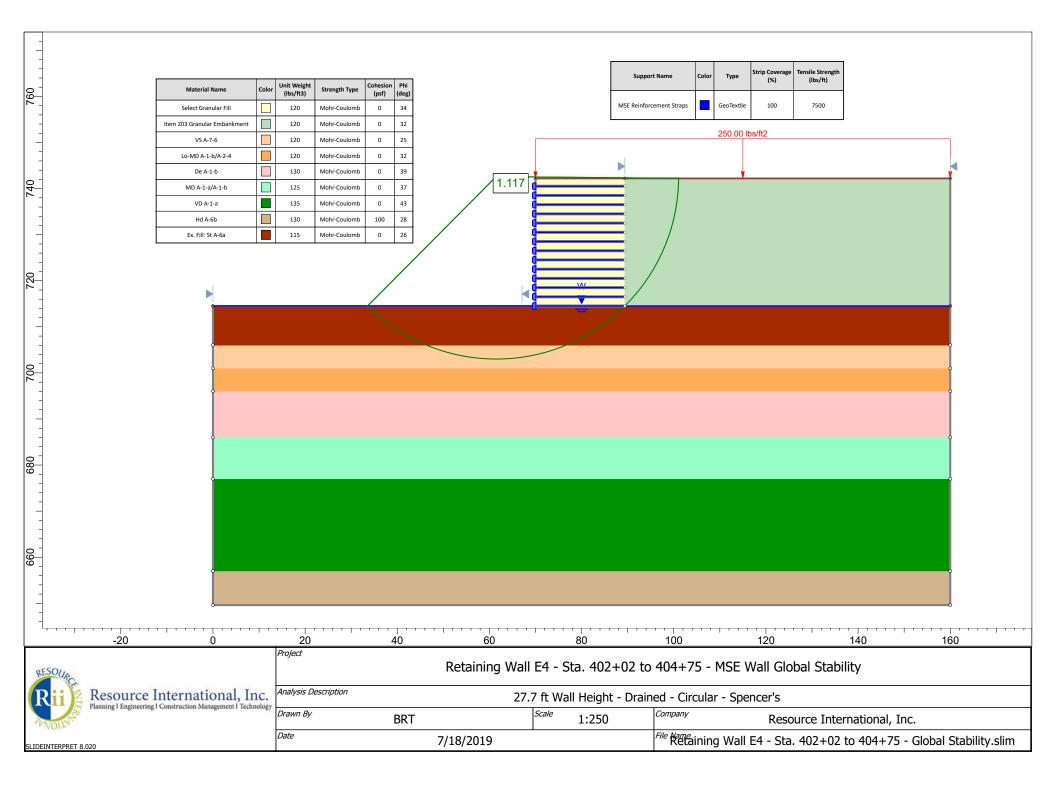
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_p')]$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

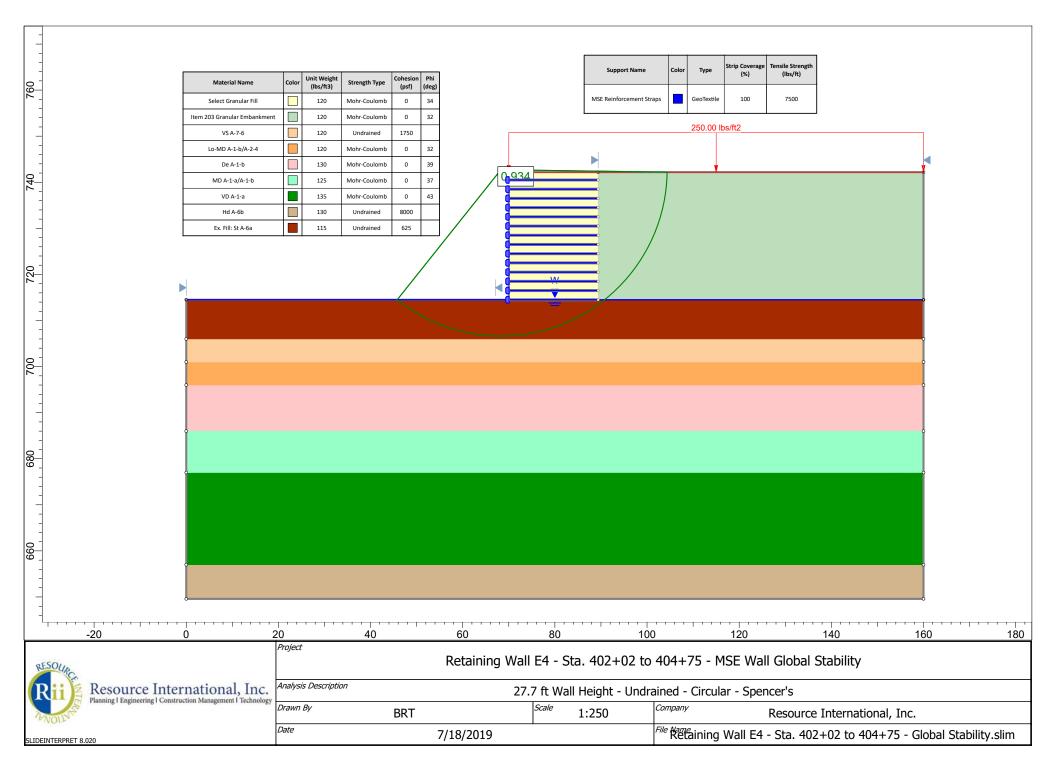
10. $S_c = H(1/C')\log(\sigma_{vf}/\sigma_{vo})$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By:	BRT	Date:	07/18/2019
Checked By:	JPS	Date:	07/18/2019

Settlement Remaining After Hold Period: 0.456 in







ЈОВ Г	RA-70-13.10	NO.	W-13-072
SHEET NO.	1	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wall	F4 - Sta. 404+75 t	o 407+0	00

			σ_{IS} =	= 250 psf						
					F	Proposed	Тор	of Wall	E I -	750 1
\uparrow		XXX	Č					X	xx EI. =	/52.1
	MSE Backt	fill	Retained S	Soil:						
		ł	ODOT Iter	m 203 Eml	bankmen	t				
		Reinforce	mont	$\gamma_{RS} = 120$	pcf					
	γ_{BF} = 120 p	ocf Straps	ment	φ_{RS} = 30 °	$c_{RS} =$	0 psf				
	φ_{BF} = 34 °			$(S_u)_{RS} = 2$	000 psf					
Proposed Bottom of Wall $\sqrt{\frac{p}{2}}$, ←									727.0
	× к в	`	Bearing Soil	: Item 203	Granula	r Embank	ment	t	— EI. =	737.0
XXX XX β_s β_s β_s β_s	<u>N</u>	γ _P	•	_s = 32°					psf	
shown on sheets 4 and 5 of 6 H	I _s	7 B		s - 02	C _{BS} - 0	P01 ()	$S_u BS$ -	- 0	pai	
MSE Wall Dimensions and Retain	ned Soil Parame	eters	<u>Bearing S</u>	oil Prop	erties:					
MSE Wall Height, (<i>H</i>) =		<u>15.1</u> ft	Bearing So							120 pc
MSE Wall Width (Reinforcement Lengt	th), (<i>B</i>) =	10.6 ft	Bearing So							32 °
MSE Wall Length, $(L) =$		750 ft	Bearing So							<mark>0</mark> ps
Live Surcharge Load, $(\sigma_{LS}) =$		250 psf	Bearing So			ar Streng	gth, [($(S_u)_{BS}$]	=	0 ps
Retained Soil Unit Weight, $(\gamma_{RS}) =$		120 pcf	Embedmer			Det -	N/c ¹¹			0.0 ft
Retained Soil Friction Angle, (φ_{RS}) =		30 °	Depth to G			BOI. 01	vvaii)	(D_W)		22.5 ft
Retained Soil Drained Cohesion ¹ , (c _{BS} Retained Soil Undrained Shear Strengt	ດ້າວການການການການກໍ່ການການເຮັດການການຮູ້ການການກ	0 psf 2000 psf	<u>LRFD Loa</u>	ed Facto EV	<u>rs</u> EH	LS				
Retained Soil Active Earth Pressure Co		0.297	Strength la		⊑⊓ 1.50	1.75	-			
MSE Backfill Unit Weight, $(\gamma_{BF}) =$	$(K_a) =$	120 pcf	Strength Ib		1.50	1.75				BDM Tables 1-2 - Active
			Suengurib				-		Earth Pres	
MSE Backfill Friction Angle, (<i>φ</i> _{BF}) = <u>Check Sliding (Loading Case - St</u>			Service I Section 11.10.	1.00 5.3	1.00	1.00	J			
	$P_{H} = P_{L}$	SHTO LRFD BDM $_{EH} + P_{LS_h}$	Section 11.10.	5.3			5)		6 09	kin/ft
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{H}$ $P_{EH} =$	SHTO LRFD BDM $E_H + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_c$	<u>Section 11.10.</u> $_{1}\gamma_{EH} = \frac{1}{2}(12)$	5.3 0 pcf)(15	.1 ft)²(0	.297)(1			6.09	kip/ft
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{H}$ $P_{EH} =$	SHTO LRFD BDM $_{EH} + P_{LS_h}$	<u>Section 11.10.</u> $_{1}\gamma_{EH} = \frac{1}{2}(12)$	5.3 0 pcf)(15	.1 ft)²(0	.297)(1			6.09	kip/ft kip/ft
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} = P_{LS_{h}}$	SHTO LRFD BDM $EH + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_a$ $= \sigma_{LS} H K_a \gamma_L$	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2} (12)$ $_{LS} = (250 \text{ p})$	5.3 0 pcf)(15 sf)(15.1 1	.1 ft)²(0 t)(0.297	.297)(1 7)(1.75)				
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} = P_{LS_{h}}$	SHTO LRFD BDM $E_H + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_c$	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2} (12)$ $_{LS} = (250 \text{ p})$	5.3 0 pcf)(15 sf)(15.1 1	.1 ft)²(0 t)(0.297	.297)(1				
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} =$ $\frac{P_{EH}}{P_{EH}} =$ $P_{LS_{h}}$ $P_{LS_{h}}$	SHTO LRFD BDM $EH + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_a$ $= \sigma_{LS} H K_a \gamma_L$	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2} (12)$ $_{LS} = (250 \text{ p})$	5.3 0 pcf)(15 sf)(15.1 1	.1 ft)²(0 t)(0.297	.297)(1 7)(1.75)				
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} =$ $\frac{P_{EH}}{P_{EH}} =$ $P_{LS_{h}}$ $P_{LS_{h}}$	SHTO LRFD BDM $EH + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_a$ $= \sigma_{LS} H K_a \gamma_L$	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2} (12)$ $_{LS} = (250 \text{ p})$	5.3 0 pcf)(15 sf)(15.1 1	.1 ft)²(0 t)(0.297	.297)(1 7)(1.75)				
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} =$ $\frac{P_{EH}}{P_{EH}} =$ $P_{LS_{h}}$ $P_{LS_{h}}$	SHTO LRFD BDM $E_H + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_{a}$ $= \sigma_{LS} H K_a \gamma_{L}$ = 6.09 kip/ff	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2} (12)$ $_{LS} = (250 \text{ p})$	5.3 0 pcf)(15 sf)(15.1 1	.1 ft)²(0 t)(0.297	.297)(1 7)(1.75)				
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} =$ $P_{EH} =$ $P_{LS_{h}}$ P_{EH} $P_{LS_{h}}$ P_{EH} P_{EH} P_{EH} P_{EH}	SHTO LRFD BDM $EH + P_{LS_h} = \frac{1}{2} \gamma_{RS} H^2 K_d$ $= \sigma_{LS} H K_a \gamma_1$ $I = 6.09 \text{ kip/fm}$ $\gamma_1 \cdot \tan \delta$	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2}(12)$ $_{LS} = (250 \text{ p})$ t + 1.96 kip/ft	5.3 0 pcf)(15 sf)(15.1 1 = 8	.1 ft)²(0 't)(0.297 3.05	.297)(1 7)(1.75) kip/ft			1.96	kip/ft
Check Sliding (Loading Case - St Sliding Force: PL Check Sliding Resistance - Drain Nominal Sliding Resistance:	$P_{H} = P_{L}$ $P_{EH} =$ $P_{EH} =$ $P_{LS_{h}}$ P_{EH} $P_{LS_{h}}$ P_{EH} P_{EH} P_{EH} P_{EH}	SHTO LRFD BDM $E_H + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_{a}$ $= \sigma_{LS} H K_a \gamma_{L}$ = 6.09 kip/ff	<u>Section 11.10.</u> $_{a} \gamma_{EH} = \frac{1}{2}(12)$ $_{LS} = (250 \text{ p})$ t + 1.96 kip/ft	5.3 0 pcf)(15 sf)(15.1 1 = 8	.1 ft)²(0 't)(0.297 3.05	.297)(1 7)(1.75) kip/ft			1.96	
Check Sliding (Loading Case - St Sliding Force:	$P_{H} = P_{L}$ $P_{EH} =$ $P_{LS_{h}}$	SHTO LRFD BDM $EH + P_{LS_h} = \frac{1}{2} \gamma_{RS} H^2 K_d$ $= \sigma_{LS} H K_a \gamma_H$ $= 6.09 \text{ kip/ff}$ $\chi \cdot \tan \delta$ $= \gamma_{BF} \cdot H \cdot B \cdot$	Section 11.10. $_{a}\gamma_{EH} = \frac{1}{2}(12)$ $_{LS} = (250 \text{ p})$ t + 1.96 kip/ft $\gamma_{EV} = (120)$	5.3 0 pcf)(15 sf)(15.1 1 = 8	.1 ft)²(0 't)(0.297 3.05	.297)(1 7)(1.75) kip/ft			1.96	kip/ft
Check Sliding (Loading Case - St Sliding Force: PL Check Sliding Resistance - Drain Nominal Sliding Resistance:	$P_{H} = P_{L}$ $P_{EH} =$ $P_{LS_{h}}$	SHTO LRFD BDM $EH + P_{LS_h} = \frac{1}{2} \gamma_{RS} H^2 K_a$ $= \sigma_{LS} H K_a \gamma_1$ $I = 6.09 \text{ kip/fm}$ $\gamma_1 \cdot \tan \delta$	Section 11.10. $_{a}\gamma_{EH} = \frac{1}{2}(12)$ $_{LS} = (250 \text{ p})$ t + 1.96 kip/ft $\gamma_{EV} = (120)$	5.3 0 pcf)(15 sf)(15.1 1 = 8	.1 ft)²(0 't)(0.297 3.05	.297)(1 7)(1.75) kip/ft			1.96	kip/ft
Check Sliding (Loading Case - St Sliding Force: PL Check Sliding Resistance - Drain Nominal Sliding Resistance:	$P_{H} = P_{L}$ $P_{EH} = P_{LS_{h}}$ $P_{EH} = P_{LS_{h}}$ P_{E} P_{E} P_{E} P_{E} P_{E} $P_{EV} = 1$ $Tan \delta$	SHTO LRFD BDM $EH + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_a$ $= \sigma_{LS} H K_a \gamma_H$ $= 6.09 \text{ kip/ff}$ $\gamma \cdot \tan \delta$ $= \gamma_{BF} \cdot H \cdot B \cdot$ $= (\tan \varphi_{BS} \le \tan \delta)$	Section 11.10. $_{a} \gamma_{EH} = \gamma_{e}(12)$ $_{LS} = (250 \text{ p})$ t + 1.96 kip/ft $\gamma_{EV} = (120)$ $\text{un } \varphi_{BF}$	5.3 0 pcf)(15 sf)(15.1 1 = { pcf)(15.1	.1 ft)²(0 ˈt)(0.297 3.05 ft)(10.	1.297)(1 7)(1.75) kip/ft 6 ft)(1.0			1.96 19.21	kip/ft kip/ft
Check Sliding (Loading Case - St Sliding Force: PL PL Check Sliding Resistance - Drain Nominal Sliding Resistance: PEV United State	$P_{H} = P_{L}$ $P_{EH} = P_{LS_{h}}$ $P_{EH} = P_{LS_{h}}$ P_{E} P_{E} P_{E} P_{E} P_{E} $P_{EV} = 1$ $Tan \delta$	SHTO LRFD BDM $EH + P_{LS_h} = \frac{1}{2} \gamma_{RS} H^2 K_d$ $= \sigma_{LS} H K_a \gamma_H$ $= 6.09 \text{ kip/ff}$ $\chi \cdot \tan \delta$ $= \gamma_{BF} \cdot H \cdot B \cdot$	Section 11.10. $_{a} \gamma_{EH} = \gamma_{e}(12)$ $_{LS} = (250 \text{ p})$ t + 1.96 kip/ft $\gamma_{EV} = (120)$ $\text{un } \varphi_{BF}$	5.3 0 pcf)(15 sf)(15.1 1 = { pcf)(15.1	.1 ft)²(0 ˈt)(0.297 3.05 ft)(10.	1.297)(1 7)(1.75) kip/ft 6 ft)(1.0			1.96 19.21	kip/ft
Check Sliding (Loading Case - St Sliding Force: PL Check Sliding Resistance - Drain Nominal Sliding Resistance:	$P_{H} = P_{L}$ $P_{EH} = P_{LS_{h}}$ $P_{EH} = P_{LS_{h}}$ $P_{EV} = P_{EV} = P_{EV}$ $P_{EV} = P_{EV} = P_{EV}$	SHTO LRFD BDM $EH + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_a$ $= \sigma_{LS} H K_a \gamma_H$ $= 6.09 \text{ kip/ff}$ $\gamma \cdot \tan \delta$ $= \gamma_{BF} \cdot H \cdot B \cdot$ $= (\tan \varphi_{BS} \le \tan \delta)$	Section 11.10. ${}_{a} \gamma_{EH} = \gamma_{2}(12)$ ${}_{LS} = (250 \text{ p})$ t + 1.96 kip/ft $\gamma_{EV} = (120)$ $\tan \varphi_{BF}$) $) \le \tan(34) \longrightarrow$	5.3 0 pcf)(15 sf)(15.1 1 = { pcf)(15.1	.1 ft)²(0 ˈt)(0.297 3.05 ft)(10.	1.297)(1 7)(1.75) kip/ft 6 ft)(1.0			1.96 19.21	kip/ft kip/ft
Check Sliding (Loading Case - St Sliding Force: PL PL Check Sliding Resistance - Drain Nominal Sliding Resistance: PEV United State	$P_{H} = P_{L}$ $P_{EH} = P_{LS_{h}}$ $P_{LS_{h}}$ $P_{EH} = P_{LS_{h}}$ $P_{LS_{h}}$ $P_{EV} = P_{EV}$ $P_{EV} = P_{EV}$ $P_{EV} = P_{EV}$ $P_{EV} = P_{EV} = P_{EV}$	SHTO LRFD BDM $EH + P_{LS_h}$ $= \frac{1}{2} \gamma_{RS} H^2 K_d$ $= \sigma_{LS} H K_a \gamma_H$ $= 6.09 \text{ kip/ff}$ $\gamma \cdot \tan \delta$ $= \gamma_{BF} \cdot H \cdot B \cdot$ $= (\tan \varphi_{BS} \le \tan 32)$ $= \tan 32$ $= 121 \text{ kip/ft} (0.62)$	Section 11.10. ${}_{a}\gamma_{EH} = \frac{1}{2}(12)$ ${}_{LS} = (250 \text{ p})$ t + 1.96 kip/ft $\gamma_{EV} = (120)$ $\text{in } \varphi_{BF}$) $j \le \tan(34) \longrightarrow$ = 11.91	5.3 0 pcf)(15 sf)(15.1 f = { pcf)(15.1 > 0.62 ≤ kip/ft	.1 ft)²(0 ˈt)(0.297 3.05 ft)(10.	1.297)(1 7)(1.75) kip/ft 6 ft)(1.0			1.96 19.21	kip/ft kip/ft



RESOURCE INTERNATIONAL, INC. 6350 PRESIDENTIAL GATEWAY COLUMBUS, OHIO 43231 PHONE: (614) 823-4949 FAX: (614) 823-4990

JOB F	RA-70-13.10	NO.	W-13-072
SHEET NO.	2	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wall	E4 - Sta. 404+75 t	o 407+0	00

MSE Wall Dimensions and Retained Soil Para	ameters	Bearing Soil Properties:		
MSE Wall Height, (<i>H</i>) =	15.1 ft	Bearing Soil Unit Weight, (γ_{BS})) =	120 pcf
MSE Wall Width (Reinforcement Length), (B) =	10.6 ft	Bearing Soil Friction Angle, (φ	_{BS}) =	32 °
MSE Wall Length, (<i>L</i>) =	750 ft	Bearing Soil Drained Cohesior	$(c_{BS}) =$	0 psf
Live Surcharge Load, (σ_{LS}) =	250 psf	Bearing Soil Undrained Shear	Strength, $[(s_u)_{BS}] =$	0 psf
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment Depth, (D_f) =		0.0 ft
Retained Soil Friction Angle, (φ_{RS}) =	30 °	Depth to Grounwater (Below E	Sot. of Wall), (D_W) =	22.5 ft
Retained Soil Drained Cohesion, $(c_{BS}) =$	0 psf	LRFD Load Factors		
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000 psf	EV EH	LS	
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength Ia 1.00 1.50	1.75 (AASHTO LRFL	O BDM Tables
MSE Backfill Unit Weight, (γ_{BF}) =	120 pcf	Strength lb 1.35 1.50	1.75 - 3.4.1-1 and 3.4 Earth Pre	
MSE Backfill Friction Angle, (φ_{BF}) =	<u> </u>	Service I 1.00 1.00		5550167
Check Sliding (Loading Case - Strength Ia) -		M Section 11.10.5.3 (Continued)		
Check Sliding Resistance - Undrained Condi	ition			
Nominal Sliding Resisting: $R_{ au} =$	$= \left(\left(S_u \right)_{BS} \leq q_s \right) \cdot P$			
	$(S_u)_{BS} = N/A$	ksf		
P_{EV}	σ /			
	$q_s = \frac{v}{2} =$	(1.81 ksf) / 2 = 0.91 ksf		
R_{τ}				
	D /			
	$ I_{FV}$ /	- (40.04 Lin/(4)) / (40.0 (4))	- 4.04 15	
	2 ₇ = (N/A ksf ≤ 0.9	= (19.21 kip/ft) / (10.6 ft) = 1 ksf)(10.6 ft) = N/A kip/ft		
R /erify Sliding Force Less Than Factored Slid	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R	2 ₇ = (N/A ksf ≤ 0.9	1 ksf)(10.6 ft) = N/A kip/ft		
R Verify Sliding Force Less Than Factored Slid	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
$\begin{array}{l} R \\ \hline \textit{/erify Sliding Force Less Than Factored Slid} \\ P_H \leq R_\tau \cdot \phi_\tau \longrightarrow \end{array}$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
$\begin{array}{l} R \\ \hline \textit{/erify Sliding Force Less Than Factored Slid} \\ P_H \leq R_\tau \cdot \phi_\tau \longrightarrow \end{array}$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
$\begin{array}{l} R \\ \hline \textit{/erify Sliding Force Less Than Factored Slid} \\ P_H \leq R_\tau \cdot \phi_\tau \longrightarrow \end{array}$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
$\begin{array}{l} R \\ \hline \textit{/erify Sliding Force Less Than Factored Slid} \\ P_H \leq R_\tau \cdot \phi_\tau \longrightarrow \end{array}$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R/erify Sliding Force Less Than Factored Slid $P_H \leq R_\tau \cdot \phi_\tau \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R/erify Sliding Force Less Than Factored Slid $P_H \leq R_\tau \cdot \phi_\tau \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
RVerify Sliding Force Less Than Factored Slid $P_H \leq R_\tau \cdot \phi_\tau \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R/erify Sliding Force Less Than Factored Slid $P_H \leq R_\tau \cdot \phi_\tau \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
RVerify Sliding Force Less Than Factored Slid $P_H \leq R_\tau \cdot \phi_\tau \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R/erify Sliding Force Less Than Factored Slid $P_H \leq R_\tau \cdot \phi_\tau \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
$\begin{array}{l} R \\ \hline \textit{/erify Sliding Force Less Than Factored Slid} \\ P_{H} \leq R_{\tau} \cdot \phi_{\tau} \longrightarrow \end{array}$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
$\begin{array}{l} R \\ \hline \textit{/erify Sliding Force Less Than Factored Slid} \\ P_{H} \leq R_{\tau} \cdot \phi_{\tau} \longrightarrow \end{array}$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R Verify Sliding Force Less Than Factored Slid $P_H \leq R_{ au} \cdot \phi_{ au} \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R Verify Sliding Force Less Than Factored Slid $P_H \leq R_{ au} \cdot \phi_{ au} \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R Verify Sliding Force Less Than Factored Slid $P_H \leq R_{ au} \cdot \phi_{ au} \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R Verify Sliding Force Less Than Factored Slid $P_H \leq R_{ au} \cdot \phi_{ au} \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R Verify Sliding Force Less Than Factored Slid $P_H \leq R_ au \cdot \phi_ au \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		
R Verify Sliding Force Less Than Factored Slid $P_H \leq R_ au \cdot \phi_ au \longrightarrow$	R ₇ = (N/A ksf ≤ 0.9 ling Resistance - Ur N/A	1 ksf)(10.6 ft) = N/A kip/ft ndrained Condition		



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MSE Wall Dimensions and Retained MSE Wall Height, (<i>H</i>) = MSE Wall Width (Reinforcement Length), (MSE Wall Length, (<i>L</i>) =	Soil Parameters 15.1 ft	Bearing Soil Properties:	
MSE Wall Height, (<i>H</i>) = MSE Wall Width (Reinforcement Length), (
MSE Wall Width (Reinforcement Length),	15.1 ft		
		Bearing Soil Unit Weight, $(\gamma_{BS}) =$	<u>120</u> pcf
MSE Wall Length $(I) =$		Bearing Soil Friction Angle, (φ_{BS}) =	<u>32</u> °
	<u>750 ft</u>	Bearing Soil Drained Cohesion, $(c_{BS}) =$	0 psf
Live Surcharge Load, (σ_{LS}) =	<u>250</u> psf	Bearing Soil Undrained Shear Strength, $[(s_u)_{B_i}]$	· · · · · · · · · · · · · · · · · · ·
Retained Soil Unit Weight, (γ_{RS}) =	<u>120</u> pcf	Embedment Depth, (D_f) =	0.0 ft
Retained Soil Friction Angle, (φ_{RS}) =	<u>30</u> °	Depth to Grounwater (Below Bot. of Wall), (D	_w) = 22.5 ft
Retained Soil Drained Cohesion, (c_{BS}) =	<u> </u>	LRFD Load Factors	
Retained Soil Undrained Shear Strength, [$(S_u)_{RS}$] = 2000 psf	EV EH LS	
Retained Soil Active Earth Pressure Coeff.	$, (K_a) = 0.297$	Strength la 1.00 1.50 1.75] (AAS	HTO LRFD BDM Tables
MSE Backfill Unit Weight, (γ_{BF}) =	120 pcf		1-1 and 3.4.1-2 - Active
MSE Backfill Friction Angle, (φ_{BF}) =	<u>34</u> °	Service I 1.00 1.00 1.00 J	Earth Pressure)
Check Eccentricity (Loading Case - S	Strength Ia) - AASHTO LRFD	BDM Section 11.10.5.5	
	$e = \frac{B}{2} - x_o$		
	$\epsilon - /2$ *o		
$\begin{array}{c c} x_{j} & P_{EV} \\ \uparrow & \uparrow & \downarrow \end{array}$	$\mathbf{r} = \frac{M_{EV} - M_{H}}{M_{EV} - M_{H}}$	= (101.81 kip·ft/ft - 45.43 kip·ft/ft) / (19.21 kip/fi	t) = 2.93 ft
	P_{EH} P_{EV}		<i>γ</i> – 2.35 π
	M 101.01		
	$M_{EV} = 101.81$		
$\begin{array}{c} x_{o} & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ &$	$M_H = 45.43$	kip·ft/ft > Defined below	
$ \langle B_2 \rangle \rightarrow $	$P_{EV} = 19.21$	kip/ft -	
	e = (10.6 ft)/2 - 2.9	93 ft = 2.37 ft	
Resisting Moment, <i>M</i> _{EV} :	$M_{EV} = P_{EV}(x_1)$		
	$P_{_{EV}} = \gamma_{_{BF}} \cdot H \cdot B$	$\gamma_{EV} = (120 \text{ pcf})(15.1 \text{ ft})(10.6 \text{ ft})(1.00) =$	19.21 kip/ft
P_{EV}	r - B/ - (10)	<u> </u>	
	$x_1 - \frac{7}{2} = (10)$.6 ft) / 2 = 5.30 ft	
	$M_{} = (19.21)$	kip/ft)(5.30 ft) = 101.81 kip·ft/ft	
1 x ₁ ~			
Overturning Moment, <i>M_H</i> :	$M_{H} = P_{EH}(x_2) + P_{L}$	$S_{k}(x_{3})$	
	$P - 1/\gamma H^2 K$	$_{a}\gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(15.1 \text{ ft})^{2}(0.297)(1.5) =$	6.09 kip/ft
$\overset{x_3}{\vdash} \overset{P_{LS_k}}{\vdash} I$	$P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma_{L}$	s_{S} = (250 psf)(15.1 ft)(0.297)(1.75) = 1	.96 kip/ft
	$x_2 = H_3 = (15)$.1 ft) / 3 = 5.03 ft	
		.1 ft) / 2 = 7.55 ft	
	$M_{H} = (6.09)$	kip/ft)(5.03 ft) + (1.96 kip/ft)(7.55 ft) = 45	5.43 kip∙ft/ft
Check Eccentricity			
$e < e_{\rm max} \longrightarrow 2.37 {\rm ft} < 3.53$	S ft OK		
Limiting Eccentricity: e_{max} =	$= \frac{\nu}{3} \rightarrow e_{\text{max}} = (10)$.6 ft) / 3 = 3.53 ft	



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MSE Wall Dimensions and Retained Soil Paran	<u>neters</u>	Bearing Soil Properti	<u>PS:</u>	
MSE Wall Height, (H) =	15.1 ft	Bearing Soil Unit Weight	$(\gamma_{BS}) =$	120 pcf
MSE Wall Width (Reinforcement Length), (B) =	10.6 ft	Bearing Soil Friction Ang	le, (φ_{BS}) =	32 °
MSE Wall Length, (L) =	750 ft	Bearing Soil Drained Col	nesion, $(c_{BS}) =$	0 psf
Live Surcharge Load, (σ_{LS}) =	250 psf	Bearing Soil Undrained S	Shear Strength, $[(s_u)_{BS}] =$	0 psf
Retained Soil Unit Weight, (γ_{RS}) =	120 pcf	Embedment Depth, (D_f)	=	0.0 ft
Retained Soil Friction Angle, (φ_{RS}) =	30 °	Depth to Grounwater (Be	low Bot. of Wall), $(D_W) =$	22.5 ft
Retained Soil Drained Cohesion, (c_{RS}) =	0 psf	LRFD Load Factors		
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$	 2000 psf	EV EI	H LS	
Retained Soil Active Earth Pressure Coeff., $(K_a) =$	0.297	Strength la 1.00 1.5	50 1.75 J	
MSE Backfill Unit Weight, $(\gamma_{BF}) =$	120 pcf	Strength lb 1.35 1.5	(AASHTO LRFL	
MSE Backfill Friction Angle, (φ_{BF}) =	<u>. 20</u> po. 34 °	Service I 1.00 1.0	Farth Pre	
Check Bearing Capacity (Loading Case - Stren	igth lb) - AASHTO	LRFD BDM Section 11.10.5.	4	
$P_{LS_{y}}$				
$q_{eq} = $	P_V			
	/ <i>B</i> '			
$x_i P_{EV} \downarrow B B'=$	= B - 2e = 10	.6 ft - 2(1.49 ft) = 7.62	ft	
\uparrow^{3}	5 /	.6 ft - 2(1.49 ft) = 7.62 = (10.6 ft) / 2 - 3.81 ft =		
	$e = \frac{B}{2} - x_{o}$	= (10.6 ft) / 2 - 3.81 ft =	1.49 ft	
\mathbf{R}				
	$x_{o} = \frac{M_{V} - M_{H}}{2}$	= (162.01 kip·ft/ft - 45	47 kip·ft/ft) / 30.57 kip/ft =	3.81 f
$x_{o} \leftarrow \rightarrow e$	P_V			
$\leftarrow B_2 \rightarrow a$	= (30.57 kin/ft)) / (7.62 ft) = 4.01	ksf	
$\leftarrow B' \rightarrow \gamma$				
$M_{V} = P_{EV}(x_{1}) + P_{LS}(x_{1}) = (\gamma_{BF} \cdot H)$	$(\mathbf{x}_{1}, \mathbf{B}, \mathbf{y}_{2})$	$+(\sigma \ldots B \cdot \gamma \ldots)(r_{1})$		
$IIV - IEV(M1) + LS_v(M1) - VBF - I$	$I D I EV ((x_1))$	1 (O LS B I LS (A1))		
$M_V = [(120 \text{ pcf})(15.1 \text{ ft})(10.6 \text{ ft})(1.35)]$)](5.3 ft) + [(250 psf))(10.6 ft)(1.75)](5.3 ft) =	162.01 kip·ft/ft	
$M_{H} = P_{EH}(x_{2}) + P_{LS}(x_{3}) = (\frac{1}{2}\gamma_{RS})$	$U^2 K \chi \gamma \gamma$	$(- UV \times V_{2})$		
$M_{H} - I_{EH} (x_{2}) + I_{LS_{h}} (x_{3}) - (7_{2})^{r} RS^{T}$	$(I \Lambda_a)_{EH} (\lambda_2)$	$+ (O_{LS}IIK_a/LS)(x_3)$		
$M_{H} = [\frac{1}{2}(120 \text{ pcf})(15.1 \text{ ft})^{2}(0.297)(1.5)$	5)](5.03 ft) + [(250 p	osf)(15.1 ft)(0.297)(1.75)](7.55	ft) = 45.47 kip.f	t/ft
$P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$	$+\sigma_{LS}\cdot B\cdot \gamma_{LS}$	S		
$P_V = (120 \text{ pcf})(15.1 \text{ ft})(10.6 \text{ ft})(1.35) +$	(250 psf)(10.6 ft)(1	.75) = 30.57 kip/ft		
Check Bearing Resistance - Drained Condition	<u>1</u>			
Nominal Bearing Resistance: $q_n = cN_{cm} + cm$	- $\gamma D_f N_{qm} C_{wq}$ +	$= \frac{1}{2} \frac{\gamma D N}{m} m C_{wy}$		
$N_{cm} = N_c s_c i_c$ = 35.74	$N_{qm} = N_q s_q d_q l$	i_q = 23.32 N_y	$m_m = N_\gamma s_\gamma i_\gamma$ = 30.09	
	1 · · · ·	7		
N _c = 35.49	N _q = 23.18		$N_{\gamma} = 30.21$	
$S_c = 1+(7.62 \text{ ft}/750 \text{ ft})(23.18/35.49)$	$s_q = 1.006$		$s_{\gamma} = 0.996$	
= 1.007	$d_q = 1+2\tan(32)$		i_{γ} = 1.000 (Assumed)	
i_c = 1.000 (Assumed)	1.000		$C_{w\gamma}$ = 22.5 ft > 1.5(7.62 ft) + 22.	5 ft = 1.00
	$i_q = 1.000$ (<i>i</i>	Assumed)		
	$C_{wq} = 22.5 \text{ ft} >$	0.011 – 1.000		
a (0 ==0/25 720) + (400 ==0/2 0 %)				
$q_n = (0 \text{ psf})(35.738) + (120 \text{ pcf})(0.0 \text{ ft})(0.0 \text{ ft}$			0) = 13.76 ksf	
	(23.319)(1.000) + ½	a(120 pcf)(7.6 ft)(30.089)(1.00 Use β _s = <u>26.6</u>		b = 15.0
$q_n=$ (0 psf)(35.738) + (120 pcf)(0.0 ft)(Verify Equivalent Pressure Less Than Factored	(23.319)(1.000) + ½	k(120 pcf)(7.6 ft)(30.089)(1.00) Use $\beta_s = 26.6$ nce $RC_{BC} = 0.58$	0) = 13.76 ksf $H_s = 22.0$ ft <i>l</i> (Per AASHTO LRFD BDM Secti (Per AASHTO LRFD BDM Table	on 10.6.3.1.2



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$\begin{split} \text{MSE Wall Width (Reinforcement Length). (B) = 10.6 ft Bearing Soil Friction Angle, (\varphi_{AS}) = 32 °. \\ \text{MSE Wall Length, (L) = 1} 750 ft Bearing Soil Undrained Shears Strength, (\xi_{AS}) = 0 psf Retained Soil Undrained Shear Strength, (\xi_{AS}) = 120 pcf Embedment Depth, (D_{f}) = 0.0 ft Retained Soil Undrained Shear Strength, (\xi_{AS}) = 30 ° Depth to Grouwner (Below Bot of Wall), (D_{H}) = 22.5 ft Retained Soil Undrained Shear Strength, (\xi_{AS}) = 0 psf LRFD Load Factors Retained Soil Undrained Shear Strength, (\xi_{AS}) = 0.297 Strength Ia 1.00 1.50 1.75 Retained Soil Active Earth Pressure Coeff., (K_{A}) = 0.297 Strength Ia 1.36 1.50 1.75 Strength Ib 1.35 1.50 1.75 Strength Ib 1.36 I I.50 I I.50 Strength Ib II $	$ \begin{split} & \text{MSE Wall Width (Reinforcement Length), (B) = 10.6 \text{ ft}} & \text{Bearing Soil Friction Angle, } (p_{2S}) = 32^{\frac{1}{2}} \\ & \text{MSE Wall Length, } (L) = 1250 \text{ psf} & \text{Bearing Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0 \text{ psf} \\ & \text{Retained Soil Untrained Shear Strength, } [(s_n)_{SI}] = 120 \text{ pcf} & \text{Embedment Depth, } (D_f) = 0.0 \text{ ft} \\ & \text{Retained Soil Untrained Shear Strength, } [(s_n)_{SI}] = 0 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0.200 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0.200 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0.200 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0.200 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0.200 \text{ psf} \\ & \text{Retained Soil Undrained Shear Strength, } [(s_n)_{SI}] = 0.200 \text{ psf} \\ & \text{Strength Ia } 1.00 \text{ 1.50 } 1.75 \\ & \text{MSE Backfill Unit Weight, } (y_{ar}) = 34^{\frac{1}{20}} \text{ Strength Ib } 1.35 \text{ 1.50 } 1.75 \\ & \text{MSE Backfill Priction Angle, } (g_{ar}) = 34^{\frac{1}{20}} \text{ Strength Ib } 1.35 \text{ 1.50 } 1.75 \\ & \text{MSE Backfill Priction Angle, } (g_{ar}) = 34^{\frac{1}{20}} \text{ Strength Ib } 1.00 \text{ 1.00 } 1.00 \text{ 1.00 } 1.00 \\ & \text{MSE Backfill Priction Angle, } (g_{ar}) = 2.510 \\ & N_{am} = N_{a} S_{a} q_{d} q_{i} q = 1.000 \\ & N_{c} = 5.140 \\ & N_{cm} = N_{c} S_{c} i_{c} = 5.150 \\ & N_{qm} = N_{q} S_{q} q_{d} q_{i} q = 1.000 \\ & S_{c} = 1+7.62 \text{ M}[6](750 \text{ h}]) = 1.002 \\ & S_{q} = 1.000 \\ & (Assumed) \\ & 1.000 \\ & C_{wq} = 22.5 \text{ ft} 1.000 \\ & S_{v} = 1.000 \\ & (Assumed) \\ & C_{wq} = 22.5 \text{ ft} 1.00 \\ & (Assumed) \\ & C_{wq} = 22.5 \text{ ft} 1.00 \\ & (C_{wq} = 22.5 \text{ ft} 1.5(2.2 \text{ ft} + 22.5 \text{ ft} = 1.00 \\ & (C_{wq} = 22.5 \text{ ft} 1.000 \\ & (C_{wq} = 22.5 \text{ ft} 1.5(2.2 \text{ ft} + 22.5 \text{ ft} = 1.0$	MSE Wall Width (Reinforcement Length), $(B) =$ 10.6 ftMSE Wall Length, $(L) =$ 750 ftLive Surcharge Load, $(\sigma_{LS}) =$ 250 psfRetained Soil Unit Weight, $(\gamma_{RS}) =$ 120 pcfRetained Soil Friction Angle, $(\varphi_{RS}) =$ 30 °Retained Soil Drained Cohesion, $(c_{BS}) =$ 0 psfRetained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000 psfRetained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120 pcf	ft ft psf pcf ° psf psf psf pcf °	Bea Bea Em Dep LR Stro Stro Stro Ser	Bearing Soil Bearing Soil Bearing Soil Embedment Depth to Gro LRFD Loa Strength la Strength lb	bil Frictio bil Draine bil Undra nt Depth, crounwate ad Fact EV a 1.00 o 1.35	on Angle, ed Cohes ained She h, $(D_f) =$ ter (Below tors EH 0 1.50 5 1.50	$(\varphi_{BS}) =$ sion, (c_{BS}) ear Streng w Bot. of LS 1.75 1.75	gth, [(s _u)] Wall), (<i>L</i>), (D _W) = (AASHTO 3.4.1-1 al	=(=(=) TO LRFD BDA and 3.4.1-2 -	32 ° 0 ps 0 ps 0.0 ft 22.5 ft DM Tables 2 - Active
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	MSE Wall Length, $(L) =$ 750 ft Live Surcharge Load, $(\sigma_{LS}) =$ 250 psf Retained Soil Unit Weight, $(\gamma_{RS}) =$ 120 pcf Retained Soil Friction Angle, $(\varphi_{RS}) =$ 30 ° Retained Soil Drained Cohesion, $(c_{BS}) =$ 0 psf Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000 psf Retained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297 MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120 pcf	ft psf pcf ° psf psf pcf °	Bea Bea Em Dep LR Stro Stro Stro Stro Stro	Bearing Soil Bearing Soil Embedment Depth to Gro LRFD Loa Strength la Strength lb	bil Draine bil Undra nt Depth frounwate ad Fact EV a 1.00 b 1.35	ed Cohes ained She ain, $(D_f) =$ ter (Below tors EH 0 1.50 5 1.50	sion, (c _{BS} ear Streng w Bot. of ' LS 1.75 1.75	gth, [(s _u)] Wall), (<i>L</i>), (D _W) = (AASHTO 3.4.1-1 al	= 2; = 2; TO LRFD BDN and 3.4.1-2 ·	0 ps 0 ps 0.0 ft 22.5 ft 0M Tables 2 - Active
Live Surcharge Load, $(\sigma_{LS}) =$ $\overline{250}$ psfBearing Soil Undrained Shear Strength, $([S_n]_N] =$ $\overline{0}$ psfRetained Soil Unit Weight, $(\sigma_N) =$ $\overline{120}$ pcfEmbedment Depth $(D_r) =$ $\overline{0.0}$ ftRetained Soil Drained Cohesion, $(c_N) =$ $\overline{0}$ psfLRP Load FactorsRetained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psfLRP Load FactorsRetained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psfLRP Load FactorsRetained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(S_n)_{NS}] =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Continued $(g_{NT}) =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Contanues $(g_{NT}) =$ $\overline{0}$ psf $LRP Load Factors$ Retained Soil Contanues $(g_{NT}) =$ $\overline{0}$ psf $LRP Load Factors$ Check Bearing Resistance - Undrained Condition $(g_{NT}) =$ $(g_{NT}) =$ Nominal Bearing Res	Live Surcharge Load, $(\sigma_{LS}) =$ $\overline{250}$ psfBearing Soil Undrained Shear Strength, $[(s_u)_{SS}] =$ $\overline{0}$ psfRetained Soil Unit Weight, $(\gamma_{SS}) =$ $\overline{120}$ pcfEmbedment Depth, $(D_r) =$ $\overline{0.0}$ ftRetained Soil Drained Cohesion, $(c_{SS}) =$ $\overline{0}$ psfLRP Load FactorsRetained Soil Undrained Shear Strength, $[(s_u)_{SS}] =$ $\overline{0.09}$ psf $LRP Load Factors$ Retained Soil Undrained Shear Strength, $[(s_u)_{SS}] =$ $\overline{0.297}$ Strength la 1.001.00Strength IN Weight, $(\gamma_{SF}) =$ $\overline{120}$ pcfStrength la 1.001.00 1.00 Ste Backfill Untweight, $(\gamma_{SF}) =$ $\overline{120}$ pcfStrength la 1.00 1.00 1.00 Ste Backfill Wieght, $(\gamma_{SF}) =$ $\overline{34} + 3$ Service l 1.00 1.00 $3.4 + 3$ Ste Backfill Priction Angle, $(\phi_{SF}) =$ $\overline{34} + 3$ Service l 1.00 1.00 1.00 Ste Backfill Priction Angle, $(\phi_{SF}) =$ $\overline{34} + 3$ Service l 1.00 1.00 1.00 Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (Continued) $3.4 + 3$ $3.4 + 3$ $3.4 + 3$ $3.4 + 3$ Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{jm} C_{w\gamma}$ $N_{gm} = N_{\gamma} S_{\gamma} i_{\gamma} = 0.000$ $N_{z} = 1.000$ $N_{z} = 1.000$ $N_{z} = 1.000$ N_{c} = 5.140 $N_q = 1.000$ $S_r = 1.000$ $S_r = 1.000$ $S_r = 1.000$ $S_r = 1.000$ $i_c = 1.000$ (Assumed) $d_q = 1+2tan(or)(1+an(or)/than (0.0775 2t))$ $i_{\gamma} = 1.000$ (Assumed) 1.00	Live Surcharge Load, $(\sigma_{LS}) =$ 250 psfRetained Soil Unit Weight, $(\gamma_{RS}) =$ 120 pcfRetained Soil Friction Angle, $(\varphi_{RS}) =$ 30 °Retained Soil Drained Cohesion, $(c_{BS}) =$ 0 psfRetained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000 psfRetained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120 pcf	psf pcf psf psf pcf °	Bea Em Dej LR Stru Stru Stru Ser	Bearing Soil Embedment Depth to Gro LRFD Loa Strength la Strength lb	bil Undra nt Depth rounwate ad Fact EV a 1.00 b 1.35	ained She $(D_f) =$ ter (Below tors EH 0 1.50 5 1.50	w Bot. of ¹ LS 1.75 1.75	gth, [(s _u)] Wall), (<i>L</i>), (D _W) = (AASHTO 3.4.1-1 al	= 2: TO LRFD BDM and 3.4.1-2	0 ps 0.0 ft 22.5 ft 0M Tables 2 - Active
Retained Soil Unit Weight, $(\gamma_{RS}) = 120 \text{ pcf}$ Embedment Depth, $(D_f) = 0.1 \text{ min} 1000 \text{ fr}$ Retained Soil Friction Angle, $(\varphi_{RS}) = 0 \text{ pf}$ Depth to Grouwater (Below Bot. of Wall), $(D_w) = 22.5 \text{ fr}$ Retained Soil Undrained Shear Strength, $(S_w)_{RS} = 2000 \text{ pf}$ Retained Soil Undrained Shear Strength, $(S_w)_{RS} = 2000 \text{ pf}$ Retained Soil Active Earth Pressure Coeff., $(K_w) = 0.297$ Strength Ia 1.00 1.50 1.75 MSE Backfill Unit Weight, $(\gamma_w) = 3.4 \text{ s}^{-2}$ Strength Ib 1.35 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{W'}) = 3.4 \text{ s}^{-2}$ Service I 1.00 1.00 1.00 1.00 Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (Continued) Check Bearing Resistance - Undrained Condition Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{jm} C_{w\gamma}$ $N_{cm} = N_c S_c I_c = 5.150$ $N_{qm} = N_q S_q d_q I_q = 1.000$ $N_y = 0.000$ $S_c = 1+(762 \text{ trif(5)}(750 \text{ tri})) = 1.002$ $S_q = 1.000$ $S_c = 1+(762 \text{ trif(5)}(750 \text{ tri})) = 1.002$ $S_q = 1.000$ $I_{cw} = 22.5 \text{ tries} 0.00 \text{ f}$ $I_{j} = 1.000$ (Assumed) $I_{cw} = 1.000$ (Assumed) $C_{wq} = 22.5 \text{ tries} 0.00 \text{ f}$ $I_{j} = 1.000$ (Assumed) $Q_{m} = N_c S_c I_c = 0 \text{ pf}/(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ Verify Equivalent Pressure Less Than Factored Bearing Resistance $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \rightarrow N/A$ $RC_{RC} = N/A$ (Per AASHTO LRFD BDM Section 10.6.3.1.2c) $\rightarrow \text{ Use}$ $\beta_s = 26.6^{\circ}$ $H_s = 22.0 \text{ ft}$ $b = 15.00 \text{ ft}$	Retained Soil Unit Weight, $(\gamma_{RS}) = 120 \text{ pcf}$ Embedment Depth, $(D_f) = 0.0 \text{ fm}$ Retained Soil Friction Angle, $(\varphi_{RS}) = 0 \text{ psf}$ Entred Cohesion, $(c_{RS}) = 0 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Retained Soil Undrained Shear Strength, $[(S_g)_{RS}] = 2000 \text{ psf}$ Strength Ib 1.35 1.50 1.75 Strength Ib 1.35 1.50 1.75 Strength Ib 1.35 1.50 1.76 Retained Soil Left Id	Retained Soil Unit Weight, $(\gamma_{RS}) =$ 120 pcfRetained Soil Friction Angle, $(\varphi_{RS}) =$ 30 °Retained Soil Drained Cohesion, $(c_{BS}) =$ 0 psfRetained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000 psfRetained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120 pcf	pcf ° psf psf pcf °	Em Dej LR Stru Stru Ser	Embedment Depth to Gro LRFD Loa Strength la Strength lb	nt Depth, Grounwate EV a 1.00 b 1.35	$\begin{array}{l} \text{n, } (D_f) = \\ \text{ter (Below} \\ \hline \\ \text{tors} \\ \hline \\ \\ \text{EH} \\ 0 \\ 1.50 \\ \hline \\ 5 \\ 1.50 \end{array}$	w Bot. of ' LS 1.75 1.75	Wall), (<i>I</i>), (D _W) = (AASHTO 3.4.1-1 al	= 2: TO LRFD BDM and 3.4.1-2	0.0 ft 22.5 ft DM Tables 2 - Active
Retained Soil Friction Angle, $(\varphi_{RS}) = 30^{\circ}$ Retained Soil Drained Cohesion, $(c_{RS}) = 0$ psf LRFD Load Factors Retained Soil Drained Cohesion, $(c_{RS}) = 0$ psf LRFD Load Factors Retained Soil Active Earth Pressure Coeff., $(X_a) = 0.297$ ASE Backfill Unit Weight, $(\gamma_{RT}) = 120$ pcf ASE Backfill Unit Weight, $(\gamma_{RT}) = 120$ pcf Strength Ib 1.35 1.50 1.75 ASE Backfill Priction Angle, $(\varphi_{RT}) = 120$ pcf Strength Ib 1.35 1.50 1.75 Service I 1.00 1.00 1.00 2heck Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (continued) 2heck Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{pm} C_{w\gamma}$ Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{pm} C_{w\gamma}$ N _{cm} = N _c s _c i _c = 5.150 N _{qm} = 1.000 N _{pm} = N _y s _y i _y = 0.000 S _c = 1+(7.82 N(5)(750 ft))) = 1.002 S _q = 1.000 N _c = 5.140 N _q = 1.000 (Assumed) i _c = 1.000 (Assumed) d _q = 1+2tam(0^{\circ})(1-ain(0^{\circ}))tan^{-1}(0.0 M7.62 ft)) i _y = 1.000 (Assumed) 1.000 (Assumed) C _{wq} = 22.5 ft > 0.00 C _{wq} = 2.5 ft > 0.00 C _{wq} =	Retained Soil Friction Angle, $(\varphi_{RS}) = 30^{\circ}$ Depth to Grounwater (Below Bot. of Wall), $(D_{w}) = 22.5$ ft Retained Soil Drained Cohesion, $(c_{w}) = 0$ psf LRFD Load Factors Retained Soil Active Earth Pressure Coeff., $(X_{a}) = 0.297$ ASE Backfill Unit Weight, $(\gamma_{RF}) = 120$ pcf ASE Backfill Unit Weight, $(\gamma_{RF}) = 120$ pcf Strength Ib 1.35 1.50 1.75 ASE Backfill Unit Weight, $(\gamma_{RF}) = 120$ pcf Strength Ib 1.35 1.50 1.75 ASE Backfill Priction Angle, $(\varphi_{RF}) = 2000$ psf Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (continued) Check Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{ym} C_{w\gamma}$ $N_{cm} = N_c S_c i_c = 5.150$ $N_{qm} = N_q S_q d_q i_q = 1.000$ $N_{ym} = N_y S_y i_\gamma = 0.000$ $S_c = 1+(7.62 N(50(750 h))) = 1.002$ $S_q = 1.000$ $S_\gamma = 1.000$ $i_c = 1.000$ (Assumed) $d_q = 1+2 \tan(0^{\circ})(1+\sin(0^{\circ}))^{+} \tan^{\circ}(0.0 h7.62 h)$ $i_\gamma = 1.000$ (Assumed) 1.000 $C_{w\gamma} = 22.5 h > 1.5(7.62 h) + 22.5 h = 1.1$ $i_q = 1.000$ (Assumed) $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $Pressure Less Than Factored Bearing Resistance q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \rightarrow 4.01 \text{ ksf} \leq (NA \text{ ksf})(NA)(0.65) = N/A \text{ ksf} \rightarrow N/ARC_{wc} = N(A (Per AASHTO LRFD BDM Section 10.6.3.12c) \rightarrow Use \beta_s = 26.6^{\circ} H_s = 22.0 \text{ ft} b = 15.0$	Retained Soil Friction Angle, $(\varphi_{RS}) =$ 30Retained Soil Drained Cohesion, $(c_{BS}) =$ 0Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000PsRetained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120	° psf psf °	Dej LR Stru Stru Sej	Depth to Gro LRFD Loa Strength la Strength lb	ad Fact EV 1.00 1.35	ter (Below tors EH 0 1.50 5 1.50	LS 1.75 1.75] (# }	(AASHTO 3.4.1-1 a	= 2: TO LRFD BDN and 3.4.1-2 -	22.5 ft DM Tables 2 - Active
Retained Soil Drained Cohesion, $(c_{ss}) = 0$ psf Retained Soil Undrained Shear Strength, $[(s_n)_{ss}] = 2000$ psf Retained Soil Undrained Shear Strength, $(s_n)_{ss} = 0.297$ Strength lb 1.00 1.50 1.75 ASE Backfill Unit Weight, $(y_{BF}) = 120$ pcf Strength lb 1.35 1.50 1.75 ASE Backfill Friction Angle, $(\varphi_{BF}) = 120$ pcf Strength lb 1.35 1.50 1.75 Service I 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.	Retained Soil Drained Cohesion, $(c_{ss}) = 0$ psf Retained Soil Undrained Shear Strength, $[(s_s)_{ss}] = 2000$ psf Retained Soil Undrained Shear Strength, $[(s_s)_{ss}] = 2000$ psf Retained Soil Active Earth Pressure Coeff., $(K_s) = 0.297$ Strength lb 1.00 1.50 1.75 Strength lb 1.35 1.50 1.00 Strength lg 1.00 1.00 1.00 Strength lg 1.000 N _g = 0.000 N _c = 5.140 N _g = 0.000 N _c = 5.140 N _g = 1.000 N _g = 0.000 S _c = 14(762 https://strenth) = 1.002 S _g = 1.000 S _c = 14(762 https://strenth) = 1.002 S _g = 1.000 S _c = 1.000 (Assumed) S _c = 1.	Retained Soil Drained Cohesion, $(c_{BS}) =$ 0psfRetained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000psfRetained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120pcf	psf psf pcf °	LR Stru Stru Stru Ser	LRFD Loa Strength la Strength lb	ad Fact EV a 1.00 o 1.35	tors EH 0 1.50 5 1.50	LS 1.75 1.75] (# }	(AASHTO 3.4.1-1 a	TO LRFD BDN and 3.4.1-2	DM Tables 2 - Active
Retained Soil Undrained Shear Strength, $[(S_a)_{ab}] = 2000 \text{ psf}$ Retained Soil Active Earth Pressure Coeff., $(K_a) = 0.297$ MSE Backfill Unit Weight, $(\gamma_{BF}) = 120 \text{ pcf}$ Strength lb 1.35 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{BF}) = 34^{\circ}$ Service 1 1.00 1.00 1.00 Check Bearing Capacity (Loading Case - Strength lb) - AASHTO LRFD BDM Section 11.10.5.4 (continued) Check Bearing Resistance - Undrained Condition Nominal Bearing Resistance: $q_n = CN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma BN_{jm} C_{w\gamma}$ $N_{cm} = N_c s_c i_c = 5.150$ $N_q m = N_q s_q d_q i_q = 1.000$ $N_c = 5.140$ $N_c = 1.000$ (Assumed) $i_c = 1.000$ (Assumed) $i_c = 1.000$ (Assumed) $i_q = 1.000$ (Assumed) $Q_m = 1.000$ (Assumed) $M_{cm} = 22.5 \pi > 1.5(76 \pi) + 22.5 \pi = 1.$ $i_q = 1.000$ (Assumed) $Q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $Q_n = N(R_{BC} \cdot \phi_b \rightarrow 4.01 \text{ ksf} \le (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \rightarrow N/A$ $RC_{BC} = N/A$ (Per AASHTO LRFD BDM Section 10.6.3.1.2c) \rightarrow Use $\beta_s = 26.6^{\circ}$ $H_s = 22.0 \text{ ft} b = 15.0 \text{ ft} b = $	Retained Soil Undrained Shear Strength, $[(S_n)_{nN}] = 2000 \text{ psf}$ Retained Soil Active Earth Pressure Coeff., $(K_n) = 0.297$ MSE Backfill Unit Weight, $(\gamma_{BF}) = 120 \text{ pcf}$ Strength la 1.00 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{BF}) = 120 \text{ pcf}$ Strength lb 1.35 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{BF}) = 120 \text{ pcf}$ Strength lb 1.35 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{BF}) = 120 \text{ pcf}$ Strength lb 1.35 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{BF}) = 120 \text{ pcf}$ Strength lb 1.35 1.50 1.75 MSE Backfill Friction Angle, $(\varphi_{BF}) = 120 \text{ pcf}$ Strength lb 1.35 1.50 1.00 1.00 1.00 1.00 1.00 1.00 1.0	Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$ 2000Retained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120	psf °	Stru Stru Ser	Strength Ia Strength Ib	EV a 1.00 b 1.35	EH 1.50 5 1.50	1.75 1.75	- 3	3.4.1-1 a	and 3.4.1-2 -	2 - Active
Retained Soil Active Earth Pressure Coeff., $(K_a) = 0.297$ MSE Backfill Unit Weight, $(\gamma_{ar}) = 3.4.71$ and $3.4.12$. Active Earth Pressure) MSE Backfill Friction Angle, $(\varphi_{mr}) = 3.4.71$ and $3.4.12$. Active Earth Pressure) MSE Backfill Friction Angle, $(\varphi_{mr}) = 3.4.71$ and $3.4.12$. Active Earth Pressure) Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (Continued) Check Bearing Resistance - Undrained Condition Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{zm} C_{w\gamma}$ $N_{cm} = N_c s_c i_c = 5.150$ $N_{qm} = N_q s_q d_q i_q = 1.000$ $N_{zm} = N_r s_r i_r = 0.000$ $S_c = 1.000$ (Assumed) $i_c = 1.000$ (Assumed) $i_c = 1.000$ (Assumed) $I_{qn} = 1.000$ (Assumed) $C_{wq} = 22.5 \text{ ft} > 1.6(7.62 \text{ ft})((5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $Q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $Q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$	Retained Soil Active Earth Pressure Coeff., $(K_a) = 0.297$ MSE Backfill Unit Weight, $(\gamma_{ar}) = 1.00$ MSE Backfill Unit Weight, $(\gamma_{ar}) = 1.00$ MSE Backfill Friction Angle, $(\varphi_{mr}) = 1.00$ Service 1 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1	Retained Soil Active Earth Pressure Coeff., $(K_a) =$ 0.297MSE Backfill Unit Weight, $(\gamma_{BF}) =$ 120	pcf	Stro Ser	Strength Ib	a 1.00 b 1.35) 1.50 5 1.50	1.75 1.75	- 3	3.4.1-1 a	and 3.4.1-2 -	2 - Active
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{l lllllllllllllllllllllllllllllllllll$	MSE Backfill Unit Weight, $(\gamma_{BF}) = 120$ pcf	•	Stro Ser	Strength Ib	1.35	5 1.50	1.75	- 3	3.4.1-1 a	and 3.4.1-2 -	2 - Active
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	anna an	•	Sei					- 3	3.4.1-1 a	and 3.4.1-2 -	2 - Active
$\begin{aligned} &\text{MSE Backfill Friction Angle, } (\varrho_{BE}) = \underline{34}^{\circ} & \text{Service I} 1.00 1.00 1.00 1.00] \\ &\text{Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (Continued) \\ &\text{Check Bearing Resistance:} q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma BN_{pm} C_{wy} \\ &N_{cm} = N_c S_c i_c = 5.150 \\ &N_{qm} = N_q S_q d_q i_q = 1.000 \\ &N_c = 5.140 \\ &N_q = 1.000 \\ &S_c = 1+(7.62 \text{ tr})(5)(750 \text{ tr})) = 1.002 \\ &S_q = 1.000 \\ &S_c = 1.000 \\ &I_c = 1.$	$\begin{aligned} &\text{MSE Backfill Friction Angle, } (\varphi_{BE}) = \underline{34}^{\circ} & \text{Service I} 1.00 1.00 1.00 1.00] \\ &\text{Check Bearing Capacity (Loading Case - Strength Ib) - AASHTO LRFD BDM Section 11.10.5.4 (continued) \\ &\text{Check Bearing Resistance:} q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma BN_{jm} C_{wy} \\ &N_{cm} = N_c S_c i_c = 5.150 \\ &N_{qm} = N_q S_q d_q i_q = 1.000 \\ &N_c = 5.140 \\ &S_c = 1+(7.62 \text{ tr})(5)(750 \text{ tr})) = 1.002 \\ &S_q = 1.000 \\ &S_c = 1+(7.62 \text{ tr})(5)(750 \text{ tr})) = 1.002 \\ &S_q = 1.000 \\ &S_c = 1.000 \\ &I_c $	MSE Backfill Friction Angle, (φ_{BF}) =34 °			Service I	1.00) 1.00	1.00	J	Eai	ann Pressun	ne)
Check Bearing Resistance - Undrained ConditionNominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{jm} C_{w\gamma}$ $N_{cm} = N_c s_c i_c$ = 5.150 $N_{qm} = N_q s_q d_q i_q$ = 1.000 $N_{jm} = N_\gamma s_\gamma i_\gamma$ = 0.000 $N_c = 5.140$ $N_q = 1.000$ $N_\gamma = 0.000$ $s_\gamma = 1.000$ $s_\gamma = 1.000$ $s_c = 1+(7.62 trl((5)(750 tr)))$ = 1.002 $s_q = 1.000$ $s_\gamma = 1.000$ $i_c = 1.000$ (Assumed) $d_q = 1+2 \tan(0^{\circ})(1-\sin(0^{\circ}))^{12} \tan^{-1}(0.0 tr7.62 tr})$ $i_\gamma = 1.000$ (Assumed) $u_q = 1.000$ (Assumed) $C_{wq} = 22.5 \text{ tr} > 0.0 \text{ tr} = 1.000$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ tr})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ tr})(0.000)(1.000)$ = N/A ksfVerify Equivalent Pressure Less Than Factored Bearing Resistance $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow$ 4.01 ksf $\leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf}$ \longrightarrow $RC_{Bc} = N/A$ (Per AASHTO LRFD BDM Section 10.6.3.1.2c) \longrightarrow Use $\beta_s = \underline{26.6}^\circ$ $H_s = \underline{22.0 \text{ tr}}$	Check Bearing Resistance - Undrained ConditionNominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{pm} C_{w\gamma}$ $N_{cm} = N_c s_c i_c$ = 5.150 $N_{qm} = N_q s_q d_q i_q$ = 1.000 $N_c = 5.140$ $N_q = 1.000$ $N_\gamma = 0.000$ $s_c = 1+(7.62 ht[(5)(750 h)])$ = 1.002 $s_q = 1.000$ $s_\gamma = 1.000$ $i_c = 1.000$ (Assumed) $d_q = 1+2tan(0^{\circ})(1-sin(0^{\circ}))tan^{-1}(0.0 ft7.62 ft)$ $i_\gamma = 1.000$ $u = 1.000$ $C_{w\gamma} = 22.5 ft > 1.5(7.62 ft) + 22.5 ft = 1.$ $u = 1.000$ $C_{wq} = 22.5 ft > 0.0 ft = 1.000$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 ft)(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 ft)(0.000)(1.000) = N/A \text{ ksf}$ Verify Equivalent Pressure Less Than Factored Bearing Resistance $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A$ (Per AASHTO LRFD BDM Section 10.6.3.12c) \longrightarrow Use $\beta_s = 26.6^{\circ}$ $H_s = 22.0 \text{ ft}$ $b = 15.0 \text{ ft}$			TO LRFD BD								
Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{ym} C_{wy}$ $N_{cm} = N_c S_c i_c = 5.150$ $N_{qm} = N_q S_q d_q i_q = 1.000$ $N_{ym} = N_y S_y i_y = 0.000$ $N_c = 5.140$ $N_q = 1.000$ $N_y = 0.000$ $s_c = 1+(7.62 \text{ fv})(5(750 \text{ ft})) = 1.002$ $s_q = 1.000$ $S_y = 1.000$ $i_c = 1.000$ (Assumed) $d_q = 1+2 \tan(0^\circ)(1-\sin(0^\circ))^{\text{Ptan}^-1}(0.0 \text{ ft}/7.62 \text{ ft})$ $i_y = 1.000$ (Assumed) 1.000 $C_{wy} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1.$ $i_q = 1.000$ (Assumed) $C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ Verify Equivalent Pressure Less Than Factored Bearing Resistance $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \rightarrow N/A$	Nominal Bearing Resistance: $q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \frac{1}{2} \gamma B N_{ym} C_{w\gamma}$ $N_{cm} = N_c S_c i_c = 5.150$ $N_{qm} = N_q S_q d_q i_q = 1.000$ $N_{ym} = N_\gamma S_\gamma i_\gamma = 0.000$ $N_c = 5.140$ $N_q = 1.000$ $N_\gamma = 0.000$ $s_c = 1+(7.62 \text{ ft})(5(750 \text{ ft})) = 1.002$ $s_q = 1.000$ $s_\gamma = 1.000$ $i_c = 1.000$ (Assumed) $d_q = 1+2 \tan(0^\circ)[1-\sin(0^\circ)] \tan^{-1}(0.0 \text{ ft}/62 \text{ ft})$ $i_\gamma = 1.000$ (Assumed) 1.000 $C_{w\gamma} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1.00$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ Verify Equivalent Pressure Less Than Factored Bearing Resistance $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \rightarrow N/A$	<u> Check Bearing Capacity (Loading Case - Strength Ib) - AAS</u>	ASHTO LEFE		D BDM Sect	<u>tion 11</u>	.10.5.4 ((Continue	<u>d)</u>			
$N_{cm} = N_c S_c i_c = 5.150 \qquad N_{qm} = N_q S_q d_q i_q = 1.000 \qquad N_{\gamma m} = N_\gamma S_\gamma i_\gamma = 0.000$ $N_c = 5.140 \qquad N_q = 1.000 \qquad N_\gamma = 0.000$ $s_c = 1+(7.62 \text{ ft})(5)(750 \text{ ft})) = 1.002 \qquad S_q = 1.000 \qquad S_\gamma = 1.000$ $i_c = 1.000 \text{ (Assumed)} \qquad d_q = 1+2\tan(0^\circ)(1-\sin(0^\circ))^{P\tan^{-1}}(0.0 \text{ ft}7.62 \text{ ft}) \qquad i_\gamma = 1.000 \text{ (Assumed)}$ $C_{w\gamma} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1.$ $i_q = 1.000 \text{ (Assumed)} \qquad C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = \text{N/A } \text{ ksf}$ $Perify Equivalent Pressure Less Than Factored Bearing Resistance$ $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (\text{N/A } \text{ ksf})(\text{N/A})(0.65) = \text{N/A } \text{ ksf} \longrightarrow \text{N/A}$	$\begin{split} N_{cm} &= N_c S_c i_c = 5.150 & N_{qm} = N_q S_q d_q i_q = 1.000 & N_{\gamma m} = N_\gamma S_\gamma i_\gamma = 0.000 \\ N_c &= 5.140 & N_\gamma = 0.000 \\ s_c &= 1+(7.62 \ \text{tr}([5)(750 \ \text{tr})]) &= 1.002 & s_q = 1.000 \\ i_c &= 1.000 & (\text{Assumed}) & 1.002 & s_q = 1.000 \\ d_q &= 1+2 \ \text{tan}(0^\circ)[1-\sin(0^\circ)]^{\text{tan}^\circ}(0.0 \ \text{tr}(7.62 \ \text{tr}) = 1.000 & (\text{Assumed}) \\ C_{wq} &= 22.5 \ \text{tr} > 1.000 & (\text{Assumed}) \\ C_{wq} &= 22.5 \ \text{tr} > 0.0 \ \text{t} = 1.000 \\ Q_n &= (0 \ \text{psf})(5.150) + (120 \ \text{pcf})(0.0 \ \text{th})(1.000)(1.000) + \frac{1}{2}(120 \ \text{pcf})(7.6 \ \text{th})(0.000)(1.000) &= \text{N/A} \ \text{ksf} \\ \hline \text{/erify Equivalent Pressure Less Than Factored Bearing Resistance} \\ \hline q_{eq} &\leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \ \text{ksf} \leq (\text{N/A} \ \text{ksf})(\text{N/A})(0.65) = \text{N/A} \ \text{ksf} \longrightarrow \text{N/A} \\ RC_{BC} &= \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{Use} \beta_s = \underline{26.6}^\circ H_s = \underline{22.0 \ \text{ft}} b = \underline{15.00}^\circ \\ \hline \text{Matrix} = 15.00 \\ \hline \text{Matrix} = 10.00 \\$											
$N_{c} = 5.140 \qquad N_{q} = 1.000 \qquad N_{\gamma} = 0.000 \qquad S_{\gamma} = 1.000 \qquad S_{\gamma} = 1.00$	$N_{c} = 5.140 \qquad N_{q} = 1.000 \qquad N_{\gamma} = 0.000 \qquad S_{\gamma} = 1.000 \qquad (Assumed) \qquad 1.000 \qquad C_{w\gamma} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1.$ $i_{q} = 1.000 \text{ (Assumed)} \qquad C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000 \qquad S_{\gamma} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1.$ $i_{q} = 1.000 \text{ (Assumed)} \qquad C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000 \qquad S_{\gamma} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1.$ $i_{q} = 1.000 \text{ (Assumed)} \qquad C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000 \qquad S_{\gamma} = 1.000 \qquad S_{\gamma} = 0.00 $			$_{vq}$ + $\frac{1}{2}\gamma BN$		vγ						
$s_{c} = 1+(7.62 \text{ tr} I(5)(750 \text{ tr})) = 1.002 s_{q} = 1.000 \qquad s_{\gamma} = 1$	$s_{c} = 1+(7.62 \text{ tr} I(5)(750 \text{ tr})) = 1.002 s_{q} = 1.000 \qquad s_{\gamma} = 1$		$I_a s_a d_a i_a =$		1.000					= 0.	0.000	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$											
$\begin{array}{c} 1.000 \\ i_{q} = 1.000 \\ C_{wq} = 22.5 \text{ft} > 1.5(7.62 \text{ft}) + 22.5 \text{ft} = 1. \\ i_{q} = 1.000 \\ C_{wq} = 22.5 \text{ft} > 0.0 \text{ft} = 1.000 \\ \end{array}$ $\begin{array}{c} Q_{n} = (0 \text{psf})(5.150) + (120 \text{pcf})(0.0 \text{ft})(1.000)(1.000) + \frac{1}{2}(120 \text{pcf})(7.6 \text{ft})(0.000)(1.000) \\ = N/A \\ \text{ksf} \\ \end{array}$ $\begin{array}{c} \text{/erify Equivalent Pressure Less Than Factored Bearing Resistance} \\ q_{eq} \leq q_{n} \cdot RC_{BC} \cdot \phi_{b} \rightarrow 4.01 \\ \text{ksf} \leq (\text{N/A ksf})(\text{N/A})(0.65) = \text{N/A ksf} \\ RC_{BC} = N/A \\ \end{array}$ $\begin{array}{c} \text{/erify Equivalent Pressure Less Than Factored Bearing Resistance} \\ \text{Model of the section 10.6.3.1.2c} \\ Model of the section 10.6$	$\begin{array}{c} 1.000 \\ i_{q} = 1.000 \text{ (Assumed)} \\ C_{wq} = 22.5 \text{ ft} > 1.5(7.62 \text{ ft}) + 22.5 \text{ ft} = 1. \\ i_{q} = 1.000 \text{ (Assumed)} \\ C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000 \end{array}$ $\begin{array}{c} Q_{n} = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf} \\ \hline \text{/erify Equivalent Pressure Less Than Factored Bearing Resistance} \\ \hline Q_{eq} \leq q_{n} \cdot RC_{BC} \cdot \phi_{b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \rightarrow N/A \\ RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \rightarrow \text{Use} \beta_{s} = 26.6 H_{s} = 22.0 \text{ ft} b = 15.0 H_{s} = 22.0 H_{s} =$		1.000				S	$r_{\gamma} = 1.$.000			
$i_{q} = 1.000 \text{ (Assumed)}$ $C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000$ $q_{n} = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $Verify \text{ Equivalent Pressure Less Than Factored Bearing Resistance}$ $q_{eq} \leq q_{n} \cdot RC_{BC} \cdot \phi_{b} \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{ Use } \beta_{s} = 26.6^{\circ} \text{ H}_{s} = 22.0 \text{ ft} \text{ b} = 15.0^{\circ}$	$i_{q} = 1.000 \text{ (Assumed)}$ $C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000$ $q_{n} = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $Perify Equivalent Pressure Less Than Factored Bearing Resistance$ $q_{eq} \leq q_{n} \cdot RC_{BC} \cdot \phi_{b} \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{Use} \beta_{s} = 26.6^{\circ} \text{ H}_{s} = 22.0 \text{ ft} b = 15.0^{\circ}$	i_c = 1.000 (Assumed) d_q =	1.000	00		1/7 62 ft)	i					
$C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $/\text{erify Equivalent Pressure Less Than Factored Bearing Resistance}$ $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{Use} \beta_s = 26.6^{\circ} \text{ H}_s = 22.0 \text{ ft} b = 15.0^{\circ}$	$C_{wq} = 22.5 \text{ ft} > 0.0 \text{ ft} = 1.000$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $/\text{erify Equivalent Pressure Less Than Factored Bearing Resistance}$ $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{Use} \beta_s = 26.6^{\circ} \text{ H}_s = 22.0 \text{ ft} b = 15.0^{\circ}$		1.000	00	n(0°)]²tan⁻¹(0.0 ft/			γ = 1.	.000 (As	(Assumed	ed)	
$q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $/\text{erify Equivalent Pressure Less Than Factored Bearing Resistance}$ $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{Use} \beta_s = \underline{26.6}^\circ H_s = \underline{22.0} \text{ ft} b = \underline{15.0}^\circ$	$q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000) + \frac{1}{2}(120 \text{ pcf})(7.6 \text{ ft})(0.000)(1.000) = N/A \text{ ksf}$ $/\text{erify Equivalent Pressure Less Than Factored Bearing Resistance}$ $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(N/A)(0.65) = N/A \text{ ksf} \longrightarrow N/A$ $RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.2c)} \longrightarrow \text{Use} \beta_s = \underline{26.6}^\circ H_s = \underline{22.0} \text{ ft} b = \underline{15.0}^\circ$		1.000 1+2tan(0°)[1-sir 1.000)0)0 :2tan(0°)[1-sin(0°)] ² 1)0			С			ເດີ້ເວົ້າການການການການການການ		= 1
$\begin{aligned} & \text{/erify Equivalent Pressure Less Than Factored Bearing Resistance} \\ & q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (\text{N/A ksf})(\text{N/A})(0.65) = \text{N/A ksf} \longrightarrow \text{N/A} \\ & RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.2c}) \longrightarrow \text{Use} \beta_s = \underline{26.6}^\circ H_s = \underline{22.0} \text{ ft} b = \underline{15.0}^\circ \end{aligned}$	$\begin{array}{l} & & \\$		1.000 1+2tan(0°)[1-sir 1.000 1.000 (Assum	00 00 -2tan(0°)[1-sin(0°)] ² 1 00 00 (Assumed)	ned)		С			ເດີ້ເວົ້າການການການການການການ		= 1
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + 1/2(120 pt	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000			' _{wy} = 22	2.5 ft > 1.5(1.5(7.62 ft)	t) + 22.5 ft	= 1
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ /erify Equivalent Pressure Less Than Factored Bearing Res	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + ½(120 Resistance	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0	0.000)(1	1.000)	' _{wy} = 22	2.5 ft > 1.5(N//	1.5(7.62 ft)	t) + 22.5 ft	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ <i>/erify</i> Equivalent Pressure Less Than Factored Bearing Response $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(1000)$	1.000 1+2tan(0°)[1-sir 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + ½(120 pt Resistance sf)(N/A)(0.65)	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $/erify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Pressure Less Pressure Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $/erify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Pressure Less Pressure Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $/erify Equivalent Pressure Less Than Factored Bearing Res q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $/erify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Pressure Less Pressure Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pr$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pr$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pr$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Pr$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)	= 22 Wy = 22	2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Residues q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Restriction Q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Restriction Q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \le q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \le (\text{N/A ksf})(RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.})$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \le q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \le (\text{N/A ksf})(RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.})$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \le q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \le (\text{N/A ksf})(RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.})$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{erify Equivalent Pressure Less Than Factored Bearing Res}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \le q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \le (\text{N/A ksf})(RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.})$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \le q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \le (\text{N/A ksf})(RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.})$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \le q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \le (\text{N/A ksf})(RC_{BC} = \text{N/A} (\text{Per AASHTO LRFD BDM Section 10.6.3.1.})$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ erify Equivalent Pressure Less Than Factored Bearing Res $q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b \longrightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A \text{ (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{erify Equivalent Pressure Less Than Factored Bearing Res}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{erify Equivalent Pressure Less Than Factored Bearing Res}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{erify Equivalent Pressure Less Than Factored Bearing Res}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $Verify Equivalent Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure Less Than Factored Bearing Rescurs Pressure Less Than Factored Bearing Rescurs Pressure Less Pressure L$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{wq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{Verify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	
		$C_{mq} = 2$ $q_n = (0 \text{ psf})(5.150) + (120 \text{ pcf})(0.0 \text{ ft})(1.000)(1.000)$ $\frac{\text{(rify Equivalent Pressure Less Than Factored Bearing Res}}{q_{eq} \leq q_n \cdot RC_{BC} \cdot \phi_b} \rightarrow 4.01 \text{ ksf} \leq (N/A \text{ ksf})(RC_{BC} = N/A (Per AASHTO LRFD BDM Section 10.6.3.1.)}$	1.000 1+2tan(0°)[1-sin 1.000 1.000 (Assum 22.5 ft > 0.0 ft 000) + $\frac{1}{2}(120 \text{ pc})$ Resistance sf)(N/A)(0.65) 3.1.2c) \longrightarrow	$\frac{1}{2} \frac{1}{2} \frac{1}$	ned) = 1.000 pcf)(7.6 ft)(0 = N/A ksf	0.000)(1	1.000)		2.5 ft > 1.5(N/, N/A	N/A	t) + 22.5 ft ksf	



JOB	FRA-70-13.10	NO.	W-13-072
SHEET NO.	6	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wa	F4 - Sta 404+75 t	o 407+0	0

	etained Soil Paran	neters	Bearing Soil	Properties:		
MSE Wall Height, (<i>H</i>) =		15.1 ft	Bearing Soil Un	it Weight, $(\gamma_{BS}) =$		120 pc
MSE Wall Width (Reinforcement L	.ength), (<i>B</i>) =	10.6 ft	Bearing Soil Fri	ction Angle, $(\varphi_{BS}) =$		32 °
MSE Wall Length, (L) =		750 ft	Bearing Soil Dr	ained Cohesion, (c_{BS}) =	0 ps
Live Surcharge Load, $(\sigma_{LS}) =$		250 psf	Bearing Soil Un	ndrained Shear Streng	gth, $[(s_u)_{BS}] =$	0 ps
Retained Soil Unit Weight, (γ_{RS}) =		120 pcf	Embedment De	$epth, (D_f) =$		0.0 ft
Retained Soil Friction Angle, (φ_{RS})) =	<u>30</u> °		water (Below Bot. of	Wall), $(D_W) =$	22.5 ft
Retained Soil Drained Cohesion, (a	$c_{BS}) =$	0 psf	LRFD Load F	actors		
Retained Soil Undrained Shear Str	rength, $[(S_u)_{RS}] =$	2000 psf	E	EV EH LS		
Retained Soil Active Earth Pressur	re Coeff., $(K_a) =$	0.297	Strength la 1	.00 1.50 1.75) (AASHTO LRFD	
MSE Backfill Unit Weight, $(\gamma_{BF}) =$		120 pcf	Strength lb 1	.35 1.50 1.75	- 3.4.1-1 and 3.4	
MSE Backfill Friction Angle, (φ_{BF}) :	=	<u>34</u> °	Service I 1	.00 1.00 1.00	Earth Pre	ssure)
Settlement Analysis (Loading	Case - Service I)	- AASHTO LRFD BE	OM Section 11.10.	<u>4.1</u>		
$P_{LS_{\nu}}$						
	$q_{eq} = \frac{1}{2}$	$P_{V}/$				
	-1 eq	<i>и</i> и и и и и и и и и и и и и и и и и и				
x_2 P_{EV}	B'=	B - 2e = 10.6	ft - 2(1.32 ft) =	7.96 ft		
Ϋ1 I I K I \	$-I_{LS}$					
	$-P_{LS_h} P_{EH} \qquad e^{-P_{LS_h}} P_{EH} \qquad e^{-P_{EH}} e^{-P_{EH}$	$e = \frac{B}{2} - x_o =$	(10.6 ft) / 2 - 3 9	8 ft = 1.32	ft	
	1	$\mathbf{x}_o = \frac{M_V - M_H}{P_u}$	= (115 84 kir	o∙ft/ft - 28.9 kip∙ft/ft)	/ 21.86 kip/ft =	3.98
<i>x</i> ₀ < ×> 1 <i>p</i>	· · · · · · · · · · · · · · · · · · ·	$\cdot^{o} P_{V}$				
$\mathcal{L}_{\mathcal{B}}$						
$ \in B/2 $	<i>a</i>	= (21.86 kip/ft) /	(7.06.#) -	0.75		
$ \begin{array}{l} B' \\ M_{V} = P_{EV}(x_{1}) + P_{LS_{V}} \\ M_{V} = [(120 \text{ pcf})(15)] \end{array} $	$(x_1) = (\gamma_{BF} \cdot H)$.1 ft)(10.6 ft)(1.00)	$(H \cdot B \cdot \gamma_{EV})(x_1) +$](5.3 ft) + [(250 psf)(1	$\left(\sigma_{LS} \cdot B \cdot \gamma_{LS}\right)$ 0.6 ft)(1.00)](5.3 ft) = 115.84	kip-ft/ft	
	$(x_{1}) = (\gamma_{BF} \cdot H)$ (x_{1}) = (\gamma_{BF} \cdot H) (x_{3}) = (\gamma_{2} \gamma_{RS}) (x_{3}) = (\gamma_{2} \gamma_{RS}) (1.00) (1.	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1)]$ $H^2 K_a \gamma_{EH} (x_2) +$ $0)](5.03 \text{ ft}) + [(250 \text{ ps})]$ $+ \sigma_{LS} \cdot B \cdot \gamma_{LS}$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft - $(\sigma_{LS} H K_a \gamma_{LS})$ f)(15.1 ft)(0.297)(1	(x_1)) = 115.84 (x_3)	kip·ft/ft 28.90 kip-ft	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(1)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$	$(x_{1}) = (\gamma_{BF} \cdot H)$ (x_{1}) = (\gamma_{BF} \cdot H) (x_{3}) = (\gamma_{2} \gamma_{RS}) (x_{3}) = (\gamma_{2} \gamma_{RS}) (1.00) (1.	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1)]$ $H^2 K_a \gamma_{EH} (x_2) +$ $0)](5.03 \text{ ft}) + [(250 \text{ ps})]$ $+ \sigma_{LS} \cdot B \cdot \gamma_{LS}$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft - $(\sigma_{LS} H K_a \gamma_{LS})$ f)(15.1 ft)(0.297)(1	(x_1)) = 115.84 (x_3) .00)](7.55 ft) =		
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(1)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$	$(x_{1}) = (\gamma_{BF} \cdot H)$ $(x_{1}) = (\gamma_{BF} \cdot H)$ $(x_{3}) = (\gamma_{2} \gamma_{RS})$ $(x_{3}) = (\gamma_{2} \gamma_{RS}$	$H \cdot B \cdot \gamma_{EV} (x_1) +$](5.3 ft) + [(250 psf)(1) $H^2 K_a \gamma_{EH} (x_2) +$ 0)](5.03 ft) + [(250 ps + $\sigma_{LS} \cdot B \cdot \gamma_{LS}$ (250 psf)(10.6 ft)(1.0)	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $-(\sigma_{LS}HK_a\gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86	(x_1)) = 115.84 (x_3) .00)](7.55 ft) =		
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(1)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constants	$(x_{1}) = (\gamma_{BF} \cdot F)$ (x_{1}) = (\gamma_{BF} \cdot F) (x_{3}) = (\gamma_{2} \gamma_{RS} - F) (x_{3}) = (\gamma_{2} \gamma_{RS} - F) (x_{3}) = (\gamma_{2} \gamma_{2}	$H \cdot B \cdot \gamma_{EV} (x_1) +$](5.3 ft) + [(250 psf)(1) $H^2 K_a \gamma_{EH} (x_2) +$ 0)](5.03 ft) + [(250 ps + $\sigma_{LS} \cdot B \cdot \gamma_{LS}$ (250 psf)(10.6 ft)(1.0)	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $-(\sigma_{LS}HK_a\gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between	28.90 kip-fi	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(1)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constants	$(x_1) = (\gamma_{BF} \cdot F)$ $(x_1) = (\gamma_{BF} \cdot F)$ $(x_3) = (\gamma_2 \gamma_{RS})$ $(x_4) = (\gamma_2 \gamma_{RS})$	$H \cdot B \cdot \gamma_{EV} (x_1) + [(250 \text{ psf})(1)] + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} + \sigma_{LS}$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $-(\sigma_{LS}HK_a\gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86 t:)(x ₁)) = 115.84)(x ₃) .00)](7.55 ft) = kip/ft Distance Between Borings Along Wall	28.90 kip-fi	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [1/2(120 \text{ pcf})(15)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constants Boring Tot Cent	$(x_1) = (\gamma_{BF} \cdot F)$ $(x_1) = (\gamma_{BF} \cdot F)$ $(x_3) = (\gamma_2 \gamma_{RS})$ $(x_4) = (\gamma_2 \gamma_{RS})$ $(x_5) = (\gamma_2 \gamma_{RS})$	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1)]$ $H^2 K_a \gamma_{EH} (x_2) +$ $0)](5.03 \text{ ft}) + [(250 \text{ ps})]$ $+ \sigma_{LS} \cdot B \cdot \gamma_{LS}$ $(250 \text{ psf})(10.6 \text{ ft})(1.0)]$ $\boxed{\text{fferential Settlement}}$ $Total Settlement at Wall Facing$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ $0.6 \text{ ft}(1.00)](5.3 \text{ ft}$ $-(\sigma_{LS}HK_a\gamma_{LS})$ $f)(15.1 \text{ ft})(0.297)(1)$ $0) = 21.86$ $\frac{\text{t:}}{1000}$ 1000 ft	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between	28.90 kip-fi	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(1)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constants Boring Tot Center of C	$(x_1) = (\gamma_{BF} \cdot H)$ $(x_1) = (\gamma_{BF} \cdot H)$ $(x_3) = (\gamma_2 \gamma_{RS})$ $(x_4) = (\gamma_2 \gamma_{RS})$ $(x_5) = (\gamma_2 \gamma_{RS})$	$H \cdot B \cdot \gamma_{EV} (x_1) +$](5.3 ft) + [(250 psf)(1 $H^2 K_a \gamma_{EH} (x_2) +$ 0)](5.03 ft) + [(250 ps + $\sigma_{LS} \cdot B \cdot \gamma_{LS}$ (250 psf)(10.6 ft)(1.0 fferential Settlement Total Settlement at Wall Facing 5.175 in	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $(\sigma_{LS} H K_a \gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86 $\underline{t:}$ Time for 90% Consolidation 23 days	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between Borings Along Wall Facing	28.90 kip-fi	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [1/2(120 \text{ pcf})(15)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constant of Constan	$(x_1) = (\gamma_{BF} \cdot H)$ $(x_1) = (\gamma_{BF} \cdot H)$ $(x_3) = (\gamma_2 \gamma_{RS})$ $(x_4) = (\gamma_2 \gamma_{RS})$ $(x_5) = (\gamma_2 \gamma_{RS})$	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} +$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $(\sigma_{LS} H K_a \gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86 $\underline{t:}$ Time for 90% Consolidation 23 days 8 days	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between Borings Along Wall Facing 160 ft	28.90 kip-fi	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [1/2(120 \text{ pcf})(11)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constant of Center of Constant of Center of C	$(x_{1}) = (\gamma_{BF} \cdot F)$ (x_{1}) = (\gamma_{BF} \cdot F) (x_{3}) = (\gamma_{2} \gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) ($H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf}) + \sigma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \sigma_{LS} +$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $(\sigma_{LS} H K_a \gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86 $t:$ Time for 90% Consolidation 23 days 8 days 90 days	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between Borings Along Wall Facing 160 ft 175 ft	28.90 kip-fi Differential Settlement Alon Wall Facing 1/4600 1/650	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [1/2(120 \text{ pcf})(1)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constants Boring Tot Boring Tot Boring Cent B -020-4-13 B -114-9-13 B -114-7-13	$(x_{1}) = (\gamma_{BF} \cdot F)$ (x_{1}) = (\gamma_{BF} \cdot F) (x_{3}) = (\gamma_{2} \gamma_{RS} + F) (x_{4}) = (\gamma_{RS} + F) (x_{4}) = (\gamma_{RS} + F) (x_{4}) = (\g	$H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1) + (250 $	$\frac{\sigma_{LS} \cdot B \cdot \gamma_{LS}}{\sigma_{LS} + \sigma_{LS}}$ 0.6 ft)(1.00)](5.3 ft - ($\sigma_{LS} HK_a \gamma_{LS}$) f)(15.1 ft)(0.297)(1) 0) = 21.86 <u>t:</u> Time for 90% Consolidation 23 days 8 days 90 days 100 days	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between Borings Along Wall Facing 160 ft 175 ft 215 ft	28.90 kip-fi	
$M_{V} = [(120 \text{ pcf})(15)]$ $M_{H} = P_{EH} (x_{2}) + P_{LS_{h}}$ $M_{H} = [1/2(120 \text{ pcf})(11)]$ $P_{V} = P_{EV} + P_{LS} = \gamma_{B}$ $P_{V} = (120 \text{ pcf})(15.1)$ Settlement, Time Rate of Constant of Centers Boring Tote Centers Boring Tote Centers B-020-4-13 B-114-9-13 B-114-8-13	$(x_{1}) = (\gamma_{BF} \cdot F)$ (x_{1}) = (\gamma_{BF} \cdot F) (x_{3}) = (\gamma_{2} \gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) (x_{3}) = (\gamma_{RS} A) ($H \cdot B \cdot \gamma_{EV} (x_1) +$ $](5.3 \text{ ft}) + [(250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf})(1) + (250 \text{ psf}) + \sigma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \sigma_{LS} +$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})$ 0.6 ft)(1.00)](5.3 ft $(\sigma_{LS} H K_a \gamma_{LS})$ f)(15.1 ft)(0.297)(1) 0) = 21.86 t: Time for 90% Consolidation 23 days 8 days 90 days	(x_1)) = 115.84 $)(x_3)$.00)](7.55 ft) = kip/ft Distance Between Borings Along Wall Facing 160 ft 175 ft	28.90 kip-fi Differential Settlement Alon Wall Facing 1/4600 1/650	

Boring B-114-7-13

H _{Embank} =	23.7	ft	Height of embankment below wall to existing grade
H _{Wall} =	15.1	ft	Wall height
B=	38.8	ft	Width equal to total height of wall and embankment
D _w =	0.0	ft	Depth below bottom of embankment
q _{Embank} =	2,844	psf	Pressure due to embankment fill below wall
q _{Wall} =	2,750	psf	Equivalent bearing pressure at bottom of wall
q _e =	5,594	psf	Total pressure at bottom of embankment

Ye -	5,594	psr	rotai press		n of embanki	inen														Total S	Settlement at	Center of R	einforced So	il Mass		Total Sett	lement at Fa	cing of Wall]
Layer	Soil Class.	Soil Type	Layer (⁻ Depth ft)	Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	I ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)
1	A-6a	С	0.0	2.5	2.5	1.3	125	313	156	78	2,078	33	0.207	0.031	0.530				0.03	1.000	5,593	5,672	0.220	2.637	0.500	2,797	2,875	0.120	1.439
	A-6a	С	2.5	5.5	3.0	4.0	125	688	500	250	2,250	33	0.207	0.031	0.530				0.10	0.996	5,574	5,825	0.226	2.708	0.500	2,796	3,046	0.111	1.337
	A-7-6	С	5.5	8.3	2.8	6.9	120	1,024	856	425	2,425	41	0.279	0.042	0.593				0.18	0.983	5,501	5,926	0.246	2.952	0.499	2,791	3,216	0.116	1.389
2	A-7-6	С	8.3	10.5	2.2	9.4	120	1,288	1,156	569	2,569	41	0.279	0.042	0.593				0.24	0.963	5,385	5,954	0.179	2.142	0.497	2,781	3,350	0.082	0.987
	A-7-6	С	10.5	13.0	2.5	11.8	120	1,588	1,438	704	2,704	41	0.279	0.042	0.593				0.30	0.935	5,233	5,937	0.188	2.255	0.495	2,767	3,472	0.086	1.031
3	A-2-6	G	13.0	15.5	2.5	14.3	120	1,888	1,738	848	2,848					8	10	57	0.37	0.900	5,037	5,885	0.037	0.442	0.491	2,747	3,595	0.027	0.330
	A-1-a	G	15.5	18.5	3.0	17.0	125	2,263	2,075	1,014	5,014					28	34	112	0.44	0.857	4,797	5,811	0.020	0.244	0.486	2,716	3,730	0.015	0.182
4	A-1-a	G	18.5	21.5	3.0	20.0	125	2,638	2,450	1,202	5,202					28	33	107	0.52	0.808	4,523	5,725	0.019	0.228	0.478	2,675	3,877	0.014	0.171
-	A-1-a	G	21.5	24.5	3.0	23.0	125	3,013	2,825	1,390	5,390					28	31	103	0.59	0.760	4,250	5,640	0.018	0.212	0.469	2,625	4,015	0.013	0.161
	A-1-a	G	24.5	28.0	3.5	26.3	125	3,450	3,231	1,593	5,593					28	30	99	0.68	0.709	3,969	5,562	0.019	0.229	0.458	2,564	4,158	0.015	0.176
5	A-1-b	G	28.0	32.0	4.0	30.0	135	3,990	3,720	1,848	5,848					77	79	323	0.77	0.656	3,668	5,516	0.006	0.071	0.445	2,487	4,335	0.005	0.055
0	A-1-b	G	32.0	37.0	5.0	34.5	135	4,665	4,328	2,175	6,175					77	75	297	0.89	0.598	3,346	5,520	0.007	0.082	0.427	2,387	4,562	0.005	0.065
6	A-1-b	G	37.0	42.0	5.0	39.5	125	5,290	4,978	2,513	6,513					21	19	73	1.02	0.543	3,035	5,548	0.024	0.282	0.406	2,273	4,785	0.019	0.230
7	A-6b	С	42.0	47.0	5.0	44.5	125	5,915	5,603	2,826	6,826	31	0.189	0.019	0.514				1.15	0.495	2,769	5,594	0.019	0.222	0.386	2,159	4,985	0.015	0.185
'	A-6b	С	47.0	52.0	5.0	49.5	125	6,540	6,228	3,139	7,139	31	0.189	0.019	0.514				1.28	0.454	2,540	5,679	0.016	0.193	0.366	2,048	5,187	0.014	0.163
	A-7-6	С	52.0	56.0	4.0	54.0	130	7,060	6,800	3,430	7,430	41	0.279	0.028	0.593				1.39	0.422	2,361	5,792	0.016	0.191	0.349	1,953	5,384	0.014	0.165
8	A-7-6	С	56.0	60.0	4.0	58.0	130	7,580	7,320	3,701	7,701	41	0.279	0.028	0.593				1.49	0.397	2,221	5,922	0.014	0.172	0.335	1,873	5,574	0.012	0.150
	A-7-6	С	60.0	64.9	4.9	62.5	130	8,217	7,899	4,002	8,002	41	0.279	0.028	0.593				1.61	0.372	2,082	6,083	0.016	0.187	0.320	1,788	5,790	0.014	0.165
1. $\sigma_p' = \sigma_v$	'+σ _{m;} Estimat	te σ_m of 2,0	00 psf in exi	sting fill mate	erial and 4,00	00 psf (moder	ately overco	onsolidated) f	for natural s	oil deposits; F	Ref. Table 11	2, Coduto 2	2003								Total	Settlement:		15.451 in		Total	Settlement:		8.380 in

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{p'})$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. S_c = H(1/C')log($\sigma_{vf}'/\sigma_{vo}'$); Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Calculated By:	BRT	Date:	7/18/2019
Checked By:	JPS	Date:	7/18/2019

Boring B-114-7-13

H _{Embank} =	23.7	ft	Height of embankment below wall to existing grade		A-6a	A-7-6 (Upper)	A-6b	A-7-6 (Lower)		
H _{Wall} =	15.1	ft	Wall height	c _v =	600	150	300	150	ft²/yr	Coefficient of consolitation
B=	38.8	ft	Width equal to total height of wall and embankment	t =	100	100	100	100	days	Time following completion of construction
D _w =	0.0	ft	Depth below bottom of embankment	H _{dr} =	5.5	7.5	10	23	ft	Length of longest drainage path considered
q _{Embank} =	2,844	psf	Pressure due to embankment fill below wall	T _v =	5.434	0.731	0.822	0.078		Time factor
q _{Wall} =	2,750	psf	Equivalent bearing pressure at bottom of wall	U =	100	87	89	31	%	Degree of consolidation
q _e =	5,594	psf	Total pressure at bottom of embankment							
				(S _c) _t =	7.568	in	Settlement of	complete at	90% of prim	nary consolidation

																							Total Se	ettlement at l	Facing of Wall		mplete at 90% of onsolidation
Layer	Soil Type	Soil Type	,	Depth ft)	Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	Layer Settlement (in)	(S _c) _t ⁽¹¹⁾ (in)	Layer Settlement (in)
1	A-6a	С	0.0	2.5	2.5	1.3	125	313	156	78	2,078	33	0.207	0.031	0.530				0.08	0.500	2,797	2,875	0.120	1.439	2.776	1.439	2.776
I	A-6a	С	2.5	5.5	3.0	4.0	125	688	500	250	2,250	33	0.207	0.031	0.530				0.26	0.500	2,796	3,046	0.111	1.337	2.770	1.337	2.770
	A-7-6	С	5.5	8.3	2.8	6.9	120	1,024	856	425	2,425	41	0.279	0.042	0.593				0.46	0.499	2,791	3,216	0.116	1.389		1.209	
2	A-7-6	С	8.3	10.5	2.2	9.4	120	1,288	1,156	569	2,569	41	0.279	0.042	0.593				0.62	0.497	2,781	3,350	0.082	0.987	3.407	0.859	2.964
	A-7-6	С	10.5	13.0	2.5	11.8	120	1,588	1,438	704	2,704	41	0.279	0.042	0.593				0.78	0.495	2,767	3,472	0.086	1.031		0.897	
3	A-2-6	G	13.0	15.5	2.5	14.3	120	1,888	1,738	848	2,848					8	10	57	0.94	0.491	2,747	3,595	0.027	0.330	0.330	0.330	0.330
	A-1-a	G	15.5	18.5	3.0	17.0	125	2,263	2,075	1,014	5,014					28	34	112	1.13	0.486	2,716	3,730	0.015	0.182	_	0.182	
4	A-1-a	G	18.5	21.5	3.0	20.0	125	2,638	2,450	1,202	5,202					28	33	107	1.32	0.478	2,675	3,877	0.014	0.171	0.690	0.171	0.690
	A-1-a	G	21.5	24.5	3.0	23.0	125	3,013	2,825	1,390	5,390					28	31	103	1.52	0.469	2,625	4,015	0.013	0.161		0.161	
	A-1-a	G	24.5	28.0	3.5	26.3	125	3,450	3,231	1,593	5,593					28	30	99	1.74	0.458	2,564	4,158	0.015	0.176		0.176	
5	A-1-b	G	28.0	32.0	4.0	30.0	135	3,990	3,720	1,848	5,848					77	79	323	1.99	0.445	2,487	4,335	0.005	0.055	0.120	0.055	0.120
-	A-1-b	G	32.0	37.0	5.0	34.5	135	4,665	4,328	2,175	6,175					77	75	297	2.28	0.427	2,387	4,562	0.005	0.065		0.065	
6	A-1-b	G	37.0	42.0	5.0	39.5	125	5,290	4,978	2,513	6,513					21	19	73	2.62	0.406	2,273	4,785	0.019	0.230	0.230	0.230	0.230
7	A-6b	С	42.0	47.0	5.0	44.5	125	5,915	5,603	2,826	6,826	31	0.189	0.019	0.514				2.95	0.386	2,159	4,985	0.015	0.185	0.348	0.164	0.310
	A-6b	С	47.0	52.0	5.0	49.5	125	6,540	6,228	3,139	7,139	31	0.189	0.019	0.514				3.28	0.366	2,048	5,187	0.014	0.163		0.145	
	A-7-6	С	52.0	56.0	4.0	54.0	130	7,060	6,800	3,430	7,430	41	0.279	0.028	0.593				3.58	0.349	1,953	5,384	0.014	0.165		0.051	1
8	A-7-6	С	56.0	60.0	4.0	58.0	130	7,580	7,320	3,701	7,701	41	0.279	0.028	0.593				3.84	0.335	1,873	5,574	0.012	0.150	0.479	0.046	0.149
	A-7-6	С	60.0	64.9	4.9	62.5	130	8,217	7,899	4,002	8,002	41	0.279	0.028	0.593				4.14	0.320	1,788	5,790	0.014	0.165		0.051	

1. $\sigma_p' = \sigma_{vo'} + \sigma_{m}$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_0 = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_p')]$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. $S_c = H(1/C')\log(\sigma_{vf}/\sigma_{vo})$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By:	BRT	Date:	07/18/2019
Checked By:	JPS	Date:	07/18/2019

Settlement Remaining After Hold Period: 0.812 in

Boring B-114-8-13

H _{Embank} =	30.0	ft	Height of embankment below wall to existing grade
H _{Wall} =	9.0	ft	Wall height
B=	39.0	ft	Width equal to total height of wall and embankment
D _w =	0.0	ft	Depth below bottom of embankment
q _{Embank} =	3,600	psf	Pressure due to embankment fill below wall
q _{Wall} =	1,610	psf	Equivalent bearing pressure at bottom of wall
q _e =	5,210	psf	Total pressure at bottom of embankment

q _e =	5,210	psr	rotai press	sure at pottor	m of embank	Inent														r					1				
																				Total S	Settlement at	Center of R	einforced So	il Mass		Total Sett	tlement at Fa	cing of Wall	
Layer	Soil Class.	Soil Type	Laye	r Depth (ft)	Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	I (7)	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)
1	A-4a	С	0.0	2.0	2.0	1.0	120	240	120	58	2,058	32	0.198	0.030	0.522				0.03	1.000	5,210	5,267	0.167	2.002	0.500	2,605	2,663	0.090	1.077
	A-4a	С	2.0	5.5	3.5	3.8	120	660	450	216	2,216	32	0.198	0.030	0.522				0.10	0.997	5,195	5,411	0.246	2.947	0.500	2,604	2,820	0.117	1.401
	A-6b	С	5.5	9.0	3.5	7.3	115	1,063	861	409	2,409	38	0.252	0.038	0.569				0.19	0.981	5,113	5,522	0.267	3.209	0.499	2,598	3,007	0.119	1.429
2	A-6b	С	9.0	11.0	2.0	10.0	115	1,293	1,178	554	2,554	38	0.252	0.038	0.569				0.26	0.957	4,985	5,539	0.140	1.680	0.497	2,588	3,141	0.061	0.731
-	A-6b	С	11.0	13.0	2.0	12.0	115	1,523	1,408	659	2,659	38	0.252	0.038	0.569				0.31	0.933	4,861	5,519	0.131	1.573	0.494	2,576	3,235	0.057	0.679
	A-6b	С	13.0	15.5	2.5	14.3	115	1,810	1,666	777	2,777	38	0.252	0.038	0.569				0.37	0.902	4,697	5,474	0.152	1.820	0.491	2,559	3,336	0.065	0.783
3	A-1-a	G	15.5	18.0	2.5	16.8	125	2,123	1,966	921	4,921					26	33	107	0.43	0.863	4,496	5,417	0.018	0.216	0.486	2,534	3,455	0.013	0.161
•	A-1-a	G	18.0	20.5	2.5	19.3	125	2,435	2,279	1,078	5,078					26	31	103	0.49	0.822	4,285	5,362	0.017	0.203	0.480	2,503	3,580	0.013	0.152
4	A-1-b	G	20.5	24.0	3.5	22.3	130	2,890	2,663	1,274	5,274					30	35	113	0.57	0.774	4,031	5,305	0.019	0.231	0.472	2,459	3,733	0.015	0.174
	A-1-b	G	24.0	28.0	4.0	26.0	130	3,410	3,150	1,528	5,528					30	33	107	0.67	0.715	3,726	5,254	0.020	0.241	0.460	2,395	3,923	0.015	0.184
5	A-1-a	G	28.0	32.5	4.5	30.3	135	4,018	3,714	1,826	5,826					85	88	379	0.78	0.654	3,410	5,236	0.005	0.065	0.444	2,314	4,140	0.004	0.051
	A-1-a	G	32.5	37.0	4.5	34.8	135	4,625	4,321	2,153	6,153					85	83	347	0.89	0.597	3,112	5,264	0.005	0.060	0.426	2,222	4,375	0.004	0.048
6	A-6b	С	37.0	40.9	3.9	39.0	120	5,093	4,859	2,429	6,429	36	0.234	0.023	0.553				1.00	0.550	2,867	5,296	0.020	0.239	0.409	2,133	4,561	0.016	0.193
•	A-6b	С	40.9	44.8	3.9	42.9	120	5,561	5,327	2,653	6,653	36	0.234	0.023	0.553				1.10	0.512	2,667	5,320	0.018	0.213	0.393	2,050	4,703	0.015	0.175
7	A-7-6	С	44.8	48.4	3.6	46.6	125	6,011	5,786	2,878	6,878	42	0.288	0.029	0.600				1.19	0.479	2,496	5,374	0.018	0.211	0.378	1,972	4,850	0.015	0.176
	A-7-6	С	48.4	52.0	3.6	50.2	125	6,461	6,236	3,104	7,104	42	0.288	0.029	0.600				1.29	0.451	2,348	5,452	0.016	0.190	0.364	1,899	5,002	0.013	0.161
8	A-7-6	С	52.0	57.5	5.5	54.8	130	7,176	6,819	3,402	7,402	42	0.288	0.029	0.600				1.40	0.419	2,183	5,585	0.021	0.256	0.347	1,810	5,212	0.018	0.220
5	A-7-6	С	57.5	63.5	6.0	60.5	130	7,956	7,566	3,791	7,791	42	0.288	0.029	0.600				1.55	0.384	2,003	5,793	0.020	0.239	0.327	1,705	5,496	0.017	0.209
1. $\sigma_p' = \sigma_v$	_o '+σ _{m;} Estima	te σ_m of 2,0	00 psf in exi	isting fill mat	terial and 4,0	00 psf (moder	ately overco	onsolidated) f	or natural so	oil deposits; F	Ref. Table 11.	2, Coduto 2	2003								Total	Settlement:		15.594 in		Total	Settlement:		8.003 in

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{p'})$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. S_c = H(1/C')log($\sigma_{vf}'/\sigma_{vo}'$); Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Calculated By:	BRT	Date:	7/18/2019
Checked By:	JPS	Date:	7/18/2019

Boring B-114-8-13

H _{Embank} =	30.0	ft	Height of embankment below wall to existing grade		A-4a (Ex. Fill)	A-6b (Upper)	A-6b (Lower)	A-7-6		
H _{Wall} =	9.0	ft	Wall height	c _v =	1000	300	300	150	ft²/yr	Coefficient of consolitation
B=	39.0	ft	Width equal to total height of wall and embankment	t =	90	90	90	90	days	Time following completion of construction
D _w =	0.0	ft	Depth below bottom of embankment	H _{dr} =	5.5	8	8	26.5	ft	Length of longest drainage path considered
q _{Embank} =	3,600	psf	Pressure due to embankment fill below wall	T _v =	8.151	1.156	1.156	0.053		Time factor
q _{Wall} =	1,610	psf	Equivalent bearing pressure at bottom of wall	U =	100	95	95	26	%	Degree of consolidation
q _e =	5,210	psf	Total pressure at bottom of embankment							
				(S _c) _t =	7.236	in	Settlement c	omplete at	90% of pri	mary consolidation

														·									Total Se	ettlement at	Facing of Wall		mplete at 90% of consolidation
Layer	Soil Type	Soil Type	Layer (f	Depth t)	Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	I ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	Layer Settlement (in)	(S _c) _t ⁽¹¹⁾ (in)	Layer Settlement (in)
4	A-4a	С	0.0	2.0	2.0	1.0	120	240	120	58	2,058	32	0.198	0.030	0.522				0.11	0.500	2,605	2,663	0.090	1.077	2.477	1.077	2.477
1	A-4a	С	2.0	5.5	3.5	3.8	120	660	450	216	2,216	32	0.198	0.030	0.522				0.42	0.500	2,604	2,820	0.117	1.401	2.477	1.401	2.477
	A-6b	С	5.5	9.0	3.5	7.3	115	1,063	861	409	2,409	38	0.252	0.038	0.569				0.81	0.499	2,598	3,007	0.119	1.429		1.358	
2	A-6b	С	9.0	11.0	2.0	10.0	115	1,293	1,178	554	2,554	38	0.252	0.038	0.569				1.11	0.497	2,588	3,141	0.061	0.731	3.622	0.694	3.441
2	A-6b	С	11.0	13.0	2.0	12.0	115	1,523	1,408	659	2,659	38	0.252	0.038	0.569				1.33	0.494	2,576	3,235	0.057	0.679	5.022	0.645	3.441
	A-6b	С	13.0	15.5	2.5	14.3	115	1,810	1,666	777	2,777	38	0.252	0.038	0.569				1.58	0.491	2,559	3,336	0.065	0.783		0.744	
3	A-1-a	G	15.5	18.0	2.5	16.8	125	2,123	1,966	921	4,921					26	33	107	1.86	0.486	2,534	3,455	0.013	0.161	0.313	0.161	0.313
	A-1-a	G	18.0	20.5	2.5	19.3	125	2,435	2,279	1,078	5,078					26	31	103	2.14	0.480	2,503	3,580	0.013	0.152	0.010	0.152	0.010
4	A-1-b	G	20.5	24.0	3.5	22.3	130	2,890	2,663	1,274	5,274					30	35	113	2.47	0.472	2,459	3,733	0.015	0.174	0.358	0.174	0.358
	A-1-b	G	24.0	28.0	4.0	26.0	130	3,410	3,150	1,528	5,528					30	33	107	2.89	0.460	2,395	3,923	0.015	0.184	0.000	0.184	0.000
5	A-1-a	G	28.0	32.5	4.5	30.3	135	4,018	3,714	1,826	5,826					85	88	379	3.36	0.444	2,314	4,140	0.004	0.051	0.099	0.051	0.099
	A-1-a	G	32.5	37.0	4.5	34.8	135	4,625	4,321	2,153	6,153					85	83	347	3.86	0.426	2,222	4,375	0.004	0.048	0.000	0.048	0.000
6	A-6b	С	37.0	40.9	3.9	39.0	120	5,093	4,859	2,429	6,429	36	0.234	0.023	0.553				4.33	0.409	2,133	4,561	0.016	0.193	0.368	0.183	0.350
	A-6b	С	40.9	44.8	3.9	42.9	120	5,561	5,327	2,653	6,653	36	0.234	0.023	0.553				4.76	0.393	2,050	4,703	0.015	0.175	0.000	0.167	0.000
7	A-7-6	С	44.8	48.4	3.6	46.6	125	6,011	5,786	2,878	6,878	42	0.288	0.029	0.600				5.18	0.378	1,972	4,850	0.015	0.176	0.337	0.046	0.088
	A-7-6	С	48.4	52.0	3.6	50.2	125	6,461	6,236	3,104	7,104	42	0.288	0.029	0.600				5.58	0.364	1,899	5,002	0.013	0.161	0.001	0.042	0.000
8	A-7-6	С	52.0	57.5	5.5	54.8	130	7,176	6,819	3,402	7,402	42	0.288	0.029	0.600				6.08	0.347	1,810	5,212	0.018	0.220	0.429	0.057	0.112
Ŭ	A-7-6	С	57.5	63.5	6.0	60.5	130	7,956	7,566	3,791	7,791	42	0.288	0.029	0.600				6.72	0.327	1,705	5,496	0.017	0.209	0.120	0.054	0.112

1. $\sigma_p' = \sigma_{vo'} + \sigma_{m}$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_0 = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

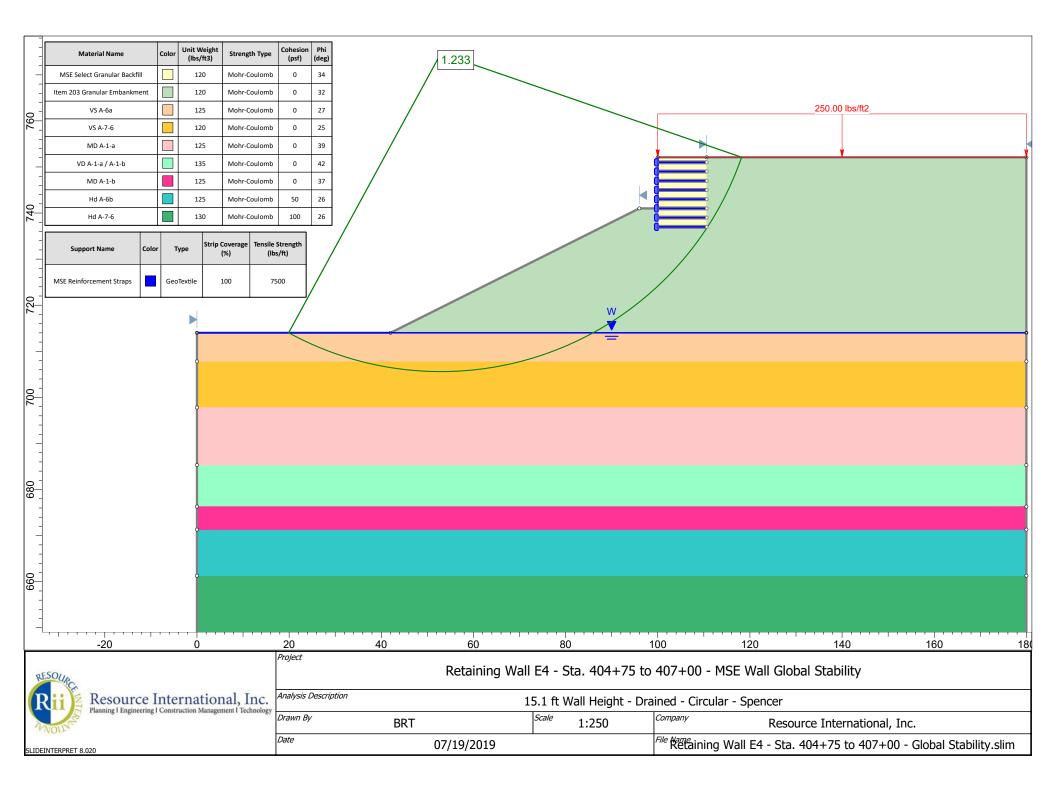
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}/\sigma_p')]$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

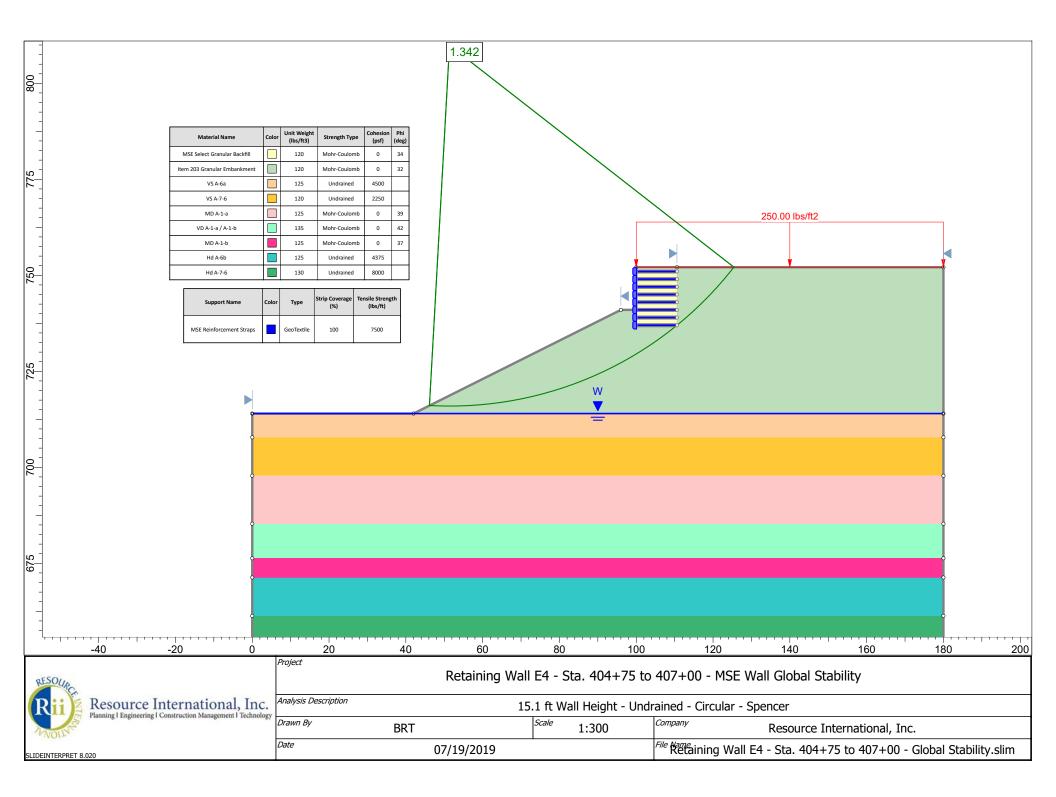
10. $S_c = H(1/C')\log(\sigma_{vf}/\sigma_{vo})$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By:	BRT	Date:	07/18/2019
Checked By:	JPS	Date:	07/18/2019

Settlement Remaining After Hold Period: 0.767 in







JOB I	RA-70-13.10	NO.	W-13-072
SHEET NO.	1	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wal	I E4 - Sta 407+00 t	o 409+5	50

	K──── B ───────────────────────	$\sigma_{\scriptscriptstyle LS}=$ 250 psf	
		Proposed Top of Wall	EL = 753.6
		XX XXX	LI 735.0
	MSE Backfill		
		Retained Soil:	
F	$\frac{\gamma_{BF}}{\varphi_{BF}} = 34^{\circ}$	ODOT Item 203 Embankment	
	i	γ_{RS} = 120 pcf	
	Reinforcement / Straps	φ_{RS} = 30° c_{RS} = 0 psf	
	► '	$(S_u)_{RS}$ = 2000 psf	
Proposed Bottom of Wall	,		
	ery Stiff A-4a, A-6b, A-7-6 and	γ_{BS} = 120 pcf φ_{BS} = 25° c_{BS} = 0 psf $(S_u)_{BS}$ = 1000 ps	El. = 711.5
Loose to Medium Dense A-2-	-	$\gamma_{BS}^{-} = 120 \text{ pci} \varphi_{BS}^{-} = 25 \text{ c}_{BS}^{-} = 0 \text{ psi} (S_u)_{BS}^{-} = 1000 \text{ ps}$	51
ISE Wall Dimensions and Retain	ned Soil Parameters	Bearing Soil Properties:	
ISE Wall Height, (<i>H</i>) =	42.1 ft	Bearing Soil Unit Weight, (γ_{BS}) =	120 pc
ISE Wall Width (Reinforcement Leng	g(th), (B) = 29.5 ft	Bearing Soil Friction Angle, (φ_{BS}) =	25 °
ISE Wall Length, (<i>L</i>) =	750 ft	Bearing Soil Drained Cohesion, (c_{BS}) =	<mark>0</mark> ps
ive Surcharge Load, (σ_{LS}) =	250 psf	Bearing Soil Undrained Shear Strength, $[(S_u)_{BS}] =$	1000 ps
etained Soil Unit Weight, (γ_{RS}) =	<u>120</u> pcf	Embedment Depth, (D_f) =	4.0 ft
etained Soil Friction Angle, (φ_{RS}) =	<u>30</u> °	Depth to Grounwater (Below Bot. of Wall), (D_W) =	0.0 ft
etained Soil Drained Cohesion ¹ , (c_B	ີ່ທີ່ກໍ່ການການການບໍ່ການການອົງການການອົງການການສູ່ <mark></mark>	LRFD Load Factors	
etained Soil Undrained Shear Streng		EV EH LS	
etained Soil Active Earth Pressure C	anangananangan ining nanangananang sa sa sa s ananang nanang n		LRFD BDM Tables
	100 4		10110 11
ISE Backfill Unit Weight, $(\gamma_{BF}) =$ ISE Backfill Friction Angle, $(\varphi_{BF}) =$:heck Sliding (Loading Case - S Sliding Force:	$\frac{120 \text{ pcf}}{34} \circ$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$	Service I 1.00 1.00 1.00	d 3.4.1-2 - Active h Pressure)
ISE Backfill Friction Angle, $(\varphi_{BF}) =$:heck Sliding (Loading Case - S Sliding Force:	$\underline{34}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$	Service I 1.00 1.00 1.00 $\int E^{art}$ M Section 11.10.5.3 $\zeta_a \gamma_{EH} = \gamma_2(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$	h Pressure) '.38 kip/ft
ISE Backfill Friction Angle, $(\varphi_{BF}) =$:heck Sliding (Loading Case - S Sliding Force:	$\underline{34}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$	Service I 1.00 1.00 1.00 \square Earth <u>M Section 11.10.5.3</u> $\zeta_a \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$	h Pressure)
ISE Backfill Friction Angle, $(\varphi_{BF}) =$:heck Sliding (Loading Case - S Sliding Force:	$\underline{34}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\frac{LS_{h}}{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$	Service I 1.00 1.00 1.00 $\int E^{art}$ M Section 11.10.5.3 $\zeta_a \gamma_{EH} = \gamma_2(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$	h Pressure) '.38 kip/ft
ISE Backfill Friction Angle, $(\varphi_{BF}) =$ Sheck Sliding (Loading Case - S Sliding Force:	$\frac{34}{}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\frac{LS_{h}}{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3 $\zeta_a \gamma_{EH} = \gamma_2(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$ $\gamma_{LS} = (250 \text{ psf})(42.1 \text{ ft})(0.297)(1.75) = 5.$	h Pressure) '.38 kip/ft
ISE Backfill Friction Angle, $(\varphi_{BF}) =$:heck Sliding (Loading Case - S Sliding Force:	$\frac{34}{}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\frac{LS_{h}}{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3 $\zeta_a \gamma_{EH} = \gamma_2(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$ $\gamma_{LS} = (250 \text{ psf})(42.1 \text{ ft})(0.297)(1.75) = 5.$	h Pressure) '.38 kip/ft
ISE Backfill Friction Angle, $(\varphi_{BF}) =$ Sheck Sliding (Loading Case - S Sliding Force:	$\frac{34}{}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\frac{LS_{h}}{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3 $\zeta_a \gamma_{EH} = \gamma_2(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$ $\gamma_{LS} = (250 \text{ psf})(42.1 \text{ ft})(0.297)(1.75) = 5.$	h Pressure) '.38 kip/ft
ISE Backfill Friction Angle, (φ _{BF}) = Heck Sliding (Loading Case - S) Sliding Force: P Heck Sliding Resistance - Drain Nominal Sliding Resistance:	$\underline{34}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\frac{LS_{h}}{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$ $P_{H} = 47.38 \text{ kip}$ $P_{LS} = P_{EV} \cdot \tan \delta$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3 $\zeta_a \gamma_{EH} = \gamma_2(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47$ $\gamma_{LS} = (250 \text{ psf})(42.1 \text{ ft})(0.297)(1.75) = 5.$	h Pressure) 7.38 kip/ft 47 kip/ft
ISE Backfill Friction Angle, (φ _{BF}) = Check Sliding (Loading Case - S Sliding Force:	$\underline{34}^{\circ}$ trength la) - AASHTO LRFD BDI $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\frac{LS_{h}}{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$ $P_{H} = 47.38 \text{ kip}$ $P_{LS} = P_{EV} \cdot \tan \delta$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3	h Pressure) 7.38 kip/ft 47 kip/ft
ISE Backfill Friction Angle, (φ _{BF}) = Heck Sliding (Loading Case - S) Sliding Force: P Heck Sliding Resistance - Drain Nominal Sliding Resistance:	$\underline{ 34}^{\circ}$ $\underline{ trength a)} \cdot AASHTO LRFD BDI$ $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\underline{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$ $\underline{P_{H}} = 47.38 \text{ kip}$ $\underline{P_{EV}} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \leq 1)$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3	h Pressure) 7.38 kip/ft 47 kip/ft 9.03 kip/ft
ISE Backfill Friction Angle, $(\varphi_{BF}) =$ Sheck Sliding (Loading Case - S Sliding Force: P Heck Sliding Resistance - Drain Nominal Sliding Resistance: P P L	$\underline{ 34}^{\circ}$ $\underline{ trength a)} \cdot AASHTO LRFD BDI$ $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\underline{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$ $\underline{P_{H}} = 47.38 \text{ kip}$ $\underline{P_{EV}} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \leq 1)$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3	h Pressure) 7.38 kip/ft 47 kip/ft
ISE Backfill Friction Angle, (φ _{BF}) = Heck Sliding (Loading Case - S) Sliding Force: P Heck Sliding Resistance - Drain Nominal Sliding Resistance:	$\underline{ 34}^{\circ}$ $\underline{ trength a)} \cdot AASHTO LRFD BDI$ $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $\underline{P_{EH}} P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$ $\underline{P_{H}} = 47.38 \text{ kip}$ $\underline{P_{EV}} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \leq 1)$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3 $ \int_{a} \gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0.297)(1.5) = 47 $ $ \gamma_{LS} = (250 \text{ psf})(42.1 \text{ ft})(0.297)(1.75) = 5. $ b) ft + 5.47 kip/ft = 52.85 kip/ft $2 \cdot \gamma_{EV} = (120 \text{ pcf})(42.1 \text{ ft})(29.5 \text{ ft})(1.00) = 148$ tan φ_{BF}) 5) $\leq \tan(34) \longrightarrow 0.47 \leq 0.67 \longrightarrow \tan \delta =$	h Pressure) 7.38 kip/ft 47 kip/ft 9.03 kip/ft
ISE Backfill Friction Angle, $(\varphi_{BF}) =$ Sheck Sliding (Loading Case - S Sliding Force: Prevent Sliding Resistance - Drain Nominal Sliding Resistance: P_{EV} R_{τ}	$\underline{ 34}^{\circ}$ $\underline{ trength la) - AASHTO LRFD BDI}$ $P_{H} = P_{EH} + P_{LS_{h}}$ $P_{EH} = \frac{1}{2} \gamma_{RS} H^{2} K$ $P_{EH} = \frac{1}{2} \gamma_{RS} H K_{a} \gamma$ $P_{LS_{h}} = \sigma_{LS} H K_{a} \gamma$ $P_{H} = 47.38 \text{ kip}$ $\underline{P_{H}} = 47.38 \text{ kip}$ $\underline{P_{EV}} = \gamma_{BF} \cdot H \cdot B$ $\tan \delta = (\tan \varphi_{BS} \leq 1)$ $\tan \delta = \tan(24)$	Service I 1.00 1.00 1.00 \square Earth M Section 11.10.5.3	h Pressure) 7.38 kip/ft 47 kip/ft 9.03 kip/ft



RESOURCE INTERNATIONAL, INC. 6350 PRESIDENTIAL GATEWAY COLUMBUS, OHIO 43231 PHONE: (614) 823-4949 FAX: (614) 823-4990

JOB F	RA-70-13.10	NO.	W-13-072
SHEET NO.	2	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wall	F4 - Sta, 407+00 t	o 409+	50

MSE Wall Dimensions and Retained Soil Para	ameters	Bearing Soil Pro	operties:		
MSE Wall Height, (<i>H</i>) =	42.1 ft	Bearing Soil Unit V			120 pct
MSE Wall Width (Reinforcement Length), $(B) =$	29.5 ft	Bearing Soil Friction	on Angle, $(\varphi_{BS}) =$		25 °
MSE Wall Length, (<i>L</i>) =	750 ft	Bearing Soil Drain	ed Cohesion, (c BS) =	0 psf
Live Surcharge Load, $(\sigma_{LS}) =$	250 psf	Bearing Soil Undra	ined Shear Streng	gth, $[(s_u)_{BS}] =$	1000 pst
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment Depth	$(D_f) =$		4.0 ft
Retained Soil Friction Angle, (φ_{RS}) =	30 °	Depth to Grounwa	ter (Below Bot. of	Wall), $(D_W) =$	0.0 ft
Retained Soil Drained Cohesion, (c_{BS}) =	0 psf	LRFD Load Fact	tors		
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}]$ =	2000 psf	EV	EH LS		
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength la 1.00	1.50 1.75		D BDM Tables
MSE Backfill Unit Weight, (γ_{BF}) =	120 pcf	Strength lb 1.35	1.50 1.75	- 3.4.1-1 and 3	.4.1-2 - Active
MSE Backfill Friction Angle, (φ_{BF}) =	<u>34</u> °	Service I 1.00	1.00 1.00	J Earth P	ressure)
Check Sliding (Loading Case - Strength Ia) - /	AASHTO LRFD BDM	<u>M Section 11.10.5.3 (Co</u>	<u>ntinued)</u>		
Check Sliding Resistance - Undrained Condit	lion				
Nominal Sliding Resisting: $R_{ au} =$	$\left(\left(S_{u}\right)_{BS} \leq q_{s}\right) \cdot B$				
	$(S_u)_{BS} = 1.00$	ksf			
P_{EV}					
	$q_s = \frac{\sigma_v}{2} =$	(5.05 ksf) / 2 = 2.5	53 ksf		
	* » / <u>/</u>				
	/ ת				
$\sum_{n=1}^{\infty} \sum_{i=1}^{\infty} \sum_{j=1}^{\infty} \left(S_{ij} \right)_{RS} \leq q_{s}$	$\sigma_{\rm u} = \frac{P_{EV}}{D}$	= (149.03 kip/ft) / (2	9.5 ft) =	5.05 ksf	
		3 ksf)(29.5 ft) = 29.	50 kip/ft		
/erify Sliding Force Less Than Factored Slid	ing Resistance - Ur	Idrained Condition			
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition	50 kip/ft 52.85 kip/ft ≤ :	29.50 kip/ft	ERROF
/erify Sliding Force Less Than Factored Slid	ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
<u>Verify Sliding Force Less Than Factored Slidi</u> $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
<u>Verify Sliding Force Less Than Factored Slidi</u> $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
/erify Sliding Force Less Than Factored Slid $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
<u>Verify Sliding Force Less Than Factored Slidi</u> $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
<u>Verify Sliding Force Less Than Factored Slidi</u> $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition		29.50 kip/ft	
<u>Verify Sliding Force Less Than Factored Slidi</u> $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition			
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition			
Verify Sliding Force Less Than Factored Slidi $P_H \le R_\tau \cdot \phi_\tau \longrightarrow 52.85$ kip/ft ≤ (ing Resistance - Ur 29.50 kip/ft)(1.0) = 2	Idrained Condition			



JOB	FRA-70-13.10	NO.	W-13-072
SHEET NO.	3	OF	6
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Retaining Wa	F4 - Sta, 407+00 t	o 409+5	50

WWW.RESOURCEINT			
MSE Wall Dimensions and Retained Soil Para	a <u>meters</u>	Bearing Soil Properties:	
MSE Wall Height, (<i>H</i>) =	42.1 ft	Bearing Soil Unit Weight, $(\gamma_{BS}) =$	120 pcf
MSE Wall Width (Reinforcement Length), (B) =	29.5 ft	Bearing Soil Friction Angle, (φ_{BS}) =	25 °
MSE Wall Length, (L) =	750 ft	Bearing Soil Drained Cohesion, $(c_{BS}) =$	0 psf
Live Surcharge Load, $(\sigma_{LS}) =$	250 psf	Bearing Soil Undrained Shear Strength, $[(s_u)_{BS}] =$	1000 psf
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment Depth, (D_f) =	4.0 ft
Retained Soil Friction Angle, $(\varphi_{RS}) =$	<u></u>	Depth to Grounwater (Below Bot. of Wall), $(D_W) =$	0.0 ft
Retained Soil Drained Cohesion, $(c_{RS}) =$	0 psf	LRFD Load Factors	
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$	 2000 psf	EV EH LS	
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength la 1.00 1.50 1.75] (440/070/070	
MSE Backfill Unit Weight, $(\gamma_{BE}) =$	120 pcf	(AASHTO LRFL Strength lb 1.35 1.50 1.75 ≻ 3.4.1-1 and 3.4	
MSE Backfill Friction Angle, (φ_{BF}) =	<u>34</u> °	Service I 1.00 1.00 1.00 Service I 1.00	essure)
Check Eccentricity (Loading Case - Strength		BDM Section 11.10.5.5	
e = 1	$B_2 - x_o$		
x_{i} P_{EV} P_{EV}	M M		
\uparrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow LS_h $_D$ X_o	$=\frac{H}{P} = =$:(2198.19 kip·ft/ft - 779.88 kip·ft/ft) / (149.03 kip/ft) =	9.52 ft
	P_{EV}		
	M_{EV} = 2198.19		
$x_o k \rightarrow e$	M_H = 779.88	kip·ft/ft - Defined below	
$+B/_{\rightarrow}$	P_{EV} = 149.03	kip/ft	
e	e = (29.5 ft)/2 - 9.52	2 ft = 5.23 ft	
Resisting Moment, M_{EV} : M_{EV}	$=P_{EV}(x_1)$		
$\frac{1}{EV}$	$-I_{EV}(x_1)$		
P_{r}	$\gamma_{PF} = \gamma_{PF} \cdot H \cdot B \cdot$	γ_{EV} = (120 pcf)(42.1 ft)(29.5 ft)(1.00) = 149.03	3 kip/ft
$ P_{EV} $			
	$= B/_{2} = (29.5)$	5 ft) / 2 = 14.75 ft	
	/ 2		
	$M_{} = (149.03)$	kip/ft)(14.75 ft) = 2198.19 kip-ft/ft	
	EV = (10000)		
x_I			
Overturning Moment, M_H : M_H	$= P_{EH}(x_2) + P_L$	(x_{2})	
	$EH \setminus 2 I = L_{i}$	\mathfrak{I}_h . Not \mathfrak{I}_h in the interval of th	
P_{r}	$\gamma_{H} = \frac{1}{2} \gamma_{PS} H^{2} K_{a}$	$\gamma_{EH} = \frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^2(0.297)(1.5) = 47.38$	8 kip/ft
$ \begin{array}{c c} x_3 \\ \uparrow \end{array} \end{array} \xrightarrow{P_{LS_h}} P_I $	$s = \sigma_{IS} H K_a \gamma_{IS}$	$_{S}$ = (250 psf)(42.1 ft)(0.297)(1.75) = 5.47	kip/ft
	$_{2} = H_{2} = (42.7)$	1 ft) / 3 = 14.03 ft	
	, , , ,		
	$_{3} = \frac{H}{2} = (42.7)$	1 ft) / 2 = 21.05 ft	
	$M_{\mu} = (47.38 \text{ k})$	kip/ft)(14.03 ft) + (5.47 kip/ft)(21.05 ft) = 779.88	kip∙ft/ft
	Π		
Check Eccentricity			
$e < e_{\rm max} \longrightarrow 5.23$ ft < 9.83 ft	OK		
		5 ft) / 3 = 9.83 ft	
$e < e_{\text{max}} \rightarrow 5.23 \text{ ft} < 9.83 \text{ ft}$ Limiting Eccentricity: $e_{\text{max}} = \frac{B}{3}$		5 ft) / 3 = 9.83 ft	



JOB F	RA-70-13.10	NO.	W-13-072
SHEET NO.	4	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wal	I F4 - Sta 407+00 t	o 409+5	50

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MSE Wall Dimensions and Retained Soil Para		Bearing So							
MSE Wall Height, (<i>H</i>) =	42.1 ft	Bearing Soil					<u>120</u> pcf		
MSE Wall Width (Reinforcement Length), (B) =	<u>29.5</u> ft	Bearing Soil					<u>25</u> °		
MSE Wall Length, (L) =	750 ft	Bearing Soil	0 psf						
Live Surcharge Load, $(\sigma_{LS}) =$	250 psf	Bearing Soil	= <u>1000</u> psf						
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment	Embedment Depth, (D_f) =						
Retained Soil Friction Angle, (φ_{RS}) =	<u>30</u> °	Depth to Gro	ounwate	· (Below	Bot. of	Wall), (D_W)	= 0.0 ft		
Retained Soil Drained Cohesion, (c_{BS}) =	0 psf	LRFD Load	d Facto	<u>rs</u>					
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$	2000 psf		EV	EH	LS				
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength Ia	1.00	1.50	1.75) (AASHTI	0 LRFD BDM Tables		
MSE Backfill Unit Weight, (γ_{BF}) =	120 pcf	Strength Ib	1.35	1.50	1.75	- 3.4.1-1	and 3.4.1-2 - Active		
MSE Backfill Friction Angle, (φ_{BF}) =	<u>34</u> °	Service I	1.00	1.00	1.00	JE	arth Pressure)		
Check Bearing Capacity (Loading Case - Strer	ngth lb) - AASHTO I	RFD BDM Secti	on 11.1	0.5.4					
$P_{LS_{\mathbf{v}}}$				<u></u>					
	P /								
$q_{eq} =$	$\frac{1}{B'}$								
$x_3 \mid P_{EV} \mid B' =$	= B - 2e = 29.	.5 ft - 2(3.64 ft)	= 2	2.22	ft				
$2 \wedge I \qquad \qquad$	~ /								
	$e = \frac{B}{2} - x_o = \frac{B}{2} - x_o = \frac{B}{2} - x_o = \frac{B}{2} - x_o = \frac{B}{2} - \frac{B}{2$	= (29.5 ft) / 2 - 1	1.11 ft	=	3.64	ft			
	$x_o = \frac{M_V - M_H}{P_U}$	= (3158.01	kip∙ft/ft ·	. 779.84	4 kip∙ft/	ft) / 214.1 k	ip/ft = 11.11 ft		
$x_o \leftarrow + e$	P_{V}								
de construction de la constru									
$\leftarrow B_2 \rightarrow q_{-2}$	= (214.1 kip/ft)	/ (22.22 ft) =	9.64	ksf					
$\leftarrow B' \rightarrow$	(,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,								
$M_{V} = P_{EV}(x_{1}) + P_{LS}(x_{1}) = (\gamma_{BF} \cdot H)$	$(I \cdot R \cdot \gamma)(r)$	$+(\sigma \cdot B \cdot \gamma)$)(r))					
= III V I EV (V 1) I LS (V 1) V BF =	$I = I = I = V (\mathcal{M}_1)$	1 OLS D IL	LS /(~1)						
$M_V = [(120 \text{ pcf})(42.1 \text{ ft})(29.5 \text{ ft})(1.35)](2000)$	14 75 ft) + [(250 psf)	(29 5 ft)(1 75)](14	l 75 ft)	= 31	58 01	kin.ft/ft			
$M_{V} = [(120 \text{ pol})(42.1 \text{ fr})(20.0 \text{ fr})(1.00)](1.00)]$	14.70 ft) · [(200 p31)	(20.011)(1.70)](14	r. 70 ft.)	- 01	00.01				
$M_{H} = P_{EH}(x_{2}) + P_{LS}(x_{3}) = (\frac{1}{2}\gamma_{RS})$	$H^2 K \chi$ (r)	$\perp (\sigma HK \gamma)$	Yr	ſ					
$IVI_{H} = I_{EH} (X_2) + I_{LS_h} (X_3) - (/2) RS^{J}$	$(I \ \mathbf{K}_a) \in (\mathcal{N}_2)$	$+ (O_{LS}IIK_a)$	LS JA3	/					
$M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0.297)(1.5))$	$1/(14.03 \text{ ft}) \pm 1/(250 \text{ pc})$	of)(12 1 ft)(0 207)	(1 75))(21 05 fi) =	779.84	kin ft/ft		
$M_{H} = [2(120 \text{ pcl})(42.1 \text{ ft})(0.297)(1.3)]$)](14.03 lt) + [(230 p	51)(42.111)(0.297)	(1.75)](2	21.05 n	, –	119.04	кірчілі		
$P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \cdot B \cdot \gamma_{EV}$	$\perp \sigma \cdot B \cdot \gamma$								
$I_V - I_{EV} + I_{LS} - \gamma_{BF} \cdot II \cdot D \cdot \gamma_{EV}$	$\neg \neg O_{LS} \cdot D \cdot \gamma_{LS}$								
$P_V = (120 \text{ pcf})(42.1 \text{ ft})(29.5 \text{ ft})(1.35) +$	(250 psf)(29.5 ft)(1	$(75) = 214^{\circ}$	1 kip/	ft					
Check Bearing Resistance - Drained Condition	2								
Nominal Bearing Resistance: $q_n = c N_{cm}$ +	$-\gamma D_f N_{qm} C_{wq} +$	$\frac{1}{2} \gamma BN_m C_{w\gamma}$,						
	<i>y</i> 1 1	í í		* *	X 7				
$N_{cm} = N_c s_c i_c$ = 21.03	$N_{qm} = N_q s_q d_q i$	_q = 11.40		$N_{\gamma m} =$	$= N_{\gamma} s$	$i_{\gamma}i_{\gamma} = 10$.75		
	N_q = 10.66				, = 10				
N _c = 20.72				c	= 0.9	988			
$N_c = 20.72$ $S_c = 1+(22.22 \text{ ft}/750 \text{ ft})(10.66/20.72)$	$s_q = 1.014$			sγ	- 0.,				
	$s_q = 1.014$	°)[1-sin(25°)]²tan ⁻¹ (4.0 ft/	22.22 ft)			000 (Assume	ed)		
S_c = 1+(22.22 ft/750 ft)(10.66/20.72)	$s_q = 1.014$ $d_q = 1+2\tan(25^\circ)$ 1.055		'22.22 ft)	i,	= 1.0				
$S_c = 1+(22.22 \text{ ft/750 ft})(10.66/20.72)$ = 1.015	$s_q = 1.014$ $d_q = 1+2\tan(25^\circ)$ 1.055		'22.22 ft)	i,	= 1.0	000 (Assume			
$S_c = 1+(22.22 \text{ ft/750 ft})(10.66/20.72)$ = 1.015	$s_q = 1.014$ $d_q = 1.014$ 1.055 $i_q = 1.000$ (A	Assumed)	22.22 ft)	i,	= 1.0	000 (Assume			
$S_c = 1+(22.22 \text{ ft/750 ft})(10.66/20.72)$ = 1.015	$s_q = 1.014$ $d_q = 1+2\tan(25^\circ)$ 1.055	Assumed)	'22.22 ft)	i,	= 1.0	000 (Assume			
$S_c = 1+(22.22 \text{ ft/750 ft})(10.66/20.72)$ = 1.015 $i_c = 1.000 \text{ (Assumed)}$	$s_q = 1.014$ $d_q = 1+2\tan(25^\circ)$ $i_q = 1.000$ (A $C_{wq} = 0.0 \text{ ft} > 4$	Assumed) .0 ft = 0.500		<i>i y</i> <i>C</i> w	= 1.0 $_{\gamma} =$ 0.0	000 (Assume 0 ft < 1.5(22.22 f	t) + 4.0 ft = 0.50		
$S_c = 1+(22.22 \text{ ft/750 ft})(10.66/20.72)$ = 1.015	$s_q = 1.014$ $d_q = 1+2\tan(25^\circ)$ $i_q = 1.000$ (A $C_{wq} = 0.0 \text{ ft} > 4$	Assumed) .0 ft = 0.500		<i>i y</i> <i>C</i> w	= 1.0 $_{\gamma} =$ 0.0	000 (Assume			
$s_{c} = 1+(22.22 \text{ ft}/750 \text{ ft})(10.66/20.72)$ $= 1.015$ $i_{c} = 1.000 \text{ (Assumed)}$ $q_{n} = (0 \text{ psf})(21.031) + (120 \text{ pcf})(4.0 \text{ ft})(4.0 \text{ ft})(4$	$s_{q} = 1.014$ $d_{q} = 1.014$ 1.055 $i_{q} = 1.000 \text{ (A}$ $C_{wq} = 0.0 \text{ ft} > 4$ $11.404 \text{)}(0.500) + \frac{1}{2}(4)$	Assumed) .0 ft = 0.500 120 pcf)(22.2 ft)(1	10.749)(i _y C _w 0.500)	= 1.0 ₇ = 0.0 =	000 (Assume) ft < 1.5(22.22 f 9.90	t) + 4.0 ft = 0.50 ksf		
$S_c = 1+(22.22 \text{ ft/750 ft})(10.66/20.72)$ = 1.015 $i_c = 1.000 \text{ (Assumed)}$	$s_{q} = 1.014$ $d_{q} = 1.014$ 1.055 $i_{q} = 1.000 \text{ (A}$ $C_{wq} = 0.0 \text{ ft} > 4$ $11.404 \text{)}(0.500) + \frac{1}{2}(4)$	Assumed) .0 ft = 0.500 120 pcf)(22.2 ft)(1	10.749)(i _y C _w 0.500)	= 1.0 ₇ = 0.0 =	000 (Assume) ft < 1.5(22.22 f 9.90	t) + 4.0 ft = 0.50 ksf		
$S_{c} = 1+(22.22 \text{ ft}/750 \text{ ft})(10.66/20.72)$ $= 1.015$ $i_{c} = 1.000 \text{ (Assumed)}$ $q_{n} = (0 \text{ psf})(21.031) + (120 \text{ pcf})(4.0 \text{ ft})(10.66/20.72)$	$s_{q} = 1.014$ $d_{q} = 1.014$ 1.055 $i_{q} = 1.000 (A$ $C_{wq} = 0.0 \text{ ft} > 4$ $11.404)(0.500) + \frac{1}{2}(C_{wq})$	Assumed) .0 ft = 0.500 120 pcf)(22.2 ft)(1 I <u>cce</u> Use	10.749)(∋ φ _b =	i _y C _w 0.500) 0.65	= 1.0 ₇ = 0.0 =	000 (Assume) ft < 1.5(22.22 f 9.90 SHTO LRFD I	t) + 4.0 ft = 0.50		



јов F	RA-70-13.10	NO.	W-13-072
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Retaining Wall	F4 - Sta, 407+00 t	o 409+5	50

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MSE Wall Dimensions and Retained Soil Para	ameters	Bearing Soil Pro	nerties:	
MSE Wall Height, (<i>H</i>) =	42.1 ft	Bearing Soil Unit W		120 pcf
MSE Wall Height, $(R) =$ MSE Wall Width (Reinforcement Length), $(B) =$	29.5 ft	Bearing Soil Friction		25 °
MSE Wall Length, (L) =	750 ft	Bearing Soil Draine		0 psf
		ເອັດການການອັດການການການການຄົດການການການການການການການການ		
Live Surcharge Load, $(\sigma_{LS}) =$	250 psf		ned Shear Strength,	
Retained Soil Unit Weight, $(\gamma_{RS}) =$	120 pcf	Embedment Depth,		<u>4.0</u> ft
Retained Soil Friction Angle, (φ_{RS}) =	<u>30</u> °		er (Below Bot. of Wall), $(D_W) = 0.0$ ft
Retained Soil Drained Cohesion, (c_{BS}) =	<u>0</u> psf	LRFD Load Facto	<u>ors</u>	
Retained Soil Undrained Shear Strength, $[(S_u)_{RS}] =$	2000 psf	EV	EH LS	
Retained Soil Active Earth Pressure Coeff., (K_a) =	0.297	Strength la 1.00	1.50 1.75	(AASHTO LRFD BDM Tables
MSE Backfill Unit Weight, (γ_{BF}) =	120 pcf	Strength lb 1.35	1.50 1.75 -	3.4.1-1 and 3.4.1-2 - Active
$MSE \; Backfill \; Friction \; Angle, \; (\varphi_{BF}) =$	<u>34</u> °	Service I 1.00	1.00 1.00 🗍	Earth Pressure)
Check Bearing Capacity (Loading Case - Stre		RFD BDM Section 11.	10.5.4 (Continued)	
Check Bearing Resistance - Undrained Cond	lition			
Nominal Bearing Resistance: $q_n = cN_{cm}$	$+ \gamma D_f N_{qm} C_{wq} + \gamma$	$V_2 \gamma BN_{\gamma m} C_{w\gamma}$		
$N_{cm} = N_c s_c i_c = 5.170$	$N_{qm} = N_q s_q d_q i_q$	= 1.000	$N_{\gamma m} = N_{\gamma} s_{\gamma} i_{\gamma}$	= 0.000
N _c = 5.140	N_q = 1.000		$N_{\gamma} = 0.000$	
$S_c = 1+(22.22 \text{ ft/}[(5)(750 \text{ ft})]) = 1.006$			$s_{\gamma} = 1.000$	
$i_c = 1.000$ (Assumed)		1-sin(0°)]²tan⁻¹(4.0 ft/22.22 ft)	$i_{\gamma} = 1.000$	(Assumed)
	1.000		-Decement - Decement - Construction - Constructio - Construction - Construction - Construction -	1.5(22.22 ft) + 4.0 ft = 0.8
			$C_{1,m} = 0.0 \pi < 7$,
$q_n = (1000 \text{ psf})(5.170) + (120 \text{ pcf})(4.0)$	$i_q = 1.000$ (As: $C_{wq} = 0.0 \text{ ft} > 4.0$ $0 \text{ ft}(1.000)(0.500) + \frac{1}{2}(7)$	ft = 0.500 120 pcf)(22.2 ft)(0.000)		5.41 ksf
/erify Equivalent Pressure Less Than Factor	$i_q = 1.000$ (As: $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}$ (* red Bearing Resistanc	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
	$i_q = 1.000$ (As: $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}$ (* red Bearing Resistanc	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>		
Verify Equivalent Pressure Less Than Factor	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}$ (7) red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
/erify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	
Verify Equivalent Pressure Less Than Factor $q_{eq} \leq q_n \cdot \phi_b \longrightarrow 9.64$ ksf	$i_q = 1.000$ (Ass $C_{wq} = 0.0 \text{ ft} > 4.0$ 0 ft)(1.000)(0.500) + $\frac{1}{2}(7)$ red Bearing Resistanc f \leq (5.41 ksf)(0.65) = 3.5	ft = 0.500 120 pcf)(22.2 ft)(0.000) <u>e</u>	(0.500) =	



јов Б	RA-70-13.10	NO.	W-13-072
SHEET NO.	6	OF	6
CALCULATED BY	BRT	DATE	7/12/2019
CHECKED BY	JPS	DATE	7/12/2019
Retaining Wal	50		

MSE Wall Dimensions and Retained	Soil Parame	eters	Bearing Soil Pr	operties:				
MSE Wall Height, (<i>H</i>) =		42.1 ft	Bearing Soil Unit	Weight, $(\gamma_{BS}) =$		120 pc		
MSE Wall Width (Reinforcement Length), ((B) =	29.5 ft	Bearing Soil Fricti	on Angle, $(\varphi_{BS}) =$		25 °		
MSE Wall Length, (L) =	`	750 ft	Bearing Soil Drair	ned Cohesion, (c_{BS})) =	0 ps		
Live Surcharge Load, $(\sigma_{LS}) =$		250 psf	Bearing Soil Undr	ained Shear Streng	ear Strength, $[(s_u)_{BS}] =$			
Retained Soil Unit Weight, $(\gamma_{RS}) =$		 120 pcf	Embedment Dept			<u>1000</u> ps 4.0 ft		
Retained Soil Friction Angle, $(\varphi_{RS}) =$		<u></u>	3000000. <u>8</u> 000000000000000000000000000000	ater (Below Bot. of)	Wall), $(D_W) =$	0.0 ft		
Retained Soil Drained Cohesion, $(c_{RS}) =$		0 psf	LRFD Load Fac					
Retained Soil Undrained Shear Strength, [($(S_{})_{RS}$] =	2000 psf	EV	<u> </u>				
Retained Soil Active Earth Pressure Coeff.		0.297	Strength la 1.00					
MSE Backfill Unit Weight, $(\gamma_{BE}) =$, (<i>a</i>)	120 pcf	Strength lb 1.3		(AASHTO LRFL - 3.4.1-1 and 3.4			
MSE Backfill Friction Angle, (ϕ_{BF}) =		34 °	Service I 1.00		Earth Pre			
				0 1.00 1.00	1			
Sattlement Analysia (Leading Case			M Cootion 11 10 1	4				
Settlement Analysis (Loading Case -	- Service I) -	AASHTU LRFU BL	DM Section 11.10.4.	1				
$P_{LS,}$								
	$q_{eq} = P_{p}$							
	$q_{eq} = \gamma$	/ <i>B</i> '						
$\begin{array}{c c} x_3 \\ x_3 \\ \end{array}$	B'=I	B - 2e = 29.5	ft - 2(3.25 ft) =	23.00 ft				
$\begin{array}{c c} x_3 \\ \uparrow \\ \hline \\ R \\ \hline \\ R \\ \hline \\ R \\ \hline \\ \hline \\ R \\ \hline \\ \hline$		B /						
$ _{R} \downarrow _{\Lambda}$	е	$= \frac{D}{2} - x_o =$	(29.5 ft) / 2 - 11.5 f	t = 3.25	ft			
		$\tilde{M}_{\nu} - M_{\nu}$	= (2307.03 kip·ft/					
	x _o	$f = \frac{1}{P}$	= (2307.03 kip·ft/	ft - 508.93 kip∙ft/ft) / 156.41 kip/ft	= 11.5		
$x_o \leftarrow \rightarrow e$		P_V						
B/								
$< B_2 >$	$q_{eq} =$	= (156.41 kip/ft)	/ (23 ft) = 6.	.80 ksf				
$\leftarrow B' \rightarrow$ $M_{V} = P_{EV}(x_{1}) + P_{LS_{V}}(x_{1}) =$ $M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.3)]$	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14	4.8 ft) + [(250 psf)(2	$\left(\sigma_{LS}\cdot B\cdot\gamma_{LS} ight)$ (2 19.5 ft)(1.00)](14.8 ft)	= 2307.03	kip·ft/ft			
$\overleftarrow{\leftarrow} B' \rightarrow $ $M_V = P_{EV}(x_1) + P_{LS_V}(x_1) =$	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\gamma_2 \gamma_{RS} H)$ 0.297)(1.00)]($\cdot B \cdot \gamma_{EV} - \beta$ 5 ft)(1.00) + (2)	$ \cdot B \cdot \gamma_{EV} (x_1) + (250 \text{ psf})(2) + (250 \text{ psf})(2) + (14.03 \text{ ft}) + (250 \text{ ps}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} \cdot B \cdot \gamma_{$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(z)$ (9.5 ft)(1.00)](14.8 ft) - $(\sigma_{LS}HK_a\gamma_{LS})(z)$ f)(42.1 ft)(0.297)(1.00) 0) = 156.41 k	$\begin{array}{l} x_1 \\ = & 2307.03 \\ x_3 \\ \end{array}$	kip-ft/ft 508.93 kip-f			
$\leftarrow B' \rightarrow$ $M_{V} = P_{EV}(x_{1}) + P_{LS_{V}}(x_{1}) =$ $M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.4)$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) =$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0)$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H$ $P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5)$ Settlement, Time Rate of Consolidation Boring Total Settle Center of Reference of Referen	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\gamma_{2}^{\prime} \gamma_{RS} H)$ 0.297)(1.00)](1.00)](1.00)](1.00) + (2.00) 6 ft)(1.00) + (2.00)	$ \cdot B \cdot \gamma_{EV} (x_1) + (250 \text{ psf})(2) + (250 \text{ psf})(2) + (14.03 \text{ ft}) + (250 \text{ ps}) + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} \cdot B \cdot \gamma_{$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(z)$ $(\sigma_{LS} + B \cdot \gamma_{LS})(z)$ $(\sigma_{LS} + H K_a \gamma_{LS})(z)$ (42.1 ft)(0.297)(1.00) (42.1 ft)(0.297)(1.00) (1.00) = 156.41 k (1.00) = 156.41 k	x ₁) = 2307.03 x ₃) D)](21.05 ft) = ip/ft Distance Between Borings Along Wall	508.93 kip-f			
$\leftarrow B' \rightarrow$ $M_{V} = P_{EV}(x_{1}) + P_{LS_{v}}(x_{1}) =$ $M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.4)$ $M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) =$ $M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0)$ $P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H$ $P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5)$ Settlement, Time Rate of Consolidat Boring Total Settle Center of Resources and the settle of the	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\frac{1}{2} \gamma_{RS} H)$ 0.297)(1.00)](1.00)](1.00)](1.00) + (2.00) 6 ft)(1.00) + (2.00)	$ \cdot B \cdot \gamma_{EV})(x_1) + $ $ 4.8 \text{ ft}) + [(250 \text{ psf})(2) + (14.03 \text{ ft}) + [(250 \text{ psf})(2) + (14.03 \text{ ft}) + [(250 \text{ psf})(2) + \sigma_{LS} \cdot B \cdot \gamma_{LS} + \sigma_{LS} \cdot B \cdot \gamma_{LS} $ $ 250 \text{ psf})(29.5 \text{ ft})(1.0) $ $ erential Settlement at Wall Facing $	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(z) = (\sigma_{LS} H K_a \gamma_{LS})(z)$ $(\sigma_{LS} H K_a \gamma_{LS})(z) = (\sigma_{LS} H K_a \gamma_{LS})(z)$ $f)(42.1 \text{ ft})(0.297)(1.00)$	x ₁) = 2307.03 x ₃) D)](21.05 ft) = ip/ft Distance Between	508.93 kip-f			
$\begin{array}{l} \overleftarrow{\leftarrow} B' \rightarrow \end{array} \\ M_{V} = P_{EV}(x_{1}) + P_{LS_{V}}(x_{1}) = \\ M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.9) \\ M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) = \\ M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0) \\ P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \\ P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5) \\ \end{array} \\ \begin{array}{l} \end{array} \\ \begin{array}{l} \textbf{Settlement, Time Rate of Consolidati} \\ \hline \textbf{Boring} & \hline \textbf{Center of Resolution} \\ \hline \textbf{Soil Main B-020-4-13} & 10.464 \end{array} \end{array}$	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\frac{V_2}{\gamma_{RS}} H)$ 0.297)(1.00)]($\cdot B \cdot \gamma_{EV} - \frac{1}{5}$ 6 ft)(1.00) + (2) ion and Different at a binforced ass 4 in	$ \cdot B \cdot \gamma_{EV})(x_1) + $ $ 4.8 \text{ ft}) + [(250 \text{ psf})(2) + \\ (14.03 \text{ ft}) + [(250 \text{ psf})(x_2) + \\ (14.03 \text{ ft}) + [(250 \text{ psf}) + \sigma_{LS} + \sigma_{LS} + B \cdot \gamma_{LS} + \\ 250 \text{ psf})(29.5 \text{ ft})(1.0) \\ \hline erential Settlement at Wall Facing \\ \hline 5.175 \text{ in} \\ \hline $	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(z) = (\sigma_{LS} H K_a \gamma_{LS})(z)$ $(\sigma_{LS} H K_a \gamma_{LS})(z) = (\sigma_{LS} H K_a \gamma_{LS})(z)$ $f)(42.1 \text{ ft})(0.297)(1.00)$	$\begin{array}{l} x_1 \\ = & 2307.03 \\ x_3 \\ \end{array}$ $\begin{array}{l} x_3 \\ \end{array}$ $\begin{array}{l} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$	508.93 kip-f			
$\begin{array}{l} \overleftarrow{\leftarrow} B' \rightarrow & \\ M_{V} = P_{EV}\left(x_{1}\right) + P_{LS_{V}}\left(x_{1}\right) = \\ M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.9) \\ M_{H} = P_{EH}\left(x_{2}\right) + P_{LS_{h}}\left(x_{3}\right) = \\ M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0) \\ P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \\ P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5) \\ \end{array}$ Settlement, Time Rate of Consolidati Boring Total Settle Boring Total Settle B-020-4-13 10.464 B-114-9-13 7.697	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\gamma_2 \gamma_{RS} H)$ 0.297)(1.00)](1.00)[(1.00)](1.00)[(1.00)	$ \cdot B \cdot \gamma_{EV})(x_{1}) + \\ 4.8 \text{ ft}) + [(250 \text{ psf})(2 \\ I^{2}K_{a}\gamma_{EH})(x_{2}) + \\ (14.03 \text{ ft}) + [(250 \text{ psf})(2 \\ + \sigma_{LS} \cdot B \cdot \gamma_{LS} \\ 250 \text{ psf})(29.5 \text{ ft})(1.0 \\ \hline \\ $	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(z)$ $(\sigma_{LS} H K_a \gamma_{LS})(z)$ $(\sigma_{LS} H K_a \gamma_{LS})(z)$ $f)(42.1 \text{ ft})(0.297)(1.00)$ $(0) = 156.41 \text{ k}$ (1) (1) (1) (2) (2) (2) (2) (2) (3)	x_1) = 2307.03 x_3) D)](21.05 ft) = iip/ft Distance Between Borings Along Wall Facing 160 ft	508.93 kip-f			
$ \begin{array}{l} \overleftarrow{\leftarrow} B' \rightarrow \end{array} \\ M_{V} = P_{EV}(x_{1}) + P_{LS_{V}}(x_{1}) = \\ M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.9) \\ M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) = \\ M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0) \\ P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \\ P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5) \\ \end{array} \\ \hline \begin{array}{l} \textbf{Settlement, Time Rate of Consolidati} \\ \hline \textbf{Boring} & \hline \textbf{Total Settle} \\ \hline \textbf{Center of Resolution} \\ \textbf{Soil Max} \\ \hline \textbf{B-020-4-13} & 10.464 \\ \hline \textbf{B-114-9-13} & 7.697 \\ \hline \textbf{B-114-8-13} & 15.594 \end{array} $	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\frac{1}{2} \gamma_{RS} H)$ 0.297)(1.00)](1 $\cdot B \cdot \gamma_{EV} - \frac{1}{2}$ 6 ft)(1.00) + (2 $\frac{1}{2}$ ion and Difference inforce inforc inforce inforce inforce inforce	$ \cdot B \cdot \gamma_{EV})(x_{1}) + 4.8 \text{ ft}) + [(250 \text{ psf})(2)] + (14.03 \text{ ft}) + (14.03 \text{ ft}) + (14.03 \text{ ft}) + [(250 \text{ psf})(2)] + (14.03 \text{ ft}) + (14.03 \text{ ft}$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(3)$ $(\sigma_{LS} H K_a \gamma_{LS})(3)$ $(\sigma_{LS} H K_a \gamma_{LS})(3)$ $(42.1 \text{ ft})(0.297)(1.00)$ $(1.00) = 156.41 \text{ k}$	x ₁) = 2307.03 x ₃) D)](21.05 ft) = iip/ft Distance Between Borings Along Wall Facing 160 ft 175 ft	508.93 kip-f			
$ \begin{array}{l} \overleftarrow{\leftarrow} B' \rightarrow \end{array} \\ M_{V} = P_{EV}(x_{1}) + P_{LS_{V}}(x_{1}) = \\ M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.4) \\ M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) = \\ M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0) \\ P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \\ P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5) \\ \end{array} \\ \hline \begin{array}{l} \textbf{Settlement, Time Rate of Consolidati} \\ \hline \textbf{Boring} & \hline \textbf{Total Settle} \\ \hline \textbf{Center of Resolution} \\ \hline \textbf{Soil Max} \\ \hline \textbf{B-114-9-13} & 7.697 \\ \hline \textbf{B-114-8-13} & 15.594 \\ \hline \textbf{B-114-7-13} & 15.457 \\ \end{array} $	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\gamma_{2} \gamma_{RS} H)$ 0.297)(1.00)](1 $\cdot B \cdot \gamma_{EV} - \frac{1}{2}$ 5 ft)(1.00) + (2 ion and Differentiate inforced ass 4 in - \frac{1}{2} 4 in - 1 in - 1	$ \cdot B \cdot \gamma_{EV})(x_{1}) + 4.8 \text{ ft}) + [(250 \text{ psf})(2) + (250 ps$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(z)$ $(\sigma_{LS} H K_a \gamma_{LS})(z)$ $(\sigma_{LS} H K_a \gamma_{LS})(z)$ $f)(42.1 \text{ ft})(0.297)(1.00)$ $(0) = 156.41 \text{ k}$ (1) (1) (1) (2) (2) (2) (2) (2) (3)	x_1) = 2307.03 x_3) D)](21.05 ft) = iip/ft Distance Between Borings Along Wall Facing 160 ft	508.93 kip-f			
$ \begin{array}{l} \overleftarrow{\leftarrow} B' \rightarrow \end{array} \\ M_{V} = P_{EV}(x_{1}) + P_{LS_{V}}(x_{1}) = \\ M_{V} = [(120 \text{ pcf})(42.1 \text{ ft})(29.9) \\ M_{H} = P_{EH}(x_{2}) + P_{LS_{h}}(x_{3}) = \\ M_{H} = [\frac{1}{2}(120 \text{ pcf})(42.1 \text{ ft})^{2}(0) \\ P_{V} = P_{EV} + P_{LS} = \gamma_{BF} \cdot H \\ P_{V} = (120 \text{ pcf})(42.1 \text{ ft})(29.5) \\ \end{array} \\ \hline \begin{array}{l} \textbf{Settlement, Time Rate of Consolidati} \\ \hline \textbf{Boring} & \hline \textbf{Total Settle} \\ \hline \textbf{Center of Resolution} \\ \textbf{Soil Max} \\ \hline \textbf{B-020-4-13} & 10.464 \\ \hline \textbf{B-114-9-13} & 7.697 \\ \hline \textbf{B-114-8-13} & 15.594 \end{array} $	$= (\gamma_{BF} \cdot H)$ 5 ft)(1.00)](14 $= (\gamma_{2} \gamma_{RS} H)$ 0.297)(1.00)](1 $\cdot B \cdot \gamma_{EV} - \frac{1}{2}$ 5 ft)(1.00) + (2 ion and Differentiate inforced ass 4 in - \frac{1}{2} 4 in - 1 in - 1	$ \cdot B \cdot \gamma_{EV})(x_{1}) + 4.8 \text{ ft}) + [(250 \text{ psf})(2)] + (14.03 \text{ ft}) + (14.03 \text{ ft}) + (14.03 \text{ ft}) + [(250 \text{ psf})(2)] + (14.03 \text{ ft}) + (14.03 \text{ ft}$	$(\sigma_{LS} \cdot B \cdot \gamma_{LS})(3)$ $(\sigma_{LS} H K_a \gamma_{LS})(3)$ $(\sigma_{LS} H K_a \gamma_{LS})(3)$ $(42.1 \text{ ft})(0.297)(1.00)$ $(1.00) = 156.41 \text{ k}$	x ₁) = 2307.03 x ₃) D)](21.05 ft) = iip/ft Distance Between Borings Along Wall Facing 160 ft 175 ft	508.93 kip-f			

Boring B-017-2-09

H _{Embank} =	16.0	ft	Height of embankment below wall to existing grade
H _{Wall} =	25.8	ft	Wall height
B=	41.8	ft	Width equal to total height of wall and embankment
D _w =	0.0	ft	Depth below bottom of embankment
q _{Embank} =	1,920	psf	Pressure due to embankment fill below wall
q _{Wall} =	4,350	psf	Equivalent bearing pressure at bottom of wall
q _e =	6,270	psf	Total pressure at bottom of embankment

																				Total S	Settlement a	t Center of R	einforced Sc	oil Mass		Total Set	tlement at Fa	cing of Wall	
Layer	Soil Class.	Soil Type	Laye	r Depth (ft)	Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	1 ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)
1	A-4a	С	0.0	3.5	3.5	1.8	115	403	201	92	2,092	21	0.099	0.015	0.436				0.04	1.000	6,268	6,361	0.166	1.987	0.500	3,135	3,227	0.095	1.134
2	A-1-b	G	3.5	6.0	2.5	4.8	120	703	553	256	2,256					13	22	79	0.11	0.995	6,241	6,497	0.045	0.536	0.500	3,133	3,389	0.036	0.429
	A-4a	С	6.0	8.5	2.5	7.3	115	990	846	394	2,394	21	0.099	0.015	0.436				0.17	0.985	6,173	6,567	0.096	1.150	0.499	3,128	3,522	0.049	0.590
3	A-4a	С	8.5	11.0	2.5	9.8	115	1,278	1,134	525	2,525	21	0.099	0.015	0.436				0.23	0.966	6,057	6,582	0.089	1.072	0.497	3,119	3,645	0.045	0.541
	A-4a	С	11.0	13.5	2.5	12.3	115	1,565	1,421	657	2,657	21	0.099	0.015	0.436				0.29	0.940	5,895	6,552	0.083	0.999	0.495	3,105	3,762	0.042	0.501
4	A-3a	G	13.5	16.0	2.5	14.8	115	1,853	1,709	788	2,788					5	7	48	0.35	0.909	5,697	6,486	0.048	0.576	0.492	3,084	3,873	0.036	0.435
4	A-3a	G	16.0	18.5	2.5	17.3	115	2,140	1,996	920	2,920					5	6	47	0.41	0.873	5,475	6,395	0.044	0.533	0.488	3,058	3,977	0.034	0.403
5	A-2-6	G	18.5	23.5	5.0	21.0	125	2,765	2,453	1,142	5,142					21	25	86	0.50	0.817	5,121	6,263	0.043	0.518	0.479	3,006	4,149	0.033	0.393
6	A-1-a	G	23.5	27.5	4.0	25.5	135	3,305	3,035	1,444	5,444					72	80	328	0.61	0.749	4,698	6,141	0.008	0.092	0.467	2,929	4,373	0.006	0.071
0	A-1-a	G	27.5	32.0	4.5	29.8	135	3,913	3,609	1,752	5,752					72	75	299	0.71	0.689	4,322	6,074	0.008	0.098	0.453	2,843	4,596	0.006	0.076
7	A-6a	С	32.0	37.0	5.0	34.5	125	4,538	4,225	2,072	6,072	35	0.225	0.023	0.546				0.83	0.629	3,943	6,015	0.034	0.404	0.437	2,738	4,810	0.027	0.319
0	A-6b	С	37.0	42.0	5.0	39.5	125	5,163	4,850	2,385	6,385	36	0.234	0.023	0.553				0.94	0.573	3,593	5,978	0.030	0.361	0.418	2,620	5,005	0.024	0.291
ð	A-6b	С	42.0	47.0	5.0	44.5	125	5,788	5,475	2,698	6,698	36	0.234	0.023	0.553				1.06	0.524	3,289	5,987	0.026	0.313	0.399	2,501	5,199	0.021	0.257
9	A-6b	С	47.0	55.0	8.0	51.0	130	6,828	6,308	3,125	7,125	36	0.234	0.023	0.553				1.22	0.471	2,953	6,078	0.035	0.418	0.375	2,349	5,474	0.029	0.352
1. σ _p ' = σ	_{vo} '+σ _{m;} Estima	ate σ_m of 2,0	000 psf in exi	sting fill mat	erial and 4,00	0 psf (moder	ately overco	onsolidated) f	for natural so	il deposits; R	Ref. Table 11	.2, Coduto	2003	•	-	•	•	•	•		Tota	I Settlement:		9.057 in		Total	Settlement:		5.790 in

2. $C_c = 0.009(LL-10)$; Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_{v}'/\sigma_{p'}) + [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{p'}) + [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{p$

10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Calculated By:	BRT	Date:	7/18/2019
Checked By:	JPS	Date:	7/18/2019

Boring B-017-2-09

					A-4a				
H _{Embank} =	16.0	ft	Height of embankment below wall to existing grade		(Ex. Fill)	A-6a	A-6b		
H _{Wall} =	25.8	ft	Wall height	c _v =	1000	600	300	ft²/yr	Coefficient of consolitation
B=	41.8	ft	Width equal to total height of wall and embankment	t =	55	55	55	days	Time following completion of construction
D _w =	0.0	ft	Depth below bottom of embankment	H _{dr} =	3.8	5	23	ft	Length of longest drainage path considered
q _{Embank} =	1,920	psf	Pressure due to embankment fill below wall	T _v =	10.435	3.616	0.085		Time factor
q _{Wall} =	4,350	psf	Equivalent bearing pressure at bottom of wall	U =	100	100	33	%	Degree of consolidation
q _e =	6,270	psf	Total pressure at bottom of embankment						
				(S _c) _t =	5.187	in	Settlement	complete	at 90% of primary consolidation

																							Total Se	ettlement at l	Facing of Wall		mplete at 90% of Consolidation
Layer	Soil Type	Soil Type	Layer (1	Depth ft)	Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	l ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	Layer Settlement (in)	(S _c) _t ⁽¹¹⁾ (in)	Layer Settlement (in)
1	A-4a	С	0.0	3.5	3.5	1.8	115	403	201	92	2,092	21	0.099	0.015	0.436				0.07	0.500	3,135	3,227	0.095	1.134	1.134	1.134	1.134
2	A-1-b	G	3.5	6.0	2.5	4.8	120	703	553	256	2,256					13	22	79	0.18	0.500	3,133	3,389	0.036	0.429	0.429	0.429	0.429
	A-4a	С	6.0	8.5	2.5	7.3	115	990	846	394	2,394	21	0.099	0.015	0.436				0.28	0.499	3,128	3,522	0.049	0.590		0.590	
3	A-4a	С	8.5	11.0	2.5	9.8	115	1,278	1,134	525	2,525	21	0.099	0.015	0.436				0.38	0.497	3,119	3,645	0.045	0.541	1.632	0.541	1.632
	A-4a	С	11.0	13.5	2.5	12.3	115	1,565	1,421	657	2,657	21	0.099	0.015	0.436				0.47	0.495	3,105	3,762	0.042	0.501		0.501	7
4	A-3a	G	13.5	16.0	2.5	14.8	115	1,853	1,709	788	4,788					5	7	48	0.57	0.492	3,084	3,873	0.036	0.435	0.838	0.435	0.838
4	A-3a	G	16.0	18.5	2.5	17.3	115	2,140	1,996	920	4,920					5	6	47	0.67	0.488	3,058	3,977	0.034	0.403	0.030	0.403	0.030
5	A-2-6	G	18.5	23.5	5.0	21.0	125	2,765	2,453	1,142	5,142					21	25	86	0.81	0.479	3,006	4,149	0.033	0.393	0.393	0.393	0.393
6	A-1-a	G	23.5	27.5	4.0	25.5	135	3,305	3,035	1,444	5,444					72	80	328	0.99	0.467	2,929	4,373	0.006	0.071	0.146	0.071	0.146
0	A-1-a	G	27.5	32.0	4.5	29.8	135	3,913	3,609	1,752	5,752					72	75	299	1.15	0.453	2,843	4,596	0.006	0.076	0.140	0.076	0.140
7	A-6a	С	32.0	37.0	5.0	34.5	125	4,538	4,225	2,072	6,072	35	0.225	0.023	0.546				1.34	0.437	2,738	4,810	0.027	0.319	0.319	0.319	0.319
Q	A-6b	С	37.0	42.0	5.0	39.5	125	5,163	4,850	2,385	6,385	36	0.234	0.023	0.553				1.53	0.418	2,620	5,005	0.024	0.291	0.548	0.096	0.181
0	A-6b	С	42.0	47.0	5.0	44.5	125	5,788	5,475	2,698	6,698	36	0.234	0.023	0.553				1.72	0.399	2,501	5,199	0.021	0.257	0.040	0.085	0.101
9	A-6b	С	47.0	55.0	8.0	51.0	130	6,828	6,308	3,125	7,125	36	0.234	0.023	0.553				1.98	0.375	2,349	5,474	0.029	0.352	0.352	0.116	0.116

1. $\sigma_p' = \sigma_{vo}' + \sigma_{m}$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_o/(1+e_o)](H)\log(\sigma_{v'}/\sigma_{vo'})$ for $\sigma_{p'} \le \sigma_{vo'} < \sigma_{v'}; [C_r/(1+e_o)](H)\log(\sigma_{p'}/\sigma_{vo'}) + [C_o/(1+e_o)](H)\log(\sigma_{v'}/\sigma_{p'})]$ for $\sigma_{vo'} < \sigma_{p'} < \sigma_{v'};$ Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By:	BRT	Date:	07/18/2019
Checked By:	JPS	Date:	07/18/2019

Settlement Remaining After Hold Period: 0.603 in

Boring B-018-2-13

H=	42.1	ft	Total wall height
B'=	23.0	ft	Effective footing width due to eccentricity
D _w =	0.0	ft	Depth below bottom of wall
q _e =	6,800	psf	Equivalent bearing pressure at bottom of wall

																				Total S	Settlement at	Center of R	einforced Sc	il Mass		Total Set	tlement at Fa	acing of Wall	
Layer	Soil Class.	Soil Type		Depth ft)	Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	⁽⁷⁾	$\Delta \sigma_v^{(8)}$ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)	I ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	S _c ^(9,10) (ft)	S _c (in)
1	A-2-4	G	0.0	1.5	1.5	0.8	120	180	90	43	2,043					18	36	117	0.03	1.000	6,799	6,842	0.028	0.338	0.500	3,400	3,443	0.024	0.292
2	A-6b	С	1.5	4.0	2.5	2.8	120	480	330	158	2,158	40	0.270	0.041	0.585				0.12	0.995	6,763	6,921	0.288	3.456	0.500	3,398	3,556	0.165	1.978
2	A-6b	С	4.0	6.5	2.5	5.3	120	780	630	302	2,302	40	0.270	0.041	0.585				0.23	0.968	6,581	6,884	0.259	3.107	0.498	3,384	3,686	0.143	1.721
2	A-4a	С	6.5	8.5	2.0	7.5	120	1,020	900	432	2,432	28	0.162	0.024	0.491				0.33	0.923	6,279	6,711	0.120	1.443	0.493	3,356	3,788	0.066	0.795
3	A-4a	С	8.5	10.5	2.0	9.5	120	1,260	1,140	547	2,547	28	0.162	0.024	0.491				0.41	0.873	5,937	6,484	0.110	1.319	0.488	3,316	3,863	0.061	0.733
4	A-1-b	G	10.5	13.5	3.0	12.0	125	1,635	1,448	699	4,699					22	30	98	0.52	0.804	5,470	6,169	0.029	0.347	0.477	3,247	3,945	0.023	0.275
4	A-1-b	G	13.5	16.5	3.0	15.0	125	2,010	1,823	887	4,887					22	28	93	0.65	0.724	4,922	5,808	0.026	0.314	0.462	3,140	4,026	0.021	0.253
	A-1-a	G	16.5	22.0	5.5	19.3	135	2,753	2,381	1,180	5,180					57	67	252	0.84	0.623	4,237	5,417	0.014	0.173	0.435	2,957	4,137	0.012	0.143
5	A-1-a	G	22.0	28.0	6.0	25.0	135	3,563	3,158	1,598	5,598					57	61	222	1.09	0.516	3,510	5,107	0.014	0.164	0.395	2,688	4,286	0.012	0.139
	A-1-a	G	28.0	33.0	5.0	30.5	135	4,238	3,900	1,997	5,997					57	57	201	1.33	0.440	2,990	4,987	0.010	0.119	0.359	2,439	4,436	0.009	0.103
	A-7-6	С	33.0	38.0	5.0	35.5	125	4,863	4,550	2,335	6,335	45	0.315	0.032	0.624				1.54	0.386	2,625	4,960	0.032	0.381	0.328	2,232	4,567	0.028	0.339
	A-7-6	С	38.0	43.0	5.0	40.5	125	5,488	5,175	2,648	6,648	45	0.315	0.032	0.624				1.76	0.343	2,335	4,983	0.027	0.320	0.301	2,047	4,695	0.024	0.290
6	A-7-6	С	43.0	49.0	6.0	46.0	125	6,238	5,863	2,992	6,992	45	0.315	0.032	0.624				2.00	0.306	2,079	5,071	0.027	0.320	0.275	1,869	4,861	0.025	0.294
	A-7-6	С	49.0	55.0	6.0	52.0	125	6,988	6,613	3,368	7,368	45	0.315	0.032	0.624				2.26	0.273	1,855	5,223	0.022	0.266	0.250	1,702	5,070	0.021	0.248
1. $\sigma_p' = \sigma_v$	o'+σ _{m:} Estima	te σ_m of 2,0	00 psf in exi	sting fill mate	erial and 4,00	0 psf (moder	ately overco	nsolidated)	for natural so	oil deposits; F	ef. Table 11	.2, Coduto 2	2003	•							Tota	Settlement:		12.067 in		Total	Settlement:	I	7.604 in

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. Cr = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_o/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{p'})$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. $S_c = H(1/C')log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Calculated By:	BRT	Date: 7/18/2019
Checked By:	JPS	Date: 7/18/2019

Boring B-018-2-13

					A-6b	A-4a			
H=	42.1	ft	Total wall height		(Ex. Fill)	(Ex. Fill)	A-7-6		
B'=	23.0	ft	Effective footing width due to eccentricity	c _v =	300	1000	150	ft²/yr	Coefficient of consolitation
D _w =	0.0	ft	Depth below bottom of wall	t =	100	100	100	days	Time following completion of construction
q _e =	6,800	psf	Equivalent bearing pressure at bottom of wall	H _{dr} =	5	4	22	ft	Length of longest drainage path considered
				T _v =	3.288	17.123	0.085		Time factor
				U =	100	100	33	%	Degree of consolidation

 $(S_c)_t = 6.819$ in Settlement complete at 90% of primary consolidation

																							Total Se	ttlement at I	Facing of Wall		mplete at 90% of onsolidation
Layer	Soil Type	Soil Type	-	Depth t)	Layer Thickness (ft)	Depth to Midpoint (ft)	γ (pcf)	σ _{vo} Bottom (psf)	σ _{vo} Midpoint (psf)	σ _{vo} ' Midpoint (psf)	σ _p ' ⁽¹⁾ (psf)	LL	C _c ⁽²⁾	C _r ⁽³⁾	e _o ⁽⁴⁾	N ₆₀	(N1) ₆₀ ⁽⁵⁾	C' ⁽⁶⁾	Z _f /B	l ⁽⁷⁾	Δσ _v ⁽⁸⁾ (psf)	σ _{vf} ' Midpoint (psf)	Sc ^(9,10) (ft)	S _c (in)	Layer Settlement (in)	(S _c) _t ⁽¹¹⁾ (in)	Layer Settlement (in)
1	A-2-4	G	0.0	1.5	1.5	0.8	120	180	90	43	2,043					18	36	117	0.03	0.500	3,400	3,443	0.024	0.292	0.292	0.292	0.292
2	A-6b	С	1.5	4.0	2.5	2.8	120	480	330	158	2,158	40	0.270	0.041	0.585				0.12	0.500	3,398	3,556	0.165	1.978	3.699	1.978	3.699
2	A-6b	С	4.0	6.5	2.5	5.3	120	780	630	302	2,302	40	0.270	0.041	0.585				0.23	0.498	3,384	3,686	0.143	1.721	3.099	1.721	3.099
2	A-4a	С	6.5	8.5	2.0	7.5	120	1,020	900	432	2,432	28	0.162	0.024	0.491				0.33	0.493	3,356	3,788	0.066	0.795	1.528	0.795	1.528
3	A-4a	С	8.5	10.5	2.0	9.5	120	1,260	1,140	547	2,547	28	0.162	0.024	0.491				0.41	0.488	3,316	3,863	0.061	0.733	1.520	0.733	1.526
4	A-1-b	G	10.5	13.5	3.0	12.0	125	1,635	1,448	699	4,699					22	30	98	0.52	0.477	3,247	3,945	0.023	0.275	0.528	0.275	0.528
4	A-1-b	G	13.5	16.5	3.0	15.0	125	2,010	1,823	887	4,887					22	28	93	0.65	0.462	3,140	4,026	0.021	0.253	0.526	0.253	0.528
	A-1-a	G	16.5	22.0	5.5	19.3	135	2,753	2,381	1,180	5,180					57	67	252	0.84	0.435	2,957	4,137	0.012	0.143		0.143	
5	A-1-a	G	22.0	28.0	6.0	25.0	135	3,563	3,158	1,598	5,598					57	61	222	1.09	0.395	2,688	4,286	0.012	0.139	0.385	0.139	0.385
	A-1-a	G	28.0	33.0	5.0	30.5	135	4,238	3,900	1,997	5,997					57	57	201	1.33	0.359	2,439	4,436	0.009	0.103	-	0.103	1
	A-7-6	С	33.0	38.0	5.0	35.5	125	4,863	4,550	2,335	6,335	45	0.315	0.032	0.624				1.54	0.328	2,232	4,567	0.028	0.339		0.112	
6	A-7-6	С	38.0	43.0	5.0	40.5	125	5,488	5,175	2,648	6,648	45	0.315	0.032	0.624				1.76	0.301	2,047	4,695	0.024	0.290	1.171	0.096	0.386
0	A-7-6	С	43.0	49.0	6.0	46.0	125	6,238	5,863	2,992	6,992	45	0.315	0.032	0.624				2.00	0.275	1,869	4,861	0.025	0.294] '.'/'	0.097	0.360
	A-7-6	С	49.0	55.0	6.0	52.0	125	6,988	6,613	3,368	7,368	45	0.315	0.032	0.624				2.26	0.250	1,702	5,070	0.021	0.248]	0.082	7

1. $\sigma_p' = \sigma_{vo}' + \sigma_{m}$; Estimate σ_m of 2,000 psf in existing fill material and 4,000 psf (moderately overconsolidated) for natural soil deposits; Ref. Table 11.2, Coduto 2003

2. C_c = 0.009(LL-10); Ref. Table 6-9, FHWA GEC 5

3. C_r = 0.15(Cc) for the existing fill and 0.10(Cc) for the natural soil deposits; Ref. Section 8.11, Holtz and Kovacs 1981

4. $e_o = (C_o/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981

5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77 \log(40/\sigma_{vo}')] \le 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS

6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS

7. Influence factor for strip loaded footing

8. $\Delta \sigma_v = q_e(I)$

9. $S_c = [C_o/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \le \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \le \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_o/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_{vf}' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesiv soil layers)

10. $S_c = H(1/C')\log(\sigma_{vi}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

11. $(S_c)_t = S_c(U/100)$; U = 100 for all granular soils at time t = 0

Calculated By:	BRT	Date:	07/18/2019
Checked By:	JPS	Date:	07/18/2019

Settlement Remaining After Hold Period: 0.785 in

800						
	Material Name	Color	Unit Weight (Ibs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
د] د	MSE Backfill		120	Mohr-Coulomb	0	34
	Item 203 Embankment		120	Mohr-Coulomb	0	32
	Ex. Fill: Lo-MD A-2-4		120	Mohr-Coulomb	0	26
L	Ex. Fill: St-VS A-6b		120	Mohr-Coulomb	0	25
	Ex. Fill: St-VS A-4a		120	Mohr-Coulomb	0	27
L	MD-De A-1-b		125	Mohr-Coulomb	0	38
	De-VD A-1-a		125	Mohr-Coulomb	0	42
ΞL	VS-Hd A-7-6		125	Mohr-Coulomb	50	26
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Image: Second		Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	
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