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November 21, 2011

Beyer Blinder Belle Architects & Planners LLP
3307 M Street, NW, Suite 301
Washington, DC 20007

Attention: Jill Cavanaugh

Re: Subsurface Investigation
Washington Monument Security Improvements
Washington, DC
MRCE File 11594

Dear Ms. Cavanaugh:

In accordance with our proposal dated April 1, 2011, we summarize herein the results of our soils and foundation investigation for the Washington Monument Security Improvements.

EXHIBITS

The following exhibits are attached to illustrate our report:

Drawing No. B-1	Boring Location Plan
Drawing No. GS-1	Geologic Section A-A
Drawing No. GS-2	Geologic Section B-B
Drawing No. GS-R	Geotechnical Reference Standards
Figure S-1	Site-Specific Seismic Liquefaction Screening Diagram
Table No. 1	Allowable Loading
Table No. 2	Allowable Excavation
Appendix A	Boring Logs
Appendix B	Finite Element Analysis of Proposed Excavation
Appendix C	BBB Cross Sections and Plan Alt.A.1 & A.4

AVAILABLE INFORMATION

The following items used in the preparation of our report were obtained from BBB Architects:

1. A topographic survey of the site prepared by Dewberry, dated December 6, 2010.

2. A report entitled *Geotechnical Investigation, Proposed Access System, Washington Monument, Washington DC*, dated July 16, 1998, prepared by Woodward Clyde Consultants for Universal Builders Supply, Inc.

The following items were obtained from our files:

a. A report entitled *Subsurface Investigation, Monument Grounds and Visitor Facility, Washington Monument, Washington, DC,* dated June 2, 2002, prepared by Mueser Rutledge Consulting Engineers (MRCE) for Olin Partnership and Hartman Cox Architects. This report incorporates earlier reports by MRCE.

b. A report entitled *Loading Limitations, Washington Monument Grounds, Washington, D.C., 1962,* dated December 31, 1962, prepared by Edward S. Barber, Consulting Engineer, for the Department of the Interior.

c. Logs of borings made in 1930 for a study of the Washington Monument.

d. A report entitled *Potomac River Basin, Modifications to Washington, DC, and Vicinity Flood Protection Project, Washington, District of Columbia,* , dated May 1992, prepared by the Department of the Army, Baltimore District, Corps of Engineers.

The following item was obtained from the Internet:

3. A report entitled *Report on Flooding and Stormwater in Washington, DC* , dated January 2008, prepared by the National Capital Planning Commission obtained from http://www.ncpc.gov/DocumentDepot/Publications/FloodReport2008.pdf

SITE DESCRIPTION

The Washington Monument is located on a grassy knoll on the National Mall between Constitution and Independence Avenues, between 15th and 17th Streets. The Monument was originally to have been located at the intersection of an east-west axis passing through the Capitol with a north-south axis passing through the White House. Due to poor soil conditions, the Monument site was adjusted to coincide with the highest point of ground in this vicinity.

The Monument grounds have been regraded on several occasions, the most recent being in the early 2000s. The Monument is surrounded by a plaza consisting of granite pavers. The elevation of the plaza is approximately Elev. 39 referenced to National Geodetic Vertical Datum of 1929 (NGVD 29), a mean sea level datum.

SITE HISTORY

The history of the construction of the Monument is well-documented in a number of works and there is no need to repeat it here. In brief, the foundations were constructed in 1848 and the shaft was begun at the end of 1848. Construction halted in 1854 and resumed in 1878 with underpinning of the original foundations. The underpinning was carried to about Elev. +2.
The remainder of the Monument was constructed between 1878 and 1884. Settlement has been monitored throughout its history, but available records date back to 1878. They indicate that total settlement between 1879 and 1992 was about 7 inches, due to the compression of the T1(D) clay. During the 7-year completion of the Monument, 4.5 inches of this settlement occurred. During the subsequent 106 years (1886-1992) settlement was less than 2.5 inches.

PROJECT DESCRIPTION

The current project is to provide security improvements to the Monument in the form of a visitor screening facility. Multiple alternatives are being considered for the security improvements, all of which involve the construction of a screening facility on the Monument grounds and a means of conducting the screened visitors to the Monument in a secure fashion.

Some of the alternatives involve creating a below-grade entrance to the Monument accessed by a ramp or ramps down from the plaza level. Others combine a below-grade entrance with regrading of the Monument grounds. Still others involve construction of a security facility atop the plaza or at a remote location on the grounds.

SUBSURFACE INVESTIGATION

The goal of the subsurface investigation was to develop information and provide general foundation recommendations appropriate to all of the alternatives under consideration. In an effort to address foundation conditions at all locations under consideration, we planned a boring program consisting of 10 test borings to 50 feet. After discussion with representatives of NPS and BBB, it was decided not to drill borings through the plaza surrounding the Monument because of the difficulty in removing and replacing the granite pavers without damage. Consequently eight of the borings were spaced relatively evenly outside the limits of the plaza, and the remaining two borings were placed at a greater distance from the plaza in areas where excavation or other earthwork may be performed.

FIELD EXPLORATION

Field work began on August 4, 2011 and finished on August 17, 2011. Ten borings numbered B-101 through B-110P were made outside the perimeter of the Monument plaza.

Borings were made by GeoServices Corporation of Forestville, MD. All field work was performed under the inspection of our Mr. William Hobson. Boring locations and elevations were determined in the field by Mr. Hobson. Elevations are referenced to the National Geodetic Vertical Datum, a mean sea level datum.

Representative soil samples were recovered from the borings with a two-inch split spoon sampler driven with a 140-pound hammer free-falling 30 inches. The number of blows required to advance the sampler through each of three six-inch intervals was recorded. The Standard Penetration Test (SPT) resistance, an index of the density of the material sampled, is calculated by summing the blows from the second and third intervals.

Borings were advanced and stabilized using weighted drilling fluid and temporary casing, and extended to depths of 50 feet. Piezometers were installed in three of the completed borings to determine present groundwater levels.

After completion of the borings, the samples were shipped to our office. Samples were reexamined in our laboratory and field descriptions were verified or revised as necessary. All soil samples are described in accordance with the system shown on Drawing No. GS-R. Groundwater levels were recorded in the three piezometers during and after the field work. Readings are shown on the appropriate piezometer record sheets.

SUBSURFACE CONDITIONS

The results of the boring program are shown on the boring logs attached as Appendix A. The logs include sample number, depth, blow count, individual soil descriptions for each sample and descriptions of drilling operations. Our interpretation of subsurface conditions is illustrated on Geologic Sections A-A and B-B, shown on Drawings Nos. GS-1 and GS-2. Generalized descriptions of the soil strata encountered in the borings are summarized below in order of their occurrence with increasing depth:

Stratum F - Fill

The uppermost material encountered in all of the recent borings is fill ranging in thickness from 9 to 18 feet. Stratum F consists of loose to very compact brown silty fine to medium sand grading to fine to coarse sand, some silt with fine sandy silt, trace to some gravel, trace brick, cinders, glass, clay, vegetation, shells.

Stratum T1(A) - Sandy Silt

This stratum was encountered beneath Stratum F in 5 of the recent borings and beneath Stratum T2 in three borings. Measured thicknesses ranged from 5 to 14.5 feet. Stratum T2 was interlensed with Stratum T1(A) in three of the recent borings. Stratum T1(A) consists of loose to medium compact brown fine sandy silt, trace clay, clay pockets, gravel, lignite or stiff brown clayey silt to silty clay, trace to some fine sand, trace gravel, lensed with silty fine sand, and fine sandy clay.

Stratum T2 - Silty Sand

Stratum T2 was encountered beneath Stratum F in five of the recent borings and ranged in thickness from 8.5 to 24.5 feet in thickness. Stratum T2 was also encountered below Stratum T1(A) in eight of the recent borings and ranged in thickness from 5 to 20.5 feet. Stratum T2 consists of loose to medium compact brown silty fine to medium sand, trace clay, gravel, grading to fine to medium sand, some silt, trace clay, gravel.

Stratum T3 - Sand and Gravel

Stratum T3 was encountered beneath Stratum T2 in all ten borings and ranged in thickness from 6 to 18 feet. Stratum T3 consists of compact to very compact brown fine to coarse sandy gravel, trace to some silt, grading to gravelly fine to coarse sand, some silt, with occasional boulders and cobbles.

Stratum T1(D) - Plastic Clay

Stratum T1(D) was encountered beneath Stratum T3 in Boring B-107 at a depth of 43 feet and continued to the bottom of the boring at 50 feet. Stratum T1(D) typically consists of soft to stiff gray plastic clay to silty clay, trace to some fine sand, trace fine sand layers and pockets, gravel. The two samples recovered during this investigation consist of soft to stiff gray silty fine sand, trace clay and gravel, and are presumably from a sand layer or pocket within the clay.

Stratum D - Decomposed Rock

Stratum D was encountered below Strata T1(D) or T3 in two borings in our 2001 investigation, at depths of about 85 feet. Stratum D consists of very compact gray micaceous fine to medium sand, some silt, trace to some rock fragments.

Groundwater

Groundwater was measured in three permanent piezometers installed during the field work. Groundwater levels corresponded to Elev. -2.5 to -5.0

EXISTING FOUNDATIONS

The Monument foundations bear on Stratum T3 which in turn bears on Stratum T1(D). Stratum T3 is a sandy gravel. Settlements due to application of new loads on granular soils typically occur almost immediately. Stratum T1(D) is a relatively compressible plastic clay to silty clay. Settlements due to application of new load on fine-grained soils typically occur over long time periods.

FINITE ELEMENT ANALYSIS

BBB provided information regarding various alternative schemes for the security improvements. They requested us to consider Alternatives A.1 and A.4 as those having the greatest volume of excavation which could affect the Monument. We considered the area and estimated depth of excavation for these two alternatives and determined that Alternative A.1 would have a larger impact on the Monument because the excavation is closer to the Monument.

Alternative A.1 consists of 13 ft wide ramps located east of the existing Monument plaza. The entrance to the top of the ramps is from east of the Monument. The ramps lead both north and south following the curvature of the plaza to a point about 7 ft below grade; turning 180 degrees and the leading in the opposite direction to a depth of 14 ft to the entrance to the security screening facility below the edge of the plaza. West of the security screening facility will be a tunnel extending into the Monument leading to the elevator which will be lowered to receive passengers at this level. Refer to Appendix C for a plan and sections showing this Alternative.

We considered an east-west section through the Monument and grounds. We performed a three dimensional numerical analysis to assess the deformations and differential settlement of the Washington Monument due to the proposed excavation. We used the monument loads provided by Silman Associates and the excavation due to the proposed A1 scheme by BBB. Deformations such as heaving or settlement at the edges of the Monument foundation were monitored and the differential settlement along the east-west direction of the Monument was calculated. Results of our analysis indicate that engineered design solutions will be required to minimize movement of the foundation. These solutions will involve balancing any change in weight loading on the east side of the foundation with an equal change on the west side. This may be accomplished by replacing existing fill on the west side with lighter fill material. A memorandum describing the numerical modeling and summarizing the results of the three dimensional numerical analysis is included as Appendix B of this report.

EVALUATION OF LIQUEFACTION POTENTIAL

We performed liquefaction potential evaluation using the state-of-practice as presented in the ASCE summary report of the 1996 and 1998 NCEER workshops (Youd et al. 2001, the "NCEER procedure"). Key parameters that influence liquefaction potential assessment are the design earthquake magnitude (Mw), Peak Ground Acceleration (PGA), and the groundwater level. Taking into account the historic importance and prominence of the Washington Monument, we chose a conservative approach in assessing the liquefaction potential at the site. We chose a conservative design earthquake event with moment magnitude (Mw) of 6 and used a PGA of 0.1 g, equivalent to a 2,500-yr return period earthquake event and consistent with a stiff soil site (Site Class D). The SPT N-values were corrected using an energy correction CE of 1.1, to account for the higher energy transfer efficiency of the automatic hammers. Based on stabilized piezometer readings, we have taken the ground water table at Elevation -3, approximately 39 ft below the existing ground surface. Lastly, we conservatively assumed the subsurface soils were relatively clean with fines content equal to 0%.

CONCLUSIONS

Based on the results of our field exploration and analyses, we conclude the following:

1. Figure S-1 shows the result of the SPT liquefaction analysis. A total of 10 borings from the MRCE investigation were screened. The figure presents the limiting field SPT N-values required to provide a factor of safety (FS) of 1.4 for clean cohesionless soils. SPT N-values plotting to the right of the curve indicate that liquefaction for that soil layer is unlikely, while N-values plotting to the left of the curve indicate that liquefaction is probable during the design earthquake event.

   All of the SPT N-values plot to the right of the limiting curve. This means that the FS is greater than 1.4 for all samples retrieved below the ground water elevation and that liquefaction is unlikely during the design earthquake event

2. Soil stratigraphy is as presented in earlier MRCE reports.

3. Water is at approximately Elev. –2.5 to -5.

4. As the deepest alternatives are expected to require excavations to about 20 feet below plaza level, corresponding to Elev. +19, no dewatering will be required to construct the proposed facilities.

5. As no dewatering is anticipated, there will be no drying of Stratum T1(D), the clay layer which indirectly supports the Monument.

6. The analysis performed for Alternative A.1 indicates that engineered solutions will be required to minimize movement of the foundation. These solutions will involve balancing any change in weight loading on the east side of the foundation with an equal change on the west side. This may be accomplished by replacing existing fill on the west side with lighter fill material.

   The analysis performed for the tunnel only portion of Alternative A.1 indicates that this construction has a minimal impact on the Monument. However, Alternative A.4 will include this tunnel plus an additional length of tunnel further from the Monument. Based on this, Alternative A.4 will also require an engineered solution to minimize movement of the foundation.

7. Prior to the start of construction of any alternatives, we recommend a monitoring system be installed on the Monument to provide data on any movements of the Monument.

8. Above-grade security improvement alternatives would be founded below the plaza level. The plaza consists of pavers over reinforced concrete over gravel, which is in turn supported by fill overlying the Monument foundations. Normally a permanent structure requires footings extending below the frost line, which in Washington, DC is 2.5 ft below grade.

Very light structures could be designed to be unaffected by differential movement resulting from minor movement from freezing and thawing. Provided that an above-grade structure imposes relatively light loads similar to the existing screening facility, this would not require any weight loading modifications around the foundations. Additional analyses may be required for a heavily loaded structure on the plaza to determine its impact on the Monument.

Foundations for structures would be constructed below the frost line, which would require penetrating the plaza. These foundations would bear on the fill. Allowable bearing pressures on the fill are 0.5 tsf. Footing subgrades should be inspected by an experienced geotechnical engineer. Any loose or soft fill materials should be removed and replaced with compacted granular fill or lean concrete.

9. Below-grade security improvement alternatives would bear in the deeper fill or on soils of Stratum T1(A). We anticipate that the new loads imposed by the foundations will generally not exceed the weight of the soil removed. Allowable bearing pressures in the deeper fill are 1.0 tsf and in Stratum T1(A) 1.5 tsf. Footing subgrades should be inspected and remedial measures followed as described above.

10. Braced below-grade walls will be entirely above the water table. They should be designed for lateral pressures of 75 psf per foot of depth below grade plus surcharge loading. Braced walls would include those for any tunnel. Tunnel roof slabs should be designed for 130 pcf per foot of cover, plus the weight of the slab. A surcharge live load should be added to the above design numbers in the event that maintenance vehicles are operated near or above the structure, or that a large event on the Mall could cause crowds to gather near or above the structure.

11. Large unbalanced mass excavations could cause significant differential movements of the Monument foundations, resulting in unacceptable tilting of the Monument. Tables 1 and 2 illustrate dimensions of allowable loading and excavation at varying distances from the Monument. As stated in our 1973 report, "… a settlement of the edge of the foundation of about 0.2 inches…. would cause a tilt of the shaft from plumb of about 0.8 inches. While this represents an extremely small angle change, less than one part in six thousand, or an angle change of less than one minute of arc, and is probably less than that caused by the heat of the sun on one side of the Monument, it is suggested that this be considered the maximum tolerable tilt movement caused by any new construction." The engineered solution is intended to balance the loads so as not to cause measurable movement.

12. Subgrade conditions for support of flexible and rigid pavements, including sidewalks, are generally good. In the current borings, the shallow fill consisted of loose to compact sand and sandy silt, soft to stiff clayey silt, and soft clay. These borings represent conditions at 10 discrete locations on the Monument grounds. Much of the shallow fill was placed or graded as controlled fill when the grounds were improved in the early 2000s and was presumably compacted when placed. Foot traffic and maintenance vehicle traffic have further compacted the ground to its present state. Areas of soft or loose soils which are

exposed during pavement construction will require recompaction or excavation and replacement with granular fill.

13. The floor of the existing elevator pit may have to be lowered four to six feet to accommodate the new lower position of the elevator following construction of the below grade entrance into the Monument. Excavation for this pit should have minimal impact on the 126.5 ft wide Monument base. However, it may be prudent to perform some form of ground stabilization below the existing elevator pit before beginning this excavation. A concept plan for safely making a horizontal penetration through the original Monument foundation was developed in 2002. The key to making this plan successful is to make the opening as small as is practical and to provide positive support to the opening as the tunneling is progressed.

14. To determine flood implications, we reviewed the 1992 Army Corps of Engineers flood study and the NCPC 2008 flood study. Both documents indicate that the 100-year flood level on the Mall is El. 15.6 relative to NGVD. As noted above, anticipated construction for the Security Improvements project will extend no deeper than approximately El. 19. This will result in all construction occurring above the 100-year flood level. For the 100-year storm, the risk of flooding is minimal and there is no need for tiedown anchors.

15. As changes in groundwater levels tend to lag changes in surface water levels, and the Monument sits on high ground when compared to the surrounding grades, groundwater under flood conditions is not expected to pose a threat to the existing or proposed structures. This is because any rise in surface water due to flooding is expected to be a short-term event and is not expected to last long enough to cause the groundwater on the Monument grounds to rise.

16. Where new below-grade structures are planned, we recommend that the slabs be underlain by a 12-inch layer of crushed stone atop a separation geotextile. The stone should be separated from the concrete slab by a polyethylene vapor barrier. This combination will provide a drainage layer which will help prevent moisture from wicking up through the slab. The drainage system would lead to a gravity drain or a sump pump.

17. Fill placed to support structures should consist of granular soils with less than 15 percent by weight passing a No. 200 sieve. Fill should be placed in lifts not exceeding 12 inches in loose thickness and compacted by several passes of a heavy vibratory roller. Compaction should meet or exceed 95 percent of maximum dry density as determined by ASTM D 1557 (modified Proctor).

    Soils to be excavated from the Monument grounds may be reused as compacted fill provided that they can be compacted to the standard specified above. It may be difficult to achieve this level of compaction with finer-grained soils, particularly during periods of wet or cold weather when drying of the soils is not practical.

Excavation and fill placement should be subject to the limits specified in our 2002 report. We have included the tabulated recommendations for convenience as Tables 1 and 2.

Please contact us if you have any questions concerning this report.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS

By: ______________________
Hugh S. Lacy, PE

By: ______________________
Douglas W. Christie, PE

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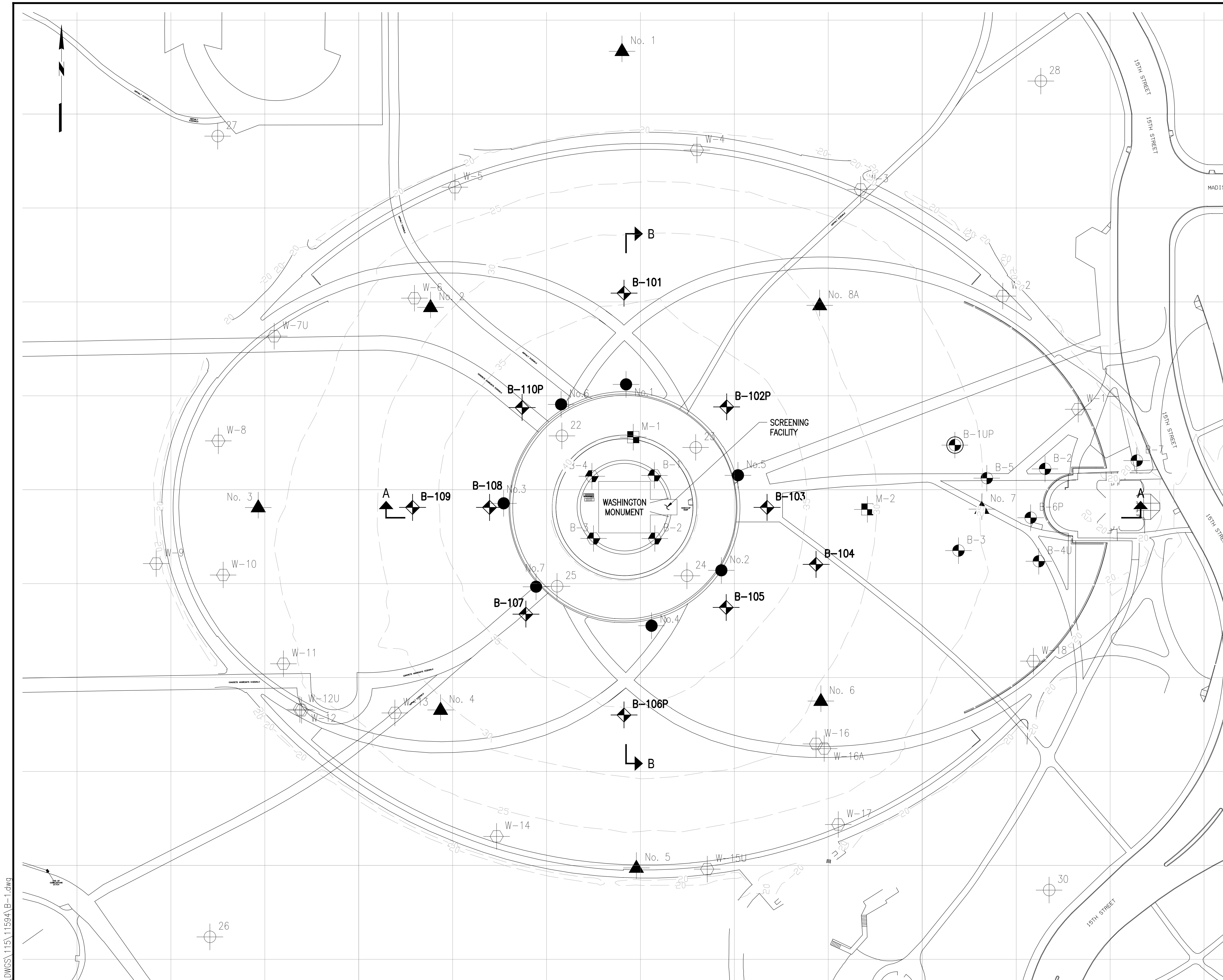
EXHIBITS



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BORING LEGEND:

B-101 – DRY SAMPLE BORING FOR SECURITY IMPROVEMENTS MADE IN 2011
P INDICATES PIEZOMETER INSTALLED

B-6P – DRY SOIL SAMPLE BORING FOR VISITOR FACILITY MADE IN 2002
P INDICATES PIEZOMETER INSTALLED

B-1UP – UNDISTURBED SOIL SAMPLE BORING FOR VISITOR FACILITY MADE IN 2002
P INDICATES PIEZOMETER INSTALLED

W-1 – DRY SOIL SAMPLE BORING FOR RETAINING WALL MADE IN 2002

W-7U – UNDISTURBED SOIL SAMPLE BORING FOR RETAINING WALL MADE IN 2002

B-1 – BORING MADE IN 1998

M-1 – BORING MADE IN 1973

24 – BORING MADE IN 1962

No.1 – INNER RING BORING MADE IN 1930

No.6 – OUTER RING BORING MADE IN 1930

GENERAL NOTES:

1. FOR GEOLOGIC SECTIONS A-A AND B-B SEE DRAWING NOS. GS-1 AND GS-2.
2. BASE PLAN FOR DRAWING NO. B-1 WAS TAKEN FROM A 1991 SITE PLAN SURVEYED BY DEWBERRY AND DAVIS, AND MODIFIED FOR 1995 15TH STREET REALIGNMENT.
3. ELEVATIONS SHOWN REFER TO THE NATIONAL GEODETIC VERTICAL DATUM
4. BORINGS WERE MADE BY GEOSERVICES CORPORATION IN AUGUST 2011 UNDER THE INSPECTION OF MRCE.

GRAPHIC SCALE

50' 0 50' 100'

REV.	DATE	BY	DESCRIPTION

NATIONAL PARK SERVICE

WASHINGTON DC

BEYER BLINDER BELLE ARCHITECTS

WASHINGTON DC

MUESER RUTLEDGE CONSULTING ENGINEERS

14 PENN PLAZA – 225 W. 34TH STREET, NY, NY 10122

SCALE	MADE BY: C.P.J.	DATE: 09/12/11	FILE NUMBER
AS NOTED	CH'KD BY: D.C.	DATE: 09/12/11	11594

BORING LOCATION PLAN

DRAWING NUMBER B-1

SECTION A–A

NOTES:

1. FOR GENERAL NOTES AND BORING LOCATION PLAN SEE DRAWING NO. B–1.
2. STRATIFICATIONS SHOWN ON GEOLOGIC SECTIONS ARE INFERRED BETWEEN AND BEYOND THE ILLUSTRATED BORINGS AND MAY OR MAY NOT ACCURATEL.Y REPRESENT TRUE SUBSURFACE CONDITIONS.
3. DRILLING MUD LEVEL.S MEASURED IN BORINGS MAY OR MAY NOT REPRESENT ACTUAL GROUND WATER LEVEL.S.
4. SOIL CLASSIFICATIONS WERE MADE BY MRCE AND MAY NOT AGREE WITH THE DRILLER'S CLASSIFICATIONS.
5. SEE DRAWING GS–R FOR BORING LEGEND AND SUMMARY OF UNIFIED SOIL CLASSIFICATION SYSTEM.

GENERAL STRATA DESCRIPTIONS

STRATUM (F)	FILL:	LOOSE TO VERY COMPACT BROWN SILTY FINE TO MEDIUM SAND GRADING TO FINE TO COARSE SAND, SOME SILT AND FINE SANDY SILT, TRACE TO SOME GRAVEL, TRACE BRICK, CONCRETE, CLAY, VEGETATION, SHELLS.
STRATUM (T1(A))	(TERRACE DEPOSITS) SANDY SILT:	LOOSE TO MEDIUM COMPACT BROWN FINE SANDY SILT , TRACE CLAY, CLAY POCKETS, GRAVEL., LIGNITE OR STIFF BROWN CLAYEY SILT TO SILTY CLAY TRACE TO SOME FINE SAND, TRACE GRAVEL, LENSED WITH SILTY FINE SAND, AND FINE SANDY CLAY.
STRATUM (T2)	(TERRACE DEPOSITS) SILTY SAND:	MEDIUM COMPACT BROWN SILTY FINE TO MEDIUM SAND, GRADING TO FINE TO MEDIUM SAND, SOME SILT, TRACE CLAY, GRAVEL.
STRATUM (T3)	(TERRACE DEPOSITS) SAND AND GRAVEL:	COMPACT TO VERY COMPACT BROWN FINE TO COARSE SANDY GRAVEL, TRACE TO SOME SILT, GRADING TO GRAVELLY FINE TO COARSE SAND, SOME SILT, WITH OCCASIONAL BOULDERS AND COBBLES
STRATUM (T1(D))	(TERRACE DEPOSITS) PLASTIC CLAY:	SOFT TO STIFF GRAY PLASTIC CLAY TO SILTY CLAY, TRACE TO SOME FINE SAND, TRACE FINE SAND LAYERS AND POCKETS, GRAVEL.
STRATUM (D)	(WISSAHICKON SCHIST) DECOMPOSED ROCK:	VERY COMPACT GRAY MICACEOUS FINE TO MEDIUM SAND, SOME SILT, TRACE TO SOME ROCK FRAGMENTS

GRAPHIC SCALE

20' 10' 0 20' 40'

NATIONAL PARK SERVICE
WASHINGTON DC

WASHINGTON MONUMENT SECURITY IMPROVEMENTS
WASHINGTON DC

BEYER BLINDER BELLE ARCHITECTS
WASHINGTON DC

MUESER RUTLEDGE CONSULTING ENGINEERS
14 PENN PLAZA – 225 W. 34TH STREET, NY, NY 10122

SCALE					FILE NO.
AS SHOWN	MADE BY	C.P.J.	DATE	09/12/11	11594
	CH'KD BY	D.W.C.	DATE	09/12/11	

GEOLOGIC SECTION A–A

DRAWING NO. GS–1

SECTION B—B

NOTES:

1. FOR GENERAL NOTES AND BORING LOCATION PLAN SEE DRAWING NO. B-1.
2. STRATIFICATIONS SHOWN ON GEOLOGIC SECTIONS ARE INFERRED BETWEEN AND BEYOND THE ILLUSTRATED BORINGS AND MAY OR MAY NOT ACCURATEL.Y REPRESENT TRUE SUBSURFACE CONDITIONS.
3. DRILLING MUD LEVEL.S MEASURED IN BORINGS MAY OR MAY NOT REPRESENT ACTUAL GROUND WATER LEVEL.S.
4. SOIL CLASSIFICATIONS WERE MADE BY MRCE AND MAY NOT AGREE WITH THE DRILLER'S CLASSIFICATIONS.
5. SEE DRAWING GS-R FOR BORING LEGEND AND SUMMARY OF UNIFIED SOIL CLASSIFICATION SYSTEM.

GENERAL STRATA DESCRIPTIONS

STRATUM (F)	FILL:	LOOSE TO VERY COMPACT BROWN SILTY FINE TO MEDIUM SAND GRADING TO FINE TO COARSE SAND, SOME SILT AND FINE SANDY SILT, TRACE TO SOME GRAVEL, TRACE BRICK, CONCRETE, CLAY, VEGETATION, SHELLS.
STRATUM (T1(A))	(TERRACE DEPOSITS) SANDY SILT:	LOOSE TO MEDIUM COMPACT BROWN FINE SANDY SILT , TRACE CLAY, CLAY POCKETS, GRAVEL., LIGNITE OR STIFF BROWN CLAYEY SILT TO SILTY CLAY TRACE TO SOME FINE SAND, TRACE GRAVEL, LENSED WITH SILTY FINE SAND, AND FINE SANDY CLAY.
STRATUM (T2)	(TERRACE DEPOSITS) SILTY SAND:	MEDIUM COMPACT BROWN SILTY FINE TO MEDIUM SAND, GRADING TO FINE TO MEDIUM SAND, SOME SILT, TRACE CLAY, GRAVEL.
STRATUM (T3)	(TERRACE DEPOSITS) SAND AND GRAVEL:	COMPACT TO VERY COMPACT BROWN FINE TO COARSE SANDY GRAVEL, TRACE TO SOME SILT, GRADING TO GRAVELLY FINE TO COARSE SAND, SOME SILT, WITH OCCASIONAL BOULDERS AND COBBLES
STRATUM (T1(D))	(TERRACE DEPOSITS) PLASTIC CLAY:	SOFT TO STIFF GRAY PLASTIC CLAY TO SILTY CLAY, TRACE TO SOME FINE SAND, TRACE FINE SAND LAYERS AND POCKETS, GRAVEL.
STRATUM (D)	(WISSAHICKON SCHIST) DECOMPOSED ROCK:	VERY COMPACT GRAY MICACEOUS FINE TO MEDIUM SAND, SOME SILT, TRACE TO SOME ROCK FRAGMENTS

GRAPHIC SCALE

20' 10' 0 20' 40'

NATIONAL PARK SERVICE
WASHINGTON DC

WASHINGTON MONUMENT
SECURITY IMPROVEMENTS
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AS SHOWN	C.P.J.	09/12/11	11594
	CHKD BY D.W.C.	09/12/11	

GEOLOGIC SECTION B–B — DRAWING NO. GS–2

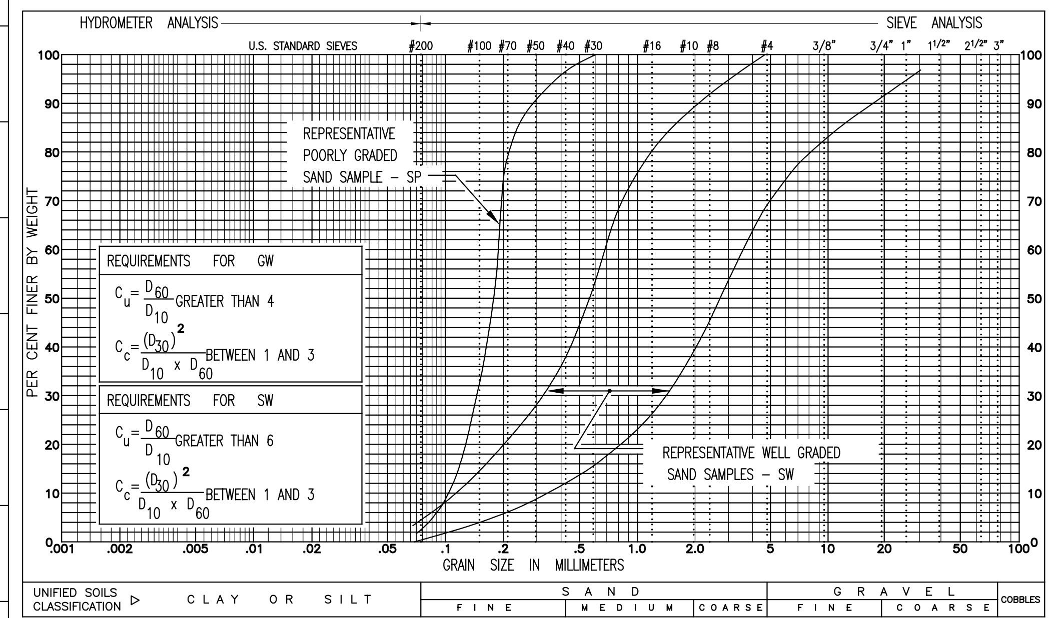
UNIFIED SOIL CLASSIFICATION (INCLUDING IDENTIFICATION AND DESCRIPTION)

MAJOR DIVISIONS (1)	(2)	(2)	GROUP SYMBOLS (3)	TYPICAL NAMES (4)	FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 3 IN. AND BASING FRACTIONS ON ESTIMATED WEIGHTS) (5)		
COARSE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE.	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.	WIDE RANGE IN GRAIN SIZES AND SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES.		
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.	PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING.		
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT-MIXTURES.	NONPLASTIC FINES OR FINES WITH LOW PLASTICITY (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES.	PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE. (FOR VISUAL CLASSIFICATION, THE 1/4 -IN. SIZE MAY BE USED AS EQUIVALENT TO THE NO. 4 SIEVE SIZE)	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.	WIDE RANGE IN GRAIN SIZES AND SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES.		
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.	PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING.		
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT-MIXTURES.	NONPLASTIC FINES OR FINES WITH LOW PLASTICITY (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES.	PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		
FINE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE					IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN NO. 40 SIEVE SIZE		
					DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PL)
	SILTS AND CLAYS	LIQUID LIMIT IS LESS THAN 50	ML	INORGANIC SILTS, SANDY SILTS, ROCK FLOUR, OR CLAYEY SILTS WITH SLIGHT PLASTICITY.	NONE TO SLIGHT	QUICK TO SLOW	NONE
			CL	INORGANIC CLAYS, OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.	MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY.	SLIGHT TO MEDIUM	SLOW	SLIGHT
	SILTS AND CLAYS	LIQUID LIMIT IS GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS.	SLIGHT TO MEDIUM	SLOW TO NONE	SLIGHT TO MEDIUM
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.	HIGH TO VERY HIGH	NONE	HIGH
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.	MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS.	READILY IDENTIFIED BY COLOR, ODOR, SPONGY FEEL AND FREQUENTLY BY FIBROUS TEXTURE.		

MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE / MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE — THE NO. 200 SIEVE SIZE IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE

BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS, I.E.: SP-SC POORLY GRADED SAND WITH CLAY BINDER.

LABORATORY CLASSIFICATION CRITERIA

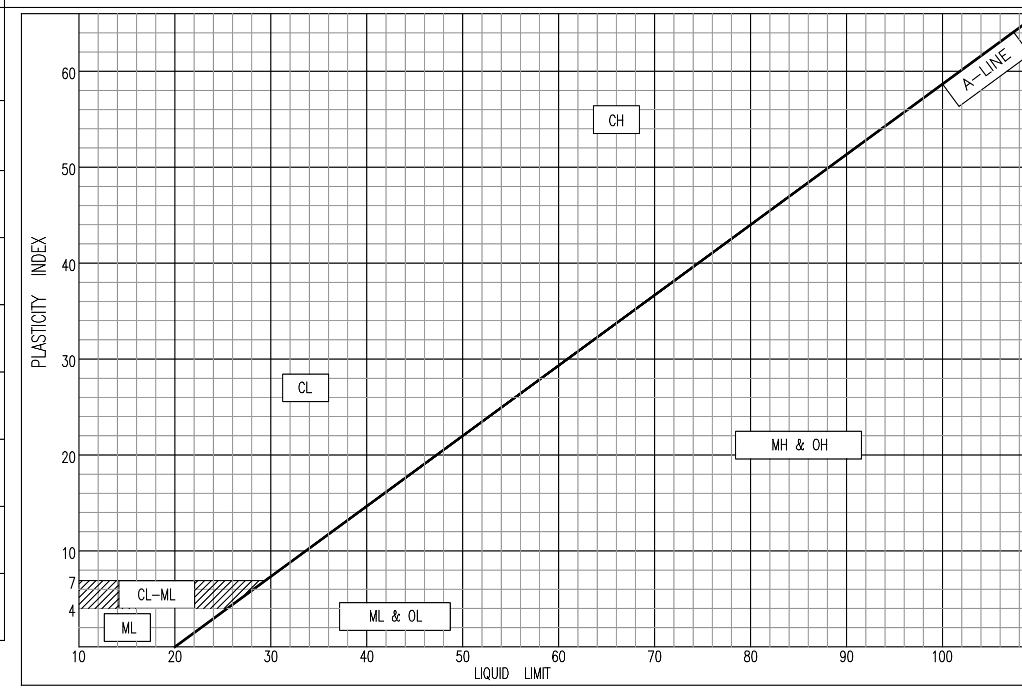


GRAIN SIZE PLOT

COBBLE 3-12"
BOULDER > 12"

DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN NO. 200 SIEVE SIZE) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:

LESS THAN 5%	GW, GP, SW, SP
MORE THAN 12%	GM, GC, SM, SC
5% TO 12%	BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS, I.E.: SP-SM, GP-GM.



PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS

TERMINOLOGY USED IN MRCE SOIL DESCRIPTIONS

DEGREE OF COMPACTION FOR NON-PLASTIC SOIL

DEGREE OF COMPACTION	BLOWS* PER FOOT
LOOSE	0 TO 10
MEDIUM COMPACT	11 TO 29
COMPACT	30 TO 50
VERY COMPACT	GREATER THAN 50

* STANDARD PENETRATION RESISTANCE USING 140 LB. HAMMER FREE FALLING 30 INCHES TO DRIVE A 2 INCH O.D. SPLIT-SPOON SAMPLER.

CONSISTENCY OF CLAY AND CLAYEY SILT+

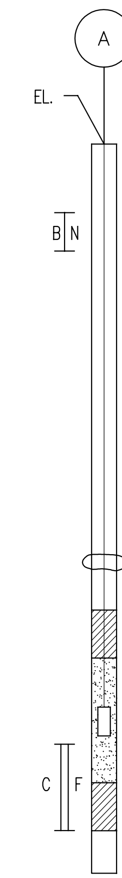
CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TSF)	IDENTIFICATION CHARACTERISTICS
SOFT	LESS THAN 0.5	EASILY REMOLDED WITH SLIGHT FINGER PRESSURE
MEDIUM	0.5 TO 1.0	REQUIRES SUBSTANTIAL PRESSURE FOR REMOLDING
STIFF	1.0 TO 4.0	DIFFICULT TO REMOLD WITH FINGERS
HARD	GREATER THAN 4.0	CANNOT BE REMOLDED WITH FINGERS

\+ NONPLASTIC SILTS ARE DESCRIBED USING DEGREE OF COMPACTION AS PRESENTED FOR NON-PLASTIC SOIL.

DESCRIPTION OF CONSTITUENT PERCENTAGES AS USED IN SOIL SAMPLE CLASSIFICATIONS

1% TO 12% -	"TRACE"
13% TO 30% -	"SOME"
31% TO 49% -	ADJECTIVE FORM OF SOIL GROUP (EG. SANDY)
EQUAL AMOUNT -	"AND" (EG. SAND AND GRAVEL)

BORING LEGEND

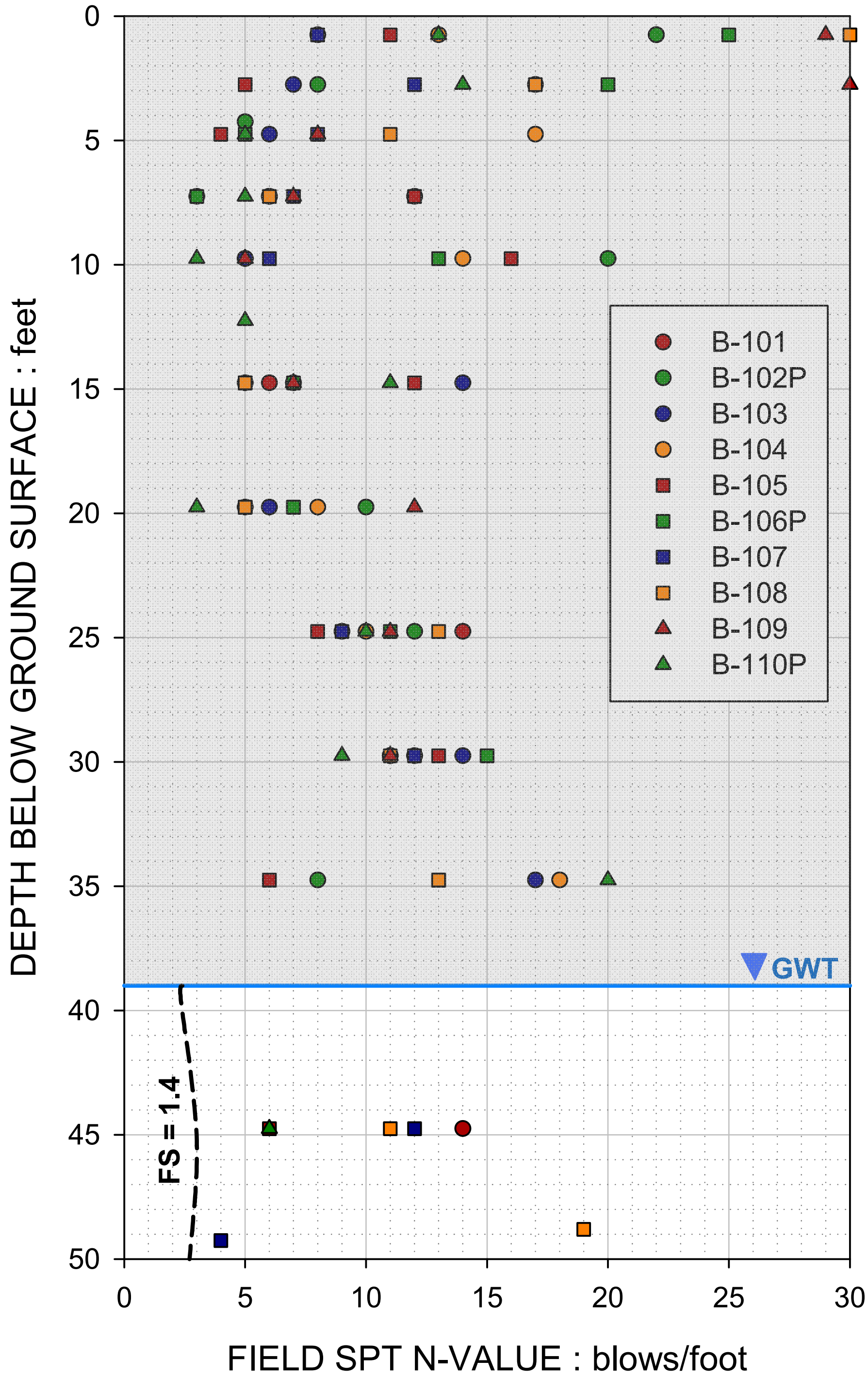


A —	NUMBER, TYPE AND LOCATION OF BORING
EL. —	GROUND SURFACE ELEVATION AT BORING
B —	NUMBER AND TYPE OF SAMPLE
	D - DRY SAMPLE TAKEN WITH 2 INCH O.D. SPLIT SPOON
	U - UNDISTURBED SAMPLE TAKEN WITH 3 INCH O.D. FIXED PISTON TYPE SAMPLER
	UD - UNDISTURBED SAMPLE EXTRUDED IN FIELD AND PLACED IN JAR DUE TO POOR RECOVERY OR DISTURBANCE
	S - THIN TUBE SAMPLE TAKEN WITH SHELBY TUBE SAMPLER
	W - WASH SAMPLE
	NR - NO RECOVERY
I —	LENGTH OF SAMPLE ATTEMPT
N —	STANDARD PENETRATION RESISTANCE. NUMBER OF BLOWS FROM 140 LB. HAMMER FREE FALLING 30 INCHES REQUIRED TO DRIVE 2 INCH O.D. SPLIT SPOON SAMPLER ONE FOOT AFTER INITIAL PENETRATION OF 6 INCHES, UNLESS A SPECIFIC PENETRATION IS INDICATED.
	P - PRESSED OR PUSH SAMPLE
	WH - SAMPLE TAKEN UNDER WEIGHT OF HAMMER AND RODS
	WR - SAMPLE TAKEN UNDER WEIGHT OF RODS
E —	AVERAGE NATURAL WATER CONTENT OF SAMPLE, IN PERCENT OF DRY WEIGHT
G —	UNIFIED SOIL CLASSIFICATON GROUP SYMBOL OF SAMPLE
[J = / K =]	ATTERBERG LIQUID LIMIT VALUE / ATTERBERG PLASTIC LIMIT VALUE
[L] —	COMPRESSIVE STRENGTH IN TSF DETERMINED FROM UNCONFINED COMPRESSION TEST
(M) —	COMPRESSIVE STRENGTH IN TSF DETERMINED FROM UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
▼ —	GROUNDWATER LEVEL OBSERVED IN BORING *- MUD LEVEL
▽ —	GROUNDWATER LEVEL OBSERVED IN PIEZOMETER
C —	ROCK CORE NUMBER
‖ —	LENGTH OF CORE RUN
F —	LENGTH OF CORE RECOVERED EXPRESSED AS A PERCENT OF THE LENGTH OF CORE RUN
R —	ROCK QUALITY DESIGNATION—THE SUM OF THE LENGTHS OF PIECES OF RECOVERED CORE WHICH ARE EQUAL TO OR GREATER THAN FOUR INCHES IN LENGTH, EXPRESSED AS A PERCENTAGE OF THE TOTAL LENGTH OF CORE RUN. LENGTHS ARE MEASURED BETWEEN IN-SITU SEPARATIONS AND MECHANICAL BREAKS RESULTING FROM CORING ARE IGNORED.
	IMPERVIOUS SEAL
	SAND FILTER SURROUNDING PIEZOMETER INTAKE ELEMENT
	INTAKE ELEMENT
	COBBLE OR BOULDER

MUESER RUTLEDGE CONSULTING ENGINEERS
225 WEST 34th STREET — 14 PENN PLAZA
NEW YORK, NY 10122

GEOTECHNICAL REFERENCE STANDARDS

DRAWING NO. GS-R



NOTES:

1. Liquefaction potential evaluation is based on Youd et al. 2001, the "NCEER Procedure."
2. Design earthquake event: M_w = 6 and PGA = 0.1 g, equivalent to a 2,500-yr return period earthquake event & consistent with a stiff soil site (Site Class D).
3. FS = Factor of Safety
4. Design Ground Water Table (GWT) is approximately 39 ft below ground surface.
5. Soil above the GWT is not liquefiable.

WASHINGTON MONUMENT		
Washington		District of Columbia
MUESER RUTLEDGE CONSULTING ENGINEERS 14 PENN PLAZA – 225 W 34TH STREET, NEW YORK NY 10122		
SCALE N/A	MADE BY: CZB DATE: 09-23-11 CH'KD BY: JG DATE: 09-23-11	FILE No. 11594
SITE-SPECIFIC SEISMIC LIQUEFACTION SCREENING DIAGRAM		FIGURE No. S-1

TABLE 1

ALLOWABLE LOADING

Distance from Monument center	Allowable permanent net increase	Allowable permanent net decrease	Remarks
up to 63 feet	500 psf	500 psf	Minimize lateral extent 500 psf may be relaxed for small footprint after study
63 to 150 feet	1000 psf	1500 psf asymmetrically	
		2000 psf symmetrically	
150 to 200 feet	1500 psf	2000 psf	limits for asymmetric loading with lateral dimensions of more than 150 feet
200 feet or more	unspecified	unspecified	

Loading is subject to analysis in every case to determine its effects on the subsoils.

TABLE 2

ALLOWABLE EXCAVATION

Distance from Monument center	Allowable excavation	Remarks
up to 115 feet	No deeper than Elev. 16	Maximum width open at any time is 45 feet
115 to 150 feet	Following a line from Elev. 16 at 1V:2.6H	Maximum width open at any time is between 45 and about 100 feet, proportional to distance from Monument center
150 feet or more	No deeper than Elev. 0	Maximum width open at any time is about 100 feet

Excavation is subject to notes 1 and 2 below.

1. Excavation or a widespread structure symmetrically placed which would approach the limitation on maximum load removal must be carried out with great caution. Specifications should require a program of excavation in which load removal on opposite sides of the Monument would be reasonably will balanced at all stages of the operation.

2. In general, it would be preferable to stabilize the sides of excavations near the Monument by cutting on sloped banks rather than by driving sheet piling of soldier piles for a cofferdam. Where vertical-wall cofferdams are absolutely necessary these could be formed by soldier piles placed in pre-augered holes.

APPENDIX A

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO. B-101
SHEET 1 OF 2
FILE NO. 11594
SURFACE ELEV. 34.2
RES. ENGR. WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
09:30	1D	0.0	6-8	Brown fine sandy silt, trace gravel, roots (Fill)	F		DRILLED	
08-04-11		1.5	14	(ML)			AHEAD	
Wednesday	2D	2.0	10-8	Do 1D (Fill) (ML)			4"	
Cloudy To		3.5	9					
Clear	3D	4.0	7-16	Brown fine sandy silt, some gravel (Fill) (ML)		5		
		5.5	16					
	4D	6.5	5-3	Red brown fine sandy silt, trace gravel (Fill) (ML)				
		8.0	3					
	5D	9.0	4-2	Brown fine sandy silt, trace clay (Fill) (ML)		10		
		10.5	3					
	6D	14.0	4-3	Medium brown silty clay, trace fine sand, cinders,		15		
		15.5	3	glass (Fill) (CL)		16		
	7D	19.0	3-2	Medium brown silty clay, trace fine sand, (CL)	T1(A)	20		WC=22
		20.5	3					
	8D	24.0	5-5	Brown fine sandy clay (CL)		25		WC=25
		25.5	9					
						27.5		
	9D	29.0	3-5	Brown silty fine to medium sand (SM)	T2	30		
		30.5	6					
						32.5		
	10D	34.0	17-19	Brown fine to coarse sand, some gravel, trace	T3	35		
		35.5	26	silt (SP-SM)				
	11D	39.0	10-17	Brown fine to coarse sand, trace gravel, silt		40		
		40.5	17	(SP-SM)				
	12D	44.0	9-7	Brown gravelly fine to coarse sand, trace silt		45		
		45.5	7	(SP-SM)				WC=Water Content in percent of dry weight.
	13D	48.5	20-21	Brown gravelly fine to coarse sand, trace silt				
14:30		50.0	23	(SP-SM)		50		End of Boring at 50'.

MRCE Form BL-1

BORING NO. B-101

MUESER RUTLEDGE CONSULTING ENGINEERS

PROJECT	WASHINGTON MONUMENT SECURITY IMPROVEMENTS	BORING NO.	B-101
		SHEET	2 OF 2
		FILE NO.	11594
LOCATION	WASHINGTON, DC	SURFACE ELEV.	34.2
BORING LOCATION	SEE BORING LOCATION PLAN	DATUM	NGVD 29

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	X YES		NO
TRUCK		MECHANICAL		DIA., IN. 4	DEPTH, FT. FROM	0	TO 9
SKID		HYDRAULIC	X	DIA., IN.	DEPTH, FT. FROM		TO
BARGE	CME-750	OTHER		DIA., IN.	DEPTH, FT. FROM		TO
OTHER							

TYPE AND SIZE OF:

D-SAMPLER	2" O. D. SPLIT SPOON
U-SAMPLER	
S-SAMPLER	
CORE BARREL	
CORE BIT	
DRILL RODS	

DRILLING MUD USED	X YES NO
DIAMETER OF ROTARY BIT, IN.	3-3/4
TYPE OF DRILLING MUD	REVERT
AUGER USED	X YES NO
TYPE AND DIAMETER, IN.	TO START HOLE
CASING HAMMER, LBS.	AVERAGE FALL, IN.
*SAMPLER HAMMER, LBS. 140	AVERAGE FALL, IN. 30

*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED   YES   X NO   SKETCH SHOWN ON

STANDPIPE:	TYPE		ID, IN.		LENGTH, FT.		TOP ELEV.
INTAKE ELEMENT:	TYPE		OD, IN.		LENGTH, FT.		TIP ELEV.
FILTER:	MATERIAL		OD, IN.		LENGTH, FT.		BOT. ELEV.

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR	GEOSERVICES, INC.		
DRILLER	JAMES BEAVERS	HELPERS	BRIAN ROBERTSON
REMARKS	BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.		
RESIDENT ENGINEER	WILLIAM HOBSON	DATE	08-04-11
CLASSIFICATION CHECK:	CHERYL J. MOSS	TYPING CHECK:	CHERYL J. MOSS

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO.	B-102P
SHEET 1 OF	3
FILE NO.	11594
SURFACE ELEV.	37.5
RES. ENGR.	WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	5-11	Brown fine sandy silt, trace gravel (Fill) (ML)			DRILLED	
08-05-11		1.5	11				AHEAD	
Friday	2D	2.0	5-4	Do 1D (Fill) (ML)			4"	
Cloudy To		3.5	4				↓	
Clear	3D	3.5	3-2	Do 1D (Fill) (ML)		5		
		5.0	3					
	4D	6.5	2-1	Soft brown fine sandy clay (Fill) (CL)				
		8.0	2		F			
	5D	9.0	2-10	Brown clayey fine sand (Fill) (SC)		10		
		10.5	10					
	6D	14.0	2-2	Medium brown silty clay, trace fine sand, concrete		15		
		15.5	3	(Fill) (CL)		16		
	7D	19.0	4-4	Stiff brown silty clay, some fine sand, trace		20		
		20.5	6	gravel (CL)				
					T1(A)			
	8D	24.0	3-5	Stiff brown silty clay, some fine sand (CL)		25		WC=18
		25.5	7					
						27.5		
	9D	29.0	4-6	Brown silty fine sand (SM)		30		
		30.5	6					
					T2			
	10D	34.0	4-5	Do 9D, trace clay (SM)		35		
		35.5	3					
						37		
	11D	39.0	34-66/2"	Brown gravelly fine to coarse sand, trace silt		40		
		39.7		(SP-SM)				
					T3			
	12D	44.0	39-38	Brown gravel (GP)		45		WC=Water Content
		45.5	25					in percent of dry
								weight.
14:20	13D	48.5	100/6"	Brown gravelly fine to coarse sand, trace silt		49		End of Boring at 49'.
		49.0		(SP-SM)		50		

MRCE Form BL-1

BORING NO. B-102P

Mueser Rutledge Consulting Engineers
14 Penn Plaza - West 34th Street
New York, NY 10122

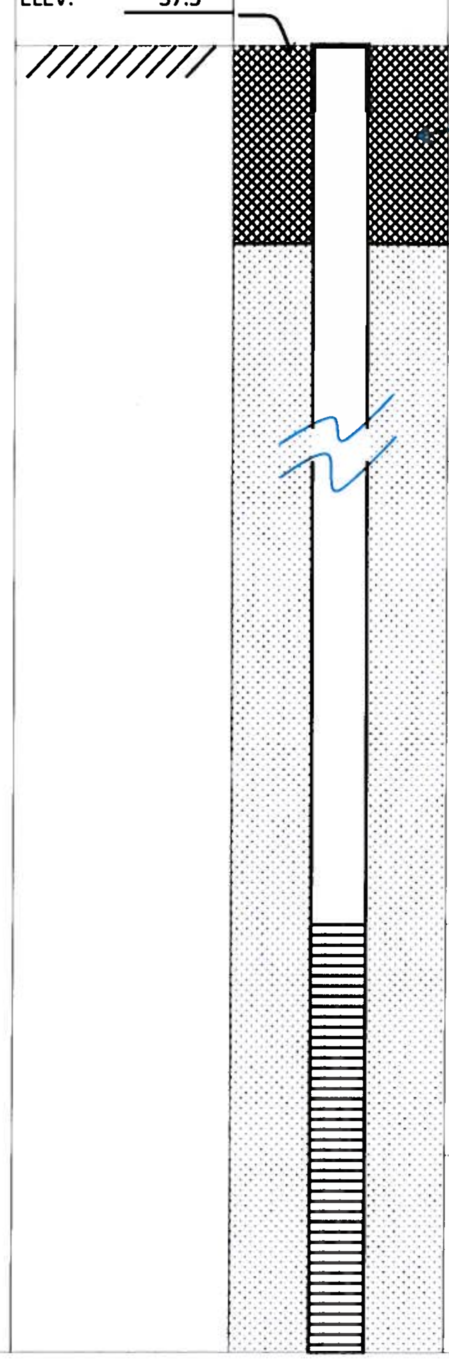
PIEZOMETER RECORD

SHEET 2 OF 3
FILE NO. 11594
TASK NO.

MUESER RUTLEDGE CONSULTING ENGINEERS

PROJECT: Washington Monument Security Improvements
PIEZOMETER NO. B-102P
LOCATION: Washington D.C.
PIEZOMETER LOCATION: SEE BORING LOCATION PLAN
DATE OF INSTALLATION 8/9/2011
RESIDENT ENG. Bill Hobson

STRATA	PIEZOMETER INSTALLATION DETAILS	DEPTH (FT)
GROUND SURFACE ELEV. 37.5		



PIEZOMETER TYPE PVC

INTAKE POINT
depth to bottom, ft = 50
depth to top, ft = 40
length, ft = 10 = L
diameter, in = 2 , ft = 0.17 = 2R

STANDPIPE/RISER
elevation of rim, ft = 37.5
diameter, in = 2 , ft = 0.17 = 2r

READING TIME		DEPTH - RIM TO WATER	ELEVATION OF WATER	REMARKS
DATE	CLOCK			
8/12/11	7:40	42.1	-4.6	
8/31/11	7:40	42.5	-5.0	

SAND
GRAVEL
BENTONITE
GROUT

GROUND SURFACE ELEV. 37.5

PIEZOMETER NO. B-102P

MUESER RUTLEDGE CONSULTING ENGINEERS

		BORING NO.	B-102P
		SHEET	3 **OF** 3
PROJECT	WASHINGTON MONUMENT SECURITY IMPROVEMENTS	**FILE NO.**	11594
LOCATION	WASHINGTON, DC	**SURFACE ELEV.**	37.5
BORING LOCATION	SEE BORING LOCATION PLAN	**DATUM**	NGVD 29

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	X YES		NO	
TRUCK		MECHANICAL		DIA., IN.	4	DEPTH, FT. FROM	0	TO 9
SKID		HYDRAULIC	X	DIA., IN.		DEPTH, FT. FROM		TO
BARGE		OTHER		DIA., IN.		DEPTH, FT. FROM		TO
OTHER	CME-750							

TYPE AND SIZE OF:

D-SAMPLER	2" O. D. SPLIT SPOON
U-SAMPLER	
S-SAMPLER	
CORE BARREL	
CORE BIT	
DRILL RODS	

DRILLING MUD USED	X YES	NO
DIAMETER OF ROTARY BIT, IN.	3-3/4	
TYPE OF DRILLING MUD	REVERT	
AUGER USED	X YES	NO
TYPE AND DIAMETER, IN.	TO START HOLE	

CASING HAMMER, LBS.		AVERAGE FALL, IN.	
*SAMPLER HAMMER, LBS.	140	AVERAGE FALL, IN.	30

*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					SEE PIEZOMETER SHEET.

PIEZOMETER INSTALLED X YES NO SKETCH SHOWN ON SEE SHEET NO. 2

STANDPIPE:	TYPE	PVC	ID, IN.	2	LENGTH, FT.	40	TOP ELEV.	37.5
INTAKE ELEMENT:	TYPE	PVC	OD, IN.	2	LENGTH, FT.	10	TIP ELEV.	-12.5
FILTER:	MATERIAL	SAND	OD, IN.	3-3/4	LENGTH, FT.	45	BOT. ELEV.	-12.5

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-09-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MRCE Form BS-1 **BORING NO.** B-102P

MUESER RUTLEDGE CONSULTING ENGINEERS
BORING LOG

BORING NO. B-103
SHEET 1 OF 2
FILE NO. 11594
SURFACE ELEV. 37.5
RES. ENGR. WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	2-4	Brown fine sandy silt, some gravel (Fill) (ML)	F		DRILLED	
08-16-11		1.5	4				AHEAD	
Thursday	2D	2.0	3-3	Brown silty fine sand, trace coarse sand			4"	
Clear to		3.5	4	(Fill) (SM)				
Partly Cloudy	3D	4.0	3-3	Do 2D (Fill) (SM)		5		
		5.5	3					
	4D	6.5	2-2	Top: Brown fine sandy silt, trace clay (ML)				
		8.0	4	Bot: Gray fine to medium sand, trace silt,				
				gravel (Fill) (SP-SM)		9		
	5D	9.0	3-3	Brown clayey fine sand (SC)	T2	10		
		10.5	2					
	6D	14.0	1-4	Dark brown clayey fine sand, trace gravel (SC)		15		Random gravel.
		15.5	10					
						17.5		
	7D	19.0	2-3	Medium brown fine sandy clay (CL)	T1(A)	20		WC=23
		20.5	3					
	8D	24.0	3-3	Do 7D (CL)		25		WC=22
		25.5	6					
	9D	29.0	3-6	Brown fine sandy silt, some clay (ML)		30		
		30.5	8					
						32		
	10D	34.0	5-6	Brown silty fine sand (SM)	T2	35		
		35.5	11					
						37		
	11D	39.0	25-37	Brown gravelly fine to coarse sand, some silt	T3	40		
		40.5	43	(SM)				
	12D	44.0	15-33	Brown gravelly fine to coarse sand, trace silt		45		WC=Water Content
		45.5	39	(SP-SM)				in percent of dry
								weight.
13:00	13D	48.5	43-57/6"	Do 12D (SP-SM)				
		49.5				49.5		End of Boring at 49.5'.

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-103
SHEET 2 OF 2
FILE NO. 11594
SURFACE ELEV. 37.5
DATUM NGVD 29

PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION WASHINGTON, DC
BORING LOCATION SEE BORING LOCATION PLAN

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG
TRUCK
SKID
BARGE
OTHER CME-750

TYPE OF FEED DURING CORING
MECHANICAL
HYDRAULIC X
OTHER

CASING USED [X] YES [ ] NO
DIA., IN. 4 DEPTH, FT. FROM 0 TO 9
DIA., IN. DEPTH, FT. FROM TO
DIA., IN. DEPTH, FT. FROM TO

TYPE AND SIZE OF:
D-SAMPLER 2" O. D. SPLIT SPOON
U-SAMPLER
S-SAMPLER
CORE BARREL
CORE BIT
DRILL RODS

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. AVERAGE FALL, IN.
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON

STANDPIPE: TYPE ID, IN. LENGTH, FT. TOP ELEV.
INTAKE ELEMENT: TYPE OD, IN. LENGTH, FT. TIP ELEV.
FILTER: MATERIAL OD, IN. LENGTH, FT. BOT. ELEV.

PAY QUANTITIES
3.5" DIA. DRY SAMPLE BORING LIN. FT. 50 NO. OF 3" SHELBY TUBE SAMPLES
3.5" DIA. U-SAMPLE BORING LIN. FT. NO. OF 3" UNDISTURBED SAMPLES
CORE DRILLING IN ROCK LIN. FT. OTHER:

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-16-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO. B-104
SHEET 1 OF 2
FILE NO. 11594
SURFACE ELEV. 33.8
RES. ENGR. WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	2-4	Brown fine sandy silt, trace roots, gravel, brick			DRILLED	
08-15-11		1.5	9	(Fill) (ML)			AHEAD	
Monday	2D	2.0	12-17	Brown fine sandy silt (Fill) (ML)			4"	Cemented.
Clear to		3.5	16					
Partly Cloudy	3D	4.0	8-9	Do 2D (Fill) (ML)	F	5		
		5.5	8					
	4D	6.5	5-7	Brown fine sandy silt, trace gravel, brick, clay				
		8.0	5	(Fill) (ML)				
						9		
	5D	9.0	11-8	Brown clayey fine sand, trace gravel (SC)		10		
		10.5	6					
	6D	14.0	3-3	Brown clayey fine sand (SC)		15		
		15.5	4		T2			
	7D	19.0	3-4	Do 6D (SC)		20		
		20.5	4					
						22.5		
	8D	24.0	3-4	Medium brown fine sandy clay (CL)		25		WC=20
		25.5	6		T1(A)			
						27.5		
	9D	29.0	6-6	Brown clayey fine sand (SC)		30		
		30.5	5					
					T2			
	10D	34.0	9-9	Brown fine sand, some silt, trace clay (SM)		35		
		35.5	9					
						37		
	11D	39.0	23-25	Brown gravelly fine to coarse sand, trace silt		40		
		40.5	17	(SP-SM)				
					T3			
	12D	44.0	16-35	Do 11D (SP-SM)		45		
		45.2	65/3"					WC=Water Content
								in percent of dry
								weight.
13:00	13D	48.5	70	Do 11D (SP-SM)				
		49.1	30/0.5"			49.1		End of Boring at 49.1'.

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-104
SHEET 2 **OF** 2
PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS **FILE NO.** 11594
LOCATION WASHINGTON, DC **SURFACE ELEV.** 33.8
BORING LOCATION SEE BORING LOCATION PLAN **DATUM** NGVD 29

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	X YES		NO
TRUCK		MECHANICAL		DIA., IN. 4	DEPTH, FT. FROM 0	TO	9
SKID		HYDRAULIC	X	DIA., IN.	DEPTH, FT. FROM	TO	
BARGE		OTHER		DIA., IN.	DEPTH, FT. FROM	TO	
OTHER	CME-750						

TYPE AND SIZE OF:
D-SAMPLER 2" O. D. SPLIT SPOON
U-SAMPLER
S-SAMPLER
CORE BARREL
CORE BIT
DRILL RODS

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. AVERAGE FALL, IN.
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON

STANDPIPE:	TYPE		ID, IN.		LENGTH, FT.		TOP ELEV.	
INTAKE ELEMENT:	TYPE		OD, IN.		LENGTH, FT.		TIP ELEV.	
FILTER:	MATERIAL		OD, IN.		LENGTH, FT.		BOT. ELEV.	

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-15-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MRCE Form BS-1 **BORING NO.** B-104

MUESER RUTLEDGE CONSULTING ENGINEERS
BORING LOG

BORING NO. B-105
SHEET 1 OF 2
FILE NO. 11594
SURFACE ELEV. 37.2
RES. ENGR. WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	2-6	Brown fine sandy silt, trace roots (Fill) (ML)			DRILLED	
08-12-11		1.5	5				AHEAD	
Friday	2D	2.0	3-2	Brown silty fine sand, trace roots (Fill) (SM)			4"	
Clear To		3.5	3					
Partly Cloudy	3D	4.0	2-2	Brown fine sandy silt, trace clay (Fill) (ML)		5		
		5.5	2		F			
	4D	6.5	9-5	Brown fine sandy silt, trace brick (Fill) (ML)				
		8.0	7					
	5D	9.0	3-10	Stiff brown fine sandy clay, some brick (Fill) (CL)		10		
		10.5	6					
						12.5		
	6D	14.0	3-5	Brown clayey fine sand (SC)		15		
		15.5	7					
	7D	19.0	3-3	Do 6D, trace gravel (SC)		20		
		20.5	4					
	8D	24.0	2-3	Brown clayey fine sand, trace gravel (SC)	T2	25		
		25.5	5					
	9D	29.0	4-6	Brown clayey fine sand (SC)		30		
		30.5	7					
	10D	34.0	4-3	Do 9D (SC)		35		Saturated.
		35.5	3					
						37		
	11D	39.0	37-40	Brown gravelly fine to coarse sand, trace silt		40		Possibly cemented.
		40.5	29	(SP-SM)				
					T3			
	12D	44.0	3-3	Brown gravelly fine to coarse sand, trace silt,		45		
		45.5	3	clay pocket (SP-SM)				
	13D	48.5	20-24	Brown gravelly fine to coarse sand, trace silt				
13:00		50.0	38	(SP-SM)		50		End of Boring at 50'.

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO.	B-105
SHEET	2 OF 2
FILE NO.	11594
SURFACE ELEV.	37.2
DATUM	NGVD 29

PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION WASHINGTON, DC
BORING LOCATION SEE BORING LOCATION PLAN

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	[X] YES [ ] NO			
TRUCK		MECHANICAL		DIA., IN.	4	DEPTH, FT. FROM	0	TO 9
SKID		HYDRAULIC	X	DIA., IN.		DEPTH, FT. FROM		TO
BARGE		OTHER		DIA., IN.		DEPTH, FT. FROM		TO
OTHER	CME-750							

TYPE AND SIZE OF:
D-SAMPLER 2" O. D. SPLIT SPOON
U-SAMPLER
S-SAMPLER
CORE BARREL
CORE BIT
DRILL RODS

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. ______ AVERAGE FALL, IN. ______
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON

STANDPIPE:	TYPE		ID, IN.		LENGTH, FT.		TOP ELEV.
INTAKE ELEMENT:	TYPE		OD, IN.		LENGTH, FT.		TIP ELEV.
FILTER:	MATERIAL		OD, IN.		LENGTH, FT.		BOT. ELEV.

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-08-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO. B-106P
SHEET 1 OF 3
FILE NO. 11594
SURFACE ELEV. 34.5
RES. ENGR. WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	3-11	Brown fine sandy silt, trace roots, brick (Fill) (ML)			DRILLED	
08-11-11		1.5	14				AHEAD	
Thursday	2D	2.0	12-14	Do 1D (Fill) (ML)			4"	
Clear To		3.5	6					
Partly Cloudy	3D	4.0	6-3	Do 1D (Fill) (ML)	F	5		
		5.5	2					
	4D	6.5	2-1					
		8.0	2	Brown clayey fine sand (Fill) (SC)				
	5D	9.0	4-8	Stiff brown silt, some fine sand, trace clay, brick		10		
		10.5	5	(CL)				
					T1(A)			
	6D	14.0	3-3	Medium brown fine sandy clay (CL)		15		WC=20
		15.5	4					
						17.5		
	7D	19.0	2-3	Brown clayey fine sand (SC)		20		
		20.5	4					
	8D	24.0	3-5	Brown clayey fine sand (SC)		25		
		25.5	6					
					T2			
	9D	29.0	3-6	Do 8D (SC)		30		
		30.5	9					
	10D	34.0	5-10	Brown fine sand, some silt, trace clay (SM)		35		
		35.5	30			35.5		
						38		
	11D	39.0	26-29	Brown gravelly fine to coarse sand, trace silt		40		
		40.5	37	(SP-SM)				
					T3			
	12D	44.0	57	Brown gravelly fine to coarse sand, some silt		45		
		45.0	63/6"	(SM)				WC=Water Content
								in percent of dry
								weight.
	13D	48.5	44-36	Brown gravelly fine to coarse sand, trace silt				
14:00		50.0	28	(SP-SM)		50		End of Boring at 50'.

MRCE Form BL-1

BORING NO. B-106P

Mueser Rutledge Consulting Engineers

14 Penn Plaza - West 34th Street
New York, NY 10122

PIEZOMETER RECORD

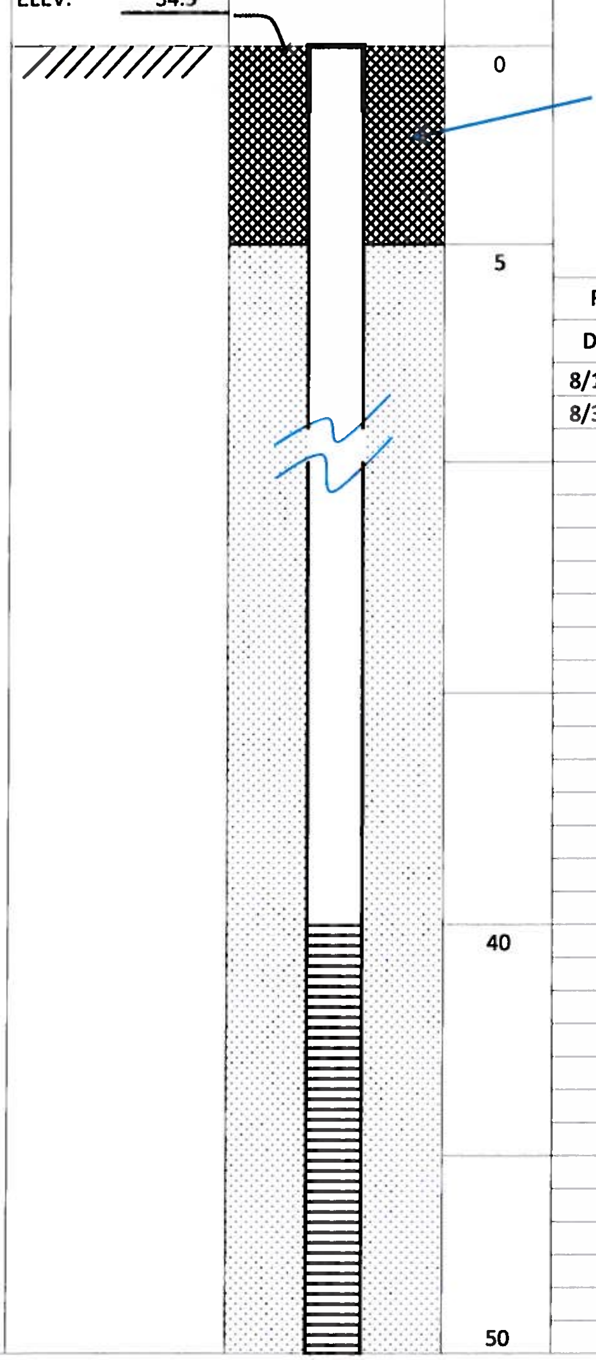
SHEET 2 OF 3
FILE NO. 11594
TASK NO.

MUESER RUTLEDGE CONSULTING ENGINEERS

PROJECT: Washington Monument Security Improvements
LOCATION: Washington D.C.
PIEZOMETER LOCATION: SEE BORING LOCATION PLAN
PIEZOMETER NO. B-106P
DATE OF INSTALLATION 8/11/2011
RESIDENT ENG. Bill Hobson

STRATA | PIEZOMETER INSTALLATION DETAILS | DEPTH (FT)

GROUND SURFACE
ELEV. 34.5



PIEZOMETER TYPE PVC

INTAKE POINT
depth to bottom, ft = 50
depth to top, ft = 40
length, ft = 10 = L
diameter, in = 2, ft = 0.17 = 2R

STANDPIPE/RISER
elevation of rim, ft = 34.5
diameter, in = 2, ft = 0.17 = 2r

READING TIME		DEPTH - RIM TO WATER	ELEVATION OF WATER	REMARKS
DATE	CLOCK			
8/12/11	8:10	37.1	-2.6	
8/31/11	7:00	37.0	-2.5	

SAND | GRAVEL | BENTONITE | GROUT

GROUND SURFACE ELEV. 34.5

PIEZOMETER NO. B-106P

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-106P
SHEET 3 **OF** 3
PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS **FILE NO.** 11594
LOCATION WASHINGTON, DC **SURFACE ELEV.** 34.5
BORING LOCATION SEE BORING LOCATION PLAN **DATUM** NGVD 29

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	X YES		NO
TRUCK		MECHANICAL		DIA., IN. 4	DEPTH, FT. FROM	0	TO 9
SKID		HYDRAULIC	X	DIA., IN.	DEPTH, FT. FROM		TO
BARGE		OTHER		DIA., IN.	DEPTH, FT. FROM		TO
OTHER	CME-750						

TYPE AND SIZE OF:

D-SAMPLER 2" O. D. SPLIT SPOON
U-SAMPLER
S-SAMPLER
CORE BARREL
CORE BIT
DRILL RODS

DRILLING MUD USED: [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED: [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. AVERAGE FALL, IN.
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					SEE PIEZOMETER SHEET.

PIEZOMETER INSTALLED [X] YES [ ] NO SKETCH SHOWN ON SEE SHEET NO. 2

STANDPIPE:	TYPE	PVC	ID, IN.	2	LENGTH, FT.	40	TOP ELEV.	34.5
INTAKE ELEMENT:	TYPE	PVC	OD, IN.	2	LENGTH, FT.	10	TIP ELEV.	-15.5
FILTER:	MATERIAL	SAND	OD, IN.	4	LENGTH, FT.	45	BOT. ELEV.	-15.5

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-11-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MRCE Form BS-1 **BORING NO.** B-106P

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO.	B-107
SHEET 1 OF	2
FILE NO.	11594
SURFACE ELEV.	37.1
RES. ENGR.	WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	2-3	Brown fine sandy silt, trace clay, roots (Fill) (ML)			DRILLED	Organic odor.
08-08-11		1.5	5				AHEAD	
Tuesday	2D	2.0	5-6	Do 1D (Fill) (ML)			4"	
Cloudy To		3.5	6				↓	
Clear	3D	4.0	4-4	Do 1D (Fill) (ML)		5	↓	
		5.5	4				↓	
	4D	6.5	8-3	Do 1D (Fill) (ML)	F		↓	
		8.0	4				↓	
							↓	
	5D	9.0	5-3	Medium brown silty clay, trace fine to coarse		10		WC=20
		10.5	3	sand (CL)				
						12.5		
	6D	14.0	6-2	Brown gravelly fine to coarse sand, some silt		15		
		15.5	3	(SM)				
	7D	19.0	2-2	Brown clayey fine to medium sand (SC)		20		
		20.5	3					
	8D	24.0	2-3	Do 7D (SC)	T2	25		
		25.5	6					
	9D	29.0	5-5	Do 7D (SC)		30		Saturated.
		30.5	7					
	10D	34.0	4-4	Brown silty fine sand (SM)		35		
		35.5	9					
						37		
	11D	39.0	25-23	Brown fine to coarse sand, some gravel, trace	T3	40		
		40.5	28	silt (SP-SM)				
						43		
	12D	44.0	3-4	Dark gray silty fine sand, trace gravel (SM)		45		
		45.5	8					WC=Water Content
					T1(D)			in percent of dry
								weight.
	13D	48.5	4-2	Dark gray silty fine sand, trace clay (SM)				
13:00		50.0	2			50		End of Boring at 50'.

MRCE Form BL-1

BORING NO. B-107

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-107
SHEET 2 OF 2

PROJECT	WASHINGTON MONUMENT SECURITY IMPROVEMENTS	FILE NO.	11594
LOCATION	WASHINGTON, DC	SURFACE ELEV.	37.1
BORING LOCATION	SEE BORING LOCATION PLAN	DATUM	NGVD 29

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	[X] YES [ ] NO			
TRUCK		MECHANICAL		DIA., IN.	4	DEPTH, FT. FROM	0	TO 9
SKID		HYDRAULIC	X	DIA., IN.		DEPTH, FT. FROM		TO
BARGE		OTHER		DIA., IN.		DEPTH, FT. FROM		TO
OTHER	CME-750							

TYPE AND SIZE OF:

D-SAMPLER	2" O. D. SPLIT SPOON	DRILLING MUD USED	[X] YES [ ] NO
U-SAMPLER		DIAMETER OF ROTARY BIT, IN.	3-3/4
S-SAMPLER		TYPE OF DRILLING MUD	REVERT
CORE BARREL		AUGER USED	[X] YES [ ] NO
CORE BIT		TYPE AND DIAMETER, IN.	TO START HOLE
DRILL RODS			

CASING HAMMER, LBS. ______ AVERAGE FALL, IN. ______
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON

STANDPIPE:	TYPE		ID, IN.		LENGTH, FT.		TOP ELEV.	
INTAKE ELEMENT:	TYPE		OD, IN.		LENGTH, FT.		TIP ELEV.	
FILTER:	MATERIAL		OD, IN.		LENGTH, FT.		BOT. ELEV.	

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-08-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MRCE Form BS-1

BORING NO. B-107

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

PROJECT:	WASHINGTON MONUMENT SECURITY IMPROVEMENTS	BORING NO.	B-108
LOCATION:	WASHINGTON, DC	SHEET 1 OF	2
		FILE NO.	11594
		SURFACE ELEV.	38.0
		RES. ENGR.	WILLIAM HOBSON

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	5-12	Brown fine to coarse sandy silt, trace gravel			DRILLED	
08-05-11		1.5	18	(Fill) (ML)			AHEAD	
Thursday	2D	2.0	12-10	Brown silty gravel, some fine to coarse sand			4"	
Cloudy To		3.5	7	(Fill) (GM)				
Clear	3D	4.0	5-4	Brown fine to coarse sandy silt (Fill) (ML)		5		
		5.5	7		F			
	4D	6.5	11-3	Brown clayey fine to coarse sand, trace gravel				
		8.0	3	(Fill) (SC)				
								Pushing a large piece
	5D	9.0	25-31	Brown clayey gravel, some fine to coarse sand		10		of gravel.
		10.5	6	(Fill) (GC)				
						12		
	6D	14.0	5-2	Medium brown silty clay, some fine sand, trace	T1(A)	15		WC=25
		15.5	3	gravel (CL)				
						17.5		
	7D	19.0	3-2	Brown clayey fine to medium sand (SC)		20		
		20.5	3					
	8D	24.0	3-6	Brown clayey fine sand (SC)		25		
		25.5	7					
					T2			
	9D	29.0	4-4	Brown clayey fine sand (SC)		30		
		30.5	7					
	10D	34.0	5-6	Brown silty fine sand, trace clay (SM)		35		
		35.5	7					
						38		
	11D	39.0	15-41	Brown gravelly fine to coarse sand, some		40		
		40.5	12	clay (SC)				
					T3			
	12D	44.0	16-7	Do 11D (SC)		45		WC=Water Content
		45.5	4					in percent of dry
								weight.
14:30	13D	48.5	81-19/1"	Brown gravelly fine to coarse sand, some				Contains either decom-
		49.1		silt (SM)		49.1		posed rock or decom-
								posed pieces of gravel.
								End of Boring at 49.1'.

MRCE Form BL-1

BORING NO. B-108

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-108
SHEET 2 OF 2
FILE NO. 11594
SURFACE ELEV. 38.0
DATUM NGVD 29

PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION WASHINGTON, DC
BORING LOCATION SEE BORING LOCATION PLAN

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING	
TRUCK		MECHANICAL	
SKID		HYDRAULIC	X
BARGE		OTHER	
OTHER	CME-750		

CASING USED [X] YES [ ] NO

DIA., IN.	DEPTH, FT. FROM	TO
4	0	9

TYPE AND SIZE OF:

D-SAMPLER	2" O. D. SPLIT SPOON
U-SAMPLER	
S-SAMPLER	
CORE BARREL	
CORE BIT	
DRILL RODS	

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. ____ AVERAGE FALL, IN. ____
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON ____

STANDPIPE:	TYPE		ID, IN.		LENGTH, FT.		TOP ELEV.	
INTAKE ELEMENT:	TYPE		OD, IN.		LENGTH, FT.		TIP ELEV.	
FILTER:	MATERIAL		OD, IN.		LENGTH, FT.		BOT. ELEV.	

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-05-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO.	B-109
SHEET 1 OF	2
FILE NO.	11594
SURFACE ELEV.	32.8
RES. ENGR.	WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS

LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:00	1D	0.0	9-8	Dark brown fine sandy silt, trace gravel (Fill) (ML)			DRILLED	
08-17-11		1.5	21				AHEAD	
Wednesday	2D	2.0	21-21	Brown fine sandy silt, some gravel (Fill) (ML)			4"	
Clear To		3.5	9					
Partly Cloudy	3D	4.0	4-4	Brown silt, some fine sand (Fill) (ML)	F	5		
		5.5	4					
	4D	6.5	3-4	Brown clayey silt, some fine sand (Fill) (ML)				
		8.0	3					
						9		
	5D	9.0	2-2	Brown silty fine sand, trace clay (SM)		10		
		10.5	3					
					T2			
	6D	14.0	3-3	Brown clayey fine sand (SC)		15		
		15.5	4					
						17.5		
	7D	19.0	3-7	Stiff brown fine sandy clay (CL)		20		
		20.5	5		T1(A)			
						22.5		
	8D	24.0	4-5	Brown silty fine sand, trace gravel, clay (SM)		25		
		25.5	6					
					T2			
	9D	29.0	4-5	Brown clayey fine sand, trace silt (SC)		30		
		30.5	6					
						32		
	10D	34.0	42-58/6"	Brown gravelly fine to coarse sand, trace silt		35		
		35.0		(SP-SM)				
	11D	39.0	22-27	Do 10D (SP-SM)		40		
		40.5	24		T3			
	12D	44.0	26-33	Do 10D (SP-SM)		45		
		45.5	39					
	13D	48.5	39-30	Do 10D (SP-SM)				
13:00		50.0	45			50		End of Boring at 50'.

MRCE Form BL-1

BORING NO. B-109

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-109
SHEET 2 OF 2
FILE NO. 11594
SURFACE ELEV. 32.8
DATUM NGVD 29

PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION WASHINGTON, DC
BORING LOCATION SEE BORING LOCATION PLAN

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED		[X] YES	[ ] NO
TRUCK		MECHANICAL		DIA., IN.	4	DEPTH, FT. FROM 0	TO 9
SKID		HYDRAULIC	X	DIA., IN.		DEPTH, FT. FROM	TO
BARGE		OTHER		DIA., IN.		DEPTH, FT. FROM	TO
OTHER	CME-750						

TYPE AND SIZE OF:
D-SAMPLER 2" O. D. SPLIT SPOON
U-SAMPLER
S-SAMPLER
CORE BARREL
CORE BIT
DRILL RODS

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. AVERAGE FALL, IN.
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					NO WATER LEVEL OBSERVATIONS MADE.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON

STANDPIPE:	TYPE	ID, IN.		LENGTH, FT.		TOP ELEV.	
INTAKE ELEMENT:	TYPE	OD, IN.		LENGTH, FT.		TIP ELEV.	
FILTER:	MATERIAL	OD, IN.		LENGTH, FT.		BOT. ELEV.	

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-17-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MUESER RUTLEDGE CONSULTING ENGINEERS
BORING LOG

BORING NO. B-110P
SHEET 1 OF 3
FILE NO. 11594
SURFACE ELEV. 37.8
RES. ENGR. WILLIAM HOBSON

PROJECT: WASHINGTON MONUMENT SECURITY IMPROVEMENTS
LOCATION: WASHINGTON, DC

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
07:30	1D	0.0	3-5	Brown fine sandy silt, some gravel, trace brick			DRILLED	
08-10-11		1.5	8	(Fill) (ML)			AHEAD	
Thursday	2D	2.0	7-7	Brown fine sandy silt (Fill) (ML)			4"	
Clear To		3.5	7					
Partly Cloudy	3D	4.0	5-2	Brown fine sandy silt, trace gravel (Fill) (ML)		5		
		5.5	3					
	4D	6.5	2-2	Brown fine sandy silt, trace clay (Fill) (ML)				
		8.0	3					
	5NR	9.0	3-1	No recovery	F	10		
		10.5	2					
	6D	11.5	1-2	Brown & black fine sandy silt, trace clay				
		13.0	3	(Fill) (ML)				
								From 14' to 16.5', lost
	7D	14.0	10-6	Brown & black fine to coarse sand, some silt,		15		1.5 tubs of drilling mud.
		15.5	5	trace gravel (Fill) (SM)				7D: WC=20
						18		
	8D	19.0	2-1	Soft brown fine sandy clay, trace gravel (CL)		20		
		20.5	2					
					T1(A)			
	9D	24.0	4-4	Brown fine sandy silt, trace clay (ML)		25		
		25.5	6					
						28		
	10D	29.0	4-4	Brown clayey fine sand, trace gravel (SC)		30		
		30.5	5					
					T2			
	11D	34.0	5-5	Brown silty fine sand, trace clay (SM)		35		
		35.5	15					
	12D	39.0	35-65/2"	Brown gravelly fine to coarse sand, trace silt		40		
		39.7		(SP-SM)				
					T3			
	13D	44.0	3-3	Brown & gray gravelly fine to coarse sand,		45		
		45.5	3	some clay (SC)				WC=Water Content
								in percent of dry
								weight.
	14D	48.5	22-75	Brown fine to coarse sand, some gravel,				
14:20		50.0	33	trace clay (SP-SC)		50		End of Boring at 50'.

BORING NO. B-110P

Mueser Rutledge Consulting Engineers
14 Penn Plaza - West 34th Street
New York, NY 10122

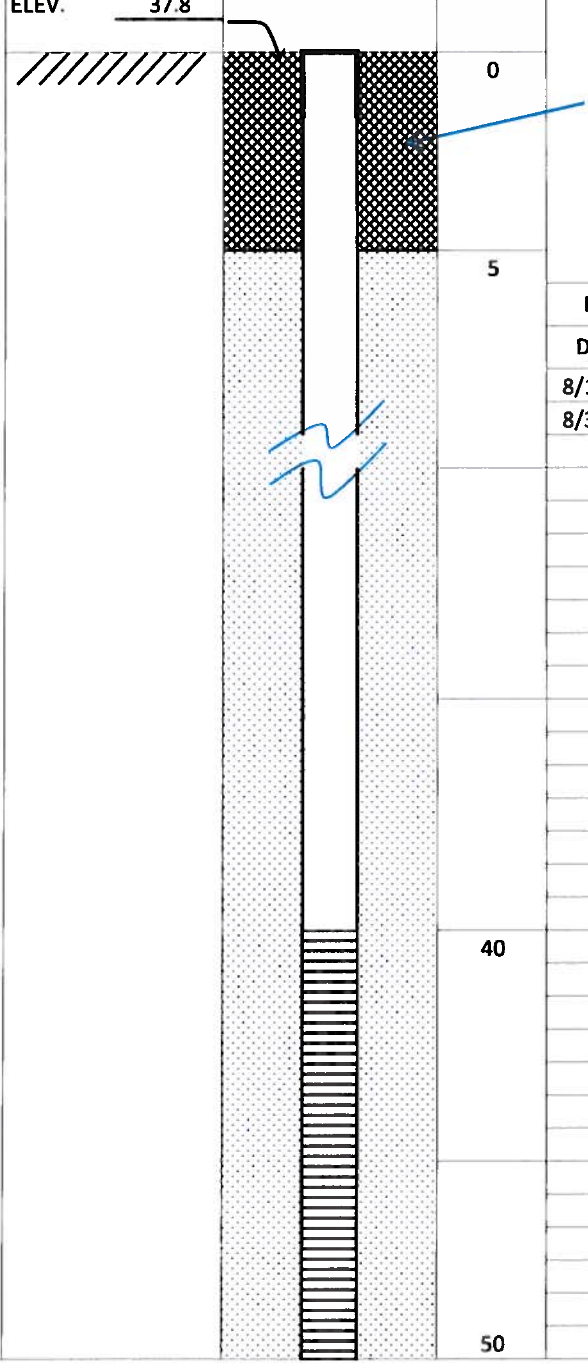
PIEZOMETER RECORD

SHEET 2 OF 3
FILE NO. 11594
TASK NO.

MUESER RUTLEDGE CONSULTING ENGINEERS

PROJECT: Washington Monument Security Improvements
PIEZOMETER NO. B-110P
LOCATION: Washington D.C.
PIEZOMETER LOCATION: SEE BORING LOCATION PLAN
DATE OF INSTALLATION 8/10/2011
RESIDENT ENG. Bill Hobson

STRATA	PIEZOMETER INSTALLATION DETAILS	DEPTH (FT)
GROUND SURFACE ELEV. 37.8		



PIEZOMETER TYPE PVC

INTAKE POINT
depth to bottom, ft = 50
depth to top, ft = 40
length, ft = 10 = L
diameter, in = 2 , ft = 0.17 = 2R

STANDPIPE/RISER
elevation of rim, ft = 37.8
diameter, in = 2 , ft = 0.17 = 2r

READING TIME		DEPTH - RIM TO WATER	ELEVATION OF WATER	REMARKS
DATE	CLOCK			
8/12/11	8:30	38.4	-0.6	
8/31/11	8:00	42.7	-4.9	

SAND
GRAVEL
BENTONITE
GROUT

GROUND SURFACE ELEV. 37.8

PIEZOMETER NO. B-110P

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING NO. B-110P
SHEET 3 **OF** 3
PROJECT WASHINGTON MONUMENT SECURITY IMPROVEMENTS **FILE NO.** 11594
LOCATION WASHINGTON, DC **SURFACE ELEV.** 37.8
BORING LOCATION SEE BORING LOCATION PLAN **DATUM** NGVD 29

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED	X YES	NO	
TRUCK		MECHANICAL		DIA., IN. 4	DEPTH, FT. FROM 0	TO 9	
SKID		HYDRAULIC	X	DIA., IN.	DEPTH, FT. FROM	TO	
BARGE		OTHER		DIA., IN.	DEPTH, FT. FROM	TO	
OTHER	CME-750						

TYPE AND SIZE OF:
D-SAMPLER 2" O. D. SPLIT SPOON
U-SAMPLER
S-SAMPLER
CORE BARREL
CORE BIT
DRILL RODS

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN. 3-3/4
TYPE OF DRILLING MUD REVERT

AUGER USED [X] YES [ ] NO
TYPE AND DIAMETER, IN. TO START HOLE

CASING HAMMER, LBS. ____ AVERAGE FALL, IN. ____
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*AUTOMATIC HAMMER

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
					SEE PIEZOMETER SHEET.

PIEZOMETER INSTALLED [X] YES [ ] NO SKETCH SHOWN ON SHEET NO. 2

STANDPIPE:	TYPE	PVC	ID, IN.	2	LENGTH, FT.	40	TOP ELEV.	37.8
INTAKE ELEMENT:	TYPE	PVC	OD, IN.	2	LENGTH, FT.	10	TIP ELEV.	-12.2
FILTER:	MATERIAL	SAND	OD, IN.	3-3/4	LENGTH, FT.	45	BOT. ELEV.	-12.2

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	50	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.		OTHER:	

BORING CONTRACTOR GEOSERVICES, INC.
DRILLER JAMES BEAVERS HELPERS BRIAN ROBERTSON
REMARKS BOREHOLE BACKFILLED WITH BENTONITE PELLETS UPON COMPLETION.
RESIDENT ENGINEER WILLIAM HOBSON DATE 08-09-11
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: CHERYL J. MOSS

MRCE Form BS-1 **BORING NO.** B-110P

APPENDIX B

Mueser Rutledge
Consulting Engineers
14 Penn Plaza · 225 West 34th Street · New York, NY 10122
Tel: (917) 339-9300 · Fax: (917) 339-9400
www.mrce.com

MEMORANDUM

To: Jill Cavanaugh, Beyer Blinder Belle Architects & Planners LLP
From: James Go and Michael Law
Re: Finite Element Analysis of Proposed Excavation
Washington Monument Security Improvements
Washington, DC
File: MRCE File No. 11594
Date: November 18, 2011

In accordance with our proposal dated April 1, 2011, Mueser Rutledge Consulting Engineers (MRCE) performed an engineering study to evaluate the impact of the proposed excavation (Alternative A1) near the Washington Monument (the "Monument"). This memorandum summarizes our assumptions, methodology, and results of our study.

PROJECT BACKGROUND

The current project aims to provide security improvements to the Monument in the form of a visitor screening facility. Multiple alternatives are being considered for the security improvements, all of which involve the construction of a screening facility on the Monument grounds and a means for screened visitors to access the Monument in a secure fashion.

Beyer Blinder Belle Architects & Planners LLP (BBB) provided us information regarding the various alternatives for the security improvements and requested us to consider Alternatives A1 and A4. Both alternatives, A1 and A4, include a below grade screening facility and excavation/regrading east of the Monument. Based on the close proximity of the excavation to the Monument and the larger volume of proposed excavation, we judged that Alternative A1 would have a more significant impact on the Monument than Alternative A4 and was therefore selected for this study.

AVAILABLE INFORMATION

We reviewed available geotechnical data and foundation details to perform our study. The following reports, survey data, and structural calculations were specifically used in our study:

- A topographic survey of the site prepared by Dewberry, dated December 6, 2010
- A report titled Subsurface Investigation, Monument Grounds and Visitor Facility, Washington Monument, Washington, DC, dated June 2, 2002, prepared by Mueser Rutledge Consulting Engineers for Olin Partnership and Hartman Cox Architects. This report incorporates earlier reports by MRCE
- A paper titled The Washington Monument Case History dated August 28, 2009 written by J. Briaud, B. Smith, K. Rhee, H. Lacy, and J. Nicks and published by the International Journal of Geoengineering Case Histories Volume 1, Issue 3, pp 170-188
- An undated load takedown spreadsheet provided to us by Silman Associates on September 19,2011

- The complete list of available information is summarized in our subsurface investigation report (MRCE, 2011).

SITE DESCRIPTION & SUBSURFACE CONDITIONS

The Washington Monument is located on a grassy knoll on the National Mall between Constitution and Independence Avenues, between 15th and 17th Streets. The Monument grounds have been regraded on several occasions, the most recent being in the early 2000s. The Monument is surrounded by a plaza consisting of granite pavers. The elevation of the plaza is approximately Elev. 39 referenced to National Geodetic Vertical Datum of 1929 (NGVD 29), a mean sea level datum. In general, grades tend to be sloped one foot or less within 150 feet of the Monument, and sloped one to two feet within 150 to 200 feet from the Monument. A detailed discussion of the subsurface conditions, as well as boring logs and laboratory tests can be found in the 2002 and 2011 MRCE Subsurface Investigation Reports.

WASHINGTON MONUMENT DETAILS

Completed in 1884, the Monument is an obelisk standing 555.5 ft tall and is made of marble, granite, and bluestone gneiss. Construction of the Monument started in 1843 and by 1854, the shaft had reached a height of 152 ft above the top of the foundations. The original foundation was built in pyramidal shape with stepped sides, made of blue gneiss blocks set in a mortar of hydraulic cement, stone, lime, and sand. The pyramidal foundation was 23 ft high and 80 feet square at its base. From 1854 to 1878, construction of the Monument did not progress much and by 1876, the Corps of Engineer investigating board concluded that the proposed height of the structure must be reduced due to excessive pressures on the existing foundation. Upon the advice of a second board, an underpinning operation was carried out between late 1879 and June 1880 which involved placing concrete pads 13.5 ft thick and required excavation of over 70 percent of the original base area of the pyramidal foundations. The concrete underpinning was extended 23 ft beyond the original base on all sides and provides a bearing area of 16,000 sq. ft. From 1880 to 1881, fill was placed around the Monument to form a terrace to bring the ground level up to the top of the foundation. Construction of the shaft then resumed until completion in 1884. A detailed description of the site history including measured settlements can be found in the 2002 MRCE Subsurface Investigation Report.

PROPOSED ALTERNATIVE A1

Figure 1a shows the conceptual drawing of Alternative A1 by BBB. This alternative includes a recessed east entry below the plaza and a tunnel approximately 12 to 24 ft wide x 150 ft long x 15 ft deep leading to the Monument. The recessed entry would require a semi-circular asymmetric excavation from 120 ft to 150 ft east of the Monument. The recessed entry is composed of mirror-image 13-ft wide ramps starting at existing grade east of the excavation, dropping down approximately 6 ft to the north and south, and then make a 180-degree turn and dropping down another 8 ft to the tunnel entrance (see Figure 1b).

FINITE ELEMENT ANALYSIS

To evaluate the impact of the proposed excavation on the Monument, we performed a numerical study using the three-dimensional finite element (FE) program PLAXIS 3D Foundation. The program allows for 3D deformation analysis of foundation structures and allows for simulation of stresses and strains experienced by the subsurface soils to the phased construction of the Monument and excavation for the recessed entry. We also performed a preliminary two-dimensional FE analysis using PLAXIS 2D assuming plain strain conditions. However, due to the 3D nature of the excavation, we judged that a 3D analysis is more appropriate and thus presented in this memorandum.

Finite Element Model

Figure 2 shows the idealized 3D FE model and an east-west section of the Monument foundation and the surrounding Monument grounds. Fifteen node quadratic wedge elements were used to model both the subsurface soils and Monument foundation with finer elements in the vicinity of the Monument foundation. With the Monument at the center, the model extends approximately 1,000 ft wide, 1,000 ft long, and 118 ft deep to minimize boundary effects. Vertical boundaries were restrained along the horizontal normal to the boundary, while the bottom of the model was restrained in all directions (x, y, and z). The pyramidal Monument foundation is modeled explicitly using quadrilateral elements, while above ground portion of the Monument is represented as a distributed load acting on the top of the foundation based on the dead load provided by Silman Associates.

The uppermost fill varies in thickness from 12 ft to 25 ft forming a mound at the Monument. The ground surface elevations in the model generally follow the 2010 topographic survey. The underlying strata considered in our analysis were of uniform thickness consisting of 13.5 ft of Stratum T2/T1(A), 24 ft of Stratum T3, 40 ft of T1(D), and 15 ft of Stratum D. The groundwater table was conservatively taken to be at Elev.0. The Monument foundation is supported directly on Stratum T3 and is underlain by Strata T1(D) and D.

Material Properties

To describe the soil and rock behaviors, we used the linear elastic model for Strata F, T1(A)/T2, and D and the Monument foundation, and the Hardening Soil (HS) model for Strata T3 and T1(D). The HS model features a stress-dependent stiffness and an unload/reload response for more realistic estimates of Strata T3 and T1(D) material response. Tables 1 and 2 summarize the material properties assumed in our analysis. We selected the material properties based on the in-house and published geotechnical data, laboratory test results, and empirical correlations. Since most of the settlement/swelling response would come from Stratum T1(D), we calibrated our HS model using laboratory consolidation tests data. We first corrected the laboratory test data using the Schmertmann (1955) graphical procedure to account for sample disturbance. The corrected consolidation parameters (C_C and C_S) were then used to calibrate the Stratum T1(D) HS model in PLAXIS. Figure 3 shows the actual laboratory test data, Schmertmann corrected data, and calibrated PLAXIS HS model.

Initial Stresses and Calculation Phases

Phased analyses were performed to simulate an in-situ stress state of the FE model. Figure 4 shows the initial phase of our FE model which consists of Strata T2/T1(A), T3, T1(D), and D. The model was first brought to equilibrium under geostatic K_o conditions. To simulate the overconsolidated nature of Stratum T1(D), we applied a uniform aerial load of 7.5 ksf at the surface (see Figure 5) and then removed the load to simulate an OCR profile of 2 to 3 for Stratum T1(D) as measured in our previous subsurface investigation (see Figure 6).

The next several phases consisted of constructing and loading the original foundation (see Figure 7), underpinning of the original foundation (see Figure 8), building of the mound and increasing the load to the current level (see Figure 9). The calculation phases followed the actual sequence of the Monument as described in the previous section. Figure 10 shows the current in-situ vertical effective stress (σ'_v) used in our analysis (before excavation). To keep track of the induced deformations due to the proposed excavation, displacements were reset to zero prior to simulation of excavation.

Calculation Results

As the design is still in the conceptual stage, the depth and geometry for the excavation were approximated in this study. The excavated volume takes into account the net reduction of loads due to the excavated soil, the weight of the structure, and backfilled soil at the end of construction. Deformations such as heaving or settlement at the edges of the base of the Monument (see Figure 11) were monitored in the model and the differential settlement along the east-west direction of the Monument was calculated. Excavation was performed in stages, first excavating the tunnel, and then the recessed entry.

Figure 12 shows the excavation for the tunnel. Figure 13 shows the vertical displacements due to the excavation for the tunnel. Results of our analysis indicate that the edge of the monument foundation closest to the excavation (Point A) will heave on the order of 0.2 inch (upward) while the edge of the monument foundation furthest from the excavation (Point B) will have negligible movement. Differential settlement due to this stage of excavation along the base of the foundation is on the order of 0.01% (0.01/100).

Figure 14 shows the excavation for the tunnel and recessed entrance for Alternative A1. Figure 15 shows the vertical displacements due to the excavation for the tunnel and recessed entrance for the assumed soil profile. Results of our analysis indicate that the edge of the monument foundation closest to the excavation (Point A) will heave on the order of 0.4 inch (upward) while the edge of the monument foundation furthest from the excavation (Point B) will settle on the order of 0.1 inch (downward). Differential settlement along the base of the foundation is on the order of 0.03% (0.03/100). We expect 90% of the movements to occur during the relatively short duration of construction.

We note that the settlement and heave estimates are based upon a uniform subsurface profile, average soil parameters obtained from a limited number of laboratory tests, and an excavation geometry based on a conceptual scheme. We recommend that the settlement and heave estimates be revised once the final scheme is selected and that parametric studies be performed to determine sensitivity to soil parameters and stratification.

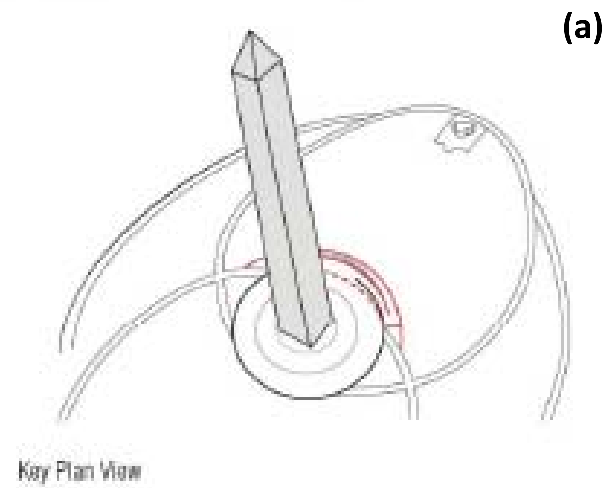


Figure 1. a) Conceptual drawing of Alternative A1 by BBB

b) Cross section along direction of ramps.

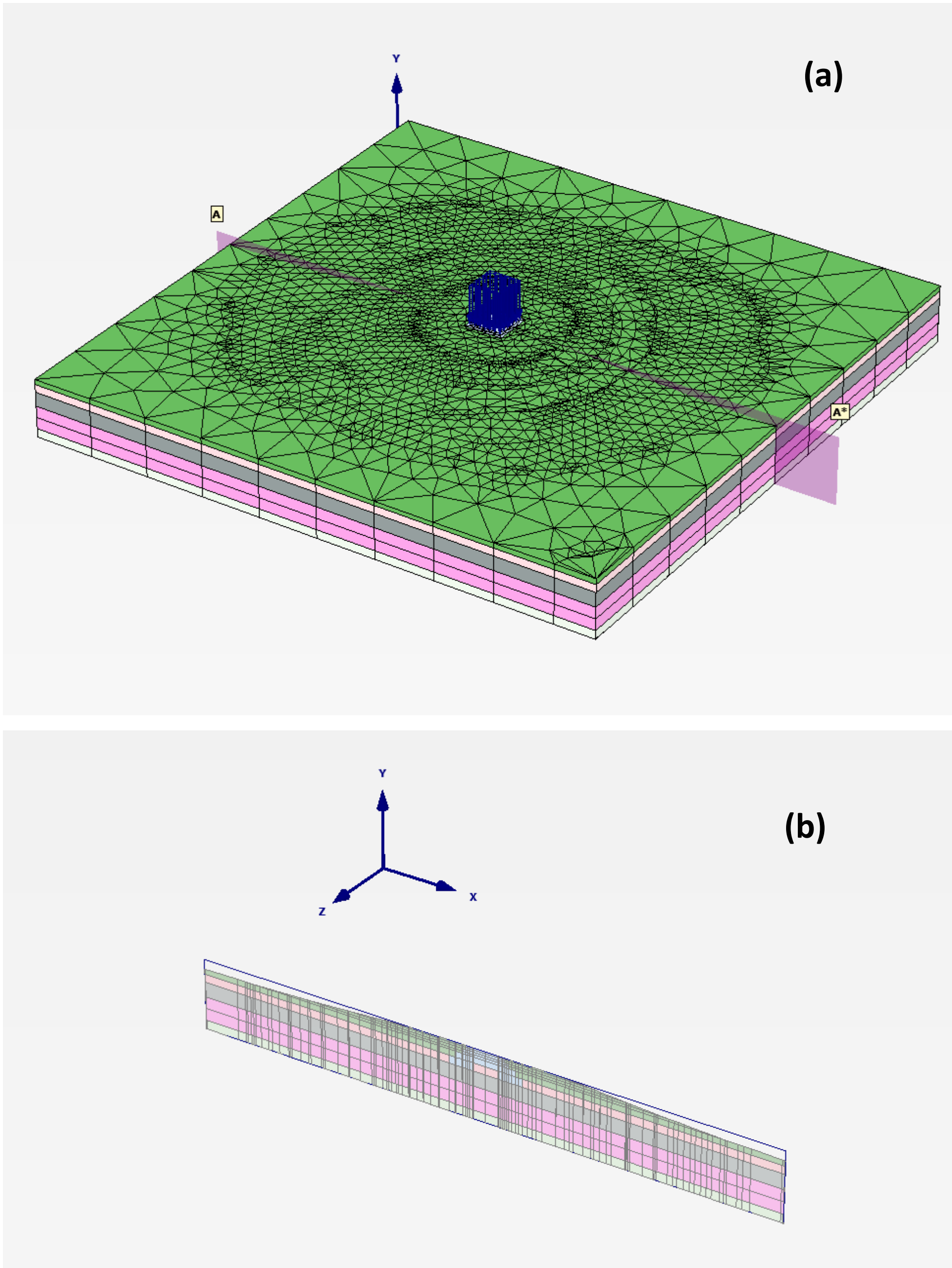


Figure 2. Finite Element Model: a) 3D Model, b) section along east-west direction.

Table 1. Summary of Linear Elastic Material Properties – Strata F, T2, D, and Monument Foundation.

Stratum	γ (lb/ft^3)	ν	E (ksf)
Fill	130	0.30	380
Stratum T2	130	0.30	515
Stratum D	150	0.20	60,000
Masonry	150	0.20	570,000

γ: Unit weight
ν: Poisson's Ratio
E: Young's Modulus

Table 2. Summary of Hardening Soil Material Properties – Strata T1(D) and T3.

Stratum	γ (lb/ft^3)	E_{50ref} (ksf)	E_{oedref} (ksf)	E_{urref} (ksf)	c' (ksf)	ϕ (°)	ψ (°)	ν_{ur}	power (m)
Stratum T1(D)	130	18	15	62	0	28	0	0.20	1.0
Stratum T3	130	550	370	1,650	0	36	0	0.20	0.5

γ: Unit weight
ν_{ur}: Poisson's Ratio
E_{50ref}, E_{oedref}, E_{urref}, m: PLAXIS HS Parameters
c': Effective cohesion
ϕ: Effective friction angle

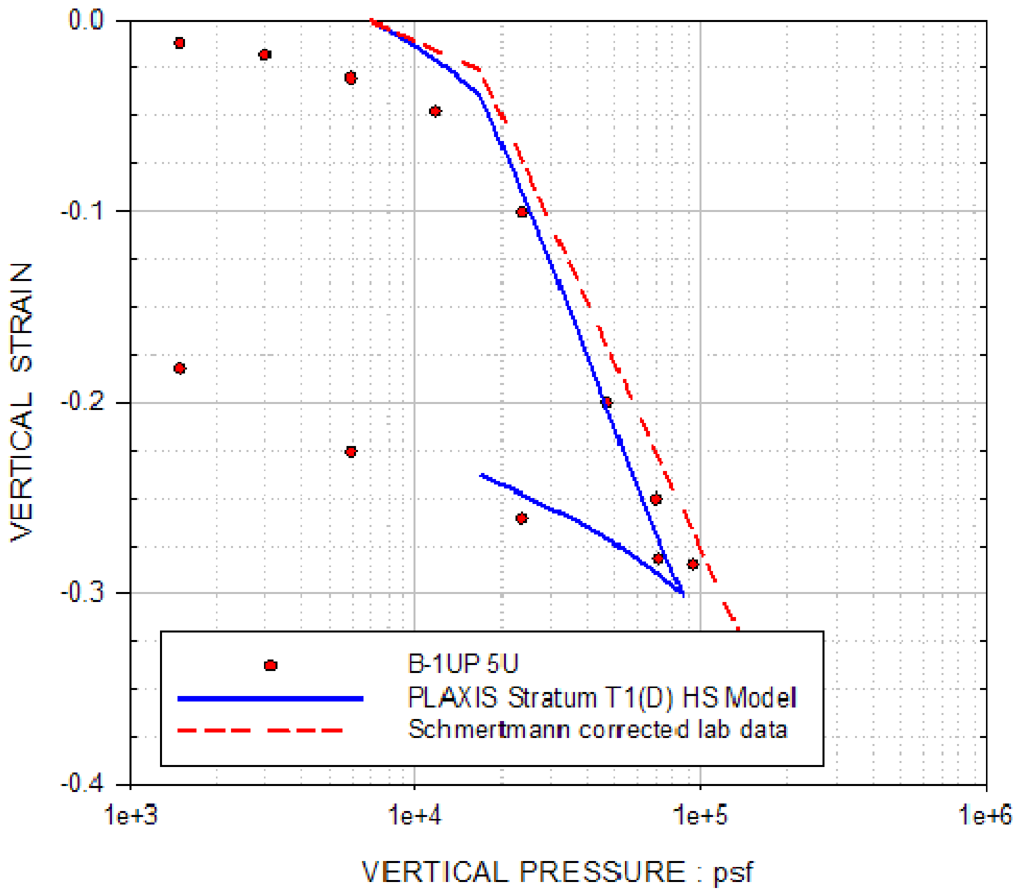


Figure 3. Calibration of PLAXIS Stratum T1(D) HS model.

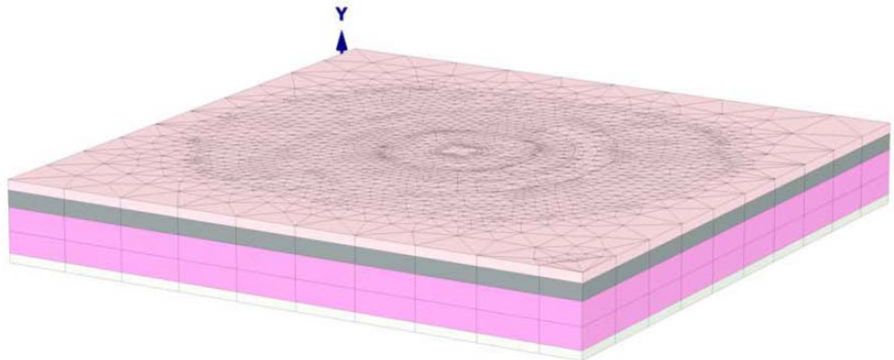


Figure 4. Initial FE Model

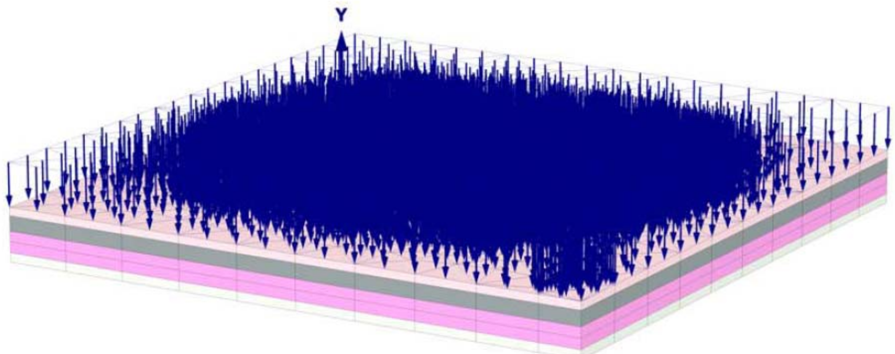


Figure 5. 7.5 ksf initial load.

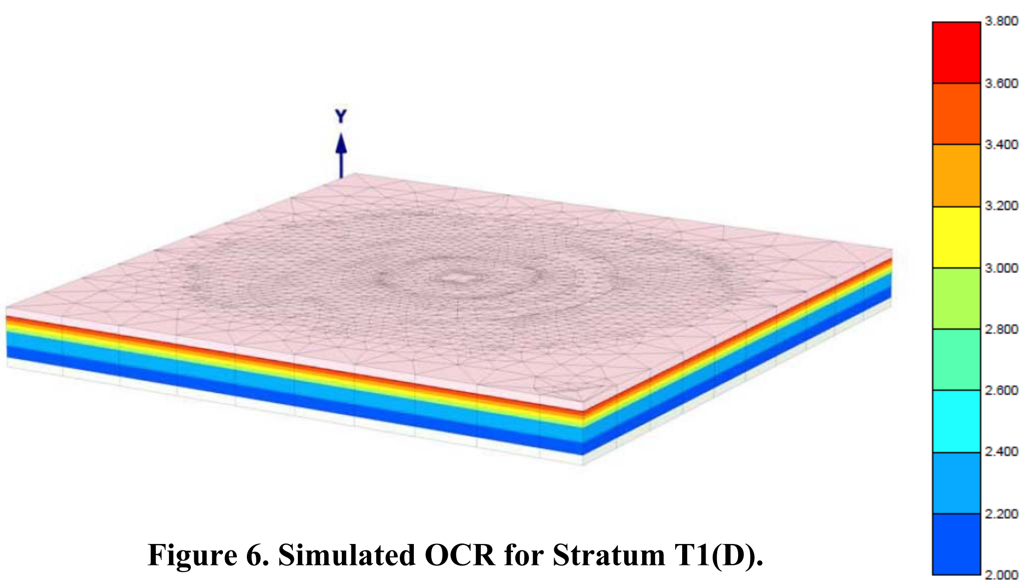


Figure 6. Simulated OCR for Stratum T1(D).

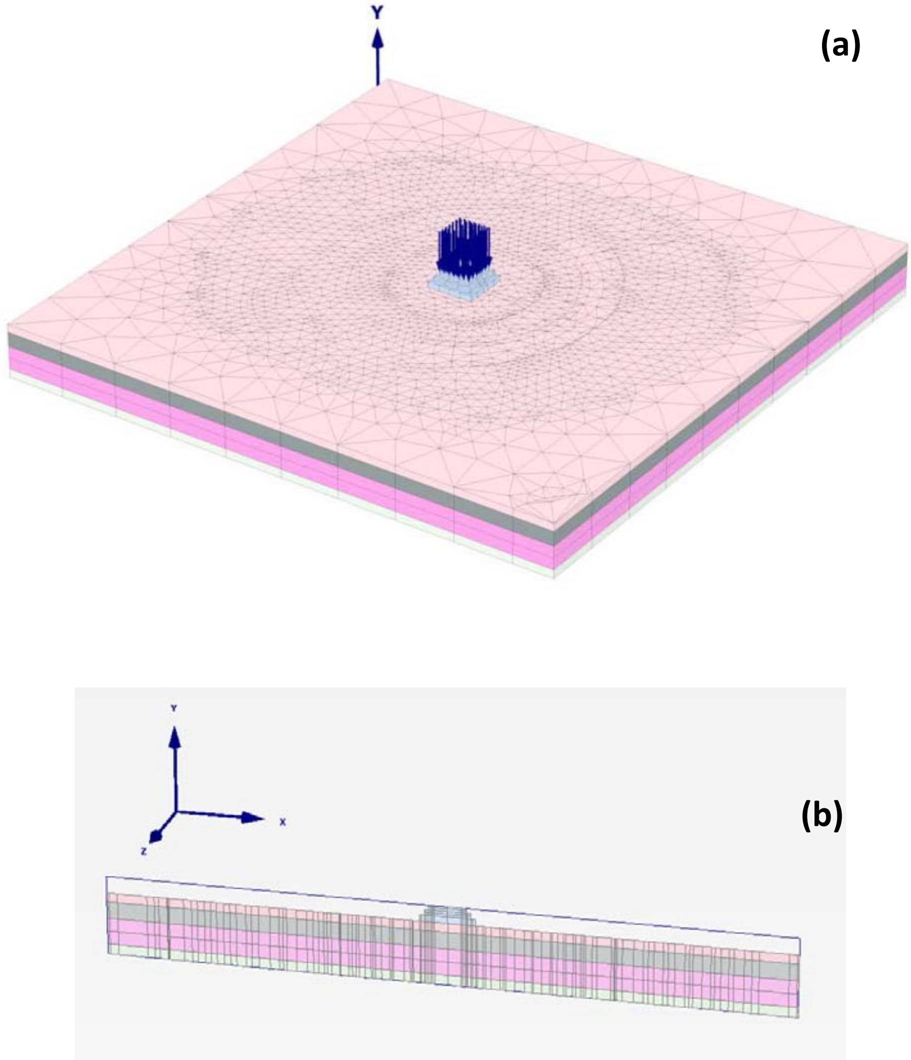
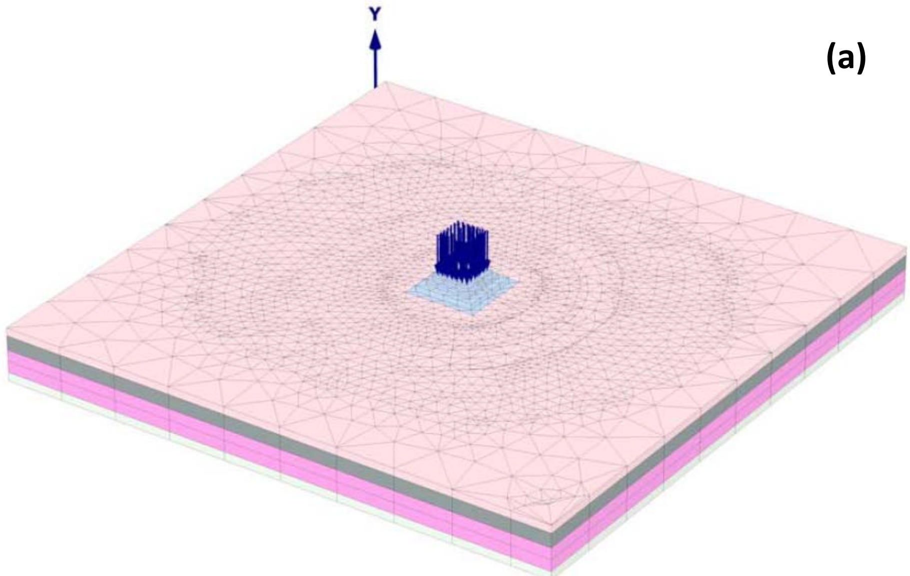


Figure 7. Construct original foundation: a) 3D view; b) section along east-west of Monument.



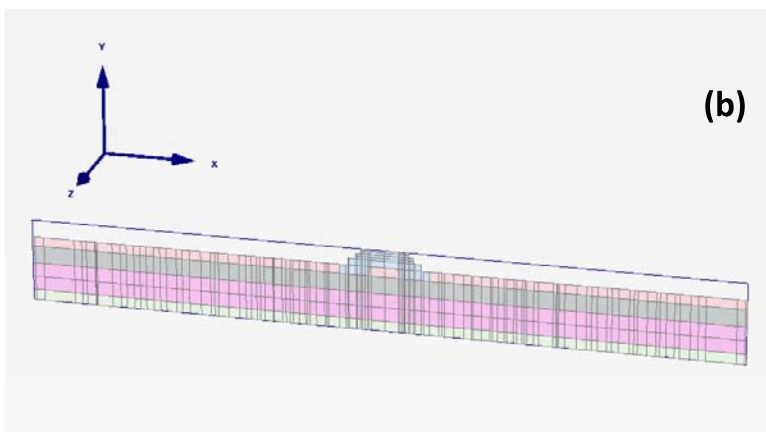


Figure 8. Underpinning of Monument foundation: a) 3D view; b) section along east-west of Monument.

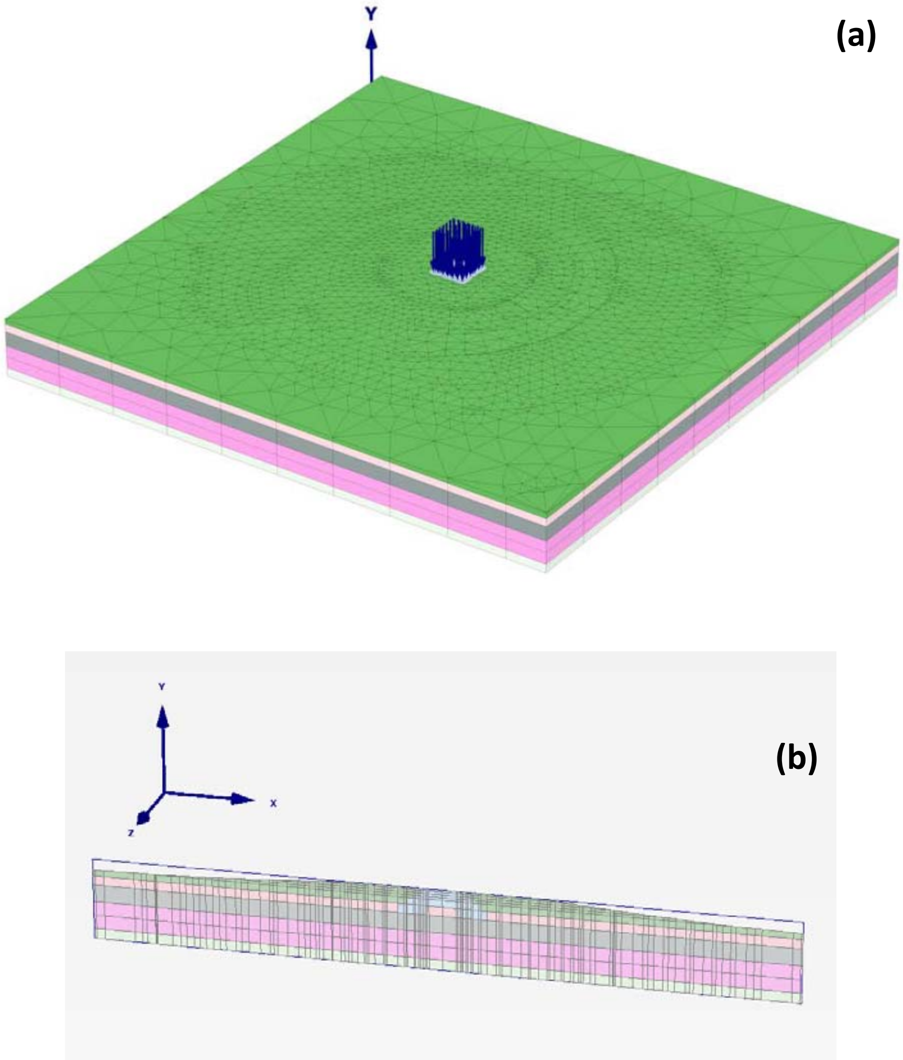


Figure 9. Construction of mound: a) 3D view; b) section along east-west of Monument.

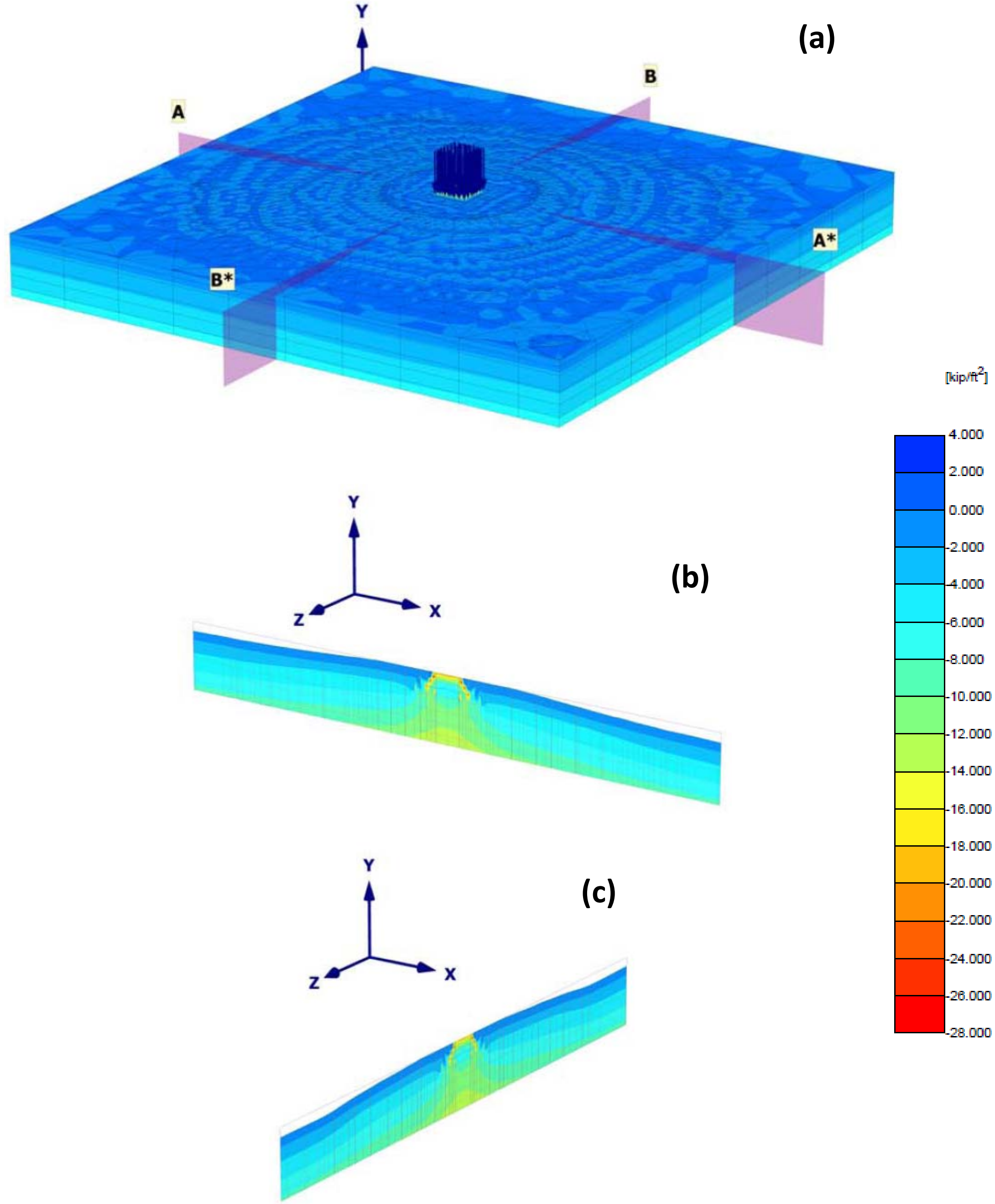


Figure 10. In-situ vertical effective stress: a) 3D model; b) Section A-A*; c) Section B-B*.

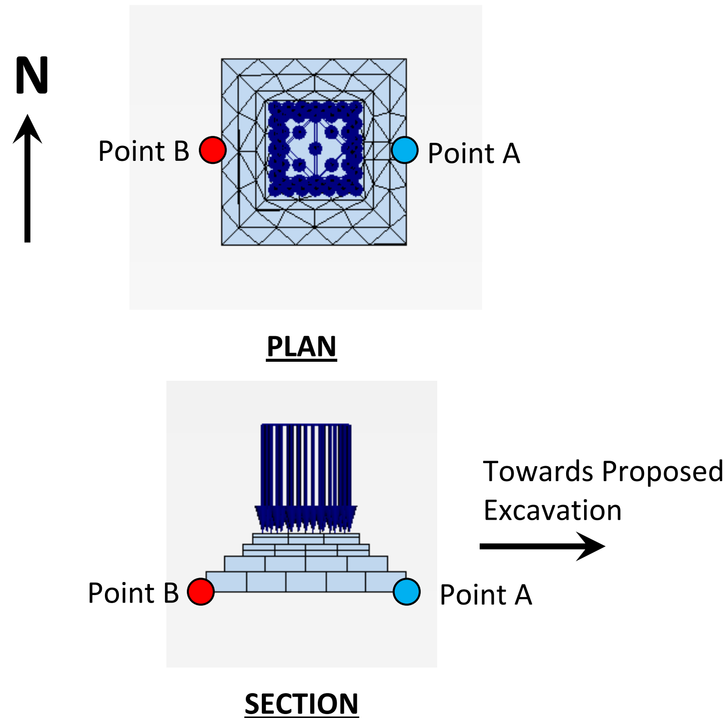


Figure 11. Points monitored during excavation

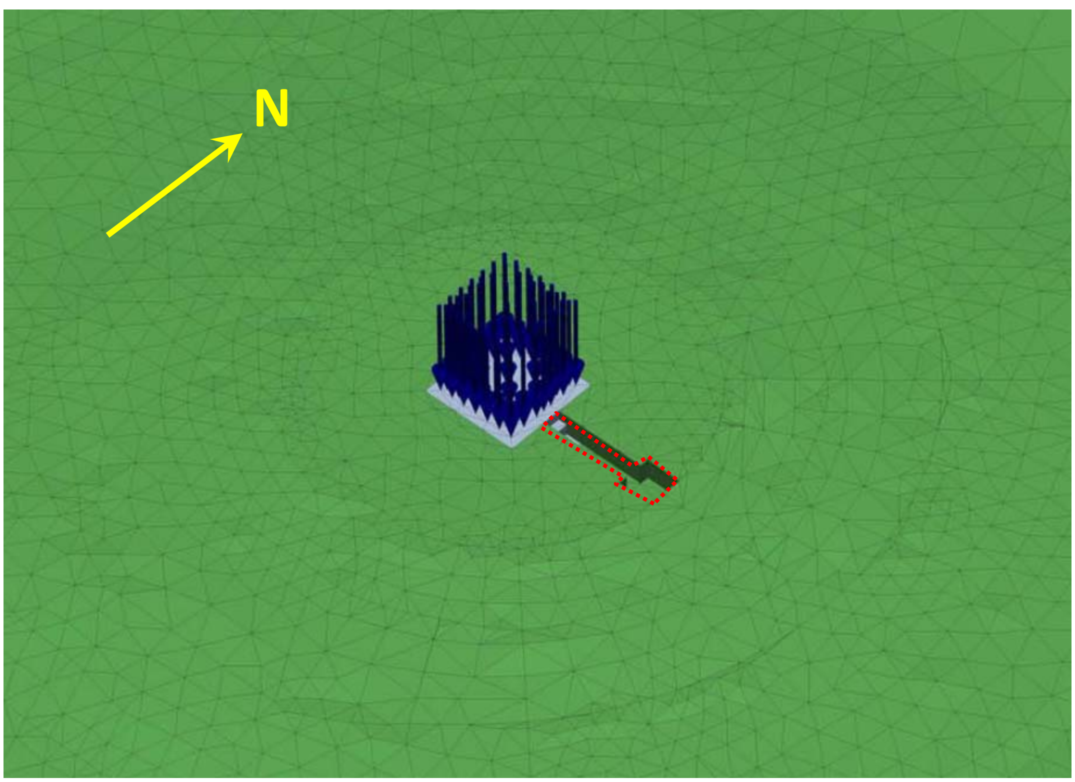


Figure 12. Excavation for Alternative A1: tunnel.

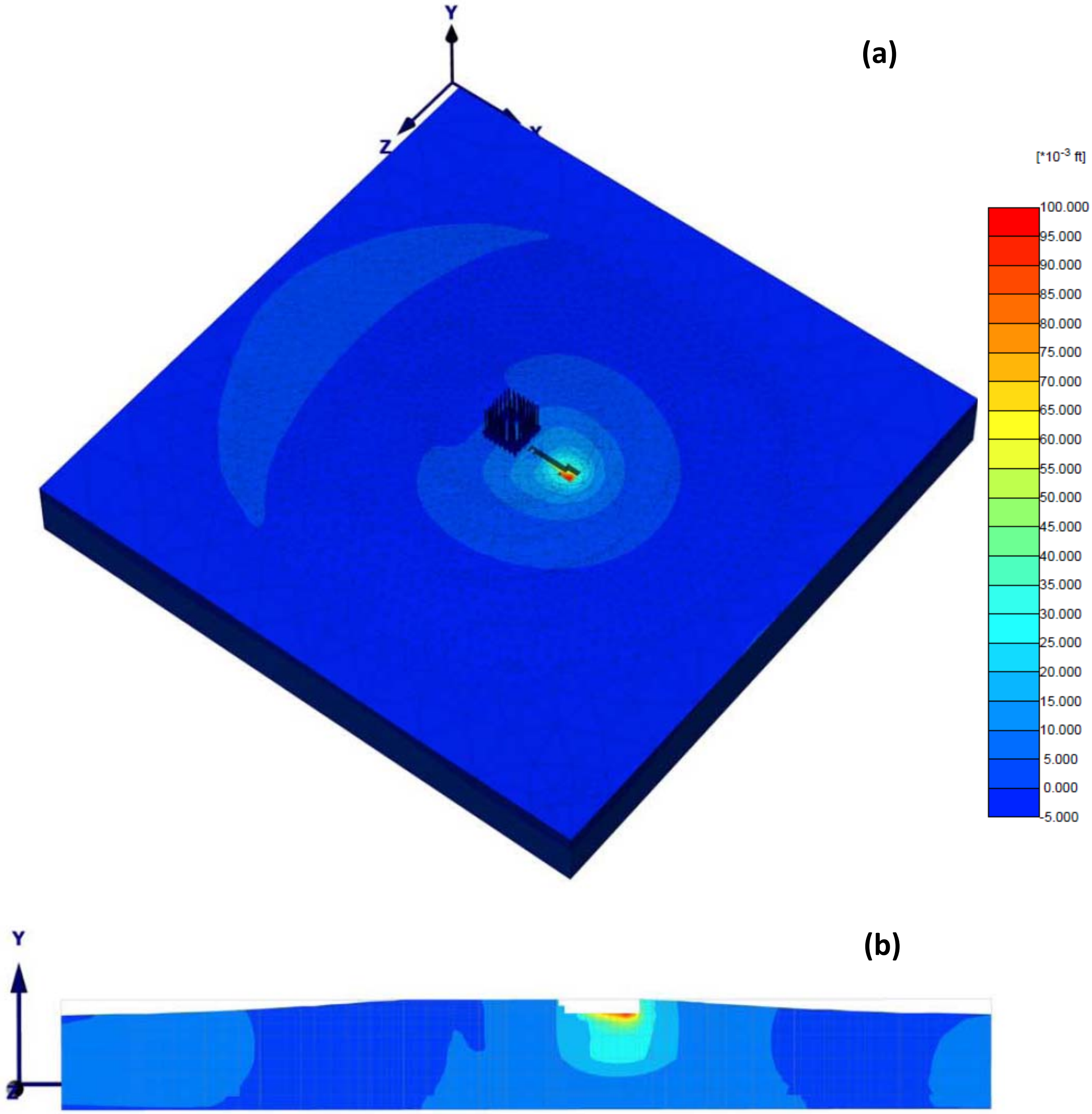


Figure 13. Vertical displacements due to tunnel excavation: a) 3D view; b) section along east-west of Monument.

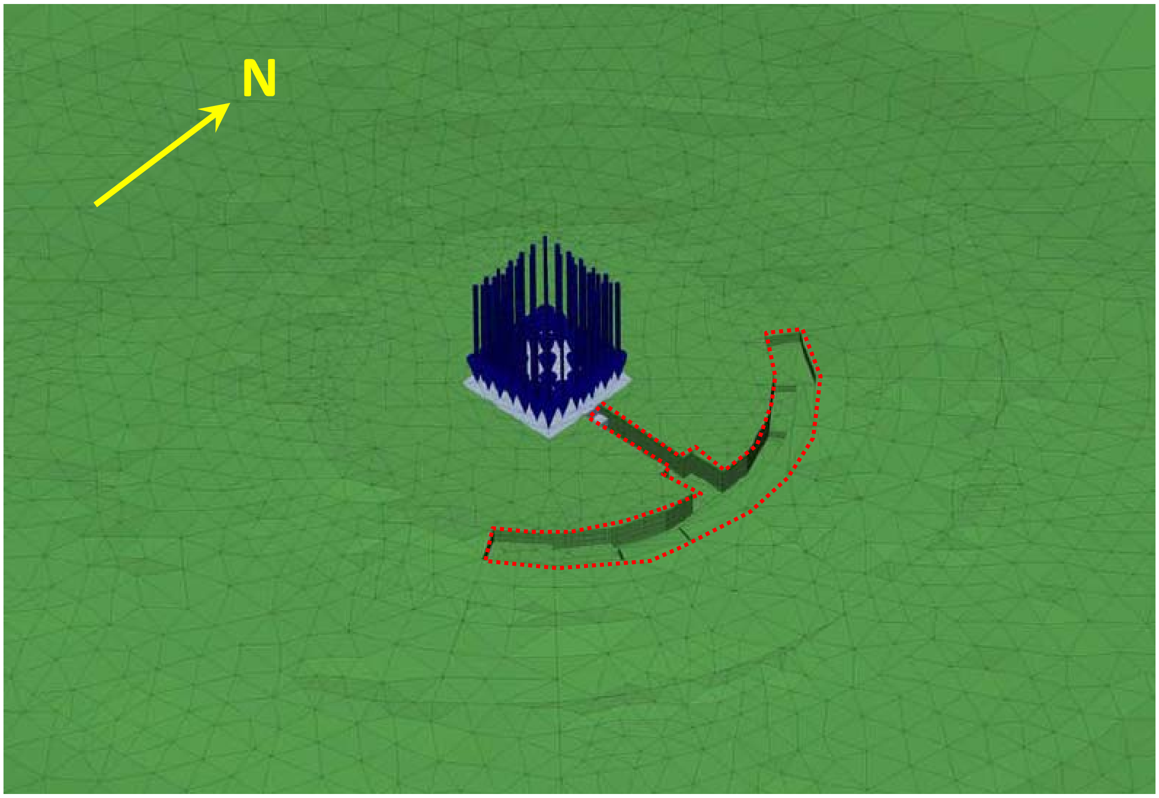


Figure 14. Excavation for Alternative A1: tunnel and recessed entrance.

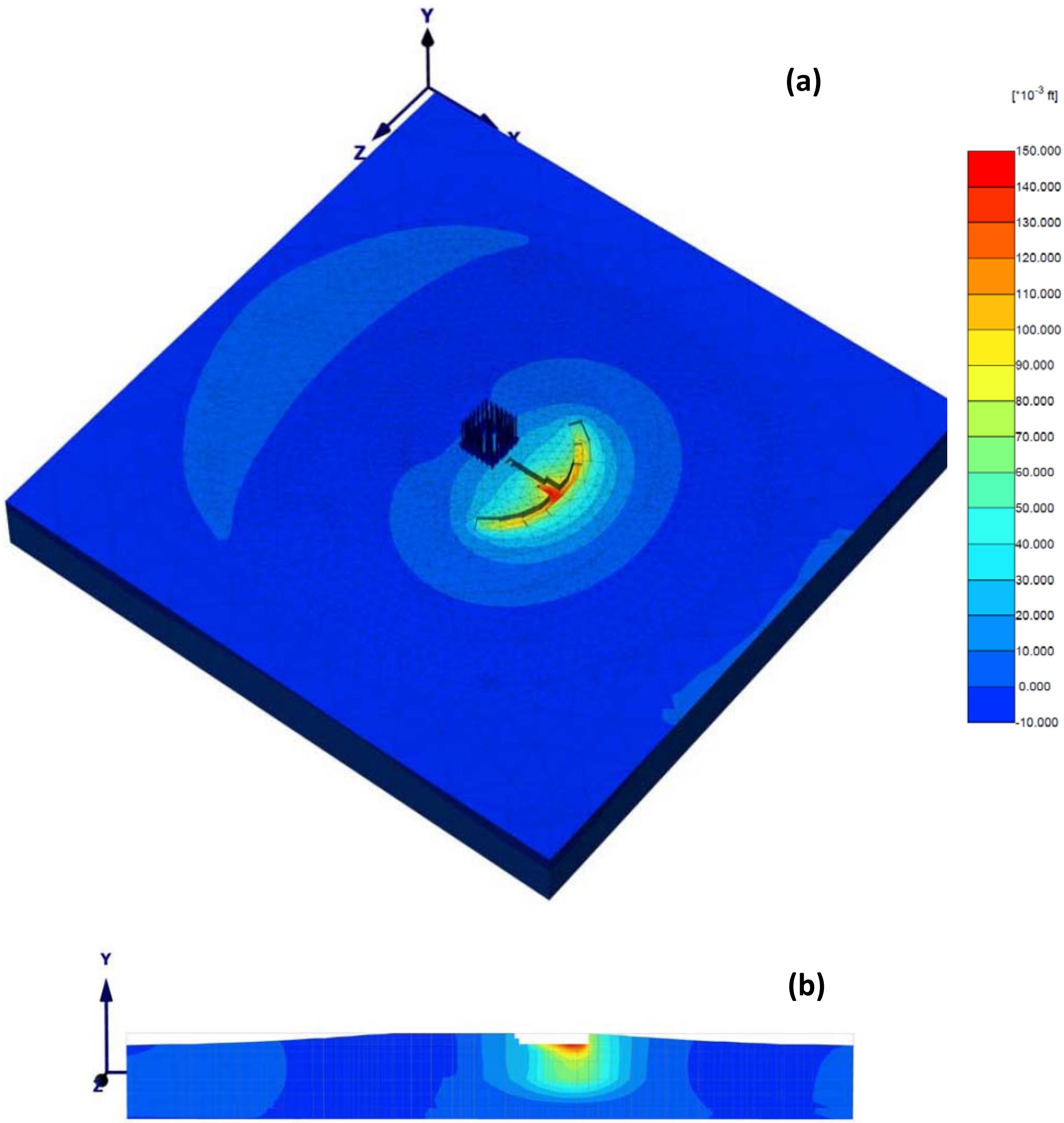
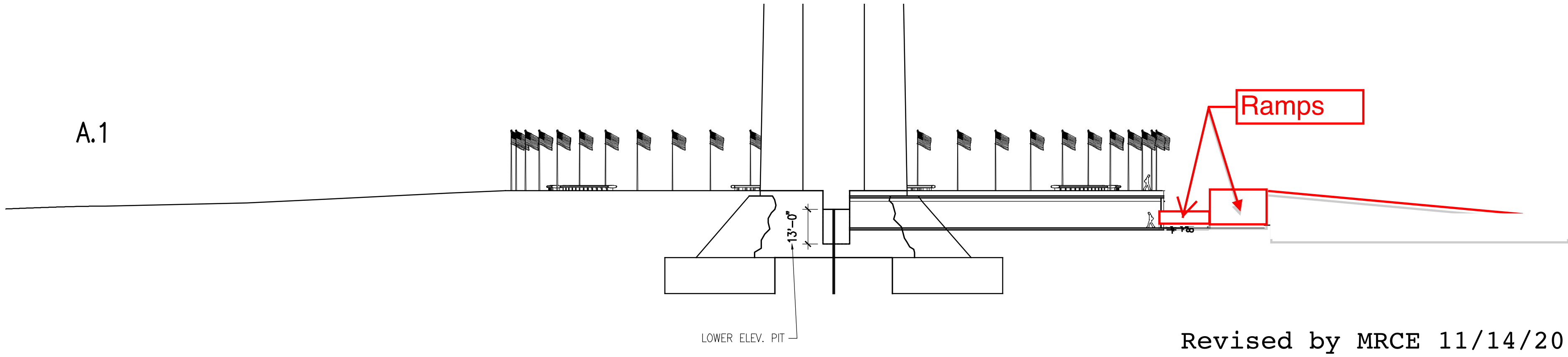
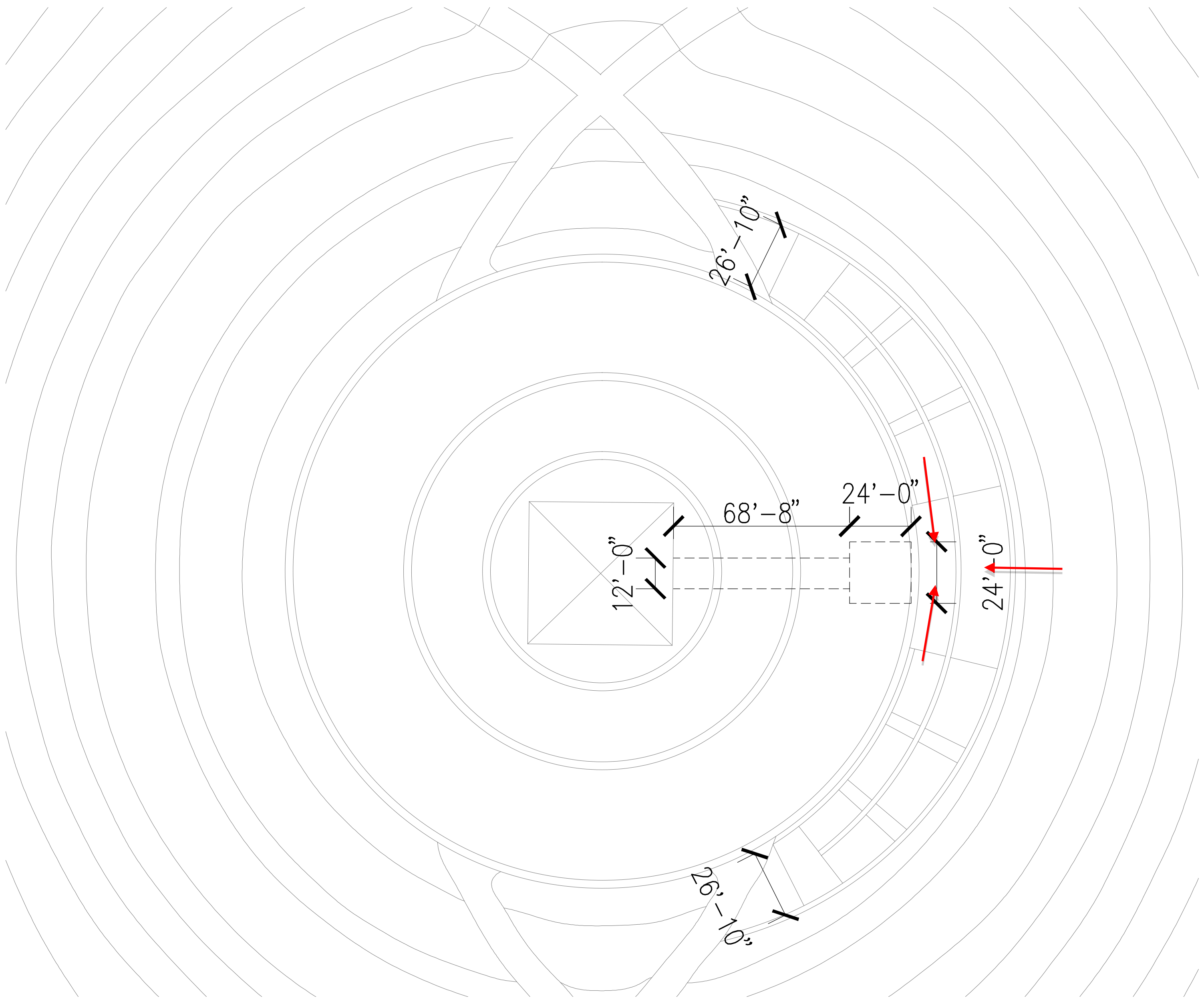


Figure 15. Vertical displacements due to tunnel and recessed entrance excavation: a) 3D view; b) section along east-west of Monument.

APPENDIX C



Revised by MRCE 11/14/2011



Alternative A1

Beyer Blinder Belle
Architects & Planners LLP

Washington Monument Visitor Security Screening
Concept Design Layout

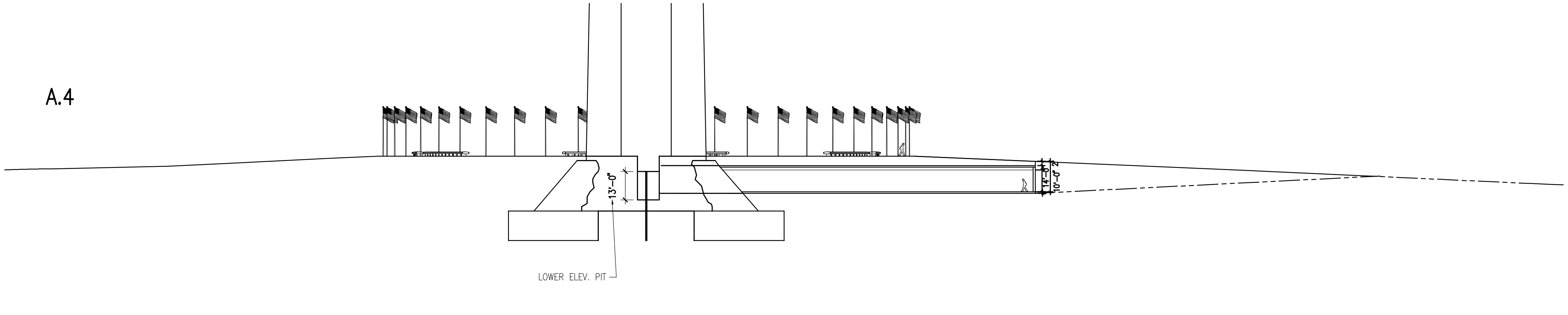
UNIT LAYOUT INFORMATION

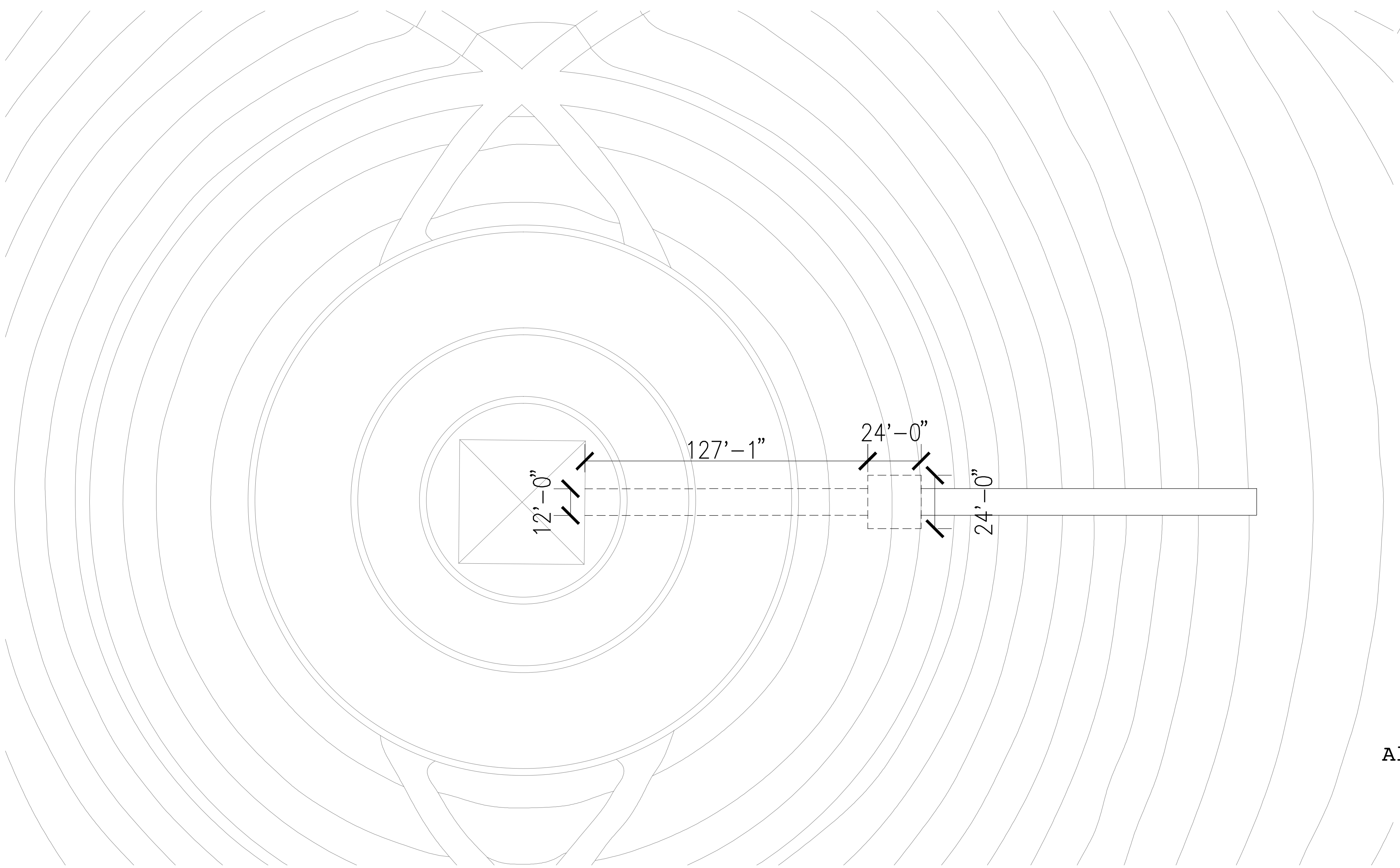
CROSS SECTIONS

DATE 08/09/2011

GRAPHIC SCALE
30' 20' 10' 0 30' 60'

A.4





Alternative A4

Beyer Blinder Belle
Architects & Planners LLP

Washington Monument Visitor Security Screening
Concept Design Layout

UNIT LAYOUT INFORMATION

CROSS SECTIONS

DATE 08/09/2011

GRAPHIC SCALE
30' 20' 10' 0 30' 60'