Geotechnical Engineering Report

United States Olympic Museum
South Sierra Madre Street and West Vermijo Avenue
Colorado Springs, Colorado
June 24, 2015
Terracon Project Number: 23155021

Prepared for:
U.S. Olympic Museum
Colorado Springs, Colorado

Prepared by:
Terracon Consultants, Inc.
Colorado Springs, Colorado

June 24, 2015

U.S. Olympic Museum
P.O. Box 681
Colorado Springs, Colorado 80901

Attn: Mr. Stan Rovira, LEED AP

Re: Geotechnical Engineering Report
United States Olympic Museum
South Sierra Madre Street and West Vermijo Avenue
Colorado Springs, Colorado
Terracon Project Number: 23155021

Terracon Consultants, Inc. (Terracon) has performed geotechnical engineering and environmental services for the above referenced project. This study was performed in general accordance with our Proposal No. P2315032R3, dated March 27, 2015. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project. Results of well installation and environmental services are reported under a separate cover.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Robert M. Hernandez, P.E.
Project Geotechnical Engineer

Ryan W. Feist, P.E.
Geotechnical Services Manager

Copies to: Addressee (2)

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EXECUTIVE SUMMARY

A Geotechnical Engineering Report has been prepared for the proposed United States Olympic Museum, located at South Sierra Madre Street and West Vermijo Avenue in Colorado Springs, Colorado. Nine borings were advanced to depths of about 34½ to 59½ feet below the existing ground surface within the general vicinity of the proposed building and pavement areas. The following geotechnical considerations were identified:

- Approximately 6 to 12 feet of fill materials comprised of a matrix of sand, gravel, and cinders was encountered at this site. Based on the previous property use as coal storage, we anticipate there may be pockets with high concentrations of cinders, coal, or other related material. We recommend the use of deep foundations for support of the structures. It is our opinion that shallow-spread footings and slabs-on-grade are not considered suitable for support of structures without full or partial removal and replacement of the fill materials as compacted fill. As an alternative, installing a soil improvement system (e.g., Geopiers®, vibro-replacement stone columns, etc.) to improve bearing conditions for spread footing foundations may also be considered.

- At the time of our geotechnical exploration, maximum building loading was anticipated to range up to 800 kips. Subsequent to our geotechnical exploration, maximum loading was revised and ranges up to 2,530 kips. Our borings may not extend deep enough to account for the revised higher loading with respect to a deep foundation system. The drilled pier recommendations contained in this report are considered suitable for loading up to 800 kips, and are considered preliminary for loading beyond 800 kips. Additional exploration may be required within areas where loading exceeds 800 kips.

- The 2012 International Building Code, Table 1613.5.2 IBC seismic site classification for this site is D.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
UNITED STATES OLYMPIC MUSEUM
SOUTH SIERRA MADRE STREET AND WEST VERMIJO AVENUE
COLORADO SPRINGS, COLORADO

Project No. 23155021
June 24, 2015

1.0 INTRODUCTION

A Geotechnical Engineering Report has been prepared for the proposed United States Olympic Museum, located at South Sierra Madre Street and West Vermijo Avenue in Colorado Springs, Colorado. Seven borings were advanced to depths of approximately 34½ to 59½ feet below the existing ground surface within the general vicinity of the proposed building and pavement areas. Boring Logs along with an Exploration Plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil and bedrock conditions
- groundwater conditions
- foundation design and construction
- pavement thickness design and construction
- floor slab design and construction
- earthwork
- drainage

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	See Appendix A, Exploration Plan
Proposed construction	The proposed museum will reportedly consist of a two to three story structure occupying a gross footprint of approximately 56,000 square feet.
Building construction	The building is anticipated to be constructed out of structural steel framing with stainless steel exterior panels on metal studded wall construction.
Finished floor elevations	Mechanical Room: 5,957 feet Basement Level: 5,966 feet First Floor: 5,978 feet

ITEM	DESCRIPTION
Maximum loads (reported)	Columns: 2,530 kips Walls: 6 kips per lineal foot Slab: 150 psf
Grading	Up to 13 feet of cut and 8 feet of fill is estimated based on provided finished floor elevations
Cut and fill slopes	Anticipated to be flatter than 4H:1V with maximum heights up to 8 feet.
Free-standing retaining walls	Anticipated to be up to 20 feet high at the location of the pedestrian ramp along the west side of the planned structure.
Below grade areas	A mechanical room will be constructed up to 9 feet below proposed basement level.
Pavements	Loading areas and a plaza area supporting HS-20 loading. A pedestrian ramp will also be located along the west side of the property and may support emergency access vehicles.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The project site is located at South Sierra Madre Street and West Vermijo Avenue in Colorado Springs, Colorado.
Existing improvements	The proposed site (and adjacent land) for Olympic Museum has been used since the early 1900s for a variety of industrial and commercial uses including coal storage for the former Colorado Springs Fuel and Power Company, former building supply storage yard, and a vehicle repossession storage facility. The site is currently developed with two, single-story, industrial buildings, as well as asphalt concrete and Portland cement concrete pavements. We understand the middle structure shown on Exhibit A-4 was demolished within the past three to four years. We are unaware if foundations were removed or if replacement backfill from foundation removal was properly compacted.
Current ground cover	Predominantly asphalt pavement with some areas of concrete and earthen cover.
Existing topography	Ground surface within the vicinity of proposed improvements generally slopes downward to the west to southwest at an approximate 30:1 to 40:1 (horizontal:vertical) slope. Ground surface east of the site slopes upward toward Sierra Madre at an approximate 3:1 slope. An approximate 4-foot high, 200-foot long retaining wall is present within the southeastern corner of the site adjacent to Sierra Madre.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum	Material Encountered	Consistency/Density
Stratum 1	6 to 12 feet	Fill materials comprised of sand, gravel, and cinders	Very loose to loose
Stratum 2	15 to 28 feet	Sand with varying amounts of silt and gravel, trace cobbles	Loose to medium dense
Stratum 3	18 to 23 feet (MW-1, MW-2, MW-4 to MW-6	Weathered claystone bedrock	Firm
Stratum 4	34½ to 59½ feet	Shale bedrock	Very hard

Conditions encountered at the boring locations are indicated on the attached boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Further details of the borings can be found on the boring logs in Appendix A of this report.

3.2 Groundwater

Groundwater was encountered at the following depths at the time of field exploration:

Boring	Depth to Bottom of Boring	Depth to Groundwater from Existing Site Grade (While Drilling)	Depth to Groundwater from Existing Site Grade and Elevation (06/09/2015)
B-1	34½ feet	Not Encountered	Backfilled upon completion
B-2	34½ feet	14 feet	Backfilled upon completion
B-3	34½ feet	24 feet	Backfilled upon completion
MW-1	59½ feet	24½ feet	11.3 feet / 5,956.5 feet
MW-2	59½ feet	19 feet	17.6 feet / 5,952.7 feet
MW-3	59½ feet	19 feet	22.2 feet / 5,948.3 feet
MW-4	59½ feet	19 feet	18.2 feet / 5,951.8 feet
MW-5	59½ feet	14 feet	19.7 feet / 5,949.9 feet
MW-6	59½ feet	25½ feet	23.8 feet / 5,946.8 feet

These observations represent groundwater conditions at the time of the field exploration, and may not be indicative of other times, or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the results of our field investigation, laboratory testing program and geotechnical analyses, development of the site is considered feasible from a geotechnical viewpoint provided that the conclusions and considerations provided herein are incorporated into the design and construction of the project. Existing fill and potentially compressible soils will require particular attention in the design and construction.

Approximately 6 to 12 feet of fill materials comprised of a matrix of sand, gravel, and cinders was encountered at this site. Based on the previous property use as the site may have been used for coal or cinder storage. We anticipate there may be pockets of fill soils with high concentrations of cinders, coal, or other related material. We recommend the use of deep foundations for support of the structures. It is our opinion that shallow-spread footings and slabs-on-grade are not considered suitable for support of structures without full or partial removal and replacement of the fill materials as compacted fill. As an alternative, installing a soil improvement system (e.g., Geopiers®, vibro-replacement stone columns, etc.) to improve bearing conditions for spread footing foundations may also be considered.

We also recommend removal of fill materials within pavement areas and replacement as compacted fill. If the owner is willing to accept an increased risk of movement beyond 1-inch in pavement areas, partial removal and replacement of fill materials may be considered.

Terracon's services did not include delineating the horizontal or vertical extent of the existing fill material. There exists the potential for construction debris to be encountered within the fill on other portions of the site. Based upon the boring log data, the potential is considered to be moderate to high. This can be observed by additional geotechnical exploration or evaluation at the site. If additional exploration is not performed, the owner should make allowances for such conditions to existing in the preparation of the project budget and/or construction plans.

The encountered fill materials may be considered suitable for reuse as compacted fill provided cinders and coal are uniformly dispersed and not more than 5 percent by weight. Full time observation and a performance based specification for compaction will need to be developed if the owner choses to reuse the existing fill materials as compacted fill during construction.

Boring MW-4 was advanced to the full depth of exploration, 59½ feet, when initially drilled. The location was offset 15 feet to the east to install the monitoring well rather than grouting the original location to the desired depth of the well. An obstruction was encountered at 17 feet at the offset location. The location was offset again another 5 feet to the west and a similar obstruction was encountered at 17 feet. It is unclear if this is an old foundation from previous site development. Additional exploration could be performed, if requested, to observe the approximate extents of the obstruction. This could include Ground Penetrating Radar or Geoprobing to assist in observing the lateral extents of the obstruction.

We recommend foundations associated with existing structures (buildings, retaining walls) be completely removed and backfilled with compacted fill in areas of new foundations. Existing foundations should be removed within 2 feet of slabs-on-grade and pavement subgrade level. Existing utilities to be abandoned should be removed within 10 feet of the proposed building perimeter. Abandoned utilities to remain in place beyond the perimeter should be grouted and capped.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined herein. The recommendations contained in this report are based upon the results of data presented herein, engineering analyses, and our current understanding of the proposed project.

4.2 Earthwork

4.2.1 Site Preparation

Prior to placing any fill, partial or full removal of existing fill materials, vegetation and any otherwise unsuitable material should be removed from the proposed floor slab, foundation, and pavement areas. The subgrade should also be proof-rolled where possible or probed with a metal T-probe to aid in locating loose, soft, or otherwise undesirable areas. Proof-rolling can be performed with a loaded tandem axle dump truck. Unacceptable soil should be removed or mitigated in place prior to placing fill.

Although evidence of underground facilities was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected underground facilities are encountered, such features should be removed and the excavation benched to expose firm, approved materials prior to backfill placement and/or construction.

4.2.2 Material Types

Engineered fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
On-Site Fill Soils	N/A	The on-site fill soils are considered acceptable for reuse as compacted fill in slab areas provided no more than 5 percent of combined coal and cinders (by weight) are used and the material is uniformly dispersed.
On-Site Soils	SW-SM, SP-SM, SM	The on-site native soils are considered suitable for reuse as compacted fill beneath foundations, slabs, and pavements.
Imported Soils	Varies	Imported soils meeting the gradation outlined herein can be considered acceptable for use as engineered fill beneath foundations and slabs.

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.

Imported soils should conform to the following:

Gradation	Percent finer by weight (ASTM C136)
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	35 (max)

- Liquid Limit……………………………………………………NP
- Plastic Limit…………………………………………………..NP

4.2.3 Compaction Requirements

ITEM	DESCRIPTION
Fill Lift Thickness	8-inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack, plate compactor) is used
Compaction Requirements [1]	■ 95% of the materials maximum dry density (ASTM D698) ■ Performance based specification will need to be developed with full time testing for re-use of material containing coal and cinders.
Water Content [2]	Within three percent of optimum water content for granular soil.

1. We recommend that engineered fill be tested for water content and compaction during placement. Should the results of the in-place density tests indicate the specified water or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified water and compaction requirements are achieved.
2. Specifically, water levels should be maintained low enough to allow for satisfactory compaction to be achieved without the compacted fill material pumping when proof rolled.

4.2.4 Grading and Drainage

All grades must be adjusted to provide positive drainage away from the structure during construction and maintained throughout the life of the proposed project. Infiltration of water into utility or foundation excavations must be prevented during construction. Landscaped irrigation adjacent to foundation systems should be minimized or eliminated. Water permitted to pond near or adjacent to the perimeter of the structures (either during or post-construction) can result in significantly higher soil movements than those discussed in this report. As a result, any estimations of potential movement described in this report cannot be relied upon if positive drainage is not obtained and maintained, and water is allowed to infiltrate the fill and/or subgrade. Exposed ground should be sloped at a minimum of 10 percent grade for at least 10 feet beyond the perimeter of the building, where possible. Asphalt pavement or concrete flatwork should be sloped at a minimum of 2 percent beyond the building perimeter. Where ADA or other requirements or existing site features limit the gradient, slopes on the order of ½ to 1 percent minimum are considered acceptable. Backfill against footings, exterior walls and in utility line trenches should be well compacted and free of all construction debris to reduce the possibility of water infiltration. After building construction and prior to project completion, we recommend that verification of final grading be performed to document that positive drainage, as described above, has been achieved.

Where paving or flatwork abuts the structure, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water. Consideration should be given to snow removal practices that will minimize the stockpiling of snow adjacent to structural improvements.

Roof drains should discharge on pavements or be extended away from the structure a minimum of 5 feet through the use of splash blocks or downspout extensions. A preferred alternative is to have the roof drains discharge to storm sewers by solid pipe or other appropriate outfall.

The on-site native soils are granular in nature. Based on the consistency of the on-site native soils, and anticipating a similar granular material for compacted fill, a perimeter drainage system is not considered necessary.

4.2.5 Construction Considerations

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Should unstable subgrade conditions develop, stabilization measures will need to be employed. Options for subgrade stabilization can include removal of unsuitable material and replacement with approved fill material. An alternative can include the use of geogrid overlain by CDOT Class 5 or 6 aggregate base course. The depth of aggregate base course will depend on the severity of unstable soils.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and re-compacted prior to floor slab and pavement construction.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

4.3 Foundation Systems

4.3.1 Design Recommendations – Drilled Pier Foundations

Drilled pier foundations are considered suitable for support of the proposed building. At the time of our geotechnical exploration, maximum building loading was anticipated to range up to 800 kips. Subsequent to our geotechnical exploration, maximum loading was revised and ranges up to 2,530 kips. Our borings may not extend deep enough to account for the revised higher loading. The recommendations contained in this section are considered suitable for loading up to 800 kips, and are considered preliminary for loading beyond 800 kips. Additional exploration may be required for foundations where loading exceeds 800 kips. For this project, we recommend the following:

DESCRIPTION	STRAIGHT SHAFT PIERS
Minimum embedment into unweathered bedrock	5 feet, or two pier diameters (2D), whichever is greater
Minimum pier diameter	24 inches
Minimum spacing between piers	3 pier diameters
Frost depth for grade beams	30 inches

DESCRIPTION	STRAIGHT SHAFT PIERS
Pier concrete slump (cased piers)	7 to 9 inches
Approximate total movement [1]	1 inch

1. The foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the quality of the earthwork operations, and maintaining uniform soil water content throughout the life of the structure. The estimated movements are based on maintaining uniform soil water content during the life of the structure. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage and irrigation practices should be incorporated into the design and operation of the facility. Failure to maintain soil water content and positive drainage will nullify the movement estimates provided above.

A summary of the drilled pier foundation design recommendations is shown below. The maximum end bearing pressures given in the table are based on the cross-sectional area of the tip of the drilled shaft. Skin friction (S_d) should be applied to the surface area of the drilled shaft for that given length interval below a depth of 30 inches. The combination of skin friction and end bearing pressure can be used to determine the vertical compression capacity. The skin friction value should be used to determine the uplift capacity of the soil. For lateral load and overturning design, we have included beam on elastic foundation spring constants, lateral equivalent earth pressures, and more commonly used LPILE parameters. For calculation of lateral deflection using the beam on elastic foundation method, a coefficient of subgrade reaction listed on the table may be used for the analysis. Lateral load design parameters are valid for maximum soil strain of 1 percent for the native soils and ½ percent for bedrock acting over a distance of one shaft diameter. The passive pressure, coefficient of horizontal subgrade reaction, and LPILE parameters are ultimate values; therefore, appropriate factors of safety should be applied in the pier design. All shafts should be reinforced full-depth for the applied axial, lateral and uplift stresses imposed.

DESCRIPTION	MATERIAL TYPE AND DEPTH, FEET			
	Fill Materials (Sand)	**Sand Soils**	**Weathered Bedrock**	**Unweathered Bedrock**
Allowable Vertical Parameters:				
Bearing, psf	N/A	N/A	N/A	40,000 psf*
Skin friction, psf	N/A	130	480	2,500 psf*
Ultimate Lateral Parameters				
Beam on Elastic Foundation:				
Passive, EFP,psf/ft	150	290	440	450
Soil Code	4 (Sand)	4 (Sand)	9 (Weak Rock)	9 (Weak Rock)
Unit Weight above Groundwater (pci)	0.052	0.072	0.078	0.084
Unit Weight below Groundwater (pci)	N/A	0.036	N/A	N/A
Undrained Shear Strength, Cu (psi)	N/A	N/A	25	110

DESCRIPTION	MATERIAL TYPE AND DEPTH, FEET			
	Fill Materials (Sand)	**Sand Soils**	**Weathered Bedrock**	**Unweathered Bedrock**
Angle of internal Friction, ϕ (degrees)	15	32	---	---
Horizontal Modulus of Subgrade Reaction:				
k (static) pci	20	125	2,000	2,000
k (cyclic) pci	20	125	800	800
Strain at 50% of Maximum Stress, ε_{50}	N/A	N/A	0.004	0.004

*Minimum 5-foot embedment or 2 pier diameters, whichever is greater. May be increased to 50,000 psf bearing and 3,000 psf skin friction when piers extend greater than 20 feet into unweathered bedrock. We recommend supplemental test borings be performed where bottom of pier depths extend to within two pier diameters of the current boring depths. Consideration may be given to performing pressure meter testing for increased skin friction and end bearing values.

The provided lateral parameter design values do not include a factor-of-safety, which should be applied. We recommend neglecting skin friction and lateral resistance for the upper 36 inches of drilled piers because of the effects of frost penetration.

Piers should be considered to work in group action if the horizontal spacing is less than 6 pier diameters. A minimum practical horizontal spacing between piers of at least 3 diameters should be maintained, and adjacent piers should bear at the same elevation. The capacity of individual piers must be reduced when considering the effects of group action. Capacity reduction is a function of pier spacing and the number of piers within a group. If group action analyses are necessary, capacity reduction factors can be provided for the analyses.

4.3.2 Drilled Pier Construction Considerations

Drilling to design depths should be possible with single-flight power augers equipped with rock teeth. Difficult drilling should be anticipated due to the presence of very hard bedrock, groundwater, and caving associated with sand soils. Casing, mud or slurry drilling, and other specialized installation techniques will be required to properly drill and clean piers prior to concrete placement. Pier concrete should be placed soon after completion of drilling and cleaning. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

A tremie or casing should be used for concrete placement. If casing is used for pier construction, it should be withdrawn in a slow, continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or the creation of voids in pier concrete. Pier concrete should have a relatively high fluidity when placed in cased pier holes or through a tremie.

Free-fall concrete is not considered acceptable for placement in piers. The use of a bottom-dump hopper, or an elephant's trunk discharging near the bottom of the hole where concrete segregation will be minimized, is recommended. Shaft bearing surfaces must be free of loose materials prior to concrete placement.

Due to potential necking of drilled piers constructed below groundwater, we recommend cross-hole sonic logging of 20 percent of the piers, including high capacity piers as determined by the structural engineer. This method utilizes two to three 2-inch PVC pipes attached to the reinforcing cages per drilled pier to provide access for non-destructive observation of post-construction drilled pier integrity. Sonic echo testing may also be performed on selected piers as additional non-destructive testing. We also recommend consideration be given to at least one pile load test prior to full scale production to observe the performance of design parameters presented herein.

4.3.3 Driven Pile Foundations

Steel piles driven to virtual refusal into the underlying bedrock are considered suitable for deep foundation support of the proposed building. For this project, we recommend the criteria in the following table:

DESCRIPTION	RECOMMENDATIONS
Recommended pile driving energy for steam, air, or diesel hammers	60,000 foot-pounds
Approximate movement	½ inch

As a result of driving the piles to virtual refusal, we do not recommend using skin friction (S_d) values in combination with end bearing capacity.

Steel H-piles driven into the shale bedrock to virtual refusal should be designed for an allowable capacity equal to the cross sectional area of the H-pile multiplied by the working stress. Virtual refusal criteria, as defined by the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, is no more than one inch of penetration for the final ten blows. This virtual refusal criteria should be specified for construction.

Uplift capacity of the piles will be developed by friction in the soils and weathered bedrock surrounding the piles. We have provided skin friction values for uplift in the table below. Skin friction should be applied to the rectangular surface area of the H-pile for that given length interval below a depth of 30 inches. In each case, the uplift capacity may be increased by the weight of the individual pile. Uplift pile capacities may be increased by one-third when considering wind and/or earthquake loading.

DESCRIPTION	MATERIAL TYPE AND DEPTH, FEET		
	Sands	Weathered Shale	Unweathered Shale
Allowable Uplift Skin Friction for Native Soils and Bedrock, psf	50	350	2,000

We anticipate virtual refusal within the unweathered bedrock. We also anticipate refusal of an HP57 pile of about 10 to 15 feet of embedment into unweathered bedrock. Uplift forces on piles should be resisted by a combination of dead-load and pile penetration below a depth of 12 feet and into competent shale. The heave force can be resisted by skin friction in the soil profile, weathered shale, and unweathered shale beginning at a depth of 12 feet below the proposed ground surface. Uplift forces due to short term equipment loading conditions can be applied to the soil profile below a depth of 36 inches.

Groups of piles required to support concentrated loads will require appropriate reductions of the axial capacities based on the effective envelope of the pile group. This reduction can be avoided by spacing piles at a minimum distance of at least six diameters (widths) center to center. Piles spaced less than recommended should be evaluated on an individual basis to determine appropriate reductions in axial capacities.

4.3.4 Driven Pile Foundation Construction Considerations

The contractor should select a driving hammer and cushion combination which is capable of installing the selected piling without overstressing the pile material. The contractor should submit the pile driving plan and the pile hammer-cushion combination to the engineer for evaluation of the driving stresses in advance of pile installation.

Some ground heave may be experienced as a result of pile driving at each site. Therefore, it is recommended the top elevations of the initial piles be surveyed. If any heave is noted after the driving of subsequent piles, the piles should be redriven to their original top elevation. This problem can be particularly acute in pile groups.

The pile hammer should be operated at the manufacturer's recommended stroke when measuring penetration resistance. A representative of the geotechnical engineer should observe pile driving operations on a full-time basis. Each pile should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance, depth of embedment and general pile driving operations.

Driven pile resistances should be observed through the use of dynamic Pile Driving Analyzer (PDA). PDA with signal matching (CAPWAP) testing should be performed during initial driving and during pile re-strike several days after initial driving. The PDA may also be utilized (in conjunction with a CAPWAP study) to evaluate uplift resistance. We recommend that a minimum of three piles be tested for this portion of the project.

4.3.5 Rammed Aggregate Column Foundation Soil Improvement System

Another option for support of the proposed building may include installing a soil improvement system (e.g., Geopiers®, vibro-replacement stone columns) to improve bearing conditions for spread footing foundations. Ground improvement procedures are usually proprietary, with design and installation performed by a specialty contractor. We recommend that this report be provided to the ground improvement contractors/designers. Preliminarily, we anticipate the following design parameters:

DESCRIPTION	Column
Net allowable bearing pressure [1]	5,000 to 7,000 psf
Approximate horizontal spacing of stone columns beneath foundations	3 to 5-foot centers
Approximate depth of stone columns	15 to 20 feet

The ground improvement procedures described above generally involve installing columns of compacted crushed stone into the native matrix soils, with various methods of installation. Due to the specialty of the ground improvement procedures, we recommend that a performance specification be used for ground improvement systems. Due to the presence of groundwater and potential for caving sands, a specification should be included that outlines how the holes will be kept open to properly install stone columns

The ground improvement system normally includes a specialized method of placing and compacting granular fill. As such, we recommend that general considerations applicable to placing compacted fill also be implemented when installing ground improvement system elements per the manufacturer's standard design and installation requirements. For example, the granular fill used to form the element should not include frozen material. We recommend that no permanent portion of an element be installed in frozen soil (some elements are over-built during installation, and then excavated later during foundation construction), and that any portion of an element that is allowed to freeze after construction be removed and replaced. The granular fill used to form the element should be capped with compacted cohesive soil to prevent surface water from entering the element during the time interval between element installation and placing foundation concrete. Surface grading should promote runoff of surface water away from the construction area.

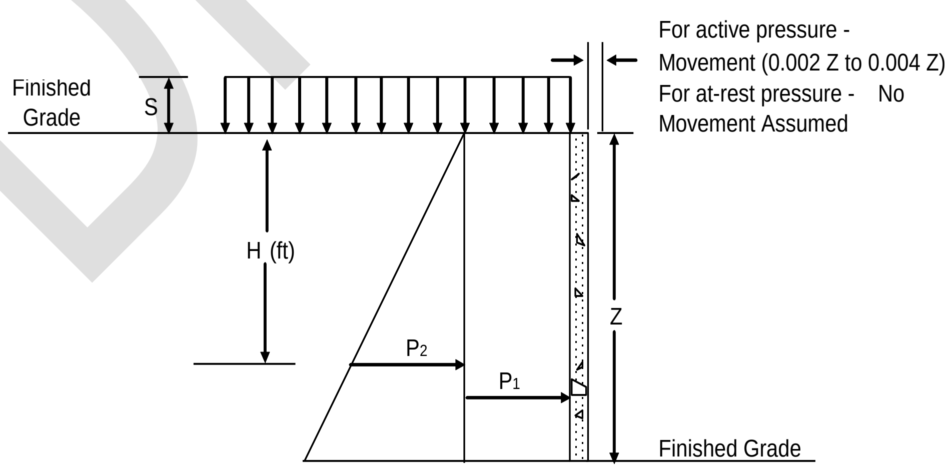
4.4 Seismic Considerations

Code Used	Site Classification
2009 International Building Code (IBC) [1]	D[2]
Mapped Spectral Acceleration for Short Periods, S_s [2]	0.185
Mapped Spectral Acceleration for a 1-second period, S_1 [2]	0.059

1. In general accordance with the *2009 International Building Code,* Table 1613.5.2. The 2009 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination as borings for this project extended to a maximum depth of approximately 59½ feet. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a higher seismic site class.
2. In general accordance with the Pikes Peak Regional Building Code

4.5 Lateral Earth Pressures

Reinforced concrete walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall rotation. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.



EARTH PRESSURE COEFFICIENTS

Earth Pressure Conditions	Coefficient For Backfill Type	Equivalent Fluid Pressure (pcf)	Surcharge Pressure, P_1 (psf)	Earth Pressure, P_2 (psf)
Active (Ka)	Imported granular soils - 0.33	42	(0.33)S	(42)H
At Rest (Ko)	Imported granular soils - 0.5	63	(0.5)S	(63)H
Passive (Kp)	Imported granular soils - 3	375	---	---

Backfill placed against structures should consist of granular soils. For the values to be valid, the granular backfill must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and at-rest cases, and 60 degrees from vertical for the passive case. Additional conditions applicable to lateral earth pressures conditions include:

- Imported or on-site soils meeting the gradation presented in Section 4.2.2 of this report used for design.
- For active earth pressure, wall must rotate about base, with top lateral movements 0.002 Z to 0.004 Z, where Z is wall height
- For passive earth pressure, wall must move horizontally 0.005 Z for dense sand or 0.01 Z for loose sand to mobilize resistance.
- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 125 pcf
- Horizontal backfill, compacted to at least 95% of ASTM D698 maximum dry density
- Loading from heavy compaction equipment not included
- No groundwater acting on wall
- Lateral earth pressures are considered ultimate. We recommend a safety factor of 2 be applied.
- Ignore passive pressure in frost zone

4.6 Floor Slab

4.6.1 Design Recommendations

ITEM	DESCRIPTION
Floor slab support[1]	■ We recommend existing fill materials within the building floor slab area be removed prior to construction. ■ If the owner is willing to accept an increased risk of movement beyond 1-inch, partial removal and replacement of a minimum of 4 feet of the existing fill materials is considered acceptable. The upper 1-foot of the compacted fill should consist of imported sand soils meeting the gradation presented herein. ■ In areas of native sand soils, slabs should bear in a minimum of 12 inches of scarified, water conditioned, and recompacted sand soils. ■ If slabs are in a transition area of native and fill materials, we recommend a minimum of 4 feet of compacted fill in fill areas, and a minimum of 2 feet of compacted fill in native areas.

1. We recommend subgrade be maintained in a relatively moist condition until the floor slab is constructed. If the subgrade should become desiccated prior to construction, the affected material should be removed or the materials scarified, moistened, and re-compacted. Upon completion of grading operations in the building area, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slab.

Where appropriate, saw-cut control joints should be placed in the slab to help control the location and extent of cracking. The use of a vapor retarder should be used directly beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

4.6.2 Construction Considerations

We recommend subgrades be maintained at the proper moisture condition until floor slabs and are constructed. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier, areas where backfilled trenches are located, as well as the backfill zone adjacent to the existing structure. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material with properly compacted fill. All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the base rock and concrete.

4.7 Pavements

4.7.1 Subgrade Preparation

We recommend removal of fill materials within pavement areas and replacement as compacted fill. If the owner is willing to accept an increased risk of movement beyond 1-inch in pavement areas, partial removal and replacement of fill materials to a depth of 4 feet below pavement subgrade may be considered. Prior to placing any fill, the subgrade should be proof-rolled to aid in locating loose, soft, or otherwise undesirable areas. Proof-rolling can be performed with a loaded tandem axle dump truck. Stabilization measures will need to be employed should the proofroll encounter unstable subgrade conditions. Options for subgrade stabilization can include removal of unsuitable material and replacement with approved fill material. An alternative can include the use of Mirafi RS380i, or equivalent, overlain by the 4 feet of proposed fill. If the exposed surface (4 feet below proposed pavement subgrade) ruts for more than 1 to 2 inches, consideration should be given to using CDOT Class 5 or 6 aggregate base course. The depth of aggregate base course will depend on the severity of unstable soils

We recommend the moisture content and density of the top 12 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within one day prior to commencement of actual paving operations and after precipitation events. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.7.2 Design Considerations

Design of pavements for the project has been based on the procedures outlined in the National Asphalt Pavement Association (NAPA) Information Series 109 (IS-109). Equivalent single-axle loads (ESALs) were not provided at the time of report preparation. We have based our pavement thickness design based on the following assumed ESALs of 36,500 and 110,000 for the proposed Light Duty and Heavy Duty pavement areas, respectively, over a 20-year design life. We have based our pavement thickness design by interpolation between the NAPA design traffic classes presented below:

- **Traffic Class II** – Traffic consisting of autos, home delivery trucks, trash pickup, occasional moving vans, and ESAL's up to 27,000.

- **Traffic Class III** – Up to 10 single-unit or 3-axle semi-trailer trucks per day or equivalents: average gross vehicle weight should be less than the legal limit. Considered for ESAL's up to 110,000.

Traffic classifications and/or design ESAL's should be reviewed and approved by the owner prior to commencement of pavement operations. In addition to the flexible pavement design analyses, a rigid pavement design analysis was completed, based upon American Concrete Institute (ACI) 330R-01; Guide for Design and Construction of Concrete Parking Lots. A modulus of rupture of 600 psi was used for pavement concrete.

The anticipated soils at pavement subgrade have an estimated design class of "good" according to Table B of NAPA IS-109. As a minimum, we suggest the following pavement sections be considered:

Traffic Classification	Alternative	Asphalt Concrete (in.)	Portland Cement Concrete (in.)	Base Course (in.)	Compacted soils (ft.)
Light Duty	A	4	---	4	4 feet
	B	---	5	---	
Heavy Duty	A	4½	---	4	
	B	---	6	---	

Each alternative should be investigated with respect to current material availability and economic conditions. A minimum of 7 inches of rigid concrete is recommended at the location of dumpsters where trash trucks park and load.

4.7.3 Construction Considerations

Asphalt concrete should be composed of a mixture of aggregate, filler and additives, if required, and approved bituminous material. The asphalt concrete should conform to approved mix designs stating the Hveem properties, optimum asphalt content, job mix formula and recommended mixing and placing temperatures and designed to a minimum 50 gyrations as determined by CDOT Superpave. Aggregate used in plant-mixed asphalt concrete should meet Colorado Department of Transportation Grading S or SX specifications. Mix designs should be submitted prior to construction to verify their adequacy. Asphalt material should be placed in maximum 3-inch lifts and should be compacted to a minimum of 92 to 96 percent of the maximum theoretical density as determined by CP 51.

Where rigid pavements are used, the concrete should be based on an approved CDOT mix design.

Sealing of construction joints is essential to protect the subgrade and promote long term performance of concrete pavement. Joints should be sealed with a sealant designed especially for pavements subject to truck and car traffic. The joints should be sealed as soon as possible (in accordance with sealant manufacturers instructions) to minimize infiltration of water into the soil.

The performance of all pavements can be enhanced by reducing excess water, which can reach the subgrade soils. The following recommendations should be considered at minimum:

- Site grading at a minimum 2 percent grade away from the pavements;
- Compaction of any utility trenches for landscaped areas to the same criteria as the pavement subgrade;
- Install drainage surrounding areas anticipated for snow management and snow banks;
- Snow management plans should be developed designating areas outside pavement and planter areas for stockpiling of snow;
- Sealing or providing area drains and curb cuts in all landscaped areas in, or adjacent to pavements to reduce or prevent water migration to subgrade soils;
- Placing compacted backfill against the exterior side of curb and gutter; and,
- Placing curb, gutter and/or sidewalk directly on subgrade soils without the use of base course materials.

Preventative maintenance should be planned and provided for through an on-going pavement management program in order to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment.

Preventive maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

Recommended preventative maintenance policies for asphalt concrete pavements, based upon type and severity of distress, can be provided. Prior to implementing any maintenance additional engineering observation is recommended to determine the type and extent of preventative maintenance.

4.8 Exterior Slabs

Exterior slabs should be supported on a minimum of 12 inches of water conditioned and compacted fill meeting the requirements presented in Section 4.2.2 of this report. Exterior slabs-on-grade, exterior architectural features, and utilities founded in backfill may experience some movement due to the volume change of the material. Additional recommendations to reduce potential movement are as follows:

- minimizing moisture increases in the backfill
- controlling moisture-density during placement of backfill
- using designs which allow vertical movement between the exterior features and adjoining structural elements
- placing effective control joints on relatively close centers

4.9 Corrosion Considerations

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. These values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Boring	Sample Depth	Soluble Sulfate (Percent)	Soluble Chloride (Percent)	Electrical Resistivity (ohm.cm)	pH
MW-1	1-10 feet	0.005	0.0031	2,257	7.5
MW-5	1-10 feet	0.010	0.0007	4,237	7.3

Results of soluble sulfate testing indicate that samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 4.3.1 of the ACI Design Manual. However, it has been our experience that claystone and shale bedrock can have moderate to high sulfate concentrations. If drilled piers are considered for support of the building, we recommend the use of sulfate resistant concrete. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications.

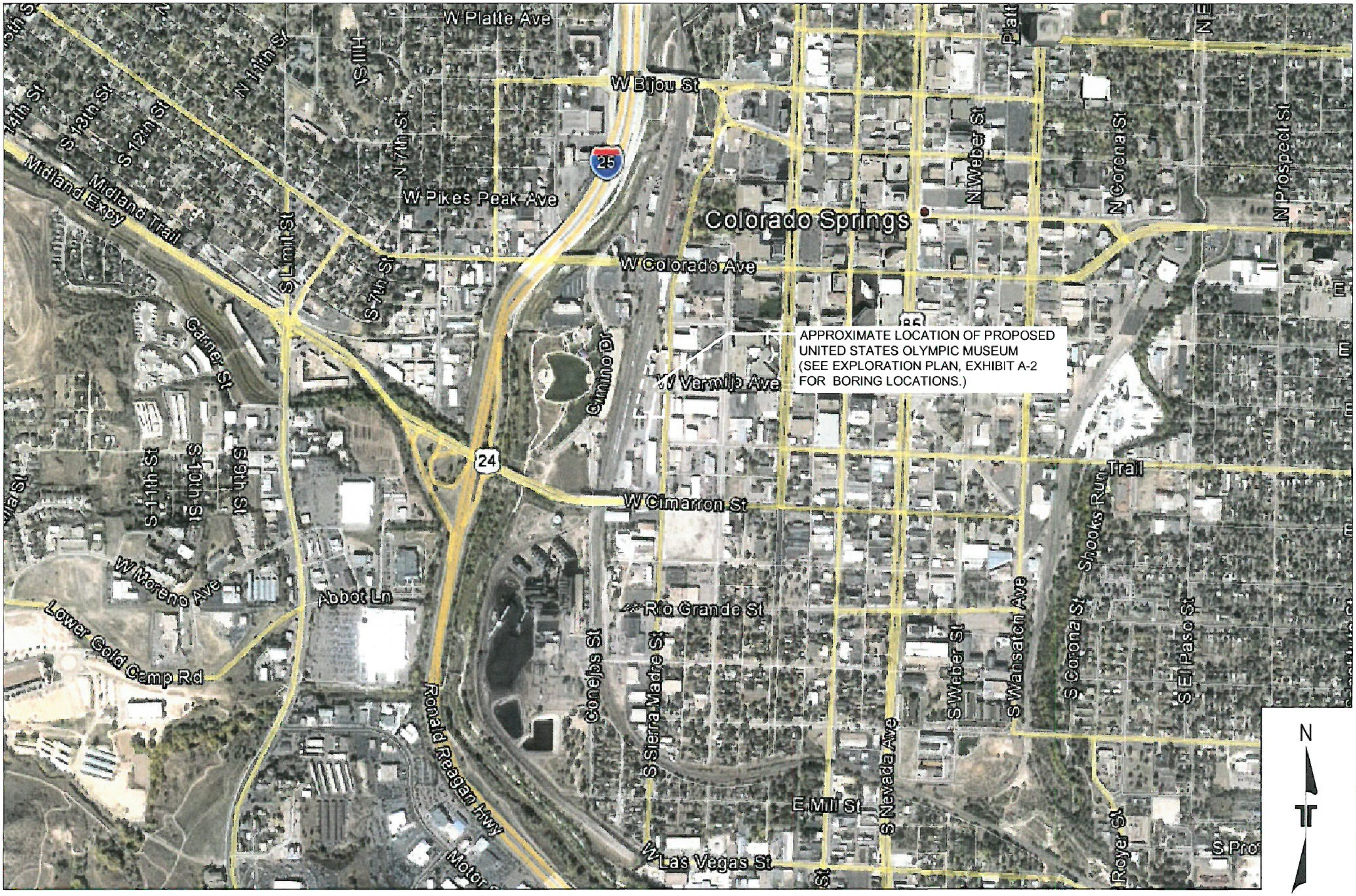
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION



NOTE: AERIAL SITE DRAWING OBTAINED FROM GOOGLE EARTH ON JUNE 9, 2015,USED AS BASE DRAWING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	RWF	Project No.	23155021
Drawn By:	RMH	Scale:	NOT TO SCALE
Checked By:	RWF	File No.	Fig1-SVD
Approved By:	RWF	Date:	06-09-2015

Terracon
Consulting Engineers and Scientists

4172 Center Park Drive Colorado Springs, Colorado 80916
PH. (719) 597-2116 FAX. (719) 597-2117

SITE VICINITY PLAN

U.S. Olympic Museum

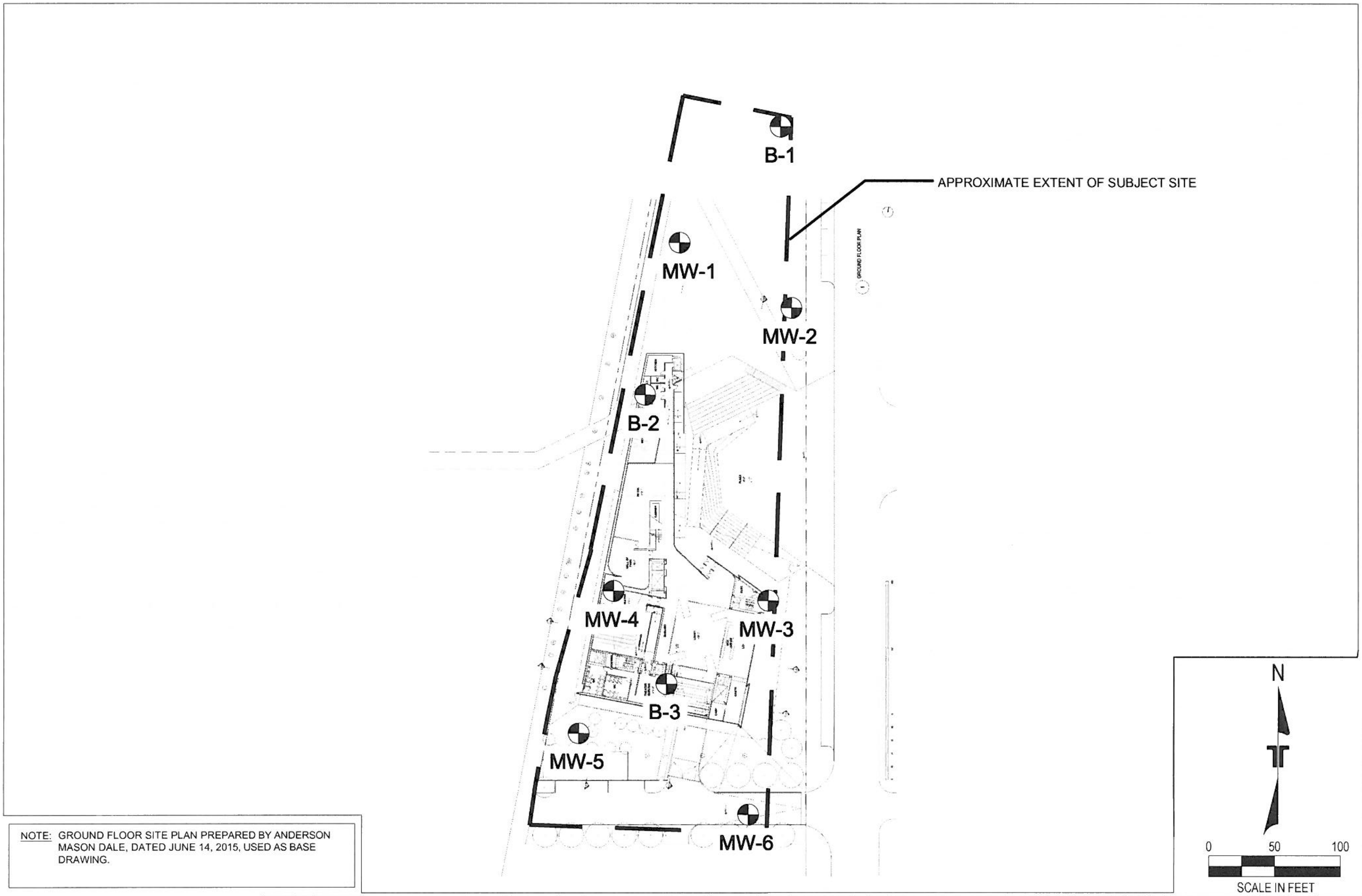
UNITED STATES OLYMPIC MUSEUM

SOUTH SIERRA MADRE STREET AND WEST VERMIJO AVENUE

COLORADO SPRINGS COLORADO

Ex. No.

A-1



NOTE: GROUND FLOOR SITE PLAN PREPARED BY ANDERSON MASON DALE, DATED JUNE 14, 2015, USED AS BASE DRAWING.

LEGEND

B-1 — APPROXIMATE LOCATION OF TEST BORING

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	RWF	Project No.	23155021
Drawn By:	RMH	Scale:	AS SHOWN
Checked By:	RWF	File No.	Fig1-BLP
Approved By:	RWF	Date:	06-09-2015

Terracon
Consulting Engineers and Scientists
4172 Center Park Drive Colorado Springs, Colorado 80916
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EXPLORATION PLAN WITH PROPOSED IMPROVEMENTS

U.S. Olympic Museum

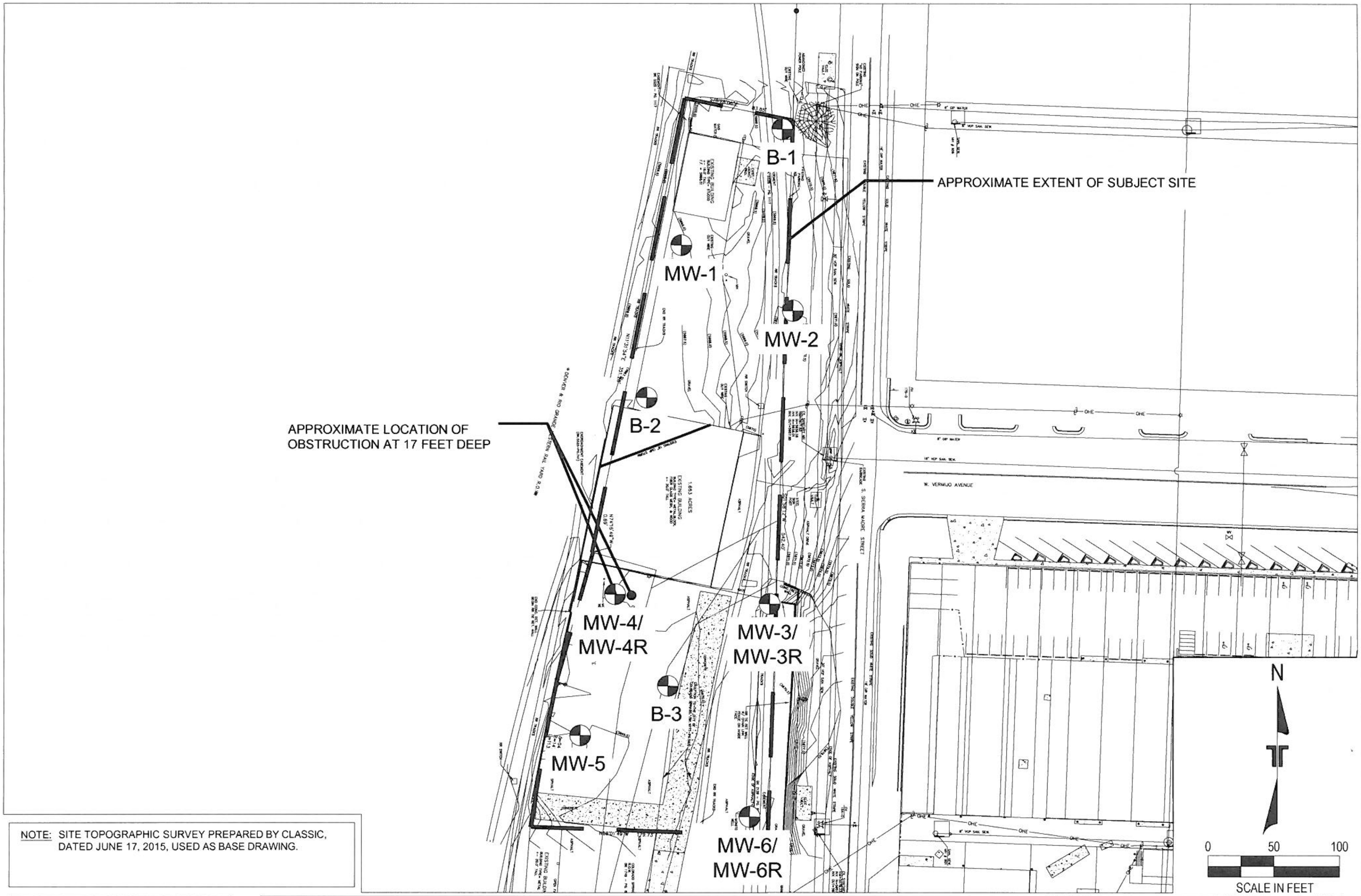
UNITED STATES OLYMPIC MUSEUM

SOUTH SIERRA MADRE STREET AND WEST VERMIJO AVENUE

COLORADO SPRINGS COLORADO

Ex. No.

A-2



NOTE: SITE TOPOGRAPHIC SURVEY PREPARED BY CLASSIC, DATED JUNE 17, 2015, USED AS BASE DRAWING.

LEGEND

B-1 — APPROXIMATE LOCATION OF TEST BORING

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	RWF	Project No.	23155021
Drawn By:	RMH	Scale:	AS SHOWN
Checked By:	RWF	File No.	Fig1-BLP
Approved By:	RWF	Date:	06-09-2015

Terracon
Consulting Engineers and Scientists
4172 Center Park Drive Colorado Springs, Colorado 80916
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EXPLORATION PLAN WITH SITE TOPOGRAPHY

U.S. Olympic Museum

UNITED STATES OLYMPIC MUSEUM

SOUTH SIERRA MADRE STREET AND WEST VERMIJO AVENUE

COLORADO SPRINGS COLORADO

Ex. No. A-3

NOTE: AERIAL SITE IMAGE OBTAINED FROM GOOGLE EARTH ON JUNE 9, 2015, USED AS BASE DRAWING.

LEGEND

B-1 APPROXIMATE LOCATION OF TEST BORING

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	RWF	Project No.	23155021
Drawn By:	RMH	Scale:	AS SHOWN
Checked By:	RWF	File No.	Fig1-BLP
Approved By:	RWF	Date:	06-09-2015

Terracon
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EXPLORATION PLAN WITH EXISTING SITE FEATURES

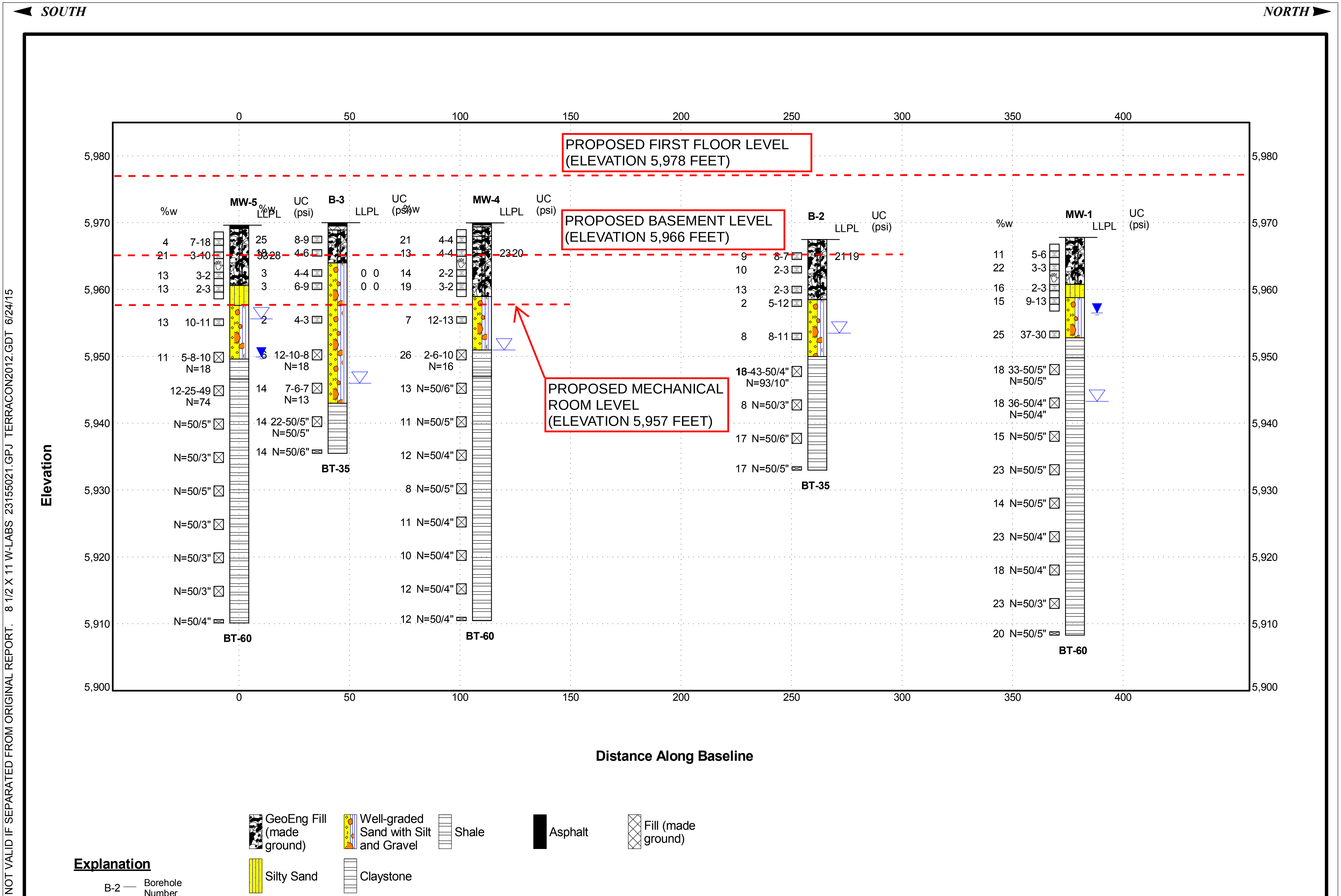
U.S. Olympic Museum

UNITED STATES OLYMPIC MUSEUM

SOUTH SIERRA MADRE STREET AND WEST VERMIJO AVENUE

COLORADO SPRINGS COLORADO

Ex. No. A-4



NOTES:
See Exhibit A-2 for orientation of soil profile.
See General Notes in Appendix C for symbols and soil classifications.
Soils profile provided for illustration purposes only.
Soils between borings may differ
AR - Auger Refusal
BT - Boring Termination

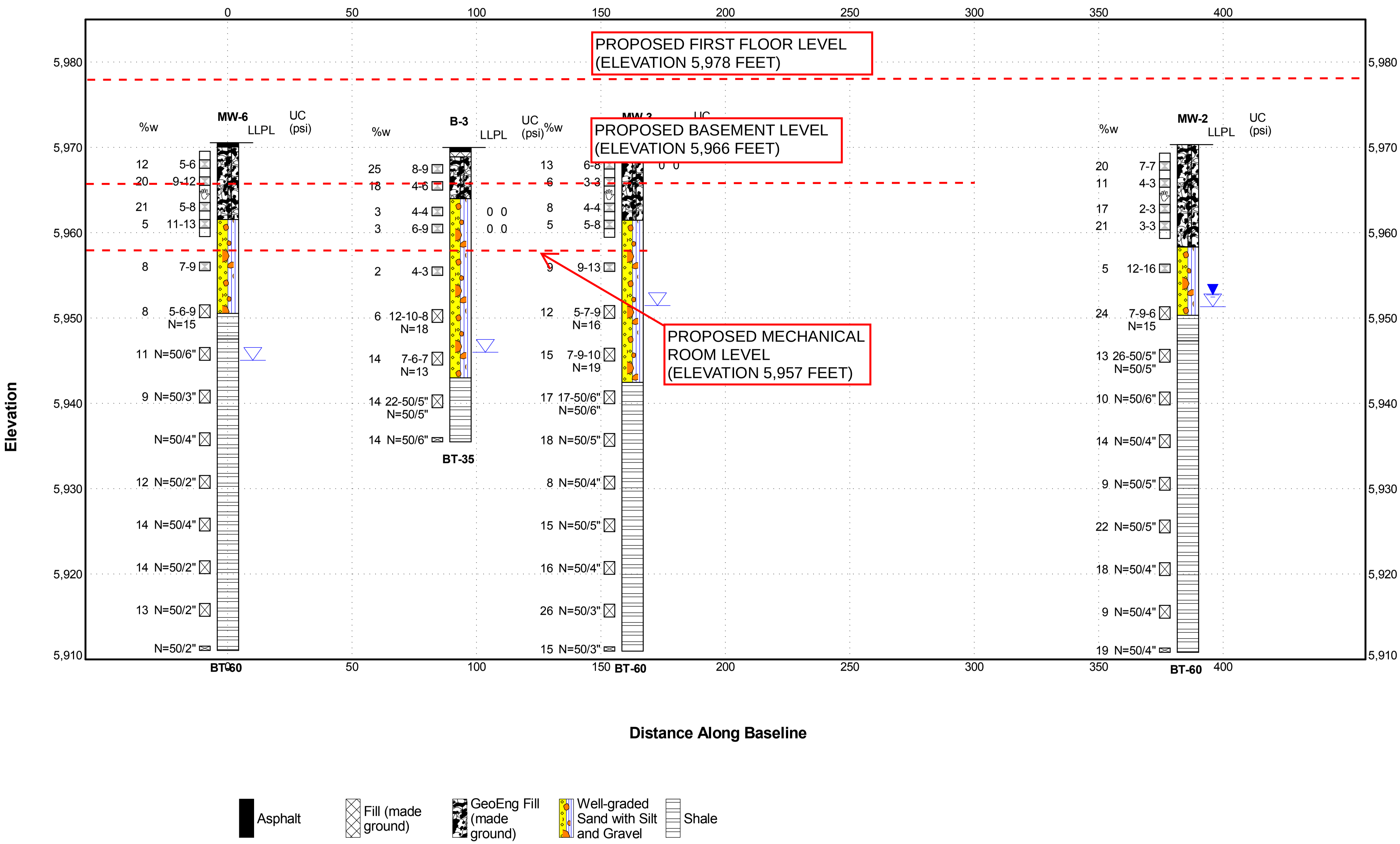
Project Manager: BR	Project No.: 23155021
Drawn by: RMH	Scale: N.T.S
Approved by: RWF	File Name: 23155021.WF
Date: 6/24/2015	

Terracon
4172 Center Park Drive
Colorado Springs, Colorado
PH. 719-597-2116 FAX. 719-597-2117

SUBSURFACE PROFILE

FENCE DIAGRAM WESTERN PROPERTY BOUNDARY
U.S. OLYMPIC MUSEUM
SIERRA MADRE STREET AND VERMIJO AVENUE
COLORADO SPRINGS, COLORADO

EXHIBIT
A-5



Explanation

- B-3 — Borehole Number
- Moisture Content — %w
- LL PL — Liquid and Plastic Limits
- Sampling — Borehole Lithology
- AR / BT — Borehole Termination Type
- ▽ Water Level Reading at time of drilling.
- ▼ Water Level Reading after drilling.

NOTES:
See Exhibit A-2 for orientation of soil profile.
See General Notes in Appendix C for symbols and soil classifications.
Soils profile provided for illustration purposes only.
Soils between borings may differ
AR - Auger Refusal
BT - Boring Termination

Project Manager: BR	Project No.: 23155021
Drawn by: RMH	Scale: N.T.S
Approved by: RWF	File Name: 23155021.WF
Date: 6/24/2015	

Terracon
4172 Center Park Drive
Colorado Springs, Colorado
PH. 719-597-2116 FAX. 719-597-2117

SUBSURFACE PROFILE

FENCE DIAGRAM EASTERN PROPERTY BOUNDARY
U.S. OLYMPIC MUSEUM
SIERRA MADRE STREET AND VERMIJO AVENUE
COLORADO SPRINGS, COLORADO

EXHIBIT A-5

Field Exploration Description

Nine test borings were drilled between May 12 and May 18, 2015 to depths of approximately 34½ to 59½ feet below existing site grade at the approximate location shown on the Exploration Plan, Exhibit A-2, with a track-mounted drill rig using 4¼-inch diameter hollow-stem auger.

The boring locations were located in the field by referencing existing site features. Elevations were obtained at the boring locations by interpolation of contours on the provided site layout. Elevations at monitoring well locations were provided by the project surveyor. The accuracy of the boring locations and elevations should only be assumed to the level implied by the method used.

Lithologic logs of the borings were recorded by the Terracon field representative during drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon and ring barrel samplers. Representative bulk samples of subsurface materials were also obtained.

Penetration resistance measurements were obtained by driving the split-spoon and ring barrel samplers into the subsurface materials with a 140-pound hammer falling 30 inches. The penetration resistance value is a useful index to the consistency, relative density or hardness of the materials encountered.

An automatic SPT hammer was used to advance the sampler in the boring performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the barrel blow counts, SPT values, and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

Groundwater measurements were made in the borings at the time of site exploration and up to 21 days after drilling in selected monitoring wells. Borings B-1 to B-3 were backfilled with auger cuttings prior to leaving the site. Monitoring wells set with a minimum 10 feet of two-inch diameter, slotted PVC pipe. Solid PVC pipe was installed to the ground surface. The lower 10 feet of the wells were backfilled with silica sand, followed by approximately 2 feet of hydrated bentonite chips, then cement bentonite grout to the ground surface. The wells were completed with a flush mount, locking caps at the ground surface. Due to insufficient groundwater within Monitoring Wells MW-3, MW-4, and MW-6, supplemental Monitoring Wells MW-3R, MW-4R, MW-6R were installed to deeper depths and approximately 5 to 10 feet from previously installed wells. Results of well installation and environmental services are reported in the Terracon Limited Site Investigation report.

BORING LOG NO. B-1

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum, Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue, Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8305° Longitude: -104.8292°

Surface Elev.: 5970 (Ft.)

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2	**ASPHALT CONCRETE**, approximately 2½ inches.	5970								
	FILL - SILTY SAND (SM), brown to dark brown, very loose to loose, fine to medium grained, trace gravel.				6-6	84	7	116		
			5		3-3	18.8	8	106	18-15-3	18
8.0		5962			5-5	16.5	4	105		
11.0	**SILTY CLAYEY SAND (SC-SM)**, light brown, loose, fine to coarse grained.	5959	10		4-4	5.5	6	110	18-14-4	16
	WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM), light brown, medium dense, fine to coarse grained.		15		9-19	3.9	2	112		
	trace clay at 19 feet.		20		5-8-11 N=19	2.8	8			
23.5	apparent cobbles from 22 to 23 feet.	5946.5								
	SHALE, dark gray, very hard		25		11-43-50/3" N=93/9"	2.1	15			
			30		38-50/2" N=50/2"	3.7	13			
34.5		5935.5			N=50/5"	5.5	11			

Boring Terminated at 34.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow stem

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed.

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 5/12/2015	Boring Completed: 5/12/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-8

BORING LOG NO. B-2

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.83° Longitude: -104.8297°
Northing: 364148.38 Easting: 192038.86

Surface Elev.: 5967.5 (Ft.)

GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - SILTY SAND (SM), brown to dark brown, very loose to loose, with coal cinders, wood, concrete, and brick fragments.				8-7	1.3	9	113	21-19-2	22
		5			2-3	.3	10	95		
	9.0 — 5958.5				2-3	1.2	13	110		
	WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM), light brown, loose to medium dense, fine to coarse grained.	10			5-12	1.3	2	114		
		15	▽		8-11	.8	8	119		
	17.5 — 5950									
	SHALE, dark gray, very hard	20			16-43-50/4" N=93/10"	2.1	13			
		25			N=50/3"	1.7	8			
		30			N=50/6"	5.3	17			
	34.5 — 5933				N=50/5"	2.6	17			
	Boring Terminated at 34.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS
▽

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 5/12/2015 | Boring Completed: 5/12/2015
Drill Rig: CME-55 | Driller: Vine
Project No.: 23155021 | Exhibit: A-9

BORING LOG NO. B-3

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8294° Longitude: -104.8296°
Northing: 363928.51 Easting: 192054.99

Surface Elev.: 5970 (Ft.)

DEPTH		ELEVATION (Ft.)
0.5	**ASPHALT CONCRETE**, approximately 5 inches.	5969.5
1.1	**BASE COURSE**, approximately 8 inches.	5969
6.0	**FILL - SILTY SAND (SM)**, brown to dark brown, loose, fine to medium grained, with coal cinders.	5964
27.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, loose to medium dense, fine to coarse grained, sample disturbed at 7 feet. poorly graded sand lens at 9 feet. apparent cobbles from 16 to 17 feet.	5943
34.5	**SHALE**, dark gray, hard to very hard	5935.5

Boring Terminated at 34.5 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
~2.5			8-9	3.2	25	68		
~4.5			4-6	1.1	18	86		
~7.5			4-4	ND	3		NP	5
~9.5			6-9	1.2	3	107	NP	3
~14.5			4-3	.6	2	103		
~20			12-10-8 N=18	1.1	6			
~25	▽ (approx. 23.5)		7-6-7 N=13	2.5	14			
~30			22-50/5" N=50/5"	1.7	14			
~34.5			N=50/6"	7.8	14			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 5/12/2015	Boring Completed: 5/12/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-10

WELL LOG NO. MW-1

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8304° Longitude: -104.8296°
Northing: 364262.87 Easting: 192065.04

Surface Elev.: 5967.8 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0–7.0	**FILL - SILTY SAND (SM)**, brown to dark brown, loose, fine to medium grained, with coal cinders.	5961
7.0–9.0	**SILTY SAND (SM)**, brown, loose, fine to medium grained.	5959
9.0–15.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, medium dense to dense, fine to coarse grained. apparent cobbles from 10 to 11 feet.	5953
15.0–18.0	**WEATHERED CLAYSTONE**, dark brown, very dense	5950
18.0–59.5	**SHALE**, dark gray, very hard	5908.5
	Boring Terminated at 59.5 Feet	

DEPTH (Ft.) (approx.)	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2.5	5-6	ND	11	107		
4.5	3-3	ND	22	100		
7.5	2-3	1.6	16	107		
9.5	9-13	1.5	15	107		
14.5	37-30	1.7	25	97		
20	33-50/5" N=50/5"	.5	18			
25	36-50/4" N=50/4"	ND	18			
30	N=50/5"	ND	15			
35	N=50/5"	ND	23			
40	N=50/5"	2	14			
45	N=50/4"	.4	23			
50	N=50/4"	ND	18			
55	N=50/3"	2.1	23			
59.5	N=50/5"	5.8	20			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings converted into monitoring wells.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *5/13/2015*
- ▽ *5/21/2015*
- ▼ *06/09/2015*

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Well Started: 5/13/2015	Well Completed: 5/13/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-11

WELL LOG NO. MW-2

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8301° Longitude: -104.8292°
Northing: 364213.51 Easting: 192149.78

Surface Elev.: 5970.32 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
	FILL - SILTY SAND (SM), brown to dark brown, very loose to loose, fine to medium grained, with coal cinders. trace clay at 9 feet.	
12.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, loose to medium dense, fine to coarse grained.	5958.5
20.0	**WEATHERED CLAYSTONE**, dark brown, firm	5950.5
23.0	**SHALE**, dark gray, very hard	5947.5
59.5	***Boring Terminated at 59.5 Feet***	5911

DEPTH (Ft.)	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
~2.5	7-7	ND	20	89		
~4.5	4-3	ND	11	105		
~7.5	2-3	ND	17	98		
~9.5	3-3	.1	21	96		
~14.5	12-16	ND	5	111		
~20	7-9-6 N=15	ND	24			
~25	26-50/5" N=50/5"	ND	13			
~30	N=50/6"	.8	10			
~35	N=50/4"	.6	14			
~40	N=50/5"	2.8	9			
~45	N=50/5"	ND	22			
~50	N=50/4"	3.8	18			
~55	N=50/4"		9			
~59.5	N=50/4"		19			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings converted into monitoring wells.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS
- ▽ *5/13/2015*
- ▽ *5/21/2015*
- ▼ *06/09/2015*

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Well Started: 5/13/2015	Well Completed: 5/13/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-12

WELL LOG NO. MW-3

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum, Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue, Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8296° Longitude: -104.8298°
Northing: 363991.09 Easting: 192132.14

Surface Elev.: 5970.48 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0–9.0	**FILL - SILTY SAND (SM)**, brown, very loose to loose, fine to medium grained, with coal cinders.	5961.5
9.0–28.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, loose to medium dense, fine to medium grained. apparent cobbles from 12½ to 13 feet. apparent cobbles from 22 to 23½ feet.	5942.5
28.0–59.5	**SHALE**, dark gray, very hard	5911

Boring Terminated at 59.5 Feet

FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
6-8	.4	13	107	NP	40
3-3	.2	6	106		
4-4	.3	8	104		
5-8	.5	5	107		
9-13	.3	9	109		
5-7-9 N=16	ND	12			
7-9-10 N=19	.5	15			
17-50/6" N=50/6"	.4	17			
N=50/5"	1.1	18			
N=50/4"	7.1	8			
N=50/5"	18.4	15			
N=50/4"	7.4	16			
N=50/3"	.7	26			
N=50/3"	7.1	15			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings converted into monitoring wells.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS
5/14/2015
06/09/2015

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Well Started: 5/14/2015	Well Completed: 5/14/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-13

WELL LOG NO. MW-4

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum, Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue, Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8296° Longitude: -104.8293°
Northing: 363998.39 Easting: 192014.85

Surface Elev.: 5969.98 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0.3	**ASPHALT CONCRETE**, approximately 3½ inches.	5969.5
0.6	**BASE COURSE**, approximately 4 inches.	5969.5
2.0	**FILL - WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, brown, loose, fine to coarse grained.	5968
4.0	**FILL - LEAN CLAY WITH GRAVEL (CL)**, brown, medium stiff	5966
11.0	**FILL - SILTY SAND (SM)**, brown, very loose to loose, fine grained, with coal cinders.	5959
19.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, loose to medium dense, fine to coarse grained. apparent cobbles from 12½ to 13½ feet.	5951
23.0	**WEATHERED CLAYSTONE**, dark brown, firm	5947
59.5	**SHALE**, dark gray, very hard	5910.5

Well boring offsest 10 feet east and hit auger refusal at 17 feet.

Boring Terminated at 59.5 Feet

DEPTH (Ft.)	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
~2.5	4-4	.4	21	93		
~4.5	4-4	.8	13	97	23-20-3	24
~7.5	2-2	.4	14	107		
~9.5	3-2	.7	19	100		
~14.5	12-13	.7	7	108		
~19.5	2-6-10 N=16	.5	26			
~24.5	N=50/6"	.7	13			
~29.5	N=50/5"	5.1	11			
~34.5	N=50/4"	7.9	12			
~39.5	N=50/5"	14.6	8			
~44.5	N=50/4"	23.4	11			
~49.5	N=50/4"	11.8	10			
~54.5	N=50/4"	20.4	12			
~59.5	N=50/4"	16.3	12			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings converted into monitoring wells.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

5/14/2015
06/09/2015

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Well Started: 5/14/2015	Well Completed: 5/14/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-14

WELL LOG NO. MW-5

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8292° Longitude: -104.8299°
Northing: 363890.72 Easting: 191988.49

Surface Elev.: 5969.63 (Ft.)

DEPTH	Description	ELEVATION (Ft.)
0.5	**ASPHALT CONCRETE**, approximately 6 inches.	5969
9.0	**FILL - SILTY SAND (SM)**, brown, very loose to medium dense, fine to medium grained, with coal cinders.	5960.5
12.0	**SILTY SAND (SM)**, brown, very loose, fine grained, trace gravel.	5957.5
20.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, medium dense, fine to medium grained.	5949.5
23.0	**WEATHERED CLAYSTONE**, dark brown, firm	5946.5
59.5	**SHALE**, dark gray, very hard, trace calcium deposits.	5910
	Boring Terminated at 59.5 Feet	

FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
7-18	5.5	4	114		
3-10	5.6	21	69	33-28-5	15
3-2	2.4	13	106		
2-3	3.6	13	95		
10-11		13	106		
5-8-10 N=18	ND	11			
12-25-49 N=74	7.1				
N=50/5"	6.4				
N=50/3"	15.4				
N=50/5"	32.8				
N=50/3"	20.6				
N=50/3"	25.3				
N=50/3"	30.3				
N=50/4"	31.8				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings converted into monitoring wells.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

5/15/2015
5/21/2015
06/09/2015

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Well Started: 5/15/2015	Well Completed: 5/18/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-15

WELL LOG NO. MW-6

PROJECT: U.S. Olympic Museum

CLIENT: U.S. Olympic Museum, Colorado Springs, Colorado

SITE: Sierra Madre Street and Vermijo Avenue, Colorado Springs, Colorado

LOCATION See Exhibit A-2

Latitude: 38.8291° Longitude: -104.8293°
Northing: 363829.21 Easting: 192117.12

Surface Elev.: 5970.55 (Ft.)

DEPTH	DESCRIPTION	ELEVATION (Ft.)
0.5	**ASPHALT CONCRETE**, approximately 6 inches.	5970
9.0	**FILL - SILTY SAND (SM)**, brown, loose, fine grained, with coal cinders.	5961.5
20.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, light brown, loose to medium dense, fine to coarse grained. samples disturbed at 9 and 14 feet.	5950.5
23.0	**WEATHERED CLAYSTONE**, dark brown, firm	5947.5
59.5	**SHALE**, dark gray, very hard, trace calcium deposits.	5911

Boring Terminated at 59.5 Feet

DEPTH (Ft.)	FIELD TEST RESULTS	VAPOR TEST (ppm)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
~2.5	5-6	2.9	12	105		
~4.5	9-12	3.8	20	89		
~7.5	5-8	4.4	21	89		
~9.5	11-13	3.9	5			
~14.5	7-9	1.9	8			
~20	5-6-9 N=15	3.4	8			
~25	N=50/6"	5.5	11			
~30	N=50/3"	4	9			
~35	N=50/4"	42				
~40	N=50/2"	5.8	12			
~45	N=50/4"	2	14			
~50	N=50/2"	3.9	14			
~55	N=50/2"	2.1	13			
~59.5	N=50/2"	3.3				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4 1/4" Hollow Stem

Abandonment Method:
Borings converted into monitoring wells.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- *5/18/2015*
- *06/09/2015*

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Well Started: 5/15/2015	Well Completed: 5/18/2015
Drill Rig: CME-55	Driller: Vine
Project No.: 23155021	Exhibit: A-16

APPENDIX B

LABORATORY TESTING

Laboratory Testing

Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer. An applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials. The field descriptions were confirmed or modified as necessary, and were classified in general accordance with the Unified Soil Classification System described in Appendix C.

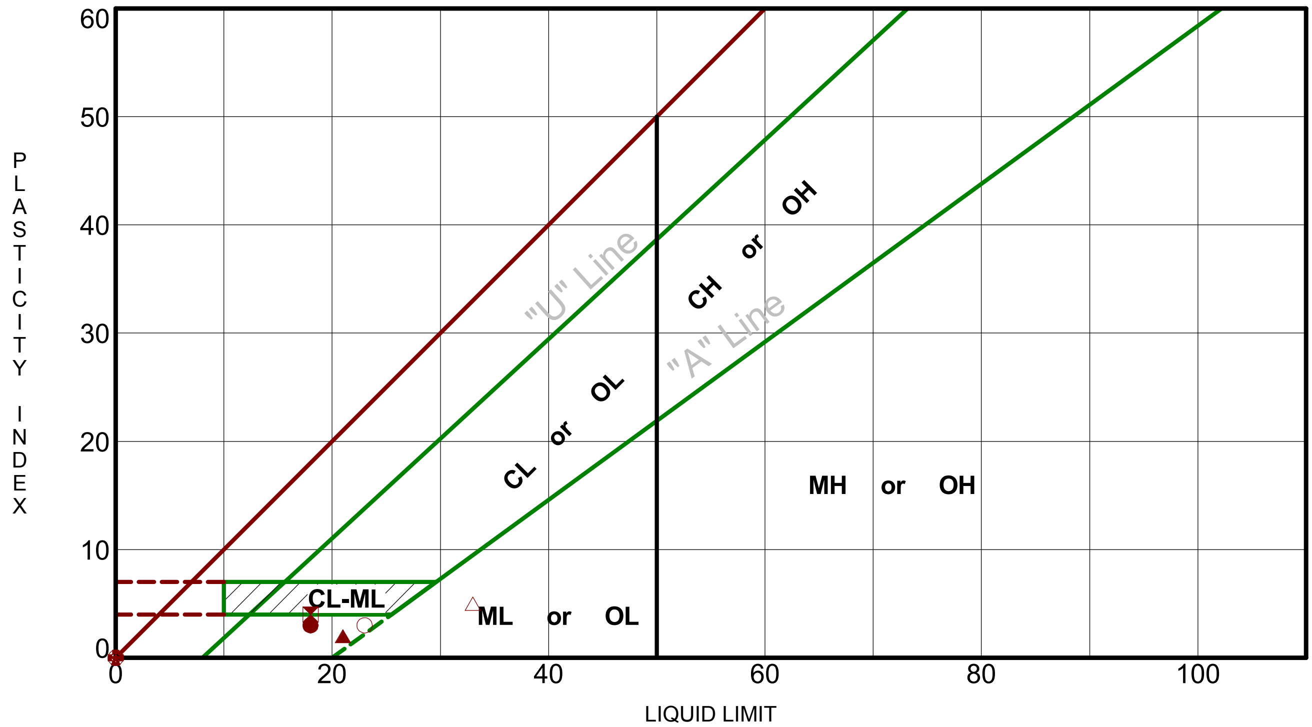
Laboratory test results are presented on the Boring Log and in Appendix B, and were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable Terracon test standards.

Selected soil samples were tested for the following engineering properties:

- Water content
- Dry density
- Grain size
- Plasticity index
- Electrical resistivity
- pH
- Water soluble sulfate content
- Water soluble chloride content

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B-1	4 - 5	18	15	3	18	SM	SILTY SAND
⧗	B-1	9 - 10	18	14	4	16	SC-SM	SILTY, CLAYEY SAND
▲	B-2	2 - 3	21	19	2	22	SM	FILL-SILTY SAND(SM)
★	B-3	7 - 8	NP	NP	NP	5	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
⊙	B-3	9 - 10	NP	NP	NP	3	SP	POORLY GRADED SAND with GRAVEL
✿	MW-3	2 - 3	NP	NP	NP	40	SM	SILTY SAND
○	MW-4	4 - 5	23	20	3	24	SM	FILL-SILTY SAND(SM)
△	MW-5	4 - 5	33	28	5	15	SM	SILTY SAND

PROJECT: U.S. Olympic Museum

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

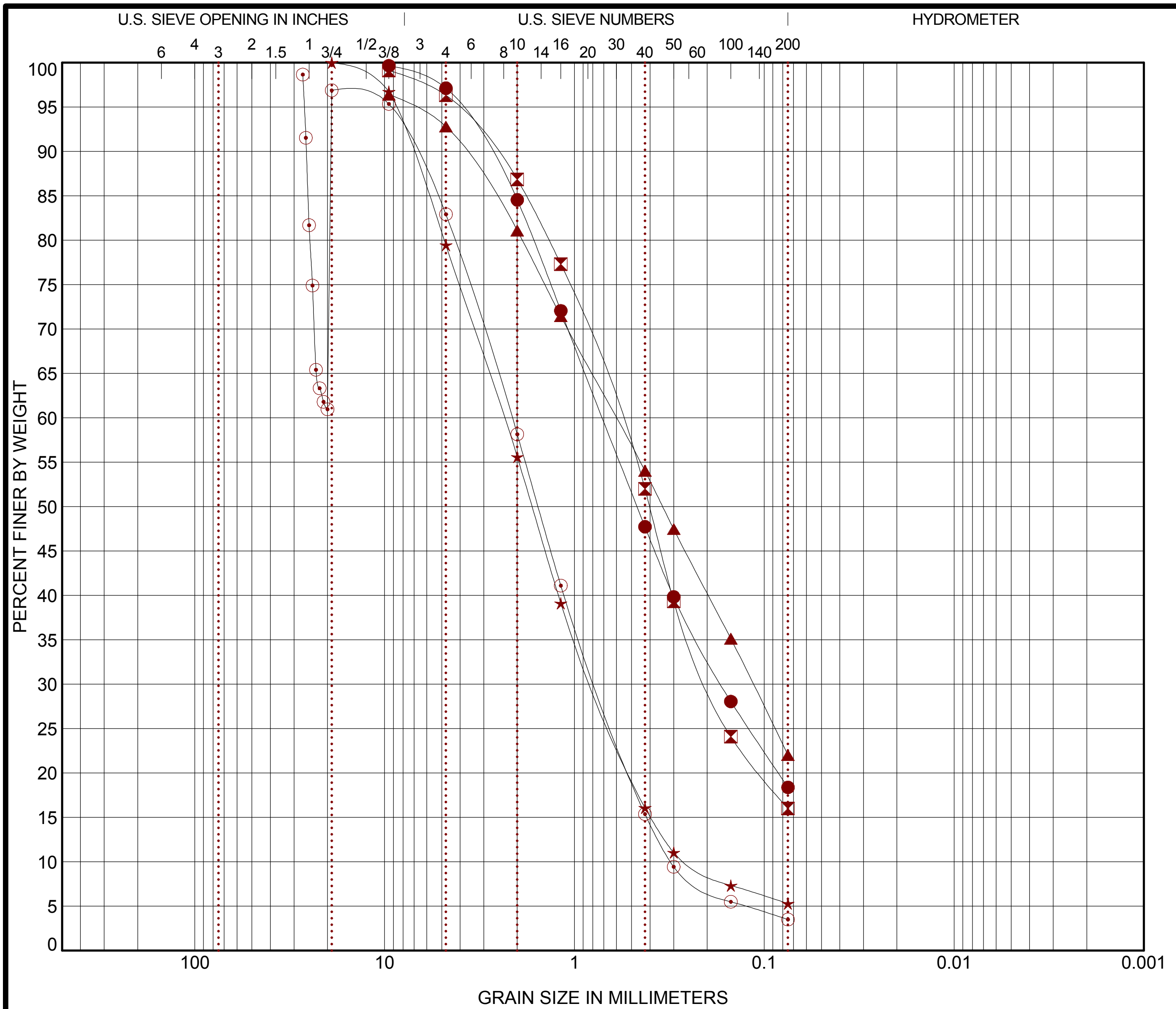
PROJECT NUMBER: 23155021

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



	Boring ID	Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-1	4 - 5	SILTY SAND(SM)	18	15	3		
⧗	B-1	9 - 10	SILTY, CLAYEY SAND(SC-SM)	18	14	4		
▲	B-2	2 - 3	FILL-SILTY SAND(SM)	21	19	2		
★	B-3	7 - 8	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	NP	NP	NP	1.07	9.50
⊙	B-3	9 - 10	POORLY GRADED SAND with GRAVEL(SP)	NP	NP	NP	0.20	29.43

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
●	B-1	4 - 5	9.5	0.711	0.168		2.5	78.7	18.4	
⧗	B-1	9 - 10	9.5	0.587	0.196		2.8	80.3	16.0	
▲	B-2	2 - 3	9.5	0.603	0.114		3.6	70.8	22.0	
★	B-3	7 - 8	19	2.346	0.788	0.247	20.5	74.2	5.3	
⊙	B-3	9 - 10	27	9.13	0.76	0.31	15.7	79.4	3.5	

PROJECT: U.S. Olympic Museum

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

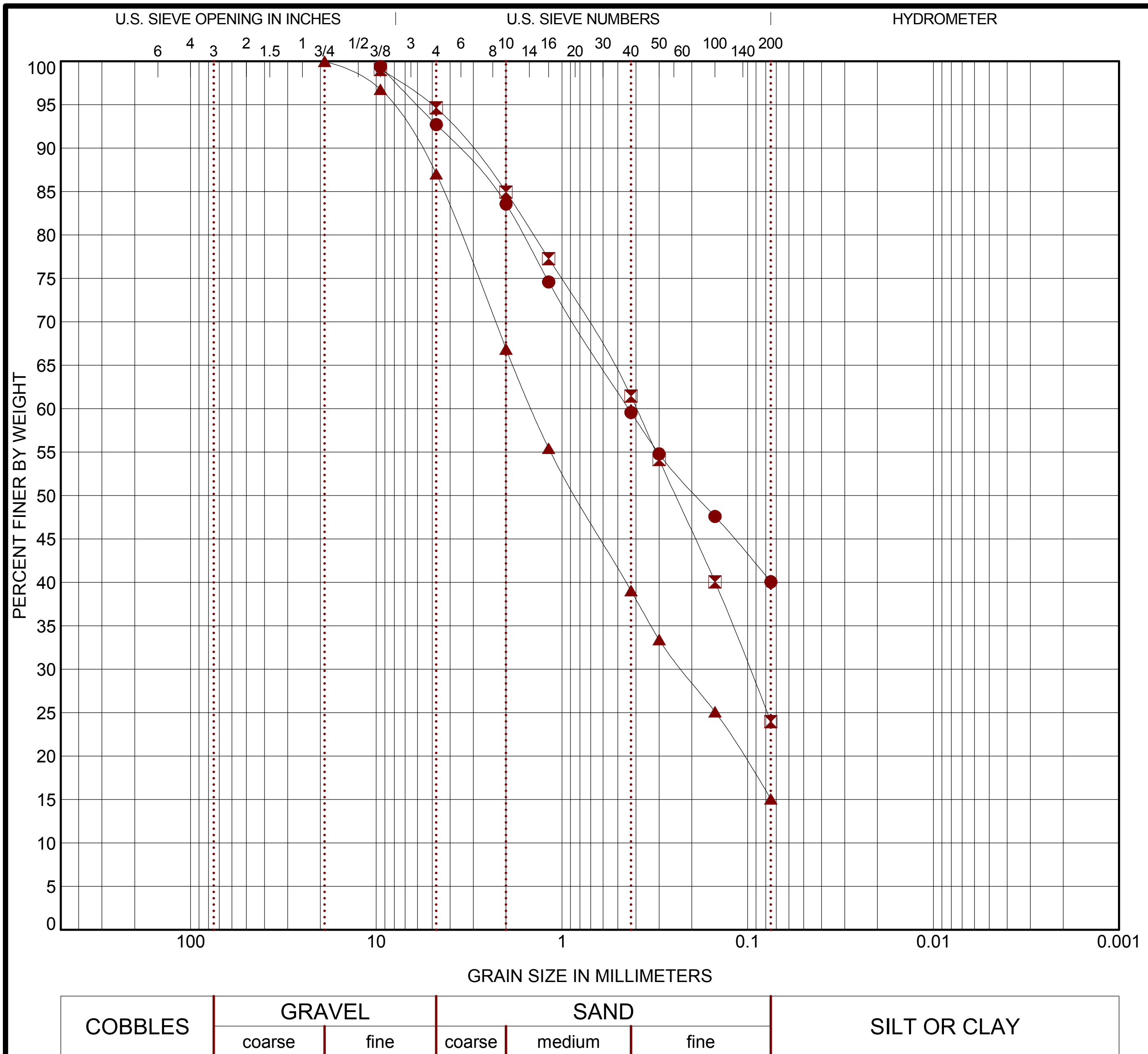
PROJECT NUMBER: 23155021

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

EXHIBIT: B-3

GRAIN SIZE DISTRIBUTION

ASTM D422



Boring ID	Depth	USCS Classification	LL	PL	PI	Cc	Cu
● MW-3	2 - 3	SILTY SAND(SM)	NP	NP	NP		
⧗ MW-4	4 - 5	FILL-SILTY SAND(SM)	23	20	3		
▲ MW-5	4 - 5	SILTY SAND(SM)	33	28	5		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
● MW-3	2 - 3	9.5	0.438			6.7	52.7	40.1	
⧗ MW-4	4 - 5	9.5	0.397	0.097		4.4	70.7	24.0	
▲ MW-5	4 - 5	19	1.456	0.226		13.0	72.0	15.1	

PROJECT: U.S. Olympic Museum

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

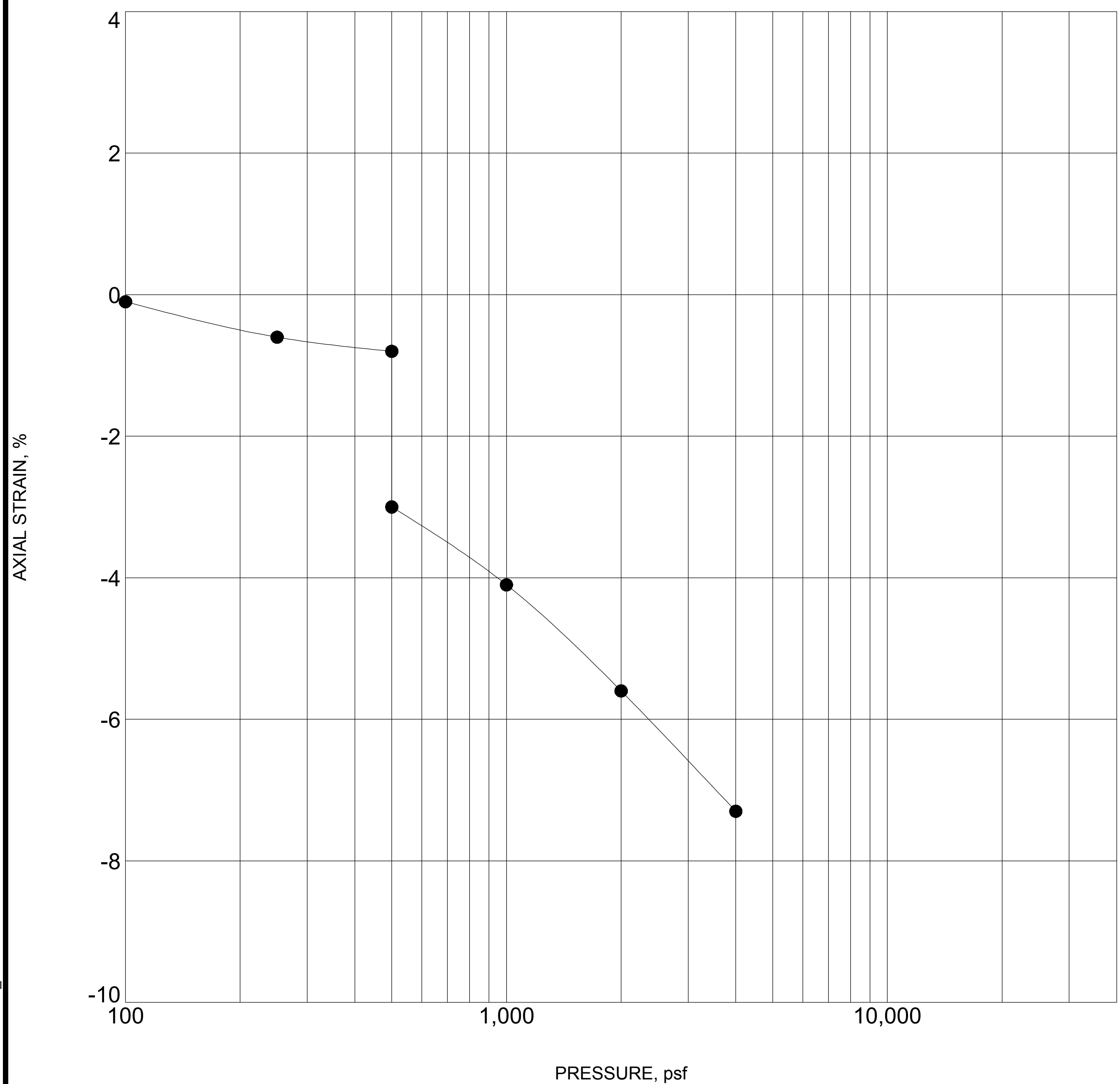
PROJECT NUMBER: 23155021

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

EXHIBIT: B-4

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-1	7 - 8 ft	FILL-SILTY SAND(SM)	105	4

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

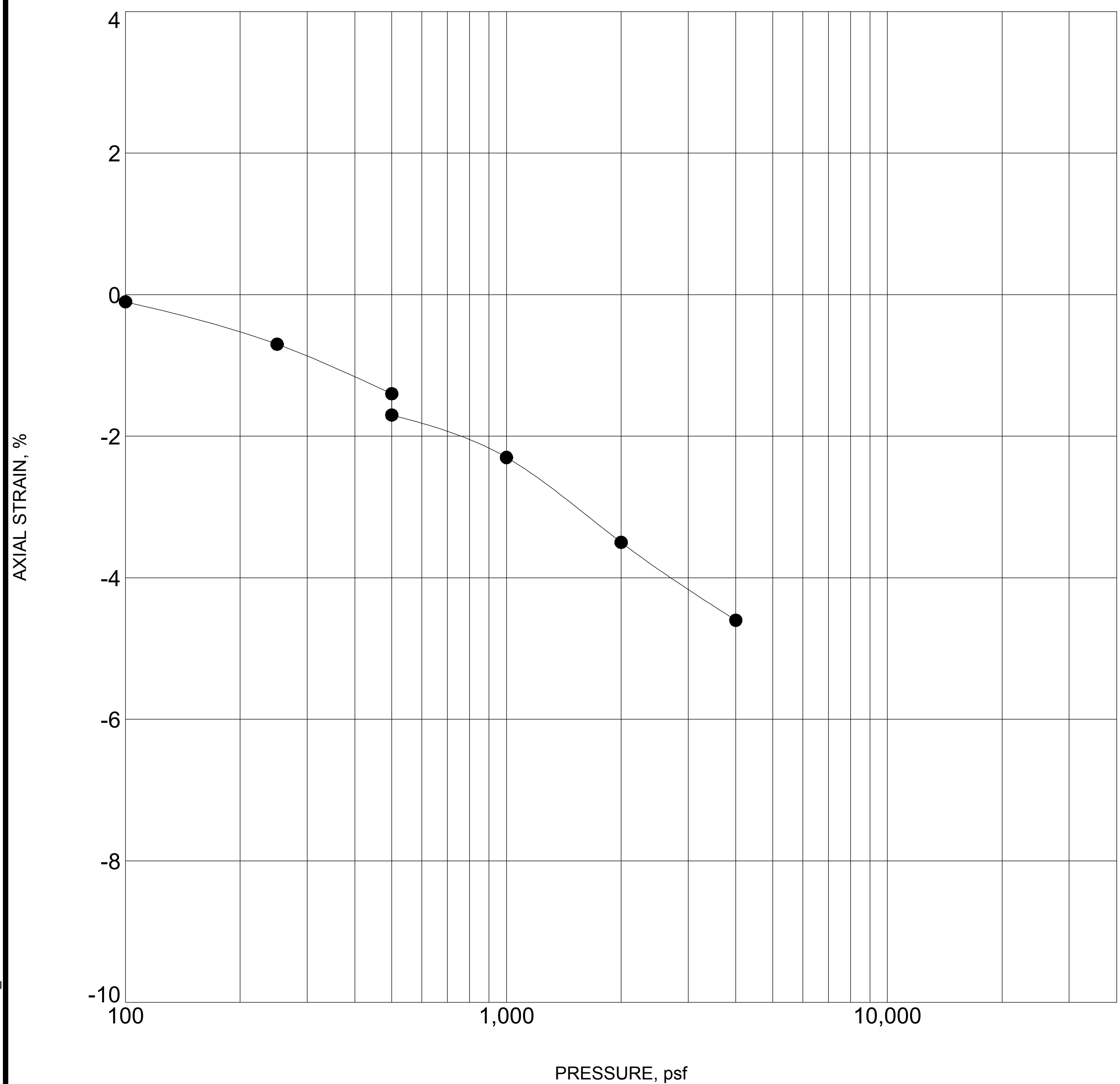
PROJECT NUMBER: 23155021

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

EXHIBIT: B-5

SWELL CONSOLIDATION TEST

ASTM D4546



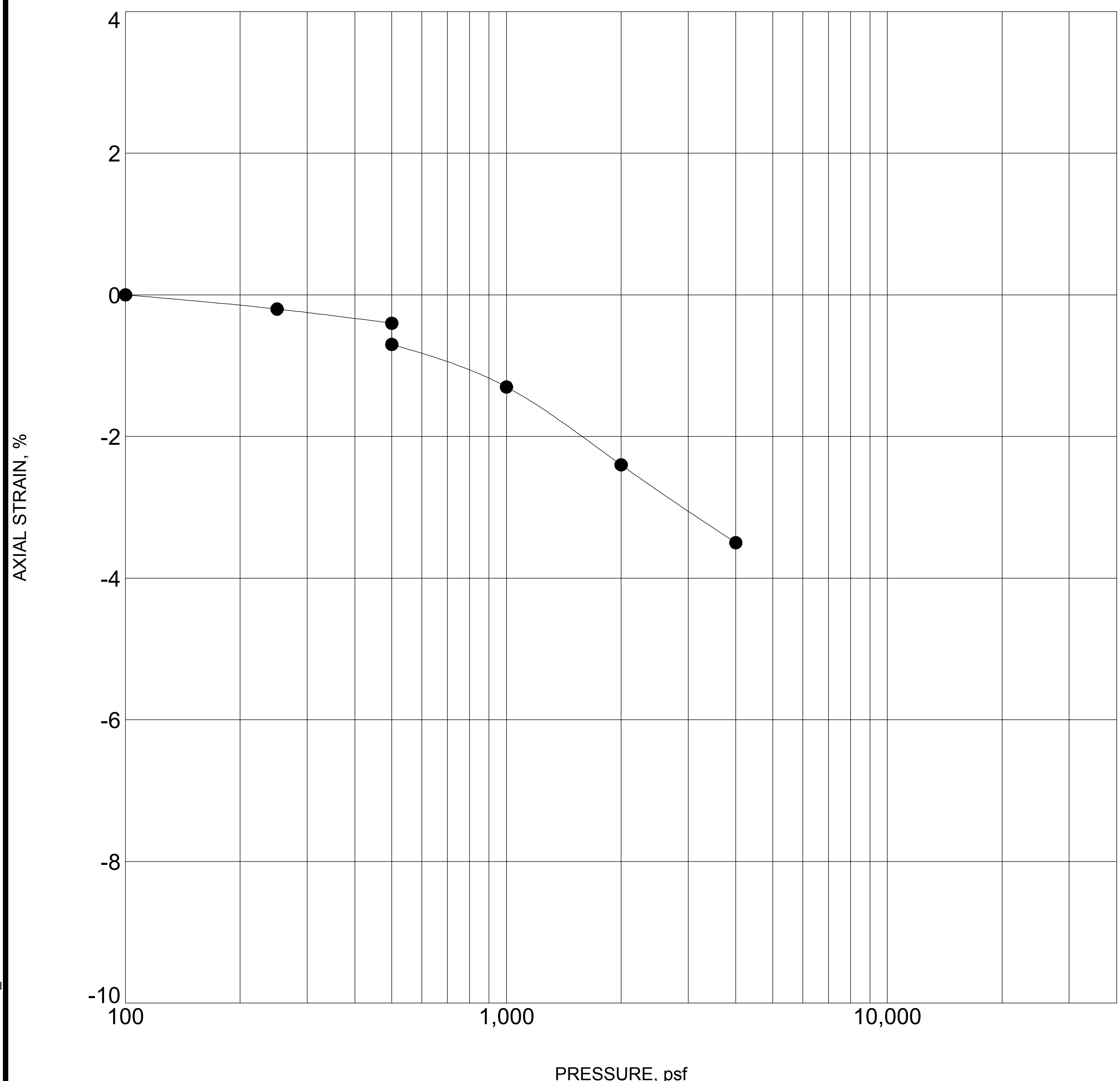
Specimen Identification		Classification	γ_d, pcf	WC, %
●	B-1 9 - 10 ft	SILTY, CLAYEY SAND(SC-SM)	110	6

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum	Terracon	PROJECT NUMBER: 23155021
SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado	4172 Center Park Drive Colorado Springs, Colorado	CLIENT: U.S. Olympic Museum Colorado Springs, Colorado
		EXHIBIT: B-6

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification		Classification	γ_d, pcf	WC, %
●	B-2 2 - 3 ft	FILL-SILTY SAND(SM)	113	9

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CONSOL_STRAIN-USCS 23155021.GPJ TERRACON2012.GDT 6/24/15

PROJECT: U.S. Olympic Museum

SITE: Sierra Madre Street and Vermijo Avenue
Colorado Springs, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

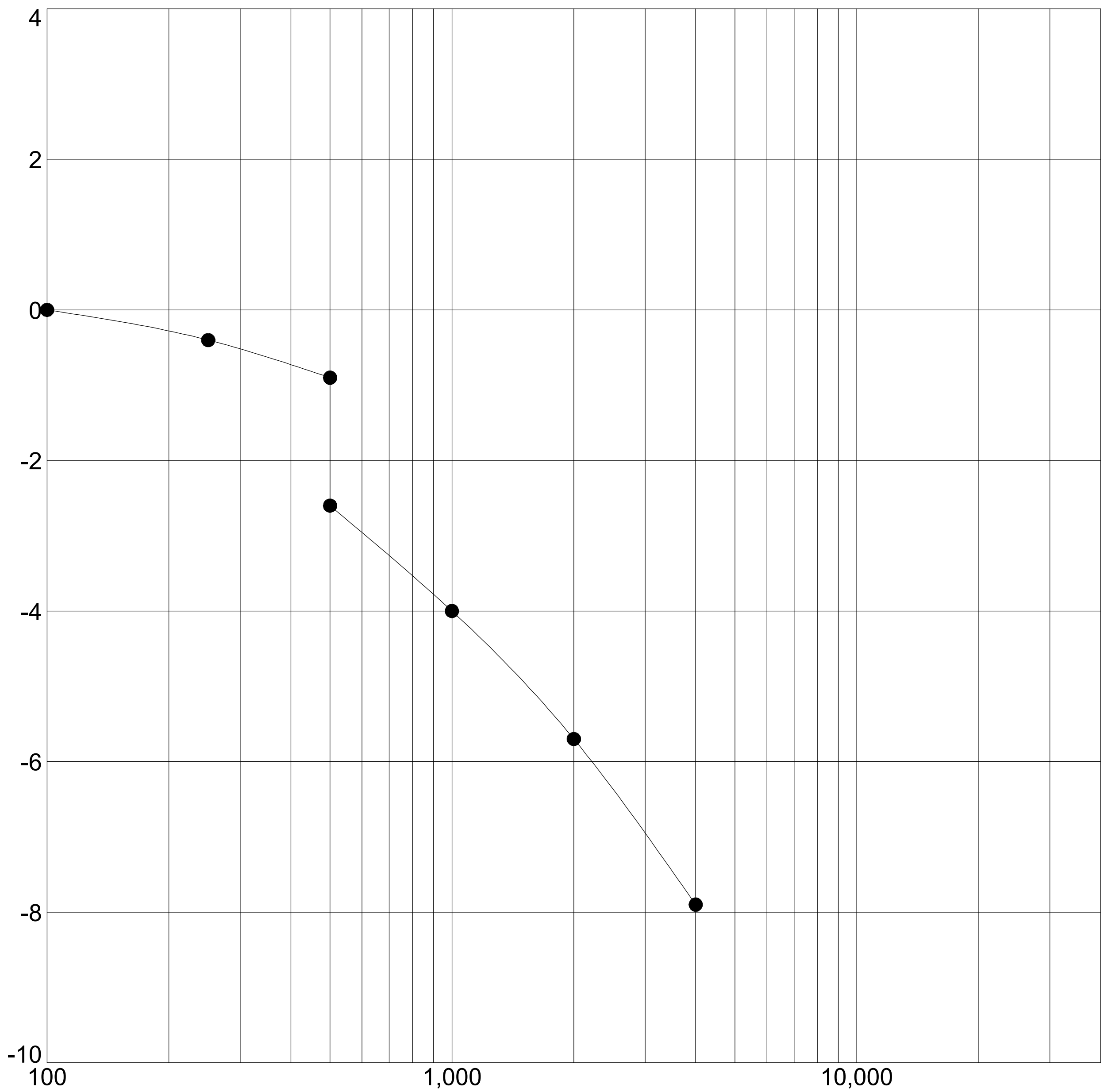
PROJECT NUMBER: 23155021

CLIENT: U.S. Olympic Museum
Colorado Springs, Colorado

EXHIBIT: B-7

SWELL CONSOLIDATION TEST

ASTM D4546



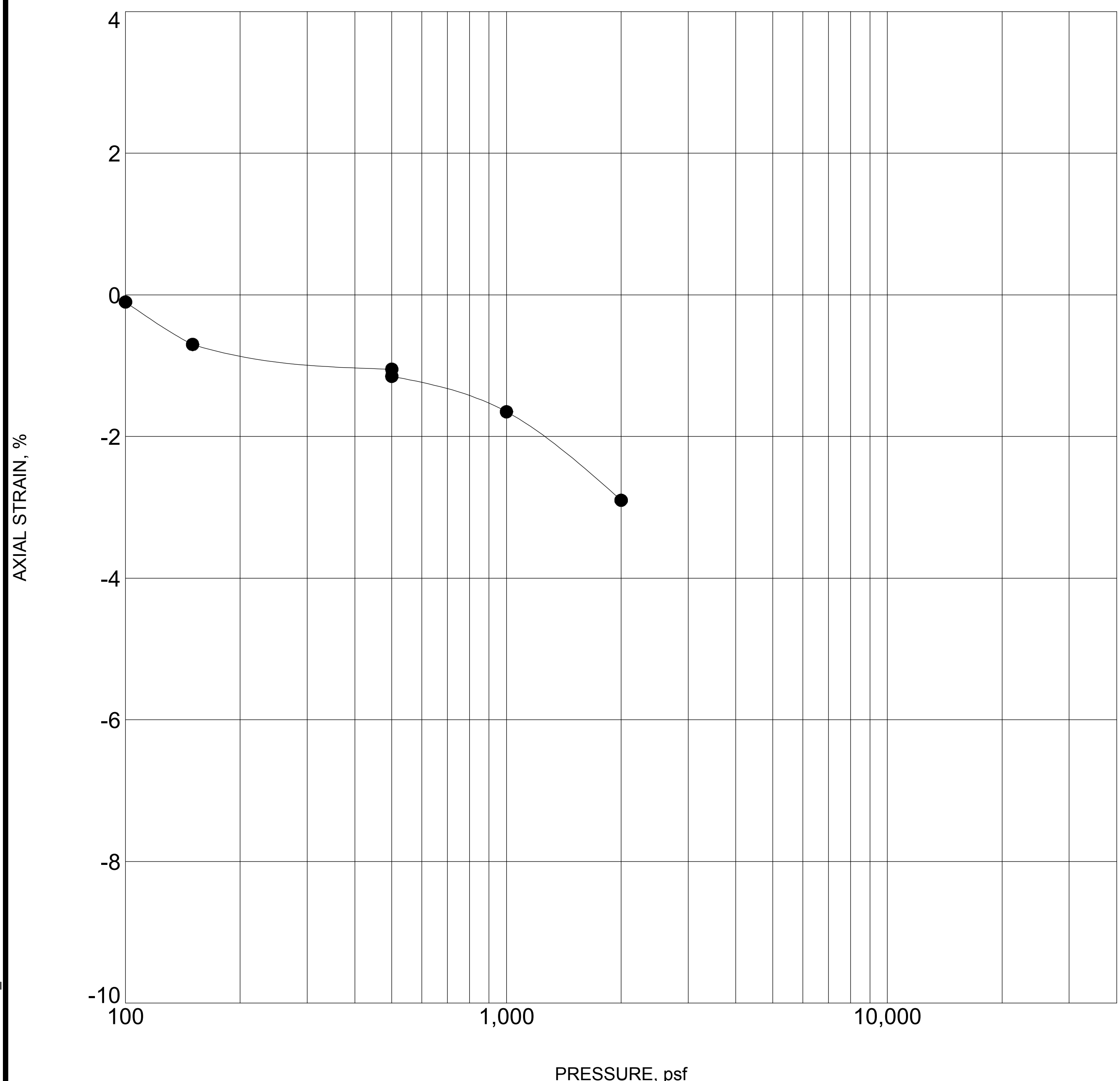
Specimen Identification		Classification	γ_d, pcf	WC, %
●	B-2 4 - 5 ft	FILL-SILTY SAND(SM)	95	10

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: 23155021
SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado		CLIENT: U.S. Olympic Museum Colorado Springs, Colorado
		EXHIBIT: B-8

SWELL CONSOLIDATION TEST

ASTM D4546



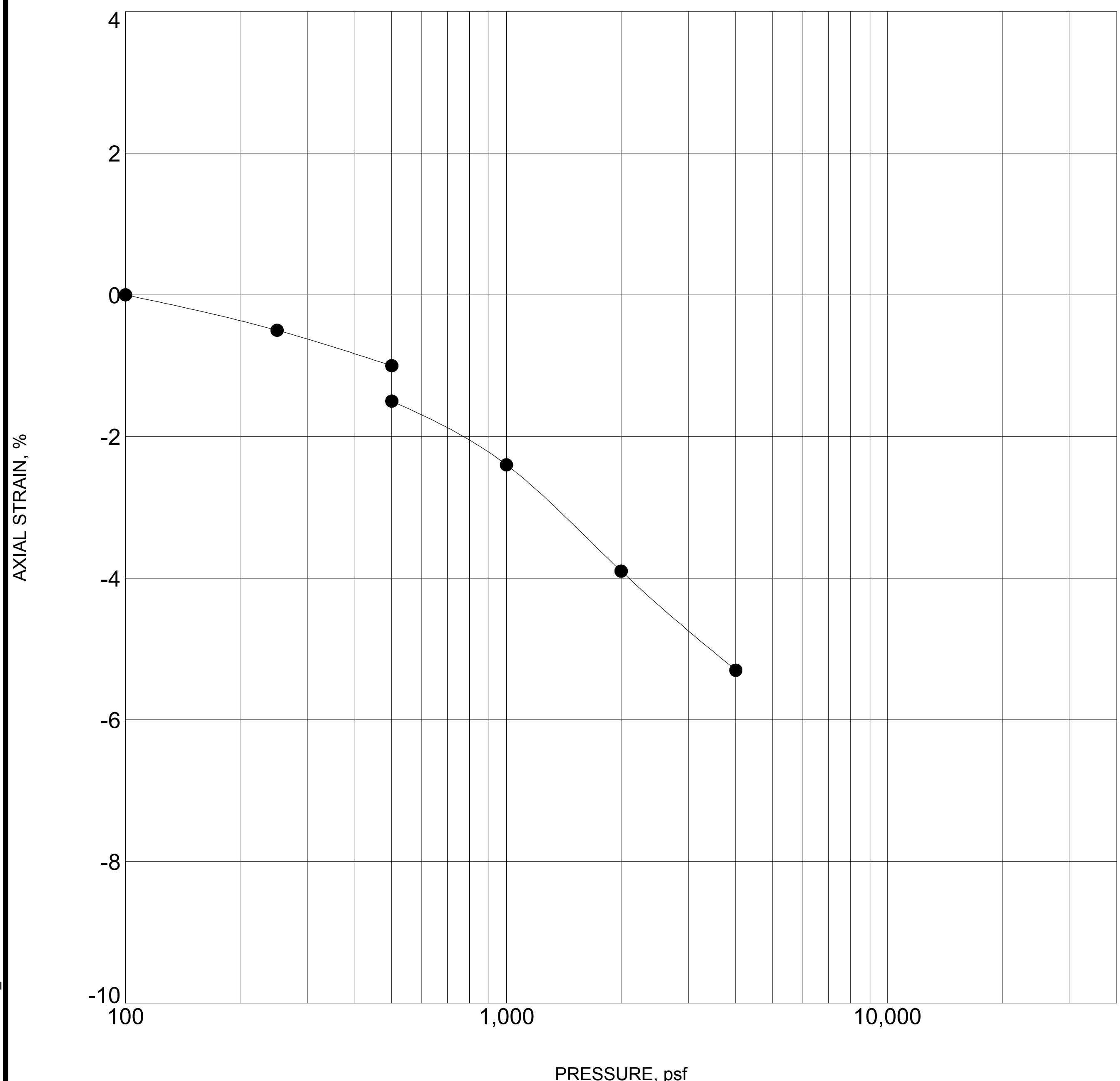
Specimen Identification		Classification	γ_d, pcf	WC, %
●	MW-2 4 - 5 ft	FILL-SILTY SAND(SM)	105	11

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum	Terracon	PROJECT NUMBER: 23155021
SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado	4172 Center Park Drive Colorado Springs, Colorado	CLIENT: U.S. Olympic Museum Colorado Springs, Colorado
		EXHIBIT: B-9

SWELL CONSOLIDATION TEST

ASTM D4546



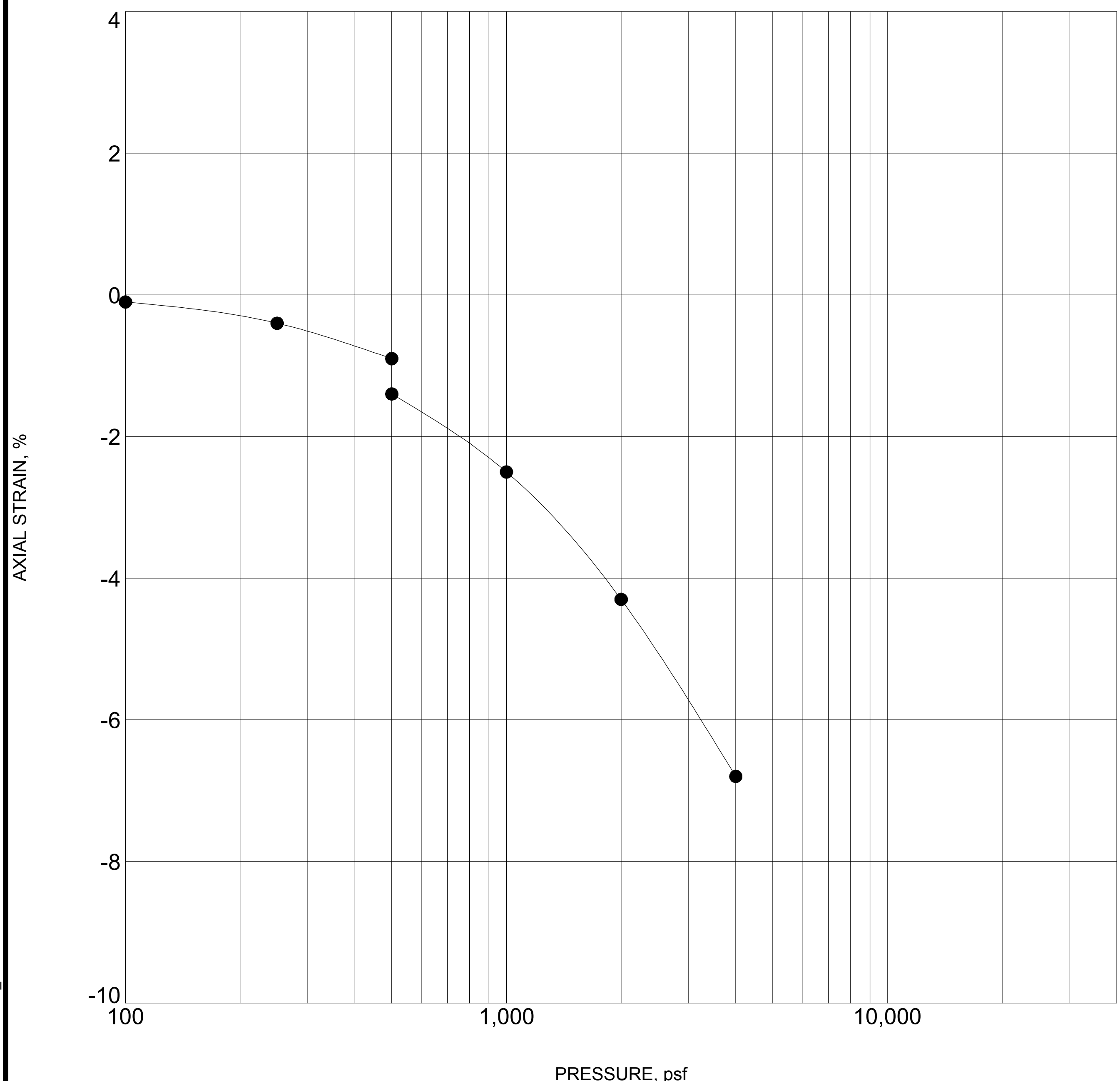
Specimen Identification		Classification	γ_d, pcf	WC, %
●	MW-3 7 - 8 ft	FILL-SILTY SAND(SM)	104	8

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: 23155021
SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado		CLIENT: U.S. Olympic Museum Colorado Springs, Colorado
		EXHIBIT: B-10

SWELL CONSOLIDATION TEST

ASTM D4546



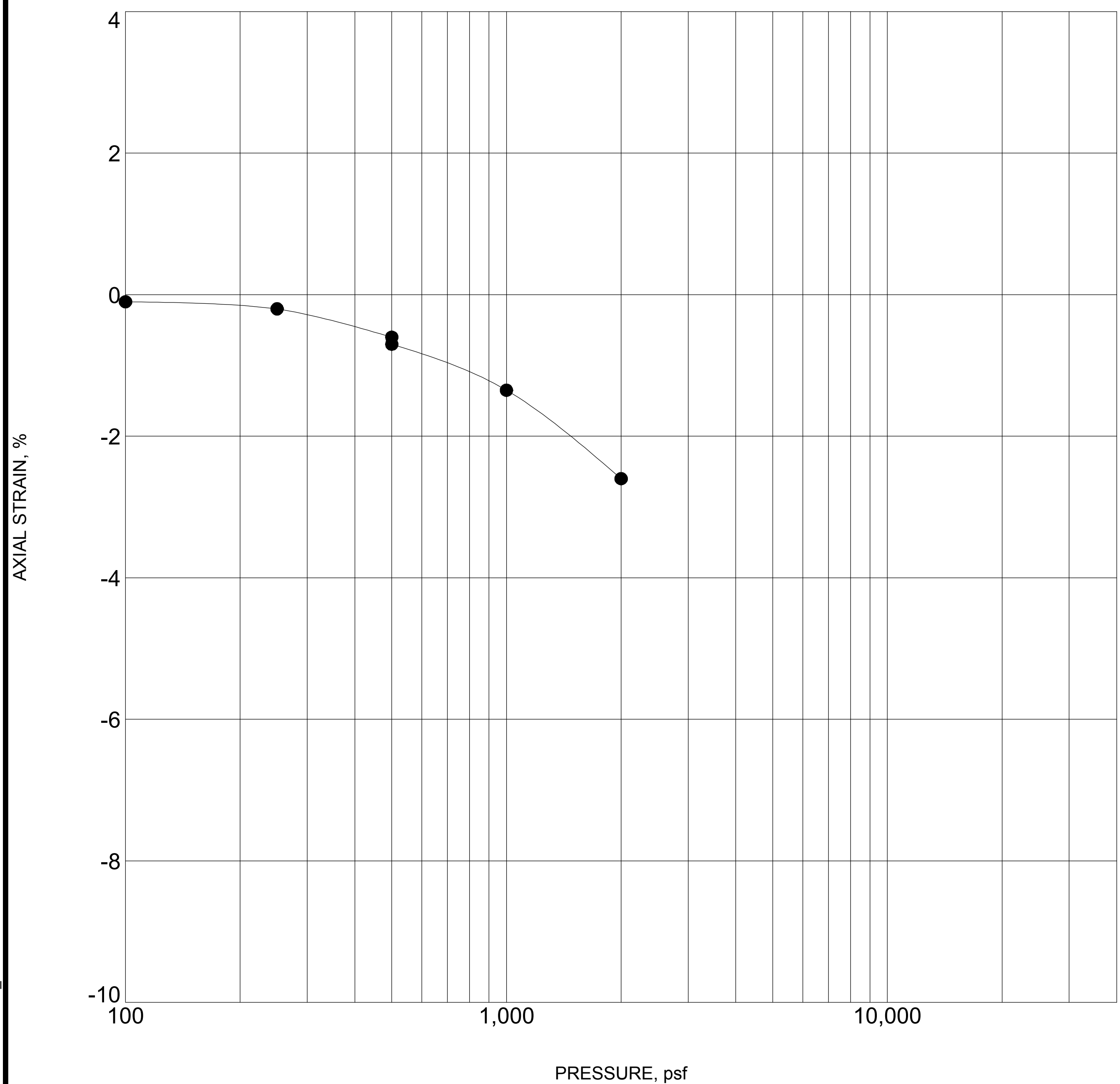
Specimen Identification		Classification	γ_d, pcf	WC, %
●	MW-4 4 - 5 ft	FILL-SILTY SAND(SM)	97	13

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum	Terracon	PROJECT NUMBER: 23155021
SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado	4172 Center Park Drive Colorado Springs, Colorado	CLIENT: U.S. Olympic Museum Colorado Springs, Colorado
		EXHIBIT: B-11

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification		Classification	γ_d, pcf	WC, %
●	MW-5 7 - 8 ft	FILL-SILTY SAND(SM)	106	13

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: U.S. Olympic Museum	Terracon	PROJECT NUMBER: 23155021
SITE: Sierra Madre Street and Vermijo Avenue Colorado Springs, Colorado	4172 Center Park Drive Colorado Springs, Colorado	CLIENT: U.S. Olympic Museum Colorado Springs, Colorado
		EXHIBIT: B-12

Colorado Analytical
LABORATORIES, INC.

Analytical Results

TASK NO: 150522042

Report To: Ryan Feist
Company: Terracon, Inc. - Colo Springs
4172 Center Park Drive
Colo. Springs CO 80916

Bill To: Accounts Payable
Company: Terracon, Inc. - Lenexa
13910 W. 96th Terrace
Lenexa KS 66215

Task No.: 150522042
Client PO:
Client Project: US Olympic Museum 23155021

Date Received: 5/22/15
Date Reported: 5/29/15
Matrix: Soil - Geotech

Customer Sample ID 23155021 Boring MW-1 1-10 Ft.
Lab Number: 150522042-01

Test	Result	Method
Chloride - Water Soluble	**0.0031 %**	AASHTO T291-91/ ASTM D4327
pH	**7.5 units**	AASHTO T289-91
Resistivity	**2257 ohm.cm**	AASHTO T288-91
Sulfate - Water Soluble	**0.005 %**	AASHTO T290-91/ ASTM D4327

Customer Sample ID 23155021 Boring MW-5 1-10 Ft.
Lab Number: 150522042-02

Test	Result	Method
Chloride - Water Soluble	**0.0007 %**	AASHTO T291-91/ ASTM D4327
pH	**7.3 units**	AASHTO T289-91
Resistivity	**4237 ohm.cm**	AASHTO T288-91
Sulfate - Water Soluble	**0.010 %**	AASHTO T290-91/ ASTM D4327

Abbreviations/ References:

AASHTO - American Association of State Highway and Transportation Officials.
ASTM - American Society for Testing and Materials.
ASA - American Society of Agronomy.
DIPRA - Ductile Iron Pipe Research Association Handbook of Ductile Iron Pipe.

Steve Nielson

DATA APPROVED FOR RELEASE BY

240 South Main Street / Brighton, CO 80601-0507 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507 / Fax: 303-659-2315

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
Ring Sampler	Rock Core
Grab Sample	No Recovery

WATER LEVEL

- **Water Initially Encountered**
- **Water Level After a Specified Period of Time**
- **Water Level After a Specified Period of Time**

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	**Hand Penetrometer**
(T)	**Torvane**
(b/f)	**Standard Penetration Test (blows per foot)**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance				**BEDROCK**		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3	< 30	< 20	Weathered
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4	30 - 49	20 - 29	Firm
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9	50 - 89	30 - 49	Medium Hard
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18	90 - 119	50 - 79	Hard
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42	> 119	>79	Very Hard
			Hard	> 8,000	> 30	> 42			

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

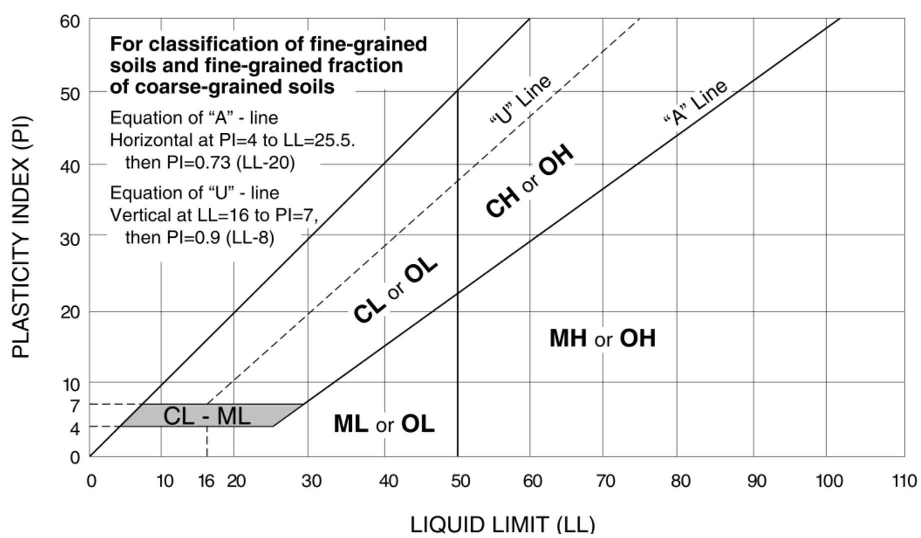


Exhibit C-2

GENERAL NOTES

Description of Rock Properties

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [a]		
Spacing	**Joints**	**Bedding/Foliation**
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD)		Joint Openness Descriptors	
RQD, as a percentage	**Diagnostic description**	**Openness**	**Descriptor**
Exceeding 90	Excellent	No Visible Separation	Tight
90 – 75	Good	Less than 1/32 in.	Slightly Open
75 – 50	Fair	1/32 to 1/8 in.	Moderately Open
50 – 25	Poor	1/8 to 3/8 in.	Open
Less than 25	Very poor	3/8 in. to 0.1 ft.	Moderately Wide
		Greater than 0.1 ft.	Wide

a. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976.

U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.