Geotechnical Engineering Report

VA Medical Center Geri-Psych Ward Addition

Sheridan, Wyoming

August 14, 2015

Project No. 26155024

Prepared for:

Calvin L. Hinz Architects, PC
Elkhorn, Nebraska 68022

Prepared by:

Terracon Consultants
Billings, Montana

Professional Engineer (Civil)
Gary W. Rome
4749
Date 8-14-2015
WYOMING

Terracon

August 14, 2015

Calvin L. Hinz Architects, PC
3705 North 200th Street
Elkhorn, Nebraska 68022

Attn: Ms. Rebecca Block, AIA, NCARB, LEED Green Associate
P: [402] 291-6941
F: [402] 291-9193
E: rblock@clharchitects.com

Re: Geotechnical Engineering Report
VA Medical Center Geri-Psych Ward Addition
Sheridan, Wyoming
Terracon Project Number: 26155024

Dear Ms. Block:

Terracon Consultants (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in accordance with the scope, terms and conditions in our proposal, Proposal No. G2614199, dated May 14, 2015, and authorized by Calvin L. Hinz Architects, PC (CLH Architects) on June 8, 2015 via signed Agreement for Services between Terracon and CLH Architects. This report presents the findings of the subsurface exploration and provides geotechnical recommendations for foundation design and construction for the proposed Geri-Psych Ward Addition at the VA Hospital in Sheridan, Wyoming.

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.

Orlando L. Boscan, P.E.
Geotechnical Manager

Gary W. Rome, P.E.
Regional Manager

Reviewed by: Brent Wilkins, P.E.

Enclosures

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EXECUTIVE SUMMARY

A geotechnical investigation has been performed for a building addition at the VA Medical Center in Sheridan, Wyoming. The current design concept considers a building option without basement and another option that includes a 6-foot deep basement. Two (2) soil borings, labeled B-01 and B-02, were drilled each to a depth of 17 feet below existing grade for the building addition. This report provides geotechnical recommendations for the design and construction of foundations for the proposed structure. These recommendations are based on the project information currently available and as described herein.

Based on the information obtained from our subsurface exploration and anticipated typical building loads, the foundation system at this site is recommended to primarily consist of shallow spread and strip footings. If a partial basement is not included in the final design, ground improvement will be required for shallow foundations. The following geotechnical conditions and design concepts have been used in the preparation of this report:

- Subsurface conditions encountered at the site generally consist of about 1 foot of top soil overlying silt with sand to depths of approximately 4 and 6 feet. Silty clayey sand with gravel was encountered below the silt with sand to a depth of approximately 12 feet. A layer of silty sand with gravel was observed below the silty clayey sand to a depth of 17 feet, the completion depth of the soil borings. It should be noted that the encountered soils were generally observed to be soft or loose in the upper 6 to 10 feet below existing grade. Groundwater was noted at a depth of approximately 17 feet in Boring B-02. Groundwater was not encountered in Boring B-01 during our drilling activities.

- Based on information provided by CLH Architects, it is our understanding that recommendations for supporting the structure on shallow foundations, with and without basement, are expected for the proposed building addition; those recommendations are provided herein.

- 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 summary 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
VA Medical Center Geri-Psych Ward Addition
Sheridan, Wyoming
Project No. 26155024
August 14, 2015

1.0 INTRODUCTION

Terracon has performed a geotechnical investigation for a proposed building addition at the VA Hospital in Sheridan, Wyoming. The focus of the geotechnical investigation was to characterize subsurface conditions at the project site and provide appropriate design and construction recommendations for the proposed addition structure foundations.

The purpose of this investigation is to provide information and geotechnical engineering recommendations relative to:

- Subsurface conditions
- Selection of appropriate foundation type
- Earthwork considerations
- Foundation design and construction
- Seismic considerations
- Corrosion Considerations

2.0 PROJECT INFORMATION

2.1 Site Location

ITEM	DESCRIPTION
Location	44.830028^{o} North, 106.988512^{o} West; the site is located within the existing VA Medical Center, approximately 2 miles northwest of downtown Sheridan, Wyoming.
Existing improvements	The VA Medical Center consists of a 40-acre complex with several buildings, driveways, parking areas, and recreational areas. An existing two-story building, about 190 by 190 feet in overall plan dimensions, lies just south of the proposed Geri-Psych Ward addition.
Current ground cover	Consists of landscaped grass.
Existing ground elevation	Ranges from approximately 3,894 feet to 3,898 feet.
Existing Topography	Survey data provided by CLH Architects indicate that there is a grade difference of approximately 4 feet across the site.

2.2 Project Description

ITEM	DESCRIPTION
Proposed structure	The proposed improvements consist of a 18,237 square foot, single-story, building addition to include fifteen (15) 350 square foot housing units and a 2,000 square foot physical therapy unit. Reportedly, loads for a future second story will be included in the current design. Reportedly, CLH Architects is considering an option for a 6.5-foot deep basement.
Finished floor elevation	First Level: 3,893.66 feet Basement (if included): 3,887.16 feet.
Maximum loads	Maximum column loads are 175 kips for the option without basement, and 275 kips for the design with basement.
Maximum allowable settlement	Total settlement, maximum, 1 inch (assumed) Differential settlement less than 1 inch (assumed)
Grading	Anticipated excavations to: -Level the site and to match the first floor elevation of the existing building. -Build the basement. - Remove and replace unsuitable soils beneath foundations.

3.0 SUBSURFACE CONDITIONS

3.1 Surficial Geology

The project site is on alluvial deposits primarily consisting of fine-grained and some coarse-grained materials. These materials were encountered to a depth of 17 feet, the maximum depth explored during our field activities. It is anticipated that bedrock materials from the Fort Union Formation can be encountered at deeper depths below the alluvial soils.

3.2 Generalized Subsurface Profile

Based on the observations and results of the field exploration and laboratory testing program, subsurface conditions at the proposed building addition site can be generalized as follows:

GENERALIZED SUBSURFACE PROFILE

Description	Approximate Depth to Bottom of Stratum (feet below existing grade)	Material Encountered	Consistency/Density
Stratum 1 Fine-Grained Soils	4 to 6	Brown Silt with Sand	Soft to Stiff
Stratum 2 Granular Soils	17	Brown Silty Clayey Sand with Gravel and Light Brown Silty Sand with Gravel	Loose to Very Dense

Subsurface conditions encountered are described in further detail on the boring logs (Exhibits A-4 and A-5) in Appendix A and in the following subsections. Stratification boundaries on the boring logs represent the approximate location of changes in soil types as could be estimated from field observation and laboratory test data; the in-situ transition between materials may be gradual. Laboratory test data (including moisture content) are shown on the boring logs.

3.2.1 Subsurface Conditions

A surficial layer of topsoil, about 1 foot in thickness, was encountered at the ground surface during our field activities. Below the topsoil, the fine-grained soil of Stratum 1 was encountered to depths of 4 and 6.4 feet. This fine-grained soil consists of silt with sand. Recorded Standard Penetration Test “N” values (SPT N-values) from 4 to 10 blows per foot indicate that the encountered silt is soft to stiff. A Liquid Limit of 23, a Plastic Limit of 20, and moisture contents ranging from 10 to 29 percent were measured within Stratum 1. In addition, a value of materials finer than a No. 200 sieve (percentage of fines) of 73 percent was measured.

The silty clayey sand with gravel of Stratum 2 was encountered below Stratum 1 to a depth of 17 feet below existing grade, the completion depth of the borings for this project. Based on recorded SPT N-values ranging from 5 to 58 blows per foot, the relative density of the encountered granular soils is loose to very dense. Percentage of fines of 20 to 42 percent and moisture contents varying from 4 to 15 percent were measured in the Stratum 2 granular soil. In addition, the results of plasticity testing indicate a Liquid Limit of 22 and a Plastic Limit of 18 within the fines of the sandy material of Stratum 2.

3.3 Groundwater

Borings B-01 and B-02 were observed while drilling and after completion for the presence and level of groundwater. Groundwater was observed at a depth of 17 feet below existing grade in Boring B-02. Groundwater was not encountered in Boring B-01 during drilling. It should be noted that groundwater observations during the field investigation do not fully reflect seasonal or long-term groundwater conditions which will be influenced by precipitation, hydrologic impacts originating off-site, and other factors beyond the scope of this investigation. Therefore, groundwater levels during construction or at other times in the life of the structure may vary from the conditions indicated on the boring logs.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on information provided by CLH Architects, we understand that the proposed first level and basement finished floor elevations were selected to match the finished floor elevations of the existing building. In addition, the building addition's first level is planned to have a finished floor elevation of 3,893.66 feet. This elevation is close to a depth of approximately 2 feet below existing grade at the boring locations for this project. Furthermore, the finished floor elevation for the basement is proposed at 3,887.16 feet, which is close to a depth of about 8 feet below existing grade.

Considering the above-described floor elevations and the encountered subsurface conditions at the site, shallow foundation consisting of shallow spread or strip footings may be used for the proposed building addition with or without basement. However, ground improvement will likely be required for the building option without partial basement. We have therefore provided foundation recommendations in this report for both building addition options

4.2 Earthwork

Earthwork activities for this project should be evaluated by Terracon to include: field observations and testing of fill and backfill activities, subgrade preparation, and other geotechnical conditions involved with construction of the project.

4.2.1 Site and Subgrade Preparation

The selection of earthwork methods and equipment can have a significant impact on the success of site grading and excavation operations. Our recommendations for site and subgrade preparation have been developed based on the findings of our investigation and our understanding of local standard construction practices and capabilities.

Vegetation, root systems, and topsoil should be removed from the development areas, along with any other unsuitable or deleterious materials such as construction debris, desiccated soil, and frozen soil, among others. After the site has been stripped and cut to grade, the exposed subgrade should be scarified and recompacted to a depth of 8 inches. It is anticipated that general excavation for the proposed construction can be accomplished with conventional earthmoving equipment such as tractor mounted backhoes and tracked excavators. Care should be applied during excavations to minimize disturbance of the soils at the base of excavations. In addition, the excavation equipment should be positioned above and/or outside of bearing surface boundaries to limit disturbance to the foundation soils.

The Contractor is 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 the sides and bottom of excavations. Excavations should be designed to comply with all applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Upon completion of site preparation earthwork, care should be taken to maintain the subgrade moisture content prior to construction of slabs and foundations. Heavy construction traffic over the completed subgrade should be avoided. Unstable subgrade conditions could develop during general construction operations, particularly if the soils are wet and/or subjected to repetitive construction traffic. In the event that unstable subgrade conditions develop, we recommend implementing proper drainage measures, limiting construction traffic, and the scarification and recompaction of the problem areas to improve the stability of the subgrade.

The site should be graded to prevent ponding of surface water on the prepared subgrades or inside excavations. In the event that the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected material should be removed or scarified, moisture conditioned, and recompacted prior to construction.

The geotechnical engineer and/or their representative should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during foundation and subgrade preparation including excavation methods, placement and compaction of engineered fills, and backfilling of excavations.

4.2.2 Material Requirements

It is anticipated that excavated materials will be used to the extent practical as trench/foundation backfill. The material suitability should be evaluated by the geotechnical engineer prior to use. Moisture conditioning and processing of on-site soils likely will be required.

Fill material should meet the following material property requirements:

Fill Type	USCS Classification	Acceptable Location for Placement
Imported Structural Fill[1,2]	SP, SW, SM, SC, GP, GW, GM, GC and dual symbols	Below slabs and as replacement backfill
Imported Structural Fill[1,3]	SP, SW, GP, GW and dual symbols	Below foundations
On-Site Soil	SC-SM	The non-organic, low-plasticity, on-site soil types can be used for trench/foundation backfill and landscaping.

1. Imported structural 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. Each proposed fill material type should be sampled and evaluated by the geotechnical engineer prior to its delivery and/or use.
2. Imported structural fill should meet the criteria of WYDOT Grading J specifications.
3. Imported structural fill should meet the criteria of WYDOT Grading W specifications.

If imported material is required for use as trench backfill or for structural fill purposes, the material should be a granular material and conform to the above criteria for imported structural fill meeting WYDOT Grading J specifications. Additionally, the material should be submitted to the project geotechnical engineer for review and approval. For general site grading purposes, native materials may be suitable.

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 or plate compactor) is used
Minimum Compaction Requirement[1,2] (ASTM D698)	**Structural fill (beneath foundations and slabs):** 97% **Wall/Trench backfill:** 95% **Miscellaneous fill (non-structural areas):** 90%

1. We recommend that each lift of engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. Moisture levels should be maintained to allow for satisfactory compaction to be achieved without the fill material yielding/pumping.

4.2.4 Utility Trench Backfill

All trench excavations should be made with sufficient working space to adequately permit construction operations including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. All trenches that penetrate beneath the building walls or foundations should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate beneath the structure. We recommend constructing an effective clay “trench plug” that extends at least 5 feet from the foundation. The plug material should consist of clay compacted at a water content at or above the optimum water content. The clay fill should be placed to completely surround the utility above the bedding zone and be compacted in accordance with recommendations of this report.

4.2.5 Surface Grading and Drainage

Positive drainage away from structures should be established during construction and maintained throughout the life of the proposed building addition to prevent ponding of water next to walls or foundations. Similarly, positive drainage away from open excavations should be provided to avoid significant water infiltration into utility trenches and foundation excavations during construction. Ponded water next to the building and within open excavations may result in significant soil movements than could exceed the building or utility lines allowable movement design criteria.

In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 10 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of debris to reduce the possibility of moisture infiltration.

Downspouts, roof drains, or scuppers should discharge onto splash blocks or gutter extensions beyond the backfill zone when the ground surface beneath such features is not protected by exterior slabs or area paving. Sprinkler systems should not be installed within 10 feet of foundation walls. Landscaped irrigation near the foundation system should be minimized, eliminated, or strictly regulated.

4.3 Basement Construction

Groundwater was encountered at a depth of 17 feet below existing grade during our field exploration. Therefore, we consider that the construction of the proposed basement should not have significant issues regarding groundwater. However, the following recommendations are presented to further limit any problems with groundwater and surface water on basement walls and foundations.

To reduce the potential for surface water to impact foundation bearing soils and enter the basement of the building addition, the installation of a perimeter drainage system is recommended. The drainage system should be constructed around the exterior perimeter of the basement foundation, and sloped at a minimum 1/8 inch per foot to a suitable outlet, such as a sump and pump system.

The drainage system should consist of a properly sized perforated pipe, embedded in free-draining gravel, and placed in a trench at least 12 inches in width. Gravel should extend up the wall to within 2 feet of the ground surface and the top 2 feet of backfill should be a low permeability soil. The system should be underlain with a polyethylene moisture barrier, sealed to the foundation walls, and extended at least to the edge of the backfill zone. The gravel should be covered with drainage fabric prior to placement of foundation backfill.

To further reduce the potential for groundwater to affect the floor slab subgrade, an underslab drainage system can be used. The floor slab subgrade should be graded to drain to a sump and pump system incorporated with the perimeter drain. The drain system should include appropriate sized perforated drain pipe embedded in at least 8 inches of free draining gravel. The drain pipes should be sloped to provide positive drainage to the sump.

4.4 Building Foundations

The following subsections present our shallow foundation recommendations for the proposed building addition. These recommendations are provided for the new structure with and without a basement.

4.4.1 Shallow Foundations – Building Without Basement

We consider that the encountered loose/soft soils, in the upper 6 to 10 feet below existing grade, are not suitable for supporting the proposed foundations loads. These soils, in their current state, exhibit low bearing capacity and high compressibility. As such, we recommend improving the encountered unsuitable soils by installing rammed aggregate piers (RAPs).

RAP ground improvement utilizes closely spaced columns of compacted crushed stone to improve the overall density and resulting strength of the soil mass, thus providing support for conventional shallow foundations. This method allows the existing soils to remain in place without need for overexcavation. The design of the pier system, including spacing, depth and size, is typically determined by a design/build specialty contractor based on the level of desired improvement and the anticipated foundation loads. Because the designer and installation contractor are the same, the use of RAP's is typically contracted on a performance basis centered on a specified bearing capacity and settlement criteria. If this method is selected, a specialty contractor should be engaged early in the design process to help evaluate the benefit of various design capacities versus costs. The RAP system should be applied beneath all footing elements in order to realize the full benefit of uniform foundation support. Care should be taken by the RAP contractor when installing the piers near the existing building in order to avoid causing damage to the existing foundations and below-grade walls.

A benefit of RAPs is the level of settlement control and bearing capacity can be designed into the system, thus allowing the system to be tailored to the structure. Due to the level of foundation loads anticipated for the building, we suggest that the RAP system be designed to a reasonably high bearing capacity to aid in reducing the size of footings. Based on the site soil conditions and our experience in the northern Wyoming area, we anticipate that a RAP system may provide an allowable soil bearing capacity for shallow footings on the order of 6,500 psf, or greater. The RAP system should also be designed to limit total settlement along the south wall of the building addition to less than ¾ inch in order to reduce the potential for differential settlement between the existing building and the new building addition.

Description	Spread/Strip Foundations
Maximum allowable bearing pressure [1]	6,500 psf
Minimum foundation dimensions	Columns: 2.5 feet Walls: 1.5 feet
Minimum embedment below finished grade for frost protection [2]	4 feet
Coefficient of friction for footings bearing on RAP improved soils or structural fill	0.5
Allowable passive lateral earth pressure for footings - native soils	200 psf/ft
Allowable passive lateral earth pressure for footings - structural fill	350 psf/ft
Approximate settlement from foundation loads	less than 1 inch
Approximate differential settlement [3]	½ - ¾ of total settlement

1. The recommended maximum allowable bearing pressure assumes the bearing soils have been improved with RAP, and includes proposed foundation loads and the weight of footing and backfill.
2. Minimum embedment for frost protection applies to perimeter foundations and footings beneath unheated areas.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, and the quality of the RAP installation operations. The estimates provided are based on maximum column loads shown.

4.4.2 Foundation Recommendations – Building With Basement

As mentioned earlier, the proposed basement finished floor is planned at about 8 feet below existing grade. The encountered soils at this depth are primarily medium-dense to dense native granular materials. Based on this, we recommend that the building loads be supported on shallow spread/strip footings with a minimum depth of embedment of 2 feet below the basement finished floor elevation. It should be noted that unsuitable soils may still be encountered at the proposed embedment depth below the basement floor. Unsuitable soils should be removed and replaced with properly placed and compacted structural fill following the recommendations presented in this report.

Based on information provided by CLH Architects, we understand that several new foundations for the proposed building addition will be installed adjacent to foundations of the existing building. During installation of the new foundations, care should be taken to prevent undermining existing foundations. We recommend that new foundation excavations do not advance bellow the bottom elevation of existing foundations without the implementation of proper underpinning measures. In contrast, new foundations placed in close proximity and above existing foundations could cause overlapping stresses and additional settlements on the existing building. The effects of installing new foundations adjacent to existing foundations should be evaluated on a case-by-case basis.

Description	Spread/Strip Foundations
Maximum allowable bearing pressure [1]	4,500 psf
Lateral Earth Pressure on Basement Walls[2]	25*H (psf)
Minimum foundation dimensions	Columns: 2.5 feet Walls: 1.5 feet
Minimum embedment below finished basement floor	2.5 feet
Coefficient of friction for footings bearing on native sand or structural fill	0.5
Allowable passive lateral earth pressure for footings on native soils	200 psf/ft
Allowable passive lateral earth pressure for footings on structural fill	350 psf/ft
Approximate settlement from foundation loads	less than 1 inch
Approximate differential settlement [3]	½ - ¾ of total settlement

1. The recommended maximum allowable bearing pressure is based on the removal of soft/loose soils and placement of structural fill, if required. In addition, the provided loads and weight of footing and backfilled are considered.
2. The term "H" is the basement wall embedment depth in feet.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. The estimates provided are based on maximum column and bearing wall loads shown.

4.4.3 Foundation Construction Considerations

Foundation excavations should be conducted to bearing surface by means of excavation equipment fitted with a smooth bucket and operating above and outside the limits of the bearing surface. It is critical that the base of foundation excavations be observed to ensure that the bearing surface has been neat cut to limit disturbance and is free of water, debris, and soft or loose materials prior to placing foundation concrete. If unsuitable bearing soils are encountered in footing excavations, such excavations should be extended deeper to suitable bearing materials under the direction of our geotechnical engineer. Excavation for footings may be neat cut with vertical walls to allow for placement of foundation concrete directly against native soils, limiting the potential for water infiltration to bearing surface.

4.5 Floor Slabs

We recommend proper preparation of the bearing surface for floor slabs to reduce the risk of excessive slab movements and cracking. We recommend a 1-foot thick layer of WYDOT Grading J material be installed for improvement of near surface soils for slab support.

4.5.1 Floor Slab Design Recommendations

Item	Description
Floor slab support[1]	Minimum one (1) foot of structural fill material over properly prepared subgrade
Modulus of subgrade reaction	100 pounds per square inch per inch (psi/in) for point loading conditions

1. Imported structural fill should consist of WYDOT Grading J material compacted in accordance with Item 4.2.2. The subgrade should be compacted as recommended in section 4.2.2 to correct construction disturbance. If the subgrade should become wet, softened or desiccated prior to construction of floor slabs, the affected material should be removed or the materials scarified, moisture conditioned, and recompacted.
2. Floor slabs should be structurally independent of any building foundation elements and partition walls to mitigate potential damage due to differential performance of slabs or foundations.

Where appropriate, saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or any cracks that develop should be sealed with a water-proof, non-extruding compressible compound.

The use of a vapor barrier should be considered 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 Seismic Considerations

Based on the encountered subsurface soil conditions, the site is generally not considered to have high seismic potential. Based on our evaluation of the geology at the project, the site can be characterized as outlined in the following table.

Code Used	Site Classification
2012 International Building Code (IBC) [1]	D[2]

1. In general accordance with the2012 IBC, Table 1613.5.2.

2. The 2012 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. The borings for the project extended to a maximum depth of approximately 17 feet and the seismic site class definition considers that the silty sand continues below the maximum depth of the subsurface exploration. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration, if desired.

4.7 Corrosion Protection

One representative soil sample was submitted for soluble sulfate, pH and electrical resistivity testing. Results are summarized in the following table:

Boring Number	Depth, Ft.	Material	Soluble Sulfate Content, %	Resistivity, ohm-cm	pH
B-01	2.0-4.0	Silt with Sand (ML)	Not Detected	1,420	7.5

Resistivity values between 1,000 and 3,000 ohm-cm indicate a highly corrosive environment for exposed metal, based on American Galvanizers Association (AGA) evaluation and methodology. The client should consult with a certified corrosion engineer to develop corrosion countermeasures, if exposed metal hardware or fixtures will be included within the project area.

Testing of pH showed a value of 7.5 indicating slightly alkaline soils. Based on this pH value, soils would have a slight attack potential on buried metals but little to no effect on buried concrete structures.

A soluble sulfate content by weight was not detected in the sample submitted for sulfate testing. Based on this test result, sulfate attack on buried concrete would be negligible. No specific water/cement ratio or specific cement type is required. However, additional testing should be conducted once final bearing elevation is reached to ensure the integrity of concrete used in contact with site soils.

5.0 GENERAL COMMENTS

The analysis and recommendations presented in this report are based upon the data obtained from the boring performed at the indicated location and from client-provided load information discussed in this report. This report does not reflect variations that may occur 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 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 expressed or implied, are intended or made. Site safety, excavation support, and dewatering issues 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

Field Exploration Description

The boring locations were laid out on the site by the field representative measuring from available site features and utilizing available project information. Coordinates for these locations were established using a hand-held GPS unit. Ground surface elevations were estimated from topographical information provided by CLH Architects. The location and ground surface elevation of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

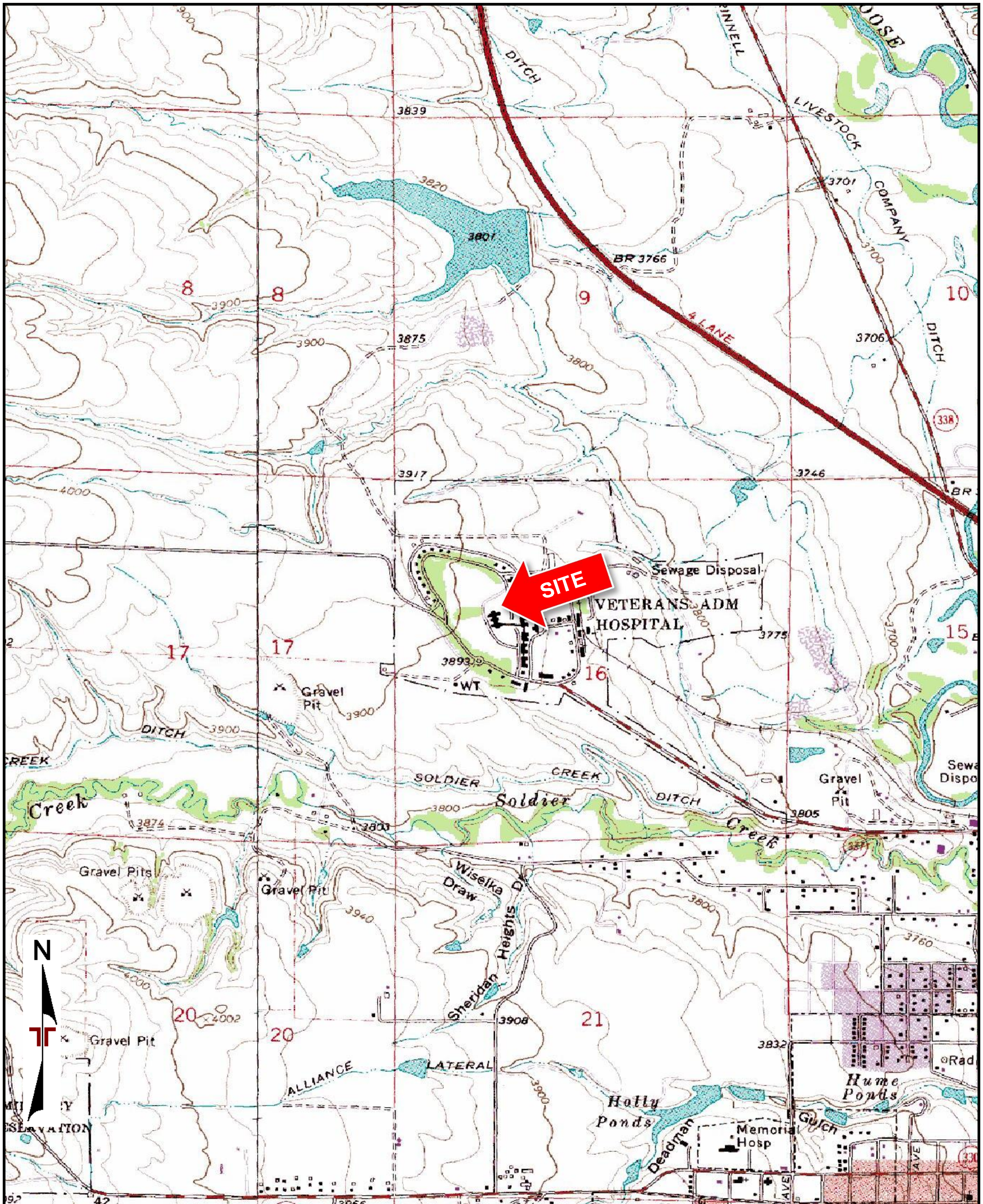
The borings were drilled with a CME 55 drill rig using hollow stem augers. Samples of the soil encountered in the borings were typically obtained using the split-barrel and thin walled tube sampling procedures

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 24-inch penetration by means of a 140-pound C.M.E. auto-hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in-situ relative density of cohesionless soils and consistency of cohesive soils.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this project sites. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings and bentonite chips prior to the drill crew leaving the site.

Field logs of the borings were prepared by our engineer. These logs included visual classifications of the materials encountered during drilling as well as the driller’s interpretation of the subsurface conditions between samples. The final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: HULTZ DRAW, WY (1/1/1977) and SHERIDAN, WY (1/1/1977).

Project Manager: O. Boscan	Project No. 26155024
Drawn by: O. Boscan	Scale: 1"=24,000 SF
Checked by: B. Wilkins	File Name: locations.pdf
Approved by: G. Rome	Date: 08/15/15

Terracon
2110 Overland Ave. Suite 124
Billings, MT 59102

SITE LOCATION

VA Med. Center Geri-Psych Ward Addition
1898 Fort Rd
Sheridan, WY

Exhibit
A-2

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

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: O. Boscan	Project No. 26155024	Terracon	EXPLORATION PLAN	Exhibit
Drawn by: O. Boscan	Scale: AS SHOWN	2110 Overland Ave. Suite 124	VA Med. Center Geri-Psych Ward Addition	A-3
Checked by: B. Wilkins	File Name: locations.pdf	Billings, MT 59102	**1898 Fort Rd**	
Approved by: G. Rome	Date: 08/15/15		**Sheridan, WY**	

BORING LOG NO. B-01

PROJECT: Geri-Psych Ward Addition

CLIENT: Calvin L. Hinz Architects, PC

SITE: VA Medical Center, Sheridan, Wyoming

LOCATION See Exhibit A-2

Latitude: 44.82998° Longitude: -106.9884°

DEPTH	Description	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1.0	**TOPSOIL**, dark brown	Split spoon	4-6-4 N=10	10		
4.0	**SILT WITH SAND (ML)**, brown, stiff, with clay pockets - medium-stiff below 2 feet	Split spoon	3-3-2 N=5	10		
12.0	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, loose	Split spoon	1-3-2 N=5	13		42
	- tube sampler refusal at 6.8 feet	Tube		9		
		Split spoon	4-4-4 N=8	7		
	- medium dense below 10 feet	Split spoon	1-7-12 N=19	9	22-18-4	
17.0	**SILTY SAND WITH GRAVEL (SM)**, light brown, dense to very dense	Split spoon	7-18-16 N=34	4		
		Split spoon	17-29-29 N=58	8		24

Boring Terminated at 17 Feet

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

Hammer Type: Automatic

Advancement Method:
3 1/4" I.D. Hollow Stem Auger

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:

Latitude and Longitude obtained using a handheld GPS unit. Ground elevation estimated from topographic information provided by CLH Architects.

WATER LEVEL OBSERVATIONS

Water was not encountered during drilling

No long-term measurements taken

Terracon
2110 Overland Ave., Suite 124
Billings, Montana

Boring Started: 6/30/2015	Boring Completed: 6/30/2015
Drill Rig: CME 55	Driller: S. Eddy
Project No.: 26155024	Exhibit: A-4

BORING LOG NO. B-02

PROJECT: Geri-Psych Ward Addition

CLIENT: Calvin L. Hinz Architects, PC

SITE: VA Medical Center, Sheridan, Wyoming

LOCATION See Exhibit A-2

Latitude: 44.83017° Longitude: -106.98865°

DEPTH	Description
1.0	**TOPSOIL**, dark brown
6.4	**SILT WITH SAND (ML)**, brown, soft, with clay pockets
12.0	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, dense
17.0	**SILTY SAND WITH GRAVEL (SM)**, light brown, dense
	Boring Terminated at 17 Feet

Sample	Field Test Results	Test Type	Compressive Strength (psf)	Strain (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	0-2-2 N=4				18			
2	2-2-2 N=4				16			73
3					19		23-20-3	
4	3-17-18 N=35				13			
5	9-19-17 N=36				9			21
6	31-35-15 N=50				15			
7	14-22-24 N=46				5			20
8	19-22-19 N=41				9			

Water level observation: ▽ at approximately 17 ft.

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

Hammer Type: Automatic

Advancement Method:
3 1/4" I.D. Hollow Stem Auger

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:

Latitude and Longitude obtained using a handheld GPS unit. Ground elevation estimated from topographic information provided by CLH Architects.

WATER LEVEL OBSERVATIONS

▽ *Water encountered during drilling*

No long-term measurements taken

Terracon
2110 Overland Ave., Suite 124
Billings, Montana

Boring Started: 6/30/2015	Boring Completed: 6/30/2015
Drill Rig: CME 55	Driller: S. Eddy
Project No.: 26155024	Exhibit: A-5

APPENDIX B

LABORATORY TESTING

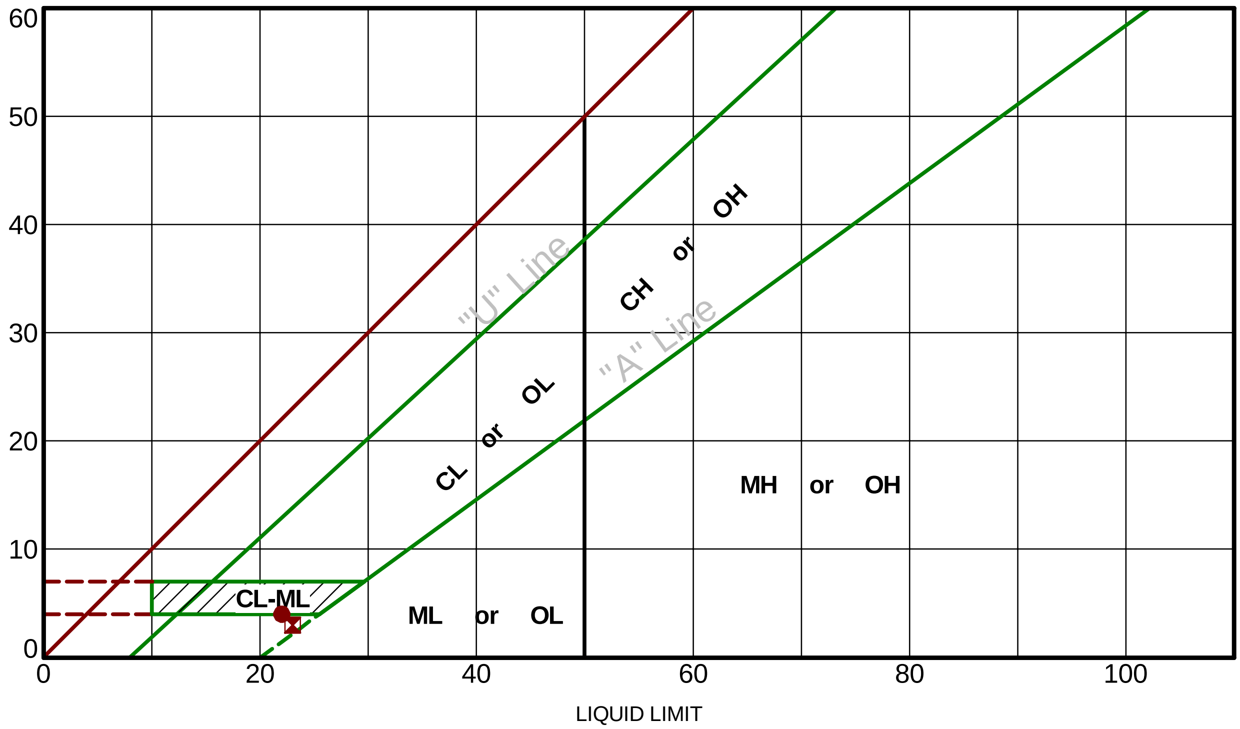
Laboratory Test Description

Moisture content, density, Atterberg Limits, grain size distribution, and consolidation-swell tests were performed in our geotechnical laboratory to evaluate the classification characteristics and compressibility of the recovered samples. In addition, electrical resistivity, soluble sulfates, and pH test were performed to assess corrosion potential. These tests were conducted according to their respective ASTM standard.

As part of the testing program, all samples were examined in the laboratory by our experienced personnel and classified in accordance with the attached General Notes and the Unified Soil Classification System (USCS) based on the texture and plasticity of the soils along with the results of testing. The group symbol for the USCS is shown in the appropriate column on the boring log and a brief description of the classification system is included with this report in Appendix C.

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	**B-01**	**10 - 12**	**22**	**18**	**4**		**SC-SM**	**SILTY CLAYEY SAND WITH GRAVEL**
⊠	**B-02**	**4 - 6**	**23**	**20**	**3**		**ML**	**SILT WITH SAND**

PROJECT: Geri-Psych Ward Addition

SITE: VA Medical Center
Sheridan, Wyoming

Terracon
2110 Overland Ave., Suite 124
Billings, Montana

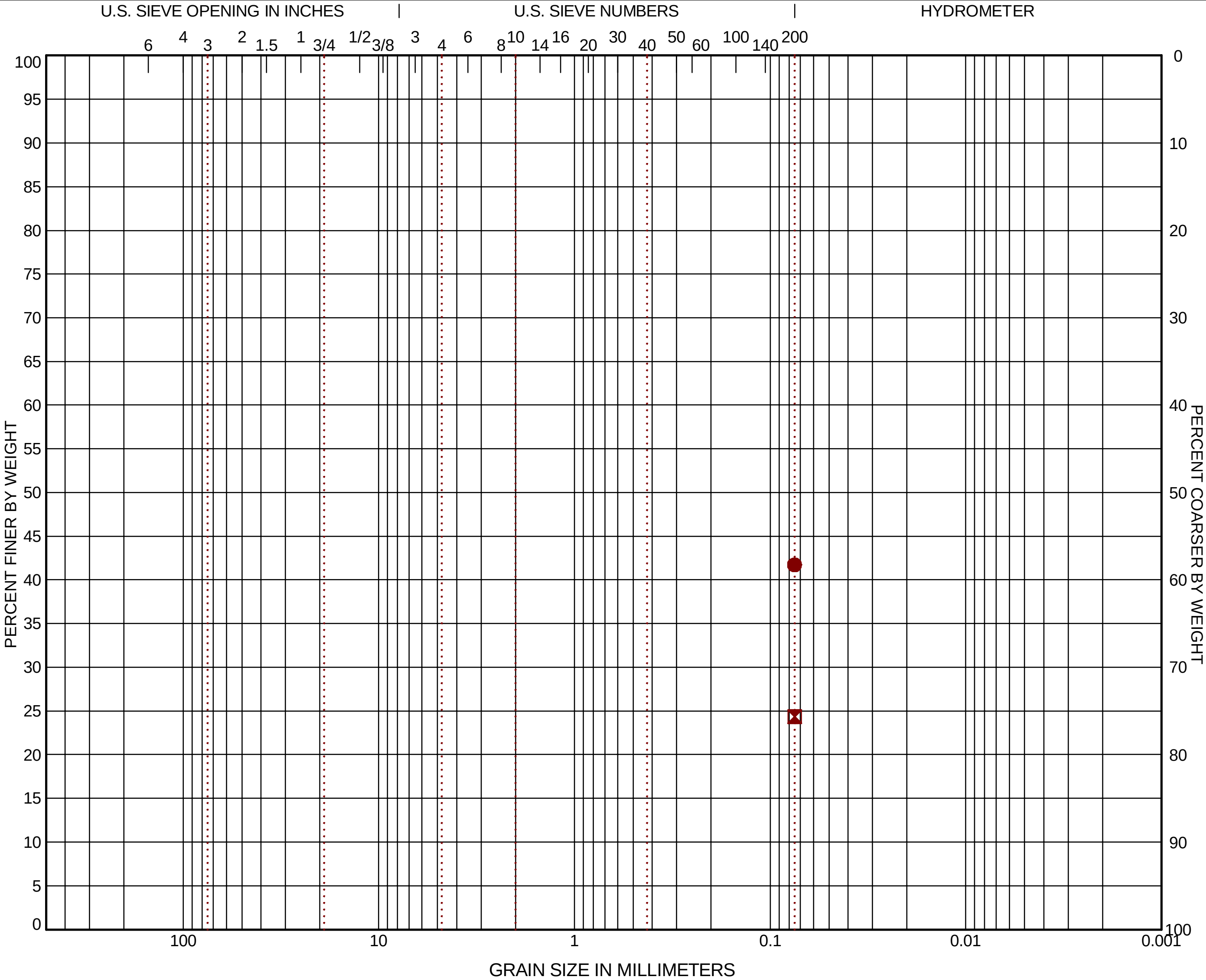
PROJECT NUMBER: 26155024

CLIENT: Calvin L. Hinz Architects, PC

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-01**	**4 - 6**					**41.7**		
⊠	**B-01**	**15 - 17**					**24.4**		

	GRAIN SIZE		
	●	⊠	
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_C			
C_U			

SIEVE (size)	PERCENT FINER ●	PERCENT FINER ⊠	
3"			
2"			
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#10			
#20			
#40			
#80			
#200	**41.72**	**24.37**	

SOIL DESCRIPTION

● SILTY CLAYEY SAND w/GRAVEL (SC-SM)

⊠ SILTY SAND w/GRAVEL (SM)

REMARKS

●

⊠

PROJECT: Geri-Psych Ward Addition

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Terracon
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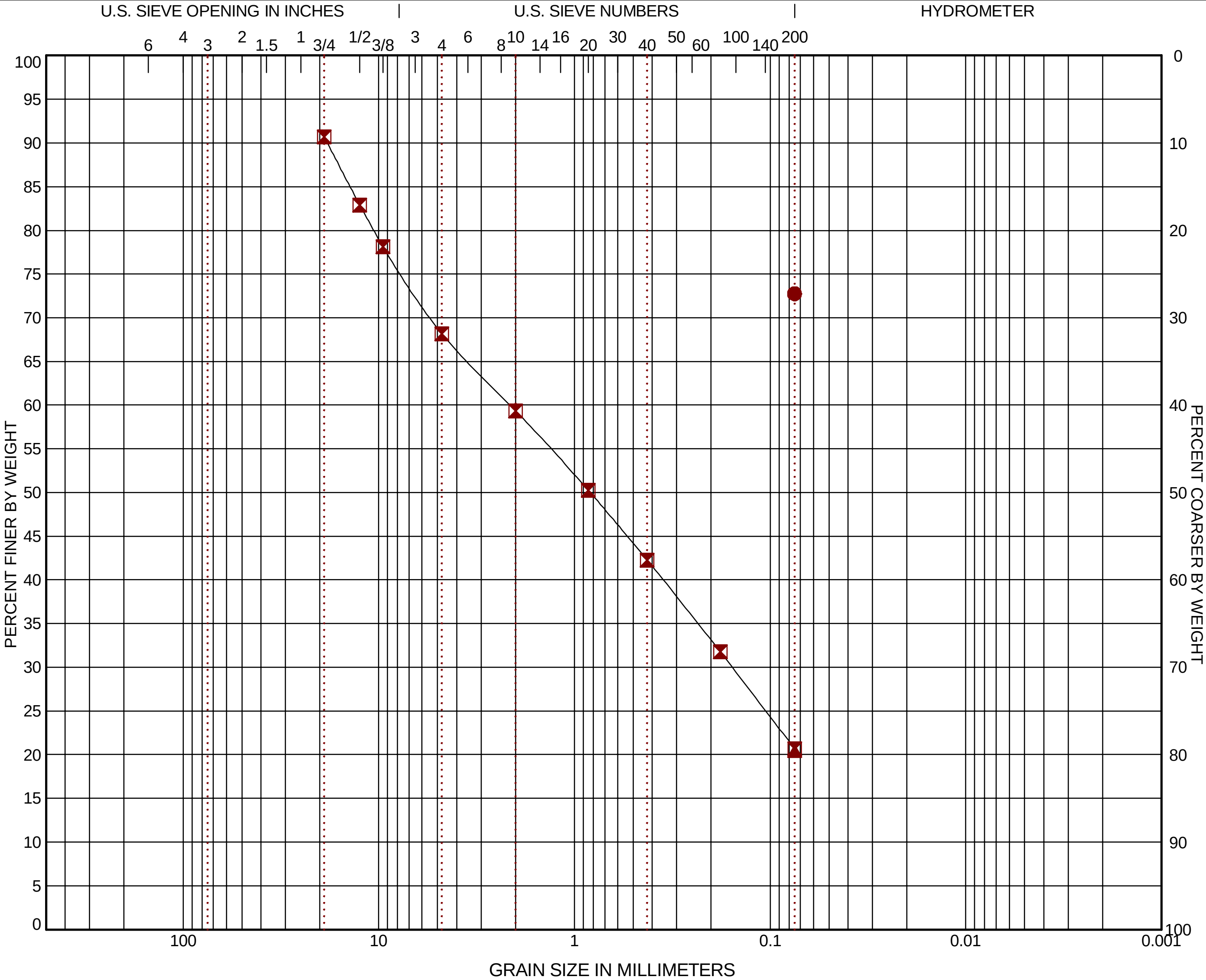
PROJECT NUMBER: 26155024

CLIENT: Calvin L. Hinz Architects, PC

EXHIBIT: B-3

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-02**	**2 - 4**					**72.7**		
⊠	**B-02**	**8 - 10**		**22.5**	**47.5**		**20.7**		
▲	**B-02**	**12 - 14**					**20.4**		

	GRAIN SIZE ●	GRAIN SIZE ⊠	GRAIN SIZE ▲
D_{60}		**2.131**	
D_{30}		**0.156**	
D_{10}			
COEFFICIENTS			
C_C			
C_U			

SIEVE (size)	PERCENT FINER ●	PERCENT FINER ⊠	PERCENT FINER ▲
3"			
2"			
1 1/2"			
1"			
3/4"		**90.73**	
1/2"		**82.91**	
3/8"		**78.12**	
#4		**68.18**	
#10		**59.35**	
#20		**50.25**	
#40		**42.28**	
#80		**31.77**	
#200	**72.74**	**20.69**	**20.39**

SOIL DESCRIPTION
- ● SILT w/SAND (ML)
- ⊠ SILTY CLAYEY SAND w/GRAVEL (SC-SM)
- ▲ SILTY SAND w/GRAVEL (SM)

REMARKS
- ●
- ⊠
- ▲

PROJECT: Geri-Psych Ward Addition

SITE: VA Medical Center
Sheridan, Wyoming

Terracon
2110 Overland Ave., Suite 124
Billings, Montana

PROJECT NUMBER: 26155024

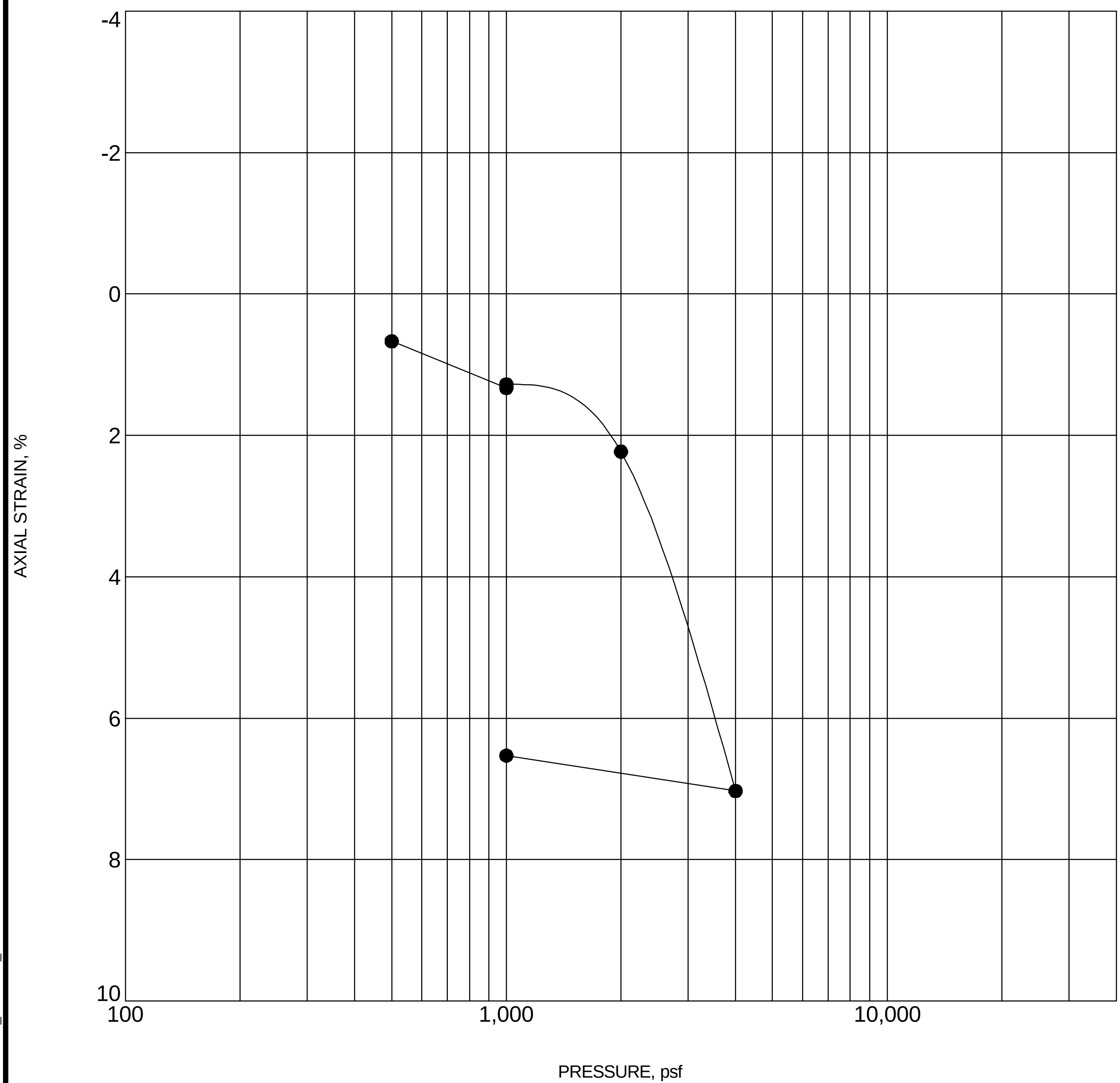
CLIENT: Calvin L. Hinz Architects, PC

EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 26155024 VA HOSPITAL ADDITION.GPJ TERRACON2012.GDT 8/13/15

SWELL CONSOLIDATION TEST

ASTM D2435



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-02	4 - 6 ft	SILT WITH SAND (ML)	104	18

NOTES: Sample inundated with water at 1,000 psf

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. TC_CONSOL_STRAIN-USCS 26155024 VA HOSPITAL ADDITION.GPJ TERRACON2012.GDT 8/13/15

PROJECT: Geri-Psych Ward Addition	Terracon 2110 Overland Ave., Suite 124 Billings, Montana	PROJECT NUMBER: 26155024
SITE: VA Medical Center Sheridan, Wyoming		CLIENT: Calvin L. Hinz Architects, PC
		EXHIBIT: B-5

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			
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.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			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

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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [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 / Liquid limit - not dried < 0.75	OL	Organic clay [K,L,M,N]
					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 / Liquid limit - not dried < 0.75	OH	Organic clay [K,L,M,P]
					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-inch (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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.