Gordon Spilker Huber
Geotechnical Consultants, Inc.

REPORT
GEOTECHNICAL STUDY
PROPOSED ADDITION TO THE EXISTING UNIVERSITY NEUROPSYCHIATRIC INSTITUTE FACILITY
501 CHIPETA WAY
UNIVERSITY OF UTAH RESEARCH PARK
SALT LAKE CITY, UTAH
PROJECT-20161; FMSC-0000000138

Submitted To:

The University of Utah
Facilities Management
V. Randall Turpin University Services Building
1795 East South Campus Drive, Room 201
Salt Lake City, Utah 84112-9403

Submitted By:

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

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Job No. 0128-042-09

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The University of Utah
Facilities Management
V. Randall Turpin University Services Building
1795 East South Campus Drive, Room 201
Salt Lake City, Utah 84112-9403

Attention: Ms. Deborah Alto, Staff Architect/Project Manager

Ladies and Gentlemen:

Re: Report
Geotechnical Study
Proposed Addition to the Existing
University Neuropsychiatric Institute Facility
501 Chipeta Way
University of Utah Research Park
Salt Lake City, Utah
Project-20161; FMSC-0000000138

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed at the site of the proposed addition, which is to be constructed onto the north end of the existing University Neuropsychiatric Institute (UNI) facility at 501 Chipeta Way in Salt Lake City, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. A more detailed layout of the site showing the proposed and existing structures, parking areas, roadways, and site-specific topography is presented on Figure 2, Site Plan. The locations of the borings drilled in conjunction with this study are also presented on Figure 2.

During the course of this study, many of the conclusions and recommendations were presented to Ms. Deborah Alto, project manager.

Gordon Spilker Huber Geotechnical Consultants, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123
Tel: (801) 685-9190 Fax: (801) 685-2990
www.gshgeotech.com

1.2 OBJECTIVES AND SCOPE

The objectives and scope of or study were planned in discussions between Ms. Deborah Alto of The University of Utah, Facilities Management, and Mr. Bill Gordon of Gordon Spilker Huber Geotechnical Consultants, Inc. (GSH).

In general, the objectives of this study were to:

1. Accurately define and evaluate the subsurface soil and groundwater conditions in the area of the proposed new building addition and the proposed new pavement areas to the north and east.

2. Provide appropriate foundation, earthwork, subdrain, and pavement recommendations and geoseismic information to be utilized in the design and construction of the proposed facilities.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the drilling, logging, and sampling of seven borings.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

Authorization was provided verbally and subsequently by returning a signed Notice to Proceed, Contract Number: FMSC-0000000138, Project Name: 0881 UNI Expansion (DFCM) University Project Number: Proj-20161, Project Manager: Alto, Deborah, dated May 28, 2009.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration borings, projected groundwater conditions, and the layout and design data discussed in Section 2., Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

The proposed addition will be a maximum of four levels in height, will be irregular in configuration, and will attach onto the north end of the existing structure to the immediate southeast. The main level of the proposed addition will be established at the main level of the existing building with matching floor elevations at the interface. At this time, only a preliminary expansion feasibility study has been completed. Anticipated construction will consist of wood or light steel-frame construction with a masonry veneer. Structural loads will be transmitted down through column and bearing walls to the supporting foundations. At this time, maximum column and wall loads are projected to be on the order of 250 to 300 kips and 8 to 10 kips per lineal foot At-grade floor slabs will be typically light (100 to 150 pounds per square foot).

At present, the site is primarily a terraced parking lot. Site development will require a moderate amount of earthwork in the form of site grading. We estimate that maximum cuts and fills to achieve design building grades could be on the order of six feet and/or the main level will be partially below grade along the east and northeast.

Paved visitor and an extensive staff parking is to be located to the west and east of the proposed addition, respectively, with accompanying access roadways. Projected traffic in the parking areas should consist of a light volume of automobiles and light trucks and occasional medium-weight trucks. In primary roadway areas, traffic is projected to consist of a moderate volume of automobiles and light trucks, a light volume of medium-weight trucks, and occasional heavy-weight trucks.

3. SITE INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 7 borings were explored to depths ranging from 5.0 to 41.5 feet below existing grade. Auger refusal on dense gravel/cobbles and/or a boulder was encountered in Boring B-3 at a depth of 16 feet below the surface. The borings were drilled using a truck-mounted drill rig equipped with hollow-stem augers. Locations of the borings are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, relatively undisturbed and small disturbed samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent

inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3G, Log of Borings. Soils were classified in accordance with the nomenclature described on Figure 4, Unified Soil Classification System.

A 3.25-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) was utilized in the majority of the subsurface sampling at the site. Additionally, a 2.0-inch outside diameter, 1.380inch inside diameter drive sampler (SPT) was utilized at select locations. The blow-counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling operations, one and one-quarter-inch diameter slotted PVC pipe was installed in Borings B-1 and B-2 in order to provide a means of future monitoring the groundwater fluctuations.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was performed. The program included moisture and density, chemical, and collapse-consolidation tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

To aid in classifying the soils and to help correlate other test data, moisture and density tests were performed on selected, relatively undisturbed samples. The results of these tests are presented on the boring logs, Figures 3A through 3G.

3.2.3 Chemical Tests

To determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the sandy clay/clayey sand soils encountered in Boring B-2 at a depth of 2.5 feet below existing grade. The results of the chemical tests are tabulated below:

Boring No.	Depth (feet)	pH	Total Water Soluble Sulfate (mg/Kg-dry)
B-2	2.5	8.84	9.5

3.2.4 Collapse-Consolidation Tests

A collapse-consolidation test was performed on each of two representative samples of the near-surface clay soils, in order to assess moisture sensitivity and load deformation characteristics. The collapse tests were performed as follows:

1. Load sample at in-situ moisture content to specific axial pressure.
2. Measure and record axial deflection.
3. Saturate sample.
4. Measure and record resulting collapse.

The test results are tabulated below:

Boring No.	Depth (feet)	Soil Type	Natural Dry Density (pcf)	Natural Moisture Content (percent)	Axial Load When Saturated (psf)	Collapse (-) or Swell (+) (percent)
B-1	5.5	CL	110	13.3	100	0.0
B-2	5.5	CL	107	11.8	1,600	.66 (-)

The results of the tests indicate that the near-surface silty clay soils tested do not exhibit collapsible characteristics. Subsequent to the collapse tests, normal consolidation test loading was applied. The results of this loading show that the soils and moderately over-consolidation. When loaded below the over-consolidation pressure, the soils will exhibit moderately low compressibility characteristics. Detailed results of the tests are maintained within our files and can be transmitted, upon your request.

4. SITE CONDITIONS

4.1 SURFACE

The site is located at the southeast corner of Chipeta Way and Tabby Lane, and directly north of the existing UNI building. Overall, the site slopes moderately to the west. The site is generally comprised of an existing paved parking area constructed in a stepped terrace fashion with landscape areas separating each parking level. Ground cover vegetation and numerous trees are also present. Located to the east beyond existing pavements is an undeveloped area covered by a moderate to dense growth of scrub oak and various weeds and grasses with Colorow Way beyond. The site is bound to the west by Chipeta Way with existing two- to three-story buildings beyond. Located immediately north is Tabby Lane with the Fort Douglas Cemetery beyond.

4.2 SUBSURFACE SOIL AND GROUNDWATER

Borings B-1 through B-4 were completed within the proposed building footprint and Borings B-4 through B-7 were completed within the proposed staff parking area. At Borings B-1 through B-4, the surface is blanketed by three inches of asphalt concrete underlain by five to six inches of aggregate base. The existing pavement is in fair condition with visible cracking throughout. At Borings B-5 through B-7, the surface is blanketed with approximately three inches of topsoil (root mat). Below the pavement and topsoil, the subsurface soils encountered to the depths penetrated consist of layers of silty clay, clayey sand, clayey gravel, occasional silty sands, and mixtures of these soils ranging in thickness from 1.5 feet up to 12.0 feet. The silty clay layers were predominately encountered within the upper 10 feet within Borings B-2 and B-4 and will control foundation design. These clays are stiff to very stiff, moist, dark brown and brown, and moderately over-consolidated. The granular soils encountered range from loose to dense, are moist, and brown. At Boring B-3, auger refusal on dense gravel/cobbles or a boulder was encountered at a depth of 16 feet below the surface.

Existing fills on the order of four to six feet thick are projected in portions of the proposed addition footprint and are related to previous site grading.

Groundwater was not observed within the depths of the borings at the time of the drilling operations. Seasonal isolated and random "perched" groundwater conditions in the near-surface sequence must be anticipated, especially during the late spring and early summer months.

Springs were encountered in conjunction with the construction of the existing facilitates to the south.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The results of this study indicate that the proposed addition can be supported upon conventional spread and continuous wall foundations established upon suitable natural soils or properly placed and compacted structural fill extending to suitable natural soils. Higher footing loads will require some thickness of granular replacement structural fill to control settlements.

At this time, it is projected that the existing and new addition structures will be supported separately and will not be sharing loading at the interface. When further design has been completed, GSH must be notified to review proposed loading so that projected settlements can be checked.

Some existing fills may exist at the surface from previous construction. As potential fills are likely to consist of on-site soil, they may be difficult to identify with respect to the natural soils. Footing and mass excavations must be observed by a qualified geotechnical engineer during initial earthwork.

In the following sections, detailed discussions pertaining to earthwork, foundations, lateral resistance and pressure, floor slabs, subdrains, and the geoseismic setting of the site are provided.

5.2 EARTHWORK

5.2.1 Site Preparation

Preparation of the site will consist of the removal of the existing asphalt concrete pavement, surface vegetation, topsoil, root bulbs, sod, rubbish, non-engineered fills, and any other deleterious materials from beneath an area extending out at least three feet beyond the perimeter of the proposed addition and two feet beyond associated exterior flatwork and pavements. In proposed pavement areas, existing pavements may be left in place if they do not interfere with proposed grades and they are broken-up so as to not act as a water trap.

Subsequent to stripping and prior to the placement of floor slabs, structural site grading fill and pavements, the exposed subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed to a maximum depth of two feet and replaced with structural fill.

As discussed earlier, springs were encountered in conjunction with construction of the existing facilitates to the south. Subdrains discussed later in this report may need to be installed during initial construction to control potential springs.

5.2.2 Excavations

Temporary construction excavations in cohesive soil, not exceeding four feet in depth, may be constructed with near-vertical sideslopes. Temporary excavations up to 10 feet deep in fine-grained cohesive soils shall be constructed with sideslopes no steeper than one-half horizontal to one vertical. Excavations deeper than 10 feet are not anticipated at the site.

For granular (cohesionless) soils, construction excavations not exceeding four feet and above the water table shall be no steeper than one-half horizontal to one vertical. For excavations up to 10 feet in granular soils and above the water table, the slopes shall be no steeper than one horizontal to one vertical. Excavations encountering loose and or saturated cohesionless soils will be very difficult and will require very flat sideslopes and/or shoring, bracing and dewatering.

Also, the contractor should anticipate occasional to some cobbles and boulders indicative of soils in the area.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated.

5.2.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and in some areas, replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. For structural site grading fill, the maximum particle size shall not exceed four inches; although, occasional larger particles, not exceeding eight inches in diameter, may be incorporated if placed randomly in a manner such that "honeycombing" does not occur and the desired degree of compaction can be achieved. The maximum particle size within structural fill placed within confined areas should generally be restricted to two inches.

The on-site soils may be re-utilized as structural site grading fill. However, it should be noted that unless moisture control is maintained, utilization of fine-grained soils as structural site grading fill <u>will be very difficult, if not impossible</u>, during wet and cold periods of the year.

Only granular soils are recommended as structural fill below footings and in confined areas, such as around foundations and within utility trenches. Imported granular structural fill should consist of a fairly well-graded mixture of sand and gravel with less than 20 percent fines.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

All structural fill shall be placed in lifts not exceeding eight inches in loose thickness. Structural fills beneath the area extending out at least 3 feet from the perimeter of the proposed addition and no more than 10 feet thick must be compacted to at least 95 percent of the maximum dry density as determined by the AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria. If the fills are greater than 10 feet, the compaction must be increased to 98 percent of the above-defined criteria. Structural fills extending outside 3 feet from the structure which are greater than 5 feet thick must be compacted to 92 percent of the above-defined criteria. Structural fills greater than eight feet thick are not anticipated at the site. Structural fills less than 5 feet thick, which are not beneath an area extending out at least 3 feet from the perimeter of the structure, should be compacted to at least 90 percent of the above-defined criteria.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade should be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation should consist of the removal of all loose or disturbed soils.

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[1] American Association of State Highway and Transportation Officials
[2] American Society for Testing and Materials

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, paved areas, etc.) shall be placed to the same material and density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill shall be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they shall be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1a or A-1b (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways, the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction.

Fine-grained soils, such as the natural on-site silty clays, are not recommended for use as trench backfill.

5.2.6 Areal Settlements

Based on existing topography, some cutting and filling will likely be required to achieve design grades.

Areal settlements resulting from site grading fills as much as eight feet should be less than one-half inch. The majority of this settlement will occur during placement. These settlements are in addition to settlements induced by foundation and floor slab loads. To reduce the total settlement that the structure will realize, site grading fill must be placed as far in advance of other construction as possible.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The results of our analysis, based on the projected loads, indicate that the proposed structure may be supported upon conventional spread and/or continuous wall foundations established upon suitable natural soils and/or granular structural fill extending to suitable natural soils. Varying thicknesses of granular structural fill will be required beneath the footings to control total and differential settlements.

For design, the following parameters are recommended:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions	- 3,500 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.3.2 Installation

Under no circumstances should the footings be established upon soft, loose or disturbed soils, uncontrolled fills, non engineered fills, sod, rubbish, frozen soils, debris or within ponded water. If unsuitable soils are encountered, they must be totally removed and replaced with compacted granular structural fill. The width of the replacement fill below footings should be equal to the width of the footing plus one additional foot for each foot of fill thickness placed.

5.3.3 Settlements

Settlements of shallow foundations designed and constructed in accordance with the recommendations presented herein and supporting the anticipated loads as discussed in Section 2., Proposed Construction, are tabulated on the following page.

Foundation	Loading	Bearing Pressure (psf)	Replacement Fill Thickness (feet)	Projected Maximum Settlement (inches)
Spread	up to 100 kips	3,500	0	½ to ⅝ ±
	100 to 200 kips	3,500	18	½ to ⅝ ±
	200 to 250 kips	3,500	30	½ to ⅝ ±
	250 to 300 kips	3,500	36	½ to ⅝ ±
Wall	up to 8 kips/ft	3,500	0	½ to ⅝ ±
	8 to 10 kips/ft	3,500	12	½ to ⅝ ±

Settlements will occur rapidly with approximately 50 to 60 percent of the quoted settlements occurring during construction.

5.4 LATERAL RESISTANCE

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.40 should be utilized for natural soils and up to 0.45 may for imported granular structural fill soils. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.5 LATERAL PRESSURES

The lateral pressure parameters, as presented herein, are for backfills, which will consist of drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid walls, generally not exceeding 10 feet in height, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal and that the granular fill within three feet of the wall will be compacted with hand-operated compacting equipment.

For seismic loading of below-grade walls up to 4-feet tall, uniform pressures of 35 and 65 pounds per square foot should be added for active and more rigid walls, respectively. For seismic loading of below-grade walls up to 8-feet tall, uniform pressures of 70 and 130 pounds per square foot should be added for active and more rigid walls, respectively.

5.6 FLOOR SLABS

Floor slabs may be established upon suitable natural soils, and/or upon structural fill extending to these suitable natural soils. Under no circumstances should floor slabs be established upon loose or disturbed surficial soils, non-engineered fills, sod, rubbish, deleterious materials, frozen soils, or within ponded water.

Groundwater was not encountered within the borings at the time of the fieldwork. However, seasonal "perched" conditions may be encountered. To act as a capillary break and to facilitate construction and curing, it is recommended that floor slabs be directly underlain by at least four inches of "free-draining" fill, such as three-quarters- to one-inch minus clean gap-graded gravel. Preferably, the gravel would be crushed; that is, angular, to improve trafficability during construction.

Settlements of at-grade floor slabs supporting light loads will be negligible.

5.7 CEMENT TYPES

Laboratory tests indicate that the site soils contain negligible amounts of water soluble sulfates. Therefore, concrete which will be in contact with the site soils may be prepared using Type I or IA cement.

5.8 SUBDRAINS

5.8.1 General

During the construction of the existing footings, a number of springs and other "perched" groundwater conditions were observed. Collection and subdrains were installed and have collected and controlled the groundwater conditions.

5.8.2 Perimeter Foundation Subdrain

Although groundwater was not observed within the borings at the time of completion, it is our recommendation that a perimeter foundation subdrain system be installed on the up-gradient and side-gradient portions of all below-grade walls of the structure.

Foundation subdrains should consist of two components. The first component consists of placing a four-inch diameter perforated or slotted, plastic or PVC pipe subdrain enclosed in clean gap-graded "free-draining" gravel. The invert of a subdrain should be located at least 18 inches

below the top of the lowest adjacent slab. The gravel portion of the drain should extend 2 inches below and laterally around the pipe and 12 inches above the top of the lowest adjacent slab. The gravel zone must be installed immediately adjacent to the perimeter footings and the foundation walls and separated from natural soils utilizing a geotextile, such as Mirafi 140N or equivalent. The slope of this subdrain should be at least 0.25 percent. The second component of the foundation subdrain is a chimney drain, which must extend up from the top of the foundation subdrain to within 12 inches of final grade. This may consist of a zone of "free-draining" gravel at least six inches wide (construction will likely dictate that it be at least two feet wide), or a synthetic drain board, such as Miradrain or equivalent. Gravel installed within the chimney drain must also be separated from the natural or subsequent backfill soils utilizing a geotextile as described above.

The upper 18 inches above the chimney drain should be capped with compacted fine-grained soil to reduce surface water infiltration into the drain. Adequate surface drainage away from the structure should be maintained.

Prior to the placement of the chimney/foundation subdrain, the outside of the subgrade walls must be appropriately dampproofed as a minimum if the subgrade level is for mechanical purposes or must be waterproofed if occupied.

5.8.3 Area Subdrains

In pavement or other surface areas which become saturated or where springs may be encountered, particularly during construction, an area subdrain or cut off drain may be required. Area subdrain details may be provided, at the owners request, as needed where and when conditions should warrant.

5.9 PAVEMENTS

The natural fine-grained soils will exhibit poor pavement support characteristics when saturated or nearly saturated. Considering these soils as the design subgrade soils and the projected traffic conditions, the pavement sections on the following pages are recommended.

Parking Areas

(Light to Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and No Heavy-Weight Trucks)
[2 equivalent 18-kip axle loads per day]

Flexible:

2.5 inches	Asphalt concrete
7.0 inches	Aggregate base course
Over	Properly prepared natural subgrade soils, and/or structural site grading fill extending to natural subgrade soils

Rigid:

5.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Properly prepared natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

Primary Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and Occasional Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base course
Over	Properly prepared natural subgrade soils, and/or structural site grading fill extending to natural subgrade soils

Rigid:

6.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base course
Over	Properly prepared natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base course, over properly prepared natural subgrade or site grading structural fills extending to natural subgrade.

The above rigid pavement sections are for non-reinforced Portland cement concrete. Construction of the rigid pavement should be in sections 10 to 12 feet in width with construction or expansion joints or one-quarter depth saw-cuts on no more than 12-foot centers. Saw-cuts must be completed within 24 hours of the "initial set" of the concrete and should be performed under the direction of the concrete paving contractor. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.10 GEOSEISMIC SETTING

5.10.1 General

Utah municipalities adopted the International Building Code (IBC) 2006 on January 1, 2007. The IBC 2006 code determines the seismic hazard for a site based upon 2002 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The addition must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2006 edition.

5.10.2 Faulting

Based on our review of available literature, no active faults pass through or immediately adjacent to the site. The nearest active fault is the East Bench portion of the Wasatch fault approximately one-half to one mile west of the site. The Wasatch fault zone is considered capable of generating earthquakes as large as magnitude 7.3[3].

5.10.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions, of the IBC 2006 can be utilized.

5.10.4 Ground Motions

The IBC 2006 code is based on 2002 USGS mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (40.7591 degrees north and 111.8231 degrees west, respectively), the values for this site are tabulated on the following page.

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[3] Arabasz, W.J., Pechmann, J.C., and Brown, E.D., 1992, Observational seismology and the evaluation of earthquake hazards and risk in the Wasatch Front area, Utah, in Gori, P.L., and Hays, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper 1500-D, 36 p.

Spectral Acceleration Value, T Seconds	Site Class B-C Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration	59.2	59.2
0.2 Seconds, (Short Period Acceleration)	$S_S = 148.0$	$S_{MS} = 148.0$
1.0 Seconds (Long Period Acceleration)	$S_1 = 57.7$	$S_{M1} = 86.5$

The IBC 2006 code design accelerations (S_{DS} and S_{D1}) are based on multiplying the above accelerations (adjusted for site class effects) for the MCE event by two-thirds (⅔).

5.10.5 Liquefaction

The site is located in an area that has been identified by Salt Lake County as having a "very low" liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Groundwater was not encountered within the depths penetrated, 5.0 to 41.5 feet. Additionally due to the clayey nature of the soils and the medium dense to dense nature of the deeper granular soils, liquefaction is not anticipated to occur during the design seismic event.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Respectfully submitted,

GSH Geotechnical Consultants, Inc.

Bryan N. Roberts, State of Utah No. 276476
Professional Engineer

Reviewed by:

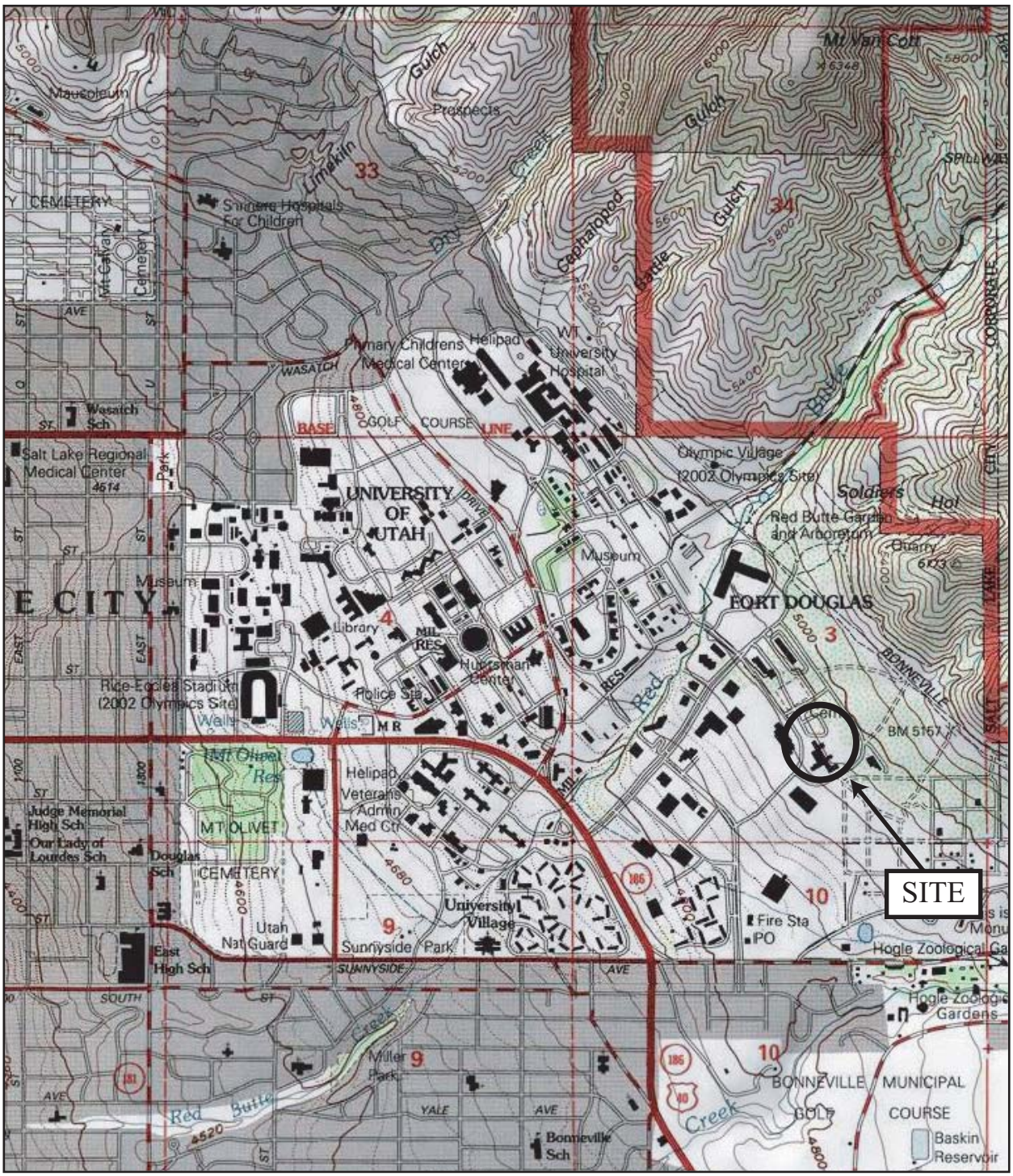
William J. Gordon, State of Utah No.146417
Professional Engineer

BNR/WJG:sn

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3G, Log of Borings
Figure 4, Unified Soil Classification System

Addressee (3 + email)
c: Mr. Bill Bowen, State of Utah, DFCM (1 + email)

UNIVERSITY OF UTAH
JOB NO. 0128-042-09



SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAPS
TITLED "FORT DOUGLAS, UTAH" AND "SUGAR HOUSE, UTAH"
BOTH DATED 1998

GSH
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Geotechnical Consultants, Inc.

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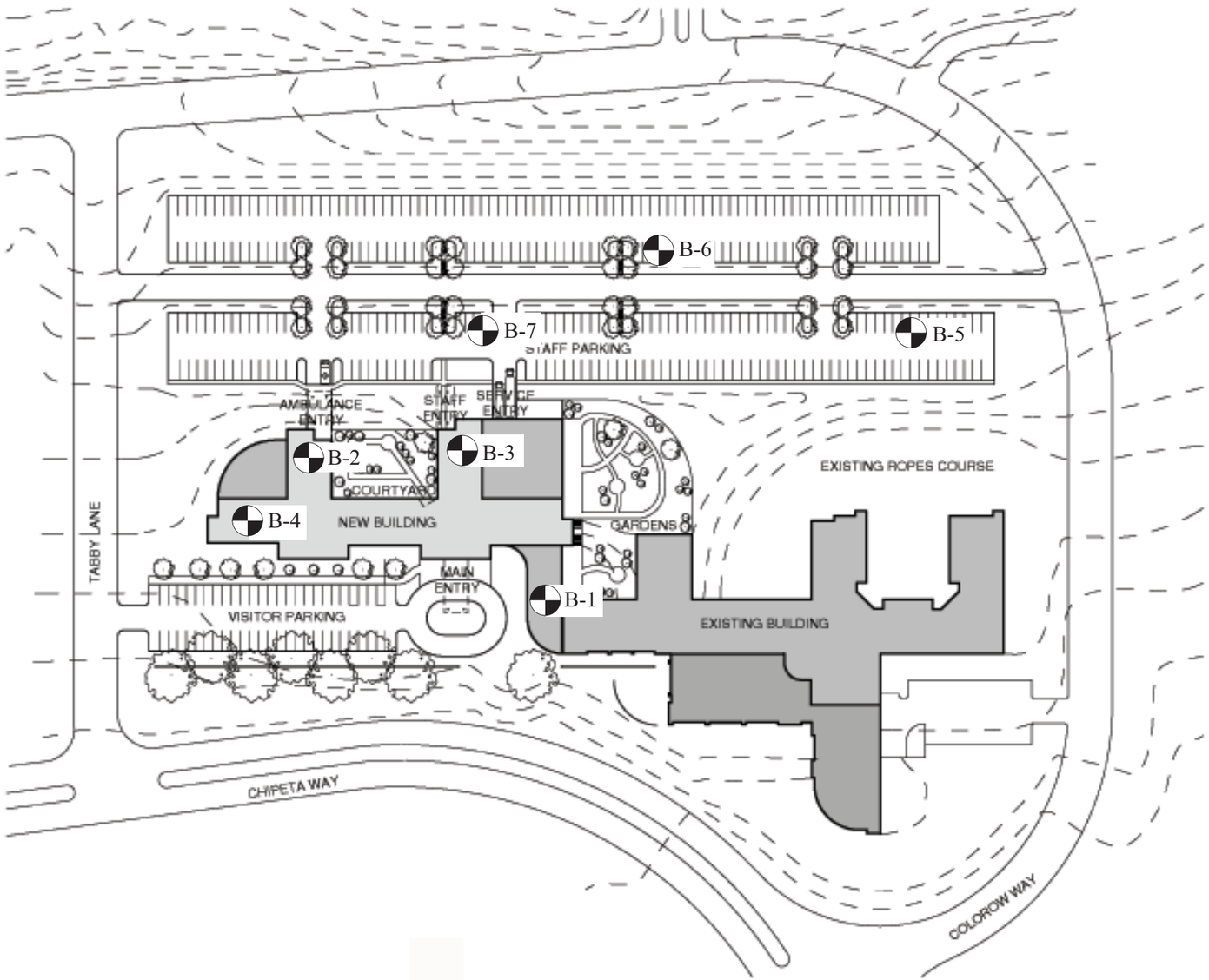
JOB NO. 0128-042-09



REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"SITE PLAN, EXPANSION FEASIBILITY STUDY,
UNIVERSITY HEALTH CARE, UNIVERSITY NEUROPSYCHIATRIC INSTITUTE"
BY FFKR ARCHITECTS, DATED MAY 5, 2009

APPROXIMATE SCALE: 1" = 145'

FIGURE 2
SITE PLAN

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Gordon Spilker Huber
Geotechnical Consultants, Inc.

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 06-08-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		3" ASPHALT CONCRETE									
		6" 3/4" ROADBASE									
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; light mottling; brown (GC)									moist very stiff
				47							
		SANDY CLAY/CLAYEY SAND with occasional fine and coarse gravel; fine to coarse sand; trace pinholes; light brown mottling (CL/SC)	5								moist very stiff/medium dense
				29		13.3		110			
		SILTY FINE SAND with trace clay; light reddish-brown (SM)		38		13.4		98			moist medium dense
		grades with occasional clay lenses	10	32							
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; oxidation; brown (GC)	15	51							moist medium dense
		FINE AND COARSE GRAVELLY CLAY with some fine to coarse sand; oxidation; brown (CL)	20	31							stiff
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3A

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
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Client: University of Utah
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Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		GRAVELLY CLAY/CLAYEY GRAVEL with numerous clay clasts; fine and coarse gravel; gray and brown (GC)		23							moist stiff/loose
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand and cobbles at tip; tannish-brown (GC)	30	93							moist dense
			35	41							
		FINE AND COARSE GRAVELLY CLAY with some fine to coarse sand; light brownish-tan (CL)	40	71							moist hard
		Stopped drilling at 40.0'. Stopped sampling at 41.5'. No groundwater encountered at time of drilling. Installed 1-1/4" diameter skotted PVC pipe to 41.5'.	45								
			50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3A
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
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Client: University of Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 06-08-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		3" ASPHALT CONCRETE									
		6" 3/4" ROADBASE									
		SANDY CLAY/CLAYEY SAND with trace to some fine and coarse gravel; fine to coarse sand; trace pinholes; light mottling; brown (CL/SC)									moist stiff/loose
				24							
											moist stiff
		SILTY CLAY with some fine sand; trace pinholes; light brown mottling; brown (CL)	5								
				22		11.8		107			
			10								stiff
				100+		17.5		104			moist very dense
		SILTY FINE TO COARSE SAND with occasional fine and coarse gravel; brown (SM)									
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; mottling; oxidation; brown (GC)									
			15								moist dense
				74							
			20								
				56							
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3B

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 06-08-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		SILTY CLAY with some fine to coarse sand and occasional fine and coarse gravel; brown (CL)		52							moist very stiff
		grades fine and coarse gravelley clay with some fine to coarse sand; gray									
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; yellow and brown mottling/oxidation; light gray (GC)	30	100+							moist very dense
		grades grayish-brown	35	100+							
			40	54							
		Stopped drilling at 40.0'. Stopped sampling at 41.5'. No groundwater encountered at time of drilling. Installed 1-1/4" diameter skotted PVC pipe to 41.5'.	45								
			50								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3B
(con't)

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 3-3/4" ID Hollow-Stem Auger
Date Drilled: 06-08-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		3" ASPHALT CONCRETE									
		6" 3/4" ROADBASE									
		GRAVELLY CLAY/CLAYEY GRAVEL with trace to some fine to coarse sand; fine and coarse gravel; brown (CL/GC)									moist stiff/loose
				22							
											very stiff/medium dense
		grades with light brown mottling	5	31							
		SILTY FINE SAND light reddish-brown (SM)		25							moist loose
		GRAVELLY CLAY/CLAYEY GRAVEL with some fine to coarse sand; fine and coarse gravel; light oxidation; brown and gray clasts (CL/GC)	10								moist very stiff/medium dense
				51							
		drilling indicates occasional cobbles	15								
		Drilling refusal at 16.0'.									
		Stopped sampling at 14.5'.									
		No groundwater encountered at time of drilling.	20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3C

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 4-1/4" ID Hollow-Stem Auger
Date Drilled: 06-09-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface	0								
		3" ASPHALT CONCRETE									
		6" 3/4" ROADBASE									
		SILTY CLAY with some fine to coarse sand; blocky; roots; dark brown (CL)									moist very stiff
				27		12.5		122			
											moist very stiff/medium dense
		SANDY CLAY/CLAYEY SAND with trace to some fine and coarse gravel; fine to medium sand; trace pinholes; reddish-brown (CL/SC)	5	33		11.9		116			
		CLAYEY FINE TO COARSE SAND with trace silt; occasional layers to 4" thick of fine to coarse sand; brown (SC)									moist medium dense
			10	35							
			15	18							
		GRAVELLY CLAY/CLAYEY GRAVEL with some fine sand; fine and coarse gravel; brown (CL/GC)		17							moist very stiff/loose
			20	100+							hard/very dense
		Stopped drilling at 20.0'. Stopped sampling at 20.5'. No groundwater encountered at time of drilling.	25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3D

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 4-1/4" ID Hollow-Stem Auger
Date Drilled: 06-09-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		CLAYEY FINE TO COARSE SAND with some fine and coarse gravel; major root (topsoil) to 2"; mottling; brown (SC)	0								loose to 3" moist "loose" to "medium dense"
			5								
		Stopped drilling at 5.0'.									
		Stopped sampling at 5.0'.									
		No groundwater encountered at time of drilling.									
			10								
			15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3E

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 4-1/4" ID Hollow-Stem Auger
Date Drilled: 06-09-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; major root (topsoil) to 3"; dark brown (GC)	0								loose to 3"-4" moist "medium dense"
			5								
		Stopped drilling at 5.0'.									
		Stopped sampling at 5.0'.									
		No groundwater encountered at time of drilling.									
			10								
			15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3F

Gordon Spilker Huber Geotechnical Consultants, Inc.
Salt Lake City, Utah 84123

Project Name: Proposed Addition to the Existing UNI Facility
Project No.: 0128-042-09
Location: 501 Chipeta Way, U of U Research Park, SLC, UT
Client: University of Utah
Drilling Method: 4-1/4" ID Hollow-Stem Auger
Date Drilled: 06-09-09
GSH Field Rep.: RJG
Elevation: Approximate Overall Site 4945' to 4965' +/-
Water Level: No groundwater encountered.
Remarks:

Graphical Log	Water Level	DESCRIPTION	DEPTH FT.	BLOWS/FT	SAMPLE SYMBOL	MOISTURE (%)	% PASSING 200	DRY DENSITY (PCF)	Liquid Limit (%)	Plastic Limit (%)	REMARKS
		Ground Surface									
		CLAYEY FINE AND COARSE GRAVEL with some fine to coarse sand; major root (topsoil) to 3"; dark brown (GC)	0								loose to 3" moist "medium dense"
			5								
		Stopped drilling at 5.0'.									
		Stopped sampling at 5.0'.									
		No groundwater encountered at time of drilling.									
			10								
			15								
			20								
			25								

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 3G

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. [2] (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures.

IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	GRAPH SYMBOL	LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

[1] Boundary classifications: –Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW–GC, well graded gravel–sand mixture with clay binder.
[2] All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

- Bulk / Bag Sample
- Thin Wall
- Standard Penetration Split Spoon Sampler
- No Recovery
- Rock Core
- 3-3/4" ID D&M Sampler
- 3" ID D&M Sampler
- Water Level
- California Sampler

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thichness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

DESCRIPTION	%
Trace	<5
Some	5 - 12
With	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 4

GSH
Gordon Spilker Huber
Geotechnical Consultants, Inc.