RB&G
ENGINEERING, INC.

February 14, 2012

Kurt Baxter
DFCM
4110 State Office Building
Salt Lake City, UT 84114

Re: UVU Student Life Center & Parking Structure
Final Geotechnical Investigation

Dear Mr. Baxter:

A Final Geotechnical Investigation has been completed for the proposed Student Life Center & Parking Structure to be located on the Utah Valley University in Orem, Utah. The results of the study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

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UTAH VALLEY UNIVERSITY
STUDENT LIFE CENTER
AND PARKING STRUCTURE
Orem, Utah

Final Geotechnical Investigation

INTRODUCTION

This report outlines the results of a geotechnical investigation performed for the proposed Student Life Center and Parking Structure to be located on the Utah Valley University (UVU) Campus in Orem, Utah. Figure 1 is a vicinity map showing the location of the project relative to the surrounding area.

RB&G Engineering conducted a preliminary geotechnical investigation for this project and presented the findings of that investigation in a report dated April 4, 2011. At the time of the preliminary report, the proposed Student Life Center was expected to be located in the existing parking area immediately east of the Liberal Arts Building and south of the new Library Building, and a new Parking Structure was expected to be constructed in the existing parking lot immediately north of the Sorensen Student Center.

Subsequent to completion of the preliminary geotechnical investigation, the project site plan was revised substantially. Based on the current site plan (see Figure 2 in this report), the proposed Student Life Center will be an L-shaped structure that connects to the north side of the existing Sorensen Student Center and also connects to the east side of the existing Physical Education Building. Based on architectural drawings made available to us, we understand that much of the Student Life Center's ground floor in the westerly leg of the structure will be omitted, allowing construction of a concrete plaza beneath the building in the area just east of the PE Building. The proposed new Parking Structure will be attached to the east side of the new Student Life Center. The current site plan also indicates a playing field will be constructed in the existing parking lot east of the Liberal Arts Building. Fire lanes, driveways, and other flatwork will exist at various locations throughout the site.

RB&G Engineering also performed the geotechnical investigation for the new Library building located north of the project area in 2006. During the initial phases of the library investigation, five borings were drilled in the parking lot area east of the Liberal Arts building. Three of these borings are located within the current project site. The locations of the 2006 borings (06-1 through 06-5), along with the 2011 preliminary borings (11-1 through 11-4) and the new borings for this report (11-5 through 11-16), are shown on Figure 2. Information from previous investigations has been utilized where applicable, during preparation of this report.

The information contained in the report is discussed under the following headings: (1) Geological and Existing Site Conditions, (2) Field and Laboratory Testing Procedures, (3) Subsurface Soil and Water Conditions, (4) Foundation Considerations and Recommendations, (5)Site Preparation and Compacted Fill Requirements, and (6) Pavement Design.

I. GEOLOGICAL AND EXISTING SITE CONDITIONS

The UVU Orem Campus is located between 800 South and 1200 South and between 600 West and Interstate 15 in Orem, Utah. The surface soils in this area have been mapped as Lacustrine sand deposits laid down during the regressive phase of ancient Lake Bonneville (upper Pleistocene). Previous campus investigations indicate that the subsurface soils consist of interbedded sands, silts and clays. In the parking lot area north of the existing Sorenson Student center, we found that the mapped soil deposits are overlain by 10 to 15 feet of relatively gravelly soil, some of which may be imported fill used to grade the site.

The Wasatch Fault is located near the base of the Wasatch Mountain Range, about 4 to 4.5 miles east of the site. Utah County Natural Hazards Maps identify this area as having moderate liquefaction potential.

The Liberal Arts building is located immediately west of the northerly portion of the site, and the Sorensen Student Center building is located immediately south of the southerly portion of the project. No significant cracking was observed in foundation walls. The lack of visible foundation distress suggests that existing foundations are generally performing in a satisfactory manner.

The topography throughout the area slopes gently downward in a northwesterly direction. The elevation of the parking lot north of the Sorensen Student Center ranges from about 4620 feet at the southeast corner to 4606 feet along the east edge. The grassy area west of this parking lot slopes gently down to the west such that the existing ground surface is near elevation 4602 feet near the east edge of the Physical Education Building. The elevation of the parking area east of the Liberal Arts building ranges from about 4601 feet at the southeast corner to 4597 feet at the northeast corner.

As shown in Figure 2, a raised berm with grass and trees is located on the east side of the northerly portion of the site, and parking strips in the southern portion are also landscaped in lawn grass and trees. The pavement in parking areas shows significant cracking. Most concrete sidewalks in the area are in very good condition, with only a few cracks noted.

No major water conveyance facilities or other water bodies exist in the immediate vicinity which would influence the groundwater level at this site. However, the groundwater level is influenced by irrigation practices on the Provo-Orem bench located east of campus. Other than the information provided above, no surficial conditions appear to exist at this site which would adversely affect foundation performance.

II. FIELD AND LABORATORY TESTING PROCEDURES

The subsurface investigation was performed using a CME 55 rotary drill rig with a tri-cone rock bit and NW casing to advance the boring and water as the drilling fluid. During the subsurface investigation, sampling was performed at three-foot intervals in the upper 25 to 30 feet and at five-foot intervals thereafter. Both disturbed and undisturbed samples were obtained during the field investigations. Disturbed samples were obtained by driving a 2-inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a height of 30 inches. The number of blows required to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows required to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value, corrected for overburden and hammer energy, provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of the cohesive material, since the penetration resistance of materials of this type is a function of the moisture content. Considerable care must be exercised in interpreting the standard penetration value in gravelly-type soils, particularly where the size of the granular particles exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with a reasonable core recovery, the standard penetration value provides a good indication of the in-place density of gravelly-type material.

It will be noted that it was not possible to drive the sampling spoon through the full 18 inches at some sampling locations. Where the sampling tube could not be driven through the full 18 inches, the number of blows recorded while driving the spoon through a given depth of penetration is shown on the boring logs.

Undisturbed samples were obtained at select locations by pushing a thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. The location at which the undisturbed samples were obtained is shown on the boring logs.

Miniature vane shear tests, which provide an indication of the undrained shearing strength of cohesive materials, were performed on samples of the clay soil during the field investigations. The results of these tests are shown on the boring logs as the torvane value in tsf.

Each sample obtained in the field was classified in the laboratory according to the Modified Unified Soil Classification System. The symbol designating the soil type according to this system is presented on the boring logs. A description of the Modified Unified Soil Classification System is presented in the appendix, and the meanings of the various symbols shown on the logs can be obtained from this figure.

Laboratory tests performed during this investigation to define the characteristics of the subsurface material throughout the proposed site included:

- In-place dry unit weight
- Natural moisture content
- Atterberg Limits
- Mechanical analyses
- Unconfined compressive strength
- One-dimensional consolidation

Testing was performed following procedures outlined in the ASTM International standards.

III. SUBSURFACE SOIL AND WATER CONDITIONS

Student Life Center and Parking Structure Area

The characteristics of the subsurface material were evaluated by drilling 12 borings (Borings 11-1 through 11-12) to depths of between 41.5 and 91.5 feet at the approximate locations shown in Figure 2. The logs for the borings are presented in the appendix, and it will be observed that the near-surface soil profile generally consists of dense granular soils within the upper 10 to 15 feet, underlain by a transition zone of medium dense to dense silty sand ranging from about 2 to 7 feet thick. Each of the borings then encountered a zone of loose to very loose sandy nonplastic silt and silty sand ranging from about 6 to 12 feet thick. Firm lean clay was the predominant soil from about elevation 4594 to 4553 feet, followed by dense silty sand. The dense silty sand extended to the bottom of the borings for Borings 11-1, 11-2, 11-3, and 11-12, in which the elevation at the bottom of each boring ranged from about 4540 to 4520 feet. The silty sand in Boring 11-4 extended to elevation 4545 feet, and was underlain by stiff lean clay to the bottom of the hole at 4539 feet. The silty sand in Boring 11-7 extended to about elevation 4525 feet, with the underlying firm lean clay extending to the bottom of the boring at elevation 4522 feet.

The dense granular soils in the upper 10 to 15 feet were generally classified as silty gravel with sand and possible cobbles on the east half of the site, but transitioned to predominantly silty sands beneath the west leg of the proposed building footprint (see Borings 11-9 through 11-12). The bottom of the dense granular soil was encountered at about elevation 4600 feet along the east side of the proposed Parking Structure (Borings 11-2, 11-5, and 11-8), and sloped down in a westerly direction across the site to about elevation 4593 feet at the west end of the proposed Student Life Center (Borings 11-11 and 11-12). Similar westerly-trending slopes were observed in the underlying soil stratification. The bottom of the moderately dense sandy zone was logged near elevation 4597 feet at the east end of the site and sloped down to about elevation 4587 feet at the west end. The transition from the loose silt/sand zone occurred between elevations 4589 and 4586 feet at the east end of the site, and sloped down to about elevation 4576 feet at the west end of the site.

The loose silt/sand zone averaged about 8 feet thick across most of the site, but the average thickness of this zone increased to about 12 feet in the last three borings (11-10, 11-11, 11-12). Sandy silt was the predominant soil type in this zone, with approximately 70 percent of the soil samples classifying as sandy silt. Borings 11-3 and 11-11 varied from the general trend in that the loose silt/sand zone contained mostly silty sand. The cross sections identified in Figure 2 are shown on Figures 3a through 3c and show the approximate thickness of the liquefiable zone and groundwater level.

At the time of the preliminary investigation (Feb-Mar 2011), the groundwater level in Borings 11-1 and 11-4 was measured at a depth of about 23 feet below the ground surface, or approximate elevation 4587 feet. In the latest investigations (Oct-Nov 2011), we have found the groundwater level in the parking area to be somewhat higher. The table below summarizes the groundwater levels measured at the site. The table is organized from east to west across the site. The asterisks in the table identify measurements that were taken during drilling, and it should be recognized that these measurements may be affected by water introduced during the drilling process. Measurements not marked by an asterisk were taken at least a day after drilling, and should therefore be the most reliable indicators of the static groundwater level.

Test Hole No.	General Boring Location	Ground Elevation (ft)	Groundwater Depth (ft)		Groundwater Elevation (ft)	Month of Measurement
11-2	E	4616.4	24.0	*	4592.4	Feb-Mar
11-5	E	4614.4	19.4	*	4595.0	Oct-Nov
11-8	E	4615.5	20.5		4595.0	Oct-Nov
11-1	C	4610.6	23.5		4587.1	Feb-Mar
11-4	C	4609.6	23.0		4586.6	Feb-Mar
11-7	C	4613.1	21.0	*	4592.1	Oct-Nov
11-9	C	4605.5	17.0		4588.5	Oct-Nov
11-3	W	4606.9	18.0	*	4588.9	Feb-Mar
11-6	W	4605.8	16.4		4589.4	Oct-Nov
11-10	W	4603.1	15.6		4587.5	Oct-Nov
11-11	W	4602.7	16.7		4586.0	Oct-Nov
11-12	W	4602.2	10.0	*	4592.2	Oct-Nov

* Measured during drilling.

The water levels listed in the table above show that the groundwater surface generally slopes down in a westerly direction across the site. The groundwater elevation was also higher in a given area in the Oct-Nov measurements than it was in the Feb-Mar measurements, indicating seasonal fluctuations. We estimate that groundwater levels at the site will generally peak in the mid to late summer due to irrigation in the site vicinity, and recede to seasonal lows in the winter prior to spring runoff. For design, we recommend assuming that the groundwater level could rise as much as two feet above the Oct-Nov readings listed in the table. Surface water and perched water flowing from the east could impact the structure, and we therefore recommend that drainage be provided along the east side of the site to redirect or intercept such flows.

Northerly Playing Field and Driveway Areas

Three borings drilled during the 2006 study (06-1, 06-1, 06-3) were also used to evaluate the characteristics of the subsurface material. These borings were drilled to depths of between 50 and 70 feet. The logs for the 2006 borings are presented in the appendix. It will be observed that the surface profile consists of a near surface zone of very loose to medium dense silty sand (SM) and sandy silt (ML) extending to depths varying from 8 to 24 feet (elev. 4584 to 4575 ft), followed predominantly by firm to stiff lean clay (CL) to a depth of between 37 and 51 feet (4561 to 4548 ft).

Four supplemental borings (11-13 through 11-16) were drilled in 2011 to depths of 10 feet to assess pavement support conditions for anticipated driveways and fire lanes around the perimeter of the proposed playing field. Each of these borings was drilled through three inches of asphalt pavement underlain by 3 to 18 inches of sand and gravel base and sub-base. Below the pavement surface and base layers, the soil profile consisted of silty sand to the bottom of each boring. The silty sand ranged from medium dense to very dense in the upper 4 to 6 feet, and was generally in a medium dense state at greater depths.

Groundwater was measured at a depth of between 8 and 13 feet below the existing ground surface (elev. 4588.5 and 4586.5 ft) during the March 2006 subsurface investigations in the proposed playing field area.

The results of classification, density and moisture tests are presented on the boring logs, and the results of the laboratory soil classification and compressive strength tests are are summarized in Table 1, Summary of Test Data in the appendix.

It will be noted that the silty sand samples tested in the 2011 investigations had 14 to 48% silt, and the sandy silt layers contained 15 to 50% sand. The silt encountered above depths of 25 feet was generally non-plastic. Plastic silt samples encountered at depths greater than 25 feet had liquid limits ranging from 25 to 36 and plasticity indices between 2 and 11. The liquid limit of the lean clay and silty clay samples ranged from 21 to 41, and the plasticity index varied from 6 to 16. The unconfined compressive strength ranged from about 1050 to 3100 psf.

The compressibility characteristics of the lean clay were evaluated by performing 11 consolidation tests on samples obtained during the 2011 study. The 2006 study also contains the results of a consolidation test on a sample from Boring 06-1. The results of these tests are also presented in the appendix.

During performance of the consolidation tests, each sample was permitted to absorb water at the beginning of the test to determine the effect of moisture on the compressibility characteristics of these materials. Expansive soils always experience an increase in void ratio on absorbing water. It will be observed from these tests that no increase in the void ratio occurred as the sample absorbed moisture. It is concluded from the consolidation and classification tests that the subsurface materials at this site do not have expansive characteristics.

IV. FOUNDATION CONSIDERATIONS AND RECOMMENDATIONS

A. FOUNDATION TYPES AND BEARING CAPACITIES

We understand that the proposed Student Life Center and Parking Structure will each have four levels. The finished floor elevation of the bottom level for the Parking Structure is expected to be between elevation 4607 and 4606 feet. The finished floor elevation of the Student Life Center will be near 4603 feet to match the existing PE Building and Sorenson Building floor elevations. We recommend that all exterior foundations be located at a depth below finished grade sufficient to provide frost protection, which is about 2.5 feet in this area, and that interior footings be located at least 1 foot below floor level.

Based on a design meeting with the project architect and structural engineers, we understand that column loads for the project will range from a minimum of 250 kips to a maximum of about 1500 kips. We have assumed that wall loads could be as large as 10 klf. Foundation options considered during this report include spread footings on native soil, compacted fill, or short aggregate piers, as well as deep foundations.

1. *Spread Footings on Native Soil*

Liquefaction of the loose silty sand and sandy silt layers encountered between depths of about 15 and 27 feet throughout the sites would result in a loss of shear strength, strain related settlement, and potential for lateral displacement. The liquefaction analysis is discussed in Section IV.B of this report. The estimated residual strength of the liquefied zones averages about 450 psf over the east portion of the site where the proposed Parking Structure is to be located, and about 350 psf over the central and west portion of the site under the proposed Student Life Center. While the central and west portions of the site are expected to have somewhat lower residual liquefied soil strengths, they will also have a thicker overlying unliquefied soil layer that will better distribute foundation stresses. In estimates of bearing resistance for footings situated three to four feet below the finished floor elevations, the increasing thickness of the upper dense soil zone from east to west across the site tends to compensate for the decline in estimated residual strength from east to west.

The estimated average total settlement due to liquefaction ranges from 0.9 to 2.6 inches in the proposed building area, with an average estimated liquefaction-induced settlement of 1.6 inch. We estimate that liquefaction-induced settlement may cause differential settlement of about 1 inch over horizontal distances as short as 20 feet. Lateral spread analyses indicate potential lateral displacements in the range of 2.5 to 4 feet could occur as a result of liquefaction. The lateral spread analyses assume continuity of liquefiable zones for a significant distance west-northwest of the site.

We do not anticipate that the proposed structures can tolerate the estimated magnitude of lateral spread displacement. The estimated settlements resulting from liquefaction may also be problematic. We anticipate that ground improvement of a relatively large area will be required to resist lateral spreading, and that few, if any, shallow foundations will be supported on the natural soil without some sort of prior replacement or improvement.

If footings are to be located on native soil in areas not subjected to ground improvement, the following bearing capacity recommendations are applicable. A factor of safety of 2.5 was used for allowable bearing capacity of the dense surficial sand and gravel, and a factor of safety of 1.3 was used for the liquefied soils in the seismic event.

Student Life Center and Parking Structure Area

Listed in the following table are allowable bearing capacity values for footings located at or above elevation 4604 ft within the east portion of the site (Parking Structure area). This table is also applicable to foundations situated at or above elevation 4599 feet on the west portion of the site (adjacent to the existing Physical Education Building). The allowable bearing capacity for larger footings is limited by the low anticipated residual strength of the liquefied material following the design seismic event.

Footing Width (ft)	Continuous Footings	Square Footings
2	3500	3130
4	4450	4590
6	3560	6040
8	2940	5450
10	2630	4550
12	2420	4000
14	2270	3630
16	2160	3360

Playing Field Area

At the time of this report, we have not been informed of footing types or loading magnitudes anticipated in this area. If structures are proposed in this area, the table below may be used to estimate the allowable soil bearing capacity for footings located on the native soil or compacted fill at about elevation 4600 feet in the anticipated playing field area. The allowable bearing capacity for larger footings is limited by the loose silty sand and low residual strength of the liquefied material following the design seismic event.

Footing Width (ft)	Continuous Footings	Square Footings
2	2640	2370
4	2440	3450
6	1920	4170
8	1660	3120
10	1510	2570
12	1410	2230
14	1330	2000
16	1280	1830

If the structures cannot tolerate the magnitude of settlement described above, options to support the structures include over-excavation and replacement of the liquefiable soil zone, spread footings on short aggregate piers designed to reinforce and increase the strength of the liquefiable soil zone, and/or deep foundations used to bypass the liquefiable zone. Foundation options are discussed separately below.

2. Over-excavation and Replacement of Liquefiable Soil Zone

Removing and replacing all of the loose silt and sand would allow design of footings for a total foundation settlement of less than 1 inch and differential settlement less than 0.5 inch. This would require excavating approximately 16 to 22 feet below the floor elevation of 4603 feet, to elevations ranging from 4587 to 4581 feet beneath the east and central portions of the building area. The required over-excavation at the west end of the Student Life Center (adjacent to the existing Physical Education Building) would extend to about elevation 4575 feet, roughly 28 feet below the proposed finished floor elevation of 4603 feet. Dewatering would be required to lower the water table in the excavation area at least 8 to 10 feet on average.

The liquefiable silty sand and non-plastic sandy silt can be used as backfill beneath the building footprint provided that it is moisture conditioned to within 2% of optimum moisture, placed in lifts not exceeding 8 inches in thickness, and compacted to an in-place unit weight equal to at least 95% of the maximum density as determined by ASTM D 1557. It should be recognized that moisture conditioning of these soils could require substantial time and effort, particularly during the wetter seasons. Imported fill should consist of granular soils having a maximum size of 4 inches with not more than 30% passing the No. 200 sieve. The fines should have a plasticity index less than 6.

If the loose silt/sand zone is completely over-excavated and replaced, the allowable bearing capacity for continuous footings and square footings can be selected from the table below. The values in the table are applicable to footings located at or above elevation 4600 feet.

Footing Width (ft)	Continuous Footings	Square Footings
2	4690	4210
4	5880	4930
6	5760	5640
8	4750	6360
10	4080	6700
12	3450	5440
14	2910	4370
16	2620	3790

In the table above, the bearing capacity of the larger footings is limited by the capacity of the clayey soils underlying the liquefiable soil zone that is to be replaced.

The "continuous footings" column above applies to footings with length to width (L:W) ratios longer than about 5:1. We understand that some long footings supporting multiple columns may be used to support structural loads. Long rectangular footings measuring 6 x 20 feet to 10 x 40 feet may be designed using an allowable bearing capacity of 5000 psf if the liquefiable sand and silt in the footing area are completely overexcavated and replaced with structural fill.

If the over-excavation and replacement option described above is selected, the plan area of the bottom of the over-excavation should include the footing area plus a lateral distance of at least 0.70Z on all sides, where Z is the depth of over-excavation below the bottom of the footing.

3. *Spread Footings on Short Aggregate Piers or Stone Columns*

A significant increase in bearing capacity can be obtained using short aggregate piers to reinforce the native soils beneath footings. Based upon the results of the subsurface investigation, it is our opinion that an allowable bearing capacity in the order of 4000 to 5000 psf can be achieved using an aggregate pier system. Piers should extend through the loose sand and silt zone and into the lean clay. Design and installation of aggregate piers requires a specialty contractor and the actual magnitude of soil improvement is dependent on the equipment and methods used. Specialty contractors that we are aware of with experience in this area include Geopier Foundation Company and Hayward Baker. We recommend that the specialty contractor's design be reviewed by the geotechnical engineer and that the geotechnical engineer observe installation periodically throughout construction.

The ground improvement area for each footing should include the footing area plus a horizontal distance equal to at least 0.70Z on all sides, where Z is the depth from the bottom of the footing to the bottom of the stone columns.

4. *Deep Foundations*

Driven Piles

Consideration has been given to supporting the structure on driven piles extending 10 feet into the dense silty sand underlying the clay. It is anticipated that the piles would extend to between elevation 4530 and 4545 feet. Additional deeper borings will be required if this option is selected. The estimated pile length varies between about 65 and 75 feet. Axial compressive capacities for 12.75-inch, 14-inch, and 16-inch (outside diameter) closed-end concrete-filled steel pipe piles are summarized on the following table.

Pipe Pile Outside Diameter (inches)	Ultimate Skin Friction (kips)	Ultimate End Bearing (kips)	Allowable Capacity Assuming Factor of Safety = 2.25 (kips)
12.75	103	115	97
14.0	123	138	116
16.0	159	181	151

The estimated pile capacities listed above are generalized for the project site for use in foundation type selection. We can provide refined analyses and estimated pile toe elevations for specific locations if needed.

Pile layouts should be designed with a minimum center-to-center spacing of 3 pile diameters between piles. A factor of safety of 2.25 has been used to calculate the allowable capacities. This factor of safety assumes that dynamic pile testing (PDA) will be performed during driving of at least one pile at each of the four corners of the site, and also during driving of a pile near the center of the structure. If this option is selected, pile uplift capacity, lateral capacity, and pile group settlement can be evaluated for the proposed pile group layouts. We recommend that the geotechnical engineer's representative be present during pile installation and load testing.

Drilled Shafts

Drilled shafts have also been considered as a foundation option for supporting the structure. It has been assumed that the shafts will be drilled 10 feet into the dense silty sand referenced in the Driven Pile section above. Procedures outlined in FHWA-H1-88-042, Drilled Shafts: Construction Procedures and Design Methods, have been used to determine the ultimate axial compressive capacity (nominal resistance) of drilled shafts. Capacity analyses have been performed for straight-sided drilled shafts using soil parameters obtained from the borings. If allowable stress design methods are used, we recommend that a factor of safety of 2.5 be applied to the ultimate capacity to determine the allowable capacity. It has been assumed that high quality construction, good specifications and excellent inspection will exist for each foundation. The estimated capacities of the drilled shafts can be taken from the table below.

Shaft Diameter (ft)	Ultimate Side Resistance (kips)	Ultimate End Resistance (kips)	Total Ultimate Capacity (kips)	Allowable Capacity (kips)
3.0	228	314	542	217
3.5	265	427	692	277
4.0	303	558	861	344
4.5	341	706	1047	419
5.0	379	872	1251	500

The estimated drilled shaft capacities listed above are generalized for the project site for use in foundation type selection. We can provide refined analyses and estimated drilled shaft toe elevations for specific locations if needed.

The allowable uplift resistance of a single drilled shaft may be taken as the ultimate side resistance value shown on the table above divided by a factor of safety of 3.0. A center-to-center spacing of at least three shaft diameters should exist to minimize interaction and overlapping stresses between shafts, which would result in reduced capacity. If this option is selected, we can provide settlement estimates and recommended drilled shaft toe elevations for proposed shaft layouts and loads at specific locations within the site.

The design of rebar and concrete should follow established guidelines. Concrete should be placed by tremie methods to ensure that no voids exist within the shafts. Concrete used for shafts should have a relatively high slump (6 inches or greater) to allow workability and proper placement between reinforcement and the sides of the shafts. Within each shaft, concrete should be placed in a generally continuous manner to prevent cold joints and other problems associated with excessive waits between concrete trucks. It is essential that drilled shaft construction be carefully inspected to ensure that loose material is removed from the base and that the concrete is placed using proper procedures.

5. *Mat Foundation*

The use of a large-area mat foundation may be considered for supporting the proposed structure. An allowable bearing capacity of 1200 psf could be used for the mat foundation to limit the estimated consolidation settlements to 1 inch under static loading conditions. A heavily-reinforced mat foundation will be more effective than a system of discrete spread footings in accommodating differential settlements. However, a mat foundation will not fully address the lateral spread hazard associated with the site.

Summary of Foundation Options

If the foundations for the proposed facilities are designed in accordance with the recommendations outlined above for spread footings on compacted fill, for short aggregate piers, or for deep foundations, the maximum settlement of any footing should not exceed one inch and differential settlement throughout the structure should not exceed 0.5 inch. It is generally recognized that the tolerable differential settlement for steel and concrete structures is about 0.002 times the column spacing. This criterion is tantamount to a differential settlement of about 0.5 inch for column spacings of 20 feet and 0.7 inch for column spacings of 30 feet. Since it is not anticipated that the column spacing will be less than 20 feet, a differential settlement of 0.5 inch should be satisfactory for the proposed facilities.

Each foundation option discussed above may present various advantages and disadvantages for this project, including those listed below:

- Over-excavation and replacement of the liquefiable soils:
  - This option presents the surest means of mitigating settlements and lateral movements associated with liquefaction, and would also provide the largest bearing resistance among the shallow foundation options.

    - Replacement of the liquefiable soils would require "additional" excavation depths ranging from about 21 to 27 feet (measured from bottom of finished floor or existing ground elevation, whichever is lowest), and an average of at least 8 to 10 feet below the water table.
    - Construction dewatering of the liquefiable soils for excavation and replacement would likely be most efficiently achieved using a system of closely-spaced well points. The soils at the bottom of the excavation would be saturated and relatively soft, and would likely require stabilization before placing compacted fill. Stabilization and dewatering for this scenario are discussed further in Section V of this report.
    - Complete over-excavation of the liquefiable soils would likely require extensive shoring adjacent to existing structures.
- Installation of short aggregate piers or stone columns to reinforce the liquefiable soil:
    - These ground improvement techniques avoid shoring and dewatering work that would be necessary to completely replace the liquefiable soils.
    - These methods improve the liquefiable soils to a lesser degree than would be accomplished by complete replacement.
    - This option would likely require pre-drilling through the dense surface soils, which may add substantial cost and time to the installation operation.
    - The pre-drilling necessary to install aggregate piers or columns at the site would be somewhat counterproductive because it would perforate the existing good shallow bearing soils at the site with relatively large diameter holes.
    - Stone column installation vibrations could be a concern adjacent to existing buildings or utilities.
- Driven Piles:
    - Driven piles can be used to support large loads with relatively low potential for foundation settlement.
    - Lateral spreading will likely cause failure of the piles unless the liquefiable soils are mitigated using ground improvement.
    - Pile driving vibrations may be problematic adjacent to existing buildings.
- Drilled Shafts:
    - Like driven piles, drilled shafts can be used to support large loads with relatively low settlement potential.
    - It may be possible to design drilled shafts to resist lateral spreading loads.
    - Due to the high water table and presence of loose granular layers, drilling mud and/or casing will likely be required for shaft excavation.

- Mat Foundation
  - A heavily-reinforced mat foundation will better accommodate liquefaction-induced settlements than a system of spread footings.
  - While a structure supported on a mat foundation will likely perform better in a lateral spread event than a structure on spread footings, it is unlikely that a mat foundation will satisfactorily accommodate the anticipate magnitudes of lateral spreading.

It may be worthwhile to consider one or more combinations of the options listed above. For example, excavation of the dense surface soils prior to installing aggregate piers/columns might be more cost-effective than pre-drilling. The excavation could terminate somewhere between elevations 4600 and 4595 feet on average, keeping the bottom of the excavation about 5 feet above groundwater so that dewatering would be unnecessary and work could be conducted on reasonably stable soils. The need for shoring adjacent to existing buildings would be substantially reduced compared to the shoring required for deeper excavations into less-stable material to completely remove of the liquefiable soils. This approach might also shorten stone columns to the extent that they could be installed using smaller and more cost-effective equipment than would be necessary for deeper columns.

Another hybrid approach that may merit consideration is the use of aggregate piers or columns to mitigate liquefaction-induced settlement and lateral spread, along with drilled shafts under large foundation loads and adjacent to existing vibration-sensitive structures.

Finally, it may be worthwhile to investigate other specialty ground improvement methods. For example, jet grout columns could be installed in the liquefiable soil zone via relatively small-diameter holes drilled through the dense overlying soil. The jet grouting technique is typically more costly than aggregate columns or piers, but it may be more competitive after accounting for the cost of drilling to reach the soil zone requiring mitigation. Jet grouting might also be more favorable in terms of vibration impacts on existing facilities; however, the potential for undermining of adjacent structures would have to be evaluated. We can coordinate with a ground improvement contractor to assess feasibility and costs of jet grouting and similar options if desired by the design team.

B. SEISMIC CONSIDERATIONS

The site is located at about latitude 40.2797° North and longitude 111.7153° West. Mapped probabilistic peak ground acceleration (PGA) and spectral acceleration (SA) values are tabulated below:

Probabilistic ground motion values in %g.

	10%PE in 50 yr	2%PE in 50 yr
PGA	17.71	50.69
0.2 sec SA	42.23	115.09
1.0 sec SA	14.25	48.58

The values below are intended for use with the 2009 International Building Code (IBC) and ASCE 7-05, and should be adjusted based on the site class in accordance with the referenced standards. We can provide risk-targeted seismic values for use with the 2012 IBC and ASCE 7-10 if needed.

The allowable soil bearing pressure indicated above may be increased by one-third where seismic forces are included in the structural loads. If the frictional resistance of the footings and floor slabs are used to resist seismic forces, we recommend a coefficient of friction of 0.45 be used to calculate these forces. See Section C below for recommendations related to resistance provided by passive earth pressures.

A liquefaction analysis has been performed for the site assuming a seismic event having a probability of exceedence of 2% in 50 years. Tabulated below are the zones in each boring which have a factor of safety less than 1.0.

BORING NO.	ZONE (FT)
06-1	6 – 14
06-2	12 – 14
06-3	15 – 23
11-1	16 – 26
11-2	20 – 29
11-3	16 – 24
11-4	16 – 23
11-5	17 – 25
11-6	14 – 20
11-7	22 – 27
11-8	18 – 29
11-9	15 – 25
11-10	14 – 25
11-11	15 – 27
11-12	17 – 27

Liquefaction of the loose layers will result in a reduction of shear strength to an estimated value of about 450 psf in the east portion of the building area and about 350 psf in the central and west portions. Liquefaction-induced settlement in the building area ranges from 0.9 to 2.6 inches, with an average of approximately 1.6 inch. The larger settlements estimated within the building area are generally associated with borings on the west side of the site near the existing Physical Education Building. Approximately 2 inches of total liquefaction-induced settlement were estimated based on the 2006 borings in the playing field area. Lateral spread displacements in the order of 2.5 to 4 feet have also been estimated due to liquefaction of the loose silt/sand zone. It will be noted that the estimated lateral spread displacement is substantially larger than was estimated in the preliminary report for several reasons. The first is that the Oct-Nov water level measurements are higher than previously measured. The higher water levels result in a greater thickness of liquefiable soils to be considered in the lateral spread estimates. The higher water levels also incorporate soils with lower fines contents in the liquefiable layer, and the lateral spread correlation equation is very sensitive to the fines content for the types of liquefiable materials present at the site. Finally, based on additional site elevation data we determined that the prevailing ground slope and the slope of the bottom of the liquefiable soil layer are larger than assumed in previous lateral spread estimates.

The estimated liquefaction-induced settlements of shallow foundations and floor slabs in the proposed building area can be reduced to about 1 inch of total settlement and less than 0.5 inch of differential settlement over a distance of 20 feet by installing short aggregate piers or stone columns at an area ratio of about 14 percent of the mitigation area. Liquefaction-induced settlements can be more completely mitigated by over-excavating and replacing the liquefiable soil zone. Improvements in allowable foundation bearing capacity associated with these mitigation approaches are outlined in Section IV.A of this report.

Installation of stone columns to mitigate settlements of the Parking Structure and Student Life Center footings andfloor slabs using short aggregate piers or stone columns as described above will provide satisfactory resistance to lateral spreading for proposed buildings.

If the impacts of liquefaction are mitigated by replacing the liquefiable soils or reinforcing them using ground improvement techniques as discussed above, the site should be classified as Site Class D in accordance with Chapter 20 of ASCE 7. If liquefaction is not mitigated, Site Class F should be assumed unless the structure’s fundamental period of vibration is less than or equal to 0.5 second.

C. LATERAL EARTH PRESSURES

It is not anticipated that earth-retaining structures will be required for the proposed facility. If earth-retaining structures are required, however, and if backfilling is performed using granular material, and if the backfill behind the wall is horizontal, we recommend that the earth pressures be calculated using the following equation, along with the earth pressure coefficient outlined below:

$$P = \tfrac{1}{2}\, \gamma\, K\, H^2$$

Where	P	=	total lateral force on wall, plf
	K	=	earth pressure coefficient
	γ	=	unit weight of soil (125 pcf)
	H	=	height of retained soil against wall

The earth pressure coefficient used in designing the walls will depend upon whether the wall is free to move during backfilling operations, or whether the wall is restrained during backfilling. If the wall is free to move during backfilling operations and the backfill material is granular soil, we recommend an active earth pressure coefficient of 0.30 be used in the above equation to calculate the lateral earth pressures. If the walls are restrained from any movement during backfilling and the backfill material is granular soil, we recommend an at-rest earth pressure coefficient of 0.45 be used to calculate the lateral earth pressure.

The additional active earth pressure due to ground acceleration equal to two thirds of the MCE may be estimated using a coefficient of 0.19. The seismic ground motion will reduce the available passive resistance. This reduction may be accounted for as an earth pressure acting in the direction opposite the passive resistance, and computed using a coefficient of 0.54. The pressure diagrams for these forces may be roughly approximated as inverted triangles, such that the resultant forces of the seismic components act at heights of approximately 2H/3 above the base of the wall.

For non-yielding walls, the increase in earth pressure corresponding to the seismic event may be estimated using the equation $P_{EQ} = a_h \gamma H^2$, where a_h is a seismic coefficient of 0.34. This force is in addition to the at-rest pressure, and acts at a height of about 0.53H above the base of the wall.

It should be recognized that the pressures calculated by the above equation are earth pressures only and do not include hydrostatic pressures. Where hydrostatic pressures may exist behind a retaining structure, we recommend either the wall be designed to resist hydrostatic pressure, or that a drainage system be placed behind the wall to prevent the development of hydrostatic pressures.

D. FLOOR SLABS

We recommend that a free-draining granular layer be placed beneath all floor slabs. The free-draining granular layer should be at least 4 inches thick and should have a maximum size less than 1 inch and not more than 5% passing a 200 sieve. The free-draining material should be densified using at least 4 passes of a smooth drum 5-ton vibratory roller or equivalent. If the above specifications are followed, the granular layer will prevent the accumulation of moisture beneath the floor slab and will also serve adequately as a base beneath the floor slabs. Where moisture sensitive flooring, such as tile flooring systems, is planned, it is recommended that a vapor retarder/barrier be placed directly beneath the concrete floor, in lieu of the free-draining granular layer. It is recommended that the vapor barrier conform to ASTM E 1745 Class A requirements. A subgrade modulus of 250 pci can be used for design of floor slabs.

V. SITE PREPARATION AND COMPACTED FILL REQUIREMENTS

As indicated above, much of the site is covered with asphalt parking, and it is recommended that the asphalt surface course be removed from beneath the entire footprint of the structures.

Temporary excavations less than 15 feet deep in the dense granular on-site soils should be adequately stable at slopes of 1.5 horizontal to 1 vertical or flatter. Erosion protection or surface water control may be necessary to maintain temporary slopes. If the decision is made to over-excavate and replace the liquefiable soil zone, excavated side slopes as steep as 2 horizontal to 1 vertical can be used for dewatered areas. Temporary shoring and retaining structures should be designed by a Professional Engineer.

Stabilization of the subgrade clay will be required prior to placement of fill. Stabilization techniques are dependent upon conditions encountered and construction methods. Where very soft clay exists, it is anticipated that cobble rock will provide the most effective means of stabilization. Where cobble rock is required, it should consist of 3 to 8 inch rock placed in single lifts, tamped into the clay such that the voids are filled. Excess cobbles which cannot be tamped into the clay should be removed to prevent migration of fines into the voids, which would result in settlement. Placement of a geotextile fabric, such as Mirafi 600X or equivalent will be effective in stabilizing moderately soft areas. Dewatering should be performed such that the groundwater level is maintained at least 2 feet below the working surface.

We recommend that imported fill used to establish final grade throughout the site consist of granular soil having a maximum size of 4 inches with less than 30% passing a No. 200 sieve. We recommend that the material passing a No. 200 sieve have a plasticity index less than 6. The fill should be compacted to an in-place density equal to at least 95% of the maximum density as determined by ASTM D 1557.

Grading around each structure should be performed in such a manner that all surface water will flow freely from the area and that no ponding will occur adjacent to the structure which will permit deep percolation into the foundation area. Roof drains should extend well beyond the building lines to prevent seepage into the foundation soils. Sprinkler heads located adjacent to the building should be directed away from the structure to prevent the percolation of water into the foundation zone.

Backfilling around foundation walls should be performed using granular material densified to an in-place unit weight equal to at least 90% of the maximum laboratory density indicated above.

VI. PAVEMENT DESIGN

Pavement borings for anticipated driveways and fire lanes encountered medium dense to very dense silty sand at the subgrade level.

In providing recommendations for pavement design, an equivalent single axle load (ESAL) of 33,200 has been used. This value is comparable to 1500 passenger cars and light trucks, 25 box trucks, and one fire truck per month over a design life of 30 years. If traffic loading is significantly different than what has been assumed, it is requested that we be notified so that appropriate modifications can be made in pavement design. The flexible pavement thickness has been determined using the AASHTO Structural Number Procedure. The following additional assumptions have been made in determining the flexible pavement thickness:

Design E-18's	= 33,200
Reliability	= 85%

Overall Deviation	= 0.45
Resilient Modulus	= 10,500 psi
Initial Serviceability	= 4.2
Terminal Serviceability	= 2.0

The results of the analysis indicates that a flexible pavement consisting of 3 inches of an asphalt surface course plus 6 inches of untreated granular base will be adequate to support the contemplated traffic. In performing the analysis, it has been assumed that the upper 8 inches of the natural material will be scarified and re-densified to an in-place unit weight equal to 92% of the maximum laboratory density, as determined by ASTM D 1557, resulting in a CBR value of 7.0 for the natural granular material. If fine-grained soils (silt or clay) are encountered at the subgrade level, it is recommended that these areas be over-excavated to a depth of 1 foot below subgrade level, and that the excavation be backfilled with granular borrow. The on-site sands and gravels can be used as granular borrow. The granular borrow should meet compaction requirements outlined above.

All base material should be densified to an in-place unit weight equal to 95% of the maximum laboratory density indicated above and all untreated granular base should conform to Utah Department of Transportation Specifications. Mineral aggregates used in the asphalt surface course should conform to Section 02741 of the standard specifications of the Utah State Department of Transportation. Mixing, placing, and densification of all asphalt materials should also conform to UDOT standards.

The following additional assumptions have been made for the rigid pavement design:

Design E 18's	= 33,200
Reliability	= 90%
Modulus of Rupture	= 650 psi
Modulus of Elasticity	= 4,400,000
Drainage Coefficient	= 1.0
Resilient Modulus of Subgrade	= 510
Initial Serviceability Factor	= 4.5
Terminal Serviceability Factor	= 2.0

Based upon the above parameters, the results of the analysis indicate that a pavement section consisting of 4 inches of roadbase and a minimum of 4 inches of Portland cement concrete will be sufficient to support the anticipated loading. We recommend that the pavement section be increased to 4 inches of roadbase and 6 inches of PCC to reduce the risk of cracking associated with frost heave.

All joints for concrete pavement should be laid out in a rectangular pattern, and the joint spacing for driveways should not exceed 15 feet. A joint spacing of this magnitude should accommodate the contraction of the concrete, and under these conditions, steel reinforcing will not be required. We recommend that all joints in driveways where truck traffic will be relatively heavy be doweled. We recommend that the dowels have a diameter of 7/8" and an embedment length of at least six inches. The total dowel length should not be less than 16 inches.

VII. LIMITATIONS

The conclusions and recommendations presented in this report are preliminary and are based upon the results limited field and laboratory tests. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout this site which could not be defined during this investigation. If conditions are encountered during construction which differ from those described in this report, it is requested that we be contacted so that impacts on the design may be evaluated and addressed as necessary. It is anticipated that continued coordination will occur between the design team and our organization to select appropriate ground improvement criteria, specify improvement criteria, and finalize foundation design.

The information contained in this report is provided for the specific location and purpose of the client named herein and is not intended or suitable for reuse by any other person or entity whether for the specified use, or for any other use. Any such unauthorized reuse, by any other party is at that party's sole risk and RB&G Engineering, Inc. does not accept any liability or responsibility for its use.

Figures

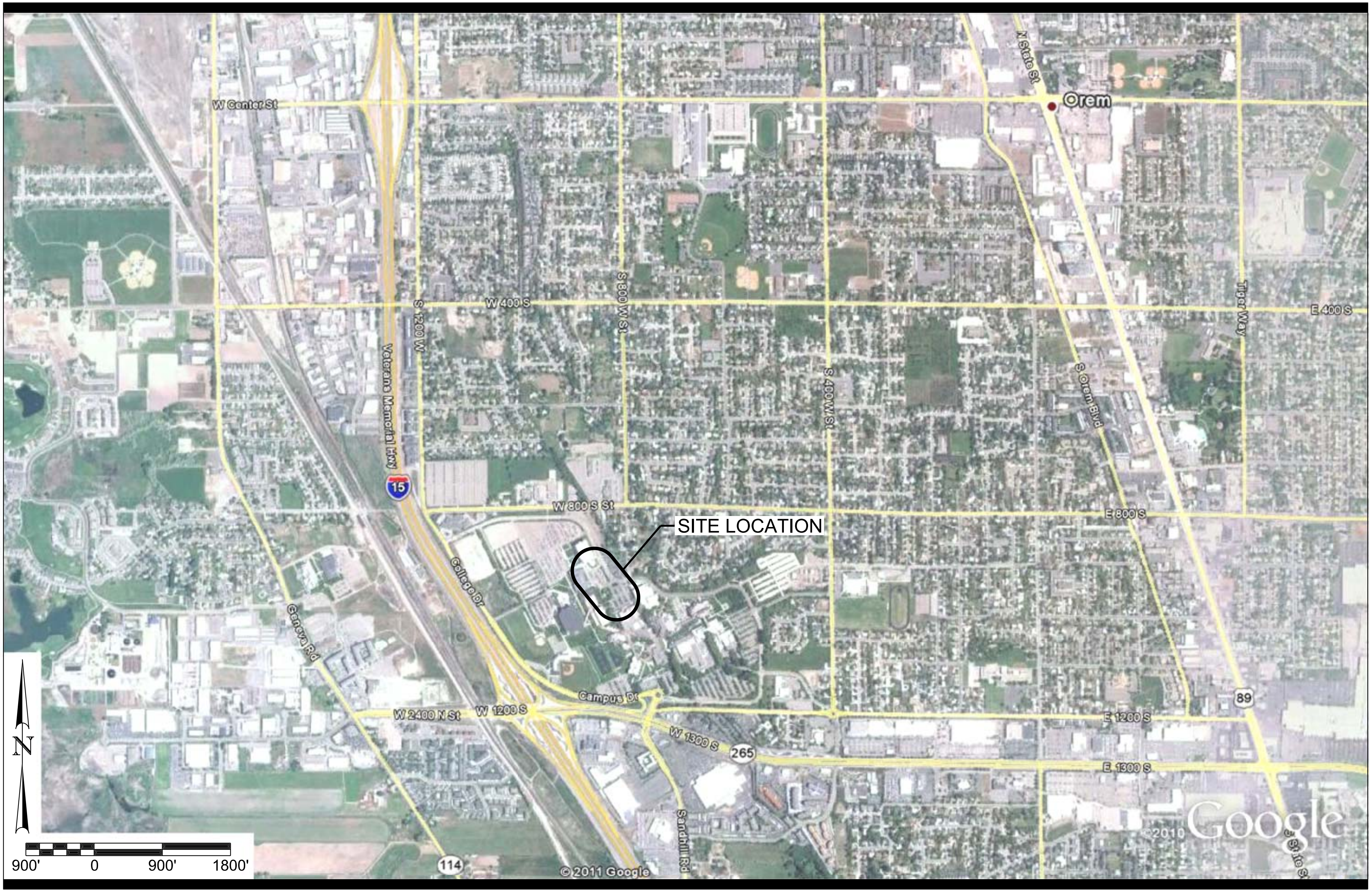

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Figure 1 VICINITY MAP

Utah Valley University Student Life Center & Parking Structure

Orem, Utah County, Utah

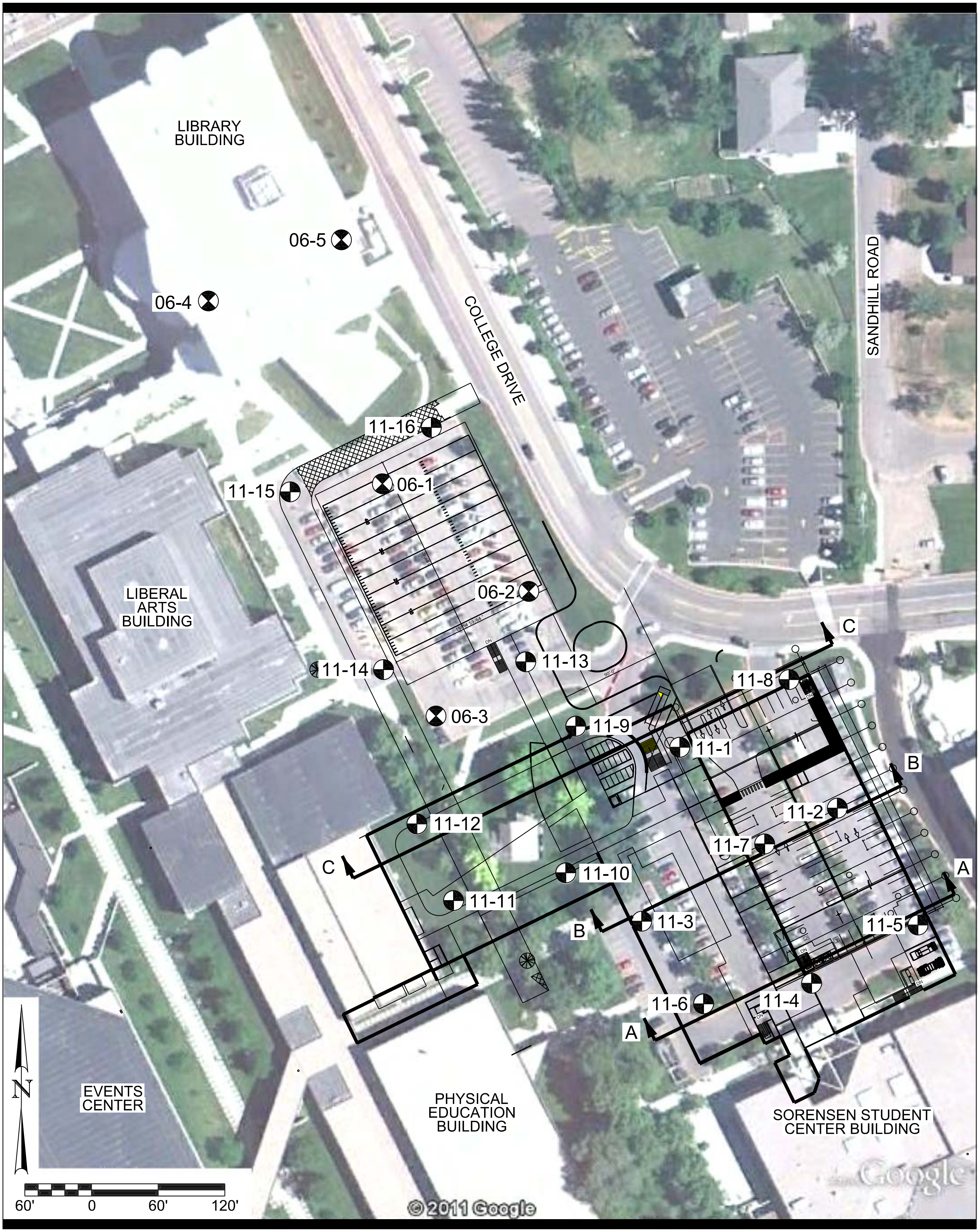

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Figure 2 SITE PLAN & TEST HOLE LOCATIONS

Utah Valley University Student Life Center & Parking Structure

Orem, Utah County, Utah

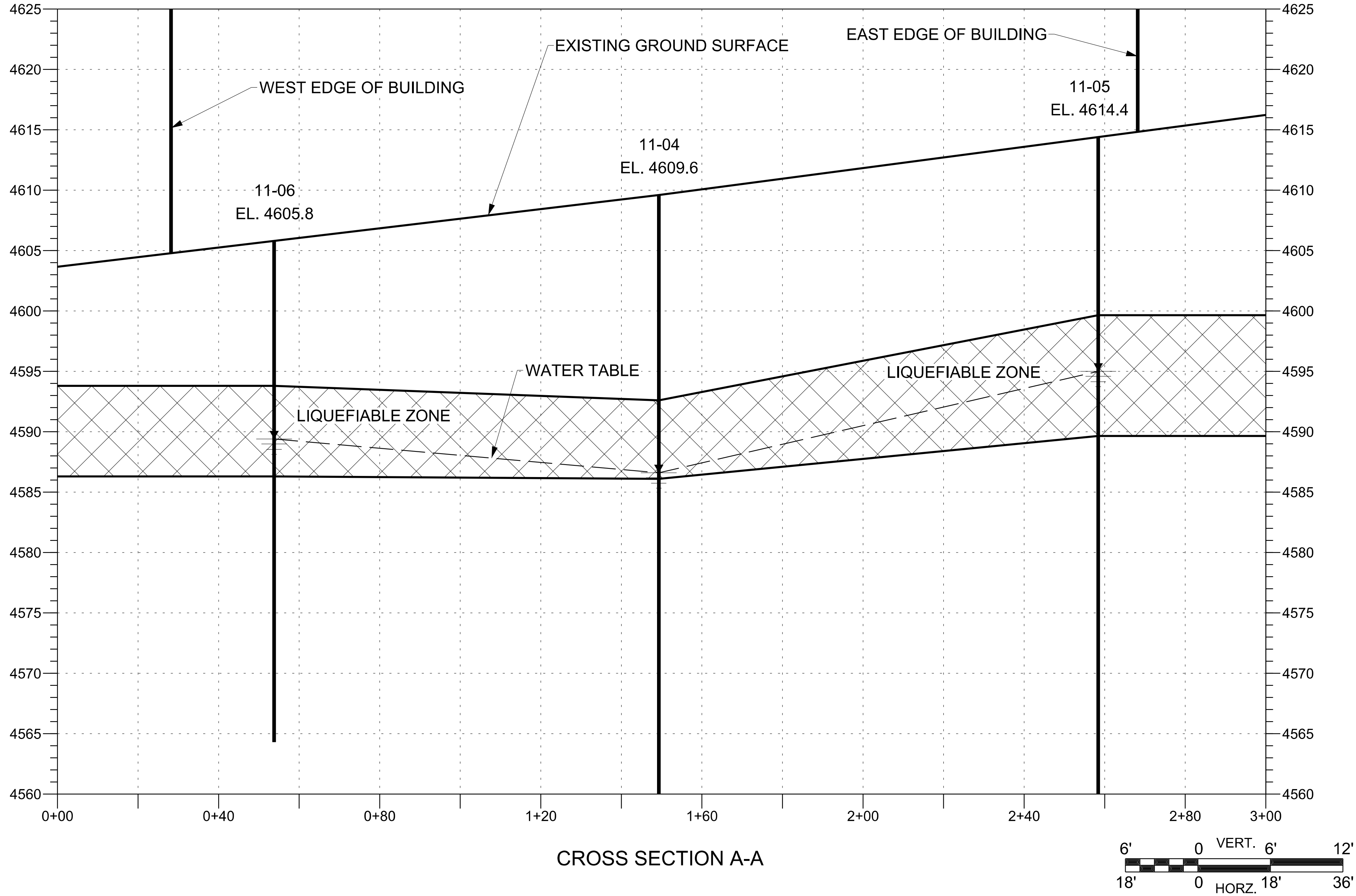

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Figure 3a CROSS SECTION A-A

Utah Valley University Student Life Center & Parking Structure

Orem, Utah County, Utah

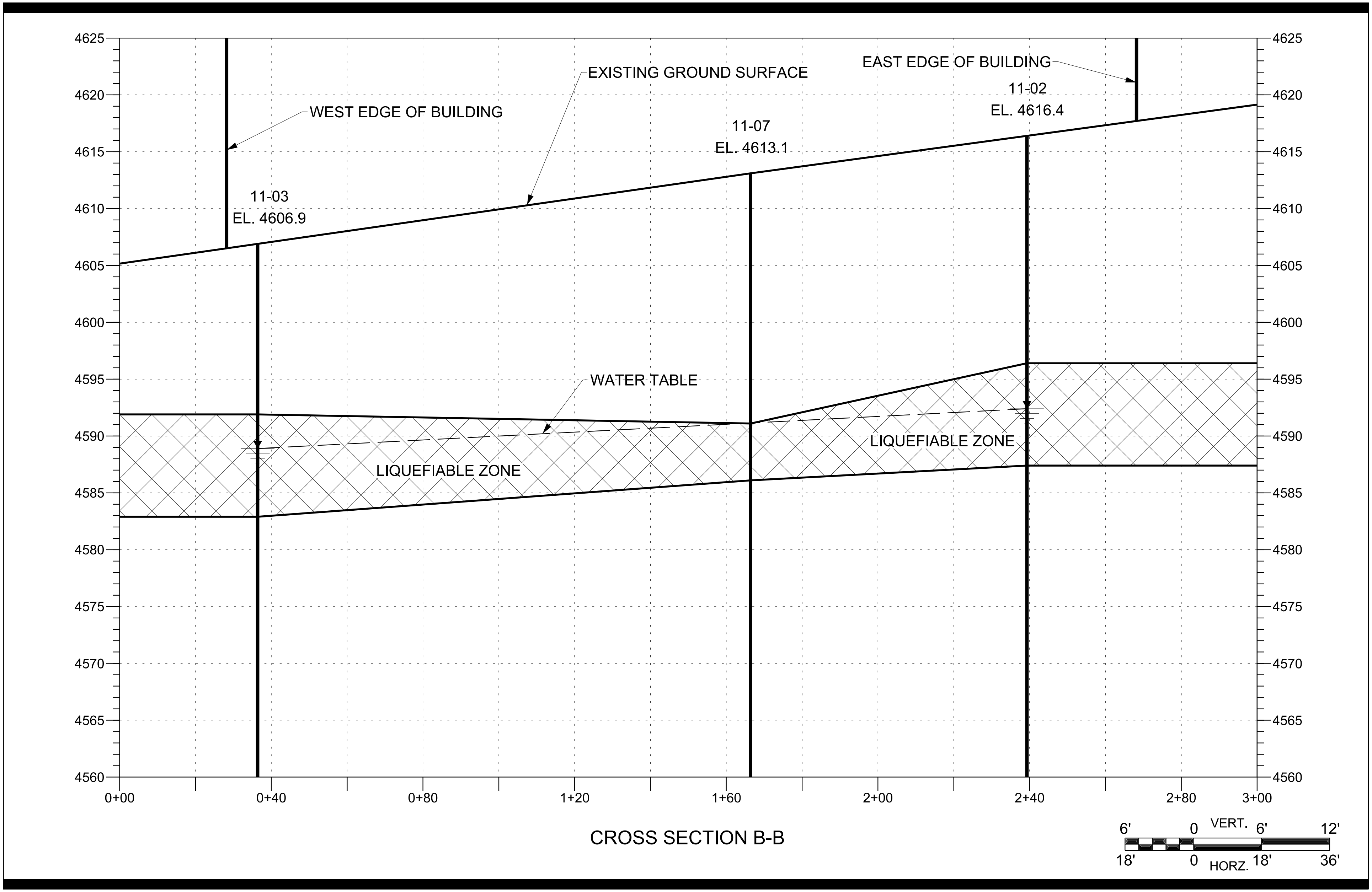

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Figure 3b CROSS SECTION B-B

Utah Valley University Student Life Center & Parking Structure

Orem, Utah County, Utah

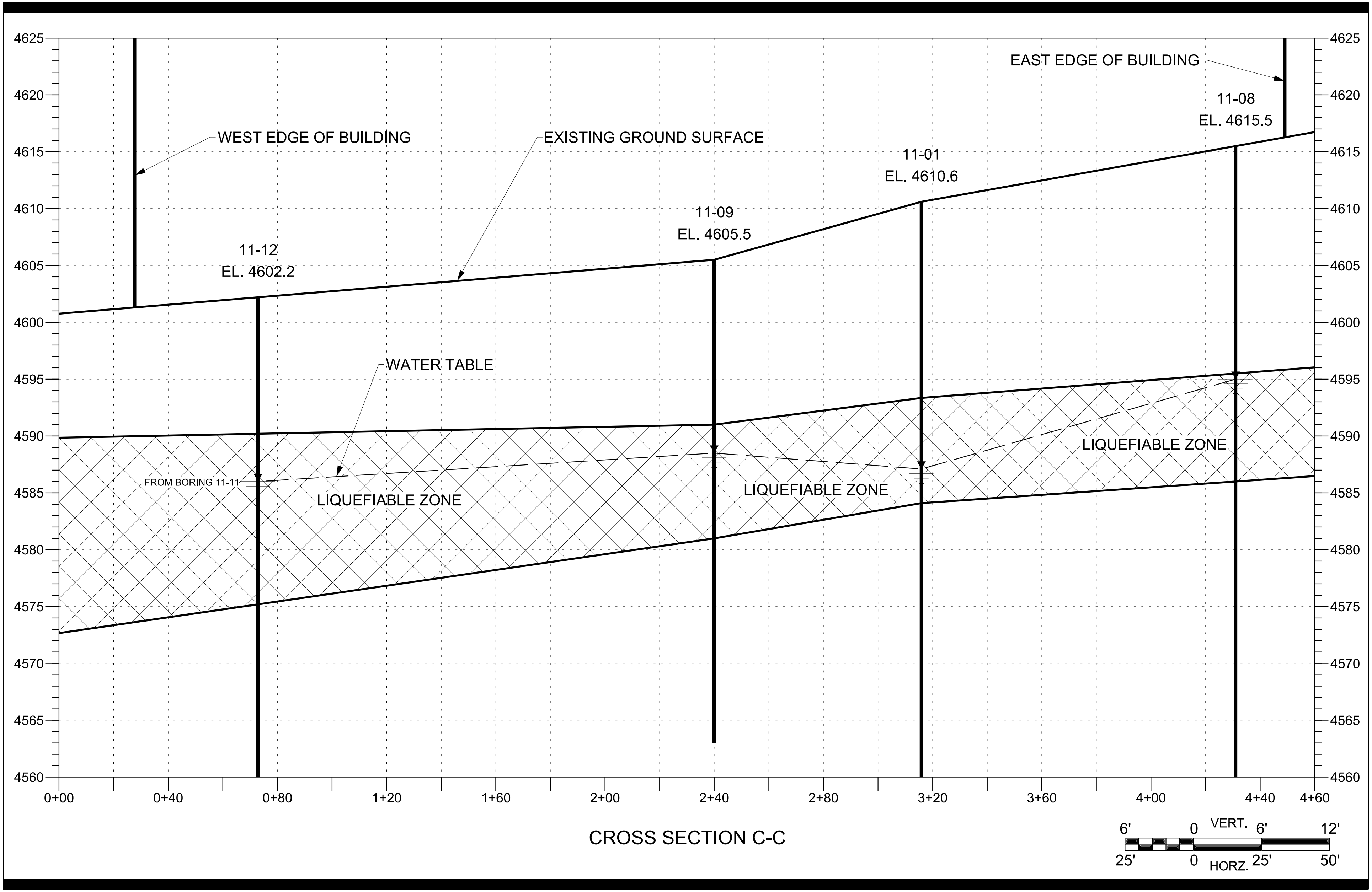

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Figure 3c CROSS SECTION C-C

Utah Valley University Student Life Center & Parking Structure

Orem, Utah County, Utah

Appendix

Unified Soil Classification System

Major Divisions			Group Symbols		Typical Names
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	**Gravels** *more than half of coarse fraction is larger than No. 4 sieve size*	**Clean Gravels** *little or no fines*	**GW**		Well graded gravels, gravel-sand mixtures, little or no fines
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels With Fines *appreciable amount of fines*	**GM***	**d**	Silty gravels, poorly graded gravel-sand-silt mixtures
				u	
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	**Clean Sands** *little or no fines*	**SW**		Well graded sands, gravelly sands, little or no fines
			SP		Poorly graded sands, gravelly sands, little or no fines
		Sands with Fines *appreciable amount of fines*	**SM***	**d**	Silty sands, poorly graded sand-silt mixtures
				u	
			SC		Clayey sands, poorly graded sand-clay mixtures
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	**Silts and Clays** *liquid limit is less than 50*		**ML**		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	**1**	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
				2	
			OL		Organic silts and organic silt-clays of low plasticity
	Silts and Clays *liquid limit is greater than 50*		**MH**		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			**Pt**		Peat and other highly organic soils

Laboratory Classification Criteria

For laboratory classification of coarse-grained soils

Determine percentage of gravel and sand from grain-size curve.

Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows:

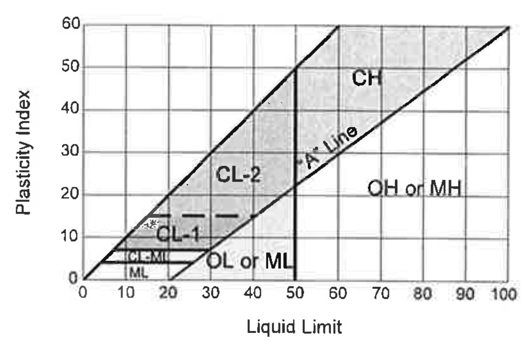
Less than 5% GW, GP, SW, SP .

More than 12% GM, GC, SM, SC

5% to 12% Borderline cases requiring use of dual symbols**

Group	Criteria	
GW	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
GC	Atterberg limits above "A" line, or PI greater	
SW	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
SC	Atterberg limits above "A" line, or PI greater	

For laboratory classification of fine-grained soils



Plasticity Chart

NOTE: USCS Modified to include CL-type subcategories

*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the PI is 6 or less, the suffix u used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example GW-GC, well graded gravel-sand mixture with clay biner.)

DRILL HOLE LOG

BORING NO. 11-01

SHEET 1 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 18.0' **AFTER 24 HOURS:** ▼ 23.5'

PROJECT NUMBER: 201101.012
DATE STARTED: 2/23/11
DATE COMPLETED: 2/23/11
GROUND ELEVATION: 4610.6'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
4610	0	Disturbed	18	11,17,35,(99+)	GM / SM	lt. brown, wet / dk. brown, moist, very dense	SILTY GRAVEL W/SAND (fill)								
		Disturbed	18	25,21,35,(99+)	SM	gray-brown, very moist, very dense	SILTY GRAVEL W/SAND possible cobbles		14.1		NP	35	51	14	
4605	5	Disturbed	9	15,20,38,(99+)	SM	brown, moist, very dense									
4600	10	Disturbed	10	55,45,50/4"	GM	brown, moist, very dense	SILTY GRAVEL W/SAND possible cobbles								
		Disturbed	10	12,14,17,(49)	SM	brown, moist, dense	SILTY SAND								
4595	15	Disturbed	12	11,11,16,(38)	SM	brown, moist, dense									
		Disturbed	12	5,5,5,(13)	ML	brown, wet, med. dense	SANDY SILT		31.4		NP	0	46	54	
4590	20	Disturbed	18	3,2,4,(8)	ML	brown, wet, loose									
4585	25	Disturbed	18	3,3,4,(9)	ML	brown, wet, loose			34.2		NP	0	31	69	
		Disturbed	18	2,3,4,(8) *0.30*	CL	brown, very moist, firm	LEAN CLAY								
4580	30	Undisturbed	18	Pushed *0.55*	CL-2	brown, very moist to wet, stiff		80.6	34.7	38	15				CT UC 1834 psf
4575	35	Disturbed	18	3,3,5,(9) *0.40*	CL	brown, very moist, firm	LEAN CLAY sandy silt layers								
4570	40	Undisturbed	16	Pushed *0.65*	SM	brown, wet	SILTY SAND clay layers to 2" thick		22.8		NP	0	55	45	
							LEAN CLAY sandy silt layers								

DH_LOGV1 UVU_SLC_PS.GPJ US_EVAL.GDT 11/15/11

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LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) 0.45 — Blow Count per 6"; $(N_1)_{60}$ Value; Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-01

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 18.0' **AFTER 24 HOURS:** ▼ 23.5'

PROJECT NUMBER: 201101.012
DATE STARTED: 2/23/11
DATE COMPLETED: 2/23/11
GROUND ELEVATION: 4610.6'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
4565			Disturbed	18	3,4,8,(12) 0.20	CL	brown, wet, soft to firm	LEAN CLAY sandy silt layers								
4560	50		Undisturbed	18	Pushed 0.85	CL-1	brown, wet, stiff		90.5	28.0	31	11				CT UC 2613 psf
4555	55		Disturbed	18	8,9,11,(19) 0.10 0.40	ML	brown, wet, med. dense	SANDY SILT many clay & sand lenses and/or layers								
4550	60		Undisturbed	12	Pushed	SM	brown, wet	SILTY SAND occasional clay layers to 1" thick								
			Disturbed	13	2,3,6,(8)	SM	brown, wet, loose (poor sample, flowing sand)									
4545	65		Disturbed	18	9,33,35,(60)	SM	brown, wet, very dense									
4540	70		Disturbed	18	8,29,32,(53)	SM	brown, wet, very dense									
								BOH								
4535	75															
4530	80															
4525	85															

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6): Blow Count per 6", (N₁)₆₀ Value; 0.45: Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45: Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-02

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 24.0' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 3/1/11
DATE COMPLETED: 3/1/11
GROUND ELEVATION: 4616.4'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Rec. (in)	Sample (See Legend)	USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
	0				4" ASPHALT								
4615		15	19,19,51,(99+)	GM / GC	brown & gray, vwery moist — SILTY GRAVEL W.SAND (fill); dk. brown, moist, very dense — CLAYEY GRAVEL W/SAND possible cobbles								
		13	11,19,30,(99+)	GM	brown, moist, very dense		9.1		NP	53	34	13	
4610	5	13	15,40,57,(99+)	GM	brown, moist, very dense — SILTY GRAVEL W/SAND possible cobbles								
	10	11	37,60,50/2.5"	GM	brown, very moist, very dense								
4605		11	39,40,54,(99+)	GM	brown, very moist, very dense								
4600	15	8	14,20,17,(49)	SM	brown, very moist, dense — SILTY SAND								
		10	6,7,9,(21)	SM	brown, moist, med. dense								
4595	20	13	4,5,6,(13)	SM	brown, wet, med. dense — SILTY SAND sandy silt layers		30.0		NP	0	56	44	
	25 (water ▽ 24.0')	13	3,4,5,(10)	ML	brown, wet, loose — SANDY SILT sand layers								
4590		18	3,2,6,(9)	ML	brown, wet, loose		34.0		NP	0	32	68	
4585	30	18	Pushed 0.35	ML	brown, wet, firm — SILT W/SAND plastic		30.0	30	6				UC 1569 psf
4580	35	18	2,3,3,(6) 0.35	CL	brown, very moist, firm — LEAN CLAY sand lenses								
4575	40	18	Pushed 0.45	CL-2	brown, very moist, firm	82.4	32.6	36	15				CT

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6", $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-02

SHEET 2 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 24.0' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 3/1/11
DATE COMPLETED: 3/1/11
GROUND ELEVATION: 4616.4'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
			Disturbed	18	0.40	CL	brown, very moist, firm									
4570					3,6,10,	ML	brown, wet, med. dense	SANDY SILT								
4565	50		Pushed	18	Pushed 0.30	CL-1	brown, wet, firm	LEAN CLAY silt & sand lenses and/or layers	85.9	29.0	30	10	0	4	96	CT UC 1669 psf
4560	55		Disturbed	17	5,4,6,(9) 0.35	CL	gray, wet, firm									
4555	60		Disturbed	18	9,12,17,(26) 0.90	CL	brown, wet, stiff	LEAN CLAY sand layers to 1" thick								
4550	65		Disturbed	15	10,20,37,(49)	SM	brown, wet, dense	SILTY SAND		18.1		NP	0	70	30	
4545	70		Disturbed	18	10,8,18,(22) 0.30	SM	brown, wet, med. dense	SILTY SAND many clay layers to 2" thick								
4540	75		Disturbed	3	32,33,35,(55)	SM	brown, wet, very dense	SILTY SAND								
4535	80		Disturbed	12	30,26,42,(54)	SM	brown, wet, very dense									
								BOH								
4530	85															

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6", ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-03

SHEET 1 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 18.0' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 2/28/11
DATE COMPLETED: 2/28/11
GROUND ELEVATION: 4606.9'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft) scale: 4605, 4600, 4595, 4590, 4585, 4580, 4575, 4570, 4565
Depth (ft) scale: 5, 10, 15, 20, 25, 30, 35, 40

Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
					3" ASPHALT								
Disturbed	13	25,17,16,(70)	GM	gray, very moist, dense	SILTY GRAVEL W/SAND (SLAG) (fill)								
Disturbed	11	26,60,50/4"	GP-GM	lt. brown, very moist, very dense	GRAVEL W/SILT & SAND possible cobbles								
Disturbed	12	18,20,16,(73)	GP-GM	lt. brown, very moist, dense			8.3		NP	48	44	8	
Disturbed	0	26,25,23,(81)	-	no recovery									
Disturbed	12	8,8,10,(28)	SM	brown, moist, med. dense	SILTY SAND occasional silt layers								
Disturbed	16	5,5,4,(13)	SM	brown, very moist to wet, med. dense									
Disturbed	18	2,3,3,(8)	SM	brown, wet, loose			33.5		NP	0	61	39	
Undisturbed	17	Pushed	ML	brown, wet	SILT W/SAND								
Disturbed	18	1,2,5,(9)	ML	brown, wet, loose			33.6		NP	0	24	76	
Disturbed	18	2,3,3,(7) 0.40	CL	brown w/rust layers, wet, firm	LEAN CLAY sand lenses								
Undisturbed	18	Pushed 0.34	CL-2	brown, very moist, firm		87.6	32.0	38	15				CT UC 1647 psf
Disturbed	18	5,6,7,(14) 0.30	CL	brown, very moist, firm	LEAN CLAY sand layers to 2" thick								
Undisturbed	17	Pushed 0.30	SM	brown, wet	SILTY SAND		24.6		NP	0	62	38	UC 1354 psf
			CL-1	brown, very moist to wet, firm	LEAN CLAY sand layers to 0.5" thick		26.1	29	9	0	14	86	

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6" ; ← $(N_1)_{60}$ Value ; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED ; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-03

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 18.0' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 2/28/11
DATE COMPLETED: 2/28/11
GROUND ELEVATION: 4606.9'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Sample Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
		18	2,4,6,(10) *0.30*	CL	brown, wet, firm	LEAN CLAY sand layers to 0.5" thick								
4560														
	50	18	*0.42*	CL	brown, wet, firm									
			Pushed	CL,ML,SM	brown, wet	INTERBEDDED CLAY, SILT & SAND LAYERS TO 3" THICK								
4555		16	7,10,16,(25) *0.23*	CL,ML,SM	brown, wet, med. dense/soft									
	55	16	10,9,9,(17) *0.35*	CL	brown, wet, firm	LEAN CLAY silt and/or sand lenses								
4550														
	60	17	15,12,22,(31)	SM	brown, wet, dense	SILTY SAND silt & clay lenses & layers								
4545														
	65	13	21,24,22,(41)	SM	brown, wet, dense			23.5		NP	0	80	20	
4540														
	70	17	23,31,36,(58)	SM	brown, wet, very dense	SILTY SAND								
4535														
	75	17	23,28,21,(41)	SM	brown, wet, dense	SILTY SAND silt layers to 2" thick								
4530						BOH								
	80													
4525														
	85													
4520														

RB&G ENGINEERING, INC.

LEGEND:
DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; ← $(N_1)_{60}$ Value; *0.45* ← Torvane (tsf)
UNDISTURBED SAMPLE — PUSHED *0.45* ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-04

SHEET 1 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 18.0' **AFTER 24 HOURS:** ▼ 23.0'

PROJECT NUMBER: 201101.012
DATE STARTED: 2/24/11
DATE COMPLETED: 2/24/11
GROUND ELEVATION: 4609.6'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Field Description	Material Description	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
	0						5" ASPHALT								
		Disturbed	10	25,15,22,(79)	GP-GM	gray, very moist, very dense	GRAVEL W/SILT & SAND (SLAG) (fill)								
		Disturbed	9	16,28,50/5"	GM	brown, moist, very dense									
4605	5	Disturbed	14	25,44,57,(99+)	GM	brown, moist, very dense	SILTY GRAVEL W/SAND possible cobbles								
4600	10	Disturbed	12	30,28,22,(84)	GM	brown, moist, very dense									
		Disturbed	10	8,10,12,(33)	SM	brown, very moist, dense	SILTY SAND								
4595	15	Disturbed	13	5,6,7,(18)	ML	brown, very moist, med. dense									
	▽	Disturbed	16	3,3,4,(9)	ML	brown, wet, loose	SANDY SILT sand layers								
4590	20	Disturbed	18	2,4,4,(10)	ML	brown, wet, loose			35.1		NP	0	41	59	
	▼														
4585	25	Disturbed	18	2,3,3,(7) 0.30	CL	brown, very moist, firm									
4580	30	Undisturbed	18	Pushed 0.60	CL	brown, wet, stiff	LEAN CLAY sand lenses								
4575	35	Disturbed	18	4,5,5,(11) 0.30	CL	brown, wet, firm									
4570	40	Undisturbed	17	Pushed	ML	brown, wet	SANDY SILT		27.5		NP	0	33	67	
		Disturbed	17	4,4,4,(8) 0.30	SM	brown, wet	SILTY SAND								
					CL	brown, wet, firm	LEAN CLAY sand and/or silt lenses								
4565															

DH LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) ← Blow Count per 6", ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-04

SHEET 2 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 18.0' **AFTER 24 HOURS:** ▼ 23.0'

PROJECT NUMBER: 201101.012
DATE STARTED: 2/24/11
DATE COMPLETED: 2/24/11
GROUND ELEVATION: 4609.6'
LOGGED BY: J. OLSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Disturbed	18	4,6,7,(13) 0.50	CL	brown, wet, firm	LEAN CLAY sand and/or silt lenses								
4560	50		Pushed	18	Pushed 0.40	CL-1	brown, wet, firm			27.4	33	14	0	4	96	UC 1534 psf
4555	55		Disturbed	17	5,10,13,(22) 0.20	CL	brown w/rust layers, wet, soft	LEAN CLAY interbedded w/silty sand layers								
4550	60		Disturbed	17	25,38,41,(72)	SM	brown, wet, med. dense	SILTY SAND								
4545	65		Disturbed	16	9,10,15,(22) 0.55	CL	brown w/rust, wet, stiff	LEAN CLAY interbedded w/silty sand layers								
4540	70		Pushed	0	Pushed	-	no recovery (smashed end of shelby tube)									
								BOH								
4535	75															
4530	80															
4525	85															
4520																

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-05

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE

CLIENT: MHTN ARCHITECTS, INC.

LOCATION: SEE SITE PLAN

DRILLING METHOD: 08-CME-55 / N.W. CASING

DRILLER: T. KERN

DEPTH TO WATER - INITIAL: ▽ 19.4' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012

DATE STARTED: 10/25/11

DATE COMPLETED: 10/25/11

GROUND ELEVATION: 4614.4'

LOGGED BY: S.C., J.P., J.B.

Elev. (ft)	Depth (ft)	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
		11	38,25,20,(91)	SP-SM	gray, moist	SLAG ROADBASE								
				GM	brown, moist, very dense	(SAND W/SILT & GRAVEL)								
4610	5	13	23,30,46,(99+)	GM	brown, moist, very dense	SILTY GRAVEL W/SAND possible cobbles								
4605	10	10	24,35,32,(99+)	GM	brown, moist, very dense									
4600	15	11	6,5,6,(15)	SM	brown, moist, med. dense	SILTY SAND		21.2		NP	0	54	46	
4595 ▽		4	4,4,3,(9)	SM	brown, very moist, loose									
	20	1	3,3,4,(8)	ML	brown, wet, loose	SANDY SILT								
4590		18	2,2,2,(5)	ML	brown, wet, loose			33.9		NP	0	44	56	
	25	18	2,1,2,(3) *T 0.20*	CL	brown, wet, soft	LEAN CLAY W/SAND silt lenses								
4585	30	14	Pushed *T 0.55*	ML	brown, wet, stiff	SILT W/SAND plastic	83.7	33.6	36	11				CT UC 2458 psf
4580	35	18	2,2,3,(5) *T 0.30*	ML	brown, wet, firm									
4575	40	9	Pushed	SP-SM	brown, wet	SAND W/SILT clay layers to 2" thick		21.8		NP	0	91	9	
4570	45	9	8,12,13,(24)	SP-SM	brown, wet, med. dense	SAND W/SILT								
4565	50	12	3,6,13,(18) *T 0.30*	CL	brown, wet, firm to stiff	LEAN CLAY W/SAND silty sand lenses & layers								
4560	55	18	Pushed	CL	gray-brown, wet									
						BOH								
4555														

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G
ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6" / $(N_1)_{60}$ Value; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; *0.45* ← Torvane (tsf)

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- SS = Soluble Salt
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-06

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 16.3' **AFTER 24 HOURS:** ▼ 16.4' 11/15/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/27/11
DATE COMPLETED: 10/27/11
GROUND ELEVATION: 4605.8'
LOGGED BY: S. CHAFFIN, J. BOONE

Elev. (ft)	Depth (ft)	Sample Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
4605		12	33,14,9,(46)	SP-SM / SM	gray, moist / brown, moist, dense	4" ASPHALT / SLAG ROADBASE (SAND W/SILT & GRAVEL)								
						SILTY SAND W/GRAVEL								
4600	5	8	20,17,11,(57)	SM	brown, moist, dense									Chem.
						SILTY SAND								
4595	10	10	11,11,15,(40)	SM	brown, moist, dense									
		14	6,4,6,(15)	ML	brown, moist, med. dense									
4590	15	3	4,2,3,(7)	ML	brown, wet, loose	SANDY SILT		27.4		NP	0	42	58	
		17	4,2,4,(8)	ML	brown, wet, loose			25.6		NP	0	50	50	
4585	20	18	2,1,3,(5)	CL-ML	brown, wet, soft	SILTY CLAY W/SAND lean clay lenses		32.8	28	6	0	22	78	
		18	2,3,2,(6) T 0.25	CL-1	brown, wet, soft			34.9	36	13				
4580	25	13	Pushed T 0.45	CL	brown, wet, firm									
						LEAN CLAY W/SAND								
4575	30	18	3,3,4,(8) T 0.85	CL	brown, very moist, stiff									
4570	35	15	Pushed T 0.30	SM	brown, wet			23.4		NP	0	52	48	
						SILTY SAND lean clay lenses & layers to 2" thick								
	40			SM	brown, wet									
4565		18	6,7,16,(23) T 0.35	CL	brown, wet, firm	LEAN CLAY W/SAND								
						BOH								

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6", ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-07

SHEET 1 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 19.8' **AFTER 24 HOURS:** ▼ DRY @ 20' 11/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/25/11
DATE COMPLETED: 10/25/11
GROUND ELEVATION: 4613.1'
LOGGED BY: S.C., J.P., J.B.

Elev. (ft) scale: 4610, 4605, 4600, 4595, 4590, 4585, 4580, 4575, 4570, 4565
Depth (ft) scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
					4.5" ASPHALT								
Disturbed	16	13,17,34,(99+)	GM	brown, moist	ROADBASE (SILTY GRAVEL W/SAND)								
			SP-SM	gray, moist, very dense	SLAG (SAND W/SILT & GRAVEL)								
Disturbed	15	27,43,55,(99+)	GM	brown, moist, very dense	SILTY GRAVEL W/SAND possible cobbles								
Disturbed	15	23,39,51,(99+)	GM	brown, moist, very dense									
Disturbed	0	25,32,35,(85)	-	no recovery									
Disturbed	0	20,19,21,(47)	-	no recovery	SILTY SAND								
Disturbed	10	12,8,10,(20)	SM	brown, wet, med. dense									
Disturbed	15	3,3,4,(8)	ML	brown, wet, loose	SANDY SILT		28.8		NP	0	50	50	
Disturbed	18	3,3,4,(8)	ML	brown, wet, loose									
Disturbed	18	2,2,3,(6) T 0.10	CL-1	brown, wet, very soft	LEAN CLAY W/SAND silt lenses & layers		35.7	34	11				
Undisturbed	18	Pushed T 0.40	CL	brown, wet, firm									
Disturbed	18	4,5,6,(11) T 0.20	ML	brown, wet, med. dense/soft	SILT W/SAND plastic								
Undisturbed	15	T 0.31 Pushed T 0.60	ML	brown, wet, firm		101.2	24.6	25	2	0	25	75	CT UC 1270 psf
			CL	brown, very moist, stiff	LEAN CLAY W/SAND silt lenses								
Disturbed	18	6,6,7,(12) T 0.60	CL	brown, very moist, stiff									

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) ← Blow Count per 6", (N1)60 Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-07

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 19.8' **AFTER 24 HOURS:** ▼ DRY @ 20' 11/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/25/11
DATE COMPLETED: 10/25/11
GROUND ELEVATION: 4613.1'
LOGGED BY: S.C., J.P., J.B.

Elev. (ft)	Depth (ft)	Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
		Undisturbed	15	Pushed T 0.40	CL-1	brown, very moist, firm — LEAN CLAY W/SAND, silt lenses	94.9	25.0	29	8				UC 1937 psf
4560	55				CL	brown, very moist								
		Disturbed	18	9,14,21,(31)	SM	brown, wet, dense — SILTY SAND, clay lenses								
4555	60	Undisturbed	10	Pushed T 0.35	CL-1	brown, very moist, firm — LEAN CLAY W/SAND	91.8	24.7	28	8	0	29	71	CT
4550	65	Disturbed	14	31,27,27,(42)	SM	brown, wet, dense — SILTY SAND								
4545	70	Disturbed	15	14,17,18,(27) T 0.25	ML	brown, wet, med. dense — SANDY SILT, plastic, sand lenses & layers								
4540	75	Disturbed	14	35,32,35,(53)	SM	brown, wet, very dense								
4535	80	Disturbed	12	25,28,38,(51)	SM	gray, wet, very dense — SILTY SAND								
4530	85	Disturbed	10	32,33,39,(54)	SM	gray, wet, very dense								
4525	90	Disturbed	16	9,9,20,(21) T 0.30	CL	gray, very moist, firm — LEAN CLAY W/SAND, silty sand layers to 1" thick								
						BOH								
4520	95													
4515														

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-08

SHEET 1 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ N.M. **AFTER 24 HOURS:** ▼ 20.5' 11/15/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/31/11
DATE COMPLETED: 10/31/11
GROUND ELEVATION: 4615.5'
LOGGED BY: S.C., J.P., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
4615			Disturbed	14	14,29,25,(99+)	GM / SM	brown, moist / gray, moist, very dense	SILTY GRAVEL W/SAND								
								SILTY SAND W/GRAVEL								
4610	5		Disturbed	10	18,12,8,(40)	SM	brown, moist, dense									
4605	10		Disturbed	14	30,64,90,(99+)	GM	gray & brown, moist, very dense	SILTY GRAVEL W/SAND possible cobbles								
4600	15		Disturbed	10	36,45,26,(90)	GM	brown, moist, very dense									
4595	20 ▼		Disturbed	18	4,7,7,(17)	ML	brown, wet, med. dense									Chem.
			Disturbed	18	3,4,6,(12)	ML	brown, wet, med. dense	SANDY SILT								
4590	25		Disturbed	18	2,5,8,(15)	ML	brown, wet, med. dense			34.9		NP	2	45	53	
			Disturbed	18	2,3,4,(8)	ML	brown, wet, loose									
4585	30		Undisturbed	18	Pushed *T 0.25*	CL-1	brown, wet, soft		85.9	36.5	38	14				UC 1064 psf
4580	35		Disturbed	18	2,3,4,(7) *T 0.35*	CL	brown, very moist, firm	LEAN CLAY W/SAND sand lenses & layers to 1" thick								
4575	40		Undisturbed	12	Pushed *T 0.50*	CL-1	brown, very moist, stiff		88.5	31.0	34	12				CT UC 2670 psf

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:
DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)
UNDISTURBED SAMPLE — PUSHED 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-08

SHEET 2 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ N.M. **AFTER 24 HOURS:** ▼ 20.5' 11/15/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/31/11
DATE COMPLETED: 10/31/11
GROUND ELEVATION: 4615.5'
LOGGED BY: S.C., J.P., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
4570			Disturbed	18	T 0.38	CL	brown, very moist, firm								
					2,5,7,(12)	SM	brown, wet — SILTY SAND								
					T 0.40	CL	brown, very moist, firm — LEAN CLAY W/SAND								
							SAND (driller's observation)								
4565	50		Disturbed	18	4,5,6,(10) T 0.55	CL	brown, moist, stiff — LEAN CLAY W/SAND sand lenses & layers								
							SAND (driller's observation)								
4560	55		Disturbed	18	4,6,7,(12) T 0.55	CL	brown, moist, stiff — LEAN CLAY W/SAND sand lenses & layers								
4555	60						SAND (driller's observation)								
							LEAN CLAY W/SAND								
4550	65		Disturbed	18	T 0.35	CL	brown, moist, firm								
					3,10,17,(21)	SM	brown, wet, med. dense — SILTY SAND								
							BOH								
4545	70														
4540	75														
4535	80														
4530	85														

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-09

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 16.8' **AFTER 24 HOURS:** ▼ 17.0' 11/15/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/28/11
DATE COMPLETED: 10/28/11
GROUND ELEVATION: 4605.5'
LOGGED BY: S. CHAFFIN, J. BOONE

Elev. (ft)	Depth (ft)	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
4605	0	Disturbed	7	3,5,6,(22)	SM	dk. brown, moist, med. dense — SILTY SAND								
4600	5	Disturbed	3	15,22,32,(99+)	SM	dk. brown, moist, very dense								
4595	10	Disturbed	9	8,8,11,(31)	SM	brown, moist, dense								
		Disturbed	11	7,8,9,(25)	SM	brown, moist, med. dense								
4590	15	Disturbed	16	6,5,6,(15)	ML	brown, wet, med. dense — SANDY SILT								
		Disturbed	18	3,3,4,(9)	ML	brown, wet, loose		31.2		NP	0	44	56	
4585	20	Disturbed	16	2,3,4,(9)	ML	brown, wet, loose								
		Disturbed	18	2,3,4,(8)	SM	brown, wet, loose — SILTY SAND		33.8		NP	0	52	48	
4580	25	Disturbed	18	2,1,2,(4) T 0.20	CL	brown, wet, soft — LEAN CLAY W/SAND, sand and/or silt lenses & layers								
4575	30	Undisturbed	18	Pushed T 0.41	CL	brown, very moist, firm								
4570	35	Disturbed	17	2,3,7,(11) T 0.40	CL	brown, very moist, firm								
4565	40	Undisturbed	13	Pushed T 0.20	CL	brown, very moist, soft								
		Disturbed	18	3,5,5,(10) T 0.50	SM	brown, wet — SILTY SAND								
					CL	brown, very moist, firm — LEAN CLAY W/SAND								
						BOH								

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) ← Blow Count per 6", (N₁)₆₀ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-10

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 15.5' **AFTER 24 HOURS:** ▼ 15.6' 11/15/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/27/11
DATE COMPLETED: 10/27/11
GROUND ELEVATION: 4603.1'
LOGGED BY: S.C., J.P., J.B.

Elev. (ft): 4600, 4595, 4590, 4585, 4580, 4575, 4570, 4565, 4560
Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40

Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
Disturbed	8	1,3,4,(14)	SM	dk. brown, moist, med. dense	SILTY SAND W/GRAVEL								
Disturbed	10	7,9,12,(42)	SM	brown, moist, dense	SILTY SAND								
Disturbed	12	7,7,11,(33)	SM	brown, moist, dense									
Disturbed	12	6,8,11,(31)	SM	brown, moist, dense									
Disturbed	12	6,6,7,(19)	SM	brown, very moist, med. dense									
Disturbed	18	4,4,5,(12)	SM	brown, wet, med. dense			17.8		NP	0	54	46	
Disturbed	16	2,2,3,(7)	ML	brown, wet, loose	SANDY SILT		30.3		NP	0	44	54	
Disturbed	16	3,3,3,(8)	ML	brown, wet, loose									
Disturbed	18	3,3,4,(9)	ML	brown, wet, loose			30.9		NP	0	38	62	
Disturbed	18	2,2,3,(6) T 0.20	CL	brown, wet, soft	LEAN CLAY W/SAND silt and/or sand lenses & layers to 1" thick								
Undisturbed	14	Pushed T 0.25 T 0.31	CL-1	brown, very moist, firm		88.2	33.3	36	12				UC 2356 psf
Disturbed	18	3,4,10,(15) T 0.25	CL	brown, very moist, firm									
Disturbed	18	5,5,8,(13)	CL,SM	brown, wet to very moist	INTERBEDDED SILTY SAND & LEAN CLAY LAYERS								
					BOH								

DH LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-11

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ 17.1'   **AFTER 24 HOURS:** ▼ 16.7' 11/15/11

PROJECT NUMBER: 201101.012
DATE STARTED: 10/27/11
DATE COMPLETED: 10/27/11
GROUND ELEVATION: 4602.7'
LOGGED BY: J. PRICE, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Disturbed	13	2,4,6,(22)	SM	brown, moist, med. dense	SILTY SAND								
4600			Disturbed	14	26,26,27,(99+)	SM	brown, moist, very dense									
	5		Disturbed	10	10,14,23,(80)	SM	brown, moist, very dense	SILTY SAND W/GRAVEL								
4595			Disturbed	9	23,26,19,(78)	SM	brown, moist, very dense									
	10		Disturbed	18	5,8,10,(29)	ML	brown, moist, med. dense	SANDY SILT								
4590			Disturbed	18	4,6,9,(22)	SM	brown, moist, med. dense									
	15		Disturbed	13	2,4,6,(14)	SM	brown, very moist, med. dense	SILTY SAND								
4585			Disturbed	10	4,5,7,(15)	SM	brown, wet, med. dense			25.4		NP	0	67	33	
	20		Disturbed	7	3,4,3,(9)	ML	brown, wet, loose	SANDY SILT								
4580			Disturbed	8	2,2,3,(6)	SM	brown, wet, loose	SILTY SAND		34.5		NP	0	53	47	
	25		Disturbed	18	1,2,2,(5)	SM	brown, wet, loose			33.2		NP	0	56	44	
4575			Disturbed	18	1,2,1,(3) T 0.20	CL	brown, wet, soft	LEAN CLAY W/SAND silt and/or sand lenses & layers								
	30		Undisturbed	14	Pushed T 0.25	CL	brown, very moist, firm	LEAN CLAY W/SAND vertical sand lenses								
4570																
	35		Disturbed	18	0,1,3,(4) T 0.20	CL	brown, very moist, soft	LEAN CLAY W/SAND silt and/or sand lenses & layers to 1" thick								
4565																
	40		Disturbed	18	4,5,5,(10) T 0.35	CL	brown, very moist, firm									
								BOH								
4560																

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6"; (6) — $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-12

SHEET 1 OF 2

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE

CLIENT: MHTN ARCHITECTS, INC.

LOCATION: SEE SITE PLAN

DRILLING METHOD: 08-CME-55 / N.W. CASING

DRILLER: T. KERN

DEPTH TO WATER - INITIAL: ▽ 10.0' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012

DATE STARTED: 10/28/11

DATE COMPLETED: 10/31/11

GROUND ELEVATION: 4602.2'

LOGGED BY: S.C., J.P., J.B.

Elev. (ft) / Depth (ft)	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
4600	Disturbed	14	3,4,13,(34)	SM	dk. brown, moist, dense — SILTY SAND								
5 / 4595	Disturbed	16	15,15,22,(75)	SM	lt. to dk. brown, moist, very dense — SILTY SAND slightly plastic								
10 ▽	Disturbed	15	6,7,9,(26)	SM	brown, very moist, med. dense								
4590	Disturbed	9	4,4,5,(13)	SM	brown, wet, med. dense — SILTY SAND								
15	Disturbed	9	4,8,9,(23)	SM	brown, wet, med. dense								
4585	Disturbed	18	2,3,4,(9)	SM	brown, wet, loose		26.0		NP	0	74	26	
20	Disturbed	18	2,2,2,(5)	ML	brown, wet, loose		33.0		NP	0	45	55	
4580	Disturbed	18	1,2,3,(6)	ML	brown, wet, loose — SANDY SILT								
25	Disturbed	18	1,2,3,(6)	ML	brown, wet, loose		32.8		NP	0	25	75	
4575 / 30	Undisturbed	14	Pushed *T 0.55*	CL-2	brown, moist, stiff — LEAN CLAY W/SAND silt and/or sand lenses	87.7	32.5	39	16				UC 3111 psf
4570 / 35	Disturbed	17	*T 0.15*	CL	brown, very moist, soft								
			3,8,10,(19)	SM	brown, wet, med. dense — SILTY SAND								
4565 / 40	Undisturbed	14	Pushed *T 0.53*	ML	brown, very moist, stiff — SILT W/SAND plastic, sand lenses	94.6	24.7	26	4	0	15	85	CT UC 2118 psf
4560					INTERBEDDED SILTY SAND & LEAN CLAY LENSES & LAYERS TO 1.5" THICK								

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6"; (6) — $(N_1)_{60}$ Value; *0.45* — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; *0.45* — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-12

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE

CLIENT: MHTN ARCHITECTS, INC.

LOCATION: SEE SITE PLAN

DRILLING METHOD: 08-CME-55 / N.W. CASING

DRILLER: T. KERN

DEPTH TO WATER - INITIAL: ▽ 10.0' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012

DATE STARTED: 10/28/11

DATE COMPLETED: 10/31/11

GROUND ELEVATION: 4602.2'

LOGGED BY: S.C., J.P., J.B.

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Disturbed	18	3,7,9,(15)	SM,CL	brown, wet, med. dense	INTERBEDDED SILTY SAND & LEAN CLAY LENSES & LAYERS TO 1.5" THICK								
4555																
	50		Undisturbed	16	Pushed *T 0.55*	CL-2	gray-brown, moist, stiff	LEAN CLAY W/SAND sand lenses	90.4	29.5	38	16				CT
4550																
	55		Disturbed	15	7,6,15,(19) *T 0.51*	CL	brown, moist, stiff	LEAN CLAY W/SAND silty sand layers to 3" thick								
4545																
	60		Disturbed		26,32,30,(54)	SM	brown, wet, dense	SILTY SAND								
4540																
	65		Disturbed	14	20,27,33,(51)	SM	brown, wet, dense									
4535																
	70		Disturbed	14	28,37,40,(63)	SM	brown, wet, dense									
4530																
	75		Disturbed	13	32,36,39,(60)	SM	gray, wet, dense									
4525																
	80		Disturbed	14	30,34,39,(57)	SM	gray, wet, dense									
								BOH								
4520																
	85															
4515																

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6", $(N_1)_{60}$ Value; *0.45* — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; *0.45* — Torvane (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- SS = Soluble Salt
- DC = Dispersive Clay
- Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-13

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ 6.0' **AFTER 24 HOURS:** N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 11/1/11
DATE COMPLETED: 11/1/11
GROUND ELEVATION: 4600.4'
LOGGED BY: S. CHAFFIN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
								3" ASPHALT								
4600						GM	brown, moist	ROADBASE (SILTY GRAVEL W/SAND)								
				17	23,18,41,(99+)	SM	brown, moist, very dense									
				17	26,31,32,(99+)	SM	brown, moist, very dense									
				15	21,24,23,(95)	SM	brown, moist, very dense									
4595	5			11	11,9,10,(38)	SM	brown, moist, dense	SILTY SAND								
				13	4,6,6,(20)	SM	brown, moist, med. dense									
4590	10							BOH								

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-14

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ N.M. **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 11/1/11
DATE COMPLETED: 11/1/11
GROUND ELEVATION: 4597.9'
LOGGED BY: S. CHAFFIN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
							3" ASPHALT								
						GM	ROADBASE (SILTY GRAVEL W/SAND) brown, moist								
				15	8,12,16,(57)	SM	SILTY SAND brown, moist, very dense								
				15	11,15,11,(52)	SM	brown, moist, very dense		13.3		NP	2	63	35	
4595															
				18	8,7,6,(26)	SM	brown, moist, med. dense								
	5														
				13	6,6,9,(30)	SM	brown, moist, med. dense								
4590															
				13	6,6,8,(23)	SM	brown, moist, med. dense								
	10						BOH								
4585															

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-15

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ N.M. **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 11/1/11
DATE COMPLETED: 11/1/11
GROUND ELEVATION: 4596.2'
LOGGED BY: S. CHAFFIN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
								3" ASPHALT								
						GM	lt. brown, moist	ROADBASE (SILTY GRAVEL W/SAND)								
4595				14	11,23,15,(77)	GM	dk. brown, moist, very dense	SILTY GRAVEL W/SAND								
				13	8,11,17,(57)	SM	dk. brown, moist, very dense	SILTY SAND								
				10	9,14,8,(44)	SM	brown, moist, dense	SILTY SAND W/GRAVEL								
	5			14	5,6,5,(22)	SM	brown, moist, med. dense									
4590								SILTY SAND								
				18	5,5,6,(18)	SM	brown, moist, med. dense									
	10							BOH								
4585																

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6): Blow Count per 6", $(N_1)_{60}$ Value; 0.45: Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45: Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 11-16

SHEET 1 OF 1

PROJECT: UVU STUDENT LIFE CENTER & PARKING STRUCTURE
CLIENT: MHTN ARCHITECTS, INC.
LOCATION: SEE SITE PLAN
DRILLING METHOD: 08-CME-55 / N.W. CASING
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ N.M. **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201101.012
DATE STARTED: 11/1/11
DATE COMPLETED: 11/1/11
GROUND ELEVATION: 4598.7'
LOGGED BY: S. CHAFFIN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
							3" ASPHALT								
				15	9,11,13,(42)	SM	brown, moist — SILTY SAND W/GRAVEL								
						GM	gray, moist, med. dense — SILTY GRAVEL W/SAND								
				13	6,6,11,(34)	SM	gray, moist, dense		14.5		NP	5	78	17	
4595				8	9,5,6,(22)	SM	gray, moist, med. dense								
	5			1	6,8,7,(30)	SM	gray, moist, med. dense — SILTY SAND								
4590				18	3,5,6,(18)	SM	brown, moist, med. dense								
	10						BOH								
4585															

DH_LOGV1 UVU_SLC_PS.GPJ US EVAL.GDT 11/15/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6"; (6) ← $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 06-1

SHEET 1 OF 2

PROJECT: UTAH VALLEY STATE COLLEGE DIGITAL LEARNING CENTER
CLIENT: UTAH VALLEY STATE COLLEGE
LOCATION: SEE SITE PLAN
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ 7.0' AFTER 24 HOURS: ▼ 9.2' 3/27/06

PROJECT NUMBER: 200601.007
DATE STARTED: 3/23/06
DATE COMPLETED: 3/23/06
GROUND ELEVATION: 4597.6'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
							brown	4" ASPHALT								
			Disturbed	11	11,10,12	GM SM	brown, moist, med. dense	5" SILTY GRAVEL W/SAND								
4595																
			Disturbed	15	10,8,8	SM	dk. brown, moist, med. dense			15.2			0	53	47	
	5															
			Disturbed	16	2,2,1	SM	dk. brown, moist, very loose	SILTY SAND		22.5			0	58	42	
4590																
	10		Disturbed	3	0,0,0	SM	dk. brown, wet, very loose									
4585			Disturbed	16	1,1,2	ML	brown, wet, very loose	SANDY SILT		36		NP	0	46	54	
	15		Disturbed	19	1,1,2 *0.20*	CL	lt. brown, moist, soft	LEAN CLAY W/SANDY SILT LAYERS								
4580																
	20		Undisturbed	17	Pushed *0.54*	CL	lt. brown, moist, stiff			82.5	34.5	37	14			CT UC
4575																
	25		Disturbed	14	8,4,4	CL	lt. brown, moist, firm	LEAN CLAY W/SILTY SAND LAYERS								
4570																
	30		Undisturbed	18	Pushed *0.34*	CL	lt. brown, moist, firm									
4565																

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) — Blow Count per 6"; (6) = $(N_1)_{60}$ Value; *0.45* = Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED *0.45* — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 06-1

PROJECT: UTAH VALLEY STATE COLLEGE DIGITAL LEARNING CENTER
CLIENT: UTAH VALLEY STATE COLLEGE
LOCATION: SEE SITE PLAN
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ 7.0' **AFTER 24 HOURS:** ▼ 9.2' 3/27/06

PROJECT NUMBER: 200601.007
DATE STARTED: 3/23/06
DATE COMPLETED: 3/23/06
GROUND ELEVATION: 4597.6'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
				12	3,9,11 *0.15*	CL	lt. brown, moist, stiff — LEAN CLAY W/SILTY SAND LENSES								
4560															
	40			15	4,9,12	SM	brown, wet, med. dense — SILTY SAND								
4555															
	45			14	17,29,30	SP-SM	gray-brown, moist, very dense — POORLY GRADED SAND W/SILT								
4550															
	50			14	11,22,17	SM	brown, moist, dense								
4545															
	55			19	10,20,60/5"	SM	brown, moist, very dense — SILTY SAND								
4540															
	60			18	10,32,40	SM	brown, moist, very dense								
4535															
				11	24,27,34	SM	brown, moist, very dense — SILTY SAND W/CLAY LAYERS								
	65														
4530															
				0	30,41,47	-	very dense								

DH_LOGV1 200601_007_LOGS.GPJ US EVAL.GDT 4/5/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) ← Blow Count per 6", $(N_1)_{60}$ Value; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED; 0.45 ← Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 06-2

SHEET 1 OF 2

PROJECT: UTAH VALLEY STATE COLLEGE DIGITAL LEARNING CENTER
CLIENT: UTAH VALLEY STATE COLLEGE
LOCATION: SEE SITE PLAN
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ N.M. **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.007
DATE STARTED: 3/29/06
DATE COMPLETED: 3/29/06
GROUND ELEVATION: 4599.9'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
								3" ASPHALT								
			Disturbed	15	16,46,50	SM	brown, moist, very dense	SILTY SAND W/GRAVEL		13.5			28	57	15	
			Disturbed	15	11,16,19	SM	brown, moist, dense	SILTY SAND		8.5			0	80	20	
4595	5		Disturbed	15	5,5,6	SM	lt. brown, moist, med. dense									
4590	10		Disturbed	15	3,2,2	SM	brown, wet, very loose			29.8			0	65	35	
			Disturbed	15	4,3,5	SM	brown, wet, loose									
4585	15		Disturbed	14	2,5,5	ML	brown, wet, loose	SANDY SILT		34.6		NP	0	29	71	
4580	20		Disturbed	17	3,2,3	CL	brown, wet, firm	SANDY LEAN CLAY								
4575	25		Undisturbed	18	Pushed *0.54*	CL	brown, moist, firm	LEAN CLAY W/SAND LENSES								
4570	30		Disturbed	7	4,2,2	CL	brown, wet, soft									

DH_LOGV1 200601_007_LOGS.GPJ US EVAL.GDT 4/5/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — 2,3,2,(6) *0.45*: Blow Count per 6"; $(N_1)_{60}$ Value; Torvane (tsf)

UNDISTURBED SAMPLE — PUSHED *0.45*: Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 06-2

PROJECT: UTAH VALLEY STATE COLLEGE DIGITAL LEARNING CENTER
CLIENT: UTAH VALLEY STATE COLLEGE
LOCATION: SEE SITE PLAN
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ N.M. **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 200601.007
DATE STARTED: 3/29/06
DATE COMPLETED: 3/29/06
GROUND ELEVATION: 4599.9'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Undisturbed	15	Pushed	CL / SM									
			Disturbed	13	3,7,9	SM	SILTY SAND: brown, moist, med. dense								
4560	40		Disturbed	17	3,5,10 *0.60*	CL	LEAN CLAY W/SAND LENSES: lt. brown, moist, stiff								
4555	45		Disturbed	14	3,19,22 *0.39*	CL	lt. brown, moist, hard								
4550	50		Disturbed	12	7,10,16 *0.20*	CL	brown, moist, hard								
4545	55														
4540	60														
4535	65														

DH_LOGV1 200601_007_LOGS.GPJ US EVAL.GDT 4/5/11

RB&G ENGINEERING, INC.

LEGEND:
DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6"; (6) — $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)
UNDISTURBED SAMPLE: PUSHED; 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

DRILL HOLE LOG

BORING NO. 06-3

PROJECT: UTAH VALLEY STATE COLLEGE DIGITAL LEARNING CENTER

CLIENT: UTAH VALLEY STATE COLLEGE

LOCATION: SEE SITE PLAN

DRILLING METHOD: CME-55 NO. 2 / N.W. CASING

DRILLER: D. SAMPSON

DEPTH TO WATER - INITIAL: ▽ 13.0' **AFTER 24 HOURS:** ▼ 13.0'3/29/06

PROJECT NUMBER: 200601.007

DATE STARTED: 3/28/06

DATE COMPLETED: 3/28/06

GROUND ELEVATION: 4599.3'

LOGGED BY: G. PEASLEE

Sample Type	Rec. (in)	See Legend	USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	Other Tests
				3" ASPHALT								
Disturbed	15	22,25,55	GM	gray-brown, moist, dense SILTY GRAVEL W/SAND								
Disturbed	12	17,18,25	GP-GM	gray-brown, moist, dense POORLY GRADED GRAVEL W/SILT & SAND		5.8			69	25	6	
Undisturbed	17	Pushed	SM	SILTY SAND								
Disturbed	11	4,5,6	SM	brown, moist, med. dense		18.6			0	78	22	
Disturbed	10	5,6,7	SP	gray-brown, moist, med. dense POORLY GRADED SAND								
Disturbed	11	3,4,6	SM	brown, wet, loose SILTY SAND								
Disturbed	15	2,1,3	ML/SM	brown, wet, loose SANDY SILT TO SILTY SAND		31.5		NP	0	50	50	
Disturbed	18	2,1,4	ML/SM	brown, wet, loose								
Undisturbed	18	Pushed 0.71	CL	brown, moist, stiff LEAN CLAY W/SAND LENSES								
Undisturbed	17	Pushed	CL	brown, moist								
Disturbed	18	7,8,10	CL	brown, moist, very stiff								

Elev. (ft): 4595, 4590, 4585, 4580, 4575, 4570, 4565

Depth (ft): 5, 10, 15, 20, 25, 30

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6", $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED 0.45 — Torvane (tsf)

OTHER TESTS

UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

RB&G ENGINEERING, INC.

DRILL HOLE LOG

BORING NO. 06-3

PROJECT: UTAH VALLEY STATE COLLEGE DIGITAL LEARNING CENTER
CLIENT: UTAH VALLEY STATE COLLEGE
LOCATION: SEE SITE PLAN
DRILLING METHOD: CME-55 NO. 2 / N.W. CASING
DRILLER: D. SAMPSON
DEPTH TO WATER - INITIAL: ∇ 13.0' **AFTER 24 HOURS:** ▼ 13.0'3/29/06

PROJECT NUMBER: 200601.007
DATE STARTED: 3/28/06
DATE COMPLETED: 3/28/06
GROUND ELEVATION: 4599.3'
LOGGED BY: G. PEASLEE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
			Disturbed	12	7,8,11 *0.35*	CL	lt. brown, moist, very stiff								
4560	40		Undisturbed	17	Pushed	CL	LEAN CLAY W/SAND LENSES								
4555	45		Disturbed	14	5,6,9 *0.20*	CL	lt. brown, moist, stiff								
4550	50		Disturbed	5	4,5,17	CL	lt. brown, moist, very stiff								
4545	55														
4540	60														
4535	65														
4530															

DH_LOGV1 200601_007_LOGS.GPJ US EVAL.GDT 4/5/11

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE: 2,3,2,(6) — Blow Count per 6"; (6) — $(N_1)_{60}$ Value; 0.45 — Torvane (tsf)

UNDISTURBED SAMPLE: PUSHED; 0.45 — Torvane (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay
Chem. = pH, Resistivity, Sulfate, Chloride

RB&G ENGINEERING, INC.

Table 1

SUMMARY OF TEST DATA

PROJECT: UVU Student Center & Parking Structure
LOCATION: Orem Campus see site plan
PROJECT NO. 201101-012
FEATURE: Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			PERCENT FINER THAN 0.005 mm	UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO CLASSIFICATION)
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY		
11-01	3-4.5		14.1				NP	35	51	14		SM
	18-19.5		31.4				NP	0	46	54		ML
	24-25.5		34.2				NP	0	31	69		ML
	30-31.5	80.6	34.7	uc 1834	38	23	15					CL-2
	40-41.5		22.8				NP	0	55	45		SM
	50-51.5	90.5	28.0	uc 2613	31	20	11					CL-1
11-02	3-4.5		9.1				NP	53	34	13		GM
	21-22.5		30.0				NP	0	56	44		SM
	27-28.5		34.0				NP	0	32	68		ML
	30-31.5	86.9	34.0	uc 1569	30	24	6					ML
	40-41.5	82.4	32.6		36	21	15					CL-2
	50-51.5	85.9	29.0	uc 1669	30	20	10	0	4	96		CL-1
	65-66.5		18.1				NP	0	70	30		SM
11-03	6-7.5		8.3				NP	48	44	8		GP-GM
	18-19.5		33.5				NP	0	61	39		SM
	22.5-24		33.6				NP	0	24	76		ML
	30-31.5	87.6	32.0	uc 1647	38	23	15					CL-2
	40-41.5(top)		24.6				NP	0	62	38		SM
	40-41.5(bottom)	95.3	26.1	uc 1354	29	19	9	0	14	86		CL-1
	65-66.5		23.5				NP	0	80	20		SM
11-04	21-22.5		35.1				NP	0	41	59		ML
	40-41.5		27.5				NP	0	33	67		ML
	50-51.5	92.8	27.4	uc 1534	33	19	14	0	4	96		CL-1

NP=Non-Plastic

RB&G ENGINEERING, INC.

Table 1
SUMMARY OF TEST DATA

PROJECT: UVU Student Center & Parking Structure — PROJECT NO.: 201101-012-2

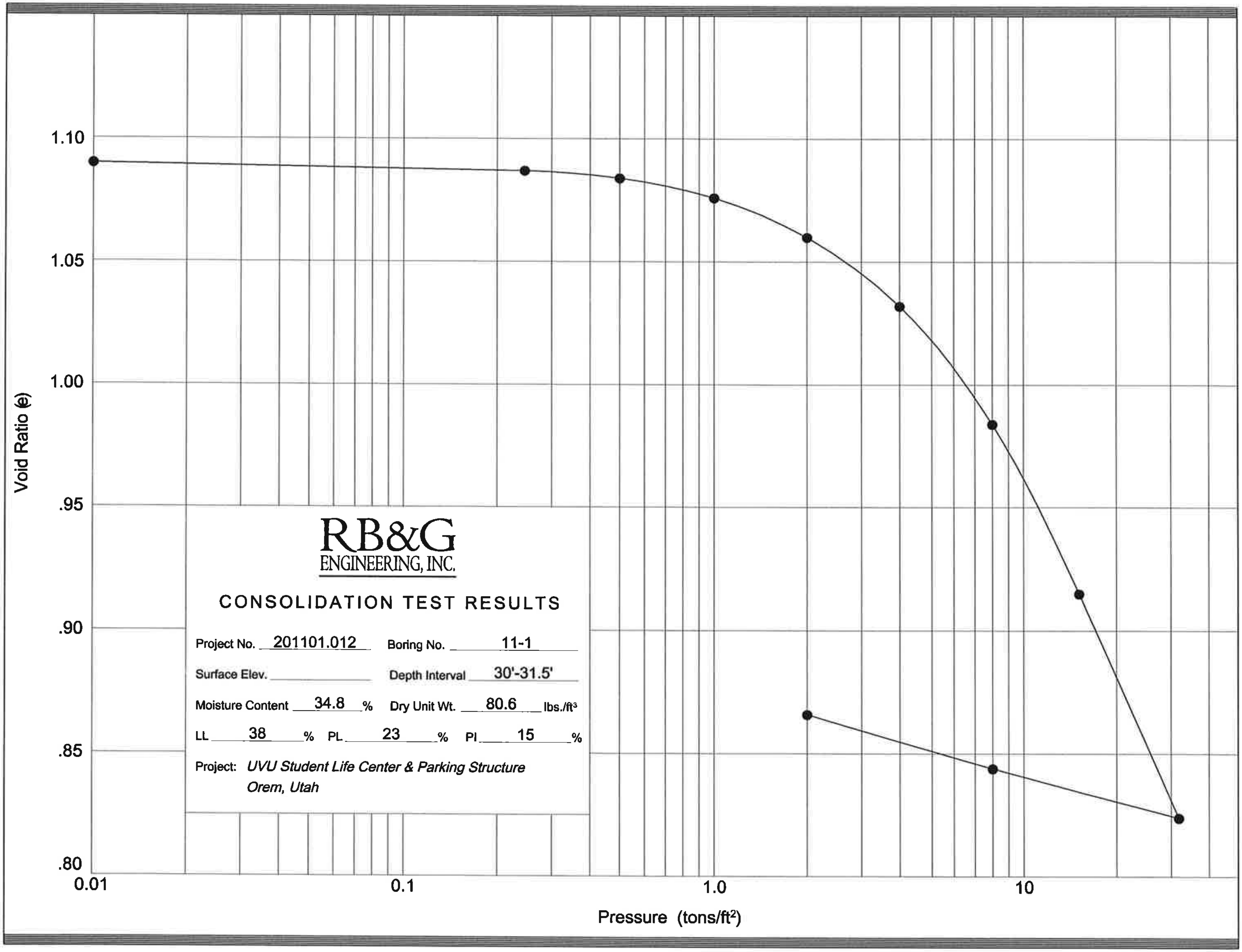
LOCATION: Orem, UT see site plan — FEATURE: Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			PERCENT FINER THAN 0.005 mm	UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO CLASSIFICATION)
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY		
11-05	15-16.5		21.2				NP	0	54	46		SM
	22.5-24		33.9				NP	0	44	56		ML
	30-31.5	83.7	33.6	UC 2458	36	25	11					ML
	40-41.5		21.8				NP	0	91	9		SP-SM
11-06	12.5-14		27.4				NP	0	42	58		ML
	17.5-19		25.6				NP	0	50	50		ML
	20-21.5		32.8		28	22	6	0	22	78		CL-ML
	22.5-24		34.9		36	23	13					CL-1
	35-36.5		23.4				NP	0	52	48		SM
11-07	22.5-24		28.8				NP	0	50	50		ML
	27.5-29		35.7		34	23	11					CL-1
	40-41.5	101.2	24.6	UC 1270	25	23	2	0	25	75		ML
	50-51.5	91.8	24.7	UC 1938	29	21	8					CL-1
	60-61.5		24.4		28	20	8	0	29	71		CL-1
11-08	25-26.5		34.9				NP	2	45	53		ML
	30-31.5	85.9	36.5	UC 1064	38	24	14					CL-1
	40-41.5	88.5	30.9	UC 2670	34	22	12					CL-1
11-09	17.5-19		31.2				NP	0	44	56		ML
	22.5-24		33.8				NP	0	52	48		SM
11-10	15-16.5		17.8				NP	0	54	46		SM
	17.5-19		30.3				NP	0	46	54		ML
	22.5-24		30.9				NP	0	38	62		ML
	30-31.5	88.2	33.3	UC 2356	36	24	12					CL-1
11-11	17.5-19		25.4				NP	0	67	33		SM
	22.5-24		34.5				NP	0	53	47		SM
	25-26.5		33.2				NP	0	56	44		SM
11-12	17.5-19		26.0				NP	0	74	26		SM
	20-21.5		33.0				NP	0	45	55		ML
	25-26.5		32.8				NP	0	25	75		ML
	30-31.5	87.7	32.5	UC 3111	39	23	16					CL-2
	40-41.5	94.6	24.7	UC 2118	26	22	4	0	15	85		ML
	50-51.5	90.4	29.5		38	22	16					CL-2
11-14	1.5-3		13.3				NP	2	63	35		SM
11-16	1.5-3		14.5				NP	5	78	17		SM

		pH	Resistivity ohm cm	Chloride mg/kg-dry	Sulfate mg/kg-dry						
11-06	5-6.5	9.3	2300.0	<51.2	<5.12						
11-08	20-21.5	8.1	3500.0	28.0	21.1						

NP=Non-Plastic

H:\2011\012_UVU StudentLifeCtr&PrkngStruct\Task 2 Final\Lab Testing\Testing Summary



RB&G ENGINEERING, INC.

CONSOLIDATION TEST RESULTS

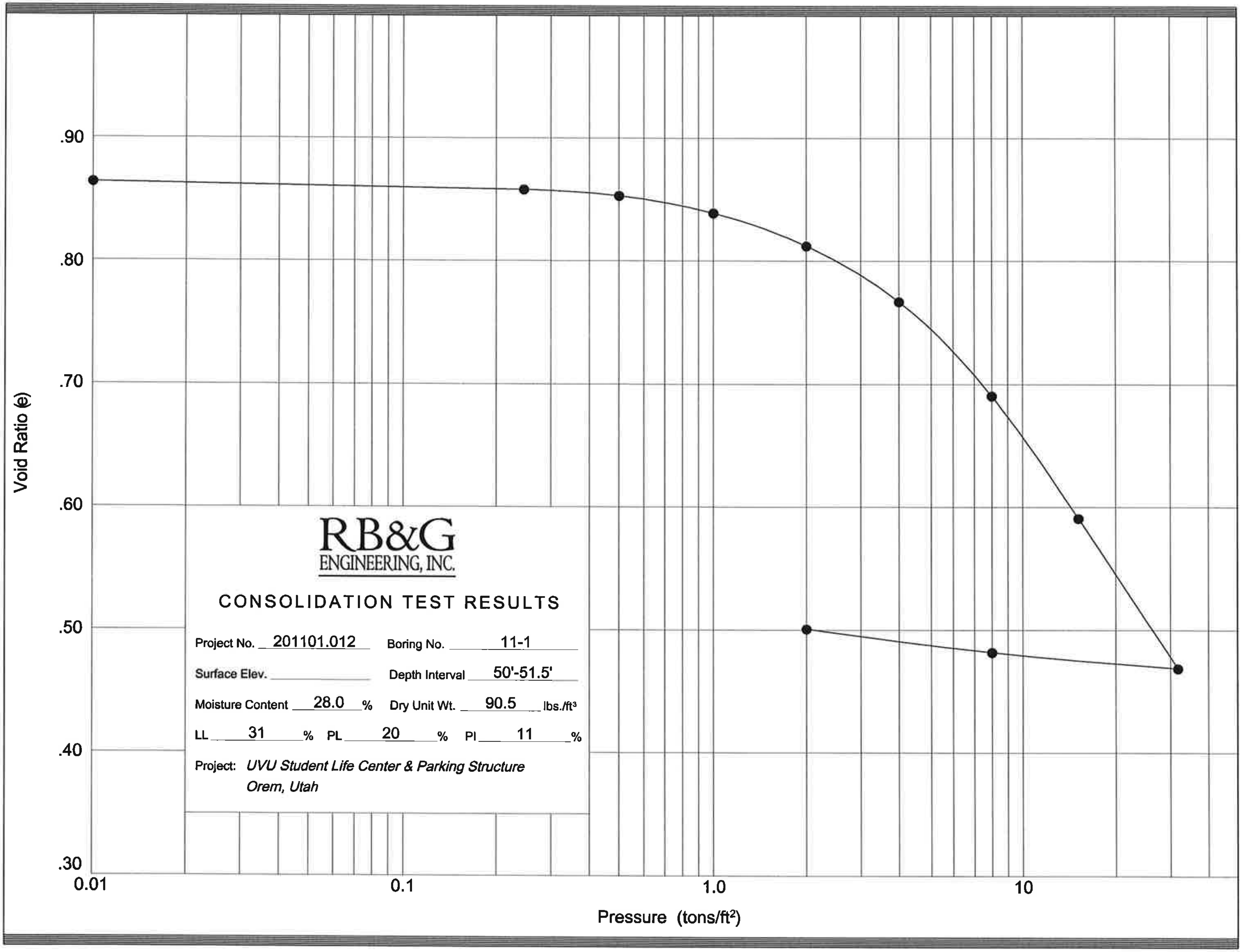
Project No. 201101.012 Boring No. 11-1

Surface Elev. ______ Depth Interval 30'-31.5'

Moisture Content 34.8 % Dry Unit Wt. 80.6 lbs./ft³

LL 38 % PL 23 % PI 15 %

Project: *UVU Student Life Center & Parking Structure*
Orem, Utah



RB&G ENGINEERING, INC.

CONSOLIDATION TEST RESULTS

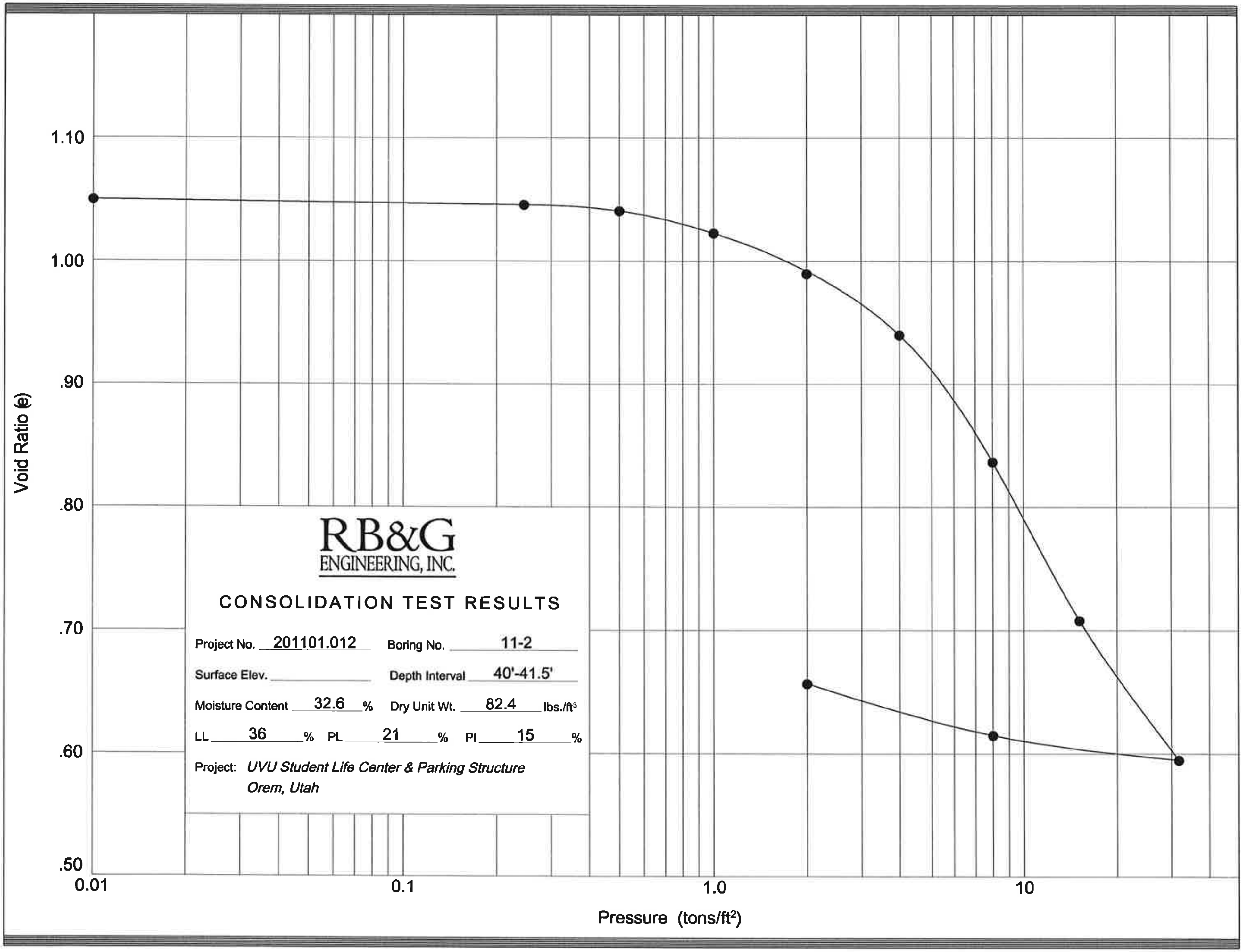
Project No. 201101.012 Boring No. 11-1

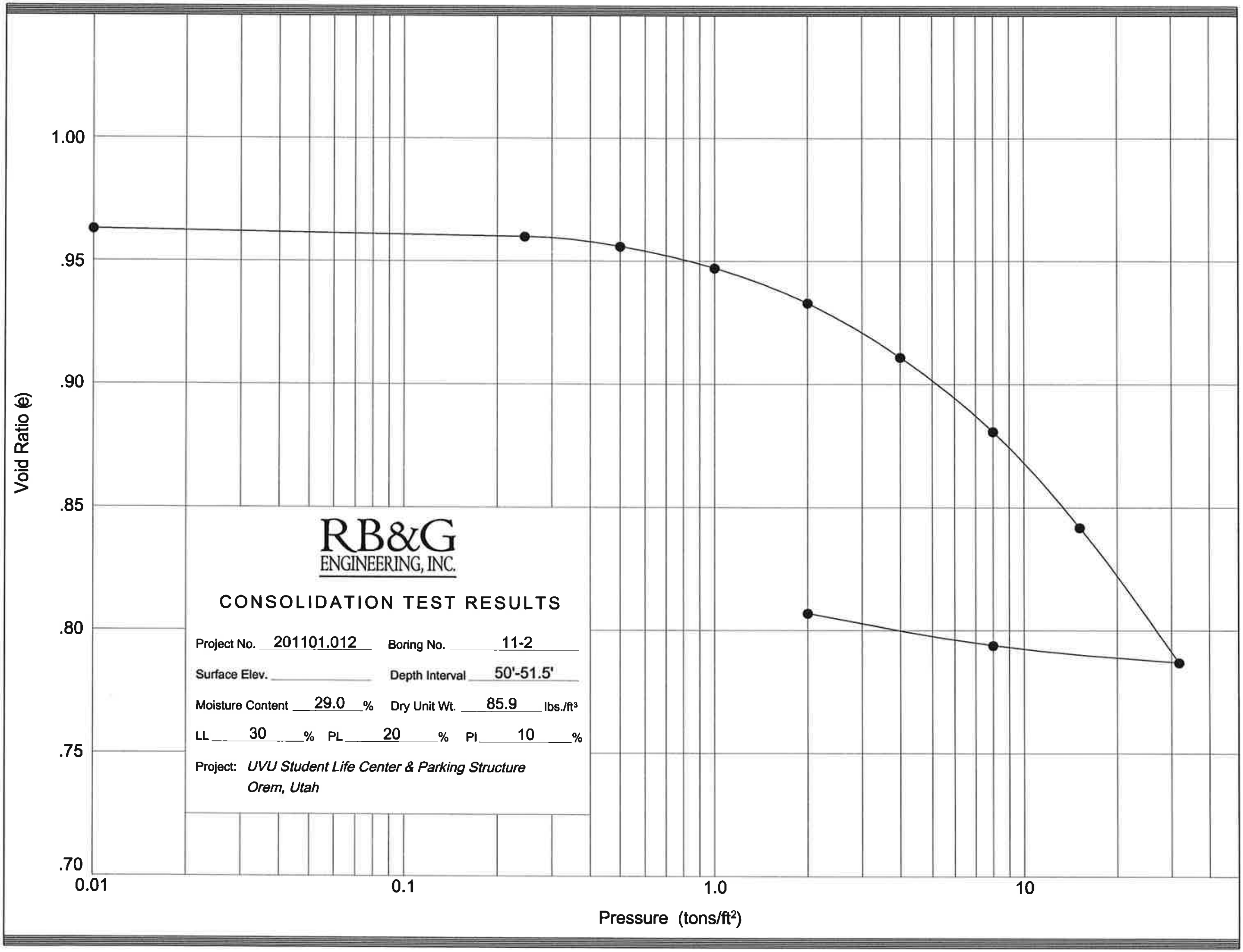
Surface Elev. ______ Depth Interval 50'-51.5'

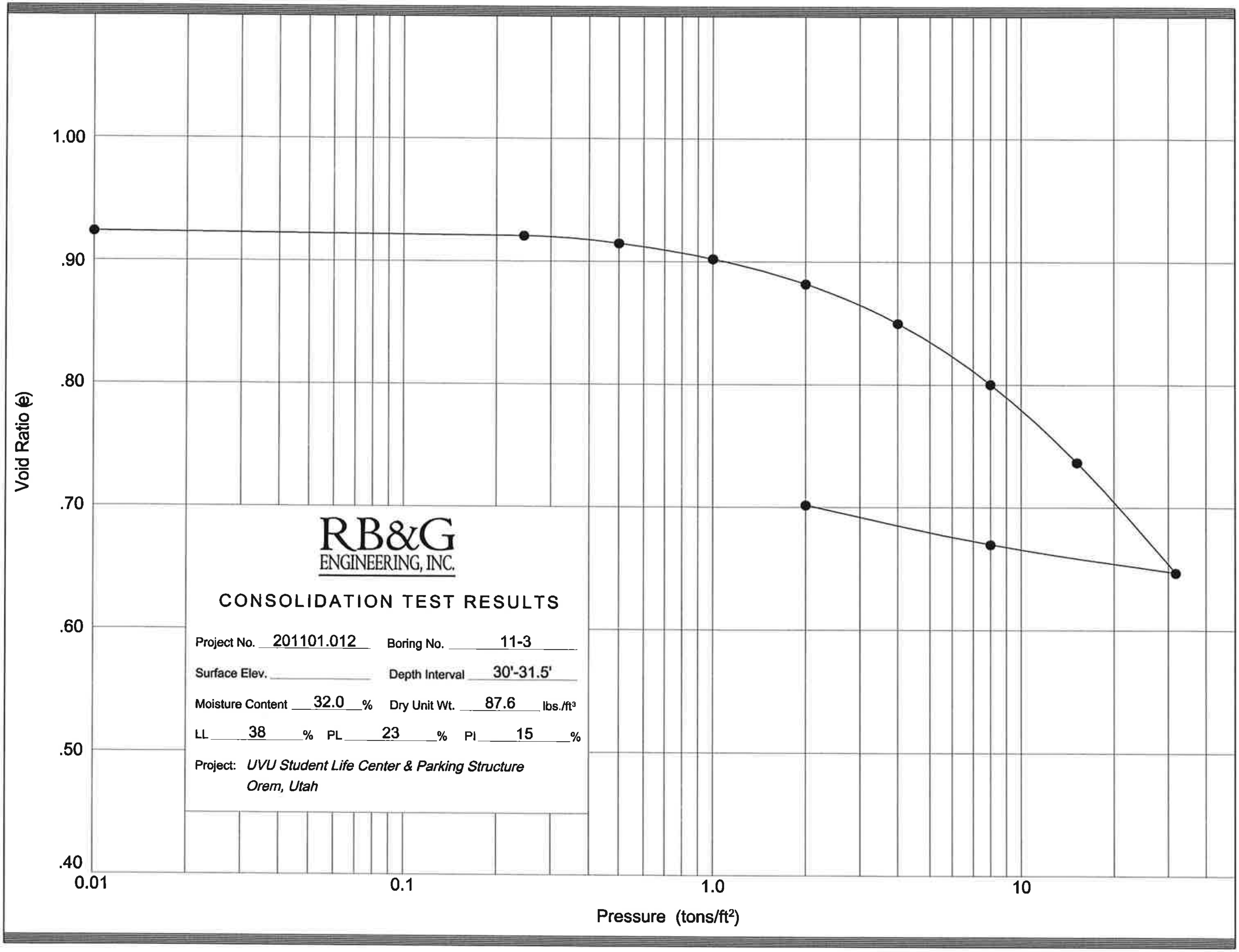
Moisture Content 28.0 % Dry Unit Wt. 90.5 lbs./ft³

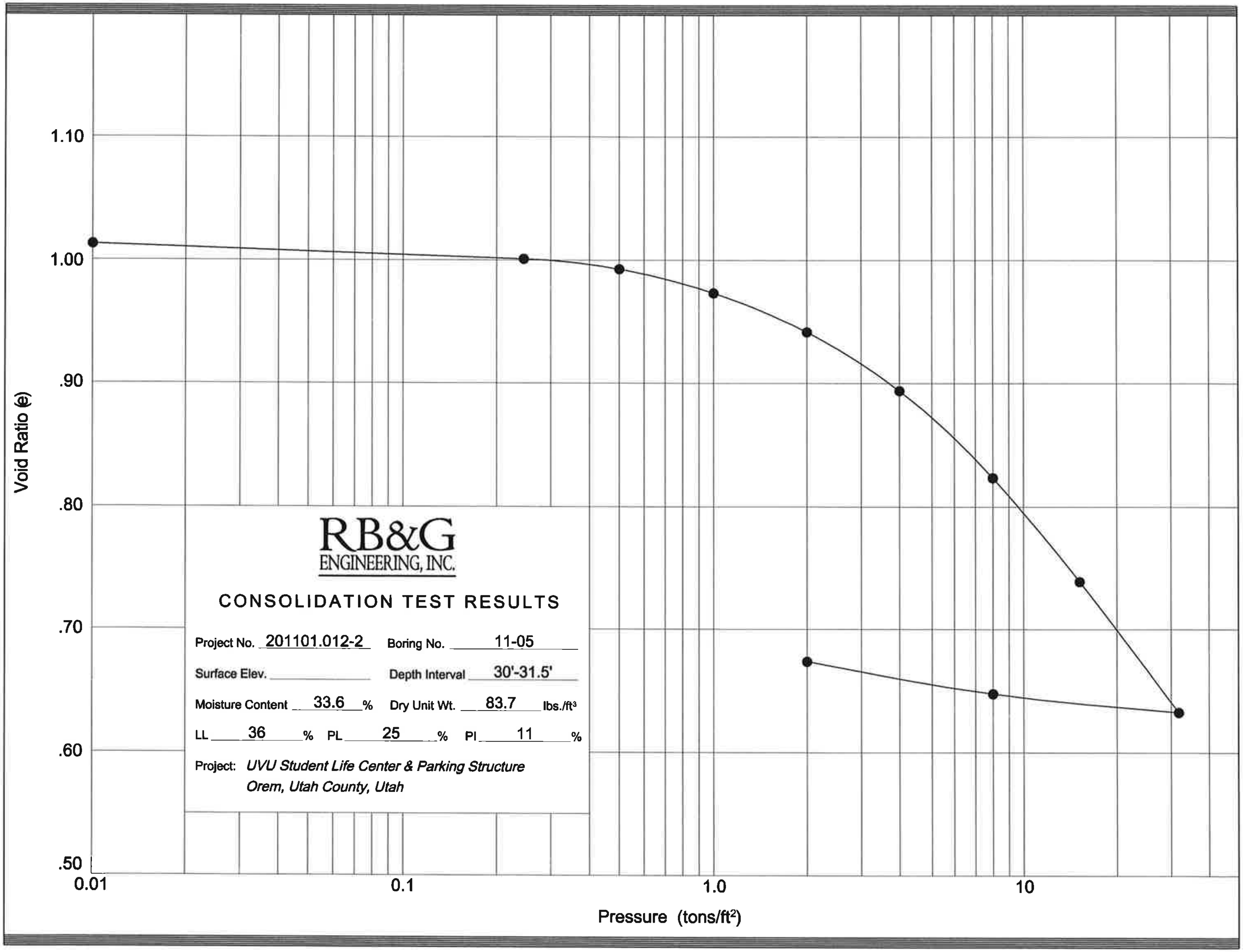
LL 31 % PL 20 % PI 11 %

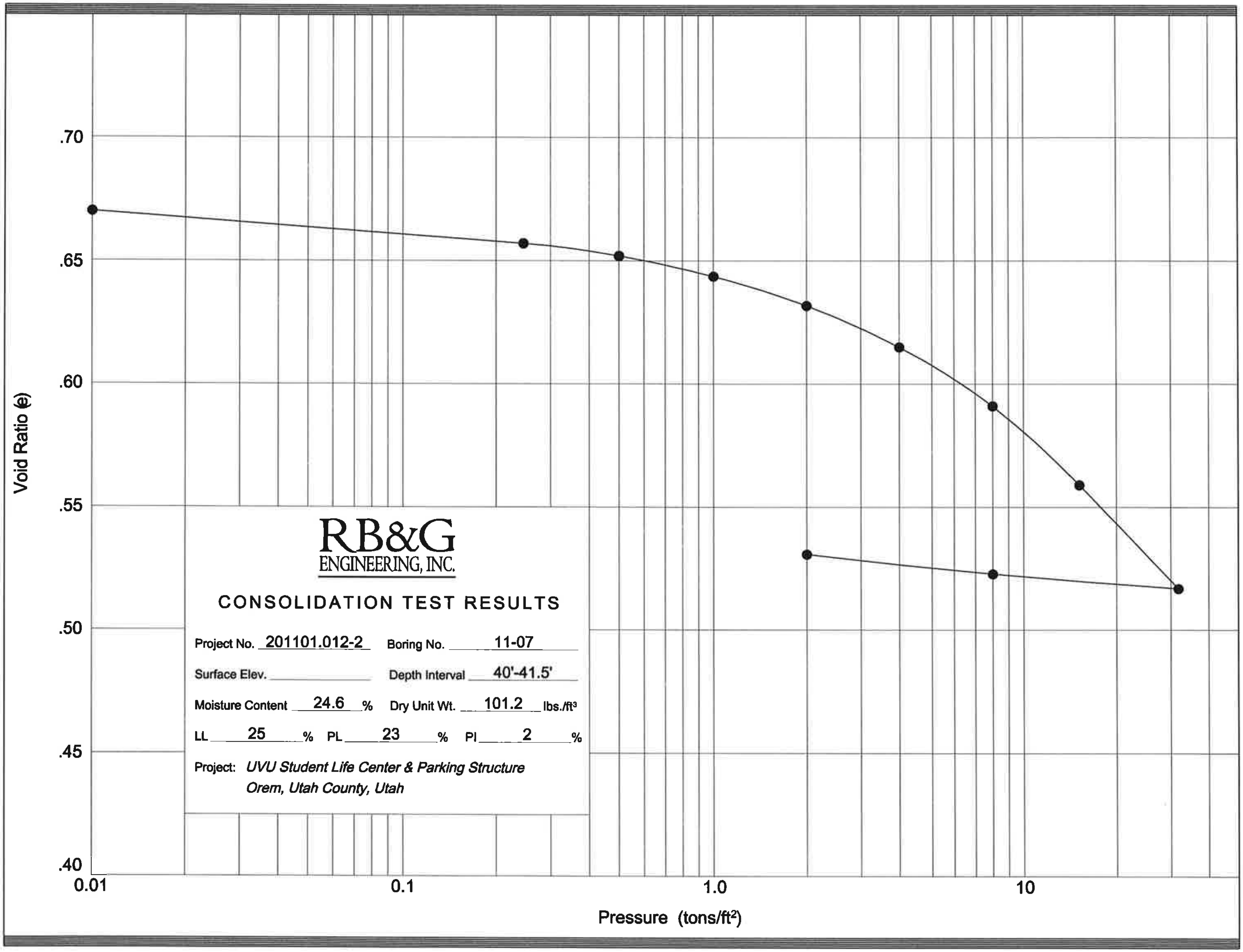
Project: *UVU Student Life Center & Parking Structure*
Orem, Utah

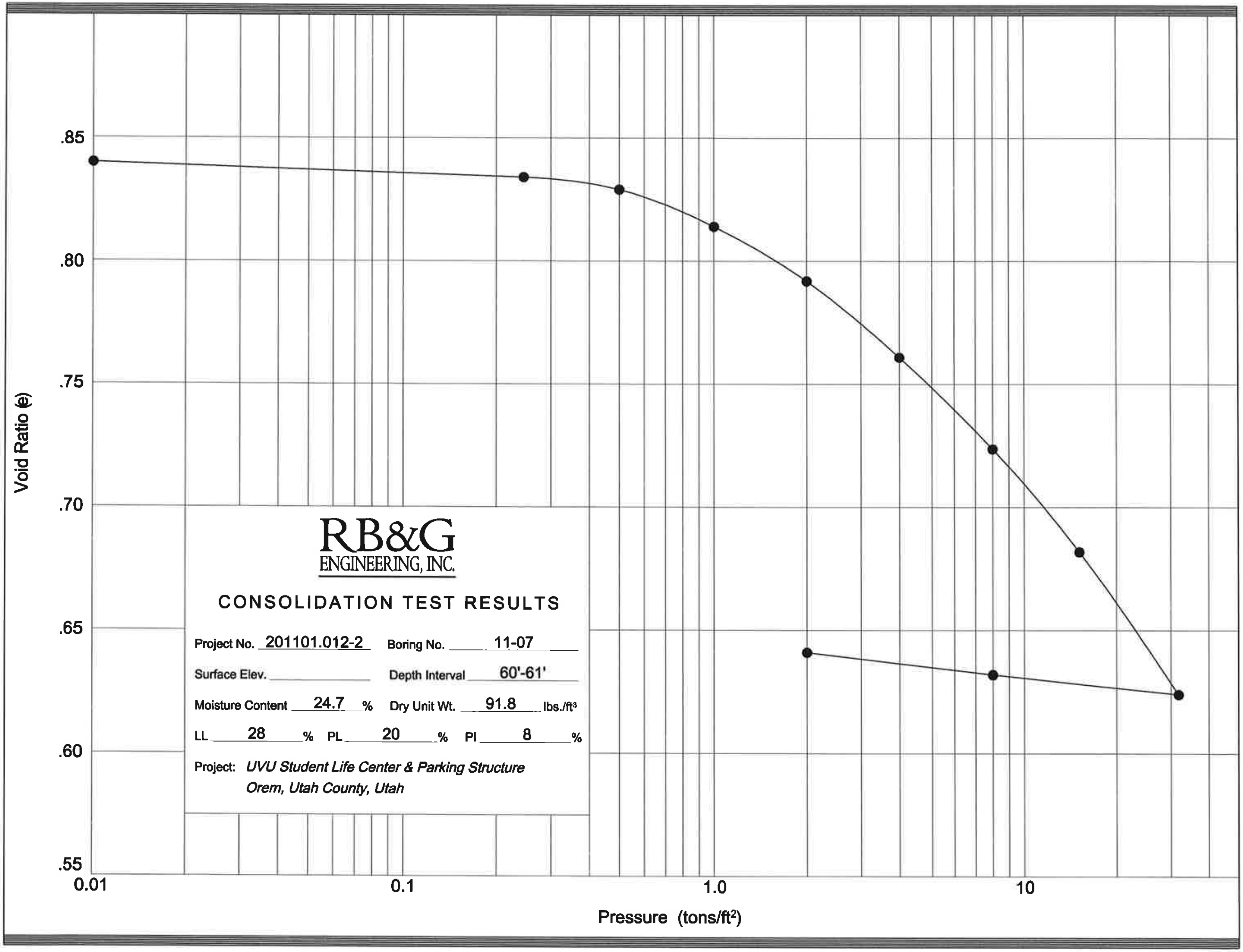

1.10
1.00
.90
.80
.70
.60
.50
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING, INC.
CONSOLIDATION TEST RESULTS
Project No. 201101.012
Boring No. 11-2
Surface Elev.
Depth Interval 40'-41.5'
Moisture Content 32.6 %
Dry Unit Wt. 82.4 lbs./ft³
LL 36 %
PL 21 %
PI 15 %
Project: UVU Student Life Center & Parking Structure
Orem, Utah


RB&G ENGINEERING, INC.
CONSOLIDATION TEST RESULTS
Project No. 201101.012
Boring No. 11-2
Surface Elev.
Depth Interval 50'-51.5'
Moisture Content 29.0 %
Dry Unit Wt. 85.9 lbs./ft³
LL 30 %
PL 20 %
PI 10 %
Project: UVU Student Life Center & Parking Structure
Orem, Utah
Void Ratio (e)
1.00
.95
.90
.85
.80
.75
.70
0.01
0.1
1.0
10
Pressure (tons/ft²)


RB&G
ENGINEERING, INC.
CONSOLIDATION TEST RESULTS
Project No. 201101.012
Boring No. 11-3
Surface Elev.
Depth Interval 30'-31.5'
Moisture Content 32.0 %
Dry Unit Wt. 87.6 lbs./ft³
LL 38 %
PL 23 %
PI 15 %
Project: UVU Student Life Center & Parking Structure
Orem, Utah
Void Ratio (e)
1.00
.90
.80
.70
.60
.50
.40
0.01
0.1
1.0
10
Pressure (tons/ft²)


1.10
1.00
.90
.80
.70
.60
.50
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING, INC.
CONSOLIDATION TEST RESULTS
Project No. 201101.012-2
Boring No. 11-05
Surface Elev.
Depth Interval 30'-31.5'
Moisture Content 33.6 %
Dry Unit Wt. 83.7 lbs./ft³
LL 36 %
PL 25 %
PI 11 %
Project: UVU Student Life Center & Parking Structure
Orem, Utah County, Utah


.70
.65
.60
.55
.50
.45
.40
Void Ratio (e)
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G
ENGINEERING, INC.
CONSOLIDATION TEST RESULTS
Project No. 201101.012-2
Boring No. 11-07
Surface Elev.
Depth Interval 40'-41.5'
Moisture Content 24.6 %
Dry Unit Wt. 101.2 lbs./ft³
LL 25 %
PL 23 %
PI 2 %
Project: UVU Student Life Center & Parking Structure
Orem, Utah County, Utah



RB&G ENGINEERING, INC.

CONSOLIDATION TEST RESULTS

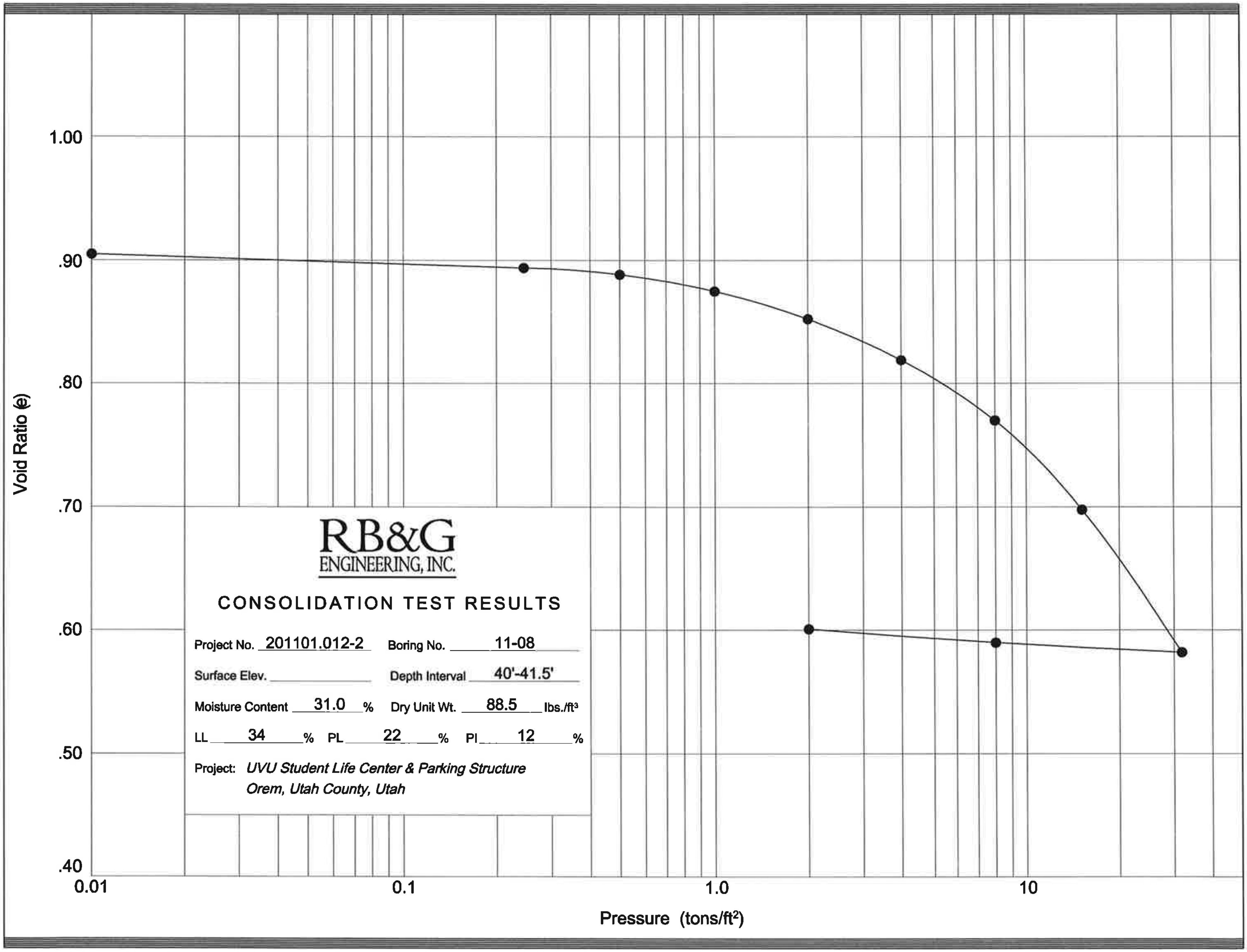
Project No. 201101.012-2 Boring No. 11-07

Surface Elev. ______ Depth Interval 60'-61'

Moisture Content 24.7 % Dry Unit Wt. 91.8 lbs./ft³

LL 28 % PL 20 % PI 8 %

Project: *UVU Student Life Center & Parking Structure*
Orem, Utah County, Utah



RB&G ENGINEERING, INC.

CONSOLIDATION TEST RESULTS

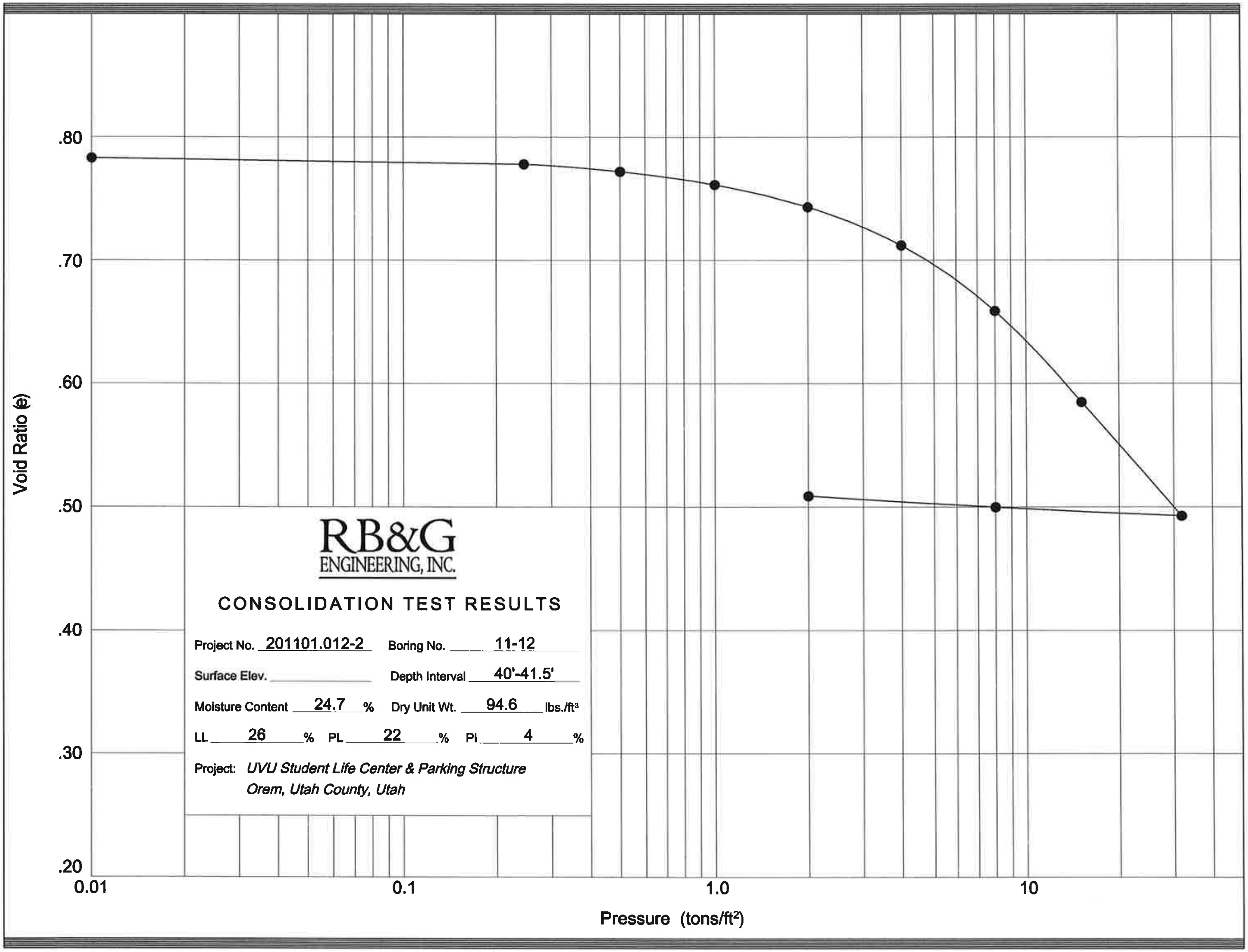
Project No. 201101.012-2 Boring No. 11-08

Surface Elev. ______ Depth Interval 40'-41.5'

Moisture Content 31.0 % Dry Unit Wt. 88.5 lbs./ft³

LL 34 % PL 22 % PI 12 %

Project: *UVU Student Life Center & Parking Structure*
Orem, Utah County, Utah



RB&G ENGINEERING, INC.

CONSOLIDATION TEST RESULTS

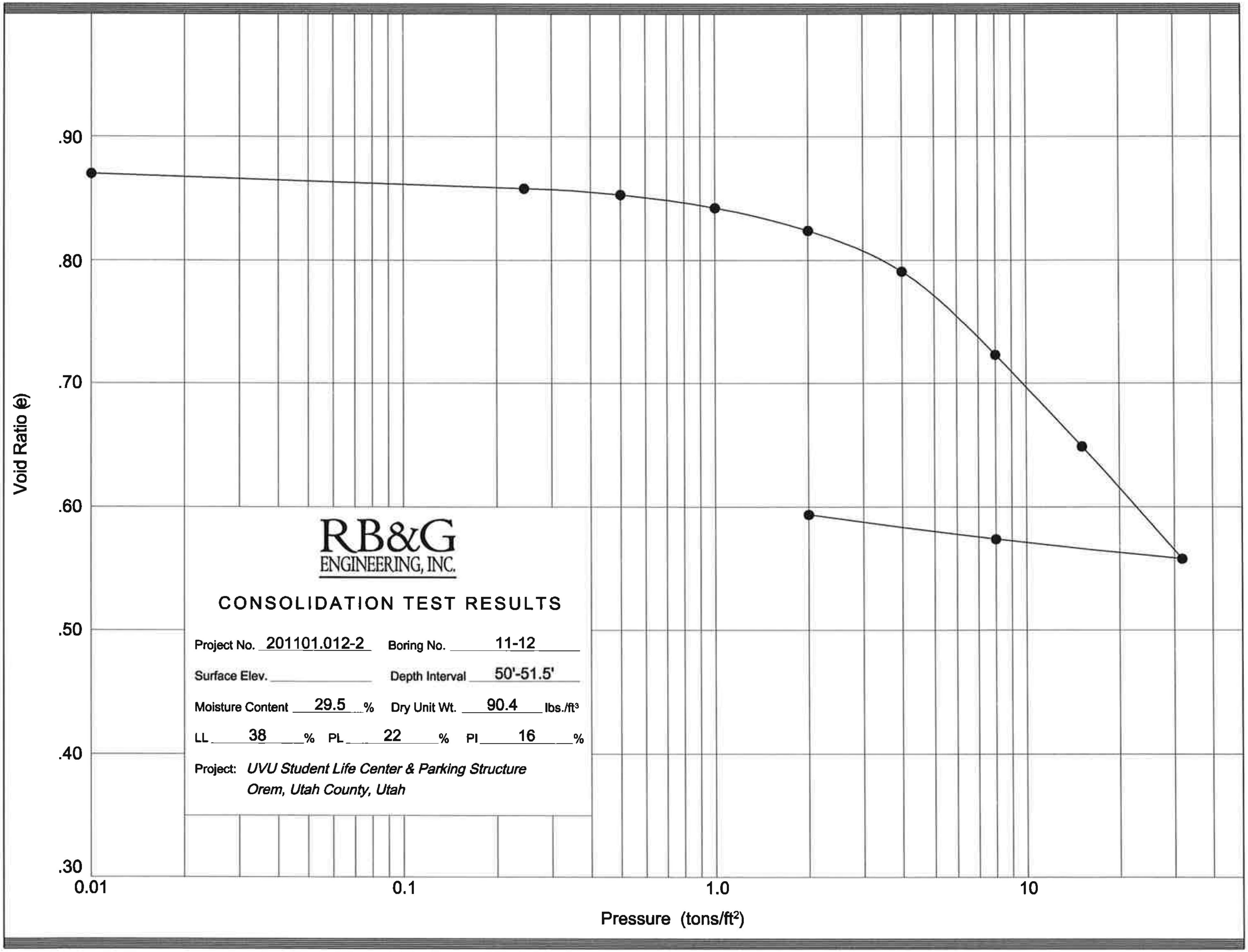
Project No. 201101.012-2 Boring No. 11-12

Surface Elev. ______ Depth Interval 40'-41.5'

Moisture Content 24.7 % Dry Unit Wt. 94.6 lbs./ft³

LL 26 % PL 22 % PI 4 %

Project: *UVU Student Life Center & Parking Structure*
Orem, Utah County, Utah



RB&G ENGINEERING, INC.

CONSOLIDATION TEST RESULTS

Project No. 201101.012-2 Boring No. 11-12

Surface Elev. ______ Depth Interval 50'-51.5'

Moisture Content 29.5 % Dry Unit Wt. 90.4 lbs./ft³

LL 38 % PL 22 % PI 16 %

Project: *UVU Student Life Center & Parking Structure*
Orem, Utah County, Utah

Table 1

SUMMARY OF TEST DATA

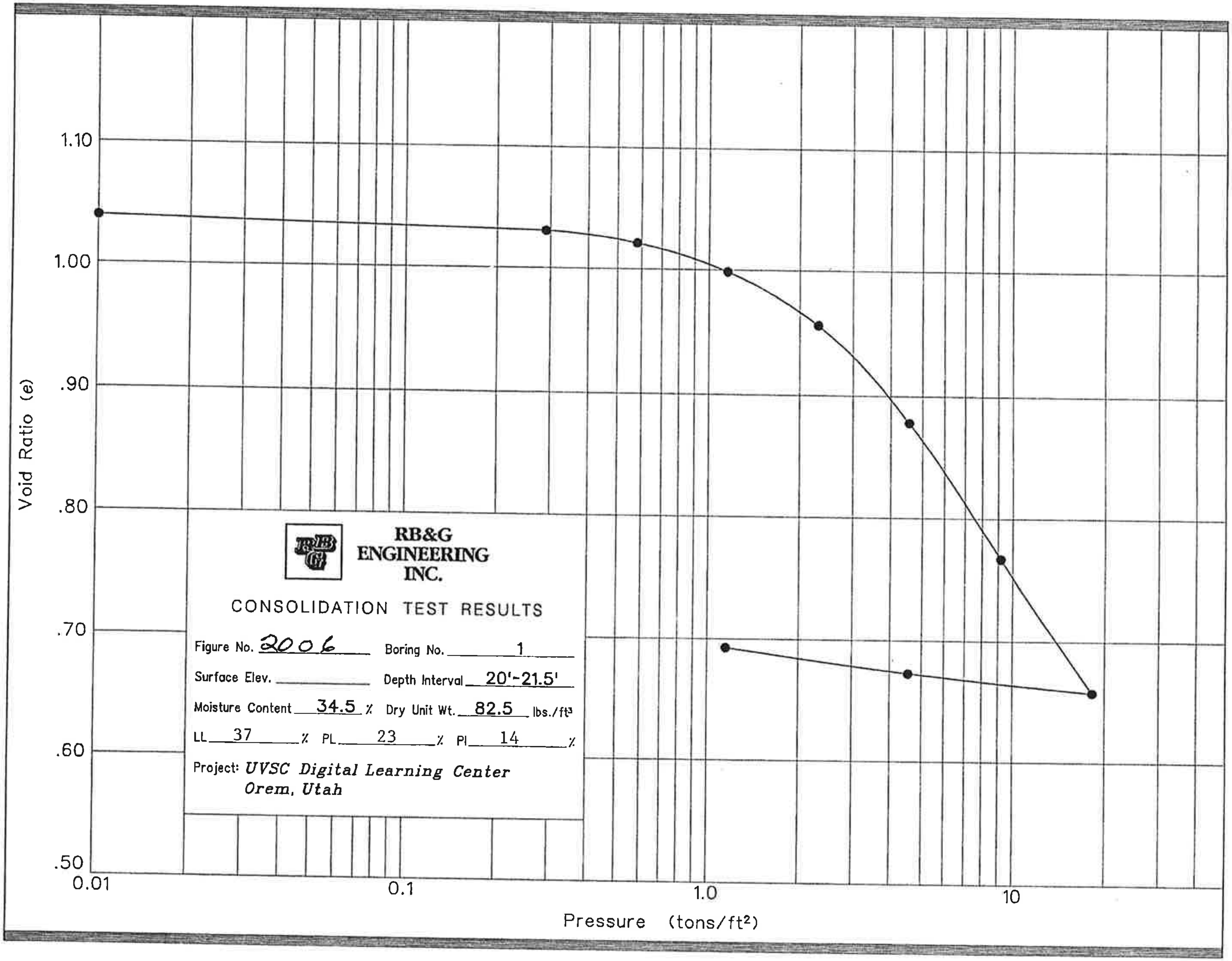
2006 BORING

PROJECT Utah Valley State College Digital Learning Center PROJECT NO. 200601-007
LOCATION Orem, Utah FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE		UNCONFINED COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
1	3-4.5	16		15.2					0	53	47	SM
	6-7.5	3		22.5					0	58	42	SM
	12-13.5	3		36.0				NP	0	46	54	ML
	20-21.5		82.5	34.5	*2160 / 665	37	23	14				CL
2	0.4-1.9	96		13.5					28	57	15	SM
	3-4.5	35		8.5					0	80	20	SM
	9-10.5	4		29.8					0	65	35	SM
	15-16.5	10		34.6				NP	0	29	71	ML
3	3-4.5	43		5.8					69	25	6	GP-GM
	7.5-9	11		18.6					0	78	22	SM
	15-16.5	3		31.5				NP	0	50	50	ML / SM
4	0.4-1.9	33				21	17	4				ML
	3-4.5	10		19.1				NP	0	42	58	ML
	6-7.5			26.6				NP	0	36	64	ML
	9-10.5		86.5	33.9		41	23	18				CL
	15-16.5			28.1	*2880 / 855	40	20	20				CL
5	0.5-2	67		11.5					25	51	24	SM
	6-7.5		103.1	23.0				NP	0	36	64	ML
	15-16.5		83.6	34.7	*2000 / 627	39	21	18				CL

NP=Nonplastic

*Torvane value used to estimate unconfined compressive strength.



Void Ratio (e)
1.10
1.00
.90
.80
.70
.60
.50
0.01
0.1
1.0
10
Pressure (tons/ft²)
RB&G ENGINEERING INC.
CONSOLIDATION TEST RESULTS
Figure No. 2006
Boring No. 1
Surface Elev.
Depth Interval 20'-21.5'
Moisture Content 34.5 %
Dry Unit Wt. 82.5 lbs./ft³
LL 37 %
PL 23 %
PI 14 %
Project: UVSC Digital Learning Center Orem, Utah

February 14, 2012

RB&G
ENGINEERING, INC.

Kurt Baxter
DFCM
4110 State Office Building
Salt Lake City, UT 84114

Re: UVU Student Life Center & Parking Structure
Final Geotechnical Investigation – Supplemental Letter

Dear Mr. Baxter:

We are providing this letter as a supplement to our Final Geotechnical Report for the UVU Student Life Center project. The final report is dated February 2012. This letter addresses various questions and requests brought to our attention by the structural designers of the project.

Topic 1: Allowable Bearing Capacity of Spread Footings on Improved Ground

Under heading 3 in Section IV.A, the geotechnical report states our opinion that installation of stone columns or aggregate piers through the liquefiable soils will improve the allowable bearing capacity for spread footings to values in the order of 4000 to 5000 psf. In December 2011, we sought and obtained preliminary ground improvement pricing information of the project from two geotechnical contractors. It should be recognized that the information provided by the contractors in December was based on an assumption that footings would be designed for an allowable bearing capacity of 4000 psf.

We believe that improving the allowable bearing capacity to 5000 psf is achievable and will be more cost-effective than enlarging the footings to accommodate a bearing capacity of 4000 psf. We therefore recommend that the foundations generally be designed using an allowable bearing capacity of 5000 psf (with the possible exception of very large footings, as discussed in the paragraph below). This requirement should be clearly stated on the foundation drawings and in the ground improvement specification.

For very large footings, the clay underlying the improved liquefiable soils will control the allowable bearing capacity. To ensure that the bearing capacity of the clay is not exeeded, we recommend that the allowable bearing capacity of any square footings larger than 12 x 12 ft be capped by the values shown in the table under heading 2 in Section IV.A. of the geotechnical report. Any rectangular footing larger than 10 x 40 feet should be evaluated on a case by case basis, as the clay underlying the improved ground will limit the allowable bearing capacity of such large footings to a value less than 5000 psf. We believe that these limitations for large footings will be more cost-effective than extending the ground improvement deeper in an attempt to improve the bearing capacity of the clay.

Topic 2: Seismic Bearing Capacity of Spread Footings

As stated in Section IV.B of the geotechnical report, the allowable bearing capacity can be increased by one third for loads that include seismic forces. We recommend that the required seismic bearing capacity be stated on the foundation drawings and in the ground improvement specification.

Topic 3: Ground Improvement Requirements Shown on the Plans

The recommended ground improvement area ratio of 14 percent for the floor slab areas can be achieved using 3-foot diameter stone columns or aggregate piers on an equilateral triangular pattern with center-to-center spacing of 7.6 feet, or a square grid with center-to-center spacing of 7.1 feet. One of these layouts could be depicted on the plans for illustrative purposes; however, it should be clearly stated that the contractor may use larger or smaller column diameters at different spacing to achieve the required area ratio

The ground improvement contractor will also be required to provide closer spacing if necessary under footings to achieve the specified allowable bearing capacity. As stated in the geotechnical report, the ground improvement area for each footing should include the footing footprint plus a horizontal distance of 0.70Z on all sides, where Z is the depth from the bottom of the footing to the bottom of the ground improvement. We anticipated that the ground improvement depth will often be in the range of 14 to 17 feet below the footings in the main building area. Therefore, footing ground improvement areas including the footing plus a horizontal distance of at least 12 feet on all sides can be shown on the plans for the main building area. For footings supporting the westerly leg of the building the improvement depth is somewhat deeper, and we recommend that the ground improvement areas include each footing footprint plus a horizontal distance of at least 15 feet on all sides.

Topic 4: Refined Drilled Shaft Capacities

The estimated drilled shaft capacities in the final geotechnical report are generalized for the project site. Site-specific capacity and settlement information based on Borings 11-4, 11-5, and 11-16 is attached for use at the interface between the new structure and the existing Sorenson Building. Site-specific capacity and settlement information based on Borings 11-11 and 11-12 is also attached for use at the interface between the new structure and the existing PE Building. This information has been provided previously by email to the structure designers.

Topic 5: Closely-Spaced Drilled Shafts

During initial design of drilled shaft foundations at interfaces with existing buildings, we were informed that lateral clearance and footing size constraints resulted in shaft spacing closer than recommended in the draft geotechnical report. This issue was addressed in part by including estimated capacities for smaller-diameter shafts in the information described under Topic 4 above. We also provided a brief summary of shaft spacing and group effect guidelines that is attached to this letter for reference.

Topic 6: Micropiles

To further address lateral clearance and spacing issues for drilled shafts located at interfaces with existing buildings, we suggested that drilled micropiles be considered to support footings at these interfaces. Recommendations for design of micropiles are provided below.

- At the interface with the existing Sorenson Building, the estimated micropile toe elevation is 4540 feet, approximately 63 feet below the anticipated building floor elevation.
    - The estimated ultimate geotechnical capacity for axial compression loading is 144 kips for a 10-inch diameter micropile, and 173 kips for a 12-inch diameter micropile.
- At the interface with the existing PE building, the estimated micropile toe elevation is 4534 feet, which is about 69 feet below the anticipated building floor elevation.
    - The estimated ultimate geotechnical capacity for axial compression loading is 165 kips for a 10-inch diameter micropile, and 198 kips for a 12-inch diameter micropile.
- The ultimate resistance estimates above neglect resistance above and within the liquefiable soils.
- The allowable resistance for the various load cases may be estimated by dividing the ultimate resistance by 2.5 for static compression, 3.0 for static uplift, 1.0 for seismic compression, and 1.5 for seismic uplift.
- Micropile capacities and load-displacement relationships should be verified by load testing.
    - For preliminary evaluations of micropile axial stiffness, we estimate that the vertical displacement of the pile relative to the soil will be in the order of 0.1 inch when loaded at 40% of the ultimate capacity, and approximately 0.4 inch when loaded at 80% of the ultimate capacity. These estimates apply only to the

movement of the grouted pile body relative to the adjacent soil, and do not account for compression of the micropile itself.

- Battered micropiles should extend to the same toe elevations as vertical micropiles.
    - Geotechnical capacities of battered micropiles for axial compression and tension may be assumed to be the same as for vertical piles for foundation design purposes.
- Micropile design should account for the presence of liquefiable soils above the clay.
    - Micropile design should consider the use of casing or sleeves above the clay to increase the pile stiffness and/or to make the pile independent of the soil within and above this zone.
    - Settlements of the liquefiable silt and sand and overlying layers may have severe impacts upon the seismic performance of battered micropiles, and must be considered in design.

If there are any questions regarding the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

PROFESSIONAL ENGINEER S. ROBERT JOHNSON No. 5148753 2/14/12 STATE OF UTAH

S. Robert Johnson, P.E.
bep/jal

Bradford E. Price, P.E.

REGISTERED PROFESSIONAL ENGINEER NO.162291 BRADFORD E. PRICE 2/14/12 STATE OF UTAH

cc: Garth Shaw, GSBS Architects
Ron Reaveley, Reaveley Engineers & Associates

Summary of Drilled Shaft Estimated Geotechnical Capacities

Utah Valley University - New Student Life Center

<u>These apply only at the south end of the building near Borings 11-4, 11-5, and 11-16</u>

Shafts should be drilled with casing and must extend at least 10 feet into the deep sand layer.
Estimated drilled shaft toe elevation is 4540 ft, approximately 63 feet anticipated building floor elevation.
Factor of Safety for Allowable Geotechnical Compression Capacity is 2.5
Factors of Safety for Uplift Capacities are 1.5 for Seismic and 3.0 for Static

Drilled Shaft Diameter [in]	Estimated Geotechnical Axial Compression Capacities									Uplift Capacities	
	Ultimate (Nominal) Capacities			Seismic (Liquefied) Capacities			Allowable (Working) Capacities			Seismic (Liquefied) [kip]	Static (Working) [kip]
	Side [kip]	Toe [kip]	Total [kip]	Side [kip]	Toe [kip]	Total [kip]	Side [kip]	Toe [kip]	Total [kip]		
24	182	124	306	146	124	271	73	50	122	97	61
30	220	194	415	176	194	371	88	78	166	118	73
36	256	280	536	204	280	484	102	112	214	136	85
42	289	381	670	230	381	611	116	152	268	153	96
48	319	498	817	252	498	750	128	199	327	168	106
60	371	778	1149	290	778	1068	149	311	460	194	124

Estimated Drilled Shaft Settlement Behavior Under Axial Loading:

These are estimates only of the shaft settlement relative to the adjacent soil. Compression of the shaft itself is not included.

Load	Deflection
0.1	0.2
0.2	0.4
0.3	0.6
0.4	0.8
0.5	1.1
0.6	1.5
0.7	2.0
0.8	2.6
0.9	3.7
1.0	5.3

In table at left:

1. Loads are normalized by dividing the actual load by the maximum capacity (Ultimate Capacity for static case, Seismic Capacity for seismic case).
2. Deflections are normalized as percentages of the shaft diameter.

<u>Static Example for 36-inch diameter shaft:</u>

- Shaft has ultimate capacity of 536 kips (from table above).
- If loaded to the allowable capacity of 214 kips (from table above), the ratio of load to ultimate capacity is 214/536 = 0.4.
- From table at left, the estimated vertical deflection is 0.8% of the shaft diameter, or approximately 0.3 inch.

<u>Seismic Example for 36-inch diameter shaft:</u>

- Shaft has seismic capacity of 484 kips (from table above).
- If loaded to 387 kips, the ratio of load to seismic capacity is approximately 0.8.
- From table at left, the estimated vertical deflection is 2.6% of the shaft diameter, or approximately 0.9 inch.

Summary of Drilled Shaft Estimated Geotechnical Capacities

Utah Valley University - New Student Life Center

<u>These apply only at the west end of the building near Borings 11-11 and 11-12</u>

Shafts should be drilled with casing and must extend at least 10 feet into the deep sand layer.
Estimated drilled shaft toe elevation is 4534 ft, approximately 68 feet below existing ground surface.
Factor of Safety for Allowable Geotechnical Compression Capacity is 2.5
Factors of Safety for Uplift Capacities are 1.5 for Seismic and 3.0 for Static

Drilled Shaft Diameter [in]	Estimated Geotechnical Axial Compression Capacities									Uplift Capacities	
	Ultimate (Nominal) Capacities			Seismic (Liquefied) Capacities			Allowable (Working) Capacities			Seismic (Liquefied) [kip]	Static (Working) [kip]
	Side [kip]	Toe [kip]	Total [kip]	Side [kip]	Toe [kip]	Total [kip]	Side [kip]	Toe [kip]	Total [kip]		
24	302	151	453	208	151	359	121	60	181	139	101
30	369	236	605	252	236	488	148	94	242	168	123
36	433	339	772	293	339	633	173	136	309	196	144
42	494	462	955	332	462	793	197	185	382	221	165
48	603	603	1206	419	603	1022	241	241	482	279	201
60	721	942	1663	493	942	1436	288	377	665	329	240

Estimated Drilled Shaft Settlement Behavior Under Axial Loading:

These are estimates only of the shaft settlement relative to the adjacent soil. Compression of the shaft itself is not included.

Load	Deflection
0.1	0.2
0.2	0.4
0.3	0.6
0.4	0.9
0.5	1.2
0.6	1.6
0.7	2.1
0.8	2.7
0.9	3.8
1.0	5.2

In table at left:

1. Loads are normalized by dividing the actual load by the maximum capacity (Ultimate Capacity for static case, Seismic Capacity for seismic case).
2. Deflections are normalized as percentages of the shaft diameter.

<u>Static Example for 36-inch diameter shaft:</u>

- Shaft has ultimate capacity of 772 kips (from table above).
- If loaded to the allowable capacity of 309 kips (from table above), the ratio of load to ultimate capacity is 309/772 = 0.4.
- From table at left, the estimated vertical deflection is 0.9% of the shaft diameter, or approximately 0.3 inch.

<u>Seismic Example for 36-inch diameter shaft:</u>

- Shaft has seismic capacity of 633 kips (from table above).
- If loaded to 500 kips, the ratio of load to seismic capacity is approximately 0.8.
- From table at left, the estimated vertical deflection is 2.7% of the shaft diameter, or approximately 1.0 inch.

Drilled Shaft Group Effects for Axial Capacity

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- FHWA Drilled shaft manual recommends that center-to-center spacing never be closer than

2B + 0.04D + 0.5 ft.

This recommendation ensures a minimum clear distance of 1B will exist between the bottoms of two adjacent shafts if each are placed up to 3 inches from the specified location and up to 2% out of plumb.

- From AASHTO LRFD Bridge Design Specifications (5th Edition, 2010):

"In addition to the overlap effects discussed below, drilling of a hole for a shaft less than three shaft diameters from an exisiting shaft reduces the effective stresses against both the side and base of the existing shaft. As a result, the capacities of the individual drilled shafts within a group tend to be less than the corresponding capacities of isolated shafts.

"If casing is advanced in front of the excavation heading, this reduction need not be made."

- Typical requirement of AASHTO/DOT design specs is to use a minimum center-to-center spacing of 2.5B between shafts. If shafts are in cohesionless soils (our shaft side resistance is about 50% or more from cohesionless soils, and our toe resistance is 100% from cohesionless soils) AASHTO/DOT specs recommend an efficiency factor of 0.65 at 2.5B spacing and a factor of 1.0 at 4B spacing, with the efficiency factor interpolated between these two points for intermediate spacings.
- If the drilled shaft specification requires that the casing always be within 5 ft of the bottom of the excavation, it might be reasonable to increase the efficiency factor to 0.80 at 2.5B spacing.