GSH

June 27, 2013
Job No. 1104-002-13

Mr. Dave Helm
% Peterson Engineering
7107 South 400 West #1
Midvale, Utah 84047

Mr. Helm:

Re: Addendum Letter
Green Haven Subdivision
Between 11800 & 11911 South 1985 & 2160 West
Riverton, Utah
(40.5350 N; -111.9446 W)

As requested, this letter clarifies the pavement subgrade preparation recommendations contained in our recent geotechnical study dated June 17, 2013[1] performed for the proposed Green Haven Subdivision to be located between approximately 11800 and 11911 South, 1985 and 2160 West in Riverton, Utah. In our report we recommended that the flexible pavement section consist of 3 inches of asphalt concrete and 8 inches of aggregate base course placed on properly prepared disturbed and/or natural subgrade soils and/or structural site grading fill extending to properly prepared disturbed and/or natural subgrade soils. The "properly prepared" subgrade soils (consisting of disturbed or undisturbed natural soils) consists of scarifying the upper 10 to 12 inches of the exposed subgrade (after stripping) and recompacting. The recompacted subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered during proofrolling, they must be removed (to a maximum depth of 2 feet) and replaced with structural fill as described in our report. After proofrolling is completed, the pavement materials may be placed and compacted.

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[1] "Report, Geotechnical Study, Green Haven Subdivision, Between 11800 & 11911 South 1985 & 2160 West, Riverton, Utah", GSH Job No. 1104-002-13.

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If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

Respectfully submitted,

GSH Geotechnical, Inc.

William G. Turner, P.E.
State of Utah No. 171715
Senior Geotechnical Engineer

WGT:jlh

Addressee (email)

GSH

REPORT
GEOTECHNICAL STUDY
GREEN HAVEN SUBDIVISION
BETWEEN 11800 & 11911 SOUTH 1985 & 2160 WEST
RIVERTON, UTAH
(40.5350 N; -111.9446 W)

Submitted To:

Mr. Dave Helm
c/o Peterson Engineering
7107 South 400 West #1
Midvale, Utah 84047

Submitted By:

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123

June 17, 2013

Job No. 1104-002-13

GSH

June 17, 2013
Job No. 1104-002-13

Mr. Dave Helm
c/o Peterson Engineering
7107 South 400 West #1
Midvale, Utah 84047

Mr. Helm:

Re: Report
Geotechnical Study
Green Haven Subdivision
Between 11800 & 11911 South 1985 & 2160 West
Riverton, Utah
(40.5350 N; -111.9446 W)

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed for the proposed Green Haven Subdivision to be located at approximately between 11800 and 11911 South, 1985 and 2160 West in Riverton, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1999, is presented on Figure 1, Vicinity Map. A more detailed layout of the site showing the proposed locations of lots and existing facilities is presented on Figure 2, Site Plan. The locations of the test pits excavated in conjunction with this study are also presented on Figure 2.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. David Peterson with Peterson Engineering, and Mr. Bryan Roberts of GSH Geotechnical Consultants, Inc. (GSH).

In general, the objectives of this study were to:

1. Accurately define and evaluate the subsurface soil and groundwater conditions across the site.

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2. Provide appropriate foundation, earthwork, subdrain, and pavement recommendations to be utilized in the design and construction of the proposed development or structure.

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

1. A field program consisting of the excavation/drilling, logging, and sampling of 8 test pits.

2. A laboratory testing program.

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

1.3 AUTHORIZATION

Authorization was provided via our Professional Services Agreement No. 13-0531 dated May 22, 2013.

1.4 PROFESSIONAL STATEMENTS

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

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

2. PROPOSED CONSTRUCTION

The proposed construction consists of constructing single family residences on about 22 lots for the 11.45 acre site. Site development will require a minimal to moderate amount of earthwork in the form of site grading. We estimate that maximum cuts and fills to achieve design grades will be less than 2 to 5 feet.

Paved streets will also be a part of the overall development. Traffic over the roadway will consist of a moderate volume of automobiles and light trucks and a light volume of medium- and heavy-weight trucks.

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3. INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 8 test pits were explored to a depth of about 16 feet below existing grade. The test pits were excavated using a rubber tire-mounted backhoe. Locations of the test pits are presented on Figure 2.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the excavation operations, a continuous log of the subsurface conditions encountered was maintained. In addition, relatively undisturbed and small disturbed samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3H, Test Pit Log. Soils were classified in accordance with the nomenclature described on Figure 4, Key to Test Pit Log (USCS).

Samples representative of the soil layers encountered were obtained and placed in sealable bags and plastic containers. Following completion of excavating and logging, each test pit was backfilled. Although an effort was made to compact the backfill with the backhoe, backfill was not placed in uniform lifts and compacted to a specific density. Consequently, settlement of the backfill with time is likely to occur.

3.2 LABORATORY TESTING

3.2.1 General

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

3.2.2 Moisture and Density Tests

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

3.2.3 Partial Gradation Tests

To aid in classifying the soils and to provide general index parameters, partial gradation tests were performed upon representative samples of the soils encountered in the exploration borings. The results of the tests are tabulated below:

	Percent Passing	
Sieve Size	**TP-1 @ 10 ft**	**TP-4 @ 9.5 ft**
No. 200	33	11
Soils Classification	SM	SP-SM

3.2.4 Chemical Tests

To determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the silty clay soils encountered in Test Pit 4 at a depth of 5 feet below existing grade. The results of the chemical tests are tabulated below:

Test Pit No.	Depth (feet)	Soil Classification	pH	Total Water Soluble Sulfate (ppm)
TP-4	5	CL	8.03	81

3.2.5 Consolidation Test

To provide data necessary for our settlement analyses, consolidation tests were performed on representative samples of the silty clay soils encountered at the site. The data obtained from this test was used to calculate foundation movements which could occur on the anticipated foundation loadings. Based upon data obtained from the consolidation test, the silty clay soils within the upper 4 to 5 feet exhibit a potential for hydro-collapse. The silty clay soils below a depth of 5 feet do not exhibit such collapse potential, but exhibit moderate compressibility characteristics under the anticipated loadings. Detailed results of the tests are maintained within our files and can be transmitted to you, at your request.

4. SITE CONDITIONS

4.1 SURFACE

The site is located primarily on land that has been used for agriculture and pasture in the past. Access to the lots in the subdivision development will be provided via a street extending eastward from 2160 West Street and a cul-de-sac extending northward from that street. The

topography of the site is relatively flat, with a slight downward slope toward the east. The site is bordered on the north, east, and south by existing residences, and on the west by 2160 West Street.

4.2 SUBSURFACE SOIL AND GROUNDWATER

The soil conditions encountered in the test pits, to the depths penetrated, consisted of up to 6 inches of topsoil overlying natural layers of silty clay, silty fine sand, and fine to coarse sandy gravel soils extending to the maximum depth explored of about 16 feet below the existing ground surface. The silty clay soils typically contained some fine sand, were slightly moist to very moist, medium stiff to stiff (estimated), brown in color, and are anticipated to exhibit moderate strength and moderate compressibility characteristics under the anticipated loading range. The silty sand soils generally contained trace gravel, were slightly moist to moist, medium dense (estimated), brown in color, and are anticipated to exhibit moderate to high strength and low compressibility characteristics under the anticipated loading range. The sandy gravel soils generally contained some silt fines, were slightly moist to moist, medium dense, brown in color, and are anticipated to exhibit moderately high strength and low compressibility characteristics under the anticipated loading range.

The lines designating the interface between soil types on the boring logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

Groundwater was not encountered in the test pits during the field exploration, but oxidation mottling, a visual indicator of possible water levels in the past, were observed at various depths. Seasonal and longer-term groundwater fluctuations on the order of 1 to 2 feet are projected, with the highest seasonal levels generally occurring during the late spring and early summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The proposed residences may be supported upon conventional spread and continuous wall foundations placed on suitable natural soils and/or structural fill extending to suitable natural soils.

The most significant geotechnical aspect of the site is the presence of hydro-collapsible silty clay soils (will settle upon wetting) within the upper 4 to 5 feet. It is recommended that footings not be placed directly on these soils. GSH must be contacted to observe that any problematic soils have been removed prior to footing construction.

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

5.2 EARTHWORK

5.2.1 Site Preparation

Following demolition of any existing surface structures, removal of all surface vegetation, topsoil, root bulbs, sod, rubbish, construction debris, non-engineered fill, and any other deleterious materials from areas which will ultimately be structurally loaded, can take place. We estimate that approximately 3 inches of stripping will be necessary to remove major roots, vegetation, and organics. Vegetation and other deleterious materials should be removed from the site. Stripped topsoil will be unsuitable for structural fill but may be stockpiled for subsequent landscaping purposes.

The upper approximately 12 to 18 inches of surficial soils, including topsoil, may have been disturbed as a result of past agricultural activities and weathering. These soils must be completely removed from all foundation areas, but if properly prepared and if the topsoil portion is excluded, may be allowed to remain in pavement areas.

Subsequent to stripping and prior to the placement of floor slabs, structural site grading fill and pavements, the exposed subgrade (consisting of disturbed or undisturbed natural soils) must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed to a maximum depth of 2 feet and replaced with structural fill.

Following the above operations, pavements or structural site grading fill may be placed in areas of the proposed structures. Footings must not be placed on topsoil, vegetation, non-engineered fill, and natural silty clay soils within the upper 5 feet.

5.2.2 Excavations

Temporary construction excavations not exceeding 4 feet in depth and not encountering the groundwater table may be constructed with near-vertical sideslopes. If cohesive soils and groundwater are encountered, near-vertical sideslopes may still be used. If granular soils are encountered below the water table, very flat sideslopes will be required.

Deeper excavations not exceeding 10 to 12 feet in depth will require flatter sideslopes, shoring and bracing, and/or dewatering if necessary. Some sloughing of the sandy and gravelly soils on the sides of the excavations is anticipated.

To minimize disturbance to the underlying soils, it is our recommendation that footings be excavated with a backhoe equipped with a smooth-lip bucket.

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

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5.2.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and in some areas, replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. For structural site grading fill, the maximum particle size should generally not exceed 4 inches; although, occasional larger particles, not exceeding 8 inches in diameter may be incorporated if placed randomly in a manner such that "honeycombing" does not occur and the desired degree of compaction can be achieved. The maximum particle size within structural fill placed within confined areas should generally be restricted to 2 inches.

The on-site soils may be utilized as structural site grading fill. However, it should be noted that unless moisture control is maintained, utilization of the natural on-site silty clay soils as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year. Only granular soils are recommended as structural fill in confined areas, such as around foundations and within utility trenches.

Although not anticipated at this site, to stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or 1.5- to 2.0-inch gravel (stabilizing fill) should be utilized.

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

5.2.4 Fill Placement and Compaction

Coarse gravel and cobble mixtures (stabilizing fill) if utilized, should be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent fill material placed over the coarse gravels and cobbles should be adequately compacted so that the "fines" are "worked into" the voids in the underlying coarser gravels and cobbles.

All structural fill shall be placed in lifts not exceeding 8 inches in loose thickness. Structural fills shall be compacted in accordance with the percent of the maximum dry density as determined by the ASTM[1] D-1557 (AASHTO[2] T-180) compaction criteria in accordance with the table on the following page.

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

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 8	95
Outside area defined above	0 to 5	90
Outside area defined above	5 to 8	95

Structural fills greater than 8 feet thick are not anticipated at the site.

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

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

5.2.5 Utility Trenches

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

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

The natural fine-grained silty clay soils are not recommended for use as trench backfill.

5.2.6 Areal Settlements

Areal settlements resulting from site grading fills as much as 5.0 feet should be less than 0.5 inch. These settlements are in addition to settlements induced by foundation and floor slab loads. To reduce the total settlement that the structure will realize, site grading fill must be placed as far in advance of other construction as possible. The majority of this settlement will occur during placement.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed residential structures may be supported upon conventional spread and continuous wall foundations place on suitable natural soils or structural fill extending to suitable natural soils. In order to control total and differential settlements, we recommend that all footings extend at least 5 feet below existing grade or be underlain by compacted granular structural fill extending to suitable natural soils (approximately 5' below grade). If used, structural fill should extend to suitable natural soils and should not be underlain by sod, rubbish, topsoil, non-engineered fill, disturbed soil, or other unsatisfactory materials. For design, the following recommended parameters are provided:

Minimum Depth of Embedment for Frost Protection	- 30 inches
Minimum Depth of Embedment for Non-frost Conditions	- 15 inches
Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Width for Isolated Spread Footings	- 24 inches
Net Bearing Pressure for Real Load Conditions	- 2,000 pounds per square foot*
Bearing Pressure Increase for Seismic Loading	- 50 percent

* This assumes that all footings will be placed at least 5 feet below existing grade on natural granular soils or on granular structural fill that extends to a minimum 5 feet below existing grade.

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

5.3.2 Installation

Under no circumstances should the footings be installed directly on soils within the upper 5 feet, or upon soft or disturbed soils, construction debris, frozen soil, or within ponded water.

If the natural soils upon which the footings are to be established become loose or disturbed, they must be removed and replaced with granular structural fill. If the natural granular soils or granular structural fill upon which the footings are to be established become disturbed, they should be recompacted to the requirements for structural fill or be removed and replaced with structural fill.

The width of structural replacement fill, as required below footings, should be extended laterally at least 6 inches beyond the edges of the footings in all directions for each foot of fill thickness beneath the footings. For example, if the width of the footing is 2 feet and the thickness of the structural fill beneath the footing is 1 foot, the width of the structural fill at the base of the footing excavation would be a total of 3 feet, centered below the footing.

5.3.3 Settlements

Maximum settlements of foundations designed and installed in accordance with recommendations presented herein and supporting maximum anticipated loads as discussed in Section 2, Proposed Construction, are anticipated to be on the order of 0.5 to 0.75 inch.

Approximately 50 percent of the quoted settlement should occur during construction.

5.4 LATERAL RESISTANCE

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

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

5.5 LATERAL PRESSURES

The lateral pressure parameters as presented within this section, assume that the backfill will consist of a drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For

active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid basement walls that are not more than 10 inches thick and 12 feet or less in height, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid non-yielding walls, granular backfill should be considered equivalent to a fluid with a density of at least 60 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal, that the granular fill has been placed and lightly compacted, not as a structural fill. If the fill is placed as a structural fill, the values should be increased to 45 pounds per cubic foot, 60 pounds per cubic foot, and 120 pounds per cubic foot, respectively. If the slope behind the wall is two horizontal to one vertical the values for purely active walls and basement walls should increase to 57 pounds per cubic foot and 67 pounds per cubic foot, respectively.

For seismic loading, a uniform pressure of 150 pounds per square foot should be added.

5.6 FLOOR SLABS

Floor slabs may be established upon properly prepared existing soils at least 2 feet below the existing ground surface, on suitable undisturbed natural soils at least 5 feet below the existing ground surface, and/or upon structural fill extending to a minimum 5 feet below the existing ground surface. Topsoil is not considered suitable. Properly prepared existing soils consist of scarifying at least 10 inches below the excavation bottom, compacting the soils until firm, and proofrolling as described above in Section 5.2.1. To provide a capillary break, it is recommended that floor slabs be directly underlain by at least 4 inches of "free-draining" fill, such as "pea" gravel or 0.75- to 1.0-inch minus clean gap-graded gravel. Settlements of lightly to moderately loaded floor slabs are anticipated to be minor.

5.7 PAVEMENTS

The natural near-surface silty clay soils are anticipated to exhibit poor to fair pavement support characteristics when saturated or nearly saturated. Considering the natural silty clays as the design subgrade soils and given the projected traffic conditions, the following pavement sections are recommended:

Flexible Pavements:
(Asphalt Concrete)
(Moderate Volume of Automobiles and Light Trucks
with Occasional Medium and Heavy Trucks)
[3 equivalent 18-kip axle loads per day]

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

fill extending to properly prepared disturbed and/or natural subgrade soils

Utilization of a filter fabric, such as Mirafi 500X or equivalent, over soft subgrade may also be advantageous.

Asphalt concrete and base course components should meet the requirements and be placed in accordance with Riverton City specifications.

5.8 GEOSEISMIC SETTING

5.8.1 General

Utah municipalities have adopted the International Building Code (IBC) and International Residential Code (IRC) for One- to Two-Family Dwellings 2009. The IRC 2009 code refers to the IBC 2009 code, which determines the seismic hazard for a site based upon 2002 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2009 edition.

5.8.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The site is located outside fault investigation zones identified by Salt Lake County. The nearest active fault is the Salt Lake Segment of the Wasatch Fault, located nearly 6 miles east-southeast of the site. The Wasatch Fault Zone is considered capable of generating earthquakes as large as magnitude 7.3[3].

5.8.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Table 1613.5.2, Site Class Definitions, of the IBC 2009 can be utilized.

5.8.4 Ground Motions

The IRC 2009 code is based on 2002 USGS mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake

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

(MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. Accordingly, based on the site latitude and longitude (40.5350 degrees north and 111.9446 degrees west, respectively), the ground motion values for this site are a Short Period Map Value (S_S) of 1.20g, a Residential Site Value (S_{DS}) of 0.82g, and a Residential Seismic Design Category of D_1.

5.8.5 Liquefaction

The site is located in an area that has been identified by Salt Lake County as having "very low" liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event.

Saturated sand soils were not encountered at the site, thus we concur with the very low liquefaction potential designation.

5.9 SITE OBSERVATIONS

As previously mentioned, we recommend that a qualified geotechnical engineer observe the foundation excavations and identify that suitable soils have been encountered.

GSH

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

Respectfully submitted,

GSH Geotechnical, Inc.

William G. Turner, P.E.
State of Utah No. 171715
Senior Geotechnical Engineer

Reviewed by:

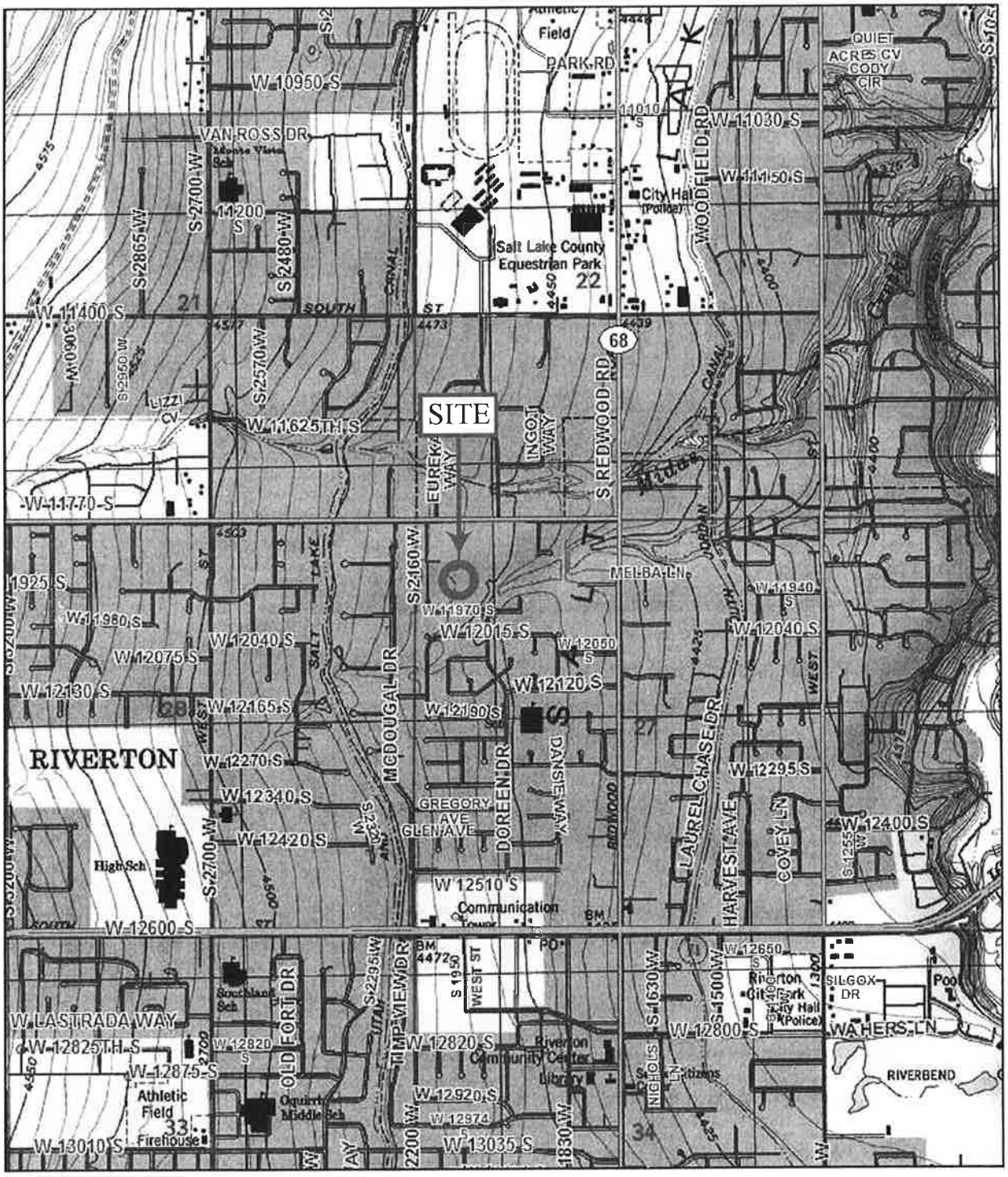
Alan D. Spilker, P.E.
State of Utah No. 334228
President/Senior Geotechnical Engineer

WGT/ADS:lb

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3H, Test Pit Log
Figure 4, Key to Test Pit Log (USCS)

Addressee (3 + email)

DAVE HELM
JOB NO. 1104-002-13



SCALE IN FEET
1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP(S)
ENTITLED "MIDVALE, UTAH" DATED 1999

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DAVE HELM
JOB NO. 1104-002-13

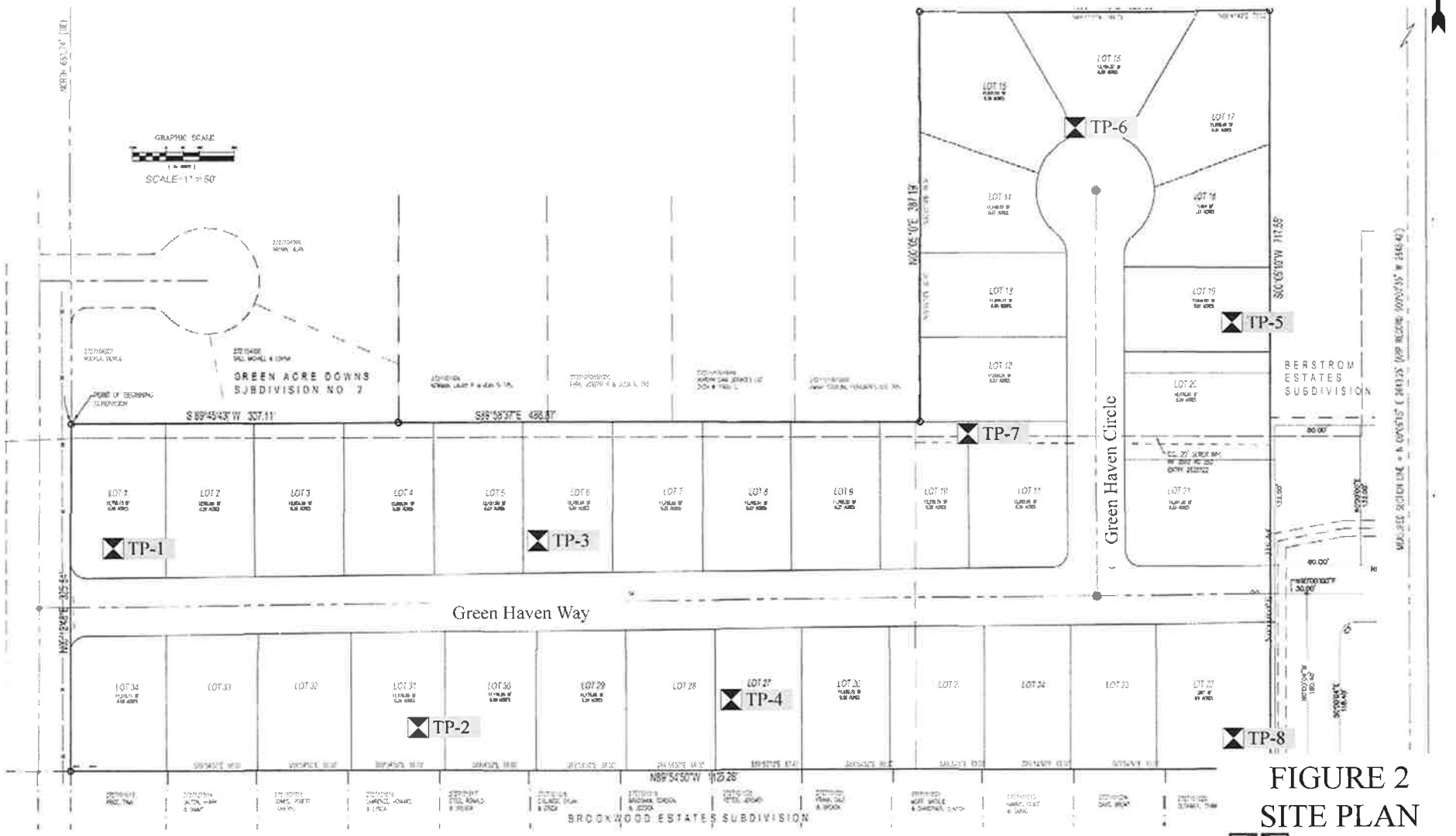

FIGURE 2
SITE PLAN

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REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"GREEN HAVEN SUBDIVISION" BY PETERSON ENGINEERING, P.C., NOT DATED

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TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-1

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West. Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
		6" MUCKY HORSE AREA, LOOSE								
	CL	**SILTY CLAY** with some fine sand; brown								moist medium stiff to stiff
		grades with some oxidation mottling			26	95				stiff
	SM	**SILTY FINE SAND** with trace gravel; brown with some oxidation mottling	5 10		23		33			moist medium dense
	SP	**FINE TO COARSE SAND** with some fine and coarse gravel and trace silt; brown								moist medium dense
	GP	**FINE AND COARSE SANDY GRAVEL** with trace silt; brown	15							moist medium dense
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20 25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

GSH — TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-2

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West, Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
		3" TOPSOIL								
	CL	**SILTY CLAY** with some fine sand; brown								moist medium stiff
		grades with some oxidation mottling								very moist
			5		52	63				soft to medium stiff
	GP/GM	**FINE TO COARSE SANDY FINE AND COARSE GRAVEL** with some silt; brown	10							moist medium dense
	GM	**SILTY FINE SAND** with some clay; brown								moist medium dense
	GP/GM	**FINE TO COARSE SANDY FINE AND COARSE GRAVEL** with trace clay; brown	15							moist medium dense
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving. Installed 1-1/4" diameter slotted PVC pipe to 16.0'.	20 25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3B

GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-3

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West, Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	CL	**SILTY CLAY** with some fine sand; brown with some oxidation mottling			26	84				moist medium stiff
	SM	**SILTY FINE SAND** brown with some oxidation mottling	10							moist medium dense
	GP/GM	**FINE TO COARSE SANDY FINE AND COARSE GRAVEL** with silt; brown with some oxidation mottling	15							moist medium dense
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20 25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3C

GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-4

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West, Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	CL	**SILTY CLAY** with some fine sand; brown with some oxidation mottling			33	87				moist to very moist medium stiff
	SP/SM	**FINE SAND** with some silt and trace gravel; gray/brown	5		9	11				moist medium dense
	CL	**SILTY CLAY** with some silt; brown with some oxidation mottling	10							moist medium stiff
	GP/GM	**FINE TO COARSE SANDY FINE AND COARSE GRAVEL** with some silt; brown	15							moist medium dense
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3D

GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-5

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West. Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
		3" TOPSOIL								
	SM	**SILTY FINE SAND** brown grades with some oxidation mottling	5							slightly moist to moist medium dense
	CL	**SILTY CLAY** with some fine sand; brown with some oxidation mottling	10							moist medium stiff to stiff
			15							
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3E

GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-6

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West, Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	CL	**SANDY CLAY** with clayey fine sand; brown								moist medium stiff to medium dense
	CL	**SILTY CLAY** with some fine sand; brown with some oxidation mottling			31	85				moist medium stiff
	SM	**SILTY FINE SAND** brown with some oxidation mottling	5							moist medium dense
	CL	**SILTY CLAY** with some fine sand; brown with some oxidation mottling								moist medium stiff
		grades with some oxidation mottling	10							
	GP/GM	**FINE TO COARSE SANDY FINE AND COARSE GRAVEL** with trace silt; brown								moist medium dense
			15							
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3F

GSH — TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-7

CLIENT: Dave Helm
PROJECT NUMBER: 1104-002-13
PROJECT: Green Haven Subdivision
DATE STARTED: 05/29/13 **DATE FINISHED:** 05/29/13
LOCATION: Between 11800 &11911 South 1985 & 2160 West, Riverton, Utah
GSH Field Rep.: HRW
DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe
ELEVATION: ---
GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	SM	**SILTY FINE SAND** brown with some oxidation mottling								slightly moist
	CL	**SILTY CLAY** with some fine sand; brown with some oxidation mottling			7	78				slightly moist to moist
			5							
			10							
	SM	**SILTY FINE SAND** brown with some oxidation mottling grades with trace gravel								moist medium dense
			15							
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20							
			25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3G

GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-8

CLIENT: Dave Helm **PROJECT NUMBER:** 1104-002-13

PROJECT: Green Haven Subdivision **DATE STARTED:** 05/29/13 **DATE FINISHED:** 05/29/13

LOCATION: Between 11800 &11911 South 1985 & 2160 West. Riverton, Utah **GSH Field Rep.:** HRW

DRILLING METHOD/EQUIPMENT: JCB 214S - Backhoe **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (05/29/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	CL	**SILTY CLAY** with some fine sand and trace gravel; brown grades with some oxidation mottling								slightly moist medium stiff
	SM	**SILTY FINE SAND** brown with some oxidation mottling	15							moist medium dense
		End of exploration at 16.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	20 25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3H

PROJECT: Green Haven Subdivision
PROJECT LOCATION: Btwn 11800 & 11911 S 1985 & 2160 W, Rivertion, UT
PROJECT NUMBER: 1104-002-13

KEY TO TEST PIT LOG

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
1	2	3	4	5	6	7	8	9	10	11

COLUMN DESCRIPTIONS

1. **Water Level:** Depth to measure groundwater table. See symbol below.
2. **USCS:** Graphic depiction of subsurface material encountered; typical symbols are explaned below.
3. **Description:** Description of material encountered; may include color, moisture, grain size, density/consistency, etc.
4. **Depth (ft.):** Depth in feet below the ground surface.
5. **Sample Symbol:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.
6. **Moisture (%):** Water content of soil sample measured in laboratory, expressed as percentage of dry weight of specimen.
7. **Dry Density (pcf):** The density of a soil measured in laboratory; expressed as pounds per cubic foot.
8. **% Passing 200:** Fines content of soil sample passing a No. 200 sieve measured in laboratory; expressed as a percentage.
9. **Liquid Limit (%):** Water content at which a soil changes from plastic to liquid behavior.
10. **Placsticity Index (%):** Range of water content at which a soil exhibits plastic properties.
11. **Remarks:** Comments and observations regarding drilling or sampling made by driller or field personnel. Other field and laboratory test results using the following abbreviations:

CEMENTATION:	MODIFIERS:	MOISTURE CONTENT (FIELD TEST):
Weakly: Crumbles or breaks with handling of slight finger pressure.	Trace <5 %	**Dry:** Absence of moisture, dusty, dry to the touch.
Moderately: Crumbles or breaks with considerable finger presssure.	Some 5 - 12%	**Moist:** Damp but no visible water.
Strongly: Will not crumble or break with finger pressure.	With >12%	**Saturated:** Visible water, usually soil below water table.

Descriptions and stratum lines are interpretive, field descriptions may have been modified to reflect lab test results. Descriptions on the logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOLS Graph	SYMBOLS Letter	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS: More than 50% of No. 200 sieve size.	GRAVELS: More than 50% of coarse fraction retained in No. 4 sieve.	CLEAN GRAVELS (little or no fines)		GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
				GP	Poorly Graded Gravel, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (appreciable amount of fines)		GM	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS: More than 50% of coarse fraction passing through No. 4 sieve.	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	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS: More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS: Liquid limit less than 50%			ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
				CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
				OL	Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS: Liquid limit greater than 50%			MH	Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
				CH	Inorganic Clays of High Plasticity, Fat Clays
				OH	Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS				PT	Peat, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications

STRATIFICATION:

DESCRIPTION	THICKNESS
Seam	up to 1/8"
Layer	1/8" - 12"

STRATIFICATION:

Occasional: One or less per 6" of thickness.
Numerous: More than one per 6" of thickness.

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Bulk/Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- No Recovery
- 3.25" OD 2.42" ID D&M Sampler
- 3.0" OD 2.42" ID D&M Sampler
- California Sampler
- Thin Wall

LOG KEY SYMBOL

- Water Level

FIGURE 4

GSH