REPORT
PAVEMENT STUDY
PROPOSED BAMBROUGH SUBDIVISION
APPROXIMATELY 4202 WEST 3600 NORTH
WEBER COUNTY, UTAH

Submitted To:

Kade Bambrough
5162 South 5900 West
Hooper, Utah 84315

Submitted By:

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September 20, 2013

Job No. 1464-01N-13

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Mr. Kade Bambrough
5162 South 5900 West
Hooper, Utah 84315

Attention: Mr. Kade Bambrough

Gentlemen:

Re: Report
Pavement Study
Proposed Bambrough Subdivision
Approximately 4202 West 3600 North
Weber County, Utah
(41.3293 N; -112.0781 W)

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our pavement study performed for the proposed Bambrough Subdivision to be located at approximately 4202 West 3600 North in Weber County, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. A more detailed layout of the site showing the proposed locations of existing facilities is presented on Figure 2, Site Plan. The location of the test pit excavated in conjunction with this study is also presented on Figure 2.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Kade Bambrough (Developer) and Mr. Andrew Harris of GSH Geotechnical, Inc. (GSH).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions at the site.

2. Provide appropriate earthwork and pavement recommendations to be utilized in the design and construction of the proposed subdivision infrastructure.

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

1. A field program consisting of the excavating, logging, and sampling of 1 test pit.

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 by returning a signed copy of our Professional Services Agreement No. 13-0913N dated September 9, 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 borings, projected groundwater conditions, and the layout and design data discussed in Section 2, Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH must be informed so that our recommendations can be reviewed and amended, if necessary.

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

2. PROPOSED CONSTRUCTION

It is our understanding that the proposed construction will consist of subdividing and constructing a three lot residential subdivision of the approximately 7.5 acre parcel located at approximately 4202 West 3600 North in Weber County, Utah. The location and layout of the proposed subdivision is shown on Figure 2. Development of the subdivision infrastructure is likely to include site grading, installation of utilities to service the proposed homes, and construction of a residential street to provide access to the proposed homes. It is anticipated that the residential street will be constructed of asphalt pavement with relatively light projected traffic that includes primarily passenger vehicles, daily delivery trucks, daily buses, and an occasional semi-tractor/trailer combination. Maximum anticipated site grading cuts and fills are anticipated to be minor, on the order of 2 feet or less.

3. INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil conditions at the site, a test pit was explored to a depth of about 4 feet below existing grade. The test pit was excavated using a small-sized track mounted excavator. The location of the test pit is 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 excavating operations, a continuous log of the subsurface conditions encountered was maintained. In addition, 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 laboratory testing. Detailed graphical representation of the subsurface conditions encountered is presented on Figure 3A, Log of Test Pit. Soils were classified in accordance with the nomenclature described on Figure 4, Key to Test Pits (USCS).

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 gradation, compaction, and California Bearing Ratio tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Gradation Test

To aid in classifying the soils and to provide general index parameters, a gradation test was performed on a representative sample of the soils encountered in the exploration test pit. The results of the test are tabulated on the following page.

			Percent Passing Sieve											
Boring No	Depth (feet)	Soil Type	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 10	No. 40	No. 50	No. 100	No. 200
TP-1	1.0	SM	100	100	100	100	100	100	100	100	98	97	37	14

3.2.3 Compaction Test

A compaction (Standard Proctor) test was performed in accordance with the (ASTM[1] D-698) specifications. The test was performed in order to determine maximum dry density and optimum

[1] American Society for Testing and Materials

moisture content of a representative sample of the near-surface silty sands obtained from Test Pit TP-1. The data was then used in preparation of the California Bearing Ratio (CBR) test sample. This soil type will be the primary subgrade soil within pavement areas. The results of the compaction test are presented below:

Boring No.	Depth (feet)	Soil Classification	Optimum Moisture Content (percent)	Maximum Dry Density (pcf)
TP-1	1 – 3	SM	11.2	111.8

3.2.4 California Bearing Ratio (CBR) Test

To determine subgrade characteristics and to provide data for design of the proposed pavements, a California Bearing Ratio (CBR) test was performed on the representative sample of silty sands and gravels obtained from Test Pit TP-1. The test was performed in accordance with the Utah Department of Transportation Procedure 8-9-22 "California Bearing Ratio Soil" as presented in the Utah State Department of Highways Manual of Instruction, Part 8, Materials. The results of the CBR test is presented below:

Soil Classification	SM		
Before Soaking	Dry Density	109.1	pcf
	Moisture Content	10.9	percent
After Soaking	Dry Density	110.2	pcf
	Moisture Content (Upper 1" of Sample)	14.0	percent
	Surcharge	50	psf
	Swell	0	percent
CBR	Surcharge	50	psf
	At 0.1" penetration	35.2	percent
	At 0.2" penetration	34.8	percent

4. SITE CONDITIONS

4.1 SURFACE

The subject property consists of a roughly rectangular-shaped parcel of open, undeveloped land which has been used for agricultural purposes. The site is surrounded by open, vacant fields on the north and west. A farmhouse and outbuildings are also located to the west of the proposed development. To the east, the site is bound by single-family residential homes and 3675 North. The south side of the site is bordered by 3600 North. The topography of the site is nearly flat, with a slight slope downward toward the west.

4.2 SUBSURFACE SOIL AND GROUNDWATER

The soil conditions encountered in the test pit, to the depth penetrated, consisted of up to 6 inches of topsoil overlying primarily medium to fine, silty sand (SM). The sand soils were medium dense, dry to slightly moist, and light brown to brown in color, and will exhibit moderately high strength and low compressibility characteristics. The top 12 inches at the surface are disturbed from plowing/disking.

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

Groundwater was not encountered in the test pit during our field investigation. Seasonal and longer-term groundwater fluctuations could occur, with the highest seasonal levels generally occurring during the late spring and early summer months. We do not anticipate that groundwater levels will affect construction of the pavements infrastructure.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The most significant geotechnical aspect of the site is the grading required to construct the residential street within the subdivision. GSH must observe excavations to verify that topsoil/disturbed soils have been completely removed prior to the placement of structural site grading fills or pavements. This involvement will help prevent the unnecessary removal of suitable soils, limiting needless time delays and cost issues. GSH can be contacted to discuss this issue in further detail.

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

5.2 EARTHWORK

5.2.1 Site Preparation

Initial site preparation shall consist of the removal of all surface vegetation, topsoil, root bulbs, sod, rubbish, construction debris, and any other deleterious materials. We estimate that approximately 6 inches of stripping may 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.

Further preparation of the exposed subgrade shall consist of proofrolling 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 (up to a maximum depth of 2 feet) and replaced with structural fill.

5.2.2 Excavations

Temporary construction excavations in the site soils, not exceeding 4 feet in depth, may be constructed with near-vertical sideslopes. Temporary excavations up to 10 feet deep in the site soils shall be constructed with sideslopes no steeper than one-half horizontal to one vertical. Excavations deeper than 10 feet are not anticipated at the site. If excessive sloughing occurs, if groundwater is encountered, or where extensive layers of clean granular soils are encountered GSH must be contacted to provide additional recommendations and the sideslopes should be appropriately flattened and/or shoring/bracing utilized.

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

5.2.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and in some areas, replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. For structural site grading fill, the maximum particle size 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 granular soils may be utilized as structural site grading fill. Only granular soils are recommended as structural fill in confined areas, such as around foundations and within utility trenches. Imported structural fill shall consist of a well-graded mixture of sand and gravel with less than 25 percent fines (clays and silts) and less than 30 percent larger than three-quarters of an inch.

To stabilize soft subgrade conditions or where structural fill is required to be placed closer than 1.0 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

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[2] D-1557 (AASHTO[3] T-180) compaction criteria in accordance with the table below:

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
Aggregate Road Base	---	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.

If utilized for stabilizing fill, coarse gravel and cobble mixtures should be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto

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

the surface continuously at least twice. As an alternative, the stabilizing fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent structural fill 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.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall 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 2 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.

5.3 PAVEMENTS

The natural silty sand soils will exhibit good pavement support characteristics when saturated or nearly saturated. Our laboratory testing on the native silty sand soils indicated a California Bearing Ratio of about 35. Considering the silty sands as the design subgrade soils and the projected traffic conditions, the following pavement section is recommended.

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

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

Asphalt concrete and base course components should meet the requirements and be placed in accordance with the Utah Department of Transportation specifications.

5.4 SITE OBSERVATIONS

Prior to placement of pavements and site grading fills, a geotechnical engineer from GSH must verify that all disturbed soils and non-engineered fills (if encountered) have been removed and suitable subgrade conditions encountered.

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.

Andrew M. Harris, P.E.
State of Utah No. 7420456
Senior Geotechnical Engineer

Reviewed by:

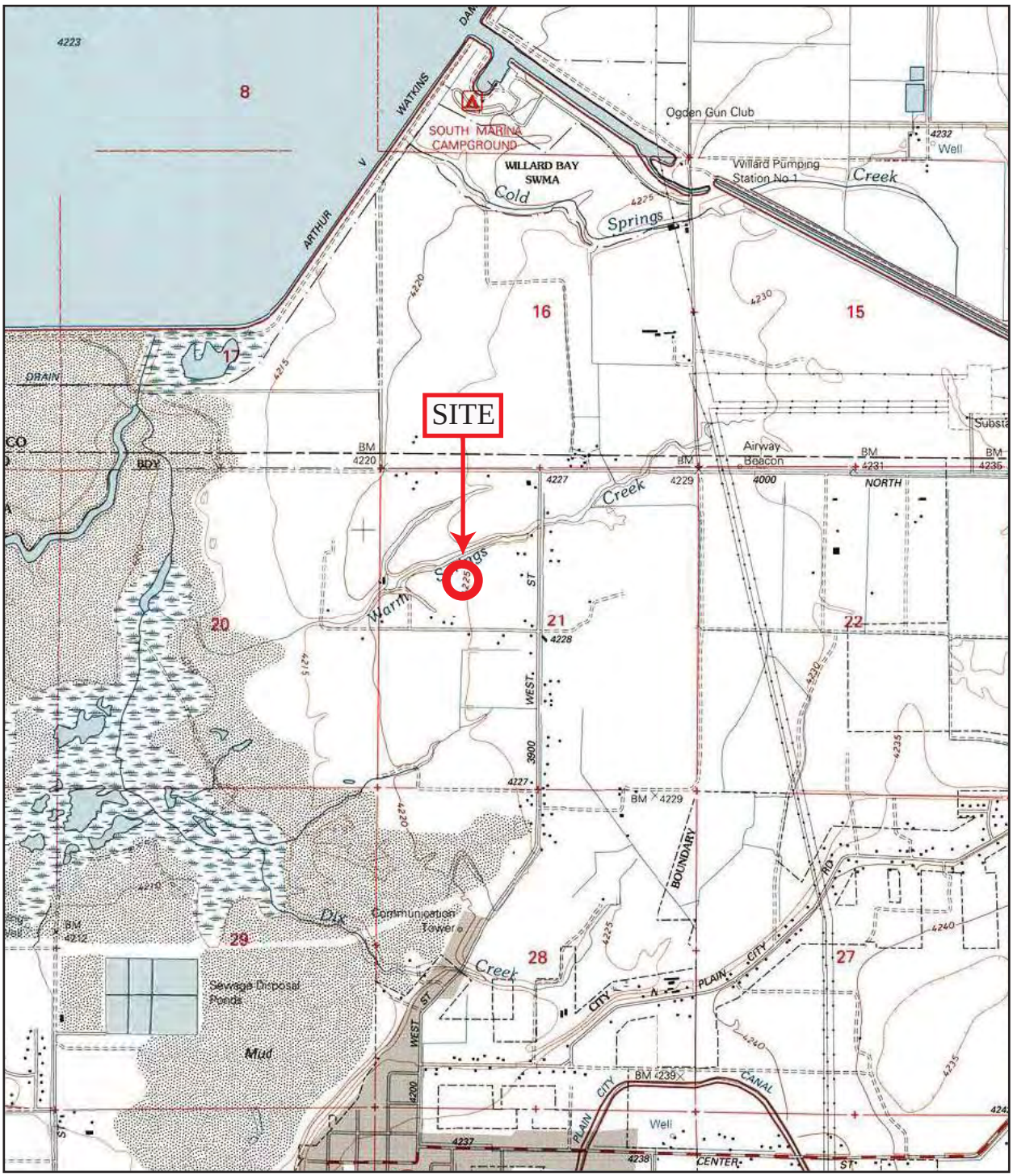
Michael S. Huber, P.E.
State of Utah No. 343650
Vice President, Senior Geotechnical Engineer

AMH/WGT:mmh

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figure 3A, Boring Log
Figure 4, Key to Boring Log (USCS)

Addressee (3 + email)

KADE BAMBROUGH
JOB NO. 1464-01N-13



SCALE IN FEET
1000 0 1000 2000

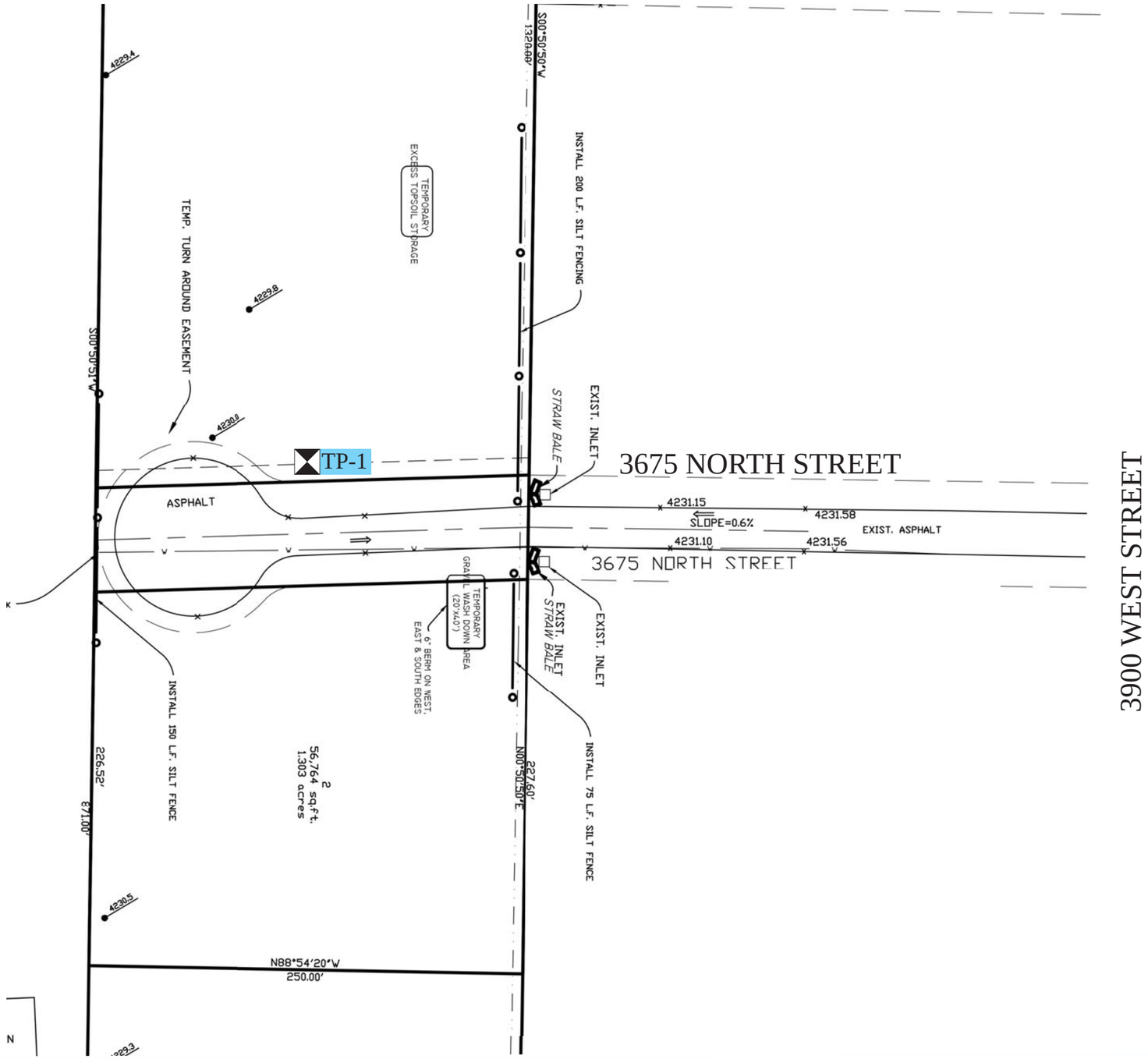
FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP(S)
ENTITLED "PLAIN CITY, UTAH"
DATED 1998

GSH

KADE BAMBROUGH
JOB NO. 1464-01N-13

NOT TO SCALE



REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
DOWNLOADED FROM GOOGLE EARTH
IMAGERY DATE: 6/17/2010.

FIGURE 2
SITE PLAN

GSH

TEST PIT LOG

Page: 1 of 1

TEST PIT: TP-1

CLIENT: Kade Bambrough **PROJECT NUMBER:** 1464-01N-13

PROJECT: Bambrough Subdivision **DATE STARTED:** 09/11/13 **DATE FINISHED:** 09/11/13

LOCATION: Approx. 4202 West 3600 North, Weber County, Utah **GSH Field Rep.:** AMH

DRILLING METHOD/EQUIPMENT: Mini - Excavator **ELEVATION:** ---

GROUNDWATER DEPTH: No groundwater encountered (09/11/13)

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0							
	ML	**FINE SANDY SILT** dark brown, major roots (topsoil) up to 3"; organic rich								dry loose
	SM	**SILTY FINE SAND** light brown to brown								dry to slightly moist medium dense
		End of exploration at 4.0'. No groundwater encountered at time of excavation. No significant sidewall caving.	5 10 15 20 25							

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

PROJECT: Bambrough Subdivision
PROJECT LOCATION: 4202 West 3600 North, Weber County, Utah
PROJECT NUMBER: 1464-01N-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