GEOTECHNICAL INVESTIGATION AND NATURAL HAZRADS EVALUATION

Proposed Water Treatment Plant and Storage Tank
Ogden City
Ogden, Utah

Prepared by:

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September 26, 2012

SUNRISE ENGINEERING

September 26, 2012

Cliff Linford, P.E.
Sunrise Engineering, Inc.- Salt Lake Municipality Group
12227 South Business Park Drive, Suite 220
Draper, UT 84020

Re: Geotechnical Investigation and
Natural Hazards Evaluation
For Proposed Water Treatment Plant and Storage Tank
Ogden, Utah

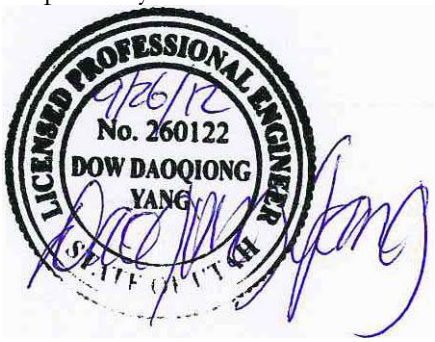
Dear Cliff:

Enclosed herein is the report of a geotechnical investigation and natural hazards evaluation for the above referenced project. This report presents the results of the geotechnical subsurface exploration, geologic hazards evaluation, engineering analyses and recommendations for design and construction of the proposed water treatment plant and 300,000-gallon water storage tank in Ogden, Utah.

We appreciate the opportunity to provide geotechnical services to you for this project. Should you have any questions about the report, or if we may be of further service in any way, please contact us at (801)523-0100.

Sincerely,
SUNRISE ENGINEERING, INC.

Prepared by:



Dao Yang, P.E.
Project Engineer/Hydrogeologist

Reviewed by:

Derek Anderson, P.E.
Service Center Manager

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FIGURES

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1 INTRODUCTION

Ogden City has proposed to construct a new water treatment plant and replace an existing 200,000-gallon water storage tank with a 300,000-gallon tank in the southwestern quarter of Section 16, Township 6 North, Range 1 East, Salt Lake Base and Meridian (SLBM), as shown in **Figure 1**. This report presents a summary of a geotechnical investigation and natural hazards evaluation at the proposed project site.

1.1 Objectives

The objectives of the geotechnical investigation and natural hazards evaluation are to:

- Evaluate subsurface soil/rock and groundwater conditions at the project site.
- Provide appropriate foundation, earthwork and pavement recommendations.
- Evaluate potential impacts from identified natural hazards at the project site.

1.2 Scope of Work

The following tasks have been completed:

- Review of available geologic and soil data within the project area
- Drilling of six borings
- Analysis of geotechnical data
- Provision of recommendations for design and construction of the proposed structure

2 PROPOSED CONSTRUCTION

A treatment plant will be constructed at the existing treatment plant site and a 300,000-gallon water storage tank will be constructed at an existing 200,000-gallon water storage tank site. The existing tank will be demolished before the new tank is constructed at the same location. At the present time, no outlines of the proposed construction are available.

3 SITE INVESTIGATION

3.1 General Geology

According to King (2001), the project site is underlain by the alluvium and colluvium (Qac) of Quaternary age. The formation includes stream and fan alluvium and colluvium, and, locally, mass-movement deposits. Beneath the alluvium and colluvium is the Humbug formation (Mh) of Mississippian age. The Humbug formation consists of dolomite, sandstone and dolomitic sandstone. It is about 800-1,000 feet in thickness.

The closest fault is approximately 3,000 feet southwest of the project site. The up-thrown block is on the east side of the approximately north-south-trending normal fault.

3.2 Boring Drilling

To evaluate the subsurface conditions at the project site, six borings (B-1 through B-6) were drilled to 50 feet below grade using an ODEX drilling rig from September 17 to 19, 2012. **Figure 2** shows the location of each boring at the project site. Four borings (B-1 through B-4) were drilled at the treatment plant site and the other two (B-5 and B-6) were drilled at the tank site. Boring logs are provided in **Appendix A**. The following is a summary of the subsurface soil materials encountered during drilling:

At the treatment plant site:

> From the surface to a depth of approximately 45 feet, the subsurface soil consists primarily of Gravel with clay, silt and sand at borings B-1 through B-4. At 45 feet, Clay was encountered at borings B-1 and B-4, and sand with gravel was encountered at borings B-2 and B-3. At 50 feet, sand and gravel or sand with gravel was encountered at borings B-1 through B-4. Groundwater was encountered at a depth of approximately 18 feet below grade.

At the tank site:

> Fill material was encountered from the surface to a depth of approximately 3 feet at boring B-5 and 10 feet at boring B-6. At boring B-6, an approximately 5-foot thick layer of silt was encountered below the fill material at boring B-6, but this layer was not encountered at boring B-5. Then, a large boulder with a thickness of 5 feet at boring B-6 and 6 feet at boring B-5 was encountered. Below the large boulder are interbedded sand, silt, gravel and clay. Groundwater was encountered at a depth of approximately 40 feet below grade.

Due to the presence of gravel, not much soil material could be collected from most sampling depths at the treatment plant site. Five soil samples collected from the tank site were delivered Utah Testing and Engineering for gradation and classification testing. The five samples were classified as sand and silt (SM) or silt (ML). An Atterberg test could not be performed on the samples since they are non-plastic. The laboratory results of the five samples are provided in **Appendix B**.

3.3 Geologic Hazards

3.3.1 Active Fault and Surface Fault Rupture

In geology, an active fault is a fault which has had displacement or seismic activity during the geologically recent period. In the United States, an active fault is generally defined as a fault which has displaced earth materials during the Holocene Epoch (during the last 11,000 or so years before present). Active faults are the most common sources of earthquakes and tectonic movements.

There is no fault at the site and the closest fault is approximately 3,000 feet southwest of the project site (King, 2001). However, this fault is not an active fault. According to Christensen and Shaw (2008a), the closest Quaternary fault to the site is approximately 1 mile to the west. Therefore, a trench program is not required to study the hazards of surface fault rupture.

3.3.2 Site Class

Treatment Plant Site: Based on the soil samples collected during the drilling of borings B-1 through B-4, the treatment plant site can be classified as **Site Class C** (very dense soil and soft rock) as defined in Table 1613.5.2 of the International Building Code (International Code Council, 2009).

Tank Site: Based on the soil samples collected during the drilling of borings B-5 and B-6, the tank site can be classified as **Site Class D** (stiff soil) as defined in Table 1613.5.2 of the International Building Code (International Code Council, 2009).

3.3.3 Liquefaction

Soil liquefaction describes the behavior of soils that, when loaded, suddenly suffer a transition from a solid state to a liquefied state, or having the consistency of a heavy liquid. Liquefaction is more likely to occur in loose to moderately saturated granular soils with poor drainage, such as silty sands or sands and gravels capped or containing seams of impermeable sediments. During wave loading, usually cyclic undrained loading, e.g. seismic loading, loose sands tend to decrease in volume, which produces an increase in their pore water pressures and consequently a decrease in shear strength, i.e. reduction in effective stress. Deposits most susceptible to liquefaction are young (Holocene-age, deposited within the last 10,000 years) sands and silts of similar grain size (well-sorted), in beds at least meters thick, and saturated with water. Such deposits are often found along riverbeds, beaches, dunes, and areas where windblown silt (loess) and sand have accumulated. Some examples of liquefaction include quicksand, quick clay, turbidity currents, and earthquake liquefaction.

Treatment Plant Site: The soil encountered at borings B-1 through B-4 was very dense soil and soft rock. While groundwater was encountered at a depth of 18 feet below grade, the soil at the site is not liquefiable during a strong earthquake event.

Tank Site: The soil encountered at borings B-5 and B-6 was stiff sand and silt, large boulder and clay. While groundwater was encountered at a depth of 40 feet, the soil at the site is not liquefiable during a strong earthquake event.

Moreover, according to Christensen and Shaw (2008b), the project site is not within the liquefaction special study areas.

3.3.4 Landslide

A landslide or landslip is a geological phenomenon which includes a wide range of ground movement, such as rock falls, deep failure of slopes and shallow debris flows, which can occur in offshore, coastal and onshore environments. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability. Typically, pre-conditional factors build up specific sub-surface conditions that make the area/slope prone to failure, whereas the actual landslide often requires a trigger before being released.

According to Christensen and Shaw (2008c), the project site is within the landslide special study areas. The map edited by Christensen and Shaw was generated based on natural topographic slopes.

If the natural topographic slope of an area is greater than 30%, the area is classified to be within the landslide special study zone. Conducting a special landslide study is not within the scope of this investigation.

However, the existing water storage tank has been in operation at the site since the 1950s. No landslide hazards, including slides, rock falls and debris flows, have even occurred at the site. Moreover, according to the Utah Division of Homeland Security (2008), no historic landslide has occurred at the tank and adjacent area.

Furthermore, the dense vegetative cover, including trees, upslope of the tank site can prevent rainfall from impacting the soil directly and reduces surface runoff. The root systems can add strength to shallow slope materials. However, should there be a forest fire at the tank site and the adjacent area that would destroy the vegetative cover and trees, the landslide hazard potential at the tank site would increase and proper slope-stabilizing measures might be required.

3.3.5 Rock Fall

Based on the topographic information in **Figure 1**, the natural land slope is less than 5% at the treatment plant site. Therefore, rock fall is not a concern at the treatment plant site. However, the natural land slope at the tank site is approximately 40%. Rock fall may be a concern at the tank site. Since the mountain slope is covered with tall trees and dense vegetation, rock fall hazard at the tank site may be low.

3.3.6 Floodplain

A floodplain is flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It includes the floodway, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. A 100-year flood is calculated to be the level of flood water expected to be equaled or exceeded every 100 years on average. The 100-year flood is more accurately referred to as the 1% flood, since it is a flood that has a 1% chance of being equaled or exceeded in any single year. Based on the expected flood water level, a predicted area of inundation can be mapped.

The Federal Emergency Management Agency (FEMA) website was searched for Flood Insurance Rate Maps (FIRMs) of the project area. According to the FEMA FIRM index map, the project area is supposed to be covered by FRIM 49057C0300E. However, this FIRM has not been published.

Therefore, at the present time, there is not enough data to determine if the site is within the 100-year flood zone. However, the existing treatment plant has been in operation at the site since the 1950s and has not experienced any flooding. The tank site is approximately 30 feet higher than the treatment plant site.

3.3.7 Avalanche Path

An avalanche is a rapid flow of snow down a slope, from either natural triggers or human activity. Typically occurring in mountainous terrain, an avalanche can mix air and water with the descending snow. Powerful avalanches have the capability to entrain ice, rocks, trees, and other material on the

slope. Avalanches are primarily composed of flowing snow, and are distinct from mudslides, rock slides, and serac collapses on an icefall. In mountainous terrain avalanches are among the most serious objective hazards to life and property, with their destructive capability resulting from their potential to carry an enormous mass of snow rapidly over large distances.

The treatment plant site is located in the valley and is not likely to be impacted by avalanche hazards because it is not located immediately below steep slopes. The tank site is located on a slope. The topographic slope at the tank site is about 40% (see **Figure 1**). If the mountain slope is not stable, the tank site has the potential to be impacted by avalanches. However, there is no historic record regarding avalanches that have occurred at the tank site and in adjacent areas. The mountain slope is covered with dense vegetation and trees.

4 DESIGN RECOMMENDATIONS

Based on the investigation, detailed geotechnical recommendations are presented in the following sections.

4.1 Site Preparation

Topsoil, manmade fills (where encountered) and soils loosened by construction activities should be removed from the building pad, pavement areas and concrete flatwork areas prior to foundation excavation and placement of site grading fills. Following stripping, the subgrade should be proof-rolled to a firm, non-yielding condition or 90% of maximum dry density. Soft areas detected during the proof-rolling operation should be removed and replaced with structural fill. If the soft soils extend more than 1.5 feet deep, stabilization may be required. The use of stabilization should be approved by the geotechnical engineer and would likely consist of over-excavating the area by at least 1.5 ft, placing a geofabric (such as Mirafi 600X)) or a geogrid (such as Tensar BX-1100) at the bottom of the excavation over which a stabilizing fill consisting of angular coarse gravel with cobbles is placed up to the design subgrade. Vegetation and other deleterious materials should be removed from the site. The stripped soils will be unsuitable as structural fill but may be stockpiled for later use in landscaped areas.

4.2 Excavation and Site Grading

Earthwork will be required to level the construction site. Shallow temporary construction excavations not exceeding four feet in depth may be constructed with near-vertical side slopes. Temporary cut slopes may be constructed at side slopes of 1.5:1.0 (horizontal: vertical). It is the responsibility of the contractor to provide safe working conditions in connection with below grade excavations.

4.3 Structural Fill

Structural fill should be placed to support structures, pavements and exterior concrete flatwork, and should be approved by the geotechnical engineer. Imported material for structural fill should consist of non-plastic, well graded granular material with less than 20 percent fines (material passing No. 200 sieve) and should pass laboratory proctor tests using ASTM D1557. The moisture content of structural fill should be conditioned to near optimum water content, placed in uniform lifts not

exceeding eight inches in loose thickness, and compacted to the following minimum percentages of the maximum dry density as determined by ASTM D1557:

a.	Below Spread or wall and Mat Footings	95%
b.	Below Floor Slabs	95%
c.	Trench Backfill	
	i. Below Foundations	95%
	ii. Below Slabs	95%
	iii. Other Areas	90%
d.	Subgrade Wall and Footing Backfill	90% min., 95% max.
e.	Beneath Pavement	90%

Prior to placement of the structural fill, proof-rolling of previously stripped subgrade should be accomplished by passing heavy rubber-tired construction equipment uniformly over the subgrade.

4.4 Permanent Slopes

All final cut and fill slopes, if any, shall be graded to 2.0:1.0 (horizontal: vertical) or retained. It is recommended that structures be constructed far enough back from the crest of fill slopes so that the base of the foundation is below an imaginary line extending up from the toe of the slope at a gradient of 2.0:1.0 (horizontal : vertical).

4.5 Foundations

4.5.1 Footings

Based on the on-site soil conditions, it is recommended that the treatment plant building be constructed on conventional spread and continuous footing foundation and water storage ponds or tank be constructed on mat-slab foundations. Footings should not be installed on loose or disturbed soil, undocumented fill, topsoil, construction debris, frozen soil, or within ponded water. If unsuitable soils are encountered, they should be over excavated and replaced with structural fill. Structural fill placed below footings should extend laterally beyond the edges of the foundation a distance of 1.5 feet and then 1 foot for every foot of depth below the foundation. If the exposed soils on which the footings are to be founded become loose or disturbed, they should be re-compacted before the concrete is placed.

4.5.2 Design Criteria

Based on the available data and in compliance with applicable building codes, the recommended design parameters for foundations and footings at the treatment plant site are as follows:

Condition	Parameter Values
Continuous (Wall) Footings – bearing capacity	2,500 pounds per square foot (psf)
Isolated spread footings – bearing capacity	2,500 psf
Mat-slab foundations	2,500 psf
Increase above values for short term, transient loads by	30%
Exterior footing depth below adjacent final grade	36 inches
Interior footing embedment below subgrade	18 inches
Minimum continuous footing width	24 inches

Based on the available data and in compliance with applicable building codes, the recommended design parameters for foundations and footings at the tank site are as follows:

Condition	Parameter Values
Continuous (Wall) Footings – bearing capacity	2,000 pounds per square foot (psf)
Isolated spread footings – bearing capacity	2,000 psf
Mat-slab foundations	2,000 psf
Increase above values for short term, transient loads by	30%
Exterior footing depth below adjacent final grade	36 inches
Interior footing embedment below subgrade	18 inches
Minimum continuous footing width	24 inches

4.5.3 Settlement

Due to the load of the proposed construction, the total settlement of footings designed and constructed in accordance with the recommendations in Sections 4.5.1 and 4.5.2 is anticipated to be less than ½ inch.

4.5.4 Lateral Pressure

Excavation walls and retaining walls will be subjected to horizontal loads from lateral earth pressure of backfill. When the granular fill is lightly compacted, drained and the surface of the soil slope behind the wall is horizontal, the backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot for active pressure. For very rigid non-yielding walls, the backfill should be considered equivalent to a fluid with a density of at least 60 pounds per cubic foot for active pressure. If the fill is placed as a structural fill, the values presented above should be increased to 70 and 120 pounds per cubic foot, respectively.

4.5.5 Lateral Resistance

Resistance to lateral loads at the bottom of the footings can be calculated based on a coefficient of friction of 0.3. 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 250 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. These are ultimate frictional and passive pressure values and should be used with appropriate safety factors in design. Note that fill against the sides of footings

should be placed and compacted to at least 90% of maximum dry density as indicated in Section 4.3 (Structural Fill).

4.5.6 Drainage

Drainage design should provide for rapid removal of water from foundation soils and pavement materials, both during and after construction. Roof drainage should be discharged at least 5 feet away from the facilities. Drainage design should provide for intercepting water and directing it away from cut and fill slopes.

4.5.7 Pavements

Based on the soil conditions (assuming a CBR value of 20) and the assumed light traffic, the following pavement support recommendations are given for the treatment plant: a 3-inch-thick asphaltic concrete surface over an 8-inch-thick aggregate base course underlain by a 6-inch-thick Class 2 subbase.

4.5.8 Cement Type

A composite soil sample was collected from each of borings B-3 and B-6 at depths from 5 to 15 feet. The two soil samples were delivered under proper chain-of-custody protocols to a laboratory for analysis of sulfate. The laboratory result of the samples, attached in **Appendix B**, indicates that the sulfate concentration in the soil samples is 27.9 parts per million (ppm) in the sample collected from boring B-3 and 37.3 ppm in the sample collected from boring B-6, both negligible levels. Therefore, Cement Type I (normal, general-purpose cement suitable for all uses) is recommended for the construction of the tank and treatment facilities.

5 LIMITATIONS

The analyses and recommendations presented in this report are based upon the data obtained from six borings at the indicated locations (**Figure 2**). This report does not reflect variations which may occur at other areas or across the site. The nature and extent of such variations may not become evident until construction. If variations appear evident, it will be necessary to reevaluate the recommendations of this report.

This report has been prepared for the exclusive use for specific application to the project discussed and has been prepared in accordance with currently accepted geotechnical engineering practices. No warranties, either expressed or implied, are provided. In the event that any changes in the nature, design or location of the project as outlined in this report are planned, the recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the geotechnical engineer.

6 REFERENCES

Christensen, G.E. and L.M. Shaw. 2008a. Surface Fault Rupture Special Study Areas, Wasatch Front and Nearby Areas, Utah.

Christensen, G.E. and L.M. Shaw. 2008b. Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah.

International Code Council (ICC). 2009. *International Building Code.*

King, J.K. 2001. Progress Report: Geologic Map of the Ogden 30' X 60' Quadrangle, Utah and Wyoming. Utah Geological Survey Open-File Report 380.

Utah Division of Homeland Security. 2008. Utah Natural Hazards Handbook.

Figures

PROPOSED TREATMENT PLANT SITE

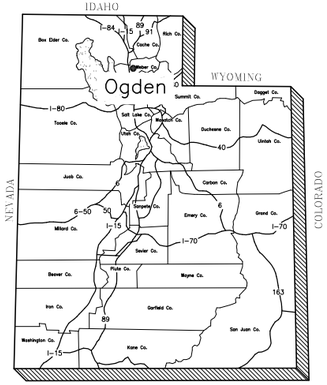
PROPOSED WATER STORAGE TANK SITE

NORTH

SCALE

0 1000' 2000'

AREA MAP



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OGDEN CITY

WATER TREATMENT PLANT GEOTECHNICAL INVESTIGATION

SITE VICINITY MAP

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
04310	DY	DY	DSA	01 of 02	FIG. 1

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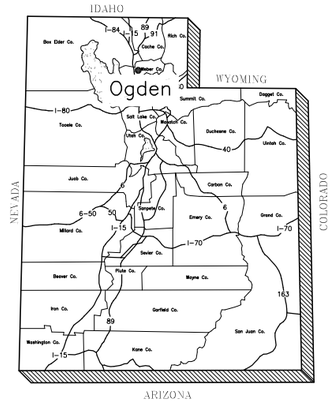
NORTH

SCALE

0 25' 50'

AREA MAP



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OGDEN CITY

WATER TREATMENT PLANT
GEOTECHNICAL INVESTIGATION
SITE MAP

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
04310	DY	DY	DSA	02 of 02	FIG. 2

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Appendices

Appendix A
Boring Logs

BORING LOG

Boring No: B-1

Project Name	Geotechnical - Ogden City Treatment Plant	**Drilled By**	Earthcore Drilling Inc.
Project No	S04310/0005	**Drill Rig**	MB-80
Client	Ogden City, Utah	**Logged By**	D. Yang
Location	N41°15'15.21" W111°50'52.79"	**Date**	9/17/2008
Elevation	4822 Feet	**Note**	Odex 4 1/4 OD

Depth (ft)	Graphical Log		SPT Test Blows (6 in)	Blows (6 in)	Blows (6 in)	Blows (ft)	Recovery (in)	Wet Density (pcf)	Moisture (%)	Water Level (ft)	USCS classification	
0												0-3": Asphalt and 3"-5', structural fill consisting of gravel and clay, slightly moist
											GC	
5		SPT	50(1")			Refusal					GC	At 5', gravel with clay, gray, dry.
10		SPT	7	35	24	59					GC	At 10', gravel with clay, gray, dry.
15		SPT	27	19	50(5")	Refusal				▼	GC	At 15', gravel with clay and sand, gray, dry.
20		SPT	13	22	18	40					GP	At 20', gravel and sand, saturated.
25		SPT	13	22	24	46					GP	At 25', gravel and sand, saturated.
30		SPT	13	19	13	32					GP	At 30', gravel and sand, saturated.
35		SPT	13	19	13	32					GP	At 35', gravel and sand, saturated.
40		SPT	11	11	14	25					GP	At 40', gravel and sand, saturated.
45		SPT	3	3	7	10					CL	At 45', gray clay, plastic, saturated
50		SPT	5	20	34	54					SM	At 50', silty sand with gravel, saturated.

BORING LOG

Boring No: B-2

Project Name	Geotechnical - Ogden City Treatment Plant	**Drilled By**	Earthcore Drilling Inc.
Project No	S04310/0005	**Drill Rig**	MB-80
Client	Ogden City, Utah	**Logged By**	D. Yang
Location	N41°15'16.05" W111°50'53.07"	**Date**	9/17/2008
Elevation	4813 Feet	**Note**	Odex 4 1/4 OD

Depth (ft)	Graphical Log		SPT Test Blows (6 in)	Blows (6 in)	Blows (6 in)	Blows (ft)	Recovery (in)	Wet Density (pcf)	Moisture (%)	Water Level (ft)	USCS classification	
0												0-1': topsoil and 1'-5', structural fill consisting of gravel and clay, slightly moist
											GC	
5		SPT	13	9	10	19					GC	At 5', gravel with clay, gray, slightly moist.
10		SPT	10	8	10	18					GC	At 10', gravel with clay, gray, slightly.
15		SPT	50(1")			Refusal				▼	GC	At 15', gravel with clay and sand, gray, dry.
20		SPT	20	18	27	45					GP	At 20', gravel and sand, saturated.
25		SPT	14	23	22	45					GP	At 25', gravel and sand, saturated.
30		SPT	15	21	15	36					GP	At 30', gravel and sand, saturated.
35		SPT	50(5")			Refusal					GP	At 35', gravel and sand, saturated.
40		SPT	32	44	44	88					GP	At 40', gravel and sand, saturated.
45		SPT	5	8	15	23					SP	At 45', sand with gravel, saturated
50		SPT	5	20	34	54					SP	At 50', sand with gravel, saturated.

BORING LOG

Boring No: B-3

Project Name	Geotechnical - Ogden City Treatment Plant	**Drilled By**	Earthcore Drilling Inc.
Project No	S04310/0005	**Drill Rig**	MB-80
Client	Ogden City, Utah	**Logged By**	D. Yang
Location	N41°15'16.15" W111°50'52.23"	**Date**	9/18/2008
Elevation	4811 Feet	**Note**	Odex 4 1/4 OD

Depth (ft)	Graphical Log		SPT Test Blows (6 in)	Blows (6 in)	Blows (6 in)	Blows (ft)	Recovery (in)	Wet Density (pcf)	Moisture (%)	Water Level (ft)	USCS classification	
0												0-1': topsoil and 1'-5', structural fill consisting of gravel and clay, slightly moist
											GC	
5		SPT	10	15	29	44					GC	At 5', gravel with clay, gray, slightly moist.
10		SPT	25	15	15	30					GC	At 10', gravel with clay, gray, slightly.
15		SPT	10	11	50(3")	Refusal				▼	GC	At 15', gravel with clay and sand, gray, dry.
20		SPT	27	19	26	45					GP	At 20', gravel and sand, saturated.
25		SPT	15	21	25	46					GP	At 25', gravel and sand, saturated.
30		SPT	14	22	16	38					GP	At 30', gravel and sand, saturated.
35		SPT	50(4")			Refusal					GP	At 35', gravel and sand, saturated.
40		SPT	32	35	47	82					GP	At 40', gravel and sand, saturated.
45		SPT	7	9	14	23					SP	At 45', sand with gravel, saturated
50		SPT	7	19	35	54					SP	At 50', sand with gravel, saturated.

BORING LOG

Boring No: B-4

Project Name	Geotechnical - Ogden City Treatment Plant	**Drilled By**	Earthcore Drilling Inc.
Project No	S04310/0005	**Drill Rig**	MB-80
Client	Ogden City, Utah	**Logged By**	D. Yang
Location	N41°15'15.55" W111°50'52.04"	**Date**	9/18/2008
Elevation	4819 Feet	**Note**	Odex 4 1/4 OD

Depth (ft)	Graphical Log		SPT Test Blows (6 in)	Blows (6 in)	Blows (6 in)	Blows (ft)	Recovery (in)	Wet Density (pcf)	Moisture (%)	Water Level (ft)	USCS classification	
0												0-1': topsoil and 1'-5', structural fill consisting of gravel and clay, slightly moist
											GC	
5		SPT	45	19	15	34					GC	At 5', gravel with clay, gray, dry.
10		SPT	10	19	19	38					GC	At 10', gravel with clay, gray, dry.
15		SPT	50(2")			Refusal				▼	GC	At 15', gravel with clay and sand, gray, dry.
20		SPT	50(5")			Refusal					GP	At 20', gravel and sand, saturated.
25		SPT	50(4")			Refusal					GP	At 25', gravel and sand, saturated.
30		SPT	15	20	15	35					GP	At 30', gravel and sand, saturated.
35		SPT	50(4")			Refusal					GP	At 35', gravel and sand, saturated.
40		SPT	15	16	17	33					GP	At 40', gravel and sand, saturated.
45		SPT	5	7	9	16					CL	At 45', gray clay with sand, plastic, saturated
50		SPT	15	25	50(3")	Refusal					GP	At 50', gravel with sand, saturated.

BORING LOG

Boring No: B-5

Project Name	Geotechnical - Ogden City Treatment Plant	**Drilled By**	Earthcore Drilling Inc.
Project No	S04310/0005	**Drill Rig**	MB-80
Client	Ogden City, Utah	**Logged By**	D. Yang
Location	N41°15'12.47" W111°50'55.44"	**Date**	9/18/2008
Elevation	4844 Feet	**Note**	Odex 4 1/4 OD

Depth (ft)	Graphical Log		SPT Test Blows (6 in)	Blows (6 in)	Blows (6 in)	Blows (ft)	Recovery (in)	Wet Density (pcf)	Moisture (%)	Water Level (ft)	USCS classification	
0											GC	0-3': fill consisting of gravel and clay, slightly moist. 3-9': rock.
5		SPT	50(0")			Refusal					Rock	At 5', rock.
10		SPT	10	13	18	31					SM	At 10', sand and silt and gravel, dry, dense.
15		SPT	8	9	12	21					ML	At 15', silt with clay and sand, slightly moist, dense
20		SPT	10	17	8	25					SM	At 20', sand and silt with gravel, dense, slightly moist
25		SPT	6	6	8	14					ML	At 25', silt with clay, slightly moist
30		SPT	11	50(5")		Refusal					GC	At 30', gravel with clay.
35		SPT	50(4")			Refusal					GC	At 35', gravel with clay.
40		SPT	12	15	16	31					GC	At 40', gravel with clay, saturated.
45		SPT	5	4	4	8					CL	At 45', gray clay with gravel, plastic, saturated
50		SPT	15	19	26	45					GC	At 50', gravel with clay, saturated.

BORING LOG

Boring No: B-6

Project Name	Geotechnical - Ogden City Treatment Plant	**Drilled By**	Earthcore Drilling Inc.
Project No	S04310/0005	**Drill Rig**	MB-80
Client	Ogden City, Utah	**Logged By**	D. Yang
Location	N41°15'12.73" W111°50'55.07"	**Date**	9/19/2008
Elevation	4842 Feet	**Note**	Odex 4 1/4 OD

Depth (ft)	Graphical Log		SPT Test Blows (6 in)	Blows (6 in)	Blows (6 in)	Blows (ft)	Recovery (in)	Wet Density (pcf)	Moisture (%)	Water Level (ft)	USCS classification	
0											GC	0-5': fill consisting of gravel and clay, slightly moist.
5		SPT	9	15	14	29					GC	At 5', fill consisting of gravel and clay, slightly moist.
10		SPT	16	17	18	35					ML	At 10', silt with gravel.
15		SPT	34	50(3")		Refusal						15-20': rock
20		SPT	14	29	26	55					SM	At 20', sand and silt with gravel, dense, slightly moist
25		SPT	3	5	21	26					SP	At 25', sand with gravel, slightly moist
30		SPT	4	5	6	11					SM	At 30', loose sand and silt.
35		SPT	3	3	4	7					SM	At 35', loose sand and silt.
40		SPT	6	9	17	26					CL	At 40', stiff clay with sand and silt, saturated.
45		SPT	7	10	7	17					CL	At 45', gray clay with gravel, plastic, saturated
50		SPT	6	7	9	16					GC	At 50', gravel with gray clay, saturated.

Appendix B
Geotechnical Soil Testing Results

REPORT OF SIEVE ANALYSIS

CLIENT: Sunrise Engineering
Attn: Dao Yang
12227 South Business Park Drive, Suite 220
Draper, Utah 84020

PROJECT: Ogden Tank

REPORT: 00036-001
DATE: Spetember 25, 2012
LAB NUMBER: 0046

SAMPLE SOURCE: Samples Submitted 9/19/2012
METHOD OF TEST: ASTM C-136/C-117

RESULTS

U.S. Standard Sieve Number	Percent Passing, By Weight				
	B5 (10'-11.5')	B5 (15'-16.5')	B5 (20')	B6 (10')	B6 (20')
1 1/2"	100	100	100	100	100
3/4"	96	100	96	96	96
3/8"	81	100	96	95	81
#4	74	100	96	95	65
#10	69	100	95	95	51
#40	54	99	92	93	36
#100	29	88	45	71	25
#200	20	65	22	52	20
Natural Moisture	13.2	18.2	9.8	5.4	3.8

Atterberg Limits (ASTM D-4318					
Sample Depth	B5 (10'-11.5')	B5 (15'-16.5')	B5 (20')	B6 (10')	B6 (20')
Liquid Limit	NP	NP	NP	NP	NP
Plastic Limit	NP	NP	NP	NP	NP
Classification	SM	ML	SM	ML	SM

Respectfully submitted,
Utah Testing and Engineering

Donald F. Kattelman
Operations Manager

Appendix C
Chemical Soil Testing Results

CHEMTECH-FORD
LABORATORIES

9/24/2012

Work Order: 1208816

Sunrise Engineering Inc.

Attn: Dao Yang

12227 S. Business Park Dr #220

Draper, UT 84020

Client Service Contact: Linda Daniels 801.262.7299

The analyses presented on this report were performed in accordance with the National Environmental Laboratory Accreditation Program (NELAP) unless noted in the comments, flags or case narrative. If the report is to be used for regulatory compliance, it should be presented in its entirety, and not be altered.

NELAP ACCREDITED TNI LABORATORY

Approved By:

Dave Gayer, Laboratory Director

CHEMTECH-FORD LABORATORIES

Certificate of Analysis

Lab Sample No.: 1208816-01

Name:	**Sunrise Engineering Inc.**	***Sample Date:***	9/18/2012 2:00 PM
Sample Site:	B-3	***Receipt Date:***	9/19/2012 1:00 PM
Comments:		***Sampler:***	Dao Yang
Sample Matrix:	Solid	***Project:***	Other

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Inorganic								
Sulfate, Soluble	27.9	100	mg/kg wet	9/24/2012 7:00	TSM	EPA 325.2	CTFID10218	

6100 South Stratler
Murray, UT 84107
801-262-7299 Office

CHEMTECH-FORD LABORATORIES

Certificate of Analysis

Lab Sample No.: 1208816-02

Name:	**Sunrise Engineering Inc.**	***Sample Date:***	9/19/2012 10:00 AM
Sample Site:	B-6	***Receipt Date:***	9/19/2012 1:00 PM
Comments:		***Sampler:***	Dao Yang
Sample Matrix:	Solid	***Project:***	Other

Parameter	Sample Result	Minimum Reporting Limit	Units	Analysis Date/Time	Analyst Initials	Analytical Method	CAS No.	Flag
Inorganic								
Sulfate, Soluble	37.3	100	mg/kg wet	9/24/2012 7:00	TSM	EPA 325.2	CTFID10218	

Abbreviations

ND = Not detected at the corresponding Minimum Reporting Limit.
1 mg/L = one milligram per liter or 1 mg/Kg = one milligram per kilogram = 1 part per million.
1 ug/L = one microgram per liter or 1 ug/Kg = one microgram per kilogram = 1 part per billion.
1 ng/L = one nanogram per liter or 1 ng/Kg = one nanogram per kilogram = 1 part per trillion.

Flag Descriptions

HD

CHEMTECH - FORD ANALYTICAL LABORATORY

CHAIN OF CUSTODY

COMPANY: Sunrise Engineering

ADDRESS:

CITY/STATE/ZIP:

PHONE #: FAX:

CONTACT: Dao Yang PROJECT:

EMAIL:

BILLING ADDRESS:

BILLING CITY/STATE/ZIP:

PURCHASE ORDER #:

TURNAROUND REQUIRED:* Monday - 9/24 AM

** Expedited turnaround subject to additional charge*

CHEMTECH-FORD LABORATORIES

___ Mark 'X' here if you want a copy sent to DEQ Division of Drinking Water.

RUSH

S-8194, ULINE, 800-295-5510

MATRIX
DW = Drinking Water
WW = Wastewater
W = Water
S = Soil
SO = Solid
SL = Sludge
O = Other

ANALYTICAL TESTS REQUESTED

Bacteriological

R = Routine
I = Investigative
TG = Trigger Source
CO = Confirmation

REPEAT
OR = Original Location
UP = Upstream
DN = Downstream

Lab ID #		SAMPLE IDENTIFICATION	SAMPLE DATE	SAMPLE TIME	Drinking Water FACILITY ID	Sulfide	FIELD: Residual Chlorine	Total Coliform + E. coli (Present/Absent)	Total Coliform + E. coli (Enumerated)	HPC (Plate Count)	E. coli only	Repeat (Fail #)	SYSTEM #
8816 -01	1.	B-3	9/8/12	1400	S	✓							
-02	2.	B-6	9/9/12	1000	S	✓							
	3.												
	4.												
	5.												
	6.												
	7.												
	8.												
	9.												
	10.												

Sampled by: [print] Dao Yang

Sampled by: [signature] Dao Yang

ON ICE NOT ON ICE

Special Instructions:

Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time
Dao Yang	9/9/12 13:00		9/9/12 1300
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time
Relinquished by: [signature]	Date/Time	Received by: [signature]	Date/Time

CHEMTECH-FORD 6100 South Stratler Street (380 West) Murray, UT 84107 Phone: 801-262-7299 FAX: 801-262-7378 www.chemtechford.com

CHEMTECH-FORD LABORATORIES

Sample Receipt Checklist

Lab ID #: 8816

Delivery Method: (circle one)

UPS FedEX USPS

Walk-In Courier Chemtech

Sample(s) sealed: Yes / No

Appropriate container/preserve: Yes / No

Temperature 18 C°

	Lab ID #	Bottle Type	Lot # (preservative)	No. of Subsample(s)	Preserved by client / third party	Preserved in Receiving/Laboratory	Vials submitted with headspace	Sample submitted past hold time	Filtered by client in field
1	01-02	G	–						
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

Comments:

G- 8oz. glass

Bottle Type	
Plastic	**Glass**
A- Plastic Unpreserved	**D-** 625 ($Na_2S_2O_3$)
B- Miscellaneous Plastic	**G-** Glass Unpreserved
C- Cyanide Qt (NaOH)	**H-** HAAs (NH_4Cl)
F- Sulfide Qt (NaOH/Zn Acetate)	**J-** 508/515/525 (Na_2SO_3)
M- Metals Pint (HNO_3)	**O-** Oil & Grease (1:1 HCl)
N- Nutrient Pint (H_2SO_4)	**P-** Phenols (H_2SO_4)
R- Radiological Gallon (HNO_3)	**T-** TOC/TOX (H_3PO_4)
S- Sludge Cups/Tubs	**U-** 531 (MCAA, $Na_2S_2O_3$)
Q- Plastic Bags	**V-** 524/THMs (Ascorbic Acid)
E- Coliform/Ecoli	**W-** 8260 (1:1 HCl)
Additional Volumes	**X-** Vial Unpreserved
Q- quart 1/2pt- half pint	**Y-** 624/504 ($Na_2S_2O_3$)
P- pint 1/2- half gallon	**Z-** Miscellaneous Glass