GEOTECHNICAL EVALUATION
MANCHESTER FIELDS SUBDIVISION
1900 WEST 11900 SOUTH
RIVERTON, UTAH
WT JOB NO. 6123JT052

Western Technologies Inc.
The Quality People
Since 1955

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Prepared for:

HENRY WALKER HOMES

May 6, 2013

Warren D. Clyde, P.E.
Principal

LICENSED PROFESSIONAL ENGINEER
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May 6, 2013

Henry Walker Homes
500 North Marketplace Drive, Suite 201
Centerville, Utah 84014

Attn: Mr. Benson J. Whitney

Re: Geotechnical Evaluation
Manchester Fields Subdivision
1900 West 11900 South
Riverton, Utah

WT Job No. 6123JT052

Western Technologies, Inc. (WT) has completed the geotechnical evaluation for the proposed Manchester Fields Subdivision to be located near 1900 West 11900 South in Riverton, Utah. This study was performed in general accordance with our proposal number 6123PT044, dated April 8, 2013. The results of our evaluation, including the boring location diagram, boring logs, laboratory test results, and geotechnical recommendations are attached.

We appreciate being of service to you in the geotechnical engineering phase of this project and are prepared to assist you during the construction phases as well. If design conditions change, or if you have any questions concerning this report or any of our materials testing, special inspection, or consulting services, please do not hesitate to contact us. We look forward to working with you on future projects.

Sincerely,
WESTERN TECHNOLOGIES INC.
Geotechnical Engineering Services

Warren D. Clyde, P.E.
Principal

Copies to: Addressee (5)

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GEOTECHNICAL EVALUATION
MANCHESTER FIELDS SUBDIVISION
1900 WEST 11900 SOUTH
RIVERTON, UTAH
WT JOB NO. 6123JT052

1.0 PURPOSE

This report contains the results of our geotechnical evaluation for the proposed Manchester Fields Subdivision to be located near 1900 West 11900 South in Riverton, Utah. The purpose of these services is to provide information and recommendations regarding:

- Foundation design parameters, including footing types, depths, allowable bearing capacities, and estimated settlements
- Lateral earth pressures
- Earthwork, including site preparation, fill placement, and suitability of existing soils for fill materials
- Drainage
- Pavements
- Seismic considerations
- Corrosivity
- Excavation conditions
- Slabs-on-grade
- Groundwater
- Geologic hazards

Results of the field exploration, field tests, and laboratory tests are presented in the Appendices.

2.0 PROJECT DESCRIPTION

Project information supplied by Mr. Benson J. Whitney on April 8, 2013 indicates that the proposed buildings are to be a 1 to 2-story, single family houses with basements using wood frame construction. The maximum wall and column loads are assumed to be 3 to 5 kips per linear foot and 75 to 100 kips, respectively. We anticipate that the ground floor level will be at or slightly above existing site grade and that no extraordinary slab criteria are required. On-site asphalt paved areas for local roadways and rigid pavement sections for driveways and sidewalks will be constructed. Final site grading plans were not available at the time of this report. Should our assumptions not be correct, we should be notified immediately.

3.0 SCOPE OF SERVICES

3.1 Field Exploration

Four borings were drilled to depths ranging from 16 to 21.5 feet below existing grade in the proposed building areas. In addition, two borings were drilled to depths of 6.5 feet in the proposed local road area. The borings were at the approximate locations shown on the attached Boring Location Diagram. A field log was prepared for each boring. These logs contain visual classifications of the materials encountered during drilling as well as interpolation of the subsurface conditions between samples. Final logs, included in Appendix A, represent our interpretation of the field logs and may include modifications based on laboratory observations and tests of the field samples. The final logs describe the materials encountered, their thicknesses, and the locations where samples were obtained.

The Unified Soil Classification System was used to classify soils. The soil classification symbols appear on the boring logs and are briefly described in Appendix A. Local and regional geologic characteristics were used to estimate the seismic design criteria and evaluate subsidence zones.

3.2 Laboratory Analyses

Laboratory analyses were performed on representative soil samples to aid in material classification and to estimate pertinent engineering properties of the on-site soils for preparation of this report. Testing was performed in general accordance with applicable ASTM test methods. The following tests were performed and the results are presented in Appendix B.

- Water Content
- Dry Density
- Plasticity
- Minus #200 Sieve
- Consolidation/Swell/Collapse

3.3 Analyses and Report

Analyses were performed and this report was prepared for the exclusive purpose of providing geotechnical engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. We are available to discuss the scope of such studies with you.

This geotechnical engineering report includes a description of the project, a discussion of the field and laboratory testing programs, a discussion of the subsurface conditions, and design recommendations as required to satisfy the purpose previously described.

4.0 SITE CONDITIONS

4.1 Surface

At the time of our exploration, the site was vacant field. The ground surface was flat and contained a sparse growth of grass and weeds. Imported fill piles were located on the site with some spread fill areas. Site drainage trended to the north and east as sheet surface flow.

4.2 Subsurface

As presented on Logs of the borings, surface soils to depths of inches to 1 foot consist of topsoil or spread fill. The materials underlying the surface soils and extending to the full depth of exploration consisted of clay, silt, sand and gravel layers. Highly plastic clay was present in borings B-1 and B-3.

4.3 Groundwater

Groundwater not encountered at the time of exploration. These observations represent the groundwater conditions at the time of measurements and may not be indicative of other times. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions, groundwater withdrawal and recharge, local irrigation practices, and future development.

4.4 Geology

The site is located in the Jordan Valley west of the western slope of the Central Wasatch Range section of the Middle Rocky Mountains Province. The Wasatch Range trends north-south and includes broad alluvial valley bottoms and low hills in the north and rugged mountains cut by deep valleys in the south. The site is in an area bounded by the Great Salt Lake to the north, the Oquirrh Mountains to the west, the Traverse Mountains to the south, and the Wasatch Mountains to the east. Most of the area is sloping gently down to the east. The site is located on the fine-grained lacustrine deposits including brown, dark brown, grayish-brown and gray calcareous, laminated silt, and sandy silt (*Geologic Map of the Midvale Quadrangle, Salt Lake County, Utah*, Utah Geological Survey, 2000).

4.5 Geologic Hazards

The nearest mapped fault is approximately 6 miles to the east. According to the Salt Lake County *Surface Fault Rupture Liquefaction Potential Special Study Areas Map,* the site is located in a "very low" liquefaction potential area and surface fault rupture is not expected at the site.

5.0 GEOTECHNICAL PROPERTIES & ANALYSIS

5.1 Laboratory Tests

Laboratory test results (see Appendix B) indicate that native subsoils near shallow foundation level exhibit low compressibility at existing water contents. However, expansion was observed in Boring B-1 to a depth of 8 feet and a collapse was observed in samples from Boring 1 at 2.5 feet when the water content is increased.

Near-surface soils near basement foundation levels are of moderate to high plasticity. Only the high plasticity soils in boring B-1 exhibit expansion potential when confined by loads approximating foundation and saturated. Soils in all other borings at this elevation did not exhibit expansion.

Chemical tests were performed on a representative sample to determine the sulfate exposure for concrete due to sulfates in the on-site soils. The sulfate content test was performed by American West Analytical Laboratories and the results are presented in **Appendix B**

5.2 Field Tests

Native subsoils near shallow foundation level exhibited low to moderate to high resistance to penetration using the standard penetration test method (ASTM D1586) (or Ring-lined barrel sampling (ASTM D3550)). These soils correlate to have low to moderate bearing capacity in their present condition.

The boring logs included in this report are indicators of subsurface conditions only at the specific location and date noted. Variations from the field conditions represented by the borings may become evident during construction. If variations appear, we should be contacted to re-evaluate our recommendations.

6.0 RECOMMENDATIONS

6.1 General

Recommendations contained in this report are based on our understanding of the project criteria described in Section 2.0, Project Description, and the assumption that the soil and subsurface conditions are those disclosed by the borings (and test pits). Others may change the plans, final elevations, number and type of structures, foundation loads, and floor levels during design or construction. Substantially different subsurface conditions from those described herein may be encountered or become known. Any changes in the project criteria or subsurface conditions shall be brought to our attention in writing.

6.2 Design Considerations

The borings indicate the presence of collapsible soils at the surface. The collapsible soils consolidate with an increase in moisture content. Structures and related improvements situated on collapsible clay soils could be subject to relatively large movements if the foundation soils experience an increase in moisture content. If collapsible soils are encountered during earthwork operations, the collapsible soils should be removed and be replaced with engineered fill or garage footings should extend to non collapsible soils at the same elevation as the basement foundations.

Expansive soils were encountered in boring B-1 to depths of 8 feet. Structures and related improvements situated on the expansive soils could be subject to relatively large movements if the foundation soils experience an increase in moisture content. Expansive soils should be removed and be replaced with engineered fill

6.3 Foundations

Conventional spread and continuous wall footings may be used to support houses with basements. Footings may be founded one foot or so, below the finished basement floor elevations using an allowable bearing pressure of up to 1500 psf. In the area that expansive soils were encountered in the boring basement footings should be a minimum of 8 feet below the existing site grades or the expansive soils should be removed and be replaced with engineered fill extending to a minimum of 8 feet below the existing site grades. Garage footings should be extended to the same elevation as basement footings. Minimum footing depth below any adjacent soil surface due to frost is 2.5 feet.

Fill should not be used for support of any foundations or slabs unless it is placed and compacted to the requirements for engineered fill.

Thickened slab sections can be used to support interior partitions, provided that:

- loads do not exceed 900 plf,
- the thickened sections are supported undisturbed native soils,
- thickened sections have a minimum width of 12 inches, and
- thickness and reinforcement are consistent with structural requirements.

We anticipate that the total and differential movement of the proposed structures, supported as recommended, should be less than 1 inch and ½ inch respectively. Additional foundation movements could occur if water from any source infiltrates the foundation soils. Therefore, proper drainage should be provided in the final design and during construction.

All footings, stem walls, and masonry walls should be reinforced to reduce the potential for distress caused by differential foundation movements. The use of joints at openings or other discontinuities in masonry walls is recommended.

We recommend that the geotechnical engineer or his representative observe the footing excavations before reinforcing steel and concrete are placed. This observation is to assess whether the soils exposed are similar to those anticipated for support of the footings. Any soft, loose or unacceptable soils should be undercut to suitable materials and backfilled with approved fill materials or lean concrete. Soil backfill should be properly compacted.

6.4 Lateral Design Criteria

Lateral loads may be resisted by concrete interface friction and by passive resistance. For shallow foundations bearing on properly compacted fill at this site, we recommend the following lateral resistance criteria:

- Coefficient of Friction..... 0.28
- Passive Pressure..... 250 psf/ft

The frictional resistance and the passive pressure may be combined without reduction in determining the total lateral resistance.

6.5 Earth Retaining Structures

a. Unrestrained Structures

Earth retaining structures less than 8 feet in height, above any free water surface, with level backfill and no surcharge loads may be designed using the equivalent fluid pressure method. Recommended equivalent fluid pressures and coefficients of base friction for unrestrained elements are:

- Active:
  - Undisturbed subsoil ..... 35 psf/ft
  - Compacted granular backfill ..... 30 psf/ft
  - Compacted site soils (non-clay) ..... 35 psf/ft
  - Clay site soils.....not recommended for use

- Passive:
  - Shallow wall footings.....250 psf/ft
  - Shallow column footings .....400 psf/ft

- Coefficient of base friction 0.40*

  * The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.

b. Restrained Structures

Where the design includes restrained elements, the following equivalent fluid pressures are recommended:

- At-rest:
  - Undisturbed subsoil ..... 60 psf/ft
  - Compacted granular backfill ..... 55 psf/ft

The equivalent fluid pressures presented herein do not include the lateral pressures arising from the presence of:

- hydrostatic conditions, submergence or partial submergence
- sloping backfill, positively or negatively
- surcharge loading, permanent or temporary
- seismic or dynamic conditions

We recommend a free-draining soil layer or manufactured geosynthetic material, be constructed adjacent to the back of any retaining walls. A filter may be required between the soil backfill and drainage layer. This drainage zone should help prevent development of hydrostatic pressure on the wall. This vertical drainage zone should be tied into a gravity drainage system at the base of the wall. It is important that all backfill be properly placed and compacted. Backfill should be mechanically compacted in layers. Flooding or jetting should not be permitted. Care should be taken not to damage the walls when placing the backfill. Backfills should be observed and tested during placement.

Fill against footings, stem walls, basement walls and retaining walls should be compacted to densities specified in **Earthwork**. Medium to high plasticity clay soils should not be used as backfill against retaining walls. Compaction of each lift adjacent to walls should

be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures that could result in wall movements.

6.6 Seismic Considerations

For structural designs based upon the International Residential Code 2009, the following criteria will apply based upon approximate latitude and longitude coordinates. S_s, the spectral acceleration for short periods, is 1.21g. S_1, the spectral acceleration for a 1-second period, is 0.50g. Site Class D - F_a is 1.02 and F_v is 1.50. The Residential Site Value is 0.82g and the IRC Seismic Design Category is D1.

Liquefaction potential at the site is shown as "very low" according to the *Surface Rupture Liquefaction Potential Special Study Areas, Salt Lake County, Utah* (Salt Lake County, 2002) map. Based upon the fine grained, stiff soils encountered in the borings liquefaction is not anticipated on this site.

6.7 Conventional Slab-on-Grade Support

Basement Floor slabs can be supported on properly placed and compacted fill or approved natural soils. The slab subgrade should be prepared by the procedures outlined in this report. A minimum 4-inch layer of base course should be provided beneath all slabs to help prevent capillary rise and a damp slab.

For design of interior slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci) for the on-site clays and a value of 250 pci for the engineered fill.

The use of vapor retarders is desirable for any slab-on-grade where the floor will be covered by products using water based adhesives, wood, vinyl backed carpet, impermeable floor coatings (urethane, epoxy, acrylic terrazzo, etc.) or where the floor will be in contact with moisture sensitive equipment or product. When used, the design and installation should be in accordance with the recommendation given in ACI 302.2R-06.

All concrete placement and curing operations should follow the American Concrete Institute manual recommendations. Improper curing techniques and/or high slump (high water-cement ratio) could cause excessive shrinkage, cracking or curling. Concrete slabs should be allowed to cure adequately before placing vinyl or other moisture sensitive floor covering.

6.8 Drainage

The major cause of soil problems in this vicinity is moisture increase in soils below structures. Therefore, it is extremely important that positive drainage be provided during

construction and maintained throughout the life of the proposed development. Infiltration of water into utility or foundation excavations must be prevented during construction. No planters or other surface features that could retain water adjacent to the building should be constructed.

In areas where sidewalks or paving do not immediately adjoin the structure, protective slopes should be provided with an outfall of about 5 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to minimize the possibility of moisture infiltration.

If planters and/or landscaping are adjacent to or near the structure, we recommend the following:

- Planters should be sealed.
- Grades should slope away from the structure(s).
- Only shallow rooted landscaping should be used.
- Watering should be kept to a minimum.

The onsite clay soils are classified as Group II according to the 2009 International Residential code Table R405.1. Therefore, a perimeter drain is required for all enclosed habitable or usable spaces located below grade.

6.9 Corrosivity to Concrete

For determining the exposure categories and classes for concrete in accordance with **Section 1904 Durability Requirements** for concrete of the *2009 International Building Code,* sulfate exposure from the soils at the site classify as "Not Appliciable (S0)" according to Table 4.2.1 *American Concrete Institute Building Code* (ACI 318).

6.10 Pavements

The on-site soils are considered as poor quality materials for support of pavements. Local road usage is anticipated to be consist of mainly passenger cars, weekly truck traffic for garbage pickup and occasional truck traffic for deliveries. On this basis, a daily traffic value of 41 Equivalent 18-kip Single Axle Loads (ESAL) was estimated for local roadways. A resilient modulus (M_r) of 4000 pounds per square inch corresponding to a CBR Value of 2.6 was assigned to the on-site soil. A reliability value of 85 percent was assigned to the facility that corresponds to occasional interruption of traffic for pavement repairs. Based upon these parameters, the resulting pavement sections according to the AASHTO procedure for a 20-year design life are:

Traffic Area	Asphaltic Concrete Pavement (inches)	Untreated Base Course (inches)	Subbase Course (inches)
Local Roadways	3	6	12
	3.5	6	8

The "design life" of a pavement is defined as the expected life at the end of which reconstruction of the pavement will need to occur. Normal maintenance, including crack sealing, slurry sealing, and/or chip sealing, should be performed during the life of the pavement.

Bituminous surfacing should be constructed of dense-graded, central plant-mix, asphalt concrete. Base course material should conform with specification requirements for Untreated Base of the City of Riverton or Utah Department of Transportation specifications.

Material and compaction requirements should conform to recommendations presented under **Earthwork**. The gradient of paved surfaces should ensure positive drainage. Water should not pond in areas directly adjoining paved sections.

7.0 EARTHWORK

7.1 General

The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section. Any excavating, trenching, or disturbance that occurs after completion of the earthwork must be backfilled, compacted and tested in accordance with the recommendations contained herein. It is not reasonable to rely upon our conclusions and recommendations if any future unobserved and untested trenching, earthwork activities or backfilling occurs.

Although underground facilities such as septic tanks, cesspools, basements, utilities, and dry wells were not observed, such features might be encountered during construction. These features should be demolished in accordance with the recommendations of the geotechnical engineer. Any loose or disturbed soils resulting from demolition should be removed or recompacted as engineered fill and any excavations should be backfilled in accordance with recommendations presented herein.

7.2 Site Clearing

Strip and remove any existing vegetation, organic topsoils, debris, old foundations and any other deleterious materials from the building and pavement areas. The building area is

defined as that area within the building footprint plus 5 feet beyond the perimeter of the footprint. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction.

7.3 Excavation

We anticipate that excavations for shallow foundations and utility trenches for the proposed construction can be accomplished with conventional equipment.

On-site clayey soils will pump or become unworkable at high water contents. Workability may be improved by scarifying and drying. Overexcavation of wet zones and replacement with granular materials may be necessary. The use of lightweight excavation and compaction equipment may be required to minimize subgrade pumping.

The soils to be penetrated by the proposed excavations may vary significantly across the site. Our soil classifications are based solely on the materials encountered in widely spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are found at the time of construction, we should be contacted immediately to evaluate the conditions encountered.

7.4 Temporary Excavations and Slopes

If any excavation, including a utility trench, is extended to a depth of more than 20 feet, it will be necessary to have the side slopes designed by a professional engineer.

As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance back from the crest of the slope at least equal to the slope height. The exposed slope face should be protected against the elements.

We recommend that the contractor retain a geotechnical engineer to observe the soils exposed in all excavations and provide engineering design for the slopes. This will provide an opportunity to classify the soil types encountered, and to modify the excavation slopes as necessary. This also allows the opportunity to analyze the stability of the excavation slopes during construction.

7.5 Foundation Preparation

Unless expansive soils are encountered in the excavation, specialized treatment of existing soils within foundation areas is not required. Footings should bear upon undisturbed native soils or engineered fill. In areas of expansive soils, the expansive soils should be removed to non-expansive soils and be replaced with engineered fill.

Since collapsible soils were encountered in the surface soils at a depth of 2.5 feet, garage footings should bear at the same elevation as basement footings.

7.6 Conventional Interior Slab Preparation

Prior to the placement of fill or aggregate base course, the exposed soil should consist of native undisturbed soils. All underslab utility trenches should be backfilled with untreated base or clean 3/8 to 3/4 inch gravel.

7.7 Exterior Slab Preparation

Exterior concrete grade slabs may heave due to moisture changes or frost, resulting in cracking or vertical offsets. This potential would be greatest where slabs overlie compacted clayey subgrade soils or in areas where the passage of construction equipment has inadvertently densified subsoils. To reduce the potential for damage, we recommend:

- Use of fill with low expansion potential
- Placement of effective control joints on relatively close centers
- Moisture-density control during placement of subgrade fills
- Provision for adequate drainage in areas adjoining the slabs
- Use of designs which allow vertical movement between the exterior slabs and adjoining structural elements

7.8 Pavement Preparation

After the site has been stripped of topsoil and fill the subgrade should be cut to the elevation required to allow the pavement section, subgrade should be scarified, moistened as required, and recompacted for a minimum depth of 10 inches prior to placement of fill and pavement materials.

7.9 Materials

Imported materials may be used as fill material for the following:

- foundation areas
- interior slab areas
- pavement subbaseareas
- backfill

On-site soils are not recommended for use as subbase or engineered fill below footings. Clean on-site soils may be used as engineered fill below the subbase course in pavement areas provided it is placed and compacted to the requirements for engineered fill.

Imported soils should conform to the following:

- Gradation (ASTM C136):

	percent finer by weight
6"	100
4"	85-100
¾"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	20 (max)

The materials used below footings and slabs should be reasonable free of rocks or lumps having a particle diameter greater than 6 inches. Acceptance of the quantity of oversize material shall be at the discretion of the geotechnical engineer.

7.10 Placement and Compaction

a. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

b. Uncompacted fill lifts should not exceed 10 inches.

c. Frozen soils or soils mixed with snow should not be used.

d. Materials should be compacted to the following:

Material Compaction (ASTM D1557)	Minimum Percent
• On-site soil, reworked and fill:	
Below footings	95
Below slabs-on-grade	90
Below pavement	95
• Imported soil:	
Below footings	95
Below slabs-on-grade	90
Below pavement	95
• Untreated base course below slabs-on-grade	95
• Untreated base below pavement	95
• Nonstructural backfill	90

On-site clayey soils should be compacted within a water content range of 0 to 3 percent above optimum. Imported and on-site granular soils with low expansion potential should be compacted within a water content range of 1 percent below to 3 percent above optimum.

7.11 Compliance

Recommendations for slabs-on-grades, foundations, and pavement elements supported on compacted fills or prepared subgrade depend upon compliance with **Earthwork** recommendations. To assess compliance, observation and testing should be performed under the direction of a geotechnical engineer.

8.0 LIMITATIONS

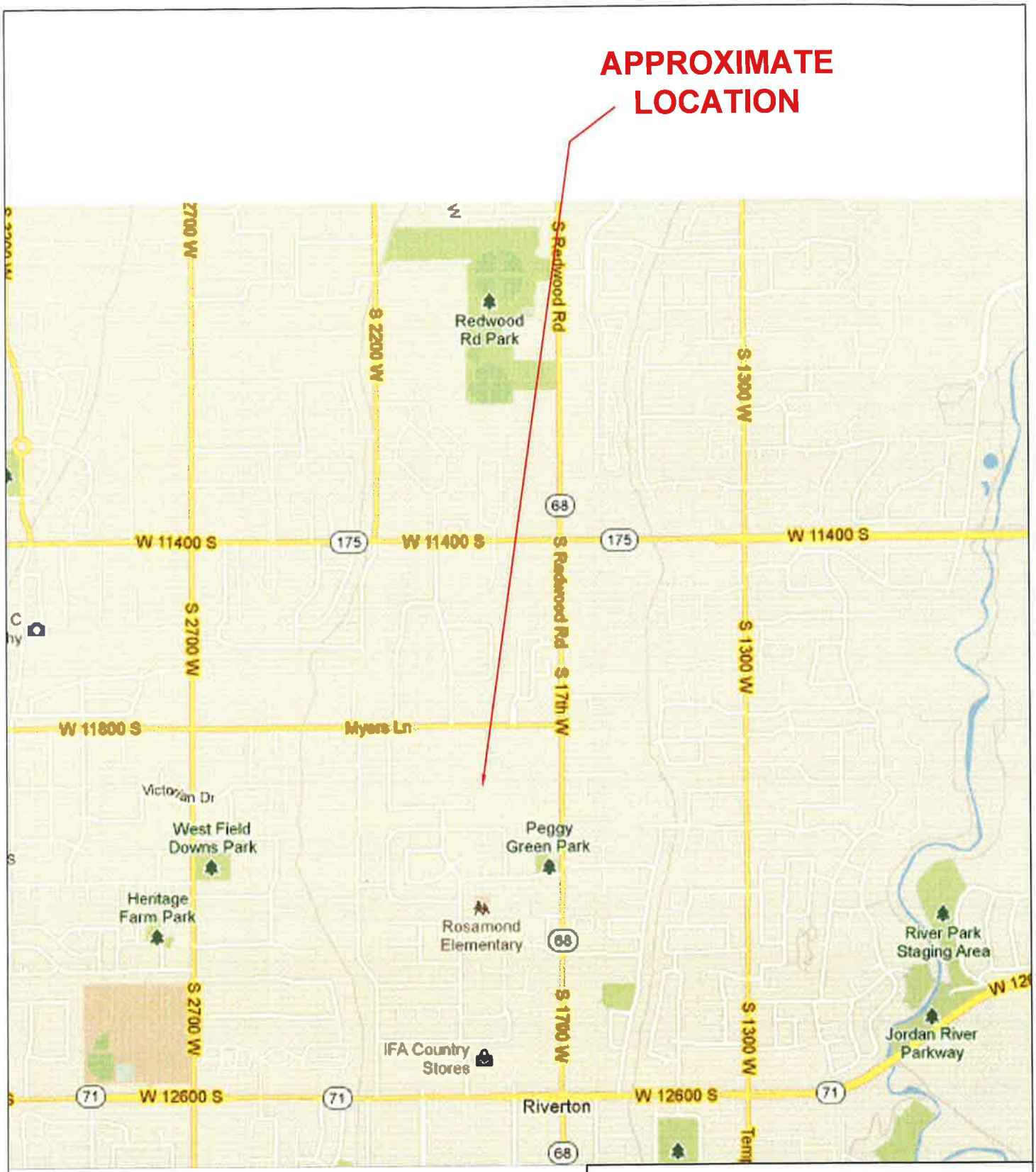
This report has been prepared assuming the project criteria described in Section 2.0. If changes in the project criteria occur, or if different subsurface conditions are encountered or become known, the conclusions and recommendations presented herein shall become invalid. In any such event, WT should be contacted in order to assess the effect that such variations may have on our conclusions and recommendations.

The recommendations presented are based entirely upon data derived from a limited number of samples obtained from widely spaced borings. The attached logs are indicators of subsurface conditions only at the specific locations and times noted. This report assumes the uniformity of the geology and soil structure between borings, however variations can and often do exist. Whenever any deviation, difference or change is encountered or becomes known, WT should be contacted.

This report is valid for the earlier of one year from the date of issuance, a change in circumstances, or discovered variations. After expiration, no person or entity shall rely on this report without the express written authorization of WT.

9.0 CLOSURE

We prepared this report as an aid to the designers of the proposed project. The comments, statements, recommendations and conclusions set forth in this report reflect the opinions of the authors. These opinions are based upon data obtained at the location of the borings, and from laboratory tests. Work on your project was performed in accordance with generally accepted standards and practices utilized by professionals providing similar services in this locality. No other warranty, express or implied, is made.



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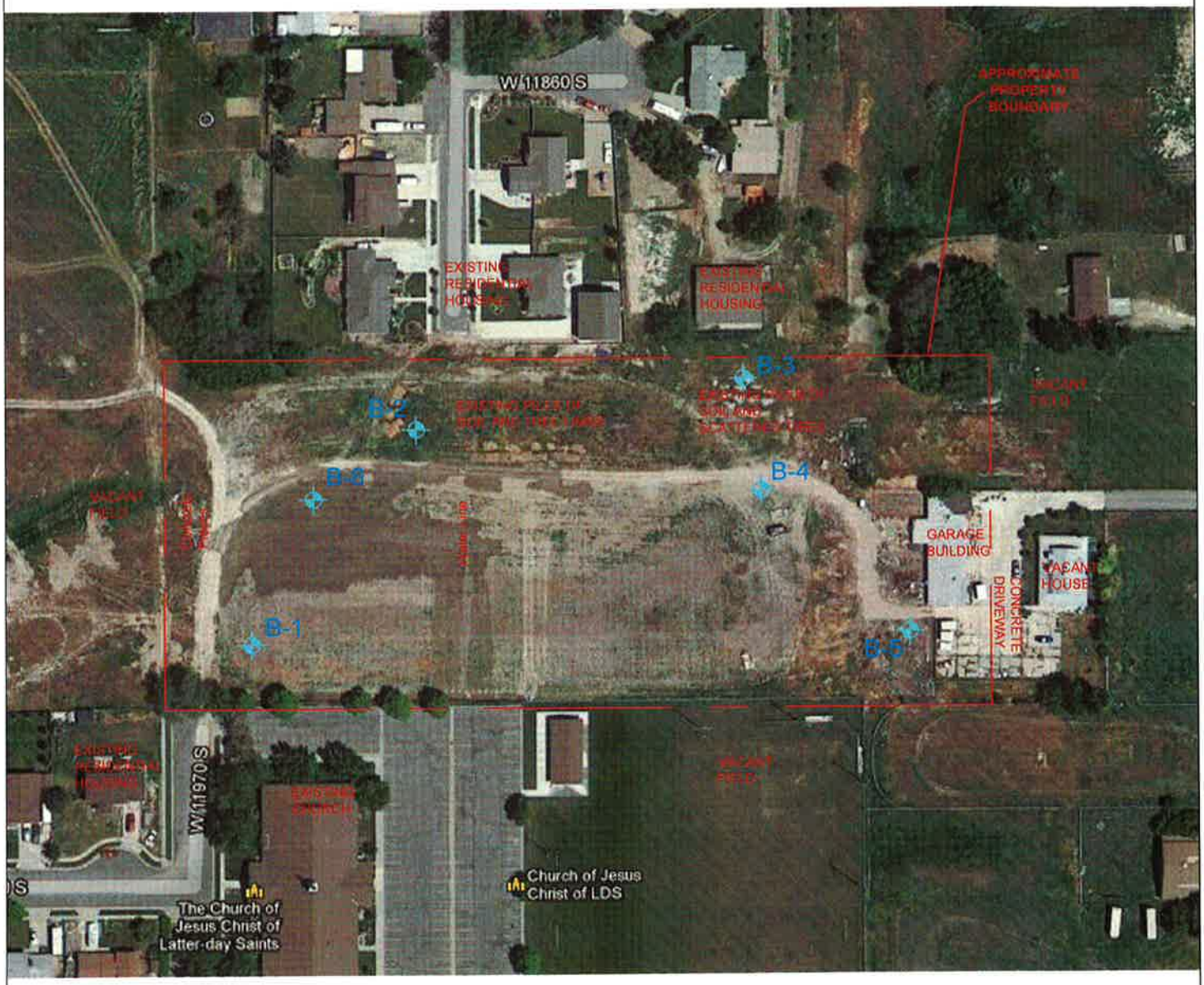
MANCHESTER FIELDS SUBDIVISION	
Property Vicinity Map	
Western Technologies, Inc.	
Job No. 6123JT052	Plate: A-1



LEGEND

Approximate Boring Location

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Not to scale

MANCHESTER FIELDS SUBDIVISION	
Boring Location Diagram	
Western Technologies, Inc.	
Job No. 6123JT052	Plate: A-2

Allowable Soil Bearing Capacity	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
Backfill	A specified material placed and compacted in a confined area.
Base Course	A layer of specified material placed on a subgrade or subbase.
Base Course Grade	Top of base course.
Bench	A horizontal surface in a sloped deposit.
Caisson	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
Concrete Slabs-On-Grade	A concrete surface layer cast directly upon a base, subbase or subgrade.
Crushed Rock Base Course	A base course composed of crushed rock of a specified gradation.
Differential Settlement	Unequal settlement between or within foundation elements of a structure.
Engineered Fill	Specified material placed and compacted to specified density and/or moisture conditions under observations of a representative of a soil engineer.
Existing Fill	Materials deposited through the action of man prior to exploration of the site.
Existing Grade	The ground surface at the time of field exploration.
Expansive Potential	The potential of a soil to expand (increase in volume) due to absorption of moisture.
Fill	Materials deposited by the actions of man.
Finished Grade	The final grade created as a part of the project.
Gravel Base Course	A base course composed of naturally occurring gravel with a specified gradation.
Heave	Upward movement
Native Grade	The naturally occurring ground surface.
Native Soil	Naturally occurring on-site soil.
Rock	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
Sand and Gravel Base	A base course of sand and gravel of a specified gradation.
Sand Base Course	A base course composed primarily of sand of a specified gradation.
Scarify	To mechanically loosen soil or break down existing soil structure.
Settlement	Downward movement.
Soil	Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
Strip	To remove from present location.
Subbase	A layer of specified material placed to form a layer between the subgrade and base course.
Subbase Grade	Top of subbase.
Subgrade	Prepared native soil surface.

MANCHESTER FIELDS SUBDIVISION	
Definition of Terminology	
Western Technologies Inc.	
Job No.: 6123JT052	Plate: A-1

COARSE-GRAINED SOILS

LESS THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE
GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	
GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% FINES	
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% FINES	
SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE
SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	
SM	SILTY SANDS, SAND-SILT MIXTURES, MORE THAN 12% FINES	
SC	CLAYEY SANDS, SAND-CLAY MIXTURES, MORE THAN 12% FINES	

NOTE: Coarse-grained soils receive dual symbols if they contain 5% to 12% fines (e.g., SW-SM, GP-GC).

FINE-GRAINED SOILS

MORE THAN 50% FINES

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
OL	ORGANIC SILTS OR ORGANIC SILT-CLAYS OF LOW PLASTICITY	
MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS	SILTS AND CLAYS LIQUID LIMIT MORE THAN 50
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY	
PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS

NOTE: Fine-grained soils may receive dual classification based upon plasticity characteristics.

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	Above 12 in.
COBBLES	3 in. – 12 in.
GRAVEL	No. 4 – 3 in.
Coarse	3/4 in. – 3 in.
Fine	No. 4 – 3/4 in.
SAND	No. 200 – No. 4
Coarse	No. 10 – No. 4
Medium	No. 40 – No. 10
Fine	No. 200 – No. 40
*Fines (Silt or Clay)	Below No. 200

NOTE: Only sizes smaller than three inches are used to classify soils

CONSISTENCY

CLAYS & SILTS	BLOWS PER FOOT*
VERY SOFT	0 – 2
SOFT	2 – 4
FIRM	4 – 8
STIFF	8 – 16
VERY STIFF	16 – 32
HARD	Over 32

RELATIVE DENSITY

SANDS & GRAVELS	BLOWS PER FOOT*
VERY LOOSE	0 – 4
LOOSE	4 – 10
MEDIUM DENSE	10 – 30
DENSE	30 – 50
VERY DENSE	Over 50

*Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1 3/8 inch ID) split spoon (ASTM D1586).

PLASTICITY OF FINE GRAINED SOILS

PLASTICITY INDEX	TERM
0	NON-PLASTIC
1 – 7	LOW
8 – 25	MEDIUM
Over 25	HIGH

DEFINITION OF WATER CONTENT

DRY
SLIGHTLY DAMP
DAMP
MOIST
WET
SATURATED

MANCHESTER FIELDS SUBDIVISION

Method of Classification

Western Technologies Inc.

Job No.: 6123JT052 | Plate: A-2

The number shown in **"BORING NO."** refers to the approximate location of the same number indicated on the "Boring Location Diagram" as positioned in the field by pacing or measurement from property lines and/or existing features, or through the use of Global Positioning System (GPS) devices.

"DRILLING TYPE" refers to the exploratory equipment used in the boring wherein **HSA = hollow stem auger**, and the dimension presented is the outside diameter of the HSA used.

"N" in "BLOWS/FT." refers to a 2-in. outside diameter split-barrel sampler driven into the ground with a 140 lb. drop-hammer dropped 30 in. repeatedly until a penetration of 18 in. is achieved or until refusal. The number of blows, or "blow count", of the hammer is recorded for each of three 6-in. increments totaling 18 in. The number of blows required for advancing the sampler for the last 12 in. (2^{nd} and 3^{rd} increments) is defined as the Standard Penetration Test (SPT) "N"-Value. Refusal to penetration is considered more than 50 blows per foot. (Ref. ASTM D 1586).

"R" in "BLOWS/FT." refers to a 2.5-in. outside diameter ring-lined split spoon sampler driven into the ground with a 140 lb. drop-hammer dropped 30 in. repeatedly until a penetration of 12 in. is achieved or until refusal. The number of blows required to advance the sampler 12 in. is defined as the "R" blow count. The "R" blow count requires an engineered conversion to an equivalent SPT N-Value. Refusal to penetration is considered more than 50 blows per foot. (Ref. ASTM D 3550).

"SAMPLE TYPE" refers to the form of sample recovery, in which **N = Split-barrel sample, R = Ring-lined sample, G = Grab sample, B = Bucket sample, C = Core sample** (ex. diamond bit rock coring).

"DRY DENSITY (LBS/CU FT)" refers to the laboratory-determined dry density in pounds per cubic foot. The symbol **"NR"** indicates that no sample was recovered. The symbol **"DU"** indicates that determination of dry density was not possible.

"MOISTURE CONTENT (% OF DRY WT.)" refers to the laboratory-determined water content in percent (Ref. ASTM D2216).

"USCS" refers to the "Unified Soil Classification System" Group Symbol for the soil type as defined by ASTM D 2487 and D 2488. The soils were classified visually in the field, and where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the date(s) noted. Variations in subsurface conditions and characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

The stratification lines shown on the boring logs represent our interpretation of the approximate boundary between soil or rock types based upon visual field classification at the boring location. The transition between materials is approximate and may be more or less gradual than indicated.

MANCHESTER FIELDS SUBDIVISION	
Boring Log Notes	
Western Technologies Inc.	
Job No.: 6123JT052	Plate: A-3

DATE DRILLED: 4-19-13
LOCATION: See Location Diagram
ELEVATION: Not Determined

BORING NO. B-1

EQUIPMENT TYPE: Mobile B-80
DRILLING TYPE: 7"HSA
FIELD ENGINEER: K. Parks

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOW COUNTS	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
					0			TOPSOIL; sandy clay, light brown, moist
		R		16 19 17		CL		CLAY; trace sand, light brown, very stiff, damp
		R		8 12 18	5	CH		CLAY; highly plastic, light brown, very stiff, damp
		R		9 11 15		CL		CLAY; trace sand, brown, moist
		R		9 10 16	10	ML		SANDY SILT; brown, iron oxide stains, moist
		R		21 42 50	15	GM		SANDY GRAVEL; brown, very dense, moist
					20			AUGER REFUSAL AT 16.5 FEET

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

WESTERN TECHNOLOGIES INC.

PROJECT: MANCHESTER FIELDS SUBDIVISION
REF. NO.: 6123JT052

BORING LOG

PLATE
A-4

DATE DRILLED: 4-19-13
LOCATION: See Location Diagram
ELEVATION: Not Determined

BORING NO. B-2

EQUIPMENT TYPE: Mobile B-80
DRILLING TYPE: 7"HSA
FIELD ENGINEER: K. Parks

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOW COUNTS	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
								FILL; gravelly sandy silt, light brown to white
		R		16 14 9		SM		SILTY GRAVELLY SAND; brown, medium dense, moist
		R		5 6 11	5	SC		CLAYEY SAND: some gravel, brown, medium dense, moist
		R		8 8 16		CL		CLAY; brown, very still, wet
		R		4 7 14	10			
						SC		GRAVELLY CLAYEY SAND; brown, very dense, moist
		R		19 35 40	15			
								AUGER REFUSAL AT 17 FEET
					20			

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

WESTERN TECHNOLOGIES INC.

PROJECT: MANCHESTER FIELDS SUBDIVISION
REF. NO.: 6123JT052

BORING LOG

PLATE
A-5

DATE DRILLED: 4-19-13
LOCATION: See Location Diagram
ELEVATION: Not Determined

BORING NO. B-3

EQUIPMENT TYPE: Moble B-80
DRILLING TYPE: 7"HSA
FIELD ENGINEER: K. Parks

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOW COUNTS	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
								TOPSOIL; light brown, gravelly silt, moist
						SC		CLAYEY GRAVELLY SAND; brown, medium dense, moist
		R		20 17 17				
						CH		CLAY; highly plastic, light brown to gray, iron oxide stains, stiff to very stiff, moist
		R		4 6 8	5			
		R		4 10 11				
						CL		SANDY CLAY; brown, stiff, moist
		R		7 7 7	10			
						SM		SILTY GRAVELLY SAND; brown, iron oxide stains, very dense, moist
		R		23 27 28	15			
						CL		SANDY CLAY; brown, iron oxide stains, very stiff, wet
		R		5 9 12	20			
								BORING TERMINATED AT 21.5 FEET

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.

PROJECT: **MANCHESTER FIELDS SUBDIVISION**
REF. NO.: **6123JT052**

PLATE
A-6

BORING LOG

DATE DRILLED: 4-19-13
LOCATION: See Location Diagram
ELEVATION: Not Determined

BORING NO. B-4

EQUIPMENT TYPE: Moble B-80
DRILLING TYPE: 7"HSA
FIELD ENGINEER: K. Parks

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOW COUNTS	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
						ML		SILT; with gravel, light brown, very stiff, damp
		R		11 15 18				... light brown to gray
		R		11 9 16	5			... iron oxide stains
								BORING TERMINATED AT 6.5 FEET
					10			
					15			
					20			

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.

PROJECT: **MANCHESTER FIELDS SUBDIVISION**
REF. NO.: **6123JT052**

BORING LOG

PLATE
A-7

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

DATE DRILLED: 4-19-13
LOCATION: See Location Diagram
ELEVATION: Not Determined

BORING NO. B-5

EQUIPMENT TYPE: Moble B-80
DRILLING TYPE: 7"HSA
FIELD ENGINEER: K. Parks

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOW COUNTS	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
								TOPSOIL; sandy silt, brown, moist
		R		12 14 16		SC		CLAYEY SAND; light brown to gray, iron oxide stains, sand layers, damp
		R		8 12 15	5			... light brown,
		R		6 17 15		CL		SANDY CLAY; sand layers, light brown to gray, very stiff, moist
		R		7 8 20	10			
		R		4 5 6	15			... brown, iron oxide stains, stiff, moist
		R		11 15 16	20			... very stiff
								BORING TERMINATED AT 21.5 FEET

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

WESTERN TECHNOLOGIES INC.

PROJECT: MANCHESTER FIELDS SUBDIVISION
REF. NO.: 6123JT052

BORING LOG

PLATE
A-8

DATE DRILLED: 4-19-13
LOCATION: See Location Diagram
ELEVATION: Not Determined

BORING NO. B-6

EQUIPMENT TYPE: Moble B-80
DRILLING TYPE: 7"HSA
FIELD ENGINEER: K. Parks

MOISTURE CONTENT (% OF DRY WT.)	DRY DENSITY (LBS/CU FT)	SAMPLE TYPE	SAMPLE	BLOW COUNTS	DEPTH (FEET)	USCS	GRAPHIC	SOIL DESCRIPTION
		R		4 6 9	0	CL		CLAY; brown to light gray, stiff to very stiff, damp to wet
		R		5 15 19	5			
								BORING TERMINATED AT 6.5 FEET
					10			
					15			
					20			

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater Not Encountered**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

WESTERN TECHNOLOGIES INC.

PROJECT: MANCHESTER FIELDS SUBDIVISION
REF. NO.: 6123JT052

BORING LOG

PLATE
A-9

PHYSICAL PROPERTIES

Boring No.	Depth (ft)	Soil Class.	In-Situ		Percent Passing		Atterberg Limits		Consolidation/Collapse/Swell			Remarks
										Total Comp. (%)		
			Dry Density (pcf)	Moisture Content (%)	#4	#200	LL	PI	Surcharge (KSF)	In-Situ	After Saturation	
B-1	2.5	CL	90.9	11.8	100	96	38	19	0.42	-0.87		
									0.84	-1.27		
									1.67	-1.60	-7.84	1
									3.34		-11.84	
									6.67		-15.71	
									13.29		-19.10	
									6.67		-18.85	
									3.34		-18.50	
B-1	5	CH	77.7	26.9	100	99	55	30	0.42	-0.63		
									0.84	-1.12		
									1.68	-1.62	-0.09	1
									3.35		-0.46	
									9.70		-1.70	
									13.38		-3.73	
									6.70		-3.38	
									3.35		-2.84	
B-1	7.5	CL	79.0	31.4	100	95	42	19	0.4	-0.71		
									0.8	-20.5		
									1.7	-3.31	-2.99	1
									3.4		-3.97	
									6.7		-5.93	
									13.4		-8.98	
									6.7		-8.66	
									3.4		-8.13	

NOTE: NP – nonplastic

REMARKS

Classification / Particle Size

1. Submerged to approximate saturation

2. Samples very dry, high disturbance of samples when trimmed for consolidation

Moisture-Density Relationship

4. Tested ASTM D698/AASHTO T99

5. Tested ASTM D1557/AASHTO T180

MANCHESTER FIELDS SUBDIVISION

Physical Properties

Western Technologies Inc.

Job No.: 6123JT052 | Plate: B-1

PHYSICAL PROPERTIES

Boring No.	Depth (ft)	Soil Class.	In-Situ		Percent Passing		Atterberg Limits		Consolidation/Collapse/Swell			Remarks
			Dry Density (pcf)	Moisture Content (%)	#4	#200	LL	PI	Surcharge (KSF)	Total Comp. (%) In-Situ	Total Comp. (%) After Saturation	
B-1	10	ML	85.0	11.6	100	55	--	NP	0.4	-0.44		
									0.8	-0.70		
									1.7	-1.06	-3.08	1
									3.7		-5.04	
									7.9		-7.11	
									16.2		-8.97	
									7.9		-8.98	
									3.7		-8.87	
B-2	2.5	SM	106.0	5.6	76	10	--	NP				
B-2	5	SC	101.6	23.2	85	38	25	10	1.6	-4.17	-4.09	1
B-2	7.5		105.3	20.4					1.6	-2.78	-2.83	1
B-3	5	CH	65.9	72.3	95	90	51	26	0.4	-2.24		
									0.8	-3.07		
									1.7	-4.29	-4.43	1
									3.7		-6.82	
									7.9		-12.07	
									16.2		-15.22	
									7.9		-15.12	
									3.7		-14.82	
B-3	10	CL			100	63	32	10	0.4	-1.48		
									0.8	-2.03		
									1.7	-2.93	-3.32	1
									2.8		-5.90	
									7.0		-9.60	
									15.3		-16.32	
									7.0		-15.04	
									2.8		-14.70	

NOTE: NP – nonplastic

REMARKS

Classification / Particle Size

1. Submerged to approximate saturation

2. Samples very dry, high disturbance of samples when trimmed for consolidation

Moisture-Density Relationship

4. Tested ASTM D698/AASHTO T99

5. Tested ASTM D1557/AASHTO T180

MANCHESTER FIELDS SUBDIVISION

Physical Properties

Western Technologies Inc.

Job No.: 6123JT052 | Plate: B-2

PHYSICAL PROPERTIES

Boring No.	Depth (ft)	Soil Class.	In-Situ		Percent Passing		Atterberg Limits		Consolidation/Collapse/Swell			Remarks
			Dry Density (pcf)	Moisture Content (%)	#4	#200	LL	PI	Surcharge (KSF)	Total Comp. (%) In-Situ	Total Comp. (%) After Saturation	
B-5	5	SC	83.6	23.3	100	22	41	25	0.4	-2.45		
									0.8	-3.89		
									1.7	-5.58	-5.45	1
									3.8		-7.31	
									7.9		-9.50	
									16.2		-11.84	
									7.9		-11.82	
									3.8		-11.80	

NOTE: NP – nonplastic

REMARKS

Classification / Particle Size

1. Submerged to approximate saturation

2. Samples very dry, high disturbance of samples when trimmed for consolidation

Moisture-Density Relationship

4. Tested ASTM D698/AASHTO T99

5. Tested ASTM D1557/AASHTO T180

MANCHESTER FIELDS SUBDIVISION

Physical Properties

Western Technologies Inc.

Job No.: 6123JT052 | Plate: B-3

INORGANIC ANALYTICAL REPORT

Client: Western Technologies, Inc. **Contact:** Warren Clyde
Project: Manchester Fields / 6143PO269
Lab Sample ID: 1305161-001
Client Sample ID: 6123JT052 B-4 @ 2.5-4
Collection Date: 4/19/2013
Received Date: 5/7/2013 0940h

Analytical Results

Compound	Units	Date Prepared	Date Analyzed	Method Used	Reporting Limit	Analytical Result	Qual
Chloride	mg/kg-dry		5/8/2013 1452h	SW9251	5.74	**27.2**	&
Sulfate	mg/kg-dry		5/8/2013 0930h	SM4500-SO4-E	5.74	**12.7**	&

& - Analysis is performed on a 1:1 DI water extract for soils.

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