CITY OF FOUNTAINS
HEART OF THE NATION

KANSAS CITY
MISSOURI

ADDENDUM NUMBER 1

Project Number **89008260**

Project Title **NW Waukomis Drive**
Federal STP-3451(402)

ISSUE DATE: **12/16/2022**

Bidders are hereby notified that the Bidding and Contract Documents for the above project, for which Bids are to be received on **January 24, 2023**, are amended as follows:

Information to Bidders The following is provided to Bidders for information only:

1. The Design Professional has conducted soil investigations and geotech reports for design purposes only. The geotech reports do not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotech reports have been requested by bidders and are included with this addenda. The geotech reports are deemed as not suitable for contractor's use, contractor is using them at their risk and the reports are merely suggestive of the nature of the tested material, not representative of entire site conditions. Acknowledgement of this addenda shows acceptance of all risks associated with any use.

2. Plan sheet file was updated for the file "Final Plans 170 thru 252.pdf" to a more legible resolution.

NOTE: Bidders must acknowledge receipt of this Addendum by listing the number and date, where provided, on the Bid Form - Document 00410.

REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION

WAUKOMIS DRIVE IMPROVEMENTS
KANSAS CITY, MISSOURI
TSI PROJECT NUMBER 20152027

WALTER P. MOORE, INC.
920 Main Street
Kansas City, Missouri 64105

geotechnical, inc

8248 NW 101st Terrace, #5
Kansas City, Missouri 64153

December 23, 2016

The Design Professional has conducted a soil investigation and geotech report for design purposes only. The geotech report does not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotech report has been requested by bidders and is included with this addenda. The geotech report is deemed as not suitable for contractor's use, contractor is using it at their risk and the report is merely suggestive of the nature of the tested material, not representative of entire site conditions. Acknowledgement of this addenda shows acceptance of all risks associated with any use.

8248 NW 101st Terr. #5
Kansas City, MO 64153
816.599.7965 (tel)
816.599.7967 (fax)
www.tsigeotech.com

PROFESSIONAL SERVICE SINCE 1989

December 23, 2016

Mr. Dan Brown, PE
WALTER P. MOORE, INC.
920 Main Street
Kansas City, Missouri 64105

Re: **Report of Subsurface Exploration and Geotechnical Engineering Evaluation**
Waukomis Drive Improvements
Kansas City, Missouri
TSi Project No. 20152027

Dear Mr. Brown:

TSi Geotechnical, Inc. (TSi) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the referenced project and is pleased to submit this report of our findings to Walter P. Moore, Inc. (WPM). The purpose of our work was to determine subsurface conditions at specific exploration locations and to gather data on which to prepare geotechnical recommendations for the planned improvements to Waukomis Drive in Kansas City, Missouri. This report describes the exploration procedures used, exhibits the data obtained, and presents our evaluations and recommendations relative to the geotechnical engineering aspects of the project.

We appreciate the opportunity to assist you with this project. If you have any questions, or if we may be of further service to you, please call us.

Respectfully submitted,
TSI GEOTECHNICAL, INC.

STATE OF MISSOURI
JAMES A. JACOBE
NUMBER
PE-2015017008
PROFESSIONAL ENGINEER
12/23/16

Denise Hervey / JAJ 12/23/16

Jim Jacobe, PE
Project Manager

Denise Hervey, PE
Principal

CONTENTS

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION WAUKOMIS DRIVE IMPROVEMENTS KANSAS CITY, MISSOURI

1.0 SCOPE OF WORK

This report summarizes the results of a geotechnical study performed for the planned improvements to Waukomis Drive between I-29 and 1400 feet north of NW 62nd Street in Kansas City, Missouri. The study was performed in general accordance with TSi's proposal to WPM, dated November 6, 2014, which identified the following items for inclusion in this study report:

- Subsurface conditions at the boring locations;
- Laboratory test results;
- Influence of groundwater on the project;
- Infiltration and dewatering recommendations;
- Lateral earth pressures for subsurface structures;
- Foundation recommendations for box culverts and retaining walls;
- Stream bank stabilization recommendations;
- Pavement recommendations;
- Minimum setback recommendations for excavations near existing structures;
- Seismic site classification per MoDOT guidelines;
- Excavation and general construction considerations; and
- Recommendations for fill and backfill materials, placement, and compaction.

2.0 SITE AND PROJECT DESCRIPTIONS

The following project understanding is based on discussions with WPM, and a site reconnaissance by an engineer from TSi. The project consists of widening Waukomis Drive from I-29 to 1,400 feet north of NW 62nd Street in Kansas City, Missouri. The general location of the project site is shown below. The Site and Boring Location Plan, Figure 1 in Appendix A, provides a more detailed plan of the project area.

The project will consist of widening Waukomis Drive from the exit ramp of northbound I-29 to approximately 1400 feet north of NW 62nd Street. This project includes widening the existing two-lane roadway, extending the box culverts at two creek crossings, and stabilizing the stream banks of the two creeks.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

TSi conducted an exploration program between May 8 and 13, 2015 consisting of six soil borings, designated as Borings B-01 to B-06. WPM selected and surveyed the boring locations in the field. Borings B-01 to B-04, and B-06 were drilled in the roadway. Boring B-05 was drilled on the slope east of Waukomis Drive and just south of NW 62nd St. Borings B-01 to -03 were drilled to a depth of 15 feet. Borings B-04 to -06 were extended to auger refusal. The logs from this exploration are included in Appendix B. The approximate locations of the borings are indicated on the Site and Boring Location Plan, Figure 1 in Appendix A.

The borings were drilled using a CME-550 rubber tire drill rig to advance hollow stem or solid flight auger drilling tools. A geotechnical specialist from TSi directed the exploration procedures in the field, maintained a field log of the conditions encountered in the borings, and collected and classified the samples recovered. Split-spoon and Shelby tube samples were recovered from most of the borings. Split-spoon samples were recovered using a 2-inch outside-diameter, split-barrel sampler, driven by an automatic hammer, in accordance with ASTM D 1586. The split-spoon samples were placed in plastic bags for later testing in the laboratory. Three-inch Shelby tube samples were obtained in accordance with ASTM D 1587. The Shelby tube samples were preserved by sealing the entire sample in the tube.

The results of the field tests and measurements were recorded on field logs and appropriate data sheets by TSi's engineer. Those data sheets and logs contain information concerning the exploration methods, samples attempted and recovered, indications of the presence of various subsurface materials, and the observation of groundwater. The field logs and data sheets contain the engineer's interpretations of the conditions between samples, based on the performance of the exploration equipment and the cuttings brought to the surface. The final logs included in this report were based on the field logs, modified as appropriate based on the results of laboratory testing of soil and rock samples.

3.2 LABORATORY TESTING

A laboratory testing program was conducted by TSi to determine selected engineering properties of the obtained soil and rock samples. The following laboratory tests were performed on the samples recovered from the borings:

- visual descriptions by color and texture (ASTM 2488);
- natural moisture content (ASTM D 2216);
- Atterberg limits of cohesive soil (ASTM D 4318);
- percent of soil finer than a No. 200 sieve (ASTM D 1140);
- unit weight of soil (ASTM D 7263);
- unconfined compressive strength of soil (ASTM D 2166);
- direct shear (ASTM D 3080);
- sieve analysis of selected granular materials (ASTM D 422); and
- grain size analysis with hydrometer (ASTM D 422).

The results of the laboratory tests are summarized on the boring logs. TSi has also included the results of grain size analyses are located in Appendix C. The analyses and conclusions contained in this report are based on field and laboratory test results and on the interpretations of the subsurface conditions as reported on the logs. Only data pertinent to the objectives of this report have been included on the logs; therefore, these logs should not be used for other purposes.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered at the boring locations are shown on the logs in Appendix B. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at these locations on the dates shown; the reported conditions may be different at other locations or at other times.

4.1 GENERALIZED SUBSURFACE PROFILE

At the surface, Borings B-01 through B-04 and B-06 encountered 4.5 to 11.0 inches of asphaltic concrete, which was typically underlain by 1.5 to 7 inches of crushed limestone gravel. An exception to this was Boring B-03 which encountered 16 inches of crushed asphaltic concrete below the road surface. Boring B-05 was not drilled in the roadway and encountered 6 inches of lean clay with roots and organics at the surface. The roadway or surficial soils were underlain by at least 14 feet of lean or fat clays (CL or CH, in accordance with the Unified Soil Classification System) with varying amounts of sand and gravel. The clays were brown or gray in color. In the deeper borings, B-04 to B-06, the clays contained limestone pieces as the borings neared the underlying limestone bedrock.

Moisture content tests of the clays ranged from 14% to 35% while the dry unit weights of the clays ranged from 89 pounds per cubic foot (pcf) to 103 pcf. Undrained shear strengths of the clay ranged from 0.22 tons per square feet (tsf) to 1.42 tsf. Atterberg limits tests on samples of the clay resulted in liquid limits (LL) of 33 to 59 and plasticity index values (PI) of 13 to 39.

Limestone bedrock was encountered in Borings B-04, B-05, and B-06 at depths of 16.5, 29.0, and 19.5 feet, respectively. The limestone was generally brown to gray, hard, and highly weathered. Table 1 contains the depth and elevation of limestone bedrock along with the depth and elevation of auger refusal in each boring. In general, the augers were able to be advanced through the more weathered upper limestone bedrock.

TABLE 1
BEDROCK DEPTHS

Boring Location	Limestone Bedrock Depth (ft.)	Auger Refusal Depth (ft.)
B-04	16.5	17.3
B-05	29.0	29.5
B-06	19.5	20.8

NE = Not Encountered

4.2 GROUNDWATER

Groundwater was observed in three of the six borings while drilling. Table 2 contains the depth and elevation where groundwater was encountered. The presence or absence of groundwater at a particular location does not necessarily mean that groundwater will be present or absent at that location at other times. Seasonal variations, the water level in the adjacent creeks, and other unknown considerations could cause fluctuations in water levels and the presence of water in the soils. Groundwater will likely be perched on top of the limestone bedrock during rainy seasons. Groundwater may also be perched within joints in the limestone bedrock during periods of rainy weather.

TABLE 2
GROUNDWATER DEPTHS

Boring Location	Groundwater Depth (ft.)
B-01	5.5
B-02	12.5
B-03	NE
B-04	NE
B-05	NE
B-06	18.5

NE = Not Encountered

5.0 ENGINEERING ASSESSMENTS AND RECOMMENDATIONS

5.1 SWELLING CLAY CONSIDERATIONS

Laboratory tests indicated that some of the on-site soils are moderate to high plasticity clays with high shrink/swell potential. High plasticity (fat) clays may be exposed during grading at the site. Fat clays are of concern with regard to their potential for volume change. This concern applies to this material whether it is in its natural condition or used as fill material. This material tends to swell when it absorbs water and to shrink when it dries out. Potential detrimental effects for development of the site include heaving, settlement, and differential movements of structures and pavements constructed directly over these materials.

It is recommended that where high plasticity clays (CH) are found at the subgrade levels of the proposed pavements, they should be over excavated to a depth of 12 inches below the subgrade level. These materials should be replaced with Low Volume Change (LVC) fill material, as discussed in Section 6.4 of this report.

In addition to the removal and replacement or treatment, some relatively simple design and construction considerations are recommended that will help to maintain the natural moisture content of the fat clays. Avoiding conditions that could result in excessive wetting or drying of the fat clays will reduce their potential for volume change. The following design and construction precautions are recommended:

1. Positive surface drainage should be provided during construction to prevent ponding of water in and around any excavations or the exposed subgrade.

2. Storm water runoff should be collected and carried away from the roadway to avoid saturating the subgrade.

5.2 ADJACENT STRUCTURE CONSIDERATIONS

Existing structures adjacent to trenches and excavations should be monitored when the distance between the edge of the excavation and the structure is less than the total depth of the excavation. In these cases the structure should be closely monitored for any unacceptable movement during construction. If the measurements show unacceptable movement, the construction activities should be halted and stabilization of the adjacent structures should be considered.

5.3 STREAM BANK STABILIZATION

In addition to the improvements along Waukomis Drive, WPM has asked us to give recommendations on stream bank stabilization at eight locations adjacent to the roadway. Drill rig access was limited at these locations, so engineers from TSi walked the creek channels to observe the selected slopes and probe the creek bottom to estimate the material's consistency. TSi has also included photographs of the creek bank sections in question. The photographs of the stream banks are shown in Appendix D and are labeled Creek Bank A through H. Bank erosion was observed at Creek Bank H which is located near chain link fence as part of the property line for Line Creek Elementary School. An exposed utility line was also observed at Creek Bank E.

The erosion of the banks is likely due to the development in the area. More surficial runoff from homes, streets and parking lots have increased the flow in the creek. The creek bottom consists of limestone bedrock, which has likely increased the velocity of the water in the creek. During rain events, the creek attempts of increase its capacity by widening which contributes to erosion.

Piles of construction debris, including concrete and asphalt, were observed in the creek in several places. Existing slope failures could also be observed in the creek channels at several locations. The debris and slope failures have likely altered the creek path and led to the erosion of creek banks in unfortunate locations.

Under typical operating conditions, the creek banks could be stabilized by laying them back at a slope of 3 Horizontal to 1 Vertical (3H:1V) or flatter. A rapid drawdown event is an extreme case where the creek fills due to a downstream blockage which is then suddenly released, rapidly emptying the creek. In this extreme case, the banks would not be stable without armoring such as with 3-foot blankets of rip rap. Preliminary global stability analyses of the normal and rapid drawdown conditions are included in Appendix E. The analyses were performed with SLOPE/W using an allowable stress design (ASD) method where a factor of safety (FS) greater than 1.3 is generally considered acceptable under typical operating conditions, and a FS greater than 1.0 is generally considered acceptable under extreme conditions.

A 3H:1V slope for the creek banks may not be possible in several locations along the creeks. In cases where a 3H:1V slope is not possible, or rip rap is not desirable, a structure could be constructed to shield the clay from erosion. These structures would have to be constructed to the appropriate flood elevation as selected by the CITY. The structure would also need the ability to drain quickly to avoid a rapid drawdown condition. Gabion baskets are commonly used for this purpose.

Stabilizing the banks with rip rap or gabion baskets would only act as a temporary solution and may move the problem downstream. Other solutions such as redirecting the creeks' path and calming measures to lower the water velocity may be a more cost effective solution for this project. TSi recommends that a stream bank stabilization specialist be consulted for value engineering.

5.4 Reinforced Concrete Box Culverts

As discussed previously, two reinforced concrete box (RCB) culverts will be extended as part of the project. TSi understands that the RCBs will be cast-in-place, and the following recommendations are based on this understanding. The bottom slab of these structures will act as a mat foundation to support the structure and overlying fill. The bottom slab will be supported by clay soils. The base of the RCB may be designed as a foundation with a net allowable bearing pressure of 3,000 psf for structural dead load plus maximum live load.

The subgrade below the existing drainage structures may be soft and require over excavation and placement of controlled fill to provide the required allowable bearing pressure. These foundations should be verified by a representative of TSi prior to placement of the structure.

The bottom slabs should be underlain by at least 6.0 inches of well-graded, clean, crushed limestone aggregate with a maximum particle size of 0.75 inch. Slabs may be designed using a modulus-of-subgrade reaction (k) of 20 pounds per cubic inch (pci). If a higher modulus value is desired, alternative subgrade preparation measures can be considered. For shear loads on the mat, an allowable coefficient of friction of 0.25 may be used for the concrete soil interface. This parameter includes a factor of safety of 1.5.

5.5 LATERAL EARTH PRESSURES FOR RCBS

Lateral earth pressure parameters are provided for the design of the RCBs for this project. The sidewalls of these structures will be restricted from movement at the top and therefore should be designed to resist at-rest earth pressures. Earth pressures are a function of the excavation configuration and the backfill materials. Table 3 provides recommended design parameters for RCB sidewalls with horizontal surfaces behind the wall.

TABLE 3
LATERAL EARTH PRESSURE PARAMETERS FOR RCB SIDEWALLS

Parameter		Backfilled with Crushed Limestone	Backfilled with Cohesive Soil
At-Rest Equivalent Fluid Pressure	Drained	55 pcf	65 pcf
	Undrained	90 pcf	95 pcf
Passive Equivalent Fluid Pressure	Drained	480 pcf	280 pcf
	Undrained	310 pcf	195 pcf
Soil Unit Weight		130 pcf	115 pcf
Angle of Internal Friction for Backfill		34º	25º
Assumed Surcharge Condition		None	None
Slope Profile behind Wall		Horizontal	Horizontal

No factor of safety or resistance factor has been applied to the above values.

Drained values should be used for the calculation of lateral pressures for the RCB sidewalls. Significant movement of the RCB sidewall would generally be necessary to develop the full values of passive pressures given; typically the passive values stated are reduced by up to one-half for design. The effects of vertical surcharge loads are not included for the stated fluid pressures.

5.6 RCB Foundation Settlement

The structural load on the culvert mat will result in minor compression of the soil and bedrock beneath the slab. Based on the subgrade conditions and assuming the foundations are properly installed, the maximum anticipated settlement of these foundations due to the structural loads should be less than 1 inch. Differential settlements across the structure should be less than 0.5 inch. The majority of this settlement should take place during construction as the loads are applied to the foundations.

5.7 Pavement Design

Based on the general character of the on-site subsurface conditions and assuming a properly prepared subgrade, a California Bearing Ratio (CBR) value of 2 is considered appropriate for use in designing the flexible pavement sections for cut and fill areas of the site. Rigid pavement design can be based on a modulus-of-subgrade reaction (k) of 75 pounds per cubic inch (pci) for the subgrade. These values for rigid and flexible pavement design are based on the requirement that the pavement subgrade is prepared in accordance with the recommendations provided in this report. On this basis, it is suitable to use the standard City of Kansas City, Missouri pavement sections for the project.

TSi does not recommend placing a pavement section directly on the existing soils. Taking into consideration the moisture sensitivity and plasticity of the native soils, TSi recommends either placing acceptable imported fill material as defined in Section 6.4, or stabilizing the subgrade with “Class C” fly ash to limit subgrade deterioration, especially during wet weather, and to provide for a more durable pavement. The stabilized pavement subgrade is less prone to potential damage from seasonal shrink and swell of the clay soils and less susceptible to subgrade failures during the life of the pavements. The stabilized section would function as a sub-base for the pavement section. The top 9 inches of pavement subgrade should be replaced with acceptable material, or stabilized with “Class C" fly ash applied at a rate of 15% of the treated soil on a dry weight basis. The stabilized soils should be compacted as recommended in Section 6.5 of this report. Suggested specifications for the fly ash stabilization can be provided if desired.

5.8 Seismic Site Classification

Based on MoDOT EPG Figure 751.9.1.3.3, the project site is located within Seismic Performance Category (SPC) “A”. As such, the soils at the site are not considered susceptible to liquefaction or substantial settlement or loss in strength when subject to the design earthquake loading. The seismic analysis and design procedures outlined in MoDOT EPG 751.9.1 are not required for this project.

6.0 SITE PREPARATION AND EXCAVATION CONSIDERATIONS

6.1 SUBGRADE PREPARATION

Construction areas should be stripped of existing pavement, organic soil, and any deleterious materials prior to site excavation and grading. Tree stumps and root balls should also be removed. Care should be taken during stripping to prevent excessive disturbance of the underlying soil. After the removal of these materials, and where further excavation is not required, the exposed subgrade should be proofrolled. Proofrolling is accomplished by passing over the subgrade with proper equipment such as a loaded tandem-axle dump truck or scraper and observing the subgrade for pockets of excessively soft, wet, disturbed, or otherwise unsuitable soils. Any unacceptable materials thus found should be excavated and either recompacted or replaced with new structural fill.

Prior to placing fill in any area, the subgrade should be scarified to a depth of about 6 inches, the moisture content adjusted to near its optimum moisture content, and the subgrade recompacted in accordance with recommendations made in subsequent sections of this report. The recommended proofrolling and/or scarification and recompaction may be waived if, in the opinion of a geotechnical engineer, this procedure would be detrimental or unnecessary. Following satisfactory preparation of the subgrade, controlled fill material may be placed.

6.2 EXCAVATIONS

The clayey soils can be excavated using conventional earth moving equipment and methods. Excavations deeper than 15 feet for utilities along some sections parts of the roadway may encounter weathered or intact limestone bedrock. Bedrock excavations may require hydraulic breakers or other hard rock excavation methods. The most suitable means to excavate the bedrock materials should be determined in the field.

Trenching, excavating, and bracing should be performed in accordance with OSHA (Occupational Safety and Health Administration) regulations and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the existing clay soils at the site are considered Type C, which requires a side slope for excavations of not steeper than 1.5H:1.0V. The natural soils encountered around the existing culverts are considered Type C soils and require a side slope no steeper than 1.5H:1.0V. Worker safety and classification of the excavation soil is the responsibility of the contractor. Also according to OSHA requirements, any excavation extending to a depth of more than 20 feet must be designed by a registered professional engineer.

6.3 SUBGRADE PROTECTION

Construction areas should be properly drained in order to reduce or prevent surface runoff from collecting on the exposed subgrade. Any ponded water on the exposed subgrade should be removed immediately. Temporary storm-water swales and collection areas may be required to control surface water flow into low areas of the site.

To prevent unnecessary disturbance of the subgrade soils, heavy construction vehicles should be restricted from traveling through the finished subgrade. If areas of disturbed subgrade develop, they should be properly repaired in accordance with the recommendations in this report.

The clay soils that are present at the site are highly susceptible to disturbance from construction traffic, especially during rainy weather. Consideration should be given to leaving cut areas 1 to 2 feet higher than planned subgrade until immediately before paving operations are planned. The extra material that is left in place would protect the final subgrade from disturbance.

Immediately prior to construction of the pavement, it is recommended that the exposed subgrade be evaluated to determine whether moisture contents are within the recommended range and to identify areas disturbed by construction operations. Moisture conditioning of wet or dry areas is recommended prior to construction of the pavement section. Areas disturbed by construction traffic should be reworked.

6.4 Fill and Backfill Materials

Structural fill should consist of approved soils or crushed limestone material, free of organic matter and debris. Fill material placed within 18 inches of the pavements should consist of select LVC fill material. LVC fill should consist of approved, well-graded granular materials or low to moderate plasticity cohesive soil. Low to moderate plasticity cohesive materials used as LVC fill should consist of inorganic clay with a liquid limit less than 45 and a plasticity index of less than 25. Based on laboratory tests performed, the granular fill should have a maximum particle size of 1.0 inch. The lean clay soils present on this site could be used as either structural fill or LVC fill. Fill materials from off-site sources should be approved prior to their use. Soil with decayable material such as wood, metal, or vegetation is not acceptable.

Some of the soil on the site will require the addition of moisture prior to compaction. This should be performed in a controlled manner using a tank truck with a spray bar, and the moistened soil should be thoroughly blended with a disk or pulverizer to produce a uniform moisture content. Repeated passages of the equipment may be required to achieve a uniform moisture content. Fat clays should be compacted wet of their optimum moisture content. If pavements are constructed during the winter season, fill materials should be carefully observed to see that no ice or frozen soils are placed as fill or remain in the base materials upon which fill is placed.

Some of the on-site soil may require moisture reduction prior to compaction. During warm weather, moisture reduction can generally be accomplished by disking, or otherwise aerating the soil. When air-drying is not possible, a moisture-reducing chemical additive, such as lime or Class C fly ash, could be used as a drying agent.

6.5 Fill and Backfill Placement

Cohesive fill should be compacted to a dry density of at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the soil. Granular material, such as crushed limestone, placed for structure or pavement support, should be compacted to at least 100% of the standard Proctor maximum dry density. The moisture content of lean clay or granular fill at the time of compaction should be within ±3% of the optimum moisture content of the material as determined by the standard Proctor compaction test. The moisture content of fat clay fill materials should be from the optimum moisture content to 4% above optimum. Open-graded granular material used for drainage backfill should be compacted to at least 60% of the relative density of the material (ASTM D 4253 and D 4254). Fill should be placed in loose lifts not in excess of 8.0 inches thick, and compacted to the aforementioned criterion. However, it may be necessary to place fill in thinner lifts to achieve the recommended compaction when using small hand-operated equipment.

6.6 GROUNDWATER CONSIDERATIONS

Groundwater was observed during drilling in borings near the creek and will likely be encountered during the construction of the reinforced box culverts. The presence or absence of groundwater at a particular location does not necessarily mean that groundwater will be present or absent at that location at other times. Seasonal variations and other unknown considerations will cause fluctuations in creek water levels and the presence of water in the soils. If groundwater is encountered in an excavation, it is anticipated that it could be handled by shallow swales and a sump and pump arrangement in most situations.

7.0 REPORT LIMITATIONS

This geotechnical report has been prepared for the exclusive use of **WALTER P. MOORE, INC.** for the specific application to the subject project. The information and recommendations contained in this report have been made in accordance with generally accepted geotechnical and foundation engineering practices; no other warranties are implied or expressed.

The assessments and recommendations submitted in this report are based in part upon the data obtained from the borings. The nature and extent of variations between the borings may not be evident at this time. If variations appear evident at a later date, it may be necessary to re-evaluate the recommendations of this report.

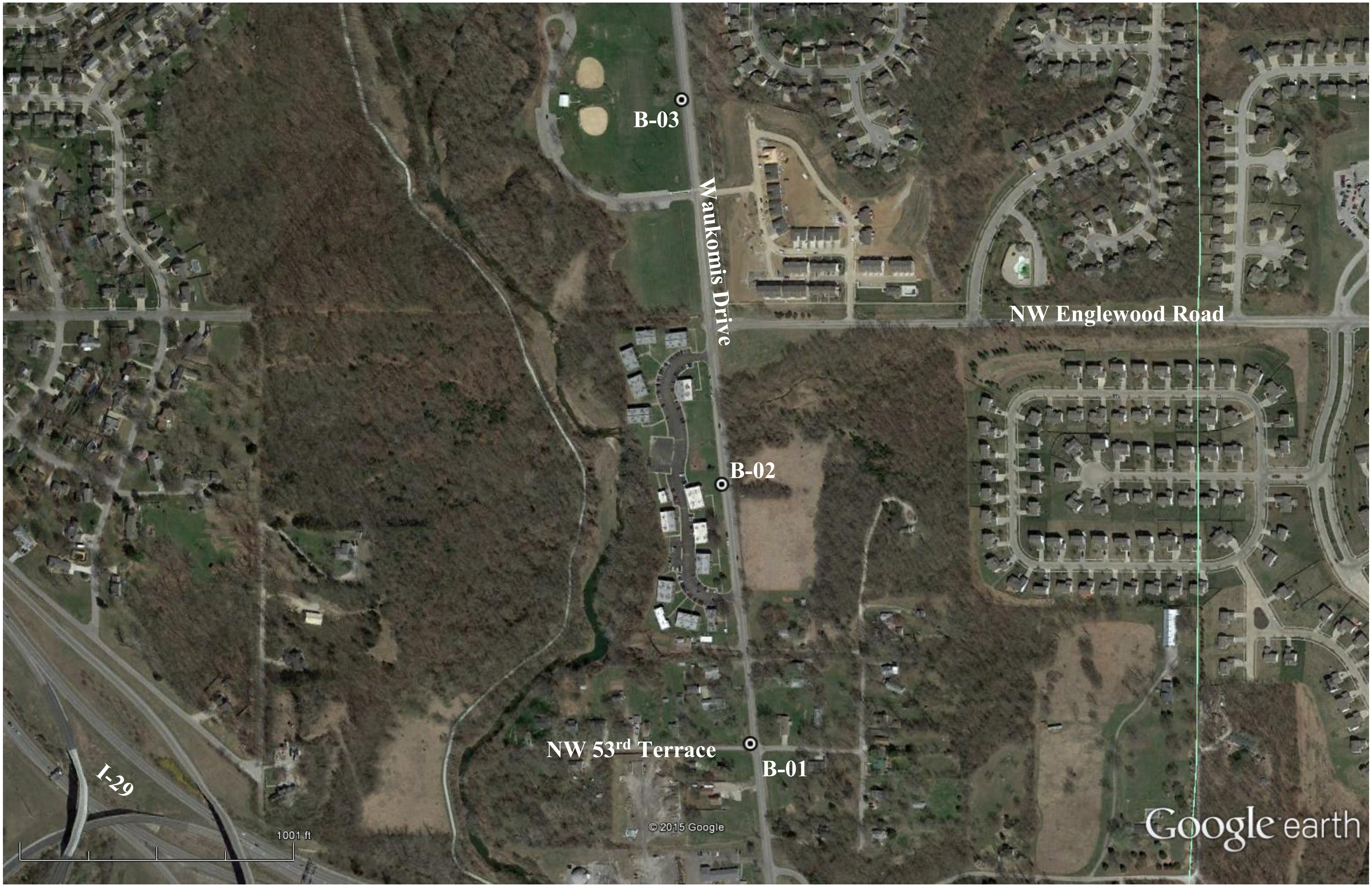
We emphasize that this report was prepared for design purposes only and may not be sufficient to prepare an accurate construction bid. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design purposes.

If conditions at the site have changed due to natural causes or other operations, this report should be reviewed by TSi to determine the applicability of the analyses and recommendations considering the changed conditions. The report should also be reviewed by TSi if changes occur in the structure location, size, and type, in the planned loads, elevations, grading and site development plans or the project concepts.

TSi requests the opportunity to review the final plans and specifications for the project prior to construction to verify that the recommendations in this report are properly interpreted and incorporated in the design and construction documents. If TSi is not accorded the opportunity to make this recommended review, we can assume no responsibility for the misinterpretation of our recommendations.

APPENDIX A

Site and Boring Location Plan

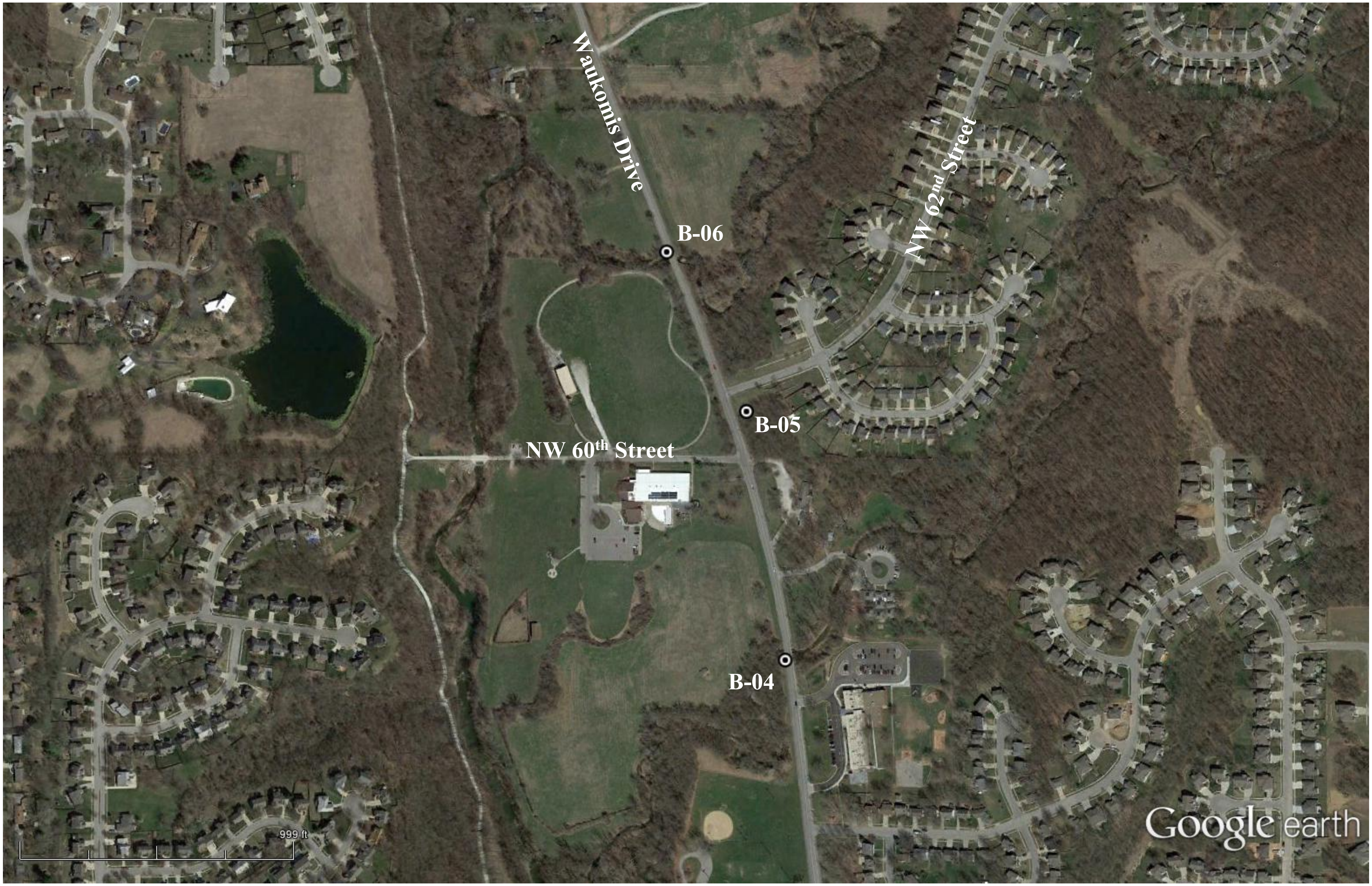


Legend

◉ Bore Hole

N
W E
S

Figure 1A, Site and Boring Location Plan		Project No. 20152027
Waukomis Drive Kansas City, Missouri		TSI
Not to Scale	Approved by: JJ	



Legend

Bore Hole

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Figure 1B, Site and Boring Location Plan		Project No. 20152027
Waukomis Drive Kansas City, Missouri		TSI
Not to Scale	Approved by: JJ	

APPENDIX B

Boring Logs
General Notes
Unified Soil Classification System

LOG OF BORING NO. B-01

Project Description: **Waukomis Drive**
Kansas City, Missouri

TSi Engineering
1322 Adams Street
Kansas City, KS 66103
(913) 749-4010 (913) 749-4011 FAX

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Asphaltic concrete (11.0")										
				Crushed limestone gravel (6")										
				Dark gray, lean CLAY (CL)										
		SS-1		- with dark brown below 3.5 ft.	100		3 3 4	1.50			26			
5				∇										
		ST-2		Dark brown and gray, fat CLAY (CH), trace sand and gravel	100			2.50	0.22	94	27	59	20	39
		SS-3		- brown below 8.5 ft. (92% passing No. 200 sieve)	100		2 3 3	1.25			27			
10														
		SS-4			100		1 2 2	0.25			29			
15				Boring terminated at 15 ft.										
20														
25														
30														

Completion Depth:	15.00
Date Boring Started:	5/8/15
Date Boring Completed:	5/8/15
Engineer/Geologist:	KH
Project No.:	20152027

Remarks: Boring drilled with CME 550 using FA and auto SPT. Groundwater encountered at 5.5 ft. during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-02

Project Description: **Waukomis Drive Kansas City, Missouri**

TSi Engineering
1322 Adams Street
Kansas City, KS 66103
(913) 749-4010 (913) 749-4011 FAX

Surface El.:

Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Asphaltic concrete (4.5")										
				Crushed limestone gravel (7")										
				Dark gray, lean CLAY (CL), trace sand										
5		SS-1		- brown below 3.5 ft.	100		2 2 2	1.00			27			
		ST-2			100			0.50	0.26	96	25	41	16	25
10		SS-3			100		1 2 2	0.25			28			
				∇										
15		SS-4		(90% passing No. 200 sieve)	100		1 2 1	<0.25			29			
				Boring terminated at 15 ft.										
20														
25														
30														

Completion Depth:	15.00
Date Boring Started:	5/8/15
Date Boring Completed:	5/8/15
Engineer/Geologist:	KH
Project No.:	20152027

Remarks: Boring drilled with CME 550 using FA and auto SPT. Groundwater encountered at 12.5 ft. during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-03

Project Description: **Waukomis Drive**
Kansas City, Missouri

TSi Engineering
1322 Adams Street
Kansas City, KS 66103
(913) 749-4010 (913) 749-4011 FAX

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Asphaltic concrete (7.5")										
				Crushed asphaltic concrete gravel (16")										
				Brown, fat CLAY (CH), trace sand										
		SS-1			94		2 3 4				26			
5		ST-2			100			3.50	0.53	95	27	54	17	37
		SS-3		- dark brown, with silt below 8.5 (95% passing No. 200 sieve)	100		2 2 3				27			
10														
		SS-4			100		2 1 2				29			
15				Boring terminated at 15 ft.										
20														
25														
30														

Completion Depth: 15.00
Date Boring Started: 5/8/15
Date Boring Completed: 5/8/15
Engineer/Geologist: NC
Project No.: 20152027

Remarks: Boring drilled with CME 550 using FA and auto SPT. Groundwater not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-04

Project Description: **Waukomis Drive**
Kansas City, Missouri

TSi Engineering
1322 Adams Street
Kansas City, KS 66103
(913) 749-4010 (913) 749-4011 FAX

Surface El.:
Location: **See Site and Boring Location Plan**

Samples	Sample #	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		Asphaltic concrete (9.0")										
		Crushed limestone gravel (2")										
ST	ST-1	Brown, lean CLAY (CL), trace sand and gravel	71			2.00			21	42	17	25
SS	SS-2	(85% passing No. 200 sieve)	33		2 2 2				24			
ST	ST-3		100			4.00	0.33	89	26	35	22	13
SS	SS-4	Brown, fat CLAY (CH), trace sand	94		2 3 5				24			
		LIMESTONE, highly weathered										
		Boring terminated at 17.3 ft.										

Completion Depth: 17.30
Date Boring Started: 5/8/15
Date Boring Completed: 5/8/15
Engineer/Geologist: NC
Project No.: 20152027

Remarks: Boring drilled with CME 550 using FA and auto SPT. Groundwater not encountered during drilling. Auger refusal at 17.3 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-05

Project Description: **Waukomis Drive**
Kansas City, Missouri

TSi Engineering
1322 Adams Street
Kansas City, KS 66103
(913) 749-4010 (913) 749-4011 FAX

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Black, lean clay, with roots and organics (6")										
				Brown, silty, fat CLAY (CH), trace sand										
		ST-1			75			2.75	1.01	97	26	56	20	36
5														
		SS-2		- stiff below 6 ft.	89		3 6 12	3.00			21			
		ST-3			92			>4.5	1.42	103	18	56	25	31
10														
		SS-4			78		5 8 11	>4.5			19			
15														
		SS-5		- light brown below 18.5 ft. (96% passing No. 200 sieve)	94		4 7 10	4.25			21			
20														
		SS-6		- brown with weathered limestone and limestone pieces below 23.5 ft.	56		5 7 12	1.00			20			
25														
		SS-7			83		6 50/2"				14			
				LIMESTONE, highly weathered										
				Boring terminated at 29.5 ft.										
30														

Completion Depth:	29.50	Remarks:	Boring drilled with CME 550 using FA and auto SPT. Groundwater not encountered during drilling. Auger refusal at 29.5 ft.
Date Boring Started:	5/13/15		
Date Boring Completed:	5/13/15		
Engineer/Geologist:	KH		
Project No.:	20152027		

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-06

Project Description: **Waukomis Drive**
Kansas City, Missouri

TSi Engineering
1322 Adams Street
Kansas City, KS 66103
(913) 749-4010 (913) 749-4011 FAX

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Asphaltic concrete (8.0")										
				Crushed limestone gravel (1.5")										
		ST-1		Brown and gray lean CLAY (CL), trace sand	50			4.25				45	16	29
		SS-2		- dark brown below 3.5 ft.	22		4 3 4				24			
5														
		SS-3		(88% passing No. 200 sieve)	56		2 2 2	0.75			23			
		ST-4		- brown, trace fine sand below 8.0 ft.	96			1.75	0.38	99	22	33	18	15
10														
		SS-5		- dark brown and gray below 13.5 ft. - brown below 14.2 ft.	100		2 2 2				25			
15														
		SS-6		- with limestone pieces below 18.5 ft.	56		3 6 34				35			
20				LIMESTONE, highly weathered										
				Boring terminated at 20.8 ft.										
25														
30														

Completion Depth: 20.80
Date Boring Started: 5/13/15
Date Boring Completed: 5/13/15
Engineer/Geologist: KH
Project No.: 20152027

Remarks: Boring drilled with CME 550 using FA and auto SPT. Groundwater encountered at 18.5 ft. during drilling. Auger refusal at 20.8 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

GENERAL NOTES

The number of borings is based on: topographic and geologic factors; the magnitude of structure loading; the size, shape, and value of the structure; consequences of failure; and other factors. The type and sequence of sampling are selected to reduce the possibility of undiscovered anomalies and maintain drilling efficiency. Attempts are made to detect and/or identify occurrences during drilling and sampling such as the presence of water, boulders, gas, zones of lost circulation, relative ease or resistance to drilling progress, unusual sample recovery, variation in resistance to driving split-spoon samplers, unusual odors, etc. However, lack of notation regarding these occurrences does not preclude their presence.

Although attempts are made to obtain stabilized groundwater levels, the levels shown on the Logs of Boring may not have stabilized, particularly in more impermeable cohesive soils. Consequently, the indicated groundwater levels may not represent present or future levels. Groundwater levels may vary significantly over time due to the effects of precipitation, infiltration, or other factors not evident at the time indicated.

Unless otherwise noted, soil classifications indicated on the Logs of Boring are based on visual observations and are not the result of classification tests. Although visual classifications are performed by experienced technicians or engineers, classifications so made may not be conclusive.

Generally, variations in texture less than one foot in thickness are described as layers within a stratum, while thicker zones are logged as individual strata. However, minor anomalies and changes of questionable lateral extent may appear only in the verbal description. The lines indicating changes in strata on the Logs of Borings are approximate boundaries only, as the actual material change may be between samples or may be a gradual transition.

Samples chosen for laboratory testing are selected in such a manner as to measure selected physical characteristics of each material encountered. However, as samples are recovered only intermittently and not all samples undergo a complete series of tests, the results of such tests may not conclusively represent the characteristics of all subsurface materials present.

Notation Used on Boring Logs

Approximate Proportions

Trace	<15%
With	15-30%
Modifier	>30%

Clay or clayey may be used as major material or modifier, regardless of relative proportions, if the clay content is sufficient to dominate the soil properties.

Particle Size

Boulders		>12 Inches
Cobbles		12 Inches – 3 Inches
Gravel		
	Coarse	3 Inches – ¾ Inch
	Fine	¾ Inch – No. 4 Sieve (4.750 mm)
Sand		
	Coarse	No. 4 – No. 10 Sieve (2.000 mm)
	Medium	No. 10 – No. 40 Sieve (0.420 mm)
	Fine	No. 40 – No. 200 Sieve (0.074 mm)
Silt		No. 200 Sieve - 0.002 mm
Clay		< 0.002 mm

Penetration – Blows

Number of impacts of a 140-pound hammer falling a distance of 30 inches to cause a standard split-barrel sampler, 1 3/8 inches I.D., to penetrate a distance of 6 inches. The number of impacts for the first 6 inches of penetration is known as the seating drive. The sum of the impacts for the last 12 inches of penetration is the Standard Penetration Test Resistance or "N" value, blows per foot. For example, if blows = 6-8-9, "N" = 8+9 or 17.

Other Notations

Recovery % – length of recovered soil divided by length of sample attempted.

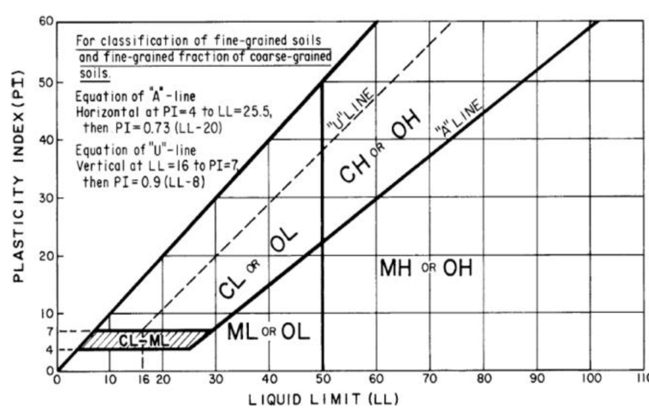
50/2"	Impacts of hammer to cause sampler to penetrate the indicated number of inches
WR	Sampler penetrated under the static loading of the weight of the drill rods
WH	Sampler penetrated under the static loading the weight of the hammer and drill rods
HSA	Hollow stem auger drilling method
FA	Flight auger drilling method
RW	Rotary wash drilling methods with drilling mud
AH	Automatic hammer used for Standard Penetration Test sample
SH	Safety hammer with rope and cathead used for Standard Penetration Test sample

Graphic Symbols

▽	Depth at which groundwater was encountered during drilling
▼	Depth at which groundwater was measured after drilling
	Standard Penetration Test Sample, ASTM D1586
	3-inch diameter Shelby Tube Sample, ASTM D1587
G	Sample grabbed from auger
	NX Size rock core sample

TSi geotechnical

UNIFIED SOIL CLASSIFICATION SYSTEM, (ASTM D-2487)

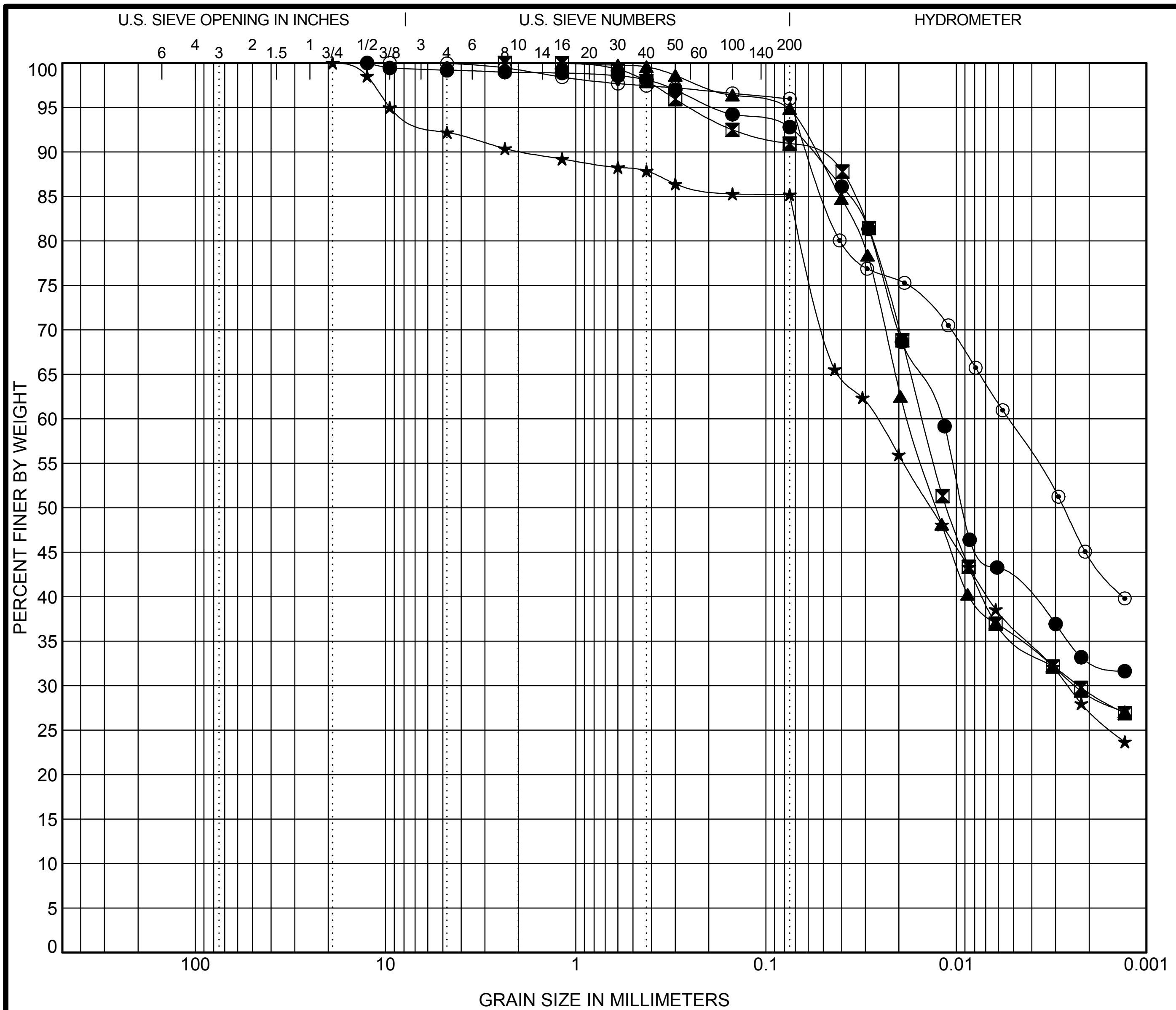
Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of materials is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-Grained soils are classified as follows: Less than 5 per cent: GW, GP, SW, SP; More than 12 per cent: GM, GC, SM, SC; 5 to 12 per cent: Borderline cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.1. less than 4	Above "A" line with P.1. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line with P.1. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-mix mixtures		Atterberg limits about "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits about "A" line with P.I. greater than 7	
Fine-grained soils (More than half of materials 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, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of medium to high plasticity, organic silts			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			

[a]Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 26 or less and the P.1. is 6 or less; the suffix u used when L.L. is greater than 28.

[b]Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

APPENDIX C

Laboratory Test Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

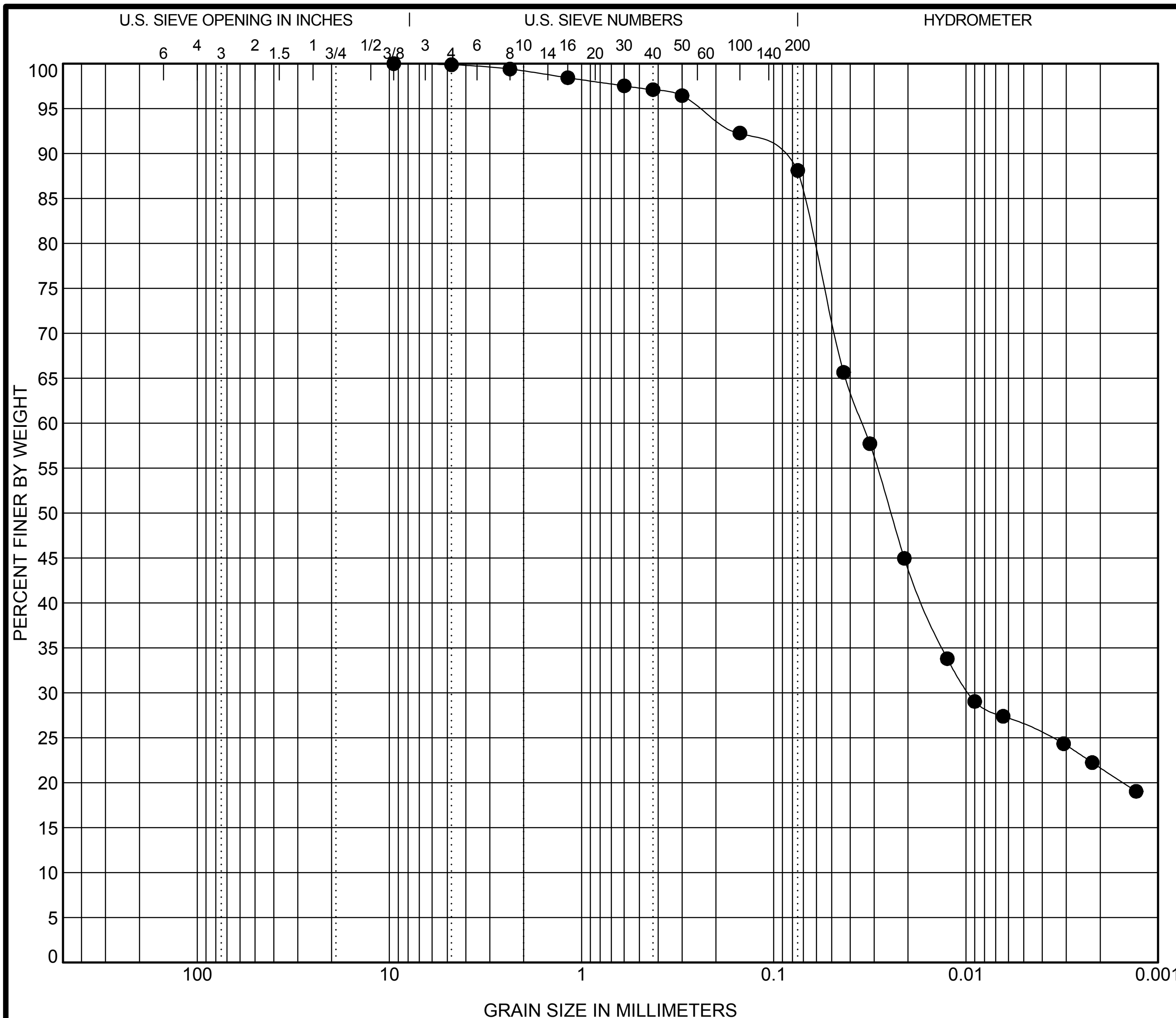
Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-01	8.5						
⧗	B-02	13.5						
▲	B-03	8.5						
★	B-04	3.5						
⊙	B-05	18.5						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-01**	**8.5**	**12.5**	**0.012**			**0.8**	**6.4**	**51.3**	**41.5**
⧗	**B-02**	**13.5**	**2.36**	**0.015**	**0.002**		**0.0**	**9.0**	**55.5**	**35.5**
▲	**B-03**	**8.5**	**1.18**	**0.018**	**0.002**		**0.0**	**5.1**	**59.3**	**35.5**
★	**B-04**	**3.5**	**19**	**0.026**	**0.003**		**7.8**	**7.0**	**48.6**	**36.6**
⊙	**B-05**	**18.5**	**9.5**	**0.005**			**0.1**	**4.0**	**36.9**	**59.1**

GRAIN SIZE DISTRIBUTION

TSI geotechnical, inc.
8248 NW 101st Terrace, #5
Kansas City, Missouri 64153

PROJECT NAME: Waukomis Drive	Tested By:
PROJECT LOCATION: Kansas City, Missouri	Calculated By:
PROJECT NUMBER: 20152027	Checked By:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-06**	**6.0**						

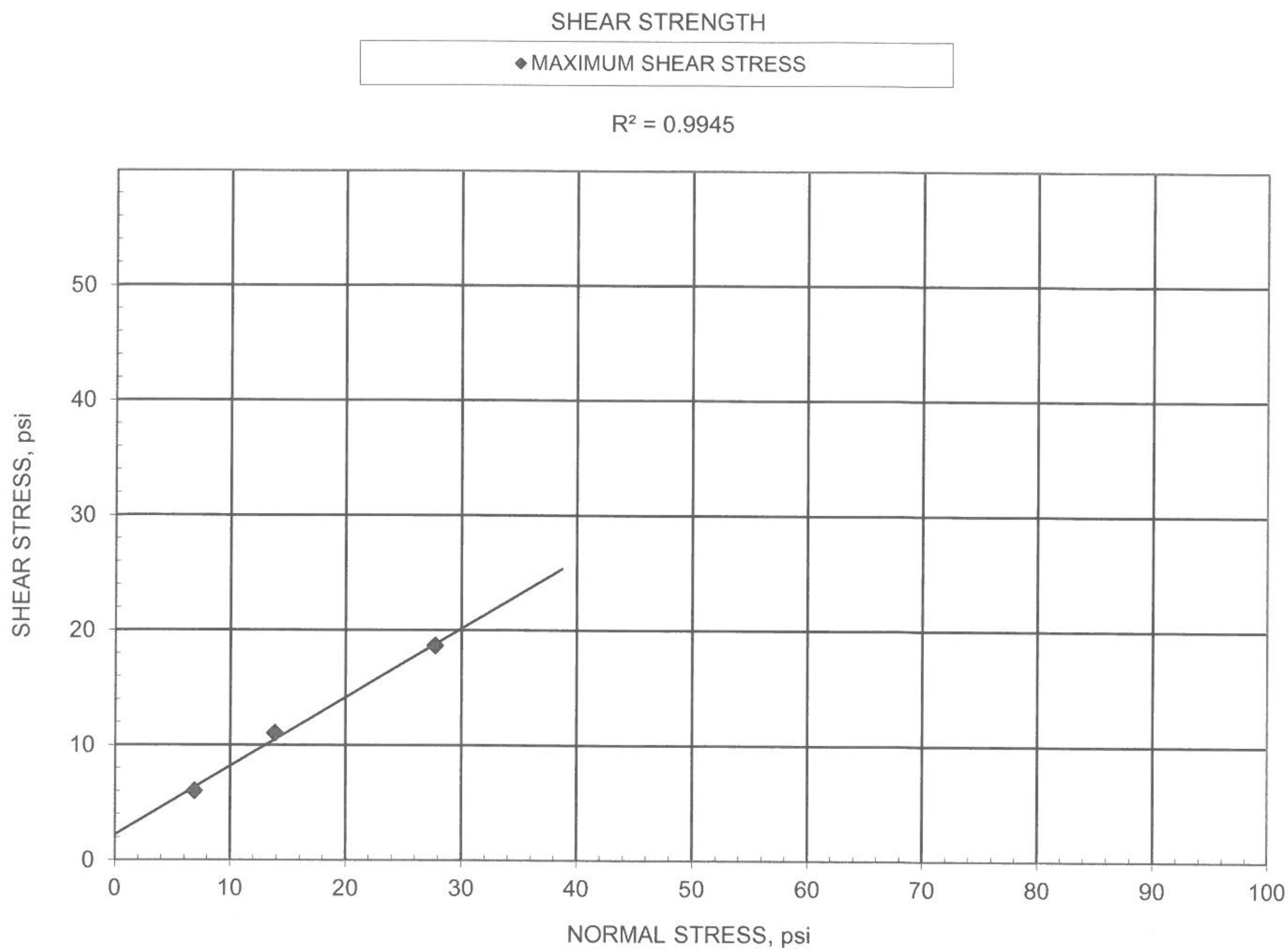
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-06**	**6.0**	**9.5**	**0.035**	**0.01**		**0.1**	**11.8**	**61.8**	**26.4**

TSI geotechnical, inc.
8248 NW 101st Terrace, #5
Kansas City, Missouri 64153

GRAIN SIZE DISTRIBUTION

PROJECT NAME: Waukomis Drive	Tested By:
PROJECT LOCATION: Kansas City, Missouri	Calculated By:
PROJECT NUMBER: 20152027	Checked By:

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



		FRICTION ANGLE		COHESION	NORMAL STRESS, psi	NORMAL STRESS, psi	NORMAL STRESS, psi
AT MAXIMUM SHEAR STRESS		30.9 deg		2.2 psi	6.94	13.88	27.77
INITIAL AREA, mm2	3174.8	INITIAL MOISTURE, %			25.2	24.9	24.3
INITIAL LENGTH, mm	25.36	INITIAL DRY DENSITY, pcf			94.5	94.0	97.0
SPECIFIC GRAVITY	2.70	INITIAL SATURATION, %			87	85	89
SG TESTED		INITIAL VOID RATIO			0.78	0.79	0.74
SG ASSUMED	X	FINAL MOISTURE, %			26.8	26.3	25.0
LIQUID LIMIT	35	FINAL SATURATION, %			92	93	95
PLASTIC LIMIT	22	FINAL VOID RATIO			0.79	0.76	0.71
PLASTICITY INDEX	13	MAXIMUM SHEAR STRESS, psi			5.99	11.03	18.62
SAMPLE TYPE	SHELBY TUBE	RATE OF LOADING, in/min			0.0007	0.0007	0.0007
DESCRIPTION	LEAN CLAY						

PROJECT NAME: WAUKOMIS DRIVE BORING NO. B-04

LOCATION: TSI PROJECT SAMPLE NO. ST-3

JOB NO.: 02156326 DEPTH, feet 8 TO 10

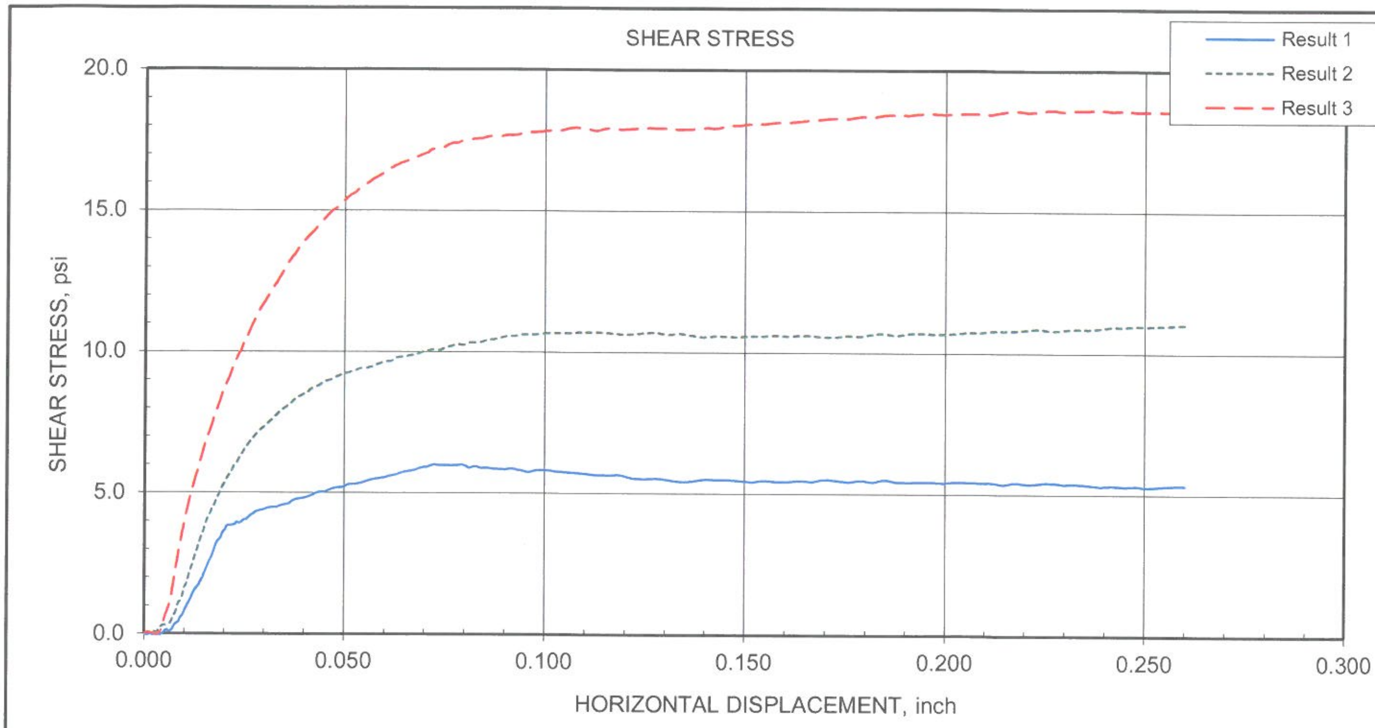
DATE: 6/9/2015

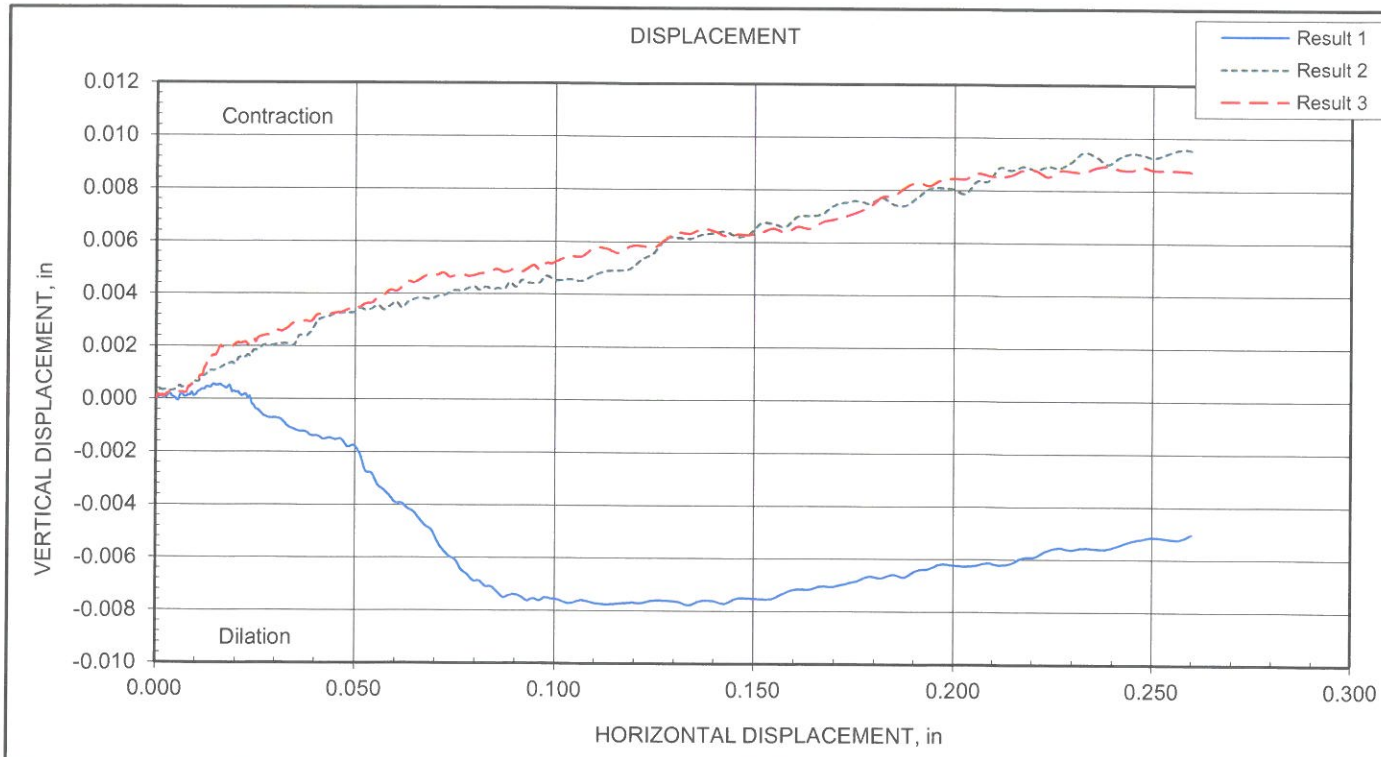
N:\Projects\2015\02156326\Working Files\Laboratory-Field Data-Boring Logs\Waukomos Drive\[02156326 DS B04-ST3-8.0.xls]Re

Terracon

WAUKOMIS DRIVE
TSI PROJECT
02156326
6/9/2015

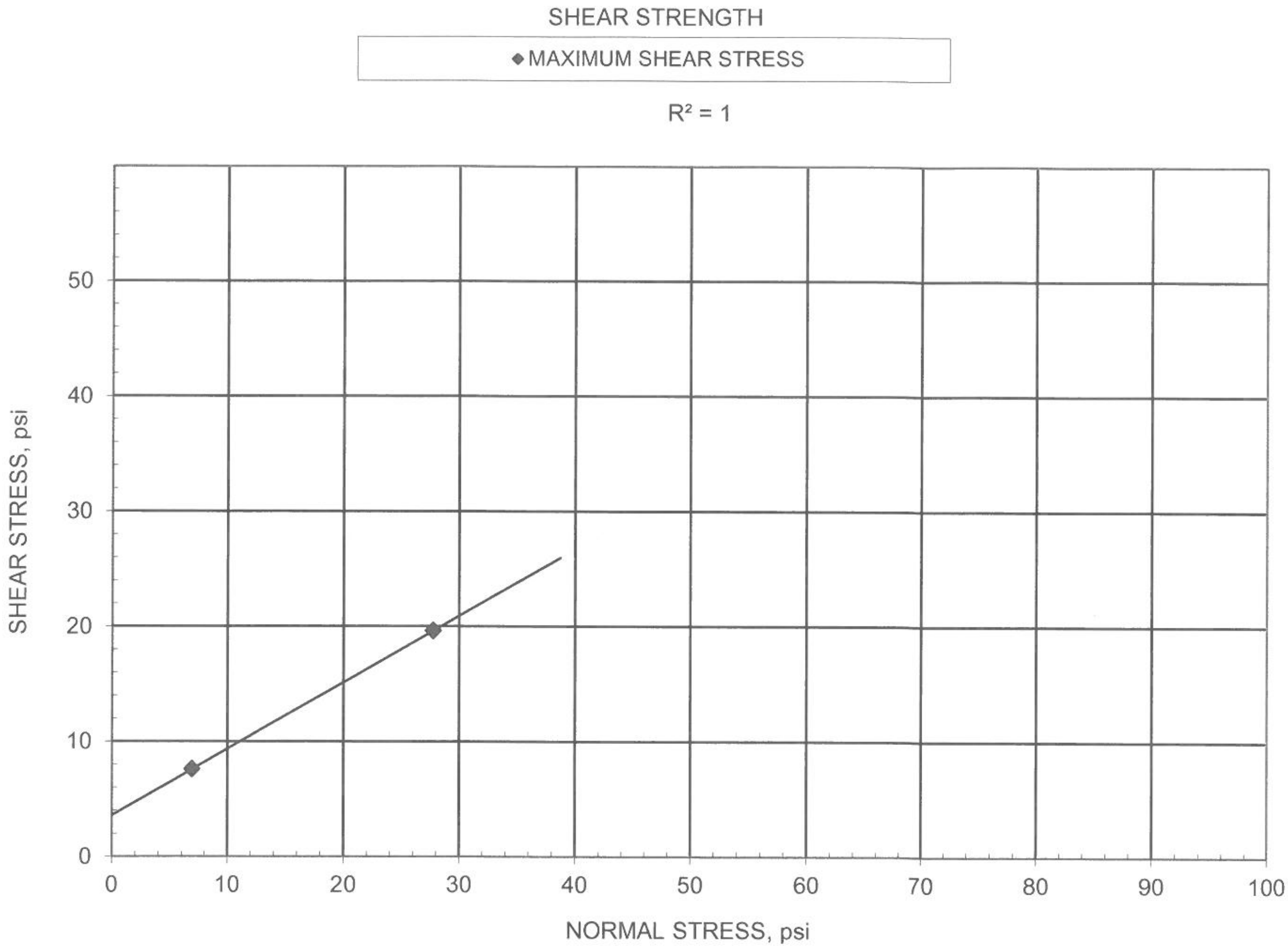
BORING NO.	B-04
SAMPLE NO.	ST-3
DEPTH, feet	8 TO 10





Terracon

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



		FRICTION ANGLE / COHESION	NORMAL STRESS, psi	NORMAL STRESS, psi
AT MAXIMUM SHEAR STRESS		30.0 deg / 3.6 psi	6.95	27.76
INITIAL AREA, mm2	3173.0	INITIAL MOISTURE, %	18.3	18.5
INITIAL LENGTH, mm	25.33	INITIAL DRY DENSITY, pcf	108.1	108.4
SPECIFIC GRAVITY	2.70	INITIAL SATURATION, %	88	90
SG TESTED		INITIAL VOID RATIO	0.56	0.55
SG ASSUMED	X	FINAL MOISTURE, %	21.3	19.7
LIQUID LIMIT	45	FINAL SATURATION, %	97	98
PLASTIC LIMIT	16	FINAL VOID RATIO	0.59	0.54
PLASTICITY INDEX	29	MAXIMUM SHEAR STRESS, psi	7.59	19.61
SAMPLE TYPE	SHELBY TUBE	RATE OF LOADING, in/min	0.0007	0.0007
DESCRIPTION	LEAN CLAY			

PROJECT NAME: WAUKOMIS DRIVE

BORING NO. B-06

LOCATION: TSI PROJECT

SAMPLE NO. ST-1

JOB NO.: 02156326

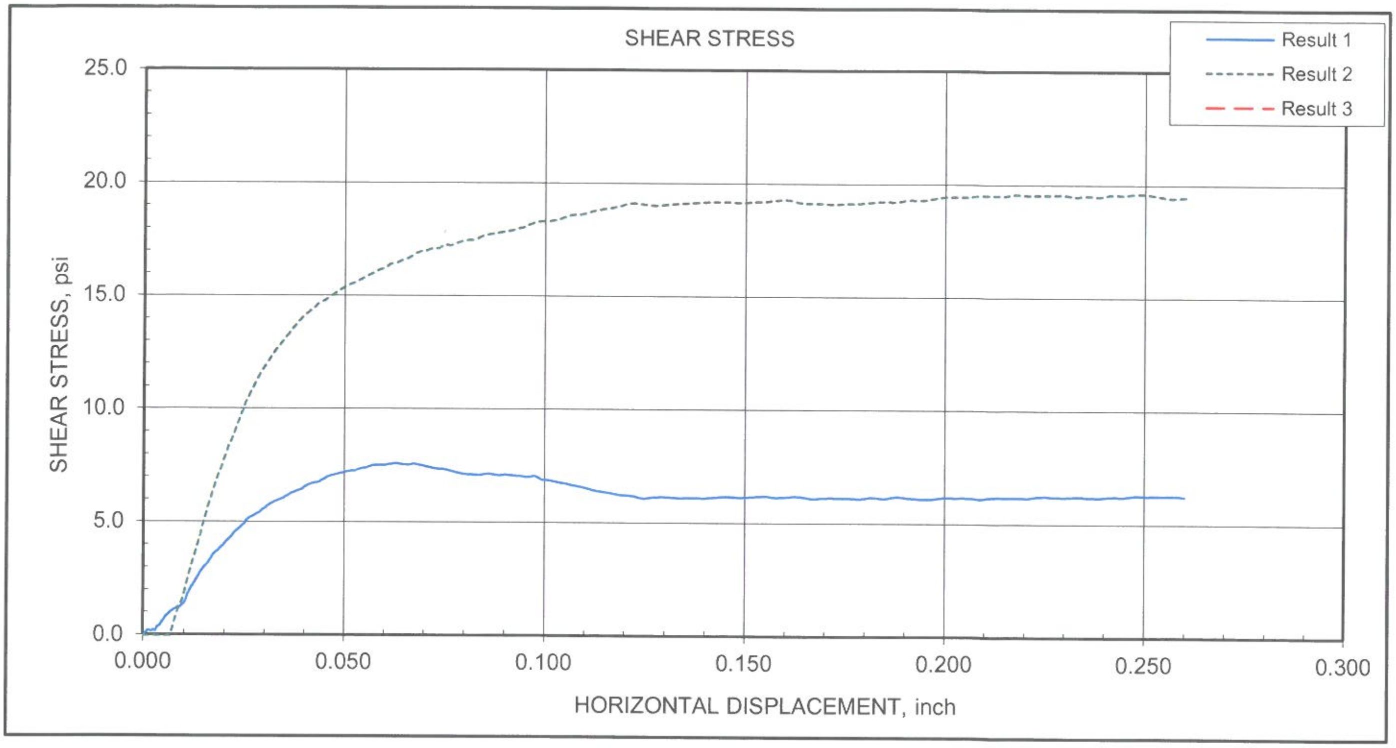
DEPTH, feet 1 TO 3

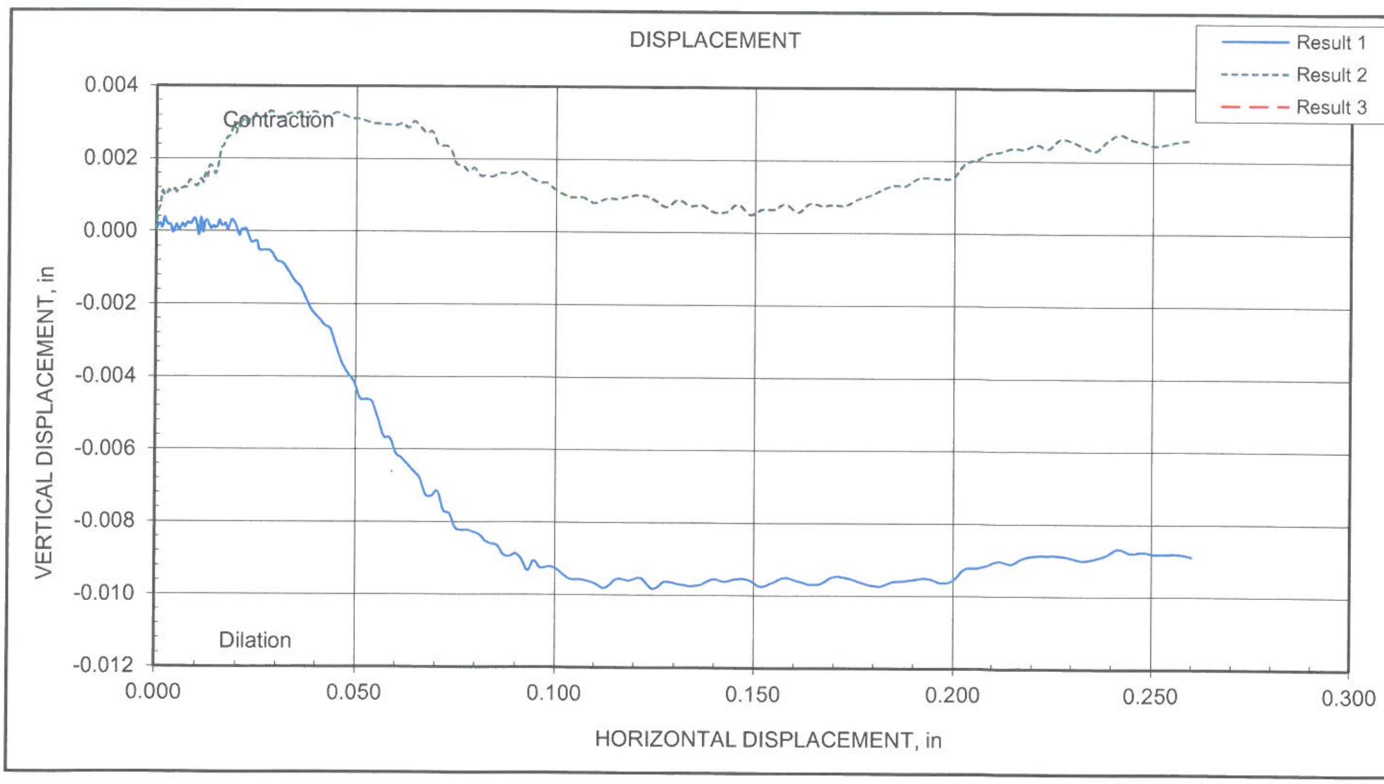
DATE: 6/9/2015

Terracon

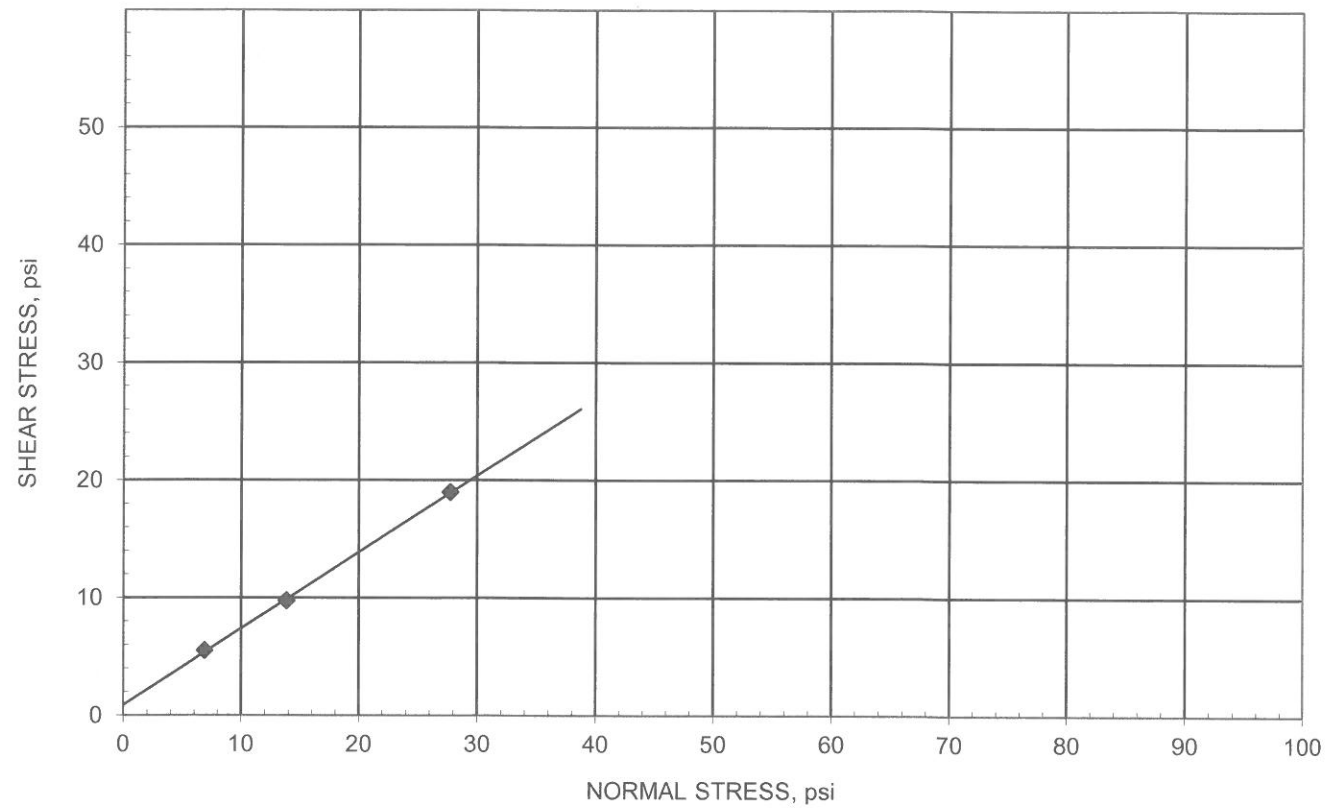
WAUKOMIS DRIVE
TSI PROJECT
02156326
6/9/2015

BORING NO.	B-06
SAMPLE NO.	ST-1
DEPTH, feet	1 TO 3





DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



				NORMAL STRESS, psi	NORMAL STRESS, psi	NORMAL STRESS, psi
		FRICTION ANGLE	COHESION			
AT MAXIMUM SHEAR STRESS		33.0 deg	0.9 psi	6.94	13.87	27.76
INITIAL AREA, mm2	3170.5	INITIAL MOISTURE, %		21.0	22.0	20.8
INITIAL LENGTH, mm	25.33	INITIAL DRY DENSITY, pcf		101.6	99.5	102.8
SPECIFIC GRAVITY	2.70	INITIAL SATURATION, %		86	86	88
SG TESTED		INITIAL VOID RATIO		0.66	0.69	0.64
SG ASSUMED	X	FINAL MOISTURE, %		21.6	21.2	19.3
LIQUID LIMIT	33	FINAL SATURATION, %		90	90	94
PLASTIC LIMIT	18	FINAL VOID RATIO		0.65	0.64	0.55
PLASTICITY INDEX	15	MAXIMUM SHEAR STRESS, psi		5.50	9.74	18.97
SAMPLE TYPE	SHELBY TUBE	RATE OF LOADING, in/min		0.0007	0.0007	0.0007
DESCRIPTION	LEAN CLAY WITH SAND					

PROJECT NAME: WAUKOMIS DRIVE

BORING NO. B-06

LOCATION: TSI PROJECT

SAMPLE NO. ST-4

JOB NO.: 02156326

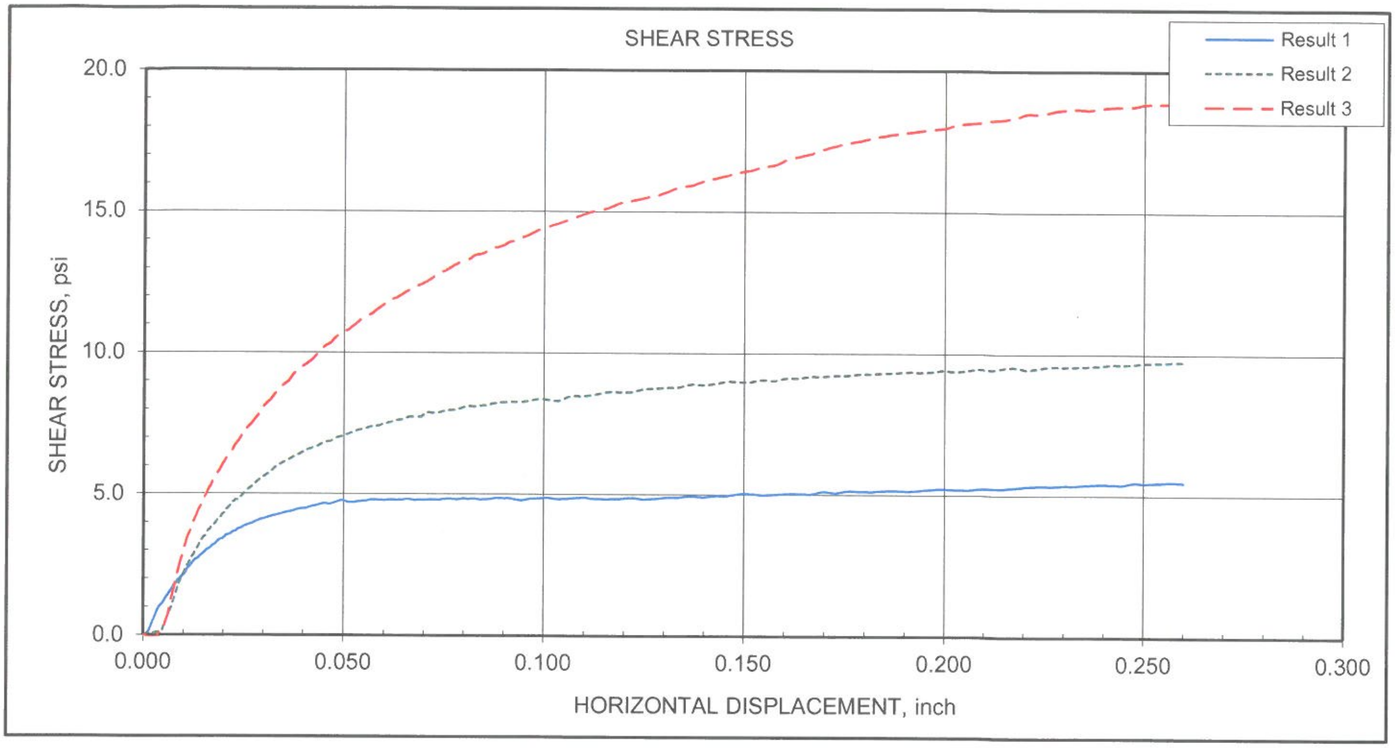
DEPTH, feet 8 TO 10

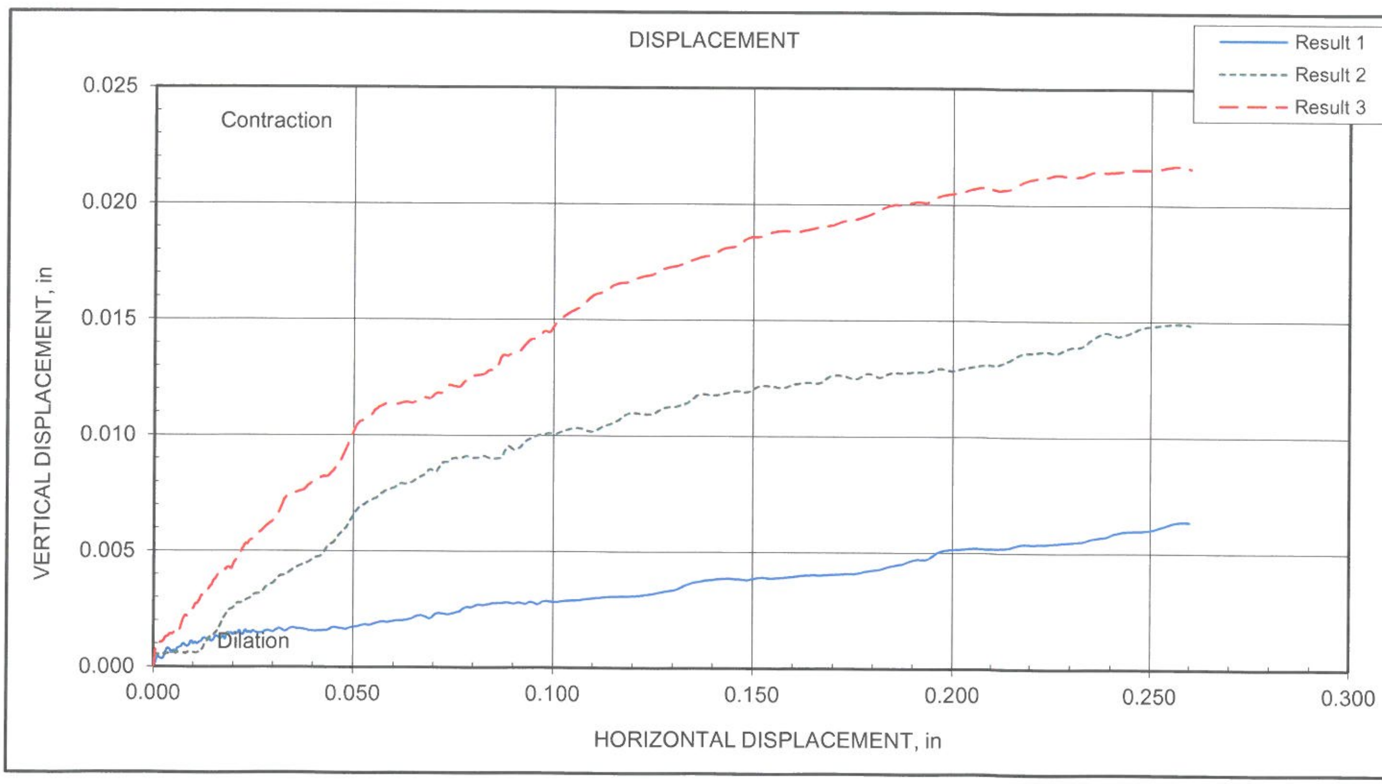
DATE: 6/9/2015

Terracon

WAUKOMIS DRIVE
TSI PROJECT
02156326
6/9/2015

BORING NO.	B-06
SAMPLE NO.	ST-4
DEPTH, feet	8 TO 10

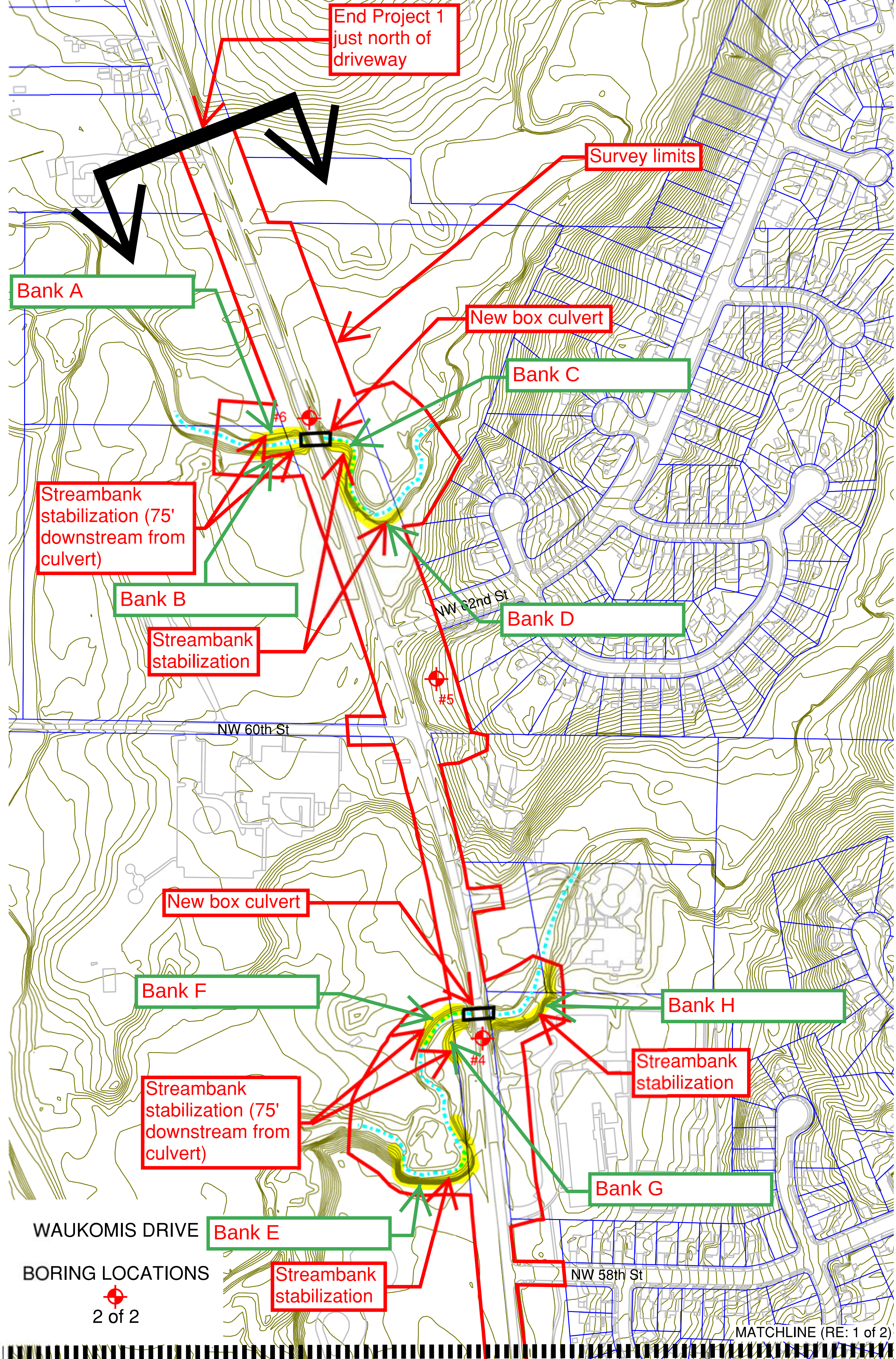




Terracon

APPENDIX D

Stream Bank Photographs


End Project 1 just north of driveway
Survey limits
Bank A
New box culvert
Bank C
#6
Streambank stabilization (75' downstream from culvert)
Bank B
Bank D
Streambank stabilization
#5
NW 60th St
New box culvert
Bank F
Bank H
#4
Streambank stabilization
Streambank stabilization (75' downstream from culvert)
Bank G
WAUKOMIS DRIVE
Bank E
BORING LOCATIONS
Streambank stabilization
NW 58th St
2 of 2
MATCHLINE (RE: 1 of 2)

Creek Bank A **Waukomis Drive** **20152027**

Creek Bank A appears to be gradually sloped. (facing Northeast toward Waukomis Drive)

Creek Bank B **Waukomis Drive** **20152027**

Creek Bank B is steeply sloped to nearly vertical. (facing East toward existing box culvert under Waukomis Drive)

Creek Bank C **Waukomis Drive** **20152027**

Creek Bank C is gradually sloped. (facing West toward existing box culvert under Waukomis Drive)

Creek Bank D **Waukomis Drive** **20152027**

Creek Bank D is steeply sloped along Waukomis Drive. Limited space for regrading. (facing Southwest, Waukomis Drive and utility corridor are directly adjacent to the creek bank shown here)

Creek Bank D **Waukomis Drive** **20152027**

Creek Bank D is steeply sloped to vertical around the creek bend. (facing South)

Creek Bank E **Waukomis Drive** **20152027**

Creek Bank E is steeply sloped to vertical. (facing South at the creek bend)

Creek Bank E **Waukomis Drive** **20152027**

Creek Bank E is steeply sloped to vertical with exposed utility line. (facing Southeast at the creek bend)

Creek Bank F **Waukomis Drive** **20152027**

Creek Bank F is steeply sloped. (facing Northwest, away from Waukomis Drive)

Creek Bank G **Waukomis Drive** **20152027**

Creek Bank G is gradually sloped, with limestone bedrock apparent at the creek bottom. (facing South along Waukomis Drive)

Creek Bank H **Waukomis Drive** **20152027**

Creek Bank H is steeply sloped to vertical at this creek bend. Line Creek Elementary School is nearby this slope and has a chain link fence a few feet from the top of the slope. (facing South)

Creek Bank H **Waukomis Drive** **20152027**

Creek Bank H is steeply sloped to vertical at this creek bend. (facing Southeast)

APPENDIX E

Global Stability Analysis Results

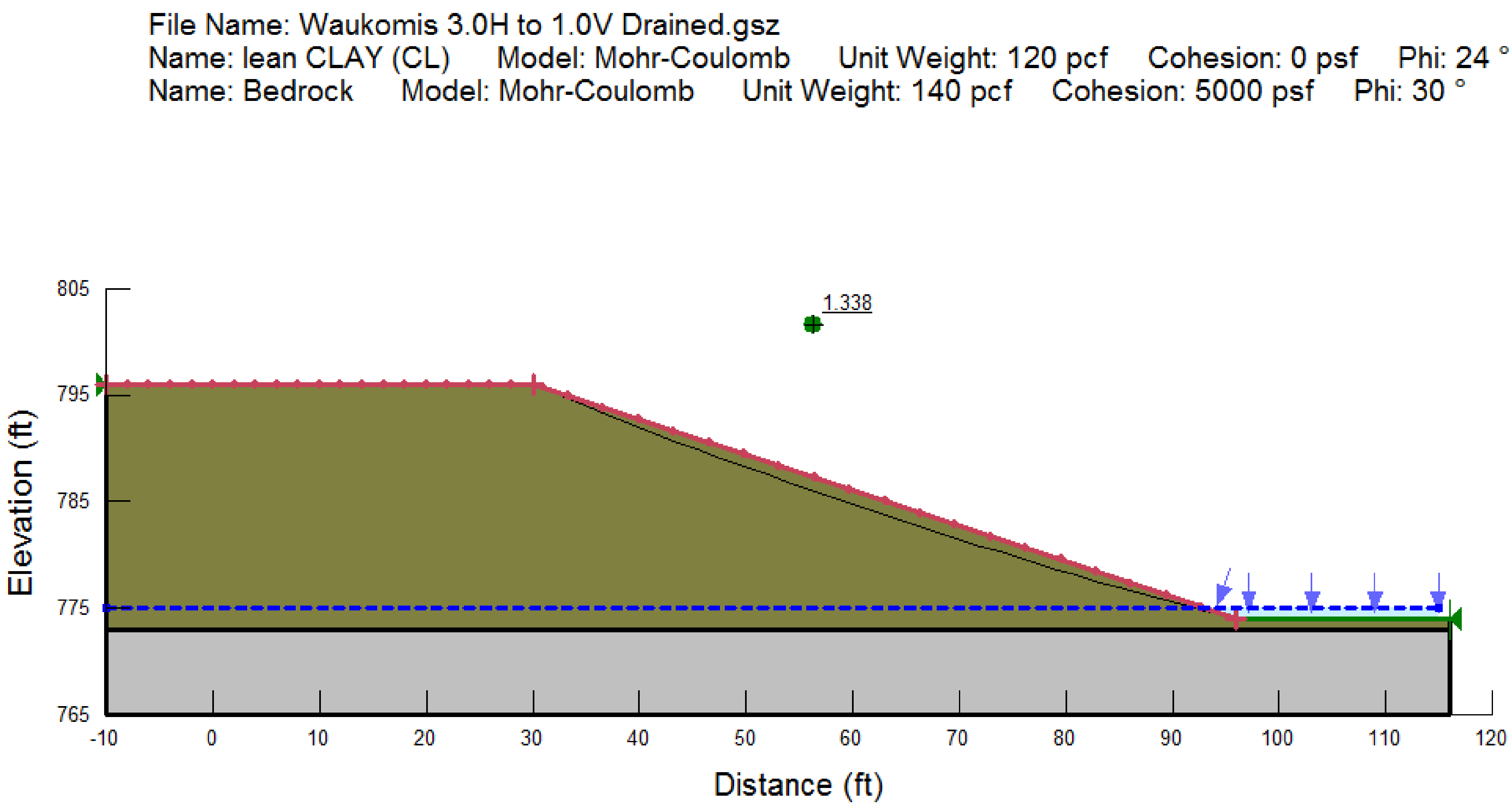


Figure 2: Waukomis 3.0H:1.0V Slope Drained		Project No. 20152027
Waukomis Drive Kansas City, Missouri		
Not to Scale	Approved by: JJ	

File Name: Waukomis 3to1 Undrained.gsz
Name: lean CLAY (CL) Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 1500 psf
Name: Bedrock Model: Mohr-Coulomb Unit Weight: 140 pcf Cohesion: 5000 psf Phi: 30 °

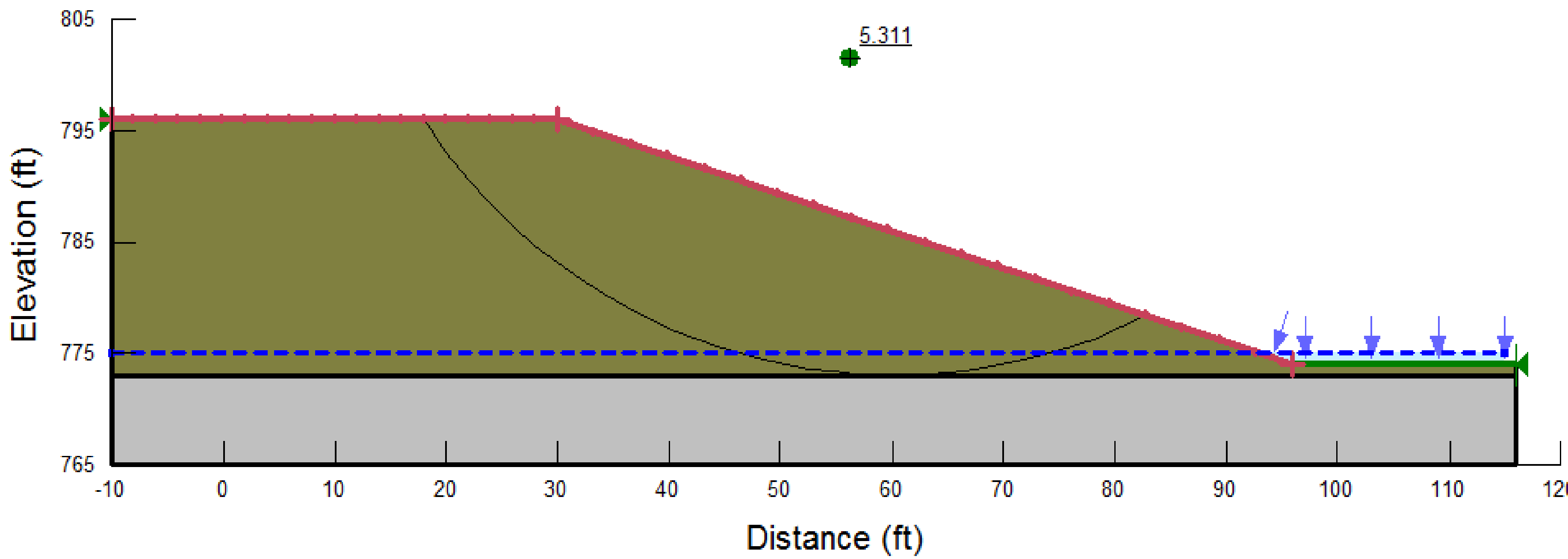


Figure 3: Waukomis 3.0H:1.0V Slope Undrained		Project No. 20152027
Waukomis Drive Kansas City, Missouri		
Not to Scale	Approved by: JJ	

REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION

WAUKOMIS DRIVE WATER MAIN
KANSAS CITY, MISSOURI
WSD PROJECT NUMBER 89008260
TSI PROJECT NUMBER 20152027.01

WALTER P. MOORE
1100 Walnut St., Suite 1825
Kansas City, Missouri 64106

TSi geotechnical, inc.

8248 NW 101st Terrace #5
Kansas City, Missouri 64153

March 29, 2019

The Design Professional has conducted a soil investigation and geotech report for design purposes only. The geotech report does not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotech report has been requested by bidders and is included with this addenda. The geotech report is deemed as not suitable for contractor's use, contractor is using it at their risk and the report is merely suggestive of the nature of the tested material, not representative of entire site conditions. Acknowledgement of this addenda shows acceptance of all risks associated with any use.

8248 NW 101st Terr, #5
Kansas City, MO 64153
816.599.7965 (tel)
816.599.7967 (fax)
www.tsigeotech.com

PROFESSIONAL SERVICE SINCE 1989

March 29, 2019

Mr. Mike Haake, PE
WALTER P. MOORE
1100 Walnut St., Suite 1825
Kansas City, Missouri 64106

Re: Report of Subsurface Exploration and Geotechnical Engineering Evaluation Waukomis Drive Water Main Kansas City, Missouri TSi Project No. 20152027.01

Dear Mr. Haake:

TSi Geotechnical, Inc. (TSi) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the referenced project and is pleased to submit this report of our findings to Walter P. Moore (WPM). The purpose of our work was to determine subsurface conditions at specific exploration locations and to gather data on which to prepare geotechnical recommendations for the water main improvements along Waukomis Drive in northern Kansas City, Missouri. This report describes the exploration procedures used, documents the data obtained, and presents our evaluations and recommendations relative to the geotechnical engineering aspects of the project.

We appreciate the opportunity to assist you with this project. If you have any questions, or if we may be of further service to you, please call us.

Respectfully submitted,
TSI GEOTECHNICAL, INC.

Brooke Sidebottom, EI
Staff Engineer

STATE OF MISSOURI
BRIAN
WILLIAM ROBBEN
NUMBER
PE-2004017235
PROFESSIONAL ENGINEER
3/29/19

Brian Robben, PE, RG
Geotechnical Department Manager

For: Denise B. Hervey, PE
Principal

CONTENTS

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION WAUKOMIS DRIVE WATER MAIN KANSAS CITY, MISSOURI

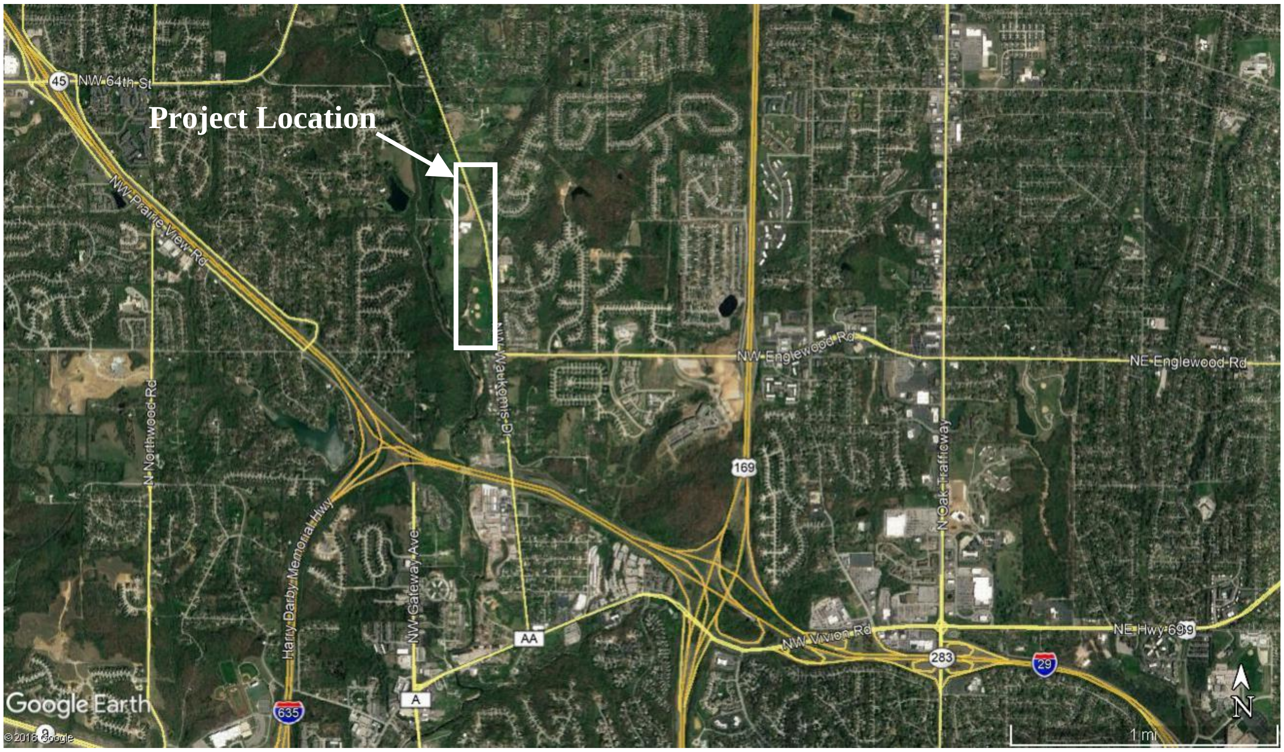
1.0 SCOPE OF SERVICES

This report summarizes the results of a geotechnical study performed for the proposed Waukomis Drive Water Main, extending from NW Englewood Road to the south to about 1000 feet north of NW 62nd Street in Kansas City, Missouri. The study was performed in general accordance with TSi's proposal to WPM dated January 31, 2018. Based on TSi's understanding of the project, the following items have been identified for inclusion in this study report:

- Subsurface conditions at the boring locations;
- Laboratory test results;
- Influence of groundwater;
- Lateral earth pressures for subsurface structures;
- Bedrock depths and elevations;
- Pipe bedding recommendations;
- Seismic site classification;
- Excavation considerations;
- General construction considerations; and
- Recommendations for fill and backfill materials, placement, and compaction;

2.0 SITE AND PROJECT DESCRIPTIONS

The following project understanding is based on discussions with WPM, and a site reconnaissance by a geotechnical engineer from TSi. The project will consist of the installing approximately 4,000 feet of a new, 36-inch diameter water main along Waukomis Drive in Kansas City, Missouri. The general location of the project site is shown below. The Site and Boring Location Plan, Figures 1a through 1c in Appendix A, provide a more detailed plan of the project area.



3.0 Field Exploration and Laboratory Testing

3.1 Field Exploration

TSi conducted an exploration program at the project site on March 21, 2019 consisting of 13 soil borings, designated as Borings B-01 to B-13. The logs from this exploration are included in Appendix B of this report. The boring locations were selected by WPM, and located in the field by TSi. The ground surface elevations at the as-drilled boring locations were not available at the time of this report.

The borings were drilled using a CME 550 ATV-mounted drill rig to advance flight auger drilling tools. Split-spoon and Shelby tube samples were recovered from the borings. Split-spoon samples were recovered using a 2-inch outside-diameter, split-barrel sampler, driven by an automatic hammer, in accordance with ASTM D 1586. Three-inch Shelby tube samples were obtained in accordance with ASTM D 1587. The Shelby tube samples were preserved by sealing the entire sample in the tube. The split-spoon samples were placed in plastic bags for later testing in the laboratory.

The results of the field tests and measurements were recorded on field logs and appropriate data sheets by TSi's geotechnical specialist. Those data sheets and logs contain information concerning the exploration methods, samples attempted and recovered, indications of the presence of various subsurface materials, and the observation of groundwater. The field logs and data sheets contain the specialist's interpretations of the conditions between samples, based on the performance of the exploration equipment and the cuttings brought to the surface. The final logs included in this report were based on the field logs, modified as appropriate based on the results of laboratory testing of soil samples.

4.0 Subsurface Conditions

Details of the subsurface conditions encountered at the boring locations are shown on the logs in Appendix B. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at these locations on the date shown; the reported conditions may be different at other locations or at other times.

4.1 Generalized Subsurface Profile

The surficial materials encountered at the project site generally consisted of brown lean clay with roots and organics. The surficial materials were generally underlain by native soils. The native soils primarily consisted of lean clay (CL in accordance with Unified Soil Classification System (USCS)) with varying amounts of gravel in some borings. The native soils continued to the planned termination depths or auger refusal in all borings except for Borings B-07 and B-13. Medium to coarse grained sand (SP in accordance with USCS) was encountered below the native cohesive soils in Boring B-13 starting at a depth of 6.0 feet. Weathered limestone was encountered below the native cohesive soils in Boring B-07 starting at a depth of 6.0 feet. Standard penetration test N-values in the native soils varied across the project site ranging from weight of hammer (0 blows per foot (bpf)) to 17 bpf. Moisture contents ranged from 11% to 35%. Undisturbed Shelby tube samples taken in the native soils yielded an undrained shear strengths of 0.45 tons per square foot (tsf) to 1.43 tsf and unit weights of 97 pounds per cubic feet (pcf) to 103 pcf. Auger refusal on apparent limestone bedrock was encountered at 8.7 feet and 9.2 feet in borings B-07 and B-08, respectively.

4.2 Groundwater

Groundwater was not observed in the borings during drilling. The presence or absence of groundwater at a particular location does not necessarily mean that groundwater will be present or absent at that location at other times. Seasonal variations and other unknown considerations could cause fluctuations in water levels and the presence of water in the soils.

5.0 ENGINEERING ASSESSMENTS AND RECOMMENDATIONS

5.1 LATERAL EARTH PRESSURES

Lateral earth pressure parameters are provided for the design of the buried structures, such as manholes, that may be included in the project. It is assumed that the walls of these structures will be restricted from movement at the top and therefore should be designed to resist at-rest earth pressures. Earth pressures are a function of the excavation configuration and the backfill materials. Lateral earth pressure parameters are provided in Table 1 for the design of these subsurface structures. Hydrostatic forces should be added to the analyses below the design groundwater level unless the structure is designed with a permanent underdrain and pump system to prevent buildup of hydrostatic forces on the structure.

Below-grade structures that are restricted from movement at the top, such as footings or foundation walls, should be designed to resist at-rest pressures. Walls that are free to move and deflect at the top should be designed to resist active earth pressures. A horizontal deflection at the top of the wall of approximately 1% of the freestanding wall height is typically required to permit active pressure to develop. Earth pressures are a function of the excavation configuration and the backfill materials.

TABLE 1
LATERAL EARTH PRESSURE PARAMETERS FOR SUBSURFACE STRUCTURES*

Parameter		Backfilled with Crushed Limestone	Backfilled with Cohesive Soil	Backfill with Cohesionless Soil
At-Rest Equivalent Fluid Pressure	Drained	55 pcf	72 pcf	63 pcf
	Undrained	91 pcf	99 pcf	94 pcf
Active Equivalent Fluid Pressure	Drained	35 pcf	51 pcf	42 pcf
	Undrained	81 pcf	88 pcf	83 pcf
Passive Equivalent Fluid Pressure	Drained	480 pcf	308 pcf	375 pcf
	Undrained	310 pcf	217 pcf	250 pcf
Soil Unit Weight		130 pcf	125 pcf	125 pcf
Angle of Internal Friction for Backfill		35°	25°	30°
Assumed Surcharge Condition		None	None	None
Slope Profile Behind Structure		Horizontal	Horizontal	Horizontal

* No factor of safety has been applied to the above values

Significant wall movements would generally be necessary to develop the full values of passive pressures given; typically, the passive values stated are reduced by up to one-half for design.

To prevent the accumulation of water behind new subsurface walls and resulting hydrostatic pressure, a free-draining granular backfill material is recommended for the walls. The drainage backfill material should be encased in a nonwoven geotextile having a minimum weight of 8 ounces per square yard. A perforated pipe should be placed at the base of the wall to collect the water and carry it to daylight, to a storm sewer, or to a sump.

The effects of vertical surcharge loads or sloping ground behind the wall are not included for the stated fluid pressures. The effect of surface loading may be included as a uniform horizontal load against the wall equal to one-half the vertical load intensity.

5.2 Soil Excavation Considerations

Care should be taken to ensure the soft soils in Borings B-11 and B-13 do not create a quick condition near the flowline elevation. These soils could cause sluffing during excavation and may require shoring.

5.3 Bedrock Excavation Considerations

Two of the borings at this site encountered limestone bedrock. Construction budgets and schedules should anticipate some rock excavation in these areas. The weathered upper portion of the bedrock can probably be excavated using conventional excavators. As the limestone gets harder with depth, it may not be able to be excavated using conventional excavation machinery equipped with rock bucket teeth. The limestone excavations may require the utilization of jackhammers or hoe-rams. If the limestone encountered is too hard for these machines, other methods including blasting may have to be employed, where allowable. The most suitable means to excavate the bedrock materials should be determined by the contractor in the field.

5.4 Pipe Support

TSi recommends that the water main be supported by 6 inches of crushed aggregate base placed over a properly prepared soil subgrade. The aggregate will provide a uniform base for support of the pipe and a stable working surface during construction. The aggregate base should be compacted according to Section 6.4 of this report.

Excavations for the pipe subgrades should be done carefully to not excessively disturb the soil base. If soft subgrade soils are encountered in the bottom of the trench, the soft soils should be overexcavated, up to 2 feet below the pipe, and replaced with crushed aggregate base.

Where the transmission main trench is to be excavated into bedrock, an additional 9 inches of bedrock should be excavated to allow for the placement of 9 inches of crushed stone below the pipe. This base will prevent the pipe from bearing on a non-yielding hard surface.

The City of Kansas City Missouri and APWA Division II Specification requirements should be followed in the selection of pipe bedding materials and embedment depths.

To prevent the pipe bedding and backfill from acting as a conduit for the flow of groundwater along the pipe, clay or flowable fill plugs could be installed at 100-foot intervals along the alignment. The clay plugs should be compacted in accordance with the cohesive fill specification in Section 6.4.

5.5 Pipe Settlement and Loading

TSi understands a portion of the proposed water main elevations will be in bedrock. If bedrock is directly supporting the crushed granular bedding material, settlement of the pipe should be insignificant. Pipe that is supported by stiff in-situ soils should experience less than 1-inch of settlement.

Pipe loading at the site will vary with the embedment depth of the pipe. In general, the depth of pipe embedment in feet should be multiplied by 125 pcf (moist unit weight in pounds per cubic foot) to calculate the total overburden pressure on the pipe in pounds per square foot.

5.6 Thrust Block Foundations

The proposed thrust blocks may be supported by shallow spread footing foundations bearing in native lean clay soils and may be designed for a net allowable bearing pressure (pressure in excess of adjacent overburden pressure) of up to 1,500 pounds per square foot (psf) for structural dead load plus maximum live load.

Foundations in soil should be excavated with a smooth-edged, clawless excavating bucket to reduce disturbance of the bearing surface. Appropriate equipment should be used for excavations in bedrock and intermediate geomaterials. The excavations should be kept dry, and foot traffic should be kept to a minimum to limit disturbance. Any loose or soft material that accumulates or develops at the footing subgrade should be removed prior to the placement of concrete. If zones of soft soils are encountered at the foundation support level, they should be removed and replaced with properly compacted fill, or the footings should be deepened to bear on stiffer soil.

Concrete should be placed as soon as practical after the excavation has been completed to avoid deterioration of the bearing surface due to excessive drying, or excessive wetting caused by precipitation. Alternately, a thin layer of lean concrete could be placed over the excavation floor to protect the bearing surface.

5.7 Seismicity

Based on the general soil characteristics and the depth to bedrock, as determined by field and laboratory tests, the project area is designated as Site Class C in accordance with the 2012 revisions of the International Building Code (IBC). The soils at the site are not susceptible to liquefaction or to substantial settlement, slope instability, or loss in strength when subject to the design earthquake loading.

6.0 Site Preparation and Excavation Considerations

6.1 Excavations

Construction areas should be stripped of organic soil and any deleterious materials along the trench alignment prior to trench excavation. Tree stumps and root balls should also be removed.

Trenching, excavating, and bracing should be performed by the contractor in accordance with OSHA (Occupational Safety and Health Administration) regulations and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the soil at the site is considered Type C, which requires a side slope for excavations of not steeper than 1.5 horizontal to 1.0 vertical (1.5H:1V). Worker safety and classification of the excavation soil is the responsibility of the contractor. Also according to OSHA requirements, any excavation extending to a depth of more than 20 feet requires sheeting, shoring, and bracing, or other means of extra support designed by a registered professional engineer. An excavation retention system, such as soldier piles and lagging or sheet piling, may be used as an alternate to sloping back the sides of trench excavations.

6.2 Subgrade Protection

Construction areas should be properly graded in order to reduce or prevent surface runoff from collecting on the exposed subgrade in trench excavations. Any ponded water on the exposed subgrade or trench bottom should be removed immediately. Temporary storm water swales and collection areas may be required to control surface water flow into low areas of the site or into trench excavations.

To prevent unnecessary disturbance of the subgrade soils in the bottom of the trench, foot traffic should be minimized to prevent disturbance of the subgrade. If areas of disturbed subgrade develop, they should be properly repaired by removing and replacing the disturbed subgrade with properly compacted fill. Another option for improving a weak subgrade is overexcavation of the soft material to a depth of not more than 2 feet then use of a geogrid or geotextile placed at the bottom of the excavation, and backfilling with a properly compacted crushed limestone.

6.3 Fill and Backfill Materials

In general, trench backfill or engineered fill placed over the pipe should consist of clay or well-graded granular soils with a maximum particle size of 3 inches. The clay soils encountered in the borings are suitable for use as fill. Fill materials from off-site sources should be approved prior to their use. Soil with decayable material such as wood, trash, metal, or vegetation is not acceptable.

Rock fragments, such as limestone and shale, can be used in the trench backfill and engineered fills that are more than 2 feet below final grade and not within 2 feet of the water pipe. Rock fragments should be less than 6 inches in maximum overall dimension, assuming a minimum trench width of 7 feet. The rock fill should contain a sufficient amount of clay and smaller rock fragment sizes to fill voids between fragments. The fill should be placed in a manner that will achieve compaction of the clay around and between the limestone fragments. Placement and compaction of rock fill should be closely observed on a full-time basis by an experienced engineering technician, since testing the density of the rock fill may not be possible or may not provide meaningful results.

Some of the soil on the site will require the addition of moisture prior to compaction. This should be performed in a controlled manner, and the moistened soil should be thoroughly blended to produce a uniform moisture content. Fat clays and shale should be compacted wet of their optimum moisture content. If fill is placed during the winter season, fill materials should be carefully observed to see that no ice or frozen soils are placed as fill or remain in the base materials upon which fill is placed.

Some of the on-site soil may require moisture reduction prior to compaction. During warm weather, moisture reduction can generally be accomplished by disking, or otherwise aerating the soil. When air-drying is not possible, a moisture-reducing chemical additive, such as lime or Class C fly ash, could be used as a drying agent.

6.4 Fill and Backfill Placement

Cohesive fill should be compacted to a dry density of at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the soil. Granular material, such as crushed stone, used should be compacted to at least 100% of the standard Proctor maximum dry density. The moisture content of lean clay at the time of compaction should generally be within ±2% of the optimum moisture content of the material as determined by the standard Proctor compaction test. Fat clay or shale material should be placed and maintained at a moisture content ranging from 0 to 4% wet of the optimum. Fill should be placed in loose lifts not in excess of 8 inches thick, and compacted to the aforementioned criterion. However, it may be necessary to place fill in thinner lifts to achieve the recommended compaction when using small hand-operated equipment.

7.0 Construction Observation and Testing

It is recommended that TSi be retained during construction to perform testing and observation services for the following items:

- Observation of the trench bottom prior to backfilling and installation of the pipe; and
- Placement and compaction of trench backfill materials.

These Quality Assurance services should help to verify the design assumptions and maintain construction procedures in accordance with the project plans, specifications, and good engineering practice.

8.0 REPORT LIMITATIONS

This geotechnical report has been prepared for the exclusive use of **WALTER P. MOORE** for the specific application to the subject project. The information and recommendations contained in this report have been made in accordance with generally accepted geotechnical and foundation engineering practices; no other warranties are implied or expressed.

The assessments and recommendations submitted in this report are based in part upon the data obtained from the borings. The nature and extent of variations between the borings may not be evident at this time. If variations appear evident at a later date, it may be necessary to re-evaluate the recommendations of this report.

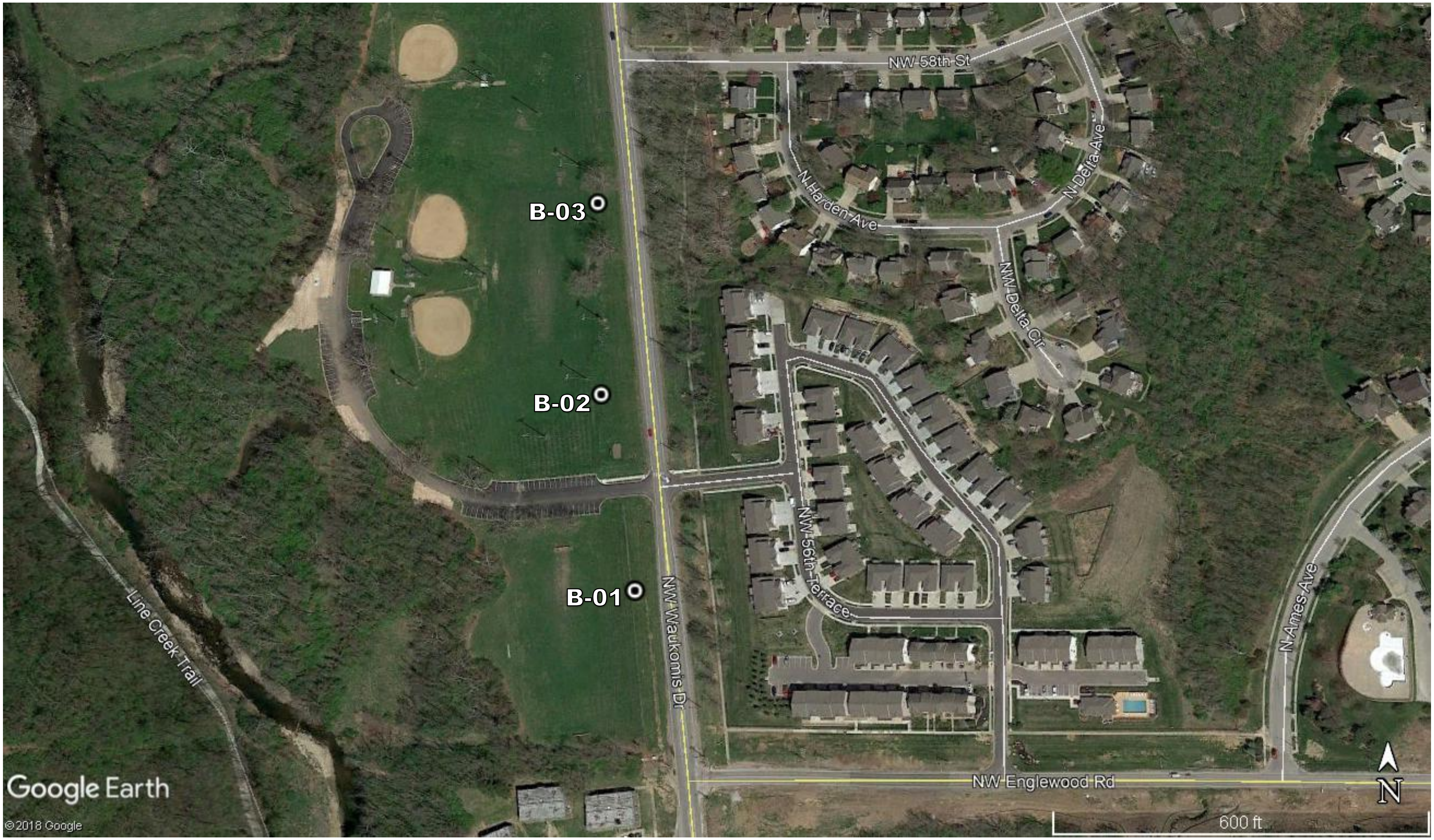
We emphasize that this report was prepared for design purposes only and may not be sufficient to prepare an accurate construction bid. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design purposes.

If conditions at the site have changed due to natural causes or other operations, this report should be reviewed by TSi to determine the applicability of the analyses and recommendations considering the changed conditions. The report should also be reviewed by TSi if changes occur in the location, size, and type, in the planned loads, elevations, grading and site development plans or the project concepts.

TSi recommends we be afforded the opportunity to review the final plans and specifications for the project prior to construction to verify that the recommendations in this report are properly interpreted and incorporated in the design and construction documents. If TSi is not accorded the opportunity to make this recommended review, we can assume no responsibility for the misinterpretation of our recommendations.

APPENDIX A

Site and Boring Location Plan



Legend

Boring Location

Figure 1a, Site and Boring Location Plan		Project No. 20152027.01
Waukomis Drive Water Main Kansas City, Missouri		
Not to Scale	Approved by: TBS	

Legend

Boring Location

Figure 1b, Site and Boring Location Plan		Project No. 20152027.01
Waukomis Drive Water Main Kansas City, Missouri		TSi geotechnical, inc.
Not to Scale	Approved by: TBS	

Legend

Boring Location

Figure 1c, Site and Boring Location Plan		Project No. 20152027.01
Waukomis Drive Water Main Kansas City, Missouri		TSi geotechnical, inc.
Not to Scale	Approved by: TBS	

APPENDIX B

Boring Logs
General Notes
Unified Soil Classification System

LOG OF BORING NO. B-01

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown and gray, lean CLAY, with roots and organics										
				Brown and gray, lean CLAY (CL)										
		SS-1			72		3 3 5				24			
		ST-2			58				1.43	103	23			
5														
		SS-3			83		3 3 5				27			
		SS-4			89		3 3 3				29	39	20	19
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-02

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown and gray, lean CLAY, with roots and organics										
				Brown and gray, lean CLAY (CL)										
		SS-1			72		3 4 7				31			
		SS-2			78		3 5 8				25			
5														
		SS-3			56		3 3 5				27	39	18	21
		SS-4			61		3 3 3				28			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-03

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown and gray, lean CLAY, with roots and organics										
				Brown and gray, lean CLAY (CL)										
		SS-1			72		2 3 6				24			
		SS-2			78		3 5 8				25			
5														
		ST-3			63				0.45	97	27			
		SS-4			89		2 3 3				29			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth:	10.0
Date Boring Started:	3/21/19
Date Boring Completed:	3/21/19
Engineer/Geologist:	SM
Project No.:	20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-04

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
				Brown, silty lean CLAY (CL)										
		SS-1			72		3 3 5				22			
		ST-2			58				0.74	101	25			
5														
		SS-3			83		3 3 5				25			
		SS-4			89		3 3 3				25			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-05

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, lean CLAY, with roots and organics										
				Brown, lean CLAY (CL)										
		SS-1			100		3 4 5				23			
5		SS-2			100		3 4 5				24			
		ST-3			75				0.42	98	25			
10		SS-4			100		3 4 4				22			
				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-06

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, lean CLAY, with roots and organics										
				Brown, lean CLAY (CL)										
		SS-1			100		6 5 7				24			
5		SS-2			89		4 5 8				23			
		SS-3			100		3 4 5				23			
10		SS-4			100		2 3 4				25	32	19	13
				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-07

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
		SS-1		Brown, silty lean CLAY (CL)	100		3 5 7				22			
		ST-2		- with limestone fragments below 3.0 ft.	29						16			
5														
		SS-3		LIMESTONE, light brown, weathered, trace clay	83		50/0"				15			
		SS-4		Boring terminated at 8.7 ft.	83		50/2"				8			
10														
15														
20														
25														

Completion Depth: 8.7
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling. Auger refusal encountered at 8.7 feet.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-08

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, lean CLAY, with roots and organics										
				Brown, lean CLAY (CL)										
		SS-1			56		4 3 3				22			
		SS-2			100		3 3 3				22			
5														
		ST-3									22			
		SS-4		- with limestone fragments below 8.5 ft.	75		8 50/2"				21			
				Boring terminated at 9.2 ft.										
10														
15														
20														
25														

Completion Depth: 9.2
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling. Auger refusal encountered at 9.2 feet.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

KC LOG WITH LAB WAUKOMIS DRIVE WATER MAIN.GPJ 3/27/19

LOG OF BORING NO. B-09

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
				Brown, silty lean CLAY (CL)										
		SS-1			72		5 3 7				27			
		ST-2			71				0.83	97	26			
5														
		SS-3			100		3 4 5				29	45	17	28
		SS-4			89		3 3 6				28			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-10

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
				Brown, silty lean CLAY (CL)										
		SS-1			83		3 6 6				27			
5		SS-2			72		4 5 8				27			
		ST-3			75				1.26	100	23			
10		SS-4			94		5 8 9				22	34	18	16
				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-11

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
				Brown, silty lean CLAY (CL)										
		SS-1			100		3 3 6				18			
		ST-2			58				0.63	109	19			
5														
				- trace fine sand below 6.0 ft.										
		SS-3			100		1 1 2				29			
		SS-4			39		WH WH WH				26			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth:	10.0
Date Boring Started:	3/21/19
Date Boring Completed:	3/21/19
Engineer/Geologist:	SM
Project No.:	20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-12

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
				Brown, silty lean CLAY (CL)										
		SS-1			100		6 7 8				18			
		SS-2			100		6 4 6				22			
5														
		SS-3			78		3 3 3				35			
		SS-4			67		1 2 2				26			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.0
Date Boring Started: 3/21/19
Date Boring Completed: 3/21/19
Engineer/Geologist: SM
Project No.: 20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-13

Project Description: **Waukomis Drive**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965

Surface El.:
Location: **See Site and Boring Location Plan**

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, silty lean CLAY, with roots and organics										
				Brown, silty lean CLAY (CL)										
		SS-1			39		4 5 5				24			
		SS-2			44		2 3 2				30			
5														
				Brown, fine-grained SAND (SP), with clay and limestone fragments										
		ST-3									14			
		SS-4			33		5 8 7				11			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth:	10.0
Date Boring Started:	3/21/19
Date Boring Completed:	3/21/19
Engineer/Geologist:	SM
Project No.:	20152027.01

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

GENERAL NOTES

The number of borings is based on: topographic and geologic factors; the magnitude of structure loading; the size, shape, and value of the structure; consequences of failure; and other factors. The type and sequence of sampling are selected to reduce the possibility of undiscovered anomalies and maintain drilling efficiency. Attempts are made to detect and/or identify occurrences during drilling and sampling such as the presence of water, boulders, gas, zones of lost circulation, relative ease or resistance to drilling progress, unusual sample recovery, variation in resistance to driving split-spoon samplers, unusual odors, etc. However, lack of notation regarding these occurrences does not preclude their presence.

Although attempts are made to obtain stabilized groundwater levels, the levels shown on the Logs of Boring may not have stabilized, particularly in more impermeable cohesive soils. Consequently, the indicated groundwater levels may not represent present or future levels. Groundwater levels may vary significantly over time due to the effects of precipitation, infiltration, or other factors not evident at the time indicated.

Unless otherwise noted, soil classifications indicated on the Logs of Boring are based on visual observations and are not the result of classification tests. Although visual classifications are performed by experienced technicians or engineers, classifications so made may not be conclusive.

Generally, variations in texture less than one foot in thickness are described as layers within a stratum, while thicker zones are logged as individual strata. However, minor anomalies and changes of questionable lateral extent may appear only in the verbal description. The lines indicating changes in strata on the Logs of Borings are approximate boundaries only, as the actual material change may be between samples or may be a gradual transition.

Samples chosen for laboratory testing are selected in such a manner as to measure selected physical characteristics of each material encountered. However, as samples are recovered only intermittently and not all samples undergo a complete series of tests, the results of such tests may not conclusively represent the characteristics of all subsurface materials present.

NOTATION USED ON BORING LOGS

APPROXIMATE PROPORTIONS

TRACE	<15%
WITH	15-30%
MODIFIER	>30%

Clay or clayey may be used as major material or modifier, regardless of relative proportions, if the clay content is sufficient to dominate the soil properties.

PARTICLE SIZE

BOULDERS		>12 Inches
COBBLES		12 Inches – 3 Inches
GRAVEL		
	Coarse	3 Inches – ¾ Inch
	Fine	¾ Inch – No. 4 Sieve (4.750 mm)
SAND		
	Coarse	No. 4 – No. 10 Sieve (2.000 mm)
	Medium	No. 10 – No. 40 Sieve (0.420 mm)
	Fine	No. 40 – No. 200 Sieve (0.074 mm)
SILT		No. 200 Sieve - 0.002 mm
CLAY		< 0.002 mm

PENETRATION – BLOWS

Number of impacts of a 140-pound hammer falling a distance of 30 inches to cause a standard split-barrel sampler, 1 3/8 inches I.D., to penetrate a distance of 6 inches. The number of impacts for the first 6 inches of penetration is known as the seating drive. The sum of the impacts for the last 12 inches of penetration is the Standard Penetration Test Resistance or “N” value, blows per foot. For example, if blows = 6-8-9, “N” = 8+9 or 17.

OTHER NOTATIONS

Recovery % – length of recovered soil divided by length of sample attempted.

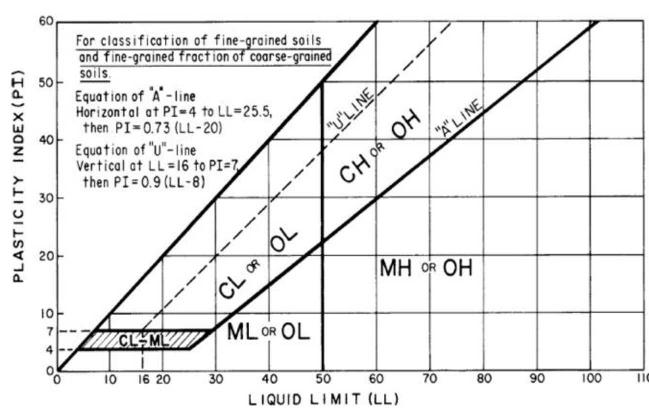
50/2”	Impacts of hammer to cause sampler to penetrate the indicated number of inches
WR	Sampler penetrated under the static loading of the weight of the drill rods
WH	Sampler penetrated under the static loading the weight of the hammer and drill rods
HSA	Hollow stem auger drilling method
FA	Flight auger drilling method
RW	Rotary wash drilling methods with drilling mud
AH	Automatic hammer used for Standard Penetration Test sample
SH	Safety hammer with rope and cathead used for Standard Penetration Test sample

GRAPHIC SYMBOLS

- Depth at which groundwater was encountered during drilling
- Depth at which groundwater was measured after drilling
- Standard Penetration Test Sample, ASTM D1586
- 3-inch diameter Shelby Tube Sample, ASTM D1587
- G Sample grabbed from auger
- NX Size rock core sample

TSi geotechnical

UNIFIED SOIL CLASSIFICATION SYSTEM, (ASTM D-2487)

Major Divisions			*Group Symbols*	*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (More than half of materials is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-Grained soils are classified as follows: Less than 5 per cent GW, GP, SW, SP; More than 12 per cent GM, GC, SM, SC; 5 to 12 per cent Borderline cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a] d / u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below “A” line or P.1. less than 4	Above “A” line with P.1. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below “A” line with P.1. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a] d / u	Silty sands, sand-mix mixtures		Atterberg limits about “A” line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits about “A” line with P.I. greater than 7	
Fine-grained soils (More than half of materials 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, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of medium to high plasticity, organic silts			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt	Peat and other highly organic soils			

[a]Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 26 or less and the P.1. is 6 or less; the suffix u used when L.L. is greater than 28.

[b]Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

The Design Professional has conducted a soil investigation and geotech report for design purposes only. The geotech report does not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotech report has been requested by bidders and is included with this addenda. The geotech report is deemed as not suitable for contractor's use, contractor is using it at their risk and the report is merely suggestive of the nature of the tested material, not representative of entire site conditions. Acknowledgement of this addenda shows acceptance of all risks associated with any use.

TSi geotechnical, inc.

8248 NW 101st Terr, #5
Kansas City, MO 64153
816.599.7965 (tel)
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October 29, 2020

Mr. Mike Haake, PE
WALTER P. MOORE
1100 Walnut St., Suite 1825
Kansas City, Missouri 64106

Re: Geotechnical Engineering Report Addendum
Waukomis Drive Improvements
Kansas City, Missouri
TSi Job Number 20152027.02

Dear Mr. Haake,

TSi Geotechnical, Inc. (TSi) is pleased to submit this addendum to Walter P. Moore (WPM) for the above referenced project. The purpose of this addendum is to provide recommendations after reviewing current pavement design and fill requirements on KCMO Capital Improvement roadway projects. This addendum will also include basic foundation recommendations for proposed new bridge structures. Some bridge foundation recommendations included in this addendum were originally included in an email to WPM dated October 16, 2019. Findings in our report submitted to WPM dated December 23, 2016 for this site are still current and valid in addition to this addendum.

PROJECT DESCRIPTION

The project will consist of widening Waukomis Drive from the exit ramp of northbound I-29 to approximately 1400 feet north of NW 62nd Street in Kansas City, Missouri. This project also includes replacing the existing metal culverts with a precast concrete bridge system and stabilizing the stream banks of the two creeks.

PAVEMENT RECOMMENDATIONS

TSi was provided the attached typical fill section via email on February 10, 2020. Recommendations previously given for pavement design in TSi's geotechnical report dated December 23, 2016 are still accurate and applicable after the review of the provided typical fill section for KCMO Capital Improvement roadway projects.

PRECAST BRIDGE FOUNDATION RECOMMENDATIONS

TSi's report dated December 23, 2016 included recommendations for two reinforced concrete box (RCB) culverts. After the geotechnical report had been issued, TSi was informed that it was decided to replace the existing metal culverts with a precast concrete bridge system in lieu of RCB culverts. The following details were provided by Leigh & O'Kane's bridge engineer via an email dated October 13, 2019:

Table 1
Approximate Bridge Footing Elevations and Loading

Bridge	Boring Location from Geotechnical Report dated December 23, 2019	Approximate Top of Footing Elevation (ft.)	Approximate Bottom of Footing Elevation (ft.)	Max Vertical Service Load (k/ft.)*
Old Maid's Creek	B-04	776.3	774.0	26
East Fork Line Creek	B-06	781.6	779.0	32

*Max vertical service load value does not include the foundation self-weight.

The boring logs from borings listed in the above table indicate shallow weathered limestone bedrock is anticipated at the bridge locations. At Borings B-04 and B-06, the top portion of highly weathered limestone bedrock was encountered at approximately 16.5 feet and 19.5 feet below ground surface, respectively. The upper highly weathered portions of bedrock should be excavated until competent bedrock is exposed using suitable means determined by the contractor in the field. TSi has recommended an end bearing value of 5,000 pounds per square foot (psf) to be used for bridge abutments bearing on competent limestone bedrock.

Based on the general character of the limestone at the abutment locations, and assuming the footings properly installed, the anticipated total and differential settlement of these foundations due to the structural loads should be negligible if the foundations are bearing on competent limestone bedrock.

CLOSURE

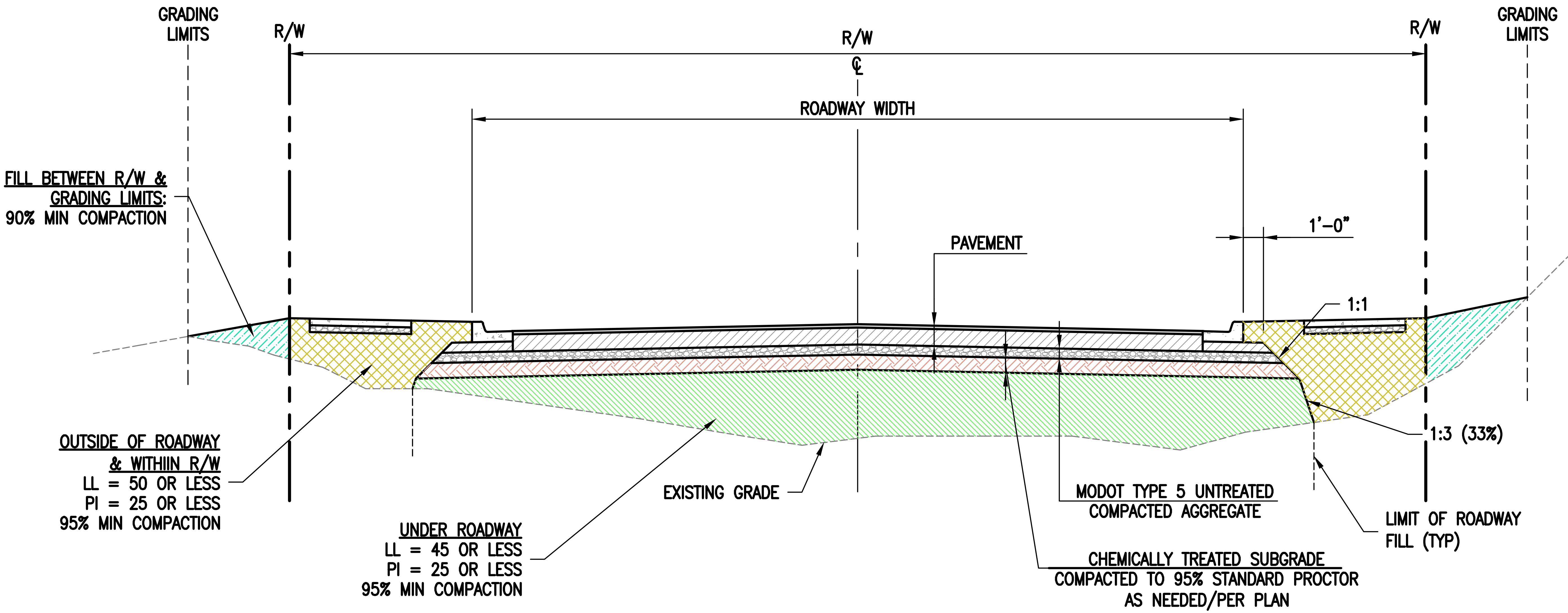
Please feel free to call us if you have any questions or if you wish to discuss this report addendum in greater detail.

Sincerely,
TSI GEOTECHNICAL, INC.

Brooke Sidebottom, EI
Staff Engineer

Nilesh R. Lal, PE	for: Denise Hervey, PE
Geotechnical Department Manager	Principal

Attachment – KCMO Typical Fill Section



1 TYPICAL FILL SECTION

3/16" = 1'-0"