GEOTECHNOLOGY INC
FROM THE GROUND UP

SUBSURFACE EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
HAYS, KANSAS

Prepared for:

HDR ENGINEERING, INC.
Lee's Summit, Missouri

Prepared by:

GEOTECHNOLOGY, INC.
Overland Park, Kansas

Geotechnology Job No. J024918.01

October 9, 2015

GEOTECHNOLOGY INC
FROM THE GROUND UP

October 9, 2015 J024918.01

Mr. Matt Say, P.E.
HDR Engineering, Inc.
3741 NE Troon Drive
Lee's Summit, Missouri 64064

SUBSURFACE EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
HAYS, KANSAS

Dear Mr. Say:

Presented in this report are the results of a subsurface exploration conducted for the referenced project. This exploration was conducted in accordance with our Proposal P024918.01 dated July 24, 2015. This report includes our understanding of the project, observed site conditions, conclusions and recommendations, and support data as given in the Table of Contents.

It has been our pleasure to provide these services to you, and we would welcome the opportunity to provide other services during the course of the project. Please contact us if you need further information about this document.

Respectfully submitted,

GEOTECHNOLOGY, INC.

MATTHEW H. McQUALITY
LICENSED
12211
KANSAS
PROFESSIONAL ENGINEER

Anthony W. Roth, P.E.
Project Engineer

Matt McQuality, P.E.
Branch Manager
Oct 9, 2015

AWR/MHM/FC:awr/ljd

Copies submitted: (2) hard copies
(1) electronic

J024918.01

SUBSURFACE EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
HAYS, KANSAS

TABLE OF CONTENTS

Page

I. EXECUTIVE SUMMARY 1

II. PROJECT DATA 1
Authorization 1
Purpose and Scope of Services 1
Project and Site Description 2

III. FIELD EXPLORATION AND LABORATORY TESTING 2
Field Exploration 2
Laboratory Testing 3

IV. SUBSURFACE CONDITIONS 3
Stratigraphy 3
Groundwater 5

V. DESIGN CONSIDERATIONS AND RECOMMENDATIONS 5
General 5
Site Grading 7
Foundation Recommendations 9
Floor Slabs 10
Lateral Earth Pressures 11
Seismicity 12
Pavement Considerations 12
Sloped Excavation and Shoring Considerations 12
Permanent Slopes 14
Dewatering 14

VI. RECOMMENDED ADDITIONAL SERVICES 14

VII. LIMITATIONS OF REPORT 15

SUBSURFACE EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
HAYS, KANSAS

TABLE OF CONTENTS
-Continued-

ILLUSTRATIONS

Plate
Site Location and Topography 1
Aerial Photograph of Site and Boring Locations 2

APPENDICES

Important Information about This Geotechnical-Engineering Report .....A
Logs of Borings B-1 through -13 .....B
Boring Log: Terms and Symbols
Rock Core: Terms and Symbols
Rock Core Photographs.....C
Grain Size Distribution and Consolidation Test Results.....D

SUBSURFACE EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
HAYS, KANSAS

SECTION I - EXECUTIVE SUMMARY

The executive summary is provided solely for the purposes of overview. Details are omitted; any one of which could be crucial to the recommendations of this report. Any party who relies on this report must read the full report.

- This phase of the project consists of constructing an influent pump station, headworks building, aeration blower building, sludge drying beds, biological treatment basins, secondary clarifiers, and UV disinfection building.
- The natural soil profile includes medium stiff to hard, high and low plasticity clay overlaying loose to dense sand. Shale bedrock occurs at depths of 32 to 40 feet.
- Fill was identified in two of the borings to depths of 3 and 13 feet. The fill should be considered uncontrolled and should be removed to prepare the site for construction.
- High plasticity soils must be remediated beneath floor slabs and lightly-loaded foundations.
- Excavation groundwater control will be required for construction of the influent pump station, and potentially for the biological treatment basins and secondary clarifiers.
- Up to 10 feet of fill may be required in the south portion of the site. The weight of the planned is fill is anticipated to result in approximately 1 inch of settlement.
- Mat and/or shallow foundations can be utilized for support of the planned structures.

SECTION II - PROJECT DATA

AUTHORIZATION

The services documented in this report are provided in accordance with the terms and conditions given in HDR Engineering Inc.'s (HDR) Task Order No. 11, dated July 31, 2015, and the scope of services described in Geotechnology, Inc.'s (Geotechnology) proposal P024918.01 dated July 24, 2015. HDR is the representative of the City of Hays, Kansas (City of Hays) for the selection of the Design-Build Team for the project.

PURPOSE AND SCOPE OF SERVICES

The purpose of our services was to explore subsurface conditions relative to design and construction of the influent pump station; headworks, aeration blower, and UV disinfection buildings; secondary clarifiers; biological treatment basins, and the sludge drying bed area. Important information prepared by the Geotechnical Business Council for studies of this type is presented in Appendix A for your review.

printed on recycled paper

PROJECT AND SITE DESCRIPTION

The project includes upgrades to the existing wastewater treatment plant in Hays, Kansas. The project will be designed and constructed on a design-build basis, and details of the structures will be developed in the future. The subsurface exploration pertains to the following anticipated structures:

- Influent Pump Station – Concrete structure, 30 to 35 feet deep.
- Headworks Building – Concrete structure, 45 feet by 70 feet in plan dimension with water channels and equipment floor; may have two levels and a deeper grit collection basin.
- Biological Treatment Basins – Concrete basins with approximately 20-foot side water depth; approximate overall dimensions of approximately 300 feet by 120 feet.
- Aeration Blower Building – Single-story building (optional).
- Secondary Clarifiers – Two, 70-foot diameter concrete basins with approximately 20-foot side water depth.
- UV Disinfection – Concrete structure, 30 feet by 45 feet in plan dimension with water channels and equipment.
- Sludge Drying Bed Area –Slab-on-grade with light building or cover.

In addition to the structures, approximately 10 feet of fill is required to reach finished grades in the south portion of the site.

The site is located on the south side of Old Highway 40 Bypass and east of US Highway 183. Military Reserve Road bounds the site on the east. The original plant was constructed in 1953, and improvements were constructed in 1967 and 1992. The site location and topography of the area per the 2012 U.S.G.S. maps are shown on Plate 1. An aerial photograph of the site is shown on Plate 2.

SECTION III - FIELD EXPLORATION AND LABORATORY TESTING

FIELD EXPLORATION

The field exploration consisted of drilling 13 borings, designated as Borings B-1 through -13, at approximately the locations shown on Plate 2. The borings were drilled using a Diedrich D-50 rotary drill rig equipped with 3 ¾-inch hollow stem augers. Rotary wash drilling techniques were generally used below depths of 10 to 25 feet. Auger refusal or split-spoon sampler refusal material was encountered in each of the borings. Standard penetration tests (SPTs) were performed using an automatic hammer. Split-spoon and thin-walled tube samples were obtained at the depths indicated on the boring logs presented in Appendix B. Borings B-1, -9, and -12 were extended into bedrock using NQ wire-line coring techniques. Upon completion of the borings, the holes were backfilled with a cement-bentonite grout. Explanations of the

terms and symbols used on the boring logs are also provided in Appendix B. Photographs of the rock core are presented in Appendix C.

A geologist from Geotechnology provided technical direction during the field exploration. The geologist logged samples and prepared descriptive logs of the material encountered. The boring logs represent conditions observed at the time of exploration, and have been edited by a professional engineer to incorporate the results of the laboratory tests. The borings were located in the field by our geologist using a consumer-grade, portable global positioning system (GPS) device. Ground surface elevations indicated on the boring logs were interpolated from Google Earth computer software. The boring locations and elevations are considered approximate. If more precise data are required, a registered surveyor should be retained to establish boring locations and elevations.

Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by Geotechnology in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and times where sampling was conducted. The passage of time may result in changes in conditions, interpreted to exist, at or between the locations where sampling was conducted.

LABORATORY TESTING

Laboratory testing was performed to estimate engineering and index properties of the soil. Moisture contents were determined for select soil and shale samples. Unconfined compressive strength tests and dry unit weight determinations were performed on select thin-walled tube samples. A one-dimensional consolidation test was performed on a select thin-walled tube sample. Grain size distribution and percent passing No. 200 sieve were performed on select samples. Laboratory test results are generally presented on the boring logs in Appendix B. The results of the grain size distribution and consolidation tests are presented in Appendix D.

SECTION IV - SUBSURFACE CONDITIONS

STRATIGRAPHY

Subsurface conditions encountered in the borings are summarized below for each of the areas of planned improvement:

Influent Pump Station (Boring B-1). Stiff, high plasticity clay occurs to a depth of 15 feet. The clay transitions to fine to coarse, loose to medium dense, silty sand. The sand becomes coarse and dense at a depth of 34 feet. Auger refusal occurred at a depth of 35 feet.

The boring was extended into shale to a depth of 40 feet. The shale is black and dark gray, slightly to moderately weathered, and moderately hard.

Headworks Building (Borings B-2 and -3). In Boring B-2, stiff to soft, low plasticity clay occurs to a depth of 15 feet. Fill was encountered in Boring B-3 to a depth of 13 feet. The fill consists of lean clay to a depth of 3 feet, underlain by fine to coarse sand to a depth of 13 feet. Beneath the fill is stiff to soft, low plasticity clay to a depth of 22 feet. Beneath the clay in both borings is fine to coarse, loose to dense sand. Shale was encountered in the borings at respective depths of 31 and 32 feet. The shale is black, soft and highly weathered. The borings were terminated at refusal in shale at approximate depths of 33 and 35 feet.

Existing Reclaimed Water Storage Basin (Boring B-4). Fill comprised of lean clay was encountered to a depth of 3 feet. Hard to medium stiff, high plasticity clay occurs beneath the fill, and the clay transitions to stiff to medium stiff, low plasticity clay at a depth of 12 feet. Beneath the clay at a depth of 23 feet is loose to medium dense, silty sand and sand with trace silt to the approximate auger refusal depth of 37 feet.

Sludge Drying Beds (Boring B-5). Low to high plasticity clay was encountered to a depth of 18 feet. The clay is tan and brown, and medium stiff to very stiff. Below the clay is sand with silt. The sand is generally medium dense in consistency. Auger refusal occurred at an approximate depth of 38 feet.

Biological Treatment Basins (Borings B-6 through -9). High and low plasticity clays occur to depths of 12 to 22 feet. The consistency of the clay is medium stiff to very stiff. Beneath the clay is sand and sand with silt with loose to medium dense consistencies. Auger refusal occurred in Borings B-6 through -8 at respective depths of 33, 28 and 33 feet. At Borings B-6 and -9 shale occurs below a depth of 27 feet to the respective auger refusal depths of 33 and 30 feet. Boring B-9 was extended into the auger refusal material. Recovered rock core samples are black, moderately hard, slightly to moderately weathered shale. Boring B-9 was terminated at a depth of approximately 36 feet.

Aeration Blower Building, Secondary Clarifiers, and UV Disinfection (Borings B-10 through -13). High plasticity, medium stiff to very stiff clay occurs to depths of 6 to 8 feet, where the clay transitions to low plasticity, medium stiff to stiff clay. The clay transitions to sand with trace silt and silty sand at a depth of 12 feet in each boring. The consistency of the sand is generally loose. Shaley clay was sampled in Borings B-12 and -13 above shale. Below the sand in Borings B-10 and -11 and the shaley clay in Borings B-12 and -13 is soft, black, highly weathered shale. Auger refusal occurs at depths of 31 to 36 feet. At Boring B-12 the auger refusal material consisted of black and white, moderately hard, fresh to slightly weathered, limey shale.

GROUNDWATER

The depths at which groundwater was detected are summarized in the following table.

GROUNDWATER SUMMARY	
Boring	**Depth to Groundwater (feet)**
B-1	18
B-2	NE
B-3	NE
B-4	24
B-5	NE
B-6	19
B-7	18
B-8	18
B-9	19
B-10	18
B-11	19
B-12	19
B-13	19

"NE" denotes that groundwater was not encountered prior to commencement of rotary wash drilling techniques.

Groundwater levels were estimated at the time of drilling from elevated moisture contents of collected samples or by the presence of water on the drilling tools prior to commencement of rotary was drilling techniques. Rotary wash drilling techniques include the introduction of water into the borehole, which can mask the presence of groundwater. Groundwater levels might not have stabilized before backfilling the boreholes. Groundwater may be perched near the top of rock. Free water may be trapped in permeable zones within the fill. Consequently, the observed groundwater levels might not represent present or future levels. Groundwater levels could vary substantially over time due to the effects of seasonal variation in precipitation, recharge, or other factors not evident at the time of exploration.

SECTION V – DESIGN CONSIDERATIONS AND RECOMMENDATIONS

GENERAL

This report section includes conclusions and general recommendation for each of the planned structures. The reader should refer to subsequent report sections for detailed recommendations. The Design-Build Team shall ultimately be responsible for conclusions and design recommendations for the improvements on this project.

Influent Pump Station. Excavation to a depth of approximately 35 feet is expected for the influent pump station. The base of the excavation may be in sand below the groundwater or in shale. A temporary shoring system will likely be required. Temporary shoring systems are discussed in a subsequent report section. Dewatering techniques will be necessary as discussed herein. The foundation for the structure may be designed as a mat. Lateral earth pressures from adjacent soils and surface loads must be considered in design of the walls.

Headworks Building. Fill encountered in Boring B-3 should be considered uncontrolled and should be removed and replaced with controlled fill. The foundation for the headworks building can be designed as a mat. Alternatively, the headworks buildings can be supported on conventional shallow footings and the floor slab can be grade-supported.

Existing Reclaimed Water Storage Building. Fill encountered in Boring B-4 should be considered uncontrolled. Prior to construction in this area, fill should be removed and replaced with controlled fill. Excavations resulting from demolition activities of nearby structures must be backfilled with controlled fill. It is not yet determined if a structure will be constructed in this area. If final construction plans include improvements in this area, additional subsurface exploration is recommended after demolition of existing structures.

Sludge Drying Beds. High plasticity clay beneath subgrade for the drying beds should be remediated as discussed herein. High plasticity clay beneath lightly-loaded footings should also be remediated. Depending on the size of the drying bed area, additional exploration may be warranted to confirm subsurface conditions are consistent with the conditions in Boring B-5.

Biological Treatment Basins. Excavation to an approximate depth of 20 feet will be required for construction of the biological treatment basins. The base of the excavation will be within sands below groundwater or within shale. Groundwater control will be required during construction. Lateral earth pressures must be considered during design of the walls of the basins. The foundation for the biological treatment basins may be designed as a mat.

Aeration Blower Building, Secondary Clarifiers, and UV Disinfection. Foundations for the aeration blower building may be designed as shallow footings with grade-supported slabs. High plasticity clay beneath slab subgrades and lightly-loaded footings should be remediated as discussed later in this report. Fill may be required to reach finished grades for the structures. Fill must be placed in lifts and compacted as discussed in the following report subsection. Settlement of underlying soil due to the weight of the engineered fill is estimated to result in approximately 1 inch of settlement.

The secondary clarifier tank foundations can be designed as a mat. The UV disinfection building foundations can be designed as conventional shallow footings or a mat. Lateral earth pressures must be considered during design of below-grade walls.

SITE GRADING

Site Preparation. To prepare the site for construction, the areas of the planned structures should be stripped of vegetation, soft soil, old fill, and other deleterious materials. Existing utilities that cross beneath planned structures and associated trench backfill must be removed, and the trenches then backfilled with controlled fill. Excavations resulting from demolition of existing structures must be backfilled with controlled fill. The exposed subgrade should be observed by the geotechnical engineer prior to fill placement. Proofrolling with a loaded tandem axle dump truck may be considered as a means of evaluating the subgrade. Soft soils or yielding areas observed during proofrolling should be overexcavated and backfilled with soil or crushed rock compacted to the levels specified in the Compaction Summary.

Remediation of High Plasticity Clay. Geotechnology recommends that high plasticity clay within 24 inches of floor slab subgrades and within 24 inches of lightly-loaded footings [1,000 pounds per square foot (psf)] be excavated and replaced with low volume change material (LVC) as discussed herein, or modified by the incorporation of hydrated lime or Type C fly ash with less than 5 percent sulfate. Agricultural lime cannot be substituted for hydrated lime. As a measure to improve pavement performance, high plasticity clay within 12 inches of pavement subgrades could also be remediated.

If lime treatment is selected, the lime should be blended into the soil using tilling equipment. The application rate of hydrated lime should be determined by laboratory testing at the time of construction, but is expected to range from 4 to 7 percent dry weight. During blending, the soil moisture content must be at least 5 percent wet of the optimum moisture content to facilitate stabilization of the clay mineralogy. Therefore, wetting of the lime-soil blend could be required. The lime-treated soil should also be allowed to cure before it is compacted. The appropriate cure time should be determined during construction, and depending on the soil temperature, may range from 4 to 24 hours. The treated soil should be compacted as outlined in the Compaction Summary.

If soil stabilization with fly ash amendment is selected, the fly ash should be applied at a rate of 15 percent dry weight. The fly ash and soil should be thoroughly mixed within ½ hour after introduction. Generally, the soil is moisture conditioned prior to amendment and adjusted following introduction of the fly ash. Fly ash mixing should not be performed at ambient or soil temperatures below 40 degrees Fahrenheit. Compaction of the fly ash-supplemented soil should be completed within one hour after incorporation. Compaction after two hours could cause degradation of the soil strength.

If excavation and replacement is selected, the overexcavation can be backfilled with low plasticity soil (liquid limit less than 45 percent), well-graded granular fill with a 2-inch maximum particle size, or high plasticity soil that has been modified as previously discussed. The backfill should be placed and compacted as specified in the subsequent Compaction Summary. Funds should be provided in the construction budget for treatment of high plasticity clay. Additionally, the potential for excess soils where overexcavation is required should be considered in final grading plans if a balanced site is required.

The methods of modification suggested above are based on generally accepted standards in the local engineering community. Clay properties, including plasticity, moisture content, density, swell pressure, and mineralogy are extremely variable and could, in some instances, be conducive to more severe swell pressures and volume change potential than can be mitigated by nominal treatment. Consequently, when constructing in an area where high plasticity clay is present, it should be recognized that there is an inherent risk of distress associated with shrink or swell of the soil, even with treatment of the subgrade soil.

Suitable Fill Materials. The excavated materials are expected to include low and high plasticity clay with variable moisture contents, sand, and shale. Low plasticity clay can be reused for engineered provided the material is placed as discussed herein. The highly plastic clay may be re-used as engineered fill provided the material is placed at least 24 inches below floor slab and footing subgrade, and 12 inches below the pavement subgrade. High plasticity clay may be re-used at shallower depths provided it is modified as outlined herein. High plasticity clay should not be used as wall backfill. The existing fill is expected to be suitable for re-use as fill provided the material is free of deleterious material and is well-graded.

Imported fill should consist of low plasticity (lean), cohesive soil (liquid limit less than 45) or well-graded granular materials. Acceptable fill soils include non-organic materials designated CL, CL-ML, and GW by ASTM D 2487.

Fill and Backfill Placement. Fill or backfill should be placed in uniform lifts and compacted. The loose lift thickness should not exceed 8 inches. The fill should be systematically compacted to the levels given in the Compaction Summary. Fill or backfill should be placed at moisture contents compatible with the required density. Depending on the moisture at the time of construction, drying or wetting may be required to achieve proper compaction. Deleterious material should not be included in fill, and the fill should not be placed on soft materials or frozen ground.

COMPACTION SUMMARY

Category	Minimum Compaction [a]
Fine-Grained Soil and Pavement Subgrade	95% [b]
Well-Graded Crushed Rock	100%

[a] Measured as a percent of the maximum dry density as determined by the standard Proctor test (ASTM D 698, AASHTO T 99).
[b] Moisture content within zero to plus 4% of the optimum moisture content.

Trench Backfill. Settlement of trench backfill can result in unsightly depressions and localized failures. The magnitude of settlement can be substantially reduced by mechanical compaction of the trench backfill. Well-graded crushed rock should be used as backfill in pavement and floor slab areas and compacted to the minimum level specified in the Compaction Summary. Poorly-graded ("clean") rock must not be used for trench backfill. Clean rock can collect water which can soften the underlying cohesive soils or, in the presence of expansive soils, promote heaving.

Settlement. Up to 10 feet of fill is understood to be required in the south portion of the site. Based on the results of the borings and the laboratory tests, the weight of the planned fill is expected to result in approximately 1 inch of settlement.

Subgrade Protection. Drainage of construction areas should be provided to protect the foundation excavations, pavement subgrades, and temporary slopes from the detrimental effects of weather conditions during construction. Finished subgrades and foundation excavations should be kept free of standing water at all times.

Collection and Disposal of Site Water. Final grades should be sloped away from structures. Managing site water is important in successful foundation and pavement performance. Water from surface runoff, downspouts, and subsurface drains, if any, should be collected and discharged through a site drainage system.

Control of surface runoff should be maintained in compliance with the rules and regulations set forth in the Federal Water Pollution Control Act (1977). Additionally, permits related to site grading activities and control of stormwater during construction activities should be obtained from the applicable governmental jurisdiction(s).

FOUNDATION RECOMMENDATIONS

Strip and Spread Footings. The headworks building, sludge drying beds, and aeration blower building can be supported by shallow footings. Strip and spread footings may be proportioned for net allowable bearing pressures of 2,000 psf and 2,500 psf, respectively, provided these footings bear on naturally-occurring, firm soil and/or engineered fill placed in accordance with the recommendations of this report. High plasticity clay should be remediated beneath lightly-loaded footings with a bearing pressure of 1,000 psf or less. The minimum lateral dimensions for strip and spread footings should be 18 and 24 inches, respectively. These dimensions will facilitate hand cleaning or compaction of loosened soils that result from the excavation process. Exterior footings bearing in soil should be embedded 36 inches below the lowest adjacent exterior grade to provide protection from seasonal moisture variations and frost penetration.

Footing excavations must be evaluated prior to concrete placement. If local zones of soft soil are encountered at footing bearing elevations, excavations should be extended through the soft soil to firmer material, and the overexcavation should be backfilled with concrete or lean concrete. Concrete should be placed the same day that footing excavations are completed. If concrete cannot be placed the same day, then the excavations can be deepened 3 inches and lean concrete can be placed as a measure to reduce the potential for subgrade disturbance.

Shallow foundations proportioned and constructed as recommended above could settle approximately 1 inch. Differential settlement between any two adjacent footings could be approximately 1 inch. Estimated settlement values contained in this report are based on our experience with projects of a similar nature and the results of the consolidation test.

Mat Foundations. The influent pump station, headworks building, biological treatment basins, UV disinfection building, and the secondary clarifier can each be supported on a mat foundation. Groundwater must be maintained at a depth of at least 3 feet below the lowest excavation for each mat foundation during construction. Sand subgrades must be compacted using vibrating compaction equipment prior to concrete placement. Soil-supported mat foundations should exhibit a total settlement of less than 1 inch due to structural loads.

MAT FOUNDATION DESIGN CRITERIA			
Structure	**Bearing Material**	**Net Allowable Bearing Pressure**	**Modulus of Subgrade Reaction, k_c**
Influent Pump Station	Native sand	2,500 psf	17 pci
Headworks Building	Native clay and controlled fill	2,000 psf	14 pci
Biological Treatment Basins	Native clay or sand	2,000 psf	14 pci
UV Disinfection Building	Native Clay	2,000 psf	14 pci
Secondary Clarifier	Native sand	2,500 psf	17 pci

Lateral Resistance. Lateral loads may be resisted by available frictional resistance between the base of the footing and the soil subgrade. Resistance to sliding can be computed assuming an ultimate coefficient of friction of 0.35 for cohesive soils; however, the maximum resistance should be limited to 750 psf. Ultimate passive resistance, if required, can be computed assuming an equivalent fluid pressure of 250 pounds per cubic foot. Safety factors should be applied to determine the allowable sliding and passive resistances. Passive resistance in the top 36 inches of soil should be neglected due to seasonal variations in moisture and frost penetration.

Uplift Resistance. Uplift loads can be resisted by the dead weight of the footings and the structure, and frictional resistance between the sides of the footings and the soil. An allowable resistance of 750 psf can be used for frictional resistance between the sides of the footings and the soil if the footings are earth-formed or compacted backfill is placed around them. Frictional resistance in the top 36 inches of soil should be neglected due to seasonal variations in moisture and frost penetration.

FLOOR SLABS

Uncontrolled fill and high plasticity clay below floor slabs must be remediated as previously discussed. The floor slabs can be designed using a vertical subgrade modulus of 100 pounds per cubic inch (pci). The floor slabs should be underlain by a 4- to 6-inch layer of well-graded crushed rock compacted as specified in the Compaction Summary. A 6-mil or thicker plastic sheet should be placed below the floor in areas intended for human occupancy to reduce the potential for moisture to permeate the slab. Notwithstanding other structural considerations, slab-on-grade floors should be designed to allow for differential movements that normally occur between the floor slab, columns, and foundation walls.

LATERAL EARTH PRESSURES

Below-grade walls should be designed to withstand lateral earth pressures caused by adjacent soil and any surcharge load. Design lateral pressures from surcharge loads should be added to the lateral earth pressure load. Lateral earth pressures can vary with wall restraint conditions, type of backfill, slope of the ground surface behind the wall, and method of backfill compaction. High plasticity soil should not be used as backfill since considerable lateral loads may develop with these potentially expansive soils.

Design values are provided in in the following table for soil lateral loads on the below-grade walls. It is assumed that the surface of the backfill behind the wall will be horizontal, and the wall will be subject to active or at-rest conditions. If tilting or deflection is not tolerable, at-rest earth pressures should be assumed.

LATERAL EARTH PRESSURE VALUES ON WALLS WITH HORIZONTAL BACKFILL		
Description of Backfill	**Design Soil Lateral Load (psf per foot of depth)**	
	At-rest	**Active**
Inorganic clays of low to medium plasticity (CL)	65h + 0.55q	45h + 0.40q
Well-graded gravel-sand mix (GW/SW) (e.g., 1-inch minus)	50h + 0.40q	30h + 0.25q

Where:

h = depth below adjacent grade, feet
q = surcharge load, psf

In giving these values, it is assumed that hydrostatic pressures will not develop behind the walls and that the wall backfill will be compacted as previously recommended. Therefore, the walls should be provided with a drain system to allow for dissipation of water pressures from behind the wall. Undrained walls may be subjected to additional pressures from groundwater, perched water or surface water infiltration. For undrained conditions, equivalent fluid weights of 90 pcf and 100 pcf may be used for active and at-rest case designs, respectively.

For the above equations to be valid for sand or gravel backfill, the backfill should be placed in a wedge extending upward and away from the base of the wall at a 45-degree angle or flatter. If sand and gravel are to be placed within a steeper wedge, the values for low plasticity soil given above should be used. Further, soft uncompacted soil on the excavation slope should be removed prior to placement of backfill. Design drawings should reflect this requirement.

SEISMICITY

Per the general procedures of Section 1613 of the 2006 edition of the International Building Code (IBC 2006), the soil profile at the project site can be defined as Site Class D, Stiff Soil. The mapped maximum considered earthquake spectral response acceleration is 12.8 percent gravity (0.128g) at short periods (S_S) and 4.1 percent gravity (0.041g) at 1-second periods (S_1).

PAVEMENT CONSIDERATIONS

We understand the roads and driveways are designated as collector/industrial and commercial based on the City of Hays Development Policy Manual. The specified pavement sections are:

- 7 inches of non-reinforced, dowelled joint concrete; or
- 7 inches of asphaltic concrete underlain by 4 inches of base rock

We recommend the concrete pavement section be used where heavy wheel loads are concentrated, particularly at approaches to trash dumpsters and truck loading areas. Base rock for the asphaltic concrete pavement section shall meet the requirements of Section 02514 – Aggregate Base Course of the City specifications. KDOT AB-3 crushed rock is considered to meet the requirements of the City specification.

Pavement service life can decrease substantially if the pavement is constructed on a poor subgrade, if it has poor surface or subsurface drainage, and/or if the pavement is not maintained. Periodic maintenance, such as filling cracks and sealing, is required for any pavement section.

If pavements are not constructed immediately after grading, the subgrade should be shaped to prevent ponding. Minor ponding, even of short duration, can cause softening of a soil subgrade to a substantial depth. If there is substantial lapse of time between grading and paving, or if the subgrade is disturbed by construction activities, the subgrade should be proofrolled with a loaded, tandem-wheeled dump truck. Soft spots observed during initial construction or proofrolling should be removed and replaced with compacted soil or rock. The required removal depth should be determined at the time of construction and could be limited with use of geotextile or geogrid.

SLOPED EXCAVATION AND SHORING CONSIDERATIONS

Sloped Excavations. In areas where back slopes are feasible, excavation slopes should be consistent with safety regulations. Worker safety and classification of soil type is the responsibility of the contractor. The materials encountered during excavations for the proposed project are anticipated to consist of fine-grained soil. The natural fine-grained soil can generally be classified as OSHA Type B soil. OSHA guidelines provide for temporary slopes performed in Type B materials to be constructed at 1V:1H or flatter. Excavations that extend into sand and/or below the groundwater surface should be constructed at 1V:1.5H or flatter. Excavations deeper than 20 feet must be designed by a professional engineer.

The contractor should be aware that excavation depths and inclinations (including adjacent existing slopes) should not exceed those specified in local, state or federal safety regulations, e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if not followed, the contractor, or earthwork or utility subcontractors could be subjected to substantial penalties. Construction site safety is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods and sequencing of construction operations.

Temporary slopes left open may undergo sloughing and result in an unstable situation. The contractor should evaluate stability and failure consequences before open cut slopes are made. Minor sloughing of open face slopes may occur. If the slope is expected to remain open for an extended time, an impermeable membrane covering the slopes could be considered as a means to reduce the potential for slope degradation and instability.

It is important to note that soils encountered in the construction excavations may vary across the site and that even if the OSHA criteria are used, there is a potential for slope failure. If different subsurface conditions are encountered at the time of construction, the Design-Build Team should reevaluate the conditions encountered.

Shoring Considerations. Due to the proximity of adjacent wastewater treatment structures, excavated temporary slopes may not be feasible at all locations, and temporary retention systems might be required. While different temporary shoring types and configurations can be used, the more common types that are applicable to this site are soldier pile and lagging, soil-nail walls, tangent walls (closely spaced drilled piers) and sheet piles. Brief discussions of potential temporary shoring methods are presented herein. Other methods of temporary shoring, however, may also be considered, and it may be possible to incorporate the retention system as a permanent structural component.

- Soldier Piles and Lagging: Construction of soldier piles involves placing steel H-piles in predrilled holes that are subsequently backfilled with flowable fill or lean concrete. As the excavation proceeds downward, timber lagging or steel sheeting is installed between the exposed H-piles to restrain the exposed cohesive soil. Additional lateral resistance may be obtained by installing internal bracing or tiebacks.
- Tangent Walls: Tangent walls are closely spaced drilled piers that are extended below the bottom of the excavation. Reinforcing steel is placed and the drilled pier excavation is filled with concrete. As the excavation proceeds downward, shotcrete facing is installed between the piers to restrain the exposed material. Depending on the depth of excavation, internal bracing or tiebacks can be used to supplement the system stability.
- Soil Nail Walls: Soil nail walls involve reinforcing the natural fine-grained soil with approximately 1-inch diameter steel rods that are grouted into predrilled holes. The grouted bars resist tensile forces by the pull-out resistance provided by the friction along the grout-soil interface. The exposed soil face is subsequently covered with wire mesh and sprayed with shotcrete.

- Sheet piles: Interlocking sheet piles that are vibrated or driven into the ground can be considered. The sheet pile penetration depth below the excavation should be properly designed to limit stress deflection of the sheeting. Depending on the depth of excavation, internal bracing or tiebacks can be used to supplement the system stability. Following backfilling, the sheet piles can be extracted using vibrating methods. Ground vibrations caused by sheet pile installation techniques, however, should be considered due to the presence of nearby structures.

The Design-Build Team should be responsible for design, installing and monitoring the shoring system. Project specifications should indicate tolerances or wall movement, and require that the wall be designed in accordance with OSHA requirements. The shoring system can also be used as the back form for perimeter structure walls. Appropriate factors of safety should be applied.

PERMANENT SLOPES

Slopes should be constructed of compacted fill and slightly over-built, then cut back to remove un-compacted soil or slough on the slope face. Based on our experience, permanent slopes for this site can be designed for an inclination of 3H:1V or flatter. If slopes are to be steeper than 3H:1V, a global stability analysis should be performed.

DEWATERING

Based on the groundwater conditions encountered during drilling, groundwater seepage should be expected in excavations that extend into the sand strata and below the groundwater level. Well points should be installed in areas where excavation is to extend below the groundwater in sand in order to maintain the groundwater level at least 3 feet below the deepest working grades. Sump/pump pits can typically be used to control groundwater in excavations in fine-grained soil. Surfaces should be sloped to prevent precipitation from entering excavations.

SECTION VI – RECOMMENDED ADDITIONAL SERVICES

The conclusions and recommendations given in this report are based on interpretation of exploration data and Geotechnology's experience. The Design-Build Team must recognize that variations could occur from conditions observed in the borings, particularly within existing fills or previously developed areas. Design recommendations are based on data from borings, sampling, and related procedures. Actual subsurface conditions could vary from those encountered in the borings. Therefore, design recommendations are subject to adjustment in the field, based on subsurface conditions encountered during construction. Construction observation services are viewed as a continuation of the design process. Geotechnology, HDR and the City of Hays will not be responsible for improper use of recommendations or failure by others, including the Design-Build Team, to recognize conditions that can be detrimental to the successful completion of the project or its performance.

On-site construction observation and material testing services are required during site grading since placement techniques can significantly impact performance of the completed project. Foundation bearing surfaces and floor slab subgrades should be observed before placing concrete or base course, respectively, to establish that the soil or rock conditions are consistent with conditions encountered during the field exploration.

Construction observation is intended to enhance compliance with project plans and specifications. It is not insurance, nor does it constitute a warranty or guarantee of any type. In all cases, the Design-Build Team is solely responsible for the quality of their work.

SECTION VII - LIMITATIONS OF REPORT

This report has been prepared on behalf of the City of Hays and HDR for the exclusive use of the Design-Build Team for specific application to the named project as described herein. If this report is provided to prospective subcontractors, the Design-Build Team should make it clear that the information is provided for factual data only and not as a warranty of subsurface conditions included in this report. Unanticipated soil or rock conditions may require additional effort to attain a properly constructed project.

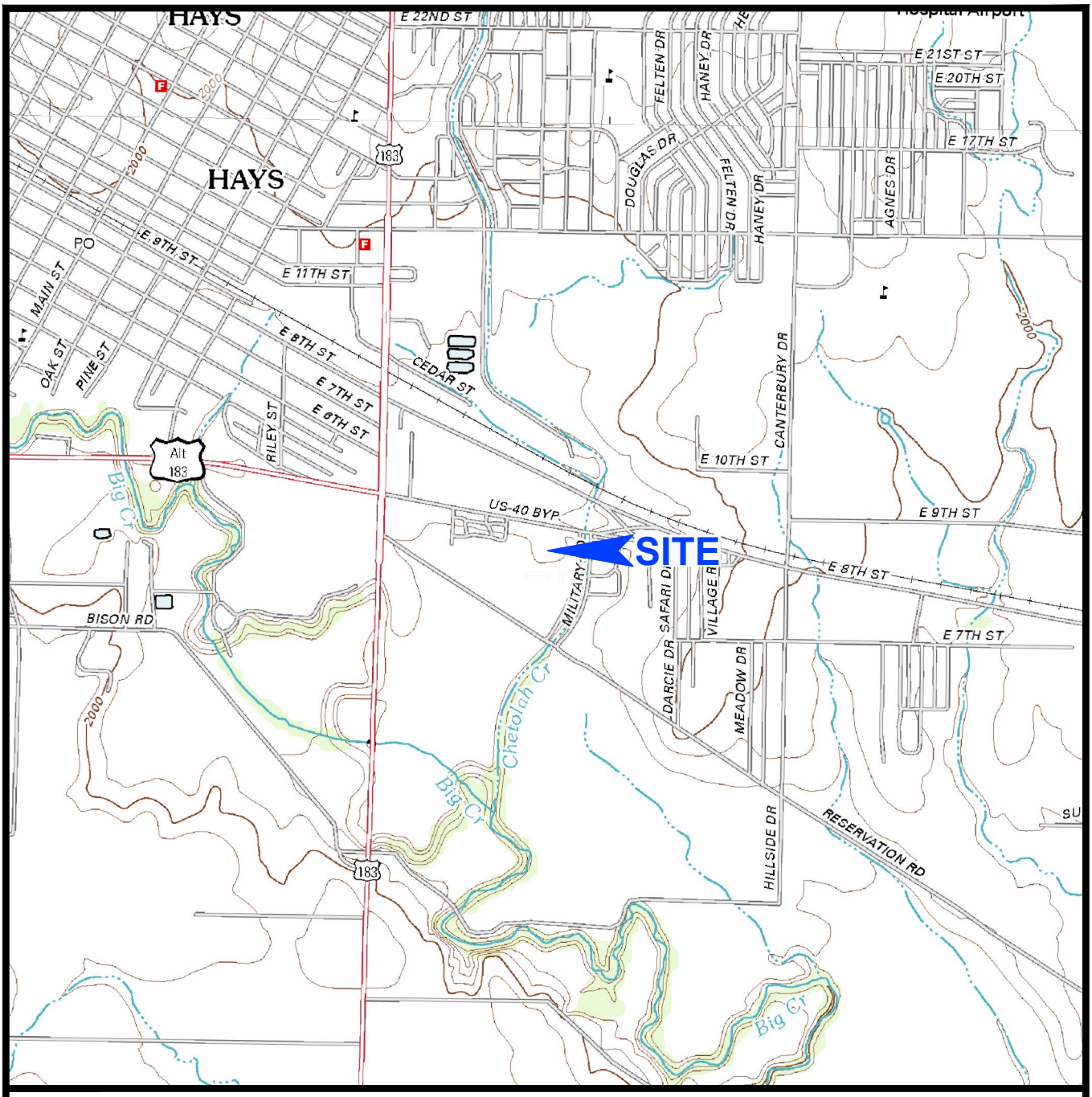
Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. No other representation, expressed or implied, is included or intended.

Unless specifically stated in our proposal or this report, the scope of our services for this phase of the project did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic material in the soil, surface water, groundwater or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client. Our scope did not include any services to investigate or detect the presence of mold or any other biological contaminants (such as spores, fungus, bacteria, viruses, and the by-products of such organisms) on and around the site, or any services designed or intended to prevent or lower the risk of the occurrence of an infestation of mold or other biological contaminants.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the subsurface exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Discrete sampling cannot be relied on to accurately reflect natural variations in stratigraphy that may exist between sample locations and/or intervals. Unless specifically noted, the scope of our services did not include an assessment of the effects of flooding and natural erosion of adjacent creeks or rivers near the project site.

The recommendations included in this report have been based in part on assumptions about natural variations in site stratigraphy that may only be completely evaluated during earthwork and foundation construction. Accordingly, Geotechnology should be retained to perform construction observation and complete its geotechnical engineering service using observational methods. Geotechnology cannot assume liability for the adequacy of its recommendations when they are used in the field without Geotechnology being retained to observe construction.

The conclusions or recommendations presented in this report should not be used if the nature, design, or location of the facilities is changed or if there is a substantial lapse in time between the submittal of this report and the start of work at the site. Geotechnology will not be responsible for any claims, damages, or liability associated with any other party's interpretations of the subsurface data or reuse of the subsurface data or engineering analyses in this report without our express written authorization.



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Hays South and Hays North, Kansas quadrangles, last revised in 2012.

0 2,000 4,000

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: AWR	App'vd By: MH M
Date: 9-18-15	Date: 10-1-15	Date: 10-1-15

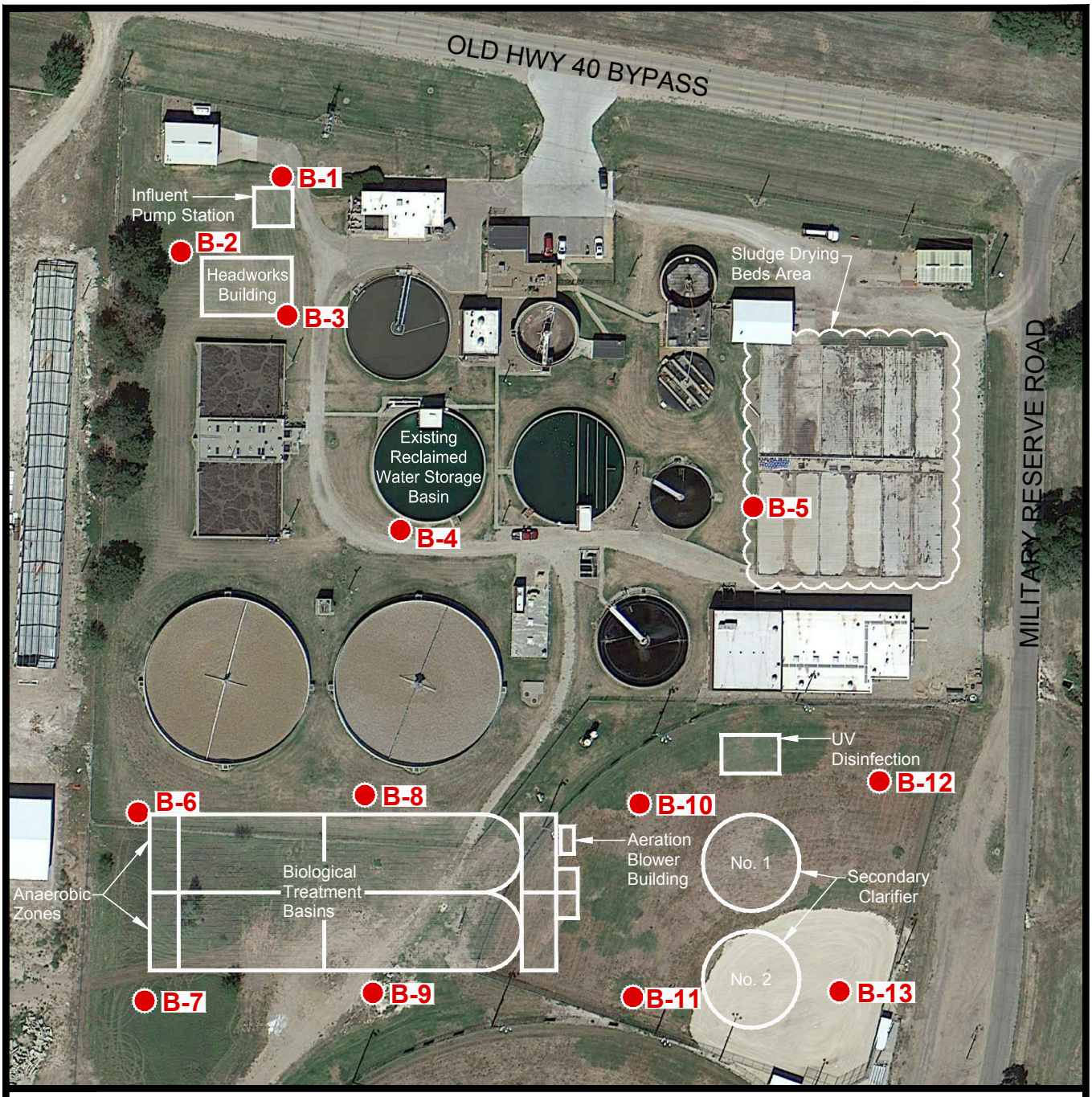
GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment
Plant Improvements
Hays, Kansas

SITE LOCATION AND TOPOGRAPHY

Project Number
J024918.01

PLATE 1



NOTES

1. Plan adapted from a September 8, 2013 aerial photograph courtesy of Google Earth and an undated drawing marked "Exhibit A" and titled "Alternative 3 - Conventional 5 Stage with Secondary Clarifiers" prepared by HDR.

2. Borings were located in the field with a consumer-grade GPS device and are shown approximate only.

LEGEND

● Boring Location

0 120 240

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: AWR	App'vd By: MHM
Date: 10-1-15	Date: 10-1-15	Date: 10-1-15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements
Hays, Kansas

AERIAL PHOTOGRAPH OF SITE AND BORING LOCATIONS

Project Number J024918.01

PLATE 2

APPENDIX A

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

Copyright 2015 by Geoprofessional Business Association (GBA). Duplication, reproduction, or copying of this document, or its contents, in whole or in part, by any means whatsoever, is strictly prohibited, except with GBA's specific written permission. Excerpting, quoting, or otherwise extracting wording from this document is permitted only with the express written permission of GBA, and only for purposes of scholarly research or book review. Only members of GBA may use this document as a complement to or as an element of a geotechnical-engineering report. Any other firm, individual, or other entity that so uses this document without being a GBA member could be commiting negligent or intentional (fraudulent) misrepresentation.

APPENDIX B

LOGS OF BORINGS B-1 THROUGH -13
BORING LOG: TERMS AND SYMBOLS
ROCK CORE: TERMS AND SYMBOLS

Surface Elevation 1980 | Completion Date: 8/24/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - tan, fat, stiff, trace roots in top 7 inches - (CH)	4-5-5	SS1
		4-7-7	SS2
5		3-4-7	SS3
		3-5-6	SS4
10			
	soft	2-1-2	SS5
15	SILTY SAND - tan, fine to coarse, loose to medium dense - (SM)		
		4-5-5	SS6
20			
		4-2-5	SS7
25			
		5-5-6	SS8
30			
	SAND - tan, coarse, dense - SP	10-50/5"	SS9
35	SHALE - black, moderately weathered, moderately hard	100% / 73%	NQ1
	SHALE - dark gray, slightly weathered, moderately hard, limey		
40	Boring terminated at 40 feet.		

SHEAR STRENGTH, tsf: △ - UU/2 ○ - QU/2 □ - PP/2 (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE (ASTM D 1586): ▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %: PL 10 20 30 40 50 LL

66 >>

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 18 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 25 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS: Split-spoon refusal at 35 feet.

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 1

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1980 | Completion Date: 8/24/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - tan-brown, lean, stiff to hard - CL		
		4-4-5	SS1
		99	ST2
5		4-6-8	SS3
		4-5-6	SS4
10			
	soft	1-1-2	SS5
15	SAND - tan, fine to medium, loose, trace to some silt - SP-SM		
		4-3-3	SS6
20			
		7-7-2	SS7
25			
	medium dense	12-13-16	SS8
30	SHALE - black, highly weathered, soft		
	Boring terminated at split-spoon sampler refusal at 32.8 feet.	23-50/4"	SS9
35			
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 10 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS: Auger refusal at 32 feet.

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 2

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1981 | Completion Date: 8/24/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	FILL - brown, lean clay, with coarse sand	7-7-6	SS1
	FILL - tan, fine to coarse, poorly graded sand, with silt	8-13-12	SS2
5		2-2-2	SS3
		1-1-1	SS4
10			
	CLAY - tan, lean, stiff to soft - (CL)	4-5-5	SS5
15			
		2-2-2	SS6
20			
	SAND - tan, medium to coarse, medium dense, trace to some silt - SW-SM	8-10-12	SS7
25			
		9-12-13	SS8
30			
	SHALE - black, highly weathered, soft	14-41 -50/3"	SS9
35	Auger refusal at 35 feet.		
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

91

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 10 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 3

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1985 | Completion Date: 8/25/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	FILL - brown, lean clay	4-3-4	SS1
	CLAY - dark brown, fat, hard to medium stiff - (CH)	110	ST2
5		2-2-5	SS3
		3-5-7	SS4
10			
	CLAY - dark brown, lean, stiff to medium stiff - CL	3-3-6	SS5
15			
		2-3-3	SS6
20			
	SILTY SAND - tan, fine to medium, loose to medium dense - SM	3-5-2	SS7
25			
		7-8-8	SS8
30			
	SAND - tan, medium to coarse, medium dense, trace silt - SP	9-10-12	SS9
35			
	Auger refusal at 36.5 feet.		
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

62 >>

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 24 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 25 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 4

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1981 | Completion Date: 8/25/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - tan and brown, lean to fat, stiff to very stiff - CL-CH	6-9-9	SS1
		3-5-5	SS2
5	CLAY - tan, lean, stiff to medium stiff - (CL)	105	ST3
		4-7-9	SS4
10			
15	sandy	2-3-3	SS5
	SAND - tan, fine to medium, medium dense, some silt, some clay balls - SP-SM	4-5-8	SS6
20			
25		3-6-6	SS7
30		4-6-6	SS8
35	dense	16-23-21	SS9
	Auger refusal at 37.5 feet.		
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 15 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 5

Project No. J024918.01

Surface Elevation 1981 | Completion Date: 8/25/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - tan, brown, lean to fat, stiff to very stiff - (CL-CH)	3-4-5	SS1
		7-9-8	SS2
5		6-7-12	SS3
		99	ST4
10			
	silty, medium stiff	2-2-3	SS5
15			
	SAND - tan, fine to medium, medium dense - SP	3-5-7	SS6
20			
	SAND - tan, fine to coarse, loose, trace silt - SW	10-4-4	SS7
25			
	SHALE - dark gray, highly weathered, soft	13-28-48	SS8
30			
	Auger refusal at 32.5 feet.		
35			
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

76

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 20 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 6

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1979 | Completion Date: 8/26/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, medium stiff to stiff - CH	3-4-4	SS1
		98	ST2
5		2-3-4	SS3
	CLAY - tan, lean, medium stiff - CL	2-3-3	SS4
10			
	SAND - tan, fine to medium, medium dense - SP	1-5-7	SS5
15			
	SAND - fine to coarse, very loose to medium dense, with silt - (SW-SM)	2-2-1	SS6
20			
		9-9-12	SS7
25			
	Auger refusal at 28 feet.		
30			
35			
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 18 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 10 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 7

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1981 | Completion Date: 8/27/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, medium stiff to very stiff - (CH)		
		5-6-6	SS1
		3-2-3	SS2
5		99	ST3
		4-5-7	SS4
10			
	CLAY - tan, lean, stiff to medium stiff, sandy - CL		
		2-4-5	SS5
15			
		1-2-3	SS6
20			
	SAND - tan, fine to coarse, loose to medium dense, with silt - SW-SM		
		3-4-5	SS7
25			
		8-9-8	SS8
30			
	Auger refusal at 32.5 feet.		
35			
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 18 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 15 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 8

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1978 | Completion Date: 8/26/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, medium stiff - CH	2-3-5	SS1
	CLAY - tan, lean, meduim stiff to stiff - (CL)	3-4-4	SS2
5		3-5-8	SS3
		3-4-5	SS4
10			
	SILTY SAND - tan, fine to medium, loose, with silt - (SM)		ST5
15			
		4-4-5	SS6
20			
	medium to coarse, medium dense	8-8-8	SS7
25			
	SHALE - black, very soft, highly weathered	17-29-37	SS8
30		100%/75%	NQ1
	SHALE - black, moderately hard, slightly to moderately weathered with limestone inclusions	100% / 90%	NQ2
	sandy		
35	Boring treminated at 35.5 feet.		
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

66

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS: Auger refusal at 30 feet.

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B- 9

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1978 | Completion Date: 8/26/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, medium stiff to stiff - CH	4-3-4	SS1
		9-3-9	SS2
5	CLAY - tan, lean, stiff - CL	3-5-7	SS3
		105	ST4
10	SILTY SAND - tan, fine to coarse, loose to medium dense, trace gravel - (SM)		
		3-3-3	SS5
15			
		4-6-5	SS6
20	becoming gravelly		
		6-5-6	SS7
25	SHALE - black, highly weathered, soft		
		9-17-46	SS8
30	Auger refusal at 31.5 feet.		
35			
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

63

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 18 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 10 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B-10

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1978 | Completion Date: 8/26/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, stiff - CH	4-5-5	SS1
		4-6-8	SS2
5	CLAY - tan, lean, medium stiff to stiff - (CL)	99	ST3
		2-2-3	SS4
10	SILTY SAND - tan, fine, loose - SM		
		3-2-3	SS5
15			
		3-4-3	SS6
20	SAND - tan, medium to coarse, loose, with silt - SP-SM		
		5-4-4	SS7
25	SHALE - black, highly weathered, soft		
		12-30 -50/5"	SS8
30	Auger refusal at 31 feet.		
35			
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

△ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

80

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 20 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B-11

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1977 | Completion Date: 8/25/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, medium stiff to very stiff - (CH)	3-4-4	SS1
		89	ST2
5	CLAY - tan, lean, stiff to medium stiff - CL	3-4-6	SS3
		2-3-4	SS4
10	SILTY SAND - tan, fine to medium, loose - (SM)	3-3-4	SS5
15		3-3-4	SS6
20		2-3-4	SS7
25	SAND - tan, coarse, dense, trace silt and gravel - SP	15-18-17	SS8
30	CLAY - brown, hard, fat, trace organics, shaley - CH	8-36 -50/1"	SS9
	SHALE - black, soft, highly weathered	100%/0%	NQ1
35	SHALE - black and white, moderately hard, fresh to slightly weathered, limey	100% 83%	NQ2
40	Boring terminated at 41 feet.		

GRAPHIC LOG

SHEAR STRENGTH, tsf: △ - UU/2 ○ - QU/2 □ - PP/2 (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE (ASTM D 1586): ▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %: PL 10 20 30 40 50 LL

68 >>

86

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 20 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS: Auger refusal at 35 feet.

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B-12

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

Surface Elevation 1980 | Completion Date: 8/25/15

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	CLAY - brown, fat, medium stiff to stiff - CH	2-3-5	SS1
		3-5-6	SS2
5		4-8-9	SS3
	CLAY - tan, lean, medium stiff - (CL)	3-2-3	SS4
10			
	SAND - tan, fine to medium, loose - (SP)		ST5
15			
	SILTY SAND - tan, fine to medium, loose to very loose - (SM)	6-4-4	SS6
20			
		2-1-1	SS7
25			
	CLAY - tan to orange-brown, fat, stiff, shaley - CH	4-4-11	SS8
30			
	SHALE - black, highly weathered, soft	7-15 -50/5"	SS9
35			
	Auger refusal at 35.5 feet.		
40			

GRAPHIC LOG

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL 10 20 30 40 50 LL

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 19 FEET ▽

DRILLING DATA

___ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM 15 FEET

RRM DRILLER CMB LOGGER

Diedrich D-50 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: CMB	Check by: AWR	App'vd by: MHM
Date: 9/11/15	Date: 9/21/15	Date: 10/1/15

GEOTECHNOLOGY INC
FROM THE GROUND UP

Wastewater Treatment Plant Improvements Hays, Kansas

LOG OF BORING: B-13

Project No. J024918.01

LOG OF BORING 2002 WL J024918.01 - HAYS WWTP.GPJ GTINC 0638301.GPJ 10/1/15

BORING LOG: TERMS AND SYMBOLS

GENERAL NOTES

1. *Information on each boring log is a compilation of subsurface conditions based on soil or rock classifications obtained from the field as well as from laboratory testing of samples. The strata lines on the logs may be approximate or the transition between the strata may be gradual rather than distinct. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.*
2. *Relative composition and Unified Soil Classification designations are based on visual estimates and are approximate only. If laboratory tests were performed to classify the soil, the unified designation is show in parenthesis.*
3. *Value given in Unit Dry Weight/SPT Column is either a unit dry weight in pounds per cubic foot, if adjacent to a ST sample designation, or blows per 6-inch increment if adjacent to a SS sample designation.*

ABBREVIATIONS

UU/2	*Shear Strength from Unconsolidated – Undrained Triaxial Test (ASTM D2850)*
QU/2	*Shear Strength from Unconfined Compression Test (ASTM D2166)*
SV	*Shear Strength from Field Vane (ASTM D2573)*
PL	*Plastic Limit (ASTM D4318)*
LL	*Liquid Limit (ASTM D4318)*

LEGEND

CS	Continuous Sampler
GB	Grab Sample Taken From Auger Cuttings or Wash Water Return
NX 100/42	NX Rock Core with Percent Recovery/R.Q.D. Given In Adjacent Column
PST	Three Inch Diameter Piston Tube Sample
SS	Split Spoon Sample (Standard Penetration Test)
ST	Three Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
SV	Field Vane Test

SPLIT – BARREL SAMPLER DRIVING RECORD

Blow per Foot (N-Value)	*Description*
25	*25 blows drove sampler 12 inches after initial 6 inches of seating.*
75/10"	*75 blows drove sampler 10 inches after initial 6 inches of seating.*
50/S3"	*50 blows drove sampler 3 inches during initial 6 inch seating interval.*

NOTES: 1. *To avoid damage to sampling tools, driving is limited to 50 blows during any six inch interval.*
2. *N-Value (Blow Count) is the standard penetration resistance based on the total number of blows, using a 140-lb hammer with 30-inch free fall, required to drive a split spoon the last two of three, 6-inch drive increments. (Example: 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on grid plot and may be shown as 4/7/9 in Unit Dry Weight – SPT column.*

RELATIVE COMPOSITION

Trace……...0-10 %
With/Some……...11-35 %
Soil modifier such…..... > 35 %
As silty, clayey, sandy, etc.

DENSITY OF GRANULAR SOILS

Descriptive Term:	***N—Value***
Very Loose	*0 - 4*
Loose	*5 - 10*
Medium Dense	*11 - 30*
Dense	*31 - 50*
Very Dense	*> 50*

STRENGTH OF COHESIVE SOILS

Consistency	***Undrained Shear Strength Tons Per Sq. Ft.***	***Field Test***	***Approximate N-Value Range***
Very Soft	*less than 0.12*	*Thumb will penetrate soil more than 1"*	*0 - 1*
Soft	*0.13 to 0.25*	*Thumb will penetrate soil about 1"*	*2 - 4*
Medium Stiff	*0.26 to 0.50*	*Thumb will penetrate soil about ¼"*	*5 – 8*
Stiff	*0.51 to 1.00*	*Thumb hardly indents soil*	*9 – 15*
Very Stiff	*1.01 to 2.00*	*Thumb will not indent soil, but readily indented with thumbnail*	*16 – 30*
Hard	*greater than 2.00*	*Thumbnail will not indent soil*	*> 30*

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

12" 3" ¾" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

300 76.2 19.1 4.76 2.00 0.42 0.074 0.002

SOIL GRAIN SIZE IN MILLIMETERS

SOIL STRUCTURE

Calcareous *– Having appreciable quantities of carbonate.*

Fissured *– Containing shrinkage or relief cracks, often filled with sand or silt; usually more or less vertical.*

Slickensided *– Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along those planes.*

Layer *-- Inclusion greater than 3 inches thick.*

Seam *– Inclusion 1/8 inch to 3 inches thick extending through the sample*

Parting *– Inclusion less than 1/8 inch thick.*

Pocket *– Inclusion of material of different texture that is smaller than the diameter of the sample.*

Interlayered *– Soil samples composed of alternating layers of different soil types.*

Intermixed *– Soil samples composed of pockets of different soil types and a layered or laminated structure is not evident.*

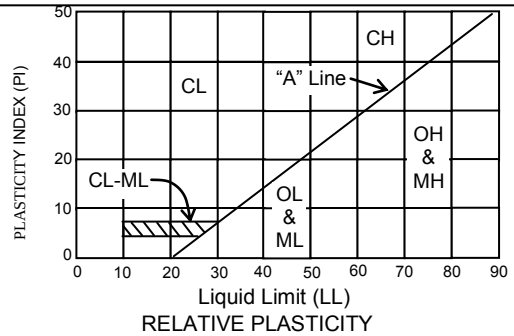
Laminated *– Soil sample composed of alternating partings or seams of different soil type.*

GEOTECHNOLOGY INC
FROM THE GROUND UP

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOL	DESCRIPTION
Coarse-Grained Soils (More than 50% Larger than No 200 Sieve Size)	Gravel and Gravelly Soils	Clean Gravels Little or no Fines	GW	Well-Graded Gravel, Gravel-Sand Mixture
			GP	Poorly –Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or no Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey Sand, Sand-Clay Mixture
Fine-Grained Soils (More than 50% Smaller than No 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Clayey Silt, Silty or Clayey Very Fine Sand, Slight Plasticity
			CL	Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts, or Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit More Than 50	MH	Silt, Fine Sandy or Silt Soil with High Plasticity
			CH	Clay, High Plasticity
			OH	Organic Clay of Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

PLASTICITY CHART



RELATIVE PLASTICITY

Nonplastic	Cannot Roll Into Ball
Trace Plasticity	Barely Roll Into Ball
Medium Plastic	Can be Rolled Into Ball
Highly Plastic	No Rupture by Kneading

VISUAL DESCRIPTION CRITERIA*

TABLE 1: CRITERIA FOR DESCRIBING ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2: CRITERIA FOR DESCRIBING PARTICLE SHAPE

Description	Criteria
Flat	Particles with width/thickness X3
Elongated	Particles with length/width X3
Flat and Elongated	Particles meet criteria for both flat and elongated

TABLE 3: CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below the water table

TABLE 4: CRITERIA FOR DESCRIBING REACTION WITH HCL

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming rapidly

TABLE 6: CRITERIA FOR DESCRIBING CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

**NOTES: 1. Tables adapted from ASTM D2488 "Description and identification of Soils" (Visual-Manual Procedure)*
2. Tables 5, 7 and 11 incorporated into other information on this plate.

TABLE 8: CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9: CRITERIA FOR DESCRIBING DILATANCY

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TABLE 10: CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 12: IDENTIFICATION OF INORGANIC FINE-GRAINED SOILS FROM MANUAL TESTS

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	none	High

ROCK CORE: TERMS AND SYMBOLS

GENERAL NOTES

A field description should be very specific and cover all aspects of the rock mass. Field logs should include coring times, notes on water losses and color, rod drops, and notes as to the locations and thickness of voids and/or seams. As a minimum, a field description should include the following, preferably in sequential order:

TERM	REFERENCE
Hardness	Table 1
Color	(1)
Crystallinity	Table 2
Bedding	Table 3
Weathering	Table 4
Fabric (if applicable)	Table 5
Jointing (including filling)	Table 6
Voids	Table 7
RQD	Table 8
Sorting Criteria	Figure 1
Angularity Criteria	Figure 2

(1) Color should be as descriptive as possible, so as to distinguish the stratum from that which surrounds it. Common colors are gray, brown, black and white and may be modified by adjectives such as light and dark. Exotic colors such as aqua, cobalt, amber and magenta may be used when necessary. If one or more colors are present it should be noted.

TABLE 1: ROCK HARDNESS

DESCRIPTION	CRITERIA
Very Soft	- Easily indented with the thumb
Soft	- Able to be scratched with a fingernail
Moderately Hard	- Easily scratched with a knife; Cannot be scratched with the fingernail
Hard	- Difficult to scratch with a knife
Very Hard	- Cannot be scratched with a knife

TABLE 2: ROCK CRYSTALLINITY

DESCRIPTION	CRITERIA
Aphanitic (Micritic)	- Crystals cannot be distinguished with the naked eye
Very Finely Crystalline	- Crystals are barely discernable with the naked eye
Finely Crystalline	- Crystals are easily discernable with the naked eye
Medium Crystalline	- Crystals are medium size; up to 1/8” in diameter
Coarsely Crystalline	- Crystals are 1/8” to 1/4” in Diameter
Very Coarsely Crystalline	- Crystals are larger than 1/4” In diameter

TABLE3: ROCK MASS BEDDING

DESCRIPTION	CRITERIA
Parting	- Less than 0.02 foot (<0.60 cm)
Band	- 0.02 to 0.2 foot (0.60 to 6.1 cm)
Thin Bed	- 0.2 to 0.5 foot (6.1 to 15.2 cm)
Medium Bed	- 0.5 to 1.0 foot (15.2 to 30.5 cm)
Thick Bed	- 1.0 to 2.0 feet (30.5 to 61.0 cm)
Massive	- Greater than 2.0 feet (>61.0 cm)

TABLE 4: ROCK WEATHERING

DESCRIPTION	CRITERIA
Fresh	- No visible signs of decomposition or discoloration
Slightly Weathered	- Slight discoloration inward from open fractures
Moderately Weathered	- Discoloration throughout, slight loss of strength, texture intact
Highly Weathered	- Specimens can be broken by hand, texture indistinct, fabric intact
Completely Weathered	- Specimens easily crumbled, minerals decomposed to soil
Residual Soil	- Advanced state of decomposition resulting in plastic soil

TABLE 5: ROCK FABRIC

DESCRIPTION	CRITERIA
Equigranular	- Grains essentially of equal size
Porphyritic	- Mixed coarse and fine grains
Amorphous	- No definite crystal form (Glass)
Platy	- Schistose or foliated, planar

TABLE 6: ROCK JOINTING

DESCRIPTION	CRITERIA	
Very Wide	>3.25 ft.	(>3 m)
Wide	1.1 – 3.25 ft.	(1-3 m)
Moderately Wide	0.3 – 1.1 ft.	(0.3 – 1 m)
Close	0.05 – 0.3 ft.	(0.05 – 0.3 m)
Very Close	<0.05 ft.	(<0.05 m)

TABLE 7: ROCK VOIDS

DESCRIPTION	CRITERIA
Dense	- Usually not discernable with the naked eye
Pit (Pitted)	- Discernable to 1/4”
Vug (Vuggy)	- 1/4” to diameter of the core
Cavity	- Larger than 6” in diameter

ROCK 8: ROCK QUALITY

PERCENT RQD	QUALITY
90 to 100	Excellent
75 to 90	Good
50 to 75	Fair
25 to 50	Poor
0 to 25	Very Poor

FIGURE 1: Sorting Criteria

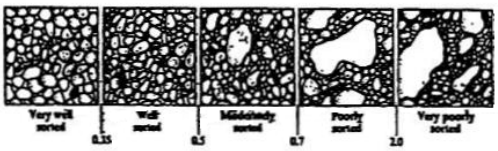
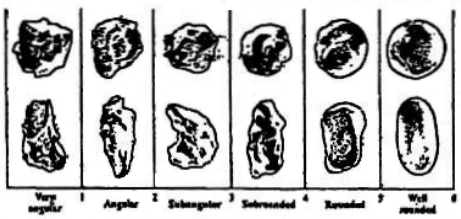


FIGURE 2: Angularity Criteria



TYPE SPECIFIC CHARACTERISTICS

CHARACTERISTICS OF DETRITAL SEDIMENTARY ROCKS

ROCK TYPE	CHARACTERISTICS
	COARSE-GRAINED
Conglomerates	- Rounded fragments of any type rock; cementing agent chiefly silica, but iron, clay, and calcareous material also common/
Breccia	- Angular fragments of any type rock; resulting from glaciation, rock falls, cave collapse, and/or fault movements.
	MEDIUM-GRAINED
Sandstones	- Predominantly quartz grains cemented by silica, iron,clay or carbonate material. Color depends on cementing agent; porous and pervious; hard and generally thickly bedded.
Arkose	- Similar to sandstone but at least 25% feldspar.
Graywacke	- Angular particles of a variety of minerals in a clay matrix; indurated, impure sandstone.
	FINE-GRAINED
Siltston	- Composition similar to sandstone but at least 50% of grains 0.002 – 0.02mm in size. Rarely forms thick beds, but often hard.
Shale	- Predominant particles, <0.002mm; a wall defined fissile fabric. Commonly interbedded with sandstone and relatively soft.
Argillites	- Hard, indurated shales devoid of fissility.
Clay Shale	- Moderately indurated shales.
Claystone	- Clay-size particles compacted into rock without a fissle structure (stiff to hard consistency).

CHARACTERISTICS OF NON-DETRITAL SEDIMENTARY ROCKS

ROCK TYPE	CHARACTERISTICS
	CALCAREOUS PRECIPITATES
Limestone	- Contains more than 50% calcium carbonate. The calcite can be precipitated chemically, organically, or it may be detrital in origin. Reacts violently with dilute HCL.
Coquina	- Weak porous rock consisting of lightly cemented shells and shell fragments.
Chalk	- Soft, porous, and fine-textured; composed of shells of microscopic organisms; usually white.
Dolomite	- Harder and heavier than limeston. Forms by alteration of limestone or by direct precipitation from sea water. Reacts with dilute HCL only when powered; hardness >5.
Gypsum	- An evaporate, commonly massive, white and soft.
Anhydrite	- An evaporate, harder than gypsum; normally white with a pearly luster and splintery fracture.
Halite	- An evaporate; a crystalline aggregate of salt.
	ORGANIC ORIGIN
Coal	- Composed of highly altered plant remains and varying amounts of clay, generally black.
	BIOGENIC AND CHEMICAL ORIGIN
Chert	- Formed by silica deposted from solution in water. May occur as nodules or relatively thick beds; hardness of 7.
Diatomite	- Soft, white, very light, porous rock.

CHARACTERISTICS OF IGNEOUS ROCKS

ROCK TYPE	CHARACTERISTICS
	COARSE TO MEDIUM GRAINED
Pegmatite	- Chiefly quartz and feldspar, occuring separately as large grains; abundant as dikes in granite.
Granite	- Most common igneous rock; normally equigranular and light in color; chiefly quartz and feldspar.
Syenite	- Light colored rock similar to granite but contains no quartz; almost entirely feldspar.
Diorite	- Equlgranular and gray to dark gray; composed of plagioclase feldspar and at least one ferromagnesian mineral.
Gabbro	- Dark colored rock composed of ferromagnesian minerals and plagiociase feldspar.
Peridotite	- Dark colored rock composed almost entirely of ferromagnesian minerals, readily altertered.
Dunite	- Very dark green; major constituent is olivine. Readily alters to serpentine.
Dolerite	- Dark colored rock, intermediate in grain size.
	FINE-GRAINED
Andesite	- Generally dark gray, green or red, fine-grained rock; occasionally porphyritic.
Basalt	- Most abundant extrusive rock; variable colors; fine-grained with a dense structure.
Rhyolite	- Microcrystalline equivalent of granite; usually white, gray or pink with a few phenocrysts.
Felsite	- A finely-crystalline variety of quartz-porphyry.
	GLASSY ROCKS
Obsidian	- Solid natural glass devoid of all crystal form.
Pumice	- Extremely vesicular glass; sponge structure.
Scoria	- Rock which has equal void space and solid mass.

CHARACTERISTICS OF METAMORPHIC ROCKS

ROCK TYPE	CHARACTERISTICS
	FOLIATED FABRIC
Gneiss	- Coarse-grained rock with imperfect follation resulting in slabbing. Chief minerals are quartz and feldspar.
Schist	- Fine-grained rock with a well-developed foliation. Mainly consists of platy minerals and commonly garnet.
Amphibolite	- Consists largely of amphibole with a schist-like foliation. Commonly hard and very dense.
Phyllite	- Soft, with a satin luster and extremely fine schistosity; very unstable cut slopes.
Slate	- Extremely fine-grained (micritic) with a very well-defined cleavage; generally hard.
	MASSIVE FABRIC
Meta-conglomerate	- Similar to conglomerate in appearance but has been fused and deformed by heat and pressure.
Quartzite	- Extensively altered sandstone; individual sand grains have been fused together.
Serpentine	- A green, soft, compact rock with a waxy luster and splintery fracture.
Soapstone	- Derived from talc; generally green in color and easily cut with a sharp knife; resists the action of heat and acids.
Hornfels	- Rocks baked by contact metamorphism into a hard aphanitic material, with concoldal fracture and generally dark gray to black in color.
Migmatite	- A complex intermixture of metamorphic and granular igneous rocks formed by injection of granite magma into foliated rocks.
Mylonites	- Produced by intense metamorphism; variable fabric due to deformation of original minerals. Common along the base of overthrust sheets.

GEOLOGIC DEFINITIONS

ARENACEOUS – A term applied to rocks that have been derived from sand or contain abundant, >30% , sand in composition.
ARGILLACEOUS – A term applied to all rock or substances composed of clay minerals or having a notable portion, >30%, clay in composition.
BRECCIATED – A rock texture with is composed of angular fragments which corresponds in size to gravel and/or pebbles.
CONGLOMERITIC – A rock texture which is composed of rounded fragments which correspond in size to gravel and/or pebbles.
FABRIC – That factor of the texture of a crystalline rock which depends on the relative sizes, shapes, and arrangements of the component crystals.
FISSILITY – A property of splitting along closely spaced parallel planes.
OOLITIC – A spherical or ellipsoidal texture, 0.25 – 2.0mm in diameter, with a concentric or radial structure.
PHANERITIC – A textural term applied to those igneous rocks in which all the grains are essentially the same size.
PORPHYRITIC- A textural term applied to those igneous rocks which have larger crystals set in a fine matrix.
SLICKENSIDE – A polished or striated surface on or within a rock or compact soil.
STYLOLITE – A term applied to parts of certain limestones which have a columnlike development that is grooved, sutured, or striated and irregular

Note: Tables, Figures and data adapted from: *"Geotechnical Engineering Investigation Manual"*, Roy E. Hunt, McGraw-Hill Book Co., New york, NY, 1984., *"Petrology Igneous, Sedimentary, and Metamorphic"*, Harvey Blatt & Ernest G. Ehlers, W. H. Freman & co., San Francisco, CA, 1982., and the U.S. Army Corps of Engineers.

APPENDIX C

ROCK CORE PHOTOGRAPHS

WASTEWATER TREATMENT
PLANT IMPROVEMENTS
HAYS, KANSAS

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	35 – 40	100	73

WASTEWATER TREATMENT
PLANT IMPROVEMENTS
HAYS, KANSAS

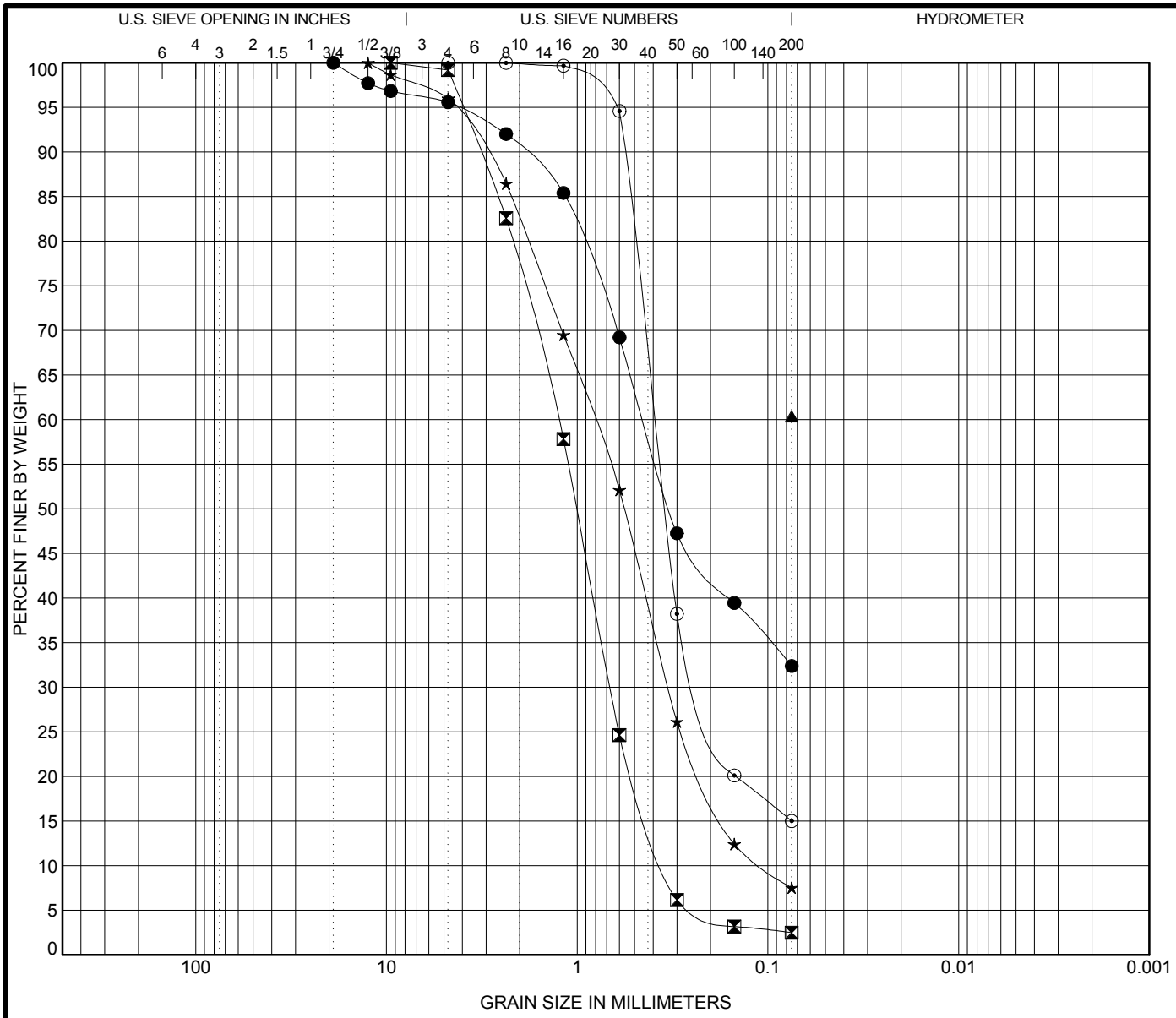
Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	30 – 30.5	100	75
2	30.5 – 35.5	100	90

WASTEWATER TREATMENT
PLANT IMPROVEMENTS
HAYS, KANSAS

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	35 – 36	100	0
2	36 – 41	100	83

APPENDIX D

GRAIN SIZE DISTRIBUTION AND CONSOLIDATION TEST RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B- 1	at 18.5'	SILTY SAND (SM)					
⊠	B- 3	at 6.0'	POORLY GRADED SAND (SP)				1.03	3.62
▲	B- 5	at 13.5'	SANDY CLAY (CL)					
★	B- 7	at 18.5'	WELL-GRADED SAND WITH SILT (SW-SM)				1.27	7.66
⊙	B- 9	at 13.0'	SILTY SAND (SM)					

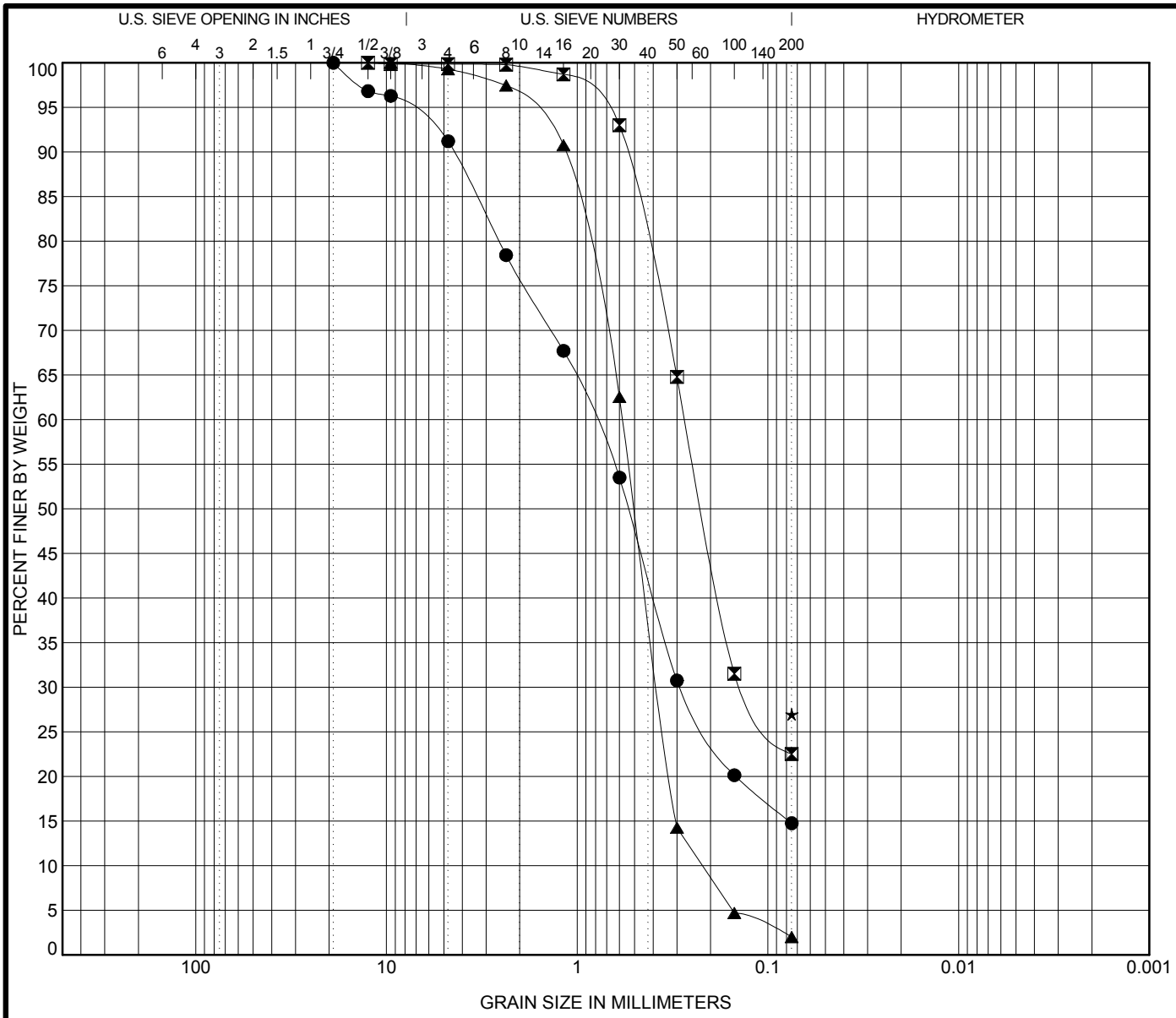
	Specimen Identification		2.00mm	0.425mm	0.075mm	0.02mm	0.002mm	0.001mm	%Silt	%Clay
●	B- 1	at 18.5'	90.4	58.3	32.4				32.4	
⊠	B- 3	at 6.0'	76.7	15.4	2.5				2.5	
▲	B- 5	at 13.5'			60.4				60.4	
★	B- 7	at 18.5'	82.4	39.2	7.5				7.5	
⊙	B- 9	at 13.0'	99.9	66.5	15.0				15.0	

GEOTECHNOLOGY INC
FROM THE GROUND UP

GRAIN SIZE DISTRIBUTION

Wastewater Treatment
Plant Improvements
Hays, Kansas
J024918.01

AMRL GRAIN SIZE GINT STD US LAB.GPJ US LAB.GDT 9/21/15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-10**	**at 18.5'**	**SILTY SAND (SM)**					
⊠	**B-12**	**at 13.5'**	**SILTY SAND (SM)**					
▲	**B-13**	**at 13.0'**	**POORLY GRADED SAND (SP)**				**1.11**	**2.63**
★	**B-13**	**at 23.5'**	**SILTY SAND (SM)**					

	Specimen Identification		2.00mm	0.425mm	0.075mm	0.02mm	0.002mm	0.001mm	%Silt	%Clay
●	**B-10**	**at 18.5'**	**75.9**	**42.2**	**14.8**				**14.8**	
⊠	**B-12**	**at 13.5'**	**99.5**	**79.0**	**22.5**				**22.5**	
▲	**B-13**	**at 13.0'**	**95.9**	**38.5**	**2.0**				**2.0**	
★	**B-13**	**at 23.5'**			**27.0**				**27.0**	

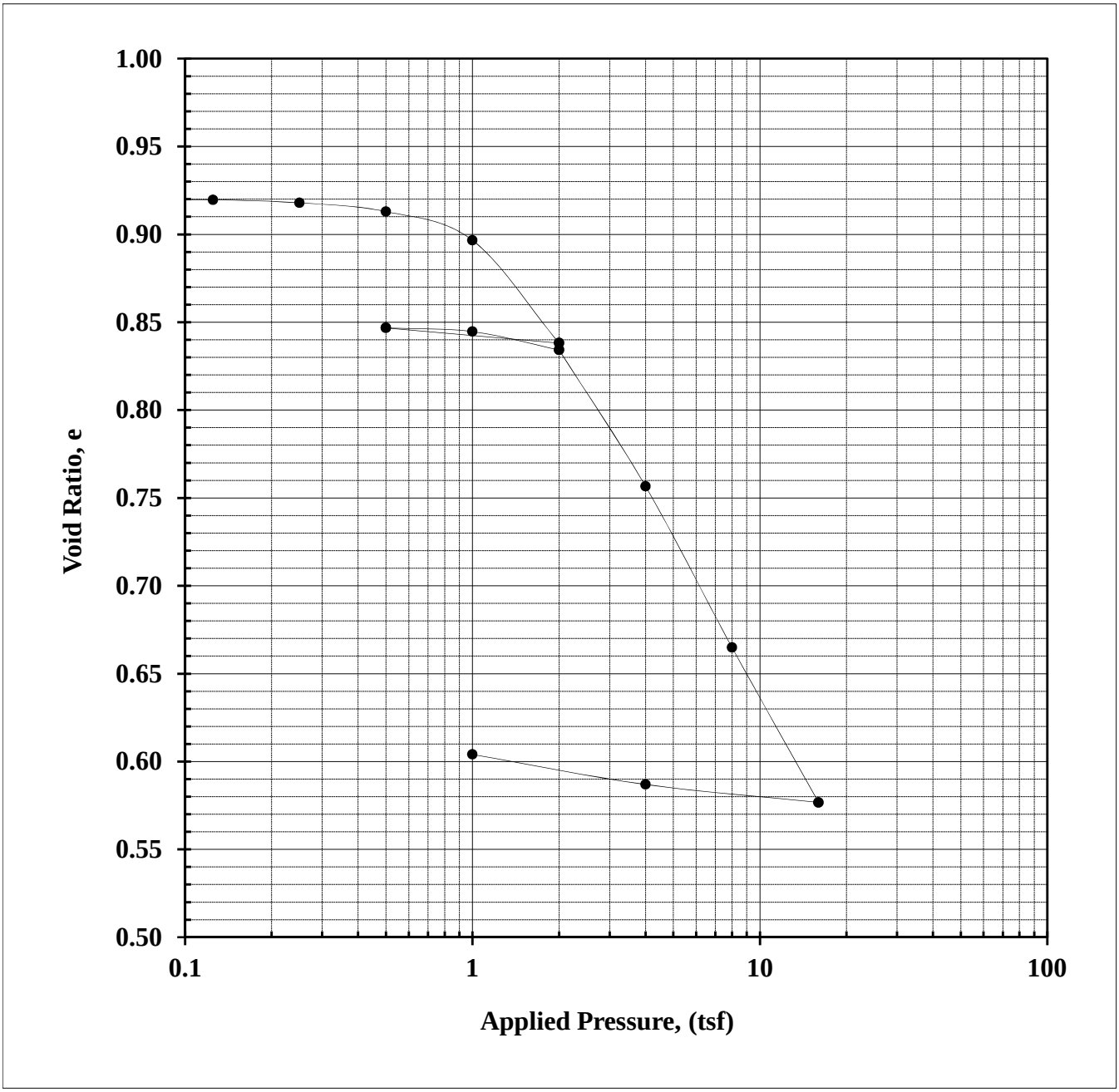
GEOTECHNOLOGY INC
FROM THE GROUND UP

GRAIN SIZE DISTRIBUTION

Wastewater Treatment
Plant Improvements
Hays, Kansas
J024918.01

AMRL GRAIN SIZE GINT STD US LAB.GPJ US LAB.GDT 9/21/15

Boring No.	B-7	GEOTECHNOLOGY INC FROM THE GROUND UP	Job No.	J024918.01
Sample No.	ST-2		Job Name	Hays, KS WWTP
Depth (ft)	3.0 - 5.0		Sheet No.	--
Tested By	CDB	**One-Dimensional Consolidation Test**	Test Date	9/9/2015
Computed By	CDB	**(ASTM D 2435)**	Checked By	MHM

Plot of Void Ratio versus Log of Pressure

Compression Index, C_c =	0.30	**Void Ratio, e_o =**	0.920	
Recompression Index, C_r =	0.02	**Preconsolidation Pressure =**	1.3	**(tsf)**