Geotechnical Engineering Report

Proposed Lift Station 66 Biofilter
30101 Black Canyon Highway
Phoenix, Arizona

August 5, 2022
Terracon Project No. 65215143

Prepared for:
Garver
8211 South 48th Street
Phoenix, Arizona

Prepared by:
Terracon Consultants, Inc.
4685 South Ash Avenue, Suite H-4
Tempe, Arizona

EXPIRES 9/30/2023

August 5, 2022

Garver
8211 South 48th Street
Phoenix, Arizona 85282

Attn: Mr. Jonathon Chill, P.E.
Phone: (480) 646-5366
Email: JMChill@GarverUSA.com

Re: Geotechnical Engineering Report
Proposed Lift Station 66 Biofilter
30101 Black Canyon Highway
Phoenix, Arizona
Terracon Project No. 65215143

Dear Mr. Chill:

Terracon Consultants, Inc. (Terracon) has completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P65215143 – Revision No. 3 dated January 5, 2022. This geotechnical engineering report presents the findings of the subsurface exploration and provides geotechnical engineering recommendations concerning earthwork and the design and construction of foundations and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
64485
EDDY F.
RAMIREZ
Date Signed 8/5/2022
ARIZONA, U.S.A.
EXPIRES 9/30/2023

Donald R. Clark

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REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	We understand the proposed improvements to the existing facility will consist of a new below grade biofilter, associated underground pipes, and new paved parking and drives. We understand the new biofilter will be approximately 10 feet below the existing ground surface
Geotechnical Characterization	The surface of the site was covered with approximately 3.5 inches of asphalt concrete. The subsurface soils beneath the pavement structure consist of loose to medium dense silty gravel with sand to a depth approximately of 5 feet, followed by dense to very dense sand with variable amounts of silt, clay, and gravel and hard sandy lean clay with sand to the maximum explored depth of 69.5 feet. The near surface silty gravel with sand and well graded sand with silt and gravel soils exhibit low plasticity characteristics. Groundwater was not encountered during the field exploration to a maximum boring depth of 69.5 feet.
Seismic Considerations	Based on the site soil properties, the site is classified as Site Class C in accordance with Chapter 20 of ASCE 7 as required by the 2015/2018 IBC
Earthwork	■ The proposed biofilter can be supported by a mat foundation bearing entirely upon undisturbed native soils. ■ In pavement areas, we recommend the subgrade should be scarified, moisture conditioned and compacted to a minimum depth of 10 inches. The moisture content and compaction of subgrade soils should be maintained pavement construction. ■ Based upon the subsurface conditions encountered at the boring location, the on-site soils should be considered as OSHA Type C soils for the project in excavations that are less than 20 feet in depth. This classification should also be applied to any engineered fill soils placed on the site during the grading operations. ■ Based on the subsurface conditions, it is anticipated that shallow excavations to a depth of 5 feet for the proposed construction can be accomplished with conventional earthmoving equipment. However, deeper excavations may require heavier construction equipment capable of handling very dense soils with variable amounts of gravel.
Temporary Shoring	We understand that there are existing structures and underground utilities near the proposed pump station excavations which may require temporary shoring during construction. If shoring is required during construction, we anticipate the shoring will include some combination of soil nail or cantilever walls. All shoring walls are anticipated to be faced with a temporary shotcrete. Geotechnical design parameters for temporary shoring will be dependent on the selected system and loading diagrams can be developed once the excavation system is chosen.

Topic [1]	Overview Statement [2]
Mat Foundations	Mat foundations can be utilized for the proposed biofilter. ■ Mat Foundations: Maximum allowable bearing pressure = any practical value up to 5,000 psf with a minimum bearing depth of 10 feet below existing grade. Mat foundations can be supported on undisturbed native soils.
Pavements	Based on the anticipated traffic data outlined in this report and with subgrade prepared as noted in **Earthwork**, the following outlines recommended minimum pavement sections for the project: Asphalt: ■ 3.0” AC over 4” ABC in Automobile Drives and Parking Areas (Light Duty) ■ 3.5” AC over 4” ABC in Light Truck Areas (Medium Duty) Concrete: ■ 5.0” PCC over 4” ABC in Automobile Drives and Parking Areas (Light Duty) ■ 6.0” PCC over 4” ABC in Light Truck Drives (Medium Duty) and Trash Enclosure Areas
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report

Proposed Lift Station 66 Biofilter
30101 Black Canyon Highway
Phoenix, Arizona
Terracon Project No. 65215143
August 5, 2022

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Lift Station 66 Biofilter project located at 30101 Black Canyon Highway in Phoenix, Arizona. The approximate location of the project is shown on the attached **Site Location** map. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Foundation design and construction
- Excavation considerations
- Lateral earth pressures
- Seismic site classification per IBC
- Pavement design and construction

The geotechnical engineering scope of services for this project included the advancement of one test boring to a depth of approximately 69.5 feet below the existing ground surface for subsurface exploration, laboratory testing, geotechnical engineering analysis, and preparation of this report.

A map showing the boring location is shown on the attached **Exploration Plan**. A log of the boring is included in the **Exploration Results** section of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in part on the boring logs and as separate graphs in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available topographic maps.

Item	Description
Parcel Information	The project is located at 30101 Black Canyon Highway in Phoenix, Arizona. See **Site Location** for additional site location information.
Existing Site Conditions	The project site is located inside an existing City of Phoenix lift station that includes various structures, equipment, and tanks.

Item	Description
Current Ground Cover	Asphalt concrete at the location of the planned improvements.
Existing Topography	The site is relatively flat.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and our final understanding of the project conditions is as follows:

Item	Description
Project Description	Based on the information provided, we understand the proposed improvements to the existing facility will consist of a new below grade biofilter and associated underground pipes. We understand the new biofilter will be approximately 10 feet below the existing ground surface. We understand excavations up to 15 feet in depth are anticipated for the construction of the new biofilter. Other on-site improvements will include new paved parking adjacent to the new biofilter area.
Proposed Construction	We understand the new biofilter will be supported on a mat foundation with dimensions of approximately 30' by 40'. We understand new parking and drive areas will generally consist of asphalt concrete or portland cement concrete pavements.
Maximum Loads (Provided)	■ Axial Load: 2,000 kips
Grading/Slopes	We understand the excavation for the construction of the proposed biofilter will extend to a depth of approximately 15 feet below finished site grades.
Below-Grade Structures	We understand the new biofilter will extend to a depth of approximately 10 feet below the finished site grades. We understand below grade perimeter walls will be constructed as part of the new biofilter.
Free-Standing Retaining Walls	None are planned.
Pavements	On-site drives and parking area pavements for automobile and truck traffic are anticipated to consist of asphalt concrete and/or portland cement concrete. On-site traffic volumes were not provided, and the following are the anticipated design equivalent single axle loads (ESALs) for the on-site pavements: ■ Automobile Drives and Parking Areas: 7,000 ESALs (Light Duty) ■ Light Truck Drives: 27,000 ESALs (Medium Duty) ■ The pavement design period is 20 years

GEOTECHNICAL CHARACTERIZATION

Geology

The project area is located in the Basin and Range physiographic province ([1]Cooley, 1967) of the North American Cordillera ([2]Stern, et al, 1979) of the southwestern United States. The southern portion of the Basin and Range province is situated along the southwestern flank of the Colorado Plateau and is bounded by the Sierra Nevada Mountains to the west. Formed during middle and late Tertiary time (100 to 15 million years ago), the Basin and Range province is dominated by fault-controlled topography. The topography consists of mountain ranges and relatively flat alluviated valleys. These mountain ranges and valleys have evolved from generally complex movements and associated erosional and depositional processes. Structurally, the site lies within the Phoenix Basin. Drainage flows to the Gila River during late Tertiary time, coupled with structural activity discussed above, are generally responsible for the present-day topography within the basin.

Typically, the ranges in this area are of small areal extent but protrude significantly above adjacent wide alluviated plains and valleys. The basin rims are formed by the mountain ranges which consist of sedimentary, igneous and metamorphic materials which have been subjected to recurrent faulting and tilting, and in some places volcanic and intrusive events. As a result of erosion, the valleys have experienced partial infilling with sedimentary material which has been deposited as alluvial fans. Occasionally, the valleys may become interlocking as a result of coalescing alluvial fans which are referred to as bajadas.

Based on review of U.S. Geological Survey (USGS) geological maps, surficial geologic conditions mapped at the site consist of Late and Middle Pleistocene surficial deposits. These deposits consist of unconsolidated to weakly consolidated alluvial fan, terrace, and basin-floor deposits with moderate to string soil development. Fan and terrace deposits are primarily poorly sorted, moderately bedded gravel and sand, and basin-floor deposits are primarily sand, silt, and clay.

Land Subsidence and Earth Fissures

The site is located within the Northern Metropolitan Phoenix area, portions of which have experienced historic and documented groundwater decline. The depletion of the groundwater table has resulted in compression of the aquifer material and the phenomenon known as areal subsidence. Earth fissures are fractures or cracks that form in alluvial basins due to substantial groundwater overdrafts that produce local subsidence. Based on a review of available Arizona Department of Water Resources (ADWR), the site is not within a mapped land subsidence area.

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[1] *Cooley, M.E., 1967, **Arizona Highway Geologic Map**, Arizona Geological Society.*
[2] *Stern, C.W., et al, 1979, **Geological Evolution of North America**, John Wiley & Sons, Santa Barbara, California.*

Earth fissures develop within land subsidence areas where a significant thickness of compressible alluvium overlies shallow irregular bedrock surfaces such as ridges and fault scarps or other subsurface features. Based on a review of available Arizona Geological Survey (AZGS) earth fissure maps, the project site is not within an earth fissure study area and no earth fissures are mapped at the project site.

Subsurface Conditions

Specific conditions encountered at the boring location are indicated on the final boring log presented in the **Exploration Results** section of this report. Stratification boundaries on the boring log represents the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Based on conditions encountered in the boring, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Description	Relative Density / Consistency
Surface	3.5 inches	3.5 inches Asphalt Concrete[1]	---
Stratum 1	5	Silty gravel with Sand	Loose to Medium Dense
Stratum 2	26	Well Graded Sand with Silt and Gravel	Dense to Very Dense
Stratum 3	39	Sandy Lean Clay with Gravel	Hard
Stratum 4	69.5 (maximum depth explored)	Clayey Sand with Gravel, Poorly Graded Gravel with Sand	Very Dense

1. Aggregate base course was not observed beneath the asphalt concrete at the boring location.

Laboratory tests were conducted on selected soil samples and the test results are presented in the **Exploration Results** section of this report. Test results indicate the near surface silty gravel with sand and well graded sand with silt and gravel soils exhibit low to medium plasticity characteristics.

Groundwater Conditions

Groundwater was not observed in the test boring at the time of our field exploration, nor when checked upon completion of drilling. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Groundwater conditions can change with varying seasonal and weather conditions, and other factors

Based on information obtained from the Arizona Department of Water Resources – Groundwater Data website (https://gisweb.azwater.gov/waterresourcedata/GWSI.aspx), the depth to regional groundwater was most recently measured in December 2, 2002 to be approximately 234 feet below the ground surface (approximate elevation of 1259 feet above mean sea level) at an Arizona Department of Water Resources (ADWR) monitored well site (Local I.D.: A-05-02 35ABD) located approximately 7,000 feet south of the site.

CORROSIVITY

The following table lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary						
Boring	Sample Depth (feet)	Soil Description	pH	Electrical Resistivity (Ω-cm)	Soluble Sulfate (ppm)	Soluble Chloride (ppm)
B-1	0-5	Silty Gravel with Sand	8.5	1,275	5	29

Results of soluble sulfate testing indicate that samples of the on-site soils tested classify as S0 according to Table 19.3.1.1 of Section 318 of the American Concrete Institute (ACI) Building Code Requirements for Structural Concrete. Therefore, American Society for Testing and Materials (ASTM) Type I/II portland cement is considered suitable for concrete at the site in contact with similar soluble sulfate concentrations. Concrete should be designed in accordance with the provisions of the ACI Building Code Requirements for Structural Concrete, Section 318, Chapter 19.

These values should be used to help determine potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction. Refer to Summary of Laboratory Results contained in **Exploration Results** for the complete results of the corrosivity testing performed on the site soils in conjunction with this geotechnical exploration. The corrosion information presented is specific to the samples tested. If the actual soils that will be in contact with the structures at the site are different than those tested, then additional corrosion testing should be performed. Terracon is not a corrosion engineer, and our scope of work was limited to performing corrosion laboratory tests on selected samples, presenting these results, and providing a brief comparison of the results to selected criteria. A qualified corrosion engineer should be consulted if corrosion of underground utilities and structures is a concern.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is C**. Subsurface explorations at this site were extended to a maximum depth of 69.5 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

GEOTECHNICAL OVERVIEW

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test boring and provided our geotechnical engineering recommendations contained in this report are properly implemented in the design and construction.

- The on-site subsurface soils generally consist of sand with variable amounts of silt, clay, and gravel and sandy lean clay with gravel. Field penetration test results near expected foundation depths indicate that the relative density of the subsurface sand soils is generally dense to very dense and the consistency of the subsurface clay soils is generally hard.

- Based on the results of the field exploration, the proposed biofilter can be supported on a reinforced concrete mat foundation with a minimum bearing depth of 10 feet below existing site grades. We recommend mat foundations be supported on approved undisturbed native soils.

- Asphalt concrete and rigid pavement systems are suitable for this site. The **Pavements** section addresses the design of the pavement systems.

- The on-site soils are considered suitable for use as engineered fill in all construction areas.

- Based upon the subsurface conditions encountered at the boring location, the on-site soils should be considered as OSHA Type C soils for the project in excavations that are less than 15 feet in depth. This classification should also be applied to any engineered fill soils placed on the site during the grading operations.

- It is anticipated that shallow excavations to a depth of 5 feet for the proposed construction can be accomplished with conventional earthmoving equipment. However, deeper excavations may require heavier construction equipment capable of handling very dense granular soils.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (included in the **Exploration Results** section), engineering analyses, and our current understanding of the proposed project.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth supported elements including foundations and pavements are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Strip and remove existing pavement, demolition debris, and other deleterious materials from proposed biofilter and pavement areas. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction. The site should be initially graded to create a relatively flat surface to receive fill, and to provide for a relatively uniform thickness of fill beneath the proposed improvement areas.

Although evidence of underground facilities such as septic tanks, cesspools, basements, and utilities was not observed during the site reconnaissance, such features will be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

The proposed biofilter can be supported by a mat foundation system bearing entirely upon undisturbed native soils. If areas of loose soils are encountered at foundation bearing depth after excavation is completed for the foundation, the subgrade soils should be surficially compacted prior to placement of the foundation system. If sufficient compaction cannot be achieved in-place, the loose soils should be removed and replaced as engineered fill.

Subgrade soils beneath pavements should be scarified, moisture conditioned and compacted to a minimum depth of 10 inches. The moisture content and compaction of subgrade soils should be maintained until pavement construction.

Fill Material Types

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than four inches in size. We understand underground pipes will be constructed as part of the project. The existing native soils are considered acceptable for use as trench backfill outside of the pipe zone. Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed 10 inches loose thickness.

Pipe bedding and shading should be in accordance with Section 601 of the 2018 Maricopa Association of Governments ([3]MAG, 2020) Specifications Section 601, bedding material for the pipes associated with the proposed biofilter should consist of a minimum 4-inch thickness of compacted granular material, defined as material for which the sum of the plasticity index and the percent passing the No. 200 sieve does not exceed 23. Pea gravel or other similar open-graded gravel materials are not acceptable for use as pipe bedding. The granular materials should not contain pieces over 1-1/2 inch in diameter. The granular bedding material should be graded so that the pipe remains in continuous contact with the bedding along the entire length of the pipe.

The pipe zone material, defined as the material from the bottom of pipe to 1-foot above the top of the pipe, should consist of compacted granular material. The existing native soils may meet the specification for granular material and recommend additional testing to show that the onsite soils meet the specification. Pea gravel or other similar open-graded gravel materials are not acceptable for use within the pipe zone. Trench backfill above the pipe zone may consist of any on-site soils with a maximum particle size of 4-inches or less. Trench backfill shall be compacted by mechanical means only, water jetting or water settling should not be permitted.

Fill Compaction Requirements

Engineered fill should meet the following compaction and moisture requirements:

[3] *Maricopa Association of Governments, 2015,* ***Uniform Standard Specifications and Details for Public Works Construction****, Arizona.*

Material Type and Location	Per the Standard Proctor Test (ASTM D 698)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction (referenced from optimum moisture content)	
		Minimum	Maximum
On-site and imported soils:			
Beneath foundations	95	-2%	+3%
Beneath pavements	95	-2%	+2%
Aggregate base course (beneath asphalt pavements)	100	-2%	+2%
Aggregate base course (beneath concrete pavements)	95	-3%	+3%
Granular Materials for Pipe Bedding and Pipe Zone Backfill	95	-2%	+2%
On-site soils for Trench Backfill for depths greater than 5 feet below finished grade	98	-2%	+2%
On-site soils for Trench Backfill at depths within 5 feet of finished grade	95	-2%	+2%
Miscellaneous backfill	95	-3%	+3%

1. The moisture content and compaction should be measured for each lift of engineered fill during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Temporary Slopes

The US Occupational Safety and Health Administration (OSHA) governs the requirements for safety in excavations. The OSHA regulations pertaining to excavations are outlined in the Code of Federal Regulations (CFR), Title 29, Part 1926 Subpart P. These regulations dictate the individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottoms. Excavations should be sloped or shored in the interest of safety following local, state and federal regulations, including current OSHA excavation and trench safety standards. Instability in the form of caving, sloughing, and raveling should be expected in deeper excavations which extend into the granular soil deposits. The contractor should be advised that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is assuming any responsibility for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

OSHA Health and Safety Standards for Excavations classify soils into three basic types (i.e., Type A, B, and C). Depending upon the soil type, OSHA required excavation slopes range from:

- 3/4H:1V (horizontal:vertical) for Type A soils;
- 1H:1V for Type B soils; and,
- 1-1/2H:1V for Type C soils.

Based upon the subsurface conditions encountered at the boring location, the on-site soils should be considered as OSHA Type C soils for the project in excavations that are less than 20 feet in depth. This classification should also be applied to any engineered fill soils placed on the site during the grading operations. For excavations encountering layered materials, the slope must be based on the most stringent slope requirements of any underlying layer penetrated based on OSHA requirements.

Care should be taken during excavation to protect the structural integrity of any existing structures or adjacent underground utilities. Depending upon factors such as the depth of excavation, the location of the existing improvements, soil conditions, temporary sheeting and/or shoring may be required. For preliminary designs, excavations should not be performed within a surface defined as 5 feet horizontal from the nearest edge of existing foundations or other settlement sensitive structures and then downward at 1 horizontal to 1 vertical slope. Flatter slopes may be required, and the contractor should be advised to consult with a Registered Professional Engineer to provide specific recommendations regarding measures to protect existing improvements.

Particular caution should be exercised when excavations are performed near existing utility lines. The OSHA trench safety guidelines for adequate side slopes based on soil types may not apply in these situations. Existing underground utilities should be shored and braced as required to maintain their integrity and appropriately designed trench boxes or sheeting and bracing should be used to provide for worker safety.

All vehicles and soil piles should be kept a sufficient lateral distance from the crest of the trench slope to maintain safe working conditions. Vehicles and soil piles located adjacent to trenches would significantly influence the stability of the slopes as outlined by the OSHA regulations. A detailed stability analysis would be required for these conditions. Additionally, vibrations from construction equipment or similar sources can influence slope stability. The exposed slope faces should be protected from the elements. Surface water should be diverted from all excavations. If water enters an excavation, it should be removed along with any loosened or softened soil. The length of open trench should be held to a minimum.

Braced Excavations

In lieu of trench slopes as defined by OSHA, trench shoring or shields (trench boxes) may be utilized by the contractor to increase excavation slopes. The contractor would be responsible for the design of the temporary shoring in accordance with applicable regulatory requirements. However, we recommend that trench shoring systems be designed on the basis of the following engineering design parameters:

Lateral Earth Pressure Design Parameters for Trench Shoring Systems			
Earth Pressure Condition [1]	Coefficient for Backfill Type	Surcharge Pressure [2, 3, 4] p_1 (psf)	Effective Fluid Pressures (psf) [4, 5] Unsaturated [6]
Active (Ka)	0.32	(0.32)S	(40)H
At-Rest (Ko)	0.48	(0.50)S	(60)H
Passive (Kp)	3.12	---	(375)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance
2. Uniform surcharge, where S is surcharge pressure.
3. Loading from heavy compaction equipment is not included in surcharge or earth pressures
4. No safety factor is included in these values.
5. Uniform, final graded backfill, compacted to at least 95 percent of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf
6. Ground water is not expected in the planned excavations at this site.

Shoring

We understand that there are existing structures and underground utilities near the proposed biofilter excavation which may require temporary shoring to construct. If shoring is required during construction, we anticipate the shoring will include some combination of soil nail or cantilever walls. All shoring walls are anticipated to be faced with a temporary shotcrete. Geotechnical design parameters for temporary shoring will be dependent on the selected system and loading diagrams can be developed once the excavation system is chosen.

The following geotechnical parameters are recommended for preliminary engineering analyses of shoring systems:

Soil Type	Depth Interval (ft)	Total Unit Weight (pcf)	Friction Angle Φ'	Cohesion (psf)	Allowable Bond Stress (psi)
Silty Gravel with Sand	0-4	120	31	---	4
Well Graded Sand with Silt and Gravel	4-15	125	38	---	12

The design of the shoring system should be completed by a Registered Professional Engineer licensed in Arizona. During the design of the shoring system, considerations should be given to tolerable settlement of the existing structures and utilities adjacent to the excavation. The owner of the existing structures and utilities should be consulted to discuss the tolerable movement of their existing structures or utilities.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. In areas where sidewalks or paving do not immediately adjoin the proposed biofilter, we recommend that protective slopes be provided with a minimum grade of approximately five percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility trenches should be compacted to the densities outlined herein and be free of all construction debris to reduce the possibility of moisture infiltration.

All grades must provide effective drainage away from the proposed biofilter and other structures during and after construction. Water permitted to pond next to the proposed biofilter and other structures can result in greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential mat foundation movements and cracked walls. Estimated movements described in this report are based on effective drainage for the life of the proposed biofilter and cannot be relied upon if effective drainage is not maintained.

Earthwork Construction Considerations

It is anticipated that shallow excavations to a depth of 5 feet for the proposed construction can be accomplished with conventional earthmoving equipment. However, deeper excavations may require heavier construction equipment capable of handling very dense soils with variable amounts of gravel. Consideration should be given to obtaining a unit price for difficult excavation in the contract documents for the project.

Surface water should not be allowed to pond on the site and soak into the soil during construction. Construction staging should provide drainage of surface water and precipitation away from the project site. Any water that collects over or adjacent to construction areas should be promptly removed, along with any softened or disturbed soils. Surface water control in the form of sloping surfaces, drainage ditches and trenches, and sump pits and pumps will be important to avoid ponding and associated delays due to precipitation and seepage.

Construction site safety is the sole responsibility of the contractor who controls the means, methods and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean that Terracon is assuming any responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least two tests in foundation areas and 2,500 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

MAT FOUNDATIONS

We understand the proposed biofilter will be founded at a depth of approximately 10 feet below the existing site grade on a mat foundation. The following table presents design recommendations mat foundations for the project:

Design Item	Description/Recommendations
Foundation Type	Mat Foundations
Maximum Design Contact Stress	Any practical pressure up to a maximum of 5,000 psf
Minimum Bearing Depth	10 feet below the existing site grade
Bearing Material	Mat foundations may be supported on undisturbed native soils.
Design Modulus of Subgrade Reaction, k	250 pci
Minimum Width	30 feet
Modulus Correction Factor[1]	$k_c=k((b+1)/2b)^2$
Total Estimated Settlement	1 inch or less

1. It is common to reduce the k-value to account for dimensional effects of large loaded areas. Where k_c is the corrected or design modulus value and b is the mat width (short dimension) or tributary loaded area.

Other Foundation Design Criteria

Mat foundations and walls should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in walls is recommended.

Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

Foundation Construction Considerations

As noted in **Earthwork**, the foundation excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

LATERAL EARTH PRESSURES

Design Parameters

The lateral earth pressure recommendations herein are applicable to the design of the proposed biofilter foundation and below grade walls.

Material Type	Earth Pressure Design Case[1]	Design Recommendation[2, 3]
On-Site Soils	Active Case (Ka)	40 psf/ft
	Passive Case (Kp)	375 psf/ft
	At-Rest Case (Ko)	60 psf/ft
	Coefficient of Sliding Friction[4]	0.45
	Total Unit Weight	120 pcf

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. The design values are based on utilizing on-site and imported soils as backfill placed and compacted as outlined in the **Earthwork** section of this report. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors.
3. The lateral earth pressures herein do not include any factor of safety, they assume drained conditions and a horizontal backfill, and they are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if such conditions are to be included in the design.
4. The coefficient of base sliding should be reduced to 0.30 when used in conjunction with passive pressure

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.

As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the wall prior to placing backfill.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Design Parameters

The design of flexible pavements for the project was based on the procedures of the National Asphalt Pavement Association (NAPA). These design procedures are specific to low-volume (low traffic) pavements such as those that will be constructed at this site. Portland Cement Concrete (PCC) pavement thicknesses are based on the American Concrete Institute (ACI) design recommendations.

The design of the recommended pavement sections was based on the following NAPA and ACI criteria:

- NAPA Traffic Class I (ACI Category A) for automobile drives and parking areas includes a maximum of 7,000 Equivalent Single 18-kip Axle Loads (ESAL's) over the design life of the pavement (Light-Duty); Average Daily Truck Traffic (ADTT)=1
- NAPA Traffic Class II (ACI Category B) for main drives and light truck drives areas includes a maximum of 27,000 ESAL's over the design life of the pavement (Medium-Duty); Average Daily Truck Traffic (ADTT)=25
- A soil characterization of "medium" based on the subgrade soils encountered at the site and expected at pavement subgrade elevation
- A Modulus of Subgrade Reaction, *k*, of 200 pci based on the soil classification of subgrade soils
- A concrete modulus of rupture of 505 psi based on a concrete compressive strength of 4,000 psi; and,
- A pavement design life of 20 years.

Pavement Section Thicknesses

Pavement sections based upon a more detailed pavement design could be provided if specific traffic loading, frequencies, and desired pavement design life are provided. As a minimum, we suggest the following typical pavement sections be considered:

Traffic Area	Alternative	Recommended Pavement Section Thickness (inches)			
		Asphalt Concrete Surface	Portland Cement Concrete	Aggregate Base Course	Total
Automobile Drives & Parking Areas (Light-Duty)	Flexible	3.0	---	4.0	7.0
	Rigid	---	5.0	4.0	9.0
Main Drives & Light Truck Drives (Medium-Duty)	Flexible	3.5	---	4.0	7.5
	Rigid	---	6.0	4.0	10.0
Trash Enclosure	Rigid	--	6.0	4.0	10.0

Design and Construction Considerations

Materials and construction of pavements for the project should be in accordance with the requirements and specifications of the Maricopa Association of Governments ([4]MAG, 2020). Base course or pavement materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

All concrete for rigid pavements should have a minimum 28-day compressive strength of 4,000 psi (i.e. MAG AA or equivalent) and be placed with a maximum slump of 4 inches. Although not required for structural support, a minimum 4-inch thick base course layer is recommended beneath concrete pavements to help reduce the potential for slab curl, shrinkage cracking, and subgrade "pumping" through joints. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

---

[4] *Maricopa Association of Governments, 2020,* ***Uniform Standard Specifications and Details for Public Works Construction****, Arizona.*

- Final grade adjacent to paved areas should slope down from the edges at a minimum of 2%; and

- The subgrade and pavement surface should have a minimum 2% slope to promote proper surface drainage.

Pavement Maintenance

Future performance of pavements constructed on the soils at this site will be dependent upon several factors, including:

- maintaining stable moisture content of the subgrade soils; and,
- providing for a planned program of preventative maintenance.

Preventative maintenance should be planned and provided for through an on-going pavement management program to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment.

Preventative maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

One test boring was drilled at the project site on February 16 and 17, 2022. The boring was drilled to a depth of approximately 69.5 feet below the existing ground surface. The approximate boring location is shown on the attached **Exploration Plan**.

Boring Layout and Elevations: Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit with an estimated horizontal accuracy of about +/-15 feet. The elevation noted on the boring log was obtained from Google Earth Pro. If a more precise elevation and boring layout are desired, we recommend the boring be surveyed.

Subsurface Exploration Procedures: The boring was advanced with a truck-mounted CME 75 drill rig utilizing 8-inch outside diameter hollow-stem augers. Hollow stem auger refusal was encountered in cemented coarse gravel and cobbles at a depth of approximately 43 feet in the test boring. Subsequently, the boring was advanced below this depth with ODEX percussion drilling methods.

At selected intervals, samples of the subsurface materials were taken at the boring location by driving split-spoon (SPT) or ring-lined barrel samplers in general accordance with ASTM Standards. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring log at the test depths. A 3-inch O.D. and 2.5-inch I.D. ring lined sampler was used for sampling in the upper 10 feet in the soil boring. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration.

Bulk samples of subsurface materials were obtained from the boring. Groundwater was not encountered during drilling and sampling. For safety purposes, the boring was backfilled with auger cuttings upon completion.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring log. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared a field boring log as part of the drilling operations. The field log included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. A final boring log was prepared from the field log. The final boring log represents the

Geotechnical Engineer's interpretation of the field log and includes modifications based on observations and the results of testing of the samples in our laboratory.

Laboratory Testing

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) as shown in the **Exploration Results** section of this report. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine the engineering properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in the **Exploration Results** section of this report. These results were used for the geotechnical engineering analyses, and the development of foundation and pavement recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local, or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil by Mass
- ASTM D2937 Standard Test Methods for Density of Soil in Place by the Drive-Cylinder Method
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
- ARIZ 236e Arizona Department of Transportation (ADOT) Determining pH and minimum resistivity of Soils and Aggregate (An Arizona Method)
- ARIZ 733b Arizona Department of Transportation (ADOT) Sulfate in Soils (An Arizona Method)
- ARIZ 736b Arizona Department of Transportation (ADOT) Chloride in Soils (An Arizona Method)

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Proposed Lift Station 66 Biofilter ■ Phoenix, Arizona
August 5, 2022 ■ Terracon Project No. 65215143

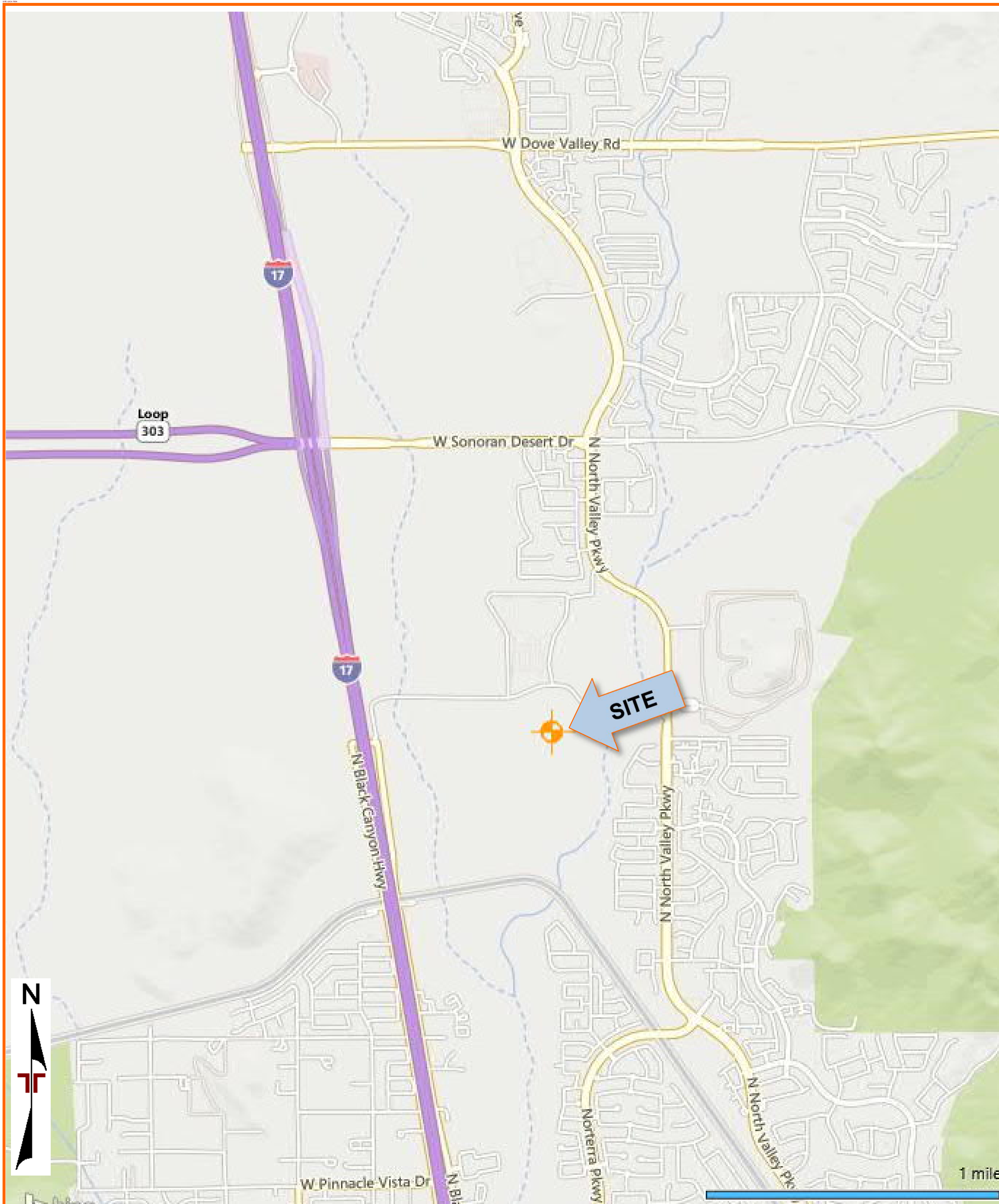


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Proposed Lift Station 66 Biofilter ■ Phoenix, Arizona
August 5, 2022 ■ Terracon Project No. 65215143

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Proposed Lift Station 66 Biofilter ■ Phoenix, Arizona

Terracon Project No. 65215143

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Auger Cuttings Ring Sampler Standard Penetration Test	▽ **Water Initially Encountered** ▽ **Water Level After a Specified Period of Time** ▼ **Water Level After a Specified Period of Time** **Cave In Encountered** Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** — **Standard Penetration Test Resistance (Blows/Ft.)** **(HP)** — **Hand Penetrometer** **(T)** — **Torvane** **(DCP)** — **Dynamic Cone Penetrometer** **UC** — **Unconfined Compressive Strength** **(PID)** — **Photo-Ionization Detector** **(OVA)** — **Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psi)**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 3.50	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	3.5 to 7.0	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	7.0 to 14.0	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	14.0 to 28.0	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	28.0 to 55.5	15 - 30	19 - 42
			Hard	> 55.5	> 30	> 42

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]		GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]		SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above “A” line [J]		CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above “A” line		CH	Fat clay [K, L, M]
			PI plots below “A” line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

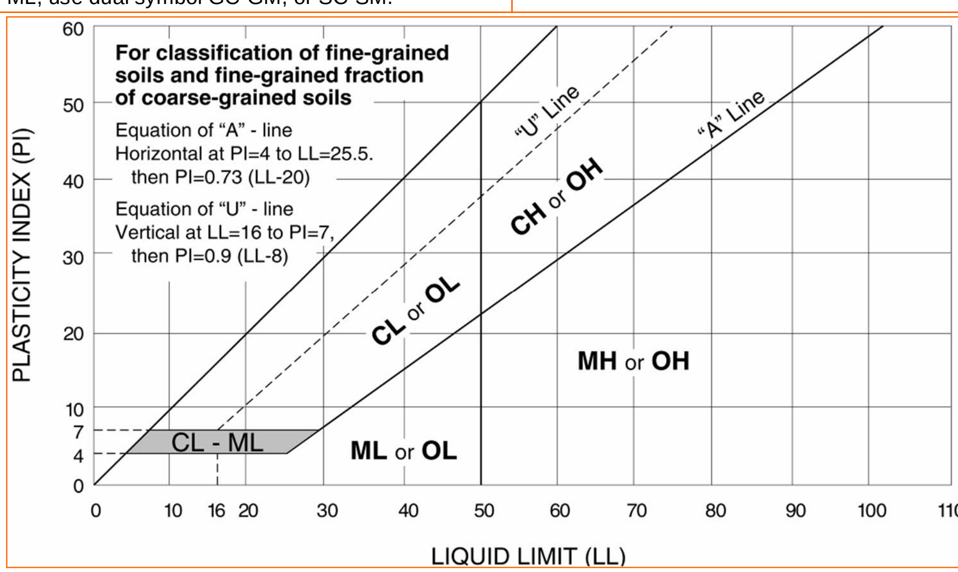
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ≥ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.



BORING LOG NO. B-1

PROJECT: Proposed Lift Station 66 Biofilter

CLIENT: Garver Tempe, Arizona

SITE: 30101 Black Canyon Highway Phoenix, Arizona

LOCATION See Exploration Plan

Latitude: 33.7550° Longitude: -112.1151°

Approximate Surface Elev.: 1542 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)
0.3	**ASPHALT CONCRETE**, approximately 3.5 inches	1542+/-
5.0	**SILTY GRAVEL WITH SAND (GM)**, fine to coarse sand, fine to coarse gravel, low plasticity, brown, loose to medium dense	1537+/-
26.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, fine to coarse sand, fine to coarse gravel, low to medium plasticity, brown, dense to very dense; trace decomposed rock (at approx. 20 ft)	1516+/-
	SANDY LEAN CLAY WITH GRAVEL (CL), fine to coarse sand, fine to coarse gravel, medium plasticity, brown, hard, moderate cementation	

DEPTH (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
~2.5	6-8	16.0	95	37-25-12	43
~4.5	13-14	6.9	115		
~9.5	50/2"	10.4			
~12.5	50/3"	10.4			
~14.5	29-30	4.6	120	38-25-13	11
~19.5	29-35-48 N=83				
~24.5	50/5"				
~29.5	50/3"				
~34.5	46-38-50/5"				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow Stem Auger and ODEX Drilling Methods

Abandonment Method:
Boring backfilled with Auger Cuttings Mixed With Cement and Capped With Asphalt Cold Patch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

Elevation obtained from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

Boring Started: 02-16-2022	Boring Completed: 02-17-2022
Drill Rig: CME 75	Driller: Wildcat Drlling Inc.
Project No.: 65215143	

BORING LOG NO. B-1

PROJECT: Proposed Lift Station 66 Biofilter

CLIENT: Garver
Tempe, Arizona

SITE: 30101 Black Canyon Highway
Phoenix, Arizona

LOCATION See Exploration Plan

Latitude: 33.7550° Longitude: -112.1151°

Approximate Surface Elev.: 1542 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
39.0	**SANDY LEAN CLAY WITH GRAVEL (CL)**, fine to coarse sand, fine to coarse gravel, medium plasticity, brown, hard, moderate cementation *(continued)*	1503+/-			X	32-50/3"				
	CLAYEY SAND WITH GRAVEL (SC), fine to coarse sand, fine to coarse gravel, low to medium plasticity, brown, very dense, moderate to strong cementation		40							
	8-inch diameter hollow stem auger refusal encountered at 43 feet, switched to ODEX drilling methods to continue boring		45		X	50/4"				
51.0		1491+/-	50		X	50/4"				
	POORLY GRADED GRAVEL WITH SAND (GP), trace clay, trace cobbles, fine to coarse sand, fine to coarse gravel, low plasticity, grayish brown to brown, very dense		55			50/1"				
63.0		1479+/-	60			50/1"				
	CLAYEY SAND WITH GRAVEL (SC), trace cobbles, fine to coarse sand, fine to coarse gravel, low to medium plasticity, brown, very dense, weak cementation		65		X	50/4"				
69.5		1472.5+/-			X	50/5"				

Boring Terminated at 69.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow Stem Auger and ODEX Drilling Methods

Abandonment Method:
Boring backfilled with Auger Cuttings Mixed With Cement and Capped With Asphalt Cold Patch

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

Elevation obtained from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

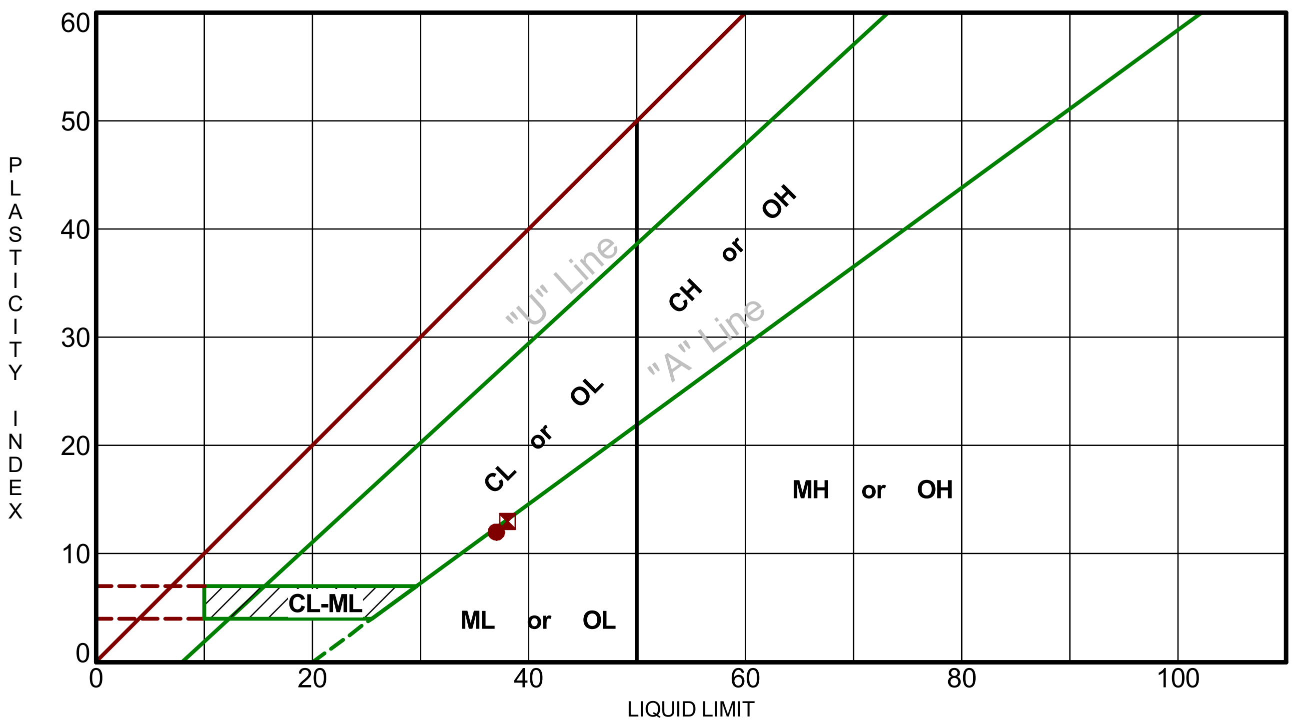
Groundwater not encountered

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

Boring Started: 02-16-2022	Boring Completed: 02-17-2022
Drill Rig: CME 75	Driller: Wildcat Drlling Inc.
Project No.: 65215143	

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	0 - 5	37	25	12	42.6	GM	SILTY GRAVEL with SAND
⊠	B-1	14 - 15	38	25	13	10.6	SW-SM	WELL-GRADED SAND with SILT and GRAVEL

PROJECT: Proposed Lift Station 66 Biofilter

SITE: 30101 Black Canyon Highway
Phoenix, Arizona

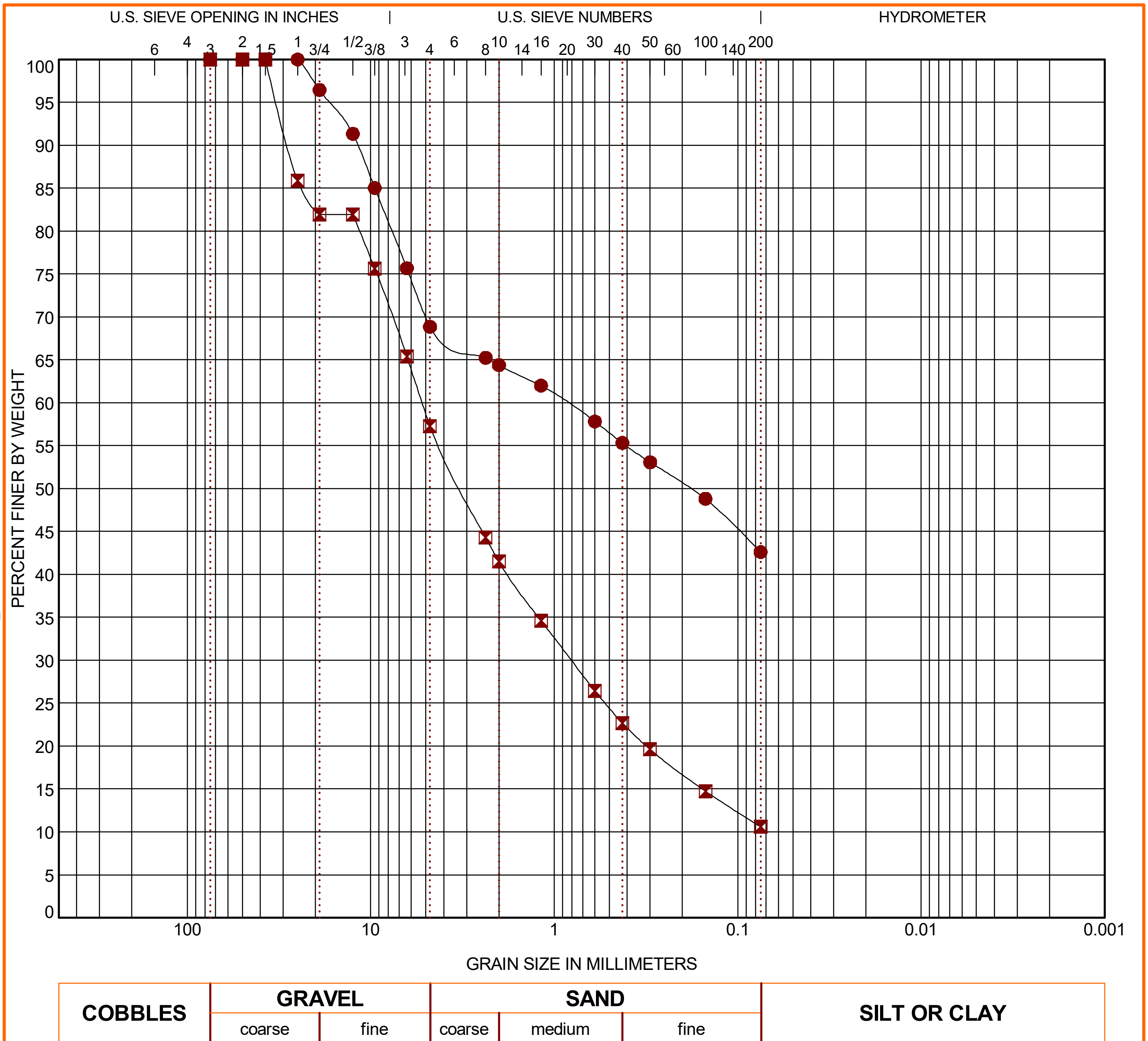
Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

PROJECT NUMBER: 65215143

CLIENT: Garver
Tempe, Arizona

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth (Ft)	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-1	0 - 5	SILTY GRAVEL with SAND (GM)		37	25	12		
⊠	B-1	14 - 15	WELL-GRADED SAND with SILT and GRAVEL (SW-SM)	4.6	38	25	13	1.82	77.02

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-1	0 - 5	75	0.854			0.0	31.1	26.3		42.6	
⊠	B-1	14 - 15	75	5.232	0.805		0.0	42.7	46.7		10.6	

PROJECT: Proposed Lift Station 66 Biofilter

PROJECT NUMBER: 65215143

SITE: 30101 Black Canyon Highway
Phoenix, Arizona

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

CLIENT: Garver
Tempe, Arizona

SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity				Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits LL	PL	PI	Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI 50	pH	Resistivity (ohm-cm)	Sulfates (ppm)	Chlorides (ppm)	
B-1	0.0 - 5.0	GM			43	37	25	12						8.5	1275	5	29	
B-1	2.0 - 3.0	GM	95	16														1, 2
B-1	4.0 - 5.0	GM	115	7														1, 2
B-1	9.0 - 9.2	SW-SM		10														2
B-1	12.0 - 12.3	SW-SM		10														2
B-1	14.0 - 15.0	SW-SM	120	5	11	38	25	13										1

REMARKS

1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4829-95.
5. Air-Dried Sample

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