Geotechnical Engineering Evaluation

BioGas Utilization Project

4901 E. Ina Road
Pima County, Arizona

Pattison ➢ Evanoff ➢ Engineering, LLC
Project No. 13-008

Geotechnical Engineering

Construction Inspection

Materials Testing

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Construction Inspection
Materials Testing

March 8, 2013

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GEOTECHNICAL ENGINEERING EVALUATION
BioGas Utilization Project
4901 E. Ina Road
Pima County, AZ

Project Number 13-008

We have completed the geotechnical evaluation for the proposed BioGas Utilization Project. Our project study results are attached.

In our opinion, the site's subsurface soil conditions can be made suitable for the proposed development provided the report's recommendations are followed. Our evaluation showed sands with varying amounts of silt and clays. Underlying the surface soils we generally found clay, sand/silt, or sand/clay mixtures. Development of the site is influenced by the presence of collapsible soils. The soil conditions and specific recommendations are presented in the report.

We are available for consultation during the various design stages. When more detailed building and equipment information is known, we should be consulted for possible supplemental recommendations. Structural loads, final grades, equipment loads and dynamics, and locations of other perimeter elements may necessitate alternative recommendations for appropriate support. To provide continuity of geotechnical services, we should perform construction observation and testing.

We thank you for selecting PATTISON EVANOFF ENGINEERING, L.L.C. and look forward to being a member of your team on the remainder of this project. If you have any questions about this report, or require additional consultation, please call us.

Sincerely,
PATTISON ➢ EVANOFF ➢ ENGINEERING, L.L.C.
Geotechnical, Construction Inspection, and Materials Testing Services

Registered Professional Engineer (Civil) CERTIFICATE NO 47658 FRANCISCO J. JACINTO Date Signed 3-8-13 ARIZONA U.S.A. Expires 03/31/2014

Registered Professional Engineer (Civil) CERTIFICATE NO 22185 JAMES W. EVANOFF, JR. DATE SIGNED 3-8-13 ARIZONA U.S.A.
Expires 9-30-14

Francisco J. Jacinto, P.E.
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INTRODUCTION

This report presents the results of our geotechnical engineering services for the BioGas Utilization Project located at 4901 E. Ina Road. The site is in Section 1, Township 13 South, Range 12 East, of the Gila and Salt River Meridian, in Marana, Arizona. The Site Plan in the Appendix shows the location of the site.

We obtained information on site conditions, performed field and laboratory testing, and performed geotechnical engineering analyses. This report presents our conclusions and recommendations regarding the engineering properties of the soils encountered and their relationship to the proposed development. Specifically, the report addresses the following information:

- General site and subsurface conditions encountered during our evaluation.
- Recommendations and design criteria for foundation systems, including allowable bearing capacity, lateral earth pressures and estimated settlements.
- Recommendations for support of concrete floor slabs.
- Recommendations for grading requirements, including site and building area preparation, fill placement, and suitability of existing soils for fill.

The Appendix contains the results of the field explorations and tests and provides a site plan showing the exploration locations.

Project Information

A structure ranging between 30,000 and 50,000 square-feet is planned for this site. Specific design details have not yet been developed. We understand that the structure will likely use steel-frame construction and have concrete slab-on-grade floors. We have not been given structural details, but expect that maximum wall and column loads will be less than 6 klf and 300 kips, respectively. We also understand that the building or portions of the site could contain specialized equipment, machinery, vessels, and other apparatus that could require separate specialized foundations. We have not been provided with a grading plan, but because the site is generally flat, we assume that finished grades will be at or near existing grades. At this time, subsurface building levels such as basements or vaults are not expected, although our explorations extend to depths that will probably enable development of recommendations for such elements if needed. Currently, we are unaware of any special or unusual equipment or features such as retaining walls, major screen walls, or off-site elements. Depending on the final development concepts and plans, additional evaluations may be necessary to provide appropriate ground support.

Evaluation and Testing

To obtain information on the conditions at this site and to determine applicable soil properties, we completed an on-site evaluation. The extent of our evaluation and testing programs is described in the following section.

- **Field Evaluation**

  Pete Moreno, a Field Specialist with our firm, reviewed the site to obtain information on the general surface conditions. He also observed the excavation of 4 borings to depths between 31 and 41.5 feet below existing site grade. The site plan shows the approximate exploration locations. The Appendix contains logs of the subsurface conditions encountered at the explorations.

  During the field exploration, the subsurface conditions were described and the encountered soils were visually logged and sampled. We used the Unified Soil Classification System to classify soils. The soil classification symbols appear on the exploration logs and are briefly described in the Appendix.

- **Laboratory Evaluation**

  We performed laboratory analyses on soil samples to aid in material classification and estimate pertinent engineering properties of the on-site soils. We performed the tests in general accordance with applicable ASTM specifications. The Appendix contains our laboratory test results.

FINDINGS

Site Conditions

The site is currently located within the Pima County Wastewater Facility. There are several structures located throughout the site. The topography of the site was generally flat with poor to fair surface drainage developing as sheet flow to the west.

Subsurface Conditions

The natural soils we encountered are interbedded alluvial deposits that are likely mostly associated with flood-plain episodes of the nearby Santa Cruz River. Some area deposits are undoubtedly associated with tributary drainages that flowed toward the Santa Cruz. Our evaluation showed sands with varying amounts of silt and clays. Underlying the surface soils we generally found clay, sand/silt, or sand/clay mixtures. Localized zones of carbonate cementation were encountered at Boring 4 at depths of about 25 feet.

Soil moisture contents were low to moderate at the time of our field evaluation and no free groundwater was encountered in any of the explorations. The groundwater conditions at the time of our evaluation represent only the conditions at the time of exploration. Groundwater levels can and often do fluctuate for various reasons including variations in precipitation, evaporation, surface runoff, and regional withdrawal or recharge. The logs in the Appendix show details of the subsurface conditions encountered during the field evaluation.

Conclusions

In our opinion, the site's natural subsurface soil and conditions can be made suitable for support of the proposed development provided the designers, contractors, and owners follow the report recommendations. Our conclusions regarding the soils and planned development are given in the following discussion.

- **Compressive Properties**

  At their existing moisture contents, the natural soils are expected to have low to moderate compressive potentials. However, at increased moisture contents a significant amount of the surface soils show moderate to moderately-high additional compression or *collapse*. Therefore, these surface soils will require special preparations to reduce the potential for settlement of overlying construction. Most commonly these preparations involve stripping and recompacting the soil which breaks down the moisture-sensitive bonds and creates a more stable soil structure.

  Without appropriate design and site preparation, the structures could experience significant differential settlement. We expect that total settlement of the proposed structure, supported as recommended, will be less than 1 inch. Differential settlement should be approximately half of the total settlement. Most settlement is expected to occur soon after construction, although additional foundation movements could occur if water from any source infiltrates the underlying soils.

  The estimated differential soil movements stated above are based on the typical climatic conditions and proper site drainage conditions. The engineered fill will mitigate, but not eliminate, the potential for additional settlement if the soils below the engineered fill become wet. Accordingly, creating and maintaining positive drainage of surface water away from the structures is imperative. Additional significant movements are possible if the underlying soils increase in moisture from other water sources such as inadequate, damaged, or obstructed subdrains, water or sewer line leaks, irrigation leaks, excessive irrigation, etc.

- **Expansive Properties**

  The existing clay soils have a moderately low remolded expansive potential. Special preparations or construction details related to swelling pressure or heave are not currently considered necessary. **Because the degree of expansiveness and thickness of expansive soil can vary considerably at this site, the earthwork must be carefully monitored by experienced personnel supervised by a Geotechnical Engineer**. The contractor should notify the Geotechnical Engineer if the soil conditions vary significantly from those shown in this report or if there are any questions regarding the type of soil or its condition.

- **Existing Fill/Construction**

  Because of the existing development, it is highly possible that fill will be encountered. We are unaware of records of compaction for any fill at this site, therefore we currently consider any encountered during construction to be uncontrolled and unsuitable for support of structures without first stripping and recompacting. Additional field evaluations would be required to delineate the vertical and lateral extents of the possible existing fill, if desired.

RECOMMENDATIONS

General

All structural elements will experience at least some differential movement and the various components must accommodate this potential. We recommend that you have the Architect, Structural Engineer, Civil Engineer, Landscape Architect, Landscaper, and any other design team member read this report and consider our comments. The basis for our comments on foundation and slab design details is primarily our experiences with recurring problems associated with many of these items.

In the following section, we provide recommendations for the supporting system that we currently believe is appropriate for the construction conditions. We do not intend to provide recommendations that prevent all undesirable effects resulting from structural movements. We intend to provide reasonable solutions to help control effects the soil may have on the structure. **Structural or equipment loads greater than 300 kips or horizontal or bending loads may require alternative foundations such as mats or deep foundations such as drilled shafts or driven piles.**

Shallow Conventional Foundations

The proposed structure can be supported by conventional shallow, spread foundations bearing ***exclusively*** on engineered fill provided the recommendations presented in our report are followed. Engineered fill should be constructed according to the recommendations given in the ***Earthwork*** section of this report. The supporting system may consist of continuous wall footings and independent spread footings and slabs-on-grade. Monolithic foundations and slabs may be used provided they are properly designed and constructed.

Subgrade preparation, any subbase fill, and backfill should be constructed according to the recommendations given in the ***Earthwork*** section of this report. The underlying natural soils could experience additional settlement if subjected to significant or prolonged moisture increases. The potential differential movement is a function of the depth and lateral extent of wetting of the supporting soils. It is extremely important, therefore, that precautions be taken in design and construction preparations to minimize the potential for moisture increases (from any source) beneath the structures.

The following table presents alternative foundation depths and allowable bearing pressures:

Footing Depth Below Finished Grade, ft.[1]	Allowable Bearing Pressure, psf[2]
1	1700
1.5	2200
2	2800
2.5	3400

1 Finished grade is the lowest adjacent grade for perimeter footings and floor level for interior footings.

2 Allowable bearing pressures depend on compliance with the Earthwork recommendations of this report.

Footings should have minimum widths of 12 inches for walls and 24 inches for columns. Governing building codes may require greater widths. A one-third increase in the bearing pressures is allowable for transient wind or seismic loads. The bearing values given are net bearing values so the weight of the concrete in the footings may be ignored.

Foundations adjacent to descending slopes should be setback at least 3 feet, horizontally, from the top of the slope. Additionally, an imaginary line extending downward at 45 degrees from a foundation edge should not intersect the slope face.

All footings, stemwalls, pedestals, and masonry walls should be reinforced to reduce the effects of potential differential movements. If foundations and adjacent slab sections are completed monolithically, we suggest that reinforcement also extend into the slabs to help minimize the possibility of longitudinal cracking along the wall. We suggest continuous reinforcement through these areas because we frequently see cracks in the slab portions of monolithic construction that parallel the foundations.

The Geotechnical Engineer or his representative ***must*** observe the site preparations and foundation excavations. The purpose of this review would be to determine if the soils and conditions are similar to those expected for support of the footings. Any soft, loose or unacceptable soils should be properly compacted and may require additional undercutting.

Floor Slabs

Floor slabs should be supported on properly prepared subgrade and base course. The contractor should prepare the subgrade, engineered fill and base course as outlined in the ***Earthwork*** section of this report. For lightly loaded slabs, a minimum 4-inch layer of base course should be provided beneath all slabs to provide more uniform support and help prevent capillary rise and a damp slab.

The slab thickness, concrete strength, and reinforcing should be designed by a Structural Engineer. As a minimum, we suggest that slabs supporting typical *light* loads be at *least* 5 inches thick and reinforced with a minimum of No. 4 reinforcing steel placed every 24 inches on-center in both directions. As an alternative, we recommend using a synthetic micro or macro fiber additive to the concrete to aid in controlling cracks from drying shrinkage and thermal changes. By *light* loads, we mean those typical of office machines, appliances, furniture, people, and other equipment and supplies resting on the slab. Loads from heavy or vibrating machinery, heavy storage racks, freezers, and such, will likely require a thicker slab, additional base course, or additional reinforcing.

We believe using reinforcing steel in slabs is beneficial for minimizing cracks and strengthening the cross-section in the event tensile or flexural stresses develop. Reinforcement should be positioned as near the mid-height of the slab as possible while maintaining codes. To provide stress relief and help eliminate random cracking, we suggest providing control joints at spacings less than 12 feet. Wider joint spacings are possible depending on the slab thickness, absence or presence of reinforcing, concrete mix design, the inclusion of synthetic fibers, and the curing environment. The joint locations should be determined by the Structural Engineer. Joint locations should be developed considering such items as shrinkage potential, slab thickness, curing, fixed element restrictions, slab penetrations, type of floor covering, and specialized equipment placement.

We assume that most of the building will contain activities of a light-industrial nature and will have exposed concrete floors. We suspect that there will also be activities and equipment that can impart impact and abrasion to the floors. For these reasons, and depending on the owner's specifications, we encourage you to evaluate the benefits of some of the modern additives and admixtures available today in addition to practical construction and curing techniques that can provide a more durable floor.

For single-course floors subject to heavy loads, you should especially *consider* the following:

- Special attention to providing a well-compacted, uniform base course. This can reduce subgrade drag during drying.
- Specifying the largest coarse aggregate available in consideration of the thickness, form dimensions, and reinforcing minimum clear distance. Larger aggregate allows less paste which will result in less shrinkage and curling. As an example, increasing aggregate size from ¾ inch to 1 ½ inch can reduce drying shrinkage by up to 25 percent.
- Joint layout and concrete placing sequence. The use of synthetic structural macro fibers could allow greater joint spacings and in some cases eliminate joints. If heavy loads are expected to travel over construction joints, dowels are recommended to help transfer loads. Diamond dowels are preferable because they allow movement in all directions. Proper dowel support should be provided during placement and finishing so that they remain in position. Keyed joints should not be used as they are generally not effective for load transfer. Very often, the more efficient way to place concrete in large areas is in long alternating strips. ACI recommends against using the checkerboard sequence of placement. Early-entry saws are recommended for cutting joints.
- Impact and abrasion resistance can be improved in a number of ways. Structural synthetic macro fibers or mineral or iron aggregates or pellets could be added to the concrete mix. Special metallic or mineral surface hardeners or shakes could be included. Such additives or toppings could be included for specific areas where there is a concentration of impact activities. Additionally, the surface finish of heavy duty slabs should be hard trowelled.
- Especially if reducing the extent of cracks and minimizing joints are desired, the use of shrinkage compensating concrete could be considered.

The proper curing of concrete, especially for flatwork (slabs), is extremely important in minimizing plastic shrinkage cracks and slab curling. We believe that many slab cracking problems can be mitigated or even eliminated by proper curing. We strongly suggest moist-curing slabs for at least a week after placement. Curing promotes more complete hydration of the cement and reduces plastic drying shrinkage, especially near the exposed upper portion of the slab. Alternatively, moist-curing for several days and then applying a liquid membrane curing compound would also be beneficial. Also important are the mix design and quality control during construction.

All concrete placement and curing operations should follow recommendations of the American Concrete Institute manual. Improper curing and excessive slump (water-cement ratio) could cause excessive shrinkage, cracking, or curling of the concrete. Concrete slabs should be allowed to cure adequately before placing vinyl or other moisture-sensitive floor covering. To prevent incomplete bonding, distortion, and water vapor entrapment, flooring should not be placed until the moisture content of the slab is at or below the manufacturer's requirements.

Seismicity

The project site is in the southeast corner of the Sonoran Seismic Source Zone, as defined in ADOT's 1992 Report No. AZ92-344, *Development of Seismic Acceleration Contour Maps for Arizona*. This zone is characterized as being tectonically stable with relatively few historic seismic events. This site has a 90% probability of not exceeding horizontal acceleration at bedrock of 0.03g in 50 years and 0.08g in 250 years. Additionally, there is a 90% probability that horizontal velocities at bedrock of 1.2 inches/second and 2.4 inches per second will not be exceeded in 50 and 250 years respectively. We recommend using a Site Class designation of D for seismic analyses using the 2012 International Building Code.

Lateral Earth Pressures

For cantilevered or restrained (at-rest case) walls or foundations above any free water surface with level backfill and no surcharge loads, the recommended equivalent fluid pressures and coefficients of base friction are presented in the following table.

EARTH PRESSURE STATE		EQUIVALENT FLUID PRESSURE, psf/ft
Active		
	Undisturbed Native Soil	33
	Granular Backfill	30
Passive		
	Undisturbed Native Soil	350
	Granular Backfill	450
At-rest (restrained)		
	Undisturbed Native Soil	53
	Granular Backfill	50
Coefficient of Base Friction = 0.40*		

* For short retaining walls with minimal cover on the outside face, the coefficient of base friction should be reduced to 0.35 when used in conjunction with passive pressure.

We do not expect submerged soil conditions; the lateral earth pressures shown therefore, do not include this condition. We should be consulted for additional recommendations if submerged conditions are to be included in the design. Any surcharge from adjacent loading will also increase the lateral pressure and must be added to the above earth pressures.

The contractor should use granular, relatively free-draining soil for retaining wall backfill to reduce the potential for hydrostatic pressure buildup. Retaining walls should be designed with a backdrain that either drains to lower ground or to a sump with a float-activated pump. The level of this drain should be lower than the lowest retained earth behind the wall; the perforations in the drain pipe should be at least 8 inches lower than the top of any interior slabs in front of the wall.

Moderate to high plasticity clay soils should not be used as backfill against retaining structures. Properly place and compact all backfill as recommended in this report. Cobbles, if present, should be removed from the soils placed adjacent to walls so high-intensity point loads do not occur. Avoid nesting of larger particles because voids could form and cause subsidence of the backfill.

Waterproof the exterior face of below-grade walls that are exposed to interior spaces to retard moisture penetration. It is important that all backfill be properly placed and compacted. Mechanically compact all backfill in layers. Water settling or flooding is not acceptable. Care should be taken to avoid damaging the walls when placing the backfill. Backfill should be inspected and tested during placement and compaction, especially if there will be overlying elements supported by the backfill such as foundations, stairs, walls, and planters.

Exterior Features

Exterior slabs-on-grade, exterior architectural features, and utilities may experience some movement due to the volume change of the underlying soils. The potential for movement and resulting distress could be reduced by the following measures:

- Minimizing moisture increases in the soil
- Moisture-density control during placement of soil
- Use of designs which allow vertical movement between the exterior features and adjoining structural elements
- Placement of effective control joints on relatively close centers
- Allowance for vertical movements in utility connections

Exterior concrete slabs may be supported on properly placed and compacted engineered fill. The contractor should prepare the slab subgrade and subbase fill as outlined in the ***Earthwork*** section of this report. Exterior slabs adjacent to the building or other structural elements should be sloped such that surface water is drained positively away from the structures. Surfaces adjacent to the slabs should also be positively sloped so that water does not pond adjacent to the slabs. Exterior patios or walkways using proprietary materials or formulations, such as resin- or epoxy-based soil or rock mixtures should be constructed in accordance with the suppliers recommendations for the specific site conditions.

Corrosivity

Soluble salt concentrations, including chlorides and sulfates, in the sampled natural soils are relatively high, indicating a generally corrosive environment. Concrete in contact with native soils should be made using either Type II cement with a minimum 6- sack-per-cubic-yard mix and a water-cement ratio less than 0.5 or with Type V cement. Concrete in contact with approved imported fill of low mineral soluble salts content (less than 0.10%), can use Type II cement.

Because of the elevated corrosive conditions in the subsoils, corrosion of buried metal conduits could occur, especially with an increase in moisture. We recommend that special protection such as the following be considered.

1. Overexcavating of utility lines and backfilling with select materials.
2. Coatings
3. Cathodic protection
4. Utility ducts or tunnels

We suggest that a corrosion specialist be consulted for possible supplemental recommendations.

Retention/Detention Basins

Retention/detention basins should be setback from structures a distance of at least 15 feet or four times the designed maximum water depth, whichever is greater. Closer placement may be possible but would require special preparations or construction or both. Furthermore, a number of factors can affect the effective seepage rate of constructed basins, some of these include the following:

- natural variations in the soil types, cementation, structure, and density across the basin
- densification of the exposed bottom during grading
- water storage episodes prior to completion can deposit finer-grained soils that can retard the expected seepage rates substantially
- larger than expected storage requirements
- the types of erosion treatments within or near the basins
- lack of, or inappropriate, maintenance
- the formation of salts and other chemical soil-water alterations
- progressive reduction of the subsurface seepage rates.

Progressive reduction of the subsurface seepage rates is an inevitable consequence, even with regular removal of any fines deposited on the bottom. Water infiltrating the soils should be expected to carry fine particles. Over time, the fine particles will be filtered by the subsurface soils, filling pore space and retarding the rate of seepage. Because of the discussed uncertainties, as well as others, we suggest that such basins be designed conservatively.

Until permanent erosion protection measures are completed, such as landscaping, building construction, revetments, ground covers, and paving, temporary sediment-retention structures should be provided. Such facilities should be provided near the sediment source and preferably prior to entering drainage channels. The types of measures and locations of sediment retention structures should be determined by a study of the conditions present during construction.

Temporary Construction Excavations

Temporary unsurcharged construction excavations should be sloped or shored. Slopes should not be steeper than 1 to 1 (horizontal to vertical) in the natural soil. Slopes may need to be flattened depending on conditions exposed during construction. If there is not enough space for sloped excavations, shoring should be used.

Various shoring systems are possible; their selection and design, however, is beyond the scope of our current evaluation. The design of a retaining system is dependent on the construction method, the sequence of operations, and adjacent construction. The contractor's and designer's responsibilities for design and construction should be clearly defined. Exposed slopes should be kept moist (but not saturated) during construction. Traffic and surcharge loads should be at least 10 feet from the top of the excavation. All excavations should be completed in accordance with the most recent OSHA requirements.

Slopes and Soil Erodibility

Both cut and fill slopes should be 2 to 1 (horizontal to vertical) or flatter and should be covered as quickly as possible with grass or other covers such as mulch, rock mulch, or jute mesh to avoid unnecessary soil losses.

Slopes should be scraped or raked across the slopes (perpendicular to flow), unless they are *trackwalked*, to aid in providing greater infiltration rates of surface water. If the slopes are shaped by *trackwalking*, with tracked vehicles, they should be worked up and down as the tread imprints will create grooves parallel to the slope which will aid infiltration rates and trap seeds.

During construction, graded unprotected areas should retain as much natural vegetation as possible. Vegetation along the perimeters of graded areas should be left intact to control erosion and serve as a

sediment trap. Exposed soil areas should be sprinkled with water during construction to reduce transportation of soil by wind. If rains are anticipated during construction, flows over the disturbed areas can be minimized by diverting upslope surface water with berms or ditches.
Erosion will increase soil loss and could cause loss of support to structures and other facilities. Periodic maintenance and prompt repair of erosional features is important to prevent unnecessary soil losses. The effectiveness of erosion control should be evaluated after heavy or prolonged rains.

Surface Drainage

A major cause of soil-related damage to structures in this region is moisture increases in the supporting soil. It is therefore extremely important to provide positive drainage away from the structure, both during construction and throughout its life. Infiltration of water into utility or foundation excavations must be prevented.

Waterlines, sewerlines, and water-retaining features should be carefully tested and inspected for leaks prior to backfilling. Planters and other surface features that could retain water in areas adjacent to the structures should be eliminated, lined, or otherwise constructed so that accumulated water is discharged onto a positive gradient at least 5 feet from the structures. If lined planters are used, vegetation should be low water-demanding and irrigation should be carefully chosen and constructed to minimize moisture infiltration into the planter structure. Furthermore, if planters are used, they should be designed as water-tight structures.

Roof rainwater, water from cooling unit condensation, and water heater drains should also be discharged onto a positive, protected, gradient at least 5 feet from the structures. Roof water discharge should be designed so that it flows onto relatively impermeable, protected surfaces on a positive gradient away from the structures. Preferably, roof water should be contained within closed conduits and discharged onto positively-sloped hard surfaces or conducted to subsurface stormwater systems.

Municipalities often impose on-site "water-harvesting" requirements. The location and design of such facilities should be carefully considered to help avoid adverse impacts to surrounding soil-supported elements. We recommend that retained water be less than 6 inches in depth and that the water surface exceed a distance of 10 feet from structural elements. Furthermore, they should be designed to meter excess water accumulation to a positively drained and protected surface. Such harvesting areas are often positioned in parking lot landscape islands. While most would generally consider these areas less critical, even lightly-loaded areas such as pavements and curbs could suffer from differential movements resulting from excessively wetted soil. To the extent possible, they should be designed so that water levels are at least 5 feet laterally from pavement edges or curbs.

In areas where sidewalks or paving do not immediately adjoin the structures, protective slopes should be provided with a positive outfall, preferably of at least 3 percent, for at least 5 feet from structure's perimeter. Backfill against footings, exterior stemwalls, and in utility and sprinkler line trenches must be well compacted and free of all construction debris to minimize the possibility of moisture infiltration.

As previously stated, elements holding or transporting water near structural elements should use high-quality materials and high-quality control measures should be used during construction. All underground piping within or near water-retaining structures should be designed with flexible couplings so minor deviations in alignment do not cause damage. Any utility knockouts should be oversized to accommodate differential movements. Nearby irrigated areas upgradient and adjacent to the construction should be eliminated as much as possible or measures should be taken to intercept and divert water from the area.

We are aware of many pavement and exterior walkway settlement problems within developments. These settlements are often related to inadequate utility backfill compaction, both in primary trenches and subsequent connection-service trenches and the introduction of water. Oftentimes, dry utility trenches are located along road or walkways and outside of curb lines (hence not protected by pavement) where surface and irrigation water can infiltrate. Furthermore, connection services from the utilities are often loosely backfilled and frequently occur *within* drainage swales, conditions that increase the potential for water to infiltrate beneath the pavement and curbs. Inadequately compacted trenches, or even trenches backfilled with soils more permeable than the adjacent soils, can act as conduits for moisture migration. It is very important, therefore, to provide adequate testing and monitoring of all backfill. If possible, it is advisable to locate connection services beyond drainage swales.

Some drainage facilities, such as rock-lined drainage swales, often degrade over time and become inefficient or ineffective. Additionally, they are often just dumped into place and not shaped so as to properly receive and channelize water. We highly recommend that such porous swales not be constructed within 10 feet of the structures unless they have significant positive gradients and are constructed to efficiently receive and direct water. A more effective and desirable method would be to conduct water through closed conduits directly to a properly prepared discharge area.

Construction Review

The Geotechnical Engineer or his representative ***must*** observe the site preparations and foundation bearing conditions. The purpose of this review would be to determine if the soils and conditions are similar to those expected for support of the footings. Subgrade preparation and engineered fill construction supporting structural elements is considered *Special Inspection* and must be completed under the *continuous* supervision of the Geotechnical Engineer. Any soft, loose or unacceptable soils should be properly compacted and may require supplemental recommendations.

We recommend surveying the finished floor elevation of all slabs-on-grade and maintaining this record. In the event of future movement, this information could be extremely helpful in assessing the conditions and providing remedial measures.

EARTHWORK

General

Our recommendations for foundations and slabs supported on compacted fills or prepared subgrade depend on compliance with the recommendations presented in this section. Observation and testing of earthwork, supervised or performed by a geotechnical engineer, is necessary to assess compliance with these recommendations.

During our field evaluation we did not observe any underground facilities such as septic tanks, cesspools, basements and utilities. However, underground features could be present as a consequence of the existing nearby development.

Site Clearing

Strip and remove any existing fill, construction remnants, vegetation, debris, loose or wet soil and other deleterious materials from the building areas and at least 5 feet beyond. The contractor should remove any remnants from previous construction from the proposed building areas. If pipes and other underground structures are not removed, they may serve as conduits for subsurface erosion resulting in voids and possible settlement of overlying facilities. Over-excavated areas resulting from removal of underground facilities and unsuitable materials should be backfilled as recommended in this report. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction.

Excavation

Shallow excavations in the soils we encountered during our evaluation should be possible with conventional equipment. The speed and ease of excavating will depend on the type of grading equipment, the skill of the operators and the structure of the deposit. If more information regarding excavation is desired, we suggest a study using equipment similar to that expected for the actual construction. The information contained in this report is intended for design and preliminary estimating purposes. Contractors reviewing the report must draw their own conclusions regarding the types of equipment and methods required to complete the construction.

Building Pad Preparation for Conventional Foundation Systems

Foundations and slabs-on-grade shall bear exclusively on engineered fill. Existing fill within the building area, if encountered, should be entirely stripped, regardless of extent, and replaced as engineered fill. The contractor shall overexcavate the natural soils, as required, to provide the thickness of engineered fill shown in the following schedule.

BUILDING ELEMENT	REQUIRED ENGINEERED FILL
Continuous wall foundations	Equal to the width of the foundation; but not less than 4 feet
Column foundations	Equal to one-half the foundation length; but not less than 4 feet
Interior slabs	At least 2 feet

The amount of engineered fill shown in the above table is the minimum amount that shall be constructed beneath the base of foundations or slabs. The engineered fill should extend laterally beyond the footing edges at least 5 feet. Where exterior walks or slabs are present along the building, the engineered fill shall extend at least 2 feet beyond their edges. It may be more economical and convenient to construct the engineered fill to a uniform base elevation across the *entire* building pad area. If this is done, the required engineered fill should be referenced below the deepest foundation bottom.

After overexcavation has been accomplished, the contractor should scarify, moisten or dry as required, and compact the exposed soils to a minimum depth of 8 inches. This 8-inch depth may be included in the required depth of compaction below foundations and slabs. The contractor should prepare the subgrade and construct engineered fill in a manner resulting in *uniform* water contents and densities after compaction. The contractor shall place and compact at least four inches of base course beneath interior slabs to provide more uniform support and help prevent a damp slab. If a vapor retarder is used, the base course should be finished fairly smooth to help avoid puncturing of the membrane during placement of reinforcing and concrete.

The Geotechnical Engineer or his representative ***must*** observe the site preparations and foundation excavations. Subgrade preparation and engineered fill construction supporting structural elements is considered Special Inspection and must be completed under the *continuous* supervision of the Geotechnical Engineer. Any soft, loose or unacceptable soils should be properly compacted and may require additional undercutting.

Because the natural soils at this site can compress under changes in moisture content, water harvesting or retention/detention may affect structures and ground-supported elements, especially sidewalks, slabs, and pavements close to the basins.

Utility Trench Backfill

Utility trenches within and beyond the building pad should be made as narrow as possible to reduce the potential for settlement of overlying slabs and other structures. The practice of digging wide trenches for the convenience of plumbers and electricians should be avoided, unless such trenches are carefully backfilled in lifts compacted to 95 percent of Standard Proctor Maximum Dry Density according to ASTM D-698.

Materials

Imported soils and existing granular soils with *low* expansive potentials and all particles passing the 6-inch sieve may be used as fill material for the following areas:

- Foundation areas
- Interior slab areas
- Pavement areas
- Backfill

The clay or clayey soils may pump or become unworkable at moisture contents at or above optimum. Workability can be improved by scarifying the soils and allowing them to dry or by mixing with drier soils or lime or cement, if necessary. Initial lift placement and compaction may require the use of lightweight equipment to minimize subgrade yielding

Imported soils should conform to the following requirements:

IMPORT SOIL PROPERTIES	
SIEVE SIZE	**PERCENT PASSING, by dry weight**
6"	100
No. 4	50-100
No. 200	40 max.
Maximum Expansive Potential = 1.5%*	
Maximum Soluble Sulfates = 0.10%	

* Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about three percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

Aggregate base course below concrete floor slabs should conform to the following requirements:

AGGREGATE BASE COURSE	
SIEVE SIZE	PERCENT PASSING, by dry weight
1"	100
3/4"	90 to 100
1/4"	45 to 75
No. 200	2 to 10
Plasticity Index = 5 max.	
The sum of PI and percent passing 200 should be at least 5	

Placement and Compaction

The contractor should place and compact fill in horizontal lifts, 8 to 10 inches in loose thickness, using equipment and procedures that will produce the recommended moisture contents and densities throughout the lift. When lighter hand-held compaction equipment is used, the loose lift thickness should be 4 to 6 inches.

Materials should be compacted to the following standards. On-site soils and imported granular soils should be compacted at a moisture content near optimum. Depending on the actual soils and compaction equipment, compaction moisture contents may need to be changed to avoid or limit soil yielding or pumping.

Soil Type and Area	Minimum Percent Compaction, ASTM D-698
On-site subgrade soils, on-site soils as subbase fill, and imported soils*	
Below foundations	95
Below slabs-on-grade	95
Base Course below slabs	95
Nonstructural backfill, *not providing lateral or vertical support of structural elements*	90

* Fill 5 feet or more below finished grade should be compacted to at least 100 percent of ASTM D-698.

CLOSURE

Additional Services

Field observation and testing during construction, and reviewing the plans and specifications are integral factors in developing and implementing our conclusions and recommendations. Our involvement during construction is important to observe compliance with the design concepts, specifications, or recommendations, and to allow efficient design changes if the subsurface conditions differ from those anticipated. Pattison Evanoff Engineering, L.L.C. offers these services and is the most qualified to determine consistency of field conditions with the data used in our analyses. It is the client's responsibility to make this report available, in its entirety, to all design team members, contractors, and owners. **When more detailed building and equipment information is known, we should be consulted for possible supplemental recommendations. Structural loads, final grades, equipment loads and dynamics, and locations of other perimeter elements may necessitate alternative recommendations for appropriate support.**

Limitations

The services we performed for this project include professional opinions and judgments based on the data collected. We performed our professional services using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in southern Arizona. We do not intend to provide recommendations that prevent all undesirable effects resulting from structural movements. We intend to provide reasonable solutions to help control effects the soil may have on the structure. We make no other warranty, expressed or implied.

We prepared the report as an aid for the design of the project. This report is not a bidding document and any contractors reviewing it must draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

Our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater, or air, on or below or around, this site. All conditions documented or observed are strictly for the information of our client. If environmental information is required, we recommend that an environmental assessment be completed which addresses these concerns.

We based our recommendations on the assumption the soil and groundwater conditions across the site are similar to those encountered at the exploration locations. The extent and nature of subsurface soil and groundwater variations may not be evident until construction. If conditions encountered during construction appear to differ from those described in this report, we should be consulted to assess the impact and provide supplemental recommendations. Our evaluation and report does not include the effects, if any, of underlying geologic hazards or regional groundwater withdrawal and we express no opinion regarding their effects on surface movement.

APPENDIX A

Geotechnical Engineering

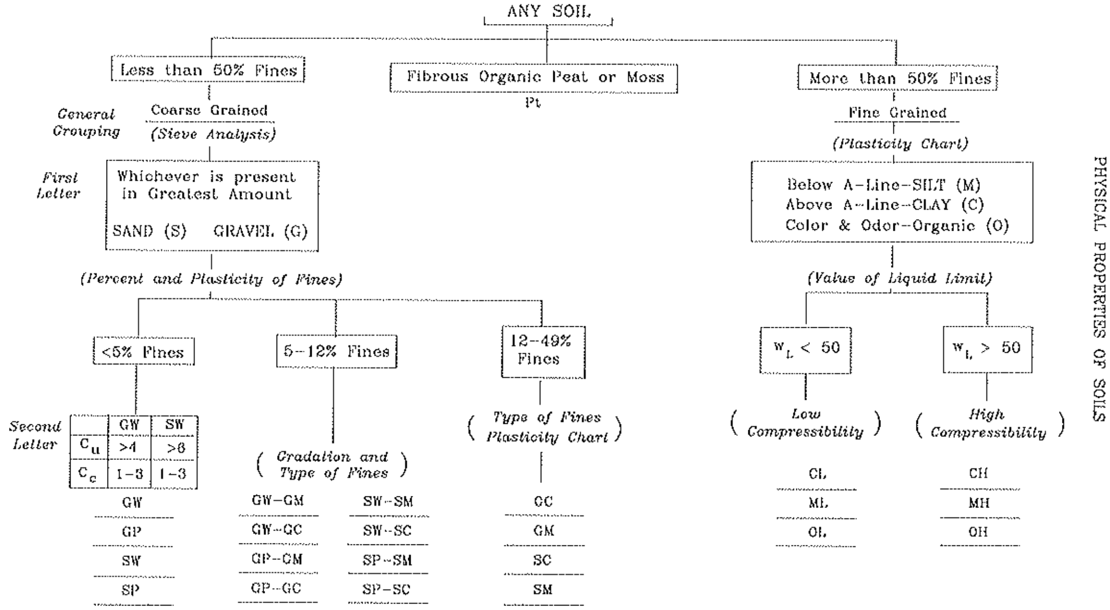
Construction Inspection

Materials Testing

PATTISON ➢ EVANOFF

ENGINEERING, LLC

UNIFIED SOIL CLASSIFICATION SYSTEM
CLASSIFICATION PROCEDURE

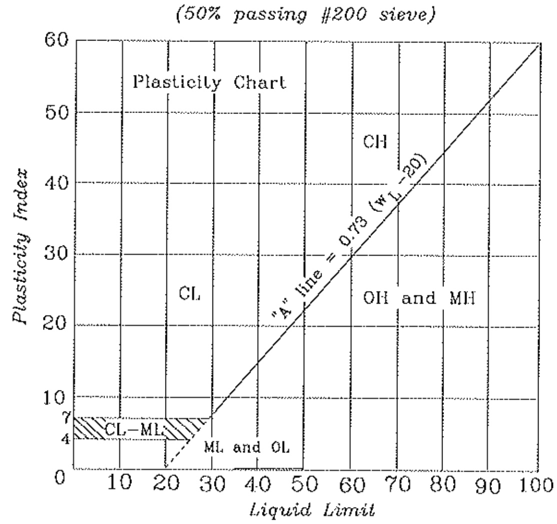


GRAIN SIZE CHART

CLASSI- FICATION	U.S. Standard Sieve Size
BOULDERS	Above 12"
COBBLES	12" to 3"
GRAVEL *Coarse* *Fine*	3" to No.4 3" to 3/4" 3/4" to No.4
SAND *Coarse* *Medium* *Fine*	No.4 to No.200 No.4 to No.10 No.10 to No.40 No.40 to No.200
SILT & CLAY	Below No. 200

FINE GRAINED SOILS

(50% passing #200 sieve)



L = low compressibility
H = high compressibility

Coarse Grained Scale

(50% retained on #200 sieve)

ADJECTIVE	%
trace	0-10
some	10-20
with	20-30
"-y" or "-ey"	30-50

P = poorly graded
W = well graded

P.I.	*ADJECTIVE*
< 1	non-plastic
1-10	low plasticity
11-25	medium plasticity
>25	high plasticity

The number shown in **Boring No.** refers to the approximate location of the same number shown on the **Site Plan** as positioned in the field by pacing from property lines and/or existing features.

The number shown in **Blows/6"** refers to the number of blows of a 140-pound weight dropped 30 inches, required to advance the sampler. **H** in **Sample Type** is a hand sample from the auger cuttings. **RS** in **Sample Type** is a 2.42-inch-inside-diameter ring sampler. Refusal to penetration for the ring sampler is considered more than 50 blows per foot. **SS** in **Sample Type** is a 2.0-inch-outside-diameter split-spoon sampler. This sampler is used to perform the Standard Penetration Test (SPT) ASTM D1586. Refusal to penetration is considered to be one of the following items: 1. A total of 50 blows has been applied during any one of the three 6-inch increments; 2. A total of 100 blows has been applied; 3. There is no observed advance of the sampler during application of 10 successive blows of the hammer.

USCS Code refers to the soil type as defined by the **Unified Soil Classification System.** The soils were visually classified in the field and, where appropriate, classifications were modified by visual examination of samples in the laboratory and by appropriate test.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans or as defining construction conditions.

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

In general, terms and symbols on the boring logs conform with **"Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics"** (ASTM D653).

PATTISON ➢ EVANOFF
ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER
B-1
SHEET 1 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks:
Flat, graded, 4" layer of 3/4" rock

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
H				0	SC-SM	SILTY, CLAYEY SAND; with gravel, dark brown, wet, medium dense, low plasticity		
RS	7 9	12/12		1–2			72	30.5
RS	7 8	12/12		5	SC	CLAYEY SAND; dark brown, slightly moist, medium dense, medium plasticity	97	12.6
RS	4 6	12/12		10		Loose		
RS	7 9	12/12		15		Moist to wet, medium dense	89	23.6
RS	7 10	12/12		20			98	9.3
RS	50/8	8/8		25		With gravel, decrease in clay, light brown, dry to damp, very dense		
				30				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

PATTISON ➢ EVANOFF
ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER
B-1
SHEET 2 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks:
Flat, graded, 4" layer of 3/4" rock

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
SS	13 17 22	18/8		30		Dense		
SS	15 17 6	18/3		35		Medium dense		
SS	50/3	3/0		40				
				40.3		BOTTOM OF HOLE AT 40.3 FEET *No Free Water Encountered*		

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

PATTISON ➢ EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-2**
SHEET 1 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks:
Flat, graded

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
H				0	ML	SANDY Silt; trace gravel, dark brown, moist, firm, low plasticity		
RS	5 6	12/12		2				
RS	6 5	12/12		5			93	11.7
RS	5 4	12/12		10		Dry to damp	92	3.3
				12	CL	SANDY CLAY; trace gravel, brown, moist, hard, medium plasticity		
RS	18 31	12/12		15			93	19.9
RS	50/ 10	10/10		20				
SS	8 7 7	16/16		25	SP-SM	SAND; trace silt, brown, damp, medium dense, non-plastic		
				30				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

PATTISON ➢ EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-2** SHEET 2 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks:
Flat, graded

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
RS	18 25	12/12		30		With gravel, dry to damp, medium dense		
				31		BOTTOM OF HOLE AT 31 FEET *No Free Water Encountered*		
				32				
				33				
				34				
				35				
				36				
				37				
				38				
				39				
				40				
				41				
				42				
				43				
				44				
				45				
				46				
				47				
				48				
				49				
				50				
				51				
				52				
				53				
				54				
				55				
				56				
				57				
				58				
				59				
				60				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

PATTISON ➢ EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-3**
SHEET 1 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract

Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks: Flat, graded

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
H				0	CL	SANDY CLAY; trace gravel, dark brown, moist, firm, low plasticity		
RS	5 3	12/12		2			70	8.1
RS	5 7	12/12		4–5	CL-ML	SANDY SILT; trace clay, dark brown, damp, firm, low plasticity	99	8.1
RS	6 8	12/12		10	SP-SM	SAND; trace silt, brown, damp, loose, non-plastic	96	5.1
RS	4 5	12/12		15				
RS	15 30	12/12		20	SC	CLAYEY SAND; brown, damp, medium dense, medium plasticity		
RS	14 20	12/12		25		Dense		
				30				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

PATTISON ➢ EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-3**
SHEET 2 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks:
Flat, graded

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
RS	21 21	12/12		30	SP-SM	SAND; trace silt and gravel, brown, dry to damp, medium dense, non-plastic		
				31				
				32				
				33				
				34				
RS	22 21	12/12		35				
				36				
				37				
				38				
				39				
SS	8 25 28	18/18		40		Very dense		
				41				
				42		BOTTOM OF HOLE AT 41.5 FEET *No Free Water Encountered*		
				43				
				44				
				45				
				46				
				47				
				48				
				49				
				50				
				51				
				52				
				53				
				54				
				55				
				56				
				57				
				58				
				59				
				60				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

PATTISON ➢ EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-4** SHEET 1 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks: Flat, graded, 4" layer of 3/4" rock

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
H				0	CL	SANDY CLAY; with gravel, brown, moist, stiff, medium plasticity		
RS	8 10	12/12		1–2			76	13.3
RS	4 4	12/12		5–6		Damp	79	7.7
RS	6 6	12/12		10–11	SC	CLAYEY SAND; brown, damp, loose, medium plasticity	84	5.3
RS	20 37	12/12		15–16		Dense		
RS	16 20	12/12		20–21		Light cementation		
RS	21 30	12/12		25–26		Moderate cementation		
				30				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

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Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-4**
SHEET 2 OF 2

Client: The Ashton Company

Project: Pima County Regional Wastewater Reclamation Department Job Order Contract

Location: 4901 E. Ina Road Pima, AZ

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: PM Date: 1/21/13
Subsurface Conditions or Remarks:
Flat, graded, 4" layer of 3/4" rock

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
RS	50/9	9/9		30				
				31		BOTTOM OF HOLE AT 30.75 FEET *No Free Water Encountered*		
				32				
				33				
				34				
				35				
				36				
				37				
				38				
				39				
				40				
				41				
				42				
				43				
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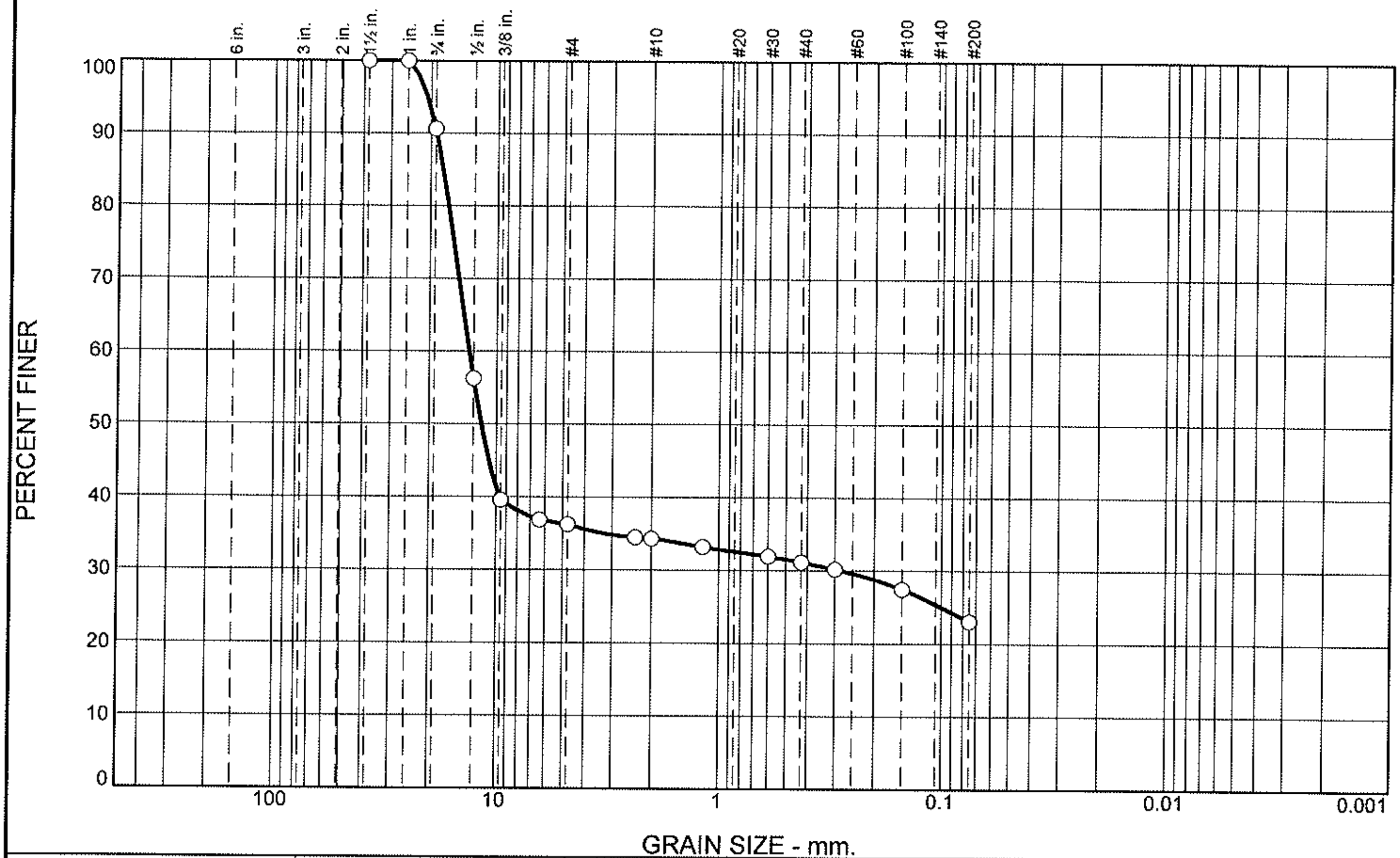
				53				
				54				
				55				
				56				
				57				
				58				
				59				
				60				

Sample Type Key:
- SS = Split Spoon
- RS = Ring Sample
- H = Hand Sample

Drilling Equipment:
CME 75 Drill Rig equipped with 6-5/8" OD x 3-1/4" ID hollow stem, continuous-flight auger

SIEVE TEST RESULTS



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	9	55	2	3	8	23	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1-1/2"	100		
1"	100		
3/4"	91		
1/2"	56		
3/8"	40		
1/4"	37		
#4	36		
#8	34		
#10	34		
#16	33		
#30	32		
#40	31		
#50	30		
#100	27		
#200	23		

* (no specification provided)

Material Description

SILTY, CLAYEY SAND; with gravel, dark brown, wet, medium dense, low plasticity

Atterberg Limits

PL= 27 LL= 31 PI= 4

Coefficients

D_{90}= 18.8616 D_{85}= 17.5778 D_{60}= 13.2721
D_{50}= 11.6892 D_{30}= 0.2822 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GM AASHTO= A-1-b

Remarks

Source of Sample: B-1 **Depth:** 0-1.5

Date: 3/8/13

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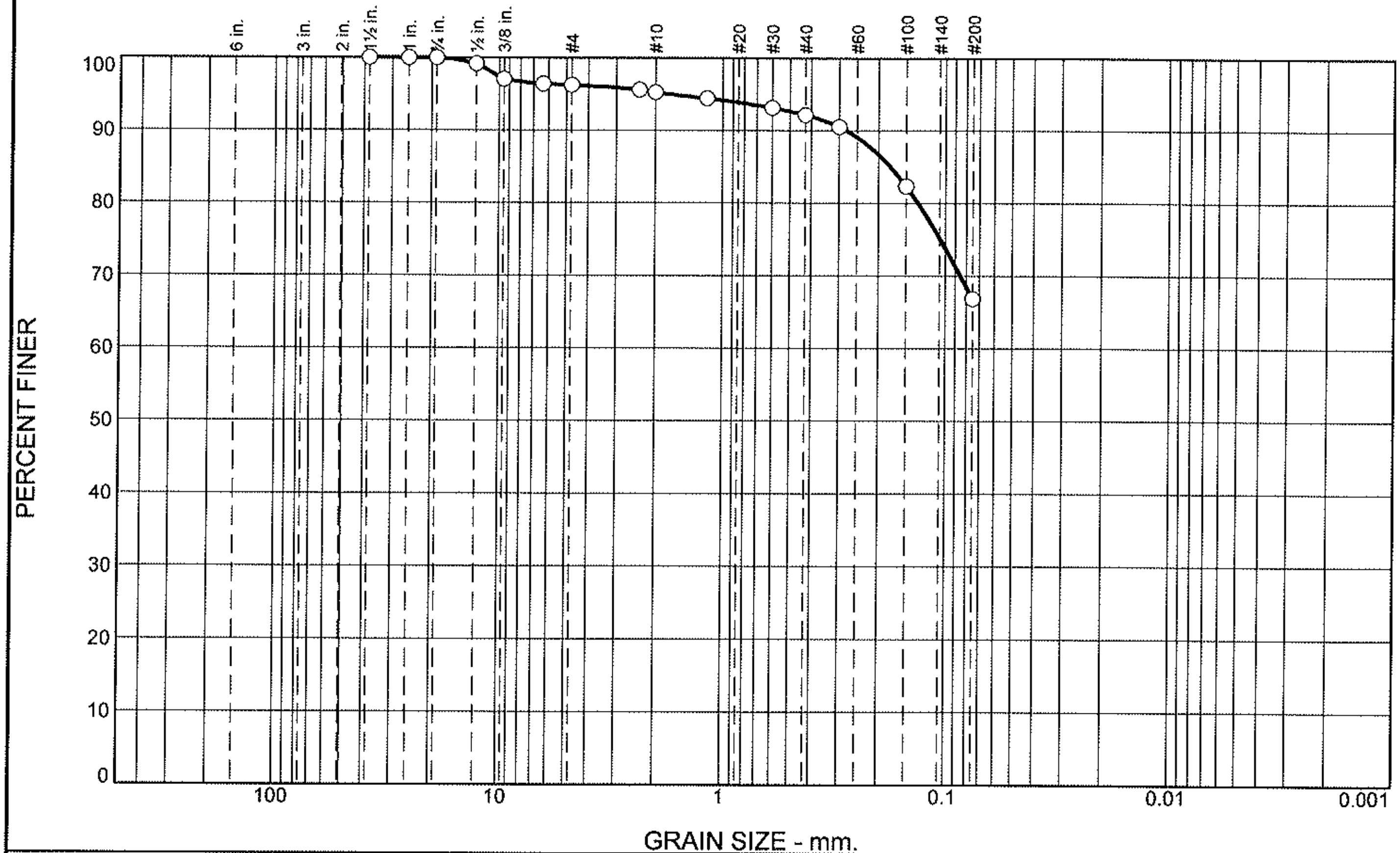
Geotechnical Engineering • Construction Inspection • Materials Testing

Client: The Ashton Company
Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Project No: 13-008 **Figure** A-11

Tested By: PM **Checked By:** FJ

SIEVE TEST RESULTS



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	4	1	3	25	67	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	99		
3/8"	97		
1/4"	96		
#4	96		
#8	96		
#10	95		
#16	94		
#30	93		
#40	92		
#50	91		
#100	82		
#200	67		

* (no specification provided)

Material Description

SANDY Silt; trace gravel, dark brown, moist, firm, low plasticity

Atterberg Limits

PL= 25 LL= 28 PI= 3

Coefficients

D_{90}= 0.2783 D_{85}= 0.1765 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(1)

Remarks

Source of Sample: B-2 **Depth:** 0-1.5

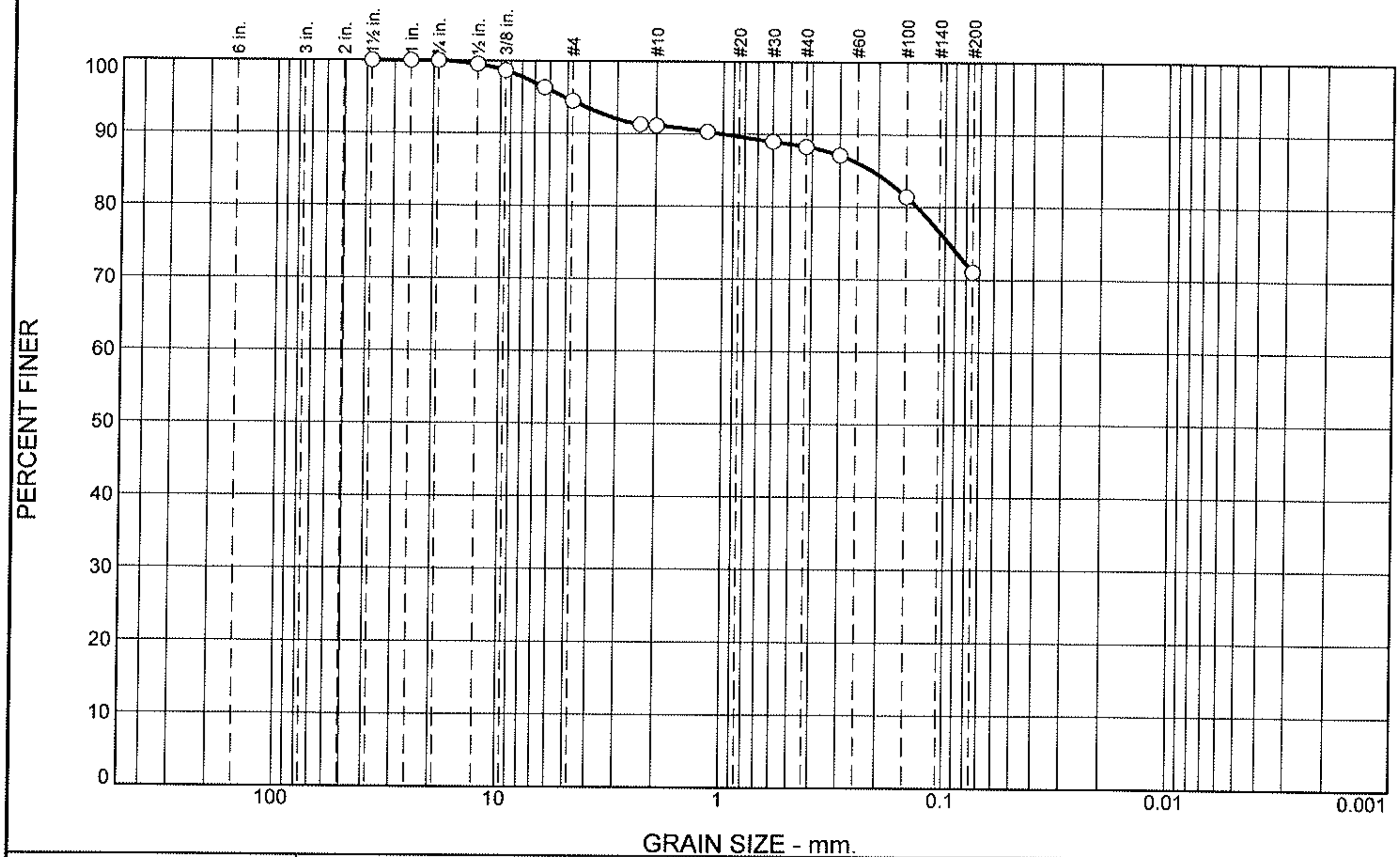
Date: 3/8/13

PATTISON ➢ EVANOFF ENGINEERING, INC.
Geotechnical Engineering • Construction Inspection • Materials Testing

Client: The Ashton Company
Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Project No: 13-008 **Figure** A-12

Tested By: PM **Checked By:** FJ

SIEVE TEST RESULTS



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	6	3	3	17	71	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1-1/2"	100		
1"	100		
3/4"	100		
1/2"	99		
3/8"	99		
1/4"	96		
#4	94		
#8	91		
#10	91		
#16	90		
#30	89		
#40	88		
#50	87		
#100	81		
#200	71		

* (no specification provided)

Material Description

SANDY CLAY; trace gravel, dark brown, moist, firm, low plasticity

Atterberg Limits

PL= 24 LL= 32 PI= 8

Coefficients

D_{90}= 1.0179 D_{85}= 0.2142 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(5)

Remarks

Source of Sample: B-3 **Depth:** 0-1.5

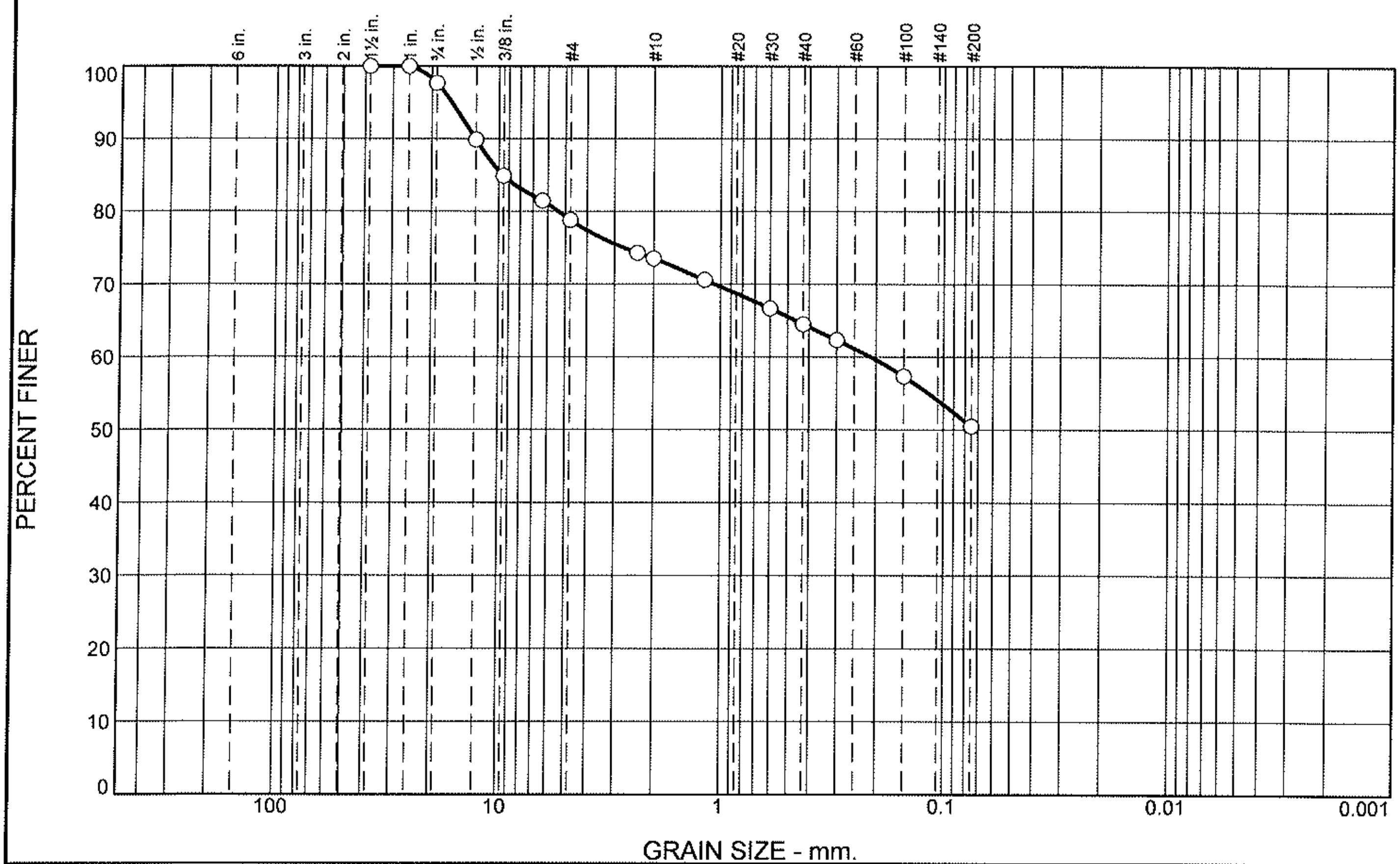
Date: 3/8/13

PATTISON ➢ EVANOFF
ENGINEERING, INC.
Geotechnical Engineering • Construction Inspection • Materials Testing

Client: The Ashton Company
Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Project No: 13-008 **Figure** A-13

Tested By: PM **Checked By:** FJ

SIEVE TEST RESULTS



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	19	5	9	15	50	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1-1/2"	100		
1"	100		
3/4"	98		
1/2"	90		
3/8"	85		
1/4"	81		
#4	79		
#8	74		
#10	74		
#16	71		
#30	67		
#40	65		
#50	62		
#100	57		
#200	50		

* (no specification provided)

Material Description

SANDY CLAY; with gravel, brown, moist, stiff, medium plasticity

Atterberg Limits

PL= 21 LL= 35 PI= 14

Coefficients

D_{90}= 12.7742 D_{85}= 9.6003 D_{60}= 0.2112
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(4)

Remarks

Source of Sample: B-4 **Depth:** 0-1.5

Date: 3/8/13

PATTISON ≻ EVANOFF ENGINEERING, INC.
Geotechnical Engineering • Construction Inspection • Materials Testing

Client: The Ashton Company
Project: Pima County Regional Wastewater Reclamation Department Job Order Contract
Project No: 13-008 **Figure** A-14

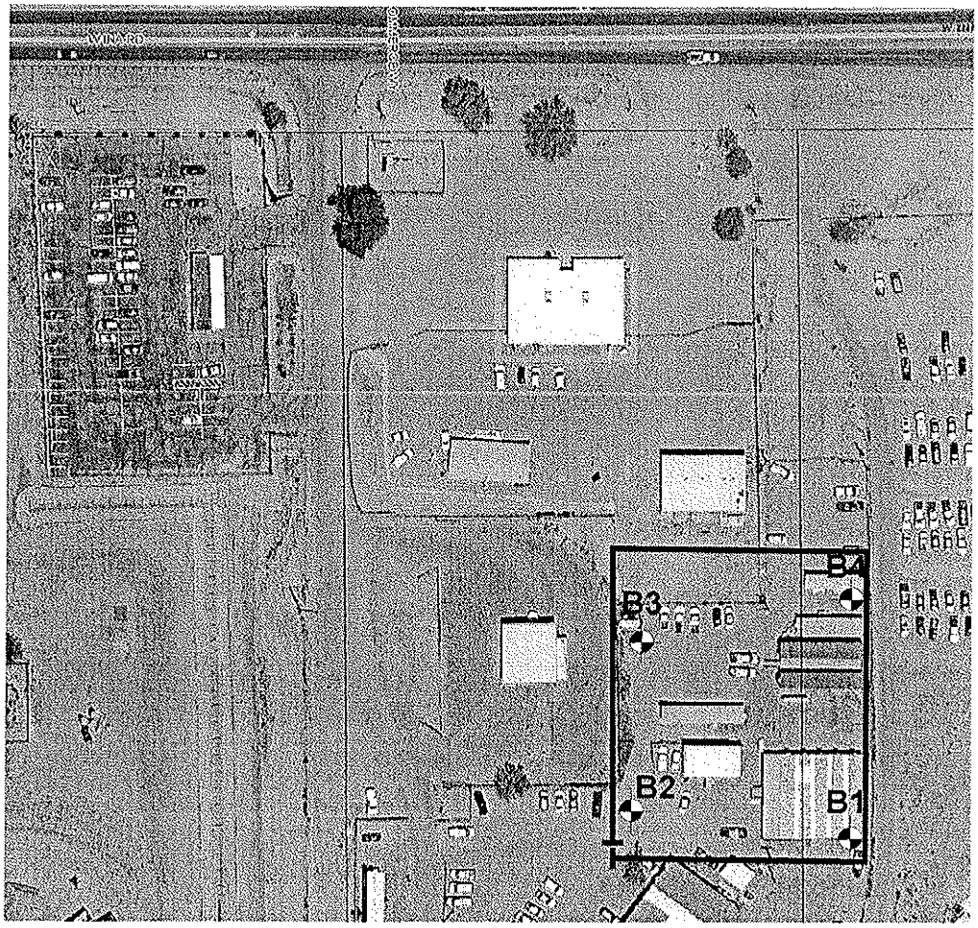
Tested By: PM **Checked By:** FJ

Boring No.	Depth, ft.	Initial Dry Density, pcf	Initial Water Content, %	Compression Properties		Expansion Properties	
				Applied Pressure, ksf	Total Compression, %	Applied Pressure, ksf	Total Expansion, %
1	1.5-2.5	72	30.5	1.0	8.8		
				2.0	10.3		
				4.0	12.8		
				4.0*	20.3		
1	5-6	97	12.6				
1	15-16	89	23.6	1.0	2.7		
				2.0	3.6		
				4.0	5.6		
				4.0*	6.1		
1	20-21	98	9.3				
2	5-6	93	11.7	1.0	2.8		
				2.0	4.4		
				4.0	4.6		
				4.0*	8.9		
2	10-11	92	3.3	1.0	0.5		
				2.0	0.8		
				4.0	1.3		
				4.0*	2.7		
2	15-16	93	19.9				
3	1.5-2.5	70	18.5	1.0	2.4		
				2.0	5.1		
				4.0	8.1		
				4.0*	20.3		
3	5-6	99	8.1				
3	10-11	96	5.1				
4	0-1.5	102**	15.1			0.1*	2.3
4	1.5-2.5	76	13.3				
4	5-6	79	7.7	1.0	2.0		
				2.0	3.2		
				4.0	4.3		
				4.0*	15.5		
4	10-11	84	5.3	1.0			
				2.0			
				4.0			
				4.0*			

* Sample Inundated With Water

** Sample remolded to approximately 95% of ASTM D698 at about 3% below optimum moisture

Sample Location	Depth, ft	Soil Class.	Liquid Limit	Plasticity Index	Percent Passing No. 200 Sieve
1	5-6	SC	55	22	34
2	15-16	CL	54	22	96
3	5-6	CL	30	6	94



BORING LOCATION

N

NOT TO SCALE

PATTISON ➢ EVANOFF ➢ ENGINEERING, L.L.C.

Geotechnical, Construction Inspection, and Materials Testing Services

SITE AND EXPLORATION LOCATION PLAN

BioGas Utilization Project
4901 E. Ina Road
Pima County, Arizona

Project No. 13-008	FJJ	6March13

APPENDIX B

Geotechnical Engineering

Construction Inspection

Materials Testing

PATTISON ➢ EVANOFF
ENGINEERING, LLC

February 14, 2013

TURNER
LABORATORIES INC.

Francisco Jacinto
Pattison-Evanoff Engineering
1129 N. Winstell
Tucson, AZ 85716

TEL (520) 881-1234
FAX (520) 881-4919

RE: Soil

Work Order No.: 13B0067
Order Name: Bio Generator 13-008

Dear Francisco Jacinto,

Turner Laboratories, Inc. received 1 sample(s) on 02/04/2013 for the analyses presented in the following report.

All results are intended to be considered in their entirety, and Turner Laboratories, Inc. is not responsible for use of less than the complete report. Results apply only to the samples analyzed. Samples will be disposed of 30 days after issue of our report unless special arrangements are made.

The pages that follow may contain sensitive, privileged or confidential information intended solely for the addressee named above. If you receive this message and are not the agent or employee of the addressee, this communication has been sent in error. Please do not disseminate or copy any of the attached and notify the sender immediately by telephone. Please also return the attached sheet(s) to the sender by mail.

Please call if you have any questions.

Respectfully submitted,

Turner Laboratories, Inc.
ADHS License AZ0066

Terri L. Garcia

Terri Garcia
Technical Director

Client: Pattison-Evanoff Engineering
Project: Soil
Work Order: 13B0067
Date Received: 02/04/2013

Order: Bio Generator 13-008

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Matrix	Collection Date/Time
13B0067-01	13-008 B-4 (0-1.5)	Soil	02/04/2013 0910

Client:	Pattison-Evanoff Engineering
Project:	Soil
Work Order:	13B0067
Date Received:	02/04/2013

Case Narrative

Turner Laboratories, Inc. is not licensed for the determination of resistivity, chloride, sulfate, fluoride, orthophospate, or sulfide in a soil matrix.

All soil, sludge, and solid matrix determinations are reported on a wet weight basis unless otherwise noted.

ND Not Detected at or above the PQL

PQL Practical Quantitation Limit

DF Dilution Factor

Client:	Pattison-Evanoff Engineering	**Client Sample ID:**	13-008 B-4 (0-1.5)
Project:	Soil	**Collection Date/Time:**	02/04/2013 0910
Work Order:	13B0067	**Matrix:**	Soil
Lab Sample ID:	13B0067-01	**Order Name:**	Bio Generator 13-008

Analyses	Result	PQL	Qual	Units	DF	Prep Date	Analysis Date	Analyst
Anions by Ion Chromatography-E300								
Chloride	910	100		mg/Kg	10	02/11/2013 0845	02/11/2013 1638	EW
Sulfate	1800	500		mg/Kg	10	02/11/2013 0845	02/11/2013 1638	EW

Turner Laboratories, Inc.

Date: 02/14/2013

Client: Pattison-Evanoff Engineering
Project: Soil
Work Order: 13B0067
Date Received: 02/04/2013

QC Summary

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch 1302107 - E300										
Blank (1302107-BLK1)				Prepared & Analyzed: 02/11/2013						
Chloride	ND	10	mg/Kg							
Sulfate	ND	50	mg/Kg							
LCS (1302107-BS1)				Prepared & Analyzed: 02/11/2013						
Chloride	12		mg/L	12.50		96	90-110			
Sulfate	13		mg/L	12.50		103	90-110			
LCS Dup (1302107-BSD1)				Prepared & Analyzed: 02/11/2013						
Chloride	12		mg/L	12.50		96	90-110	0.2	20	
Sulfate	13		mg/L	12.50		101	90-110	2	20	
Matrix Spike (1302107-MS1)	**Source: 13B0286-02**			Prepared & Analyzed: 02/11/2013						
Chloride	13		mg/L	12.50	1.7	92	80-120			
Sulfate	18		mg/L	12.50	6.1	97	80-120			
Matrix Spike Dup (1302107-MSD1)	**Source: 13B0286-02**			Prepared & Analyzed: 02/11/2013						
Chloride	13		mg/L	12.50	1.7	91	80-120	1	10	
Sulfate	18		mg/L	12.50	6.1	95	80-120	1	10	

TURNER LABORATORIES INC.
2445 N. Coyote Drive, Suite 104
Tucson, Arizona 85745
(520) 882-5880
Fax: (520) 882-9788
www.turnerlabs.com

CHAIN OF CUSTODY/LABORATORY ANALYSIS REQUEST FORM

TURNER WORK ORDER # 13B0067 DATE 2/4/13 PAGE ____ OF ____

PROJECT NAME BIO GENERATOR # 13-008
CONTACT NAME Francisco Jacinto
COMPANY NAME Pattison Evanoff ENG.
ADDRESS 1129 N. Winstel BLVD. 85716
Tucson AZ PHONE 520 881-1234 FAX
SAMPLER'S SIGNATURE [signature]

CIRCLE ANALYSIS REQUESTED AND/OR CHECK THE APPROPRIATE BOX

SAMPLE I.D.	DATE	TIME	LAB I.D.	SAMPLE MATRIX*	NUMBER OF CONTAINERS	Base Neutrals 625/8270 ☐ Acids ☐	Volatile Organics 624/524.2/8260	TTHMS ☐ HAAS ☐	Pesticides 8081 ☐ PCB's 8082 ☐	NO_2 ☐ NO_3 ☐ TKN ☐	Oil and Grease Grav. 1664A ☐	TCLP Analysis VOA ☐ Semi-VOA ☐ Pest. ☐	Metals TCLP ☐ Dissolved ☐ RCRA8 ☐ Total ☐	Cyanide Total ☐ Amen. ☐ WAD ☐	SDWA-INORGANICS PRIMARY ☐ SECONDARY ☐	Coliform MPN ☐ Colilert ☐	pH ☐ Cl_2 ☐ Cl_2 ☐	COD ☐ TSS ☐ BOD ☐	Sulfates/chlorides			
13-008 B4(0-1.5)	2/4/13	9:00am		Soil	1														✓			

1. RELINQUISHED BY:	2. RECEIVED BY:
Signature: [signature]	Signature:
Printed Name: Pete Moreno	Printed Name:
Firm: Pattison Evanoff	Firm:
Date/Time: 2.4.13 9:39	Date/Time:

3. RELINQUISHED BY:	4. RECEIVED BY:
Signature:	Signature: [signature]
Printed Name:	Printed Name: Bob Villawel
Firm:	Firm: TURNER LABORATORIES, INC.
Date/Time:	Date/Time: 2/4/13 9:38

TURNAROUND REQUIREMENTS:
X Standard (approx. 10 days)*
___ Next Day ___ 2 Day ___ 5 Day*
___ Email Preliminary Results To:
* Working Days

REPORT REQUIREMENTS:
___ I. Routine Report
___ II. Report (includes DUP, MS, MSD, as required, may be charged as samples)
___ III. Date Validation Report (Includes All Raw Data) Add 10% to invoice

INVOICE INFORMATION:
Account ___ Y ___ N
P.O. #
Bill to:

SAMPLE RECEIPT:
Total Containers 1
Temperature 17.5
☐ Wet Ice NA ☐ Blue Ice

* LEGEND
DW = DRINKING WATER
GW = GROUNDWATER
SD = SOLID
SG = SLUDGE
SL = SOIL
ST = STORMWATER
WW = WASTEWATER

SPECIAL INSTRUCTIONS/COMMENTS:
Compliance Analysis: ☐ Yes ☐ No
ADEQ Forms: ☐ Yes ☐ No
Mail ADEQ Forms: ☐ Yes ☐ No

Custody Seals ☐
Container Intact ☑
COC / Labels Agree ☑

Preservation Confirmation ☑
Appropriate Head Space ☑
Received Within Hold Time ☑