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GEOTECHNICAL EVALUATION
PROPOSED TWO BOX CULVERTS
ALONG SAGUARO BLVD. & BAYFIELD DR.
FOUNTAIN HILLS, ARIZONA

FCDMC Contract No. 2011C020; Assignment No. 3
Kleinfelder Project No.: 138494

March 26, 2014

Prepared for:
Mr. Art Glover, P.E.
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2801 West Durango Street
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Reviewed By:
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Senior Principal Geotechnical Engineer

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March 26, 2014
Project No.: 138494

Mr. Art Glover, P.E.
Flood Control District of Maricopa County
Engineering Division
2801 West Durango Street
Phoenix, Arizona 85009

SUBJECT: Geotechnical Evaluation
Proposed Two Box Culverts
Along Saguaro Boulevard and Bayfield Drive
Fountain Hills, Arizona
FCDMC Contract No. 2011C020; Assignment No. 3

Dear Mr. Glover:

This report transmits the findings of our geotechnical evaluation for the proposed Two Box Culverts along Saguaro Boulevard and Bayfield Drive in Fountain Hills (Maricopa County), Arizona. Our services were performed in general accordance with the scope of services presented in our Proposal No. 137804\TEM13P0406R2, dated November 27, 2013. Kleinfelder's work was performed under our existing On-Call Contract No. 2011C020 with the Flood Control District of Maricopa County (FCDMC). This evaluation provides geotechnical recommendations for use during the design and construction for the proposed project.

We appreciate the opportunity to be of service on this project. If we can be of additional assistance as the design progresses, please do not hesitate to contact us.

Sincerely,

KLEINFELDER, INC.

Ramon Padilla, P.E.
Geotechnical Project Manager

Reviewed By:
Keith H. Dahlen, P.E.
Senior Principal Geotechnical Engineer

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1 INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical exploration for the proposed Two Box Culverts along Saguaro Boulevard and Bayfield Drive in Fountain Hills, Arizona. The approximate location of the site is shown on the Boring and Test Pit Location Map, Figure 1.

The exploration included site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. The purposes of this exploration were to provide information regarding the surface and subsurface soil conditions and general site geology, and to provide geotechnical recommendations for design and construction for the proposed Two Box Culverts and associated pavements.

The recommendations contained in this report are subject to the limitations presented in the 'Limitations' section of this report. In addition, as a member of ASFE (The Association of Engineering Firms Practicing the Geosciences), a brochure prepared by ASFE is included in this report. We recommend that all individuals using this report read the limitations along with the accompanying ASFE document.

1.2 PROJECT DESCRIPTION

We understand the project is in the early stages of design, and project plans showing structure and project details were not available at the time of this report. Based on the information provided, we understand the project includes replacing existing storm drain roadway crossings (comprised of multiple 60-inch diameter pipes) with box culverts at the intersection of Ashbrook Wash with Saguaro Boulevard and Bayfield Drive in Fountain Hills, Arizona. Saguaro Boulevard is a 5 lane roadway (2 lanes each way and 1 middle turn lane) classified as a minor arterial roadway; and Bayfield Drive is a 2-lane roadway (1 lane each way) classified as a local roadway.

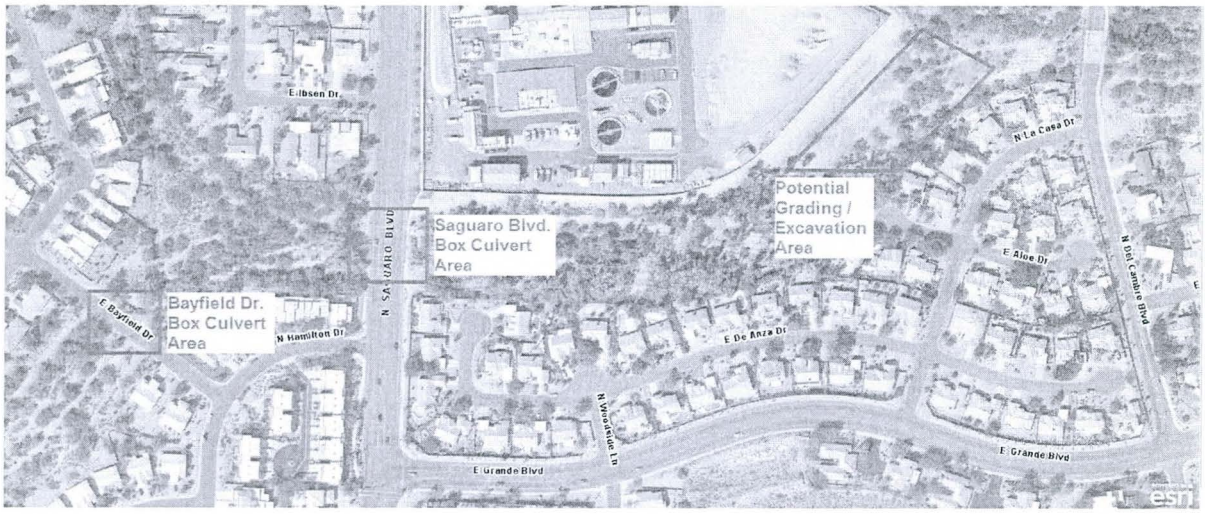
The proposed box culvert along Saguaro Boulevard is located approximately 500 feet north of Grande Boulevard. The culvert at Saguaro Boulevard is planned as 6 reinforced concrete box segments each measuring 10 feet wide by 6 feet deep by 104 feet long. The culvert will include

45 degree flared wingwalls and inlet edge bevel. The planned upstream (west) invert elevation is 1,576.7 feet, and the downstream (east) invert elevation is 1,575 feet.

The proposed box culvert along Bayfield Road is located approximately 700 feet northwest of the intersection of Saguaro Boulevard and Grande Boulevard. The culvert at Bayfield Drive is planned as 6 reinforced concrete box segments each measuring 10 feet wide by 5 feet deep by 53 feet long. The culvert will include 45 degree flared wingwalls and inlet edge bevel. The planned upstream (west) invert elevation is 1,587 feet, and the downstream (east) invert elevation is 1,586 feet.

In addition, we understand the project includes tree removal over approximately 2 acres of wash area located approximately 900 feet east of the proposed Saguaro Boulevard box culvert. Some grading and excavation may also be performed as part of the tree removal operations.

The following aerial photograph outlines the approximate locations of the proposed box culverts and grading/excavation area.



2 FIELD EXPLORATION

Prior to our field exploration, Kleinfelder staked the boring locations, cleared work areas with the Arizona Bluestake Center, and obtained a Town of Fountain Hills right-of-way permit (Permit No. E-2013-198). The borings and test pits were performed away from the paved traffic lanes; therefore, traffic control was not required. We notified the Flood Control District of Maricopa County (FCDMC) and the Town of Fountain Hills inspector of our field work schedule.

2.1 PROPOSED BOX CULVERTS

The exploratory borings were performed on January 6, 2014, by Rollina Katako, E.I.T. of Kleinfelder. The subsurface soil conditions at the site of the proposed box culverts were explored by drilling a total of 4 borings (designated as B1 through B4). Borings B1 and B2 were drilled in the area of the Bayfield Drive box culvert, and Borings B3 and B4 were drilled in the area of the Saguaro Boulevard box culvert. The borings were drilled on the graded shoulder adjacent to the existing roadways. The approximate locations of the borings are shown on Figure 1 (Boring and Test Pit Location Map).

The borings were drilled with a truck-mounted D-120 drill-rig and crew supplied by D&S Drilling, Inc. The borings were drilled using 8-inch outer diameter (OD) hollow-stem augers to depths of about 20 feet below the existing ground surface (bgs). During the field exploration, the soils encountered were visually classified, logged, and sampled by Kleinfelder's field engineer. Relatively undisturbed samples of the subsurface materials were obtained using a ring sampler with a 2.42-inch inside diameter (ID) and 3-inch OD. Disturbed samples of soils were obtained using a standard penetration test (SPT) split spoon sampler with a 1.375-inch ID and 2-inch OD. Bulk samples of drill cuttings were also collected at selected depths from the borings. The SPT and ring samplers were driven 18 and 12 inches, respectively, using a hydraulic actuated 140-pound hammer free falling 30 inches. Unless noted otherwise on the boring logs, the sample driving resistance was recorded as number of blows per six inches of penetration. The penetration results are presented on the borings logs adjacent to each sample. The recovered soil samples were removed from the sampler, sealed to reduce moisture loss and submitted to the laboratory. The borings were grouted upon completion. The logs of the exploratory borings are presented in Appendix A.

2.2 PROPOSED GRADING / EXCAVATION WASH AREA

The subsurface soil conditions at the site of the proposed grading/excavation wash area were explored by excavating 6 test pits (designated as TP1 through TP6) on January 10, 2014. The test pits were excavated with a John Deere 310G backhoe and crew supplied by D&S Drilling, Inc. This work was supervised by Rollina Katako, E.I.T. of Kleinfelder. The approximate locations of the test pits are shown on Figure 1 (Boring and Test Pit Location Map).

The test pits were excavated using a 2-foot wide bucket to depths ranging from approximately 1 to 6.5 feet bgs. During the field exploration, the soils encountered were visually classified, logged, and sampled by Kleinfelder's field engineer. Bulk samples of excavated soils were collected at selected depths from the test pits. The test pits were backfilled upon completion. The logs of the exploratory test pits are presented in Appendix A.

In addition, we performed nuclear density tests at different elevations within the test pits. The results of our nuclear density tests are presented in Appendix E.

3 LABORATORY TESTING

Selected laboratory tests were performed on representative samples recovered from the field exploration to support our field classification and to provide information regarding engineering characteristics and properties of the subsurface soils. The laboratory testing program consisted of the following:

Table 3.1 – Laboratory Testing Program

Laboratory Test	Sample Type	Number of Tests	Purpose of Test
Sieve Analysis (ASTM C136)	Bulk	7	Soil Classification and Pavement Design
Atterberg Limits (ASTM D4318)	Bulk	7	Soil Classification and Pavement Design
Compression Test (ASTM D2435)	Bulk	2	Soil Settlement Characteristics
Standard Proctor (ASTM D698)	Bulk	4	Compaction Characteristics
Remolded Swell (ASTM D4546)	Bulk	2	Expansion Potential of On-Site Soils
pH and Resistivity (Ariz 236)	Bulk	2	Preliminary Soil Corrosion Characteristics
Sulfates and Chlorides (Ariz 733/736)	Bulk	2	Preliminary Soil Corrosion Characteristics
Moisture/Density* (ASTM D2216/D2937)	Ring	3	In-Situ Density and/or Moisture Conditions

* Dry density and moisture content information is presented on the boring logs.

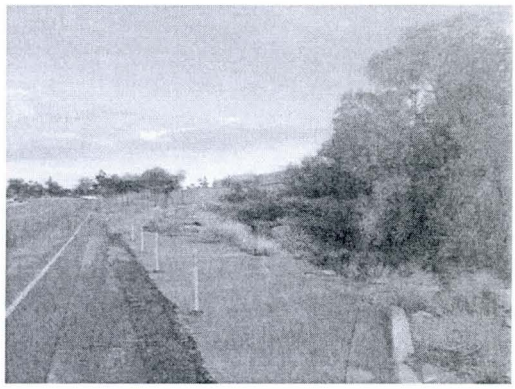
The results of the laboratory tests are presented on the laboratory test data sheets in Appendix B. The laboratory test results are also summarized on the boring logs in Appendix A.

4 GENERAL SITE CONDITIONS

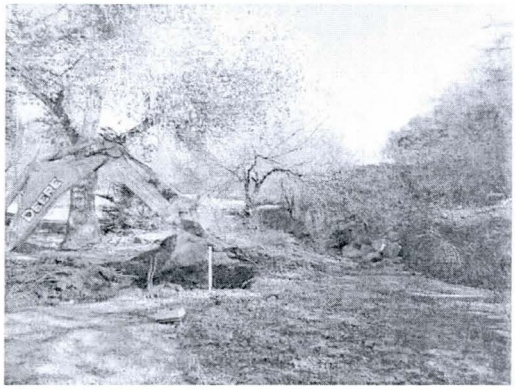
4.1 SURFACE CONDITIONS

The site of the proposed box culverts consisted of the existing paved roadways of Bayfield Drive and Saguaro Boulevard at the Ashbrook Wash crossings. Saguaro Boulevard is a 5-lane roadway (2 lanes each way and 1 middle turn lane) classified as a minor arterial roadway; and Bayfield Drive is a 2-lane roadway (1 lane each way) classified as a local roadway. Several existing 60-inch diameter corrugated metal drain pipes were in place to convey occasional storm-water flowing along Ashbrook Wash underneath these roadways. The roadways were relatively flat at the proposed box culvert locations, and as the surrounding ground surface extended away from the roadway it generally sloped down into the wash. The roadway and wash areas at the site were generally bounded by residential developments. Vegetation in the wash consisted of a moderate to dense growth of shrubs, trees, weeds, and grass. The following are a few general pictures of the site.

Picture 1 – Bayfield Dr. – Facing NW



Picture 2 – Saguaro Blvd. – Facing N



Picture 3 – Ashbrook Wash – Test Pit TP4

4.2 SUBSURFACE CONDITIONS

The subsurface profiles encountered at the boring locations were found to be relatively similar. Individual boring logs with detailed descriptions are presented in Appendix A of this report.

At the location of Borings B1 and B2 (Bayfield Drive box culvert area), fill materials comprised of silty sand (SM) with gravel were encountered in the upper roughly 1 foot below the existing ground surface (bgs). The fill soils were underlain by native deposits of silty and clayey sand (SM & SC), which extended to depths of about 5 and 6 feet bgs. The silty and clayey sands exhibited plasticities in the low range, had apparent relative densities in the medium dense to very dense range, and contained no cementation. Beginning at depths of about 5 to 6 feet bgs and extending to the final depths of exploration (about 20 feet bgs), the silty and clayey sands were underlain by stratified deposits of silty gravel (GM), poorly-graded gravel (GP), and clayey gravel (GC). These subsurface gravel deposits exhibited plasticities in the non-plastic to medium range, had apparent relative densities in the medium dense to very dense range, contained occasional cobbles, and contained variable cementation. Beginning at depths of about 14 feet, the presence of possible conglomerate bedrock was noted.

At the location of Borings B3 and B4 (Saguaro Boulevard box culvert area), fill materials comprised of silty gravel (GM) and silty sand (SM) with gravel were encountered in the upper roughly 1 foot bgs. The fill soils were underlain by native deposits of clayey sand (SC), which extended to the final depths of exploration (about 20 feet bgs). The clayey sands exhibited plasticities in the low range, had apparent relative densities in the medium dense to very dense range, and contained variable cementation. At depths of about 7 to 9 feet bgs, stratified deposits of silty and poorly-graded gravels with cobbles were noted. Occasional layers of conglomerate rock (cemented soils) were noted at various depths.

At the location of Test Pits TP1 through TP6 (Ashbrook Wash area, east of Saguaro Boulevard), various deposits including clayey and silty sand (SC & SM) with gravel, and clayey and silty gravel (GC, GM & GC-GM) were encountered to depths ranging from about 1 to 3.5 feet bgs. These coarse-grained deposits exhibited plasticities in the non-plastic to medium range and contained variable cementation. At some of the test pit locations, the coarse-grained surface soils were underlain by organic soils which included thin layers of soils with significant amounts of organics. Backhoe bucket refusal on moderately to strongly cemented conglomerate soils

comprised of clayey gravel (GC) was encountered at the test pit locations at depths ranging from about 1 to 6.5 feet bgs.

Groundwater was encountered at the location of Borings B2 and B3 at depths of about 19 and 17 feet bgs, respectively. In addition, groundwater was encountered at the location of Test Pit 5 at a depth of about 4 feet bgs. It is possible that variations in groundwater elevations may occur due to seasonal changes, run-off, precipitation, perching, irrigation, or construction activities.

5 GENERAL SITE GEOLOGY

The site is located in the northeastern part of the Phoenix Basin, which is a broad alluvial basin within the Basin and Range physiographic province. The basin is almost completely surrounded by mountains composed primarily of granite, metamorphic, and volcanic rocks and minor amounts of consolidated sedimentary rocks. The valley floor is underlain by basin-fill sediments. Additionally, in the Phoenix Basin, alluvial deposits form the main water-bearing units and consist mainly of clay, silt, sand, and gravel.

The basin-filled sediments range in thickness from a few tens of feet near the mountains to more than 1,200 feet in the central part of the area (Cooley, M.E., 1973, map showing distribution and estimated thickness of alluvial deposits in the Phoenix area Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-845-C). Crystalline rocks, which consist mainly of schist, gneiss, granite, and felsic to mafic volcanic rocks, are present in the mountains that border the alluvium deposits. Well-cemented conglomerate and sandstone may also be present in some areas (Lancy, R.L.; Ross, P.P.; and Littin, G.R.; April 1978; maps showing Ground-Water Conditions in the Eastern Part of the Salt River Valley).

6 ENGINEERING ANALYSES AND RECOMMENDATIONS

6.1 GENERAL

Geotechnical engineering recommendations for the support of the proposed Two Box Culverts are presented in the following sections. These recommendations are based on our understanding of the project, and the results of our field exploration and laboratory testing for the site.

The following sections of this report present our recommendations regarding foundations, lateral design parameters, moisture protection, construction considerations, engineered fill, and site preparation and grading.

6.2 FOUNDATIONS

We understand the culvert at Saguaro Boulevard is planned as 6 reinforced concrete box segments each measuring 10 feet wide by 6 feet deep by 104 feet long; and the culvert at Bayfield Drive is planned as 6 reinforced concrete box segments each measuring 10 feet wide by 5 feet deep by 53 feet long. We understand the box culverts will be supported by mat-slab foundations embedded at shallow depths below finished grade. Both box culverts will include 45 degree flared wingwalls and inlet edge bevel.

Based on the results of the field exploration and laboratory testing, we recommend foundations be supported on properly placed and compacted engineered fill. The engineered fill should be prepared and placed as recommended in the "Site Preparation and Grading" section of this report.

Foundations and associated structural elements should be well reinforced. Where appropriate, the structural elements should include frequent joints and reinforcement to help distribute stress in the event of differential foundation movements. Where possible, site drainage sloping away from structures is recommended to reduce potentials for moisture increases in bearing soils.

The following table presents foundation design recommendations for mat-slab and wingwall foundations embedded at selected depths below finished grade.

Table 6.2.1 – Foundation Recommendations			
Foundation Type	**Embedment Depth Below Finished Grade**	**Minimum Depth of Engineered Fill Beneath Foundations**	**Allowable Foundation Bearing Pressure**
Mat/Slab*	1.0 foot	2 foot**	2,000 psf
Wing Wall Continuous Footing*	2.0 feet	2 foot**	2,000 psf

*Note 1: A perimeter turn-down is recommended to extend 4 feet below the bottom of the footing or slightly below the anticipated scour depth, whichever depth is greater. A perimeter turn-down along the upstream and downstream sides of the culvert is recommended to extend 4 feet below the invert of the culvert or slightly below the anticipated scour depth, whichever is greater.

**Note 2: The upper 6 inches of engineered fill underlying the bottom of the foundation should consist of aggregate base course (Section 702.2 of the MAG Standard Specifications).

Foundation excavations should be observed by the geotechnical engineer or their qualified representative to evaluate the bearing conditions prior to the placement of reinforcement and concrete. Footing embedment depth is defined as the depth of the footing base below finished grade or lowest adjacent grade within 5 feet of the footing edge, whichever is deeper. The tabulated foundation bearing pressures should be considered allowable maximums for dead plus design live loads. For transient loading analysis such as for wind or seismic loading, the bearing capacity for the above-referenced foundation conditions may be increased by one-third.

We estimate a modulus of subgrade reaction (k_s) value of 230 pounds per square inch per inch of deflection (pci) may be used for mat-slab foundations supported on compacted engineered fill soils. In an effort to reduce lateral moisture infiltration into the bearing soils, we recommend the foundations include a perimeter turn-down (or thickened edge) extending a minimum of 4 feet below the bottom of the foundation or to slightly below the anticipated scour depth, with the greater depth to govern. We understand that rip rap will be placed extending to a depth of approximately 2.75 feet adjacent to the both sides of the box culverts in order to provide additional scour protection.

Total settlements for foundations designed and constructed in accordance with the recommendations presented in this report are estimated on the order of ¾-inch or less, provided foundation bearing soils remain at their present and natural moisture conditions. Differential foundation settlements should be approximately half of the total settlements. Occasional fluctuations in moisture content in the bearing soils are anticipated at the box culvert location.

Additional post-construction movements of similar or greater magnitude could occur if the compacted fill and/or natural soils beneath the foundation level were to experience an increase in moisture content. Therefore, the recommendations presented in this report are intended to reduce the potential for additional post-construction movements.

6.2.1 LATERAL DESIGN PARAMETERS

Walls retaining soils should be designed for the lateral earth pressure imposed by these soils. The magnitude of the lateral earth pressure is a function of the backfill material and the rigidity of the retaining structure. On-site soils may be suitable for wall backfill provided they meet the specifications outlined in this report for engineered fill. The recommended lateral earth pressure values presented below assume the backfill satisfies the requirements presented in this report for engineered fill. Walls which are free to deflect sufficiently to mobilize the full active earth pressure condition should be designed for an active equivalent fluid unit weight of 34 pounds per cubic foot (pcf). Walls which are restrained from lateral movement should be designed for the at rest condition using an equivalent fluid unit weight of 56 pcf. Retaining walls should be designed to drain water and avoid hydrostatic pressures. These recommendations assume a horizontal backfill surface, no surcharge loadings, no seepage, and no groundwater behind the wall.

Horizontal loads acting on foundations cast in open excavations against undisturbed native soil or properly placed and compacted fill will be resisted by friction acting along the base of the footing and by passive earth pressures against the loaded side of the footing. If design makes use of passive earth pressure against backfill, it is important that a representative of the engineer of record be present to monitor and test backfill placement and compaction. Foundations designed to provide passive resistance should have the backfill soils adjacent to the footings compacted to a minimum of 95 percent of the maximum ASTM D698 dry density in order to develop passive resistance with low strains.

The friction acting along the base of the footings founded on compacted structural fill soils may be computed using a coefficient of friction equal to 0.42. An ultimate lateral passive earth pressure may be computed using an equivalent fluid weighing 370 pcf for the sides of footings cast against undisturbed soil or properly placed and compacted backfill. The maximum allowable passive pressure for shallow foundations should not exceed 1,500 pounds per square

foot. Passive pressure in the upper foot should be neglected unless confined by concrete slab-on-grade or pavement.

6.3 PAVEMENT DESIGN

We understand that as the proposed box culverts are constructed, the construction excavations will require the removal and replacement of a relatively thin strip of the existing pavement located adjacent to the edges of the box culverts and the roadway. The design for the new asphalt concrete (AC) pavement section for these roadway improvements was performed in general accordance with available local design charts and MCDOT technical guidelines. The following table presents minimum recommended pavement sections for the proposed project based upon the technical guidelines of the MCDOT Roadway Design Manual, the anticipated traffic, and the subgrade soil conditions we encountered.

Table 6.3.1 – Recommended Minimum Pavement Section

Roadway Section	Roadway Classification	Asphalt Concrete (AC) (½" mix)	Aggregate Base Course (ABC)	Subgrade Preparation Depth
Bayfield Drive	Local Road	2.5"	6"	12"
Saguaro Boulevard	Minor Arterial	5"	10"	12"

Site grading within the new pavement areas should be accomplished as recommended in the "Site Preparation and Grading" section of this report. A compacted subgrade of on-site soils or imported soils with comparable supporting properties is assumed. In an effort to reduce water infiltration and retard premature oxidation of the surfacing, the pavement surface should be sealed after the first summer of use, and routinely thereafter.

6.4 PRELIMINARY EARTHWORK FACTORS

Preliminary earthwork (shrink/swell) factors were estimated based on the results of the laboratory and field testing, and from past experience with similar soils. The earthwork factors are based on a comparison of the in-situ dry densities from ring samples and field nuclear density tests to the density of bulk samples compacted to 95 percent of maximum dry density as determined by ASTM D698. The site surface soils to depths of approximately 2 to 5 feet are

estimated to have variable earthwork factors ranging from 5 percent swell to about 20 percent shrinkage, with an estimated average on the order of approximately 5 percent shrinkage. These estimates are general in nature, and are based on our experience, limited data from our field exploration, and the soil conditions we encountered at the site. Earthwork factors may vary dependent upon the actual subsurface conditions, which may include variations in soil gradations and gravel/rock contents. The earthwork shrinkage values are expected to be larger in areas subjected to higher levels of compaction or where the existing natural soils are looser. The earthwork shrinkage values are also expected to be lower in areas subjected to lower levels of compaction or where the existing natural soils are denser.

6.5 EXCAVATION CHARACTERISTICS

The following general comments regarding excavation conditions are based on boring and test pit data. A John Deere, 310G backhoe with a 2-foot-wide bucket was used to excavate Test Pits TP1 through TP6, and backhoe bucket refusal was encountered within the test pits on moderately- to strongly-cemented soils (possible conglomerate bedrock) at depths ranging from about 1 to 4 feet bgs. Based on the subsurface conditions encountered within the borings, excavations within the upper roughly 1 to 4 feet bgs should be possible using conventional earth excavating equipment capable of handling medium dense to very dense variably cemented soils with variable amounts of gravel and cobbles. Deeper excavations may require heavier excavating equipment due to increased cementation, conglomerate bedrock, gravel, and cobble (and possible boulder) contents. We recommend that the earthwork contractor make his own assessment to satisfy himself as to the type of equipment required to excavate through these deposits.

Based on our field observations and test results, temporary excavations in native soils may be cut at a maximum inclination of 1.5:1 (horizontal:vertical). Excavations up to 4 feet deep may be unshored provided they are sloped back at a ratio of no steeper than 1.5:1 (horizontal:vertical). Slopes may need to be further flattened or shored based on conditions encountered during construction. All excavations should be planned and executed in accordance with current OSHA recommendations for a type C soil (Federal Register 29 CFR Part 1926) and applicable local governing agency standards and procedures. Excavations into very dense conglomerate materials may be planned and executed in accordance with current OSHA recommendations for Type B soil (Federal Register 29 CFR Part 1926) and applicable local governing agency standards and procedures. All parties should understand that safety of construction personnel is the sole responsibility of the Contractor. If trench shoring is used to minimize the excavation

width and keep traffic lanes open, the Engineer of Record should review shoring designs and soil parameters utilized by the shoring designer.

All construction surcharge loads and traffic loads should be kept a distance equal to the depth of the excavation away from the edge of the trench excavations, unless specifically accounted for in the shoring design.

6.6 PERMANENT SLOPES

We recommend that permanent unprotected cut slopes be constructed at a gradient no steeper than 3H:1V (horizontal to vertical). For cut and fill slopes with slope paving (protected by rip-rap and/or grouted rip-rap), we recommend they be constructed at a gradient no steeper than 2H:1V. To reduce the potential for surface erosion, the design of grading at the top of slopes subject to significant overland water flows in should intercept and redirect surface runoff.

6.7 PRELIMINARY SOIL CORROSION CHARACTERISTICS

Corrosion is most likely to occur in soils with high moisture contents. Limited laboratory tests were performed on samples of the site soils to determine their pH, laboratory minimum resistivity, and soluble sulfate and chloride contents. The results of these laboratory tests are included in Appendix B. We recommend that the results of our laboratory testing be reviewed by a person or firm experienced in corrosion protection designs for the actual construction at the site, and/or by the appropriate pipe or material manufacturer. These results are general in nature and may not be representative of site conditions. A qualified corrosion engineer should be consulted if corrosion of underground utilities is a concern or if a detailed evaluation is necessary.

Laboratory resistivity tests were performed to provide information to evaluate the preliminary potential corrosivity of the on-site soils. A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is provided below.

Resistivity in ohm-centimeters	Corrosivity Category
0 to 1,000	severely corrosive
1,000 to 2,000	corrosive
2,000 to 10,000	moderately corrosive
over 10,000	mildly corrosive

The minimum resistivities measured in the lab ranged from 1,879 to 1,946 ohm-cm, indicating the on-site soils would be categorized as corrosive toward ferrous metals.

Protection from corrosion may be necessary for metallic conduits. While in dry field conditions of our arid environments, these soils may not contribute to significant corrosion; however, increases in soil moisture will generally result in reduced resistivities, and increased potential for corrosion. According to the Arizona Department of Transportation (ADOT) Materials Preliminary Engineering and Design (MPE&D) Manual, the following types of culvert pipe may be used for various resistivity ranges:

- For resistivities greater than 2000 ohm-cm, galvanized-coated steel AASHTO M-36, aluminum coated steel AASHTO M-36, aluminum alloy AASHTO M-196 or bituminous-coated AASHTO M-190 pipe should be used.
- For resistivities between 500 and 1999 ohm-cm, aluminum alloy AASHTO M-196 or bituminous-coated AASHTO M-190 pipe should be used.
- For resistivities less than 500 ohm-cm bituminous coated AASHTO M-190 pipe should be used.

The above-recommended culvert types are applicable for soils with a pH in the range of 5.0 to 9.0. Laboratory tests indicate pH values varied between 8.0 and 8.2.

Laboratory tests showed chloride contents between 15 ppm and 29 ppm indicating a low corrosion potential.

The laboratory results for sulfate (SO_4) contents were 0.0030 and 0.0050 percent (or 30 and 50 parts per million), which is significantly less than 0.1 percent. According to the 2006 or 2009 Editions of the International Building Code (IBC), which refers to provisions in the American Concrete Institute (ACI) 318, Section 4.3, results less than 0.1 percent indicate a negligible level of sulfate exposure. Based on these results, concrete in contact with site soils with these type of sulfate contents should be either Type II or Type I low alkali Portland cement, which are typical cements used throughout Arizona. The soluble chlorides content of the tested site soils

were 0.0015 and 0.0029 percent (or 15 and 29 parts per million), indicating a low corrosion potential to concrete reinforcing steel.

If corrugated metal pipe culverts are to be used, then a preliminary evaluation of the type of metal pipe and coating can be performed by the pH and resistivity of in-place materials listed above. The type of pipe and coating used should be based on the actual bedding and backfill soils around the pipe. Specific testing of particular pipe installations and pipe backfill was not performed. As an alternative, high-density polyethylene (HDPE) piping could be considered for the project.

7 SITE PREPARATION AND GRADING RECOMMENDATIONS

7.1 ENGINEERED FILL

Engineered (compacted) fill used within proposed box culvert areas should be inorganic soils (site derived or imported) with equal or better support characteristics than those materials which were encountered by Kleinfelder. The on-site soils encountered at the box-culvert borings generally consisted of clayey and silty sand with gravel with low to medium plasticities, which are suitable to be used as engineered fill for the project. On-site soils excavated from the box-culvert areas may be used as engineered fill as approved by the geotechnical engineer provided the engineered fill soils are coarse-grained materials free of vegetation, organics, debris, and contain no rocks or clumps larger than 4 inches nominal diameter.

Any imported fill or backfill materials used at the site should conform to the Maricopa Association of Governments' (MAG) Standard Specifications for Imported Borrow (MAG Section 210.2), as amended by FCDMC.

The materials placed adjacent to the box culverts and similar structures (such as behind retaining walls) should be comprised of Structure Backfill. Structure Backfill should conform to Section 206 (and Section 702) of the MAG Standard Specifications.

Any proposed imported fill or backfill materials should meet the design criteria for this project and be approved by the geotechnical engineer and/or FCDMC prior to importing.

7.2 AGGREGATE BASE COURSE

Aggregate Base materials used for the support of asphalt concrete pavements should conform to Section 702.2 of the MAG Standard Specifications.

7.3 ASPHALTIC CONCRETE

Pavement materials should be as specified in the requirements of MAG Standard Specifications for Asphalt Concrete (MAG Section 710). Placement requirements for the asphaltic concrete

pavement should be in accordance with the requirements presented in Section 321 of the MAG Standard Specifications for Asphalt Concrete Pavement.

7.4 TACK COAT

If applicable, a tack coat shall be applied as necessary to provide proper bonding prior to the placement of succeeding asphalt concrete layers. The tack coat shall be as specified in Section 329 of the MAG Standard Specifications.

7.5 SITE GRADING

The following site grading recommendations are intended to provide support for the proposed new replacement pavement strips and box-culvert foundations at the site. Therefore, the grading activities at the site should be performed under observation and testing directed by the geotechnical engineer.

Trash, debris, vegetation (including roots) and other organics, any existing spread fill, any unstable (soft, loose, disturbed, water softened, etc.) soils, and other deleterious materials should be removed from proposed pavement and structure areas prior to construction. This site grading should extend laterally a minimum of 5 feet beyond structure areas. All areas of excavation should be observed and approved by a representative of the geotechnical engineer after clearing and before any filling operations begin at the site.

Where applicable, the subgrade preparation should be performed as outlined in Section 301 of the MAG Standard Specifications. In proposed pavement areas, the ground surface should be prepared to a minimum depth of 12 inches below finished subgrade. Subgrade preparation should consist of over-excavating, scarification, moisture conditioning, and compaction.

Within the proposed new culvert foundation areas, over-excavate the soils to a minimum depth of 2 feet below the bottom of foundation or 5 feet below the existing ground surface at the time of our field exploration, the greater depth to govern. The over-excavation should also extend laterally 2 feet beyond the edge of the foundations, and completely through any existing fill, backfill, disturbed soils, or other unsuitable material. Proof-roll the exposed native soils at the base of the over-excavation section under the direct supervision of the geotechnical engineer. Following the approval of the geotechnical engineer, backfill the over-excavated area with

approved on-site or imported engineered fill soils compacted as recommended in the following section.

If soft, loose, disturbed, water softened, low density, or other undesirable materials are encountered in proposed pavement or culvert areas, the area should be deepened to extend through these undesirable materials. The deepened area could be backfilled with on-site soils or engineered fill with the approval of the geotechnical engineer. The extent of removal of unsuitable materials should be indicated by the geotechnical engineer. Alternatively, a lean concrete (Controlled Low Strength Material – MAG Section 728, 1 sack slurry mix) may be used to backfill with the approval of the geotechnical engineer.

7.6 FILL PLACEMENT AND COMPACTION

Moisture conditioned on-site or imported engineered or structural fill materials should be placed in 6 to 8-inch thick loose lifts and compacted to elevate the site to specified finished grade. The materials shall be uniform with respect to material type and moisture content. The moisture content must be maintained until covered by the placement of the next lift.

In proposed box-culvert foundation areas, the lifts of approved on-site or imported engineered fill soils should be moisture conditioned within 2 percentage points from their optimum moisture content, and uniformly compacted to a minimum of 95 percent of their maximum dry density as determined by ASTM D698. Engineered fills at depths greater than 5 feet below grade should be compacted to a minimum of 100 percent of their maximum dry density as determined by ASTM D698.

In proposed pavement areas, the subgrade preparation and lifts of on-site or imported engineered fill soils should be moisture conditioned to 2 percentage points below their optimum moisture content or lower, and uniformly compacted to a minimum of 95 percent of their maximum dry density as determined by ASTM D698. Aggregate Base Course (ABC) should be moisture conditioned to optimum moisture content or lower, and uniformly compacted to a minimum of 100 percent of the maximum dry density as determined by ASTM D698.

Observation and testing should be performed as necessary in order to meet the project requirements and the recommendations presented in this report.

8 CLOSURE

8.1 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by the Client. We recommend the Client retain Kleinfelder to review any plans and specifications, including any revisions or modifications to the plans and specifications, in order to corroborate the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, the Client must obtain written approval from Kleinfelder's engineer that such changes do not affect our recommendations. Changes by others to recommendations contained in this report may vitiate Kleinfelder's recommendations.

This report may be used only by the Client and their representatives, and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on site and off site), or other factors may change over time, and additional work may be required with the passage of time. Any party other than the Client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

Kleinfelder offers various levels of investigative and engineering services to suit the varying needs of different clients. It should be recognized that definition and evaluation of geologic and environmental conditions are a difficult and inexact science. Judgments leading to conclusions and recommendations are generally made with incomplete knowledge of the subsurface conditions present due to the limitations of data from field studies. Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. Since detailed study and analysis involves greater expense, our clients participate in determining levels of service that provide adequate information for their purposes at acceptable levels of risk. More extensive studies, including subsurface studies or field tests, should be performed to reduce uncertainties. Acceptance of this report will indicate that the Client has reviewed the document and determined that it does not need or want a greater level of service than provided.

8.2 ADDITIONAL SERVICES

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction process to verify compliance with these recommendations. These tests and observations should include, but not necessarily be limited to, the following:

- Observations and testing during the site grading, preparation and earthwork.
- Consultation as may be required during construction.

We also recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

Important Information About Your

Geotechnical Engineering Report

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

The following information is provided to help you manage your risks.

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

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

Read the Full Report

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

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

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

Give Contractors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

Rely on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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e-mail: info@asfe.org www.asfe.org

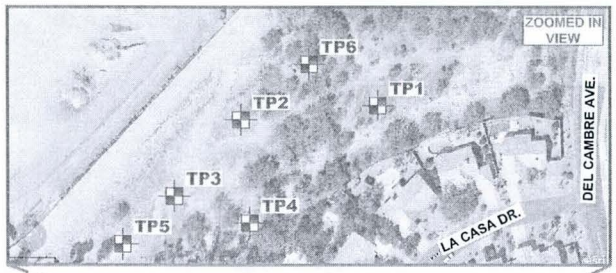
IIGER06045.0M

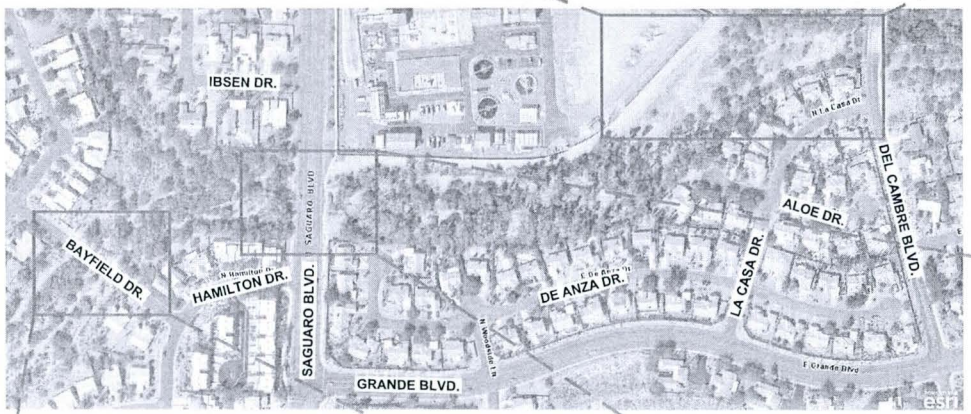
FIGURES

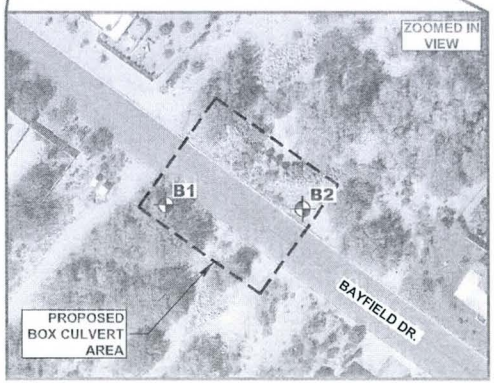
EXPLANATION

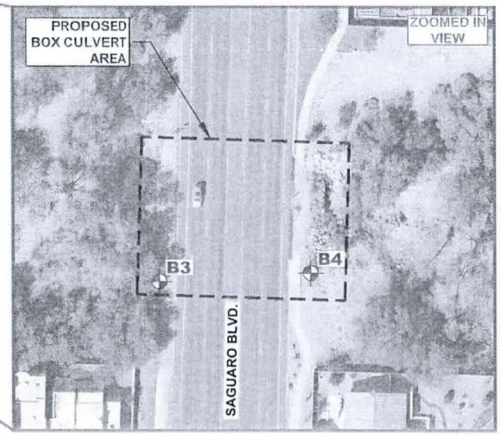
- APPROXIMATE BORING LOCATION
- APPROXIMATE TEST PIT LOCATION

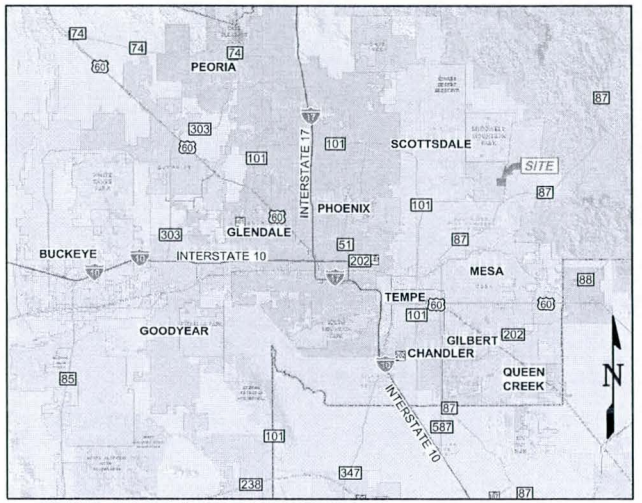
NOT TO SCALE











REFERENCE: IMAGE FROM MARICOPA COUNTY ASSESSORS' OFFICE

VICINITY MAP

NOT TO SCALE

REFERENCE: IMAGES FROM MARICOPA COUNTY ASSESSORS' OFFICE.

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PROJECT NO.	138494
DRAWN:	01/2014
DRAWN BY:	DMF
CHECKED BY:	RP
FILE NAME:	138494_F1.dwg

BORING AND TEST PIT LOCATION MAP

PROPOSED TWO BOX CULVERTS
ALONG SAGUARO BOULEVARD AND BAYFIELD DRIVE
FOUNTAIN HILLS, ARIZONA

FIGURE **1**

ATTACHED IMAGES: Images: Base1.jpg Images: Base2 - B1-B2.jpg Images: Base3 - B3-B4.jpg Images: Base4 - TP.jpg Images: Vicinity1.jpg
ATTACHED XREFS:
RIVERSIDE, CA CAD FILE: L:\2014\CADD\138494\ LAYOUT: 1 PLOTTED: 29 Jan 2014, 4:54pm, DFahrney

APPENDIX A

SAMPLE/SAMPLER TYPE GRAPHICS

BULK SAMPLE

CALIFORNIA SAMPLER
(3 in. (76.2 mm.) outer diameter)

STANDARD PENETRATION SPLIT SPOON SAMPLER
(2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)

GROUND WATER GRAPHICS

WATER LEVEL (level where first observed)

WATER LEVEL (level after exploration completion)

WATER LEVEL (additional levels after exploration)

OBSERVED SEEPAGE

NOTES

1. The report and log key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.

2. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.

3. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

4. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.

5. In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.

6. Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.

7. If sampler is not able to be driven at least 6 inches, 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu ≥4 and 1≤ Cc≤3		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu <4 and/ or 1>Cc >3		GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu ≥4 and 1≤ Cc≤3		GW-GM	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
					GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu <4 and/ or 1>Cc >3		GP-GM	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
					GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES			GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
					GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
					GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu ≥6 and 1≤ Cc≤3		SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu <6 and/ or 1>Cc >3		SP	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu ≥6 and 1≤ Cc≤3		SW-SM	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
					SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu <6 and/ or 1>Cc >3		SP-SM	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
					SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES			SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
					SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
					SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)				ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
					CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
					CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
					OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)				MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
					CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
					OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

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PROJECT NO.:	138494
DRAWN BY:	BP
CHECKED BY:	RP
DATE:	1/14/2014
REVISED:	1/29/2014

GRAPHICS KEY

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

A-1

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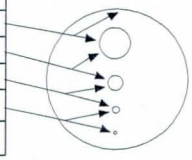
GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #10	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller

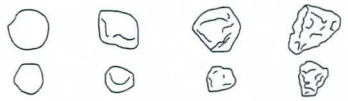


Munsell Color

NAME	ABBR
Red	R
Yellow Red	YR
Yellow	Y
Green Yellow	GY
Green	G
Blue Green	BG
Blue	B
Purple Blue	PB
Purple	P
Red Purple	RP

ANGULARITY

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



PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit
High (H)	> 50	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit

MOISTURE CONTENT

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

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12- 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

NOTE: AFTER TERZAGHI AND PECK, 1948

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT N-VALUES
Very Soft	0 - 4
Soft	5 - 8
Moderately Firm	9 - 15
Firm	16 - 29
Very Firm	30 - 49
Hard	50+

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

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DATE:	1/14/2014
REVISED:	1/29/2014

SOIL DESCRIPTION KEY

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

A-2

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Date Begin - End:	1/06/2014	**Drill Company:**	D&S Drilling, Inc.	**BORING LOG B1**	
Logged By:	R. Katako, EIT	**Drill Crew:**	Jay / Danny		
Hor.-Vert. Datum:	NAD83	**Drill Equipment:**	Diedrich D-120	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	**Exploration Method:**	Hollow Stem Auger		
Weather:	60 degrees, clear	**Bore Log Diameter:**	8 in. O.D.		

Latitude: 33.61339° N
Longitude: -111.71771° W
Approximate Surface Elevation (ft.): 1,594.0
Surface Condition: Sand and gravel on roadway shoulder

Approx. Elevation (feet)	Depth (feet)	Graphical Log	Description	Sample Type	Blow Counts(BC)= Uncorr. blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
			FILL: SILTY SAND with GRAVEL (SM): non-plastic, brown, slightly moist											
			NATIVE: SILTY SAND with GRAVEL (SM): low plasticity, brown, slightly moist, dense to very dense, non- cemented		BC=11 50/4"	6 in.	SM			67	19	27	5	
1590	5		**SILTY GRAVEL (GM)**: with cobbles, non-plastic, brown, gray, light brown, slightly moist, medium dense		BC=8 9 10	6 in.								Hollow stem auger chatter Hollow stem auger chatter
			very dense and stratified with thin layers of silty sand (SM) below 7 feet		BC=32 30 25	8 in.								
1585	10		**POORLY-GRADED GRAVEL (GP)**: non-plastic, pale red, light brown, reddish brown, slightly moist, dense		BC=14 19 18	2 in.								
1580	15		**CLAYEY GRAVEL (GC): POSSIBLE CONGLOMERATE BEDROCK**, low plasticity, light brown, gray, slightly moist, very dense, moderately cemented		BC=50/2"	NR								
1575	20		dense and with possible conglomerate bedrock at 19 feet		BC=17 25 20	11 in.								
1570														

The exploration was terminated at approximately 20.5 ft. below ground surface. The exploration was backfilled with cement grout on January 06, 2014.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
A hand-held Garmin GPS unit was used to locate the exploration with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
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BORING LOG B1

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-3

PAGE: 1 of 1

Date Begin - End:	1/06/2014	**Drill Company:**	D&S Drilling, Inc.	**BORING LOG B2**	
Logged By:	R. Katako, EIT	**Drill Crew:**	Jay / Danny		
Hor.-Vert. Datum:	NAD83	**Drill Equipment:**	Diedrich D-120	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	**Exploration Method:**	Hollow Stem Auger		
Weather:	60 degrees, clear	**Bore Log Diameter:**	8 in. O.D.		

Latitude: 33.61335° N
Longitude: -111.71737° W
Approximate Surface Elevation (ft.): 1,594.0
Surface Condition: Sand and gravel on roadway shoulder

Approx. Elevation (ft)	Depth (ft)	Graphical Log	Description	Sample Type	Blow Counts(BC)= Uncorr. blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
			FILL: SILTY SAND with GRAVEL (SM): non-plastic, brown, gray, slightly moist											
			NATIVE: CLAYEY SAND with GRAVEL (SC): low plasticity, brown, gray, slightly moist, medium dense				SC			70	13	31	9	Chlorides= 15 ppm pH= 8.0 Sulfates= 30 ppm Resistivity= 1879 ohms-cm
					BC=13	12 in.		6.3	110					
1590	5		light brown below 4 feet		BC=12 15 13	10 in.								
			POORLY-GRADED GRAVEL (GP): non-plastic, light brown, gray, slightly moist, dense											
			weakly cemented, stratified with thin layers of silty gravel (GM) below 7 feet		BC=20 17 22	8 in.								
1585	10				BC=14 22 17	7 in.								Hollow stem auger chatter
1580	15		**CLAYEY GRAVEL (GC): POSSIBLE CONGLOMERATE BEDROCK**, low to medium plasticity, light brown, brown, slightly moist, dense, moderately cemented		BC=19 23 21	13 in.								Hollow stem auger chatter
1575 ▽			wet, perched groundwater encountered, very dense and with possible conglomerate bedrock at 19 feet		BC=39 50/5"	7 in.								
	20													
1570														

The exploration was terminated at approximately 20 ft. below ground surface. The exploration was backfilled with cement grout on January 06, 2014.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 19 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
A hand-held Garmin GPS unit was used to locate the exploration with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

BORING LOG B2

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-4

PAGE: 1 of 1

Date Begin - End:	1/06/2014	**Drill Company:**	D&S Drilling, Inc.	**BORING LOG B3**	
Logged By:	R. Katako, EIT	**Drill Crew:**	Jay / Danny		
Hor.-Vert. Datum:	NAD83	**Drill Equipment:**	Diedrich D-120	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	**Exploration Method:**	Hollow Stem Auger		
Weather:	60 degrees, clear	**Bore Log Diameter:**	8 in. O.D.		

Latitude: 33.61369° N
Longitude: -111.71577° W
Approximate Surface Elevation (ft.): 1,585.0

Surface Condition: Sand and gravel on roadway shoulder

Approx. Elevation (feet)	Depth (feet)	Graphical Log	Description	Sample Type	Blow Counts(BC)= Uncorr. blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
			FILL: SILTY GRAVEL (GM): non-plastic, brown, gray, slightly moist											
			NATIVE: CLAYEY SAND with GRAVEL (SC): low plasticity, light brown, gray, red brown, dry to slightly moist, very dense, possible weathered conglomerate		BC=50/9"	9 in.	SC	3.9	121	59	16	25	9	Hollow stem auger chatter
1580	5		reddish brown and trace white, dense, weakly cemented, and trace calcareous veins below 5 feet		BC=23 30 17	10 in.								Hollow stem auger chatter
			very dense and stratified with thin layers of poorly-graded gravel with cobbles below about 7 feet		BC=50/3"	NR								Extreme hollow stem auger chatter
1575	10		dense below 9 feet		BC=45 22 19	14 in.								Extreme hollow stem auger chatter
1570	15		perched groundwater encountered at about 17 feet		BC=12 15 17	NR								
			very dense below about 19 feet		BC=21 50/3"	1 in.								
1565	20													

The exploration was terminated at approximately 20 ft. below ground surface. The exploration was backfilled with cement grout on January 06, 2014.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 17 ft. below ground surface during drilling.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
A hand-held Garmin GPS unit was used to locate the exploration with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

BORING LOG B3

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-5

PAGE: 1 of 1

Date Begin - End:	1/06/2014	**Drill Company:**	D&S Drilling, Inc.	**BORING LOG B4**	
Logged By:	R. Katako, EIT	**Drill Crew:**	Jay / Danny		
Hor.-Vert. Datum:	NAD83	**Drill Equipment:**	Diedrich D-120	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	**Exploration Method:**	Hollow Stem Auger		
Weather:	60 degrees, clear	**Bore Log Diameter:**	8 in. O.D.		

Latitude: 33.61370° N
Longitude: -111.71542° W
Approximate Surface Elevation (ft.): 1,585.0

Surface Condition: Sand and gravel on roadway shoulder

Approximate Elevation (feet)	Depth (feet)	Graphical Log	Field Exploration: Sample Type	Field Exploration: Blow Counts(BC)= Uncorr. blows/6 in.	Field Exploration: Recovery (NR=No Recovery)	Laboratory Results: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
													FILL: SILTY SAND with GRAVEL (SM): non-plastic, brown, gray, slightly moist
						SC			60	19	26	8	**NATIVE: CLAYEY SAND with GRAVEL (SC)**: low plasticity, brown, gray, slightly moist, dense; Chlorides= 29 ppm; pH= 8.2; Sulfates= 50 ppm; Resistivity= 1946 ohms-cm
				BC=25 24 20	12 in.								
1580	5			BC=32	12 in.		5.4	116					Hollow stem auger chatter
						SC			66	17	27	10	
				BC=11 12 14	8 in.								trace fine gravel, light reddish brown, trace tan, and medium dense at 7.5 feet
1575	10			BC=15 19 25	12 in.								brown, gray, dense, and stratified with thin layers of silty gravel (GM) below 9 feet; Hollow stem auger chatter
				BC=17 20 25	8 in.								light brown, light reddish brown, tan, gray, and weakly cemented below 14 feet, Hollow stem auger chatter
1570	15												
				BC=42 50/5"	8 in.								very dense, weakly cemented, possible conglomerate bedrock at 19 feet
1565	20												

The exploration was terminated at approximately 20 ft. below ground surface. The exploration was backfilled with cement grout on January 06, 2014.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during drilling or after completion.

GENERAL NOTES:
The exploration location and elevation are approximate and were estimated by Kleinfelder.
A hand-held Garmin GPS unit was used to locate the exploration with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
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DATE:	1/30/2014
REVISED:	

BORING LOG B4

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-6

PAGE: 1 of 1

Date Begin - End:	1/10/2014	**Excavation Co.:**	D&S Drilling, Inc.	**TEST PIT LOG TP1**
Logged By:	R. Katako, EIT	**Excavation Crew:**	Dustin Miller	
Hor.-Vert. Datum:	NAD83	**Excavation Equip.:**	John Deere 310G Rubber Tire Backhoe	
Exploration Plunge:	-90 degrees	**Excav. Dimensions:**	4'W X 10'L X 4'D in.	
Weather:	50 degrees, clear			

Depth (feet)	Graphical Log	FIELD EXPLORATION	Sample Type	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Latitude: 33.61487° N Longitude: -111.71151° W No Elevation Available Surface Condition: Sand and gravel, small trees in wash									
		CLAYEY SAND with GRAVEL (SC): medium plasticity, brown, gray, moist moderately cemented and with black organics below 1.5 feet		SC			73	29	40	19	
5		**CLAYEY GRAVEL (GC)**: **POSSIBLE CONGLOMERATE BEDROCK**, low to medium plasticity, light brown, gray, tan, slightly moist, moderately to strongly cemented, weathered conglomerate The exploration was terminated because of backhoe refusal at approximately 4 ft. below ground surface on conglomerate consisting of moderately to strongly cemented soil. The exploration was backfilled with excavated material on January 10, 2014.									
10											
15											
20											

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during excavation or after completion.

GENERAL NOTES:
A hand-held Garmin GPS unit was used to locate the excavation with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

TEST PIT LOG TP1

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-7

PAGE: 1 of 1

Date Begin - End:	1/10/2014	**Excavation Co.:**	D&S Drilling, Inc.	**TEST PIT LOG TP2**
Logged By:	R. Katako, EIT	**Excavation Crew:**	Dustin Miller	
Hor.-Vert. Datum:	NAD83	**Excavation Equip.:**	John Deere 310G Rubber Tire Backhoe	
Exploration Plunge:	-90 degrees	**Excav. Dimensions:**	4'W X 6'L X 1'D in.	
Weather:	50 degrees, clear			

Depth (feet)	Graphical Log	FIELD EXPLORATION	Sample Type	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Latitude: 33.61477° N Longitude: -111.71198° W No Elevation Available Surface Condition: Small shrubs, grass, sand in wash									
		CLAYEY GRAVEL (GC): POSSIBLE CONGLOMERATE BEDROCK, low plasticity, light brown, gray, tan, slightly moist, moderately to strongly cemented, weathered conglomerate									

The exploration was terminated because of backhoe refusal at approximately 1 ft. below ground surface on conglomerate consisting of moderately to strongly cemented soil. The exploration was backfilled with excavated material on January 10, 2014.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during excavation or after completion.

GENERAL NOTES:
A hand-held Garmin GPS unit was used to locate the excavation with an accuracy of roughly 9 feet.

5

10

15

20

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CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

TEST PIT LOG TP2

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

A-8

PAGE: 1 of 1

Date Begin - End:	1/10/2014	**Excavation Co.:**	D&S Drilling, Inc.	**TEST PIT LOG TP3**
Logged By:	R. Katako, EIT	**Excavation Crew:**	Dustin Miller	
Hor.-Vert. Datum:	NAD83	**Excavation Equip.:**	John Deere 310G Rubber Tire Backhoe	
Exploration Plunge:	-90 degrees	**Excav. Dimensions:**	4'W X 9'L X 1.8'D in.	
Weather:	50 degrees, clear			

Depth (feet)	Graphical Log	FIELD EXPLORATION	Sample Type	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Latitude: 33.61452° N Longitude: -111.71231° W No Elevation Available Surface Condition: Sand, gravel, and cobbles									
		SILTY GRAVEL (GM): non-plastic, brown, gray, white, slightly moist, with 1-to-2 inch black asphalt debris at 1.1 feet									
		ORGANIC LEAN CLAY (OL): low plasticity, dark gray, slightly moist, with fine sand									
		CLAYEY GRAVEL (GC): **POSSIBLE CONGLOMERATE BEDROCK**, low plasticity, light brown, gray, tan, pale red, slightly moist, moderately to strongly cemented, weathered conglomerate									
5		The exploration was terminated because of backhoe refusal at approximately 2 ft. below ground surface on conglomerate consisting of moderately to strongly cemented soil. The exploration was backfilled with excavated material on January 10, 2014.									
10											
15											
20											

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during excavation or after completion.

GENERAL NOTES:
A hand-held Garmin GPS unit was used to locate the excavation with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

TEST PIT LOG TP3

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-9

PAGE: 1 of 1

Date Begin - End:	1/10/2014	**Excavation Co.:**	D&S Drilling, Inc.	**TEST PIT LOG TP4**
Logged By:	R. Katako, EIT	**Excavation Crew:**	Dustin Miller	
Hor.-Vert. Datum:	NAD83	**Excavation Equip.:**	John Deere 310G Rubber Tire Backhoe	
Exploration Plunge:	-90 degrees	**Excav. Dimensions:**	3'W X 8'L X 3'D in.	
Weather:	50 degrees, clear			

Depth (feet)	Graphical Log	FIELD EXPLORATION	Sample Type	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Latitude: 33.61443° N Longitude: -111.71199° W No Elevation Available Surface Condition: Sand, gravel, and cobbles									
		SILTY SAND with GRAVEL (SC): medium plasticity, light brown, brown, gray, slightly moist, with medium roots reddish brown, weakly cemented below about 2 feet		SM			69	18	44	14	
		CLAYEY GRAVEL (GC): **POSSIBLE CONGLOMERATE BEDROCK**, low plasticity, light brown, gray, tan, pale red, slightly moist, moderately to strongly cemented, weathered conglomerate									
5		The exploration was terminated because of backhoe refusal at approximately 3 ft. below ground surface on conglomerate consisting of moderately to strongly cemented soil. The exploration was backfilled with excavated material on January 10, 2014.									
10											
15											
20											

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during excavation or after completion.

GENERAL NOTES:
A hand-held Garmin GPS unit was used to locate the excavation with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

TEST PIT LOG TP4

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-10
PAGE: 1 of 1

Date Begin - End:	1/10/2014	**Excavation Co.:**	D&S Drilling, Inc.	**TEST PIT LOG TP5**
Logged By:	R. Katako, EIT	**Excavation Crew:**	Dustin Miller	
Hor.-Vert. Datum:	NAD83	**Excavation Equip.:**	John Deere 310G Rubber Tire Backhoe	
Exploration Plunge:	-90 degrees	**Excav. Dimensions:**	4'W X 10'L X 6.5'D in.	
Weather:	50 degrees, clear			

Depth (feet)	Graphical Log	FIELD EXPLORATION	Sample Type	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Latitude: 33.61443° N Longitude: -111.71254° W No Elevation Available Surface Condition: wood chips and dense medium sized bushes									
		FILL: SILTY, CLAYEY GRAVEL (GC-GM): with cobbles, low plasticity, brown to red brown, slightly moist, with black organics and tree stumps									
		NATIVE: ORGANIC LEAN CLAY (OL): low plasticity, dark gray, black, moist, with 6" organic layer at 2 feet									
▽		perched groundwater encoutered at about 4 feet									
5		**CLAYEY GRAVEL (GC): POSSIBLE CONGLOMERATE BEDROCK**, low plasticity, light brown, gray, tan, pale red, wet, moderately to strongly cemented, weathered conglomerate									
		The exploration was terminated because of backhoe refusal at approximately 6.5 ft. below ground surface on conglomerate consisting of moderately to strongly cemented soil. The exploration was backfilled with excavated material on January 10, 2014.									
10											
15											
20											

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 4 ft. below ground surface during excavation.

GENERAL NOTES:
A hand-held Garmin GPS unit was used to locate the excavation with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

TEST PIT LOG TP5

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-11
PAGE: 1 of 1

TEST PIT LOG TP6

Date Begin - End:	1/10/2014	**Excavation Co.:**	D&S Drilling, Inc.
Logged By:	R. Katako, EIT	**Excavation Crew:**	Dustin Miller
Hor.-Vert. Datum:	NAD83	**Excavation Equip.:**	John Deere 310G Rubber Tire Backhoe
Exploration Plunge:	-90 degrees	**Excav. Dimensions:**	4'W X 10'L X 3'D in.
Weather:	50 degrees, clear		

Depth (feet)	Graphical Log	FIELD EXPLORATION	Sample Type	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Latitude: 33.61497° N Longitude: -111.71176° W No Elevation Available Surface Condition: Sand and gravel, medium trees in wash									
		SILTY, CLAYEY GRAVEL (GC-GM): low plasticity, gray, light brown, slightly moist, with fine roots with cobbles, light brown, gray, reddish brown, weakly to moderately cemented at 2 feet									
		CLAYEY GRAVEL (GC): **POSSIBLE CONGLOMERATE BEDROCK**, low plasticity, light brown, gray, tan, pale red, reddish brown, slightly moist, moderately to strongly cemented, weathered conglomerate									
5		The exploration was terminated because of backhoe refusal at approximately 3 ft. below ground surface on conglomerate consisting of moderately to strongly cemented soil. The exploration was backfilled with excavated material on January 10, 2014.									
10											
15											
20											

GROUNDWATER LEVEL INFORMATION:
Groundwater was not encountered during excavation or after completion.

GENERAL NOTES:
A hand-held Garmin GPS unit was used to locate the excavation with an accuracy of roughly 9 feet.

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PROJECT NO.:	138494
DRAWN BY:	RK
CHECKED BY:	RP
DATE:	1/30/2014
REVISED:	

TEST PIT LOG TP6

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
A-12

PAGE: 1 of 1

APPENDIX B

Exploration ID	Approx. Sample Depth (ft.)	Sample Description	Moisture Content (%)	Dry Density (pcf)	Sieve Analysis			Atterberg Limits			Swell/Compression	Other Tests
					Passing 3/4 inch Sieve (%)	Passing #4 Sieve (%)	Passing #200 Sieve (%)	LL	PL	PI		
B1	1.0	SILTY SAND WITH GRAVEL (SM)			85	67	19	27	22	5		
B2	1.0	CLAYEY SAND WITH GRAVEL (SC)			92	70	13	31	22	9		Chlorides= 15 ppm pH= 8.0 Sulfates= 30 ppm Resistivity= 1879 ohms-cm
B2	2.0		6.3	110								
B3	1.0	CLAYEY SAND WITH GRAVEL (SC)			85	59	16	25	16	9		
B3	2.0		3.9	121								
B4	1.0	CLAYEY SAND WITH GRAVEL (SC)			92	60	19	26	18	8		Chlorides= 29 ppm pH= 8.2 Sulfates= 50 ppm Resistivity= 1946 ohms-cm
B4	5.0		5.4	116								
B4	6.0	CLAYEY SAND WITH GRAVEL (SC)			94	66	17	27	17	10		
TP1	0.0	CLAYEY SAND WITH GRAVEL (SC)			89	73	29	40	21	19		
TP4	2.0	SILTY SAND WITH GRAVEL (SM)			92	69	18	44	30	14		

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PROJECT NO.:	138494
DRAWN BY:	BP
CHECKED BY:	RP
DATE:	1/14/2014
REVISED:	1/29/2014

LABORATORY TEST RESULT SUMMARY

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

TABLE

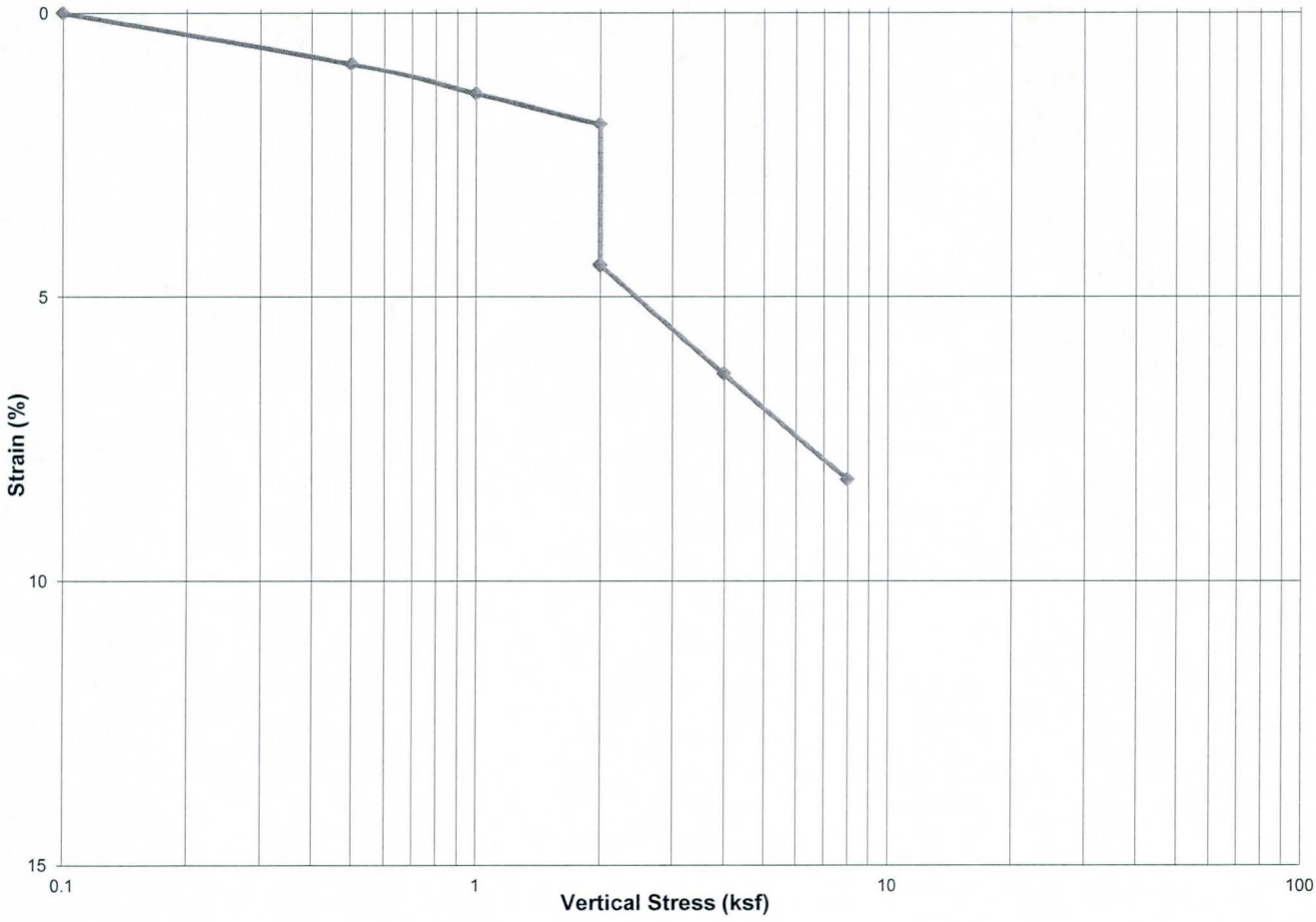
B-1

SAMPLE SOURCE: **B2 @ 2-3'**

SPECIFIC GRAVITY: 2.65 (estimated)

	INITIAL	FINAL
Volume (in^3)	4.60	4.23
Moisture Content (%)	8.0	14.3
Dry Density (pcf)	106.5	116.0
Void Ratio	0.6	0.4
Degree of Saturation (%)	38	100

Saturated at 2 ksf: 2.5% Collapse



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ONE-DIMENSIONAL CONSOLIDATION (ASTM D 2435)
Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
B2

Report Date:	Project Number:
February 2014	138494

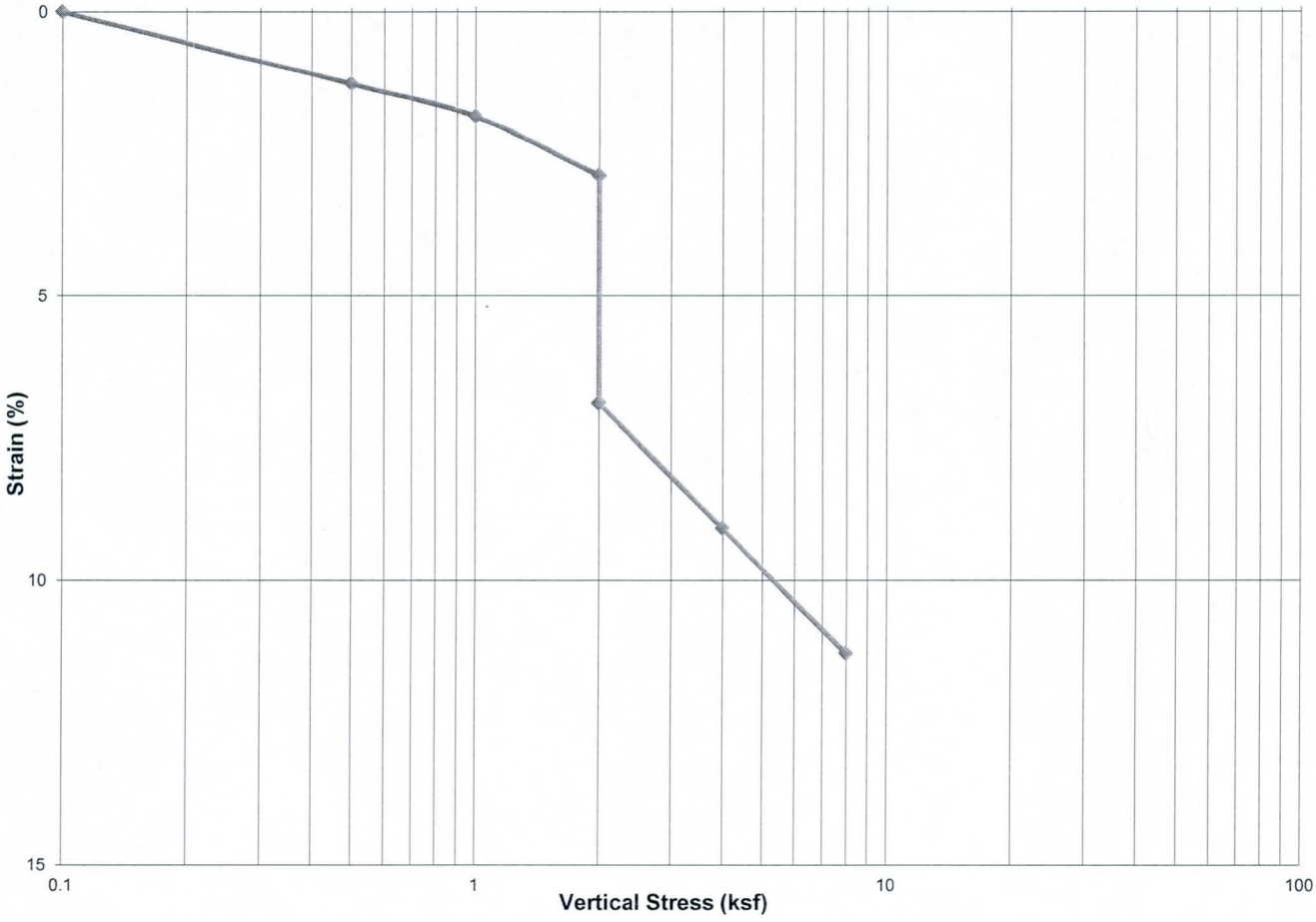
13146-1

SAMPLE SOURCE: **B4 @ 5-6'**

SPECIFIC GRAVITY: 2.65 (estimated)

	INITIAL	FINAL
Volume (in^3)	4.60	4.08
Moisture Content (%)	7.3	14.5
Dry Density (pcf)	104.0	117.3
Void Ratio	0.6	0.4
Degree of Saturation (%)	33	100

Saturated at 2 ksf: 4.0% Collapse



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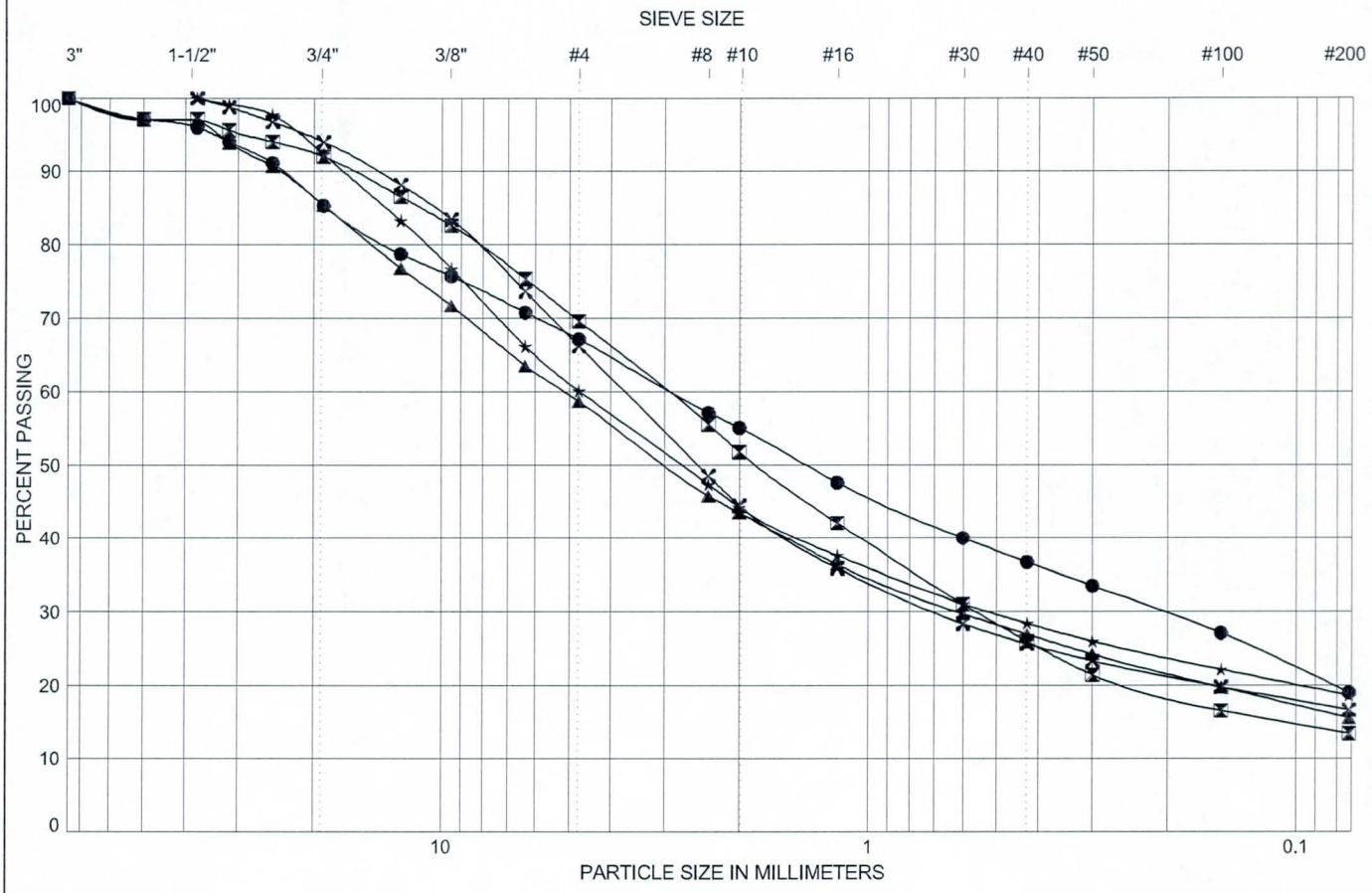
ONE-DIMENSIONAL CONSOLIDATION (ASTM D 2435)
Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE
B3

Report Date:	Project Number:
February 2014	138494

13146-1



Percent Passing

Symbol	Exploration ID	Approx. Depth (ft.)	Sample No.	3/4 inch	#4	#200	Liquid Limit	Plastic Limit	Plastic Index	Sample Description
●	B1	1 - 5	N/A	85	67	19	27	22	5	SILTY SAND WITH GRAVEL
⧓	B2	1 - 5	N/A	92	70	13	31	22	9	CLAYEY SAND WITH GRAVEL
▲	B3	1 - 5	N/A	85	59	16	25	16	9	CLAYEY SAND WITH GRAVEL
★	B4	1 - 5	N/A	92	60	19	26	18	8	CLAYEY SAND WITH GRAVEL
✕	B4	6 - 9	N/A	94	66	17	27	17	10	CLAYEY SAND WITH GRAVEL

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PROJECT NO.:	138494
DRAWN BY:	BP
CHECKED BY:	RP
DATE:	1/14/2014
REVISED:	1/29/2014

SIEVE ANALYSIS

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

B-4

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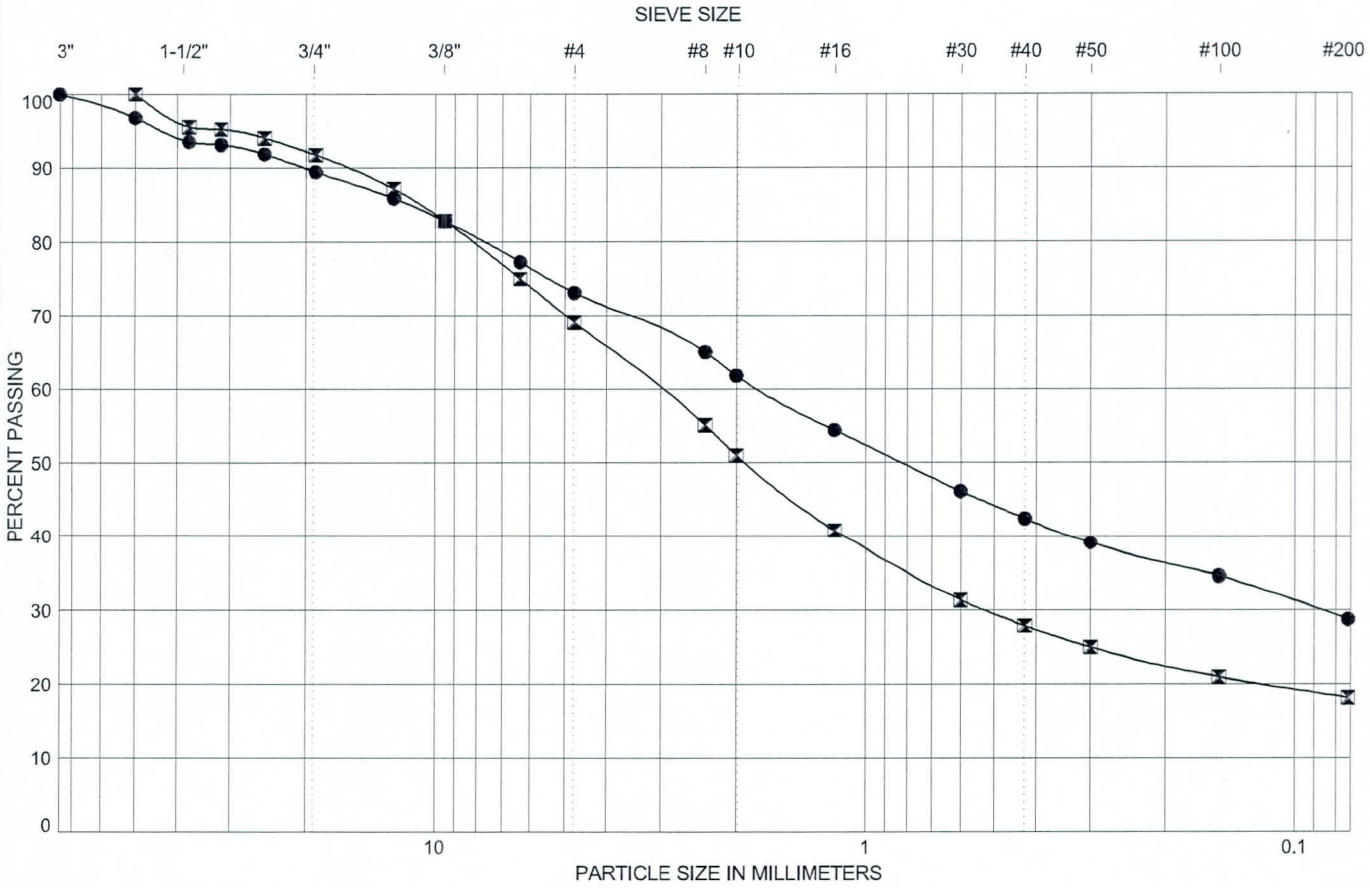

Percent Passing

Symbol	Exploration ID	Approx. Depth (ft.)	Sample No.	3/4 inch	#4	#200	Liquid Limit	Plastic Limit	Plastic Index	Sample Description
●	TP1	0 - 1.5	N/A	89	73	29	40	21	19	CLAYEY SAND WITH GRAVEL
⧓	TP4	2 - 3	N/A	92	69	18	44	30	14	SILTY SAND WITH GRAVEL

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PROJECT NO.:	138494
DRAWN BY:	BP
CHECKED BY:	RP
DATE:	1/14/2014
REVISED:	1/29/2014

SIEVE ANALYSIS

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

B-5

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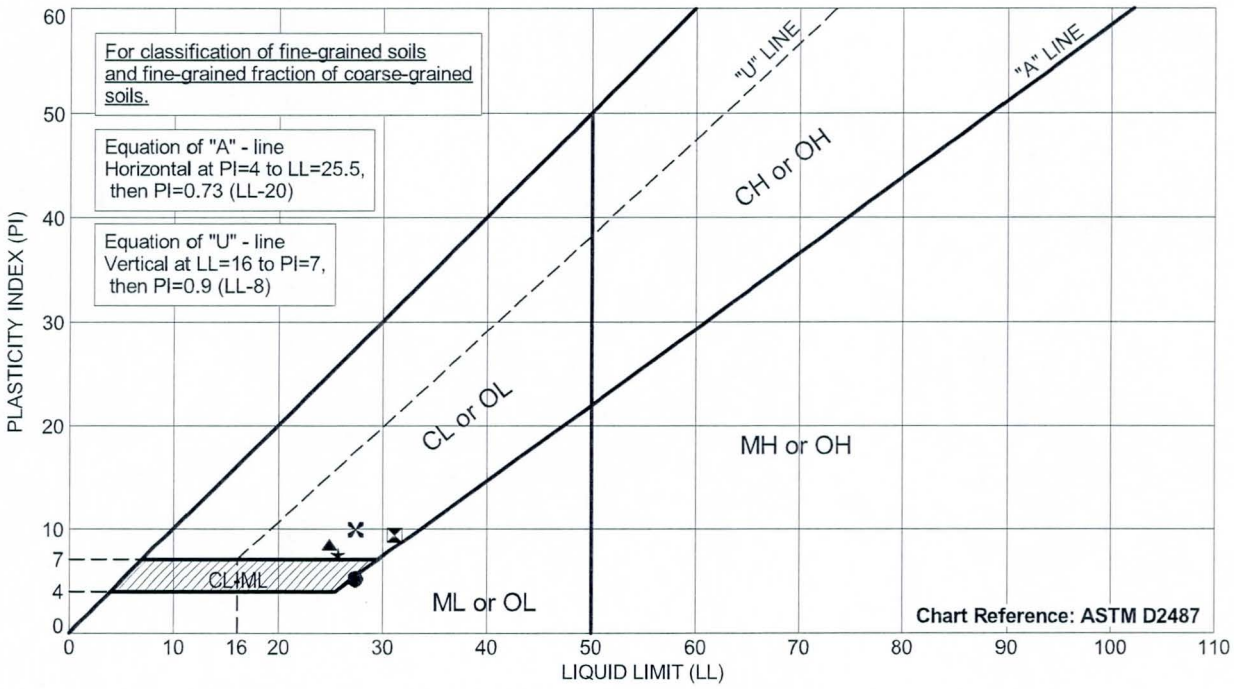

Symbol	Exploration ID	Approx. Depth (ft.)	Sample No.	Liquid Limit	Plastic Limit	Plasticity Index	Sample Description
●	B1	1 - 5	N/A	27	22	5	SILTY SAND WITH GRAVEL
⧓	B2	1 - 5	N/A	31	22	9	CLAYEY SAND WITH GRAVEL
▲	B3	1 - 5	N/A	25	16	9	CLAYEY SAND WITH GRAVEL
★	B4	1 - 5	N/A	26	18	8	CLAYEY SAND WITH GRAVEL
✕	B4	6 - 9	N/A	27	17	10	CLAYEY SAND WITH GRAVEL

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PROJECT NO.:	138494
DRAWN BY:	BP
CHECKED BY:	RP
DATE:	1/14/2014
REVISED:	1/29/2014

ATTERBERG LIMITS

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

B-6

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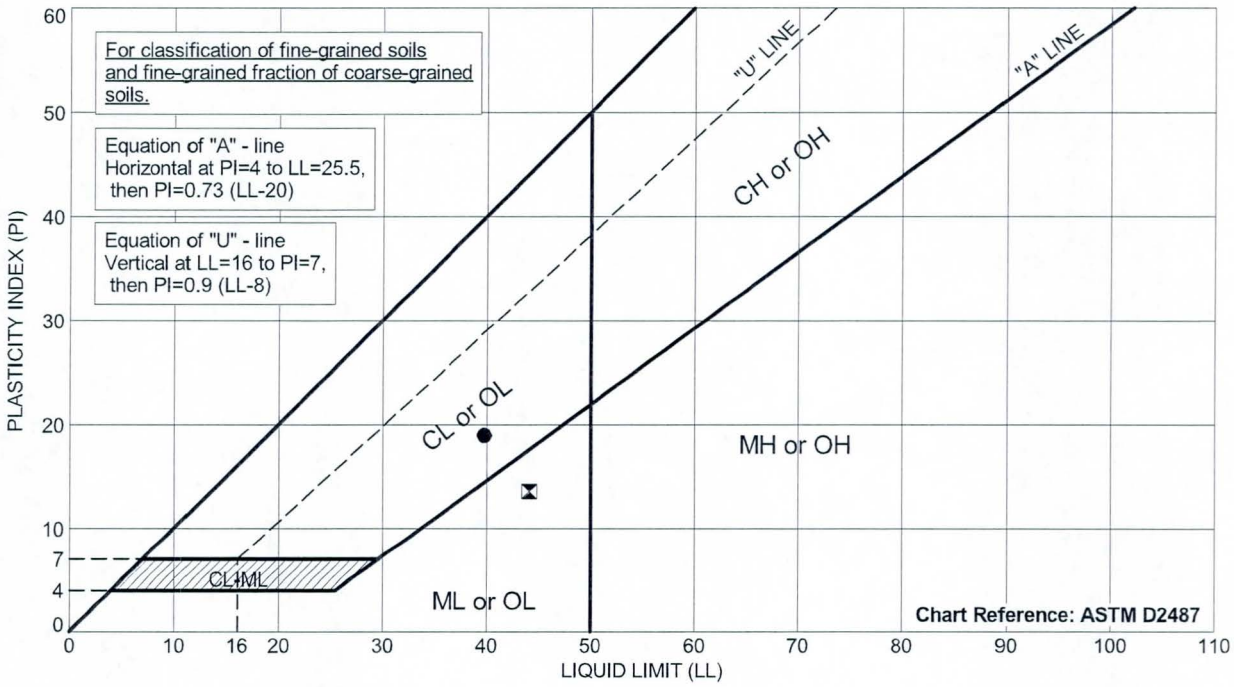

Symbol	Exploration ID	Approx. Depth (ft.)	Sample No.	Liquid Limit	Plastic Limit	Plasticity Index	Sample Description
●	TP1	0 - 1.5	N/A	40	21	19	CLAYEY SAND WITH GRAVEL
⧓	TP4	2 - 3	N/A	44	30	14	SILTY SAND WITH GRAVEL

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PROJECT NO.:	138494
DRAWN BY:	BP
CHECKED BY:	RP
DATE:	1/14/2014
REVISED:	1/29/2014

ATTERBERG LIMITS

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

PLATE

B-7

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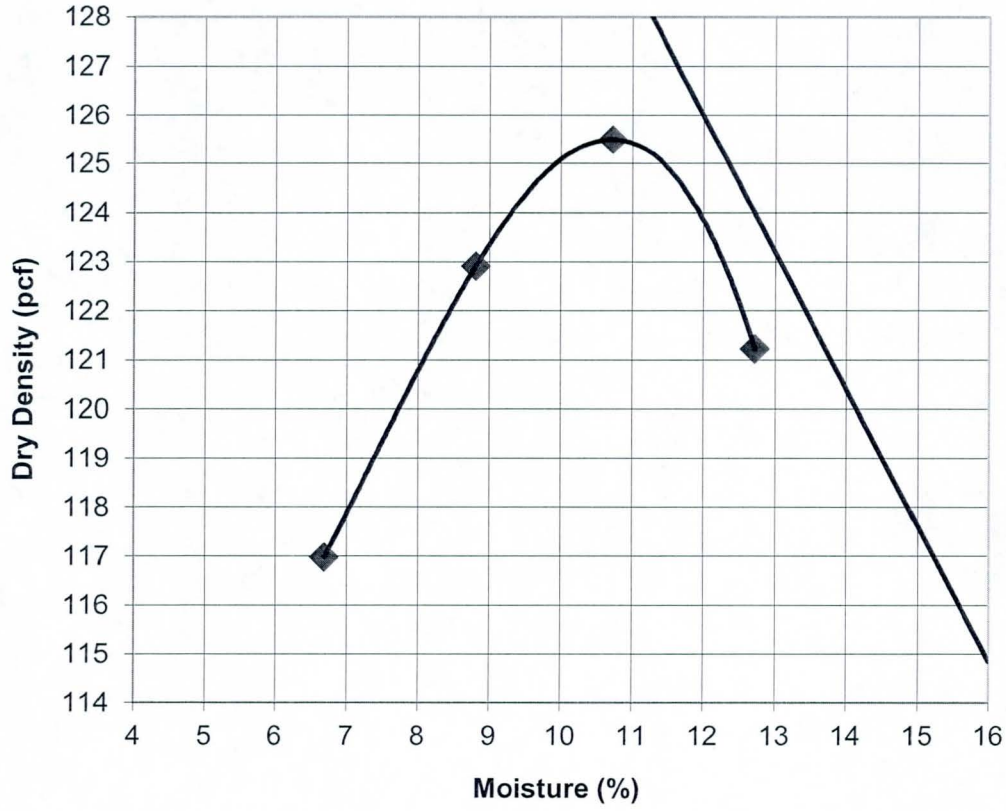
SAMPLE SOURCE: **B2 @ 1-5'**

Maximum Dry Density: **125.5 pcf**
Optimum Moisture Content: **10.7 %**



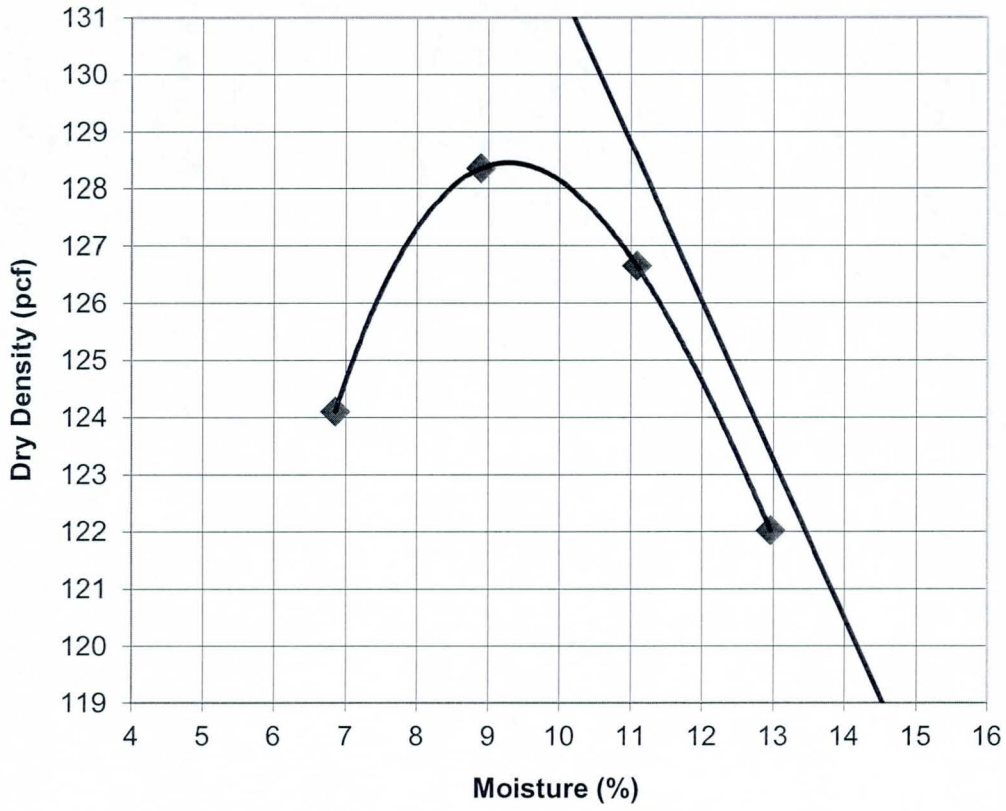
The zero air void curve represents an assumed specific gravity of 2.65

KLEINFELDER Bright People. Right Solutions.	**STANDARD PROCTOR (ASTM D698A)**	PLATE
Report Date: February 2014 / Project Number: 138494	Proposed Two Box Culverts Along Saguaro Blvd. and Bayfield Dr. Fountain Hills, Arizona	B8

14003-5

SAMPLE SOURCE: **B4 @ 1-5'**

Maximum Dry Density: **128.4 pcf**
Optimum Moisture Content: **9.3 %**



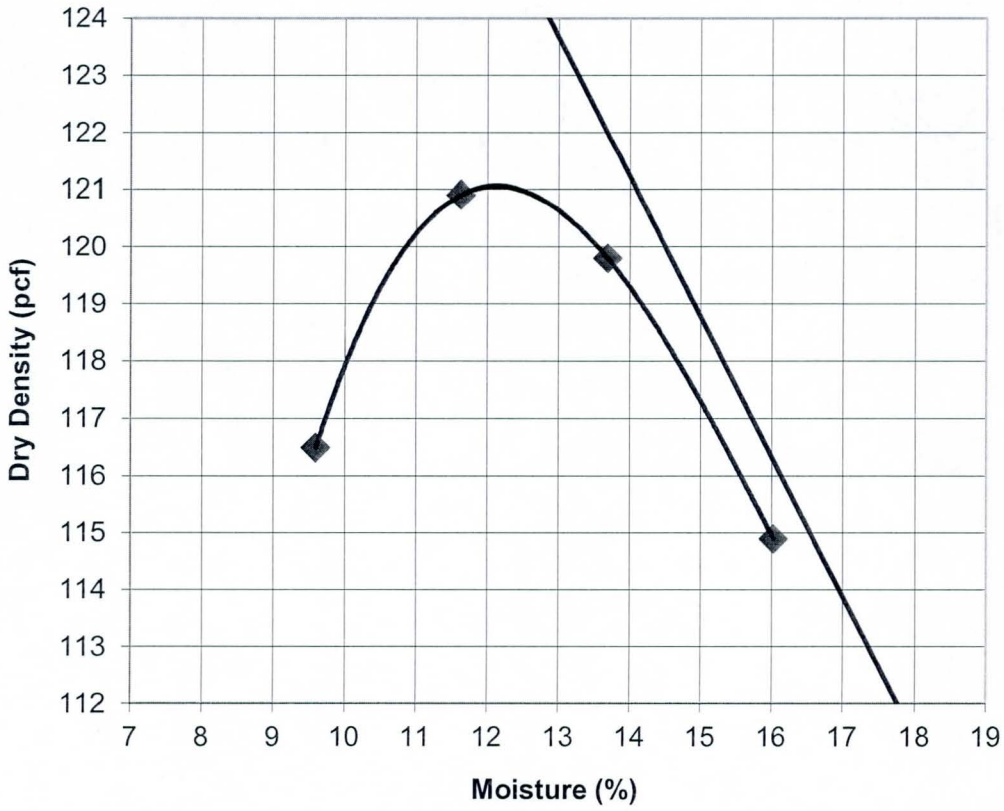
The zero air void curve represents an assumed specific gravity of 2.65

KLEINFELDER Bright People. Right Solutions.		**STANDARD PROCTOR (ASTM D698A)**	PLATE
Report Date: February 2014	Project Number: 138494	Proposed Two Box Culverts Along Saguaro Blvd. and Bayfield Dr. Fountain Hills, Arizona	B9

14003-7

SAMPLE SOURCE: **TP1 @ 0-1.5'**

Maximum Dry Density: **121.0 pcf**
Optimum Moisture Content: **12.1 %**



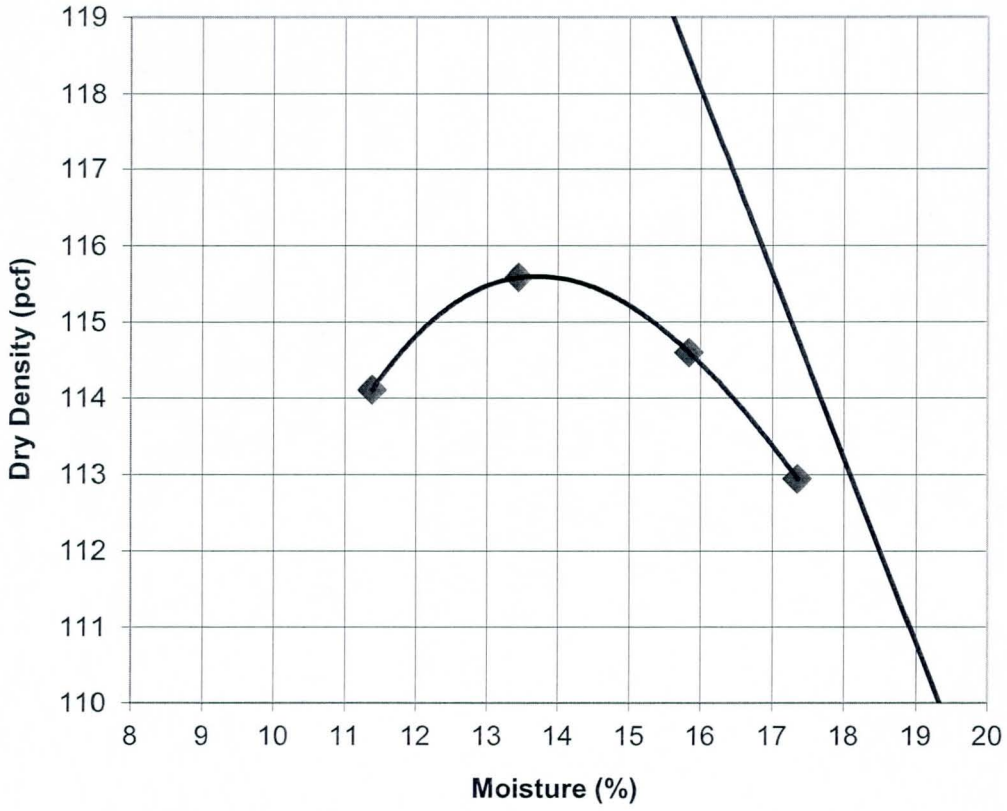
The zero air void curve represents an assumed specific gravity of 2.65

KLEINFELDER Bright People. Right Solutions.		**STANDARD PROCTOR (ASTM D698C)**	PLATE
Report Date: February 2014	Project Number: 138494	Proposed Two Box Culverts Along Saguaro Blvd. and Bayfield Dr. Fountain Hills, Arizona	B10

14004-1

SAMPLE SOURCE: **TP4 @ 2-3'**

Maximum Dry Density: **115.6 pcf**
Optimum Moisture Content: **13.7 %**



The zero air void curve represents an assumed specific gravity of 2.70

KLEINFELDER Bright People. Right Solutions.	STANDARD PROCTOR (ASTM D698C)	PLATE
Report Date: February 2014 / Project Number: 138494	Proposed Two Box Culverts Along Saguaro Blvd. and Bayfield Dr. Fountain Hills, Arizona	B11

14004-2

SAMPLE SOURCE: **B2 @ 1-5'**

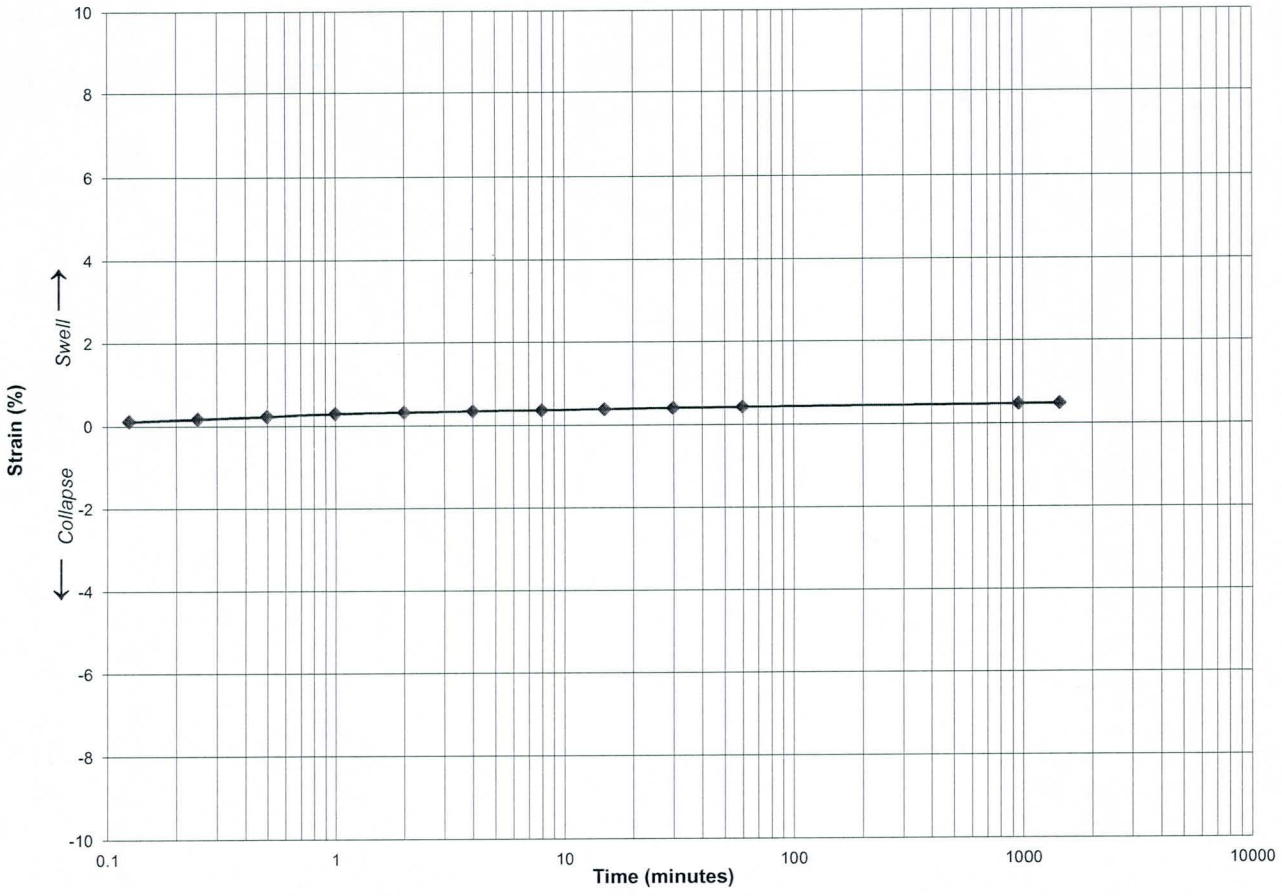
SPECIFIC GRAVITY: 2.65 (estimated)

Maximum Dry Density (pcf): 125.5
Optimum Moisture (%): 10.7

APPLIED STRESS: 144 psf

TEST PREPARATION: Specimen remolded to approximately 95% of maximum dry density at approximately 3% below optimum moisture, as determined by a standard proctor (ASTM D698).

0.5% Swell



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ONE-DIMENSIONAL FREE SWELL (ASTM D4546)

PLATE
B12

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

Report Date:	Project Number:
February 2014	138494

14003-5

SAMPLE SOURCE: **B4 @ 1-5'**

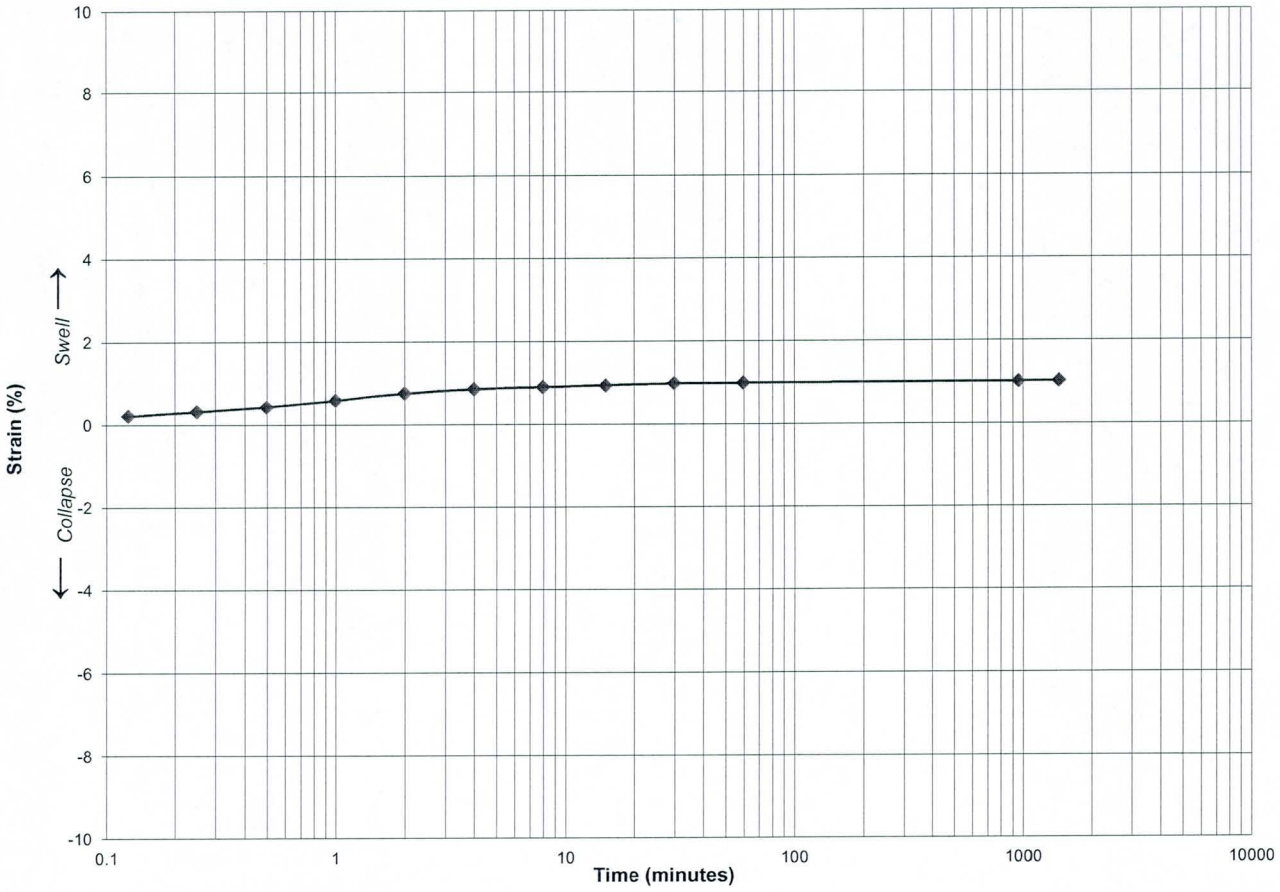
SPECIFIC GRAVITY: 2.65 (estimated)

Maximum Dry Density (pcf): 128.4
Optimum Moisture (%): 9.3

APPLIED STRESS: 144 psf

TEST PREPARATION: Specimen remolded to approximately 95% of maximum dry density at approximately 3% below optimum moisture, as determined by a standard proctor (ASTM D698).

1.0% Swell



KLEINFELDER
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ONE-DIMENSIONAL FREE SWELL (ASTM D4546)

PLATE
B13

Proposed Two Box Culverts
Along Saguaro Blvd. and Bayfield Dr.
Fountain Hills, Arizona

Report Date:	Project Number:
February 2014	138494

14003-7

MOTZZ LABORATORY, INC.

Soil Analysis Report

Kleinfelder
Sandra Lohkamp
1335 W Auto Dr
Tempe AZ 85284

Project: 138494-Saguaro Club
Sampler:
Date Received: 1/8/2014
Date Reported: 1/10/2014

PO Number: WO 14003

Lab Number: 909137-01 **14003-05 B2 @ 1'-5'**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	30	ppm	
Chloride, Cl	ARIZ 736	15	ppm	

Lab Number: 909137-02 **14003-07 B4 @ 1'-5'**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	50	ppm	
Chloride, Cl	ARIZ 736	29	ppm	

APPENDIX C

KLEINFELDER
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f | 480.763.1212

SOIL AND AGGREGATE

Project Number: 138494

Client Name: Flood Control District of Maricopa County
Address: 2801 West Durango Street
Phoenix, AZ 85009
Project Name: FCDMC Ashford Wash
Location: NW of N. Del Combre Ave. & E. Grande Blvd., Fountain Hills, AZ
Ref. Elevation: 0' = Subgrade Elevation

Field Technician: R. Katako Date: 1/10/2014
Proctor Method: ASTM D698C
Rock Corrected: no
Gauge ID: 19691 Standard Count: 1968, 676
Mode: Direct

Densities were performed on: ☑ :Site ☐ :Building ☐ :Offsite

Test No.	Approximate Location	Approximate Elevation (ft.)	Curve Lab. No.	Wet Density (pcf)	Dry Density (pcf)	**Laboratory Max. Dry Density (pcf)**	**Opt. Moisture (%)**	Actual Compaction (%)	Specified Compaction (%)	Specified Moisture Content Range (%)	Moisture Content (%)	Notes: (see below)	P = Pass F = Fail
1	TP1 Oriented North	-1'	14004-1	123.6	109.5	121.0	12.1	90			12.9	1	
2	TP1 Oriented West	-1'	14004-1	115.7	102.2	121.0	12.1	84			13.2	1	
3	TP1 Oriented South	-3.5'	14004-1	103.7	88.5	121.0	12.1	73			17.2	1	
4	TP1 Oriented South	-3.5'	14004-1	110.1	95.7	121.0	12.1	79			15.0	1	
5	TP1 Oriented West	-3.5'	14004-1	108.8	93.5	121.0	12.1	77			16.4	1	

Notes:
1. Subgrade
2. Subbase Fill
3. Base Course
4. Trench Backfill
5. Engineered Fill
6. Structural Backfill

Reviewed by: Ramon Padilla

KLEINFELDER
Bright People. Right Solutions.

1335 West Auto Drive
Tempe, AZ 85284
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SOIL AND AGGREGATE

Project Number: 138494

Client Name: Flood Control District of Maricopa County

Address: 2801 West Durango Street
Phoenix, AZ 85009

Project Name: FCDMC Ashford Wash

Location: NW of N. Del Combre Ave. & E. Grande Blvd., Fountain Hills, AZ

Ref. Elevation: 0' = Subgrade Elevation

Field Technician: R. Katako Date: 1/10/2014

Proctor Method: ASTM D698C

Rock Corrected: no

Gauge ID: 19691 Standard Count: 1968, 676

Mode: Direct

Densities were performed on: ☑ :Site ☐ :Building ☐ :Offsite

Test No.	Approximate Location	Approximate Elevation (ft.)	Curve Lab. No.	Wet Density (pcf)	Dry Density (pcf)	**Laboratory Max. Dry Density (pcf)**	**Opt. Moisture (%)**	Actual Compaction (%)	Specified Compaction (%)	Specified Moisture Content Range (%)	Moisture Content (%)	Notes: (see below)	P = Pass F = Fail
1	TP2 Oriented West	-.8'	14004-1	115.1	101.9	121.0	12.1	84			12.9	1	
2	TP2 Oriented South	-.8'	14004-1	109.2	92.2	121.0	12.1	76			18.4	1	

Notes:
1. Subgrade
2. Subbase Fill
3. Base Course
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5. Engineered Fill
6. Structural Backfill

Reviewed by: Ramon Padilla

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SOIL AND AGGREGATE

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Densities were performed on: ☑ :Site ☐ :Building ☐ :Offsite

Test No.	Approximate Location	Approximate Elevation (ft.)	Curve Lab. No.	Wet Density (pcf)	Dry Density (pcf)	**Laboratory Max. Dry Density (pcf)**	**Opt. Moisture (%)**	Actual Compaction (%)	Specified Compaction (%)	Specified Moisture Content Range (%)	Moisture Content (%)	Notes: (see below)	P = Pass F = Fail
1	TP3 Oriented North 2"	-1'	14004-2	109.9	98.9	115.6	13.7	86			11.1	1	
2	TP3 Oriented West 2"	-1'	14004-2	120.3	104.5	115.6	13.7	90			15.1	1	
3	TP3 Oriented North 2"	-1'	14004-2	120.4	105.0	115.6	13.7	91			14.7	1	

Notes:
1. Subgrade
2. Subbase Fill
3. Base Course
4. Trench Backfill
5. Engineered Fill
6. Structural Backfill

Reviewed by: Ramon Padilla

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SOIL AND AGGREGATE

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Field Technician: R. Katako Date: 1/10/2014
Proctor Method: ASTM D698C
Rock Corrected: no
Gauge ID: 19691 Standard Count: 1968, 676
Mode: Direct

Densities were performed on: ☑ :Site ☐ :Building ☐ :Offsite

Test No.	Approximate Location	Approximate Elevation (ft.)	Curve Lab. No.	Wet Density (pcf)	Dry Density (pcf)	**Laboratory Max. Dry Density (pcf)**	**Opt. Moisture (%)**	Actual Compaction (%)	Specified Compaction (%)	Specified Moisture Content Range (%)	Moisture Content (%)	Notes: (see below)	P = Pass F = Fail
1	TP4 Oriented North	-1'	14004-2	124.0	104.4	115.6	13.7	90			18.8	1	
2	TP4 Oriented West	-1'	14004-2	122.5	104.3	115.6	13.7	90			17.5	1	
3	TP4 Oriented North	-3'	14004-2	123.5	112.6	115.6	13.7	97			9.7	1	
4	TP4 Oriented West	-3'	14004-2	127.9	116.0	115.6	13.7	100			10.3	1	

Notes:
1. Subgrade
2. Subbase Fill
3. Base Course
4. Trench Backfill
5. Engineered Fill
6. Structural Backfill

Reviewed by: Ramon Padilla

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SOIL AND AGGREGATE

Project Number: 138494

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Rock Corrected: no
Gauge ID: 19691 Standard Count: 1968, 676
Mode: Direct

Densities were performed on: ☑ :Site ☐ :Building ☐ :Offsite

Test No.	Approximate Location	Approximate Elevation (ft.)	Curve Lab. No.	Wet Density (pcf)	Dry Density (pcf)	**Laboratory Max. Dry Density (pcf)**	**Opt. Moisture (%)**	Actual Compaction (%)	Specified Compaction (%)	Specified Moisture Content Range (%)	Moisture Content (%)	Notes: (see below)	P = Pass F = Fail
1	TP5 Oriented West 8"	-1'	14004-2	125.6	111.9	115.6	13.7	97			12.2	1	
2	TP5 Oriented North 8"	-1'	14004-2	130.3	116.7	115.6	13.7	100			11.7	1	

Notes:
1. Subgrade
2. Subbase Fill
3. Base Course
4. Trench Backfill
5. Engineered Fill
6. Structural Backfill

Reviewed by: Ramon Padilla

KLEINFELDER
Bright People. Right Solutions.

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Gauge ID: 19691 Standard Count: 1968, 676
Mode: Direct

Densities were performed on: ☑ :Site ☐ :Building ☐ :Offsite

Test No.	Approximate Location	Approximate Elevation (ft.)	Curve Lab. No.	Wet Density (pcf)	Dry Density (pcf)	**Laboratory Max. Dry Density (pcf)**	**Opt. Moisture (%)**	Actual Compaction (%)	Specified Compaction (%)	Specified Moisture Content Range (%)	Moisture Content (%)	Notes: (see below)	P = Pass F = Fail
1	TP6 Oriented North BS	-1'	14004-1	127.3	120.0	121.0	12.1	99			6.1	1	
2	TP6 Oriented West BS	-1'	14004-1	128.9	121.5	121.0	12.1	100			6.1	1	
3	TP6 Oriented North BS	-3'	14004-1	129.1	119.2	121.0	12.1	99			8.3	1	
4	TP6 Oriented West BS	-3'	14004-1	125.8	115.7	121.0	12.1	96			8.7	1	
5	TP6 Oriented West BS	-3'	14004-1	127.7	118.8	121.0	12.1	98			7.5	1	

Notes:
1. Subgrade
2. Subbase Fill
3. Base Course
4. Trench Backfill
5. Engineered Fill
6. Structural Backfill

Reviewed by: Ramon Padilla