GEOTECHNICAL EVALUATION
GANTZEL ROAD
HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA
PINAL COUNTY PROJECT NO. 2170001

PREPARED FOR:
T.Y. Lin International
60 East Rio Salado Parkway, Suite 501
Tempe, Arizona 85281

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
3202 East Harbour Drive
Phoenix, Arizona 85034

August 22, 2014
Project No. 601868005

August 22, 2014
Project No. 601868005

Mr. James Barr, PE
T.Y. Lin International
60 East Rio Salado Parkway, Suite 501
Tempe, Arizona 85281

Subject: Geotechnical Evaluation
Gantzel Road
Hunt Highway to Bella Vista Road
Pinal County Project No. 2170001

Dear Mr. Barr:

In accordance with our revised proposal dated February 7, 2013, and your authorization, Ninyo & Moore has performed a geotechnical evaluation for the above-referenced project. The attached report presents our methodologies, findings, conclusions, and recommendations regarding the geotechnical conditions at the project site.

We appreciate the opportunity to be of service to you during this phase of the project.

Sincerely,
NINYO & MOORE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 41716
KEVIN L. PORTER
Date Signed 8-22-14
ARIZONA U.S.A.
EXPIRES 12/31/16

Kevin L. Porter, PE
Senior Engineer

Soumitra Guha, PhD, PE, GE
Principal Engineer

DCR/KLP/SG/clj

Distribution: (1) Addressee (Electronic Copy)

TABLE OF CONTENTS

Page

1. INTRODUCTION 1
2. SCOPE OF SERVICES 1
3. SITE DESCRIPTION 2
4. PROJECT DESCRIPTION 3
5. FIELD EXPLORATION AND LABORATORY TESTING 3
6. GEOLOGY AND SUBSURFACE CONDITIONS 4
   6.1. Geologic Setting 4
   6.2. Subsurface Conditions 5
      6.2.1. Alluvium 5
      6.2.2. Groundwater 5
7. GEOLOGIC HAZARDS 6
   7.1. Land Subsidence and Earth Fissures 6
   7.2. Faulting 7
8. CONCLUSIONS 7
9. RECOMMENDATIONS 8
   9.1. Earthwork 8
      9.1.1. Excavations 8
      9.1.2. Grading, Fill Placement, and Compaction 9
      9.1.3. Imported Fill Material 12
   9.2. Pavement Design Summary 12
      9.2.1. Traffic Volumes and Truck Factor Growth Rates 12
      9.2.2. Resilient Modulus 13
      9.2.3. Serviceability 13
      9.2.4. Standard Deviation and Level of Reliability 13
      9.2.5. Pavement Design Recommendations 13
   9.3. Corrosion 14
   9.4. Concrete 15
   9.5. Site Drainage 15
   9.6. Pre-Construction Conference 16
   9.7. Construction Observation and Testing 16
10. LIMITATIONS 16
11. REFERENCES 18

Tables

Table 1 – Approximate Station Limits for Subgrade Improvement Areas.....11
Table 2 – Recommended Pavement Section.....13

Figures

Figure 1 – Site Location
Figure 2 – Boring Locations

Appendices

Appendix A – Boring Logs
Appendix B – Laboratory Testing

1. INTRODUCTION

In accordance with our proposal dated February 7, 2013, and your authorization, we have performed a geotechnical evaluation for the proposed Gantzel Road Improvement project in Pinal County, Arizona. The project consists of the design and construction of Gantzel Road. The purpose of our evaluation was to assess the subsurface conditions along the project alignment in order to formulate geotechnical recommendations for design and construction. This report presents the results of our evaluation and our geotechnical conclusions and recommendations regarding the proposed improvements.

2. SCOPE OF SERVICES

The scope of our services for the project generally included:

- Reviewing available geologic literature, geologic maps, and aerial photographs pertinent to the project site.
- Obtaining Right-of-Way permits from Pinal County to conduct field work within County Right-of-Way.
- Conducting a visual geologic reconnaissance of the project area.
- Conducting a site visit to mark out the boring locations and notifying Arizona Blue Stake of the locations prior to excavating.
- Drilling, logging, and sampling of seven small-diameter exploratory borings to depths of up to approximately 5 feet below ground surface (bgs). The boring logs are presented in Appendix A.
- Performing laboratory tests on selected samples obtained from the borings to evaluate in-situ moisture content and dry density, gradation analysis, Atterberg limits, Proctor density, R-value, swell potential, and corrosivity characteristics (including pH, minimum electrical resistivity, soluble sulfate, and chloride contents). The results of the laboratory testing are presented on the boring logs in Appendix A and/or in Appendix B.
- Preparing this report presenting our findings, conclusions, and recommendations regarding the design and construction of the proposed improvements.

Our scope of services did not include environmental consulting services such as hazardous waste sampling or analytical testing at the site. A detailed scope of services and estimated fee for such services can be provided upon request.

3. SITE DESCRIPTION

The project alignment is situated within Section 20 in Township 3 South, Range 8 East relative to the Salt River Meridian Baseline, along the proposed alignment of Gantzel Road in Pinal County, Arizona as shown on Figure 1. At the time of our evaluation, Gantzel Road was a partially asphalt concrete (AC)-paved, north-south trending two-lane road between Bella Vista Road and Denim Trail. Gantzel Road south of Denim Trail is an unpaved roadway and agricultural land. The roadway was flanked by undeveloped desert and agricultural land near the northeastern limits, and residential development and agricultural land near the southern limits. The San Tan Mountains are situated to the west of the alignment.

Based on the *Sacaton NE, Arizona 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Map (2011)*, the elevation of the project site ranged from approximately 1,500 feet relative to mean sea level (MSL) at the northern limits to approximately 1,520 feet MSL near the southern limits. The topography of the site vicinity generally slopes from the southwest down to the northeast.

Several aerial photographs were reviewed for this project. A 1937 Flood Control District of Maricopa County (FCDMC) photograph depicted undeveloped desert land that is dissected by many northeast-southwest traversing natural drainages. A 2000 FCDMC photograph depicted agricultural land within the limits of the project. A 2002 FCDMC photograph depicted the beginning of residential construction along the western limit of the site. Photographs from Google Earth™ were also reviewed. A 1992 Google Earth™ photograph depicted agricultural land use within the site limits. A 2003 Google Earth™ photograph depicted Gantzel Road as a paved roadway, in its current alignment. A 2005 Google Earth™ photograph depicted grading for the residential development east of the project alignment. The subsequent Google Earth™

photographs show the residential development and agricultural use as it is depicted in the current 2013 photograph.

4. PROJECT DESCRIPTION

The project consists of the design and construction of Gantzel Road, from Hunt Highway to Bella Vista Road. The roadway will be designed in two phases; Phase 1 from Bella Vista Road south to Omega Drive, and Phase 2 from Omega Drive across existing agricultural land to Hunt Highway. We understand that portions of Bella Vista Road will be widened in some areas. The new roadway will consist of three lanes in each direction separated by a raised median with curb, gutter, and sidewalks. We understand that the existing pavement will be removed and the new roadway will generally be near existing grade, except for portions of Phase 2, where up to several feet of grade-raise fill may be needed to establish the roadway profile across the agricultural land.

We understand that the new roadway section will consist of an AC section and the roadway will be designed using the American Association of State Highway and Transportation (AASHTO) pavement design method.

5. FIELD EXPLORATION AND LABORATORY TESTING

On November 14, 2013, and July 30, 2014, Ninyo & Moore conducted subsurface explorations at the project site in order to evaluate the existing subsurface conditions and to collect soil samples for laboratory testing. The field exploration consisted of drilling, logging, and sampling of seven small-diameter exploratory borings, denoted as B-1 through B-7, to a depth of up to about 5 feet bgs using a CME-75 truck-mounted drill rig equipped with hollow-stem augers. Figure 2 presents the approximate locations of the soil borings. Bulk and relatively undisturbed soil samples were collected at selected depth intervals from the exploratory borings. Detailed descriptions of the soils encountered in the borings are presented on the boring logs in Appendix A.

The soil samples collected from our field exploration were transported to the Ninyo & Moore laboratory in Phoenix, Arizona for geotechnical laboratory testing. The analysis included in-situ moisture content and dry density, gradation analysis, Atterberg limits, Proctor density, R-value, swell potential, and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). The results of the in-situ moisture content and dry density testing are presented on the boring logs in Appendix A. A description of each laboratory test method, and the remainder of the test results are presented in Appendix B.

6. GEOLOGY AND SUBSURFACE CONDITIONS

The geology and subsurface conditions at the site are described in the following sections.

6.1. Geologic Setting

The project site is situated in the Sonoran Section of the Basin and Range physiographic province. The Basin and Range physiographic province is typified by broad alluvial valleys separated by steep, discontinuous, and subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 10 to 18 million years ago during the Mid- to Late-Tertiary. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with alluvium from the erosion of the surrounding mountains as well as from river deposition. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site generally consists of two units described as Holocene (<10,000 years) alluvial deposits. One unit which underlies much of the site, generally consists of low terrace alluvial deposits of silt, sand, gravel, cobbles, and boulders with very

little calcic cementation. These deposits are generally near active ephemeral streams. The other geologic unit is described as young (<5,000 years) ephemeral stream deposits that generally consist of poorly sorted deposits of silt, sand, gravel, cobbles, and boulders (Huckleberry, 1994).

6.2. Subsurface Conditions

Our knowledge of the subsurface conditions at the project site is based on our field exploration and laboratory testing, and our understanding of the general geology of the area. Detailed descriptions of the subsurface conditions encountered in our borings are presented in Appendix A.

6.2.1. Alluvium

Alluvium was encountered at the surface of our borings and extended to the total explored depths. We also anticipate that several feet of tilled alluvium will be encountered within the existing farm fields located in Phase 2, although the borings were not advanced within the fields. The alluvium encountered generally consisted of loose to very dense clayey sand and very stiff to hard sandy clay in our borings. Varying amounts of gravel along with scattered caliche filaments and nodules were also observed.

6.2.2. Groundwater

Groundwater was not encountered in our borings. Based on well data provided by the Arizona Department of Water Resources (ADWR), the average regional groundwater table has historically been measured at approximately 350 feet bgs in nearby wells. Groundwater levels can fluctuate due to seasonal variations in precipitation, irrigation, groundwater withdrawal or injection, and in areas where the alignment crosses ephemeral washes. In general, groundwater is not anticipated to be a constraint to the design and construction of the project.

7. GEOLOGIC HAZARDS

The following sections describe potential geologic hazards at the site, including land subsidence and earth fissures, and faulting.

7.1. Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land (Schumann and Genualdi, 1986). From 1948 to 1983, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation resulting in large areas of land subsidence.

In Arizona, earth fissures are generally associated with land subsidence, and pose an on-going geologic hazard. Earth fissures generally form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Reportedly, earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces (Schumann and Genualdi, 1986).

The Arizona Geological Survey (AZGS) has published maps of documented earth fissure study areas in Arizona. The closest AZGS study area is the Chandler Heights Study Area to the northwest of the project site (AZGS, 2008). Based on our review of this AZGS earth fissure map, the nearest documented earth fissures are located approximately 4 miles northwest of the project along Skyline Drive near the intersection of San Tan Heights Boulevard. A larger network of earth fissures is located west of the intersection of Thompson Road and Hunt Highway approximately 4.5 miles to the northwest of the site. Due to the unpredictable nature of earth fissures, as well as the difficulty of observing fissures that are not yet projected to the surface, earth fissures may be a constraint to the

design and construction of the project. If an earth fissure or soil cracking is encountered during construction, specifically during the earthwork operations, Ninyo & Moore should be notified immediately for further recommendations.

7.2. Faulting

The site lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations, review of pertinent geologic data, and analysis of aerial photographs, faults are not located on or adjacent to the property. The closest Quaternary fault to the project site is the Sugarloaf Fault Zone, situated approximately 35 miles to the north of the site. The Sugarloaf Fault Zone is situated along the western margin of a small sedimentary basin near the bottom of the Mazatzal Mountains. This fault zone is a series of northwest-striking normal faults that generally dip to the northeast. Recent movement along this fault was approximately 130,000 years ago during the Middle to Late Pleistocene epoch. The slip-rate category of this fault is less than 0.2 millimeters per year (Pearthree, 1998).

8. CONCLUSIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, it is our opinion that the proposed construction for the new roadway improvements is feasible from a geotechnical standpoint, provided that the recommendations of this report are incorporated into the design and construction of the proposed project, as appropriate. Geotechnical considerations include the following:

- The near-surface on-site soils should be excavatable using heavy-duty excavation equipment in good working condition.
- Imported soils and soils generated from on-site excavation activities that exhibit relatively low plasticity indices can generally be used as engineered fill.

- Based on the results of our field and laboratory evaluations, it is our opinion that new pavements should be founded on a zone of moisture-conditioned and compacted engineered fill. We estimate an earthwork (shrinkage) factor of approximately 10 to 20 percent for the on-site soils.

- Corrosivity test results indicate that the subgrade materials are generally corrosive to ferrous materials and the sulfate content of the soils presents a negligible sulfate exposure for concrete.

- Groundwater levels, based on historic nearby well data, indicate that regional groundwater depths are approximately 350 feet bgs.

- No known or documented geologic hazards are present underlying the site; however, earth fissures have been documented about 4.5 miles northwest of the project alignment. If an earth fissure or soil cracking is encountered during construction, specifically during the earthwork operations, Ninyo & Moore should be notified immediately for further recommendations.

9. RECOMMENDATIONS

Based on our understanding of the project, the following recommendations are provided for the design and construction of the proposed roadway improvements. If the proposed construction is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations.

9.1. Earthwork

The following sections provide our earthwork recommendations for this project. In general, the earthwork specifications contained in Maricopa Association of Governments (MAG), *Uniform Standard Specifications and Details for Public Works Construction*, are expected to apply, except as noted.

9.1.1. Excavations

Our evaluation of the excavation characteristics of the on-site materials is based on the results of our exploratory borings, site observations, and our experience with similar materials. Based on our evaluation, excavation of the near-surface on-site surface soils

can generally be accomplished using heavy-duty excavation equipment in good working condition. However, caliche nodules and filaments were encountered in some of our borings. This material might be more difficult to excavate and might slow the excavation rate depending on the actual degree of cementation encountered during construction. In addition, based on historical aerial photography review, several natural drainages crossed the project alignment. This may result in changes in soil conditions along the alignment that may not have been observed in our widely spaced borings.

For planning purposes, when considering temporary excavations, we recommend that the Occupational Safety and Health Administration (OSHA) soil "*Type C*" be used for the fill and alluvial soils, and a temporary side slope of 1.5 horizontal to 1 vertical (1.5H:1V), or flatter, be used for sloped excavations that are less than 20 feet deep.

9.1.2. Grading, Fill Placement, and Compaction

Vegetation and debris from the clearing operation, as well as demolition debris (if any), should be removed from the site and disposed of at a legal dumpsite. Obstructions that extend below finish grade, if present, should be removed and the resulting holes filled with compacted soil.

The geotechnical consultant should carefully evaluate any areas of soft or wet soils prior to placement of grade-raise fill or other construction. Drying or overexcavation of some materials may be appropriate.

On-site and imported soils that exhibit relatively low plasticity indices are generally suitable for re-use as engineered fill. Relatively low plasticity indices are defined as a Plasticity Index (PI) value of less than 15, as defined by the American Society for Testing and Materials (ASTM) Test Method D 4318. The Atterberg limits test performed on selected samples from our borings resulted in PI values ranging from 14 to 20. As such, it is our opinion that some of the on-site soils will not be suitable for re-use as engineered fill during construction unless suitably mixed or processed with other

materials. Because our borings are spaced widely apart along the project alignment, not every soil condition could be observed in the field during our field exploration. As such, there may be areas of unacceptable soils encountered during construction. Additional field sampling and laboratory testing may be needed during construction to evaluate the suitability of the site soils.

In addition to the above recommendations, suitable fill below new pavement should not have an R-value less than 25, or include organic material, construction debris, or other non-soil fill materials. Rock particles and clay lumps should not be larger than 4 inches in dimension. Unsuitable fill material should be disposed of off-site or in non-structural areas.

Based on relative densities observed in our borings, for preparation to receive grade-raise fill or new pavement within Phase 1, we recommend that the existing materials be improved to a depth of 12 inches, or more. This improvement may include scarification or overexcavation and replacement with moisture-conditioned and compacted engineered fill, as noted below.

Based on the presence of tilled alluvium in the fields within Phase 2, and that grade-raise fill will be needed to establish the roadway profile, we recommend that the existing soils be overexcavated to a depth of 3 feet below existing grade and replaced with moisture-conditioned and compacted engineered fill, as noted below.

Engineered fill material should be compacted by appropriate mechanical methods to 95 percent relative compaction, as evaluated by ASTM D 698 at a moisture content generally near optimum. The improvement below these areas should extend laterally to a distance that is equivalent to the depth of improvement beyond the embankment fill or pavement footprint.

As stated previously, the borings disclosed alluvial deposits, consisting primarily of clayey sand and sandy clay. The laboratory testing indicates that some of the existing

subgrade soils may have low R-values and/or a high percentage of material passing the No. 200 sieve and/or a high plasticity. Therefore, we recommend that the roadway subgrade areas that exhibited R-values less than 25 be improved by overexcavation and replacement with suitable material. The depth of overexcavation should be as needed to provide 3 or more feet of suitable material beneath the pavement section. This improvement should extend laterally to a distance that is equivalent to the depth of improvement beyond the edge of the pavement. For areas to receive 3 or more feet of engineered fill, subgrade improvement is not needed, except as noted in preparation for fill placement, provided the upper 3 feet has an R-value of 25 or more. As an alternative, a geogrid may be placed beneath the aggregate base (AB) layer on the exposed subgrade.

Table 1 summarizes the area where overexcavation will probably be needed. Improvement may be needed at other locations if the exposed subgrade material does not meet the R-value requirement.

Table 1 – Approximate Station Limits for Subgrade Improvement Areas

Boring No.	R-Value	Approximate Station Limits
B-2	17*	149+00 to 157+00±
Notes: * Tested R-value		

Engineered fill should be placed in horizontal lifts no more than approximately 8 inches in loose thickness and compacted by appropriate mechanical methods to a relative compaction of 95 percent as evaluated by ASTM D 698 and at a moisture content generally near optimum. An earthwork (shrinkage) factor of 10 to 20 percent for the on-site soils is estimated.

Following the overexcavation as described above, and prior to the placement of new fill, the resulting exposed surface should be carefully evaluated by Ninyo & Moore for

the presence of soft, loose, or wet native alluvial soils. Proof-rolling of the exposed surface should be observed by Ninyo & Moore. Based on this evaluation, additional remediation may be needed. This could include scarification of the exposed surface. This additional remediation, if needed, should be addressed by the geotechnical consultant during the earthwork operations.

9.1.3. Imported Fill Material

Imported fill, if utilized, should consist of granular material meeting the specifications outlined in MAG Section 210. In addition, material needed within 3 feet of the roadway subgrade should have an R-value of 25 or more. Import material in contact with ferrous materials should preferably have low corrosion potential [minimum resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million (ppm)]. In lieu of this, corrosion protection techniques (e.g., cathodic protection, pipe wrapping, etc.), can be implemented. A corrosion specialist should be consulted for recommendations. Imported material in contact with concrete should have a soluble sulfate content of less than 0.1 percent. The geotechnical consultant should evaluate such materials and details of their placement prior to importation.

9.2. Pavement Design Summary

For the new pavements, we assume that an asphaltic concrete section will be used. The pavement section given below is assumed to bear on imported or improved on-site soils with an R-value of 25, or more. The pavement design was performed in general accordance with AASHTO Pavement Design Methods.

9.2.1. Traffic Volumes and Truck Factor Growth Rates

The traffic loading information used for the roadway design was obtained from TY Lin International. For Gantzel Road, a two-way average daily traffic (ADT) value of 18,000 vehicles per day along with 6 percent heavy trucks and an annual growth rate of 2 percent was used for the design of this roadway.

9.2.2. Resilient Modulus

As discussed above, a design R-value of 25 was used in our analysis. Based on an R-value of 25 and a seasonal variation factor of 1.2, a resilient modulus of 13,356 pounds per square inch (psi) was calculated.

9.2.3. Serviceability

An initial serviceability of 4.1 and a terminal serviceability of 2.6 were used for the design of flexible pavements. The resulting serviceability index loss is 1.5.

9.2.4. Standard Deviation and Level of Reliability

A standard deviation of 0.45 was used for the design of the roadway pavement. A level of reliability of 90 percent was used for the design. A standard normal deviation (Z_R) value of -1.282 was used for 90 percent reliability.

9.2.5. Pavement Design Recommendations

Based on the inputs noted above, the 20-year design Equivalent Single Axle Loads (ESALs) was calculated to be about 2,816,500, resulting in a structural number of 3.38 inches. Table 2 below presents our recommended pavement section for Gantzel Road. The AC and AB gradation should meet MAG 2013 or any Pinal County specifications.

Table 2 – Recommended Pavement Section

Pavement Section	AC (in)	AB (in)	Pavement Section Thickness (in)
Gantzel Road	6.0	8.0	14.0

As an alternative, if the subgrade is mechanically stabilized with a layer of geogrid reinforcement beneath the AB layer, the pavement section can be reduced to 5 inches of AC over 6 inches of AB over a triaxial TX-5 geogrid conforming to MAG Section 306, or better. If other geogrid types are considered, calculations should be submitted and

approved by Pinal County demonstrating that they meet the design ESALs and structural number noted above.

9.3. Corrosion

The corrosion potential was evaluated using the results of our laboratory testing on a soil sample obtained from one of our borings that was considered representative of the subsurface soils at the project site.

Laboratory testing consisted of pH, minimum electrical resistivity, and chloride and soluble sulfate contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236b, while sulfate and chloride tests were performed in accordance with Arizona Tests 733 and 736 respectively. The results of the corrosivity tests are presented in Appendix B.

The pH of the selected soil sample was 7.7, which is considered to be alkaline. The minimum electrical resistivity of the sample tested was 684 ohm-cm, which is considered to be corrosive to ferrous materials. The chloride content of the sample tested was 111 ppm, which is also considered corrosive to ferrous materials. The soluble sulfate content of the samples tested was 0.012 percent by weight, which represents a negligible sulfate exposure to concrete.

The results of the chloride content and minimum electrical resistivity tests on the sample tested indicate that the materials are considered to be corrosive to ferrous materials. Based on our experience with other nearby projects, we recommend that special consideration be given to the use of heavy-gauge, corrosion-protected, underground steel pipe. As an alternative, plastic pipe could be considered. A corrosion specialist should be consulted for further recommendations.

9.4. Concrete

Laboratory chemical tests performed on a select soil sample from our borings indicated a sulfate content of 0.012 percent by weight. Based on American Concrete Institute (ACI) guidelines, the on-site soils should be considered to have a negligible sulfate exposure for concrete.

Notwithstanding the sulfate test results and due to the limited number of chemical tests performed, as well as our experience with similar soil conditions and regional practice, we recommend that "Type II" cement be used for the construction of concrete structures at this site. Due to potential uncertainties as to the use of reclaimed irrigation water, or topsoil that may contain higher sulfate contents, pozzolan, or admixtures designed to increase sulfate resistance may be considered.

The concrete should have a water-cementitious materials ratio no more than 0.50 by weight for normal weight aggregate concrete. The structural engineer should select the concrete design strength based on the project specific loading conditions. However, higher strength concrete may be selected for increased durability, resistance to slab curling and shrinkage cracking.

9.5. Site Drainage

Surface drainage should be provided to divert water away from the paved surfaces. Surface water should not be permitted to pond on or adjacent to pavement areas. To deter accumulation of water below the new pavement sections, the subgrade soils below the new pavement sections should be sloped away from the center toward the edges of the roadway.

Furthermore, given the close proximity of a documented earth fissure to the site, it is important that uncontrolled surface runoff not occur. The Civil Engineer should provide recommendations to address these concerns.

9.6. Pre-Construction Conference

We recommend that a pre-construction conference be held. Representatives of the owner, the civil engineer, the geotechnical consultant, and the contractor should be in attendance to discuss the project plans and schedule. Our office should be notified if the project description included herein is incorrect, or if the project characteristics are significantly changed.

9.7. Construction Observation and Testing

During construction operations, we recommend that a qualified geotechnical consultant perform observation and testing services for the project. These services should be performed to evaluate exposed subgrade conditions, including the extent and depth of overexcavation, to evaluate the suitability of proposed borrow materials for use as fill, and to observe placement and test compaction of fill soils. If another geotechnical consultant is selected to perform observation and testing services for the project, we request that the selected consultant provide a letter to the owner, with a copy to Ninyo & Moore, indicating that they fully understand our recommendations and that they are in full agreement with the recommendations contained in this report. Qualified subcontractors utilizing appropriate techniques and construction materials should perform construction of the proposed improvements.

10. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced

through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

11. REFERENCES

American Association of State Highway and Transportation (AASHTO), 1993, Design of Pavement Structures.

American Concrete Institute (ACI), Building Code Requirements for Structural Concrete (ACI 318) and Commentary (ACI 318R).

American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards.

Arizona Department of Water Resources (ADWR), 2013, "GWSI Groundwater Maps" https://gisweb.azwater.gov/waterresourcedata/: accessed November 2013.

Arizona Geological Survey (AZGS), 2008, Earth Fissure Map of the Chandler Heights Study Area: Pinal and Maricopa Counties, Arizona, DM-EF-1.

Euge, K.M., Schell, B.A., and Lam, I.P., 1992, Development of Seismic Acceleration Contour Maps for Arizona: Arizona Department of Transportation Report No. AZ 92-344: dated September.

Huckleberry, Gary, 1994, Surficial Geology of the Santan Mountains Piedmont Area, Northern Pinal and Eastern Maricopa Counties, Arizona: Arizona Geological Survey OFR 94-07, Sheet 2 of 2, Sacaton NE 7.5-Minute Quadrangle, Scale 1:24,000.

International Code Council (ICC), 2012, International Building Code (IBC).

Maricopa Association of Governments (MAG), Uniform Standard Specifications and Details for Public Works Construction.

Ninyo & Moore, In-house proprietary information.

Occupational Safety and Health Administration (OSHA), 1992 (Revised), Title 29 of the Code of Federal Regulations (CFR), Part No. 1926 - Safety and Health Regulations for Construction, Subpart P - Excavations.

Pearthree, P.A, Huckleberry, G., 1994, Surficial Geologic Map of the Mesa 30' x 60' Quadrangle, Arizona, Arizona Geological Survey Open-File Report 94-24.

Pearthree, P.A., 1998, Quaternary Fault Data and Map for Arizona: Arizona Geological Survey, Open-File Report 98-24.

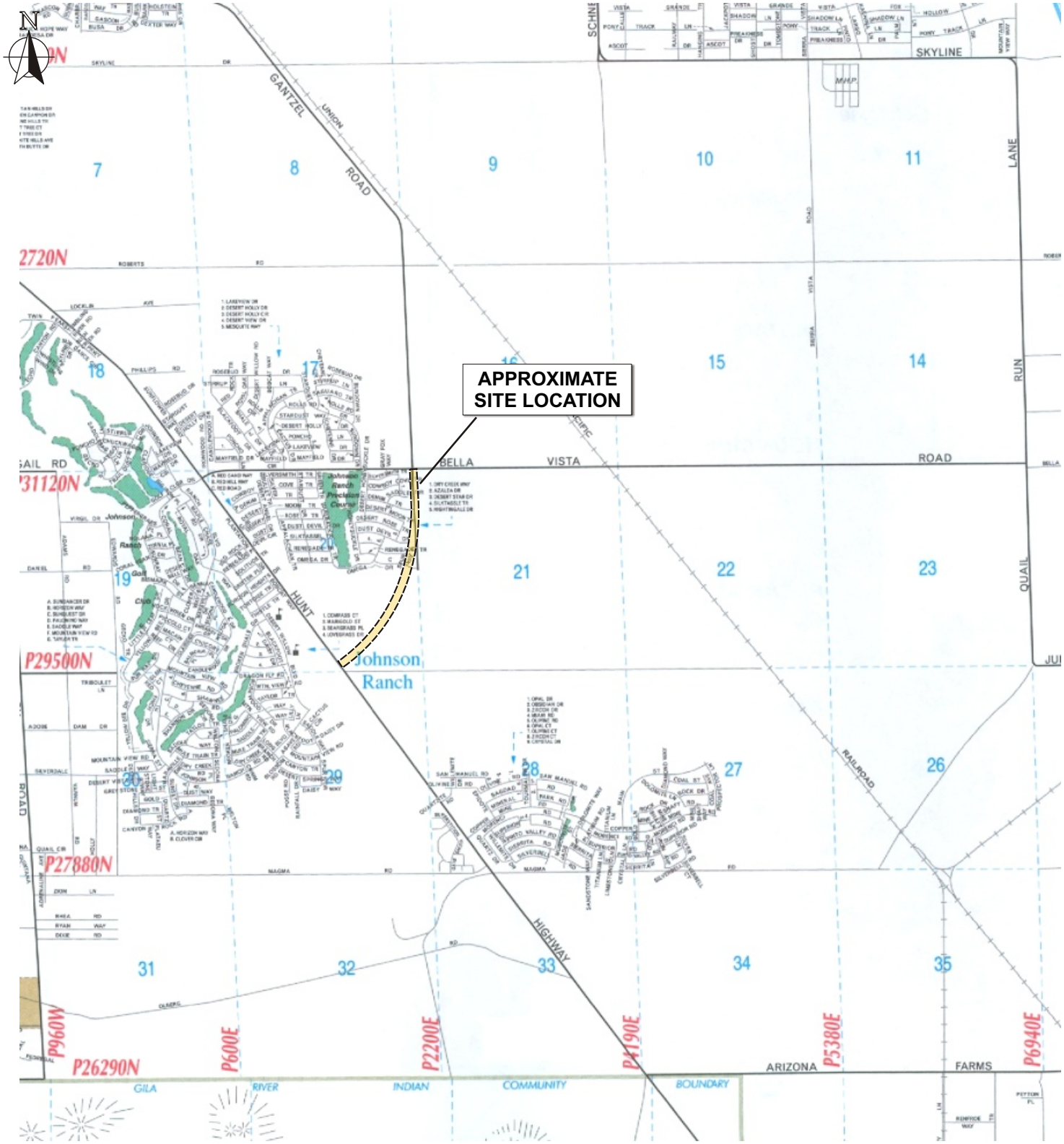
Schumann, H.H. and Genualdi, R., 1986, Land Subsidence, Earth Fissures, and Water Level Changes in Southern Arizona: Arizona Geological Survey OFR 86-14, Scale 1:500,000.

United States Geological Survey (USGS), 2011, Sacaton NE – Arizona- Maricopa County 7.5-Minute topographic map. Scale: 1:24,000.

United States Geological Survey (USGS), 2014, U.S. Seismic Design Maps, page URL: http://geohazards.usgs.gov/designmaps/us/application.php.

Referenced Aerial Photographs

Source	Photo Dates
Flood Control District of Maricopa County	1937, 2000, 2002
Google Earth™	1992, 2003, 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2013



Source: Phoenix Mapping Service, Tucson Metro Edition, 2008.

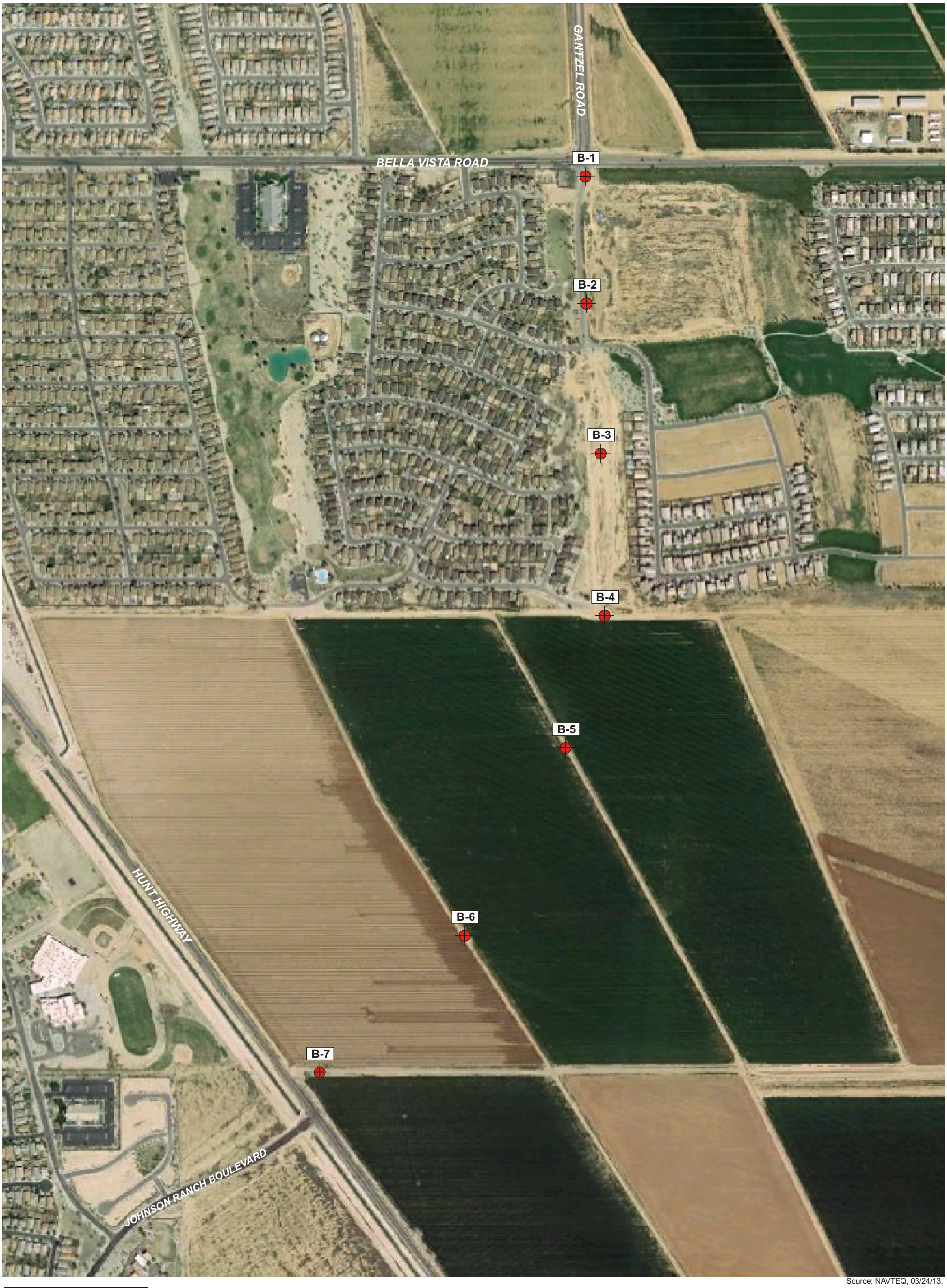
0 2200

Approximate Scale:
1 inch = 2200 feet

Note: Dimensions, directions, and locations are approximate.

Ninyo & Moore	SITE LOCATION	FIGURE
PROJECT NO: 601868005 / DATE: 8/14	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	1

file no: 1868vmap1113



Source: NAVTEQ, 03/24/13.

LEGEND

B-7 Boring Location

N

0 2500

Approximate Scale:
1 inch = 2500 feet

Note: Dimensions, directions, and locations are approximate.

file no: 1868blm0814

Ninyo & Moore	BORING LOCATIONS	FIGURE
PROJECT NO: 601868005 / DATE: 8/14	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	2

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following methods.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a 140-pound hammer in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

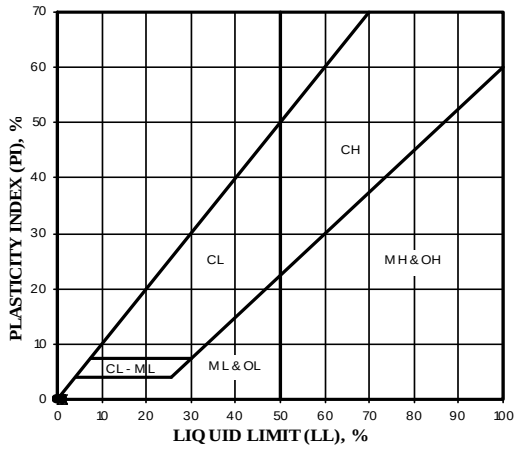
U.S.C.S. METHOD OF SOIL CLASSIFICATION

MAJOR DIVISIONS		SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (More than 1/2 of soil > No. 200 Sieve Size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction < No. 4 sieve size	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than 1/2 of soil < No. 200 sieve size)	SILTS & CLAYS Liquid Limit <50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

GRAIN SIZE CHART

CLASSIFICATION	RANGE OF GRAIN	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	306 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
Coarse	3" to 3/4"	76.2 to 19.1
Fine	3/4" to No. 4	19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.075
Coarse	No. 4 to No. 10	4.76 to 2.00
Medium	No. 10 to No. 40	2.00 to 0.420
Fine	No. 40 to No. 200	0.420 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

PLASTICITY CHART



Ninyo & Moore

U.S.C.S. METHOD OF SOIL CLASSIFICATION

Updated Nov. 2011

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0	■							Bulk sample.
		■						Modified split-barrel drive sampler.
		☒						No recovery with modified split-barrel drive sampler.
		▬						Sample retained by others.
		◤						Standard Penetration Test (SPT).
5		⁄						No recovery with a SPT.
		▯	XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
		⁄						No recovery with Shelby tube sampler.
		▤						Continuous Push Sample.
				⚲				Seepage.
10				▽				Groundwater encountered during drilling.
				▼				Groundwater measured after drilling.
						▦	SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
						▨	CL	Dashed line denotes material change.
15								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

Ninyo & Moore

BORING LOG

Explanation of Boring Log Symbols

PROJECT NO.	DATE	FIGURE

Updated Nov. 2011

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL	ALLUVIUM: Brown, damp, hard, sandy CLAY; trace gravel.
			57					
			17					Very stiff; scattered caliche filaments.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 11/14/13 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

DATE DRILLED 11/14/13 BORING NO. B-1

GROUND ELEVATION 1,496' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY HAH

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-1

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SC	ALLUVIUM: Brown, damp, medium dense, clayey SAND.
			15					
			74/11"					Very dense; scattered caliche nodules.
5								Total Depth = 4.4 feet. Groundwater not encountered during drilling. Backfilled on 11/14/13 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

DATE DRILLED 11/14/13 BORING NO. B-2

GROUND ELEVATION 1,496' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY HAH

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-2

DATE DRILLED	11/14/13	BORING NO.	B-3
GROUND ELEVATION	1,501' ± (MSL)	SHEET 1	OF 1
METHOD OF DRILLING	CME-75, 8" Diameter Hollow-Stem Auger (D&S Drilling)		
DRIVE WEIGHT	140 lbs. (Automatic)	DROP	30"
SAMPLED BY DM	LOGGED BY DM	REVIEWED BY HAH	

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■					▨	SC	ALLUVIUM: Brown, damp, medium dense to dense, clayey SAND.
	■	■	42	10.3	97.2	▨		
	■					▨		
	■		22			▨		Dense; scattered caliche nodules.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 11/14/13 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-3

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SC	ALLUVIUM: Brown, damp, medium dense, clayey SAND; few gravel; scattered caliche nodules.
			16					
			48					Dense.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 11/14/13 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

DATE DRILLED 11/14/13 BORING NO. B-4

GROUND ELEVATION 1,502' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY HAH

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-4

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■						CL	ALLUVIUM: Brown, moist, hard, sandy CLAY; few gravel; scattered caliche nodules.
	■		28	14.0	96.4			
	■							
	■		14					Very stiff.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 7/30/14 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

DATE DRILLED 7/30/14 BORING NO. B-5

GROUND ELEVATION 1,507' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill, Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-5

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SC	ALLUVIUM: Brown, moist, medium dense, clayey SAND; scattered caliche nodules.
			11					
			27					
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 7/30/14 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

DATE DRILLED 7/30/14 BORING NO. B-6

GROUND ELEVATION 1,513' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill, Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-6

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SC	ALLUVIUM: Brown, moist, loose, clayey SAND; trace gravel.
			12	10.8	95.8			
			12					Medium dense; scattered caliche nodules.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 7/30/14 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
10								
15								
20								

DATE DRILLED 7/30/14 BORING NO. B-7

GROUND ELEVATION 1,516' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill, Inc.)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

Ninyo & Moore

BORING LOG

GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD
PINAL COUNTY, ARIZONA

PROJECT NO.	DATE	FIGURE
601868005	8/14	A-7

APPENDIX B

LABORATORY TESTING

Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A.

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 through B-5. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

Atterberg Limits

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-6.

Maximum Dry Density and Optimum Moisture Content Test

The maximum dry density and optimum moisture content of a selected representative soil sample was evaluated in general accordance with ASTM D 698. The results of this test are summarized on Figure B-7.

R-Value

The resistance value, or R-value, for site soils was evaluated in general accordance with ASTM D 2844. A sample was prepared and evaluated for exudation pressure and expansion pressure. The equilibrium R-value is reported as the lesser or more conservative of the two calculated results. The test results are shown on Figure B-8.

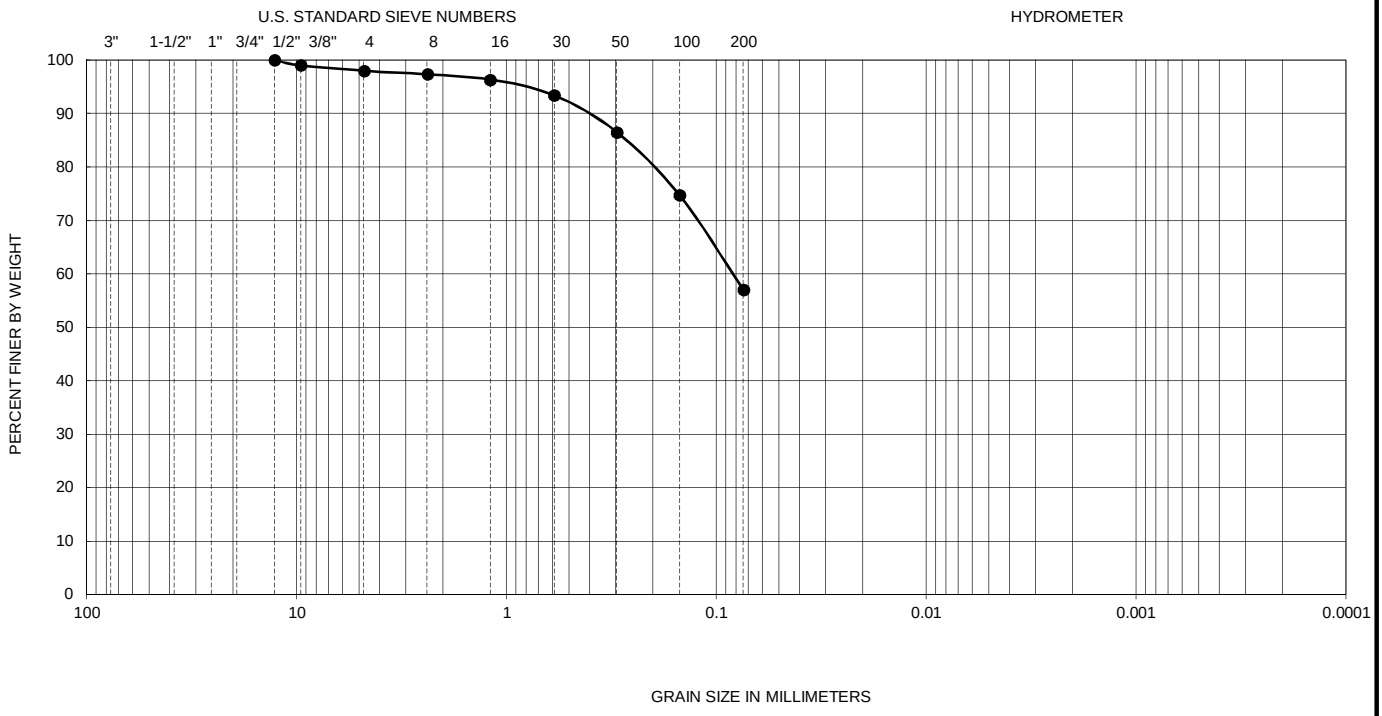
Swell Potential Tests

A remolded swell test was performed on a selected remolded soil sample in general accordance with ASTM D 4546. The sample was remolded to approximately 95 percent of maximum density at approximately 2 percent below optimum moisture as evaluated by ASTM D698, and then submerged under a surcharge of approximately 144 psf. The percent of swell was recorded as a ratio of the amount of vertical swell to the original height of the sample. The result of the test is summarized on Figure B-9.

Soil Corrosivity Tests

Soil pH and resistivity tests were performed on a representative sample in general accordance with Arizona Test Method 236b. The soluble sulfate and chloride contents of a selected sample was evaluated in general accordance with Arizona Test Method 733 and Arizona Test Method 736, respectively. The test results are presented on Figure B-10.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

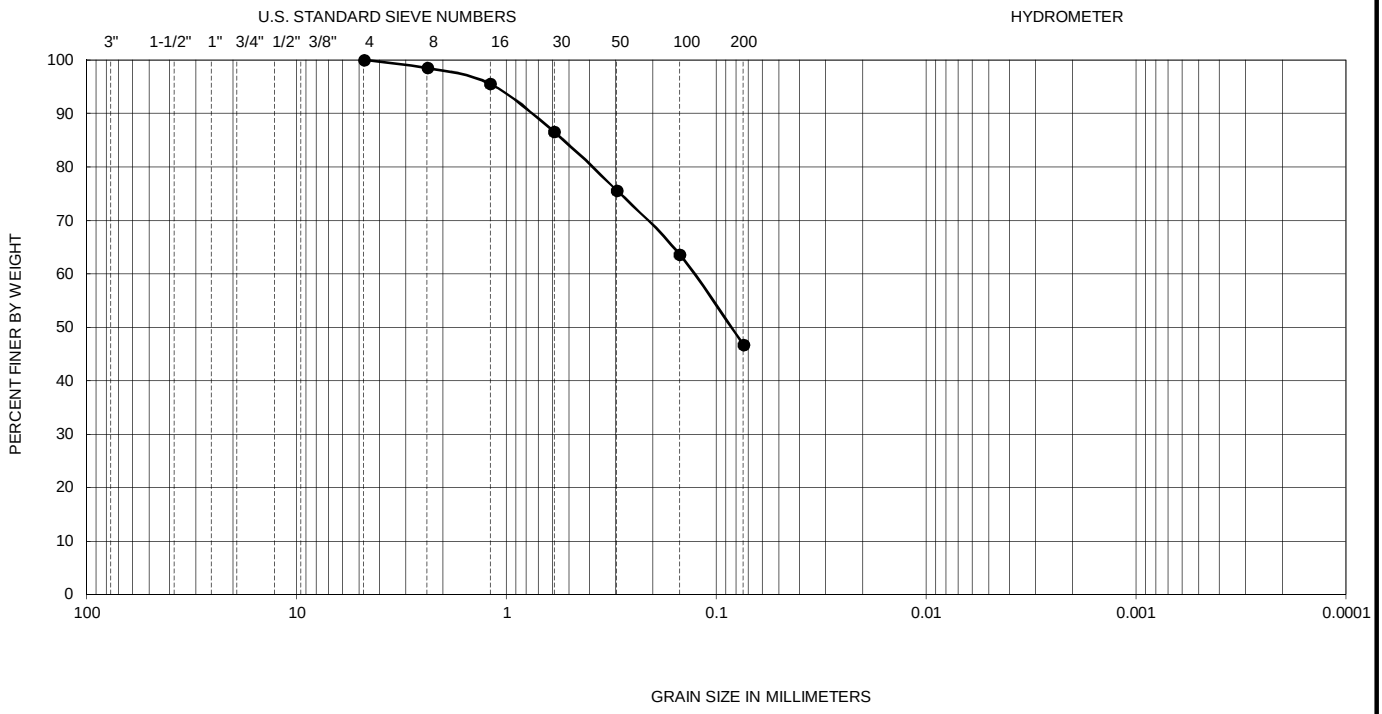


Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-1	0.0-5.0	32	18	14	--	--	--	--	--	57	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-1
601868005 / 8/14		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

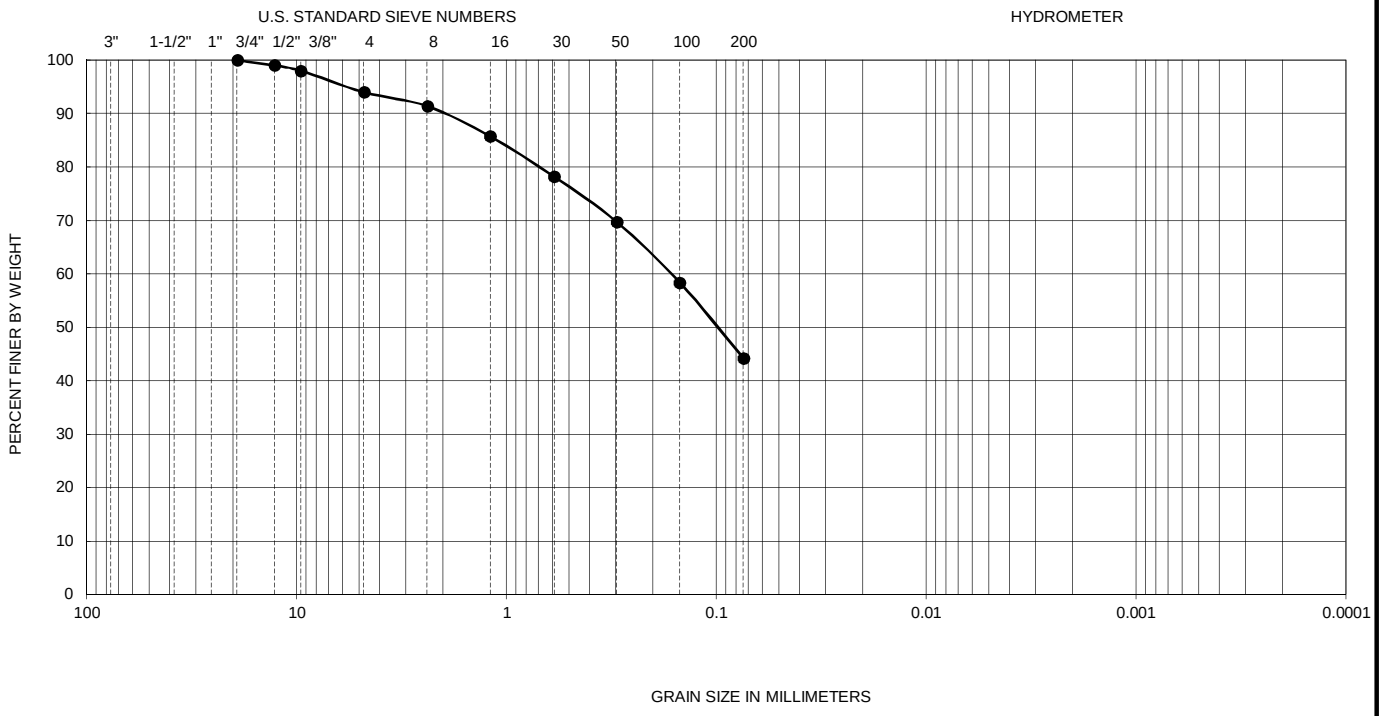


Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-2	0.0-4.4	33	19	14	--	--	--	--	--	47	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-2
601868005 / 8/14		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

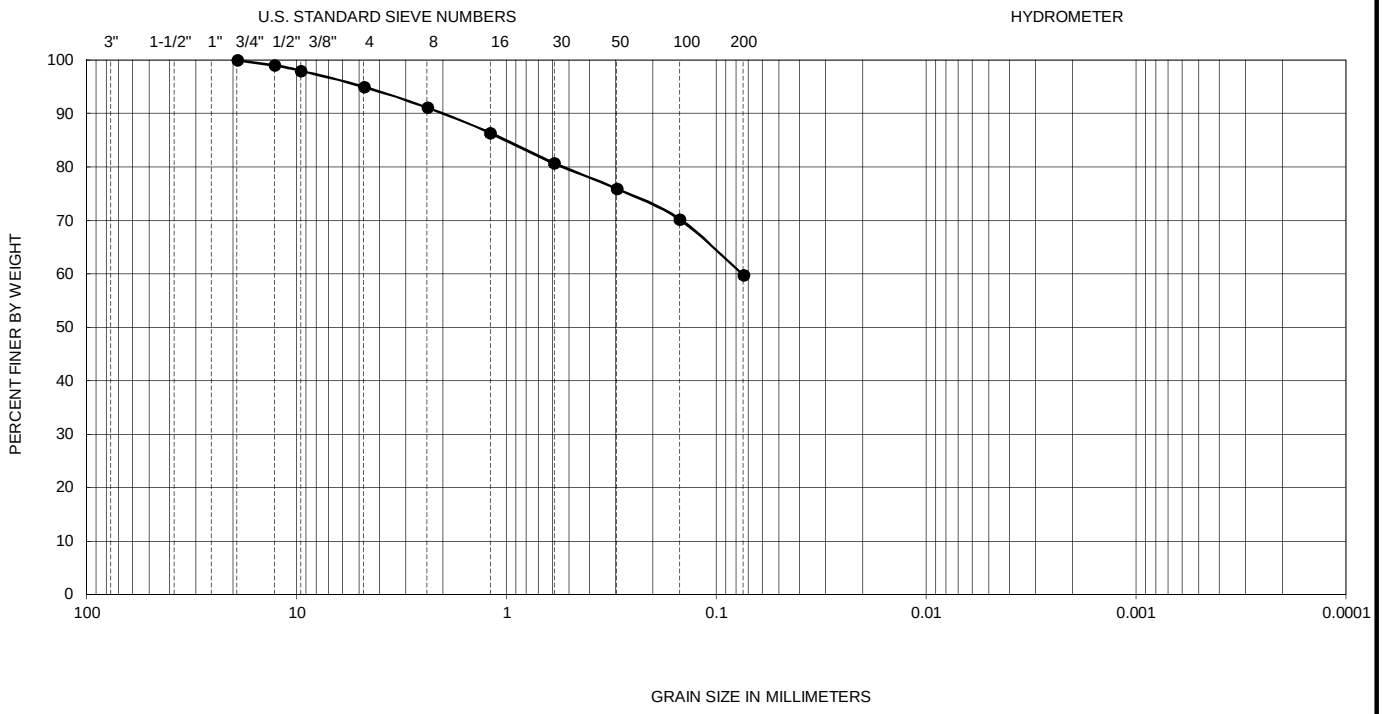


Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-4	0.0-5.0	35	17	18	--	--	--	--	--	44	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-3
601868005 / 8/14		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

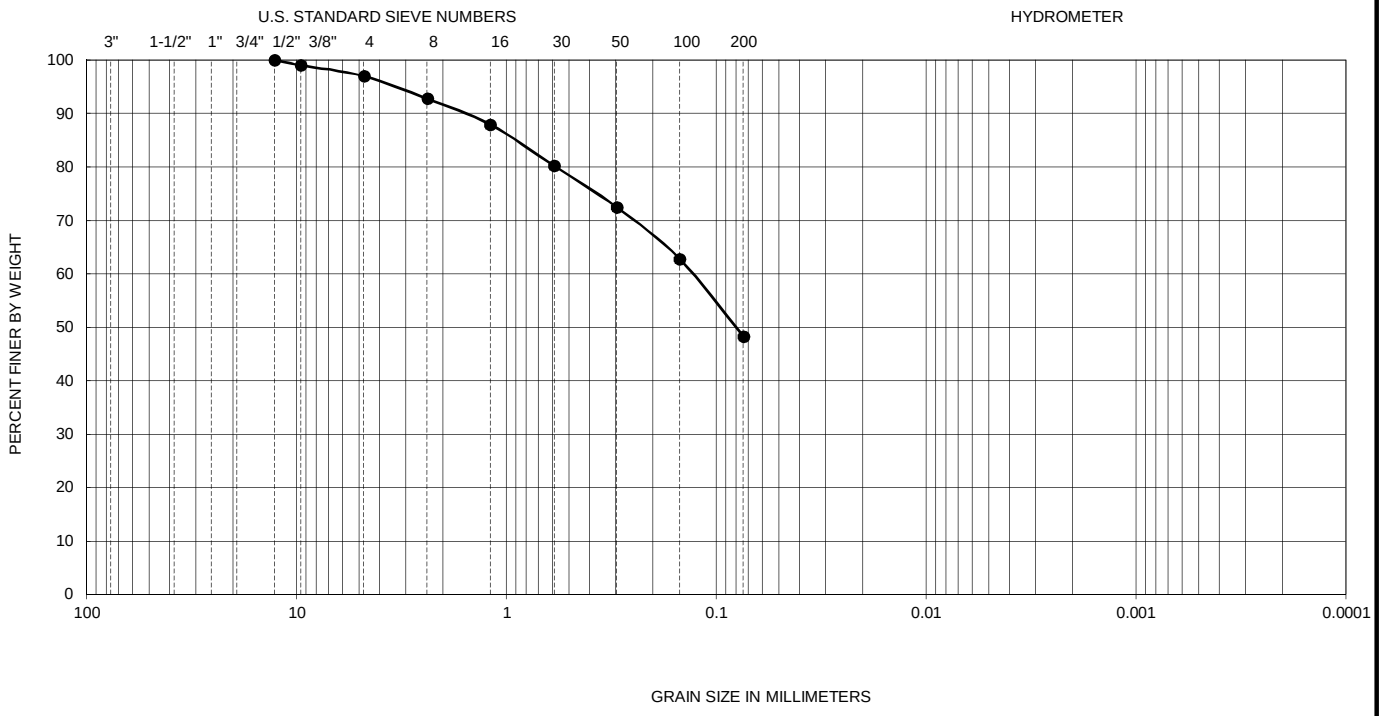


Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-5	0.0-5.0	38	19	19	--	--	--	--	--	60	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-4
601868005 / 8/14		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

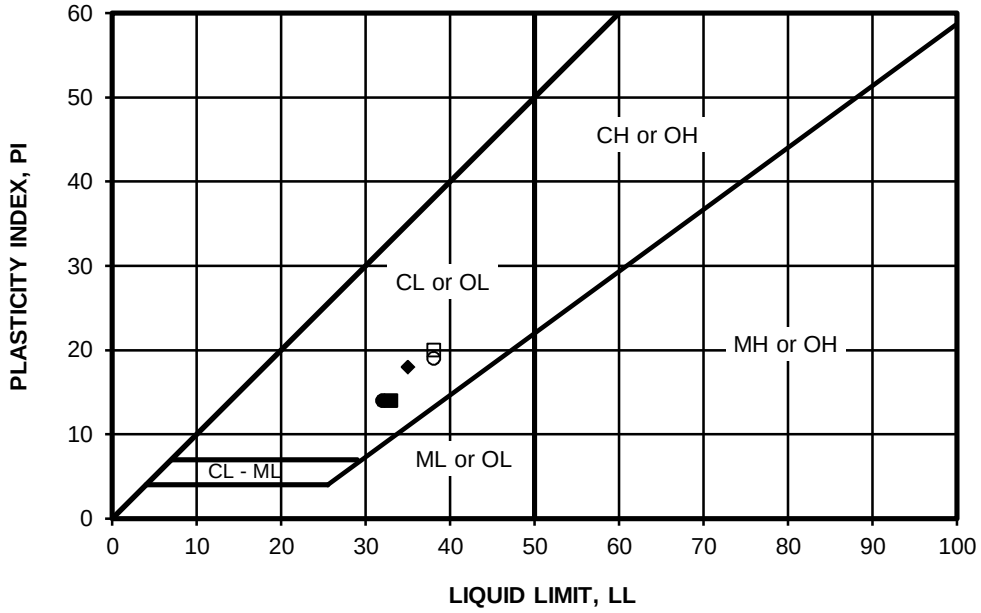


Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-7	0.0-5.0	38	18	20	--	--	--	--	--	48	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

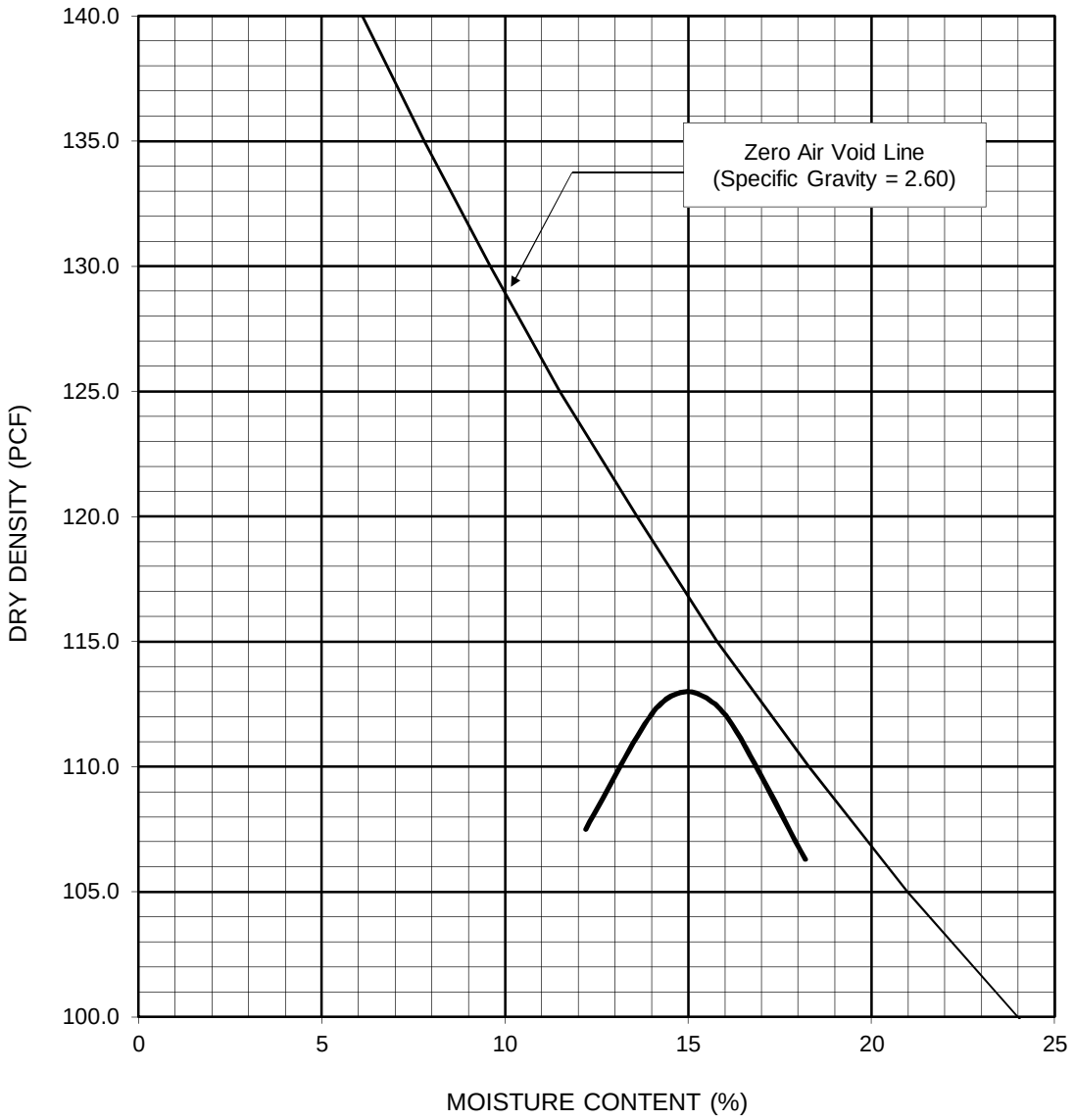
Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-5
601868005 / 8/14		

SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
●	B-1	0.0-5.0	32	18	14	CL	CL
■	B-2	0.0-4.4	33	19	14	CL	SC
◆	B-4	0.0-5.0	35	17	18	CL	SC
○	B-5	0.0-5.0	38	19	19	CL	CL
□	B-7	0.0-5.0	38	18	20	CL	SC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

Ninyo & Moore	ATTERBERG LIMITS TEST RESULTS	FIGURE
PROJECT NO. 601868005 / DATE 8/14	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-6



Sample Location	Depth (ft)	Soil Description	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
B-3	0.0-5.0	CLAYEY SAND	113.0	15.0
Dry Density and Moisture Content Values Corrected for Oversize (ASTM D 4718-87)			115.0	14.0

PERFORMED IN GENERAL ACCORDANCE WITH ☐ ASTM D 1557 ☑ ASTM D 698 METHOD ☑ A ☐ B ☐ C

Ninyo & Moore	PROCTOR DENSITY TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-7
601868005 / 8/14		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	SOIL TYPE	R-VALUE
B-2	0.0-4.4	SC	17

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2844

Ninyo & Moore	R-VALUE TEST RESULTS	FIGURE
PROJECT NO. / DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-8
601868005 / 8/14		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	SOIL TYPE	% SWELL
B-3	0.0-5.0	SC	2.48

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546, METHOD B

COMPACTED AT 95% -2% OPTIMUM

Ninyo & Moore		SWELL POTENTIAL TEST RESULTS	FIGURE
PROJECT NO.	DATE	GANTZEL ROAD - HUNT HIGHWAY TO BELLA VISTA ROAD PINAL COUNTY, ARIZONA	B-9
601868005	8/14		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-1	0.0-5.0	7.7	685	117	0.012	111

[1] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236b
[2] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733
[3] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736