amec

Final Geotechnical Report
Sonoqui Wash Channelization, Phase II
Chandler Heights Road to Crismon Road
Queen Creek, Arizona

amec

Celebrating 50 Years of Service in Arizona

Final Geotechnical Report
Sonoqui Wash Channelization, Phase II
Chandler Heights Road to Crismon Road
Queen Creek, Arizona

Submitted to:

Stanley Consultants, Inc.
Phoenix, Arizona

Submitted by:

AMEC Earth & Environmental, Inc.
Tempe, Arizona

Registered Professional Engineer (Civil)
CERTIFICATE NO.
37284
DANIEL N.
FRECHETTE
Date Signed 9-29-09
ARIZONA, U.S.A.
Expires 03/31/2011

September 24, 2009

AMEC Job No. 08-117-01090

September 24, 2009
AMEC Job No. 08-117-01090

Stanley Consultants, Inc.
2929 East Camelback Road
Suite 130
Phoenix, Arizona 85016-4425

Attn: Scott Buchanan, P.E.

Re: Final Geotechnical Investigation Report
Sonoqui Wash Channelization, Phase II
Chandler Heights Road to Crismon Road
Queen Creek, Arizona

Submitted herewith is the Final Geotechnical Investigation Report prepared by AMEC Earth & Environmental, Inc. for the above referenced project. The final report incorporates design changes and comments to the Draft Geotechnical Investigation Report, dated June 5, 2009. Included are the results of a site reconnaissance to look for the potential presence of ground cracks; the results of test drilling and laboratory analysis; and recommended criteria for foundations, excavation, embankment design, pavement design and temporary slopes.

Should you have any questions concerning the recommendations presented in this report, please do not hesitate in contacting us.

Respectfully submitted,

AMEC Earth & Environmental, Inc.

Registered Professional Engineer (Civil) CERTIFICATE NO. 37284 DANIEL N. FRECHETTE Date Signed 9-24-09 ARIZONA, U.S.A. Expires 03/31/2011

Daniel N. Fréchette, Ph.D., P.E.
Senior Geotechnical Engineer

Reviewed by:

Registered Professional Engineer (Civil) CERTIFICATE NO. 40209 BRETT A. HOWEY Date Signed 9/24/09 ARIZONA, U.S.A. Expires 12/31/09

Brett A. Howey, P.E.
Senior Geotechnical Engineer

c: Addressee (3 bound and 1 CD)

G:\Engineering Department\2008 Projects\08-117-01090 Sonoqui Wash II\Report\Phase II - Final Report\Final Sonoqui Wash II Geotechnical Rpt doc

AMEC Earth & Environmental, Inc.
1405 West Auto Drive
Tempe, Arizona 85284-1016
Tel +1 (480) 940-2320
Fax +1 (480) 785-0970 www.amec.com

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1
2.0 PROJECT DESCRIPTION 1
3.0 INVESTIGATION 1
3.1 RECONNAISSANCE FOR GROUND CRACKS 1
3.2 SUBSURFACE EXPLORATION 1
3.3 LABORATORY TESTING 2
3.4 DATA FROM EXISTING GEOTECHNICAL REPORTS 2
4.0 SITE CONDITIONS AND GEOTECHNICAL PROFILE 3
4.1 SITE CONDITIONS 3
4.2 GEOTECHNICAL PROFILE 3
4.3 GROUNDWATER AND SOIL MOISTURE CONDITIONS 4
5.0 DISCUSSION AND RECOMMENDATIONS 4
5.1 STABILITY ANALYSIS 5
5.1.1 Methodology and Typical Cross Section 5
5.1.2 Soil Parameters 5
5.1.3 Stability Analysis Results 5
5.2 FOUNDATIONS FOR WALLS, DROP STRUCTURES AND OTHER CONCRETE STRUCTURES 6
5.2.1 Design Criteria for Downward Loads 6
5.2.2 Resistance to Lateral Loads 6
5.2.3 Estimated Settlements 6
5.2.4 Surface Preparation 7
5.2.5 Walls, Drop Structures and Other Concrete Structure Design 7
5.2.6 Structure Backfill 7
5.3 SITE GRADING 7
5.3.1 Structural Fill 8
5.4 EARTHWORK FACTORS 8
5.5 EXCAVATION 9
5.6 SLOPES 9
5.6.1 Temporary Slopes 9
5.6.2 Permanent Slopes 9
5.7 PAVEMENTS 9
5.7.1 Materials Quality and Construction Requirements 10
5.7.2 Asphaltic Concrete 11
5.8 PIPE BEDDING AND BACKFILL 11
5.9 CORROSION POTENTIAL 12
5.9.1 Metal Pipes 12
5.9.2 Concrete Structures 12
6.0 SUBSIDENCE AND RELATED HAZARDS 13
6.1 BACKGROUND 13
6.2 RESULTS OF RECONNAISSANCE-LEVEL SITE VISIT 13
7.0 REFERENCES 14

TABLE OF CONTENTS (CONT.)

LIST OF FIGURES

Figure 1 Vicinity Map
Figure 2 Site Plan
Figure 3 Allowable Types of Culvert

LIST OF APPENDICES

Appendix A Field Investigation
Appendix B Laboratory Test Results
Appendix C Boring Logs from Previous AMEC Investigations: Chandler Heights Road over Sonoqui Wash and Sonoqui Wash Channelization, Phase I
Appendix D Borings Logs from Related Investigation: Riggs Road Improvements, Ellsworth Road to Meridian Road
Appendix E Slope Stability Results

Registered Professional Engineer (Civil)
CERTIFICATE NO.
37284
DANIEL N.
FRECHETTE
Date Signed 9-24-09
ARIZONA, U.S.A.
Expires 03/31/2011

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation performed by AMEC Earth & Environmental, Inc. (AMEC) for Phase II of the Sonoqui Wash Channelization Study. The project is located in Queen Creek and unincorporated areas of Maricopa County, Arizona. The purpose of this investigation was to examine the geotechnical profile beneath the site and to evaluate the engineering properties of the subsurface materials. This information was used to provide criteria for foundations, embankment design, pavement design and temporary slopes, and to prepare recommendations related to site grading, excavation and other aspects of the project where soil properties or behavior should be considered. A reconnaissance-level site visit also was performed to look for the potential presence of ground cracks.

2.0 PROJECT DESCRIPTION

Details of the project were provided by Scott Buchanan, P.E. of Stanley Consultants, Inc. It is understood that a multi-use channel capable of conveying storm water resulting from a 100-year storm event will be constructed for Sonoqui Wash. The Phase II study limits of the channelization project extend from Chandler Heights Road southeast to Riggs Road along the existing alignment of the wash, and then eastward along Riggs Road to Crismon Road, a total distance of approximately 3.5 miles. A concrete box culvert is planned at Hawes Road where it crosses Sonoqui Wash and a concrete box culvert or a bridge is planned at Riggs Road where it crosses Sonoqui Wash. The project is located in Sections 27, 28, 29, 33, and 34 of Township 2 South and Range 7 East of the Gila and Salt River Baseline and Meridian. A vicinity map showing the location of the project is presented as Figure 1.

3.0 INVESTIGATION

3.1 Reconnaissance for Ground Cracks

A reconnaissance-level site visit to look for evidence of ground cracks was performed on April 9, 2009 by Ken Fergason, P.G. and Karen Anglin, both with AMEC. During the site visit, the project alignment was visually inspected for ground cracks, and for evidence of aligned potholes, aligned vegetation or other features which might indicate the presence of ground cracks. In some areas of the alignment, particularly the northern portion of the alignment, it was difficult to observe ground conditions because dense vegetation concealed the ground surface.

3.2 Subsurface Exploration

A boring located near Chandler Heights Road was deleted from the drilling program, since geotechnical data are available from four borings drilled for the Chandler Heights Bridge. A boring located south of Chandler Heights Road also was deleted, since geotechnical data are available from a boring drilled near this location during Phase I of the channelization study.

The subsurface program included the drilling of eleven borings to depths ranging from 15 to 25 feet below existing site grades, and the collection of one shallow subsurface sample

(1 foot) using a shovel. The borings were completed utilizing subcontracted, rubber tired, 2-wheel and 4-wheel, CME-75 truck-mounted drill rigs owned and operated by Geomechanics Southwest, Inc. (GSI) advancing 6 5/8-inch outside diameter (O.D.) hollow-stem auger. Standard penetration (split-spoon) testing and sampling were performed at selected intervals in the borings. Bulk samples of auger cuttings also were obtained for laboratory testing.

Encountered soils were visually inspected and classified in the field and logged in accordance with ASTM D2487 (Unified Soil Classification System). Borehole logging and field supervision were performed by Ms. Anglin of AMEC. Logs of the test borings are presented in Appendix A of this report, along with a description of drilling and sampling procedures. All boring locations were staked in the field by AMEC using GPS and existing surface features. The boring locations are shown on Figure 2.

The drilling program was performed during the week of April 6, 2009. Prior to initiating the drilling program, a dust control permit (No. E090601) was obtained from the Maricopa County Air Quality Department. In addition, Arizona Blue Stake (Ticket No. 2009033100873) was contacted to locate underground utilities in proximity to the borings and property owners were notified of the drilling schedule.

3.3 Laboratory Testing

The moisture content and dry density of selected samples recovered from the borings were determined. Results for these tests are provided on the boring logs and laboratory reports for these tests are presented in Appendix B. Grain-size analysis, Atterberg limits (plasticity index) and moisture-density relationship (standard Proctor) tests also were performed on selected samples. In addition, pH and resistivity, and sulfates and chlorides were performed for the sample collected where Sonoqui Wash crosses Hawes Road. Laboratory reports for these tests are presented in Appendix B.

3.4 Data from Existing Geotechnical Reports

Data from three existing geotechnical investigations was reviewed and used in the preparation of this report.

The first geotechnical investigation was performed for a proposed bridge at Chandler Heights Road over Sonoqui Wash. The investigation was performed by AMEC in 2004 for the Maricopa County Department of Transportation (MCDOT). The investigation consisted of four borings (M-1 through M-4) advanced to a depth of 80 feet below the existing ground surface at the proposed bridge location. Logs of the four borings are provided in Appendix C and the boring locations are shown on Figure 2. Because this information was available, Boring B-1 of the current drilling program was deleted.

The second geotechnical investigation was performed for Phase I of the Sonoqui Wash channelization study. This study was performed by AMEC in 2004 for Stanley Consultants, Inc. Because Boring B-24 drilled during the Phase I study was in close proximity to Boring B-2 of the

current drilling program, Boring B-2 of the current program was deleted. The log for Boring B-24 is provided in Appendix C and the boring location is shown on Figure 2.

The third geotechnical investigation was performed for planned improvements to Riggs Road between Ellsworth and Meridian Roads. This 2007 investigation was performed by Ninyo and Moore for the Town of Queen Creek. The investigation included the drilling of seven borings to a depth of 5 feet below the existing ground surface along the Riggs Road alignment between Ellsworth and Crismon Roads. Logs for the seven borings and a site plan showing their locations are located in Appendix D.

4.0 SITE CONDITIONS AND GEOTECHNICAL PROFILE

4.1 Site Conditions

Sonoqui Wash is located within the Town of Queen Creek and in unincorporated areas of Maricopa County. The planned 3.5-mile channelized wash will run diagonally between Chandler Heights Road and Riggs Road, and then eastward along Riggs Road to Crismon Road (Figure 1). Water within the wash flows from east to west. The recently closed Queen Creek landfill is located northeast of the intersection of Hawes and Riggs Roads. The wash parallels the southwest boundary of the landfill. The existing Sonoqui Wash channel is relatively well defined to the north and west of the landfill, and the wash in this area is generally surrounded by vacant desert land and single-family residences. The wash channel is poorly defined to the south and east of the landfill, and the channel alignment in this area is generally surrounded by agricultural fields and single-family residences. An equestrian center is being constructed on the east side of the closed landfill. Vegetation along the existing wash alignment mostly consists of creosote bushes, grasses and small shrubs.

4.2 Geotechnical Profile

The subsurface soils encountered at the site can be generalized into a two-strata system as follows:

- **Stratum A:** An upper horizon of fine-grained soils predominantly consisting of clayey sand, sandy clay, silty sand and sandy silt extends from the ground surface to depths of 8 to 9 feet below existing site grades between Chandler Heights Road and Riggs Road, and from the ground surface to depths of 13.5 to 20 feet along the Riggs Road alignment. In the five borings drilled along Riggs Road, Stratum A extended to a depth of 13.5 feet below existing grades in three borings (B-13, B-14 and B-18); and extended to depths of 20 feet and 18.5 feet below existing grades in Borings B-15 and B-17, respectively.

  The sand fraction is predominantly fine grained and only trace amounts of gravel were encountered in Stratum A. The soils vary from nonplastic to medium in plasticity, with an increase in plasticity corresponding to an increase in silt and clay content. The soils

generally are uncemented and brown. In general, the soils are soft to moderately firm, although very soft and very firm soils also occur within Stratum A.

The Ninyo and Moore boring logs (Ninyo & Moore, 2007) for proposed improvements to Riggs Road between Ellsworth and Meridian Roads were reviewed. In general, the logs identify the presence of soft to very stiff soils consisting of clay and sandy clay to a depth of 5 feet below existing grades.

- **Stratum B**: The lower horizon is slightly coarser grained and predominantly consists of sand with silt, sand with silt and gravel, and sand and gravel. There appears to be a general increase of gravel with depth, although this did not hold true for all borings. Sand with clay was detected in the bottom of Boring B-8 and clayey sand was encountered in the bottom of Borings B-6 and B-18. These clayey soils occurred at depths of 18.5 to 21 feet below existing grades.

  Both the sand and gravel fractions are predominantly fine grained, although well graded gravel was noted in several borings and small cobbles were noted in two borings (B-5 and B-6). The soils are generally nonplastic to low in plasticity, although the clayey soils are low to medium plasticity. The soils generally are uncemented and brown, gray or reddish-brown. In general, the soils are medium dense to dense or moderately firm to firm.

4.3 Groundwater and Soil Moisture Conditions

No free groundwater was encountered to the depth of the investigation in any of the borings performed for this project or the previously mentioned projects. The moisture condition of the soils can be described as slightly moist to moist in zones.

5.0 DISCUSSION AND RECOMMENDATIONS

The channelization of Sonoqui Wash in the project area follows the existing wash alignment for the majority of the project. In these areas the wash is to be widened and deepened and have side slopes varying from 3H:1V to 6H:1V (horizontal to vertical). A portion of Sonoqui Wash is adjacent to the landfill near the northeast corner of Riggs Road and Hawes Road. Two borings were completed in the channel adjacent to the landfill. During drilling of these borings no leaching from the landfill was visually observed. No laboratory testing was completed to check for leaching.

Presented in the following sections are results of analyses of global slope stability of the proposed wash geometry, and pavement designs for new and reconstructed roadways. Recommendations are provided regarding foundation design, site grading, earthwork factors, excavatibility, temporary and permanent slopes, and pipe corrosion potential. A discussion of subsidence and related hazards is also presented.

5.1 Stability Analysis

5.1.1 Methodology and Typical Cross Section

A conventional static stability analysis of the proposed embankment cross section of interest was performed using the computer program SLOPE/W (Geo-Slope International, 2008). The comprehensive formulation of SLOPE/W makes it possible to easily analyze both simple and complex slope stability problems using a variety of methods to calculate the factor of safety.

The critical channel cross section after construction for most of the project is anticipated to be 3H:1V slope. There may be isolated areas that have a 1.5H:1V slope to try to minimize vegetation disturbance. The maximum height is approximately 12 feet with a minimum of 1 foot freeboard. AMEC performed slope stability analyses for both cross sections with the results shown in Appendix E. The particular design conditions considered are listed in Table 5.1.1-1:

TABLE 5.1.1-1
SLOPE STABILITY DESIGN CONDITIONS

Case	Design Condition	Slope
I	End of construction	Upstream
II	Sudden drawdown from maximum pool	Upstream

5.1.2 Soil Parameters

The geotechnical parameters required for slope stability analysis include the unit weights and shear strengths of the materials present in the cross section. All borings were used to determine the geotechnical parameters for the analyses. The geotechnical parameters for the soils at the critical channel cross section are conservative and considered saturated conditions as presented in Table 5.1.2-1.

TABLE 5.1.2-1
GEOTECHNICAL PARAMETERS ASSUMED FOR STABILITY ANALYSIS

Depth (feet)	Description	ϕ (degrees)	c (psf)	γ (pcf)	γ_{sat} (pcf)
0-15	Silty Sand	34	100	100	110
15-25	Sand and Gravel	36	0	110	115

5.1.3 Stability Analysis Results

Calculated factor of safety (FOS) values are listed in Table 5.1.3-1 and analysis results are included in Appendix E. The calculated FOS values are larger than the minimum required values by the U.S. Army Corps of Engineers (1970).

TABLE 5.1.3-1
RESULTS OF STATIC STABILITY ANALYSES

Slope	Case	Condition	Slope	Calculated FOS	Minimum Required FOS
3H:1V					
	I	End of Construction	Upstream	3.26	1.4
	II	Sudden Drawdown	Upstream	1.48	1.0
1.5H:1V					
	I	End of Construction	Upstream	2.12	1.4
	II	Sudden Drawdown	Upstream	1.12	1.0

5.2 Foundations for Walls, Drop Structures and Other Concrete Structures

5.2.1 Design Criteria for Downward Loads

Recommended design criteria for spread-type or mat-type foundations for support of drop structures or walls bearing on properly compacted fill, as discussed in Section 5.2.4, are presented in the table below.

Depth of Footing Below Existing Grade (feet)	Loading Condition	Recommended Allowable Uniform Soil Bearing Pressure (pounds per square foot)
5	Dead load plus live load	1,500
10	Dead load plus live load	2,000

Recommended minimum widths for square and continuous footings are 2.0 and 1.5 feet, respectively.

5.2.2 Resistance to Lateral Loads

The passive soil resistance provided by structural fill, placed and compacted in accordance with the recommendations presented in this report, against walls and concrete structures should be considered as being equal to the forces exerted by a fluid of 300 pounds per square foot per foot of depth. A coefficient of friction of 0.40 is recommended for computing the lateral resistance between the base of the structure foundation and the underlying soils when analyzing lateral loads.

5.2.3 Estimated Settlements

It is estimated that the total settlement of foundations designed in accordance with the above recommendations will not exceed 1 inch.

5.2.4 Surface Preparation

The exposed surface immediately beneath walls, drop structures and other concrete structures should be overexcavated 2 feet. The exposed subgrade should be inspected by the geotechnical engineer for the presence of any soft zones. Such zones should also be overexcavated. The overexcavated soil should be replaced with backfill meeting the requirements of Section 5.2.6. All fill should be compacted to at least 95 percent of maximum dry density and to within 2 percent of the optimum moisture content as determined by ASTM D698.

5.2.5 Walls, Drop Structures and Other Concrete Structure Design

Walls, drop structures and other concrete structures likely will be cast-in-place reinforced concrete. The walls will be subjected to earth pressures represented by a hydrostatic load diagram of about 55 pounds per square foot per foot of depth for level backfill, assuming rigid wall conditions, and using free-draining wall backfill as recommended in Section 5.2.6.

5.2.6 Structure Backfill

Free-draining granular backfill should be utilized behind the walls up to an elevation equal to 2 feet below adjacent finished grade. The grading requirements for the free-draining backfill material as determined by ASTM C136, should be as follows:

Sieve Size (square openings)	Percent Passing by Weight (%)
3-inch	100
1 ½-inch	80 to 100
No. 4	30 to 100
No. 200	0 to 15

The plasticity index of the fraction of material passing the No. 40 sieve should be five or less when tested by ASTM D4318.

Based on laboratory tests, the native soils will not meet the granular backfill requirements.

Granular material should be placed in loose lifts with a maximum thickness of 1.0 foot and mechanically compacted. If the gradation of the fill is generally fine enough to permit testing by conventional means, the fill should be compacted to a density of at least 95 percent of maximum dry density as determined in accordance with ASTM D698.

5.3 Site Grading

All vegetation and debris should be removed from areas designated for fill.

The native soils should be scarified to a depth of 6 inches, compacted to within the range of two percent below to two percent above the optimum moisture content, and to at least 95 percent of maximum dry density in accordance with ASTM D698.

Where soils are too coarse to test by conventional methods, a minimum roller requirement should be used. The ground surface should be subjected to at least eight passes of a heavy vibratory roller having a static weight of at least 25,000 pounds. The weight of the vibratory portion (including the drum, shaft and internal machinery) should be at least 12,000 pounds. The frequency of vibration during operation should be between 1,100 and 1,500 cycles per minute and the dynamic force at the operating frequency should not be less than 40,000 pounds. The maximum roller speed during operation should be no greater than 1.5 miles per hour. The compaction equipment used should be subject to approval by the geotechnical engineer.

5.3.1 Structural Fill

All structural fill utilized on the project should be free of vegetation, debris and other deleterious material, and should contain no particles larger than four inches in diameter. All structural fill should be compacted to within the range of two percent below to two percent above the optimum moisture content and to a density of at least 95 percent of maximum dry density as determined by ASTM D698.

In general, structural fill should have no more than 75 percent by weight passing the No. 200 sieve and should have a plasticity index of no more than 10 when tested by ASTM D4318. It appears that the most on-site soils encountered during the investigation will meet the above criteria.

5.4 Earthwork Factors

It is anticipated that the existing channel is to be widened in some areas and filled in other areas as part of this project. The in-place density of soils within the proposed channel alignment were evaluated through sampling and testing. Twenty-one relatively undisturbed ring samples (depth of approximately 25 feet or shallower), including 16 in the upper 10 feet, were tested for density and moisture content. Sample locations and results of the tests are presented in Appendix B.
The mean in-place dry density of soils within the proposed channel alignment was found to be 97.6 pounds per cubic foot (pcf) in the upper 5 feet. The mean standard Proctor maximum dry density was determined to be 118.6 pcf, based on laboratory tests. Utilizing a 95 percent of maximum dry density value of 112.7 pcf to represent the compacted fills, an estimated earthwork factor of 13 percent shrink is determined. If the compacted embankment fill dry density is assumed to be at 100 percent of maximum dry density (118.6 pcf), a shrink factor of 18 percent is determined.

An estimated earthwork factor of 15 percent shrink is recommended for use in design estimates for this project. This recommended factor is based on the above estimates and our understanding of prior construction experience in the Phoenix metropolitan area. Actual

construction excavation, fill handling and placement, and compaction procedures, in particular the staging and phasing of the required excavations and the moisture content and degree of compaction of the fill, will determine the fill characteristics and final, in-place embankment fill densities, and therefore the earthwork factors.

5.5 Excavation

The soils encountered at the site are predominantly moderately firm in the upper five feet increasing to firm to very firm with depth, with occasional hard zones. Based on the predominantly firm to very firm nature of the soils, it appears that conventional construction equipment will be able to excavate to the full depth required.

5.6 Slopes

5.6.1 Temporary Slopes

It is recommended that temporary cut slopes be no steeper than 1.5H:1V within the native granular soils. These recommended slopes are based on the uncemented materials encountered in the borings and OSHA requirements (OSHA, 1990). Steeper temporary excavations, including those to employ trench shoring, should be made only if based on stability analyses by a registered geotechnical engineer. The analysis should take into account the slope angles, trench geometries, and any surcharge loadings due to equipment and spoil piles.

5.6.2 Permanent Slopes

It is recommended that permanent cut or embankment slopes be no steeper than 1.5H:1V. When permanent slopes of 1.5H:1V are utilized a positive measure to protect the surface of the slope, possibly consisting of soil cement, gabions or another alternative, should be utilized. To improve the aesthetics of the project and to minimize rilling and slope erosion 3H:1V slopes are recommended. However, it is still anticipated that some rilling will occur on unprotected slopes.

5.7 Pavements

Pavement design analysis was performed for the proposed crossings of Sonoqui Wash at Hawes Road and Riggs Road and for the new Marsh Road located south of Riggs Road between 201st Avenue and 204th Avenue. A box culvert is planned at Hawes Road and a box culvert or a bridge is planned at Riggs Road. The existing structural section at each location is unknown. An attempt was made to determine the existing structural section through as-built plans but the as-builts could not be located.

Soil samples adjacent to the areas requiring new pavement obtained during the field investigation were tested to obtain the required subgrade information. The subgrade information is presented in Table 5.7-1.

TABLE 5.7-1
SUBGRADE INFORMATION

Location	Boring Location	Subgrade Information		Correlated R-Value
		Plasticity Index	Percent Passing No. 200 Sieve	
Hawes Road	B-8A	2	41	52
Riggs Road	B-11	4	57	39
Marsh Road	B-14	1	60	48

Recently Ninyo & Moore (2007) completed a pavement design for Riggs Road between Ellsworth Road and Meridian Road. The Riggs Road Sonoqui Wash crossing is located less than 1 mile west of Ellsworth Road. The subgrade conditions at the reconstructed areas of Riggs Road and Hawes Road are better than the design subgrade value recommended by Ninyo & Moore for the Riggs Road pavement design. Therefore, AMEC decided to use the Ninyo & Moore pavement design for Riggs Road at the reconstructed sections of Riggs Road and Hawes Road. AMEC followed the Maricopa County Department of Transportation design procedure for local roads to determine the pavement section for Marsh Road. Table 5.6-2 includes the recommended pavement sections for the three roadways.

TABLE 5.6-2
RECOMMENDED PAVEMENT STRUCTURAL SECTIONS

Structural Element	Thickness (inches)		
	Hawes Road	Riggs Road	Marsh Road
Asphalt Rubber – Asphaltic Concrete (AR-AC)	1.5	1.5	---
Asphaltic Concrete (AC)	4	4	2.5
Aggregate Base (AB)	4	4	6
Stabilized Subgrade (lime or cement)	6	6	---

Due to limited quantities of stabilized subgrade on the project it may not be cost effective to construct the stabilized subgrade layer. If desired the stabilized subgrade could be replaced with 8 inches of aggregate base.

5.7.1 Materials Quality and Construction Requirements

The materials quality and construction requirements should conform to the following sections of the current "Uniform Standard Specifications for Public Works Construction" sponsored and prepared by the Maricopa Association of Governments:

Item	Section(s)
Aggregate Base	310 & 702.2
Bituminous Prime Coat	315
Asphaltic Concrete	321 & 710
Stabilized Subgrade	309 or 311
Asphalt Rubber-Asphaltic Concrete	325

The type of seal coat should be determined based on construction performance.

5.7.2 Asphaltic Concrete

A type C19 mineral aggregate or approved alternate should be utilized. The job mix formula should be established using the Marshall method of mix design (ASTM D1559), with design parameters determined by MAG Section 710. The following criteria should be used in the mix design:

Oil Type – PG70-10
Number of blows, each end of specimen – 75
Stability, pounds – 1,800 minimum
Percent air voids – 3 to 5
Percent voids in mineral aggregate – 14 minimum
Index of retained strength, % - 60 minimum

The stripping potential of the job mix formulation should be determined in accordance with MAG Section 710. The type and quantity of anti-strip additive, if required, should be assessed to meet local agency specification requirements.

5.8 Pipe Bedding and Backfill

Excavation, bedding, backfilling, and compaction of the sewer line should be in accordance with Maricopa Association of Governments Standards and Specifications (1998). The native soils are acceptable for use as trench backfill but not as the bedding material. Table 5.8-1 summarizes the backfill compaction requirements for trench backfill.

TABLE 5.8-1
BACKFILL COMPACTION REQUIREMENTS FOR TRENCH BACKFILL

Backfill Type	Location	From Surface to 2 Feet Below Surface	From 2 feet Below Surface to 1 Foot Above Top of Pipe	From 1 Foot Above Top of Pipe to Bottom of Trench
I	Under existing or proposed pavement, curb, gutter, sidewalk or when any part of trench is within 2 feet of the above	100% for ABC, 95% for native soils	90%	90%
II	Under any utility easement, alley outside of Type I	85%	85%	90%
III	Around any structures or exposed utilities	95% in all cases		

Relative compaction values presented in the table are based on the maximum dry density as determined in accordance with ASTM D698. The moisture content during placement should be within 2 percent below to 2 percent above the optimum moisture content. Water settlement of the trench backfill should not be allowed.

5.9 Corrosion Potential

5.9.1 Metal Pipes

The corrosion potential of a soil sample recovered in Boring B-8A in the vicinity of the dip crossing at Hawes Road was estimated. The location was characterized for the use of prospective corrugated metal pipe (CMP) utilizing laboratory pH and electrical resistivity testing, performed in accordance with Arizona Test Method 236. Results of the corrosion potential testing are presented in Appendix B.

The laboratory pH value was 7.9 and the resistivity value was 3,453 ohm-centimeters (ohm-cm). Figure 203.01-5 of the Preliminary Engineering and Design Manual (ADOT, 1989), as shown in Figure 3, indicates that there are no restrictions on the type of metal pipe that can be used.

5.9.2 Concrete Structures

Relative to potential for attack of concrete, one set of soluble sulfates and chlorides tests were performed on samples of site soils recovered from selected borings, in accordance with Arizona Test Methods 733 and 736. The sample was obtained near Boring 8A near the Sonoqui Wash crossing of Hawes Road. Total soluble sulfates are 23 parts per million (ppm). The sulfate tests measure the water-leachable or "available" sulfate content. These results were compared to Table 4.3.1 (Requirements for Concrete Exposed to Sulfate-Containing Solutions), specifically the "Sulfate (SO_4) in water, ppm" column in the table in Section 4.3 of the American Concrete Institute (ACI) Manual of Concrete Practice (ACI 318/318R, 2001). The test result

was found to be "negligible" (SO_4 ppm less than 150) in terms of sulfate exposure, indicating that Type I or Type II Portland cement would be adequate for concrete structures in contact with these materials.

Chloride test result is 9 ppm. Regarding chloride attack, Section 4.4.2 of ACI 318/318R (2001) indicates that when concretes are exposed to external sources of chlorides, the water-cementitious materials ratio, concrete strength, and minimum concrete cover requirements should be evaluated by the designer. The magnitude of the concentration of chloride in the external source is not specified by ACI.

6.0 SUBSIDENCE AND RELATED HAZARDS

6.1 Background

The project site is located in an area that has experienced subsidence. The subsidence is the result of a significant lowering of the water table and compaction of basin-fill deposits. The decline in the water table is the result of groundwater withdrawals that far exceed the rate of recharge. Where differential rates and magnitudes of subsidence occur over relatively short distances, horizontal strains can become sufficient to cause earth fissuring. Fissures commonly develop along the perimeter of subsiding basins, often in apparent association with buried or protruding bedrock highs, suspected mountain-front faults, or distinct facies changes in basin-fill deposits. The closest known fissure to the channel is located approximately 3,500 feet southwest of where Sonoqui Wash crosses Hawes Road. Other known fissures are located approximately one mile south of where the channel parallels Riggs Road (AZGS, 2008).

The Phase I study concluded that the eastern end of the Phase I section of Sonoqui Wash has probably experienced greater groundwater withdrawal, and therefore greater subsidence, than the western end of the section. While no specific investigations were conducted during Phase II of the study, it is possible that similar conditions exist for the Phase II section of the wash. If differential subsidence were to occur along the channelized wash in the future, the grade along the channel could be impacted and the risk of earth fissuring could increase.

6.2 Results of Reconnaissance-Level Site Visit

No evidence of earth fissures was found during the site walk through visual ground inspection, however dense vegetation made it difficult to observe ground conditions in some areas. The visual ground inspection did identify evidence of desiccation cracking in the vicinity of borings B-8 and B-6. The desiccation cracks were predominantly trending to the northwest, parallel to a dirt access road on the south side of Sonoqui Wash. The dirt road is located at the north end of an open field near the northwest corner of Hawes Road and Riggs Road.

A more comprehensive study including a literature review and aerial photographic analysis would be required to more fully evaluate the potential presence of ground cracks within the project corridor.

7.0 REFERENCES

ACI Manual of Concrete Practice, 2001, Part 3--Use of Concrete in Buildings – Design, Specifications and related topics.

AMEC Earth & Environmental, Inc. (AMEC), 2004, Final Geotechnical Investigation report, Sonoqui Wash Channelization, PCN #480-04-31, Gilbert and Queen Creek, Arizona. AMEC Job No. 3-117-001097, 25 October.

AMEC Earth & Environmental, Inc. (AMEC), 2004, Geotechnical Investigation Report, Chandler Heights Road Over Sonoqui Wash, Queen Creek, Arizona, AMEC Job No. 3-117-001090, 22 January.

Arizona Department of Transportation (ADOT), 1989, Preliminary Engineering and Design Manual, 3rd Edition, March.

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

GeoSlope International, Ltd., 2008, Stability Modeling with Slope/W 2007, An Engineering Methodology, Fourth Edition, Calgary, Alberta, Canada.

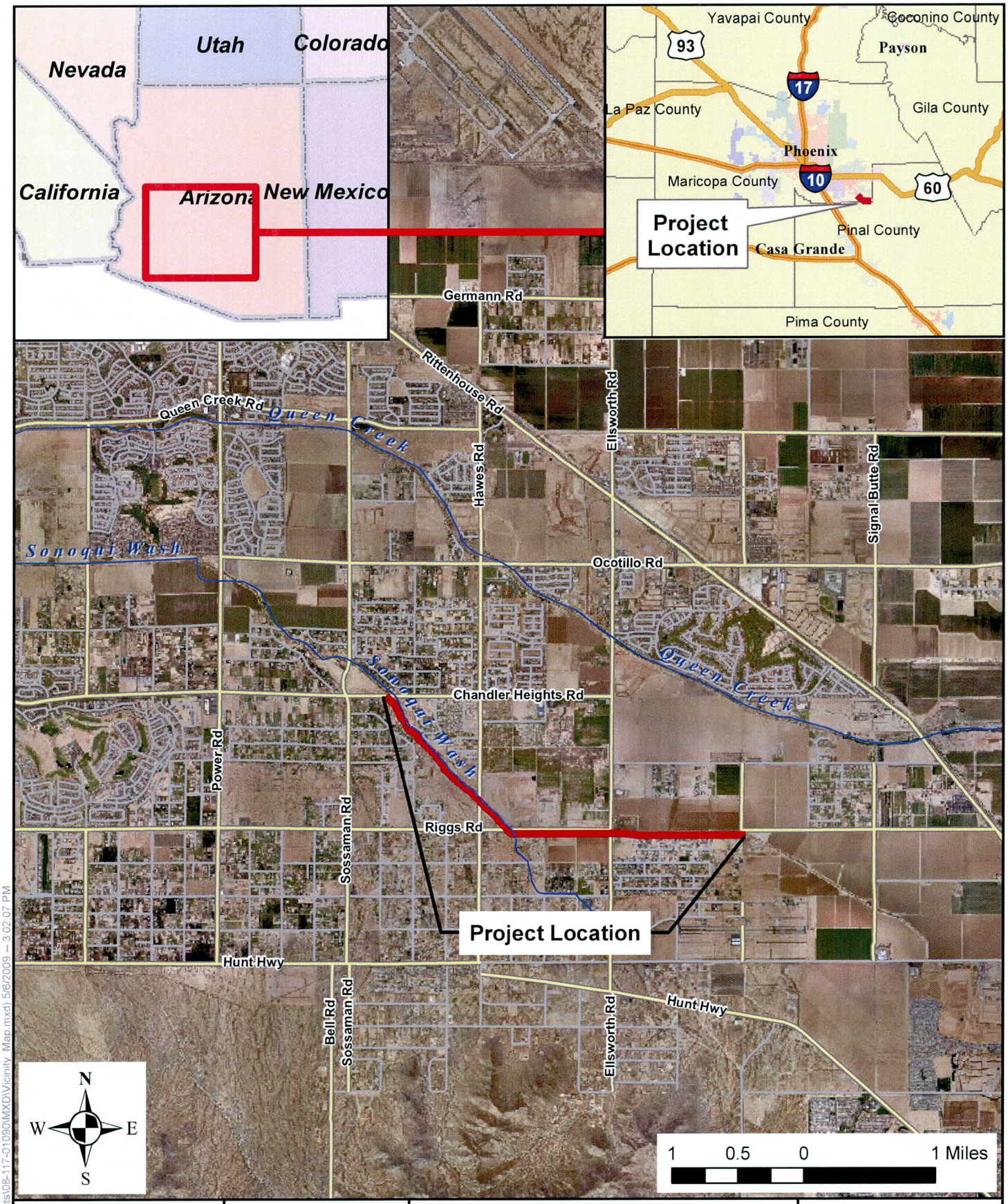
Maricopa Association of Governments. 1998. Uniform Standard Specifications for Public Works Construction. Arizona.

Ninyo & Moore, Geotechnical and Environmental Sciences Consultants, 2007, Geotechnical Evaluation, Riggs Road Improvements, Ellsworth Road to Meridian Road, Queen Creek, Arizona, Project No. 601435001, 26 June.

Occupational Safety and Health Administration (OSHA), 1990, Construction Standards for Excavations (29 CFR Part 1926.650-652) Subpart P.

U.S. Army Corps of Engineers, 1970, Engineering and Design, Stability of Eart and Rock-Fill Dams, Engineer Manual 1110-2-1902, April 1.

FIGURES



JOB NO.:	08-117-01090
PM:	DNF
DATE:	4/6/2009
MAP PROJ:	SP AZ C 83
SCALE:	As Shown

The map shown here has been created with all due and reasonable care and is strictly for use with AMEC Project Number 0811701090. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind as AMEC assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.

Sonoqui Wash Channelization, Phase II
Chandler Heights to Crismon Road
Queen Creek, Arizona

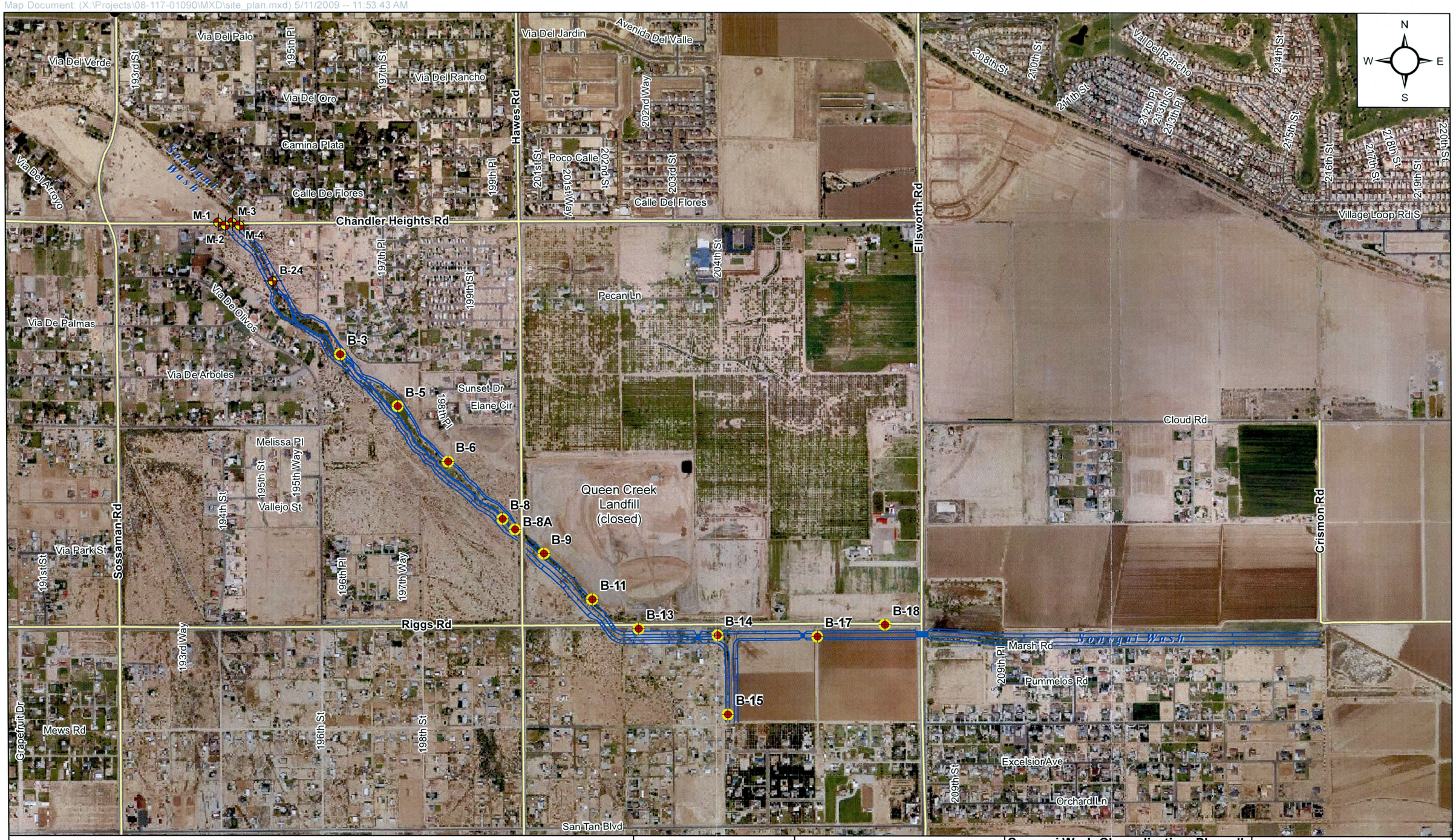
VICINITY MAP

FIGURE **1**

amec

Map Document: (X:\Projects\08-117-01090\MXD\Vicinity_Map.mxd) 5/6/2009 -- 3:02:07 PM

Map Document: (X:\Projects\08-117-01090\MXD\site_plan.mxd) 5/11/2009 -- 11:53:43 AM



LEGEND

- Boring Locations - Previous Investigations
- Boring Locations - Current Investigation
- Planned Channel Improvements

0 500 1,000 2,000 Feet

Job No:	08-117-01090
PM:	DNF
Date:	4/2/2009
Scale:	1" = 1200'
Map Proj.:	AZ SPC 83 FT

The map shown here has been created with all due and reasonable care and is strictly for use with AMEC Project Number 08-117-01090. This map has not been certified by a licensed land surveyor, and any third party use of this map comes without warranties of any kind as AMEC assumes no liability, direct or indirect, whatsoever for any such third party or unintended use.

Sonoqui Wash Channelization, Phase II
Chandler Heights to Crismon Road
Queen Creek, Arizona

Site Plan

FIGURE **2**

amec

ALLOWABLE TYPES OF CULVERT PIPE FOR ph RANGE 5.0 TO 9.0

Resistivity (ohm-cm)	Allowable Pipe
2000 or Greater	A[2] - B - C - D
500-1999	C - D
Less than 500	D

TYPES OF CULVERT PIPE

A) Galvanized Coated Steel (AASHTO M-36)

B) Aluminum Coated Steel (AASHTO M-36)

C) Aluminum Alloy (AASHTO M-196)

D) Bituminous Coated (AASHTO M-190)

Notes: (1) If ph is outside the range of 5.0 to 9.0, a special study of the situation should be made.

(2) Not allowed when ph is less the 6.0.

JOB NO.	08-117-01090
DESIGN:	DNF
DRAWN:	GWH
DATE:	6/2009
SCALE:	NTS

ALLOWABLE TYPES OF CULVERT FOR ph RANGE 5.0 TO 9.0[1] FROM ADOT (1989)

SONOQUI WASH CHANNELIZATION - PHASE II
QUEEN CREEK, ARIZONA

FIGURE 3

amec

APPENDIX A

FIELD INVESTIGATION

TEST DRILLING EQUIPMENT AND PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8-inch O.D., 3 1/4-inch I.D. hollow stem auger or 4 1/2-inch solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Cummins diesel engines capable of delivering about 11.4 kN-m torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 90 kN (20,000 pounds) downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or "river-run" material or harder bedrock, which require other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42-inch diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP-1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9-inch O.D. by 6-inch I.D. or 6 5/8-inch O.D. by 4-inch I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1-foot increments, as noted on the boring logs. Standard penetration tests or 2.42-inch diameter ring samples taken are noted on the boring logs.

Core Boring Rock core samples are retrieved using a CME-75 drill rig, SAITECH GH 3 rig or Burley 2500, 4500 or 4000. The GH 3 is a portable hydraulic core drill. The GH 3 is powered by a Kohler two-cylinder 25-horsepower engine. The hydraulics motor which feeds a two-speed transmission and powers the BW spindle. This unit has a 3-foot stroke and is hand-fed with a 2,000 pound push-pull capability. The GH 3 has the capability of drilling with either B- or N-size core steel using standard or wireline systems. N-size core is the preferred size and it has a nominal O.D. of about 2 inches. The Burley 2500 and 4500 series are portable hydraulic core drills. The 4500 series is capable of a track-mounted or skid-type chassis. The Burley 2500 and 4500 series are powered by 44 and 75 HP power units, respectively, provide up to 2,000 foot-pounds (ft.-lbs.) of torque and in excess of 1,000 revolutions per minute (RPM) of spindle speed. Both rigs are capable of retrieving either N- or H-sized core using wireline systems. The N-size core has a nominal O.D. of about 2 inches and the H-size of about 2.4 inches. The Burley 4000 is a track-mounted core drill.

The CME-75 utilizes a wireline core drilling system that takes N-size cores. Using the NQ wireline system, core is recovered quickly by retrieving the core-laden inner tube through the drill string.

TEST DRILLING EQUIPMENT AND PROCEDURES (Cont.)

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samples in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

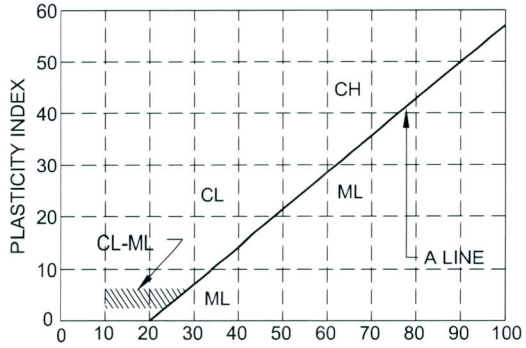
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the United Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see " The Unified Soil Classification System " ASTM Designation: D2487

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
					GP	Poorly graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixture.
			Limits plot below "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixture.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot below "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	SILTS OF LOW PLASTICITY (Liquid limit less than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid limit more than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	CLAYS OF LOW PLASTICITY (Liquid limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid limit more than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% to 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

PROJECT Sonoqui Wash II
Queen Creek, Arizona

amec

JOB NO. 08-117-01090 **DATE** 4/7/09

LOCATION Channel
N811061.97 E778649.87
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1371'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	3-3-4			CL	slightly moist soft	**SANDY CLAY,** predominantly fine grained, subangular to subrounded sand, low plasticity, brown
				U	9	97	3	SM	slightly moist soft	**SILTY SAND,** trace fine grained, subangular to subrounded gravel, predominantly fine grained, subangular to subrounded, nonplastic, brown
5				S	4-5-5			ML	slightly moist moderately firm to very firm	**SANDY SILT,** predominantly fine grained, subangular to subrounded sand, low plasticity, light brown
10				S	9-9-11			SP-SM	slightly moist firm	**SAND WITH SILT & GRAVEL,** trace to some predominantly fine grained, subangular to subrounded gravel, predominantly fine to medium grained, subangular to subrounded sand, nonplastic to low plasticity, light brown
15				S	19-29-15			GP/SP	slightly moist dense	**SAND & GRAVEL,** well graded, subangular to subrounded sand, predominantly fine grained, subangular gravel, light brown to gray
20										Stopped Auger at 14'6" Stopped Sampler at 16'
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-3

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/7/09

LOCATION Channel
N810379.82 E779405.53
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	1-2-2			ML	slightly moist to moist very soft	**SANDY SILT,** predominantly fine grained, subangular to subrounded sand, medium plasticity, brown
				S	2-4-5					
								SM	slightly moist to moist moderately firm	**SILTY SAND WITH GRAVEL,** some predominantly fine grained, subangular to subrounded gravel, predominantly medium to fine grained, subangular to subrounded, nonplastic, dark reddish-brown note: decrease in fines below 4'
5				S	5-5-2		8			
								SP	slightly moist to moist medium dense	**SAND WITH GRAVEL,** rare cobbles up to 4" in diameter, trace to some coarse grained, subangular gravel, predominantly medium grained, subangular to subrounded sand, nonplastic, reddish-brown note: increase in coarse grained, subangular sand & increase in subangular gravel
10				U	23					
15				S	8-7-12					
										Stopped Auger at 14'6" Stopped Sampler at 16'
20										
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-5

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/9/09

LOCATION Channel
N809653.43 E780059.74
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1382'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	3-4-4		5	ML	slightly moist soft to moderately firm	**SILT WITH SAND,** some predominantly fine grained, subangular to subrounded sand, low plasticity, brown note: increase in sand below 2'
				S	3-7-7		5			
5				U	32	97	6	SP-SM	slightly moist firm	**SAND WITH SILT,** predominantly fine to medium grained, subangular to subrounded sand, nonplastic, light brown
10				S	7-9-10		2	SP	slightly moist medium dense	**SAND,** trace predominantly fine grained, subangular to subrounded gravel, predominantly fine to medium grained, subangular to subrounded sand, light brown
15				U	86	110	3	SP	slightly moist very dense	**SAND WITH GRAVEL,** rare small cobble, some well graded, subangular to subrounded gravel, predominantly medium to coarse grained, subangular to subrounded sand, nonplastic, reddish-brown to gray
20				S	42-50/6"		4	SC	slightly moist hard	**CLAYEY SAND,** occasional to trace fine grained, subangular to subrounded gravel, predominantly fine to medium grained, subangular to subrounded, weakly to moderately cemented, nonplastic, reddish-brown to white
25										Stopped Auger at 19'6" Sampler refused at 20'6"

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-6

PROJECT Sonoqui Wash II
Queen Creek, Arizona

amec

JOB NO. 08-117-01090 **DATE** 4/9/09

LOCATION Channel
N808899.12 E780772.15
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1381'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				U A	11	86	8	CL	slightly moist moderately firm	**CLAY WITH SAND,** some predominantly fine grained, subangular to subrounded sand, medium plasticity, brown note: occasional calcium carbonate filaments
				S	4-4-6					
								SM	slightly moist moderately firm	**SILTY SAND WITH GRAVEL,** trace to some fine grained, subangular to subrounded gravel, predominantly fine grained, subangular to subrounded sand, nonplastic, brown
5				S	4-4-6		3			
								SP-SM	slightly moist very firm	**SAND WITH SILT & GRAVEL,** considerable predominantly fine grained, subangular gravel, predominantly fine to medium grained, subangular to subrounded sand, nonplastic, light brown to gray
10				U	68					
								SP-SM	slightly moist firm	**SAND WITH SILT,** trace to some predominantly fine grained, subangular to subrounded gravel, predominantly medium grained, subangular to subrounded sand, nonplastic, brown
15				S	8-18-12					
								SP/GP	slightly moist hard	**SAND & GRAVEL,** considerable predominantly fine grained, subangular to subrounded gravel, considerable predominantly medium to coarse grained sand, nonplastic, brown to gray
20				U	100/9"					
										Stopped Auger at 19'6" Sampler refused at 20'3"
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-8

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/7/09

LOCATION N808761.76 E780935.12

RIG TYPE Hand Shovel
BORING TYPE
SURFACE ELEV. 1379'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				A			3	SM	slightly moist	**SILTY SAND WITH GRAVEL,** trace small subangular cobbles up to 4" in diameter, trace to some predominantly coarse grained, subangular gravel, predominantly fine grained, subangular to subrounded sand, low plasticity, brown
										Stopped Shovel at 1'
5										
10										
15										
20										
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-8A

PROJECT Sonoqui Wash II
Queen Creek, Arizona

amec

JOB NO. 08-117-01090 **DATE** 4/6/09

LOCATION Channel
N807840.97 E781940.86
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1384'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	1-3-5			CL-ML	slightly moist soft to firm	**SANDY SILTY CLAY,** predominantly fine grained, subangular to subrounded sand, low plasticity, brown note: decrease in fines below 2'
				U	14					
5				S	3-6-10	96	7			note: uncemented to weakly cemented below 4'
10				S	8-8-11			SP-SM	slightly moist medium dense	**SAND WITH SILT,** predominantly medium grained, subangular to subrounded sand, nonplastic, light brown
15				U	50/11"	113	3	SP-SM	slightly moist hard to moderately firm	**SAND WITH CLAY & GRAVEL,** considerable predominantly coarse grained, subangular gravel, predominantly medium to fine grained, subangular to subrounded sand, nonplastic, light brown
20				S	6-6-8					
25										Stopped Auger at 19'6" Stopped Sampler at 21'

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-11

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/6/09

LOCATION Channel
N807455.66 E782550.85
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1389'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				U	13	100	4	CL	slightly moist	**SILTY CLAY WITH SAND,** occasional coarse grained, subangular to subrounded gravel, some predominantly fine grained, subangular to subrounded sand, low to medium plasticity, brown
				A					moderately firm	
				S	6-7-6					note: decrease in gravel & calcium carbonate nodules below 2'
5				S	5-5-6					
10				S	5-4-6				slightly moist to moist	
								SP	slightly moist to moist	**SAND,** trace fine grained gravel, predominantly medium grained, subangular to subrounded, nonplastic, brown
15				U	22	105	4		medium dense	
										note: increase in gravel below 18'
20				S	10-11-15					
										Stopped Auger at 19'6" Stopped Sampler at 21'
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-13

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/6/09

LOCATION Channel
N807370.69 E783584.55
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1393'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S	3-5-6		7	ML	slightly moist	**SANDY SILT,** predominantly fine grained, subangular to subrounded sand, low plasticity, brown
				A					moderately firm to very firm	
				S	5-6-7		4			
5				U	28	95	5			
10				S	21-24-21		8			note: moderately cemented & brown to light brown in color below 9'
								SP-SM	slightly moist	**SAND WITH SILT,** predominantly medium grained, subangular to subrounded sand, nonplastic, brown
15				U	15	116	3		very firm	
20				S	12-14-18		4			
								SP-SM	slightly moist	**SAND WITH SILT & GRAVEL,** trace to some predominantly fine grained, subangular to subrounded gravel, predominantly medium to coarse grained, subangular to subrounded sand, nonplastic, gray to reddish-brown
25				S	18-21-25		4		very firm	

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-14

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/6/09

LOCATION Channel
N807370.69 E783584.55
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1393'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
25								SP-SM		**SAND WITH SILT & GRAVEL,** continued
										Stopped Auger at 24'6" Stopped Sampler at 26'
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-14

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/6/09

LOCATION Channel
N806335.83 E783720.74
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1397'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	1-2-2			SC	slightly moist very soft	**CLAYEY SAND,** trace fine grained, subrounded gravel, predominantly fine to medium grained, subangular to subrounded, low plasticity, brown
				U	14			SC	slightly moist moderately firm	**CLAYEY SAND,** predominantly fine to medium grained, subangular to subrounded sand, low to medium plasticity, brown note: rare to occasional calcium carbonate nodules
5				S	8-5-7					
								CL	slightly moist to moist	**SANDY CLAY,** predominantly fine grained, subangular to subrounded sand, low to medium plasticity, brown
10				U	15	109	15			
15				S	3-4-5					
								SM	slightly moist hard	**SILTY SAND,** trace fine grained, subangular to subrounded gravel, predominantly medium to coarse grained, subangular to subrounded, moderately cemented, low plasticity, reddish-brown
20				U	50/6"					
										Stopped Auger at 19'6" Sampler refused at 20'
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-15

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/7/09

LOCATION Channel
N807355.06 E784898.25
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1399'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	6-5-5			CL	slightly moist moderately firm	**SANDY CLAY,** predominantly fine grained, subangular to subrounded sand, low plasticity, brown
				U	12			SC	slightly moist soft	**CLAYEY SAND,** predominantly fine to medium grained, subangular to subrounded sand, low to medium plasticity, reddish-brown
5				S	3-4-4					
								CL	slightly moist to moist moderately firm to firm	**SANDY CLAY,** predominantly fine grained, subangular to subrounded sand, medium plasticity, brown
10				S	5-6-7					
										note: increase in fine to medium grained, subangular to subrounded sand below 13'
15				S	9-9-10					
								SP-SC	slightly moist firm	**SAND WITH SILT & GRAVEL,** considerable fine grained, subangular to subrounded gravel, predominantly medium grained, subangular to subrounded sand, nonplastic, reddish-brown to white
20				U	25	114	4			
										note: decrease gravel below 23'
25				S	9-9-10					

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-17

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/7/09

LOCATION Channel
N807355.06 E784898.25
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1399'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
25			X							**SAND WITH SILT & GRAVEL,** continued
										Stopped Auger at 24'6" Stopped Sampler at 26'
30										
35										
40										
45										
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-17

PROJECT Sonoqui Wash II
Queen Creek, Arizona

JOB NO. 08-117-01090 **DATE** 4/7/09

LOCATION Channel
N807509.77 E785787.94
RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1401'
DATUM Stanley Basemap Files

Depth in Feet	Blows Per Foot	Graphical Log	Sample	Sample Type	Blow Count (S) Per 6-inches (U) Per 12-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification or Rock Unit	REMARKS	VISUAL CLASSIFICATION
0				S A	14-11-6			SC	slightly moist firm	**CLAYEY SAND,** trace fine grained, subangular gravel, predominantly fine to medium grained, subangular to subrounded, low to medium plasticity, brown
				S	1-2-2			CL-ML	slightly moist to moist	**SILTY CLAY WITH SAND,** rare fine grained, subangular to subrounded gravel, some predominantly fine grained, subangular to subrounded sand, low plasticity, brown
5				U	7	102	11		very soft to moderately firm	
10				S	4-4-7					
15				U	40			SP-SM	slightly moist medium dense	**SAND WITH SILT & GRAVEL,** some predominantly fine grained, subangular gravel, predominantly medium grained, subangular to subrounded sand, nonplastic, reddish-brown to gray
20				S	13-10-8			SC	slightly moist to moist firm	**CLAYEY SAND,** predominantly fine grained, subangular to subrounded, weakly cemented, medium plasticity, brown
25										Stopped Auger at 19'6" Stopped Sampler at 21'

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - Thin Walled Shelby tube sample
P - Pressuremeter Test
NR - No Recovery

LOG OF TEST BORING NO. B-18

APPENDIX B

LABORATORY TEST RESULTS

LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive 1-inch high 2.5-inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inch per minute. The machine is designed to receive one of the 1-inch high 2.42-inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	4/15/09

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**
													PERCENT PASSING BY WEIGHT										
B-3 @ 2.0-3.0'	SM	NV	NP	19	33	59	70	77	83	85	86	89	91	96	100	100	100	100	100	100	100	100	3
B-5 @ 4.5-6.0'	SM	NV	NP	18	27	45	55	62	72	76	76	79	81	84	89	94	100	100	100	100	100	100	10
B-6 @ 0.0-1.5'	ML	25	3	81	97	99	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	13
B-8 @ 0.0-1.0'	CL	35	14	83	91	95	97	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	20
B-8 @ 4.5-6.0'	SM	NV	NP	38	53	63	67	70	74	77	79	84	86	89	91	100	100	100	100	100	100	100	22
B-9 @ 4.5-5.5'	SM	18	1	46	66	91	97	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	29
B-9 @ 19.5-20.4'	SP-SC	24	5	8.4	13	23	32	40	61	75	79	90	93	97	100	100	100	100	100	100	100	100	32
B-11 @ 2.0-3.0'	CL-ML	22	4	57	85	95	96	97	98	99	100	100	100	100	100	100	100	100	100	100	100	100	35
B-11 @ 14.5-15.4'	SP-SM	NV	NP	7.0	10	20	30	39	53	58	60	64	65	66	67	67	67	67	67	100	100	100	38
B-13 @ 14.5-15.5'	SP	NV	NP	4.9	8	18	28	38	63	77	81	90	93	96	96	100	100	100	100	100	100	100	45

AASHTO R18

REVIEWED BY CY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
SAMPLE SOURCE:	SEE BELOW	**DATE ASSIGNED:**	4/15/09

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

				Silt or	SAND								GRAVEL									COBBLES	
				Clay	Fine			Medium			Coarse		Fine				Coarse						
Location & Depth	**USCS**	**LL**	**PI**	**#200**	**#100**	**#50**	**#40**	**#30**	**#16**	**#10**	**#8**	**#4**	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1 1/4"**	**1 1/2"**	**2"**	**3"**	**6"**	**Lab #**

PERCENT PASSING BY WEIGHT

B-14 @ 4.5-5.5'	ML	19	1	60	78	88	92	94	97	99	99	100	100	100	100	100	100	100	100	100	100	100	50
B-15 @ 9.5-10.5'	CL	25	8	68	83	92	94	96	99	99	100	100	100	100	100	100	100	100	100	100	100	100	59
B-17 @ 19.5-20.5'	SP-SM	NV	NP	5.6	8	15	24	32	48	58	62	73	77	84	90	100	100	100	100	100	100	100	68
B-18 @ 4.5-5.5'	CL-ML	24	6	78	87	91	92	93	96	97	97	98	99	100	100	100	100	100	100	100	100	100	73
B-8A @ 0.0-1.0'	SM	22	2	41	57	64	66	67	70	72	73	76	78	80	81	84	86	88	90	90	100	100	77

AASHTO R18

REVIEWED BY CY

amec

PROJECT: Sonoqui Wash Channelization-Phase II
LOCATION: Chandler Heights Road to Crimson Road
MATERIAL: Soil
SAMPLE SOURCE: SEE BORING

JOB NO: 08-117-01090
WORK ORDER NO: 1
LAB NO: SEE BELOW
DATE ASSIGNED: 4/15/09

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD(ASTM D2937)

LAB #	BORING	MOISTURE WET WT. (g)	MOISTURE DRY WT. (g)	MOISTURE MOISTURE CONTENT	NUMBER OF RINGS	WET WEIGHT & RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
3	B-3 @ 2.0-3.0'	367.0	357.1	2.8%	6.0	980.4	256.9	97.1
15	B-6 @ 4.5-5.5'	743.7	704.5	5.6%	6.0	1,001.4	257.5	97.2
17	B-6 @ 14.5-15.5'	687.0	666.0	3.2%	5.0	911.7	224.5	110.3
20	B-8 @ 0.0-1.0'	284.4	262.9	8.2%	5.0	772.7	211.0	86.0
29	B-9 @ 4.5-5.5'	307.1	287.4	6.9%	5.0	829.3	212.8	95.5
35	B-11 @ 2.0-3.0'	314.7	293.7	7.2%	5.0	836.3	214.5	96.1
38	B-11 @ 14.5-15.4'	305.0	296.1	3.0%	5.0	924.2	218.8	113.4
41	B-13 @ 0.0-1.0'	627.7	606.1	3.6%	5.0	847.1	219.0	100.4
45	B-13 @ 14.5-15.5'	383.3	368.7	4.0%	6.0	1,049.1	262.2	104.5
50	B-14 @ 4.5-5.5'	288.5	276.0	4.5%	5.0	825.1	226.5	94.8
52	B-14 @ 14.5-15.5'	577.2	558.8	3.3%	4.0	766.5	188.7	115.8
59	B-15 @ 9.5-10.5'	371.0	323.5	14.7%	5.0	973.2	219.6	108.8
68	B-17 @ 19.5-20.5'	371.6	356.9	4.1%	5.0	936.6	219.4	114.1
73	B-18 @ 4.5-5.5'	347.1	313.9	10.6%	5.0	905.8	222.4	102.3

REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	See Below
SAMPLE SOURCE:	See Below	**DATE ASSIGNED:**	4/15/09

MOISTURE CONTENT OF SOIL (ASTM D2216)

LAB #	BORING & DEPTH	WET WT. (gram)	DRY WT. (gram)	MOISTURE CONTENT
10	B-5 @ 4.5-6.0'	225.4	209.4	7.6%
13	B-6 @ 0.0-1.5'	185.2	176.1	5.2%
14	B-6 @ 2.0-3.5'	380.0	363.2	4.6%
16	B-6 @ 9.5-11.0'	442.2	435.5	1.5%
18	B-6 @ 19.5-20.5'	446.1	427.2	4.4%
22	B-8 @ 4.5-6.0'	275.8	267.2	3.2%
32	B-9 @ 19.5-20.4'	422.5	406.6	3.9%
48	B-14 @ 0.0-1.5'	410.4	382.9	7.2%
49	B-14 @ 2.0-3.5'	511.7	489.9	4.4%
51	B-14 @ 9.5-11.0'	374.8	346.2	8.3%
53	B-14 @ 19.5-21.0'	615.3	592.1	3.9%
54	B-14 @ 24.5-26.0'	383.0	370.1	3.5%
77	B-8A @ 0.0-1.0'	892.4	868.1	2.8%

AASHTO R18

REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	See Below
SAMPLE SOURCE:	See Below	**DATE ASSIGNED:**	04/15/09

pH & RESISTIVITY (AZ 236)

LAB NO	SAMPLE SOURCE	RESISTIVITY (Ohm-cm)	pH
77	B-8A @ 0.0-1.0'	3,453	7.9

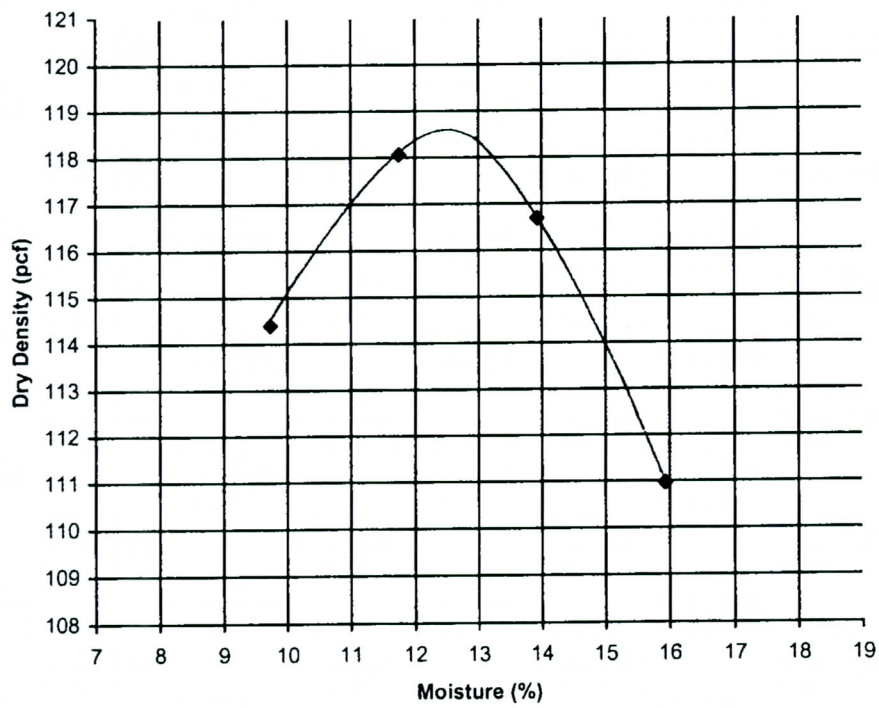
REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	1
SAMPLE SOURCE:	B-3 @ 0.0-4.5'	**DATE SAMPLED:**	4/15/09

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)

MAXIMUM DRY DENSITY (pcf):	118.5
OPTIMUM MOISTURE (%):	12.5



NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

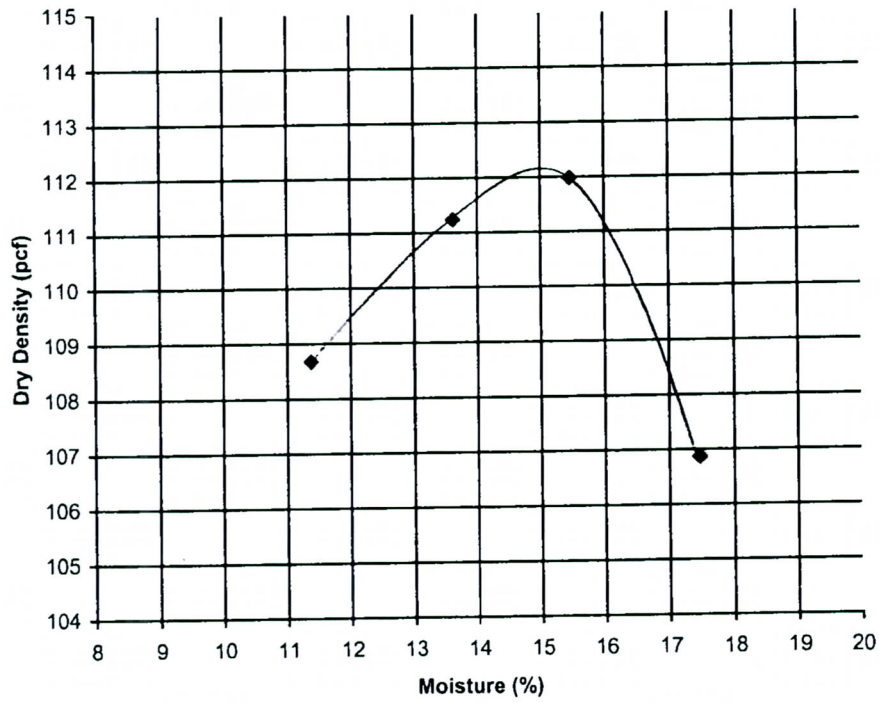
REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	12
SAMPLE SOURCE:	B-6 @ 0.0-4.5'	**DATE SAMPLED:**	4/15/09

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)

MAXIMUM DRY DENSITY (pcf):	112.1
OPTIMUM MOISTURE (%):	15.0



NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

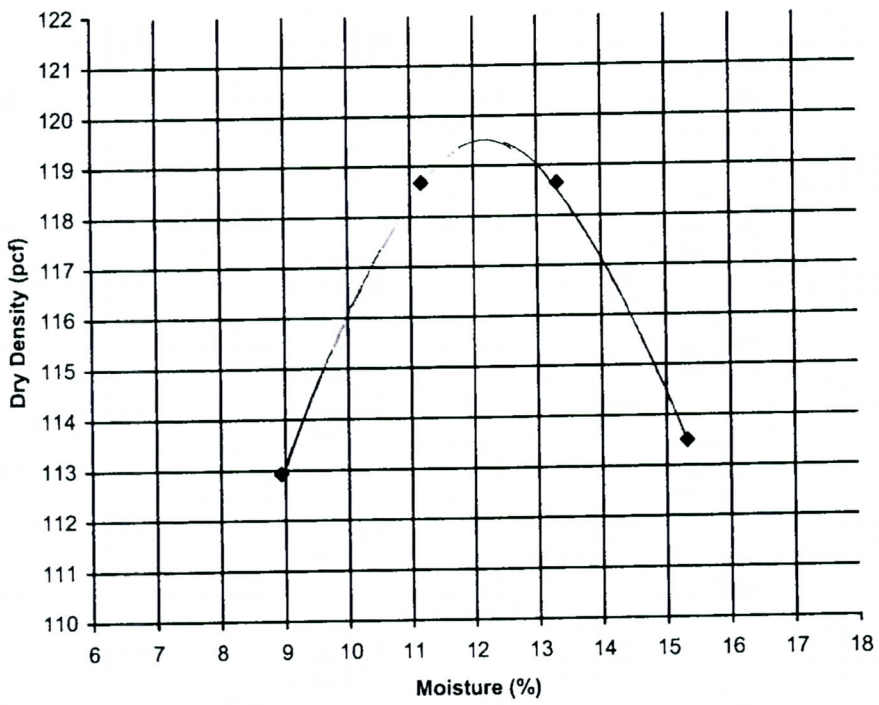
REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	26
SAMPLE SOURCE:	B-9 @ 0.0-4.5'	**DATE SAMPLED:**	4/15/09

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)

MAXIMUM DRY DENSITY (pcf):	119.4
OPTIMUM MOISTURE (%):	12.2



NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

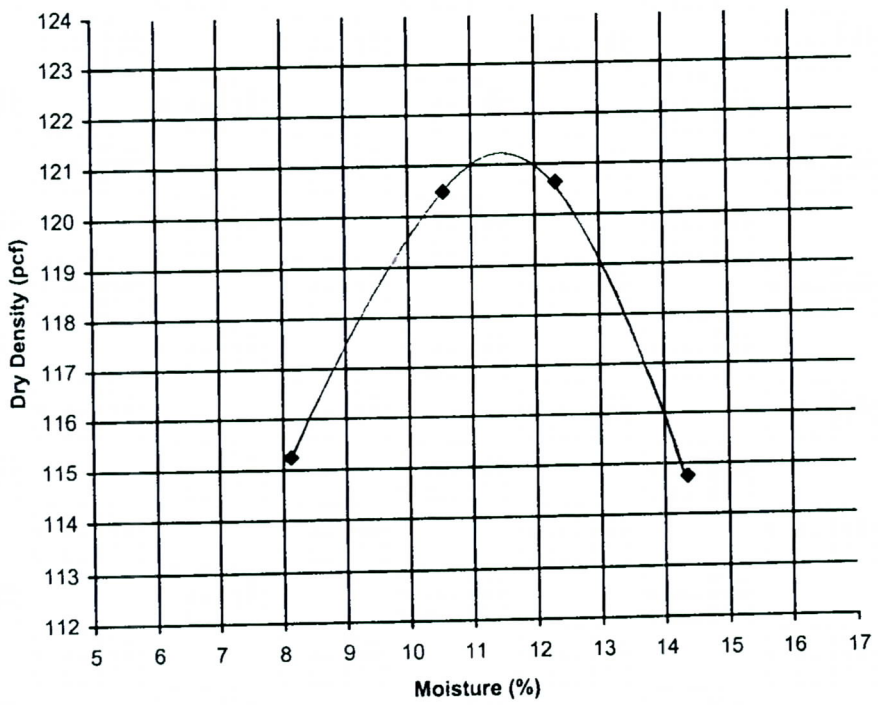
REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	62
SAMPLE SOURCE:	B-17 @ 0.0-4.5'	**DATE SAMPLED:**	4/15/09

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)

MAXIMUM DRY DENSITY (pcf):	121.2
OPTIMUM MOISTURE (%):	11.4



NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AAP AASHTO R18

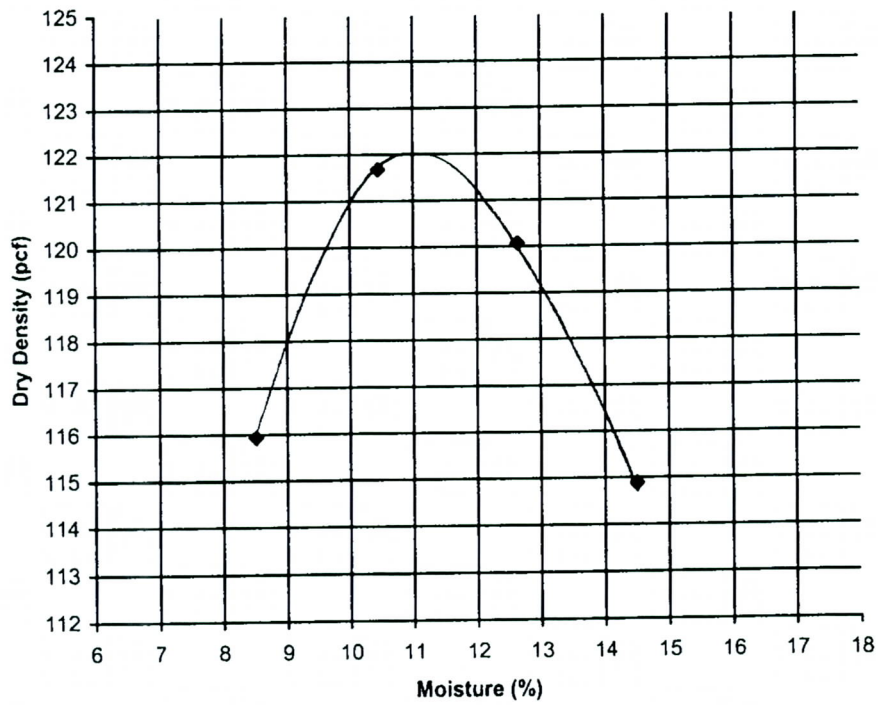
REVIEWED BY

amec

PROJECT:	Sonoqui Wash Channelization-Phase II	**JOB NO:**	08-117-01090
LOCATION:	Chandler Heights Road to Crimson Road	**WORK ORDER NO:**	1
MATERIAL:	Soil	**LAB NO:**	40
SAMPLE SOURCE:	B-13 @ 0.0-4.5'	**DATE SAMPLED:**	4/15/09

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING STANDARD EFFORTS (12,400ft-lb-ft/cu.ft) (ASTMD698A)

MAXIMUM DRY DENSITY (pcf):	122.0
OPTIMUM MOISTURE (%):	11.0



NOTE: THE ZERO AIR VOIDS CURVE REPRESENTS A SPECIFIC GRAVITY OF: ASSUMED.

THIS IS A SUMMARIZED REPORT OF THE REFERENCED PROCEDURES AND DOES NOT INCLUDE ALL REPORTING REQUIREMENTS. ADDITIONAL DATA CAN BE PROVIDED AT CLIENT'S REQUEST.

AASHTO R18

REVIEWED BY

MOTZZ LABORATORY, INC.
2113 S 48th St Suite 109
Tempe, AZ 85282

Soil Analysis Report

AMEC
Mr. Cliff Metz
1405 West Auto Drive
Tempe , AZ 85284-1016

Project: 08-117-01090 WO2
Sampler:
Date Received: 9/22/2009
Date Reported: 9/22/2009
PO Number: 08-117-01090

Lab Number: 900870-01 **Lab# 78 B-8B 0.0 - 1.0**

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	23	ppm	
Chloride, Cl	ARIZ 736	9	ppm	

APPENDIX C

BORING LOGS FROM PREVIOUS AMEC INVESTIGATIONS: CHANDLER HEIGHTS ROAD OVER SONOQUI WASH AND SONOQUI WASH CHANNELIZATION, PHASE I

TEST DRILLING EQUIPMENT AND PROCEDURES

Description of Subsurface Exploration Methods

Auger Boring Drilling through overburden soils is performed with 6 5/8-inch O.D., 3 1/4-inch I.D. hollow stem auger or 4 1/2-inch solid stem continuous flight auger. Carbide insert teeth are normally used on bits so they can penetrate soft rock or very strongly cemented soils. A CME-75 truck-mounted drill rig is used to advance the auger. The drill rigs are powered with six-cylinder Cummins diesel engines capable of delivering about 11.4 kN-m torque to the drill spindle. The spindle is advanced with twin hydraulic rams capable of exerting 90 kN (20,000 pounds) downward force.

Generally, refusal to penetration of the auger is adopted as top of the SGC or "river-run" material or harder bedrock, which require other techniques for penetration. Grab samples or auger cuttings may be taken as necessary. Standard penetration tests or 2.42-inch diameter ring samples are taken in conjunction with the auger borings as needed, with the sampling interval and type being indicated on the boring logs.

Hammer Drill Drilling with the Hammer drill is accomplished with a Drill Systems AP-1000 drill rig advancing a double-walled drive casing with a link-belt 180 diesel pile driving hammer, having a rated energy of 8,100 foot-pounds per blow. Where noted on the boring log, the hammer is equipped with a supercharger which can boost the energy to approximately 12,000 foot-pounds per blow. The supercharger is used only in portions of the boring where blow counts are relatively high. Cuttings are removed with compressed air by a reverse circulation process, and are collected in a cyclone from which grab samples are obtained. The drive casing is either 9-inch O.D. by 6-inch I.D. or 6 5/8-inch O.D. by 4-inch I.D. and employs an expendable bit of slightly larger diameter than the O.D. of the casing. Hammer blows required to advance the drive casing are recorded in 1-foot increments, as noted on the boring logs. Standard penetration tests or 2.42-inch diameter ring samples taken are noted on the boring logs.

Core Boring Rock core samples are retrieved using a CME-75 drill rig, SAITECH GH 3 rig or Burley 2500, 4500 or 4000. The GH 3 is a portable hydraulic core drill. The GH 3 is powered by a Kohler two-cylinder 25-horsepower engine. The hydraulics motor which feeds a two-speed transmission and powers the BW spindle. This unit has a 3-foot stroke and is hand-fed with a 2,000 pound push-pull capability. The GH 3 has the capability of drilling with either B- or N-size core steel using standard or wireline systems. N-size core is the preferred size and it has a nominal O.D. of about 2 inches. The Burley 2500 and 4500 series are portable hydraulic core drills. The 4500 series is capable of a track-mounted or skid-type chassis. The Burley 2500 and 4500 series are powered by 44 and 75 HP power units, respectively, provide up to 2,000 foot-pounds (ft.-lbs.) of torque and in excess of 1,000 revolutions per minute (RPM) of spindle speed. Both rigs are capable of retrieving either N- or H-sized core using wireline systems. The N-size core has a nominal O.D. of about 2 inches and the H-size of about 2.4 inches. The Burley 4000 is a track-mounted core drill.

The CME-75 utilizes a wireline core drilling system that takes N-size cores. Using the NQ wireline system, core is recovered quickly by retrieving the core-laden inner tube through the drill string.

TEST DRILLING EQUIPMENT AND PROCEDURES (Cont.)

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 test procedure. In many cases, 2-inch O.D., 1 3/8-inch I.D. samples are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3-inch O.D. samples lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free fall drop hammer required to advance the samples in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2- or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per 6 inches on the boring logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587), pitcher samplers, Denison samplers or continuous CME samplers. Where samples of rock are required, they are obtained by NQ diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings. Also, representative samples are obtained from the cuttings from the hammer and Schramm drill rig.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares the boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the boring logs.

TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. **Relative Density.** Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. **Relative Consistency.** Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. **Relative Firmness.** Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

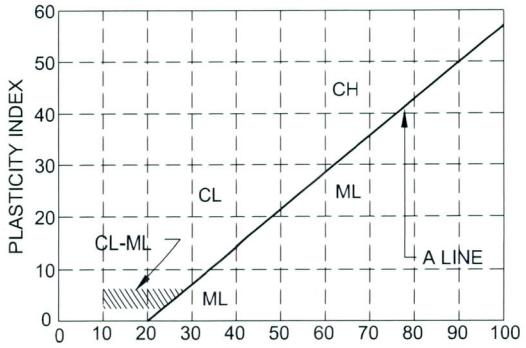
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the United Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see " The Unified Soil Classification System " ASTM Designation: D2487

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	**GRAVELS** (50% or less of coarse fraction passes No. 4 sieve)	**CLEAN GRAVELS** (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
					GP	Poorly graded gravels, gravel-sized mixtures or sand-gravel-cobble mixture.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixture.
			Limits plot below "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixture.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	**CLEAN SANDS** (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot below "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	**SILTS** LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	**SILTS OF LOW PLASTICITY** (Liquid limit less than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid limit more than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	**CLAYS OF LOW PLASTICITY** (Liquid limit less than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid limit more than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% to 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	7-6-4		3	SM	slightly moist medium dense	3" of Aggregate Base Course **SILTY SAND,** some fine grained gravel, nonplastic, brown
5				S	3-5-6		3			
10				S	7-7-9		4			
								SP	slightly moist medium dense to dense	**SAND,** predominantly medium to fine grained, nonplastic, brown
15				U	24		2			
20				S	9-19-25		3			note: fine grained sand from 20'6" to 23'
								SC	slightly moist very firm to hard	**CLAYEY SAND,** some fine grained gravel, poorly graded sand, weakly lime cemented, low to medium plasticity, light brown
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
		none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-1

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				U	33	96	7	SC	slightly moist	**CLAYEY SAND,** continued
									very firm to hard	note: thin layers of strong lime cementation throughout strata
30				S	25-50/3"		8			
35				U	50/5 1/2"		13			
40				S	27-31-50/5"		15			
45				S	23-36-50/6"		12			
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-1

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	50/4"		6		slightly moist hard	
55			X	S	24-27-48		9			
60			X	S	38-50/5 1/2"		6			
								SP	slightly moist very dense	**GRAVELLY SAND,** fine grained gravel, poorly graded sand, nonplastic, light brown
65			X	S	16-31-40		4			
								SC/CL	slightly moist hard	**CLAYEY SAND TO SANDY CLAY,** predominantly medium to fine grained sand, weakly to moderately lime cemented, low to medium plasticity, light brown
70			X	S	50/3"		9			
75										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-1

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				S	50/5"				slightly moist hard	
								SP	slightly moist very dense	**GRAVELLY SAND,** fine grained gravel, poorly grained sand, nonplastic, light brown
80				S	28-39-40					
										Stopped Auger at 80' Stopped Sampler at 81'6"
85										
90										
95										
100										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-1

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.2'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0								SM	slightly moist medium dense	3" of Aggregate Base Course over **SILTY SAND,** predominantly medium to fine grained, nonplastic, brown
5				S A	4-5-7					
10				S	13-13-13			CL-ML	slightly moist firm to very firm	**SILTY CLAY TO CLAYEY SILT,** some fine grained sand, low plasticity, brown note: weakly lime cemented below 15'
15				S	14-15-22					
20				U	25	109	3	SM	slightly moist medium dense	**SILTY SAND,** considerable fine grained gravel, poorly graded sand, nonplastic, brown
25								SC	slightly moist firm to hard	**CLAYEY SAND,** predominantly medium to fine grained, weakly to moderately lime cemented, low plasticity, brown to light brown

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-2

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.2'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				S	10-10-12			SC	slightly moist firm to hard	**CLAYEY SAND,** continued
30				U	50/2" NR					
35				S	50/6"					
40				U	50/ 4 1/2"					
45				S	21-32-50/6"					
								SM	slightly moist	**SILTY SAND,** considerable fine grained gravel, poorly graded sand, nonplastic, brown
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-2

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.2'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				U	54		5	SP	slightly moist very dense	**GRAVELLY SAND,** continued
								SC	slightly moist hard	**CLAYEY SAND,** some fine grained gravel, predominantly medium to fine grained, weakly lime cemented, low plasticity, brown
55				S	50/5"					
60				S	41-50/5"			SP	slightly moist very dense	**GRAVELLY SAND,** fine grained gravel, poorly graded sand, nonplastic, brown
65				S	23-26-50/4"					
								SC/CL	slightly moist hard	**CLAYEY SAND TO SANDY CLAY,** predominantly medium to fine grained sand, weakly to moderately lime cemented, low to medium plasticity, light brown to brown
70				S	17-29-50/6"					
75										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-2

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/9/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1373.2'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				S	22-45-50/4"			SC/CL		**CLAYEY SAND TO SANDY CLAY** continued
								SP	slightly moist very dense	**GRAVELLY SAND,** fine grained gravel, poorly graded sand, nonplastic, brown
80				S	38-46-50/6"					
										Stopped Auger at 80' Stopped Sampler at 81'6"
85										
90										
95										
100										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-2

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1372.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S A	6-11-12			SC	slightly moist firm	Aggregate Base Course over **CLAYEY SAND,** fine to medium grained sand, low plasticity, brown
								SM	slightly moist medium dense	**SILTY SAND,** fine grained, nonplastic, brown
5				U	14					
10				S	10-15-15			CL-ML	slightly moist firm to very firm	**CLAYEY SILT TO SILTY CLAY,** some fine grained sand, weakly lime cemented, low plasticity, brown
15				U	82					
								SP	slightly moist firm	**GRAVELLY SAND,** fine grained gravel, poorly graded sand, nonplastic
20				S	9-13-14					
								CL	slightly moist	**SANDY CLAY,** trace of fine grained gravel, weakly lime cemented, low to medium plasticity, brown
25										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-3

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1372.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				U	32	109	11	CL	slightly moist firm to hard	**SANDY CLAY,** continued note: moderately lime cementation below 27'
30				S	50/6"					
35				S	38-50/6"					
40				U	38-50/5"			CH	slightly moist hard	**CLAY,** some fine grained sand, medium to high plasticity, weakly to moderately lime cemented, dark brown
45				S	19-21-42			SC	slightly moist hard	**CLAYEY SAND,** poorly graded, weakly lime cemented, low plasticity, brown
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-3

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1372.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				U	72			SP-SM	slightly moist very dense	**SAND,** some silt, predominantly fine grained, weakly lime cemented, nonplastic
								SC	slightly moist very hard	**CLAYEY SAND,** poorly graded, weakly lime cemented, low to medium plasticity, light brown
55				S	39-50/5"					
60				S	50/3"		9			
								SP	slightly moist very dense	**SAND,** some fine grained gravel, poorly graded sand, weakly lime cemented, nonplastic, brown
65				S	18-19-32					
70				U	47					
								CL	slightly moist very firm to hard	**SILTY CLAY,** some fine grained sand, weakly lime cemented, low to medium plasticity, brown
75										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-3

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1372.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				S	18-24-39			CL	slightly moist firm to hard	**SILTY CLAY,** continued
								SP	slightly moist very dense	**GRAVELLY SAND,** fine grained gravel, poorly graded sand, nonplastic, brown
80				S	50/5"					Stopped Auger at 80' Sampler refused at 80'5"
85										
90										
95										
100										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-3

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1369.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				SM	slightly moist medium dense to dense	3" of Aggregate Base Course **SILTY SAND,** predominantly fine grained, nonplastic, brown
5				S	12-14-22		5			
								SC	slightly moist hard to firm	**CLAYEY SAND,** predominantly medium to fine grained, weakly to moderately lime cemented, low plasticity, brown
10				U	38-50/5"		10			
15				S	9-11-12		13			
20				U	68		12			
25										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1:38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-4

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1369.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25				S	12-23-50/2"		8	SC	slightly moist hard	**CLAYEY SAND,** continued
								CH	slightly moist firm to very firm	**SILTY CLAY,** some fine grained sand, medium to high plasticity, brown
30				S	15-16-21		18			
35				U	49		21			
40				S	12-24-25		18	SC	slightly moist very firm to hard	**CLAYEY SAND,** poorly graded, weakly lime cemented, low plasticity, light brown note: intermittent thin layers of fine grained gravel throughout
45				S	17-29-40		7			
50										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-4

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1369.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				U	47	103	15	SC	slightly moist very firm to hard	**CLAYEY SAND,** continued
55				S	17-29-38		10			
								SP-SM	slightly moist hard	**SAND,** some to considerable silt, predominantly fine grained sand, nonplastic, brown
60				U	48		7			
								SC-CL	slightly moist hard	**CLAYEY SAND TO SANDY CLAY,** predominantly medium to fine grained sand, weakly lime cemented, low to medium plasticity, light brown
65				S	31-50/6"		11			
								ML	slightly moist to moist firm	**SANDY SILT,** low plasticity, brown
70				S	8-10-11		16			
								SP	slightly moist very dense to dense	**GRAVELLY SAND,** fine grained gravel, poorly graded sand, nonplastic, grayish-brown
75										

GROUNDWATER

	DEPTH(ft)	HOUR	DATE
▽		none	
▼			
▽			
▼			

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-4

PROJECT Chandler Heights Road Bridge over Sonoqui Wash

JOB NO. 3-117-001090 **DATE** 12/8/03

LOCATION

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. 1369.4'
DATUM MCDOT - Point No. 1005 NEC Section 30 T2S R7E

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
75				S	38-32-34			SP		**GRAVELLY SAND,** continued
80				S	15-18-17					
								SM	slightly moist	**SILTY SAND,** predominantly fine grained, nonplastic to low plasticity, brown
										Stopped Auger at 80' Stopped Sampler at 81'6"
85										
90										
95										
100										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - CME sample

LOG OF TEST BORING NO. M-4

PROJECT Sonoqui Wash Channelization

JOB NO. 3-117-001097 **DATE** 3/19/04

LOCATION See Site Plan

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. ~1368'
DATUM Stanley Consultants, Inc. Survey Data

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	1-2-2			SM	slightly moist very soft to moderately firm	**SANDY SILT,** predominantly fine grained sand, low to medium plasticity, light brown
5				S	4-6-8					
								CL	slightly moist moderately firm	**SANDY CLAY,** predominantly fine grained sand, low plasticity, light brown
10				S	10-5-7					note: increase in sand content at 11'
								SM	slightly moist moderately firm to firm	**SILTY SAND,** predominantly fine grained, subangular to subrounded, nonplastic, light brown
15				S	6-5-8		2			
				A						
20				U	26 NR					note: increasing grain size at depth
								SP	slightly moist medium dense to dense	**SAND,** some fine grained gravel, trace of silt, predominantly fine to medium grained, subangular to subrounded, nonplastc, light brown
25				U	45	117	1			

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-24

PROJECT Sonoqui Wash Channelization

JOB NO. 3-117-001097 **DATE** 3/19/04

LOCATION See Site Plan

RIG TYPE CME-75
BORING TYPE 6 5/8" Hollow Stem Auger
SURFACE ELEV. ~1368'
DATUM Stanley Consultants, Inc. Survey Data

Depth in Feet	Drill Rate Min/ft.	Graphical Log	Sample	Sample Type	Blow Count Per 6-inches	Dry Density lbs. per Cubic ft.	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
25								SP		**SAND,** continued
								ML	slightly moist very firm	**SANDY SILT,** predominantly fine grained sand, low plasticity, whitish-brown
30				S	10-16-15					
										note: increase in plasticity at 34'
35				S	15-20-25					
										Stopped Auger at 34'6" Stopped Sampler at 36'
40										
45										
50										

GROUNDWATER

DEPTH(ft)	HOUR	DATE
	none	

SAMPLE TYPE

A - Drill cuttings
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
C - 3" O.D. CME tube sample
NR - No Recovery

LOG OF TEST BORING NO. B-24

APPENDIX D

BORINGS LOGS FROM RELATED INVESTIGATION:
RIGGS ROAD IMPROVEMENTS,
ELLSWORTH ROAD TO MERIDIAN ROAD

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

GEOTECHNICAL EVALUATION
RIGGS ROAD IMPROVEMENTS
ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PREPARED FOR:
Town of Queen Creek
22350 South Ellsworth Road
Queen Creek, Arizona 85242

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
3001 South 35th Street, Suite 6
Phoenix, Arizona 85034

June 26, 2007
Project No. 601435001

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

June 26, 2007
Project No. 601435001

Mr. Dick Schaner
Special Transportation Projects Manager
Town of Queen Creek
22350 South Ellsworth Road
Queen Creek, Arizona 85242

Subject: Geotechnical Evaluation
Riggs Road Improvements
Ellsworth Road to Meridian Road
Queen Creek, Arizona

Dear Mr. Schaner:

In accordance with your initial authorization dated March 31, 2006, and upon your verbal authorization for additional work issued April 26, 2007, Ninyo & Moore has performed a geotechnical evaluation for the above-referenced project. The attached report describes our design methodology, and presents our findings, conclusions, and recommendations regarding the proposed roadway improvements along the project corridor and supercedes our previous report dated January 15, 2007.

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 6-26-07 ARIZONA, U.S.A.

Kevin L. Porter, P.E.
Senior Project Engineer

Steven D. Nowaczyk, P.E.
Principal Engineer

JSR/KLP/SAH/SDN/pjs

Distribution: (2) Addressee
(8) Greg Froehlich/EPS Group

LEGEND

B-6 ●	Approximate Boring Locations
P-2 ▲	Approximate Percolation Test Location

0 600

Approximate Scale:
1 inch = 600 feet
Source: Maricopa County Assessor's GIS Site, 2006.
NOTE: ALL DIMENSIONS, LOCATIONS, AND DIRECTIONS ARE APPROXIMATE.

Ninyo & Moore		BORING LOCATION MAP	FIGURE
PROJECT NO: 601435001	DATE: 06/07	RIGGS ROAD IMPROVEMENTS ELLSWORTH ROAD TO MERIDIAN ROAD QUEEN CREEK, ARIZONA	2

1435bim0506a

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 free-falling from a height of 30 inches in general accordance with ASTM D 1586-99. 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 hammer or the kelly bar of the drill rig in general accordance with ASTM D 3550-01. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer or bar, 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.

DATE DRILLED 06/05/06 BORING NO. B-1

GROUND ELEVATION -- SHEET 1 OF 1

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

BASELINE STATION = 100+40± LATERAL OFFSET = 60'±R

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							CL	ALLUVIUM: Brown, damp, stiff to very stiff, fine sandy CLAY; trace to few silt; scattered fine to coarse gravel at surface.
			10					
			8	9.0	102.8		CL-ML	Brown, damp, stiff, sandy silty CLAY; scattered caliche filaments.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 06/05/06 promptly after completion of drilling. 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.
10								
15								

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PROJECT NO.	DATE	FIGURE
601435001	06/07	A-1

DATE DRILLED	06/05/06	BORING NO.	B-2
GROUND ELEVATION	--	SHEET 1 OF 1	
METHOD OF DRILLING	CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)		
BASELINE STATION =	111+00±	LATERAL OFFSET =	90'±L
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							CL	ALLUVIUM: Brown, damp, stiff, CLAY with sand; trace to few silt.
			14	10.8	105.9			
			8					
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 06/05/06 promptly after completion of drilling. 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.
10								
15								

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PROJECT NO.	DATE	FIGURE
601435001	06/07	A-2

DATE DRILLED 06/05/06 BORING NO. B-3

GROUND ELEVATION -- SHEET 1 OF 1

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

BASELINE STATION = 120+00± LATERAL OFFSET = 0±

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							CL	ALLUVIUM: Brown, damp, stiff, fine sandy CLAY; trace to few silt.
			9					
			11	16.9	96.8			Moist; scattered caliche filaments.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 06/05/06 promptly after completion of drilling. 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.
10								
15								

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PROJECT NO.	DATE	FIGURE
601435001	06/07	A-3

DATE DRILLED	06/05/06	BORING NO.	B-4
GROUND ELEVATION	--	SHEET 1 OF 1	
METHOD OF DRILLING	CME-75, 8" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)		
BASELINE STATION =	129+00±	LATERAL OFFSET =	0±
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	■					▨	CL	ALLUVIUM: Brown, damp, stiff, CLAY; few sand; trace to few silt; scattered caliche filaments.
	■		10					
	■							
	■		4					Firm.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 06/05/06 promptly after completion of drilling. 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.
10								
15								

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PROJECT NO.	DATE	FIGURE
601435001	06/07	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, damp, firm to stiff, fine to medium sandy CLAY; trace to few silt.
			5					
			6					
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 06/05/06 promptly after completion of drilling. 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.
10								
15								

DATE DRILLED 06/05/06 BORING NO. B-5

GROUND ELEVATION -- SHEET 1 OF 1

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

BASELINE STATION = 139+50± LATERAL OFFSET = 50±L

SAMPLED BY DM LOGGED BY DM REVIEWED BY HAH

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PROJECT NO.	DATE	FIGURE
601435001	06/07	A-5

DATE DRILLED 06/05/06 BORING NO. B-6

GROUND ELEVATION -- SHEET 1 OF 1

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

BASELINE STATION = 153+00± LATERAL OFFSET = 0±

SAMPLED BY DM LOGGED BY DM REVIEWED BY HAH

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						CL	ALLUVIUM: Brown, damp, very stiff, fine to medium sandy CLAY; trace to few silt.
		15	9.2	98.9			
		8					Stiff.
5							Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 06/05/06 promptly after completion of drilling. 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.
10							
15							

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

PROJECT NO.	DATE	FIGURE
601435001	06/07	A-6

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, stiff, CLAY; scattered caliche filaments.
			10					
			2					Soft.
5								Total Depth = 5 feet. Groundwater not encountered during drilling. Backfilled on 05/21/07 promptly after completion of drilling. 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.
10								
15								

DATE DRILLED 05/21/07 BORING NO. B-16

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-75, 6" Diameter Hollow-Stem Auger (Enviro-Drill Inc.)

BASELINE STATION = 135+00± LATERAL OFFSET = 0±

SAMPLED BY WTD LOGGED BY WTD REVIEWED BY KJT

Ninyo & Moore

BORING LOG

RIGGS ROAD IMPROVEMENTS - ELLSWORTH ROAD TO MERIDIAN ROAD
QUEEN CREEK, ARIZONA

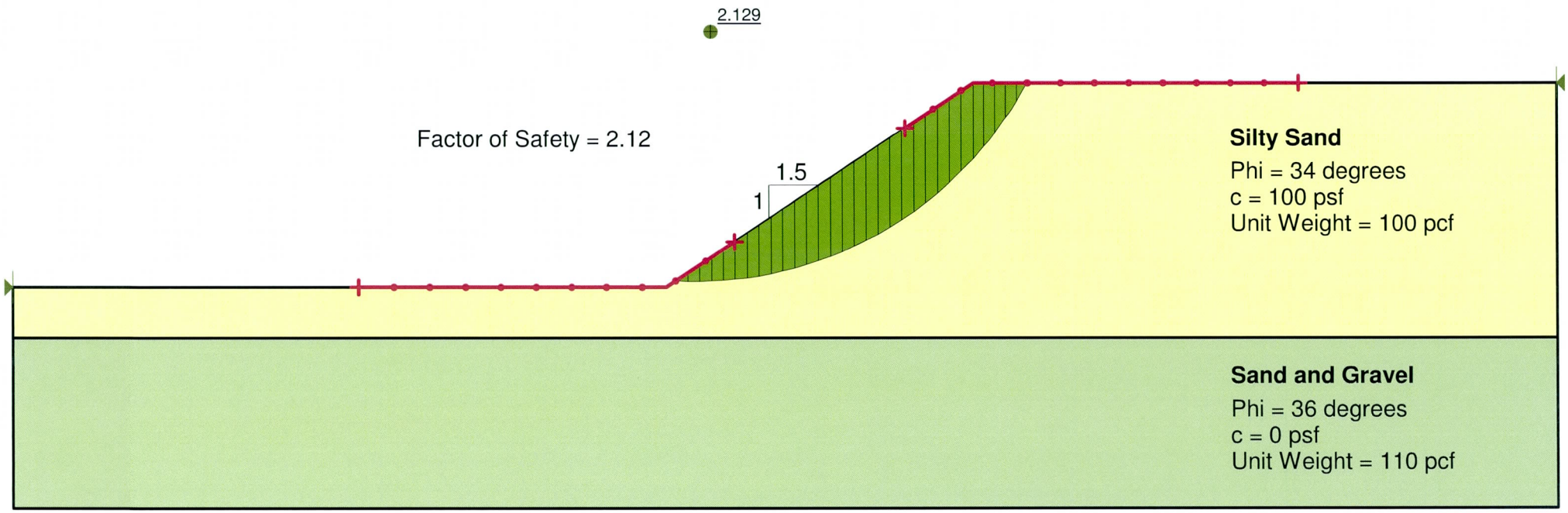
PROJECT NO.	DATE	FIGURE
601435001	06/07	A-16

APPENDIX E

SLOPE STABILITY RESULTS

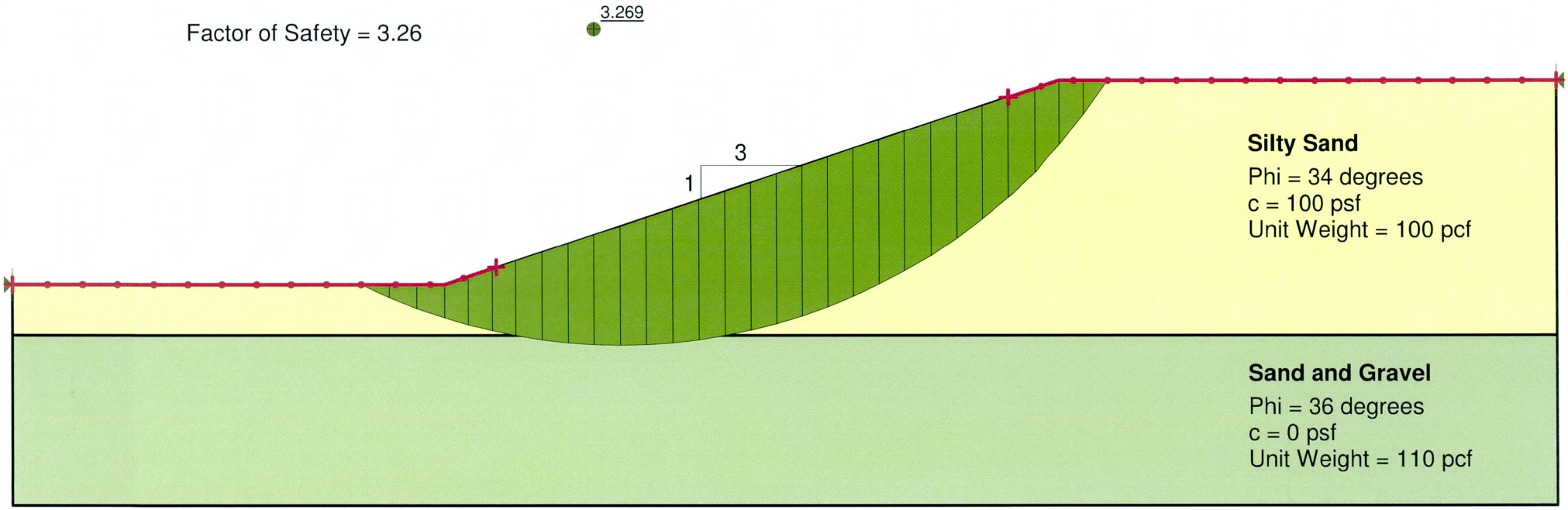
Sonoqui Wash Channelization, Phase II
Job No. 08-117-01090

Case I - End of Construction



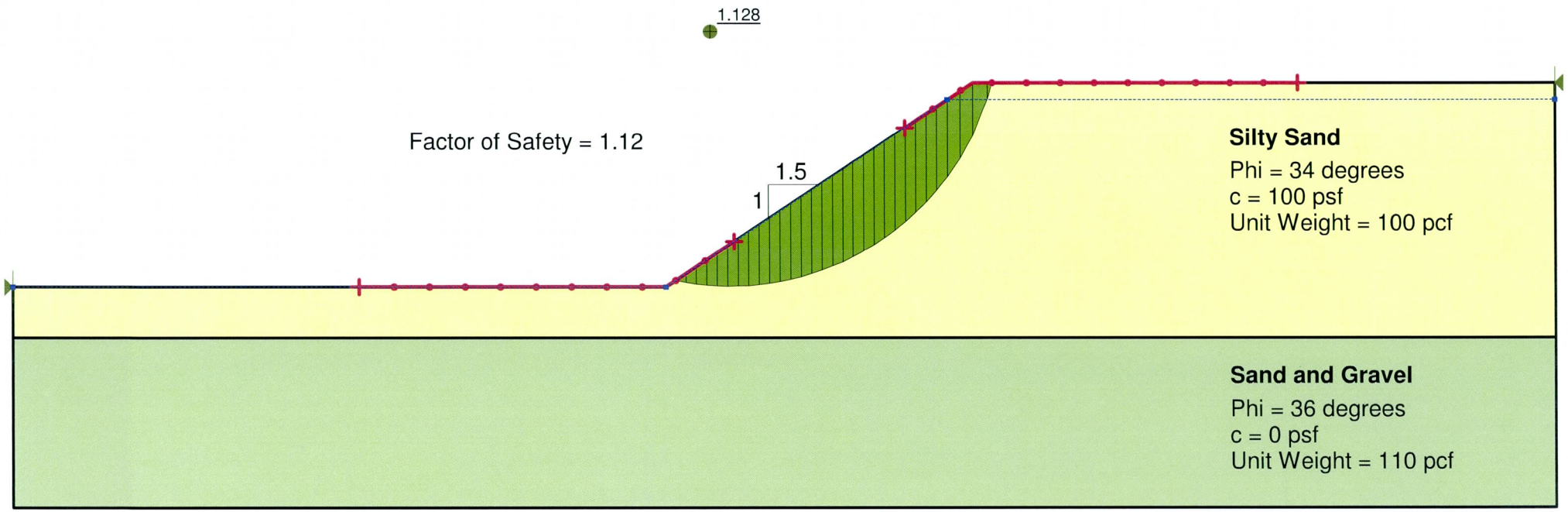
Sonoqui Wash Channelization, Phase II
Job No. 08-117-01090

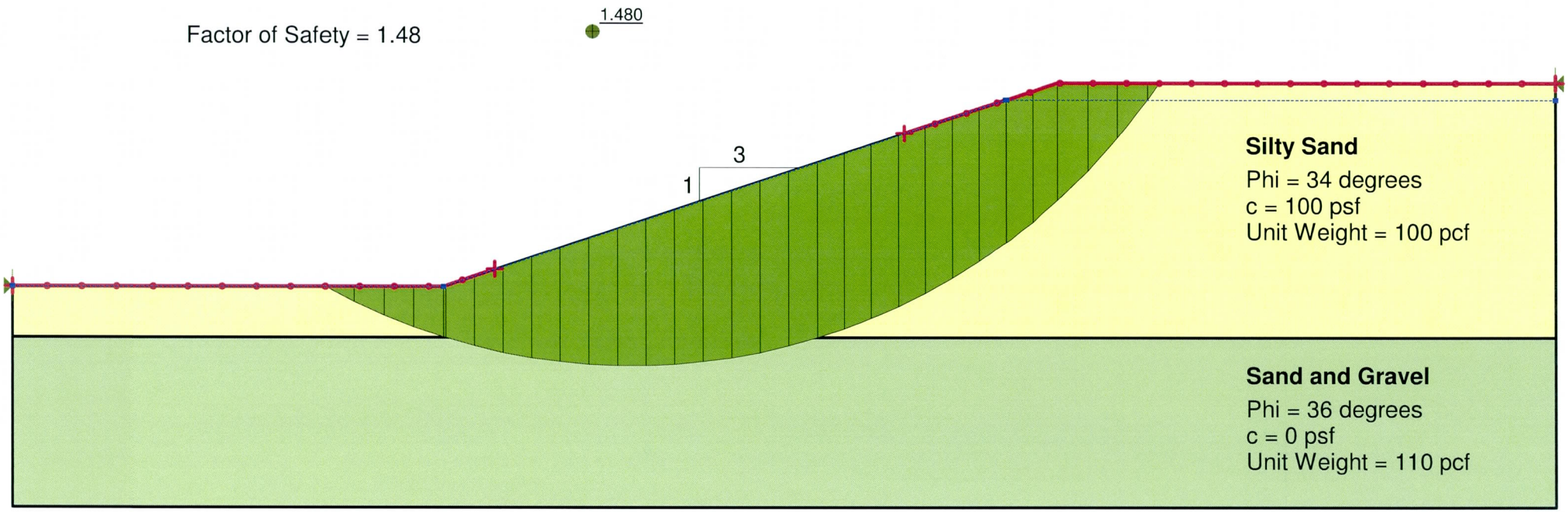
Case I - End of Construction



Sonoqui Wash Channelization, Phase II
Job No. 08-117-01090

Case II - Sudden Drawdown



Sonoqui Wash Channelization, Phase II
Job No. 08-117-01090

Case II - Sudden Drawdown