

# Geotechnical Evaluation

## McDowell Recharge Basins Improvements

12100 McDowell Road  
Avondale, Arizona

City of Avondale  
399 East Lower Buckeye Road | Avondale, Arizona 85323

August 2, 2019 | Project No. 606042002



Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

**Ninyo & Moore**  
Geotechnical & Environmental Sciences Consultants



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August 2, 2019  
Project No. 606042002

Mr. Michael Navabi, PE, LEED AP, D.WRE, BCEE  
Public Works Engineering Project Manager  
City of Avondale  
399 East Lower Buckeye Road  
Avondale, Arizona 85323

Subject: Geotechnical Evaluation  
McDowell Recharge Basins Improvements  
12100 McDowell  
Avondale, Arizona

Dear Mr. Navabi:

In accordance with our proposal dated April 9, 2019, and your authorization, Ninyo & Moore has performed a geotechnical evaluation for the above-referenced site. The attached report presents our methodology, findings, conclusions, and recommendations regarding the geotechnical conditions at the project site.

Ninyo & Moore appreciates the opportunity to be of service to you on this project.

Respectfully submitted,  
**NINYO & MOORE**

**Rachelle E. Mason**  
Senior Staff Engineer

REM/JSR/tp

Distribution: (1) Addressee (via e-mail)

**Jeffrey Rodgers, PE, PG**  
Principal Engineer

# CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
<b>2</b>	<b>SCOPE OF SERVICES</b>	<b>1</b>
<b>3</b>	<b>SITE DESCRIPTION</b>	<b>1</b>
<b>4</b>	<b>AERIAL PHOTOGRAPH REVIEW</b>	<b>2</b>
<b>5</b>	<b>PROPOSED REMEDIATION</b>	<b>3</b>
<b>6</b>	<b>FIELD EXPLORATION AND LABORATORY TESTING</b>	<b>3</b>
<b>6.1</b>	<b>Laboratory Testing</b>	<b>4</b>
<b>7</b>	<b>GEOLOGY AND SUBSURFACE CONDITIONS</b>	<b>4</b>
<b>7.1</b>	<b>Geologic Setting</b>	<b>4</b>
<b>7.2</b>	<b>Subsurface Conditions</b>	<b>5</b>
	7.2.1 Sediment	5
	7.2.2 Alluvium	5
	7.2.3 Groundwater	5
<b>8</b>	<b>RECOMMENDATIONS</b>	<b>6</b>
<b>8.1</b>	<b>Removal of Sediment</b>	<b>6</b>
<b>9</b>	<b>LIMITATIONS</b>	<b>7</b>
<b>10</b>	<b>REFERENCES</b>	<b>9</b>

## TABLES

1 – Summary of Aerial Photograph Review	2
2 – Test Pit Summary	3
3 – Sediment Removal Recommendations	6

## FIGURES

1 – Site Location
2 – Test Pit Locations
3 – Sediment Removal Boundaries

## APPENDICES

A – Test Pit Logs

B – Laboratory Testing

# 1 INTRODUCTION

In accordance with our proposal dated April 9, 2019, and your authorization, we have performed a sediment evaluation for the proposed McDowell Recharge Basins Improvements project located at 12100 McDowell Road in Avondale, Arizona. The purpose of our evaluation was to assess the presence of sediment accumulation at the bottom of the existing basins at the project site in order to provide remediation approaches to improve the percolation rate. This report presents the results of our evaluation, and our geotechnical considerations and recommendations regarding the proposed remediation.

## 2 SCOPE OF SERVICES

The scope of our services for this project generally included:

- Reviewing readily available geotechnical data, aerial photographs, and published geologic literature, including maps and reports pertaining to the project site and vicinity.
- Conducting a geologic reconnaissance of the site.
- Marking out the boring locations at the project site, and notifying Arizona 811 of the boring locations prior to drilling.
- Excavating, logging, and sampling of 14 exploratory test pits. These test pits extended from 3 to 10-feet below ground surface (bgs). The test pit logs are presented in Appendix A.
- Collecting bulk soil samples in the test pits at selected depths for laboratory testing and analysis.
- Performing laboratory tests on selected samples obtained from the test pits to evaluate in-situ moisture content, particle-size gradation, and Atterberg limits. The in-situ moisture content results are presented on the test pit logs in Appendix A. The remainder of the laboratory test results are presented in Appendix B.
- Preparing this report presenting our findings, conclusions, and recommendations regarding the remediation approaches.

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

## 3 SITE DESCRIPTION

The project site is located at 12100 McDowell Road in Avondale, Arizona (Figure 1). At the time of our evaluation, the site consisted of four groundwater recharge basins. The basins receive treated effluent from Avondale's Water Reclamation Facility as well as surface water from Salt River Project and Central Arizona Project from the City's Crystal Gardens wetlands facility. The

site was bound by the Agua Fria River to the north and west, residential properties to the east and southeast, and McDowell Road to the south.

According to the Tolleson, Arizona 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Map (2018), the site is at an average elevation of roughly 990 feet relative to mean sea level. Based on information from this topographic quadrangle map, the ground surface at the site vicinity gently slopes from the northeast to the southwest.

## 4 AERIAL PHOTOGRAPH REVIEW

Aerial photographs dated 1937 through 2018 from the Flood Control District of Maricopa County website were reviewed for this project. A summary of the observations noted for each aerial photograph is presented in Table 1:

Table 1 – Summary of Aerial Photograph Review			
Photograph Date(s)	Site	Adjacent Properties	
1937, 1949, 1959	Agua Fria River bed and embankment.	North:	River bed and agricultural land.
		South:	River bed and agricultural land.
		East:	Agricultural land.
		West:	Agua Fria River and agricultural land.
1969, 1976	Agua Fria River bed and embankment.	North:	River bed and agricultural land.
		South:	River bed, agricultural land and McDowell Road.
		East:	Agricultural land.
		West:	Agua Fria River and agricultural land.
1986, 1993, 1996	Agua Fria River bed and embankment	North:	River bed and agricultural land.
		South:	River bed, undeveloped land and McDowell Road that has been diverted southwest.
		East:	Agricultural land.
		West:	Agua Fria River and agricultural land.
1998	Site has been developed for retention basins.	North:	Agua Fria River.
		South:	River bed, undeveloped land and McDowell Road that has been diverted southwest.
		East:	Residential development.
		West:	Agua Fria River and residential.

**Table 1 – Summary of Aerial Photograph Review**

Photograph Date(s)	Site	Adjacent Properties	
2000, 2001, 2002, 2003, 2004, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017	Retention basins	North:	Agua Fria River.
		South:	River bed, undeveloped land and McDowell Road that has been diverted southwest and beginning development of sports complex and park.
		East:	Residential development.
		West:	Agua Fria River and residential.

## 5 PROPOSED REMEDIATION

The project includes plans to improve the McDowell Recharge Basins Facility’s operational efficiencies at its current water delivery rate of 11,500 acre feet per year including optimizing storage retention in the basins. We understand sedimentation from the incoming water has reduced the infiltration rate of the existing recharge basins. The City of Avondale plans to remediate Basins 1 through 4 to improve infiltration rates in these basins.

## 6 FIELD EXPLORATION AND LABORATORY TESTING

On June 6 through July 10, 2019, Ninyo & Moore conducted a subsurface exploration at the site in order to evaluate the subsurface conditions and to collect soil samples for laboratory testing. Our evaluation consisted of excavating, logging, and sampling fourteen test pits using a Case 560 Super N Backhoe. The test pits, denoted as TP-1 through TP-4, extended to depths between approximately 3 to 10 feet bgs (Figure 2). Bulk soil samples were collected at selected intervals. Descriptions of the soils encountered are presented in the test pit logs in Appendix A. Table 2 presents the depth of each test pit at the site:

**Table 2 – Test Pit Summary**

Basin	Test Pit	Approximate Depth (ft)
1	TP-1A	6
1	TP-1B	6
1	TP-1C	6
1	TP-1D	6
2	TP-2A	3
2	TP-2B	3
2	TP-2C	3
3	TP-3A	4

**Table 2 – Test Pit Summary**

Basin	Test Pit	Approximate Depth (ft)
3	TP-3B	4
3	TP-3C	3
4	TP-4A	10
4	TP-4B	6
4	TP-4C	6
4	TP-4D	6

## 6.1 Laboratory Testing

The soil samples collected from our excavating activities were transported to the Ninyo & Moore laboratory in Phoenix, Arizona. In addition, Ninyo & Moore performed laboratory tests on selected samples obtained from the test pits to evaluate the in-situ moisture content, particle-size gradation, and Atterberg limits.

The in-situ moisture content results are presented on the test pit logs in Appendix A. A description of the laboratory testing as well as the remainder of the laboratory test results are presented in Appendix B.

## 7 GEOLOGY AND SUBSURFACE CONDITIONS

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

### 7.1 Geologic Setting

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

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



The surficial geology of the site is described as latest Quaternary (0 to 10,000 years) age alluvial channel, fan, and low terraces of major drainages (Demsey, 1989). The United States Department of Agriculture Web Soil Survey described the site as generally consisting of Brios Loamy Sand, Torripsamments and Torrifluvents, and Vint Fine Sandy Loam. Loam is an agriculture soil classification that refers to a soil comprised of a mixture of clay, silt, and sand.

## **7.2 Subsurface Conditions**

Our knowledge of the subsurface conditions at the project site is based on the results of our exploratory test pits and our understanding of the general geology of the area. The test pit logs contains our field test results, as well as our interpretation of the conditions likely to exist between actual samples retrieved. Therefore, the test pit logs contains both factual and interpretive information. Lines delineating subsurface strata on the test pit logs are intended to group soils having similar engineering properties and characteristics. They should be considered approximate, as the actual transition between soil types may be gradual. Detailed stratigraphic information as well as a key to the soil symbols and terms used on the test pit logs are provided in Appendix A.

### **7.2.1 Sediment**

Sediment was encountered at the surface of the test pits and extended between 0.1 to 1.5 feet bgs. In our test pits, the sediment generally consisted of lean clays (CL) and clayey sands (SC).

### **7.2.2 Alluvium**

Native alluvial soil was encountered below the sediment and extended to the test pit termination depths. In our test pits, the alluvium generally consisted of medium dense well graded sands with silt (SW-SM), silty sands (SM) and poorly graded gravels (GP). Varying quantities of cobbles and possible boulders were also observed in our test pits.

### **7.2.3 Groundwater**

Groundwater was not encountered in our test pits. Based on well data from the Arizona Department of Water Resources, the depth to groundwater has been estimated to be about 45 feet bgs. Groundwater levels can fluctuate due to seasonal variations, irrigation, groundwater withdrawal or injection, and other factors. In general, groundwater is not anticipated to be a constraint to the construction of the project.

## 8 RECOMMENDATIONS

The following sections present our geotechnical recommendations and were developed based on our understanding of the proposed remediation (Section 5), the observed subsurface conditions (Section 7.2), and our experience. If the proposed remediation is changed from that discussed herein or subsurface conditions other than those shown on the test pit logs (Appendix A) are observed at the time of construction, Ninyo & Moore should be retained to conduct a review of the new information and to evaluate the need for additional recommendations.

### 8.1 Removal of Sediment

If the proposed remediation is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations. Due to the relatively widely spaced nature of our test pits, soil conditions not observed in our test pits may be encountered during remediation.

Sediment removal should be done by scraping the recommended removal depth in each basin and sub basin. Scarification of the exposed surface is not recommended for this project as it may increase the potential of less permeable sediment soils mixing with underlying soils.

Basins 1 and 4 were divided in to sub-boundaries based on varying thickness of sediment encountered in our test pits. Basin sediment removal boundaries as well as recommended removal depths are presented on Figure 3. Table 3 presents the estimated areas, recommended removal depths and estimated volume of sediment removal. The estimated volume of sediment to be removed was based on estimated surface areas of the basin and the recommended thicknesses removed.

<b>Location</b>	<b>Area, ft<sup>2</sup></b>	<b>Recommended Removal Depth, ft</b>	<b>Estimated Sediment Removal Volume, yd<sup>3</sup></b>
Basin-1North	55,392	1.5	3,078
Basin-1South	139,689	0.5	2,587
Basin-2	223,253	0.5	4,135
Basin-3	186,389	0.5	3,451
Basin-4North	40,913	2.0	3,031
Basin-4Middle	113,513	1.0	4,204
Basin-4South	39,752	1.5	2,209

## 9 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

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

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

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

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

## 10 REFERENCES

- Aerial Photograph Review, FCDMC; dated 1937, 1949, 1953, 1976, 1991, 1993, 1996, 2000, 2002, 2003, 2004, 2006, 2007, 2008, 2010, 2011, 2013, 2015, 2017, 2018.
- Arizona Department of Water Resources (ADWR), “GWSI Groundwater Maps” <https://gisweb.azwater.gov/waterresourcedata/>.
- ASTM International (ASTM), Annual Book of ASTM Standards.
- Demsey, 1989, Geologic Map of Quaternary and Upper Tertiary Alluvium in the Phoenix South 30' X 60' Quadrangle, AZ: Arizona Geological Survey, Open-File Report Series OFR 89-7: scale 1:100,000.
- Euge, K.M., Schell, B.A., and Lam, I.P., 1992, Development of Seismic Acceleration Contour Maps for Arizona: Arizona Department of Transportation Report No. AZ 92-344: dated September.
- International Code Council (ICC), 2015, International Building Code (IBC).
- Maricopa Association of Governments (MAG), 2019, Uniform Standard Specifications and Details for Public Works Construction.
- Ninyo & Moore, In-house proprietary information.
- Occupational Safety and Health Administration (OSHA), Title 29 of the Code of Federal Regulations (CFR), Part No. 1926 - Safety and Health Regulations for Construction, Subpart P - Excavations.
- United States Department of Agriculture (USDA), Soil Survey website. <http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>.
- United States Geological Survey (USGS), 2018, Tolleson, Arizona, 7.5-Minute Series (Topographic): scale 1 = 24,000.



# FIGURES

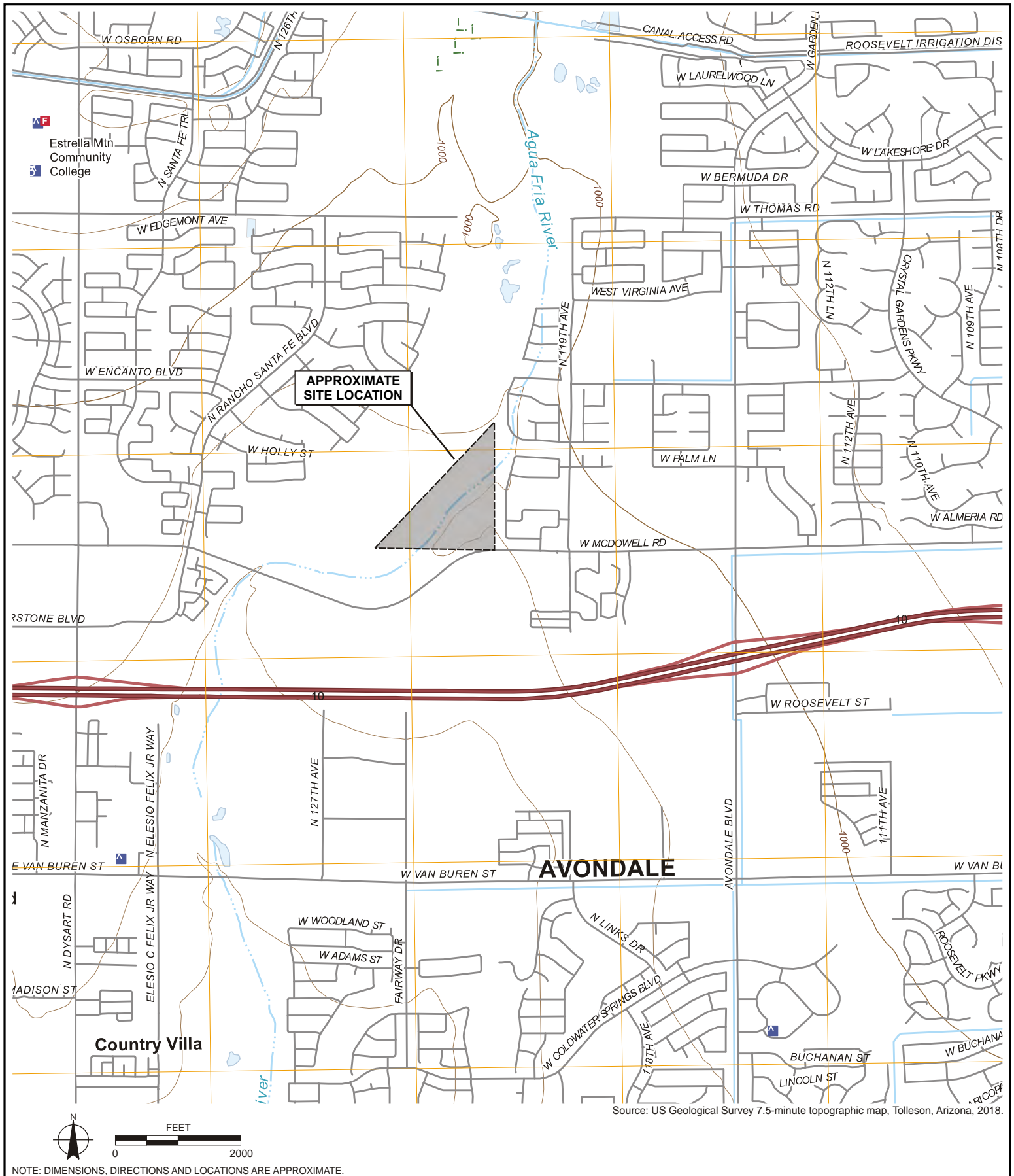



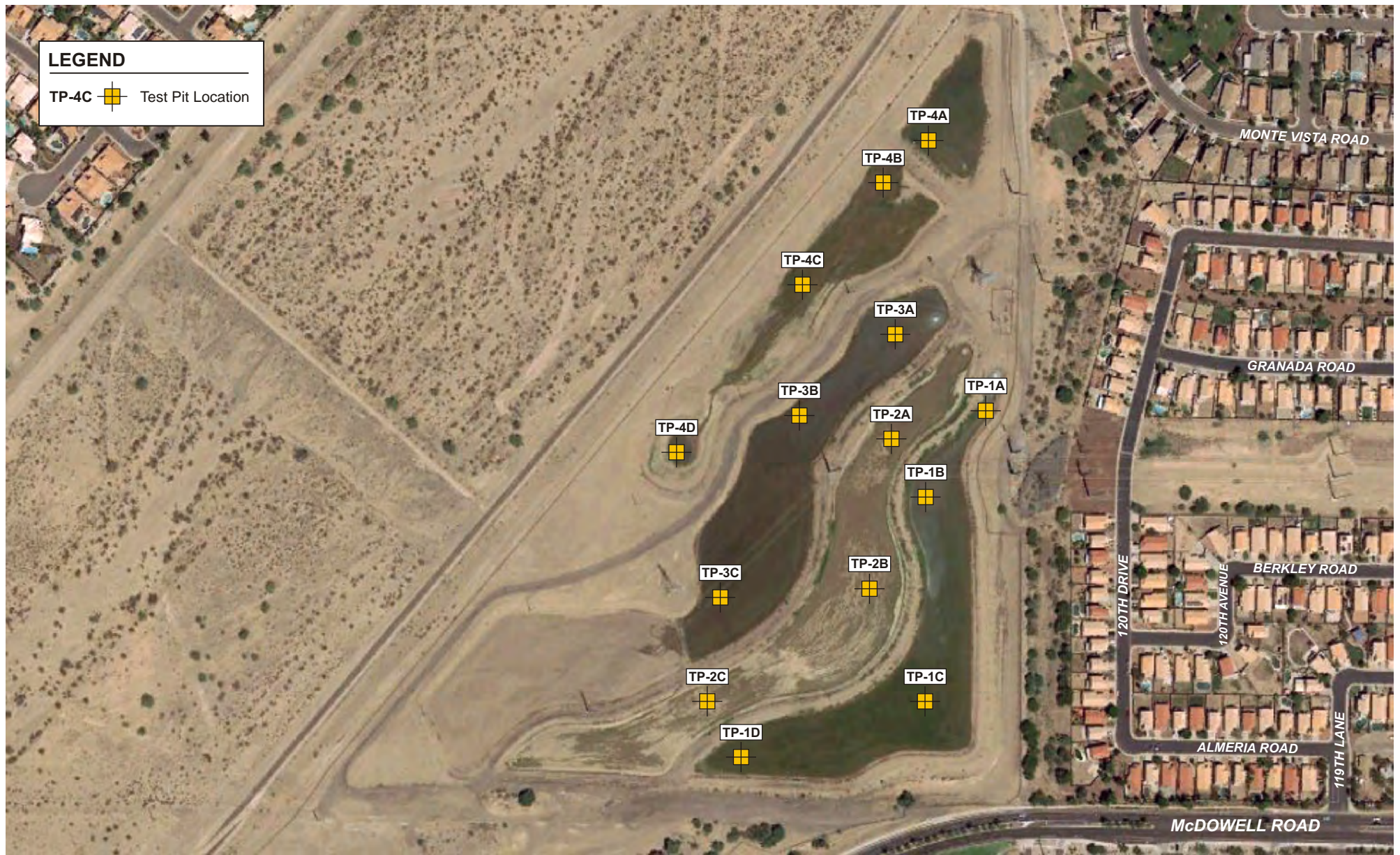
FIGURE 1

**SITE LOCATION**

McDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
 AVONDALE, ARIZONA

**LEGEND**

TP-4C  Test Pit Location



Source: NAVTEQ, 08/28/18.



NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

bsm file no: 6042blm0719a





Source: NAVTEQ, 08/28/18.



NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

**FIGURE 3**

**SEDIMENT REMOVAL BOUNDARIES**

McDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA



# APPENDIX A

## Test Pit Logs

# APPENDIX A

## TEST PIT LOGS

### **Field Procedure for the Collection of Disturbed Samples**

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

#### **Bulk Samples**

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

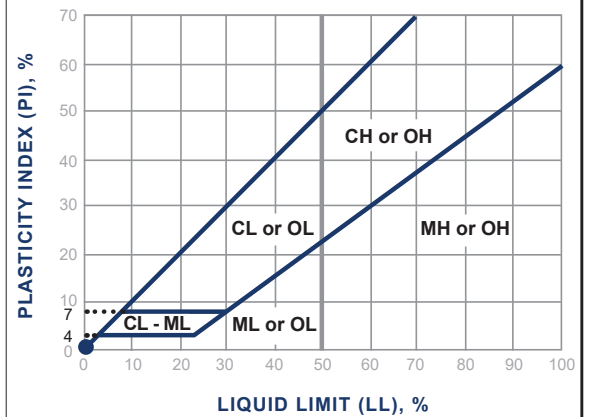
## Soil Classification Chart Per ASTM D 2488

Primary Divisions		Secondary Divisions			
		Group Symbol	Group Name		
<b>COARSE-GRAINED SOILS</b> more than 50% retained on No. 200 sieve	<b>GRAVEL</b> more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL	
			GP	poorly graded GRAVEL	
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt	
			GP-GM	poorly graded GRAVEL with silt	
			GW-GC	well-graded GRAVEL with clay	
			GP-GC	poorly graded GRAVEL with	
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL	
			GC	clayey GRAVEL	
		<b>SAND</b> 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
				SP	poorly graded SAND
	SAND with DUAL CLASSIFICATIONS 5% to 12% fines		SW-SM	well-graded SAND with silt	
			SP-SM	poorly graded SAND with silt	
			SW-SC	well-graded SAND with clay	
			SP-SC	poorly graded SAND with clay	
	SAND with FINES more than 12% fines		SM	silty SAND	
			SC	clayey SAND	
			SC-SM	silty, clayey SAND	
	<b>FINE-GRAINED SOILS</b> 50% or more passes No. 200 sieve	<b>SILT and CLAY</b> liquid limit less than 50%	INORGANIC	CL	lean CLAY
				ML	SILT
CL-ML				silty CLAY	
ORGANIC			OL (PI > 4)	organic CLAY	
			OL (PI < 4)	organic SILT	
<b>SILT and CLAY</b> liquid limit 50% or more		INORGANIC	CH	fat CLAY	
			MH	elastic SILT	
			OH (plots on or above "A"-line)	organic CLAY	
		ORGANIC	OH (plots below "A"-line)	organic SILT	
Highly Organic Soils		PT	Peat		

## Grain Size

Description	Sieve Size	Grain Size	Approximate Size
Boulders	> 12"	> 12"	Larger than basketball-sized
Cobbles	3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	Rock-salt-sized to pea-sized
	Medium	#40 - #10	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	Flour-sized to sugar-sized
Fines	Passing #200	< 0.0029"	Flour-sized and smaller

## Plasticity Chart



## Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

## Consistency - Fine-Grained Soil

Consistency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

DATE EXCAVATED \_\_\_\_\_  
 GROUND ELEVATION \_\_\_\_\_  
 METHOD OF EXCAVATION \_\_\_\_\_

**TEST PIT DIAGRAM**

**EXCAVATION LOG  
 EXPLANATION SHEET**

DEPTH (FEET)	SAMPLES			MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
	Bulk	Driven	Sand Cone				
0	█	←				SM	<u>FILL:</u> Bulk sample.
1		←				ML	Dashed line denotes material change. Drive sample.
2		←	█	⚡			Sand cone performed. Seepage.
3		←		∇			Groundwater encountered during excavation. No recovery with drive sampler.
4		←		∇			Groundwater encountered after excavation. Sample retained by others.
5		←		xx/xx			Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
6		←					No recovery with Shelby tube sampler.
7		←				SM	<u>ALLUVIUM:</u> Solid line denotes unit change. Attitude: Strike/Dip
8		←					b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam
9		←					s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Sheared Bedding Surface
10		←					The total depth is a solid line that is drawn at the bottom of the excavation log.
11		←					
12		←					

SCALE 1 inch = 2 feet

**FIGURE B-1**

**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk

Driven

Sand Cone

SAMPLES

MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

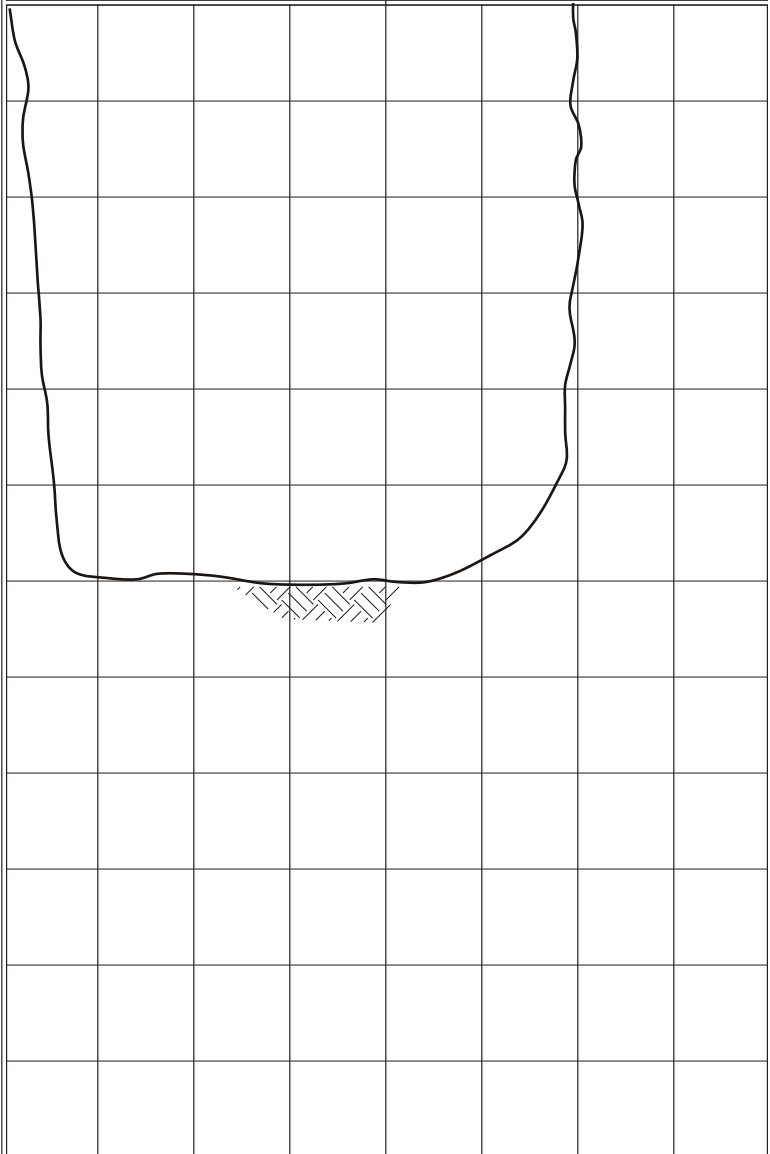
DATE EXCAVATED 6/25/19 TEST PIT NO. TP-1A

GROUND ELEVATION 984' ± (MSL) LOGGED BY DM

METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE

LOCATION BASIN 1 (SEE FIGURE 2)

**DESCRIPTION**



SC

SEDIMENT:  
Brown, dry, medium dense, clayey SAND.

SM

ALLUVIUM:  
Brown, moist, medium dense, silty SAND; trace gravel.

Few gravel.

Increase in silt content.

Total Depth = 6 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

**Notes:**

Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

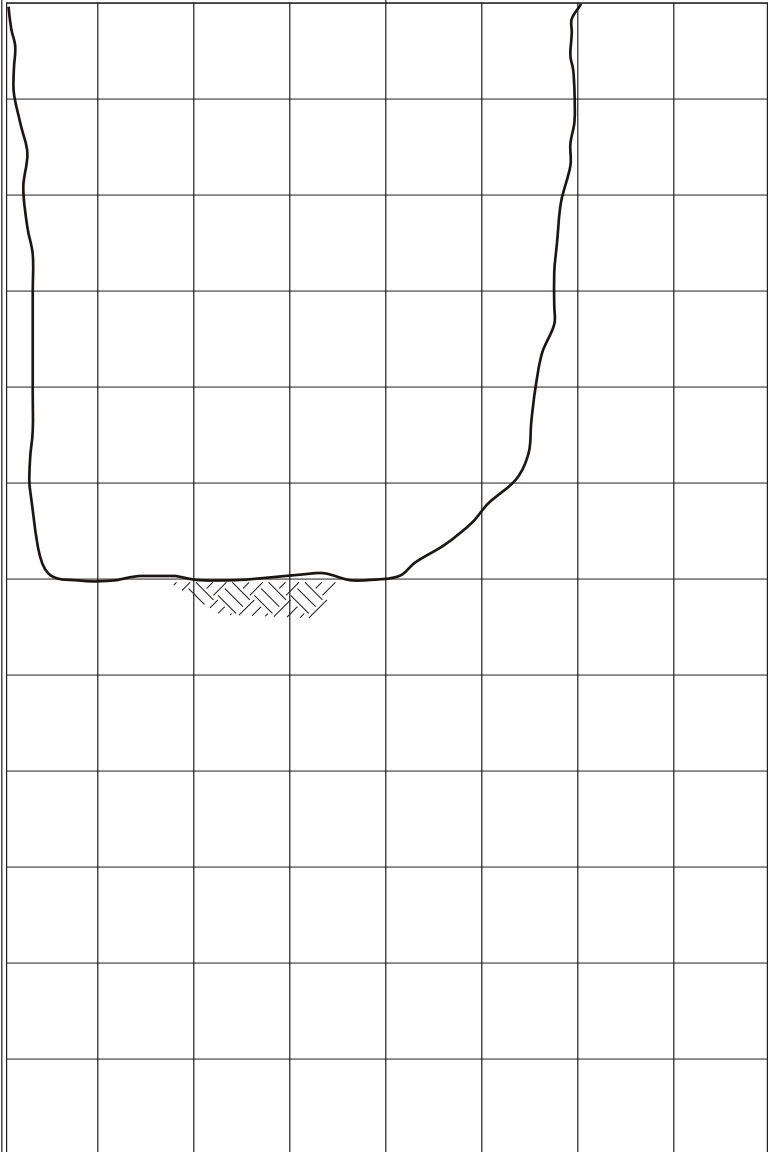
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 6/25/19 TEST PIT NO. TP-1B  
GROUND ELEVATION 983' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 1 (SEE FIGURE 2)

**DESCRIPTION**



CL

SEDIMENT:  
Brown, dry, medium dense, sandy lean CLAY; trace gravel.

SM

ALLUVIUM:  
Brown, moist, medium dense, silty SAND; few gravel.

Total Depth = 6 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

**Notes:**

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

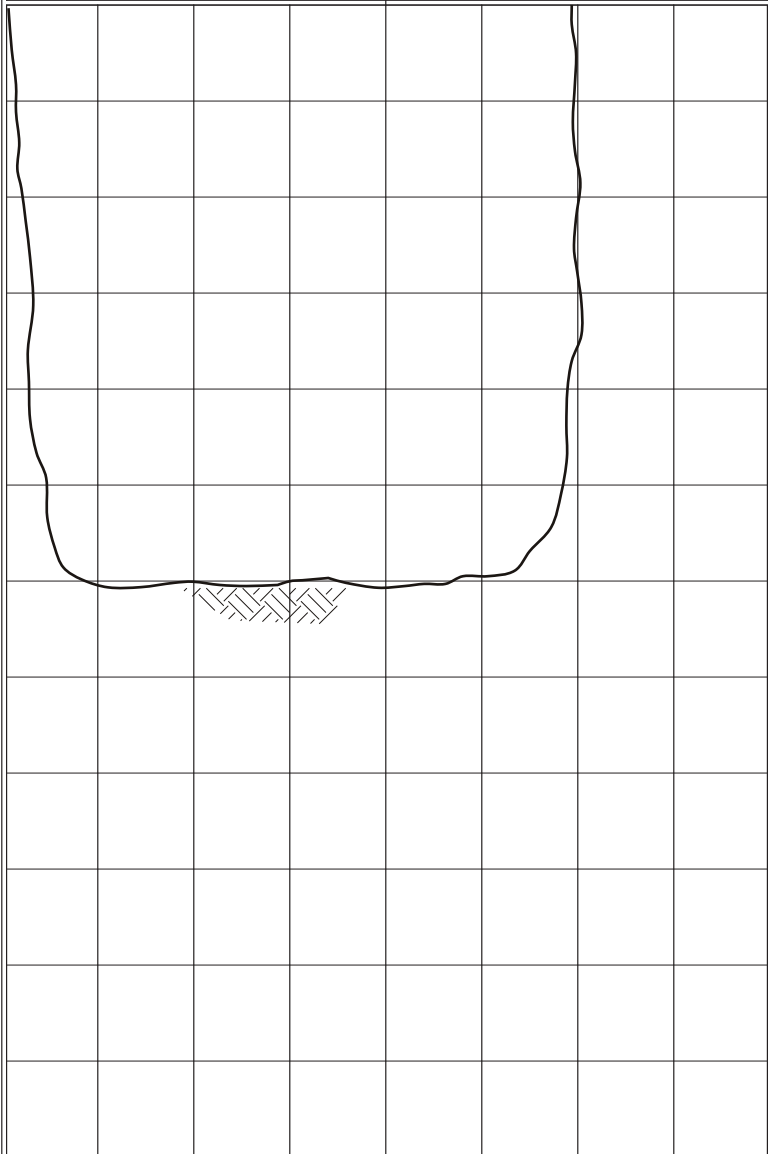
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 6/25/19 TEST PIT NO. TP-1C  
GROUND ELEVATION 981' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 1 (SEE FIGURE 2)

**DESCRIPTION**



SC  
SP

SEDIMENT:  
Brown, dry, loose, clayey SAND.  
ALLUVIUM:  
Brown, moist, medium dense, poorly graded SAND; few gravel; cobbles and possible boulders.

SM

Brown, moist, medium dense, silty SAND; few gravel; cobbles and possible boulders.

Total Depth = 6 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone  
SAMPLES

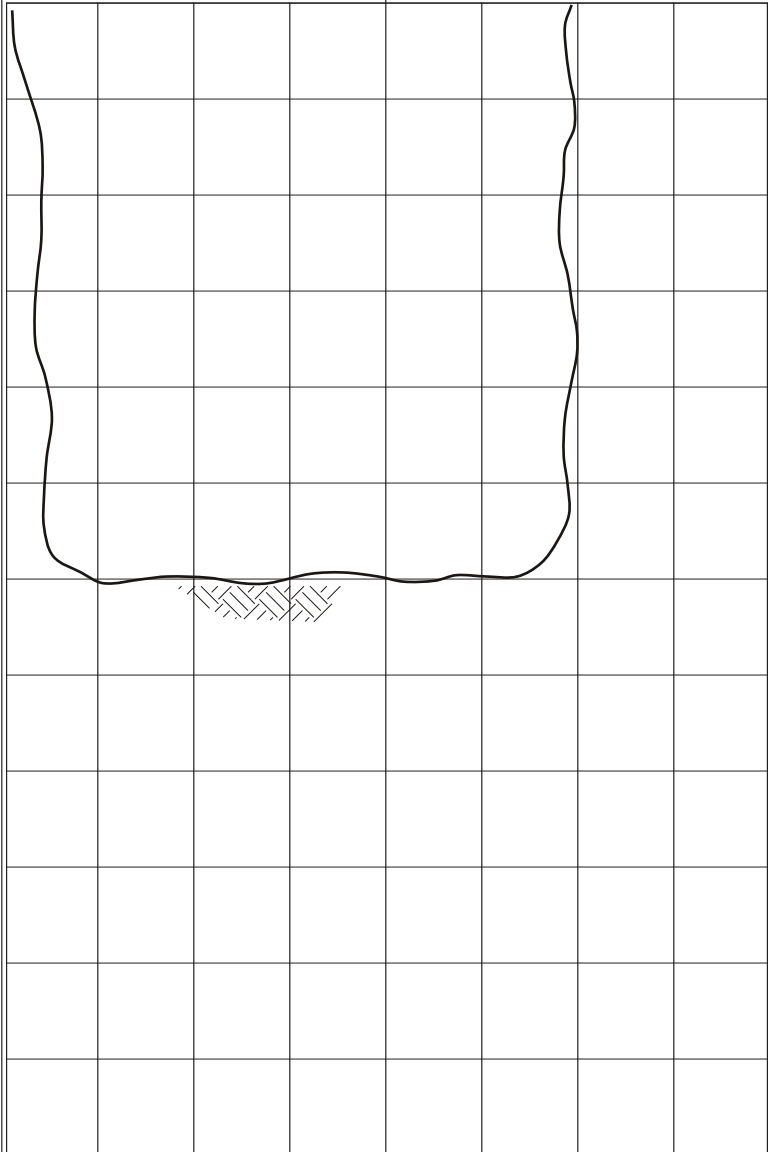
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 6/25/19 TEST PIT NO. TP-1D  
GROUND ELEVATION 981' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 1 (SEE FIGURE 2)

**DESCRIPTION**



0			7.4	SC
2			4.8	SM
4				
6				
8				
10				
12				

**SEDIMENT:**  
Brown, dry, medium dense, clayey SAND.

**ALLUVIUM:**  
Brown, moist, medium dense, silty SAND; few gravel; cobbles and possible boulders.

Increase in silt content.

Total Depth = 6 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

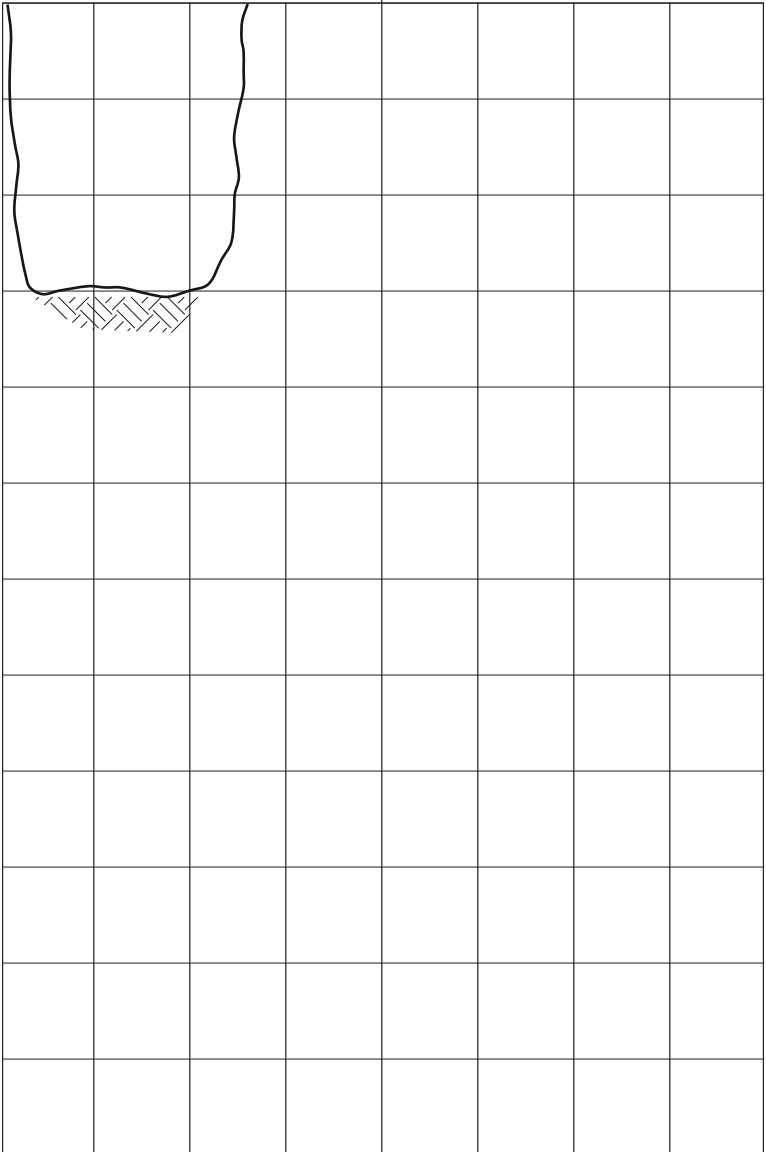
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 7/10/19 TEST PIT NO. TP-2A  
GROUND ELEVATION 981' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 2 (SEE FIGURE 2)

**DESCRIPTION**



SC  
SEDIMENT:  
Brown, dry, loose, clayey SAND.

SM  
ALLUVIUM:  
Brown, moist, medium dense, silty SAND; trace gravel.

Total Depth = 3 feet.  
Groundwater not encountered during excavation.  
Backfilled on 7/10/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk

Driven

Sand Cone

SAMPLES

MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

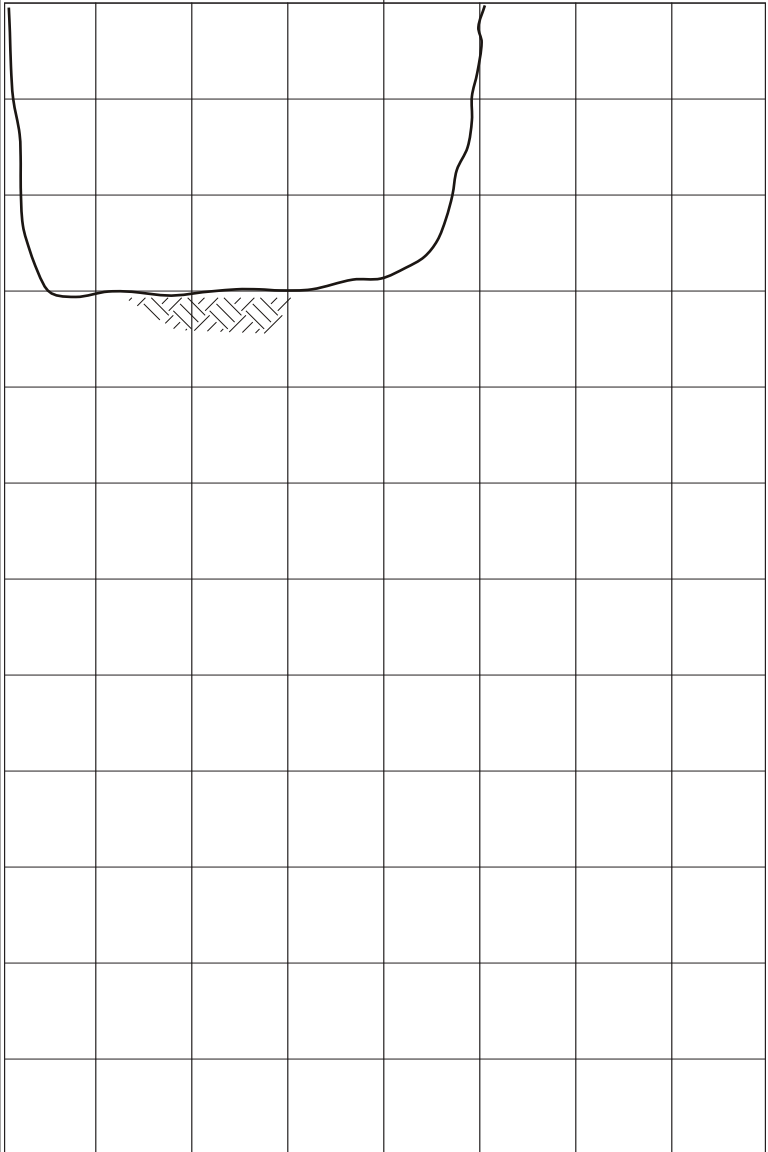
DATE EXCAVATED 7/10/19 TEST PIT NO. TP-2B

GROUND ELEVATION 982' ± (MSL) LOGGED BY DM

METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE

LOCATION BASIN 2 (SEE FIGURE 2)

**DESCRIPTION**



SC  
SW-SM

SEDIMENT:  
Brown, dry, loose, clayey SAND.  
ALLUVIUM:  
Brown, moist, medium dense, well-graded SAND with silt; few to little gravel; cobbles and possible boulders.

Total Depth = 3 feet.  
Groundwater not encountered during excavation.  
Backfilled on 7/10/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk

Driven

Sand Cone

SAMPLES

MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

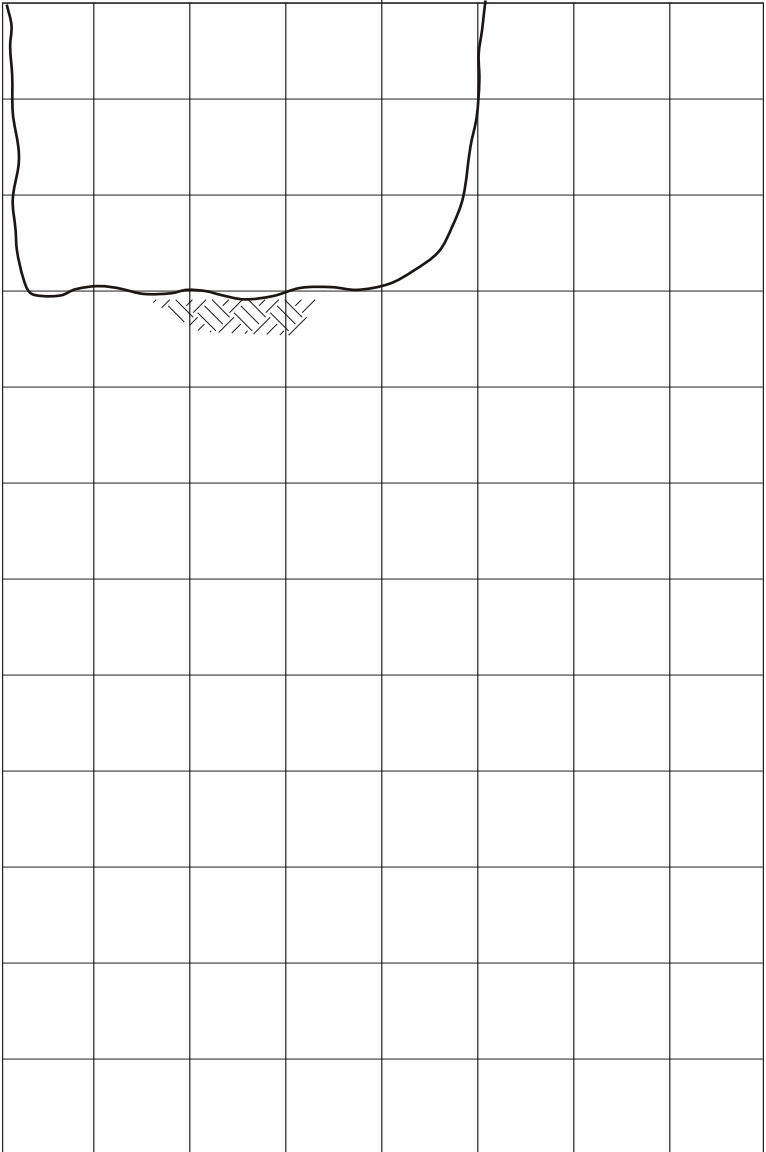
DATE EXCAVATED 7/10/19 TEST PIT NO. TP-2C

GROUND ELEVATION 980' ± (MSL) LOGGED BY DM

METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE

LOCATION BASIN 2 (SEE FIGURE 2)

**DESCRIPTION**



0			10.4	SC
7.5			7.5	SM
2				
4				
6				
8				
10				
12				

SEDIMENT:  
Brown, dry to moist, medium dense, clayey SAND.

ALLUVIUM:  
Brown, moist, medium dense, silty SAND; few gravel; cobbles and possible boulders.

Total Depth = 3 feet.  
Groundwater not encountered during excavation.  
Backfilled on 7/10/19 shortly after completion of excavating.

Notes:  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

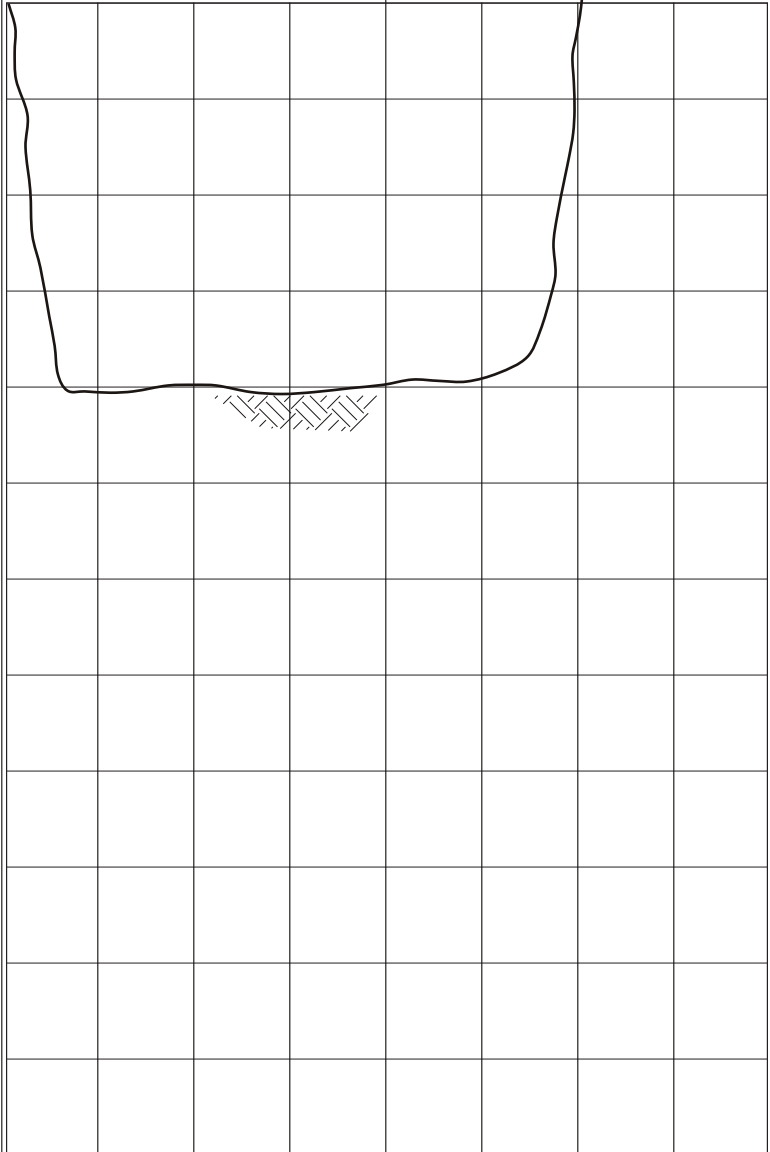
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 7/2/19 TEST PIT NO. TP-3A  
GROUND ELEVATION 982' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 3 (SEE FIGURE 2)

**DESCRIPTION**



SC

SEDIMENT:  
Brown, moist, medium dense, clayey SAND; trace gravel.

SM

ALLUVIUM:  
Brown, moist, medium dense, silty SAND.

Total Depth = 4 feet.  
Groundwater not encountered during excavation.  
Backfilled on 7/2/19 shortly after completion of excavating.

**Notes:**

Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

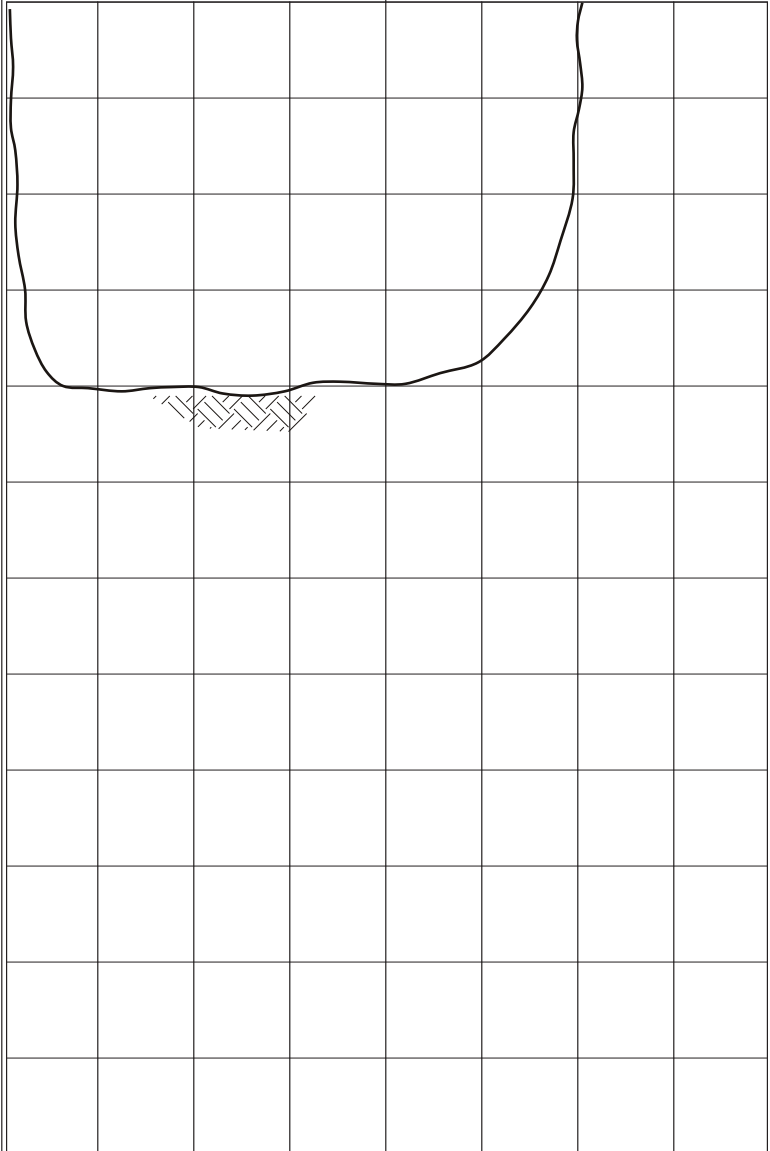
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 7/2/19 TEST PIT NO. TP-3B  
GROUND ELEVATION 982' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 3 (SEE FIGURE 2)

**DESCRIPTION**



0		5.0	SC
4.7			GP
2			
4			
6			
8			
10			
12			

**SEDIMENT:**  
Brown, dry, medium dense, clayey SAND.

**ALLUVIUM:**  
Brown, moist, medium dense, poorly graded GRAVEL with sand; trace silt; cobbles and possible boulders.

Total Depth = 4 feet.  
Groundwater not encountered during excavation.  
Backfilled on 7/2/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

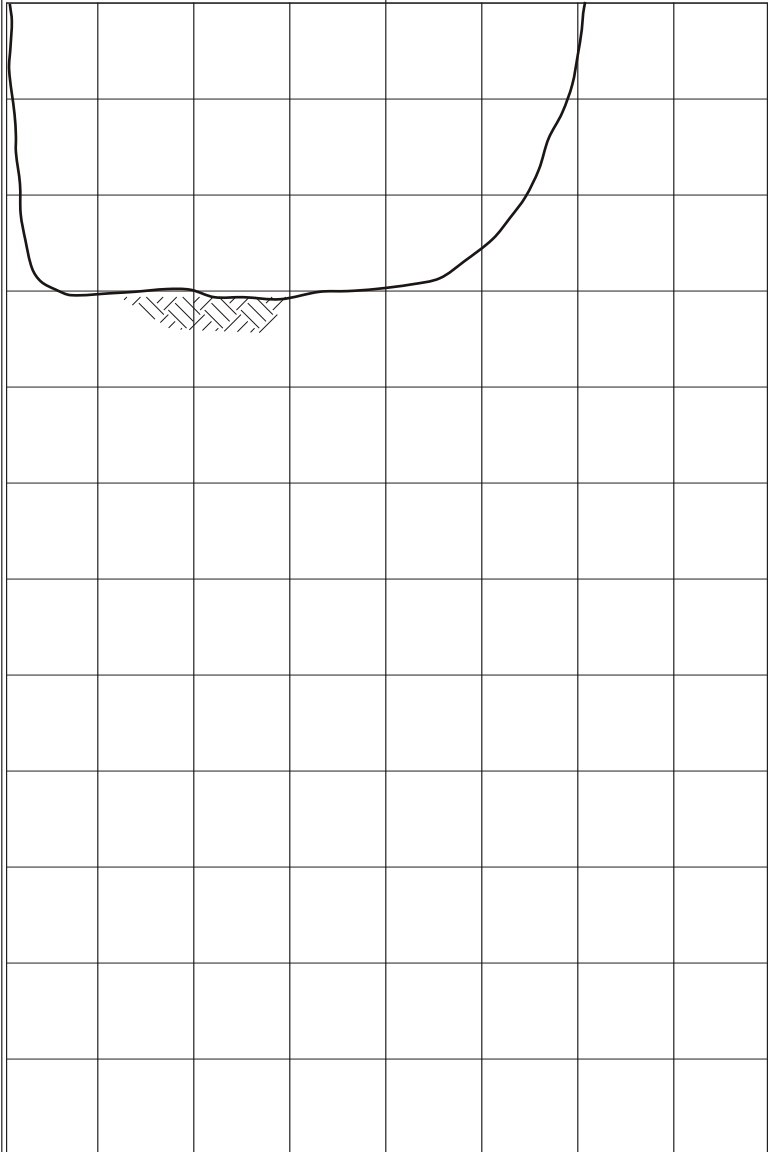
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 7/2/19 TEST PIT NO. TP-3C  
GROUND ELEVATION 981' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 3 (SEE FIGURE 2)

**DESCRIPTION**



SC  
SM

SEDIMENT:  
Brown, dry, loose, clayey SAND.  
ALLUVIUM:  
Brown, moist, medium dense, silty SAND; trace gravel.

Total Depth = 3 feet.  
Groundwater not encountered during excavation.  
Backfilled on 7/2/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

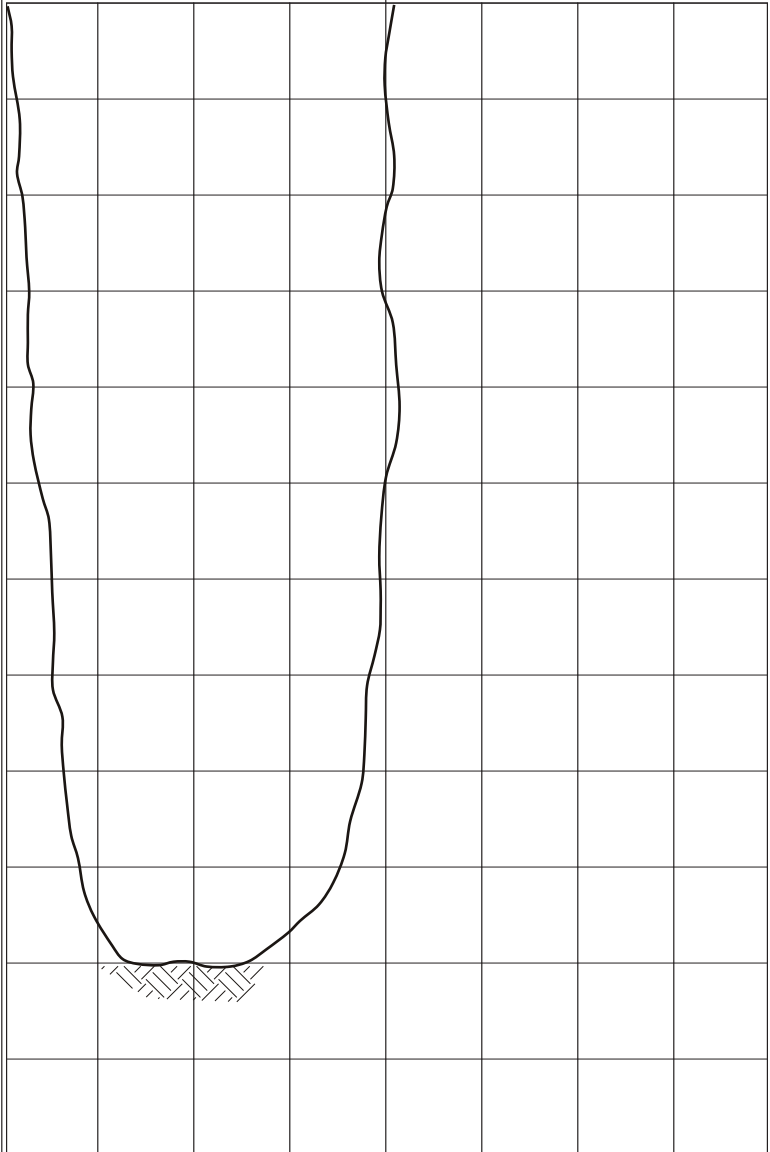
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 6/25/19 TEST PIT NO. TP-4A  
GROUND ELEVATION 983' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 4 (SEE FIGURE 2)

**DESCRIPTION**



SC

SEDIMENT:  
Brown, dry, medium dense, clayey SAND; trace gravel.

SM

ALLUVIUM:  
Brown, moist, medium dense, silty SAND; few gravel.

Total Depth = 10 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

Notes:

Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors



**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 6/25/19 TEST PIT NO. TP-4A

GROUND ELEVATION 983' ± (MSL) LOGGED BY DM

METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE

LOCATION BASIN 4 (SEE FIGURE 2)

**DESCRIPTION**

as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

12  
14  
16  
18  
20  
22  
24



**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk

Driven

Sand Cone

SAMPLES

MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

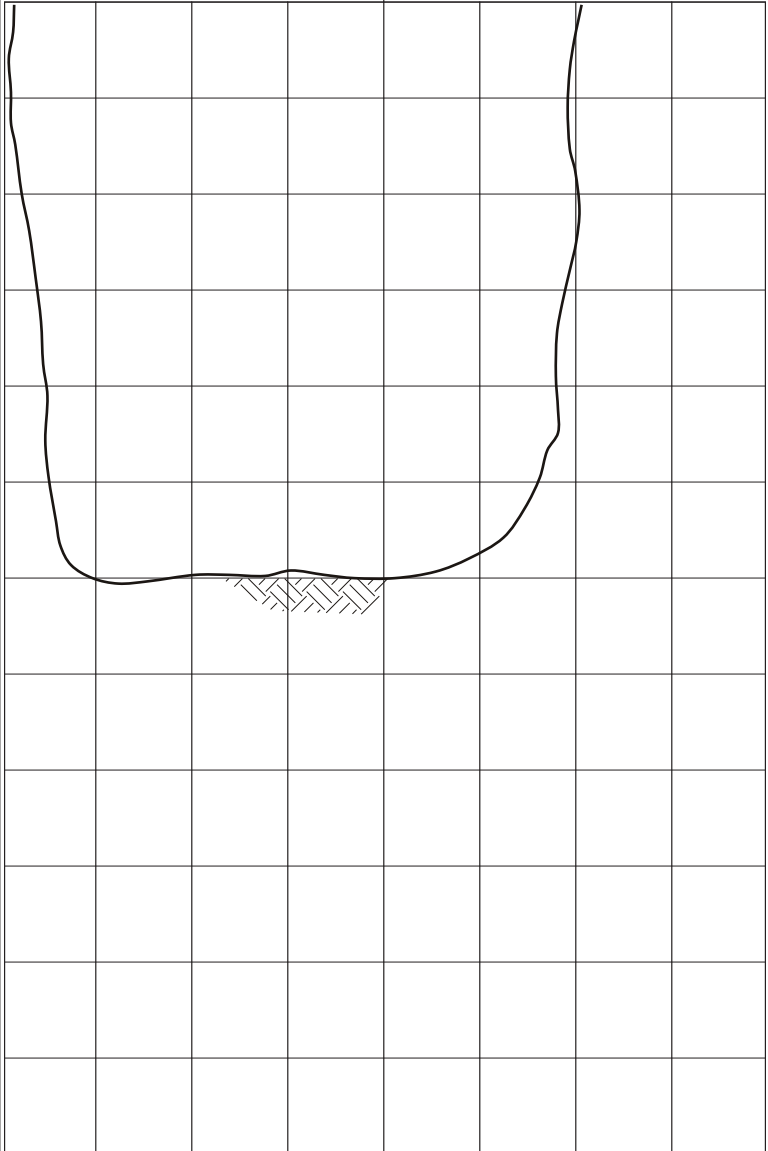
DATE EXCAVATED 6/25/19 TEST PIT NO. TP-4C

GROUND ELEVATION 983' ± (MSL) LOGGED BY DM

METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE

LOCATION BASIN 3 (SEE FIGURE 2)

**DESCRIPTION**



SC  
SM

**SEDIMENT:**  
Brown, dry, medium dense, clayey SAND.

**ALLUVIUM:**  
Brown, moist, medium dense, silty SAND; few gravel; cobbles and possible boulders.

Total Depth = 6 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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**TEST PIT LOG**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA

PROJECT NO.

DATE

606042002

8/19

DEPTH (FEET)

Bulk  
Driven  
Sand Cone

SAMPLES

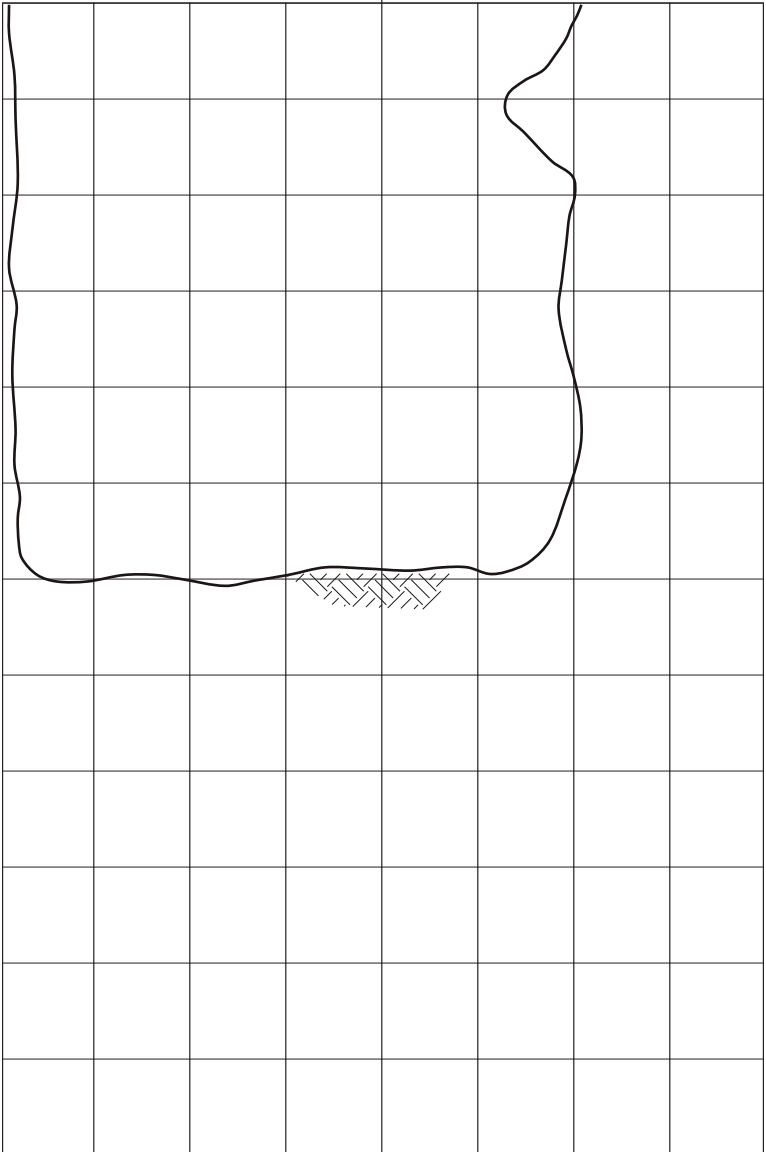
MOISTURE (%)

DRY DENSITY (PCF)

CLASSIFICATION  
U.S.C.S.

DATE EXCAVATED 6/25/19 TEST PIT NO. TP-4D  
GROUND ELEVATION 980' ± (MSL) LOGGED BY DM  
METHOD OF EXCAVATION CASE 560 SUPER N BACKHOE  
LOCATION BASIN 3 (SEE FIGURE 2)

**DESCRIPTION**



SC

SEDIMENT:  
Brown, dry, medium dense, clayey SAND.

SM

ALLUVIUM:  
Brown, moist, medium dense, silty SAND; trace gravel; cobbles and possible boulders.

Total Depth = 6 feet.  
Groundwater not encountered during excavation.  
Backfilled on 6/25/19 shortly after completion of excavating.

**Notes:**  
Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

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# APPENDIX B

## Laboratory Testing

# APPENDIX B

## LABORATORY TESTING

### **Classification**

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D2488. Soil classifications are indicated on the logs of the exploratory test pits in Appendix A.

### **In-Place Moisture**

The moisture content of disturbed samples obtained from the exploratory test pits were evaluated in general accordance with ASTM D2216. The test results are presented on the logs of the exploratory test pits in Appendix A.

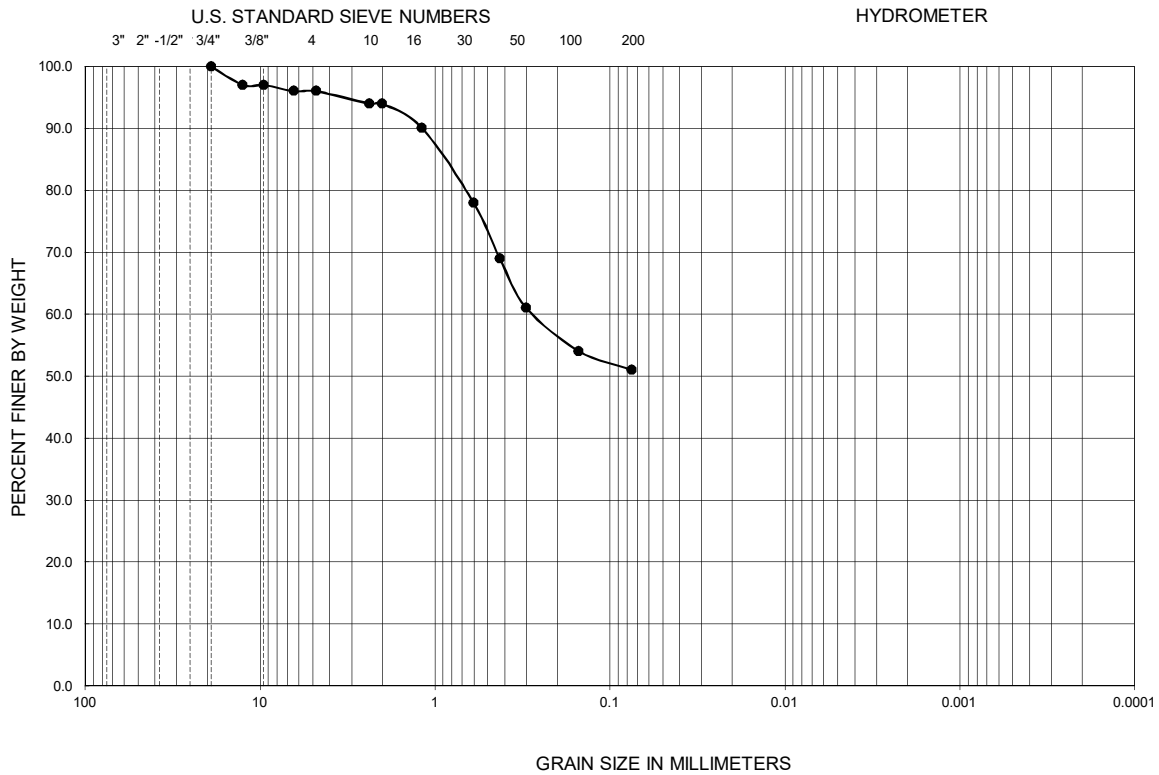
### **Gradation Analysis**

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D422. The grain-size distribution curves are shown on Figures B-1 through B-8. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

### **Atterberg Limits**

Atterberg limits Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-9.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-1B	0.0-1.4	32	16	16	--	--	0.28	--	--	51.0	CL

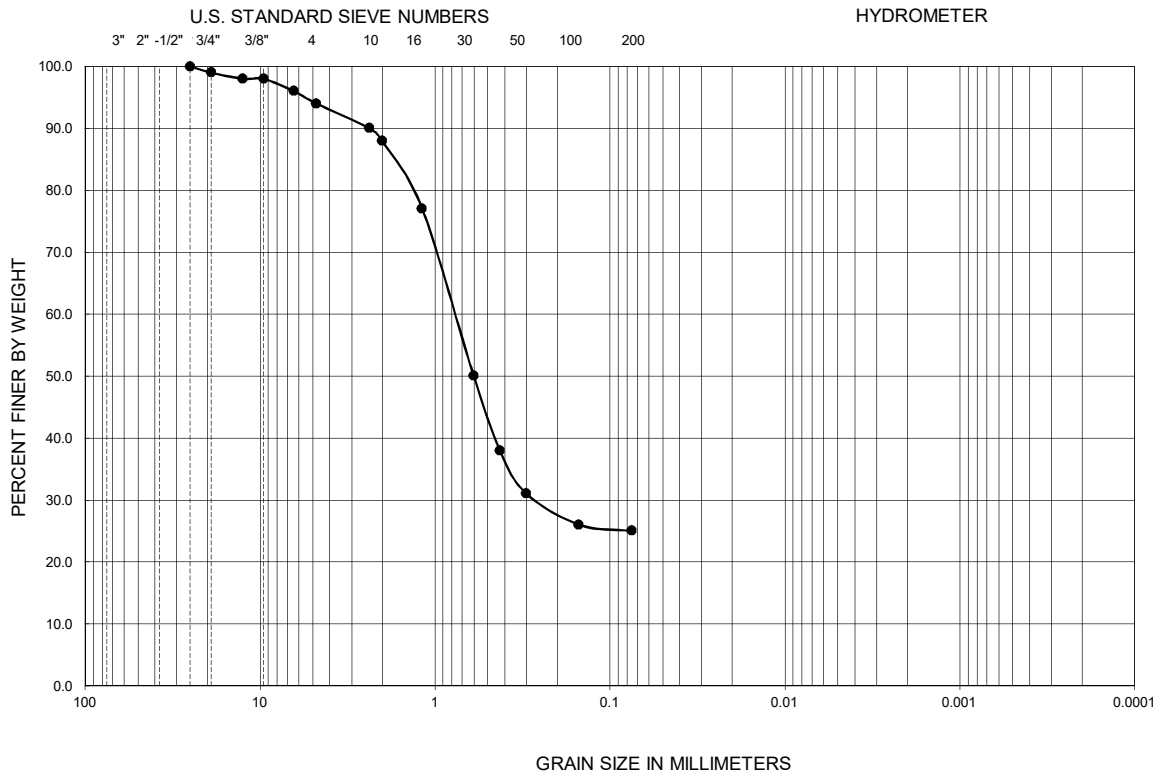
PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-1

**GRADATION TEST RESULTS**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
 AVONDALE, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-1C	2.0-3.0	--	--	NP	--	0.264	0.76	--	--	25.0	SM

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

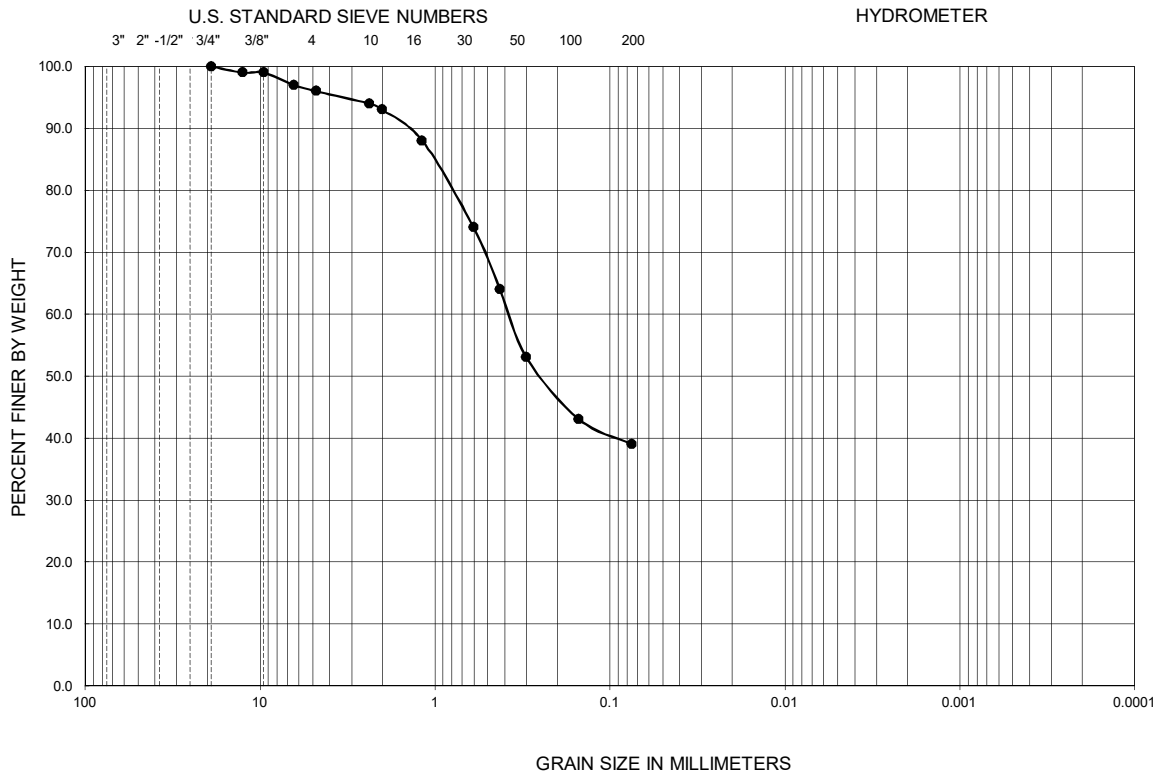
FIGURE B-2

**GRADATION TEST RESULTS**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA



GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

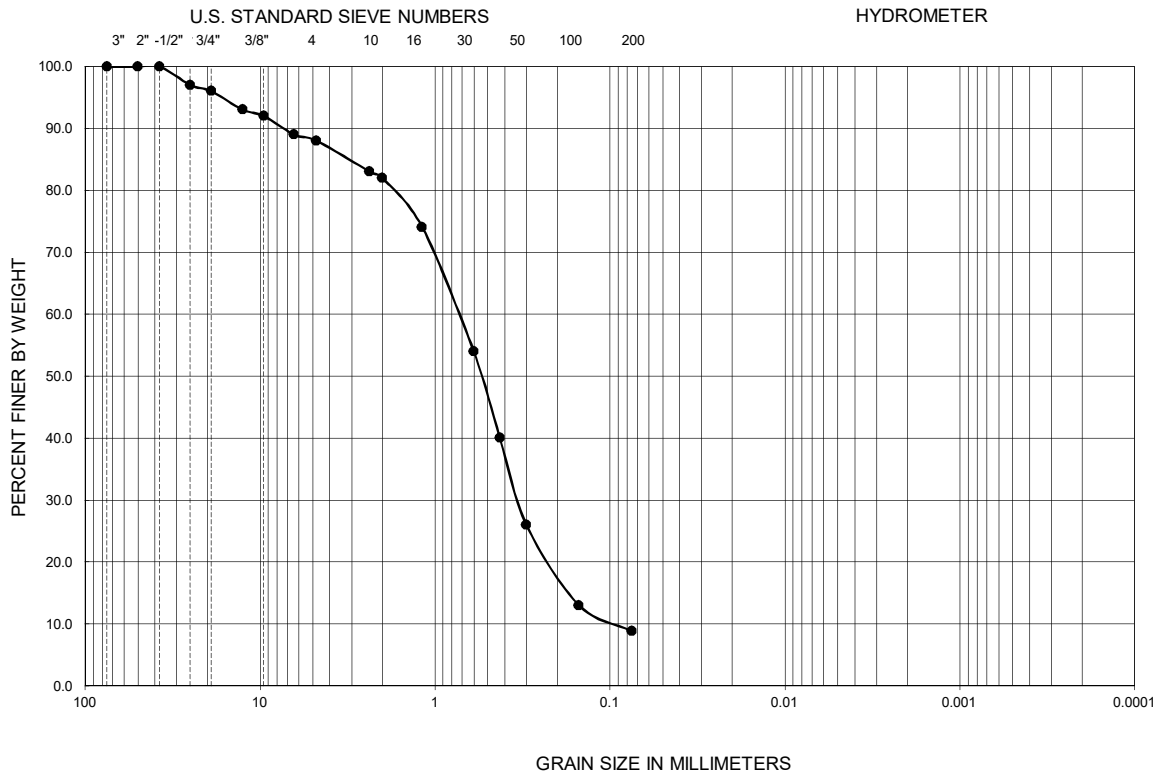


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-2A	0.0-0.5	33	17	16	--	--	0.38	--	--	39.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-3

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-2B	0.1-3.0	--	--	NP	0.090	0.337	0.72	8.0	1.7	8.8	SW-SM

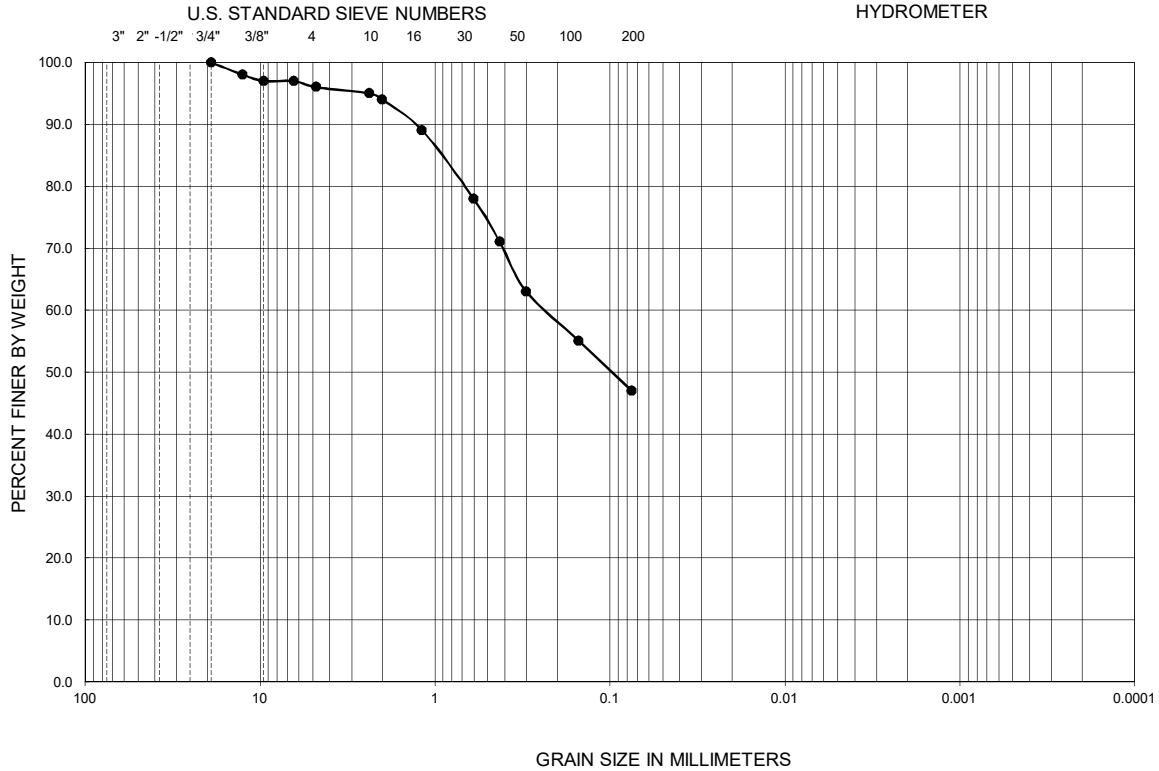
PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-4

**GRADATION TEST RESULTS**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
 AVONDALE, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-3A	0.0-0.5	42	19	23	--	--	0.23	--	--	47.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

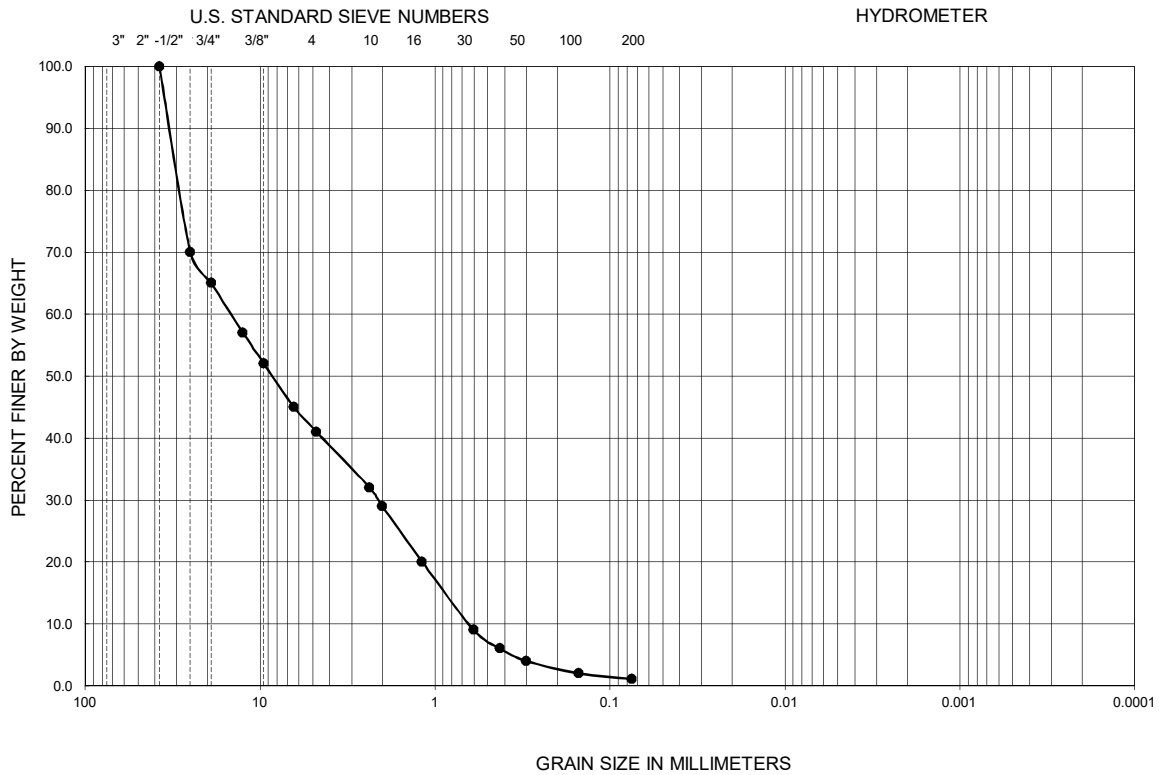
FIGURE B-5

**GRADATION TEST RESULTS**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION

AVONDALE, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-3B	0.2-3.0	--	--	NP	0.623	2.126	14.79	23.7	0.5	1.1	GP

NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

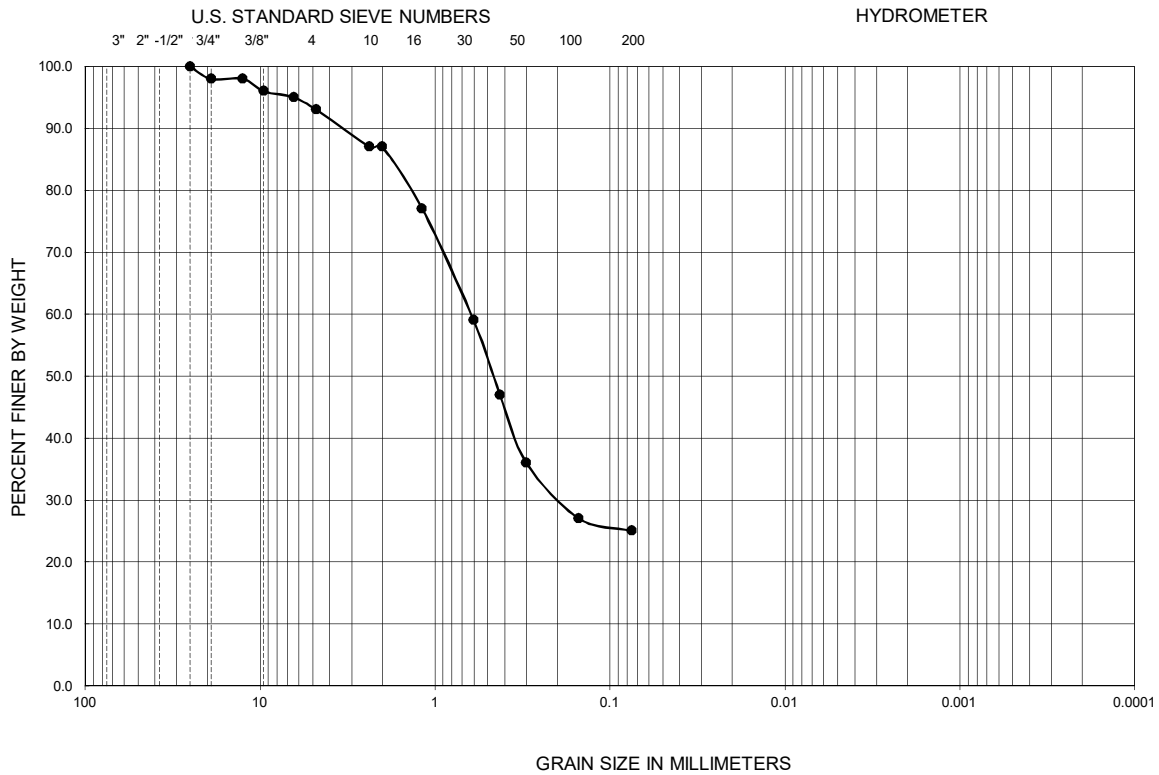
FIGURE B-6

**GRADATION TEST RESULTS**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION  
AVONDALE, ARIZONA



GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>	Passing No. 200 (percent)	USCS
●	TP-4C	0.4-3.0	--	--	NP	--	0.190	0.61	--	--	25.0	SM

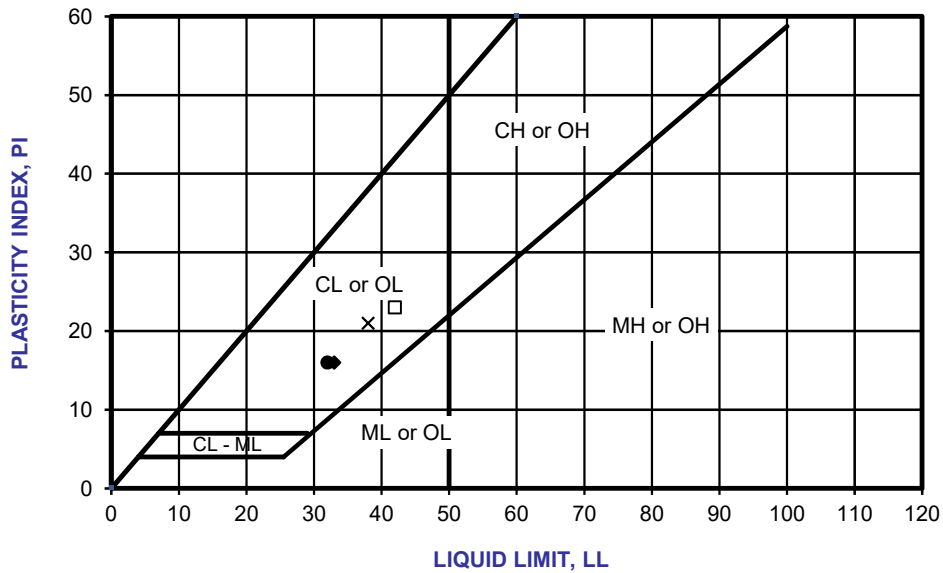
NP - INDICATES NON-PLASTIC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-8

SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	TP-1B	0.0-1.4	32	16	16	CL	CL
■	TP-1C	2.0-3.0	-	-	NP	ML	SM
◆	TP-2A	0.0-0.5	33	17	16	CL	SC
○	TP-2B	0.1-3.0	-	-	NP	ML	SW-SM
□	TP-3A	0.0-0.5	42	19	23	CL	SC
△	TB-3B	0.2-3.0	-	-	NP	ML	GP
X	TP-4A	0.0-0.5	38	17	21	CL	SC
+	TP-4C	0.4-3.0	-	-	NP	ML	SM

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

FIGURE B-9

**ATTERBERG TEST RESULTS**

MCDOWELL RECHARGE BASINS SEDIMENT EVALUATION

AVONDALE, ARIZONA

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