Gillespie Area Drainage Master Study

Sediment Sample Memo & Sediment Study Areas Memo

Flood Control District of Maricopa County

August 2013

Submitted by:
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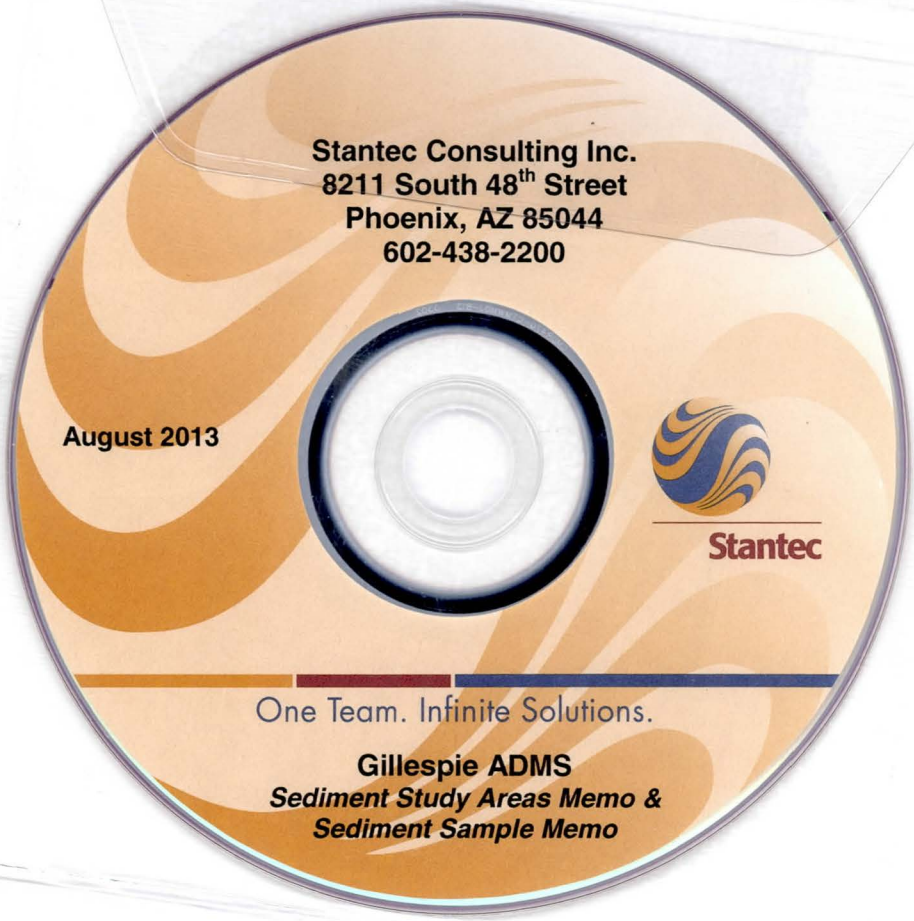
Flood Control District of Maricopa County

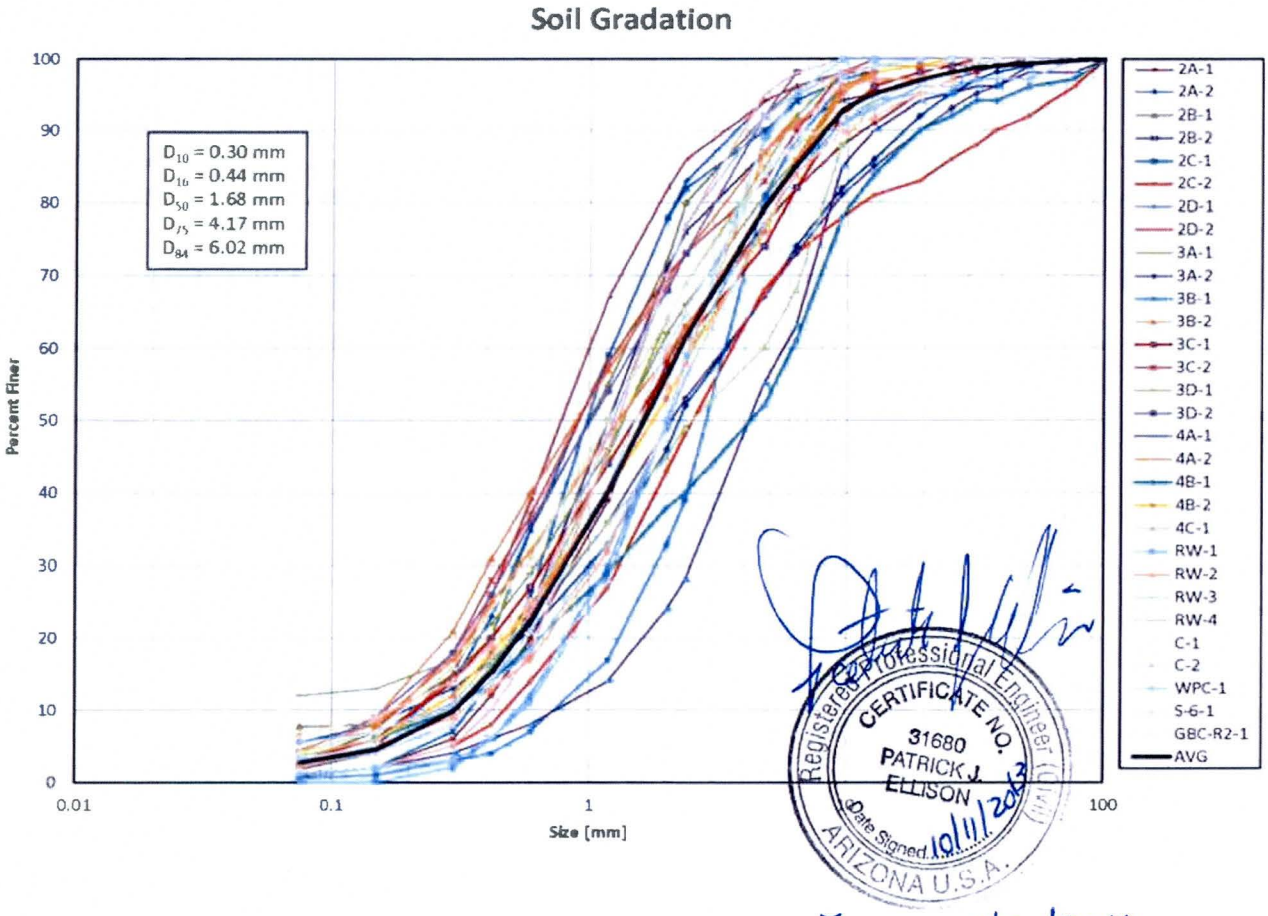
Gillespie ADMS

Sediment Sample Memo
&
Sediment Study Areas Memo



Gillespie Area Drainage Master Study

Sediment Sample Memo



Registered Professional Engineer (Civil)
CERTIFICATE NO. 31680
PATRICK J. ELLISON
Date Signed 10/11/2013
ARIZONA U.S.A.

Expires 9/30/2015

August, 2013

181300167

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Plate 1 Sediment Sample Locations

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1.0 Introduction

1.1 PURPOSE

The Sediment Sampling and Testing task for the Gillespie Area Drainage Master Study (ADMS) consists of collecting sediment samples and determining the size gradation of the samples. Sediment samples were collected throughout the project watershed at specific locations. These locations include non-engineered channels where deposition of sediment was apparent, up-stream of the pool area behind the Gila Bend Canal, throughout the reach of Rainbow Wash where the lateral migration analyses will be conducted, and across the alluvial fan study areas in the Buckeye Hills and Maricopa Mountains. The scope of work for this task is provided as Appendix A.

1.2 STUDY AREA

The study area is located in southwestern Maricopa County approximately 10 miles south of the Town of Buckeye. The study area consists of approximately 148 square miles of land and is bisected by State Route 85 and bordered on the west by the Gila River. Figure 1 depicts the location of the Gillespie ADMS study area.

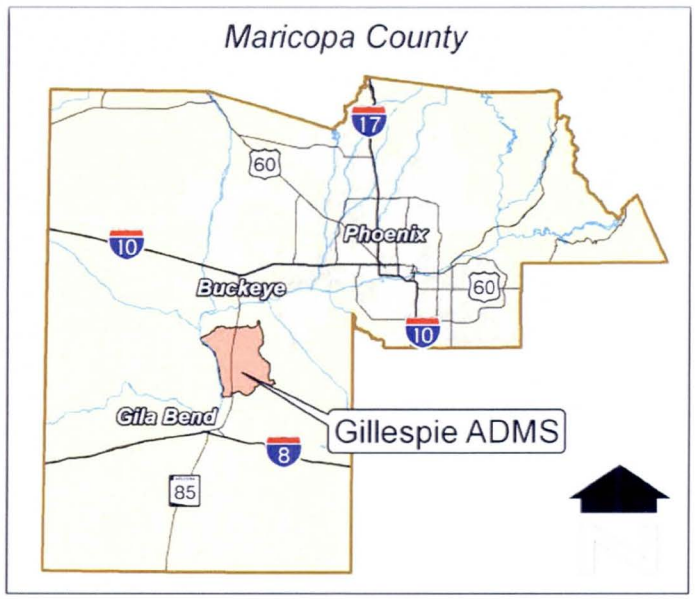

Figure 1, Project Location Map

2.0 Sediment Samples

2.1 SEDIMENT SAMPLE LOCATIONS

Sediment sample locations with identification are depicted on Plate 1. Samples were collected at specific locations of interest. Table 1 lists soil sample identifiers and the reason why the sample or samples were collected. Other notable features depicted on Plate 1 are FEMA Effective Flood hazard Zones, location of engineered and non-engineered channels, location of the Gila Bend Canal and the location of non-engineered embankments.

Table 1, Soil Sample Summary

Sediment Samples Identifiers	Comment
2A-1, 2A-2, 2B-1, 2B-2, 2C-1, 2C-2, 2D-1, 2D-2, 3A-1, 3A-2, 3B-1, 3B-2, 3C-1, 3C-2, 3D-1, 3D-2, 4A-1, 4A-2, 4B-1, 4B-2, 4C-1, 4C-2	Sediment samples collected in the Buckeye Hills Alluvial Fan Evaluation Area. Results will be used in alluvial fan and sediment yield evaluations.
AFS-1 through AFS-12	Sediment samples collected for the Maricopa Mountains Alluvial Fan # 1 Evaluations. Results will be used in alluvial fan and sediment yield evaluations.
Samples that begin with the letters GBC	Sediment samples collected upstream of the Gila Bend Canal to be used in the sediment yield evaluations.
Samples that begin with the letters RW	Sediment samples collected for Rainbow Wash will be used in the total scour analyses and in sediment yield evaluations.
ADOT 1, S1, S-6-1, C1, C2	Miscellaneous samples collected in non-engineered channels (ADOT 1, C1 and C2) and samples collected at Gila Bend Canal Siphon # 1(S1) and Siphon #6 (S-6-1). Results will be used in sediment yield evaluations.

2.2 SIEVE ANALYSES

Sediment samples were sent to geotechnical labs for sieve analyses testing to obtain size gradation for each sample. Results of sieve analyses are presented in Appendix B.

The sieve sizes used for the analyses are:

Table 2, Sieve Sizes

Sieve	Sieve Opening (mm)	Sieve	Sieve Opening (mm)
#200	0.075	1/4 inch	6.350
#100	0.149	3/8 inch	9.525
#50	0.297	1/2 inch	12.7
#40	0.420	3/4 inch	19.05
#30	0.595	1 inch	25.40
#16	1.180	1 1/4 inch	31.75
#10	2.00	1 1/2 inch	38.1
#8	2.36	2 inch	50.8
#4	4.75	3 inch	76.2
		4 inch	101.6
		6 inch	152.4

2.2.1 Gradation Plots

Sediment gradation plots for each of the collected samples are depicted in Figures 2, 3, 4, 5 and 6. Sediment sample plots have been grouped according to the listings under the Sediment Sample Identifier column of Table 1. The sediment size gradation plot for sediment sample S1 (depicted in Figure 6) collected downstream of Gila Bend Canal Siphon 1 shoes that the sample is a very fine grained sample. The channel at this location is cut into fine grained Gila River floodplain sediments. The gradation plot reflects the gradation of floodplain sediments.

A specific scope item for samples collected for Rainbow Wash was to determine if there is a recognizable trend in the distribution of grain size between samples. Figure 5 depicts gradation plots for the Rainbow Wash sediment samples. With the exception of Sample RW-4, size gradations are very similar between the different samples. The plot indicates that the sediment size for Sample RW-4 is typically smaller than what is depicted for the other samples. Sample RW- 4 was collected downstream of the confluence with the West Prison Channel. A hypothesis that the finer grained material in Rainbow Wash at the confluence is due to sediment from the West Prison Channel could be made, however the gradation plot for a sample collected in the West Prison Channel (WPC-1) indicates that the sediment size is very similar to Rainbow Wash samples RW-1, RW-2 and RW-3. It is uncertain why Sample RW-4 is finer grained than the other sample collected in Rainbow Wash.

A profile plot depicting longitudinal change in the D_{84}, D_{50} and D_{16} for Rainbow Wash is provided as Figure 8. The location of the Rainbow Wash profile and sediment samples are depicted in Figure 7.

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Figure 2, Size Gradation Plot for Buckeye Hill Alluvial Fans Samples

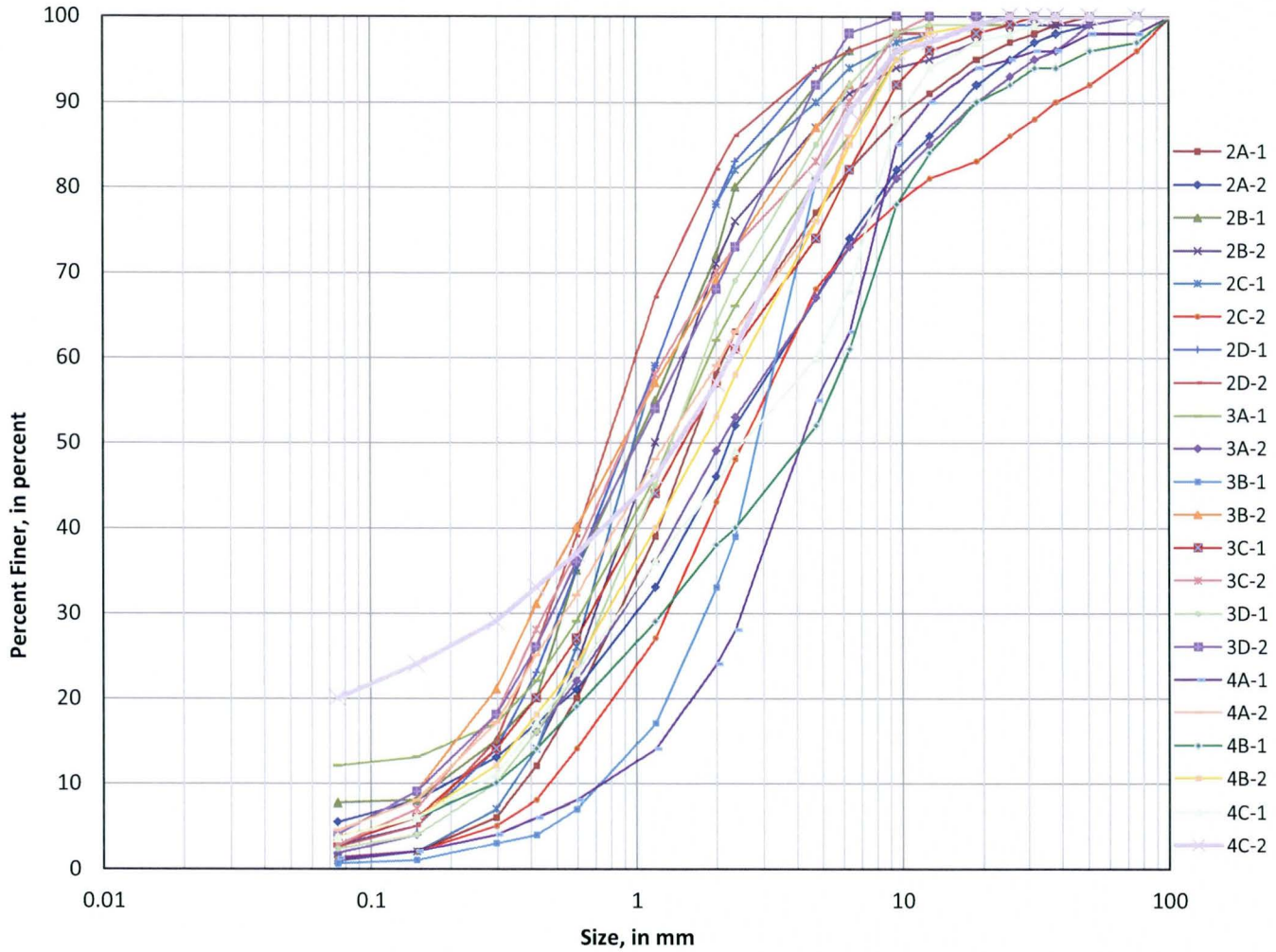


Figure 3, Size Gradation Plot for Maricopa Mountains Alluvial Fan #1 Samples

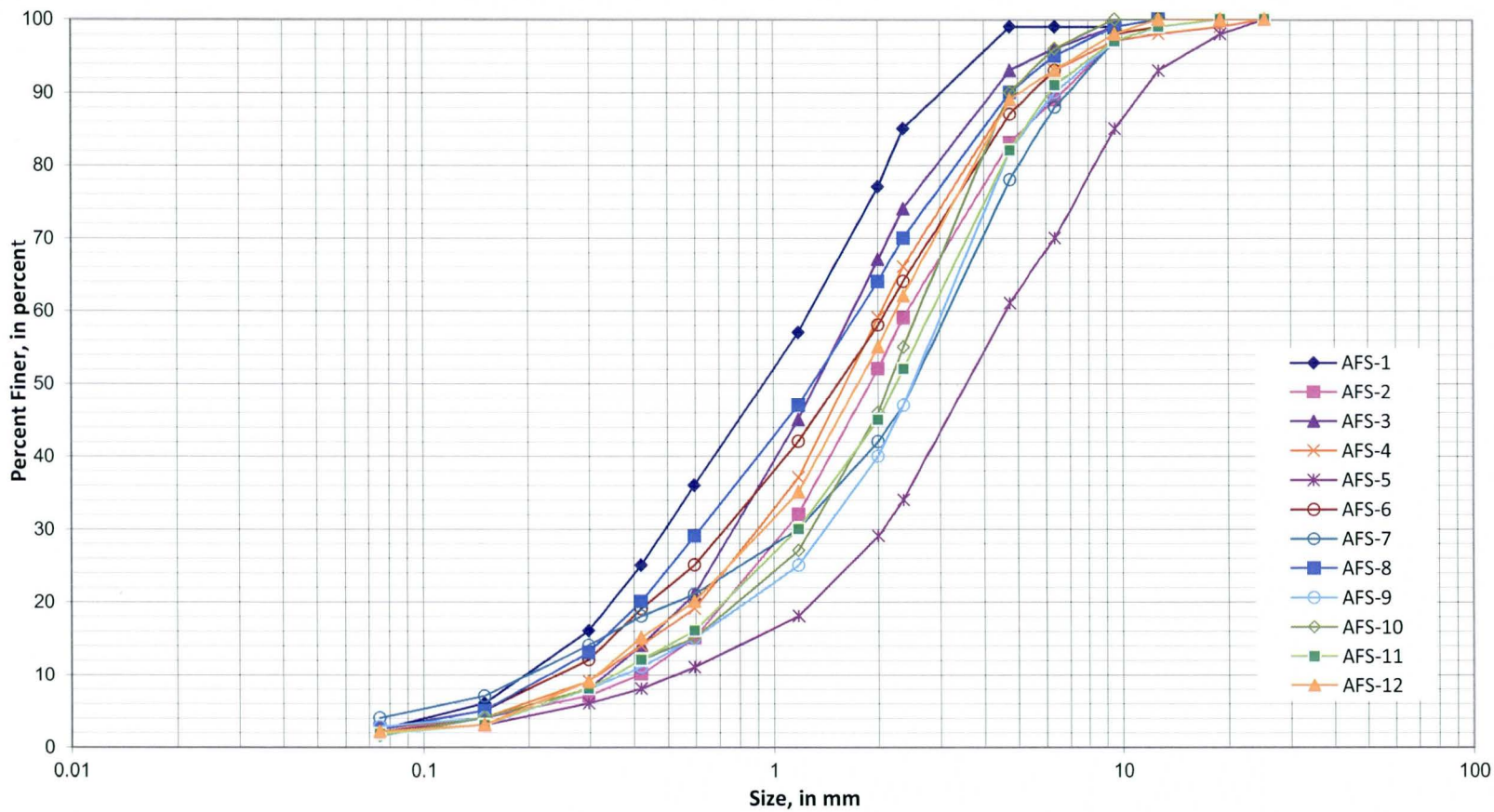


Figure 4, Size Gradation Plot for Samples collected Upstream of the Gila Bend Canal

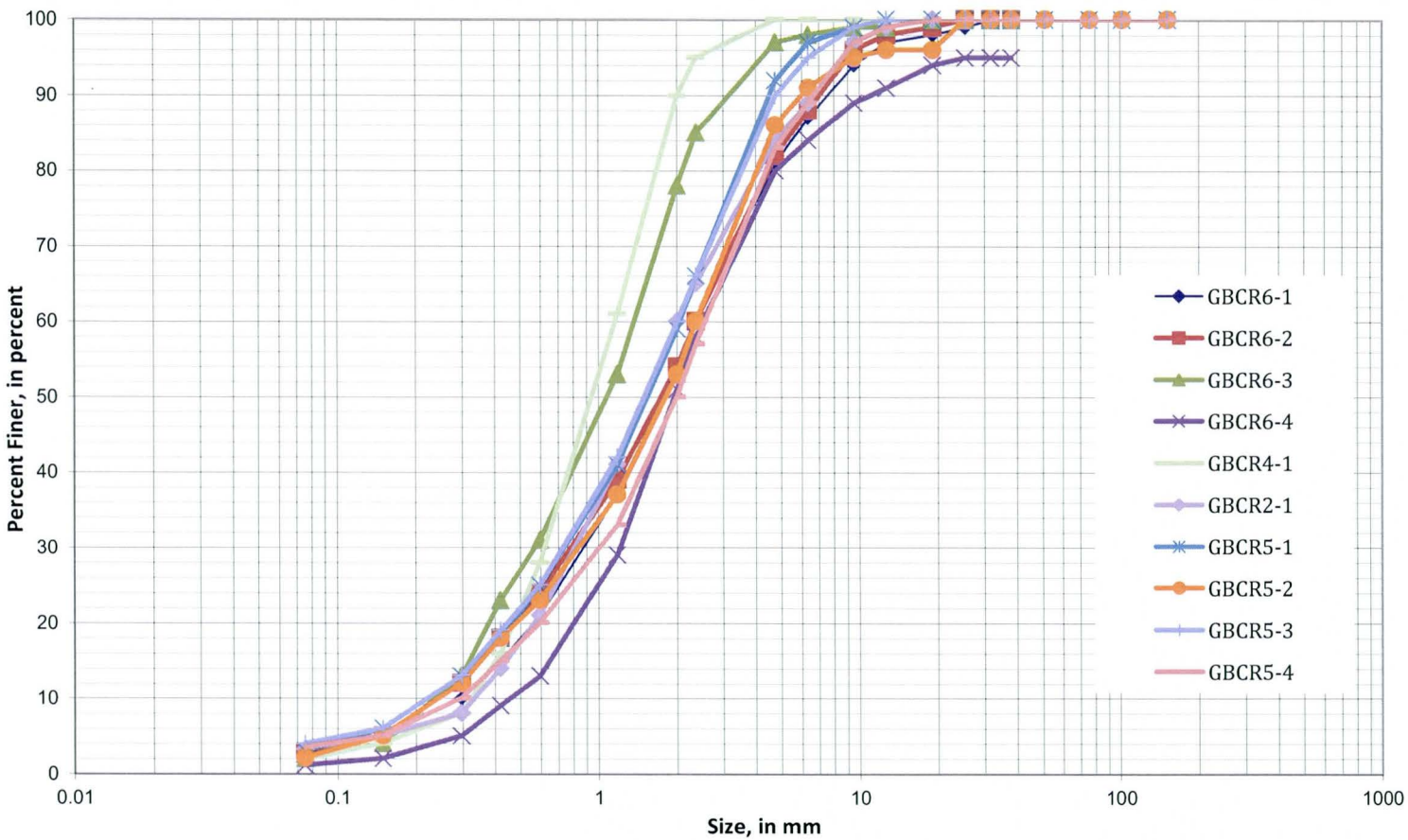


Figure 5, Size Gradation Plot for Rainbow Wash Samples

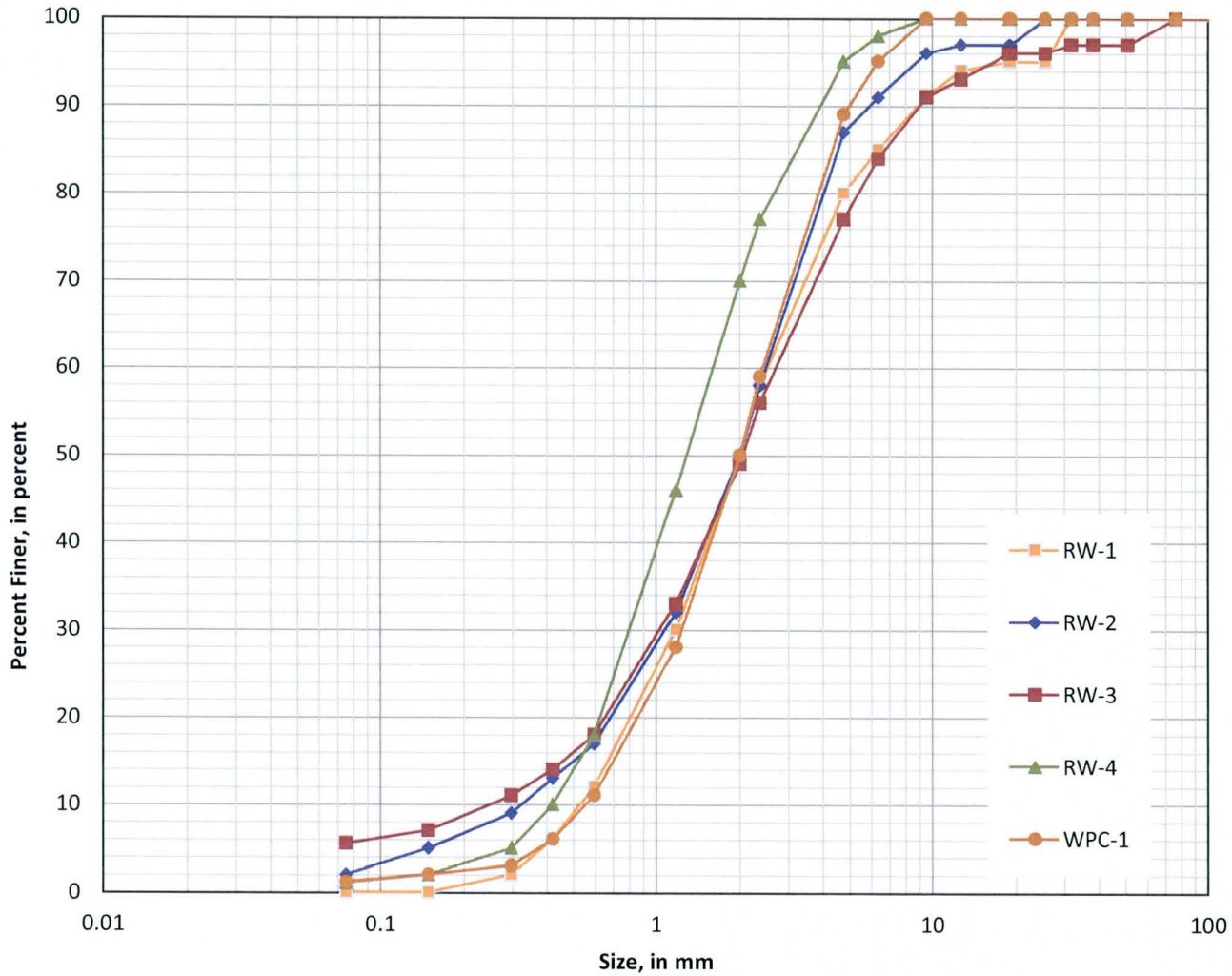
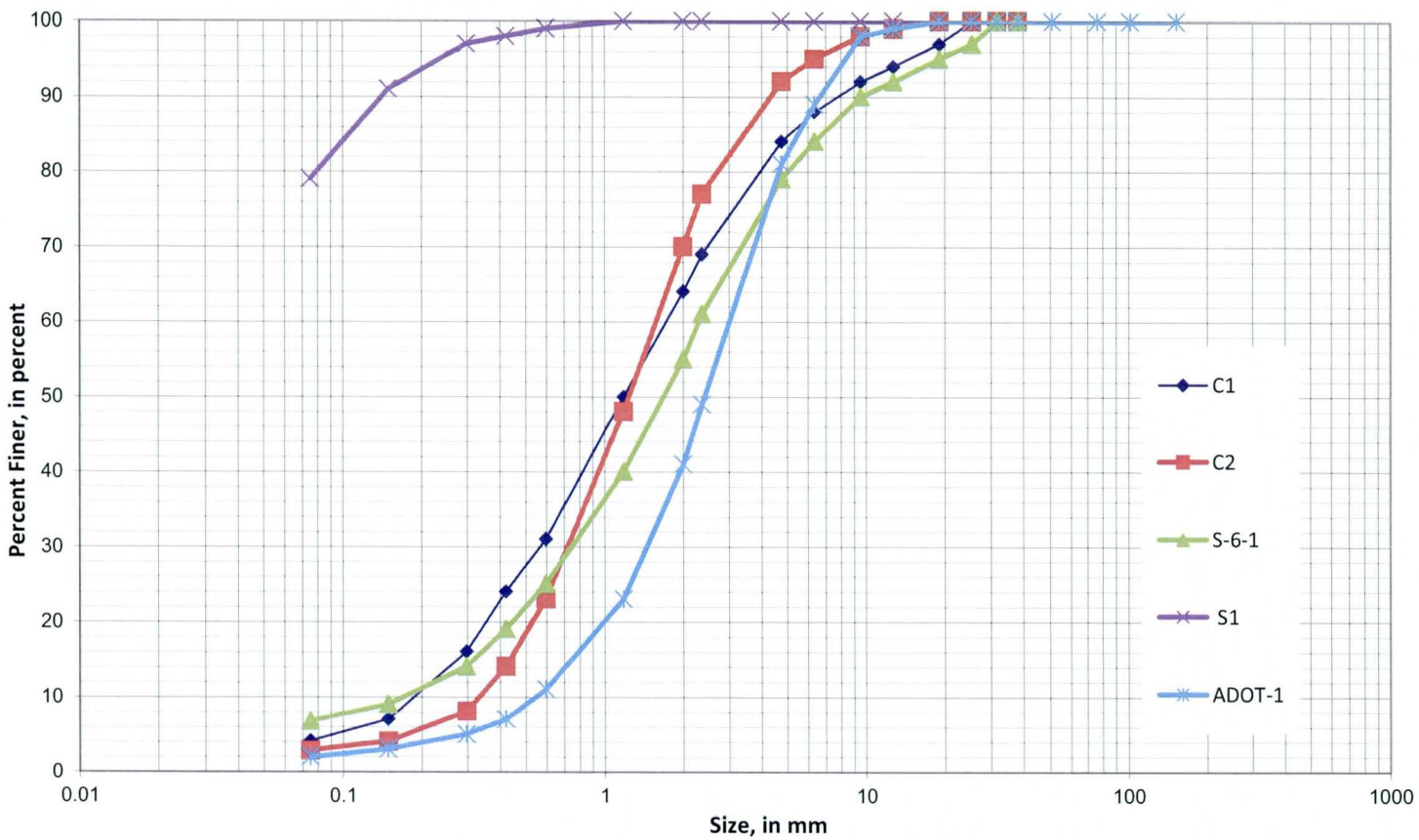


Figure 6, Size Gradation Plot for Miscellaneous Samples



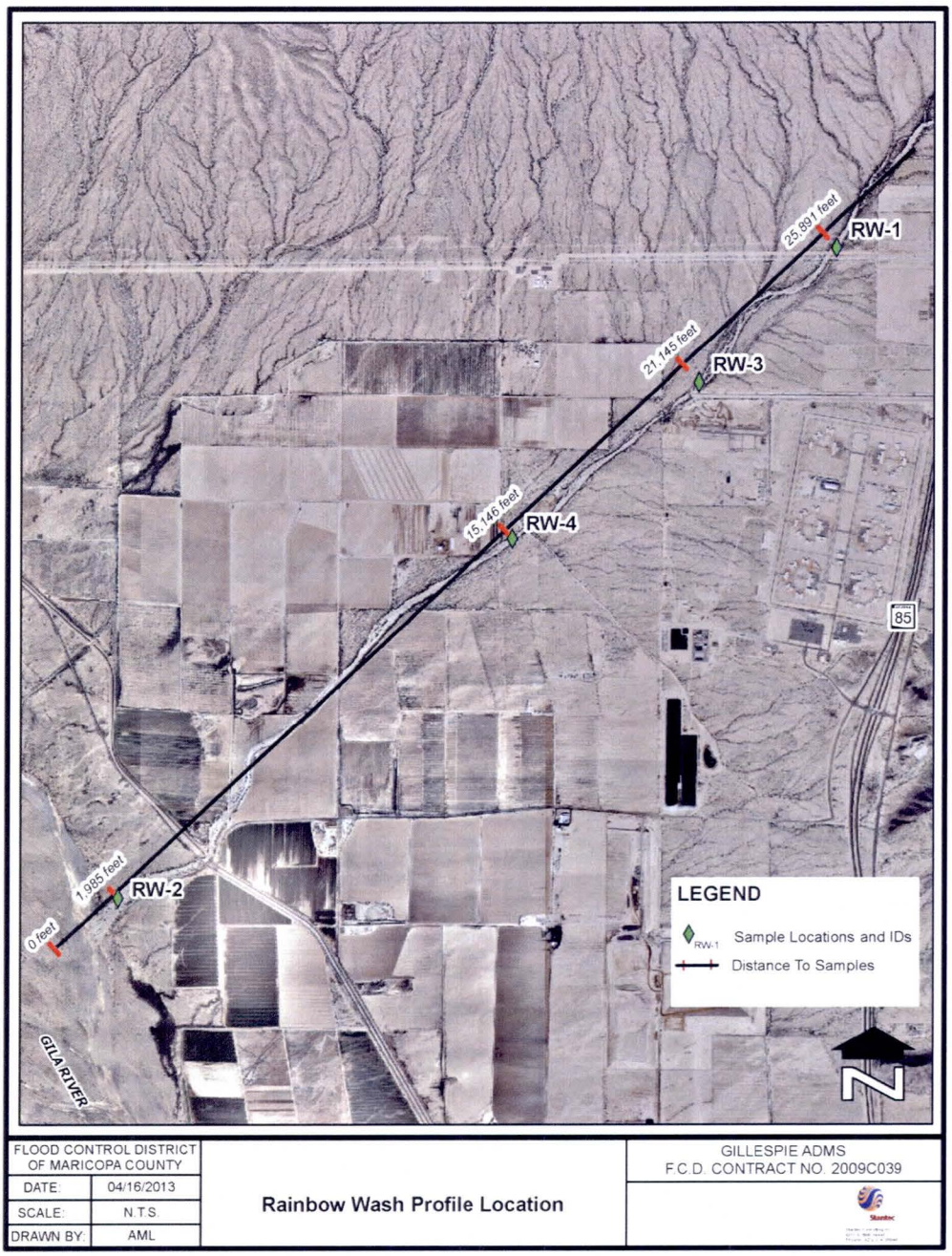
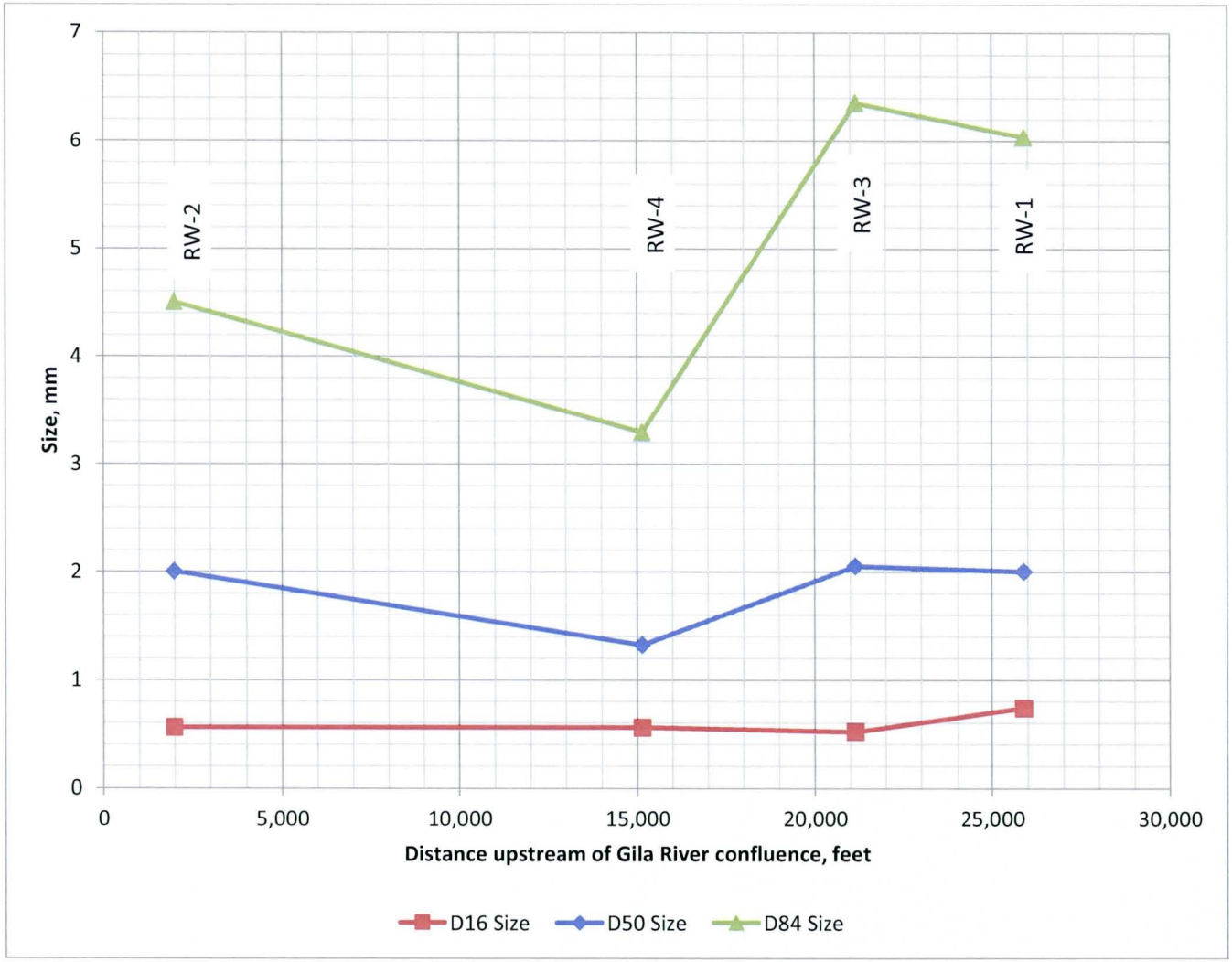


Figure 7, Rainbow Wash Profile Location

Figure 8, Rainbow Wash Samples, Average D_{16}, D_{50}, & D_{84} from Gila River confluence



Appendix A

Task Description

3.6.4 Sediment Sampling and Testing

The CONSULTANT shall collect sediment samples of bed and bank material while conducting subtasks to the Identify Sediment Study Areas Task (3.6.1) for analyses. Sediment sampling, analyses and testing shall include:

- Size gradation of samples (up to 35 samples) will be performed by sieve analysis, and data plotted. The 35 samples will include 5 samples for scour areas, 15 samples to support sediment yield/capacity analysis and 15 samples in Rainbow Wash to support the lateral migration analysis. The sediment distribution for coarse grained samples will be estimated using a pebble-count procedure (if necessary). All procedures should be consistent with the methods given by the USBR (Pemberton and Lara, 1984)[1].

- For Rainbow Wash, the longitudinal variability of bed material size gradation will be investigated and displayed by graphical means.

- The CONSULTANT shall prepare a Sediment Sampling Technical Data Notebook. The notebook will include test data, gradation plots, plots of the longitudinal change in size if applicable, and any other supporting data.

Appendix B
Sediment Sample Sieve Data

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	1
SAMPLE SOURCE:	~~ASF1~~ - Stantec Consulting,Inc. AFS-1	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	100
3/8 in	99
1/4 in	99
#4	99
#8	85
#10	77
#16	57
#30	36
#40	25
#50	16
#100	6
#200	2.4

AASHTO R18

Reviewed by:

amec

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	2
SAMPLE SOURCE:	ASF2- Stantec Consulting,Inc. AFS-2	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	99
3/8 in	97
1/4 in	89
#4	83
#8	59
#10	52
#16	32
#30	15
#40	10
#50	7
#100	4
#200	2.5

AASHTO R18

Reviewed by: _____

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	3
SAMPLE SOURCE:	~~ASF3~~- Stantec Consulting,Inc. AFS-3	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	100
3/8 in	99
1/4 in	96
#4	93
#8	74
#10	67
#16	45
#30	21
#40	14
#50	8
#100	4
#200	2.0

AASHTO R18

Reviewed by: _____

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	4
SAMPLE SOURCE:	~~ASF4~~- Stantec Consulting,Inc. AFS-4	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	99
1/2 in	98
3/8 in	97
1/4 in	93
#4	89
#8	66
#10	59
#16	37
#30	19
#40	14
#50	9
#100	4
#200	2.5

AASHTO R18

Reviewed by: Cy

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	5
SAMPLE SOURCE:	ASF5- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11
	AFS-5		

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	98
1/2 in	93
3/8 in	85
1/4 in	70
#4	61
#8	34
#10	29
#16	18
#30	11
#40	8
#50	6
#100	3
#200	1.8

AASHTO R18

Reviewed by: Cy

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	6
SAMPLE SOURCE:	~~ASF6~~- Stantec Consulting,Inc. AFS-6	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	99
3/8 in	98
1/4 in	93
#4	87
#8	64
#10	58
#16	42
#30	25
#40	19
#50	12
#100	5
#200	2.5

AASHTO R18

Reviewed by: CY

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	7
SAMPLE SOURCE:	~~ASF7~~- Stantec Consulting,Inc. AFS-7	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	99
3/8 in	97
1/4 in	88
#4	78
#8	47
#10	42
#16	30
#30	21
#40	18
#50	14
#100	7
#200	4.0

AASHTO R18

Reviewed by: CW

amec

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	8
SAMPLE SOURCE:	~~ASF8~~- Stantec Consulting,Inc. AFS-8	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	100
3/8 in	99
1/4 in	95
#4	90
#8	70
#10	64
#16	47
#30	29
#40	20
#50	13
#100	5
#200	2.4

AASHTO R18

Reviewed by: Cy

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	9
SAMPLE SOURCE:	~~ASF9~~- Stantec Consulting,Inc. AFS-9	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	99
3/8 in	97
1/4 in	90
#4	82
#8	47
#10	40
#16	25
#30	15
#40	11
#50	8
#100	4
#200	2.8

AASHTO R18

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amec

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	10
SAMPLE SOURCE:	~~ASF10~~- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

AFS-10

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	100
3/8 in	100
1/4 in	96
#4	90
#8	55
#10	46
#16	27
#30	15
#40	12
#50	8
#100	4
#200	1.5

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Reviewed by: _____

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	11
SAMPLE SOURCE:	~~ASF11~~ AFS-11 Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	99
3/8 in	97
1/4 in	91
#4	82
#8	52
#10	45
#16	30
#30	16
#40	12
#50	8
#100	3
#200	1.8

AASHTO R18

Reviewed by: Cy

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	12
SAMPLE SOURCE:	~~CBC~~R4-1- Stantec Consulting,Inc. GBC	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	100
3/8 in	100
1/4 in	100
#4	100
#8	95
#10	90
#16	61
#30	28
#40	16
#50	8
#100	4
#200	1.9

AASHTO R18

Reviewed by: Cy

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	13
SAMPLE SOURCE:	GBCR5-1- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	100
3/8 in	99
1/4 in	97
#4	92
#8	66
#10	59
#16	41
#30	25
#40	18
#50	13
#100	6
#200	3.0

AASHTO R18

Reviewed by: _____

amec

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	14
SAMPLE SOURCE:	6BCR6-1- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	99
3/4 in	98
1/2 in	97
3/8 in	94
1/4 in	87
#4	81
#8	60
#10	54
#16	37
#30	21
#40	15
#50	10
#100	5
#200	3.3

AAR AASHTO R18

Reviewed by: _____

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	15
SAMPLE SOURCE:	GBCR6-2- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	99
1/2 in	98
3/8 in	96
1/4 in	88
#4	82
#8	60
#10	54
#16	39
#30	24
#40	18
#50	12
#100	5
#200	2.6

AASHTO R18

Reviewed by: CY

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	16
SAMPLE SOURCE:	GBCR6-3- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	100
1 1/4 in	100
1 in	100
3/4 in	100
1/2 in	99
3/8 in	99
1/4 in	98
#4	97
#8	85
#10	78
#16	53
#30	31
#40	23
#50	13
#100	4
#200	2.0

AASHTO R18

Reviewed by: _____

PROJECT:	Gillespie ADMS # 181300167	**JOB NO:**	1920111128
LOCATION:	Maricopa County	**WORK ORDER NO:**	1
MATERIAL:	Native Soil	**LAB NO:**	17
SAMPLE SOURCE:	GBCR6-4- Stantec Consulting,Inc.	**SAMPLE DATE:**	10/28/11

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	% PASS.
6 in	100
4 in	100
3 in	100
2 in	100
1 1/2 in	95
1 1/4 in	95
1 in	95
3/4 in	94
1/2 in	91
3/8 in	89
1/4 in	84
#4	80
#8	58
#10	51
#16	29
#30	13
#40	9
#50	5
#100	2
#200	1.1

AASHTO R18

Reviewed by: _____

amec

PROJECT:	Gillespie ADMS #181300167	**JOB NO:**	19-2011-1128
LOCATION:	Maricopa County, AZ	**WORK ORDER NO:**	2
MATERIAL:	Native Soil	**DATE ASSIGNED:**	11/17/11
SAMPLE SOURCE:	SEE BELOW		

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

RW-3				5.5	7	11	14	18	33	49	56	77	84	91	93	96	96	97	97	97	100	100	19
GBCR5-4				3.5	5	10	15	20	33	50	57	83	89	97	99	100	100	100	100	100	100	100	20
RW-2				2	5	9	13	17	32	50	58	87	91	96	97	97	100	100	100	100	100	100	21
AFS-12 ~~WP-16~~				2.1	3	9	15	20	35	55	62	89	93	98	100	100	100	100	100	100	100	100	22
WPC-1				1.2	2	3	6	11	28	50	59	89	95	100	100	100	100	100	100	100	100	100	23
RW-4				1.1	2	5	10	18	46	70	77	95	98	100	100	100	100	100	100	100	100	100	24
C-1				4.1	7	16	24	31	50	64	69	84	88	92	94	97	100	100	100	100	100	100	25
C-2				2.8	4	8	14	23	48	70	77	92	95	98	99	100	100	100	100	100	100	100	26
GBCR5-2				2.1	5	12	18	23	37	53	60	86	91	95	96	96	100	100	100	100	100	100	27
GBCR5-3				4	6	13	19	25	42	60	66	90	95	99	100	100	100	100	100	100	100	100	28

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AASHTO R18

REVIEWED BY MEK

amec

PROJECT:	Gillespie ADMS #181300167	**JOB NO:**	19-2011-1128
LOCATION:	Maricopa County, AZ	**WORK ORDER NO:**	2
MATERIAL:	Native Soil	**DATE ASSIGNED:**	11/17/11
SAMPLE SOURCE:	SEE BELOW		

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

ADOT-1				1.9	3	5	7	11	23	41	49	81	89	98	99	100	100	100	100	100	100	100	29
RW-1				0	0	2	6	12	30	50	58	80	85	91	94	95	95	100	100	100	100	100	30

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AASHTO R18

REVIEWED BY MCT

amec

PROJECT:	Gillespie ADMS #181300167	**JOB NO:**	19-2011-1128
LOCATION:	Maricopa County, AZ	**WORK ORDER NO:**	3
MATERIAL:	Native Soil	**DATE ASSIGNED:**	1/26/12
SAMPLE SOURCE:	SEE BELOW		

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

S-6-1 ~~S-6-1~~				6.7	9	14	19	25	40	55	61	79	84	90	92	95	97	100	100	100	100	100	31
GBCR2-1 ~~GBC-R2-1~~				3.2	5	8	14	21	41	60	65	84	89	97	99	100	100	100	100	100	100	100	32
S1 ~~C-1~~				79	91	97	98	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100	33

AASHTO R18

REVIEWED BY

Alpha Geotechnical & Materials, Inc.

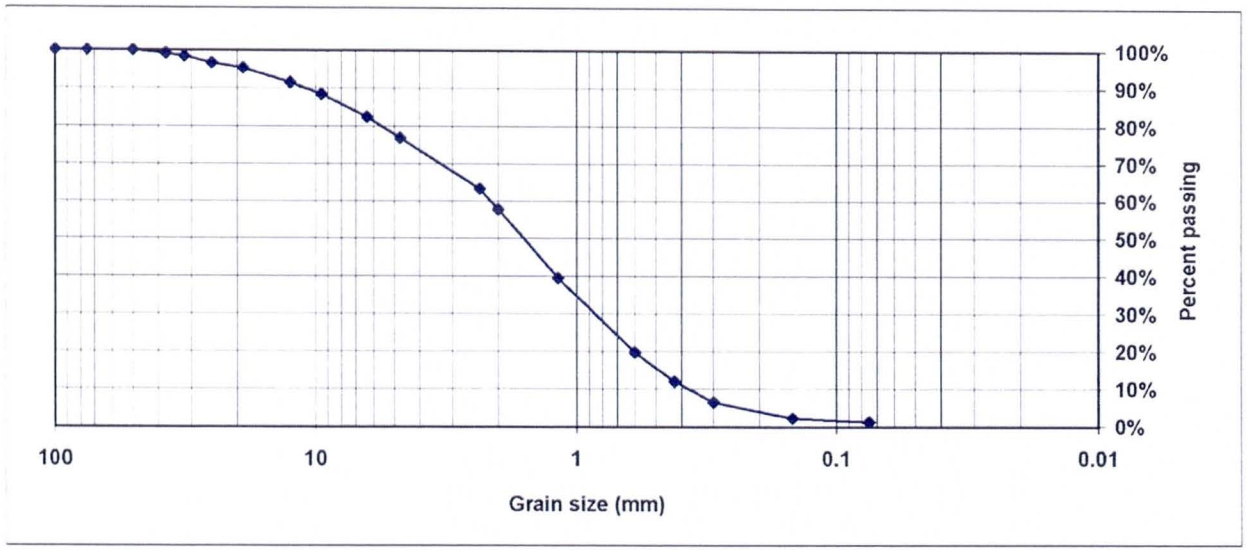
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2A-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12549
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	99
1 1/4 in / 32 mm	98
1 in / 25 mm	97
3/4 in / 19 mm	95
1/2 in / 12.5 mm	91
3/8 in / 9.5 mm	88
1/4 in / 6.4 mm	82
#4, 4.75mm	77
#8, 2.36mm	63
#10, 2.00mm	58
#16, 1.18mm	39
#30, 0.60mm	20
#40, .425mm	12
#50, .300mm	6
#100, .150mm	2
#200, .075mm	1.3



Reviewed by: AW

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

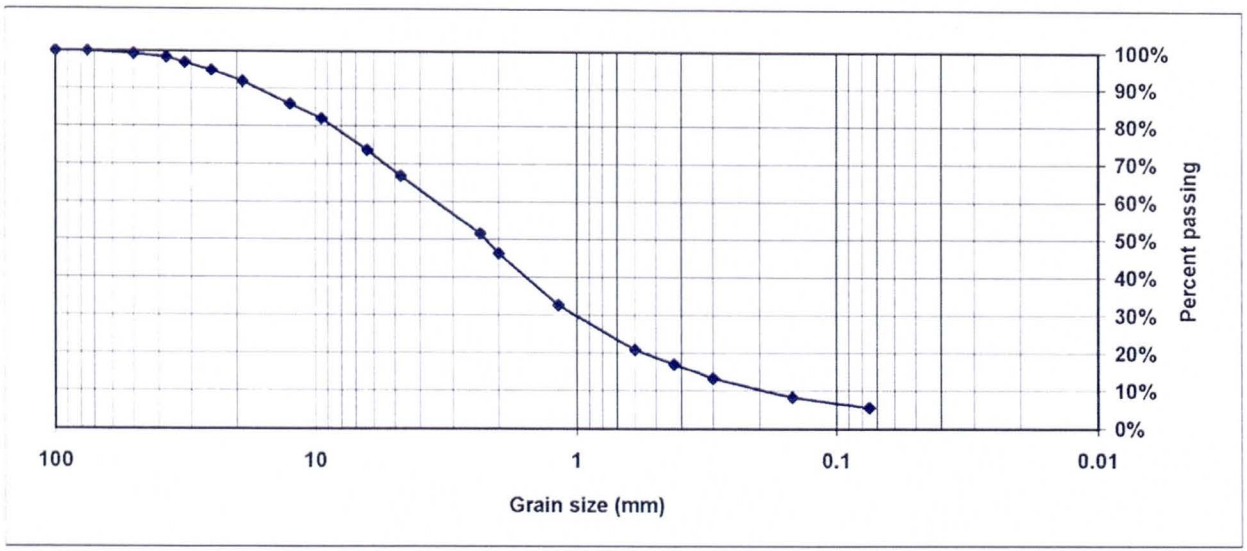
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2A-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12550
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	99
1 1/2 in / 37.5mm	98
1 1/4 in / 32 mm	97
1 in / 25 mm	95
3/4 in / 19 mm	92
1/2 in / 12.5 mm	86
3/8 in / 9.5 mm	82
1/4 in / 6.4 mm	74
#4, 4.75mm	67
#8, 2.36mm	52
#10, 2.00mm	46
#16, 1.18mm	33
#30, 0.60mm	21
#40, .425mm	17
#50, .300mm	13
#100, .150mm	8
#200, .075mm	5.5



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

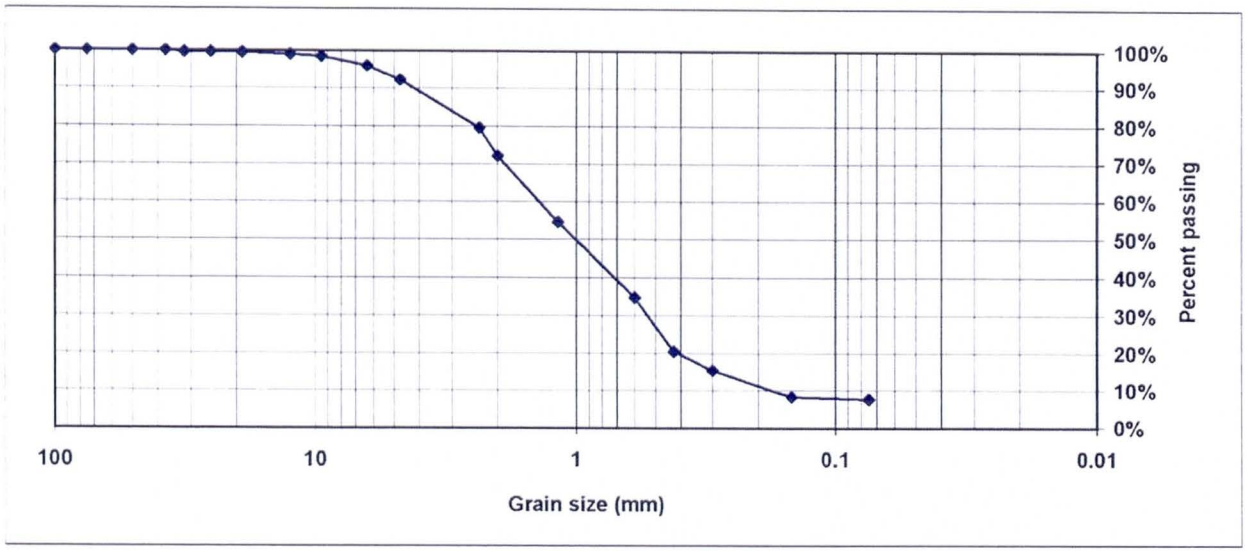
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2B-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12551
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	99
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	96
#4, 4.75mm	92
#8, 2.36mm	80
#10, 2.00mm	72
#16, 1.18mm	55
#30, 0.60mm	35
#40, .425mm	20
#50, .300mm	15
#100, .150mm	8
#200, .075mm	7.7



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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

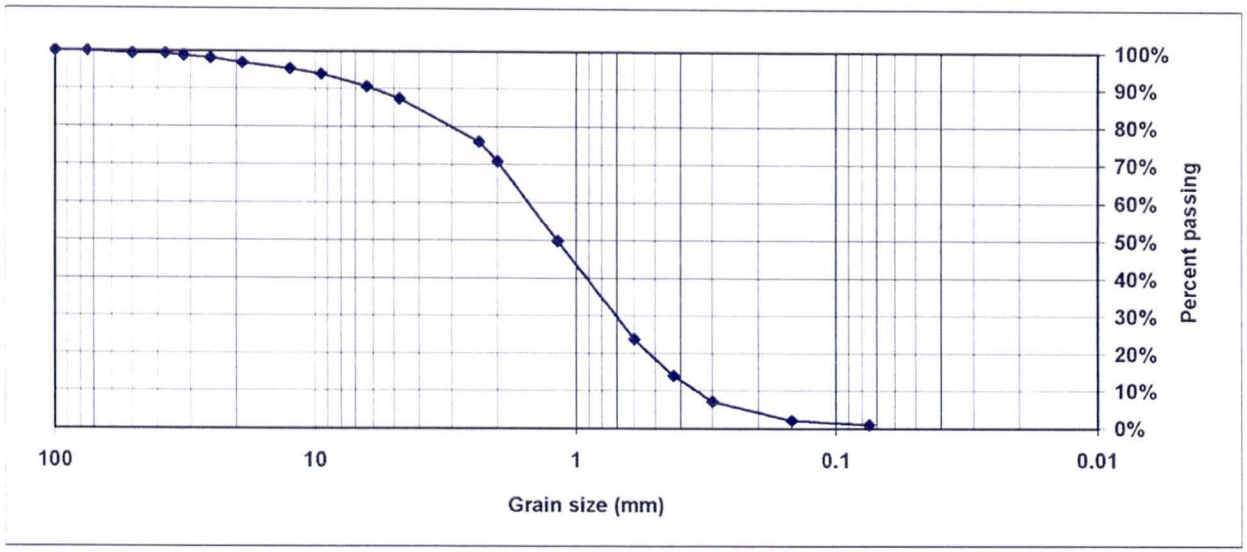
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2B-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12552
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	99
1 1/2 in / 37.5mm	99
1 1/4 in / 32 mm	99
1 in / 25 mm	98
3/4 in / 19 mm	97
1/2 in / 12.5 mm	95
3/8 in / 9.5 mm	94
1/4 in / 6.4 mm	91
#4, 4.75mm	87
#8, 2.36mm	76
#10, 2.00mm	71
#16, 1.18mm	50
#30, 0.60mm	24
#40, .425mm	14
#50, .300mm	7
#100, .150mm	2
#200, .075mm	0.9



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

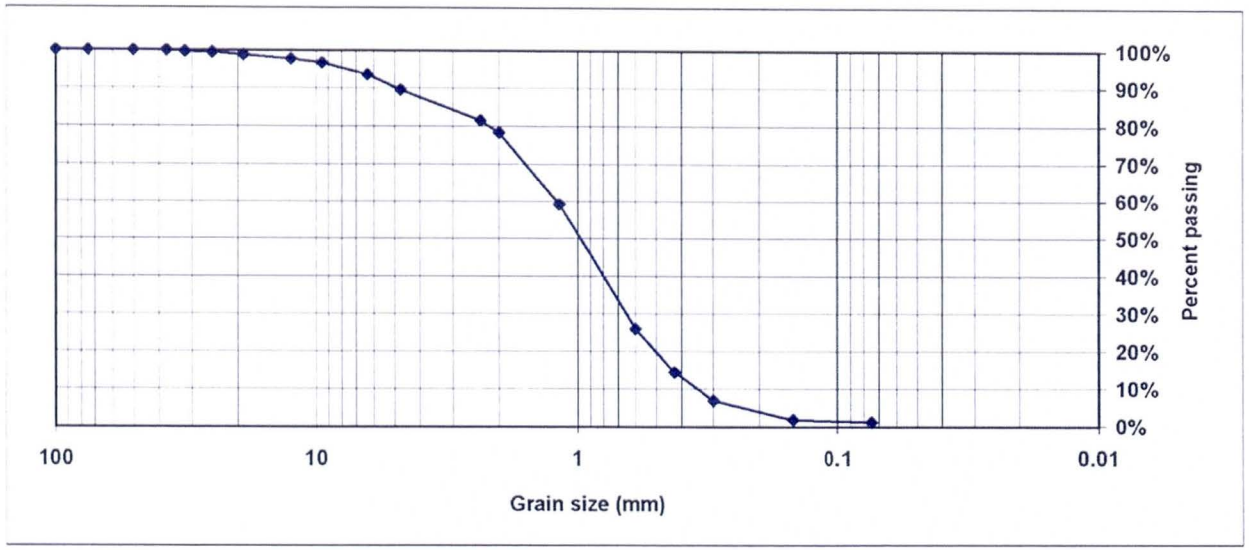
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2C-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12553
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	99
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	97
1/4 in / 6.4 mm	94
#4, 4.75mm	90
#8, 2.36mm	82
#10, 2.00mm	78
#16, 1.18mm	59
#30, 0.60mm	26
#40, .425mm	14
#50, .300mm	7
#100, .150mm	2
#200, .075mm	1.2



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

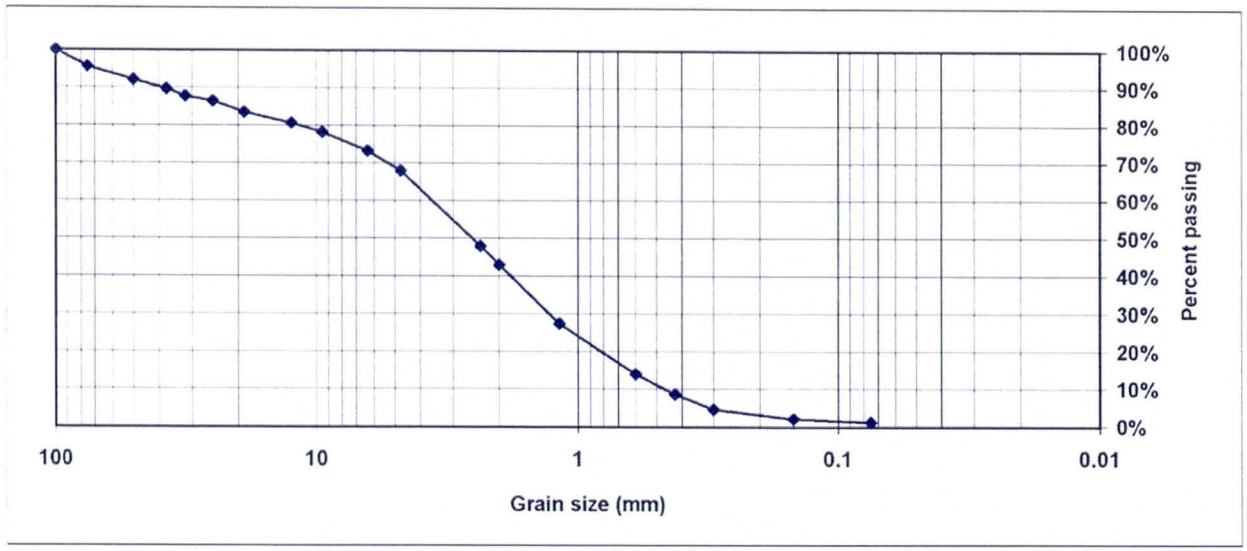
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2C-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12554
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	96
2 in / 50mm	92
1 1/2 in / 37.5mm	90
1 1/4 in / 32 mm	88
1 in / 25 mm	86
3/4 in / 19 mm	83
1/2 in / 12.5 mm	81
3/8 in / 9.5 mm	78
1/4 in / 6.4 mm	73
#4, 4.75mm	68
#8, 2.36mm	48
#10, 2.00mm	43
#16, 1.18mm	27
#30, 0.60mm	14
#40, .425mm	8
#50, .300mm	5
#100, .150mm	2
#200, .075mm	1.2



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2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

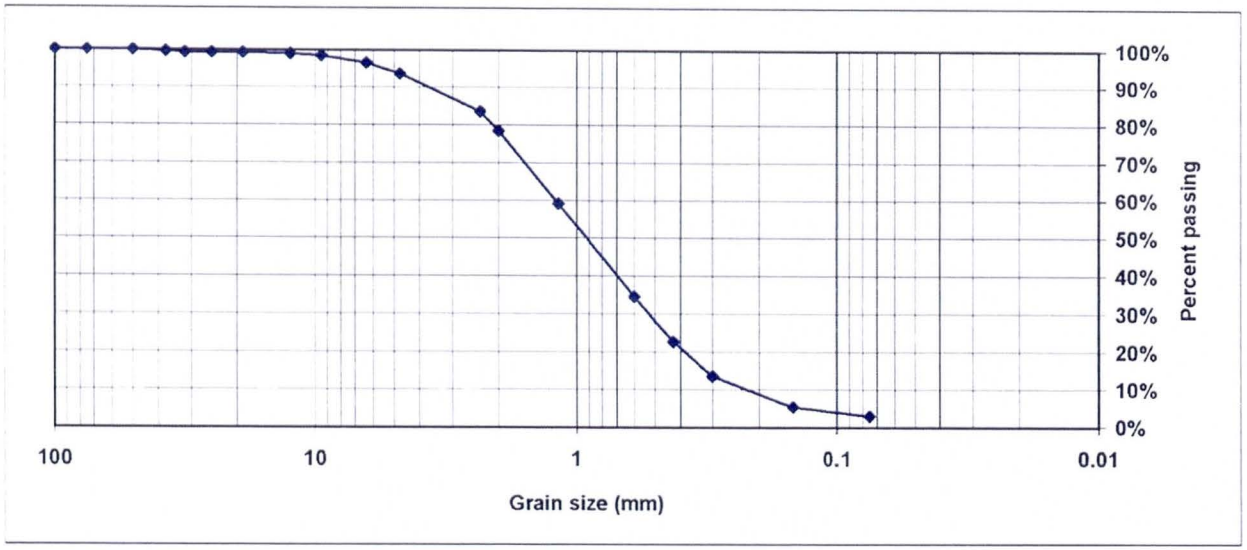
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2D-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12555
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	99
1 in / 25 mm	99
3/4 in / 19 mm	99
1/2 in / 12.5 mm	99
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	96
#4, 4.75mm	94
#8, 2.36mm	83
#10, 2.00mm	78
#16, 1.18mm	59
#30, 0.60mm	35
#40, .425mm	23
#50, .300mm	14
#100, .150mm	5
#200, .075mm	2.9



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Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

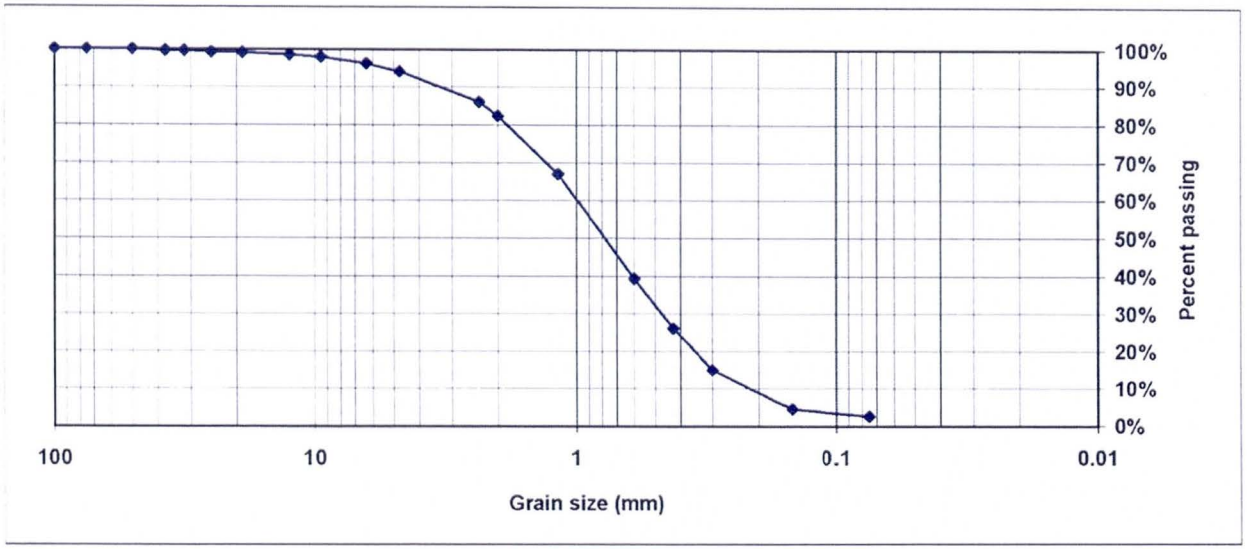
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 2D-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12556
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	99
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	96
#4, 4.75mm	94
#8, 2.36mm	86
#10, 2.00mm	82
#16, 1.18mm	67
#30, 0.60mm	39
#40, .425mm	26
#50, .300mm	15
#100, .150mm	5
#200, .075mm	2.6



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Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

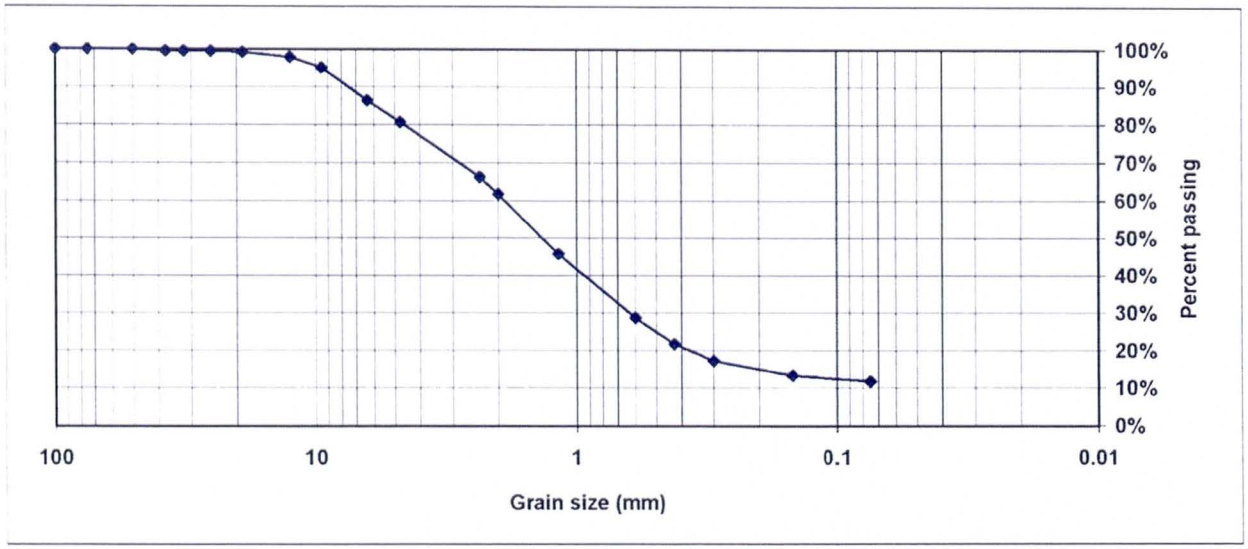
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3A-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12557
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	99
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	95
1/4 in / 6.4 mm	86
#4, 4.75mm	81
#8, 2.36mm	66
#10, 2.00mm	62
#16, 1.18mm	46
#30, 0.60mm	29
#40, .425mm	22
#50, .300mm	17
#100, .150mm	13
#200, .075mm	12.0



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Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

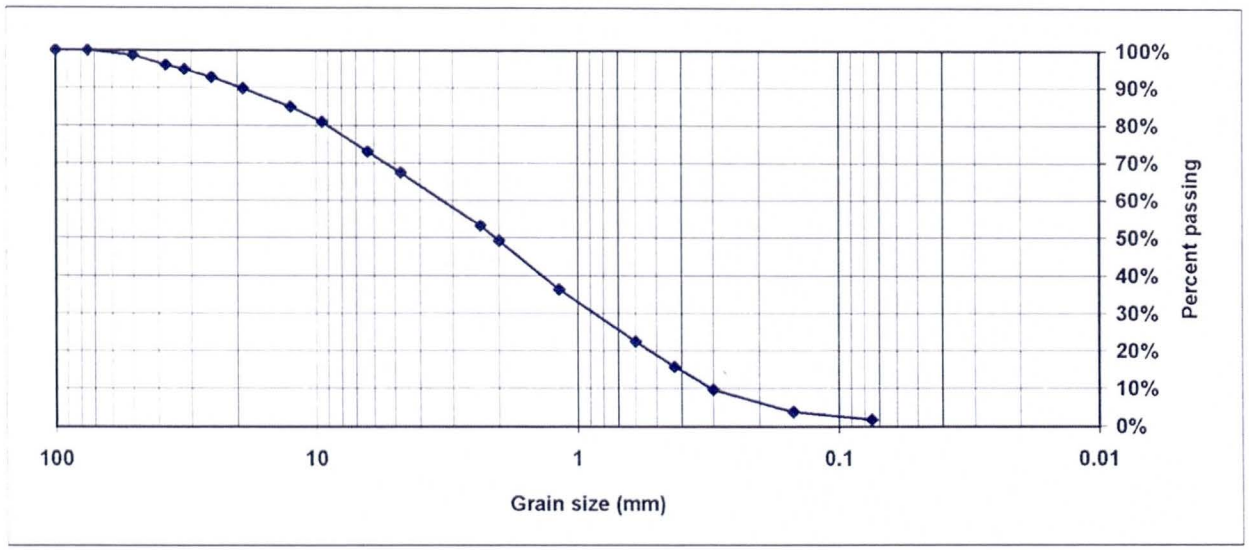
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3A-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12558
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	99
1 1/2 in / 37.5mm	96
1 1/4 in / 32 mm	95
1 in / 25 mm	93
3/4 in / 19 mm	90
1/2 in / 12.5 mm	85
3/8 in / 9.5 mm	81
1/4 in / 6.4 mm	73
#4, 4.75mm	67
#8, 2.36mm	53
#10, 2.00mm	49
#16, 1.18mm	36
#30, 0.60mm	22
#40, .425mm	16
#50, .300mm	10
#100, .150mm	4
#200, .075mm	1.8



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Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

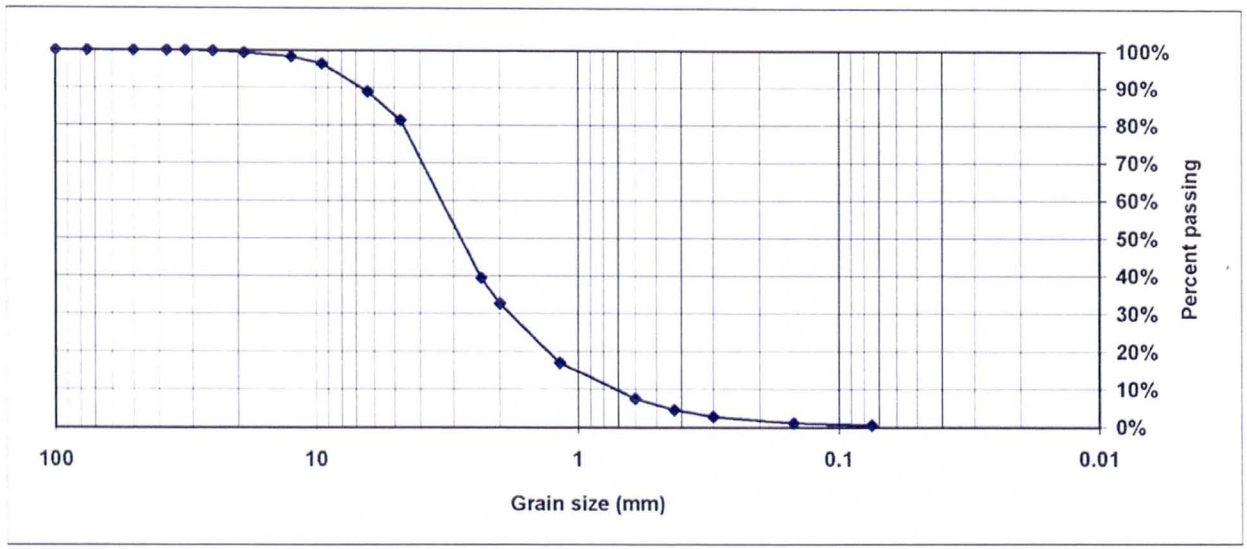
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3B-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12559
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	96
1/4 in / 6.4 mm	89
#4, 4.75mm	81
#8, 2.36mm	39
#10, 2.00mm	33
#16, 1.18mm	17
#30, 0.60mm	7
#40, .425mm	4
#50, .300mm	3
#100, .150mm	1
#200, .075mm	0.6



Reviewed by: AW

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

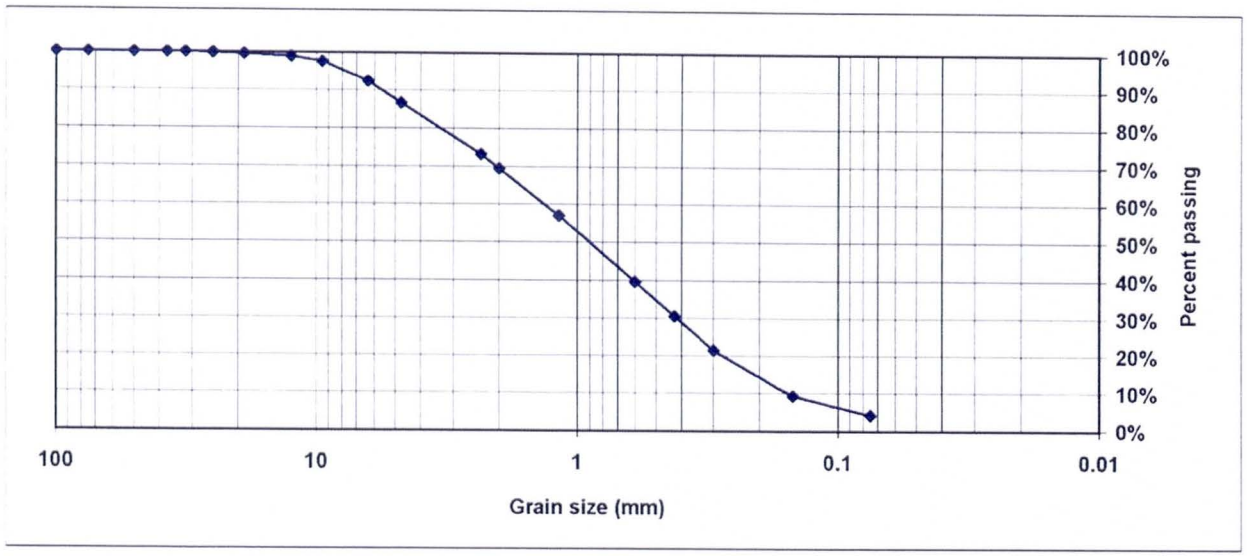
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3B-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12560
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37 5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12 5 mm	99
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	92
#4, 4 75mm	87
#8, 2 36mm	73
#10, 2 00mm	69
#16, 1 18mm	57
#30, 0 60mm	40
#40, 425mm	31
#50, 300mm	21
#100, .150mm	9
#200, .075mm	4.1



Reviewed by: AW

Alpha Geotechnical and Materials, Inc.
2504 West Southern Avenue
Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

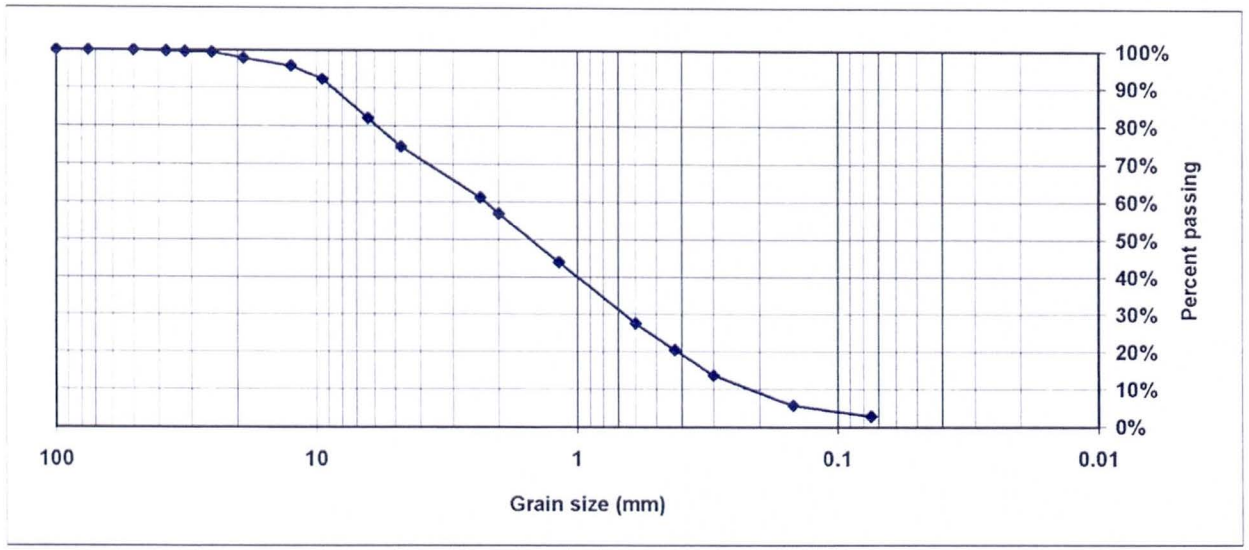
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3C-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12561
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	99
3/4 in / 19 mm	98
1/2 in / 12.5 mm	96
3/8 in / 9.5 mm	92
1/4 in / 6.4 mm	82
#4, 4.75mm	74
#8, 2.36mm	61
#10, 2.00mm	57
#16, 1.18mm	44
#30, 0.60mm	27
#40, .425mm	20
#50, .300mm	14
#100, .150mm	6
#200, .075mm	2.9



Reviewed by: AW

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Alpha Geotechnical & Materials, Inc.

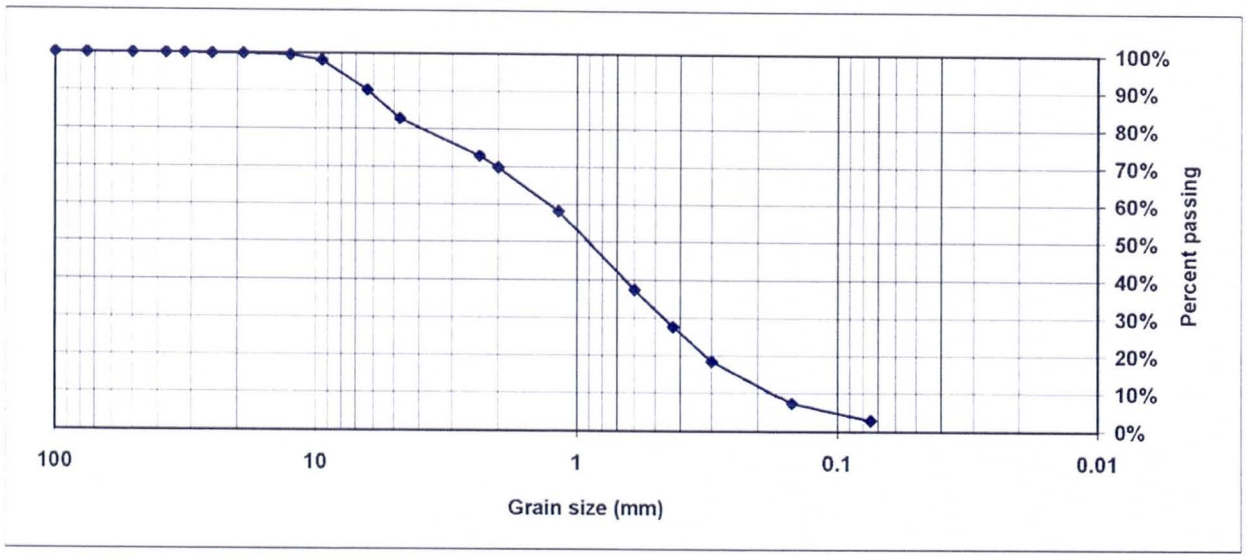
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3C-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12562
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	100
1/2 in / 12.5 mm	100
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	90
#4, 4.75mm	83
#8, 2.36mm	73
#10, 2.00mm	70
#16, 1.18mm	58
#30, 0.60mm	37
#40, .425mm	28
#50, .300mm	18
#100, .150mm	7
#200, .075mm	2.8



Reviewed by: AW

Alpha Geotechnical and Materials, Inc.
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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

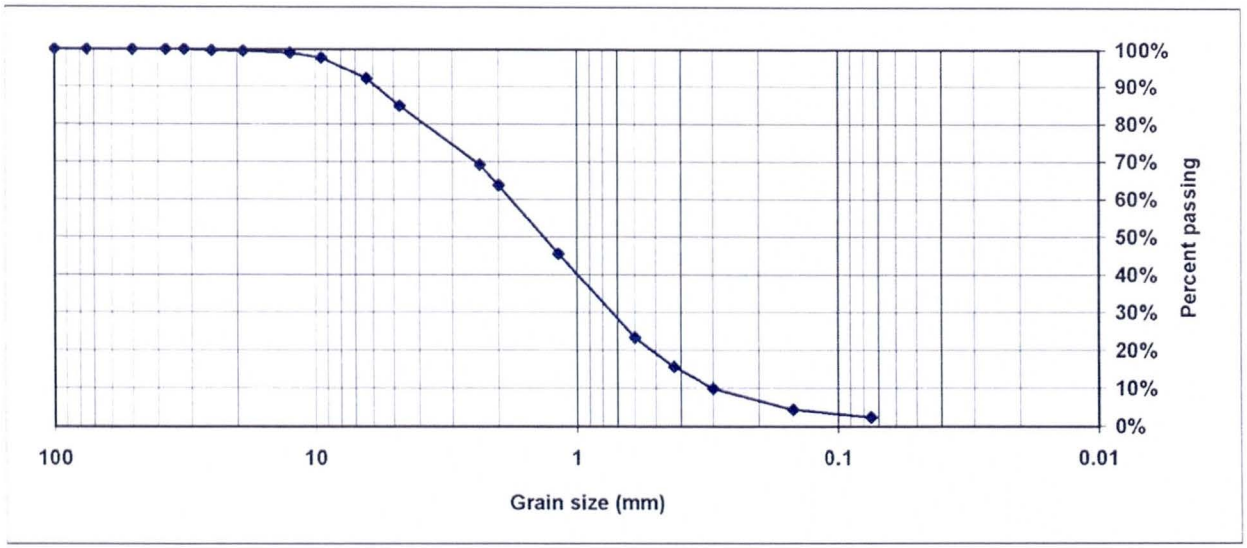
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3D-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12563
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	99
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	92
#4, 4.75mm	85
#8, 2.36mm	69
#10, 2.00mm	64
#16, 1.18mm	45
#30, 0.60mm	23
#40, .425mm	16
#50, .300mm	10
#100, .150mm	4
#200, .075mm	2.3



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

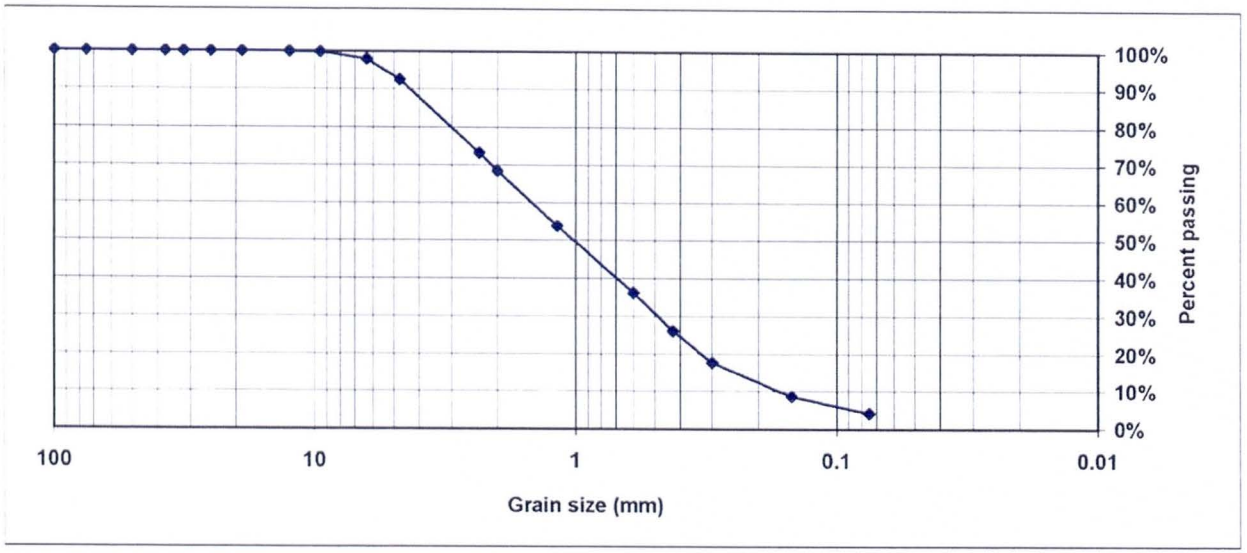
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 3D-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12564
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	100
1/2 in / 12.5 mm	100
3/8 in / 9.5 mm	100
1/4 in / 6.4 mm	98
#4, 4.75mm	92
#8, 2.36mm	73
#10, 2.00mm	68
#16, 1.18mm	54
#30, 0.60mm	36
#40, .425mm	26
#50, .300mm	18
#100, .150mm	9
#200, .075mm	4.1



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

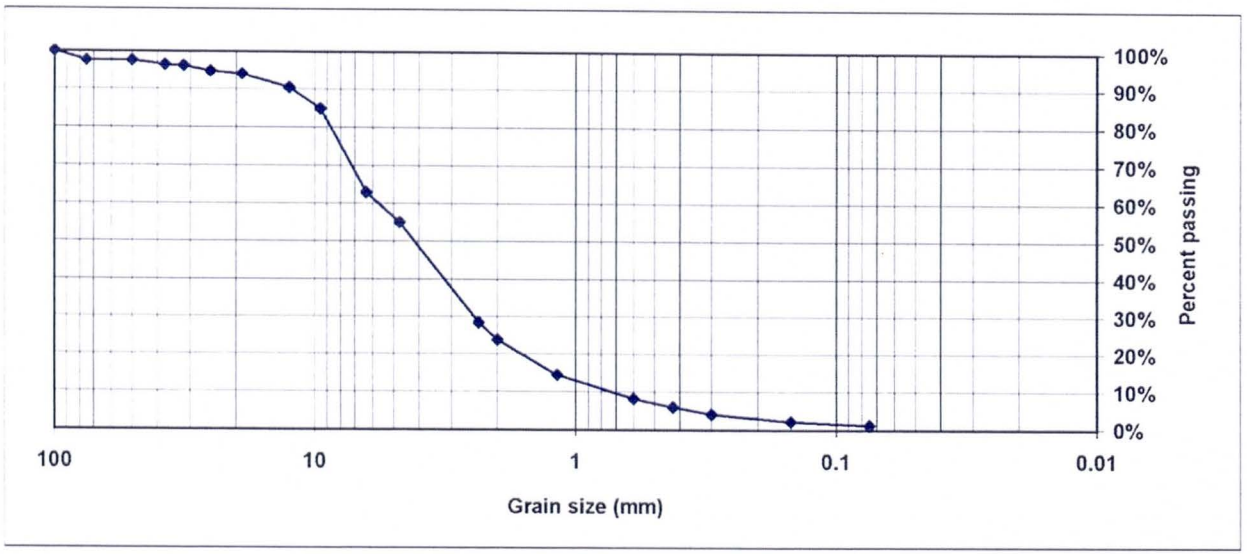
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 4A-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12565
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	98
2 in / 50mm	98
1 1/2 in / 37.5mm	96
1 1/4 in / 32 mm	96
1 in / 25 mm	95
3/4 in / 19 mm	94
1/2 in / 12.5 mm	90
3/8 in / 9.5 mm	85
1/4 in / 6.4 mm	63
#4, 4.75mm	55
#8, 2.36mm	28
#10, 2.00mm	24
#16, 1.18mm	14
#30, 0.60mm	8
#40, .425mm	6
#50, .300mm	4
#100, .150mm	2
#200, .075mm	1.2



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

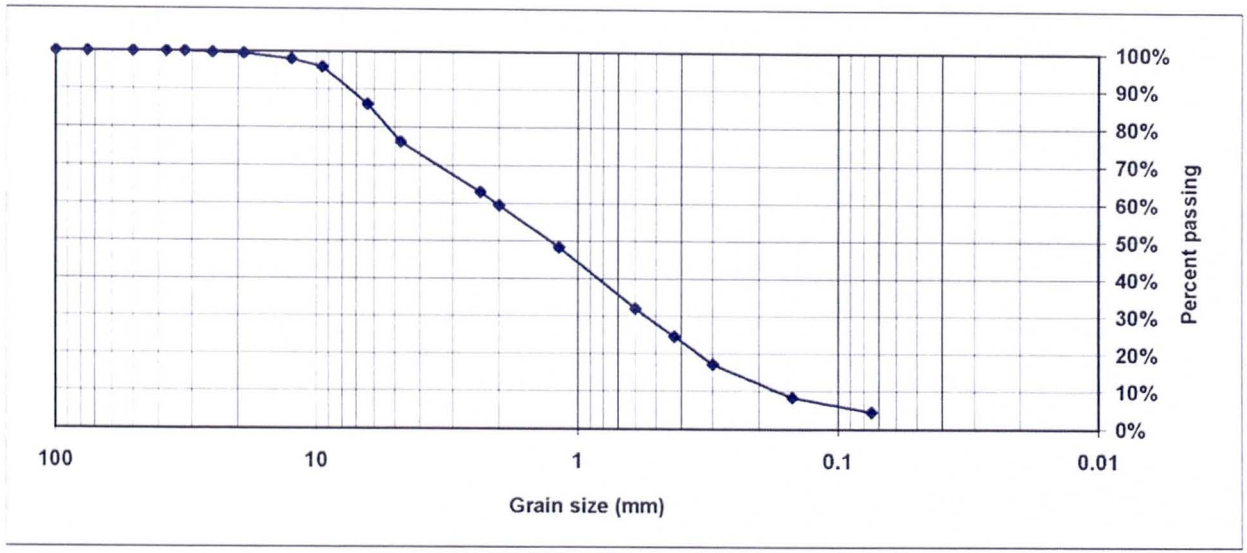
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 4A-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12566
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	96
1/4 in / 6.4 mm	86
#4, 4.75mm	76
#8, 2.36mm	63
#10, 2.00mm	59
#16, 1.18mm	48
#30, 0.60mm	32
#40, .425mm	25
#50, .300mm	17
#100, .150mm	8
#200, .075mm	4.5



Reviewed by: AW

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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

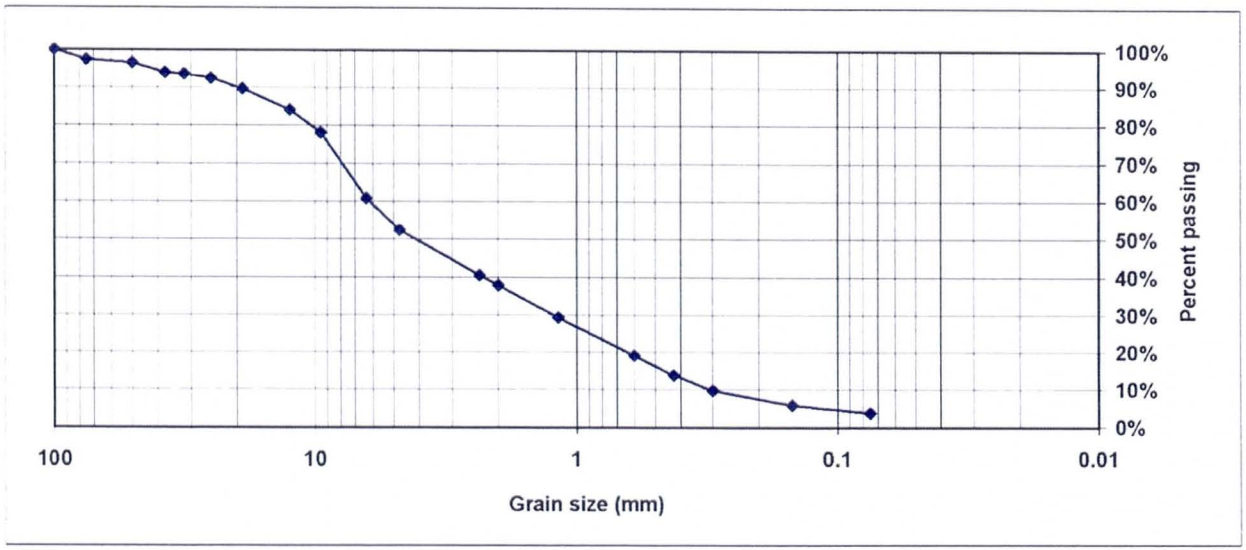
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 4B-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12567
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	97
2 in / 50mm	96
1 1/2 in / 37.5mm	94
1 1/4 in / 32 mm	94
1 in / 25 mm	92
3/4 in / 19 mm	90
1/2 in / 12.5 mm	84
3/8 in / 9.5 mm	78
1/4 in / 6.4 mm	61
#4, 4.75mm	52
#8, 2.36mm	40
#10, 2.00mm	38
#16, 1.18mm	29
#30, 0.60mm	19
#40, .425mm	14
#50, .300mm	10
#100, .150mm	6
#200, .075mm	3.7



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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

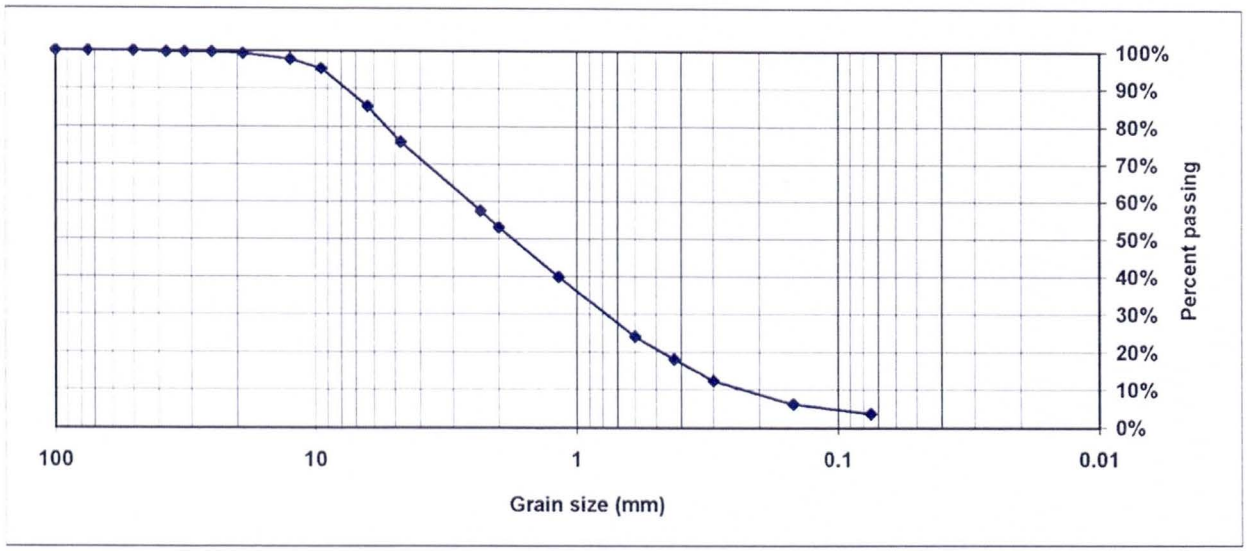
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 4B-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12568
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	95
1/4 in / 6.4 mm	85
#4, 4.75mm	76
#8, 2.36mm	58
#10, 2.00mm	53
#16, 1.18mm	40
#30, 0.60mm	24
#40, .425mm	18
#50, .300mm	12
#100, .150mm	6
#200, .075mm	3.7



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Alpha Geotechnical and Materials, Inc.
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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

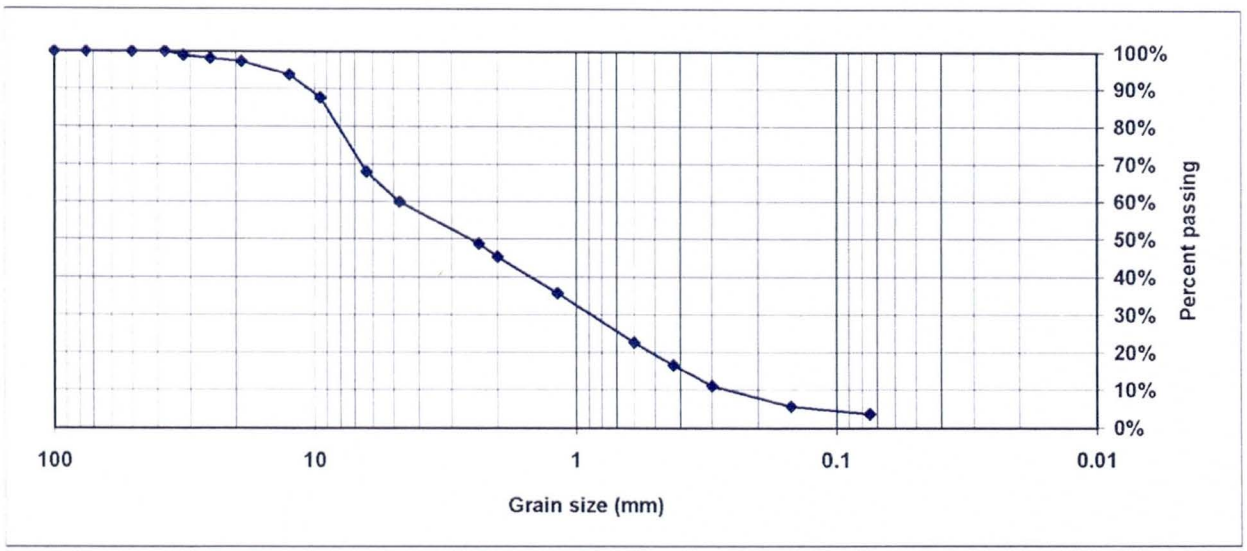
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 4C-1
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12569
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	99
1 in / 25 mm	98
3/4 in / 19 mm	97
1/2 in / 12.5 mm	94
3/8 in / 9.5 mm	88
1/4 in / 6.4 mm	68
#4, 4.75mm	60
#8, 2.36mm	49
#10, 2.00mm	45
#16, 1.18mm	36
#30, 0.60mm	23
#40, .425mm	17
#50, .300mm	11
#100, .150mm	6
#200, .075mm	3.6



Reviewed by: AW

Alpha Geotechnical and Materials, Inc.
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Tempe, Arizona 85282

Alpha Geotechnical & Materials, Inc.

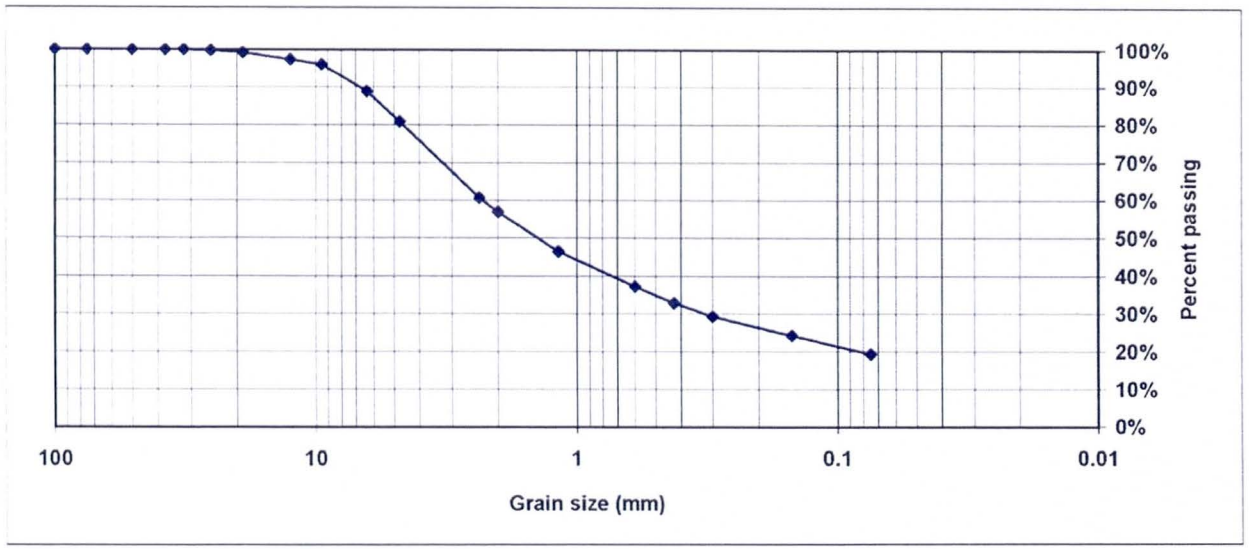
Project: Gillespie ADMS
Location: Rainbow Wash watershed
Material: Native Soil
Sample Source: 4C-2
Proposed Use: Pads

Project Number: 11-L-2283
Sample Number: 12570
Sample Date: 10/17/11
Sampled by: AW

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T27/T11)

Mechanical Analysis

Sieve Size	% Passing
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	97
3/8 in / 9.5 mm	96
1/4 in / 6.4 mm	89
#4, 4.75mm	81
#8, 2.36mm	61
#10, 2.00mm	57
#16, 1.18mm	46
#30, 0.60mm	37
#40, .425mm	33
#50, .300mm	29
#100, .150mm	24
#200, .075mm	20.0



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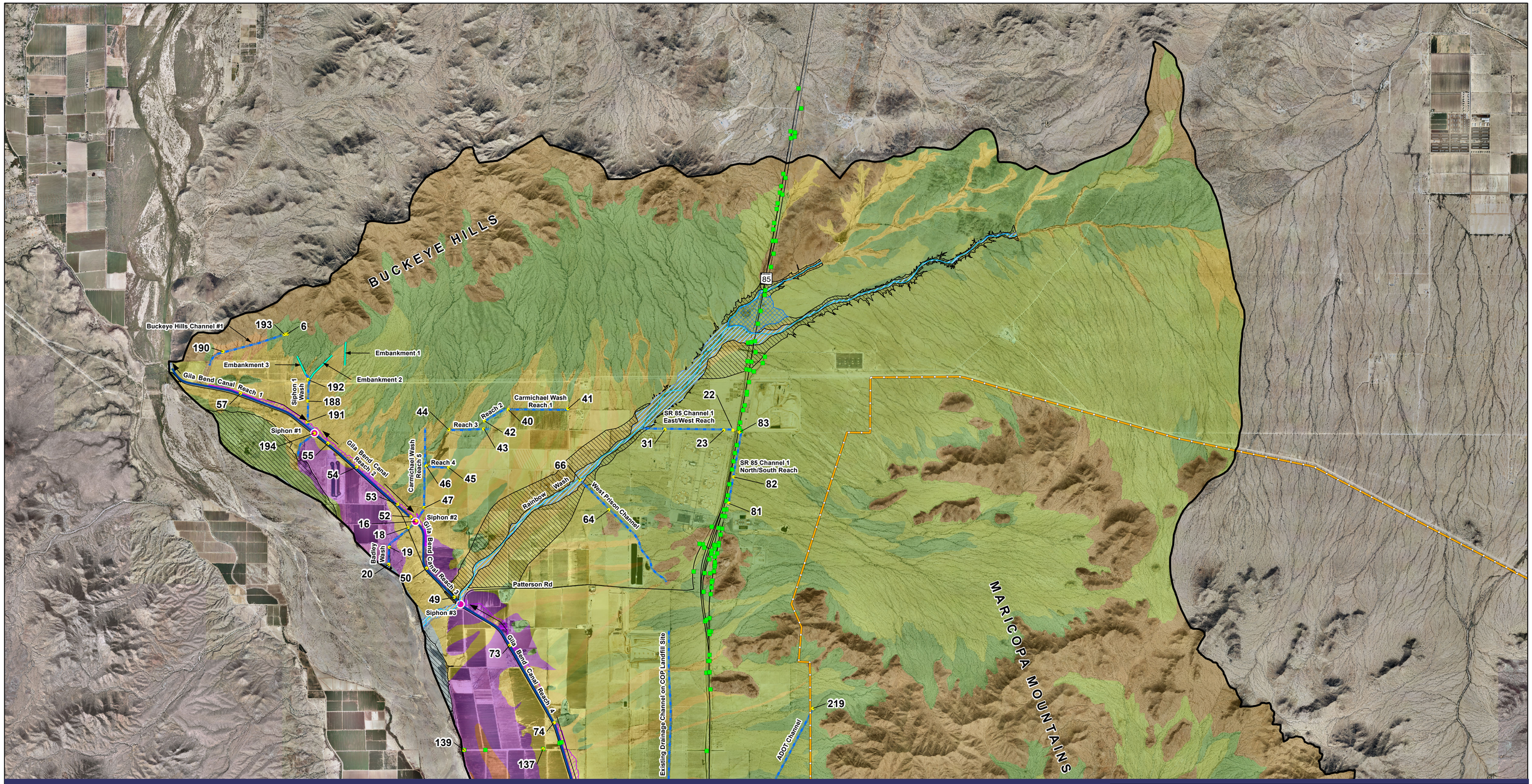
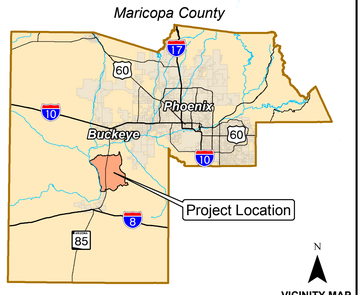
Tempe, Arizona 85282

Plates





NOTES:

Aerial imagery flight dates Oct 2009 and Nov 2006
V:\52813\active\181300167\GIS\Project\NRCS_Er_Fa_Map_Plate_1_Sheet_1.mxd

LEGEND:

- 45 Waypoint with ID
- Culvert
- Clogged Culvert
- Siphon Location
- Road
- Gila Bend Canal
- Channel
- Embankment
- Project Boundary
- National Monument Boundary

FEMA Flood Zone

- A
- AE
- AO
- FW

EROSION FACTOR

- 0
- 0.02
- 0.05
- 0.1
- 0.17
- 0.2

LOW RANGE 0 to 0.20

- 0.24
- 0.32
- 0.37
- 0.49
- 0.55

MODERATE RANGE 0.25 to 0.45

HIGH RANGE 0.45 to 0.65

PLATE 1
NRCS EROSION FACTOR MAP
SHEET 1 OF 2

N

0 3,000 6,000
Feet

GILLESPIE AREA DRAINAGE MASTER STUDY
F.C.D. CONTRACT NO. 2009C039

Flood Control District of Maricopa County
2801 W. Durango St. Phoenix, AZ 85009

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Gillespie Area Drainage Master Study

Sediment Study Areas Memo

Registered Professional Engineer (Civil)
CERTIFICATE NO.
31680
PATRICK J.
ELLISON
Date Signed 10/4/2013
ARIZONA U.S.A.

Expires 9/30/2015

August 2013

181300167

Stantec

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Registered Professional Engineer (Civil)
CERTIFICATE NO. 31680
PATRICK J. ELLISON
Date Signed 10/11/2013
ARIZONA U.S.A.
Expires 9/30/2015

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1.0 Identification of Sediment Study Areas

1.1 INTRODUCTION

This report describes the evaluations conducted to identify potential sedimentation and erosion issue areas within the Gillespie ADMS project area. The conveyance capacity of washes, constructed channels, and drainage facilities that drain storm water runoff from the mountains and valleys of the project area to the Gila River could be minimized by erosion and sedimentation. When flood conveyance is minimized associated flood hazards are exacerbated.

1.1.1 Purpose

An understanding of the sedimentation process of a watershed enables engineers and planners to formulate a course of action to mitigate sediment and erosion issues. To this end the purpose of the Identification of Sediment Study Areas task (Appendix A) of the Gillespie ADMS scope of work is to define specific areas within the project area where detailed sedimentation and erosion evaluations should be conducted. This will be the first step to developing an understanding of the sedimentation and erosion issues that are unique to the project area. The types of detailed evaluations that could be recommended include sediment transport, scour, lateral migration and sediment yield evaluations.

1.1.2 Location

Figure 1 depicts the location of the Gillespie ADMS project area. The project area includes properties within the jurisdiction of the Town of Buckeye, Town of Gila Bend, unincorporated Maricopa County and the Woolsey Flood Protection District.

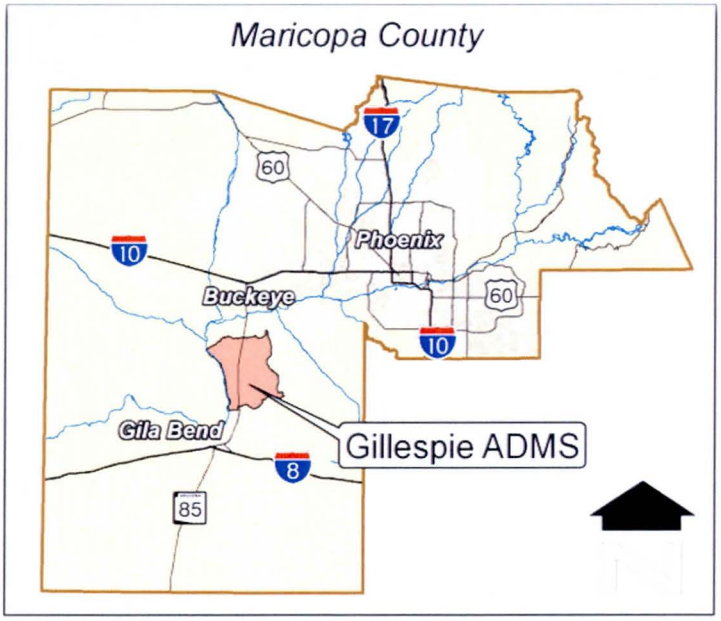


Figure 1 - Project Location Map

2.0 Erosion and Sedimentation Issues

2.1 METHODOLOGY

The approach to identifying potential sedimentation and erosion issue areas integrates information and data from project stakeholders, National Resource Conservation Services (NRCS), Arizona Geological Survey (AZGS), Desert Research Institute (DRI) and field visits. Through stakeholder meetings and personal interviews, sedimentation issues observed within drainage infrastructure operated by Woolsey Flood Protection District were obtained. Engineering and soil properties and soil unit descriptions published by the NRCS and geologic descriptions of the surficial geology developed by AZGS and DRI were evaluated to determine the composition and distribution of sediment deposits that would suggest an active and ongoing sedimentation and erosion process. Field visits were conducted to observe the physical condition of washes and drainage facilities and to gather evidence of erosion and sedimentation.

2.2 STAKEHOLDER INPUT

2.2.1 Significance

Gillespie ADMS project stakeholders include the Town of Buckeye, the Town of Gila Bend and the Woolsey Flood Protection District (WFPD). The Woolsey Flood Protection District conducts maintenance for select agricultural drainage infrastructure located within the project area. Through project progress meetings and WFPD board meetings, stakeholders were given the opportunity to relate their knowledge of flooding, erosion and sedimentation within the project area. Members of the WFPD, given their history of farming in the area and effort in protecting agricultural property from flooding, provided firsthand knowledge of flood, erosion and sedimentation hazards. The towns of Buckeye and Gila Bend recently annexed areas within the project area and have yet to gain firsthand knowledge concerning flood hazards in the area.

Project team members met with the WFPD to discuss drainage issues within the project area. Drainage, erosion and sedimentation issues discussed are listed below. Locations of specific issue areas are depicted on Plate 3.

- Sedimentation within drainage facilities has been an issue.
- There are potential sediment and drainage issues at the Upper Woods Wash crossing of Old US 80. Channel alignment is at a bad angle to roadway alignment.
- There are sediment issues in the ADOT Channel where it bends to the northwest directing flow to Siphon #4 and Layton Wash.
    - WFPD has been maintaining sediment accumulation in the ADOT Channel (where the channel bends to northwest).
- Vegetation issues (in regard to blocking flow) have been identified in the Paloma Lift Station Wash and reaches of Carmichael Wash.
- Gila Bend Canal issues:
    - Sedimentation occurs upstream of the Gila Bend Canal.
    - Drains (siphon condition) conveying stormwater flows beneath the canal have filled with sediment.

- Historically the Gila Bend Canal has been overtopped by storm water and failure has occurred.
    - At locations along the west bank the canal bank has been lowered to facilitate a control breach.
        - Drainage channels such as John's Wash and Woods Road Wash commence at potential breach locations or at locations where there is a drainage pipe beneath the canal.
- There used to be a constriction of the canal at the Woods Road crossing that would result in a backwater condition that caused overtopping of the canal.
- There have been issues with culvert crossings beneath the canal. Culverts have collapsed, presumably facilitating seepage that ultimately led to an embankment failure.
    - The most recent failure was south of the De Jong Dairy (out of the project area).
- There were several embankment failures near De Jong Dairy before the canal was lined.
- There is a culvert on the east side of the canal, near the northeast corner of the De Jong Dairy that does not extend completely beneath the canal. This may be a potential failure mode for the canal.

- ADOT SR 85 Drainage Structures
    - The north-south reach of the SR 85 Channel #1 is experiencing sedimentation.
        - Failure of the gabion drop structures in the east-west segment of the SR 85 Channel has been observed.

2.3 NRCS SOILS SURVEYS

2.3.1 Significance

NRCS soil data provides descriptions of soil characteristics, an interpretation for the landform type, properties and qualities of soil units, and a typical soil profile for each soil map unit. The type and distribution of soil units and associated characteristics can be used to aid in the evaluation and identification of potential sediment issue areas. Soil properties of particular interest in regard to sedimentation are erosion factors. An erosion factor indicates the susceptibility of a soil to sheet and rill erosion by water. Erosion factors range in value from 0.02 to 0.55 for soils within the project area. The higher the value, the more susceptible the soil is to sheet and rill erosion by water (NRCS. May 1997). Natural and constructed channels within and/or downstream of areas where the erosion factor is high, may have a potential for aggradation if the channel does not have the capacity to convey the sediment load delivered to the channel. In areas where the erodibility of the soil is low the sediment delivered to channels may not be sufficient to establish sediment equilibrium and channel degradation could occur.

Soil erosion factors for the project area were reviewed to identify areas that may be interpreted to be prone to sediment and erosion issues. Erosion factors were grouped into low, moderate and high categories to facilitate the evaluation. Soil units with erosion factors that ranged in value between 0 and 0.2 were assigned to a low erodibility category, values between 0.25 and 0.4 were assigned to a moderate category and values that fall between 0.4 or greater were assigned a high category. These ranges are consistent with values cited in the *Technical Guide to RUSLE use in Michigan*, NRCS-USDA State Office of Michigan (NRCS-USDA State Office of Michigan, 2001). Some of the soil map units within the project area are mapped as a complex,

containing two or more soil types that may have different erosion factors. NRCS Erosion factors listed in Appendix A of the River Mechanics Manual for DDMSW (FCDMC, April 2010) were utilized in the evaluation.

2.3.2 Conclusions

Plate 1, titled NRCS Erosion Factor Map depicts soil erosion factor categories, constructed channel locations, culverts, locations where the Gila Bend Canal is siphoned, embankments, Gila Bend Canal, GIS waypoint locations where field visits were conducted and key roadways within the project area. The map shows that a number of constructed channels are located in Moderate to High or High Erosion Factor areas. Drainage facilities located within these areas may be subject to sedimentation and erosion issues due to the high erodibility characteristics of the soil units. The sedimentation issue may be manifested by an accumulation of sediment within the facility, which was derived from a significant drainage area that was underlain by highly erodible soils. If a facility is constructed within highly erosive soils and not adequately armored or maintained, structural elements of the facility could be undermined leading to failure. Figure 2 depicts a gabion basket grade control structure that has failed due to erosion. Figure 3 depicts the banks of Rainbow Wash at a location where the soil erosion factor is high. The following constructed channels are located in Moderate to High Erosion Factor areas:

- SR85 Channel 1
- Lower Reach of Siphons 1 Wash
- Badley Wash
- Turner Draw
- Layton Wash
- Portions of Gila Bend Canal Channel reaches 2, 3, and 4
- Woods Road Wash
- John's Wash
- Paloma Lift Station Wash
- Lower Reaches of Upper Woods Wash

Figure 2 - Failure of a grade control structure due to erosion

Figure 3 - Rainbow Wash banks in highly erosive soils unit

A major drainage corridor within the project area is Rainbow Wash. The watershed draining to Rainbow Wash is underlain by soils with low, moderate, and high erosion factors. The majority of the watershed is underlain by soils with erosion factors that are in the upper low range. Based on the distribution and extent of soil erosion factor categories we postulate that there is a potential for significant sediment yield within Rainbow Wash, and that there is a potential for lateral migration of channel banks to occur, where banks are located in soil units with high erosion factors. Figure 4 depicts the accumulation of sediment and bed forms within Rainbow Wash.

Figure 4 - Sediment in Rainbow Wash

2.4 GEOLOGIC MAPPING

Detailed geologic mapping of portions of the Gillespie ADMS conducted by the Desert Research Institute (DRI) and the Arizona Geological Survey (AZGS) was used as a tool to help identify potential sediment issue areas. DRI mapped geologic units within the upper portion of the Rainbow Wash watershed. Their findings are published in a report titled *Terrain, Soils and Runoff Potential in the Rainbow Wash Watershed, Maricopa County, Arizona (DRI, February, 2010).* AZGS mapped surficial geology of portions of the Gillespie ADMS in support of alluvial fan evaluations conducted for the Gillespie ADMS. The results of their efforts are published in a report titled *Surficial Geology and Flood Hazards on the Western Piedmont of the Maricopa Mountains and the Southern Piedmont of the Buckeye Hills, Maricopa County, Arizona* (AZGS OFR-12-07/DGM-75, 2012) *by Jeri J. Young, Joseph P. Cook and Philip A. Pearthree.*

2.4.1 Significance

The type, distribution and age of geologic units underlying the project area can yield information for identifying potential sediment issue areas. Descriptions of geologic units include discussions concerning composition, soil development, and stability of a surface. Stable surfaces are characterized as older deposits with a developed soil horizon where rubification is evident and calcium carbonate coatings on clasts or calcium carbonate horizons are constituents of the soil profile. Typically a stable surface is covered with deposits of lag gravels that are varnished. Unstable surfaces are characterized by young deposits with poor soil development where rubification and calcium carbonate is absent or minor. Unstable surfaces are typically dissected by active washes. A stable or inactive surface is more resistant to the erosion process than unstable or active surfaces. Drainage facilities within and downstream of active unstable areas would be prone to sediment issues.

Geologic units described by DRI and AZGS have characteristics that are similar in composition and texture. The similar characteristics allow for a correlation between DRI and AZGS geologic units to be made. The Geologic units Qf3, Qf4 and Qf5 mapped by DRI are considered active unstable units based on composition and texture. These units correlate with the Holocene deposits mapped by AZGS. Characteristics of the geologic units Qf2, Qf1 and Older Alluvium mapped by DRI are similar to Pleistocene deposits mapped by AZGS. Characteristics of Holocene deposits such as weak soil development, lack of varnish on surface gravels, spatial association with active drainage channels and the presence of distributary channel networks are indicators of active areas where lateral migration of banks and aggradation are elements of the erosion and sedimentation process. Characteristics of Pleistocene deposits include well developed soil horizons with the presence of calcium carbonate, varnished surface gravels, and drainages with well incised channels that display a dendritic tributary drainage pattern. Due to the calcium carbonate accumulation and cementation, channel banks are resistant to lateral migration. Characteristics of Pleistocene deposits are indicators of areas that are more resistant to erosion than the Holocene deposits.

Geologic maps depicting the type and distribution of the geologic units are provided as Plate 2. Characteristics of the geologic units are described in unit descriptions prepared by DRI and AZGS. Descriptions of geologic units are:

DRI

Pediment: Pediment (QTpd) landform surfaces either have a thin veneer of loose and angular cobble- and gravel-sized clasts (lag) or they are devoid of a surface cover and are exposed with characteristics similar to Mountain Highland landforms. Slopes typically range from 1 to 15 percent.

Older Alluvium: Older alluvium (Qoa) landforms typically have surfaces that slope 0 to 15 percent, and slightly steeper slopes of up to 20 percent that lead to watercourses. The surface cover consists of a discontinuous lag deposit of gravels and cobbles that commonly forms a moderately- to strongly-developed desert pavement. Clasts at the surface are frequently varnished and occasionally have calcium carbonate coatings, implying that the original surface of the landform has been eroded and modified since deposition, but has remained relatively stable for considerable time since the last erosional event. The pavement is generally underlain by a silty Av horizon followed by a moderately rubified, cambic silty sand horizon.

Alluvial Fan (Qf1): Alluvial fan (Qf1) landforms typically have broadly rounded to flat upper interfluve surfaces that slope 0 to 10 percent, and slightly steeper slopes of up to 15 percent that lead to watercourses. Compared to younger alluvial fans in the watershed, these landforms are moderately dissected by incipient to well-formed watercourses and active washes. A discontinuous, thin veneer of tightly-packed subangular to angular cobble- and gravel-sized clasts forms a moderately- to strongly-developed desert pavement. This pavement is generally underlain by a silty Av horizon followed by a moderately rubified, cambic silty sand horizon.

Alluvial Fan (Qf2): Alluvial fan (Qf2) landforms typically have flat surfaces that slope 0 to 2 percent and have a thin veneer of loosely-packed subangular to angular small cobble- and gravel-sized clasts that form a weakly-developed desert pavement. This pavement is generally underlain by a thin, silty Av horizon followed by a weakly rubified, cambic silty sand horizon. These alluvial fans are weakly dissected by shallowly incised active washes.

Alluvial Fan (Qf3): Alluvial fan (Qf3) landforms typically have surfaces that slope 0 to 2 percent and have a discontinuous surface lag of subangular to angular, small to medium gravel-sized clasts. The soil has no Av horizon and exhibits minimal rubification and structure. The alluvial fans exhibit incipient dissection from active washes.

Alluvial Terrace (Qf4): The alluvial terrace (Qf4) landforms typically have surfaces that slope 0 to 1 percent, have a discontinuous lag of subangular to angular small gravel-sized clasts, and exhibit moderately- to well-formed bar-and-swale microtopography. The alluvial terraces are associated with the active floodplain and are commonly dissected and crossed by alluvial washes. Soils on these units are poorly formed with weak platy structure.

Active Wash (Qf5): Active wash (Qf5) landforms are relatively narrow, sinuous features having surfaces that typically slope 0 to 10 percent. The surface cover consists of loose sand, gravels, and/or cobbles and there is no soil development.

AZGS

Holocene Deposits

Qyc – Active channel deposits; light gray, moderately to poorly sorted, unconsolidated sand, pebbles and cobbles, locally with small boulders in channels and bars of larger

washes; lightly vegetated except along channel margins; both tributary and distributary channels are mapped separately from surrounding deposits where large enough to delineate at mapping scale.

Surface roughness: low to moderate; generally low vegetation size and density except along margins, channels relatively smooth, but bed roughness varies with particle size

Infiltration potential: moderate to high.

Qy3 – Smaller channel, bar, and low terrace deposits that are part of the active drainage system; channel and bar deposits typically consist of light gray, poorly sorted sand and pebbles, with some cobbles and boulders; terraces typically are less than 3 feet above adjacent active channels and consist of similar deposits, but typically are partially or totally mantled by sand and silt; deposits of this unit have no soil development and the associated vegetation consists of bursage, creosote, palo verde, iron Woods, and mesquite.

Surface roughness: moderate to high; relatively high vegetation density outside channels; variable local topography

Infiltration potential: moderate to high.

Qy2 – Low terrace deposits along larger channels; typically at least 3 feet above active channels and not laterally extensive; deposits consist of moderately sorted sand, pebbles and cobbles, and are commonly capped by sand and silt deposits; surface gravel is not varnished and soil development is very weak, with no clay accumulation and weak carbonate accumulation; associated vegetation includes mostly creosote with some palo verde, iron Woods and mesquite.

Surface roughness: moderate; vegetation generally small, medium density; variable particle size

Infiltration potential: moderate to high.

Qya – Laterally extensive young alluvial fan or sheet flood deposits; surfaces are light gray to brown in color; deposits are very poorly to poorly sorted sand, pebbles, cobbles and rare boulders; channels are incised less than 5 feet and typically much less than that; weakly integrated networks of very small distributary channels are common; soil development is very weak with no clay accumulation and minimal carbonate accumulation; Qya units are dominated by creosote with some small shrubs and desert trees such as palo verde and mesquite.

Surface roughness: moderate; vegetation generally small, low to medium density, coppice mounds around bushes; variable particle size, but surface gravel generally limited

Infiltration potential: moderate.

Pleistocene Deposits

Qy1 – Intermediate terrace deposits along channels and inactive portions of alluvial fans; surfaces are at least 3 feet above adjacent channels; deposits consist of poorly to moderately sorted silt, sand, pebbles, and cobbles, with some small boulders; gravel clasts on Qy1 surfaces are generally unvarnished or weakly varnished; gravel bar and swale deposits are about 1 foot high; soil development is weak, with incipient calcium carbonate accumulation; Qy1 surfaces are dominated by creosote.

Surface roughness: medium; vegetation generally small, medium density; variable particle size; smooth to gently undulating local topography

Infiltration potential: moderate.

Qiy – Pleistocene alluvial fan deposits that have been substantially eroded or partially buried by younger deposits; some areas retain characteristics of Pleistocene relict surfaces, such as gravel surface lags and moderate soil development, but in other areas these characteristics have been modified by erosion or partially obscured by younger deposits; this unit designation is applied to areas where the spatial relationships between Pleistocene and younger deposits are complex, and topographic relief between surfaces of different ages is a few feet or less.

Surface roughness: medium; vegetation generally small, low density; areas partially covered by gravel; gently undulating local topography

Infiltration potential: moderate to low.

Qi3 – Lightly to moderately dissected relict alluvial fan and terrace deposits; deposits consist of poorly sorted sand, pebbles, cobbles, and silt, with some small boulders and clay; gravel clasts on Qi3 surfaces are weakly to moderately varnished; pavements, where present, vary from weak to moderate; surfaces are generally fairly smooth between incised drainages, which are up to about 6 ft deep; soil development is weak to moderate, with visible calcium carbonate accumulation; Qi3 surfaces are typically lightly vegetated, with small trees along incised drainages and sparse creosote bushes on planar surfaces.

Surface roughness: medium; vegetation generally small, low density; surfaces typically partially covered by gravel; smooth local topography

Infiltration potential: low.

Qi2 – Moderately dissected relict alluvial fan and terrace deposits; deposits consist of poorly sorted sand, pebbles, cobbles, and silt, with some small boulders and clay; gravel clasts on Qi2 surfaces are vary from darkly to lightly varnished; pavements vary from weak to moderately strong; surfaces are generally fairly smooth between incised drainages, which are up to about 10 ft deep; soil development is moderate, with visible calcium carbonate accumulation; Qi2 surfaces are typically lightly vegetated, with small trees along incised drainages and sparse creosote bushes on planar surfaces.

Surface roughness: medium; vegetation generally small, low density; surfaces typically partially covered by gravel; smooth local topography

Infiltration potential: low.

Qi1 – Eroded relict alluvial fans; deposits consist of poorly sorted pebbles, cobbles, sand and silt, with some small boulders and clay; varnish on gravel clasts is variable, from darkly varnished to weakly varnished; pavements vary from weak to strong depending on preservation; surfaces are generally rounded, and planar remnants between incised drainages up to 30 ft deep; soil development is strong, with abundant calcium carbonate accumulation and some cementation; Qi1 surfaces are typically lightly vegetated, with small trees along incised drainages and sparse creosote bushes on rounded surfaces.

Surface roughness: medium; vegetation generally small, low density; surfaces typically covered by gravel

Infiltration potential: low.

Qi – Undifferentiated Pleistocene alluvial fan and terrace deposits;

QTa – Deeply dissected relict alluvial fans deposits; consist of moderately cohesive sand and gravel with no preservation of the original surface capping alluvial surface; soil development is variable as a result of erosion;

Other units

Qtc – Hillslope colluvium; designated only near bedrock hills.

R – Bedrock, undivided; this unit includes granitic rocks and metamorphic rocks such as gneiss; also includes areas covered by colluvium.

2.4.2 Conclusions

Some of the surficial geologic units underlying the project area display characteristics that are a function of active erosion and sedimentation processes. Characteristics of Holocene deposits such as weak soil development, lack of varnish on surface gravels, spatial association with active drainage channels and the presence of distributary channel networks are indicators of active areas where lateral migration of banks and aggradation are elements of the erosion and sedimentation process. Characteristics of Pleistocene deposits include well developed soil horizons with the presence of calcium carbonate, varnished surface gravels, and drainages with well incised channels that display a dendritic tributary drainage pattern. Due to the calcium carbonate accumulation and cementation channel bank are not as prone to lateral migration as channels with no cementation. Pleistocene geologic units define areas that are inactive, stable areas, where flood and erosion hazards are more predictable than in active unstable areas.

Plate 2, titled Surficial Geology depicts surficial geologic units, locations of constructed channels, culvert locations, locations where the Gila Bend Canal is siphoned, embankments, Gila Bend Canal, key roadways and areas considered to be inactive or active erosion and sedimentation areas based on surficial geology. Sediment yield from active erosion and sedimentation areas would be greater than what might be expected from inactive areas. Drainage facilities located within or downstream of active areas would have a higher potential for the development of sedimentation and erosion issues than facilities located within inactive stable areas. Facilities located in active areas would require a higher degree of inspection and maintenance.

2.5 FIELD INVESTIGATIONS

2.5.1 Significance

Field investigations were conducted to identify active or incipient sedimentation problem areas within the existing drainage network. Potential sediment problem areas that were typical to field investigations include:

- areas of abnormal sediment production such as disturbed land or denuded land surfaces
- areas experiencing local erosion
- areas of local sediment deposition

- watercourses exhibiting streambed aggradation or degradation
- watercourses with banks that are susceptible to lateral migration

The results from evaluations of NRCS soil data and geologic mapping were used to identify potential sediment issue areas where field investigation would be conducted. These areas include areas with natural watercourses and roadway and agricultural drainage facilities. Descriptions of drainage facilities detailing the type and location of the facility, observed evidence of scour or deposition, density of vegetation and conveyance capacity limitations are provided in following sections. Representative photos of drainage facilities are provided in Appendix B. Plate 1 depicts the locations where field visits were conducted to observe the physical characteristics of a facility. The locations are identified by a number which corresponds to a GIS waypoint.

2.5.2 Existing Drainage Network

The existing drainage network consists of natural washes and constructed drainage facilities. Drainage facilities are comprised of constructed channels, embankments that delineate stormwater runoff to a facility and drainage structures that convey runoff across roadways and the Gila Bend Canal. Washes drain runoff from the Buckeye Hills and the Maricopa Mountains to drainage facilities or to Rainbow Wash. Stormwater runoff collected in drainage facilities drain to the Gila Bend Canal, Rainbow Wash or to the Gila River. Runoff concentrated up stream of the Gila Bend Canal drains laterally behind the canal to six openings in the canal where it outfalls to a drainage facility. Plates 1, 2 and 3 depict the location of drainage facilities within the project area.

2.5.2.1 Washes

Washes within the project area typically display two drainage patterns, tributary dendritic and distributary. Dendritic patterns form in areas where the subsurface geology has similar resistance to weathering. Channels forming the dendritic pattern are typically well incised and convey runoff and sediment delivered to the channel. A distributary pattern is formed when a wash bifurcates and multiple channels branch off from the main channel joining adjacent channels or rejoining the main channel downstream. Due to the changes in hydraulic conditions between the main channel and downstream branches sedimentation in the form of aggradation takes place thus decreasing flood conveyance. Flood hazards and erosion hazards associated with distributary systems are less predictable than those associated with a tributary dentritic system.

2.5.2.1.1 Tributary Flow Areas

Flood hazards in areas where the drainage pattern is tributary are easily predictable because channels are typically single thread channels that are well incised, channel banks are stable in regards to lateral migration, evidence of channel bifurcations and channel avulsions is typically not present and channels have sediment transport capacity to convey sediment that is delivered to the channel. Channels are typically in a state of dynamic equilibrium where sediment and erosion issues would not be present or issues would be limited to specific areas. Figure 5 depicts a typical tributary drainage pattern in the Gillespie ADMS project area. Figure 6 is a picture of a channel with a tributary drainage pattern.

Figure 5 - Tributary flow pattern

Figure 6 - Incised tributary channel

2.5.2.1.2 Distributary

Flood hazards in areas where the drainage pattern is distributary are harder to define than in areas defined by tributary drainage patterns because the erosion and sedimentation process is dynamic and variable. The process is variable because the hydraulic and sediment transport conditions are constantly changing. Channel geometry is typically ill defined and variable with channel bifurcations, avulsions and lateral migration occurring throughout a reach. Because of these characteristics sediment and erosion issues are expected in areas where distributary flow patterns are prevalent. Figure 7- depicts a typical distributary flow pattern within the Maricopa Mountains. Figure 8 and 9 depicts typical characteristics of distributary channels.

Damage to property located in distributary flow areas can occur both by flooding and erosion. The natural characteristics of distributary flow deem themselves as problematic to development.

Characteristics of distributary flow areas cited in State Standard SS 4-95, *(January 1995) Identification of and Development within Sheet Flow Areas*, are presented as the first order bullets listed below. Subordinate bullets list significance of the subject presented in the first order bullet.

- A significant amount of the flow is not conveyed in well-defined channels but as overland flow.
    - Greater area of sediment source due to the surface area of overland flow.
- Shallow bands of flow (sheet flow) occur between faster bands of concentrated flow (streams).
    - Promotes deposition of wash load in sheet flow areas.
- Sheet flows over poorly vegetated areas often have the ability to transport large sediment particles over long distances.
- Sheet flooding has markedly different hydraulic characteristics for sediment-laden and sediment-deprived flows.
    - In areas where the flow is sediment laden aggradation would occur as sediment transport decreases due to loss of flow volume as sheet flooding expands over greater areas.
    - In areas where sediment deprived flow occurs, channel avulsions and head cutting could occur.
- Significant loss of flow volume may occur during sheet flooding due to infiltration and other abstractions.
    - Promotes aggradation.
- Sheet flow often enters a larger channel of a drainage system that intersects its flow, but occasionally dissipates due to infiltration or other loss mechanisms before reaching a channel.
    - Promotes aggradation.
- Very poorly-defined channels downstream of a relatively large drainage area.
    - In these areas channel characteristics indicated that there is a high potential for lateral migration, stream bifurcation, channel avulsions and aggradation.

2.5.2.1.3 Conclusions

Plate 3, titled Flooding and Drainage issues, depicts wash thalwegs provided by the District, locations of constructed channels, culvert locations, locations where the Gila Bend Canal is siphoned, embankments, Gila Bend Canal, key roadways and distributary flow areas. Wash thalwegs that display a distributary flow pattern were highlighted to identify areas where channels are subject to bifurcations, split flow, avulsions and lateral migration. These areas would be prone to sedimentation and erosion issues.

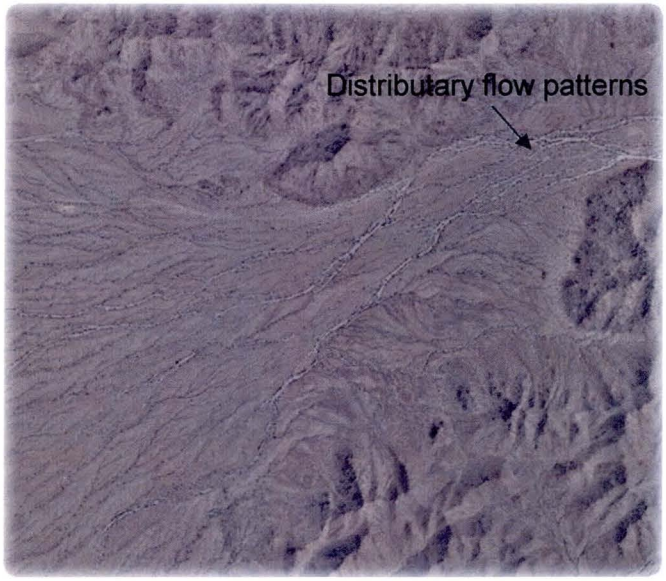


Figure 7 - Distributary flow pattern

Figure 8 - Typical distributary channel

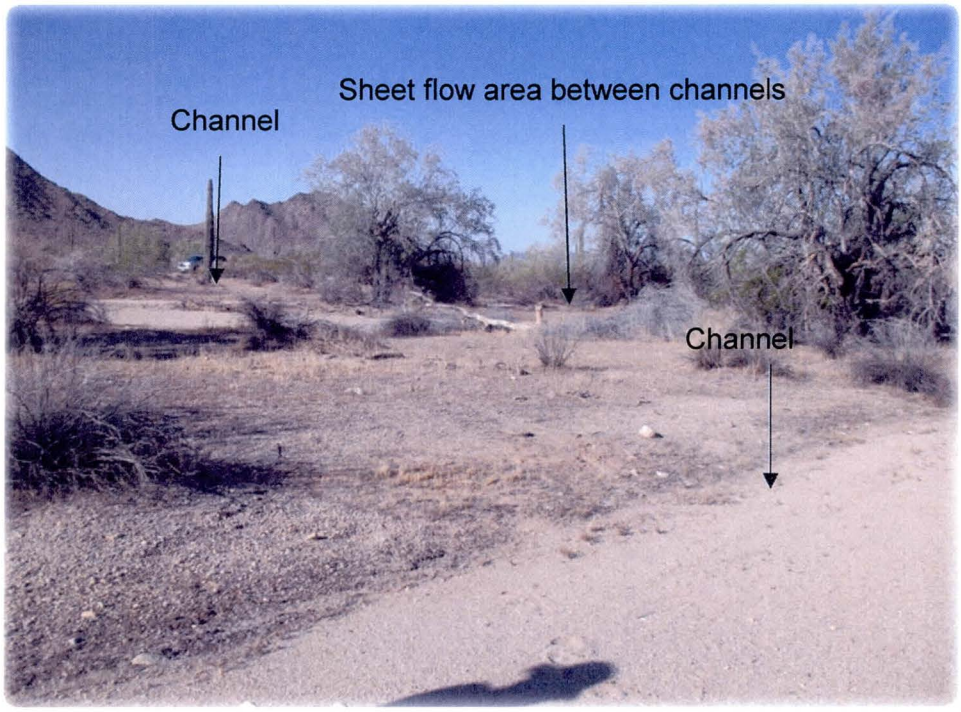


Figure 9 - Sheet flow area between distributary channels.

2.5.3 Drainage Facilities

Drainage facilities within the project area include engineered channels, non-engineered channels, embankments and culvert structures. Descriptions and locations of the facility are discussed in the following sections.

2.5.3.1 Engineered Channels

Engineered channels within the project area were designed as part of an Arizona Department of Transportation (ADOT) project or a City of Phoenix (COP) project. As part of the SR 85 construction project, channels were constructed on the east side of SR 85 to collect runoff draining from the Maricopa Mountains. Collected runoff is drained to culvert structures. Runoff conveyed by the culvert structures drains to natural washes or constructed channels. The COP has constructed the Layton Wash Channel and a portion of the channel network that will outfall to Layton Wash. The COP channels collect runoff from their landfill site. Channels that are considered engineered channels include, SR 85 Channel 1, SR 85 Channel 2 and Layton Wash (Figure 10). Characteristics of engineered channels are listed in Table 1.

Figure 10 - Layton Wash (engineered channel)

2.5.3.2 Non-Engineered Channels

Non-Engineered channels within the project area are channels that were constructed to convey runoff around and/or away from agricultural areas and to convey flow to SR 85 culvert structures. Due to geometric variation in size and alignment the channels are considered non-engineered. Non-engineered channels typically have an embankment section (levee like) and an excavated section. Material excavated from the channel was placed on the down slope side of the channel. Non-Engineered channel drain runoff to Rainbow Wash, the Gila Bend Canal and the Gila River. Characteristics of Non-Engineered channels are listed in Table 2. Figure 11 Carmichael Wash Reach 1 is an example of a non-engineered channel.

Figure 11 - Carmichael Wash (non-engineered channel)

2.5.3.3 Embankments

Embankments in the project area are non-engineered and function to direct flow away from agricultural areas or to drainage corridors. Due to erosion adjacent to the embankments channels have formed. At the downstream terminus of the embankment runoff conveyed by the channel is no longer confined and begins to spreads out, losing its ability to convey sediment. There is an accumulation of sediment over a broad area near the end of the embankment. Embankments 2 (Figure 12) and 3 direct flow to Siphon #1 Wash. Embankment 1 directs flow away from Embankment 2.

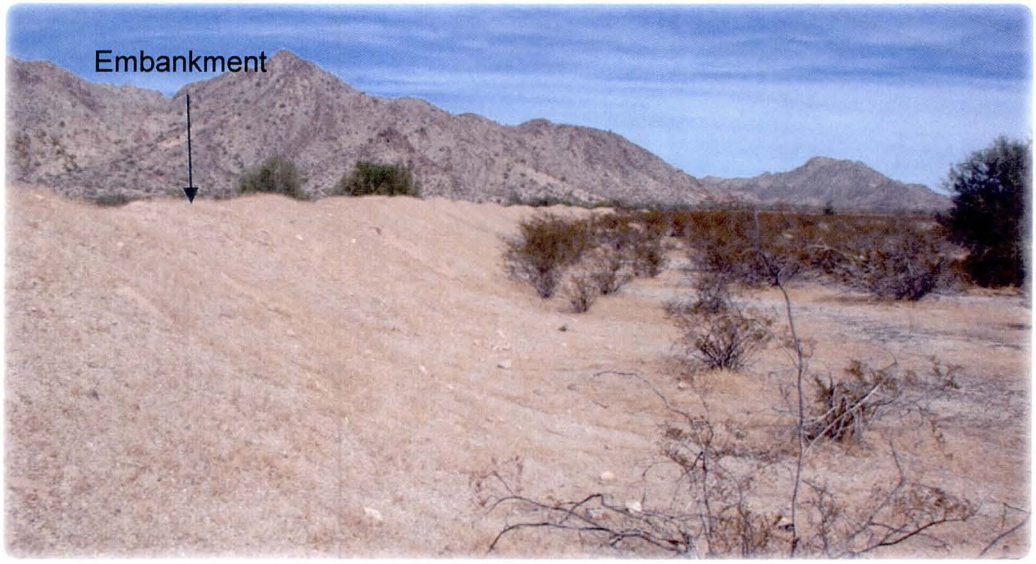


Figure 12 - Embankment 2

2.5.3.4 Culverts

Culverts are an integral element of a drainage network typically conveying runoff across roadways. A culvert's capacity to convey runoff is dependent on its size, available headwater depth, and the presence or absence of sediment and debris within the culvert. Observation of drainage culverts was conducted for the study area to determine if there were sedimentation or erosion issues. The observations were made in the field and through review of Project Engineering Consultants, Ltd. (PEC) report titled *Hydraulic Analysis of Culverts along SR85* that was prepared for the Gillespie ADMS project. Evidence that indicated that there are culvert sedimentation issues primarily occurred at culvert crossings of the Gila Bend Canal. Culvert locations where sediment was identified as an issue are highlighted on Plate 1 and 3. Figure 13 depicts minor erosion at the outlet of a culvert. Figure 14 depicts debris accumulation at a culvert structure.

Figure 13 - Erosion at outlet of culvert at Old US 80/Paloma Lift Station Wash

Figure 14 - Culvert at Old US 80/Paloma Lift Station Wash clogged with debris

Table 1-Engineered Channel Characteristics

Channel	Channel Characteristics	Occurrence of Vegetation	Capacity Limitations (observation)
SR 85 Channel 1 WP 81- WP 83	The SR 85 Channel 1 is an engineered trapezoidal channel consisting of two reaches. The north-south reach, extending from WP 81 to WP 83 is a collector channel that intercepts flow draining from the east. Channel depths vary from 2 to 4 feet. The top width of the channel averages approximately 100 feet. The east–west reach, extending from WP 22 to WP 33 conveys flow to Rainbow Wash. Eight grade control structures consisting of gabion mattresses and baskets have been constructed in the east-west reach. Channel depth varies from 6 to 8 feet and the channel top width varies from 90 to 110 feet. Side slopes of both reaches are armored with dump rip rap. The channel is located within moderately erosive soils. Extensive damage to grade control structures and rilling of side slopes from erosion was observed.	Sparse vegetation occurs within the channel.	Due to the extensive damage to the grade control structures the channel is not functioning as designed.
SR 85 Channel 2 WP 212	The SR 85 Channel 2 is an engineered trapezoidal channel that collects runoff draining from the east. Collected runoff is then conveyed to a box culvert at SR 85. The top width of the channel is approximately 50 feet. Channel depth varies from 5 to 8 feet. Channel side slopes and bottom are armored with gabion mattresses. The channel was recently been constructed. No sedimentation or erosion issues were observed.	Sparse vegetation.	No evidence of capacity limitations was observed.
Layton Wash WP 140 and WP 143	Layton Wash located between WP 143 and WP 140 is an engineered trapezoidal channel cut into highly erosive soils. The channel banks are lined with a gabion mattress. At locations gabion basket grade control structures have been provided. The bed is composed of silt and clay. Bank heights vary from 8 to 10 feet. The top width of the channel averages approximately 130 feet.	The channel is recently constructed and clean of vegetation	At the location where the channel outfalls to the Gila River the channel abruptly stops. Backwater from this abrupt transition will overtop channel banks.

Table 2-Non-Engineered Channel Characteristics

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Badley Wash Siphon # 2 To WP 20	Badley Wash is an excavated channel extending from Siphon # 2 to the Gila River. Channel bed material is composed of sand and gravels. Banks are primarily composed of firm soil. Channel bottom width varies from 20 to 60 feet with an average width of approximately 40 feet. Heights of banks vary from 6 to 10 feet and are near vertical in the northeast-southwest trending reach. In the north-south trending reach banks have been graded to a slope of approximately 3:1. Undermining of channel banks and bank sloughing has occurred. Channel banks have side slopes that are slightly to moderately sloughed or eroded. The lower reach is underlain by highly erosive soils.	Downstream of Siphon #2 to Old US 80, dense vegetation occurs along and between channel banks. Downstream of Old US 80 sparse to moderate vegetation occurs at the toe of banks, vegetation within the channel bottom is sparse. Vegetation primarily consists of desert shrubs and trees.	Channel capacity is limited at locations because of dense vegetation.
Carmichael Wash Reach 1 WP 41 to WP 40	This reach is characterized by an excavated and bermed earthen channel. The bermed embankment portion of the channel forms the south bank. The channel and banks are predominately composed of firm soil with varying amounts of caliche. Minor sand and gravels occur along the channel bed. Channel dimensions are irregular with the channel bottom width varying in dimensions from 20 to 30 feet. The height of the south bank is approximately 6 feet whereas the north bank height varies between 2 and 4 feet. The south bank is composed predominantly of fill material whereas the north bank has been cut into existing soil horizons. At locations channel banks are near vertical. Channel banks have side slopes that are slightly to moderately sloughed or eroded.	Density of vegetation along the banks and within the channel varies from sparse to dense. Vegetation type consists of grasses, shrubs and trees with trees and shrubs being the dominant type of vegetation. There is a significant amount of dead brush (tumble weeds) at locations within the channels.	Channel capacity will vary with channel bottom width and height. Channel capacity is limited at locations of dense vegetation.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Carmichael Wash Reach 2 WP 40 to WP 42	This reach is characterized by an excavated and bermed earthen channel. The bermed embankment portion of the channel forms the southeast bank. The channel and banks are predominately composed of firm soil with varying amounts of caliche. Sand and gravels occur along the channel bed. The channel bottom width is approximately 30 feet. The height of the south bank varies from 6 to 8 feet. The north bank height varies between 4 and 8 feet. The south bank is composed predominantly of fill material whereas the north bank has been cut into existing soil horizons. At location channel banks are near vertical. Channel banks have side slopes that are slightly to moderately sloughed or eroded. The channel out falls to a natural wash.	Density of vegetation along the toe of banks and within the channel varies from sparse to moderate. Vegetation type consists of grass-es, shrubs and trees with trees and shrubs being the dominant type of vegetation.	Channel capacity will vary with bank height.
Carmichael Wash Reach 3 WP 43 to WP 44	This reach is characterized by an excavated and bermed earthen channel. The bermed embankment portion of the channel forms the south bank. The channel and banks are predominately composed of firm soil with varying amounts of caliche. Sand and gravels occur along the channel bed. The channel bottom width varies from approximately 20 to 25 feet. The height of the south bank is approximately 6 feet. The north bank height varies between 2 and 4 feet. The south bank is composed predominantly of fill material whereas the north bank has been cut into existing soil horizons. At loca-tions channel banks are near vertical. Channel banks have side slopes that are slightly to moderately sloughed or eroded. The channel out falls to a natural wash.	Density of vegetation along banks varies from moderate to dense whereas vegeta-tion in the channel is sparse. Vegetation type consists of grasses, shrubs and trees with trees and shrubs being the dominant type of vegetation.	Channel capacity will vary with bank height.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Carmichael Wash Reach 4 WP 45 to WP 46	This reach is characterized by an excavated and bermed earthen channel. The bermed embankment portion of the channel forms the south bank. The channel and banks are predominately composed of firm soil with varying amounts of caliche. The channel bottom width varies from approximately 40 to 50 feet. The height of the south bank varies between 4 to 6 feet. The north bank height varies between 2 and 4 feet. The south bank is composed predominantly of fill material whereas the north bank has been cut into existing soil horizons. Channel banks have side slopes that are slightly to moderately sloughed or eroded. The channel out falls to the Lower Carmichael Wash Reach 5.	Density of vegetation along the banks and within the channel is very dense. The dominant vegetation type is Salt Cedar.	Channel capacity is limited because of the dense vegetation.
Carmichael Wash Reach 5 North of WP 46	This reach is characterized by an excavated earthen channel. The channel and banks are predominately composed of firm soil with varying amounts of caliche. Sand and gravels occur along the channel bed. The channel bottom width varies from approximately 20 to 25 feet. The height of the east and west banks varies between 2 and 4 feet. At locations channel banks are near vertical. Channel banks have side slopes that are slightly to moderately sloughed or eroded. Near WP 46 sediment has been deposited on top of flotsam suggesting the channel has had an aggradation event.	Density of vegetation along banks varies from moderate to dense whereas vegetation in the channel is sparse. Vegetation type consists of grasses, shrubs and trees with trees and shrubs being the dominant type of vegetation.	Channel capacity will vary with bank height.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Carmichael Wash Reach 5 Lower Reach (below WP 46)	This reach is characterized by an excavated earthen channel. The channel and banks are predominately composed of firm soil. Sand and gravels occur along the channel bed. The channel bottom width averages approximately 30 to 40 feet in width. The heights of the banks vary between 4 and 6 feet. Channel banks have side slopes that are slightly to moderately sloughed or eroded. The cannel out falls to Siphon #2.	Density of vegetation along the banks and within the channel is sparse to very dense. The dominant vegetation type is Salt Cedar.	Channel capacity is limited because of the dense vegetation.
West Prison Channel (WP 64 and 66)	This channel is characterized by an excavated and bermed earthen channel with the berm being located on the west side of the channel. The channel and banks are composed of firm soil with varying amounts of caliche. Silt, sand and minor amounts of gravel occur in the channel bed. The channel bottom width varies from 15 to 20 feet. The west bank height varies from 4 to 6 feet whereas the east bank height varies from 2 to 4 feet. At locations channel banks are near vertical. Channel banks have side slopes that are slightly to moderately sloughed or eroded. The channel outfalls to Rainbow Wash. Mud deposits occur upstream of the confluence with Rainbow Wash.	Density of vegetation along the banks and within the channel varies from sparse to moderate. Vegetation type consists of grasses, shrubs and trees with trees and shrubs being the dominant type of vegetation.	No apparent capacity limitations were observed.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Woods Road Wash Reach 1 WP150 to WP 151	This reach is characterized by an excavated and bermed earthen channel with the berm located on the north side of the channel. The channel and banks are composed of firm soil and gravels. Sand and gravels occur in the channel bed. The channel bottom width varies from 30 to 50 feet. The north bank height varies from 8 to 10 feet whereas the south bank varies from 6 to 8 feet. Channel banks have side slopes that are moderately to badly sloughed or eroded.	Sparse vegetation occurs along channel banks and bottom. Vegetation primarily consists of desert shrubs and trees.	Channel capacity will vary with channel bottom width and embankment height.
Woods Road Wash Reach 2 WP151 to WP 152	This reach is characterized by an ill-defined excavated and bermed earthen channel with the berm located on the west side of the channel. The channel and banks are composed of firm soil. Silt, sand and gravels occur in the channel bed. The channel bottom width varies from 30 to 40 feet. Bank heights vary from 1 to 2 feet. The channel is located in highly erosive soils.	Sparse vegetation occurs along channel banks and bottom. Vegetation primarily consists of desert shrubs and trees.	Channel capacity is significantly less than the upstream reach.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Woods Road Wash Reach 3 WP 152 to 153	This reach is characterized by an excavated earthen channel within the agricultural fields. The channel and banks are composed of firm soil. Silt and sand occur in the channel bottom. The channel bottom is approximately 20' in width. Bank heights vary from 2 to 4 feet. Channel banks have side slopes that are slightly sloughed or eroded. At locations of agricultural road crossings the channel is not continuous. This reach the channel is excavated into highly erosive soils.	Sparse vegetation occurs along channel banks and bottom. Vegetation primarily consists of weeds.	Due to the dimensions of the channel and the discontinuous nature, the channel has limited capacity to convey storm water runoff.
John's Wash Reach 1 Gila Bend Canal to WP 101	This reach is characterized by an excavated earthen channel. The channel and banks are composed of firm soil and gravels. Sand and gravels occur in the channel bed. The channel bottom width varies from 15 to 40 feet. The bank height varies from 6 to 12 feet. Channel banks have side slopes that are slightly sloughed or eroded.	Sparse vegetation occurs along channel banks and bottom. Vegetation primarily consists of desert shrubs and trees.	Channel capacity will vary with channel bottom width and height.
John's Wash Reach 2 WP 101 to 109	This reach is characterized by a V to trapezoidal shaped earthen channel within agricultural fields. The channel and banks are composed of firm soil. Silt and sand occur in the channel bottom. The channel bottom varies between 1 and 10 feet in width. Bank height varies from 2 to 4 feet. Channel banks have side slopes that are slightly sloughed or eroded. At locations of agricultural road crossings the channel is not continuous. In this reach the channel is excavated into highly erosive soils.	Vegetation appears to be maintained. Sparse vegetation occurs along channel banks and bottom. Vegetation primarily consists of weeds.	Due to the dimensions of the channel and the discontinuous nature, the channel has limited capacity. The capacity of Reach 1 far exceeds the capacity of Reach 2.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Paloma Lift Station Wash Reach 1 WP 102 to WP 105	This reach is characterized by an excavated /natural earthen channel that spills from the Gila Bend Canal. The upper reaches of the channel follows a natural channel alignment; however the channel appears to have been augmented by excavation. Reach 1 predominately parallels Old US 80. Channel bottom width varies from 5 to 80 feet. Bank heights vary from 10 to 12 feet. At locations, side slopes are sloughed and eroded. Inspection of aerial photographs and topography indicates that there has been an event resulting in bank lateral migration. The channel does not always have a positive grade. This could be due to a buildup of sediment at the confluence with the wash that drains Siphon # 5.	Vegetation along the banks and within the channel is very dense. The dominant vegetation type is Salt Cedar.	Channel capacity is limited because of the dense vegetation and lack of positive grade.
Paloma Lift Station Wash Reach 2 WP 105 to WP 117	This reach is characterized by a trapezoidal shaped earthen channel within agricultural fields. The channel banks are composed of loose soil and gravels. Course sand and gravels occur in the channel bottom. The channel bottom varies between 30 and 35 feet in width. Bank heights vary from 3 to 4 feet. Channel banks have side slopes that are slightly sloughed or eroded. At locations of agricultural road crossings the channel is not continuous. In this reach the channel is excavated into highly erosive soils.	Dense vegetation occurs along the banks. Sparse vegetation occurs in the channel bottom.	Vegetation along channel banks and variable bank height limits channel capacity.
Paloma Lift Station Wash Reach 3 WP 117 to WP114	This reach extends into the Gila River floodplain and is characterized by banks that are bermed embankments forming a trapezoidal section. Channel top width varies from 60 to 80 feet. Channel depths vary from 2 to 6 feet.	Dense vegetation occurs along the banks and channel bottom.	Vegetation and variable bank height limits channel capacity.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation/)
Upper Woods Wash (North-South Reach) WP 121 to WP 119	The north-south channel reach is a collector channel that intercepts flow from natural washes that drain runoff from the east. The west bank is composed of fill material that was placed to an average height of 9 feet above the invert of the channel. The height of the east bank is variable. At tributary confluences the invert of the channel meets the invert of the tributary. In the area between tributaries the bank is defined by the cut that was made in ridges that separate the tributaries. The east bank height varies from 0 to 10 feet. The width of the channel varies from 80 to120 feet. No notable scour or sedimentation was observed in the channel.	Sparse vegetation occurs within the channel.	No evidence in regard to capacity limitations was observed.
Upper Woods Wash (East–West Reach) WP 119 to WP 160	This reach of Upper Woods Wash is characterized by a trapezoidal channel cut into moderately to highly erodible soils. The banks of the reach upstream of Old US 80 in part are composed of fill material. The south bank upstream of Old US 80 forms a levee between the channel and agricultural fields. Bank heights vary from 8 to 10 feet. The top width of the channel varies from 80 to140 feet. No notable scour or sedimentation was observed in the channel. Piping has occurred in the levee section upstream of Old U.S. 80.	Sparse vegetation occurs within the channel.	No evidence in regard to capacity limitations was observed.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
ADOT Channel WP 219 to WP 98	The ADOT channel is an excavated and bermed earthen channel. The bermed embankment portion of the channel forms the northwest and north banks. The channel and banks are predominately composed of firm soil with varying amounts of caliche. The majority of the channel appears to have been cut into a cemented soil horizon. Sand and gravels occur along the channel bed. At WP 218 there is an accumulation of sediment. The sediment is from a tributary drainage area located east of WP 218. The channel top width varies from 30 to 80 feet. Bank heights vary from 2 to 10 feet. The lower portions of the northwest and north banks are cut into a cemented soil horizon. The embankment sections are composed of fill material excavated from the channel. The southeast and south banks have been cut into existing soil horizons. At locations channel banks are near vertical. Channel banks have side slopes that are slightly to moderately sloughed or eroded. Between WP 90 and WP 97 channel bed material transitions from a predominately cemented soil horizon to sand. Downstream of WP 97 (at the channel bend) the south bank appears to be composed completely of sand that has been removed from the channel. It appears that sedimentation at this location has been a maintenance issue. Based on the distribution of sand behind and to the west of the south bank, it appears that bank failure has historically occurred.	Moderate to sparse vegetation occurs along channel banks. The density of vegetation in the channels is sparse. Vegetation primarily consists of desert shrubs and trees.	Channel capacity will vary with channel bottom width and height. Channel capacity is limited at locations of dense vegetation. A potential failure mode exists downstream of WP 97 where the bank is composed of sand.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Siphon # 1 Channel WP191 to WP194	The Siphon # 1 Channel's appearance suggest it may be a natural channel however its straight alignment suggests that it was excavated. The channel drains runoff directed to it by Embankment #1 and Embankment #2. Approximately 600 feet upstream of WP 191 the channel depth is approximately 2 feet and the top width averages approximately 40 feet. Downstream of this location the depth ranges from 1 to 2 feet and the top width varies from 5 to 10 feet. The coarser sediment fraction dominated by sand and fine gravels observed in the upstream reaches is no longer present in the downstream reach. Silts, clays and sand dominate over sand and fine gravels. Bank caving is evident in the downstream reach.	Moderate to sparse vegetation occurs along channel banks. The density of vegetation in the channels is sparse. Vegetation primarily consists of desert shrubs, trees and grass.	Approximately half way between WP 188 and WP191 the channel loses capacity where there is a transition from predominately confined flow to predominately sheet flow.
Buckeye Mtn. Channel #1 WP 193 to Gila Bend Canal	The Buckeye Mountain Channel #1 is an excavated and bermed earthen channel with variable channel dimensions. The bermed embankment portion of the channel extends from WP 193 to approximately 1,300 feet to the west of WP 190. The embankment is off set from the main channel by approximately 20 feet and forms the south bank. The channel depth for the reach upstream of WP193 as measured from channel invert to toe of embankment ranges from 2 to 6 feet and the top width varies from 20 to 100 feet. The embankment height ranges from 2 to 4 feet. At a point approximately 1,300 feet downstream of WP 193 the channel is an excavated channel. Depths range from 2 to 6 feet and top widths vary from 30 to 50 feet. The channel out falls to the area upstream of the Gila Bend Canal.	Moderate to sparse vegetation occurs along channel banks. The density of vegetation in the channels is predominately sparse. Upstream of the Gila Bend Canal the density of the vegetation in the channel increases. Vegetation primarily consists of desert shrubs and trees.	Channel dimensions decrease in the downstream direction thus conveyance capacity decreases. At locations along the embankment the distribution of sediment downstream of the embankment suggest that historically the embankment has failed. Upstream of these locations are points of tributary inflow.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
SR 85 Channel 3 WP 228	The SR 85 Channel 3 is a trapezoidal channel cut into soil horizons with calcium carbonate accumulations. Channel top width varies from is 30 to 60 feet. Channel depth varies from 2 to 4 feet. At locations channels side slopes are sloughed and eroded. No sedimentation or erosion issues were observed.	Moderate to sparse vegetation occurs along channel banks. The density of vegetation in the channels is sparse. Vegetation primarily consists of desert shrubs and trees.	No evidence of capacity limitations was observed.
SR 85 Channel 4 WP 226	The SR 85 Channel 4 is a trapezoidal channel cut into soil horizons with calcium carbonate accumulations. Channel top width is approximately 30 feet. Channel depth varies from 5 to 6 feet. At locations channels side slopes are sloughed and eroded. No sedimentation or erosion issues were observed.	Moderate to sparse vegetation occurs along channel banks. The density of vegetation in the channels is sparse. Vegetation primarily consists of desert shrubs and trees.	No evidence of capacity limitations was observed.

Table 2-Non-Engineered Channel Characteristics Cont.

Channel	Channel Characteristics (WP= Waypoint Location, see Plate 1)	Occurrence of Vegetation	Capacity Limitations (observation)
Gila Bend Canal Channel Reaches 1, 2, 3, 4 and 5	Channels located adjacent and to the east of the Gila Bend Canal have been provided to drain flow to locations where the canal is siphoned below natural grade. The siphon locations provide an opening in the canal alignment for runoff to drain through. Channels are typically trapezoidal channels of varying depth and top width. At locations there is more than one channel. At these locations, channels parallel one another and appear to have been constructed at different time periods. Eventually the parallel channels join. Reaches 2, 3, and 4 are reaches where there are multiple channels. With the exception of Reach 1 runoff upstream of the canal within the channels and along the east embankment depending on depth of flow could drain either to the north or to the south to a siphon location. Runoff concentrated in Reach 1 drains to the Siphon #1 opening. Sediment in the size range of greater than sand was not observed indicating that wash load is the dominate size material being transported to the canal. The channels are cut into moderately to highly erosive soils. At locations bank sloughing and caving was observed.	With the exception of Reach 3 vegetation density in the channels is sparse to moderate. In Reach 3 irrigation tail water ponds within the drainage channel support dense vegetation.	No evidence of capacity limitations was observed.
Gila Bend Canal Channel Reach 6	The channel in Reach 6 is a trapezoidal shaped channel. The east embankment of the Gila Bend Canal is the west bank of the channel. The east bank has been excavated into a soil horizon with abundant calcium carbonate. The east bank is not continuous. It primarily occurs at locations where ridges that divide tributary drainage have been excavated to provide a continuous channel. Channel top width is approximately 40 feet. Channel depth as measured from top of canal embankment to channel invert varies from 10 to 18 feet. Channel bed material is typically fine silts and clays. There is a minor sand component at locations of tributary inflow. The areas immediately upstream of the canal and drainage channels paralleling the canal have been identified as Sediment Issue Areas on Plate 3.	Vegetation densities in the channel range from sparse to moderate.	No evidence of capacity limitations was observed.

2.5.3.5 Conclusions

Conclusions made from field observation are summarized in Table 3.

Table 3-Field Observation Summary

Drainage Facility	Sedimentation Issues	Erosion Issues	Potential Conveyance Issues	Comments
ADOT Channel	X	X	X	In the reach to the east of SR 85, sediment accumulation from tributary inflow was observed. Continued accumulation will limit the conveyance capacity of the channel. In the reach downstream of SR 85 at the location where the channel bends to the northwest an accumulation of sediment was observed. At this location the south bank is composed of sand and appears to have historically failed.
Badley Wash	X	X	X	Wash is located within highly erosive soils where banks have been undermined and bank sloughing has occurred adding sediment to the watercourse. At locations dense vegetation will limit conveyance capacity and promote aggradation.
Buckeye Mountain Channel #1	X	X	X	Channel dimensions decrease in the downstream direction thus conveyance capacity decreases. At locations along the embankment the distribution of sediment downstream of the embankment suggest that historically the embankment has failed. Upstream of these locations are points of tributary inflow.

Table 3-Field Observation Summary Continued

Drainage Facility	Sedimentation Issues	Erosion Issues	Potential Conveyance Issues	Comments
Carmichael Wash Reaches 1 through 4	X		X	Channel capacity will vary with channel bottom width and height. Channel capacity is limited at locations of dense vegetation. In areas of dense vegetation aggradation is expected to occur.
Carmichael Wash Reach 5	X	X	X	Aggradation in the reach located at the confluence with Reach 4 was observed.
Gila Bend Canal Channel Reaches 1 through 6	X		X	Channels appear to be maintained periodically. Bed material suggest that wash load (fine silts and clays) is the dominate component of the sediment load being transported to the canal channels. At locations of dense vegetation (Reach 3), conveyance capacity limitations would be expected. Runoff draining to the channels ponds behind the canal and can drain to the north or south to an opening in the canal located at canal siphon locations. Should runoff inflow be greater than channel conveyance capacity the canal would be overtopped creating a failure mode situation.

Table 3-Field Observation Summary Cont.

Drainage Facility	Sedimentation Issues	Erosion Issues	Potential Conveyance Issues	Comments
John's Wash			X	Reach 2 of John's Wash is located in highly erosive soils; however the reach through the farm fields appears to be maintained. Channel dimensions of Reach 2 are smaller than Reach 1 indicating capacity limitations for Reach 2. The drainage area draining to the wash is small and appears the main function of the wash is to provide drainage in the event of a breach of the Gila Bend Canal. A culvert (currently clogged) that was constructed to siphon flow beneath the Gila Bend Canal is located at the head waters of the wash.
Layton Wash				Layton Wash is a recently constructed channel and therefore no erosion or sedimentation issues where identified. However the lower portion of the wash is located in highly erosive soils, failure of grade control structures and bank protection may occur as was observed in SR 85 Channel 1.

Table 3-Field Observation Summary Cont.

Drainage Facility	Sedimentation Issues	Erosion Issues	Potential Conveyance Issues	Comments
Paloma Lift Station Wash	X		X	Paloma Lift Station Wash drains overflow from the Gila Bend Canal and runoff conveyed through the opening in the Gila Bend Canal at the location of Siphon # 5. The canal overflow supports the dense vegetation located along the reach. At locations of dense vegetation channel aggradation would be expected. Due to the variable channel geometry, conveyance capacity decreases in a downstream direction. Minor erosion was observed at the Old US 80 Culvert outlet.
Siphon #1 Wash	X	X	X	Channel capacity diminishes where there is a transition from predominately confined flow to predominately sheet flow upstream of the Gila Bend Canal. Channel bank caving, in the reach upstream of the canal was observed. Sediment drops out of the main channel at the transition to sheet flow.
SR 85 Channel 1	X	X	X	Bank rill erosion contributes to the sediment load delivered to the channel. Channel armoring and grade control structures have failed due to erosion.
SR 85 Channel 2				SR 85 Channel 2, is a recently constructed channel, no sediment and erosion issues were identified.
SR 85 Channel 3 and 4				No apparent capacity limitations due to sedimentation, erosion or vegetation were observed.

Table 3-Field Observation Summary Cont.

Drainage Facility	Sedimentation Issues	Erosion Issues	Potential Conveyance Issues	Comments
Upper Woods Wash		X		The wash is a constructed channel and appears that vegetation maintenance has occurred. The channel is not armored and the reach below Old US 80 is underlain by highly erosive soils. Erosion of side slopes should be expected in this area. Just upstream of Old US 80 piping of the south bank was observed.
West Prison Channel				No apparent capacity limitations due to sedimentation, erosion or vegetation were observed.
Woods Road Wash			X	Due to variable channel dimensions and the discontinuous nature of the channel, the channel has limited capacity to convey storm water runoff. The drainage area draining to the wash is small and appears the main function of the wash is to provide drainage in the event of a breach of the Gila Bend Canal. A culvert (currently clogged) that was constructed to siphon flow beneath the Gila Bend Canal is located at the head waters of the wash.

2.6 CONCLUSIONS AND RECOMMENDATIONS

Based on the review of soils data and surficial geology and observations made during field investigations, potential sediment and erosion issue areas can be grouped into four categories. Issues associated with distributary flow, issues associated with Rainbow Wash, issues associ-

ated with non-engineered and engineered channels and issues associated with embankments. The following sections summarize identified issues and recommendations for additional studies.

2.6.1 Distributary Flow Areas

Distributary flow areas are highlighted in yellow on Plate 3; occur within the Buckeye Hills, and valleys and alluvial plains of the Maricopa Mountains. Distributary flow areas are characterized by shallow channels with ill-defined banks and channel bifurcations. These characteristics are similar to characteristics associated with alluvial fan flood hazards. Distributary flow areas are primarily located within the Sonoran Desert National Monument, on Bureau of Land Management property and within Gillespie ADMS Alluvial Fan study areas.

We recommend that no additional sediment analyses in addition to evaluations listed in the base scope are required in distributary flow area for the following reasons:

- The distribution of the majority of distributary flow areas are located in areas that will not be developed (Sonoran Desert National Monument) or the potential for development is low (BLM property).
    - Due to low population density and/or public use, flood hazard risk would be considered low.
    - Currently there are no development plans that would result in a physical change to the watershed that would result in an increase in flood hazard risk.
    - Sedimentation and sediment characteristics in the alluvial fan studies area will be addressed in those studies.

2.6.2 Rainbow Wash

Evaluation results indicated that the Rainbow Wash sub-watershed is underlain predominately by low to highly erosive soils indicating that Rainbow Wash potentially could be subject to significant sediment yields and that there may be a potential for lateral migration in areas where the soil erodibility factor is high. Sediment yield, sediment capacity, total scour and lateral migration evaluations for the reach of Rainbow Wash commencing at the Gila River and extending upstream to SR 85 have been provided in the base scope of work. Upon review of the results of these studies additional studies may be recommended, however at this time no additional evaluations are recommended.

2.6.3 Non-Engineered and Engineered Channels

Potential sediment and erosion issue areas identified for the Non-Engineered and Engineered Channels are:

- ADOT Channel
    - In the vicinity of Waypoint 218 sediment accumulation within the ADOT channel was identified from field observations and inferred from interpretation of surficial geologic units. To the west of Waypoint 97 it appears that excess sediment within the channel has been used to form the south bank. We have also noted that the distribution of sediment on the surface to the west and southwest of the south bank indicates that the bank has failed in the past. We recommend that sediment yield, and total scour analyses be conducted for reaches of the ADOT channel. Sediment yield and sediment transport capacity should be conducted in the vicinity of Waypoints 218 and 97. Total scour evaluations should be con-

ducted in the area where the channel bends to the northwest, downstream of Waypoint 97. In the event that the Woolsey Flood Protection District desires to improve the ADOT Channel total scour analyses are recommended. Sediment yield evaluation would aid in determining the frequency of inspection and maintenance activity.

- Carmichael Wash
  - Conveyance capacity limitations were identified for Reach 4 due to the density of vegetation within the channel. Dense vegetation decreases sediment transport capacity thus promoting aggradation. The issues associated with dense vegetation can be mitigated through maintenance; therefore no additional hydraulic or river mechanics evaluations are recommended for this reach.
  - Sediment accumulation was observed in Reach 5 in the vicinity of Waypoint 46. As with Reach 4 dense vegetation occurs along the banks of Reach 5. Because some sediment accumulation was noted in the channel we recommend that sediment yield and sediment transport capacity evaluations be conducted for Reach 5.
- West Prison Channel
  - No apparent capacity limitations due to sedimentation, erosions or vegetation were observed. No additional analyses specific to river mechanics are recommended at this time however should development occur upstream or downstream of the channel additional river mechanic evaluations are recommended.
- SR 85 Channel 1
  - Erosion issues leading to failure of grade control structures and bank armoring were observed. These issues may be related to construction or due to soil conditions which would indicate that geotechnical evaluations may have not been conducted for the design. It is recommended that the Arizona Department of Transportation be made aware of the condition of the channel. A total scour analysis is recommended should the facility be redesigned.
- SR 85 Channel 2
  - SR 85 Channel 2 is a newly constructed channel, no sediment or erosion issues have been observed. No additional analyses specific to river mechanics are recommended.
- SR 85 Channels 3 and 4
  - No sediment or erosion issues have been observed for SR 85 Channels 3 and 4. No additional analyses specific to river mechanics are recommended.
- Gila Bend Canal
  - Stakeholders related that historically there have been issues with sedimentation and overtopping of the canal in runoff events. Due to the inflow of runoff the canal has breached in the past. No significant sediment issues were identified during field visit, however this may be due to maintenance activity. Since the canal functions as a dam we are recommending that sediment yield evaluations be conducted for each reach of the canal channel within the project area to establish sediment yield impacts. Should development be proposed in areas downstream of the canal an embankment breach analysis should be conducted to define potential flood hazard areas associated with a canal embankment failure.
- Channels in Agricultural Areas
  - Through the review of NRCS soils data it was determined that the lower reaches of Layton Wash, Woods Road Wash, John's Wash, Paloma Lift Station Wash

and Upper Woods Wash are located within soils characterized as moderate to highly erosive. No significant issues with sedimentation or erosion were identified from observations made during field investigations. The lack of anecdotal evidence may be due to maintenance activities and/or age of the facility. Layton Wash has recently been constructed and may have not experienced a significant runoff event.

- Woods Road Wash and John's Wash have very small contributing drainage areas. Headwaters of the channels are at the Gila Bend Canal. Thirty inch diameter steel culverts at the headwaters of Woods Road Wash and John's Wash have been provided to siphon flow ponding on the east side of the canal to downstream drainage facilities. The culverts are 100% clogged.
    - Channel capacity is variable due to variable channel geometry and at locations density of vegetation restricts flow.
    - Additional river mechanics evaluations are not recommended under the Gillespie ADMS project because it appears that the channels have not been designed for a particular peak discharge but have been constructed based on historical experience of runoff events and breaches of the Gila Bend Canal. Should improvements be recommended for these drainage facilities a total scour analyses should be conducted.
    - It is recommended that the Woolsey Flood Protection District be made aware of the culvert condition and channel capacity limitations.
    - Final project recommendations will include design considerations to be evaluated for channel improvements such as a breach analysis of the Gila Bend Canal to establish peak discharge for design, total scour and sediment evaluations.
- Layton Wash is a recently constructed engineered channel. No additional river mechanic evaluations are recommended at this time.
- Paloma Lift Station Wash is operated and maintained by Paloma Irrigation and Drainage District. Conveyance capacity limitations were identified through field observations. The width and depth of the channel decreases in a downstream direction. The conveyance capacity of the channel is limited due to dense vegetation and downstream channel geometry. Diminished flow capacity will promote aggradation. The issues associated with dense vegetation can be mitigated through maintenance; therefore no additional hydraulic or river mechanics evaluations are recommended for this reach. Final project recommendations should include maintenance, operations and design considerations for improving the channel conveyance capacity.
- Upper Woods Wash watershed in part lies outside of the Gillespie ADMS project area. Hydrologic models developed for the Gillespie ADMS area do not cover the entire drainage area contributing flow to the channel; therefore no additional river mechanics evaluations are recommended.

- Buckeye Mountain Channel #1.
    - Channel dimensions decrease in the downstream direction thus conveyance capacity decreases. At locations along the embankment section of the channel the

embankment has failed. Upstream of these locations are points of tributary inflow. Final project recommendations should include maintenance, design considerations for improving the channel conveyance capacity. Suggested river mechanics evaluations will be included in the recommended design considerations.

- Siphon #1 Wash
  - Channel capacity diminishes where there is a transition from predominately confined flow to predominately sheet flow upstream of the Gila Bend Canal. Channel bank caving, in the reach upstream of the canal was observed. Sediment drops out of the main channel at the transition to sheet flow. Final project recommendations should include maintenance, design considerations for improving the channel conveyance capacity. River mechanics evaluations (total scour) will be included in the recommended design considerations.
- Badley Wash
  - Badley Wash is located within highly erosive soils where banks have been undermined and bank sloughing has occurred adding sediment to the watercourse. If improvements are proposed for Badley Wash, it is recommended that a total scour evaluation be conducted.

2.6.4 Embankments

Embankments in the project area are non-engineered and function to direct flow away from agricultural areas or to drainage corridors. Due to erosion adjacent to the embankments, channels have formed. Should improvements be recommended for these drainage facilities a total scour analyses should be conducted. If development is proposed in areas downstream of the embankment, an embankment breach analysis should be conducted to determine design peak discharge and potential flood hazard areas.

2.6.5 Summary Table

The recommended additional study evaluations are summarized in Table 4. Recommendations are grouped into two categories. One category are evaluations recommended to be conducted as part of the Gillespie ADMS and the other category are evaluations that are recommend to be conducted as part of a maintenance plan, or channel improvement project or as part of a development plan that encroaches on a drainage facility. Sediment yield evaluations conducted as part of the Gillespie ADMS are watershed wide evaluations and cover all the listed drainage facilities whether recommended or not. Sediment yield evaluation is an important tool that can be used to understand the risk of failure of drainage facilities due to sediment deposition. Moreover, it can aid in identifying the necessary upgrades and required maintenance to ensure the future functioning of these facilities. Development pressure, type and locations will drive the need and timing of future evaluations. Drainage facilities listed in the table are depicted on Plate 3.

Table 4 - Summary of Recommended Evaluations

Drainage Facilities	Recommended evaluations to be conducted as part of the Gillespie ADMS.			Recommended evaluations to be conducted as part of a maintenance, channel improvement or development project[1].		
	Total Scour	Sediment Yield Evaluations	Lateral Migration Analyses	Total Scour	Lateral Migration Analyses	Embankment Breach Analyses
Natural Washes						
Distributary Flow/Sheet Flow Areas		X			X	
Rainbow Wash		X			X	
Engineered Channels						
SR 85 Channel 1				X[2]		
SR 85 Channel 2				X		
SR 85 Channel 3				X		
SR 85 Channel 4						
Layton Wash						
Non-Engineered Channels						
ADOT Channel		X		X		X
Carmichael Wash		X		X		X
Gila Bend Canal		X		X		X
Buckeye Mountain Channel #1		X		X		X
Siphon #1 Wash		X		X		
Badley Wash		X		X		
West Prison Channel		X		X		X
Agricultural Channels downstream of Gila Bend Canal						
Woods Road Wash		X		X		
John's Wash		X		X		
Paloma Lift Station Wash		X		X		
Upper Woods Wash		X		X	X	X
Embankments						
Embankment 1		X		X		X
Embankment 2		X		X		X
Embankment 3		X		X		X

1) Additional analyses to be conducted by parties maintaining the drainage facility or parties developing property adjacent to the facility.

2) A total scour analyses should be conducted when a repair design for failed drop structures is implemented.

3.0 References

Arizona Department of Water Resources, January 1995, State Standards for Floodplain Management, SS4-95.

Arizona Geological Survey, (AZGS OFR-12-07/DGM-75, 2012), Surficial Geology and Flood Hazards on the Western Piedmont of the Maricopa Mountains and the Southern Piedmont of the Buckeye Hills, Maricopa County, Arizona by Jeri J. Young, Joseph P. Cook and Philip A. Pearthree.

Desert Research Institute, February 2010, *Terrain Soils and Runoff Potential in the Rainbow Wash Watershed, Maricopa County, Arizona*

National Resource Conservation Service, May, 1997, Soil Survey of Gila Bend-Ajo Area, Arizona, Parts of Maricopa and Pima Counties.

NRCS-USDA State Office of Michigan, 2001 *Technical Guide to RUSLE use in Michigan*. Retrieved August 13, 2012 from http://www.iwr.msu.edu/rusle/kfactor.htm.

Appendix A

Sediment Study Areas Task Description

3.6.1 Identify Sediment Study Areas

The CONSULTANT shall recommend areas to study for sediment transport, scour, deposition, lateral migration, and other river mechanics issues as appropriate to achieve the goals and objectives of the ADMS. The following data/information shall be utilized to identify Sediment Study Areas.

3.6.1.1 Stakeholders Input

Obtain input from project stakeholders that are aware of sediment problem areas.

3.6.1.2 Soil Maps

Review soil maps to identify areas with soils that are susceptible to accelerated erosion.

3.6.1.3 Geologic Maps

Review geologic maps to identify landforms that may be conducive to increased surface erosion.

3.6.1.4 Field Reconnaissance

Conduct field reconnaissance to identify active or incipient sedimentation problem areas;

- *Areas of abnormal sediment production such as disturbed land or denuded land surfaces.*
- *Flow concentration points experiencing local erosion.*
- *Zones of sediment deposition.*
- *Watercourses exhibiting streambed aggradation or degradation.*
- *Watercourses with banks that are susceptible to lateral migration.*
- *Collect sediment samples*

3.6.1.5 Sediment Study Area Memorandum

Prepare a watershed map and memorandum that identifies active and incipient sedimentation problem areas, documents the current sedimentation conditions at each, and tabulates critical sedimentation locations. The memorandum shall provide detailed recommendations of sediment analyses that are proposed for the Gillespie ADMS. The CONSULTANT shall provide an outline of the report/memo to the DISTRICT for review and approval.

Apendix B
Field Photographs

Appendix B.1

ADOT Channel

ADOT Channel Looking upstream from WP 219

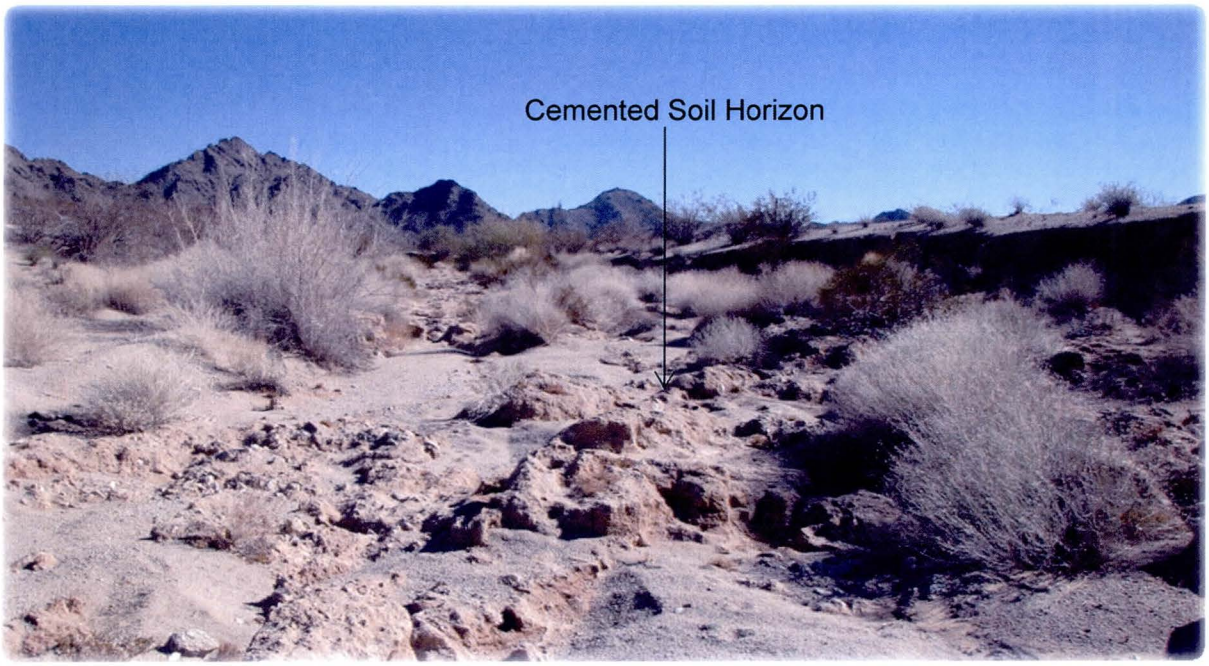
ADOT Channel Looking downstream from WP 219

ADOT Channel bed Material at WP 219

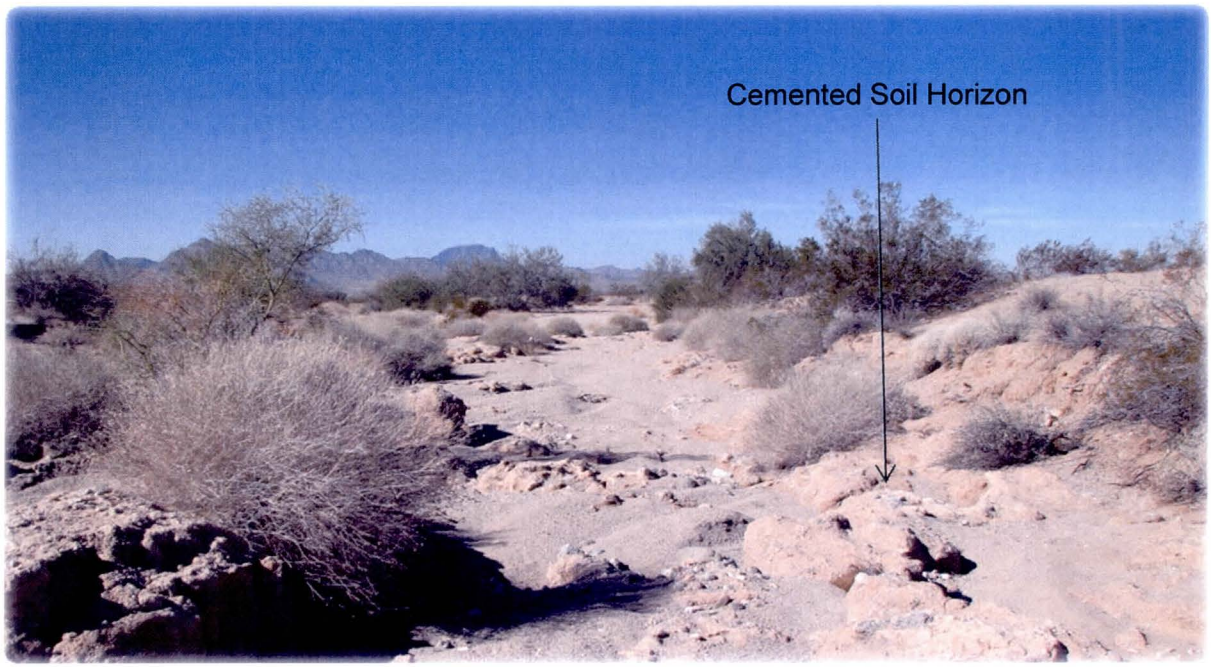
ADOT Channel Looking downstream from WP 218

ADOT Channel Looking upstream from WP 218

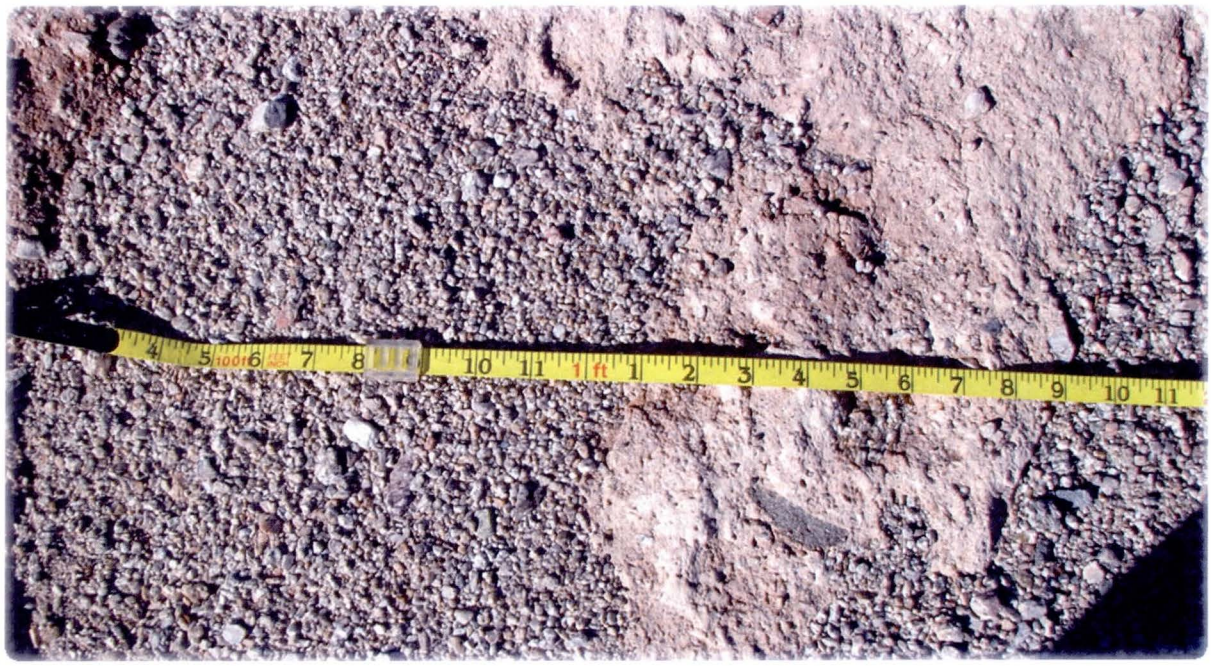
ADOT Channel bed Material at WP 218



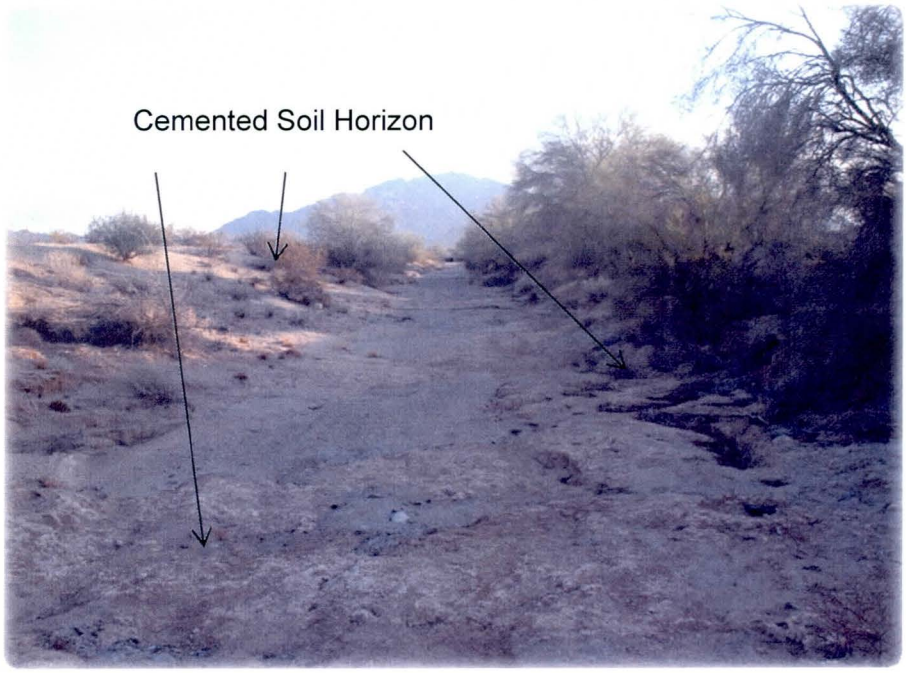
ADOT Channel Looking upstream from WP 215



ADOT Channel Looking downstream from WP 215

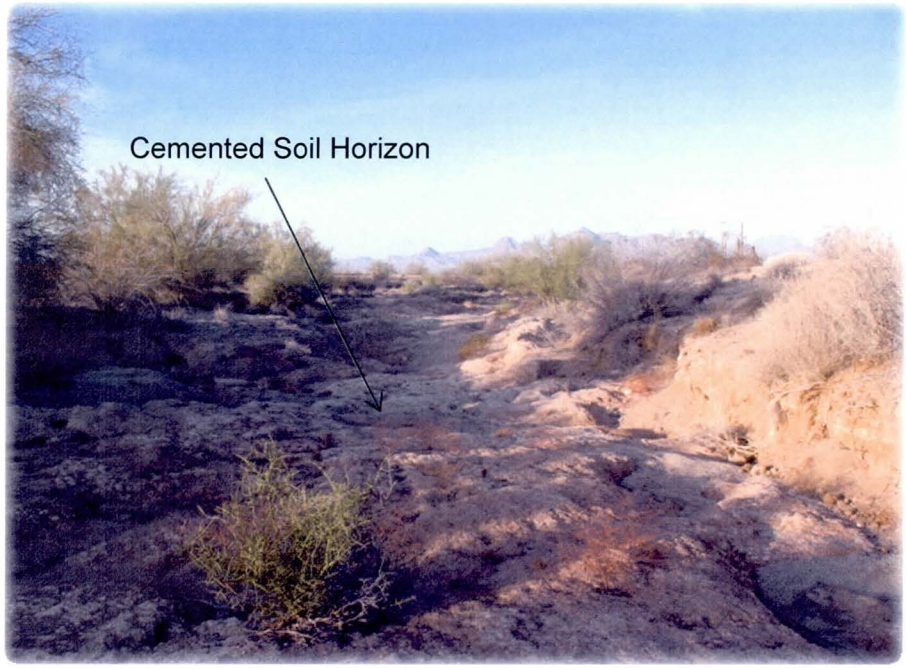


Bed material (cemented soil horizon) at WP 215

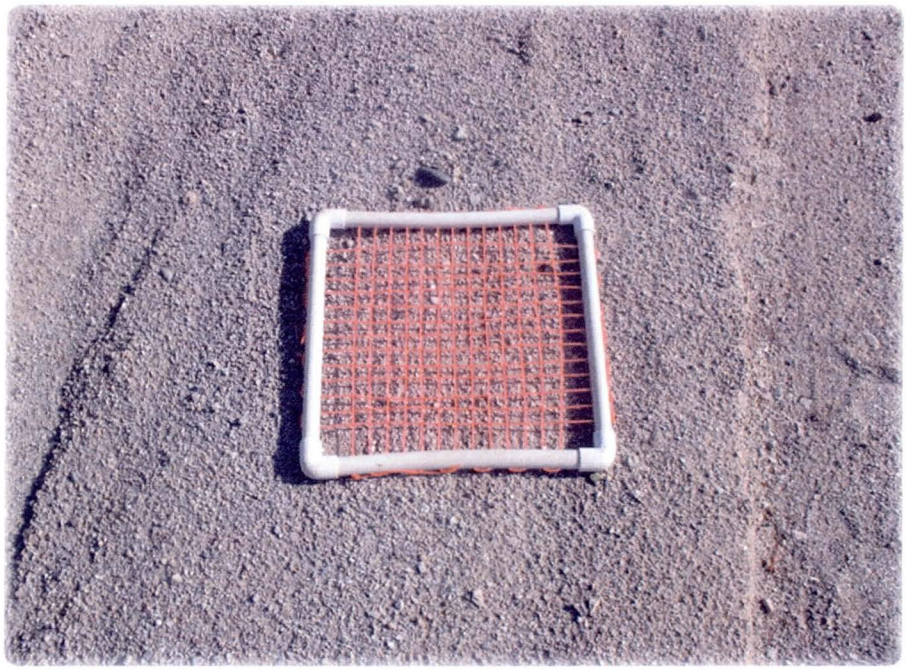


ADOT Channel Looking upstream from WP 90

Bed material (cemented soil horizon) at WP 90

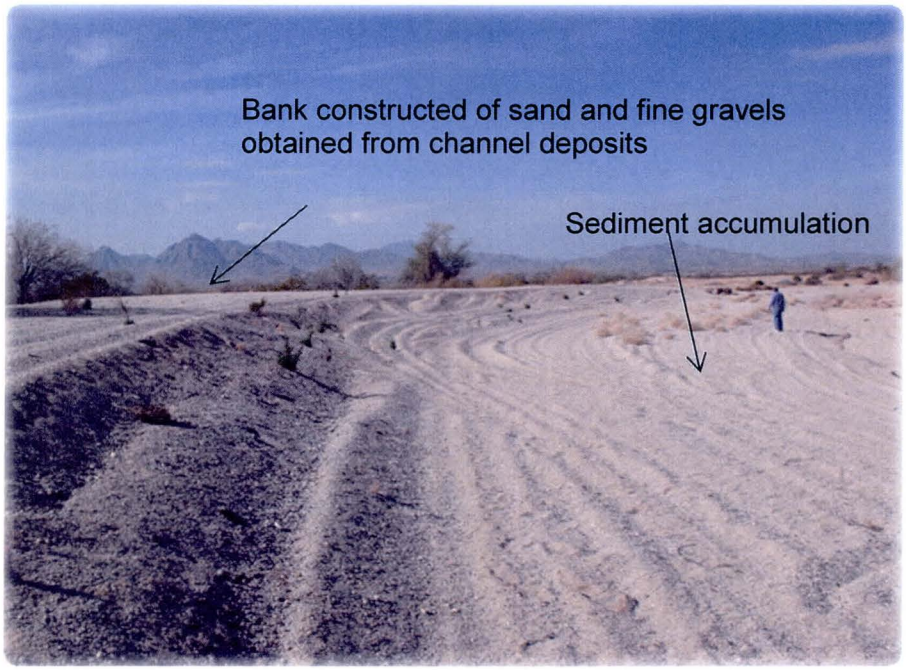


ADOT Channel Looking downstream from WP 90



ADOT Channel bed material at WP 97

ADOT Channel looking downstream from WP 97



ADOT Channel- Sediment accumulation downstream of WP 97

Appendix B.2

Badley Channel

Badley Wash downstream of Siphon #2 (WP 16)

Badley Wash bed material at WP 16

Badley Wash looking upstream of WP 18

Badley Wash looking upstream of WP 19

Badley Wash looking downstream of WP 19

Badley Wash bed material at WP 19

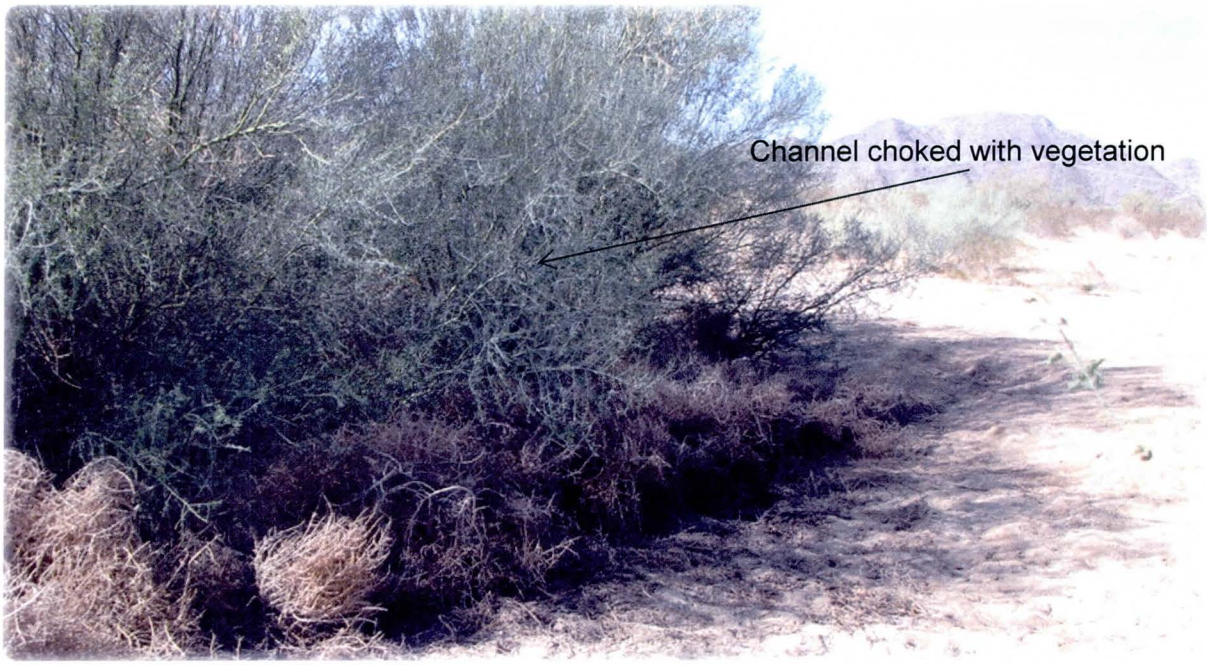
Badley Wash looking upstream of WP 20

Badley Wash looking downstream of WP 20

Badley Wash bed material at WP 20

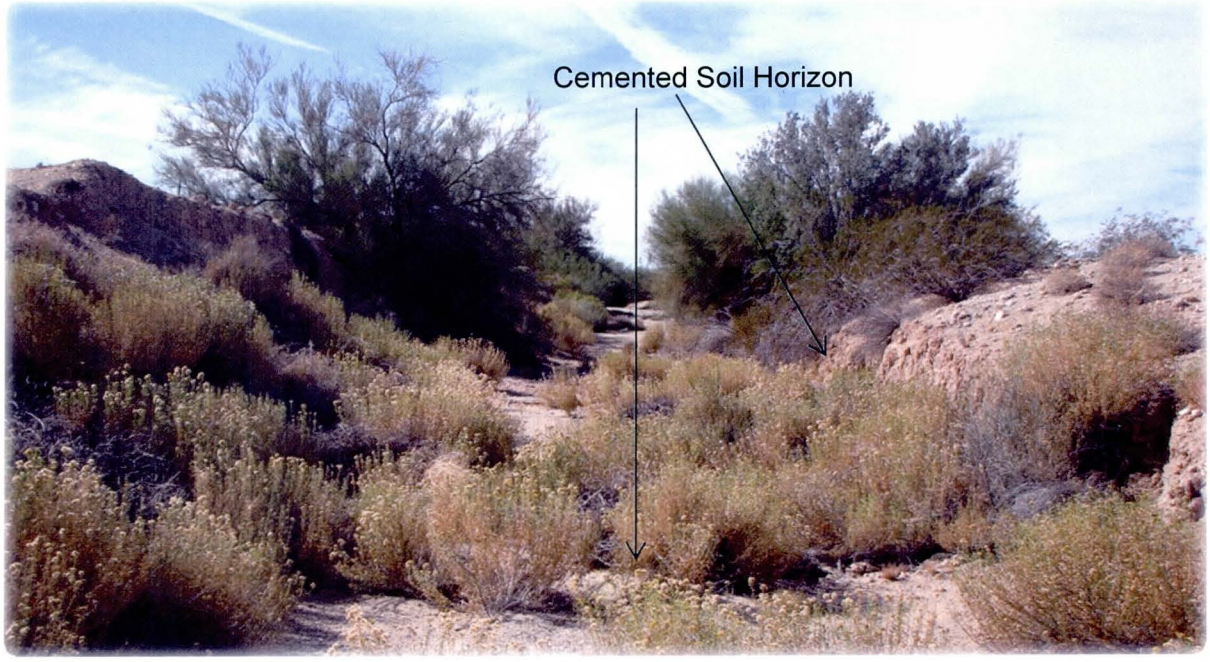
Appendix B.3

Carmichael Wash



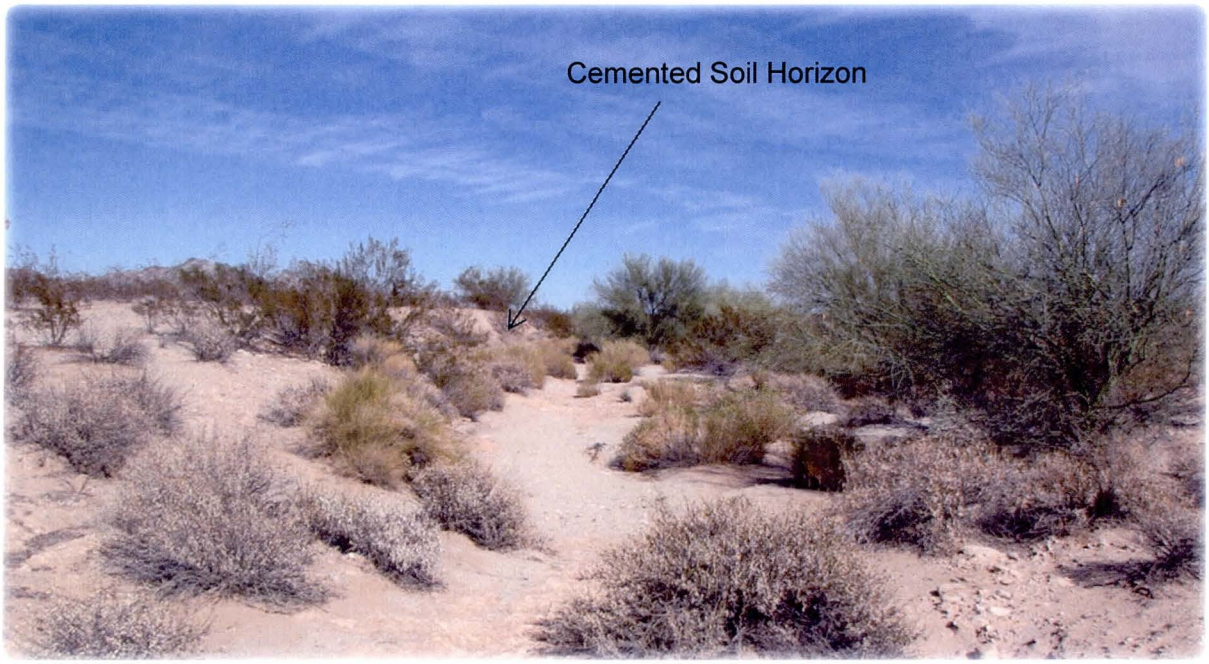
Carmichael Wash at WP 41

Carmichael Wash looking upstream from WP 40

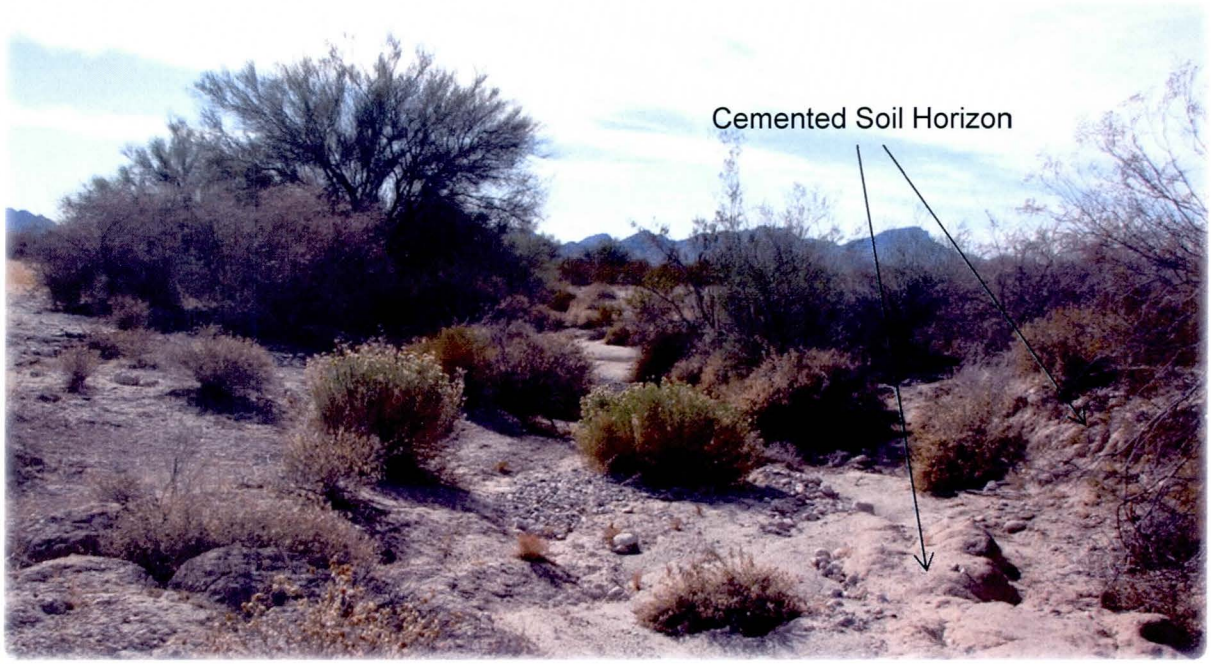


Carmichael Wash looking downstream from WP 40

Carmichael Wash bed material at WP 40 (sediment deposits on cemented soil horizon)



Carmichael Wash looking upstream from WP 42



Carmichael Wash looking downstream from WP 42

Carmichael Wash bed material at WP 42

Carmichael Wash looking upstream from WP 44

Carmichael Wash looking downstream from WP 44

Carmichael Wash bed material at WP 44

Carmichael Wash looking downstream from WP 45

Carmichael Wash looking to the east (east-west segment) upstream from WP 46

Carmichael Wash looking to the west (east-west segment) downstream from WP 46

Carmichael Wash looking to south (north-south segment) downstream from WP 46 (point in the north - south reach)

Carmichael Wash looking bed material at WP 46

Carmichael Wash looking to north upstream (north-south segment) from WP 46 (point in the north - south reach)

Carmichael Wash looking to south, downstream (north-south segment) from WP 46 (point in the north - south reach)

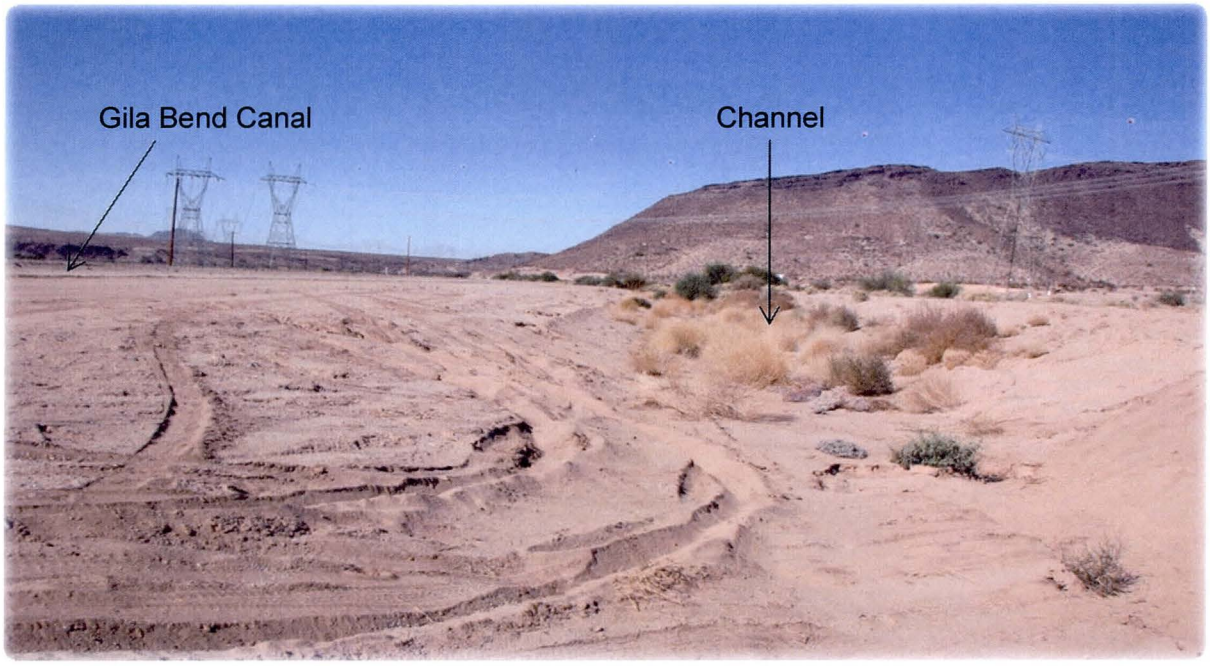
Carmichael Wash looking upstream from WP 47

Carmichael Wash looking downstream from WP 47

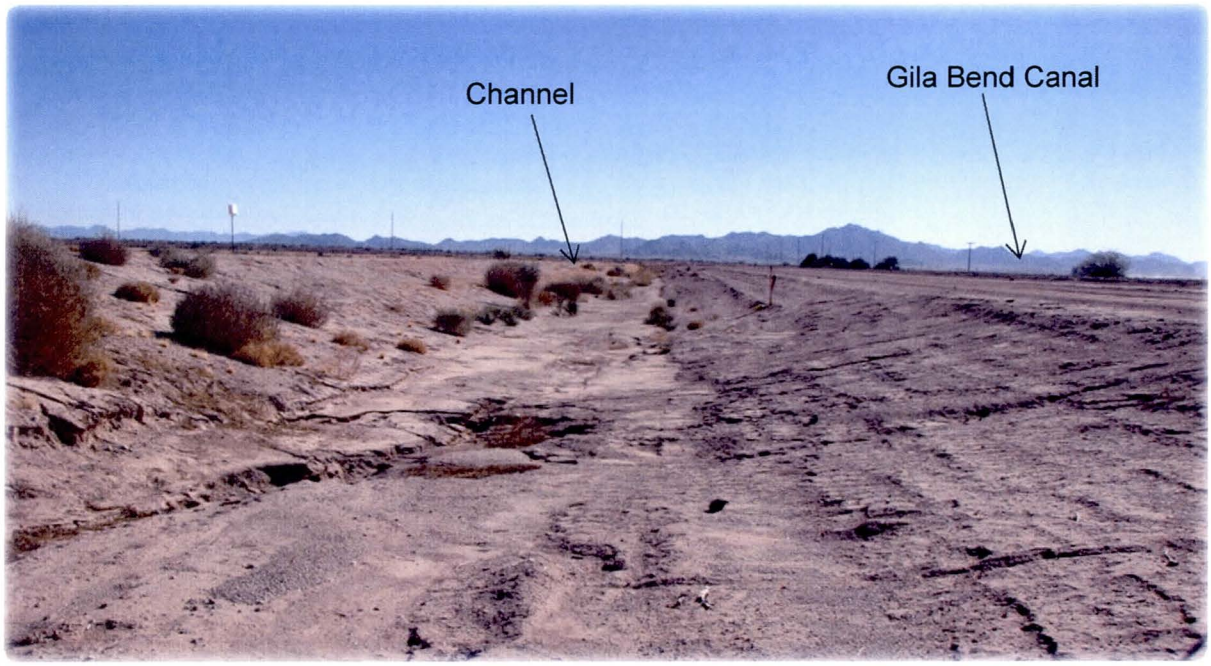
Carmichael Wash bed material at WP 47

Appendix B.4.1

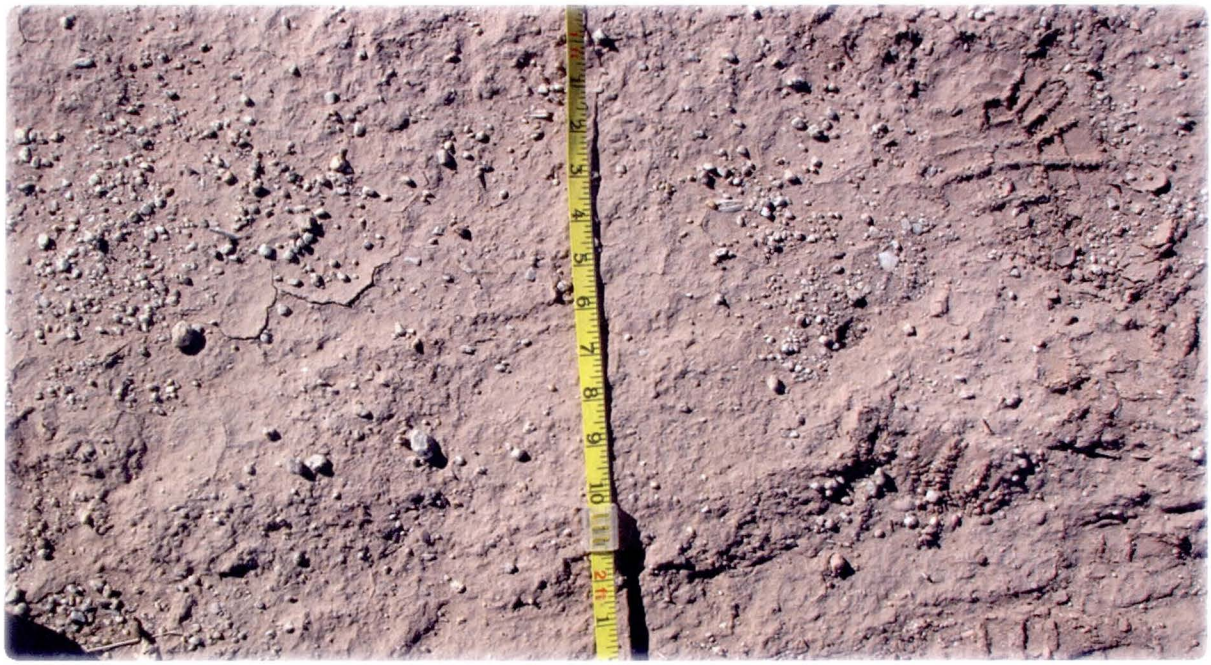
Gila Bend Canal Channel Reach 1



Channel adjacent to the Gila Bend Canal (looking upstream of WP 57)



Channel adjacent to the Gila Bend Canal looking (downstream of WP 57)

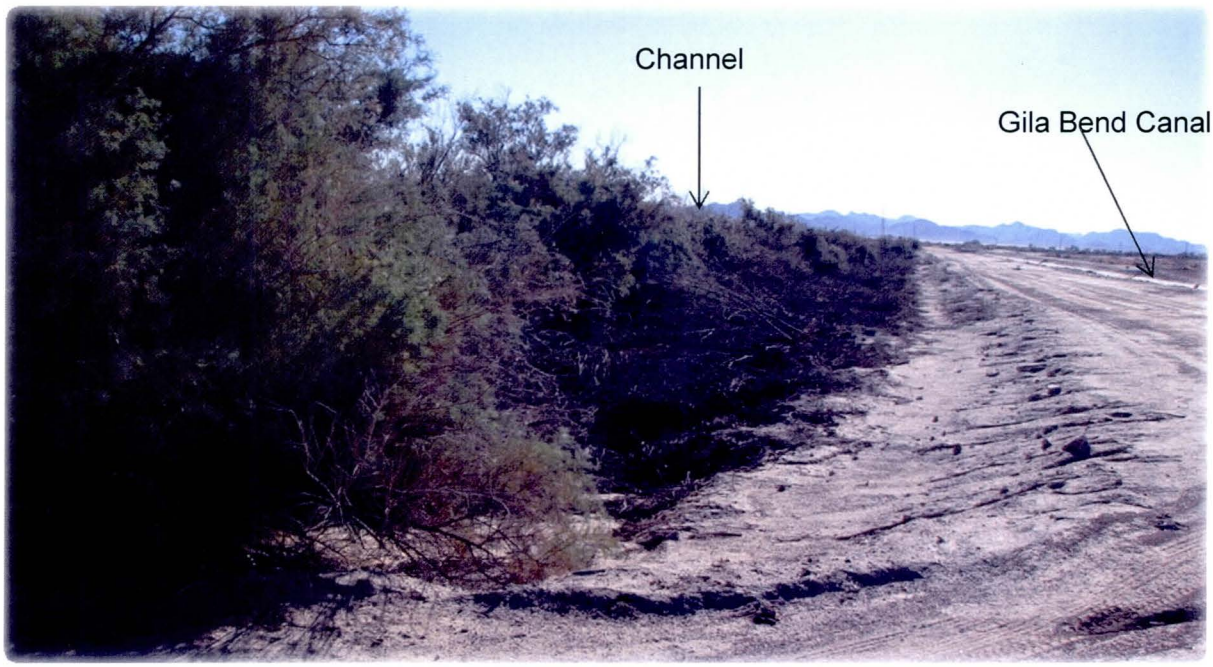


Channel bed material at WP 57

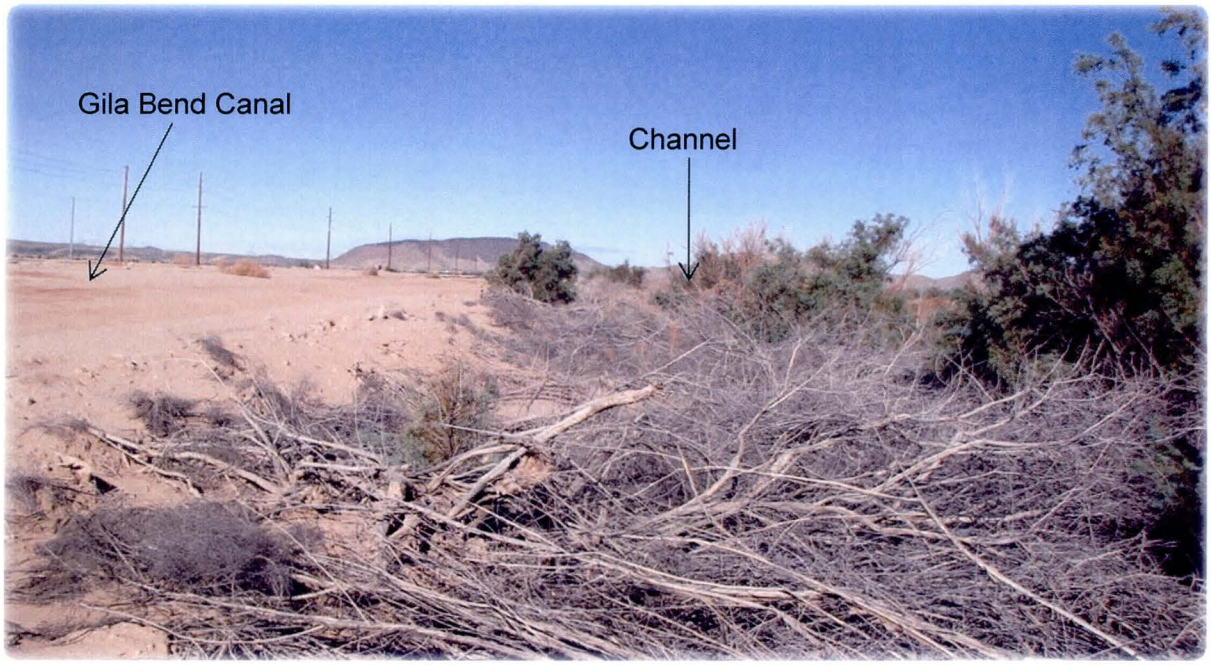
Appendix B.4.2

Gila Bend Canal Channel Reach 2

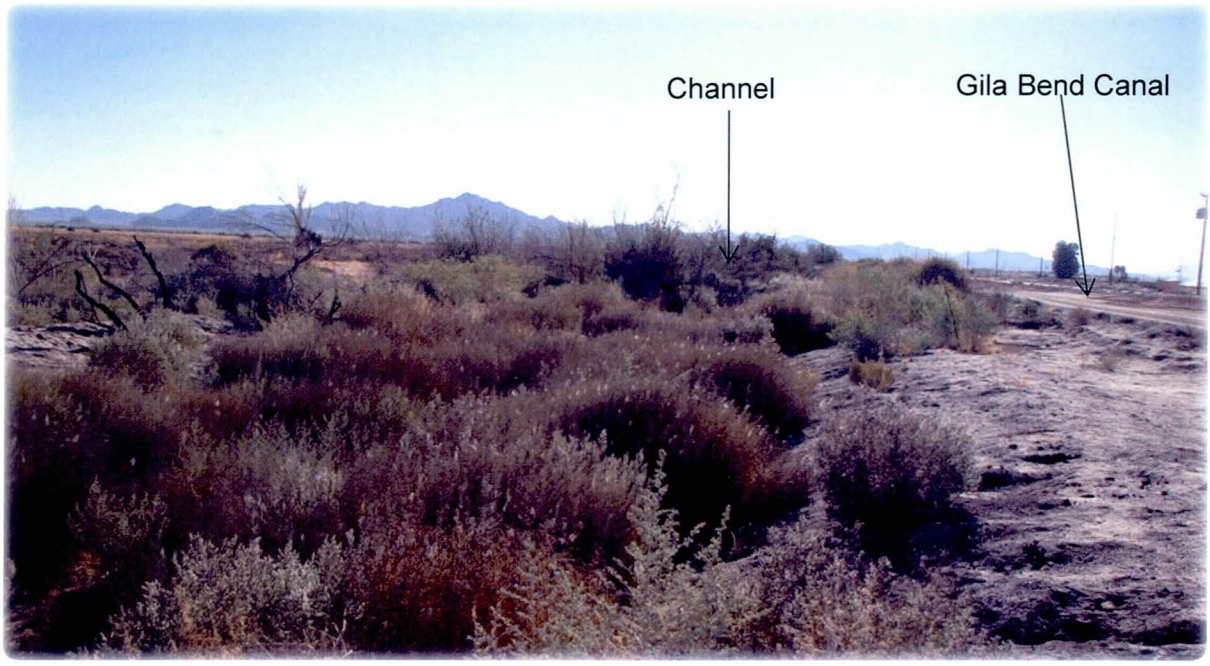
Channel adjacent to Gila Bend Canal (looking downstream of WP 52)



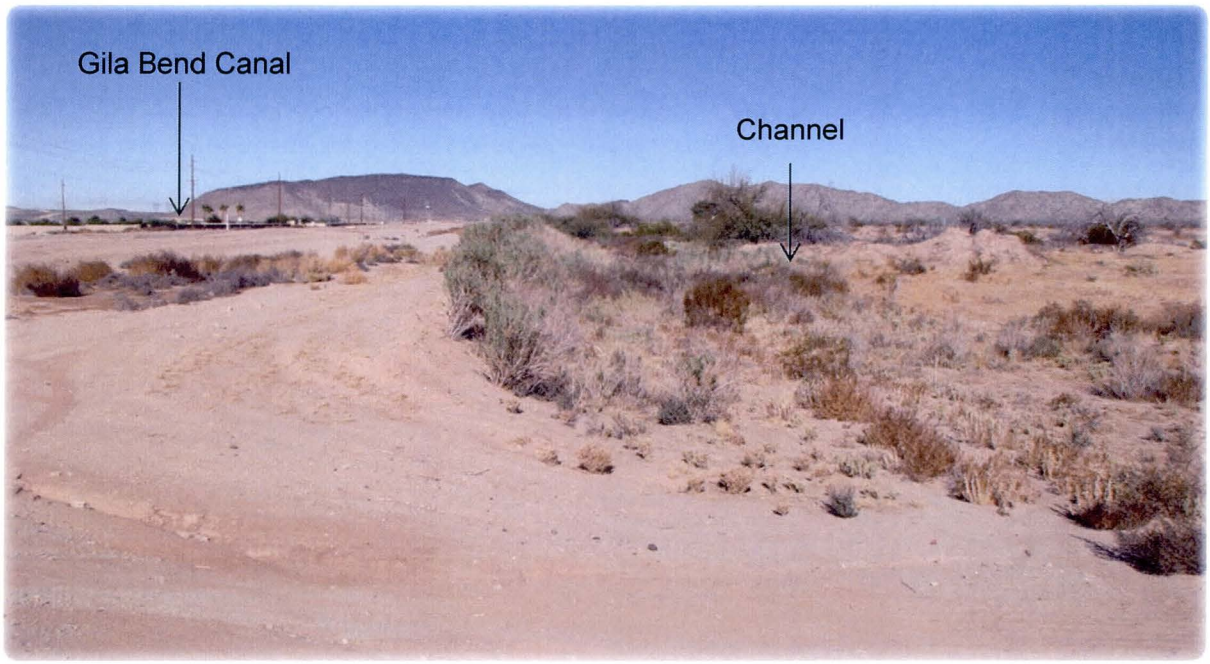
Channel adjacent to Gila Bend Canal (looking downstream of WP 53)



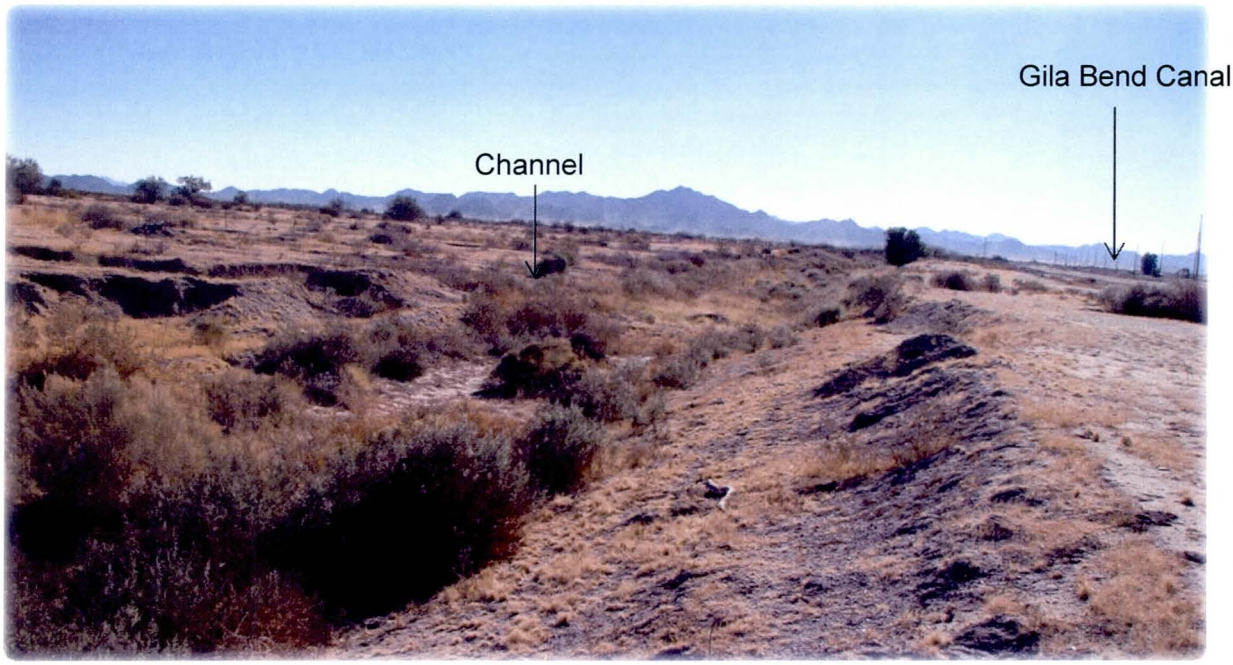
Channel adjacent to Gila Bend Canal (looking upstream of WP 53)



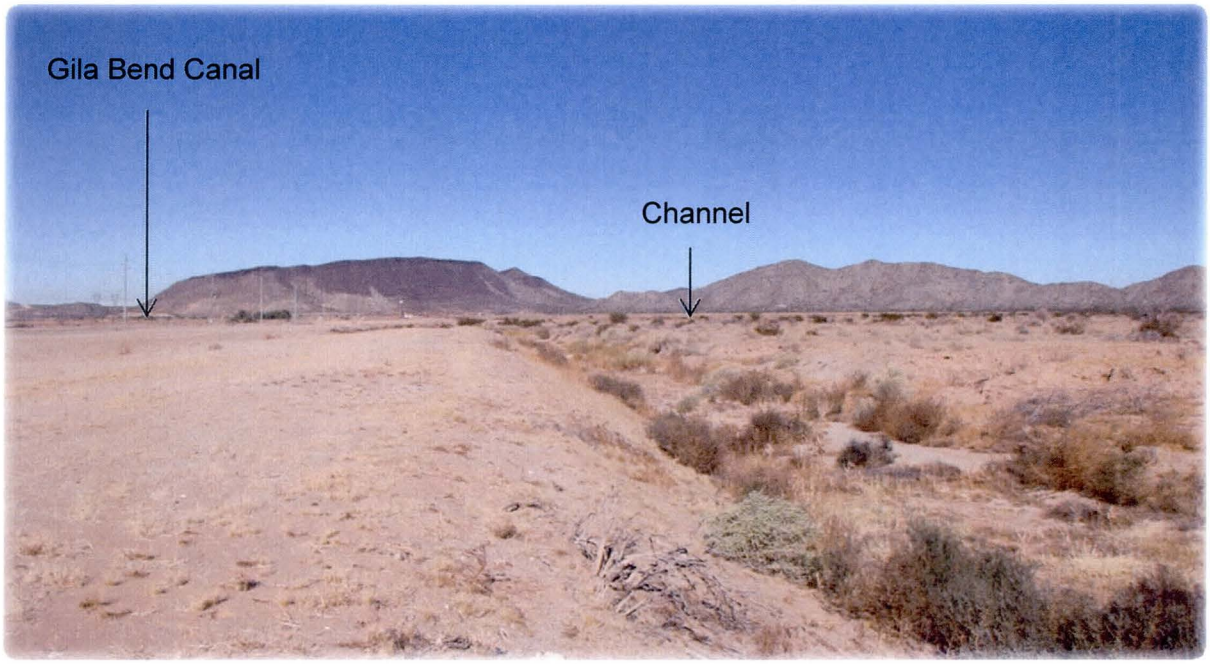
Channel adjacent to Gila Bend Canal (looking downstream of WP 54)



Channel adjacent to Gila Bend Canal (looking upstream of WP 54)



Channel adjacent to Gila Bend Canal (looking downstream of WP 55)

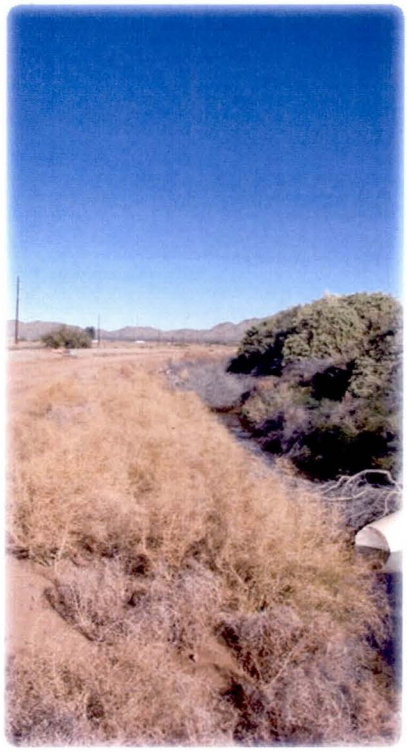


Channel adjacent to Gila Bend Canal (looking upstream of WP 55)

Appendix B.4.3

Gila Bend Canal Channel Reach 3

Channel adjacent to Gila Bend Canal (looking downstream from WP 49) near Siphon #3



Channel adjacent to Gila Bend Canal (looking upstream from WP 50)

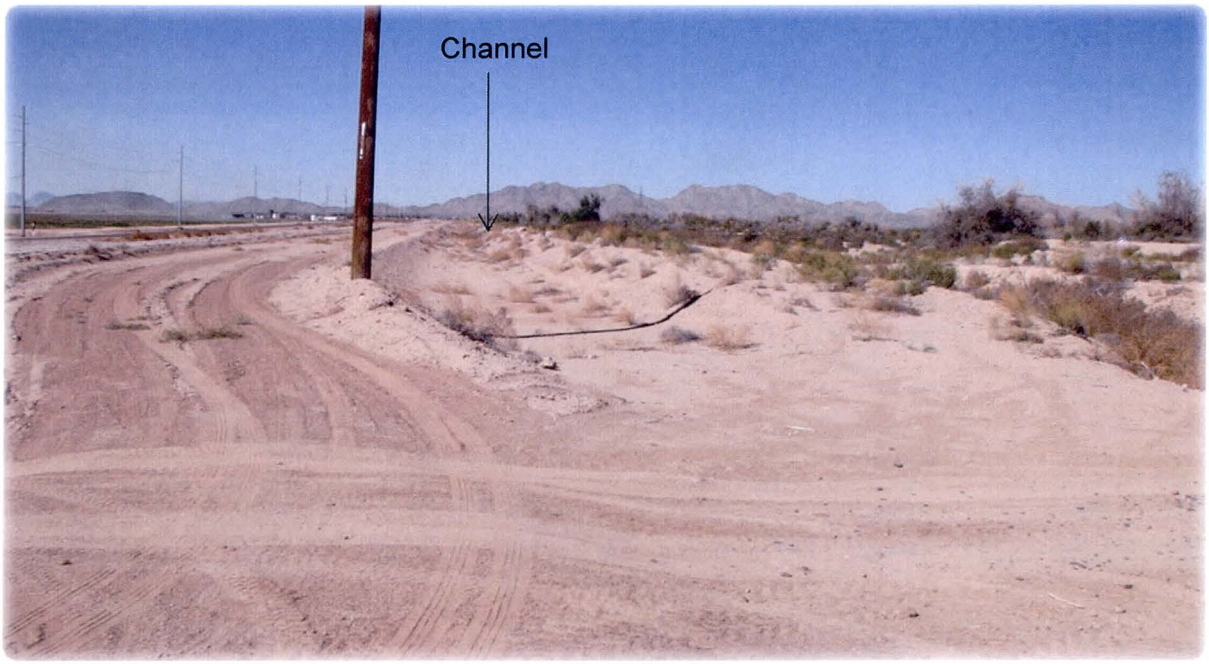
Channel adjacent to Gila Bend Canal (looking downstream from WP 50)

Appendix B.4.4

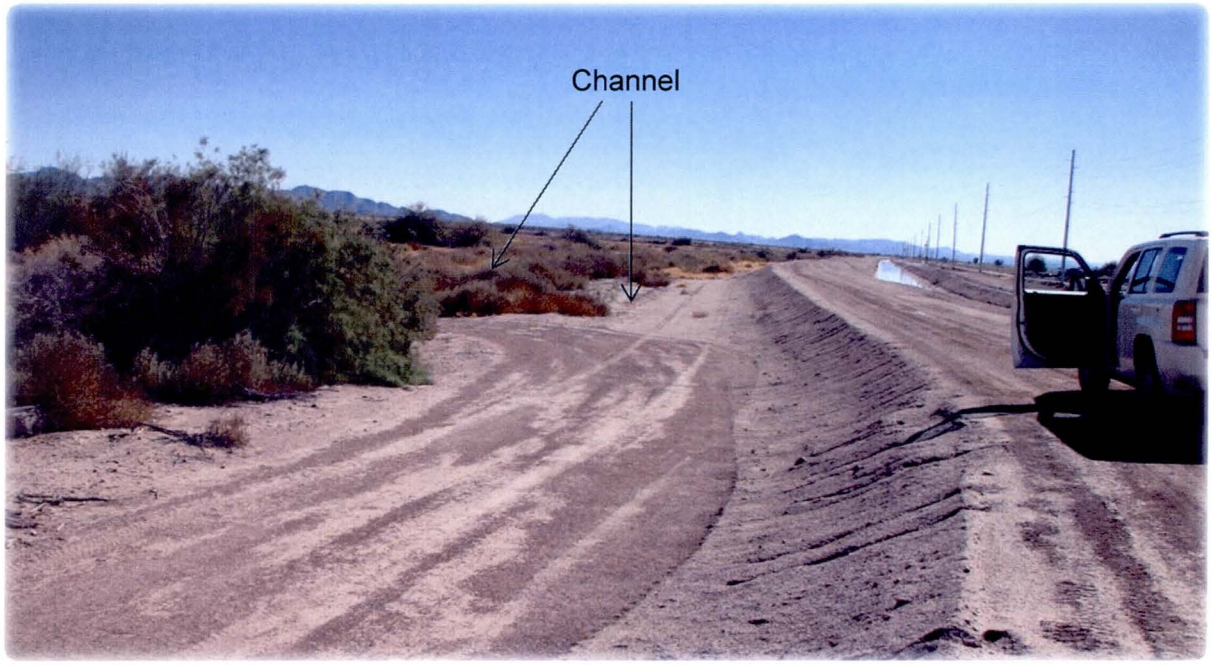
Gila Bend Canal Channel Reach 4

Channel adjacent to Gila Bend Canal (looking to the north from WP 73)

Channel adjacent to Gila Bend Canal (looking to the south from WP 73)



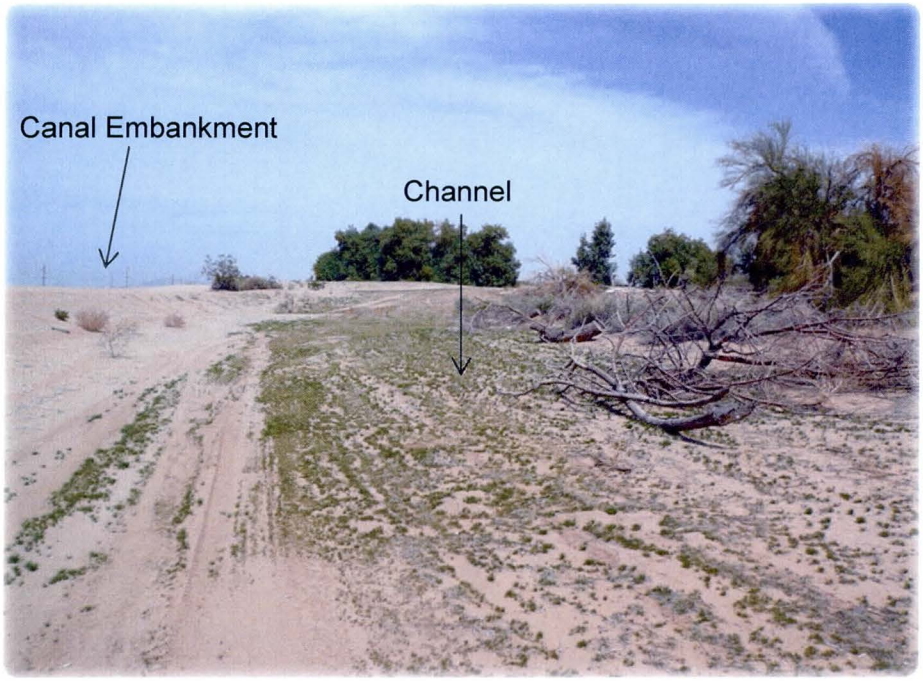
Channel adjacent to Gila Bend Canal (looking to the north from WP 74)



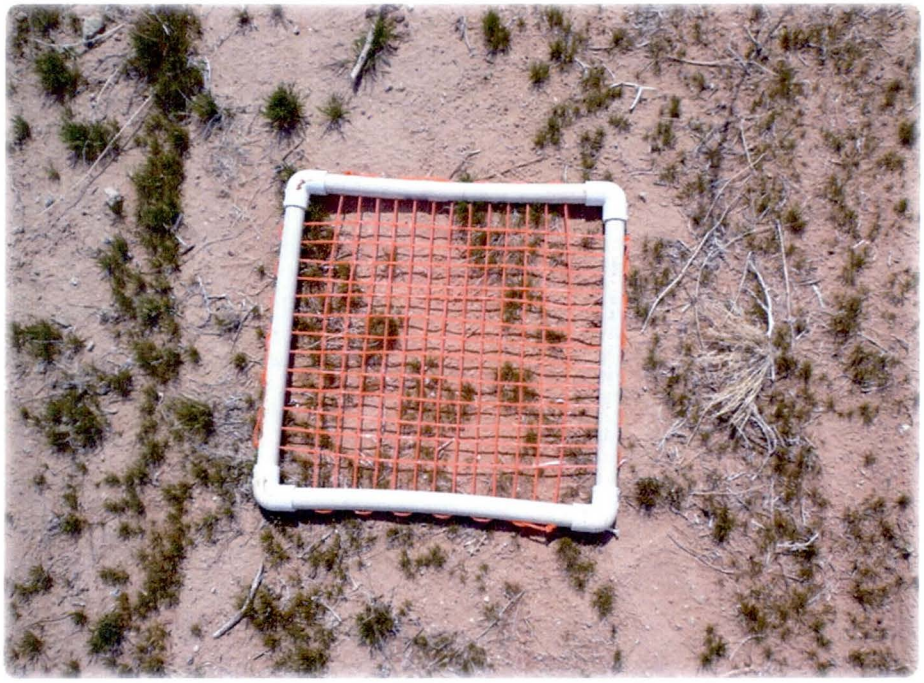
Channel adjacent to Gila Bend Canal (looking to the south from WP 74)

Appendix B.4.5

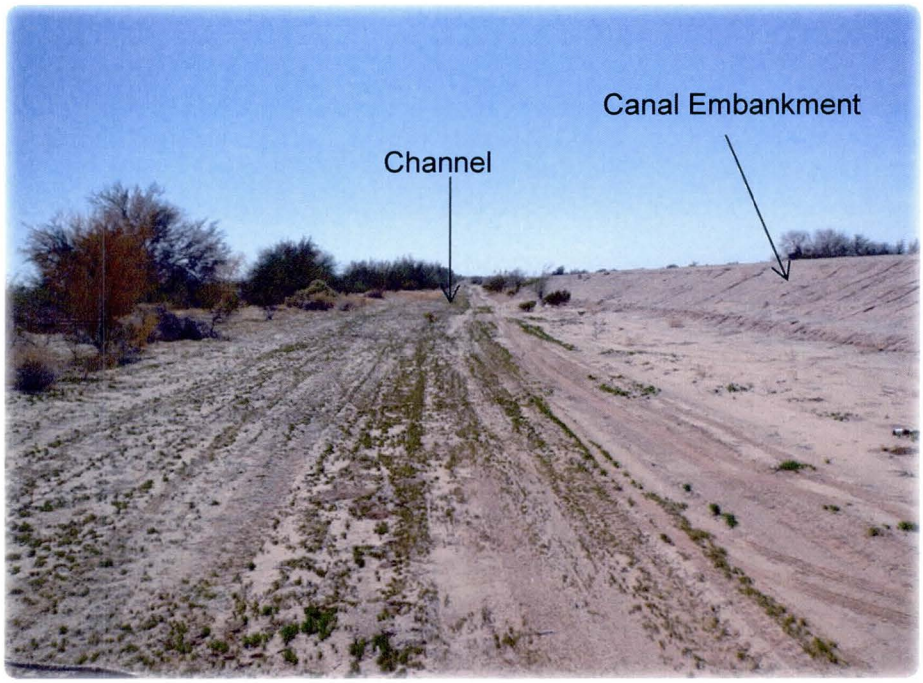
Gila Bend Canal Channel Reach 5



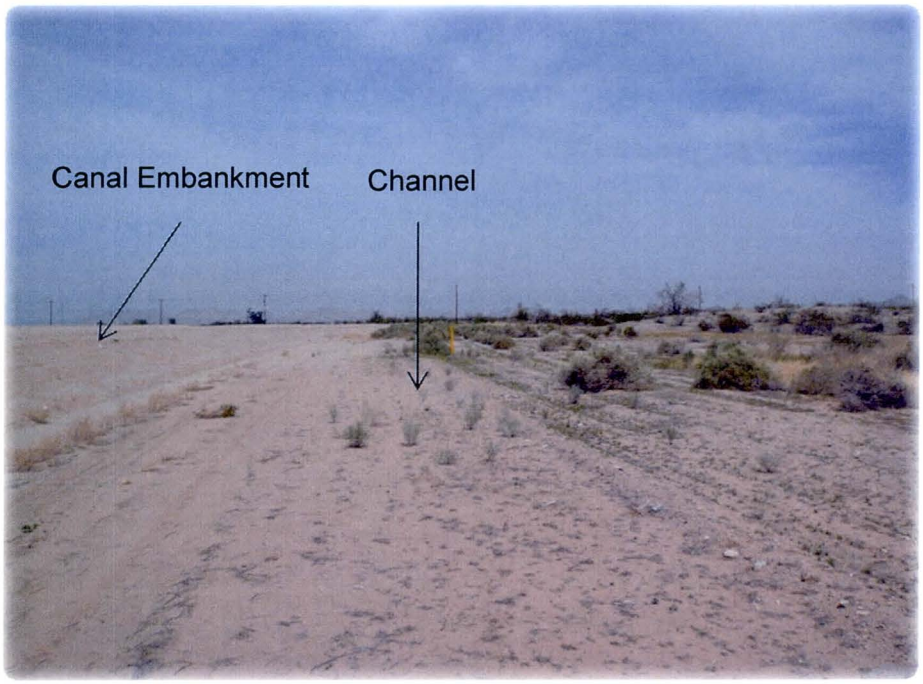
Channel adjacent to Gila Bend Canal (looking to the north from WP 178)



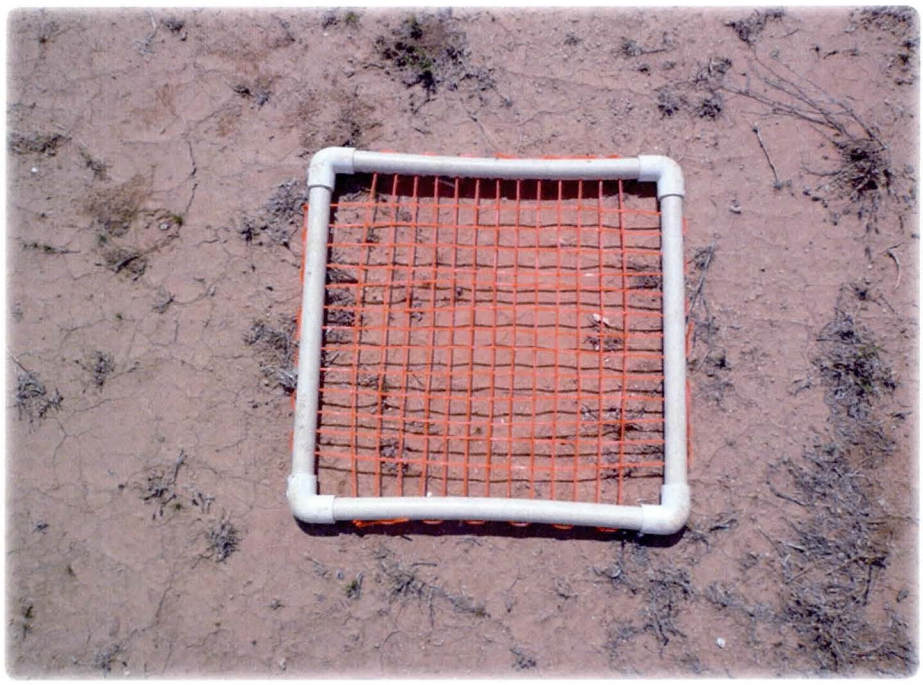
Channel bed material at WP 178



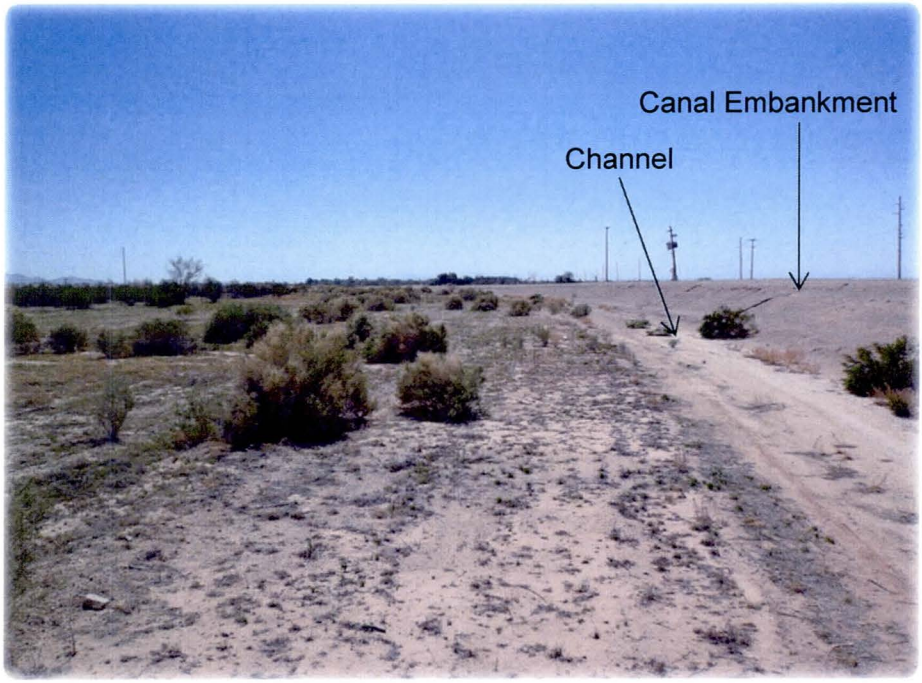
Channel adjacent to Gila Bend Canal (looking to the south from WP 178)



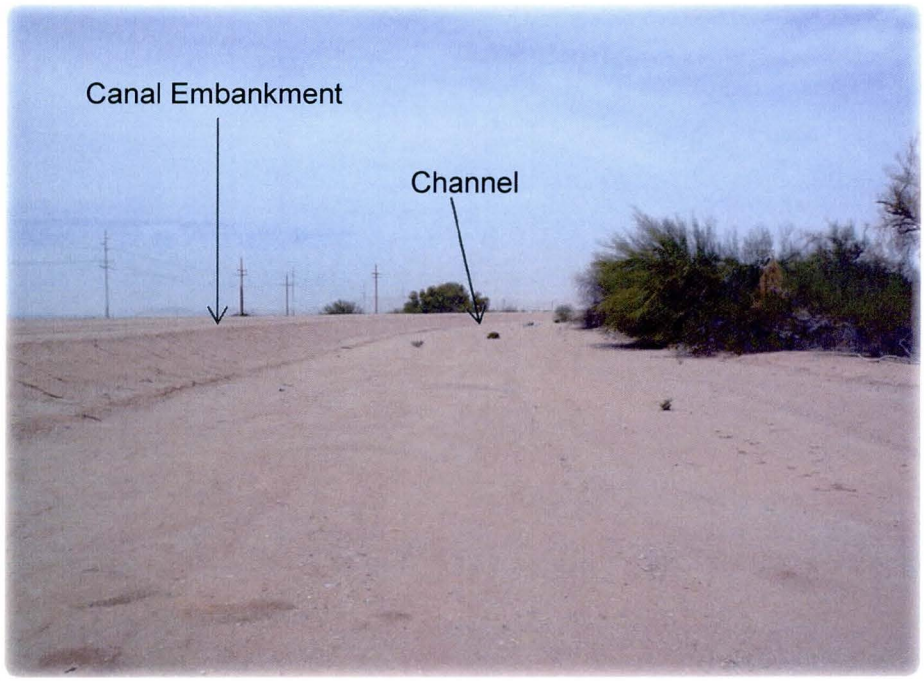
Channel adjacent to Gila Bend Canal (looking to the north from WP 181)



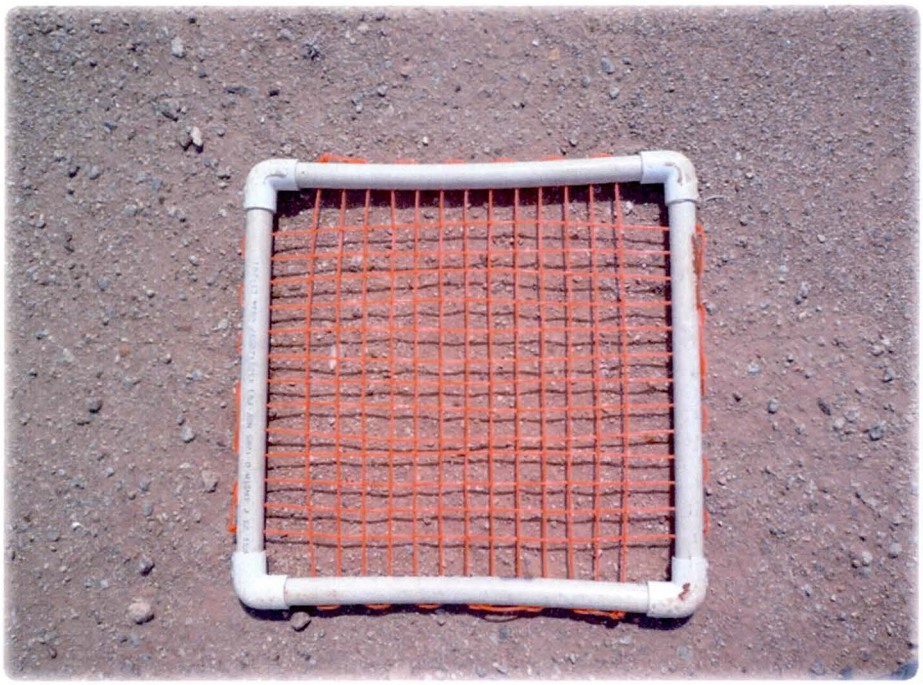
Channel bed material at WP 181



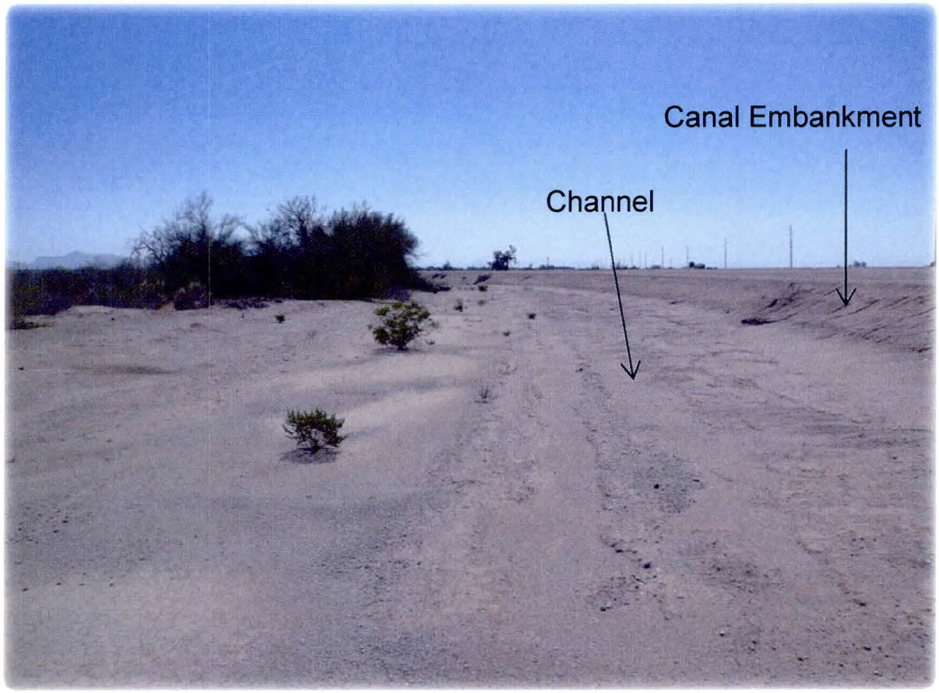
Channel adjacent to Gila Bend Canal (looking to the south from WP 181)



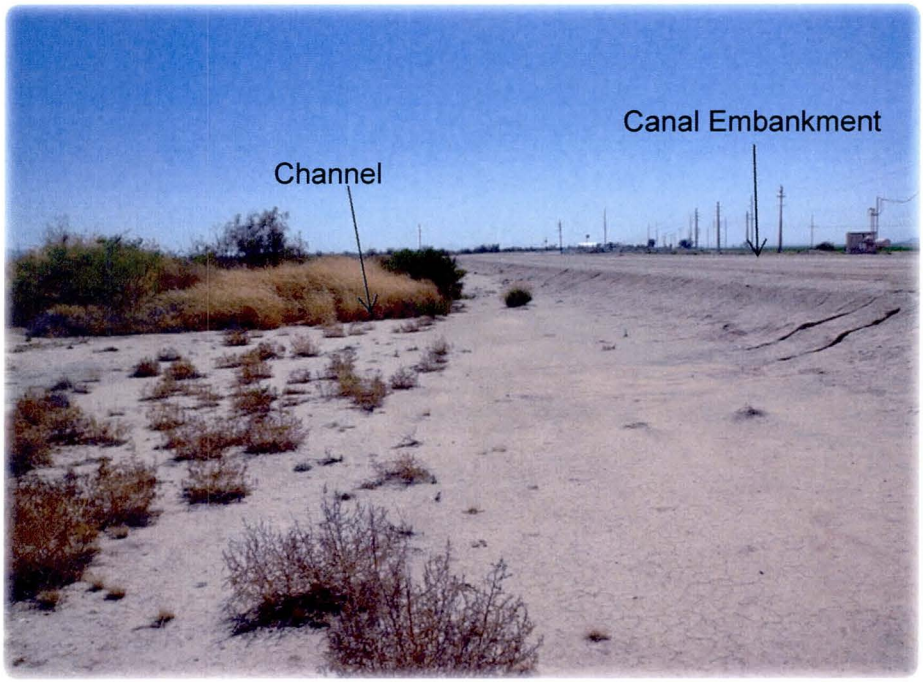
Channel adjacent to Gila Bend Canal (looking to the north from WP 182)



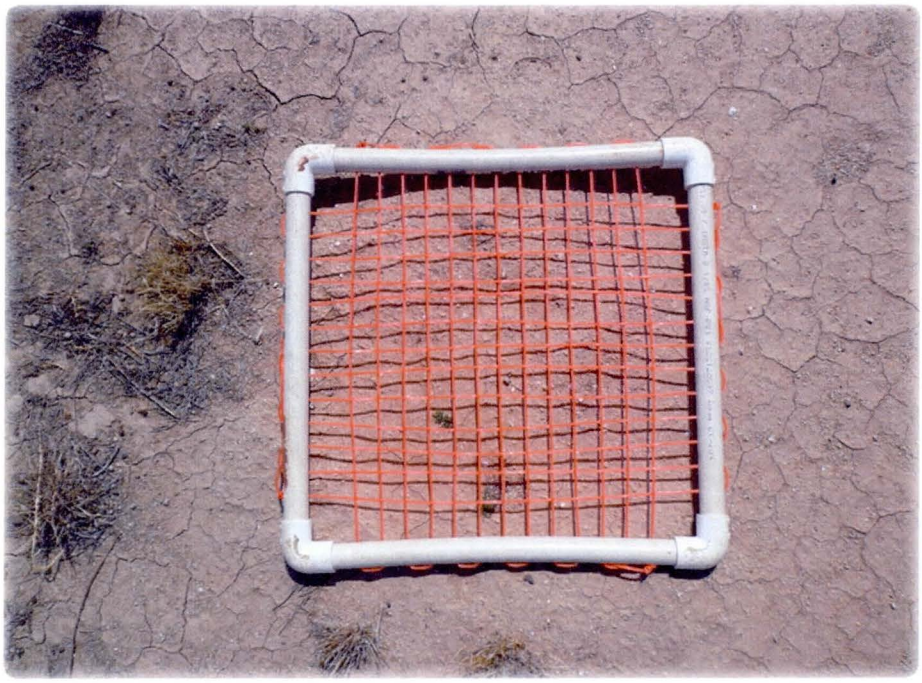
Channel bed material at WP 182



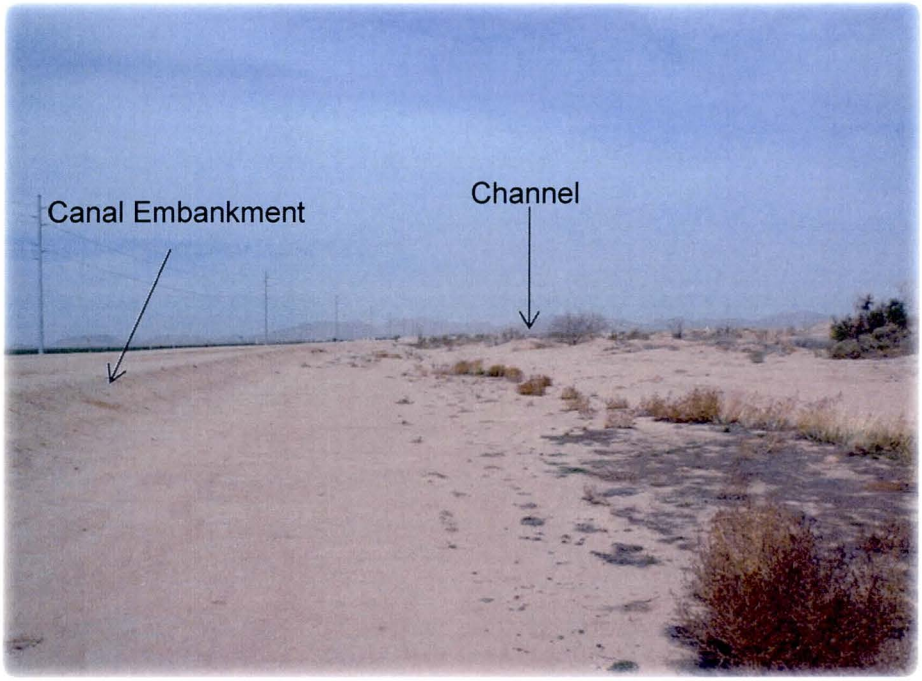
Channel adjacent to Gila Bend Canal (looking to the south from WP 182)



Channel adjacent to Gila Bend Canal (looking to the south from WP 185)



Channel bed material at WP 185



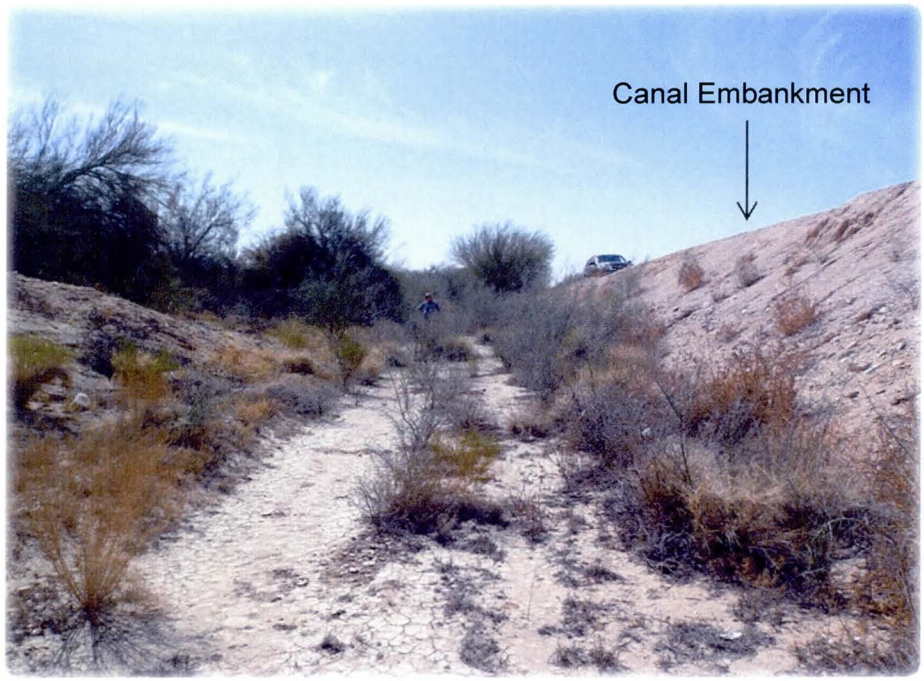
Channel adjacent to Gila Bend Canal (looking to the north from WP 185)

Appendix B.4.6

Gila Bend Canal Channel Reach 6

Channel adjacent to Gila Bend Canal (looking to the north from WP 163)

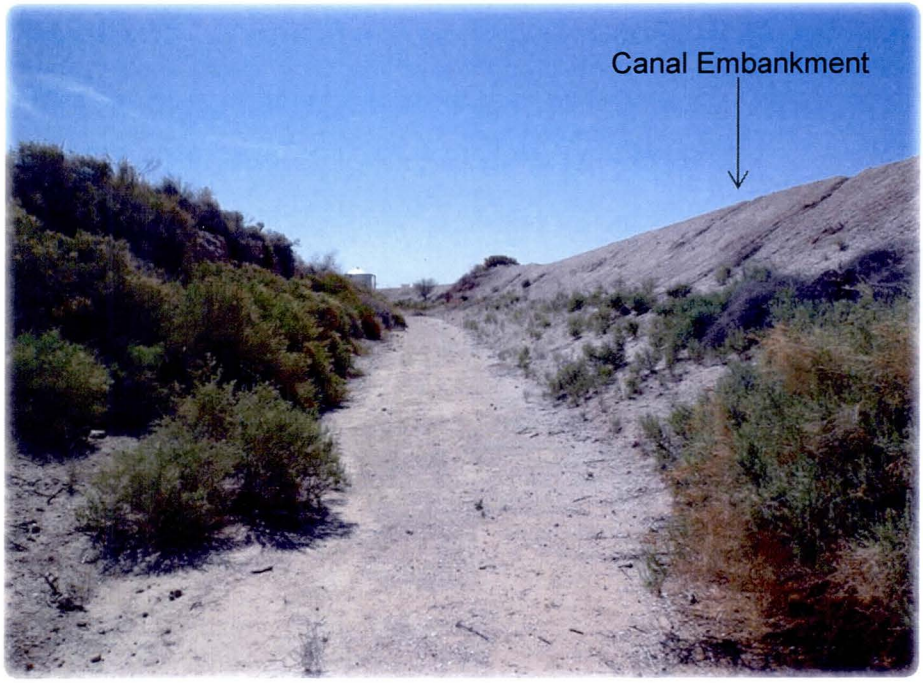
Channel bed material at WP 163



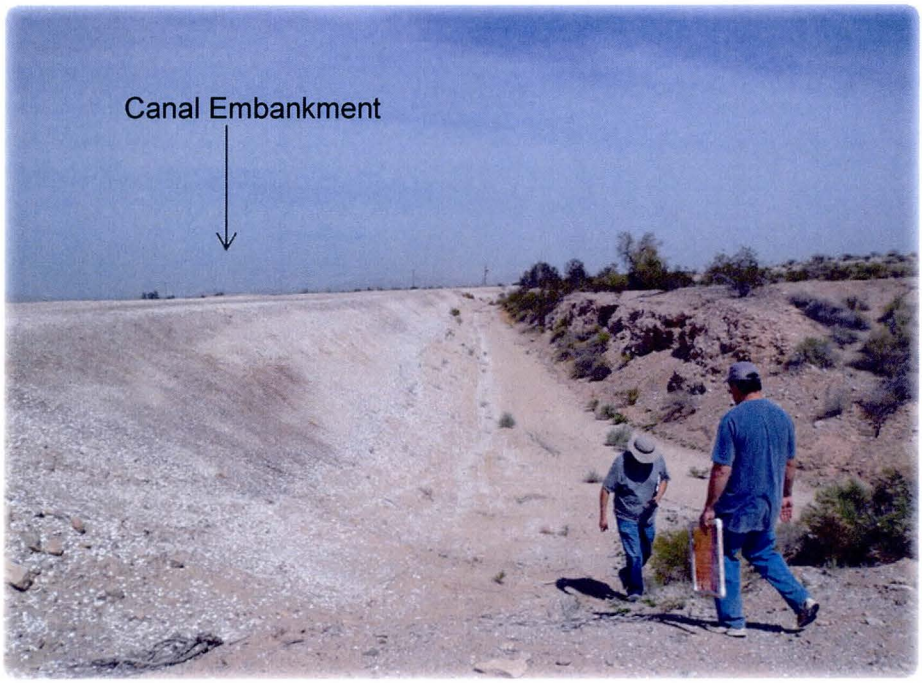
Channel adjacent to Gila Bend Canal (looking to the south from WP 163)

Channel adjacent to Gila Bend Canal (looking to the north from WP 167)

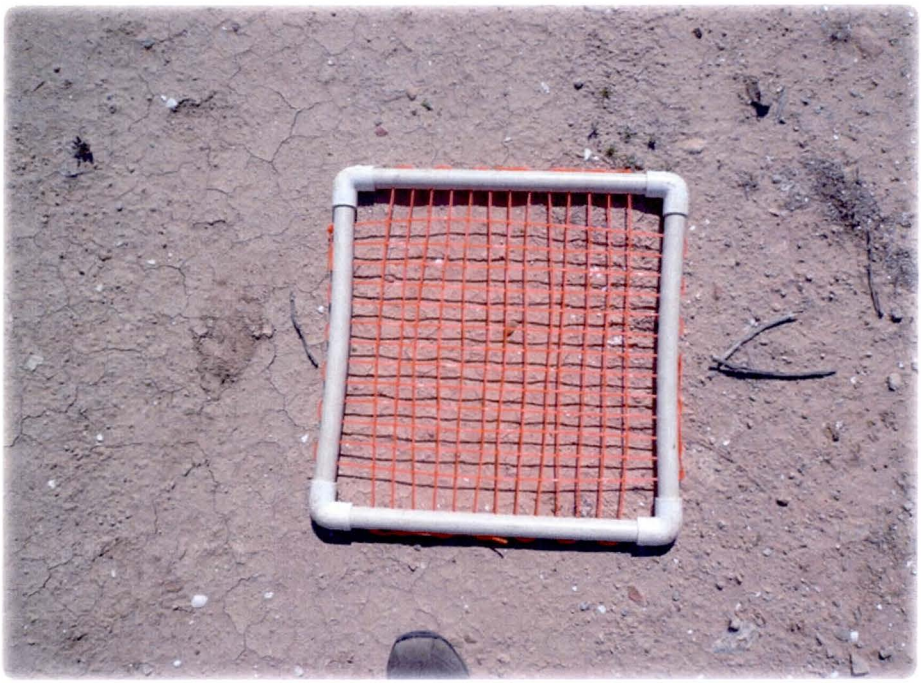
Channel bed material at WP 167



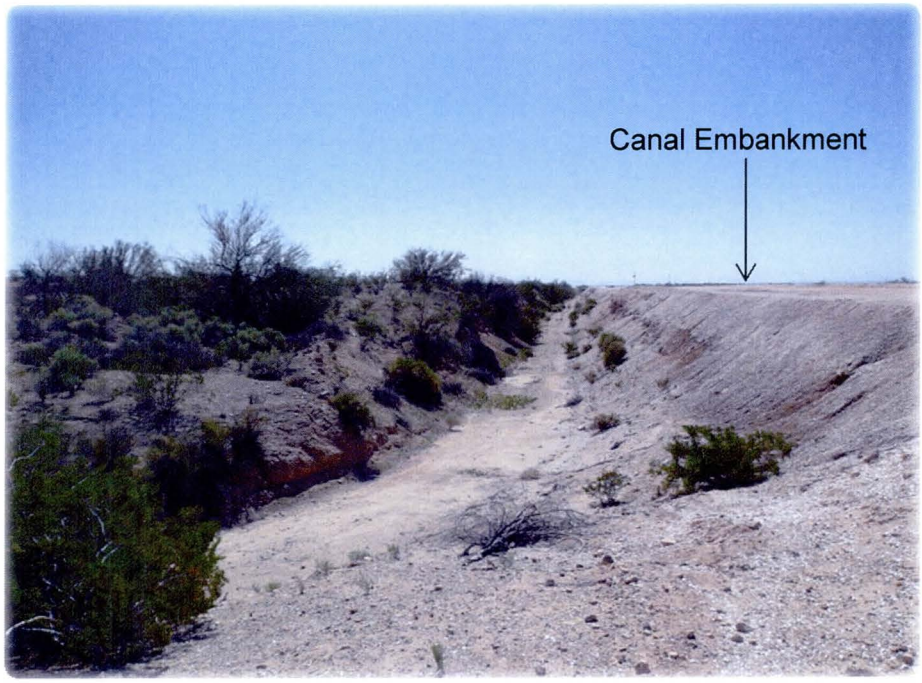
Channel adjacent to Gila Bend Canal (looking to the south from WP 167)



Channel adjacent to Gila Bend Canal (looking to the north from WP 170)

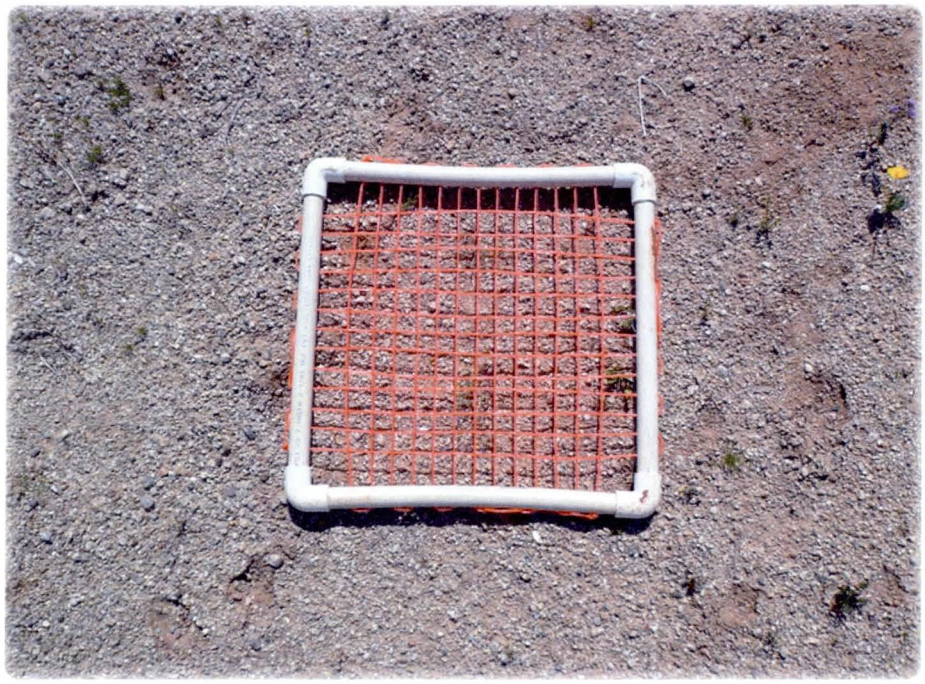


Channel bed material at WP 170

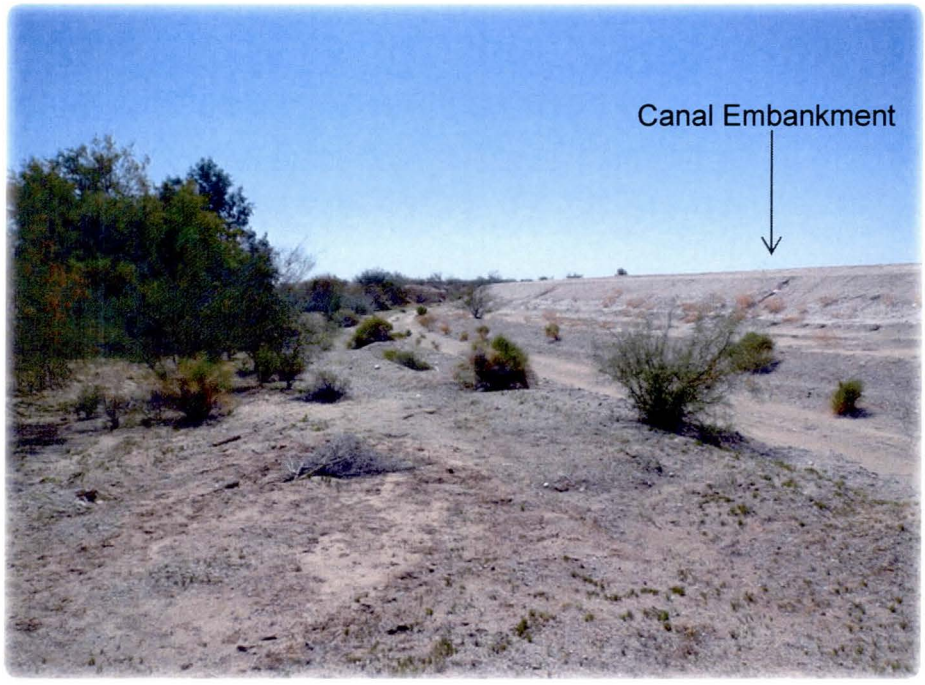


Channel adjacent to Gila Bend Canal (looking to the south from WP 170)

Channel adjacent to Gila Bend Canal (looking to the north from WP 172)



Channel bed material at WP 172



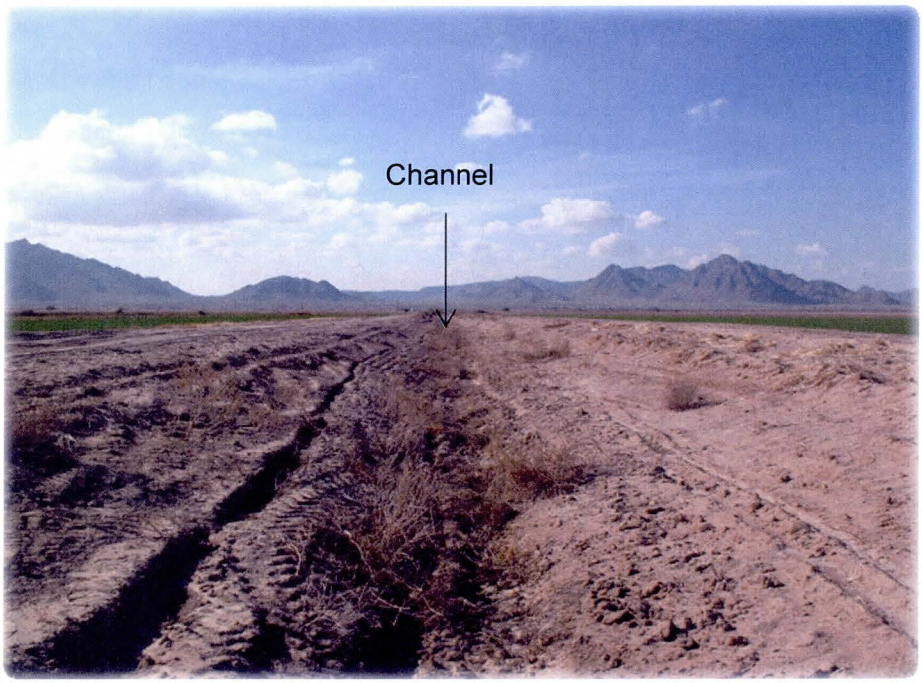
Channel adjacent to Gila Bend Canal (looking to the south from WP 172)

Appendix B.5

John's Wash

John's Wash looking upstream from WP 111

John's Wash looking downstream from WP 111



John's Wash looking downstream from WP 101

John's Wash bed material at WP 101

John's Wash looking upstream from WP 109 (at outfall to Gila River)

John's Wash bed material at WP 109

Appendix B.6

Layton Wash

Layton Wash looking downstream of WP 140 (outfall to Gila River)

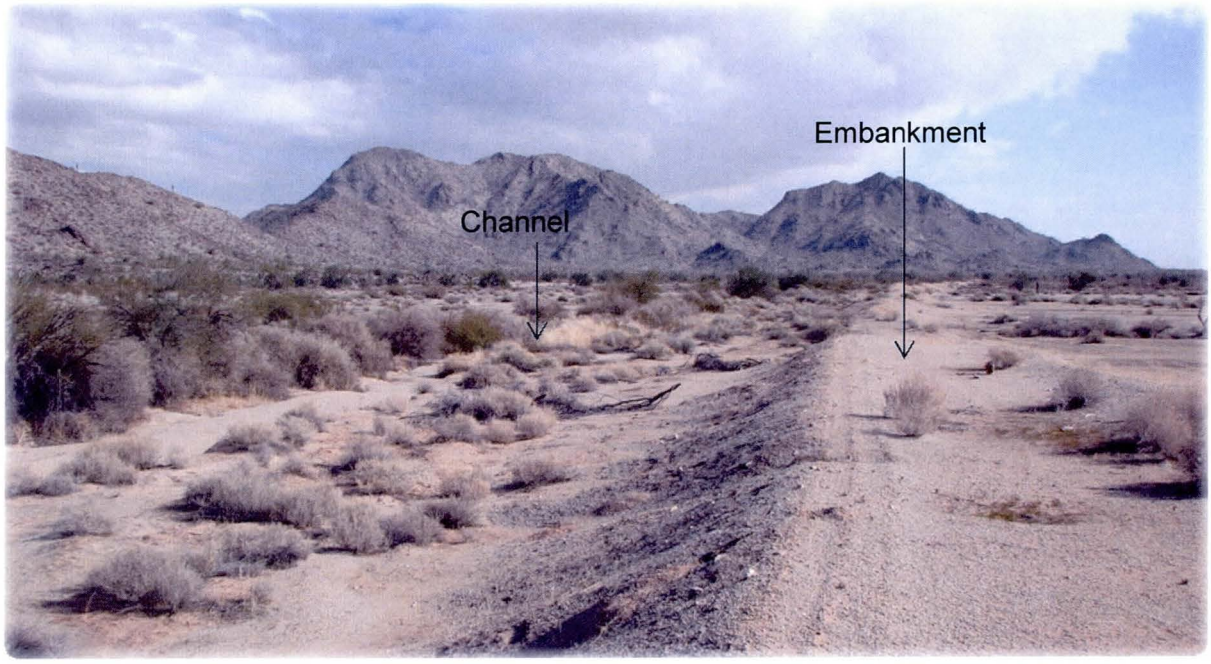
Layton Wash looking upstream from WP 140

Layton Wash grade control structure at WP 141

Layton Wash looking downstream from WP 143

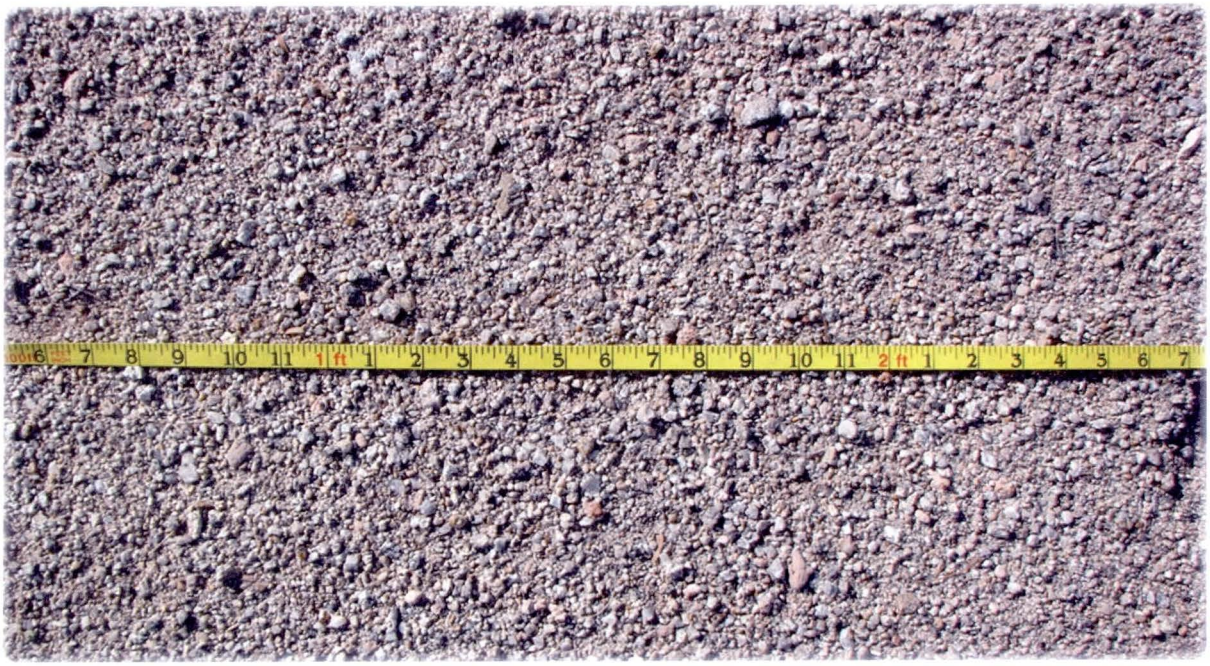
Appendix B.7

Buckeye Mountain Channel #1



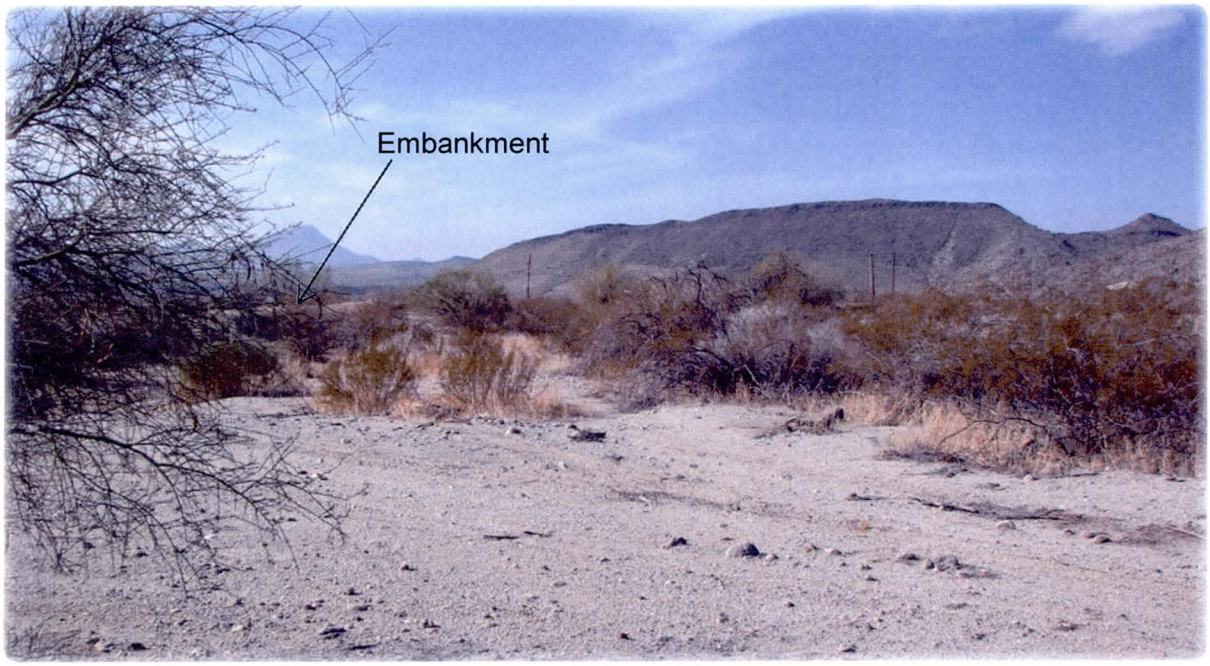
Buckeye Mtn. Channel #1 looking to the east from WP 190

Buckeye Mtn. Channel #1 looking to the west from WP 190

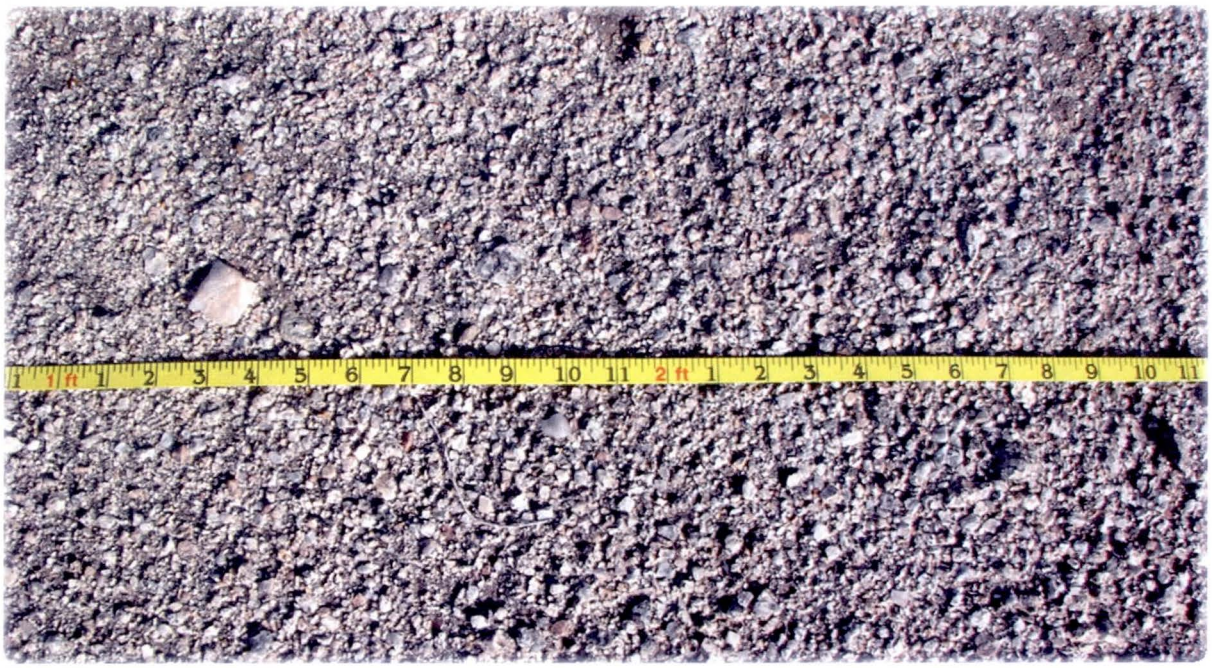


Buckeye Mtn. Channel #1 bed material at WP 190

Buckeye Mtn. Channel #1 looking to the east from WP 193 (upstream of embankment)



Buckeye Mtn. Channel #1 looking to the west from WP 193



Buckeye Mtn. Channel #1 bed material at WP 193

Buckeye Mtn. Channel #1 looking to the west from WP 6

Appendix B.8

Paloma Lift Station Wash

Paloma Lift Station Wash looking downstream from WP 103

Paloma Lift Station Wash just downstream from Old US 80 looking to the (WP 105)

Paloma Lift Station Wash looking at culverts on the east side of Old US 80 (WP 105)

Paloma Lift Station Wash (adjacent to Old US 80) looking to the north from WP 105

Paloma Lift Station Wash looking downstream from WP 105

Paloma Lift Station Wash looking to the west from WP 105

Paloma Lift Station Wash looking to the east from WP 117 (outfall to Gila River)

Paloma Lift Station Wash looking to the west from WP 114 (within Gila River floodplain)

Paloma Lift Station Wash looking to east from WP 115 (within Gila River floodplain)

Appendix B.9

Siphon #1Wash

Siphon 1 Wash looking upstream from WP 188

Siphon 1 Wash looking downstream from WP 188

Siphon 1 Wash bed material at WP 188

Appendix B.10

SR 85 Channel #1

SR 85 Channel 1 looking downstream from WP 81

SR 85 channel 1 bank armoring at WP 81

SR 85 Channel 1, failure of gabion mattress spillway at WP 82

SR85 Channel 1, looking upstream of WP 83

SR 85 Channel 1, failure of gabion mattress spillway upstream of WP 83

SR 85 Channel 1, looking downstream of WP 22

SR 85 Channel 1 bed material at WP 22

SR 85 Channel 1, Failure of gabion basket/mattress grade control structure at WP 23

SR 85 Channel 1, Failure of gabion basket/mattress grade control structure at WP 23

SR 85 Channel 1, Failure of gabion basket/mattress grade control structure at WP 31

Appendix B.11

SR 85 Channel #2

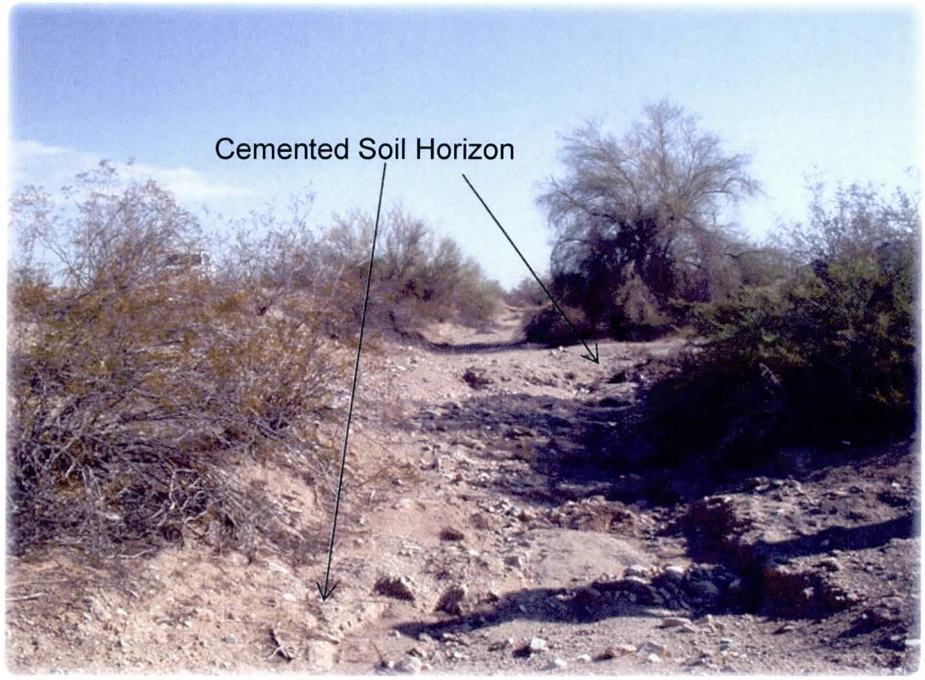
SR85 Channel 2 looking upstream of WP 212

SR85 Channel 2 looking downstream of WP 212

SR85 Channel 2 armoring at WP 212

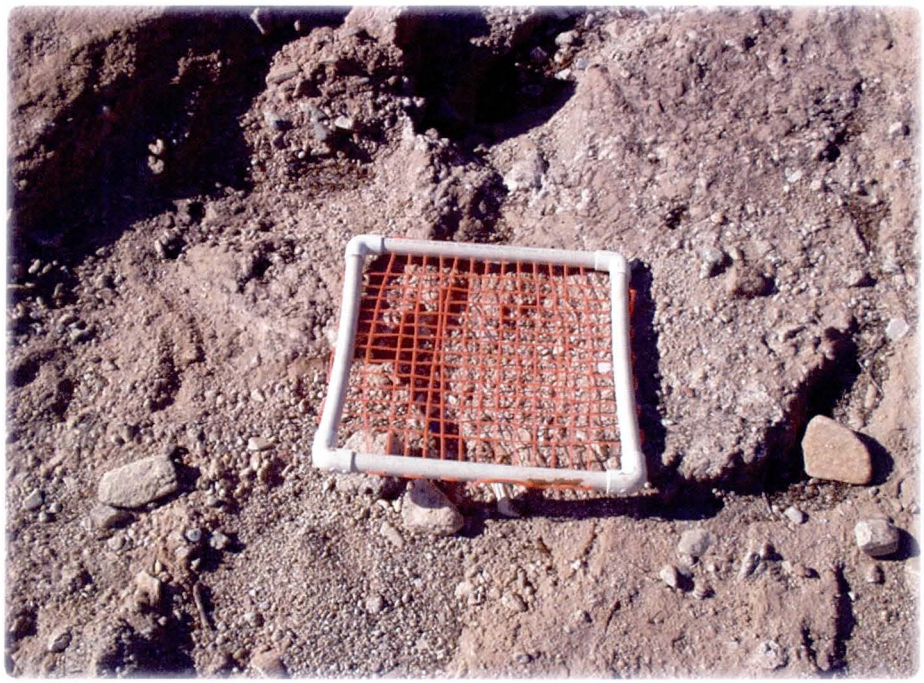
Appendix B.12

SR 85 Channel #3



SR 85 Channel 3 looking upstream from WP 228

SR 85 Channel 3 looking downstream from WP228



SR 85 Channel 3 bed material, WP 228

Appendix B.13

SR 85 Channel #4

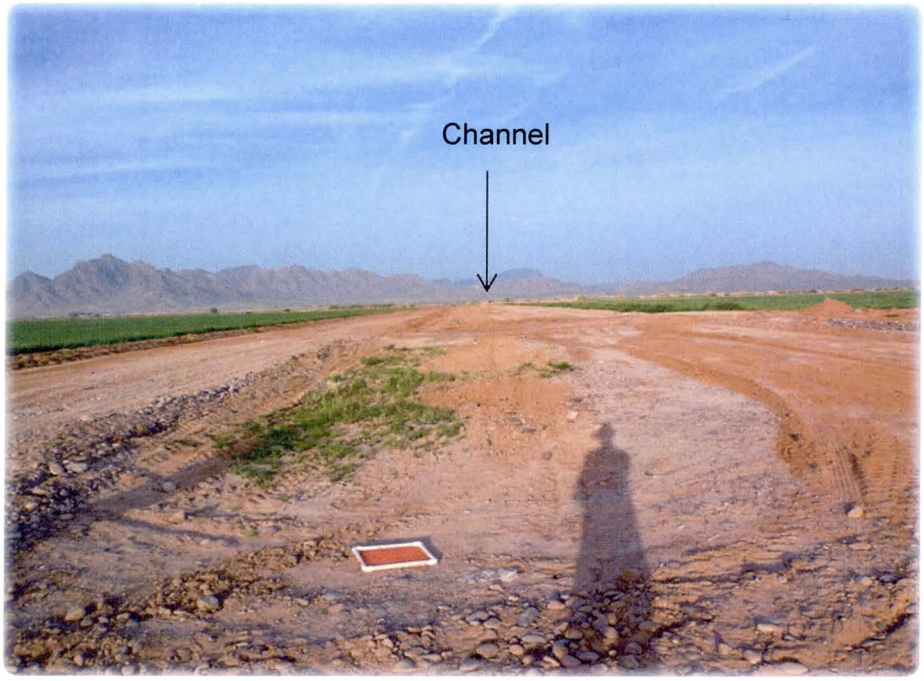
SR85 Channel 4 looking downstream from WP 226

SR85 Channel 4 looking upstream from WP 226

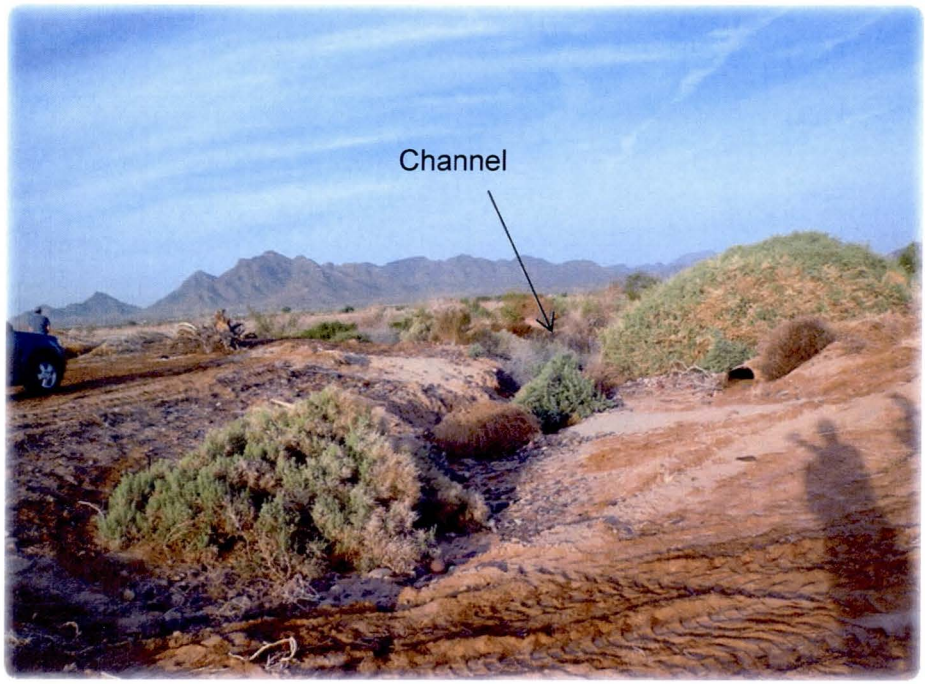
SR85 Channel 4 bed material at WP 226

Appendix B.14

Turner Draw



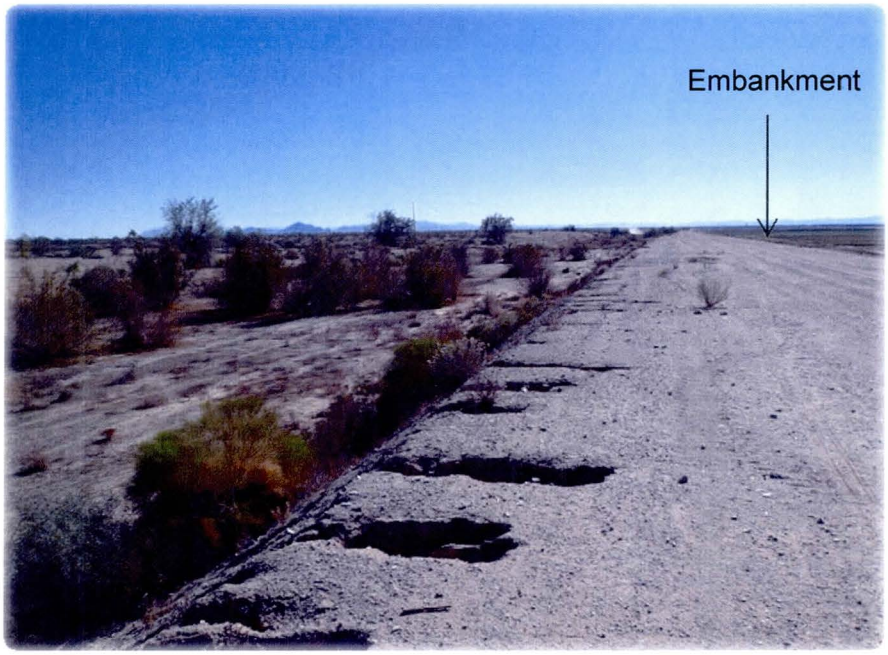
Turner Draw looking downstream from WP 137



Turner Draw looking downstream from WP 139 at outfall to Gila River

Appendix B.15

Upper Woods Wash

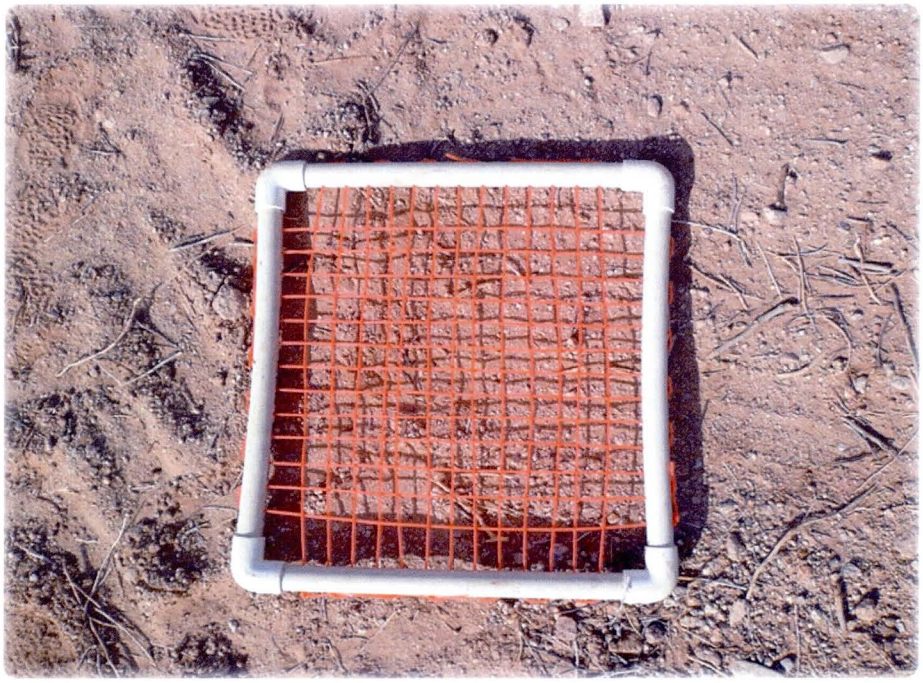


Upper Woods Wash looking to the south from WP 120

Upper Woods Wash looking to the north from WP 119

Upper Woods Wash looking to the west from WP 118

Upper Woods Wash looking to the east from WP 162

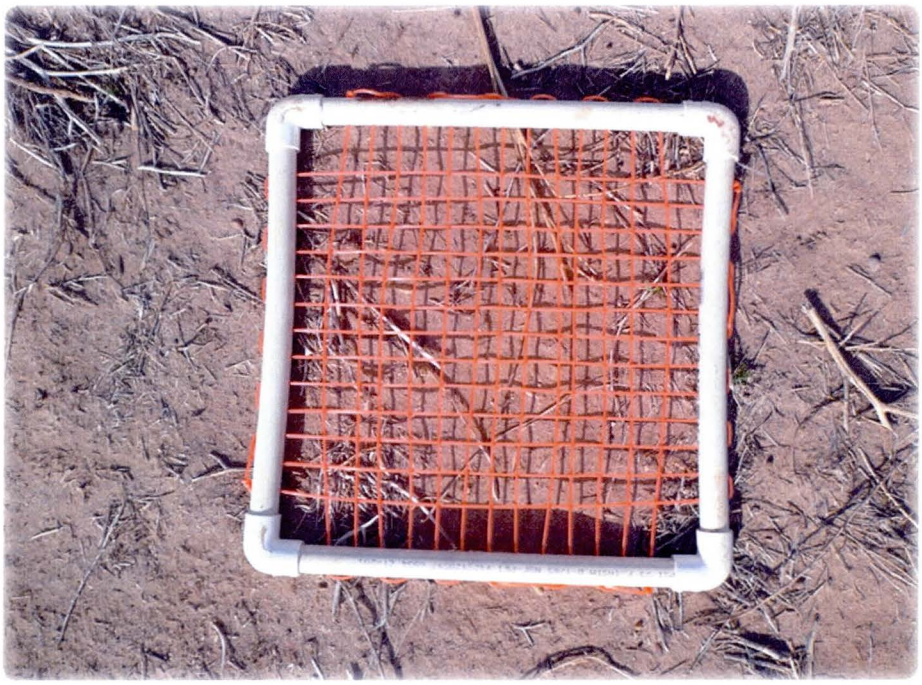


Upper Woods Wash bed material at WP 162

Upper Woods Wash looking to the west from WP 162

Piping in south bank of Upper Woods Wash at WP 162

Upper Woods Wash looking upstream of WP 160



Upper Woods Wash channel bottom.

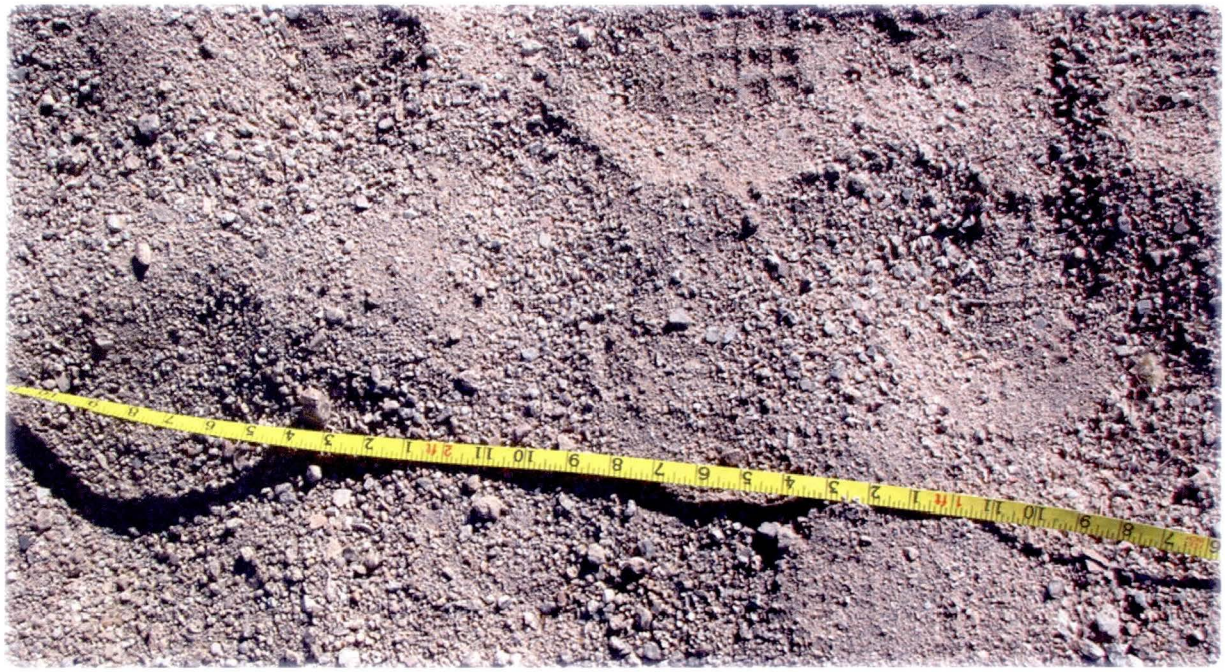
Upper Woods Wash looking downstream of WP 160 (outfall to Gila River).

Appendix B.16

West Prison Channel

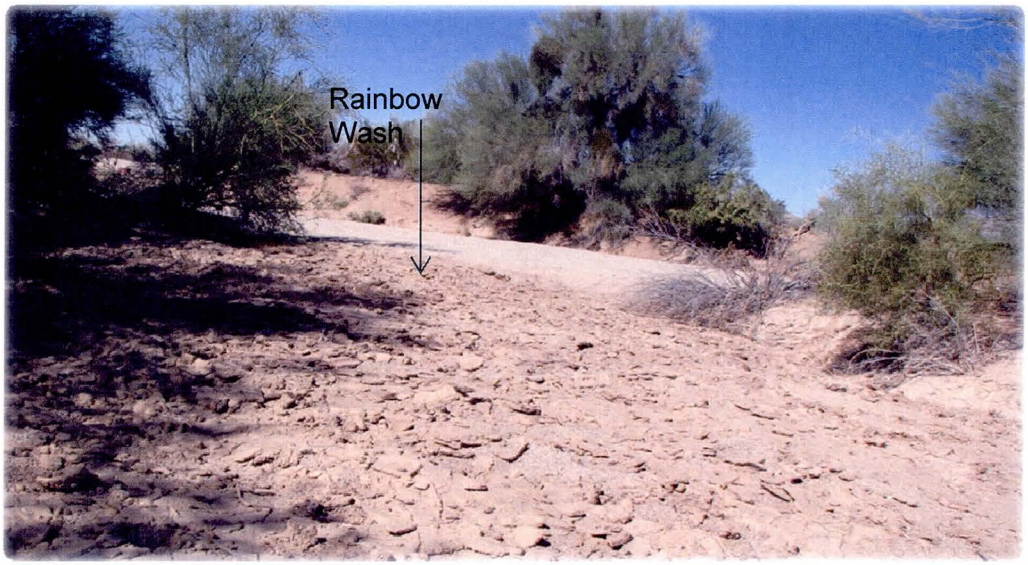
West Prison Channel looking upstream from WP 64

West Prison Channel looking downstream from WP 64

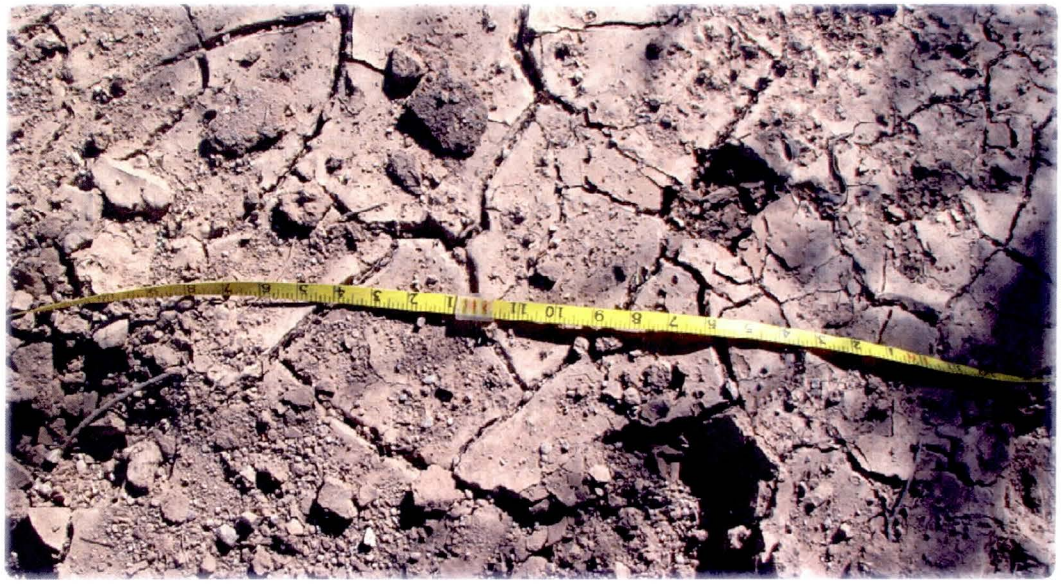


West Prison Channel bed material at WP 64

West Prison Channel looking upstream from WP 66



West Prison Channel looking downstream from WP 66 (outfall to Rainbow Wash)

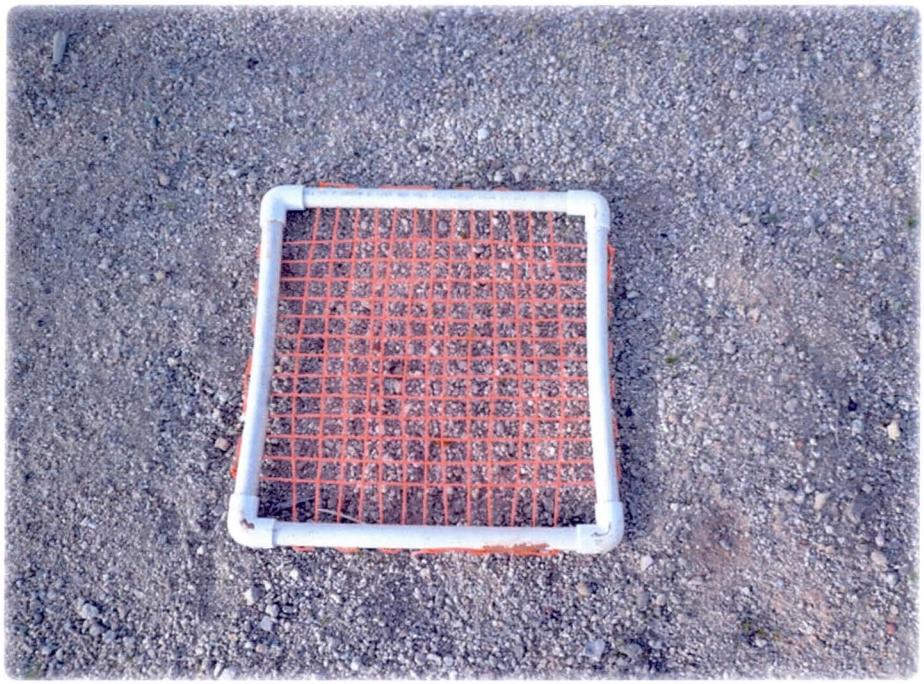


West Prison Channel bed material at WP 66

Appendix B.17

Woods Road Wash

Woods Road Wash downstream of Gila Bend Canal looking north east upstream from WP 150)



Woods Road Wash bed material (WP 150)

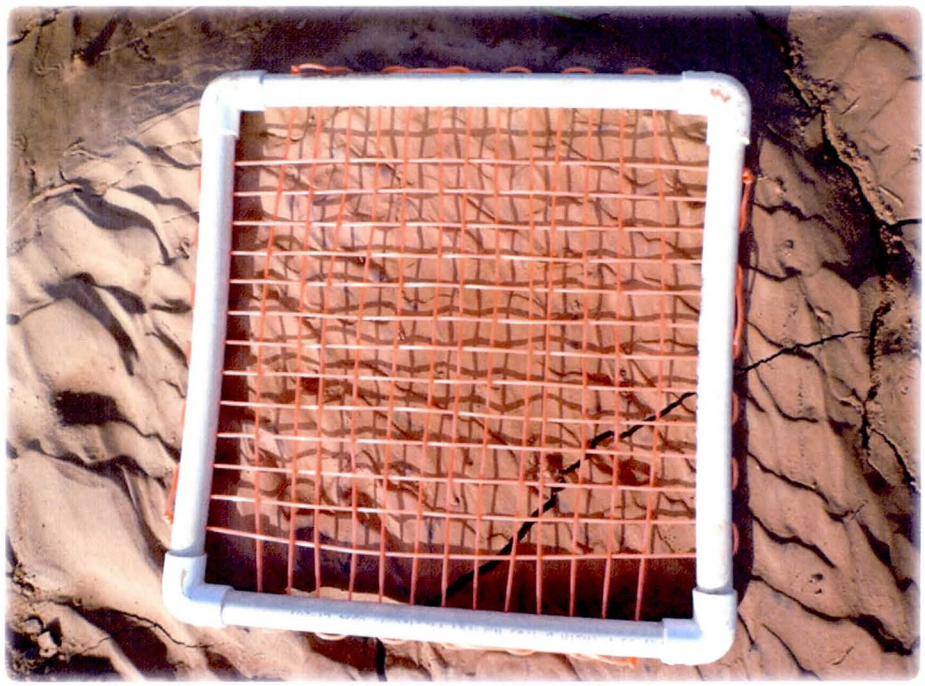
Woods Road Wash: Looking in a southwest downstream from WP 150

Woods Road Wash looking upstream from WP 151

Woods Roads Wash bed material at WP 151

Woods Road Wash looking downstream from WP 151

Woods Road Wash looking upstream from WP 152

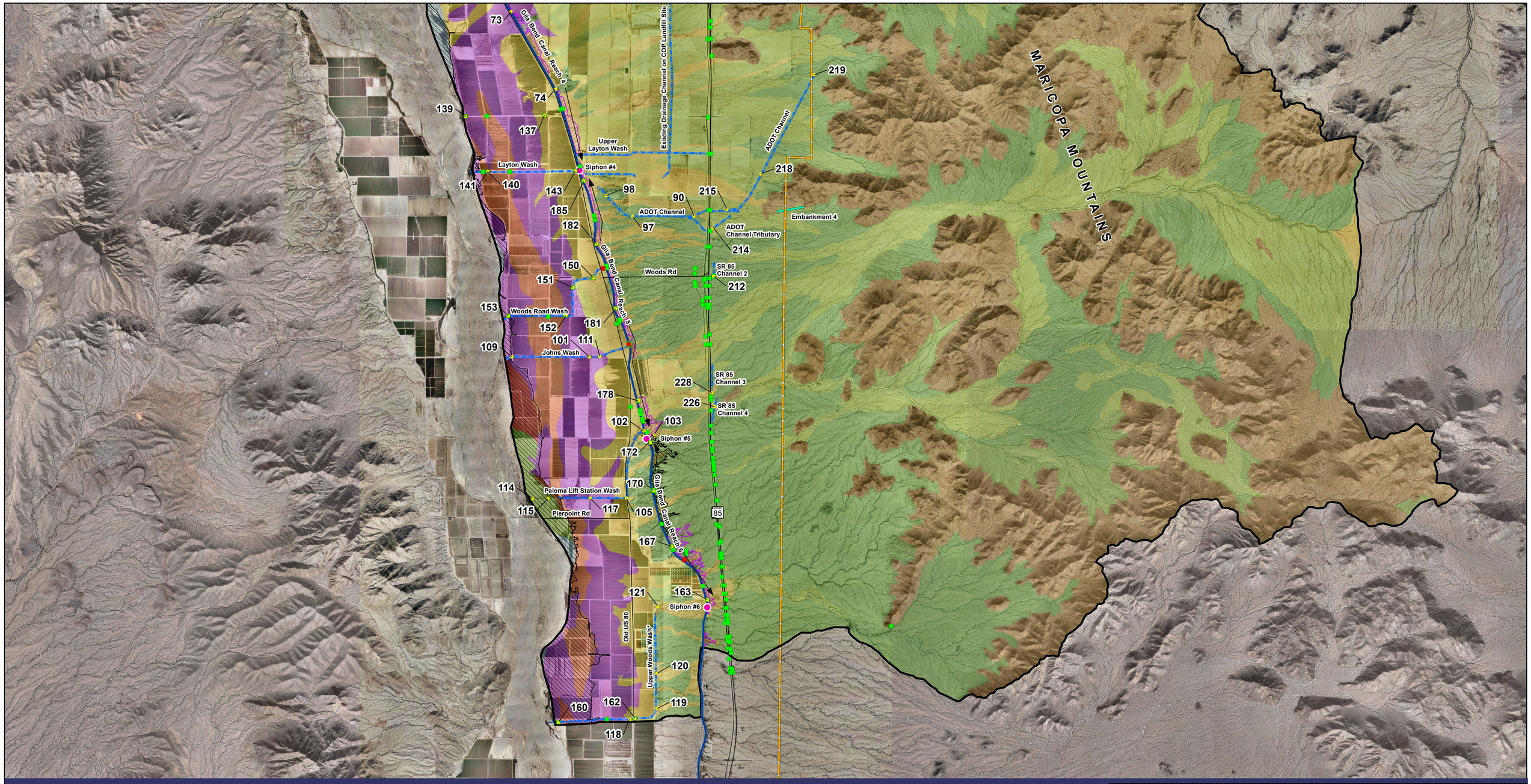


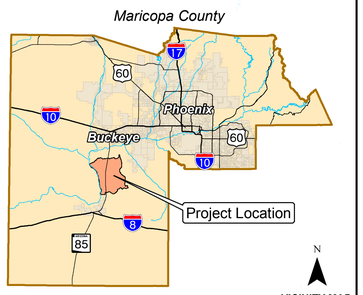
Woods Road Wash bed material at WP 152

Woods Road Wash looking downstream from WP 152

Woods Road Wash looking upstream from WP 153 at outfall to Gila River

PLATES





NOTES:

Aerial imagery flight dates Oct 2009 and Nov 2006
V:\52813\active\181300167\GIS\Project\NRCS_Er_Fa_Map_Plate_1_Sheet_2.mxd

LEGEND:

- 120 Waypoint with ID
- Culvert
- Clogged Culvert
- Siphon Location
- Road
- Gila Bend Canal
- Channel
- Embankment
- Project Boundary
- National Monument Boundary

FEMA Flood Zone

- A
- AE
- AO
- FW

EROSION FACTOR

LOW RANGE 0 to 0.20: 0, 0.02, 0.05, 0.1, 0.17, 0.2

MODERATE RANGE 0.25 to 0.45: 0.24, 0.32, 0.37

HIGH RANGE 0.45 to 0.65: 0.49, 0.55

PLATE 1
NRCS EROSION FACTOR MAP
SHEET 2 OF 2

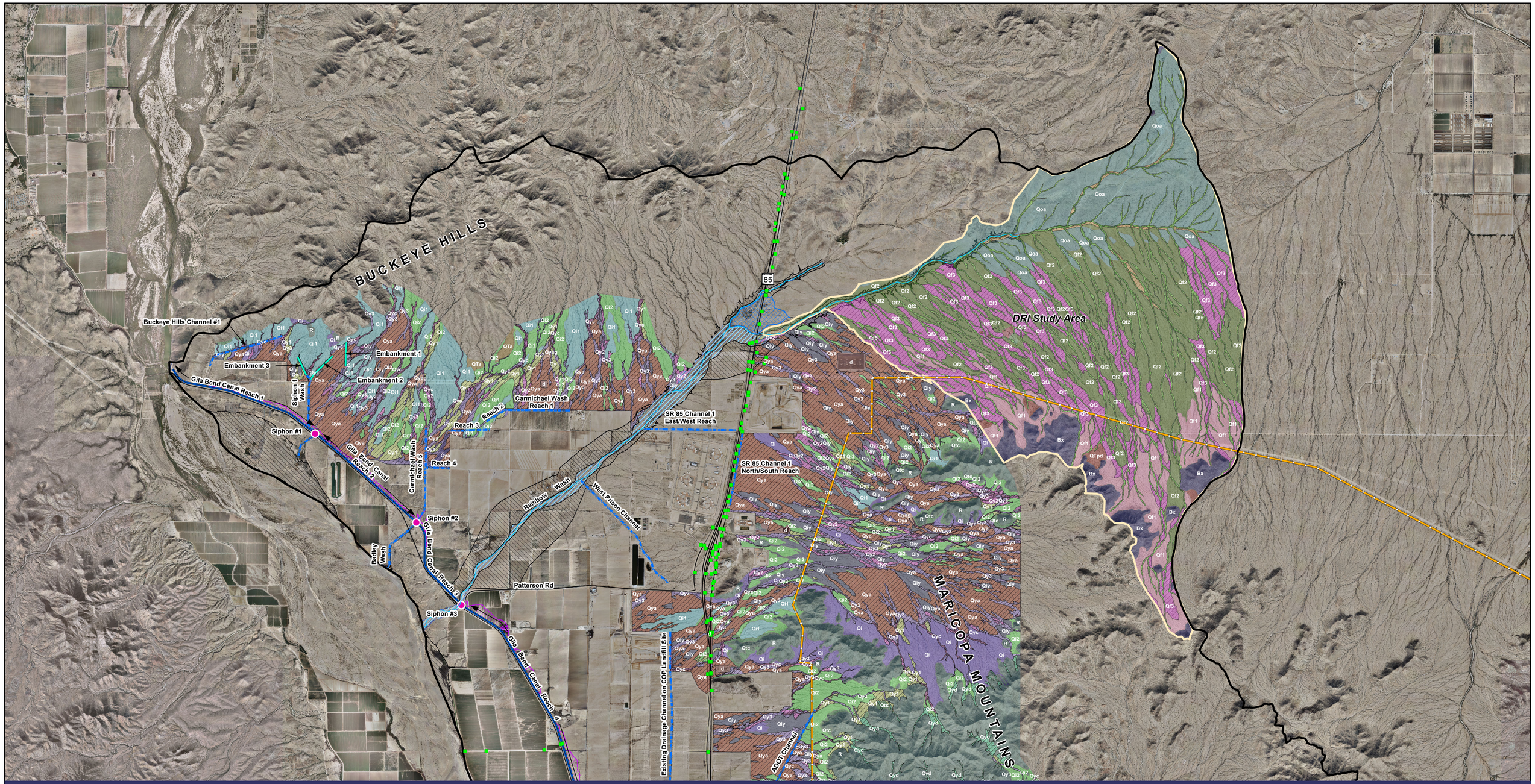
N

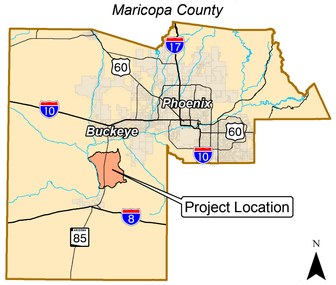
0 3,000 6,000
Feet

GILLESPIE AREA DRAINAGE MASTER STUDY
F.C.D. CONTRACT NO. 2009C039

Flood Control District of Maricopa County
2801 W. Durango St. Phoenix, AZ 85009

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044





NOTES:

Aerial imagery flight dates Oct 2009 and Nov 2006
V:\52813\active\181300167\GIS\Project\SurficialGeo_Plate_2_Sheet_1.mxd

LEGEND:

- Culvert
- Siphon Location
- Road
- Gila Bend Canal
- Channel
- Embankment
- National Monument Boundary
- Project Boundary
- Active/Unstable Areas

FEMA Flood Zone: A, AE, AO, FW

Pleistocene Deposits: Qiy, Qi3, Qi2, Qi1, Qi, QTa

Holocene Deposits: Qyc, Qy3, Qy2, Qya, Qyag, Qyd, Qy1

Other Deposits: Qtc, R, d

DRI Surficial Geologic Units: Active Wash, Qf5; Alluvial Fan, Qf1; Alluvial Fan, Qf2; Alluvial Fan, Qf3; Alluvial Terrace, Qf4; Mountain Highlands, Bx; Older Alluvium, Qoa; Pediment, QTpd

PLATE 2
SURFICIAL GEOLOGY
SHEET 1 OF 2

N

0 3,000 6,000
Feet

GILLESPIE AREA DRAINAGE MASTER STUDY
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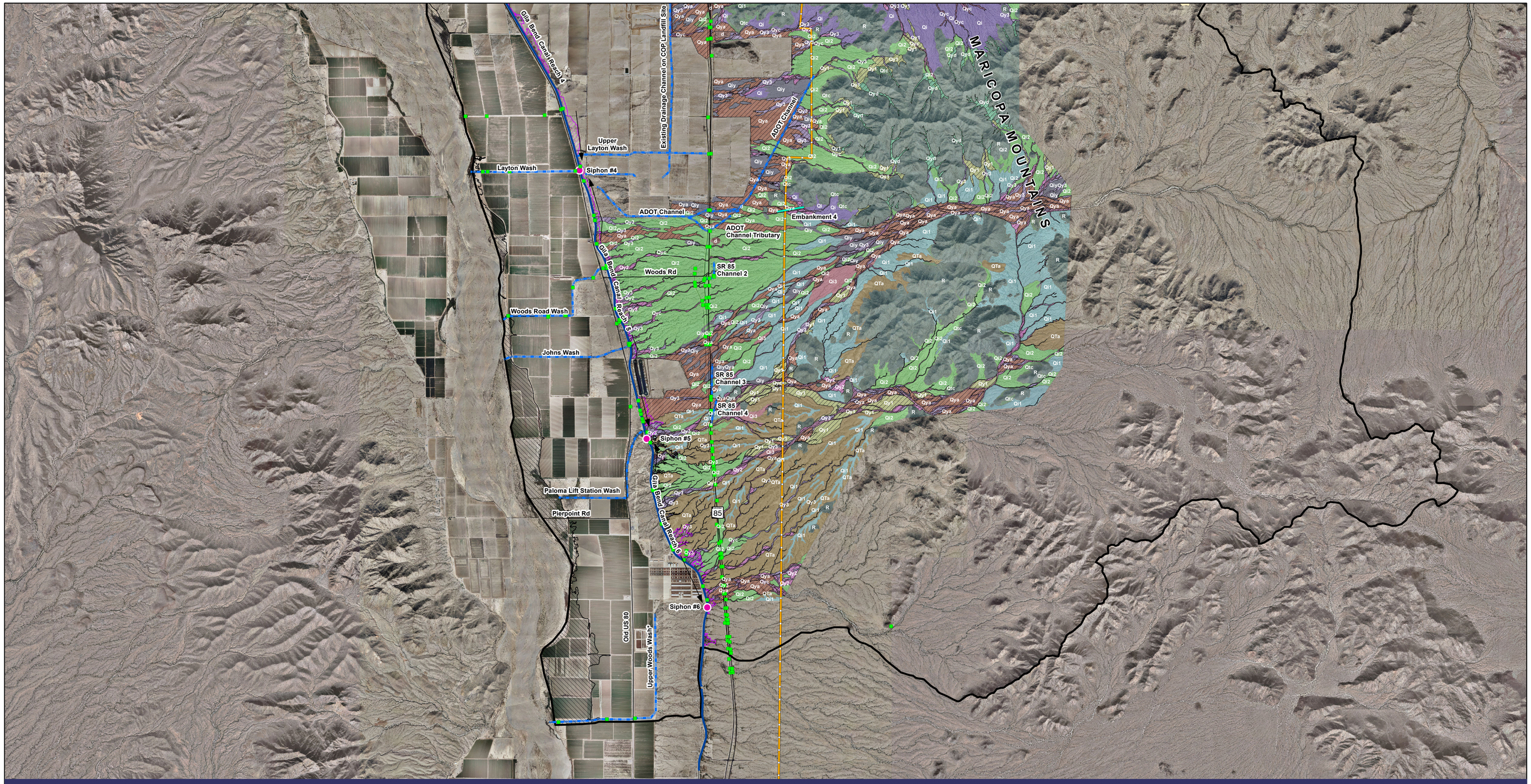

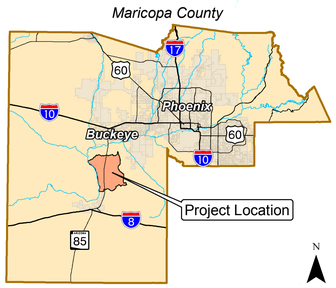

NOTES:

Aerial imagery flight dates Oct 2009 and Nov 2006
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LEGEND:

- Culvert
- Siphon Location
- Road
- Gila Bend Canal
- Channel
- Embankment
- National Monument Boundary
- Project Boundary
- Active/Unstable Areas

FEMA Flood Zone

- A
- AE
- AO
- FW

Pleistocene Deposits

- Qiy
- Qi3
- Qi2
- Qi1
- Qi
- QTa

Holocene Deposits

- Qyc
- Qy3
- Qy2
- Qya
- Qyag
- Qyd
- Qy1

Other Deposits

- Qtc
- R
- d

DRI Surficial Geologic Units

- Active Wash, Qf5
- Alluvial Fan, Qf1
- Alluvial Fan, Qf2
- Alluvial Fan, Qf3
- Alluvial Terrace, Qf4
- Mountain Highlands, Bx
- Older Alluvium, Qoa
- Pediment, QTpd

PLATE 2
SURFICIAL GEOLOGY
SHEET 2 OF 2

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0 3,000 6,000
Feet

GILLESPIE AREA DRAINAGE MASTER STUDY
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BUCKEYE HILLS

MARICOPA MOUNTAINS

Buckeye Hills Channel #1

193 6 190

Embankment 1

Embankment 2

Embankment 3

Gila Bend Canal Reach 1

Siphon 1 Wash

188 57

Siphon #1

194 55

Gila Bend Canal Reach 2

54 53 52 47

Siphon #2

16 18 19 20 50

Badley Wash

Gila Bend Canal Reach 3

Patterson Rd

49

Siphon #3

Gila Bend Canal Reach 4

73 74 139 137

Carmichael Wash Reach 5

Reach 4 45 46

Reach 3 44 42 43

Reach 2 40

Carmichael Wash Reach 1 41

Rainbow Wash 66

West Prison Channel 64

SR 85 Channel 1 East/West Reach

22 31 23 83

SR 85 Channel 1 North/South Reach

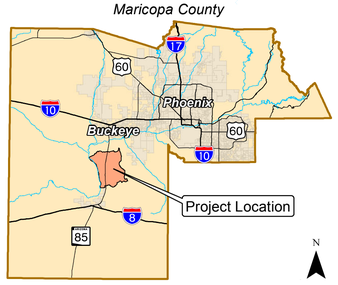
82 81

Existing Drainage Channel on COP Landfill Site

ADOT Channel

219

85



NOTES:

Aerial imagery flight dates Oct 2009 and Nov 2006
V:\52813\active\181300167\GIS\Project\DrainageIssues_Plate_3_Sheet_1.mxd

LEGEND:

- 45 Waypoint with ID
- Culvert
- Clogged Culvert
- Siphon Location
- Road
- Gila Bend Canal
- Constructed Channel
- Embankment
- Sedimentation Issues Areas
- Erosion Issues Areas
- Distributary Flow Areas (Potential Lateral Migration Issue Areas)
- Wash Thalweg
- Project Boundary
- National Monument Boundary

100-Year Flood Zone

- A
- AE
- AO
- FW

Land Owner

- BLM
- Local or State Parks
- Private
- State Trust

Areas within the Rainbow Wash 100-Year Flood Zone are potential lateral migration issue areas.

PLATE 3
FLOODING & DRAINAGE ISSUES
SHEET 1 OF 2

N

0 3,000 6,000
Feet

GILLESPIE AREA DRAINAGE MASTER STUDY
F.C.D. CONTRACT NO. 2009C039

Flood Control District of Maricopa County
2801 W. Durango St. Phoenix, AZ 85009

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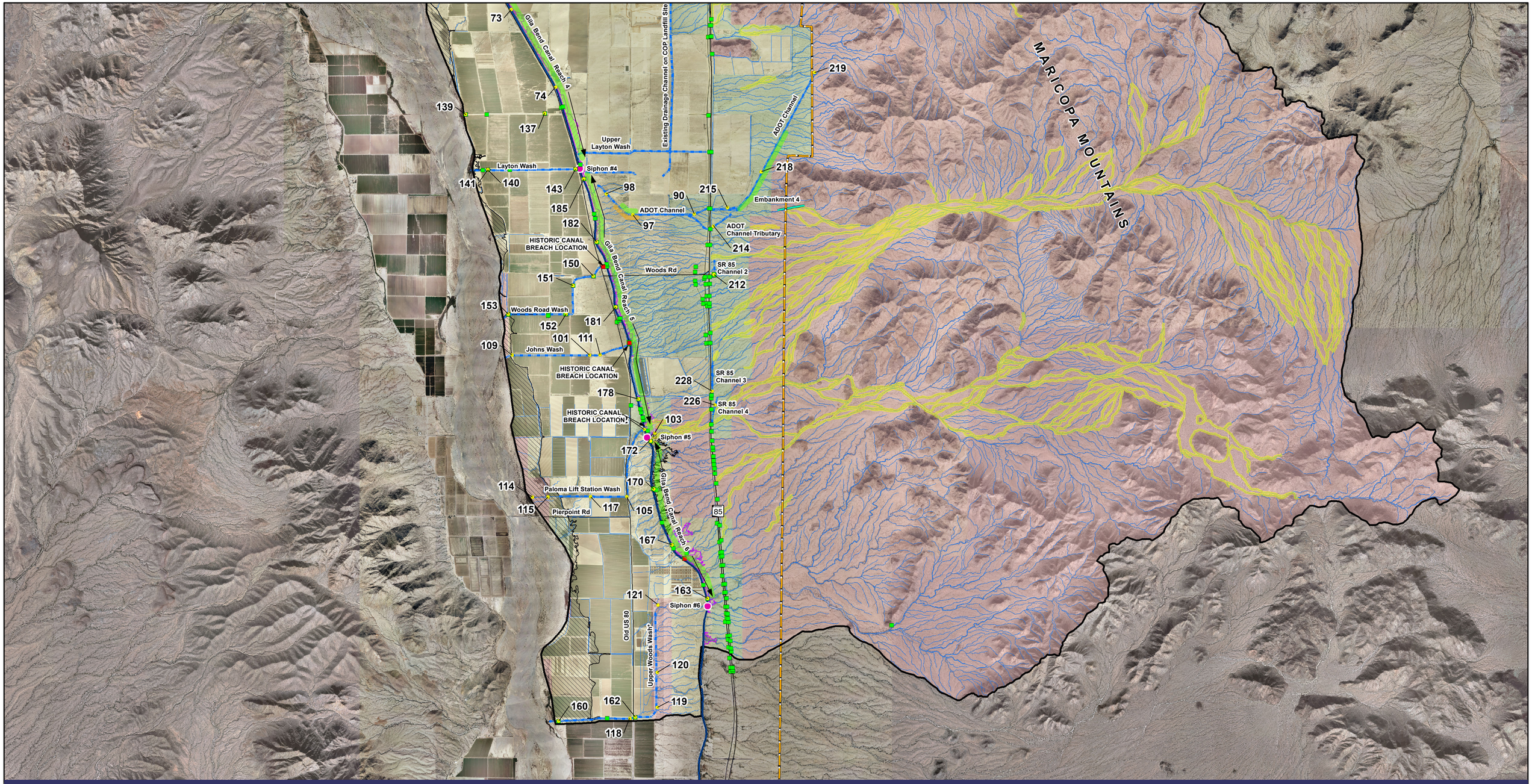
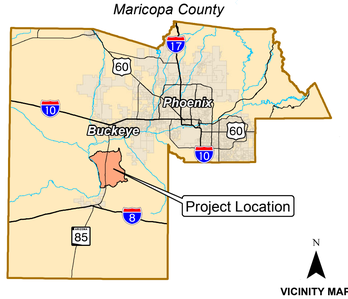
Phoenix, AZ U.S.A. 85044





NOTES:

Aerial imagery flight dates Oct 2009 and Nov 2006
V:\52813\active\181300167\GIS\Project\DrainageIssues_Plate_3_Sheet_2.mxd

LEGEND:

- 162 Waypoint with ID
- Culvert
- Clogged Culvert
- Siphon Location
- Road
- Gila Bend Canal
- Constructed Channel
- Embankment
- Sedimentation Issues Areas
- Erosion Issues Areas
- Distributary Flow Areas *(Potential Lateral Migration Issue Areas)*
- Wash Thalweg
- Project Boundary
- National Monument Boundary

100-Year Flood Zone

- A
- AE
- AO
- FW

Areas within the Rainbow Wash 100-Year Flood Zone are potential lateral migration issue areas.

Land Owner

- BLM
- Local or State Parks
- Private
- State Trust

PLATE 3
FLOODING & DRAINAGE ISSUES
SHEET 2 OF 2

N

0 3,000 6,000
Feet

Flood Control District of Maricopa County
2801 W. Durango St. Phoenix, AZ 85009

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