LAW/CRANDALL
A DIVISION OF LAW ENGINEERING
AND ENVIRONMENTAL SERVICES, INC.

REPORT OF GEOTECHNICAL INVESTIGATION (PHASE I)

Law/Crandall Project 702.41-50354.05

BASINS A, E, AND F GUADALUPE, ARIZONA ASSIGNMENT NO. 7 CONTRACT FCD 95-40

Prepared for:

FLOOD CONTROL DISTRICT
MARICOPA COUNTY, ARIZONA

SEPTEMBER 16, 1996

LAW/CRANDALL
A DIVISION OF LAW ENGINEERING
AND ENVIRONMENTAL SERVICES, INC.

September 16, 1996

Mr. Warren Rosebraugh
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Subject: **Report of Geotechnical Investigation (Phase I)**
Basins A, E, and F; Guadalupe, Arizona
Assignment No. 7
Contract FCD 95-40
Law/Crandall Project No. 702.41-50354.05

Dear Mr. Rosebraugh:

Law/Crandall (LAW) is pleased to present this report of our geotechnical investigation for the subject flood basins to be located in Guadalupe, Arizona. Our services were provided in general accordance with Phase I of our *Scope of Services and Cost Estimate for Geotechnical Investigation and Percolation Testing* dated August 8, 1996. The services for the percolation testing to be performed under Phase II are pending your authorization. Our services were authorized under Flood Control District of Maricopa County (FCDMC) Contract FCD 95-40 for *On-Call Geotechnical and Testing Services*.

Our report presents a review of the project information provided to us, a description of the subsurface conditions encountered, moisture-density relationship test results, and a general evaluation of the excavation conditions to be expected for the soils encountered at the proposed basins. We understand that recommendations for earthwork details and site preparation were not requested as part of the services to be performed under Phase I. The attachments to the report include a vicinity map, boring location plans, soil boring logs, and the results of our laboratory testing.

We appreciate this opportunity to provide our services, and we look forward to serving as your geotechnical consultant throughout this project. Please contact us if you have any questions or require additional information.

Sincerely,

LAW/CRANDALL
A Division of Law Engineering and Environmental Services, Inc.

Bruce A. Wolle, P.E. (CA)
Project Engineer

Marshall Lew, Ph.D., P.E.
Principal Engineer
Vice President

Registered Professional Engineer (Civil)
CERTIFICATE NO.
19979
MARSHALL LEW
Date Signed 9-16-96
ARIZONA, U.S.A.

BAW:ML:kjw
(50354-05)

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REPORT OF
GEOTECHNICAL INVESTIGATION
(PHASE I)

BASINS A, E, AND F
GUADALUPE, ARIZONA
ASSIGNMENT NO. 7
CONTRACT FCD 95-40

PREPARED FOR:

FLOOD CONTROL DISTRICT
MARICOPA COUNTY, ARIZONA

PREPARED BY:

LAW/CRANDALL
PROJECT 702.41-50354.05

SEPTEMBER 16, 1996

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1.0 EXECUTIVE SUMMARY

LAW completed a subsurface investigation at the three sites of the proposed flood basins located in Guadalupe, Arizona. The purpose of our investigation was to obtain general subsurface soil information in the vicinity of the proposed basins and provide the results of the field explorations and laboratory testing.

The topography of the existing ground surface at each basin is relatively flat with the exception of the south side of Basin A. Based on surface elevations observed at the proposed sites for the basins, we estimate that 3 to 5 feet of removal of soils will be required to achieve final grade elevations in the basins. Based on our subsurface explorations, the proposed location for each basin is primarily located on native soils. Our borings encountered brown silty sand with clay to a depth of about 11 feet at all three proposed basin locations. Firm to hard subsurface conditions with cemented gravelly layers were encountered and moderate excavation difficulties should be anticipated. Ground water and deleterious fills were not encountered during our field subsurface exploration.

2.0 PROJECT INFORMATION

We received project information during telephone conversations with Mr. Warren Rosebraugh during July and August 1996. Based on these conversations, we understand that three flood detention basins (Basins A, E, and F) are proposed to be constructed at the sites approximately located as shown on Figure 1. We understand that proposed construction of the basins will consist of excavation to a depth of approximately 3 to 5 feet.

We were not provided with plans for the construction details of the basins. We were advised that the basins will be sized based on infiltration properties and soil subsurface conditions. We understand the final basin grades are expected to be approximately 3 feet lower than the existing grade.

3.0 PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the subsurface conditions at the site of the proposed basins to be located in Guadalupe, Arizona. The following information is provided in our report:

- A summary of the information provided to us;
- A brief summary of our test procedures and the results of the testing conducted; and,
- A summary of surface and subsurface soil and ground water conditions encountered in the borings.

The assessment of geologic hazards, site environmental conditions or the presence of pollutants in the soil, rock, and ground water of the site was beyond the scope of this investigation.

4.0 FIELD EXPLORATION AND LABORATORY TESTING

4.1 FIELD EXPLORATIONS

The soil conditions beneath the site were explored on August 9, 1996 by drilling eight borings in the vicinity of the proposed basins. Ten borings were originally planned as part of the field exploration. The approximate locations of the borings for Basin A are shown on Figure 2, for Basin E are shown on Figure 3, and for Basin F are shown on Figure 4. The depths of the borings were dependent on both surface and subsurface conditions encountered during the drilling process. Eight borings were completed to the planned termination depth of 11 feet. Two borings planned for Basin E were not completed due to access problems and surface conditions. Details of the explorations and logs of the soil borings are presented in the attached Appendix.

4.2 LABORATORY TESTING

Laboratory tests were performed on selected samples obtained from the borings to aid in the classification of the soils and to determine the pertinent engineering properties of the basin soils. The following tests were performed:

- Atterberg Limits
- Moisture-Density Relationship
- Sieve Analysis; and,
- In-Situ Moisture Content and Dry Density Determination

The testing was performed in general accordance with applicable ASTM specifications. Details of the laboratory testing program and test results are presented in the Appendix.

5.0 SURFACE AND SUBSURFACE CONDITIONS

5.1 SURFACE CONDITIONS

According to USGS topographic maps of the area and plans provided to us, the elevation of all three basins is approximately 1,210 feet above mean sea level. The existing topography near Basin A is relatively flat and bordered along the north side by the South Branch Highline Canal. The south side of Basin A consists of a small hill approximately 10 to 15 feet higher in elevation than the rest of the basin area. The existing topography of both Basin E and Basin F is relatively flat, and both basins are bordered on the east side by the South Branch Highline Canal. General access to Basin A is from Calle Cerritos on the south side and general access to Basin F is from Calle Vauo Nawi on the north side. Access to Basin E is from Calle Guadalupe on the south side and from the South Branch Highline Canal on the east side.

Surface conditions were observed during our field exploration on August 9, 1996. At the time of our field exploration, the sites for all three basins were graded relatively flat. Basin A and Basin F were both observed to be undeveloped. The surface of Basin E contained a large quantity of solid waste debris including but not limited to discarded construction materials, wood, and automobile parts. Surface soil conditions of all three basins consisted of exposed silty sand free of vegetation growth.

5.2 SUBSURFACE CONDITIONS

The subsurface soils encountered during our exploration are described on the Test Boring Records in the Appendix. These Test Boring Records represent our interpretation of the subsurface conditions based on the field logs, visual examination of the field samples by an engineer, and tests of the collected field samples. The lines designating the interface between various strata on the Test Boring Records represent the approximate interface location; the actual transition between strata may be gradual. The following section summarizes our findings.

Subsurface conditions at Basin A were explored on August 9, 1996 by advancing three borings. The soils encountered in Borings B-1 and B-2 consisted primarily of a very firm to hard, brown, silty clayey sand with low to moderate plasticity (USCS classification of SC). The soils encountered in

Boring B-3 was advanced near the hill located on the south side of the proposed basin area and consisted of very firm to hard silty sand with low plasticity (USCS classification of SM). At all three boring locations, a cemented gravel layer at a depth of approximately 2 to 3 feet was encountered with intermittent gravel and rock lenses extending to the auger termination depth of about 11 feet below the ground surface.

Subsurface conditions at Basin E were explored on August 9, 1996 by advancing one soil boring in the vicinity of the basin. The soils encountered in Boring B-4 consisted of firm brown, silty sand with low plasticity (USCS classification of SM). Borings B-5 and B-6, were not advanced due to solid waste debris and inability to access the central basin area with drilling rig equipment. The silty sand in Boring B-4 extended to an auger termination depth of about 11 feet below the ground surface.

Subsurface conditions at Basin F were explored on August 9, 1996 by advancing four borings. The soils encountered in all four Borings B-7, B-8, B-9, and B-10 consisted primarily of a very firm to hard, brown, silty clayey sand with low to moderate plasticity (USCS classification of SC). The silty clayey sand in all four borings extended to an auger termination depth of about 11 feet below the ground surface.

The soils encountered were generally low in moisture content. Ground water and deleterious fill was not encountered in the soil borings at the time of drilling.

6.0 CONCLUSIONS AND OPINIONS

Based upon our field explorations and laboratory results, the existing native soils encountered in the three proposed basin areas (Basins A, E, and F) consist of firm to hard silty sand with fines. Layers of cemented gravel and rock were encountered in the proposed area for Basin A which may require moderate to difficult excavation efforts. We recommend the assistance of heavy equipment with ripping tools for excavation of the proposed basin areas. The surface conditions at the proposed location for Basin E consisted of a large quantity of construction debris and solid waste materials. In our opinion, these materials should be removed prior to commencement of excavation activities.

Sieve analysis and Atterberg Limits determinations on the native soil samples from the three proposed basin areas indicate the presence of fine soil particles. In our opinion, fine particles reduce the porosity of the subsurface soil matrix and will result in slower infiltration rates of the proposed basins. In addition, the presence of cemented layers will also result in lower permeability and slower infiltration rates. As outlined in Phase II of our *Scope of Services and Cost Estimate for Geotechnical Investigation and Percolation Testing* dated August 8, 1996, we recommend the evaluation of the infiltration properties at the location of each proposed basin. The percolation testing should be performed in general accordance with *Arizona Department of Environmental Quality (ADEQ) Engineering Bulletin No. 12* dated June 1989.

APPENDIX

SUMMARY OF FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

Subsurface Investigation

To explore the subsurface conditions in the area of the planned basins, ten test borings (designated B-1 through B-10) were attempted at the site. Two borings could not be advanced due to solid waste debris and the inability to access the planned boring locations. The approximate locations of the borings for Basin A are shown on Figure 2, for Basin E are shown on Figure 3, and for Basin F are shown on Figure 4.

The locations of the soil test borings were planned by FCDMC personnel and established in the field by LAW personnel. The boring locations should be considered accurate only to the degree implied by the method used. Ground surface elevations at the boring locations were established by LAW personnel.

Relatively undisturbed and bulk samples were obtained from the borings. The samples were used for classification and in laboratory testing to determine various properties of soil. Our drilling and sampling was performed in general accordance with applicable ASTM standards.

The soil borings were advanced using a truck-mounted, hollow stem auger drilling equipment. Soil samples were obtained using a 2 inch outside diameter, 1-3/8 inch inside diameter split spoon (standard SPT sampler), or a 3 inch outside diameter, 2.42 inch inside diameter California ring sampler. Soil samples were collected at intervals ranging from 2 to 10 feet, commencing at a depth of approximately 2 feet below the ground surface. Our field engineer monitored the drilling operations, logged the borings, recorded the penetration resistances of the samplers, and obtained relatively undisturbed and bulk samples for the laboratory testing.

After drilling, the boreholes were backfilled with the soil drill cuttings. At the completion of the drilling operations, the soil samples were transported to our laboratory where they were reviewed by a geotechnical engineer and samples were selected for laboratory testing.

The soils were visually classified in the field by our engineer in accordance with the Unified Soil Classification System (USCS). The logs of the borings are presented in the attached Test Boring Records. The USCS is also presented. These records present our interpretations of the subsurface conditions based on our field observations, a visual examination of samples by our engineer, and the indicated laboratory tests performed on selected samples. The lines designating the interface between various strata on the test boring records represent the approximate positions of the interface. The transition between strata may be gradual. Ground water conditions indicated in our report represent conditions only at the time of our exploration.

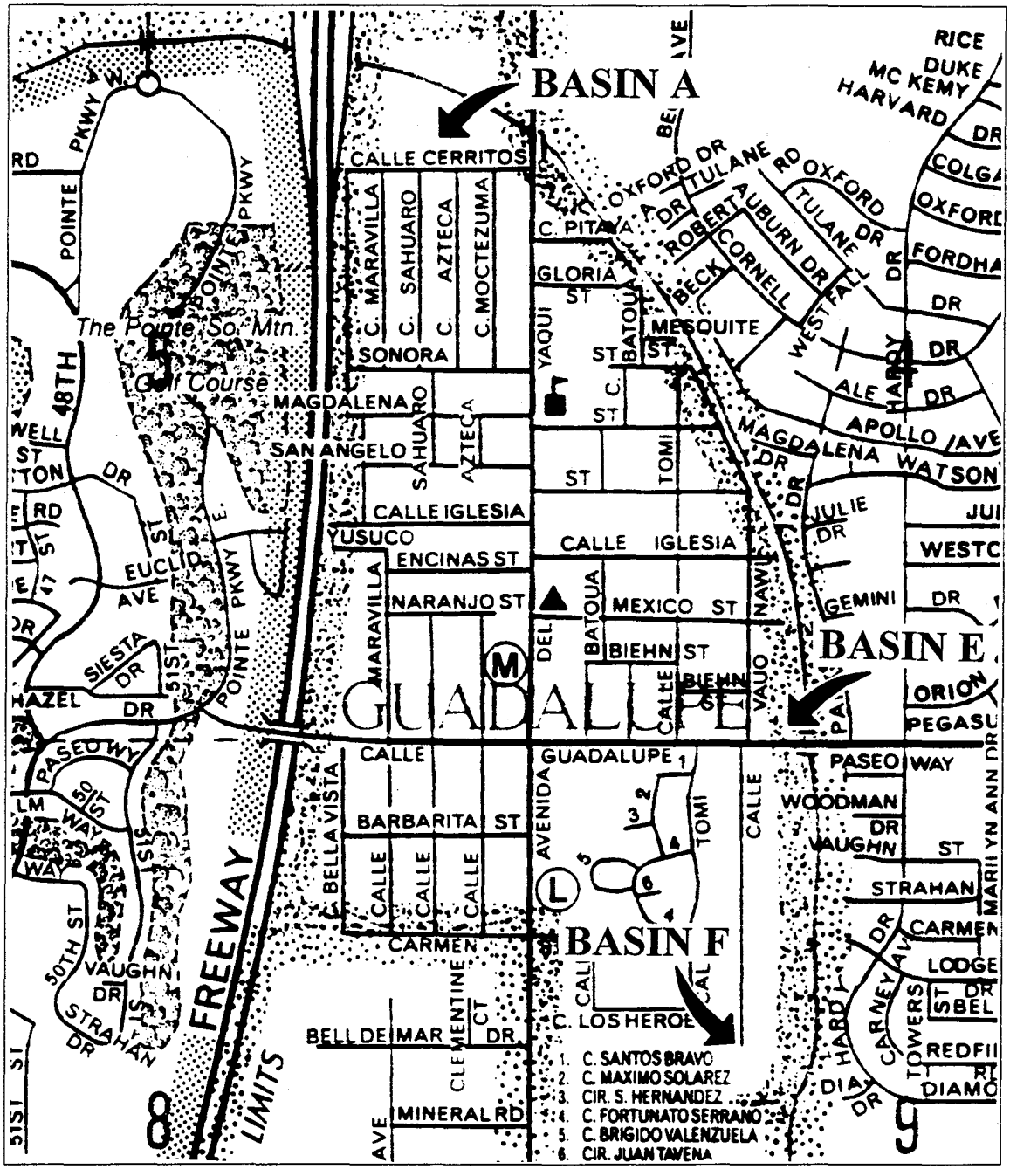
LABORATORY TESTING

Laboratory tests were performed on selected soil samples to aid in classification and to evaluate the physical and engineering characteristics of the soil. Laboratory testing included Atterberg limits testing, in-situ moisture and density determinations, moisture-density relationship, and sieve analyses to establish grain size distribution. The testing was performed in general accordance with applicable ASTM standards. We will store the collected samples for a period of 60 days, after which time they will be discarded, unless we are otherwise notified. The results of the laboratory tests are discussed in this section.

The field moisture content and dry density of the soils encountered were determined by performing tests on the undisturbed samples. Dry densities and moisture contents obtained from undisturbed ring samples indicated a range of about 94.2 to 120.4 pounds per cubic foot, and 1.3 percent to 6.2 percent, respectively. The results of the testing is presented on Table I: Summary of Laboratory Testing.

To determine the particle size distribution of the soils and to aid in classifying the soils, mechanical analyses were performed. Three sieve analyses and Atterberg limits tests were performed on selected soil samples collected from about 2 feet and 10 feet below the ground surface. Percentages of gravel sized particles ranged from 1.0 percent to 11.0 percent, percentages of sand sized particles ranged from about 50.2 percent to 63.9 percent, and percentages of fines ranged from about 27.1 percent to 46.8 percent. To aid in the classification of the soils, Atterberg limits tests were also performed on selected samples. Liquid limits ranged from no liquid limit value (NV) to 46 with plasticity indices

ranging from non-plastic (NP) to 29. The results of the testing are presented on the attached Particle Size Distribution Test Reports, Moisture-Density Relationship Test Reports, and on Table I - Summary of Laboratory Testing.



SOURCE: WIDE WORLD OF MAPS, DATED 1994.

SCALE

0 1200 2400 FEET

N

VICINITY MAP	FIGURE 1

LAW PROJECT NAME:	GUADALUPE BASINS A, E AND F
LAW PROJECT NO:	702.41-50354.05
DRAWN BY:	BLN
DATE:	9/11/96

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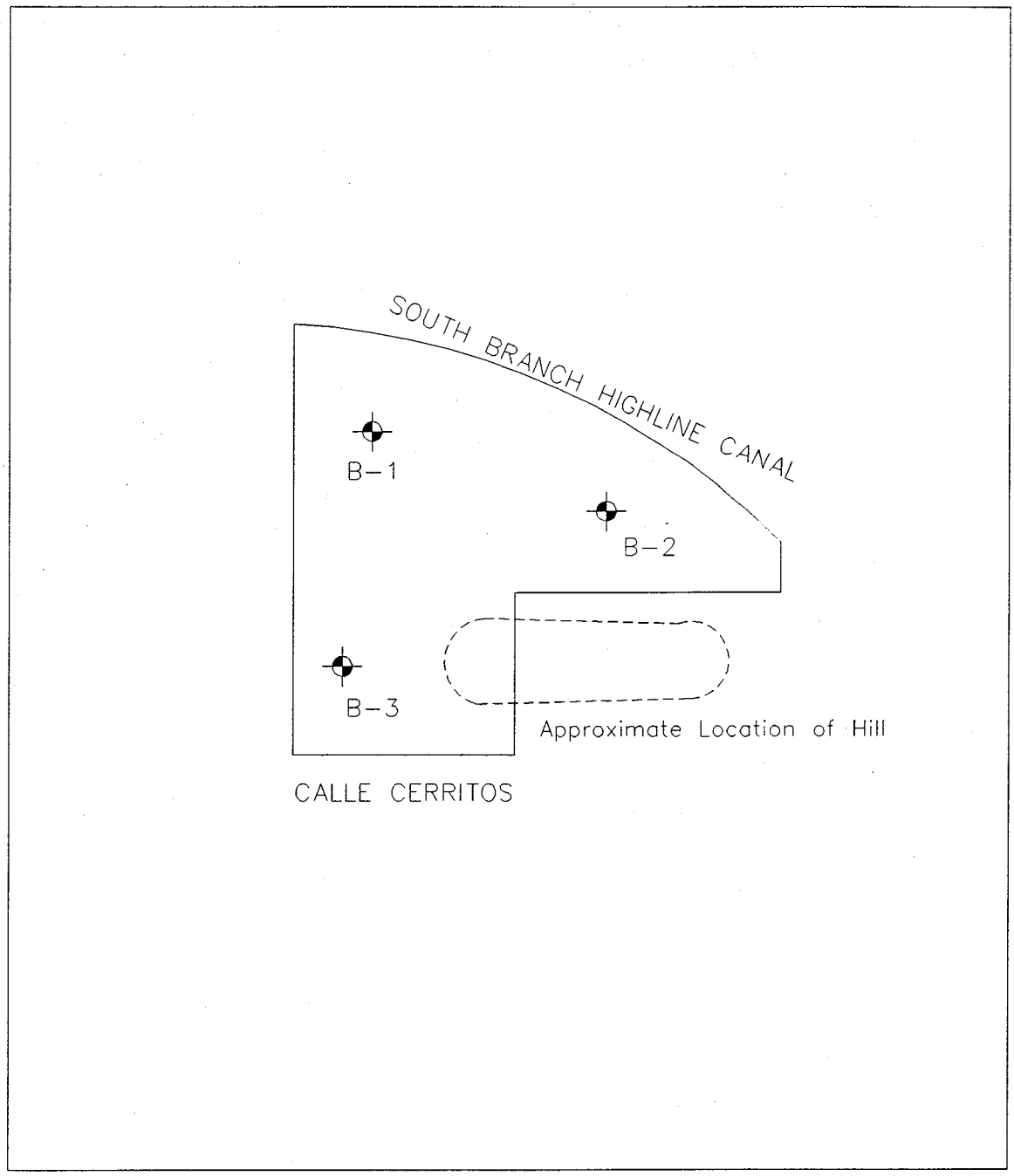
FILE NO.: 50354-5.DWG -- CHECKED: P.M._____, PRINCIPAL_____



NOT TO SCALE

N

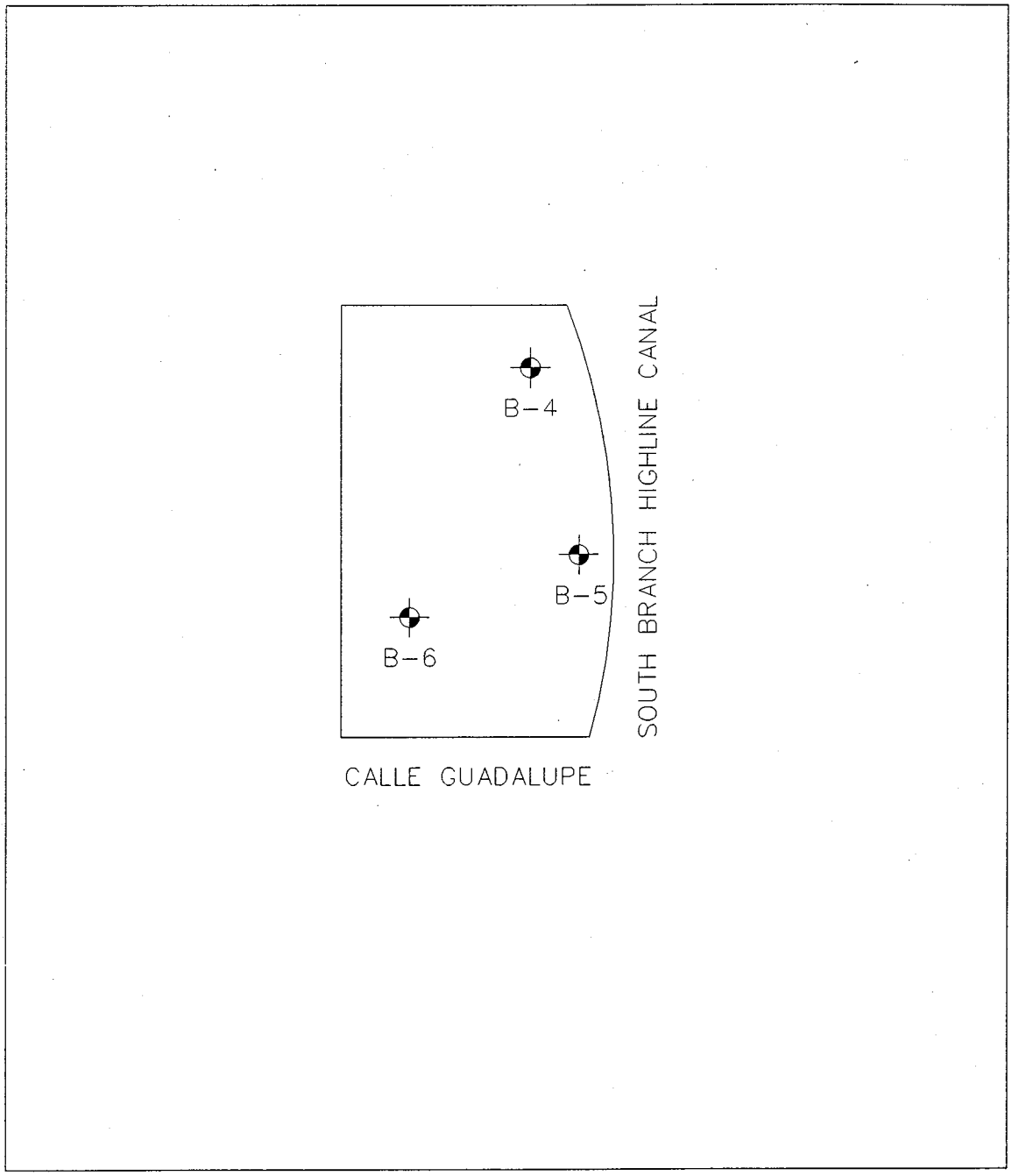
BASIN A BORING LOCATION PLAN	FIGURE 2

LAW PROJECT NAME:	GUADALUPE BASINS A, E AND F
LAW PROJECT NO:	702.41-50354.05
DRAWN BY:	BLN
DATE:	9/11/96

LAW/CRANDALL

A DIVISION OF LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

FILE NO.: 50354-5A.DWG -- CHECKED: P.M._____, PRINCIPAL_____



NOT TO SCALE

N

BASIN E BORING LOCATION PLAN

FIGURE 3

LAW PROJECT NAME: GUADALUPE BASINS A, E AND F
LAW PROJECT NO: 702.41-50354.05
DRAWN BY: BLN
DATE: 9/11/96

LAW/CRANDALL
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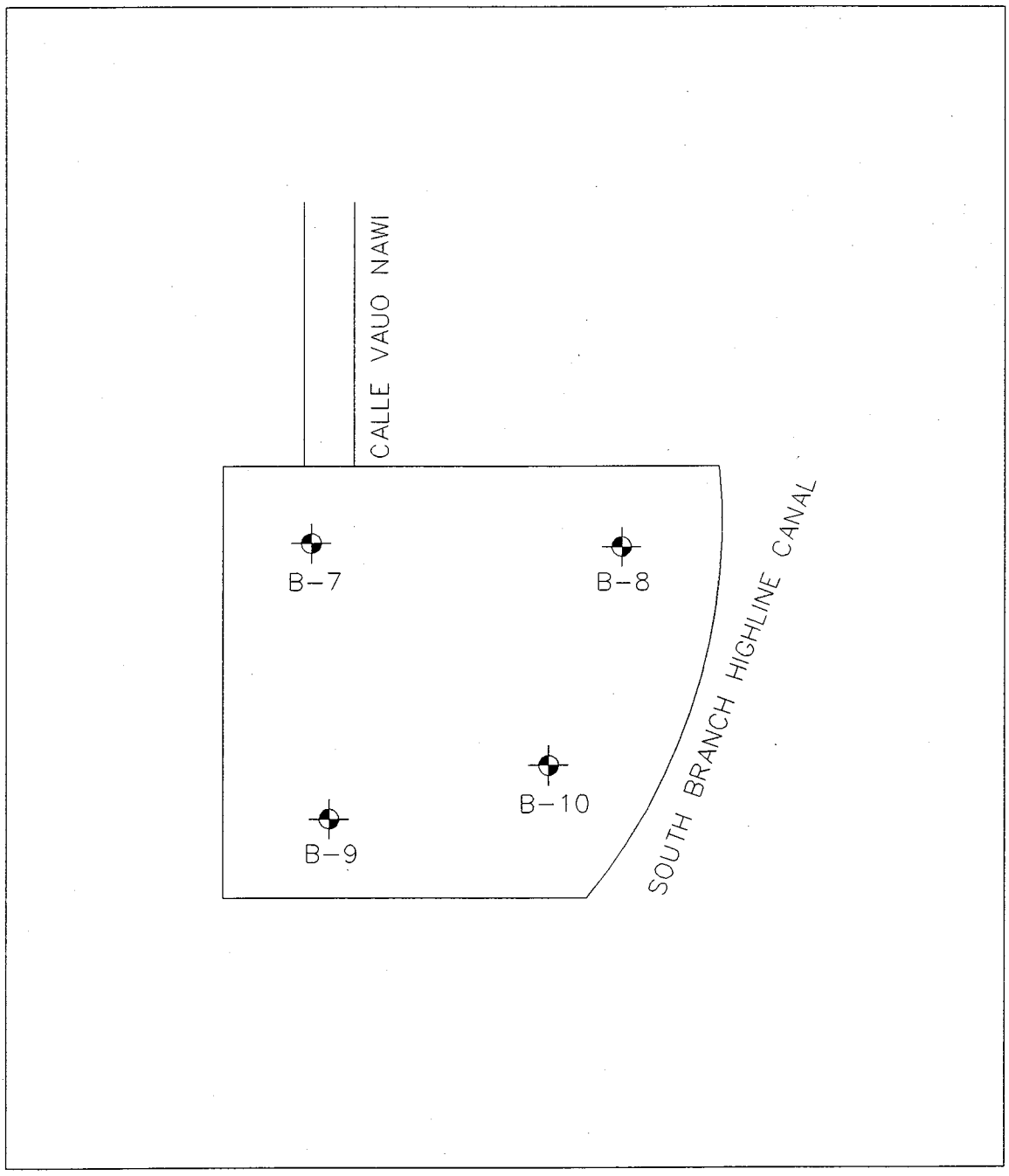
FILE NO.: 50354-5B.DWG -- CHECKED: P.M._____, PRINCIPAL_____



NOT TO SCALE

N

BASIN F BORING LOCATION PLAN

FIGURE 4

LAW PROJECT NAME: GUADALUPE BASINS A, E AND F
LAW PROJECT NO: 702.41-50354.05
DRAWN BY: BLN
DATE: 9/11/96

LAW/CRANDALL

A DIVISION OF LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

FILE NO.: 50354-5C.DWG -- CHECKED: P.M._____, PRINCIPAL_____

SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	50		R	109.1	4.6	SC		5	Brown silty clayey SAND, low moisture, moderate plasticity with cemented gravel and rock lenses.	Approximate Boring Location: NW corner of Basin A
	50		N					10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-1
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
PAGE 1 OF 1	

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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	8		R	101.8	1.3	SC		5	Brown silty clayey SAND, low moisture, moderate plasticity with cemented gravel and rock lenses.	Approximate Boring Location: East side of Basin A
	32		R	101.8	4.7			10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-2
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	47		R	117.1	2.8	SM		5	Brown silty SAND, low moisture, low plasticity with cemented gravel and rock lenses.	Approximate Boring Location: SW corner of Basin A near knoll
	50		R					10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-3
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	20		R	100.0	2.5	SM		5	Light brown silty SAND, low moisture, low plasticity.	Approximate Boring Location: NE corner of Basin E (near canal)
	35		R	104.2	3.7			10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-4
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
PAGE 1 OF 1	

LAW/CRANDALL

SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
										Attempted Boring Location: East side of Basin E (near canal) Boring not advanced due to solid waste debris at surface

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-5
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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LAW/CRANDALL

SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
									Attempted Boring Location: SW corner of Basin E Boring not advanced due to solid waste debris at surface

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-6
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	20		R	94.2	7.2	SC		5	Light brown silty clayey SAND, low moisture, moderate plasticity.	Approximate Boring Location: NW corner of Basin F
	50		R	95.0	5.0			10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-7
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	50		R	104.8	6.2	SC		5	Light brown silty clayey SAND, low moisture, moderate plasticity.	Approximate Boring Location: NE corner of Basin F (near canal)
	50		R					10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-8
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	13		R	96.4	4.8	SC		5	Light brown silty clayey SAND, low moisture, low to moderate plasticity.	Approximate Boring Location: SW corner of Basin F
	50		R					10		
									Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-9
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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SAMPLE NO.	BLOWS/FOOT	SYMBOL	TYPE N R B	DRY DENSITY (PCF)	MOISTURE CONTENT %	UNIFIED CLASSIFICATION	SYMBOL	DEPTH IN FEET	DESCRIPTION	REMARKS
	32		R			SC		5	Light brown silty clayey SAND, low moisture, low to moderate plasticity.	Approximate Boring Location: SE corner of Basin F (near canal)
	33		R					10	Approximate ground surface elevation = 1,210 ft. Total depth = 11 ft below ground surface. No groundwater encountered.	

NOTES: SPT = Standard Penetration Test; N = SPT value (140 lb hammer free-falling 30 inches); R = ring sample; 8 inch diameter borehole

TEST BORING RECORD

BORING NUMBER	B-10
DATE DRILLED	August 9, 1996
PROJECT NUMBER	702.41-50354.05
PROJECT	Guadalupe Basins A, E, & F
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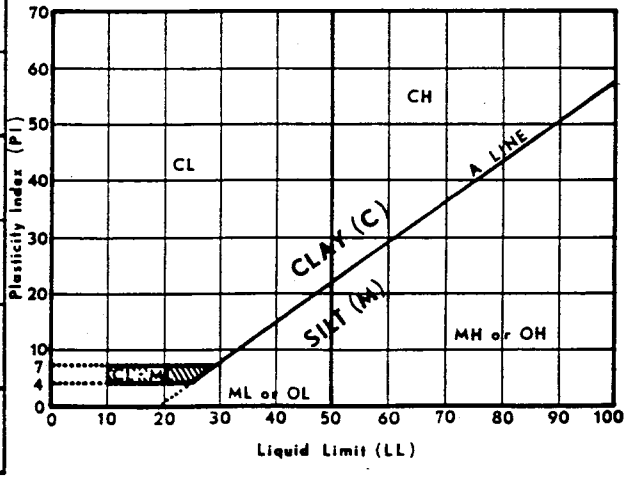
Unified Soil Classification System

Major divisions			Group Symbol	Typical names	Laboratory classification criteria
COARSE GRAINED SOILS (More than half of material is larger than No. 200 sieve)	Gravels (More than half of coarse fraction is larger than No. 4 sieve)	Clean gravels	GW	Well graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}} > 4$; $1 < C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} < 3$
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve)	Clean sands	SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}} > 6$; $1 < C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} < 3$
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines	SM	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 / Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring the use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
FINE GRAINED SOILS (More than half of material is smaller than No. 200 sieve)	Silts and clays (LL less than 50)		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and clays (LL greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
			CH	Inorganic clays of high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity, organic silts	
	Highly Organic Soils		Pt	Peat and other highly organic soils	

Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse grained soils are classified as follows:

Less than 5% ..... GW, GP, SW, SP
More than 12% ..... GM, GC, SM, SC
5 to 12% ..... Borderline cases requiring dual symbols

1. Plot intersection of PI and LL as determined from Atterberg Limits tests.
2. Points plotted above A line indicate clay soils, those below the A line indicate silt.



Plasticity Chart

UNIFIED SOIL CLASSIFICATION

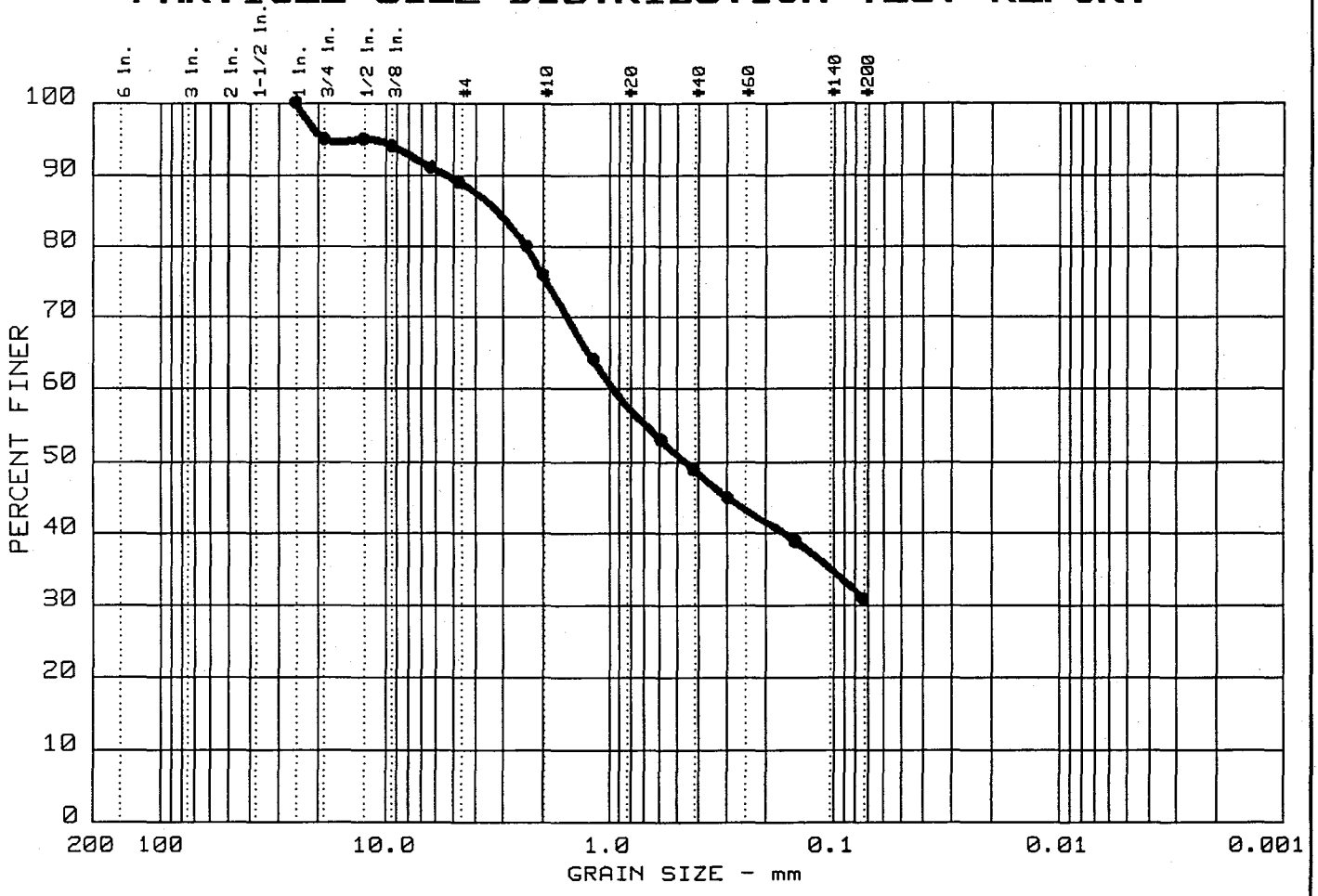
LAW/CRANDALL
Engineering and Environmental Services

TABLE I
Summary of Laboratory Testing
Basins A, E, and F
Guadalupe, Arizona
Law/Crandall Project No. 702.41-50354.05

Sample Location Boring/Depth	Sieve Analysis			In-Situ Moisture Content (%)	In-Situ Dry Density (pcf)	Consol. Swell / Collapse ±, (%)	Atterberg Limits, %		Moisture-Density Relationship ASTM D 698-78, Meth A, Std		USCS[1]
	Gravel (%)	Sand (%)	Fines (%)				Liquid Limit	Plasticity Index	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	
B-1 / (0' - 10')	NT	NT	NT	NT	NT	NT	NT	NT	123.8	9.7	SC
B-1 / (2' - 3')	NT	NT	NT	4.6	109.1	NT	NT	NT	NT	NT	SC
B-1 / (10' - 11')	11.0	58.0	31.0	NT	NT	NT	33	20	NT	NT	SC
B-2 / (2' - 3')	NT	NT	NT	1.3	101.8	NT	NT	NT	NT	NT	SC
B-2 / (10' - 11')	NT	NT	NT	4.7	101.8	NT	NT	NT	NT	NT	SC
B-3 / (2' - 3')	9.0	63.9	27.1	2.8	117.1	NT	NV	NP	NT	NT	SM
B-4 / (0' - 10')	NT	NT	NT	NT	NT	NT	NT	NT	104.1	15.7	SM
B-4 / (2' - 3')	4.0	53.6	42.4	2.5	100.0	NT	24	NP	NT	NT	SM
B-4 / (10' - 11')	NT	NT	NT	3.7	104.2	NT	NT	NT	NT	NT	SM
B-7 / (0' - 10')	NT	NT	NT	NT	NT	NT	NT	NT	119.6	11.1	SC
B-7 / (2' - 3')	NT	NT	NT	7.2	94.2	NT	NT	NT	NT	NT	SC
B-7 / (10' - 11')	NT	NT	NT	5.0	95.0	NT	NT	NT	NT	NT	SC
B-8 / (2' - 3')	1.0	62.3	36.7	6.2	104.8	NT	46	29	NT	NT	SC
B-9 / 2' - 3')	NT	NT	NT	4.8	96.4	NT	NT	NT	NT	NT	SC
B-10 / (2' - 3')	3.0	50.2	46.8	NT	NT	NT	31	13	NT	NT	SC

NP = Non-Plastic
NT = Not Tested
NV = No Value
[1]USCS = Unified Soil Classification System

PARTICLE SIZE DISTRIBUTION TEST REPORT



	%+75 mm	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	11.0	58.0	31.0		SC	33	20

SIEVE inches size	PERCENT FINER ●		
1	100.0		
0.75	95.0		
0.5	95.0		
0.375	94.0		
0.25	91.0		
	GRAIN SIZE		
D_{60}	0.95		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	89.0		
8	80.0		
10	76.0		
16	64.0		
30	53.0		
40	49.0		
50	45.0		
100	39.0		
200	31.0		

Sample information:
● B1 (10'-11')
Clayey Sand

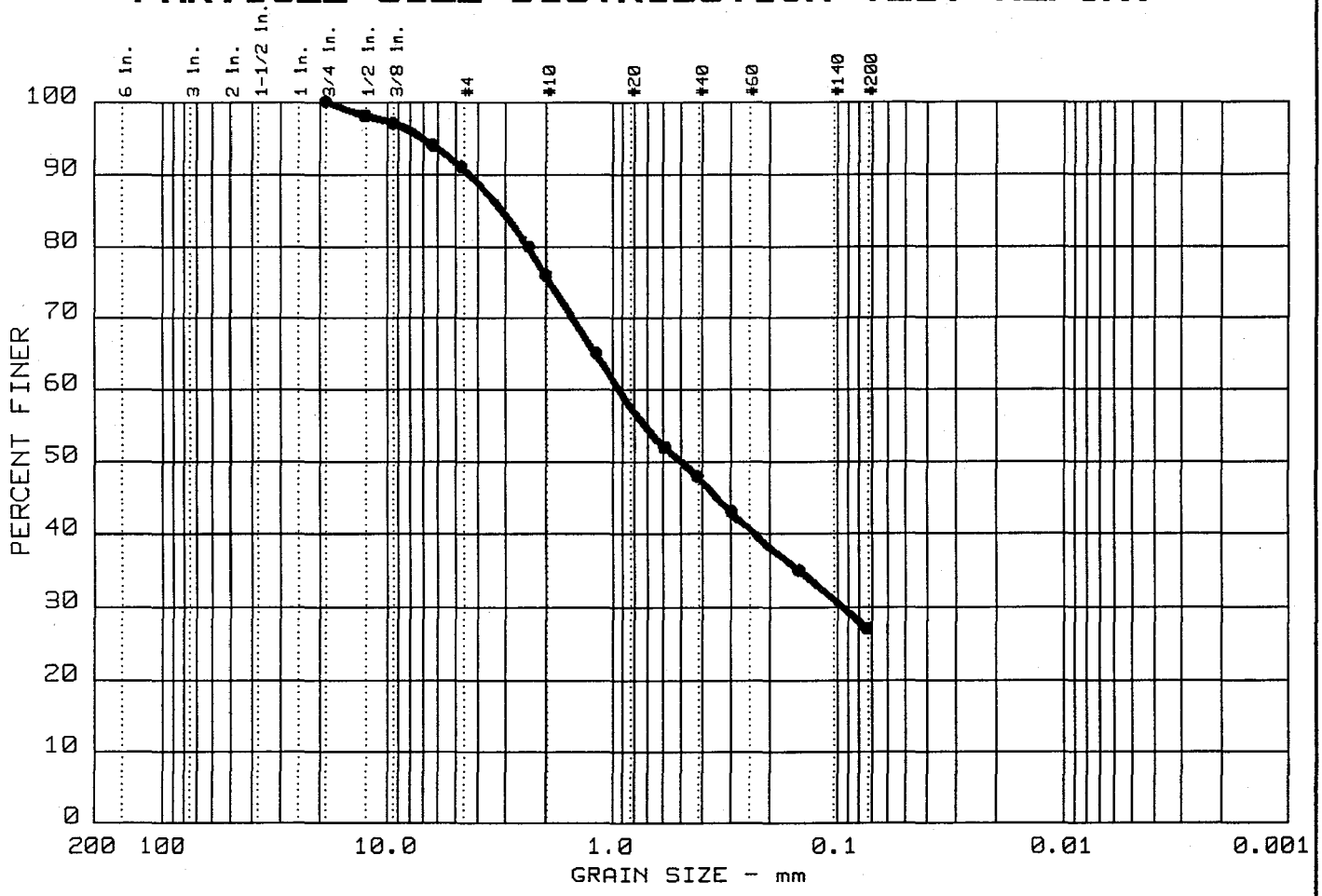
Remarks:
Law Lab No. 61178

LAW/CRANDALL, INC.

Project No.: 702.41-50354.05
Project: Guadalupe Basins A,E & F (Assign. No.7)

Date: 09-09-96 Data Sheet No. ——

PARTICLE SIZE DISTRIBUTION TEST REPORT



	%+75 mm	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	9.0	63.9	27.1		SM	NV	NP

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	98.0		
0.375	97.0		
0.25	94.0		
	GRAIN SIZE		
D_{60}	0.93		
D_{30}	0.09		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	91.0		
8	80.0		
10	76.0		
16	65.0		
30	52.0		
40	48.0		
50	43.0		
100	35.0		
200	27.1		

Sample information:
● B3 (2'-3')
Silty Sand

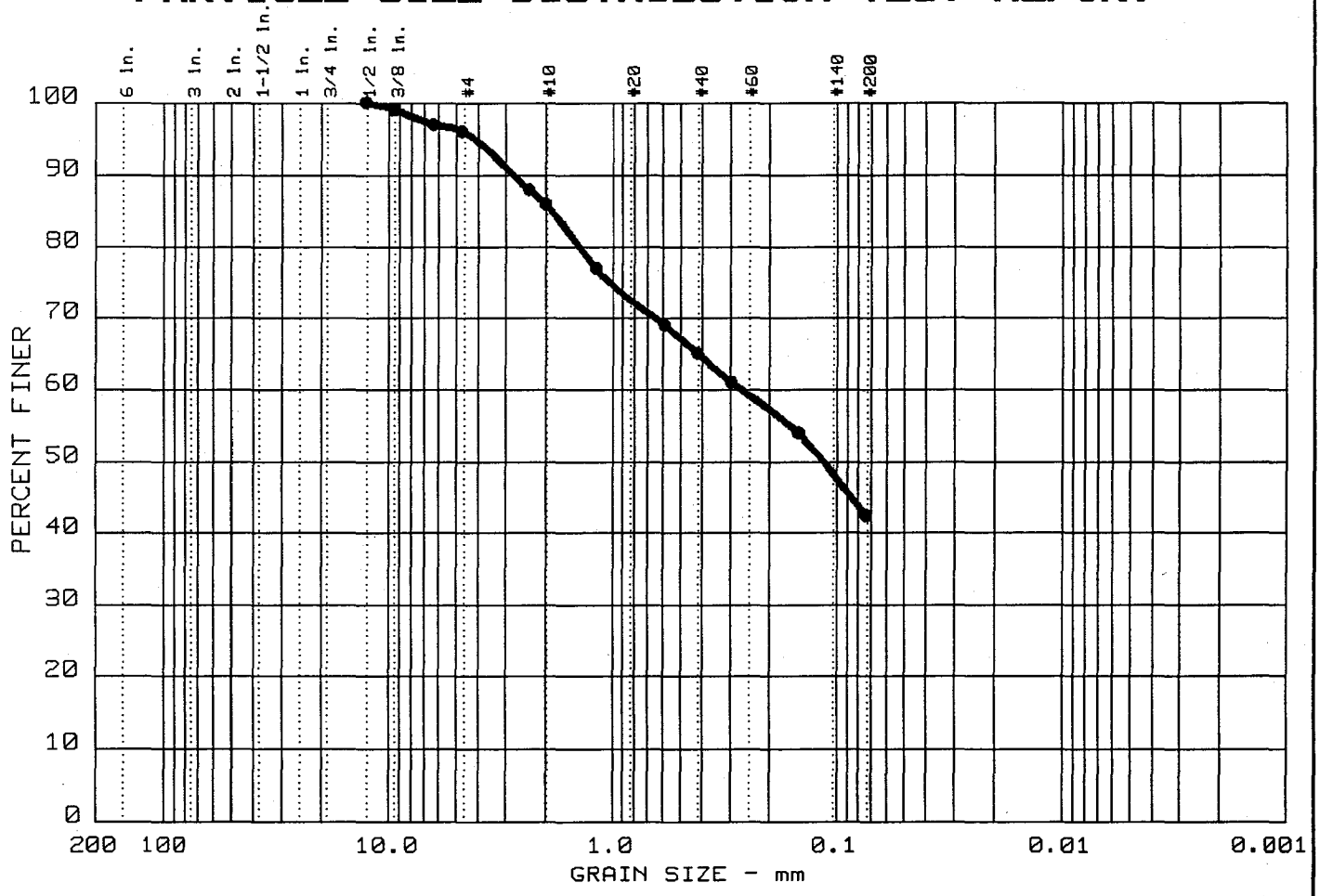
Remarks:
Law Lab No. 61181

LAW/CRANDALL, INC.

Project No.: 702.41-50354.05
Project: Guadalupe Basins A,E & F (Assign. No.7)

Date: 09-09-96 Data Sheet No. ——

PARTICLE SIZE DISTRIBUTION TEST REPORT



	%+75 mm	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	4.0	53.6	42.4		SM	24	NP

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
0.375	99.0		
0.25	97.0		
	GRAIN SIZE		
D_{60}	0.27		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	96.0		
8	88.0		
10	86.0		
16	77.0		
30	69.0		
40	65.0		
50	61.0		
100	54.0		
200	42.4		

Sample information:
● B4 (2'-3')
Silty Sand

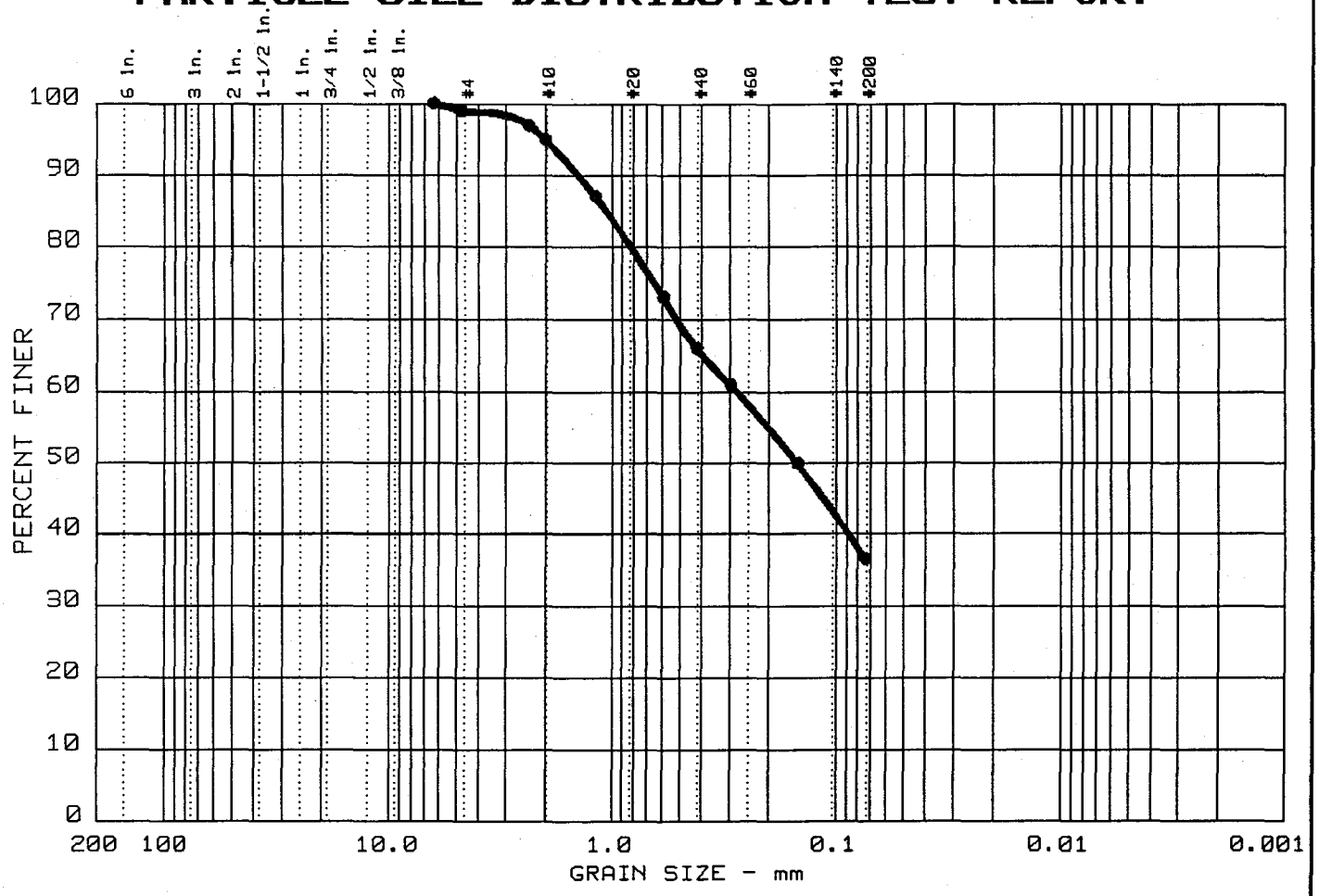
Remarks:
Law Lab No. 61182

LAW/CRANDALL, INC.

Project No.: 702.41-50354.05
Project: Guadalupe Basins A,E & F (Assign. No. 7)

Date: 09-09-96 Data Sheet No. ——

PARTICLE SIZE DISTRIBUTION TEST REPORT



	%+75 mm	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	1.0	62.3	36.7		SC	46	29

SIEVE inches size	PERCENT FINER ●		
0.25	100.0		
	GRAIN SIZE		
D_{60} D_{30} D_{10}	0.28		
	COEFFICIENTS		
C_c C_u			

SIEVE number size	PERCENT FINER ●		
4	99.0		
8	97.0		
10	95.0		
16	87.0		
30	73.0		
40	66.0		
50	61.0		
100	50.0		
200	36.7		

Sample information:
● BB (2'-3')
Clayey Sand

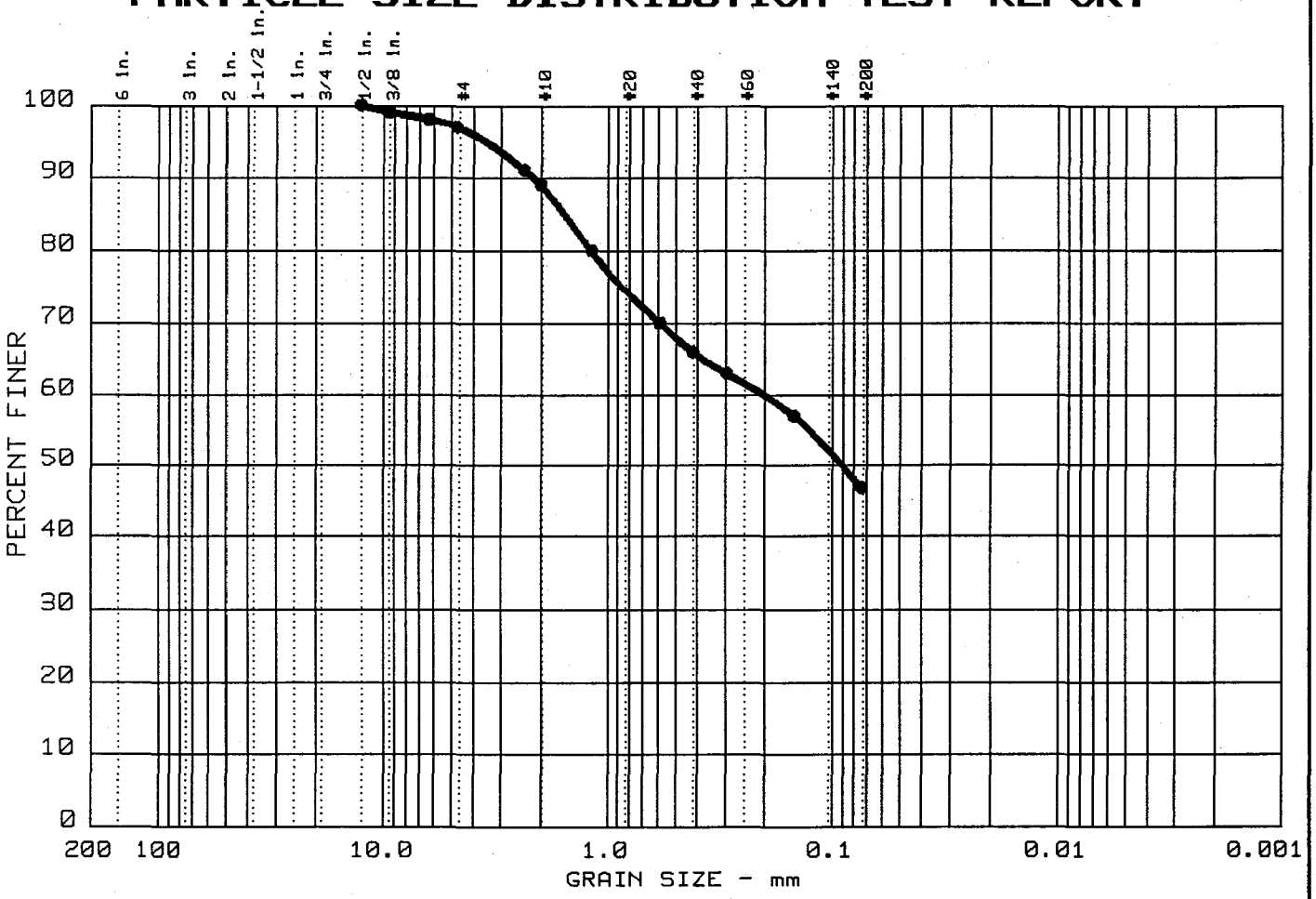
Remarks:
Law Lab No. 61191

LAW/CRANDALL, INC.

Project No.: 702.41-50354.05
Project: Guadalupe Basins A,E & F (Assign. No.7)

Date: 09-09-96 Data Sheet No. ——

PARTICLE SIZE DISTRIBUTION TEST REPORT



	%+75 mm	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	3.0	50.2	46.8		SC	31	13

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
0.375	99.0		
0.25	98.0		
GRAIN SIZE			
D_{60}	0.20		
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	97.0		
8	91.0		
10	89.0		
16	80.0		
30	70.0		
40	66.0		
50	63.0		
100	57.0		
200	46.8		

Sample information:
● B10 (2'-3')
Clayey Sand

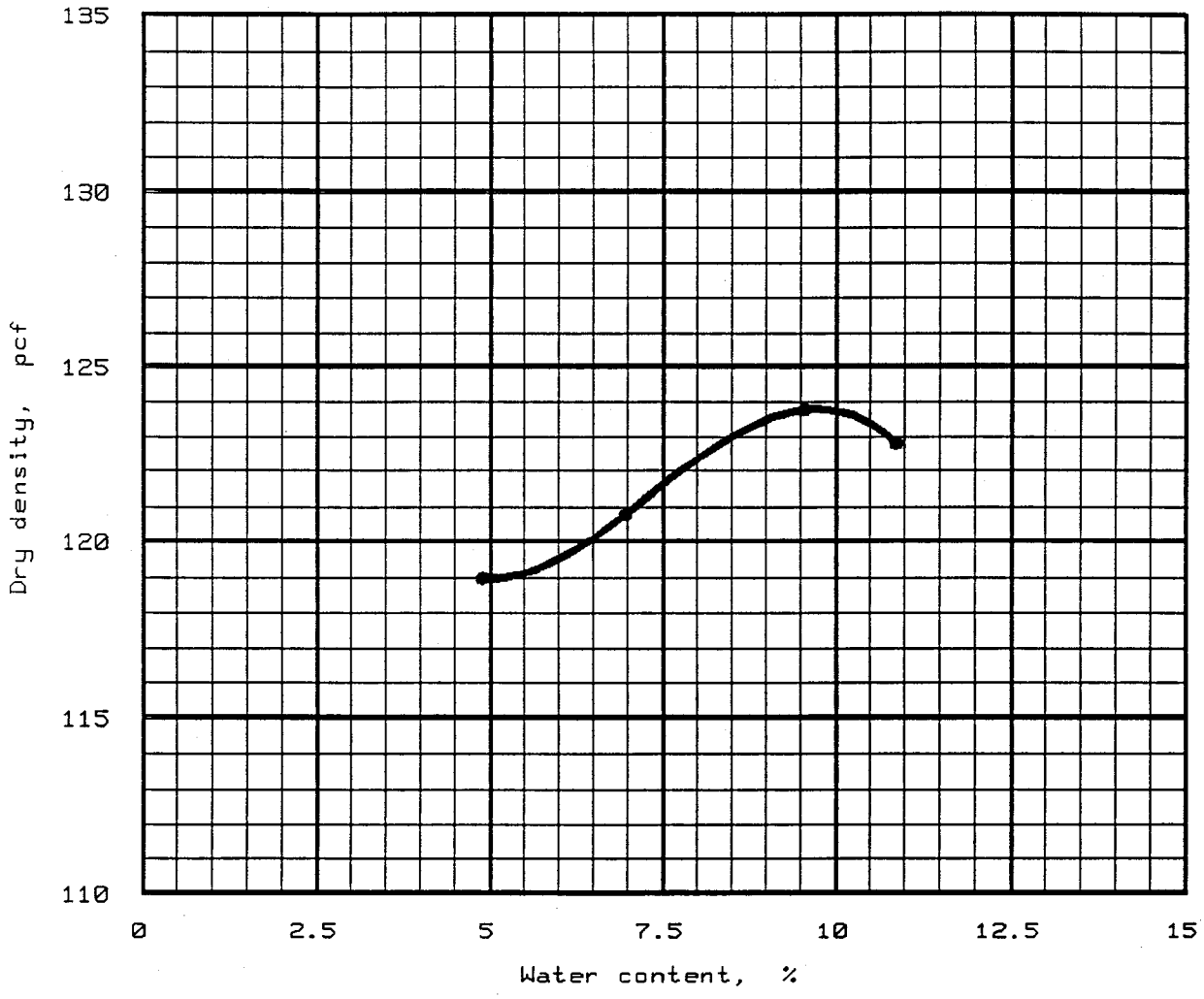
Remarks:
Law Lab No. 61194

LAW/CRANDALL, INC.

Project No.: 702.41-50354.05
Project: Guadalupe Basins A,E & F (Assign. No.7)

Date: 09-09-96 Data Sheet No. ——

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-78 Method A, Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 123.8 pcf Optimum moisture = 9.7 %	Native Soil B1 (0'-10')

Project No.: 702.41-50354.05
Project: Guadalupe Basin (Geotech)
Location: Guadalupe, Arizona

Date: 08-29-96

Remarks:

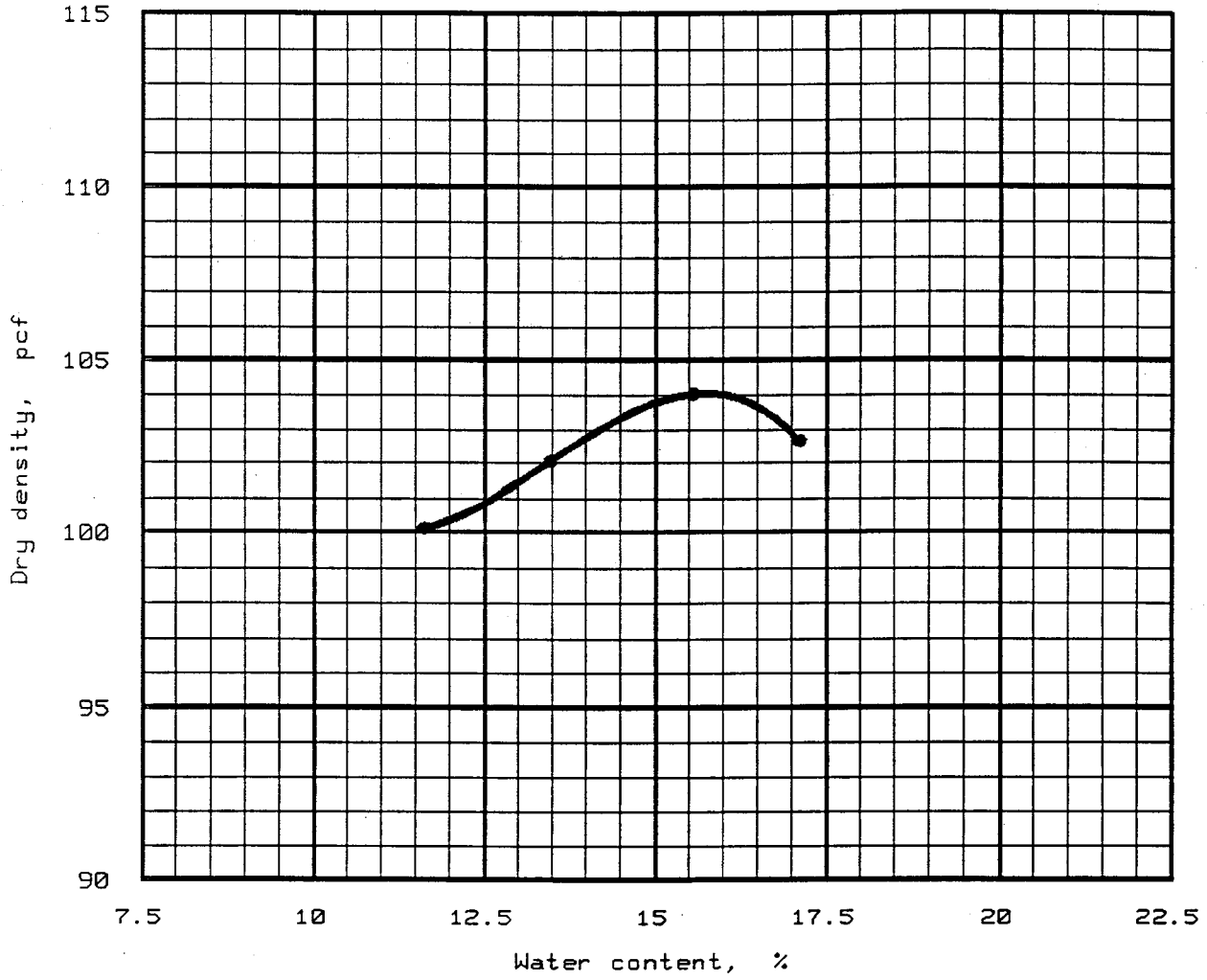
Law Lab No. 61256

MOISTURE-DENSITY RELATIONSHIP TEST

LAW/CRANDALL, INC.

Fig. No. _____

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-78 Method A, Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 104.1 pcf Optimum moisture = 15.7 %	Native Soil B4 (0'-10')

Project No.: 702.41-50354.05
Project: Guadalupe Basin (Geotech)
Location: Guadalupe, Arizona

Date: 08-29-96

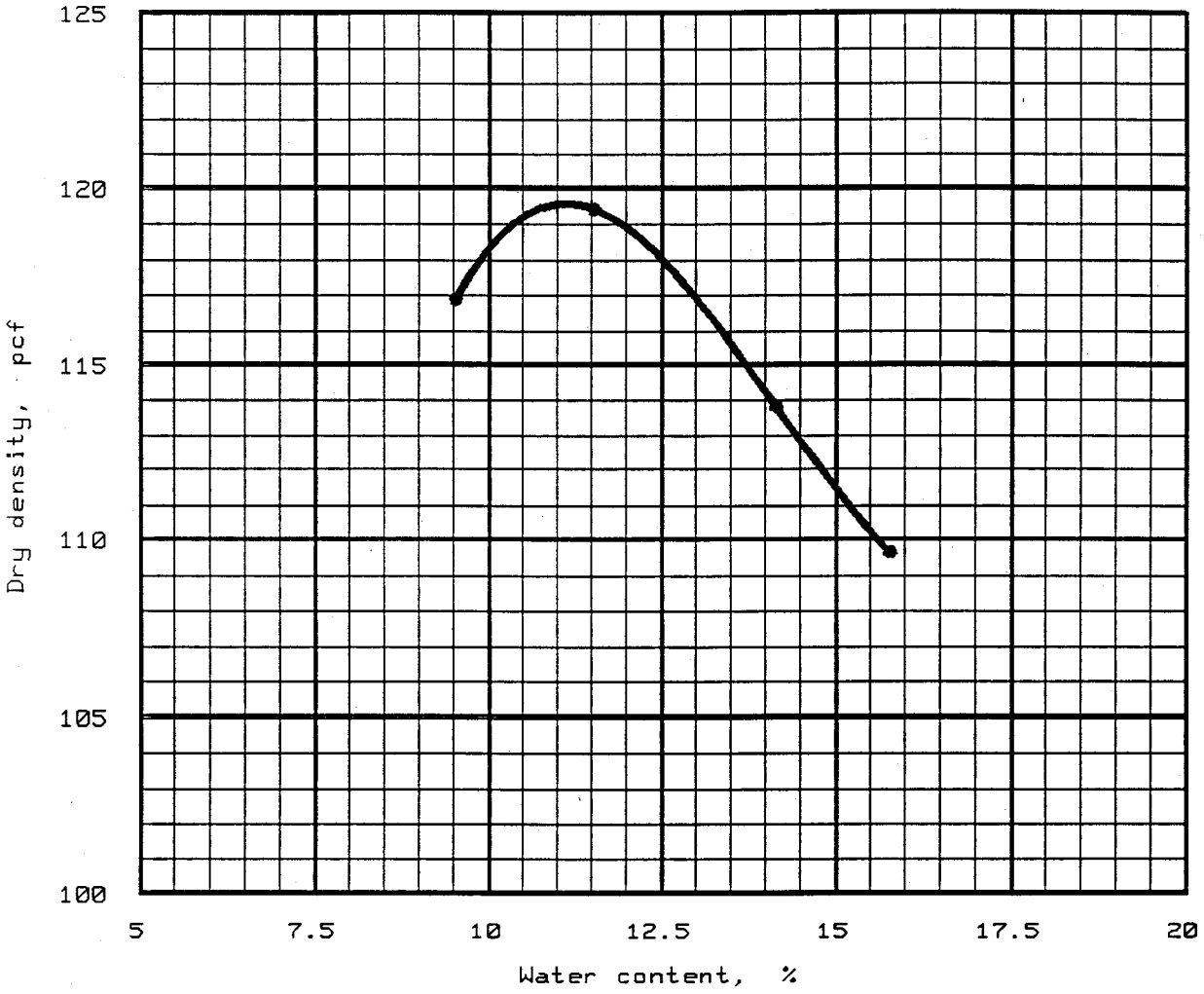
Remarks:
Law Lab No. 61257

MOISTURE-DENSITY RELATIONSHIP TEST

LAW/CRANDALL, INC.

Fig. No. _____

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-78 Method A, Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 119.6 pcf Optimum moisture = 11.1 %	Native Soil B7 (0'-10')

Project No.: 702.41-50354.05
Project: Guadalupe Basin (Geotech)
Location: Guadalupe, Arizona

Date: 08-29-96

Remarks:
Law Lab No. 61258

MOISTURE-DENSITY RELATIONSHIP TEST

LAW/CRANDALL, INC.

Fig. No. ____