
**DEATH VALLEY NATIONAL PARK
CA PRA DEVA 11 (3) BONNIE CLARE ROAD**



**PAVEMENT REPORT
JULY 2007
REPORT 07-03**

Report by:
Steve Deppmeier, Pavements Engineer
Technical Services Branch
Central Federal Lands Highway Division
Federal Highway Administration
Lakewood, Colorado

Distribution:
Project Development (3)
PM (1) Pat Flynn
Construction (2) Leo De Paula
Materials (2) Richard Duval
Tech Services - Pavements (3)
Geotech – (1) Matt DeMarco

CA PRA DEVA 11(3) BONNIE CLARE ROAD

Prepared by:


Steve Deppmeier, Pavement Engineer

Reviewed by:


Michael D. Voth, Pavement Discipline Leader

Approved for distribution by:


Michael D. Voth, Pavement Discipline Leader

7-13-07

DATE

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I. INTRODUCTION

During the week of January 12th, 2004 a pavement and subgrade soil investigation was completed along Bonnie Claire and Ubehebe Crater Roads in the Death Valley National Park. Bonnie Claire Road will be broken into three projects. The first 7.69 miles of the road, beginning at the California and Nevada stateline will be a 4R reconstruction, CA PRA DEVA 11(1) BONNIE CLAIRE with a new centerline alignment. The next 12.89 miles will be this project, CA PRA DEVA 11(3) BONNIE CLAIRE, a 3R rehabilitation with a new pavement surface and only minor grade or template changes. 11(1) and 11(3) were field investigated at the same time along with DEVA 109(1) UBEHEBE CRATER ROAD. The final portion of Bonnie Claire Road will also be 3R project, CA PRA DEVA 11(2) BONNIE CLAIRE. This project was not covered in the investigation nor in this report. CA PRA DEVA 109(1) UBEHEBE CRATER ROAD will also be a 3R project and although investigated at the same time as 11(3), it also is not covered in this report. Its length is 6.21 miles.

The investigation began on Bonnie Claire Road at the park entrance, which is also the stateline between California and Nevada. From Station 0+00 the investigation proceeded downhill in a southwest direction through Grapevine Canyon to the entrance station at Grapevine where the 11(1) 4R project ends and 11(3) 3R project starts. The investigation continued as Bonnie Claire Road curved to the southeast for 12.5 miles along the valley floor. The existing pavement was drilled every ¼ mile, with the coring locations labeled C-1, C-2...C-62. For 11(3), the first core locations is at C-17 and continuous through C-62. Large diameter cores TP-1 & TP-2, are also within the 11(3) project.

II. CLIMATE AND THE EXISTING PAVEMENT, SOILS, & GEOLOGY

Climate

Death Valley is famous as the hottest, driest place in North America. Rainfall averages 65 mm per year. Daily highs average 18° C (65° F) in January. From April to October the highs average 30° C (90° F) or higher with the month of July averaging 46° C (115° F).

Daily lows average 4° C (39° F) in December and January, the coldest months. Daily lows averages 27° C (80° F) in the summer. Freeze thaw cycle is not a problem in Death Valley.

Ground temperatures on the valley floor are about 40% higher than the surrounding air temperature. The highest ground temperature recorded was 94° C (201° F) on July 15, 1972.

Existing Pavement

The proposed project consists of rehabilitating the Bonnie Clair Road that has moderate to high severe cracking. See photographs in Appendix C. The total length of roadwork is Stations 406+00 to 985+00 (10.97 miles) for Schedule A and 406+00 to 1086+40 (12.89 miles) for Schedule B.

The history of Bonnie Claire Road is not clearly documented. The best source of information has been the February 2006 draft Bonnie Claire Road Historic Characterization Study for the portion of road between the Grapevine Ranger Station and the Nevada stateline, which is the 11(1) project segment. The original roads in the park were wagon trails that later were graded and then still later, oiled. The study states that the Civilian Conservation Corps (CCC) built a new gravel route between Stovepipe Wells and Grapevine Canyon in 1935. A request for funding to oil the road in 1937 was denied. Research is still being conducted as to when the 11(3) project road section was first oiled and then paved. 1951 is the year most often cited as the likely paving year. The road was last chip sealed in 2000. Roads in Death Valley are chip sealed about every 12 years.

PAVEMENT CONDITION: Bonnie Claire Road Sta. 406+00 to 1086+40

Milepost/Stationing	HACP Depth	Pavement Conditions
MP 7.7 to 10.25 406+00 to 541+00	2.5" Ranges 2" to 3.75"	Chip seal surface with transverse, longitudinal, and block cracks beneath the chip seals.
MP 10.25 to 13.25 541+00 to 700+00	2" Ranges 1.75" to 2.75"	Older chip seal – cracks beneath have been crack sealed, but are reflecting through, as moderate severity transverse, longitudinal, block and edge cracking.
MP 13.25 to 16.5 700+00 to 870+00	2.75" Ranges 1.5" to 3.5"	Newer chip seal with transverse, edge, and block cracks beneath the chip seals.
MP 16.5 to 18.0 870+00 to 95+000	4.25" Ranges 2" to 6"	Rough pavement w/scratch/drag marks, and shoulder patch @ MP 17 from washout.
MP 18.0 to 20.0 95+000 to 105+500	2.5" Ranges 2" to 4"	Chip seal surface is on top of at least one other chip seal. Native gravel beneath the pavement has more and bigger rock pieces. Sta 988+20 (MP 18.7) had auger refusal at 6" depth due to large cobbles and rocks. Note on plans should indicate that cobbles may be encountered during pulverization.
MP 20.0 to 20.4 105+500 to 107+700	9"	Active wash area.
MP 20.4 to 20.6 107+700 to 1086+40	3"	No visible cracks reflecting though chip seal, but surface is beginning to ravel.

PAVEMENT THICKNESSES

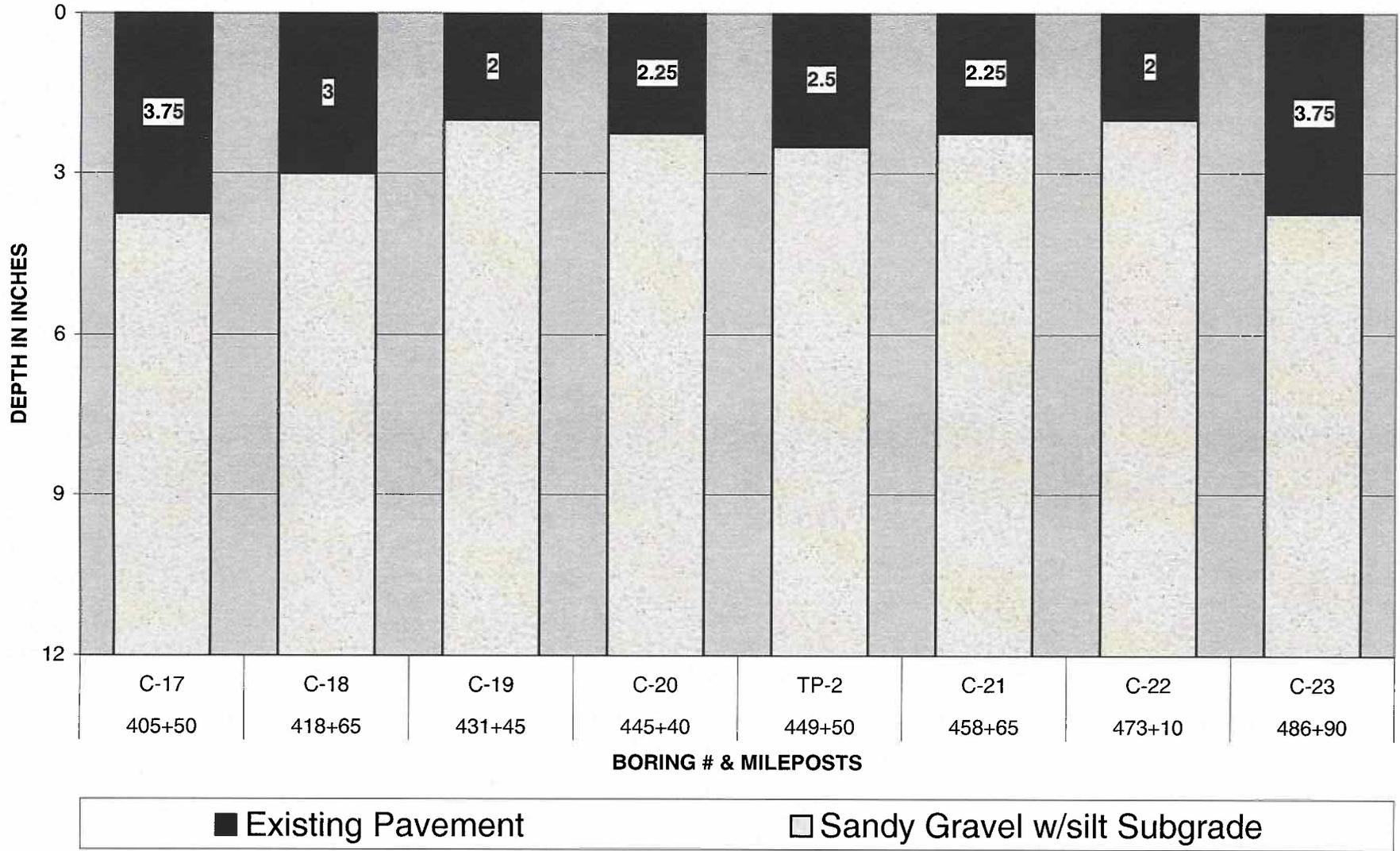


Chart 1

PAVEMENT THICKNESSES

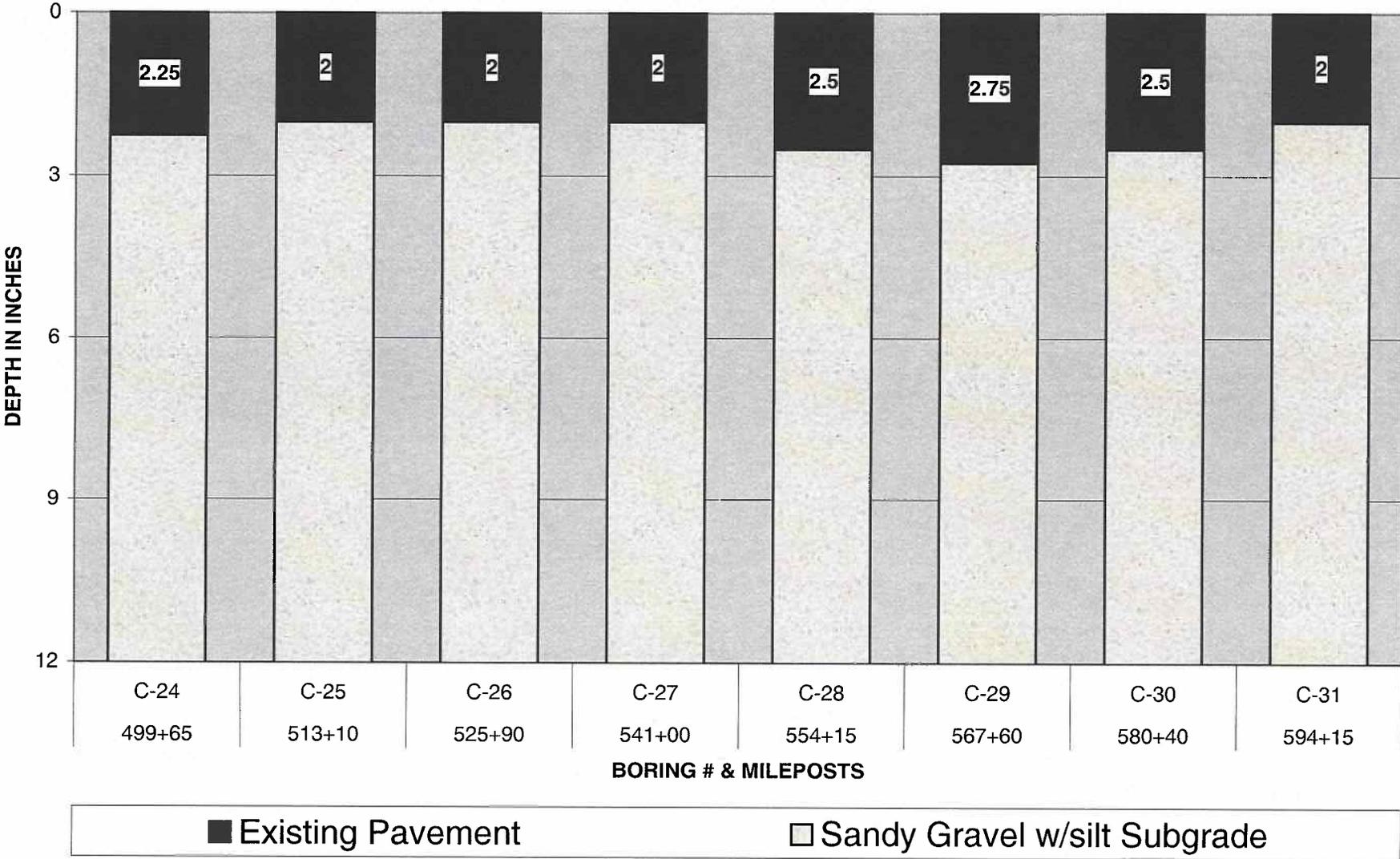


Chart 2

PAVEMENT THICKNESSES

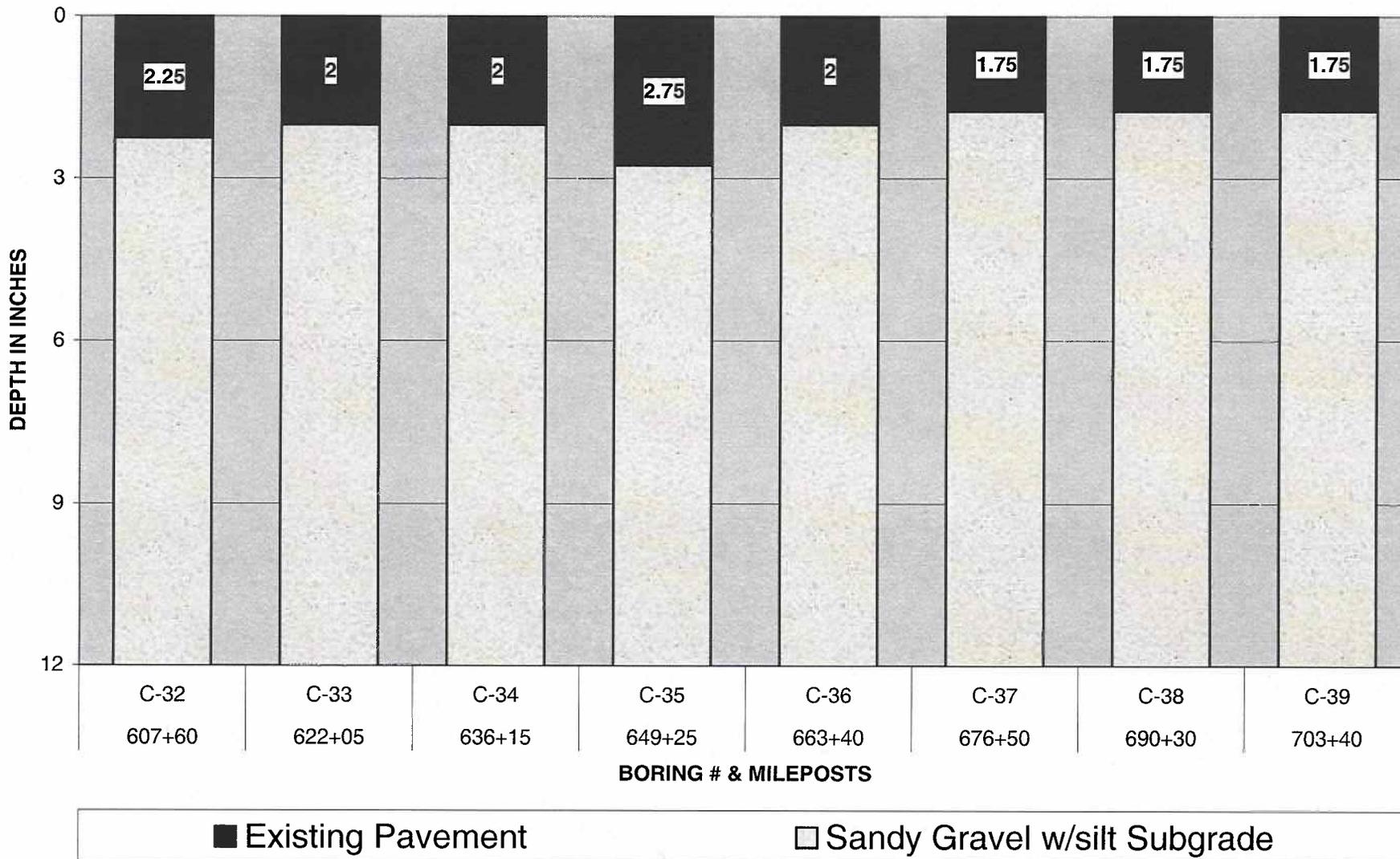


Chart 3

PAVEMENT THICKNESSES

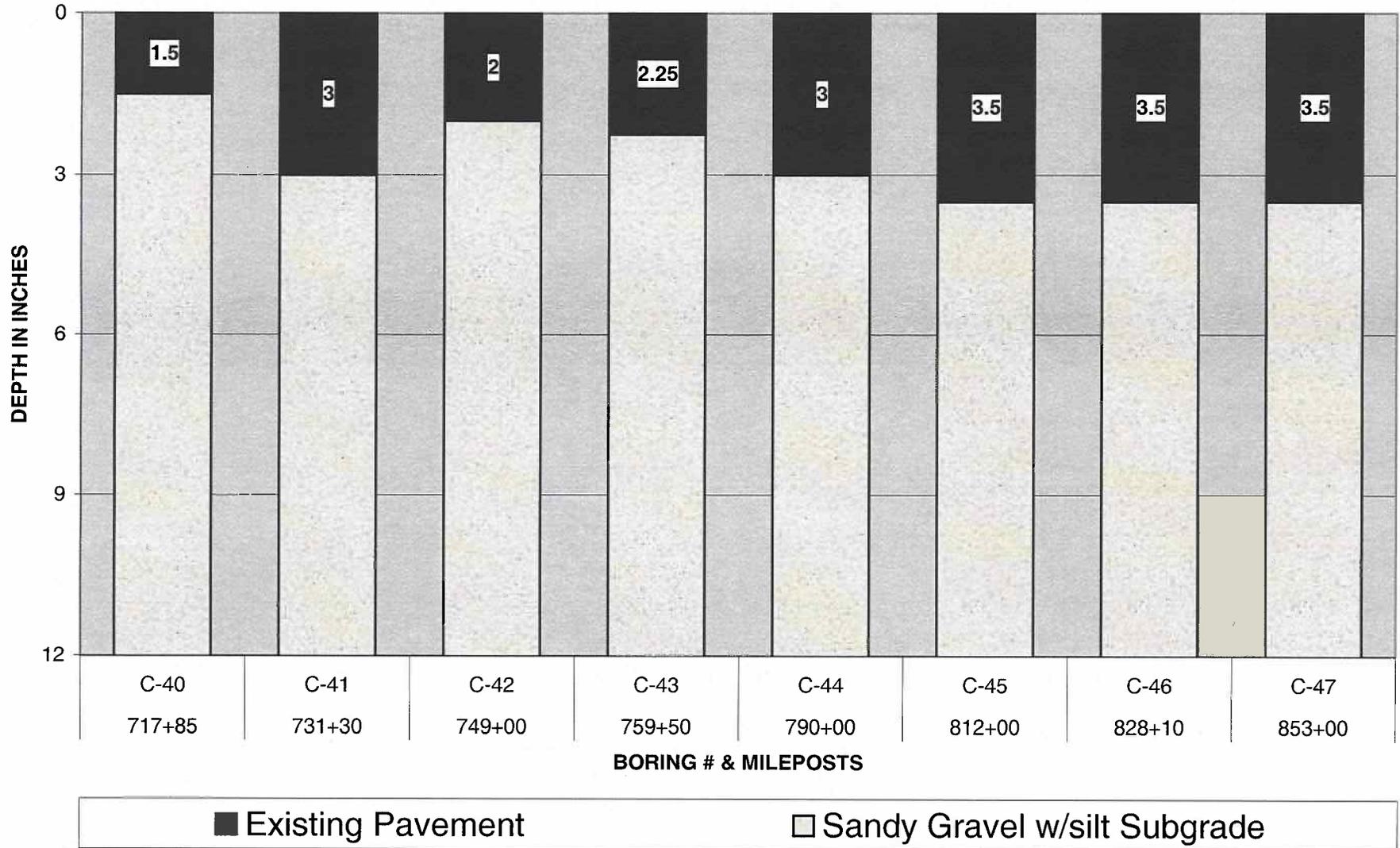


Chart 4

PAVEMENT THICKNESSES

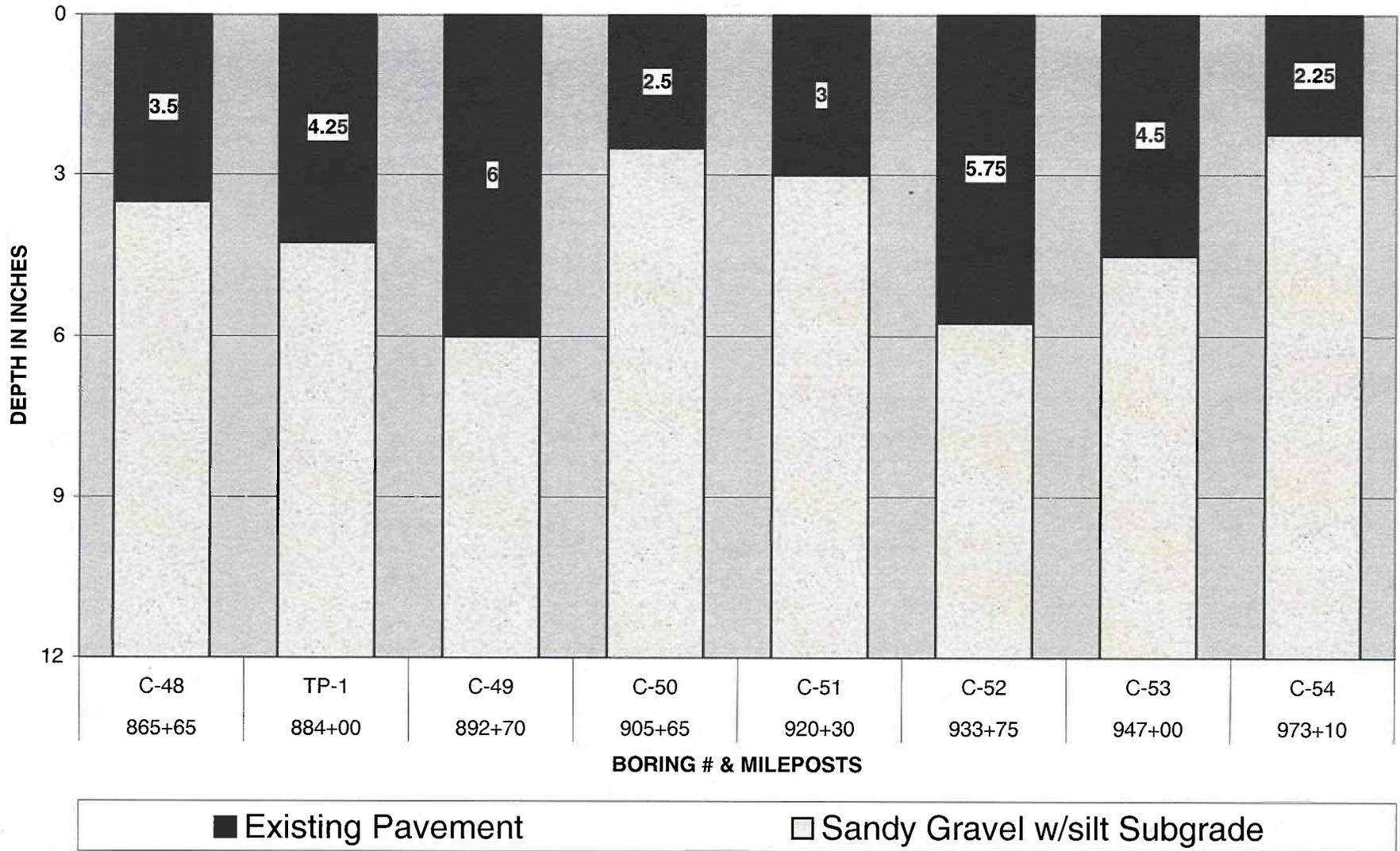


Chart 5

PAVEMENT THICKNESSES

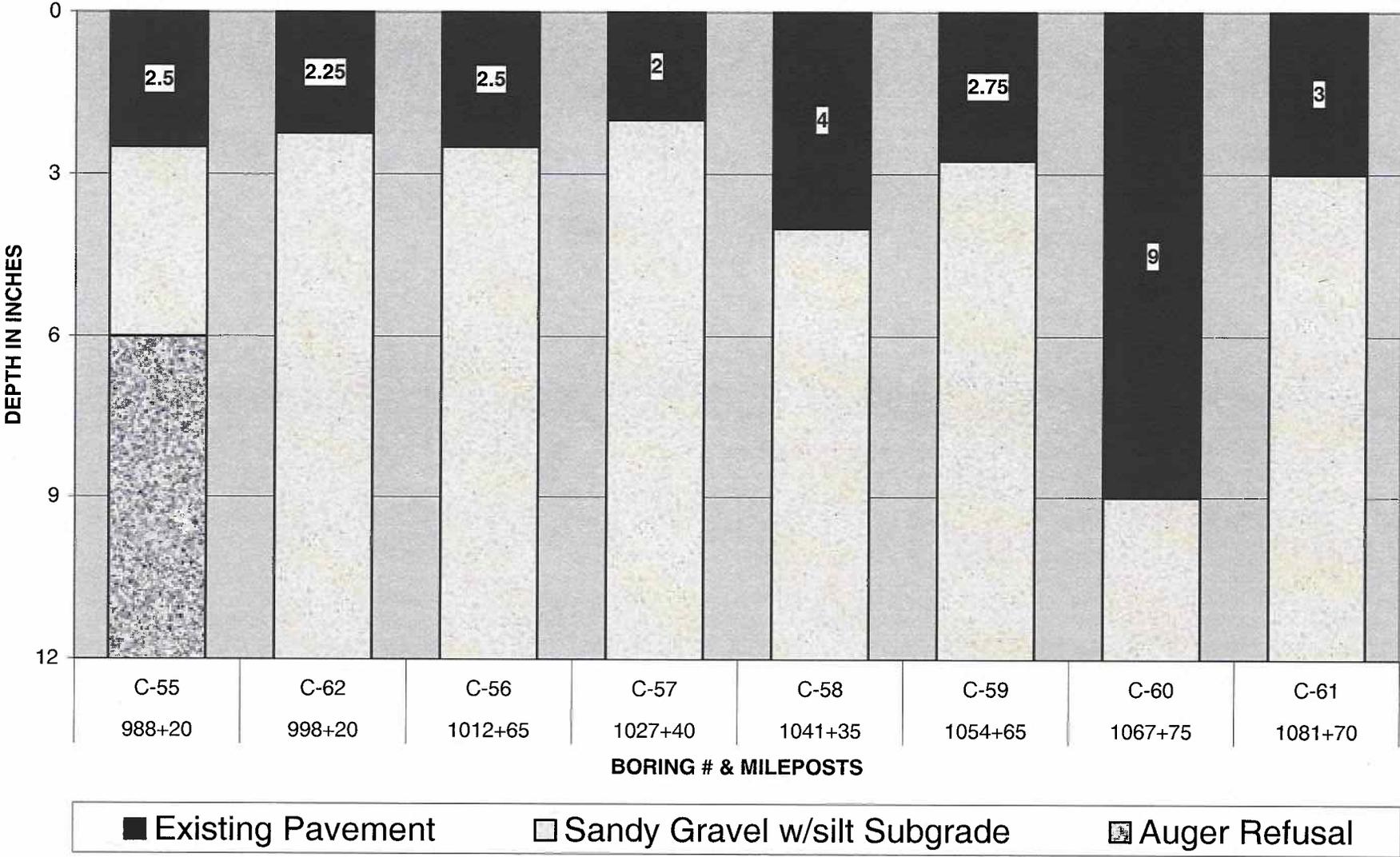


Chart 6

Geology & Soils

Death Valley National Park lies within the geologic province known as the Basin and Range. The Basin and Range Province extends throughout most of the southwest including this portion of eastern California. The Earth's crust in this region has been uplifted, stretched, and cracked to form fault lines that trend north to south. Tilting and rotating of two blocks between faults created Death Valley and the mountain ranges on either side. Bonnie Claire Road etches its way through the mountains on the east side.

For hundreds of thousands of years ending 10,000 years ago, Death Valley contained large lakes fed by abundant rainfall and melt water from receding ice age glaciers in the Sierra Nevada. Climatic change gradually dried up the valley lakes.

Exploratory drilling by USGS has not encountered bedrock on the valley floor despite 3000 feet deep borings. Subgrade material is typical alluvial fans, a mix of gravels, sands, and silts. Brackish subterranean water was encountered, remnants from the ancient lakes and the salts and other minerals that have leached into the groundwater.

III. EXPLORATION

Beginning January 12 to January 15, 2004 a two-person crew from Kleinfelder, Inc. completed 4 auger borings of 5 feet in depth for subgrade investigation and 43 pavement thickness borings of 1 foot in depth. They used a Mobile-61 truck-mounted drill rig. The National Park Service provided traffic control. All of the borings were located and logged by FHWA personnel. Only borings, C-55, Sta 988+20 achieved auger refusal. The depth of auger refusal was only 6 inches due to cobbles and large rocks. All the borings were drilled within the roadway. Soil samples were taken at these sites. CFLHD staff completed visual identification of the soils and logged the borings. Four samples were tested for R-Value, Moisture Density Relationship, in situ moisture content, and soil classification.

Typical pavement distresses were recorded and photos were taken to further document the condition of the pavement. Laboratory test results and photographs of the boring locations are provided in the appendices in the back of this report.

In addition, a materials investigation was conducted in August 1995. That investigation and Report 95-14 by Ronald Andresen drilled the Bonnie Claire Road every 2 miles. Report 95-14 refers to Bonnie Claire Road as California State Highway 267, Scotty's Castle Road.

IV. TEST RESULTS

Table 1 provides a summary of the soil properties evaluated on 4 soil samples from 11(3), Stations 406+00 to 1086+00. In addition the table includes one nearby sample from the 11(1) project and two samples from a park wide pavement investigation, Report 95-14. Appendix B contains the full laboratory report, including the test results from the 1995 pavement investigation.

TABLE 1: Bonnie Claire 3R Soil Properties

Boring/ Station	Sample Depth	AASHTO Classification	R- Value	Moisture (%) (in-situ)
*H-52 @ 378+00	5 ft	A-1-a (0)	79	-
C-16 @ 393+00	5 ft	A-1-a (0)	77	3.9
C-27 @ 541+00	5 ft	A-1-a (0)	76	8.5
C-33 @ 622+00	5 ft	A-1-a (0)	75	-
C-45 @ 812+00	5 ft	A-1-a (0)	-	2.2
C-53 @ 947+00	5 ft	A-1-a (0)	72	1.4
*H-44 @ 1117+00	5 ft	A-1-a (0)	77	-

*Note: From December 1995 Report 95-14.

The 11(3) project segment averaged 2.5” HACP thickness. No base course was present. Soil subgrades consisted of alluvial fan deposits, a mix of sand, gravel, cobbles, and silt. The lowest R-Value was 72 and the highest R-Value was 77. The laboratory results matched up well with the laboratory results from the December 1995 report. Note: cobbles are present beneath the pavement. The cobbles were typically – 3 inch in size but areas of larger cobbles within the road reclaiming prism will be present. A visual survey of the surrounding foreslopes provides is a good indicator of the subgrade make-up.

A soil modulus of 18,000 psi or equivalent R-Value of 60 was used for the pavement design. See Appendix B for all the test results. The lab result stationing is metric.

V. PAVEMENT RECOMMENDATIONS AND DISCUSSION

The NPS provided traffic counts. The reported ADT and truck loading are low. Even our minimal pavement design section easily exceeds the actual wear & tear on the roads.

The existing roadways have been chip sealed and repaired numerous times. The asphalt pavements have served their lifetime. The severity and faulting of the cracks eliminates an overlay as an option. The subgrade soil is good to excellent material. The design M_r is 18,000 psi; R-Value= 60.

CA PRA DEVA 11(3) Bonnie Claire Road:

Sta. 406+00 to Sta. 1086+40

Average existing HACP thickness is 2.5 inches

Recommended Pavement Structural Section:

3 inches HACP

4 inches FDR – Pulverizing

SN = 1.68

A note on the typical sections should state ‘reclaim to a depth of 4 inches or 1 inch below the full-depth of the pavement, whichever is larger. Pavement depth varies, averaging 2.5 inches.’

Pavement Materials

- The HACP should be Item 402, Hveem Test, Class B, and Grading E with a Type II smoothness level. The unit weight can be estimated at 145.1 lb/ft³. For antistripping additive, use Type III (Hydrated Lime) at 1%. Quantity can be estimated at 1% by weight of mix. The asphalt cement should be a PG 70-10. LTPP Bind specifies PG 76-10, which is unavailable from either California or Nevada.
- The HACP shall be placed in two lifts.
- FDR - Pulverize should be Item 303. The unit weight can be estimated at 141 lb/ft³.
- Tack coat at 0.10 gal/yd² is required between lifts and should either be a CSS-1, CSS-1h, SS-1, or SS-1h emulsion.
- A fog seal bid item 409 should be included in the contract. For determining quantities use an application rate of 0.10 gal/yd². The emulsion type can be a CSS-1, CSS-1h, SS-1, or SS-1h.
- A prime coat should be applied on the pulverized base material prior to paving. The material type should be an emulsion or cut-back asphalt formulated to penetrate. For determining quantities use an application rate of 0.30 gal/yd². An item for blotter material should be included at 14.75 lb/yd².
- Due to expected long haul times for HACP, include in the SCR the requirement for the material transfer vehicle (MTV) specification.

Drainage, Subexcavation, and other Issues

During the field investigation of January 2004, there were no major water or drainage problems that were evident concerning the roadbed. Numerous areas exist of storm run-off either washing out the road where it crosses or where existing berms along the road shoulder channels the run-off down the roadway. The berms will be eliminated and low water crossings constructed. Although no subexcavation is expected to be needed, 500 tons of subexcavation should be put in the contract to be used at the discretion of the CO.

Typical subexcavation should be 1 to 2 feet of over excavating; placement of a geotextile separation fabric, and placement of 1 to 2 feet of select borrow or the native berm material on top of the fabric. Pavement structural section should then match the mainline typical section. A positive drainage system such as daylighting the select borrow out to the foreslope or an edge drain system should be included. The Pavements Section can be contacted for further details if subexcavating an area becomes an option, 720-963-3504.

APPENDICES

A – Location Map

B – Laboratory Test Results

C – Photographs

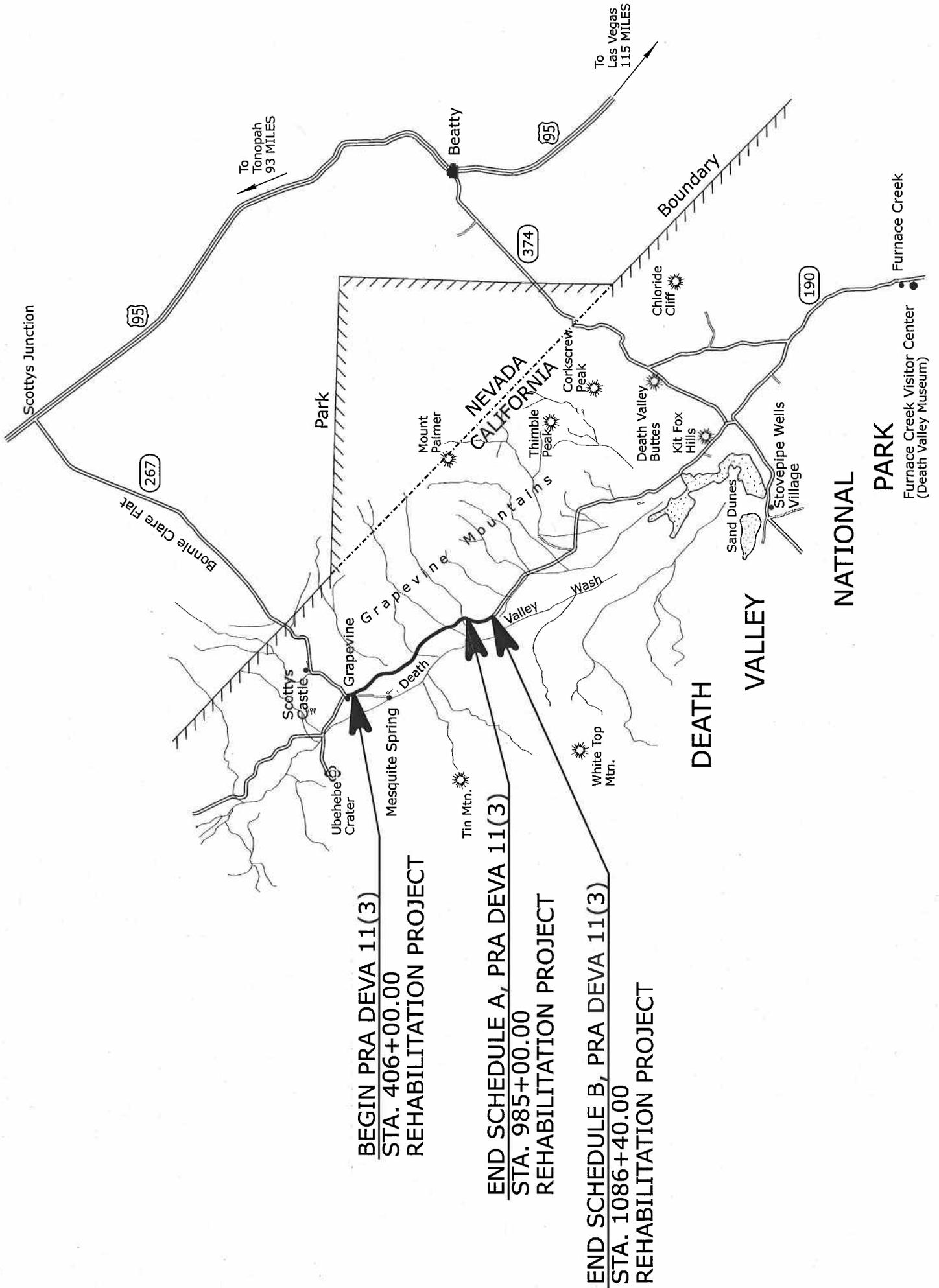
D – Pavement Design Calculations

E – Field Data Summary

F – Report 95-14

APPENDIX A

LOCATION MAP



APPENDIX B

LABORATORY TEST RESULTS



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Report of Soil or Aggregate Tests

Page 1 of 5

Project: California PRA DEVA 11 (1) Bonnie Claire Road

Submitted By: Steve Deppmeier

Date Reported: 2/2/2004

Sample Number	Lab Number	04-23-SB	04-24-RV	04-25-SB	04-26-S	04-27-SB
	Hole Number	--	--	--	--	--
	Field Number	C-1	C-5	C-7	C-9	C-10

Sample Location	Station	0+040	3+420	5+000	6+370	6+980
	Offset	--	--	--	--	--
	Depth	1 Foot	5 Feet	1 Foot	5 Feet	1 Foot

AASHTO T 11, T 27 & T 88	3"	75.0 mm					
	1 1/2"	37.5 mm		100		100	
	1"	25.0 mm		97		97	
	3/4"	19.0 mm		93		94	
	1/2"	12.5 mm		87		87	
	3/8"	9.5 mm		83		81	
	#4	4.75 mm		69		64	
	#8	2.36 mm					
	Washed Sieve Analysis % Passing	#10	2.00 mm		51		45
		#16	1.18 mm		43		38
		#30	600 µm				
		#40	425 µm		29		29
		#50	300 µm				
		#100	150 µm		17		19
		#200	75 µm		11		13
		20 µm					
		2 µm					
		1 µm					
AASHTO T 265	Moisture, %		5.3	4.3	5.6	11.4	6.8
AASHTO T 89 & T 90	Liquid Limit			NV		NV	
	Plasticity Index			NP		NP	
Soil Classification	AASHTO M 145			A-1-b (0)		A-1-a (0)	
	ASTM D 2487			SW-SM		SM	
AASHTO T 190	R -Value			74			
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution: Num. / Project File
Laboratory Darrell Harding
Pavements Steve Deppmeier
Materials 1 Copy

Remarks:
Moisture content samples were taken from sealed plastic bags.

R-Value testing was not requested for field sample numbers C-(1, 7, 9 & 10).

Reported By:

Darrell Harding



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Report of Soil or Aggregate Tests

Page 2 of 5

Project: California PRA DEVA 11 (1) Bonnie Claire Road

Submitted By: Steve Deppmeier

Date Reported: 2/2/2004

Sample Number	Lab Number	04-28-SB	04-29-SB	04-30-RV	04-31-SB	04-32-SB
	Hole Number	--	--	--	--	--
	Field Number	C-12	C-15	C-16	C-17	C-20

Sample Location	Station	8+980	11+650	11+980	12+360	13+575
	Offset	--	--	--	--	--
	Depth	1 Foot	1 Foot	5 Feet	1 Foot	1 Foot

AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm			100		
	1 1/2"	37.5 mm			94		
	1"	25.0 mm			92		
	3/4"	19.0 mm			90		
	1/2"	12.5 mm			83		
	3/8"	9.5 mm			78		
	#4	4.75 mm			60		
	#8	2.36 mm					
	#10	2.00 mm			38		
	#16	1.18 mm			30		
	#30	600 µm					
	#40	425 µm			19		
	#50	300 µm					
	#100	150 µm			12		
	#200	75 µm			7.9		
	20 µm						
	2 µm						
	1 µm						
AASHTO T 265	Moisture, %	5.7	4.3	3.9	6.1	2.8	
AASHTO T 89 & T 90	Liquid Limit			NV			
	Plasticity Index			NP			
Soil Classification	AASHTO M 145			A-1-a (0)			
	ASTM D 2487			SW-SM			
AASHTO T 190	R -Value			77			
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution: Num. / Project File
Laboratory Darrell Harding
Pavements Steve Deppmeier
Materials 1 Copy

Remarks:

Moisture content samples were taken from sealed plastic bags.

R-Value testing was not requested for field sample numbers C-(12, 15, 17 & 20).

Reported By:

Darrell Harding



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Report of Soil or Aggregate Tests

Page 3 of 5

Project: California PRA DEVA 11 (1) Bonnie Claire Road

Submitted By: Steve Deppmeier

Date Reported: 2/2/2004

Sample Number	Lab Number	04-33-SB	04-34-RV	04-35-SB	04-36-RV	04-37-SB
	Hole Number	--	--	--	--	--
	Field Number	C-22	C-27	C-29	C-33	C-36

Sample Location	Station	14+420	16+490	17+300	18+960	20+220
	Offset	--	--	--	--	--
	Depth	1 Foot	5 Feet	1 Foot	5 Feet	1 Foot

AASHTO T 11, T 27 & T 88	3"	75.0 mm					
	1 1/2"	37.5 mm		100		100	
	1"	25.0 mm		99		92	
	3/4"	19.0 mm		95		85	
	1/2"	12.5 mm		86		69	
	3/8"	9.5 mm		77		60	
	#4	4.75 mm		54		43	
	#8	2.36 mm					
	Washed Sieve Analysis % Passing	#10	2.00 mm		36		31
		#16	1.18 mm		30		26
		#30	600 µm				
		#40	425 µm		22		19
		#50	300 µm				
		#100	150 µm		16		12
		#200	75 µm		11		8.1
		20 µm					
		2 µm					
		1 µm					
AASHTO T 265	Moisture, %		4.1	8.5	5.1	--	3.4
AASHTO T 89 & T 90	Liquid Limit			NV			18
	Plasticity Index			NP			1
Soil Classification	AASHTO M 145			A-1-a (0)			A-1-a (0)
	ASTM D 2487			GP-GM			GW-GM
AASHTO T 190	R -Value			76			75
AASHTO T 288	Min. Resistivity, ohm-cm						
AASHTO T 289	pH						
AASHTO Method	Optimum Moisture, %						
	Maximum Dry Density, pcf						

Distribution:
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Pavements
Materials

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Darrell Harding
Steve Deppmeier
1 Copy

Remarks:

Moisture content samples were taken from sealed plastic bags. The plastic bag containing moisture sample field number C-33 was damaged in transit to the lab.

R-Value testing was not requested for field sample numbers C-(22, 29 & 36).

Reported By:

Darrell Harding
Darrell Harding



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Report of Soil or Aggregate Tests

Page 4 of 5

Project: California PRA DEVA 11 (1) Bonnie Claire Road

Submitted By: Steve Deppmeier

Date Reported: 2/2/2004

Sample Number	Lab Number	04-38-SB	04-39-SB	04-40-SB	04-41-S	04-42-RV
	Hole Number	--	--	--	--	--
	Field Number	C-41	C-42	C-44	C-45	C-53

Sample Location	Station	22+290	22+830	24+080	24+750	28+865
	Offset	--	--	--	--	--
	Depth	1 Foot	1 Foot	1 Foot	5 Feet	5 Feet

AASHTO T 11, T 27 & T 88	3"	75.0 mm						
	1 1/2"	37.5 mm				100	100	
	1"	25.0 mm				96	95	
	3/4"	19.0 mm				88	85	
	1/2"	12.5 mm				75	65	
	3/8"	9.5 mm				64	53	
	#4	4.75 mm				44	34	
	#8	2.36 mm						
	Washed Sieve Analysis % Passing	#10	2.00 mm				30	23
		#16	1.18 mm				26	19
		#30	600 µm					
		#40	425 µm				20	15
		#50	300 µm					
		#100	150 µm				15	12
		#200	75 µm				11	9.4
	20 µm							
	2 µm							
	1 µm							
AASHTO T 265	Moisture, %	0.8	3.6	1.8	2.2	1.4		
AASHTO T 89 & T 90	Liquid Limit				NV	NV		
	Plasticity Index				NP	NP		
Soil Classification	AASHTO M 145				A-1-a (0)	A-1-a (0)		
	ASTM D 2487				GP-GM	GP-GM		
AASHTO T 190	R -Value					72		
AASHTO T 288	Min. Resistivity, ohm-cm							
AASHTO T 289	pH							
AASHTO Method	Optimum Moisture, %							
	Maximum Dry Density, pcf							

Distribution: Num. / Project File
Laboratory Darrell Harding
Pavements Steve Deppmeier
Materials 1 Copy

Remarks:
Moisture content samples were taken from sealed plastic bags.

R-Value testing was not requested for field sample numbers C-(41, 42, 44 & 45).

Reported By:

Darrell Harding



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Report of Soil or Aggregate Tests

Page 5 of 5

Project: California PRA DEVA 11 (1) Bonnie Claire Road

Submitted By: Steve Deppmeier

Date Reported: 2/2/2004

Sample Number	Lab Number	04-43-SB				
	Hole Number	--				
	Field Number	C-58				

Sample Location	Station	31+740				
	Offset	--				
	Depth	1 Foot				

AASHTO T 11, T 27 & T 88 Washed Sieve Analysis % Passing	3"	75.0 mm				
	1 1/2"	37.5 mm				
	1"	25.0 mm				
	3/4"	19.0 mm				
	1/2"	12.5 mm				
	3/8"	9.5 mm				
	#4	4.75 mm				
	#8	2.36 mm				
	#10	2.00 mm				
	#16	1.18 mm				
	#30	600 µm				
	#40	425 µm				
	#50	300 µm				
	#100	150 µm				
	#200	75 µm				
	20 µm					
	2 µm					
	1 µm					
AASHTO T 265	Moisture, %	1.9				
AASHTO T 89 & T 90	Liquid Limit					
	Plasticity Index					
Soil Classification	AASHTO M 145					
	ASTM D 2487					
AASHTO T 190	R-Value					
AASHTO T 288	Min. Resistivity, ohm-cm					
AASHTO T 289	pH					
AASHTO Method	Optimum Moisture, %					
	Maximum Dry Density, pcf					

Distribution:
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Materials

Num. / Project File
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Steve Deppmeier
1 Copy

Remarks:
Moisture content samples were taken from sealed plastic bags.

R-Value testing was not requested for sample number C-58.

Reported By:

Darrell Harding

REPORT ON SOIL OR AGGREGATE TESTS

Project: CALIFORNIA PRP 10 DEATH VALLEY NATIONAL MONUMENT
Submitted By: RON ANDRESEN

Date Reported: 9-21-95

Sample Number	Lab Number	95-1542-RV	95-1543-RV	95-1544-RV	95-1545-RV	95-1546-RV
	Hole Number					
	Field Number	H-32	H-38	H-44	H-52	H-56

Sample Location	or MILE POST	1.7	8.0	20.0	34.0	2.5
	Location	NATURAL BRIDGE ROAD	HWY 26 NORTH BOUND. SCOTTYS CASTLE ROAD			UBEHEBE CARTER ROAD
	Offset					
	Depth	0-3'				

ASHTO T 11, 27 & 88 (% Passing)	3"	75.0 mm	100		100	100	
	1 1/2"	37.5 mm	98	100	83	99	100
	1"	25.0 mm	95	99	76	98	99
	3/4"	19.0 mm	92	96	67	94	99
	1/2"	12.5 mm	85	86	51	83	94
	3/8"	9.5 mm	80	76	42	76	90
	#4	4.75 mm	65	57	25	57	77
	#8	2.36 mm					
	#10	2.00 mm	48	41	17	39	65
	#16	1.18 mm	40	35	15	31	58
	#30	600 µm					
	#40	425 µm	25	29	12	21	46
	#50	300 µm					
	#100	150 µm	14	23	10	14	32
	#200	75 µm	8.2	17.8	7.3	10.2	23.7
	2 µm						
	0.2 µm						
	0.1 µm						
	Moisture (%)						
AASHTO T 89 & 90	Liquid Limit	NP	NP	NP	NP	NP	
	Plasticity Index	NP	NP	NP	NP	NP	
Soil Classification	AASHTO M 145	A-1-a(0)	A-1-b(0)	A-1-a(0)	A-1-a(0)	A-1-b(0)	
	ASTM D 2487	SW-SM	GM	GP-GM	SW-SM	SM	
AASHTO T 190	R-Value	74	80	77	79	77	
AASHTO T 288	Min. Resistivity (ohm-cm)						
AASHTO T 289	pH						
AASHTO T	Optimum Moisture (%)						
Method:	Max. Dry Density (pcf)						

Distribution:
Materials

3 Copies

R. ANDRESEN

Geotechnical W. FOLKMAN

Remarks:

Reported by:

Alan M. Held

Alan M. Held
Materials Specialist

Bob H. Welch, P. E.
Materials Engineer

APPENDIX C

PHOTOGRAPHS

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

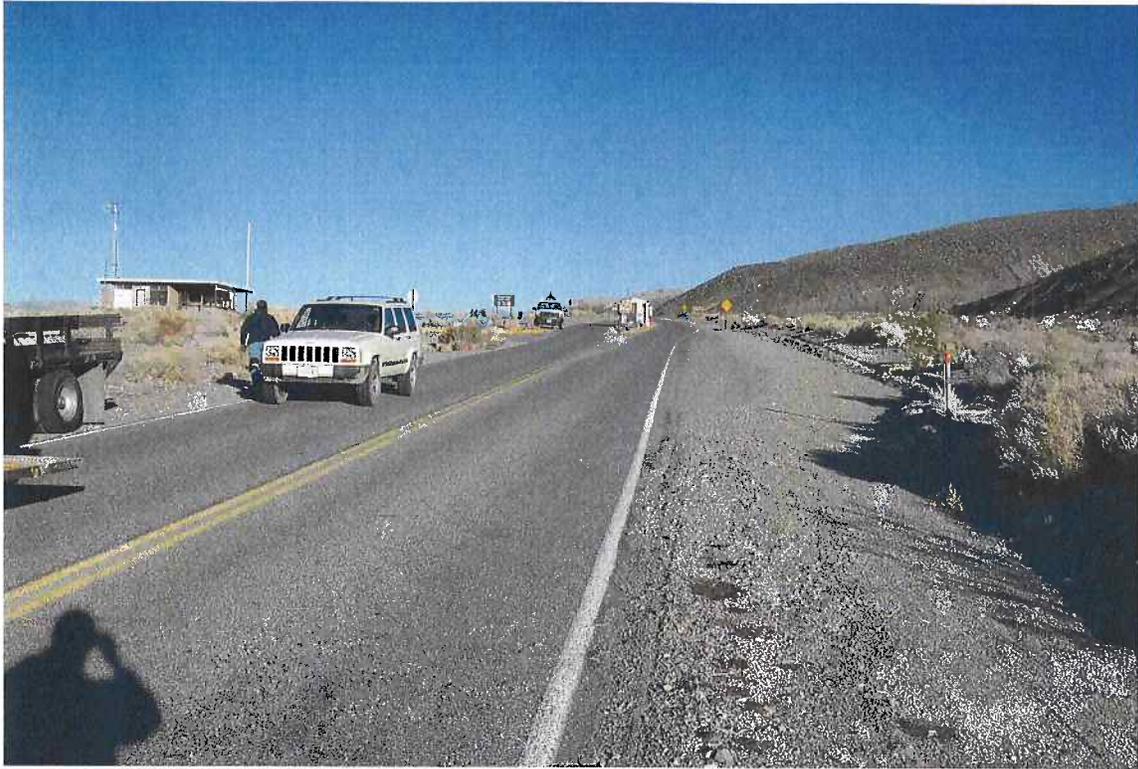


Photo 1: Grapevine Entrance Station

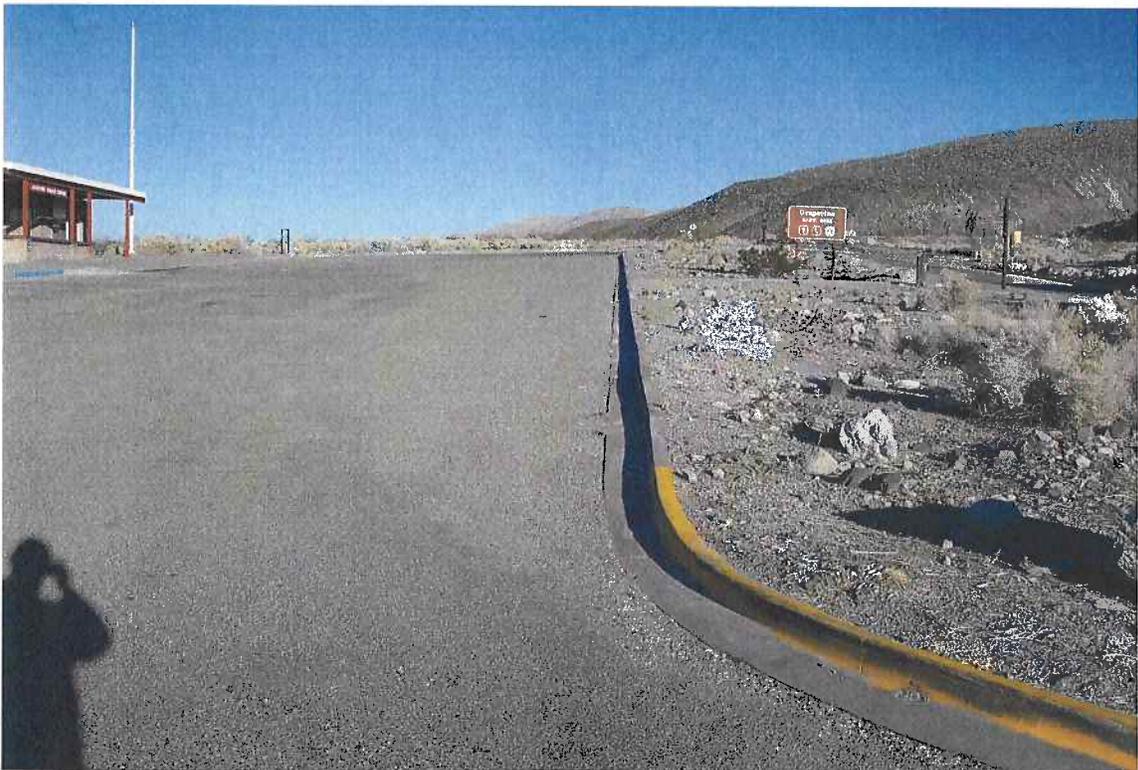


Photo 2: Grapevine Parking

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

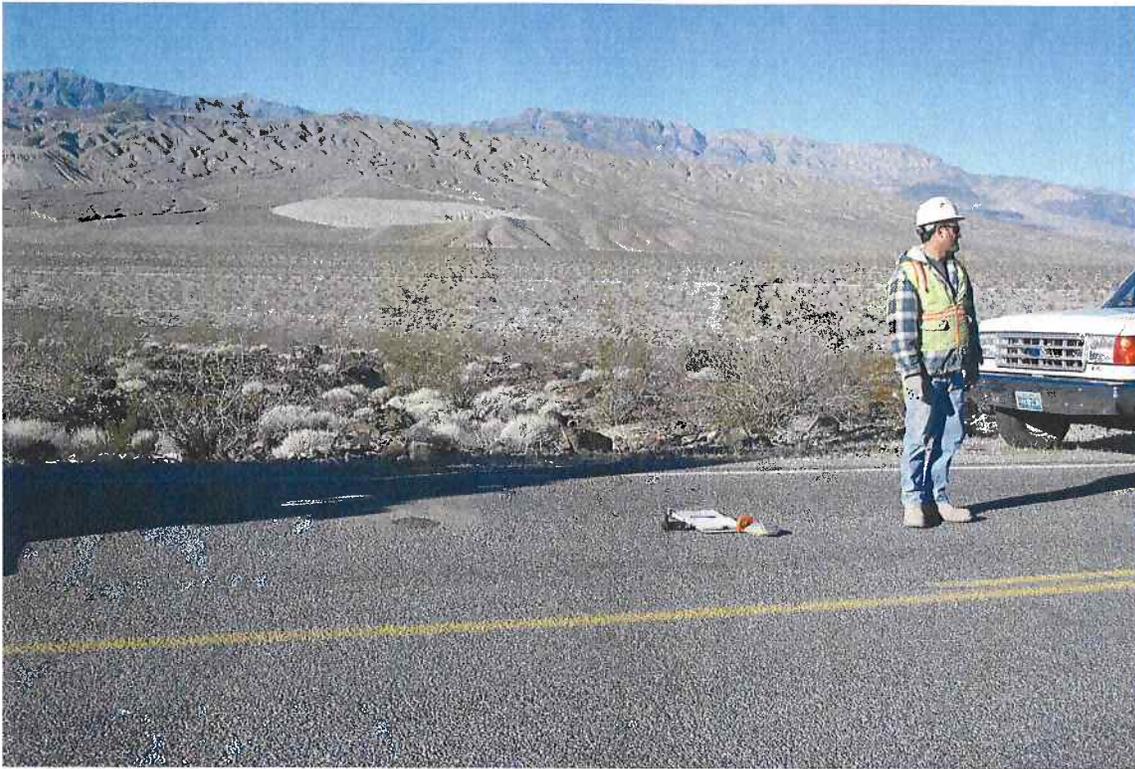


Photo 3: Sta 445+00, C-20 looking down a drainage

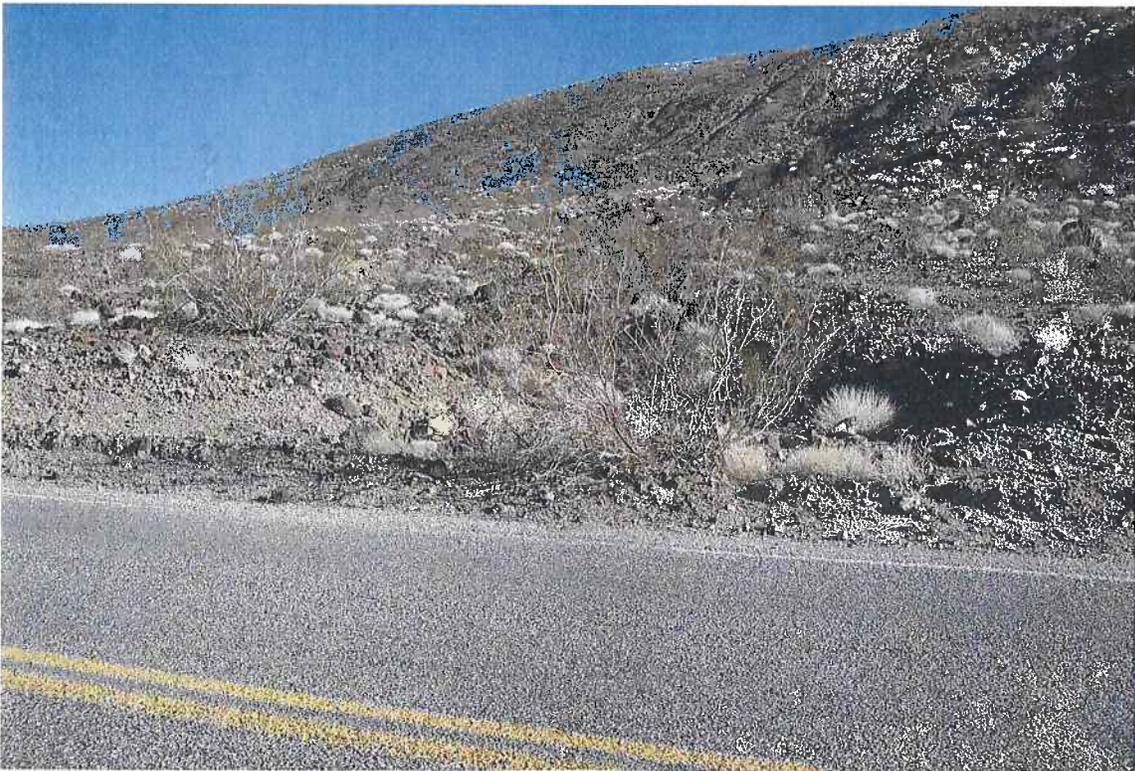


Photo 4: Sta 473+00, C-22, looking up a drainage

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

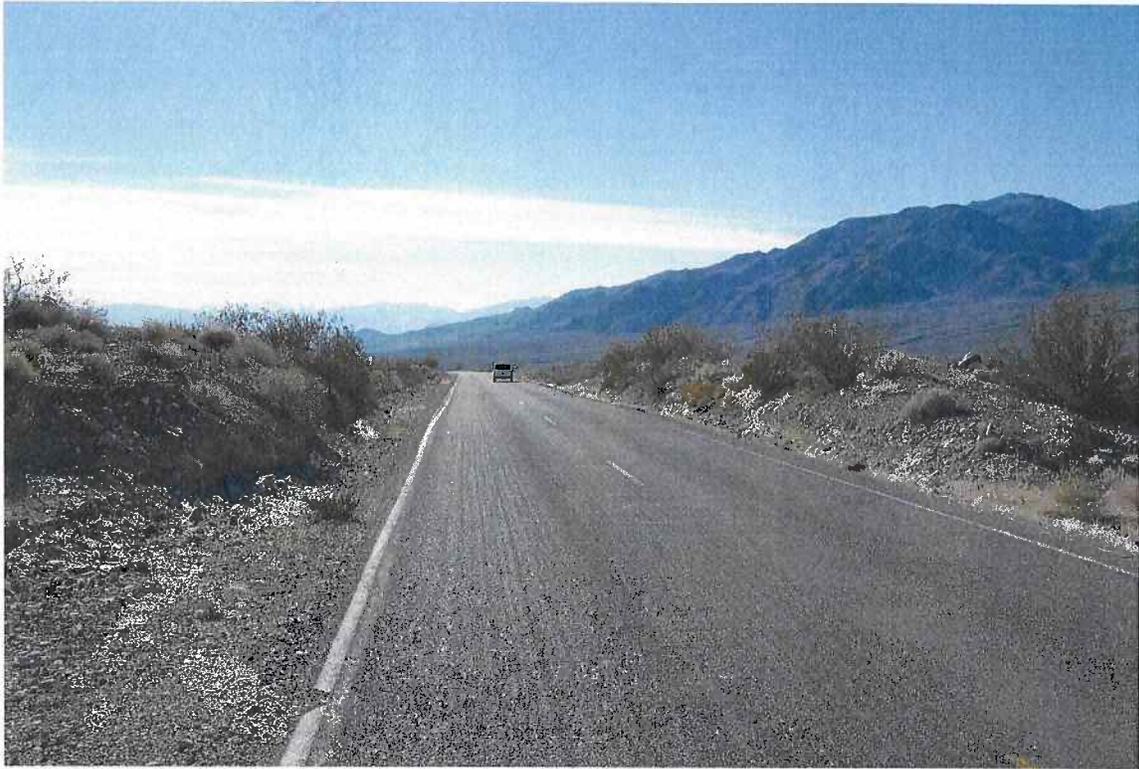


Photo 5: Sta 567+50, C-29, looking south



Photo 6: Sta 580+00, C-30, looking north

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

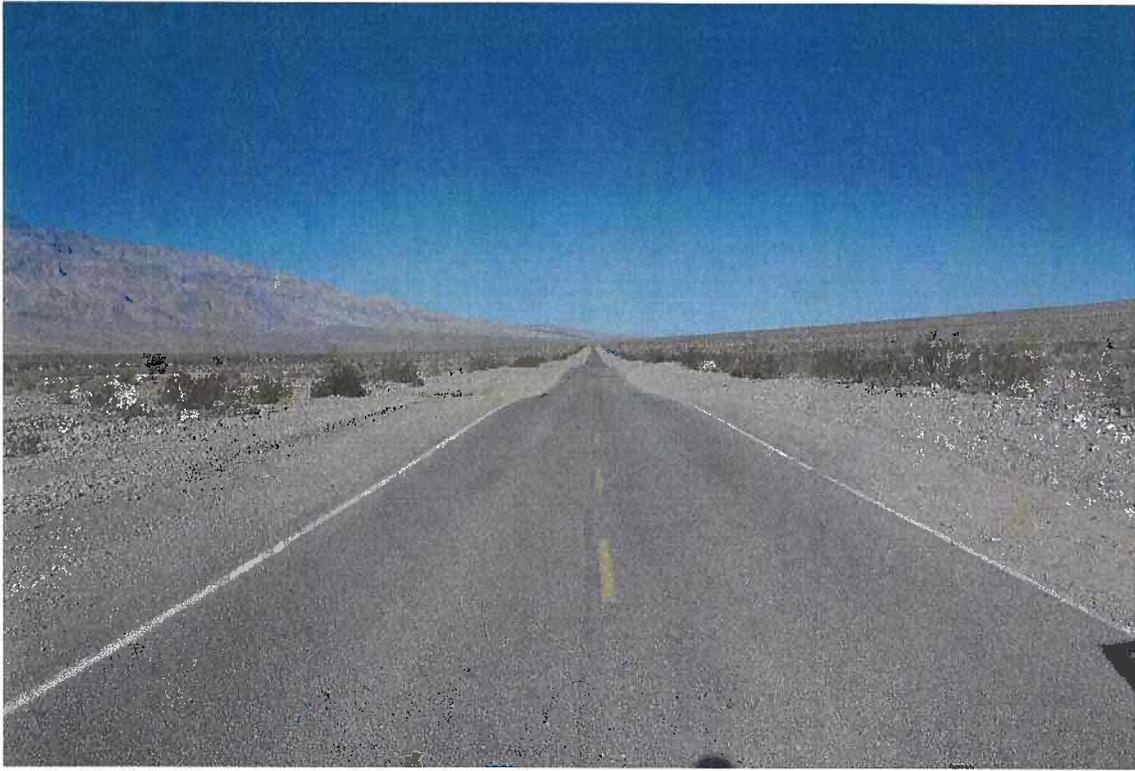


Photo 7: Looking north, typical rolling terrain



Photo 8: Same spot, looking south ~ MP 12

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

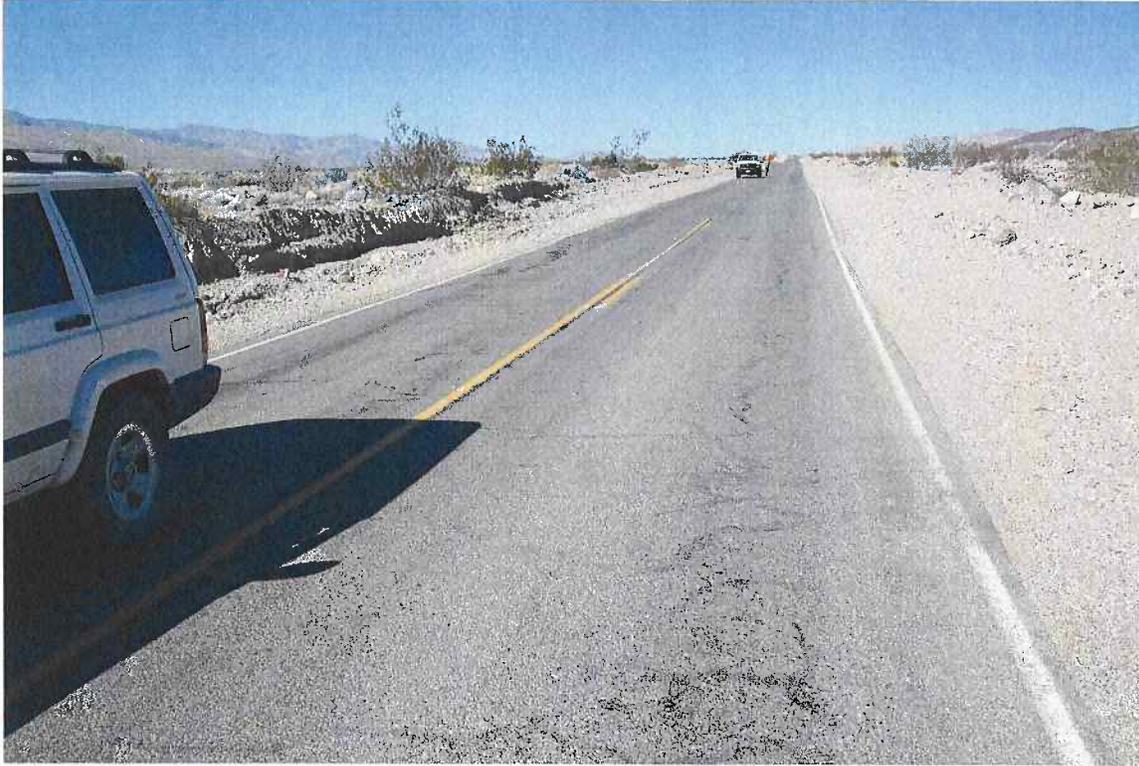


Photo 9: Sta 607+50, C-32, looking north



Photo 10: Sta 607+50, C-32, exposed soils

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD



Photo 11: Sta 649+50, C-35 looking north

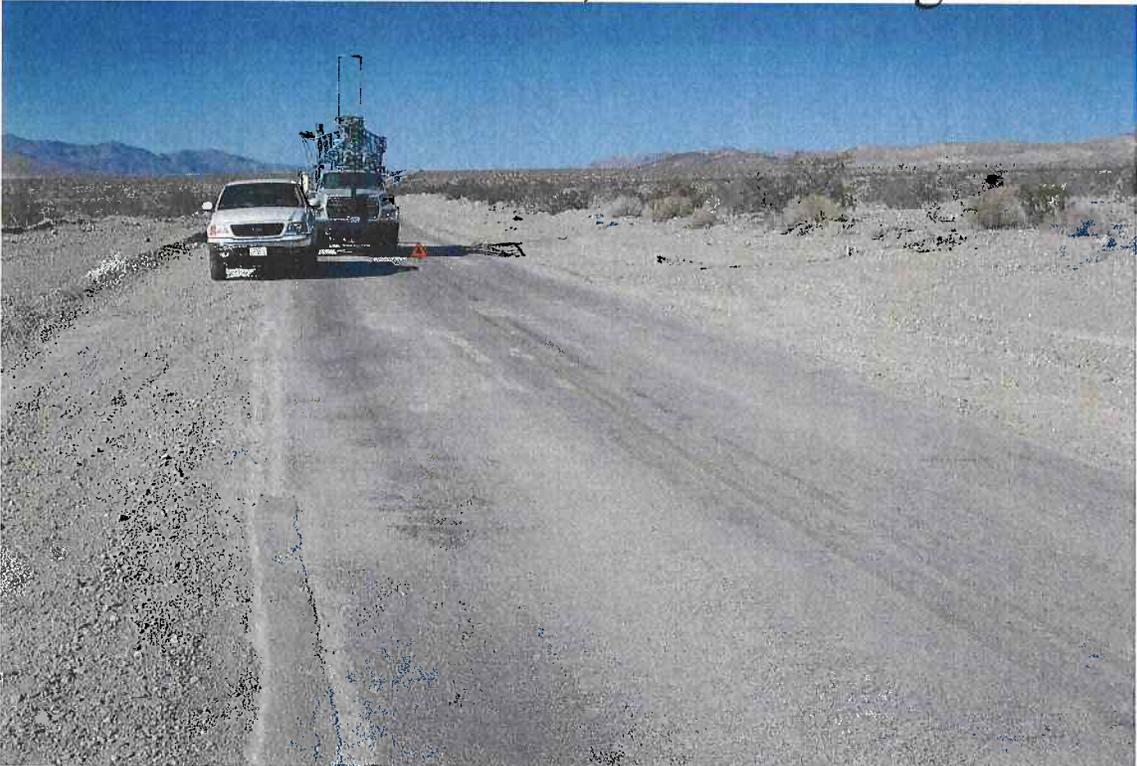


Photo 12: Sta 676+50, C-37 water overflow

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

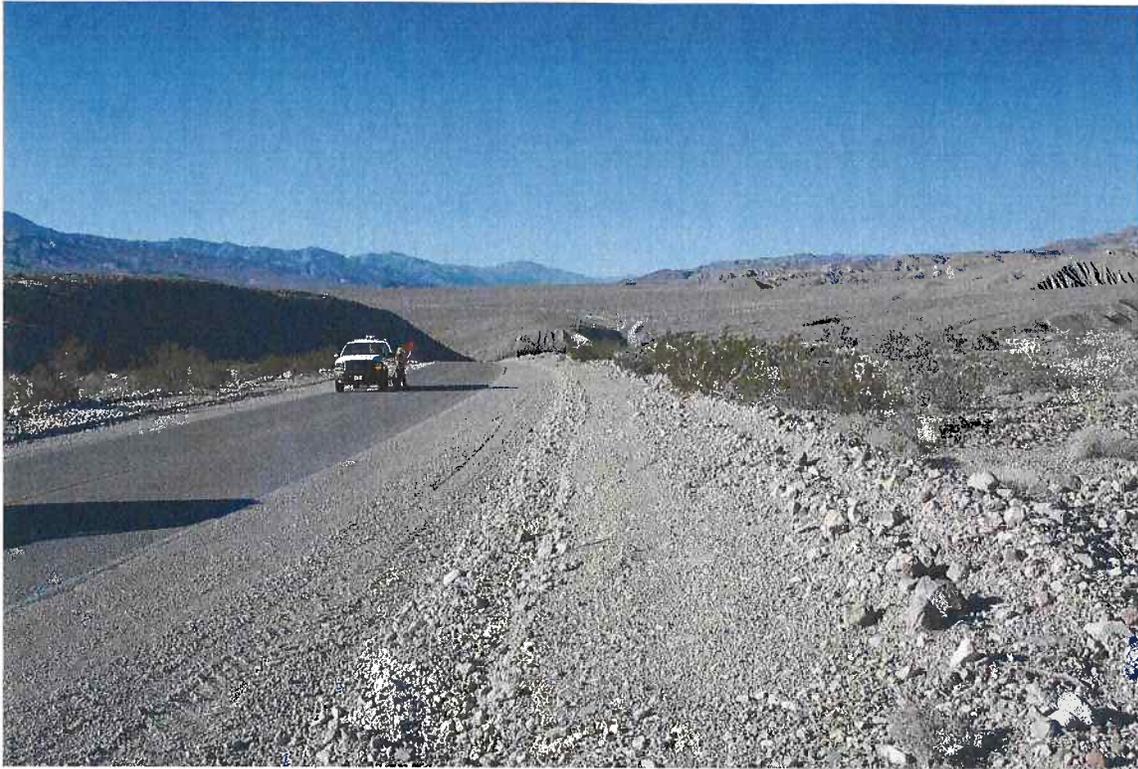


Photo 13: Sta 790+00, C-44, bad sight distance

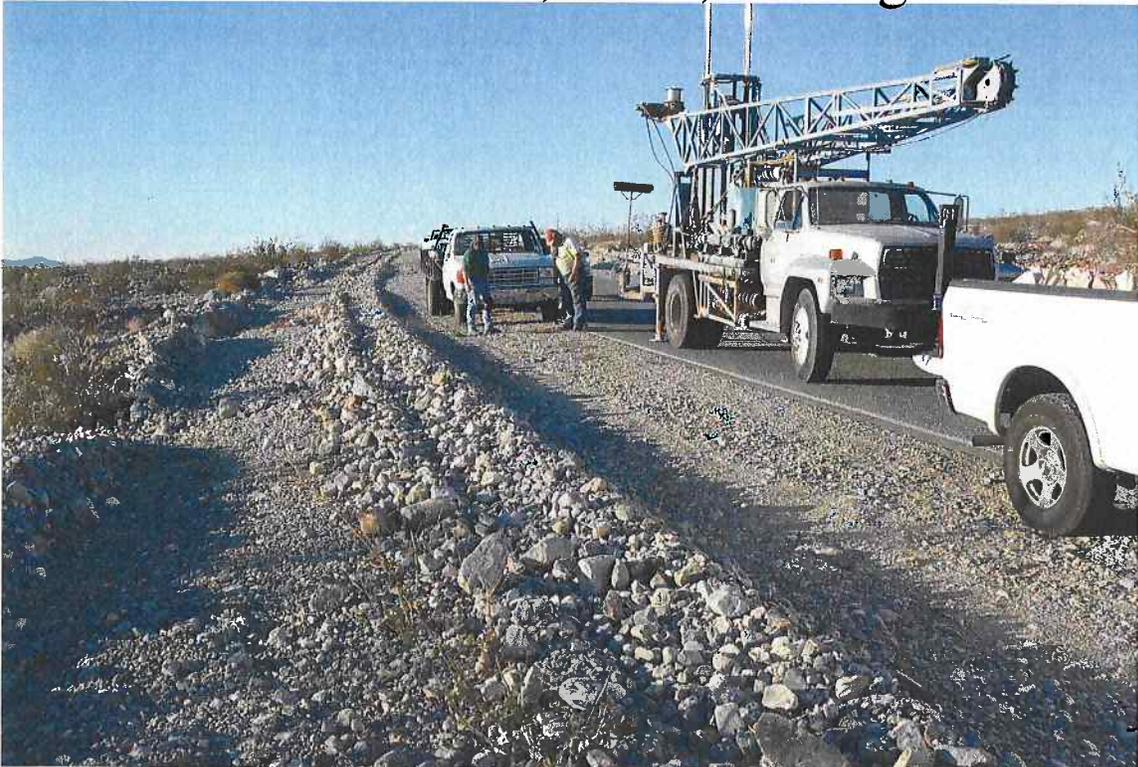


Photo 14: Sta 812+00, C-45 bony berm

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD



Photo 15: Sta 920+25, C-51, left foreslope



Photo 16: Sta 988+25, C-55, auger refusal @ 6''



Photo 17: typical boring w/sandy gravel w/silt



Photo 18: Sta 449+50, TP-2, note cobble

APPENDIX D

PAVEMENT DESIGN CALCULATIONS

1993 AASHTO Pavement Design
DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
 Computer Software Product

Flexible Structural Design Module

Bonnie Claire

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	61,872
Initial Serviceability	4.2
Terminal Serviceability	2
Reliability Level	75 %
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	18,000 psi
Stage Construction	1
 Calculated Design Structural Number	 1.38 in

Rigorous ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	547
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	60 %

<u>Vehicle Class</u>	<u>Percent of ADT</u>	<u>Annual % Growth</u>	<u>Average Initial Truck Factor (ESALs/Truck)</u>	<u>Annual % Growth in Truck Factor</u>	<u>Accumulated 18-kip ESALs over Performance Period</u>
2	96	1	0.0008	0	2,016
4	1	1	0.88	0	23,102
5	2	1	0.2	0	10,501
8	1	1	1	0	26,253
Total	100	-	-	-	61,872

Growth Simple

Total Calculated Cumulative ESALs 61,872

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	<u>Struct Coef. (Ai)</u>	<u>Drain Coef. (Mi)</u>	<u>Thickness (Di)(in)</u>	<u>Width (ft)</u>	<u>Calculated SN (in)</u>
1	HACP	0.44	1	3	-	1.32
2	Pulverize	0.12	1	3	-	0.36
Total	-	-	-	6.00	-	1.68

BindReport-3WS.txt

LTPPBind V2.1 Three closest weather Stations Report: (Date 7/7/2007)
 For Latitude/Longitude= 36.72015 / 117.0109

C=51 km	A=32 km	B=42 km
State	CA	NV
NV		
Station ID	0042319	0260718
0260150		
County	INYO	NYE
NYE		
Weather Station	DEATH VALLEY	BEATTY 8 N
AMARGOSA RANCH		
Elevation, m	-59	1082
747		
Latitude/Longitude	36.47/116.87	37.00/116.72
36.57/116.47		
Last Year Data Available	1996	1996
1996		
Low Temp. Mean (Std, N)	-4.1 (3.4,23)	-11.1 (3.0,20)
-8.6 (2.6,15)		
High 7-day Average Mean (Std, N)	49.4 (1.2,30)	39.3 (1.2,21)
42.6 (1.6,17)		
Low Temp. Drop Mean (Std, N)	19.1 (5.7,22)	16.7 (3.7,20)
19.0 (3.1,14)		
Degree Days Over 30 C (Std, N)	2158 (189,30)	561 (88,21)
1087 (152,17)		
Using HT/LT Model:LTPP/LTPP		
50% Reliability Pavement Temp.	64.5 -01.1 (50,50)	56.5 -06.3 (50,50)
59.2 -04.4 (50,50)		
>50% Rel. PG (High, Low Rel.)	70 -10 (95,98)	58 -10 (68,89)
64 -10 (93,97)		
	76 -10 (98,98)	64 -10 (98,89)
70 -10 (98,97)		
		64 -16 (98,98)
70 -16 (98,98)		



Weather and Climate

Death Valley National Park



- ◆ **Death Valley is famous as the hottest, driest place in North America.**
- ◆ **Higher elevations are cooler than the low valley. Temperatures drop 3° to 5° F with every thousand vertical feet.**
- ◆ **Sunny skies are the norm in Death Valley, but winter storms and summer monsoons can bring cloud cover and rain.**
- ◆ **Wind is common in the desert, especially in the spring. Dust storms can suddenly blow up with approaching cold fronts.**
- ◆ **Weather data was compiled from park and National Weather Service record summaries for the years 1911 through 2001 for Furnace Creek in Death Valley, California.**

Temperatures and Precipitation													
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
daily high (average)	65° F 18° C	72° F 22° C	80° F 27° C	90° F 32° C	99° F 37° C	109° F 43° C	115° F 46° C	113° F 45° C	106° F 41° C	92° F 33° C	76° F 24° C	65° F 18° C	90° F 32° C
daily low (average)	39° F 4° C	46° F 8° C	53° F 12° C	62° F 17° C	71° F 22° C	80° F 27° C	88° F 31° C	85° F 29° C	75° F 24° C	62° F 17° C	48° F 9° C	39° F 4° C	62° F 17° C
record high	89° F 32° C	97° F 36° C	102° F 39° C	111° F 44° C	122° F 50° C	128° F 53° C	134° F 57° C	127° F 53° C	123° F 50° C	113° F 45° C	97° F 36° C	88° F 31° C	134° F 57° C
record low	15° F -9° C	25° F -4° C	30° F -1° C	35° F 2° C	42° F 6° C	49° F 10° C	52° F 11° C	64° F 18° C	41° F 5° C	32° F 0° C	24° F -4° C	19° F -7° C	15° F -9° C
precipitation	.26" 0.7cm	.35" 0.9cm	.25" 0.6cm	.12" 0.3cm	.08" 0.2cm	.04" 0.1cm	.11" 0.3cm	.10" 0.3cm	.14" 0.4cm	.11" 0.3cm	.18" 0.5cm	.18" 0.5cm	1.92" 4.9cm

Changing rainfall patterns

Rainfall is 50% higher now than in the past. Yearly precipitation consistently averaged about 1.6 inches of rain for the first 60 years of record keeping. The last 30 years has seen an increase, averaging 2.5 inches of rain a year.

Longest summers

The greatest number of consecutive days with a maximum temperature of 100° F or above was 154 days in the summer of 2001. The summer of 1996 had 40 days over 120° F, and 105 days over 110° F. The summer of 1917 had 43 consecutive days with a high temperature of 120° F or above.

The highest ground temperatures

The highest ground temperature recorded was 201° F at Furnace Creek on July 15, 1972. The maximum air temperature for that day was 128° F. Ground temperature on the valley floor is about 40% higher than the surrounding air temperature.

APPENDIX E

FIELD DATA SUMMARY

CA PRA DEVA 11(3) BONNIE CLAIRE ROAD

Sampled By: S.DEPPMEIER

Note: C-1 through C-16 pertain to the roadway portion for DEVA 11(1)

<u>SAMPLE ID</u>	<u>STATIONING</u>	<u>ASPHALT THICKNESS</u>	<u>Oil Shot onto Base</u>	<u>DCP mm/Blow</u>	<u>Roadwidth</u>	<u>Benchwidth</u>	<u>BORING DEPTH</u>	<u>MATERIAL</u>	<u>AASHTO</u>	<u>ASTM</u>	<u>R-Value</u>	<u>MC</u>
C-17	405+50	3.75"	0.5"		21.8'		1'	dirty sandy gravel with silt				6.1
C-18	418+65	3"	0.5"		21.5'	27'	1'	dirty sandy gravel with silt				
C-19	431+45	2"	0.25"		21.7'	36'	1'	dirty sandy gravel with silt				
C-20	445+40	2.25"	0.25"		21.9'	30'	1'	dirty sandy gravel with silt				2.8
TP-2	449+50	2.5"	0.25"				10"	sandy gravel with silt				
C-21	458+65	2.25"	0.25"		23.0'	32'	1'	sandy gravel with silt				
C-22	473+10	2"	0.25"		21.5'		1'	sandy gravel with silt				4.1
C-23	486+90	3.75"	0.25"	3.3	21.1'	32'	1'	sandy gravel with silt				
C-24	499+65	2.25"	0.25"		21.9'	31'	1'	sandy gravel with silt				
C-25	513+10	2"	0.5"		21.6'	31'	1'	sandy gravel with silt				
C-26	525+90	2"	0.25"		20.4'	36'	1'	dirty sandy gravel with silt				
C-27	541+00	2"	0.25"		20.0'	28'	5'	dirty sandy gravel with silt	A-1-a (0)	GP-GM	76	8.5
C-28	554+15	2.5"	0.25"		20.4'	24'	1'	dirty sandy gravel with silt				
C-29	567+60	2.75"	none		20.2'	30'	1'	sandy gravel with silt				5.1
C-30	580+40	2.5"	none		20.9'	33'	1'	dirty sandy gravel with silt				
C-31	594+15	2"	none		20.4'	31'	1'	sandy gravel with silt				
C-32	607+60	2.25"	none		20.8'	34'	1'	sandy gravel with silt				
C-33	622+05	2"	none		20.9'	36'	5'	sandy gravel with silt	A-1-a (0)	GW-GM	75	
C-34	636+15	2"	0.25"		21.6'	36'	1'	same - more & bigger gravels				
C-35	649+25	2.75"	none		20.6'	36'	1'	sandy gravel with silt				
C-36	663+40	2"	0.5"		19.2'	39'	1'	sandy gravel with silt				3.4
C-37	676+50	1.75"	1.25"	4.5	20.4'		1'	sandy gravel with silt				
C-38	690+30	1.75"	0.75"		20.2'	39'	1'	wash area: very rocky -1 1/2" rock				
C-39	703+40	1.75"	0.75"		20.3'		1'	wash area: very rocky -1 1/2" rock				
C-40	717+85	1.5"	1"		20.3'	36'	1'	sandy gravel with silt				
C-41	731+30	3"	0.25"		21.1'	36'	1'	very bony sandy gravel with silt: wash repair area				0.8
C-42	749+00	2"	0.5"		18.7'	117'	1'	sandy gravel with silt				3.6
C-43	759+50	2.25"	0.75"		20.7'		1'	sandy gravel with silt				
C-44	790+00	3"	none	3.7	21.0'	39'	1'	sandy gravel with silt				1.8
C-45	812+00	3.5"	none		21.3'	36'	5'	very bony sandy gravel	A-1-a (0)	GP-GM		2.2
C-46	828+10	3.5"	shot		21.3'	39'	1'	sandy gravel with silt				
C-47	853+00	3.5"	shot		21.8'	37'	1'	sandy gravel with silt				

<u>SAMPLE ID</u>	<u>STATIONING</u>	<u>ASPHALT THICKNESS</u>	<u>Oil Shot onto Base</u>	<u>DCP mm/Blow</u>	<u>Roadwidth</u>	<u>Benchwidth</u>	<u>BORING DEPTH</u>	<u>MATERIAL</u>	<u>AASHTO</u>	<u>ASTM</u>	<u>R-Value</u>	<u>MC</u>
C-48	865+65	3.5"			21.5'		1'	sandy gravel with silt				
TP-1	884+00	4.25"					10"	sandy gravel with silt				
C-49	892+70	6"	shot	3.5	21.1'	36'	1'	bony sandy gravel with silt				
C-50	905+65	2.5"	shot		20.1'	36'	1'	sandy gravel with silt - repaired washout				
C-51	920+30	3"	0.5"		19.7'	22'	1'	sandy gravel with silt				
C-52	933+75	5.75"	0.25"		20.3'	39'	1'	sandy gravel with silt				
C-53	947+00	4.5"	0.25"		20.5'		5'	sandy gravel with silt	A-1-a (0)	GP-GM	72	1.4
C-54	973+10	2.25"	0.25"		20.8'	40'	1'	sandy gravel with silt				
C-55	988+20	2.5"	0.25"		20.8'	42'	6"	auger refusal @ 6" large rock				
C-62	998+20	2.25"	0.5"		20.3'	42'	1'	sandy gravel with silt				
C-56	1012+65	2.5"	none		21.1'	45'	1'	sandy gravel with silt				
C-57	1027+40	2"	1"		21.2'	45'	1'	as before but bigger more rocks				
C-58	1041+35	4"	0.5"		21.8'	42'	1'	sandy gravel with silt				1.9
C-59	1054+65	2.75"	1.25"		21.0'	42'	1'	sandy gravel with silt				
C-60	1067+75	9"			19.6'	42'	1'	sandy gravel with silt				
C-61	1081+70	3"	1"	4.4	20.2'	33'	1'	sandy gravel with silt				

APPENDIX F

REPORT 95-14

DEATH VALLEY NATIONAL PARK
CALIFORNIA

DECEMBER 1995
REPORT 95-14

Preliminary Investigation and Report by
Ronald D. Andresen, Pavement Engineer

Materials Branch
Central Federal Lands Highway Division
Federal Highway Administration
Denver, Colorado

Distribution

National Park Service, (2)
Tom Puto, HPC-16
Materials (2)

Prepared by:

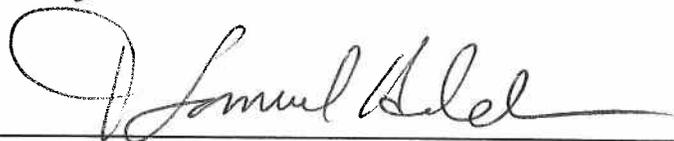


Ronald D. Andresen, Pavement Engineer

Reviewed by:



Wayne C. Folkman, Field Exploration Supervisor



T. Samuel Holder, P.E., Geotechnical Engineer

Approved for distribution by:



Bob H. Welch, P.E., Materials Engineer



DATE

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B - BORING LOGS	
C - LABORATORY TEST RESULTS	

INTRODUCTION

This investigation was initiated at the request of the National Park Service to determine if paved roads at Death Valley National Park will require reconstruction or resurfacing in the near future. All paved roads maintained by the Park Service were addressed. Paved roads maintained by the California Department of Transportation were not evaluated.

In August of 1995, the Materials Branch of the Central Federal Lands Highway Division (CFLHD), Federal Highway Administration (FHWA), conducted a materials investigation of Death Valley National Park, California. A mobile B-80 drill rig was used with the drilling accomplished by Western Technologies, Inc., Las Vegas, Nevada. Seventy-eight borings were made on the entire project. Logging bore holes, sampling, and testing was conducted by FHWA Materials personnel. Traffic control was provided by the National Park Service. A location map is included in Appendix A. The project was broken into five sections:

- Section 1: California State Highway 178 (Badwater Road), 90.67 km (56.4 miles).
- Section 2: California State Highway 267 (Scotty's Castle Road), 65.97 km (41.0 miles).
- Section 3: California State Highway 374 (Mud Canyon/Beatty Road), 28.00 km (17.4 miles).
- Section 4 Emigrant Canyon Road, 34.27 km (21.3 miles).
- Section 5: Dante's View Road, 21.40 km (13.3 miles).

The existing paved roads are narrow with a ± 6.10 m (± 20 ft.) paved surface, and .3 to .91 m (1 to 3 ft.) dirt shoulders. The paved roads follow the natural contours of the land, with little attempt to smooth the profile of the roads. Where very large washes intersect the roadway, galvanized culverts have been installed to prevent the pavement from being washed away. During periods of open channel flow, the majority of the washes that intersect the road carry water over the road. In numerous locations throughout the Park, there are sections of roadway that have been washed out and the traffic diverted to an alternate alignment. There is pavement damage from the rear bumpers of recreational vehicle scraping the surface of the pavement along the Badwater Road and Scotty's Castle Road.

TESTING PROGRAM

The subgrade samples were shipped to the FHWA Central Laboratory in Denver, Colorado, for testing and evaluation. Two pavement samples from Mud Canyon/Beatty Road were also collected. The testing program consisted of the following:

- a) Subgrade soil samples were classified using the AASHTO M 145 and ASTM D 2487 methods.

- b) Subgrade samples were tested for resistance R-value of compacted soils using AASHTO T 190.
- c) Pavement samples were visually examined to determine the cause of pavement shoving on the east side of Daylight Pass.

ROADWAY INVESTIGATION

Section One

The first section of roadway investigated was California State Highway 178, referred to as Badwater Road. Twenty-nine borings were drilled in the center of the southbound lane to the Park boundary. Two borings were made in the Badwater parking area, one boring in the Natural Bridge gravel Road, and one boring made in the Golden Canyon parking area. Pavement and base depths were measured and samples taken of the underlying subgrade. Boring logs are included in Appendix B.

Section Two

The next section was California State Highway 267, Scotty's Castle Road to the Park boundary. Twenty borings were drilled in the center of the northbound lane. Three borings were obtained on Ubehebe Crater Road, and two on Mesquite Springs Campground Road. The pavement ends at the entrance to the campground loop, no borings were made in the loop.

Section Three

Section three was California State Highway 374, beginning on Scotty's Castle Road and continuing through Mud Canyon over Daylight Pass towards Beatty, Nevada, terminating at the Park boundary. Seven borings were made in the east bound lane of the roadway. Two pavement samples were collected on the east side of Daylight Pass to determine the cause of the surface distortions of the pavement mat.

Section Four

Section four was the road beginning at California State Highway 190 and Emigrant, and proceeding through Emigrant and Nemo Canyons, and terminating at Trona Road intersection. There were seven borings obtained in the south-bound lane of the road. No borings were made on the road past Trona/Wildrose intersection. The roadway was recently reconstructed by CFLHD.

Section Five

The final section was the road leading to Dante's View, beginning at California State Highway 190 and terminating at the trailer parking turnout. Five borings were obtained in the south-bound lane. The drill rig was unable to negotiate the tight switchback curves to get to Dante's View Overlook, so no borings were made beyond the trailer parking area.

ANALYSIS

Section One

The portion of road carrying the most traffic is from 0.00 km to the Badwater parking area located at 26.78 km. This section is currently performing well and shows adequate stability. The remainder of the road is not as wide and does not carry as much traffic. The average bituminous stabilized thickness is 76.2 mm (3 in.). The base course material averages 152.4 mm (6 in.). The subgrade materials underlying the road are uniform throughout its length, 90.75 km (56.4 mile), consisting of mostly sand, gravel, and rock, with R-values of 73 to 80. There are scarring marks on the pavement where recreational vehicles have bottomed out and rear bumpers have marred the pavement surface.

Badwater parking area is currently in good condition. No deformations were found in the pavement despite the parked cars and surface temperatures in excess of 60°C (140°F). While borings were being taken, the parking area was observed to be very full. Borings made in the parking area are similar to borings in the main road. Spur roads are also similar to borings in the Badwater Road. Golden Canyon parking area has recently been reconstructed to accommodate cars, vehicles with trailers, recreational vehicles, and is handicap accessible. This parking area is in excellent condition.

Section Two

The bituminous stabilized thickness averages 76.2 mm (3 in.), and is composed of multiply layers of chip seals. No base course material is present below the pavement. Subgrade materials are uniform over the 65.97 km (41.0 miles) of roadway, and are made up of sand and gravel. Subgrade samples possess R-values of 77 to 80.

The road leading to Ubehebe Crater has a width of approximately 6.10 meters (20 ft.) with very wide shoulders. Intersecting the road at 4.98 km is a large wash. When water is present, it appears to flow along the road. Pavement thickness is 63.5 mm (2.5 in.) at .80 km, and 120.7 mm (4.75 in.) and 114.3 mm (4.5 in.) at 4.02 km and 7.56 km respectively. The pavement is made up of a large aggregate mix and overlaid with chip seals. Pavement on this stretch of road is performing well. No base course is below the pavement. Subgrade from the Ubehebe Crater Road is moist and contains silt in the area between Scotty's Castle Road and the Ubehebe Crater one-way loop. The subgrade at 7.56 km contains volcanic sand.

The road leading to the Mesquite Spring Campground is paved for 2.98 km (1.85 miles) to the beginning of the campground loop. At the end of the pavement, there is a natural spring. The Mesquite Springs Campground Road is made up of a large aggregate mix with a chip seal overlay. Pavement thickness is 63.5 mm (2.5 in.) with natural subgrade below. Subgrade material is consistent with gravelly sand with small cobbles.

Section Three

Two distinct sub-sections were observed on this stretch of road. The first section is from the intersection of Scotty's Castle Road to the summit of Daylight Pass, kilometers 0.00 to 20.92. The bituminous stabilized surface on this stretch of road is performing well, with an average depth of 63.5 mm (2.5 in.). There is no base course below the pavement. Subgrade materials consist of silty sand with an R-value of 79.

The second section from the summit of Daylight Pass east to the Park boundary, 20.92 km to 28.00 km, is not performing well. Asphalt surface shows signs of shoving and rutting in both travel lanes. The center stripe is an "S" shape rather than a straight line. Pavement is approximately 114.3 mm (4.5 in.) thick. Subgrade consist of silty clay and silty sand with an R-value of 64. Pavement rutting is due to the high asphalt content of the most recent chip seal. Visual inspection of the asphalt pavement surface shows the top 25.4 mm (1 in.) to be an over-asphalted chip seal. This has created an unstable top layer that will remain unstable. When combined with the high pavement temperatures, high asphalt content, and steep grade leading to the summit of Daylight Pass, the pavement shoves.

Section Four

The first 1.37 km (0.85 miles) of the road is a low water crossing area recently reconstructed with approximately 6.71 meters (22 ft.) road width. No borings were made in this area due to the recent construction. The remaining 32.90 km (20.45) miles of road is a compilation of bituminous treatments with some large aggregate mix in areas where the road has not been disturbed since original construction. The average pavement thickness is 76.2 mm (3 in.). There is no base course below the pavement. Subgrade materials are composed of silty sand and gravel with R-values of 73 and 75. There are two areas at 3.05 to 9.01 km and 33.31 to 34.11 km where the road enters canyons too narrow for both a road and drainage ditch so the road must serve as both. In these areas, portions of the pavement have been replaced when high water flows have occurred.

Section Five

The bituminous stabilized surface thickness of section five is approximately 63.5 mm (2.5 in.) with no base course below the pavement layer. The first 3.22 km (2 miles) of road experiences heavy truck traffic as a mine operates nearby and uses the road for access. There are low water crossings at .16 km and 9.89 km. The roadway is performing well even in areas where truck traffic is high. Subgrade material on the first 16 km (10 miles) of road consist of silty sand with an R-value of 62. The subgrade to 16.09 km is alluvial deposits with an R-value of 62. At 20.43 km near the trailer parking area, the subgrade is visibly different. The subgrade materials are volcanic and sedimentary with little gravel, having an R-value of 18. The drill rig was unable to negotiate tight switchbacks that lead to the overlook so no borings were made beyond the trailer parking area.

RECOMMENDATIONS

Our recommendations at this time are very general and will need to be analyzed along with the Road Inventory Program (RIP) previously being conducted by the Federal Highway Administration.

Items such as alignment (vertical and horizontal) proposed roadway widths, drainage, safety problems, stability problems, (cut and fill) etc., are not addressed.

Once the RIP information is available, the roadway can be broken into sections and a more detailed evaluation of the needs and costs conducted.

Several options are listed that will provide for variable pavement design lives. The overlay option should not be considered unless you are willing to live with the existing cracking reflecting through the new pavement within one to three years.

Roadway rehabilitation options that could be used:

<u>OPTION</u>	<u>ESTIMATED YEARS GAINED</u>
1. Do nothing.	0
2. Chip seal.	3 to 5
3. Double chip seal.	5 to 7
4. Overlay (1-1/2").	10 plus
5. a. Recycle existing materials (Pavement and base) into a base.	
b. Add new base, if needed.	
c. Apply double chip seal	10 plus
d. Hot asphalt concrete pavement (2")	20 plus
6. Cold in-place recycle.	
a. Double chip seal.	10 plus
b. Hot asphalt concrete pavement (2")	20 plus

Due to the climatic conditions and the generally good subgrade soils, a minimum structural section would be adequate for most sections of the road's evaluation. The structural number required for a 20-year design life is 1.52, which is equivalent to the following:

$$\begin{array}{r} 2'' \text{ pavement} \times .40 = .80 \\ 6'' \text{ base} \quad \times .12 = \underline{.72} \\ \hline 1.52 \end{array}$$

Section One

Options that could be used are: 1, 2, 3, 4, and 6.

This section is an ideal candidate for in-place cold recycling since there is adequate base and pavement to work with. A 3-inch depth of cold recycling with a 1-1/2 inch overlay would be adequate for a 20-year design life.

Section Two

Options that could be used are: 1, 2, 3, 4, and 5.

Since there is no base under the existing bituminous stabilized surface, and because the depth and gradation of the bituminous surface is non-uniform, we recommend pulverizing the existing bituminous material to 100 percent passing a 1-1/2 inch sieve, then relaying and shaping, and adding additional base for a total base depth of 6 inches, then apply a 2-inch thickness of hot asphalt concrete.

Another option is to recycle 3 inches with no additional new base and apply a 3-inch layer of hot asphalt concrete pavement over the 3-inches of recycled base.

Section Three

Options that could be used are the same as for Section Two except that if some type of overlay is proposed in the section between 20.91 km to 28.00 km, the top 1-inch of over-asphalted material should be removed.

Section Four

Same options as Section Two.

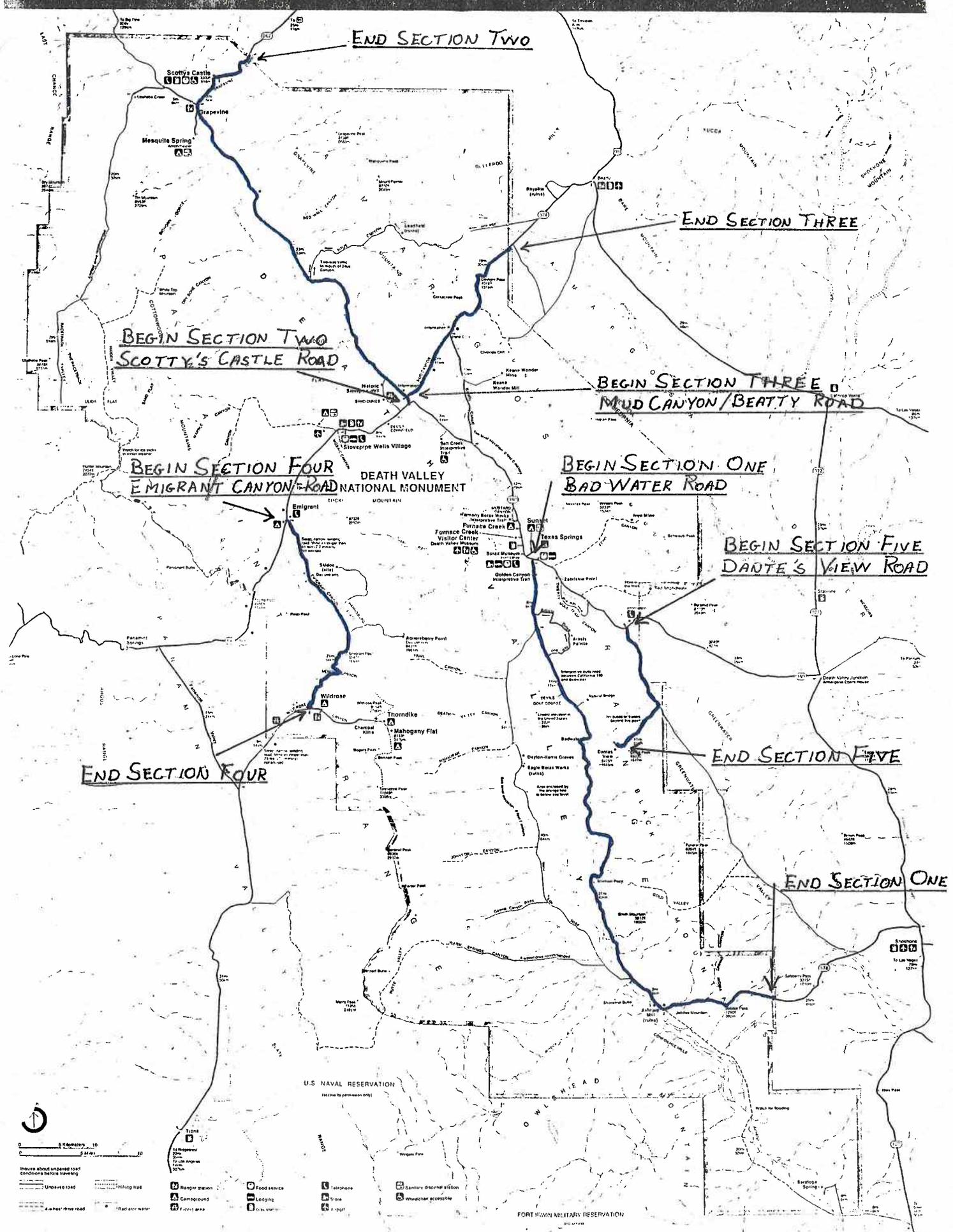
Section Five

Same options as Section Two.

APPENDIX A
LOCATION MAP

Death Valley

Death Valley National Monument is administered by the National Park Service, U.S. Department of the Interior. For more information, write: Superintendent, Death Valley National Monument, Death Valley, CA 92328. Or call: 619-786-2331 and (TTY) 619-786-2411.



END SECTION TWO

END SECTION THREE

**BEGIN SECTION TWO
SCOTTY'S CASTLE ROAD**

**BEGIN SECTION THREE
MUD CANYON/BETTY ROAD**

**BEGIN SECTION FOUR
EMIGRANT CANYON ROAD**

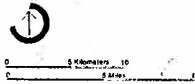
**BEGIN SECTION ONE
BAD WATER ROAD**

**BEGIN SECTION FIVE
DANTE'S VIEW ROAD**

END SECTION FOUR

END SECTION FIVE

END SECTION ONE



Inquire about unpaved road conditions before traveling.

- Ranger station
- Campground
- Food service
- Lodging
- Telephone
- Store
- Fuel pump
- Sanitary disposal station
- Recreational area

FORT HORN MILITARY RESERVATION

APPENDIX B

BORING LOGS

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State
and CA State Highway 178. Badwater road (southbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-1	0.000				
	0.161	0.000-0.064 0.064-0.216 0.216-0.914	0" - 2.5" 2.5" - 8.5" 8.5" - 3'	Pavement. Base course. Brown, sandy gravel.	
	3.218				Golden Canyon Parking.
H-2	3.379	0.000-0.064 0.064-0.216 0.216-0.914	0" - 2.5" 2.5" - 8.5" 8.5" - 3'	Pavement. Base course. Brown, sandy gravel.	Top of alluvial fan.
	4.183				Concrete low water crossing.
H-3	6.275	0.000-0.064 0.064-0.216 0.216-0.914	0" - 2.5" 2.5" - 8.5" 8.5" - 3'	Pavement. Base course. Brown, sandy gravel.	
	7.723				Exit from Artist Drive.
H-4 Sample	9.654	0.000-0.070 0.070-0.222 0.222-0.914	0" - 2.75" 2.75" - 8.75" 8.75" - 3'	Pavement. Base course. Brown, sandy gravel.	West Side Road Entrance.
H-5	13.033	0.000-0.064 0.064-0.216 0.216-0.914	0" - 2.5" 2.5" - 8.5" 8.5" - 3'	Pavement. Base course. Brown, sandy gravel.	

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State and CA State Highway 178. Badwater road (southbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-6	13.837				Artist Drive entrance.
	16.090	0.000-0.057	0" - 2.25"	Pavement.	Top of alluvial fan.
		0.057-0.210	2.25" - 8.25"	Base course.	
		0.210-0.914	8.25" - 3'	Brown sandy gravel.	
	16.975				Low water crossing.
	17.699				Devils Golf Course.
H-7	19.308	0.000-0.064	0" - 2.5"	Pavement.	Bottom of alluvial fan.
		0.064-0.216	2.5" - 8.5"	Base course.	
		0.216-0.914	8.5" - 3'	Brown sandy gravel.	
	21.078				Natural Bridge Road.
H-8	22.526	0.000-0.057	0" - 2.25"	Pavement.	Alluvial fan..
		0.057-0.210	2.25" - 8.25"	Base course.	
		0.210-0.914	8.25" - 3'	Brown sandy gravel.	
H-9	25.744	0.000-0.057	0" - 2.25"	Pavement.	Alluvial fan.
		0.057-0.210	2.25" - 8.25"	Base course.	
		0.210-0.914	8.25" - 3'	Brown sandy gravel.	
	26.790				Badwater parking area.

SUMMARY OF SOIL SURVEY

page 3 of 7

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State
and CA State Highway 178. Badwater road (southbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-10 Sample	28.962	0.000-0.057 0.057-0.210 0.210-0.914	0" - 2.25" 2.25" - 8.25" 8.25" - 3'	Pavement. Base course. Brown, sandy gravel.	Alluvial fan.
H-11	32.180	0.000-0.070 0.070-0.222 0.222-0.914	0" - 2.75" 2.75" - 8.75" 8.75" - 3'	Pavement. Base course. Brown, sandy gravel.	Edge of alluvial fan. Road width, 20 feet.
H-12	35.398	0.000-0.083 0.083-0.235 0.235-0.914	0" - 3.25" 2.25" - 9.25" 9.25" - 3'	Pavement. Base course. Brown, sandy gravel.	Edge of alluvial fan.
H-13	38.938	0.000-0.057 0.057-0.210 0.210-0.914	0" - 2.25" 2.25" - 8.25" 8.25" - 3'	Pavement. Base course. Brown, sandy gravel.	Wind-blown sand area.
H-14	41.834	0.000-0.064 0.064-0.216 0.216-0.914	0" - 2.5" 2.5" - 8.5" 8.5" - 3'	Pavement. Base course. Brown, sandy gravel.	Edge of alluvial fan.
H-15	45.052	0.000-0.057 0.057-0.210 0.210-0.914	0" - 2.25" 2.25" - 8.25" 8.25" - 3'	Pavement. Base course. Brown, sandy gravel.	Edge of alluvial fan.
H-16 Sample	48.270	0.000-0.057 0.057-0.210 0.210-0.914	0" - 2.25" 2.25" - 8.25" 8.25" - 3'	Pavement. Base course. Brown, sandy gravel.	Edge of alluvial fan.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State and CA State Highway 178. Badwater road (southbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-17	51.488	0.000-0.064 0.064-0.216 0.216-0.914	0" - 2.5" 2.5" - 8.5" 8.5" - 3'	Pavement. Base course. Gravel with cobbles.	Edge of alluvial fan.
	53.097				Mormon Point.
H-18	54.706	0.000-0.083 0.083-0.235 0.235-0.914	0" - 3.25" 3.25" - 9.25" 9.25" - 3'	Pavement. Base course. Gravel with cobbles.	Small alluvial fan.
H-19	57.924	0.000-0.076 0.076-0.229 0.229-0.914	0" - 3" 3" - 9" 9" - 3'	Pavement. Base course. Silty sand and gravel.	Alluvial fan.
H-20	61.142	0.000-0.076 0.076-0.229 0.229-0.914	0" - 3" 3" - 9" 9" - 3'	Pavement. Base course. Coarse sand and gravel.	Alluvial fan.
H-21 Sample	64.360	0.000-0.076 0.076-0.229 0.229-0.914	0" - 3" 3" - 9" 9" - 3'	Pavement. Base course. Sand, gravel, cobbles.	Alluvial fan.
	67.900				West Side Road.
H-22	68.061	0.000-0.076 0.076-0.229 0.229-0.914	0" - 3" 3" - 9" 9" - 3'	Pavement. Base course. Coarse gravel and sand.	Alluvial fan.

SUMMARY (SOIL SURVEY

5 of 7

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State
and CA State Highway 178. Badwater road (southbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-23	69.107 70.796	0.000-0.025 0.025-0.178 0.178-0.914	0" - 1" 1" - 7" 7" - 3'	Pavement. Base course. Coarse gravel.	Ashford Mills Road. Large alluvial fan.
H-24	74.015	0.000-0.076 0.076-0.229 0.229-0.914	0" - 3" 3" - 9" 9" - 3'	Pavement. Base course. Brown sand and gravel.	Alluvial fan. Road to Baker.
H-25	77.232	0.000-0.089 0.089-0.241 0.241-0.914	0" - 3.5" 3.5" - 9.5" 9.5" - 3'	Pavement. Base course. Coarse Gravel w/cobbles	Alluvial fan.
H-26 Sample	80.450	0.000-0.095 0.095-0.248 0.248-0.914	0" - 3.75" 3.75" - 9.75" 9.75" - 3'	Pavement. Base course. Brown sandy gravel.	Alluvial fan.
H-27 Sample	83.507	0.000-0.095 0.095-0.248 0.248-0.914	0" - 3.75" 3.75" - 9.75" 9.75" - 3'	Pavement. Base course. Brown sandy gravel.	Alluvial fan.
H-28	86.886	0.000-0.095 0.095-0.197 0.197-0.914	0" - 3.75" 3.75" - 7.75" 7.75" - 3'	Pavement. Base course. Brown sandy gravel.	Alluvial fan.
H-29	90.667	0.000-0.140 0.140-0.914	0" - 5.5" 5.5" - 3'	Pavement. Brown sandy gravel.	Park boundary. Alluvial fan.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: Intersection of CA State Highway 178 and Badwater Parking area.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-30	South end of Badwater parking lot.	0.000-0.095 0.095-0.914	0" - 3.75" 3.75" - 3'	Pavement. Brown sandy gravel.	South end of parking lot near island
H-31	North end of Badwater parking lot.	0.000-0.089 0.089-0.914	0" - 3.5" 3.5" - 3'	Pavement. Brown sandy gravel, coarser than H-30.	North end of parking lot near island.

BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 178 and Natural Bridge Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
	0.000				Junction of CA 178 and Natural Bridge Road.
H-32 Sample	0.483	0.000-0.914	0" - 3'	Brown sandy gravel with cobbles.	No pavement. Road is local gravel material and very rough.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 178 and Golden Canyon parking area entrance.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
	0.000				Junction of CA 178 and Golden Canyon Road.
H-33 Sample	0.161	0.000-0.051 0.051-0.914	0" - 2" 2" - 3'	New pavement. Brown sandy gravel.	Bored on the east end of the parking area.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State Highway 267. Scotty's Castle Road (northbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-34	0.000				
	0.161	0.000-0.064	0" - 2.5"	Pavement. Brown sandy gravel.	Alluvial.
		0.064-0.914	2.5" - 3'		
	0.964				Hwy. 374 Turn-off to Beatty, NV.
1.207			Information booth.		
H-35	3.218	0.000-0.064	0" - 2.5"	Pavement. Brown sandy gravel with cobbles.	Alluvial.
		0.064-0.914	2.5" - 3'		
	4.183				Wagonwheel History Point of Interest.
	4.827			Sand Dunes Road.	
H-36	6.436	0.000-0.070	0" - 2.75"	Pavement. Brown sandy gravel.	Alluvial.
		0.070-0.914	2.75" - 3'		
H-37	9.654	0.000-0.076	0" - 3"	Pavement. Brown sandy gravel.	Alluvia.
		0.057-0.914	3" - 3'		
H-38 Sample	12.872	0.000-0.070	0" - 2.75"	Pavement. Brown sandy gravel.	Culvert, alluvial.
		0.070-0.914	2.75" - 3'		

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State Highway 267. Scotty's Castle Road (northbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-39	13.837				Culvert.
	14.240				Culvert.
	14.561				Culvert.
	14.722				Culvert.
	16.090	0.000-0.064 0.064-0.914	0" - 2.5" 2.5" - 3'	Pavement. Brown sandy gravel.	Alluvial.
	19.228				Point of Interest.
H-40	19.308	0.000-0.051 0.051-0.914	0" - 2" 2" - 3'	Pavement. Brown sandy gravel.	Alluvial.
H-41	22.526	0.000-0.076 0.057-0.914	0" - 3" 3" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial.
	24.135				Titus Canyon Road.
H-42	25.744	0.000-0.127 0.127-0.914	0" - 5" 5" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial.

SUMMARY OF SOIL SURVEY

page 3 of 7

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State Highway 267. Scotty's Castle Road (northbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-43	28.962	0.000-0.127 0.127-0.914	0" - 5" 5" - 3'	Pavement. Grey sandy gravel with cobbles.	Alluvial.
H-44 Sample	32.180	0.000-0.127 0.127-0.914	0" - 5" 5" - 3'	Pavement. Grey sandy gravel with cobbles.	Alluvial.
H-45	35.398	0.000-0.102 0.102-0.914	0" - 4" 4" - 3'	Pavement. Brown sandy gravel with few cobbles.	Alluvial.
H-46	38.616	0.000-0.102 0.102-0.914	0" - 4" 4" - 3'	Pavement. Gray sandy gravel with cobbles.	Alluvial.
H-48	41.995 42.719	0.000-0.089 0.089-0.914	0" - 3.5" 3.5" - 3'	Pavement. Gray sandy gravel with cobbles.	Alluvial. Large wash, culvert.
H-49	45.052	0.000-0.064 0.064-0.914	0" - 2.5" 2.5" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State Highway 267. Scotty's Castle Road (northbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-50	48.431	0.000-0.089	0" - 3.5"	Pavement. Brown sandy gravel.	Alluvial.
	49.316	0.089-0.914	3.5" - 3'		Large wash.
	49.396				Large wash.
H-51	51.810	0.000-0.076	0" - 3"	Pavement. Gray sandy gravel.	Alluvial and volcanic.
	53.177	0.076-0.914	3" - 3'		Mesquite Springs Campground Road.
	53.982				Park Entrance Station.
	54.223				Ubehebe Crater Road.
H-52 Sample	54.706	0.000-0.114	0" - 4.5"	Pavement. Gray sandy gravel.	Alluvial and volcanic.
	56.798	0.114-0.914	4.5" - 3'		Sharp corner, tree, wash.
H-53	57.924	0.000-0.064	0" - 2.5"	Pavement. Brown sandy gravel.	Alluvial.
	58.889	0.064-0.914	2.5" - 3'		Scotty's Castle, old entrance.
	59.211				Scotty's Castle, new entrance.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and CA State Highway 267. Scotty's Castle Road (northbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-54	61.142	0.000-0.089	0" - 3.5"	Pavement. Brown sandy gravel.	Alluvial.
	65.969	0.089-0.914	3.5" - 3'		Park boundary.

BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 267 and Ubehebe Crater Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-55 Sample	0.000				Junction of CA 267 and Ubehebe Crater Road.
	0.805	0.000-0.064	0" - 2.5"	Pavement. Brown sandy gravel.	Alluvial and volcanic.
	2.574	0.064-0.914	2.5" - 3'		Service road.
H-56	4.023	0.000-0.121 0.121-0.914	0" - 4.75" 4.75" - 3'	Pavement. Brown sandy gravel cementitious.	Alluvial and volcanic.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 267 and Ubehebe Crater Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-57	4.586				Big Pine Road.
	4.988				Large wash.
	7.562	0.000-0.108 0.108-0.914	0" - 4.15" 4.15" - 3'	Pavement. Coarse sand.	Alluvial and volcanic.
	8.689				Begin one-way loop.
	9.654				Ubehebe Crater parking area.
	10.137				Rejoin two-way road.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 267 and Mesquite Spring Campground Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
	0.000				
H-58	1.126	0.000-0.057 0.057-0.914	0" - 2.25" 2.25" - 3'	Pavement. Brown sandy gravel.	Alluvial.
H-59	2.896	0.000-0.076 0.076-0.914	0" - 3" 3" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial.
	2.977				End of pavement, enter the camping ground.

SUMMARY C IL SURVEY

1 of 2

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 267 and CA State Highway 374. Road to Beatty, Nevada (eastbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-60	0.000 0.644	0.000-0.064 0.064-0.914	0" - 2.5" 2.5" - 3'	Pavement. Brown sandy gravel.	Alluvial.
H-61	5.149	0.000-0.057 0.057-0.914	0" - 2.25" 2.25" - 3'	Pavement. Gray sandy gravel.	Alluvial.
H-62	9.976 10.056	0.000-0.057 0.057-0.914	0" - 2.25" 2.25" - 3'	Pavement. Gray sandy gravel.	Alluvial. Beatty cut-off road.
H-63 Sample	14.320	0.000-0.070 0.070-0.914	0" - 2.75" 2.75" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial.
H-64	18.986 20.917	0.000-0.076 0.076-0.914	0" - 3" 3" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial. Daylight Pass Summit.
H-65	24.618	0.000-0.127 0.127-0.914	0" - 5" 5" - 3'	Pavement. Brown sandy gravel and silt.	Alluvial. Pavement is moving, top 1" of chips appear to have too much asphalt.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 267 and CA State Highway 374. Road to Beatty, Nevada (eastbound).

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-66	27.916	0.000-0.102 0.102-0.914	0" - 4" 4" - 3'	Pavement. Brown sandy gravel.	Alluvial. Pavement is moving, top 1" of chips appear to have too much asphalt. Park boundary.
	27.997				

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and Emigrant Canyon Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-67	0.000				Low water crossing with recent reconstruction. Gate. End of recent reconstruction. Partial road wash-out and skin patch. Alluvial.
	0.241				
	0.805				
	1.368				
	2.414				
	3.218	0.000-0.102 0.102-0.914	0" - 4" 4" - 3'	Pavement. Brown sandy gravel.	
H-68	7.884	0.000-0.095 0.095-0.914	0" - 3.75" 3.75" - 3'	Pavement. Brown sandy gravel.	Alluvial.
	8.045				Enter Emigrant Canyon.
	9.010				Exit Emigrant Canyon
	9.976				Low water crossing.
H-69 Sample	12.872	0.000-0.051 0.051-0.914	0" - 2" 2" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial and sedimentary.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and Emigrant Canyon Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-70	15.446				Skidoo Road.
	17.699	0.000-0.070 0.070-0.914	0" - 2.75" 2.75" - 3'	Pavement. Brown sandy gravel with silt.	Alluvial and sedimentary.
	19.308				Aguereberry Road.
	22.043				Emigrant Pass Summit
H-71	22.526	0.000-0.064 0.064-0.914	0" - 2.5" 2.5" - 3'	Pavement. Brown sandy gravel.	Sedimentary. Coarse pavement.
H-72 Sample	27.353	0.000-0.051 0.051-0.914	0" - 2" 2" - 3'	Pavement. Brown sandy gravel.	Sedimentary. Coarse pavement.
H-73	32.180	0.000-0.095 0.095-0.914	0" - 3.75" 3.75" - 3'	Pavement. Brown sandy gravel.	Sedimentary. Coarse pavement.
	33.306				Enter Nemo Canyon. Very tight curves.
	34.111				Exit Nemo Canyon.
	34.272				Gate, Trona Road.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and Dante's View Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-74	0.000				
	0.161				Low water crossing.
	2.092	0.000-0.064 0.064-0.914	0" - 2.5" 2.5" - 3'	Pavement. Brown sandy gravel.	Alluvial.
	2.333				Haul road.
	3.138 to 3.298				Mine entrance.
	3.942				Ryan's Road.
H-75	6.436	0.000-0.038 0.038-0.914	0" - 1.5" 1.5" - 3'	Pavement. Brown sandy gravel.	Alluvial.
	9.895				Low water area.
H-76 Sample	11.263	0.000-0.070 0.070-0.914	0" - 2.75" 2.75" - 3'	Pavement. Brown sandy gravel with cobbles.	Alluvial.
	12.228				Green Water Valley Road and parking area.
H-77	16.090	0.000-0.076 0.076-0.914	0" - 3" 3" " - 3'	Pavement. Brown sandy gravel.	Sedimentary.

SUMMARY OF SOIL SURVEY

Project: Death Valley National Park DATE PERFORMED: August 16-18, 1995
 BEGINNING REFERENCE LOCATION: kilometer 0.000 = Intersection of CA State Highway 190 and Dante's View Road.

Boring Number	Station to Station km	Depth Metric m	Depth English in./ft.	Description of Soil or Rock	Remarks
H-78	20.434	0.000-0.057	0" - 2.25"	Pavement.	Sedimentary and volcanic.
	21.400	0.057-0.914	2.25" - 3'	Brown sand.	Trailer parking area.
					Dante's View Overlook.

APPENDIX C
LABORATORY TEST RESULTS

REPORT ON SOIL OR AGGREGATE TESTS

Project: CALIFORNIA PRPIO DEATH VALLEY NATIONAL MONUMENT
Submitted By: RON ANDRESEN

Date Reported: 9-21-95

Sample Number	Lab Number	95-1537-RV	95-1538-RV	95-1539-RV	95-1540-RV	95-1541-RV
	Hole Number					
	Field Number	H-4	H-10	H-16	H-21	H-26

Sample Location	MILE POST	6.0	18.0	30.0	40.0	50.0
	or Location	HWY 178 SOUTHBOUND BADWATER RD				
	Offset					
	Depth	0-3'				

AASHTO T 11, 27 & 88 (% Passing)	3"	75.0 mm				100	100
	1 1/2"	37.5 mm			100	93	99
	1"	25.0 mm		100	99	91	98
	3/4"	19.0 mm	100	96	96	88	95
	1/2"	12.5 mm	96	86	85	82	84
	3/8"	9.5 mm	93	79	79	78	77
	#4	4.75 mm	81	61	61	66	59
	#8	2.36 mm					
	#10	2.00 mm	65	46	46	54	43
	#16	1.18 mm	53	38	39	46	33
	#30	600 µm					
	#40	425 µm	35	27	26	31	19
	#50	300 µm					
	#100	150 µm	22	19	16	18	11
	#200	75 µm	17.3	15.1	12.0	11.5	7.7
		2 µm					
		0.2 µm					
	0.1 µm						
	Moisture (%)						
AASHTO T 89 & 90	Liquid Limit	NV	NV	NV	NV	NV	
	Plasticity Index	NP	NP	NP	NP	NP	
Soil Classification	AASHTO M 145	A-1-b(0)	A-1-b(0)	A-1-a(0)	A-1-b(0)	A-1-a(0)	
	ASTM D 2487	SM	SM	SW-SM	SW-SM	SW-SM	
AASHTO T 190	R-Value	73	78	80	77	74	
AASHTO T 288	Min. Resistivity (ohm-cm)						
AASHTO T 289	pH						
AASHTO T Method:	Optimum Moisture (%)						
	Max. Dry Density (pcf)						

Distribution:
Materials

3 Copies

R. ANDRESEN

Geotechnical W. FOLKMAN

Remarks:

Reported by:

Alan M. Held

Alan M. Held
Materials Specialist

Bob H. Welch, P. E.
Materials Engineer

REPORT ON SOIL OR AGGREGATE TESTS

Project: CALIFORNIA PRP 10 DEATH VALLEY NATIONAL MONUMENT
Submitted By: RON ANDRESEN

Date Reported: 9-21-95

Sample Number	Lab Number	95-1542-RV	95-1543-RV	95-1544-RV	95-1545-RV	95-1546-RV
	Hole Number					
	Field Number	H-32	H-38	H-44	H-52	H-56

Sample Location	or MILE POST	1.7	8.0	20.0	34.0	2.5
	Location	NATURAL BRIDGE ROAD	HWY 26 NORTH BOUND. SCOTTYS CASTLE ROAD			UBEHEBE CARTER ROAD
	Offset					
Depth		0-3'				

ASHTO T 11, 27 & 88 (% Passing)	3"	75.0 mm	100		100	100	
	1 1/2"	37.5 mm	98	100	83	99	100
	1"	25.0 mm	95	99	76	98	99
	3/4"	19.0 mm	92	96	67	94	99
	1/2"	12.5 mm	85	86	51	83	94
	3/8"	9.5 mm	80	76	42	76	90
	#4	4.75 mm	65	57	25	57	77
	#8	2.36 mm					
	#10	2.00 mm	48	41	17	39	65
	#16	1.18 mm	40	35	15	31	58
	#30	600 µm					
	#40	425 µm	25	29	12	21	46
	#50	300 µm					
	#100	150 µm	14	23	10	14	32
	#200	75 µm	8.2	17.8	7.3	10.2	23.7
		2 µm					
		0.2 µm					
	0.1 µm						
	Moisture (%)						
AASHTO T 89 & 90	Liquid Limit	NP	NP	NP	NP	NP	
	Plasticity Index	NP	NP	NP	NP	NP	
Soil Classification	AASHTO M 145	A-1-a(0)	A-1-b(0)	A-1-a(0)	A-1-a(0)	A-1-b(0)	
	ASTM D 2487	SW-SM	GM	GP-GM	SW-SM	SM	
AASHTO T 190	R-Value	74	80	77	79	77	
AASHTO T 288	Min. Resistivity (ohm-cm)						
AASHTO T 289	pH						
AASHTO T	Optimum Moisture (%)						
Method:	Max. Dry Density (pcf)						

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REPORT ON SOIL OR AGGREGATE TESTS

Project: CALIFORNIA PRP 10 DEATH VALLEY NATIONAL PARK MONUMENT
Submitted By: RON ANDRESEN

Date Reported: 9-21-95

Sample Number	Lab Number	95-1547-RV	95-1548-RV	95-1549-RV	95-1550-RV	95-1551-RV
	Hole Number					
	Field Number	H-63	H-65	H-69	H-72	H-76

Sample Location	MILE POST	8.9	15.3	8.0	17.0	7.0
	or Location	HWY 374 EAST BOUYO, BEATTY ROAD		WILD ROSE ROAD SOUTHBOUND		DANTE'S VIEW ROAD SOUTHBOUND
	Offset					
	Depth	0-3'				

ASHTO T 11, 27 & 88 (% Passing)	3"	75.0 mm	100	100			
	1 1/2"	37.5 mm	96	99	100	100	
	1"	25.0 mm	95	98	97	98	100
	3/4"	19.0 mm	93	95	94	94	99
	1/2"	12.5 mm	85	90	85	80	94
	3/8"	9.5 mm	78	87	77	70	87
	#4	4.75 mm	58	77	57	50	63
	#8	2.36 mm					
	#10	2.00 mm	41	68	43	38	38
	#16	1.18 mm	34	63	36	33	26
	#30	600 µm					
	#40	425 µm	24	52	25	25	14
	#50	300 µm					
	#100	150 µm	16	44	17	17	8
	#200	75 µm	12.8	39.0	14.0	13.4	5.8
		2 µm					
		0.2 µm					
	0.1 µm						
	Moisture (%)						
AASHTO T 89 & 90	Liquid Limit	NP	27	NP	NP	NP	
	Plasticity Index	NP	7	NP	NP	NP	
Soil Classification	AASHTO M 145	A-1-a (0)	A-4 (0)	A-1-a (0)	A-1-a (0)	A-1-a (0)	
	ASTM D 2487	SM	SC-SM	SM	GM	SW-SM	
AASHTO T 190	R-Value	79	64	75	73	62	
AASHTO T 288	Min. Resistivity (ohm-cm)						
AASHTO T 289	pH						
AASHTO T Method:	Optimum Moisture (%)						
	Max. Dry Density (pcf)						

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R. ANDRESEN

Geotechnical W. FOLKMAN

Remarks:

Reported by:

Alan M. Held

Alan M. Held
Materials Specialist

Bob H. Welch, P. E.
Materials Engineer

REPORT ON SOIL OR AGGREGATE TESTS

Project: CALIFORNIA PRP 10 DEATH VALLEY NATIONAL MONUMENT

Submitted By: RON ANDRESEN

Date Reported: 9-21-95

Sample Number	Lab Number	95-1552-RV			
	Hole Number				
	Field Number	0-3'			

Sample Location	or Location	MILE POST 12.7 DANTE'S VIEW ROAD SOUTHBOUND			
	Offset				
	Depth	0-3			

AASHTO T 11, 27 & 88 (% Passing)	3'	75.0 mm			
	1 1/2"	37.5 mm			
	1"	25.0 mm			
	3/4"	19.0 mm	100		
	1/2"	12.5 mm	96		
	3/8"	9.5 mm	92		
	#4	4.75 mm	79		
	#8	2.36 mm			
	#10	2.00 mm	65		
	#16	1.18 mm	56		
	#30	600 µm			
	#40	425 µm	42		
	#50	300 µm			
	#100	150 µm	32		
	#200	75 µm	27.5		
	2 µm				
	0.2 µm				
	0.1 µm				
	Moisture (%)				
AASHTO T 89 & 90	Liquid Limit	41			
	Plasticity Index	11			
Soil Classification	AASHTO M 145	A-2-7(0)			
	ASTM D 2487	SM			
AASHTO T 190	R-Value	18			
AASHTO T 288	Min. Resistivity (ohm-cm)				
AASHTO T 289	pH				
AASHTO T	Optimum Moisture (%)				
Method:	Max. Dry Density (pcf)				

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