LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 320101, Battle Mountain, Nevada

Report No. FHWA-32-0101

Prepared by

Nichols Consulting Engineers, Chtd.
1885 S. Arlington Ave., Suite 111
Reno, Nevada 89509

Prepared for

Federal Highway Administration
LTPP-Division, HNR-40
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101

June 1997

Notice

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Technical Report Documentation Page

1. Report No. FHWA-32-0101	2. Government Accession No. N/A	3. Recipient's Catalog No. N/A
4. Title and Subtitle LTPP Seasonal Monitoring Program Site Installation and Initial Data Collection Section 320101, Battle Mountain, Nevada		5. Report Date June 1997 6. Performing Organization Code
7. Author(s) Srikanth S. Holikatti, Douglas J. Frith, Mark A. Potter		8. Performing Organization Report No.
9. Performing Organization Name and Address Nichols Consulting Engineers, Chtd. 1885 S. Arlington Ave., Suite 111 Reno, NV 89509		10. Work Unit No. (TRAIS) N/A 11. Contract or Grant No. DTFH61-96-C-00010
12. Sponsoring Agency Name and Address Federal Highway Administration LTPP Div., HNR-40 Turner Fairbanks Highway Research Center 6300 Georgetown Pike McLean, VA 22101-2296		13. Type of Report and Period Covered Final Report, October 1996 14. Sponsoring Agency Code HNR-40
15. Supplementary Notes Contracting Officer's Technical Representative (COTR) - Monte Symons, HNR-30		

16. Abstract This report contains a description of the instrumentation installation activities and initial data collection for test section 320101 which is a part of the LTPP Core Seasonal Monitoring Program. This is an asphalt concrete surfaced pavement test section, located on the eastbound outside lane of the Interstate, east of Battle Mountain, Nevada. This section was instrumented on October 8, 1996. The instruments installed included TDR probes for moisture content, thermistor probes for subsurface temperature, tipping bucket rain gauge for precipitation, resistivity probe for frost depth, piezometer to monitor ground water table, and an on-site datalogger. Initial data was collected on October 11, 1996. This included FWD and precipitation data, elevation, air and subsurface temperature, and TDR moisture measurements. This report also contains a description of site location, characteristics of installed equipment, and the location of installed equipment within the test section and a summary of initial data collection.

17. Key Words Seasonal Monitoring, TDR Probes, Resistivity Probe, Thermistor Probes, CR10 Datalogger, Temperature Gauge, Initial Data	18. Distribution Statement No restrictions.		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

Form DOT F 1700.7

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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SITE INSTALLATION AND INITIAL DATA COLLECTION
NEVADA SECTION 320101

INTRODUCTION

This report describes the equipment installation activities and initial data collection for test section 320101 near Battle Mountain, Nevada. The equipment installation activities were completed on October 8, 1996 and initial data was collected on October 11, 1996.

Section Location

Section 320101 is a Specific Pavement Studies (SPS) section selected for SMP. This section is located on the outside lane of eastbound Interstate Route 80, a multi-lane highway facility in the State of Nevada. The closest town to the section is Battle Mountain, Nevada. The beginning of the section is at milepost 226.4, 2.7 miles east of the Mote interchange. This section is a SPS-1, "Strategic Study of Structural Factors for Flexible Pavements" section, meeting the seasonal monitoring program core experimental design cell number 15 requirements. Figure A1 in appendix A contains a map showing the location of the section.

Section Details

The pavement section consists of 178mm of asphalt concrete (AC) with 203mm aggregate base (AB) over medium sand subgrade. The test section has a 3.70m travel lane with a 3.35m wide asphalt concrete shoulder. Additional details are summarized in table 1.

Table 1. Details of section 320101 in Nevada.

Functional Classification of Roadway	Interstate Highway, Rural, Arterial
Number of Lanes/Direction	Two
Pavement Type	Asphalt Concrete
Estimated Annual ESAL Applications on Test Lane	534 KESALs
Climatic Classification	Dry-Freeze, SMP Cell #15

Pre-installation FWD testing was conducted on the test section on March 27, 1996. FWD data was analyzed using the FWDCheck program. The results are presented in figures A2 through A5 in appendix A. The material properties of individual pavement layers are presented in table 2. Figures A6 and A7 in the appendix present the construction sampling and boring log of the instrumentation hole, respectively. Appendix A also includes the distress survey summary of the section.

Table 2. Material properties.

Description	Surface Layer	Base Layer	Subgrade
Material	AC	AB	Silty Sand
Thickness (mm)	178*	203*	N/A
Proctor Dry Density (kg/m^3)	—	—	1930
Proctor Moisture Content (%)	--	--	6.6
Field Measured Density (kg/m^3)	—	2210@4.3%MC***	1868@10.6%MC***
Laboratory Maximum Dry Density (kg/m^3)	--	2227@6%MC	1970@10.0%MC
Liquid Limit	--	--	--
Plastic Limit	--	--	--
Plastic Index	--	NP	NP
Percent Passing #200	--	19.2%	24.2%

MC Moisture Content
AC Asphalt Concrete
AB Aggregate Base
NP Non-Plastic
* Layer thickness from construction records
** Proctor density test could not be carried out on the day of instrument installation because of rains during installation.
*** Density in the field was measured using Nuclear gauge

According to information provided by the Western Region climate center at Desert Research Institute, Reno, the following climatic conditions exist in the vicinity of site:

Precipitation	:	209mm	No. of Days Above 32° C	:	62
No. of Wet Days	:	62	No. of Days Below 0° C	:	189

Note: The LTPP weather database does not have information about SPS sites at this point. Hence, information from other sources was obtained.

Installation of instrumentation was accomplished on October 8, 1996 and initial data collection was performed on October 11, 1996. Instrument installation was a cooperative effort between Nevada Department of Transportation (Nevada DOT) and Nichols Consulting Engineers (NCE) LTPP Western Region Coordination Office staff. The following personnel participated in the installation.

Sirous Alavi	:	NCE	Mark Potter	:	NCE
Srikanth Holikatti	:	NCE	Richard Smith	:	NCE
Michael Esposito	:	NCE	Kevin Kawalkowski	:	NCE
Jerry Etchenverry	:	Nevada DOT	James White	:	Nevada DOT
Lonnie See	:	Nevada DOT	Michael Denson	:	Nevada DOT

Robert Whited	:	Nevada DOT	Walter Shaffer	:	Nevada DOT
Jack Holtz	:	Nevada DOT	Donald Gillespie	:	Nevada DOT
Jeanne Thames	:	Nevada DOT	Renee Duffy	:	Nevada DOT
Mary Rice	:	Nevada DOT			

INSTRUMENT INSTALLATION

Meeting With Highway Agency

A planning meeting between NCE and Nevada DOT was held in Winnemucca, Nevada on September 4, 1996 to discuss the SMP instrumentation, required equipment, the installation schedule, and installation team responsibilities. Nevada DOT agreed to provide traffic control, equipment, and personnel to achieve instrument and piezometer hole auguring and to carry out post installation patching of the instrumentation hole and conduit trench. NCE staff performed all the SMP equipment installation. The site was inspected by Douglas Frith and Mark Potter on September 4, 1996. Distress survey and FWD testing of the section was carried out on March 27, 1996.

SMP Equipment Installed

Type and quantity of instruments installed at the section are listed in table 3. These included instrumentation to measure air and subsurface temperature, subsurface moisture content, rainfall, ground water table depth, and an equipment cabinet to house the cable ends, battery, and the CR10 datalogger. The solar panel was mounted on the equipment cabinet and connected to the battery. The rain gauge and the air temperature probe were mounted on a 51mm diameter steel pole near the equipment cabinet. The resistivity probe for frost depth was installed as the section was in the "dry-freeze" region.

Pre Installation Equipment Check and Calibration

Prior to installation, all equipment used were checked for functionality, accuracy, and calibrated whenever necessary. The air temperature probe, thermistor probe, and the rain gauge were connected to the CR10 datalogger to verify that they were functioning properly. The rain gauge was calibrated by recording the number of tips to drain out 473ml of water from the container in at least 45 minutes. For the first trial, it took 45 minutes and 101 tips to drain 473ml of water. The two screws at the bottom of the rain gauge were not adjusted, as the number of tips were within the recommended limits. The air temperature probe and the thermistor probe were checked for proper functioning by placing them in an ice bath and in direct sunlight and comparing the measured temperatures. The results indicated that both were functioning properly. The spacing of thermistor sensors within the clear plastic tube were measured and recorded. Descriptions of MRC thermistor probe and sensor spacing are presented in table 4. The CR10 datalogger and battery unit were also checked. They were found to be in working order.

Table 3. Equipment installed.

Equipment	Quantity	Serial No.
Instrument Hole		
MRC Thermistor Probe	1	32A#1
TDR Sensors	10	32A01-32A10
Resistivity Probe	1	32#AR
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16566
Battery Pack	1	None
Solar Panel		
Weather Station		
TE 525 Tipping Bucket Rain Gauge	1	12041
Air Temperature Probe	1	3042
Radiation Shield	1	None
Observation Well/Bench Mark	1	None

Table 4. Description of MRC thermistor probe and sensor spacing.

Unit No.	Channel No.	Distance from Top to Unit (m)	Remarks
1	1	0.000	Unit installed in AC layer
	2	0.152	
	3	0.305	
2	4	0.018	Unit installed in base & subgrade
	5	0.094	
	6	0.172	
	7	0.246	
	8	0.322	
	9	0.476	
	10	0.627	
	11	0.782	
	12	0.933	
	13	1.087	
	14	1.240	
	15	1.392	
	16	1.544	
	17	1.696	
	18	1.847	

Calibration of TDR probes was completed by performing two measurements in air, one with the prongs shorted at the beginning of the sensor and the other not shorted. An additional measurement was made with each TDR sensor submerged in water. The TDR measured dielectric constants were within the specified limits, and the sensors produced the expected traces and were functioning properly. Individual TDR probe traces obtained during calibration are presented in figures B1 through B10 in appendix B. Serial numbers of equipment to be installed were noted, with the exception of radiation shield. The bench mark did not have a serial number and the battery pack serial number was not recorded because the batteries get changed frequently.

The resistivity probe was checked for continuity and conductivity using a digital multi-meter. The probe was free of any problems. The spacing between each electrode was measured and recorded, these are given in table 5.

Instrument Installation

Analysis of pre-installation FWD data indicated uniformity of the section. The equipment installation followed the schedule given below:

0745	:	Depart from Battle Mountain.
0800	:	Arrive at site, start unpacking equipment in preparation for installation.
0815	:	Traffic control in place, instrumentation hole and piezometer located and marked, FWD testing of instrumentation hole.
0815-0845	:	Drill piezometer, saw cutting of thermistor unit 1 slot, conduit trench and instrument hole.
0845- 0930	:	Installation of piezometer, drill weather station pole hole, place pole and concrete the base.
0930-1000	:	Install equipment cabinet.
1000-1030	:	Excavation of instrumentation cable trench.
1030-1200	:	Layout the cables, run the cables through the conduit, drill instrument hole.
1200-1500	:	Installation of thermistor unit #2, resistivity probe, TDR probes, collection of moisture samples from each TDR location, proctor test, testing of each TDR probe, etc.
1515-1545	:	Installation of thermistor probe unit #1, into the groove previously cut in the pavement, check all equipment for proper functioning.
1545-1630	:	Patch and repair instrumentation hole and conduit trench, seal all saw cuts with silicone sealant.
1630-1730	:	Clean up site, pack all equipment, place instrument cabinet cover, and lock.
1730-1745	:	Depart from site.

Table 5. Sensor spacing in the resistivity probe.

Connector Pin Number	Electrode Number	Distance from Top (m)			Continuity	Spacing (m) between Electrodes
		Line 1	Line 2	Average		
1	1	0.028	0.028	0.028	X	0.028
20	2	0.077	0.078	0.078	X	0.050
2	3	0.130	0.131	0.131	X	0.053
21	4	0.181	0.181	0.181	X	0.051
3	5	0.233	0.233	0.233	X	0.052
22	6	0.282	0.283	0.283	X	0.050
4	7	0.333	0.334	0.334	X	0.051
23	8	0.384	0.384	0.384	X	0.051
5	9	0.438	0.436	0.437	X	0.053
24	10	0.486	0.485	0.486	X	0.049
6	11	0.537	0.537	0.537	X	0.052
25	12	0.590	0.587	0.589	X	0.052
7	13	0.638	0.638	0.638	X	0.050
26	14	0.693	0.690	0.692	X	0.054
8	15	0.739	0.738	0.739	X	0.047
27	16	0.789	0.788	0.789	X	0.050
9	17	0.842	0.841	0.842	X	0.053
28	18	0.892	0.891	0.892	X	0.050
10	19	0.943	0.942	0.943	X	0.051
29	20	0.995	0.993	0.994	X	0.052
11	21	1.043	1.044	1.044	X	0.049
30	22	1.095	1.096	1.096	X	0.052
12	23	1.147	1.148	1.148	X	0.052
31	24	1.199	1.195	1.197	X	0.050
13	25	1.249	1.248	1.249	X	0.051
32	26	1.300	1.298	1.299	X	0.051
14	27	1.349	1.348	1.349	X	0.050
33	28	1.401	1.401	1.401	X	0.053

Table 5. Sensor spacing in the resistivity probe (cont).

Connector Pin Number	Electrode Number	Distance from Top (m)			Continuity	Spacing (m) between Electrodes
		Line 1	Line 2	Average		
15	29	1.452	1.453	1.453	X	0.052
34	30	1.503	1.502	1.503	X	0.050
16	31	1.552	1.552	1.552	X	0.050
35	32	1.606	1.604	1.605	X	0.053
17	33	1.655	1.656	1.656	X	0.051
36	34	1.708	1.706	1.707	X	0.051
18	35	1.758	1.758	1.758	X	0.051
37**	36	1.806	1.806	1.806	X	0.048
Bottom		1.831	1.831	1.831		

**Pin number 37 is used instead of pin 19

Pavement and subsurface instrumentation was installed at the leave end of the section at a distance of 157.15m (station 5+15.45') from the section beginning, in a 0.30m diameter hole bored using a 252mm diameter flight auger after sawing out a 0.5m square block from the surface AC layer. The pavement temperature sensors (thermistors, unit number 1) were installed in the AC layer as per LTPP guidelines. TDR moisture probes and subsurface temperature sensors (thermistors, unit number 2) were installed in the base course and subgrade layers. The instrumentation hole was 2.10m deep. Figure C1 in appendix C presents the site layout and instrument location. All the TDR probes were placed with an "S" shaped stress relief loop in their cables. The TDR probes were placed in an offset fan pattern such that the lead wires were on the side closest to the pavement edge. TDR, resistivity, and thermistor probe lead wires were bundled and pulled through a 51mm diameter flexible electrical conduit buried in a 76mm wide trench, leading to the equipment cabinet. The equipment cabinet was located 9.75m away, to the right of lane edge on almost level ground. The installed depths of the TDR sensors are presented in table 6. All instruments at this site were installed in adherence with FHWA LTPP SMP Guidelines, April 1994.

Table 6. Installed depths of TDR sensors.

TDR Sensor No.	Depth from Pavement Surface (m)	Layer
32A01	0.275	Base
32A02	0.425	Subgrade
32A03	0.585	
32A04	0.735	
32A05	0.895	
32A06	1.050	
32A07	1.120	
32A08	1.360	
32A09	1.660	
32A10	1.950	

Each TDR probe was connected to the 1502B cable tester, while the soil around it was being compacted. TDR traces were generated during backfilling of the instrument hole to ensure that they were not damaged during installation. However, no traces could be generated due to some electric interference which was suspected to have been caused by the presence of a large number of running engines and a big air compressor in the vicinity of the instrumentation location. Subsequent visits indicated that the TDR sensors were functioning properly.

Moisture samples were collected at each TDR probe location. A representative Proctor sample was taken at a depth of 0.60m from the pavement surface and the Proctor density test was performed. Since the large beam balance was damaged, the compacted proctor sample was divided into smaller parts for the purpose of determining the weight of the sample. The moisture samples were split into two parts. One part was tested in accordance with the SMP installation and initial data collection guidelines, 1994. The other part of the sample was labeled and handed over to Nevada DOT personnel for moisture determination in their central materials laboratory. A comparison of field and laboratory determined moisture contents is presented in table 7.

Table 7. Moisture contents during installation in field and laboratory.

Sensor No.	Sensor Depth (m)	Layer	Moisture Content (% by wt)	
			Field Measured *	Lab Measured **
32A01	0.275	Base	6.4	5.3
32A02	0.425	Subgrade	4.6	4.6
32A03	0.585		5.2	4.9
32A04	0.735		5.0	5.1
32A05	0.895		8.5	7.2
32A06	1.050		6.6	5.7
32A07	1.120		5.8	5.4
32A08	1.360		10.4	9.1
32A09	1.660		12.4	11.5
32A10	1.950		14.6	13..0

* Moisture contents determined in the field from the material sampled at each TDR probe depth as per FHWA LTPP SMP installation and initial data collection Guidelines, April 1994.

** The moisture contents were determined from split samples in Nevada DOT central materials laboratory.

It is seen from the above data that field measured moisture contents were generally close to the moisture contents determined in the laboratory. Variability observed in moisture contents at some sensor depths was due to some extent to the field conditions, soil type, and limitations of the moisture determination method used.

The resistivity probe was installed in the unbound base and subgrade layers along with the thermistor unit #2 as per the SMP instrument installation guidelines. The resistivity probe leads were checked for continuity after the backfilling of the instrumentation hole. Table 8 and table 9, respectively, present the installed locations of thermistor sensors and the resistivity probe with reference to the pavement surface.

Table 8. Installed locations of MRC thermistor sensors.

Unit No.	Channel No.	Depth from Pavement Surface (m)	Remarks
1	1	0.025	AC
	2	0.084	
	3	0.152	
2	4	0.268	Base
	5	0.344	
	6	0.422	Subgrade
	7	0.496	
	8	0.572	
	9	0.726	
	10	0.877	
	11	1.032	
	12	1.183	
	13	1.337	
	14	1.490	
	15	1.642	
	16	1.794	
	17	1.946	
	18	2.097	

Table 9. Installed locations of resistivity sensors.

Connector Pin Number	Electrode Number	Depth From Pavement Surface
36	1	0.253
35	2	0.303
34	3	0.356
33	4	0.407
32	5	0.459
31	6	0.509
30	7	0.560
29	8	0.611
28	9	0.664
27	10	0.713
26	11	0.765
25	12	0.817
24	13	0.867
23	14	0.921
22	15	0.968
21	16	1.018
20	17	1.071
19	18	1.121
18	19	1.172
17	20	1.224
16	21	1.273
15	22	1.325
14	23	1.377
13	24	1.427
12	25	1.478
11	26	1.529
10	27	1.579
9	28	1.632
8	29	1.684

Table 9. Installed locations of resistivity sensors (cont).

Connector Pin Number	Electrode Number	Depth From Pavement Surface
7	30	1.734
6	31	1.784
5	32	1.837
4	33	1.888
3	34	1.939
2	35	1.990
1	36	2.038
Bottom		2.063

A 152mm diameter flight auger was used to bore the observation piezometer/benchmark at the edge of pavement shoulder at a distance of 121.95m (section station 4+00), and 5.1m to the right of lane edge. Upon completion of instrumentation installation, all wiring connections to the equipment cabinet were checked carefully for continuity and proper contacts. The "ONSITE" computer program was downloaded to the CR10 datalogger located in the equipment cabinet. The datalogger was left "ON" overnight to collect data so that the results could be evaluated the next day.

Site Repair

The instrumentation hole and the conduit trench were patched by Nevada DOT personnel with cold-mix asphalt concrete. Care was exercised to prevent damage to all of the equipment installed or the wires leading to the equipment cabinet. Subsequent tests confirmed that all the installed equipments were functioning properly. The repair patch placed on the instrument hole performed well for most of the monitoring period. Some settlement of the patch was observed in the last three data collection visits. It has also been noted that the instrument hole patch has been replaced with Portland Cement Concrete. Concerned Nevada DOT personnel have been informed of this anomaly and have been solicited to remove and replace the PCC patch with an asphalt concrete patch.

INITIAL DATA COLLECTION

Initial data was collected on October 11, 1997. The functionality of installed equipment was checked and onsite data collected by the Onsite datalogger was examined. The equipment and datalogger were functioning correctly. The battery voltage was checked and found acceptable. Mobile data was not collected using the mobile data acquisition system. The mobile data acquisition box was non functional during the seasonal instrumentation installation. Manual two point resistance and four point resistivity readings were recorded. However, mobile data collected during the subsequent data collection visits clearly indicated proper functioning of the TDR sensors.

Post-installation FWD testing of the section was performed as per the LTPP guidelines. One set of elevation surveys were measured following the LTPP guidelines. The elevation of the observation well top was assumed as 1.0 meter. The elevation survey results are presented in table D2 in appendix D.

The resistivity probe installed at this site is quite different than the probes installed at other seasonal sites. During the in-house review of site installation information, it was discovered that the pin to electrode configuration was completely random. After careful thought and discussion, a set of data sheets with proper switch positions corresponding to the electrode locations was developed to facilitate manual two point resistance and four point resistivity data collection in the field without difficulty.

SUMMARY

This report describes the SMP equipment installation activities at section 320101 located in the State of Nevada. The section is located on the eastbound outside lane of Interstate Route 80 near Battle Mountain. The beginning of the section is at milepost 226.4, 2.7 miles east of the Mote interchange. This is a SPS-1 section in the "dry-freeze" climatic zone, meeting the requirements of SMP cell number 15.

The site was inspected on September 4, 1996. A planning meeting with Nevada DOT representatives was held in Winnemucca on September 4, 1996 to discuss SMP equipment installation and work responsibilities. Successful installation of SMP equipment and initial data collection were carried out on October 8 and 11, 1996, respectively, in accordance with the LTPP SMP installation guidelines. Equipment to measure and record the following data was installed at site:

- Ambient temperature and daily rainfall.
- Pavement surface and subsurface depth-temperature profile.
- Subsurface depth-moisture profile.
- Ground water measurements.
- Frost depth measurements.

A resistivity probe was installed at this site as the site is in the "dry-freeze" zone. The equipment installation hole is located at the leave end of the section at a distance of 157.04m from the section beginning. The equipment cabinet is located 9.75m to the right of the lane edge on almost level ground. Post-installation checks indicated proper functioning of all installed equipment. Post-installation FWD testing was performed as per LTPP guidelines.

TDR traces could not be generated during their installation because of some very strong electric disturbance suspected from the large number of running engines and a big air compressor in the vicinity of the instrumentation. Mobile data was not collected using the mobile data acquisition system. The mobile data acquisition box was non-functional during the seasonal instrumentation installation. However, mobile data collected during the subsequent data collection visits clearly indicated proper functioning of the TDR sensors.

The resistivity probe installed at this site is substantially different from those installed at the other six seasonal sites. During the in-house review of the installation information it was discovered that the pin to electrode combination was completely random. After careful thought and discussion, a set of data sheets with proper switch positions corresponding to the electrode locations were developed to facilitate manual two point resistance and four point resistivity data collection in the field without any difficulty. These were the only exceptions or special conditions at this site.

APPENDIX A

Test Section Background Information

Appendix A includes the following supporting information:

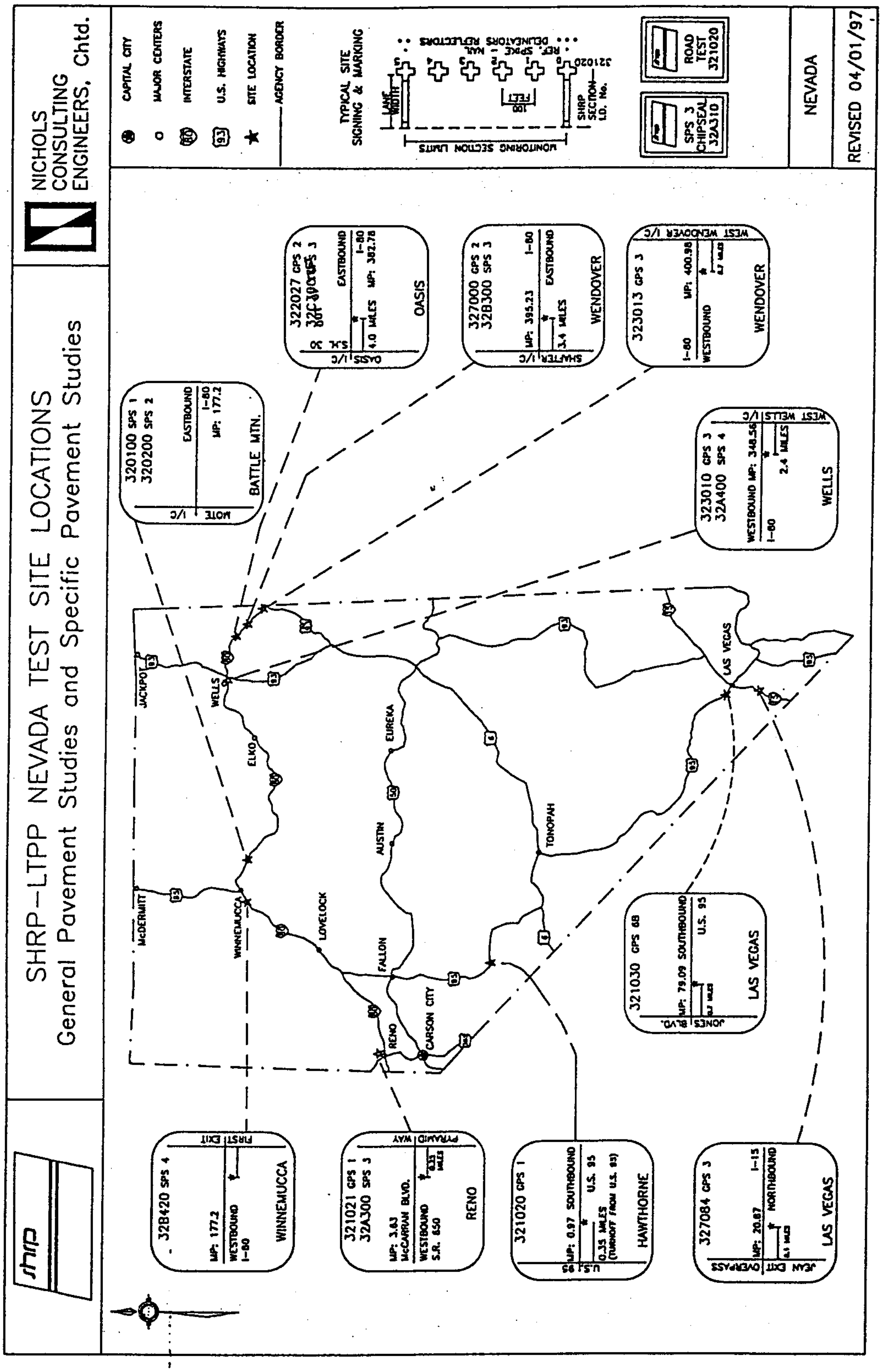


Figure A1. Site location map.

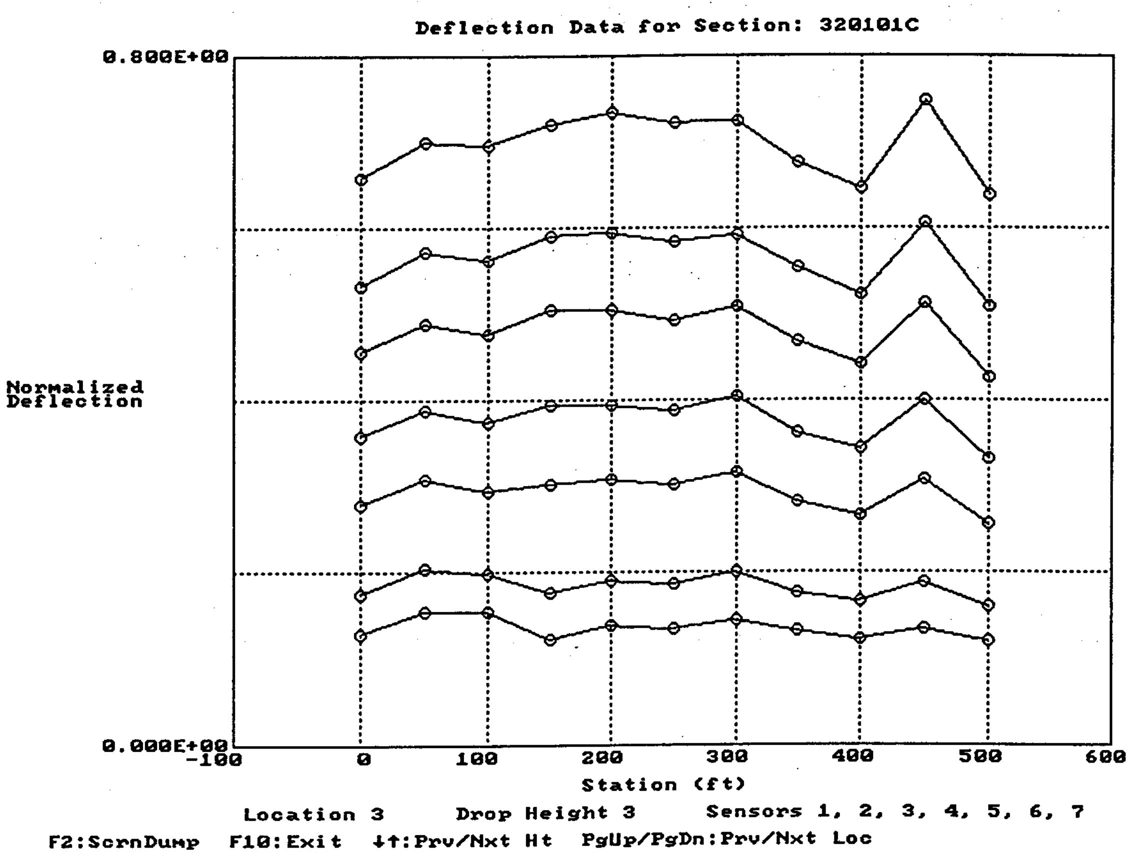


Figure A2. Normalized deflection profile from FWDCheck.

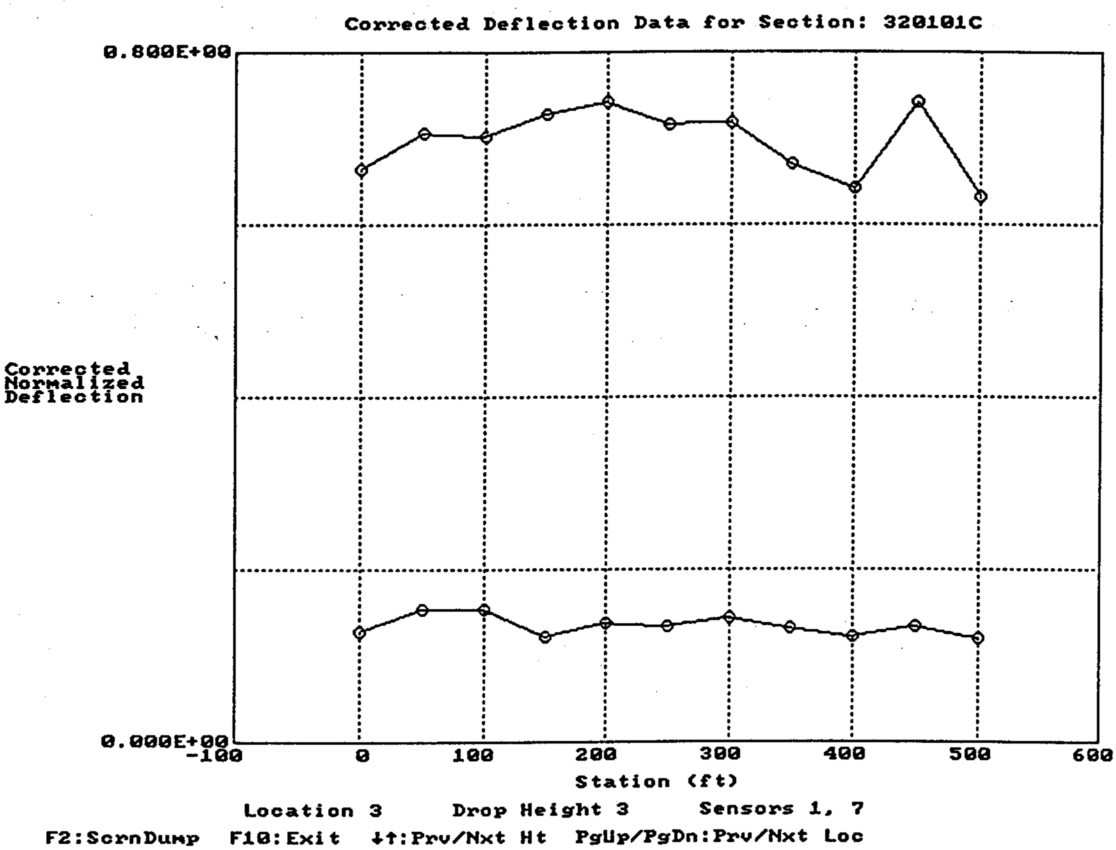


Figure A3. Corrected normalized deflection profile from FWDCheck.

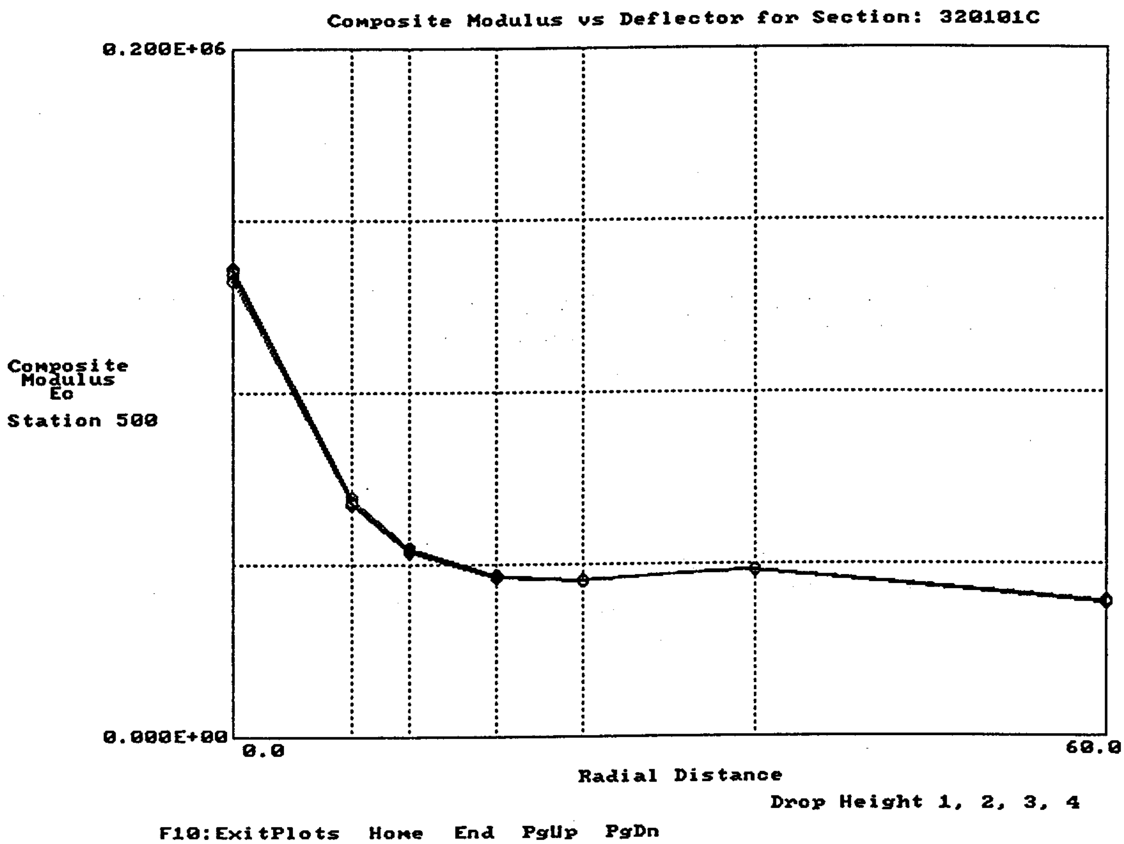


Figure A4. Composite modulus at station 5+00 from FWDCheck.

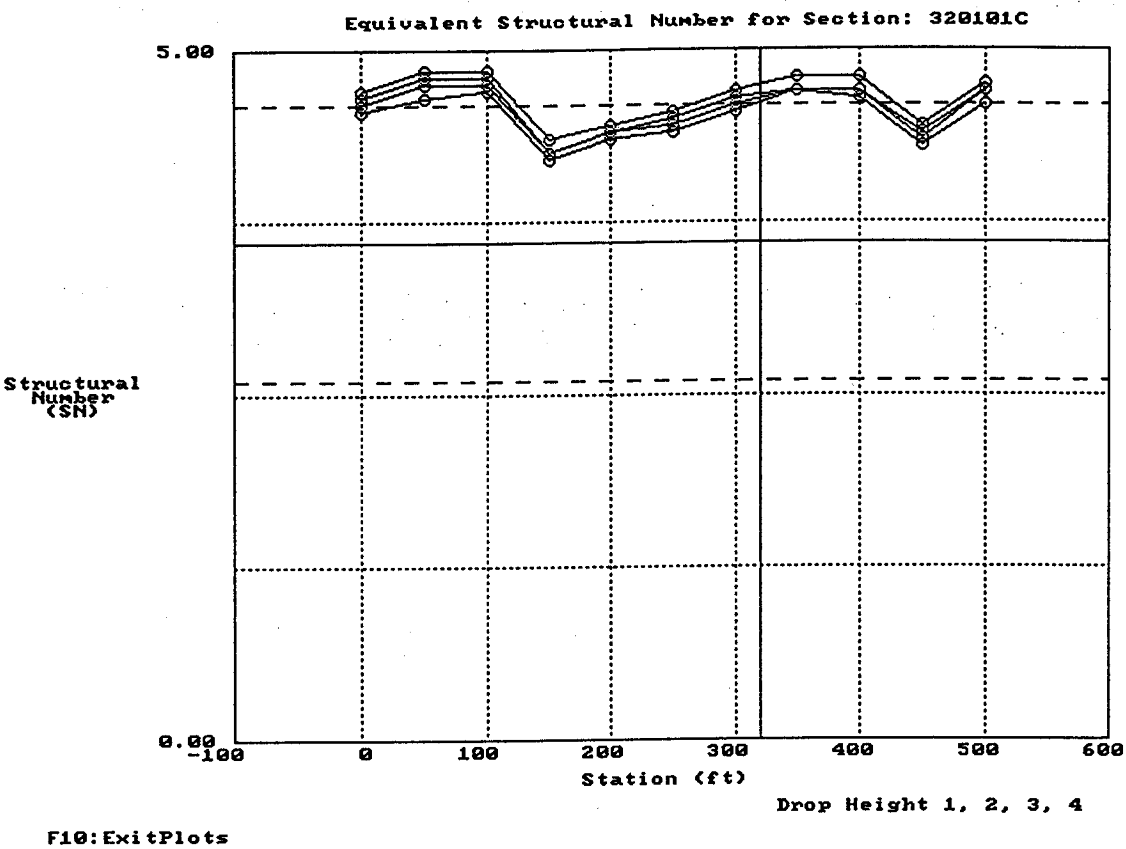


Figure A5. Equivalent structural number from FWDCheck.

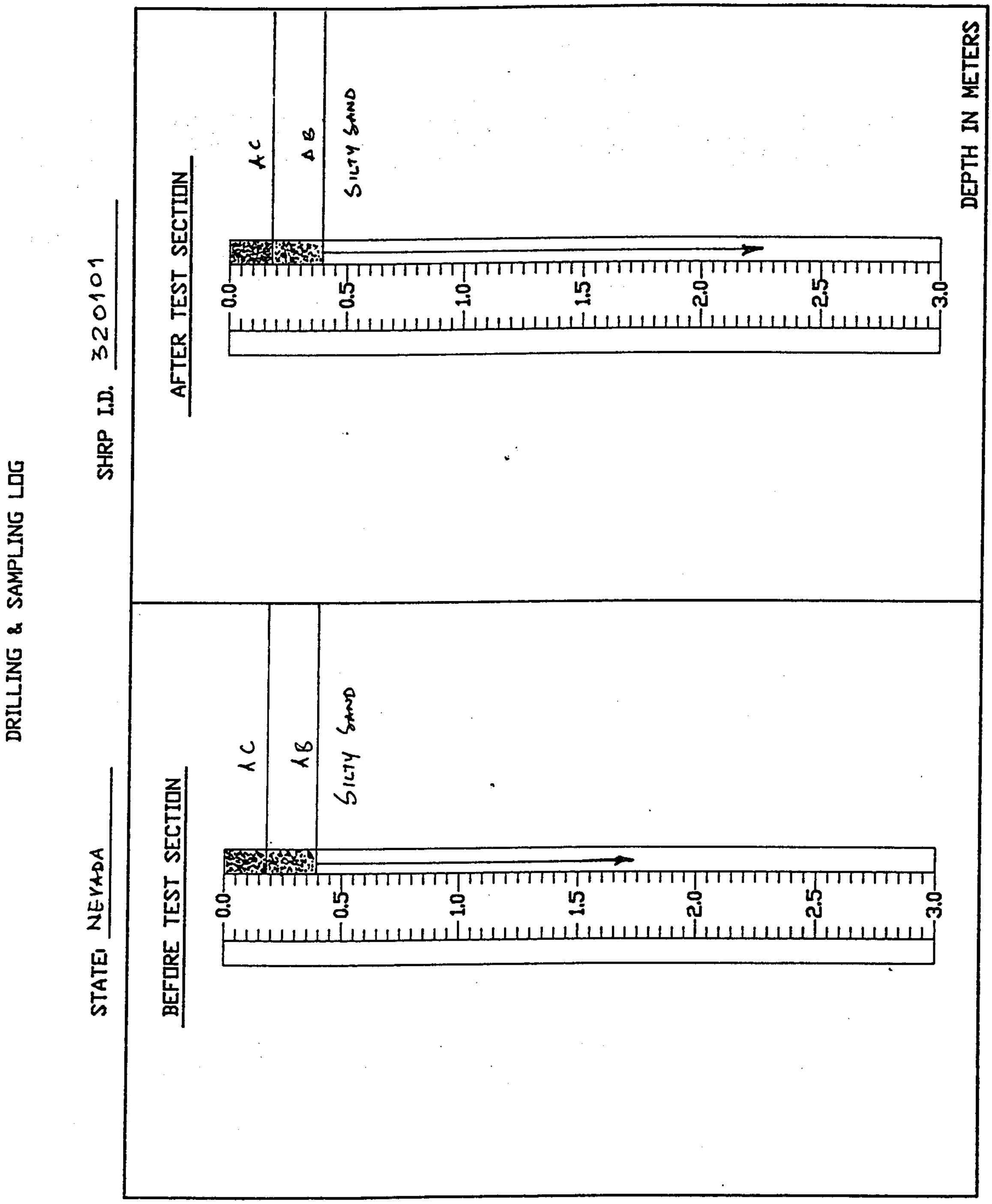


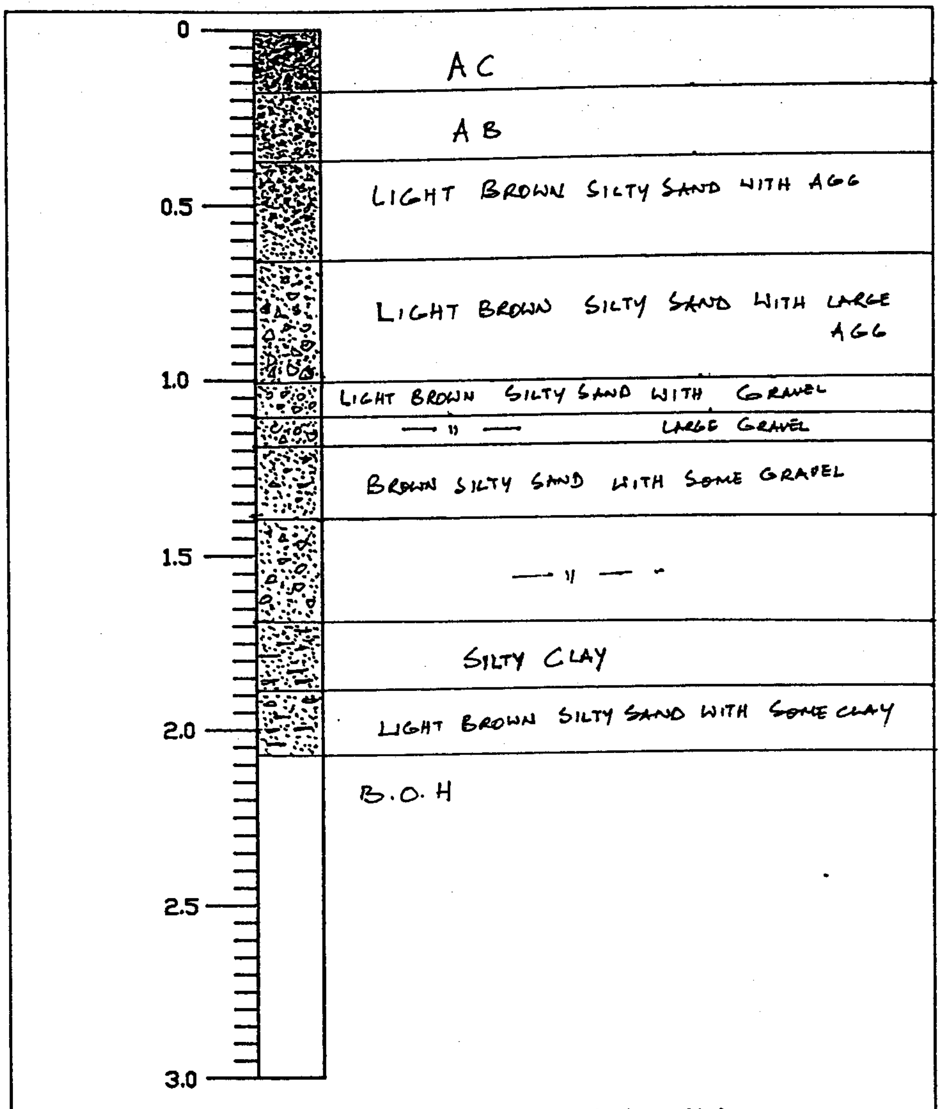
Figure A6. Sampling log of section during construction.

State ID. 32

Station 5+15.45

SHRP ID. 0101

Date(dd/mm/yy) 08/10/96



Boring Log of SMP Instrumentation Hole

Start Time 10.00

End Time 11.30

Prepared By S. HOLIKATTI

Employed By N.C.E

Figure A7. Boring log of instrument hole.

Revised December 1, 1992

Table A1. Manual distress survey summary sheets
SHEET 1

STATE ASSIGNED ID _ _ _ _

DISTRESS SURVEY — STATE CODE 32

LTPP PROGRAM — SHRP SECTION ID 0101

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 110496

SURVEYORS: _ _ _, ME_ PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) N
PAVEMENT SURFACE TEMP - BEFORE - 22.2 °C; AFTER - 22.2 °C

ENTERED
JAN 16 1997
By LW

DISTRESS TYPE	SEVERITY LEVEL: LOW	MODERATE	HIGH
CRACKING			
1. FATIGUE CRACKING (Square Meters)	___.0	___.0	___.0
2. BLOCK CRACKING (Square Meters)	___.0	___.0	___.0
3. EDGE CRACKING (Meters)	___.0	___.0	___.0
4. LONGITUDINAL CRACKING (Meters)			
4a. Wheel Path	___.0	___.0	___.0
Length Sealed (Meters)	___.0	___.0	___.0
4b. Non-Wheel Path	___.0	___.0	___.0
Length Sealed (Meters)	___.0	___.0	___.0
5. REFLECTION CRACKING AT JOINTS Number of Transverse Cracks	__0	__0	__0
Transverse Cracking (Meters)	___.0	___.0	___.0
Length Sealed (Meters)	___.0	___.0	___.0
Longitudinal Cracking (Meters)	___.0	___.0	___.0
Length Sealed (Meters)	___.0	___.0	___.0
6. TRANSVERSE CRACKING Number of Cracks	__0	__0	__0
Length (Meters)	___.0	___.0	___.0
Length Sealed (Meters)	___.0	___.0	___.0
PATCHING AND POTHOLES			
7. PATCH/PATCH DETERIORATION (Number)	__0	__0	___
(Square Meters)	___.0	___.0	___.__
8. Potholes (Number)	__0	__0	__0
(Square Meters)	___.0	___.0	___.0

Revised December 1, 1992

Table A1. Manual distress survey summary sheets (cont'd).

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 32

SHRP SECTION ID 0101

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 1/10/96

SURVEYORS: _ _ _, _ ME

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
9. RUTTING - REFER TO SHEET 3 FOR SPS-3 OR Form S1 from Dipstick Manual			
10. SHOVING (Number)			0
(Square Meters)			.0
SURFACE DEFECTS			
11. BLEEDING (Square Meters)	.0	309.0	.0
12. POLISHED AGGREGATE (Square Meters)			.0
13. RAVELING (Square Meters)	.0	.0	.0
MISCELLANEOUS DISTRESSES			
14. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 3			
15. WATER BLEEDING AND PUMPING (Number)			0
Length of Affected Pavement (Meters)			.0
16. OTHER (Describe) ______			

ENTERED JAN 1 . 1997 By HN

Revised May 29, 1992

Table A1. Manual distress survey summary sheets (cont'd).

SHEET 3

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 32

SHRP SECTION ID 0101

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 11/06/96

SURVEYORS: _ _ _, ME

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

9. RUTTING (FOR SPS-3 SITE SURVEYS)

N/A

INNER WHEEL PATH			OUTER WHEEL PATH		
Point No.	Point Distance[1] (Meters)	Rut Depth (mm)	Point No.	Point Distance[1] (Meters)	Rut Depth (mm)
1	0.	_ _ _.	1	0.	_ _ _.
2	15.25	_ _ _.	2	15.25	_ _ _.
3	30.5	_ _ _.	3	30.5	_ _ _.
4	45.75	_ _ _.	4	45.75	_ _ _.
5	61.	_ _ _.	5	61.	_ _ _.
6	76.25	_ _ _.	6	76.25	_ _ _.
7	91.5	_ _ _.	7	91.5	_ _ _.
8	106.75	_ _ _.	8	106.75	_ _ _.
9	122.	_ _ _.	9	122.	_ _ _.
10	137.25	_ _ _.	10	137.25	_ _ _.
11	152.5	_ _ _.	11	152.5	_ _ _.

14. LANE-TO-SHOULDER DROPOFF

Point No.	Point Distance[1] Meters	Lane-to-Shoulder Dropoff (mm)
1	0.	_ _ 0.
2	15.25	_ _ 0.
3	30.5	_ _ 0.
4	45.75	_ _ 0.
5	61.	_ _ 0.
6	76.25	_ _ 0.
7	91.5	_ _ 0.
8	106.75	_ _ 0.
9	122.	_ _ 0.
10	137.25	_ _ 0.
11	152.5	_ _ 0.

Note 1: "Point Distance" is the distance in meters from the start of the test section to the point where the measurement was made. The values shown are SI equivalents of the 50 ft spacing used in previous surveys.

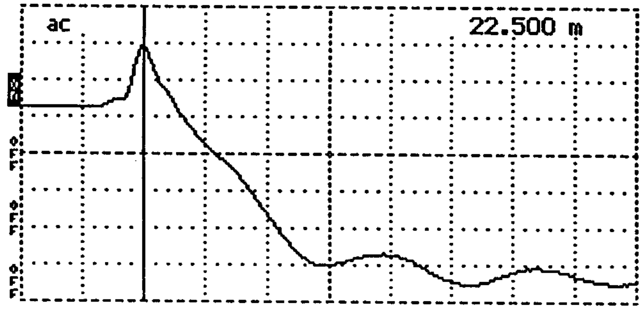
APPENDIX B

Installed Instrument Information

Appendix B includes the following supporting information:

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA01

Cursor .... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

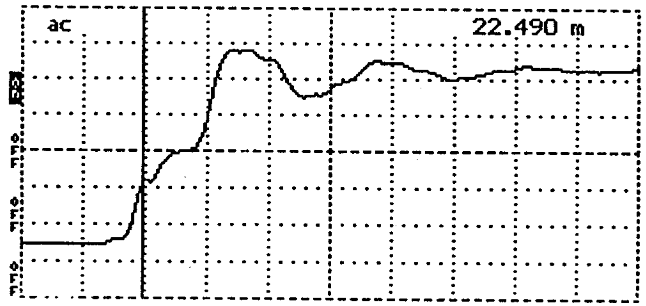


Tektronix 1502B TDR
Date 08/23/96
Cable 32SA01
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 22.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA01
Notes Air

Input Trace
Stored Trace
Difference Trace

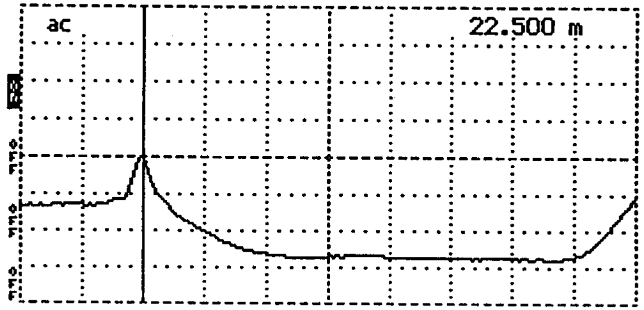
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 2 5	_ 1 . 3 _

Data Sheet SMP-C01: TDR Probe Check

Figure B1. TDR traces obtained during calibration, section 32SA01.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [32] LTPP Section ID [0101] 32SA01

Cursor .... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 223 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA01
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 32SB01 Measured Length of Coax Cable: 18.3 m

Comments:

Prepared by: Mike Egpert Employer: NCE

Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B1. TDR traces obtained during calibration, section 32SA01 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1]

32SA01

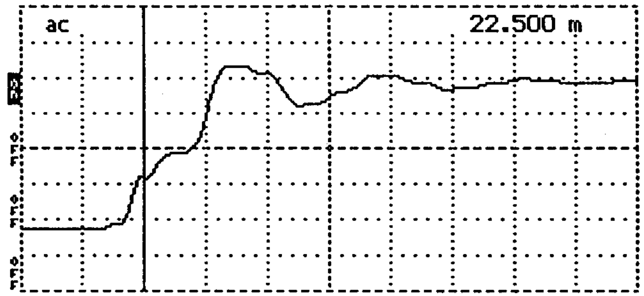
Cursor .... 22.500 m
Distance/Div ..... .25 m/div
Vertical Scale .... 223 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac

Tektronix 1502B TDR
Date 08/23/96
Cable 32SA02
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 22.500 m
Distance/Div ..... .25 m/div
Vertical Scale .... 223 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA02
Notes Air

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 2 2 5	_ 1 . 3 _

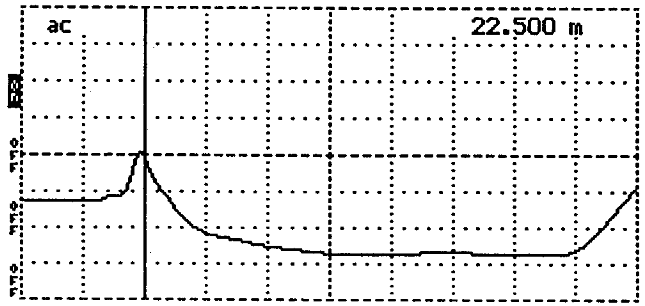
Data Sheet SMP-C01 · TDR Probe Check

Figure B2. TDR traces obtained during calibration, section 32SA02.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1]

32SA02

Cursor .... 22.500 m
Distance/Div ..... .25 m/div
Vertical Scale.... 223 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA02
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S A 0 2 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ______

Prepared by: Mike Egant Employer: NCE

Date (dd/mm/yy): 2 3 / 0 8 / 9 6

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B2. TDR traces obtained during calibration, section 32SA02 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1]

32SA03

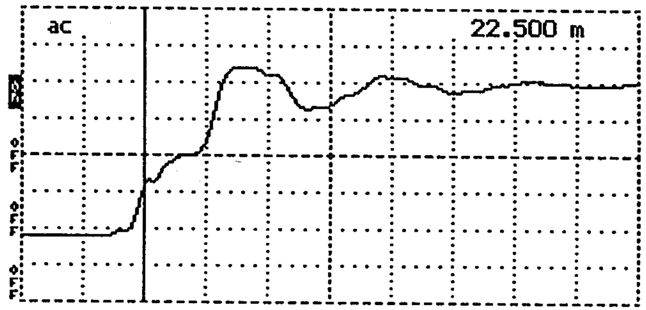
Cursor .... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 223 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power.......... ac

Tektronix 1502B TDR
Date 08/23/96
Cable 32SA03
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 223 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power.......... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA03
Notes Air

Input Trace
Stored Trace
Difference Trace

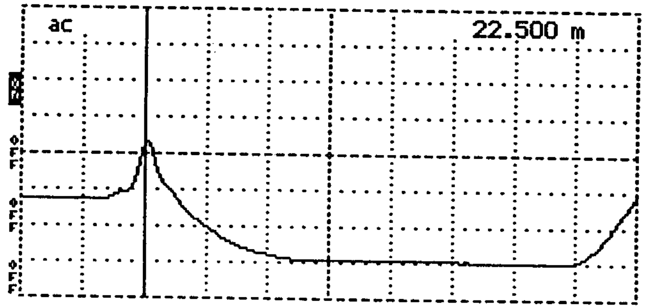
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.250	1.5

Data Sheet SMP-C01 · TDR Probe Check

Figure B3. TDR traces obtained during calibration, section 32SA03.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA03

Cursor .... 22.500 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power.......... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA03
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 3 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ____

Prepared by: Mike Egad Employer: NCE

Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B3. TDR traces obtained during calibration, section 32SA03 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA04

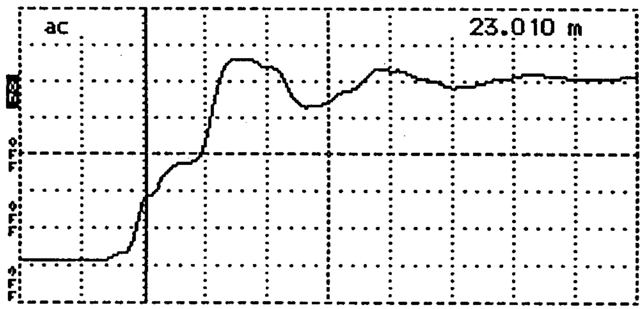
Cursor .... 23.020 m
Distance/Div ..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

Tektronix 1502B TDR
Date 08/23/96
Cable 32SA04
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 23.010 m
Distance/Div ..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA04
Notes Air

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.250	1.5

Data Sheet SMP-C01· TDR Probe Check

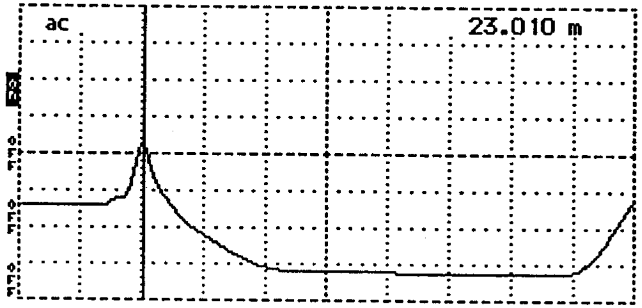
Figure B4. TDR traces obtained during calibration, section 32SA04.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1]

4

32SA04

Cursor .... 23.010 m
Distance/Div ..... .25 m/div
Vertical Scale .... 172 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA04
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	Dielectric Constant[2]
"In Water"	1.769	77.5

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S A 0 4 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ____

Prepared by: Mike Esposito Employer: NCE

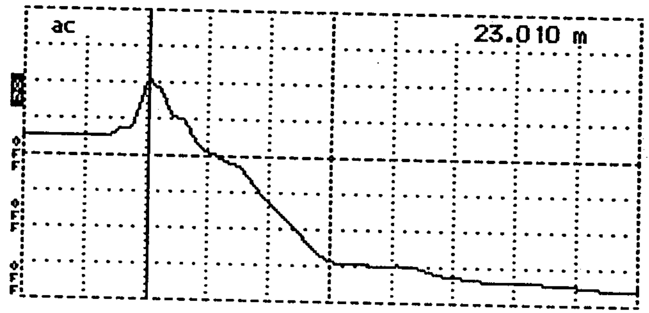
Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B4. TDR traces obtained during calibration, section 32SA04 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA05

Cursor .... 23.010 m
Distance/Div ..... .25 m/div
Vertical Scale.... 217 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

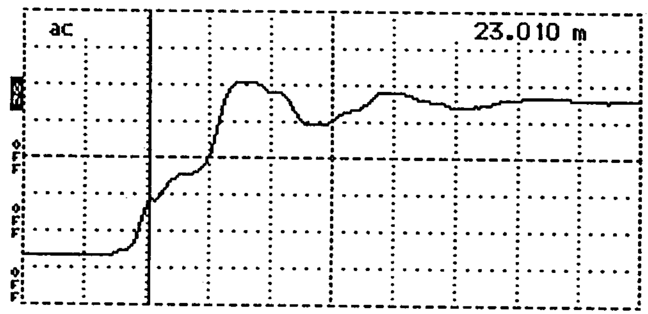


Tektronix 1502B TDR
Date 08/23/96
Cable 32SA05
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 23.010 m
Distance/Div ..... .25 m/div
Vertical Scale.... 217 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA05
Notes Air

Input Trace
Stored Trace
Difference Trace

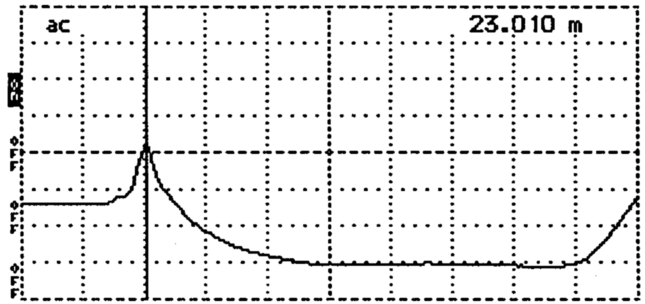
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.250	1.5

Data Sheet SMP-C01 · TDR Probe Check

Figure B5. TDR traces obtained during calibration, section 32SA05.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA05

Cursor .... 23.010 m
Distance/Div ..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power............ ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA05
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 5 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ______________________

Prepared by: Mike Esposito Employer: NCE

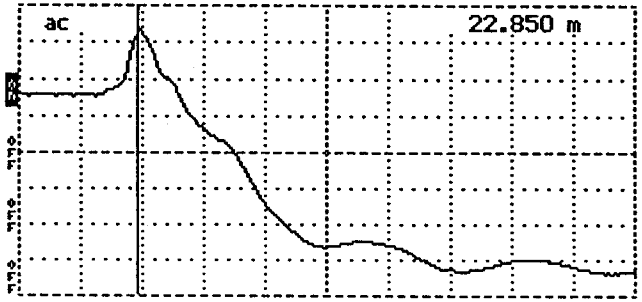
Date (dd/mm/yy): 23 / 09 / 96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B5. TDR traces obtained during calibration, section 32SA05 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA06

Cursor .... 22.850 m
Distance/Div ..... .25 m/div
Vertical Scale.... 188 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power.......... ac

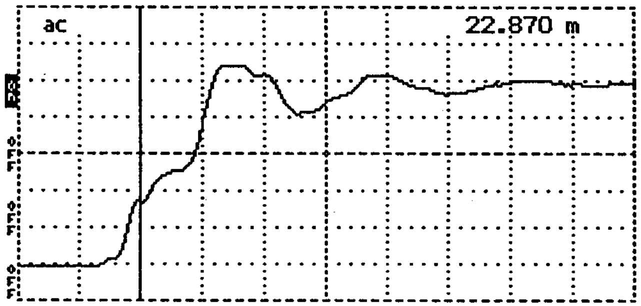


Tektronix 1502B TDR
Date 08/28/96
Cable 32 SA06
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 22.870 m
Distance/Div ..... .25 m/div
Vertical Scale.... 188 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power.......... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA06
Notes Air

Input Trace
Stored Trace
Difference Trace

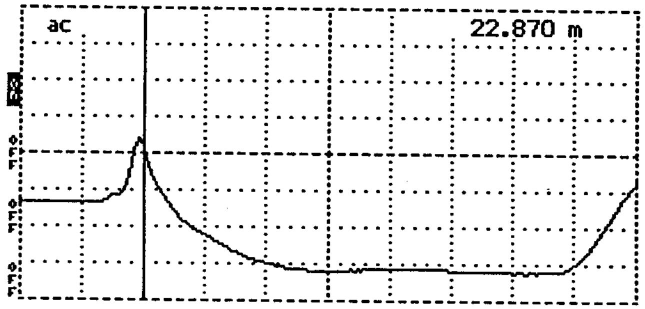
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 00	_ 1 . 0 _

Data Sheet SMP-C01 · TDR Probe Check

Figure B6. TDR traces obtained during calibration, section 32SA06.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA06

Cursor .... 22.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 172 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA06
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)[1]	Dielectric Constant[2]
"In Water"	1.725	78.0

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 6 Measured Length of Coax Cable: 1 9 . 3 m

Comments: ______

Prepared by: Mike Esposito Employer: NCE

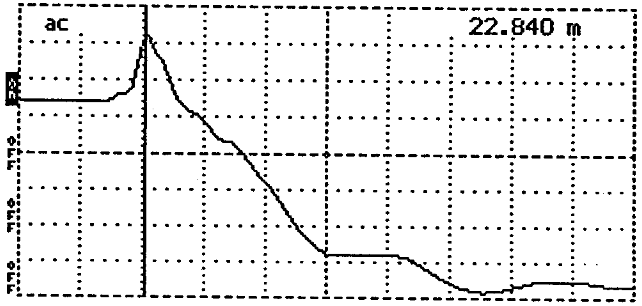
Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B6. TDR traces obtained during calibration, section 32SA06 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA07

Cursor .... 22.840 m
Distance/Div..... .25 m/div
Vertical Scale.... 172 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

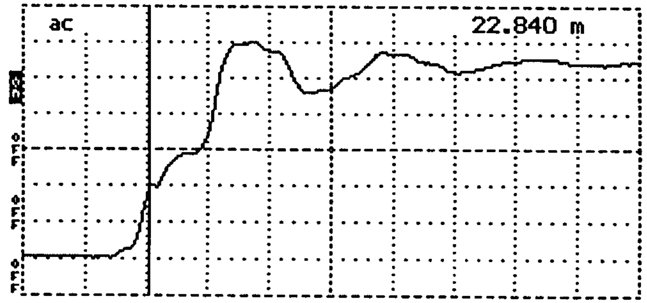


Tektronix 1502B TDR
Date 08/23/96
Cable 32SA07
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 22.840 m
Distance/Div..... .25 m/div
Vertical Scale.... 172 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA07
Notes Air

Input Trace
Stored Trace
Difference Trace

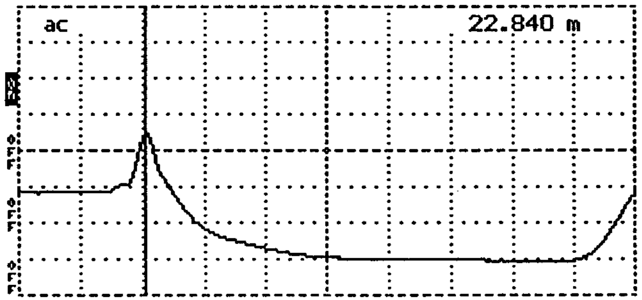
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	6 . 2 50	_ 1 . 5 _

Data Sheet SMP-C01 · TDR Probe Check

Figure B7. TDR traces obtained during calibration, section 32SA07.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA07

Cursor .... 22.840 m
Distance/Div ..... .25 m/div
Vertical Scale.... 172 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA07
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 7 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ____________________

Prepared by: Mike Esposito Employer: NCE

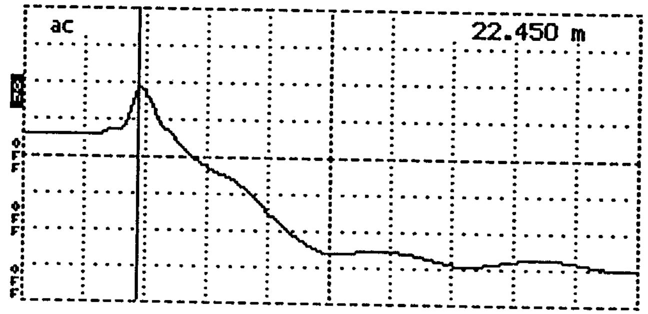
Date (dd/mm/yy): 23 / 02 / 96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B7. TDR traces obtained during calibration, section 32SA07 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA08

Cursor .... 22.450 m
Distance/Div ..... .25 m/div
Vertical Scale.... 250 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power.......... ac

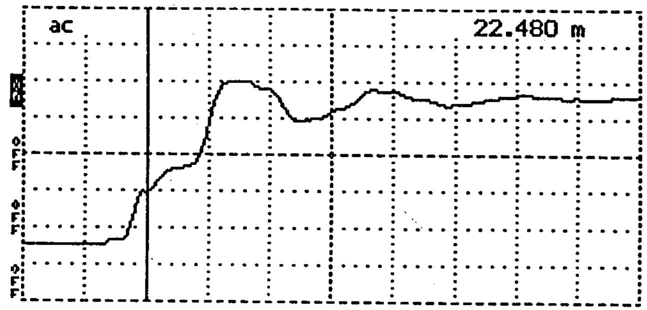


Tektronix 1502B TDR
Date 08/23/96
Cable 32SA08
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 22.480 m
Distance/Div ..... .25 m/div
Vertical Scale.... 223 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power.......... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB08
Notes Air

Input Trace
Stored Trace
Difference Trace

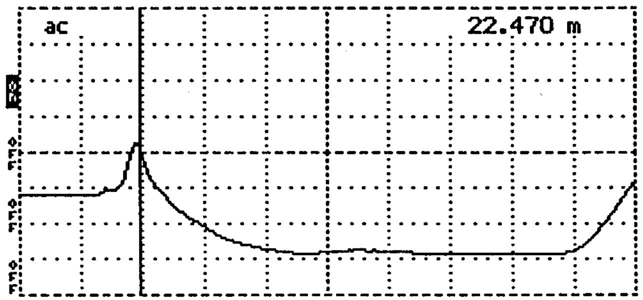
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 00	_ 1 . 0 _

Data Sheet SMP-C01: TDR Probe Check

Figure B8. TDR traces obtained during calibration, section 32SA08.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA08

Cursor .... 22.470 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA08
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 0 8 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ____________________

Prepared by: Mike Esposit Employer: NCE

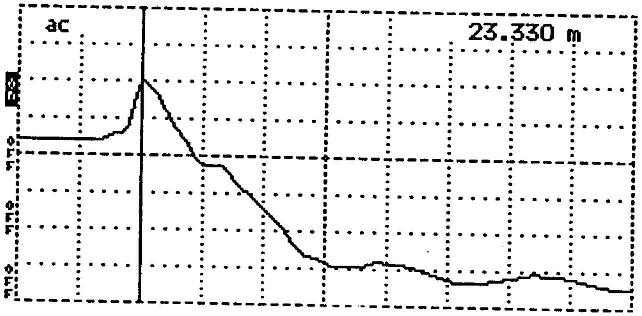
Date (dd/mm/yy): 25 / 09 / 96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B8. TDR traces obtained during calibration, section 32SA08 (cont'd).

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SA09

Cursor .... 23.330 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac

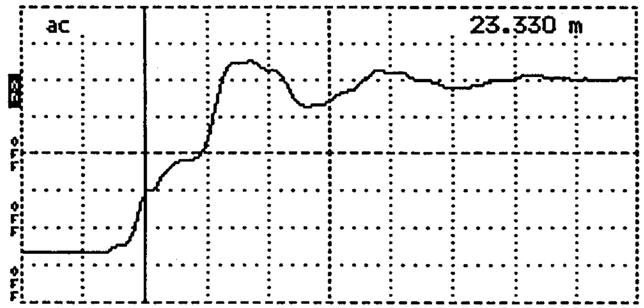


Tektronix 1502B TDR
Date 08/23/96
Cable 32SA09
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _	_ _ . _ _

Cursor .... 23.330 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA09
Notes Air

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 50	_ 1 . 5 _

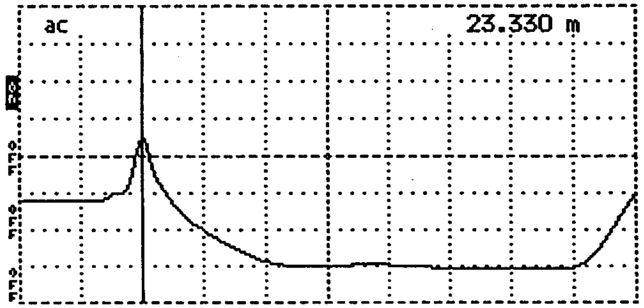
Data Sheet SMP-C01 · TDR Probe Check

Figure B9. TDR traces obtained during calibration, section 32SA09.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1]

32 SA09

Cursor .... 23.330 m
Distance/Div ..... .25 m/div
Vertical Scale .... 167 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA09
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S A 0 9 Measured Length of Coax Cable: 1 8 . 3 m

Comments: ______

Prepared by: Mike Esposito Employer: NCE

Date (dd/mm/yy): 23/08/96

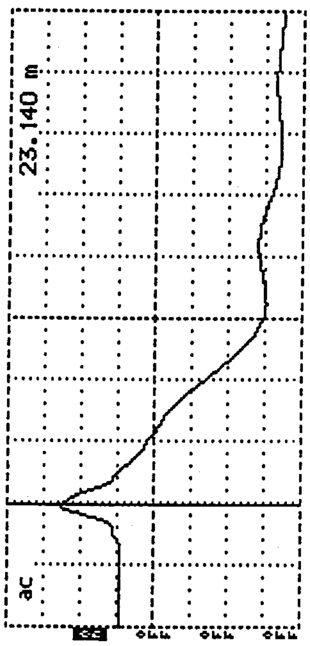
Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B9. TDR traces obtained during calibration, section 32SA09 (cont'd).

LTPP Seasonal Monitoring Program
Data Sheet SMP-C01 (Page 1)
TDR Probe Check

Agency Code	[3 2]
LTPP Section ID	[0 1 0 1] 32SA10

Cursor .... 23.140 m
Distance/Div ..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac

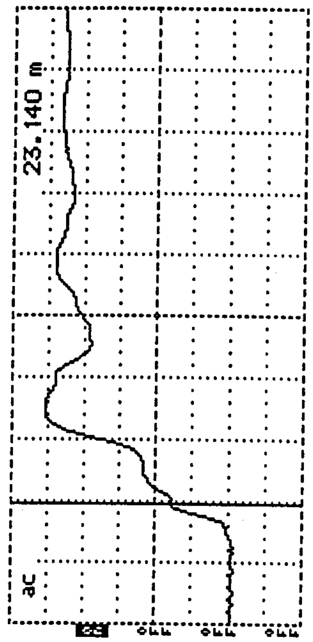


Tektronix 1502B TDR
Date 08/23/96
Cable 32SA10
Notes Short

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	_ . _ _ _	_ _ . _

Cursor .... 23.140 m
Distance/Div ..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SA10
Notes Air

Input Trace
Stored Trace
Difference Trace

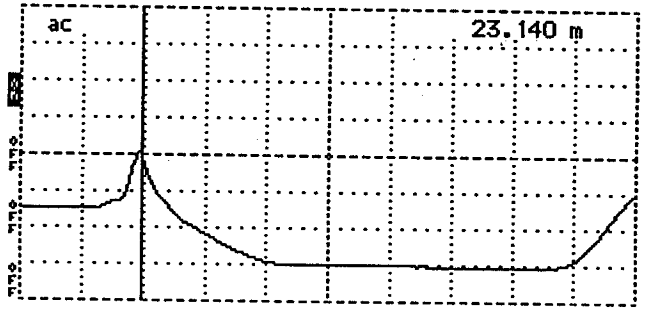
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	_ . 2 6 0	_ 1 . 0 _

Data Sheet SMP-C01 · TDR Probe Check

Figure B10. TDR traces obtained during calibration, section 32SA010.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [3 2] LTPP Section ID [0 1 0 1] 32SB10

Cursor .... 23.140 m
Distance/Div..... .25 m/div
Vertical Scale.... 193 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 08/23/96
Cable 32SB10
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.763	76.9

[1] If dielectric constant not between 0.75 and 2.0, contact FHWA LTPP Division
[2] If dielectric constant not between 76 and 84, contact FHWA LTPP Division

Note: Dielectric constant is determined as follows:

$$\varepsilon = \left[\frac{(L_a)}{(L)(V_p)}\right]^2 = \left[\frac{(D_2 - D_1)}{(L)(V_p)}\right]^2$$

where ε = dielectric constant; L_a = apparent length of probe, m; L = actual length of probe units (= 0.203 m (8 in) for FHWA probes); V_p = phase velocity setting (= 0.99).

TDR Probe Assigned Serial Number: 3 2 S B 10 Measured Length of Coax Cable: 1 8 . 3 m

Comments:

Prepared by: Mike Cepert Employer: NCE

Date (dd/mm/yy): 23/08/96

Data Sheet SMP-C01: TDR Probe Check (Continued)

Figure B10. TDR traces obtained during calibration, section 32SA010 (cont'd).

Table B1. Dielectric constants in various media during calibration.

State ID: 32 SHRP ID: 0101	Date: 26/08/96 Calibrated by: Mike Esposito		Employed by: NCE	
TDR Sensor Number	**Calibration in Air**		**Calibration in water**	
	Approx. Length of Trace	**Dielectric Constant**	**Approx. Length of Trace**	**Dielectric Constant**
32SA01	0.225	1.3	1.763	76.9
32SA02	0.225	1.3	1.763	76.9
32SA03	0.250	1.5	1.763	76.9
32SA04	0.250	1.5	1.769	77.5
32SA05	0.250	1.5	1.763	76.9
32SA06	0.200	1.0	1.775	78.0
32SA07	0.250	1.5	1.763	76.9
32SA08	0.200	1.0	1.763	76.9
32SA09	0.250	1.5	1.763	76.9
32SA10	0.200	1.0	1.763	76.9

APPENDIX C

Installation Information

Appendix C has the following supporting information:

Figure C1.	Instrumentation location within the section.
Figure C2.	Initial data collected by the onsite datalogger.
Figure C3.	General activities during installation at the site.
Figure C4.	Piezometer installation.
Figure C5.	Instrumentation hole drilling in progress.
Table C1.	Measured field moisture contents during installation.

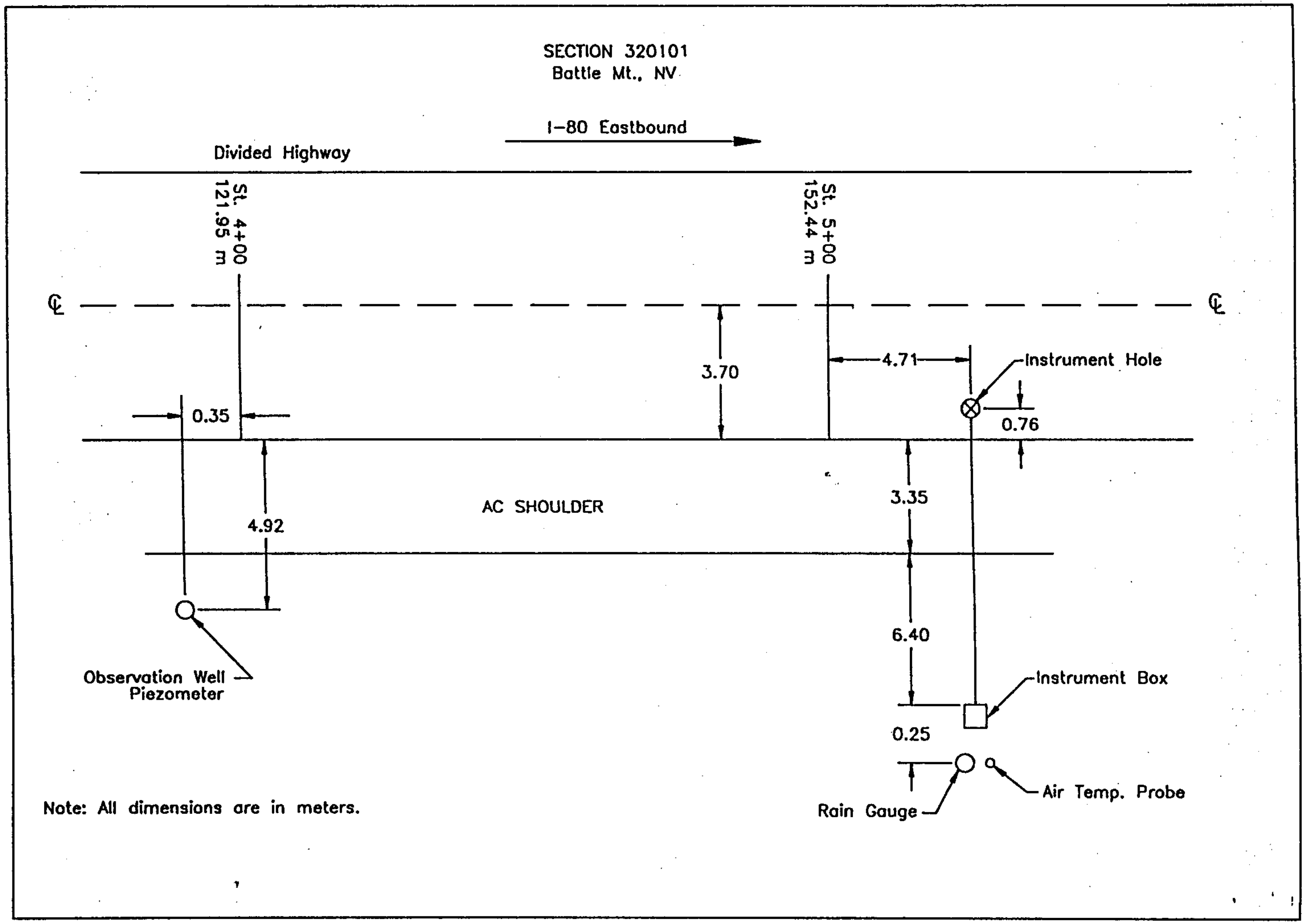


Figure C1. Instrumentation location within the section.

5	1996	282	1800	11.99	28.42	0														
6	1996	282	1800	26.84	27.39	27.2	26.22	26.18												
5	1996	282	1900	11.98	21.37	0														
6	1996	282	1900	24.12	26.61	32.78	30.02	26.67												
5	1996	282	2000	11.97	17.79	0														
6	1996	282	2000	22.26	26.73	35.78	34.4	28.84												
5	1996	282	2100	11.96	18.44	0														
6	1996	282	2100	22.16	27.07	35.66	35.84	30.65												
5	1996	282	2200	11.96	15.71	0														
6	1996	282	2200	21.49	26.75	34.7	35.95	31.61												
5	1996	282	2300	11.95	14.48	0														
6	1996	282	2300	20.7	25.95	33.44	35.45	31.95												
1	1996	282	2400	11.96	12.01	1743	11.94	2328	17.72	29.48	1733	11.91	2318	0	4067					
2	1996	282	2400	22.15	26.44	33.55	33.76	29.95	27.29	26.36	25.84	25.32	25.41	25.42	25.63	25.39	25.04	24.69	24.42	23.86
3	1996	282	2400	27.17	1742	27.7	1731	36	1959	36.07	2056	31.99	2240	28.69	2355	27.54	1731	27.01	1731	26.27
4	1996	282	2400	19.42	0	24.54	2359	26.38	1731	26.04	1736	26.13	1756	26.06	1850	25.87	1946	25.49	2128	24.84
5	1996	282	2400	11.95	13.18	0														
6	1996	282	2400	19.8	25.01	32.12	34.65	31.89												
5	1996	283	100	11.94	11.16	0														
6	1996	283	100	19.01	24.05	30.82	33.7	31.57												
5	1996	283	200	11.94	9.38	0														
6	1996	283	200	18.12	23.1	29.58	32.7	31.1												
5	1996	283	300	11.93	8.81	0														
6	1996	283	300	17.26	22.17	28.39	31.69	30.54												
5	1996	283	400	11.93	8.17	0														
6	1996	283	400	16.45	21.24	27.26	30.69	29.93												
5	1996	283	500	11.92	7.21	0														
6	1996	283	500	15.71	20.38	26.19	29.73	29.29												
5	1996	283	600	11.92	5.049	0														
6	1996	283	600	14.87	19.51	25.18	28.8	28.64												
5	1996	283	700	11.91	5.133	0														
6	1996	283	700	14.21	18.68	24.23	27.92	28												
5	1996	283	800	11.91	7.73	0														

Figure C2. Initial data collected by the onsite datalogger.

Figure C3. General activities during installation at the site.

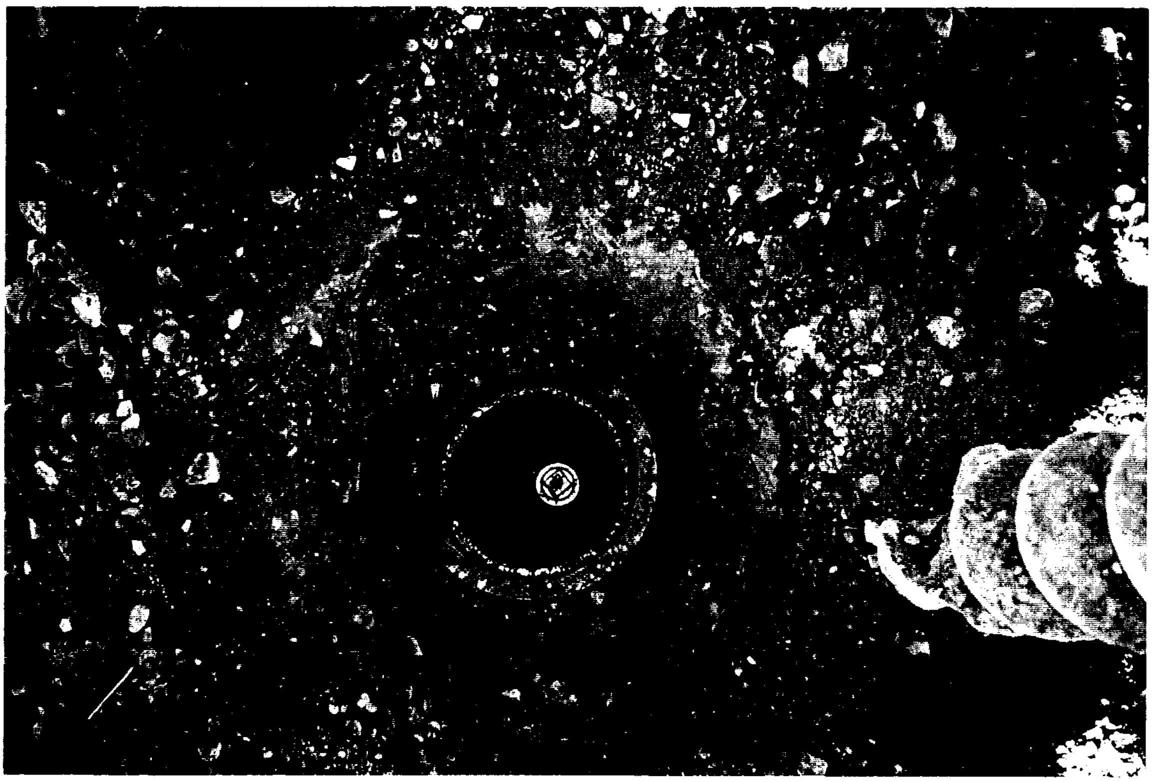


Figure C4. Piezometer installation.

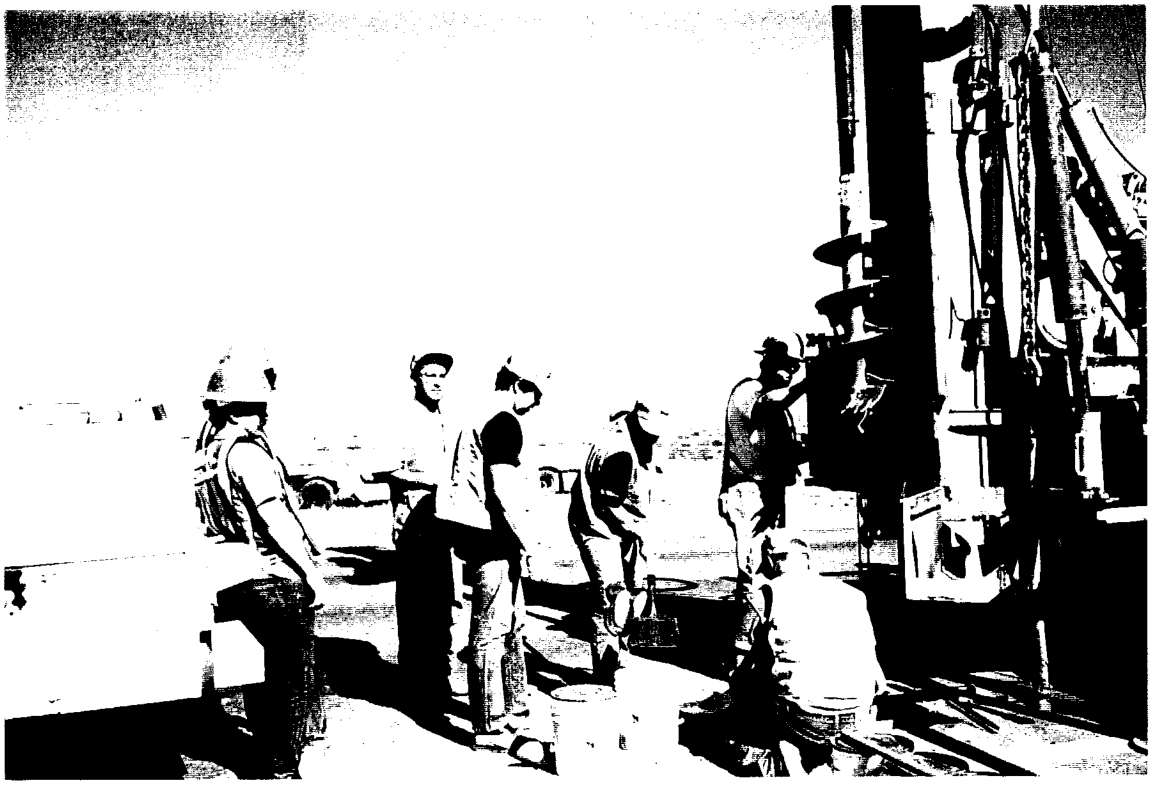


Figure C5. Instrumentation hole drilling in progress.

Table C1. Measured field moisture contents during installation.

LTPP Seasonal Monitoring Study Field Measured Moisture Contents	* State Code [32] * Test Section Number [0101]

Personnel : Srikanth Holikatti and Rachel Guan
Date : 08/10/96
Start Time : NA
Finish Time : NA
Surface Type : Asphalt Concrete
Weather Conditions : Clear, Sunny
Unusual Conditions : None

TDR Sensor Number	Field Measured Moisture Content %
10	14.6
9	12.4
8	10.4
7	5.8
6	6.6
5	8.5
4	5.0
3	5.2
2	4.6
1	6.4

APPENDIX D

Initial Data Collection

Appendix D includes the following supporting information:

Figure D1.	Hourly average air and top 5 sensor temperature recorded during initial data collection.
Table D1.	Raw data collected by the onsite datalogger.
Table D2.	Pavement elevations at the time of installation.

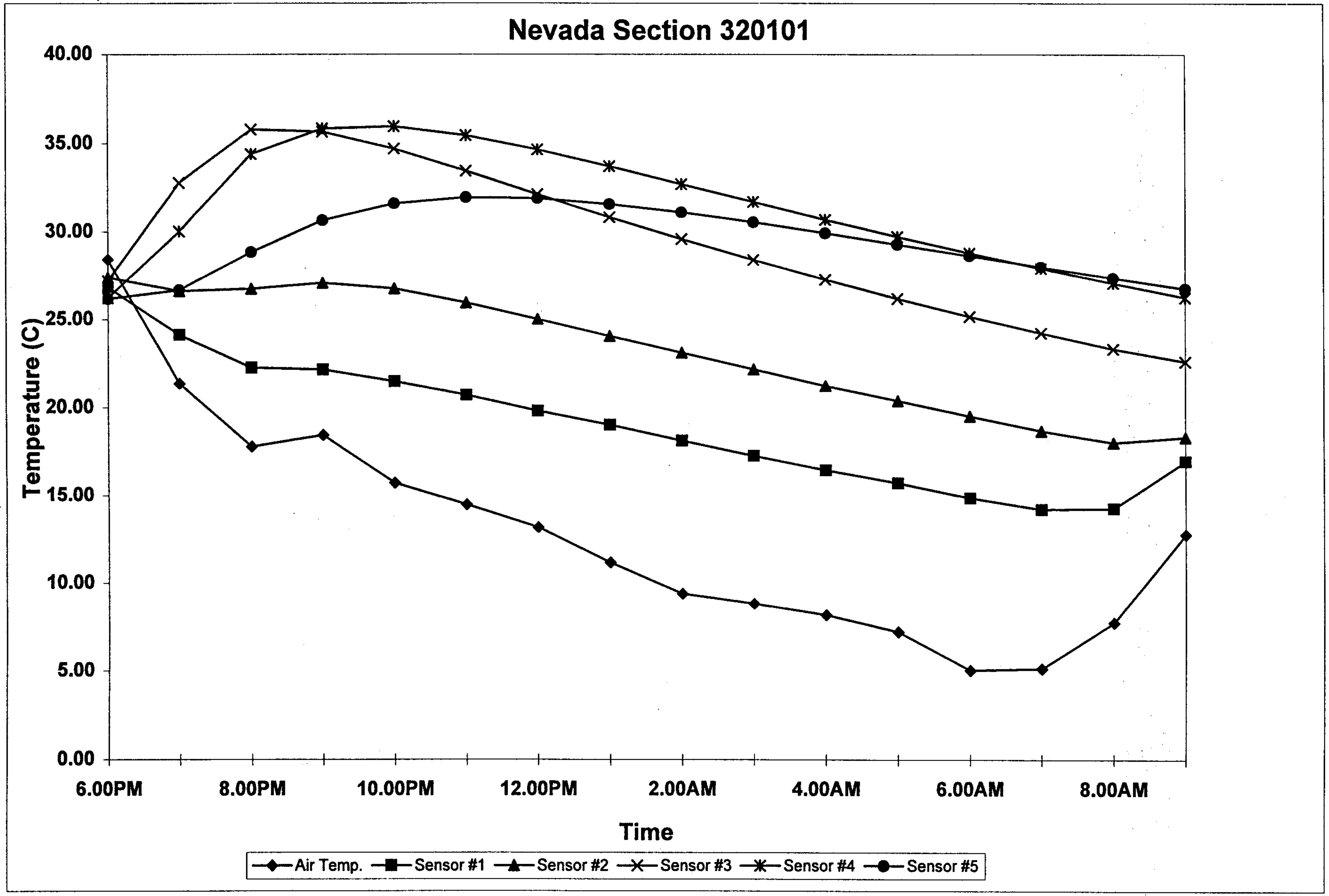


Figure D1. Hourly average air and top 5 sensor temperature recorded during initial data collection.

Table D1. Raw data collected by the onsite datalogger.

Table D2. Pavement elevations at the time of installation

Station*	Offsets in m.					Comments
	PE[1]	OWP[2]	ML[3]	IWP[4]	ILE[5]	
3+00	1.305	1.322	1.337	1.355	1.377	Observation Well/Piezometer top assumed as 1.0 meter
3+25	1.288	1.302	1.322	1.336	1.360	
3+50	1.291	1.305	1.323	1.337	1.363	
3+75	1.292	1.305	1.323	1.334	1.360	
4+00	1.286	1.297	1.317	1.329	1.355	
4+25	1.287	1.294	1.311	1.321	1.345	
4+50	1.259	1.275	1.295	1.320	1.337	
4+75	1.247	1.262	1.284	1.299	1.325	
5+00	1.238	1.255	1.275	1.290	1.313	
5+08		1.254				
5+16		1.254	1.266			
5+24		1.245				

*Customary units
[1] Pavement Edge
[2] Outer Wheelpath
[3] Middle of Lane
[4] Inner Wheelpath
[5] Inner Left Edge