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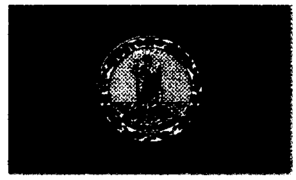

Virginia

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 510114, Danville
Virginia

Report No. FHWA-TS-96-51-02 **June 1996**

Notice

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 510114, Danville, Virginia

Report No. FHWA-TS-96-51-02

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The report is a cooperative effort between Virginia Department of Transportation (VDOT) Transportation Research Council, Long Term Pavement Performance (LTPP) Division Federal Highway Administration, and Pavement Management Systems Limited (PMSL) LTPP North Atlantic Region Coordination Office (NARCO).

16. Abstract

This report provides a description of the installation of seasonal monitoring instrumentation and initial data collection for the seasonal experimental study conducted as part of the Long Term Pavement Performance (LTPP) program at the Specific Pavement Study (SPS-1) section 510114 on route 265 in Danville, Virginia. This asphalt concrete surface pavement test section was instrumented on October 24, 1995. The instrumentation installed included time domain reflectometry probes for moisture content, thermistor probes for temperature, tipping bucket rain gauge, piezometer to monitor the ground water table, and an on-site datalogger. Initial data collection was performed on October 25, 1995 which consisted of deflection measurements with a Falling Weight Deflectometer, elevation measurements, temperature measurements, TDR measurements, and water table measurements. The report contains a description of the test site and its location, the instruments installed at the site and their locations, characteristics of the installed instruments and probes, problems encountered during installation, specific site circumstances and deviations from the standard guidelines, and a summary of the initial data collection.

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INSTRUMENTATION INSTALLATION
VIRGINIA SECTION 510114

I. Introduction

The installation of the LTPP instrumentation on seasonal site 510114 near Danville, Virginia was performed on October 23 - October 26, 1995. The test section is a SPS-1 experiment, located on Southbound Route 265 approximately 160 meters South of S.R.695. A map indicating the location detail of the site is presented in Figure A-1 of Appendix A. The highway consists of one 3.7 m wide lane in each direction, with a 3.7 m wide paved outside shoulder and an asphalt curb at the outside shoulder edge. Future transportation plans are for the current Southbound and Northbound lanes to become Southbound lanes. A guard rail was installed by the construction contractor after the installation of the site. The site had a 40 mm lift of hot mix asphalt concrete on November 28, 1995 because the design depth was not met during the initial construction of the site. All depths and thicknesses presented in this report reflect this change.

This road was constructed during the summer months of 1995 and has not been opened to traffic yet. There is minimal site history data available for this site because it is a new road. There is no FWD history, profile history, distress rating, traffic data, and weather data specific to this site. Information regarding material types and depths were extracted from construction records. Cores taken at the time of the installation were used to determine surface thickness. No laboratory data was available when this report was being prepared.

The pavement, which is built on a slightly elevated fill area, consists of 178 mm of asphalt concrete on a 302 mm dense graded aggregate base. This lies on 150 mm of cement treated subgrade soil. The subgrade predominantly consists of sandy silt with some gravel. The design depths of the entire SPS-1 project are presented in Figure A-2, Appendix A. Pavement structure information taken from the SPS material drilling logs and elevation surveys conducted during the construction are presented in Figure A-3. Properties determined from field tests and logs are shown in Table 1. The uniformity survey results are summarized in Table A-2. The deflection values and analysis results from the FWDCHECK are also presented in Appendix A.

The site is in a wet freeze zone and resides in cell 12 (thick AC on fine subgrade) of the Seasonal Monitoring Program. Below is a summary from the LTPP climate database based on ten years of data:

• Freezing Index (C-Days)	67
• Precipitation (mm)	1143
• No. of Freeze/Thaw Cycles	86
• Days Above 32°C	48
• Days Below 0°C	83
• Wet Days	117

The climatic data listed above was taken from site 512004, since there was no climatic data available for site 510114. Site 512004 is approximately 5 kilometers West of 510114, and is the closest LTPP site that could be used for climatic data. This portion of State Road 265 provides a bypass and access route on the East side of Danville taking traffic from S.R. 29 to the intersection at S.R. 58. S.R. 265, South of S.R. 58, goes to Greensboro, North Carolina.

An International Road Dynamics (IRD) Weigh In Motion (WIM) has been installed 243 meters before the site 510114. This WIM is to provide continuos volume, weight, and vehicle classification. In addition to the seasonal monitoring program climatic data, an Automated Weather Station (AWS), is also installed at this location. This weather station will be used to collect air temperature, relative humidity, solar radiation, wind speed/direction and rainfall for the SPS-1 test sections.

Installation of the instrumentation was a cooperative effort between Commonwealth of Virginia Department of Transportation (VDOT), Federal Highway Administration (FHWA) Long Term Pavement Performance (LTPP) Division, and Pavement Management Systems Limited (PMSL) LTPP North Atlantic Region Coordination Office (NARCO) staff. The main contractor for this SPS project was W.C. English. The following personnel participated in the instrumentation installation:

Buddy Wood	VDOT-Research Council
George Wise	VDOT-Lynchburg Materials
Ken J. Jenning	VDOT-Lynchburg, Materials
Dave Woolley	VDOT-Lynchburg, Materials
N. B. Walton	VDOT-Lynchburg, Materials
Tim Karnes	VDOT-Chatham Residency
Tyler Meadows	VDOT-Chatham Residency
A. W. Moore	VDOT-Chatham Residency
Henry Yeatts	VDOT-Chatham Residency
Scott Comstock	PMSL NARCO
Tim Comstock	PMSL NARCO
Brandt Henderson	PMSL NARCO
Randy Plett	PMSL NARCO
Dilan Singaraja	PMSL NARCO

Table 1. Material Properties

Description	Surface	Base	Treated Subgrade	Subgrade
Material (Code)	Dense Graded HMAC (01)	Soil Aggregate Mixture (308)	Cement Treated Soil (333)	Sandy Silt with Gravel (147)
Thickness (mm)	178	302	150	
In-Situ Density (kg/m^3)	2168	2066	1550	
In-Situ Moisture Content (%)		5.7	22.1	

* Note: Lab data had not been recieved at the time of preparation of this report.

II. Instrumentation Installation

Site Inspection and Meeting with Highway Agency

A preliminary planning meeting was held at the Lynchburg district office in Lynchburg, Virginia on September 21, 1995. The attendees at the meeting were:

• Dale Grigg	VDOT Materials
• Randy Hamilton	VDOT Chatham Res.
• A. L. Simpson	VDOT
• Buddy Wood	VDOT - Research Council
• Basel Abukhater	PMSL - NARCO
• Brandt Henderson	PMSL - NARCO
• Bill Phang	PMSL - NARCO

A presentation on the installation of seasonal monitoring instrumentation and monitoring requirements was provided by Bill Phang and Brandt Henderson of Pavement Management Systems. Reasons for picking this site for the seasonal monitoring program were discussed along with the details and the frequency of scheduled testing. Brandt Henderson then gave a more detailed description of roles and responsibilities of the agencies and the personnel involved with the installation. The list of materials required by VDOT was presented. Correspondence regarding the installation are presented in Appendix B.

A pre-installation meeting was arranged and conducted on October 20, 1995 at the VDOT district office in Lynchburg. Final details of the installation were discussed with VDOT members. A 305 mm thin wall core barrel was loaned to the VDOT materials group for coring the instrumentation hole. FWD testing, to pick the most uniform end for the installation, was conducted on October 21, 1995. The 5+00 end was slightly more uniform than the 0+00 end and provided better site distance for traffic control setup, thus it was picked for the installation. The results from the uniformity tests are provided in Appendix A. Arrangements were made to meet on site at 0800 hours on Monday October 23, 1995. This site was installed in conjunction with site 510113. The close proximity of the sites made it possible to overlap activities to make the best use of time and resources.

Equipment Installed

The equipment installed at the test site included instrumentation for measuring air, pavement, and subsurface temperatures, precipitation, subsurface moisture content, and water table. An equipment cabinet was installed to hold the datalogger, battery pack, and all electrical connections for the instrumentation. The equipment cabinet installation and wiring of the panel was completed on October 24, 1995. The equipment installed are shown in Table 2.

Table 2. Equipment Installed

Equipment	Quantity	Serial Number
Instrumentation Hole		
MRC Thermistor Probe	1	51BT
CRREL Resistivity Probe	N/A	N/A
TDR Probes	10	51B01-51B10
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16556
Campbell Scientific PS12 Power Supply	1	5620
Weather Station		
TE525MM Tipping Bucket Rain Gage	1	12093
Campbell Scientific 107-L Air Temperature Probe	1	51BAT
Observation Well/Bench Mark	1	N/A

Equipment Check/Calibration

Prior to installation, each measurement instrument was checked or calibrated. The tipping bucket rain gauge was connected to the CR10 datalogger for calibration. A plastic container with 473 ml of water was placed in the tipping bucket. The container had a small hole in the bottom, which allowed all the water to be drained out in 45 minutes. For the 473 ml of water, the tipping bucket should measure 100 tips ± 3 tips. The results were 103 tips, which was within specification.

The air temperature and thermistor probes were connected to the CR10 datalogger simultaneously. They were checked by placing the probes in ice, room temperature, and hot water. In order for the probes to pass this check, the temperatures for each probe needed to correspond to the water temperature. The check indicated that the air temperature and thermistor probes were working properly. A second check was done where the air temperature and thermistor probes were connected to the datalogger and run, in air, for 24 hours. The minimum, maximum, and mean temperature for each sensor were checked. All 18 thermistors were similar in their minimum, maximum, and mean readings respectively, therefore the probes were considered to be functioning correctly. The results from the calibration of the air temperature and the thermistor probes along with the spacing between the thermistors are presented in Appendix B.

The TDR probes used at this site were manufactured by Campbell Scientific. These probes were of the FHWA three prong design. The 6 mm stainless steel probes are 203 mm in length, mounted to a printed circuit board encased in a 15 mm epoxy coating with burial type coaxial cable used to transmit signals between the Mobile unit and the TDR probe. This probe is more rugged than the FHWA probe but it is more difficult to maneuver around the instrument hole because it is bulkier.

The function of the TDR probes was checked by performing measurements in air, water, methyl alcohol, and with the prongs shorted at the circuit board and the end of the probe. The traces were taken and the dielectric constant was calculated for the water, air, and methyl alcohol. These values were checked against expected dielectric constants for each medium. The tests indicated that all probes were functioning properly. Results of the TDR measurements are presented in Appendix B.

Equipment Installation

Final details for the installation and initial monitoring were discussed during the pre-installation meeting on the afternoon of October 20, 1995. The installation was confirmed for 0800 hours on October 23, 1995. Traffic control was not required because the section was not open to the public. The traffic control during the operational period will be provided by the VDOT Chatham residency. The pavement surface drilling and augering of the piezometer and instrumentation hole were done by agency equipment and drilling crew. The sawing of the trench was done by VDOT Chatham Residency personnel. The installation of the measurement equipment, the observation piezometer, weather station pole, and cabinet was performed by PMSL staff. Assistance was provided by VDOT local district personnel. The schedule of activities were altered because the pavement sawing machine malfunctioned.

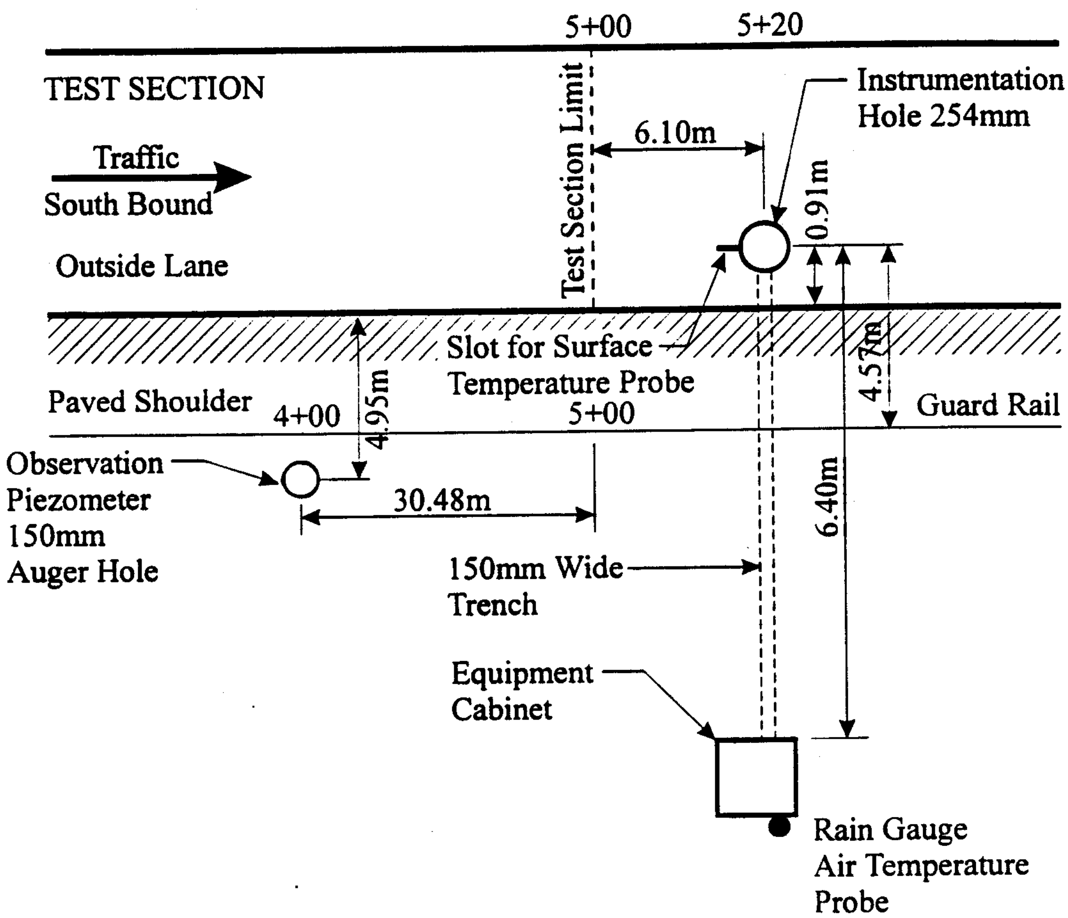
The instrumentation was installed on the South end of SPS 510114, in the Southbound lane of Route 265, approximately 160 m South of the S.R. 695 in Danville, Virginia. The combination benchmark/piezometer was placed in the shoulder at station 4+00. The in-pavement instrumentation was installed in the outer wheel path at station 5+20. The cabling from the instrumentation was placed in a 75 mm flexible conduit and buried in a trench running from the instrument hole to the equipment cabinet. The cabinet was located on the road embankment adjacent to the shoulder, 6.40 m from the centre of the instrumentation hole. The weather pole was installed 0.43 m behind the equipment cabinet. A guardrail was installed along the asphalt curb line by a subcontractor "Starkey & Associates Inc.". The guardrail I beam was offset from the trench carrying the instrumentation cables. Figure 1 provides the location and distances for the various instrumentation and equipment installed.

The installation generally followed the procedures described in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines". The combination piezometer/bench mark was installed 1.2 m from the edge of the paved shoulder to a depth of 4.28 m. Shale or water was not encountered during the drilling. The PVC access cover was seated firmly in concrete at the completion of the piezometer installation.

A core hole was drilled in the pavement surface, located in the outside wheel path 0.91 m from the edge of the travel lane at station 5+20, using a 305 mm thin wall diamond core barrel mounted to a heavy duty trailer drilling unit. A 150 mm wide by 275 mm deep trench was saw cut between the core hole and the edge of the pavement using a heavy duty pavement sawing machine. The asphalt concrete portion of the trench was removed with picks and shovels.

The instrumentation hole was excavated using a 254 mm hollow stem auger with the hollow end blocked so that material mixing did not occur. Care was taken to ensure that the excavated material was stored in the order that it was removed. A standard proctor test of the subgrade soil was conducted in the field. The sandy silt yielded a dry density of 1860 kg/m^3 (as shown in Table C-3. of Appendix C). The drilling was stopped approximately 2.15m below the surface of the pavement. The findings from the excavation of the instrumentation hole at station 5+20 are presented in Figure 2. All the material excavated from the instrument hole was placed and hand compacted in the order of removal with the TDR probes, and the thermistor probe placed at the specified locations. The 250 mm layer of soil cement was reconstructed by pulverizing the existing material and blending in 2 - 3% of cement with water. This material was tampered back into the location it was retrieved from. The location and elevation information of the instrumentation is presented in figure 2. Samples of the material placed around the TDR probes were retrieved for the field determination of the gravimetric moisture. The accuracy of the VDOT field procedure for determining moisture was such that no laboratory testing was required.

The pole for the rain gauge and air temperature probe were installed as per manual guidelines. The equipment cabinet installation and the wiring of the panel was completed on October 24, 1995.



- Height of Air Temperature Probe: 3.18m
- Height of Tipping Bucket Rain Gauge: 3.20m
- Depth of Piezometer: 4.28m

Figure 1. Location of Seasonal Monitoring Instrumentation Installed at SPS 510114

Material	Depth (mm)	Probe	TDR depth (mm)	Comments
HMAC	166			
Aggregate Soil Mixture	490	TDR 1	320	Thermistor Probe Depth 202 mm
		TDR 2	470	
Sandy Silt some Gravel-cement treat. Red-Brown	750	TDR 3	660	
same not treated	850	TDR 4	810	
Sandy Silt some Gravel lighter Reddish Brown	1890	TDR 5	970	Dry Density 1860 kg/m^3
		TDR 6	1120	
		TDR 7	1280	
		TDR 8	1440	
		TDR 9	1740	
Sandy Silt trace Gravel - lighter Reddish Brown	2150	TDR 10	2050	

Figure 2. Profile of Pavement Structure and Probe Depths, Station 5+20

To check for breakage of the TDR probes during installation, each probe was connected to the cable tester and it's wave form monitored during compaction of the material around it. The TDR traces are included in Appendix C. The cables coming from the TDR probes were staggered along the perimeter of the instrument hole to avoid water migrating along a bundle of cables. The top TDR probe was placed with the cabling and the printed circuit board facing downward to avoid contact with the asphalt concrete surface. The top of the thermistor probe was 0.202 m below the pavement surface. The cables from all instrumentation installed converged at the opening of the flexible conduit pipe which was placed about 50 mm from the edge of the core hole. The cables were then tie wrapped and passed through the 75 mm flexible conduit to the equipment cabinet. The ends of the conduit were plugged with a mastic pipe sealant.

Tables 3, and 4 present the installed depths of the TDR probes, and thermistor sensors respectively. Table 5 gives TDR, and field measured moisture content collected during the installation. A comparison of the moisture content from the TDR traces, and the field determination indicate some discrepancies. In general the TDR moistures are higher than the field determination of moisture through soil drying. This can partly be because some moisture is lost during the handling of soils in the field determination process. It should also be noted that the calculation of moisture is dependent on the calibration inputs to the TDR model. Differences of moisture content in the range of 1 to 2% are not uncommon.

Table 3. Installed Depths of TDR Sensors

Sensor #	Depth from Pavement Surface (m)	Layer
51B01	0.320	Base
51B02	0.470	
51B03	0.660	Treated Subgrade
51B04	0.810	Subgrade
51B05	0.970	
51B06	1.120	
51B07	1.280	
51B08	1.440	
51B09	1.740	
51B10	2.050	

Table 4. Installed Location of MRC Thermistor Sensor

Unit	Channel Number	Depth from Pavement Surface (m)	Remarks
1	1	0.061	This unit was installed in the AC layer.
	2	0.103	
	3	0.144	
2	4	0.223	This unit was installed below the AC layer into the subgrade.
	5	0.282	
	6	0.376	
	7	0.448	
	8	0.525	
	9	0.676	
	10	0.829	
	11	0.981	
	12	1.133	
	13	1.287	
	14	1.437	
	15	1.591	
	16	1.741	
	17	1.896	
	18	2.053	

Table 5. TDR, and Field Moisture Content During Installation

Sensor Number	Sensor Depth (m)	Layer	TDR Moisture Content (by wt)*	Field Moisture Content (by wt)*
51B01	0.320	Base	7.8	4.7
51B02	0.470		14.3	5.0
51B03	0.660	Treat. Subgrade	25.2	18.6
51B04	0.810	Subgrade	21.0	13.9
51B05	0.970		16.5	7.3
51B06	1.120		12.1	4.2
51B07	1.280		9.9	6.2
51B08	1.440		12.1	9.4
51B09	1.740		14.3	10.3
51B10	2.050		12.1	10.5

* Note: Raw data given in Appendix C

** Note: No field moisture test conducted.

Site Repair and Cleanup

The instrumentation hole and trench were repaired by placing and compacting hot-mix asphalt concrete. The VDOT personnel filled and compacted the hot-mix on October 25, 1995. Soil cover of at least 50 mm was maintained over the conduit for the extent of the paved trench. The road base material removed from the trench was used to bring it up to grade. The chunks of asphalt removed from the pavement were cleared by the VDOT personnel on October 25, 1995.

The wiring panel in the equipment cabinet was installed on October 24, 1995. All equipment checks and initial data collection was completed by October 26, 1995.

Patch/Repair Area Assessment

All indications until the site was overlayed on November 28, 1996 were that the instrument hole and trench area was in good condition. As of May 15, 1996, the overlayed pavement in the instrument hole area did not show any signs of settling or any other distresses.

III. Initial Data Collection

Initial data collection on the site and checks on functioning of installed equipment were conducted on October 26, 1995. This consisted of examination of the data collected over the day by the onsite datalogger, data collection and check of the mobile CR10 datalogger, check of the tipping bucket, deflection testing, and an elevation survey. A sample of the data collected by the onsite datalogger is presented in Appendix D (Table D-1). During the first visit to this site after the installation it was noticed that the datalogger had malfunctioned. A new datalogger was installed and it's performance is currently being monitored.

Air Temperature, Subsurface Temperature, Rain-fall Data

The air temperature, pavement subsurface temperature profile, and rainfall data, collected on October 26 by the CR10 datalogger, were examined. The thermistors top few sensors yielded higher temperatures than were expected. This was most likely because of the hot-mix asphalt concrete that was laid in the instrument hole area on October 25, 1995. All other equipment except for the datalogger, as mentioned above, appeared to be functioning properly. The battery voltages were checked and found to be acceptable. The plots of the temperature profiles are presented in Appendix D (figures D-1 and D-2).

The tipping bucket rain gauge was checked by determining the number of tips recorded from 473 ml of water discharged into the gauge over a 1 hour time period. The rain gauge was found to be operating properly.

A 40 mm overlay was placed at this site location on November 28, 1995. This overlay has resulted in the top two thermistors in the stainless steel probe becoming 61 mm and 103 mm below the ACC surface. The guideline specifies 25 mm and 83 mm for the top two sensors.

TDR Measurements

TDR data was collected using the mobile system provided by FHWA. The mobile system contains a CR10 datalogger, battery pack, two TDR multiplexers, and a resistance multiplexer circuit board. Version 2.2 of the MOBILE program was used to collect and record the TDR wave form traced for each sensor.

Figure D-3 shows the initial TDR traces collected with the MOBILE data acquisition system for all 10 sensors. The figures indicate that the multiplexers of the mobile system and TDR sensors were working properly. The trace for TDR #3 does not have a defined reflection point at the end of the probe. This probe is located in the soil cement.

Deflection Measurement Data

Deflection measurements followed procedures described in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines". The analysis results from the FWDCHECK program from the day of installation and the following day are presented in Appendix D. Since then, FWD data has been collected once every month. It should be noted that this site contains variable subgrade soil conditions.

Longitudinal Profile Data

According to the guidelines, since this is in a frost area, the survey should be performed on five different occasions; one survey during the middle of each season and one survey during the late winter period (fully frozen condition). No profile data was collected for some time at the site because there was no paint-striping indicating the lane locations. One set of profiles was collected on April 24, 1996 with an IRI value of 59.41 inches/mile.

Elevation Surveys

A surface elevation survey was performed following the guidelines. The elevation at the top of the piezometer pipe was assumed to be 1.000 meters. The survey was conducted on October 25, 1995 and the results are presented in Appendix D. On November 28, 1995 the site had a 40 mm layer of hot mix asphalt concrete placed over the existing surface. This overlay was placed in order that the design depths be met. Since then elevation surveys were performed on November 30, 1995, January 24, February 22, and April 25, 1996.

Water Depth

There was no water encountered during the drilling process and there has not been any water in the piezometer pipe since the installation. The last site visit was on May 15, 1996 and the piezometer was dry then.

IV. Summary

The installation of the seasonal monitoring instrumentation at the SPS site 510114 near Danville, VA was completed on October 24, 1995. A check of the equipment and initial data collection was completed on October 26, 1995. The instrumentation, permanently installed at the site, were:

- Time domain reflectometer probes for moisture measurements,
- Thermistor probes for pavement and soil gradient temperature measurements,
- Air temperature, thermistor probe, and tipping bucket rain gauge to record local climatic conditions, and
- Combination piezometer (well) and bench mark to determine changes in water level and pavement elevations.

The pavement gradient temperature and local climatic data are to have continuous data collection stored in an on-site datalogger. The moisture measurement is to be collected during each site visit (14 times per year) using a mobile datalogger system. The water level, and elevation data are to be collected manually during site visits.

The test section is on Southbound Route 265, 160 m South of the S.R. 695. The site is located in a predominantly fill area. The road embankment on the East side, slopes steeply downward toward a ditch. The pavement consists of one 3.7 m wide lane in each direction with a 3.7 m paved shoulder that ends at an asphalt curb. Guardrails have been installed along the curb. It is in the plans to make both Northbound and Southbound lanes into Southbound lanes. The pavement structure consists of 178 mm of asphalt concrete over 302 mm dense graded aggregate base which lies on 150 mm of cement treated subgrade. The subgrade material consists of sandy silts with some gravel. A WIM station placed 243 meters North of site 510114 will provide continuos traffic data for this section. It is expected the WIM will be operational prior to this section being opened to traffic.

All instrumentation was checked prior to installation at the PMSL facility in Amherst, NY. These initial checks indicated that the instrumentation was within specifications, as required for the seasonal monitoring program. Operational checks during the installation and the following day indicated that the surface thermistor sensors were yielding high temperatures. This was attributed to the hot laid asphalt concrete in the instrument hole area. All instrumentation other than the thermistor sensors were found to be operating well. During the second visit to the site the datalogger did not contain any data. The faulty datalogger was replaced and the new one is currently being monitored. The air temperature compared favourably with the hand held Omega temperature gauge. A check of the tipping bucket indicated it was functioning correctly with tips corresponding to the amount of water supplied.

Moisture content of the soil was determined by TDR method, and field moisture determination at the time of installation by soil drying. There were slight differences between the moisture content determined by the TDR method and the gravimetric moisture content determined in the field.

The installation generally proceeded as expected with only a few minor problems. The removal/replacement of the material from the instrumentation hole was successful, with the hot-mix being well compacted and level with the existing pavement surface at completion. The soil cement was reconstituted with 2 - 3% cement prior to placement. The TDR probe #3 that was placed in the soil cement did not have a well defined reflection point on the TDR trace, although it was still possible to interpret the trace.

This site was overlaid with approximately 40 mm of hot mix asphalt concrete on November 28, 1996. The surface thermistor probe was not repositioned with the overlay, thus the sensor depths are approximately 40 mm higher than the designed depths. The physical location of the instrumentation hole is not evident because of the overlay. The guardrail was installed subsequent to the instrumentation installation. The contractor adjusted the I beam rail supports to ensure they would not encounter the instrumentation cabling during installation of the guardrail.

Environmental data will also be monitored by an Automated Weather Station (AWS) within site distance of the seasonal site.

The ongoing monitoring of this section is progressing fairly well.

APPENDIX A

Test Section Background Information

Appendix A contains the following supporting information:

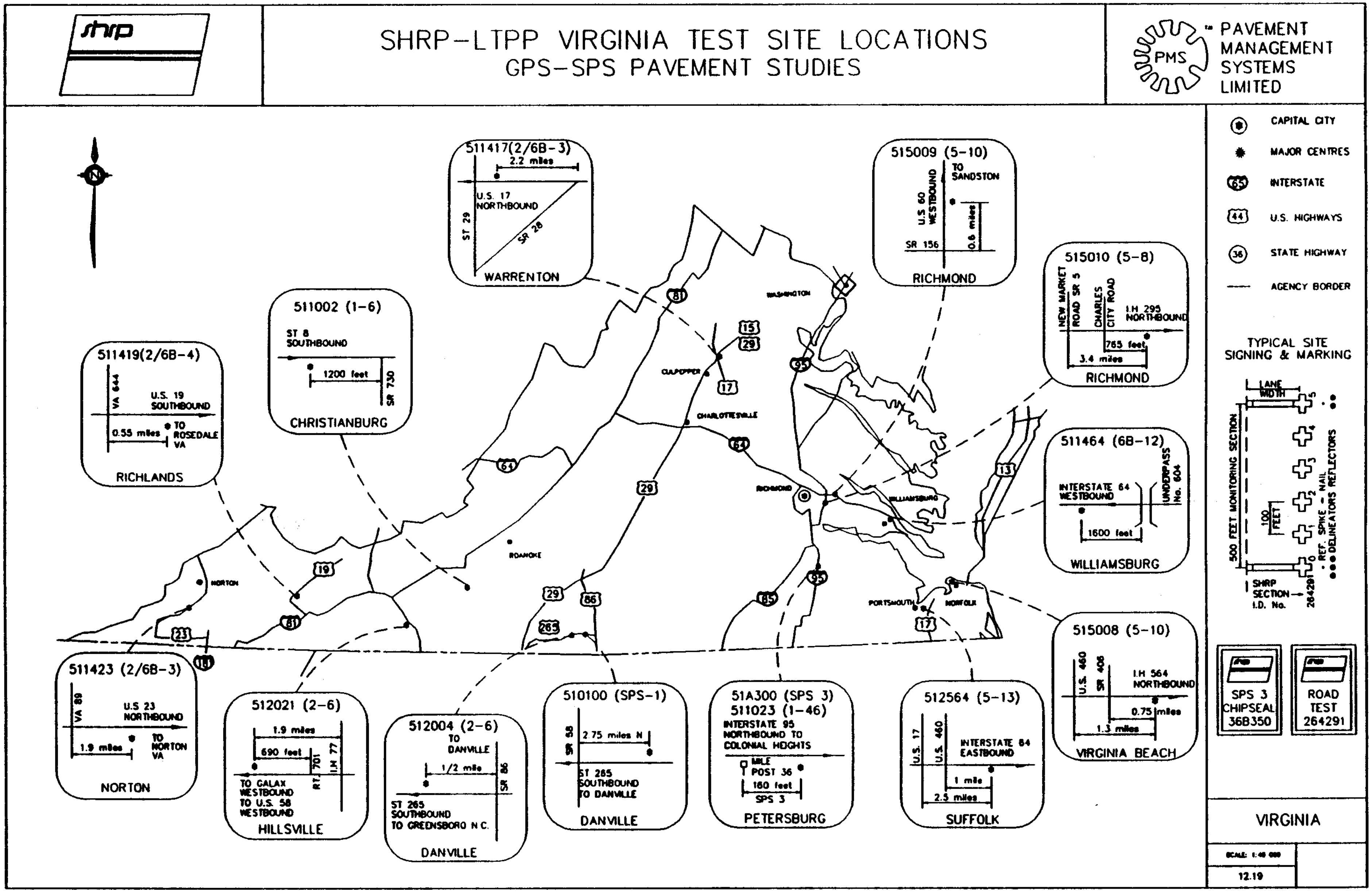


FIGURE A-1 SITE LOCATION MAP - SECTION 510114

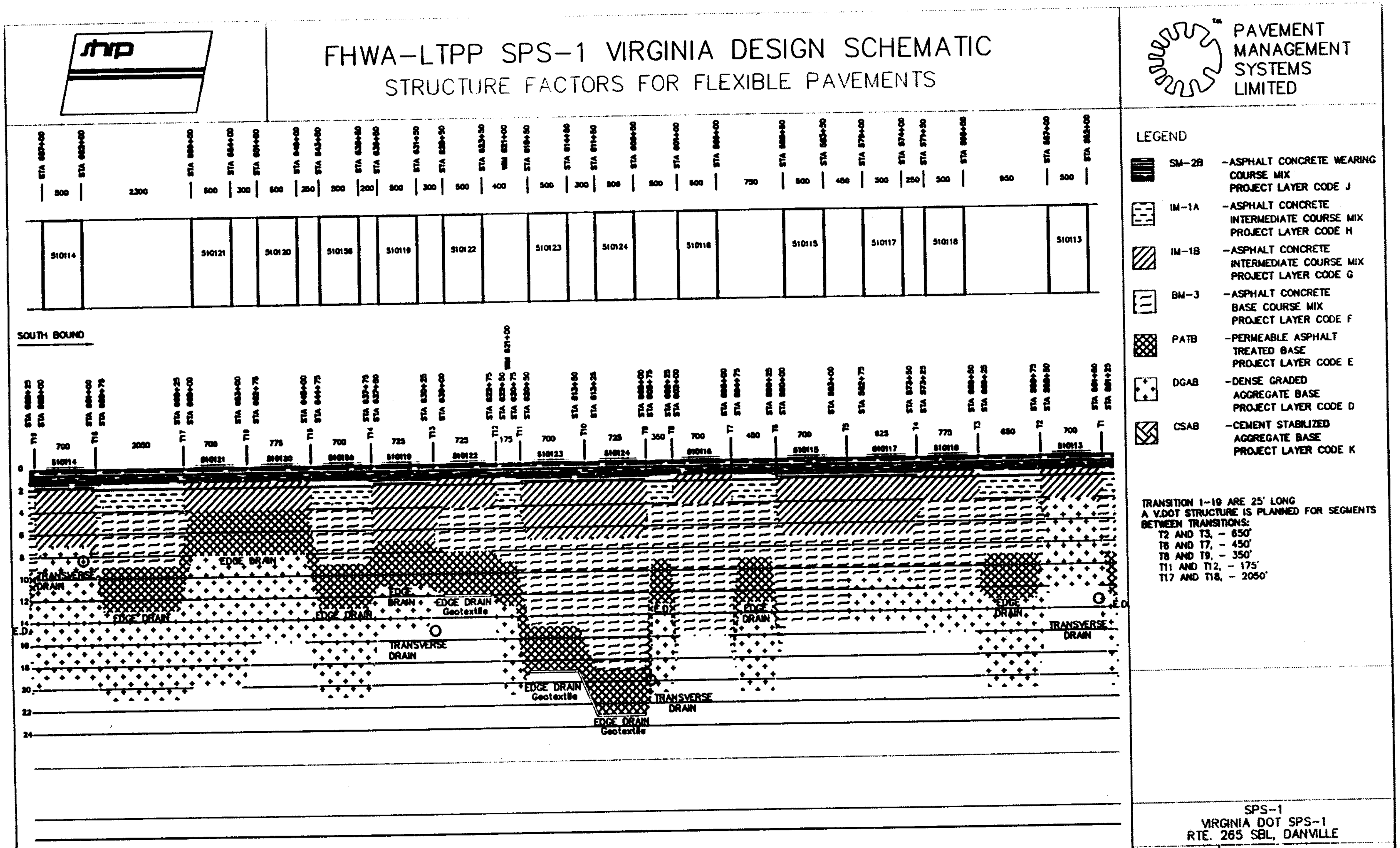
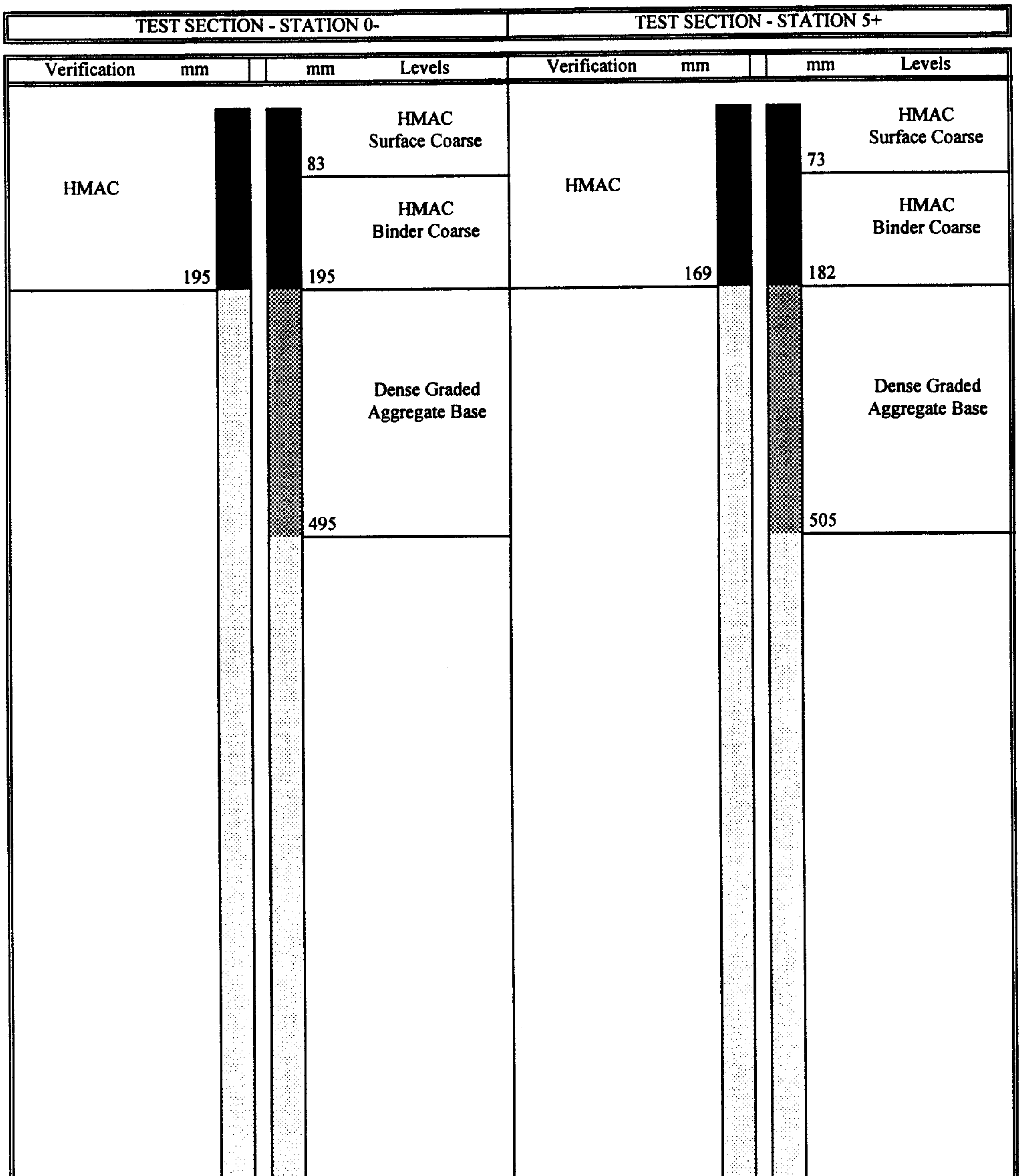


FIGURE A-2. SPS-1 DESIGN SCHEMATIC



* No site specific drilling and sampling data available. Levels were taken at 0.91m offset. Only verification data available are from the AC cores taken.

Figure A-3. Profile of Pavement Structure

Table A-1. Uniformity Survey Results

Seasonal Uniformity Survey					Falling Weight Deflectometer			
Site Number: 510114					Data Collection and			
Date Surveyed: October 21, 1995					Processing Summary			
Section Interval (ft)	Mean Deflection Values for HT 2 (mils) - Corrected							
	Sensor 1	Sensor 1 std dev	Sensor 7	Sensor 7 std dev	Subg modulus (psi)	Subg modulus std dev	Effective SN	SN std dev
-100 - 250	14.67	1.15	1.86	0.13	15019	2615	5.19	0.19
250 - 600	15.28	1.52	1.76	0.22	14354	2320	5.12	0.16

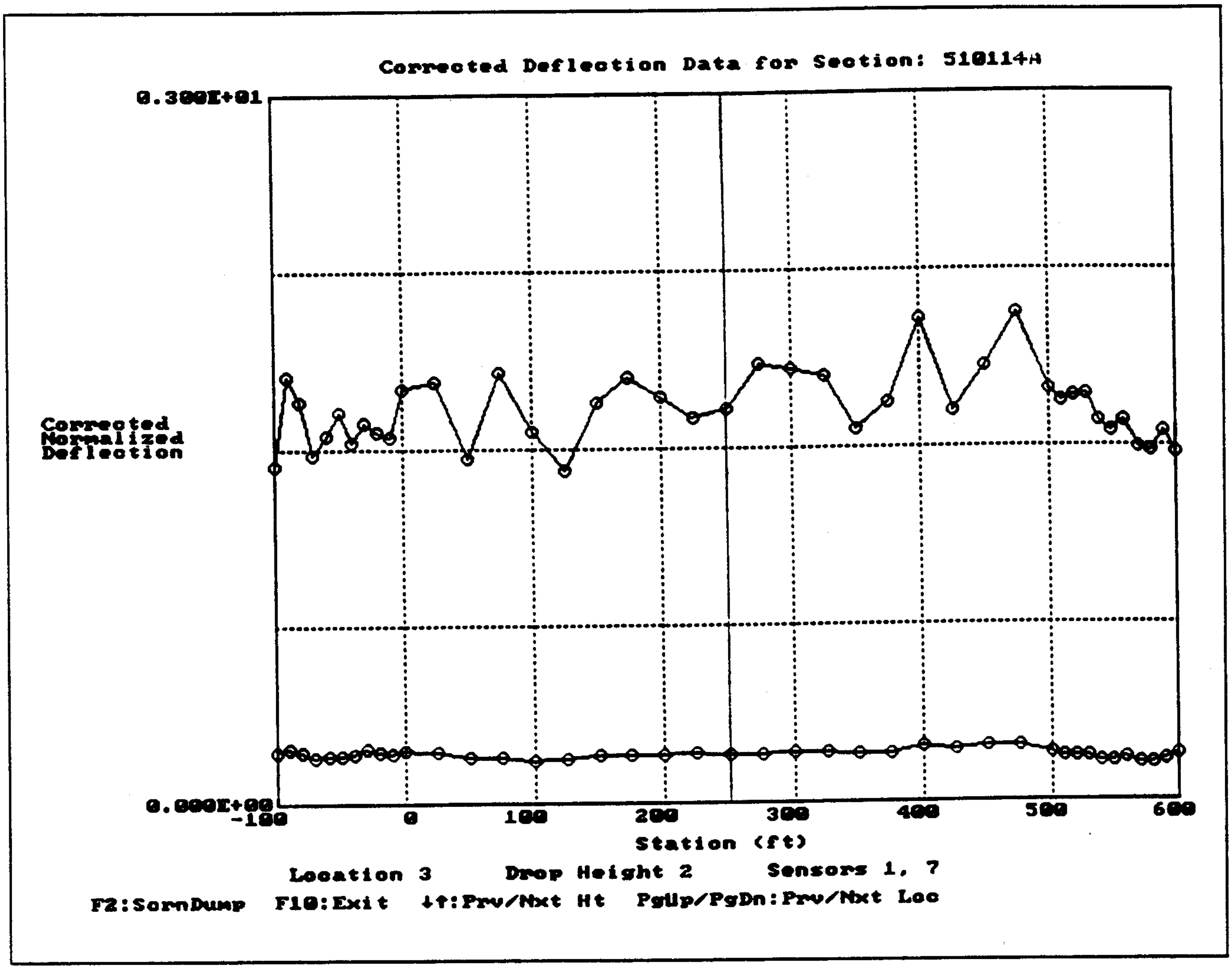


Figure A-4. Deflection Profile from FWDCHECK
(Test Date October 21, 1995)

Table A-2. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date October 21, 1995)

Flexible Pavement Thickness Statistics - 510114A - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	-100	13084	5.70
	-90	9615	5.35
	-80	11682	5.30
	-70	15222	5.40
	-60	14942	5.30
	-50	15105	5.10
	-40	15154	5.30
	-30	14864	5.20
	-20	15513	5.20
	-10	15312	5.30
	0	12974	5.10
	25	13109	5.05
	50	18600	5.25
	75	14540	4.90
	100	21329	4.95
	125	20332	5.25
	150	15765	5.00
	175	14043	4.95
	200	14239	5.05
	225	14206	5.20
	250	15771	5.05
2	275	13603	4.90
	300	14001	4.90
	325	15189	4.90
	350	16883	5.15
	375	13692	5.15
	400	10268	4.95
	425	12662	5.30
	450	11305	5.10
	475	10421	4.90
	500	12094	5.20
	510	15122	5.05
	520	14518	5.05
	530	16243	4.95
	540	15027	5.20
	550	14191	5.35
	560	13484	5.30
	570	16854	5.30
	580	19593	5.20
	590	16356	5.20
	600	15577	5.40
Subsection 1	Overall Mean	15019	5.19
	Standard Deviation	2615	0.19
	Coeff of Variation	17.41%	3.60%
Subsection 2	Overall Mean	14354	5.12
	Standard Deviation	2320	0.16
	Coeff of Variation	16.16%	3.22%

APPENDIX B

Supporting Site Visit and Installed Instrument Information

Appendix B contains the following supporting information:

Correspondence from the Site Inspection and the Planning Meeting

Table B-1. Air Temperature Thermistor Calibration

Table B-2. MRC Probe Calibration

Table B-3. Description of MRC Thermistor Probe and Sensor Spacing

Table B-4. TDR Probes Calibration

Figure B-1. TDR Traces Obtained During Calibration

FAX TRANSMITTAL

To: Dale Grigg

Date: October 12, 1995

Fax No.: (804) 947-2190

Sender: Brandt Henderson *BH*

Project No.: 5-045-11-25

File No.:

Reference: Seasonal Site Installation

Includes cover sheet plus 4 pages

☑ Original will follow by mail

MESSAGE:

To follow up your letter dated September 25, 1995, please find enclosed diagrams detailing the site plan view and projected instrument placement for Seasonal sites 510113 and 510114. The installation is scheduled for Monday October 23, 1995 and Tuesday October 24 respectively. We would like to have a pre-installation meeting at the Lynchburg office on Friday October 20, 1995, at 2:00 p.m. to discuss the final details regarding the installation. Our 12" core barrel will be with us at this time. We will contact you to confirm this meeting.

The uniformity survey will be conducted on Saturday October 21, 1995 by the FHWA FWD unit. The location for the installation will be finalised after the uniformity test. The relative location of the piezometer, instrumentation hole, equipment cabinet and instrument weather pole are identified in the attached plan view diagram. Utility clearances will be required at these locations. If there are any problems with clearances we can review and adjust the locations as part of the pre-installation meeting.

Your letter dated September 25, 1995, indicates that preparation for the installation are progressing well.

As verification of the field moisture we are requesting that the agency provide laboratory moisture values for soil samples taken at each TDR installation location. There will be 10 samples at each site for a total of 20. Proctor tests will be conducted on 1 to 2 samples from each instrument hole utilising VADOT equipment.

The Pavement Management Systems employees coming for this installation are:

Scott Comstock	Instrumentation Technician
Tim Comstock	Installation Technician
Brandt Henderson	Team Leader
Randy Plett	FWD Operator
Dilan Singaraja	Engineering Assistant

If you have not received a complete message, please call sender at:

Pavement Management Systems Limited

415 Lawrence Bell Drive, Unit 3, AMHERST, New York 14221 Ph: (716) 632-0804, Fax: (716) 632-4808

FAX TRANSMITTAL

I plan to be there on Friday October 20, 1995 with the instrumentation and the installation equipment. Randy Plett will arrive later in the day with the FHWA FWD to commence with the uniformity testing on October 21, 1995. Along with the seasonal instrumentation we will be bringing a complete weather station set-up minus the UT3 base which was forwarded to you on October 03, 1995.

If you have any questions or need further information do not hesitate to call.

We look forward to seeing you and your co-workers on October 23.

Copies: Thomas Freeman, (w/o attachments)
Aramis Lopez, (w/o attachments)
Bill Phang, (w/o attachments)
Ivan Peznik, (w/o attachments)

If you have not received a complete message, please call sender at:

Pavement Management Systems Limited

415 Lawrence Bell Drive, Unit 3, AMHERST, New York 14221 Ph: (716) 632-0804, Fax: (716) 632-1808

FILE #D.17.1

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
P.O. Box 11649
LYNCHBURG, 24506-1649

DAVID R. GEHR
COMMISSIONER

W. T. RAMEY, P.E.
DISTRICT ADMINISTRATOR

September 25, 1995

Mr. W. A. Phang, D. Eng.
Program Manager, FHWA-LTPP
Pavement Management Systems
415 Lawrence Bell Drive
Unit #3
Amherst, NY 14221

Re: VA DOT SPS-1

Project 6265-071-F02,P403
Pittsylvania County

Dear Mr. Phang:

With regard to our meeting on September 21, 1995 concerning the installation of seasonal monitoring instrumentation at two sites on the above captioned project, the following were determined:

Seasonal sites will be installed at SPS-1 Sections 510113 and 510114, within 25 L.F. of either end of each section. Deflection tests will be performed with the FHWA FWD in order to determine the uniformity of each respective section, and based on these findings the site locations will be selected. VDOT will proceed with the preparation of each potential seasonal site (2 per section) such that the necessary equipment cabinet and mast can be installed adjacent to the roadway shoulder, either behind the ditchline or behind the guardrail. The actual installation of the seasonal sites will take place the week of October 23-27. VDOT will provide an asphalt concrete core drill and a soil auger drill. PMS will provide a 12" diameter core barrel to be fitted onto VDOT's asphalt drill. VDOT will provide a 10" diameter soil auger capable of augering up to 7' deep. VDOT will also provide a proctor kit including a stove to be used for determining the density and moisture content of soil. VDOT will also furnish a pavement saw capable of cutting to a minimum depth of 7". In addition to the foregoing equipment, VDOT will also furnish the following materials:

1 bag of clean sand
1 bucket (5 gal.) of bentonite
2 - 80 lb. bags of sackrete concrete mix
2 - 24" long pieces of either 6" I.D. or 8" I.D. Sch. 40
    pvc pipe with 2 threaded cap adapters and caps

It is understood that each seasonal site installation will take approximately one day. It is also understood that work will not take place during periods of wet weather.

In addition to the seasonal sites, during the week of October 23-27 VDOT will also drill the remaining cores from the SPS-1 sites. VDOT will provide hot mix to patch the core holes. VDOT also intends to have the site for the weather station prepared by that same time such that installation of the tower and associated equipment can be facilitated.

Deflection tests will be run on the SPS-1 sections the last week in November by both VDOT's and the FHWA's FWD's. Provided the test data between the two units correlates, VDOT will perform subsequent periodic deflection testing. VDOT will be responsible for all traffic control for all subsequent testing of the SPS-1 sections once the project has been opened to traffic.

If there are any items I have overlooked, please let me know. I will keep you advised of any developments concerning the items discussed herein.

Very truly yours,

D. H. Grigg, Jr.
District Materials Engineer

DHG/bw

Cy: Mr. R. L. Hamilton
Mr. R. J. Gibson
Mr. D. L. Woolley
Mr. T. N. Karnes
Mr. G. W. Wise, Jr.
Mr. N. B. Walton, Jr.
Mr. T. E. Freeman
Mr. L. I. Pettigrew, III
Mr. B. C. Pierce
Mr. A. L. Simpson

FAX TRANSMITTAL

To: Thomas E. Freeman

Date: September 8, 1995

Fax No.: (804) 293-1990

Sender: Brandt Henderson
Bill Phang

Reference: Seasonal SPS 510113 & 510114
Installation Planning Meeting

Project No.: 5-045-11-25

File No.: 16.03

Includes cover sheet plus page

☐ Original will follow by mail

MESSAGE:

Dear Mr. Freeman,

We would like to conduct the Installation Planning Meeting on Thursday September 21, 1995 at your offices. Arrangements for the installation such as the dates, traffic control, coring and auguring equipment, supplies, and personnel have to be made. We will be sending you further detail on the site information, instrumentation layout, installation scheduling, installation team, and supplies needed as the information becomes available to us.

We will contact you to confirm the date and time of the meeting. We would appreciate it if those attending the meeting are notified once the date and time have been fixed. Thank you for your cooperation.

If you have not received a complete message, please call sender at:

Pavement Management Systems Limited

415 Lawrence Bell Drive, Unit 3, AMHERST, New York 14221 Ph: (716) 632-0804, Fax: (716) 632-4808

VIRGINIA DEPARTMENT OF TRANSPORTATION
DAVID R. GEHR, COMMISSIONER

TRANSPORTATION RESEARCH COUNCIL
GARY R. ALLEN, PH.D., DIRECTOR

VTRC
TRANSPORTATION RESEARCH COUNCIL

COMMONWEALTH of VIRGINIA

TRANSPORTATION RESEARCH COUNCIL
530 EDGEMONT ROAD
CHARLOTTESVILLE, VA 22903

UNIVERSITY OF VIRGINIA
JOHN T. CASTEEN, PRESIDENT

DEPARTMENT OF CIVIL ENGINEERING
FURMAN W. BARTON, CHAIRMAN

File No. 11-10-3

April 3, 1995

Mr. Brandt Henderson
Manager, Field and Data Operations
Pavement Management Services Limited
415 Lawrence Bell Drive
Unit #3
Amherst, New York 14221

Subject: Seasonal Site at the SPS-1 Project
Route 265 Danville Bypass

Dear Mr. Henderson:

I have discussed with my associates the possibility of including a seasonal site in our SPS-1 project, and we have decided that we can support this effort. We appreciate the limitations in the number of available candidates in the wet-freeze areas with fine subgrade soils, and therefore recognize the value to the LTPP program of including such a site in this project.

We understand that VDOT will be responsible for installing a piezometer (6-in. diameter hole to a depth of 15 ft) for water table depth monitoring. Additionally, we will provide a cover for the observation hole as well as bentonite and filter sand to be used as backfill material. We will also provide coring and auguring equipment to accomodate your installation of the instrumentation. VDOT will be responsible for sawing a trench through the pavement from the observation hole to the pavement edge for placement of equipment cables. We will provide traffic control to enable you to collect seasonal monitoring data. We understand that this will require the closing of one lane for a period of one day approximately once per month.

TELEPHONE (804) 293-1900 —— FAX (804) 293-1990

VDOT is ready to move forward with the inclusion of a seasonal site at your direction. We expect to begin construction of the SPS-1 project during the first part of May, so we look forward in the near future to your input with regard to scheduling this work.

Very truly yours,

Thomas E. Freeman

Thomas E. Freeman, P.E.
Senior Research Scientist

TEF/tef

cc: Mr. J.S. Hodge
Dr. G.R. Allen
Mr. W.T. McKeel
Mr. R.J. Gibson
Mr. D.H. Grigg, Jr.
Mr. T.A. Wiles, IV
Mr. G.W. Maupin

PAVEMENT
MANAGEMENT
SYSTEMS

January 9, 1995
50451010-13.19.1

Mr. Thomas E. Freeman
Virginia Transportation Research Council
530 Edgemont Road
Charlottesville, Virginia 22903

Dear Mr. Freeman:

The LTPP program is preparing to recruit the second round of seasonal site nominations. In accordance with your previous discussions with Dennis Morian and Basel Abukhater of our staff, it was indicated that there may be interest in including a seasonal site at the SPS-1 project. We are very interested in including a seasonal site from this project, as we are limited in the number of candidates available in the wet-freeze and no-freeze areas with fine subgrade soils. In particular we would be interested in either site 500113 or 500114.

For your information we have enclosed a "Seasonal Monitoring Program Guideline" as well as a sample of one of our existing installation reports.

Page III-24 of the "Seasonal Monitoring Program Guidelines" provides a list of the data collection activities with the level of effort required. Data is collected monthly with the exception in a wet-freeze environment, this is increased to bi-weekly during the thaw period, for a total of 14 site visits during the annual cycle. This will be the frequency of traffic control needed. A minimum of 2 cycles over a 3 year period is required for the core experiment, with the objective of obtaining up to 5 cycles over the life of the program.

In general, the seasonal instrumentation consists of moisture, temperature, water table depth, and frost depth measurements beneath the pavement. Along with this are climatic measurements of air temperature and precipitation. Pages II-27-28 of the Guidelines" indicate areas of responsibility for the FHWA, RCOC, and agency.

General items required of the agency for installation are a drill rig with the capability to drill 6" diameter hole to a 15' depth for installation of a piezometer. In addition, the cover for the observation hole, bentonite, and filter sand to fill the hole are to be provided by the agency. The agency is also to provide coring and auguring equipment for holes 10" to 12" in diameter up to a maximum depth of 7'. In addition, a concrete pavement saw must be provided to cut a trench from the observation hole to the pavement edge. This trench will carry the instrumentation cabling to the equipment cabinet adjacent to the roadway.

415 LAWRENCE BELL DRIVE
UNIT #3
AMHERST, N.Y. 14221
TEL. (716) 632-0804
FAX (716) 632-4808

The agency will also be responsible for traffic control for collecting the monthly data. This will require a lane closure approximately 300' in length at the instrument hole, for essentially one day each month.

The addition of the seasonal monitoring data, at different geographical locations promises to significantly enhance the LTPP database, and increase the potential analysis of the data.

Thank you for your consideration of supporting a seasonal data site.

Yours Sincerely,

Brandt Henderson

Brandt Henderson
Manager, Field and Data Operations
Pavement Management Systems Limited

BH/tf

enclosure

C.C. I.J. Pecnik, RE, w/o enclosure
W.A. Phang, NARO, w/o enclosure

Table B-1. Air Temperature Thermistor Calibration

LTPP Seasonal Monitoring Study	State Code	[51]
Air Temperature Thermistor Calibration	Test Section Number	[0114]

Before Operation Checks	Calibration Date (dd-mm-yy)	13-10-95
	Probe S/N	51BAT
	Operator	SC

Mobile Datalogger (24 hour)			Water Room Temperature		Ice Bath 0° C (+/- 1° C)		Hot Water 50° C (+/-)		ok
Mean	Min.	Max.	Reading	Time	Reading	Time	Reading	Time	y/n
22.57	21.61	24.56	22.4	757	0.12	913	49.9	1208	y

Probe Accepted	S.C.	(Initials)

Table B-2. MRC Probe Calibration

LTPP Seasonal Monitoring Study	State Code	[51]
MRC Probe Calibration	Test Section Number	[0114]

Before Operation Checks	Calibration Date (dd-mm-yy)	13-10-95
	Probe S/N	51BT
	Operator	SC

	Mobile Datalogger (24 hour)			Water Room Temp Time 757	Ice Bath 0 ° C (+/- 1 ° C) Time 913	Hot Water 50 ° C (+/-) Time 1208	ok
No.	Mean	Min.	Max.	Reading	Reading	Reading	y/n
1	22.22	21.51	26.71	22.1	-1.09	49.7	y
2	22.13	21.37	27.20	22.0	-0.19	52.6	y
3	22.17	21.38	27.34	22.0	0.15	44.9	y
4	22.11	21.24	25.76	22.0	2.20	47.3	y
5	22.10	21.28	27.15	22.0	2.58	48.7	y
6	22.17	21.38	27.15	22.0	1.92	47.6	y
7	22.24	21.42	27.76	22.1	0.19	48.6	y
8	22.32	21.42	28.96	22.1	1.85	47.2	y
9	22.36	21.41	29.77	22.1	1.64	50.0	y
10	22.41	21.56	29.90	22.1	0.30	49.7	y
11	22.43	21.56	30.60	22.1	1.67	50.4	y
12	22.37	21.54	30.19	22.1	2.38	52.0	y
13	22.25	21.51	29.22	22.0	1.35	50.9	y
14	22.19	21.46	29.16	21.9	4.33	50.6	y
15	22.25	21.40	29.77	21.9	3.56	49.9	y
16	22.27	21.48	29.38	21.9	1.24	50.9	y
17	22.22	21.37	29.77	21.8	1.99	48.7	y
18	22.21	21.38	28.04	21.8	2.52	48.9	y

Probe Accepted:	S.C.	(Initials)
Probe Length:	1.900	(meters)

Thermistor distance from top of probe: (meters)									
4	0.025	7	0.250	10	0.631	13	1.089	16	1.543
5	0.084	8	0.327	11	0.783	14	1.239	17	1.698
6	0.178	9	0.478	12	0.935	15	1.393	18	1.855

Table B-3. Description of MRC Thermistor Probe and Sensor Spacing

Unit	Channel No.	Distance from Top of Unit(m)	Remarks
1	1	0.025	0.3302 m long by 6.35 mm stainless steel probe installed in the AC layer.
	2	0.106	
	3	0.187	
2	4	0.025	1.900 m long by 25.4 mm PVC tube installed in the base and subgrade.
	5	0.084	
	6	0.178	
	7	0.250	
	8	0.327	
	9	0.478	
	10	0.631	
	11	0.783	
	12	0.935	
	13	1.089	
	14	1.239	
	15	1.393	
	16	1.543	
	17	1.698	
	18	1.855	

Table B-4. TDR Probes Calibration

LTPP Seasonal Monitoring Study		State Code	[51]
TDR Probes		Test Section Number	[0114]
Before Operation Checks	SC	Initial	Calibration Date (dd-mm-yy)	13-10-95
			Seasonal Site	51SB

No.	Probe (S/N)	Resistance (ohms) Core	Resistance (ohms) Shield	Probe Shorted Begin Length	Probe Shorted End Length	Air Begin Length	Alcohol Begin Length	Water Begin Length
1	51B01	0.3	0.3	15.09	15.29	15.10	15.09	15.10
2	51B02	0.2	0.2	15.11	15.31	15.12	15.10	15.11
3	51B03	0.3	0.3	15.11	15.31	15.11	15.10	15.11
4	51B04	0.3	0.3	15.25	15.45	15.26	15.24	15.24
5	51B05	0.3	0.3	15.13	15.33	15.14	15.13	15.14
6	51B06	0.3	0.3	15.10	15.29	15.12	*	15.10
7	51B07	0.3	0.3	15.10	15.29	15.11	*	15.10
8	51B08	0.4	0.3	15.23	15.42	15.24	15.21	15.23
9	51B09	0.3	0.3	15.08	15.25	15.08	15.06	15.07
10	51B10	0.3	0.3	15.13	15.31	15.15	15.12	15.12

NOTE: Record lengths from TDR

Calculation of Dielectric Constant

Probe Length 0.203 m

V_p Setting 0.99 V_p

$$\varepsilon = \left[\frac{TDRL}{(PL)(V_p)}\right]^2$$

No.	Air TDR Length	Air Dielectric Constant	Air In Spec. (?)	Alcohol TDR Length	Alcohol Dielectric Constant	Alcohol In Spec. (?)	Water TDR Length	Water Dielectric Constant	Water In Spec. (?)
1	0.20	0.97	y	0.98	23.30	y	1.78	76.89	y
2	0.20	0.97	y	0.98	23.30	y	1.79	77.75	y
3	0.20	0.97	y	1.00	24.27	y	1.79	77.75	y
4	0.20	0.97	y	0.99	23.78	y	1.78	76.89	y
5	0.20	0.97	y	0.99	23.78	y	1.81	79.50	y
6	0.19	0.88	y	0.98	23.30	y	1.78	76.89	y
7	0.19	0.88	y	0.97	22.80	y	1.79	77.75	y
8	0.19	0.88	y	1.00	24.27	y	1.78	76.89	y
9	0.20	0.97	y	1.00	24.27	y	1.80	78.62	y
10	0.20	0.97	y	1.00	24.27	y	1.81	79.50	y

* Note: Missing traces

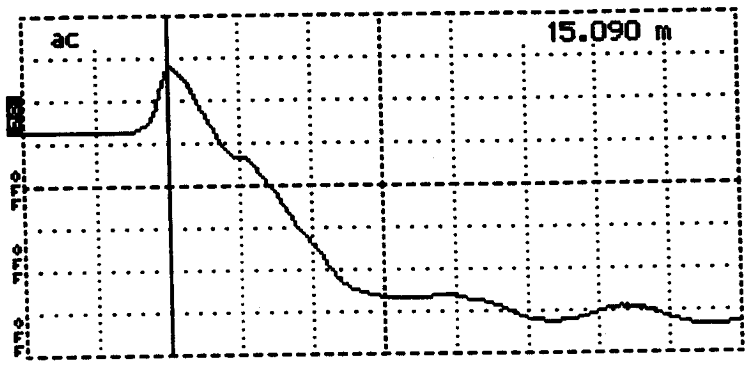
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51B01 **Date (dd/mm/yy):** 13/10/95

Probe Number 01

Trace 1 - Probe Shorted at Start

.... 15.090 m
e/Div..... .25 m/div
l Scale.... 211 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

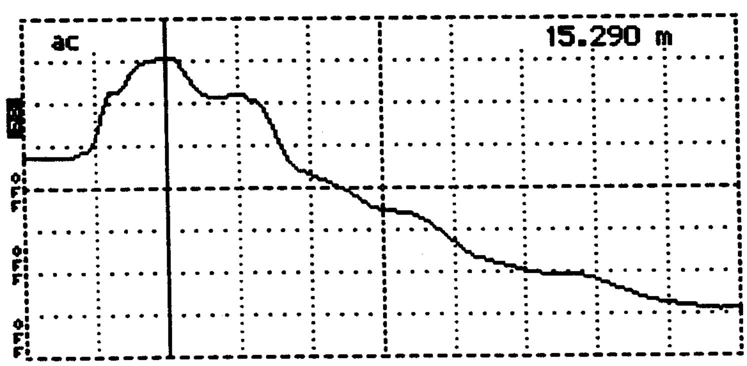


Tektronix 1502B TDR
Date 10-13-95
Cable 51B01
Notes short-start
11:37

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

sor .... 15.290 m
ance/Div..... .25 m/div
tical Scale.... 211 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B01
Notes short-end
11:39

Input Trace
Stored Trace
Difference Trace

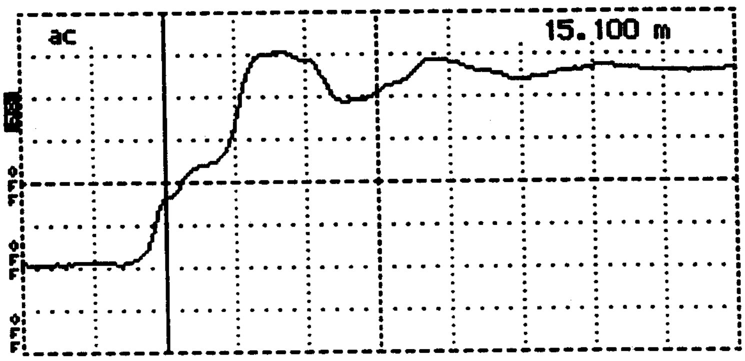
Figure B-1. TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Number 01

Trace 3 - Probe in Air

r .... 15.100 m
nce/Div ..... .25 m/div
cal Scale.... 211 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

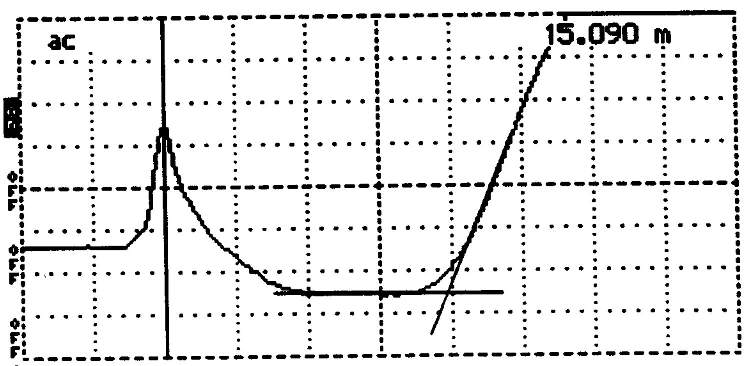


Tektronix 1502B TDR
Date 10-13-95
Cable 51B01
Notes air
11:40

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 15.090 m
ance/Div ..... .25 m/div
ical Scale.... 100 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

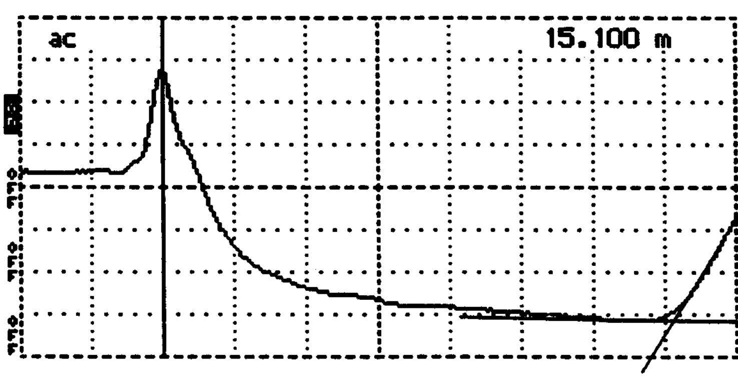


Tektronix 1502B TDR
Date 10-13-95
Cable 51B01
Notes alcohol
1229

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.100 m
ance/Div ..... .25 m/div
ical Scale.... 122 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B01
Notes water 20.6°
11:41

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

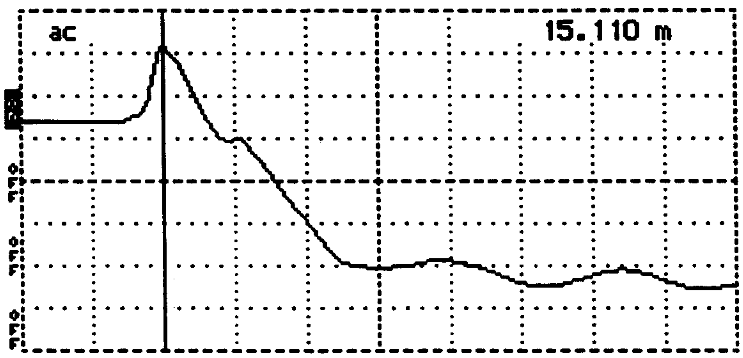
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51B02 **Date (dd/mm/yy):** 13/10/95

Probe Number 02

Trace 1 - Probe Shorted at Start

sor .... 15.110 m
ance/Div..... .25 m/div
tical Scale.... 182 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

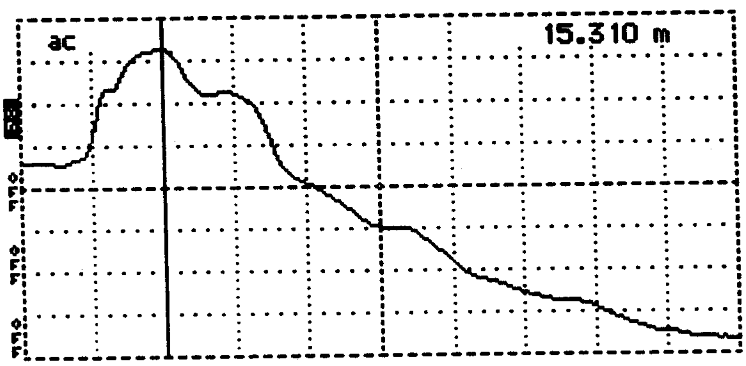


Tektronix 1502B TDR
Date 10-13-95
Cable 51B02
Notes short-start
1133

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 15.310 m
ance/Div..... .25 m/div
ical Scale.... 182 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B02
Notes short-end
1134

Input Trace
Stored Trace
Difference Trace

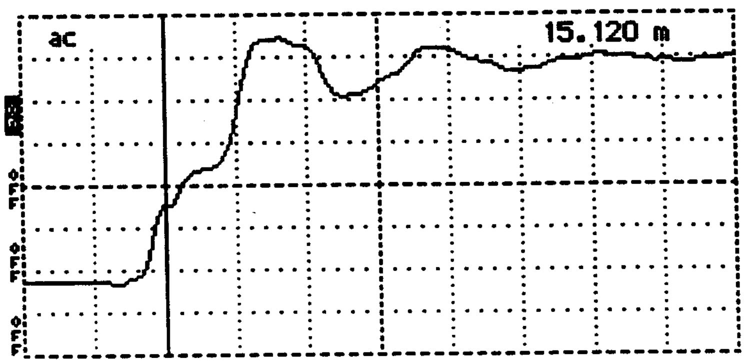
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [57] LTPP Section ID: [0114]

Probe Number 02

Trace 3 - Probe in Air

sor .... 15.120 m
ance/Div ..... .25 m/div
tical Scale .... 182 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

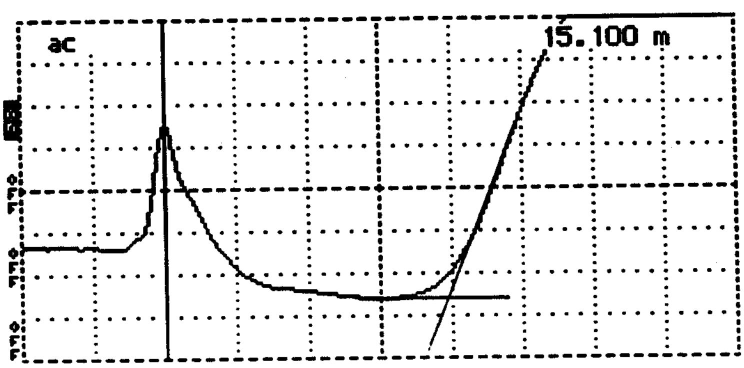


Tektronix 1502B TDR
Date 10-13-95
Cable 51B02
Notes ~~[illegible]~~ air

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

r .... 15.100 m
nce/Div ..... .25 m/div
cal Scale .... 100 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

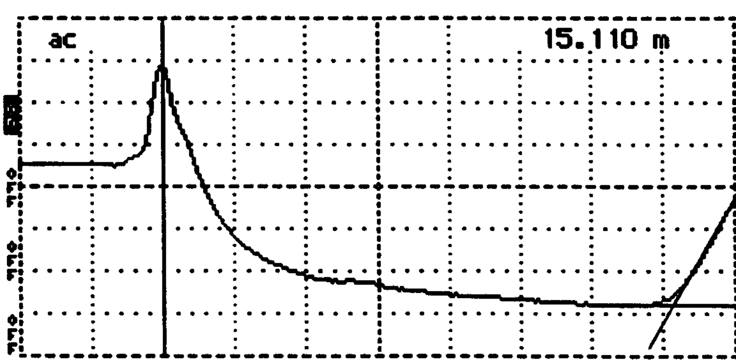


Tektronix 1502B TDR
Date 10-13-95
Cable 51B02
Notes alcohol
1230

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.110 m
nce/Div ..... .25 m/div
ical Scale .... 126 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B02
Notes water 20.6°
1138

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

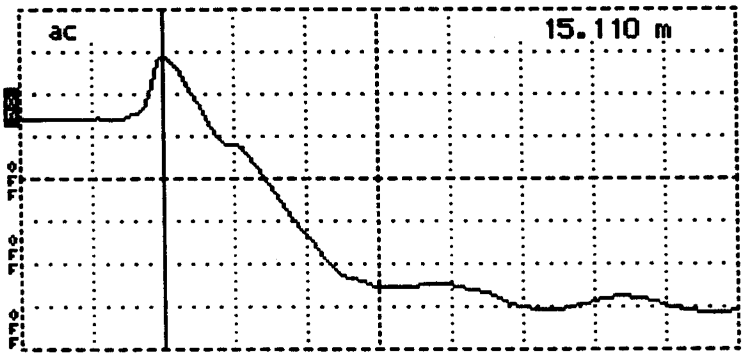
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[51] [0114]

Probe Serial Number: 51B0#3 **Date (dd/mm/yy):** 13/10/95

Probe Number 03

Trace 1 - Probe Shorted at Start

r .... 15.110 m
ce/Div ..... .25 m/div
al Scale.... 211 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

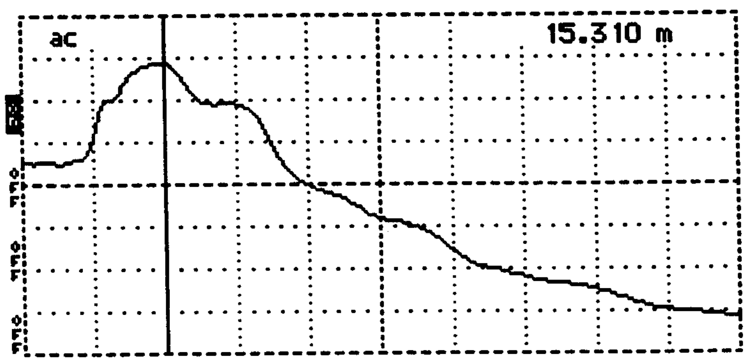


Tektronix 1502B TDR
Date 10-13-95
Cable 51B03
Notes short-start
1128

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 15.310 m
nce/Div ..... .25 m/div
ical Scale.... 211 mρ/div
.... 0.99
e Filter...... 1 avg
er .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B03
Notes short-end
1130

Input Trace
Stored Trace
Difference Trace

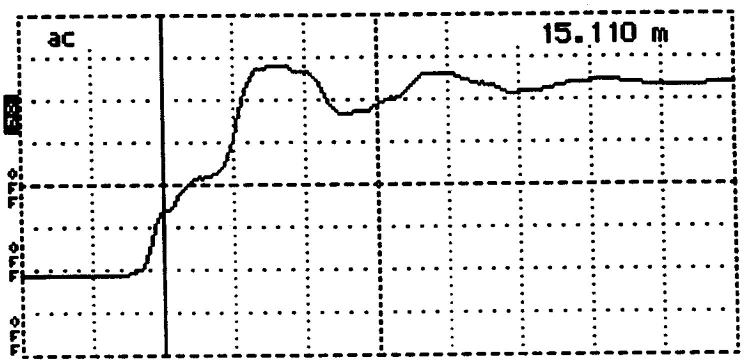
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Number 03

Trace 3 - Probe in Air

r .... 15.110 m
ce/Div..... .25 m/div
al Scale.... 211 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

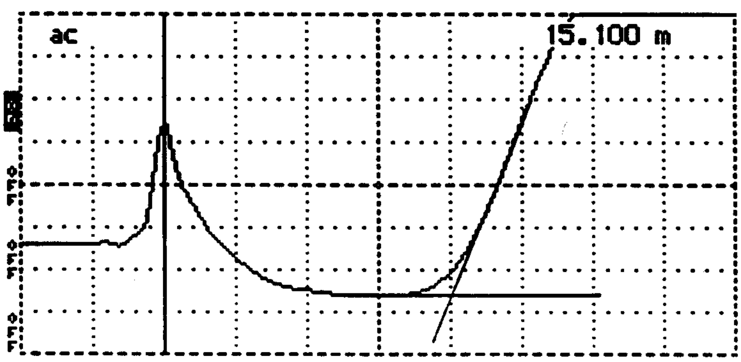


Tektronix 1502B TDR
Date 10-13-95
Cable 51B03
Notes air
1131

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

.... 15.100 m
e/Div..... .25 m/div
l Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

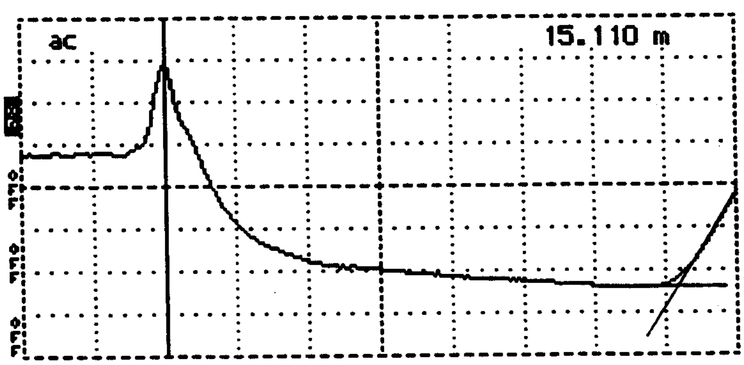


Tektronix 1502B TDR
Date 10-13-95
Cable 51B03
Notes alcohol
1226

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 15.110 m
nce/Div..... .25 m/div
cal Scale.... 133 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B03
Notes water 20.6

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

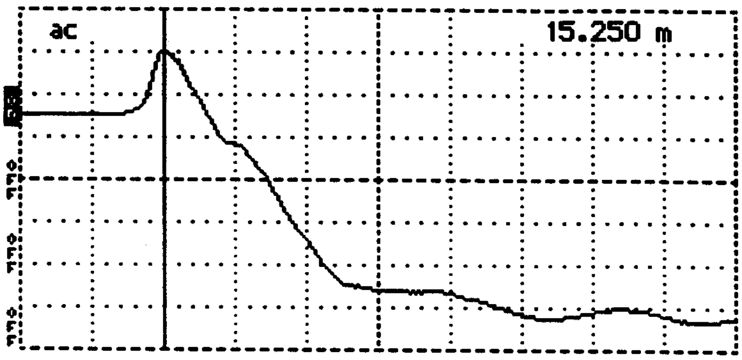
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[51] [0114]

Probe Serial Number: 51B04 **Date (dd/mm/yy):** __/__/__

Probe Number 04

Trace 1 - Probe Shorted at Start

r .... 15.250 m
nce/Div..... .25 m/div
cal Scale.... 200 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

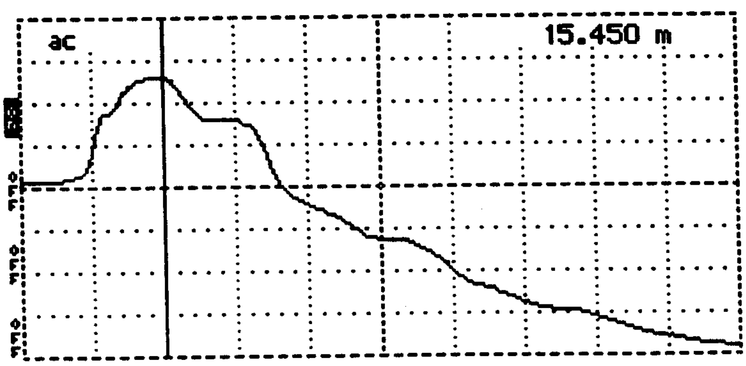


Tektronix 1502B TDR
Date 10-13-95
Cable 51B04
Notes short - start
1123

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 15.450 m
nce/Div..... .25 m/div
cal Scale.... 200 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B04
Notes short-end
1124

Input Trace
Stored Trace
Difference Trace

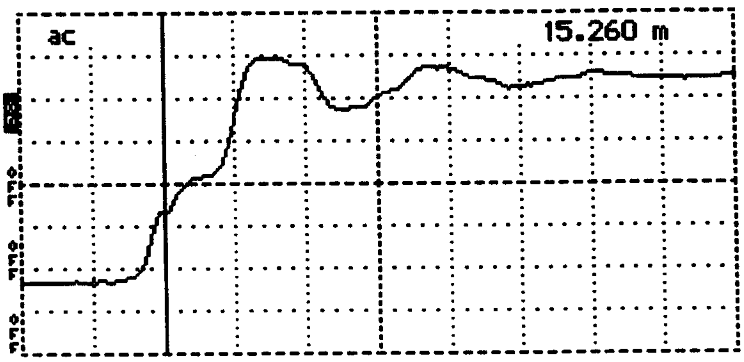
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[51] [0114]

Probe Number 04

Trace 3 - Probe in Air

r .... 15.260 m
nce/Div ..... .25 m/div
cal Scale .... 200 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

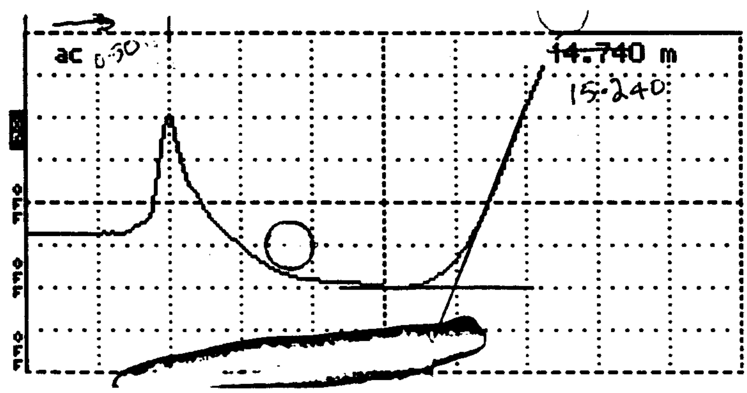


Tektronix 1502B TDR
Date 10-13-95
Cable 51B04
Notes air
1125

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 14.740 m
nce/Div ..... .25 m/div
ical Scale .... 100 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

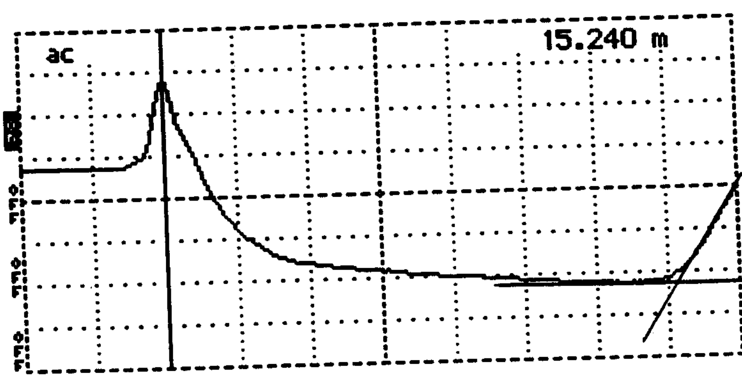


Tektronix 1502B TDR
Date 10-13-95
Cable 51B04
Notes alcohol
1224

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.240 m
nce/Div ..... .25 m/div
cal Scale .... 141 mρ/div
.... 0.99
Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B04
Notes water 20.6°

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

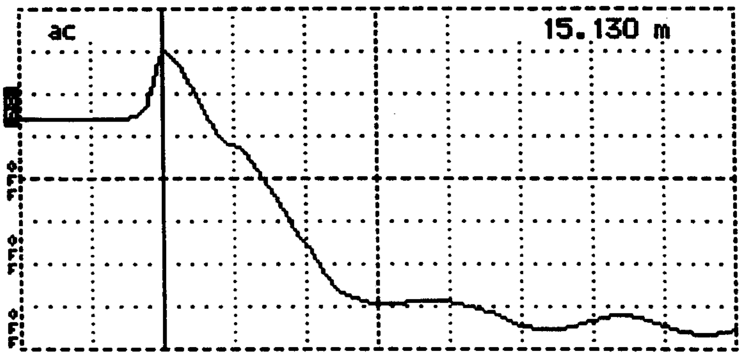
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51BC05 **Date (dd/mm/yy):** 13/10/95

Probe Number 05

Trace 1 - Probe Shorted at Start

or .... 15.130 m
nce/Div..... .25 m/div
Scale.... 193 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B05
Notes short start
11:17

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 15.330 m
ance/Div..... .25 m/div
ical Scale.... 193 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

Tektronix 1502B TDR
Date 10-13-95
Cable 51B05
Notes short-end
11:19

Input Trace
Stored Trace
Difference Trace

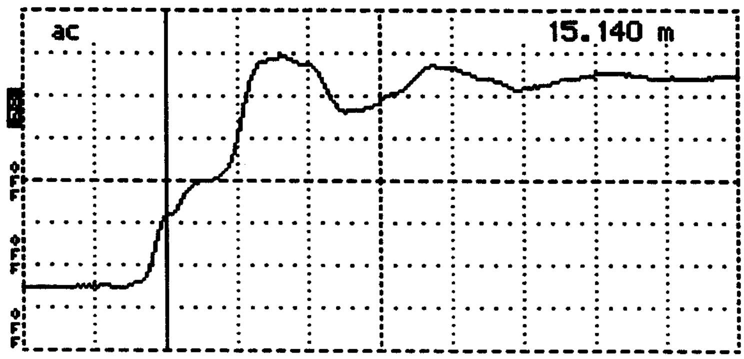
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[51] [0114]

Probe Number 05

Trace 3 - Probe in Air

or .... 15.140 m
ance/Div..... .25 m/div
ical Scale.... 193 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

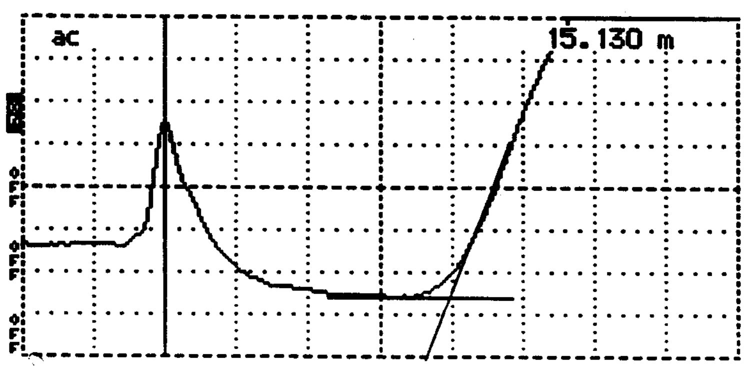


Tektronix 1502B TDR
Date 10-13-95
Cable 51B05
Notes air
1120

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 15.130 m
nce/Div..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

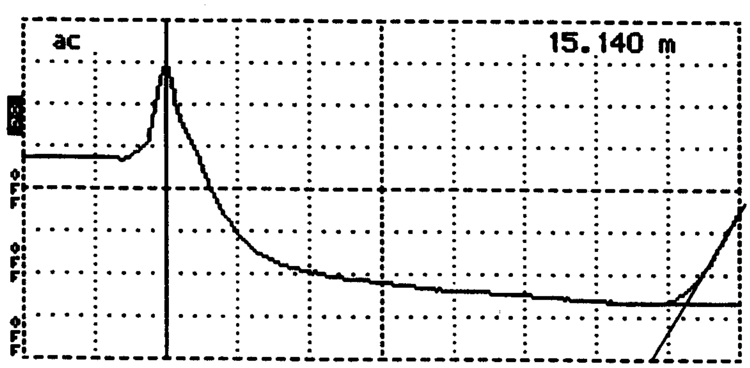


Tektronix 1502B TDR
Date 10-13-95
Cable 51B05
Notes alcohol
1227

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

sor .... 15.140 m
ance/Div..... .25 m/div
tical Scale.... 126 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B05
Notes water 20.6°
1121

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

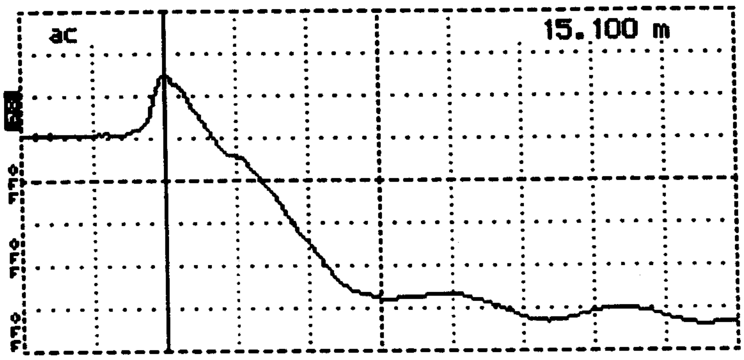
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51B06 **Date (dd/mm/yy):** 13/10/95

Probe Number 06

Trace 1 - Probe Shorted at Start

r .... 15.100 m
ce/Div ..... .25 m/div
al Scale.... 217 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

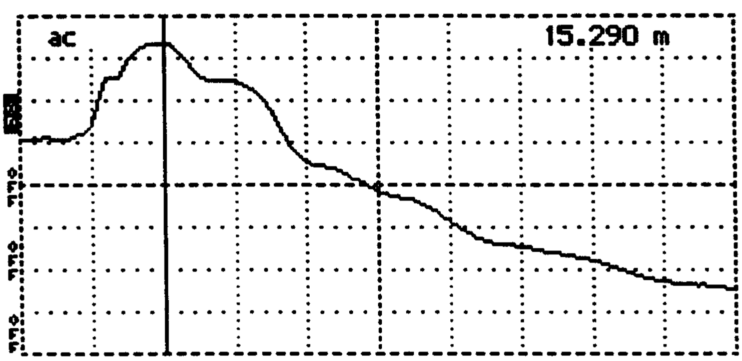


Tektronix 1502B TDR
Date 10-13-95
Cable #51B06
Notes short start

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

sor .... 15.290 m
ance/Div ..... .25 m/div
ical Scale.... 217 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B06
Notes short-end
1109

Input Trace
Stored Trace
Difference Trace

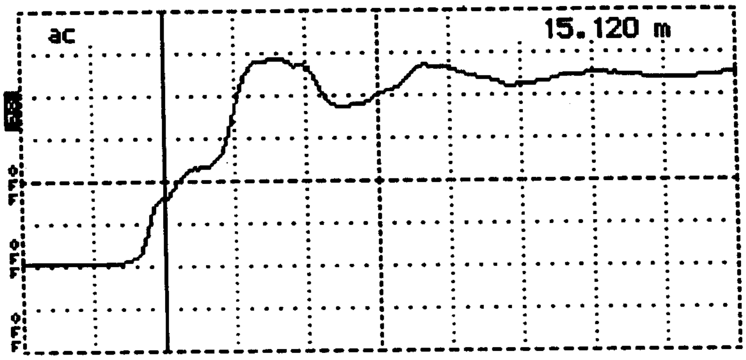
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Number 06

Trace 3 - Probe in Air

or .... 15.120 m
ance/Div..... .25 m/div
ical Scale.... 217 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



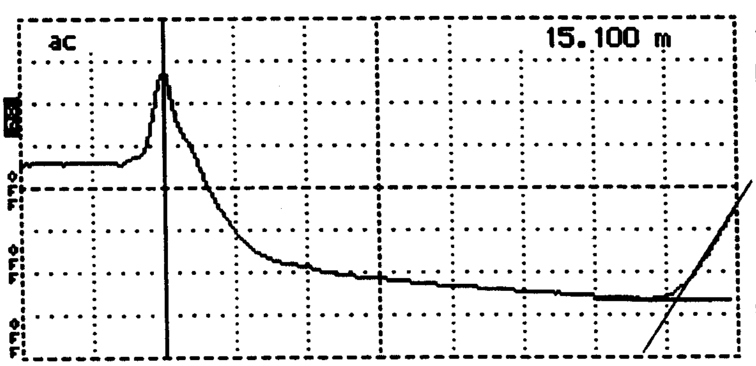
Tektronix 1502B TDR
Date 10-13-95
Cable 51B06
Notes air
1110

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

Trace 5 - Probe in Water

sor .... 15.100 m
tance/Div..... .25 m/div
tical Scale.... 133 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B06
Notes water 20.6°
11:11

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

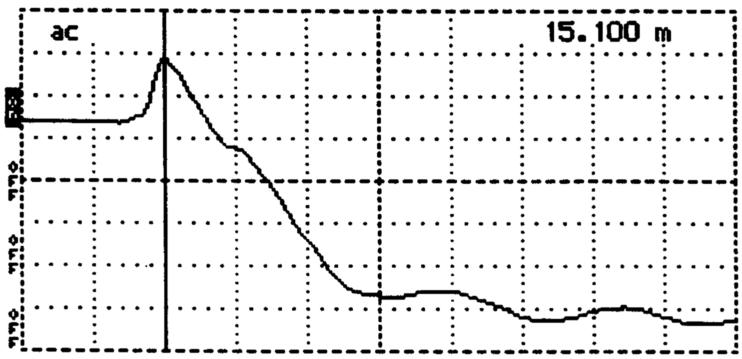
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51B07 **Date (dd/mm/yy):** 13/10/95

Probe Number 07

Trace 1 - Probe Shorted at Start

r .... 15.100 m
ce/Div..... .25 m/div
al Scale.... 205 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

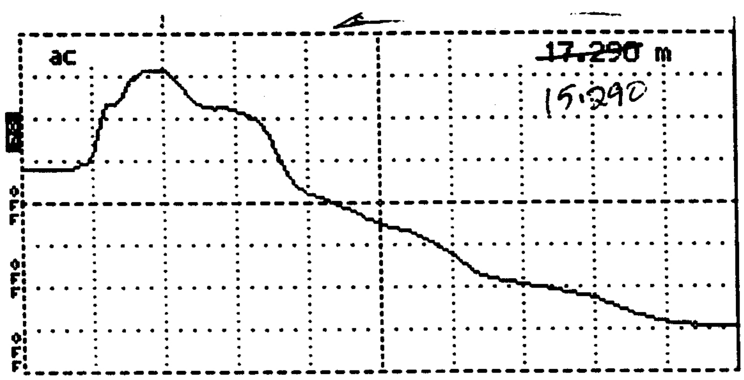


Tektronix 1502B TDR
Date 10-13-95
Cable 51B07
Notes short start
1102

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

rsor .... 17.290 m
stance/Div..... .25 m/div
rtical Scale.... 205 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B07
Notes short-end
1103

Input Trace
Stored Trace
Difference Trace

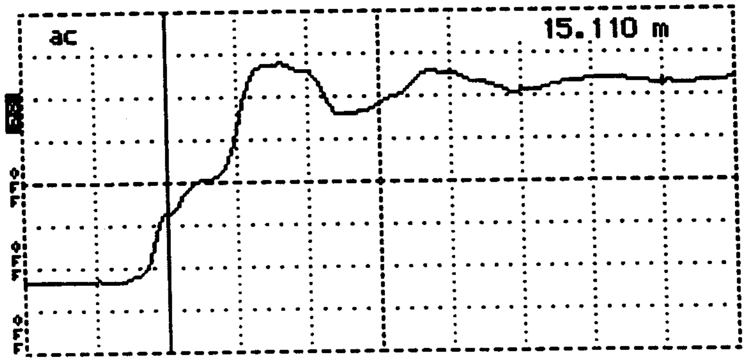
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Number 07

Trace 3 - Probe in Air

r .... 15.110 m
ce/Div ..... .25 m/div
cal Scale.... 205 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac



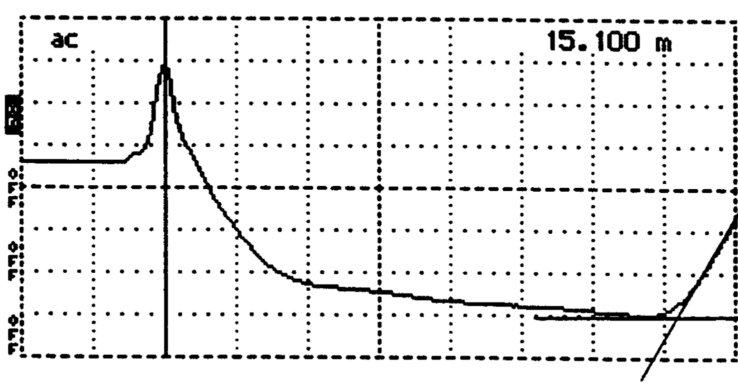
Tektronix 1502B TDR
Date 10-13-95
Cable 51B07
Notes air
1104

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

Trace 5 - Probe in Water

or .... 15.100 m
nce/Div ..... .25 m/div
ical Scale.... 118 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B07
Notes water 20.6°
1105

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

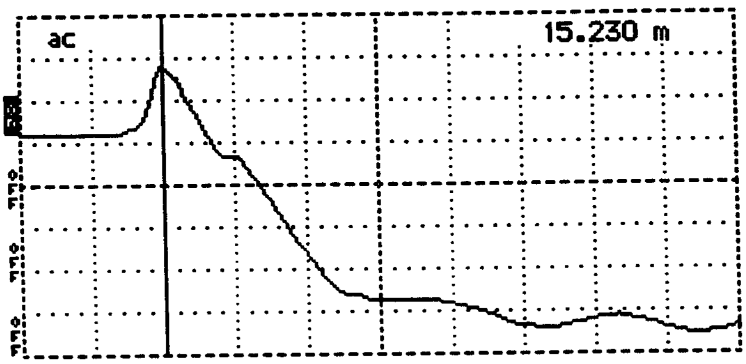
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51B08 **Date (dd/mm/yy):** 13/10/95

Probe Number 08

Trace 1 - Probe Shorted at Start

or .... 15.230 m
nce/Div..... .25 m/div
cal Scale.... 205 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

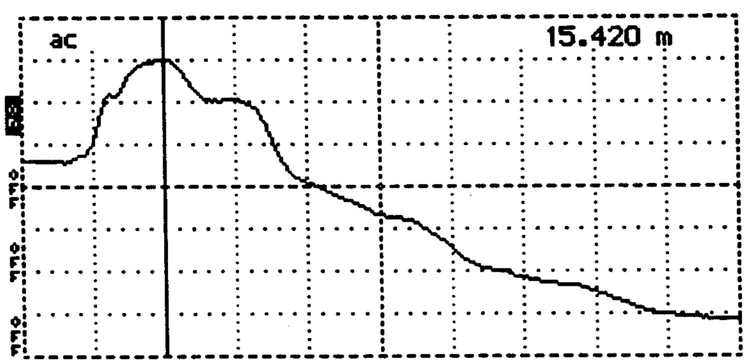


Tektronix 1502B TDR
Date 10-13-95
Cable 51B08
Notes short - start
10:50

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

or .... 15.420 m
nce/Div..... .25 m/div
cal Scale.... 205 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B08
Notes short-end
10:53

Input Trace
Stored Trace
Difference Trace

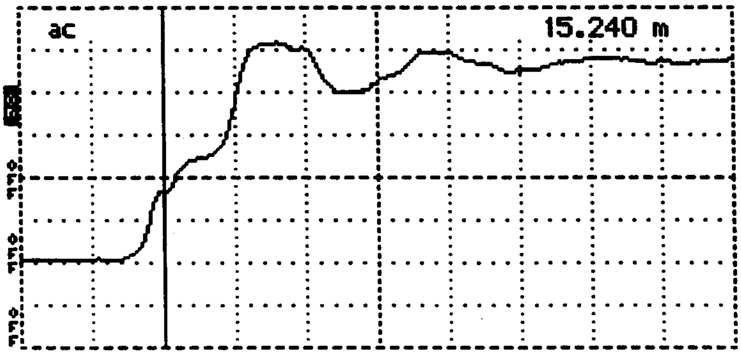
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Number C8

Trace 3 - Probe in Air

sor .... 15.240 m
ance/Div ..... .25 m/div
tical Scale.... 205 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac

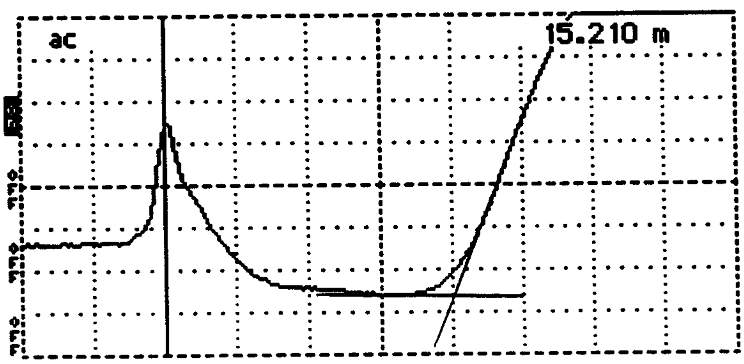


Tektronix 1502B TDR
Date 10-13-95
Cable 51B08
Notes 9/C
1055

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

r .... 15.210 m
nce/Div ..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

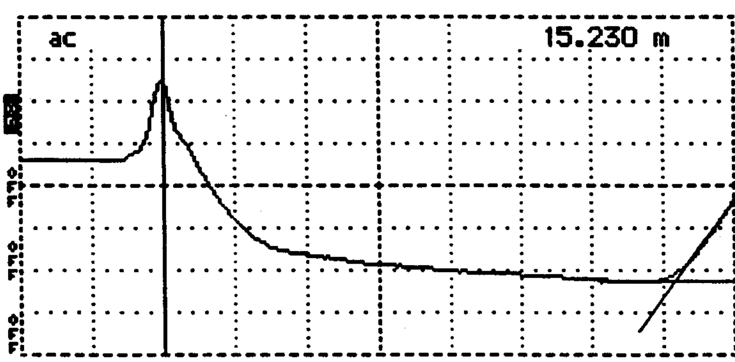


Tektronix 1502B TDR
Date 10-13-95
Cable 51B09
Notes 9/alcohol
1234

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

or .... 15.230 m
ance/Div ..... .25 m/div
ical Scale.... 149 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B08
Notes water 20
1058

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

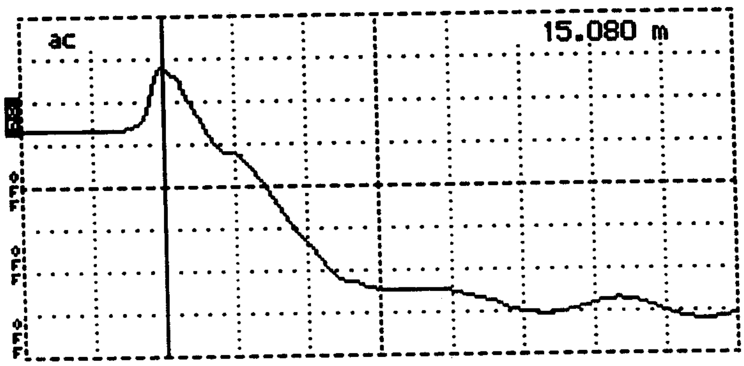
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Serial Number: 51B09 **Date (dd/mm/yy):** 23/10/95

Probe Number 09

Trace 1 - Probe Shorted at Start

or .... 15.080 m
nce/Div ..... .25 m/div
cal Scale.... 217 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

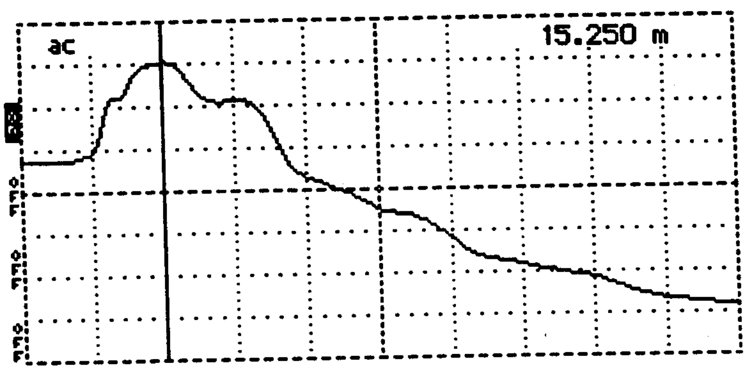


Tektronix 1502B TDR
Date 10-13-95
Cable 51B09
Notes short st
10:43

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

rsor .... 15.250 m
tance/Div ..... .25 m/div
rtical Scale.... 217 mρ/div
.... 0.99
ise Filter ...... 1 avg
wer .... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B09
Notes short end
10:45

Input Trace
Stored Trace
Difference Trace

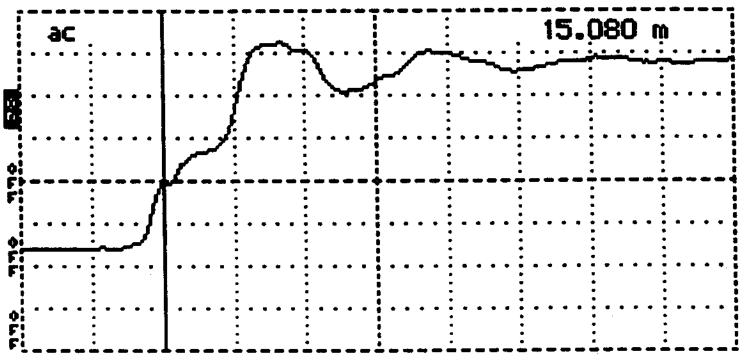
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: LTPP Section ID:	[51] [0114]

Probe Number 09

Trace 3 - Probe in Air

sor .... 15.080 m
ance/Div ..... .25 m/div
tical Scale.... 217 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B09
Notes 91C
10:46

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

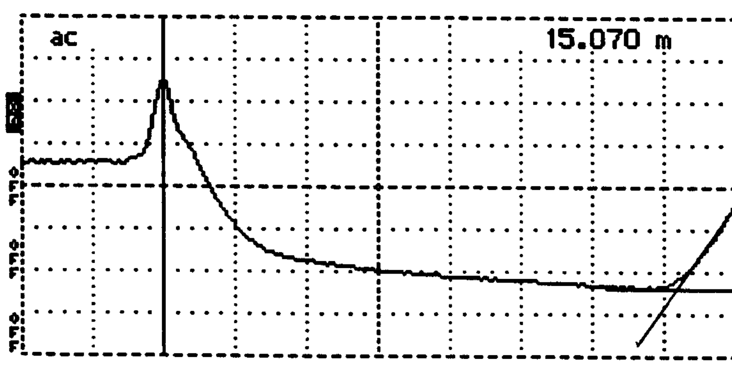
r .... 15.060 m
ce/Div ..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

Tektronix 1502B TDR
Date 10-13-95
Cable 51B09
Notes alcohol
1235

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

ursor .... 15.070 m
stance/Div ..... .25 m/div
ertical Scale.... 145 mρ/div
.... 0.99
oise Filter...... 1 avg
ower........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable 51B09
Notes water 20.6
10:47

Input Trace
Stored Trace
Difference Trace

Figure B-1(cont.). TDR Traces Obtained During Calibration

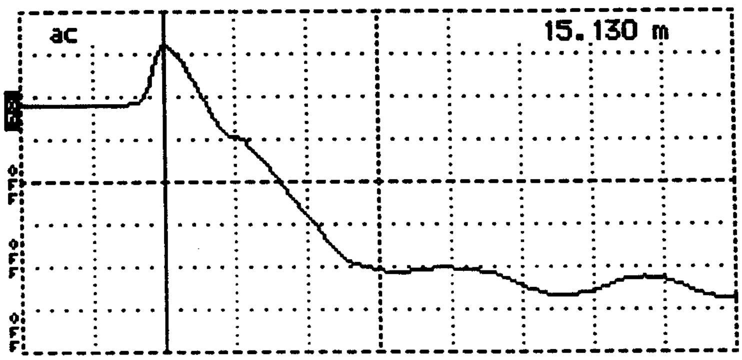
LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0111]

Probe Serial Number: 51B10 **Date (dd/mm/yy):** 13/10/95

Probe Number 10

Trace 1 - Probe Shorted at Start

r .... 15.130 m
ce/Div ..... .25 m/div
al Scale.... 217 mρ/div
.... 0.99
Filter ...... 1 avg
.... ac

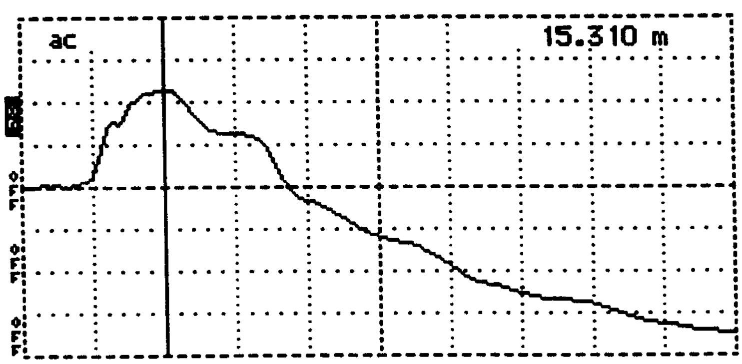


Tektronix 1502B TDR
Date 10-13-95
Cable ~~[illegible]~~ 51B10
Notes short start
10:34

Input Trace
Stored Trace
Difference Trace

Trace 2 - Probe Shorted at End

r .... 15.310 m
ce/Div ..... .25 m/div
al Scale.... 217 mρ/div
.... 0.99
Filter ...... 1 avg
.... ac



Tektronix 1502B TDR
Date 10-13-95
Cable ~~[illegible]~~ 51B10
Notes short end
1037

Input Trace
Stored Trace
Difference Trace

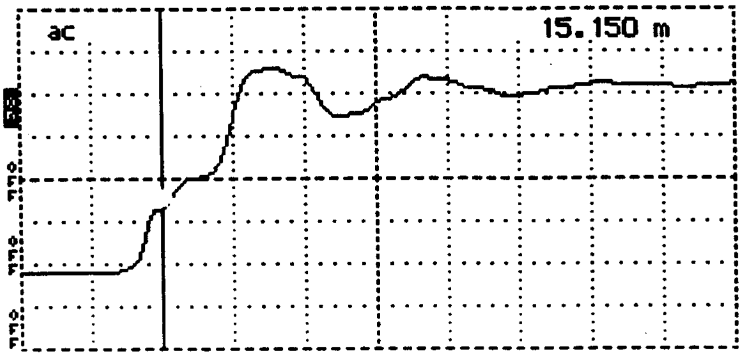
Figure B-1(cont.). TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program TDR Probe Calibration	Agency Code: [51] LTPP Section ID: [0114]

Probe Number 10

Trace 3 - Probe in Air

r .... 15.150 m
ce/Div..... .25 m/div
al Scale.... 217 mρ/div
.... 0.99
Filter...... 1 avg
.... ac

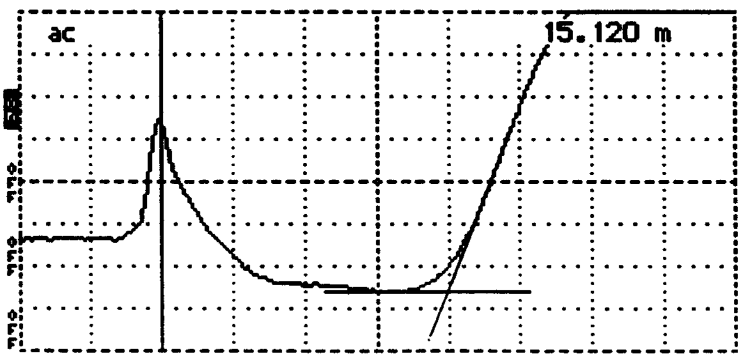


Tektronix 1502B TDR
Date 10-13-95
Cable [redacted] 51B10
Notes air
10:32

Input Trace
Stored Trace
Difference Trace

Trace 4 - Probe in Alcohol

or .... 15.120 m
nce/Div..... .25 m/div
cal Scale.... 100 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

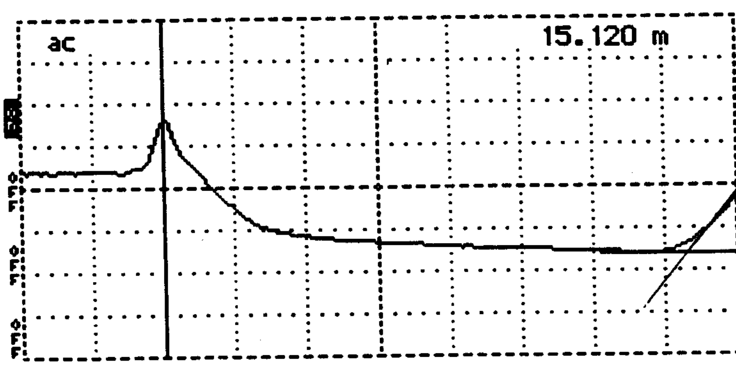


Tektronix 1502B TDR
Date 10-13-95
Cable 51B10
Notes alcohol
1236

Input Trace
Stored Trace
Difference Trace

Trace 5 - Probe in Water

r .... 15.120 m
nce/Div..... .25 m/div
cal Scale.... 217 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac



Tektronix 1502B TDR
Date 10-13-95
Cable [redacted] 51B10
Notes water
10 39 20.6°

Input Trace
Stored Trace
Difference Trace

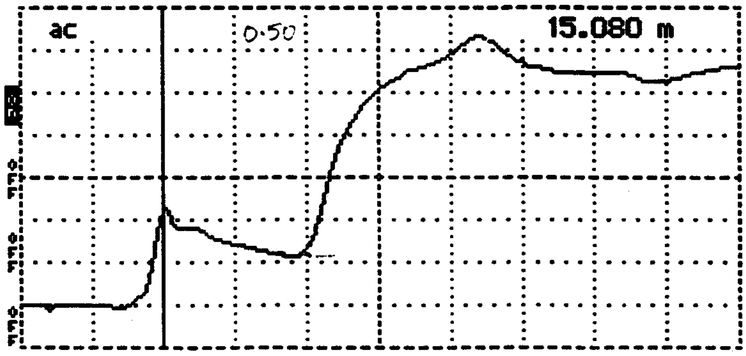
Figure B-1(cont.). TDR Traces Obtained During Calibration

APPENDIX C

Supporting Instrumentation Installation Information

Appendix C contains the following supporting information:

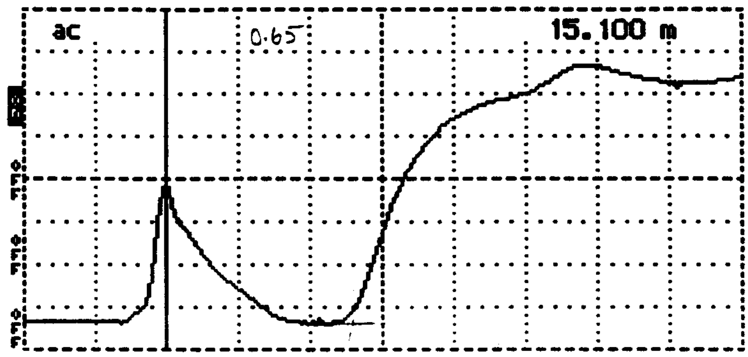
ursor .... 15.080 m
istance/Div..... .25 m/div
ertical Scale.... 137 mρ/div
P 0.99
oise Filter...... 1 avg
ower........... ac



Tektronix 1502B TDR
Date 10-24-95
Cable 51B01
Notes 1532
@installation

Input Trace
Stored Trace
Difference Trace

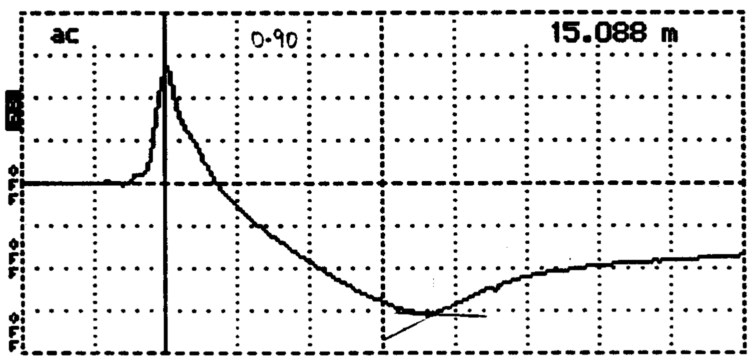
Cursor .... 15.100 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-24-95
Cable 51B02
Notes 1459
@installation

Input Trace
Stored Trace
Difference Trace

Cursor .... 15.088 m
Distance/Div..... .25 m/div
Vertical Scale.... 109 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-24-9
Cable 51B03
Notes 1437
@installation

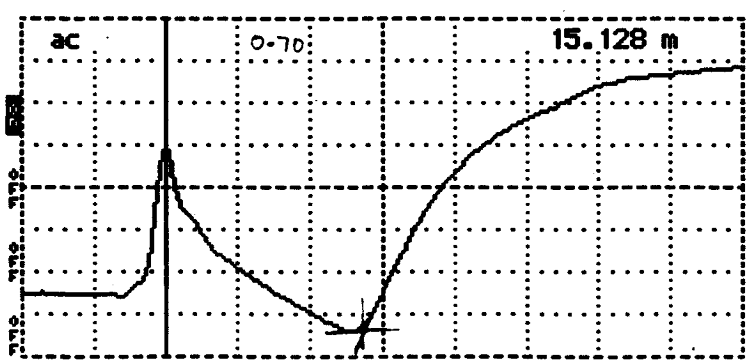
Input Trace
Stored Trace
Difference Trace

Cursor .... 15.228 m
Distance/Div..... .25 m/div
Vertical Scale.... 86.4 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

Tektronix 1502B TDR
Date 10-24-95
Cable 51B04
Notes 1412
@installation

Input Trace
Stored Trace
Difference Trace

Cursor .... 15.128 m
Distance/Div..... .25 m/div
Vertical Scale.... 86.4 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

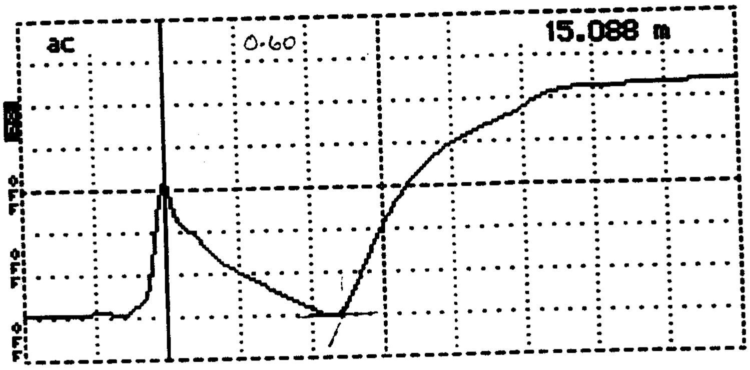


Tektronix 1502B TDR
Date 10-24-95
Cable 51B05
Notes 1338
@installation

Input Trace
Stored Trace
Difference Trace

Figure C-1. TDR Traces Measured Manually During Installation

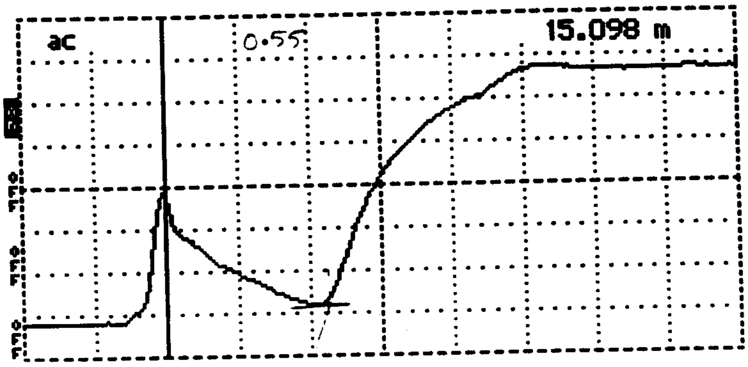
ursor .... 15.088 m
istance/Div..... .25 m/div
ertical Scale.... 100 mρ/div
P 0.99
oise Filter...... 1 avg
ower........... ac



Tektronix 1502B TDR
Date ~~??~~ 10-24-9
Cable 51B06
Notes 1319
@ installation

Input Trace
Stored Trace
Difference Trace

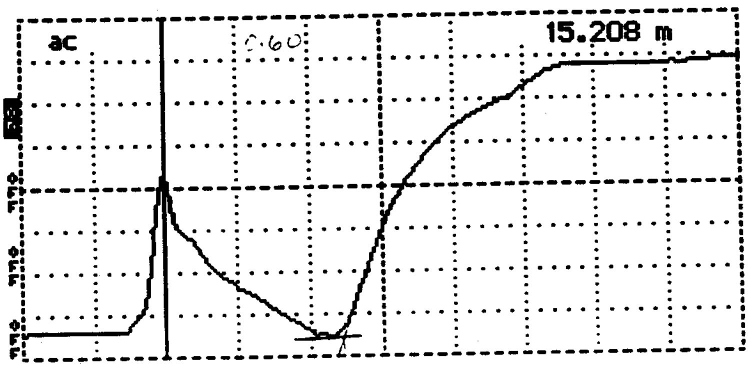
Cursor .... 15.098 m
Distance/Div..... .25 m/div
Vertical Scale.... 100 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-24-95
Cable 51B07
Notes 1258
@ installation

Input Trace
Stored Trace
Difference Trace

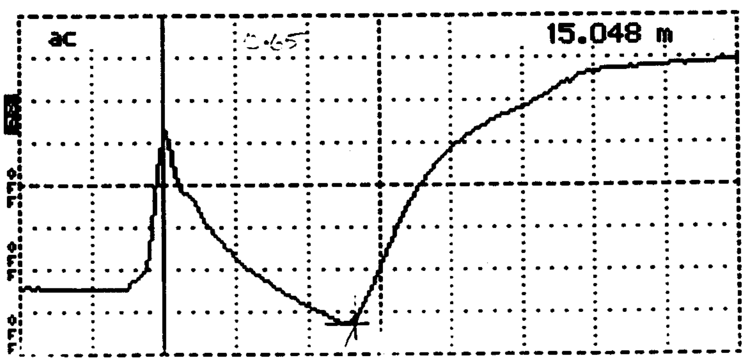
Cursor .... 15.208 m
Distance/Div..... .25 m/div
Vertical Scale.... 83.9 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-24-95
Cable 51B08
Notes 1241
@ installation

Input Trace
Stored Trace
Difference Trace

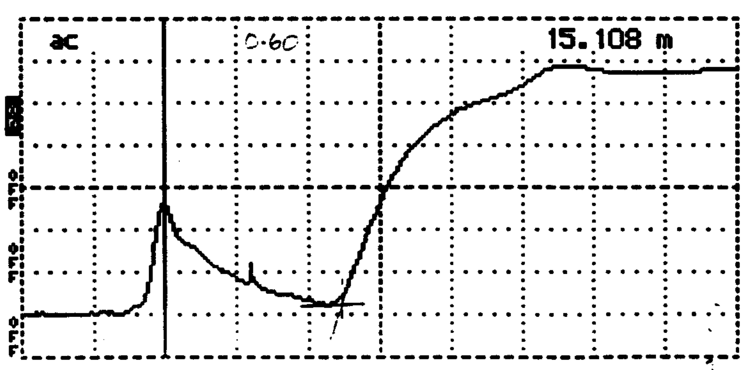
Cursor .... 15.048 m
Distance/Div..... .25 m/div
Vertical Scale.... 83.9 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 10-24-95
Cable 51B09
Notes 1232
@ installation

Input Trace
Stored Trace
Difference Trace

Cursor .... 15.108 m
Distance/Div..... .25 m/div
Vertical Scale.... 115 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date Oct. 24. 95
Cable #10 after [illegible]
Notes 510114

Input Trace
Stored Trace
Difference Trace

Figure C-1(cont.). TDR Traces Measured Manually During Installation

Table C-1. TDR Moisture Content

TDR No.	Depth (m)	TDR Length (m)	Dielectric Constant (ε)	Volumetric Moisture Content (%)	In-Situ Dry Density (kg/m³)	Gravimetric Moisture Content (%)
51B01	0.320	0.50	6.07	10.55	1860	7.8
51B02	0.470	0.65	10.25	19.42	1860	14.3
51B03	0.660	0.90	19.66	34.31	1860	25.2
51B04	0.810	0.80	15.53	28.55	1860	21.0
51B05	0.970	0.70	11.89	22.49	1860	16.5
51B06	1.120	0.60	8.74	16.39	1860	12.1
51B07	1.280	0.55	7.34	13.41	1860	9.9
51B08	1.440	0.60	8.74	16.39	1860	12.1
51B09	1.740	0.65	10.25	19.42	1860	14.3
51B10	2.050	0.60	8.74	16.39	1860	12.1

Table C-2. Field Measured Moisture Content

LTPP Seasonal Monitoring Study	State Code	[51]
In-Situ Moisture Tests	Test Section Number	[0114]

Weight (gm)	Probe 1	Probe 2	Probe 3	Probe 4	Probe 5
Weight of Pan + Wet Soil	535.2	607.8	444.5	313.0	394.6
Weight of Pan + Dry Soil	517.1	585.1	394.6	290.3	376.5
Weight of Pan	127.0	127.0	127.0	127.0	127.0
Weight of Dry Soil	390.1	458.1	267.6	163.3	249.5
Weight of Wet Soil	408.2	480.8	317.5	186.0	267.6
Weight of Moisture	18.1	22.7	49.9	22.7	18.1
Wt of Moisture/Dry Wt x 100	4.7	5.0	18.6	13.9	7.3

Weight (gm)	Probe 6	Probe 7	Probe 8	Probe 9	Probe 10
Weight of Pan + Wet Soil	462.7	435.4	444.5	517.1	462.7
Weight of Pan + Dry Soil	449.1	417.3	417.3	480.8	430.9
Weight of Pan	127.0	127.0	127.0	127.0	127.0
Weight of Dry Soil	322.1	290.3	290.3	353.8	303.9
Weight of Wet Soil	335.7	308.4	317.5	390.1	335.7
Weight of Moisture	13.6	18.1	27.2	36.3	31.8
Wt of Moisture/Dry Wt x 100	4.2	6.2	9.4	10.3	10.5

Prepared by:	N.B.W.	Employer:	VDOT
Date (dd/mm/yy):	24/10/95		

Table C-3. Field Measured Dry Density

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [51] LTPP Section ID [0114]

Depth of Representative Sample (from pavement surface): 1.2 m

Dry Density Determination:

a.	Tare Weight of Empty Mold:	2014 g	(4.44 lb)
b.	Weight of Mold and Compacted Soil:	3955 g	(8.72 lb)
c.	Weight of Compacted Soil (b-a):	1941 g	(4.28 lb)
d.	Unit Weight of Compacted Soil = (c/943.0) =		2.06 g/cm^3
	= [c/(1/30)] =		(128.4 lb/ft^3)
e.	Dry Density of Compacted Soil = [d/(1+r/100)] =		1.86 g/cm^3
			(116.3 lb/ft^3)

Moisture Content Determination:

m.	Tare Weight of Pan:	g
n.	Weight of Pan and Moisture Sample:	g
o.	Weight of Pan and Dry Sample:	g
p.	Weight of Moisture (n -o):	g
q.	Weight of Dry Sample (o - m):	g
r.	Moisture Content by Weight = [(p/q)*100] =	10.4 %

Prepared by:	N.B.W.	Employer:	VDOT
Date (dd/mm/yy):	24/10/95		

APPENDIX D

Initial Data Collection

Appendix D contains the following supporting information:

Table D-1. Sample Data from the Onsite Datalogger During Initial Data Collection, October 25, 1995

5,1995,298,1000,12.51,14.81,0
6,1995,298,1000,19.66,18.37,20.12,19.1,20.1
5,1995,298,1100,12.53,15.78,0
6,1995,298,1100,22.96,20.73,24.79,19.21,19.91
5,1995,298,1200,12.53,16.56,0
6,1995,298,1200,27.55,25.06,30.48,20.47,20.03
5,1995,298,1300,12.53,17.22,0
6,1995,298,1300,29.75,28.61,32.25,22.46,20.7
5,1995,298,1400,12.53,18.25,0
6,1995,298,1400,32.68,30.24,34.9,23.76,21.5
5,1995,298,1500,12.54,18.86,0
6,1995,298,1500,32.74,33.48,46.07,28.86,23.07
5,1995,298,1600,12.53,18.81,0
6,1995,298,1600,32,33.85,42.51,31.65,25.49
5,1995,298,1700,12.53,18.53,0
6,1995,298,1700,26.85,31.3,38.09,31.4,26.65
5,1995,298,1800,12.53,17.01,0
6,1995,298,1800,23.69,28.01,33.37,30.29,26.91
5,1995,298,1900,12.52,13.33,0
6,1995,298,1900,21.2,25.36,29.69,28.85,26.63
5,1995,298,2000,12.52,10.62,0
6,1995,298,2000,19.2,23.06,26.72,27.41,26.06
5,1995,298,2100,12.51,8.58,0
6,1995,298,2100,17.69,21.23,24.36,26.06,25.38
5,1995,298,2200,12.51,7.43,0
6,1995,298,2200,16.5,19.74,22.48,24.84,24.65
5,1995,298,2300,12.51,6.667,0
6,1995,298,2300,15.53,18.53,20.98,23.75,23.93
1,1995,298,2400,12.52,12.54,1446,12.49,942,13.85,19.5,1412,4.913,2359,0,4067
2,1995,298,2400,23.7,25.32,30.23,25.69,23.79,22.69,22.17,21.94,21.86,22.04,22.36,22.6
1,22.81,22.93,23.08,23.15,23.05,22.99
3,1995,298,2400,37.35,1355,34.29,1541,46.96,1420,31.8,1547,26.96,1723,24.49,1849,23
.42,2037,22.81,2217,22.11,2343,22.17,1003,22.48,1005,22.78,952,22.99,948,23.1,1001,2
3.27,947,23.32,948,23.18,955,23.1,1005
4,1995,298,2400,14.29,0,17.01,2359,18.79,942,19.07,1007,19.85,1055,20.51,1141,20.91,
1247,21.29,1324,21.7,1651,21.95,1938,22.25,2300,22.49,2310,22.68,2313,22.8,2231,22.
94,2322,23.01,2359,22.93,2316,22.9,2234
5,1995,298,2400,12.5,5.956,0
6,1995,298,2400,14.69,17.49,19.74,22.79,23.25

Section 510114

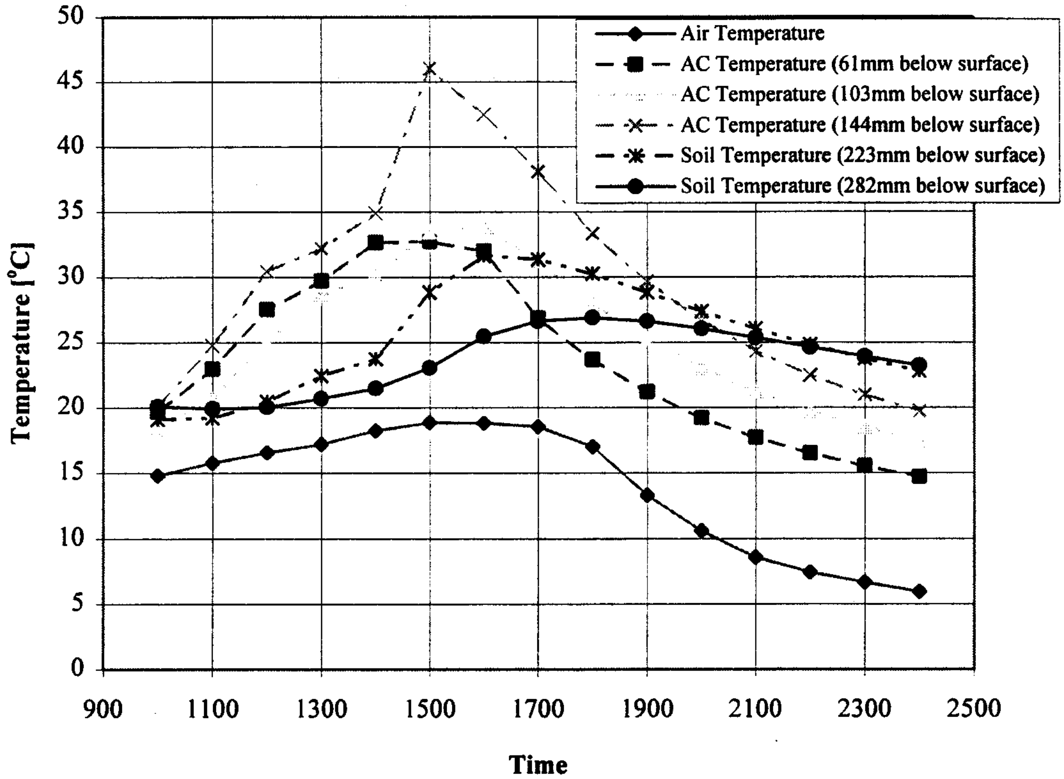


Figure D-1. Air Temperature and First Five Sub-Surface Temperatures From Initial Data Collection, October 25, 1995

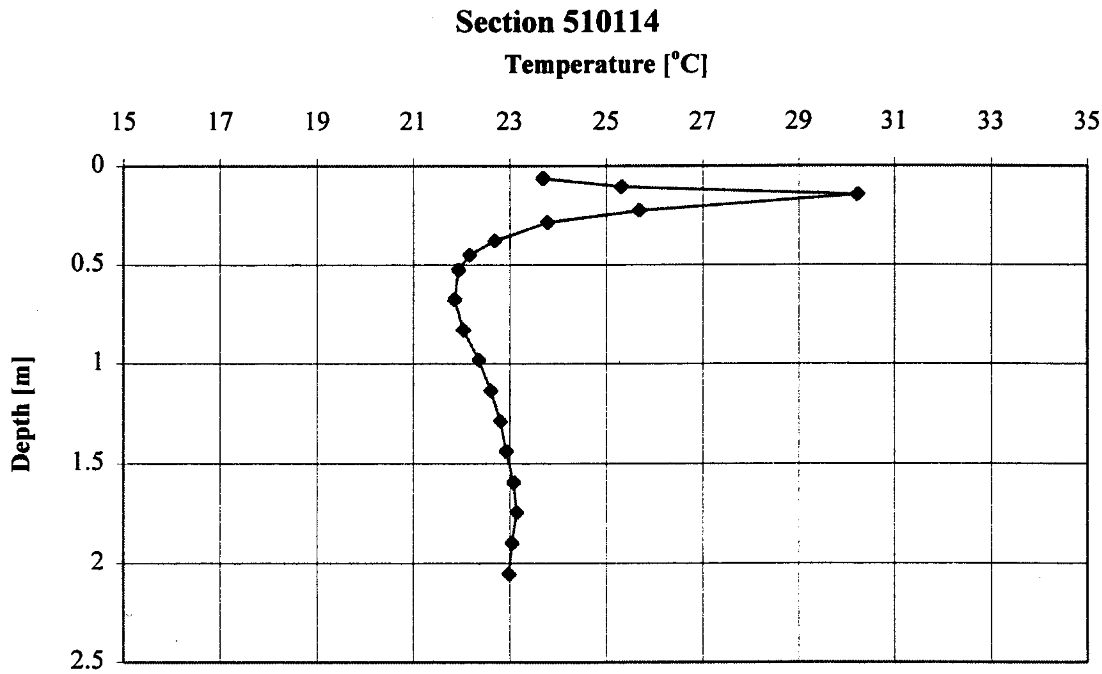


Figure D-2. Average Subsurface Temperature for all 18 Sensors From Initial Data Collection, October 25, 1995

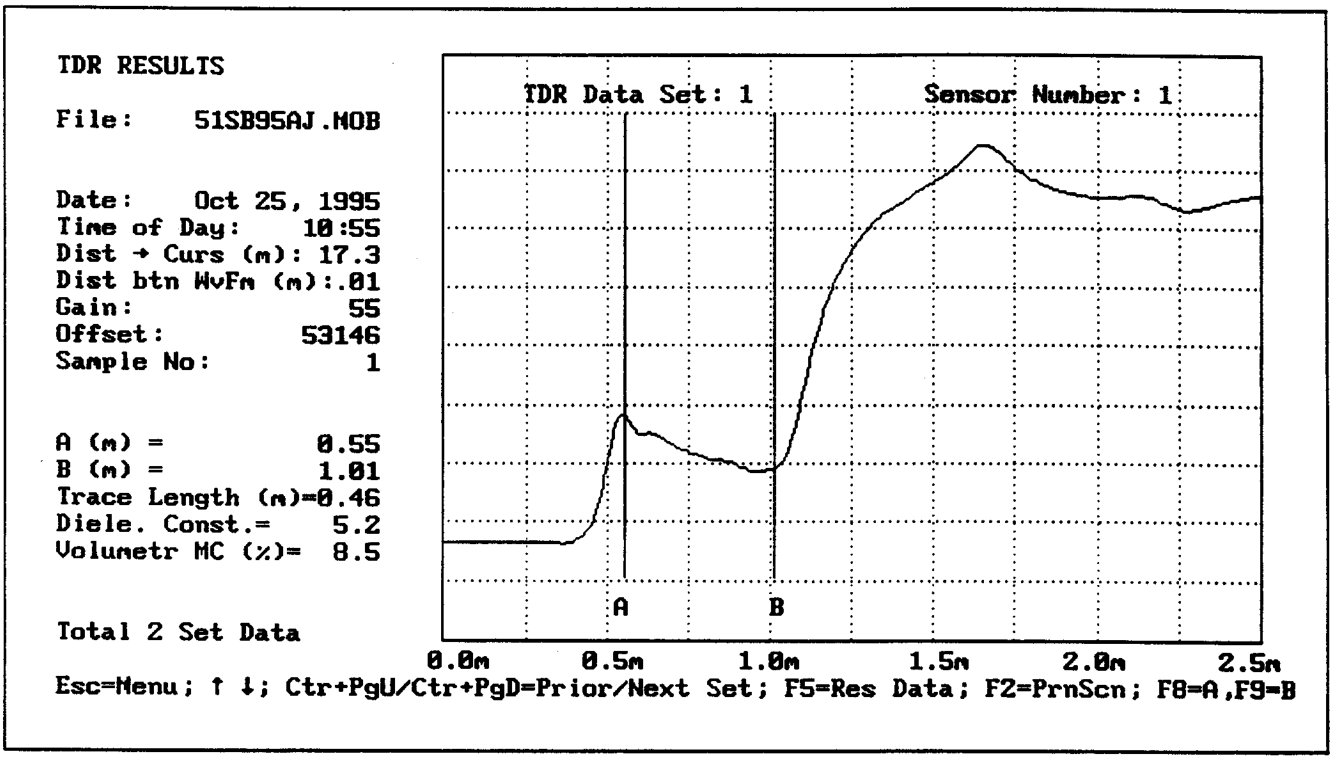


Figure D-3. Initial First Set of TDR Traces Measured with the Mobile Unit

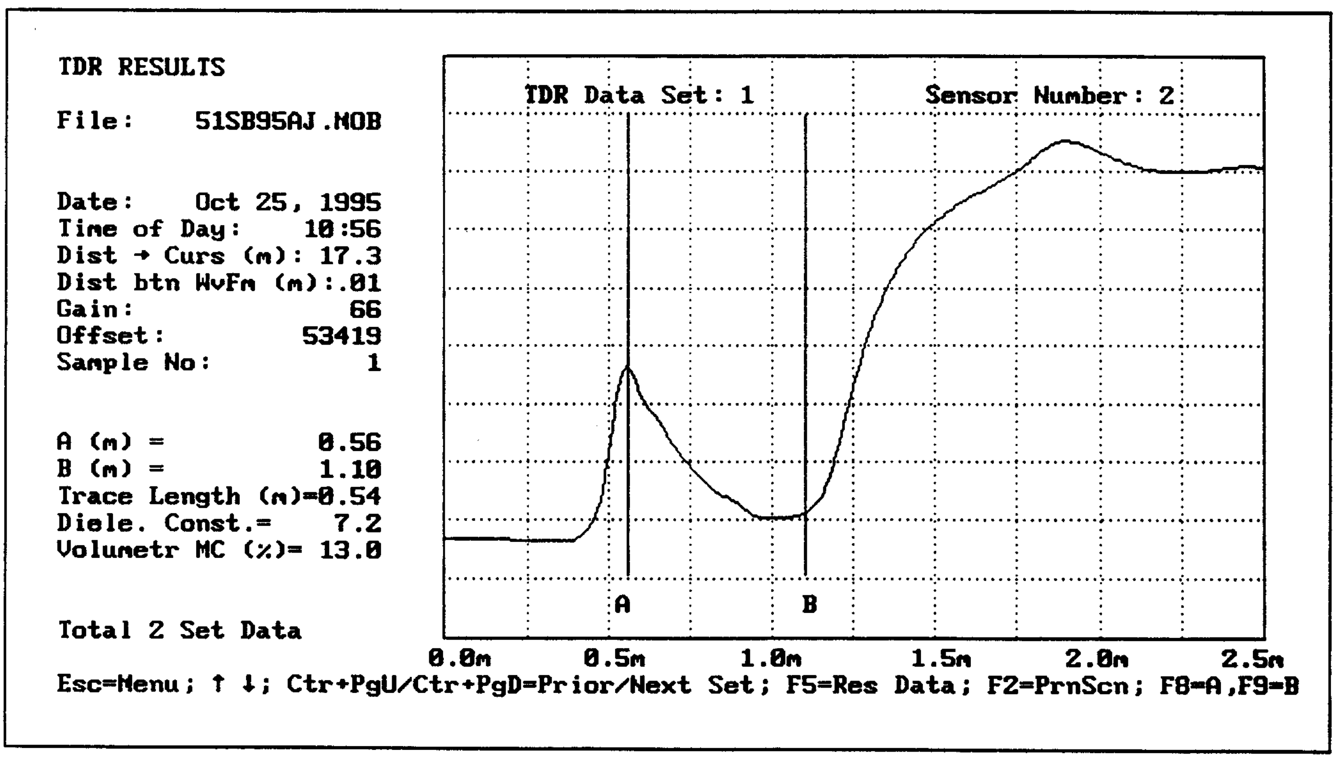


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

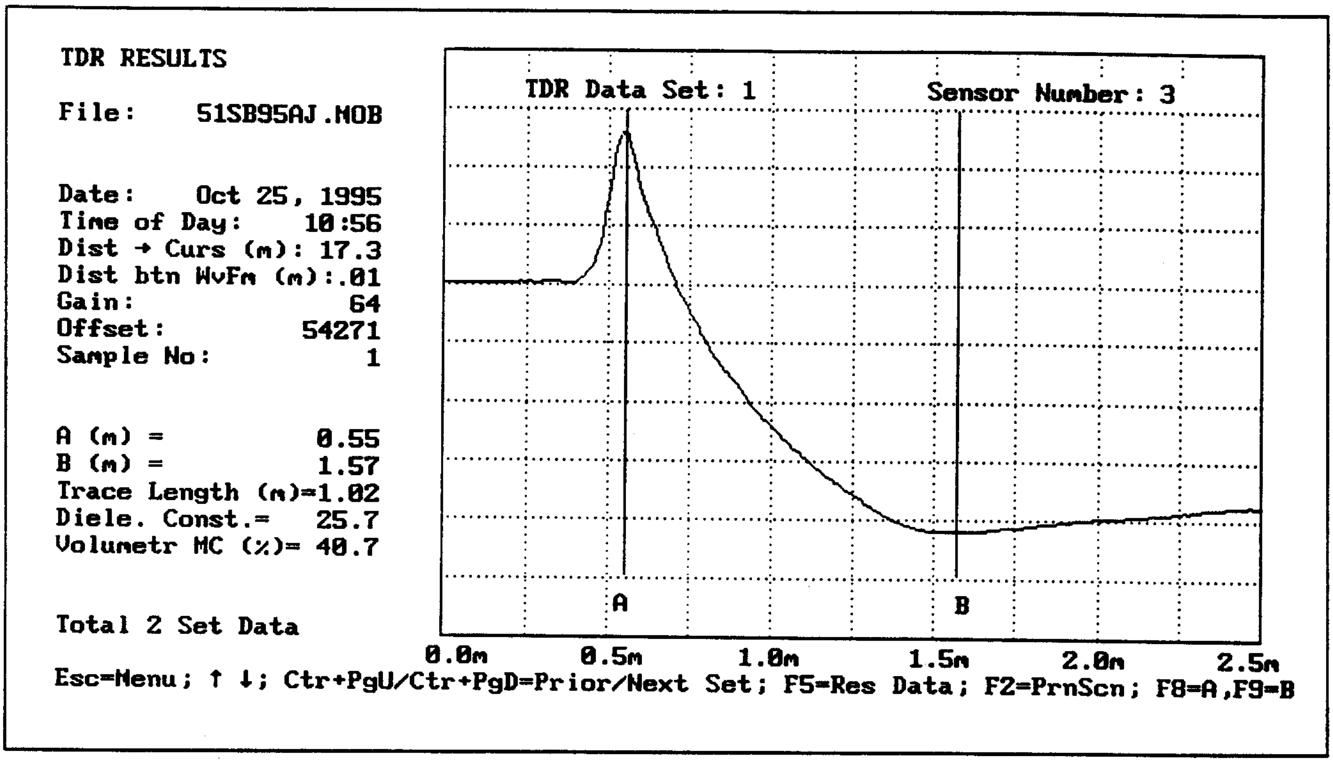


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

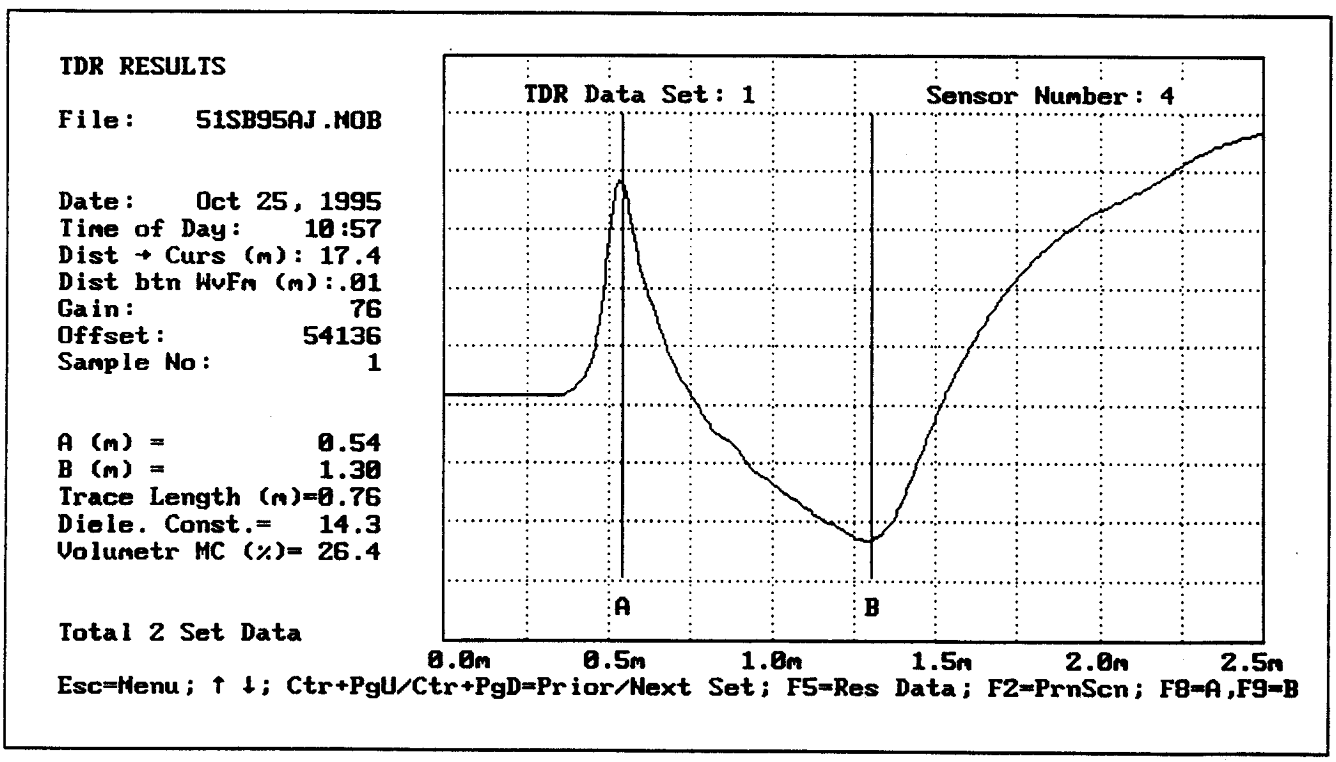


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

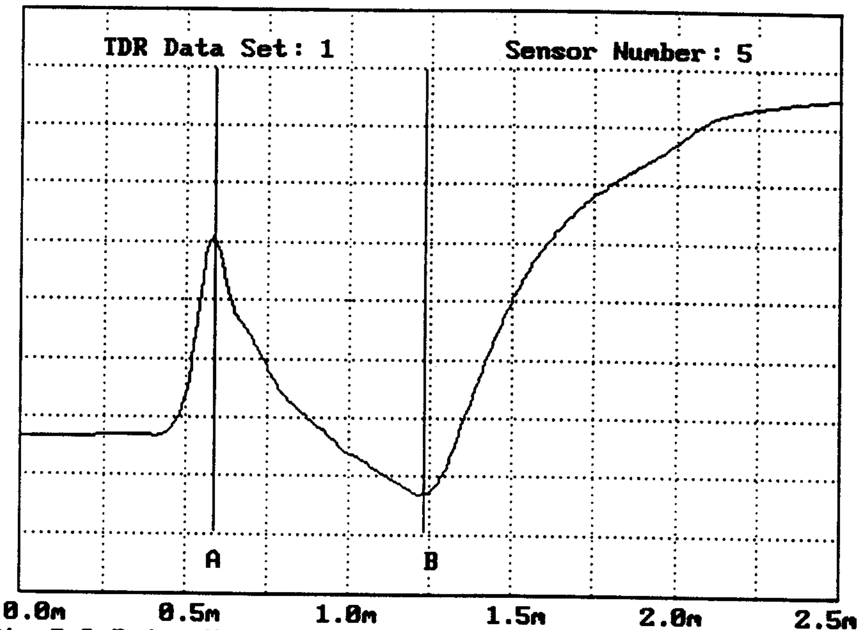
TDR RESULTS

File: 51SB95AJ.MOB

Date: Oct 25, 1995
Time of Day: 10:58
Dist → Curs (m): 17.3
Dist btn WvFm (m):.01
Gain: 73
Offset: 53810
Sample No: 1

A (m) = 0.59
B (m) = 1.23
Trace Length (m)=0.64
Diele. Const.= 10.1
Volumetr MC (%)= 19.1

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

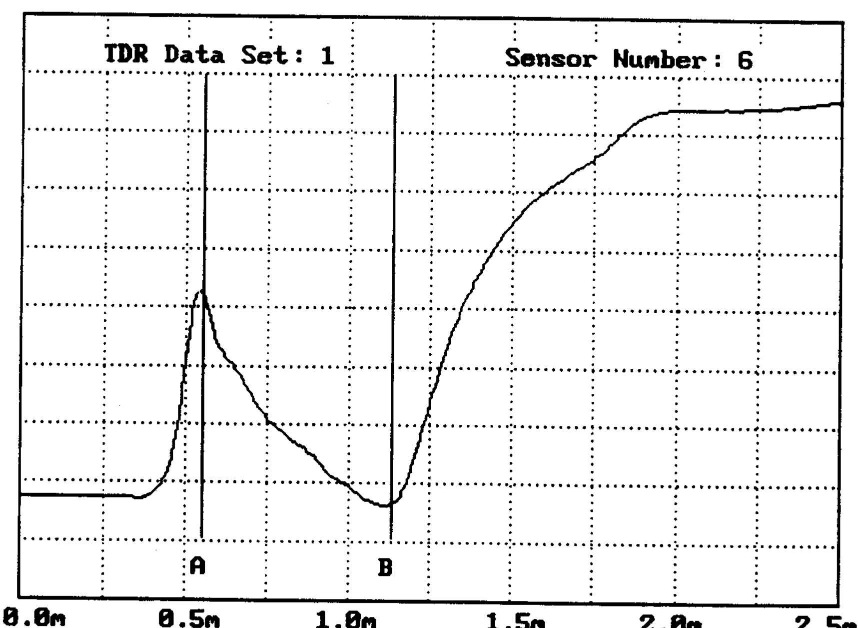
TDR RESULTS

File: 51SB95AJ.MOB

Date: Oct 25, 1995
Time of Day: 10:58
Dist → Curs (m): 17.3
Dist btn WvFm (m):.01
Gain: 73
Offset: 53607
Sample No: 1

A (m) = 0.55
B (m) = 1.13
Trace Length (m)=0.58
Diele. Const.= 8.3
Volumetr MC (%)= 15.4

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

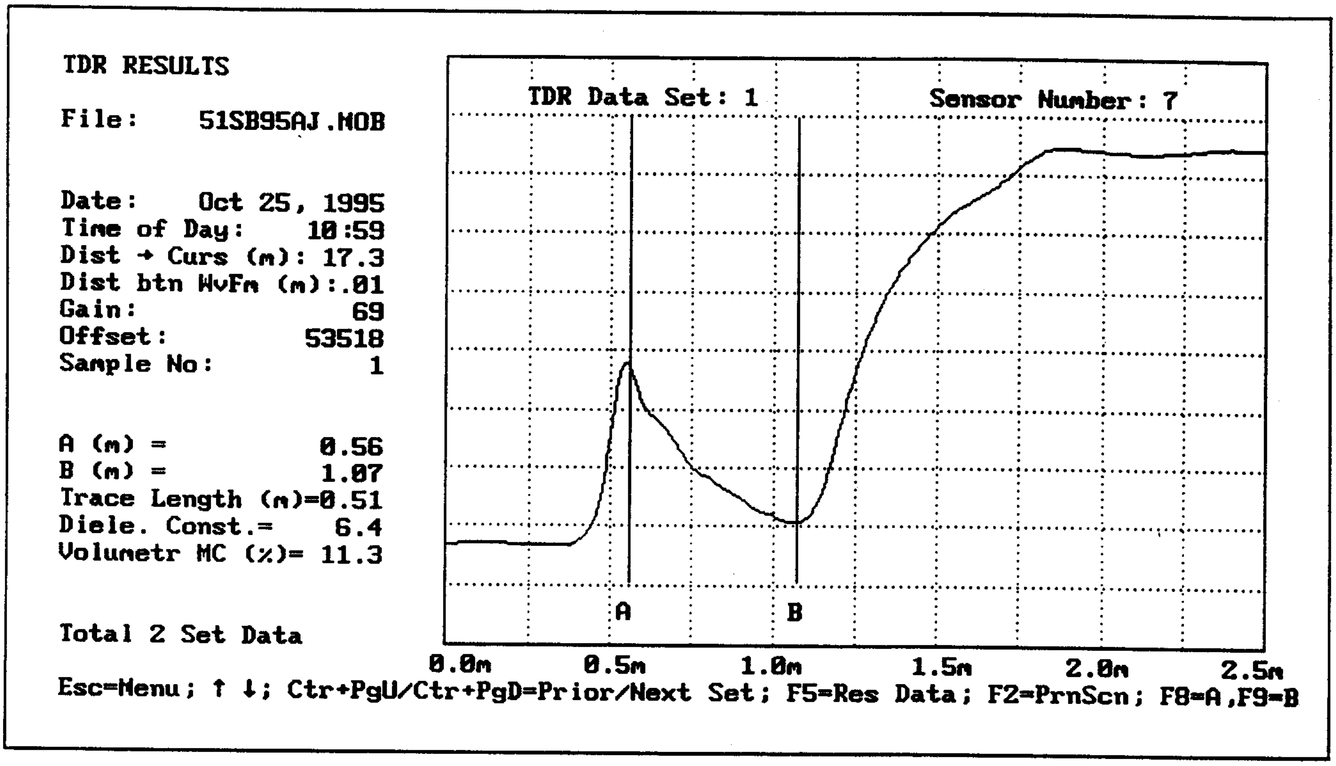


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

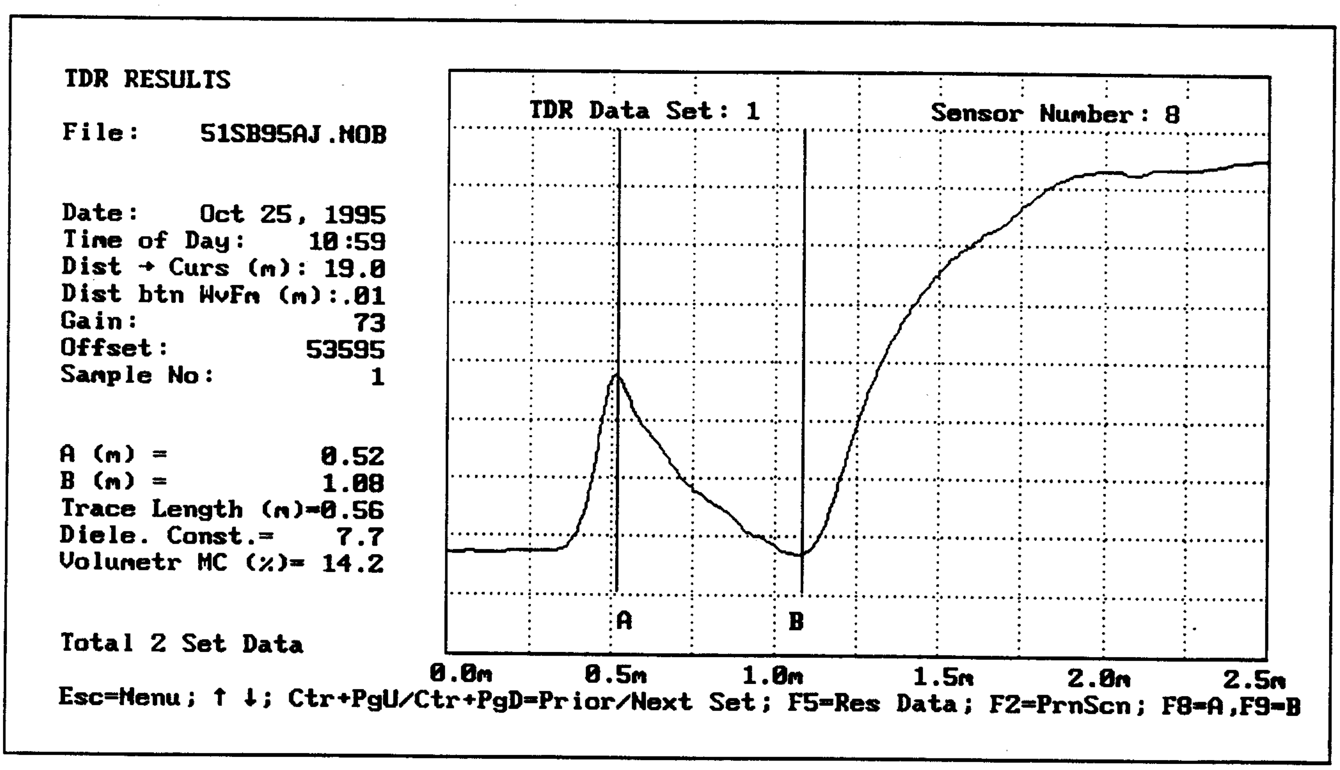


Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

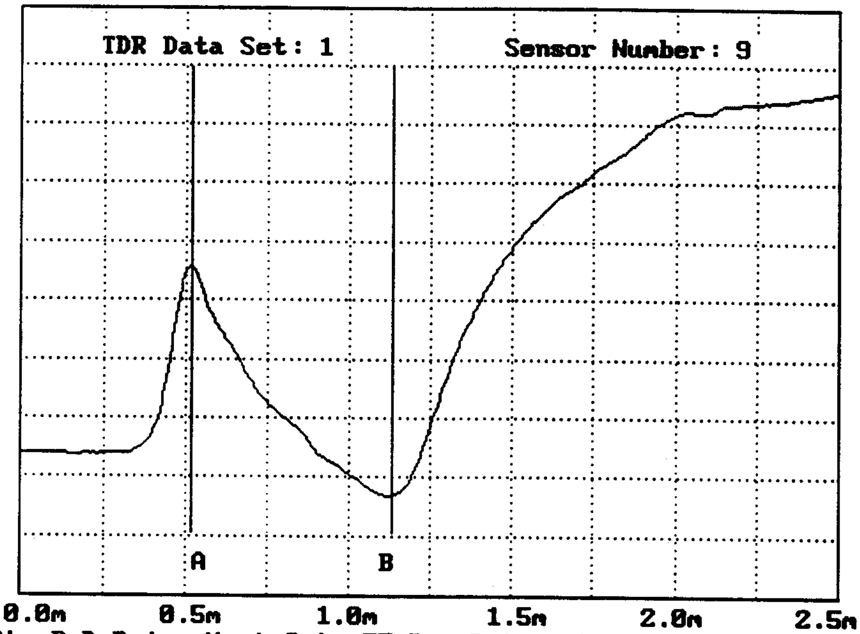
TDR RESULTS

File: 51SB95AJ.MOB

Date: Oct 25, 1995
Time of Day: 11:00
Dist → Curs (m): 18.9
Dist btn WvFm (m): .01
Gain: 75
Offset: 53756
Sample No: 1

A (m) = 0.52
B (m) = 1.13
Trace Length (m)=0.61
Diele. Const.= 9.2
Volumetr MC (%)= 17.2

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

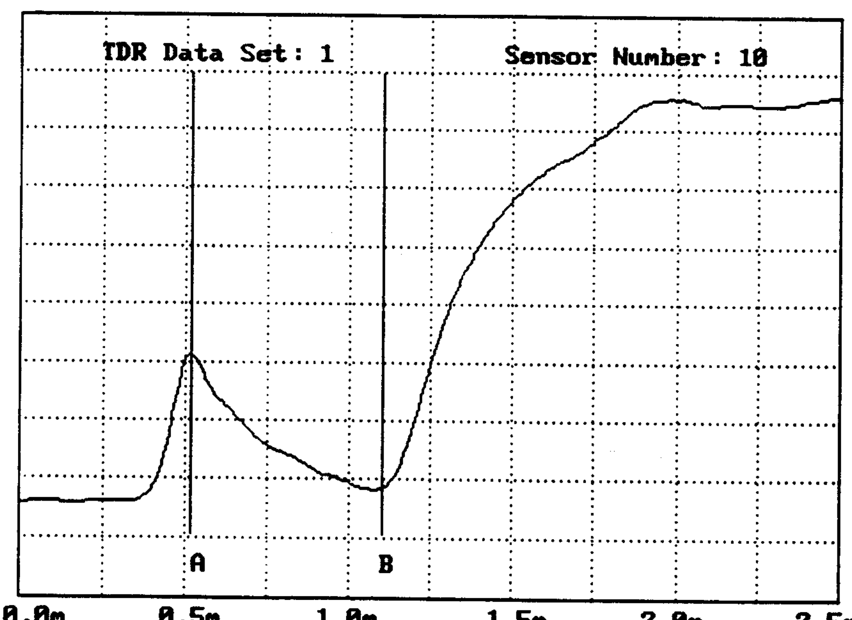
TDR RESULTS

File: 51SB95AJ.MOB

Date: Oct 25, 1995
Time of Day: 11:00
Dist → Curs (m): 18.9
Dist btn WvFm (m): .01
Gain: 67
Offset: 53467
Sample No: 1

A (m) = 0.52
B (m) = 1.10
Trace Length (m)=0.58
Diele. Const.= 8.3
Volumetr MC (%)= 15.4

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

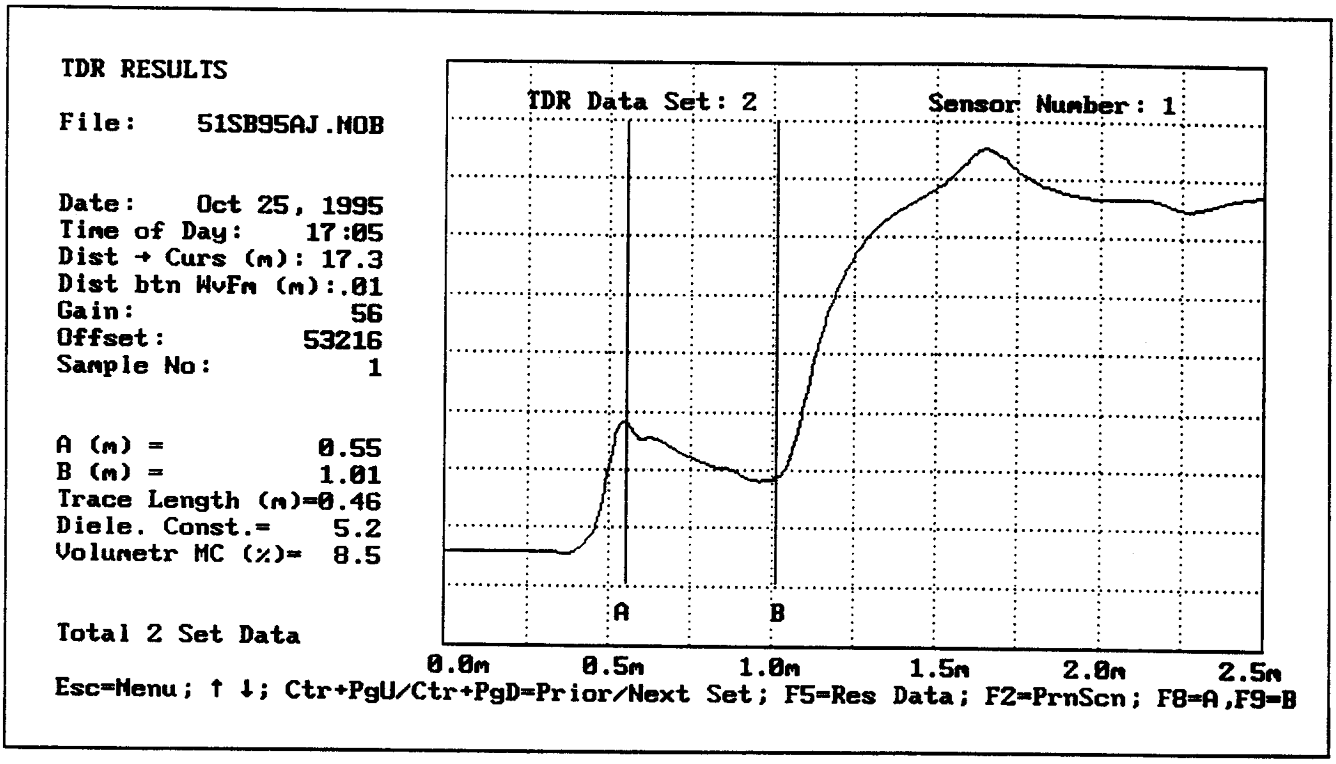


Figure D-3. Initial Second Set of TDR Traces Measured with the Mobile Unit

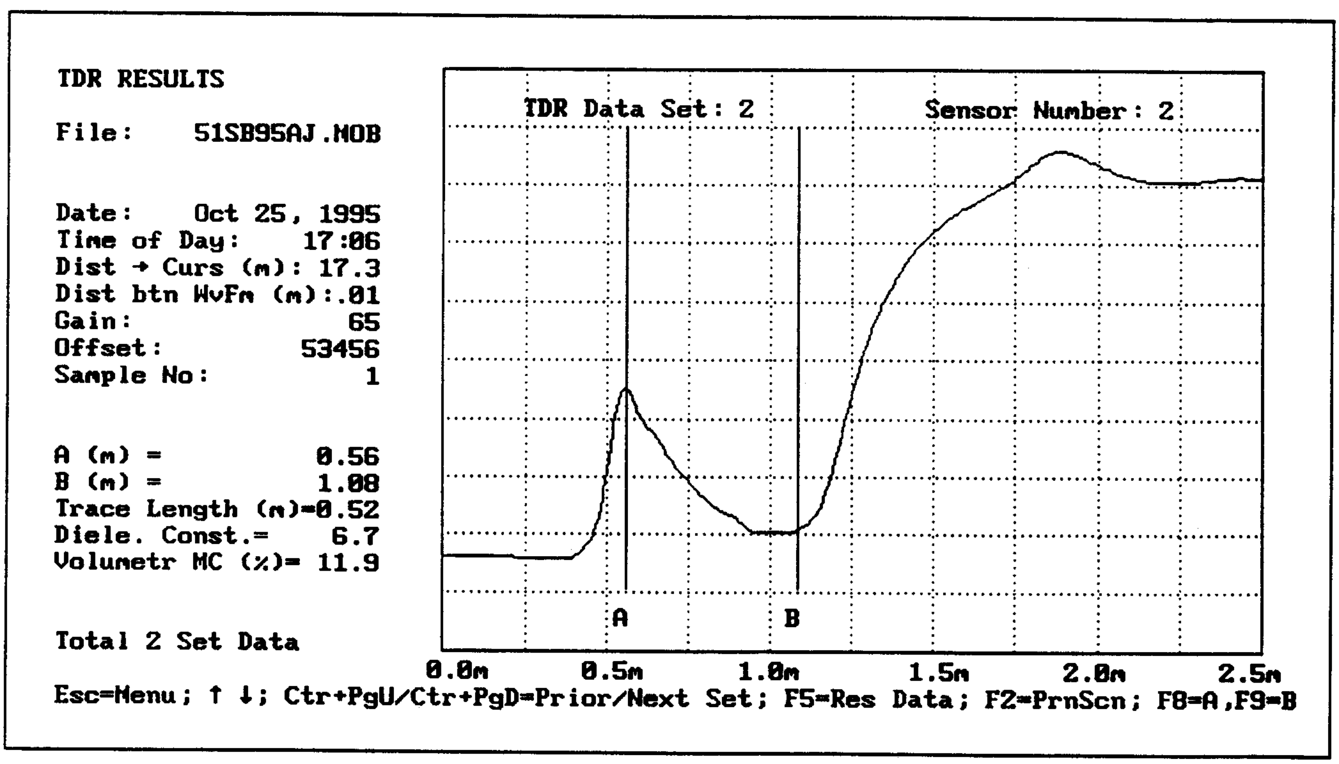


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

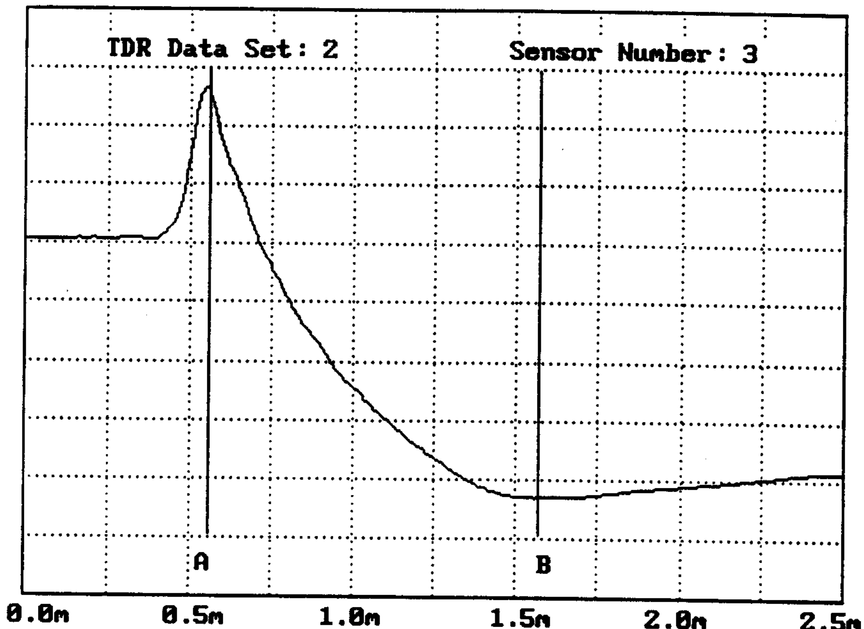
TDR RESULTS

File: 51SB95AJ.MOB

Date: Oct 25, 1995
Time of Day: 17:06
Dist → Curs (m): 17.3
Dist btn WvFm (m):.01
Gain: 64
Offset: 54351
Sample No: 1

A (m) = 0.56
B (m) = 1.57
Trace Length (m)=1.01
Diele. Const.= 25.2
Volumetr MC (%)= 40.2

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

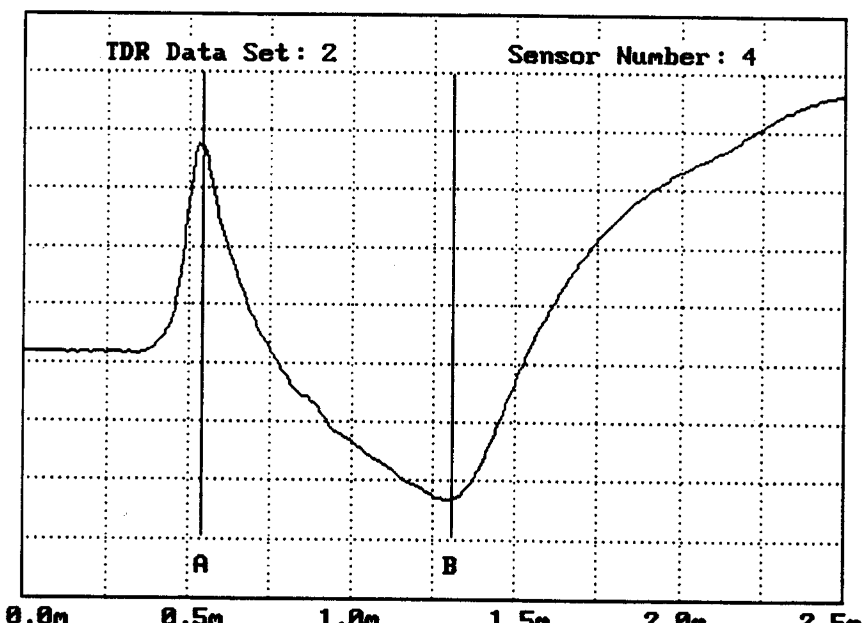
TDR RESULTS

File: 51SB95AJ.MOB

Date: Oct 25, 1995
Time of Day: 17:07
Dist → Curs (m): 17.4
Dist btn WvFm (m):.01
Gain: 75
Offset: 54206
Sample No: 1

A (m) = 0.54
B (m) = 1.31
Trace Length (m)=0.77
Diele. Const.= 14.7
Volumetr MC (%)= 27.0

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctr+PgU/Ctr+PgD=Prior/Next Set; F5=Res Data; F2=PrnScn; F8=A,F9=B

Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

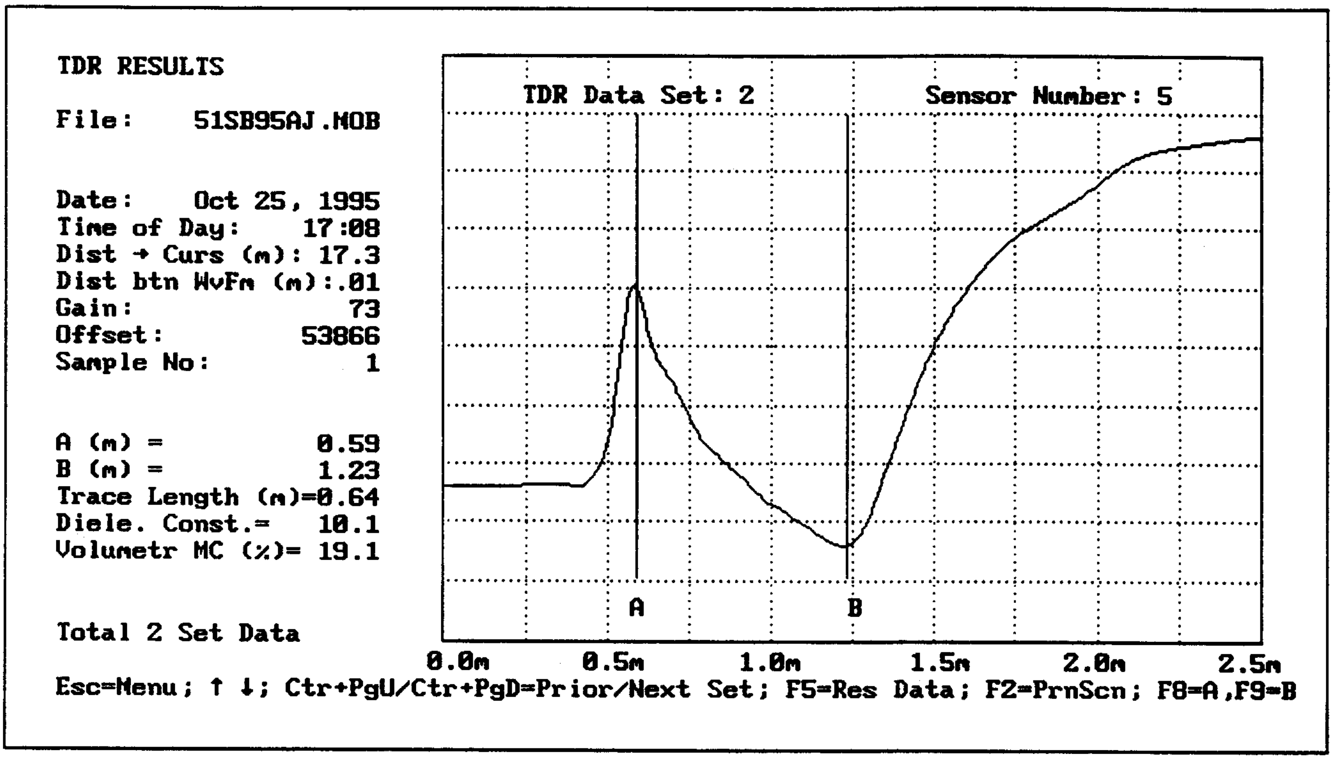


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

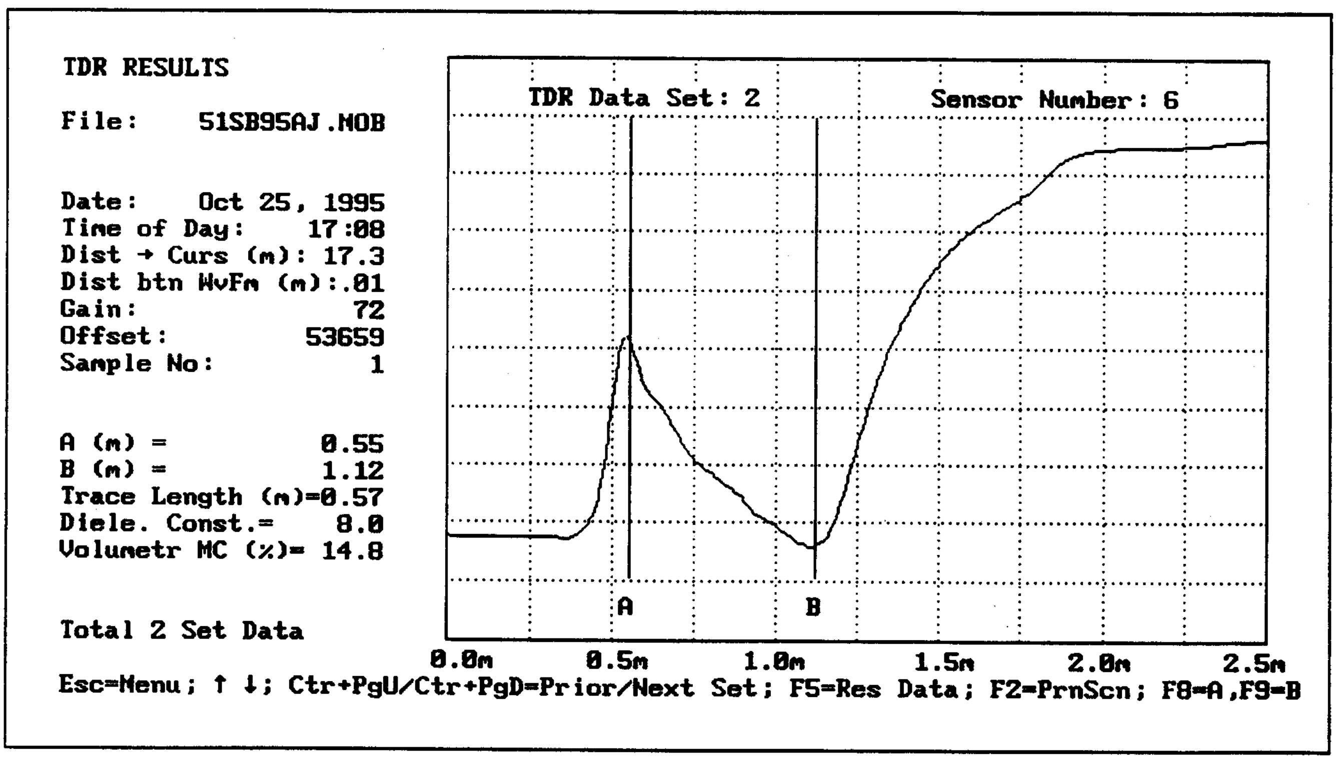


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

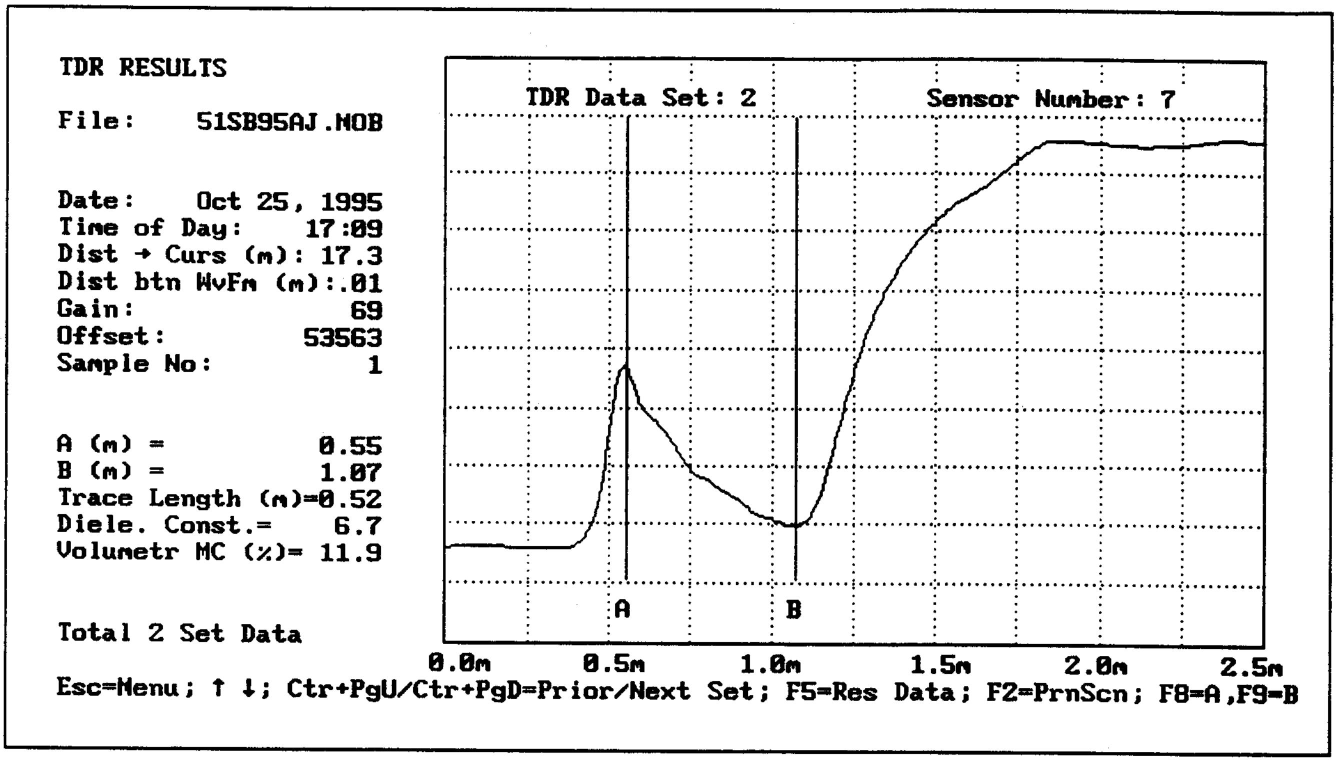


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

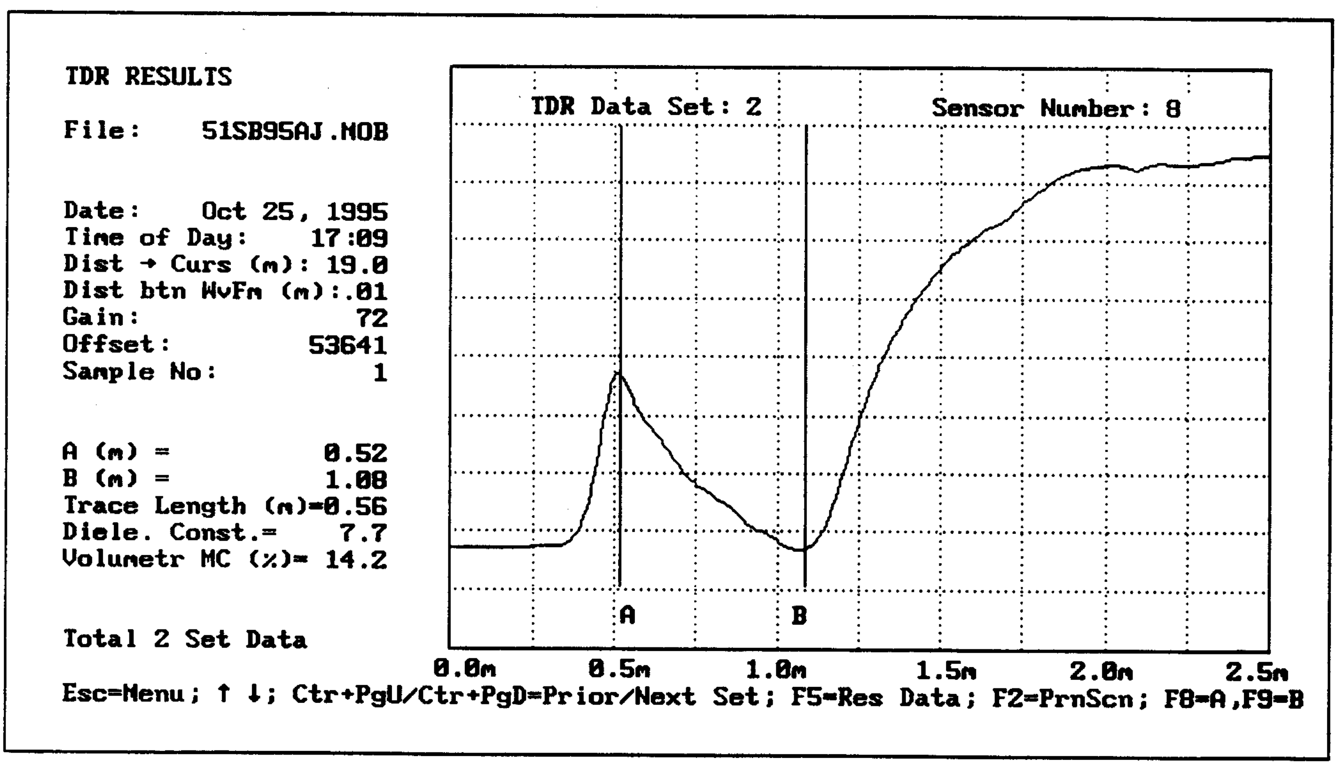


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

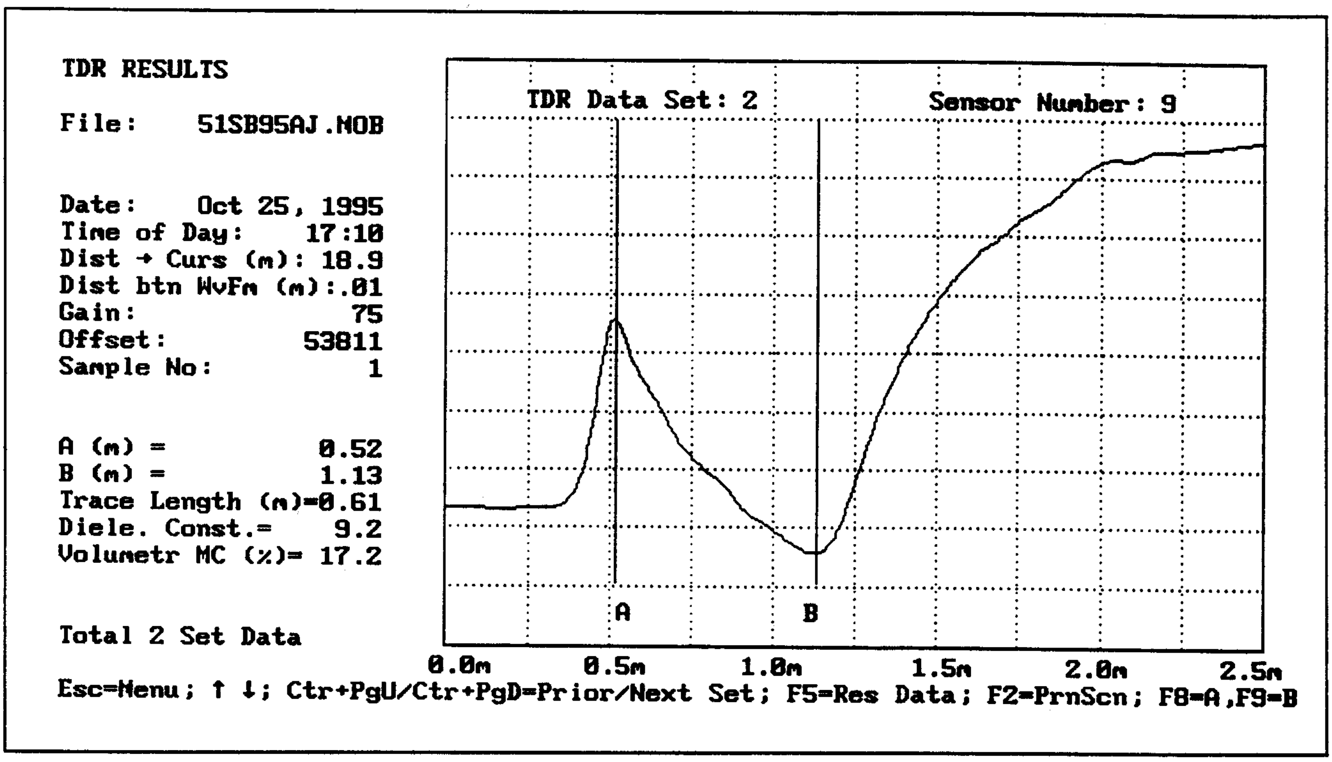


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

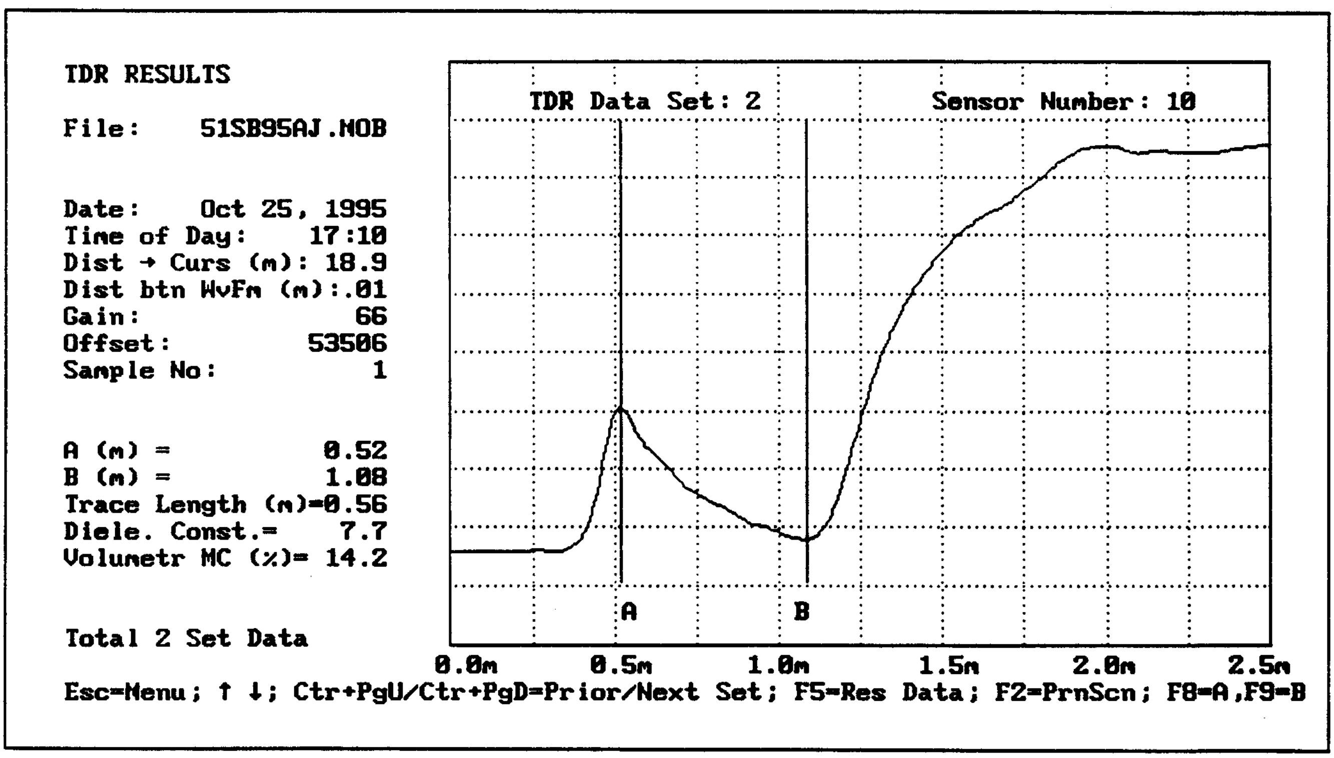


Figure D-3(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

Table D-2. Uniformity Survey Results Before and After Installation

Seasonal Uniformity Survey Site Number: 510114 Date Surveyed: October 24 - October 25, 1995	Falling Weight Deflectometer Data Collection and Processing Summary

Section Interval (ft)	Mean Deflection Values for HT 2 (mils) Corrected								Mean Temp D1 (F)
	Sensor 1	Sensor 1 std dev	Sensor 7	Sensor 7 std dev	Subg modulus (psi)	Subg modulus std dev	Effective SN	SN std dev	
300 to 530 **October 24** @ 1010	12.58	1.17	1.86	0.15	11811	1530	5.93	0.17	57.7
300 to 530 **October 24** @ 1639	17.50	1.44	1.99	0.19	13436	2106	4.83	0.15	95.4
300 to 530 **October 25** @1215	16.12	1.34	1.93	0.19	13033	1806	5.07	0.13	95.2

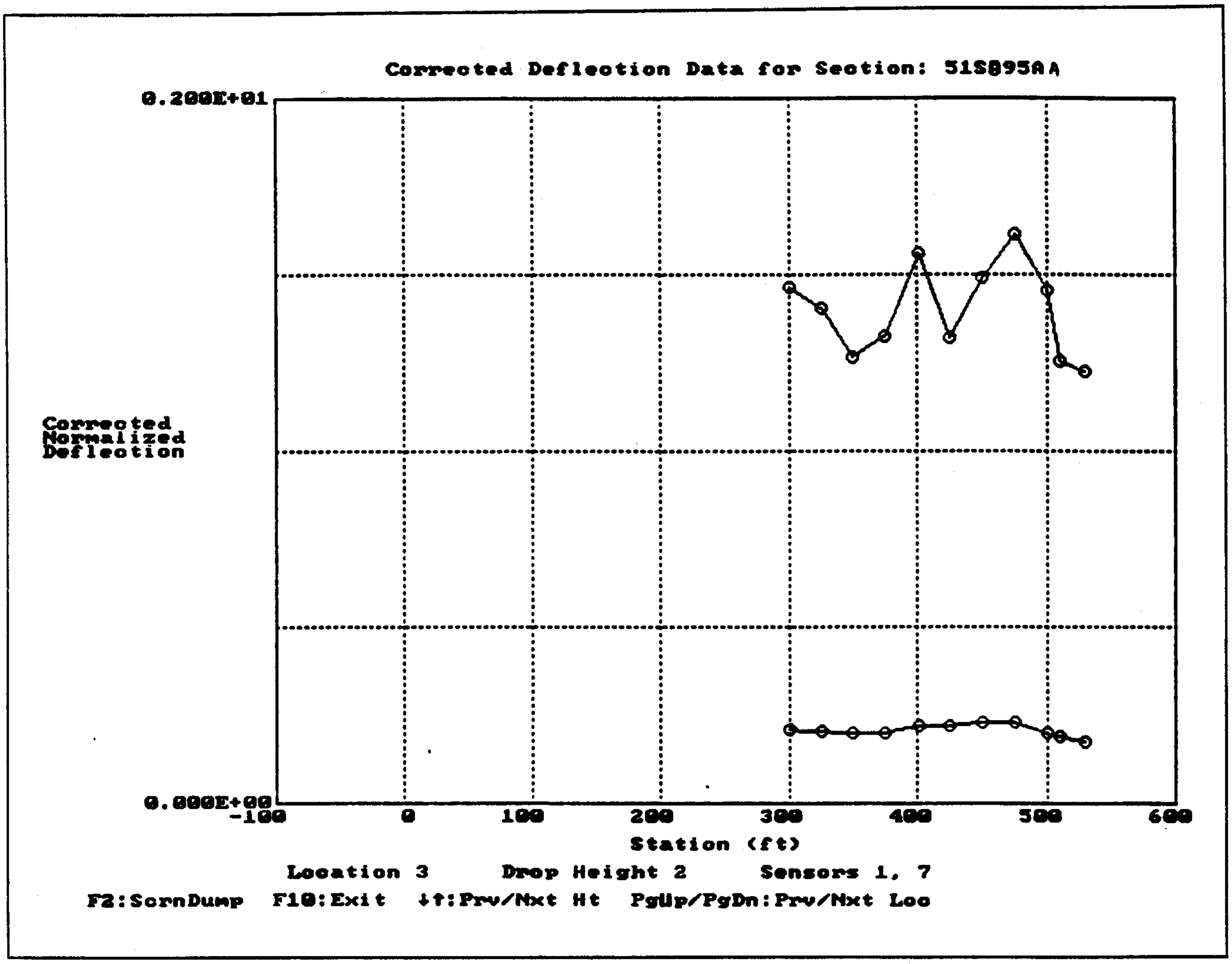


Figure D-4. Deflection Profiles from FWDCHECK
(Test Date and Time October 24, 1995 @ 1010)

Table D-3. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time October 24, 1995 @ 1010)

Flexible Pavement Thickness Statistics - 51SB95AA - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	300	11910	5.75
	325	12593	5.80
	350	14766	5.95
	375	12169	6.05
	400	10236	5.75
	425	11868	6.10
	450	10260	5.90
	475	9564	5.70
	500	10641	5.90
	510	12917	6.15
	530	12994	6.20
Subsection 1	Overall Mean	11811	5.93
	Standard Deviation	1530	0.17
	Coeff of Variation	12.95%	2.93%

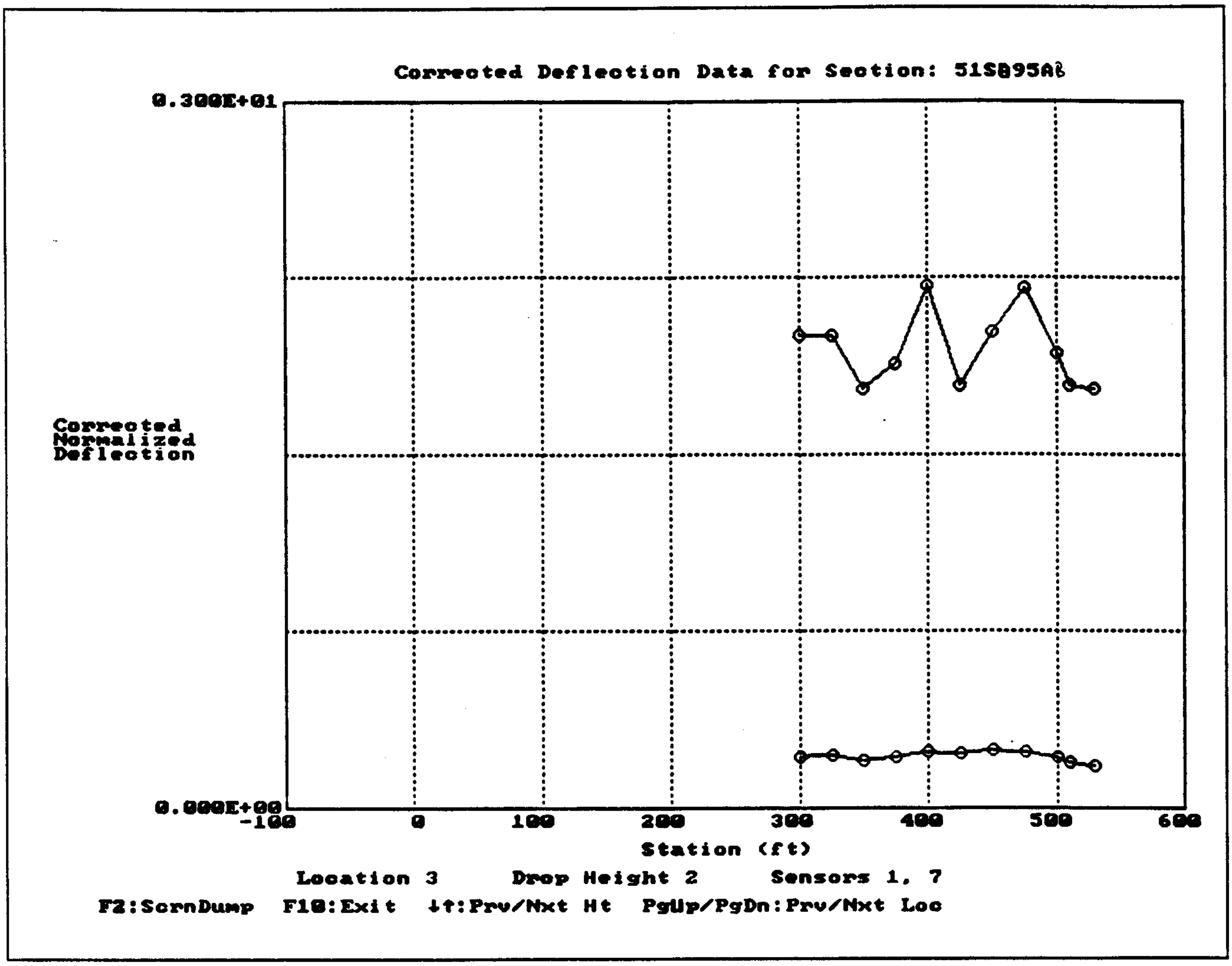


Figure D-5. Deflection Profiles from FWDCHECK
(Test Date and Time October 24, 1995 @ 1639)

Table D-4. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time October 24, 1995 @ 1639)

Flexible Pavement Thickness Statistics - 51SB95AB - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	300	14918	4.65
	325	15770	4.60
	350	16611	4.85
	375	13745	4.85
	400	11021	4.65
	425	13035	5.05
	450	11564	4.85
	475	10350	4.75
	500	11410	5.00
	510	14301	4.95
	530	15071	4.95
Subsection 1	Overall Mean	13436	4.83
	Standard Deviation	2106	0.15
	Coeff of Variation	15.68%	3.15%

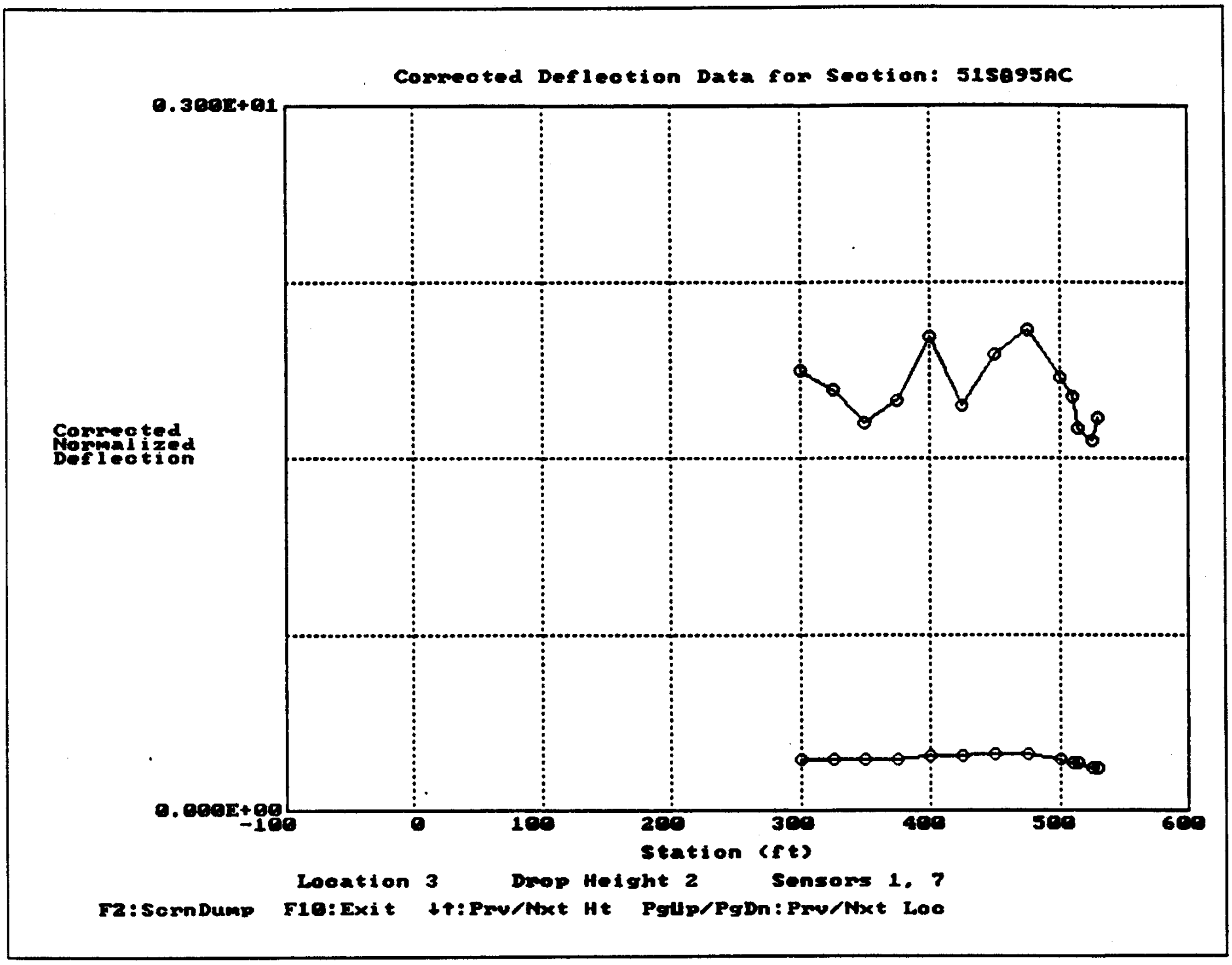


Figure D-6. Deflection Profiles from FWDCHECK
(Test Date and Time October 25, 1995 @ 1215)

Table D-5. Subgrade Modulus and Structural Number from FWDCHECK
(Test Date and Time October 25, 1995 @ 1215)

Flexible Pavement Thickness Statistics - 51SB95AC - Drop Height 2			
Subsection	Station	Subgrade Modulus	Effective SN
1	300	13786	4.90
	325	14281	4.95
	350	16062	5.05
	375	13086	5.10
	400	10982	4.90
	425	12183	5.20
	450	10983	5.00
	475	10038	4.95
	500	11095	5.15
	510	14005	5.05
	514	14015	5.25
	526	14487	5.30
	530	14427	5.15
Subsection 1	Overall Mean	13033	5.07
	Standard Deviation	1806	0.13
	Coeff of Variation	13.85%	2.60%

Table D-6. Surface Elevation Measurements

LTPP Seasonal Monitoring Study	State Code	[51]
Surface Elevation Measurements	Test Section Number	[0114]

Survey Date	October 25, 1995
Surveyed By	DS/RP
Surface Type	A/C
Benchmark	Observation Piezometer - 1.000 meters - assumed

STATION	PE m offset 0.30m	OWP m offset 0.91m	ML m offset 1.83m	IWP m offset 2.74m	ILE m offset 3.35m
3+00	2.7100	2.7250	2.7400	2.7550	2.7675
3+25	2.4125	2.4200	2.4275	2.4450	2.4550
3+50	2.1000	2.1075	2.1200	2.1375	2.1450
3+75	1.7800	1.7925	1.8150	1.8375	1.8500
4+00	1.4800	1.4950	1.5175	1.5450	1.5600
4+25	1.1800	1.1950	1.2125	1.2450	1.2600
4+50	0.8825	0.8975	0.9150	0.9375	0.9500
4+75	0.5950	0.6075	0.6200	0.6350	0.6450
5+00	0.3025	0.3100	0.3225	0.3350	0.3400
5+14	0.1350	0.1450	0.1550	0.1675	0.1700
5+20	0.0675	0.0750	0.0800	0.0925	0.0950
5+26	-0.0050	0.0025	0.0100	0.0200	0.0250

PE	Pavement Edge
OWP	Outer Wheel Path
ML	Mid Lane
IWP	Inner Wheel Path
ILE	Inner Lane Edge

* Note: The elevations have changed since the installation because there was a 40 mm lift of asphalt concrete applied to this section.

APPENDIX E

Photographs

Figure E Augering Piezometer Hole

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Figure E-3. Instrument Hole and Trench Area - Before Augering Instrument Hole

Figure E-4. Augering Instrument Hole

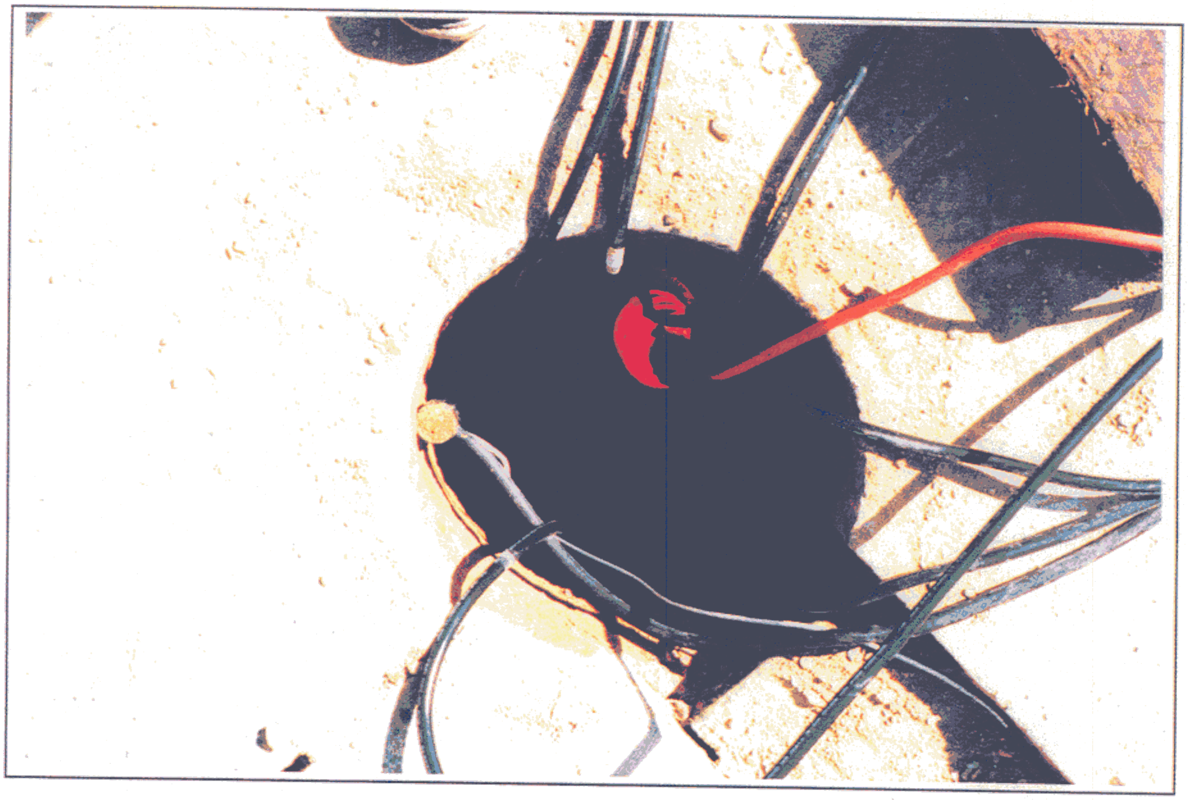

Figure E-5. Compacting Instrument Hole at TDR #5 Location

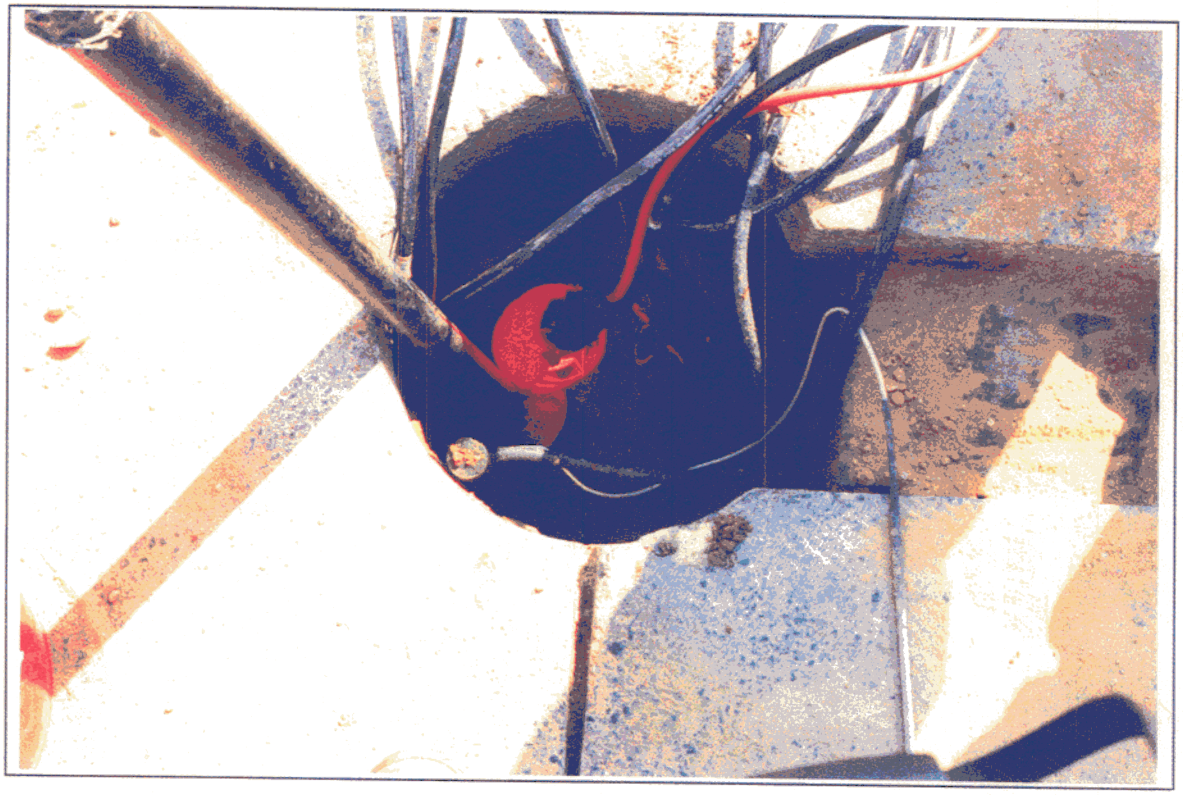

Figure E-6. Compacting Instrument Hole at TDR #3 Location

Figure E-7. Equipment Cabinet and Weather Station - Facing North

Figure E-8. Equipment Cabinet and Weather Station - Facing West

Figure E-9. Station 0+00 - Facing South

Figure E-10. Station 0+00 - Facing North