LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 281016, Kosciusko, Mississippi

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 281016, which is a part of the LTPP Core Seasonal Monitoring Program. This asphalt concrete surfaced pavement test section, which is located on SH-35 in the northbound lanes, approximately 2.25 km north of the Natchez Trail, was instrumented on 17-18 July 1995. The instrumentation installed included time domain reflectometry probes for moisture content, thermistor probe for temperature, tipping-bucket rain gauge, a piezometer observation well to monitor the ground water table, and an on-site data logger. Initial data collection was performed on 17 July 1995, which consisted of deflection measurements with a Falling Weight Deflectometer (FWD), elevation measurements, temperature measurements and TDR 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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Pavement, Highway, Instrumentation, Monitoring, Time Domain Reflectometry, Thermistor, Piezometer Observation Well, Test Equipment, Field Tests.			
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SEASONAL INSTRUMENTATION STUDY
INSTRUMENTATION INSTALLATION
MISSISSIPPI SECTION 281016/28SB

I. Introduction

The seasonal instrumentation installation of Section 281016 was performed on 17-18 July 1995.

The GPS-1 test section resides in Seasonal Cell 14 and is located in a wet-no freeze zone. The site (see Figure A-1) is in the eastbound lanes on SH-35, approximately 2.25 km north of the Natchez Trail.

The average maximum daily temperature for the months of June through August is 32.9°C and the average minimum daily temperature for the months of December through February is 1.1°C. The average annual precipitation is 1369 mm.

The pavement is a flexible structure consisting of approximately 195 mm of asphalt concrete over 525 mm of granular base. The subgrade is classified as a silty sand. The typical soil profile under the pavement is illustrated in Figure A-2. This information was obtained from bore holes drilled during the GPS material sampling and testing. The dry densities of the unbound layers are given in Table 1.

Table 1. Layer Thicknesses and Dry Densities of the Unbound Layers

Material	Layer Thickness (mm)	In Situ Dry Density (kg/m^3)
Asphalt Concrete	195	- - -
Base	525	1800
Subgrade	---	1907

The annual average daily traffic (AADT) in the GPS lane is almost 2000, of which 5.5% is truck traffic. The estimated annual ESALs on the GPS lane were 31,000. This information is based on traffic data collected on site.

Installation of the instrumentation was completed through the cooperative efforts of the Mississippi Department of Transportation (Mississippi DOT), and Southern Region Coordination Office (SRCO) staff from Brent Rauhut Engineering Inc. (BRE), with guidance and training previously provided by the Federal Highway Administration Long Term Pavement Performance office (FHWA-LTPP) and its Technical Assistance Contractor (TAC).

The following is a list of the personnel who participated in the installation:

Larry Peirce	SRCO, Brent Rauhut Engineering
Jon Peacock	SRCO, Brent Rauhut Engineering
Steve Davis	SRCO, Brent Rauhut Engineering
Robin Belt	SRCO, Brent Rauhut Engineering
Hunter Estes	SRCO, Brent Rauhut Engineering
Dan McMinn	Mississippi DOT
Gary Browning	Mississippi DOT
Reggie Jenkins	Mississippi DOT
Vernell Flemming	Mississippi DOT
Marvin Smith	Mississippi DOT

II. Instrumentation Installation

Pre-Installation Activities

A pre-installation meeting was held at the Mississippi DOT Office of Research on 18 May 1995. The meeting agenda appears in Appendix B. The participants at the meeting were personnel from the Mississippi DOT, FHWA and SRCO. At the planning meeting, roles and responsibilities for all the various tasks to be performed during installation were assigned. A slide presentation was given, highlighting the order of operations for the installations in Delta, Colorado, Grand Rapids, Minnesota and various Texas installations.

A site inspection and a manual distress survey were performed on 19 May 1995 by Larry Peirce (SRCO). Deflection testing was conducted on 18 July 1995. The 0-20 end of the test section was selected for instrumentation, based on the amount of distress present, uniformity of the deflection profile, and the fact that a driveway and merge-lane existed on the 5+00 end. Both the deflection plots and distress survey data can be found in Appendix A.

Equipment Installed

The equipment installed at the test site included instrumentation for measuring air and subsurface temperature, rainfall and subsurface moisture contents. An equipment cabinet was installed to house the cable leads from the instrumentation, the data logger and the battery pack. In addition, a piezometer observation well was set to measure the depth to the water table. A list of the equipment installed, with the respective serial numbers, is in Table 2.

Table 2. Equipment Installed

Equipment	Quantity	Serial №.
Instrument Hole		
MRC Thermistor Probe	1	187 (28BT)
TDR Sensors	10	28B01-28B10
Equipment Cabinet		
CR10 Data Logger	1	16583
Battery Package	1	Gel Cell
Weather Station		
Tipping-Bucket Rain Gauge	1	12092-693
Air Temperature Probe	1	421316
Piezometer Observation Well	1	N/A

Equipment Check/Calibration

Prior to installation, all instrumentation was checked or calibrated. The CR10 Data Logger was wired according to the Guidelines and the air temperature probe and thermistor probe were connected and monitored over a period of several hours to ensure that the sensors were working. The tipping-bucket was also connected to the data logger and the calibration was checked according to the method recommended by the manufacturer. These tests indicated that the air temperature probe and thermistor probe were working properly and that the tipping-bucket measurement was within the manufacturer's specifications. The TDR probes were also calibrated using an "in-air" test and "in-water" test for accuracy, the results of which can be found in Appendix B.

In addition to the above tests, the distances between sensors in the thermistor were measured and are presented in Table 3.

Table 3. Sensor Spacing in MRC Thermistor Probe

Unit	Channel Nº.	Distance from Top of Unit (mm)	Remarks
1	1	Not Measured	This unit was installed in the AC layer.
	2	Not Measured	
	3	Not Measured	
2	4	22	This unit was installed in the base and subgrade.
	5	105	
	6	175	
	7	251	
	8	337	
	9	480	
	10	632	
	11	786	
	12	935	
	13	1090	
	14	1241	
	15	1395	
	16	1544	
	17	1698	
	18	1845	

Location of Instrumentation

The instrumentation was installed at Station 0-20 of the test section. Approximately 940 mm from the lane edge, in the outside wheel path, a 305 mm core was removed from the pavement and a 254 mm diameter hole, 2.21 m deep, was drilled to install the thermistor probe and TDR sensors. Cables from the instrumentation were placed in a 51 mm diameter flexible conduit and buried in a 102 mm wide trench leading to the equipment cabinet located approximately 7.34 m from the lane edge.

The piezometer observation well was installed at Station 0+75 of the test section approximately 4.1 m from the lane edge. The piezometer observation well also serves as the swell-free benchmark for this project.

Installation

Installation of the monitoring equipment was begun on 18 July 1995 and was completed the following day. The Mississippi DOT provided all coring, drilling and sawing equipment and manpower for the instrumentation activities. The monitoring equipment and cabinet installation was performed by the SRCO staff. Traffic control was also provided by the Mississippi DOT.

The first day of operations included traffic control; site layout and marking; installation of the thermistor probe, TDR probes, air temperature probe and rain gauge; and wiring of the cabinet. The installation of all equipment was performed according to the procedures outlined in the "LTPP Seasonal Monitoring Program: Instrumentation and Data Collection Guidelines."

To ensure functioning of the TDR sensors during installation, the 1502B cable tester was connected to each sensor as backfilling of the instrumentation hole was performed. If a reasonable trace was displayed, it was assumed the sensor was functioning properly. The trace was printed for each TDR and the moisture content was determined using Topp's equation. The field moisture content was also measured by drying the soil on a propane stove. The TDR moisture contents, position of the TDR sensors and field moisture contents appear in Table 4. Both the field moisture contents and the field printed traces appear in Appendix C. Table 5 shows the distance from the top of the pavement to each of the individual thermistor sensors.

In addition, a single field density (one-point Proctor) test was performed on material taken at a depth of 1.24 m. The results from this test appear in Appendix C, Figure C-2.

When backfilling of the instrumentation hole was completed, the pavement core was repaired and replaced using PC-7 Epoxy and Dow 890 crack sealant. The overcuts from the pavement sawing operation (including the groove for the temperature probe) were also sealed with Dow-Corning 890 crack sealant.

Upon completion of the installation, the ONSITE program was downloaded to the onsite CR10 Data Logger and data from the air temperature probe, rain gauge and thermistor probe were collected overnight and evaluated the second day.

The second day activities included traffic control setup, evaluation of the data collected the previous night, monitoring of the TDR sensors, deflection testing and elevation surveys. The following sections describe these operations.

Table 4. Location of TDR Sensors and Measured Moisture Contents

Sensor №.	Sensor Depth (mm)	TDR Moisture Content (%, by wt)	Measured Moisture Content (%, by wt)
28B01	350	12.2	19.0
28B02	510	7.2	8.8
28B03	655	10.2	15.2
28B04	810	10.8	15.7
28B05	955	6.2	14.3
28B06	1110	10.5	17.6
28B07	1260	8.2	16.0
28B08	1415	9.2	19.7
28B09	1710	5.3	20.4
28B10	1960	7.2	20.1

Table 5. Thermistor Sensor Locations

Unit	Channel №.	Depth from Pavement Surface (mm)	Remarks
1	1	25	This unit was installed in the AC layer.
	2	98	
	3	172	
2	4	276	This unit was installed in the base and subgrade.
	5	359	
	6	429	
	7	505	
	8	591	
	9	734	
	10	886	
	11	1040	
	12	1189	
	13	1344	
	14	1495	
	15	1649	
	16	1798	
	17	1952	
	18	2099	

III. Initial Data Collection

Onsite Data Logger

The air temperature, subsurface temperatures and rainfall data were collected by the onsite CR10 Data Logger. The version of the ONSITE program used reads the thermistor probe (18 sensors) every minute. The average temperatures for the first five sensors are recorded hourly and the average temperature for every sensor is saved daily. The maximum and minimum temperature for all sensors are also saved on a daily basis.

The air temperature is read every minute by the ONSITE program and the average temperature is saved both daily and hourly. The maximum and minimum temperatures are saved daily. The precipitation is recorded on both an hourly and daily basis.

Figure D-1 shows the average hourly ambient air temperatures which were collected the night of 17 July 1995. Figure D-2 shows hourly average subsurface temperatures for the first five sensors for the same data collection period. Figure D-3 shows the measured average subsurface temperatures for all 18 sensors during the initial data collection.

Moisture Content Measurement by TDR Sensors

TDR data were collected using the mobile data logging system provided by the FHWA. The mobile system consists of a CR10 Data Logger, battery pack and two multiplexors for TDR data collection.

To begin data collection using the mobile system the TDR cable leads and 1502B cable reader were connected to the proper channels and the MOBILE program was downloaded from the notebook computer to the CR10 Data Logger. After approximately five minutes, the cable reader was triggered by the MOBILE program and the TDR traces were displayed. The data collection process was completed in approximately five minutes and was automatically repeated four hours later. The data were then uploaded to the notebook computer. Traces displayed on the cable reader indicated that the sensors were working properly. Figures D-4 through D-13 show the plots of the TDR traces obtained approximately 24 hours after installation. It should be noted that initial TDR readings yielded very low moisture contents, but have since stabilized.

Deflection Measurements

Deflection measurements were made according to the procedures outlined in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines." At this time no analysis has been performed on this data.

Elevation Surveys

The elevation of the benchmark was assumed to be 0.000 meters and surface elevations were measured following the guidelines. These elevations were measured using a Spectra-Physics Laser Plane 350 level and Lenker rod, and were converted to the SI system using soft conversion factors. The elevations are contained in Appendix D.

IV. Summary

The instrumentation installation on Section 281016 (28SB) was completed on 18 July 1995 and initial data collection was completed on 19 July 1995. Instrumentation and equipment currently at the site includes time domain reflectometry probes for moisture content measurements; a thermistor probe for monitoring temperature gradient changes in the pavement, base and subgrade layers; a tipping-bucket rain gauge; an air temperature probe; a piezometer observation well to monitor ground water table movements and serve as a permanent swell and frost-free benchmark; and an on-site data logger and battery pack. Photos from the installation day appear in Appendix E.

At the time of this report, all of the equipment installed on-site appears to be functioning properly. The installation of the instrumentation at this site went fairly smoothly and all of the equipment appears to be functioning properly.

APPENDIX A

Test Section Background Information

Appendix A contains the following information:

Figure A-1.	Site Location Map
Figure A-2.	Profile of Test Section Layers
Figure A-3 thru Figure A-7.	Plots from FWDCHECK
Figure A-8.	Manual Distress Survey Data

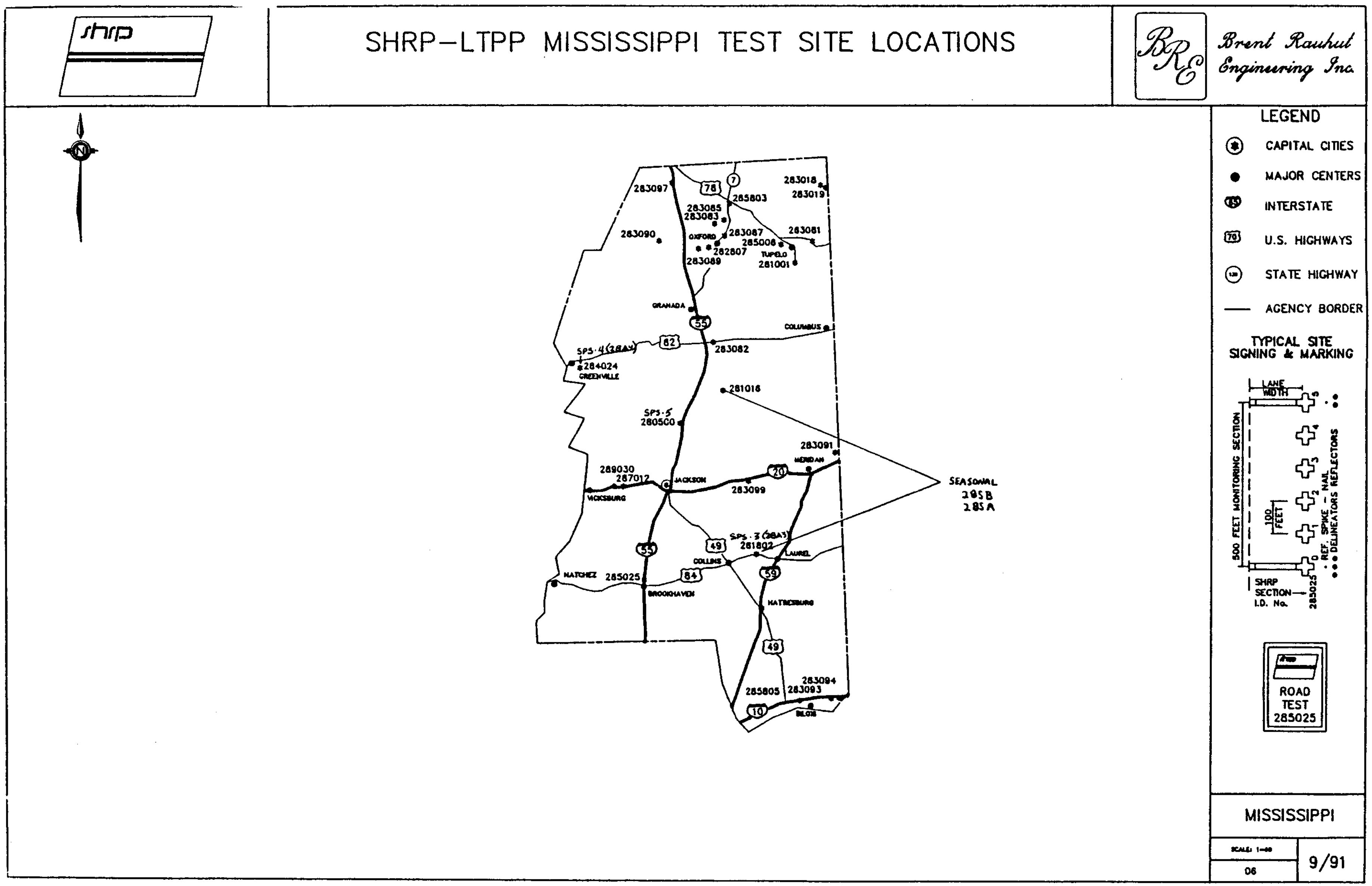


Figure A-1. Location of Test Site, GPS Test Section 281016

LTPP Seasonal Monitoring Program Data Sheet SMP-I04 Log of Instrumentation Hole	Agency Code 28SB [28] LTPP Section ID [1016]

Operator: DAN McMINN Equipment Used: ALTEC AUGER

Location: Station: 0-20 Offset: +0.94 m (from lane edge)

Bore Hole Diameter: 254. mm

Scale (m)	Strata Change[1] (m)	Material Description	Material Code[2]
0.10 0.20	.195	AC	700
0.30 0.40 0.50 0.60 0.70	.72	Red Silty Sand	59
0.80 0.90 1.00	1.06	Brown Clay w/Gravel	51
1.10 1.20 1.30 1.40 1.50	1.50	Brown Sand - Damp	57
1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50		Reddish Brown Silty Sand w/ Clay balls	60

[1] Format: _ . _ _ _ m; [2] Format: _ _ _

Prepared by: L. PEIRCE Employer: BRENT RAUHUT ENG.

Date (dd/mm/yy): 18/07/95

Data Sheet SMP-I04: Log of Instrumentation Hole

Figure A-2. Profile of Test Section Layers

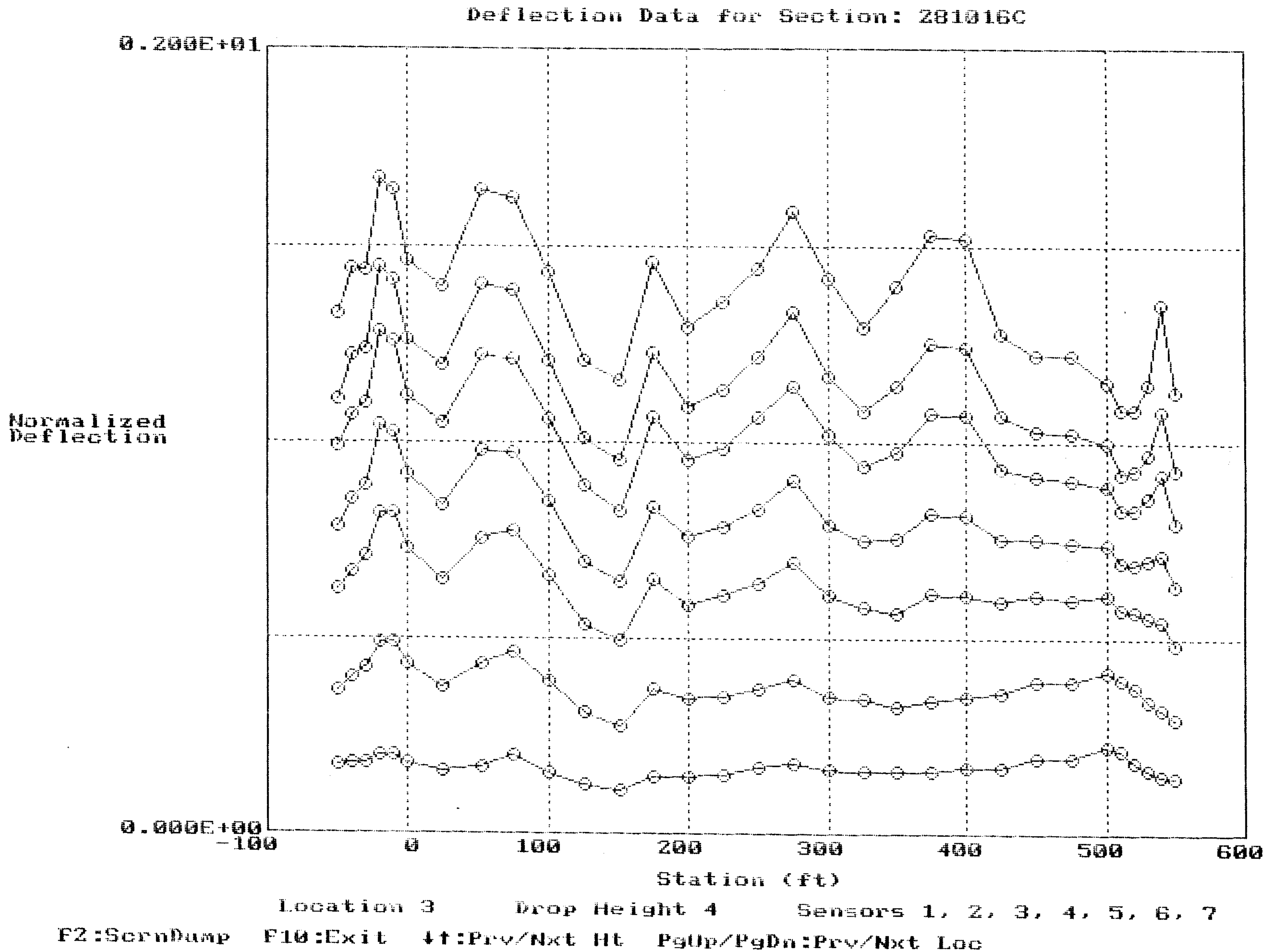


Figure A-3. Deflection Profiles from FWDCHECK

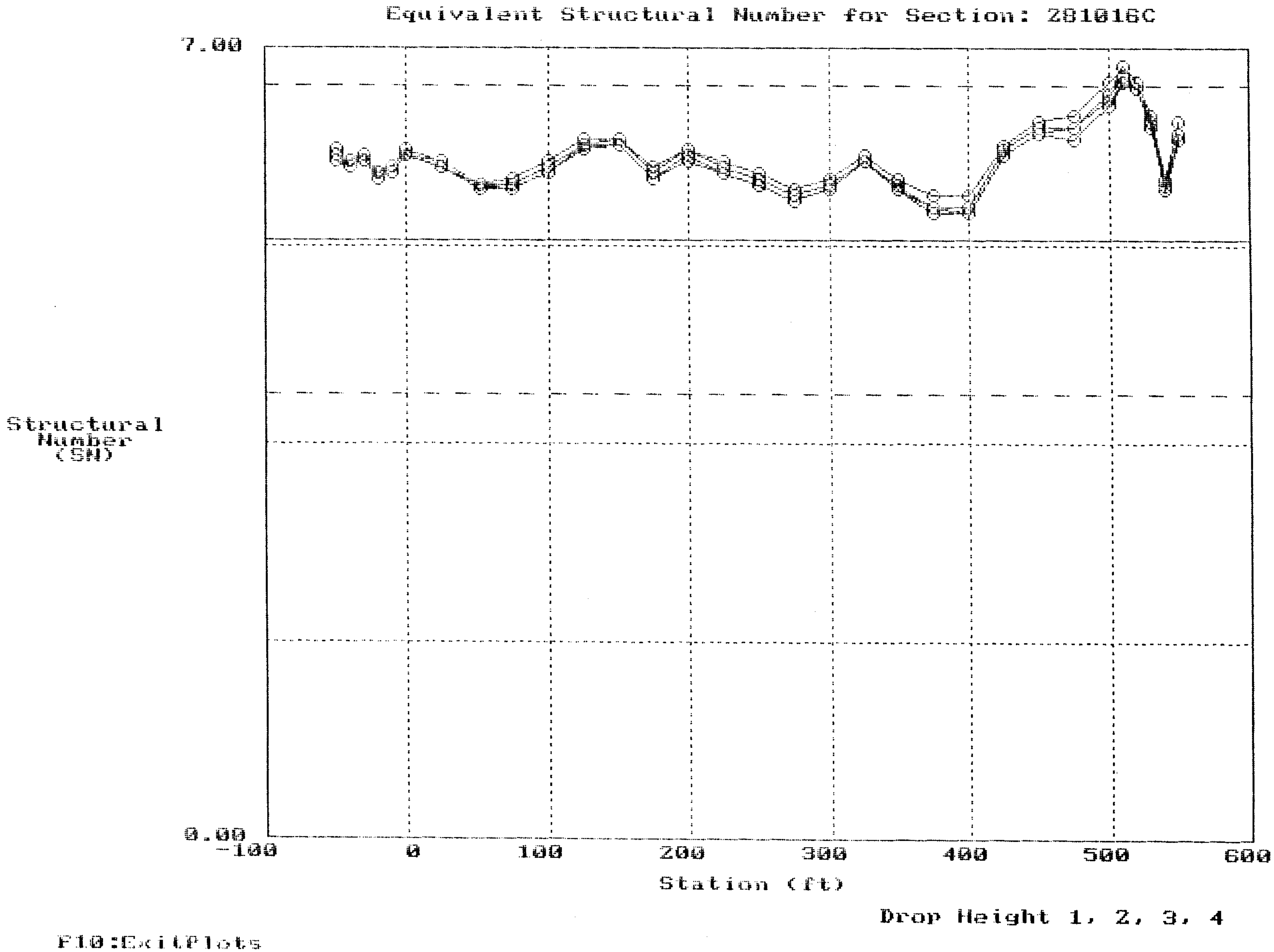


Figure A-4. Structural Number Profiles from FWDCHECK

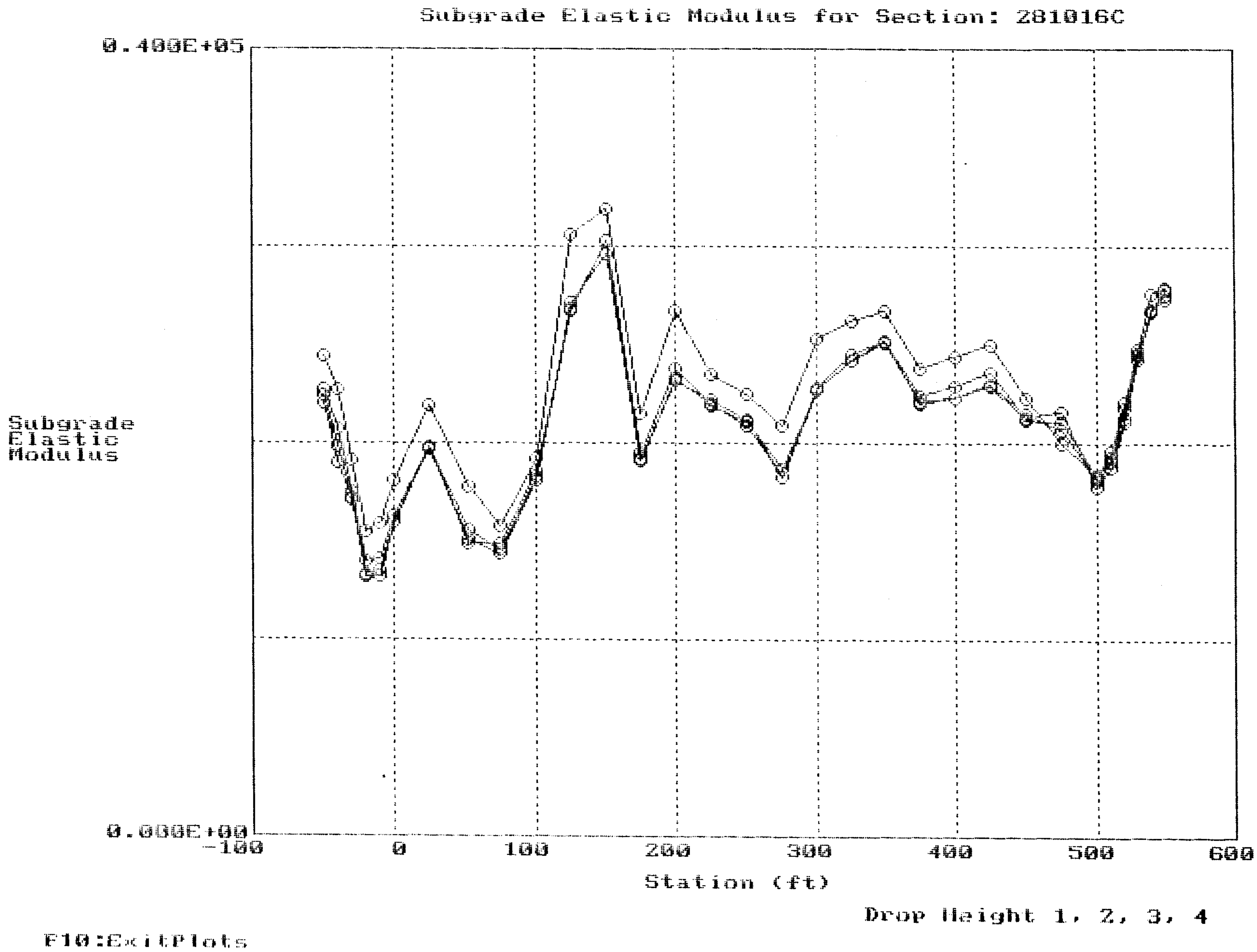


Figure A-5. Subgrade Modulus Profiles from FWDCHECK

Revised December 1, 1992

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 2 8

SHRP SECTION ID 1 0 1 6

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 0 8/0 8/9 5

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

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
CRACKING			
1. FATIGUE CRACKING (Square Meters)	0.0	0.0	0.0
2. BLOCK CRACKING (Square Meters)	0.0	0.0	0.0
3. EDGE CRACKING (Meters)	0.0	0.0	0.0
4. LONGITUDINAL CRACKING (Meters)			
4a. Wheel Path	6.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
4b. Non-Wheel Path	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
5. REFLECTION CRACKING AT JOINTS Number of Transverse Cracks	0	0	0
Transverse Cracking (Meters)	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
Longitudinal Cracking (Meters)	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
6. TRANSVERSE CRACKING Number of Cracks	0	0	0
Length (Meters)	0.0	0.0	0.0
Length Sealed (Meters)	0.0	0.0	0.0
PATCHING AND POTHOLES			
7. PATCH/PATCH DETERIORATION (Number)	0	0	0
(Square Meters)	0.0	0.0	0.0
8. Potholes (Number)	0	0	0
(Square Meters)	0.0	0.0	0.0

Figure A-9. Distress Survey Data

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 2 8

SHRP SECTION ID 1 0 1 6

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 0 2 / 2 8 / 9 5

SURVEYORS: S D _, _ _ _

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

DISTRESS TYPE	SEVERITY LEVEL LOW	MODERATE	HIGH
SURFACE DEFORMATION			
9. RUTTING - REFER TO SHEET 3 FOR SPS-3 OR Form S1 from Dipstick Manual			
10. SHOVING (Number)			_ _ 0
(Square Meters)			_ _ 0.0
SURFACE DEFECTS			
11. BLEEDING (Square Meters)	_ _ 0.0	_ _ 0.0	_ _ 0.0
12. POLISHED AGGREGATE (Square Meters)			_ _ 0.0
13. RAVELING (Square Meters)	_ _ 0.0	_ _ 0.0	_ _ 0.0
MISCELLANEOUS DISTRESSES			
14. LANE-TO-SHOULDER DROPOFF - REFER TO SHEET 3			
15. WATER BLEEDING AND PUMPING (Number)			_ _ 0
Length of Affected Pavement (Meters)			_ _ 0.0
16. OTHER (Describe) ______			

Figure A-9 (Continued). Distress Survey Data

Revised May 29, 1992

SHEET 3

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID ___ ___ ___ ___

STATE CODE 2 8

SHRP SECTION ID 1 0 1 6

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 0 3 / 0 3 / 9 5

SURVEYORS: S Z ___, ___ ___ ___

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

9. RUTTING (FOR SPS-3 SITE SURVEYS)

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

14. LANE-TO-SHOULDER DROPOFF

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

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

Figure A-9 (Continued). Distress Survey Data

State Assigned ID ______

State Code 28

SHRP Section ID 1016

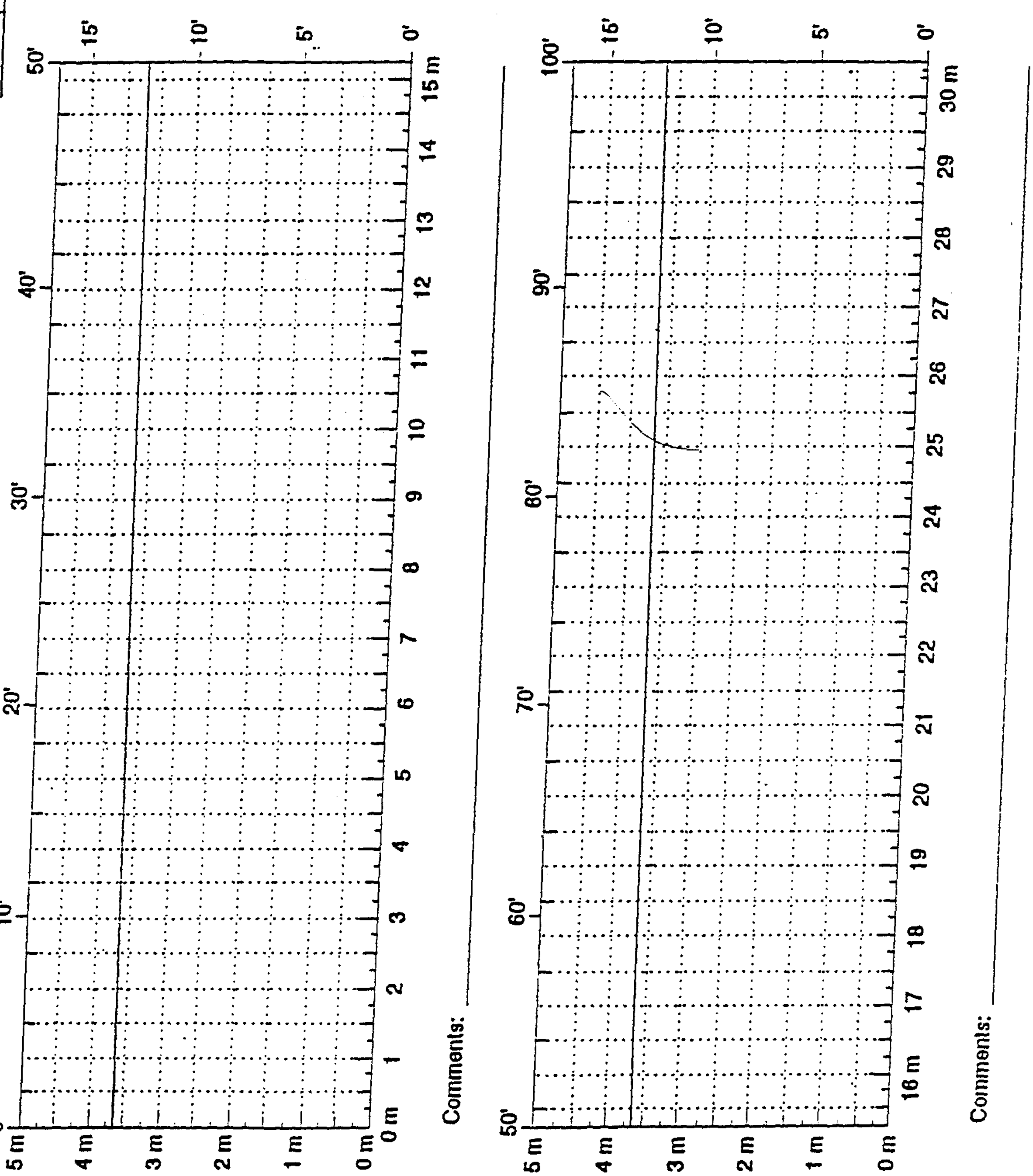


Figure A-9 (Continued). Distress Survey Data

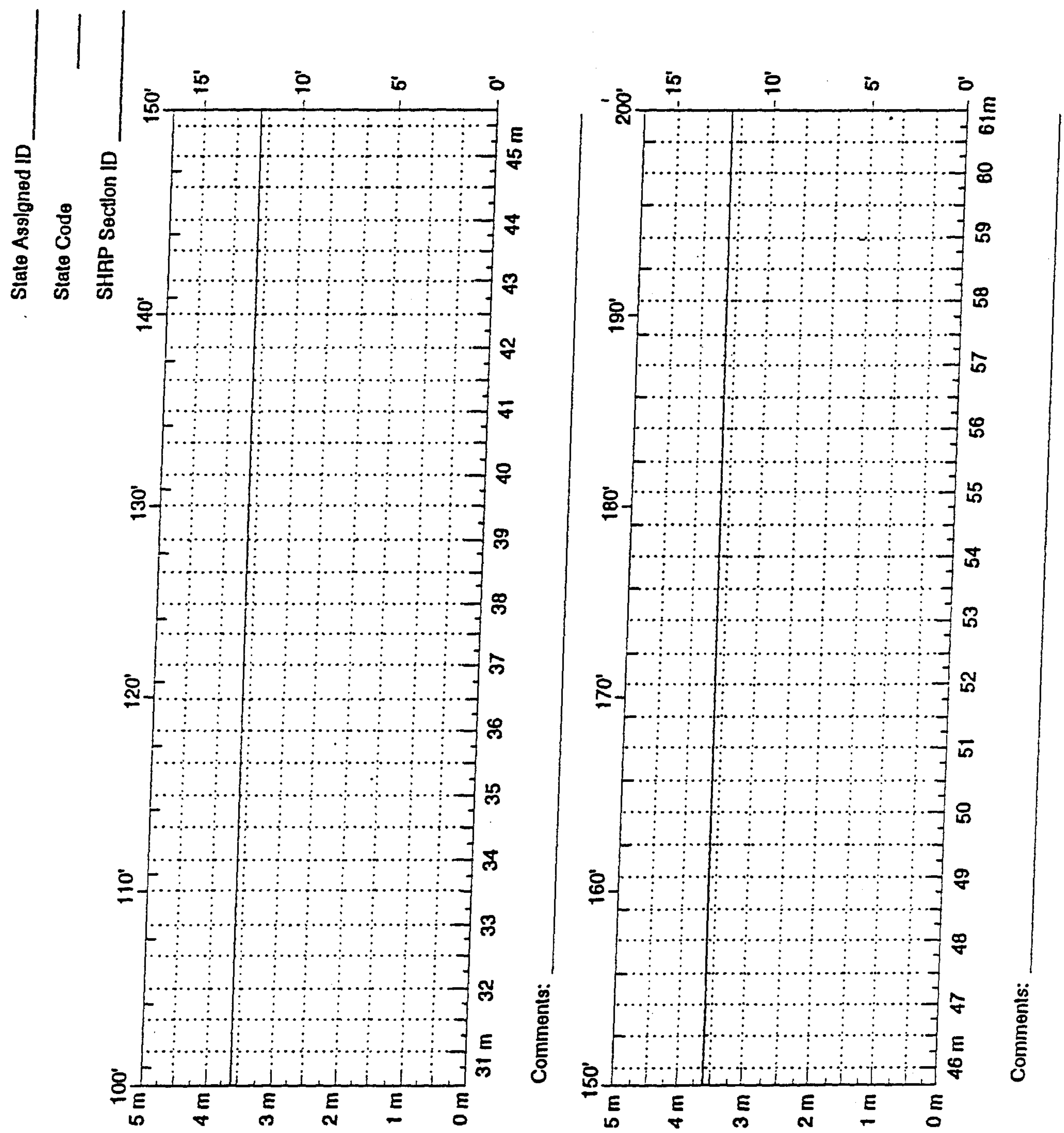


Figure A-9 (Continued). Distress Survey Data

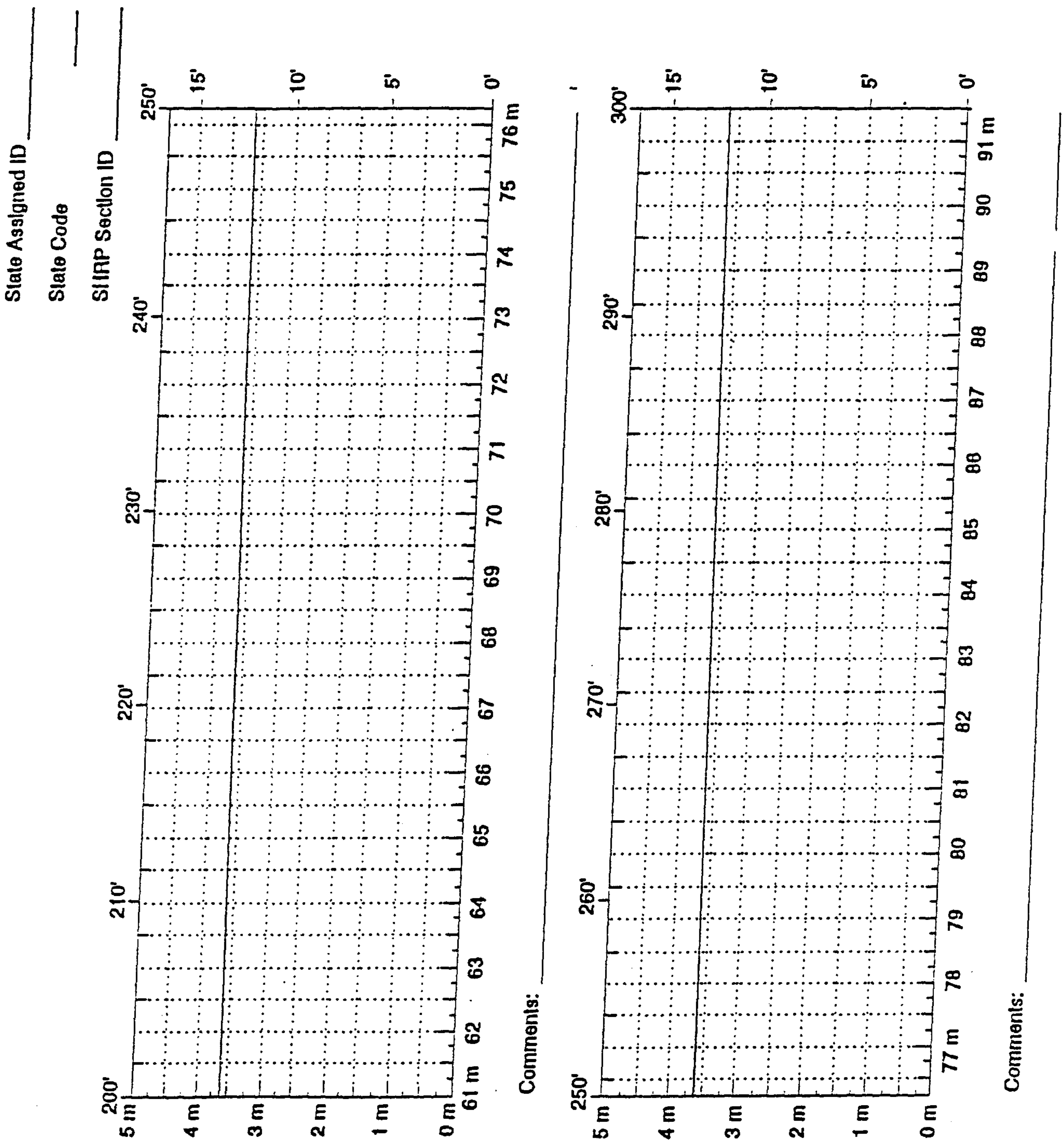


Figure A-9 (Continued). Distress Survey Data

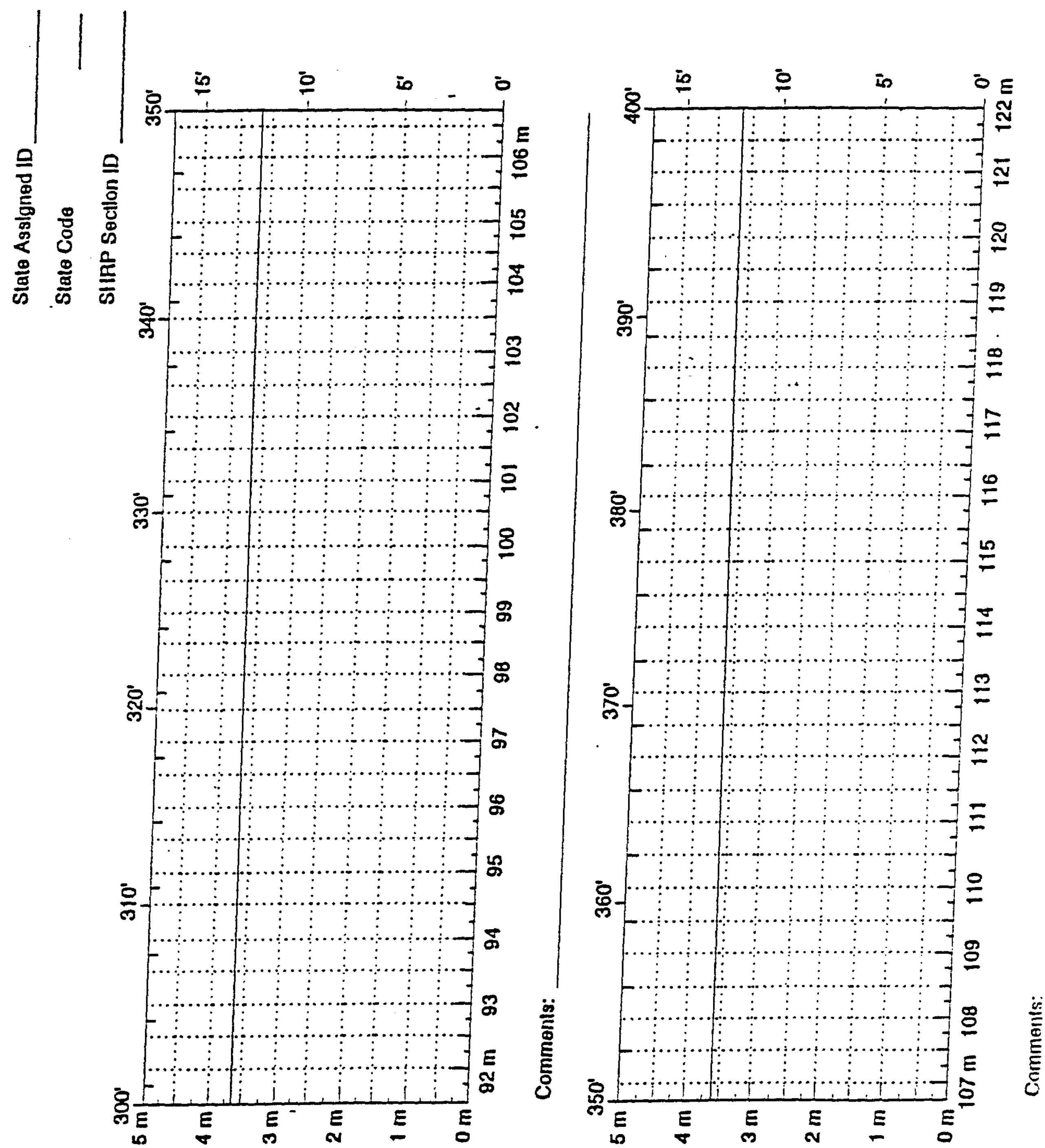


Figure A-9 (Continued). Distress Survey Data

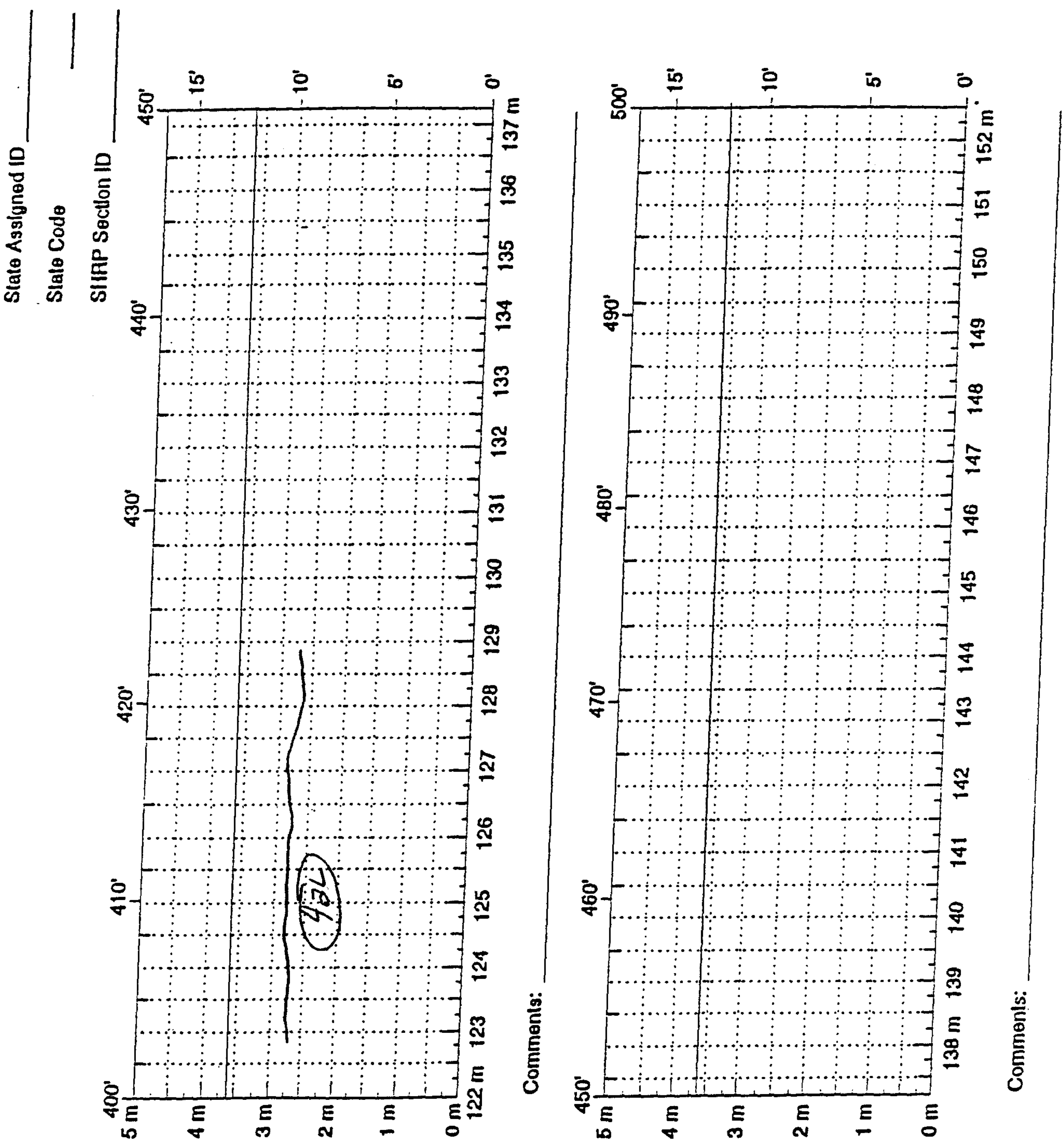


Figure A-9 (Continued). Distress Survey Data

APPENDIX B

Pre-installation Activities

Appendix B contains the following information:

Seasonal Monitoring Meeting Agenda

Seasonal Site Information

Figure B-1. TDR Traces Obtained During Calibration

AGENDA

Seasonal Monitoring Meeting

18 May 1995

I. Introductions

II. Brief Overview of the Seasonal Program

III. Roles & Responsibilities

IV. Activities on Site - Day 1

- A. Arrival
- B. Traffic Control
- C. Marking Section
- D. FWD Testing
- E. Sawing/Coring
- F. Observation Well
- G. Instrumentation Hole
- H. Weather Station
- I. Hook-up all Electronics
- J. Patching/Clean-up

V. Activities on Site - Day 2

- A. Instrumentation Check
- B. Data Collection
  - 1. FWD Testing
  - 2. Rod/Level Elevations
  - 3. Download Instrumentation Data

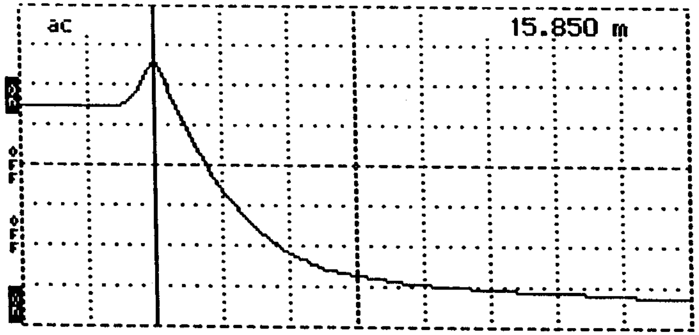
VI. Questions/Discussion

MISSISSIPPI SEASONAL SITE INFORMATION

Type	SHRP ID	Hwy №.	Location of Test Section
AC over Granular Base	281802	US-84, Covington Co. Eastbound	2.41 km W. of the Covington/ Jones Co. line.
AC over Granular Base	281016	SH-35, Attala Co. Northbound	2.25 km N. of the Natchez Trail.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [28] LTPP Section ID [SB01]

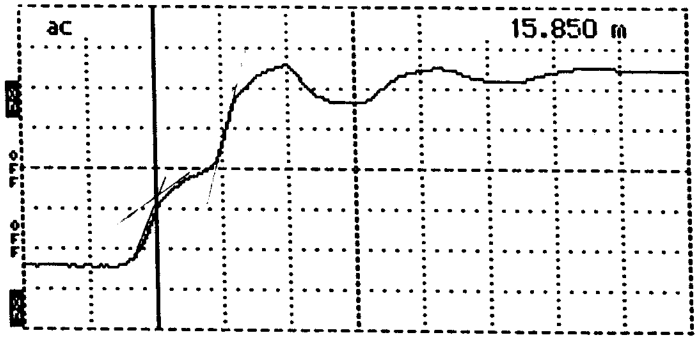
Cursor .... 15.850 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B01
Notes SHORTED
[illegible]
Input Trace
Stored Trace
Difference Trace

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

Cursor .... 15.850 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date [illegible]
Cable 28B01
Notes AIR
[illegible]
Input Trace
Stored Trace
Difference Trace

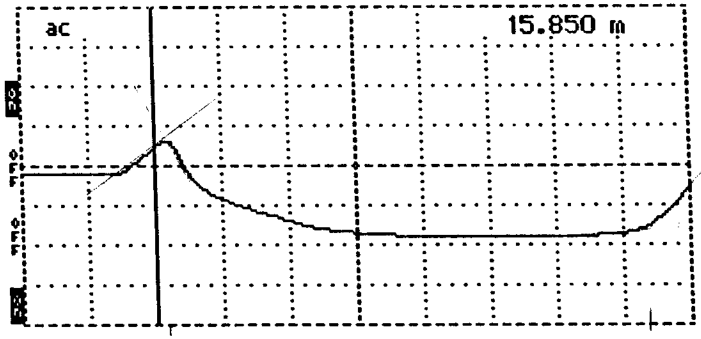
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C01: TDR Probe Check

Figure B-1. TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [28] LTPP Section ID [SB01]

Cursor .... 15.850 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date ____
Cable 28B01
Notes ____

Input Trace ____
Stored Trace ....
Difference Trace ....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.78	78.50

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 28B01 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: ____

Prepared by: Hunter Estes Employer: BRE

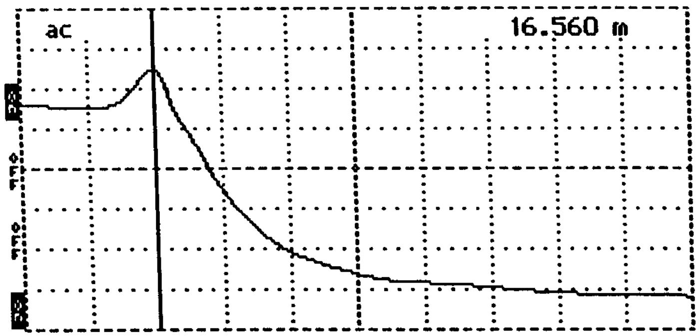
Date (dd/mmm/yy): 30/06/95

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 0 2]

Cursor .... 16.560 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac

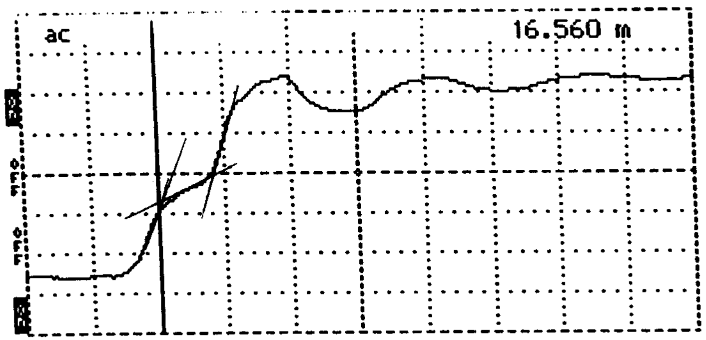


Tektronix 1502B TDR
Date 06/30/95
Cable 28B02
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.560 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B02
Notes Air

Input Trace
Stored Trace
Difference Trace

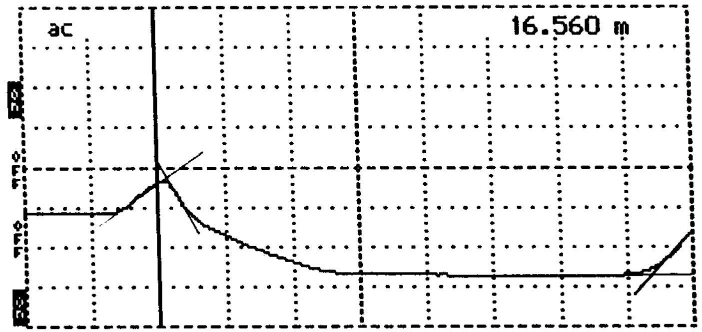
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	__ . 1 9	__ 0 . 8 9

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 0 2]

Cursor .... 16.560 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B02
Notes WATER

Input Trace ———
Stored Trace ....
Difference Trace ....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1 . 8 1	8 1 . 1 1

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 0 2   TDR Probe Length, L: 0 . 2 0 3 m   Length of Coax Cable: 1 2 . 2 m

Comments: ______________________

Prepared by: Hunter Estes   Employer: BRE

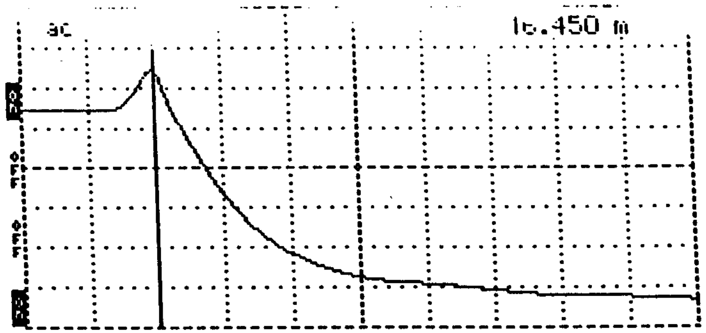
Date (dd/mmm/yy): 30 / 06 / 96

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 0 3]

Cursor .... 16.450 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac

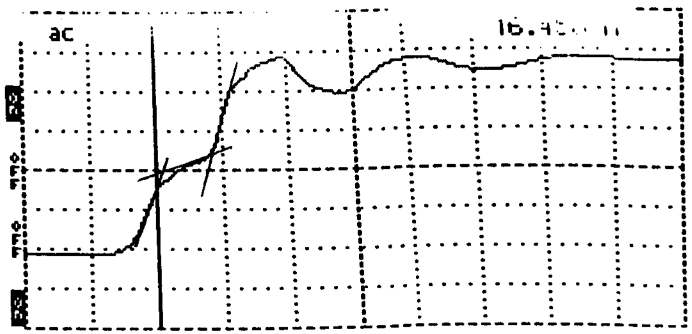


Tektronix 1502B TDR
Date 06/30/95
Cable 28B03
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.450 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B03
Notes Air

Input Trace
Stored Trace
Difference Trace

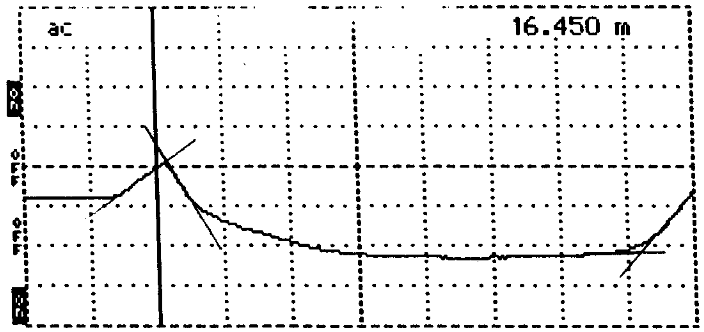
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 1 8	0 . 8 0

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 0 3]

Cursor .... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B03
Notes [illegible]

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.76	76.69

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 0 3 TDR Probe Length, L: 0 . 2 0 3 m Length of Coax Cable: 1 2 . 2 m

Comments: __________

Prepared by: Hunter Estes Employer: BRE

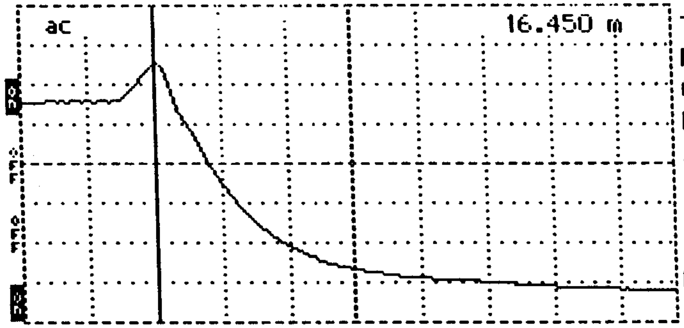
Date (dd/mmm/yy): 3 0 / 0 6 / 9 5

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 4]

Cursor .... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

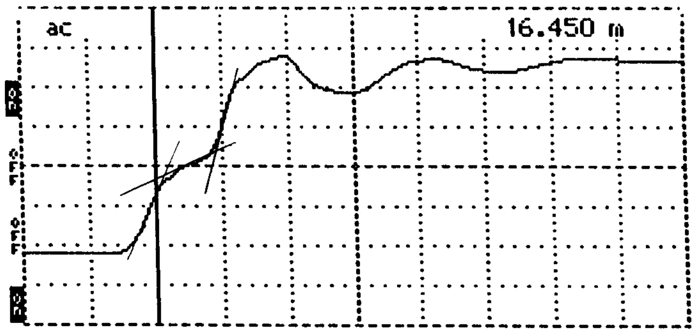


Tektronix 1502B TDR
Date 06/30/95
Cable 28B04
Notes

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B04
Notes

InputTrace
Stored Trace
Difference Trace

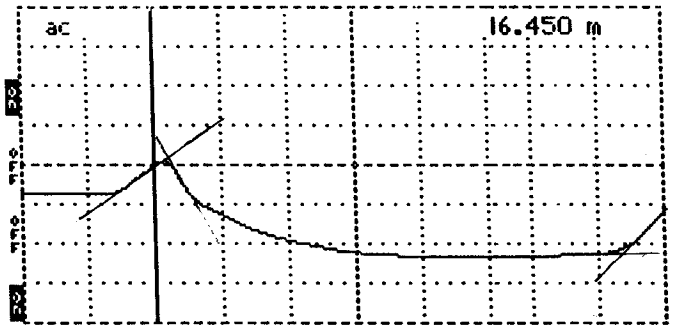
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 2 0	_ 0 . 9 9

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 4]

Cursor .... 16.450 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B04
Notes water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.80	80.22

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 0 4 TDR Probe Length, L: 0 . 2 0 3 m Length of Coax Cable: 1 2 . 2 m

Comments: ______

Prepared by: Hunter Estes Employer: BRE

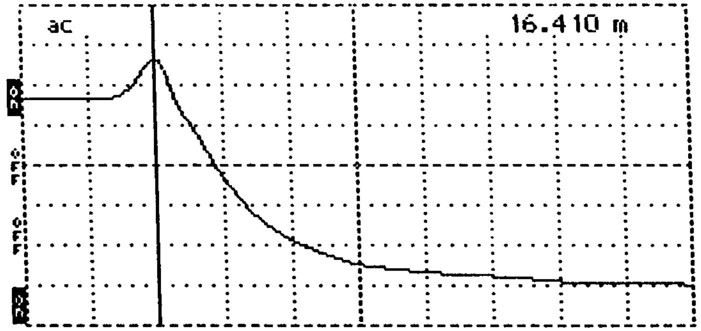
Date (dd/mmm/yy): 30 / 06 / 95

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 5]

Cursor .... 16.410 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac

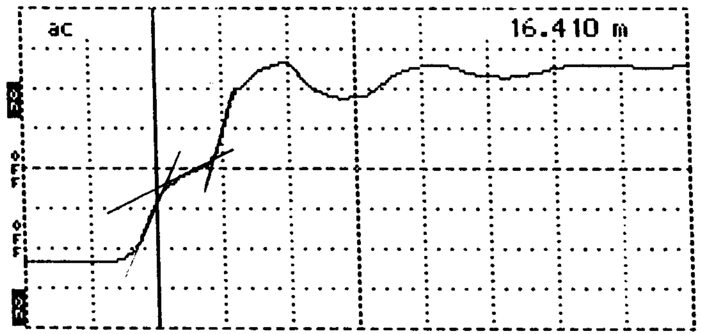


Tektronix 1502B TDR
Date 06/30/95
Cable 28B05
Notes [illegible]

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.410 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B05
Notes AIR

Input Trace
Stored Trace
Difference Trace

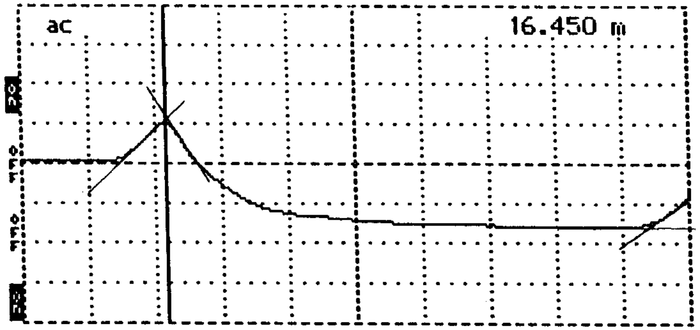
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.22	1.20

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 5]

Cursor .... 16.450 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 04/30/95
Cable 28B05
Notes WATER

Input Trace ahP
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.84	83.82

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 0 5   TDR Probe Length, L: 0 . 2 0 3 m   Length of Coax Cable: 1 2 . 2 m

Comments: ______

Prepared by: Hunter Estes   Employer: BRE

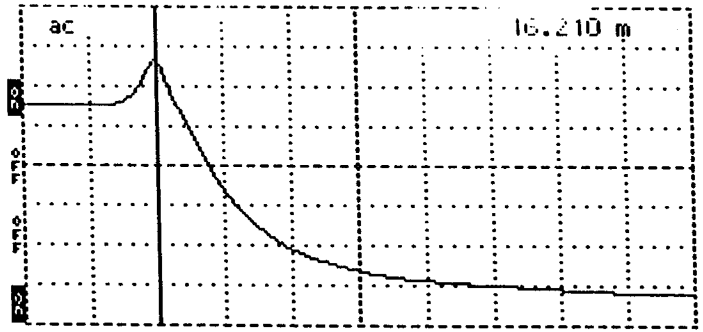
Date (dd/mmm/yy): 30 / 06 / 95

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 6]

Cursor .... 16.210 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac

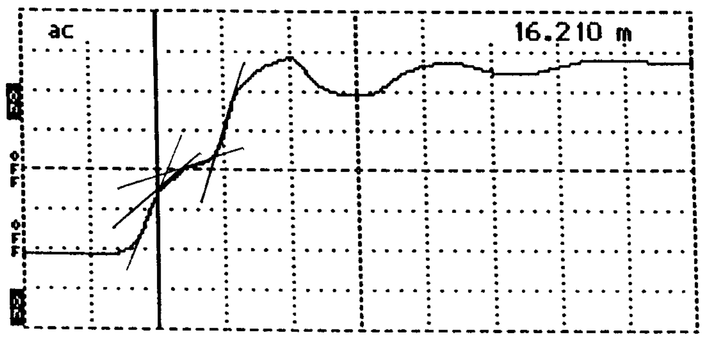


Tektronix 1502B TDR
Date 06/30/95
Cable 28B06
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.210 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B06
Notes Air

Input Trace
Stored Trace
Difference Trace

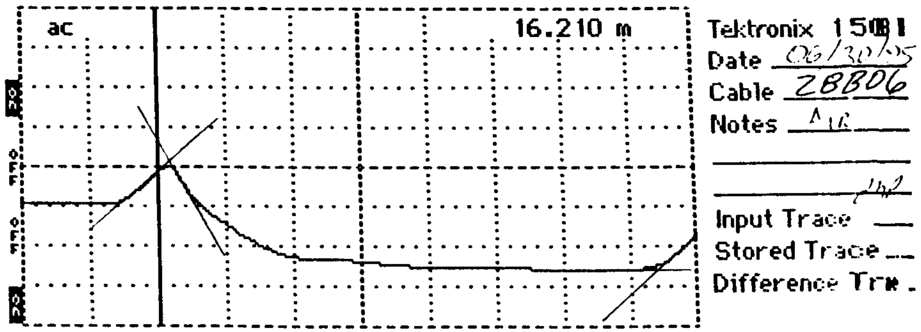
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 2 0	_ 0 . 9 9

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 0 6]

Cursor .... 16.210 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.81	81.11

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 0 6   TDR Probe Length, L: 0 . 2 0 3 m   Length of Coax Cable: 1 2 . 2 m

Comments: ____________________

Prepared by: Hunter Estes   Employer: BRE

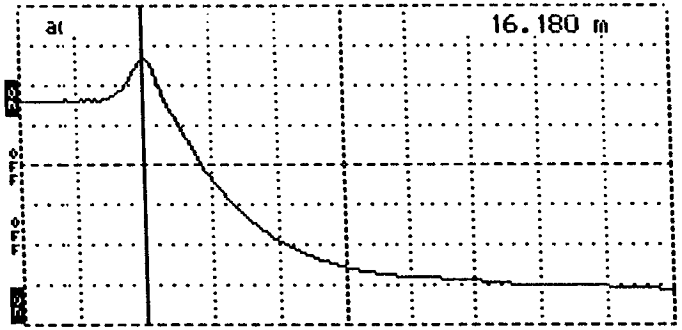
Date (dd/mmm/yy): 30 / 06 / 95

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 8 0 7]

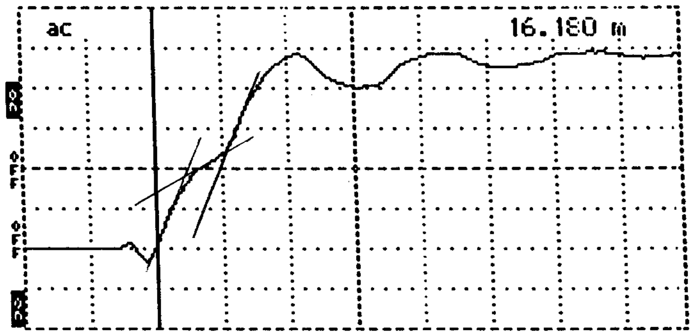
Cursor .... 16.180 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektroni 1502B TDR
Date 06/30/95
Cable 28B07
Notes SHORTED
12.2M
Input Tre
Stored hce
Differe Trace

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

Cursor .... 16.180 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter ...... 1 avg
Power .... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B07
Notes AIR (AFTER LUNCH)
Input Trace
Stored Trace
Difference Trace

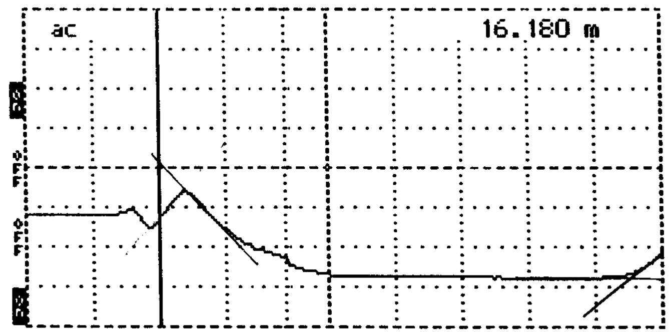
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 1 8	__ 0 . 8 0

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 7]

Cursor .... 16.180 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B07
Notes Water

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.78	78.45

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 0 7   TDR Probe Length, L: 0 . 2 0 3 m   Length of Coax Cable: 1 2 . 2 m

Comments: ______

Prepared by: Hunter Estes   Employer: BRE

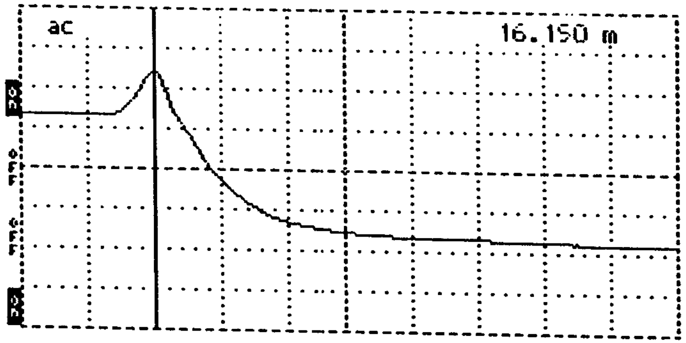
Date (dd/mmm/yy): 3 0 / _ 0 6 / 9 5

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [Z 8] LTPP Section ID [S B 0 8]

Cursor .... 16.190 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac

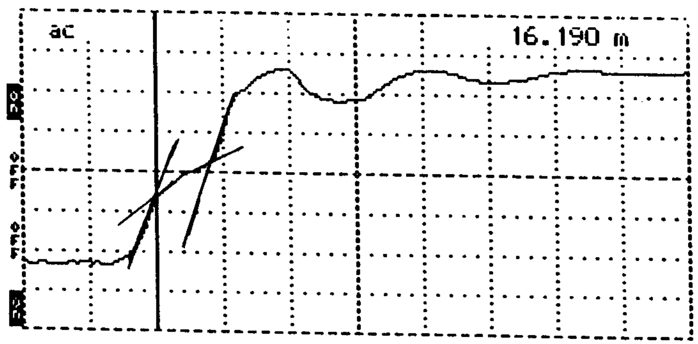


Tektronix 1502B TDR
Date 06/30/95
Cable 28B08
Notes Shorted

Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.190 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B08
Notes Air

Input Trace
Stored Trace
Difference Trace

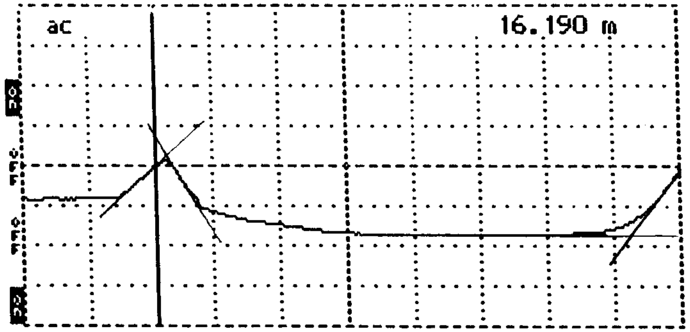
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 1 9	_ 0 . 8 9

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [28] LTPP Section ID [5 B 0 8]

Cursor .... 16.190 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B08
Notes

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.57

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 28B08 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: ______

Prepared by: Hunter Estes Employer: BRE

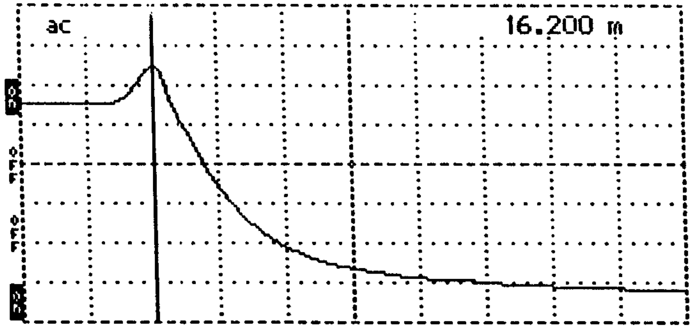
Date (dd/mmm/yy): 30/ 06/95

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [2 8] LTPP Section ID [5 B 0 9]

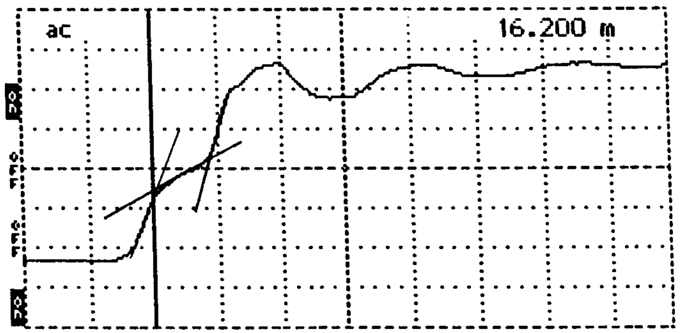
Cursor .... 16.200 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28809
Notes Shorted
Input Trace
Stored Trace
Difference Trace

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

Cursor .... 16.200 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28809
Notes Air
Input Trace
Stored Trace
Difference Trace

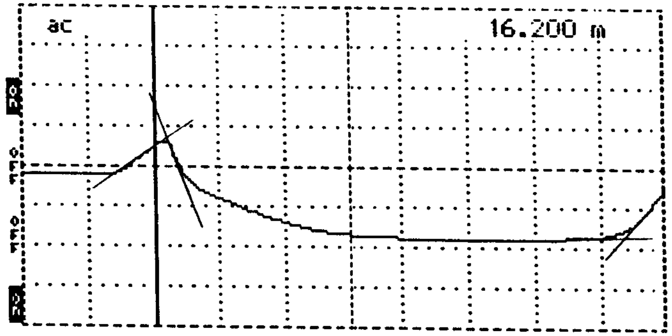
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.20	0.99

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 0 9]

Cursor .... 16.200 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B09
Notes WATER

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.79	79.33

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

<u>Note</u>: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 28B09   TDR Probe Length, L: 0.203 m   Length of Coax Cable: 12.2 m

Comments: ______________________

Prepared by: Hunter Estes   Employer: BRE

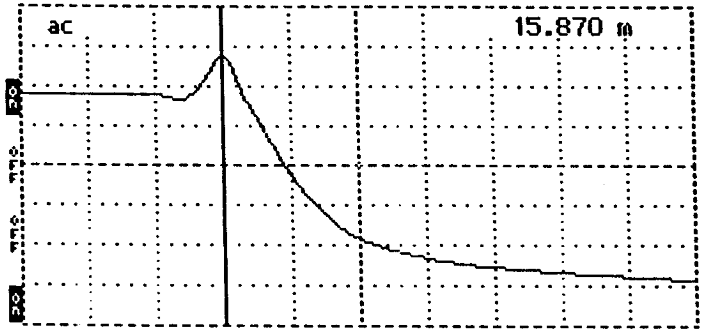
Date (dd/mmm/yy): 30 / 06 / 95

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [Z 8] LTPP Section ID [S B 1 0]

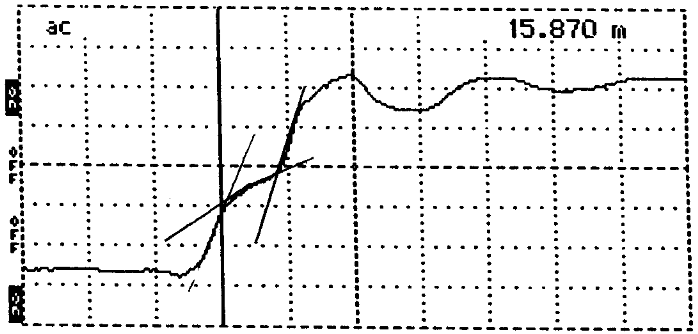
Cursor .... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B10
Notes
Input Trace 12.2 m
Stored Trace
Difference Trace

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

Cursor .... 15.870 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B10
Notes
Input Trace
Stored Trace
Difference Trace

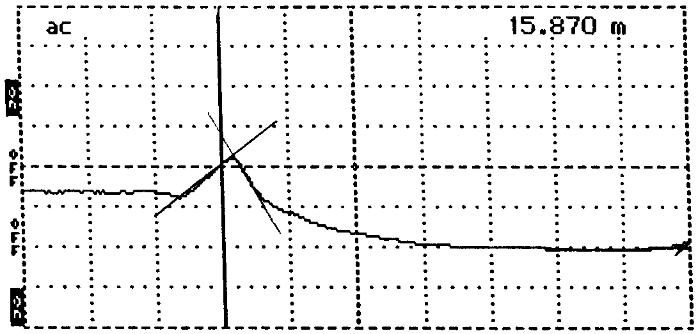
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0 . 1 9	_ 0 . 8 9

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [2 8] LTPP Section ID [S B 1 0]

Cursor .... 15.870 m
Distance/Div ..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.99
Noise Filter...... 1 avg
Power........... ac



Tektronix 1502B TDR
Date 06/30/95
Cable 28B10
Notes WATER

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1 . 7 5	7 5 . 8 3

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 2 8 B 1 0 TDR Probe Length, L: 0 . 2 0 3 m Length of Coax Cable: 1 2 . 2 m

Comments: ______

Prepared by: Hunter Estes Employer: BRE

Date (dd/mmm/yy): 3 0 / 0 6 / 9 5

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

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

APPENDIX C

Instrumentation Installation Information

Appendix C contains the following information:

Figure C-1. TDR Traces During Installation

Table C-1. Field Measured Moisture Contents

Figure C-2. Field Proctor Test

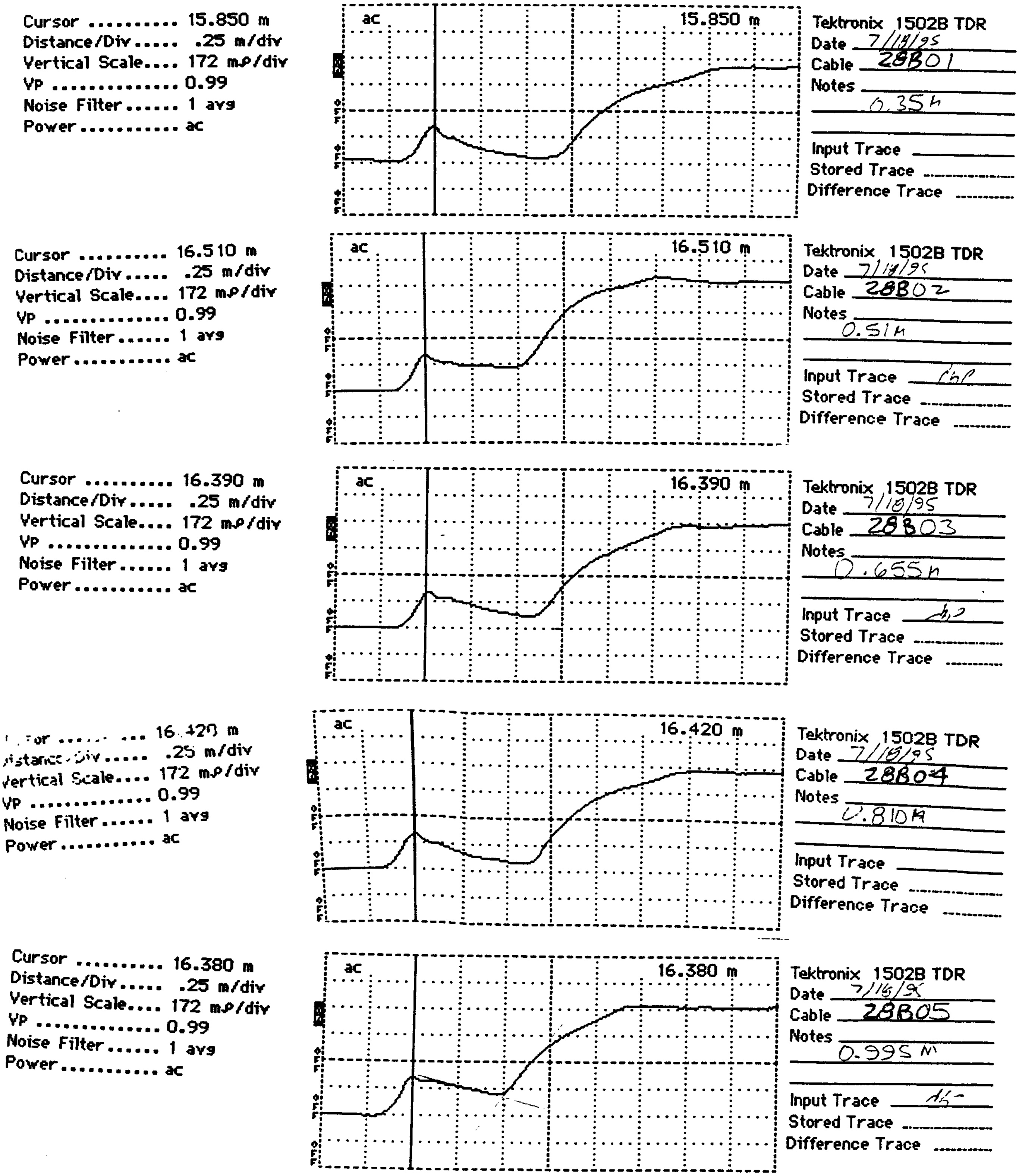
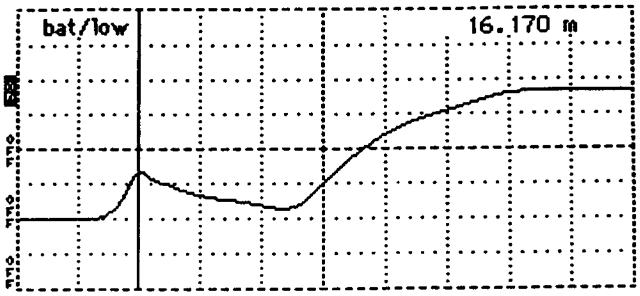


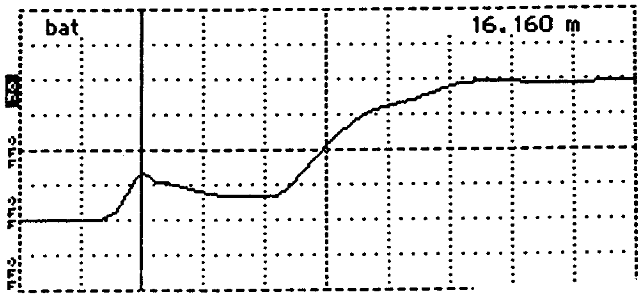
Figure C-1. TDR Traces During Installation

Cursor .... 16.170 m
Distance/Div ..... .25 m/div
Vertical Scale.... 172 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



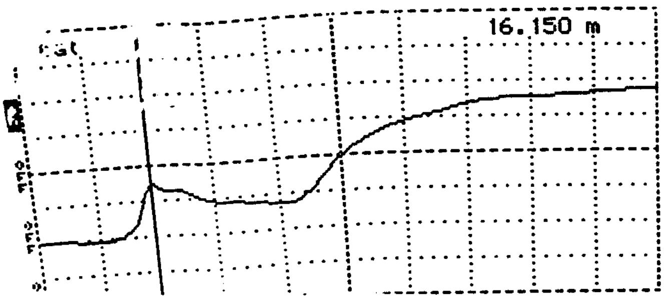
Tektronix 1502B TDR
Date 7/10/95
Cable 28B06
Notes 1.11m
Input Trace dir
Stored Trace
Difference Trace

Cursor .... 16.160 m
Distance/Div ..... .25 m/div
Vertical Scale.... 172 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



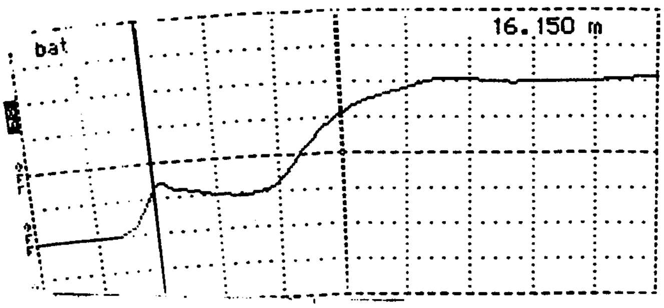
Tektronix 1502B TDR
Date 7/10/95
Cable 28B07
Notes 1.260 m
Input Trace dir
Stored Trace
Difference Trace

Cursor .... 16.150 m
Distance/Div ..... .25 m/div
Vertical Scale.... 172 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



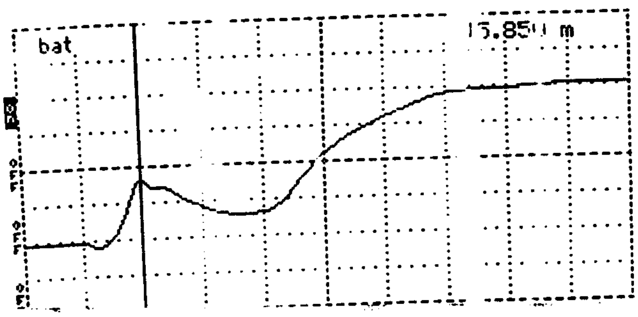
Tektronix 1502B TDR
Date 7/10/95
Cable 28B08
Notes 1.415
Input Trace dir
Stored Trace
Difference Trace

Cursor .... 16.150 m
Distance/Div ..... .25 m/div
Vertical Scale.... 172 mρ/div
Vp 0.99
Noise Filter...... 1 avg
Power........... bat/low



Tektronix 1502B TDR
Date 7/10/95
Cable 28B09
Notes 1.71m
Input Trace dir
Stored Trace
Difference Trace

Cursor .... 15.850 m
Distance/Div ..... .25 m/div
Vertical Scale.... 145 mρ/div
Vp 0.99
Noise Filter...... avg
Power........... bat



Tektronix 1502B TDR
Date 7/13/95
Cable 28B10
Notes 1.96m
Input Trace dir
Stored Trace
Difference Trace

Figure C-1 (Continued). TDR Traces During Installation

Table C-1. Field Measured Moisture Contents

SITE NO. 281016 7/18/95

MOISTURE CONTENTS FOR TDR

TDR #	WT. OF PAN(g)	(WET) PAN & SOIL(g)	(DRY) PAN & SOIL(g)	M.C. (%)
28B10	151.1	312.4	285.4	20.1%
28B09	171.1	318.7	293.7	20.4%
28B08	149.8	281.0	259.4	19.7%
28B07	178.0	327.2	306.6	16.0%
28B06	204.3	379.1	352.9	17.6%
28B05	169.4	319.9	301.1	14.3%
28B04	151.5	303.5	282.9	15.7%
28B03	148.9	268.6	252.8	15.2%
28B02	179.8	286.6	278.0	8.8%
28B01	171.3	279.0	261.8	19.0%

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [2 8] LTPP Section ID 28SB [1 0 1 6]

Depth of Representative Sample (from pavement surface): 1 . 2 4 m

Dry Density Determination:

a. Tare Weight of Empty Mold: 4 0 9 9 g (9 . 0 2 lb)

b. Weight of Mold and Compacted Soil: 6 1 3 9 g (13 . 5 1 lb)

c. Weight of Compacted Soil (b - a): 2 0 4 0 g (4 . 4 9 lb)

d. Unit Weight of Compacted Soil = (c / 943.0) = 2 . 1 6 g/cm³

([c / (1 / 30)] = 1 3 4 . 7 lb/ft³)

e. Dry Density of Compacted Soil = [d / (1 + r/100)] = 1 . 8 3 g/cm³

(1 1 4 . 1 lb/ft³)

Moisture Content Determination:

m. Tare Weight of Pan: 1 8 0 . 0 g

n. Weight of Pan and Moisture Sample: 3 5 7 . 4 g

o. Weight of Pan and Dry Sample: 3 3 0 . 2 g

p. Weight of Moisture (n - o): 2 7 . 2 g

q. Weight of Dry Sample (o - m): 1 5 0 . 2 g

r. Moisture Content by Weight = [(p / q) * 100] = 1 8 . 1 %

Comments: Soil was a brownish-red color with high clay content. Soil was hard to trim to fit color, and may have created some error in weight analysis

Prepared by: Hunter Estes Employer: BRE

Date (dd/mmm/yy): 18 / 07 / 95 July

Data Sheet SMP-I07: Representative Dry Density

Figure C-2. Field Proctor Test

APPENDIX D

Initial Data Collection

Appendix D contains the following support information:

Table D-1.	Raw Data from the On-site Data Logger
Figure D-1.	Measured Air Temperature During July Data Collection
Figure D-2.	Measured Average Subsurface Temperature for the First 5 Sensors During July Data Collection
Figure D-3.	Measured Average Subsurface Temperature for all 18 Sensors on July 18th Collection
Figure D-4 thru Figure D13.	Traces from TDR Sensor
Table D-2.	Elevation Measurements Data Sheet - AC

Table D-1. Raw Data from the On-Site Data Logger During Initial Data Collection

```
5,1995,200,100,12.17,22.95,0
6,1995,200,100,30.61,32.34,33.65,35.08,35.31
5,1995,200,200,12.17,22.88,0
6,1995,200,200,30.2,31.92,33.26,34.82,35.14
5,1995,200,300,12.17,22.7,0
6,1995,200,300,29.78,31.52,32.88,34.56,34.95
5,1995,200,400,12.17,22.62,0
6,1995,200,400,29.36,31.12,32.53,34.29,34.74
5,1995,200,500,12.17,22,0
6,1995,200,500,28.96,30.74,32.17,34.03,34.53
5,1995,200,600,12.17,21.58,0
6,1995,200,600,28.54,30.37,31.83,33.77,34.32
5,1995,200,700,12.17,21.3,0
6,1995,200,700,28.21,29.99,31.49,33.52,34.11
5,1995,200,800,12.16,21.85,0
6,1995,200,800,28.56,29.85,31.22,33.28,33.92
5,1995,200,900,12.16,23.7,0
6,1995,200,900,29.68,30.14,31.15,33.06,33.73
5,1995,200,1000,12.16,26.49,0
6,1995,200,1000,33.97,31.51,31.44,32.86,33.53
5,1995,200,1100,12.17,29.03,0
6,1995,200,1100,38.95,34.15,32.4,32.66,33.2
5,1995,200,1200,12.17,30.64,0
6,1995,200,1200,43.99,37.49,34.16,32.87,33.16
5,1995,200,1300,12.17,31.8,0
6,1995,200,1300,48.21,40.74,36.3,33.42,33.3
5,1995,200,1400,12.18,32.04,0
6,1995,200,1400,50.04,43.42,38.4,34.17,33.59
5,1995,200,1500,12.18,32.47,0
6,1995,200,1500,50.95,44.78,40.07,35.11,34.1
5,1995,200,1600,12.18,32.81,0
6,1995,200,1600,52.69,46.39,41.44,36,34.75
5,1995,200,1700,12.18,33.06,0
6,1995,200,1700,52.43,47.38,42.67,36.9,35.36
5,1995,200,1800,12.18,32.74,0
6,1995,200,1800,50.59,47.31,43.38,37.76,35.96
5,1995,200,1900,12.18,32.05,0
6,1995,200,1900,47.7,46.4,43.56,38.49,36.53
5,1995,200,2000,12.18,28.06,0
6,1995,200,2000,43.42,44.45,43.05,38.98,37.13
5,1995,200,2100,12.17,25.21,0
6,1995,200,2100,39.94,42.07,41.99,39.23,37.55
5,1995,200,2200,12.17,23.97,0
6,1995,200,2200,37.58,40.02,40.72,39.2,37.8
5,1995,200,2300,12.16,22.86,0
6,1995,200,2300,35.83,38.39,39.52,38.95,37.88
1,1995,200,2400,12.17,12.19,1712,12.15,2320,26.53,33.75,1604,21.1,613,0,4067
2,1995,200,2400,38.52,37.48,36.57,35.48,35.1,34.88,34.67,34.46,34.16,33.73,33.15,32.5,31.75,31.12,30.49,29.68,29,28.31
3,1995,200,2400,52.93,1606,47.56,1654,43.63,1816,39.29,2047,37.91,2218,36.9,2349,35.92,2356,35.07,35,34.63,146,34.11,339,33.37,406,32.69,906,31.99,140,31.27,859,30.65,910,29.93,2,29.14,826,28.46,932
4,1995,200,2400,28.16,643,29.8,719,31.07,831,32.53,1009,32.96,1141,33.36,1213,33.62,1412,33.68,1433,33.6,1730,33.26,1930,32.8,1947,32.19,1933,31.47,2006,30.86,2007,30.25,1033,29.43,1120,28.74,1047,28.1,1115
5,1995,200,2400,12.16,21.96,0
6,1995,200,2400,34.41,37.03,38.42,38.57,37.81
```

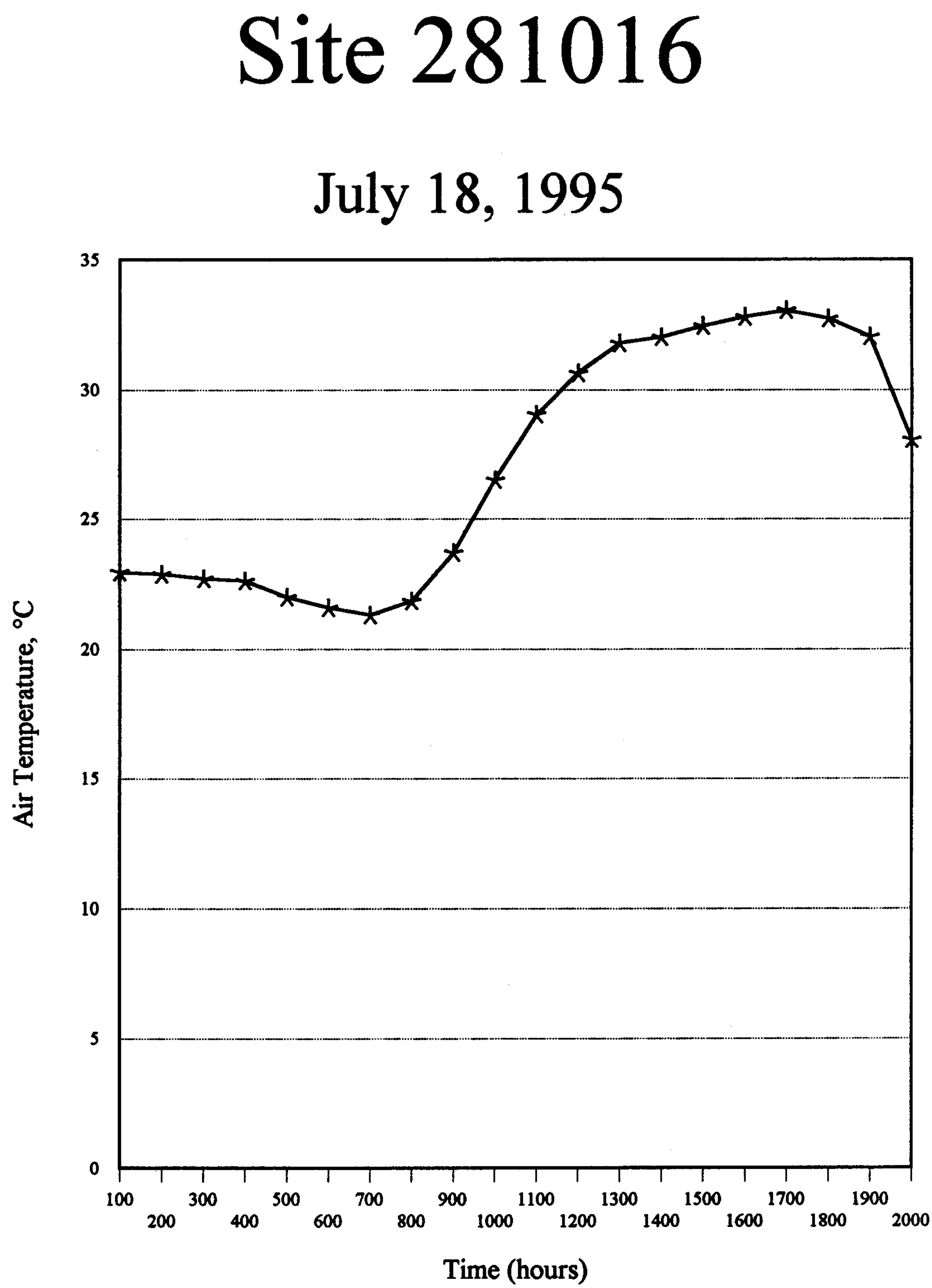


Figure D-1. Measured Air Temperature During July Data Collection.

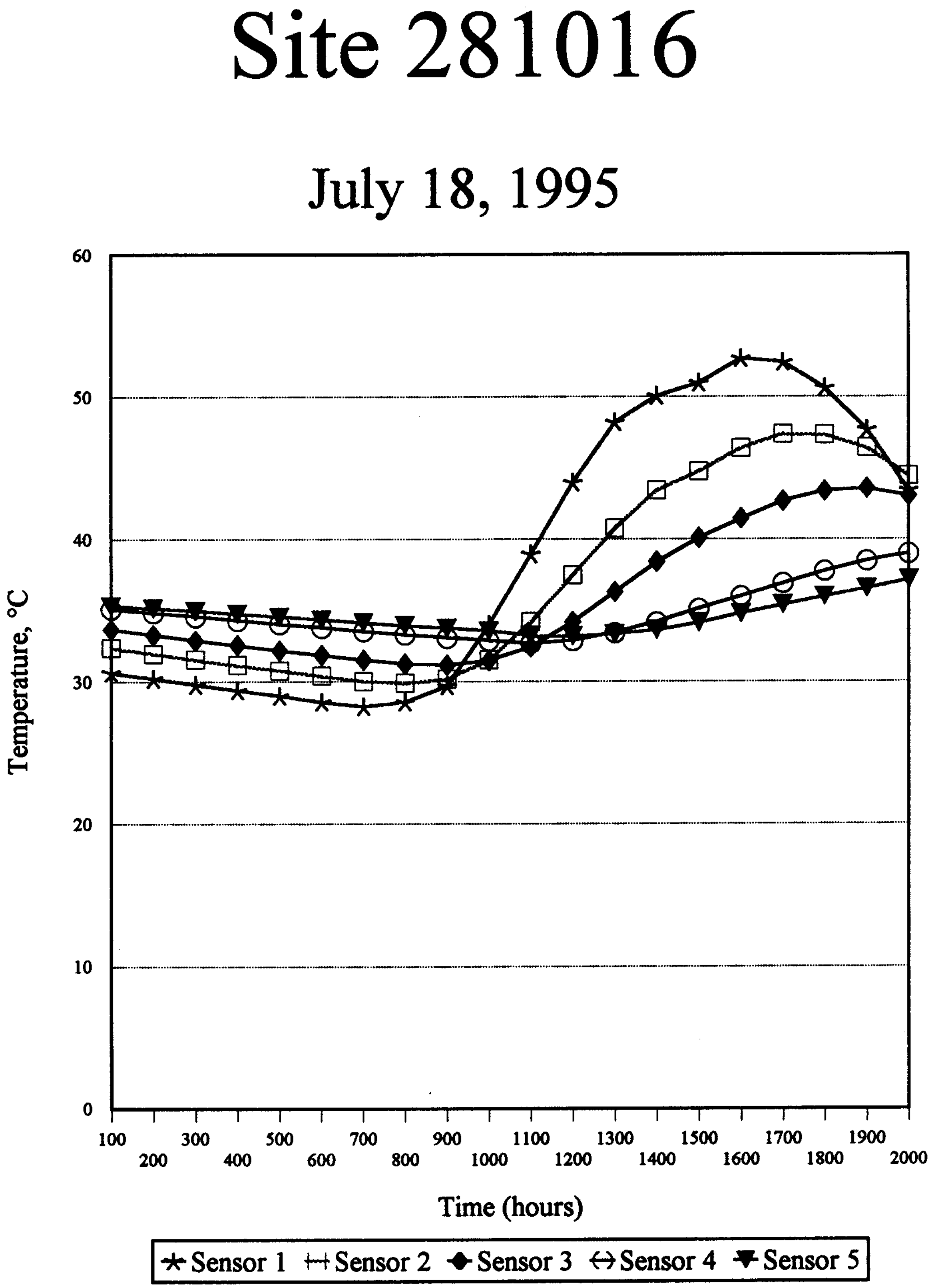


Figure D-2. Measured Average Subsurface Temperature for the First 5 Sensors During July Data Collection.

Site 281016

July 18, 1995

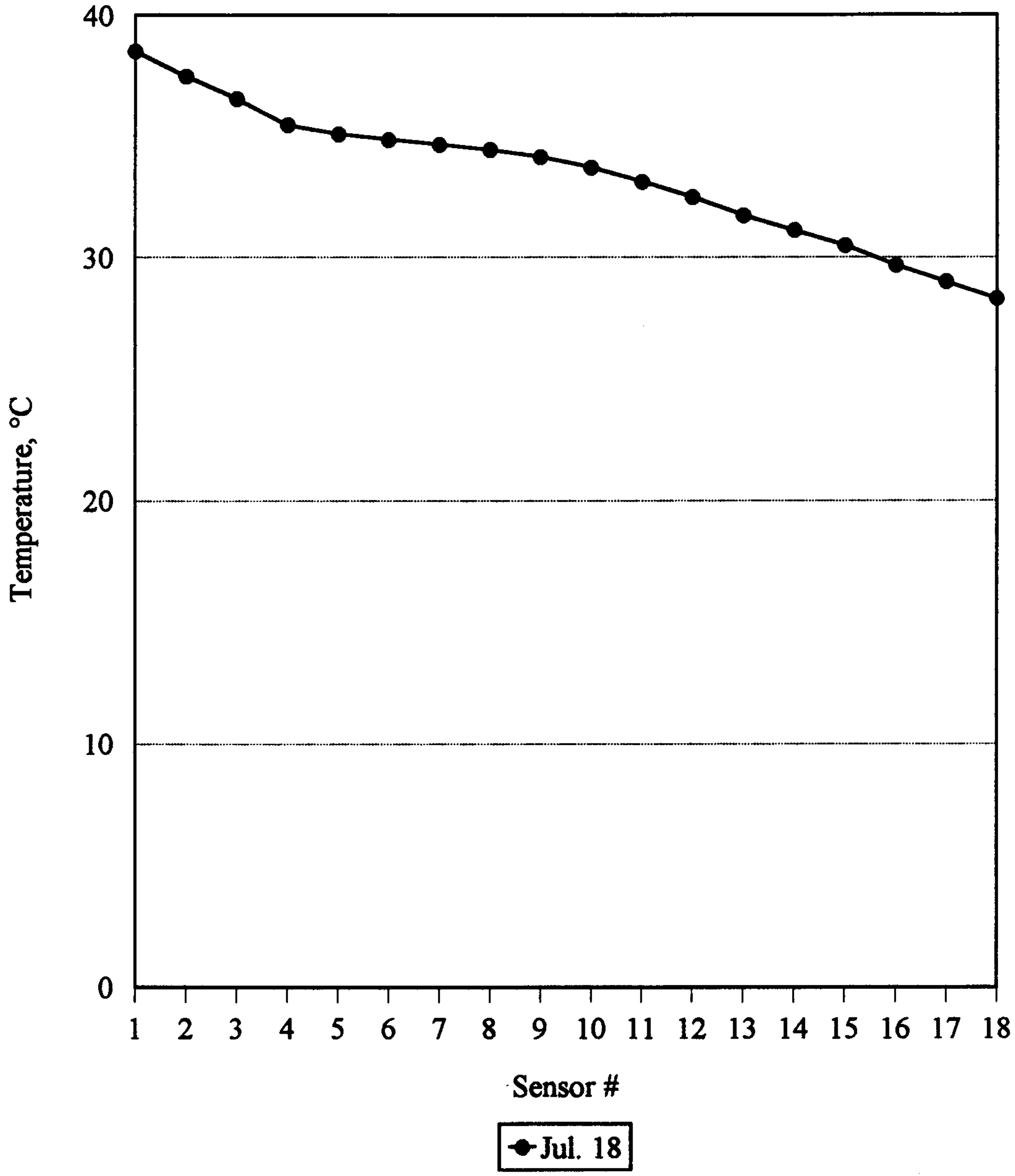


Figure D-3. Measured Average Subsurface Temperature for all 18 Sensors on July 18th.

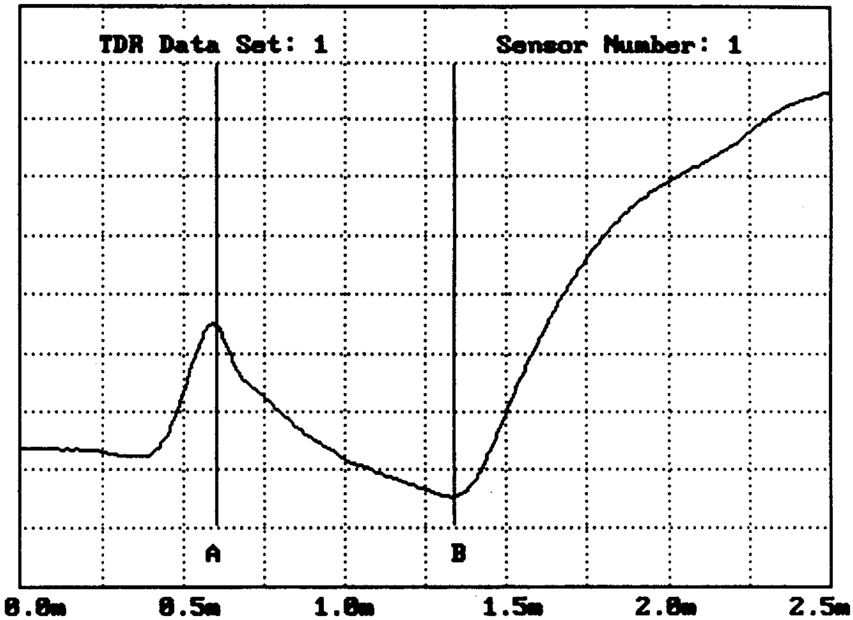
TDR RESULTS

File: 28SB95AG.MOB

Date: Jul 18, 1995
Time of Day: 13:57
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 71
Offset: 53463
Sample No: 1

A (m) = 0.60
B (m) = 1.34
Trace Length (m)=0.74
Diele. Const.= 13.5
Volumetr MC (%)= 25.2

Total 1 Set Data



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

Figure D-4. Trace from TDR Sensor 1

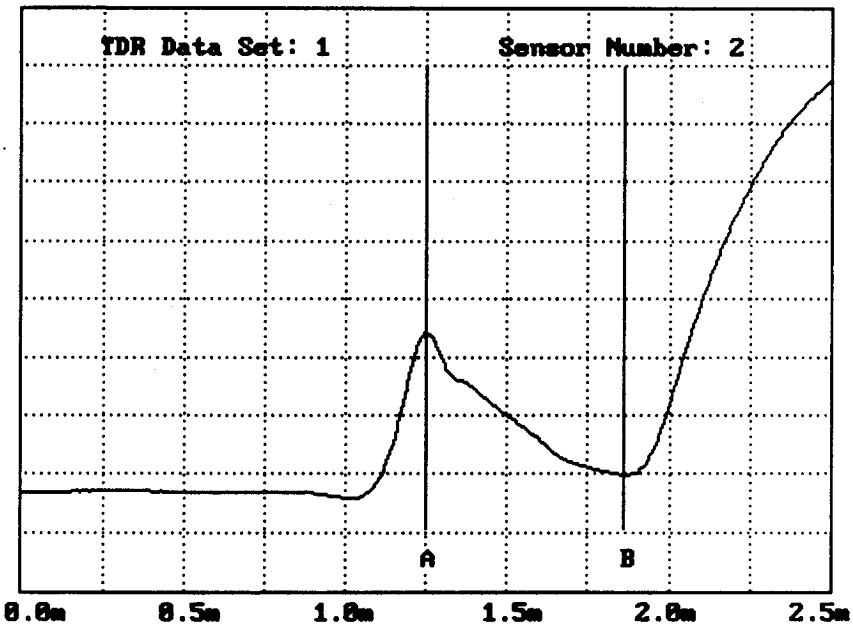
TDR RESULTS

File: 28SB95AG.MOB

Date: Jul 18, 1995
Time of Day: 13:58
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 77
Offset: 53534
Sample No: 1

A (m) = 1.25
B (m) = 1.86
Trace Length (m)=0.61
Diele. Const.= 9.2
Volumetr MC (%)= 17.2

Total 1 Set Data



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

Figure D-5. Trace from TDR Sensor 2

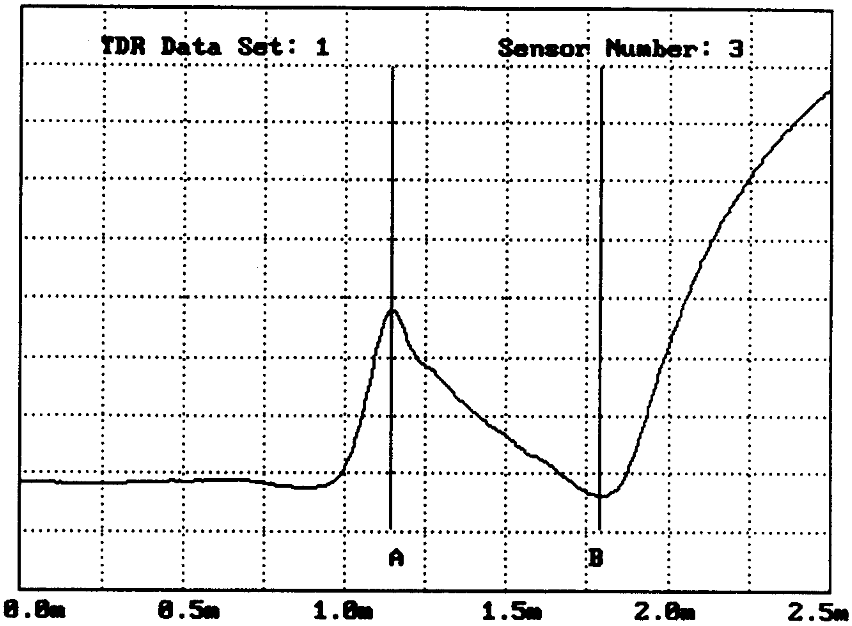
TDR RESULTS

File: 28SB95AG.MOB

Date: Jul 18, 1995
Time of Day: 13:58
Dist → Curs (m): 18.0
Dist btn WvFm (m): .01
Gain: 79
Offset: 53579
Sample No: 1

A (m) = 1.14
B (m) = 1.79
Trace Length (m)=0.65
Diele. Const.= 10.4
Volumetr MC (%)= 19.7

Total 1 Set Data



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

Figure D-6. Trace from TDR Sensor 3

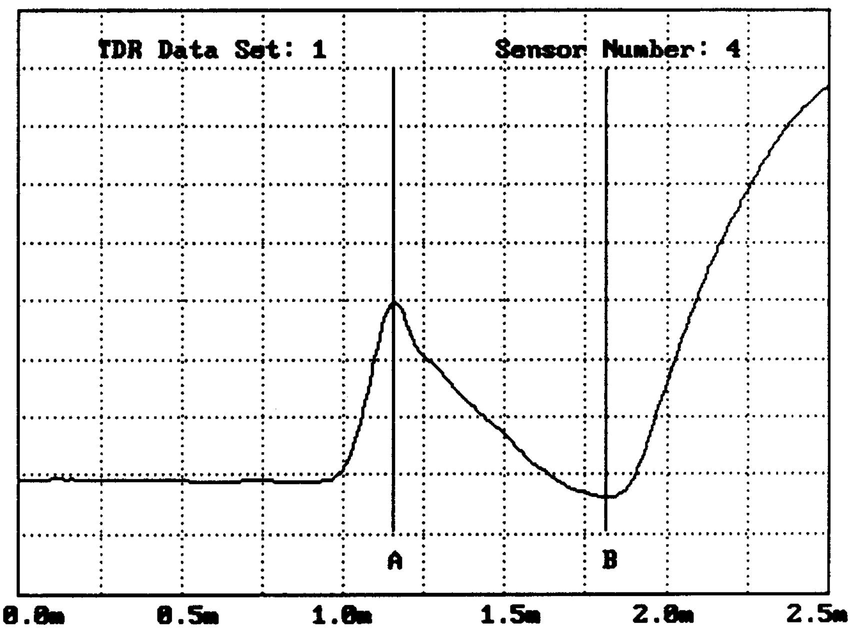
TDR RESULTS

File: 28SB95AG.MOB

Date: Jul 18, 1995
Time of Day: 13:59
Dist → Curs (m): 18.0
Dist btn WvFm (m): .01
Gain: 80
Offset: 53613
Sample No: 1

A (m) = 1.15
B (m) = 1.81
Trace Length (m)=0.66
Diele. Const.= 10.8
Volumetr MC (%)= 20.3

Total 1 Set Data



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

Figure D-7. Trace from TDR Sensor 4

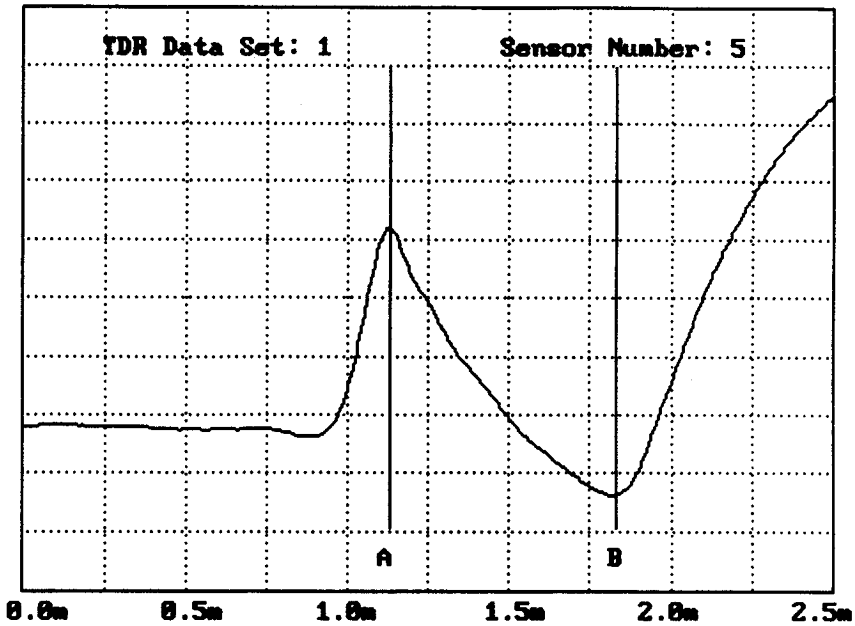
TDR RESULTS

File: 28SB95AG.MOB

Date: Jul 18, 1995
Time of Day: 14:00
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 85
Offset: 53771
Sample No: 1

A (m) = 1.13
B (m) = 1.83
Trace Length (m)=0.70
Diele. Const.= 12.1
Volumetr MC (%)= 22.8

Total 1 Set Data



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

Figure D-8. Trace from TDR Sensor 5

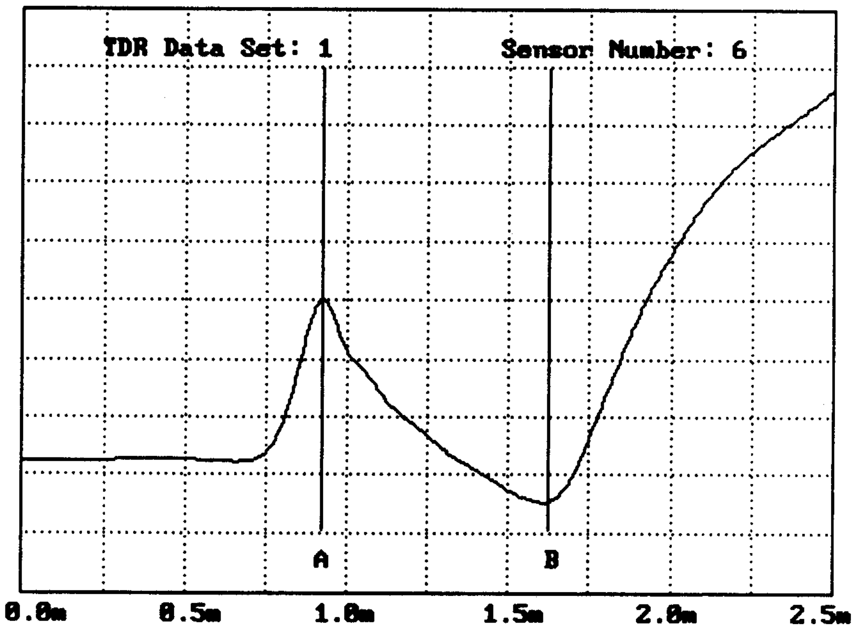
TDR RESULTS

File: 28SB95AG.MOB

Date: Jul 18, 1995
Time of Day: 14:00
Dist → Curs (m): 18.0
Dist btn WvFm (m):.01
Gain: 78
Offset: 53592
Sample No: 1

A (m) = 0.92
B (m) = 1.62
Trace Length (m)=0.70
Diele. Const.= 12.1
Volumetr MC (%)= 22.8

Total 1 Set Data



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

Figure D-9. Trace from TDR Sensor 6

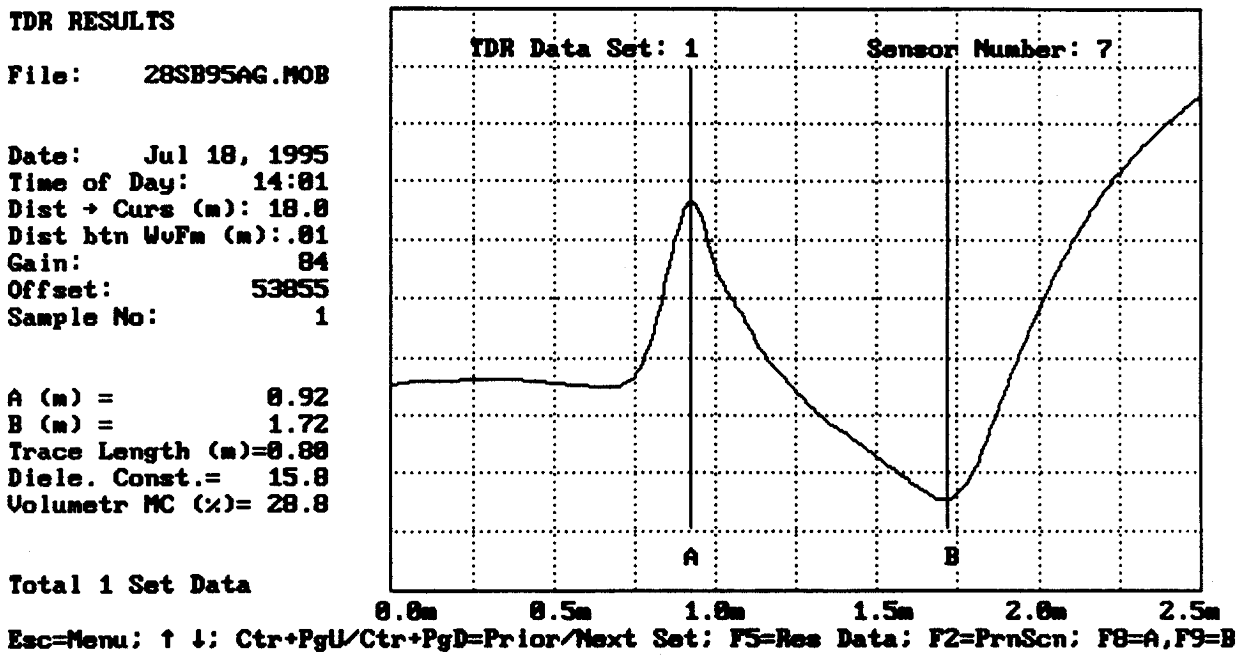


Figure D-10. Trace from TDR Sensor 7

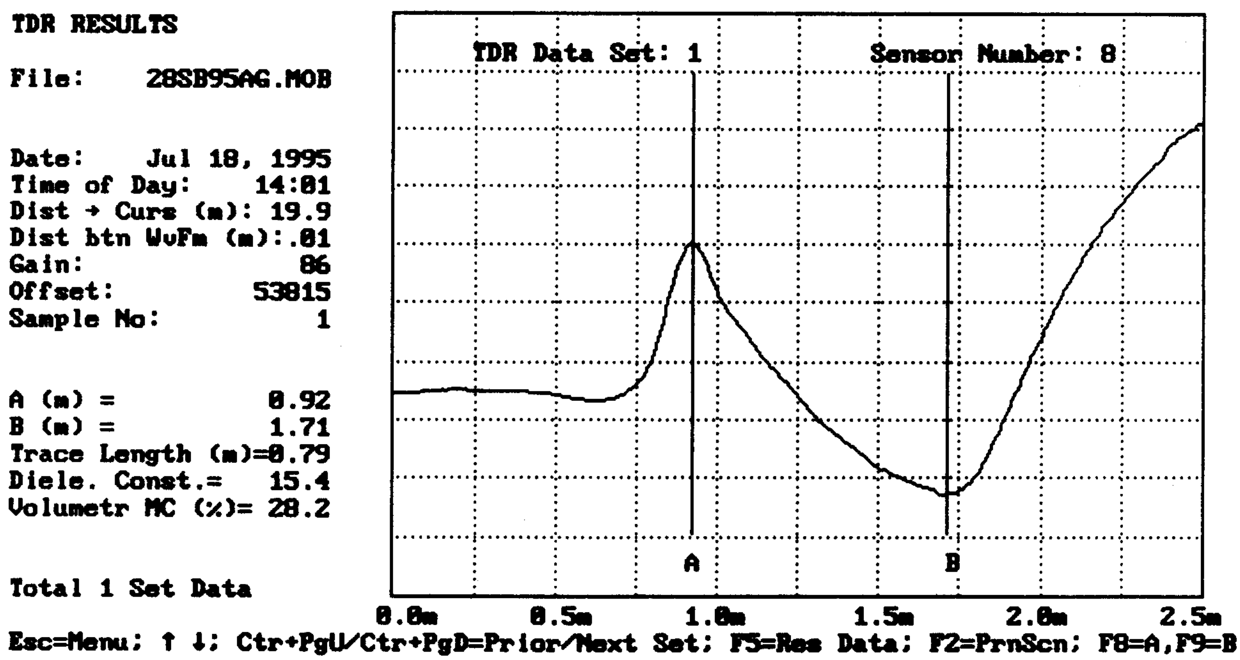


Figure D-11. Trace from TDR Sensor 8

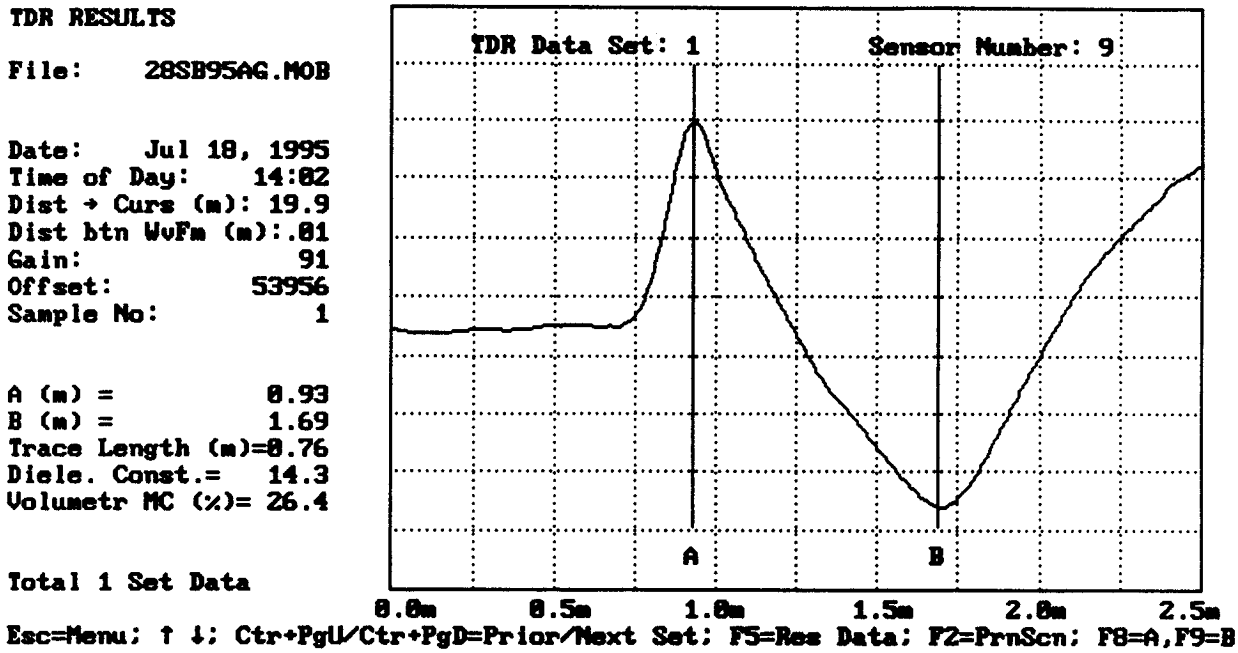


Figure D-12. Trace from TDR Sensor 9

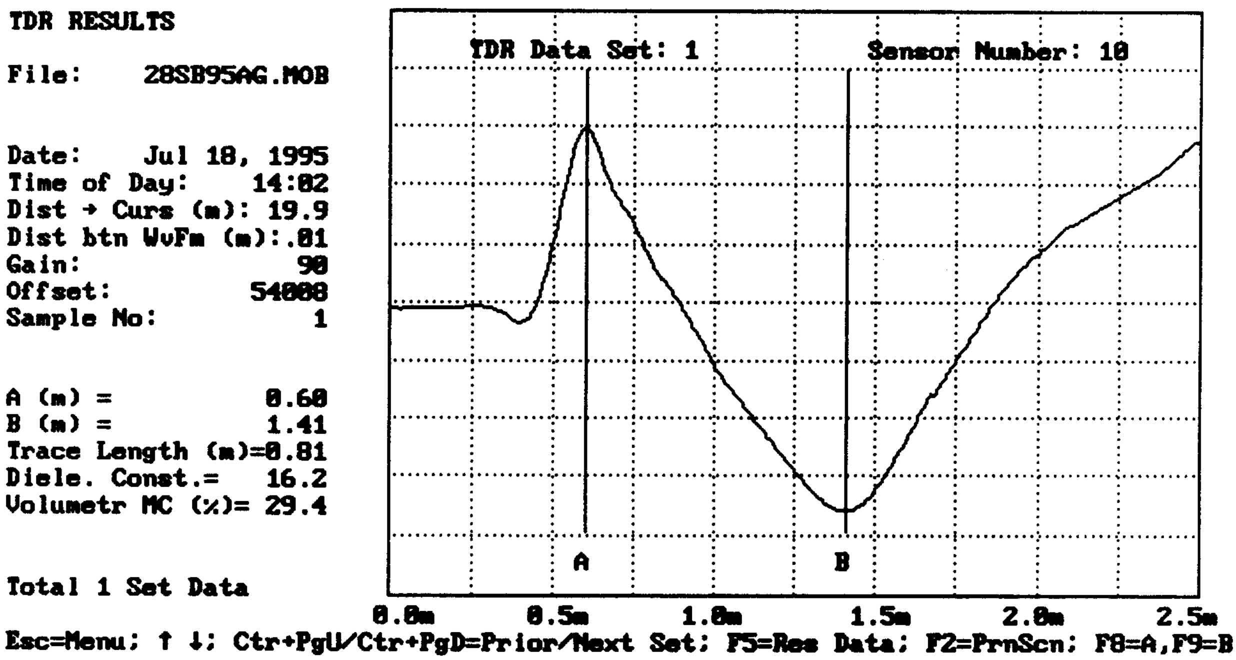


Figure D-13. Trace from TDR Sensor 10

Table D-2. Elevation Measurements Data Sheet - AC

SEASONAL MONITORING
"FLEX" TRANSVERSE ELEVATION MEASUREMENTS[1]

Station	Outside Edge		OWP		ML		IWP		Inside Edge	
	O/S	Elev.	O/S	Elev.	O/S	Elev.	O/S	Elev.	O/S	Elev.
0-30			.80	10.414						
0-20		INSTRUMENTATION								
0-10			.80	10.417	1.85	10.394				
0+00	.10	10.467	.80	10.443	1.85	10.416	2.59	10.393	3.68	10.365
0+25	"	10.493	"	10.472	"	10.445	"	10.423	"	10.390
0+50	"	10.507	"	10.486	"	10.458	"	10.433	"	10.404
0+75	"	10.509	"	10.484	"	10.455	"	10.433	"	10.401
1+00	"	10.529	"	10.507	"	10.477	"	10.450	"	10.419
1+25	"	10.550	"	10.528	"	10.499	"	10.476	"	10.445
1+50	"	10.577	"	10.555	"	10.528	"	10.503	"	10.470
1+75	"	10.591	"	10.568	"	10.540	"	10.518	"	10.489
2+00	.10	10.593	.80	10.570	1.85	10.543	2.59	10.519	3.68	10.487

Bench Mark : PK NAIL IN D.P. CAN IN TOP OF CUTOFF PWR. POLE BY SWR. MANHOLE. STA 1+90, ±60' RT. ASSUMED ELEV. 100.00
WELL TOP - 1" PIPE = 10.100
TIE IN - ✓

Comments:
CLOUDY, BREEZY, HOT, HUMID

Test Section No. 281016
Start Time (Military) 14:37
Recorded By HE, JP [illegible]

Date (dd,mm,yy) 18/07/95
Device Used LASERLEVEL
Employer BPG

[1] OWP and ML readings to be taken at FWD test locations

07/11/95

APPENDIX E

Photographs

Appendix E contains the following photographs:

Photo E-1.	Setting PK Nails to Mark Test Section
Photo E-2.	Augering of Piezometer Observation Well
Photo E-3.	Cutting of Trench with Pavement Saw
Photo E-4.	Augering and Soil Removal of Instrumentation Hole
Photo E-5.	Placement of TDRs in Instrumentation Hole
Photo E-6.	Downloading of Information from Equipment Cabinet

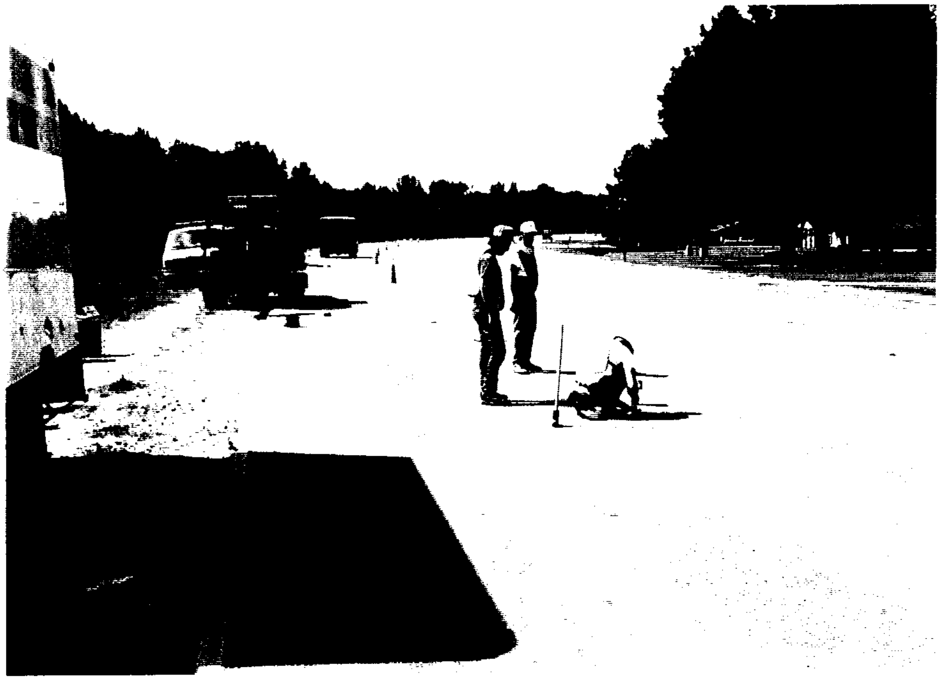


Photo E-1. Setting PK Nails to Mark Test Section

Photo E-2. Augering of Piezometer Observation Well

Photo E-3. Cutting of Trench with Pavement Saw

Photo E-4. Augering and Soil Removal of Instrumentation Hole

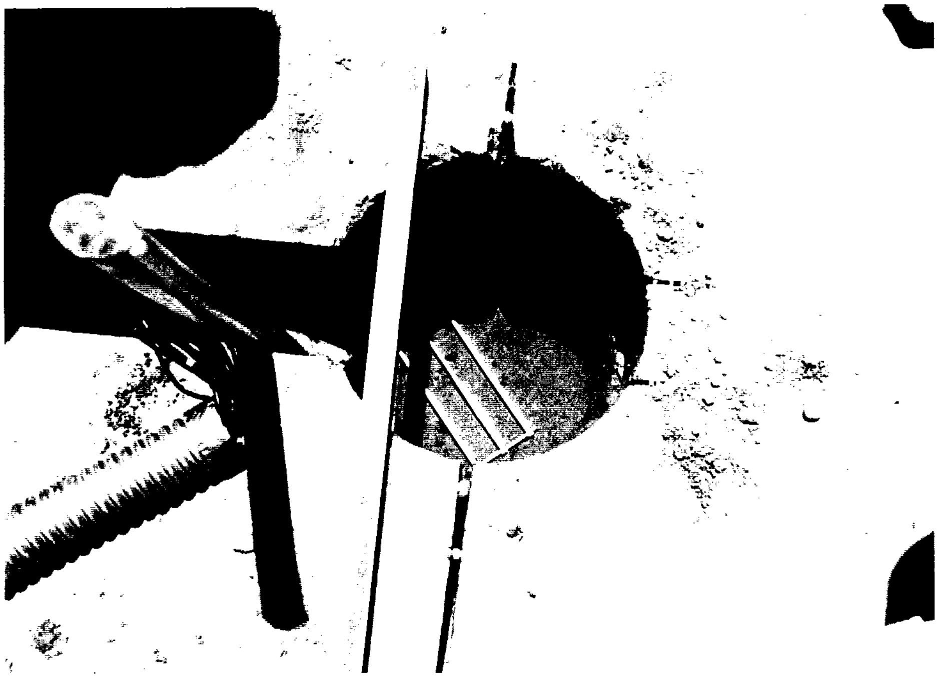


Photo E-5. Placement of TDRs in Instrumentation Hole

Photo E-6. Downloading of Information from Equipment Cabinet