LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 131005, Warner Robbins, Georgia

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Prepared for

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 131005, which is a part of the LTPP Core Seasonal Monitoring Program. This asphalt concrete surfaced pavement test section, which is located on SH-247 in the eastbound lanes, approximately 1.77 km east of the Peach/Houston County line, was instrumented on 7 August 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 8 August 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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Table of Contents

List of Tables

SEASONAL INSTRUMENTATION STUDY
INSTRUMENTATION INSTALLATION
GEORGIA SECTION 131005/13SC

I. Introduction

The seasonal instrumentation installation of Section 131005 was performed on 7-8 August 1995.

The GPS-3 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-247, approximately 1.77 km east of the Peach/Houston County line.

The average maximum daily temperature for the months of June through August is 33°C and the average minimum daily temperature for the months of December through February is 2.9°C. The average annual precipitation is 1049 mm.

The pavement is a flexible structure consisting of approximately 178 mm of asphalt concrete over 253 mm of crushed stone 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	178	- - -
Base	253	2231
Subgrade	---	1830

The annual average daily traffic (AADT) in the GPS lane is almost 4400, of which 10.5% is truck traffic. The estimated annual ESALs on the GPS lane were 18,000. This information is based on traffic data collected on site.

Installation of the instrumentation was completed through the cooperative efforts of the Georgia Department of Transportation (Georgia 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:

Jon Peacock	SRCO, Brent Rauhut Engineering
Steve Davis	SRCO, Brent Rauhut Engineering
Robin Belt	SRCO, Brent Rauhut Engineering
Hunter Estes	SRCO, Brent Rauhut Engineering
Dennis Richardson	Georgia DOT
Clyde Blaine	Georgia DOT
Ricky Kilgore	Georgia DOT
Don Montgomery	Georgia DOT

II. Instrumentation Installation

Pre-Installation Activities

A pre-installation meeting was held at the Georgia DOT office of Materials and Research on 25 May 1995. The meeting agenda appears in Appendix B. The participants at the meeting were Dennis Richardson, Lamar Caylor and Larry Peirce. 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 8 August 1995 by Steve Davis (SRCO). Deflection testing was conducted on 7 August 1995. The 5+20 end of the test section was selected for instrumentation, based on the amount of distress present and uniformity of the deflection profile. 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 Nº.
Instrument Hole		
MRC Thermistor Probe	1	288 (13CT)
TDR Sensors	10	13C01-13C10
Equipment Cabinet		
CR10 Data Logger	1	16521
Battery Package	1	Gel Cell
Weather Station		
Tipping-Bucket Rain Gauge	1	12032-693
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	16	This unit was installed in the base and subgrade.
	5	93	
	6	169	
	7	246	
	8	320	
	9	473	
	10	624	
	11	778	
	12	933	
	13	1083	
	14	1234	
	15	1388	
	16	1539	
	17	1693	
	18	1843	

Location of Instrumentation

The instrumentation was installed at Station 5+20 of the test section. Approximately 900 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, 2.08 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 6.42 m from the lane edge.

The piezometer observation well was installed at Station 3+98 of the test section approximately 6.0 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 7 August 1995 and was completed the following day. The Georgia 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 Georgia 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)
13C01	245	9.21	8.9
13C02	445	8.5	15.8
13C03	597	8.8	16.9
13C04	747	10.3	16.9
13C05	904	10.6	17.9
13C06	1051	11.0	20.6
13C07	1205	12.8	20.5
13C08	1355	8.8	18.4
13C09	1662	7.8	20.6
13C10	1963	8.5	19.8

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	89	
	3	165	
2	4	264	This unit was installed in the base and subgrade.
	5	341	
	6	417	
	7	494	
	8	568	
	9	721	
	10	872	
	11	1026	
	12	1181	
	13	1331	
	14	1482	
	15	1636	
	16	1787	
	17	1941	
	18	2091	

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 7 August 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 131005 (13SC) was completed on 7 August 1995 and initial data collection was completed on 8 August 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

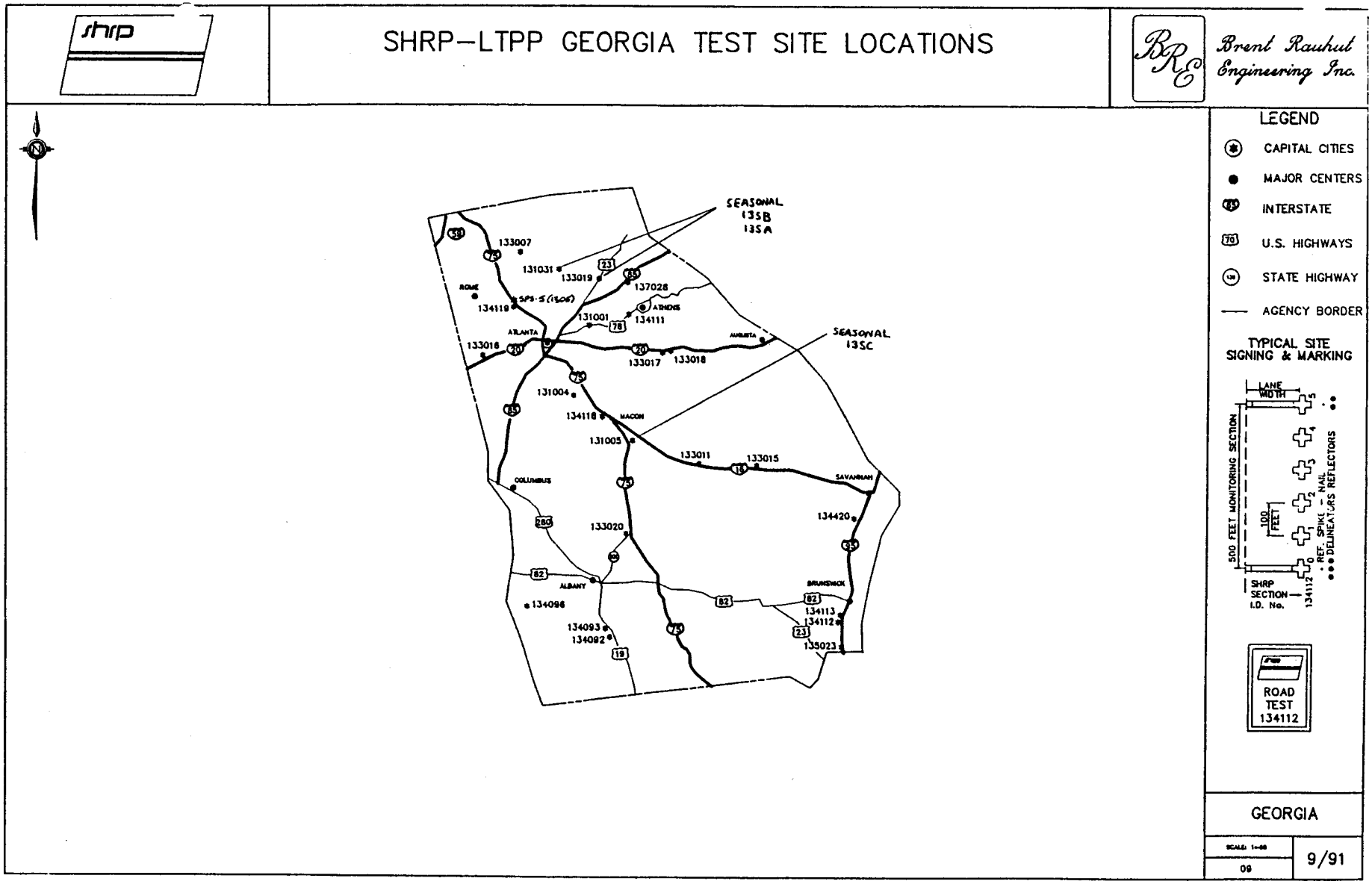


Figure A-1. Location of Test Site, GPS Test Section 131005

LTPP Seasonal Monitoring Program Data Sheet SMP-I04 Log of Instrumentation Hole	Agency Code 135C [13] LTPP Section ID [1005]

Operator: CLYDE Equipment Used: CME 75C

Location: Station: 5+20 Offset: +0.90 m (from lane edge)

Bore Hole Diameter: 254. mm

Scale (m)	Strata Change[1] (m)	Material Description	Material Code[2]
0.10	0.178M	AC	
0.20		GRAY CRUSHED STONE	23
0.30			
0.40	0.431m.		
0.50		RED/BROWN SANDY CLAY/MOIST	52
0.60			
0.70			
0.80			
0.90			
1.00			
1.10			
1.20			
1.30			
1.40			
1.50			
1.60			
1.70			
1.80			
1.90			
2.00			
2.10	2.095M.	T.D	
2.20			
2.30			
2.40			
2.50			

[1] Format: __.____ m; [2] Format: ____

Prepared by: S. DAVIS Employer: BRE

Date (dd/mm/yy): 07/08/95
aug.

Data Sheet SMP-I04: Log of Instrumentation Hole

Figure A-2. Profile of Test Section Layers

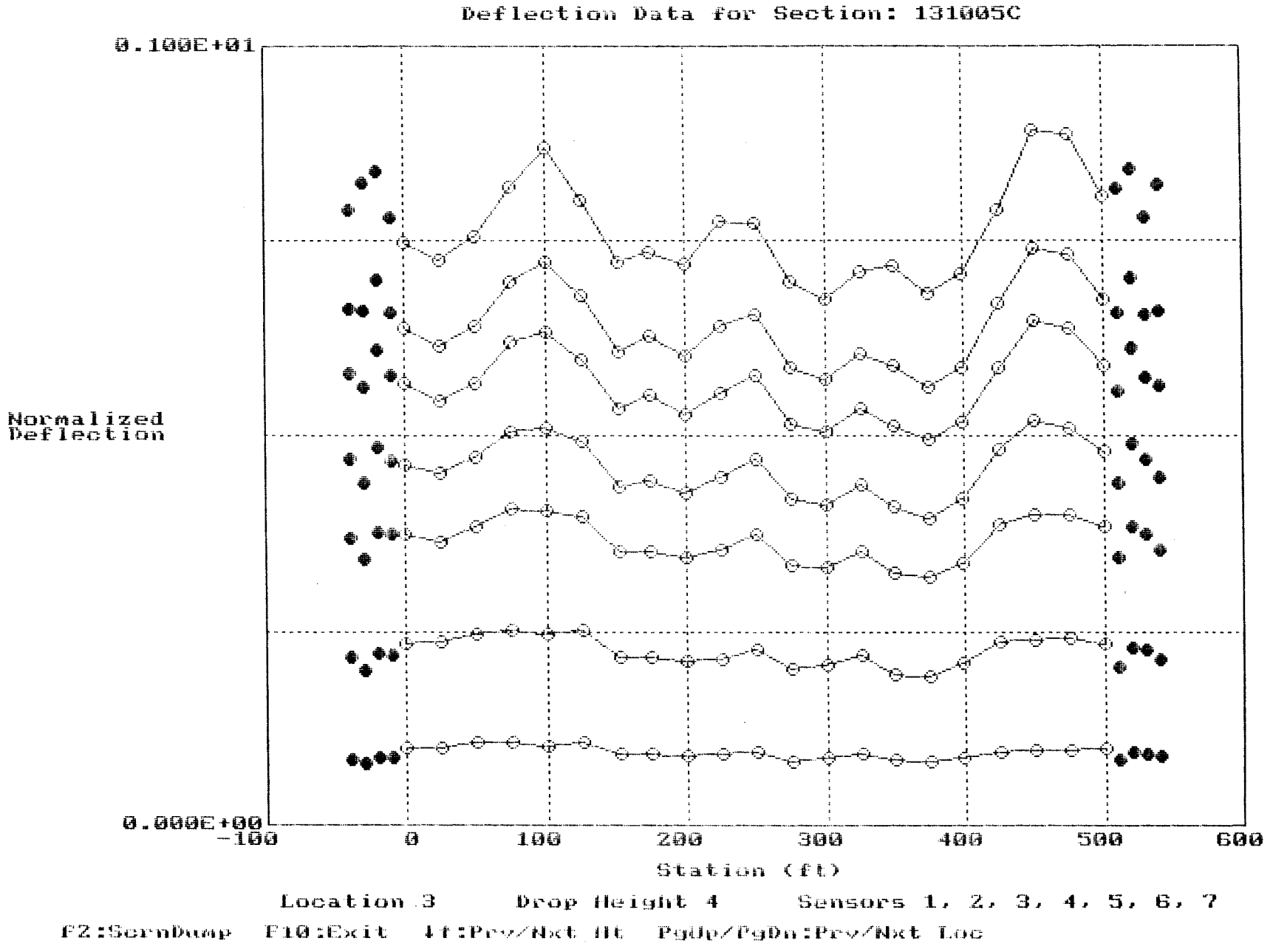


Figure A-3. Deflection Profiles from FWDCHECK

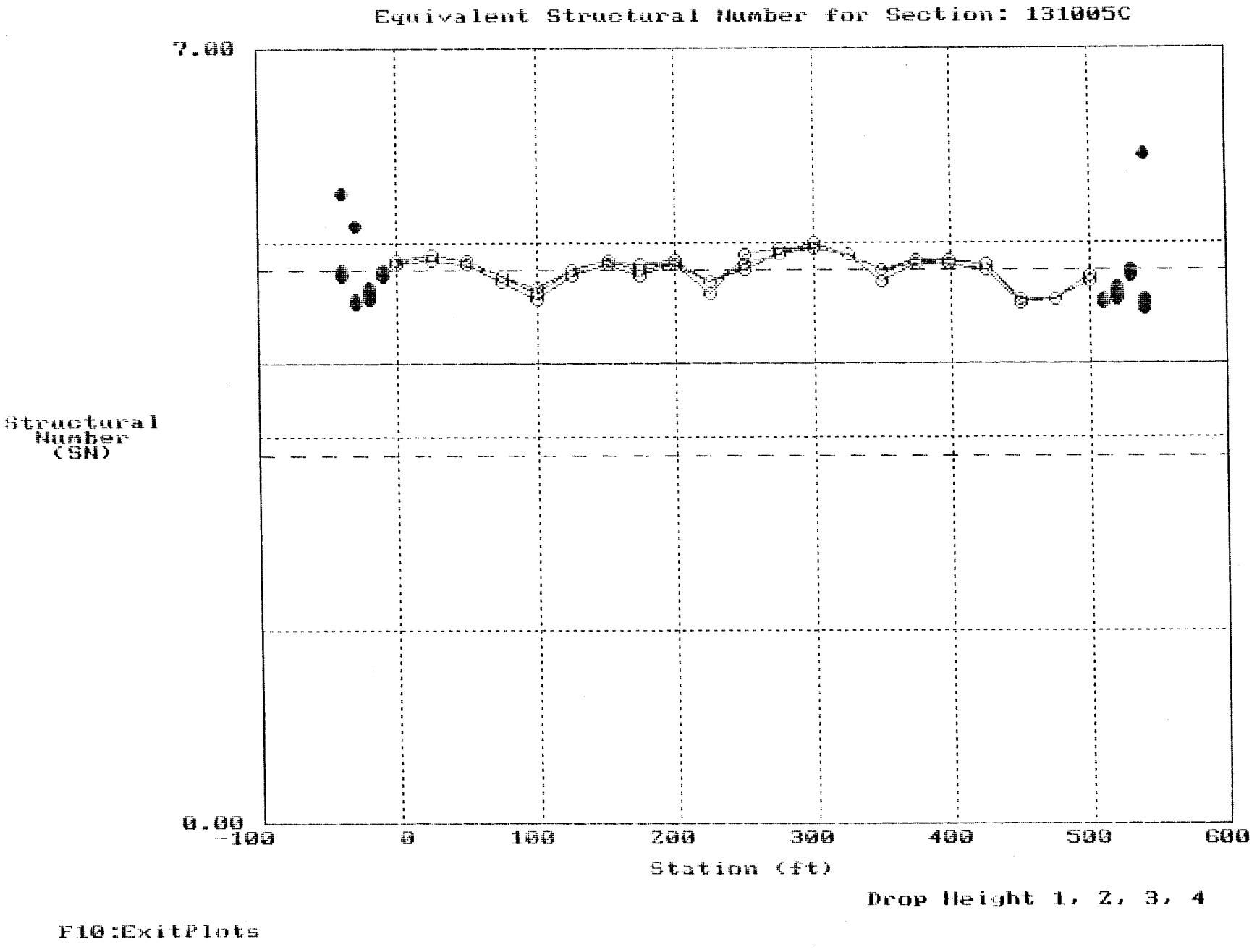


Figure A-4. Structural Number Profiles from FWDCHECK

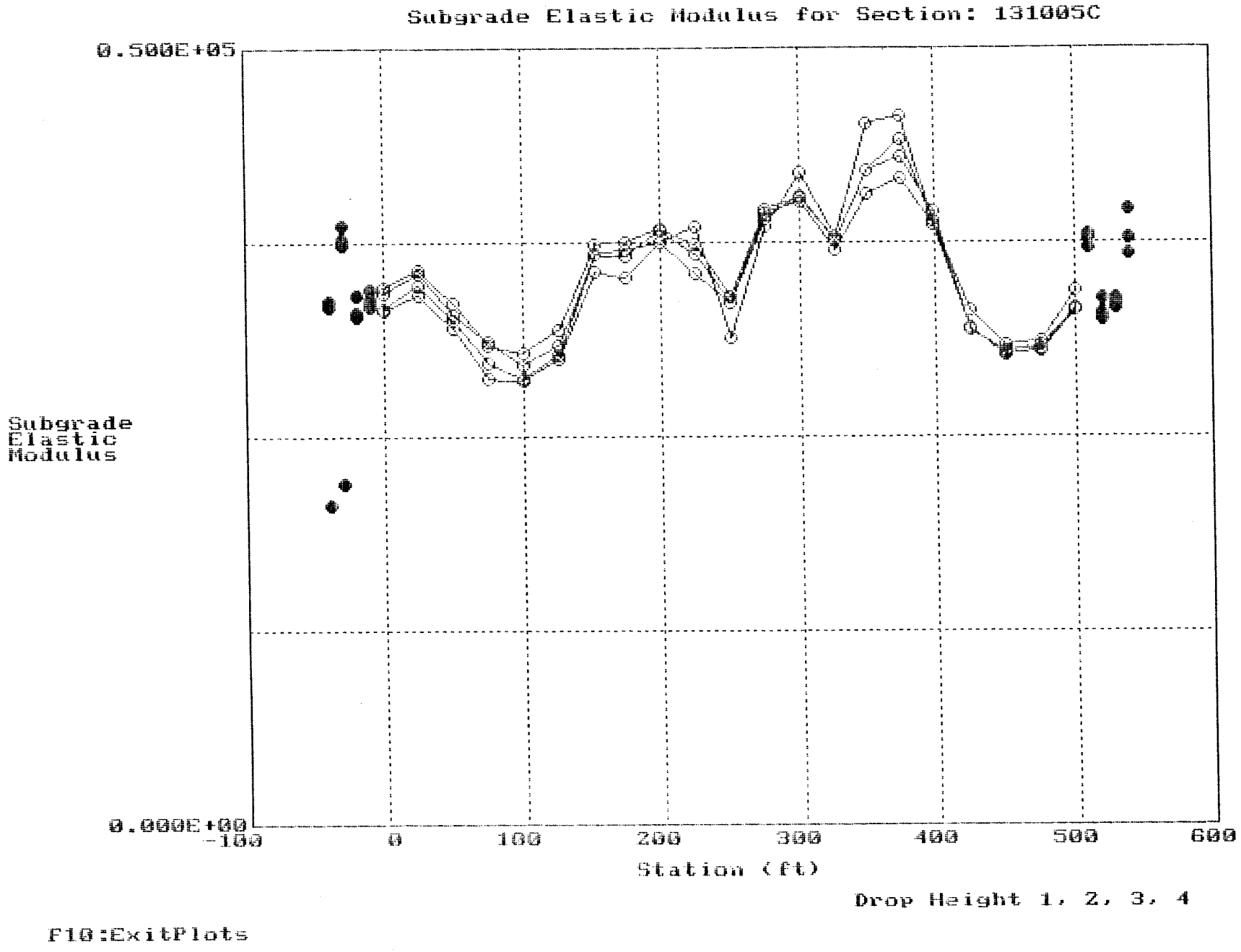


Figure A-5. Subgrade Modulus Profiles from FWDCHECK

Revised December 1, 1992

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 13

SHRP SECTION ID 1005

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/08/95

SURVEYORS: S L 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)	1.7	0	0
2. BLOCK CRACKING (Square Meters)	0	0	0
3. EDGE CRACKING (Meters)	0	0	0
4. LONGITUDINAL CRACKING (Meters)			
4a. Wheel Path	8.1	0	0
Length Sealed (Meters)	0	0	0
4b. Non-Wheel Path	131.4	0	0
Length Sealed (Meters)	0	0	0
5. REFLECTION CRACKING AT JOINTS Number of Transverse Cracks	0	0	0
Transverse Cracking (Meters)	0.0	0	0
Length Sealed (Meters)	0	0	0
Longitudinal Cracking (Meters)	_	_	_
Length Sealed (Meters)	_	_	_
6. TRANSVERSE CRACKING Number of Cracks	~~7~~ 8	0	0
Length (Meters)	~~4.9~~ 8.9	0	0
Length Sealed (Meters)	0	0	0
PATCHING AND POTHOLES			
7. PATCH/PATCH DETERIORATION (Number)	0	0	0
(Square Meters)	0	0	0
8. Potholes (Number)	0	0	0
(Square Meters)	0	0	0

Figure A-9. Distress Survey Data

Revised December 1, 1992

STATE ASSIGNED ID ____

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE CODE 13

SHRP SECTION ID 1005

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/08/95

SURVEYORS: SLD, ___

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

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

16. OTHER (Describe) ONE PATCHED FOUR INCH CORE HOLE @ 67.5 M. EXACT MAPPING OF CENTERLINE H/L NOT OBTAINED DUE TO DANGEROUS TRAFFIC POTENTIAL.

Figure A-9 (Continued). Distress Survey Data

Revised May 29, 1992

SHEET 3

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 13

SHRP SECTION ID 1005

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 08/08/95

SURVEYORS: SLO, _ _ _

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES
(CONTINUED)

9. RUTTING (FOR SPS-3 SITE SURVEYS)

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

14. LANE-TO-SHOULDER DROPOFF

Point No.	Point Distance[1] Meters	Lane-to-Shoulder Dropoff (mm)
1	0.	_ _ _
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 13

SHRP Section ID 1005

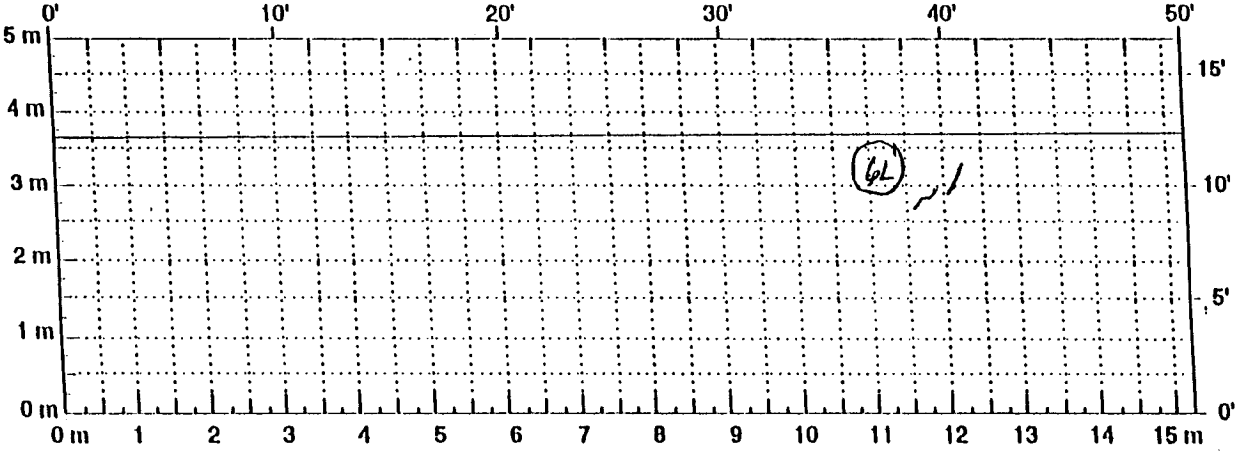
Totals

4 - 1L - 1.45m²

8 - 4aL - 8.05

2 - 4bL - 131.4m.

X - 6L - ~~4.85~~ 8.9



Comments: 4bL @ E STRIPE FOR MOST OF SECTION (130 M.)

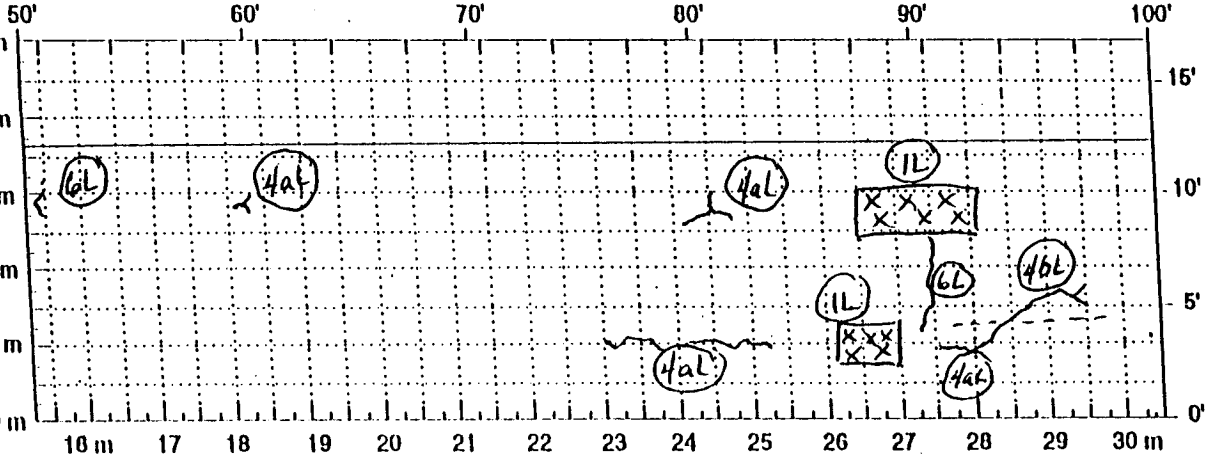
2 - 1L - 1.1m²

4 - 4aL - ~~4.0m~~

1 - 4bL - ~~1.4m~~

~~2 - 6L - 2.1m.~~

3 - 6L - 3.4m



Comments: EXACT MAPPING OF E 4bL NOT PERFORMED DUE TO DANGEROUS TRAFFIC POTENTIAL.

Figure A-9 (Continued). Distress Survey Data

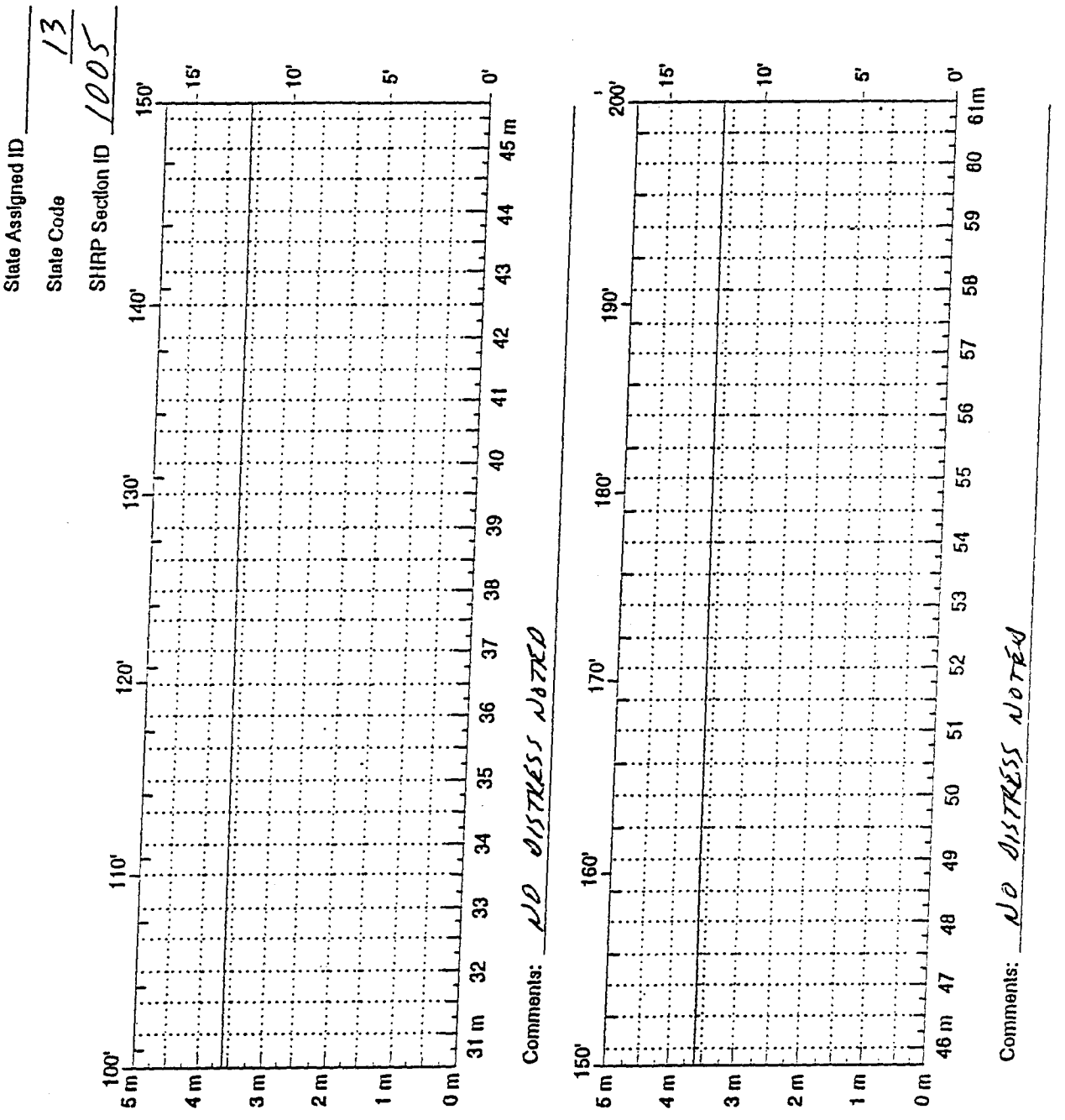
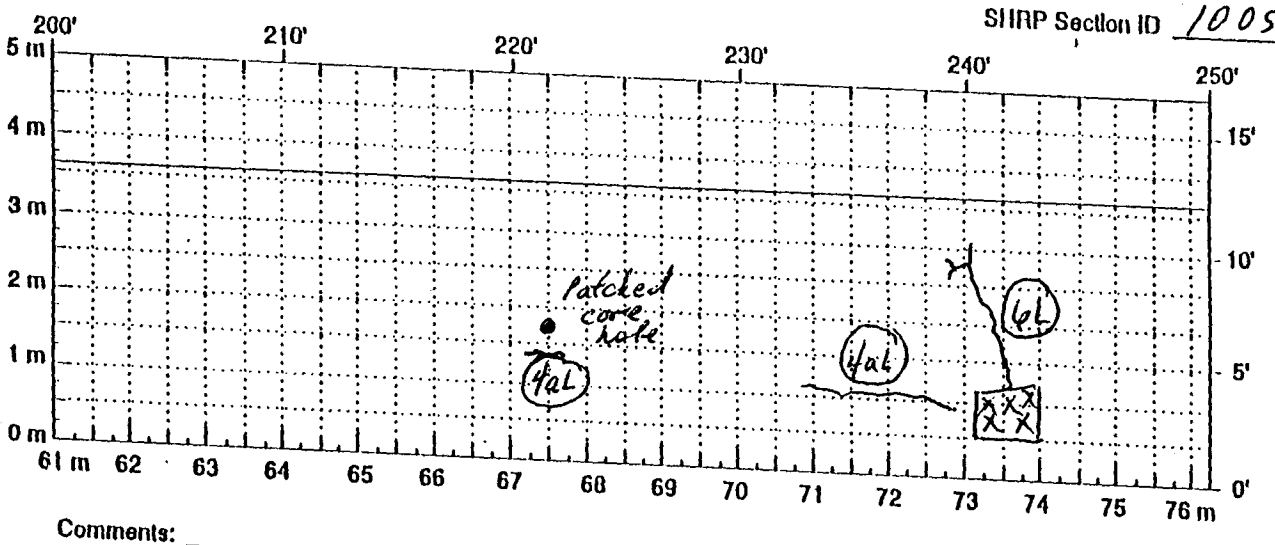


Figure A-9 (Continued). Distress Survey Data

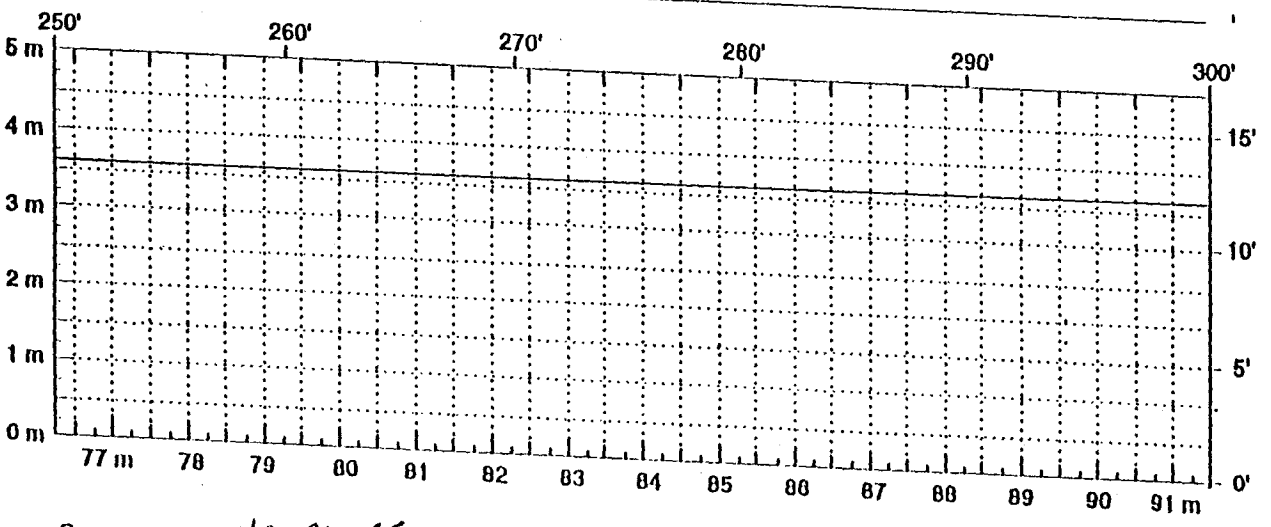
State Assigned ID _____

State Code 13

SHRP Section ID 1005



Comments: _____



1-1L-0.3m²

2-4aL-2.15m

1-6L-2.0m.

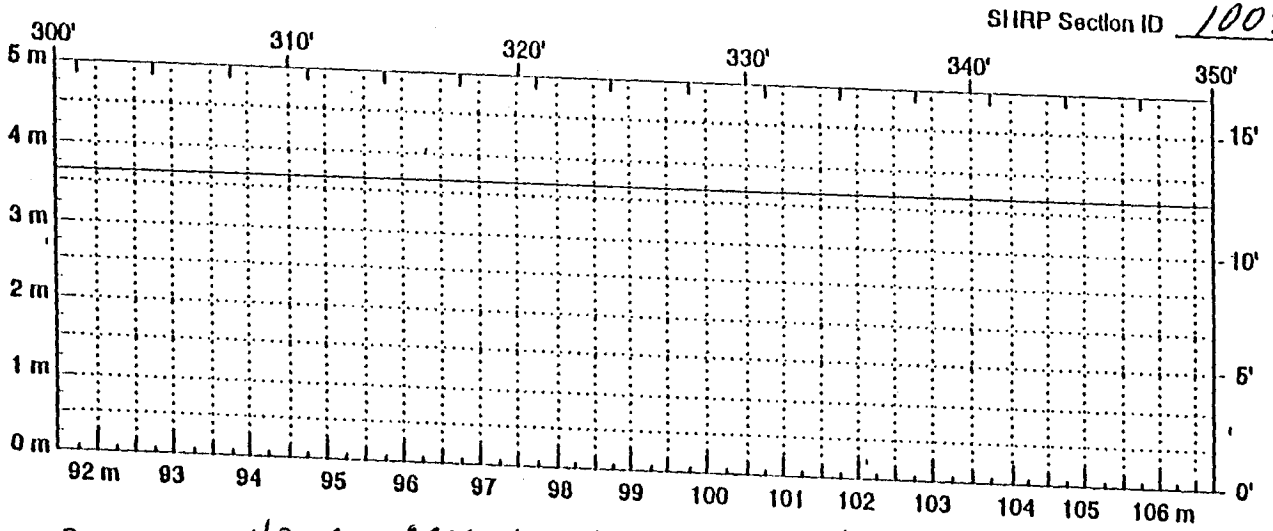
Comments: NO DISTRESS NOTED

Figure A-9 (Continued). Distress Survey Data

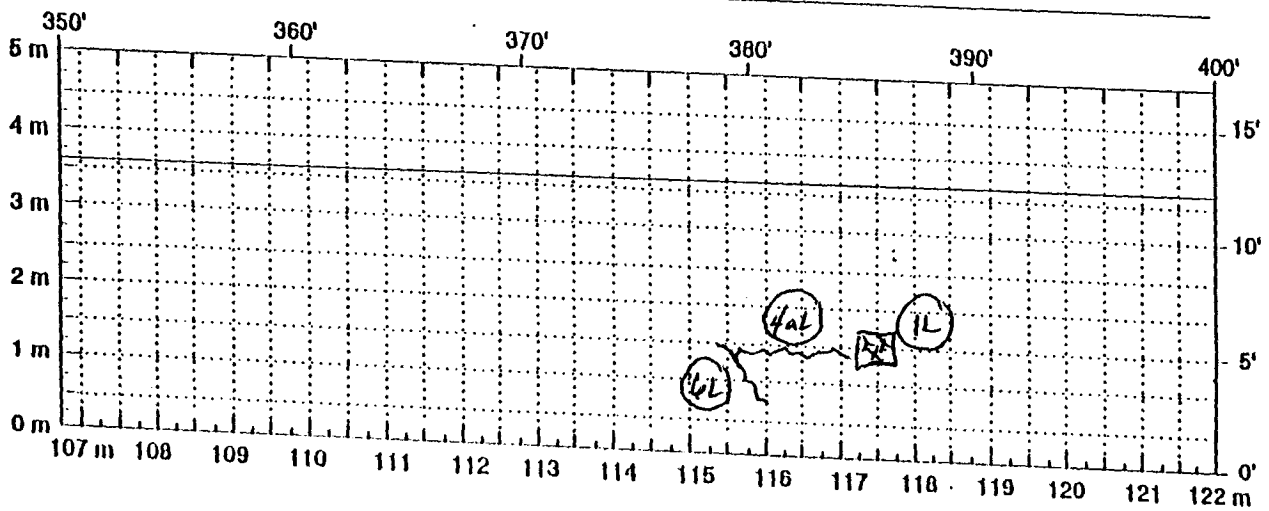
State Assigned ID _____

State Code 13

SHRP Section ID 1005



Comments: NO DISTRESS NOTED



1-1L-0.25m²
1-4aL-1.5m.
1-6L-0.75m.

Comments: _____

Figure A-9 (Continued). Distress Survey Data

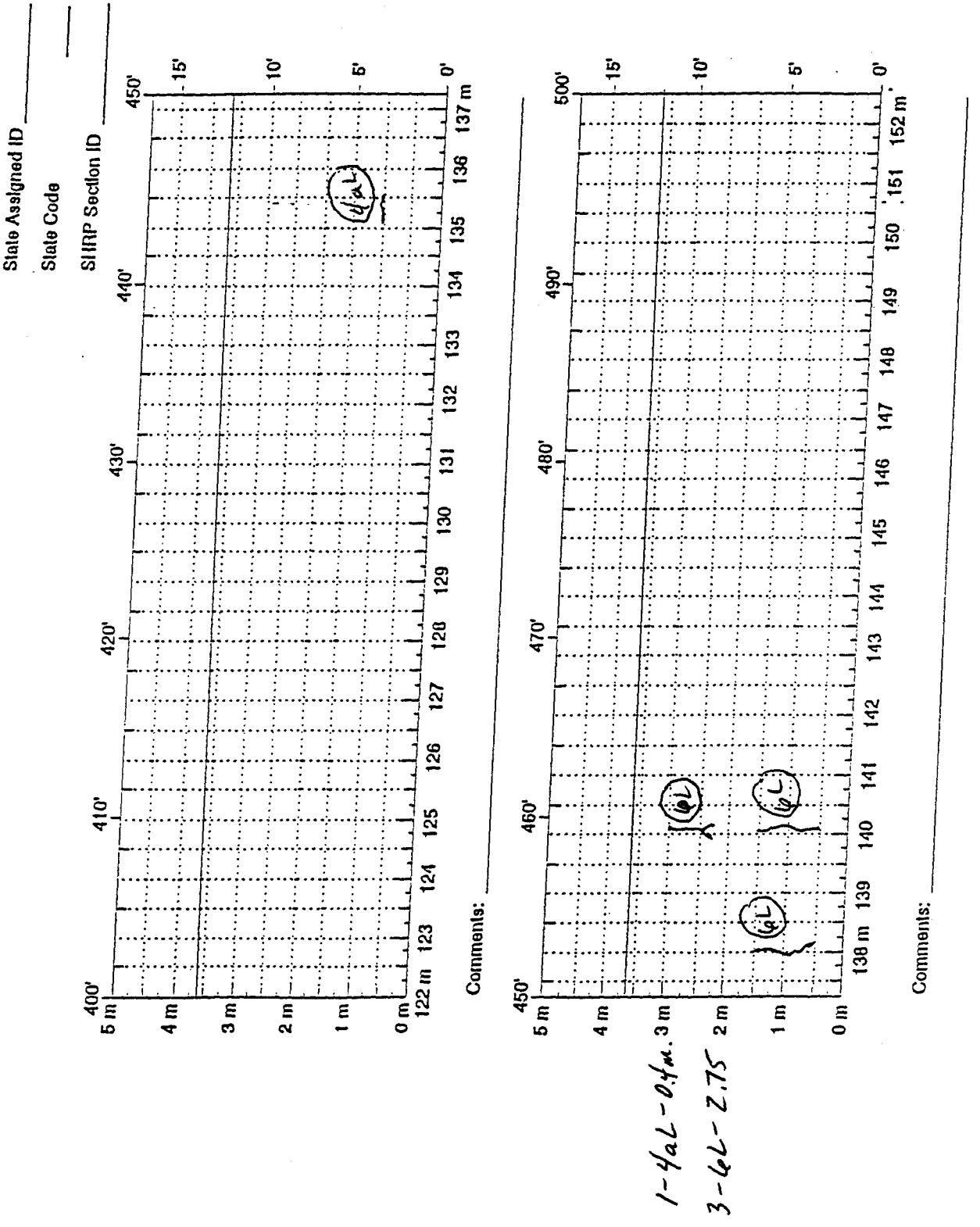


Figure A-9 (Continued). Distress Survey Data

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

25 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

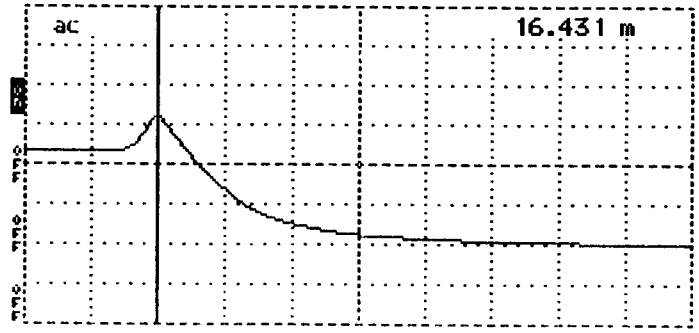
VI. Questions/Discussion

GEORGIA SEASONAL SITE INFORMATION

Type	SHRP ID	Hwy №.	Location of Test Section
JPC	133019	US-23, Hall Co. Southbound	9.66 km N. of Gainesville.
AC over Granular Base	131031	US-19, Dawson Co. Westbound	5.64 km N. of GA-53.
AC over Granular Base	131005	SH-247, Houston Co. Eastbound	1.77 km E. of the Peach/Houston Co. Line.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

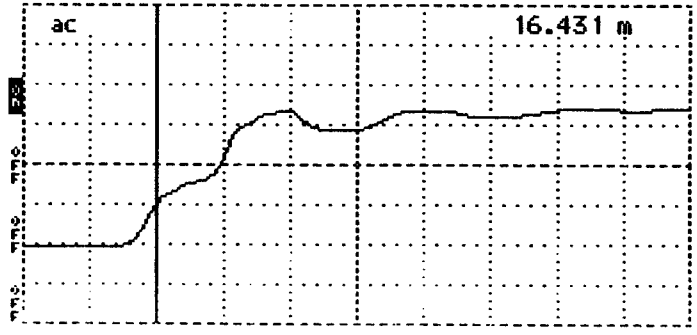
Cursor ..... 16.431 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C01
Notes shorted at 0.
12.2M
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 16.431 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C01
Notes IN AIR at 0.
apparent length 0.24m
Input Trace
Stored Trace
Difference Trace

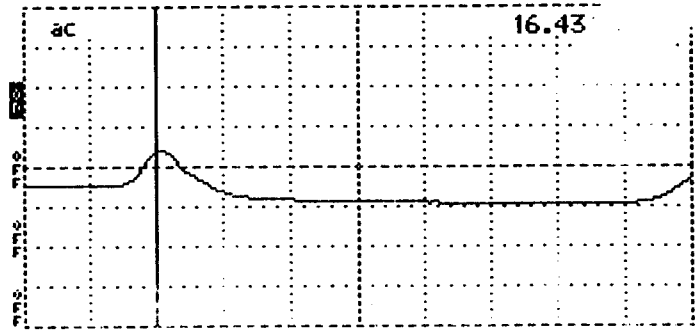
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

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 [13] LTPP Section ID [SC__]

Cursor ..... 16.431 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C01
Notes IN WATER
apparent length 1.84 M
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.84	83.88

[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: 13C01 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Steve Davis Employer: BRE

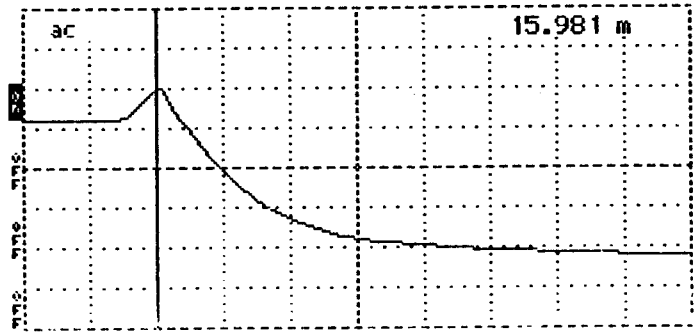
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

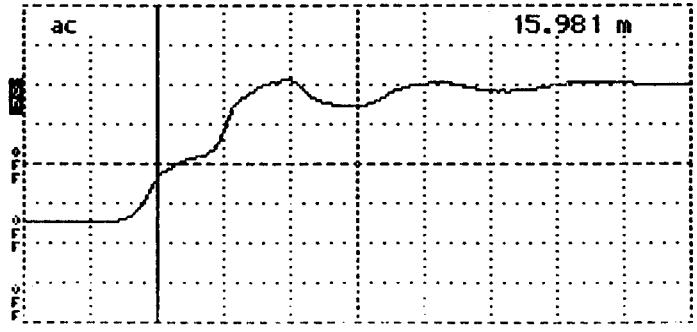
Cursor ..... 15.981 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C02
Notes shorted at 0.
12.2 m
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 15.981 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C02
Notes AIR SP
APPARENT LENGTH 0.24
Input Trace
Stored Trace
Difference Trace

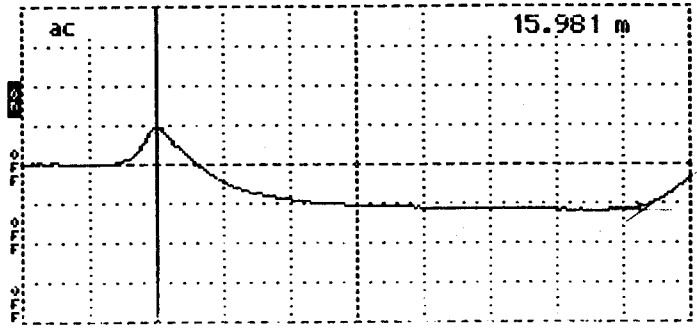
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 15.981 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C02
Notes WATER JP
APPARENT LENGTH
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.82	82.07

[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: 13C02 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2m

Comments: _____

Prepared by: Steve Davis Employer: BRE

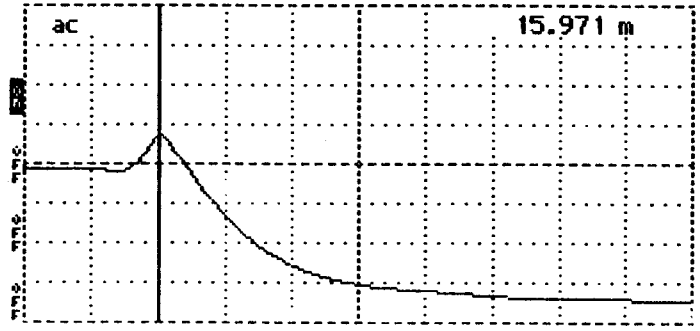
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

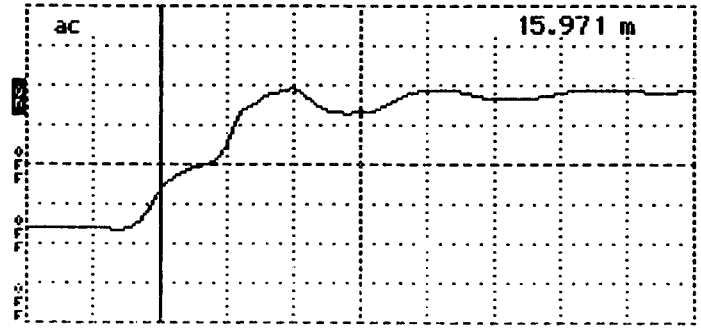
Cursor ..... 15.971 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C03
Notes shorted at 0
12.2 m
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 15.971 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C03
Notes IN AIR at 0
apparent length 0.24m
Input Trace
Stored Trace
Difference Trace

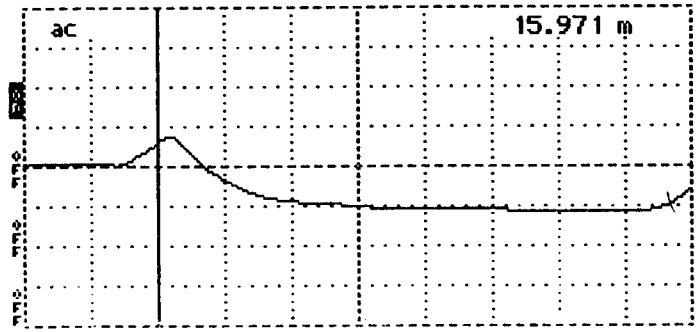
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

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

Data Sheet SMP-C01: TDR Probe Check

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 15.971 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C03
Notes IN WATER
apparent length 1.85m
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.84	83.88

[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: 13C03 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2m

Comments: _____

Prepared by: Steve Davis Employer: BRE

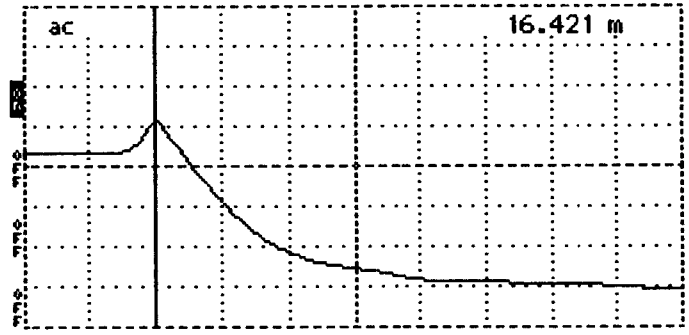
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

Cursor ..... 16.421 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



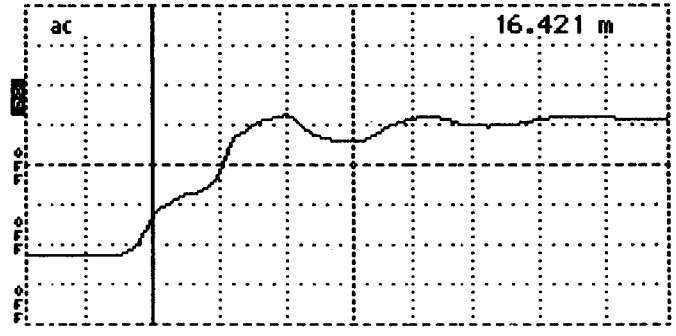
Tektronix 1502B TDR
Date 05/31/95
Cable 13C04
Notes SHORTED JP

Input Trace _____
Stored Trace .....
Difference Trace .....

12.2 ft

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

Cursor ..... 16.421 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C04
Notes AIR JP

APPARENT LENGTH 0.24

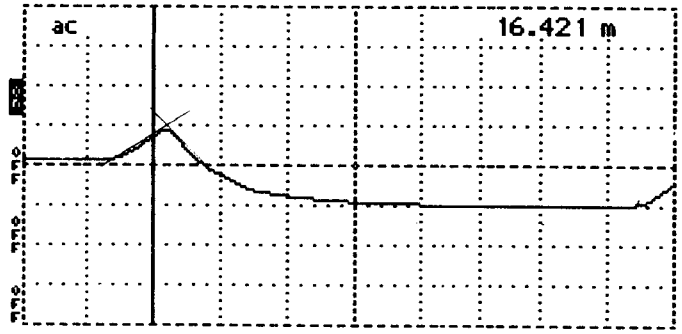
Input Trace _____
Stored Trace .....
Difference Trace .....

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 16.421 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C04
Notes WATER JP
APPROX LENGTH 1.85
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.84	83.88

[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: 13C04 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Steve Davis Employer: BRE

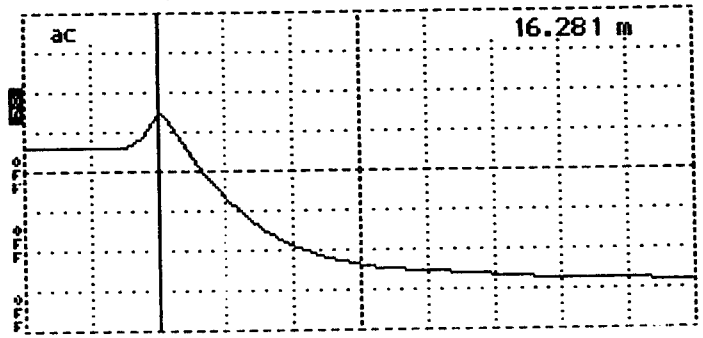
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

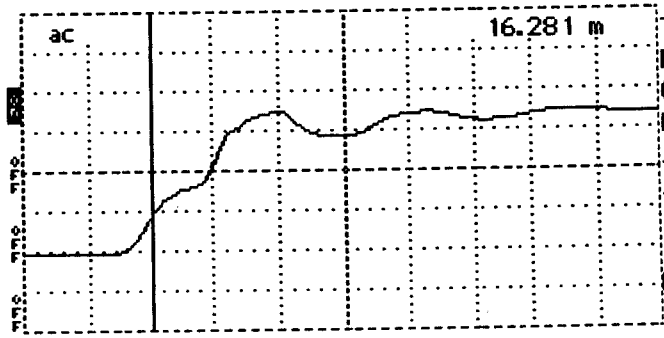
Cursor ..... 16.281 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C05
Notes Shorted SP
12.2 m
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 16.281 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502
Date 05/31/95
Cable 13C05
Notes AIR SP
A Length 0.24
Input Trace
Stored Trace
Difference Trace

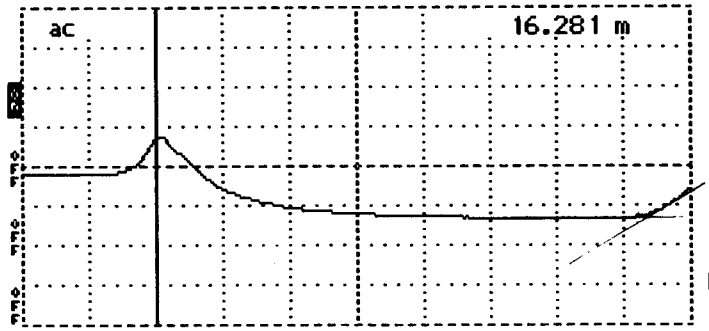
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 16.281 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/24/95
Cable 13C05
Notes WATER SP
APPARENT LENGTH 1.95
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.82	82.07

[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: 13C05 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Steve Davis Employer: BRE

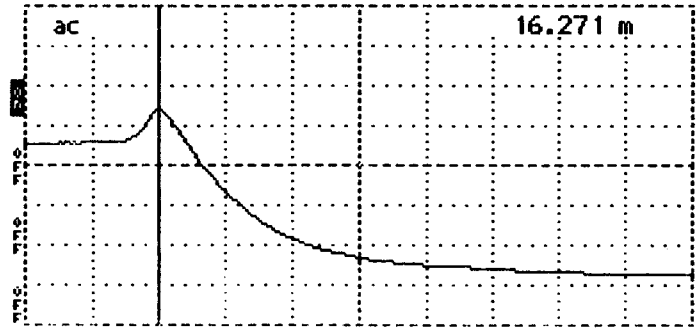
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

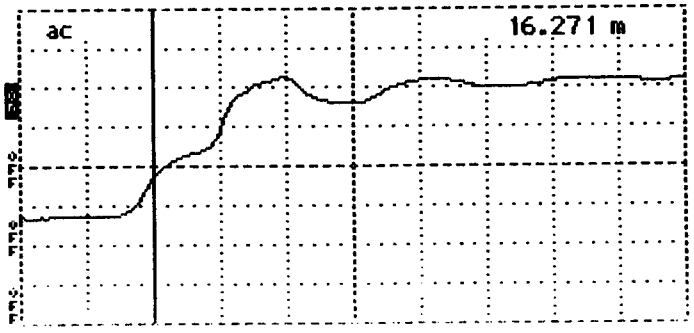
Cursor ..... 16.271 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C06
Notes SHORTED JP
12.2 n
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 16.271 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C06
Notes AIR JP
APPARENT LENGTH 0.24
Input Trace
Stored Trace
Difference Trace

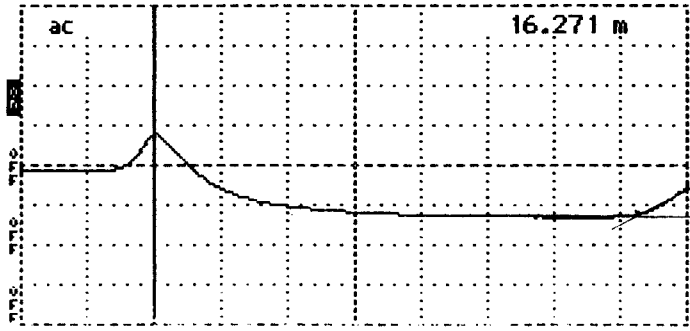
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 16.271 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mP/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C06
Notes WATER JP
APPARENT LENGTH 1.80
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.80	80.28

[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: 13C06 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Steve Davis Employer: BRE

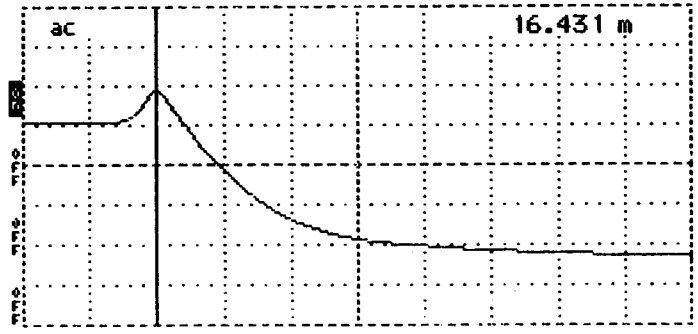
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

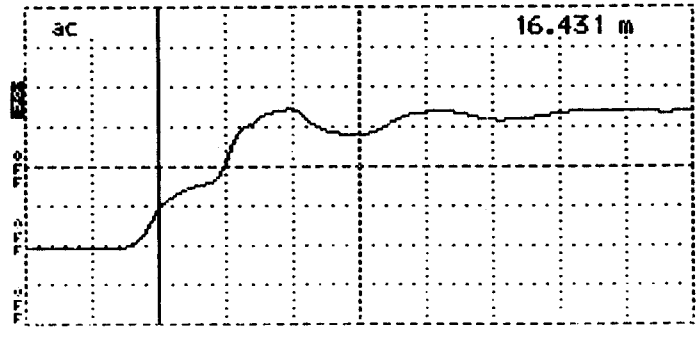
Cursor ..... 16.431 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05-31-95
Cable 13C07
Notes shorted end
Input Trace 12:2PM
Stored Trace .....
Difference Trace .....

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

Cursor ..... 16.431 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



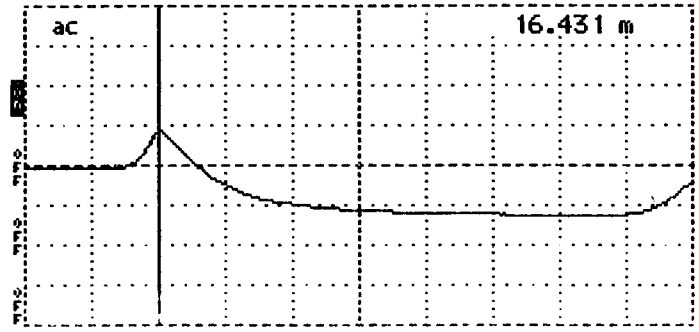
Tektronix 1502B TDR
Date 05/31/95
Cable 13C07
Notes IN AIR end
apparent length 0.24111
Input Trace _____
Stored Trace .....
Difference Trace .....

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

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [5<]]

Cursor ..... 16.431 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C07
Notes IN WATER #1
apparent length 1.84m.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.84	83.88

[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: 13C07 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Steve Davis Employer: BRE

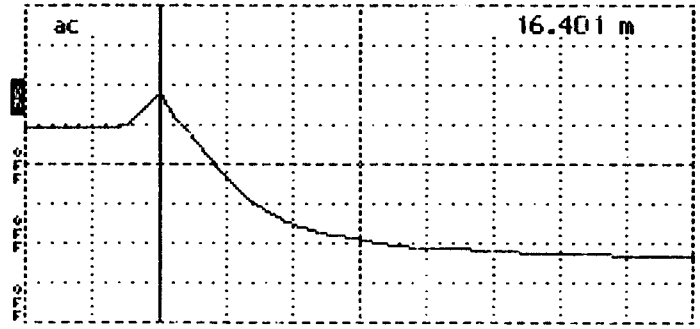
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

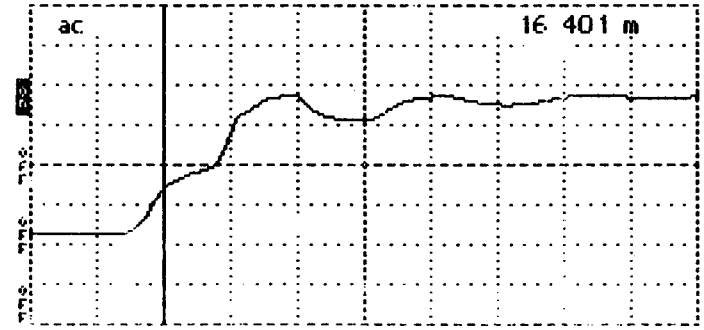
Cursor ..... 16.401 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 5/31/95
Cable 13C08
Notes shorted at 0
12.2M
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 16.401 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C08
Notes IN AIR at 0
apparent length 0.24M
Input Trace
Stored Trace
Difference Trace

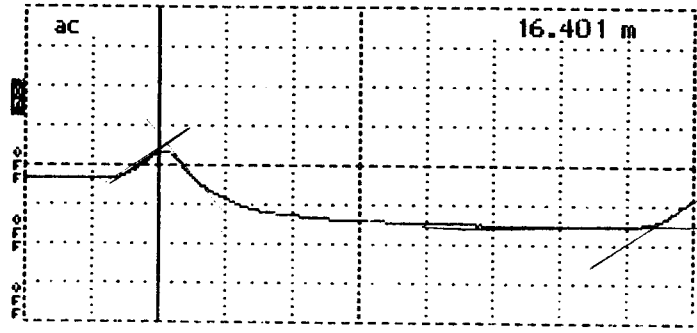
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 16.401 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C08
Notes IN WATER #1
apparent length 1.35 m.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.80	80.28

[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: 13C08 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2m

Comments: _____

Prepared by: Steve Davis Employer: BRE

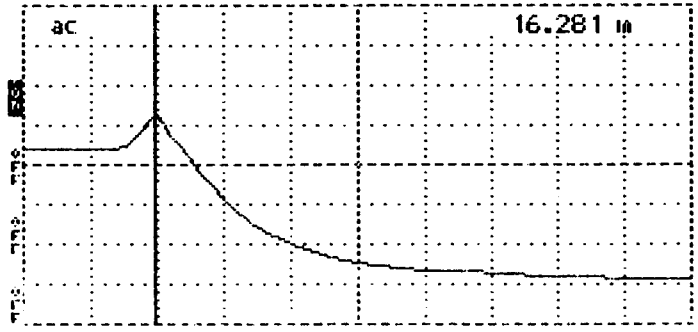
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

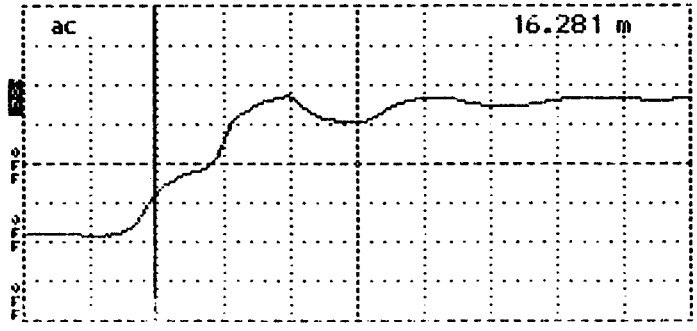
Cursor ..... 16.281 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 5/31/95
Cable 13C09
Notes Shorted at 0
12.2M
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 16.281 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 05/31/95
Cable 13C09
Notes IN AIR at 0
Apparent Length 0.24m
Input Trace
Stored Trace
Difference Trace

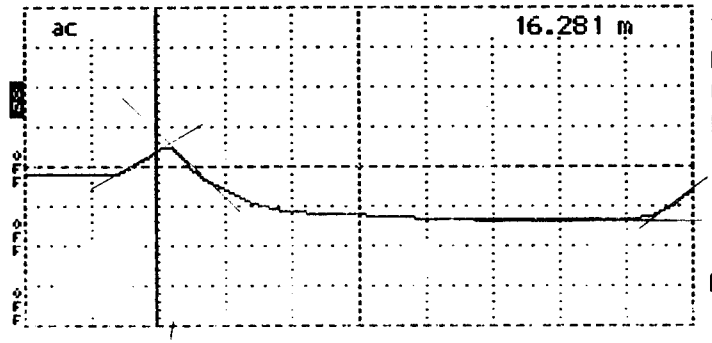
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

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

Data Sheet SMP-C01: TDR Probe Check

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]

Cursor ..... 16.281 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 5/31/95
Cable 13C09
Notes IN WATER
apparent length 1.85m.
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.80	80.28

[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: 13C09 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2m

Comments: _____

Prepared by: Steve Davis Employer: BRE

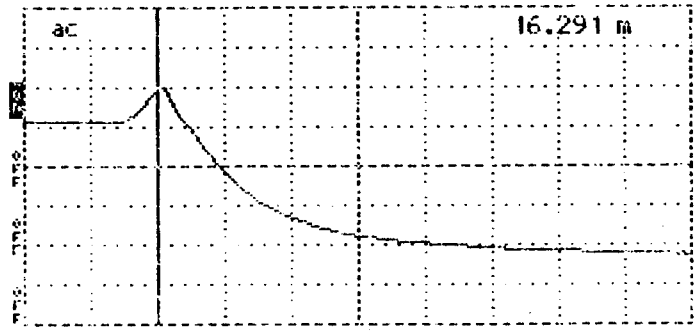
Date (dd/mmm/yy): 31/MAY/95

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 [13] LTPP Section ID [SC__]

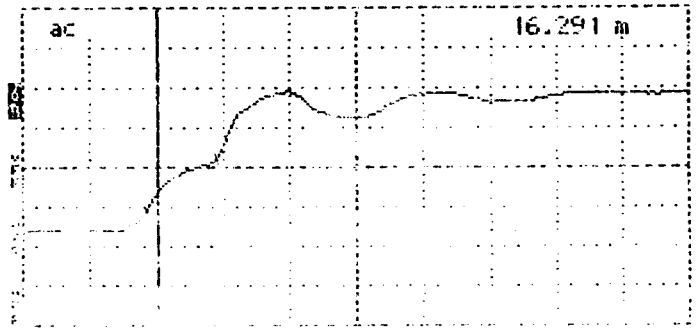
Cursor ..... 16.291 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 5/31/95
Cable 13C10
Notes shorted
10 12.2M
Input Trace
Stored Trace
Difference Trace

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

Cursor ..... 16.291 m
Distance/Div..... .25 m/div
Vertical Scale.... 250 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



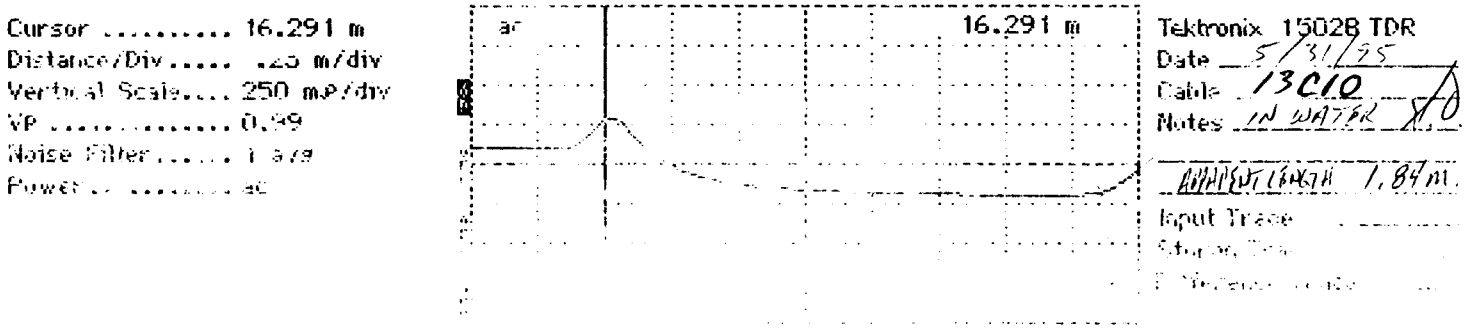
Tektronix 1502B TDR
Date 5/31/95
Cable 13C10
Notes IN AIR
APPARENT LENGTH 0.24 M
Input Trace
Stored Trace
Difference Trace

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

Data Sheet SMP-C01: TDR Probe Check

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [13] LTPP Section ID [SC__]



TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.84	83.88

[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: 13C10 TDR Probe Length, L: 0.203 m Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Steve Davis Employer: BRE

Date (dd/mmm/yy): 31/MAY/95

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

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

APPENDIX C

Instrumentation Installation Information

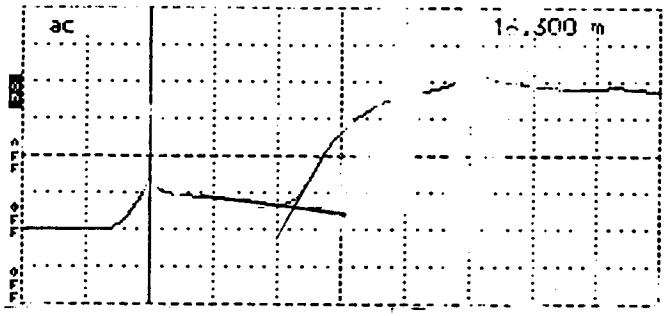
Appendix C contains the following information:

Figure C-1. TDR Traces During Installation

Table C-1. Field Measured Moisture Contents

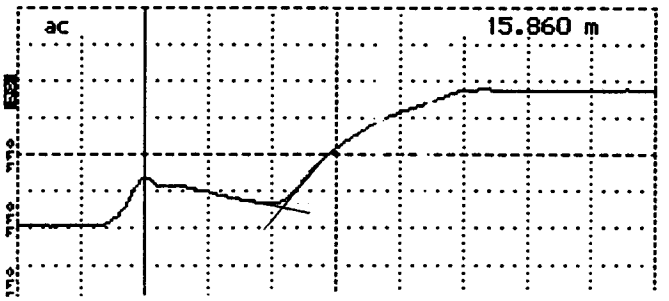
Figure C-2. Field Proctor Test

Cursor ..... 16.300 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



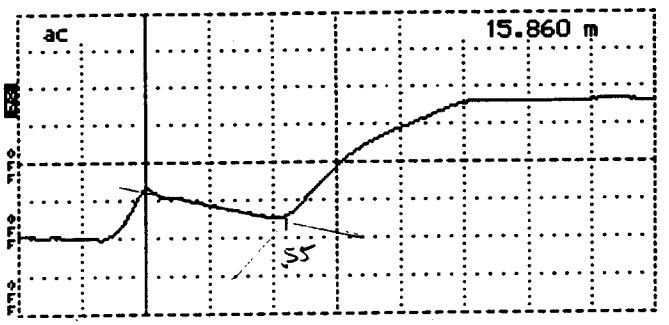
Tektronix 1502B TDR
Date 08/07/95
Cable 13C01
Notes 0.295 m
Input Trace
Stored Trace
Difference Trace

Cursor ..... 15.860 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



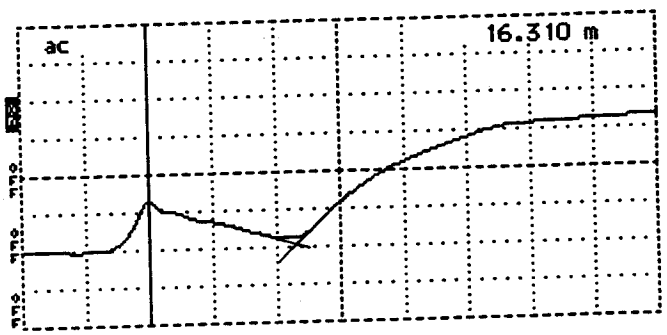
Tektronix 1502B TDR
Date 08/07/95
Cable 13C02
Notes 0.495 m
Input Trace
Stored Trace
Difference Trace

Cursor ..... 15.860 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



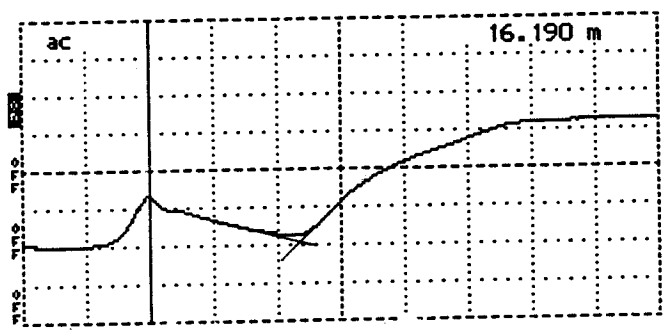
Tektronix 1502B TDR
Date 08/07/95
Cable 13C03
Notes 0.597 m
Input Trace
Stored Trace
Difference Trace

Cursor ..... 16.310 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/07/95
Cable 13C04
Notes 0.747 m
Input Trace
Stored Trace
Difference Trace

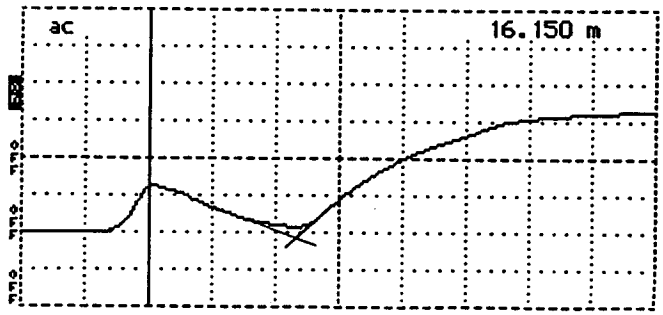
Cursor ..... 16.190 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/07/95
Cable 13C05
Notes 0.904 m
Input Trace
Stored Trace
Difference Trace

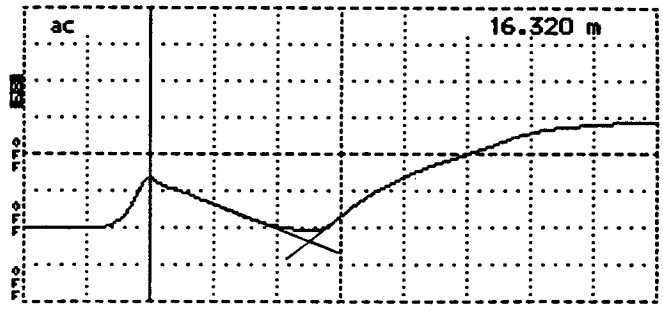
Figure C-1. TDR Traces During Installation

Cursor ..... 16.150 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



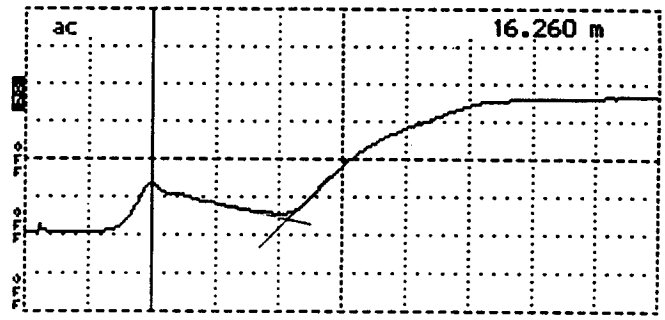
Tektronix 1502B TDR
Date 08/07/95
Cable 13C06
Notes 1.051M
Input Trace
Stored Trace
Difference Trace

Cursor ..... 16.320 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



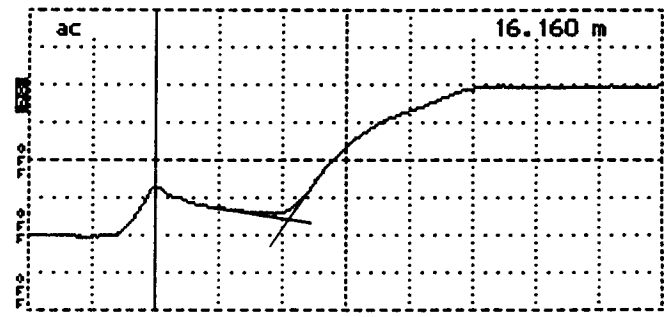
Tektronix 1502B TDR
Date 08/07/95
Cable 13C07
Notes 1.205M
Input Trace
Stored Trace
Difference Trace

Cursor ..... 16.260 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



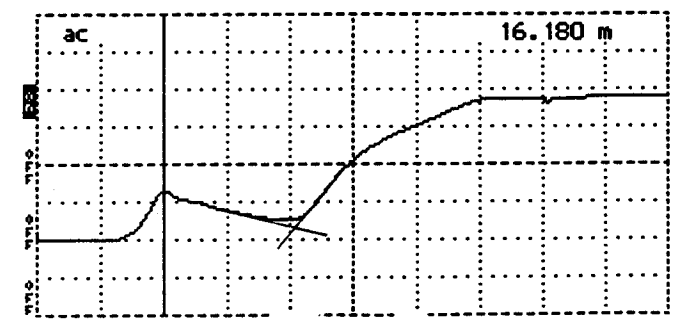
Tektronix 1502B TDR
Date 08/07/95
Cable 13C08
Notes 1.355
Input Trace
Stored Trace
Difference Trace

Cursor ..... 16.160 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 08/07/95
Cable 13C09
Notes 1.662M
Input Trace
Stored Trace
Difference Trace

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



Tektronix 1502B TDR
Date 08/07/95
Cable 13C10
Notes 1.963M
Input Trace
Stored Trace
Difference Trace

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

Table C-1. Field Measured Moisture Contents

SITE NO. 131005 8/08/95

MOISTURE CONTENTS FOR TDR

TDR #	WT. OF PAN(g)	(WET) PAN & SOIL(g)	(DRY) PAN & SOIL(g)	M.C. (%)
13C10	152.0	281.3	259.9	19.8%
13C09	149.5	277.1	255.3	20.6%
13C08	151.6	245.4	230.8	18.4%
13C07	204.6	291.0	276.3	20.5%
13C06	171.9	254.0	240.0	20.6%
13C05	151.2	275.5	256.6	17.9%
13C04	148.7	279.5	260.6	16.9%
13C03	204.5	345.4	325.0	16.9%
13C02	171.8	293.9	277.2	15.8%
13C01	150.9	255.6	247.0	8.9%

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code LTPP Section ID	13SC	[1 3] [1 0 0 5]

Depth of Representative Sample (from pavement surface): 1.22 m

Dry Density Determination:

a.	Tare Weight of Empty Mold:	4102 g	9.02 lb
b.	Weight of Mold and Compacted Soil:	6002 g	13.20 lb
c.	Weight of Compacted Soil (b - a):	1900 g	4.18 lb
d.	Unit Weight of Compacted Soil = (c / 943.0) =		2.01 g/cm³
	[c / (1 / 30)] =		125.4 lb/ft³
e.	Dry Density of Compacted Soil = [d / (1 + r/100)] =		1.69 g/cm³
			(105.4 lb/ft³)

Moisture Content Determination:

m.	Tare Weight of Pan:	172.3 g
n.	Weight of Pan and Moisture Sample:	301.0 g
o.	Weight of Pan and Dry Sample:	280.5 g
p.	Weight of Moisture (n - o):	20.5 g
q.	Weight of Dry Sample (o - m):	108.2 g
r.	Moisture Content by Weight = [(p / q) * 100] =	18.9 %

Comments: Soil is an extremely moist, reddish-brown clay, with no rocks present. Some gray and occasional white areas seen in soil.

Prepared by: Hunter Estes Employer: BRE

Date (dd/mmm/yy): 07/AUG/95

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 August Data Collection
Figure D-2.	Measured Average Subsurface Temperature for the First 5 Sensors During August Data Collection
Figure D-3.	Measured Average Subsurface Temperature for all 18 Sensors on August 9th 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

5,1995,221,100,12.82,23.19,0
6,1995,221,100,30.89,32.45,33.63,34.07,33.74
5,1995,221,200,12.81,22.97,0
6,1995,221,200,30.29,31.78,33.09,33.79,33.64
5,1995,221,300,12.81,22.63,0
6,1995,221,300,29.82,31.26,32.6,33.49,33.5
5,1995,221,400,12.81,22.3,0
6,1995,221,400,29.42,30.81,32.16,33.2,33.33
5,1995,221,500,12.81,21.95,0
6,1995,221,500,29.04,30.42,31.79,32.91,33.15
5,1995,221,600,12.81,21.73,0
6,1995,221,600,28.53,29.99,31.42,32.65,32.97
5,1995,221,700,12.81,21.14,0
6,1995,221,700,28.01,29.54,31.06,32.4,32.8
5,1995,221,800,12.81,21.29,0
6,1995,221,800,27.51,29.07,30.68,32.13,32.61
5,1995,221,900,12.81,22.63,0
6,1995,221,900,27.89,28.88,30.33,31.86,32.42
5,1995,221,1000,12.81,23.62,0
6,1995,221,1000,28.89,29.21,30.19,31.62,32.23
5,1995,221,1100,12.81,24.47,0
6,1995,221,1100,30.87,30.1,30.37,31.46,32.06
5,1995,221,1200,12.82,25.81,0
6,1995,221,1200,33.36,31.38,30.78,31.39,31.91
5,1995,221,1300,12.83,26.64,0
6,1995,221,1300,36.86,33.58,31.66,31.46,31.83
5,1995,221,1400,12.83,26.69,0
6,1995,221,1400,38.99,35.63,32.85,31.75,31.85
5,1995,221,1500,12.84,27.36,0
6,1995,221,1500,40.26,36.97,33.97,32.21,31.98
5,1995,221,1600,12.84,27.47,0
6,1995,221,1600,40.88,38,34.93,32.73,32.2
5,1995,221,1700,12.84,28.11,0
6,1995,221,1700,40.99,38.5,35.64,33.24,32.47
5,1995,221,1800,12.84,27.58,0
6,1995,221,1800,40.03,38.63,36.17,33.73,32.78
5,1995,221,1900,12.83,27.58,0
6,1995,221,1900,39.02,38.14,36.3,34.13,33.07
5,1995,221,2000,12.83,26.65,0
6,1995,221,2000,37.63,37.54,36.3,34.39,33.35
5,1995,221,2100,12.83,25.34,0
6,1995,221,2100,35.67,36.42,35.98,34.55,33.55
5,1995,221,2200,12.82,24.16,0
6,1995,221,2200,33.79,35.11,35.43,34.59,33.71
5,1995,221,2300,12.81,23.83,0
6,1995,221,2300,32.43,33.93,34.73,34.45,33.75
1,1995,221,2400,12.82,12.84,1603,12.8,844,24.53,29.09,1623,20.7,657,0,4067
2,1995,221,2400,33.44,33.35,33.17,33.02,32.86,32.76,32.6,32.46,32.2,31.54,31.15,30.74,30.2,29.82,29.27,29,28.48,28.01
3,1995,221,2400,41.21,1641,38.88,1718,36.51,1908,34.75,2100,33.9,2156,33.45,4,33.04,215,32.78,316,32.46,951,31.76,1119,31.33,954,30.91,1128,30.38,1049,29.97,1118,29.42,941,29.14,930,28.63,2046,28.17,1024
4,1995,221,2400,27.39,747,28.78,817,30.05,929,31.31,1104,31.8,1229,32.1,1412,32.15,1550,32.13,1720,31.93,2113,31.32,2205,31.01,2125,30.57,2213,30.03,2204,29.67,2213,29.15,2139,28.87,2214,28.37,2228,27.9,2140
5,1995,221,2400,12.81,23.57,0
6,1995,221,2400,31.55,33.02,34.06,34.23,33.73

Site 131005

August 9, 1995

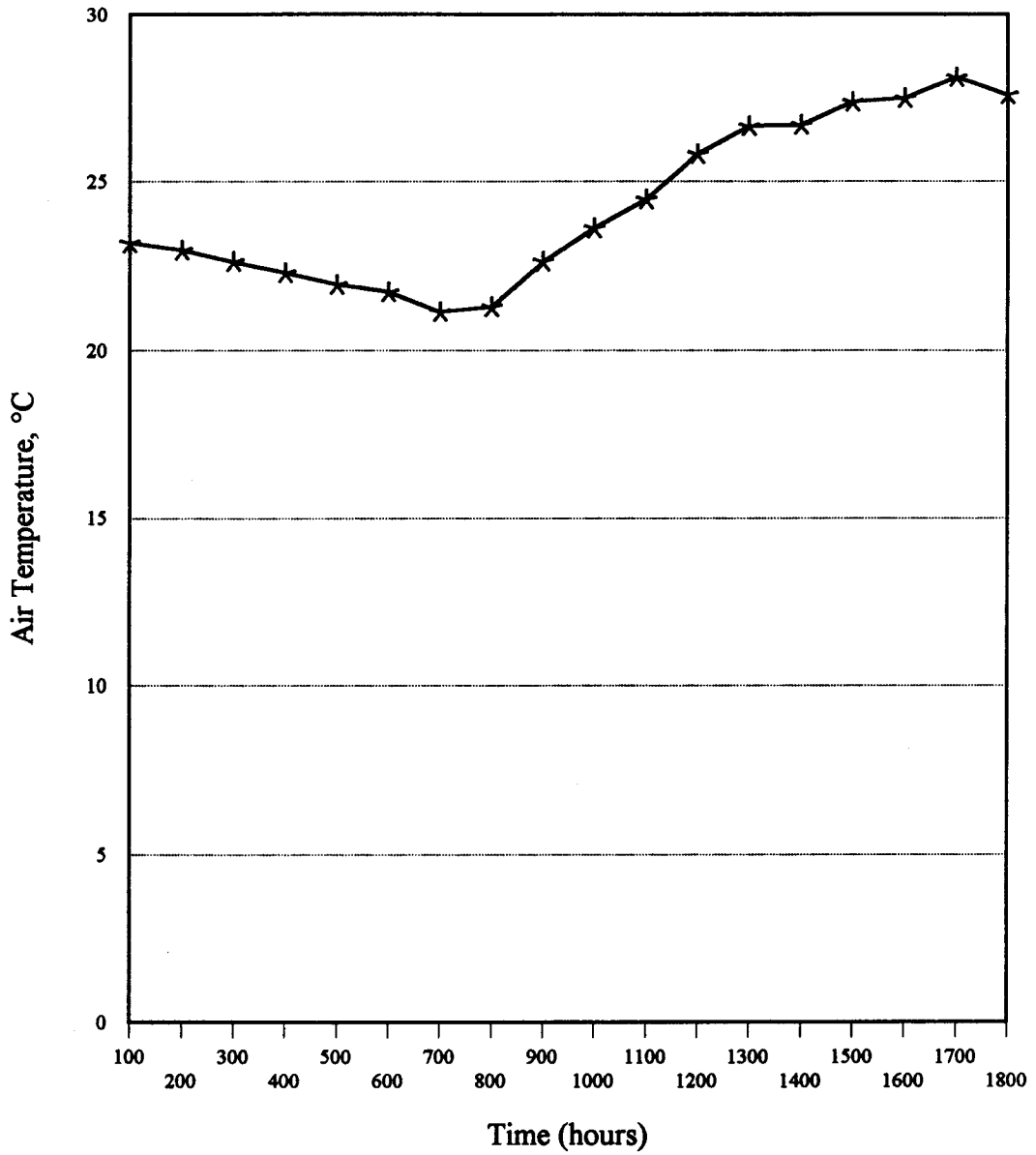


Figure D-1. Measured Air Temperature During August Data Collection.

Site 131005

August 9, 1995

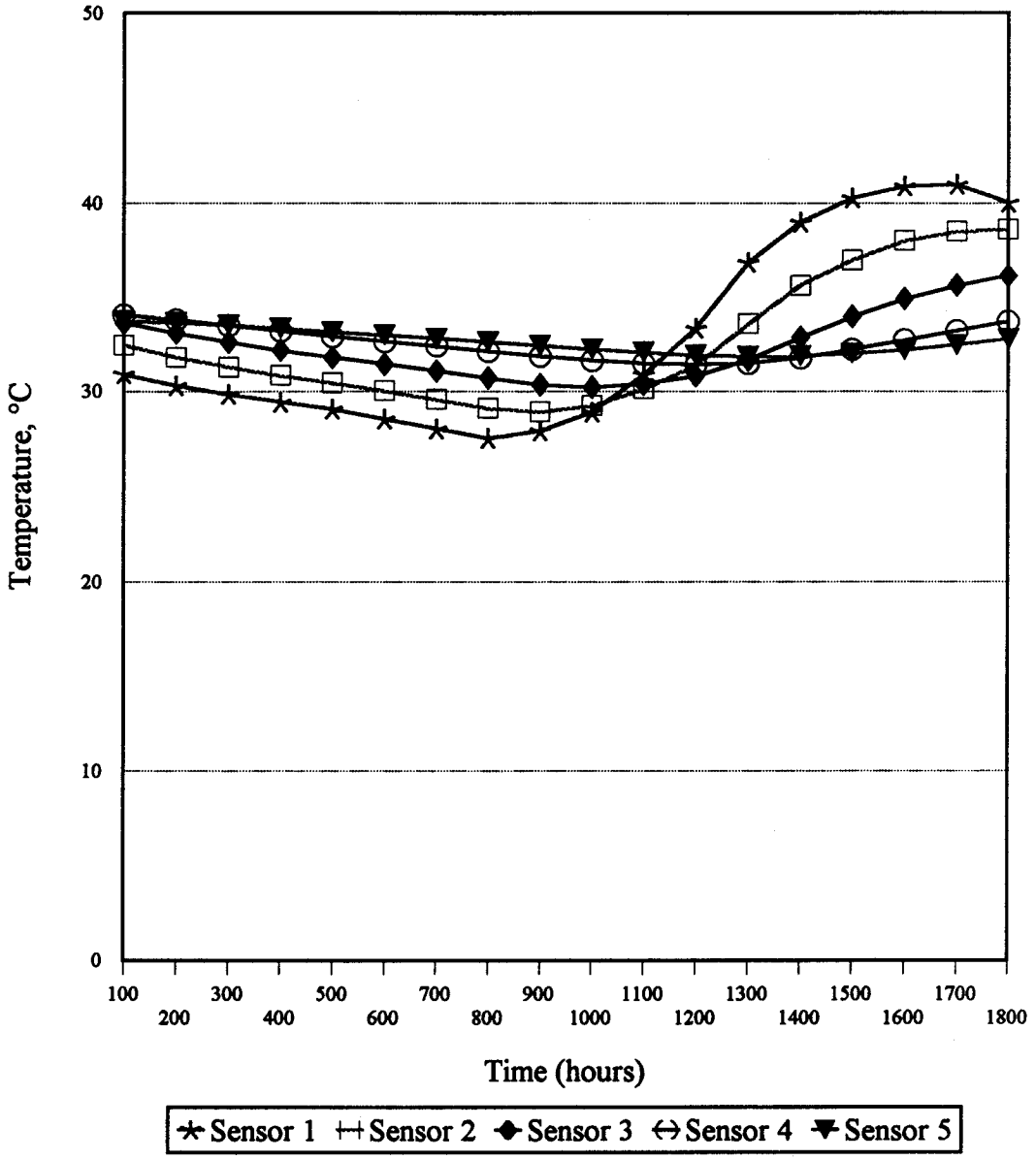


Figure D-2. Measured Average Subsurface Temperature for the First 5 Sensors During August Data Collection.

Site 131005

August 9, 1995

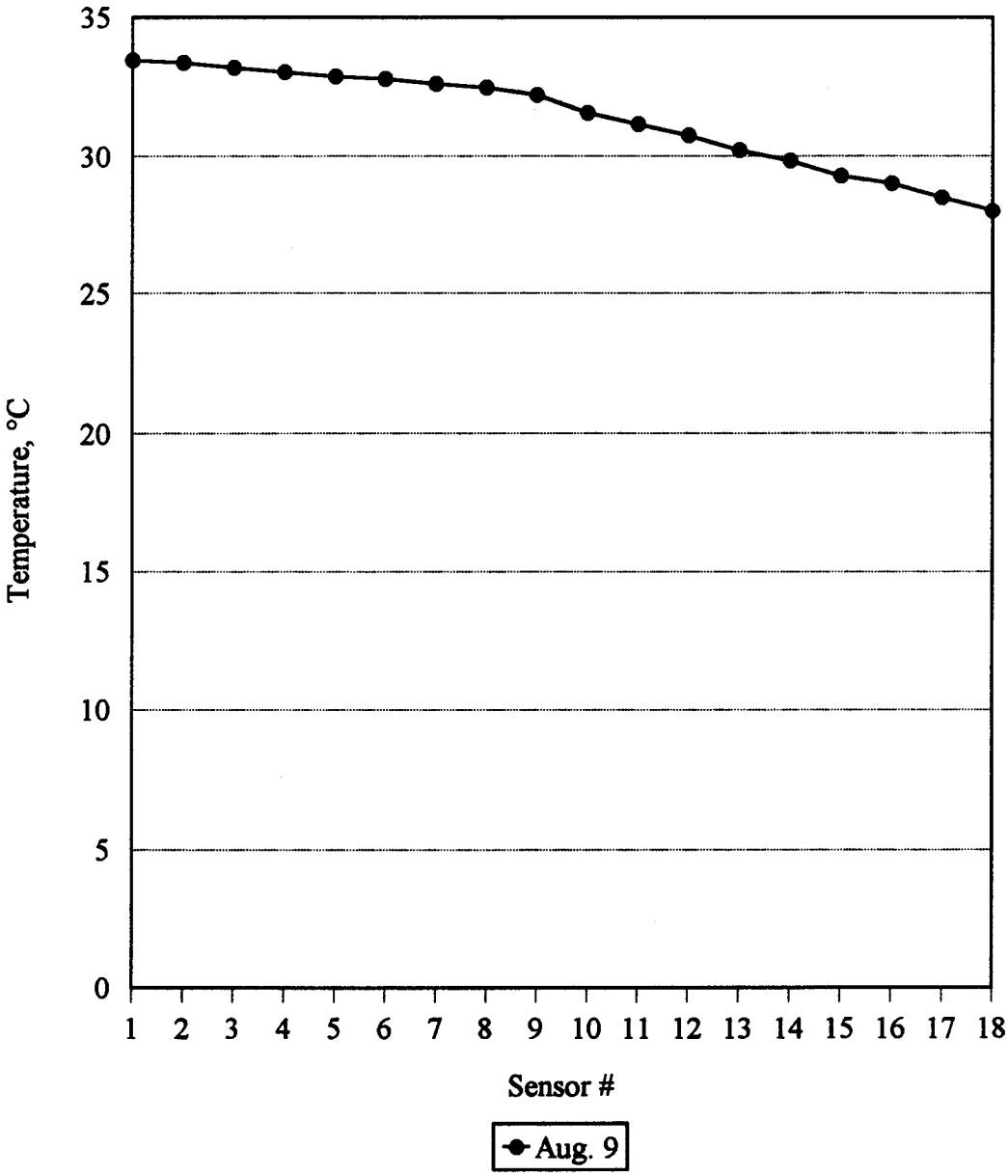


Figure D-3. Measured Average Subsurface Temperature for all 18 Sensors on August 9th.

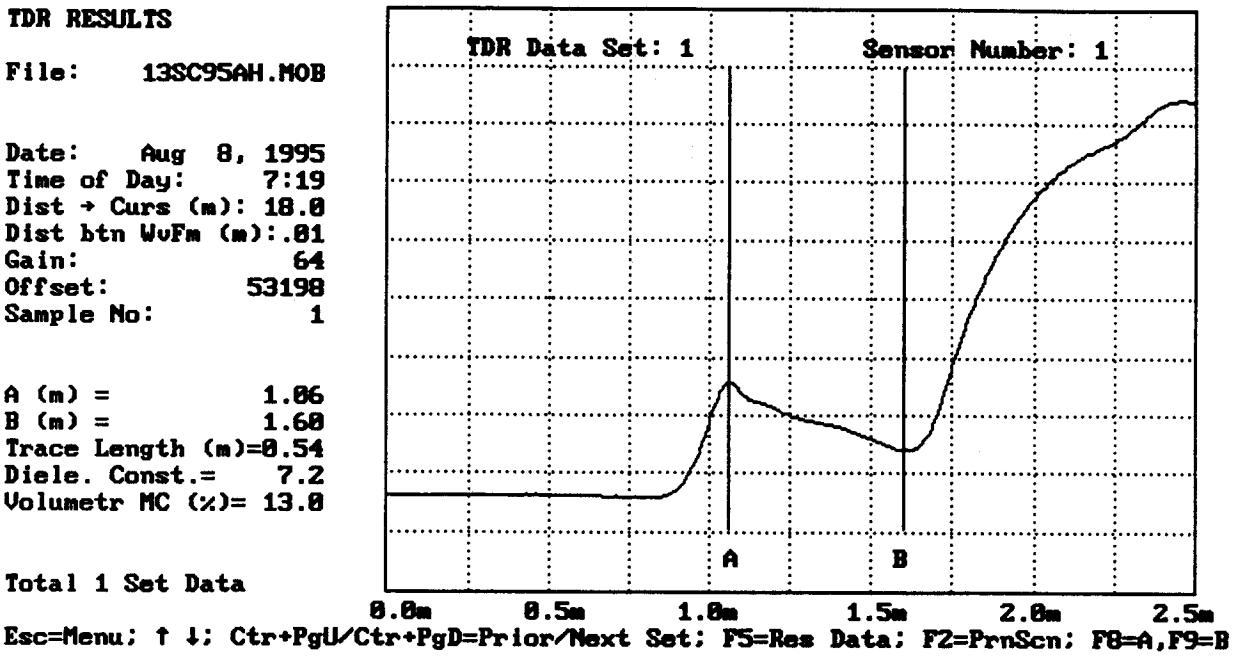


Figure D-4. Trace from TDR Sensor 1

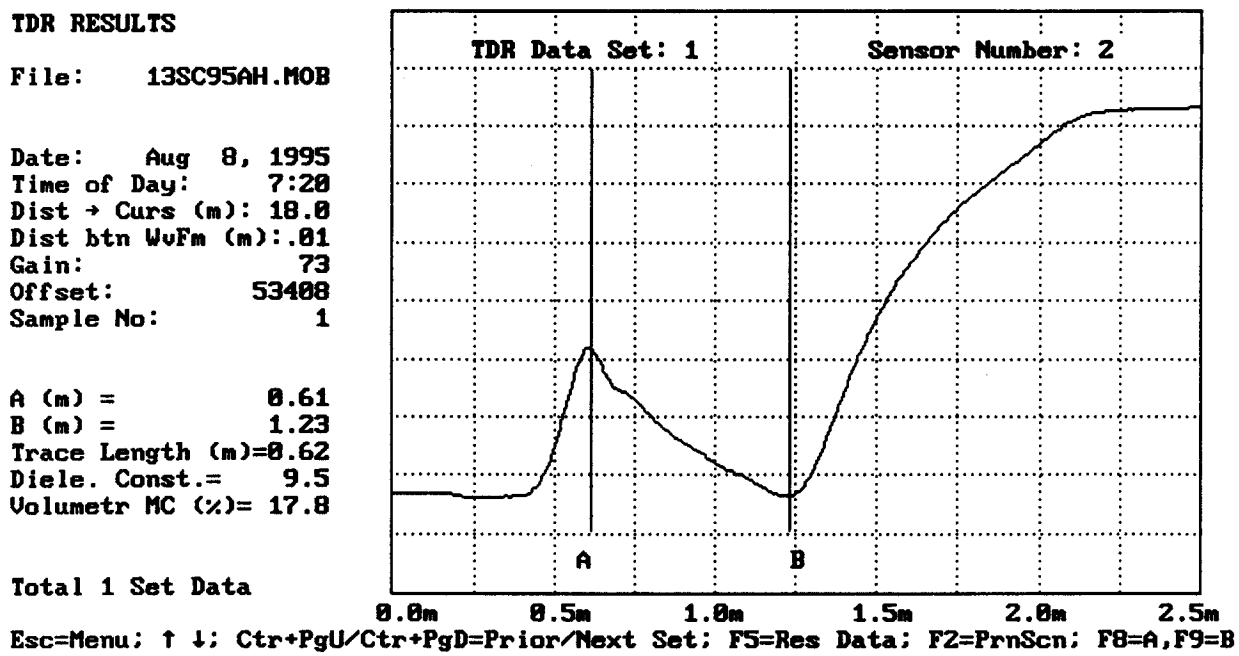


Figure D-5. Trace from TDR Sensor 2

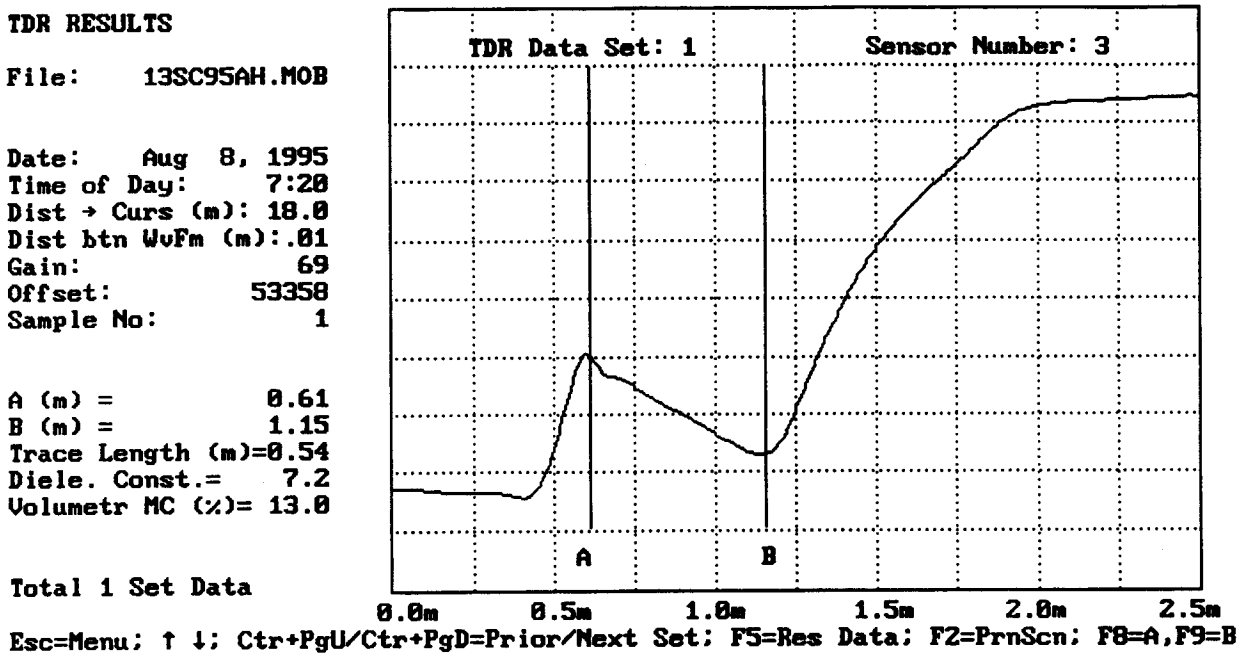


Figure D-6. Trace from TDR Sensor 3

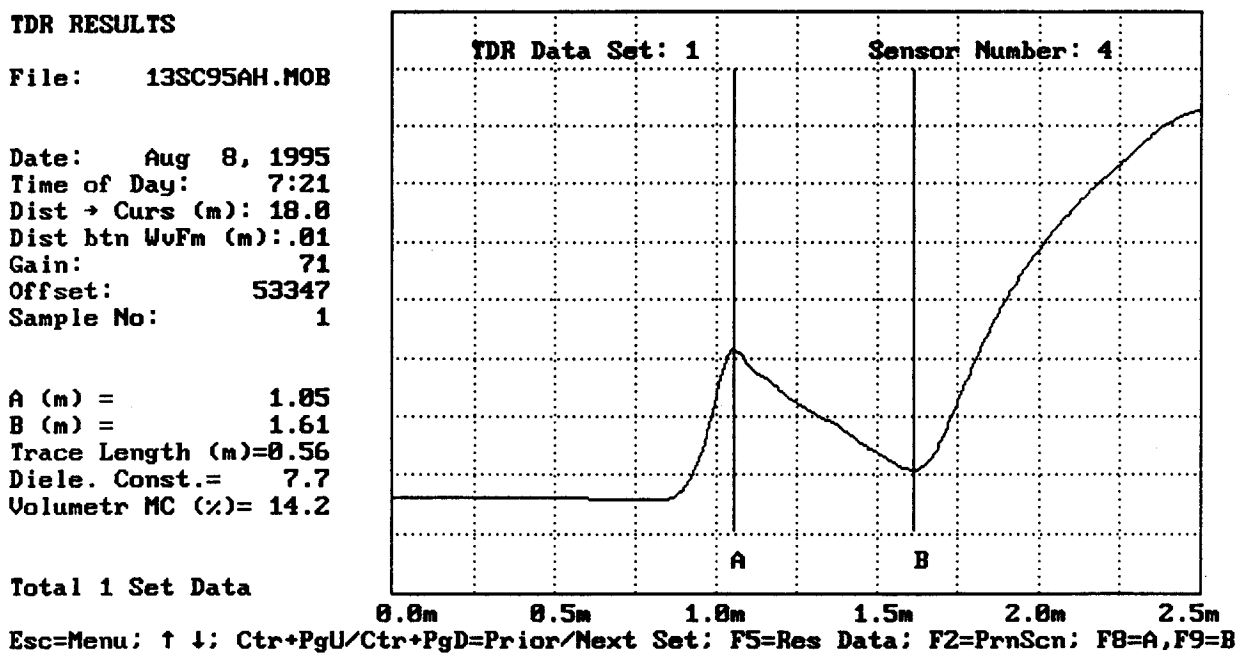


Figure D-7. Trace from TDR Sensor 4

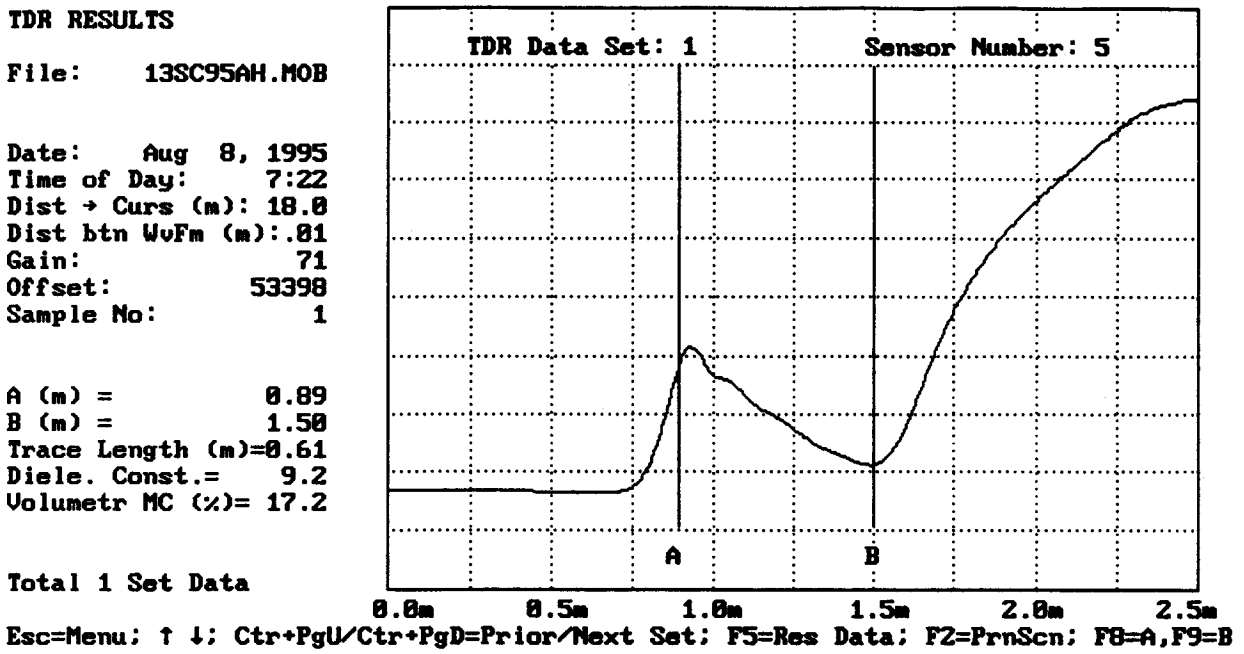


Figure D-8. Trace from TDR Sensor 5

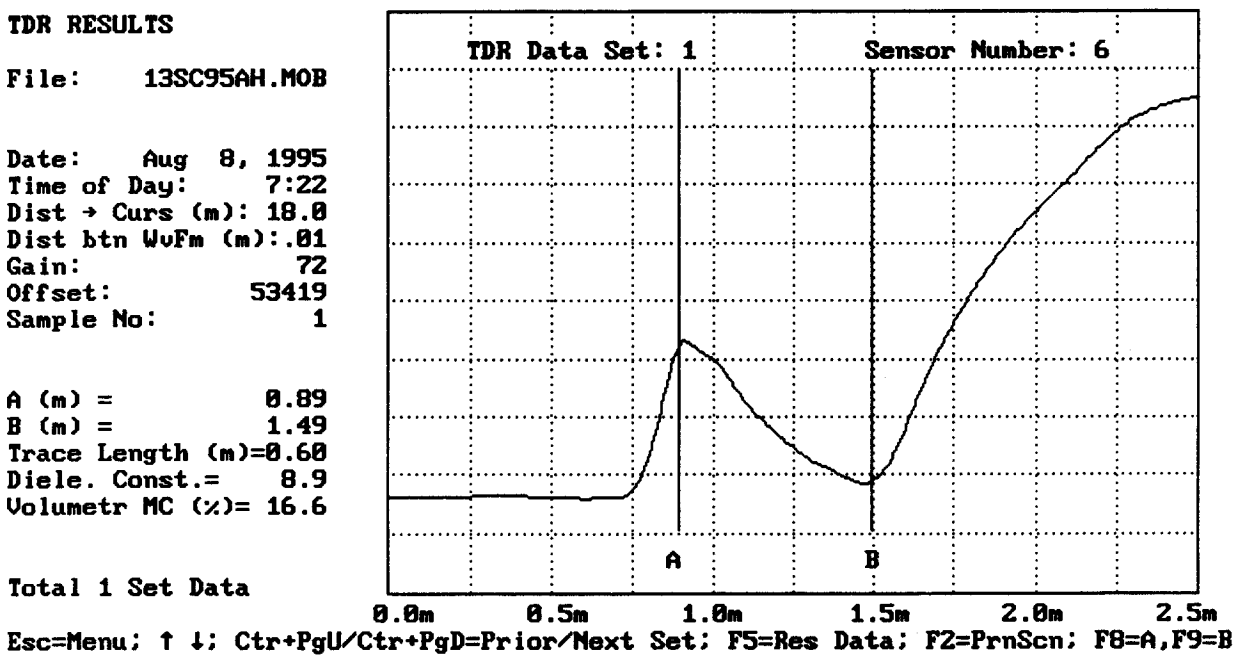


Figure D-9. Trace from TDR Sensor 6

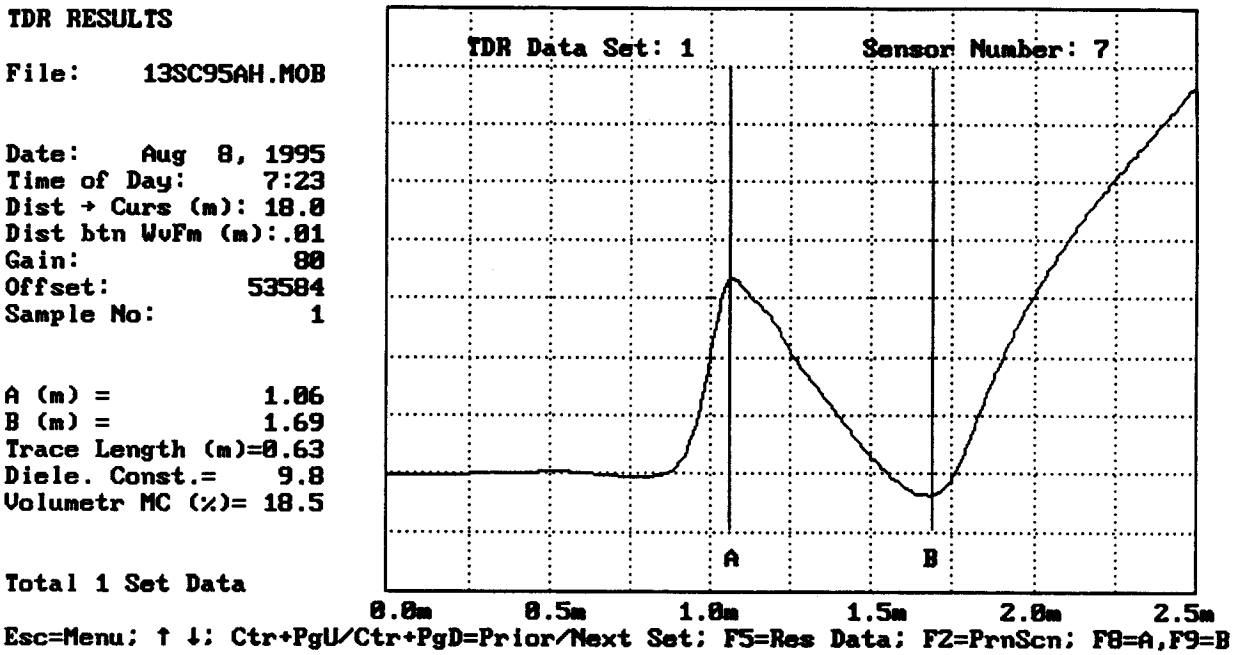


Figure D-10. Trace from TDR Sensor 7

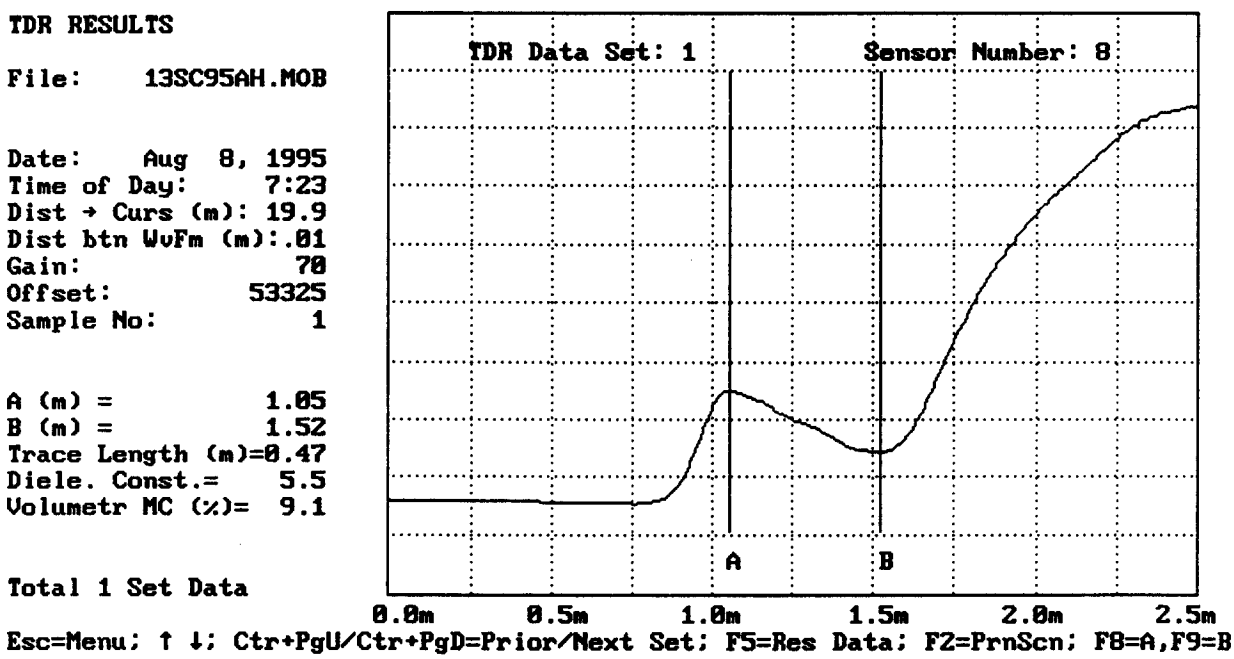


Figure D-11. Trace from TDR Sensor 8

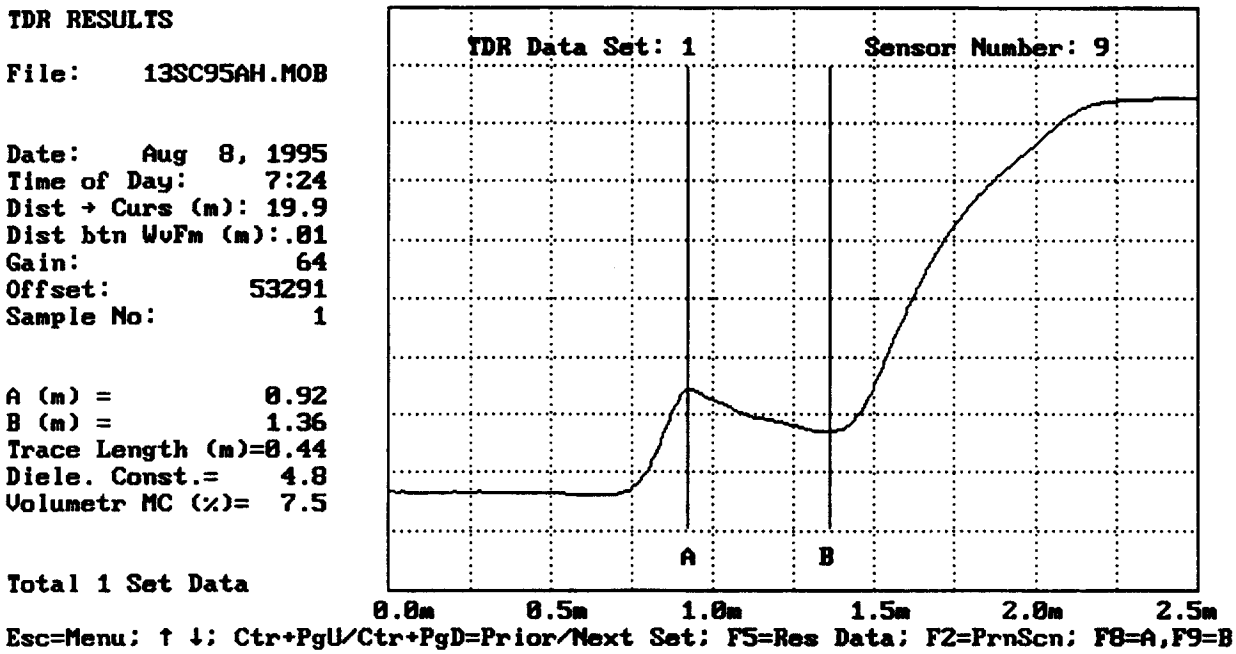


Figure D-12. Trace from TDR Sensor 9

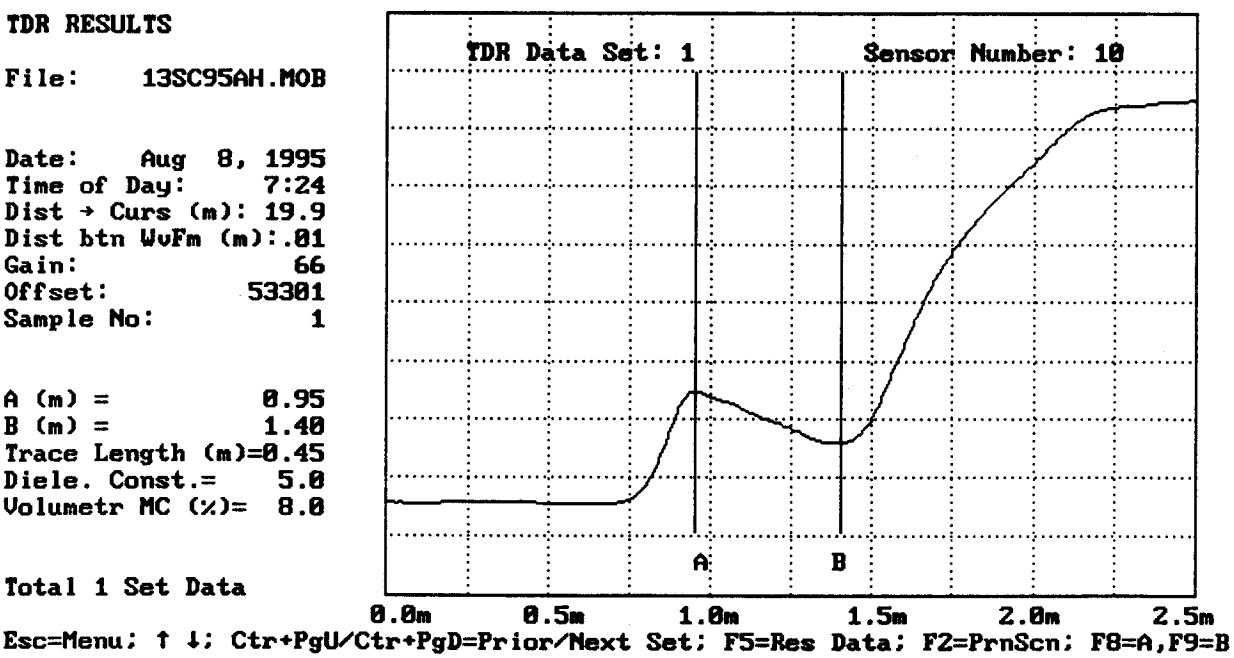


Figure D-13. Trace from TDR Sensor 10

Table D-2. Elevation Measurements Data Sheet - AC

SEASONAL MONITORING
"FLEX" TRANSVERSE ELEVATION MEASUREMENTS[1]

135C

Station	Outside Edge		OWP		ML		IWP		Inside Edge	
	O/S	Elev.	O/S	Elev.	O/S	Elev.	O/S	Elev.	O/S	Elev.
3+00	0.25	10.266	0.95	10.277	1.80	10.298	2.60	10.312	3.50	10.331
3+25	"	10.258	"	10.269	"	10.288	"	10.302	"	10.323
3+50	"	10.248	"	10.263	"	10.283	"	10.297	"	10.320
3+75	"	10.237	"	10.250	"	10.270	"	10.283	"	10.306
4+00	"	10.220	"	10.235	"	10.254	"	10.268	"	10.293
4+25	"	10.208	"	10.218	"	10.237	"	10.249	"	10.272
4+50	"	10.193	"	10.204	"	10.223	"	10.234	"	10.254
4+75	"	10.169	"	10.180	"	10.202	"	10.214	"	10.233
5+00	0.25	10.144	"	10.152	"	10.174	2.60	10.186	3.50	10.207
5+10			0.95	10.143	1.80	10.164				
5+20		INSTRUMENTATION								
5+30			0.95	10.138						

Bench Mark : TOP OF 1" GALV. MONITOR WELL PIPE STA 3+98, 10' (3.05M) RT.
ASSUMED ELEV. 10.000M
T.B.M. PAINTED + (PLUS) ON SOUTH EDGE OF CONC. CATCH BASIN STA 4+25 ℄ MEDIAN
ELEV. : 9.359m

Comments: PK NAIL BASELINE SET 0.10M OUTSIDE SHOULDER STRIPE: 3.60M PK NAIL
T. PK NAIL

DRIZZLE, CALM, HUMID TIE IN ✓

Test Section No. 131005
Start Time (Military)
Recorded By [illegible]

Date (dd,mm,yy) 08/08/95
Device Used LASERLINE
Employer BRE

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

APPENDIX E

Photographs

Appendix E contains the following photographs:

Photo E-1. General Photo of Test Section

Photo E-2. Removal of Pavement Core

Photo E-3. Removal of Soil from Instrumentation Hole

Photo E-4. Final Core Replacement and Sealant