LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
Section 481122, Floresville, Texas

Prepared by

Brent Rauhut Engineering Inc.
8240 Mopac, Suite 220
Austin, Texas 78759

Prepared for

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

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16. Abstract

This report contains a description of the instrumentation installation activities and initial data collection for test section 481122, which is a part of the LTPP Core Seasonal Monitoring Program. This asphalt concrete surfaced pavement test section, which is located on US-181 in the northbound lanes, approximately 4.02 km south of the Bexar/Wilson County line, was instrumented on November 22-23, 1993. The instrumentation installed included time domain reflectometry probes for moisture content, thermistor probes for temperature, tipping-bucket rain gauge, an observation well to monitor the ground water table, and an on-site data logger. Initial data collection was performed on November 23, 1993, which consisted of deflection measurements with a Falling Weight Deflectometer (FWD), elevation measurements, temperature measurements, TDR measurements, and electrical resistance and resistivity 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.

17. Key Words	18. Distribution Statement
Pavement, Highway, Instrumentation, Monitoring, Time Domain Reflectometry, Thermistor, Observation Well, Test Equipment, Field Tests.	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price

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SEASONAL INSTRUMENTATION STUDY
INSTRUMENTATION INSTALLATION
TEXAS SECTION 481122/48SE

I. Introduction

The seasonal instrumentation installation of Section 481122 was performed on November 22-23, 1993.

The GPS-1 test section resides in Seasonal Cell 6 and is located in a dry-no freeze zone. The site (see Figure A-1) is in the northbound lanes on US-181, approximately 4.02 km south of the Bexar/Wilson County line.

The average maximum daily temperature for the months of June through August is 35°C and the average minimum daily temperature for the months of December through February is 3.9°C. The average annual precipitation is 683 mm.

The pavement is a flexible structure consisting of approximately 81.3 mm of asphalt concrete over 393.7 mm of crushed stone base and 213.4 mm of soil aggregate subbase. The subgrade is classified as a clayey 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	81.3	---
Base	393.7	2155
Subbase	213.4	1822
Subgrade	---	1851

The annual average daily traffic (AADT) in the GPS lane is almost 3500, of which 4.9% is truck traffic. The estimated annual ESALs on the GPS lane were 48,000. This information is based on traffic data collected on site.

Installation of the instrumentation was completed through the cooperative efforts of the Texas Department of Transportation (Texas DOT) and Federal Highway Administration (FHWA) Southern Region Coordination Office (SRCO) staff from Brent Rauhut Engineering Inc. (BRE). 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
Richard Zamora	Federal Highway Administration
Andrew Whimsatt	Texas Department of Transportation

II. Instrumentation Installation

Pre-Installation Activities

A pre-installation meeting was held at the BRE offices on October 18, 1993. The meeting agenda appears in Appendix B. The Texas DOT elected to contract out both traffic control services and drilling and augering services to private firms for all seven sites in the state. Therefore, the participants at the meeting were personnel from the SRCO, the Texas DOT, Campbell Industries (traffic control services) and Jones & Neuse, Inc. (drilling and augering services). No support was required from the Districts where the seasonal sites reside. 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 and Grand Rapids, Minnesota.

A site inspection and a manual distress survey were performed on April 2, 1993 by Jerry Daleiden (SRCO). Deflection testing was conducted on September 28, 1993. The 5+00 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, an observation well was set to measure the depth to the water table. A benchmark was also set by the Texas DOT. 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	223 (48ET)
TDR Sensors	10	48E01-48E10
Equipment Cabinet		
CR10 Data Logger	1	16583
Battery Package	1	5668
Weather Station		
Tipping-Bucket Rain Gauge	1	12092-693
Air Temperature Probe	1	421316
Observation Well	1	None

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.

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 №.	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	14	This unit was installed in the base and subgrade.
	5	91	
	6	167	
	7	243	
	8	319	
	9	472	
	10	624	
	11	779	
	12	930	
	13	1082	
	14	1235	
	15	1387	
	16	1537	
	17	1690	
	18	1841	

Location of Instrumentation

The instrumentation was installed at Station 5+11 of the test section. Approximately 762 mm from the lane edge, in the outside wheel path, a 457 mm square was removed from the pavement and a 254 mm diameter hole, 1.99 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 8.08 m from the lane edge.

The observation well was installed at Station 4+00 of the test section approximately 3.7 m from the lane edge. A permanent benchmark was also set at Station 0+08 approximately 5.5 m from the lane edge.

Installation

Installation of the monitoring equipment was begun on November 22, 1993 and was completed the following day. The Texas DOT provided the pavement sawing, pavement repair materials and a permanent benchmark. Texas DOT elected to contract the traffic control to Campbell Industries and the augering operations to Jones and Neuse, Inc.. The observation well was also drilled by Jones and Neuse due to licensing and construction requirements mandated by the Texas Water Commission. The monitoring equipment and cabinet installation was performed by the SRCO staff.

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. 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.

When backfilling of the instrumentation hole was completed, the pavement was patched using a cold mix asphalt patching material. The overcuts from the pavement sawing operation (including the groove for the temperature probe) were also sealed with Dow-Corning 888 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)
48E01	246	7.25	5.26
48E02	394	6.91	9.83
48E03	533	8.73	8.82
48E04	699	5.46	8.97
48E05	851	5.31	7.57
48E06	998	4.73	6.43
48E07	1156	3.60	6.38
48E08	1308	4.02	6.57
48E09	1613	3.33	4.61
48E10	1925	----	4.34

Note: The moisture content could not be calculated for Sensor 10 due to a printer malfunction during the installation.

Table 5. Thermistor Sensor Locations

Unit	Channel №.	Depth from Pavement Surface (mm)	Remarks
1	1	13	This unit was installed in the AC layer.
	2	42	
	3	71	
2	4	123	This unit was installed in the base and subgrade.
	5	200	
	6	276	
	7	352	
	8	428	
	9	581	
	10	733	
	11	888	
	12	1039	
	13	1191	
	14	1344	
	15	1496	
	16	1646	
	17	1799	
	18	1950	

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 December 6, 1993. 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.

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 481122 was completed on November 22, 1993 and initial data collection was completed on November 23, 1993. 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 movement; a permanent swell and frost-free benchmark; and an on-site data logger and battery pack.

At the time of this report, all of the equipment installed on-site appears to be functioning properly. After the initial installation, the alkaline battery pack was replaced with a gel-cell sealed batter.

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-8.	Plots from FWDCHECK
Figure A-9.	Manual Distress Survey Data

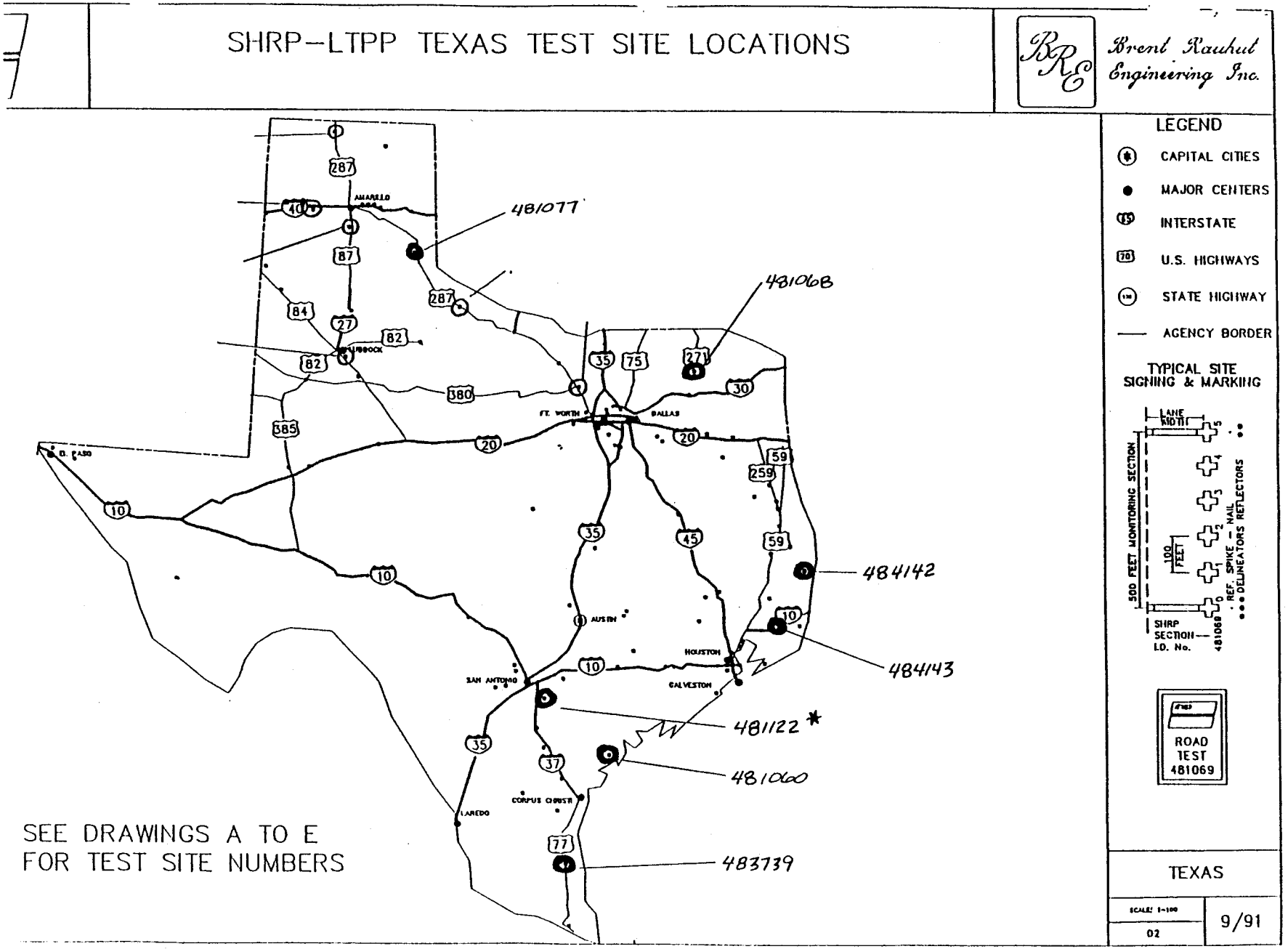


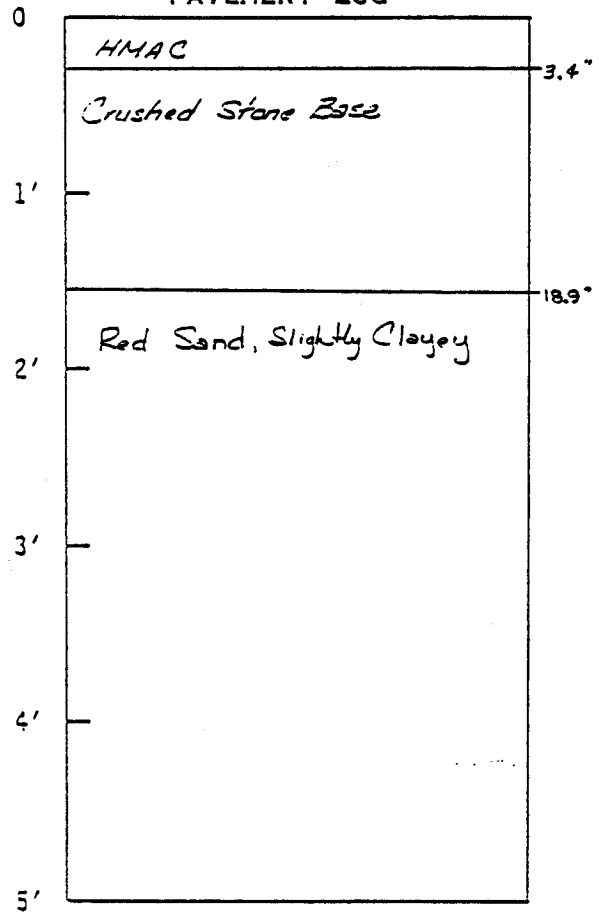
Figure A-1. Location of Test Site, GPS Test Section 481122

APPROXIMATE
SUMMARY OF FIELD LOGS
GPS TEST SECTIONS

TEST SECTION I.D. NO. 481122
STATE TEXAS

EXPERIMENT NO. GPS-1
DATE SAMPLED 2-14-90

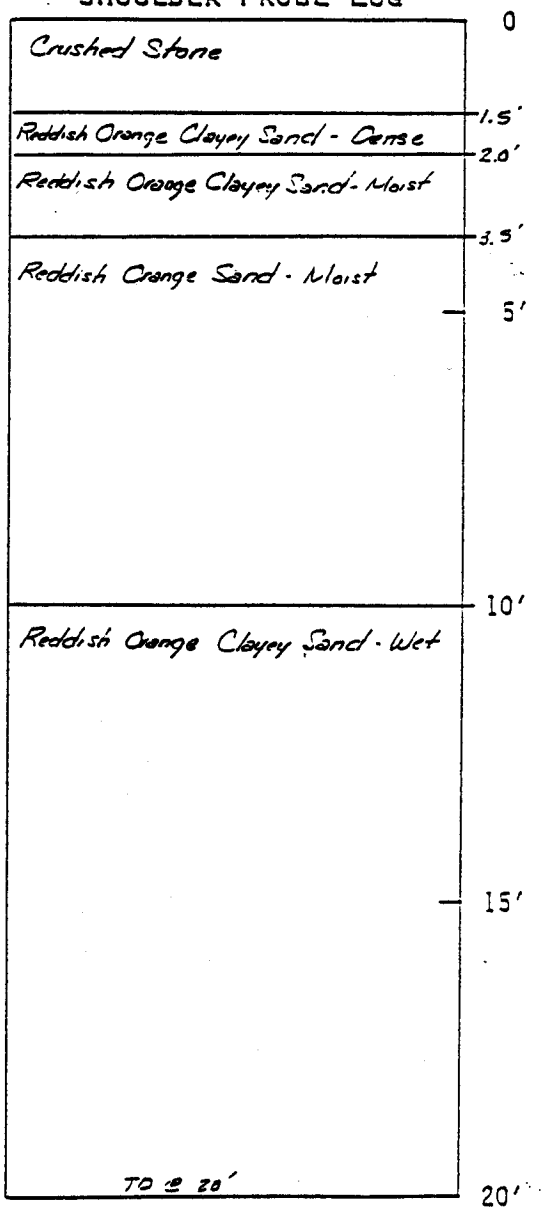
PAVEMENT LOG



Instuctions for Pavement Log:

1. Review logs of bore holes, cores, and test pit to establish approximate depths of layer changes.
2. Draw lines across log above to indicate approximate average layer depths and label to identify the materials.

SHOULDER PROBE LOG



Instructions for Shoulder Probe Log:
Same as for "Pavement Log," except depths are taken directly from field log.

Depth to Rigid Layer, >20 Ft.
(If Rigid Layer Not Encountered, Enter ">20.")

USE THIS FORM FOR ENTERING ONLY DEPTH TO RIGID LAYER INTO THE DATA BASE!

Figure A-2. Profile of Test Section Layers

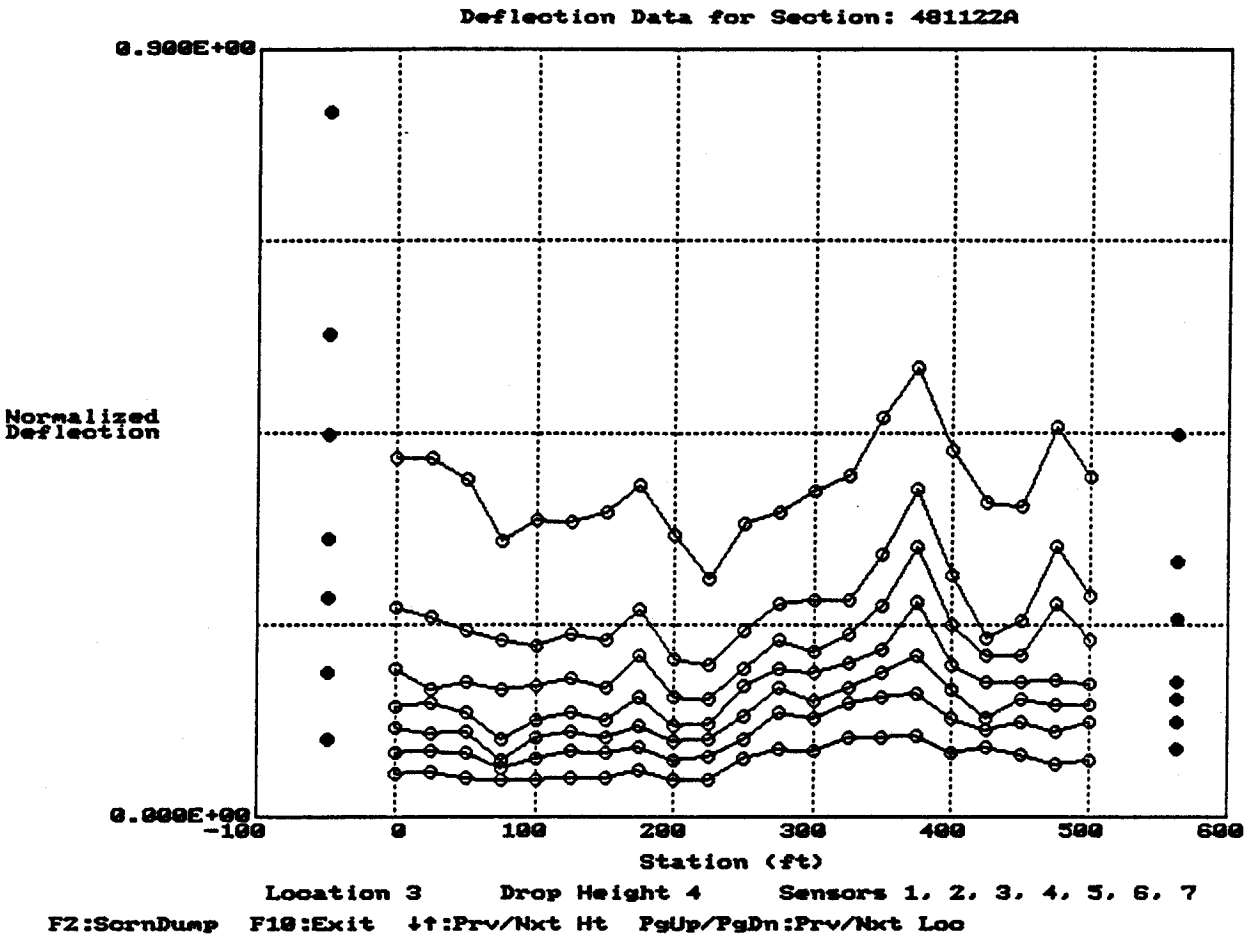


Figure A-3. Deflection Profiles from FWDCHECK

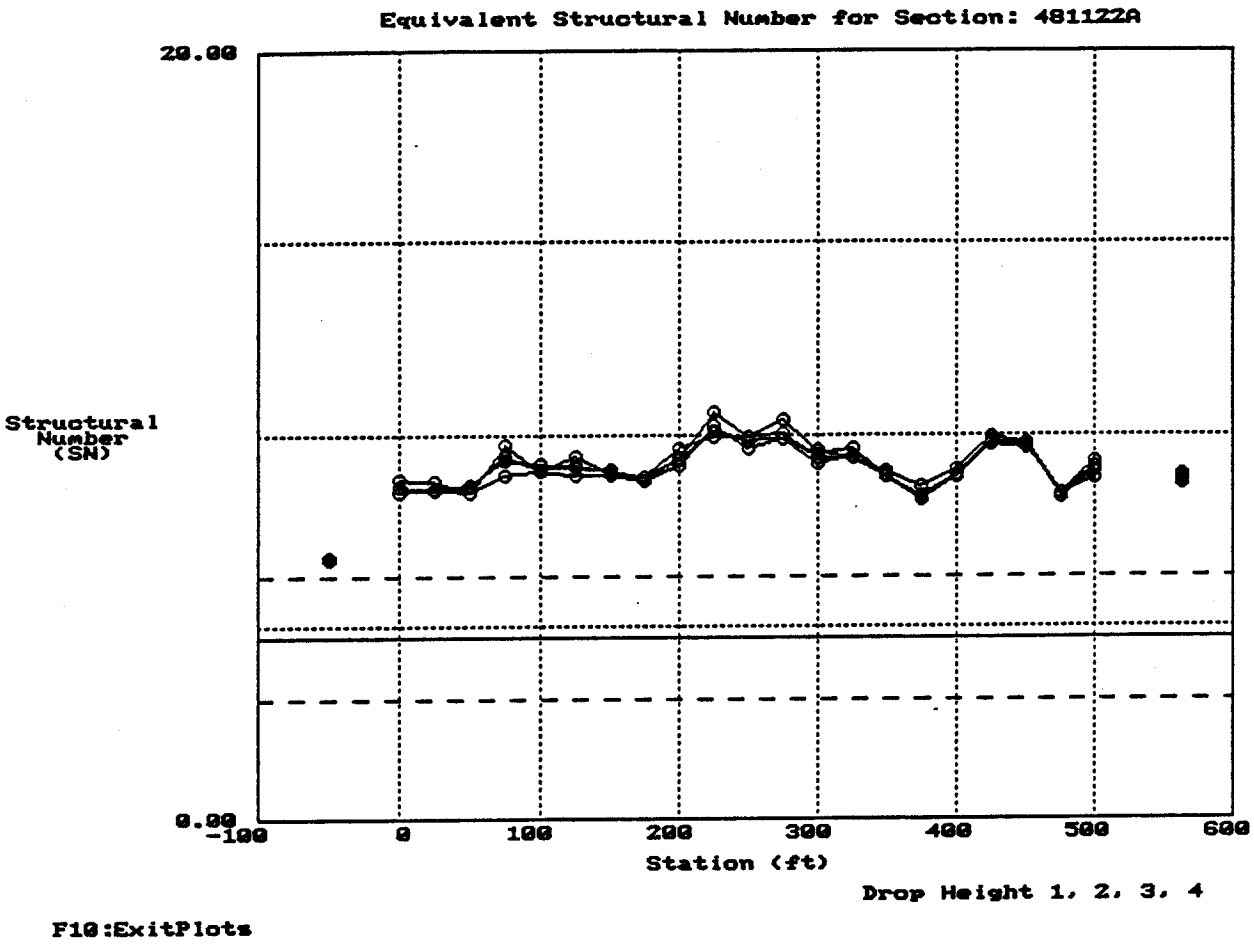


Figure A-4. Structural Number Profiles from FWDCHECK

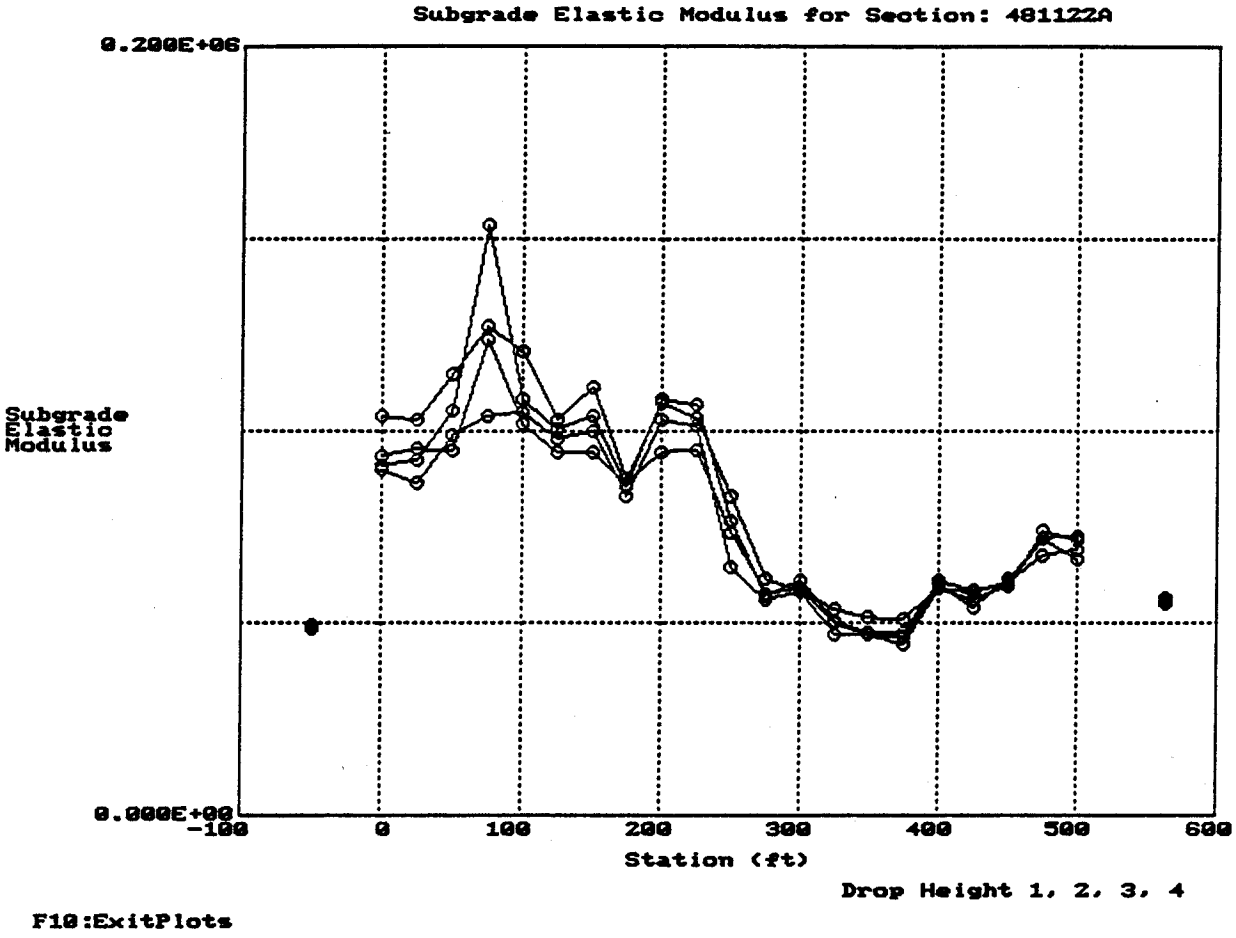


Figure A-5. Subgrade Modulus Profiles from FWDCHECK

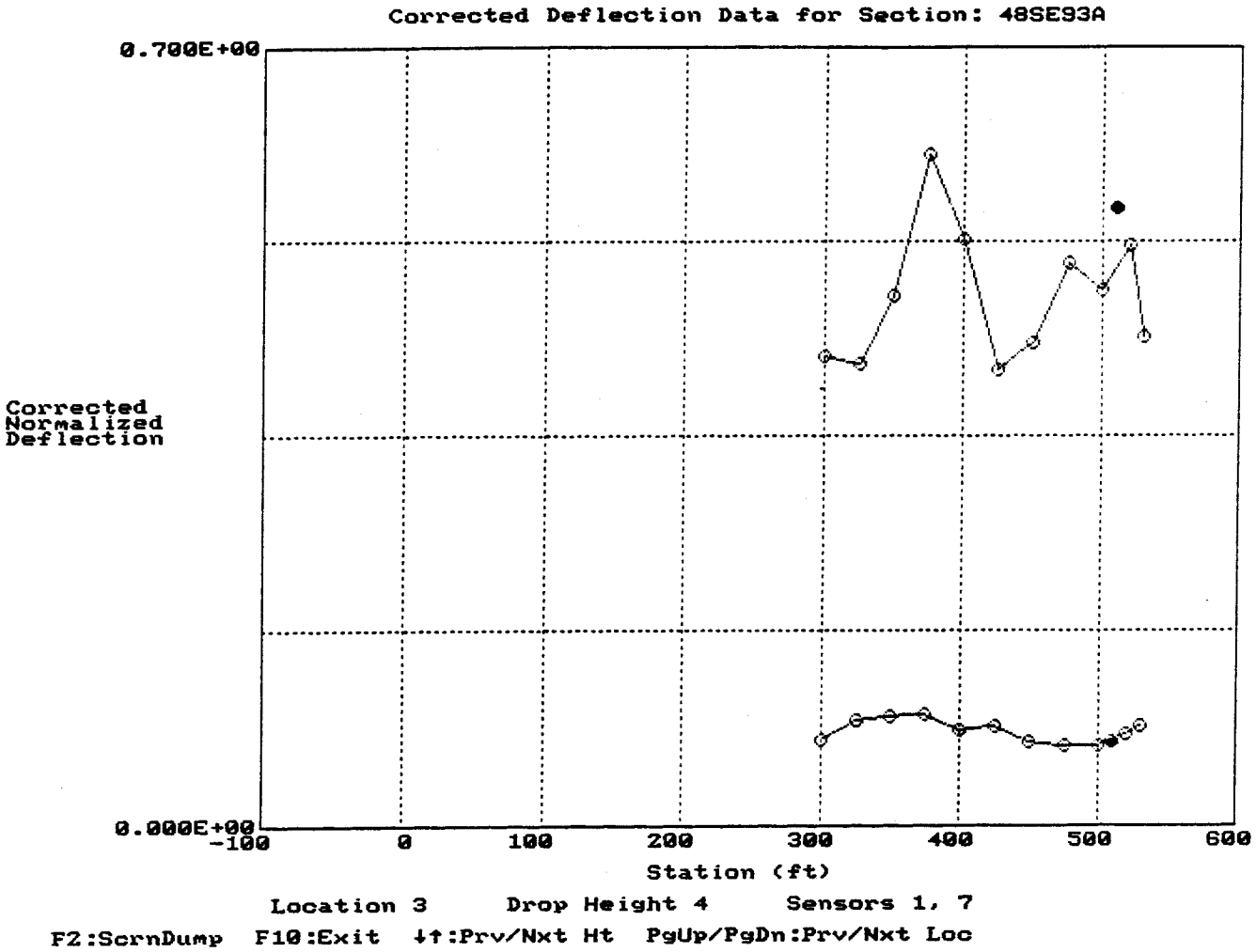


Figure A-6. Deflection Profiles from FWDCHECK on Installation Day

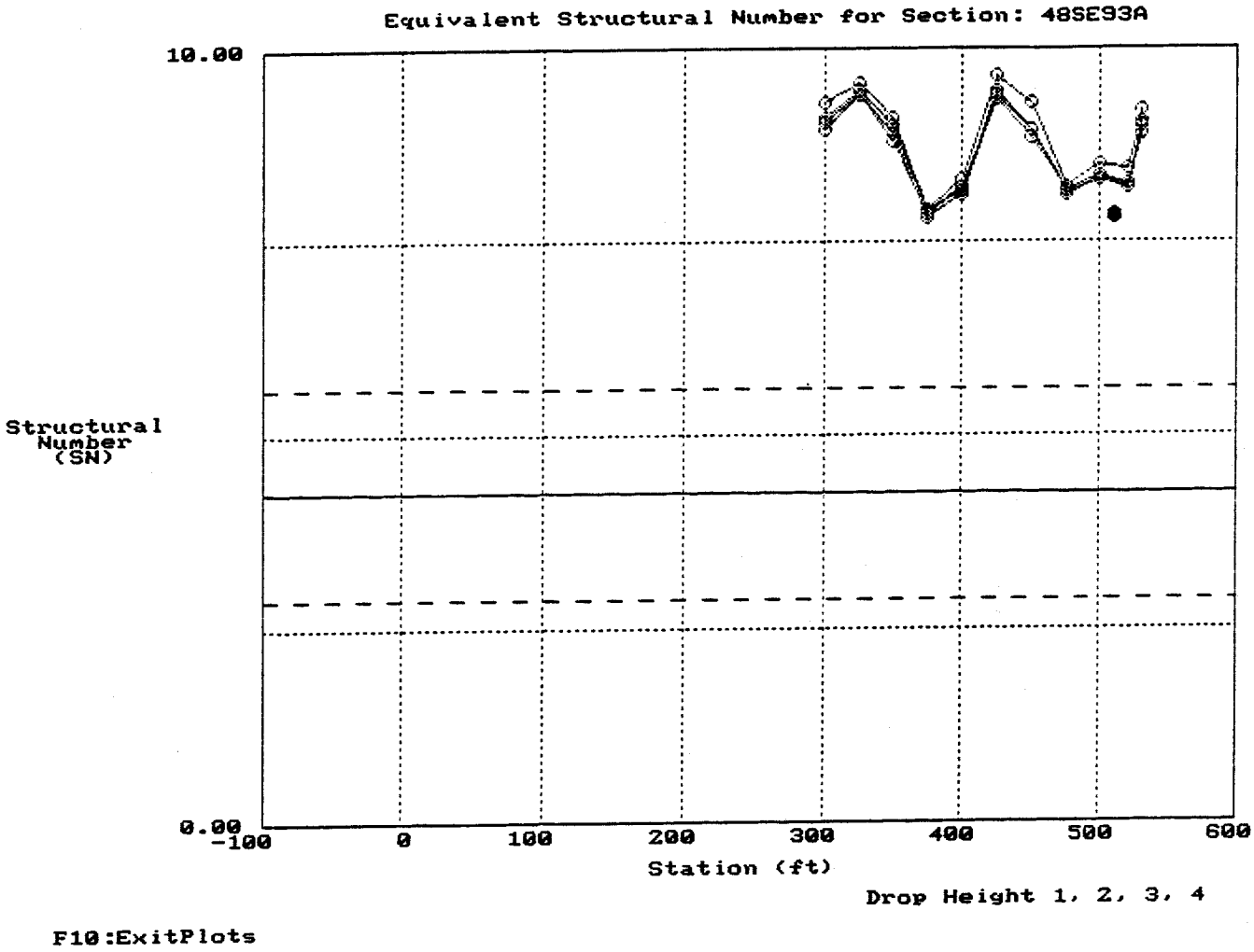


Figure A-7. Structural Number Profiles from FWDCHECK on Installation Day

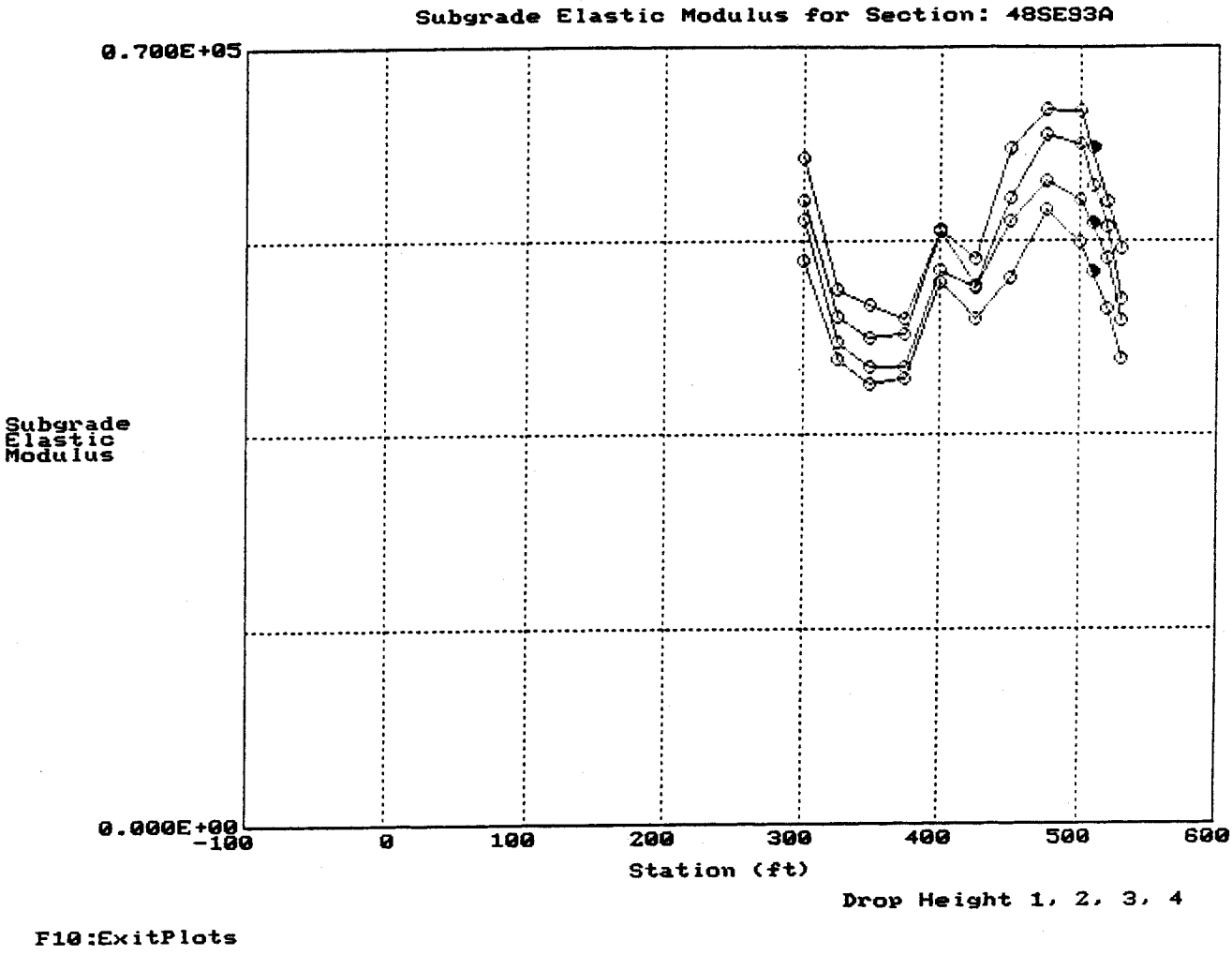


Figure A-8. Subgrade Modulus Profiles from FWDCHECK on Installation Day

Revised December 1, 1992

SHEET 1

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 1122

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES

DATE OF DISTRESS SURVEY (MONTH/DAY/YEAR) 04/02/93

SURVEYORS: JFD, _ _ _ PHOTOS, VIDEO, OR BOTH WITH SURVEY (P, V, B) B

PAVEMENT SURFACE TEMP - BEFORE _ _ 23 °C; AFTER _ _ 23 °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	_ _ 0.0	_ _ 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

N/A LOT AVAILABLE

Revised 4/13/94 JFD

Figure A-9. Distress Survey Data

Revised May 29, 1992

SHEET 2

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _____

STATE CODE 48

SHRP SECTION ID 1122

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 TRNPROF1 from Dipstick Manual			
10. SHOVING (Number)			0
(Square Meters)			2.0
SURFACE DEFECTS			
11. BLEEDING (Square Meters)	393 ~~419.4~~ ✓	0.0	0.0
12. POLISHED AGGREGATE (Square Meters)			0.0
13. RAVELING AND WEATHERING (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

SHEET 3

DISTRESS SURVEY

LTPP PROGRAM

STATE ASSIGNED ID _ _ _ _

STATE CODE 48

SHRP SECTION ID 1122

DISTRESS SURVEY FOR PAVEMENTS WITH ASPHALT CONCRETE SURFACES (CONTINUED)

9. RUTTING (FOR SPS-3 SITE SURVEYS)

INNER WHEEL PATH			OUTER WHEEL PATH		
Point No.	Distance[1] (Meters)	Point Rut Depth (mm)	Point No.	Distance[1] (Meters)	Point Rut Depth (mm)
1	0.	_ _ _.	1	0.	(NOT MEASURED) _ _ _.
2	15.25	_ _ _.	2	15.25	_ _ _.
3	30.5	_ _ _.	3	30.5	_ _ _.
4	45.75	_ _ _.	4	45.75	_ _ _.
5	61.	_ _ _.	5	61.	_ _ _.
6	76.25	_ _ _.	6	76.25	_ _ _.
7	91.5	_ _ _.	7	91.5	_ _ _.
8	106.75	_ _ _.	8	106.75	_ _ _.
9	122.	_ _ _.	9	122.	_ _ _.
10	137.25	_ _ _.	10	137.25	_ _ _.
11	152.5	_ _ _.	11	152.5	_ _ _.

14. LANE-TO-SHOULDER DROPOFF

Point No.	Point Distance[1] Meters	Lane-to-Shoulder Dropoff (mm)
1	0.	_ _ 0.
2	15.25	_ _ 0.
3	30.5	_ _ 0.
4	45.75	_ _ 0.
5	61.	_ _ 0.
6	76.25	_ _ 0.
7	91.5	_ _ 0.
8	106.75	_ _ 0.
9	122.	_ _ 0.
10	137.25	_ _ 0.
11	152.25	_ _ 0.

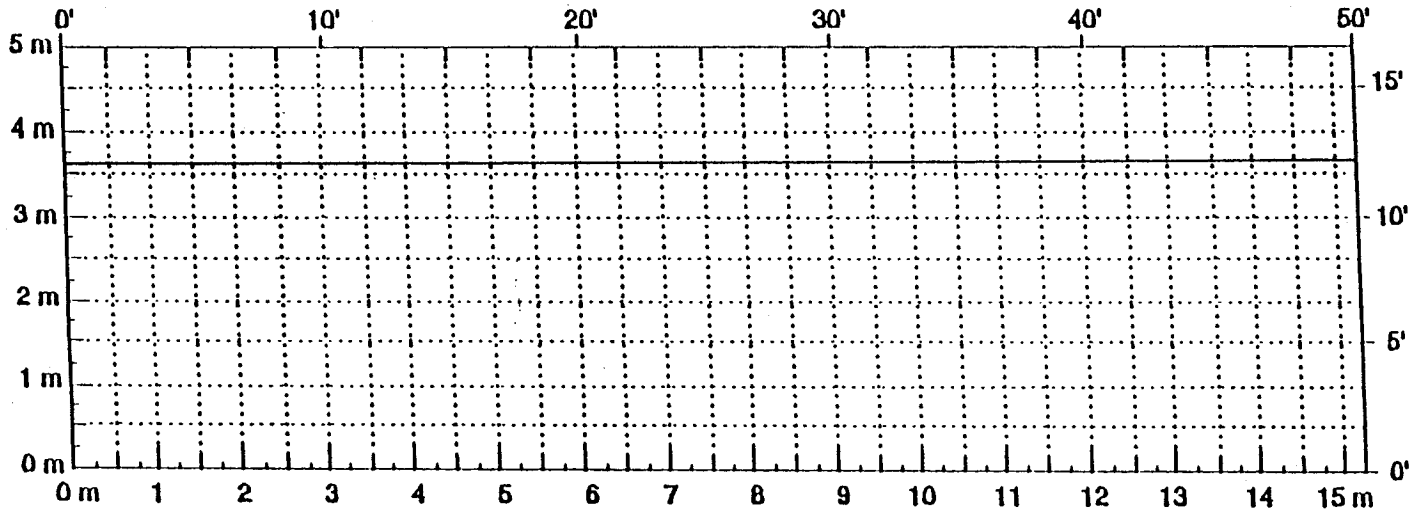
Note 1: "Point Distance" is the distance in meters from the start of the test section to the point where the measurement was made. The values shown are SI equivalents of the 50 feet spacing used in previous surveys.

Figure A-9 (Continued). Distress Survey Data

State Assigned ID _____

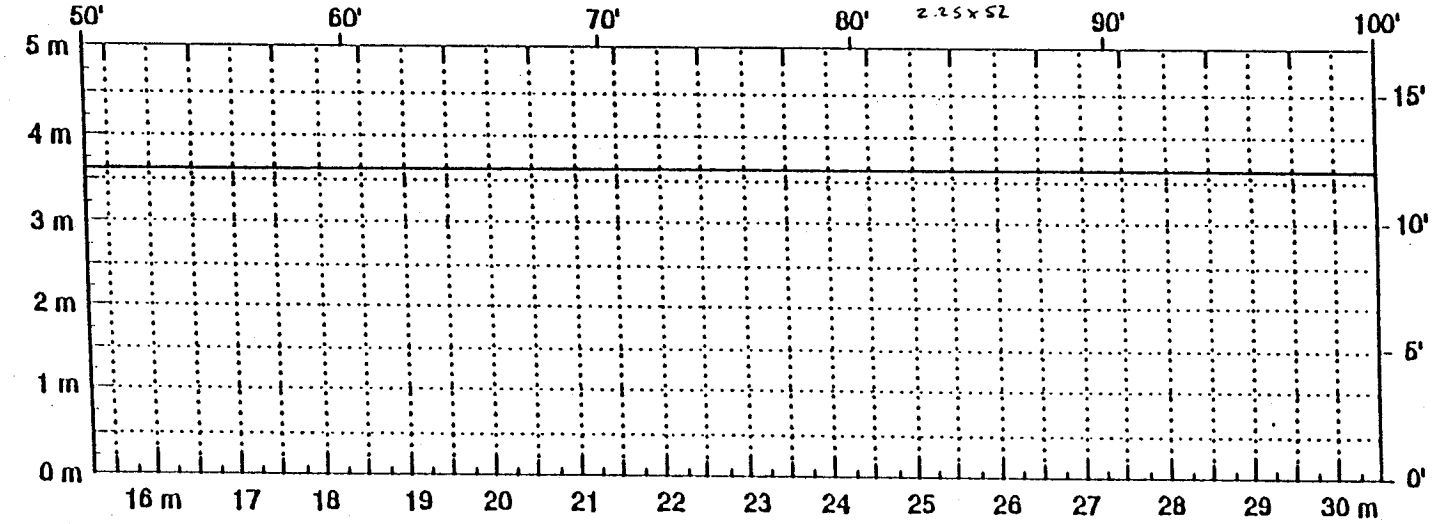
State Code 48 ___

SHRP Section ID 1122



Comments: LOW SEVERITY BLEEDING (11L) FROM 0.25 – 3 M THROUGHOUT FIRST 100.5 M 2.75× 276.375

0.25 – 2.5 M FROM 100.5 – 152.5 2.25×52



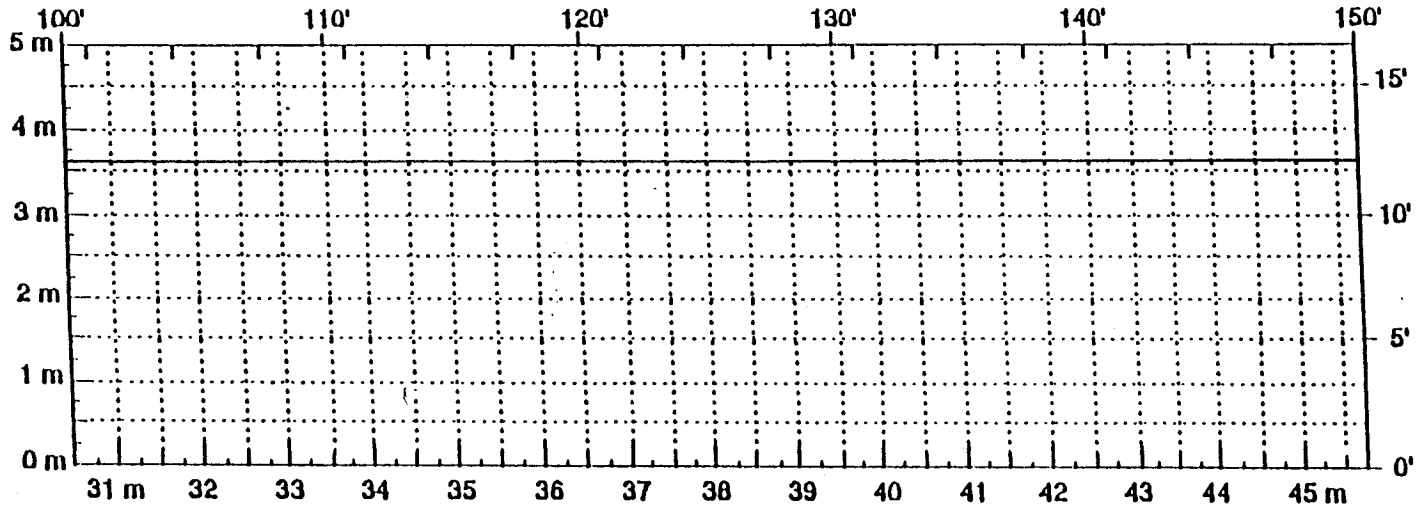
Comments: _____

Figure A-9 (Continued). Distress Survey Data

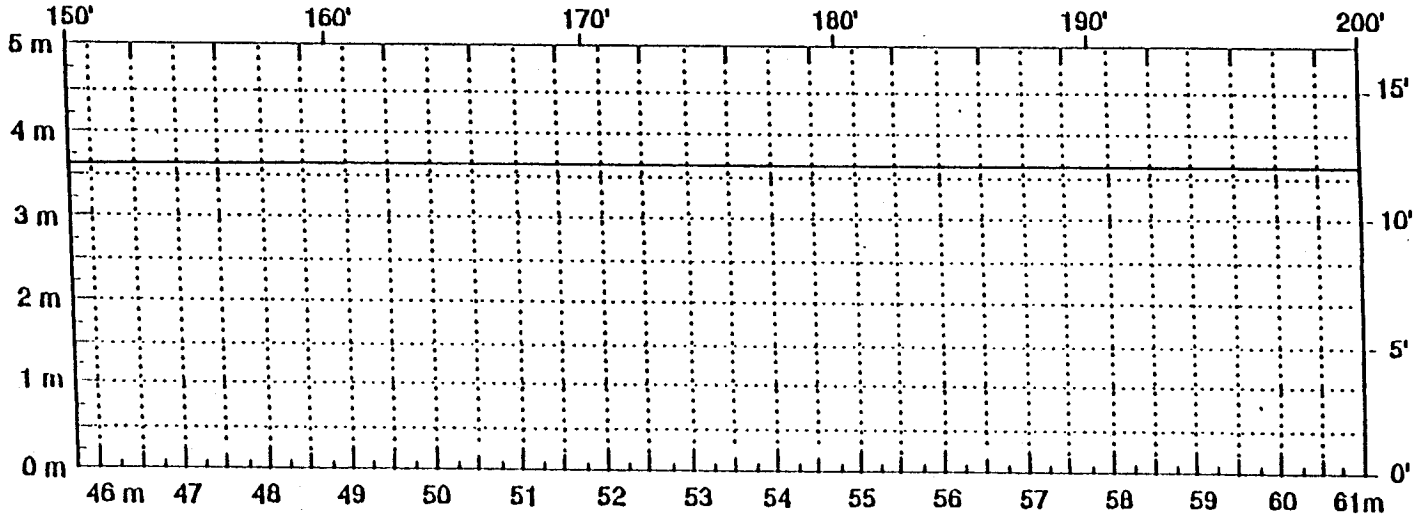
State Assigned ID _____

State Code 48 ____

SHRP Section ID 1122



Comments: _____



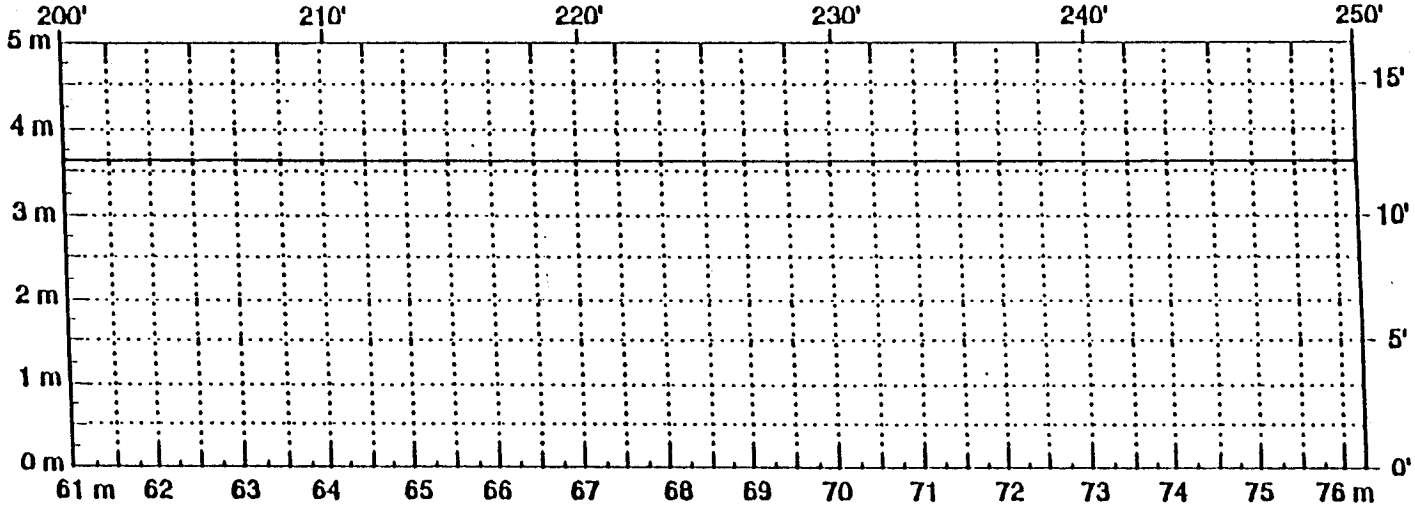
Comments: _____

Figure A-9 (Continued). Distress Survey Data

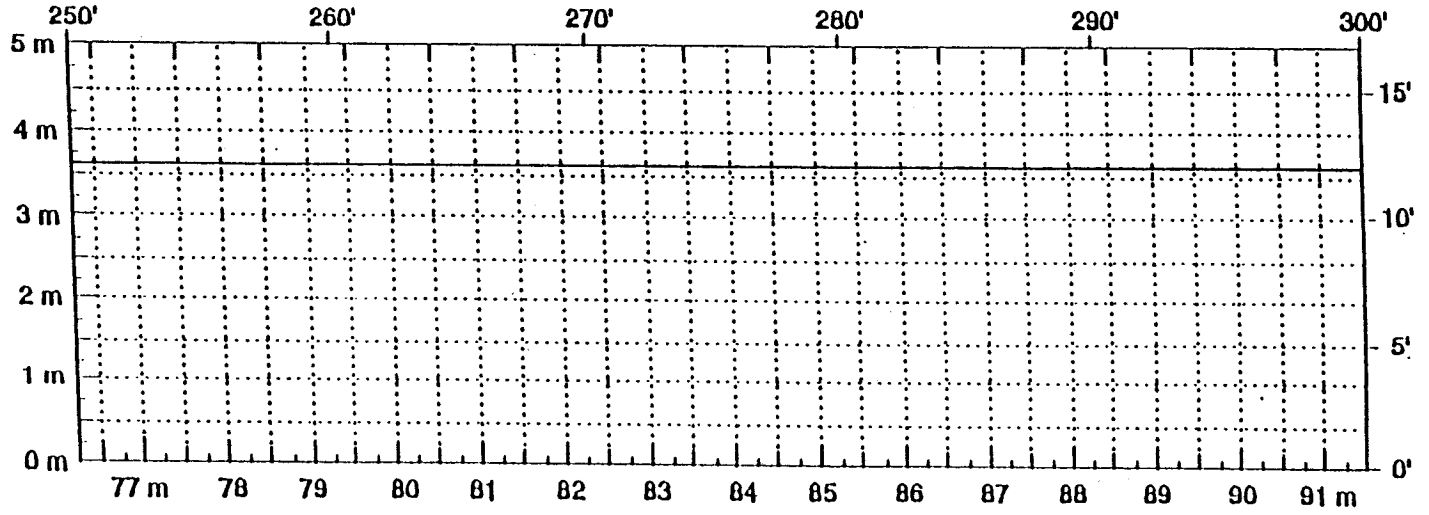
State Assigned ID _____

State Code 48

SHRP Section ID 1122



Comments: _____



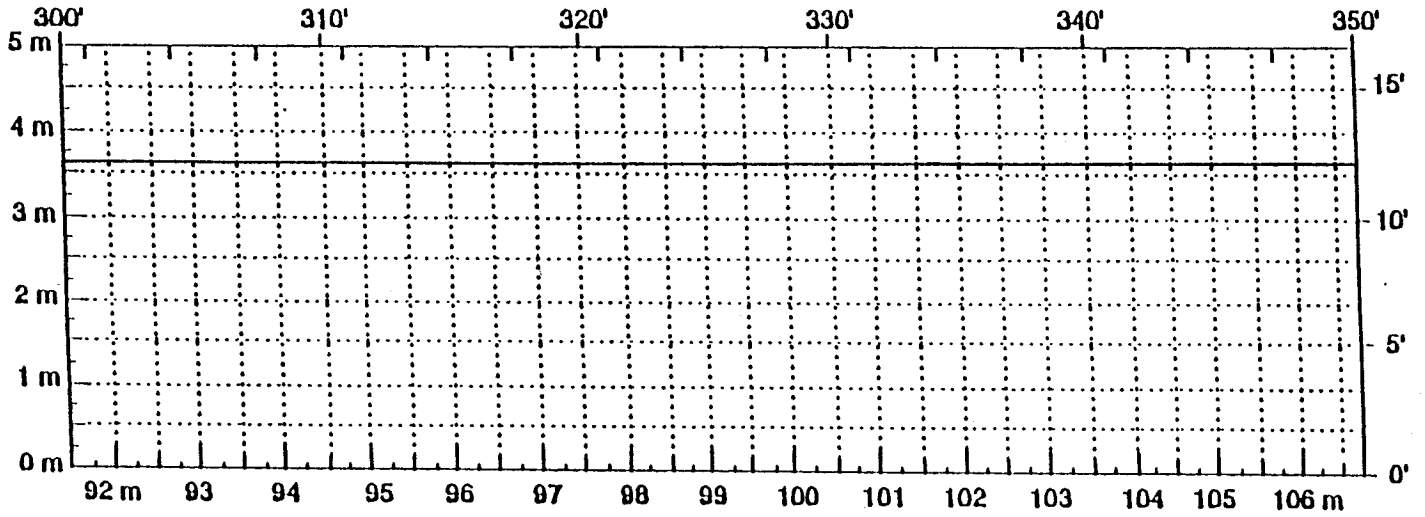
Comments: _____ _____

Figure A-9 (Continued). Distress Survey Data

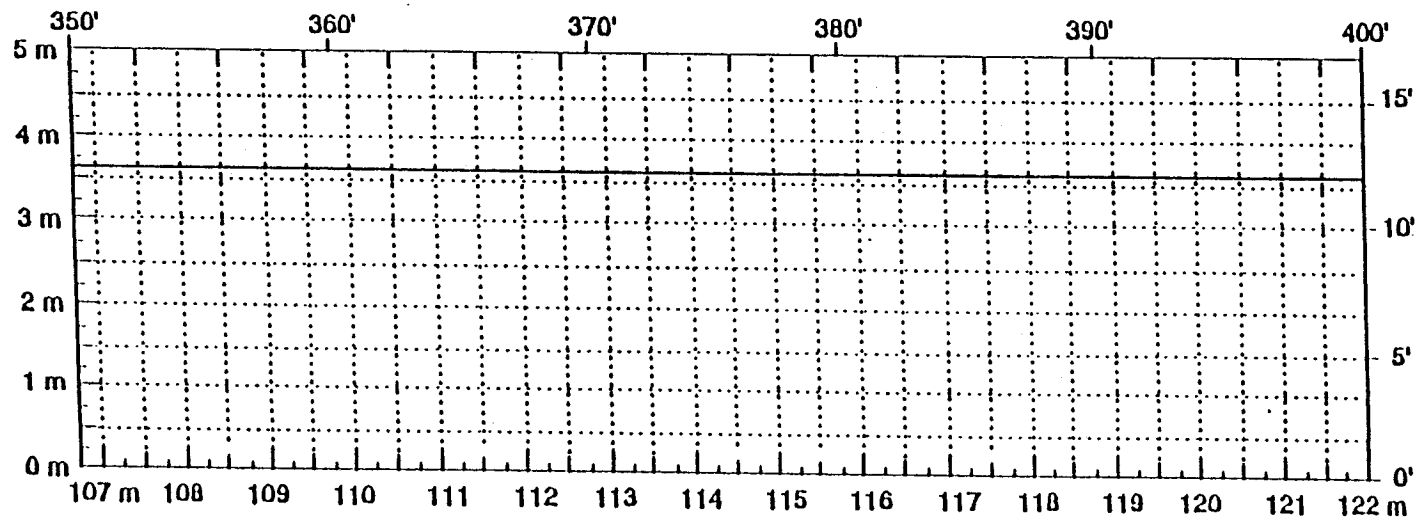
State Assigned ID _____

State Code 48

SHRP Section ID 1122



Comments: _____



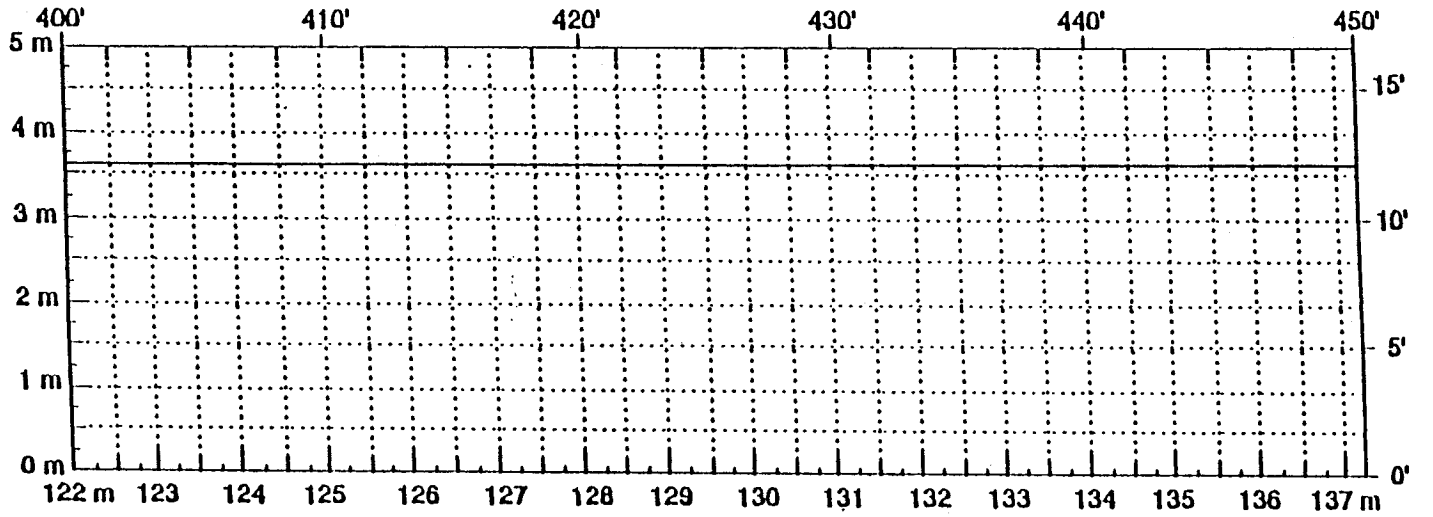
Comments: _____

Figure A-9 (Continued). Distress Survey Data

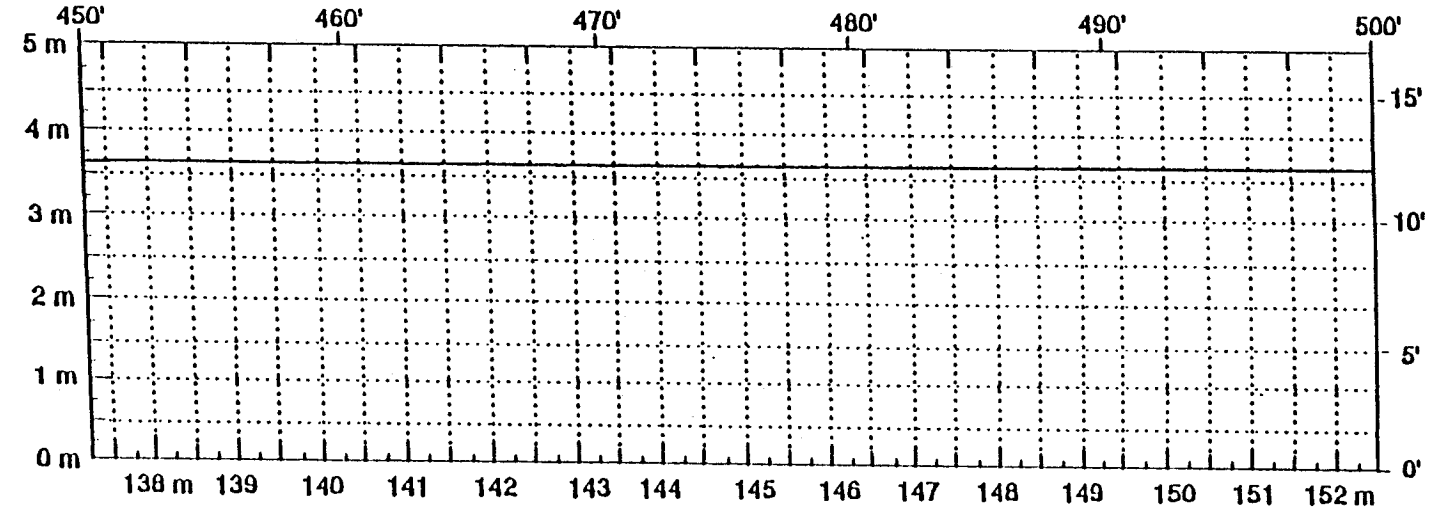
State Assigned ID _____

State Code 48

SHRP Section ID 1122



Comments: _____



Comments: _____

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
October 18, 1993

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

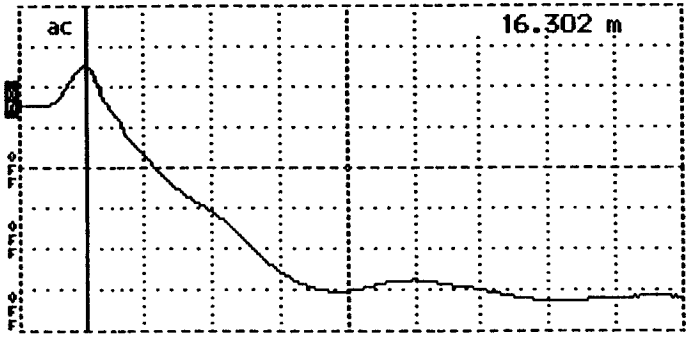
VI. Questions/Discussion

TEXAS SEASONAL SITE INFORMATION

Type	SHRP ID	Hwy. No.	Location of Test Section
AC over Granular Base	481060	US-77, Refugio Co., Northbound	0.7 mi. S. of SH-289, 2 mi. S. of the Refugio/Victoria Co. line.
AC over Granular Base	481068	SH-19, Lamar Co., Northbound	2.1 mi. N. of the North Sulfur River, 1.3 mi. S. of FM-1184.
AC over Granular Base	481077	US-287, Hall Co., Southbound	2.1 mi. S. of the Red River, 1100' N. of FM-658.
AC over Granular Base	481122	US-181, Wilson Co., Northbound	4.9 mi. N. of Loop 181, 2.5 mi. S. of the Bexar/Wilson Co. line.
AC over Granular Base	483739	US-77, Kenedy Co., Northbound	Milepost 20.05-19.95. 26.6 mi. N. of the Kenedy/Willacy Co. line, 20.1 mi. S. of the Kenedy/Kleberg Co. line.
JRCP	484142	US-96, Jasper Co., Northbound	7.6 mi. N. of US-190, 1.9 mi. S. of Recreation Rd. 255.
JRCP	484143	US-90, Jefferson Co., Eastbound	2.2 mi. E. of FM-365/SH-326, 11.0 mi. W. of FM-364.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [1123]

Cursor ..... 16.302 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mV/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac

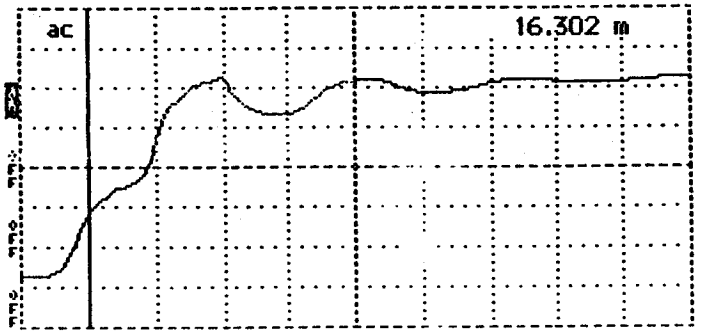


Tektronix 1502B TDR
Date 11/03/93
Cable 48E01
Notes SHORTED

Input Trace J.P.
Stored Trace .....
Difference Trace .....

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

Cursor ..... 16.302 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mV/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E01
Notes AIR

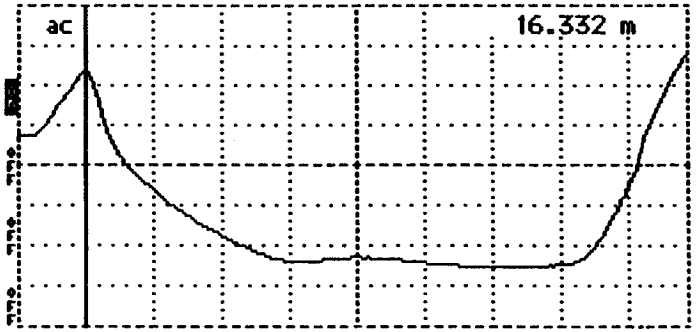
Input Trace J.P.
Stored Trace .....
Difference Trace .....

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

Figure B-1. TDR Traces Obtained During Calibration

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [48] LTPP Section ID [1122]

Cursor ..... 16.332 m
Distance/Div..... .25 m/div
Vertical Scale.... 91.5 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E01
Notes WATER
21.9°C
Input Trace S.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E01 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Gib Employer: BRE

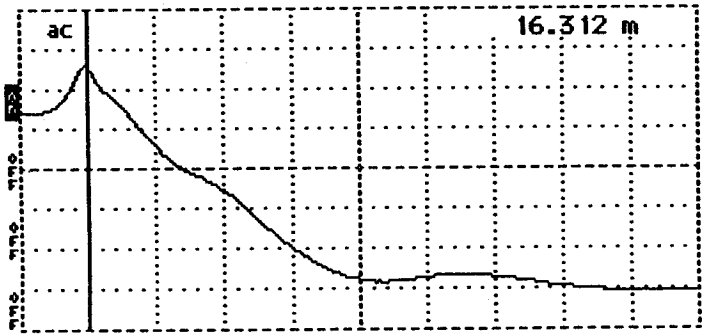
Date (dd/mm/yy): 31/08/94

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 [48] LTPP Section ID [1122]

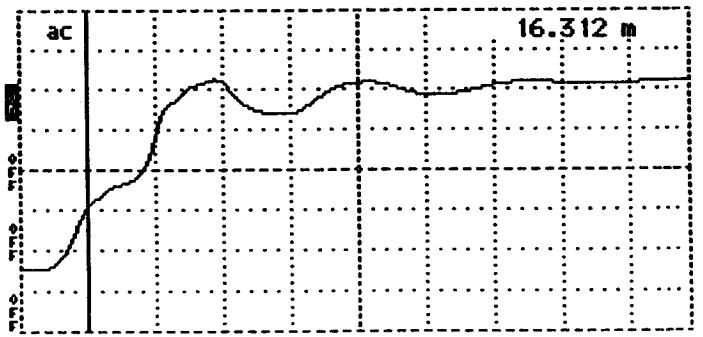
Cursor ..... 16.312 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E02
Notes SHORTED
Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor..... 16.312 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



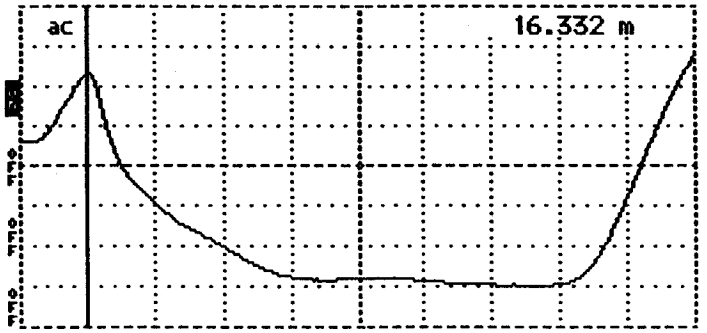
Tektronix 1502B TDR
Date 11/03/93
Cable 48E02
Notes AIR
Input Trace J.R
Stored Trace
Difference Trace

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 [48] LTPP Section ID [1122]

Cursor ..... 16.332 m
Distance/Div..... .25 m/div
Vertical Scale.... 83.9 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E02
Notes WATER
21.9°C
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E02 Measured Length of Coax Cable: 12.3 m

Comments: _____

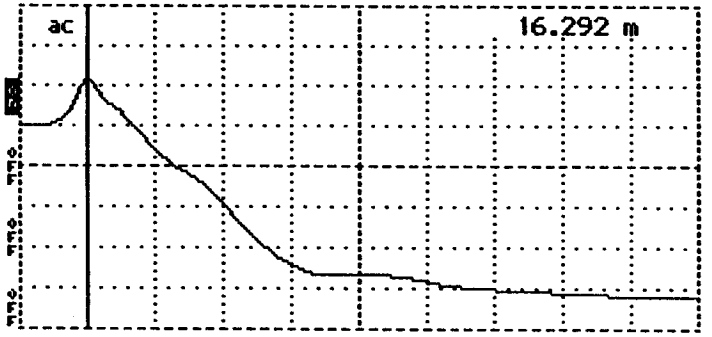
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 31/08/94

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [1123]

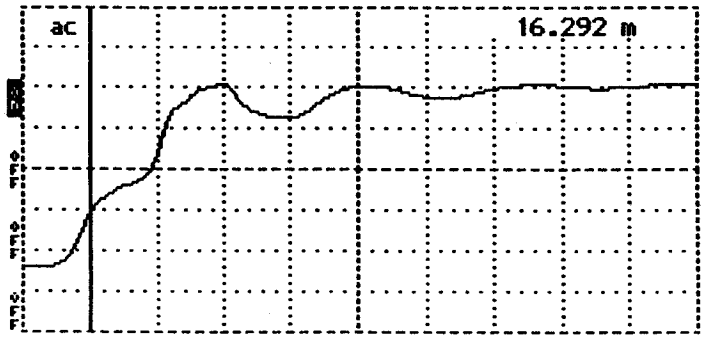
Cursor ..... 16.292 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E03
Notes Shorted
Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor ..... 16.292 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



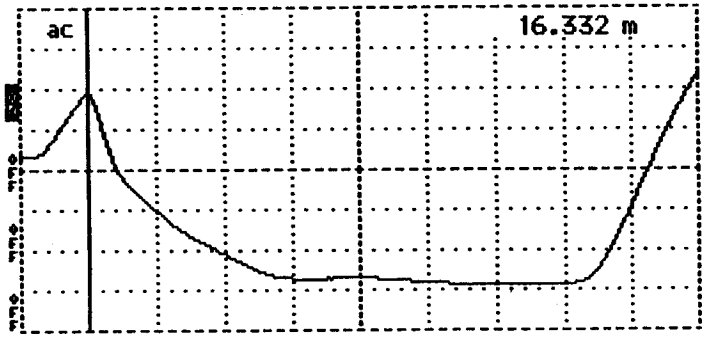
Tektronix 1502B TDR
Date 11/03/93
Cable 48E03
Notes AIR
Input Trace J.P.
Stored Trace
Difference Trace

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 [48] LTPP Section ID [1122]

Cursor ..... 16.332 m
Distance/Div..... .25 m/div
Vertical Scale.... 94.1 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E03
Notes WATER
21.9 °C
Input Trace J.01
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.27	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E03 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

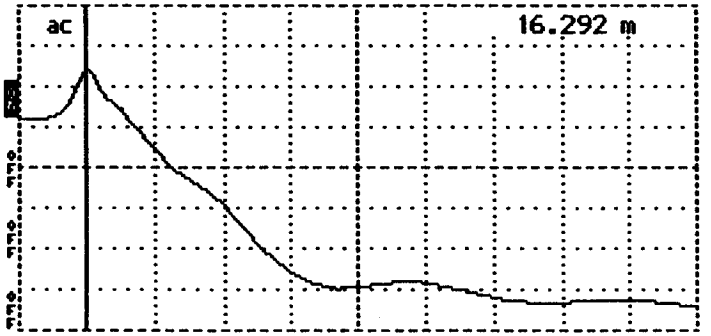
Date (dd/mm/yy): 01/09/94

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 [48] LTPP Section ID [1122]

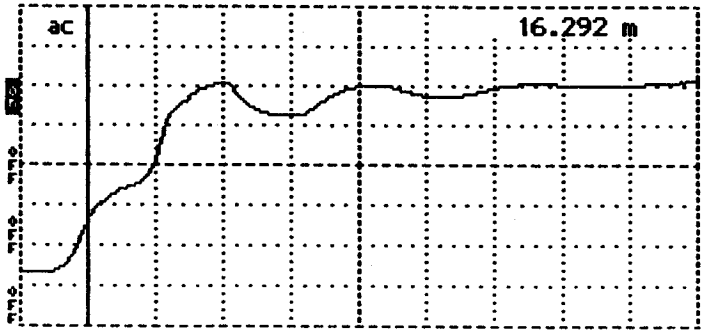
Cursor ..... 16.292 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E04
Notes SHORTED
Input Trace J.P.
Stored Trace .....
Difference Trace .....

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

Cursor ..... 16.292 m
Distance/Div..... .25 m/div
Vertical Scale.... 182 mV/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



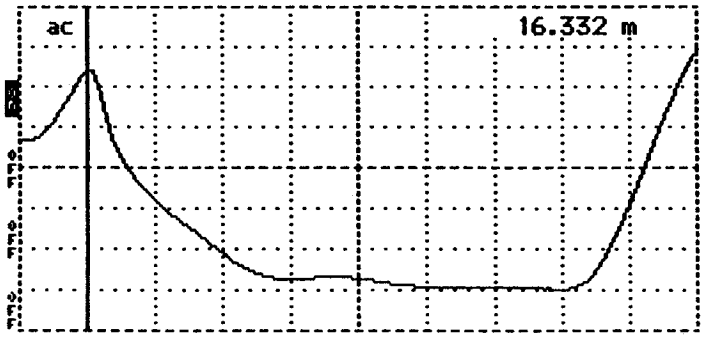
Tektronix 1502B TDR
Date 11/03/93
Cable 48E04
Notes AIR
Input Trace J.P
Stored Trace .....
Difference Trace .....

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 [48] LTPP Section ID [1122]

Cursor ..... 16.332 m
Distance/Div..... .25 m/div
Vertical Scale.... 81.6 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E04
Notes WATER
21.9°C
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E04 Measured Length of Coax Cable: 12.3 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

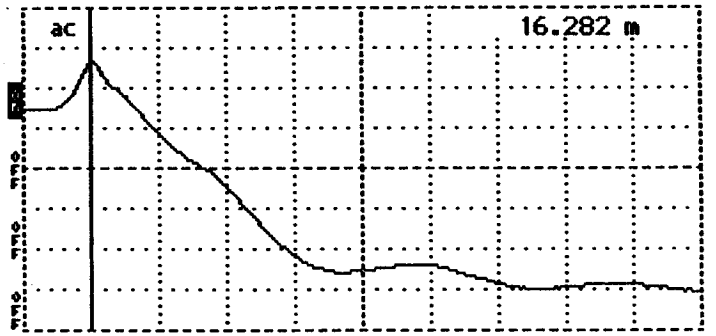
Date (dd/mm/yy): 01/09/94

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 [48] LTPP Section ID [1122]

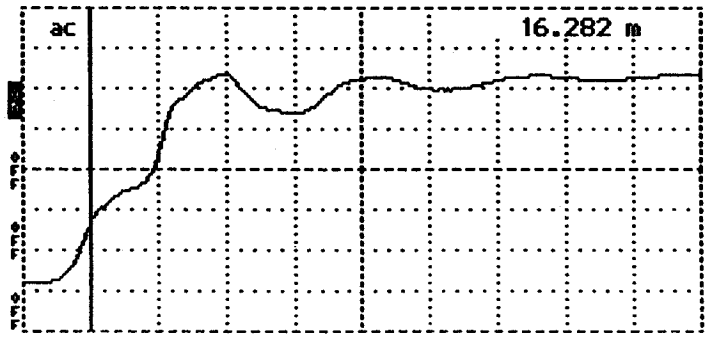
Cursor ..... 16.282 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 40E05
Notes Shorted
Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor ..... 16.282 m
Distance/Div..... .25 m/div
Vertical Scale.... 172 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



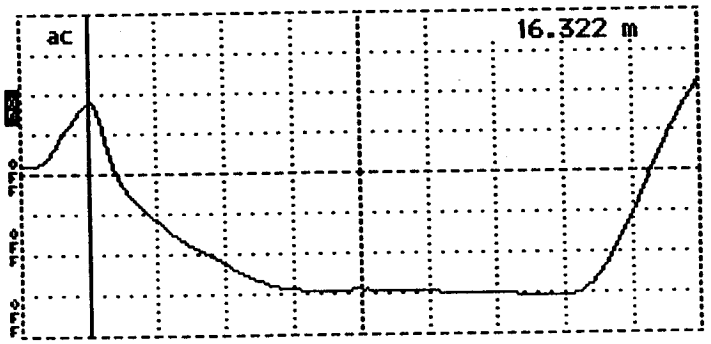
Tektronix 1502B TDR
Date 11/03/93
Cable 40E05
Notes Air
Input Trace J.P.
Stored Trace
Difference Trace

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 [48] LTPP Section ID [1 1 2 2]

Cursor ..... 16.322 m
Distance/Div..... .25 m/div
Vertical Scale.... 91.5 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E05
Notes WATER
21.9°C
Input Trace S.P1
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E05 Measured Length of Coax Cable: 12.3 m

Comments: _____

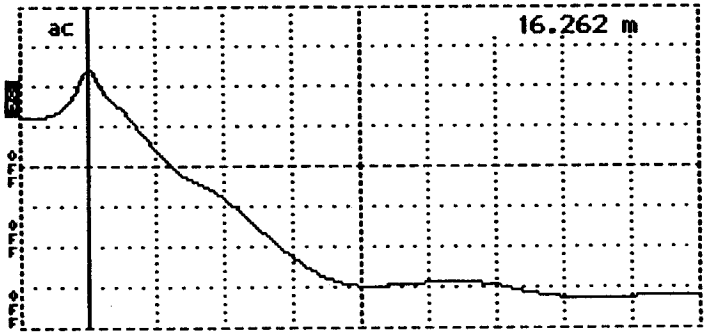
Prepared by: Matt Gb Employer: BRE

Date (dd/mm/yy): 01/09/94

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [1 1 22]

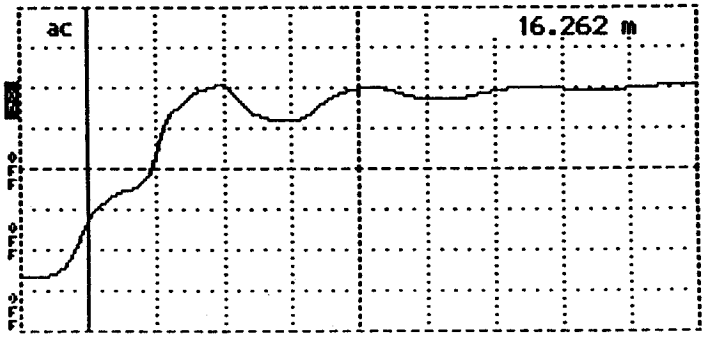
Cursor ..... 16.262 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E06
Notes SHORTED
Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor ..... 16.262 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E06
Notes AIR
Input Trace J.P.
Stored Trace
Difference Trace

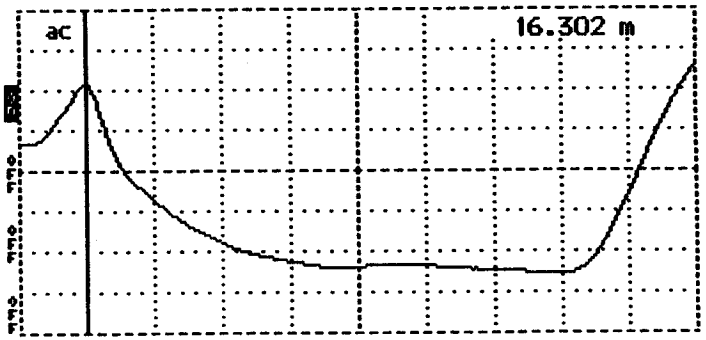
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.25	1.55

Data Sheet SMP-C . 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 [48] LTPP Section ID [1122]

Cursor ..... 16.302 m
Distance/Div..... .25 m/div
Vertical Scale.... 96.9 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date
Cable 48E06
Notes WATER 21.9°C
Input Trace J.P.
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E06 Measured Length of Coax Cable: 12.3 m

Comments:

Prepared by: MattCole Employer: BRE

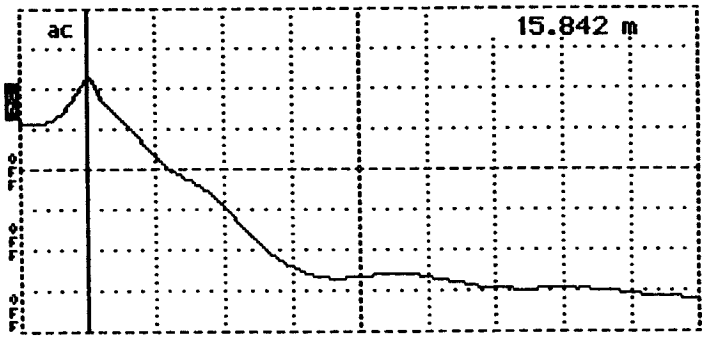
Date (dd/mm/yy): 01/09/94

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 [48] LTPP Section ID [1122]

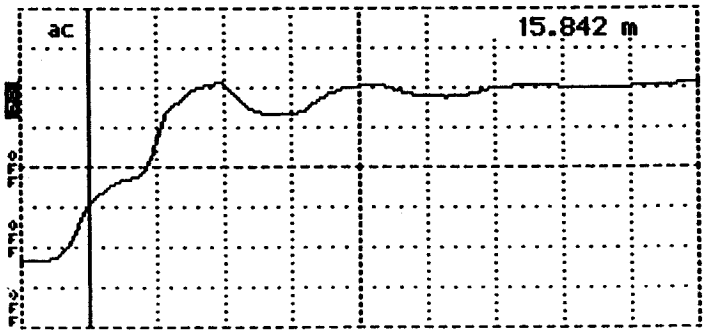
Cursor ..... 15.842 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E07
Notes SHORTED
Input Trace J.P.
Stored Trace .....
Difference Trace .....

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

Cursor ..... 15.842 m
Distance/Div..... .25 m/div
Vertical Scale.... 200 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



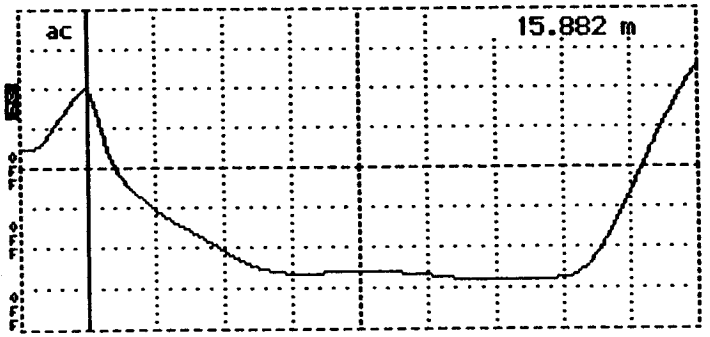
Tektronix 1502B TDR
Date 11/03/93
Cable 48E07
Notes AIR
Input Trace J.P.
Stored Trace .....
Difference Trace .....

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 [48] LTPP Section ID [1 1 2 2]

Cursor ..... 15.882 m
Distance/Div..... .25 m/div
Vertical Scale.... 94.1 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E07
Notes WATER
@ 21.9°C

Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.76	76.67

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E07 Measured Length of Coax Cable: 12.3 m

Comments: _____

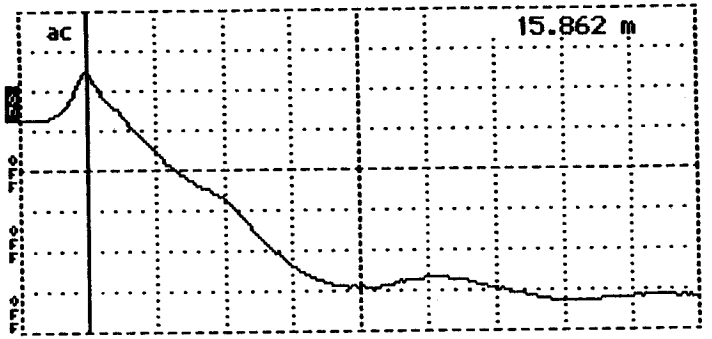
Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 01/09/94

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [1122]

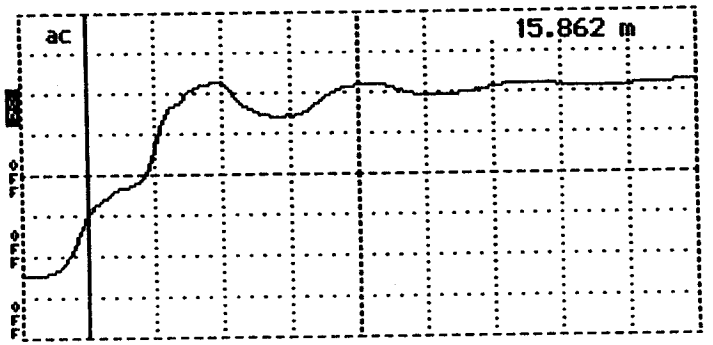
Cursor ..... 15.862 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 40E08
Notes Shorted
Input Trace S.P.
Stored Trace
Difference Trace

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

Cursor ..... 15.862 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 40E08
Notes Air
Input Trace S.P.
Stored Trace
Difference Trace

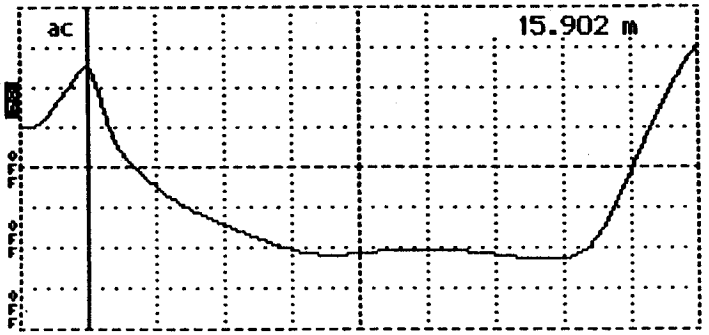
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . 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 [48] LTPP Section ID [1122]

Cursor ..... 15.902 m
Distance/Div..... .25 m/div
Vertical Scale.... 94.1 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 11/03/93
Cable 48E08
Notes WATER
21.0°C
Input Trace S.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E08 Measured Length of Coax Cable: 12.3 m

Comments: _____

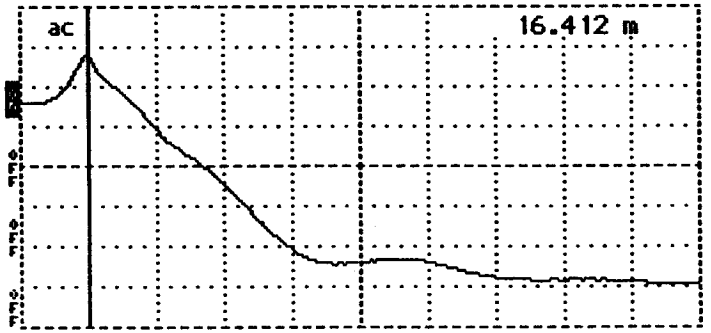
Prepared by: Matt GL Employer: BRE

Date (dd/mm/yy): 01/09/94

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [1122]

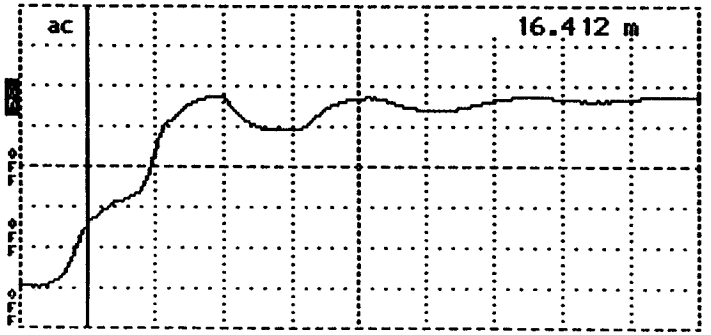
Cursor ..... 16.412 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/03/93
Cable 48E09
Notes SHORTED
Input Trace J.P.
Stored Trace
Difference Trace

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

Cursor ..... 16.412 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mρ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/02/93
Cable 48E09
Notes AIR
Input Trace J.P.
Stored Trace
Difference Trace

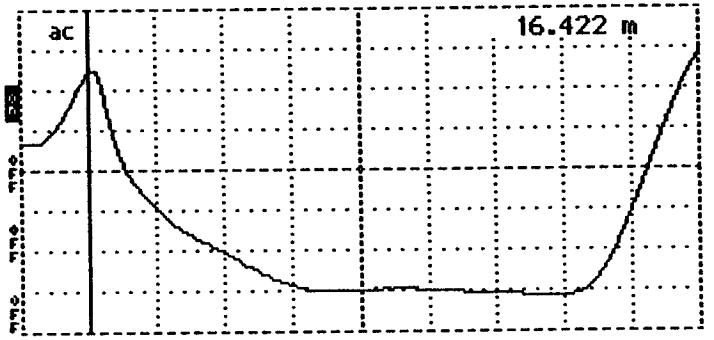
TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.24	1.43

Data Sheet SMP-C . 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 [48] LTPP Section ID [1122]

Cursor ..... 16.422 m
Distance/Div..... .25 m/div
Vertical Scale.... 79.2 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/03/93
Cable 48E09
Notes WATER 21.7° C
Input Trace S.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E09 Measured Length of Coax Cable: 12.2 m

Comments: _____

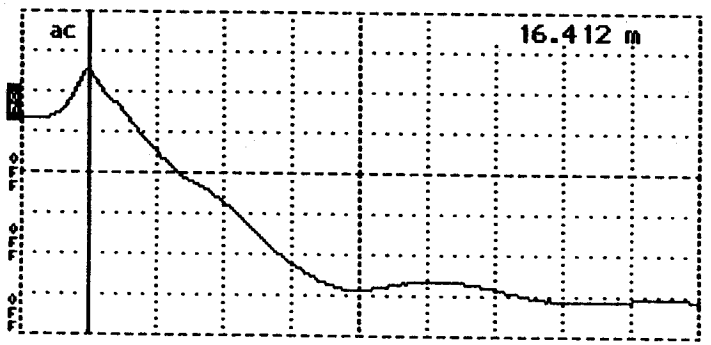
Prepared by: Matt T. Cole Employer: BRE

Date (dd/mm/yy): 01/09/94

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [48] LTPP Section ID [1127]

Cursor ..... 16.412 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac

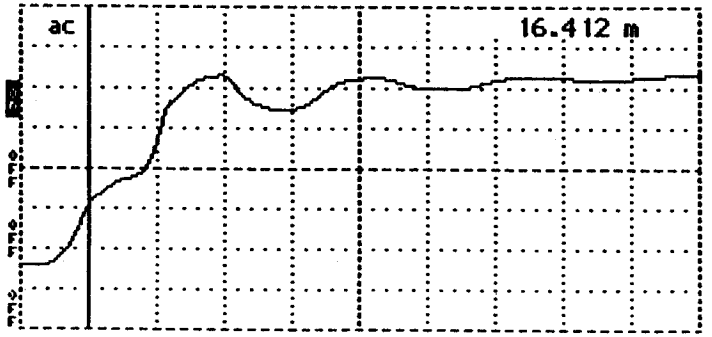


Tektronix 1502B TDR
Date 11/03/93
Cable 48E10
Notes SHORTED

Input Trace J.P.
Stored Trace .....
Difference Trace .....

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

Cursor ..... 16.412 m
Distance/Div..... .25 m/div
Vertical Scale.... 188 mΩ/div
VP 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/03/93
Cable 48E10
Notes AIR

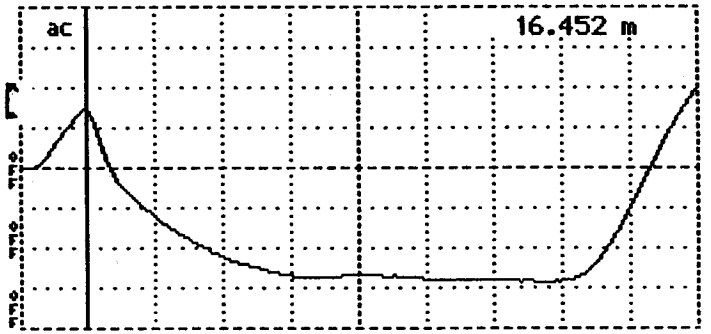
Input Trace J.P.
Stored Trace .....
Difference Trace .....

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 [48] LTPP Section ID [1122]

Cursor ..... 16.452 m
Distance/Div..... .25 m/div
Vertical Scale.... 103 mρ/div
Vp 0.99
Noise Filter..... 1 avg
Power..... ac



Tektronix 1502B TDR
Date 10/03/93
Cable 48E10
Notes WATER
21.8°C
Input Trace J.P.
Stored Trace .....
Difference Trace .....

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	1.77	77.55

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Assigned Serial Number: 48E10 Measured Length of Coax Cable: 12.2 m

Comments: _____

Prepared by: Matt Cole Employer: BRE

Date (dd/mm/yy): 01/09/94

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:

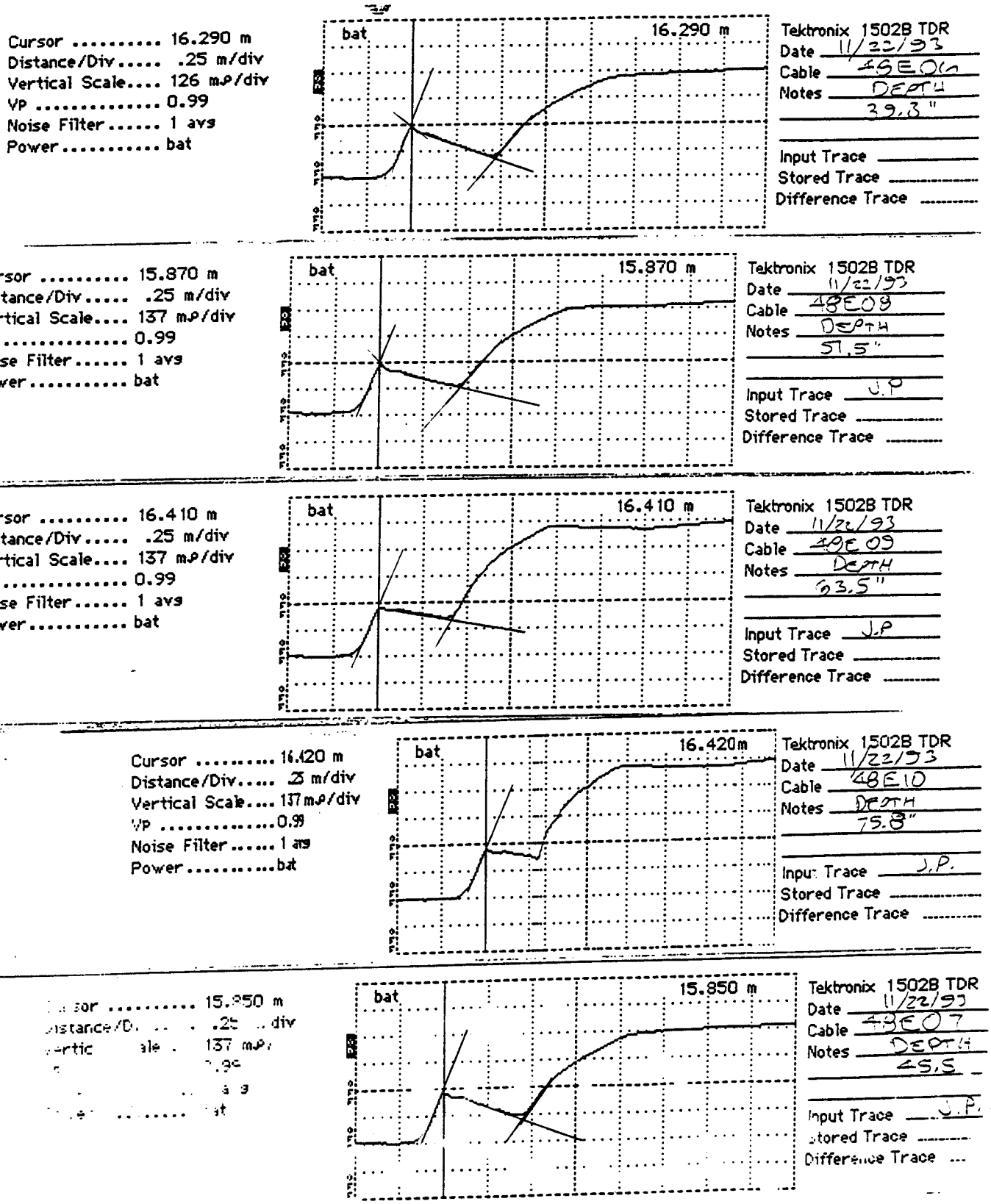


Figure C-1. TDR Traces During Installation

Table C-1. Field Measured Moisture Contents

SITE NO. 481122 11/23/93

MOISTURE CONTENTS FOR TDR

TDR #	WT. OF PAN(g)	(WET) PAN & SOIL(g)	(DRY) PAN & SOIL(g)	M.C. (%)
48E10	153.3	338.4	330.7	4.34%
48E09	203.8	448.8	438.0	4.61%
48E08	149.4	409.0	393.0	6.57%
48E07	198.6	502.1	483.9	6.38%
48E06	178.9	481.9	463.6	6.43%
48E05	152.9	448.5	427.7	7.57%
48E04	203.2	488.6	465.1	8.97%
48E03	148.8	385.8	366.6	8.82%
48E02	198.5	459.9	436.5	9.83%
48E01	178.8	495.2	479.4	5.26%

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 Initial Data Collection
Figure D-2.	Measured Average Subsurface Temperature for the First 5 Sensors During Initial Data Collection
Figure D-3.	Measured Average Subsurface Temperature for all 18 Sensors During Initial Data Collection
Figure D-4 thru Figure D13.	Traces from TDR Sensor
Table D-2.	Elevation Measurements from Installation

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

5,1993,326,1400,12.17,20.62,.1
5,1993,326,1500,12.21,20.94,0
5,1993,326,1600,12.21,21.24,0
6,1993,326,1600,25.57,23.5,21.26,18.81,18.39
7,1993,326,1601,-665.6,-1178,-1669,-2048,-2269,-2379,-2430,-2422,-2451,-2463,-2467,-2469,-2470,-2470,-2469,-2468,-2436,-2455,-2462,-2465,-2467,-2467,-2437,-2455,-2461,-2466,-2467,-2467,-2467,-2467,-2467,-2467,-2467,-2466,-2466
5,1993,326,1700,12.2,21.13,0
5,1993,326,1800,12.19,19.6,0
5,1993,326,1900,12.18,16.58,0
5,1993,326,2000,12.18,16.96,0
6,1993,326,2000,20.74,20.98,20.77,19.61,19.05
7,1993,326,2001,-831,-1431,-1986,-2355,-2540,-2621,-2653,-2667,-2673,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2675,-2674,-2673,-2673,-2673,-2673,-2673,-2673,-2673,-2673
5,1993,326,2100,12.18,16.72,0
5,1993,326,2200,12.17,16.32,0
5,1993,326,2300,12.17,15.27,0
1,1993,326,2400,12.18,12.22,1459,12,1348,17.97,21.95,1557,13.99,2352,.1
2,1993,326,2400,20.38,20.23,19.85,19.21,18.97,18.94,19.08,19.41,20.16,20.91,21.55,22.09,22.54,22.9,23.28,23.62,24.01,24.4
3,1993,326,2400,26.08,1512,24.36,1546,22.43,1612,19.91,1817,19.41,1913,19.37,2220,19.45,2329,19.68,2339,20.53,1351,21.24,1352,21.71,1355,22.2,1836,22.68,1835,23.04,1839,23.42,1821,23.7
7,2231,24.17,1836,24.52,1831
4,1993,326,2400,15.89,2359,16.55,2359,17.2,2359,18.55,2355,18.22,1447,18.35,1513,18.67,1618,19.13,1716,19.99,1833,20.72,2334,21.39,2341,21.92,1404,22.27,1350,22.55,1351,22.89,1358,23.2
1,1351,23.6,1356,24.09,1354
5,1993,326,2400,12.16,14.39,0
6,1993,326,2400,17.14,17.69,18.16,19.04,19.22
7,1993,327,1,-830,-1444,-2014,-2389,-2574,-2654,-2686,-2697,-2702,-2704,-2704,-2705,-2706,-2706,-2706,-2675,-2694,-2700,-2704,-2704,-2704,-2704,-2704,-2703,-2702,-2702,-2672,-2691,-2698,-2700,-2704,-2704,-2705,-2704,-2702
5,1993,327,100,12.16,13.47,0
5,1993,327,200,12.15,13.07,0
5,1993,327,300,12.15,12.64,0
5,1993,327,400,12.14,12.17,0
6,1993,327,400,15.24,15.87,16.54,18.09,18.71
7,1993,327,401,-779,-1406,-1995,-2393,-2591,-2674,-2706,-2689,-2715,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-2693,-2713,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999,-6999
5,1993,327,500,12.14,11.77,0
5,1993,327,600,12.13,11.51,0
5,1993,327,700,12.12,11.51,0
5,1993,327,800,12.12,12.09,0
6,1993,327,800,13.85,14.48,15.25,17.17,18.07
7,1993,327,801,-713,-1333,-1919,-2334,-2544,-2636,-2674,-2650,-2678,-2690,-2694,-2695,-2696,-2697,-2697,-2697,-2697,-2697,-2697,-2697,-2697,-2659,-2680,-2688,-2692,-2693,-2694,-2656,-2678,-2687,-2690,-2692,-2693,-2693,-2692
5,1993,327,900,12.12,13.26,0
5,1993,327,1000,12.12,16.7,0
5,1993,327,1100,12.12,20.24,0
5,1993,327,1200,12.12,22.31,0
6,1993,327,1200,20.91,19.22,17.94,17.09,17.65
7,1993,327,1201,-685.8,-1228,-1747,-2136,-2356,-2460,-2506,-2494,-2520,-2532,-2536,-2537,-2538,-2538,-2538,-2539,-2539,-2508,-2527,-2535,-2538,-2538,-2537,-2536,-2536,-2538,-2538,-2508,-2524,-2532,-2535,-2536,-2536,-2534,-2535
5,1993,327,1300,12.11,23.32,0

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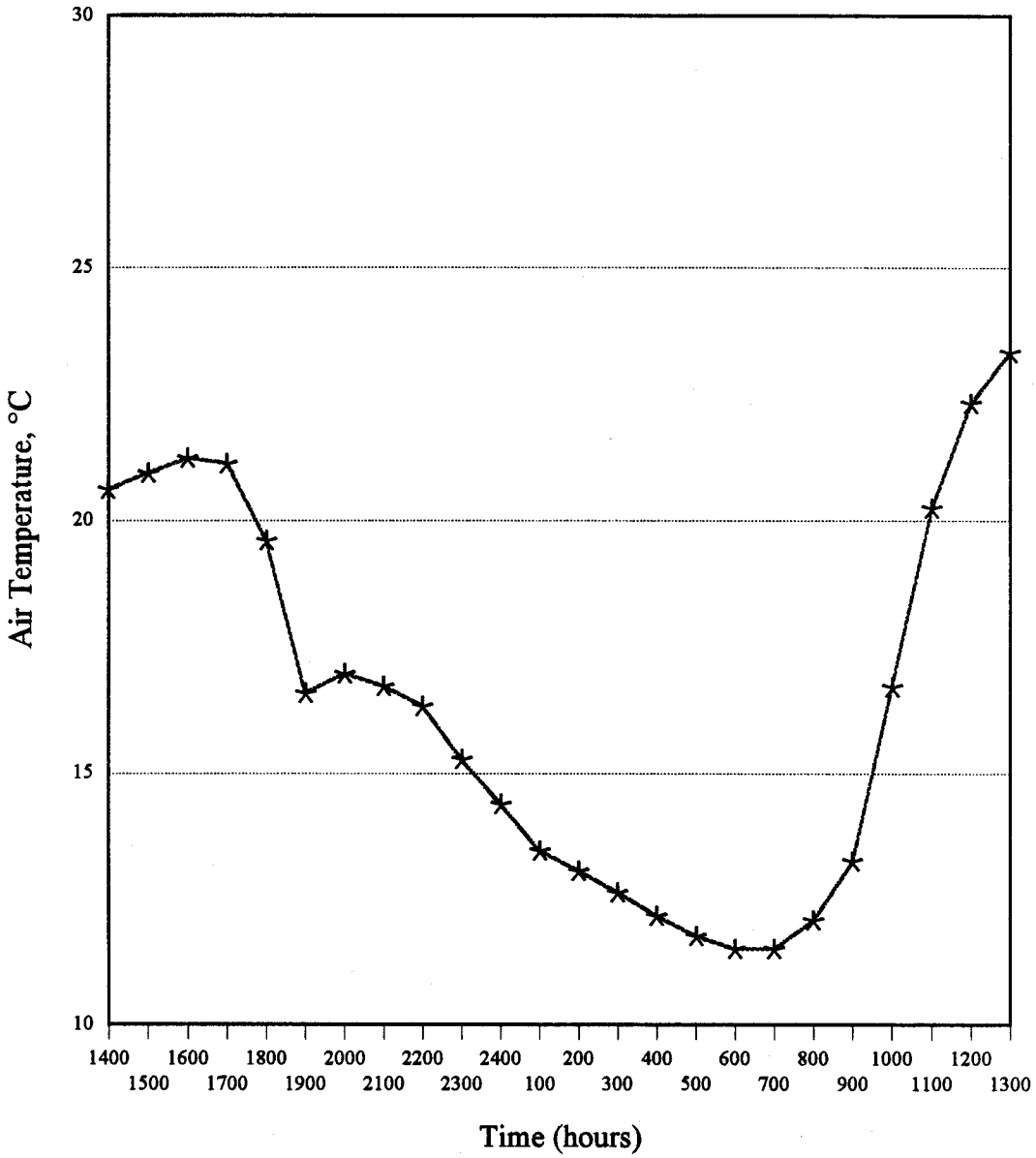

Figure D-1. Measured Air Temperature During Initial Data Collection.

Site 481122

November 23, 1993

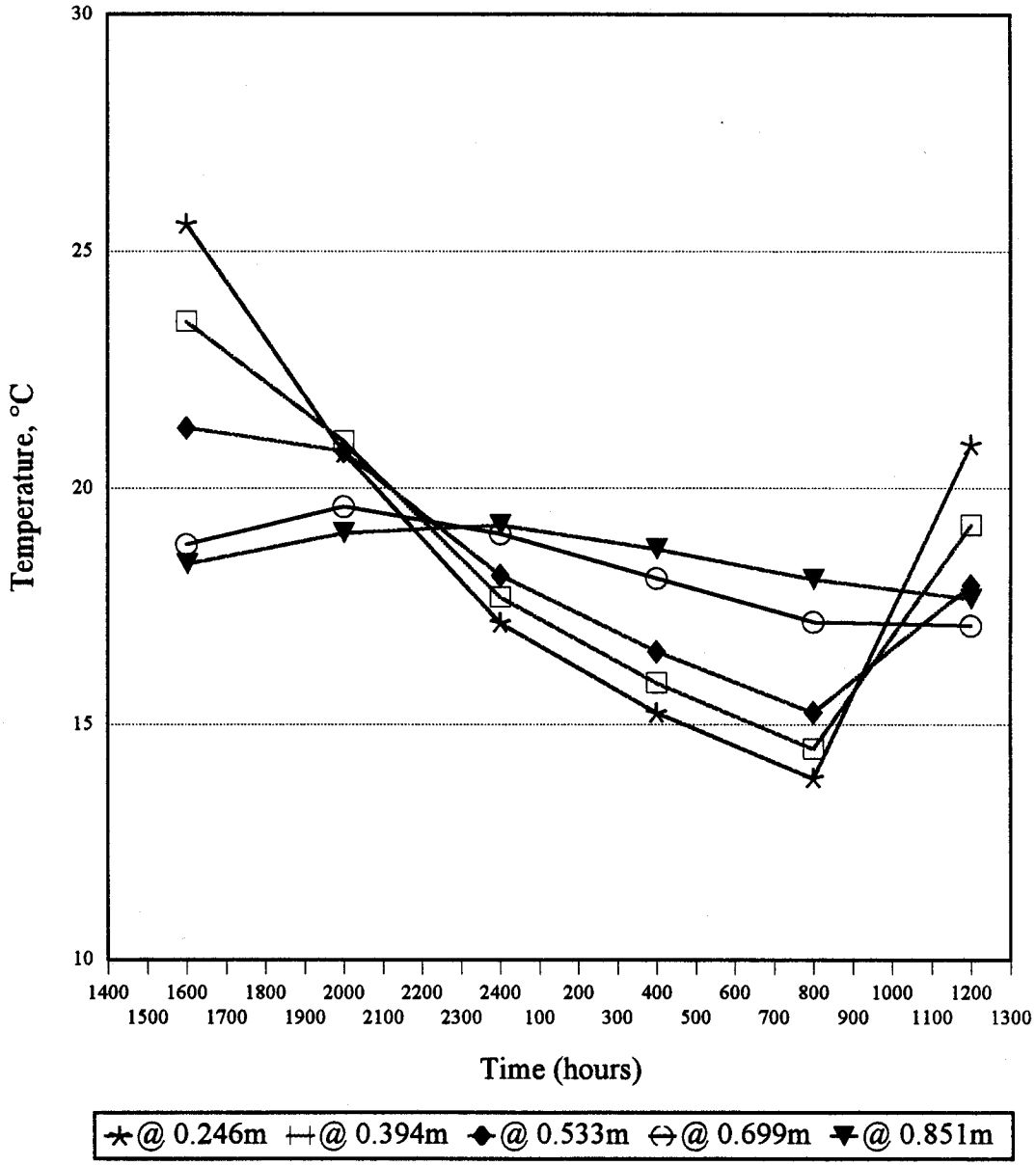

Figure D-2. Measured Average Subsurface Temperature for the First 5 Sensors During Initial Data Collection.

Site 481122

November 23, 1993

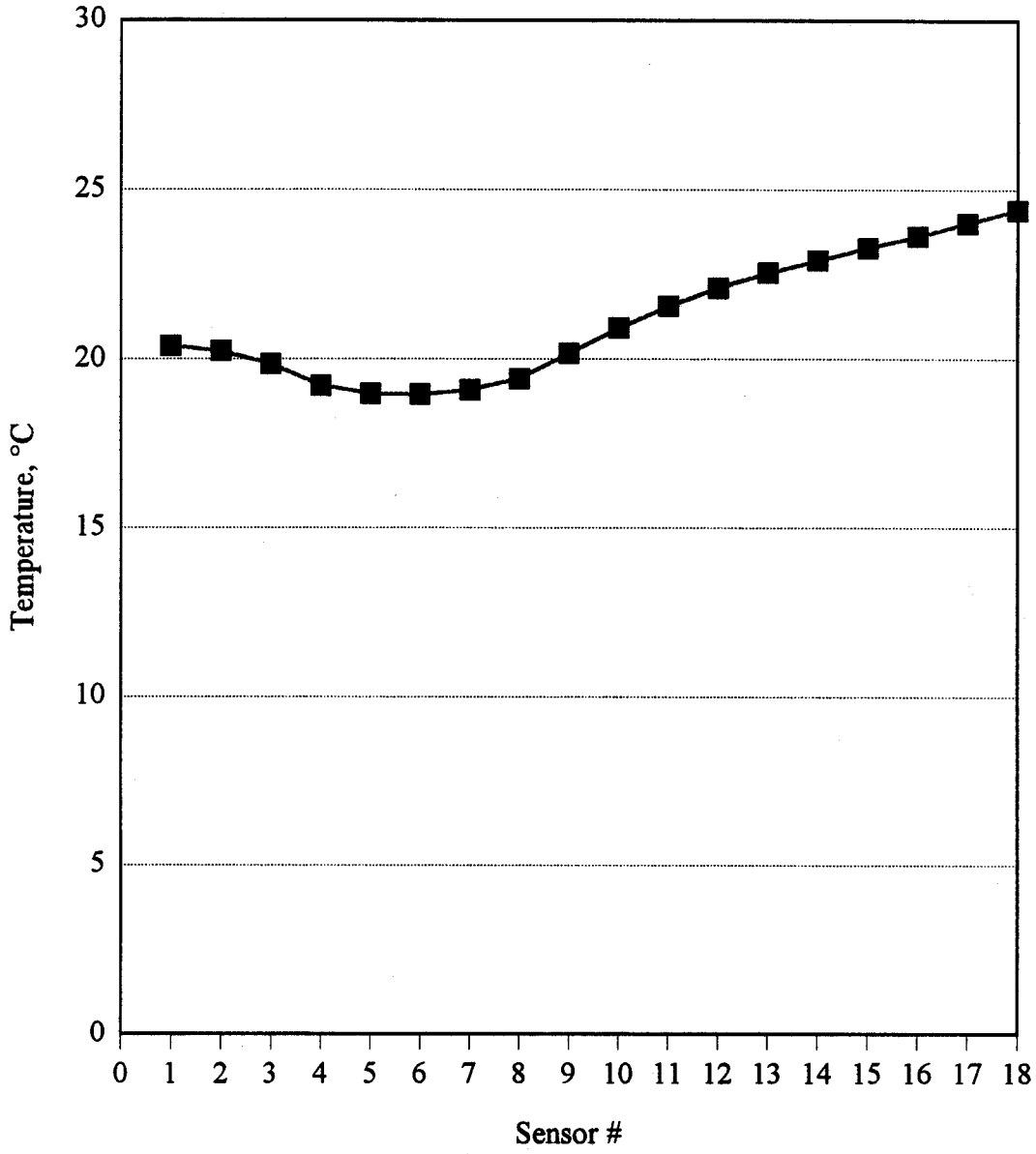

Figure D-3. Measured Average Subsurface Temperature for All 18 Sensors During Initial Data Collection.

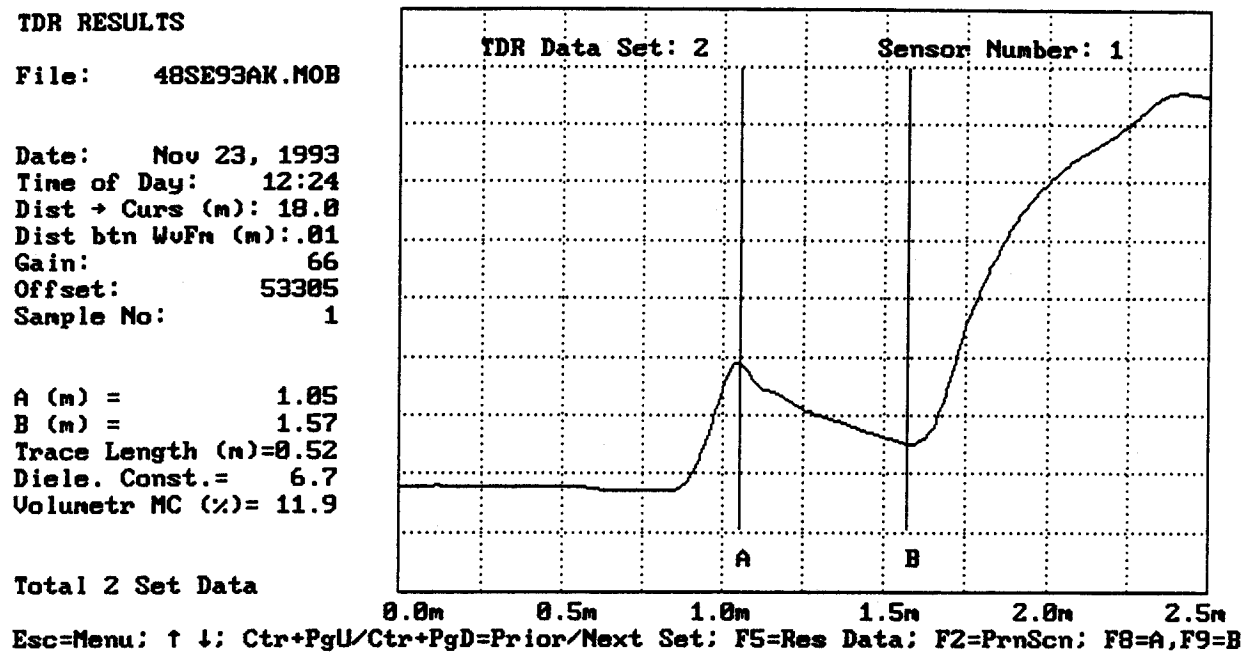

Figure D-4. Trace from TDR Sensor 1

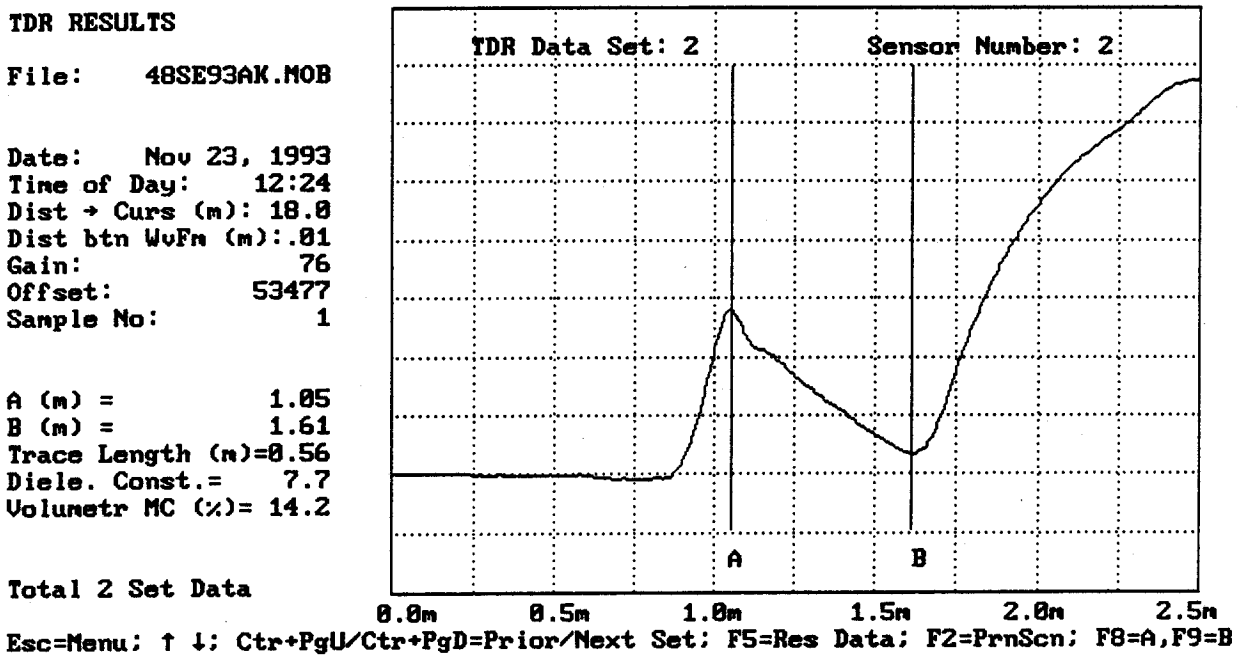

Figure D-5. Trace from TDR Sensor 2

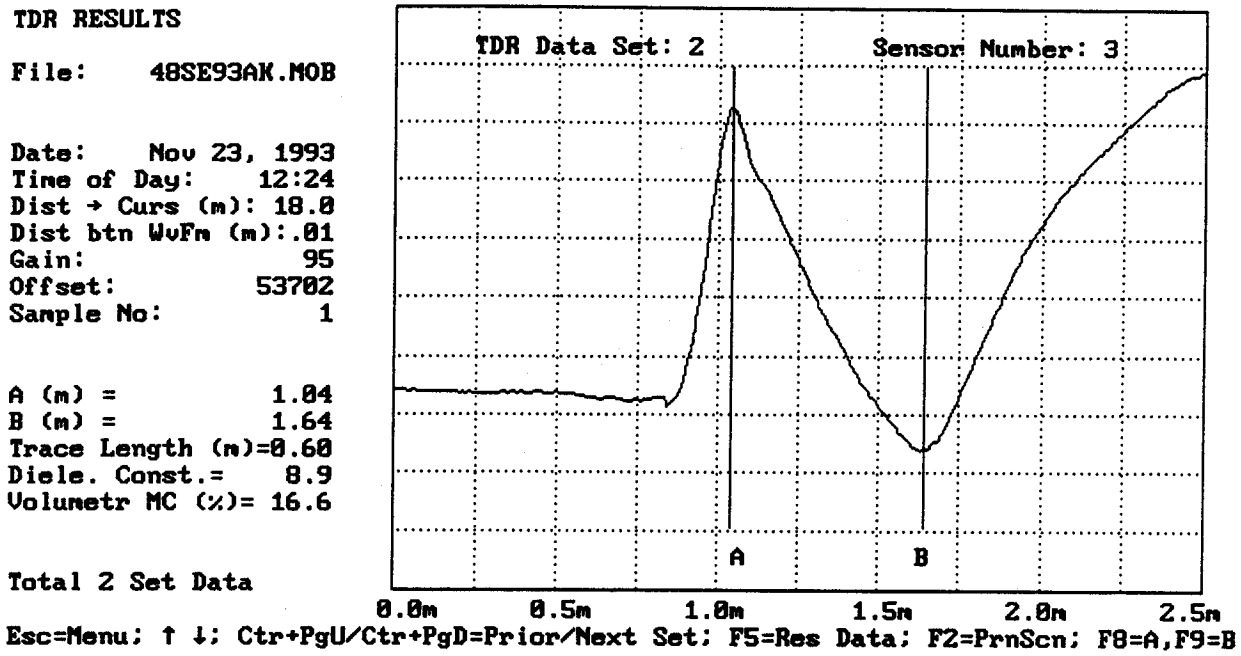

Figure D-6. Trace from TDR Sensor 3

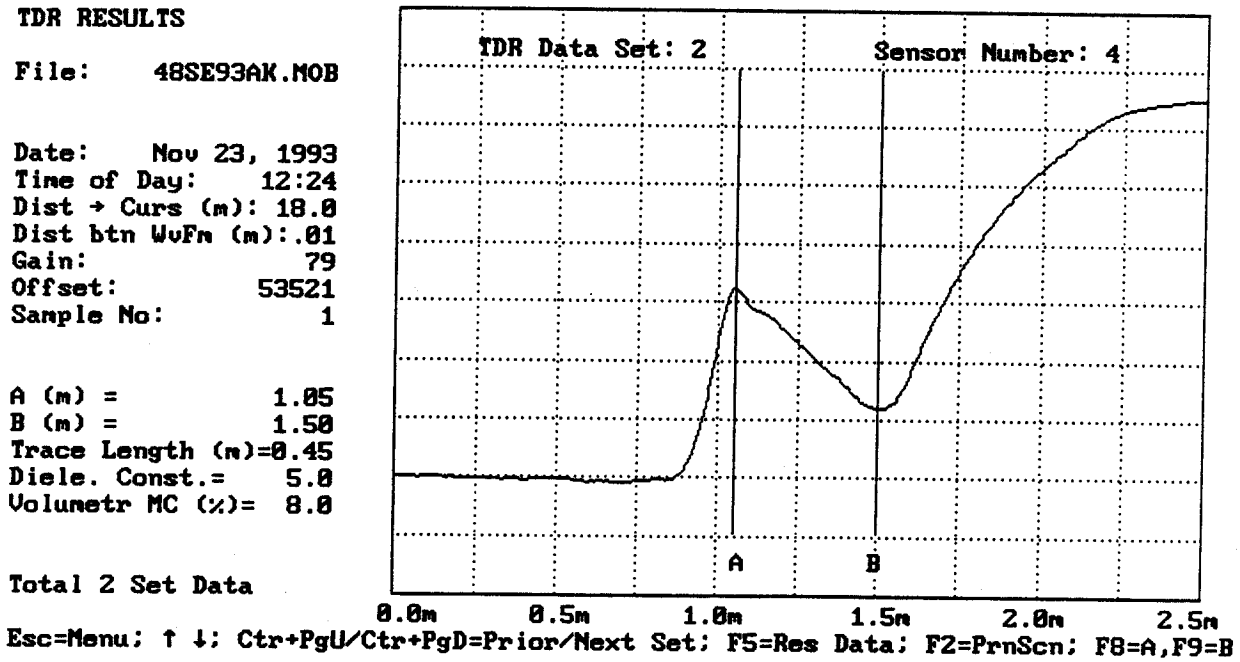

Figure D-7. Trace from TDR Sensor 4

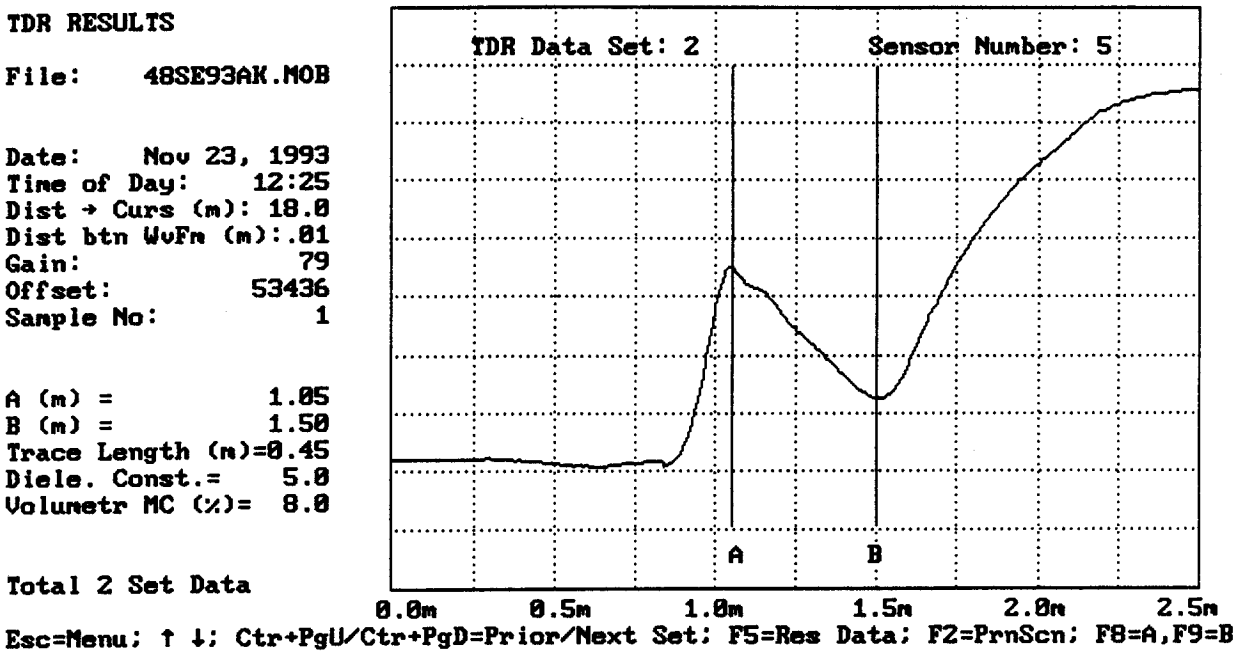

Figure D-8. Trace from TDR Sensor 5

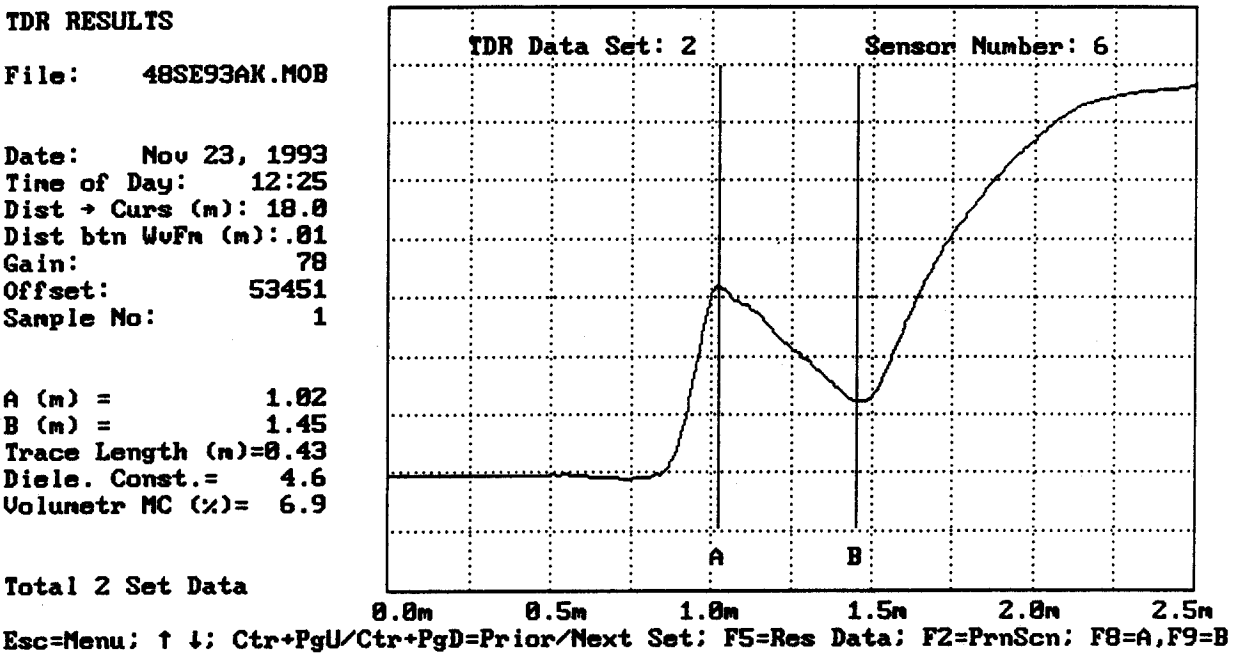

Figure D-9. Trace from TDR Sensor 6

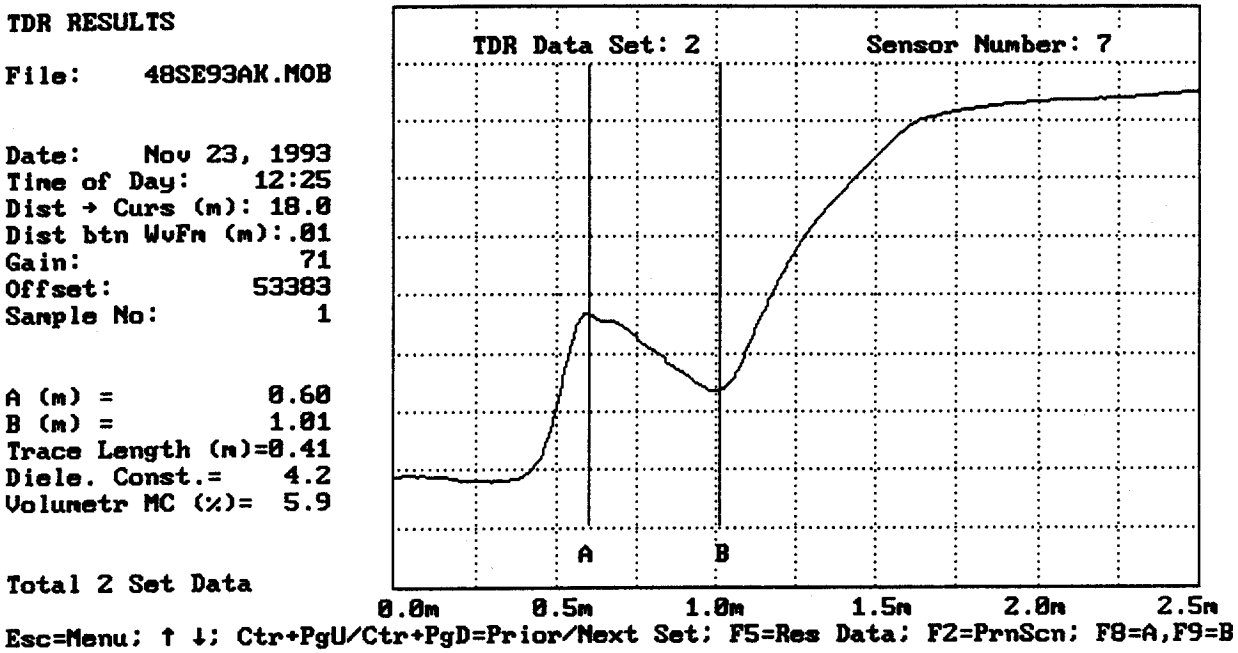

Figure D-10. Trace from TDR Sensor 7

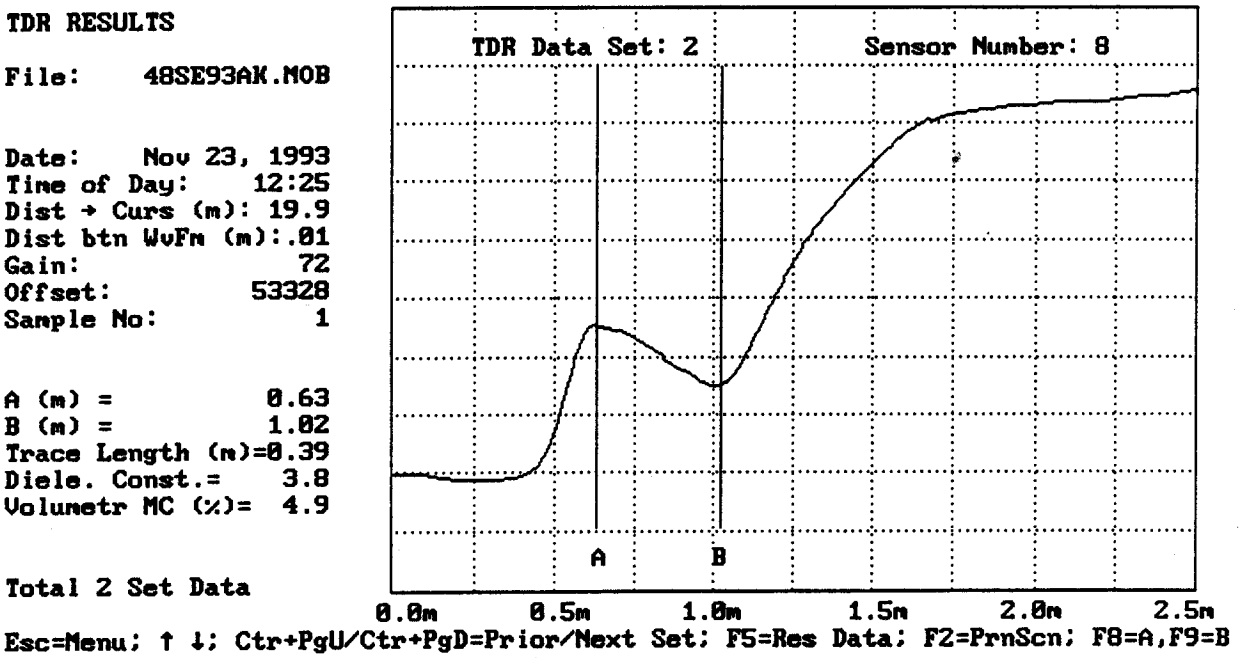

Figure D-11. Trace from TDR Sensor 8

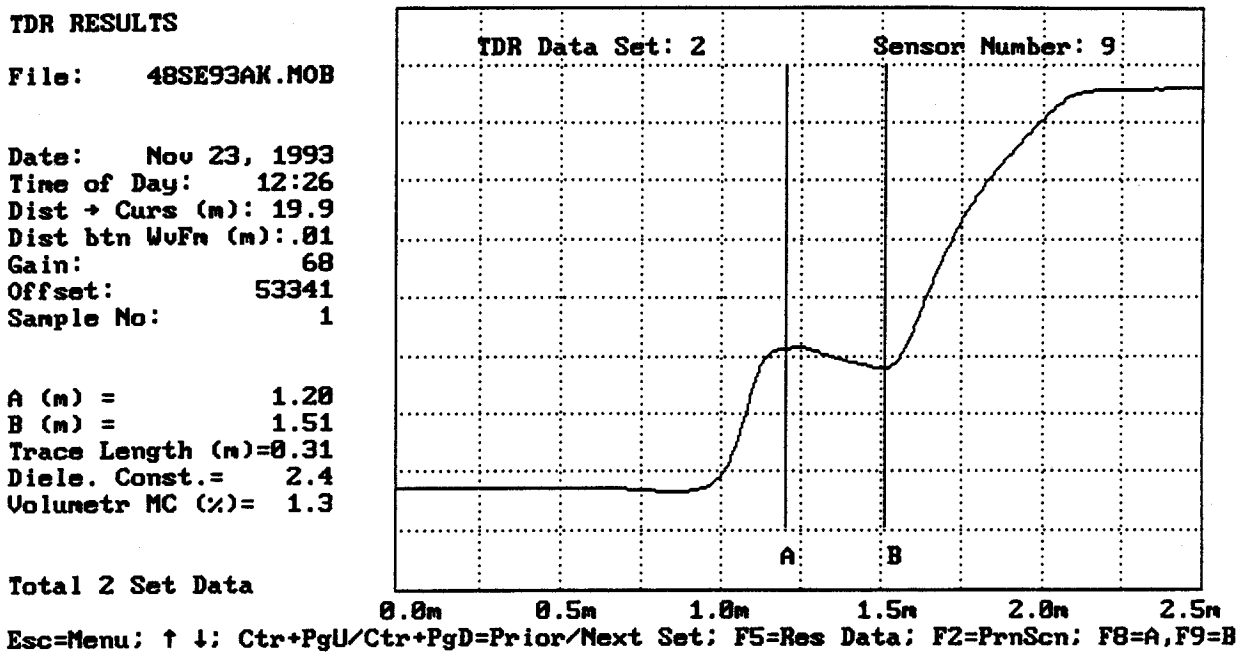

Figure D-12. Trace from TDR Sensor 9

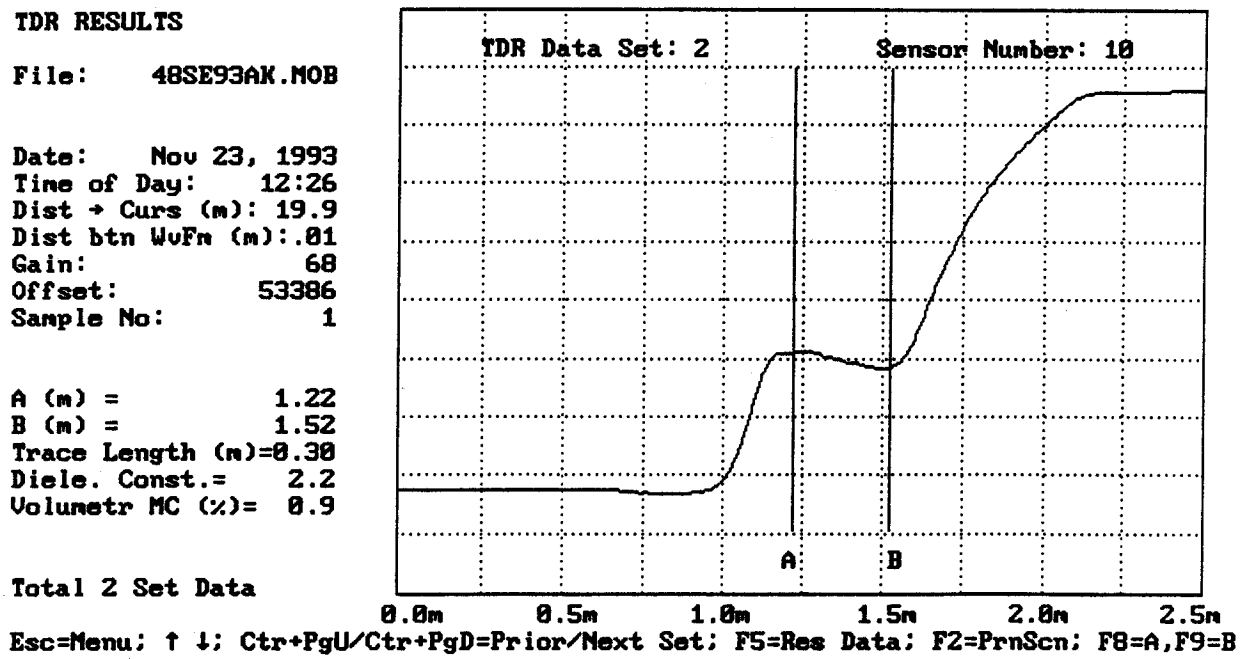

Figure D-13. Trace from TDR Sensor 10

Table D-2. Contact Resistance Measurements Data Sheet

SEASONAL MONITORING
"FLEX" TRANSVERSE ELEVATION MEASUREMENTS[1] 48SE

Station	Outside Edge		OWP		ML		IWP		Inside Edge	
	O/S M	Elev. M	O/S M	Elev. M	O/S M	Elev. M	O/S M	Elev. M	O/S M	Elev. M
3+00	.15	1.317	.85	1.336	1.85	1.367	2.60	1.372	3.90	1.397
3+25	"	1.711	"	1.731	"	1.763	"	1.771	"	1.788
3+50	"	2.100	"	2.121	"	2.152	"	2.162	"	2.189
3+75	"	2.499	"	2.518	"	2.546	"	2.552	"	2.571
4+00	"	2.880	"	2.902	"	2.927	"	2.929	"	2.938
4+25	"	3.246	"	3.263	"	3.288	"	3.292	"	3.316
4+50	"	3.600	"	3.618	"	3.646	"	3.653	"	3.674
4+75	"	3.945	"	3.961	"	3.988	"	3.993	"	4.014
5+00	"	4.273	"	4.290	"	4.318	"	4.325	"	4.353
5+10	INSTRUMENTATION									
5+20			.85	4.548	"	4.575				
5+30			.85	4.672						

TIE IN

Bench Mark: DEPARTMENT OF HIWAYS & PUBLIC TRANS. (DOT) INDEX CONTROL STA. 0+08.12 'RIGHT OF OUTSIDE SHOULDER STRIPE' INSTR. @ 0+12 ON SHLD. ASSUMED ELEV. 10.00 METERS. T.P. OUTSIDE SHLD. STRIPE DIST. 0.157. ELEV. 2.121 M. INSTR. @ 2+12A ON SHLD. T.P. PK @ 3+00 ELEV. 1.315. INSTR @ 4+00 ON SHLD. T.P. PK. @ 4+25 ELEV. 3.243

Comments: BASELINE IS PK. NAILS SET @ OUTSIDE EDGE OF OUTSIDE SHLD. STRIPE; PK. NAILS SET @ 4.00 M O/S FOR ℄, STATIONED BACK FROM 5+00

TIE IN: +0.005

Test Section No.	481122	Date	11/23/93
Start Time		Finish Time	
Recorded By	J.P., R.Z.	Device Used	LASER PLANE LEVEL

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

10/29/93

APPENDIX E

Photographs

Appendix E contains the following photographs:

Photo E-1. General Photo of Test Section

Photo E-2. Location of Instrumentation Area

Photo E-3. Preparing for Instrumentation Installation

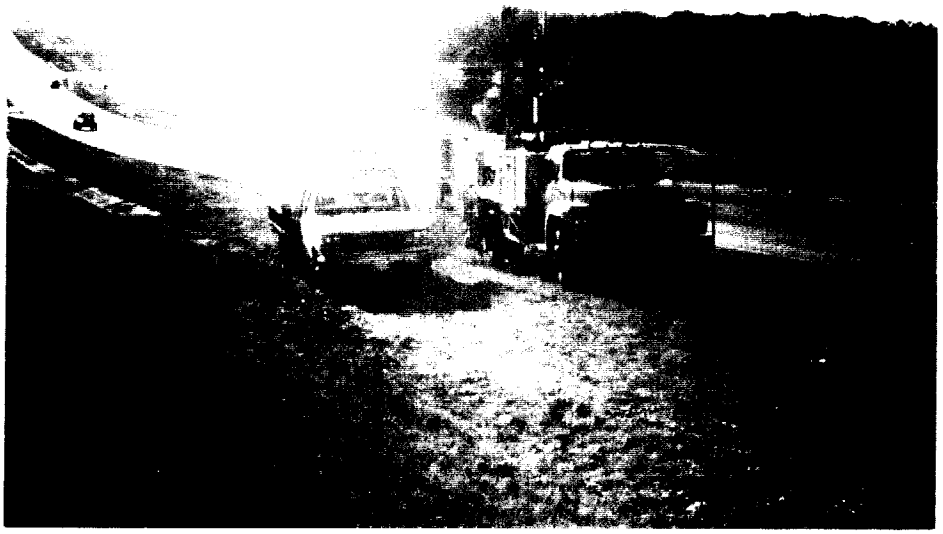

Photo E-1. General Photo of Test Section

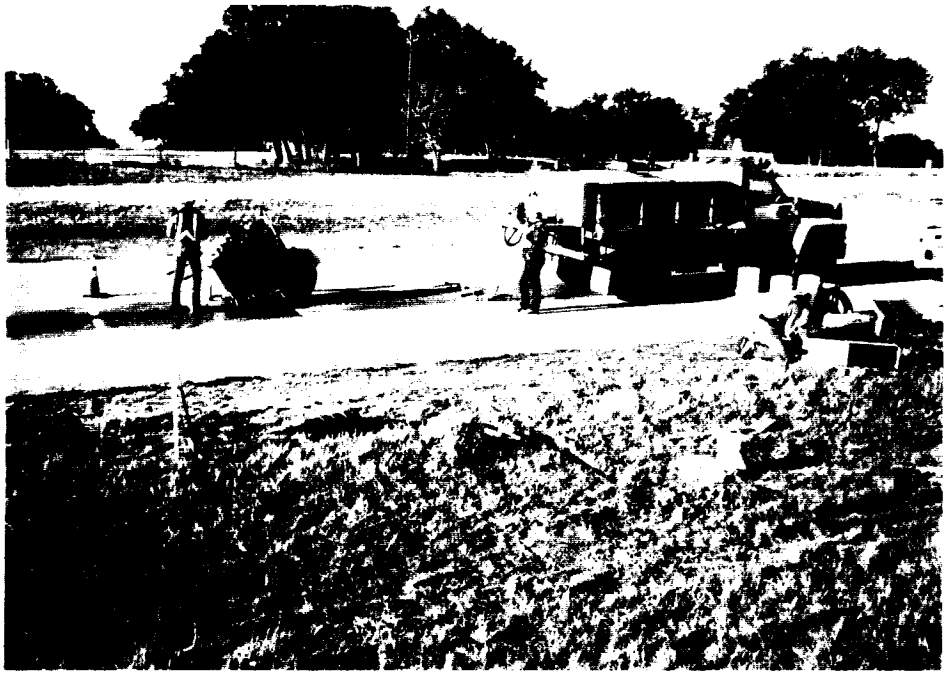

Photo E-2. Location of Instrumentation Area

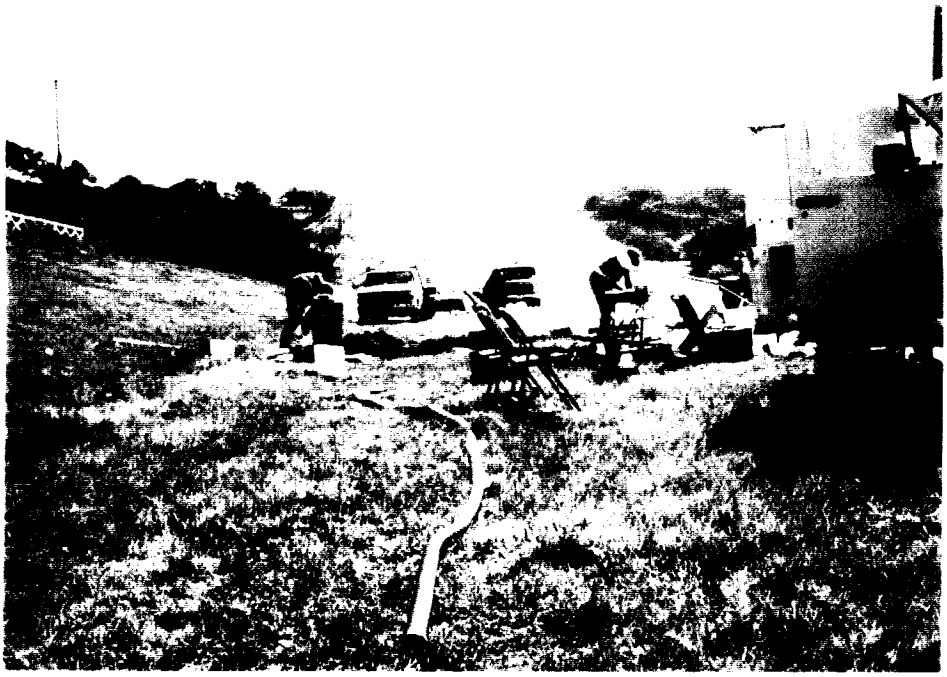

Photo E-3. Preparing for Instrumentation Installation