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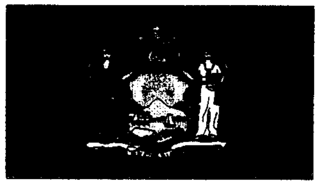

New York

LTPP Seasonal Monitoring Program

Site Installation and Initial
Data Collection
Section 364018, Oneonta
New York

Report No. FHWA-TS-95-36-01

September 1995

Notice

LTPP Seasonal Monitoring Program

Site Installation and Initial Data Collection
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The report is a cooperative effort between New York State Department of Transportation (NYSDOT) Engineering Research and Development Bureau and Pavement Management Systems Limited LTPP North Atlantic Region Coordination Office.

16. Abstract

This report provides a description of the installation of seasonal monitoring instrumentation and initial data collection for the seasonal experimental study conducted as part of the Long Term Pavement Performance (LTPP) program at the General Pavement Study (GPS) section 364018 on I 88 near Oneonta New York. This portland cement concrete surface pavement test section was instrumented on October 27, 1993. The instrumentation installed included time domain reflectometry probes for moisture content, electrical resistivity probe for frost location, thermistor probe for temperature, tipping bucket rain gage, piezometer to monitor the ground water table, and an on-site data logger. Initial data collection was performed on October 28, 1993 which consisted of deflection measurements with a Falling Weight Deflectometer, elevation measurements, temperature measurements, TDR measurements, and electrical resistance and resistivity measurements. Longitudinal profile data is collected during scheduled visits with the LTPP profiler. 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 Instrumentation, Monitoring, Survey, FWD, Profilometer, Time Domain Reflectometry, Thermistor, Piezometer, Electrical Resistance, Electrical Resistivity.		18. Distribution Statement	
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SEASONAL INSTRUMENTATION STUDY
INSTRUMENTATION INSTALLATION
NEW YORK SECTION 364018

I. Introduction

The installation of instrumentation on seasonal site 364018 near Oneonta, New York was performed on October 27 - October 28, 1993. The test section is a GPS-4 experiment, located on eastbound Interstate 88, approximately fifteen meters east of Otsego - Delaware county line (Figure A-1 in Appendix A). The highway consists of two 3.7 m wide lanes in each direction with a 3.7 m wide outside and a 1.2 m wide inside asphalt pavement shoulders.

The pavement structure is a 239 mm Jointed Reinforced Concrete Pavement (JRCP) with 12.16 m slab spacing. This resides on a coarse grained silty gravel with sand. Pavement structure information from the GPS material drilling logs is presented in Figure A-2. Properties determined from the laboratory material tests are shown in Table 1. This information is generally consistent with what was encountered on the day of installation with the exception of a gray brown silty clay with occasional gravel located at 2.007 meters. Recent construction on this section (1993), included the installation of edge drains, replacement of the shoulder material and resealing of the pavement joints.

Table A-1 in Appendix A summarizes the distress, IRI values from the Profilometer longitudinal profile measurements, and Falling Weight Deflectometer deflection values as monitored since 1989. The uniformity survey results are summarizes in Appendix A, Table A-2 and the deflection values and analysis results from the FWDCHECK are also presented in Appendix A.

The site is in a wet-freeze zone and resides in cell 32 (JRCP on coarse subgrade) of the seasonal monitoring program. The annual average frost depth is 1.01 m. Salt is frequently used for ice control at this location. Below is a summary from the LTPP climate database based on eleven years of data:

- Freezing Index (C-Days) 587
- Precipitation (mm) 1041
- No. of Freeze/Thaw Cycles 116
- Days Above 32C 2
- Days Below 0C 156
- Wet Days 170

The road was opened in 1974. The estimated annual average daily traffic (AADT) in 1992 was 10285 (two way) of which 16.0% was truck traffic on the GPS lane. The Traffic in the GPS direction carried approximately 49.6% and the GPS lane carried 42.7% of the total AADT. The estimated annual kESALs on the GPS lane in 1992 were 252.8 using vehicle ESALs, based on 186 days of AVC coverage and 163 days of WIM data in 1992.

Installation of the instrumentation was a cooperative effort between New York State Department of Transportation (NYSDOT) Engineering Research and Development Bureau and Pavement Management Systems Limited (PMSL) LTPP North Atlantic Region Coordination Office staff. The following personnel participated in the instrumentation installation:

Rick Morgan	NYSDOT, Engineering Research and Development Bureau (ERDB)
Ron Lorini	NYSDOT, Engineering Research and Development Bureau (ERDB)
Mike Doody	NYSDOT, Engineering Research and Development Bureau (ERDB)
Makbul Hossain	NYSDOT, Engineering Research and Development Bureau (ERDB)
Bob Applegate	NYSDOT, Region 9 Soils, Drilling Crew
Tim Lamoree	NYSDOT, Region 9 Soils, Drilling Crew
Carl Johnson	NYSDOT, Region 9 Soils, Drilling Crew
Angelo Ortiz	NYSDOT, Region 9 - Otsego County Residency
Dale White	NYSDOT, Region 9 - Otsego County Residency
Raymond Grabowski	NYSDOT, Region 9 - Otsego County Residency
Jeff Goman	South Central Scaffolding - Concrete Saw Operation
Ron Hoyt	NYSDOT, Main Office - Soils
Jay Dietrich	NYSDOT, Region 9 - Construction EIC on I-88 Contract
George Caswell	NYSDOT, Region 9 - Otsego County Residency
Ron Meisner	NYSDOT, Region 9 - Otsego County Residency
Ken Sickler	NYSDOT, Region 9 - Otsego County Residency
Bob Halaquist	NYSDOT, Region 9 - Otsego County Residency
Dennis Morian	Pavement Management Systems Limited (NARO)
Brandt Henderson	Pavement Management Systems Limited (NARO)
Perry Zabaldo	Pavement Management Systems Limited (NARO)
Mike Zawisa	Pavement Management Systems Limited (NARO)
Doug Marshall	Pavement Management Systems Limited (NARO)

Table 1. Material Properties

Description	Surface	Base	Subgrade
Material (Code)	Portland Cement Concrete JRCP (05)		Silty Gravel with Sand (265)
Thickness (mm)	239		
Lab Max Dry Density (kg/m^3)			2238
Lab Opt Moisture Content (%)			6.00
Lab Moisture Content (%)			5.58
In-situ Wet Density (kg/m^3) *			
In-situ Dry Density (kg/m^3) *			
In-situ Moisture Content (%) *			
Liquid Limit			0
Plastic Limit			0
Plasticity Index			NP
% Passing # 200			18.65

* Note: Not collected for PCC pavements

II. Instrumentation Installation

Site Inspection and Meeting with Highway Agency

A site review was scheduled for August 27, 1993 in conjunction with the FWD uniformity survey. The contractor was to provide traffic control but, because of scheduled work with crack sealing at this location, the survey was postponed till October 21, 1993. Unfortunately this was canceled again due to weather conditions. The decision was then made to use the July 27, 1989 FWD survey, along with a review of the present site conditions, to determine a potential location for the instrumentation. The 1989 FWD survey indicated the section to be acceptable from a deflection standpoint, with either end being suitable for instrumentation installation. The site is in overall good condition with no future plans for rehabilitation. Recent preventative maintenance included the placement of edge drains, repairing the shoulders and crack sealing the joints. The west end of the site (station 0+00) was preferable from a traffic control perspective.

A preliminary planning meeting was held with NYSDOT officials on September 10, 1993 at Albany. Attendees at the meeting were:

• Wes Yang	NYSDOT ERDB
• Rick Morgan	NYSDOT ERDB
• Debra Harbuck	NYSDOT Soils Bureau
• Robert W. Salankiewicz	NYSDOT Region 9 Research Liaison
• Ronald Mercer	NYSDOT Region 9 Materials
• Howard Reed	NYSDOT Resident Engineer - Otsego County
• Bill Phang	Pavement Management Systems Limited - NARO
• Brandt Henderson	Pavement Management Systems Limited - NARO

A presentation on the installation of seasonal monitoring instrumentation and monitoring requirements were provided by Bill Phang and Brandt Henderson. This was followed by a review and discussion on the seasonal site. Plans for the installation on October 27-28, 1993 were discussed; which covered tasks to be done by state resources and material requirements. Correspondence from the site inspection and planning meeting are provided in Appendix B.

A pre-installation meeting was held on the afternoon of October 26, 1993 at the Otsego County Residency, Oneonta, NY. Plans for the following day were discussed along with a verification check of the equipment to be used for sawing the portland cement layer, augering the instrumentation hole, cutting the trench to the instrumentation cabinet and the various supplies necessary to complete the installation and patch the pavement. Arrangements were made to have traffic control setup for 0730 hours with the sawing and cutting contractor and the drilling contractor to be on site by 0800 hours.

Equipment Installed

A permanent ~~bench mark~~ (Elevation 1082.618 Feet, 329.983 Meters) was installed on November 29, 1993 by ~~the~~ state using a railway spike set in a 203 mm diameter Elm tree at ~~SHRP station 0+67~~ (39.6 m to the right or East of the edge of pavement).

The equipment installed at the test site included instrumentation for measuring air and subsurface temperature, subsurface moisture content, frost depth, and water table. An equipment cabinet was installed to hold the datalogger, battery pack, and all electrical connections from the instrumentation. The equipment installed are shown in Table 2.

Table 2. Equipment Installed

Equipment	Quantity	Serial Number
Instrumentation Hole		
MRC Thermistor Probe	1	36AT
CRREL Resistivity Probe	1	36AR
TDR Probes	10	36A01-36A10
Equipment Cabinet		
Campbell Scientific CR10 Datalogger	1	16560
Campbell Scientific PS12 Power Supply	1	5615
Weather Station		
TE525MM Tipping Bucket Rain Gage	1	12090-693
Campbell Scientific 107-L Air Temperature Probe	1	36AAT
Observation Well/Bench Mark	1	N/A
State Benchmark	1	N/A

Equipment Check/Calibration

Prior to installation, each measurement instrument was checked or calibrated. The tipping bucket rain gauge was connected to the CR10 datalogger for calibration. A plastic container with 473 ml of water was placed in the tipping bucket. The container had a small hole in the bottom, which allowed all the water to be drained out in 45 minutes. For the 473 ml of water, the tipping bucket should measure 100 tips $\pm$ 3 tips. The results showed 97 tips, which was within specification.

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

The wiring of the resistivity probe was checked using continuity measurements between each electrode and the corresponding pins on the connector. The distance between each electrode was measured and recorded as shown in Table B-4 in Appendix B. Contact resistance measurements were performed with the probe immersed in a salt water bath. The results of these measurements are also shown in Appendix B. Due to defects in the manufacturing, clear silicon sealant was used to cover exposed wires to the electrodes. The checks on the resistivity probe indicated all electrodes were functioning properly.

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

Equipment Installation

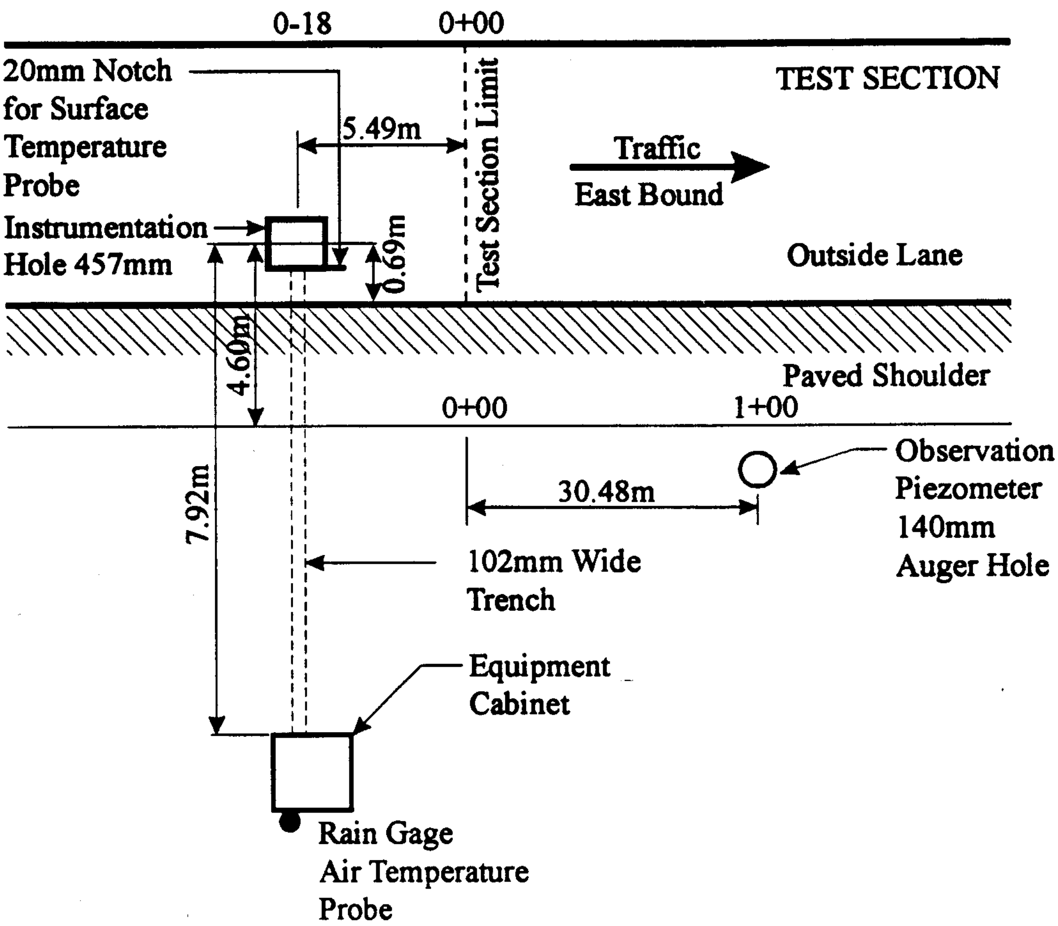
Final details for the installation and initial monitoring were discussed in a meeting on the afternoon of October 26 1993. The installation was confirmed for 0800 hours on October 27, 1993. Traffic control for the installation and monitoring, pavement surface drilling and sawing, and augering of the piezometer and instrumentation hole were provided by the NYSDOT Otsego County Region 9 district office. The installation of the measurement equipment, the observation piezometer, weather station pole, and cabinet was performed by PMSL staff with assistance from the NYSDOT Engineering R&D Bureau and the local district personnel.

The instrumentation was installed on the west end of GPS 364018, in the outside lane of I-88 near Oneonta, New York. The combination benchmark/piezometer was placed in the shoulder at station 1+00. The in-pavement instrumentation was installed in the outer wheel path at station 0-18. The cabling from the instrumentation was placed in a 51 mm flexible conduit and buried in a trench running from the instrument hole to an equipment cabinet installed 7.92 m from the instrumentation hole. The weather pole was installed immediately behind the equipment cabinet. Figure 1 provides the location and distances for the various instrumentation and equipment installed.

The installation generally followed the procedures described in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines". The combination piezometer/benchmark was installed just off the edge of the paved shoulder to a depth of 4.42 m using a 140 mm flight auger for drilling the hole. A sample of the material was retained from approximately 0.5 to 1.5 m below the surface. The hole was slightly over bored due to material collapsing into the hole. The 25.4 mm galvanized pipe was firmly pressed into the hole, followed by 1.9 m of filter sand, a 0.33 m bentonite plug with the remainder of the hole filled with the native material removed. The final elevation for the pipe was 127 mm below the natural ground level at the location of the installation. A custom made brass/steel well cap, held in location by approximately 25 kg of concrete mix, was used to cover and protect the piezometer/benchmark.

A 457 mm square hole was cut in the pavement surface, located in the outside wheel path, 0.69 m from the edge of the travel lane at station 0-18, using a heavy duty portable paving saw. A 102 mm wide by 225 mm deep saw cut was done between the block hole and the edge of the pavement, using a heavy duty pavement cutting machine, to accommodate the instrumentation cabling. The blade of the pavement saw was used to notch a location for the pavement surface temperature probe at the south edge part of the east side of the block hole.

A combination of methods were used to excavate the instrumentation hole. The driller used a 290 mm flight auger to loosen the coarse gravel base material, which was removed by hand. The finer material was pulled up by the auger, with the loose material, retrieved by a hand held post hole digger. The cohesive material, encountered at the bottom of the instrumentation hole, generally was retrieved off the auger furrows. The findings from the excavation of the instrumentation hole at station 0-18 are presented in Figure 2. All the material excavated from the instrument hole was placed and compacted in order of removal. Samples of the material placed around the TDR probes were retrieved to determine the gravimetric moisture at these locations. A field moisture determination was done at the site with sample material retained for laboratory moisture determination by the NYSDOT Engineering R&D Bureau laboratory. No additional material remained from the instrumentation hole with some material from the trench area required to top up and level the instrumentation hole. The equipment cabinet and pole for the rain gage and air temperature probe were installed as per manual guidelines. The excavation of the trench went fairly smooth as the material was a generally clean sand without cobbles or boulders. It was necessary to cut the edge drain for the installation of the 50 mm flexible conduit used to carry the instrumentation cables from the instrument hole to the equipment cabinet. The edge drain was carefully cut and resealed to ensure the integrity of the drainage system. The wiring of the instrumentation to the equipment cabinet was completed on the same day as installed.



- Height of Air Temperature Probe (center): 3.28m
- Height of Tipping Bucket Rain Gage (center): 3.18m
- Total Depth of Piezometer: 4.29m
- Distance of Piezometer Below Ground Level: 127mm

Figure 1. Location for Seasonal Monitoring Instrumentation Installed at GPS 364018

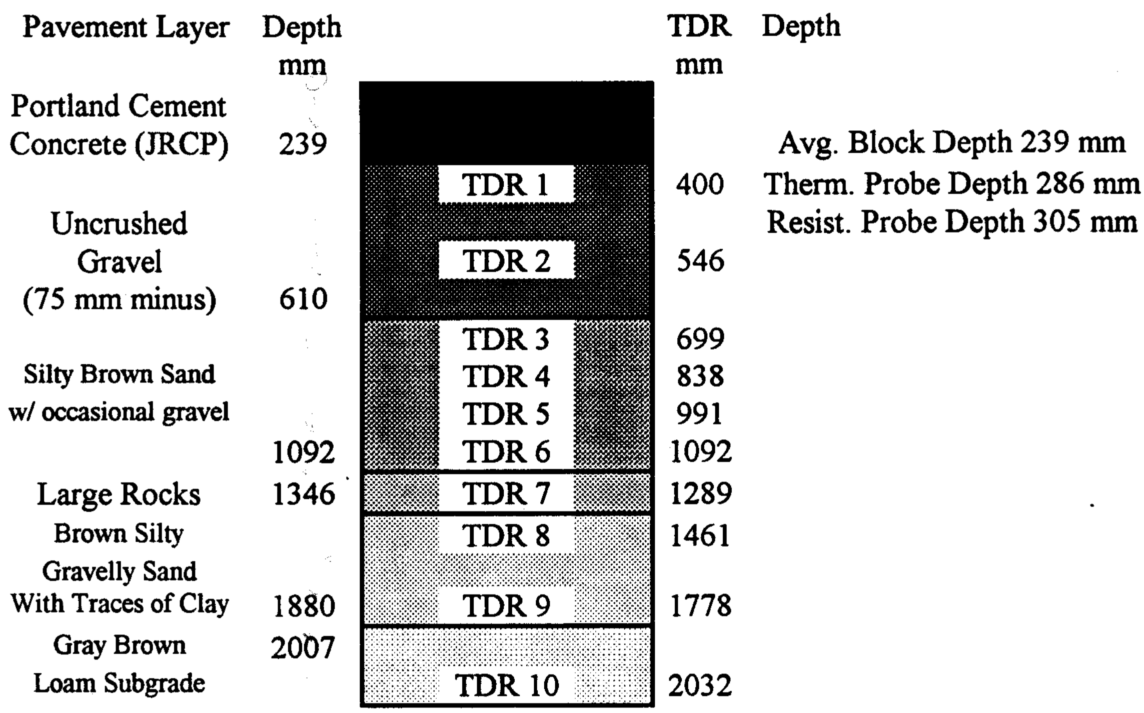


Figure 2. Profile of Pavement Structure and Probe Depths from Surface, Station 0-18

To check for breakage of the TDR probes during installation, each probe was connected to the cable tester and its wave form monitored during compaction of the material around it. A print of the TDR trace of each probe is taken at the completion of compaction at that probe location. This trace is used for moisture calculation and comparison with oven dried gravimetric moisture determined from soil sampled near the probe. The TDR traces are included in Appendix C. By alternating the TDR probes within the instrument hole we were able to keep the cables separate to avoid water from migrating along a bundle of cables attached to the probes placed at various depths. The thermistor and resistivity probes were installed at opposite sides of the instrumentation hole with the thermistor probe 0.286 m and the resistivity probe 0.305 m below the pavement surface. The cables were kept spaced as best as possible until they converged at the opening of the flexible conduit pipe, placed about 50 mm from the edge of the block hole. The cables were then tie wrapped and passed through the conduit to the equipment cabinet. The ends of the conduit were plugged with a mastic pipe sealant.

Snap rings were installed at 0.304, 1.828, and 3.353 meters from the shoulder edge of the PCC slab of each pavement joint to be tested with the FWD. A template was used to drill holes to a uniform depth and distance at each location. Snap rings were installed as per LTPP guidelines.

A comparison of the moisture content from TDR traces, field, and laboratory moisture determination indicate generally good agreement except for sensors 5 and 6, which show a poor match for the gravimetric field moisture samples, and sensors 9 and 10, which show lower moisture values for the TDR method. The calculation of moisture content from TDR method is dependent on the calibration inputs to the TDR model. In this instance, the in-situ dry density for the materials in which probes 9 and 10 are placed are probably not representative of those material. Also the model has a tendency for a better fit in sand or gravel materials.

Tables 3, 4, and 5 present the installed depths of the TDR probes, thermistor sensors, and the resistivity probe respectively. Table 6 gives TDR, field, and laboratory measured moisture content during installation.

Table 3. Installed Depths of TDR Sensors

Sensor #	Depth from Pavement Surface (m)	Layer
36A01	0.400	Base
36A02	0.546	
36A03	0.699	Subgrade
36A04	0.838	
36A05	0.991	
36A06	1.092	
36A07	1.289	
36A08	1.461	
36A09	1.778	
36A10	2.032	

Table 4. Installed Location of MRC Thermistor Sensor

Unit	Channel Number	Depth from Pavement Surface (m)	Remarks
1	1	0.025	This unit was installed in the PCC layer.
	2	0.120	
	3	0.214	
2	4	0.310	This unit was installed below the PCC layer into the subgrade.
	5	0.386	
	6	0.461	
	7	0.535	
	8	0.611	
	9	0.764	
	10	0.918	
	11	1.069	
	12	1.200	
	13	1.375	
	14	1.523	
	15	1.677	
	16	1.827	
	17	1.981	
	18	2.129	

Table 5. Location of Electrodes of the Resistivity Probe

Connector Pin Number	Electrode Number	Depth from Pavement Surface (m)
36	1	0.334
35	2	0.385
34	3	0.435
33	4	0.484
32	5	0.535
31	6	0.585
30	7	0.636
29	8	0.686
28	9	0.736
27	10	0.787
26	11	0.837
25	12	0.887
24	13	0.938
23	14	0.990
22	15	1.040
21	16	1.090
20	17	1.140
19	18	1.192
18	19	1.242
17	20	1.293
16	21	1.345
15	22	1.394
14	23	1.444
13	24	1.495
12	25	1.545
11	26	1.595
10	27	1.647
9	28	1.698
8	29	1.750
7	30	1.800
6	31	1.850
5	32	1.901
4	33	1.951
3	34	2.001
2	35	2.052
1	36	2.103

Table 6. TDR, Field, and Laboratory Moisture Content During Installation

Sensor Number	Sensor Depth (m)	Layer	TDR Moisture Content (by wt)*	Field Moisture Content (by wt)*	Lab Moisture Content (by wt)*
36A01	0.400	Base	5.10%	5.86%	5.00%
36A02	0.546		7.48%	5.78%	6.00%
36A03	0.699	Subgrade	6.67%	4.53%	6.00%
36A04	0.838		6.94%	7.38%	6.00%
36A05	0.991		6.41%	16.17%	7.00%
36A06	1.092		7.48%	18.62%	8.00%
36A07	1.289		6.14%	8.32%	8.00%
36A08	1.461		7.76%	7.54%	7.00%
36A09	1.778		8.31%	11.67%	12.00%
36A10	2.032		12.97%	21.60%	22.00%

* Note: Raw data given in Appendix C

Site Repair and Cleanup

The instrumentation hole was repaired by reinstalling the 457 mm square portland cement block. Some juggling was required to get the block level with the existing pavement surface. A minor chip occurred at the corner of the block during the leveling process. Once the block was leveled it was removed from the hole and the edge of the hole was beaded with Dow Corning 890 SL joint sealant to retain the Rezi-weld epoxy used to reattach the block to the existing structure. Two 567-gram tubes of Rezi-weld epoxy were used in the block installation. The weight of the state dump truck, which slowly moved back and forth over the block, was used to firmly seat the block into the hole.

The trench for the cabling from the instrumentation hole to the edge of pavement was leveled with crushed gravel to the existing bottom of the paved layer and a cold mix was compacted to the level of the existing surface. The remainder of the trench was filled with native material and compacted, followed by a cleanup of loose material from the paved area. Traffic control was removed at 1800 hours and the lane reopened to traffic. During the next day the instrument hole and edge of the trench were sealed using Corning 890 SL crack sealing compound. Removal of the portland cement trench material and other disposable items were handled by the NYSDOT district personnel.

Patch/Repair Area Assessment

When the site was visited on December 30, 1993 two months after installation, the instrumentation hole patch was checked. There was some settlement in the patched areas and the sealant around the instrument hole block did not hold properly. The block area was monitored for resealing, weather permitting. Over time, a break occurred in the saw cut portion on the south side of the asphalt trench area. This required extensive patching to retain pavement integrity at this location.

III. Initial Data Collection

The second day activities included initial data collection on the site and checks on functioning of installed equipment. This consisted of examination of the data collected over the day by the onsite datalogger, data collection and check of the mobile CR10 datalogger, deflection testing, and elevation survey.

Air Temperature, Subsurface Temperature, Rain-fall Data

The air temperature, pavement subsurface temperature profile, and rainfall data, collected on October 28 by the CR10 datalogger, were examined. The equipment and datalogger appeared to be functioning properly. The battery voltages were checked and found to be acceptable.

The data collected for October 28, 1993 was not sufficient to show change in temperatures. This was due to the fact that the onsite.dld program, that was downloaded to the datalogger, only records hourly averages (only field 5 data collected). The d_onsite.dld, which stores data every minute, should have been used to collect the data.

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

TDR Measurements

TDR data were collected using the mobile system provided by FHWA. The mobile system contains a CR10 datalogger, battery pack, two TDR multiplexers, and a resistance multiplexer circuit board. Version 1.0 of the MOBILE program was used to collect and record the TDR wave form traced for each sensor.

Figures D-1 and D-2 show the initial TDR wave form traces collected with the MOBILE data acquisition system for all 10 sensors. The figures indicate that the multiplexers of the mobile system and TDR sensors were working properly.

Resistance Measurement Data

Resistance data were collected in two modes, automated and manual. The MOBILE data acquisition system automatically performs two point contact resistance measurements and stores the values in terms of millivolts between adjacent electrodes. Figure D-3 shows pavement depth versus measured voltage produced by the MOBILE system.

Manual contact resistance measurements were performed using a Simpson Model 420d function generator and Fluke digital multimeters, to measure voltage and amperage. The measured contact resistance data are plotted in Figure D-4, shown in Appendix D, along with Table D-1 which shows the raw data for the 2-point resistance. No four-point resistivity test was done because the required test equipment was not available at the time of installation.

Comparison between Figure D-3 (contact resistance results from automated mode) and Figure D-4 (contact resistance results from manual mode) indicates that there is a suspected problem with either the mobile system or the manual test setup. A comparison of subsequent data sets indicated a problem existed with the manual data (poor match).

Deflection Measurement Data

Deflection measurements followed procedures described in the "LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines". During the installation, problems were detected with the buffers on the FWD test unit. Assistance was provided by the Region 9 Residency to repair (weld) the buffer stem so testing could continue. The analysis results from the FWDCHECK program from the day of installation and the following day are presented in Appendix D. Since then, twenty one more measurements have been collected with the FWD, the first on February 15, 1994 then on March 8, March 28, April 19, May 10, June 7, June 28, July 29, August 23, September 27, October 25, November 22, December 20, 1994, then on January 31, 1995, February 28, March 13, March 27, April 10, April 24, May 23, and the twenty first time on June 20, 1995.

Longitudinal Profile Data

According to the guidelines, since this is in a frost area, the survey should be performed on five different occasions; one survey during the middle of each season and one survey during the late winter period (fully frozen condition). Five surveys in total have been performed on this site, three times during 1994 and two during 1995. During 1994, the first survey was performed during the fully frozen condition (March 18, 1994), the second in the spring season (April 18, 1994), and the third in the fall season (October 26, 1994). During 1995, the first survey was performed in the winter season (January 11, 1995) and the second in the spring season (April 18, 1995). In the last two of 1994 and the last one of 1995, three sets of data have been collected on the same day, as required by the guidelines for PCC pavements.

Elevation Surveys

One set of the surface elevation survey was performed following the guidelines. It was assumed that the elevation at the top of the piezometer pipe was 1.000 meters. The survey was conducted on October 28, 1993, the day after the installation, and the results are presented in Appendix D. Since then, nine more sets of the surface elevation survey have been performed, the first on February 15, 1994 then on April 19, July 29, August 23, October 25, 1994, then on January 31, 1995, February 28, May 23, and the ninth time on June 20, 1995.

Water Depth

A check of the piezometer indicated that there was no water present.

IV. Summary

The installation of the seasonal monitoring instrumentation at the GPS site 364018 near Oneonta, NY was completed on October 27, 1993. A check of the equipment and initial data collection was completed on October 28, 1993. The instrumentation, permanently installed at the site, were:

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

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

The test section is on eastbound Interstate 88, approximately 3.2 kilometers east of Oneonta city limits. The section is on a divided highway consisting of two 3.7 m wide travel lanes in each direction with a 3.4 m wide outside and 1.2 m wide inside paved shoulders. The pavement structure is a 239 mm Jointed Reinforced Concrete Pavement (JRCP) with 12.16 m slab spacing. This resides on a coarse grained silty gravel with sand over a sand, silt, clay with occassional gravel.

All instrumentation was checked prior to installation at the PMSL facility in Amherst, NY. These initial checks indicated that the instrumentation was within specifications, as required for the seasonal monitoring program. Operational checks during installation and the following day indicated that all instrumentation was functioning properly.

The installation generally went as expected except for a number of delays that extended the installation beyond the day 1 target completion time of 1530 hours. In particular, a problem with the buffers on FWD 058 delayed the startup at the instrumentation hole. The saw cut operation was also delayed as the operator showed up at the wrong location. Otherwise the installation went fairly smooth.

The removal/replacement of the material for the instrumentation hole went very well, with the material being well consolidated around the instrumentation and the block level with the existing pavement surface at completion. A slight chip in the corner of the block resulted when the block was lowered into the instrument hole. This was patched during the installation and should have no effect on pavement performance. The material retained for laboratory moisture determination was dropped off at the NYSDOT Soil Mechanics Bureau. The moisture determination comparison between the TDR method and the field and lab moisture indicated comparable accept for sensors 5 and 6 field gravemetric results and 9 and 10 TDR results.

The ongoing monitoring of this section, except for problems encountered due to weather and technical difficulties with the FWD, has gone fairly well.

APPENDIX A

Test Section Background Information

Appendix A contains the following supporting information:

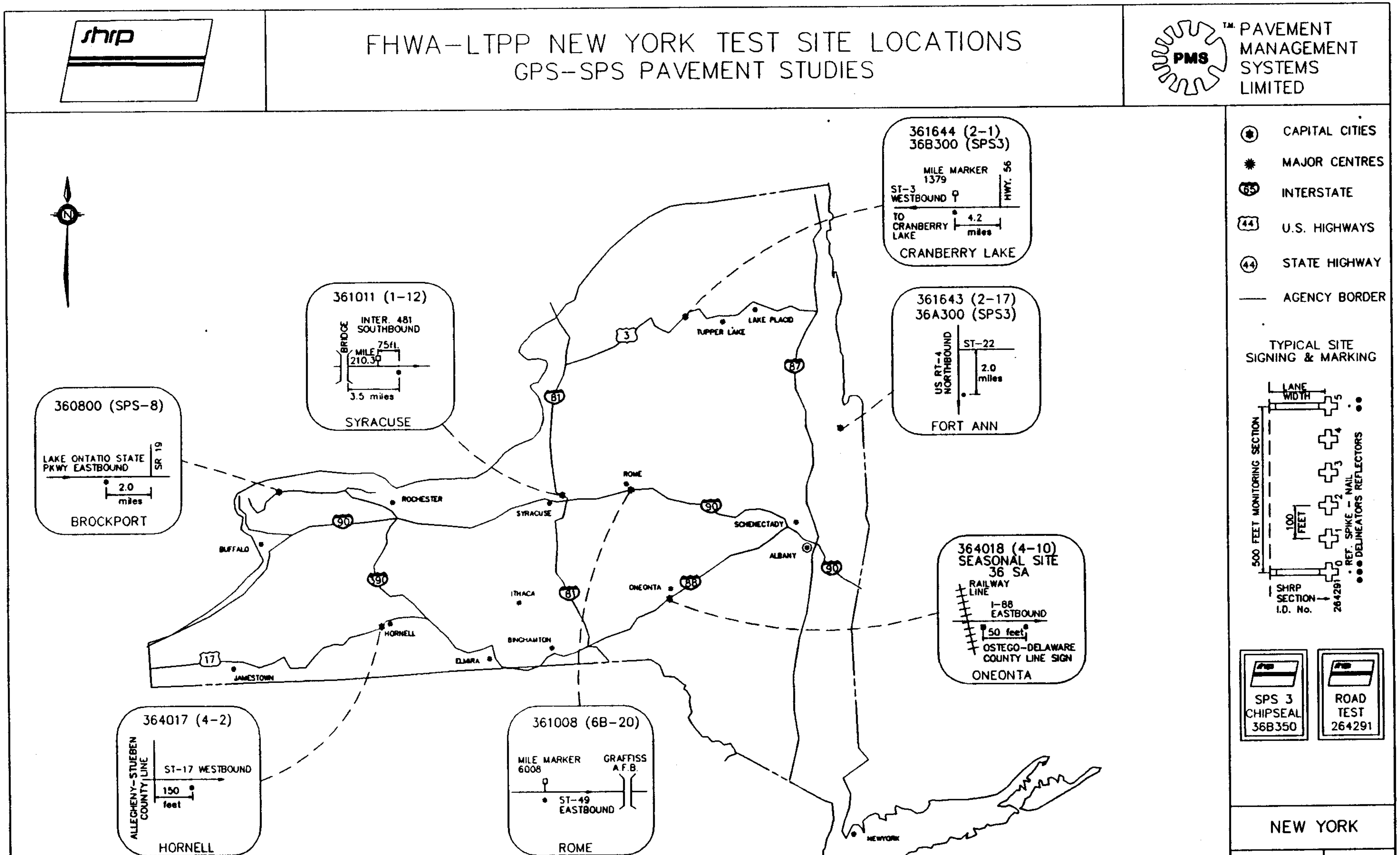


FIGURE A-1 SITE LOCATION MAP - SECTION 364018

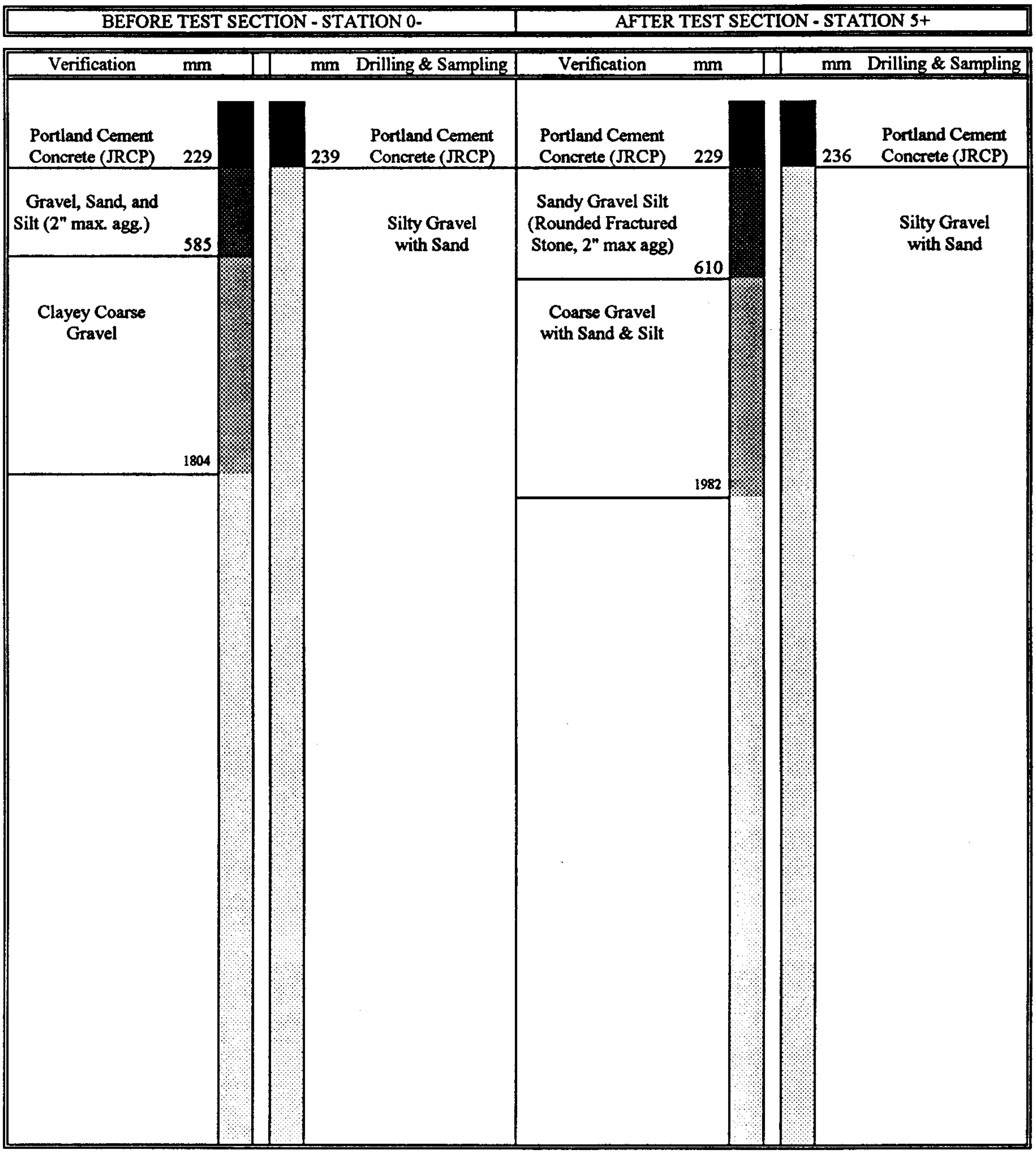


Figure A-2. Profile of Pavement Structure

Table A-1. Site Performance Summary

Distress and Profile Summary		
Distress Summary 1990	Profile Summary	
	Date (mm-dd-yy)	IRI (in/mi)
Low Sev. Long. Cracks - 19.42 ft.	08-24-89	112.63
Low Sev. Trans. Cracks - 2 @ 13.28 ft.	11-02-90	109.07
Spalled Trans. Joints - 3 @ 7.15 ft.	07-29-91	109.52
Low Sev. AC Patch - 1 @ 8.18 sq. ft.	07-10-92	106.12
	08-04-93	117.44

Falling Weight Deflectometer Data Summary

Date	Mean Value for Drop HT 2 (mils)					
	Sensor 1	Sensor 1 std. dev.	Sensor 7	Sensor 7 std. dev.	MeanTemp D1 (F)	Min/Max TempD1(F)
07-27-89	3.32	0.17	1.46	0.14	94	83/102

	Effective Thickness	Thickness std dev	Volumetric K	K std dev	Test Pit K 1	Test Pit K 2
07-27-89	9.45	0.30	310	22	297	286

Table A-2. Uniformity Survey Results

Seasonal Uniformity Survey					Falling Weight Deflectometer			
Site Number: 364018					Data Collection and			
Date Surveyed: July 27, 1989					Processing Summary			
Section Interval (ft)	Mean Deflection Values for HT 2 (mils) - Corrected							
	Sensor 1	Sensor 1 std dev	Sensor 7	Sensor 7 std dev	Volum K	Volum K std dev	Effective Thick	Thick std dev
-50					297		9.13	
70 to 518	3.32	0.17	1.46	0.14	310	22	9.45	0.30
564					286		9.13	

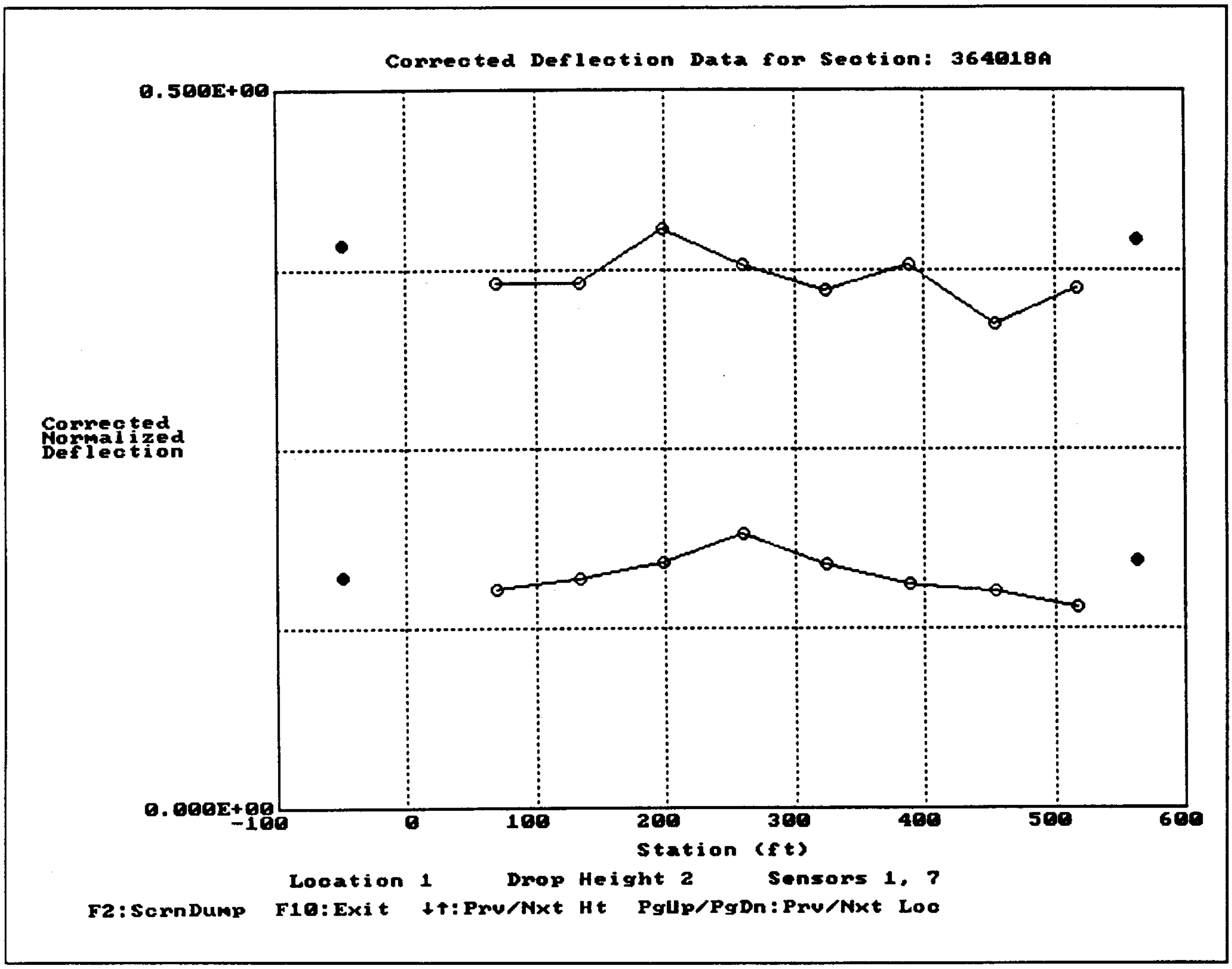


Figure A-3. Deflection Profile from FWDCHECK
(Test Date July 27, 1989)

Table A-3. Volumetric K and Effective Thickness from FWDCHECK
(Test Date July 27, 1989)

Rigid Pavement Thickness Statistics - 364018A - Drop Height 2			
Subsection	Station	Volumetric K	Effective Thickness
TP	-50	297	9.13
1	70	320	9.50
	134	314	9.50
	198	288	9.13
	260	274	9.69
	324	300	9.69
	388	313	9.13
	454	334	9.88
	518	340	9.13
TP	564	286	9.13
Subsection 1	Overall Mean	310	9.45
	Standard Deviation	22	0.30
	Coeff. of Variation	7.18%	3.14%

APPENDIX B

Supporting Site Visit and Installed Instrument Information

Appendix B contains the following supporting information:

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

TO: P. J. Mack, Technical Services Division, 7A-210
R. R. Church, Regional Director, Region 9
D. Harbuck, Region 9 Soils Liaison, 7-105
R. Mercer, Materials Engineer, Region 9
F. T. Moorhead, Regional Design Engineer, Region 9
R. Salankiewicz, Planning Group, Region 9
H. J. Reed, Resident Engineer, Otsego County, Region 9

FROM: R. J. Perry, Engineering R&D Bureau, 7A-600

SUBJECT: MEETING MINUTES

DATE: September 16, 1993

Attached for your information are the minutes of the meeting held on September 10, 1993 in Albany. The subject of this meeting was the proposed inclusion of the FHWA-LTPP-GPS (SHRP) site located on I-88 (Otsego County) in the seasonal monitoring program. The scope of this program and the responsibilities of all concerned parties were discussed.

If you have any questions concerning this matter, please contact Rick Morgan or Wes Yang of this office at (518) 457-5826.

RJP:RLM:jlc
Attachment

c: R. Dunn, Federal Highway Administration
G. Owens, Federal Highway Administration
W. Phang, PMS-NARO
B. Henderson, PMS-NARO

MINUTES OF SEPTEMBER 10, 1993 MEETING

TOPIC: SELECTION OF THE FHWA-LTPP-GPS SITE ON I-88, OTSEGO COUNTY, IN THE SEASONAL MONITORING PROGRAM

TTENDEES:

Brandt Henderson	SHRP-PMS-NARO
Bill Phang	SHRP-PMS-NARO
Debra Harbuck	Soils Bureau
Ronald Mercer	Region 9 Materials
Robert Salankiewicz	Region 9 Research Liaison
Howard Reed	Resident Engineer - Otsego Co.
Wes Yang	ER&DB
Rick Morgan	ER&DB

ISCUSSION:

1. Why I-88 was chosen as a test section of the program;
2. What the seasonal monitoring program entails; and
3. What each participating agencies' responsibilities are for installation and monitoring of the site.

MINUTES: Bill Phang began the meeting with a brief summary of the seasonal monitoring program and why the GPS site on I-88 was chosen:

I. I-88 was selected because:

   a. concrete pavement is not due for major rehab in near future;
   b. high water table; and
   c. 3-4' frost penetration

II. Testing cycle will be once a month for a year (except during spring-thaw period, then two times per month). A cycle will be done every other year. Testing to include:

   a. FWD measurements;
   b. Temperatures through the pavement structure to a depth six feet below the PCC pavement bottom;
   c. Subsurface moisture content using Time Domain Reflectometers (TDR's);
   d. Frost penetration using Resistivity Probes set at different depths through the pavement structure;
   e. Level of ground water using an open standpipe set twenty feet into pavement structure through outside shoulder;
   f. Profiles of the pavement surface using a temporary benchmark set as close as possible to the test section; and
   g. Air temperature and amount of precipitation.

Brandt Henderson then gave a more detailed description of the actual installation and test procedures and outlined the responsibilities of each participating agency:

I. FHWA Responsibilities:

a. Supply thermistor, TDR, and resistivity probes;
b. Supply rain gauge and air temperature probe; and
c. Assembly for groundwater observation well.

II. PMS–NARO Responsibilities:

a. Supply personnel and equipment for installation of probes;
b. Provide layout of FWD and survey testing patterns;
c. Supply an equipment cabinet; and
d. Performance of all testing.

III. NYSDOT Responsibilities:

a. Traffic control during installation and monthly testing;
b. Drill rig for placement of instruments and ground water observation well (10" & 6" auger);
c. Concrete saw to cut groove (9" depth) through pavement and shoulder for placement of cables from instruments to equipment cabinet;
d. Survey crew to reference permanent benchmark on groundwater observation well;
e. The following materials:

    1. Groundwater observation well cover assembly;
    2. 3 to 4 bags of Sakrete;
    3. 2 80 lb. bags of filter sand;
    4. 1 80 lb. bag of Bentonite;
    5. Generator with 2000 watt minimum capacity;
    6. Patching material for groove cut in pavement and shoulder;
    7. Joint sealant for sealing pavement core after it is replaced; and
    8. Material to repair underdrain that runs along pavement edge.

f. Maintenance of patching and sealing materials for the duration of monitoring program.

ENTATIVE SCHEDULE:

<u>Tuesday, Oct. 26</u>: Pre-installation meeting with all concerned parties at Otsego County Residency (exact time to be announced)

<u>Wednesday, Oct. 27</u>: Installation of all instruments (traffic control for entire day)

<u>Thursday, Oct. 28</u>: First set of tests (traffic control for entire day)

Table B-1. Air Temperature Thermistor Calibration

LTPP Seasonal Monitoring Study	State Code	[3 6]
Air Temperature Thermistor Calibration	Test Section Number	[4 0 1 8]

Before Operation Checks	Calibration Date mm-dd-yy	10-25-93
	Probe S/N	36AAT
	Operator	PZ + MZ

Mobile Datalogger (24 hour)			Water Room Temperature		Ice Bath 0 C (+/- 1 C)		Hot Water 50 C (+/-)		ok
Mean	Min.	Max.	Reading	Time	Reading	Time	Reading	Time	y/n
12.29	11.76	13.80	16.50	1225	0.000	1118	50.10	1316	y

Probe Accepted	PZ&MZ	(Initials)

Table B-2. MRC Probe Calibration

LTPP Seasonal Monitoring Study	State Code	[36]
MRC Probe Calibration	Test Section Number	[4018]

Before Operation Checks	Calibration Date mm-dd-yy	10-25-93
	Probe S/N	36AT
	Operator	PZ + MZ

	Mobile Datalogger (24 hour)			Water Room Temp Time 1201	Ice Bath 0 C(+/- 1 C) Time 1112	Hot Water 50 C (+/-) Time 1243	ok
No.	Mean	Min.	Max.	Reading	Reading	Reading	y/n
1	12.06	11.59	13.34	16.3	0.00	50.1	y
2	12.07	11.62	13.39	16.3	0.21	50.2	y
3	12.01	11.53	13.36	16.2	0.21	49.6	y
4	11.96	11.41	13.51	15.9	0.95	49.7	y
5	12.05	11.56	13.48	16.1	0.26	50.6	y
6	12.02	11.56	13.39	16.3	0.47	50.2	y
7	12.10	11.64	13.42	16.4	0.55	49.9	y
8	12.05	11.59	13.36	16.4	0.36	49.8	y
9	12.08	11.64	13.36	16.5	0.77	50.2	y
10	11.98	11.56	13.19	16.7	0.98	50.3	y
11	12.08	11.67	13.28	16.8	0.58	50.6	y
12	12.04	11.64	13.19	16.7	0.51	50.5	y
13	12.08	11.70	13.19	16.8	0.29	49.7	y
14	12.04	11.67	13.11	16.8	0.51	49.7	y
15	12.08	11.73	13.08	16.8	0.58	49.9	y
16	12.15	11.82	13.05	16.8	0.25	49.8	y
17	12.21	11.88	13.05	16.7	0.21	49.8	y
18	12.29	12.02	12.94	16.8	0.00	49.9	y

Probe Accepted:	MZ	(Initials)
Probe Length:	1.853	(meters)

Thermistor distance from top of probe:				(meters)					
4	.024	7	.249	10	.632	13	1.089	16	1.541
5	.100	8	.325	11	.783	14	1.237	17	1.695
6	.175	9	.478	12	.932	15	1.391	18	1.843

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

Unit	Channel No.	Distance from Top of Unit(m)	Remarks
1	1	.013	0.3302 m long by 63.5 mm stainless steel probe installed in the PCC layer
	2	.165	
	3	.318	
2	4	.024	1.853 m long by 25.4 mm PVC tube installed in the base and subgrade.
	5	.100	
	6	.175	
	7	.249	
	8	.325	
	9	.478	
	10	.632	
	11	.783	
	12	.932	
	13	1.089	
	14	1.237	
	15	1.391	
	16	1.541	
	17	1.695	
	18	1.843	

Table B-4. Resistivity Probe and Sensor Spacing

Connector Pin No.	Electrode Number	Continuity x	Measure-ment	Spacing (mm)			Dist. from Top (m)
				Line 1	Line 2	Avg.	
36	1	x	Top-1	28	30	29.0	0.0290
35	2	x	1-2	50	52	51.0	0.0800
34	3	x	2-3	51	49	50.0	0.1300
33	4	x	3-4	50	48	49.0	0.1790
32	5	x	4-5	51	50	50.5	0.2295
31	6	x	5-6	50	50	50.0	0.2795
30	7	x	6-7	52	50	51.0	0.3305
29	8	x	7-8	50	50	50.0	0.3805
28	9	x	8-9	50	50	50.0	0.4305
27	10	x	9-10	52	51	51.5	0.4820
26	11	x	10-11	49	50	49.5	0.5315
25	12	x	11-12	50	51	50.5	0.5820
24	13	x	12-13	52	50	51.0	0.6330
23	14	x	13-14	51	53	52.0	0.6850
22	15	x	14-15	50	49	49.5	0.7345
21	16	x	15-16	50	50	50.0	0.7845
20	17	x	16-17	51	50	50.5	0.8350
19	18	x	17-18	52	52	52.0	0.8870
18	19	x	18-19	49	50	49.5	0.9365
17	20	x	19-20	52	50	51.0	0.9875
16	21	x	20-21	53	52	52.5	1.0400
15	22	x	21-22	48	49	48.5	1.0885
14	23	x	22-23	50	50	50.0	1.1385
13	24	x	23-24	50	53	51.5	1.1900
12	25	x	24-25	50	49	49.5	1.2395
11	26	x	25-26	50	51	50.5	1.2900
10	27	x	26-27	51	52	51.5	1.3415
9	28	x	27-28	51	52	51.5	1.3930
8	29	x	28-29	51	52	51.5	1.4445
7	30	x	29-30	51	49	50.0	1.4945
6	31	x	30-31	50	51	50.5	1.5450
5	32	x	31-32	50	52	51.0	1.5960
4	33	x	32-33	49	50	49.5	1.6455
3	34	x	33-34	50	51	50.5	1.6960
2	35	x	34-35	50	51	50.5	1.7465
1	36	x	35-36	51	51	51.0	1.7975
			36-End	24	22	23.0	1.8205

Table B-5. Contact Resistance Calibration

LTPP Seasonal Monitoring Study					State Code		[36]
Data Sheet R1							
Contact Resistance Measurements					Test Section Number		[4018]
1. Date (Month - Day - Year)							[10-26-93]
2. Time Measurements Began (Military)							[1115]
3. Comments							In Salt Water Prior to Installation
Test Position	Connections		Voltage (ACV)		Current (ACA)		Notes
	I V	I V	Range Setting	Reading	Range Setting	Reading	
1	1	2	mV	215.1	uA	209.0	
2	3	2	mV	219.2	uA	205.4	
3	3	4	mV	220.9	uA	202.8	
4	5	4	mV	226.9	uA	194.2	
5	5	6	mV	222.0	uA	201.3	
6	7	6	mV	219.3	uA	204.7	
7	7	8	mV	219.4	uA	204.8	
8	9	8	mV	220.4	uA	203.3	
9	9	10	mV	222.1	uA	200.9	
10	11	10	mV	220.6	uA	203.2	
11	11	12	mV	221.7	uA	201.3	
12	13	12	mV	224.2	uA	197.8	
13	13	14	mV	226.3	uA	194.4	
14	15	14	mV	222.6	uA	200.3	
15	15	16	mV	220.5	uA	203.2	
16	17	16	mV	223.6	uA	198.6	
17	17	18	mV	224.0	uA	198.0	
18	19	18	mV	226.5	uA	194.1	
19	19	20	mV	227.1	uA	193.5	
20	21	20	mV	226.8	uA	193.5	
21	21	22	mV	227.4	uA	193.0	
22	23	22	mV	226.4	uA	194.6	
23	23	24	mV	226.9	uA	193.7	
24	25	24	mV	227.7	uA	192.8	
25	25	26	mV	224.8	uA	197.6	
26	27	26	mV	225.4	uA	196.5	
27	27	28	mV	224.7	uA	197.7	
28	29	28	mV	227.1	uA	195.0	
29	29	30	mV	219	uA	205.9	
30	31	30	mV	219.8	uA	204.8	
31	31	32	mV	218.8	uA	206.6	
32	33	32	mV	215.1	uA	211.1	
33	33	34	mV	214.4	uA	212.0	
34	35	34	mV	213.6	uA	211.7	
35	35	36	mV	213.1	uA	213.8	
36	37	38	mV		uA		
37	38	39	mV		uA		
38	39	40	mV		uA		
Preparer:	Michael Zawisa				Employer:	PMSL	

Table B-6. TDR Probes Calibration

LTPP Seasonal Monitoring Study	State Code	[36]
TDR Probes	Test Section Number	[4018]

Before Operation Checks	M.Z.	Initial	Calibration Date (mm-dd-yy)	10-25-93
			Seasonal Site	36SA

No.	Probe (S/N)	Resistance (ohms) Core	Resistance (ohms) Shield	Probe Shorted Begin Length	Probe Shorted End Length	Air Begin Length	Alcohol Begin Length	Water Begin Length
1	36A01	0.900	0.800	16.400	16.540	16.430	16.440	16.440
2	36A02	0.800	0.800	16.389	16.529	16.429	16.429	16.429
3	36A03	0.800	0.800	16.400	16.580	16.430	16.440	16.440
4	36A04	0.900	0.800	16.400	16.520	16.410	16.440	16.440
5	36A05	1.000	1.100	16.400	16.540	16.410	16.430	16.430
6	36A06	1.000	1.000	16.389	16.549	16.409	16.419	16.419
7	36A07	0.900	0.900	16.370	16.500	16.400	16.410	16.410
8	36A08	0.700	0.400	16.419	16.529	16.429	16.449	16.449
9	36A09	0.600	3.400	16.409	16.589	16.439	16.449	16.449
10	36A10	0.700	0.900	16.419	16.589	16.439	16.459	16.459

NOTE: Record lengths from TDR

Calculation of Dielectric Constant

Probe Length .203 m

V_p Setting .99 V_p

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

No.	Air TDR Length	Air Dielectric Constant	Air In Spec. (?)	Alcohol TDR Length	Alcohol Dielectric Constant	Alcohol In Spec. (?)	Water TDR Length	Water Dielectric Constant	Water In Spec. (?)
1	.18	0.80	y	1.18	34.47	y	1.87	86.58	y
2	.17	0.72	y	1.19	35.06	y	1.88	87.51	y
3	.18	0.80	y	1.20	35.65	y	1.88	87.51	y
4	.21	1.09	y	1.17	33.89	y	1.86	85.66	y
5	.20	0.99	y	1.22	36.85	y	1.87	86.58	y
6	.18	0.80	y	1.19	35.06	y	1.90	89.38	y
7	.19	0.89	y	1.20	35.65	y	1.89	88.44	y
8	.20	0.99	y	1.23	37.46	y	1.88	87.51	y
9	.19	0.89	y	1.18	34.47	y	1.88	87.51	y
10	.21	1.09	y	1.21	36.25	y	1.87	86.58	y

LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

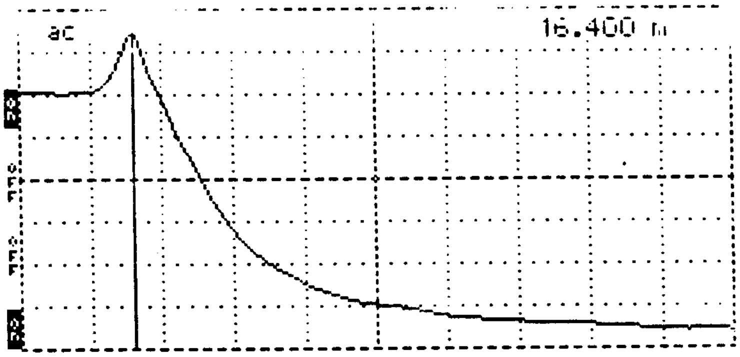
efore Operation Checks

- Calibration Date 10/25/93
- Probe S/N 36A01

Probe Number 1

DR Trace 1 - Beginning Probe Shorted

rsor .... 16.400 m
tance/Div..... .25 m/div
rtical Scale.... 154 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

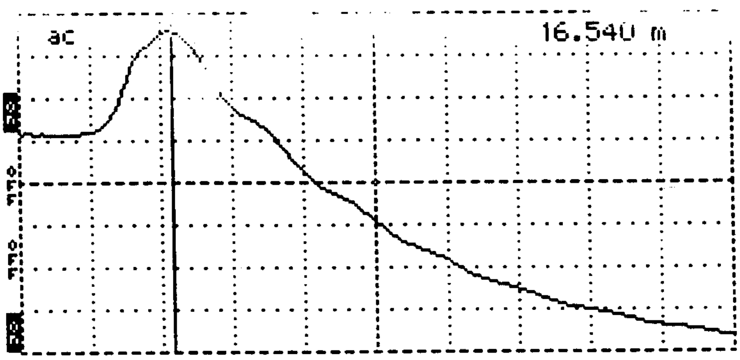


Tektronix 1502B TDR
Date 10/25/93
Cable 1
Notes Short CB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

rsor .... 16.540 m
tance/Div..... .25 m/div
rtical Scale.... 163 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

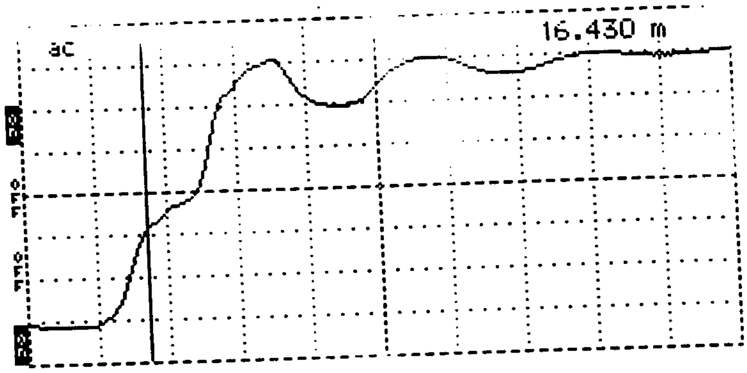


Tektronix 1502B TDR
Date 10/25/93
Cable 1
Notes Shorted

Input Trace
Stored Trace
Difference Trace

Figure B-1. TDR Traces Obtained During Calibration ace Number 3 - Probe in Air

rsor .... 16.430 m
tance/Div..... .25 m/div
rtical Scale.... 145 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 1
Notes Air

Input Trace
Stored Trace
Difference Trace

race Number 4 - Probe in Alcohol

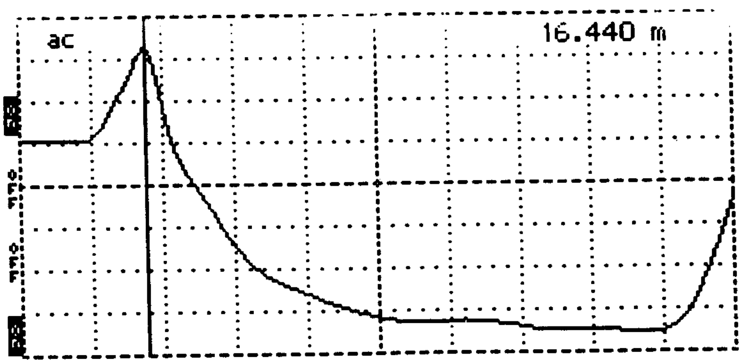
ır .... 16.440 m
ance/Div..... .25 m/div
tical Scale.... 48.6 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac

Tektronix 1502B TDR
Date 10/25/93
Cable 1
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace Number 5 - Probe in Water

rsor .... 16.440 m
tance/Div..... .25 m/div
rtical Scale.... 70.6 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 1
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

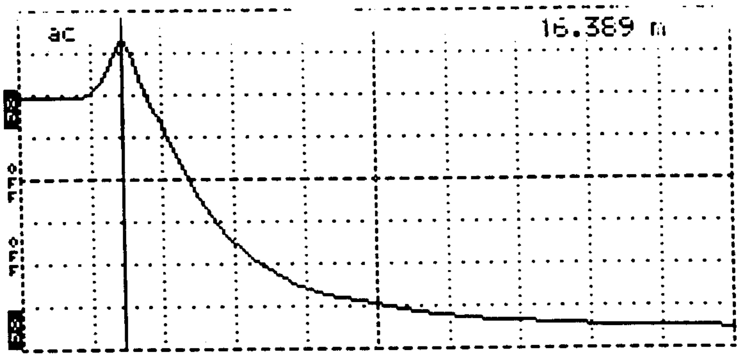
LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

Before Operation Checks
- Calibration Date 10/25/93
- Probe S/N 36A02

Probe Number 2

TDR Trace 1 - Beginning Probe Shorted

rsor .... 16.389 m
tance/Div..... .25 m/div
rtical Scale.... 158 mρ/div
 .... 0.99
se Filter...... 1 avg
wer........... ac

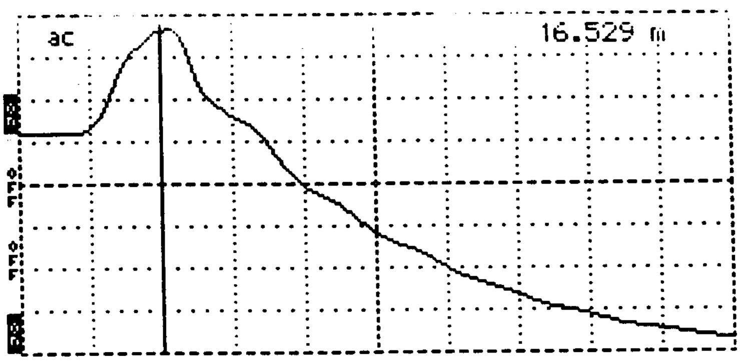


Tektronix 1502B TDR
Date 10/22/93
Cable 2
Notes Short CB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

ursor .... 16.529 m
istance/Div..... .25 m/div
ertical Scale.... 163 mρ/div
P 0.99
oise Filter...... 1 avg
ower........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 2
Notes Short End

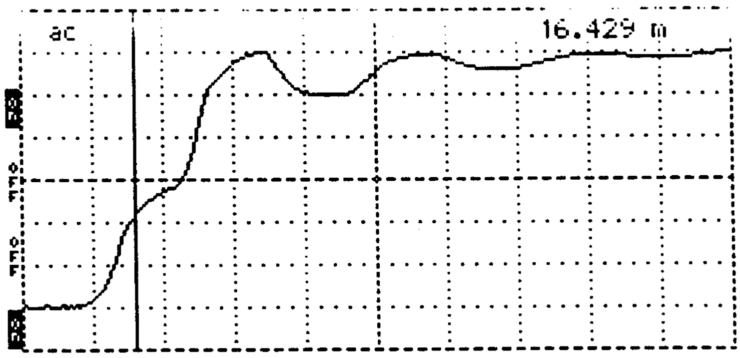
Input Trace
Stored Trace
Difference Trace

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

Probe Number 2 (cont.)

race Number 3 - Probe in Air

rsor .... 16.429 m
stance/Div..... .25 m/div
rtical Scale.... 149 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac

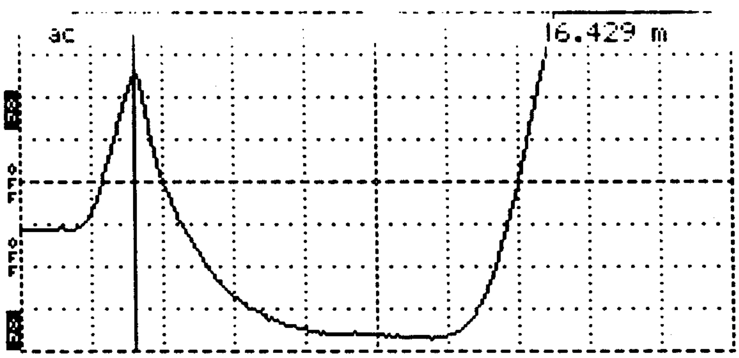


Tektronix 1502B TDR
Date 10/22/93
Cable 2
Notes Air

Input Trace
Stored Trace
Difference Trace

Trace Number 4 - Probe in Alcohol

..or .... 16.429 m
..nce/Div..... .25 m/div
rtical Scale.... 51.5 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

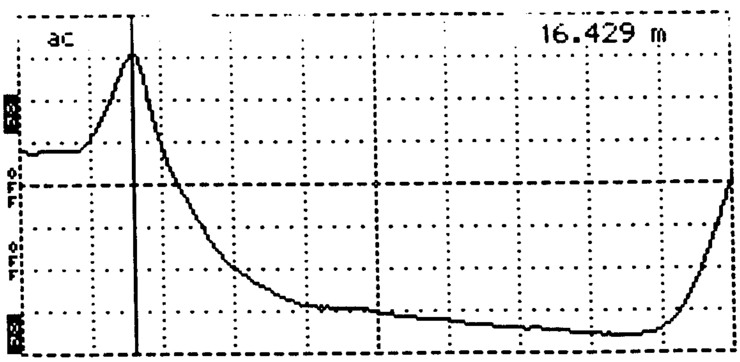


Tektronix 1502B TDR
Date 10/22/93
Cable 2
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace Number 5 - Probe in Water

rsor .... 16.429 m
tance/Div..... .25 m/div
rtical Scale.... 74.8 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 2
Notes H2O

Input Trace
Stored Trace
Difference Trace

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

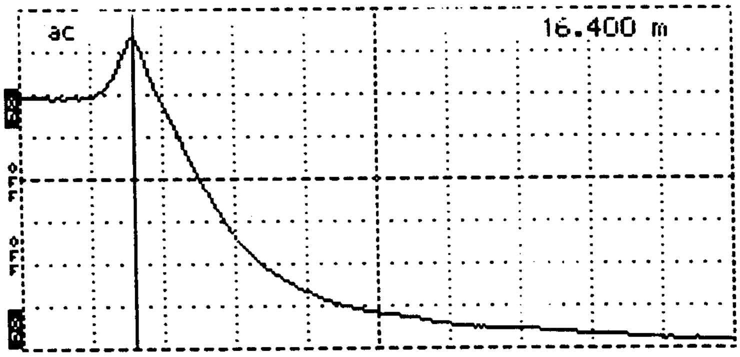
LTPP Seasonal Monitoring Study	State Code	[36]
TDR Probe Calibration	Test Section Number	[1048]

Before Operation Checks - Calibration Date 10/25/93
- Probe S/N 36A03

Probe Number 3

TDR Trace 1 - Beginning Probe Shorted

sor .... 16.400 m
tance/Div ..... .25 m/div
rtical Scale.... 149 mρ/div
.... 0.99
se Filter ...... 1 avg
wer .... ac

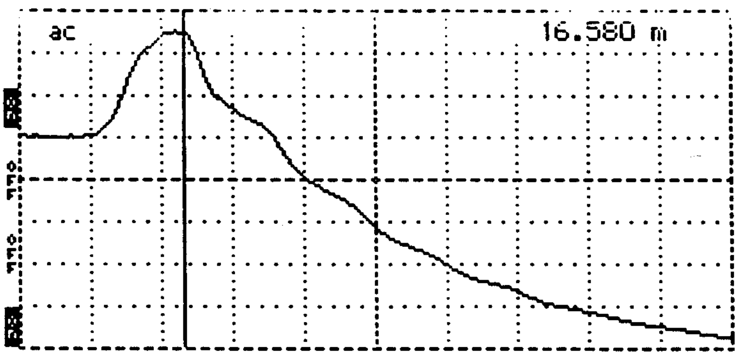


Tektronix 1502B TDR
Date 10/25/93
Cable 3
Notes Short CB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

or .... 16.580 m
ance/Div ..... .25 m/div
ical Scale.... 163 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac



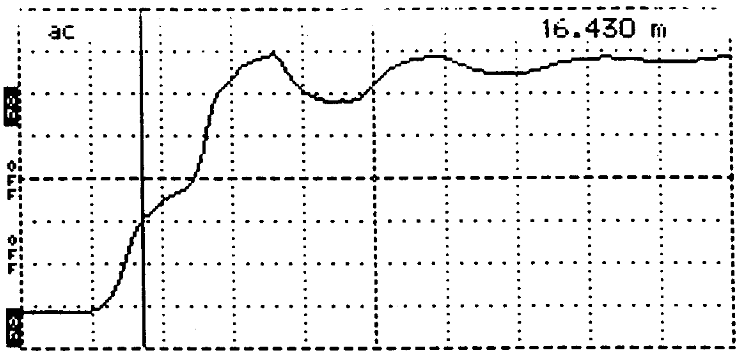
Tektronix 1502B TDR
Date 10/25/93
Cable 3
Notes Short end

Input Trace
Stored Trace
Difference Trace

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

race Number 3 - Probe in Air

rsor .... 16.430 m
stance/Div..... .25 m/div
rtical Scale.... 149 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac

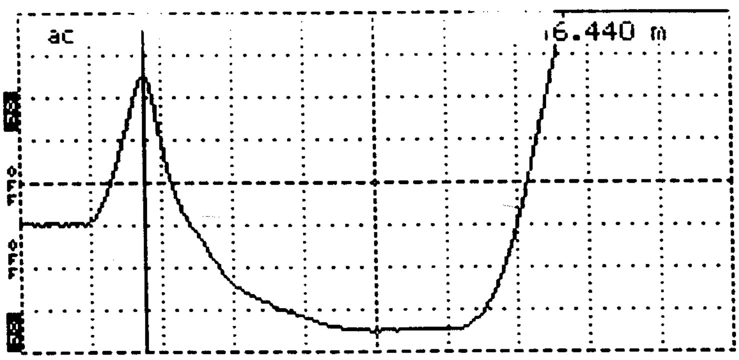


Tektronix 1502B TDR
Date 10/25/93
Cable 3
Notes Air

Input Trace
Stored Trace
Difference Trace

race Number 4 - Probe in Alcohol

'or .... 16.440 m
.ance/Div..... .25 m/div
tical Scale.... 54.5 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac

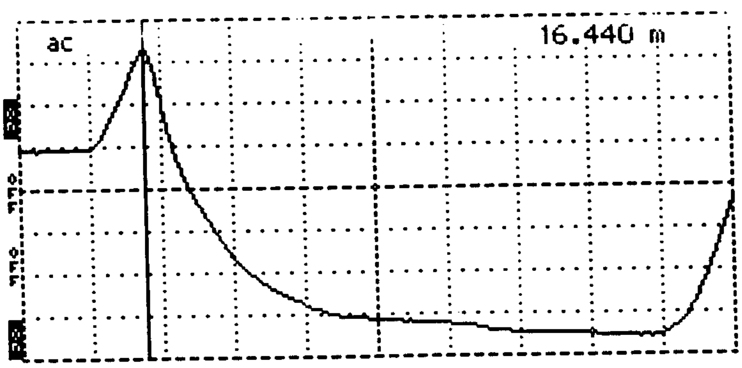


Tektronix 1502B TDR
Date 10/25/93
Cable 3
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace Number 5 - Probe in Water

rsor .... 16.440 m
tance/Div..... .25 m/div
rtical Scale.... 72.7 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 3
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

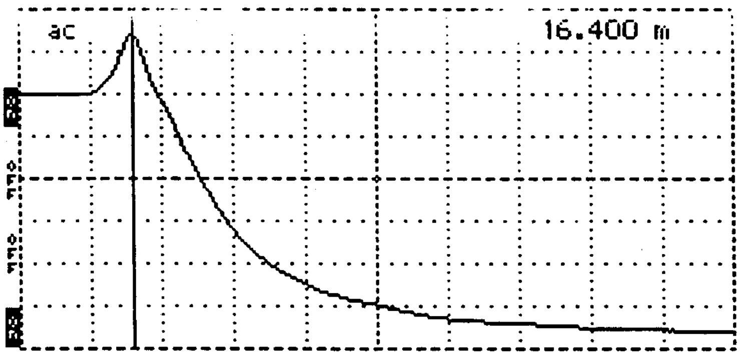
LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

efore Operation Checks
- Calibration Date 10/25/93
- Probe S/N 36A04

Probe Number 4

DR Trace 1 - Beginning Probe Shorted

sor .... 16.400 m
tance/Div..... .25 m/div
tical Scale.... 154 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac

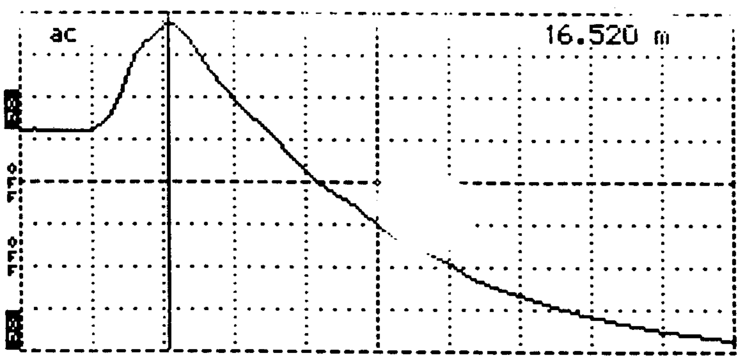


Tektronix 1502B TDR
Date 10/25/93
Cable 4
Notes ShortCB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

or .... 16.520 m
nce/Div..... .25 m/div
cal Scale.... 158 mρ/div
.... 0.99
Filter...... 1 avg
er........... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 4
Notes Shorted

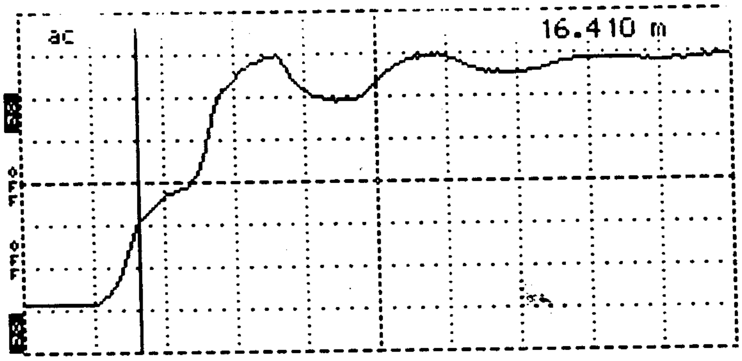
Input Trace
Stored Trace
Difference Trace

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

Probe Number 4 (cont.)

ace Number 3 - Probe in Air

r .... 16.410 m
nce/Div ..... .25 m/div
cal Scale.... 154 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac

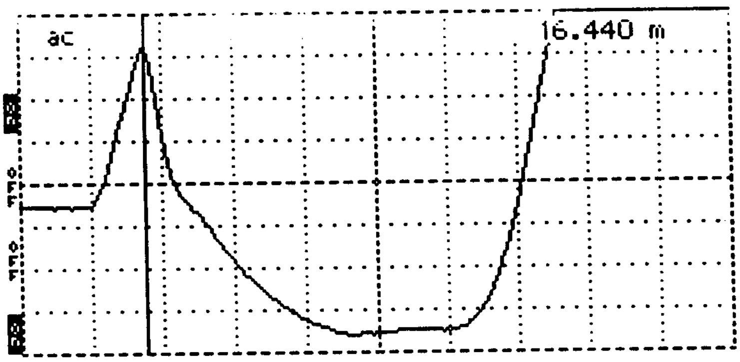


Tektronix 1502B TDR
Date 10/25/93
Cable 4
Notes Air

Input Trace
Stored Trace
Difference Trace

ace Number 4 - Probe in Alcohol

or .... 16.440 m
ance/Div ..... .25 m/div
ical Scale.... 45.9 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

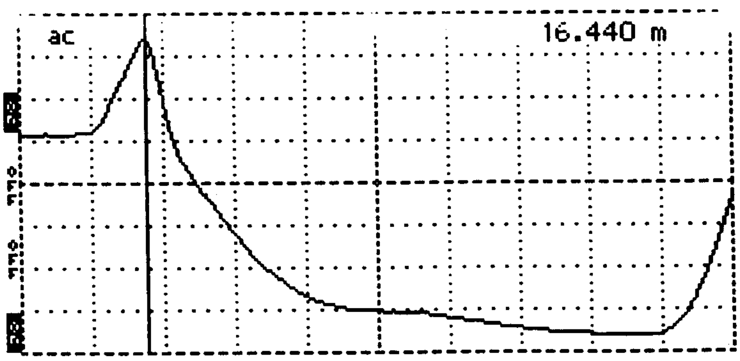


Tektronix 1502B TDR
Date 10/25/93
Cable 4
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

ace Number 5 - Probe in Water

r .... 16.440 m
ce/Div ..... .25 m/div
al Scale.... 68.6 mρ/div
.... 0.99
Filter ...... 1 avg
r .... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 4
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

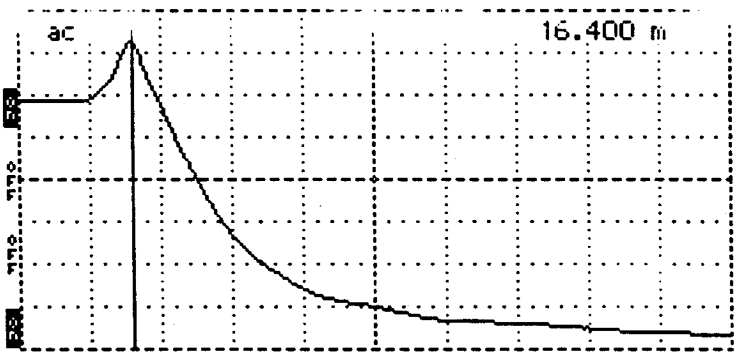
Before Operation Checks - Calibration Date 10/25/93

- Probe S/N 36A05

Probe Number 5

TDR Trace 1 - Beginning Probe Shorted

sor .... 16.400 m
ance/Div ..... .25 m/div
ical Scale.... 154 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

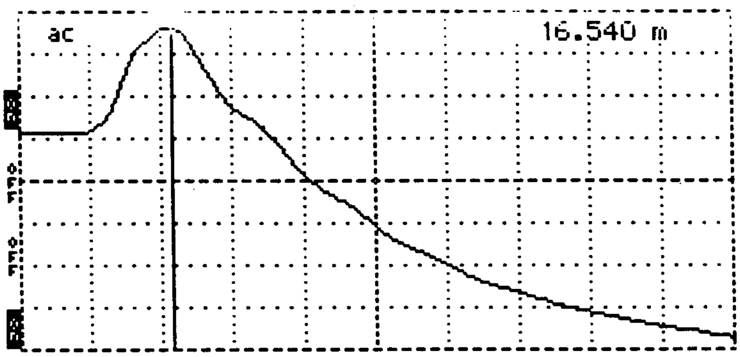


Tektronix 1502B TDR
Date 10/25/93
Cable 5
Notes Short Beg

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

rsor .... 16.540 m
tance/Div ..... .25 m/div
rtical Scale.... 158 mρ/div
.... 0.99
ise Filter ...... 1 avg
wer .... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 5
Notes Short End

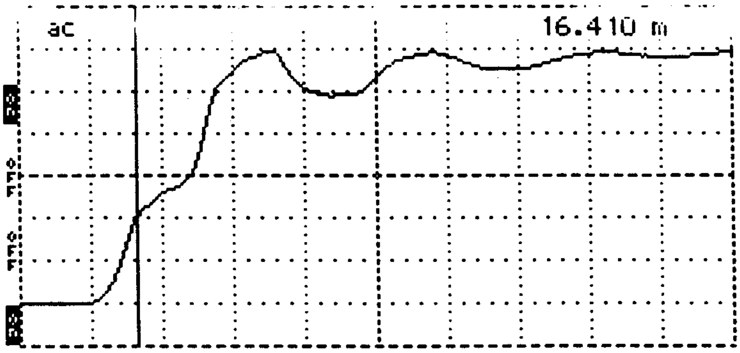
Input Trace
Stored Trace
Difference Trace

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

Probe Number 5 (cont.)

race Number 3 - Probe in Air

sor .... 16.410 m
ance/Div ..... .25 m/div
tical Scale.... 149 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac

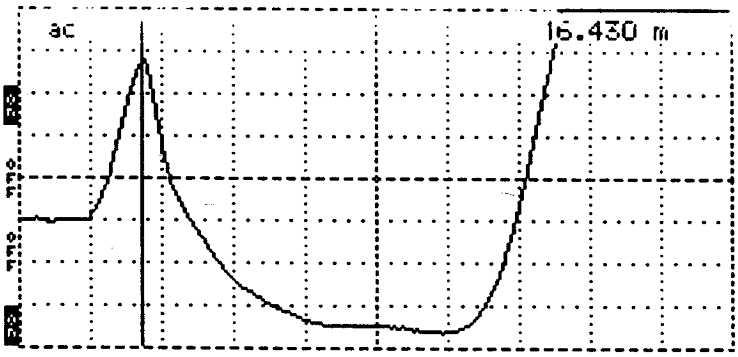


Tektronix 1502B TDR
Date 10/25/93
Cable 5
Notes Air

Input Trace
Stored Trace
Difference Trace

race Number 4 - Probe in Alcohol

sor .... 16.430 m
ance/Div ..... .25 m/div
rtical Scale.... 51.5 mρ/div
.... 0.99
ise Filter ...... 1 avg
wer .... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 5
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace Number 5 - Probe in Water

sor .... 16.430 m
tance/Div ..... .25 m/div
tical Scale.... 70.6 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... ac

Tektronix 1502B TDR
Date 10/25/93
Cable 5
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

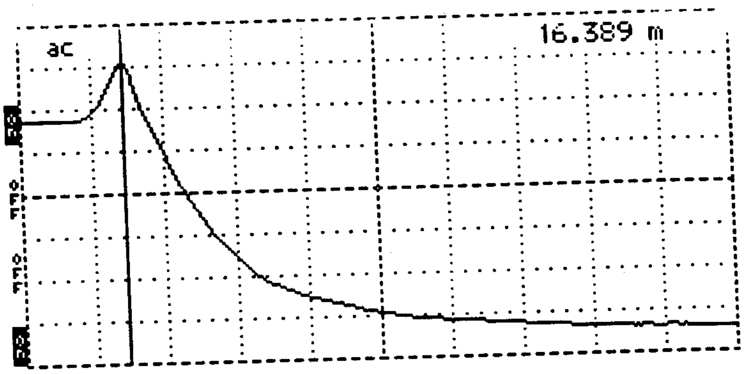
LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

Before Operation Checks
- Calibration Date 10/22/93
- Probe S/N 36A06

Probe Number 6

TDR Trace 1 - Beginning Probe Shorted

ursor .... 16.389 m
stance/Div..... .25 m/div
ertical Scale.... 167 mρ/div
P 0.99
oise Filter...... 1 avg
ower.......... ac

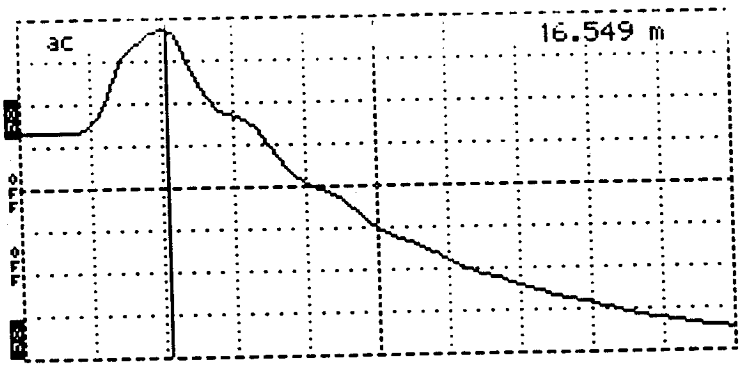


Tektronix 1502B TDR
Date 10/22/93
Cable 6
Notes Short CB

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

Trace Number 2 - Ending Probe Shorted

ursor .... 16.549 m
istance/Div..... .25 m/div
ertical Scale.... 167 mρ/div
P 0.99
oise Filter...... 1 avg
ower.......... ac



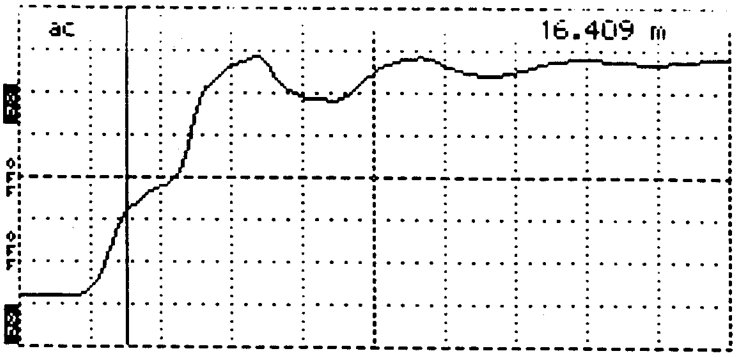
Tektronix 1502B TDR
Date 10/22/93
Cable 6
Notes Shortend

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

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

ace Number 3 - Probe in Air

or .... 16.409 m
ance/Div..... .25 m/div
ical Scale.... 158 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

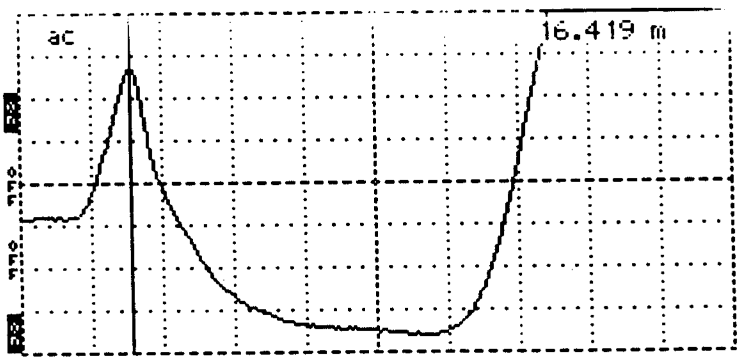


Tektronix 1502B TDR
Date 10/22/93
Cable 6
Notes Air

Input Trace
Stored Trace
Difference Trace

ace Number 4 - Probe in Alcohol

sor .... 16.419 m
ance/Div..... .25 m/div
ical Scale.... 51.5 mρ/div
.... 0.99
se Filter...... 1 avg
er........... ac

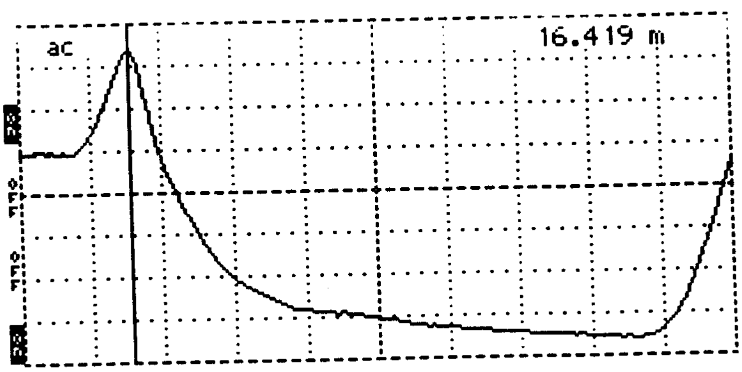


Tektronix 1502B TDR
Date 10/22/93
Cable 6
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

race Number 5 - Probe in Water

rsor .... 16.419 m
stance/Div..... .25 m/div
rtical Scale.... 72.7 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 6
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

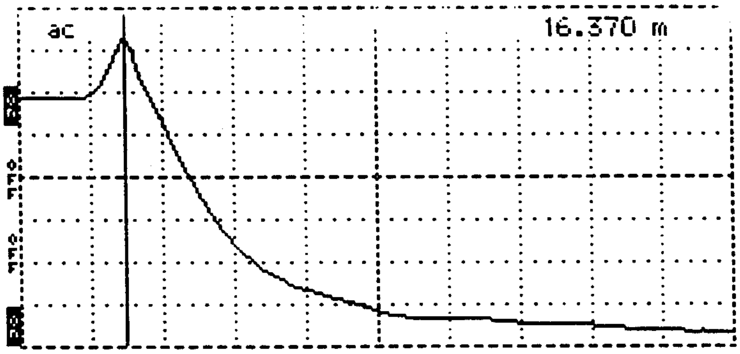
Before Operation Checks - Calibration Date 10/22/93

- Probe S/N 36AD7

Probe Number 7

TDR Trace 1 - Beginning Probe Shorted

or .... 16.370 m
nce/Div..... .25 m/div
cal Scale.... 154 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

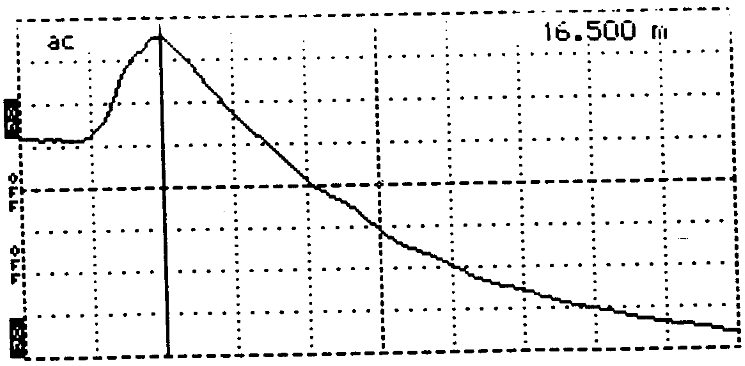


Tektronix 1502B TDR
Date 10/25/93
Cable 7
Notes Short CB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

sor .... 16.500 m
tance/Div..... .25 m/div
tical Scale.... 163 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac



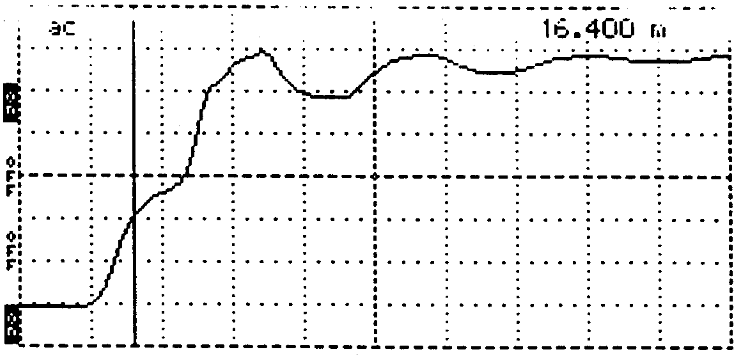
Tektronix 1502B TDR
Date 10/25/93
Cable 7
Notes Short End

Input Trace
Stored Trace
Difference Trace

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

race Number 3 - Probe in Air

r .... 16.400 m
nce/Div..... .25 m/div
cal Scale.... 149 mρ/div
.... 0.99
Filter...... 1 avg
r........... ac

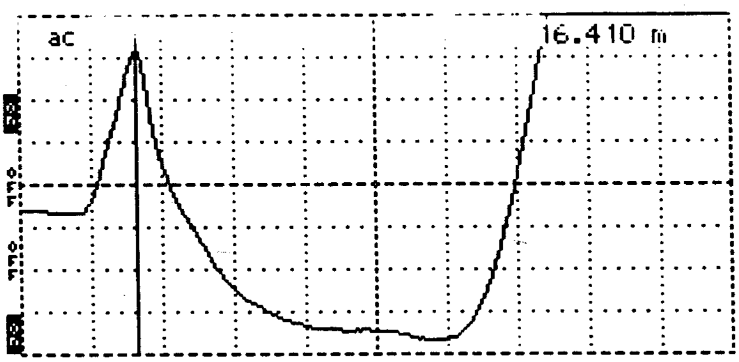


Tektronix 1502B TDR
Date 10/25/93
Cable 7
Notes Air

Input Trace
Stored Trace
Difference Trace

race Number 4 - Probe in Alcohol

sor .... 16.410 m
ance/Div..... .25 m/div
ical Scale.... 47.2 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac

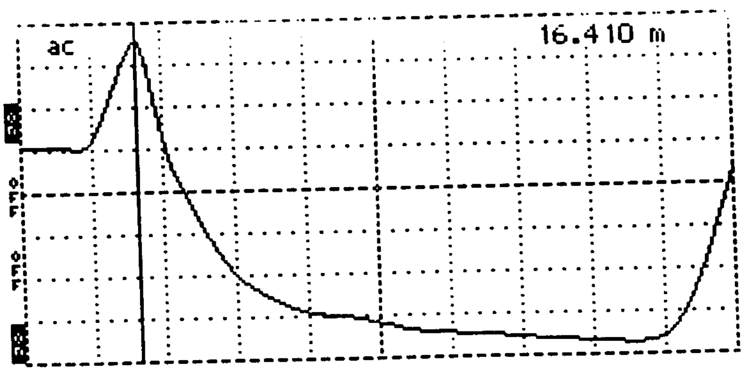


Tektronix 1502B TDR
Date 10/25/93
Cable 7
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

race Number 5 - Probe in Water

sor .... 16.410 m
tance/Div..... .25 m/div
tical Scale.... 68.6 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac



Tektronix 1502B TDR
Date 10/25/93
Cable 7
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

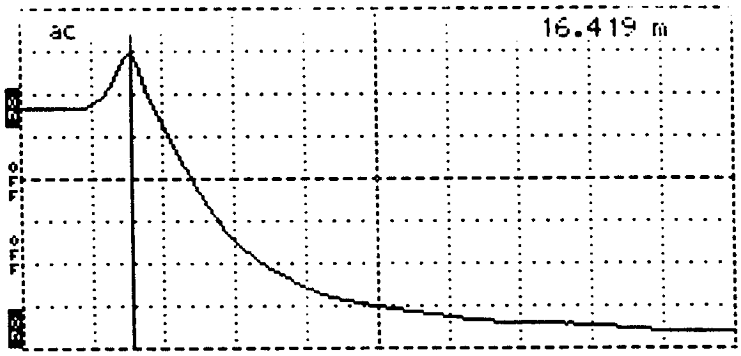
Before Operation Checks - Calibration Date 10/22/93

- Probe S/N 36A08

Probe Number 8

TDR Trace 1 - Beginning Probe Shorted

ursor .... 16.419 m
stance/Div ..... .25 m/div
ertical Scale.... 163 mρ/div
ρ 0.99
oise Filter ...... 1 avg
ower .... ac

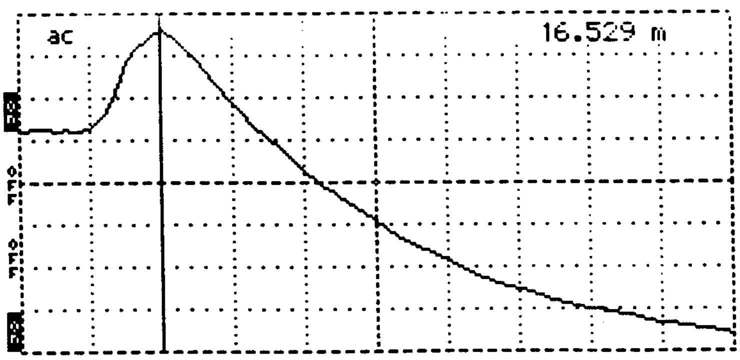


Tektronix 1502B TDR
Date 10/22/93
Cable 8
Notes Short CB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

rsor .... 16.529 m
stance/Div ..... .25 m/div
rtical Scale.... 163 mρ/div
 .... 0.99
oise Filter ...... 1 avg
ower .... ac



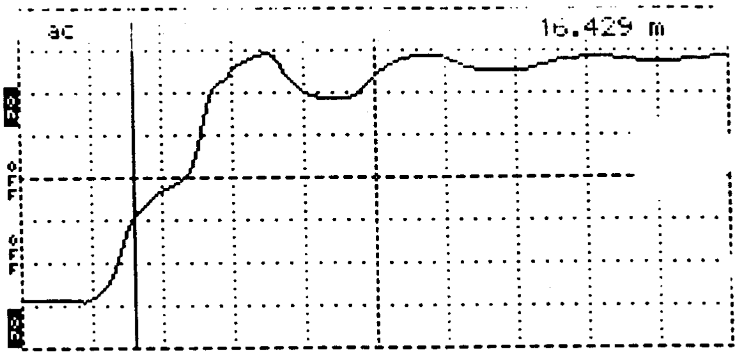
Tektronix 1502B TDR
Date 10/22/93
Cable 8
Notes Short End

Input Trace
Stored Trace
Difference Trace

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

race Number 3 - Probe in Air

sor .... 16.429 m
tance/Div..... .25 m/div
tical Scale.... 154 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac

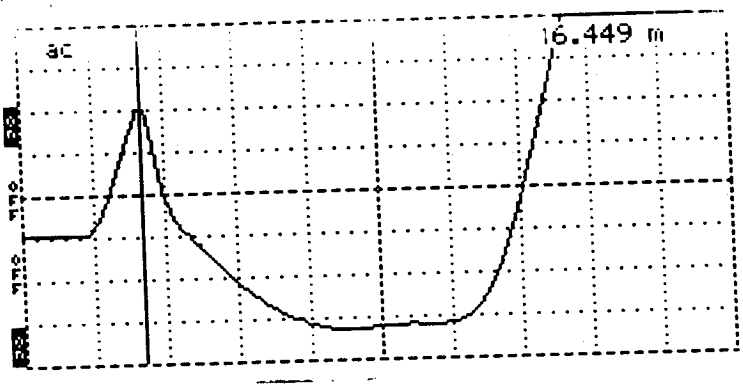


Tektronix 1502B TDR
Date 10/22/93
Cable 8
Notes Air

put Trace
ed Trace
Difference Trace

Trace Number 4 - Probe in Alcohol

rsor .... 16.449 m
ance/Div..... .25 m/div
ical Scale.... 57.7 mρ/div
.... 0.99
se Filter...... 1 avg
wer........... ac

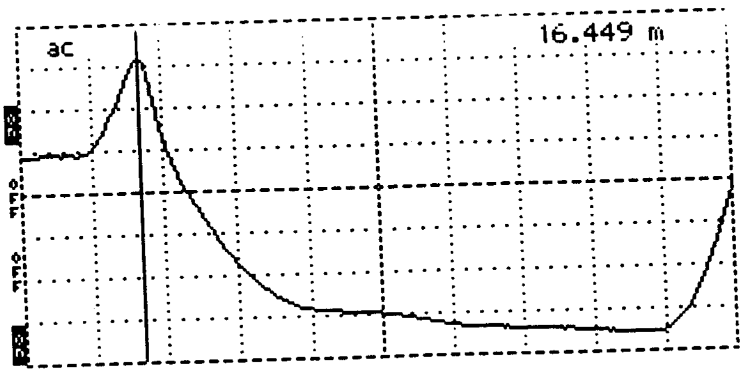


Tektronix 1502B TDR
Date 10/22/93
Cable 8
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace Number 5 - Probe in Water

ursor .... 16.449 m
istance/Div..... .25 m/div
ertical Scale.... 72.7 mρ/div
P 0.99
oise Filter...... 1 avg
ower........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 8
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

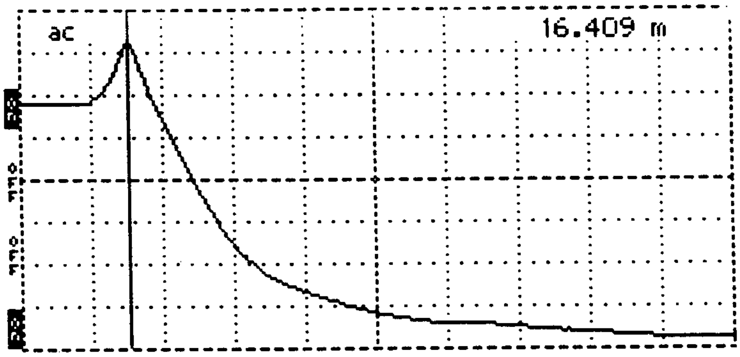
LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

efore Operation Checks - Calibration Date 10/22/93
- Probe S/N 36A09

Probe Number 9

DR Trace 1 - Beginning Probe Shorted

rsor .... 16.409 m
stance/Div..... .25 m/div
rtical Scale.... 149 mρ/div
 .... 0.99
ise Filter...... 1 avg
wer........... ac

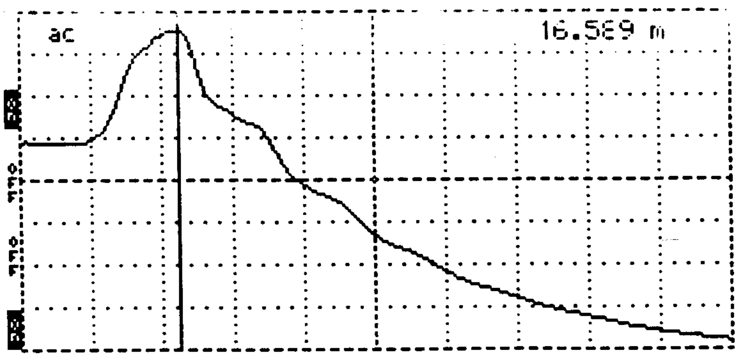


Tektronix 1502B TDR
Date 10/22/93
Cable 9
Notes Short CB

Input Trace
Stored Trace
Difference Trace

race Number 2 - Ending Probe Shorted

rsor .... 16.589 m
stance/Div..... .25 m/div
rtical Scale.... 154 mρ/div
 .... 0.99
ise Filter...... 1 avg
wer........... ac



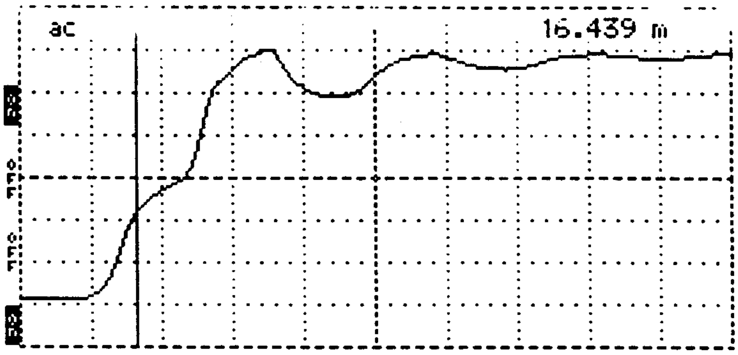
Tektronix 1502B TDR
Date 10/22/93
Cable 9
Notes Short End

Input Trace
Stored Trace
Difference Trace

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

race Number 3 - Probe in Air

or .... 16.439 m
nce/Div ..... .25 m/div
cal Scale.... 154 mρ/div
.... 0.99
Filter ...... 1 avg
er .... ac

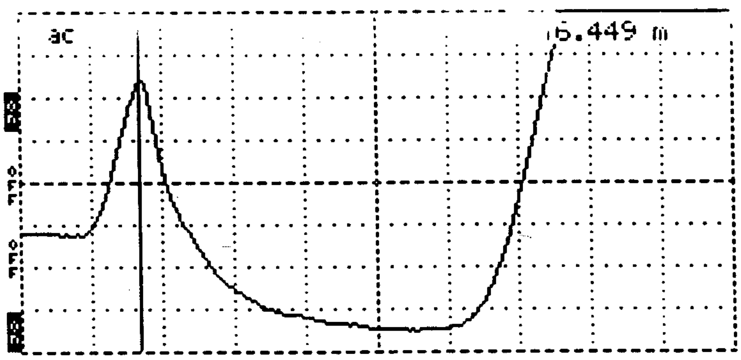


Tektronix 1502B TDR
Date 10/22/93
Cable 9
Notes Air

Input Trace
Stored Trace
Difference Trace

race Number 4 - Probe in Alcohol

or .... 16.449 m
ce/Div ..... .25 m/div
cal Scale.... 54.5 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... ac

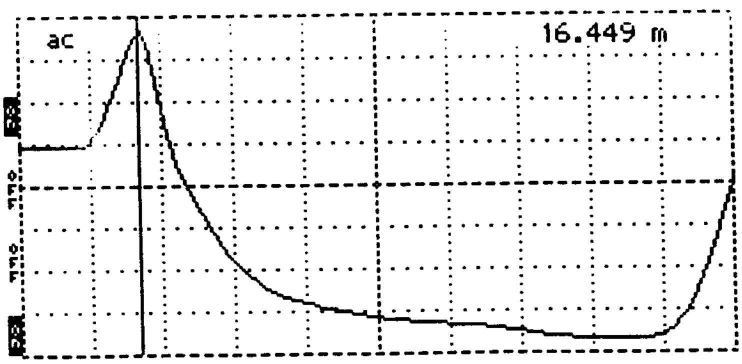


Tektronix 1502B TDR
Date 10/22/93
Cable 9
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

Trace Number 5 - Probe in Water

sor .... 16.449 m
tance/Div ..... .25 m/div
rtical Scale.... 66.7 mρ/div
.... 0.99
se Filter ...... 1 avg
wer .... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 9
Notes H_2O

Input Trace
Stored Trace
Difference Trace

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

LTPP Seasonal Monitoring Study	State Code	[3 6]
TDR Probe Calibration	Test Section Number	[1 0 4 8]

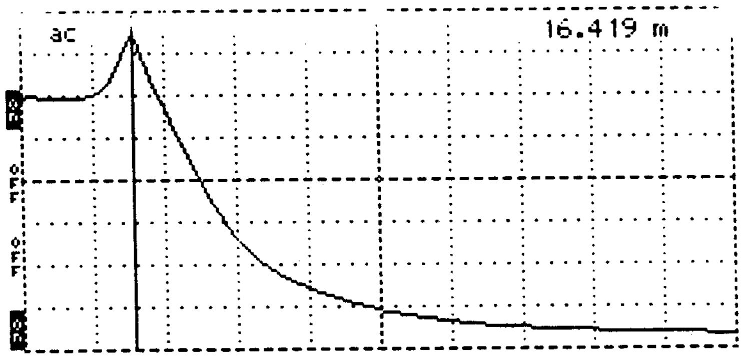
Before Operation Checks - Calibration Date 10/22/93

- Probe S/N 36A10

Probe Number 10

TDR Trace 1 - Beginning Probe Shorted

rsor .... 16.419 m
tance/Div..... .25 m/div
rtical Scale.... 154 mρ/div
.... 0.99
ise Filter...... 1 avg
wer........... ac

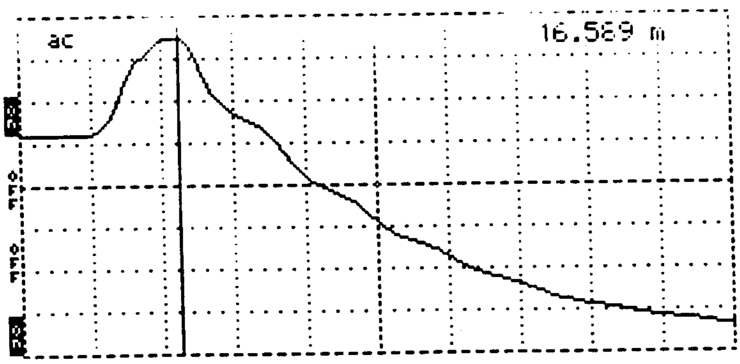


Tektronix 1502B TDR
Date 10/22/93
Cable 10
Notes Short CB

Input Trace
Stored Trace
Difference Trace

Trace Number 2 - Ending Probe Shorted

ursor .... 16.589 m
stance/Div..... .25 m/div
ertical Scale.... 172 mρ/div
P 0.99
oise Filter...... 1 avg
ower........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 10
Notes Short end

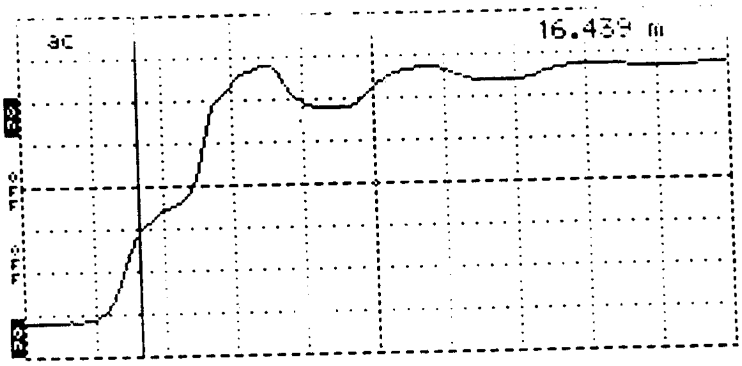
Input Trace
Stored Trace
Difference Trace

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

Probe Number 10 (cont.)

ce Number 3 - Probe in Air

sor .... 16.439 m
ance/Div..... .25 m/div
tical Scale.... 149 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

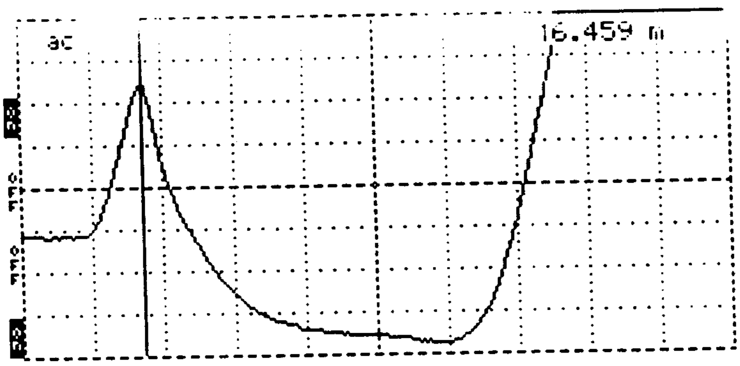


Tektronix 1502B TDR
Date 10/22/93
Cable 10
Notes Air

Input Trace
Stored Trace
Difference Trace

ace Number 4 - Probe in Alcohol

or .... 16.459 m
nce/Div..... .25 m/div
ical Scale.... 53.0 mρ/div
.... 0.99
e Filter...... 1 avg
er........... ac

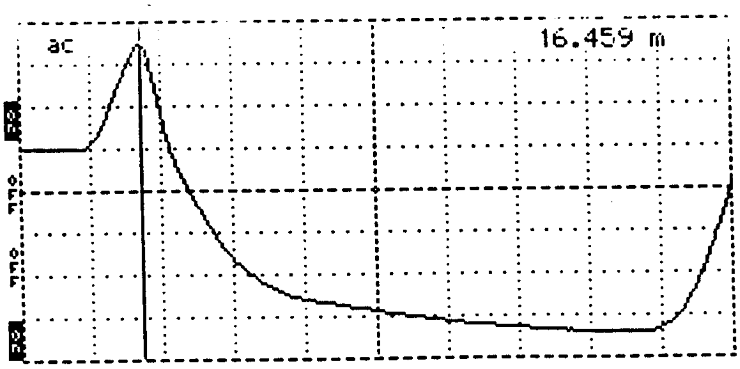


Tektronix 1502B TDR
Date 10/22/93
Cable 10
Notes Alcohol

Input Trace
Stored Trace
Difference Trace

ace Number 5 - Probe in Water

sor .... 16.459 m
tance/Div..... .25 m/div
tical Scale.... 72.7 mρ/div
.... 0.99
se Filter...... 1 avg
ver........... ac



Tektronix 1502B TDR
Date 10/22/93
Cable 10
Notes H2O

Input Trace
Stored Trace
Difference Trace

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

APPENDIX C

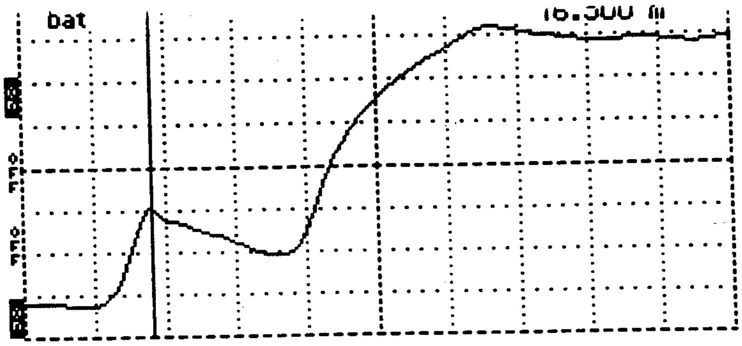
Supporting Instrumentation Installation Information

Appendix C contains the following supporting information:

Figure C-1	TDR Traces Measured Manually During Installation
Table C-1	TDR Moisture Content During Installation
Table C-2	Field Measured Moisture Content During Installation

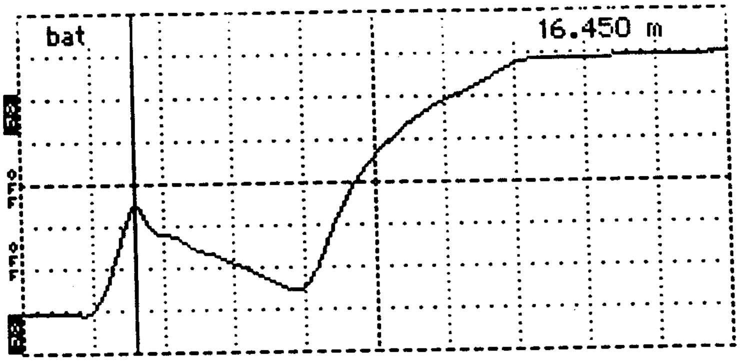
Laboratory Moisture Samples' Results as Received from the State

r .... 16.500 m
nce/Div ..... .25 m/div
cal Scale.... 10[illegible] mρ/div
.... 0.99
Filter ...... 1 avg
r .... bat/low



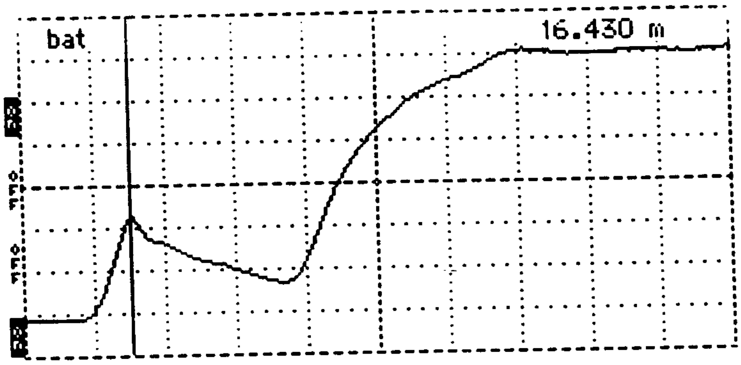
Tektronix 1502B TDR
Date 10/27/93
Cable 36A1
Notes
Input Trace
Stored Trace
Difference Trace

or .... 16.450 m
nce/Div ..... .25 m/div
cal Scale.... 81.6 mρ/div
.... 0.99
Filter ...... 1 avg
er .... bat/low



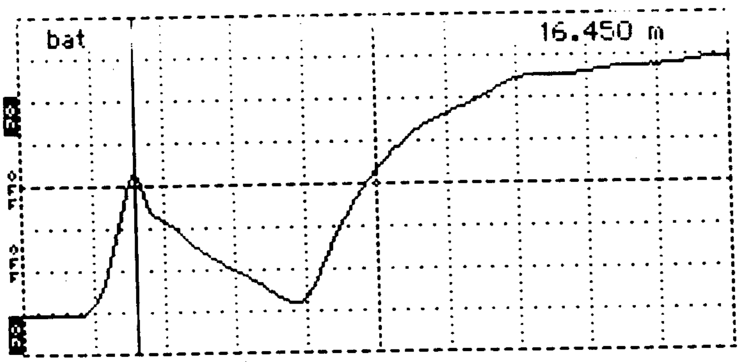
Tektronix 1502B TDR
Date 10/27/93
Cable 36A2
Notes
Input Trace
Stored Trace
Difference Trace

or .... 16.430 m
nce/Div ..... .25 m/div
cal Scale.... 94.1 mρ/div
.... 0.99
e Filter ...... 1 avg
er .... bat



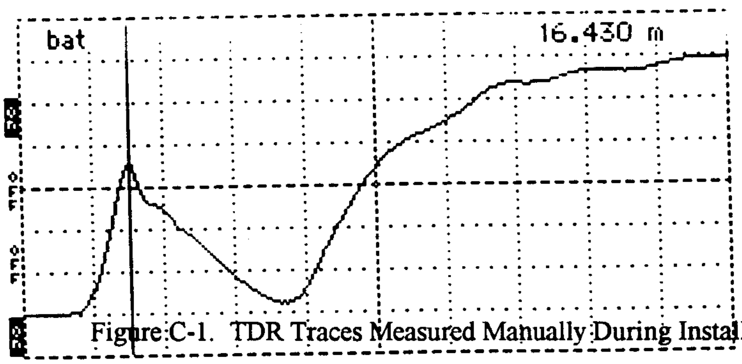
Tektronix 1502B TDR
Date 10/27/93
Cable 36A3
Notes
Input Trace
Stored Trace
Difference Trace

or .... 16.450 m
nce/Div ..... .25 m/div
cal Scale.... 66.7 mρ/div
.... 0.99
Filter ...... 1 avg
er .... bat/low



Tektronix 1502B TDR
Date 10/27/93
Cable 36A4
Notes
Input Trace
Stored Trace
Difference Trace

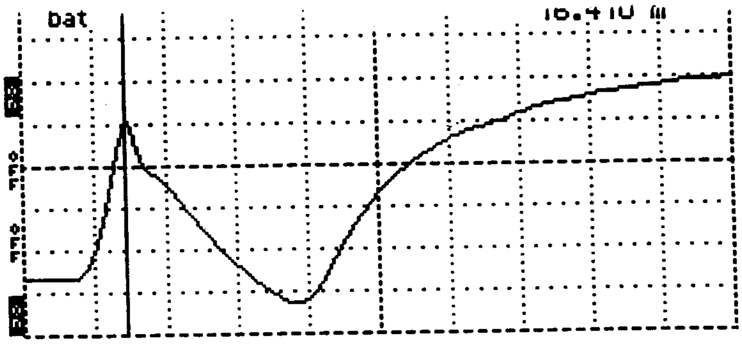
sor .... 16.430 m
ance/Div ..... .25 m/div
tical Scale.... 62.9 mρ/div
.... 0.99
se Filter ...... 1 avg
ver .... bat



Tektronix 1502B TDR
Date 10/27/93
Cable 36A5
Notes
Input Trace
Stored Trace
Difference Trace

Figure C-1. TDR Traces Measured Manually During Installation

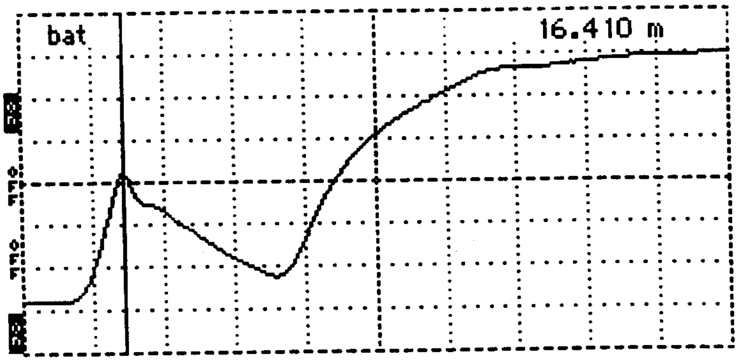
r .... 16.410 m
ce/Div ..... .25 m/div
al Scale.... 57.7 mρ/div
.... 0.99
Filter ...... 1 avg
r........... bat



Tektronix 1502B TDR
Date 10/27/93
Cable 36A6
Notes

Input Trace
Stored Trace
Difference Trace

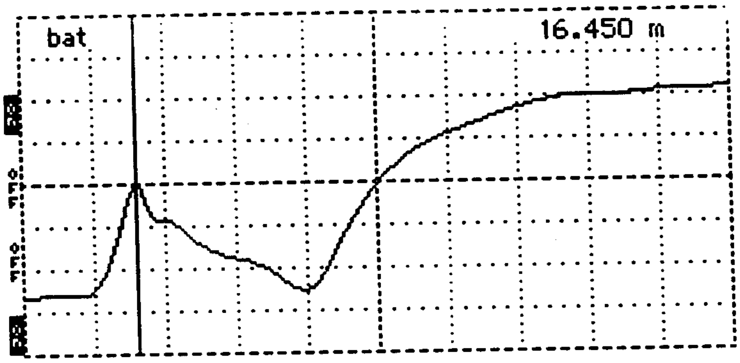
r .... 16.410 m
nce/Div ..... .25 m/div
cal Scale.... 74.8 mρ/div
.... 0.99
Filter ...... 1 avg
r........... bat



Tektronix 1502B TDR
Date 10/27/93
Cable 36A7
Notes

Input Trace
Stored Trace
Difference Trace

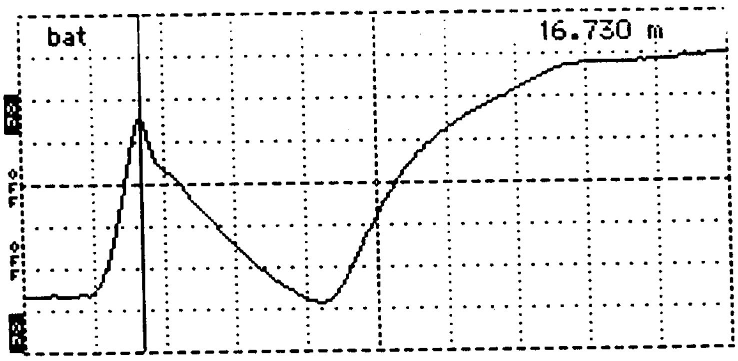
or .... 16.450 m
nce/Div ..... .25 m/div
cal Scale.... 79.2 mρ/div
.... 0.99
Filter ...... 1 avg
r........... bat



Tektronix 1502B TDR
Date 10/27/93
Cable 36A8
Notes

Input Trace
Stored Trace
Difference Trace

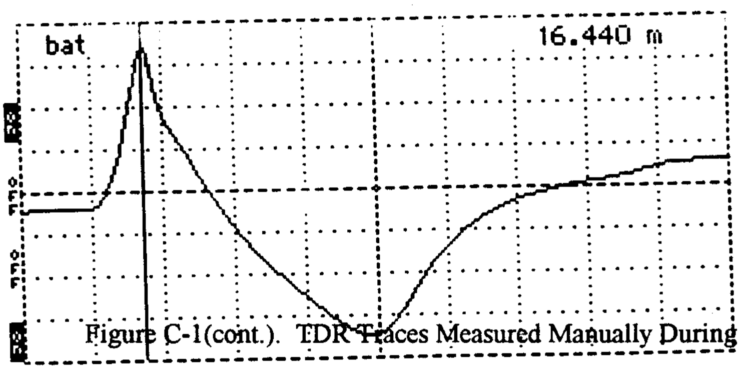
or .... 16.730 m
nce/Div ..... .25 m/div
cal Scale.... 54.5 mρ/div
.... 0.99
Filter ...... 1 avg
er........... bat



Tektronix 1502B TDR
Date 10/27/93
Cable 36A9
Notes

Input Trace
Stored Trace
Difference Trace

sor .... 16.440 m
ance/Div ..... .25 m/div
tical Scale.... 56.1 mρ/div
.... 0.99
se Filter ...... 1 avg
ver........... bat



Tektronix 1502B TDR
Date 10/27/93
Cable 36A10
Notes

Input Trace
Stored Trace
Difference Trace

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

Table C-1. TDR Moisture Content During Installation

TDR No.	TDR Length (m)	Dielectric Constant	Volumetric Moisture Content (%)	In-Situ Dry Density (kg/m^3)*	Gravimetric Moisture Content (%)
36A01	0.510	6.44	11.40	2238	5.10
36A02	0.600	8.91	16.75	2238	7.48
36A03	0.570	8.04	14.93	2238	6.67
36A04	0.580	8.33	15.54	2238	6.94
36A05	0.560	7.76	14.34	2238	6.41
36A06	0.600	8.91	16.75	2238	7.48
36A07	0.550	7.49	13.74	2238	6.14
36A08	0.610	9.21	17.36	2238	7.76
36A09	0.630	9.83	18.59	2238	8.31
36A10	0.800	15.85	29.03	2238	12.97

* Note: Lab max dry density of subgrade used since no in-situ data is collected for PCC pavements.

Table C-2. Field Measured Moisture Content During Installation

LTPP Seasonal Monitoring Study	State Code	[36]
In-Situ Moisture Tests	Test Section Number	[4018]

Weight (gm)	Probe 1	Probe 2	Probe 3	Probe 4	Probe 5
Weight of Pan + Wet Soil	288.4	212.55	286.6	209.82	167.2
Weight of Pan + Dry Soil	279.1	207.6	279.4	203.8	160.7
Weight of Pan	120.5	121.9	120.5	121.9	120.5
Weight of Dry Soil	158.6	85.7	158.9	81.9	40.2
Weight of Wet Soil	167.9	90.7	166.1	87.9	46.7
Weight of Moisture	9.3	5.0	7.2	6.0	6.5
Wt of Moisture/Dry Wt x 100	5.86	5.78	4.53	7.38	16.17

Weight (gm)	Probe 6	Probe 7	Probe 8	Probe 9	Probe 10
Weight of Pan + Wet Soil	209.8	215.5	256.0	250.7	178.2
Weight of Pan + Dry Soil	196	208.2	246.6	237.1	168.2
Weight of Pan	121.9	120.5	121.9	120.5	121.9
Weight of Dry Soil	74.1	87.7	124.7	116.6	46.3
Weight of Wet Soil	87.9	95.0	134.1	130.2	56.3
Weight of Moisture	13.8	7.3	9.4	13.6	10.0
Wt of Moisture/Dry Wt x 100	18.62	8.32	7.54	11.67	21.60

SM 282e (2/76)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

SUBSURFACE EXPLORATION LOG

REGION 9
COUNTY OTSEGO
PIN 2012.22.881
PROJECT SHEP PROJECT
SOIL SERIES
COORD. LOC.
DATE START　　DATE FINISH

HOLE
LINE
STA
OFFSET
SURF. ELEV.
DEPTH TO WATER

CASING O.D. ____ I.D. ____ WEIGHT OF HAMMER - CASING ____ LBS. HAMMER FALL - CASING ____
SAMPLER O.D. ____ I.D. ____ WEIGHT OF HAMMER - SAMPLER ____ LBS. HAMMER FALL - SAMPLER ____

DEPTH BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/.5	.5/1.0	1.0/1.5	1.5/2.0	DESCRIPTION OF SOIL AND ROCK	MOIST. CONT. %
Ø								
		37A1					Brn. sandy GRAVEL (m-npl)	5
		36A2					(Ditto) (m-npl)	6
/								
		36A3					(Ditto) (m-npl)	6
		36A4					Brn. silty SAND gravelly (m-npl)	6
/								
		36A5					Brn. silty SAND w/ occ. gravel (m-npl)	7
		36A6					(Ditto) (m-npl)	8
/								
		36A7					Brn. silty SAND gravelly (m-npl)	8
		36A8					(Ditto) (m-npl)	7
/								
		36A9					Brn. silty SAND w/ occ. gravel (m-npl)	12
		36A10					Brn. sandy SILT clayey w/ occ. gravel (m-pl)	22

THE SUBSURFACE INFORMATION SHOWN HEREON WAS OBTAINED FOR STATE DESIGN AND ESTIMATE PURPOSES. IT IS MADE AVAILABLE TO AUTHORIZED USERS ONLY THAT THEY MAY HAVE ACCESS TO THE SAME INFORMATION AVAILABLE TO THE STATE. IT IS PRESENTED IN GOOD FAITH, BUT IS NOT INTENDED AS A SUBSTITUTE FOR INVESTIGATIONS, INTERPRETATION OR JUDGMENT OF SUCH AUTHORIZED USERS.

CONTRACTOR ____ SM ____

DRILL RIG OPERATOR
SOIL & ROCK DESCRIP. [illegible]
REGIONAL SOILS ENGR.
SHEET 1 OF 1
STRUCTURE NAME/NO.

HOLE -

APPENDIX D

Initial Data Collection

Appendix D contains the following supporting information:

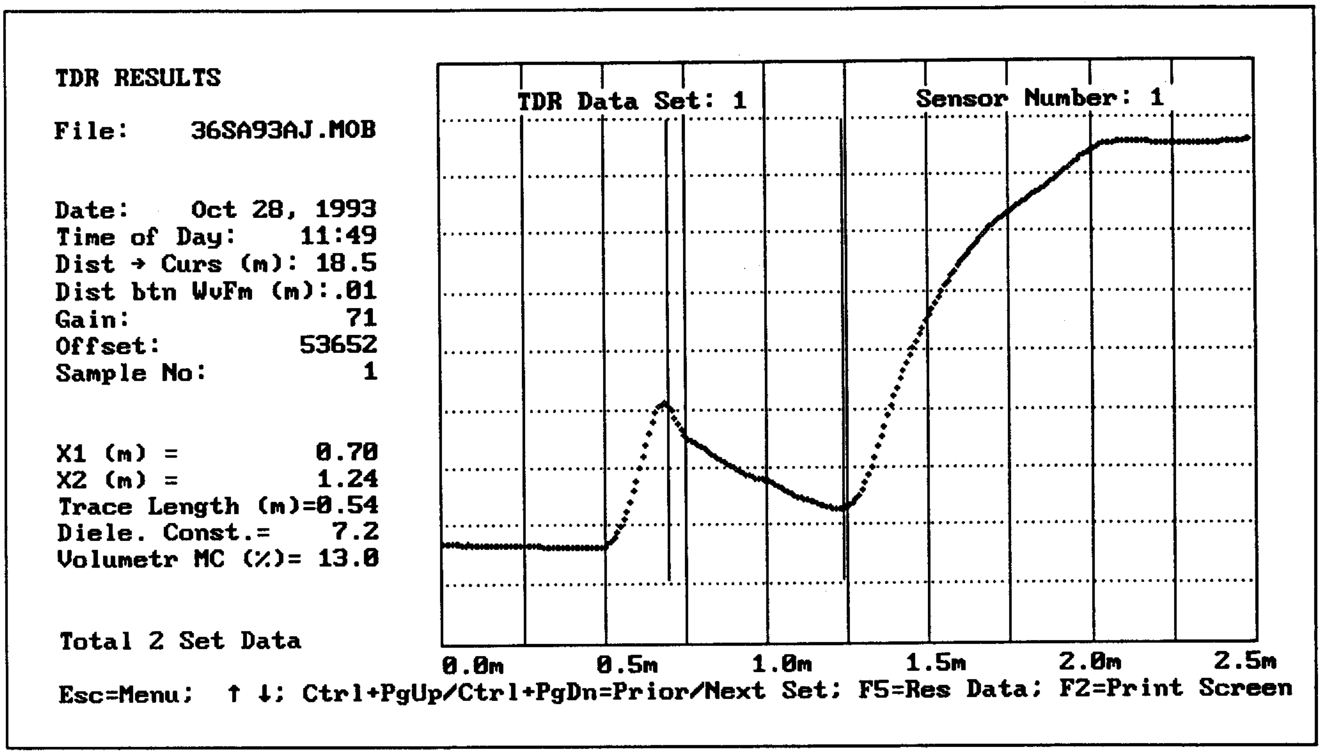


Figure D-1. Initial First Set of TDR Traces Measured with the Mobile Unit

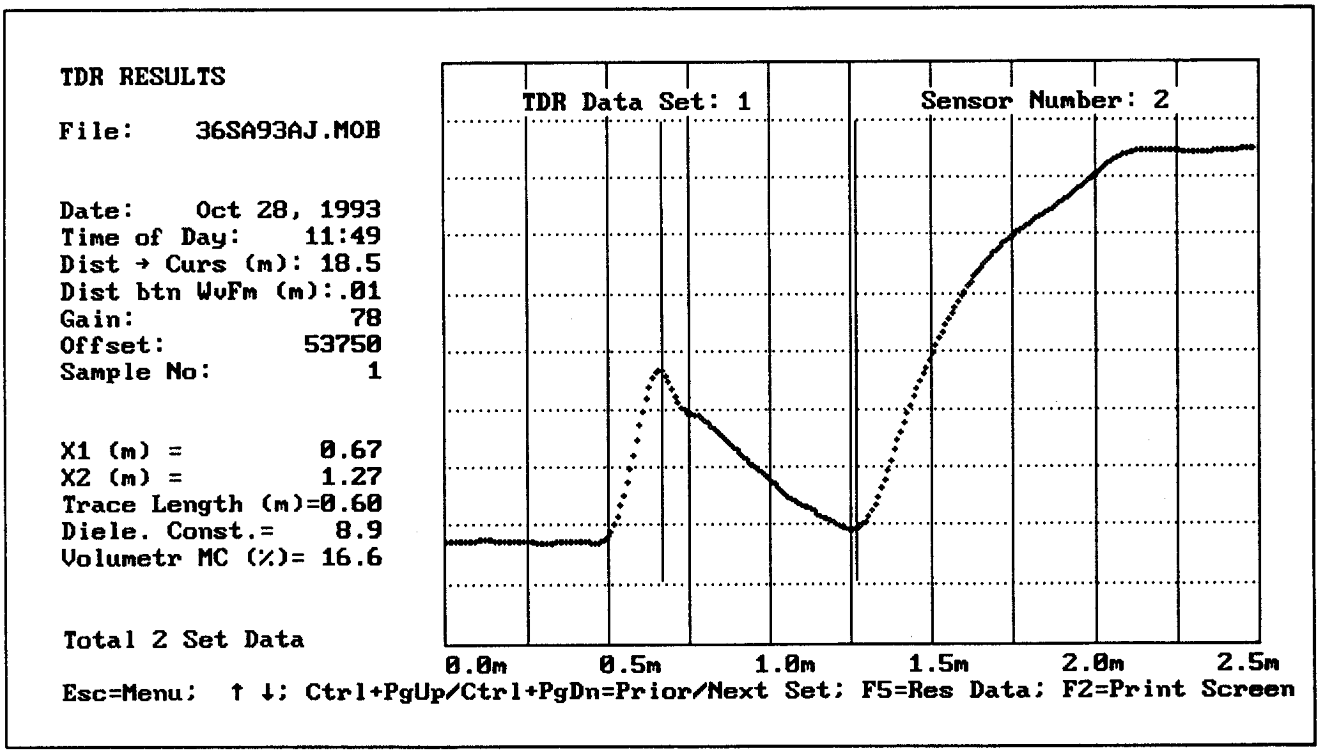


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

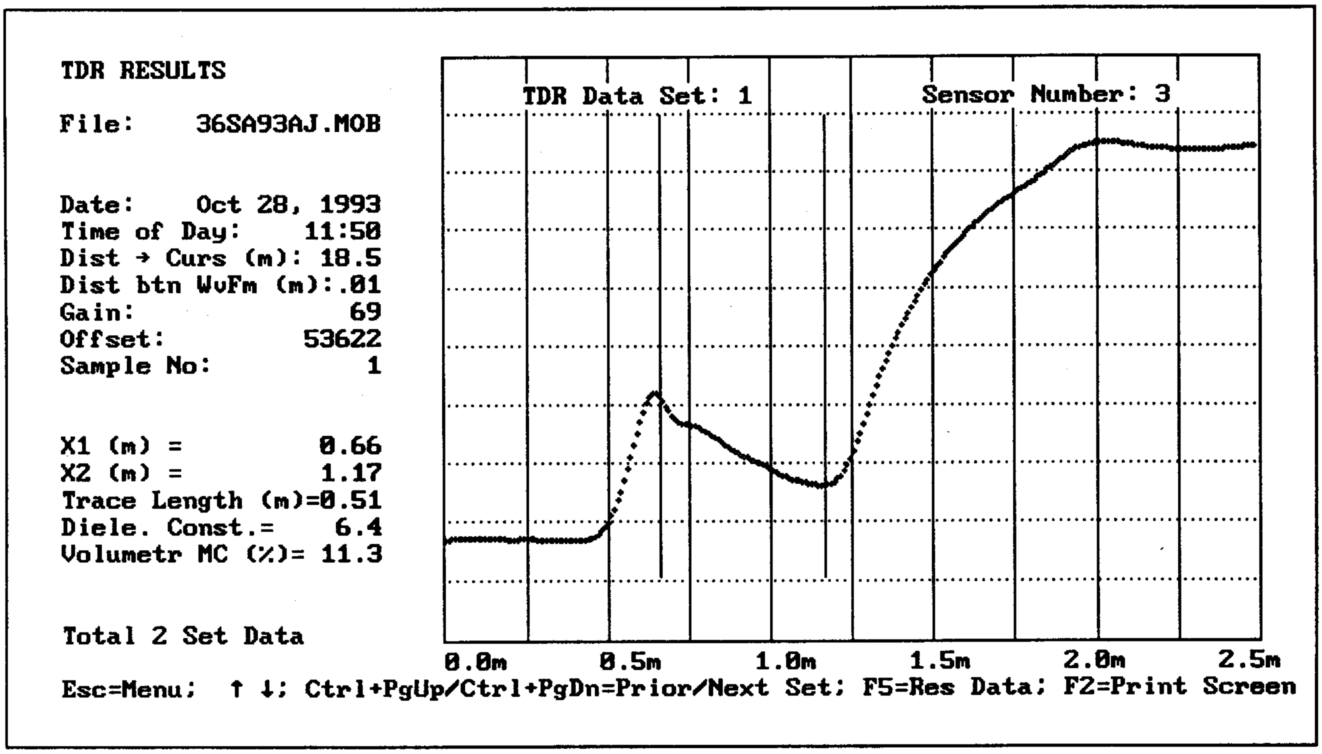


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

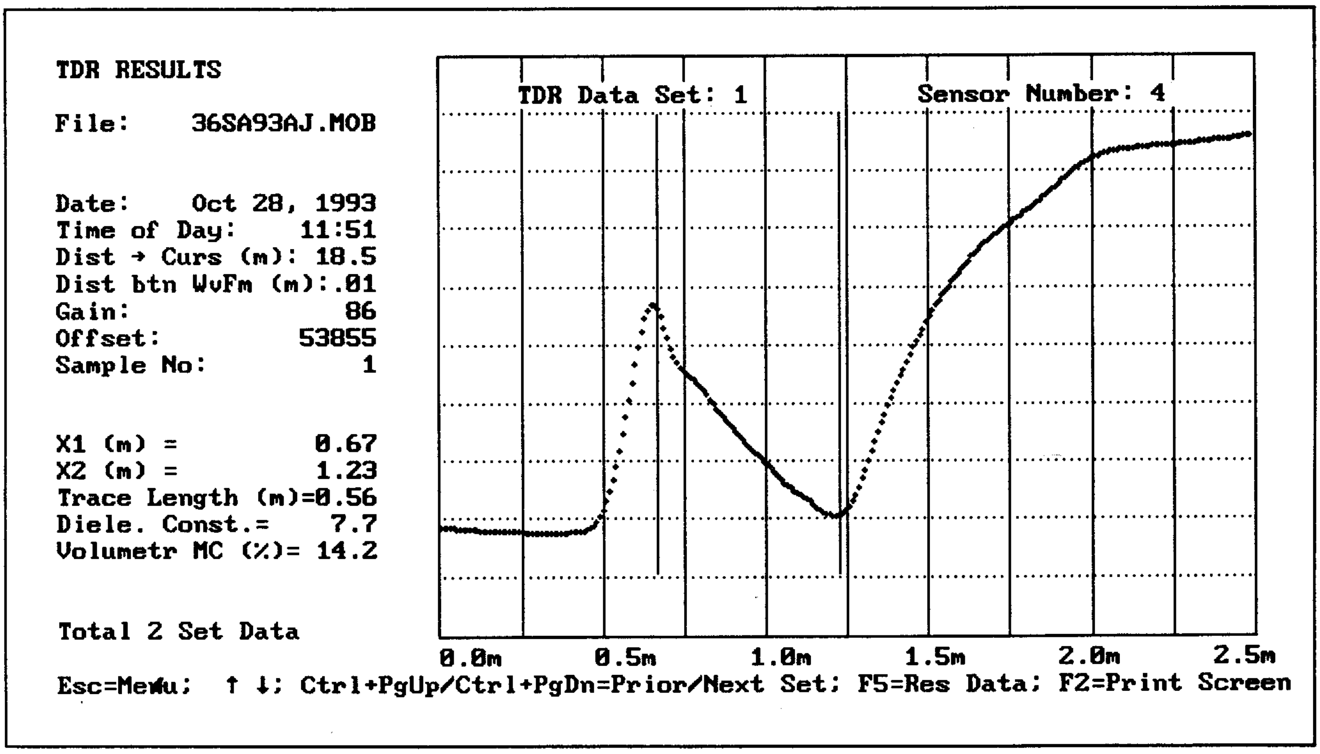


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

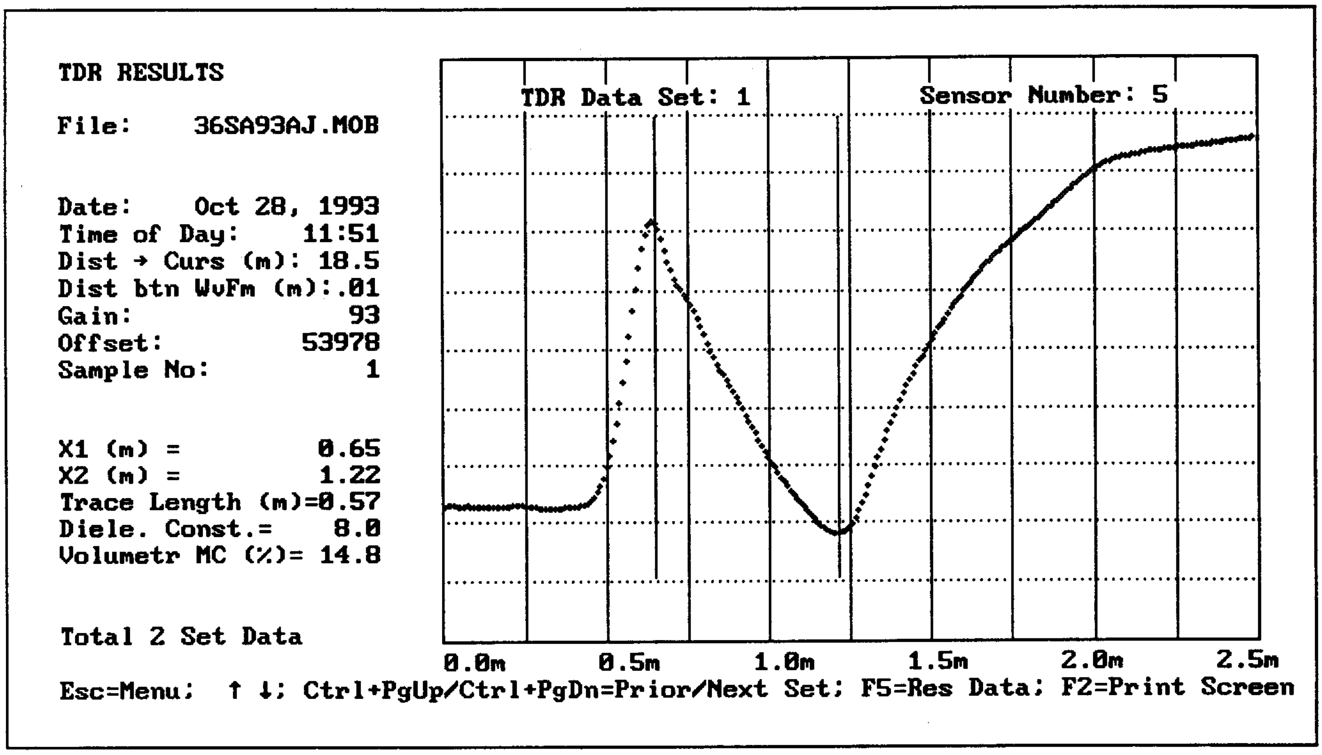


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

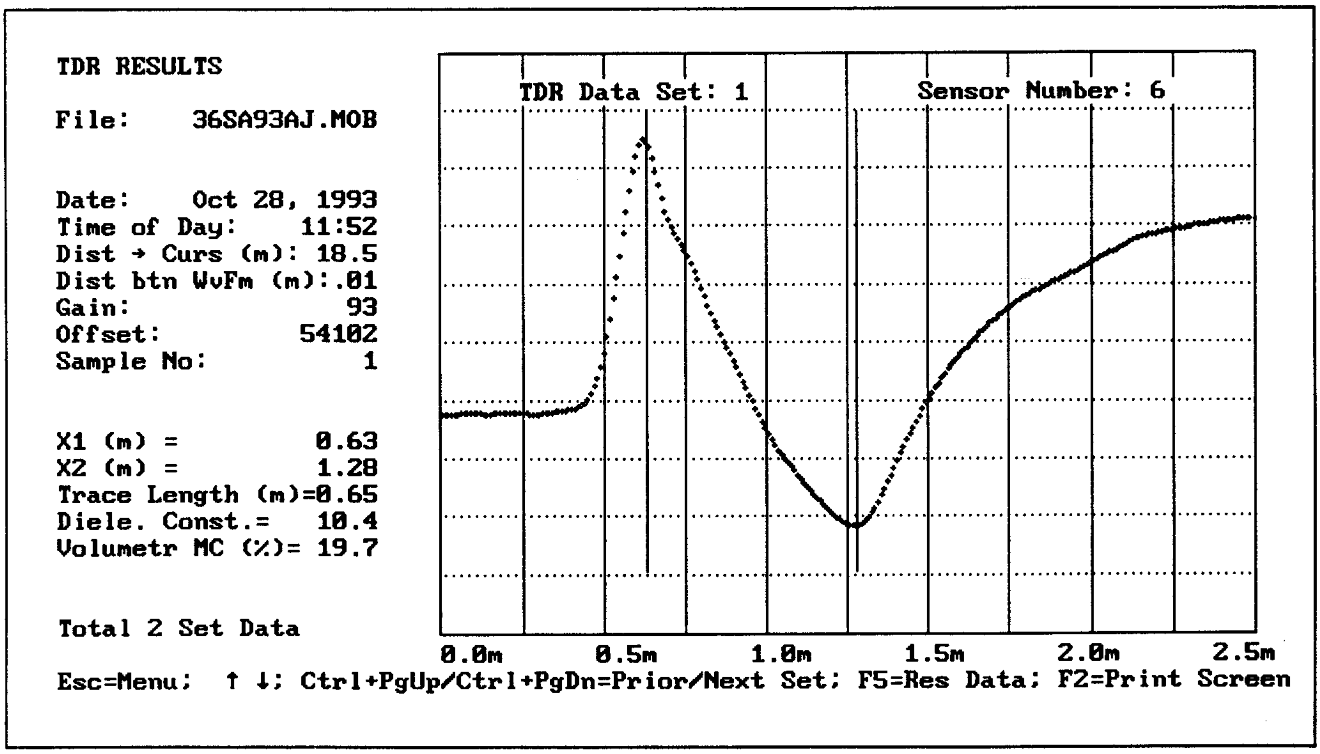


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

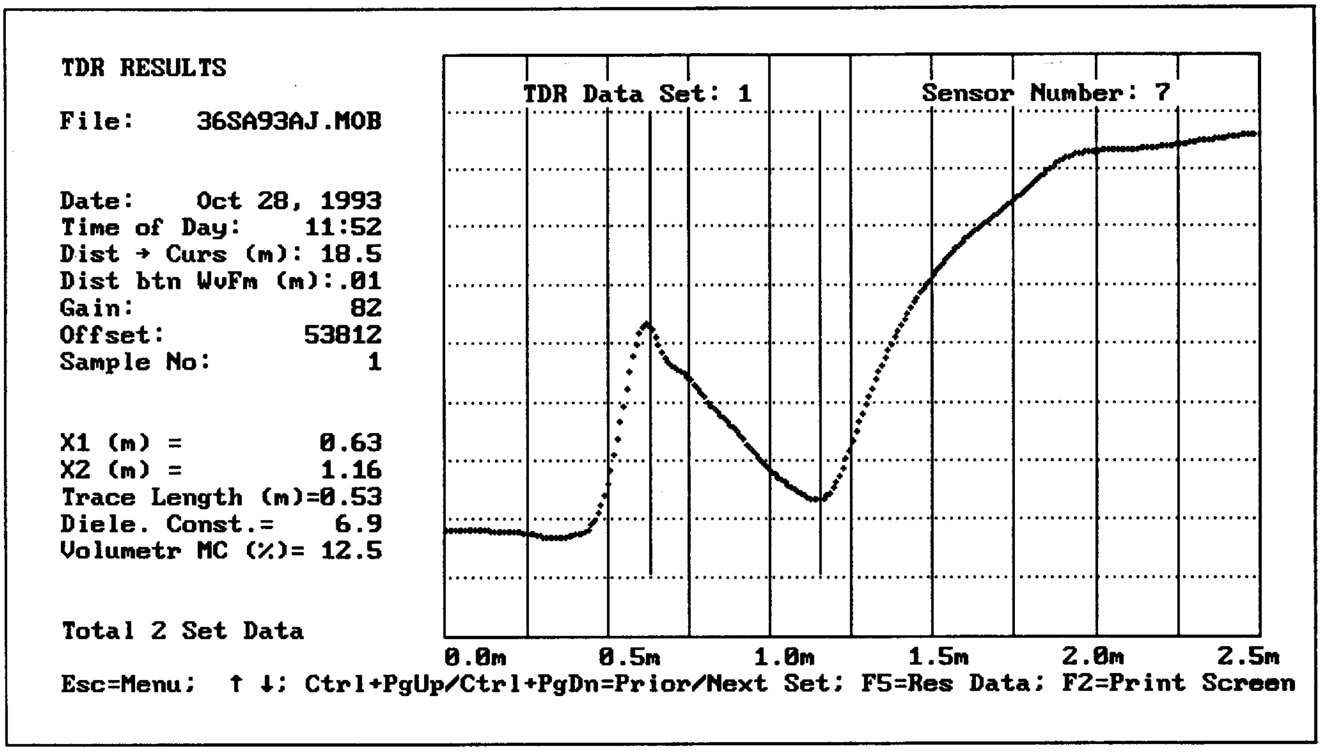


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

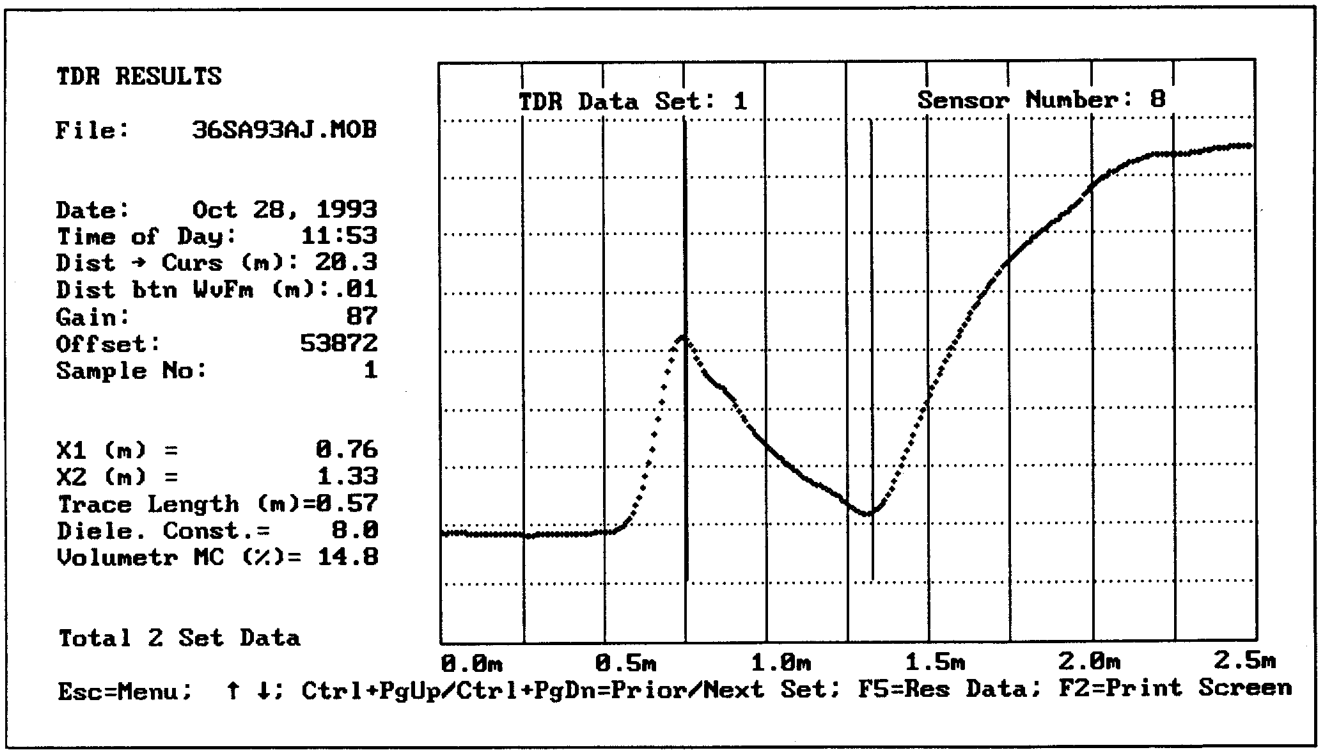


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

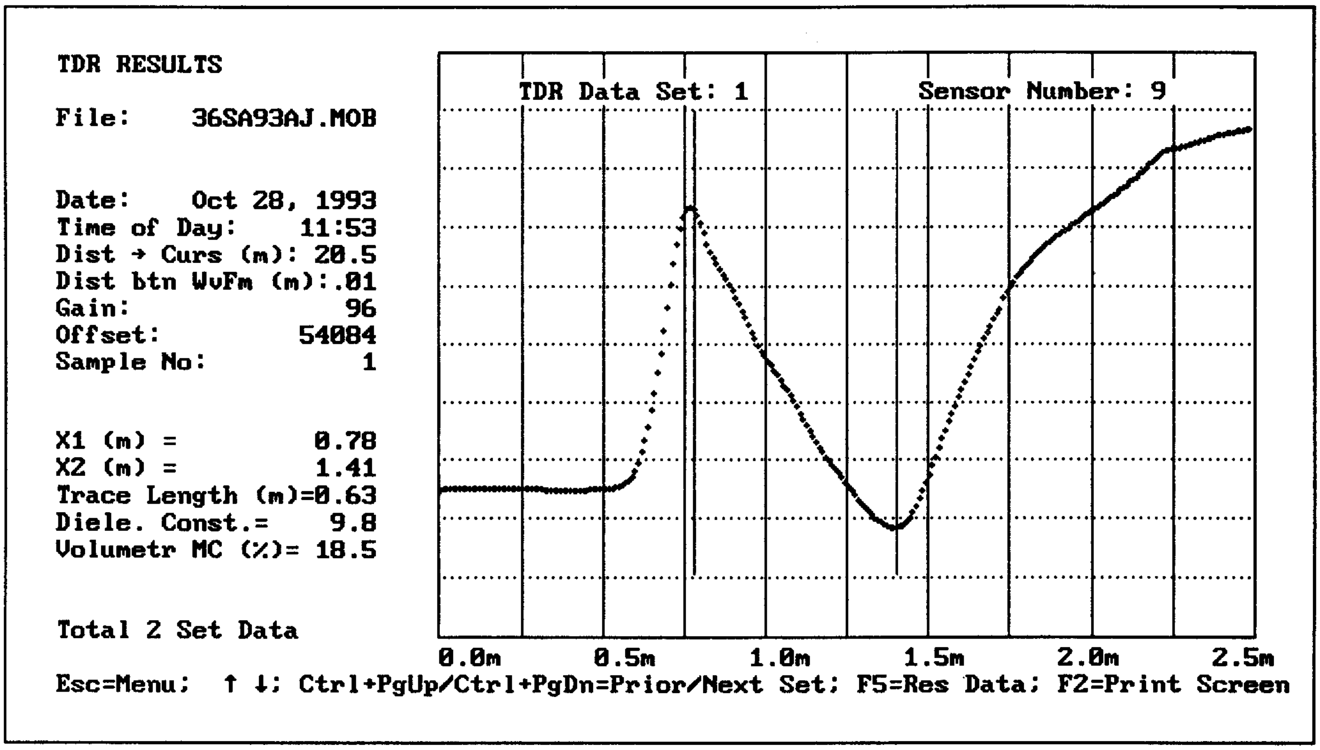


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

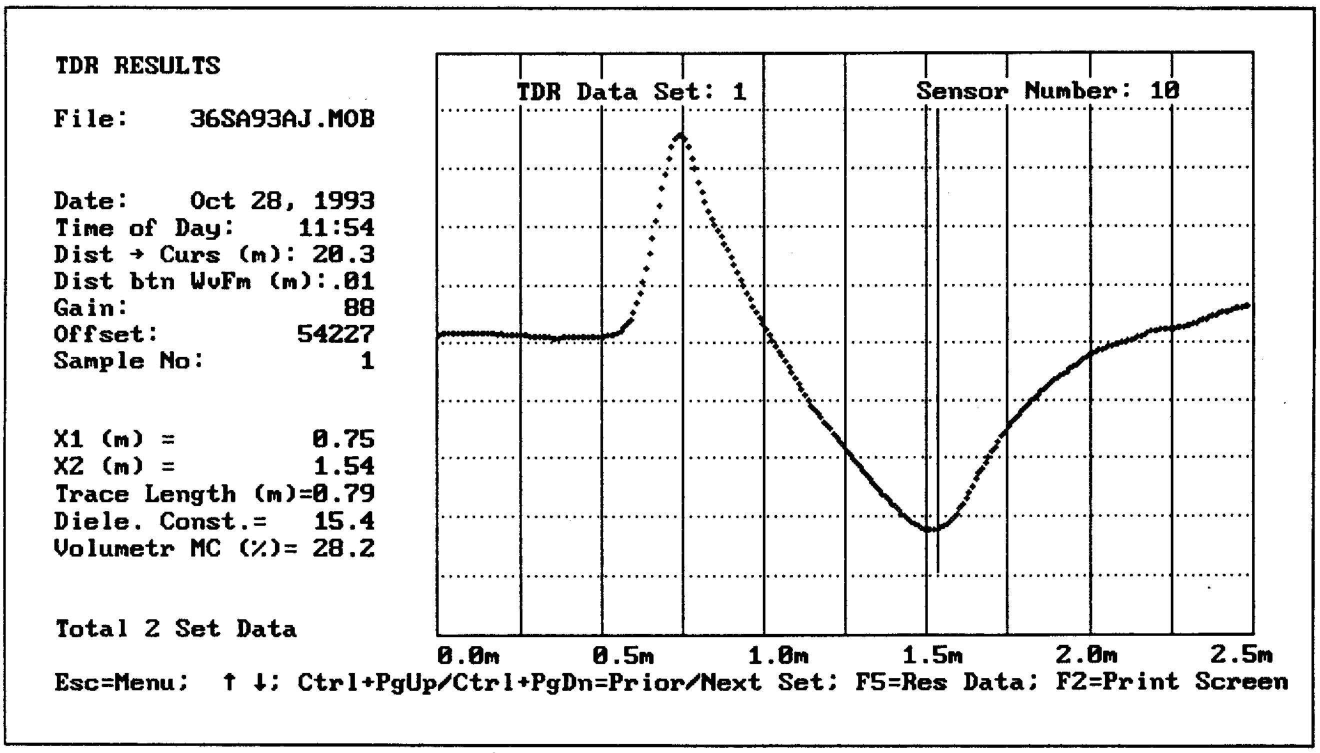


Figure D-1(cont.). Initial First Set of TDR Traces Measured with the Mobile Unit

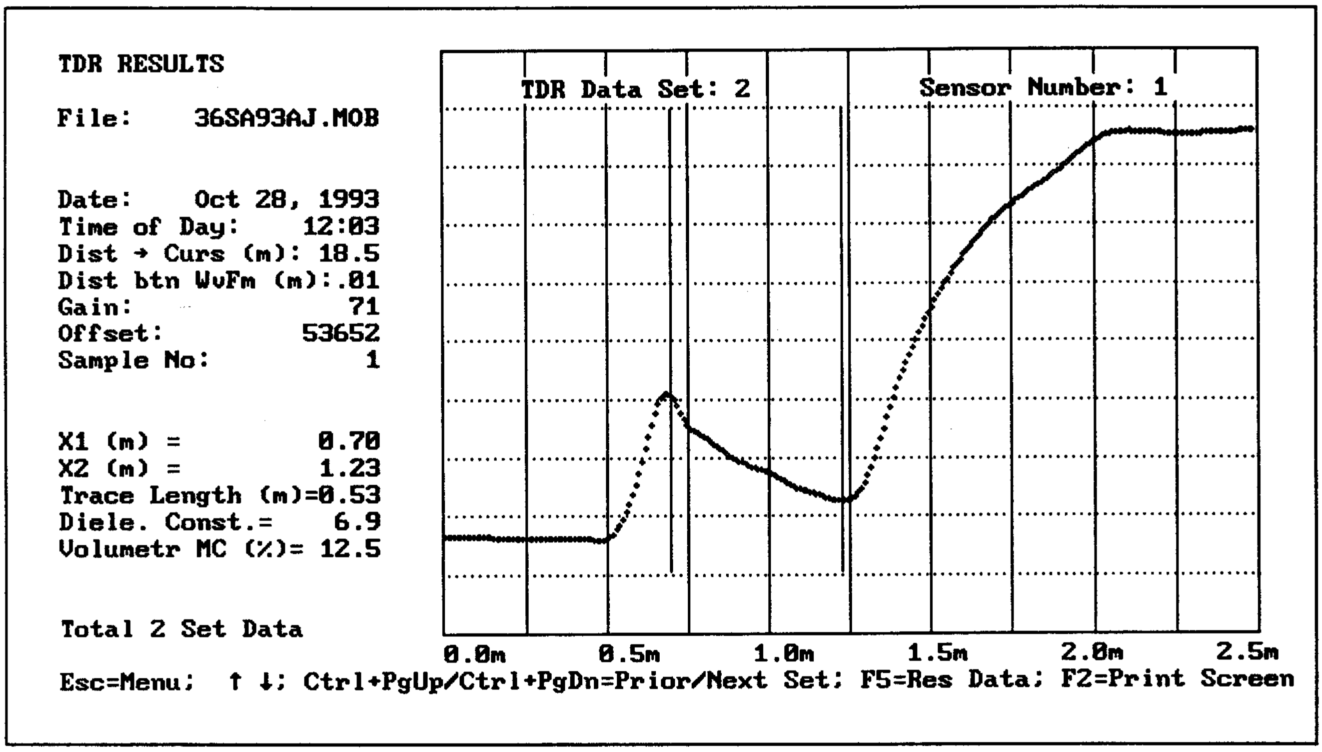


Figure D-2. Initial Second Set of TDR Traces Measured with the Mobile Unit

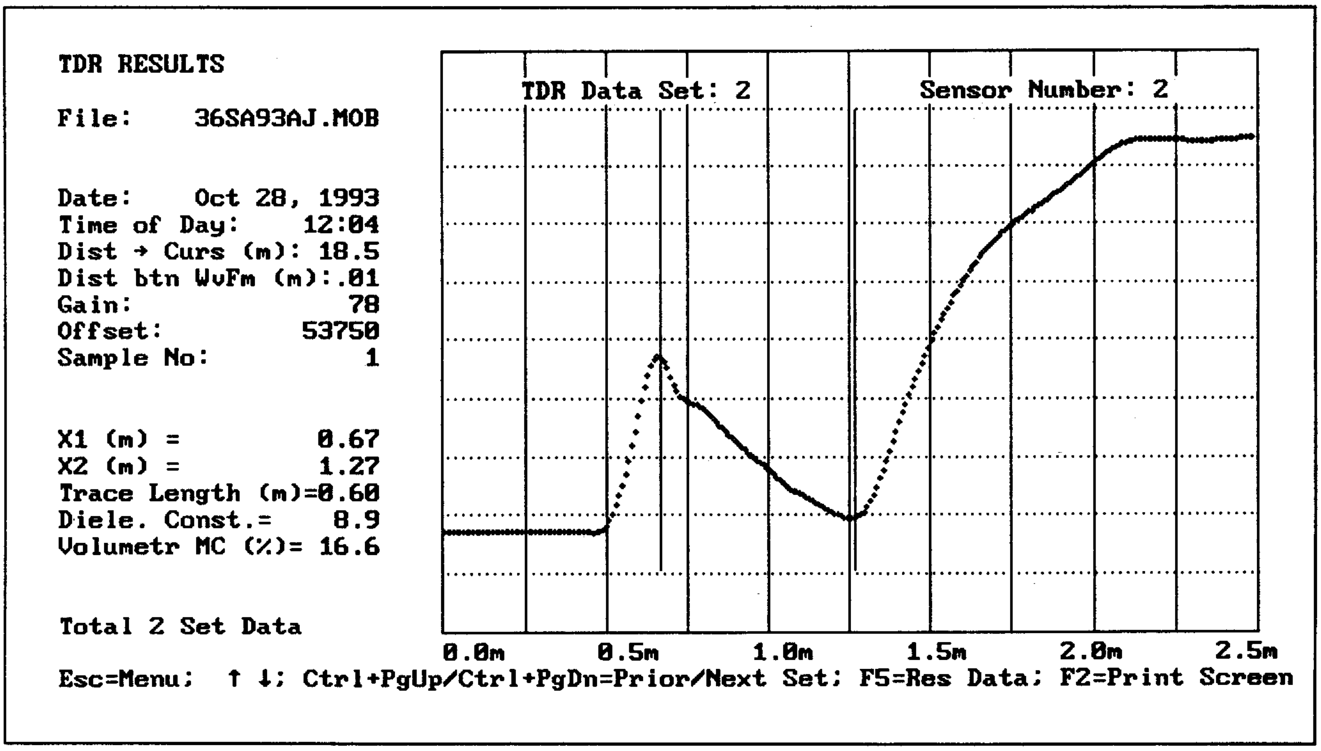


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

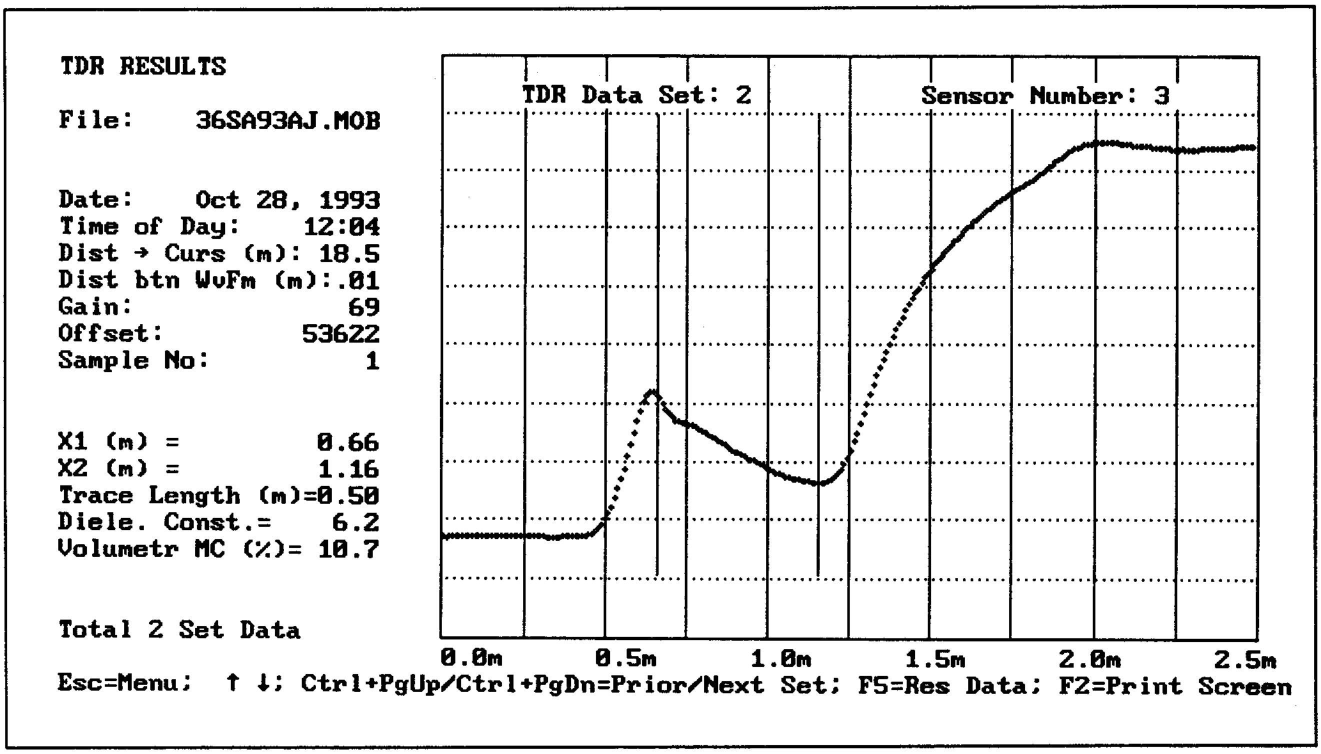


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

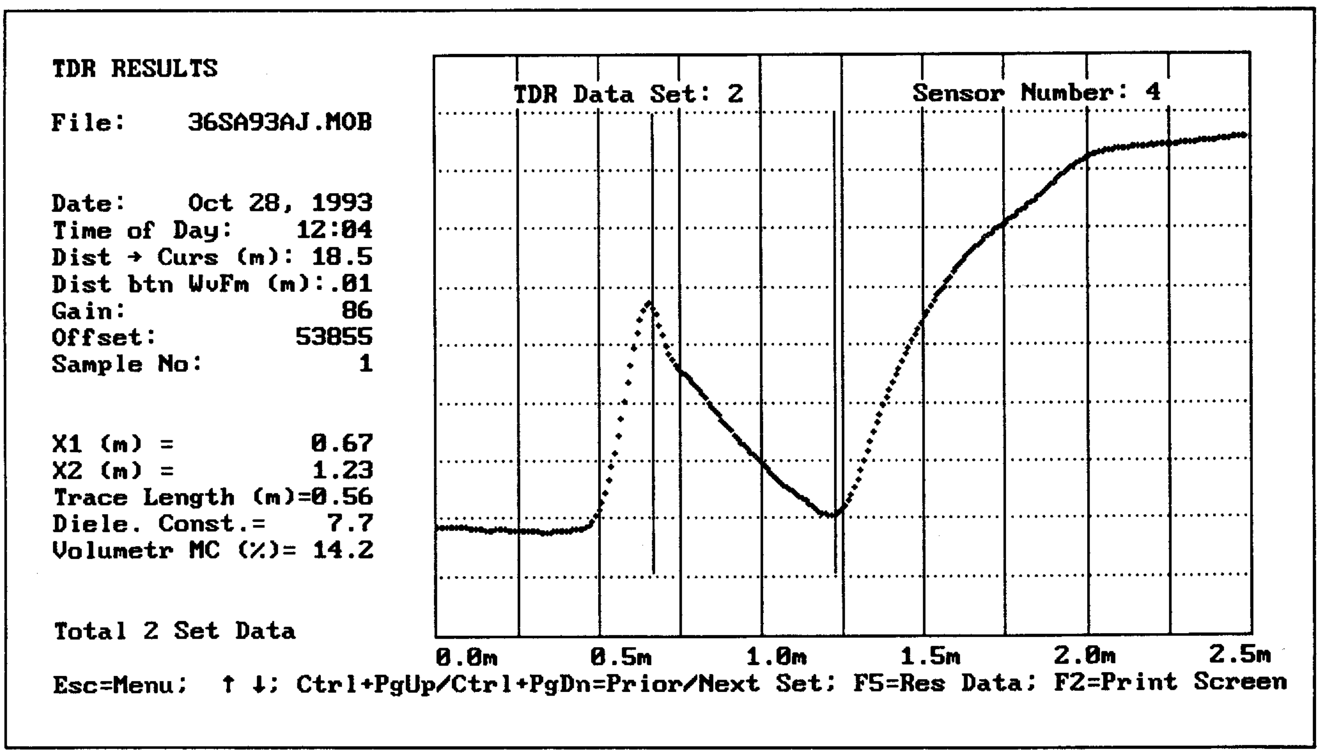


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

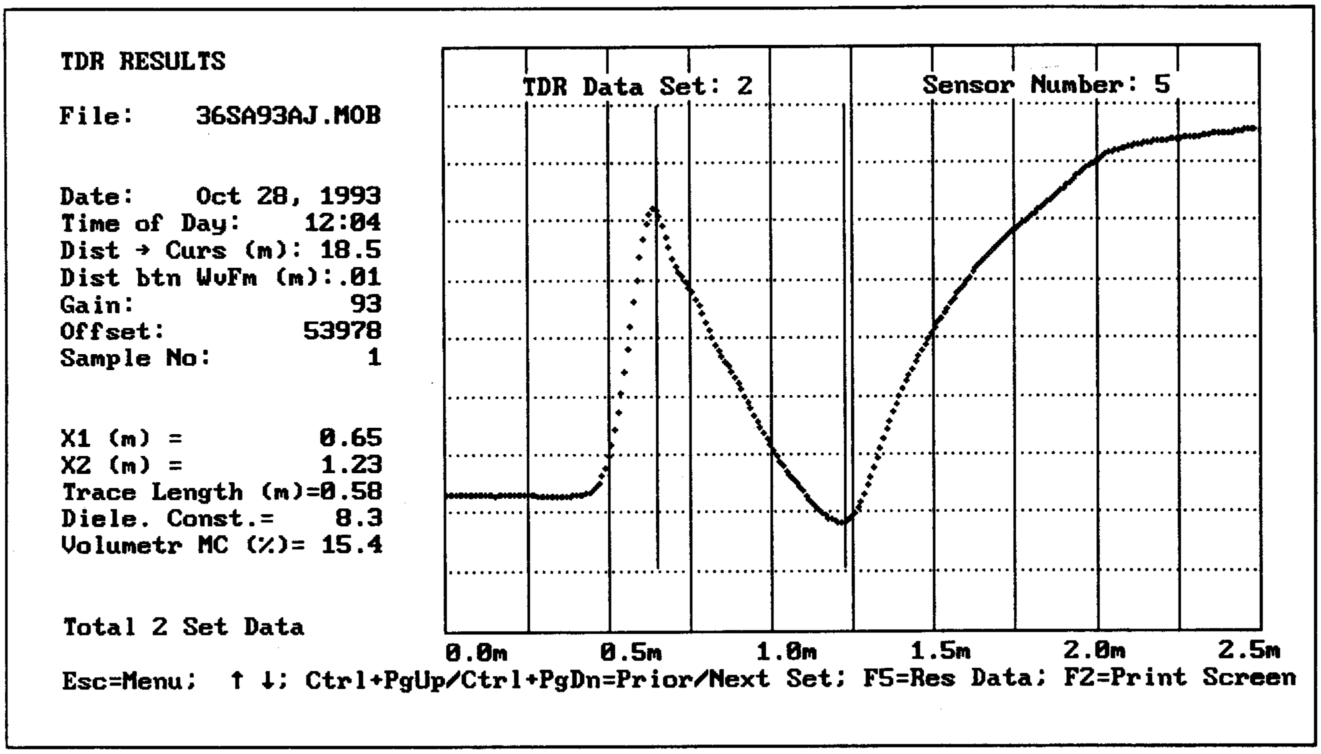


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

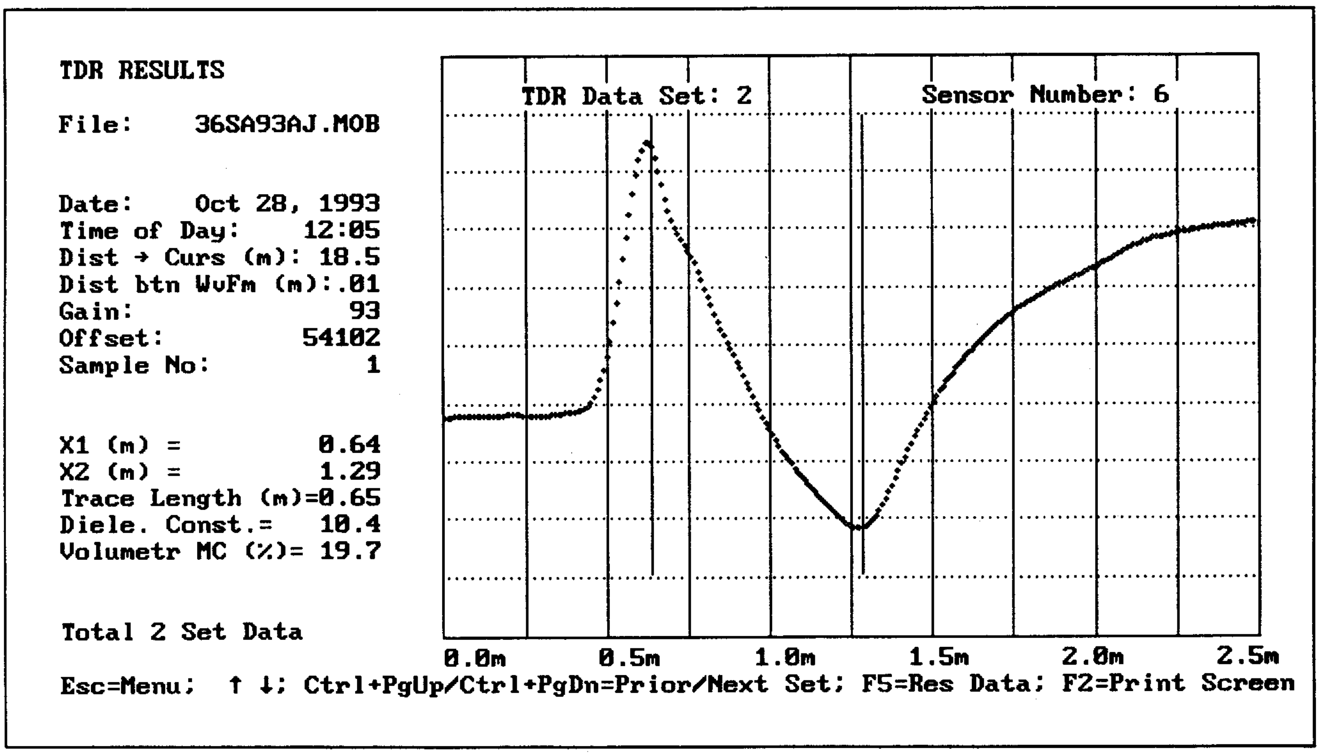


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

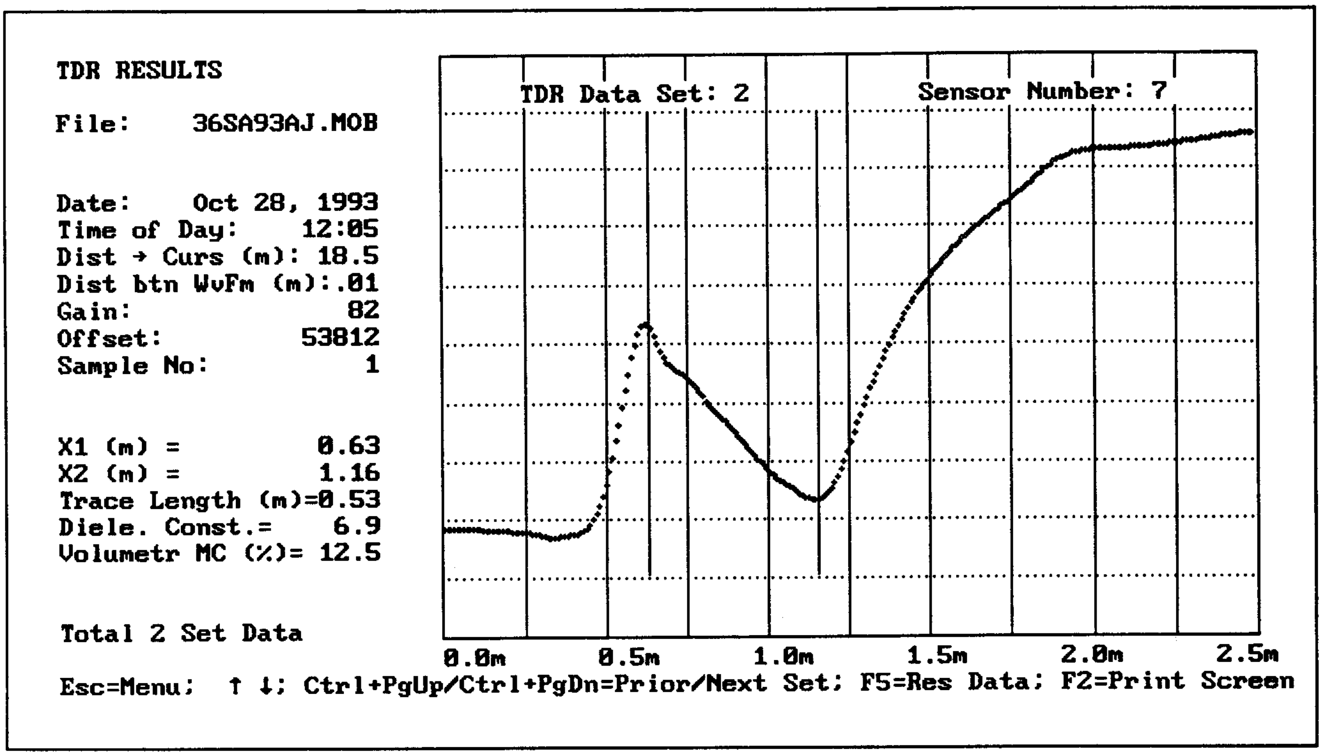


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

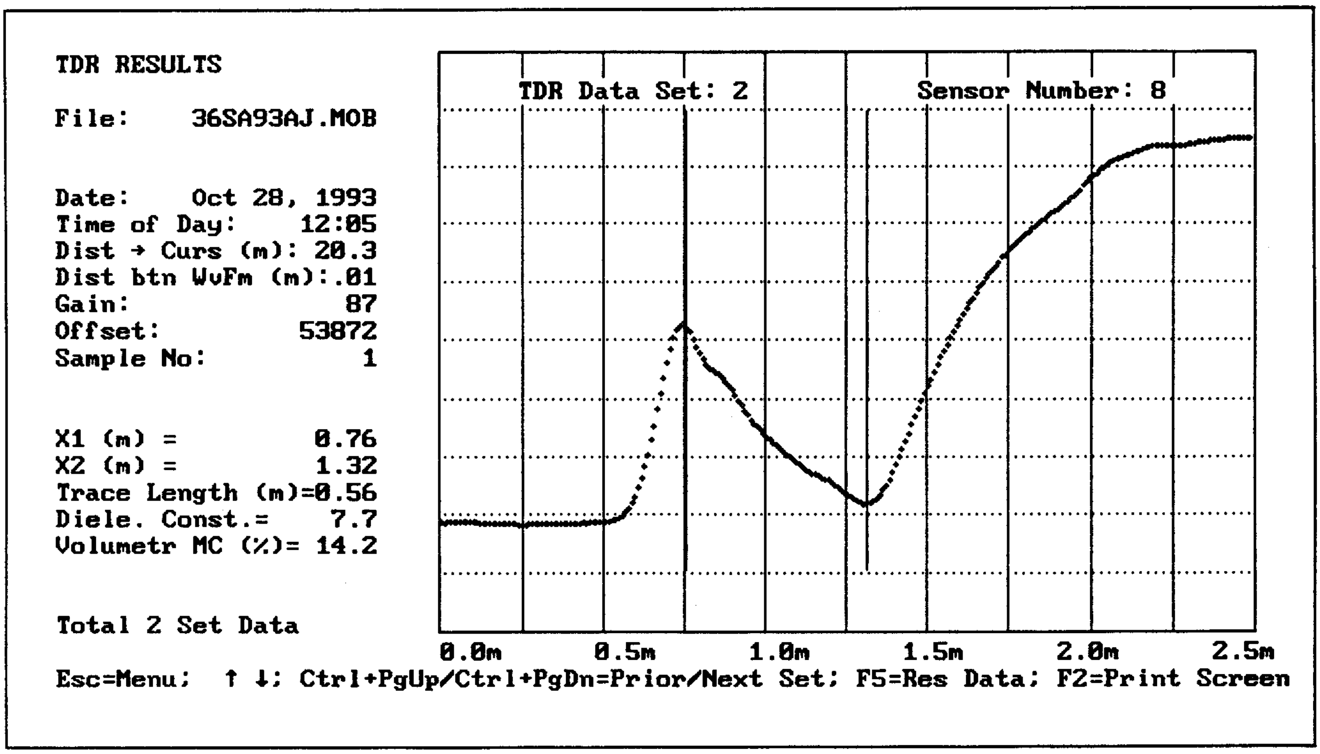


Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

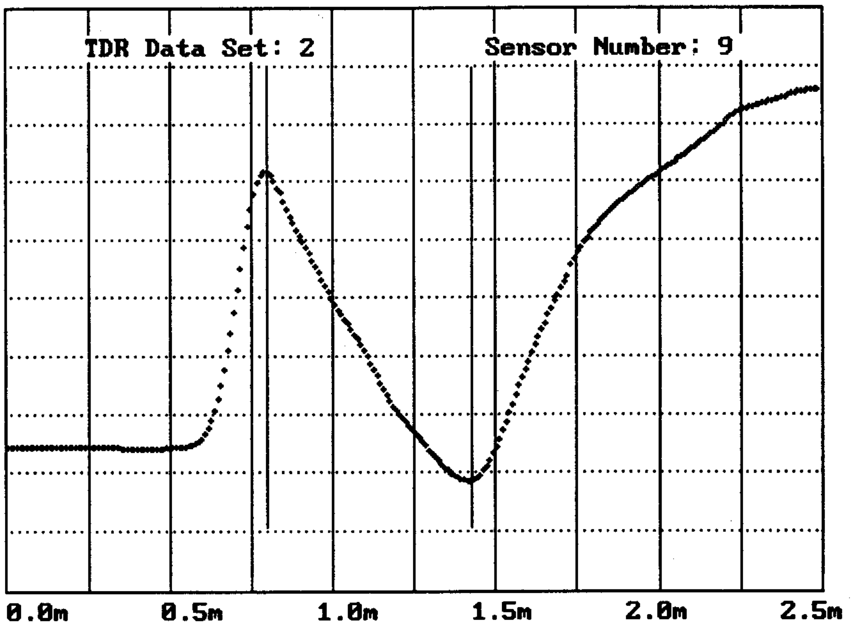
TDR RESULTS

File: 36SA93AJ.MOB

Date: Oct 28, 1993
Time of Day: 12:05
Dist → Curs (m): 20.5
Dist btn WvFm (m):.01
Gain: 96
Offset: 54084
Sample No: 1

X1 (m) = 0.80
X2 (m) = 1.43
Trace Length (m)=0.63
Diele. Const.= 9.8
Volumetr MC (%)= 18.5

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctrl+PgUp/Ctrl+PgDn=Prior/Next Set; F5=Res Data; F2=Print Screen

Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

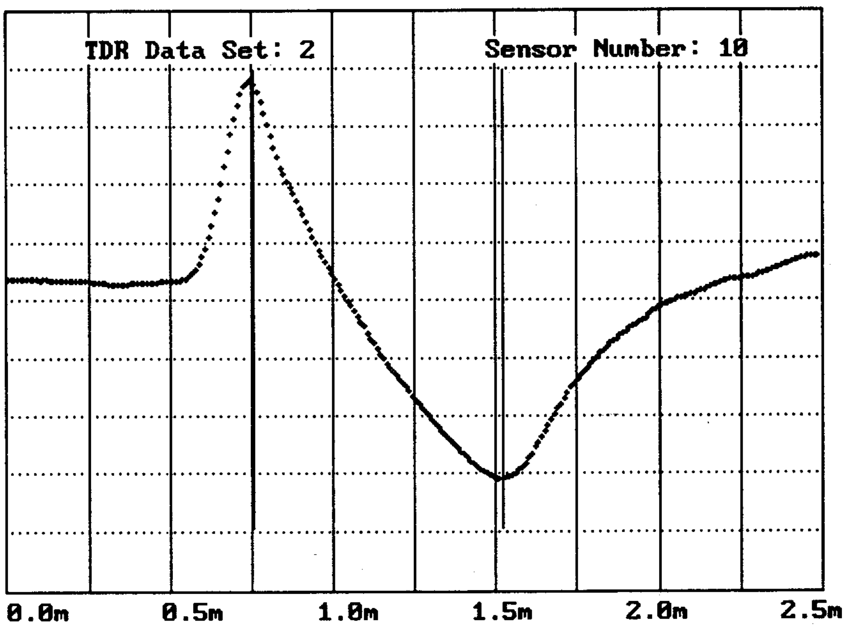
TDR RESULTS

File: 36SA93AJ.MOB

Date: Oct 28, 1993
Time of Day: 12:05
Dist → Curs (m): 20.3
Dist btn WvFm (m):.01
Gain: 88
Offset: 54227
Sample No: 1

X1 (m) = 0.76
X2 (m) = 1.53
Trace Length (m)=0.77
Diele. Const.= 14.7
Volumetr MC (%)= 27.0

Total 2 Set Data



Esc=Menu; ↑ ↓; Ctrl+PgUp/Ctrl+PgDn=Prior/Next Set; F5=Res Data; F2=Print Screen

Figure D-2(cont.). Initial Second Set of TDR Traces Measured with the Mobile Unit

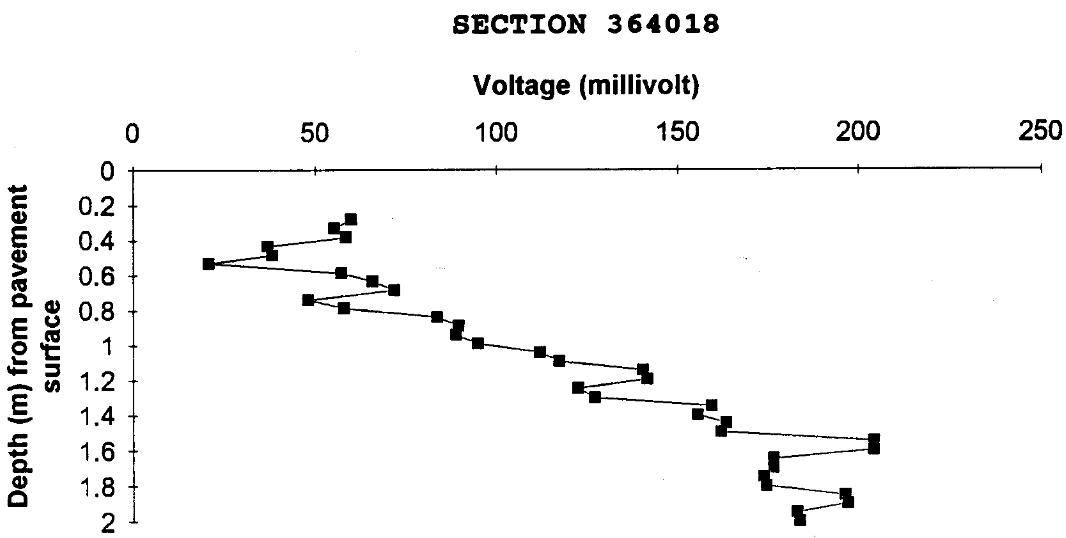


Figure D-3. Voltages Measured Using the Mobile System
During Initial Data Collection, October 28, 1993

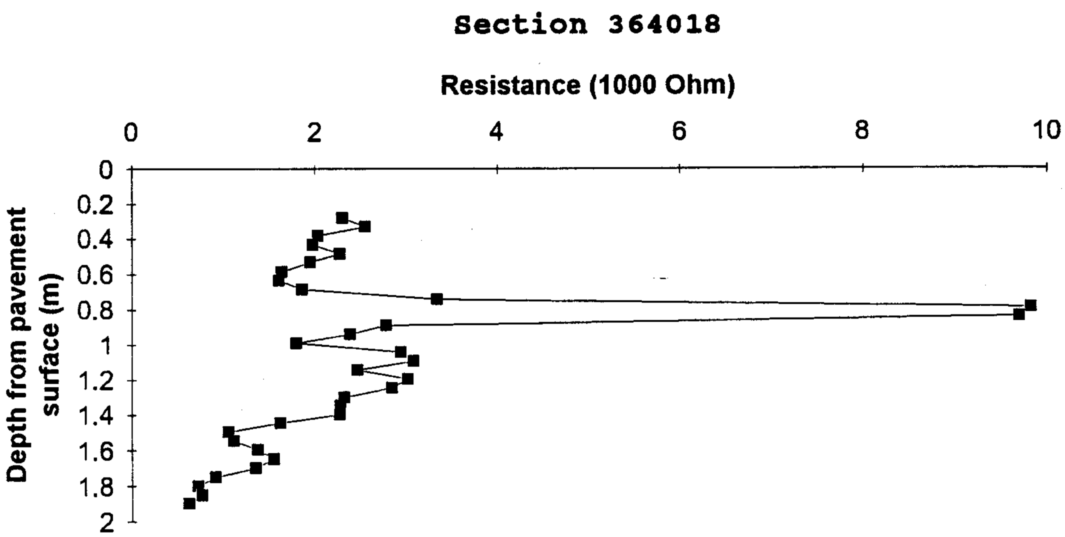


Figure D-4. Manually Collected Contact Resistance
During Initial Data Collection, October 28, 1993

Table D-1. Contact Resistance After Installation

LTPP Seasonal Monitoring Study	State Code	[36]
Data Sheet R1		
Contact Resistance Measurements	Test Section Number	[4018]

1. Date (Month-Day-Year)	[10-28-93]
2. Time Measurements Began (Military)	[1255]
3. Comments	After Installation * Note: Known Resistors

Test Position	Connections		Voltage (ACV)		Current (ACA)		notes
	I V	I V	Range Setting	Reading	Range Setting	Reading	
1	1	2	mV	274.6	uA	119.5	
2	3	2	mV	280.9	uA	110.2	
3	3	4	mV	266.8	uA	131.3	
4	5	4	mV	265.1	uA	134.1	
5	5	6	mV	274.4	uA	120.5	
6	7	6	mV	264.1	uA	135.6	
7	7	8	mV	251.5	uA	154.0	
8	9	8	mV	250.7	uA	156.2	
9	9	10	mV	261.5	uA	140.8	
10	11	10	mV	296.4	uA	88.6	
11	11	12	mV	333.1	uA	33.9	
12	13	12	mV	332.6	uA	34.3	
13	13	14	mV	287.7	uA	103.4	
14	15	14	mV	274.6	uA	114.9	
15	15	16	mV	260.8	uA	145.3	
16	17	16	mV	289.7	uA	98.6	
17	17	18	mV	290.1	uA	94.2	
18	19	18	mV	279.9	uA	113.5	
19	19	20	mV	291.3	uA	96.5	
20	21	20	mV	288.6	uA	101.6	
21	21	22	mV	276.5	uA	119.1	
22	23	22	mV	275.1	uA	120.5	
23	23	24	mV	275.0	uA	120.8	
24	25	24	mV	251.7	uA	155.4	
25	25	26	mV	218.4	uA	206.4	
26	27	26	mV	223.0	uA	199.7	
27	27	28	mV	239.9	uA	174.7	
28	29	28	mV	249.3	uA	160.6	
29	29	30	mV	238.4	uA	176.7	
30	31	30	mV	206.2	uA	224.3	
31	31	32	mV	185.4	uA	254.2	
32	33	32	mV	190.5	uA	246.4	
33	33	34	mV	172.5	uA	272.8	
34	35	34	mV	136.1	uA	326.2	
35	35	36	mV	123.7	uA	340.6	
36 *	37	38	mV		uA		
37 *	38	39	mV		uA		
38 *	39	40	mV		uA		

Preparer:	Michael Zawisa	Employer:	PMSL

Note: Large rocks between 10 and 12.

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

Seasonal Uniformity Survey	Falling Weight Deflectometer
Site Number: 364018	Data Collection and
Date Surveyed: October 27-October 28, 1993	Processing Summary

Section Interval (ft)	Mean Deflection Values for HT 2 (mils) Corrected								Mean Temp D1 (F)
	Sensor 1	Sensor 1 std dev	Sensor 7	Sensor 7 std dev	Volum K	Volum K std dev	Effective Thick.	Effective Thick. std dev	
70 to 448 **Oct 27** @ 0931	3.38	0.28	1.52	0.25	309	42	9.39	0.15	55.7
-12 to 197 **Oct 28** @ 0937	3.51	0.32	1.49	0.23	301	35	9.20	0.31	46.7
-12 to 197 **Oct 28** @ 1158	3.68	0.23	1.59	0.15	282	21	9.13	0.23	51.1

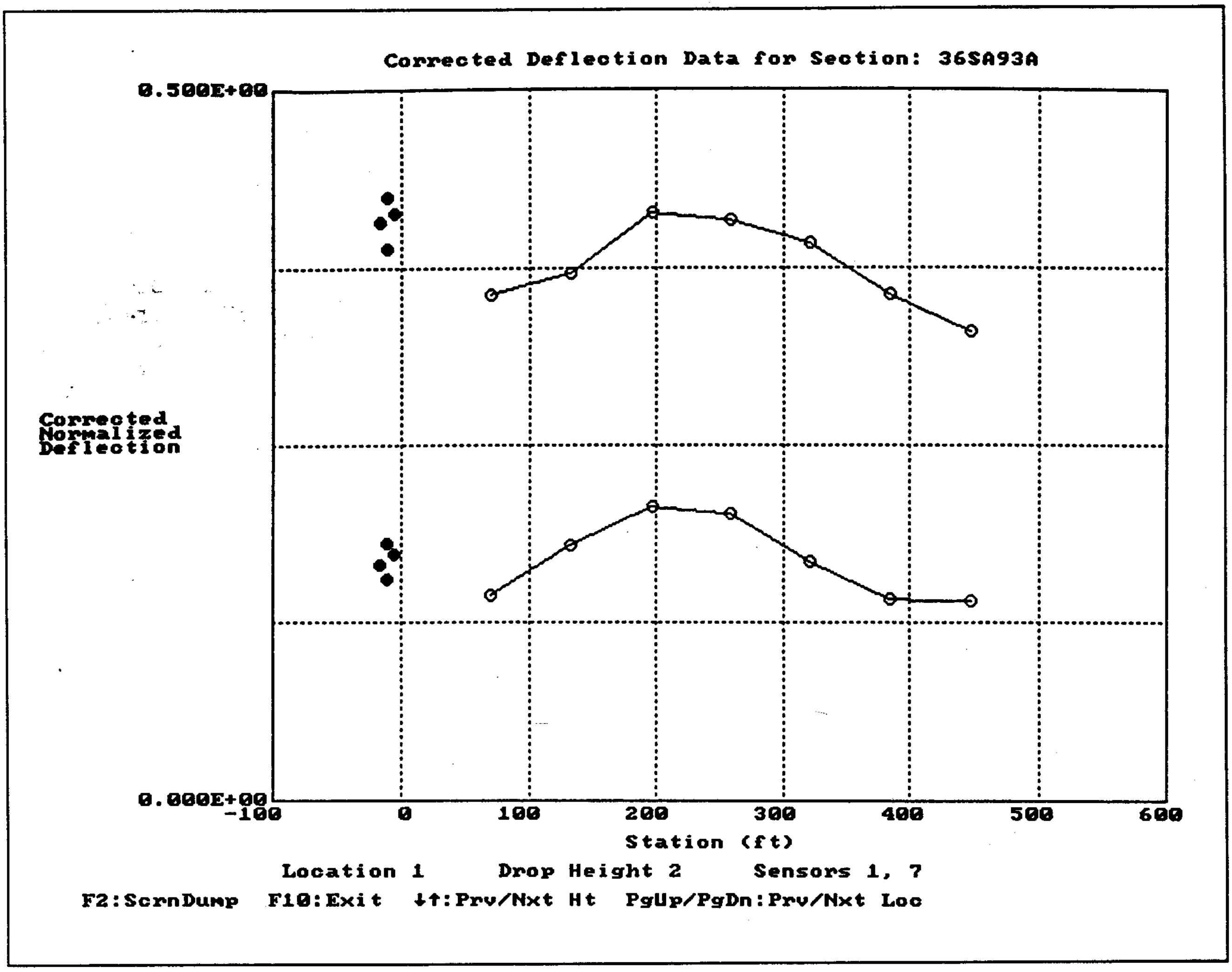


Figure D-5. Deflection Profiles from FWDCHECK
(Test Date and Time October 27, 1993 @ 0931)

Table D-3. Volumetric K and Effective Thickness from FWDCHECK
(Test Date and Time October 27, 1993 @ 0931)

Rigid Pavement Thickness Statistics - 36SA93A - Drop Height 2			
Subsection	Station	Volumetric K	Effective Thickness
TP	-18	297	8.94
1	70	341	9.50
	133	294	9.50
	197	256	9.31
	259	263	9.31
	322	302	9.13
	385	346	9.50
	448	362	9.50
TP	-12	276	8.94
Subsection 1	Overall Mean	309	9.39
	Standard Deviation	42	0.15
	Coeff. of Variation	13.44%	1.57%

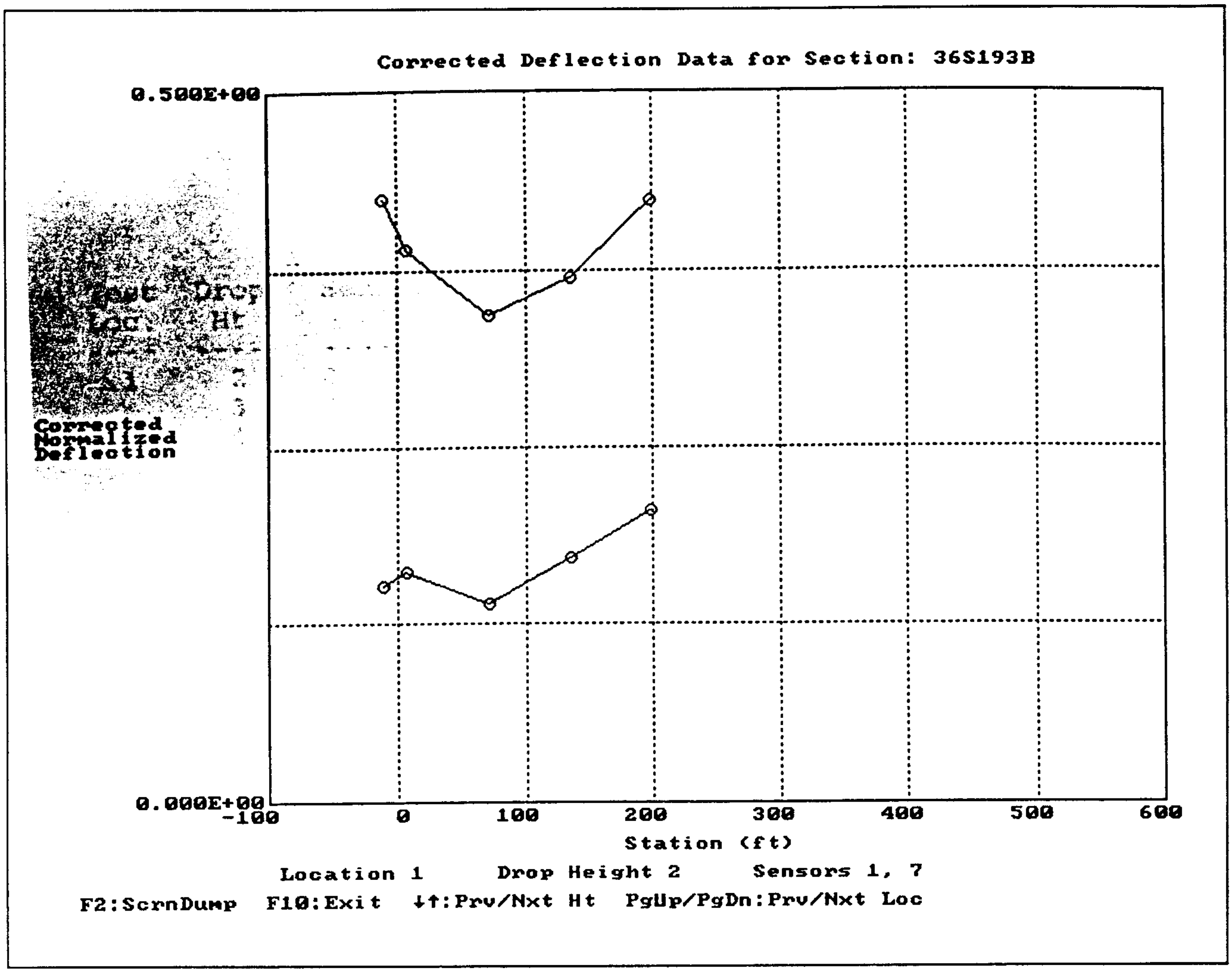


Figure D-6. Deflection Profiles from FWDCHECK
(Test Date and Time October 28, 1993 @ 0937)

Table D-4. Volumetric K and Effective Thickness from FWDCHECK
(Test Date and Time October 28, 1993 @ 0937)

Rigid Pavement Thickness Statistics - 36S193B - Drop Height 2			
Subsection	Station	Volumetric K	Effective Thickness
1	-12	301	8.75
	7	303	9.13
	70	351	9.50
	133	297	9.50
	197	253	9.13
Subsection 1	Overall Mean	301	9.20
	Standard Deviation	35	0.31
	Coeff. of Variation	11.57%	3.41%

Note: No test pit data found, therefore no results exist...

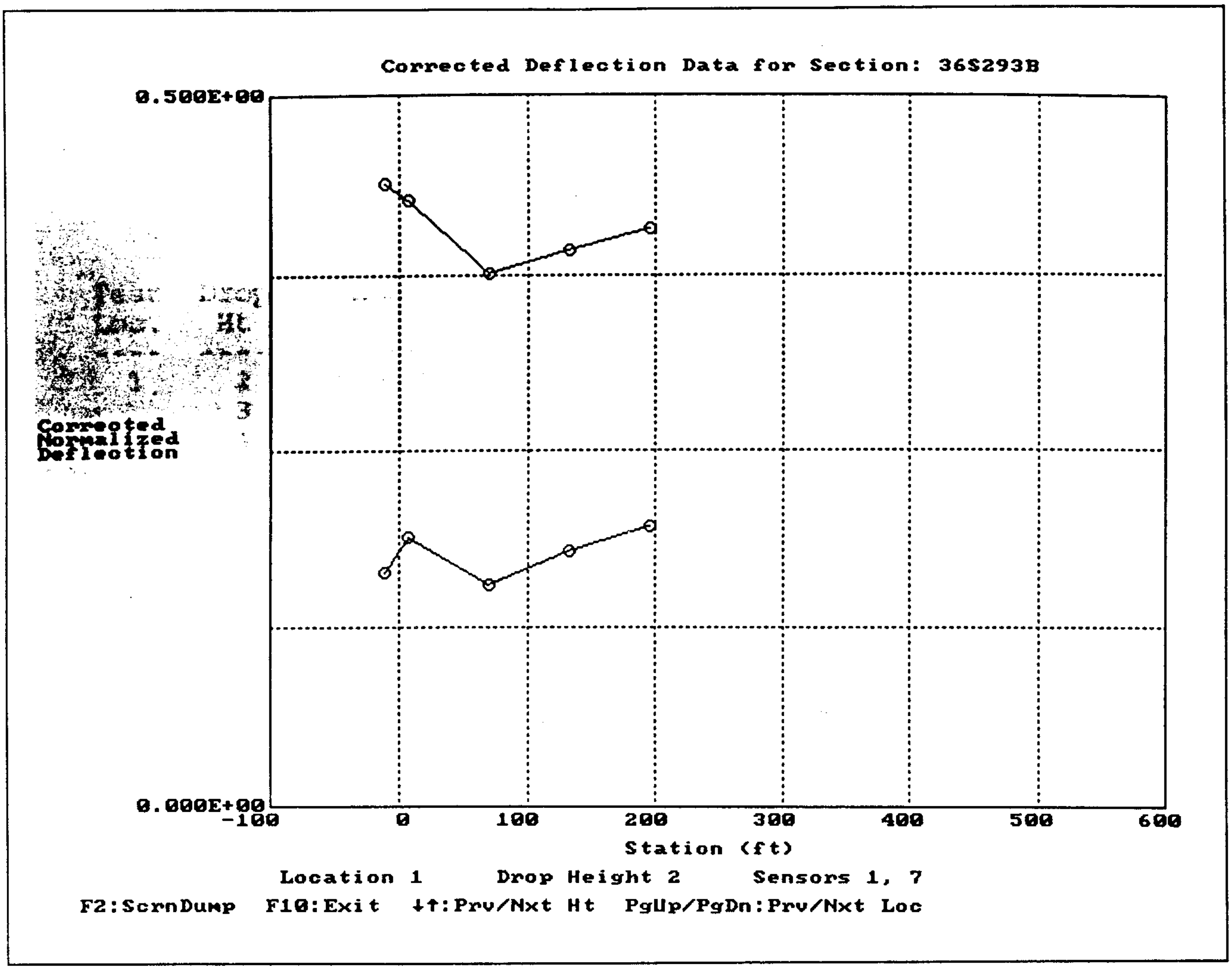


Figure D-7. Deflection Profiles from FWDCHECK
(Test Date and Time October 28, 1993 @ 1158)

Table D-5. Volumetric K and Effective Thickness from FWDCHECK
(Test Date and Time October 28, 1993 @ 1158)

Rigid Pavement Thickness Statistics - 36S293B - Drop Height 2			
Subsection	Station	Volumetric K	Effective Thickness
1	-12	284	8.75
	7	264	9.13
	70	315	9.13
	133	286	9.31
	197	264	9.31
Subsection 1	Overall Mean	282	9.13
	Standard Deviation	21	0.23
	Coeff. of Variation	7.48%	2.52%

Note: No test pit data found, therefore no results exist...

Table D-6. Surface Elevation Measurements

LTPP Seasonal Monitoring Study	State Code	[36]
Surface Elevation Measurements	Test Section Number	[4018]

Survey Date	October 28, 1993
Surveyed By	MZ & PZ
Surface Type	PCC
Benchmark	Observation Piezometer - 1.000 meters - assumed

STATION		OSE m offset 0.08 m	MS m offset 1.98m	ISE m offset 3.56m
0-29.75	3+20	1.893	1.933	1.963
0-29.50	3+30	1.893	1.933	1.963
0-12.00	3+40	1.853	1.890	1.914
0+05.75	3+60	1.747	1.780	1.811
0+38.00	3+70	1.619	1.658	1.680
0+38.25	3+80	1.619	1.658	1.680
0+69.75	4+00	1.485	1.527	1.558
1+00.75	4+10	1.366	1.411	1.439
1+01.00	4+20	1.363	1.408	1.433
1+32.50	4+40	1.256	1.296	1.323
1+63.75	4+50	1.137	1.183	1.204
1+64.00	4+60	1.131	1.180	1.204
1+95.50	5+00	1.085	1.055	1.006
2+26.25	5+20	0.875	0.927	0.957

OSE	Outer Slab Edge
MS	Mid Slab
ISE	Inner Slab Edge

APPENDIX E

Photographs

Figure E-1. Site Overview

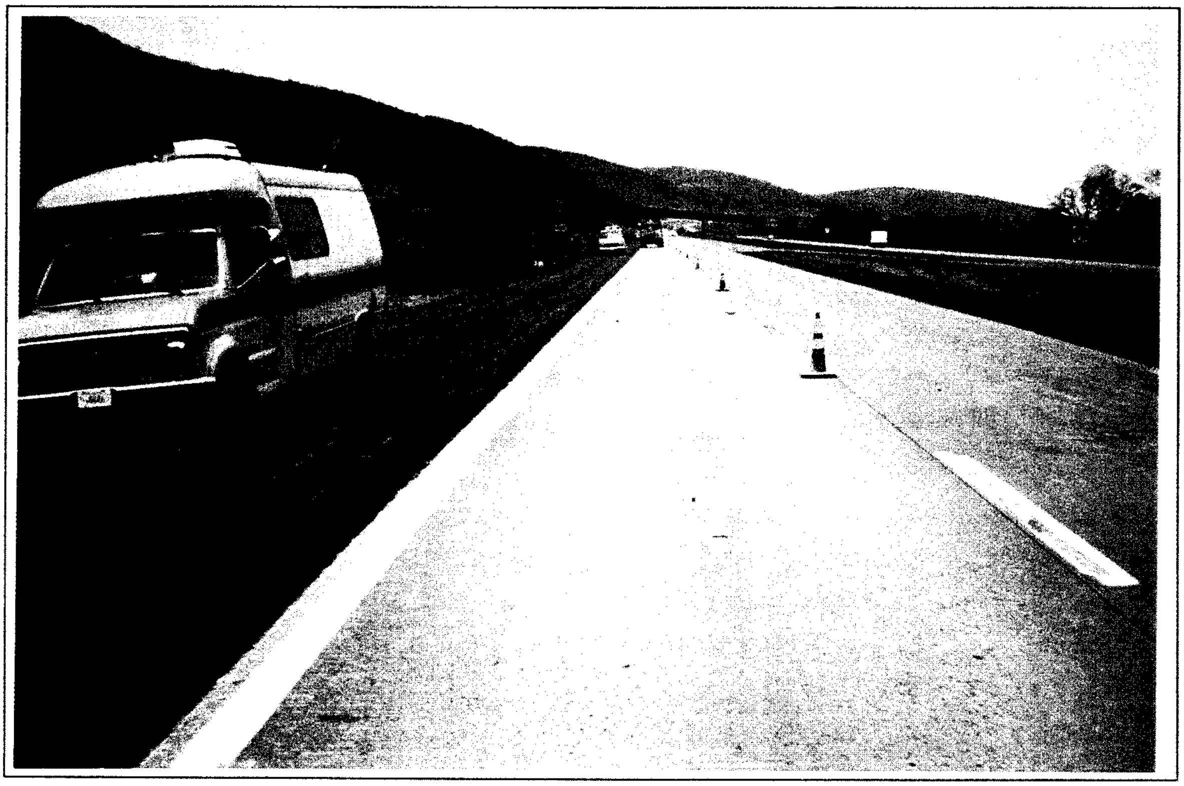


Figure E-2. Site Overview

Figure E-3. Equipment Cabinet, Air Temperature Probe, and Rain Gage

Figure E-4. Instrument Hole, Trench, and Equipment Cabinet

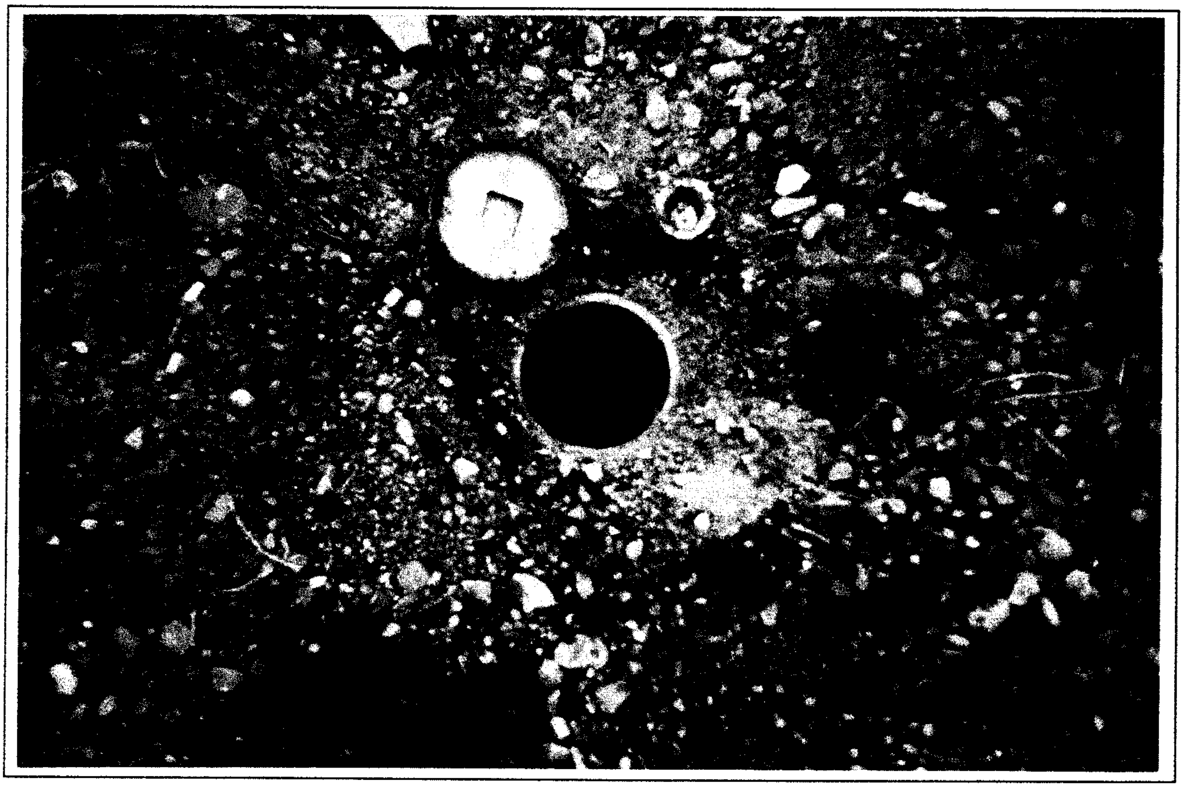


Figure E-5. Observation Well

Figure E-6. State Bench Mark

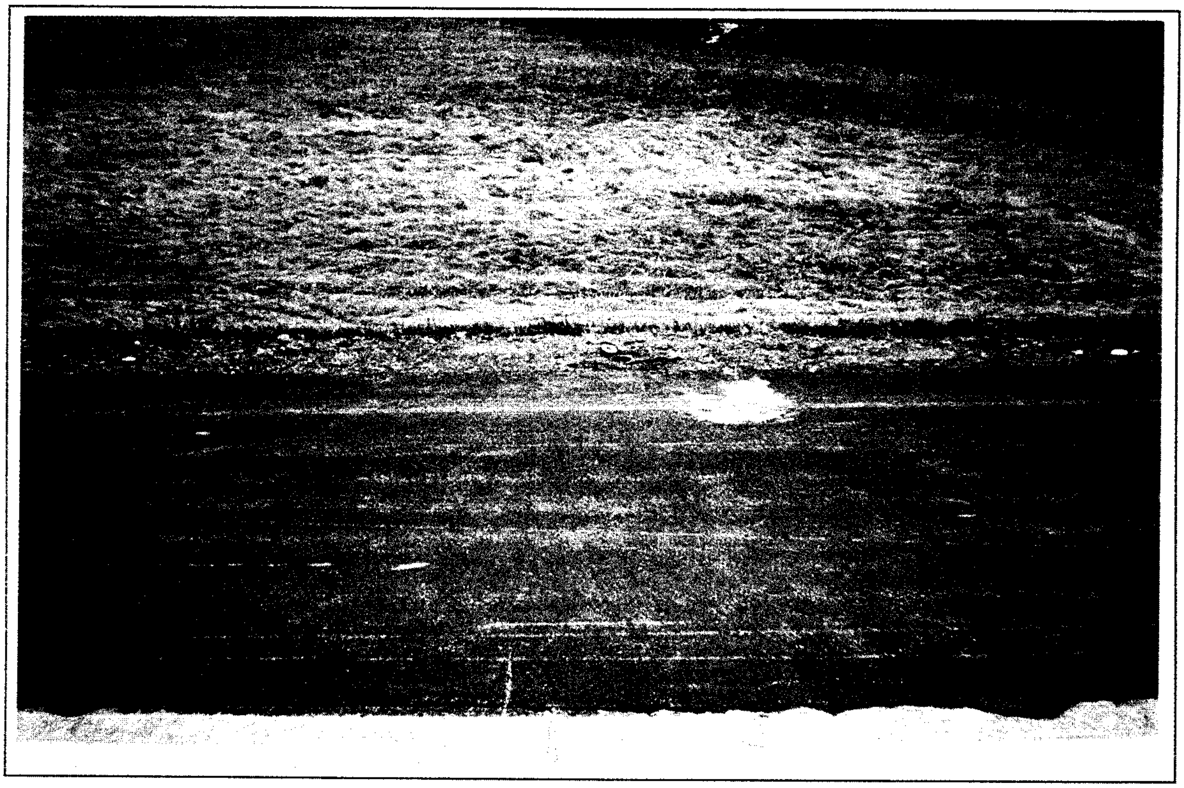


Figure E-7. Observation Well and vaguely in the background the State Bench Mark