LTPP Seasonal Monitoring Program

Site Installation Report for GPS Section 276251 (27C) Bemidji, Minnesota

Report No. FHWA-

January 1996

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Report No. FHWA-

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16. Abstract

This report contains instrumentation installation details and data collection summaries for GPS test section 276251, which is a core section in the LTPP Seasonal Monitoring Program. This asphalt concrete pavement section on U.S. Highway 2 south of Bemidji, Minnesota, was instrumented September 14, 1993. Instrumentation included time domain reflectometry (TDR) probes to estimate moisture content in unbound pavement layers, thermistor probes to measure pavement structure thermal gradients and air temperature, electrical resistivity probe to predict frost/thaw conditions, piezometer to measure water table depth below the pavement surface, and tipping-bucket rain gauge to measure precipitation.

Monitoring data was collected the day after instrument installation and roughly on a monthly basis from September 1993 to June 1995. In addition to temperature and precipitation data that were collected continuously by a datalogger at the site, monitoring data each month usually included Falling Weight Deflectometer data, TDR probe readings, frost/thaw readings, and piezometer readings. On a less regular basis, longitudinal profile data, pavement surface elevation data, and manual distress data were collected as required by FHWA guidelines. A summary of data collected is included in the report.

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Long Term Pavement Performance, LTPP, Pavement Instrumentation, Seasonal Monitoring Program, SMP, Time Domain Reflectometry, TDR, Resistance, Frost, Thaw, Temperature, Thermistor, Water Table, Piezometer, Falling Weight Deflectometer, FWD	

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LTPP Seasonal Monitoring Program
Site Installation Report for GPS Section 276251 (27C)
Bemidji, Minnesota

I. Introduction

This report contains information specific to instrument installation and monitoring data collection for the Long Term Pavement Performance (LTPP) General Pavement Study (GPS) section 276251, which is part of the core Seasonal Monitoring Program (SMP) under the Federal Highway Administration (FHWA) LTPP Division. This pavement section was instrumented on September 14, 1993, and had regular data collection through June 15, 1995. The section will be monitored every other year under the LTPP Study for a ten-year period or until it is removed from the study.

A. Test Site Location

GPS section 276251 is located in northern Minnesota on the westbound driving lane of U.S. Highway 2 on the south side of Bemidji at milepost 113.8.

B. General Test Section Information

This four-lane divided highway had the original 180-mm thick asphaltic concrete surface placed in 1982. The rest of the pavement structure consists of a 260-mm granular base on a coarse-grain subgrade. Additional background information about the section is located in Appendix A-1. This information includes, but is not limited to, the following items:

- SMP location map;
- Detailed section location map;
- SHRP Inventory Data Sheet - traffic, design factors, and layer information;
- SHRP Section Field Verification Form;
- IMS L05A and L05B tables - layer thickness and material type; and
- LTPP Form S04 - base and subgrade moisture data.

Relevant pre-installation monitoring data for the section located in Appendix A-2 includes the following:

- Pre-installation pavement distress data;
- Pre-installation FWD data (includes tests outside the section limits); and
- FWDCHECK program uniformity analysis results.

C. SMP Test Section Information

The geographic location and existing pavement structure place this section in Cell 16 of the SMP experiment, which is defined by the following parameters:

- Thick asphaltic concrete pavement (more than 127-mm thick);
- Coarse-grain subgrade;
- Freezing environment; and
- Wet environment.

This was the third SMP installation in the LTPP North Central Region, and highlights of the installation are summarized in Section IV of this report. The people involved with the installation are listed on "Data Sheet SMP-I01: List of Installed Instrumentation," which is included in Appendix C-1 along with other SMP installation forms.

Data for this 1993 installation were transferred to forms from the LTPP Seasonal Monitoring Program: Instrumentation and Data Collection Guidelines, April 1994. The 1994 forms were used to keep all installation reports uniform and to facilitate data entry into the IMS database. Data transfer included conversion from English to metric units with some rounding error. On some forms, data are not available regarding procedure modifications adopted in 1994. On these forms the cells are usually blank, and a comment is included on the form to explain the missing data.

II. Instrumentation Installation

A. Pre-Installation Activities

The Minnesota Department of Transportation (MnDOT) routinely monitors seasonal changes on pavement structures, especially regarding frost/thaw conditions for posting spring load restrictions. In this respect, MnDOT was very willing to participate in the SMP, and GPS sections 271018, 271028, 274040, and 276251 were included in the core SMP study.

Mr. Fred Maurer of MnDOT was initially contacted regarding potential sections for the core experiment in Minnesota. Mr. Maurer worked with district offices to evaluate potential sections with the requirement to defer rehabilitation at least five years. This is the minimum period required to get three years of monitoring data that is collected every other year.

Minnesota GPS sections 271023, 271028, 271029, 271087, and 276251 are all in SMP Cell 16, and sections 271028 and 276251 were approved for the core SMP experiment. With respect to GPS section 276251, MnDOT agreed to defer any rehabilitation at least long enough to get the minimum number of monitoring cycles, as long as pavement conditions were not a safety concern. Section 276251 is the control section for the SPS-3 sections at this location.

On July 15, 1993, Regional Coordination Office (RCO) staff met with MnDOT staff at the Materials and Research facility in Maplewood, Minnesota. This meeting was held to coordinate support from MnDOT's Geotechnical and Foundations Division regarding a drill rig and various materials that the Materials and Research facility would supply for the four installations in Minnesota. At this meeting, tentative installation dates were discussed for all four installations to enable MnDOT staff to verify availability of equipment and materials. Also, the RCO was looking at a very tight schedule to complete seven SMP installations in the region before winter weather conditions would prevent any additional installations. At this meeting, an August 12, 1993 date was set for a group pre-installation meeting for all MnDOT and RCO staff involved with the four installations. The agenda and notes from the meeting in Maplewood are included in Appendix B-1.

On August 12, 1993, the group pre-installation meeting was held in Baxter, Minnesota. The meeting agenda, list of participants, and notes from the meeting are included in Appendix B-1.

On the way to the group pre-installation meeting in Baxter, RCO staff stopped at GPS section 271018 to identify any installation concerns with the site and to select which end of the section to monitor. After the group meeting, RCO staff visited GPS sections 271028, 276251, and 274040. Field notes from the site visit for section 276251 are included in Appendix B-1.

At the RCO, pre-installation activities included performing instrumentation checks/calibrations, and incorporating improvements to the installation process based on field notes from previous installations. Improvements to the installation process are listed in Section IV of this report, and results from instrumentation checks/calibration are included in Appendix B-2. The checks were performed according to 1993 guidelines, but the results are reported using 1994 forms, as discussed earlier. The forms include the following:

- Data Sheet SMP-C01: TDR Probe Check;
- Data Sheet SMP-C02: Thermistor and Air Temperature Probe Check;
- Data Sheet SMP-C03: Electrical Resistivity Probe Check;
- Data Sheet SMP-C04: Function Generator, Multi-meter, and Switch Box Checks; and
- Data Sheet SMP-C05: Tipping-Bucket Rain Gauge Calibration.

For the TDR probes, checks/calibrations were done with the cable reader settings for velocity of propagation at 0.50 and the noise filter at 8.0, which are different than listed in the guidelines. Also, TDR probe 1 failed the check in water, but this was not realized until after the probe had been installed.

With respect to instrument checks on the resistivity probe, Data Sheet SMP-C03 requires "distance from top of probe" for each electrode. However, procedures in 1993 recorded "spacing between electrodes" on two separate lines about 180 degrees apart on the probe. As a consequence, cumulative errors from adding the 35 "spacings" had to be accounted for to transfer the data to the 1994 form. Adjustments were performed as described below to estimate "distance from top of probe" within ± 5 mm:

1. Obtained average values for probes checked in 1994 and 1995 for the following:
   - Electrode No. 1 assigned 29 mm (± 2 mm) if not measured;
   - Electrode No. 17 in the range 840 mm $\pm$ 3 mm as a check; and
   - Electrode No. 36 assigned at 1,805 mm from the top of the probe.
   - Average electrode spacing is (1805 - 29)/35, which is 50.74 mm.

2. Added the 35 "spacings" measured for the first line, divided the value by 35 to get the average, subtracted 50.74 mm to get adjustment value, and subtracted adjustment value from each "spacing."

3. Repeated Step 2 for the second line.

4. Added two adjusted "spacings" and divided by two to get "adjusted average spacing."

5. Recorded Electrode No. 1 at 29 mm and cumulated "adjusted average spacings" to get "distance from top of probe" for the remaining 35 electrodes.

6. Checked "distance from top of probe" for Electrode No. 17 in the range 840 mm $\pm$ 3 mm and Electrode No. 36 in the range 1,805 mm $\pm$ 2 mm.

For the air temperature probe, no readout device was available while the thermistor probe was checked. Therefore, the only check possible was to compare thermistor and air temperature probe readings obtained overnight with both probes connected to the datalogger. The air temperature probe was within ± 1.0 °C of the average reading on the thermistor probe. Also, in 1993 no forms were used to record thermistor data checks, and for this site the hand recorded data is missing.

For the resistivity probe, loose electrode wraps were tightened by twisting the lead with a needle-nose pliers, and lead wires sticking out of the potting material for the probe were covered with silicon sealant for protection during installation. Excess potting material was scrapped off the electrodes for better contact with the soil.

Pre-installation activities also required selection of the instrumentation location. From field observations during the August 12, 1993 site visit and FWDCHECK program analysis for the section, Station 3+00 to Station 5+20 was selected for monitoring, and instrumentation would be placed at Station 5+15, based on the following items:

- Avoids overhead power line crossing the road at Station 0+00;
- Less pavement distress at the test locations; and
- Subgrade strength at the instrumentation location was more representative of the adjacent monitoring section.

B. Installation Activities

Instrumentation installation was completed on September 14, 1993 in spite of cold temperatures and drizzle that continued most of the day. Some final installation activities continued on the following day. The following installation forms are included in Appendix C-1 along with field notes and photographs of the installation:

- Data Sheet SMP-I01: List of Installed Instrumentation;
- Data Sheet SMP-I02: Instrumentation Locations;
- Data Sheet SMP-I03: Log of Piezometer Hole;
- Data Sheet SMP-I04: Log of Instrumentation Hole;
- Data Sheet SMP-I05: Field Gravimetric Moisture Contents;
- Data Sheet SMP-I05(A): Lab Gravimetric Moisture Contents;
- Data Sheet SMP-I05(B): Gravimetric Moisture Comparison;
- Data Sheet SMP-I06: TDR Moisture Content; and
- Data Sheet SMP-I07: Representative Dry Density.

Piezometer installation was complicated by the coarse-grain subgrade caving in at a depth of 2.5 m with saturated sands starting at a depth of about 2.75 m. Several unsuccessful attempts were made to get the required depth, but the sands continued to cave in at about 2.5 m. Attempts with the drill rig to push the piezometer assembly into the subgrade also failed. MnDOT staff cut about 0.6 m off the bottom of the piezometer, and the drill rig was able to push the 3.73-m long piezometer assembly below the existing shoulder. It was not possible to place filter sand around the bottom of the piezometer because the hole caved in. This is not a problem because the subgrade soils are sand.

A 0.6-m long access tube was set in concrete just below the existing shoulder material to protect the top of the piezometer and provide easy access for measurements. A 3.0-m long grease sleeve was used on this piezometer to isolate the piezometer from frost heave. The grease sleeve extends about 0.2 m up into the access tube and the space between the two is filled with sand. Additional field notes on piezometer installation are included in Appendix C-1.

The lane width, referenced to the edge stripe, varied from 3.66 m to greater than 3.9 m on this curved section of roadway, and the edge stripe could not be used to locate the instrumentation hole. Instead, a lane-edge reference was established 3.66 m from the cold-joint crack down the center of the two-lane road, and wheel tracks visible on the pavement surface also supported the 3.66-m wide lane.

The established lane-edge reference was used to mark a 460-mm square for the instrumentation hole and a 125-mm wide trench for the conduit on the pavement surface at Station 5+15. FWD testing was done prior to cutting the pavement, but tests were only completed from Station 5+00 to Station 5+20 because of equipment problems.

The pavement surface above the instrumentation location was lifted out using anchors tapped into the pavement, and it was set aside for later replacement. The drill rig was moved into position over the hole and material was put into buckets as it was removed from the hole in 0.15-m lifts.

TDR probes were placed according to protocol with TDR probe 1 mid-depth in the granular base.

For installation reports from the LTPP North Central RCO, "Data Sheet SMP-I05(A): Lab Gravimetric Moisture Contents," is used to report DOT lab moisture results. Also, "Data Sheet SMP-I05(B): Gravimetric Moisture Comparison" was created to summarize moisture data obtained from field moisture tests, laboratory moisture tests, and interpretation of TDR probe data. These forms are included in Appendix C-1, and the following assumptions and conclusions were made regarding the moisture data:

- LTPP Directive Number: SM-13 "TDR Trace Interpretation Method for Calibration and Function Checks" dated August 17, 1995 was used to interpret the apparent length of each TDR trace obtained during installation for estimating moisture results. This method was specified for "calibration and function checks," but no other method had been distributed by FHWA LTPP staff. The interpreted apparent lengths are reported on "Data Sheet SMP-I06: TDR Moisture Content" in Appendix C-1.

- Equations on pages II-2 and II-5 of the LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines, April 1994 were used to convert apparent lengths to gravimetric moisture estimates for the base and subgrade materials, and the results are included on "Data Sheet SMP-I05(B): Gravimetric Moisture Comparison," located in Appendix C-1.

- All TDR probe traces printed during the installation look similar including TDR probe 1 in the crushed gravel base. Moisture estimates from TDR probes 1 through 6 and TDR probe 10 average about 1.4 percentage points greater than the average obtained between field and laboratory data. For TDR probes 7 through 9, the data was less consistent, even between the lab and field data.

- Answers to the following questions could help explain the differences seen, but they are beyond the scope of this report:

  1. Are the equations used appropriate for coarse-grain subgrade and granular base materials?
  2. How much influence does compaction have on the results?

"Data Sheet SMP-I07: Representative Dry Density," was not used in 1993, but it is included in Appendix C-1 to keep the report complete and uniform with other installation reports.

Several items were changed regarding installation of the datalogger cabinet and weather pole as follows:

- RCO staff were not able to get the 9.1-m offset from the lane edge specified on page II-23 and Figure II-12 of the LTPP Seasonal Monitoring Program: Instrumentation Installation and Data Collection Guidelines, April 1994 because the TDR cables provided were too short. The cabinet at this site is offset about 7.9 m and the weather pole is offset about 8.2 m. This places the obstructions inside the normal 9.15-m safety zone for highways. However, FHWA LTPP Division staff approved the two obstructions as break-away objects (page II-32 of manual) for placement inside the safety zone.

- The bottom of the front panel on the datalogger cabinet was notched about 0.1 m so the conduit buried about 0.3 m below the shoulder was easier to get into the cabinet, and it also slightly increased the distance the cabinet could be placed from the roadway.

- The conduit for the air temperature probe and tipping-bucket rain gauge signal wires was cut into the back of the cabinet above ground instead of running the conduit underground as shown in the guidelines. If the cables were run underground, the air temperature probe signal cable would have to be extended using special wire and resistors to compensate for increased lead resistance. Also, a union coupler was used on the weather pole about 0.3 m above ground to make pole installation easier.

For pavement repairs, the block was placed in the hole and seated by driving a truck over the hole several times. The base material was adjusted three times before the block was the same height as the pavement, and the trench for the conduit was patched with cold-mix asphalt. W.R. Meadows "REZI-WELD 1000" multi-purpose construction epoxy was poured into the saw cuts to bond the pavement thermistor probe and original pavement surface material in place. This medium-viscosity epoxy had a 45-minute pot life which was sufficient to continue adding to the saw cuts as the epoxy settled. The saw cuts were filled to within about 15 mm of the pavement surface, and Dow Corning 890-SL was used to fill the remaining saw cuts the following day.

On September 15, 1993, final wiring of the datalogger in the cabinet was completed and MnDOT installed a level-one benchmark at Station 5+02 and offset -20.42 m from the driving lane. The stainless steel rod used for the benchmark extends 22-m deep to refusal. The MnDOT benchmark is expected to be more stable then the piezometer as a reference for pavement surface elevation data.

Additional observations about the pavement repair at the instrumentation hole up to the completion of this installation report include the following:

- Within the first month after the pavement repair, the trench material settled 6.0 mm.

- On May 17, 1994, a low severity longitudinal crack was recorded between the block and the lane edge. By May 10, 1995, the longitudinal crack between the block and the lane edge had increased to medium severity.

- By August 24, 1994, the crack sealant had separated between the block and the trench.
- On September 29, 1994, hairline cracks were recorded near the saw cuts.
- On June 15, 1995, about 12 mm of settlement on the conduit trench was corrected using cold-mix asphalt patching material.

III. SMP Data Collection

A. Initial SMP Data Collection

On September 15, 1993, test locations were marked on the pavement using the edge reference established the previous day. For each transverse location, offsets were measured from the centerline cold-joint crack, because a string line could not be used on the curved roadway. PK nails were placed at offsets 0.16 m and 3.51 m, and the first set of SMP data was collected.

Four cycles of FWD data were collected, as well as elevation data and piezometer data. The RCO had not received a switch box for manual readings on the resistivity probe, and manual readings were not taken until November 17, 1993. The November resistivity probe readings along with manual data collected September 15, 1993 are included in Appendix D-1 as follows:

- One set of contact resistance data;
- One set of four-point resistivity data;
- One ground water table measurement; and
- One set of elevation data, which included shots on the MnDOT benchmark.

Computer data files obtained from automated data collection using the dataloggers included the following:

- Two sets of TDR traces and CRREL voltages; and
- Temperature and precipitation data collected from the datalogger to verify operation overnight.

Temperature data from the thermistor probe should not be entered into the IMS database because of heat given off by epoxy used to repair the pavement and disturbance of material around the probe. In addition, temperature data up to several days after instrument installation will have to be reviewed to determine when the disturbed materials came back to thermal equilibrium. Data affected by the installation will have to be edited from the computer files.

B. Routine SMP Data Collection

Routine data collection was done on the site from September 15, 1993 through June 15, 1995, and MnDOT has continued to collect temperature and frost data from the site. LTPP's standard data tracking log, which summarizes the data collected on the site, is included in Appendix D-2.

Events that influenced the data collection and that will influence data interpretation for the site include the following:

- On November 17, 1993, a relay was added to the datalogger at the site, which included a change in the data format for subsequent files.

- On October 19, 1993, reference locations for the outside wheel path (OWP), which were placed at 0.91 m were shifted to 0.76 m for all remaining data collection. This only affects the elevation data collected September 15, 1993.

Instrumentation and equipment problems at the site include the following:

- Low moisture content in the sand subgrade produces short apparent lengths for the TDR data, and changes in moisture will be difficult to estimate. Also, the second inflection point on the TDR traces cannot be extrapolated by the intersection of a zero slope line through the minimum and a line drawn tangent to the signal out the end of the probe, because the signal slope through the probe remains positive. Screen prints of the TDR data are included in Appendix D-2.

- Pin 1 on the resistivity probe plug was repaired May 10, 1995. The pin was pushed into the plug. Also, the two readings involving electrode 36 had no current, which indicates an open circuit.

- Elevation difference between piezometer and MnDOT benchmark changed about 6.0 mm during the first frost/thaw cycle after installation as shown on the plot in Appendix D-2. The benchmark movement will complicate elevation data analysis for estimating frost heave.

Other problems experienced at the site include failures with switch boxes used to collect manual resistance and resistivity data and failures of the CRREL multiplexer for automated resistance data collection. Print screens showing the failure modes for the CRREL multiplexer are included in Appendix D-2.

IV. Summary, Conclusions, and Recommendations

A. Instrumentation Installation Highlights

The following items are identified by the authors as unique or particular items of interest regarding this section in the SMP.

- This was the third SMP installation in the LTPP North Central Region, and experience gained on previous installations decreased the installation time and people required.

- The Ohio DOT was planning a SPS project that included installation of similar instrumentation used for the SMP, and representatives from the Ohio DOT and several Ohio universities flew into Bemidji to visit the site and observe the installation procedures used by RCO staff.

- Moisture changes in the pavement structure may be affected by surface drainage characteristics for the pavement section located on the low side of the super elevation around a curve.

- Data for this 1993 installation were transferred to forms from the LTPP Seasonal Monitoring Program: Instrumentation and Data Collection Guidelines, April 1994.

B. Recommendations for Improving Installations

In addition to previous modifications from other installations, the following procedure and equipment changes from protocol were used during this installation:

- Placed a thin layer of epoxy in the instrumentation hole to fill voids in the bottom of the asphalt concrete block to help prevent settlement.

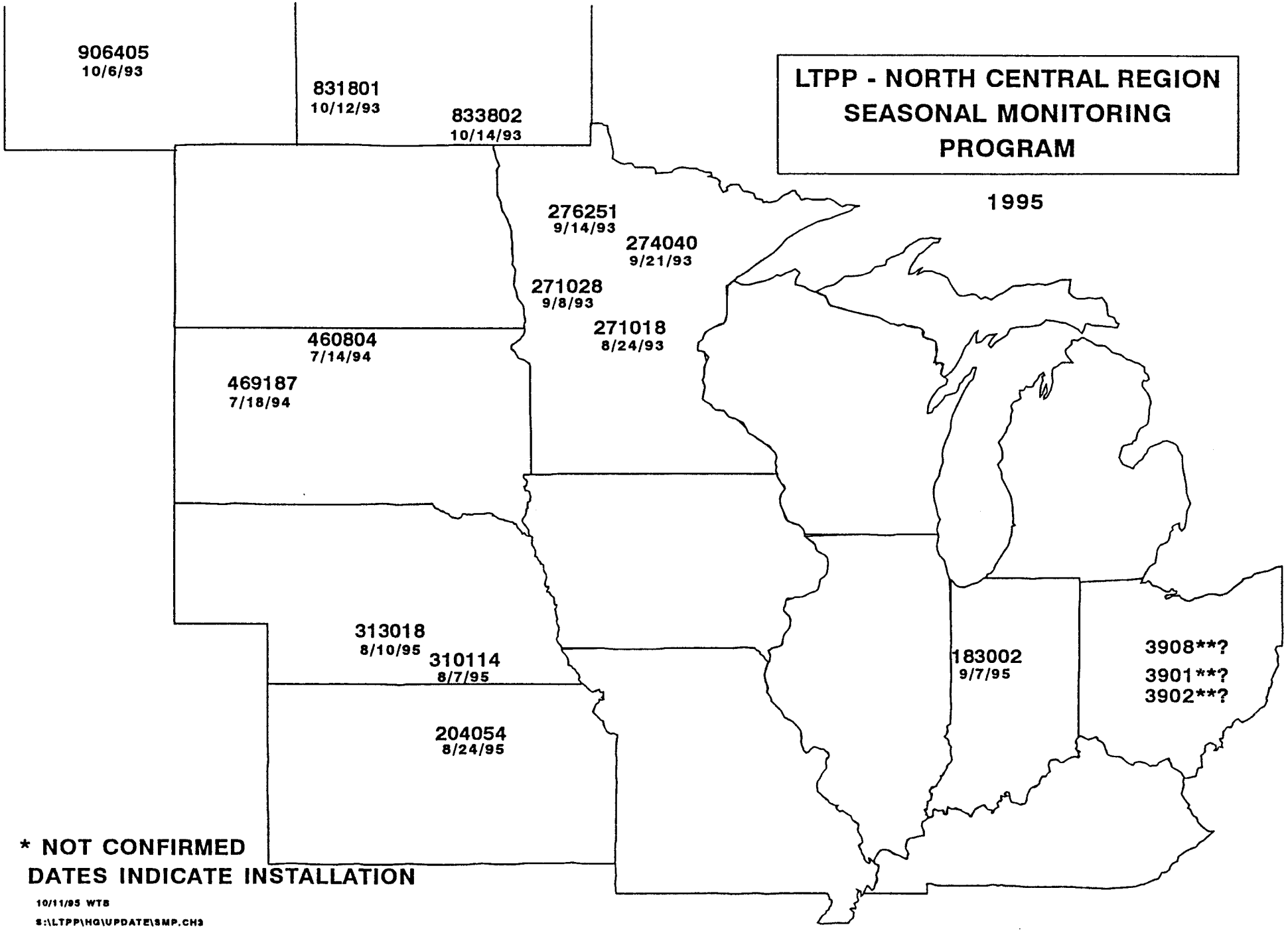
- Used a 0.1-m by 0.4-m board with five cable clips to hold TDR cables tight against the instrumentation hole while compacting materials.

- Purchased 30-m long conduit and cut it into three sections to avoid splicing 7.6-m long conduits to obtain 9.45-m long conduit required for the TDR, thermistor, and resistivity probe cables.

Appendix A-1: Test Section Background Information

Appendix A-1 contains the following test section background information:

- SMP location map;
- Detailed section location map;
- SHRP Inventory Data Sheet - traffic, design factors, and layer information;
- SHRP Section Field Verification Form;
- IMS L05A and L05B tables - layer thickness and material type; and
- LTPP Form S04 - base and subgrade moisture data.


LTPP - NORTH CENTRAL REGION
SEASONAL MONITORING
PROGRAM
1995
906405
10/6/93
831801
10/12/93
833802
10/14/93
276251
9/14/93
274040
9/21/93
271028
9/8/93
271018
8/24/93
460804
7/14/94
469187
7/18/94
313018
8/10/95
310114
8/7/95
204054
8/24/95
183002
9/7/95
3908**?
3901**?
3902**?
* NOT CONFIRMED
DATES INDICATE INSTALLATION
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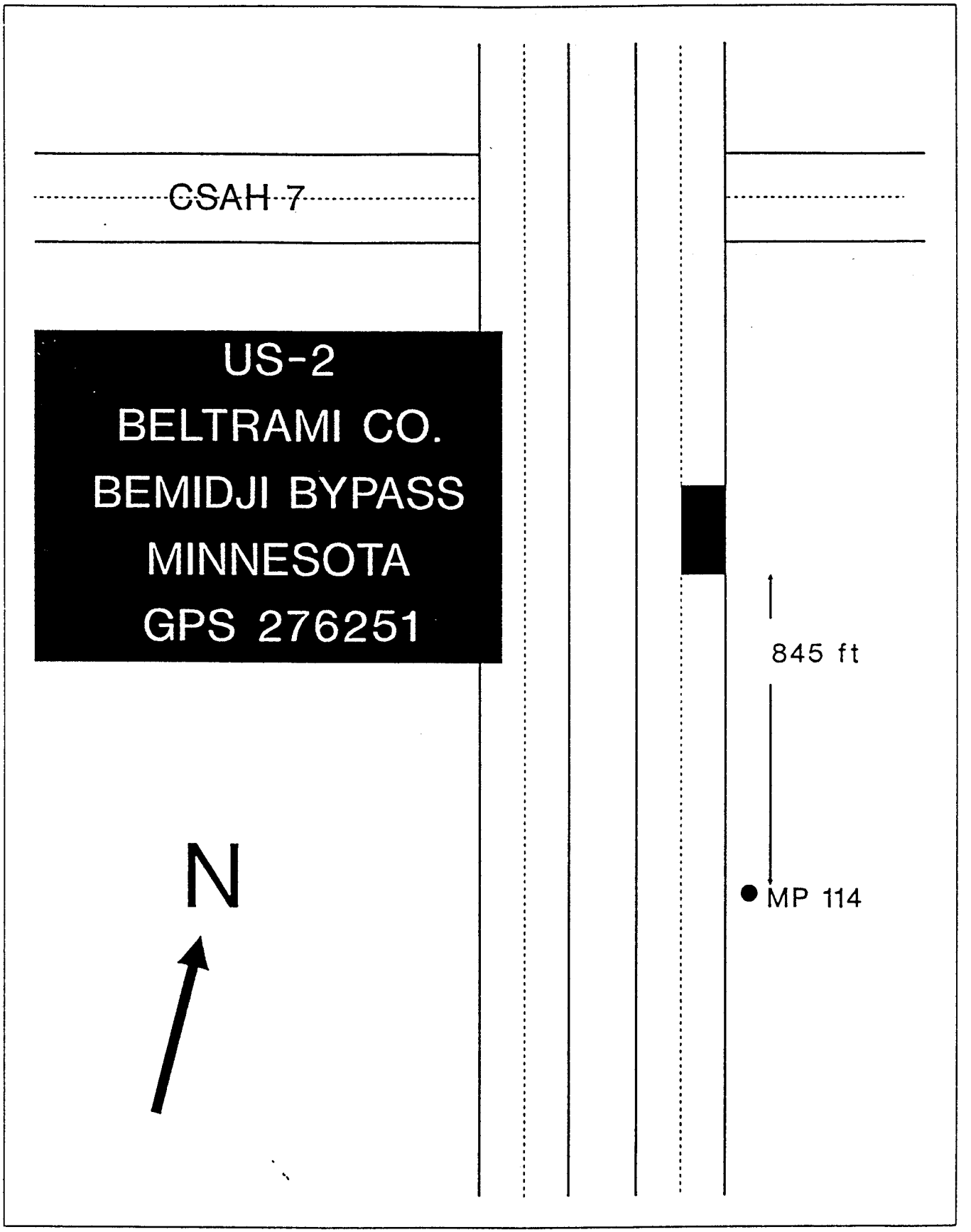

CSAH 7
US-2
BELTRAMI CO.
BEMIDJI BYPASS
MINNESOTA
GPS 276251
845 ft
MP 114
N

STRATEGIC HIGHWAY RESEARCH PROGRAM
GENERAL PAVEMENT STUDIES
Long-Term Pavement Performance Monitoring
Project Information Sheet

REGION: North Central PAVEMENT TYPE: AC on Granular Base
STATE: Minnesota

SHRP Assigned ID: 276251 District: 2 Year Open: ~~1984~~ 1982
State Assigned ID: Highway: U.S.- 2 Year Traffic: 1985
Design Cell ID: 1- 29 Length: miles AADT: 5000
Lanes: 2 Trucks: 9.4 %
Shoulder Surface Type: Asphalt Concrete
Project Status: Approved
Restrictions: SPS Site

DESIGN FACTORS - Moisture: Wet
Temperature: Freeze
Subgrade: 57 - Sand Coarse
Traffic: 60 KESAL/Yr Low (85)
AC Thickness: 6.0 in. Med (3.0, 8.0)
Base Thickness: 5.0 in. Low (10.0)
AC Stiffness: 516 ksi Low (650)

LAYER CONFIGURATION

LAYER NO.	LAYER DESCRIPTION	LAYER THICKNESS	LAYER MATERIAL TYPE
4	3 - Orig Surface	6.0	1 - HMAC, Dense Graded
3	5 - Base Layer	5.0	23 - Crushed Stone, Gravel, or Slag
2	6 - Subbase Layer	8.0	24 - Sand
1	7 - Subgrade		57 - Sand

PAVEMENT LAYER INFORMATION

ASPHALT CONCRETE LAYERS

LAY NUM	-- GRADE --- VISC	PENETR	AC CONT	AC DENS	ACVIS S 140	ACVIS 275	PEN 77	AC TRBF	AC VOID	AGG SPGR	AC STIFF
4		135	5.5	143					6.1		516

Revised June 8, 1988

SECTION FIELD VERIFICATION FORM

Date 5-1-90

Rater MARTI

State Project Code N/A

State Code 2 7

SHRP Section I.D. 6 2 5 1

Project and Section Identification

State District No. 0 2

County or Parish BELTRAMI

Route Signing (Numeric Code) 2

Interstate ..... 1 State 3

Primary ..... 2 Other 4

Route Number U S 2

LTPP Experiment Code GPS 1

Number of Through Lanes (One Direction) 2

Direction of Travel 2

Eastbound ..... 1 Northbound 3

Westbound ..... 2 Southbound 4

Available Project Length (Without Discontinuities) _____

	Start Point	End Point
Test Section Milepoints	1 1 3.8 4	1 1 3.7 5

Additional Section Location Information*: STA 847+00 - 842+00 (MP 112 = STA 749+49.00) SECTION IS JUST SOUTH OF ENTRANCE RAMP FOR CSAH 7 (5TH STREET) ON BEMIDJI BYPASS

* Include distances from two landmarks (refer to specific procedures outlined in the Initial State Visit Guidelines).

Location of monument: 1' W OF E EDGE ON BITUMINOUS SHOULDER ADJACENT TO BITUMINOUS SHOULDER IN GRANULAR SHOULDER > BOTH AT 0 AND 5 STATIONS

Geometric Information

Lane Width (Feet) 1 2.

Lane (By Number) Included in Monitoring Section 1

(Lane 1 is Outside Lane, Lane 2 is Next to Lane 1, etc.)

Shoulder Data:	Outside Shoulder	Inside Shoulder
Total Width (Feet)	1 0.	0 3.
Paved Width (Feet)	1 0.	0 3.
Surface Type		3

Turf ..... 1 Concrete 4

Granular ..... 2 Surface Treatment 5

Asphalt Concrete ... 3 Other 6

Additional Data for PCC Shoulders:

Average Joint Spacing (Feet)	N	N
Skewness of Joints (Feet)	A	A
Joints Match Pavement Joints? (Yes - 1; No - 2)		

SHRP/LTPP LAYER THICKNESS

L05A - L05B TABLES

10-AUG-93

		L05A				STA 0		STA 5		L05 B REPRESENTATIVE					
		CON	LAYER	DESC	TYPE	THICK	MATL	THICK	MATL	LAYER	DESC	TYPE	THICK	MATL	INVENTORY
27	6251	1	1	7	SS		204		204	1	7	SS		204	1
		1	2	5	GB	10	302	10.5	302	2	5	GB	10.2	302	3
		1	3	3	AC	7.9	1	6.9	1	3	3	AC	7.1	1	5

P REGION N/C
TE MN

SHRP-LTPP
FIELD MATERIAL SAMPLING
AND FIELD TESTING

STATE CODE 01

SHRP ASSIGNED ID 278251

P EXPERIMENT GPS-1 ROUTE/HIGHWAY 2 Lane 1 Direction N
/TEST: (a) Before Section ____ (b) After Section 1 FIELD SET NO. 1

IN SITU DENSITY AND MOISTURE TESTS

DCG SHEET: 24

RATOR R.A. Bailey NUCLEAR DENSITY GAUGE I.D. 844 SHEET NUMBER 9 OF 24
T DATE 8-27-90 LOCATION: STATION 5+62 TEST PIT NUMBER 1
E OF LAST MAJOR CALIBRATION 4-9-90 OFFSET 3 feet from °/s
e: Use additional sheets if necessary

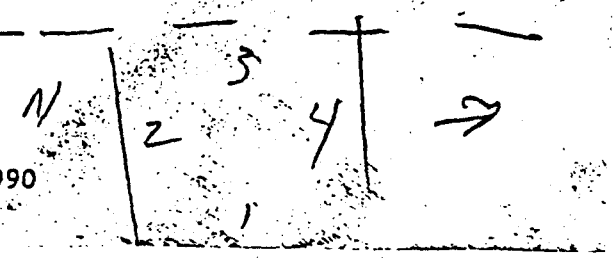
PTH FROM SURFACE TO E TOP OF THE LAYER, CHES (SEE S03)	7"				19"	
TEST TYPE	BASE COURSE TOP Result, pcf Wet	Dry	SUBBASE TOP Result, pcf Wet	Dry	SUBGRADE TOP Result, pcf Wet	Dry
ATERIAL TYPE: Inbound-G Other-T)	G					
IN SITU DENSITY, pcf (AASHTO T238-86) 1	137.6	130.1			125.0	115.7
2	132.3	124.8			123.2	114.3
3	137.5	131.1			123.4	115.3
4	139.0	132.2			126.3	118.8
AVERAGE	136.6	129.5			124.4	116.0
Method (A,B,or C)	B					
od Depth, inches	8				12	
IN SITU MOISTURE CONTENT, % (AASHTO T239-86) 1	5.8				8.0	
2	5.8				7.8	
3	4.8				7.1	
4	5.1				6.3	
AVERAGE	5.3				7.3	

NERAL REMARKS:

RTIFIED
ew Chief, Contractor
filiation:

VERIFIED AND APPROVED
C.H. Allen
SHRP Representative
Affiliation: SME

MONTH-DAY-YEAR
-19
Date



Appendix A-2: Pre-Installation Monitoring Data and FWDCHECK Results

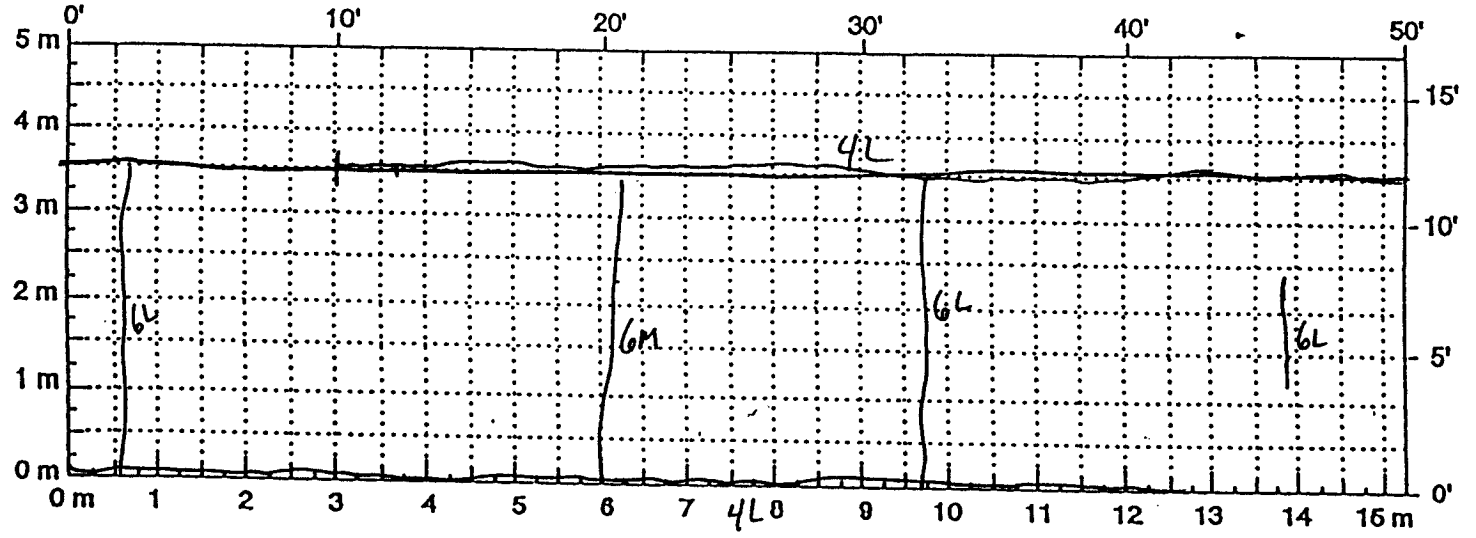
Appendix A-2 contains the following pre-installation monitoring data and FWDCHECK analysis results:

- Pre-installation pavement distress data;
- Pre-installation FWD data; and
- FWDCHECK program uniformity analysis results.

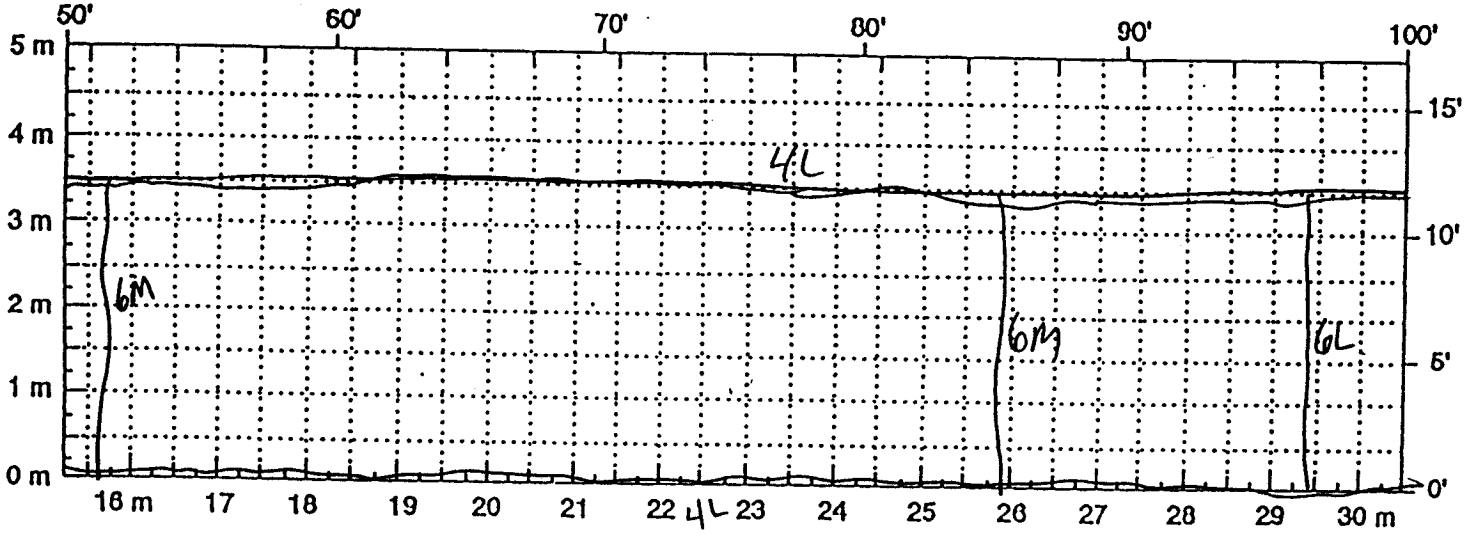
State Assigned ID 276251

State Code BJW

SHRP Section ID 7/14/93



Comments: _____

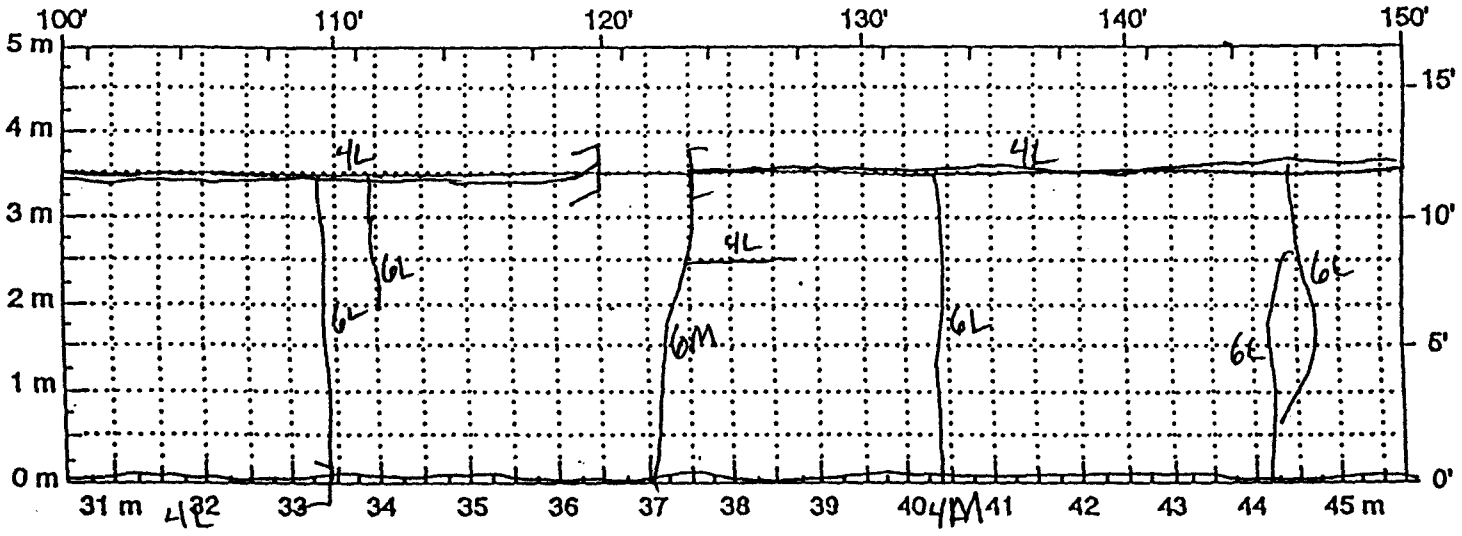


Comments: _____

State Assigned ID 276251

State Code OJW

SHRP Section ID 7/14/93



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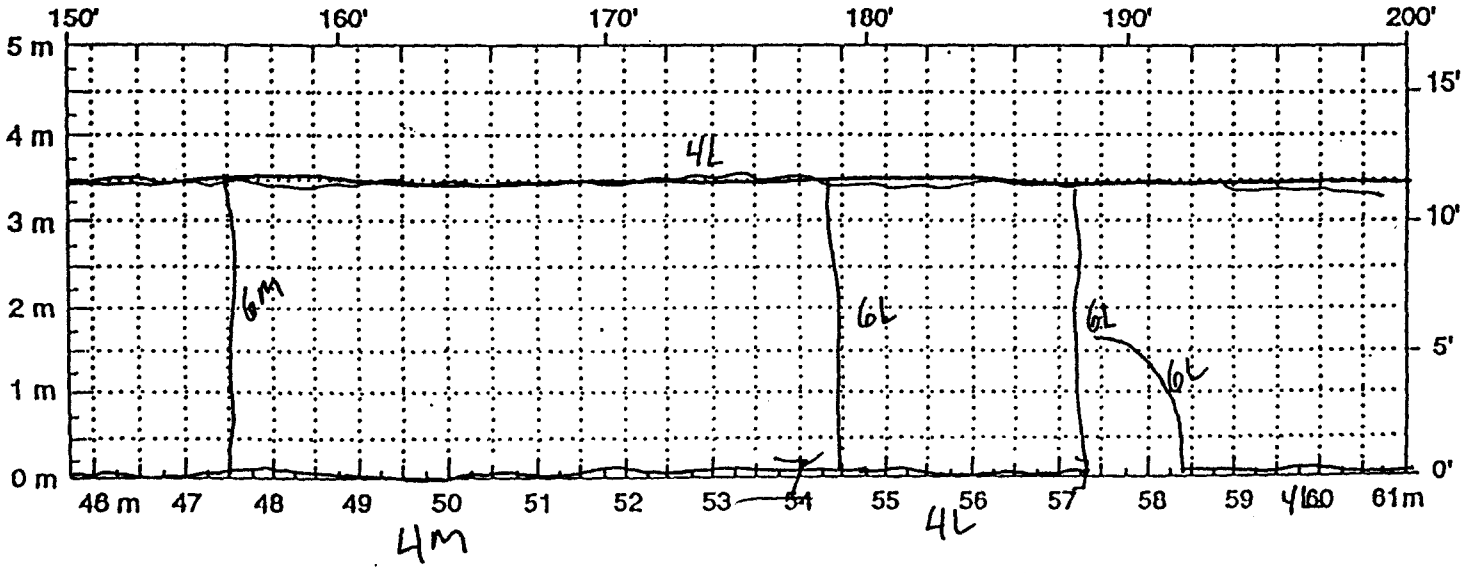
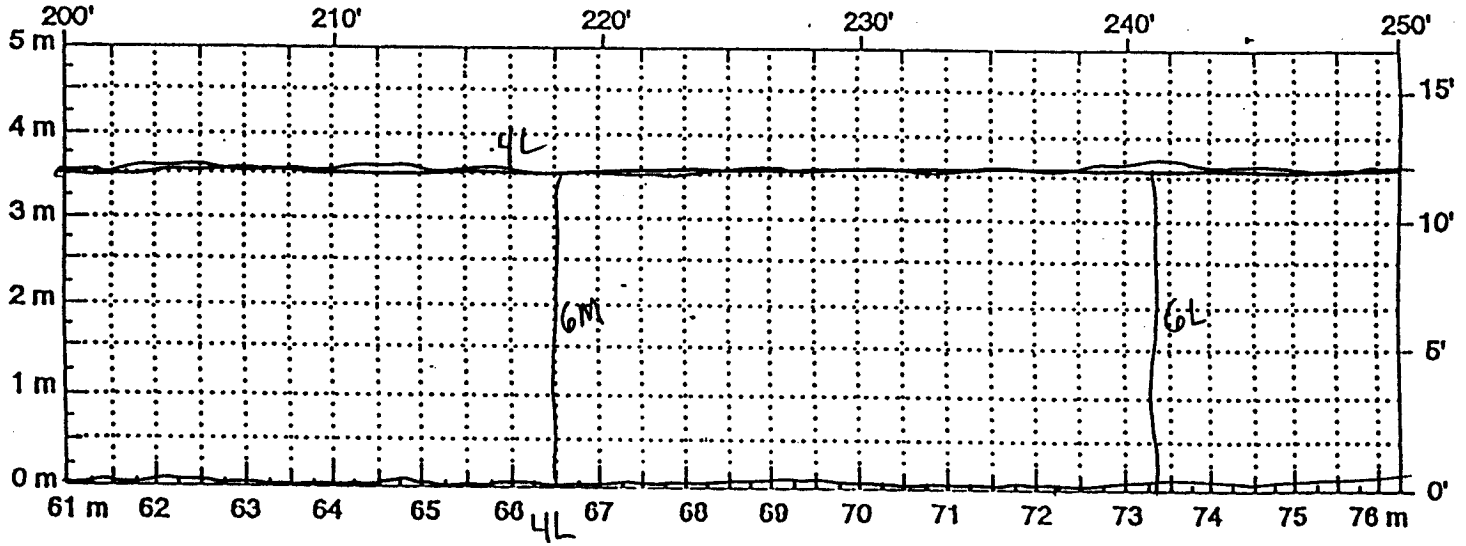


Comments: _____

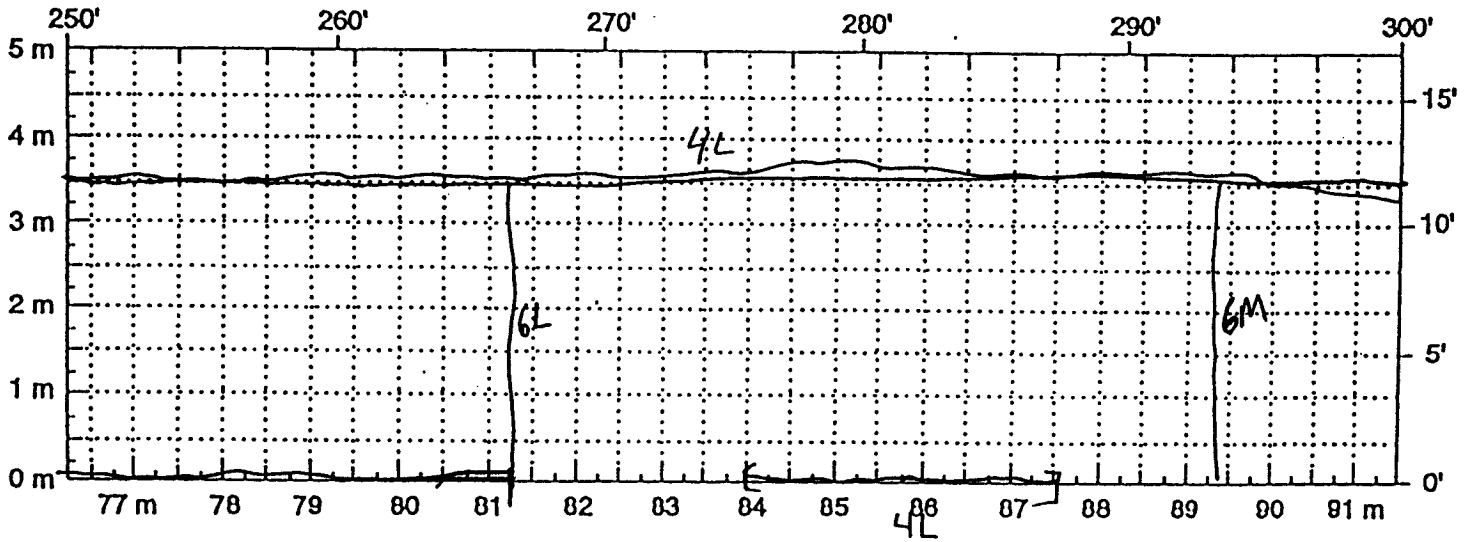
State Assigned ID 276251

State Code 13JU

SHRP Section ID 7/14/93



Comments: _____

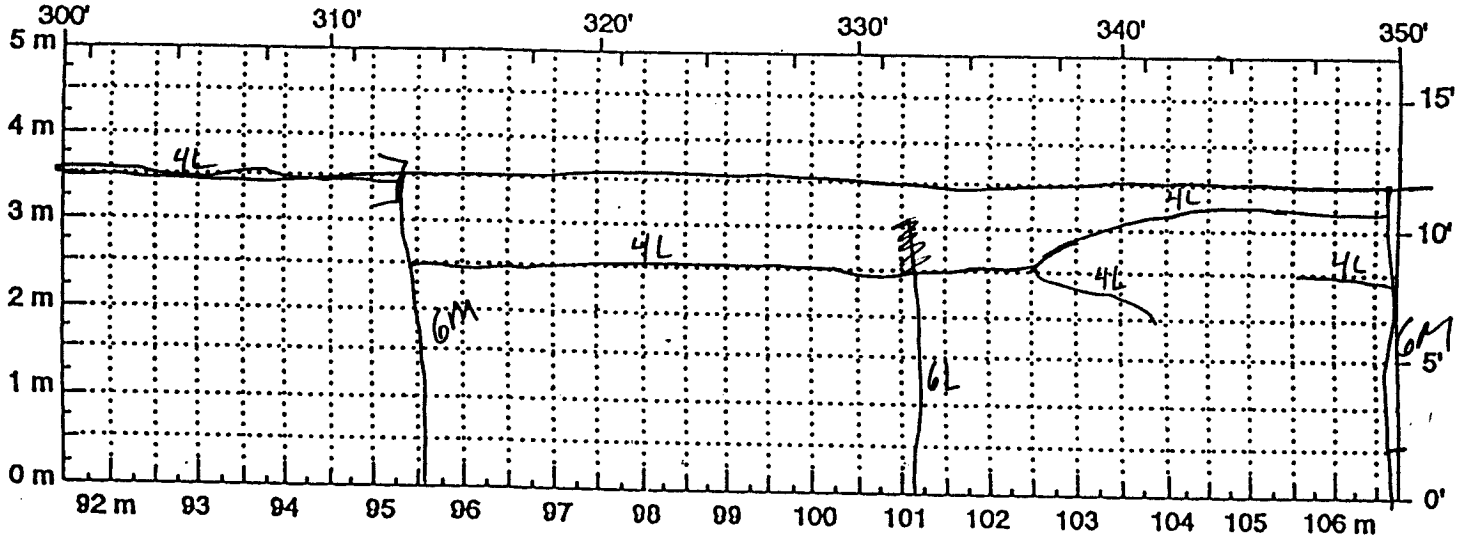


Comments: _____

State Assigned ID 276251

State Code BTW

SHRP Section ID 7/14/93



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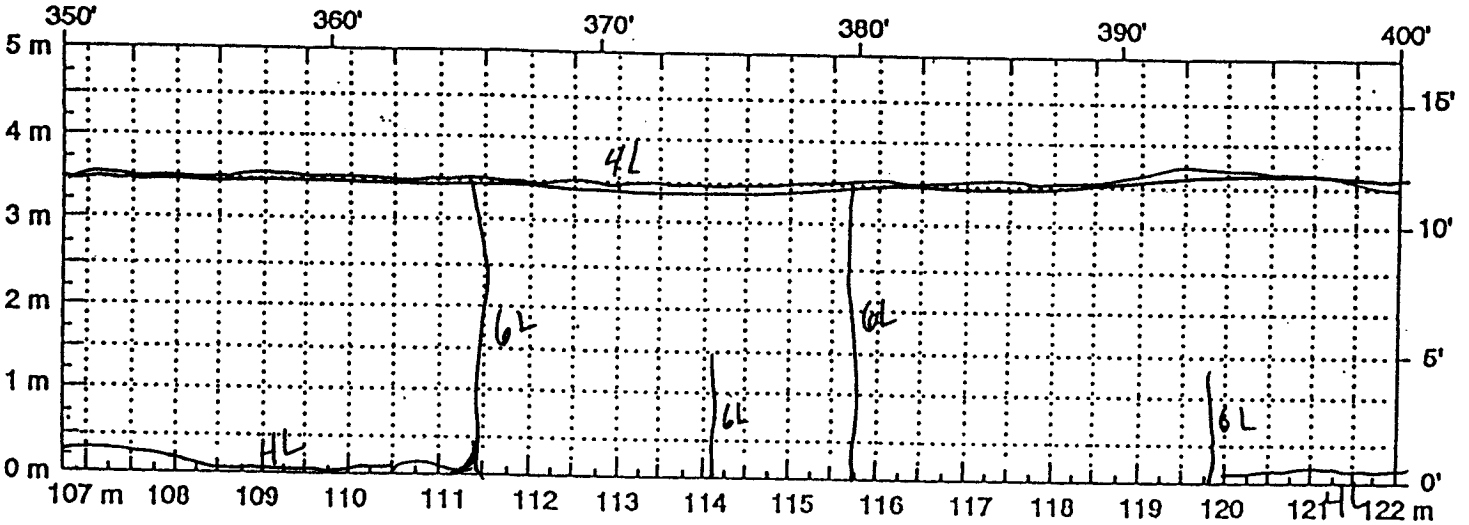
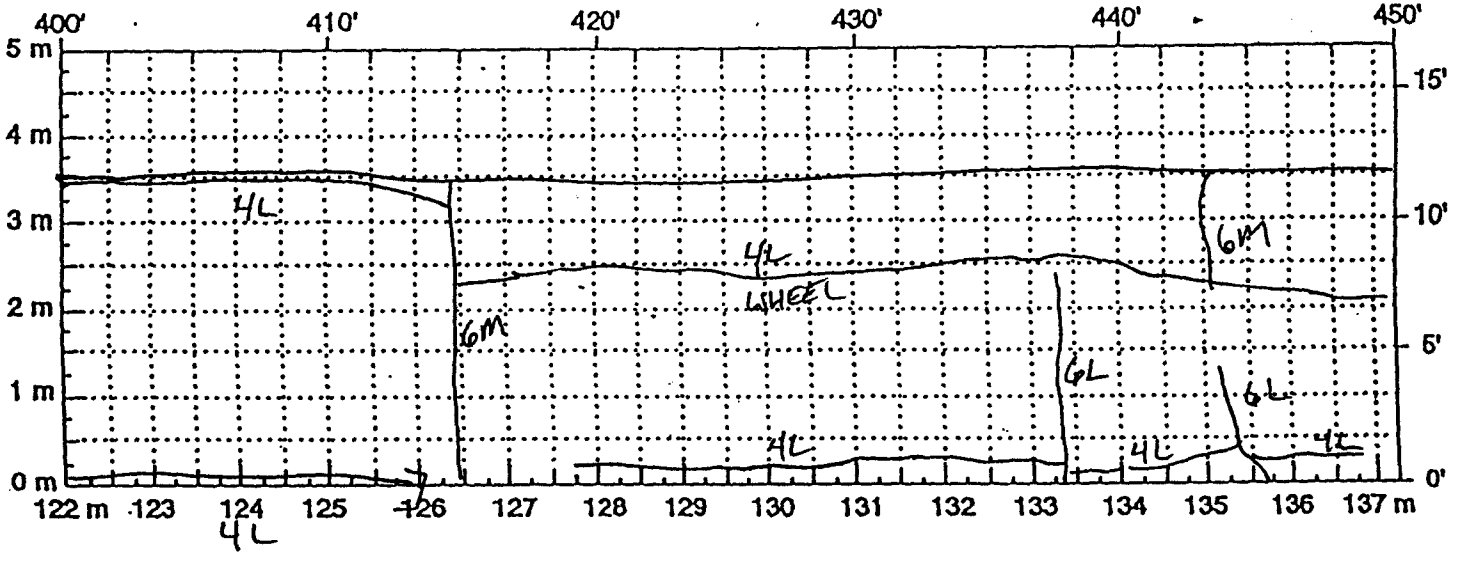


Comments: _____

State Assigned ID 276251

State Code BSU

SHRP Section ID 7/14/93



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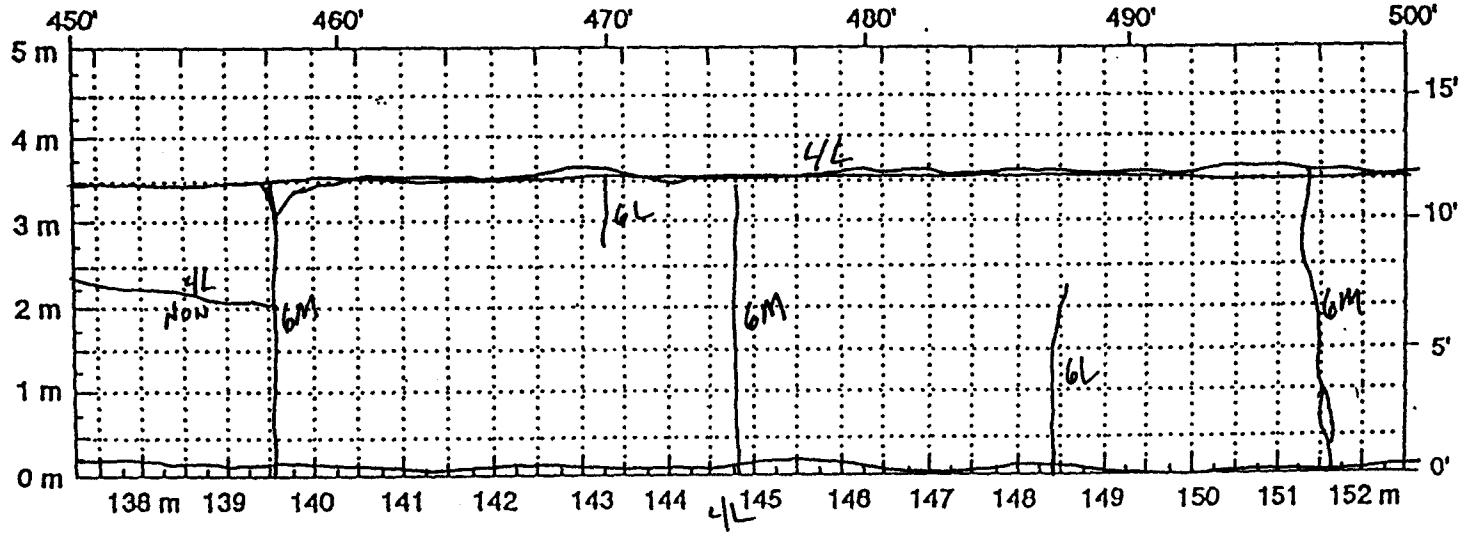


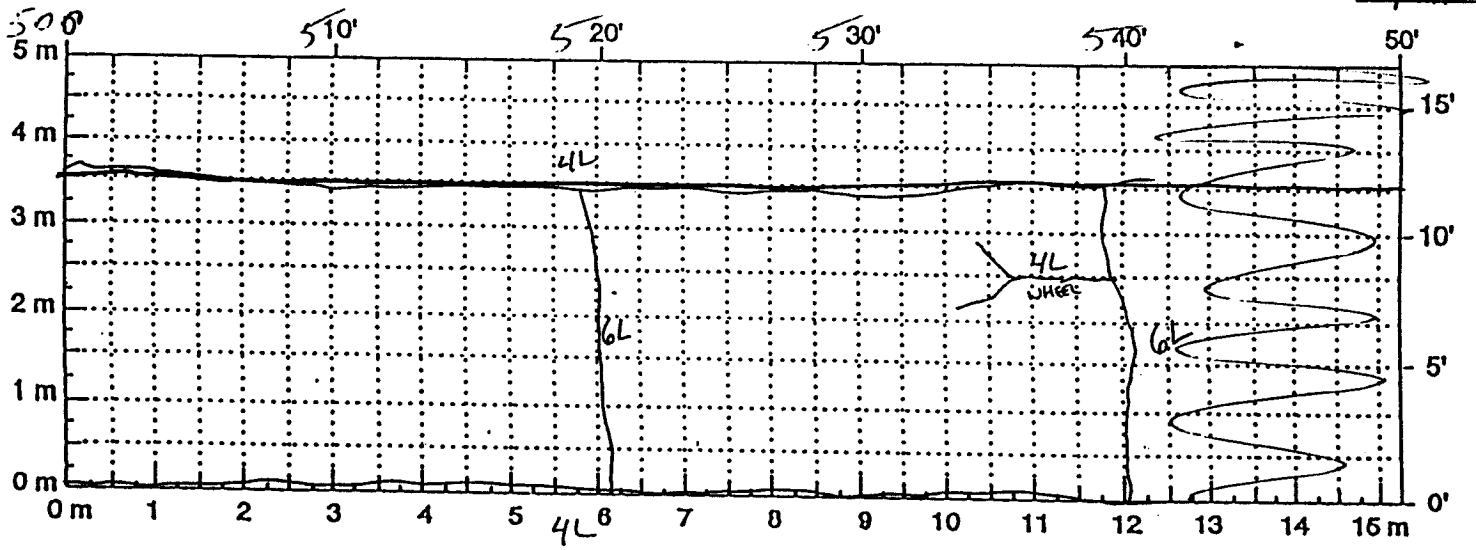
Comments:

SMP
LOC.

State Assigned ID 276251

State Code BJU

SHRP Section ID 7/14/93



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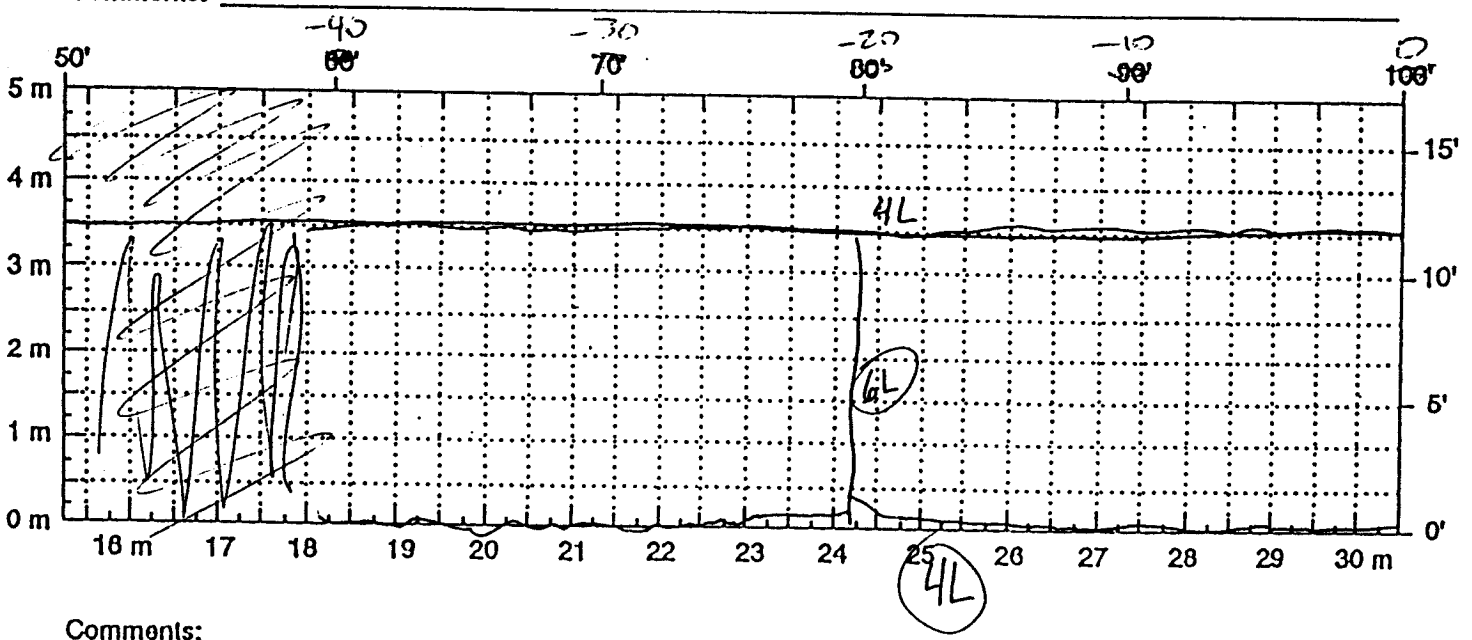

Comments:

FHWA-LTPP PAVEMENT TEMPERATURE PROFILE MEASUREMENTS

SHRP NORTH CENTRAL REGION

SHRP SECTION I.D. # 276251

AGENCY MINNESOTA

TESTING FWD

ROUTE/HIGHWAY # IS-2

FIELD SET # E

TESTING DATE 7/14/93

SHEET # 2 OF 3

LOCATION — STATION see below

DEPTH	D1 = 1.0	D2 = 3.4	D3 = 5.6	D4 =	D5 =	
MILTIME	T1 (F)	T2 (F)	T3 (F)	T4 (F)	T5 (F)	WEATHER CONDITIONS
1030	79.0	73.0	70.0			PC
1100	81.6	75.3	71.9			S
1200	85.6	77.9	73.1			S
DEPTH	D1= 1.0	D2= 3.2	D3= 4.8			
NOT TAKEN @ 11:00						
1130	81.9	78.0	75.9			S
1230	90.8	81.2	79.3			S

NOTE: USE ONLY THESE WEATHER TERMS; (S)SUNNY, (PC)PARTLY CLOUDY, (C)CLOUDY, (R)RAIN

COMMENT

TESTING COMPLETED BY:

BRAUN INTERTEC PAVEMENT INC.
FWD S/N 8002-063 (Braun FWD)

47/47

Anthony Kadlec — FWD Operator

7-14-93 — Date

10:41 930714

File: C:\FWD\DATA\276251E1.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 27621 — change to 276251

FWD S/N : 8002-083
Operator ID : KADLEC, ANTHONY J.

Stationing...: Feet

TESTS OUTSIDE SECTION FOR JMP

Diameter of Plate: 11.8
Deflector distances : 8 12 18 24 36 60

SHRP TESTING - FLEXIBLE - BASIN TEST (F0,F1,F3)
Sequence: CCC111122223333444 4

Stn: -30 Lane:F1 Temp: J/C: Air: 76 PvT: 79 10:44

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	115.9	12712	10.14	8.40	7.28	5.87	4.71	3.21	1.87
	C	116.8	12800	10.05	8.27	7.15	5.78	4.67	3.12	1.82
	C	116.5	12768	9.97	8.23	7.15	5.74	4.58	3.12	1.78
*	1	60.9	6672	5.32	4.44	3.81	3.08	2.44	1.65	0.95
*	1	60.3	6608	5.36	4.44	3.86	3.12	2.49	1.69	1.00
*	1	60.4	6624	5.36	4.48	3.90	3.12	2.49	1.69	1.00
*	1	60.7	6656	5.28	4.44	3.86	3.08	2.44	1.69	1.00
*	2	87.4	9584	7.54	6.29	5.44	4.39	3.51	2.43	1.39
*	2	87.7	9616	7.58	6.29	5.48	4.43	3.56	2.43	1.43
*	2	87.8	9632	7.54	6.29	5.44	4.39	3.47	2.38	1.34
*	2	88.0	9648	7.54	6.25	5.44	4.39	3.51	2.43	1.39
*	3	116.2	12736	9.85	8.14	7.07	5.74	4.58	3.16	1.82
*	3	116.5	12768	9.85	8.19	7.07	5.70	4.53	3.12	1.82
*	3	116.5	12768	9.85	8.19	7.07	5.74	4.58	3.12	1.82
*	3	116.7	12792	9.85	8.14	7.07	5.74	4.62	3.12	1.82
*	4	148.7	16312	12.44	10.26	8.87	7.18	5.78	3.94	2.34
*	4	149.3	16360	12.44	10.30	8.87	7.22	5.82	3.99	2.34
*	4	149.0	16336	12.44	10.30	8.91	7.22	5.78	3.99	2.34
*	4	149.3	16376	12.53	10.30	8.91	7.22	5.82	4.03	2.39

Stn: -20 Lane:F1 Temp: J/C: Air: 77 PvT: 79 10:46

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	115.5	12672	10.81	8.75	7.54	6.08	4.76	3.16	1.69
	C	115.9	12720	10.68	8.66	7.50	6.04	4.76	3.21	1.82
	C	115.7	12680	10.60	8.57	7.41	5.95	4.67	3.12	1.73
*	1	59.1	6488	5.66	4.57	3.94	3.17	2.49	1.65	0.95
*	1	59.7	6536	5.70	4.65	4.03	3.21	2.58	1.73	1.04
*	1	59.3	6496	5.70	4.65	4.03	3.25	2.58	1.73	1.04
*	1	59.3	6496	5.66	4.65	4.03	3.25	2.58	1.73	1.04
*	2	86.1	9440	8.04	6.51	5.61	4.56	3.56	2.43	1.34
*	2	86.8	9512	8.17	6.59	5.74	4.60	3.60	2.47	1.39
*	2	86.4	9480	8.00	6.55	5.66	4.56	3.56	2.43	1.34
*	2	86.8	9520	8.09	6.59	5.70	4.60	3.64	2.43	1.39
*	3	115.1	12616	10.47	8.53	7.37	5.95	4.71	3.16	1.82
*	3	115.5	12672	10.56	8.57	7.41	5.99	4.76	3.21	1.82
*	3	115.5	12672	10.52	8.57	7.37	5.95	4.71	3.16	1.82
*	3	115.7	12688	10.47	8.53	7.37	5.95	4.71	3.16	1.78
*	4	148.4	16264	13.28	10.73	9.30	7.51	5.96	4.03	2.34
*	4	149.1	16360	13.32	10.77	9.30	7.56	5.96	4.07	2.34
*	4	148.8	16320	13.32	10.77	9.34	7.51	5.96	4.03	2.34
*	4	149.0	16336	13.32	10.77	9.30	7.51	6.00	4.07	2.34

Stn: -10 Lane:F1 Temp: J/C: Air: 76 PvT: 83 10:49

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	115.8	12696	10.10	8.27	7.15	5.70	4.53	3.08	1.78
	C	115.5	12672	9.93	8.14	7.03	5.66	4.49	3.08	1.82
	C	115.5	12672	9.80	8.10	6.94	5.57	4.44	3.03	1.73
*	1	59.6	6536	5.15	4.31	3.68	2.95	2.31	1.56	0.91
*	1	59.3	6496	5.19	4.27	3.68	2.91	2.31	1.56	0.91
*	1	59.1	6480	5.15	4.27	3.68	2.91	2.31	1.56	0.91
*	1	59.4	6512	5.15	4.27	3.68	2.95	2.31	1.56	0.91
*	2	85.9	9424	7.42	6.16	5.31	4.26	3.38	2.30	1.34
*	2	86.4	9472	7.42	6.12	5.27	4.26	3.38	2.25	1.26
*	2	86.5	9496	7.42	6.16	5.31	4.26	3.38	2.30	1.26
*	2	86.8	9520	7.46	6.20	5.31	4.31	3.42	2.30	1.34
*	3	115.4	12648	9.72	7.97	6.90	5.53	4.40	2.99	1.73
*	3	115.9	12704	9.72	7.97	6.86	5.53	4.40	2.99	1.69

File: C:\FWD\DATA\276251E1.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 27621

*	3	115.5	12672	9.76	8.01	6.90	5.53	4.44	3.03	1.78
*	3	115.5	12664	9.68	7.97	6.86	5.53	4.40	2.99	1.69
*	4	148.6	16288	12.36	10.08	8.70	6.97	5.64	3.86	2.26
*	4	149.4	16384	12.36	10.13	8.70	7.01	5.69	3.86	2.30
*	4	149.4	16384	12.40	10.08	8.70	7.01	5.64	3.86	2.30
*	4	149.1	16352	12.36	10.04	8.70	7.01	5.60	3.81	2.26

Stn: 0 Lane:F1 Temp: J/C: Air: 77 PvT: 86 10:51

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.9	12600	10.68	8.75	7.58	6.12	4.84	2.73	1.69
	C	114.9	12600	10.47	8.53	7.37	5.95	4.76	2.73	1.69
	C	114.9	12600	10.39	8.49	7.37	5.91	4.71	2.73	1.69
*	1	58.1	6368	5.49	4.52	3.94	3.17	2.49	1.39	0.87
*	1	57.8	6344	5.49	4.57	3.98	3.21	2.53	1.43	0.91
*	1	57.8	6344	5.49	4.52	3.94	3.17	2.49	1.39	0.87
*	1	58.0	6360	5.49	4.52	3.94	3.17	2.53	1.43	0.91
*	2	84.5	9272	7.83	6.42	5.61	4.56	3.60	2.08	1.30
*	2	85.7	9392	7.88	6.46	5.61	4.56	3.64	2.08	1.26
*	2	85.1	9336	7.83	6.46	5.61	4.52	3.60	2.04	1.21
*	2	85.2	9344	7.83	6.46	5.66	4.56	3.64	2.08	1.30
*	3	114.9	12600	10.26	8.36	7.24	5.87	4.67	2.73	1.69
*	3	115.1	12624	10.22	8.40	7.28	5.91	4.71	2.73	1.65
*	3	115.1	12608	10.26	8.40	7.33	5.95	4.71	2.73	1.73
*	3	115.1	12624	10.31	8.40	7.33	5.91	4.71	2.77	1.73
*	4	149.3	16360	13.07	10.60	9.21	7.43	5.96	3.51	2.17
*	4	149.7	16416	13.07	10.64	9.21	7.43	5.91	3.51	2.13
*	4	149.7	16408	13.07	10.64	9.21	7.43	5.96	3.51	2.13
*	4	149.6	16400	13.07	10.64	9.25	7.47	5.96	3.55	2.17

Stn: 50 Lane:F1 Temp: J/C: Air: 76 PvT: 88 10:54

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.1	12504	11.86	10.04	8.91	7.51	4.22	2.99	1.73
	C	114.3	12544	11.60	9.78	8.65	7.30	4.22	2.95	1.73
	C	114.3	12544	11.52	9.69	8.61	7.22	4.22	2.90	1.69
*	1	58.1	6368	6.07	5.21	4.63	3.93	2.18	1.52	0.91
*	1	58.3	6392	6.07	5.21	4.63	3.93	2.18	1.52	0.91
*	1	58.6	6416	6.07	5.21	4.63	3.97	2.18	1.52	0.91
*	1	58.6	6424	6.20	5.30	4.76	4.05	2.31V	1.60	1.00
*	2	84.5	9264	8.63	7.37	6.56	5.53	3.16	2.21	1.30
*	2	84.9	9304	8.76	7.50	6.64	5.66	3.29	2.30	1.39
*	2	85.2	9352	8.71	7.45	6.60	5.61	3.20	2.25	1.34
*	2	84.9	9312	8.67	7.41	6.60	5.57	3.20	2.21	1.30
*	3	114.2	12512	11.31	9.61	8.53	7.18	4.22	2.95	1.73
*	3	114.8	12592	11.44	9.65	8.61	7.26	4.27	2.99	1.78
*	3	114.6	12568	11.35	9.61	8.53	7.18	4.18	2.90	1.69
*	3	114.8	12576	11.35	9.61	8.48	7.18	4.18	2.95	1.69
*	4	147.8	16208	14.50	12.19	10.75	9.03	5.42	3.77	2.17
*	4	148.4	16272	14.50	12.19	10.75	9.08	5.42	3.81	2.26
*	4	148.4	16272	14.54	12.19	10.75	9.03	5.42	3.86	2.30
*	4	148.3	16248	14.50	12.15	10.67	8.99	5.33	3.77	2.21

DATA NOT VARIATION

Stn: 100 Lane:F1 Temp: J/C: Air: 76 PvT: 87 10:57

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.2	12512	11.02	9.18	7.93	6.37	5.07	3.47	2.00
	C	114.6	12568	10.77	8.92	7.71	6.21	4.98	3.34	1.95
	C	114.6	12568	10.77	8.92	7.71	6.21	4.93	3.34	1.95
*	1	58.3	6384	5.70	4.74	4.16	3.33	2.62	1.82	1.08
*	1	58.4	6400	5.61	4.70	4.11	3.29	2.62	1.78	1.04
*	1	58.4	6400	5.70	4.74	4.16	3.33	2.67	1.82	1.08
*	1	58.1	6368	5.61	4.65	4.07	3.25	2.58	1.73	1.00
*	2	84.6	9280	8.09	6.68	5.83	4.69	3.78-	2.51	1.43
*	2	85.5	9376	8.21	6.85	5.96	4.77	3.82	2.64	1.52
*	2	85.7	9384	8.17	6.85	5.96	4.77	3.82	2.60	1.52
*	2	85.4	9368	8.17	6.81	5.87	4.73	3.73	2.56	1.43
*	3	114.2	12512	10.64	8.83	7.67	6.12	4.93	3.34	1.95
*	3	114.8	12576	10.60	8.88	7.63	6.12	4.93	3.34	1.91
*	3	114.5	12560	10.64	8.83	7.67	6.16	4.93	3.38	1.95
*	3	114.8	12576	10.64	8.83	7.67	6.16	4.93	3.38	1.95
*	4	148.0	16216	13.62	11.16	9.64	7.77	6.18	4.25	2.43
*	4	148.4	16264	13.74	11.25	9.73	7.81	6.31	4.33	2.52
*	4	148.1	16240	13.70	11.16	9.73	7.81	6.27	4.33	2.56

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*	4	148.0	16232	13.74	11.29	9.77	7.85	6.36	4.38	2.60

Stn: 150 Lane:F1 Temp: J/C: Air: 76 PvT: 85 10:59

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.3	12528	12.32	9.95	8.48	6.71	5.24	3.51	2.04
	C	114.2	12520	12.02	9.69	8.27	6.54	5.11	3.47	2.04
	C	114.3	12528	11.94	9.65	8.23	6.54	5.16	3.47	2.04
*	1	57.8	6336	6.33	5.17	4.41	3.46	2.71	1.78	1.04
*	1	58.0	6360	6.41	5.26	4.50	3.55	2.76	1.91	1.13
*	1	58.0	6352	6.37	5.21	4.46	3.50	2.71	1.82	1.08
*	1	58.0	6360	6.41	5.26	4.46	3.55	2.71	1.86	1.08
*	2	84.5	9256	9.01	7.33	6.26	4.98	3.87	2.60	1.52
*	2	84.5	9264	9.09	7.41	6.30	5.02	3.91	2.69	1.52
*	2	84.8	9296	9.13	7.45	6.38	5.11	3.91	2.73	1.60
*	2	84.6	9280	9.09	7.41	6.34	5.07	3.91	2.69	1.56
*	3	114.1	12512	11.81	9.52	8.14	6.46	5.07	3.47	2.04
*	3	114.2	12512	11.86	9.61	8.23	6.54	5.16	3.55	2.13
*	3	114.1	12504	11.81	9.61	8.18	6.54	5.16	3.55	2.13
*	3	114.3	12536	11.77	9.57	8.14	6.50	5.07	3.51	2.08
*	4	147.5	16184	14.96	12.06	10.28	8.19	6.44	4.46	2.60
*	4	148.0	16224	14.96	12.02	10.28	8.19	6.44	4.46	2.65
*	4	148.3	16256	15.00	12.11	10.28	8.23	6.49	4.51	2.69
*	4	148.0	16232	14.91	12.02	10.24	8.15	6.40	4.42	2.60

Stn: 200 Lane:F1 Temp: J/C: Air: 76 PvT: 86 11:02

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.5	12560	10.89	9.01	7.84	6.33	5.07	3.47	2.00
	C	114.6	12576	10.68	8.79	7.63	6.12	4.93	3.36	1.95
	C	114.6	12568	10.60	8.75	7.58	6.12	4.89	3.34	1.95
*	1	57.8	6344	5.53	4.57	3.98	3.21	2.53	1.73	1.00
*	1	57.7	6328	5.53	4.61	4.03	3.25	2.53	1.73	1.00
*	1	58.1	6368	5.57	4.65	4.03	3.25	2.62	1.78	1.04
*	1	58.0	6352	5.53	4.61	4.03	3.21	2.53	1.73	1.00
*	2	84.2	9240	8.00	6.64	5.78	4.69	3.73	2.60	1.52
*	2	84.8	9288	8.04	6.72	5.83	4.73	3.78	2.60	1.52
*	2	84.6	9280	8.00	6.68	5.83	4.69	3.73	2.56	1.47
*	2	84.8	9304	8.04	6.68	5.83	4.73	3.73	2.60	1.47
*	3	114.1	12512	10.52	8.66	7.54	6.12	4.89	3.38	2.00
*	3	114.8	12584	10.52	8.70	7.54	6.12	4.93	3.38	2.00
*	3	114.5	12560	10.52	8.70	7.54	6.12	4.93	3.38	2.00
*	3	114.6	12576	10.52	8.70	7.54	6.12	4.93	3.38	2.00
*	4	148.6	16288	13.36	10.99	9.55	7.73	6.22	4.33	2.56
*	4	149.1	16344	13.36	10.94	9.55	7.73	6.18	4.33	2.52
*	4	148.8	16320	13.36	10.99	9.55	7.73	6.22	4.33	2.56
*	4	149.1	16344	13.36	10.94	9.51	7.73	6.22	4.33	2.52

Stn: 250 Lane:F1 Temp: J/C: Air: 77 PvT: 84 11:05

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.3	12544	10.56	8.66	7.41	5.95	4.67	3.08	1.73
	C	114.6	12568	10.39	8.53	7.28	5.83	4.62	3.12	1.82
	C	114.6	12576	10.22	8.36	7.15	5.74	4.53	3.03	1.73
*	1	58.4	6400	5.49	4.52	3.90	3.12	2.44	1.60	0.95
*	1	58.3	6384	5.40	4.48	3.86	3.04	2.36	1.56	0.91
*	1	58.3	6384	5.53	4.57	3.94	3.17	2.49	1.65	1.04
*	1	58.1	6368	5.45	4.52	3.86	3.08	2.44	1.56	0.95
*	2	84.3	9256	7.71	6.33	5.48	4.39	3.47	2.30	1.30
*	2	84.6	9272	7.75	6.42	5.48	4.39	3.47	2.30	1.30
*	2	84.9	9320	7.75	6.42	5.53	4.43	3.51	2.30	1.34
*	2	84.6	9272	7.75	6.38	5.48	4.39	3.47	2.30	1.30
*	3	114.2	12520	10.10	8.27	7.11	5.70	4.53	3.03	1.78
*	3	114.8	12584	10.22	8.40	7.20	5.78	4.58	3.12	1.82
*	3	114.3	12528	10.10	8.32	7.15	5.74	4.53	3.08	1.78
*	3	114.3	12544	10.18	8.40	7.24	5.83	4.62	3.16	1.91
*	4	148.1	16248	12.90	10.56	9.04	7.26	5.73	3.94	2.34
*	4	148.8	16320	12.86	10.47	9.00	7.22	5.78	3.90	2.30
*	4	148.7	16296	12.86	10.47	9.00	7.18	5.73	3.90	2.34
*	4	148.8	16320	12.86	10.51	9.00	7.22	5.73	3.94	2.34

Stn: 300 Lane:F1 Temp: J/C: Air: 77 PvT: 85 11:09

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	114.6	12568	9.93	7.93	6.64	5.15	3.96	2.56	1.52

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	C	114.6	12560	9.68	7.67	6.47	5.02	3.91	2.51	1.47
	C	114.6	12568	9.59	7.67	6.43	5.02	3.87	2.47	1.47
*	1	58.0	6352	5.07	4.14	3.47	2.66	2.04	1.30	0.78
*	1	57.5	6304	5.11	4.14	3.47	2.70	2.04	1.30	0.78
*	1	57.8	6344	5.15	4.09	3.43	2.66	2.00	1.26	0.74
*	1	57.8	6344	5.11	4.14	3.47	2.70	2.04	1.30	0.78
*	2	83.8	9184	7.16	5.73	4.88	3.76	2.89	1.82	1.08
*	2	84.5	9256	7.21	5.86	4.93	3.84	2.93	1.91	1.13
*	2	84.5	9264	7.25	5.86	4.93	3.84	2.93	1.91	1.13
*	2	84.6	9272	7.25	5.86	4.97	3.84	2.98	1.91	1.13
*	3	114.1	12496	9.38	7.50	6.34	4.94	3.82	2.47	1.47
*	3	114.8	12576	9.43	7.58	6.34	4.98	3.87	2.47	1.47
*	3	114.8	12584	9.47	7.54	6.34	4.98	3.87	2.47	1.47
*	3	114.6	12560	9.43	7.54	6.38	4.94	3.82	2.47	1.43
*	4	148.7	16304	11.94	9.52	8.01	6.25	4.89	3.16	1.87
*	4	148.8	16328	12.02	9.57	8.05	6.29	4.98	3.21	1.91
*	4	148.8	16328	12.02	9.57	8.05	6.29	4.98	3.21	1.91
*	4	149.0	16336	11.98	9.52	8.05	6.29	4.98	3.16	1.91

Stn: 350 Lane:F1 Temp: J/C: Air: 78 PvT: 86 11:13

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.5	12328	13.62	9.95	7.97	5.78	4.18	2.47	1.43
	C	112.6	12336	13.66	10.00	7.97	5.78	4.18	2.51	1.39
	C	112.3	12320	13.66	10.04	8.01	5.83	4.27	2.51	1.43
*	1	57.4	6288	7.62	5.52	4.37	3.12	2.27	1.34	0.74
*	1	57.1	6264	7.58	5.52	4.33	3.12	2.22	1.30	0.69
*	1	57.2	6280	7.62	5.56	4.41	3.17	2.27	1.34	0.74
*	1	57.1	6272	7.58	5.52	4.37	3.12	2.27	1.34	0.74
*	2	83.9	9192	10.56	7.71	6.13	4.43	3.20	1.91	1.04
*	2	84.2	9232	10.64	7.84	6.21	4.52	3.24	1.95	1.08
*	2	84.5	9256	10.68	7.89	6.26	4.56	3.29	1.99	1.13
*	2	84.2	9232	10.60	7.80	6.17	4.47	3.20	1.95	1.04
*	3	111.9	12272	13.57	9.95	7.93	5.78	4.18	2.51	1.39
*	3	112.6	12336	13.62	10.00	7.97	5.78	4.22	2.51	1.43
*	3	112.8	12368	13.62	10.00	7.97	5.83	4.22	2.47	1.39
*	3	112.2	12296	13.62	9.95	7.93	5.78	4.18	2.47	1.39
*	4	143.3	15720	17.01	12.45	9.94	7.30	5.38	3.21	1.87
*	4	143.5	15728	16.97	12.37	9.85	7.22	5.29	3.16	1.82
*	4	143.6	15744	17.01	12.41	9.85	7.22	5.29	3.16	1.82
*	4	142.9	15664	16.97	12.41	9.90	7.26	5.33	3.16	1.87

Stn: 400 Lane:F1 Temp: J/C: Air: 79 PvT: 86 11:16

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	113.5	12448	10.01	7.97	6.81	5.28	4.00	2.60	1.52
	C	113.8	12480	9.80	7.84	6.68	5.19	4.00	2.60	1.52
	C	113.8	12480	9.80	7.80	6.64	5.19	3.96	2.56	1.47
*	1	57.1	6256	5.15	4.14	3.56	2.79	2.09	1.39	0.82
*	1	56.5	6200	5.11	4.14	3.51	2.74	2.04	1.34	0.78
*	1	57.0	6248	5.15	4.14	3.51	2.74	2.09	1.34	0.78
*	1	56.8	6232	5.11	4.14	3.51	2.74	2.09	1.34	0.78
*	2	83.5	9152	7.33	5.86	5.01	3.93	2.93	1.95	1.13
*	2	83.5	9144	7.42	5.90	5.01	3.93	2.93	1.99	1.13
*	2	83.5	9152	7.42	5.95	5.10	4.01	3.07	2.04	1.21
*	2	83.5	9160	7.33	5.82	4.97	3.88	2.98	1.95	1.13
*	3	113.3	12432	9.76	7.80	6.68	5.23	4.00	2.64	1.56
*	3	113.6	12456	9.68	7.71	6.56	5.11	3.91	2.56	1.43
*	3	113.9	12488	9.64	7.71	6.51	5.11	3.91	2.51	1.43
*	3	113.6	12456	9.72	7.76	6.56	5.15	3.96	2.56	1.52
*	4	148.1	16240	12.44	9.82	8.35	6.54	5.02	3.25	1.91
*	4	149.0	16336	12.40	9.82	8.35	6.54	5.02	3.29	1.87
*	4	148.7	16304	12.44	9.87	8.40	6.54	5.11	3.34	1.95
*	4	148.8	16320	12.48	9.87	8.44	6.59	5.07	3.34	1.95

'DATA WITH VAR.

Stn: 450 Lane:F1 Temp: J/C: Air: 79 PvT: 85 11:19

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	111.7	12256	14.75	11.12	9.17	6.12	4.53	2.64	1.52
	C	112.0	12288	14.33	10.77	8.91	6.04	4.49	2.69	1.52
	C	112.3	12312	14.12	10.69	8.87	5.91	4.44	2.60	1.52

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*	1	56.4	6184	7.83	6.03	5.01	3.29	2.49	1.39	0.82
*	1	56.2	6176	7.83	5.99	5.01	3.25	2.40	1.34	0.78
*	1	56.2	6160	7.79	5.99	5.01	3.25	2.44	1.34	0.78
*	1	56.4	6184	7.75	5.99	4.97	3.25	2.40	1.34	0.78
*	2	82.6	9064	10.68	8.19	6.86	4.56	3.42	1.99	1.13
*	2	83.0	9112	10.77	8.27	6.90	4.60	3.47	1.99	1.17
*	2	83.0	9112	10.77	8.27	6.90	4.60	3.47	2.04	1.21
*	2	83.0	9112	10.73	8.23	6.86	4.56	3.42	1.99	1.13
*	3	112.0	12272	13.78	10.38	8.61	5.83	4.36	2.56	1.47
*	3	112.2	12296	13.87	10.51	8.70	5.87	4.40	2.60	1.52
*	3	112.6	12336	13.91	10.51	8.74	5.91	4.44	2.64	1.56
*	3	112.3	12320	13.91	10.56	8.74	5.91	4.44	2.69	1.56
*	4	145.7	15960	17.47	13.10	10.84	7.35	5.56	3.34	2.00
*	4	146.4	16048	17.55	13.14	10.84	7.39	5.60	3.38	2.04
*	4	146.4	16056	17.55	13.10	10.84	7.39	5.56	3.42	2.04
*	4	146.4	16048	17.51	13.10	10.80	7.35	5.56	3.34	2.00

Stn: 500 Lane:F1 Temp: J/C: Air: 80 PvT: 86 11:22

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.9	12376	10.98	8.45	7.07	5.40	4.09	2.56	1.52
	C	112.8	12360	10.73	8.32	6.94	5.32	4.09	2.56	1.56
	C	112.8	12360	10.64	8.23	6.90	5.28	4.00	2.56	1.52
*	1	55.9	6128	5.70	4.40	3.68	2.79	2.13	1.34	0.82
*	1	56.2	6176	5.66	4.44	3.73	2.83	2.13	1.34	0.82
*	1	55.7	6096	5.57	4.35	3.60	2.74	2.04	1.26	0.74
*	1	55.7	6096	5.61	4.40	3.64	2.74	2.09	1.30	0.78
*	2	82.0	9000	8.00	6.25	5.23	3.97	2.98	1.91	1.13
*	2	82.3	9024	8.04	6.25	5.27	4.01	3.02	1.91	1.17
*	2	82.6	9056	8.04	6.25	5.27	4.01	3.02	1.91	1.17
*	2	82.5	9040	8.09	6.25	5.23	4.01	3.02	1.91	1.17
*	3	112.0	12288	10.47	8.14	6.81	5.23	3.96	2.47	1.47
*	3	112.3	12320	10.56	8.19	6.86	5.28	4.04	2.56	1.52
*	3	112.5	12336	10.56	8.19	6.86	5.28	4.00	2.51	1.52
*	3	112.5	12328	10.52	8.14	6.86	5.23	4.00	2.56	1.47
*	4	148.6	16280	13.53	10.43	8.74	6.67	5.11	3.29	1.95
*	4	149.0	16328	13.53	10.43	8.70	6.71	5.11	3.29	1.95
*	4	149.3	16368	13.53	10.43	8.74	6.71	5.11	3.29	1.95
*	4	149.1	16360	13.49	10.43	8.70	6.67	5.11	3.25	1.95

Stn: 510 Lane:F1 Temp: J/C: Air: 80 PvT: 86 11:25

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	113.2	12408	10.64	8.36	6.90	5.28	3.96	2.47	1.47
	C	113.0	12400	10.39	8.19	6.77	5.15	3.87	2.47	1.47
	C	113.0	12392	10.35	8.14	6.77	5.15	3.91	2.47	1.47
*	1	56.5	6200	5.45	4.35	3.60	2.74	2.04	1.26	0.78
*	1	56.1	6144	5.45	4.31	3.60	2.70	2.04	1.26	0.74
*	1	56.4	6176	5.45	4.35	3.60	2.74	2.04	1.30	0.78
*	1	55.9	6136	5.45	4.35	3.60	2.70	2.04	1.30	0.78
*	2	82.9	9096	7.88	6.20	5.18	3.97	2.98	1.86	1.17
*	2	82.9	9096	7.88	6.20	5.18	3.93	2.98	1.86	1.13
*	2	82.9	9096	7.88	6.20	5.14	3.93	2.98	1.82	1.13
*	2	82.8	9080	7.88	6.20	5.14	3.97	2.98	1.86	1.13
*	3	112.9	12376	10.22	8.01	6.68	5.11	3.87	2.43	1.47
*	3	112.9	12384	10.26	8.10	6.73	5.15	3.91	2.47	1.52
*	3	112.9	12384	10.26	8.10	6.73	5.19	3.91	2.51	1.52
*	3	112.8	12368	10.22	8.06	6.68	5.11	3.91	2.47	1.47
*	4	149.0	16336	13.15	10.26	8.53	6.50	4.98	3.16	1.95
*	4	148.7	16296	13.15	10.26	8.53	6.59	5.02	3.21	2.00
*	4	148.8	16320	13.20	10.30	8.53	6.59	5.02	3.21	1.95
*	4	149.1	16344	13.20	10.30	8.53	6.59	5.02	3.21	2.00

Stn: 520 Lane:F1 Temp: J/C: Air: 80 PvT: 87 11:27

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.0	12288	13.99	9.82	8.05	5.83	4.31	2.51	1.47
	C	112.2	12304	13.62	9.61	7.88	5.74	4.27	2.56	1.52
	C	111.7	12248	13.49	9.52	7.75	5.66	4.18	2.51	1.47
*	1	55.2	6056	7.37	5.17	4.20	3.00	2.13	1.26	0.74
*	1	55.4	6064	7.37	5.17	4.16	3.00	2.18	1.30	0.74
*	1	55.4	6064	7.33	5.17	4.20	3.00	2.18	1.30	0.78
*	1	55.7	6104	7.42	5.21	4.24	3.04	2.22	1.34	0.82
*	2	81.4	8936	10.31	7.24	5.96	4.31	3.16	1.91	1.13

File: C:\FWD\DATA\276251E1.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 27624(

*	2	82.2	9008	10.43	7.33	6.00	4.39	3.20	1.95	1.17
*	2	82.0	8992	10.35	7.28	5.96	4.31	3.16	1.91	1.13
*	2	82.0	8992	10.39	7.33	6.00	4.39	3.20	1.99	1.21
*	3	111.7	12248	13.36	9.44	7.75	5.66	4.18	2.56	1.52
*	3	111.9	12264	13.36	9.48	7.75	5.66	4.13	2.51	1.47
*	3	112.0	12280	13.41	9.48	7.75	5.66	4.18	2.56	1.52
*	3	112.0	12288	13.36	9.48	7.75	5.66	4.13	2.56	1.52
*	4	147.7	16192	17.09	12.11	9.90	7.22	5.33	3.29	1.95
*	4	148.3	16248	17.09	12.06	9.90	7.22	5.38	3.25	1.95
*	4	148.1	16232	17.13	12.11	9.90	7.22	5.38	3.34	2.00
*	4	148.4	16272	17.18	12.15	9.94	7.26	5.38	3.34	2.04

Stn: 530 Lane:F1 Temp: J/C: Air: 79 PvT: 88 11:32

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.9	12384	10.64	8.36	7.03	5.40	4.04	2.56	1.47
	C	113.3	12432	10.47	8.23	6.94	5.32	4.04	2.56	1.52
	C	112.9	12384	10.39	8.19	6.90	5.28	4.04	2.56	1.47
*	1	55.8	6120	5.45	4.31	3.60	2.74	2.09	1.26	0.74
*	1	55.8	6120	5.49	4.40	3.68	2.83	2.18	1.39	0.87
*	1	56.4	6176	5.45	4.31	3.64	2.79	2.13	1.30	0.82
*	1	56.4	6184	5.40	4.31	3.60	2.74	2.09	1.26	0.74
*	2	82.8	9072	7.88	6.20	5.27	4.05	3.07	1.95	1.21V
*	2	83.0	9096	7.83	6.20	5.23	4.01	3.07	1.91	1.08
*	2	82.3	9024	7.83	6.20	5.23	4.01	3.02	1.91	1.08
*	2	82.6	9064	7.79	6.20	5.23	4.01	3.02	1.91	1.04
*	3	112.5	12336	10.26	8.06	6.81	5.23	4.00	2.56	1.52
*	3	112.9	12376	10.26	8.10	6.86	5.28	4.04	2.56	1.52
*	3	113.2	12400	10.31	8.14	6.90	5.32	4.04	2.60	1.56
*	3	112.9	12384	10.31	8.14	6.86	5.32	4.04	2.60	1.52
*	4	148.8	16320	13.28	10.34	8.74	6.75	5.16	3.34	1.95
*	4	149.6	16400	13.32	10.38	8.78	6.75	5.20	3.34	1.95
*	4	149.9	16432	13.28	10.38	8.74	6.75	5.16	3.29	1.91
*	4	149.7	16408	13.28	10.34	8.74	6.75	5.20	3.34	1.95

'DATA WITH VAR.

Mileage:-.006 -> .1

11:34 930714

File: C:\FWD\DATA\276251E3.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 276251

FWD S/N : 8002-063
Operator ID : KADLEC, ANTHONY J.

TESTS OUTSIDE SECTION FOR SMP.

Stationing...: Feet

Diameter of Plate: 11.8
Deflector distances : 8 12 18 24 36 60

SHRP TESTING - FLEXIBLE - BASIN TEST (F0,F1,F3)
Sequence: CCC111122223333444 4

Stn: -30 Lane:F3 Temp: J/C: Air: 80 PvT: 82 11:36

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	113.0	12392	10.18	8.36	7.24	5.87	4.62	3.03	1.73
	C	113.5	12448	9.93	8.14	7.15	5.74	4.62	3.03	1.78
	C	113.3	12432	9.85	8.06	7.03	5.66	4.53	2.99	1.69
*	1	57.1	6256	5.36	4.44	3.90	3.12	2.49	1.60	0.95
*	1	57.4	6296	5.36	4.48	3.90	3.12	2.49	1.60	0.95
*	1	57.4	6288	5.32	4.35	3.90	3.08	2.49	1.60	0.91
*	1	57.2	6280	5.32	4.40	3.90	3.12	2.49	1.65	0.95
*	2	83.2	9120	7.54	6.25	5.48	4.43	3.56	2.34	1.39
*	2	83.6	9168	7.50	6.16	5.48	4.39	3.56	2.30	1.30
*	2	83.8	9184	7.54	6.20	5.48	4.39	3.56	2.30	1.30
*	2	83.6	9168	7.50	6.16	5.48	4.39	3.56	2.30	1.34
*	3	113.2	12408	9.80	8.01	7.03	5.70	4.58	3.03	1.73
*	3	113.3	12424	9.72	8.01	7.03	5.66	4.53	2.99	1.73
*	3	113.3	12424	9.76	7.97	7.03	5.70	4.53	3.03	1.73
*	3	113.5	12440	9.80	7.97	7.03	5.66	4.53	2.99	1.73
*	4	147.1	16128	12.23	9.95	8.78	7.05	5.73	3.81	2.26
*	4	147.8	16200	12.28	10.08	8.83	7.13	5.73	3.86	2.30
*	4	147.8	16200	12.28	10.04	8.78	7.13	5.73	3.86	2.30
*	4	147.8	16216	12.23	10.08	8.78	7.09	5.69	3.86	2.26

Stn: -20 Lane:F3 Temp: J/C: Air: 81 PvT: 82 11:39

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.9	12376	11.06	8.88	7.63	6.12	4.80	3.08	1.73
	C	113.0	12400	10.85	8.75	7.54	6.04	4.76	3.12	1.82
	C	113.0	12400	10.77	8.62	7.45	5.99	4.71	3.08	1.78
*	1	56.7	6216	5.95	4.83	4.16	3.29	2.58	1.65	0.95
*	1	56.8	6232	5.95	4.83	4.16	3.29	2.58	1.65	0.95
*	1	56.8	6232	5.91	4.78	4.16	3.25	2.53	1.60	0.91
*	1	56.8	6232	5.95	4.83	4.16	3.29	2.58	1.65	0.95
*	2	82.8	9080	8.25	6.64	5.74	4.60	3.60	2.34	1.30
*	2	83.2	9128	8.25	6.68	5.78	4.60	3.60	2.34	1.30
*	2	83.2	9120	8.30	6.68	5.78	4.64	3.64	2.34	1.34
*	2	83.5	9152	8.30	6.68	5.78	4.64	3.64	2.34	1.34
*	3	112.6	12352	10.60	8.53	7.37	5.91	4.71	3.08	1.78
*	3	112.9	12384	10.64	8.57	7.41	5.95	4.71	3.12	1.82
*	3	113.0	12400	10.60	8.53	7.37	5.91	4.67	3.08	1.78
*	3	113.2	12408	10.64	8.57	7.41	5.95	4.67	3.08	1.78
*	4	146.7	16080	13.11	10.60	9.13	7.39	5.87	3.86	2.30
*	4	147.4	16152	13.20	10.64	9.21	7.43	5.91	3.94	2.30
*	4	147.4	16168	13.15	10.64	9.17	7.43	5.87	3.90	2.21
*	4	147.2	16144	13.15	10.60	9.17	7.39	5.87	3.90	2.30

Stn: -10 Lane:F3 Temp: J/C: Air: 82 PvT: 88 11:42

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	113.0	12392	9.97	8.19	7.07	5.66	4.44	2.90	1.65
	C	112.9	12376	9.76	8.01	6.94	5.53	4.40	2.86	1.69
	C	113.3	12432	9.76	8.01	6.94	5.57	4.40	2.90	1.73
*	1	57.2	6280	5.32	4.44	3.81	3.04	2.40	1.56	0.91
*	1	56.8	6232	5.19	4.35	3.73	2.95	2.31	1.47	0.87
*	1	56.2	6176	5.19	4.31	3.73	2.95	2.31	1.47	0.87
*	1	56.8	6232	5.28	4.40	3.81	3.04	2.40	1.56	1.00
*	2	83.0	9104	7.29	6.08	5.27	4.22	3.29	2.17	1.21
*	2	83.5	9144	7.37	6.12	5.31	4.26	3.38	2.21	1.26
*	2	83.2	9120	7.33	6.08	5.27	4.22	3.33	2.12	1.21
*	2	83.5	9152	7.42	6.16	5.36	4.31	3.42	2.21	1.30
*	3	112.8	12360	9.64	7.93	6.86	5.49	4.40	2.86	1.73

File: C:\FWD\DATA\276251E3.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 276251

*	3	113.2	12416	9.64	7.89	6.81	5.49	4.36	2.82	1.65
*	3	113.0	12392	9.59	7.84	6.81	5.45	4.36	2.86	1.65
*	3	113.2	12416	9.59	7.84	6.81	5.49	4.36	2.86	1.65
*	4	147.0	16112	12.11	9.91	8.61	6.88	5.47	3.64	2.17
*	4	147.8	16216	12.15	9.95	8.61	6.92	5.56	3.68	2.21
*	4	147.8	16208	12.15	9.91	8.61	6.92	5.56	3.68	2.17
*	4	147.8	16216	12.15	9.95	8.65	6.97	5.56	3.73	2.21

Stn: 0 Lane:F3 Temp: J/C: Air: 81 PvT: 90 11:45

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.3	12320	9.89	8.10	7.07	5.74	4.62	2.77	1.65
	C	112.5	12336	9.97	8.14	7.11	5.83	4.71	2.82	1.73
	C	112.8	12360	9.89	8.06	7.07	5.74	4.58	2.73	1.60
*	1	56.1	6152	5.36	4.44	3.90	3.17	2.49	1.47	0.91
*	1	56.7	6208	5.40	4.48	3.94	3.21	2.58	1.52	0.91
*	1	56.7	6216	5.36	4.44	3.86	3.17	2.53	1.47	0.87
*	1	56.1	6144	5.40	4.44	3.90	3.17	2.53	1.47	0.91
*	2	81.9	8976	7.58	6.25	5.44	4.47	3.56	2.12	1.26
*	2	82.9	9080	7.67	6.29	5.53	4.52	3.60	2.17	1.30
*	2	82.6	9056	7.67	6.29	5.53	4.52	3.60	2.12	1.26
*	2	82.9	9088	7.62	6.29	5.48	4.47	3.56	2.12	1.26
*	3	111.9	12272	9.85	8.01	7.03	5.70	4.58	2.73	1.60
*	3	112.8	12360	9.89	8.06	7.07	5.78	4.62	2.77	1.65
*	3	112.8	12360	9.85	8.06	7.03	5.74	4.58	2.73	1.60
*	3	112.3	12320	9.85	8.01	7.03	5.74	4.58	2.73	1.60
*	4	148.3	16248	12.53	10.17	8.87	7.22	5.82	3.55	2.13
*	4	148.8	16320	12.48	10.17	8.83	7.22	5.78	3.51	2.08
*	4	149.1	16352	12.57	10.21	8.87	7.26	5.82	3.55	2.13
*	4	149.0	16336	12.57	10.21	8.87	7.26	5.87	3.55	2.13

Stn: 50 Lane:F3 Temp: J/C: Air: 82 PvT: 95 11:48

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.2	12304	12.15	10.90	9.90	5.57	4.36	2.90	1.69
	C	112.5	12328	11.86	10.56	9.55	5.49	4.31	2.82	1.69
	C	112.6	12344	11.90	10.60	9.64	5.57	4.44	2.99	1.82
*	1	56.5	6192	6.49	5.99	5.53	2.95	2.31	1.52	0.91
*	1	56.8	6224	6.49	5.99	5.53	2.95	2.31	1.52	0.91
*	1	56.7	6216	6.49	5.99	5.57	3.00	2.36	1.52	0.95
*	1	56.8	6232	6.49	5.99	5.53	2.95	2.31	1.52	0.91
*	2	82.6	9056	8.92	8.10	7.45	4.14	3.24	2.17	1.26
*	2	83.2	9120	9.01	8.19	7.50	4.18	3.29	2.21	1.30
*	2	83.3	9136	9.09	8.23	7.54	4.26	3.38	2.25	1.34
*	2	83.2	9120	9.09	8.23	7.58	4.26	3.38	2.30	1.43
*	3	112.2	12304	11.60	10.34	9.38	5.40	4.27	2.86	1.69
*	3	112.8	12368	11.65	10.43	9.51	5.49	4.36	2.95	1.78
*	3	112.6	12344	11.56	10.34	9.43	5.40	4.31	2.86	1.73
*	3	112.9	12376	11.56	10.34	9.43	5.40	4.27	2.82	1.69
*	4	145.8	15992	14.50	12.75	11.53	6.80	5.38	3.60	2.13
*	4	146.2	16040	14.45	12.75	11.48	6.75	5.33	3.60	2.13
*	4	146.4	16056	14.50	12.80	11.53	6.84	5.42	3.64	2.17
*	4	146.7	16088	14.54	12.80	11.53	6.84	5.42	3.64	2.21

Stn: 100 Lane:F3 Temp: J/C: Air: 82 PvT: 97 11:50

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.8	12368	10.52	8.62	7.45	5.99	4.76	3.16	1.78
	C	113.2	12416	10.35	8.40	7.37	5.91	4.71	3.16	1.87
	C	113.3	12424	10.22	8.36	7.28	5.87	4.67	3.12	1.82
*	1	57.1	6264	5.57	4.61	3.98	3.21	2.49	1.65	1.00
*	1	57.1	6256	5.61	4.65	4.03	3.29	2.53	1.78	1.04
*	1	57.1	6264	5.57	4.61	3.98	3.17	2.49	1.65	0.91
*	1	56.7	6216	5.49	4.57	3.94	3.17	2.44	1.60	0.95
*	2	83.0	9104	7.79	6.38	5.57	4.52	3.56	2.38	1.34
*	2	83.8	9176	7.88	6.46	5.61	4.52	3.64	2.43	1.39
*	2	83.9	9192	7.83	6.42	5.61	4.56	3.60	2.38	1.39
*	2	83.3	9144	7.83	6.42	5.61	4.56	3.64	2.38	1.39
*	3	112.8	12360	10.14	8.32	7.24	5.87	4.67	3.16	1.87
*	3	113.0	12400	10.14	8.27	7.20	5.83	4.67	3.16	1.82
*	3	113.2	12408	10.14	8.27	7.24	5.83	4.67	3.16	1.82
*	3	113.0	12392	10.18	8.32	7.24	5.87	4.71	3.21	1.87
*	4	147.5	16168	12.74	10.38	9.04	7.35	5.87	4.03	2.39

File: C:\FWD\DATA\276251E3.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 276251

*	4	148.3	16256	12.82	10.38	9.00	7.30	5.82	4.03	2.34
*	4	148.1	16240	12.82	10.38	9.00	7.35	5.87	4.03	2.39
*	4	147.7	16200	12.82	10.34	9.04	7.35	5.87	4.03	2.39

Stn: 150 Lane:F3 Temp: J/C: Air: 81 PvT: 95 11:53

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.8	12368	11.48	9.44	8.14	6.54	5.11	3.42	2.00
	C	113.2	12408	11.14	9.18	7.93	6.37	5.02	3.34	1.95
	C	113.0	12400	11.06	9.13	7.93	6.33	5.02	3.38	2.00
*	1	56.5	6192	6.03	5.00	4.33	3.42	2.62	1.73	1.00
*	1	57.0	6248	6.07	5.08	4.33	3.46	2.67	1.73	1.04
*	1	56.7	6216	6.07	5.08	4.37	3.46	2.67	1.73	1.04
*	1	57.1	6256	6.07	5.08	4.33	3.46	2.67	1.69	1.00
*	2	82.5	9040	8.42	6.98	6.04	4.85	3.78	2.51	1.47
*	2	83.3	9128	8.50	7.07	6.13	4.90	3.87	2.56	1.47
*	2	83.3	9136	8.50	7.02	6.08	4.85	3.82	2.51	1.47
*	2	82.9	9096	8.50	7.02	6.13	4.85	3.91	2.56	1.47
*	3	112.3	12320	10.93	9.05	7.84	6.33	5.02	3.38	2.04
*	3	112.6	12344	10.93	9.05	7.80	6.33	4.98	3.38	2.00
*	3	113.0	12400	10.93	9.05	7.80	6.29	4.98	3.34	2.00
*	3	112.8	12360	10.85	8.96	7.75	6.25	4.93	3.34	1.95
*	4	147.7	16200	13.70	11.20	9.68	7.81	6.18	4.20	2.52
*	4	148.8	16320	13.70	11.25	9.73	7.81	6.22	4.25	2.52
*	4	148.7	16296	13.70	11.25	9.68	7.85	6.22	4.25	2.52
*	4	148.3	16264	13.74	11.25	9.73	7.89	6.27	4.29	2.60

Stn: 200 Lane:F3 Temp: J/C: Air: 81 PvT: 95 11:56

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	113.2	12408	11.02	9.22	8.01	6.37	5.02	3.29	1.87
	C	113.3	12424	10.73	9.01	7.80	6.29	4.98	3.29	1.91
	C	113.3	12416	10.73	9.01	7.80	6.29	4.93	3.34	1.91
*	1	56.8	6224	5.82	4.96	4.28	3.42	2.67	1.78	1.04
*	1	57.0	6240	5.82	4.96	4.28	3.42	2.71	1.78	1.04
*	1	57.0	6248	5.82	4.96	4.28	3.42	2.67	1.73	1.00
*	1	57.4	6288	5.78	4.96	4.24	3.38	2.62	1.73	0.95
*	2	82.9	9096	8.21	6.89	6.00	4.81	3.82	2.51	1.47
*	2	83.8	9192	8.25	6.94	6.04	4.85	3.82	2.51	1.43
*	2	83.6	9168	8.21	6.89	6.04	4.85	3.82	2.56	1.43
*	2	83.8	9192	8.25	6.89	6.04	4.85	3.82	2.51	1.43
*	3	112.9	12376	10.60	8.88	7.71	6.25	4.93	3.29	1.95
*	3	113.3	12416	10.56	8.88	7.71	6.21	4.89	3.29	1.91
*	3	113.3	12424	10.60	8.88	7.71	6.21	4.93	3.29	1.91
*	3	113.2	12408	10.56	8.88	7.71	6.25	4.93	3.29	1.91
*	4	147.8	16208	13.36	11.12	9.64	7.77	6.22	4.20	2.43
*	4	148.1	16240	13.36	11.03	9.64	7.81	6.22	4.20	2.43
*	4	148.1	16240	13.36	11.07	9.64	7.81	6.27	4.20	2.47
*	4	148.6	16280	13.45	11.16	9.73	7.89	6.36	4.29	2.56

Stn: 250 Lane:F3 Temp: J/C: Air: 80 PvT: 92 11:59

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.2	12304	11.60	9.44	7.97	6.21	4.80	3.03	1.73
	C	112.9	12368	11.40	9.22	7.84	6.16	4.76	3.08	1.82
	C	112.6	12344	11.27	9.09	7.71	6.08	4.67	2.99	1.69
*	1	56.7	6224	6.20	5.13	4.33	3.38	2.62	1.65	1.00
*	1	56.7	6208	6.20	5.13	4.33	3.33	2.58	1.65	0.95
*	1	57.0	6240	6.24	5.13	4.37	3.38	2.62	1.65	1.00
*	1	56.5	6192	6.12	5.08	4.28	3.33	2.53	1.60	0.95
*	2	82.2	9000	8.59	6.98	5.96	4.64	3.60	2.25	1.30
*	2	83.2	9112	8.67	7.07	6.00	4.69	3.60	2.30	1.30
*	2	83.0	9112	8.71	7.11	6.04	4.77	3.64	2.34	1.34
*	2	82.9	9096	8.71	7.11	6.04	4.73	3.64	2.34	1.30
*	3	112.3	12304	11.06	9.01	7.67	6.04	4.67	3.03	1.73
*	3	112.5	12336	11.06	8.96	7.67	5.99	4.67	2.99	1.73
*	3	112.6	12344	11.10	9.05	7.71	6.08	4.71	3.08	1.78
*	3	112.9	12376	11.10	9.05	7.67	6.08	4.76	3.08	1.78
*	4	147.2	16152	13.95	11.25	9.60	7.60	5.91	3.90	2.34
*	4	148.1	16240	13.95	11.20	9.55	7.56	5.91	3.86	2.26
*	4	147.8	16208	13.91	11.20	9.55	7.56	5.87	3.86	2.26
*	4	148.4	16272	13.95	11.25	9.55	7.56	5.91	3.86	2.26

File: C:\FWD\DATA\276251E3.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 276251

Stn: 300 Lane:F3 Temp: J/C: Air: 80 PvT: 92 12:02

	Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
		C	113.0	12400	9.59	7.67	6.47	5.02	3.87	2.47	1.43
		C	113.2	12416	9.43	7.50	6.38	4.98	3.82	2.47	1.47
		C	113.3	12424	9.34	7.50	6.38	4.98	3.82	2.51	1.47
*		1	56.8	6224	5.11	4.14	3.47	2.66	2.04	1.30	0.78
*		1	57.0	6240	5.07	4.09	3.43	2.62	2.00	1.26	0.69
*		1	57.2	6272	5.11	4.14	3.47	2.66	2.04	1.26	0.74
*		1	56.8	6232	5.11	4.14	3.51	2.70	2.09	1.30	0.78
*		2	82.5	9040	7.04	5.69	4.84	3.71	2.84	1.78	1.08
*		2	83.3	9136	7.16	5.82	4.93	3.84	2.93	1.86	1.17
*		2	83.2	9128	7.12	5.77	4.93	3.80	2.93	1.82	1.08
*		2	82.9	9088	7.08	5.69	4.84	3.76	2.84	1.78	1.04
*		3	112.9	12376	9.13	7.33	6.21	4.85	3.73	2.38	1.43
*		3	113.0	12384	9.09	7.33	6.26	4.90	3.78	2.43	1.43
*		3	113.5	12448	9.22	7.41	6.30	4.94	3.82	2.51	1.47
*		3	113.2	12408	9.13	7.37	6.26	4.94	3.78	2.47	1.47
*		4	147.8	16208	11.44	9.13	7.75	6.08	4.76	3.08	1.82
*		4	148.6	16288	11.48	9.18	7.84	6.16	4.80	3.12	1.87
*		4	148.4	16272	11.48	9.18	7.80	6.12	4.76	3.12	1.87
*		4	148.7	16304	11.48	9.18	7.80	6.12	4.76	3.12	1.87

Stn: 350 Lane:F3 Temp: J/C: Air: 79 PvT: 93 12:04

	Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
		C	109.7	12040	11.98	9.69	7.97	5.78	4.27	2.38	1.34
		C	110.1	12072	11.73	9.44	7.84	5.70	4.22	2.34	1.34
		C	110.7	12144	11.69	9.39	7.84	5.66	4.27	2.34	1.34
*		1	57.2	6280	6.83	5.34	4.46	3.12	2.31	1.17	0.69
*		1	57.1	6256	6.79	5.34	4.46	3.12	2.31	1.26	0.74
*		1	57.5	6312	6.83	5.39	4.50	3.17	2.36	1.26	0.74
*		1	57.2	6272	6.91	5.39	4.50	3.17	2.36	1.30	0.78
*		2	83.5	9144	9.26	7.33	6.08	4.39	3.20	1.78	1.04
*		2	84.1	9216	9.34	7.41	6.13	4.43	3.24	1.78	1.04
*		2	84.1	9216	9.38	7.45	6.13	4.47	3.24	1.82	1.08
*		2	84.1	9208	9.34	7.41	6.08	4.39	3.20	1.78	1.00
*		3	110.3	12088	11.60	9.39	7.71	5.66	4.18	2.47	1.43
*		3	110.9	12152	11.56	9.39	7.67	5.61	4.18	2.43	1.39
*		3	110.9	12152	11.65	9.35	7.67	5.61	4.18	2.38	1.34
*		3	110.9	12152	11.60	9.31	7.63	5.61	4.13	2.43	1.39
*		4	141.2	15480	14.08	11.42	9.34	6.92	5.16	3.08	1.73
*		4	141.7	15544	14.12	11.29	9.30	6.92	5.24	2.99	1.73
*		4	141.7	15544	14.12	11.29	9.34	6.92	5.24	2.99	1.78
*		4	141.4	15512	14.03	11.20	9.25	6.88	5.20	2.95	1.73

Stn: 400 Lane:F3 Temp: J/C: Air: 80 PvT: 93 12:07

	Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
		C	113.5	12440	9.64	7.80	6.64	5.23	4.04	2.56	1.47
		C	113.6	12448	9.47	7.67	6.60	5.19	4.00	2.56	1.47
		C	113.5	12440	9.34	7.58	6.51	5.15	4.00	2.51	1.47
*		1	56.7	6216	5.03	4.09	3.51	2.74	2.09	1.30	0.74
*		1	56.8	6224	5.07	4.09	3.51	2.70	2.09	1.30	0.74
*		1	56.8	6224	5.07	4.09	3.51	2.70	2.09	1.30	0.74
*		1	56.7	6216	5.03	4.14	3.51	2.74	2.13	1.34	0.78
*		2	82.3	9016	7.08	5.77	4.97	3.88	3.02	1.86	1.08
*		2	82.9	9080	7.16	5.86	5.01	3.97	3.07	1.95	1.17
*		2	82.8	9072	7.16	5.82	5.01	3.97	3.02	1.95	1.13
*		2	82.8	9072	7.16	5.82	5.01	3.97	3.02	1.95	1.13
*		3	112.8	12368	9.22	7.45	6.43	5.11	3.96	2.51	1.43
*		3	113.3	12432	9.26	7.54	6.47	5.11	4.00	2.51	1.47
*		3	112.9	12384	9.26	7.50	6.43	5.07	3.96	2.51	1.47
*		3	113.2	12416	9.22	7.45	6.43	5.07	3.96	2.51	1.43
*		4	149.0	16336	11.77	9.48	8.14	6.42	5.02	3.21	1.87
*		4	149.6	16392	11.81	9.48	8.14	6.46	5.02	3.21	1.87
*		4	149.1	16360	11.86	9.48	8.18	6.50	5.11	3.25	1.91
*		4	149.3	16368	11.81	9.44	8.14	6.46	5.07	3.21	1.91

Stn: 450 Lane:F3 Temp: J/C: Air: 81 PvT: 94 12:10

	Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
		C	112.3	12320	10.85	8.53	7.20	5.45	4.04	2.47	1.47
		C	112.8	12360	10.60	8.36	7.03	5.32	4.00	2.43	1.47
		C	112.6	12352	10.56	8.32	7.03	5.36	4.00	2.47	1.52

File: C:\FWD\DATA\276251E3.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 276251

*	1	56.2	6168	5.74	4.61	3.86	2.87	2.13	1.26	0.69
*	1	56.7	6216	5.82	4.61	3.90	2.91	2.18	1.26	0.74
*	1	56.4	6184	5.78	4.61	3.90	2.91	2.13	1.26	0.74
*	1	56.5	6200	5.78	4.61	3.86	2.87	2.13	1.26	0.74
*	2	81.9	8976	7.96	6.33	5.36	4.05	2.98	1.82	1.08
*	2	82.6	9056	8.09	6.42	5.44	4.09	3.07	1.82	1.13
*	2	82.5	9048	8.04	6.42	5.40	4.05	2.98	1.78	1.00V
*	2	82.3	9016	8.09	6.38	5.44	4.14	3.07	1.86	1.13
*	3	112.0	12272	10.35	8.19	6.90	5.28	3.96	2.47	1.47
*	3	112.5	12336	10.39	8.23	6.98	5.32	3.96	2.47	1.52
*	3	112.6	12336	10.35	8.19	6.94	5.28	3.96	2.47	1.47
*	3	112.6	12352	10.39	8.19	6.94	5.28	3.96	2.43	1.47
*	4	147.0	16120	12.99	10.21	8.61	6.59	4.98	3.12	1.91
*	4	147.8	16208	12.99	10.26	8.65	6.63	5.02	3.12	1.91
*	4	147.7	16192	13.07	10.26	8.70	6.67	5.07	3.16	1.95
*	4	147.8	16200	13.03	10.26	8.70	6.63	5.02	3.16	1.95

'DATA WITH VAR.

Stn: 500 Lane:F3 Temp: J/C: Air: 81 PvT: 96 12:12

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	111.4	12224	11.81	9.26	7.75	5.83	4.31	2.60	1.56
	C	111.9	12272	11.52	9.05	7.58	5.66	4.27	2.56	1.52
	C	112.0	12280	11.40	8.92	7.50	5.61	4.18	2.51	1.47
*	1	55.2	6048	6.24	4.96	4.16	3.08	2.27	1.30	0.74
*	1	55.4	6072	6.28	5.00	4.20	3.12	2.31	1.39	0.82
*	1	55.7	6096	6.28	5.00	4.20	3.12	2.27	1.34	0.78
*	1	55.2	6064	6.28	5.00	4.20	3.12	2.31	1.34	0.82
*	2	81.3	8920	8.71	6.81	5.74	4.31	3.16	1.86	1.08
*	2	81.7	8960	8.76	6.89	5.74	4.35	3.20	1.95	1.13
*	2	81.7	8960	8.76	6.85	5.83	4.35	3.20	1.91	1.13
*	2	81.6	8952	8.76	6.89	5.78	4.35	3.24	1.91	1.13
*	3	110.9	12152	11.19	8.79	7.41	5.57	4.18	2.51	1.47
*	3	111.6	12232	11.19	8.79	7.37	5.57	4.13	2.51	1.43
*	3	111.7	12248	11.19	8.79	7.37	5.57	4.13	2.51	1.47
*	3	111.4	12224	11.19	8.83	7.37	5.57	4.18	2.51	1.47
*	4	148.1	16232	14.12	11.03	9.25	7.01	5.24	3.21	1.87
*	4	148.7	16304	14.16	11.07	9.30	7.05	5.29	3.21	1.91
*	4	148.7	16296	14.12	11.03	9.25	7.05	5.29	3.25	1.91
*	4	148.6	16280	14.12	11.03	9.30	7.05	5.29	3.29	1.91

Stn: 510 Lane:F3 Temp: J/C: Air: 81 PvT: 97 12:15

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.2	12304	11.27	8.92	7.41	5.66	4.18	2.56	1.47
	C	111.9	12264	10.98	8.75	7.28	5.57	4.13	2.51	1.47
	C	112.3	12312	10.93	8.70	7.28	5.53	4.13	2.51	1.47
*	1	56.1	6144	6.03	4.83	4.07	3.04	2.22	1.30	0.74
*	1	55.7	6096	5.95	4.78	4.03	3.04	2.22	1.30	0.74
*	1	56.5	6192	5.99	4.78	4.07	3.04	2.27	1.26	0.74
*	1	56.4	6176	5.99	4.78	4.03	3.04	2.18	1.30	0.74
*	2	81.6	8952	8.34	6.68	5.61	4.31	3.20	1.95	1.17
*	2	81.7	8960	8.30	6.68	5.61	4.31	3.20	1.91	1.13
*	2	81.6	8952	8.34	6.72	5.66	4.31	3.24	1.95	1.17
*	2	81.9	8968	8.25	6.64	5.57	4.22	3.11	1.86	1.08
*	3	111.6	12232	10.73	8.53	7.20	5.49	4.13	2.51	1.52
*	3	112.0	12280	10.77	8.66	7.20	5.53	4.13	2.60	1.52
*	3	111.7	12256	10.73	8.57	7.15	5.49	4.13	2.51	1.47
*	3	112.0	12280	10.73	8.57	7.15	5.49	4.09	2.51	1.47
*	4	147.4	16160	13.57	10.77	9.00	6.92	5.24	3.25	1.95
*	4	147.8	16208	13.57	10.73	9.00	6.92	5.24	3.21	1.91
*	4	147.5	16176	13.57	10.73	8.95	6.92	5.11	3.25	1.91
*	4	148.0	16224	13.62	10.77	9.04	6.97	5.24	3.25	1.95

Stn: 520 Lane:F3 Temp: J/C: Air: 82 PvT: 97 12:17

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	111.2	12192	13.87	9.78	8.05	5.91	4.36	2.51	1.43
	C	111.0	12168	13.49	9.48	7.84	5.74	4.27	2.51	1.39
	C	111.2	12184	13.36	9.48	7.80	5.87	4.40	2.47	1.21
*	1	54.9	6024	7.75	5.34	4.37	3.21	2.31	1.34	0.78
*	1	55.2	6048	7.87	5.30	4.33	3.12	2.27	1.30	0.74
*	1	55.1	6032	7.82	5.30	4.33	3.17	2.31	1.34	0.78

File: C:\FWD\DATA\276251E3.FWD
Road: US-2 WESTBOUND LANE, 2 MILES SOUTH OF US-7, BEMIDJI, MINNESOTA
Subsection: 276251

*	1	54.8	6016	7.58	5.30	4.33	3.12	2.27	1.30	0.74
*	2	80.4	8816	10.22	7.28	6.00	4.39	3.24	1.91	1.08
*	2	80.9	8864	10.26	7.33	6.04	4.43	3.24	1.91	1.08
*	2	80.9	8872	10.26	7.37	6.08	4.47	3.33	1.95	1.08
*	2	81.0	8880	10.26	7.33	6.04	4.47	3.29	1.91	1.04
*	3	110.9	12152	13.11	9.31	7.67	5.70	4.31	2.47	1.34
*	3	110.7	12144	13.11	9.31	7.67	5.87	4.49	2.51	1.43
*	3	110.7	12144	13.11	9.31	7.63	5.78	4.36	2.51	1.43
*	3	110.6	12128	13.15	9.31	7.67	5.83	4.40	2.56	1.47
*	4	146.7	16072	16.38	11.63	9.51	7.35	5.69	3.21	1.82
*	4	146.4	16056	16.30	11.55	9.43	7.35	5.69	3.16	1.78
*	4	146.4	16048	16.34	11.55	9.43	7.30	5.73	3.12	1.78
*	4	146.2	16032	16.30	11.55	9.43	7.26	5.64	3.12	1.78

Stn: 530 Lane:F3 Temp: J/C: Air: 82 PvT: 98 12:20

Sto	Hgt	psi	lbf	Df1	Df2	Df3	Df4	Df5	Df6	Df7
	C	112.8	12368	10.39	8.40	7.15	5.45	4.18	2.51	1.47
	C	112.5	12336	10.22	8.19	7.03	5.40	4.18	2.60	1.52
	C	112.8	12360	10.10	8.10	6.94	5.32	4.13	2.51	1.47
*	1	55.9	6128	5.53	4.44	3.81	2.91	2.18	1.30	0.78
*	1	56.4	6176	5.57	4.48	3.81	2.87	2.18	1.30	0.74
*	1	56.4	6184	5.53	4.52	3.81	2.91	2.13	1.30	0.74
*	1	56.8	6224	5.61	4.52	3.81	2.91	2.22	1.30	0.78
*	2	81.9	8984	7.62	6.16	5.31	4.05	3.16	1.91	1.08
*	2	82.6	9056	7.79	6.29	5.40	4.14	3.20	1.95	1.17
*	2	82.9	9088	7.71	6.29	5.36	4.14	3.16	1.91	1.13
*	2	82.6	9056	7.71	6.25	5.36	4.09	3.20	1.91	1.13
*	3	112.3	12312	9.97	8.06	6.86	5.32	4.13	2.56	1.52
*	3	112.3	12312	10.01	8.06	6.94	5.32	4.09	2.56	1.52
*	3	112.5	12328	10.01	8.10	6.94	5.36	4.13	2.56	1.52
*	3	112.3	12312	9.93	8.01	6.90	5.32	4.04	2.51	1.47
*	4	148.0	16224	12.44	10.04	8.65	6.67	5.16	3.21	1.91
*	4	148.6	16288	12.53	10.04	8.61	6.67	5.20	3.21	1.87
*	4	148.8	16328	12.53	10.08	8.65	6.71	5.24	3.29	1.91
*	4	148.8	16328	12.48	10.04	8.61	6.67	5.20	3.21	1.91

Mileage:-.006 -> .1

Summary of Data for section 276251E
Analyzed by: DANA MILLER on 08-11-1993

UNCORRECTED Overall Deflection Statistics

Mean Values (mils/kip)

Test Loc.	Drop Ht	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7
3	1	0.9516	0.7740	0.6632	0.4986	0.3818	0.2361	0.1384
	2	0.9058	0.7347	0.6320	0.4818	0.3716	0.2330	0.1354
	3	0.8573	0.6930	0.5945	0.4571	0.3550	0.2260	0.1321
	4	0.8200	0.6589	0.5646	0.4370	0.3420	0.2192	0.1296

Standard Deviations

Test Loc.	Drop Ht	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7
3	1	0.1151	0.0805	0.0761	0.0360	0.0307	0.0280	0.0170
	2	0.0960	0.0697	0.0647	0.0322	0.0300	0.0270	0.0146
	3	0.0860	0.0639	0.0580	0.0307	0.0278	0.0252	0.0149
	4	0.0778	0.0579	0.0523	0.0289	0.0265	0.0249	0.0149

Coefficient of Variation

Test Loc.	Drop Ht	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7
3	1	12.09%	10.40%	11.48%	7.22%	8.05%	11.87%	12.30%
	2	10.60%	9.48%	10.24%	6.68%	8.08%	11.60%	10.75%
	3	10.03%	9.22%	9.76%	6.71%	7.84%	11.15%	11.28%
	4	9.48%	8.79%	9.26%	6.62%	7.74%	11.36%	11.51%

Flexible Pavement Deflection Statistics - 276251E

Mean Values (mils/kip)

Test Loc.	Drop Ht	CORRECTED Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7
3	1	0.8396	0.7740	0.6632	0.4986	0.3818	0.2361	0.1384
	2	0.7989	0.7347	0.6320	0.4818	0.3716	0.2330	0.1354
	3	0.7557	0.6930	0.5945	0.4571	0.3550	0.2260	0.1321
	4	0.7225	0.6589	0.5646	0.4370	0.3420	0.2192	0.1296

Standard Deviations

Test Loc.	Drop Ht	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7
3	1	0.0962	0.0805	0.0761	0.0360	0.0307	0.0280	0.0170
	2	0.0806	0.0697	0.0647	0.0322	0.0300	0.0270	0.0146
	3	0.0726	0.0639	0.0580	0.0307	0.0278	0.0252	0.0149
	4	0.0663	0.0579	0.0523	0.0289	0.0265	0.0249	0.0149

Coefficient of Variation

Test Loc.	Drop Ht	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7
3	1	11.46%	10.40%	11.48%	7.22%	8.05%	11.87%	12.30%
	2	10.08%	9.48%	10.24%	6.68%	8.08%	11.60%	10.75%
	3	9.61%	9.22%	9.76%	6.71%	7.84%	11.15%	11.28%
	4	9.17%	8.79%	9.26%	6.62%	7.74%	11.36%	11.51%

Outlier Statistics - 276251E

Station	Height	Sensor	Number of Std. Dev.
50	1	2	2.36
50	1	3	2.99
50	2	2	2.36
50	2	3	2.99
50	3	2	2.29
50	3	3	2.93
50	4	2	2.37
50	4	3	2.93
300	1	4	-2.01
300	2	4	-2.07
300	3	4	-2.00
300	4	4	-2.10
520	1	1	2.62
520	2	1	2.43
520	3	1	2.37
520	4	1	2.28

Pavement Construction Information - 276251E

Material Code	Material Name	Layer Thickness
700	Asphaltic Concrete	7.1
302	Uncrushed Gravel	10.2

Depth to rigid foundation: 100.0 ft.

FLEXIBLE Pavement Thickness Data - 276251E
(comparison of each calculation to the expected value)

Minimum expected SN value: 3.20
Maximum expected SN value: 4.93

Height	Station	Effective SN
1	-30	5.45
2	-30	5.55
3	-30	5.65
4	-30	5.80
1	-20	5.10
2	-20	5.20
3	-20	5.40
4	-20	5.55
1	-10	5.45
2	-10	5.50
3	-10	5.65
4	-10	5.75
1	0	5.35
2	0	5.40
3	0	5.50
4	0	5.60
2	50	4.95
3	50	5.05
4	50	5.15
1	100	5.40
2	100	5.45
3	100	5.60
4	100	5.70
1	150	5.15
2	150	5.30
3	150	5.50
4	150	5.60
1	200	5.30
2	200	5.40
3	200	5.55
4	200	5.65
1	250	5.10

FLEXIBLE Pavement Thickness Data - 276251E

Height	Station	Effective SN
2	250	5.15
3	250	5.30
4	250	5.45
1	300	5.40
2	300	5.55
3	300	5.75
4	300	5.85
4	350	5.00
1	400	5.45
2	400	5.60
3	400	5.70
4	400	5.80
1	450	5.00
2	450	5.15
3	450	5.35
4	450	5.50
2	500	4.95
3	500	5.10
4	500	5.20
2	510	5.10
3	510	5.25
4	510	5.35
1	530	5.20
2	530	5.40
3	530	5.55
4	530	5.65

FLEXIBLE Pavement Thickness Statistics - 276251E

Drop height 1

Subsection	Station	Subgrade Modulus	Effective SN
No test pit data found, therefore no results exist...			
1	-30	26980	5.45
	-20	26770	5.10
	-10	27534	5.45
	0	27683	5.35
	50	27266	4.80
	100	25954	5.40
	150	24796	5.15
	200	25168	5.30
	250	25821	5.10
	300	33258	5.40
	350	33873	4.55
	400	33044	5.45
	450	33858	5.00
	500	30760	4.80
	510	33119	4.90
	520	31700	4.25
	530	32429	5.20
Subsection 1 Overall Mean:		29413	5.10
Standard Deviation:		3407	0.35
Coeff Of Variation:		11.58%	6.79%

FLEXIBLE Pavement Thickness Statistics - 276251E

Drop height 2

Subsection	Station	Subgrade Modulus	Effective SN
No test pit data found, therefore no results exist...			
1	-30	27712	5.55
	-20	27843	5.20
	-10	29443	5.50
	0	28662	5.40
	50	27564	4.95
	100	26845	5.45
	150	25118	5.30
	200	25772	5.40
	250	27927	5.15
	300	33172	5.55
	350	35091	4.70
	400	32080	5.60
	450	33133	5.15
	500	31974	4.95
	510	31479	5.10
	520	32989	4.45
	530	32033	5.40
Subsection 1 Overall Mean:		29932	5.22
Standard Deviation:		2990	0.32
Coeff Of Variation:		9.99%	6.11%

FLEXIBLE Pavement Thickness Statistics - 276251E

Drop height 3

Subsection	Station	Subgrade Modulus	Effective SN
No test pit data found, therefore no results exist...			
1	-30	28871	5.65
	-20	27883	5.40
	-10	29780	5.65
	0	30616	5.50
	50	28823	5.05
	100	27111	5.60
	150	25100	5.50
	200	26148	5.55
	250	28305	5.30
	300	34019	5.75
	350	34735	4.90
	400	34009	5.70
	450	33118	5.35
	500	33315	5.10
	510	32703	5.25
	520	34061	4.60
	530	32582	5.55
Subsection 1 Overall Mean:		30658	5.38
Standard Deviation:		3124	0.31
Coeff Of Variation:		10.19%	5.83%

FLEXIBLE Pavement Thickness Statistics - 276251E

Drop height 4

Subsection	Station	Subgrade Modulus	Effective SN
No test pit data found, therefore no results exist...			
1	-30	28561	5.80
	-20	28507	5.55
	-10	29663	5.75
	0	30838	5.60
	50	29799	5.15
	100	27509	5.70
	150	25935	5.60
	200	26556	5.65
	250	28614	5.45
	300	34777	5.85
	350	35331	5.00
	400	34406	5.80
	450	33381	5.50
	500	34067	5.20
	510	33404	5.35
	520	35557	4.70
	530	34095	5.65
Subsection 1 Overall Mean:		31235	5.49
Standard Deviation:		3294	0.32
Coeff Of Variation:		10.54%	5.76%

Summary of Results

Section uniformity:
NO Subsections were identified within the section.

tliers - Test pits: 28 combinations at each test pit
NO Test pit data was present.

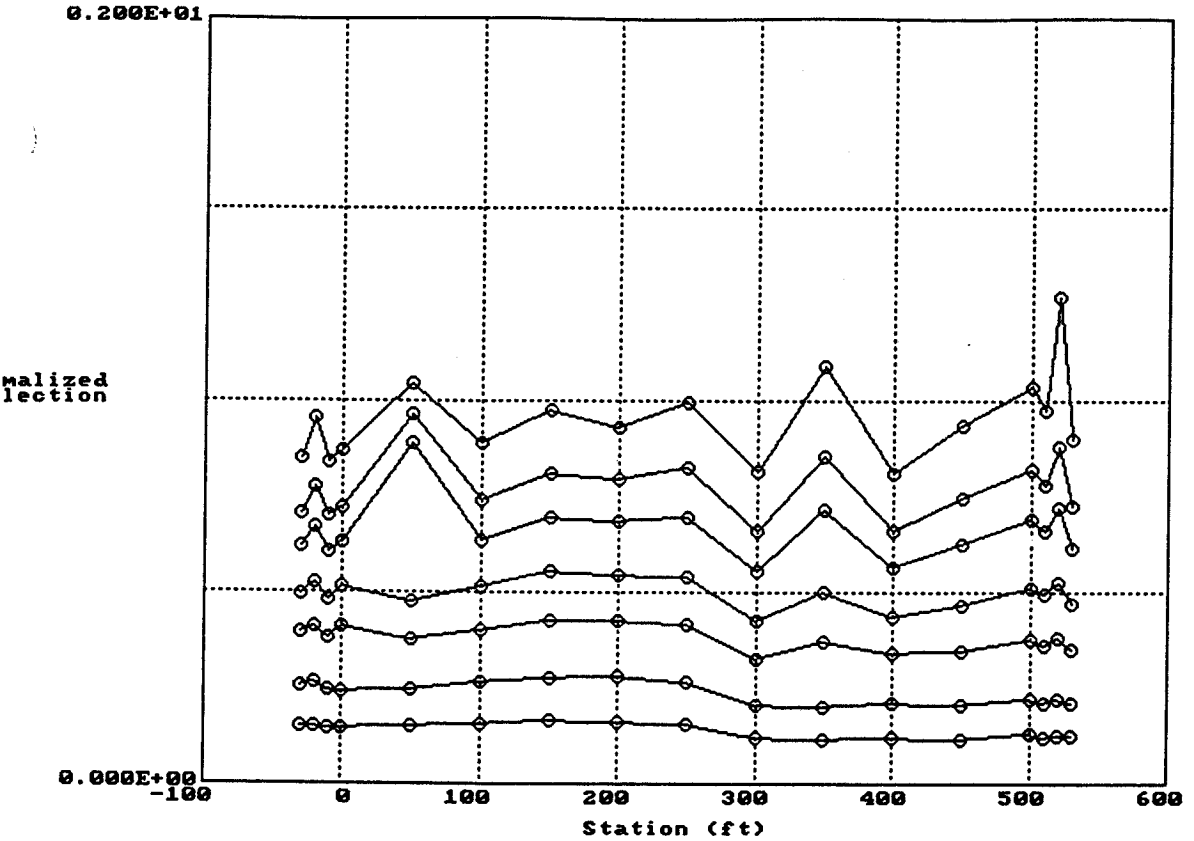
Outliers - Section data: 476 total combinations within the section
16 height/sensor/station combinations are data outliers in subsection 1.

Structural capacity - Test pits: 4 combinations at each test pit
All results for TP 1 are within the range of expected values.
All results for TP 2 are within the range of expected values.

Structural capacity - Section data: 68 total combinations within the section
58 height/station combinations are NOT within the range of expected values.

Subgrade response:
68 height/station combinations exhibit linear response.

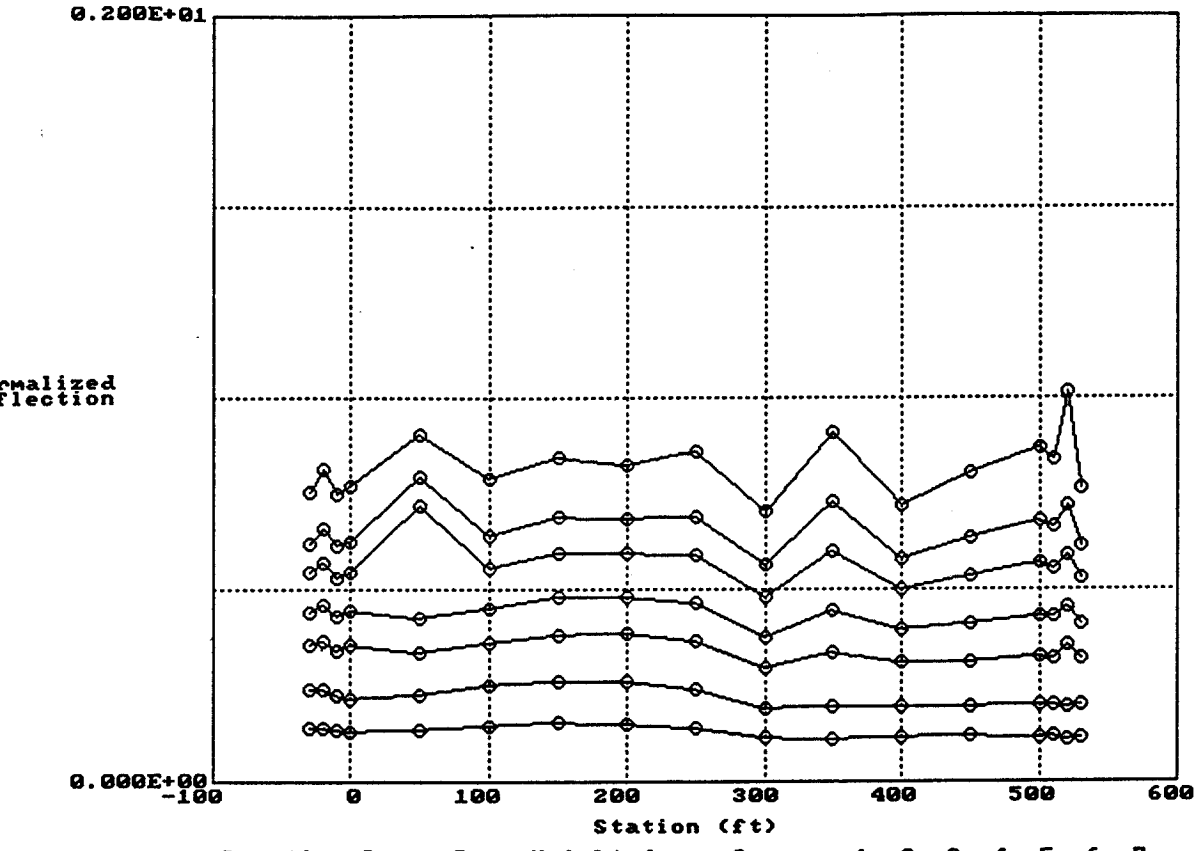
Deflection Data for Section: 276251E



Location 3 Drop Height 1 Sensors 1, 2, 3, 4, 5, 6, 7

F2:ScrnDump F10:Exit ↓↑:Prv/Nxt Ht PgUp/PgDn:Prv/Nxt Loc

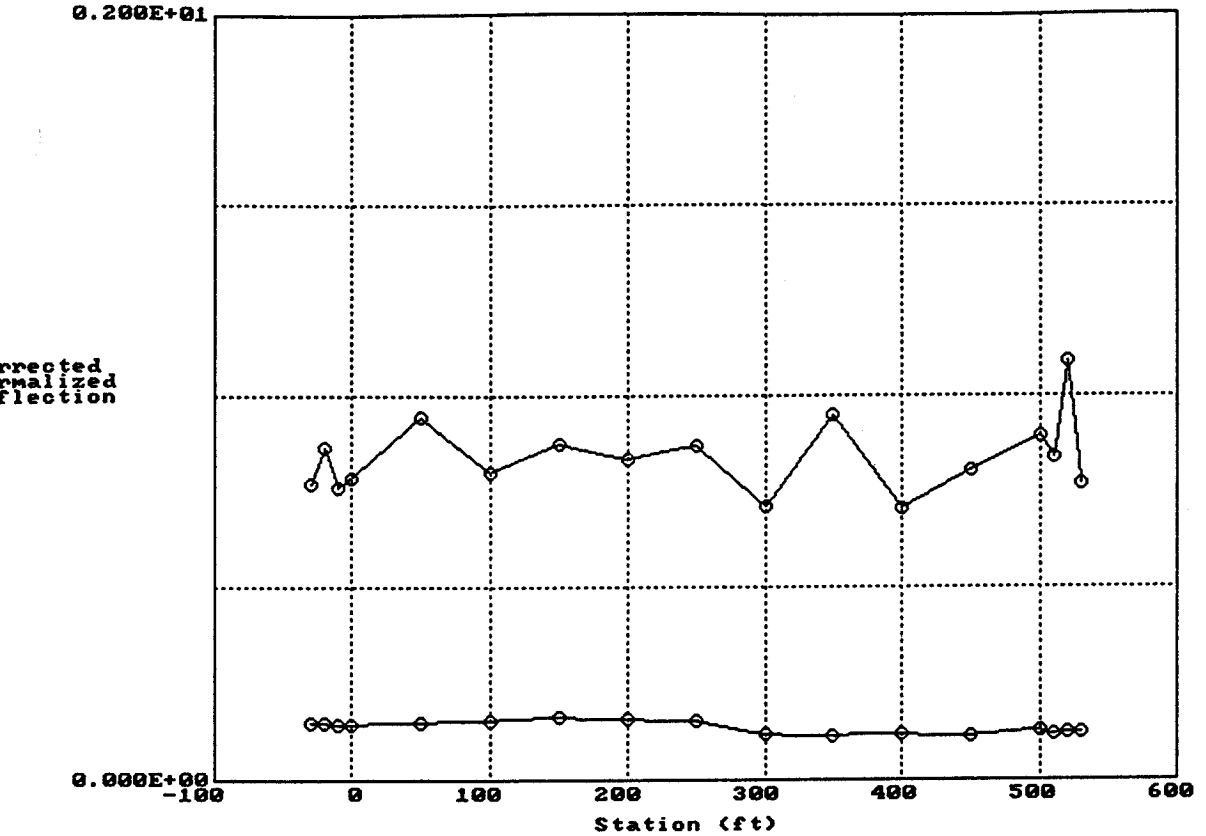
Deflection Data for Section: 276251E



Location 3 Drop Height 4 Sensors 1, 2, 3, 4, 5, 6, 7

F2:ScrnDump F10:Exit ↓↑:Prv/Nxt Ht PgUp/PgDn:Prv/Nxt Loc

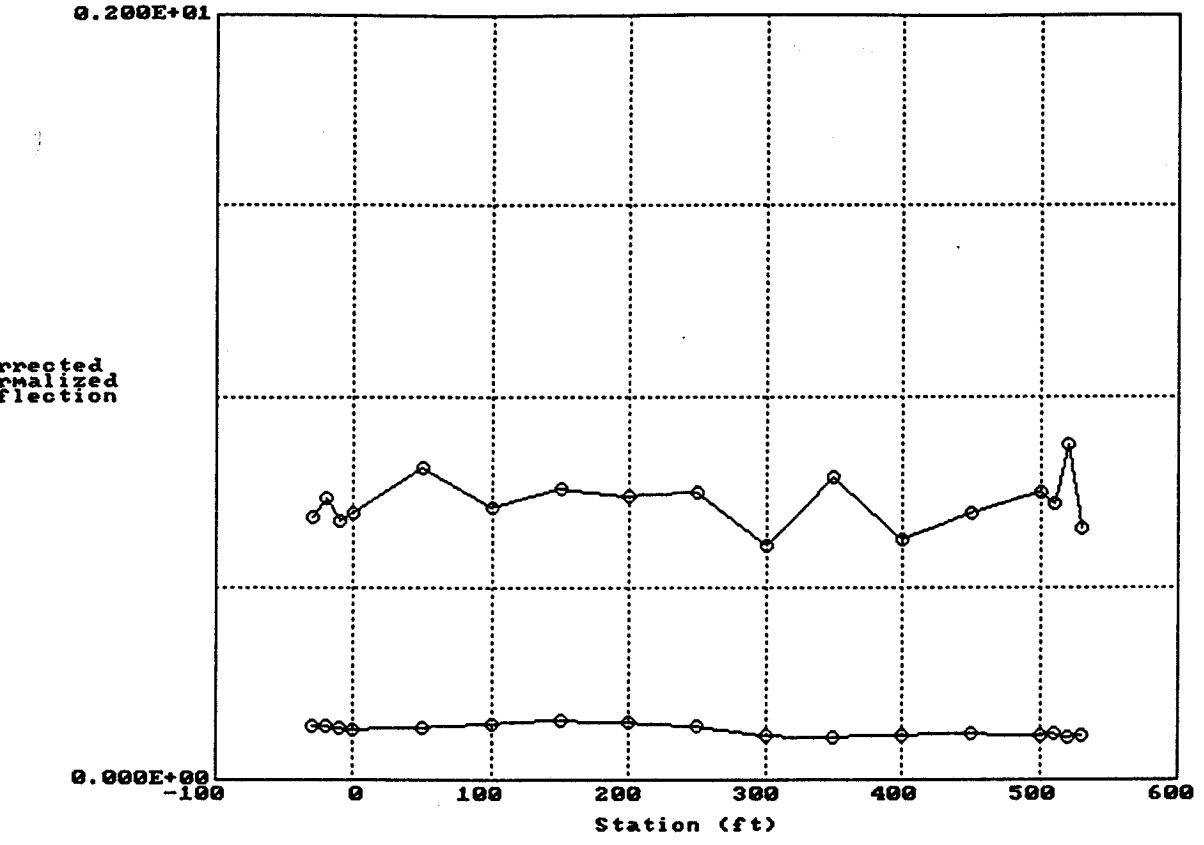
Corrected Deflection Data for Section: 276251E



Location 3 Drop Height 1 Sensors 1, 7

F2:ScrnDump F10:Exit ↓↑:Prv/Nxt Ht PgUp/PgDn:Prv/Nxt Loc

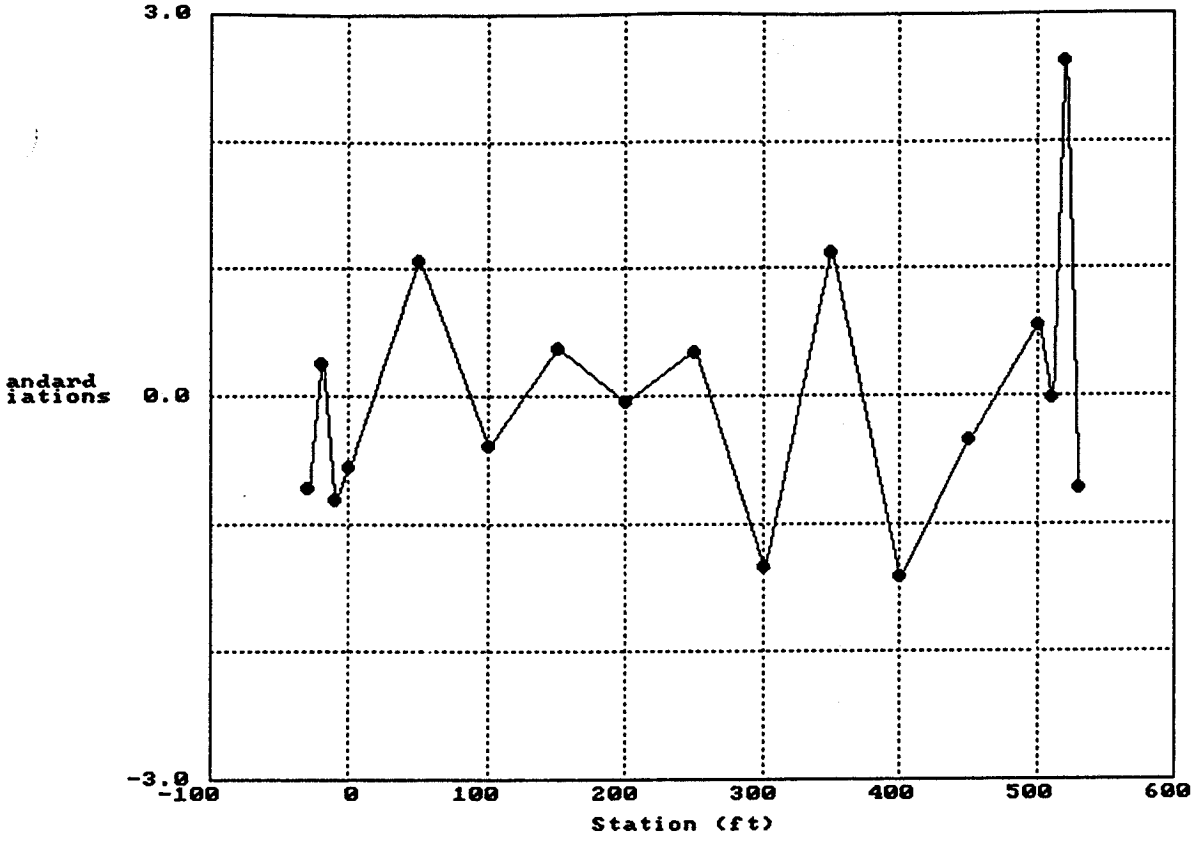
Corrected Deflection Data for Section: 276251E



Location 3 Drop Height 4 Sensors 1, 7

F2:ScrnDump F10:Exit ↓↑:Prv/Nxt Ht PgUp/PgDn:Prv/Nxt Loc

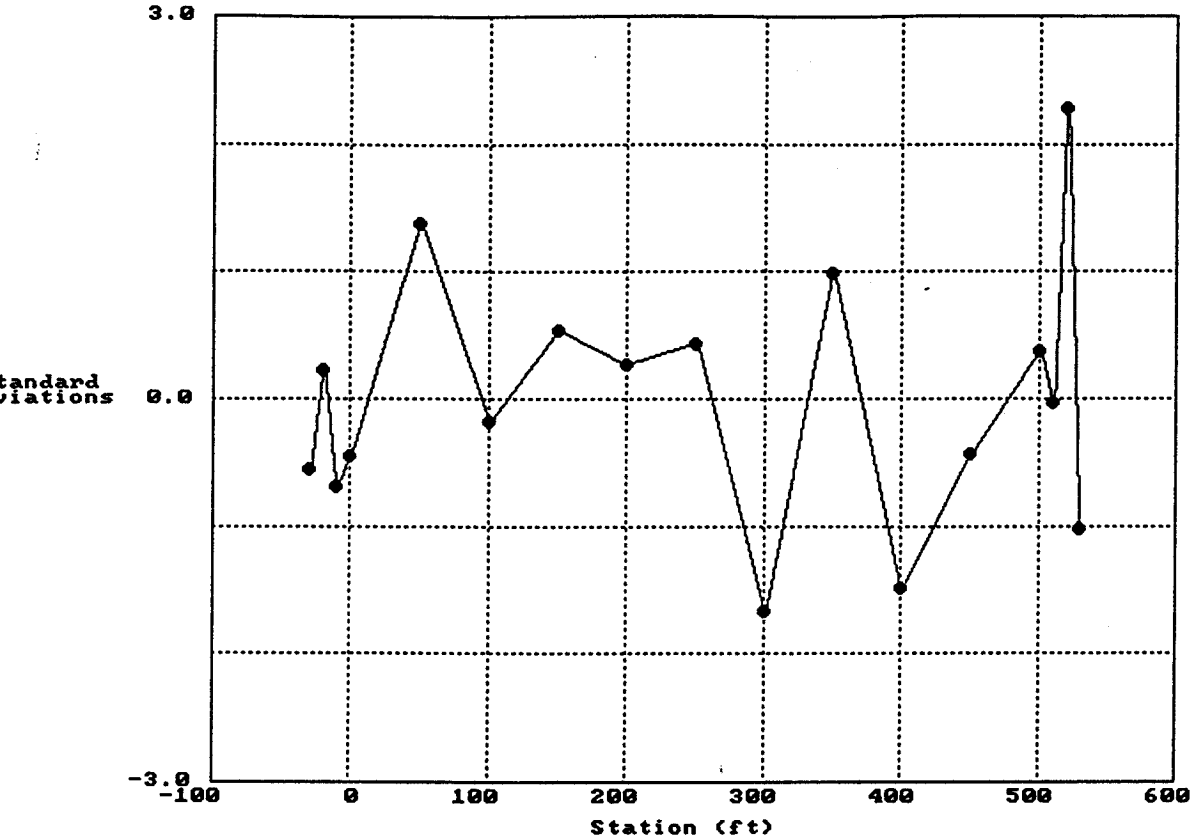
Deflection Deviation Data for Section: 276251E



Location 3 Drop Height 1 Sensor 1

F2:ScrnDump F10:Exit ↓↑:Prv/Nxt Ht ←→:Prv/Nxt Defl PgUp/PgDn:Prv/Nxt Loc

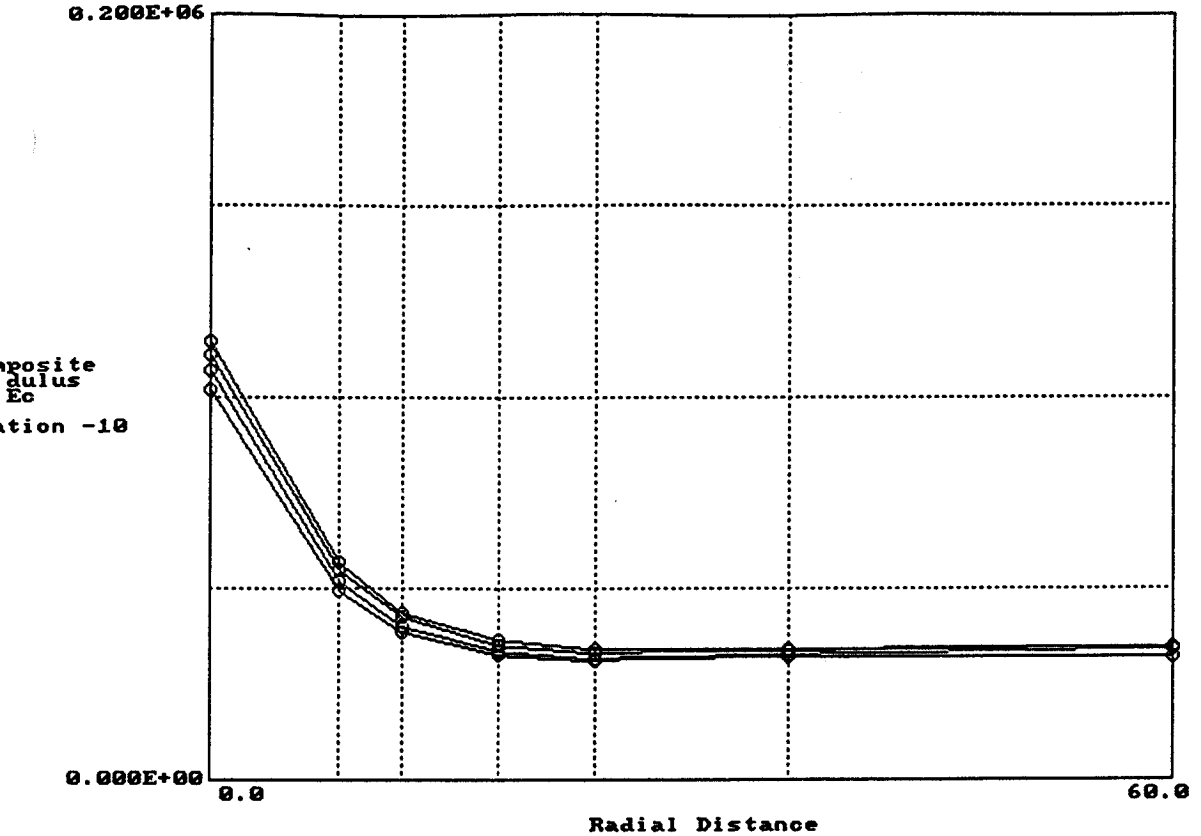
Deflection Deviation Data for Section: 276251E



Location 3 Drop Height 4 Sensor 1

F2:ScrnDump F10:Exit ↓↑:Prv/Nxt Ht ←→:Prv/Nxt Defl PgUp/PgDn:Prv/Nxt Loc

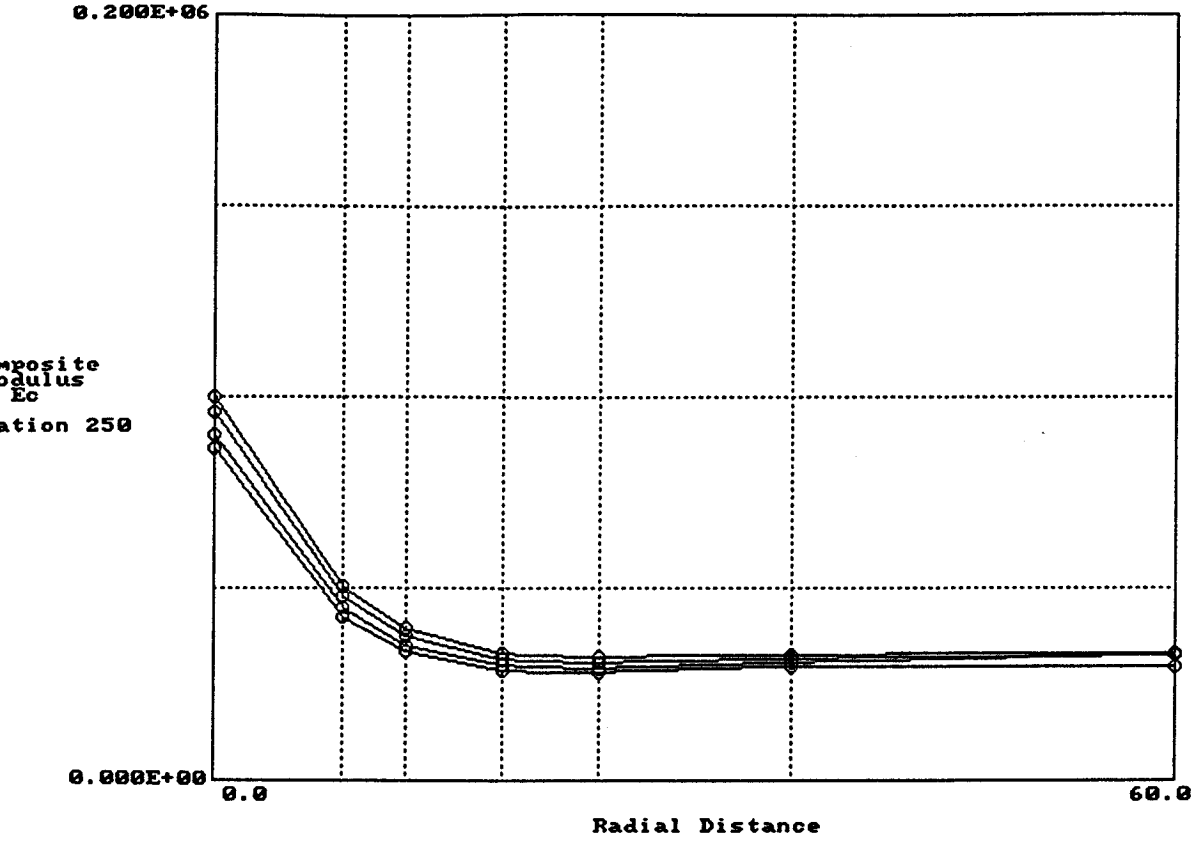
Composite Modulus vs Deflector for Section: 276251E



Drop Height 1, 2, 3, 4

F10:ExitPlots Home End PgUp PgDn

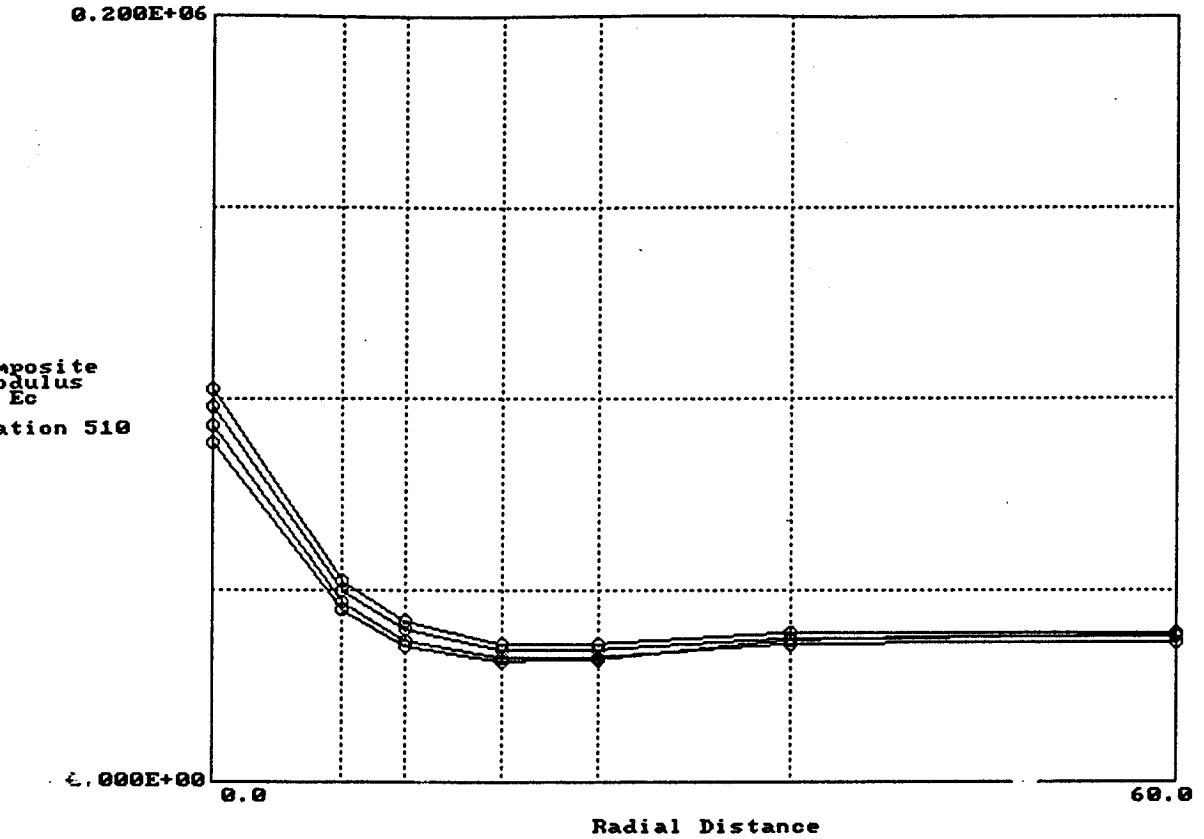
Composite Modulus vs Deflector for Section: 276251E



Drop Height 1, 2, 3, 4

F10:ExitPlots Home End PgUp PgDn

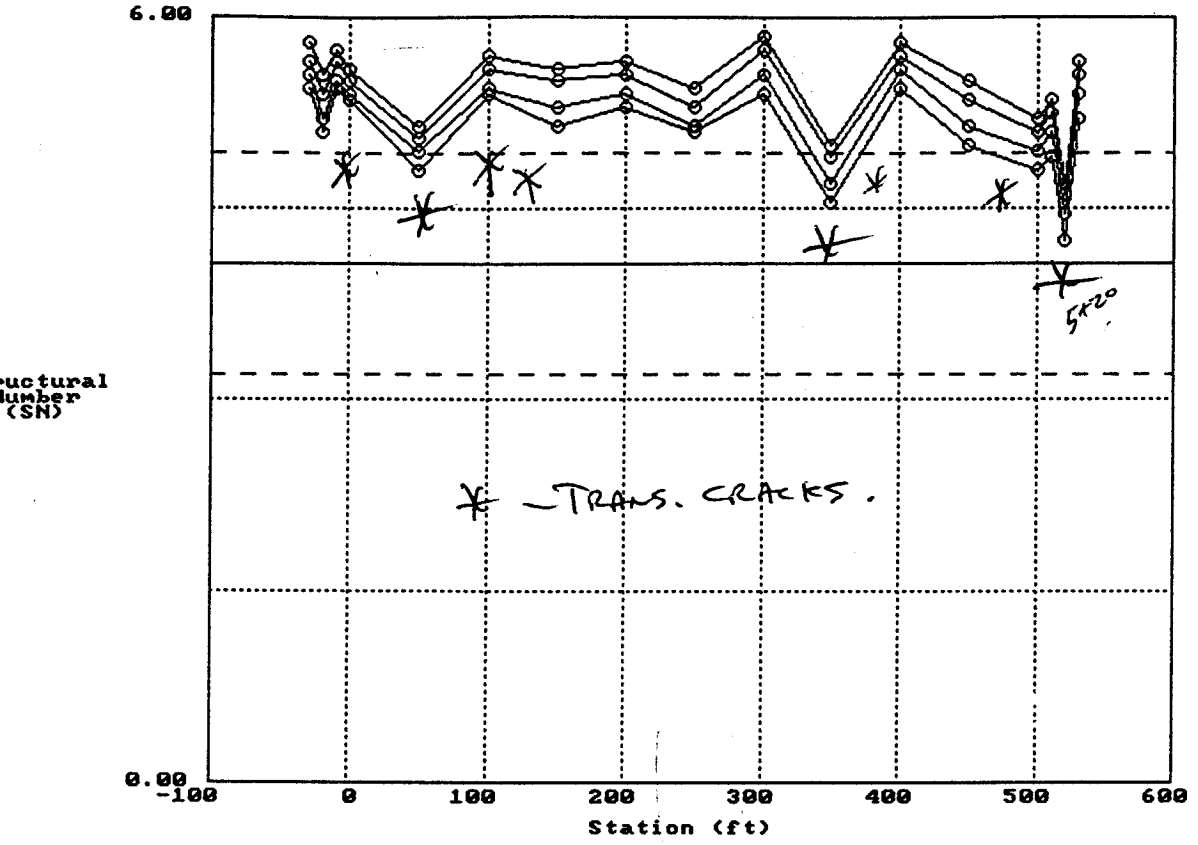
Composite Modulus vs Deflector for Section: 276251E



Drop Height 1, 2, 3, 4

F10:ExitPlots Home End PgUp PgDn

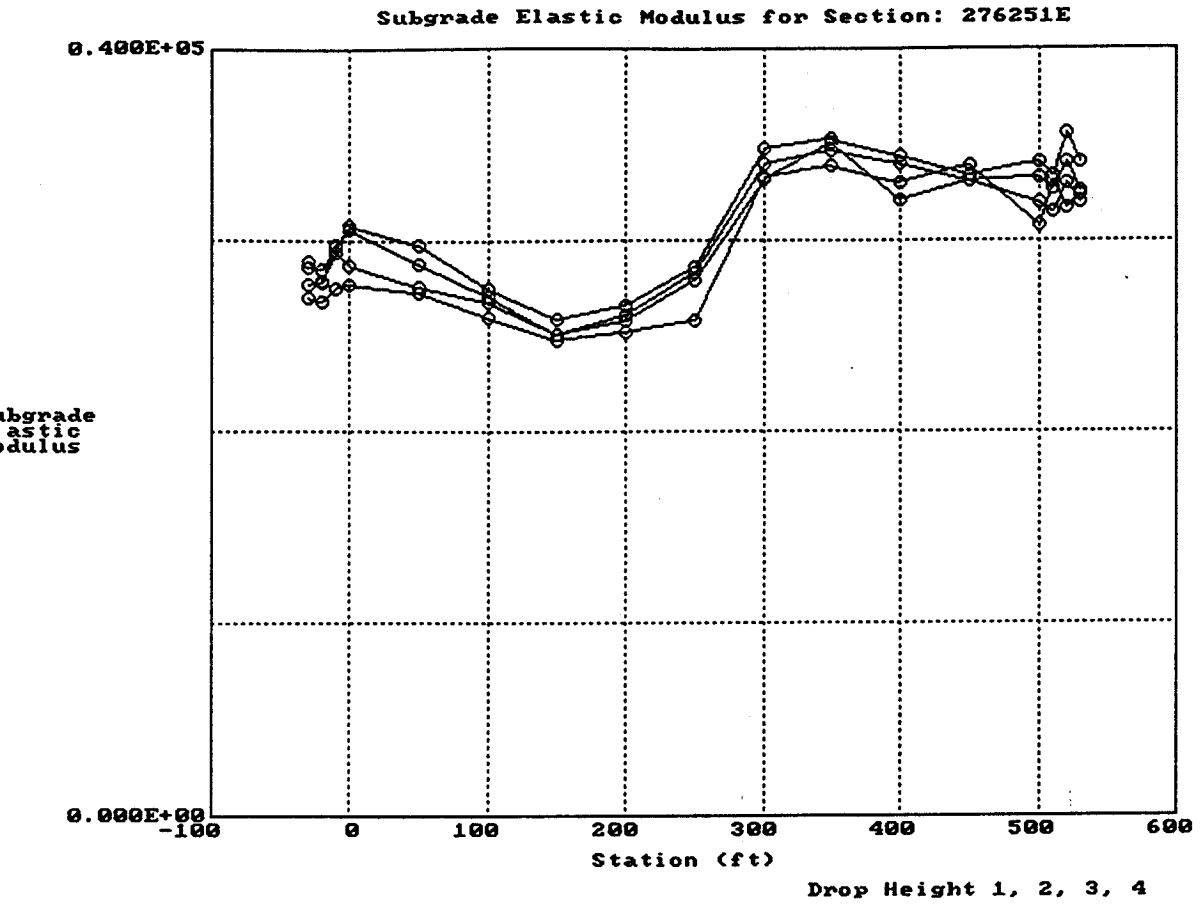
Equivalent Structural Number for Section: 276251E



Drop Height 1, 2, 3, 4

F10:ExitPlots

LESS CONCERN WITH CRACKS 3+00 to 5+00



F10:ExitPlots

Appendix B-1: Pre-Installation Site Recruitment and Coordination Information

Appendix B-1 contains the following pre-installation site recruitment and coordination information:

- SMP site recruitment notes;
- MnDOT Materials and Research meeting agenda and notes;
- Site visit field notes; and
- Pre-installation meeting agenda and notes.

276251

1991

NATIONAL RESEARCH COUNCIL

STRATEGIC HIGHWAY RESEARCH PROGRAM

North Central Region, 1404 Concordia Ave., St. Paul, MN 55104, Tel: (612) 644-2996 Fax: (612) 644-1045

RICHARD C. INGBERG
Regional Engineer

June 26, 1991

Mr. Richard H. Sullivan
Asst. Div. Dir. Tech. Serv. Div.
Mn/DOT Matls & Res. Div.
1400 Gervais
Maplewood, MN 55109

Dick

Dear ~~Mr. Sullivan~~;

Re: Seasonal monitoring of SHRP GPS Sections

The SHRP LTPP program will be monitoring 64 GPS sections located throughout the United States and Canada to determine daily, seasonal, and yearly effects of temperature, moisture and frost on pavement structures. Detailed monitoring is needed to fully understand critical pavement characteristics, and link these characteristics at specific points in time to design factors.

The monitoring activities include: running pavement deflection tests; measuring transverse and longitudinal pavement profiles; and recording temperature, moisture, and frost conditions in the pavement structure and subgrade. Each section will be monitored once a month throughout the year and several additional times during spring thaw on a two year cycle.

The agency will be responsible for helping install the instrumentation, and for providing traffic control for the monitoring activities. Typically, the monitoring activities will start at 5 to 6 a.m. or daylight, whichever is earlier, and continue up to 12 hours. The instrumentation to be installed includes temperature probes, frost probes, and moisture sensors at each site. SHRP will furnish all instrumentation but will need assistance with traffic control, coring, drilling, sawing and any other activity needed for installing the instrumentation. The latest plan calls for deflection testing to begin by late summer, and the installation of instrumentation completed by this fall.

A site selection process was used based on such factors as: surface thickness, joint spacing, frost depth, ground water table, location, section uniformity, pavement condition, sites per region and sites per agency. The following Minnesota monitoring is based on the above factors:

271016 on US 71 southbound, north of Bemidji
276251 on US 2 northbound, bypass west of Bemidji

THE NATIONAL RESEARCH COUNCIL IS THE PRINCIPAL OPERATING AGENCY OF THE NATIONAL ACADEMY OF SCIENCES AND THE NATIONAL ACADEMY OF ENGINEERING TO SERVE GOVERNMENT AND OTHER ORGANIZATIONS.

We hope that Minnesota can participate in this part of the SHRP LTPP program. We are asking for a preliminary response on whether your agency is willing to include the sites in the seasonal monitoring plan. If the sites can not be included, alternative sites will have to be found in the North Central Region. Please respond as soon as possible, but no later than July 12, 1991. Should you have any questions or wish to respond by telephone or fax instead of writing, please do not hesitate to call. If I am not available, please talk to Gene Skok, Erland Lukanen or Bob Van Sambeek.

Sincerely,

Dick

Richard C. Ingberg
Regional Engineer

rci/bw

cc: Fred Maurer, LTPP Contact
E.L. Skok
R.J. Van Sambeek

MN [illegible]

276251

BRAUN℠ INTERTEC

Description: SEASONAL – MN

Project No: DAN x 92700

Date: 3/4/93 By: RV

FRED MAURER – 779-5568

PCC – 274040 → Dist. 1 (*) okay with this section for traffic control and no scheduled maintenance
US-2 – Grand Rapids

AC – 271028 → (*) Fergus Falls (Detroit lakes) Dist. is willing to delay any work on the section as long as condition is not a safety concern.
US-10

AC – 271018 → (*) Little Falls/RANDALL – Dist. going to look @ section on 3/17/93
– 3/24/93 – Can use section – maybe repairing trans. cracks.
– Engineer indicated two sections laid out?

– 273003 → (*) still checking on – Steve O.
ST15
~2147 AADT – one lane.
Okay, very interested in participating!

– 276251 → (*) – Dist. is willing to make exception to defer any rehab.
US 2 (WB)

Craig Gilberson 218/755-3807

– 271016 → (*) already delayed work on section in 92 – tough shape
US-71 SB

– out
– will look @ overlay when SP-3 ends.

(1/2)

BRAUN℠
INTERTEC

Braun Intertec Pavement, Inc.
1983 Sloan Place
St. Paul, Minnesota 55117-2004
612-776-7522 Fax: 776-7201

Engineers and Scientists Serving the Built and Natural Environments

Memorandum

Date: July 15, 1993

To: Fred Maurer

From: Robert J. Van Sambeek RV

Re: Discussion Topics for July 15, 1993 Meeting

Drill Rig

The specific sites in Minnesota for the Seasonal Monitoring Program sponsored by FHWA-LTPP Division are listed below along with tentative dates for the installations.

- 7.2" AGG. + 4.4" AC ▷ GPS 271018 on US-10 two miles northwest of Little Falls, AC, 8/24 and 8/25 — ~~Ken Wasmie~~ — Dist. 3 Mdl.
- AGG. + 9.6" AC ▷ GPS 271028 on US-10 ten miles east of Detroit Lakes, AC, 9/8 and 9/9 — Bud Wyborny — 218-847-156
- AGG. + 7.1" AC ▷ GPS 276251 on US-2 bypass in Bemidji, AC, 9/14 and 9/15 — ~~Greg Gilbertson~~
- 6" AGG. + 8.1" PC ▷ GPS 274040 on US-2 five miles west of Grand Rapids, PCC, 9/21 and 9/22 — Equip — 218-755-3807

The dates listed above are dependant on FHWA-LTPP Division office having someone available for each installation, and Mn D.O.T. having personnel and equipment available.

Items that need to be addressed prior to installation activities are listed on the attached sheet. For some of the items only a contact name and phone number is needed at this time. For other items, several people will need to be involved regarding schedules and equipment availability.

Phone # list.

Dick Rudd 779-1110 — Dist. 9

~~FRED MAURER 612-779-5568~~ — LTPP CONTACT

~~KELVIN HOWITSON 218-828-2240~~ (Dist. 3 Soils Eng.)

~~Jerry Dempsey 612-779-5560~~

~~MIKE~~ BLAKE NELSON 612-~~779~~-5599 → ~~JERRY DEMPSEY 5560~~

[illegible]

Meet w/ BLAKE + JERRY 7/23/93

(MN/DOT BILLING CODE) WORK TYPE #
00310 ___
ACT. #

(2/2

ITEMS TO ADDRESS PRIOR TO SITE INSTALLATIONS

- Set date for meeting centrally located for all people involved in the four installations.
  - Brainard area? Ask KEN WASNIE ~~218-828-2481 Matl Eng~~
    - Kelvin ~~Howieson (Soils~~ Engineer with District 3) help organize?
  - August ~~10th or 11th?~~ Thurs Better
    - Maybe visit four sites after meeting? 8/12

8/12

  - Include following personnel?
    - LTPP contact? → FRED
    - Maintenance supervisor? — person in charge of traffic control
    - Drill rig operator?
    - FHWA Division personnel?
    - Other?
      ~~JOE KORZILIUS — MFR 612 779 5565~~
      BLAKE NELSON AND JERRY DEMPSEY.

Matl. Eng. from Each Dist.

- Option for highway agency to establish permanent bench mark at each site. — if hit peat

- Equipment requirements.
  - Drill rig
    - 12 inch core? — See if Eng. still has 12" auger
    - 10 inch minimum diameter hole required (solid stem auger?).
    - 6 inch diameter hole located about 30 feet off roadway. –
    -
    -
  - Pavement saw.
    - 10 inch cut depth maximum required for all four sites.
    -

- Supplies
  - See listings from installation guide.
  -

- SHIFT SITES #3 AND #4 TO MONDAY? — Jerry decide

-

-

-

s:\wp\bop_v\sm_pre.mn

FRED MAURER - 612-779-5568

JOE KORZILIUS - 779-5565 (INSTR.)

DAVE BULLOCK - 779-5542

MN CONTACTS

— DRILL RIG

WARREN O. PLADSEN, P.E.
Aggregate Engineer
Geotechnical Engineering Sect.

Materials & Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

612-779-5612
FAX 612-779-5616

JERRY L. DEMPSEY
Field Operations Supervisor
Foundation Unit

Blake Nelson - 5599

Materials & Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

612-779-5600
FAX 612-779-5616

— Filter Sand
— Piezometer caps
— Bentonite pellets

Quality Service Through Individual Commitment

KELVIN D. HOWIESON, P.E.
District Soils Engineer

For District Three
1991 Industrial Pk. Rd.
Baxter, MN 56401

(218) 828-2240
Fax (218) 828-2210

SURVEY IN BM? — DAVE GORG..

DICK RUDD - DIST. 9 - 779-1110

BRAUN℠
INTERTEC

BOB V

7-22-93 2:50 PM

KEN WASNIE SAID OK FOR THE MEETING ON AUG 12 FOR SEASONAL.

IT WILL IN THE DOT BLDG.

LIBRARY CONFERENCE ROOM
1991 INDUSTRIAL PARK DR. ROAD
BAXTER MN 56401

SUBURB OF BRAINERD

ABOUT 1/4 MILE ~~NORTH~~ South OF PAUL BUNYAN

WILL HAVE TO SET TIME FOR MEETING.

ROOM CAN HANDLE 30+

RRG

9/22/93
- set time for 9:30 to ≈ 12:00
- can check into availability of coffee.
- maybe bring rolls?
RV

BRAUN℠
INTERTEC

Braun Intertec Pavement, Inc.
1983 Sloan Place
St. Paul, Minnesota 55117-2004
612-776-7522 Fax: 776-7201

Engineers and Scientists Serving the Built and Natural Environments

July 29, 1993

Mr. Fred Maurer
Mn/DOT Materials and Research Laboratory
1400 Gervais Avenue
Maplewood, MN 55109

Dear Mr. Maurer:

Re: Group Meeting Announcement for Activities in FHWA's Seasonal Monitoring Program in Minnesota

A tentative meeting agenda and list of who should attend the meeting is attached. The same information, along with a cover letter, was sent to the four District Materials Engineers involved. The meeting objectives as stated in the cover letter include;

* Inform involved parties about the Seasonal Monitoring Program
* Assign and coordinate responsibilities for installation and monitoring
* Finalize schedules for equipment and traffic control requirements, and
* Address any questions or concerns about the Seasonal Monitoring Program.

Please make arrangements for people from the Materials & Research Laboratory to attend. Some names, other than yourself, that have come up in previous meetings include;

Richard Sullivan - SHRP Representative
Warren Pladsen - in charge of drilling operations on the four sections,
Blake Nelson - initial planning of installations,
Joe Korzilius - involvement with instrumentation, and
Dave Bullock - involvement with instrumentation and FWD Spring Recovery testing.

Please give copies of the meeting announcement and agenda to the people you think need to attend. It is very important that someone in charge of drilling operations attend the meeting. If you have any questions or need additional information, please call me or Ron Urbach at 800-344-7477 or 612-776-7522.

Sincerely,

Robert Van Sambeek
Project Engineer
s:\wp\bob_v\mnmtg1.sm

What: Meeting Announcement for Activities in LTPP's Seasonal Monitoring Program in Minnesota

When: August 12, 1993 from 9:30 AM to 12:00 Noon

Where: Mn/DOT Library Conference Room
1991 Industrial Park Road
Baxter, MN

(0.25 miles south of Paul Bunyan in Brainerd)

Who: State Level

SHRP Representative
LTPP Contact

District Level

Materials Engineer and/or Soils Engineer

Maintenance Superintendent or Maintenance Sub Area Supervisor

Other Interested Parties

DOT staff involved with instrumentation or spring recovery study

University students

Agenda: See next page

FHWA-LTPP SEASONAL MONITORING PROGRAM IN MINNESOTA

MEETING AGENDA

Introduction
- Review of LTPP Program and Activities
- Objectives of the Seasonal Monitoring Program
- Overview of Sensor Installation and Monitoring Activities

Test Sections
- Section Location
- Allowable Maintenance

Sensors, Sensor Layout, and Installation
- TDR Probes
- Thermistor Probe
- Resistivity Instrumentation
- Air Temperature
- Rain Gauge
- Equipment Cabinet and On-Site Instrumentation
- Observation Piezometer

Schedule
- Installation
- Monitoring

Responsibilities
- Mn/DOT State Level
  - Project contacts
- Mn/DOT District Level
  - Traffic control
  - Utility clearance
  - Pavement saw and operator
  - Filter sand
  - Bentonite pellets
  - Sac-crete
  - Pavement repairs
- Mn/DOT Materials and Research Laboratory
  - Drill rig and operator
  - Access cover for piezometer
- NCRCO and FHWA Staff
  - Instrumentation
  - Monitoring activities

Closing Comments

276251

BRAUN[SM]
INTERTEC

Braun Intertec Pavement, Inc.
1983 Sloan Place
St. Paul, Minnesota 55117-2004
612-776-7522 Fax: 776-7201

Engineers and Scientists Serving the Built and Natural Environments

July 29, 1993

Mr. Graig Gilbertson
Minnesota Department of Transportation
401 Paul Bunyan Drive S.E.
Box 490
Bemidji, MN 56601

Dear Mr. Gilbertson:

Re: Group Meeting Announcement for Activities in FHWA's Seasonal Monitoring Program in Minnesota

Braun Intertec, under contract with FHWA LTPP Division, has responsibility for the Seasonal Monitoring Program initiated by SHRP. Earlier this year, we worked together with Fred Maurer to contact the Districts regarding sections to include in the program, and GPS section 276251 on US TH-2 bypass in Bemidji in District 2A was approved for use in the program. In addition, sections by Detroit Lakes, Grand Rapids, and Little Falls were approved.

With the four sites in Minnesota relatively close together, only one group meeting is planned for the Districts involved. A tentative meeting agenda and who should attend the meeting is attached. The meeting objectives include;

* Inform involved parties about the Seasonal Monitoring Program
* Assign and coordinate responsibilities for installation and monitoring
* Finalize schedules for equipment and traffic control requirements, and
* Address any questions or concerns about the Seasonal Monitoring Program.

Please make arrangements for appropriate district people to participate in the meeting. It is very important someone in charge of traffic control and maintenance attend the meeting. If you have any questions or need additional information, please call me or Ron Urbach at 800-344-7477 or 612-776-7522.

Sincerely,

Robert Van Sambeek
Project Engineer

s:\wp\bob_v\mnmtg2a.sm

BRAUNSM
INTERTEC

276251
SITE VISIT
8/12/93

ONCERNS

* Powerline overhead @ sta. 0+00
* Crack maintenance expected
* L-Super elevation both ends

OMMENTS

- back drill rig into ditch
- 10' AC shoulder
- Section markers ~ 22' off lane stripe @ sta. 5+00
- Power pole as possible 2nd bench mark

NCLUSIONS

- Go with sta. 5+0 end

~~Sign up sheet~~

S:\WP\BOB_V\MN MTG.SM? BOB V.

NOTES

FHWA-LTPP SEASONAL MONITORING PROGRAM IN MINNESOTA
MEETING AGENDA

Send letter to each dist as follows w/ revised responsibilities locations for utility clearance sketch of area? - MP's cc - Matt + Maint.

August 12, 1993 from 9:30 AM to 12:00 Noon
Mn/DOT Library Conference Room
1991 Industrial Park Road, Baxter, MN

Introduction
- Review of LTPP Program and Activities
- Objectives of the Seasonal Monitoring Program
- Overview of Sensor Installation and Monitoring Activities

Test Sections
- Section Location
- Allowable Maintenance

Sensors, Sensor Layout, and Installation
- TDR Probes
- Thermistor Probe
- Resistivity Instrumentation
- Air Temperature
- Rain Gauge
- Equipment Cabinet and Instrument Pole
- Interface/Communications Equipment
- Observation Piezometer

Schedule
- Instrumentation Installation and Initial Monitoring
- Long Term Monitoring

Responsibilities
- Mn/DOT State Level
  - Project contacts — PR ? — C
- Mn/DOT District Level
  - Traffic control
  - Equipment
  - Materials
  - Pavement repairs — Mow GRASS? — utility clearance
- Mn/DOT Materials and Research Laboratory
  - Drill rig and operator
  - Materials
- NCRCO and FHWA Staff — PR?
  - Instrumentation
  - Monitoring activities

Closing Comments

SAFETY

? s for Dist/Agency

Cabinet location - not 30' - any problem

Piezometer location - outside paved sho

Maintenance activities - before install?

Snow plow concerns?

BM install or not?

Safety requirements - clothes

SITE VISIT

BM - 2nd alt.

Utilities - Power-lines, Culver

Drill rig in ditch.

Any Rock

Distress @ instr. hole

Required maintenance

Trees, wind consistent

Introduction

Review of LTPP Program and Activities

- see handout

Objectives of the Seasonal Monitoring Program

- Collect and analyze data to better understand the short and long term impacts of environmental factors including temperature, moisture, and frost/thaw depth on a pavement structure for improving pavement design.

- Factors defined in the core experiment monitored by FHWA-LTPP include
    - wet or dry climate
    - freeze or no freeze climate
    - pavement surface type (AC or PCC)
    - pavement surface thickness

- Factors not defined in the core experiment include
    - pavement edge drains
    - recycled materials
    - CRCP
    - shallow water table
    - shallow bedrock
    - etc.

- Agencies are encouraged to monitor supplemental sections to study factors not included in the core experiment.
    - reduced monitoring requirements
    - use existing GPS or SPS sections

Overview of Sensor Installation and Monitoring Activities

- Two days for initial instrumentation installation and monitoring

- About $10,000 of equipment installed at each site

- Monitor sections every other year (70 days over a 10 year period)

- Relate environmental variations to changes in
    - pavement, base and subgrade strength
        - deflection data collected 14 times per year
            - monthly most of year, and bi-weekly in the spring
    - ride quality
        - profile data collected five times per year
    - pavement distress
        - detailed pavement distress surveys two times per year
    - frost heave/swelling soil
        - elevation data collected five times in first year
        - elevations two times per year after the first year

Test Sections

Section Location

- 64 sections in the Core Experiment monitored under FHWA-LTPP contract

- 16 sections in the North Central Region
  - four core sections in Minnesota
    - 271018, EB US-10, MP 140, North of Little Falls
    - 271028, EB US-10, MP 58, East of Detroit Lakes
    - 274040, WB US-2, MP 173, West of Grand Rapids
    - 276251, WB US-2, MP 113, By pass in Bemidji

  - supplemental sections in Minnesota
    - none identified at this time

Allowable Maintenance

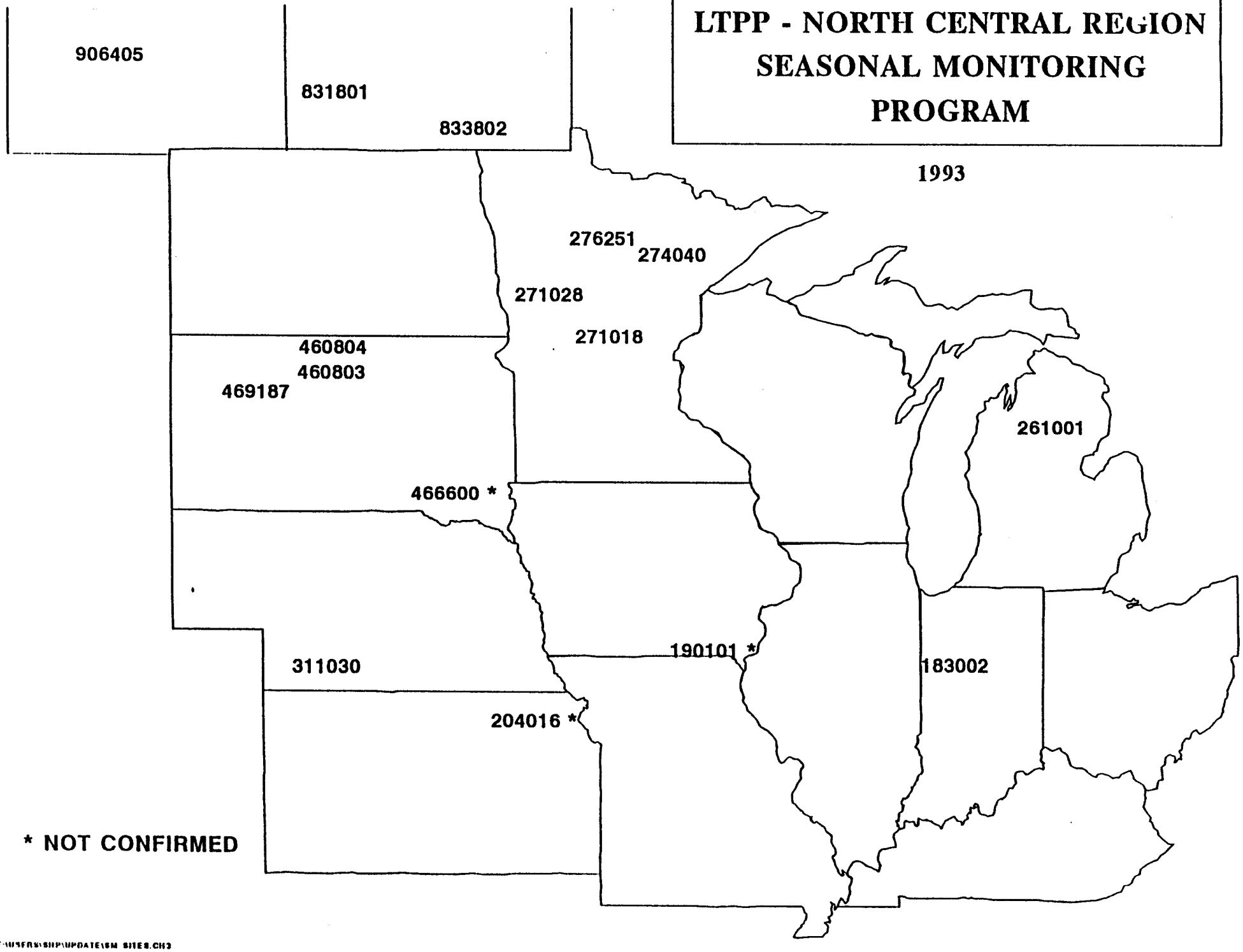
- routine maintenance

- no structural rehab preferred for ten years

- safety is primary concern

LTPP - NORTH CENTRAL REGION SEASONAL MONITORING PROGRAM

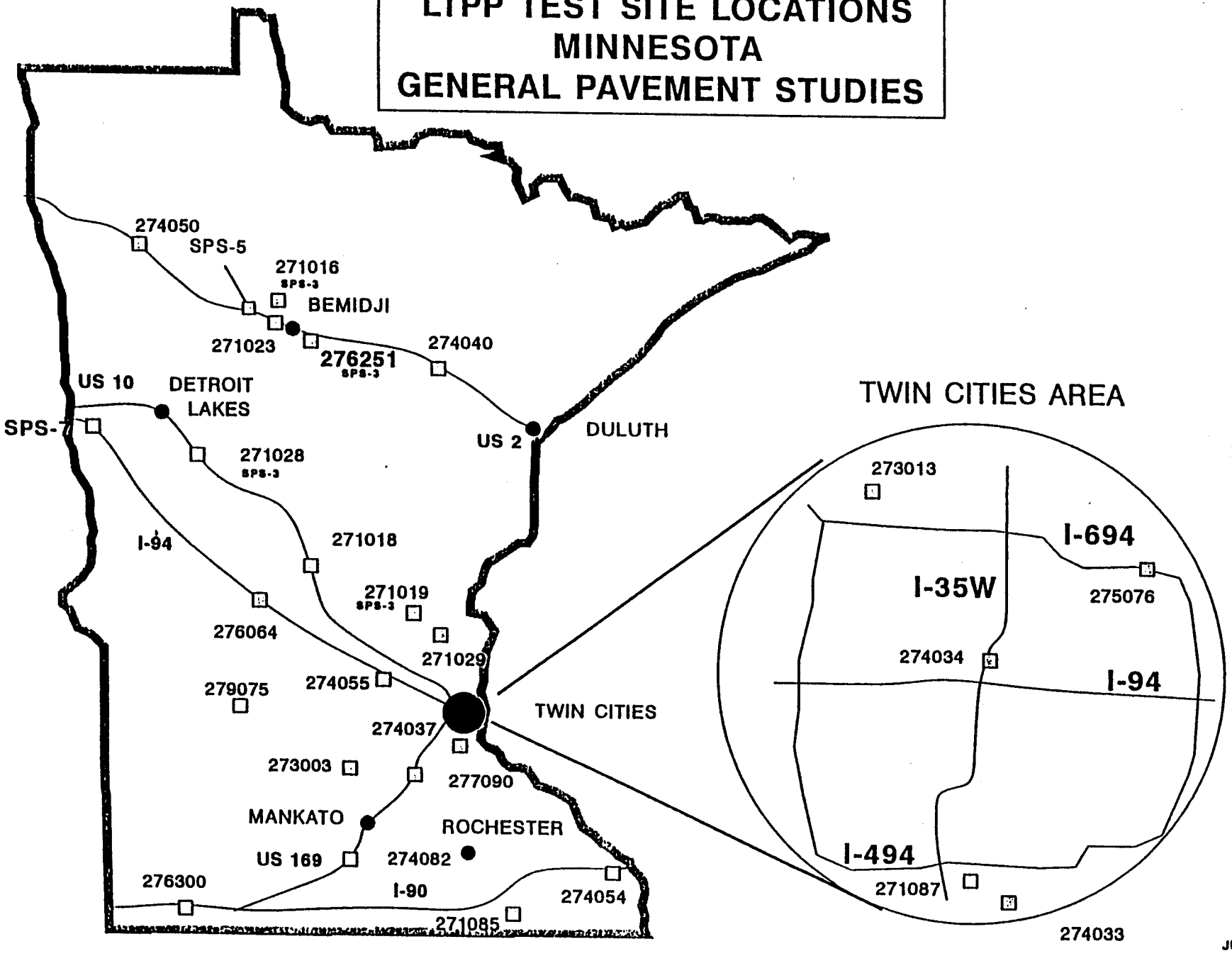
1993



* NOT CONFIRMED

F:\USERS\SHP\UPDATE\SM SITES.CH3

LTPP TEST SITE LOCATIONS
MINNESOTA
GENERAL PAVEMENT STUDIES



JUNE 1992

Sensors, Sensor Layout, and Installation

TDR (Time Domain Reflectometry) Probes

- FHWA design and manufacture
  - three prong
  - $60.00 each

- measure dielectric of material between probes and relate to moisture content
  - air = 1.0
  - dry soil = 3 to 4
  - water = 80

- calibration
  - laboratory in air and water
  - field moisture test on material placed on probes
  - retain soil samples for additional laboratory calibration

- 10 probes per installation
  - one mid-depth in the base
  - seven at six inch intervals in the top of the subgrade
  - two at 12 inch intervals approximately seven feet below the surface

- cable reader
  - generate signal for cable
  - monitor return signal
  - $8000.00

Thermistor Probe

- Measurement Research Corporation (MRC)
  - $1000.00 each

- thermistors change resistance with change in temperature

- built in multiplexer for automated readings

- two part
  - stainless steel section
    - monitor temperature gradient through the pavement surface
      - one inch deep
      - mid depth
      - one inch from bottom of pavement

  - plexiglass section
    - monitor 15 temperatures at six inch intervals

- laboratory calibration at three temperatures

Resistivity Instrumentation

- CRREL design
  - PVC probe with 36 electrodes at two inch intervals
  - $800.00 each

- large increase in resistance when moisture in the soil freezes
  - determine both frost and thaw depth

- require signal generator and multimeters
  - compute AC resistance between electrodes

- both manual measurement and automated

Air Temperature

- Campbell Scientific
  - $150.00 each

- Air probe and radiation shield

- mount on instrument pole

Rain Gauge/Tipping Bucket

- Texas Electronics
  - $255.00 each

- 0.1 mm (0.004 inches) precipitation per tip
  - liquid precipitation only

- mount on instrument pole

Equipment Cabinet and Instrument Pole

- telephone pedestal
  - break away classification
  - contain power supply, CR10 data logger, terminal strip for sensor connections, and cables for mobile reader
  - conduit runs into cabinet from instrumentation hole
  - pea rock inside base to prevent condensation

- instrument pole
  - break away classification
  - extend below frost line
  - holds rain gauge and air temperature probe

Interface/Communications Equipment

- mobile unit
  - used on site to read TDR probes and resistivity probe
  - multiplexers for automated readings

- cable reader
  - Tectronics model 1502
  - required for reading TDR probes

- computer and software
  - "onsite" used to record data everyday
  - "mobile" used to record data monthly

Observation Piezometer

- monitor depth to ground water table

- designed to act as frost free bench mark
  - Dave Esch design
  - anchor at 14 foot depth
  - sliding section extends six feet below the surface
    - filled with water proof grease

Schedule

Instrumentation Installation and Initial Monitoring

- two days required with third day as contingency
  - first day complete instrument installation
  - second day collect data

- tentative schedule
  - Aug. ~~23~~ 24 & ~~24~~ 25 - 271018, EB US-10, MP 140, North of Little Falls
  - Sept. 8 & 9 - 271028, EB US-10, MP 58, East of Detroit Lakes
  - Sept. 21 & 22 - 274040, WB US-2, MP 173, West of Grand Rapids
  - Sept. 14 & 15 - 276251, WB US-2, MP 113, By pass in Bemidji

Long Term Monitoring

- one day every month

- every other year for 10 years

Responsibilities

Mn/DOT State Level

- project contacts for maintenance activities and traffic control

Mn/DOT District Level

- traffic control for full lane closure
  - two days for initial installation and monitoring
  - lane closure for 500 foot section
    - signs, cones, and arrow board

Utility Clearance

- equipment
  - pavement saw and operator
    - if drill rig not able to core 12 inch diameter, then saw 14 inch square block out of the pavement
      - located in the outer wheel path
      - will put core back in-place on AC sections

    - equipment capable of cutting one inch deeper than estimated pavement thicknesses below
      - 271018 4.5 inch AC
      - 271028 9.6 inch AC
      - 274040 8.2 inch PCC
      - 276251 7.9 inch AC

    - saw three to four inch wide trench for conduit
      - from outer wheel path to outside pavement/shoulder

- materials

  - coordinate with Materials and Research Laboratory — Sackcrete, peagravel

Warren Thadsen

  - asphalt patch for conduit trench
    - estimate 500 pounds

  - water for mixing sackcrete and equipment clean-up
    - estimate 30 gallons

- pavement repairs

  - patch conduit trench on AC shoulders with asphalt patch

  - assist with core or block replacement on AC sections

  - assist with rapid set concrete patch for instrumentation hole and conduit trench on PCC pavements

Generator 3500 watt

Mn/DOT Materials and Research Laboratory

- drill rig and operator
  - only required for instrument installation (first day)

  - if possible, cut 12 inch core for instrumentation
    - 12 inch inside diameter core barrel required
    - core located in outer wheel path

  - bore one six-inch diameter hole for piezometer
    - 14 foot depth
    - located on shoulder

  - bore one 12 inch diameter hole for instrumentation
    - solid stem auger preferred
    - eight foot depth
    - located in outer wheel path
    - NCRCO has 12 inch diameter auger with two-inch hex drive

  - bore one 12 inch diameter hole for equipment cabinet
    - two feet deep
    - located about 26 feet outside the driving lane in the ditch

  - bore one six-inch diameter hole for the instrumentation pole
    - 10 feet deep
    - located adjacent to the equipment cabinet in the ditch

- materials

  - cover assembly for piezometer
    - must function for ten years
    - able to open in the winter

  - sackcrete for piezometer cover and instrumentation pole
    - estimate four bags required

  - quick set concrete to repair PCC sections
    - only for 274040 by Grand Rapids
    - estimate three to four cubic feet

  - bentonite pellets for sealing piezometer
    - five gallon bucket

  - filter sand for piezometer
    - 400 pounds (four bags)
    - particle size not critical

  - pea gravel for equipment cabinet
    - 500 pounds
    - 3/8 inch size preferred

NCRCO (Braun Intertec) and FHWA Staff

- instrumentation
  - provide all instrumentation
  - install all instrumentation
    - may ask DOT people for assistance

- monitoring activities
  - will collect all required monitoring data

Closing Comments

271018 – WHEN CRACK REPAIR? PROCEDURE?
– REPAIR PRIOR TO INSTALLATION?

– Cut grass

– Report to Dist. in Spring for load restricti

MP. 114 frost tube

Charge ID. (MN) → Charge Identifier 00Y310Y##

– four digit work item

– Gopher One Call – Utility Clearance

– PR – FHWA ON SITE

– SAFETY

– Utility to R.O.W. – permits for trenty

* PRIMARY CONTACTS IN DIST. FOR SMP

fax 327452

LTPP SEASONAL MONITERING MEETING

Aug 12, 1993 Brainerd

	Name	AFF: / Office	Dist	Phone No
4440 *	Andy Istvanovich	Grand Rapids Sup.	1B	(218) 327-4493
DRILLERS	Harland Vitalis	Maplewood Lab		(612) 779-5610
	Eugene Tormonen	" "		" " "
	John Savaloja	Materials	3A	218/828-2271
	Bob Matthews	Materials	3A	218 828-2231
*	Tom Stadko	Maint	2	218-755-3799
* 71018	Lee Furdham	Maint.	3A	218-828-2472
	Don Hardy	Maint.	3A	218-828-2478
276251	Gregg Gilbertson	Materials	2	218-755-3807
	PAT HUSTON	SOILS	1	218.723-4883
	Kelvin Howieson	Soils	3	218-828-2240
71018	ROBIN ALLEN	MATERIALS	3A	218-828-2768
MATL	Ford Maurer	Pav't Mgt.	C.O. MR&E	(612) 779-5568
✓	RON URBACH	BRAUN INTERTEC		612-776 7522
Instr.	Joseph Korzilius	MN/DOT	Pavt Dgn.	612-779-5565
✓	WILLIAM LOHR	FHWA	(~~Lab~~ TRAINEE)	612 776 752[illegible]
271018	KEN WATSNICE	MnDOT	3A	218-828-2481
ordinator illing	Warren Pladsen	MnDOT	MR&E	612-779-5612
*	Bud Wyberny	MnDOT	4A	218-847-1562
	Tom Swenson	MnDOT	4	218-846-074[illegible]
✓	BOB VAN SAMBEEK	BRAUN INTERTEC	—	1-800-344-7477 612-776-7522
✓	GENE SKOK	"	"	" " "

ASPHALT INSTITUTE

SECTION ID	HIGHWAY	MILEPOINT	CONTROL SECTION	DISTRICT	DISTRICT MAINTENANCE SUPERINTENDANT	MAINTENANCE SUB AREA SUPERVISOR	DISTRICT MATERIALS ENGINEER	DISTRICT SOILS ENGINEER
271018	US 10 EB	140.15	4902	3A	LEE PURDHAM (218) 828-2472 BRAINERD	GARY LOUDAN (612) 632-6116 LITTLE FALLS	KEN WASNIE (218) 828-2481 BRAINERD fax 2544	KEVIN HOWIESON (218) 828-2240 BRAINERD
271028	US 10 EB	58.26	5607	4A	DENNIS REDIG (218) 847-1575 DETROIT LAKES	JOE STEGMAIER (218) 847-1500 DETROIT LAKES	BUD WYBORNY (218) 847-1562 DETROIT LAKES	TOM SWENSON (218) 846-0743 DETROIT LAKES
276251	US 2 WB	113.00	0406	2A	LARRY SCHANUS (218) 755-2943 BEMIDJI	TOM STANKO (218) 755-3799 BEMIDJI	GRAIG GILBERTSON (218) 755-3807 BEMIDJI	TODD VONASEK (218) 755-3992 BEMIDJI
274040	US 2 WB	173.21	3103	1B	WOODIE CRAIG (218) 749-7793 VIRGINIA	ANDY ISTANOVICH (218) 327-4493 GRAND RAPIDS	ROD GARVER (218) 723-4835 DULUTH	PAT HUSTON (218) 723-4883 DULUTH

if not in call 749-7793

fax 218-755-4087

Post-It™ brand fax transmittal memo 7671 | # of pages ▸ 1

To BOB VAN SAM BEEK	From DAVE BULLOCK
Co. BRAUN	Co. MnDOT
Dept.	Phone # 779-5942
Fax # 776-7201	Fax # 779-5616

Traffic Control Contacts

BRAUN SM
INTERTEC

276251 8/31/93

Mn/DOT

BM

Dickson Hoile
296-1542
- locations to shoot in later on

- Surplus rod + pvc from Mn/ROAD

- Look @ ALL 4 SITES

John Zollers
- Caps for BM

-

- EQUIPMENT
  - Power hammer
  - Grinder
  - etc.

} Geo. crew. - ~~tool~~ Loan

- Warren still looking into caps for BM.
  - will talk to Harland Vitalis about installing.

BRAUN[SM]
INTERTEC

Braun Intertec Pavement, Inc.
1983 Sloan Place
St. Paul, Minnesota 55117-2004
612-776-7522 Fax: 776-7201

Engineers and Scientists Serving the Built and Natural Environments

Memorandum

Date: August 31, 1993

To: Graig Gilbertson - District Materials Engineer
Tom Stanko - Maintenance Sub Area Supervisor

From: Robert J. Van Sambeek RV

Re: Instrument Installation and Monitoring Activities for GPS Section 276251 on US-2 Bypass Westbound MP 114.

This letter is a follow up to District level responsibilities discussed at the August 12, 1993 meeting in Baxter, MN. Also, Fred Maurer asked that all work related to the FHWA-LTPP project be billed to charge I.D. 00 310 ####, where #### represents the four digit work item.

* Utility Clearance
  - MP 113.86 to MP 113.73 of westbound US-2 bypass.
    - 700 feet total from 100 feet west of Sta.0+00 to 100 feet east of Sta.5+00.
    - Stations marked on right edge of driving lane with white paint.
    - Clear driving lane and 40 feet north of section into the ditch.

* If possible, mow grass in area identified for utility clearance, or bring weed whip to site on September 14th.

* Traffic Control September 14th and 15th (Schedule September 16th as contingency day for weather delays or equipment break down).
  - Full lane closure MP 113.86 to MP 113.73 in the westbound driving lane.
  - Traffic control in-place by 7:30 AM both days.

* Pavement Saw and Operator on September 14th.
  - Able to saw about 9.0 inch depth.
  - Cut 14 inch square block out of the pavement in the outer wheel path.
    - Remove block in one piece to bond back in-place later in the day.
  - Cut four inch wide trench from outer wheel path across 11 foot paved shoulder.

* Materials for Equipment Installation and Pavement Repairs.
  - Six bags sackcrete.
  - 500 pounds 3/8 inch pea gravel or trap rock.
  - 500 pounds asphalt patch.
  - Water for sackcrete and equipment clean-up (Not more than 30 gallons).

* Patch four inch wide trench and assist with block replacement in the outer wheel path.

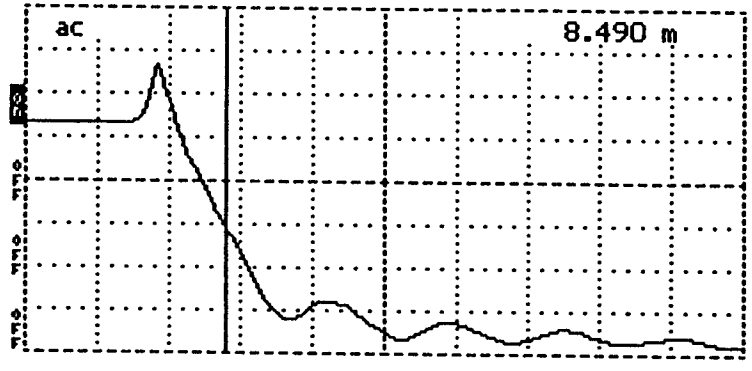
Appendix B-2: Pre-Installation Equipment Checks/Calibration Information

Appendix B-2 contains the following data sheets for the pre-installation equipment checks/calibration:

- Data Sheet SMP-C01: TDR Probe Check;
- Data Sheet SMP-C02: Thermistor and Air Temperature Probe Check;
- Data Sheet SMP-C03: Electrical Resistivity Probe Check;
- Data Sheet SMP-C04: Function Generator, Multi-meter, and Switch Box Checks; and
- Data Sheet SMP-C05: Tipping-Bucket Rain Gauge Calibration.

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

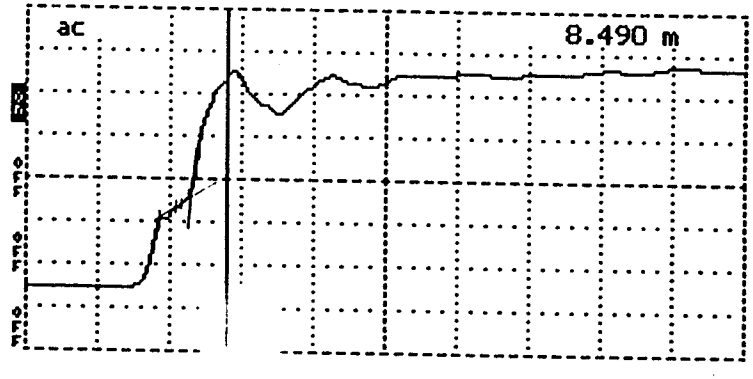
Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27601
Notes SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

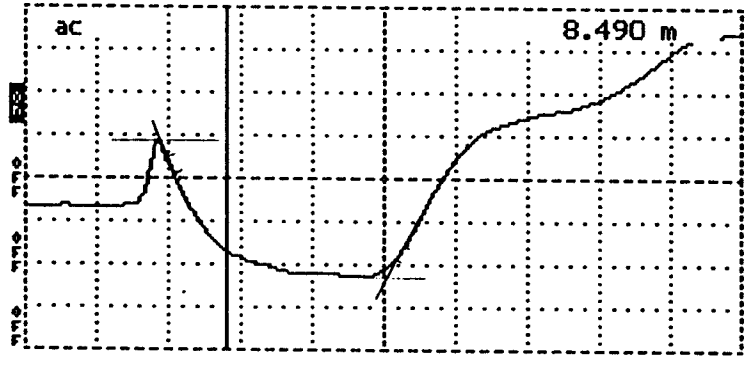


Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27601
Notes AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.11	1.17

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C01
Notes
H2O
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.78 out of range (60)	≈ 60.00

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

Note: Dielectric constant is determined as follows:

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

OUT OF RANGE FOR WATER

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

TDR Probe Serial Number: 27C01 TDR Probe Length, L: _ . (1) _ m Length of Coax Cable: _ (1) _ m

Comments: (1) Not measured in 1993, used 0.203 m for "L", and 0.5 for "Vp" instead of 0.99.

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

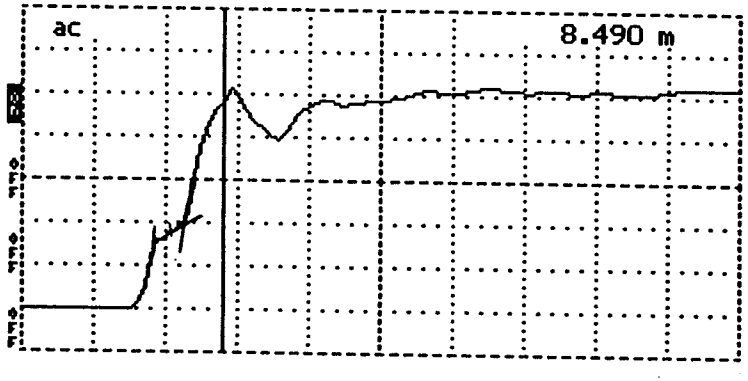
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27602
Notes
SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

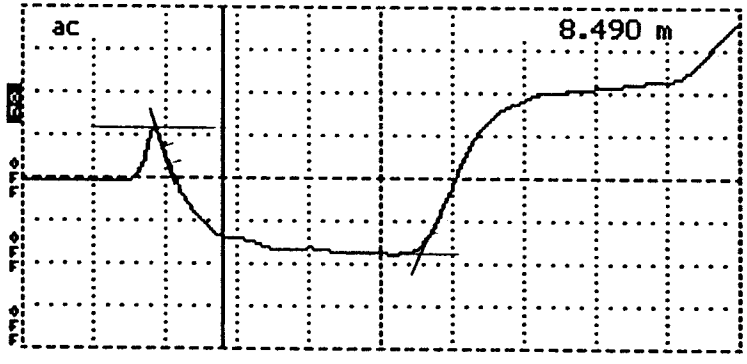


Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27602
Notes
AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"In Air"	0.11	1.17

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

ursor ..... 8.490 m
istance/Div..... .25 m/div
ertical Scale.... 177 mρ/div
P 0.50
loise Filter..... 8 avg
ower..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27C02
Notes
420

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.93	83.95

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C02 TDR Probe Length, L: __.(1)__ m Length of Coax Cable: (1).__ m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15NOV95 (installed 1993)

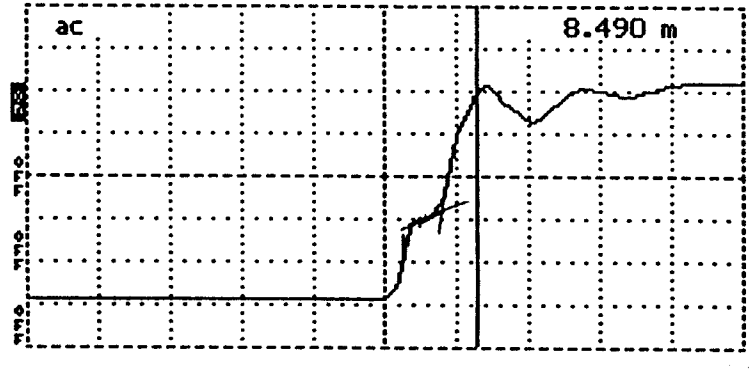
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27C03
Notes
SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

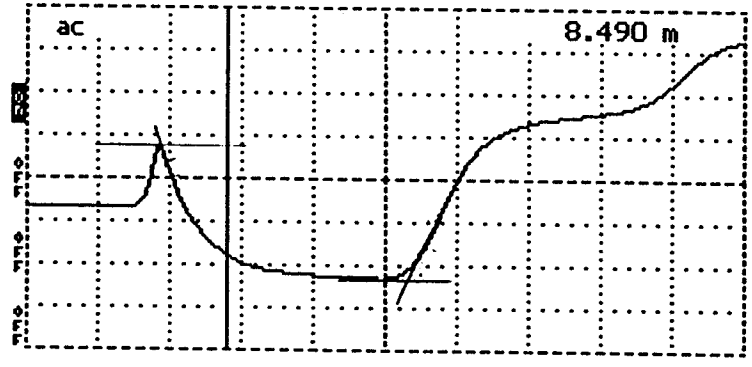


Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - 27C03
Notes
IN AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.14	1.90

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C03
Notes
Hgu
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.99	75.17

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C03 TDR Probe Length, L: _ . (1) _ m Length of Coax Cable: _ (1) . _ m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15 NOV 95 (installed 1993)

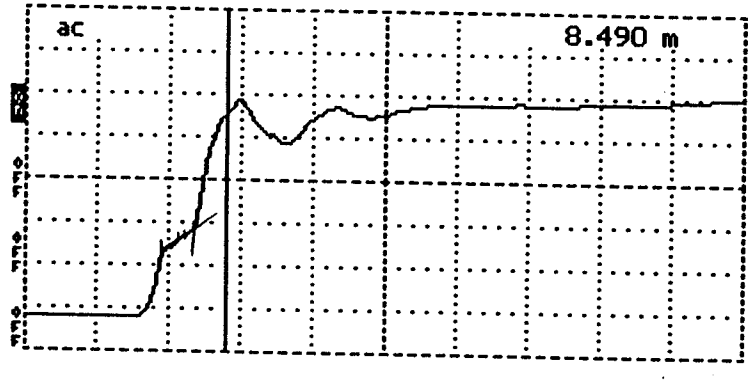
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251-927C04
Notes SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

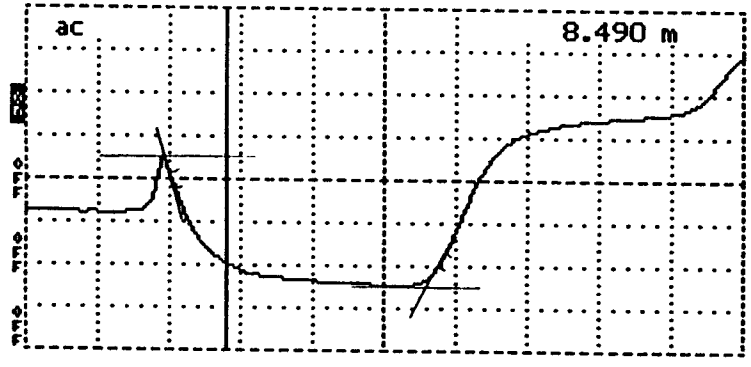


Tektronix 1502B TDR
Date 9-3-93
Cable 276251-927C04
Notes AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.12	1.40

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-8
Notes 27C04
H_2O

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.92	82.16

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C04 TDR Probe Length, L: __.(1)__ m Length of Coax Cable: (1).__ m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

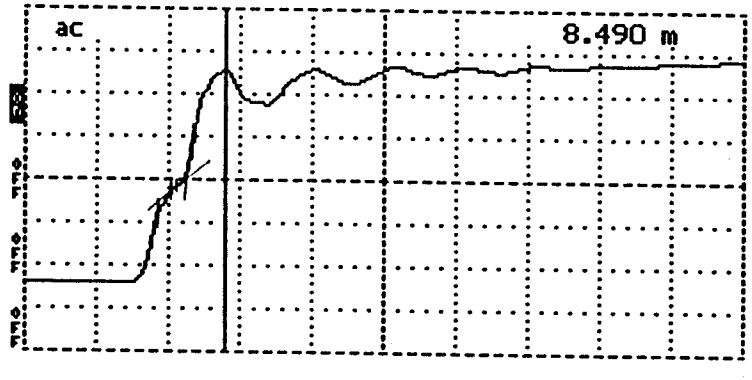
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27605
Notes SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

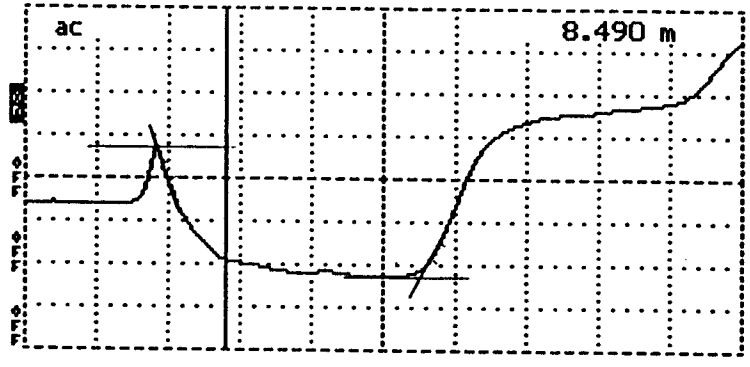


Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27605
Notes AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.11	1.17

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 27C251-27C05
Notes
H_2O

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.92	82.16

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C05 TDR Probe Length, L: __.(1)__ m Length of Coax Cable: (1).__ m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

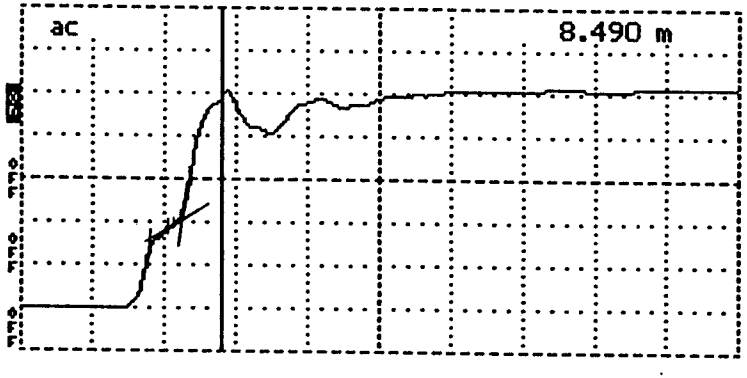
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251-B27C06
Notes SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

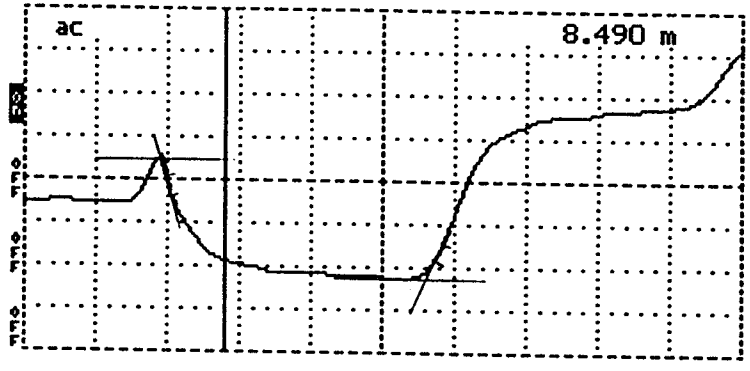


Tektronix 1502B TDR
Date 9-3-93
Cable 276251-B27C06
Notes AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.11	1.17

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C06
Notes
H2C

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.92	82.16

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C06 TDR Probe Length, L: __.(1)__ m Length of Coax Cable: (1).__ m

Comments: (1) see probe #1

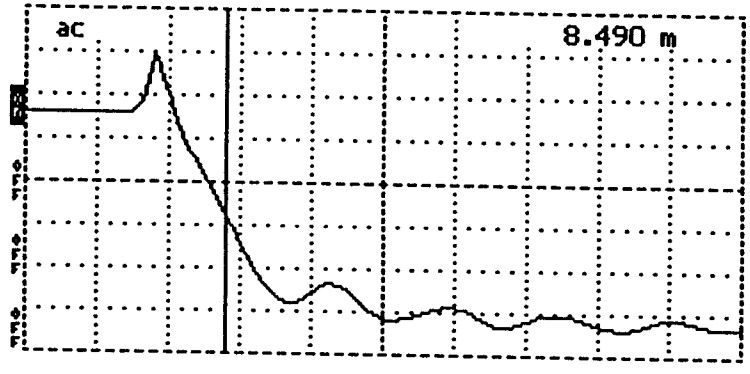
Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

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

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

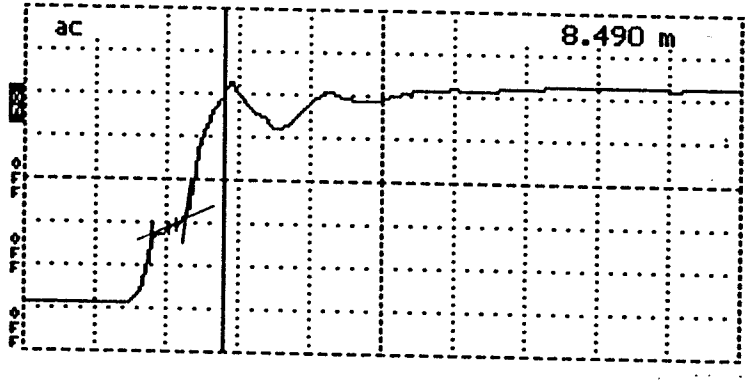
Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C07
Notes
SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C07
Notes
AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.11	1.17

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C07
Notes
H_2O

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.92	82.16

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C07 TDR Probe Length, L: _.(1)_ m Length of Coax Cable: (1)._ m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

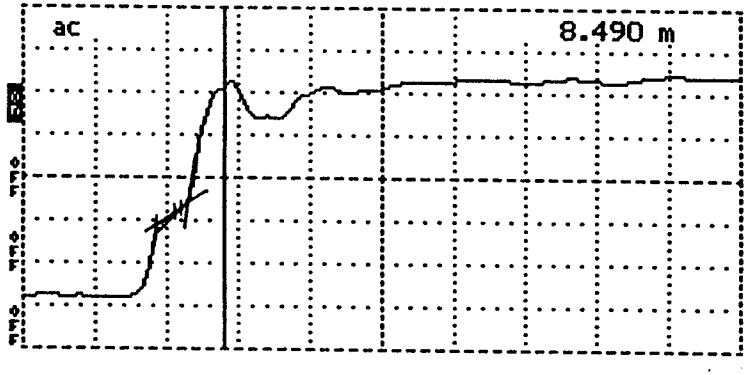
Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251-~~8~~ 27C08
Notes
SHORTED

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



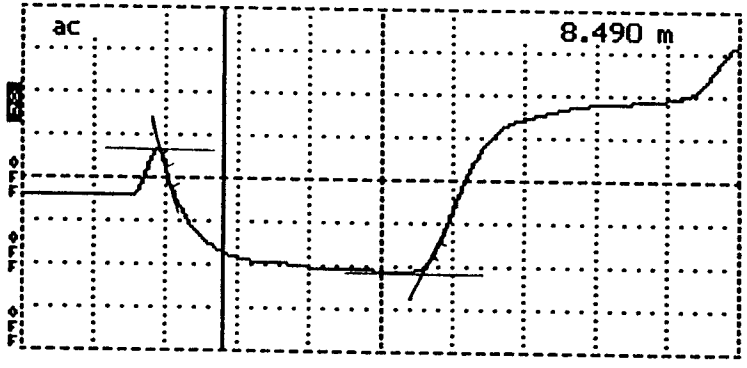
Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - ~~8~~ 27C08
Notes
AIR

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.12	1.40

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-~~8~~ 27C08
Notes
H_2O

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.90	78.62

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C08 TDR Probe Length, L: _ . (1) _ m Length of Coax Cable: (1) . _ m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

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

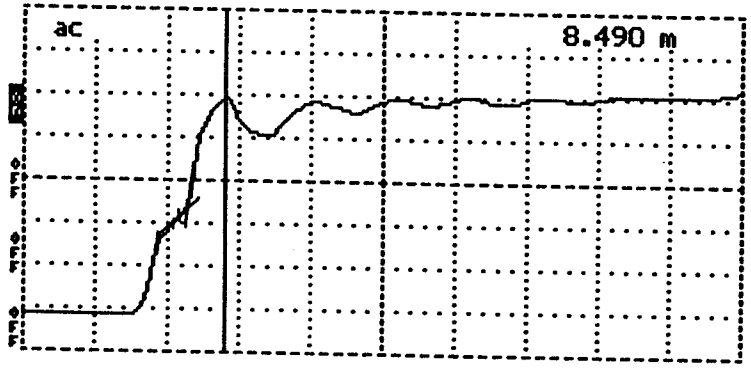
LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C09
Notes SHORTED
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

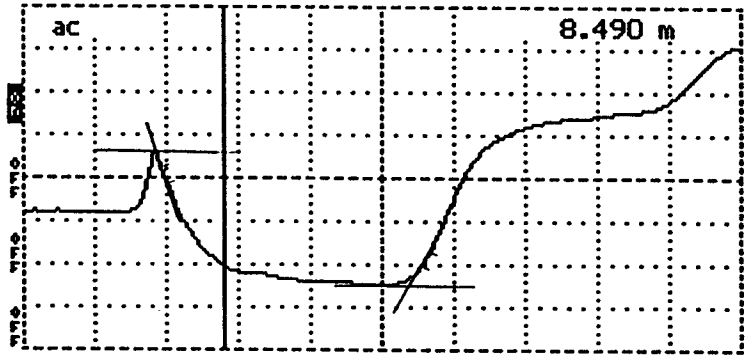


Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C09
Notes AIR
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.11	1.17

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-27C09
Notes
H_2O

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.89	76.89

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C09 TDR Probe Length, L: .(1) m Length of Coax Cable: (1). m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 1) TDR Probe Check	Agency Code [27] LTPP Section ID [6251]

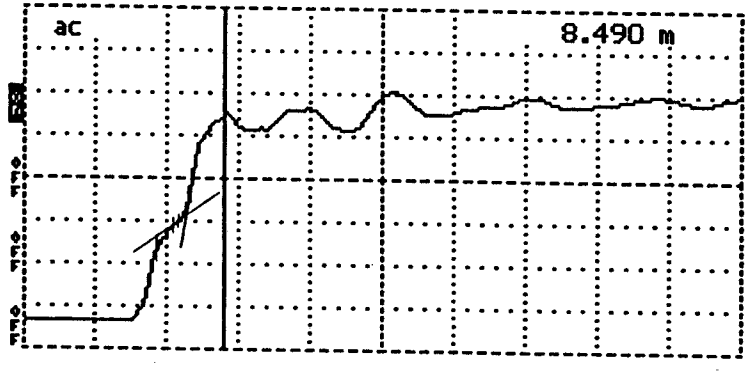
Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac

Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - ~~[illegible]~~ 27C10
Notes
SHORTED

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant
"Shorted at Start"	N/A	N/A

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
Vp 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251 - ~~[illegible]~~ 27C10
Notes
AIR

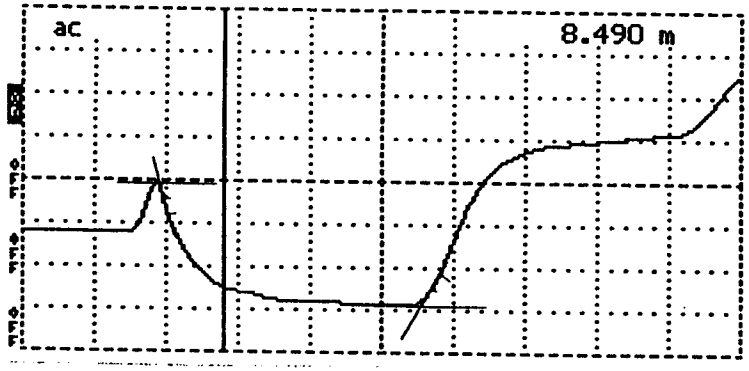
Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[1]
"In Air"	0.12	1.40

Data Sheet SMP-C01: TDR Probe Check

LTPP Seasonal Monitoring Program Data Sheet SMP-C01 (Page 2) TDR Probe Check	Agency Code [26] LTPP Section ID [6251]

Cursor ..... 8.490 m
Distance/Div..... .25 m/div
Vertical Scale.... 177 mρ/div
VP 0.50
Noise Filter..... 8 avg
Power..... ac



Tektronix 1502B TDR
Date 9-3-93
Cable 276251-~~70~~ 27C10
Notes
H_2O

Input Trace
Stored Trace
Difference Trace

TDR Trace	Apparent Length, (m)	Dielectric Constant[2]
"In Water"	0.92	82.16

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

Note: Dielectric constant is determined as follows:

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

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

TDR Probe Serial Number: 27C10 TDR Probe Length, L: .(1) m Length of Coax Cable: (1). m

Comments: (1) see probe #1

Prepared by: JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15/NOV/95 (installed 1993)

LTPP Seasonal Monitoring Program Data Sheet SMP-C02 Thermistor Probe Check	Agency Code [27] LTPP Section ID [6251]

Thermistor Probe Assigned Serial Number : [27C T]

Air Temperature Probe Assigned Serial Number: [27C A T]

Thermistor Number	Distance from Top (m)	Temperature (°C) – Calibration in: Ice-Bath; T = (1) . °C	Other ; T = (1) . °C	Comments
1	0.000	.	.	IN SS
2	0.152	.	.	PART OF
3	0.305	.	.	PROBE
4	0.017	.	.	
5	0.093	.	.	
6	0.170	.	.	
7	0.245	.	.	
8	0.320	.	.	
9	0.475	.	.	
10	0.626	.	.	
11	0.778	.	.	
12	0.930	.	.	
13	1.084	.	.	
14	1.235	.	.	
15	1.395	.	.	
16	1.537	.	.	
17	1.695	.	.	
18	1.844	.	.	
End	. (1)	n/a	n/a	
Air Probe	n/a	(1) .	(1) .	

NO FORM IN 1993 HAND RECORDED INFO NOT FOUND. PROBE WAS CHECKED.

Comments: (1) NOT MEASURED IN 1993. ALL DATA TRASFERRED FROM OLD SHEETS

Prepared by: RJV / JAH Employer: Braun Intertec Corporation

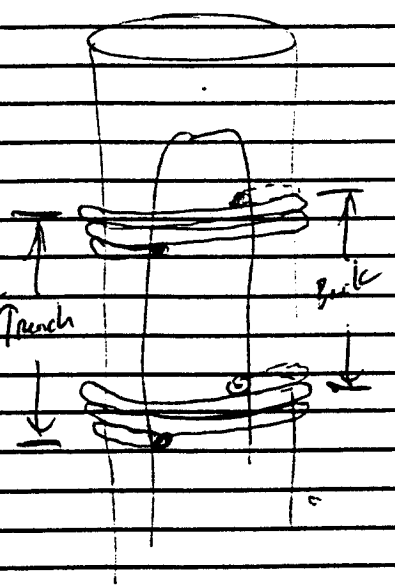
Date (dd/mmm/yy): 21 / NOV / 95 (FOR 1993 INSTALL)

Data Sheet SMP-C02: Thermistor and Air Temperature Probe Check

LTPP Seasonal Monitoring Program Data Sheet SMP-C03 Resistivity Probe Check	Agency Code [27] LTPP Section ID [6251]

Electrical Resistivity Serial Number: 27CR

DB37 Connector Pin Number	Electrode Number	Distance from Top (m) Line 1	Line 2	~~Ave~~	Continuity ✓	Spacing (m)	Comments
36	1	_.___	_.___	0.030		_.___	- Two lines on probe
35	2	_.___	_.___	0.079		0.049	for spacings in 1993
34	3	_.___	_.___	0.129		_.051	data
33	4	_.___	_.___	0.181		_.051	
32	5	_.___	_.___	0.232		_.052	* Guessing 'trench' line
31	6	_.___	_.___	0.284		_.051	had outside to outside
30	7	_.___	_.___	0.334		_.050	measurements (all too
29	8	_.___	_.___	0.384		_.051	large)
28	9	_.___	_.___	0.436		_.052	
27	10	_.___	_.___	0.487		_.051	- adjusted values to
26	11	_.___	_.___	0.539		_.052	obtain #36 @
25	12	_.___	_.___	0.589		_.050	about 1805 mm.
24	13	_.___	_.___	0.640		_.051	
23	14	_.___	_.___	0.691		_.051	
22	15	_.___	_.___	0.741		_.050	
21	16	_.___	_.___	0.792		_.050	
20	17	_.___	_.___	0.843		_.052	
19	18	_.___	_.___	0.893		_.050	
18	19	_.___	_.___	0.946		_.053	
17	20	_.___	_.___	0.996		_.050	
16	21	_.___	_.___	1.048		_.052	
15	22	_.___	_.___	1.098		_.050	
14	23	_.___	_.___	1.148		_.051	
13	24	_.___	_.___	1.200		_.051	* Trench
12	25	_.___	_.___	1.251		_.051	
11	26	_.___	_.___	1.301		_.050	
10	27	_.___	_.___	1.353		_.052	
9	28	_.___	_.___	1.403		_.050	
8	29	_.___	_.___	1.454		_.051	
7	30	_.___	_.___	1.504		_.051	
6	31	_.___	_.___	1.556		_.051	
5	32	_.___	_.___	1.606		_.050	
4	33	_.___	_.___	1.657		_.052	
3	34	_.___	_.___	1.707		_.050	
2	35	_.___	_.___	1.758		_.051	
1	36	_.___	_.___	1.809		_.051	
	Bottom	_.___	_.___	1.830	n/a	n/a	



Comments: Data from 1993 had 'spacing' versus dist. from top - all values were adjusted to get #36 @ about 1805 ±03 mm from the top.

Prepared by: RJV / JAH Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 21 / NOV / 95 (FOR 1993 INSTALL)

LTPP Seasonal Monitoring Program Data Sheet SMP-C04 Function Generator, Multimeter, and Switch Box Checks	Agency Code [27] LTPP Section ID [6251]

Start Time (military): _ _ _ _

Test Position	Switch Settings		Voltage (ACV)		Current (ACA)		Measured Resistance R = V/I (ohms)	Known Resistance (ohms)
	I_1 V_1	I_2 V_2	Range Setting	Reading	Range Setting	Reading		
36	36	37					R1 =	R1 =
37	37	38					R2 =	R2 =
38	38	39					R3 =	R3 =
39	39	00					R4 =	R4 =
36	36	37					R1 =	R1 =
37	37	38					R2 =	R2 =
38	38	39					R3 =	R3 =
39	39	00					R4 =	R4 =
36	36	37					R1 =	R1 =
37	37	38					R2 =	R1 =
38	38	39					R3 =	R1 =
39	39	00					R4 =	R2 =

Comments: NOT DONE IN 1993 -

Prepared by: RJV

Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 22 DEC 95 (FOR 1993 INSTALL)

LTPP Seasonal Monitoring Program Data Sheet SMP-C05 Rain Gauge Calibration	Agency Code [27] LTPP Section ID [6251]

General Information:

Manufacturer: TEXAS INSTRUMENTS INC

Model Number: TRP - 525 M

Serial Number: 12043

Note: The screen should be tacked inside the funnel using silicon at three to four points to prevent loss from wind.

Rain Gauge Calibration Data					
Trial	Start Time (Military)	End Time (Military)	Volume (ml)	Number of Tips	Adjustment[1] No. of Turns
1	(1)				
2					
3					

[1] Adjust gauge to obtain 100 tips ± 3 for 473 ml of water.

Comments: (1) DATA NOT RECORDED IN 1993 CHECKS, GAUGE WAS CALIBRATED PRIOR TO INSTALLATION.

Prepared by: RSV Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 15 / NOV / 95 (From 1993 DATA)

Appendix C-1: Instrumentation Installation Information

Appendix C-1 contains the following installation data sheets and associated field notes, as well as, photographs documenting the installation:

- Data Sheet SMP-I01: List of Installed Instrumentation;
- Data Sheet SMP-I02: Instrumentation Locations;
- Data Sheet SMP-I03: Log of Piezometer Hole;
- Data Sheet SMP-I04: Log of Instrumentation Hole;
- Data Sheet SMP-I05: Field Gravimetric Moisture Contents;
- Data Sheet SMP-I05(A): Lab Gravimetric Moisture Contents;
- Data Sheet SMP-I05(B): Gravimetric Moisture Comparison;
- Data Sheet SMP-I06: TDR Moisture Content;
- Data Sheet SMP-I07: Representative Dry Density; and
- Installation Photographs.

2 7 S C 9 3 A

LTPP Seasonal Monitoring Program Data Sheet SMP-I01 Instrumentation Installed and Participants	Agency Code [2 7] LTPP Section ID [6 2 5 1]

List of Equipment:

Equipment	Quantity	Serial Number(s)
Instrument Hole:		
Thermistor Probe	0 1	2 7 C T
Resistivity Probe	0 1	2 7 C R
TDR Sensors	1 0	2 7 C 0 1 to 2 7 C 1 0
Equipment Cabinet:		
Campbell Scientific CR10 Datalogger	0 1	1 6 5 3 0
Battery Package	0 1	5 5 3 7
Weather Station:		
Rain Gauge	0 1	1 2 0 4 3
Air Temperature Probe	0 1	2 7 C A T
Radiation Shield	0 1	———
Observation Piezometer/Bench Mark:	0 1	n/a

List of Participants:

Name of Participant	Agency/Employer
ROBERT VAN SAMBEEK	BRAUN INTERTEC CORP
RONALD URBACH	" " "
DANA MILLER	" " "
JOEL RECTOR	" " "
HARLAND VITALIS	MN DOT — DRILL RIG
EUGENE TORMONEN	" " "
TOM STANKO	MN DOT — DIST. 2
OHIO DOT AND UNIV. PROF.	OHIO DOT / UNIV.

Prepared by: Jerome Doles Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 11 / DEC / 95 (FOR 14Sep93 Install)

2 7 5 C 9 3 A

LTPP Seasonal Monitoring Program Data Sheet SMP-I02 Installed Instrument Location	Agency Code [27] LTPP Section ID [6251]

Longitudinal and Transverse Location of Instrumentation:

Instrument	Station (Customary Units)		Offset (m)[1]	
	Planned	Actual	Planned	Actual
Instrumentation Hole	5+15	5+15	+0.76	+0.91
* Observation Piezometer	4+00	3+99	−3.65	−3.66
Equipment Cabinet	5+15	5+15	−7.90	−7.92
Weather Station	5+15	5+15	−8.23	−8.23
DOT Benchmark		5+02		−20.42

[1] Transverse distance in meters from pavement edge (see LTTP Manual for FWD Testing) with (+) values toward mid-lane and (-) towards shoulder

* ON NOV. 17, 1993, PIEZ. 0.3231 M BELOW EOP @ sta. 4+00.

Depth Location of Instrumentation:

Instrument		Depth from Pavement Surface to Top of Probe (m)		Comments
		Planned	Actual	
Thermistor Probe	Metal Top	0.025	0.025	Not measured.
	Metal Bottom	0.155	0.150	Not measured.
	PVC Top	0.229	0.215	
Resistivity Probe		0.229	0.225	

TDR Number	Depth from Pavement Surface to Probe (m)		Comments
	Planned Location	Actual Location	
1	0.304	0.290	All depths ±0.005m
2	0.457	0.445	converted from
3	0.610	0.610	nearest 1/8 inch.
4	0.762	0.750	
5	0.914	0.900	
6	1.067	1.060	
7	1.219	1.220	
8	1.372	1.365	
9	1.676	1.670	
10	1.981	1.970	

ATTACH TOP-VIEW SKETCH OF INSTRUMENTATION HOLE SHOWING DIRECTION OF TRAFFIC AND LOCATION OF THERMISTOR AND RESISTIVITY PROBES. LABEL PROBES "T" AND "R", RESPECTIVELY

Prepared by: Jerome Dicks Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 11 Dec 95 (For 14Sep93 Install)

Data Sheet SMP-I02: Instrumentation Location

C Probe lengths not measured in 1993 used 203m All Depths ±.005m

2 7 S C 9 3 A

LTPP Seasonal Monitoring Program Data Sheet SMP-I03 Log of Piezometer Hole	Agency Code [2 7] LTPP Section ID [6 2 5 1]

Operator: H. VITALIS Equipment Used: MOBILE CORE\DRILL

Location: Station: 3 + 9 9 Offset: 3 . 6 6 m (from lane edge)

Bore Hole Diameter: 2 0 3 . mm Auger Type: Solid Stem

Scale (m)	Depth from Surface[1] (m)	Material Description	Material Code[2]
	0.150	SILTY SAND TORSOIL	214
0.5			
1.0			
1.5		SILTY SAND FINE TO MEDIUM GRAINED BROWN. (CAVE IN AT ABOUT 2.43 TO 2.74 meter DEPTH. WATER AT ABOUT 2.74m.	202
2.0			
2.5			
3.0			
3.5			
4.0			
4.5	4.570		
5.0			

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

Prepared by: Jerome Dicks Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 12/DEC/95 (For 14 Sep 93 Installation)

BRAUN[SM]
INTERTEC 276251

PIEZOMETER / BENCHMARK
9-14-93

LOCATION WAS AT STATION 3+99
OFFSET 12' FROM WHITE LINE.

STARTED TO AUGER 8" AUGER. SEVERAL
ATTEMPTS WERE MADE TO TRY TO GET
A HOLE 15' I DEEP TO INSTALL THE
PIEZOMETER.

A 5 GALLON PAIL WAS TAKEN FOR
POSSIBLE TESTING LATER. FROM 1' TO 4.5 FOOT

SATURATED SAND WAS ENCOUNTERED
AT ABOUT THE 9 FOOT DEPTH

BECAUSE OF THE SATURATED SOILS
THE HOLE KEPT CAVEING IN AT 8-9 FOOT
DEPTH. THE HOLE COULD NOT BE ADVANCED
BELOW THE 9 FOOT DEPTH

SEVERAL ATTEMPTS WERE MADE TO
PUSH THE PIEZOMETER TO A DEPTH OF
14½ FEET. IT COULD NOT BE DONE

THE DOT CUT ABOUT 2 FEET FROM THE
UPPER PART OF THE 4 FOOT SECTION OF
1" PIPE.

THE TOTAL LENGTH OF THE PIEZOMETER
WAS 12 FEET. 3 INCHES LONG.

THE PIEZOMETER WAS THEN PUSHED WITH
THE DRILL RIG TO A DEPTH OF ABOUT
12½ FOOT DEPTH.

BRAUN[SM]
INTERTEC 276251

SOIL CAVE IN WAS AT ABOUT 8 FEET BENTONITE PELLETS WERE PLACED FROM A DEPTH OF 8 FEET UP TO A DEPTH OF 6 FEET 8 INCHES.

BECAUSE OF THE CAVE IN NO FILTER SAND WAS PLACED. THE NATERAL SOILS WERE A FINE GRAINED SAND.

SOIL REMOVED FROM THE BOREHOLE DURING DRILLING WERE USED AS BACKFILL. FROM 6 FOOT DEPTH TO ABOUT 2 FEET BELOW GROUND LEVEL.

THE 4½" OD STEEL SLEEVE WAS PUT SO THE BOTTOM WAS ABOUT 2.25 FEET BELOW EXISTING GROUND.

THE STEEL SLEEVE WAS BACKFILLED WITH CONCRETE (SAKRETE) TO ABOUT 3" FROM THE TOP. LUGS WERE WELDED ON THE SIDE OF THE SLEEVE TO HELP ANCHOR IT IN THE CONCRETE.

FILTER SAND WAS USED TO FILL THE AREA BETWEEN THE SLEEVE AND THE PIEZOMETER/BENCHMARK PIPE. THIS WAS PLACED TO ABOUT 2-3 INCHES BELOW THE TOP OF THE PIEZOMETER/BENCHMARK PIPE.

27 5 C 9 3 A

LTPP Seasonal Monitoring Program Data Sheet SMP-I04 Log of Instrumentation Hole	Agency Code [27] LTPP Section ID [6251]

Operator: H. VITALIS Equipment Used: MOBILE CORE/DRILL

Location: Station: 5+15 Offset: 0.91 m (from lane edge)

Bore Hole Diameter: 290. mm

Scale (m)	Strata Change[1] (m)	Material Description	Material Code[2]
0.10 0.20	0.171	AC	700
0.30 0.40	0.425	BASE	304
0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50	1.500	SAND FINE TO MED. GRAINED BROWN	202
1.60 1.70 1.80 1.90 2.00 2.10	2.080	SAND FINE GRAINED LT BROWN MOIST	202
2.20 2.30 2.40 2.50			

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

Prepared by: RJV from RRU NOTES/FORM Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 22 DEC 95 (FROM 14-SEP-1993 INSTALL)

LTPP Seasonal Monitoring Program Data Sheet SMP-I05 Field Gravimetric Moisture Content	Agency Code [27] LTPP Section ID [6251]

TDR Probe	Probe Depth[1] (m)	Moisture Sample No.	Pan No.	Wt. of Pan (gms) = A	Wt. of Pan + Wet Soil (gms) = B	Wt. of Pan + Dry Soil (gms) = C	Wt. of Dry Soil (gms) = D = C - A	Wt. of Water (gms) = E = B - C	Moisture Content (%) = w = E/D * 100
1	0.290	10	1	223.6	501.0	#3 469.9	471.3	29.7	6.3
2	0.440	9	2	218.6	585.8	#3 554.3	560.7	25.1	4.5
3	0.610	8	3	225.0	579.5	#2 554.9	548.5	31.0	5.7
4	0.750	7	4	223.3	605.2	#2 576.4	571.7	33.5	5.5
5	0.900	6	1	223.6	351.5	#4 335.8	335.5	16.0	4.8
6	1.060	5	3	225.0	419.2	#1 403.5	402.1	17.1	4.3
7	1.220	4	4	223.3	393.2	#3 373.5	368.8	24.4	6.6
8	1.365	3	2	218.6	472.2	#4 450.0	454.7	17.5	3.9
9	1.670	2	1	223.6	547.4	#2 526.9	521.9	25.5	4.7
10	1.970	1	1	223.6	573.1	#5 540.0	540.0	33.1	6.1

[1] Distance in meters from pavement surface to TDR probe

Comments: DATA FROM 1993 DATA SHEETS. * NOTE: TARE WEIGHT AND PAN WEIGHT ARE NOT ALWAYS EQUAL; THEREFORE SOME OF THE CALCULATIONS ON THE SHEET MAY NOT SEEM VALID. HOWEVER THE DATA AND RESULTS ARE CORRECT.

Prepared by: RJV FROM 1993 DATA SHEETS Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 21/NOV/95 (FOR 1993 INSTALL) (14-SEP-1993)

2 1 5 0 1 5 A

LTPP Seasonal Monitoring Program Data Sheet SMP-I05 (A) LAB ~~Field~~ Gravimetric Moisture Content	Agency Code [27] LTPP Section ID [6251]

TDR Probe	Probe Depth[1] (m)	Moisture Sample No.	Pan No.	Wt. of Pan (gms) = A	Wt. of Pan + Wet Soil (gms) = B	Wt. of Pan + Dry Soil (gms) = C	Wt. of Dry Soil (gms) = D = C - A	Wt. of Water (gms) = E = B - C	Moisture Content (%) = w = E/D * 100
1	0.290								6.4
2	0.440								5.0
3	0.610								4.7
4	0.750								4.7
5	0.900								4.6
6	1.060								4.2
7	1.220								4.8
8	1.365								4.9
9	1.670								3.8
10	1.970								4.4

[1] Distance in meters from pavement surface to TDR probe

Comments: LAB MOISTURES DONE BY MNDOT MATLS AND RESEARCH LAB

Prepared by: RJV FROM MNDOT DATA SHEET Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 21 / NOV / 95 (FROM 14-SEP-1993 INSTALL)

LTPP Seasonal Monitoring Program Data Sheet SMP-I05 (B) Gravimetric Moisture Comparison	Agency Code [27] LTPP Section ID [6251]

TDR	SMP-I02 TDR Depth (m)	SMP-I04 Material Code	Lab Data Dry Density (pcf)	TDR Installation Data		Gravimetric Moistures		Comments
				SMP-I06 La (m)	Calculated Gravimetric (percent)	SMP-I05 Field (percent)	SMP-I05A Lab (percent)	
1	0.290	304	129.5	0.60	8.1	6.3	6.4	
2	0.445	202	116.0	0.55	7.4	4.5	5.0	
3	0.610	202	116.0	0.51	6.1	5.7	4.7	
4	0.750	202	116.0	0.51	6.1	5.5	4.7	
5	0.900	202	116.0	0.49	5.5	4.8	4.6	
6	1.060	202	116.0	0.48	5.2	4.3	4.2	
7	1.220	202	116.0	0.51	6.1	6.6	4.8	
8	1.365	202	116.0	0.46	4.6	3.9	4.9	
9	1.670	202	116.0	0.45	4.3	4.7	3.8	
10	1.970	202	116.0	0.53	6.8	6.1	4.4	

TDR Gravimetric moistures calculated using equations on pages II-2 and II-5 of FHWA-RD-94-110 with La = 0.203 m, and Vp = 0.99.

Comments: Dry Density from Form S04 test location at 5762(BASE @ 0.18 meter depth was 129.5 pcf (dry) and Subgrade @ 0.48 meter depth was 116 pcf (dry)).

Prepared by: RJV/JJD Employer: Braun Intertec Corporation Date (dd/mmm/yy): 27/DEC/95

$$\omega = \left(-330.72 + 4526.78\,La^2 - 2103.88\,La^4 + 402.25\,La^6\right)/\gamma_d \quad ; \quad La \text{ (meters)},\ \gamma_d \text{ (pcf)},\ \omega \text{ (\%)}$$

LTPP Seasonal Monitoring Program Data Sheet SMP-I06 TDR Moisture Content	Agency Code [27] LTPP Section ID [6251]

Required Settings:

Dist./Division: 0.25 m
Phase Velocity: 0.99
Noise Filter: 1 average

Probe Number	Probe Depth[1] (m)	Time (military)	Apparent Length (m)	Dielectric Constant[2]	Comments
1	0.290	(1)	0.60	8.91	
2	0.440		0.55	7.49	
3	0.610		0.51	6.44	
4	0.750		0.51	6.44	
5	0.900		0.49	5.94	
6	1.060		0.48	5.70	
7	1.220		0.51	6.44	
8	1.365		0.46	5.24	
9	1.670		0.45	5.01	
10	1.970		0.53	6.95	

[1] Distance in meters from pavement surface to TDR probe
[2] Dielectric constant is determined as follows:

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

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

ATTACH TDR TRACES TO THIS DATA SHEET.

Comments: (1) NOT RECORDED IN 1993

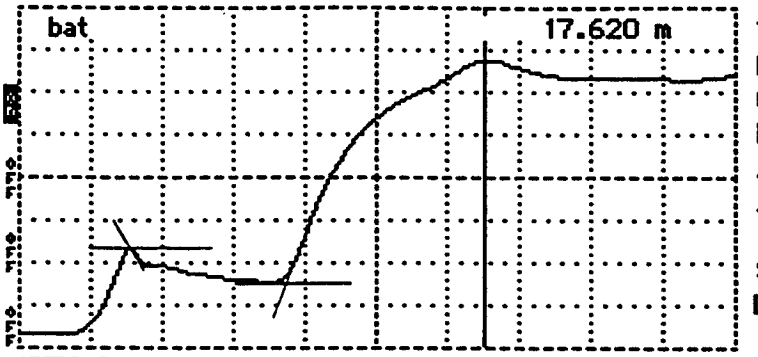
Prepared by: _____ Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 16/NOV/95 (FOR ~~07~~ 14-SEP-93 INSTALL)

..... 17.770 m
Div..... .25 m/div
Scale.... 112 mρ/div
..... 0.99
er..... 8 avg
..... bat

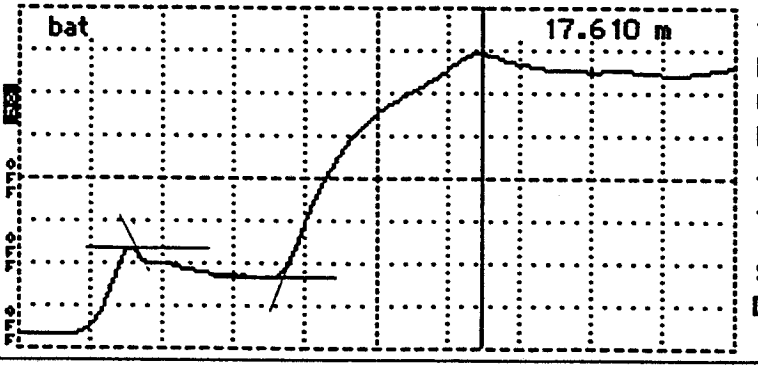
Tektronix 1502B TDR
Date 9-14-93
Cable 276251-1
Notes (27C01)
SP Fine Sand
Input Trace
Stored Trace
Difference Trace

..... 17.620 m
Div..... .25 m/div
Scale.... 112 mρ/div
..... 0.99
er..... 8 avg
..... bat



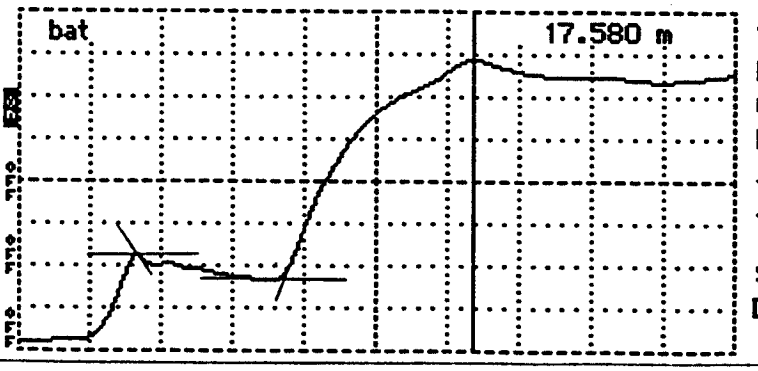
Tektronix 1502B TDR
Date 9-14-93
Cable 276251-2
Notes (27C02)
SP Fine Sand
Input Trace
Stored Trace
Difference Trace

..... 17.610 m
Div..... .25 m/div
Scale.... 112 mρ/div
..... 0.99
er..... 8 avg
..... bat



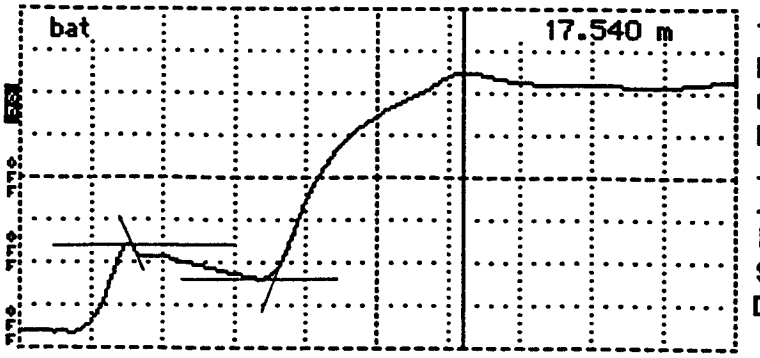
Tektronix 1502B TDR
Date 9-14-93
Cable 276251-3
Notes (27C03)
SP Fine Sand
Input Trace
Stored Trace
Difference Trace

..... 17.580 m
Div..... .25 m/div
Scale.... 112 mρ/div
..... 0.99
er..... 8 avg
..... bat



Tektronix 1502B TDR
Date 9-14-93
Cable 276251-4
Notes (27C04)
SP Fine Sand
Input Trace
Stored Trace
Difference Trace

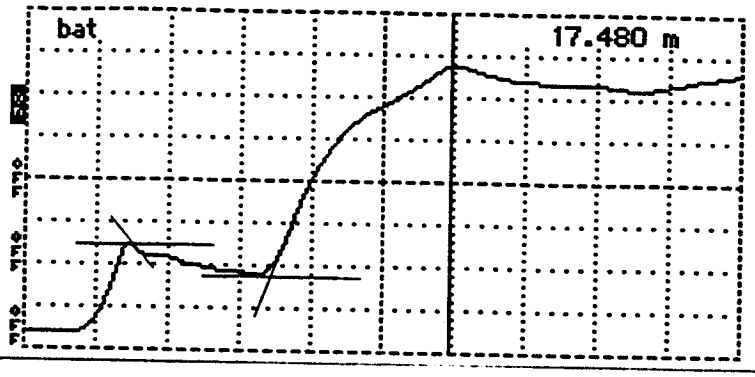
..... 17.540 m
Div..... .25 m/div
Scale.... 112 mρ/div
..... 0.99
er..... 8 avg
..... bat



Tektronix 1502B TDR
Date 9-14-93
Cable 276251-5
Notes (27C05)
SP Fine Sand
Input Trace
Stored Trace
Difference Trace

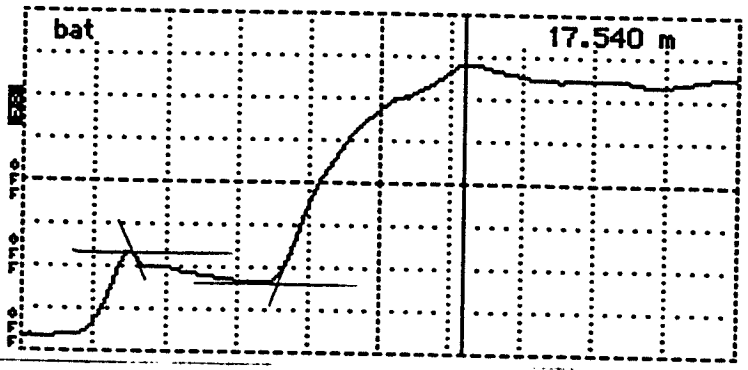
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

..... 17.480 m
Div..... .25 m/div
cale.... 112 mρ/div
..... 0.99
r..... 8 avg
..... bat



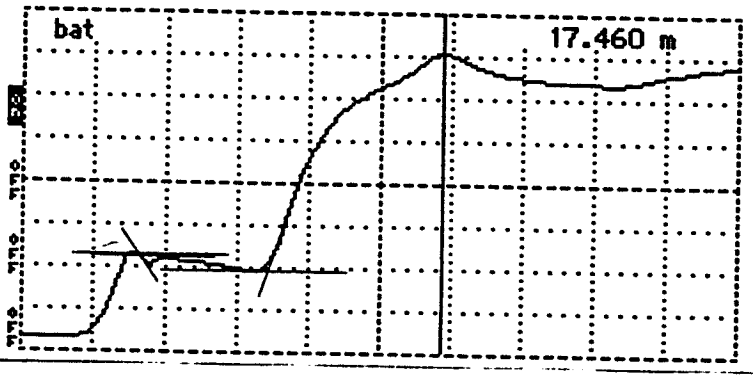
Tektronix 1502B TDR
Date 9-14-93
Cable 276251-6
Notes (27C06)
SP FINE SAND
Input Trace
Stored Trace
Difference Trace

..... 17.540 m
Div..... .25 m/div
cale.... 112 mρ/div
..... 0.99
r..... 8 avg
..... bat



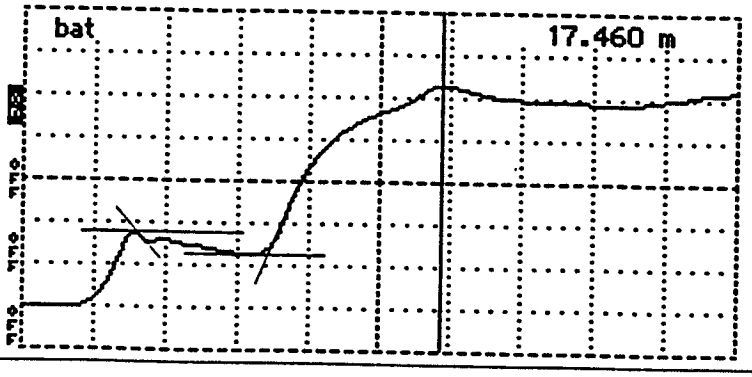
Tektronix 1502B TDR
Date 9-14-93
Cable 276251-7
Notes (27C07)
SP FINE SAND
Input Trace
Stored Trace
Difference Trace

..... 17.460 m
Div..... .25 m/div
cale.... 112 mρ/div
..... 0.99
r..... 8 avg
..... ac



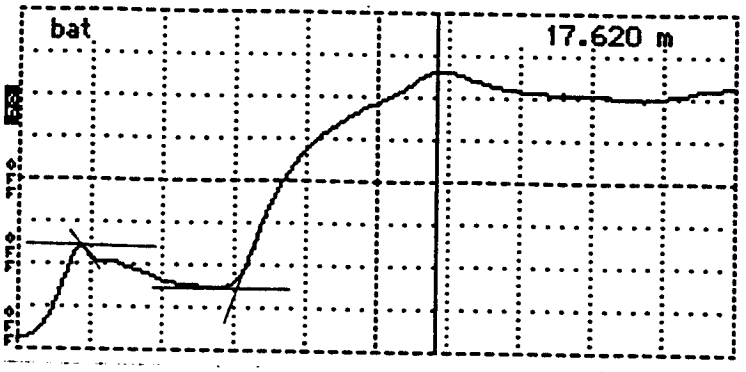
Tektronix 1502B TDR
Date 9-14-93
Cable 276251-8
Notes (27C08)
SP FINE SAND
Input Trace
Stored Trace
Difference Trace

..... 17.460 m
Div..... .25 m/div
cale.... 137 mρ/div
..... 0.99
r..... 8 avg
..... bat



Tektronix 1502B TDR
Date 9-14-93
Cable 276251-9
Notes (27C09)
SP FINE SAND
Input Trace
Stored Trace
Difference Trace

..... 17.620 m
Div..... .25 m/div
cale.... 112 mρ/div
..... 0.99
r..... 8 avg
..... bat



Tektronix 1502B TDR
Date 9-14-93
Cable 276251 10
Notes (27C10)
SP FINE SAND
Input Trace
Stored Trace
Difference Trace

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

LTPP Seasonal Monitoring Program Data Sheet SMP-I07 Representative Dry Density	Agency Code [27] LTPP Section ID [6251]

Depth of Representative Sample (from pavement surface): __ . __ __ m

Dry Density Determination:

a. Tare Weight of Empty Mold: __ __ __ __ g (__ . __ __ lb)

b. Weight of Mold and Compacted Soil: __ __ __ __ g (__ . __ __ lb)

c. Weight of Compacted Sample (b - a): __ __ __ __ g (__ . __ __ lb)

d. Unit Weight of Compacted Soil = [(b - a) / 943.0] = __ . __ __ g/cm^3

([(b - a) * 30] = __ __ __ . __ lb/ft^3)

e. Dry Density of Compacted Soil = [d / (100 - r)] = __ . __ __ g/cm^3

(__ __ __ . __ lb/ft^3)

Moisture Content Determination:

m. Tare Weight of Pan: __ __ __ . __ g

n. Weight of Pan and Moisture Sample: __ __ __ . __ g

o. Weight of Pan and Dry Sample: __ __ __ . __ g

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

q. Weight of Dry Sample (o - m): __ __ __ . __ g

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

Comments: NOT DONE IN 1993.

Prepared by: RSV Employer: Braun Intertec Corporation

Date (dd/mmm/yy): 22 / DEC / 95 (FOR 14-SEP-1993 INSTALL)

BRAUNSM
INTERTEC 276251

TIPPING BUCKET RAIN GAGE AND AIR TEMPERATURE PROBE

DRILLED HOLE WITH 11.5 INCH AUGER.
BOTTOM WAS ABOUT 9.5 FEET BELOW GROUND SURFACE.

BOTTOM SECTION OF 2" PIPE WITH FLOOR FLANGE WAS PUT AT BOTTOM OF HOLE.

ABOUT 3 BAGS OF SAKRETE WAS PUT IN AND COMPACTED AROUND THE PIPE.

THE SAKRETE WAS PLACED FROM ABOUT 4 FOOT TO 9.5 FOOT DEPTH.

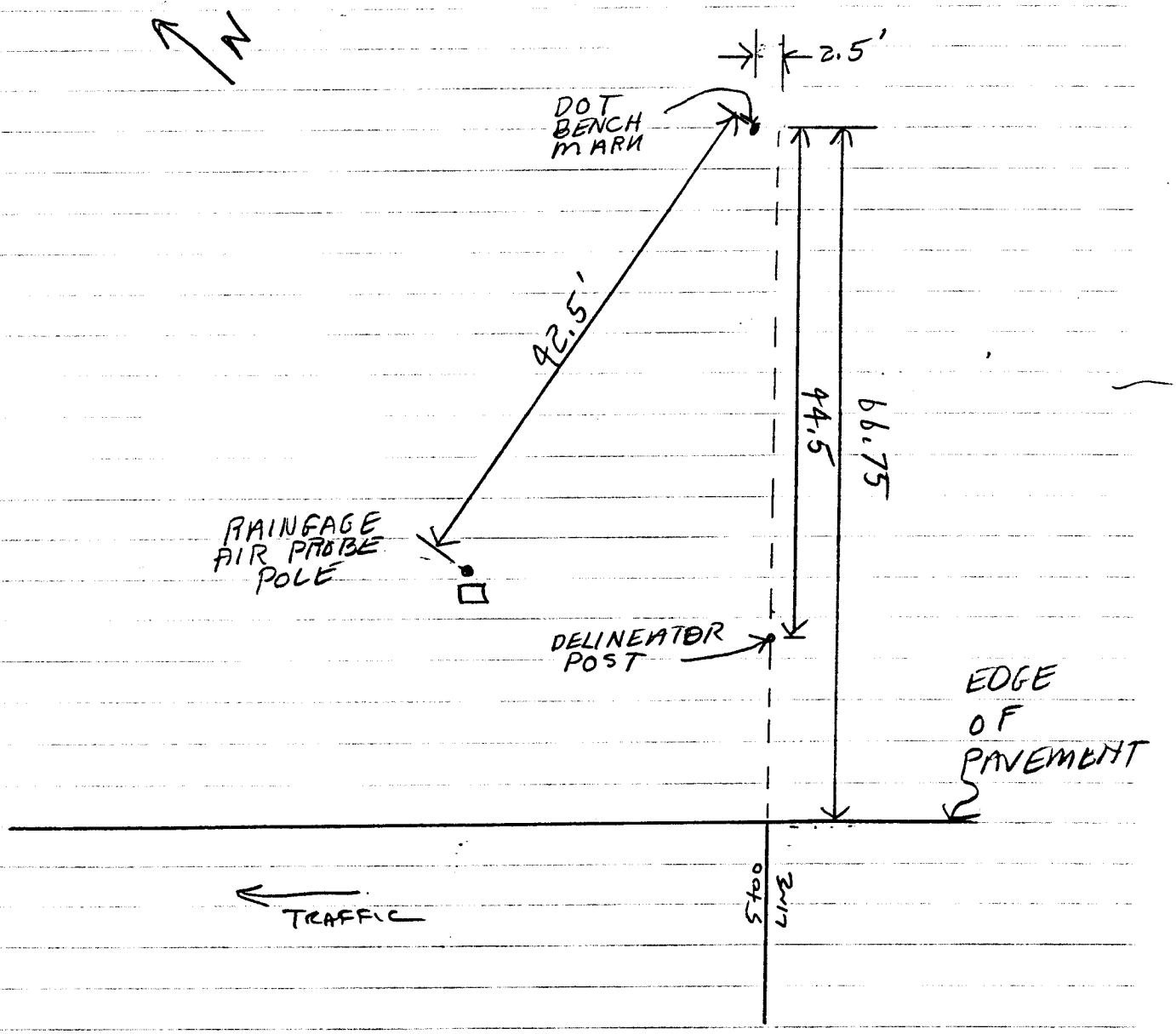
SOIL REMOVED DURING THE DRILLING WAS USED AS BACKFILL ABOUT THE SAKRETE TO THE SURFACE. SOIL WAS COMPACTED DURING BACKFILLING.

THE POLE WAS PLACED ABOUT 6 INCHES BEHIND THE EQUIPMENT CABINET.

BRAUN INTERTEC

276251

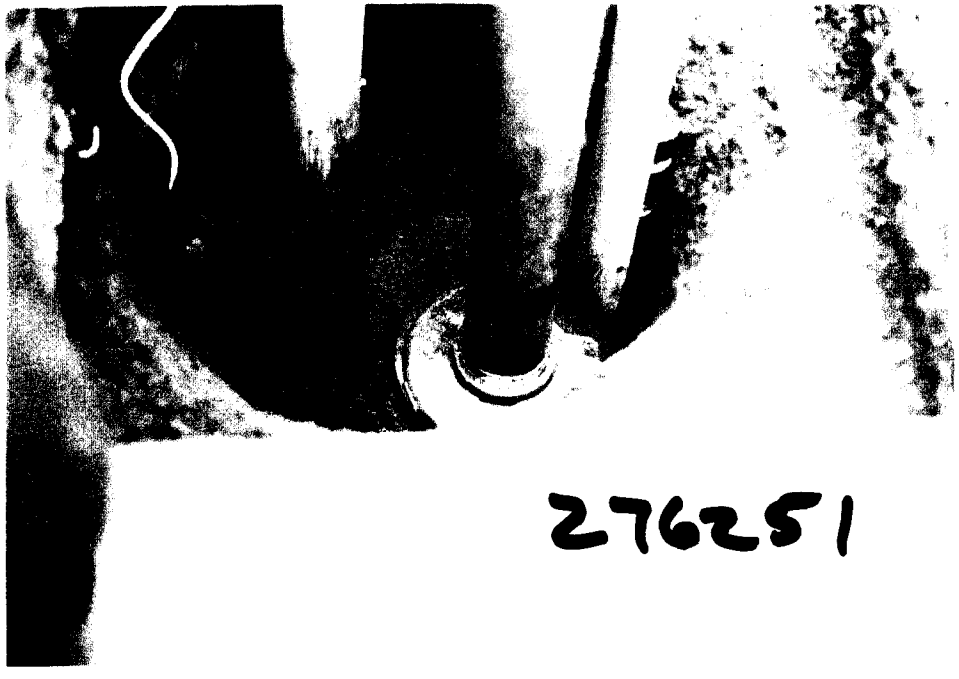
9-15-93



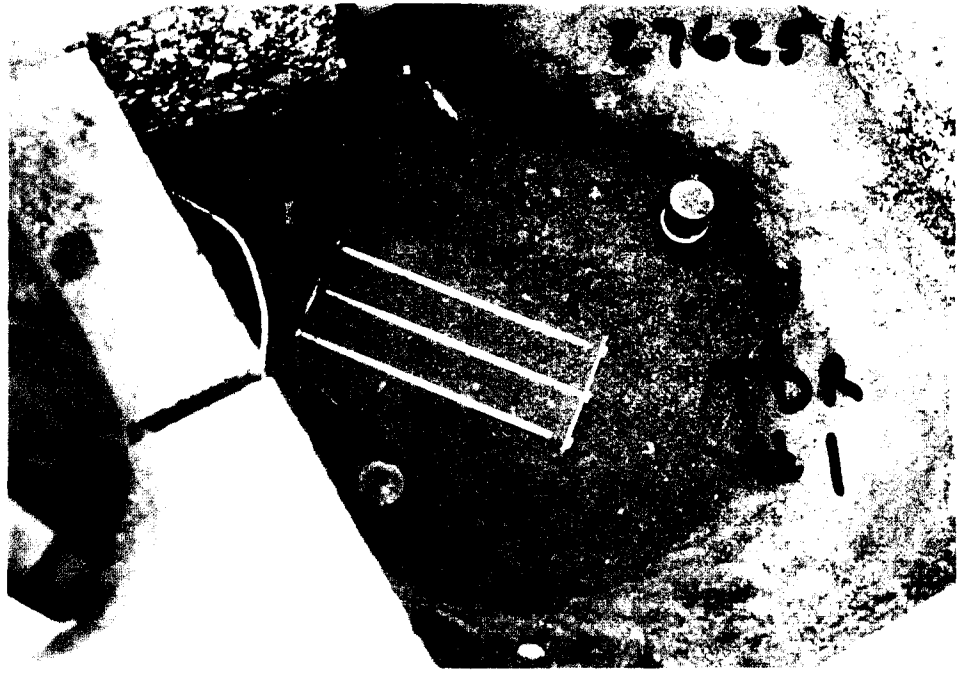
1/2" DIA. SS ROD

DRIVEN 72 FEET TO REFUSAL

276251


276251

276251


276251

Appendix D-1: Initial SMP Monitoring Data Collection

Appendix D-1 contains the following data sheets with information collected the day after instrumentation installation:

- Data Sheet SMP-D03: Contact Resistance Measurements;
- Data Sheet SMP-D04: Four-Point Resistivity Measurements;
- Data Sheet SMP-D05: Ground Water Table Measurements; and
- Data Sheet SMP-D08: Surface Elevation Measurements - AC Pavements.

275C93D

LTPP Seasonal Monitoring Study Data Sheet ~~R~~ D03 Contact Resistance Measurements	* State Code [27] * Test Section Number [6251]

1. Date (Month - Day - Year) [11 - 17 - 93]
2. Time Measurements Began (Military) [10:37]
3. Comments FHWA BOX, ALK. BATTS IN FUNCTION GENERATOR

Test Position	Connections I_1 V_1	Connections I_2 V_2	Voltage (ACV) Range Setting	Voltage (ACV) Reading	Current (ACA) Range Setting	Current (ACA) Reading	Notes	
1	1	2	V	7.57	mA	2.21		3400
2	3	2		8.15		1.93		4200
3	3	4		9.02		1.56		5800
4	5	4		9.14		1.51		6050
5	5	6		9.19		1.48		6200
6	7	6		9.54		1.33		7200
7	7	8		9.62		1.28		7500
8	9	8		9.37		1.40		6700
9	9	10		9.05		1.54		5900
10	11	10		9.00		1.56		5800
11	11	12		9.06		1.53		5900
12	13	12		8.57		1.73		4950
13	13	14		8.16		1.91		4300
14	15	14		8.56		1.74		4900
15	15	16		8.36		1.82		4600
16	17	16		8.53		1.74		4900
17	17	18		8.59		1.72		5000
18	19	18		8.33		1.84		4500
19	19	20		8.27		1.86		4450
20	21	20		8.46		1.78		4750
21	21	22		9.07		1.51		6000
22	23	22		9.51		1.32		7200
23	23	24		*5.02		*1.26	#24 OUT	4000
24	25	24		9.46		1.34		7050
25	25	26		* 0.01		* 8.21		—
26	27	26		9.06		1.51		6000
27	27	28		9.02		1.53		5900
28	29	28		8.81		1.62		5400
29	29	30		8.60		1.70		5050
30	31	30		8.63		1.69		5100
31	31	32		8.21		1.87		4400
32	33	32		7.68		2.11		3600
33	33	34		7.34		2.27		3200
34	35	34		7.12		2.38		3000
35	35	36		7.19		2.35		3050
36	37	38						
37	38	39						
38	39	40						

NO FIRST ?

Preparer RJV Employer BRAUN INTERTEC

Figure III-5 - Contact Resistant Measurements - Data Sheet R1

* CHECKED READINGS THREE TIMES WITH SAME RESULTS

275C93D

LTPP Seasonal Monitoring Study Data Sheet R2 D04 Four-Point Resistivity Measurements	* State Code [27] * Test Section Number [625 A]

1. Date (Month - Day - Year) [11-17-93]
2. Time Measurements Began (Military) NOV [10:20]
3. Comments FHWA BOX ALK. BATT IN SIG. GENERATOR

Test Position	Connections				Voltage (ACV)		Current (ACA)		Notes
	I_1	V_1	V_2	I_2	Range Setting	Reading	Range Setting	Reading	
1	1	2	3	4	V	0.431	mA	2.00	
2	2	3	4	5		0.496		1.91	
3	3	4	5	6		0.435		1.51	
4	4	5	6	7		0.468		1.43	
5	5	6	7	8		0.461		1.48	
6	6	7	8	9		-0.387		1.36	
7	7	8	9	10		0.381		1.29	6-27-95
8	8	9	10	11		0.398		1.38	
9	9	10	11	12		0.443		1.54	12-27 BP
10	10	11	12	13		0.484		1.63	
11	11	12	13	14		0.428		1.52	
12	12	13	14	15		0.441		1.67	
13	13	14	15	16		0.460		1.90	
14	14	15	16	17		0.413		1.68	
15	15	16	17	18		0.467		1.80	
16	16	17	18	19		0.418		1.76	
17	17	18	19	20		0.433		1.70	
18	18	19	20	21		0.465		1.73	
19	19	20	21	22		0.419		1.68	
20	20	21	22	23		0.545		1.72	
21	21	22	23	24		—		—	#24 OUT
22	22	23	24	25		0.427	—	1.08	
23	23	24	25	26		* 3.407		* 1.50	
24	24	25	26	27		* 2.639		* 1.60	
25	25	26	27	28		0.001		8.25	
26	26	27	28	29		0.500		1.52	
27	27	28	29	30		0.548		1.50	
28	28	29	30	31		0.523		1.59	
29	29	30	31	32		0.602		1.73	
30	30	31	32	33		* 0.557		* 1.71	
31	31	32	33	34		0.602		1.87	
32	32	33	34	35		0.554		2.06	
33	33	34	35	36		0.630		2.13	

Preparer RSV Employer BRAUN INTERTEC

Figure III-6 - Four-Point Resistivity Measurements - Data Sheet R2

* CHECKED READINGS THREE TIMES WITH SAME RESULTS

275C93B

LTPP Seasonal Monitoring Study Form ~~W~~ D05 Ground Water Table Measurement	State Code 276251 [2 7] Test Section Number [6251]

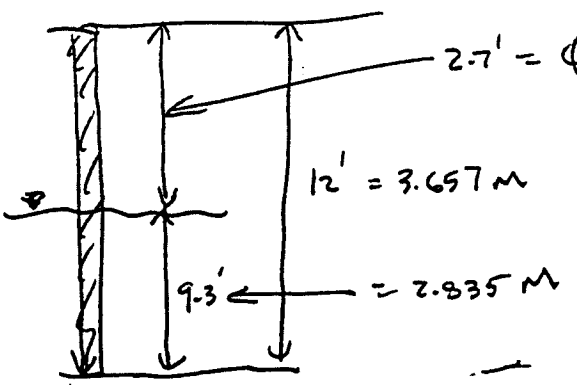
9' 3 1/4

Number	Time	Well Depth (ft)	Water Depth (ft)	Weather Conditions*	Comments
1	0830	12'	~~9.3'~~		
2					
3					
4					
5					

* Use only these weather terms: Sunny, Partly Cloudy, Cloudy, Drizzle, Rain

11/21/94

new forms



– Depth from top of pipe

RV

Collected by: RRU? Employer: BRAUN Date: ~~9~~/15/93 Sep

Figure III-7 - Ground Water Table Measurements - Data Sheet W1

275C93B

Assume Time: 1100

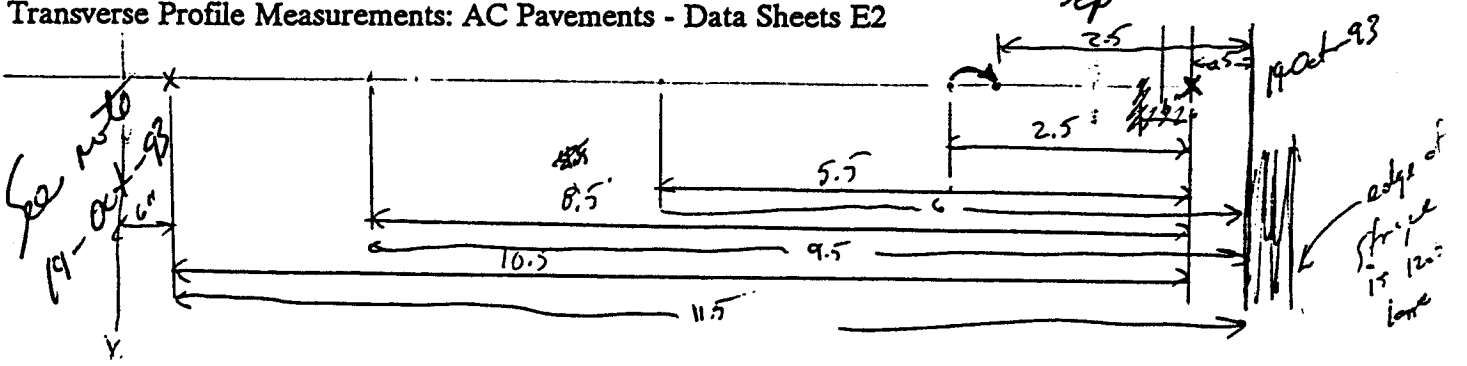
LTPP Seasonal Monitoring Study Form E2 D08 Transverse Profile Measurements-AC			State Code (27) GPS Section No. 276251 Test Section Number (6251) Sheet 1 of 2			
STA	BS	HI	IFS	TFS	ELEV	REMARKS
DOT BM	.8856	~~10.8856~~			~~10.0000~~	BM MNDOX

TYPE OF INSTRUMENT

STA	EOP 0.16	OWP 0.91	MID 1.63	IWP 2.90	CL 3.51	REMARKS
3+00 ELEV	1.3282 ~~9.5577~~	1.3066 ~~9.5790~~	1.2732 ~~9.5127~~	1.2474 ~~9.6472~~	1.3219 ~~9.6773~~	* OWP OFFSET DIFFERENT ON 275C93B DATA SET ONLY.
3+25 ELEV	1.2979 ~~9.5877~~	1.2767 ~~9.6067~~	1.2427 ~~9.5727~~	1.2155 ~~9.6761~~	1.1919 ~~9.7937~~	
3+50 ELEV	1.2714 ~~9.6142~~	1.2503 ~~9.6353~~	1.2108 ~~9.6773~~	1.1840 ~~9.7076~~	1.1568 ~~9.7288~~	
3+75 ELEV	1.2506 ~~9.6355~~	1.2283 ~~9.6573~~	1.1939 ~~9.6977~~	1.1632 ~~9.7334~~	1.1393 ~~9.7573~~	
4+00 ELEV	1.2272 ~~9.6564~~	1.2070 ~~9.6766~~	1.1720 ~~9.7136~~	1.1426 ~~9.7430~~	1.1189 ~~9.7668~~	
4+25 ELEV	1.2123 ~~9.6733~~	1.1899 ~~9.6957~~	1.1546 ~~9.7310~~	1.1242 ~~9.7614~~	1.0998 ~~9.7858~~	
4+50 ELEV	1.1964 ~~9.6892~~	1.1719 ~~9.7137~~	1.1383 ~~9.7473~~	1.1056 ~~9.7800~~	1.0809 ~~9.8052~~	
4+75 ELEV	1.1618 ~~9.7238~~	1.1370 ~~9.7486~~	1.0936 ~~9.7920~~	1.0643 ~~9.8213~~	1.0373 ~~9.8483~~	

Prepared by: BRU/DM Employer: BRAUN Date: ~~8~~-15-93 Sep

Transverse Profile Measurements: AC Pavements - Data Sheets E2



Entered. [illegible]

27SC93B

LTPP Seasonal Monitoring Study Form ~~E2~~ D08 Transverse Profile Measurements-AC			State Code (27) GPS Section No. 276251 Test Section Number (6251) Sheet ___ of ___			
STA	BS	HI	IFS	TFS	ELEV	REMARKS
BM	.8856	~~10.8856~~			~~10.0000~~	
BM				.8854		[illegible]
TYPE OF INSTRUMENT						
STA	EOP	OWP	MID	IWP	CL	REMARKS
5+00 ELEV	1.1189 ~~9.7667~~	1.0949 ~~9.7907~~	1.0567 ~~9.8289~~	1.0232 ~~9.8624~~	0.9952 ~~9.8874~~	
5+10 ELEV	1.1071 ~~9.7785~~	1.0802 ~~9.8054~~	1.0417 ~~9.8439~~	1.0077 ~~9.8779~~	.9810 ~~9.9046~~	
5+15 ELEV	PATCH ~~[illegible]~~		1.0336 ~~9.8520~~	.9996 ~~9.8860~~	0.9728 ~~9.9128~~	UP 1.0770 [illegible] 1.0720 FOWN
5+20 ELEV	1.0917 ~~9.7939~~	1.0647 ~~9.8209~~	1.0253 ~~9.8603~~	.9964 ~~9.8892~~	0.9700 ~~9.9156~~	
+ ELEV						
+ ELEV						
+ ELEV						
+ ELEV						

Prepared by: RRU Employer: Braun Date: ~~X~~-15-93 Sep

Transverse Profile Measurements: AC Pavements - Data Sheets E2

Appendix D-2: Routine SMP Monitoring Data Collection Summary

Appendix D-2 contains the following information:

- Standard LTPP SMP data tracking log;
- Field testing information sheet; and
- Screen prints documenting equipment problems.

27SC-276251, US-2 WB LANES, IN BEMIDJI, MN (MP 113.8)

Date dd/mmm/yy (ctrl+shft+d)	Visit ID	ONSITE Data			MOBILE Data		Manual Data								FWD Data				Distress		Profile		Comments
		Pvmt. Temp.	Air Temp.	Rain	TDR	Frost Volts	Backup Temp	Backup TDR	Frost 2-Pt.	Frost 4-Pt.	Water Table	Pvmt. Elev.	Joint Open.	Joint Fault	Man. Temp.	No. of Cycles/Visit OWP	ML	PE	M	P	P	D	
02-Jun-93																				X			
14-Jun-93																			X				
21-Aug-93																					X		
14-Sep-93	93A														X	1	1						INSTALLATION, MANUAL TDR DATA, FWD TESTING FROM 5+00 TO 5+20.
15-Sep-93	93B	X	X	X	X	X					X	X			X	4	4						NO RESISTIVITY SWITCH BOX.
19-Oct-93	93C	X	X	X	X	X					X				X	3	3						NO RESISTIVITY SWITCH BOX.
16-Nov-93																					X		
17-Nov-93	93D	X	X	X	X	X			X	X	X	X			X	3	3						ADDED RELAY TO ONSITE, TWO FILES FOR THE DAY.
15-Dec-93	93E	X	X	X	X	X					X	X			X	3	3						BAD RESISTIVITY SWITCH BOX.
16-Jan-94																			X				
19-Jan-94	94A	X	X	X	X	X										0	0						WEATHER REDUCED FWD TESTING, BAD RESISTIVITY SWITCH BOX.
16-Feb-94	94B	X	X	X	X	X			X	X	X	X			X	3	3						
21-Feb-94																					X		
16-Mar-94	94C	X	X	X	X	X			X	X	X	X			X	3	3						
30-Mar-94	94D	X	X	X	X	X					X	X			X	3	3						MANY REPEAT FWD TESTS, PARTIAL RESISTIVITY DATA.
13-Apr-94	94E	X	X	X	X	X			X	X	X	X			X	3	3						
15-Apr-94																					X		
03-May-94	94F	X	X	X	X	X			X	X	X				X	3	3						MANY REPEAT FWD TESTS.
17-May-94	94G	X	X	X	X	X			X	X	X	X			X	3	3						FWD D1 READINGS BAD.
22-Jun-94	94H	X	X	X	X	X			X	X	X				X	1	1						
16-Jul-94																					X		
27-Jul-94	94I	X	X	X	X	X			X	X	X	X			X	4	4						
24-Aug-94	94J	X	X	X	X	X			X	X	X	X			X	4	4		X				
29-Sep-94	94K	X	X	X	X	X			X	X	X	X			X	4	4						CHECK CALIBRATION RESISTOR FOR POSITIONS 39 AND 40. TOO HIGH?
12-Oct-94	94L	X	X	X	X	X			X	X	X				X	3	3						
09-Nov-94	94M	X	X	X	X	X			X	X	X	X			X	3	3						
10-Nov-94																					X		PROFILE DATA NOT RECIEVED BY RCO.
07-Dec-94	94N	X	X	X	X	X			X	X	X				X	3	3						

27SC-276251, US-2 WB LANES, IN BEMIDJI, MN (MP 113.8)

Date dd/mmm/yy (ctrl+shft+d)	Visit ID	ONSITE Data			MOBILE Data		Manual Data								FWD Data				Distress		Profile		Comments
		Pvmt. Temp.	Air Temp.	Rain	TDR	Frost Volts	Backup Temp	Backup TDR	Frost 2-Pt.	Frost 4-Pt.	Water Table	Pvmt. Elev.	Joint Open.	Joint Fault	Man. Temp.	No. of Cycles/Visit OWP	ML	PE	M	P	P	D	
11-Jan-95	95A	X	X	X	X	X			X	X	X					0	0						WEATHER REDUCED FWD TESTING.
20-Jan-95																					X		PROFILE DATA NOT RECIEVED BY RCO.
08-Feb-95	95B	X	X	X	X	X			X	X	X	X			X	2	2						ALL ELEVATIONS EXCEPT ML ARE SHIFTED 6" OVER ON PAVEMENT.
16-Mar-95	95C	X	X	X	X	X			X	X	X	X			X	2	2						LAST 2PT. AND 4PT. RESISTIVITY READINGS HAD 0 CURRENT?
30-Mar-95	95D	X	X	X	X	X			X	X	X	X			X	3	3		X				
13-Apr-95	95E	X	X	X	X	X			X	X	X				X	3	3						
27-Apr-95	95F	X	X	X	X	X			X	X	X				X	1	1						
10-May-95	95G	X	X	X	X	X			X	X	X	X			X	4	4						FIXED PIN #1 ON THE RESISITIVITY PROBE CABLE CONNECTOR.
15-Jun-95	95H	X	X	X	X	X			X	X	X	X			X	4	4						
02-Aug-95																			X				

276251 - 27SC

Updated 5-May-95

LOCATION - US-2 WB Lanes, on bypass in Bemidji, MN (MP 113.8)
CONTACTS - Tom Stanko (218) 755-3799, Graig Gilbertson (218) 755-3807
TEMP HOLES - Sta 5+03, Depths are about 1.1", 3.7", and 6.9" (AC thickness = 7.0").

DISTRESS COMMENTS:

Sta F1 - Tests at 25 foot intervals from Sta 3+00 to Sta 5+00, and at Sta 5+15.

325	M-LONG.CR. 2' LEFT OF LP AND SENSORS
350	M-TRANS.CR. UNDER LP AND L-LONG.CR. BEHIND THE LP
375	M-TRANS.CR. BETWEEN D6 AND D7
425	M-LONG.CR. 2' LEFT OF LP AND SENSORS
450	M-LONG.CR. NEAR LP AND ALL SENSORS
475	M-TRANS.CR. 1' BEHIND LP
515	LP ADJACENT TO INSTRUMENTATION HOLE AND M-TRANS.CR. BETWEEN D6 AND D7

Sta F3 - Tests at 25 foot intervals from Sta 3+00 to Sta 5+00, and at Sta 5+10, and 5+20.

325	L-LONG.CR. FROM LP TO D6
350	M-TRANS.CR. UNDER LP
375	M-TRANS.CR. BEHIND LP AND BETWEEN D6 AND D7
475	M-TRANS.CR. UNDER THE LP
510	D7 ON INSTRUMENTATION HOLE
520	H-TRANS.CR. 1.5' BEHIND THE LP

PIEZOMETER - Sta 4+00, 2.0 feet form the edge of paved shoulder, Depth = 3.727M.

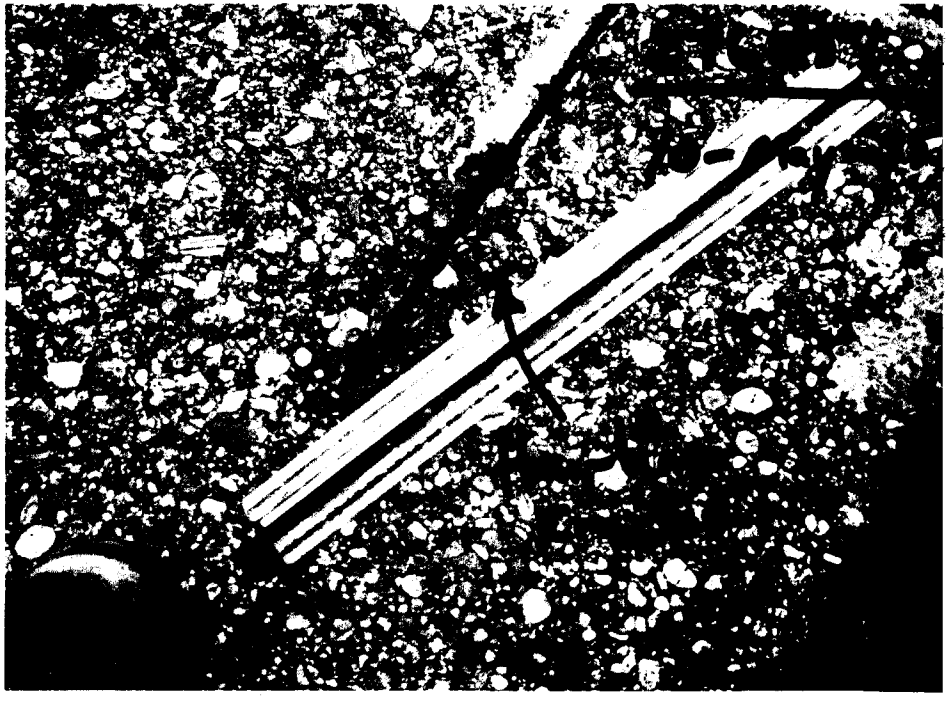
ELEVATIONS - Mn/DOT BM at Sta 5+00, 57 feet from the edge of paved shoulder.

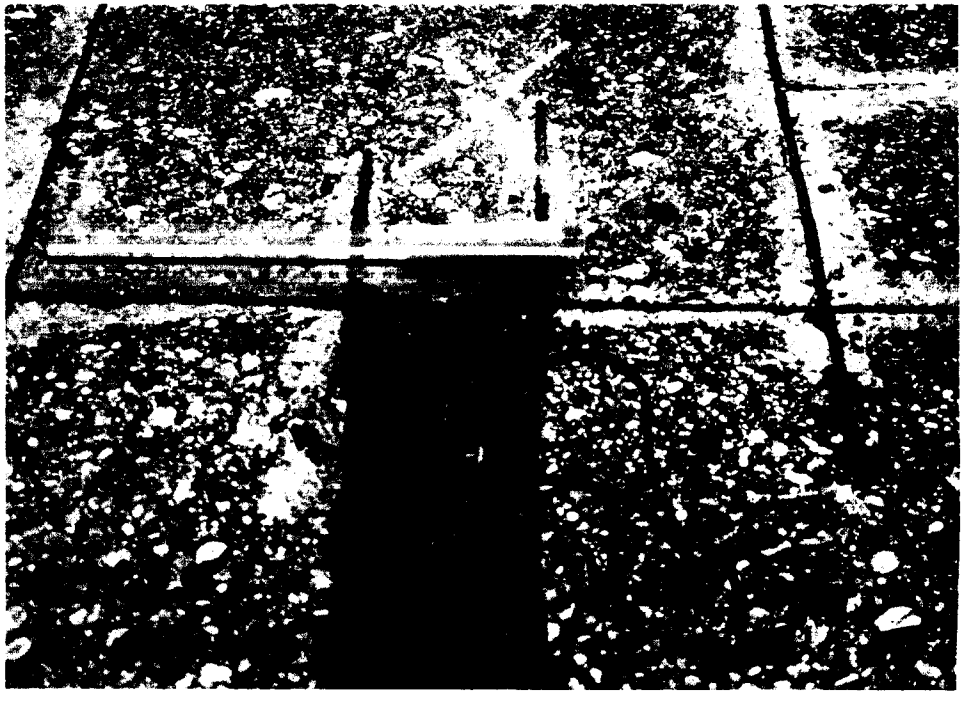
Offsets:	PE	OWP	ML	IWP	ILE	
(M)	0.16	0.76	1.83	2.90	3.51	(Assuming 12 foot lane,
(ft)	0.5	2.5	6.0	9.5	11.5	not from white stripe.)
	(nail)	(hole)	(hole)	(hole)	(nail)	

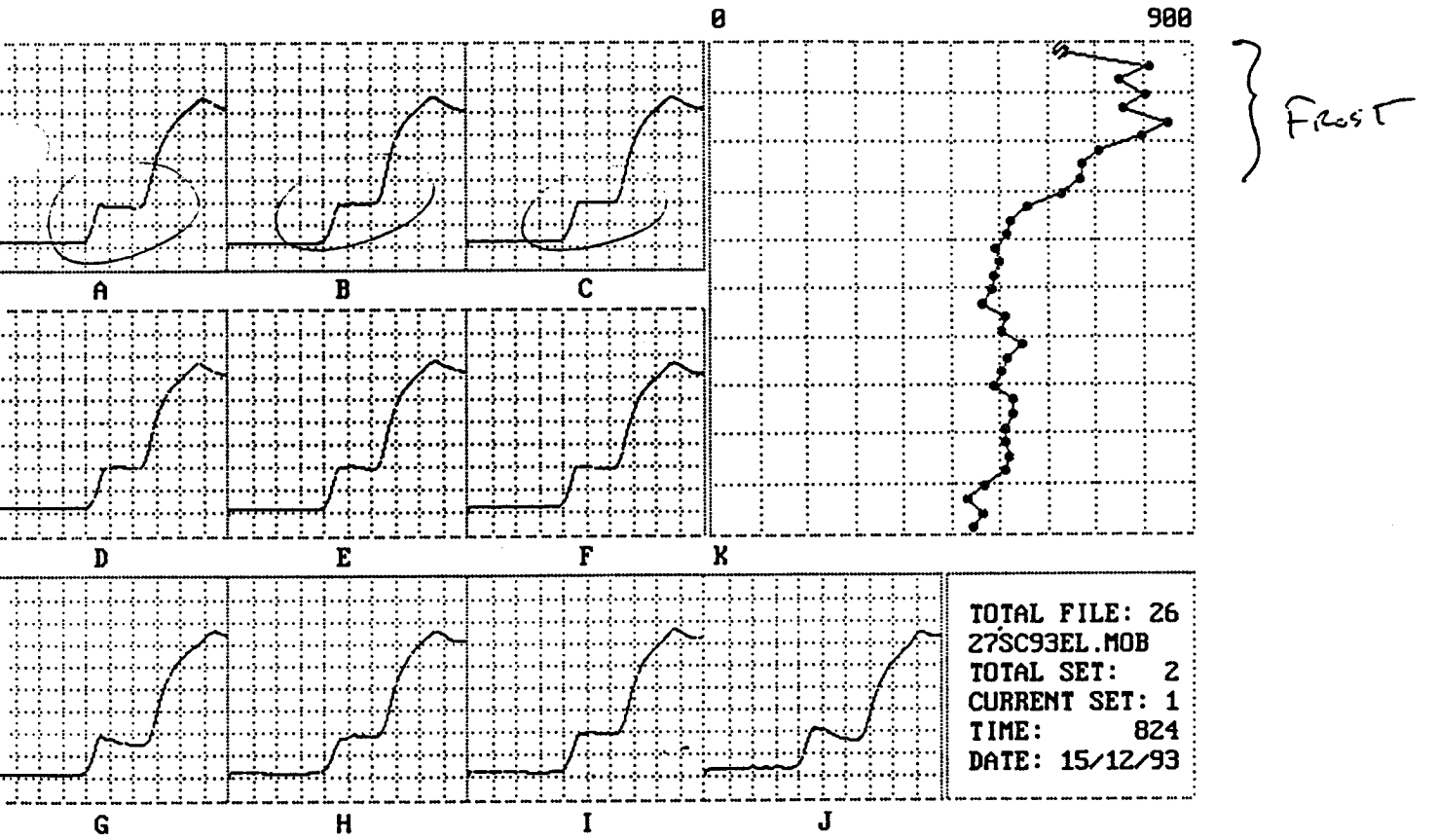
Sta: Transverse profiles every 25 feet from Sta 3+00 to Sta 5+00, and at Sta 5+10, 5+15, and 5+20.

COMMENTS
- Frank or Daryl on traffic control.
- Need to fill temperature hole about one inch.
- In 1996, may want to install nails according to current guide lines.

C-LINE #52584
35MM PRINT







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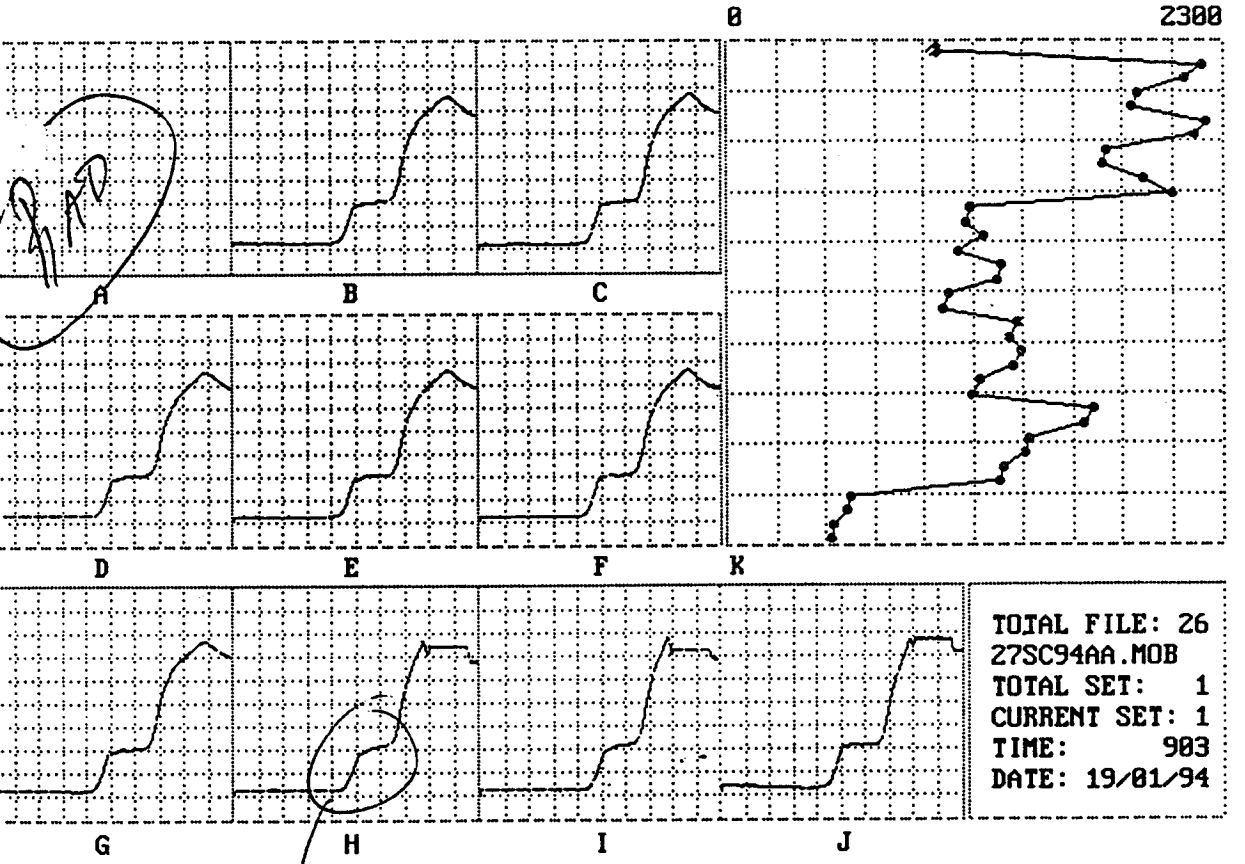
NO 2ND INFLECTION ON TDR PROBES IN FROZEN SAND ?



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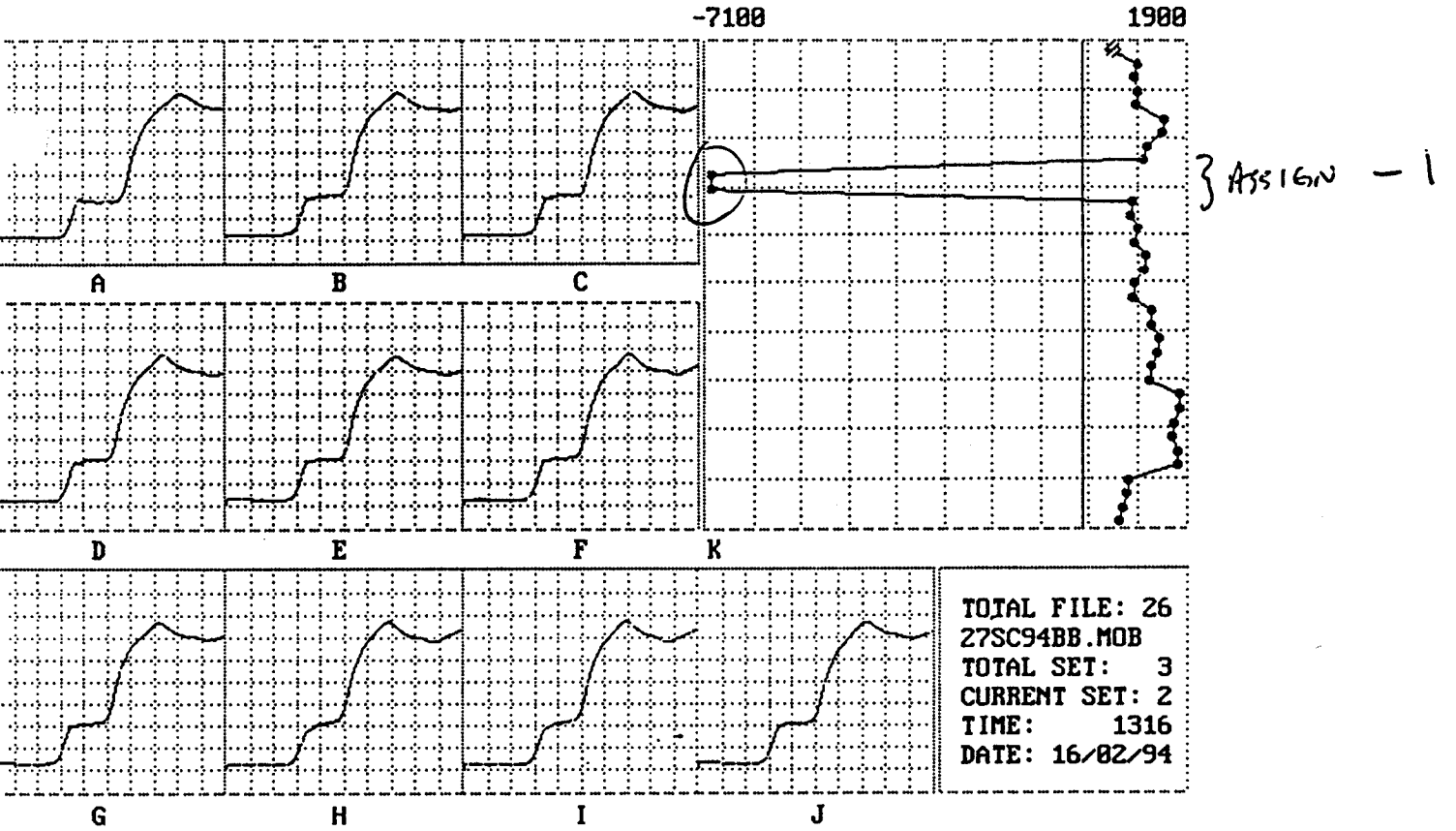
EXTREME CASE OF NO

2ND INFLECTION ON TDR TRACE

IN FROZEN SAND.



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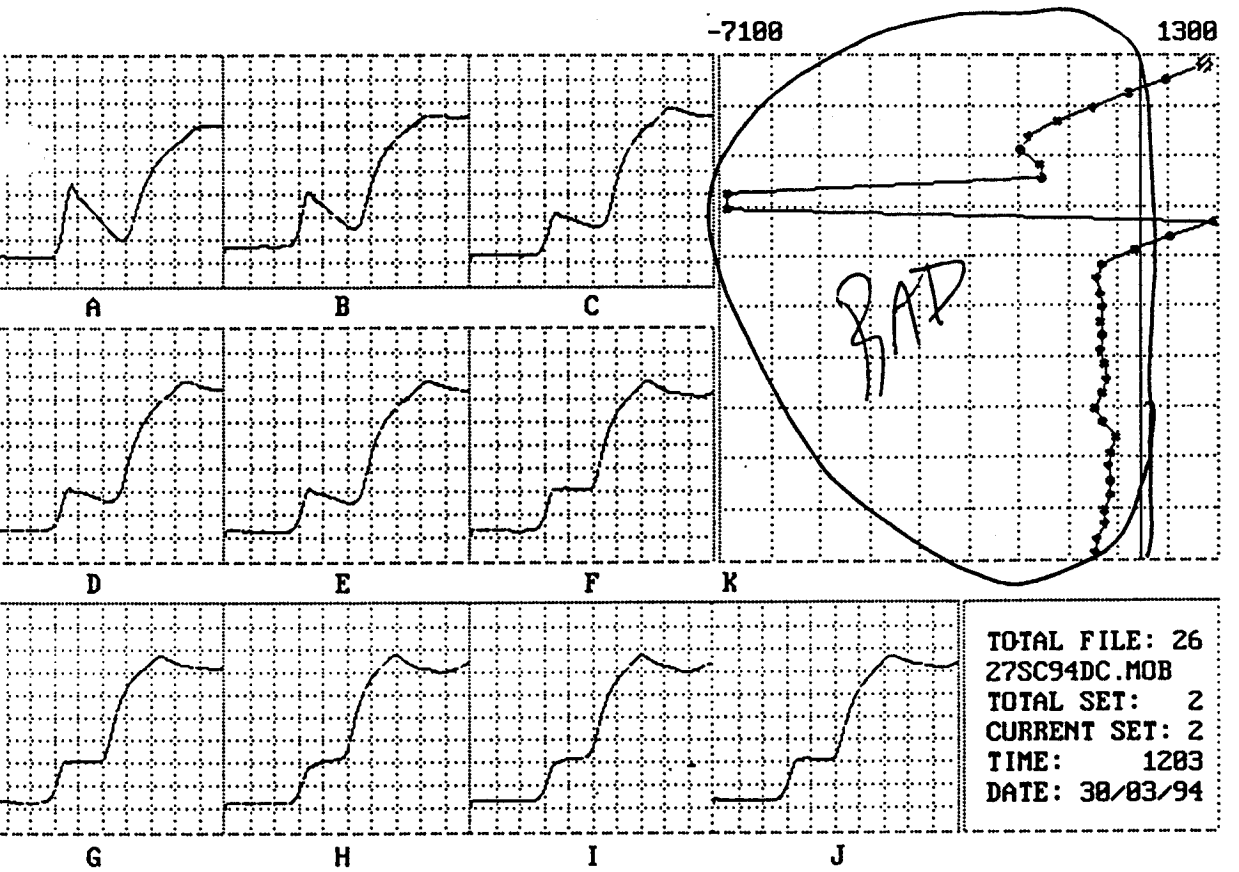
CREEL FAILURE ON 10/11 ELECTRODE



TOTAL FILE: 26
27SC94DC.MOB
TOTAL SET: 2
CURRENT SET: 2
TIME: 1203
DATE: 30/03/94

FHWA OR TAC ADVISE ?

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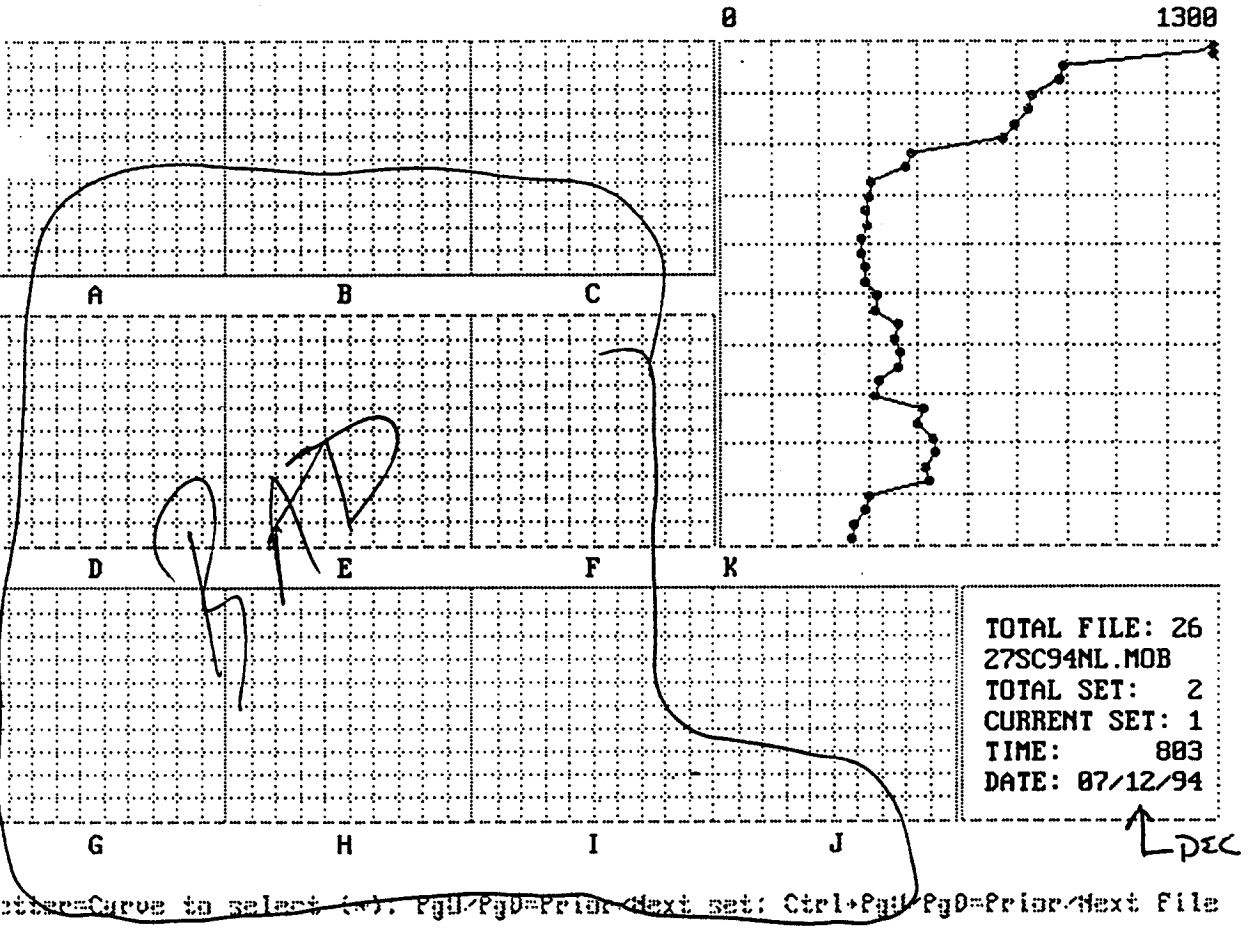
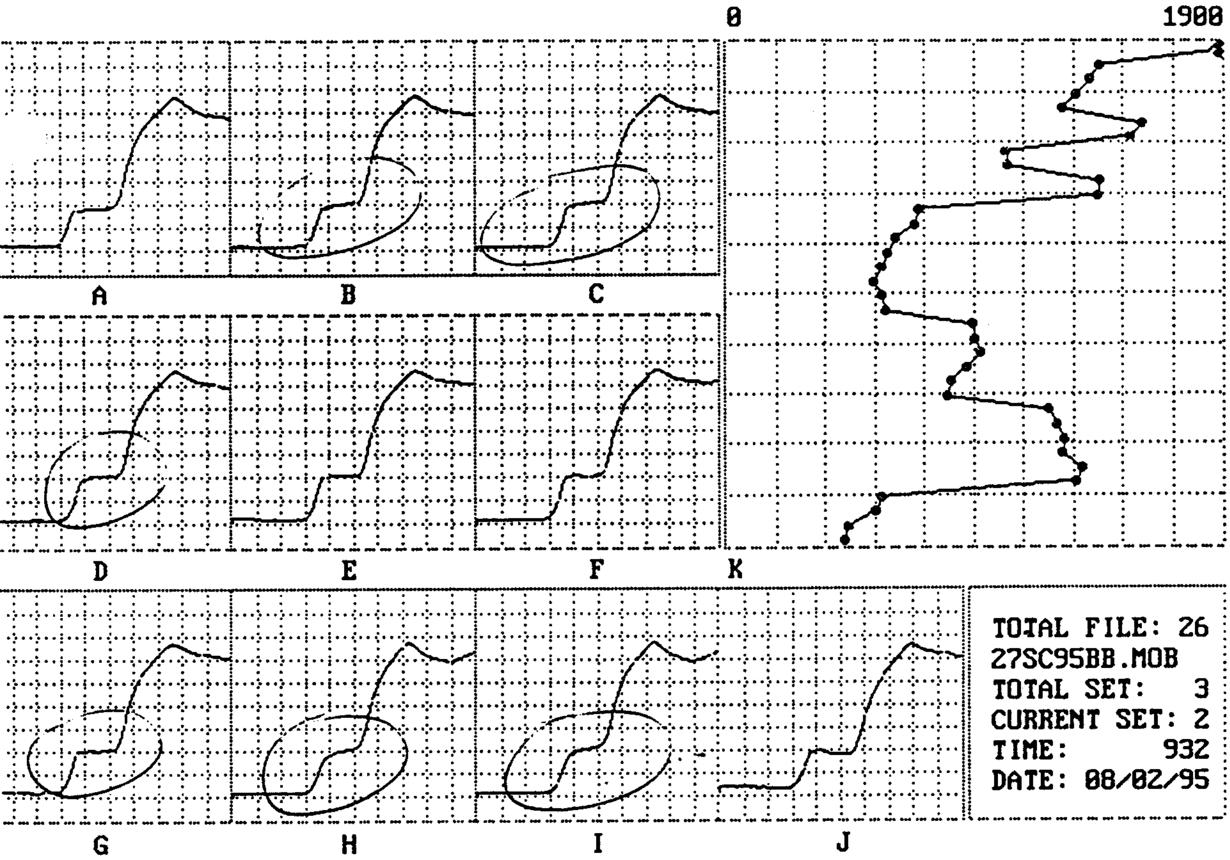
CRREL GOOD / BAD ?



ALL TDRs -6999 DATA

TOO COLD FOR CABLE READER



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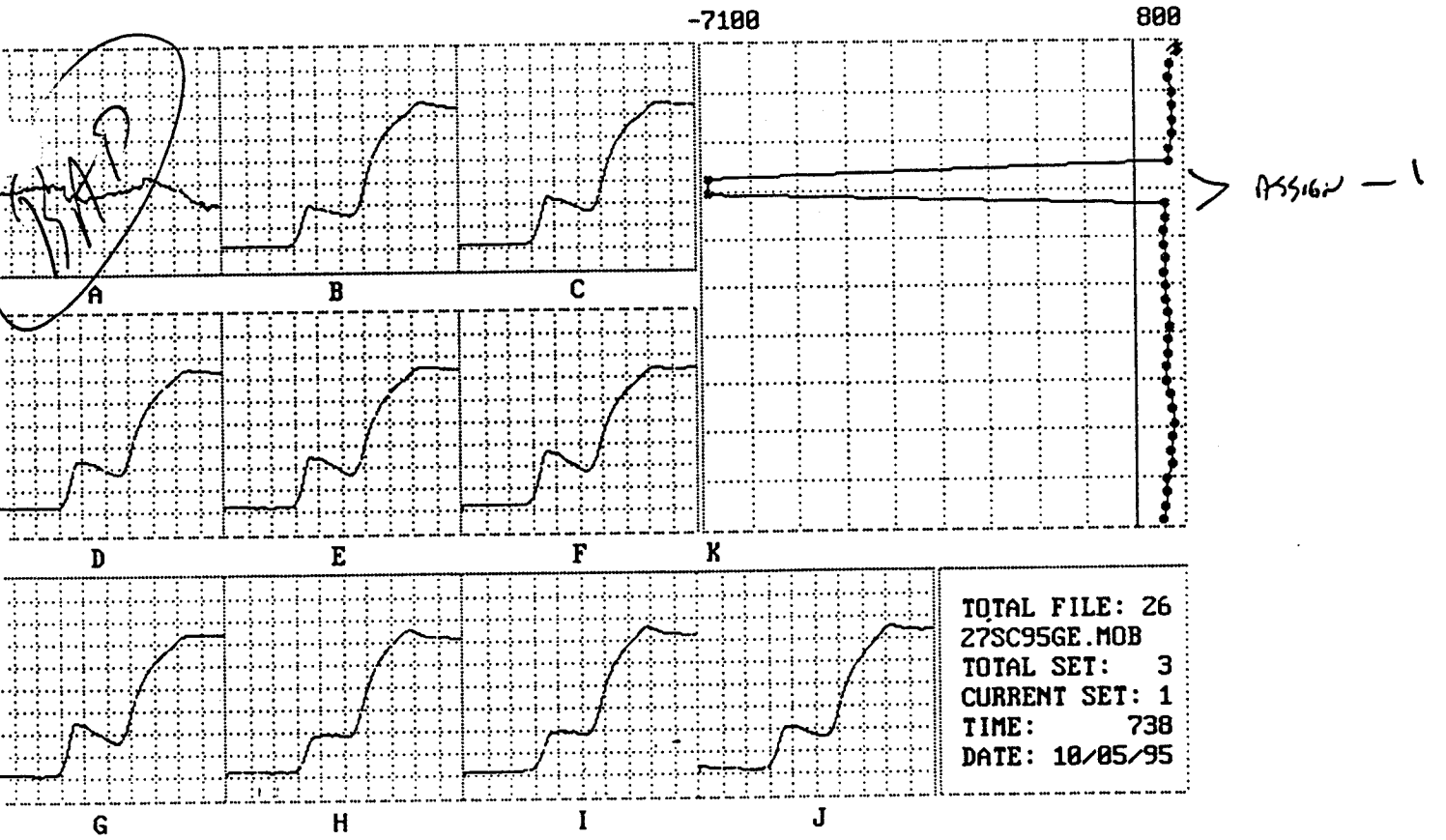
MULTIPLE TDRs WITHOUT TYPICAL 2ND INFLECTION FOR (+) to (−) SLOPE CHAGE.



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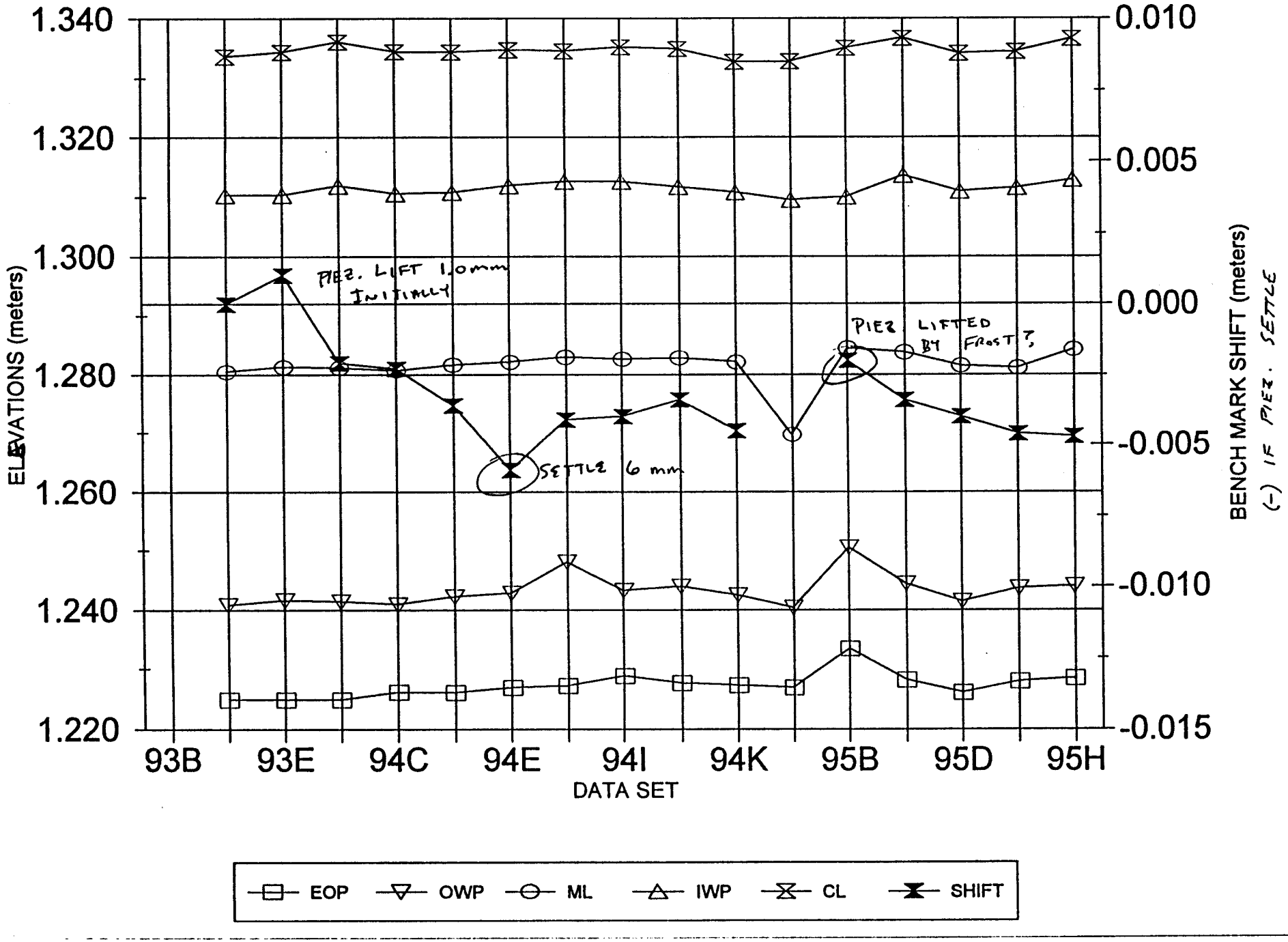
TDR #1 — VERTICAL GAIN PROBLEM

WITH NOISE

276251 (station 3+00)

SAND SUBGRADE