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State Route 138 -Test Site Evaluation

Update of Evaluation Activities in March and October 2002

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background and Scope

In 2001, Caltrans Maintenance selected a segment of State Route 138 in Los Angeles County to create test sections for the evaluation of pavement/tire noise measurements and performance of several maintenance treatments. In March 2001, the Caltrans Partnered Pavement Research Center (PRC) Contract Team (staff from University of California Pavement Research Center and Dynatest Consulting Inc.) collected and analyzed pavement data from the segment, and recommended test section locations that would provide the most uniform underlying pavement structures possible.(*1*) The objective of identifying uniform underlying pavement structures was to provide the most unbiased evaluation possible of the performance of the various treatments.

The data used to select the sections included:

- Visual surface condition survey to identify existing distresses,
- Deflection testing using a Falling Weight Deflectometer (FWD) and accompanying deflection analysis and back-calculation of stiffnesses,
- Coring to determine thicknesses and uniformity of pavement layers, and
- Dynamic Cone Penetrometer (DCP) testing to identify soil layer thicknesses and estimate stiffnesses.

Caltrans Maintenance took the recommendations in the first Technical Memorandum (*1*) from PRC, and developed a plan for six test sections within the original segment. In March 2002, Caltrans Maintenance performed some cold planing and had the entire segment overlaid with a layer of dense graded asphalt concrete (DGAC). The DGAC layer had a design thickness of 30 mm to provide a uniform surface for baseline sound pressure measurements on the test sections. The binder for the DGAC was AR-8000. The PRC performed additional measurements on the overlaid sections on March 28, 2002 for the same types of pavement data originally collected.

The maintenance treatments were placed on the sections on April 26 and 27, 2002. The locations of the various treatments and their thicknesses and types are shown in the construction plans included in Appendix A. The PRC returned to the sections on October 10, 2002 and repeated the data collection. This technical memorandum presents the results and analysis of the pavement performance related measurements made in March and October 2002.

It is planned that the PRC will continue to periodically monitor the performance of the test sections through collection and analysis of data of the types included in this and the previous technical memorandum (*1*).

1.2 Section Locations

The test section is located on California State Highway 138 between 230th Street W and 180th Street W, between the town of Gorman and city of Lancaster. The starting station for the project was 101+16.6, which corresponds to kilometer post 25.8 (mile post 16.0), and the ending station was 181+00, which corresponds to kilometer post 33.8 (mile post 21.0). The entire section length is approximately 7.98 kilometers. The pavement was divided into 6 sections corresponding to the locations of the test sections, as shown in Table 1.

Sections 2, 3 4 and 5 are the various alternatives being considered. Sections 1 and 6 are lead in and lead out sections for the noise measurements, and serve as control sections for comparison of the pavement performance.

Table 1 State Route 138 Sections (from FWD Analyses)

Section	Thickness and Treatment*	Length (m)	From Station	To Station
1	30 mm DGAC	683	101+16.6	108+00
2	75 mm OGAC	1200	108+00	120+00
3	30 mm OGAC	2800	120+00	148+00
4	30 mm RAC-O	2000	148+00	168+00
5	30 mm BWC	600	168+00	174+00
6	30 mm DGAC	700	174+00	181+00

*DGAC—dense graded asphalt concrete (Sections 1 and 6 have same material)
OGAC—open graded asphalt concrete
RAC-O—rubberized asphalt concrete (Type O [open gradation])
BWC—bituminous wearing course.

1.3 Types of Data Collected

Six types of data are being collected and analyzed for the evaluation of the test sections on Highway 138:

- Condition survey, to observe distresses at the pavement surface,
- Coring of the pavement, to determine thicknesses and examine the condition of the bound layers,
- Dynamic Cone Penetrometer (DCP) testing, including analysis of thickness and estimation of stiffness,
- Falling Weight Deflectometer (FWD) testing, including analysis of deflections and back-calculation of stiffnesses,
- Ride quality testing, as measured by the International Roughness Index (IRI), and
- Skid trailer testing, to evaluate the surface friction.

Ride quality and surface friction (skid trailer testing) were only collected in October 2002, and were collected by Caltrans.

2.0 RESULTS FROM MARCH AND OCTOBER, 2002

2.1 Condition Survey, March 2002, After Overlay

A detailed condition survey was not performed in March 2002 because the pavement had just been overlaid and was about to have the maintenance treatments applied, which left little time. The condition survey performed in April 2001 had shown severely distressed areas with fatigue cracking in the wheelpaths to the point of loose individual pieces, and some rutting of the underlying layers under the cracking.(*1*) The April 2001 condition survey also showed widespread transverse cracking caused by thermal shrinkage.

Photographs from March 2002 taken just after the overlay show that some of the distresses had already reflected up through the overlay (see Appendix B). In some of the photographs, the cracks are faintly visible in the overlay. In other areas, the areas of severe cracking to the point of loose pieces in the wheelpaths had caused the overlay to spall. The photographs also show some apparent segregation, which appears as longitudinal areas that have ravelled, and areas that appear to be over-asphalted.

Many of these problems were noted and some additional repairs were made by the contractor prior to placement of the maintenance treatments.

2.2 Condition Survey, October 2002, After Maintenance Treatments

A detailed condition survey was performed following the same procedure used in 2001:

- The entire segment was surveyed by walking and/or riding in the back of a truck moving at about 15 km/hr.
- Sections of uniform length of 100 m were evaluated and all distresses observed within each 100-m section were noted.

The results of the survey are summarized in Table 2. Photographs referenced in Table 2 from various locations in the test sections are included in Appendix D.

The photographs and condition survey results show that the cracks and surface problems observed in the leveling asphalt concrete overlay in March, 2002 are no longer visible on the surface. The results show some problems with low severity flushing and a few other local problems.

2.3 Coring Results from March 2002

During the testing in 2001, coring of the pavement was conducted in order to determine 1) materials in the pavement structure, 2) thickness of each material, and 3) a thickness profile of the entire section. Therefore, a relatively large number of cores were collected. The coring results from 2001 are presented in Figure 1.

Coring conducted on 28 March 2002 was predominantly to verify the leveling course overlay thickness for the various sections. Coring locations were selected so that the coring would not interfere with the acoustic measurements. Twelve cores were collected. Photographs of the cores are shown in Appendix C.

The coring results show total AC layer thickness including the original asphalt concrete and the leveling course. Leveling course thickness was not determined on these cores prior to their disposal, and it could not be determined from the photographs. Because of the tremendous variability in the thickness of the original asphalt layers, all that can be determined from these cores is that the total asphalt is typically thicker after the leveling course construction. The coring results are shown in Figure 2. Note that in Figure 2, CTB thicknesses were measured only at Stations 112+00 EB, 132+00 EB, 104+00 WB and 112+00 WB. Other cores did not show defined boundary between AC and CTB, or the core crumbled upon extraction.

Table 2 Summary of Condition Survey of October 2002

Section	Beginning Station	Eastbound Direction	Westbound Direction
Section 1	10116.6		Low Flushing
	10216.6		Low Flushing
	10316.6		Low Flushing
	10416.6		Low Flushing
	10516.6		Low Flushing
	10616.6		Low Flushing
	10716.6		Low Flushing
Section 2	10816.6	Pavement change	
	10916.6		
	11016.6	Core Pic	
	11116.6		
	11216.6	Cores EB+C401&2, Bald Spot on road surface (small)	
	11316.6		Blade Scrape
	11416.6		Low Flushing
	11516.6		Low Flushing
	11616.6		Low Flushing
	11716.6		Low Flushing
	11816.6		Low Flushing
	11916.6	Low Flushing	Low Flushing
Section 3	12016.6		Low Flushing
	12116.6		Low Flushing
	12216.6		Low Flushing
	12316.6		Medium Flushing
	12416.6	Pavement Change (Low ravel)	
	12516.6		
	12616.6		
	12716.6		
	12816.6		Low Flushing; Picture
	12916.6		
	13016.6	Spill Centerline (epoxy?)	Low Flushing
	13116.6		Low Flushing
	13216.6	Cores EB 1&2	Core WB 1
	13316.6		
	13416.6		
	13516.6		
	13616.6		
	13716.6		Low Flushing
	13816.6		Low Flushing
	13916.6		Low Flushing
	14016.6		Low Flushing
	14116.6		Low Flushing

Section	Beginning Station	Eastbound Direction	Westbound Direction
	14216.6		Low Flushing
	14316.6		Low Flushing
	14416.6		Low Flushing
	14516.6	Low Flushing	Low Flushing
	14616.6	Low Flushing	Low Flushing
	14716.6	Low Flushing	Low Flushing
Section 4	14816.6	Low flushing; Dirty Patch (small)	Low Flushing
	14916.6	Low Flushing	Low Flushing
	15016.6	Low Raveling (small)	
	15116.6		
	15216.6	Cores EB 1&2	Core WB 1
	15316.6		
	15416.6		
	15516.6		
	15616.6		
	15716.6		
	15816.6		
	15916.6		
	16016.6		
	16116.6		Low Flushing
	16216.6		
	16316.6		
	16416.6		
	16516.6		
	16616.6	Noticeable AC increase in mix	
	16716.6		
Section 5	16816.6		
	16916.6		
	17016.6		
	17116.6	Rough texture (cooling during placement?)	
	17216.6	Cores EB 1&2	Core WB 1
	17316.6		
Section 6	17416.6	Pavement Change	Severe Flushing
	17516.6		
	17616.6	Old Core (patched)	
	17716.6		
	17816.6		
	17916.6		
	18016.6		

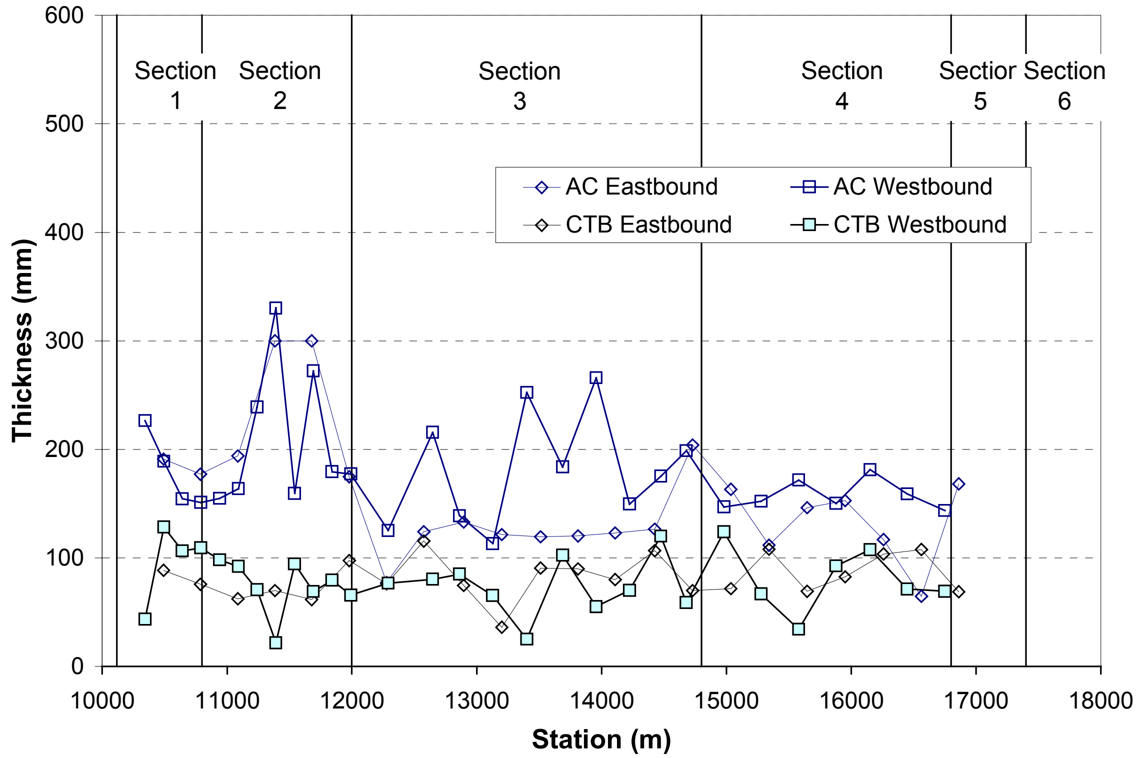

Figure 1. Coring profile for State Route 138 (April 2001).

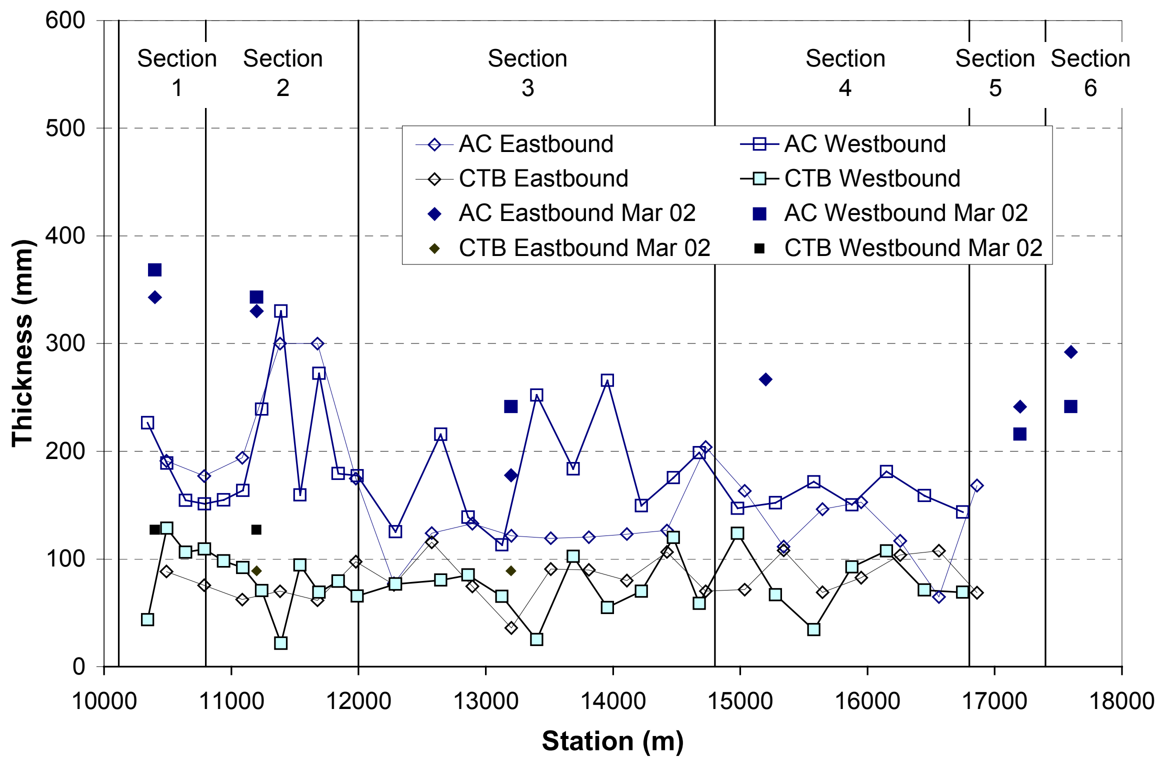

Figure 2. Coring profile for State Route 138 (April 2001 and March 2002 combined).

2.4 Coring Results from October 2002

In October 2002, 11 cores were taken in the eastbound lane and 6 in the westbound lane. The total thickness of the asphalt concrete layers is shown in Figure 3, along with the total asphalt thickness from April 2001 and March 2002. The measured thicknesses of the leveling course from these cores is shown in Figure 4; the measured thicknesses of the treatments are shown in Figure 5. The results show that in addition to the highly variable thickness of the original asphalt concrete, the combined thickness of the leveling course and maintenance treatment is highly variable as well.

Photographs of the cores taken in October 2002 are shown in Appendix E. In addition to the variable thickness of the original asphalt concrete, the cores show that the leveling course had some variability in thickness and that the treatments were constructed at the design thickness or slightly thicker. All of the cores taken over the past year show that there is a pavement reinforcing fabric in some of the cores, approximately 150 mm below the surface of the original asphalt concrete. This fabric has typically broken the bond of the asphalt concrete layers between which it was laid.

Detailed coring results are summarized in Tables 3 and 4 from March and October 2002, respectively.

2.5 Dynamic Cone Penetrometer (DCP) Testing

After the cores were removed from the core holes, DCP tests were performed on the underlying materials through the core holes. The subgrade soil layer was divided into two layers to coincide with the DCP analysis conducted in 2001. Layer 1 under the AC is assumed to be the material directly beneath the bottom of the AC layer to a depth of 0.5 m below the AC surface.

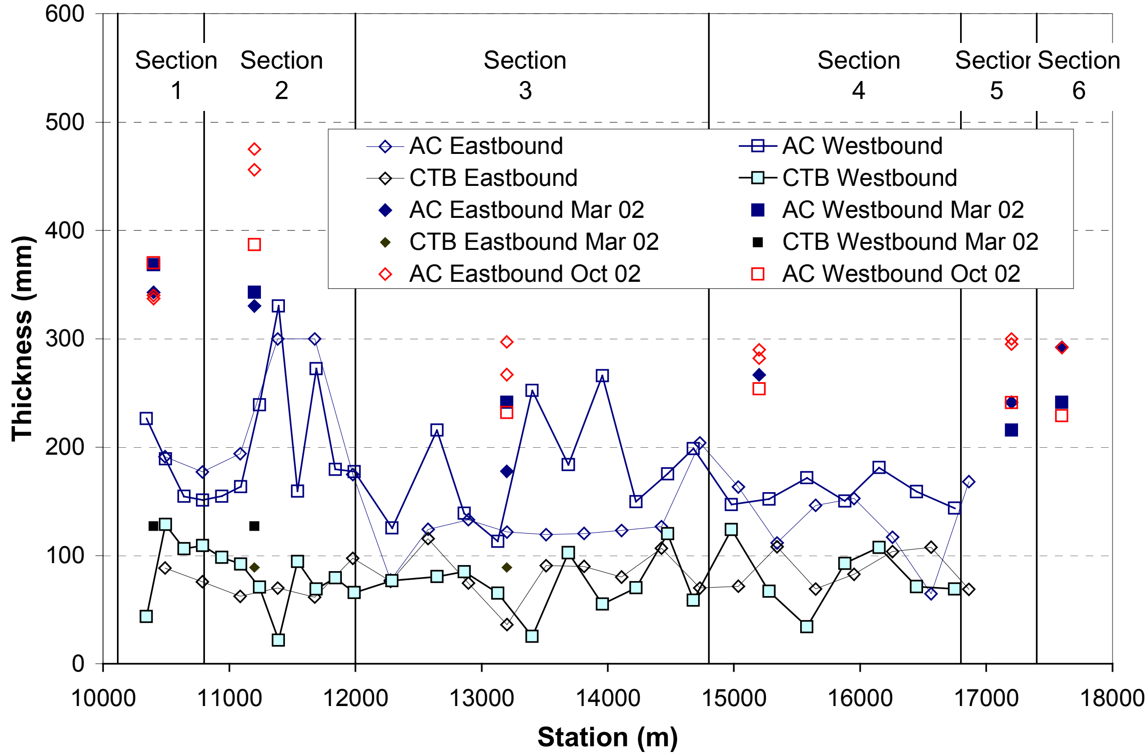

Figure 3. Coring profile for State Route 138 (March 2001, March 2002, and October, 2002 combined).

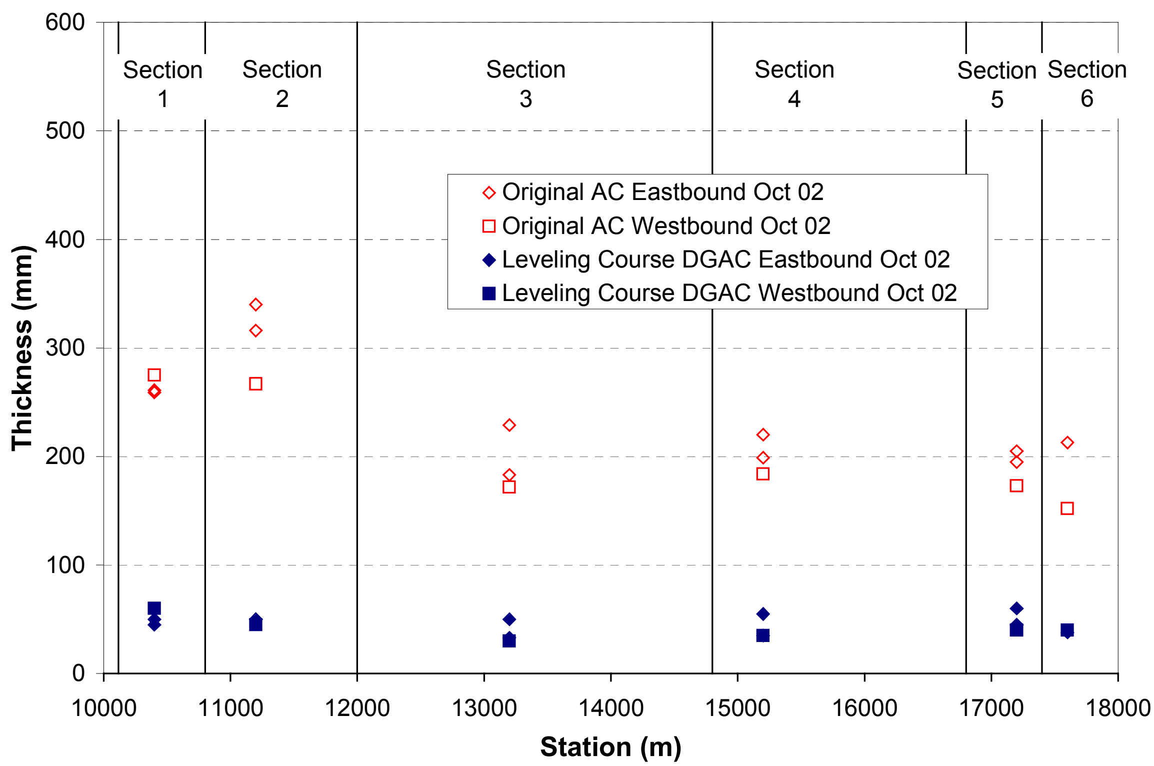

Figure 4. Thicknesses of asphalt concrete leveling course from October 2002 cores.

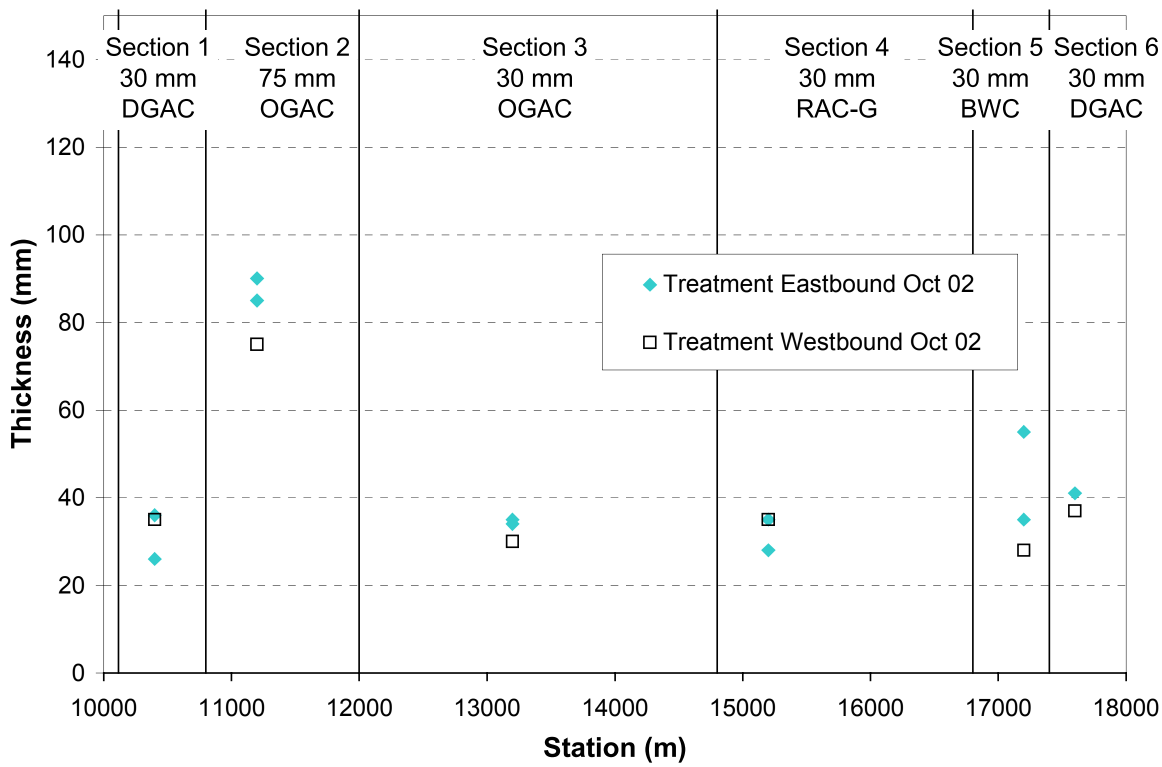

Figure 5. Thicknesses of treatments from October 2002 cores.

Table 3 Core Data from March 2002

Core	Direction	Actual Station (m)	Asphalt Concrete Thickness (mm)	Base, CTB Thickness (mm)
1	EB	10400	343	
2	EB	11200	330	89
3	EB	13200	178	89
7	EB	15200	267	
8	EB	17200	241	
9	EB	17600	292	
6	WB	10400	368	127
5	WB	11200	343	127
4	WB	13200	241	
11	WB	17200	216	
10	WB	17600	241	

Table 4 Core Data from October 2002

Core	Direction	Actual Station (m)	Total Thickness (mm)	Treatment Thickness (mm)	Leveling Course Thickness (mm)	Original AC Thickness (mm)
104+00 EB1	EB*	10400	340	36	45	259
104+00 EB2	EB	10400	337	26	50	261
112+00 EB1	EB	11200	456	90	50	316
112+00 EB2	EB	11200	475	85	50	340
132+00 EB1	EB	13200	267	34	50	183
132+00 EB2	EB	13200	297	35	33	229
152+00 EB1	EB	15200	282	28	55	199
152+00 EB2	EB	15200	290	35	35	220
172+00 EB1	EB	17200	295	55	45	195
172+00 EB2	EB	17200	300	35	60	205
176+00 EB2	EB	17600	292	41	38	213
104+00 WB2	WB	10400	370	35	60	275
112+00 WB2	WB	11200	387	75	45	267
132+00 WB2	WB	13200	232	30	30	172
152+00 WB2	WB	15200	254	35	35	184
172+00 WB2	WB	17200	241	28	40	173
176+00 WB2	WB	17600	229	37	40	152

* leveling course thickness was assumed to match design thickness, or is taken from adjacent core

Layer 2 ranges from 0.5 to 0.9 m below the surface of the pavement. Because of the variable asphalt concrete thickness the actual thickness of Layer 1 varies.

The DN (DCP number, or mm/blow) values are shown in Figures 6 and 7. The DN values are similar between March 2002 and April 2001, which is the end of the wet season at the project location. The DN values in Layer 2 from March, 2002 are somewhat less than those of April 2001, which is likely due to the smaller amount of rainfall in the spring of 2002. The DN values are lower (fewer mm/blow) in October, 2002 at the end of the dry season, which seems reasonable.

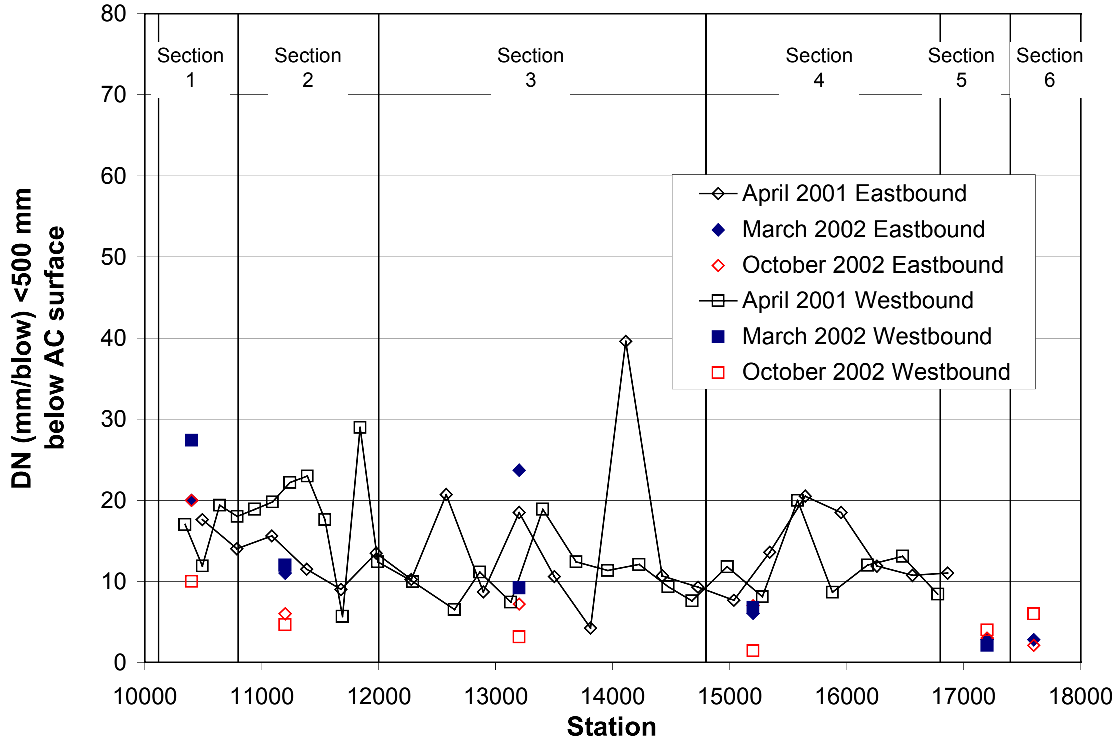

Figure 6. Layer 1 plot of DN versus station (all data from 2001 and 2002).

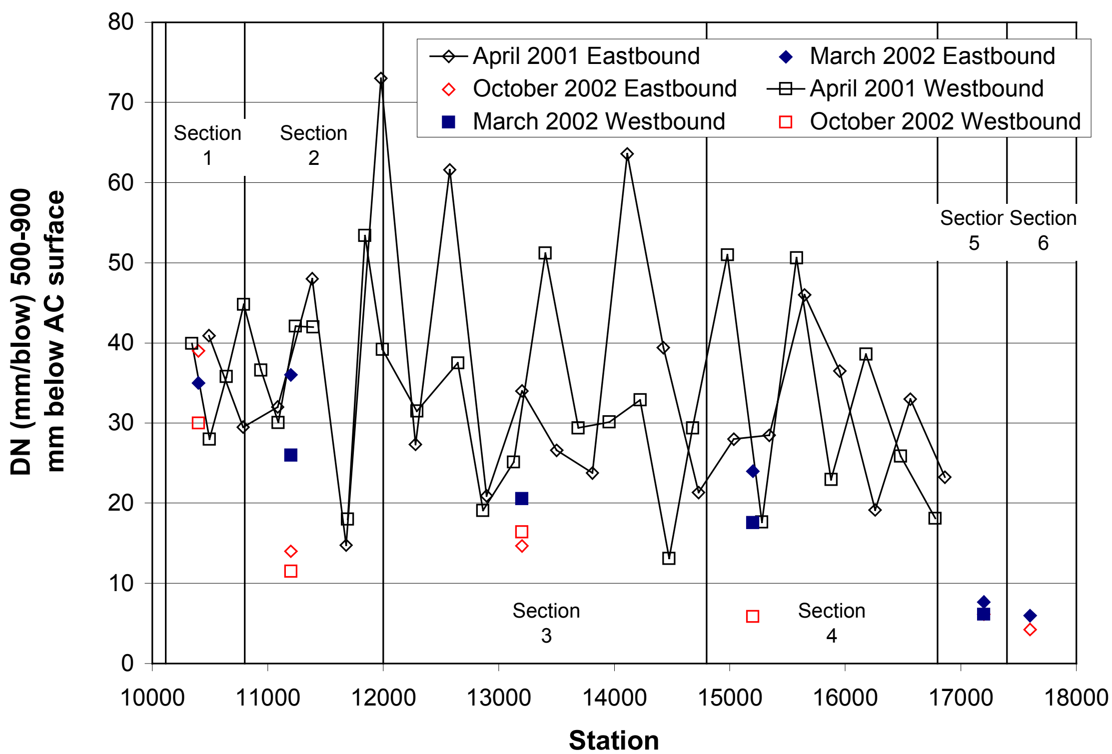

Figure 7. Layer 2 plot of DN versus station (all data from 2001 and 2002.)

Average DN values and stiffnesses are summarized in Tables 5 and 6, respectively.

Table 5 Comparison of Average DN Values

Lane	**Layer**	**DN Value (mm/blow)**		
		April 2001	**March 2002**	**October 2002**
EB	< 500 500 – 900	14 35	11 22	8 16
WB	< 500 500 - 900	14 33	11 18	5 16

Table 6 Comparison of Average E_{eff} Values

Lane	Layer	E_{eff} Values (MPa)		
		April 2001	March 2002	October 2002
EB	< 500 500 – 900	88 34	179 77	265 133
WB	< 500 500 – 900	87 36	175 74	365 137

The stiffnesses of the two unbound layers were estimated from the DCP data using the equation developed by CSIR:

$$\log(E_{eff}) = 3.04758 - 1.06166 \times \log(DN)$$

where E_{eff} is the estimated stiffness in MPa.

Estimated stiffnesses are shown plotted in Figures 8 and 9 for Layer 1 and Layer 2, respectively.

2.6 Falling Weight Deflectometer (FWD) Testing

The Dynatest Model 8081 Heavy Weight Deflectometer (HWD) test system was used to generate the requisite non-destructive testing (NDT) load-deflection data analyzed for this report.

Figures 10, 11, and 12 show normalized center deflections for April 2001, March 2002, and October 2000, respectively. The section length tested in 2001 differs from the section length

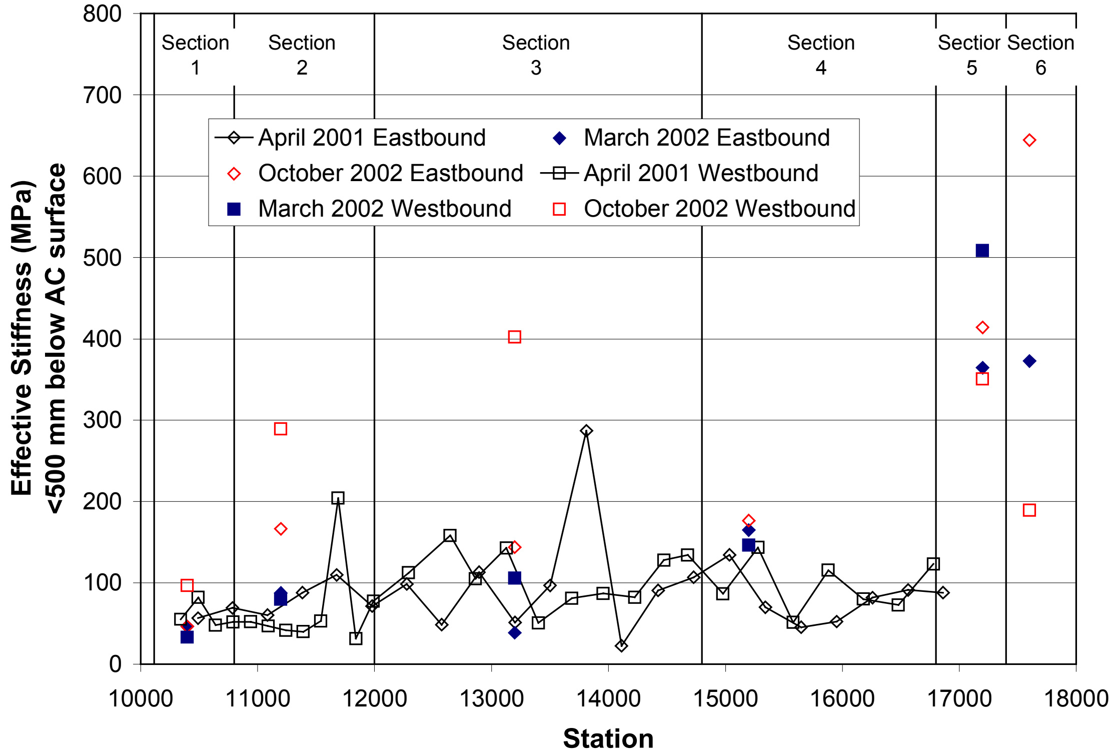

Figure 8. Layer 1 estimated stiffnesses from DCP data (all data from 2001 and 2002).

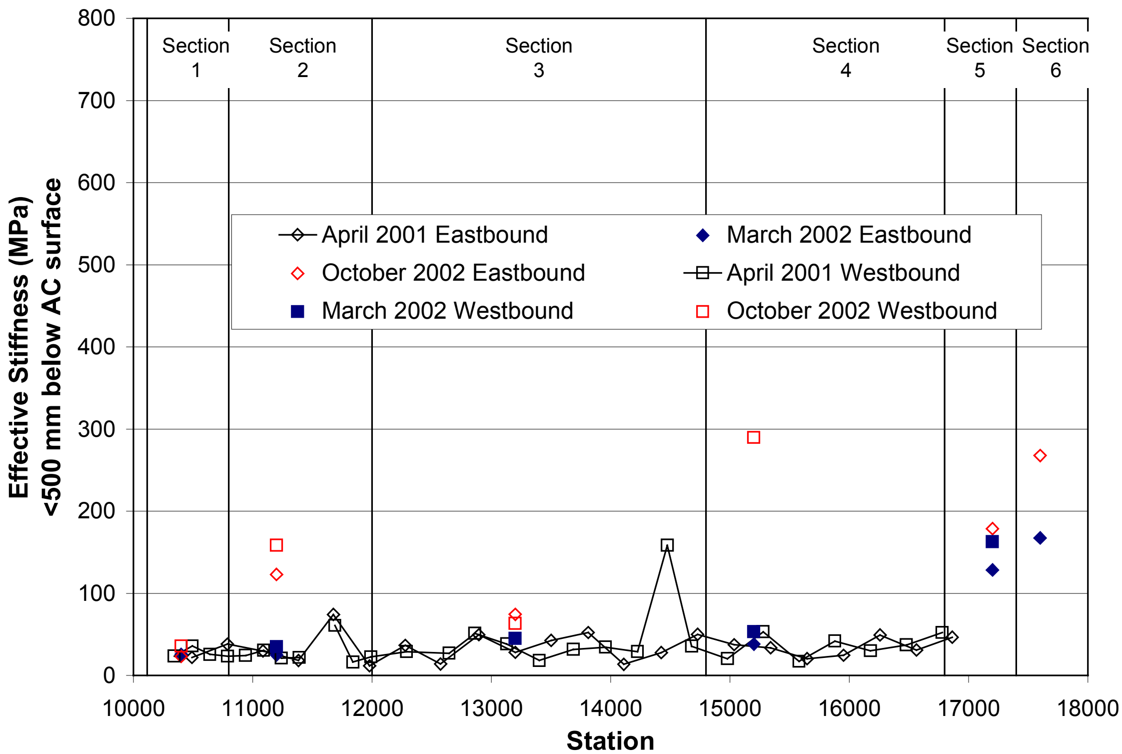

Figure 9. Layer 2 estimated stiffnesses from DCP data (all data from 2001 and 2002).

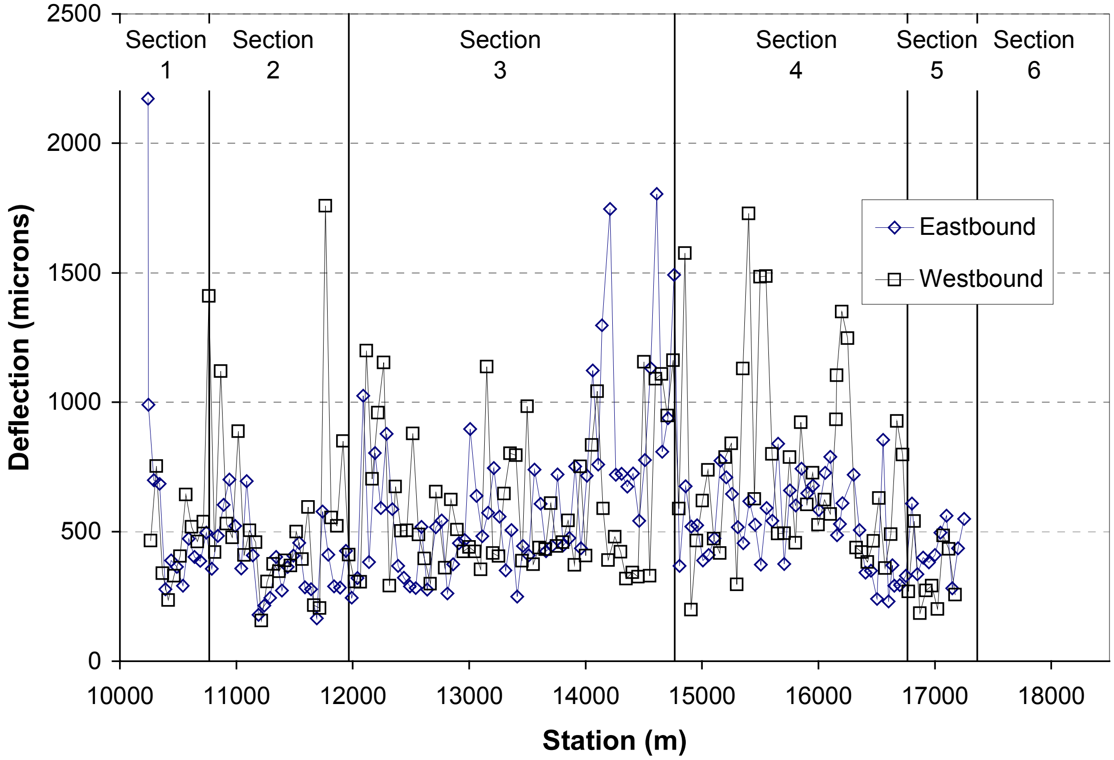

Figure 10. Center deflection, D_0, at 40 kN for eastbound and westbound lanes.

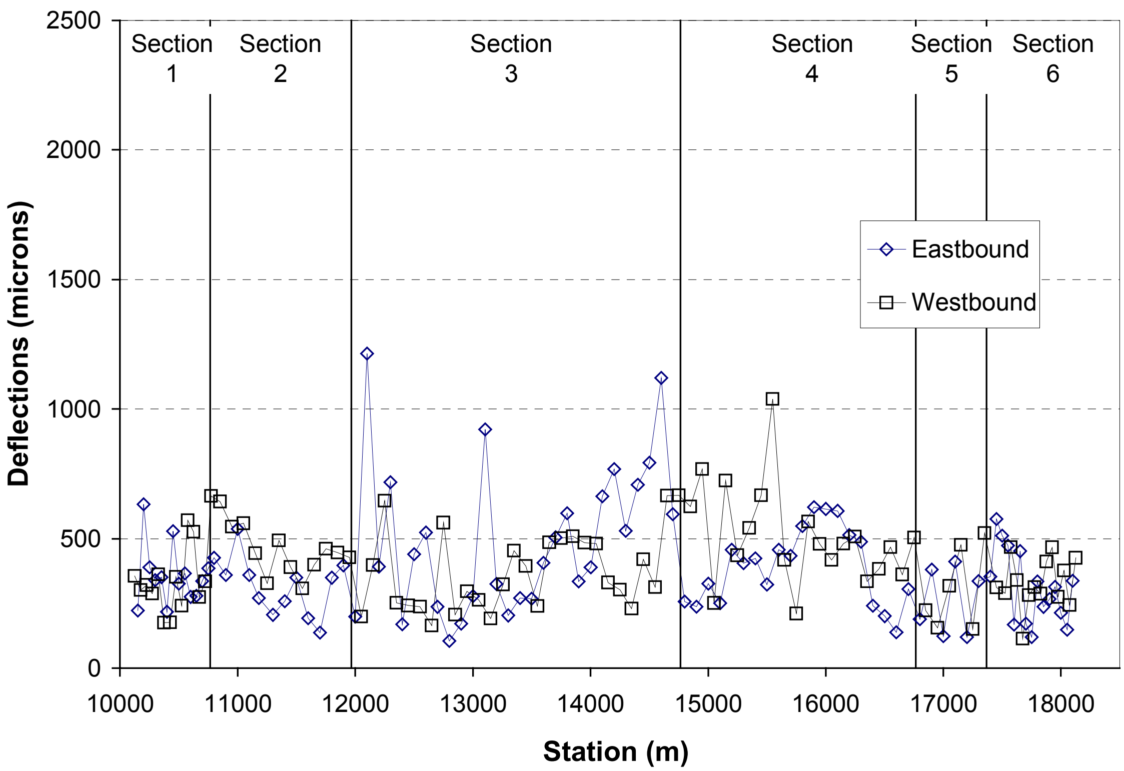

Figure 11. Center deflection, D_0, at 40 kN for east and westbound lanes.

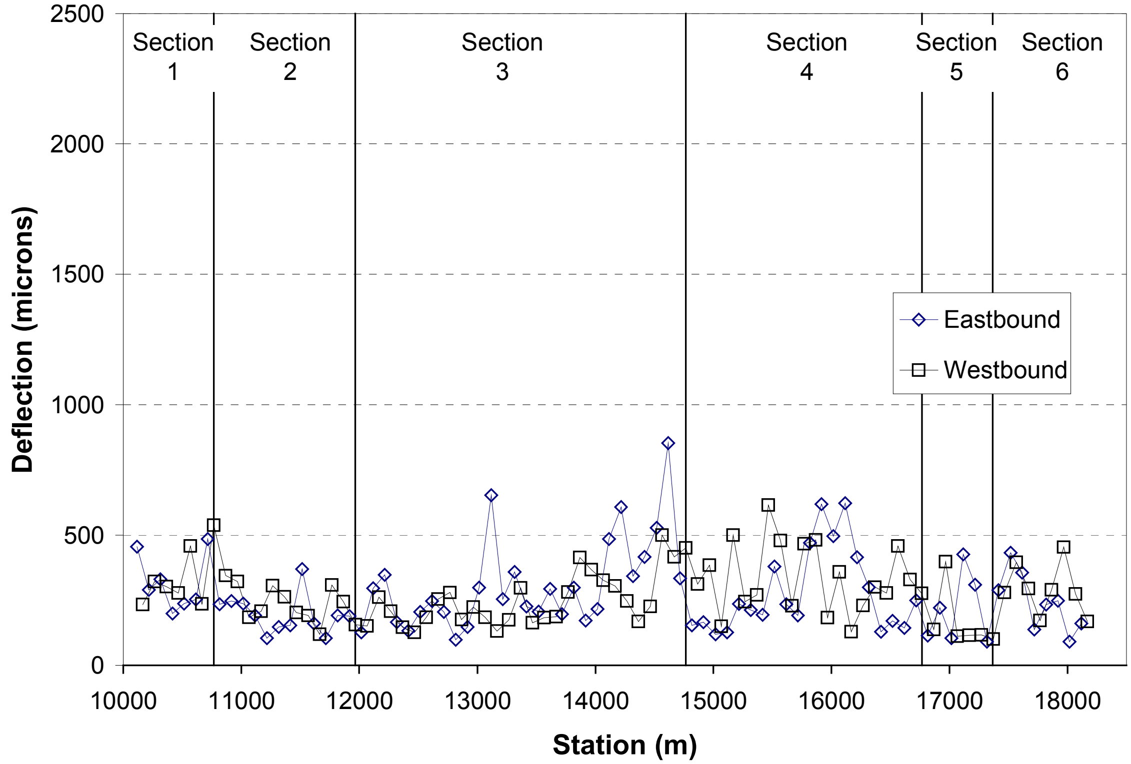

Figure 12. Center deflection, D_0, at 40 kN for east- and westbound lanes.

tested in 2002. The testing interval in 2002 was increased to 100 m for sections 2, 3, 4 and 5. An interval of 50 m was used on sections 1 and 6.

The measured deflections during 2002 are generally lower than those measured in 2001, as would be expected. Table 7 shows a comparison of the normalized center deflections for 2001 and 2002. Section 6 was not tested in 2001. Section 1 shows the most improvement, which is probably due to the significant difference between the AC overlay thicknesses of 2002. Variability in the deflections is generally similar or slightly less in 2002 than the variability in 2001, which is consistent with the placement of a thin overlay. The change in testing interval length may have had an effect on variability.

Table 7 Comparison of Normalized Center Deflections at 40 kN

Section	Lane	April 2001				March 2002				October 2002			
		Average (μ)	Std Dev. (μ)	COV (%)	84th %ile (μ)	Average (μ)	Std Dev. (μ)	COV (%)	84th %ile (μ)	Average (μ)	Std Dev. (μ)	COV (%)	84th %ile (μ)
1	EB	614	509	83	1123	362	112	31	475	321	110	34	431
	WB	554	319	58	873	353	143	41	496	338	116	34	454
2	EB	386	152	39	538	301	112	37	413	194	73	37	267
	WB	532	340	64	872	453	96	21	550	237	73	31	310
3	EB	657	343	52	1000	496	286	58	782	311	176	57	487
	WB	607	283	47	890	373	151	40	525	251	102	40	353
4	EB	534	168	31	703	389	151	39	540	281	162	58	444
	WB	738	380	51	1118	509	190	37	699	334	131	39	464
5	EB	446	106	24	552	288	131	45	418	211	135	64	346
	WB	333	134	40	467	308	161	52	468	163	116	71	279
6	EB	NA	NA	NA	NA	309	146	47	454	243	114	47	358
	WB	NA	NA	NA	NA	329	96	29	424	291	97	34	388

For the analysis of the 2002 data, certain assumptions were made in order to be consistent with the 2001 analysis. These assumptions are: 1) the asphalt concrete (AC) layer was combined with the cement treated base (CTB) layer due to the similar stiffness of the materials, and 2) a surfacing thickness (AC +CTB) of 300 mm was assumed for the 2001 analysis because of the wide variation in thickness shown in the coring data. For the 2002 analysis, an overlay thickness of 75 mm was added to the pavement thickness for sections 1 and 6, and an overlay thickness of 30 mm was added to sections 2, 3, 4 and 5. Figures 13, 14 and 15 show the moduli plots for 2001 and 2002 analyses, respectively. E1 in Figures 13 to 15 refers to the stiffness of the bound layers (all AC layers + CTB) and E2 refers to the stiffness of the soil beneath the unbound layers.

Table 8 shows a comparison between the backcalculated surface moduli of 2001 and 2002. No values are available for the 2001 analysis of Section 6. All of the sections except

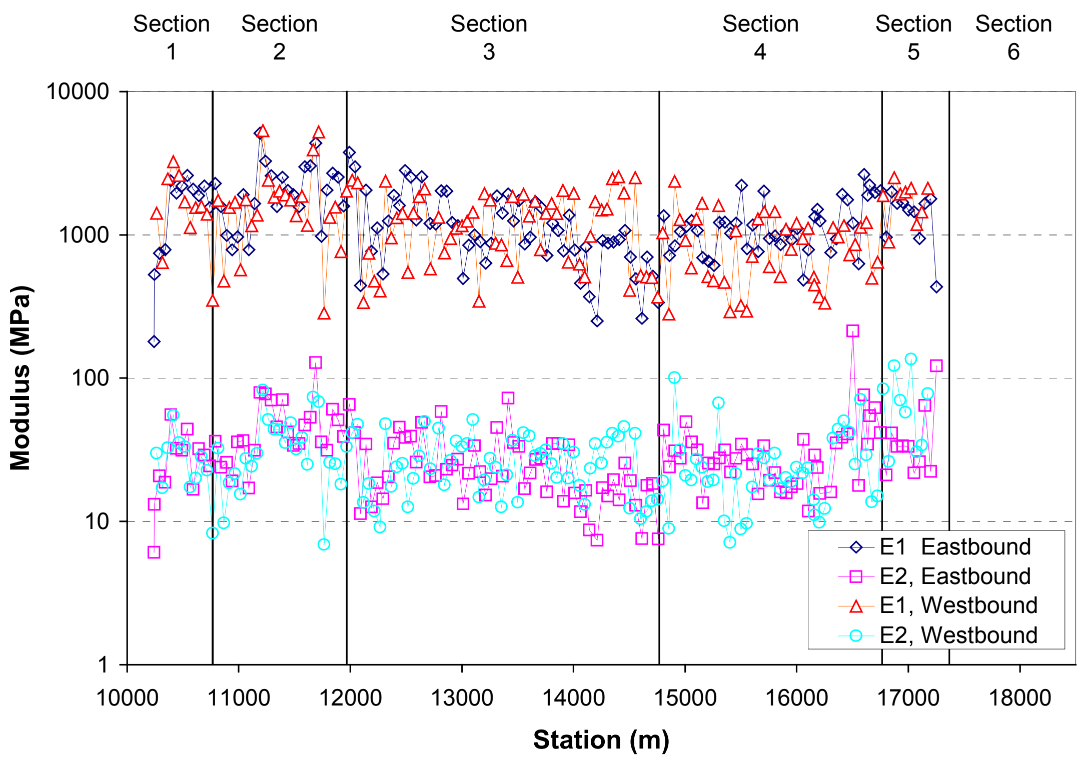

Figure 13. Backcalculated layer moduli for east- and westbound lanes, April 2001.

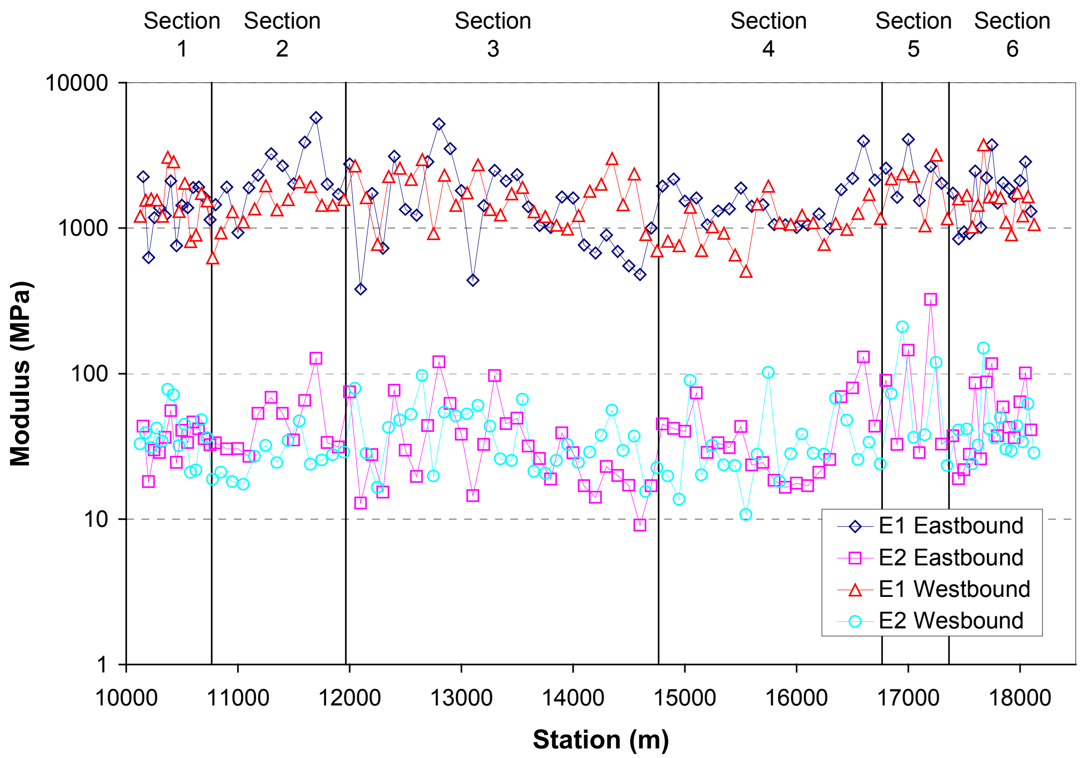

Figure 14. Backcalculated layer moduli for east- and westbound lanes, March 2002.

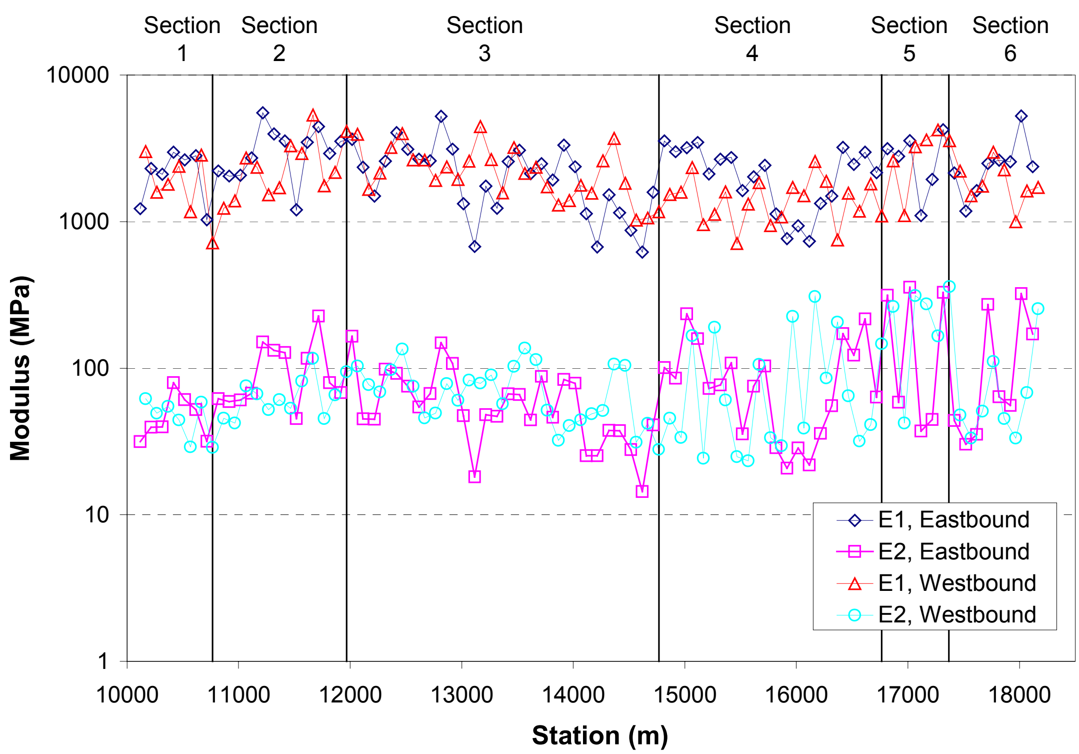

Figure 15 Backcalculated layer moduli for east- and westbound lanes, October 2002.

Table 8 Comparison of Surface Moduli

Section	Lane	April 2001				March 2002				October 2002			
		Average (MPa)	Std Dev. (MPa)	COV (%)	84^{th} %ile (MPa)	Average (MPa)	Std Dev. (MPa)	COV (%)	84th %ile (MPa)	Average (MPa)	Std Dev. (MPa)	COV (%)	84th %ile (MPa)
1	EB	1640	802	49	838	1457	493	34	964	2159	766	35	1393
	WB	1641	851	52	790	1571	703	45	868	1931	855	44	1076
2	EB	2219	1128	51	1091	2484	1297	52	1187	3141	1196	38	1945
	WB	1875	1272	68	603	1501	347	23	1154	2547	1234	48	1313
3	EB	1166	648	56	518	1617	1208	75	409	2190	1117	51	1072
	WB	1262	667	53	595	1728	687	40	1040	2304	927	40	1377
4	EB	1225	520	42	705	1616	691	43	925	2202	916	42	1286
	WB	913	482	53	431	1080	357	33	724	1454	496	34	958
5	EB	1406	478	34	927	2425	938	39	1487	2800	1131	40	1668
	WB	1768	544	31	1224	2033	806	40	1227	3059	1097	36	1963
6	EB	NA	NA	NA	NA	1818	807	44	1010	2533	1206	48	1326
	WB	NA	NA	NA	NA	1574	689	44	885	1878	596	32	1282

Table 9 Comparison of Subgrade Moduli

Section	Lane	April 2001				March 2002				October 2002			
		Average (MPa)	Std Dev. (MPa)	COV (%)	84th %ile (MPa)	Average (MPa)	Std Dev. (MPa)	COV (%)	84th %ile (MPa)	Average (MPa)	Std Dev. (MPa)	COV (%)	84th %ile (MPa)
1	EB	28	13	46	14	36	10	28	26	48	18	37	30
	WB	27	12	44	15	39	17	44	22	47	13	29	33
2	EB	48	25	52	23	49	29	59	20	100	53	53	47
	WB	35	19	54	15	27	8	30	19	67	22	33	44
3	EB	25	13	52	11	36	30	83	7	62	36	58	26
	WB	27	12	44	15	40	20	50	20	73	31	43	42
4	EB	34	32	94	3	41	28	68	13	91	63	69	28
	WB	27	21	78	7	35	24	69	11	94	84	89	11
5	EB	42	31	74	11	109	115	106	-6	190	158	83	32
	WB	69	42	61	28	83	71	86	12	237	115	49	122
6	EB	NA	NA	NA	NA	54	31	57	23	124	117	94	8
	WB	NA	NA	NA	NA	46	31	67	15	80	74	93	6

Section 1 and Section 2 westbound show an increase in average surface modulus over that calculated from the 2001 data. This is expected due to the inclusion of the overlay material in the calculation, although the effect should be relatively small, especially for those sections with only 30 mm of overlay. Lower temperatures at the time of testing in 2002 may also explain the increase in surface moduli. The pavement surface temperature ranges for deflection testing were 26 to 47 °C in April 2001; 23 to 50 °C in March 2002, and 29 to 39 °C in October 2002. A temperature correction factor for back-calculated stiffnesses has not been established. Variability of the calculated moduli is generally similar for 2001 and 2002.

A comparison between backcalculated subgrade moduli from 2001 and 2002 is shown in Table 9. Overall, the subgrade modulus shows a slight improvement. This is probably due to lower rainfall during the 2001/2002 winter than the previous winter (2000/2001), but may be related to stress sensitivity in the subgrade. Section 5 shows relatively high averages for both eastbound and westbound lanes, but also exhibits high variability. All of the data is highly variable, although the October 2002 data is less variable than the March 2002 data, which may be due to testing of a partial overlay in March. Section 6 was not tested in 2001; therefore no subgrade moduli were calculated.

2.7 Ride Quality Testing

Ride quality measurements were taken on 9 August 2001 and on 29 October 2002 by Caltrans personnel from the Office of Structural Section Design and Rehabilitation (Headquarters METS). These measurements were used to determine the International Roughness Index (IRI) for each of the pavement sections. This index relates pavement ride quality to a rating number. Typically, newly constructed pavements have an IRI ranging from

0.79 to 1.56 m/km (50 and 100 inches/mile). In the Caltrans Pavement Management System, pavements with an IRI greater than 3.16 m/km (200 inches/mile) have a higher priority for maintenance and rehabilitation. Table 10 shows the IRI calculated for each of the six (6) sections on Highway 138 in both 2001 and 2002.

Table 10 Comparison of IRI Data

Section	**August 2001**				**October 2002**			
	Average (in./mi.)	**Std Dev. (in./mi.)**	**COV (%)**	**84th %ile (in./mi.)**	**Average (in./mi.)**	**Std Dev. (in./mi.)**	**COV (%)**	**84th %ile (in./mi.)**
1	142	54	38	195	76	23	31	100
2	98	33	34	131	63	16	25	79
3	147	60	41	207	52	19	37	72
4	137	47	35	184	54	16	30	70
5	137	72	53	209	67	17	25	83
6	126	29	23	155	80	30	37	110

Note: Data reported is for ascending measurements only.

2.8 Skid Trailer Testing

Skid resistance measurements were taken on 26 July 26 2002 by personnel from the Office of Structural Section Design and Rehabilitation (Headquarters METS) using skid tester J (CHC 7572). This towed type trailer device conforms to the requirements outlined in ASTM designation E274.

Skid testing was performed in both the right and left wheel paths on Highway 138. Figure 16 is a graphical comparison of the two wheel path skid numbers.

3.0 SUMMARY

1. Destructive and non-destructive testing and evaluations were performed in March 2002 after placement of the asphalt concrete leveling course and in October 2002 after placement of the treatments on the test sections.

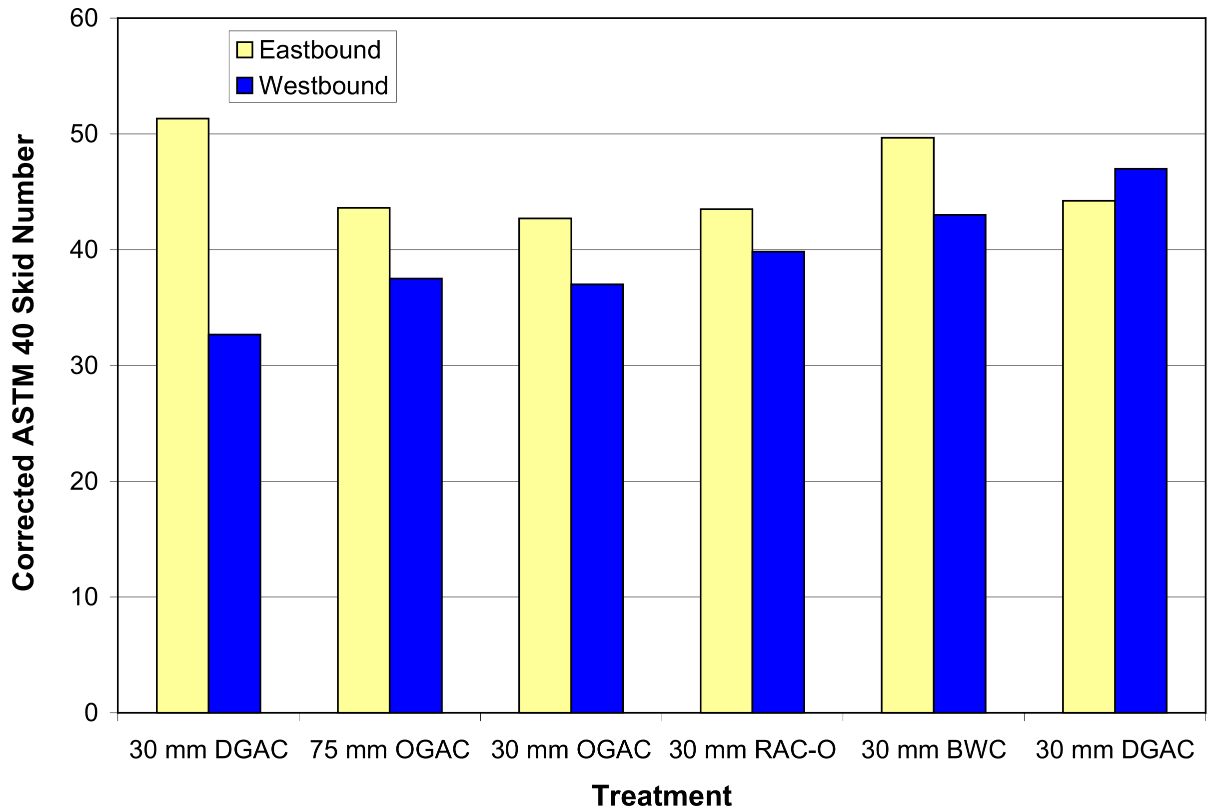

Figure 16. Comparison of skid numbers in the left and right wheelpaths on State Route 138.

2. Testing and evaluation included visual condition survey (October 2002 only), coring and measurement of asphaltic layer thicknesses, Dynamic Cone Penetrometer (DCP) testing of the underlying soils layers and estimation of the elastic stiffnesses, deflection testing and back-calculation of layer stiffnesses, profilometer testing and calculation of International Roughness Index (IRI), and skid trailer testing and calculation of skid numbers. The latter two types of testing were performed by HQ METS Office of Structural Section Design and Rehabilitation. Photographs were taken of the pavement surface and of cores.

3. The results show that after the leveling course asphalt concrete layer was placed, the following problems were observed in localized areas: reflection of underlying cracks through the overlay; after the maintenance treatments, no cracking was visible at the surface. There are some locations with flushing.

   The coring results showed highly variable thicknesses in the underlying layers, as was first documented in the more extensive coring performed in April 2001 (*1*). The leveling course and treatment thicknesses were generally close to the design thicknesses, as found from the limited coring performed in 2002.

   Stiffnesses of the underlying soils layers were found to vary seasonally and along the test sections. The seasonal variations followed expected trends of greater stiffness in the dry season compared to the wet season. This was observed from stiffnesses estimated from DCP and deflection testing.

   Stiffnesses of the combined asphaltic layers generally increased with placement of the leveling course and treatments, although there is some variability. Some of the variability can be attributed to temperature variation, although the back-calculated stiffnesses have not been corrected for temperature. Most of the variation is due to the assumption of a uniform thickness of the original asphalt concrete thickness that had to be made because of the large variability in that layer.

   Baseline measures of International Roughness Index and skid number were taken.

4.0 RECOMMENDATIONS

1. It is recommended that the test sections be monitored on an annual basis for at least the next several years. Provided that research funding remains available, this can be performed by the PRC Contract Team. Funding for annual measurement of IRI and skid

number should be made available to HQ METS Office of Structural Section Design and Rehabilitation.

2. It is recommended that materials samples be obtained for the leveling course and the treatments to permit measurement of specification properties, such as gradation and binder content. If possible, these materials should be obtained from loose samples collected during construction. Alternatively, cores or slabs can be taken on the site and these thin layers can be separated from the large mass of asphalt concrete.

5.0 REFERENCES

1. Bush, D., and J. Harvey. "State Route 138--Test Site Evaluation," Technical Memorandum prepared for the California Department of Transportation. TM-UCB-PRC-2001-2. Pavement Research Center, Institute of Transportation Studies, University of California, Berkeley. June 2001.

APPENDIX A

Plans from Treatment Construction
October 2002

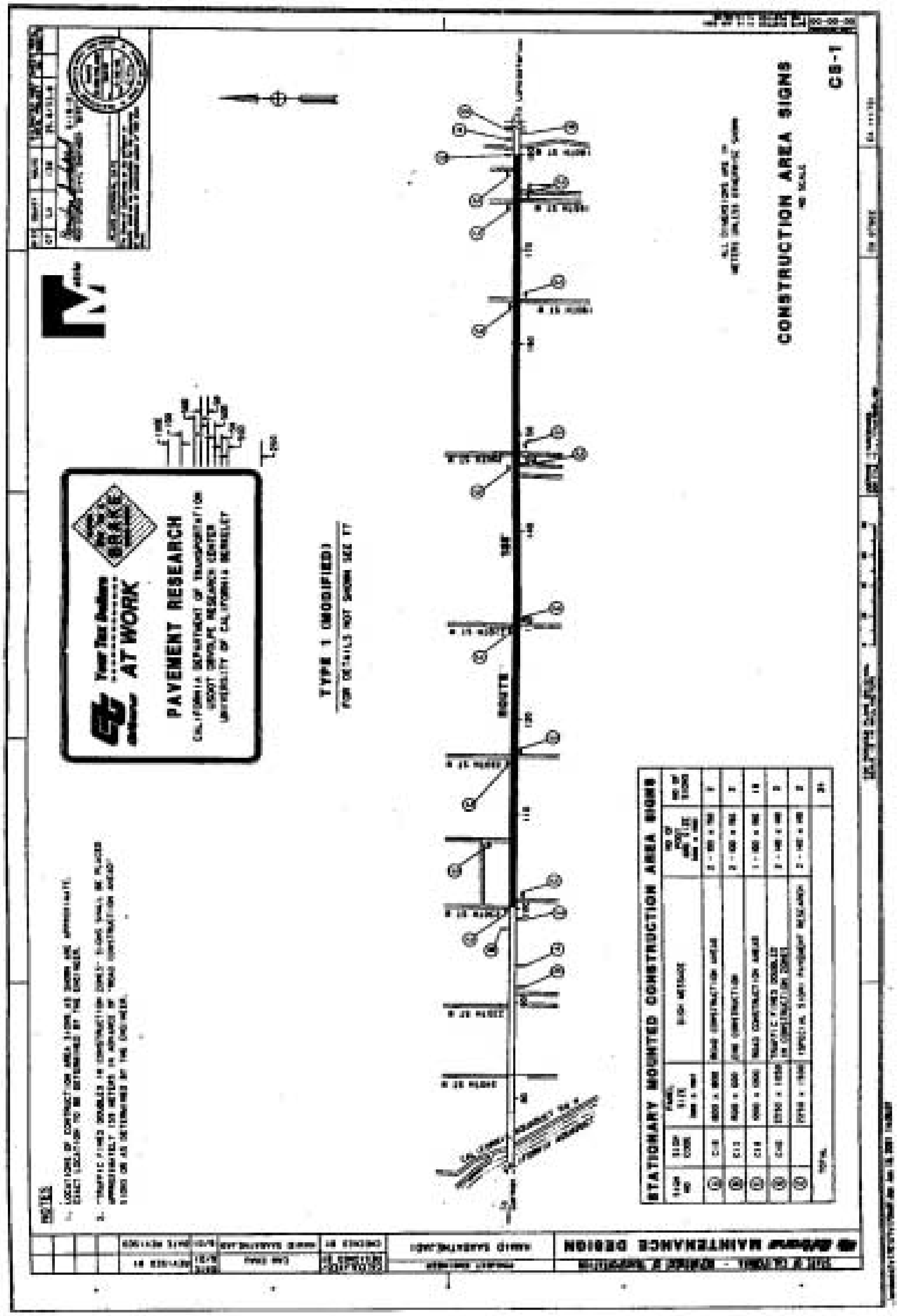

Figure A1. Signing for treatment sections.

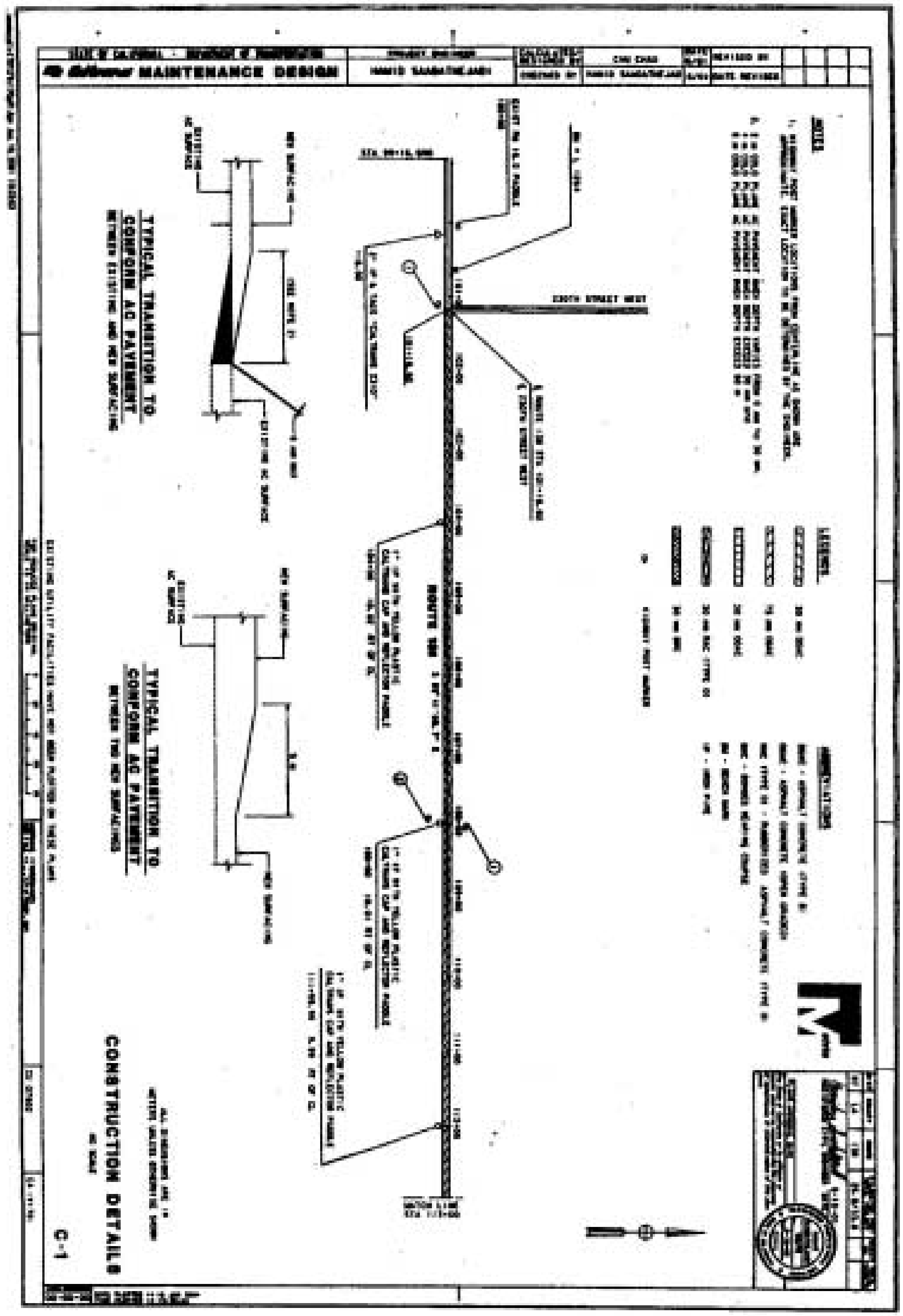

Figure A2. Construction locations (page 1 of 7).

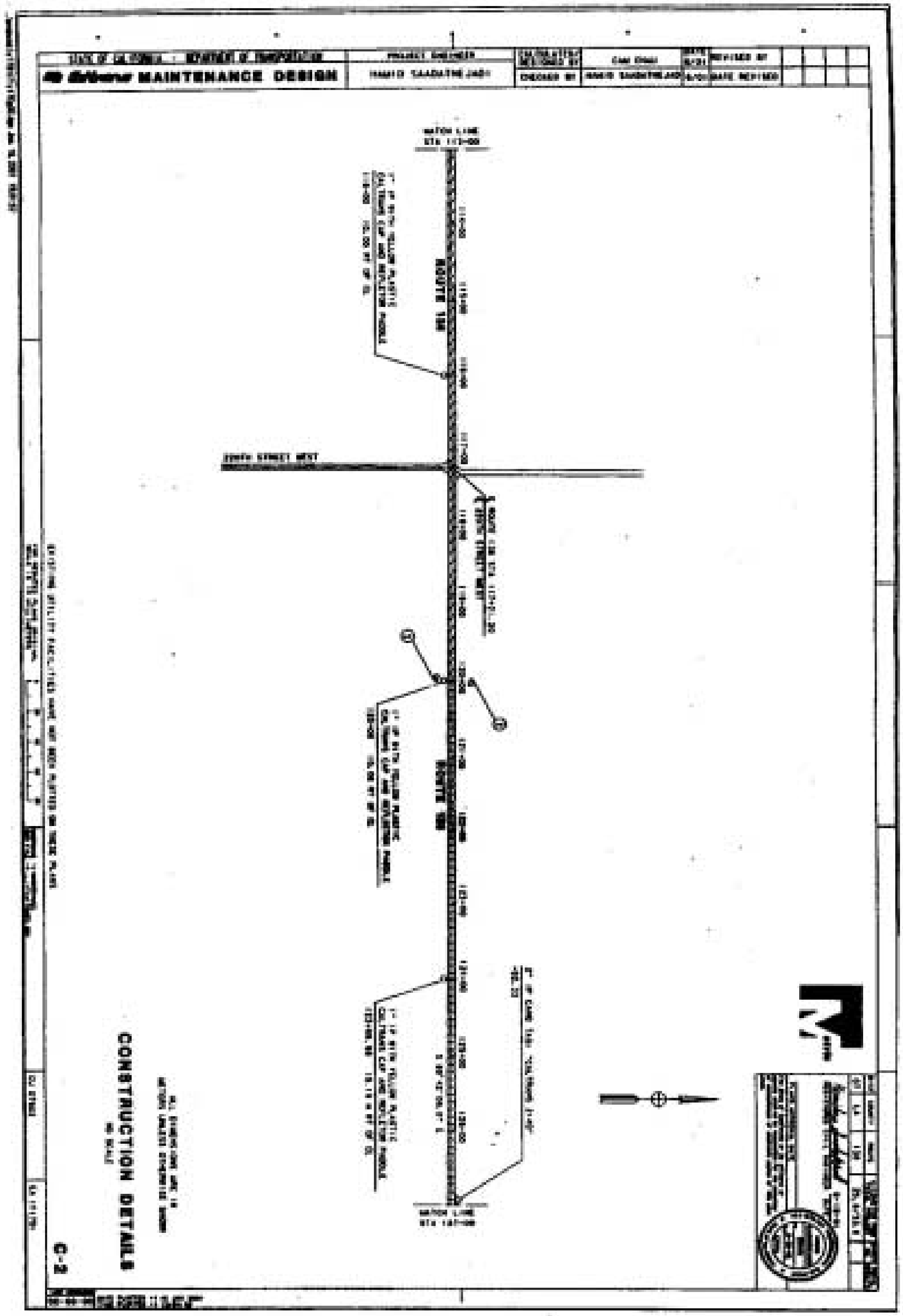

Figure A2. Construction locations (page 2 of 7).

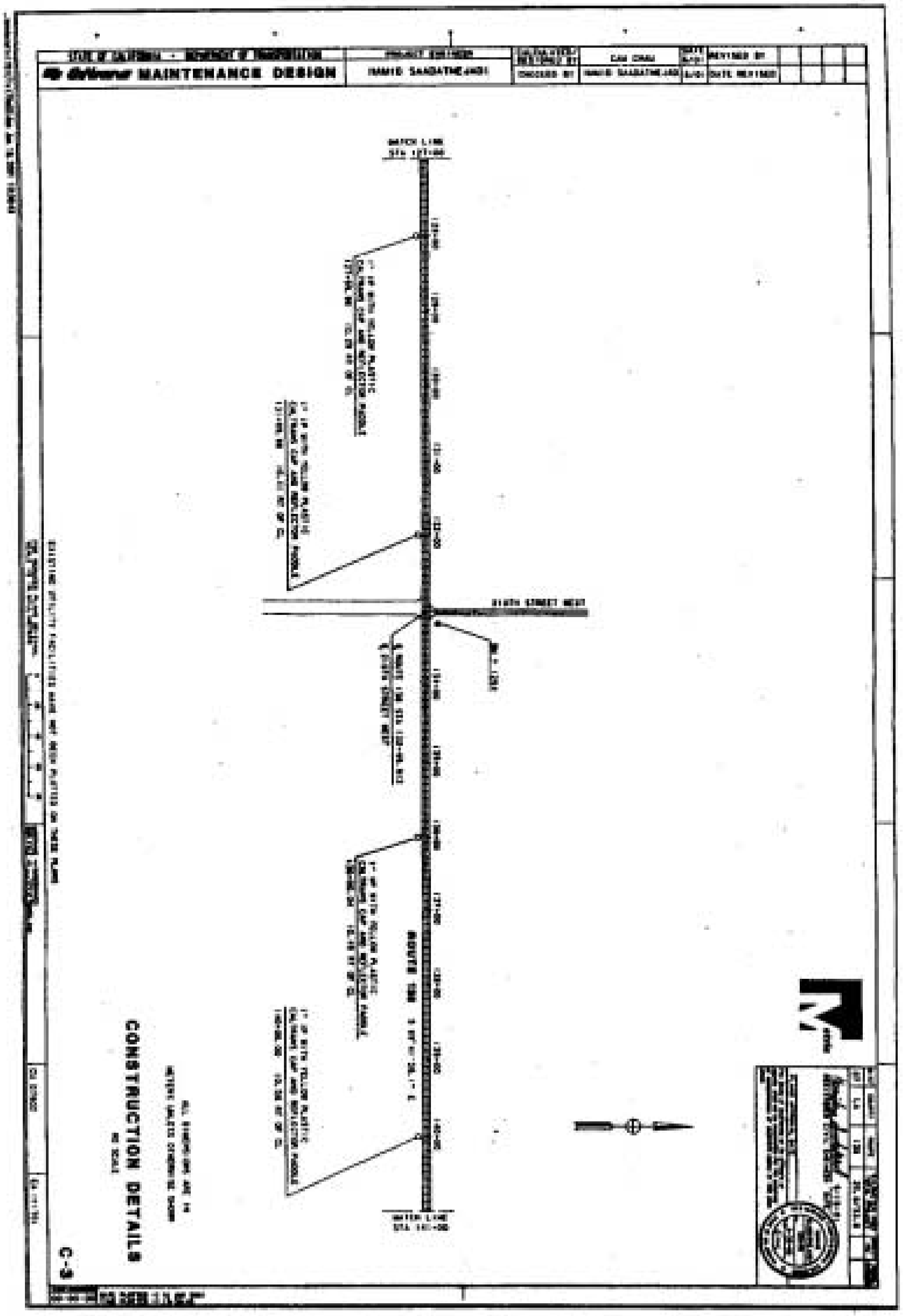

Figure A2. Construction locations (page 3 of 7).

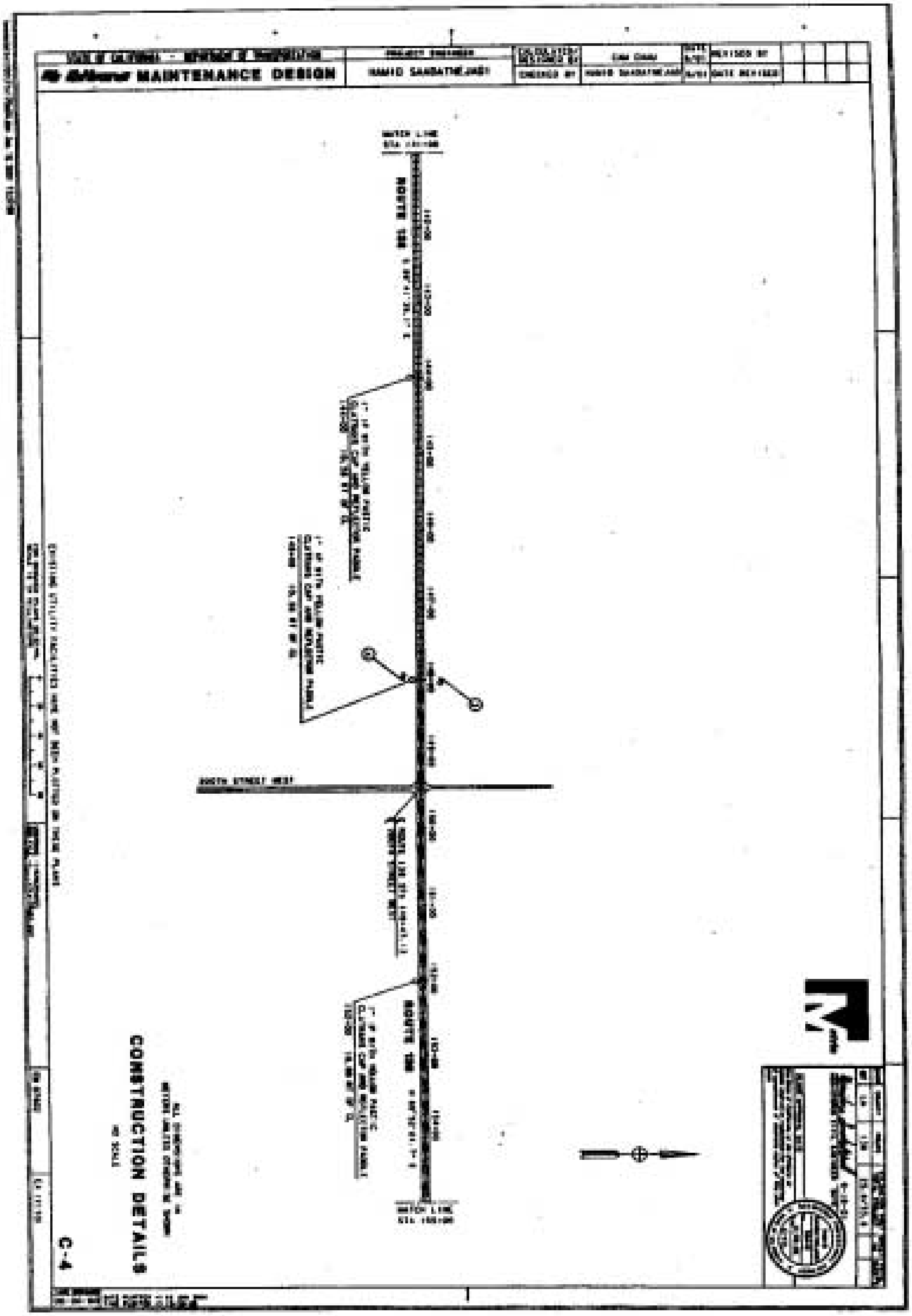

Figure A2. Construction locations (page 4 of 7).

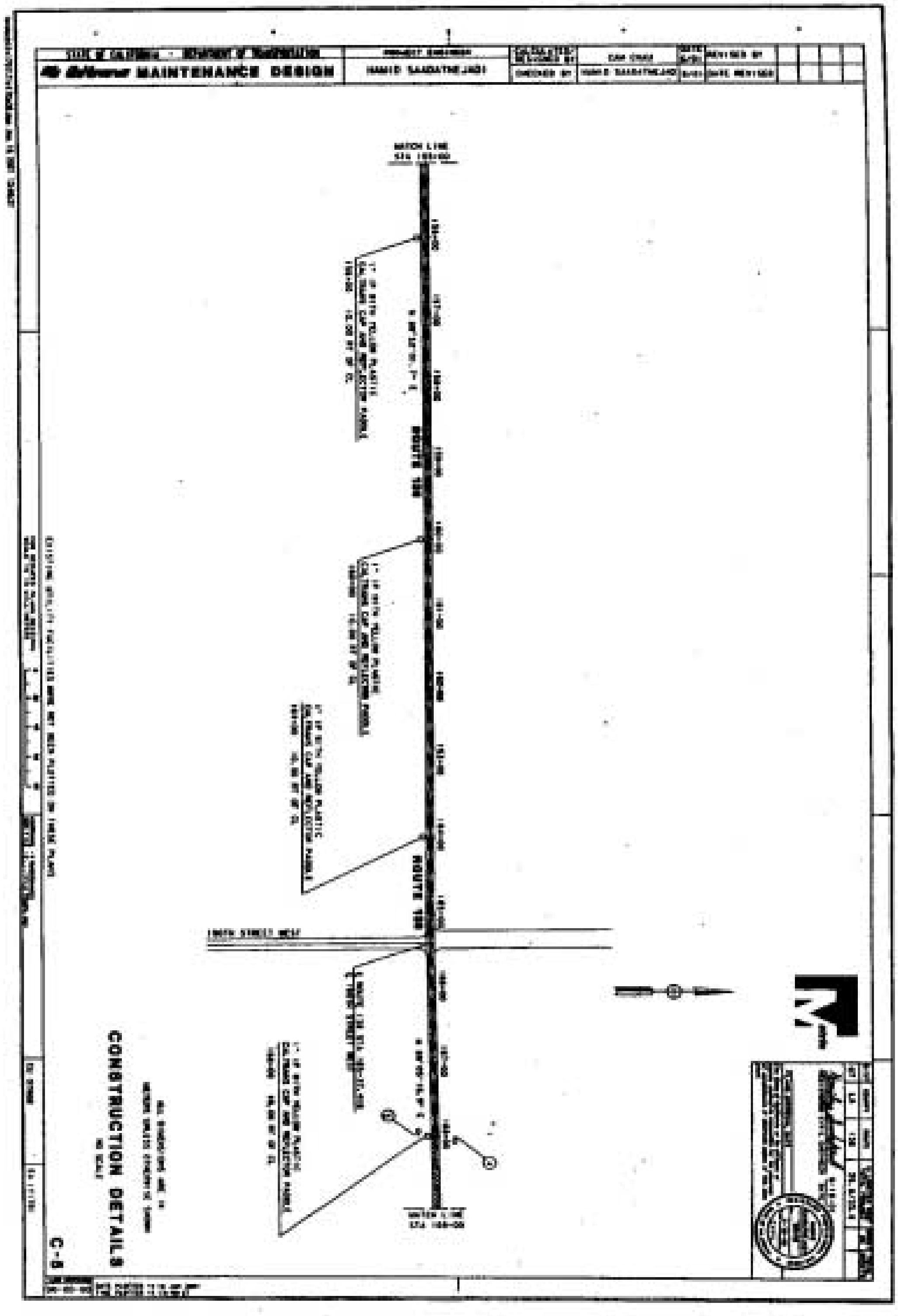

Figure A2. Construction locations (page 5 of 7).

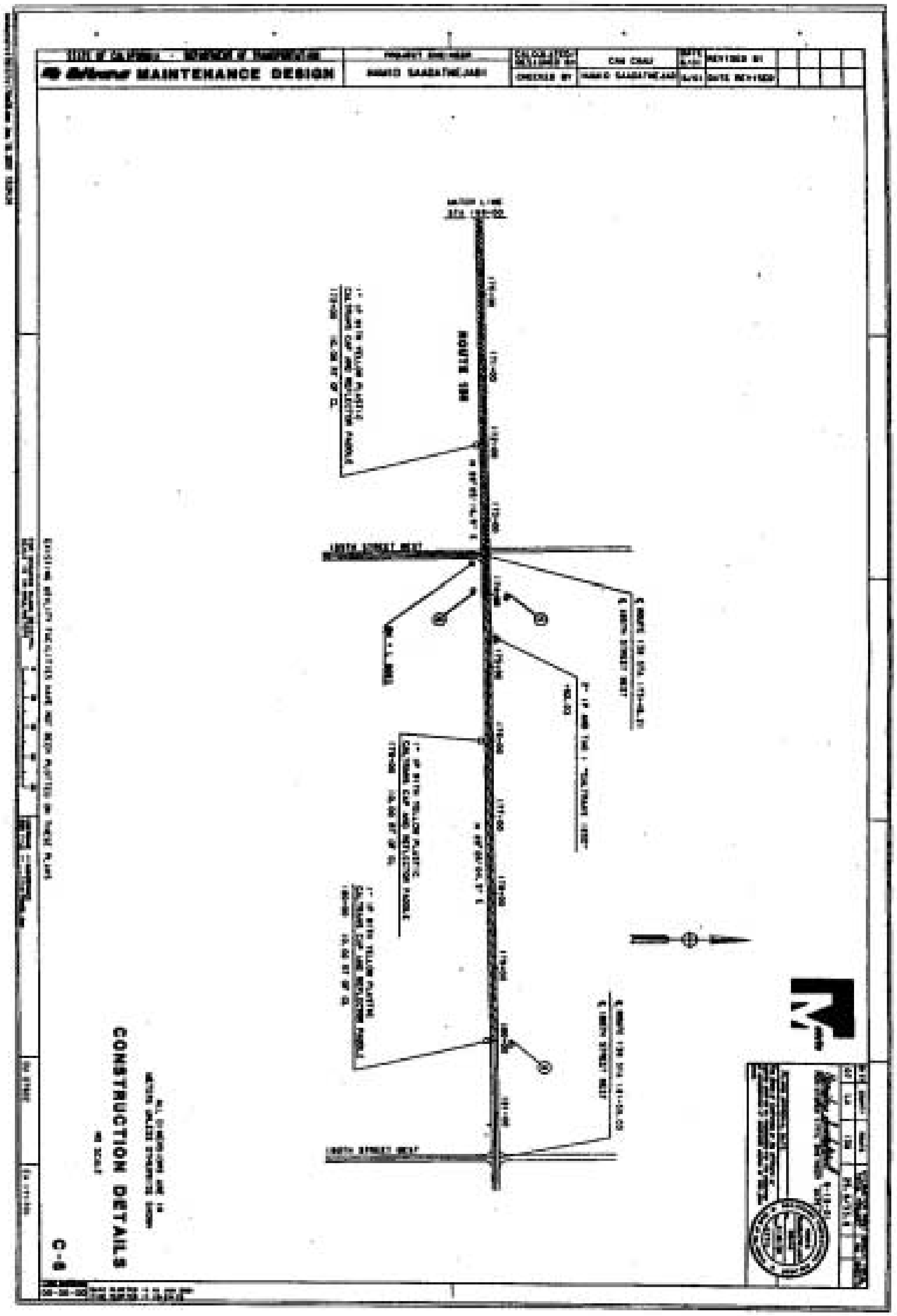

Figure A2. Construction locations (page 6 of 7).

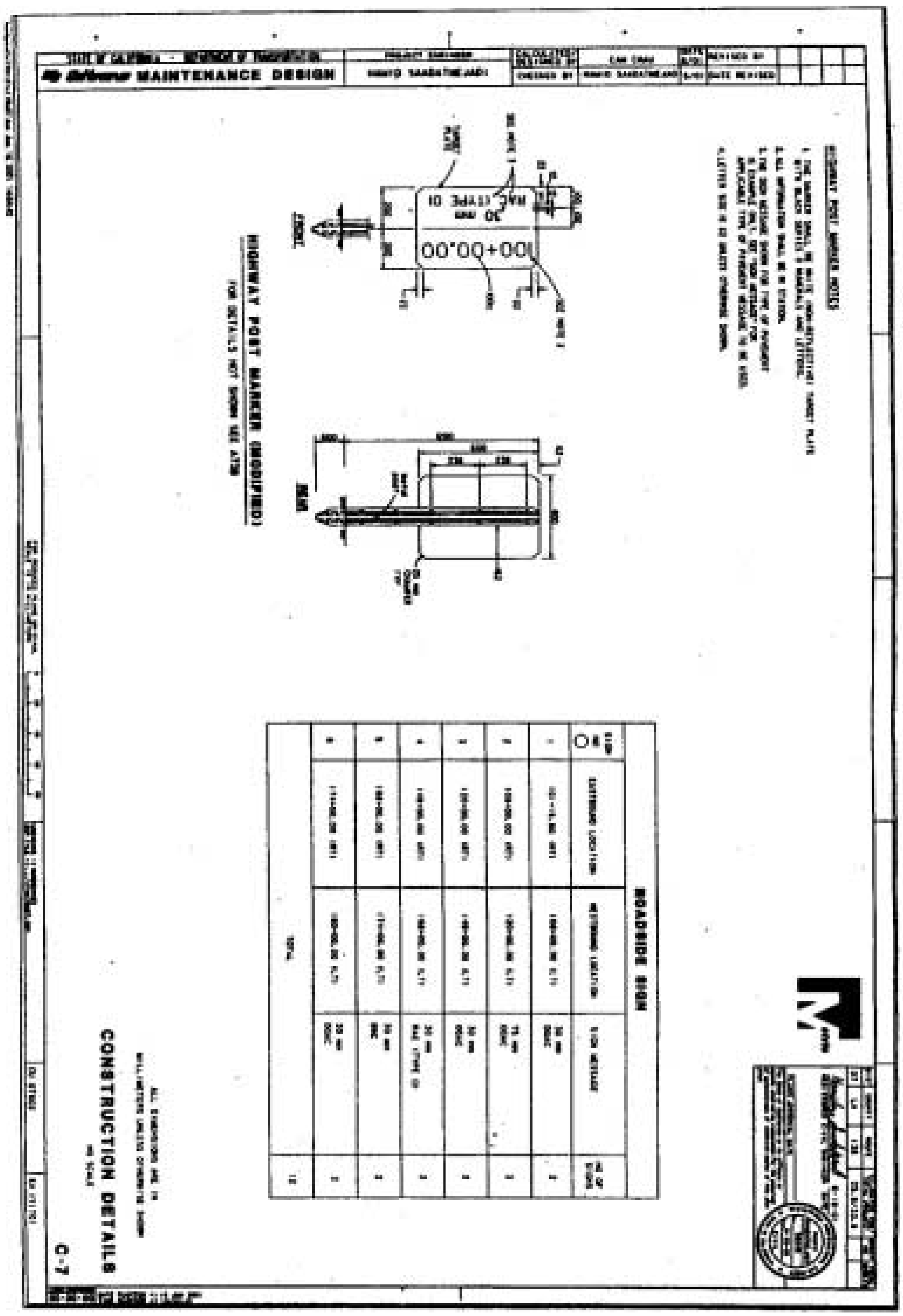

Figure A2. Construction locations (page 7 of 7).

APPENDIX B

Pavement Photos from March 2002

Figure B1. View eastward from about station 104+00

Figure B2. Area of localized reflection of wheelpath fatigue cracks through levelling course overlay.

Figure B3. Close-up of localized reflection cracking showing thickness of DGAC layer.

Figure B4. Area of segregation in levelling up course DGAC.

Figure B5. Close-up of segregated and ravelled area in levelling course DGAC.

Figure B6. Area of segregation showing high and low oil contents in levelling course DGAC.

Figure B7. Area of good appearance of levelling course DGAC.

APPENDIX C

Core Photos from March 2002

Figure C1. Coring operation in March, 2002.

Figure C2. Dynamic Cone Penetrometer (DCP) operation at station 152+00 in March, 2002.

Figure C3. Collecting subgrade soil for later laboratory testing.

Figure C4. Core from eastbound lane at station 104+00.

Figure C5. Core from westbound lane at station 104+00, including bottom segment of CTB.

Figure C6. Core from eastbound lane at station 112+00.

Figure C7. Core from westbound lane at station 112+00, including bottom segment of CTB.

Figure C8. Core from eastbound lane at station 132+00.

Figure C9. Core from westbound lane at station 132+00.

Figure C10. Core from eastbound lane at station 152+00.

Figure C11. Core from westbound lane at station 152+00, showing evidence of stripping in middle AC layers.

Figure C12. Core from eastbound lane at station 172+00.

Figure C13. Core from westbound lane at station 172+00.

Figure C14. Core from eastbound lane at station 176+00.

Figure C15. Core from westbound lane at station 176+00.

APPENDIX D

Pavement Photos from October 2002

Figure D1. View eastward from Station 104+00 (30 mm DGAC).

Figure D2. View eastward from station 115+00 (75 mm OGAC).

Figure D3. Transverse view of pavement at station 120+00 (30 mm OGAC).

Figure D4. View eastward from station 120+00 (30 mm OGAC).

Figure D5. View eastward from station 125+00 (30 mm OGAC).

Figure D6. View westward from station 127+50 (30 mm OGAC).

Figure D7. View eastward from station 130+00 (30 mm OGAC).

Figure D8. View eastward from station 135+00 (30 mm OGAC).

Figure D9. View eastward from station 140+00 (30 mm OGAC).

Figure D10. View eastward from station 145+00 (30 mm OGAC).

Figure D11. View eastward from station 150+00 (30 mm RAC).

Figure D12. Transverse view of eastbound lane at station 152+00 (30 mm RAC-G), showing core locations.

Figure D13. View eastward from station 155+00 (30 mm RAC).

Figure D14. View eastward from station 160+00 (30 mm RAC).

Figure D15. View eastward from station 165+00 (30 mm RAC).

Figure D16. View eastward from station 170+00 (30 mm BWC).

Figure D17. Transverse view of eastbound lane at station 172+00 (30 mm BWC), showing locations of cores.

Figure D18. View eastward from station 175+00 (30 mm DGAC).

Figure D19. View eastward from station 180+00 (30 mm DGAC).

APPENDIX E

Core Photos from October 2002

Figure E1. View of coring operation in October, 2002.

Figure E2. Core EB1 from station 104+00 (30 mm DGAC).

Figure E3. Core EB2 from station 104+00 (30 mm DGAC).

Figure E4. Core WB2 from station 104+00 (30 mm DGAC).

Figure E5. Core EB1 from station 112+00 (75 mm OGAC).

Figure E6. Core EB2 from station 112+00 (75 mm OGAC).

Figure E7. Core WB2 from station 112+00 (75 mm OGAC).

Figure E8. Core EB1 from station 132+00 (30 mm OGAC).

Figure E9. Core EB2 from station 132+00 (30 mm OGAC).

Figure E10. Core WB2 from station 132+00 (30 mm OGAC).

Figure E11. Core EB1 from station 152+00 (30 mm RAC).

Figure E12. Core EB2 from station 152+00 (30 mm RAC).

Figure E13. Core WB2 from westbound station 152+00 (30 mm RAC).

Figure E14. Core EB1 from station 172+00 (30 mm BWC).

Figure E15. Core EB2 from station 172+00 (30 mm BWC).

Figure E16. Core WB2 from station 172+00 (30 mm BWC).

Figure E17. Core EB2 from station 176+00 (30 mm DGAC).

Figure E18. Core WB2 from station 176+00 (30 mm DGAC).