SPS-1 Construction Report
US-54 Near Fort Madison, Iowa
Sections 190101 to 190112

SHRP North Central Region

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SPS-1 Experimental Design and Research Plan

The SPS-1 experiment has been developed to study the structural factors for flexible pavements. The objective of the study is to more precisely determine the relative influence of factors on the performance of flexible pavements. Those factors include drainage, base type and thickness, and asphalt surface thickness. The study objective includes a determination of the influence of environmental region and soil type on these factors. Accomplishing these objectives will provide substantially improved tools for use in the design and construction of new and reconstructed flexible pavements.

Some of the products of this experiment will help accomplish the objectives of the SHRP LTPP program. The key products from the SPS-1 experiment will include an evaluation of the existing design methods, development of improved design equations for new and reconstructed pavements, determination of the effects of specific design features on pavement performance, and development of a comprehensive data base for use by state and provincial engineers and other researchers.

Development of the national pavement data base is the tool to produce the analyses needed to produce the other products. This data base will permit centralized and efficient distribution of massive quantities of data to participating highway authorities, researchers, and other interested people. The data produced by this experiment will be used to evaluate existing design methods and performance equations. The AASHTO basic design equation for flexible pavements can be evaluated by comparing observed serviceability index against that predicted by the design equation. All of the inputs concerning the pavement structure, traffic, environment, drainage and material properties will be quantified. This experiment will also permit the variability associated with each of the inputs to be quantified and allow evaluation of the reliability aspects of the mode.

The proposed experimental design is aimed directly at determining the effects of the following specific pavement design features:

1. In-pavement drainage systems
2. Base type
3. Base thickness
4. Pavement thickness

The interaction of these factors will be determined in combination with the effect of environmental region and soil type. The effects of these factors will be studied under realistic performance conditions with significant materials and construction control. This experiment will add significantly to the understanding of the long-term performance of flexible pavements with asphaltic concrete surfaces.

Table 1 gives the basic experiment design for the SPS-1 experiment. The SPS-1 experiment in Iowa includes those sections listed in the J cells.

Experimental Design for SPS-1: Strategic Study of Structural Factors for Flexible Pavements

PAVEMENT STRUCTURE COMBINATIONS				FACTORS FOR MOISTURE, TEMPERATURE, SUBGRADE TYPE, AND LOCATION [1]															
				WET								DRY							
				FREEZE				NO FREEZE				FREEZE				NO FREEZE			
				FINE		COARSE		FINE		COARSE		FINE		COARSE		FINE		COARSE	
DRAINAGE	BASE TYPE	TOTAL BASE THICK	SURFACE THICK	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
NO	AGG	8"	4"		K1		M1		O1		Q1		S1		U1		W1		Y1
			7"	J1		L1		N1		P1		R1		T1		V1		X1	
		12"	4"	J2		L2		N2		P2		R2		T2		V2		X2	
			7"		K2		M2		O2		Q2		S2		U2		W2		Y2
	ATB	8"	4"	J3		L3		N3		P3		R3		T3		V3		X3	
			7"		K3		M3		O3		Q3		S3		U3		W3		Y3
		12"	4"		K4		M4		O4		Q4		S4		U4		W4		Y4
			7"	J4		L4		N4		P4		R4		T4		V4		X4	
	ATB / 4"AGG	8"	4"	J5		L5		N5		P5		R5		T5		V5		X5	
			7"		K5		M5		O5		Q5		S5		U5		W5		Y5
		12"	4"		K6		M6		O6		Q6		S6		U6		W6		Y6
			7"	J6		L6		N6		P6		R6		T6		V6		X6	
YES	PATB / AGG	8"	4"	J7		L7		N7		P7		R7		T7		V7		X7	
			7"		K7		M7		O7		Q7		S7		U7		W7		Y7
		12"	4"		K8		M8		O8		Q8		S8		U8		W8		Y8
			7"	J8		L8		N8		P8		R8		T8		V8		X8	
		16"	4"		K9		M9		O9		Q9		S9		U9		W9		Y9
			7"	J9		L9		N9		P9		R9		T9		V9		X9	
	ATB / PATB	8"	4"		K10		M10		O10		Q10		S10		U10		W10		Y10
			7"	J10		L10		N10		P10		R10		T10		V10		X10	
		12"	4"	J11		L11		N11		P11		R11		T11		V11		X11	
			7"		K11		M11		O11		Q11		S11		U11		W11		Y11
		16"	4"	J12		L12		N12		P12		R12		T12		V12		X12	
			7"		K12		M12		O12		Q12		S12		U12		W12		Y12

AGG = Dende-graded untreated aggregate base
ATB = Dense-graded asphalt treated base
PATB = 4" thick open-graded permeable asphalt-treated drainage layer, underneath ATB or over AGG base
4" AGG = 4" thick dense-graded untreated aggregate base layer underneath ATB

Table 1. Experimental Design for SPS-1

Project Details

The Iowa Department of Transportation (IDOT) constructed an SPS-1 experiment in the summer and fall of 1992. Although construction of the entire project was not completed until 1993, all work on the SHRP sections was completed in November of 1994.

The Iowa SPS-1 was constructed in the southbound driving lane of US-61, near Fort Madison (see Figure 1 for project location). The experiment consists of twelve test sections and one IDOT control section, and is built in the wet-freeze zone. The IDOT control section consists of the pavement section the Iowa DOT is using for the overall construction project. Subgrade soils are clay loam, which is classified as fine-grained. The project was initially approved as an experiment K site, but a J experiment was actually constructed.

Prior to construction, US-61 was a two-lane undivided asphalt-overlaid concrete pavement. The project included construction of two new southbound lanes along a new alignment. The existing roadway will be reconstructed and carry two lanes of northbound traffic when construction is complete. The two southbound lanes were completed first, and were used as a two-way bypass while the northbound lanes were constructed.

Traffic on US-61 is listed on the nomination as 8,450 AADT, with 17 percent trucks. the estimated 18K ESAL rate in the SHRP lane is 130K ESALS/year, with a total design 18K ESAL application of 3,900,000 over the 30-year design period.

There was some deviation from SHRP guidelines, as there are several intersecting local roads within the test site. Because traffic on these local roads is less than 5% of the mainline traffic, the project was considered acceptable. There are two horizontal curves on the project that contain sections. The curves are 2.5 and 3.0 degrees (radius of 2,291.83 and 1,909.86 feet) and are super-elevated. They are within the maximum of 3 degrees stated in the guidelines.

The plan-profile shows the land to be slightly rolling, with grades varying between 0 and 1.7%, and there are no large cuts or fills along the length of the project. All of the sections are located in shallow fill except for section J7, which is in a shallow cut.

No weather station has been installed to date, but one is scheduled for installation in 1993 or 1994. The WIM equipment will be installed in the fall of 1993. The project was opened to bypass traffic in June of 1993.

All sampling and testing was conducted by Terracon Consultants NE, Inc., a subcontractor to Cessford Construction Company of LeGrand, Iowa, who served as the general contractor. Their address is listed below:

Cessford Construction Company
P.O. Box 160
LeGrand, Iowa 50142

Phone: (515) 479-2695

Jon Allen, of the Iowa Department of Transportation served as Resident Engineer. A listing of all people who were actively involved in the project is shown below:

Iowa Department of Transportation:

Jon Allen
Iowa DOT
P.O. Box 4043
Highland Park Station
DesMoines, IA 50333
(319) 372-5345

Bernie Brown
Charles Potter
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Layout

Beginning at the north end of the project, sections were laid out according to surface thickness. The 7-inch asphalt surface sections were first, followed by those sections with 4-inch surface layers. A control section was not identified until after the project was completed, so preliminary and layer testing was not completed on it. It is located at the south end of the project.

Figure 2 shows the section layout, and Table 2 gives a description of the sections.

Table 2. Iowa SPS-1 Section Layout

Construction Station	SHRP ID	Base Type and Thickness	Surface Thickness	4" Subdrain
5256+00 - 5261+00	190108	4" PATB 8" DGAB	2" Surface 5" Binder	Yes
5243+00 - 5248+00	190104	12" ATB	2" Surface 5" Binder	No
5236+00 - 5241+00	190106	8" ATB 4" DGAB	2" Surface 5" Binder	No
297+00 - 302+00	190159 IDOT Control	9" ATB	2" Surface 2" Binder	No
227+00 - 232+00	190109	4" PATB 12" DGAB	2" Surface 5" Binder	Yes
217+00 - 222+00	190110	4" ATB 4" PATB	2" Surface 5" Binder	Yes
206+00 - 211+00	190111	8" ATB 4" PATB	2" Surface 2" Binder	Yes
189+00 - 194+00	190112	12" ATB 4" PATB	2" Surface 2" Binder	Yes
180+00 - 185+00	190101	8" DGAB	2" Surface 5" Binder	No
169+00 - 174+00	190102	12" DGAB	2" Surface 2" Binder	No
159+00 - 164+00	190105	4" ATB 4" DGAB	2" Surface 2" Binder	No
152+00 - 157+00	190103	8" ATB	2" Surface 2" Binder	No
139+50 - 144+50	190107	4" PATB 4" DGAB	2" Surface 2" Binder	Yes

Material Sampling and Testing

A summary of the Material Sampling and Testing Plan is shown in Figure 3.

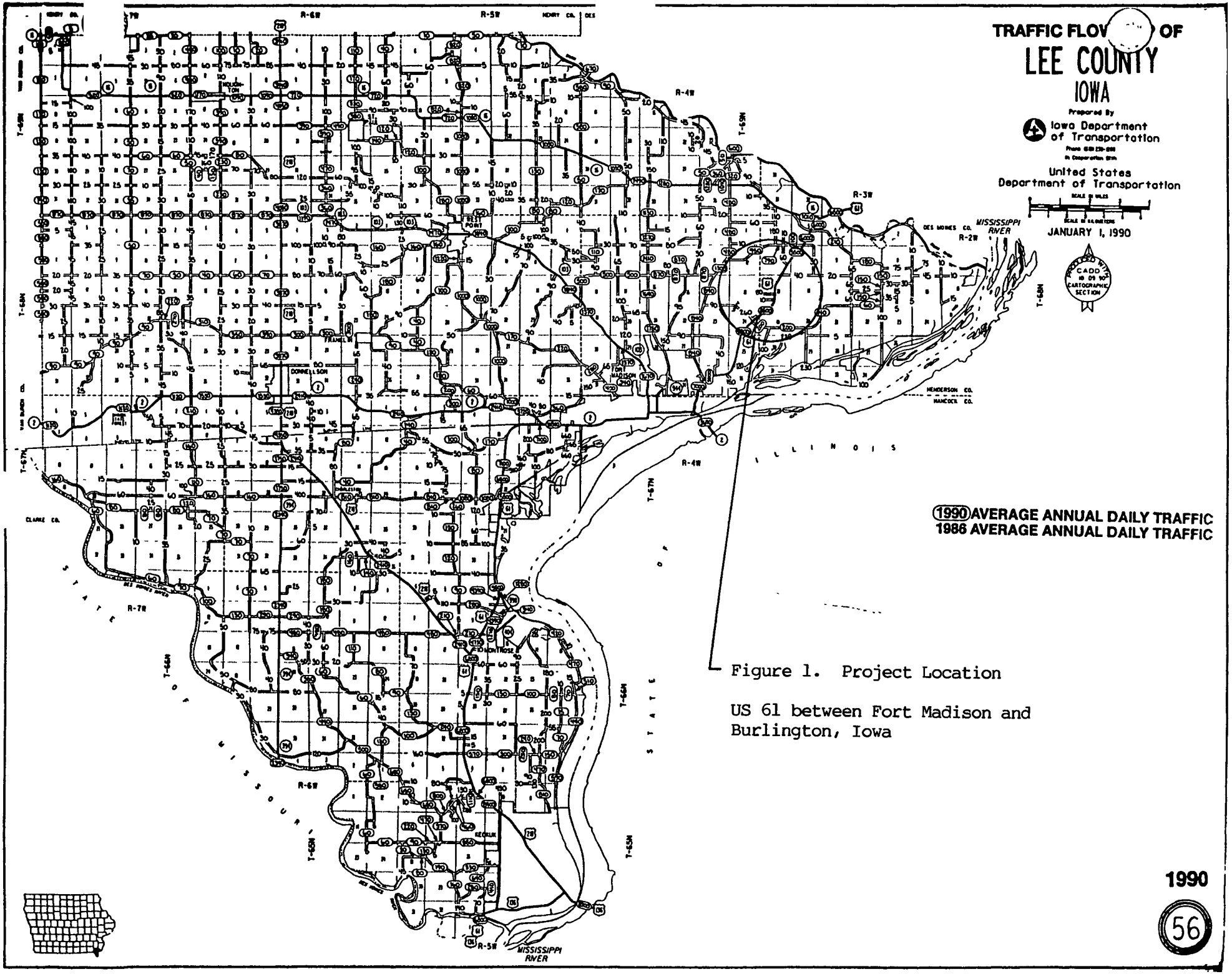


Figure 1. Project Location

US 61 between Fort Madison and Burlington, Iowa

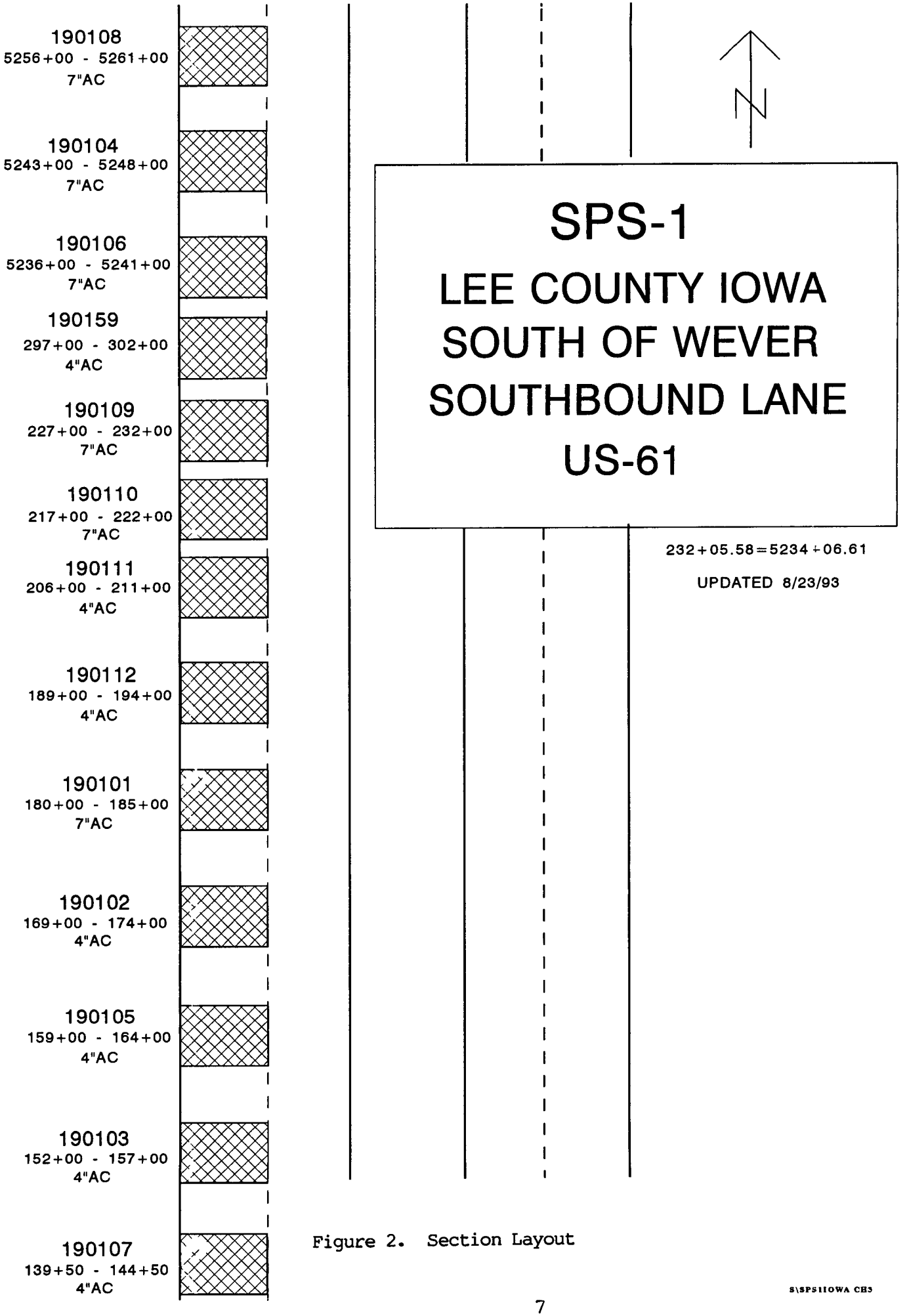


Figure 2. Section Layout

Construction

The construction schedule is shown on Figure 9. Construction was delayed due to an especially rainy season. Work began on the project April 8, 1992 and work on the SHRP sections began May 5th with sampling and testing of the subgrade materials. All subgrade material was placed and graded in June, and placement of dense graded aggregate, asphalt treated, and permeable asphalt treated base was completed in June also. Work was suspended from July 9th through the 28th, and when the Contractor attempted to pave, the subgrade was too soft to support the paver.

Work was again suspended until August 3rd. The Contractor was able to pave for only four days, and work had to be suspended due to rain and soft subgrade from August 7th through September 28th. When construction resumed, the subgrade for section J4 was reworked, as it did not pass compaction specifications. Paving resumed October 2nd, and all asphalt base was completed by October 30th. The asphalt surface course was placed November 9th through the 17th. All work was suspended for the season on November 17th, with only the driving lane of the SHRP sections actually paved to the surface course.

A side dump paver was used to keep equipment off the base material. No other special equipment was required for construction.

There were no major problems with construction, aside from the very rainy weather conditions which slowed progress. Many problems arose during construction of the permeable asphalt treated base (PATB). After the PATB was cross-sectioned, it was determined that the layer thicknesses in sections J7 and J8 were 3/4 to 1 inch thicker than specified. This was not discovered until October, and removal and replacement was not an option because of the late date. Also, milling was considered, but the effects on the PATB were unknown. For that reason, it was decided that the PATB should be left as is, and factored into the analysis.

The contractor also experienced some difficulty placing the PATB. If rolled at too high a temperature, the material compacted too much, and rolled out the sides beyond where the fabric was to wrap around. In some instances, the Contractor had to jackhammer the widened areas to accommodate the one-foot overlap of the fabric over the PATB layer. In addition, a second lift had to be placed to increase the thickness to that specified.

The Contractor also experienced problems scheduling the work and completing the project within the one construction season as specified, due to an especially heavy rainy season. Although the entire roadway section was not completed, the driving lane surface was paved in the experiment area. The shoulders and passing lane were completed in the spring of 1993.

The project test sections were opened to traffic in June of 1993.

Table 3. Construction Schedule

SPS: 1 **Agency: Iowa**

Test Section		Construction		Range of Thicknesses	MST Completed
Layer	Designation	Start	Complete		
1	Subgrade	5/5/92	6/8/92	NA	5/15/92
2	DGAB	6/9/92	6/24/92	4-12"	6/24/92
3	ATB	6/18/92	10/7/92	4-12"	8/2/92
4	PATB	6/26/92	10/24/92	4"	11/24/92
5	AC Surface	8/3/92	11/16/92	4-7"	11/24/92

Dates:
Opened to Traffic: June 1993
WIM Installed: October 1993
WIM Operational: No
Weather Station Installed: Not to date
Weather Station Operational: No

Significant Factors Which May Affect Performance of Section

Environmental
Heavy rains delayed construction several times. Also, the rain resulted in a very wet subgrade which may affect the section performance.

Construction
Due to delays, some areas of the dense graded aggregate base dried out and cracked between layer placement. Localized error in PATB tolerance resulted in two layers of material.

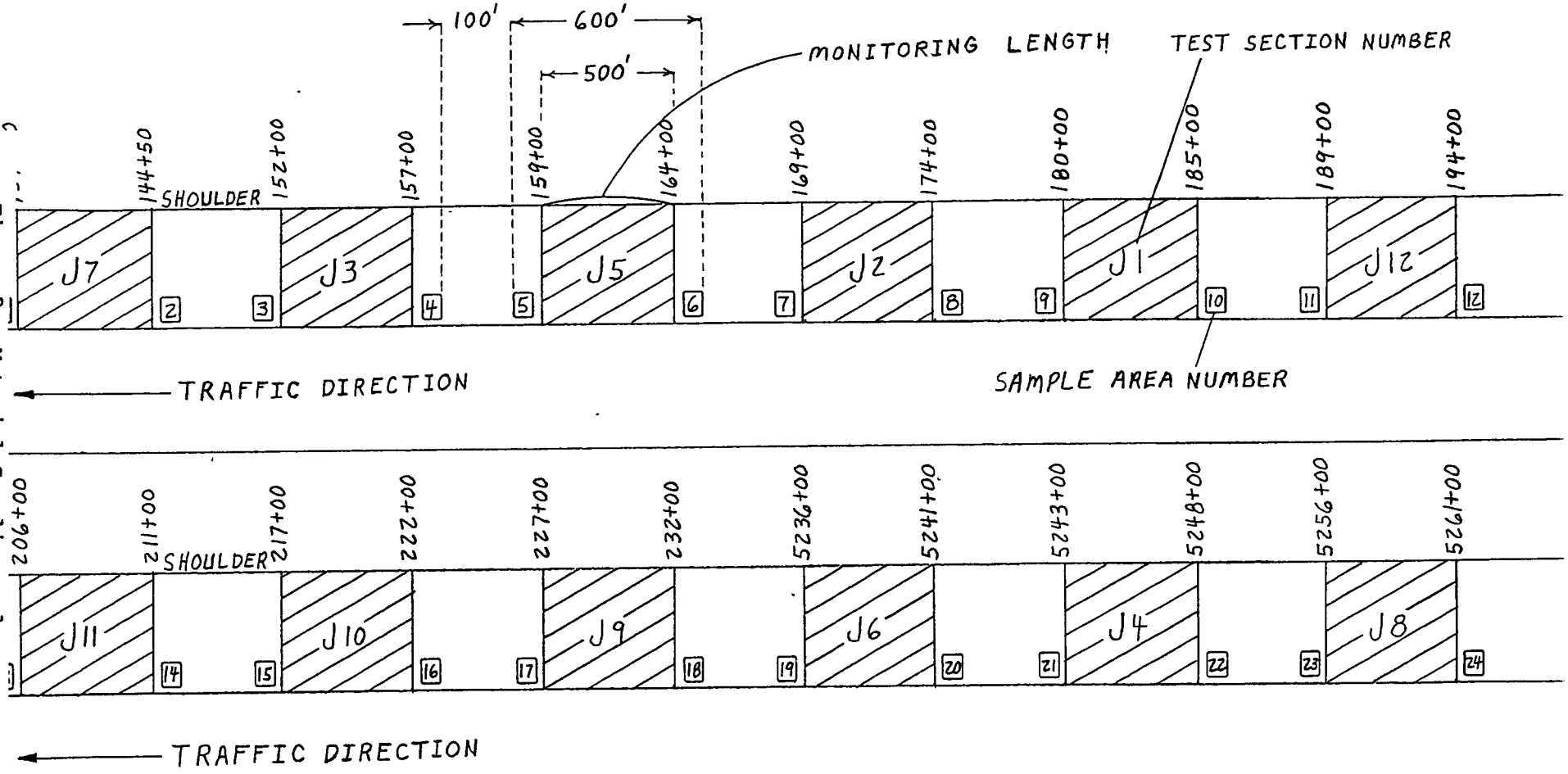
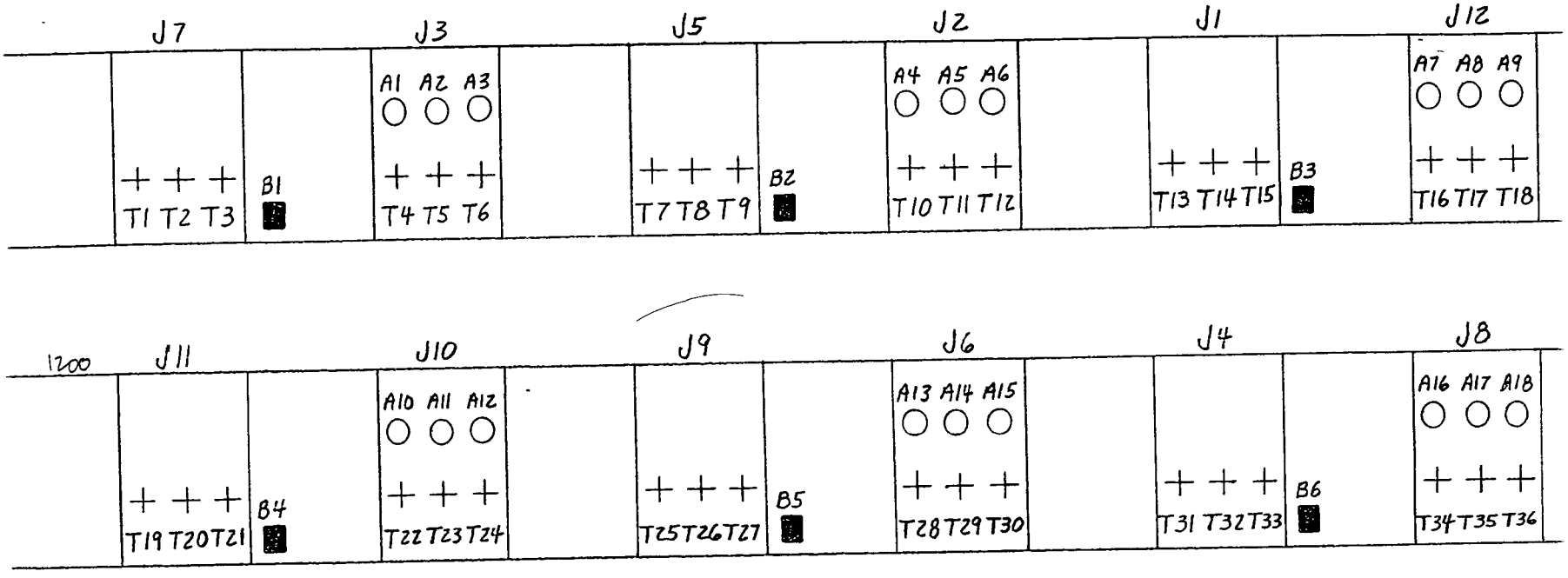


Figure 3. Material Sampling and Testing Plan

SITE LAYOUT WITH SAMPLING AREAS 2/4/92
LEE COUNTY US61 SPS-1 SBL



■ 2x2 bulk sampling location (B1-B6) to 12" below top of subgrade

○ Shelby tube/splitspoon sampling to 4' below top of subgrade (A1-A18)

+ Location of field testing (T1-T36)

Sampling and Testing Locations for Subgrade

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Testing
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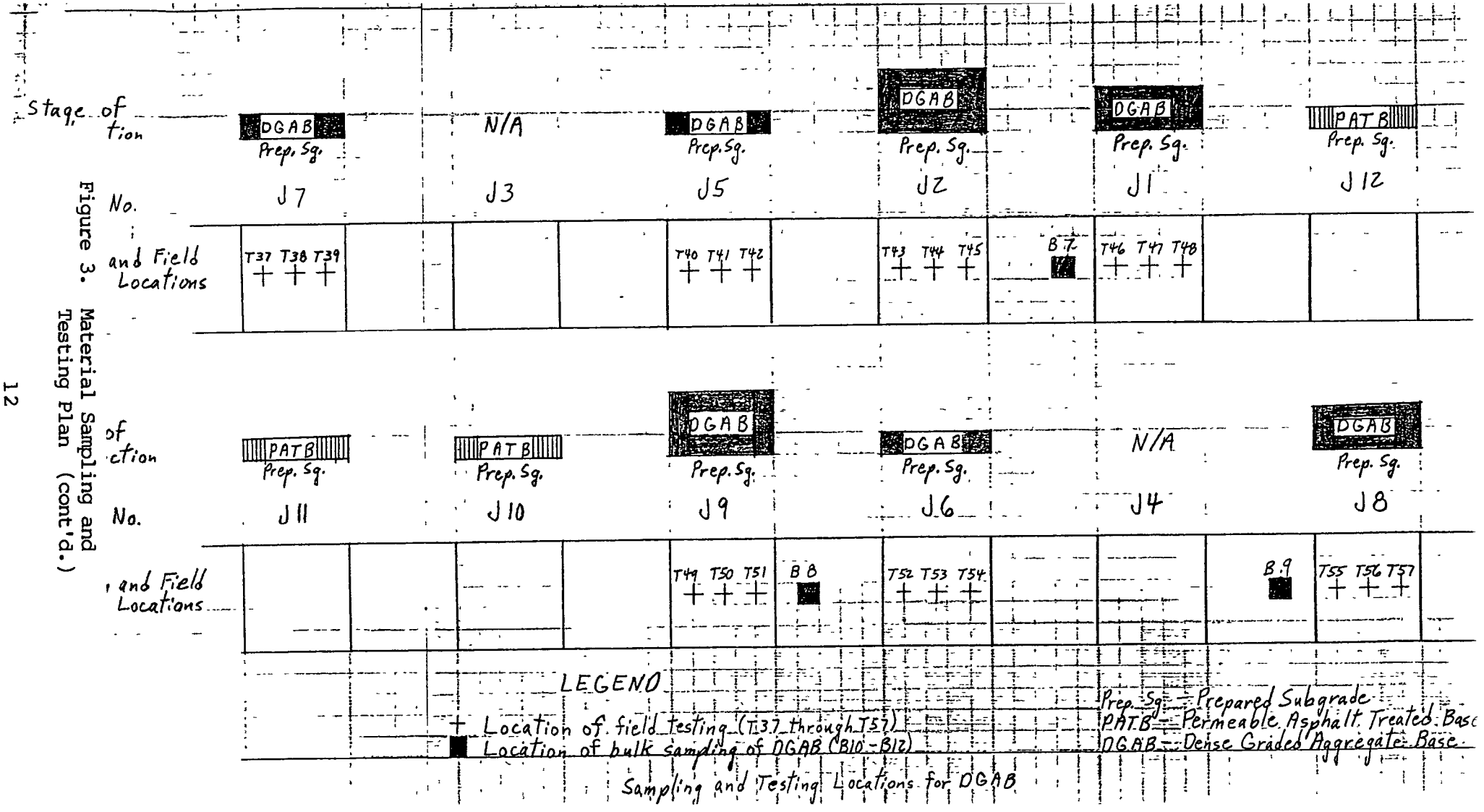
Figure 3. Material Sampling and Testing Plan (cont'd.)



Sampling and Testing Locations for DGAB

Figure 3. Material Sampling and Testing Plan (cont'd.)

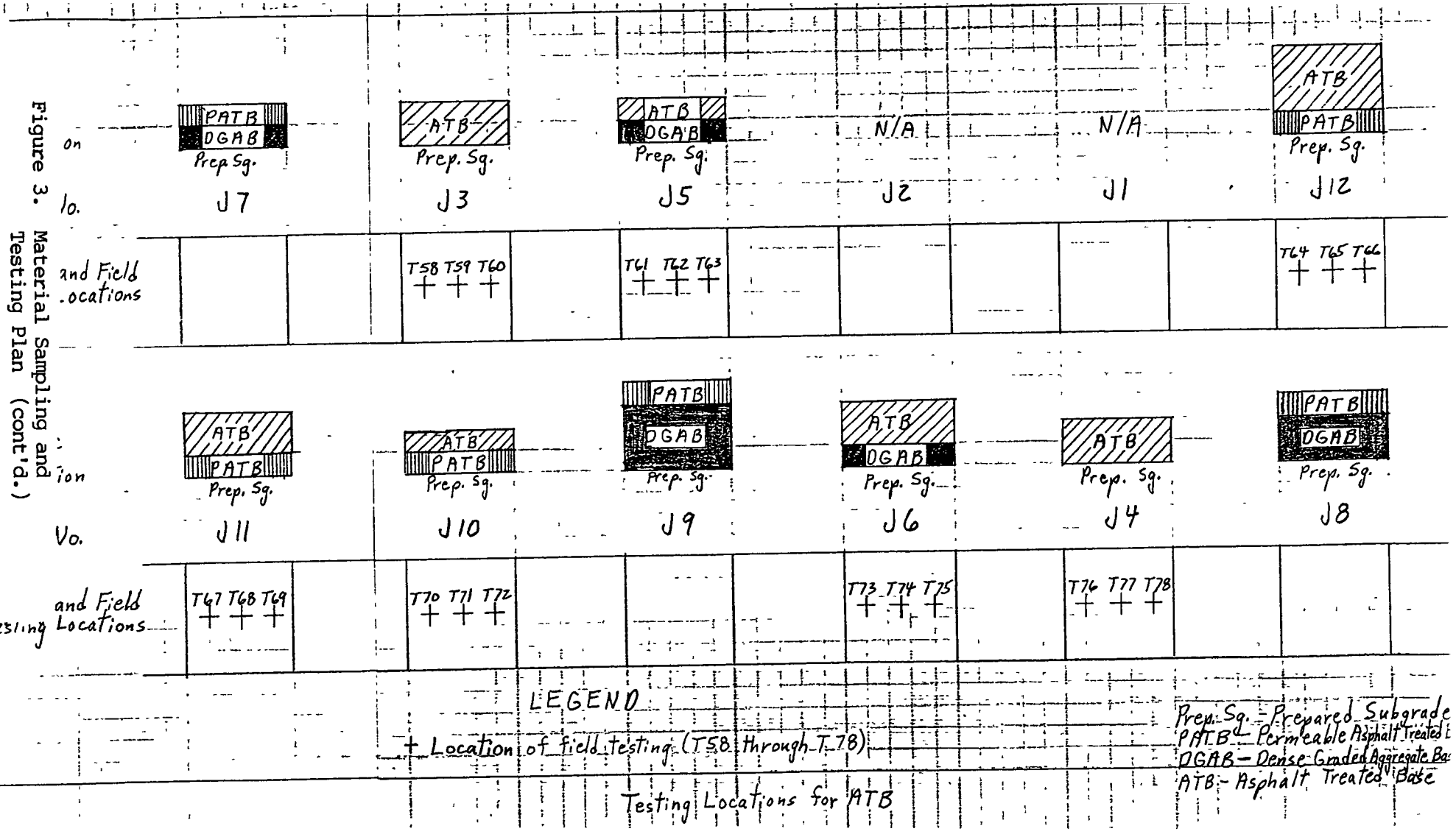
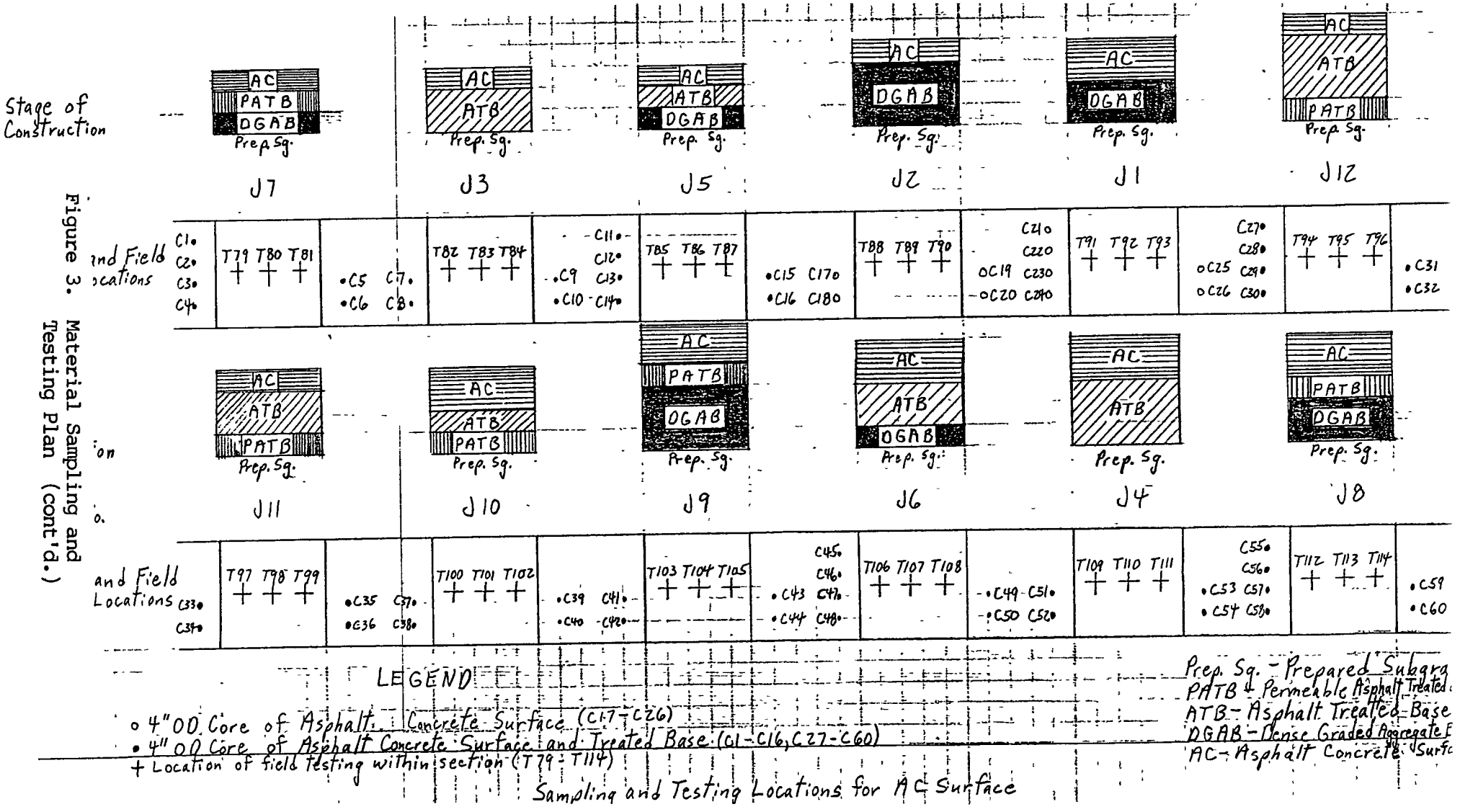


Figure 3. Material Sampling and Testing Plan (cont'd.)

Testing Locations for ATB



Sampling and Testing Locations for AC Surface

Figure 3. Material Sampling and Testing Plan (cont'd.)

Dry Subgrade Prior to Placement of Base Material

Graded Subgrade; Note Cracked Material Due to Drying

FWD Testing on Graded Base Material

Permeable Asphalt Treated Base

Placement of Asphalt Surface Layer

Fabric and Permeable Asphalt Treated Base Beneath Asphalt Surface Course

Subdrain Outlet Pipes and Transverse Culvert

Compaction of Asphalt Surface Layer

Filter Fabric and Subdrain Prior to Placement of Backfill Material