U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

Long-Term Pavement Performance Division

SPECIFIC PAVEMENT STUDIES
MATERIAL SAMPLING AND TESTING REQUIREMENTS
FOR EXPERIMENT SPS-1
STRATEGIC STUDY OF STRUCTURAL FACTORS
FOR FLEXIBLE PAVEMENTS

Federal Highway Administration
LTPP Division: HNR-40
6300 Georgetown Pike
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EXECUTIVE SUMMARY

This report contains guidelines for the development and implementation of a material sampling and testing program for each test site included in the Specific Pavement Studies' experiment SPS-1, Strategic Study of Structural Factors for Flexible Pavements. These guidelines will help the FHWA-LTPP Regional Coordination Office (RCO) develop recommendations for a field material sampling, field testing, and laboratory materials testing plan tailored for the individual test site. The FHWA-LTPP RCO and the participating state/provincial highway agency must coordinate the activities associated with the development and implementation of the recommended field sampling and testing plan to ensure compliance with the plan objectives and thus achieve the study's goals.

This report should be used in conjunction with the "SHRP Guide for Field Materials Sampling, Testing and Handling" to perform the field material drilling and sampling work. Copies of all applicable guidelines should be available during the on-site sampling and testing operations. All persons involved in the field sampling and testing operations for the SPS-1 experiment must be familiar with its content, particularly the types and numbers of samples to be obtained from the different test sections and pavement layers. This report shall also be used in conjunction with the "SHRP-LTPP Interim Guide for Laboratory Material Handling and Testing" to perform the laboratory testing procedures. Specifically, Appendices C.2 and E.2 contain test data reporting sheets and test protocols, respectively, for use in conducting the laboratory materials testing work required for this experiment.

This document is divided into four main sections covering the following topics:

- Introduction
- Development of Sampling and Testing Plans
- Field Material Sampling and Testing Requirements
- Laboratory Materials Testing Requirements

Each of these sections is, in turn, broken down into subtopics which explain specific areas of the field material sampling and testing requirements for the SPS-1 projects. In addition, this document contains three appendices that contain an example sampling plan layout schematic, field sampling and testing data forms and a reprint of the guidelines to be used for Falling Weight Deflectometer testing of each of the pavement section layers.

The original SPS-1 Material Sampling and Testing Requirements were developed in February, 1991. This revised report is a product of the experience gained, over many years, by the RCOC staff and participating agencies in the sampling and testing of SPS-1 projects. The revisions incorporate the recommendations of the SPS-1 and SPS-2 Construction Guidelines/ Material Sampling and Testing Workshop held in St. Paul Minnesota in April, 1993.

General revisions which occurred to the text in this version are as follows:

- general editorial revisions to text
- improved field sampling instructions
- added laboratory testing instructions
- added detailed sample shipping instructions
- added shipping tracking tables for each sample

Specifically, the laboratory testing instructions that were added included the following:

- Cores needed for the Materials Reference Library (MRL) for asphalt research purposes were deleted from the sampling plans,
- Sample storage requirements for the MRL materials were revised,
- Several laboratory tests were deleted as per the direction of the SPS-1/SPS-2 meeting participants,
- Specific laboratory designations for testing were identified

The following procedures for laboratory testing were also added to the guidelines:

- Complete laboratory testing instructions
- Sample handling procedures (sample splitting, etc.)
- Specific testing instructions for each type of material
- Laboratory sample handling/tracking tables
- Sample record keeping instructions
- Sample storage requirements

The SPS-1 experiment, Strategic Study of Structural Factors for Flexible Pavements, requires the construction of multiple test sections with similar design details and materials at each of sixteen sites distributed in the four climatic regions. The experimental design and construction considerations for this experiment are described in the SHRP document, "Specific Pavement Studies: Experimental Design and Research Plan for Experiment SPS-1, Strategic Study of Structural Factors for Flexible Pavements," February 1990. The SPS-1 experiment has

been developed as a coordinated national experiment to address the needs of the highway community at large. Therefore, it is important to ascertain the extent of materials uniformity at all test sites to facilitate the analysis of the influence of material/construction variability on the performance of the pavement test sections. General characterization of the pavement materials used to construct the SPS-1 test sections will assist also in the analysis of the performance of the SPS-1 projects.

In this document, the International System of Units (S.I. system) is used followed by the U.S. Customary Unit in parenthesis. This is a "soft" conversion. Although the S.I. system is used, the data sheets (Appendix D of this document) should be completed using the U.S. Customary system of measurement. A later version of this document will implement data collection forms that will require use of the S.I. system of measurement.

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SECTION 1
INTRODUCTION

1. INTRODUCTION

1.1 OVERVIEW

This report provides guidelines for the development and implementation of a material sampling and testing program for each of the test sites included in the Specific Pavement Studies' experiment SPS-1, "Strategic Study of Structural Factors for Flexible Pavements." These guidelines will be used by the FHWA-LTPP Regional Coordination Office to develop recommendations for a field testing, field material sampling, and laboratory testing plan tailored to the individual test site.

The SPS-1 experiment requires the construction of multiple test sections with similar details and materials at each of sixteen sites equally distributed among the four LTPP climatic regions. The experimental design and construction considerations for this experiment are described in the latest version of the document, "Specific Pavement Studies: Experimental Design and Research Plan for Experiment SPS-1, Strategic Study of Structural Factors for Flexible Pavements." Construction features and details for this experiment are described in the document, "Specific Pavement Studies: Construction Guidelines for Experiment SPS-1, Strategic Study of Structural Factors for Flexible Pavements." In spite of attempts to control uniformity in construction, some variation between sites will exist. Therefore, it is important to develop and implement a sampling and testing plan that will provide the information necessary to evaluate such variations and their effect on the performance of the pavement structure.

To obtain the materials characterization required for the SPS-1 experiment, the following steps are required:

1. Review of project site layout and soil profile logs.

2. Formulation of a plan for field sampling and laboratory testing. This plan should take into account site conditions, construction schedule, and the laboratory material testing requirements necessary to characterize the properties of pavement materials. An adequate number of field tests must be performed and sufficient samples must be obtained to assure that all laboratory material characterization tests can be performed.

3. Development of a field sampling and testing plan report. This report should identify sampling area locations, field test locations, type and number of samples from each location and material. The report should include tables that identify the field tests to be performed at each location and the laboratory tests to be performed on each sample.

4. Field sampling and testing of materials. In reporting results of this activity, changes made in the field to the sampling and testing plan must be recorded.

5. Testing of material samples in the laboratory and reporting of test results.

6. Compilation and storage of data. This work will include compilation of field sampling, field test and laboratory material test data and entry of this data into the National Pavement Performance Database.

The SPS-1 experiment was developed to investigate the effect of selected structural factors on the long-term performance of flexible pavements constructed on different subgrade types in different environmental regions. The structural factors include surface layer thicknesses, base type (material), drainability (permeability), and base course thicknesses. Characterization of the material properties and the variations in these properties between and within the test sections is required to evaluate causes of performance differences between test sections and provide a basis for improving current structural design methods. Materials characterization includes those parameters used in current pavement design models and mechanistic analysis models, and the engineering properties generally required to assess the characteristics and behavior of materials.

1.2 MINIMUM REQUIREMENTS

The material sampling and testing plan must be tailored to the specific features encountered on each project. For example, uniformity in subgrade materials along the test site may vary from one site to another. Also, the participating highway agency may construct supplemental test sections at the site in addition to those required for the SPS-1 experiment. To accommodate these differences, the materials sampling and testing plan for one site may vary from that required for another site. For illustration, the material sampling and testing requirements for a hypothetical and "ideal" test site are presented in this report.

The combinations of pavement layer materials and thicknesses required for the different test sections are illustrated in Figures 1 and 2 for the two complementary sites required for each subgrade-climate combination. The sites illustrated in Figures 1 and 2 include Test Sections 1 through 12 and Test Sections 13 through 24, respectively. The site used for this illustration consists of the twelve test sections that make up one of these two experimental sets.

The site layout shown in Figure 3 will be used to illustrate the materials sampling and testing requirements for a SPS-1 test site. For this site, Test Sections 1 through 12 are ordered with consideration to life expectancy, i.e. sections with anticipated lower expected life are

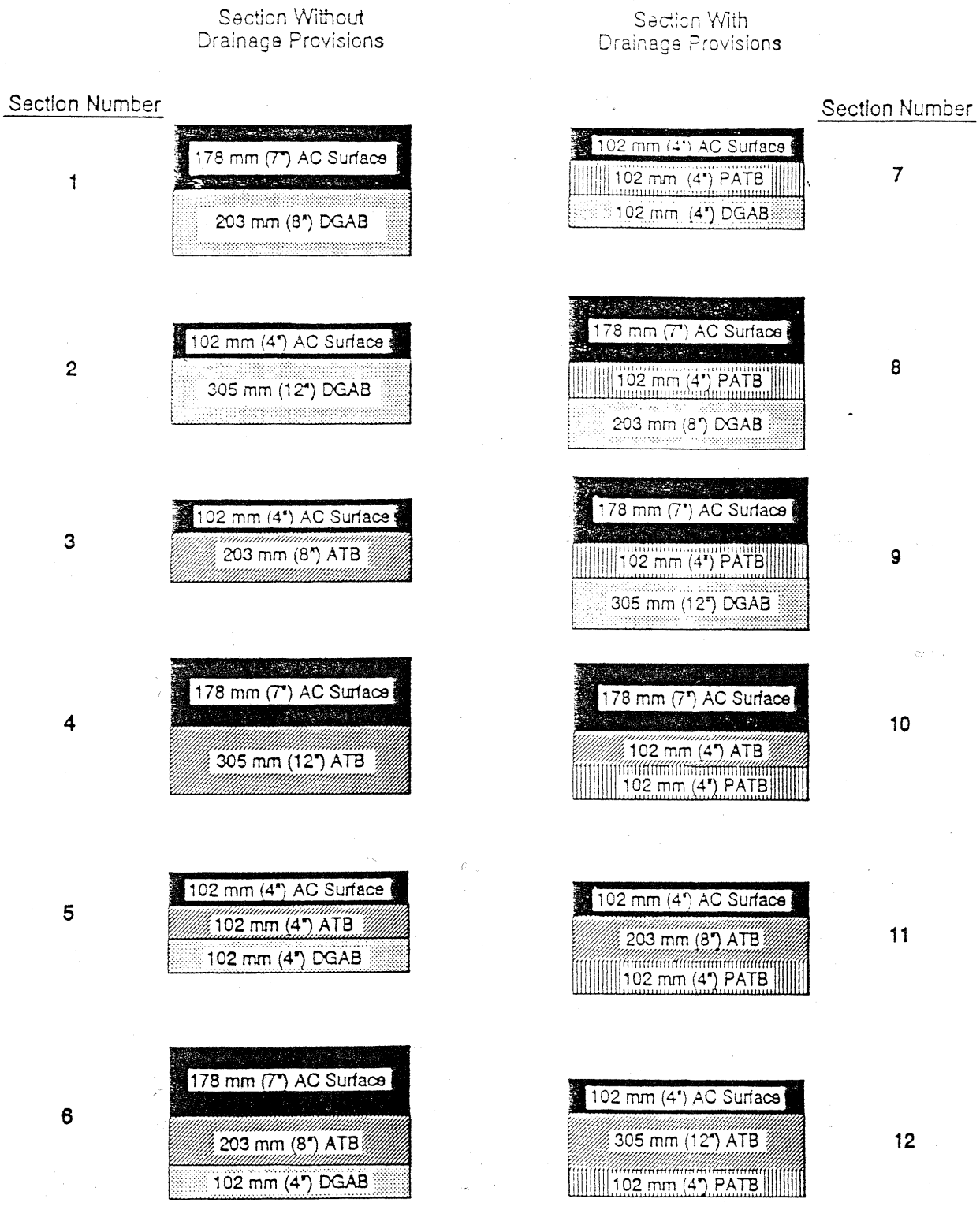


Figure 1. Pavement Cross Sections for a SPS - 1 Test Site with Test Sections 1 through 12

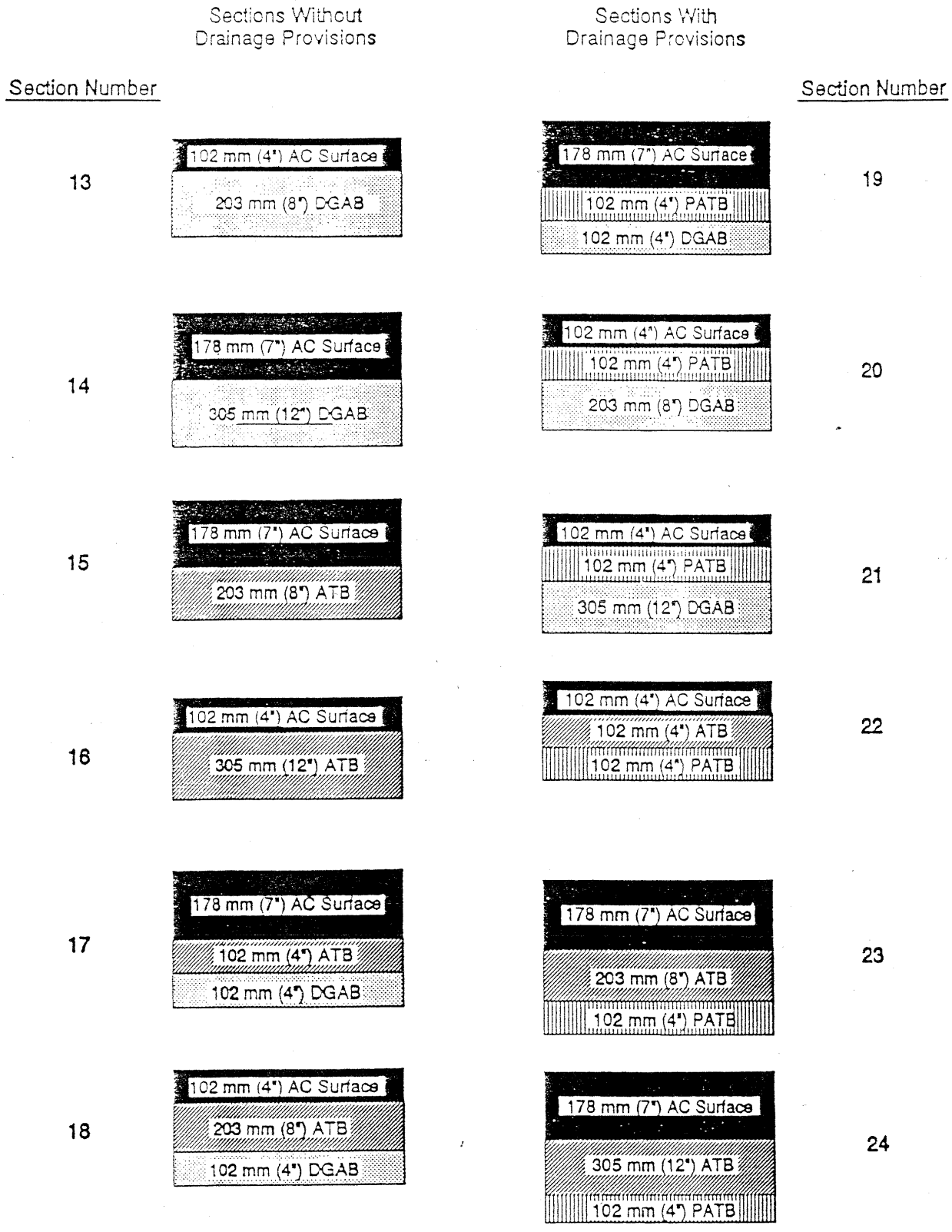


Figure 2. Pavement Cross Sections for an SPS - 1 Test Site with Test Sections 13 through 24

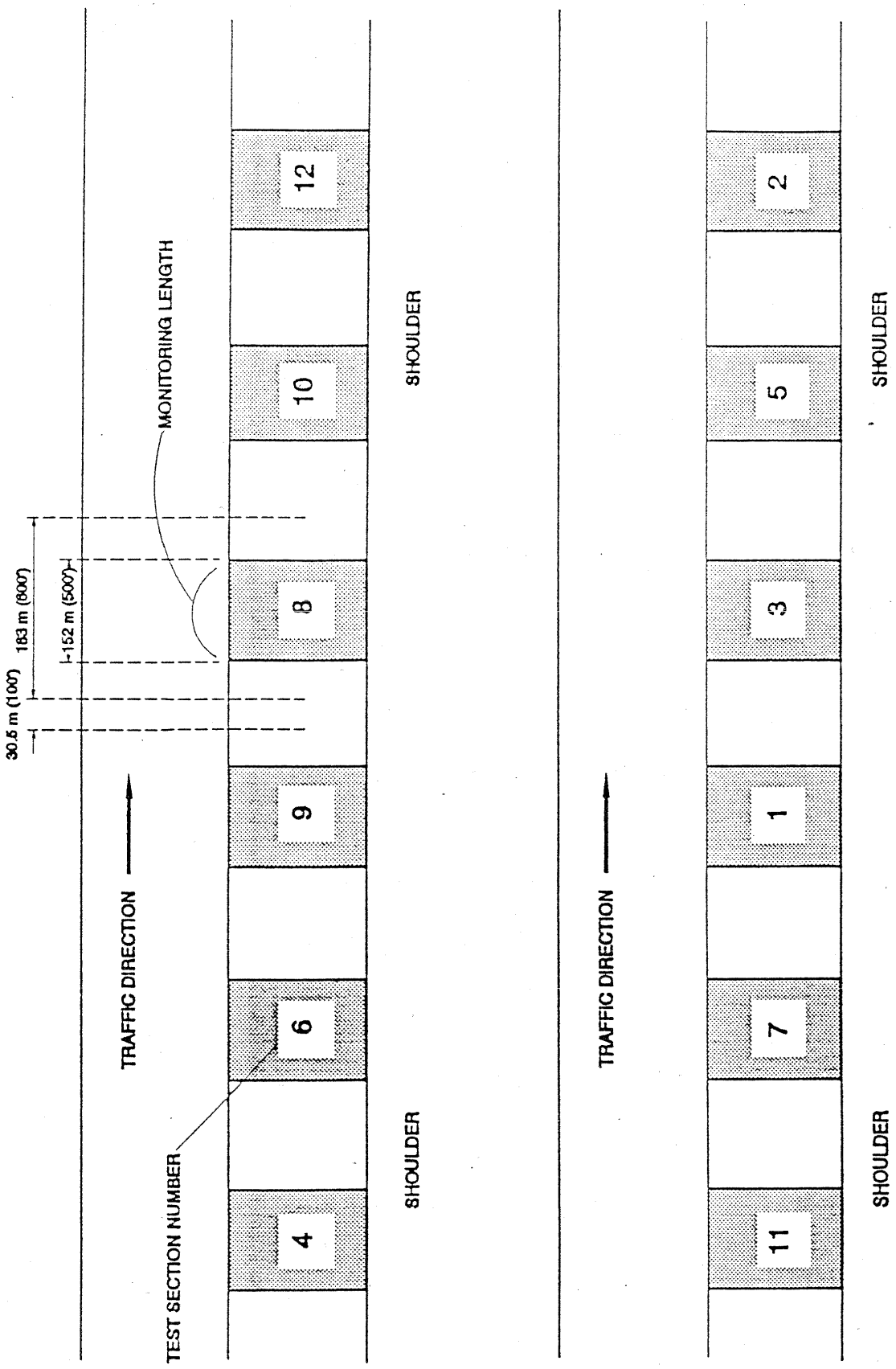


Figure 3. Example of a Site Layout

located downstream. Each test section is constructed with the same pavement structure and material over a minimum of 183 m (600 ft) length to allow for a 152 m (500 ft) monitoring length and 15 m (50 ft) of the same design and details at each end for sampling and testing. Every two adjacent sections are separated by a 30 m (100 ft) distance minimum to allow for changes in thickness, material, and other details. Locations for subgrade and base course testing are distributed throughout each test section. The materials sampling areas are located outside the 152 m (500 ft) long monitoring portion of the section but within the 15 m (50 ft) distance designated for sampling and testing.

The layouts presented in this report are based on the construction sequence, i.e. completion of subgrade preparation, base course, and surface course. Generally, the first testing and sampling will be performed on the prepared subgrade. After construction of each base layer (unbound or treated), in-place testing for density determination (and moisture content if applicable) together with retrieval of bulk samples will be performed. Finally, cores will be taken from the finished asphalt surface course and all underlying bound layers. In addition, bulk samples of the uncompacted asphalt mixture will be obtained from the paver or haul vehicle during construction. Rod and level survey measurements for thickness will be performed on each layer after they are prepared.

The guidelines for formulating the field materials sampling and laboratory testing plans for the SPS-1 experiment have been developed based on the experience gained from the materials testing program developed for the General Pavement Studies and the need for better characterization of the engineering properties of the materials within the test sites. The field testing and material sampling plan developed for each project should adequately address the field and laboratory testing needs. Therefore, a sufficient number of field tests must be performed and a sufficient number of samples must be obtained from each test site to enable adequate characterization of the pavement materials. The field testing and sampling plan illustrated in this report identifies the minimum number of field tests and samples required to achieve this objective.

1.3 COORDINATION BETWEEN FHWA STAFF, PARTICIPATING STATE AGENCY AND FHWA-RCO STAFF

Coordination among all parties involved in the field sampling and testing process is essential to ensure smooth operations in the field and minimize the impact of the sampling process on construction activities on the project.

An essential activity of the field sampling and testing activity is the establishment and continuous communication between the FHWA LTPP Regional Engineers, the FHWA LTPP RCO contractor staff, and the local state highway agency with regard to such items as planning, scheduling, responsibilities, and safety. A planning meeting to initiate this communication and

coordination should be held for each project in advance of any field operations with participation by the LTPP Regional Engineers, FHWA RCO contractor personnel, any drilling and sampling contractor personnel, construction contractor personnel, and the local state highway agency personnel. This is a very important activity. All questions and concerns about such items as sampling and field testing, layouts, scheduling, permits, responsibilities, and safety must be resolved prior to the beginning of field operations.

External coordination and communication of regional activities will be those activities related to other regions, FHWA LTPP technical assistance contract staff, and FHWA LTPP Division headquarters. These should be handled by the FHWA LTPP Regional Engineer or their designee. Such communication will assure timely execution of the work and the transmission of results. Communications after normal working hours should be sent by facsimile machine (FAX) to assure that timely information is transmitted.

SECTION 2

DEVELOPMENT OF SAMPLING AND TESTING PLANS

2. DEVELOPMENT OF SAMPLING AND TESTING PLANS

2.1 GENERAL

The details of the sampling and testing plan for each SPS-1 site will differ depending on the variability and constraints of each specific project. The sampling plan must be tailored for the specific site conditions to account for the distance between test sections, project length, subgrade variability and other conditions unique to the site. The following guidelines are presented to help simplify and standardize the process of developing an appropriate plan for the experiment.

The material sampling and testing plan should be prepared in a coordinated manner with the participation of the state/provincial highway agency and the FHWA LTPP Regional Coordination Office. In addition, the following documents must be reviewed prior to plan preparation:

1. Project plan and profile sheets.

2. Soil profile sheets.

3. Laboratory and field material testing requirements described in this document.

4. Participating highway agency specifications.

5. Other documents or information related to the project, such as field verification reports that would help determine subgrade variability along the site.

The development of sampling and testing requirements for all layers above the subgrade is relatively straight forward. However, the sampling and testing plan for the subgrade and/or embankment layer depends primarily on the variability of the subgrade material throughout the project. Generally, variability of the subgrade will be determined during the site selection process and should be a prime consideration in development of the final subgrade sampling and testing plan for the site. Plan and profile sheets will help determine the location of cut/fill sections and the possible variability in subgrade materials. The constraints imposed on the location of test sections to avoid cut/fill transitions, bridges, culverts, substructures and side hill fills and the inclusion of supplemental test sections desired by the participating agency will require a relatively long test site to accommodate all test sections. This will increase the potential for variability of the subgrade soil along the site. Therefore, the actual number of sampling locations should be based on the total site length and known variations.

Development of the field sampling requirements and plans is largely driven by the number and type of laboratory material characterization tests assigned to this experiment. A sufficient number and amount of material must be obtained in order to characterize the materials.

The overall laboratory material testing program is summarized in Table 1. This table lists the laboratory testing procedures, number of tests and type of sample needed for each layer or material that are required to characterize the material. Table 2 lists the minimum number of material samples and sample types required from each material layer of a SPS-1 site necessary to perform the needed laboratory testing. Table 3 lists the minimum number of field tests required for each finished layer of a SPS-1 site.

The sampling and testing of the pavement materials presented in the example assumes some grouping of similar materials. However, the sampling and testing locations for each specific test section should be used for other test sites regardless of test section location within the site. Appendix A contains a detailed example sampling and testing layout for the test site presented in this report.

Different types of samples of the pavement structure are required at each site, as follows:

- Thin-walled tube and/or splitspoon sampling of subgrade layers to 1.2 m (4 ft) below the top of subgrade at A-type sampling locations (if thin-wall tubes can not be extracted from the subgrade layer then splitspoon samples are to be obtained).
- Jar samples of the subgrade, embankment, and dense graded aggregate base material from B-type sampling locations.
- Bulk samples of the upper 305 mm (12 in.) of the untreated subgrade to be obtained from B-type sampling locations.
- Bulk samples of the uncompacted Dense Graded Aggregate Base (DGAB) material to be obtained from B-type sampling locations prior to base compaction.
- Bulk samples of the uncompacted permeable asphalt treated base (PATB) mixture, designated as BT-type samples, to be obtained from the paver.
- Bulk samples of the uncompacted asphalt treated base (ATB) mixture, designated BT-type samples to be obtained from the paver.
- Bulk samples of the uncompacted asphalt concrete (AC) mixtures used in the surface and binder courses, designated BA-type samples to be obtained from the paver.
- Bulk samples of the asphalt cement used in all mixtures, designated BC-type samples to be obtained at the plant.
- Cores of the asphalt surface, binder course, and dense graded asphalt treated base layers are to be obtained. These shall be 102 mm (4 in.) outer diameter cores.

Table 1 - Laboratory Materials Testing Plan

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Type of Sample Needed
SUBGRADE (when embankment ≥ 1.2 m [4 ft])				
No Testing				
SUBGRADE (when embankment < 1.2 m)				
Sieve Analysis	SS01	P51	6	Bulk
Hydrometer to 0.001 mm	SS02	P42	6	Bulk
Atterberg Limits	SS03	P43	6	Bulk
Classification	SS04	P52	6	Bulk
(visual-manual only on thin-wall tubes)			18	Thin-wall tube (if available)
Moisture-Density Relations	SS05	P55	6	Bulk
Resilient Modulus	SS07	P46	6	Thin-wall tube (if available)
			6	Bulk (only if thin-wall tubes not available)
Unit Weight (if thin-wall tube is not available, test is not conducted)	SS08	P56	6	Thin-wall tube (if available)
Natural Moisture Content	SS09	P49	6	Jar
Unconfined Comp. Strength (if thin-wall tube is not available, test is not conducted)	SS10	P54	6	Thin-wall tube (if available)
Permeability	SS11	P57	3	Thin-wall tube (if available)
Permeability	UG09	P48	6	Bulk (only if thin-wall tube not available)
EMBANKMENT < 1.2 m (4 ft) Thick				
Sieve Analysis	SS01	P51	6	Bulk
Hydrometer to 0.001 mm	SS02	P42	6	Bulk
Atterberg Limits	SS03	P43	6	Bulk
Classification	SS04	P52	6	Bulk
Moisture-Density Relations	SS05	P55	6	Bulk
Resilient Modulus	SS07	P46	6	Bulk
Natural Moisture Content	SS09	P49	6	Jar
Permeability	UG09	P48	6	Bulk

Table 1 - Laboratory Materials Testing Plan

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Type of Sample Needed
EMBANKMENT ≥ 1.2 m (4 ft) Thick				
Sieve Analysis	SS01	P51	6	Bulk
Hydrometer to 0.001 mm	SS02	P42	6	Bulk
Atterberg Limits	SS03	P43	6	Bulk
Classification	SS04	P52	6	Bulk
(visual-manual only on thin wall tube)			18	Thin-wall tube (if available)
Moisture-Density Relations	SS05	P55	6	Bulk
Resilient Modulus	SS07	P46	6	Thin-wall tube (if available)
			6	Bulk (only if thin-wall tubes not available)
Unit Weight (if thin-wall tube is not available, test is not conducted)	SS08	P56	6	Thin-wall tube (if available)
Natural Moisture Content	SS09	P49	6	Bulk
Unconfined Comp. Strength (if thin-wall tube is not available, test is not conducted)	SS10	P54	6	Thin-wall tube (if available)
Permeability	SS11	P57	3	Thin-wall tube (if available)
Permeability	UG09	P48	6	Bulks (if thin-wall tube not available)
UNBOUND GRANULAR BASE				
Particle Size Analysis	UG01	P41	3	Bulk
Sieve Analysis (washed)	UG02	P41	3	Bulk
Atterberg Limits	UG04	P43	3	Bulk
Moisture-Density Relations	UG05	P44	3	Bulk
Resilient Modulus	UG07	P46	3	Bulk
Classification	UG08	P47	3	Bulk
Permeability	UG09	P48	3	Bulk
Natural Moisture Content	UG10	P49	3	Jar
PERMEABLE TREATED ASPHALT BASE				
Asphalt Content (Extraction)	AC04	P04	3	Bulk (from paver)
Extracted Aggregate:				
Gradation of Aggregate	AG04	P14	3	Bulk (from extracted aggregate sample)

Table 1 - Laboratory Materials Testing Plan

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Type of Sample Needed
ASPHALT TREATED BASE				
Core Examination/Thickness	AC01	P01	34	102 mm (4 in.) O.D. core
Bulk Specific Gravity	AC02	P02	34	102 mm (4 in.) O.D. core
Maximum Specific Gravity	AC03	P03	3	Bulk (from paver)
Asphalt Content (Extraction)	AC04	P04	3	Bulk (from paver)
Moisture Susceptibility	AC05	P05	3	Bulk (from paver)
Resilient Modulus	AC07	P07	9	102 mm (4 in.) O.D. core
Tensile Strength	AC07	P07	12	102 mm (4 in.) O.D. core
Extracted Aggregate:				
Specific Gravity:				
Coarse Aggregate	AG01	P11	3	Bulk
Fine Aggregate	AG02	P12	3	Bulk
Gradation of Aggregate	AG04	P14	3	Bulk
NAA Test for Fine Aggregate	AG05	P14A	3	Bulk
Particle Shape				
Asphalt Cement:				
Abson Recovery	AE01	P21	3	Bulk
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	Bulk
Specific Gravity 16°C (60°F)	AE03	P23	3	Bulk
Viscosity at 25°C (77°F)	AE04	P24	3	Bulk
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	Bulk
Asphalt Cement: (From Tanker or Plant)				
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	19 l (5 gal.) Bulk sample
Specific Gravity 16°C (60°F)	AE03	P23	3	19 l (5 gal.) Bulk sample
Viscosity at 25°C (77°F)	AE04	P24	3	19 l (5 gal.) Bulk sample
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	19 l (5 gal.) Bulk sample

Table 1 - Laboratory Materials Testing Plan

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Type of Sample Needed
ASPHALTIC CONCRETE SURFACE AND BINDER				
Core Examination/Thickness	AC01	P01	60	102 mm (4 in.) core
Bulk Specific Gravity	AC02	P02	60	102 mm (4 in.) core
Maximum Specific Gravity	AC03	P03	3	Bulk (from paver)
Asphalt Content (Extraction)	AC04	P04	3	Bulk (from paver)
Moisture Susceptibility	AC05	P05	3	Bulk (from paver)
Creep Compliance	AC06	P06	3	102 mm (4 in.) core
Resilient Modulus	AC07	P07	18	102 mm (4 in.) core
Tensile Strength	AC07	P07	24	102 mm (4 in.) core
Extracted Aggregate:				
Specific Gravity:				
Coarse Aggregate	AG01	P11	3	Bulk
Fine Aggregate	AG02	P12	3	Bulk
Gradation of Aggregate	AG04	P14	3	Bulk
NAA Test for Fine Aggregate Particle Shape	AG05	P14A	3	Bulk
Asphalt Cement:				
Abson Recovery	AE01	P21	3	Bulk
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	Bulk
Specific Gravity 16°C (60°F)	AE03	P23	3	Bulk
Viscosity at 25°C (77°F)	AE04	P24	3	Bulk
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	Bulk
Asphalt Cement: (From Tanker)				
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	19 l (5 gal.) Bulk sample
Specific Gravity 16°C (60°F)	AE03	P23	3	19 l (5 gal.) Bulk sample
Viscosity at 25°C (77°F)	AE04	P24	3	19 l (5 gal.) Bulk sample
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	19 l (5 gal.) Bulk sample

Table 2 - Scope of Material Sampling

Material and Sample Description	Number of Samples	Sample Locations
Asphalt Concrete		
Coring - 102 mm (4 in.) diameter cores	60	C1-C60
Bulk Sampling (91 kg [200 lb] per sample, uncompacted)	3	B25, B26, B27 from paver
Bulk Sampling - Asphalt Cement	3	B28, B29, B30 from plant
Asphalt Treated Base		
Coring - 102 mm (4 in.) diameter cores	34	C1-C10, C21-C34, C47-C56
Bulk Sampling (91 kg [200 lb] per sample, uncompacted)	3	B19, B20, B21 from paver
Bulk Sampling - Asphalt Cement	3	B22, B23, B24
Permeable Asphalt Treated Base		
Bulk Sampling (45 kg [100 lb] per sample, uncompacted)	3	B16, B17, B18 from paver
Unbound Base/Subbase Layers (per layer)		
Bulk Sampling (181 kg [400 lb] each sample)	3	B13, B14, B15
Moisture Content Samples	3	B13, B14, B15
Embankment < 1.2 m (4 ft) Thick		
Bulk Sampling (181 kg [400 lb] each sample)	6	B7-B12
Moisture Content Samples	6	B7-B12
Subgrade		
Thin-Walled Tube Sampling (* 2 tubes)	36*	A1-A18
Splitspoon Sampling (only if thin-wall tube cannot be obtained)	36*	A1-A18
Bulk Sampling (181 kg [400 lb] each sample)	6	B1-B6
Moisture Content Samples	6	B1-B6

NOTES:

1. If different AC mixes are used for the surface course and binder course, bulk samples should be obtained from each mix.
2. Bulk samples of asphalt cement shall be obtained for each type of asphalt cement used on the project.

Table 3 - Scope of Field Testing

Material	Number of Tests	Location Designation
Asphalt Concrete		
In situ density (nuclear gauge)	36	T166-T201
Asphalt Treated Base		
In situ density (nuclear gauge)	21	T145-T165
Unbound Base/Subbase Layers (per layer)		
In situ density, moisture content (nuclear gauge)	24	T121-T144
Treated Subgrade		
In situ density, moisture content (nuclear gauge)	36	T85-T120
Embankment < 1.2 m (4 ft)		
In situ density, moisture content (nuclear gauge)	42	T43-T84
Subgrade		
In situ density, moisture content (nuclear gauge)	42	T1-T42
Shoulder auger probe	12	S1-S12

Also, bulk samples of the asphalt cement, aggregates and uncompacted asphalt concrete mixes used in the asphalt surface course of the test sections will be collected during construction for long-term storage purposes. The samples required for long-term storage are detailed in a later section.

The site specific field material sampling, field testing, and laboratory testing plan for each SPS-1 site should include the following elements:

- Project layout plan (The project layout plan is developed prior to construction and is not discussed herein).
- Laboratory testing plan.
- Detailed sampling layout.
- Detailed field testing layout.

Other items which may be included with the sampling and testing plan are soil profile logs, plan and profile sheets and other project-specific information which are pertinent to the plans. The recommended plan should be compiled and submitted for review and approval by the LTPP Regional Engineer prior to implementation.

The following sections provide details for each element of the field material sampling and laboratory testing plan for a SPS-1 test site.

2.2 SAMPLING AND FIELD TESTING LAYOUT PLAN

The sampling and field testing layout plans are used to identify the location of testing and sampling areas relative to the test sections for each sampling and testing activity. Since sampling and testing is required at different stages of construction, layouts must be developed for each stage, i.e. prepared subgrade, base course, surface course. The approximate transition lengths between test sections should be indicated on the plan.

To ensure consistency in data reporting, a detailed layer structure should be developed prior to sampling and testing for the entire SPS project (termed "Project Level") and for each individual pavement section (termed "Section Level"). In the Project Level scheme, each unique layer is designated by a letter of the alphabet. An example project level layer structure is shown in Table 4 for a typical SPS-1 project.

Several issues are involved herein. The first issue is the designation of subgrade and embankment material. The natural soil on which the pavement structure rests shall always be designated as the subgrade (layer 1). If a project or test section is located on fill material, then the project layer numbering shall contain an embankment layer.

Table 4 - Example Project Layer Numbering

Project Layer Code	Material Code	Comments
A	104	Natural Soil
B	107	Embankment
C	338	Lime-treated Subgrade
D	303	Dense Graded Aggregate Base
E	322	Permeable Asphalt Treated Base
F	319	Dense Graded Asphalt Treated Base
G	01	HMAC Binder Course
H	01	HMAC Surface Course

It must be noted that if a fill (embankment) layer is present and is greater than 1.2 m (4 ft) in thickness, the natural subgrade will NOT be sampled or tested. The fill (embankment) layer only will be sampled and tested as if it were the natural subgrade (see Tables 1 through 3).

Also, if any test section on a project is located on a treated subgrade layer, the project layering table shall contain a project layer code for this treated subgrade layer; designated as a treated subbase.

The layering for the dense graded aggregate base, permeable asphalt treated base, and dense graded asphalt treated base is rather straight forward. However, the hot mix asphalt surface course may contain two (or more) layers. If the entire surface course is comprised of the same mix design, then only one layer code is needed to represent the layer. However, if the asphalt hot mix layer is comprised of a surface and binder course which are not comprised of the same mix design (asphalt content, aggregate gradation, etc.) then these must be treated as two separate layers and coded and sampled accordingly. It should be noted that multiple lifts of the same material shall not be identified as separate layers.

After the project level layering is completed, each individual test section will use the appropriate project layer codes to designate their layer structure. Table 5 contains an example pavement layer structure for SPS-1 test section number 6.

The establishment of this project and test section level layer structure is essential to maintain consistency within the project. These layer numbers will follow the project and each test section throughout the field sampling and laboratory testing programs. Details for the proper procedures to be used to perform this layering activity can be found in the latest version of the "Specific Pavement Studies Layering Methodology" report.

2.3 SUBGRADE SAMPLING AND TESTING

When laying out the detailed sampling and testing plan for the subgrade (Layer Number 1), the following guidelines should be followed:

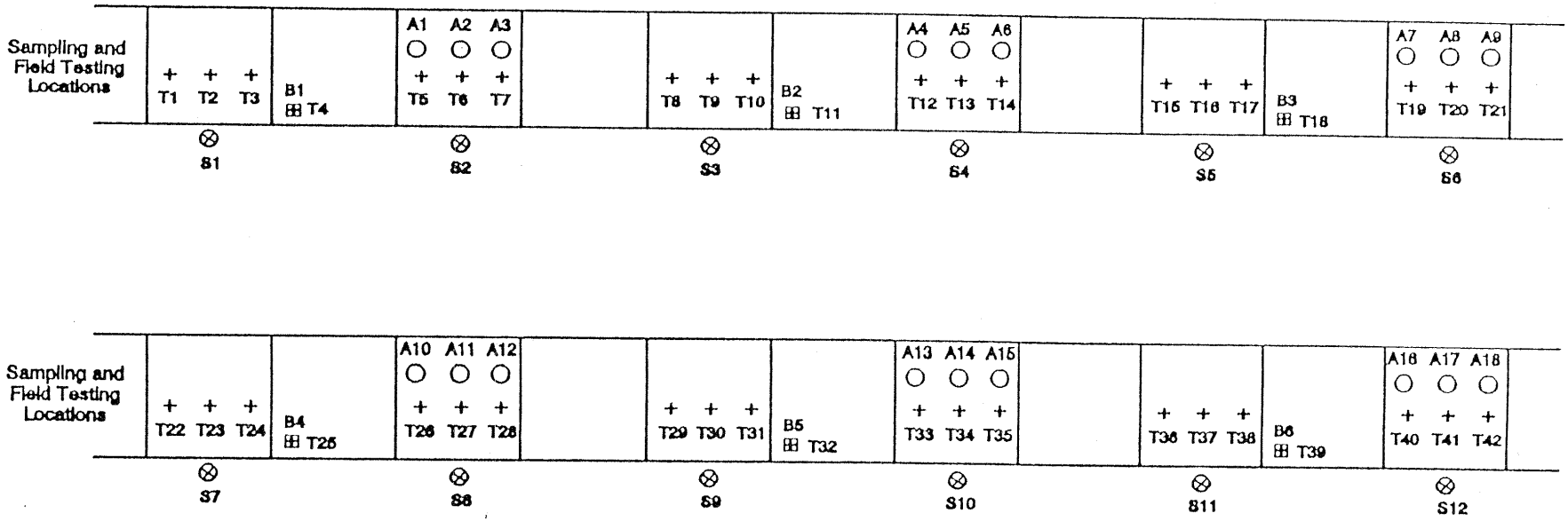
- In general, each bulk sampling area should consist of a single shallow excavation, approximately 0.6 by 0.6 m (2 by 2 ft) and 305 mm (12 in.) deep.
- Sampling locations, especially A-type locations, should not be located in cut and fill transition areas. These sampling locations must always be located completely in either a cut or fill.

Table 5 - Example Test Section Layer Numbering - Section 6

LAYER NUMBER	PROJECT LAYER CODE	LAYER THICKNESS (INCHES)	MATERIAL CODE	COMMENT
1	A	N/A	104	Natural Soil
2	B	24	107	Embankment
3	D	4	303	Dense Graded Aggregate Base
4	F	8	319	Dense Grade Asphalt Treated Base
5	G	4	01	HMAC Binder Course
6	H	3	01	HMAC Surface Course

- Bulk sampling areas (exclusive of thin wall tube samples) should be located outside the monitoring portion of the test section but in areas which are considered representative of the test section. Additionally, nuclear moisture/density testing must be conducted prior to excavation at each bulk sampling location.
- For a test section that is placed more than one mile away from another test section or group of test sections, sampling should include A-type (thin-wall tube) and at least one bulk sampling location.
- If a group of test sections is located more than a mile away from another localized group of test sections, each group shall be treated separately in determining sampling requirements.
- Sampling for supplemental test sections, such as those representing the agency's design practice, should be incorporated in the sampling and testing plan following the overall criteria established for the SPS experiment.
- Samples of embankment fill that are obtained as part of subgrade sampling should be clearly identified.
- Auger probes to a depth of 6 m (20 ft) through the shoulder should be included for each test section to determine the depth to a rigid layer. The purpose of the shoulder auger probe, designated as S-type boring, is to determine if bedrock or other significantly dense layers exist within 6 m (20 ft) of the proposed pavement surface elevation. This information is extremely important for the analysis of deflection measurements.
- If the SPS-1 project is located in an area where the presence of expansive soil is a possibility, Protocol P60 (Expansion Index of Subgrade Soils) shall be used to sample and test the subgrade material.
- As a minimum, each test section's finished subgrade layer shall have nuclear moisture/density testing performed in three positions throughout the section as illustrated in the example. In addition, approximately every other section should have thin wall tubes extracted from within the pavement section.
- Elevation measurements of the final prepared surface shall be conducted throughout the test section.

In addition, the plan should reflect the variation of the subgrade at a specific site. If there is a high degree of variability at the site, the number of bulk sampling and A-type sampling locations should be increased. Similarly, if the subgrade soil is relatively consistent, the number of bulk sampling and A-type samples may be reduced. The primary purpose of the plan is to characterize, as closely as possible, the integrity, physical properties and engineering behavior of the subgrade materials at the test site. Figure 4 shows the typical sampling and testing locations for a subgrade layer and for embankment layers greater than or equal to 1.2 m (4 ft)



LEGEND

- □ 0.6 m x 0.6 m (2' x 2') bulk sampling location (B1 - B6) to 305 mm (12") below top of subgrade/embankment
- ○ Thin wall tube/splitspoon sampling to 1.2 m (4') below top of subgrade (A1 - A18)
- ⊗ Shoulder probe (S1 - S12)
- \+ Location of field nuclear moisture/density testing (T1 - T42)

Note: Nuclear moisture/density testing must be conducted at bulk sampling location prior to excavation.

Figure 4. Sampling and Testing Locations for Subgrade (and Embankment Layers≥ 1.2 m [4 ft])

in depth. Figure 5 shows the sampling and field testing plan for embankment layers ≤ 1.2 m (4 ft) in depth and Figure 6 shows the sampling plan for treated subgrade layers.

Special rules govern the sampling and testing of the subgrade material as follow:

- If an embankment (fill) layer is greater than or equal to 1.2 m (4 ft) in thickness, it shall be considered the subgrade layer. The natural subgrade soils will not be sampled or tested (Figure 4).
- If an embankment (fill) layer is less than 1.2 m (4 ft) in thickness, it shall be sampled and tested as an embankment layer (Figure 5) and the natural subgrade shall be sampled and tested as per Figure 5. The embankment layer shall be considered a subbase layer.
- A treated material subgrade layer shall be treated as an independent layer and it shall be tested as per Figure 6.

2.4 BASE COURSE SAMPLING AND TESTING

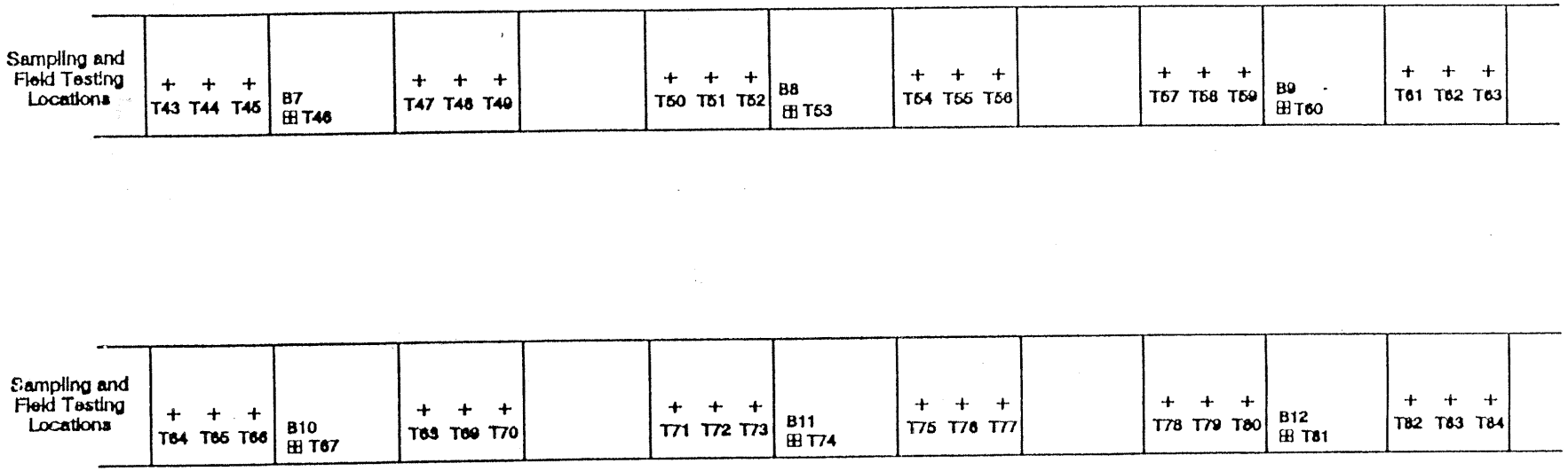
The sequence and frequency of field sampling and testing required for the base course depends on the base course material and its location within the pavement structure. Therefore, a different field sampling and test plan is required to characterize the properties of each of the base materials (DGAB, PATB and DGATB) used in the experiment. Figure 7 illustrates the sampling and testing locations for the dense graded aggregate base (DGAB).

The field sampling and field testing activities required to characterize the properties of the dense graded aggregate base material include the following:

- bulk sampling of the uncompacted base material from B-type sampling locations for laboratory testing,
- nuclear moisture and density testing throughout each test section,
- elevation measurements throughout each test section.

The field sampling and testing activities required to characterize the properties of the permeable asphalt treated base material include the following:

- bulk sampling of the uncompacted asphalt concrete material from the paver or haul vehicle immediately prior to lay-down for laboratory testing,
- elevation measurements throughout each test section.



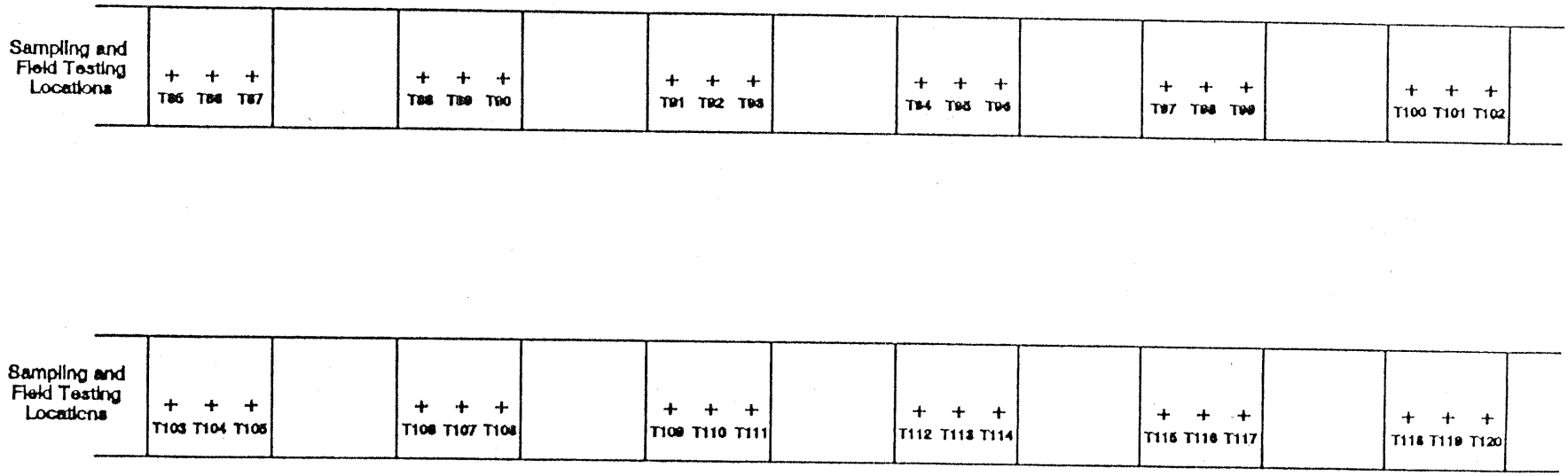
LEGEND

□ 0.6 m x 0.6 m (2' x 2') bulk sampling location (B7 - B12) to 305mm (12") below top of subgrade/embankment

\+ Location of field nuclear moisture/density testing (T43 - T84)

Note: Nuclear moisture/density testing must be conducted at bulk sampling location prior to excavation.

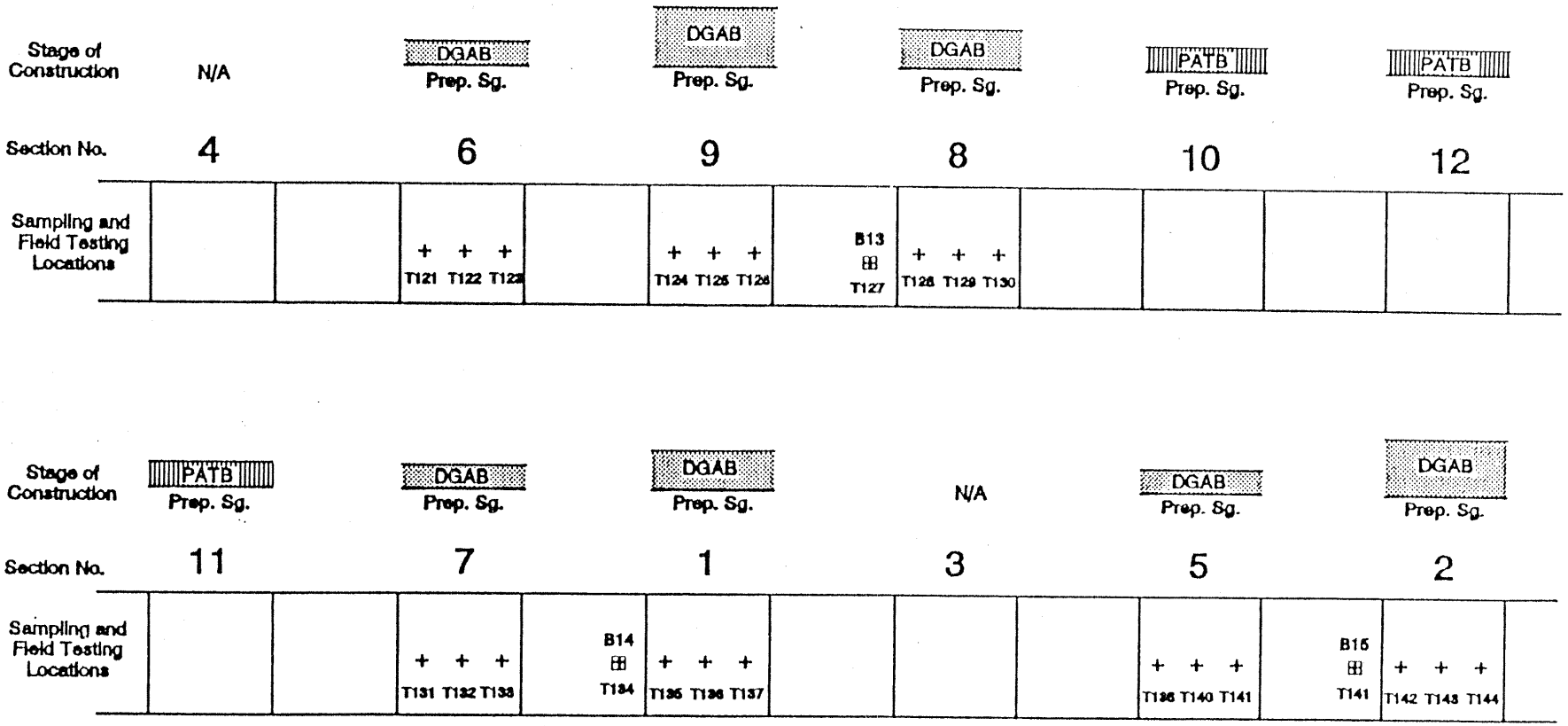
Figure 5. Sampling and Testing Locations for Embankment Layers < 1.2 m (4 ft) in depth.



LEGEND

\+ Location of field nuclear moisture/density testing (T85 - T120)

Figure 6. Testing Locations for Treated Subgrade Layers.



LEGEND

+ Location of field testing (T121 through T144)

☐ Location of bulk sampling of DGAB (B13 - B15)

Prep. Sg. - Prepared Subgrade

PATB - Permeable Asphalt Treated Base

DGAB - Dense Graded Aggregate Base

Note: Nuclear moisture/density testing must be conducted at bulk sampling location.

Figure 7. Sampling and Testing Locations for DGAB.

The field sampling and testing activities required to characterize the properties of the asphalt treated base material include the following:

- bulk sampling of the uncompacted asphalt concrete material from the paver or haul vehicle immediately prior to lay-down for laboratory testing,
- density testing by nuclear methods throughout the test sections,
- elevation measurements throughout each test section.

In addition, coring of the dense graded asphalt treated base will be performed in conjunction with coring of the asphalt surface course to obtain samples for laboratory testing. Figure 8 illustrates the testing locations for the dense graded asphalt treated base (ATB).

2.5 SURFACE COURSE SAMPLING AND TESTING

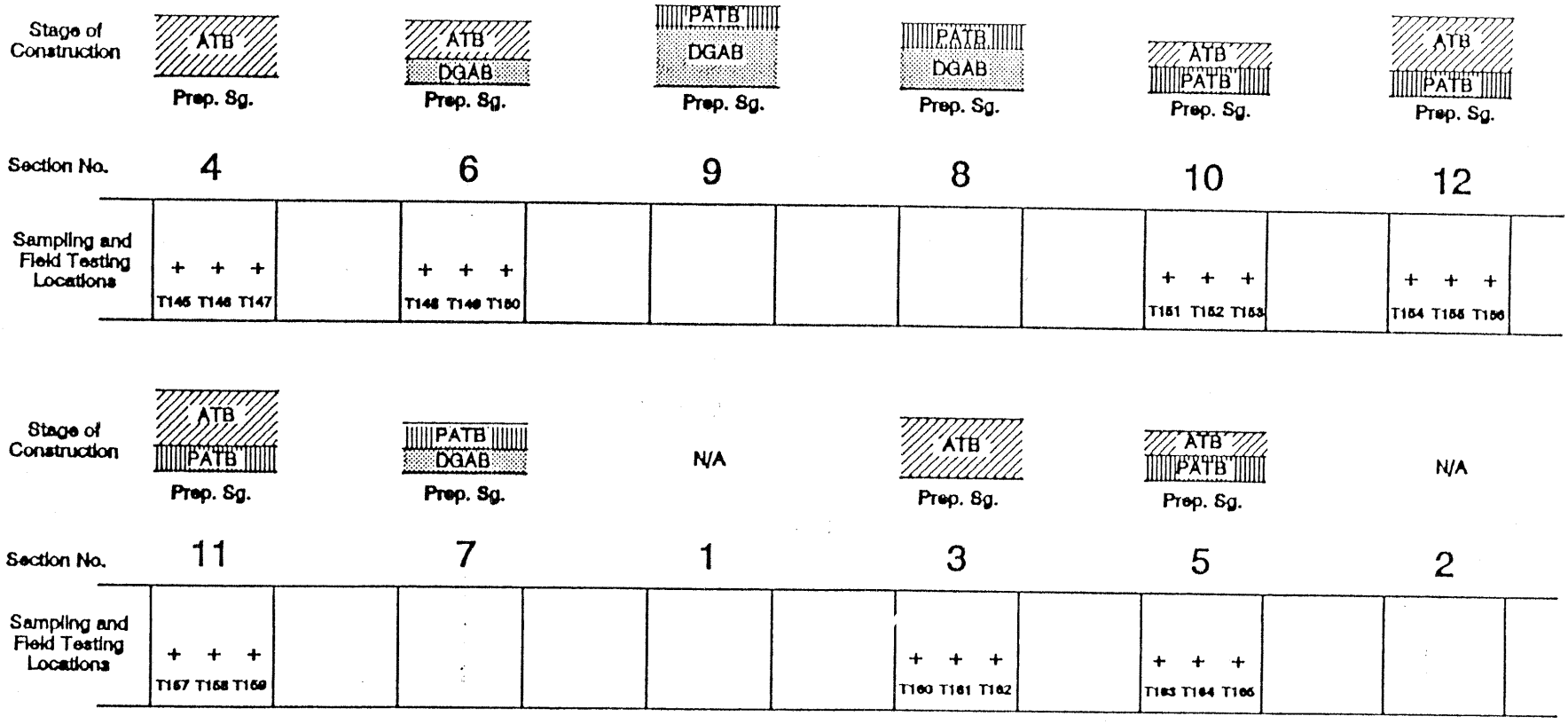
The field sampling and testing activities required to characterize the properties of the surface course material include the following:

- bulk sampling of the uncompacted mix from the paver or haul vehicle immediately prior to lay-down for laboratory testing,
- coring outside the monitoring portion of test sections to obtain samples of surface and underlying bound layers for laboratory testing,
- sampling of the asphalt cement from the plant,
- density testing by nuclear methods throughout test sections,
- elevation measurements throughout each test section.

Figure 9 illustrates the sampling and testing locations for the asphalt concrete binder and surface courses.

The purpose of the surface course sampling is to characterize the as-placed properties of the asphalt concrete materials. This includes determination of thickness, resilient modulus, specific gravity, creep compliance and tensile strength. Tests on the extracted aggregates and asphalt cements will be performed on the uncompacted bulk samples obtained from the mix plant.

The required number of resilient modulus, creep compliance and thickness tests will control the number of surface layer cores.



LEGEND

\+ Location of field nuclear density testing (T145 through T165)

Prep. Sg. - Prepared Subgrade

PATB - Permeable Asphalt Treated Base

DGAB - Dense Graded Aggregate Base

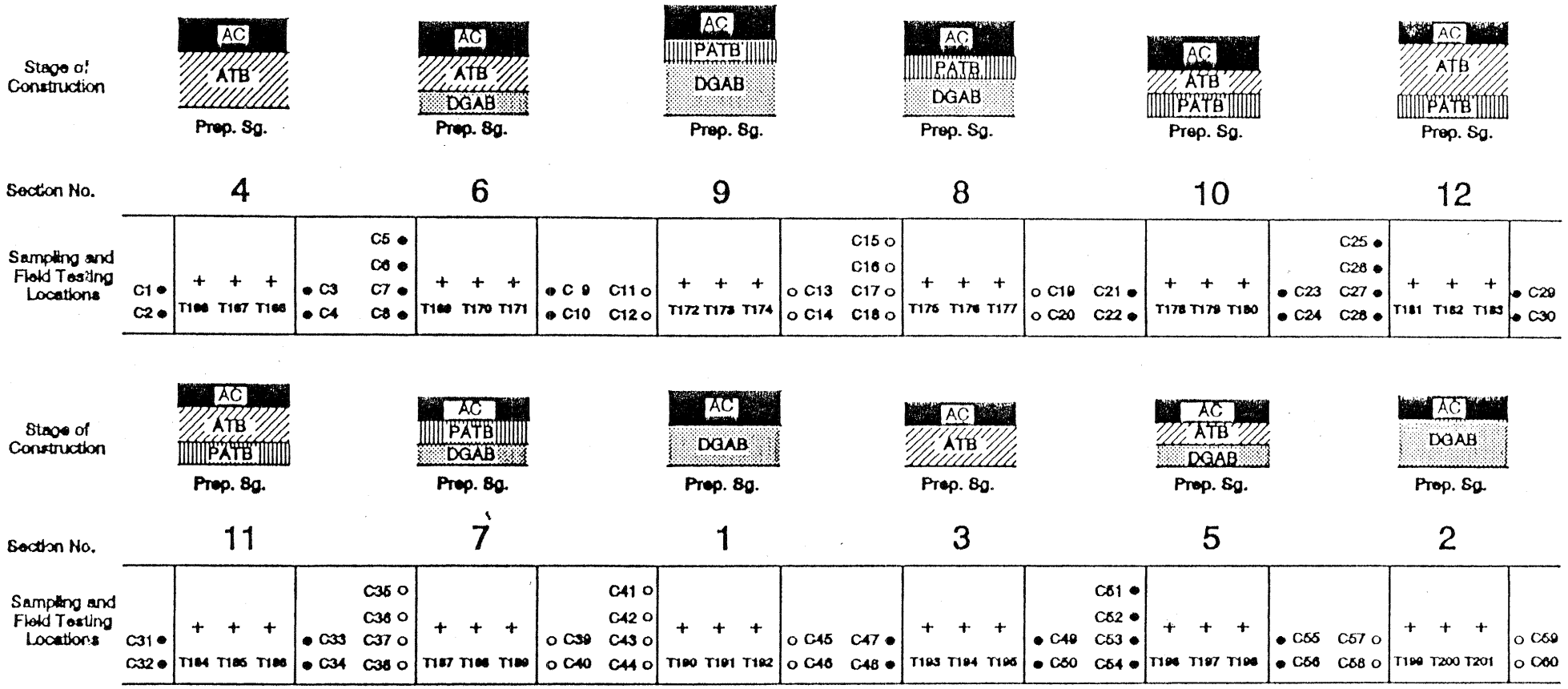
ATB - Asphalt Treated Base

Figure 8. Testing Locations for ATB.

- *Resilient modulus* - A minimum of eighteen resilient modulus tests should be performed on cores from the asphalt concrete surface. These tests will be grouped into six sampling areas of three cores each. Also, nine tests from three sampling areas of three cores each should be performed on cores from the ATB layers. In addition, a core will be required from the same general location for indirect tensile testing to be performed in conjunction with each set of three cores used for the resilient modulus test.
- *Creep compliance* - Three creep compliance test should be performed on the asphalt surface course material. Three cores obtained from the throughout the project are required for this test.
- *Thickness* - A minimum of two cores taken from locations adjacent to both ends of each test section are needed to quantify the as-placed thickness. These cores should be taken along the same transverse line at 0.9 m and 1.8 m (3 ft and 6 ft) from the edge of the travel lane.

It is important to insure that the sampling areas are located in portions of the pavement that are constructed with the same materials and layer thicknesses as the adjacent monitoring portion and thus are representative of the test section. Therefore, 183 m (600 ft) long test sections should be constructed with the same pavement structure and materials to allow 152 m (500 ft) monitoring length and a minimum of 15 m (50 ft) at each end for field sampling. The field sampling should occur within the 15 m (50 ft) at each end of the test section so as not to occur in the transition zone where material type and thickness may vary.

Detailed sampling plan layouts should be prepared for use in the field following the format shown in Appendix A. The location and type of each sample should be illustrated relative to the beginning and end of each test section and relative to the shoulder and/or the centerline of the pavement lane.



LEGEND

- ○ 102 mm (4") OD Core of Asphalt Concrete Surface (C11 - C20, C35 - C46, C57 - C60)
- ● 102 mm (4") OD Core of Asphalt Concrete Surface and Treated Base (C1 - C10, C21 - C34, C47 - C56)
- \+ Location of field nuclear density testing within section (T166 - T201)

Prep. Sg. - Prepared Subgrade
PATB - Permeable Asphalt Treated Base
DGAB - Dense Graded Aggregate Base
ATB - Asphalt Treated Base

Figure 9. Sampling and Testing Locations for AC Surface.

SECTION 3

FIELD MATERIAL SAMPLING AND TESTING

3. FIELD MATERIAL SAMPLING AND TESTING

3.1 GENERAL

This section describes procedures and guidelines for field material sampling and field testing and the handling of cores and other material samples in the field and during transfer to the laboratory for testing. These procedures should be followed as closely as possible to minimize the variability of material properties attributable to differences in field testing, field sampling, and sampling handling techniques.

Throughout this document, base and subbase materials are referred to by such terms as "bound," "treated," "untreated," etc. The terms "bound," "treated," and "stabilized" are used interchangeably and refer to base and subbase layers containing a cementing agent such as asphalt or portland cement. The terms "unbound," "untreated," and "unstabilized" are used interchangeably and refer to granular base and subbase layers containing no additional materials. Subgrade soils are classified as either fine-grained or coarse-grained soils and refer to the materials beneath a base or subbase layer.

The field material sampling and field testing activities will provide pavement material samples for laboratory testing and will yield in situ moisture and density data for each test site. Field sampling and field testing will be performed during the different phases of pavement construction to fully characterize the pavement structure constructed for each test section. This information will be used in evaluating the service life and long-term performance of the different pavement structures and details used in the experiment.

3.2 PERSONNEL REQUIREMENTS

The scope, intensity and time constraints imposed for the field drilling and sampling for this SPS experiment are such that it is recommended that additional field personnel (above and beyond those needed for routine construction/acceptance testing) be present on the site. These personnel should have sole responsibility for obtaining the necessary material samples and performing the necessary testing. It is recommended that the field crew include a qualified and experienced on-site project supervisor. This supervisor should be a senior technician, geologist, or engineer with at least five years of experience in subsurface explorations and at least three equivalent years of experience in field sampling and testing of existing pavements. This person must be familiar with all aspects of the drilling and sampling program, field drilling and sampling techniques and the timing of all field activities.

3.3 FIELD OPERATIONS

This section outlines procedures for field sampling, field testing and handling of material retrieved from the SPS-1 test site. Field operations at each site will be performed at different stages of the construction and will include the following activities:

1. The FHWA-LTPP Regional Coordination Office shall coordinate with the participating highway agency and the contractor(s) regarding the field activities involved in the testing and sampling operations. With the concurrence of the participating highway agency, the LTPP Regional Engineer shall designate a representative to assist and coordinate with the participating highway agency and contractors in ensuring that the field operations are performed in accordance with the approved field sampling and testing plan.

2. On each occasion after arriving at the test site, the responsible personnel shall lay out the sampling and testing locations and perform the sampling and testing operations in an appropriate sequence.

3. The FHWA-LTPP Regional Coordination Office field representative shall record and report problems encountered during the field operations to the LTPP Regional Engineer and obtain recommendations for resolution.

4. Test samples shall be prepared for shipping together with complete logs and other records.

Sampling and field testing operations on the prepared subgrade may be performed in the following sequence:

a) Thin-wall tube undisturbed sampling of subgrade material shall be performed as designated on the sampling plans. If thin-wall tube samples cannot be obtained, the LTPP representative may direct the use of splitspoon sampling to obtain subgrade material samples. If splitspoon samples are obtained from the test section, then these samples shall be opened and inspected in the field. The soil layers should be identified and recorded on Sampling Data Sheet 4-1 (Appendix B). Splitspoon samples need <u>not</u> be retained or shipped to the laboratory for further evaluation.

b) auger probes in the shoulder,

c) bulk sampling and nuclear moisture/density testing at bulk sampling locations,

d) moisture/density testing within the test sections, and

e) repairing and recompacting the bulk sampling areas and auger boring locations.

Sampling and field testing operations on the base course may be performed in the following sequence:

a) bulk sampling of DGAB material from sampling areas after compaction,
b) bulk sampling of the DGATB and PATB from the paver immediately prior to lay-down,
c) nuclear moisture/density testing of the in-place DGAB or nuclear density testing of the DGATB within the test sections and nuclear moisture/density testing of in-place DGAB in bulk sampling areas,
d) patching and cleanup as required.

Sampling and field testing operations on the finished surface course may be performed in the following sequence:

a) nuclear density testing within the test sections,
b) retrieval of 102 mm (4 in.) outer diameter cores of the asphalt concrete surface and bound layers in sampling areas,
c) patching and cleanup, as required.

When appropriate, a different sequence of activities may be used to improve the efficiency of the operations. Locations for bulk sampling, augering, or coring that are considered unacceptable should be replaced with alternate locations and marked on the as-sampled layout plan.

3.3.1 Shelby Tube/Splitspoon Sampling of Subgrade

This activity is required after subgrade preparation and is limited to sampling of subgrade layers within the test sections. These operations shall be performed in accordance with AASHTO T207, "Thin-wall Tube Sampling of Soils."

Thin-wall tube sampling is required for obtaining undisturbed samples of subgrade soils and/or fill (embankment) material directly below base/subbase layers. A truck mounted drill rig (or other suitable device) shall be used for the thin-wall tube sampling. Thin-wall tubes shall be 76 mm (3 in.) outer diameter (71 mm [2.8 in.] inner diameter) and a minimum of 762 mm (30 in.) long.

Undisturbed samples of the natural subgrade or fill material shall be obtained to a depth of 1.2 m (4 ft) below the top of the subgrade or fill. As mentioned previously, it should be noted that if a fill (embankment) layer is present, and is greater than 1.2 m (4 ft) in thickness, the natural subgrade will <u>not</u> be sampled or tested. The fill (embankment) <u>only</u> will be sampled and tested.

If thin-wall tube samples can not be obtained, splitspoon samples shall be obtained. A truck mounted drill rig shall be used for splitspoon sampling. Sampling shall be done using only a 64 kg (140 lb) hammer, 762 mm (30 in.) drop and a sampler as specified in AASHTO T206, "Penetration Test and Split-Barrel Sampling of Soils." Core retainers shall be used when necessary to retain soil. Care shall be exercised to provide a free fall of the hammer (minimum friction and straight pipe) and to minimize variations in drop height. It is essential that a clearly visible reference mark be identified on the splitspoon drop hammer rod so that the drop height is consistent. Blow counts shall be recorded on Sampling Data Sheet 4-1 (Appendix B).

After opening the barrel, the recovered material shall be carefully examined and logged as to the length of recovery and description of the soil. If more than one type, or obvious variation within type, of soil is encountered the depth and description of each strata shall be made. All material from the splitspoon sample may be discarded after recording the strata descriptions. If rock, boulders or other forms of dense material are encountered within 1.2 m (4 ft) of the top of the natural subgrade or fill, another attempt for sampling the subgrade shall be made at a different location with a longitudinal offset of 1.5 to 3.0 m (5 to 10 ft). If refusal occurs at the second location, splitspoon sampling shall be terminated.

3.3.2 Bulk Sampling of Subgrade (Embankment) Soil

Subgrade material shall be obtained for laboratory testing from shallow excavations. These excavations are to be performed after the subgrade or fill (embankment) has been fully prepared and is ready for base layer placement. It should be noted that if a fill (embankment) layer is present and is greater than 1.2 m (4 ft) in thickness, the natural subgrade will not be sampled. The fill (embankment) only will be sampled.

Prior to excavation of the subgrade (embankment) material, nuclear moisture/density testing shall be performed at the bulk sampling locations. In no case shall these excavations be conducted within the monitoring length of the test section. Bulk sampling of the finished subgrade within the monitoring length of test section may cause early deterioration of the pavement surface and lead to spurious measurements of pavement distress.

Excavations will typically consist of areas 0.6 m (2 ft) wide by 0.6 m (2 ft) in length. The depth and width of the sampling excavation will depend on many factors, such as depth of layer (this primarily relates to embankment layers), and method of excavation. In any case, approximately 181 kg (400 lb) of material from each sampling area shall be excavated, bagged, and shipped to the participating agency laboratory (or their designee). After receipt, this laboratory shall then split and quarter the sample according to AASHTO T248, "Reducing Field Samples of Aggregate to Testing Size," (without rejecting any material). Subsequently, the participating laboratory shall retain their portion (45 kg [100 lb]) and ship the remainder (136

kg [300 lb]) of the material to the appropriate FHWA-LTPP Materials Testing Contractor. The bulk sample sent to the state/province agency laboratory (or their designee) will be used to perform the Permeability test (LTPP Protocol P48).

3.3.3 Sampling of Uncompacted Dense Graded Aggregate Base

Sampling of the graded aggregate base shall be performed at B-type sampling locations after the base layer has been fully prepared. Prior to excavation of the base material, nuclear moisture/density testing shall be performed at the bulk sampling locations. In no case shall these excavations be conducted within the monitoring length of the test section for the reasons listed previously.

Excavations will typically consist of areas 0.6 m (2 ft) wide by 0.6 m (2 ft) in length. The depth, width, and length will depend on many factors such as the depth of the layer. Approximately 181 kg (400 lb) of material shall be excavated from each designated sampling area. After receipt, this material shall then be bagged and shipped to the participating agency laboratory (or their designee). This laboratory shall then split and quarter the sample according to AASHTO T248, "Reducing Field Samples of Aggregate to Testing Size," (without rejecting any material). Subsequently, the participating laboratory shall retain their portion (45 kg [100 lb]) and ship the remainder (136 kg [300 lb]) of the material to the appropriate FHWA-LTPP Materials Testing Contractor. The bulk sample sent to the state/province agency laboratory (or their designee) will be used to perform the Permeability test (LTPP Protocol P48).

3.3.4 Samples of Uncompacted AC Mix

The sampling of the uncompacted AC mix (PATB, ATB, and surface course) shall be performed as near as possible to the lay-down point. Every effort shall be made to obtain these samples from the paver or the hauling vehicle. These samples shall be obtained in accordance with AASHTO T168 and shipped to the laboratory in containers to be provided by LTPP. If concerns about the uniformity of the AC mix arise during construction, extra samples of 45 kg (100 lb) each shall be obtained from each type of uncompacted asphalt concrete. In addition, three samples of 19 l (5 gal) each shall be obtained from each asphalt cement type used in the AC, ATB, or PATB construction. If the same asphalt cement is used in the different asphalt cement based layers, then only one round (three samples of 19 l [5 gal]) need be obtained to characterize the asphalt cement for all layers.

3.3.5 Special Sampling Requirements

During pavement construction, additional sampling of all asphalt layers will be conducted. This includes the asphalt treated base layer, the permeable asphalt treated layer

asphalt concrete binder course (if applicable), and the finished asphalt concrete surface. It should be noted that this requirement refers to layers of asphalt materials. Different lifts of the same material are not to be considered independent layers. The samples obtained will be used as a record of the materials being used on the project and will be sent to a special facility for long-term storage. The material to be obtained for this purpose shall consist of the following:

1. 3-19 l (5 gal) pails of asphalt cement (from the plant),

2. 1-208 l (55 gal) drum of the combined and graded coarse and fine aggregate (from the plant) - for all layers except PATB,

3. 3-19 l (5 gal) pails of the finished mix uncompacted (from the paver on haul vehicle immediately prior to lay-down).

One sample of asphalt cement shall be obtained from the plant for each type of asphalt cement used on the project. Therefore, if only one type of asphalt cement was used for both the PATB and ATB layers on the project, only one sample unit (3-19 l [5 gal] pails) of the asphalt cement shall be sampled and this one sample will represent both asphalt treated layers. The asphalt cement shall be sampled from the plant using AASHTO T40, "Sampling Bituminous Materials," after the asphalt has been heated for mixing. It should be noted that a sample for long-term storage of the graded aggregates for the PATB layer is not required.

One sample of the combined and graded aggregates shall be obtained from the plant for each asphalt layer of the project (except PATB). This materials shall be sampled in conformance with applicable portions of AASHTO T2, "Sampling Aggregates." For drum plants, the aggregates should be obtained from the charging (inclined) conveyor using the bypass chute, if possible. Otherwise, the sample should be taken from the belt on the charging conveyor. For batch plants, the aggregates can be sampled from the inclined conveyor at the dryer.

The sample of finished asphalt concrete mix used in the construction of the test sections shall be sampled from the paver or haul vehicle immediately prior to lay-down. These materials shall be sampled in conformance with AASHTO T168, "Sampling Bituminous Paving Mixtures."

Containers (barrels and buckets) for the storage of these samples will be provided to the participating state agencies by the LTPP Materials Reference Library (MRL) at no cost to the state. These containers are of special manufacture to accommodate long-term storage. It will be necessary that scheduling information be furnished to the LTPP Materials Reference Library contractor as soon as this information is available. This information should, at the minimum, contain: (1) date containers needed, (2) state agency contact name, and (3) shipping address and

(4) telephone number. The contact names and telephone numbers for the LTPP Materials Reference Library are as follows:

CONTACT NAME	AFFILIATION	PHONE NO.
Mr. Andrew Brigg	Nichols Consulting Engineers Chtd.	702-358-7574
Mr. Jim Nichols	Nichols Consulting Engineers Chtd.	702-329-4955
Mr. Cal Berge	FHWA LTPP Regional Engineer	702-329-5019

The SPS-1 samples to be shipped to the MRL will be by a common carrier and the cost will be borne by the MRL contractor (Nichols Consulting Engineers Chtd.). The participating agency should contact the MRL office for exact coordination and sample shipping details. Any of the three names listed above may be contacted but it is preferable that Mr. Andrew Brigg be the primary contact point for the participating agencies.

A copy of Field Operations Information Form 1 (Appendix B) should be completed and included with the shipment and another copy of the form should be mailed separately. This will allow a trace of the shipment if it does not arrive in a timely manner.

3.3.6 Coring of Pavement Surface and Treated Layers

This activity will involve coring of the asphaltic concrete surface and asphalt treated base layers of the test sections at the locations shown on the field material sampling plan. Exploration logs must be prepared using Sampling Data Sheet 2 in Appendix B. This coring operation will occur after the construction of the final surface layer to obtain 102 mm (4 in.) diameter cores. The coring operations shall be carried out in accordance with AASHTO T24-B6, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."

Carbide or diamond bit drilling is to be performed. Mist or air cooled drilling is preferred as the best method to minimize water contamination of the underlying layers. The coring may be performed by a truck mounted drill rig or other coring equipment approved by the participating highway agency and the LTPP Regional Engineer. The cores shall be dried before packaging. If necessary to obtain cores of suitable quality, the pavement may be cooled by dry-ice or other means prior to coring. Cores of multiple layers of asphalt concrete shall not be separated in the field. The cores shall be wrapped and shipped as a single core.

It is essential for laboratory material testing that the direction of traffic be indicated on the test cores. Therefore, all cores of pavement surfaces shall be marked on the top with an arrow to show the direction of traffic. This marking should be made prior to removal of the cores from the pavement using a waterproof marking material and in a manner that will ensure

visibility after coring operations. Plugs shall not be inserted in cores intended for laboratory testing. Suction cups or wire pulls have been successfully used for core extraction.

Core locations shall be as shown on the sampling plan figures developed for the test site. It is especially important that the cores be taken perpendicular to the pavement surface, i.e. at a 90 degree angle to the surface, to ensure the recovery of straight, intact, smooth-surfaced specimens suitable for laboratory testing.

The quality of the AC cores shall be checked in the field to ensure suitable cores for laboratory testing. The suitability of the cores with respect to projections and depressions is as follows:

Excellent - The projections/depressions along the sides of the core are less than 0.25 mm (0.01 in.) in height/depth. Ship these cores to the appropriate laboratory.

Good - The projections/depressions along the sides of the core are between 0.5 mm to 2.5 mm (0.01 to 0.1 in.) in height/depth. These cores are considered marginal and should be shipped to the appropriate laboratory only if cores rated "excellent" can not be obtained.

Poor - The projections/depressions along the sides of the core are more than 2.5 mm (0.1 in.) in height/depth. These cores are <u>not</u> acceptable and should not be shipped to the laboratory unless no other suitable cores can be obtained. Another core should be drilled to replace cores rated as "poor." After two attempts to obtain a satisfactory core have been unsuccessful, the core to be shipped to the laboratory shall be selected from the "better" of the two drilled cores. The "worse" core of the two should be discarded. If a multitude of cores are retrieved in the "poor" condition, the on-site inspector should determine whether the drilling and sampling personnel are using the proper equipment and that the proper procedures are being followed.

The following is a criteria for evaluating the surface AC cores in terms of the skew of each end of the core. The suitability of the cores with respect to skewness is as follows:

Good - The specimen departs from perpendicularity to the vertical axis by less than 0.5 of a degree (1.6 mm in 152 mm [1/16 of an inch in 6 in.]). The specimen is suitable for shipment to the laboratory.

Poor - The specimen departs from perpendicularity to the vertical axis by more than 0.5 of a degree. These cores are not acceptable and should not be shipped to the laboratory unless no other suitable cores can be obtained. Another core should be drilled to replace cores rated as "poor." If, after two tries, a suitable core cannot be obtained, select the "better" core from the two and ship to the appropriate laboratory. The "worse" core of the two shall be discarded.

3.3.7 Collection of Samples, Marking, Packaging, and Shipping

Because of the research nature of this project and because samples will be shipped over long distances, it is extremely important that the sample be packaged carefully. The samples shall be packaged and preserved in accordance with ASTM D4220 (Group B), "Preparing and Transporting Soil Samples". Extreme care must be taken in packaging and shipping of test samples to eliminate damage to the samples or influence their properties.

General requirements for marking and packaging individual samples are as follows:

- Sample numbering systems (as provided later in this section).
- Indelible ink pens of black or other suitable color shall be used for marking labels.
- Labels and tags shall be of high quality moisture resistant material.
- Bags for small portions of auger and bulk samples of materials to be used for laboratory moisture content determination shall be plastic lined cloth or heavy plastic and sealable against moisture loss or gain by wire-ties. Liter-size jars adequately sealed against moisture loss or gain may also be used for this purpose.
- Bags for large bulk samples shall be heavy cloth, plastic lined with wire-tie for closing.
- Cores shall be placed in "zip-lock" storage bags or other suitable material (e.g. heavy-duty plastic or "bubble-wrap" wrap) to ensure that they are sealed from moisture, then wrapped for their entire length with tape (e.g., plastic transparent mailing tape 51 mm (2 in.) wide).

3.3.8 Sample Code Number

Each sample (core, bulk, moisture, Shelby tube, splitspoon) shall be assigned a four digit number that must be recorded on the appropriate data forms. The sample number will consist of two letters on the left side and up to three numbers on the right side.

The first letter on the left identifies the sample type in one of the following categories:

C - core sample
B - bulk sample
M - moisture sample
T - Shelby tube sample
J - splitspoon sample

The second letter from the left identifies the material type of the material in the sample in one of the following categories:

A - asphalt concrete
C - asphalt cement
T - treated material (base/subbase)
G - untreated, unbound material (base/subbase)
S - subgrade soil or fill material

The numbers on the right will designate the sample number. The numbers shall be assigned consecutively for each sample type. For example, samples taken at C-type locations can be designated CT01, CT02, CT03, etc. for the ATB material. Samples of subgrade material taken from location A1 by thin wall tube shall be designated TS01 and TS02. If a bulk sample of one layer is contained in more than one bag, then the number of bags and the same bulk sample number should be recorded on each bag.

The following is a list of valid combinations of letters and numbers making up sample code numbers:

CA24 Asphalt concrete cores.
CT24 Treated base cores.
BG01 Bulk samples from granular base. Assign numbers consecutively as samples are obtained, BG01 through BG03 or higher.
BA01 Bulk samples of uncompacted asphalt concrete. Assign numbers consecutively as samples are obtained, BA01 through BA19 for binder course material and BA20 or higher for surface course material.
BT01 Bulk samples of uncompacted asphalt treated base. Assign numbers consecutively as samples are obtained, BT01 through BT19 for permeable asphalt treated base and BT20 or higher for dense graded asphalt treated base.
BS01 Bulk samples of subgrade material from different sampling areas within the test site. Assign sample numbers consecutively (BS01, BS02, etc.) as samples are obtained.

MG01 Granular base samples obtained from bulk sampling locations solely for determining natural moisture content.

MS01 Subgrade samples obtained from bulk sampling locations for moisture content determination.

TS04 Shelby tube samples from subgrade (two Shelby tubes from A-type locations, as appropriate).

3.3.9 Labels and Tags

Each sample shall be labeled before packing in boxes and cartons. As a minimum, the following information shall be included on tags and labels:

STATE CODE
SPS PROJECT CODE
TEST SECTION NO.
CORE/SAMPLE LOCATION (as marked on sample layout plans)
SAMPLE NUMBER (four digit code)
DATE (mm-dd-yy, sampling date)
FIELD SET (one digit number which will be 1 for the first round of sampling)

3.3.10 Packaging

Suggestions for labelling and combining the samples for shipment are as follows:

1. All samples of like material (e.g., asphaltic concrete surface and binder) shall be placed in separate boxes or separate compartments of one box.

2. Each sample shall have a label or tag attached that clearly identifies the material.

3. Each core shall be surrounded with "bubble-wrap" or other acceptable cushioning material on all sides within the shipping box.

4. All bulk samples shall be marked with 2 labels or tags. One shall be placed inside the bag and one attached to the outside. A small bag or jar sample for moisture testing of each bulk sample shall be placed inside the bulk sample bag.

5. Thin-wall tube samples shall be packaged in boxes with cushioning such as "bubble-wrap" or other acceptable material for shipment to the appropriate testing laboratory.

6. All shipping boxes should be wood of suitable grade and construction to withstand shipping and subsequent moving without breakage of the box or damaging of samples.

7. All boxes should be adequately secured by nails or screws prior to shipping.

Field Operations Information Sheets 1 and 2-1 shall be sent with each shipment of materials samples.

3.3.11 Shipping

All samples should be shipped within 5 days to the laboratory designated by the participating highway agency. Each box shall be labeled to include the State Code, SPS Project Code, type(s) of samples, box number (for each series of boxes for the specific project to each delivery point). The boxes should be labeled "Handle with Care" or similar wording. Samples shall be protected against freezing and overheating.

It is recommended that each shipment be insured for an amount to cover at least twice the cost of the field work performed at the site to obtain the samples.

A copy of the bill of lading clearly showing the boxes being shipped and a receipt signed by the shipping organization shall be sent to the appropriate FHWA LTPP Regional Coordination Office.

All of the above guidelines are designed to protect the integrity of the material samples to the highest degree possible within economic limits. These materials are very important to the success of the LTPP program and should be treated with as much care as possible. Cooperation from all participants is needed to ensure that these specimens are shipped to the laboratory with a minimum of damage.

3.3.12 Patching and Clean-up

Following the completion of the sampling and testing of each layer, the sampling personnel shall be especially careful to remove all debris created by the operations. Field sampling and testing personnel shall also repair and restore all bulk sampling, auger probe, or coring locations, etc. by replacing all material and compacting the layer as per the participating agency practice. The method of repair of each type of sampling area shall be outlined in the materials sampling plan.

3.3.13 Logs and Reports

Accurate and detailed record keeping is essential for the materials sampling and testing program. During the field sampling operations, two types of forms must be completed. These are the Field Operations Information Forms and the Sampling Data Sheets. Field Operations Information Forms are used to record general information concerning the pavement test sections and the materials samples. Sampling Data Sheets are used to record the actual information for each sampling area or sampling location. A person should be designated to record data at each site on the appropriate data sheets, insure the accuracy and integrity of the collected data and forward the data sheets to the appropriate personnel. This person should have a thorough understanding of the content of the data sheets and the procedures for completing the sheets. If these forms are completed by a person other than the LTPP representative, the data sheets must be reviewed by the LTPP representative prior to forwarding the sheets to the appropriate personnel. The Field Set Number "1" has been assigned to designate all sampling and testing operations performed during site construction and shall be used when completing the material sampling and field testing forms.

3.3.13.1 A-type Sampling - Data for each A-type sampling hole shall be recorded on Sampling Data Sheet 4-1. This data should include descriptions of the subgrade layers, depth of shelby tube or splitspoon samples, and other related data. Data to be recorded on this form should include the following:

1. Material type and description for each layer of untreated materials and soils in accordance with Table C.2. of the SHRP-LTPP Guide for Field Materials Sampling, Testing and Handling.

2. Thickness of each layer encountered in the hole to the nearest 2.5 mm (0.1 in.).

3. Presence and levels of any water encountered.

4. Sample numbers.

3.3.13.2 Bulk Sampling of Subgrade - Data obtained during subgrade sampling shall be logged as the excavation progresses and reported on Sampling Data Sheet 12. The record shall include description of the exposed subgrade and thickness of any layers to the nearest 2.5 mm (0.1 in.), sample numbers and number of bags per sample, test numbers, any water seepage, sloughing, voids and other pertinent items.

3.3.13.3 Shoulder Auger Probes - Data for shoulder auger probes shall be reported using Sampling Data Sheet 9.

3.3.13.4 Core Holes - A separate log shall be completed for each core hole. The depth of penetration of each coring operation and the average length of the recovered core shall be recorded to the nearest 2.5 mm (0.1 in.). Data sheets for these logs are included in Appendix B of this document. Sampling Data Sheet 2 shall be used to record pavement cores from C-type sampling areas. These logs shall show the general type of material in accordance with terminology described in Appendix B of the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing. The general code 700 shall be used to identify asphalt cement concrete. The codes 321 and 322, shall be used in the field to classify the asphalt-treated mixes, ATB and PATB, respectively. Remarks shall include the type of cooling medium, difficulties encountered in coring, defects observed in the core (such as cracks, voids and disintegration), and other pertinent observations.

Table 6 lists the forms that should be used for recording field data and sample inventory shipping information. These forms should be completed for each sampling phase and shall be included in the field data packet.

3.3.14 Field Testing

Field testing shall include in situ density and moisture measurement on subgrade and untreated base layers as well as in situ density measurements on the compacted asphalt concrete base and surface. In addition, auger profiles will be conducted to determine the existence and depth of a rigid layer (bedrock) beneath the pavement system. Falling Weight Deflectometer (FWD) testing may be conducted on the finished pavement layers. FWD testing is recommended but is not mandatory.

3.3.14.1 In Situ Density and Moisture Measurements - In situ density/moisture testing will be conducted on all finished layers of subgrade embankment and untreated base/subbase layers. The density/moisture measurement shall be made using the direct transmission method for density and the backscatter method for moisture determination. Density determinations shall be conducted using AASHTO T238-86, "Standard Method of Test for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)" Method B - Direct Transmission.

Moisture measurements shall be conducted using AASHTO T239-86, "Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depths)" Backscatter Method. For the density test, the rod shall be imbedded 102 to 203 mm (4 to 8 in.) below the layer surface as appropriate to test the full layer. At each testing location, four readings of one minute each shall be conducted with the nuclear testing instrument rotated 90° between each reading.

Table 6 - Forms to be Completed For Each Phase of Field Material Sampling, Handling and Testing.

Subgrade - (Field Set Number 1)

Field Operations Information Form 1
Field Operations Information Form 2
Sampling Data Sheet 4
Sampling Data Sheet 6
Sampling Data Sheet 7
Sampling Data Sheet 8
Sampling Data Sheet 9

Base Course - (Field Set Number 1)

Field Operations Information Form 1
Field Operations Information Form 2
Sampling Data Sheet 2
Sampling Data Sheet 8
Sampling Data Sheet 10

Surface - (Field Set Number 1)

Field Operations Information Form 1
Field Operations Information Form 2
Sampling Data Sheet 2
Sampling Data Sheet 8
Sampling Data Sheet 10

For nuclear density/moisture testing at bulk sampling locations, a jar sample shall be obtained beneath each test for laboratory moisture testing. Minimum sample sizes shall be 0.5 kg (1 lb) for material having a maximum particle size of 6 mm (0.25 in.); 1.4 kg (3 lb) for 25 mm (1 in.) maximum particle material and 2.3 kg (5 lb) for over 25 mm (1 in.) maximum particle size materials. Extreme care shall be taken to obtain samples at the true natural field moisture condition.

Density testing will be carried out during construction on the asphalt treated base and the hot mix binder and surface courses. This testing shall be performed at the specified locations using AASHTO T238-86, backscatter mode. As with the unbound materials, each testing location shall have four readings with the density instrument rotated 90° between each reading.

Report the density, moisture, type of material, rod end depth, and thickness of the layer (from plans) for each test point. Report any unusual findings during the testing such as visible voids, oversize aggregate or cobbles, foreign material, trapped water, etc. which may have affected the measurements. Sampling Data Sheet 8-1 shall be the standard form used to record this data. Tests are not required on subgrades containing an amount of rock sufficient to preclude accurate testing.

It is recommended that two nuclear gauges be available at the test site. One gauge will serve as a stand-by in the event the primary test gauge becomes inoperative or is of questionable accuracy. Nuclear equipment and testing shall be conducted in full compliance with all Federal, state, and local regulations. Any special regulations for the use of nuclear density devices in any state shall be followed.

3.3.14.2 Auger Probes - This item is to determine if bedrock or other significantly dense hard layer exists within 6 m (20 ft) of the pavement surface. Maps from the USGS and the U.S. Department of Agriculture plus the project records and any other available information should be used to assess the need for this auger probe. These sources contain appropriate depth ranges to bedrock for mapped areas.

Augering shall be performed with a truck mounted drill using a 102 to 152 mm (4 to 6 in.) continuous flight, solid, helical augers. The auger probe shall be made in the shoulder at a location approximately in the middle of the test section.

Augering shall be performed to a depth of 6 m (20 ft) or until refusal whichever is less. When refusal occurs prior to 6 m (20 ft), the probe shall be continued at a nearby location (1.5 to 3.0 m [5 to 10 ft] away). If refusal occurs at the second location, the auger probe activity shall be terminated.

Each shoulder auger probe shall be logged using Sampling Data Sheet 9. Include the types and thicknesses of materials encountered and the total depth of the probe.

3.3.15 FWD Testing

During construction, Falling Weight Deflectometer testing of the base, subbase and subgrade materials is recommended but not mandatory. The deflection testing of the base, subbase and surface layers shall be conducted utilizing LTPP Protocol P59, "Deflection Testing of Subgrade and Base Layers," dated March, 1993. A reprint of the procedure is contained in Appendix C of this document.

3.3.16 Assembly of Data Sheets and Transmittal

The following is a description of the format that should be used for the assembly of the data sheets from each SPS-1 test site. The forms will appear in the final assembled data packet in the order illustrated in Table 6 for each construction phase of the test site. The title page will be the first (top) sheet of the data packet and it will include the following information:

1 - SHRP Region
2 - State
3 - State Code
4 - SPS Project Code
5 - Experiment Name
6 - Highway Number
7 - Date(s) of Field Material Sampling and Field Testing
8 - Submitting Contractor/Agency
9 - Total Sheets, including the Title Page.

To determine the number of sheets (item 9 above) all of the pages in the packet should be counted. The pages should then be numbered consecutively starting with the title page. For example, if there are 100 pages in the packet, the title page would be "page 1 of 100" followed by "page 2 of 100" and so forth until the last page would read: "page 100 of 100". This will insure that any lost sheets can be quickly identified and found.

After the packet has been assembled and numbered, the original and appropriate number of duplicates should be made. The original and one copy should be forwarded to the LTPP Regional Coordination Office. Also, copies should be forwarded to the participating highway agency and those laboratories designated by the agency to perform the laboratory tests on the samples. A copy shall also be forwarded to the FHWA-LTPP Laboratory Materials Testing Contractor.

3.3.17 Shipping Tracking Table

This section contains a shipping tracking table which contains instructions for disposition of samples retrieved from the field. These tables are based on the idealized sampling plan presented in this section and detailed in Appendix A of this document. Using these tracking tables (tables 7 and 8), sampling personnel can determine where each sample is supposed to be shipped and tested. A plan similar to this one should be developed for each SPS-1 project.

The Laboratory Test Number shall be assigned as per the following:

a. Beginning of the Section (Station 0-): samples of each layer that are retrieved from areas in the approach end of the test section (stations preceding 0+00) shall be assigned Laboratory Test Number '1'.

b. End of the Section (Stations 5+): samples of each layer that are retrieved from areas in the leave end of the test section (stations after 5+00) shall be assigned Laboratory Test Number '2'.

c. Middle of the Section (Stations 0+00 to 5+00): samples of each layer that are retrieved from areas in the middle of the test section (from the paver) shall be assigned Laboratory Test Number '3'.

Table 7 - Samples to be Shipped to the State/Province Laboratory (or their designee)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
Asphalt Concrete			
C1	CA01	1	102 mm (4 in.) Core
C2	CA02	1	102 mm (4 in.) Core
C4	CA04	2	102 mm (4 in.) Core
C9	CA09	2	102 mm (4 in.) Core
C10	CA10	2	102 mm (4 in.) Core
C11	CA11	1	102 mm (4 in.) Core
C12	CA12	1	102 mm (4 in.) Core
C13	CA13	2	102 mm (4 in.) Core
C14	CA14	2	102 mm (4 in.) Core
C19	CA19	2	102 mm (4 in.) Core
C20	CA20	2	102 mm (4 in.) Core
C21	CA21	1	102 mm (4 in.) Core
C22	CA22	1	102 mm (4 in.) Core
C24	CA24	2	102 mm (4 in.) Core
C29	CA29	2	102 mm (4 in.) Core
C30	CA30	2	102 mm (4 in.) Core
C31	CA31	1	102 mm (4 in.) Core
C32	CA32	1	102 mm (4 in.) Core
C33	CA33	2	102 mm (4 in.) Core
C34	CA34	2	102 mm (4 in.) Core
C39	CA39	2	102 mm (4 in.) Core
C40	CA40	2	102 mm (4 in.) Core
C45	CA45	2	102 mm (4 in.) Core
C46	CA46	2	102 mm (4 in.) Core
C48	CA48	1	102 mm (4 in.) Core
C49	CA49	2	102 mm (4 in.) Core
C50	CA50	2	102 mm (4 in.) Core
C55	CA55	2	102 mm (4 in.) Core

Table 7 - Samples to be Shipped to the State/Province Laboratory (or their designee) (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
C56	CA56	2	102 mm (4 in.) Core
C57	CA57	1	102 mm (4 in.) Core
C58	CA58	1	102 mm (4 in.) Core
C59	CA59	2	102 mm (4 in.) Core
C60	CA60	2	102 mm (4 in.) Core
B25	BA01	3	91 kg (200 lb) bulk sample
B26	BA02	3	91 kg (200 lb) bulk sample
B27	BA03	3	91 kg (200 lb) bulk sample
B28	BC04	3	19 l (5 gal) bulk sample of asphalt cement
B29	BC05	3	19 l (5 gal) bulk sample of asphalt cement
B30	BC06	3	19 l (5 gal) bulk sample of asphalt cement
Asphalt Treated Base			
C1	CT01	1	102 mm (4 in.) Core
C2	CT02	1	102 mm (4 in.) Core
C3	CT03	2	102 mm (4 in.) Core
C4	CT04	2	102 mm (4 in.) Core
C9	CT09	2	102 mm (4 in.) Core
C10	CT10	2	102 mm (4 in.) Core
C21	CT21	1	102 mm (4 in.) Core
C22	CT22	1	102 mm (4 in.) Core
C23	CT23	2	102 mm (4 in.) Core
C24	CT24	2	102 mm (4 in.) Core
C29	CT29	2	102 mm (4 in.) Core
C30	CT30	2	102 mm (4 in.) Core
C31	CT31	1	102 mm (4 in.) Core
C32	CT32	1	102 mm (4 in.) Core
C33	CT33	2	102 mm (4 in.) Core
C34	CT34	2	102 mm (4 in.) Core
C47	CT47	1	102 mm (4 in.) Core

Table 7 - Samples to be Shipped to the State/Province Laboratory (or their designee) (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
C48	CT48	1	102 mm (4 in.) Core
C49	CT49	2	102 mm (4 in.) Core
C50	CT50	2	102 mm (4 in.) Core
C55	CT55	2	102 mm (4 in.) Core
C56	CT56	2	102 mm (4 in.) Core
B19	BT20	3	91 kg (200 lb) bulk sample
B20	BT21	3	91 kg (200 lb) bulk sample
B21	BT22	3	91 kg (200 lb) bulk sample
B22	BC01	3	19 l (5 gal) bulk sample of asphalt cement
B23	BC02	3	19 l (5 gal) bulk sample of asphalt cement
B24	BC03	3	19 l (5 gal) bulk sample of asphalt cement
Permeable Asphalt Treated Base			
B16	BT01	3	45 kg (100 lb) bulk sample
B17	BT02	3	45 kg (100 lb) bulk sample
B18	BT03	3	45 kg (100 lb) bulk sample
Unbound Granular Base			
B13	BG07	1	181 kg (400 lb) bulk sample[1]
B14	BG08	1	181 kg (400 lb) bulk sample[1]
B15	BG09	1	181 kg (400 lb) bulk sample[1]
Embankment < 1.2 m (4 ft)			
B7	BG01	2	181 kg (400 lb) bulk sample[1]
B8	BG02	2	181 kg (400 lb) bulk sample[1]
B9	BG03	2	181 kg (400 lb) bulk sample[1]
B10	BG04	2	181 kg (400 lb) bulk sample[1]
B11	BG05	2	181 kg (400 lb) bulk sample[1]
B12	BG06	2	181 kg (400 lb) bulk sample[1]
Subgrade (Embankment ≥ 1.2 m [4 ft]) - If thin-wall tubes available			
B1	BS01	2	181 kg (400 lb) bulk sample[1]
B2	BS02	2	181 kg (400 lb) bulk sample[1]

Table 7 - Samples to be Shipped to the State/Province Laboratory (or their designee) (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
B3	BS03	2	181 kg (400 lb) bulk sample[1]
B4	BS04	2	181 kg (400 lb) bulk sample[1]
B5	BS05	2	181 kg (400 lb) bulk sample[1]
B6	BS06	2	181 kg (400 lb) bulk sample[1]
A1	TS01	3	Thin-Wall Tube
A3	TS05	3	Thin-Wall Tube
A4	TS07	3	Thin-Wall Tube
A6	TS11	3	Thin-Wall Tube
A7	TS13	3	Thin-Wall Tube
A8	TS15	3	Thin-Wall Tube
A10	TS19	3	Thin-Wall Tube
A12	TS23	3	Thin-Wall Tube
A13	TS25	3	Thin-Wall Tube
A15	TS29	3	Thin-Wall Tube
A16	TS31	3	Thin-Wall Tube
A18	TS35	3	Thin-Wall Tube
A3	TS06	3	Thin-Wall Tube
A4	TS08	3	Thin-Wall Tube
A6	TS12	3	Thin-Wall Tube
A7	TS14	3	Thin-Wall Tube
A8	TS16	3	Thin-Wall Tube
A10	TS20	3	Thin-Wall Tube
A12	TS24	3	Thin-Wall Tube
A13	TS26	3	Thin-Wall Tube
A15	TS30	3	Thin-Wall Tube
A16	TS32	3	Thin-Wall Tube
A18	TS36	3	Thin-Wall Tube

Table 7 - Samples to be Shipped to the State/Province Laboratory (or their designee) (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
Subgrade (Embankment ≥ 1.2 m [4 ft]) - If thinwall tubes are not available			
B1	BS01	2	181 kg (400 lb) bulk sample[1]
B2	BS02	2	181 kg (400 lb) bulk sample[1]
B3	BS03	2	181 kg (400 lb) bulk sample[1]
B4	BS04	2	181 kg (400 lb) bulk sample[1]
B5	BS05	2	181 kg (400 lb) bulk sample[1]
B6	BS06	2	181 kg (400 lb) bulk sample[1]

Note 1: The bulk sample is to be shipped to the participating agency laboratory where it is to be split and quartered. A 136 kg (300 lb.) portion of the bulk sample is then to be shipped to the FHWA-LTPP Testing Contractor Laboratory for further testing.

Table 8 - Samples to be Shipped to the
FHWA-LTPP Testing Contractor Laboratory

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
Asphalt Concrete			
C3	CA03	2	102 mm (4 in.) Core
C5	CA05	1	102 mm (4 in.) Core
C6	CA06	1	102 mm (4 in.) Core
C7	CA07	1	102 mm (4 in.) Core
C8	CA08	1	102 mm (4 in.) Core
C15	CA15	1	102 mm (4 in.) Core
C16	CA16	1	102 mm (4 in.) Core
C17	CA17	1	102 mm (4 in.) Core
C18	CA18	1	102 mm (4 in.) Core
C23	CA23	2	102 mm (4 in.) Core
C25	CA25	1	102 mm (4 in.) Core
C26	CA26	1	102 mm (4 in.) Core
C27	CA27	1	102 mm (4 in.) Core
C28	CA28	1	102 mm (4 in.) Core
C35	CA35	1	102 mm (4 in.) Core
C36	CA36	1	102 mm (4 in.) Core
C37	CA37	1	102 mm (4 in.) Core
C38	CA38	1	102 mm (4 in.) Core
C41	CA41	1	102 mm (4 in.) Core
C42	CA42	1	102 mm (4 in.) Core
C43	CA43	1	102 mm (4 in.) Core
C44	CA44	1	102 mm (4 in.) Core
C47	CA47	1	102 mm (4 in.) Core
C51	CA51	1	102 mm (4 in.) Core
C52	CA52	1	102 mm (4 in.) Core
C53	CA53	1	102 mm (4 in.) Core
C54	CA54	1	102 mm (4 in.) Core

Table 8 - Samples to be Shipped to the
FHWA-LTPP Testing Contractor Laboratory (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
Asphalt Treated Base			
C5	CT05	1	102 mm (4 in.) Core
C6	CT06	1	102 mm (4 in.) Core
C7	CT07	1	102 mm (4 in.) Core
C8	CT08	1	102 mm (4 in.) Core
C25	CT25	1	102 mm (4 in.) Core
C26	CT26	1	102 mm (4 in.) Core
C27	CT27	1	102 mm (4 in.) Core
C28	CT28	1	102 mm (4 in.) Core
C51	CT51	1	102 mm (4 in.) Core
C52	CT52	1	102 mm (4 in.) Core
C53	CT53	1	102 mm (4 in.) Core
C54	CT54	1	102 mm (4 in.) Core
Unbound Granular Base			
B13	BG07	1	136 kg (300 lb) Bulk Sample[1]
B14	BG08	1	136 kg (300 lb) Bulk Sample[1]
B15	BG09	1	136 kg (300 lb) Bulk Sample[1]
B13	MG07	1	Moisture Content Jar Sample
B14	MG08	1	Moisture Content Jar Sample
B15	MG09	1	Moisture Content Jar Sample
Embankment < 1.2 m (4 ft)			
B7	BG01	2	136 kg (300 lb) Bulk Sample[1]
B8	BG02	2	136 kg (300 lb) Bulk Sample[1]
B9	BG03	2	136 kg (300 lb) Bulk Sample[1]
B10	BG04	2	136 kg (300 lb) Bulk Sample[1]
B11	BG05	2	136 kg (300 lb) Bulk Sample[1]
B12	BG06	2	136 kg (300 lb) Bulk Sample[1]
B7	MG01	2	Moisture Content Jar Sample
B8	MG02	2	Moisture Content Jar Sample

Table 8 - Samples to be Shipped to the
FHWA-LTPP Testing Contractor Laboratory (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
B9	MG03	2	Moisture Content Jar Sample
B10	MG04	2	Moisture Content Jar Sample
B11	MG05	2	Moisture Content Jar Sample
B12	MG06	2	Moisture Content Jar Sample
Embankment $\geq$ 1.2 m (4 ft) - If thin wall tubes available			
B1	BS01	2	136 kg (300 lb) Bulk Sample[1]
B2	BS02	2	136 kg (300 lb) Bulk Sample[1]
B3	BS03	2	136 kg (300 lb) Bulk Sample[1]
B4	BS04	2	136 kg (300 lb) Bulk Sample[1]
B5	BS05	2	136 kg (300 lb) Bulk Sample[1]
B6	BS06	2	136 kg (300 lb) Bulk Sample[1]
A2	TS02	3	Thin wall Tube Sample
A2	TS03	3	Thin wall Tube Sample
A5	TS05	3	Thin wall Tube Sample
A5	TS06	3	Thin wall Tube Sample
A9	TS09	3	Thin wall Tube Sample
A9	TS10	3	Thin wall Tube Sample
A11	TS11	3	Thin wall Tube Sample
A11	TS12	3	Thin wall Tube Sample
A14	TS14	3	Thin wall Tube Sample
A14	TS15	3	Thin wall Tube Sample
A17	TS17	3	Thin wall Tube Sample
A18	TS18	3	Thin wall Tube Sample
B1	MS01	2	Moisture Content Jar Sample
B2	MS02	2	Moisture Content Jar Sample
B3	MS03	2	Moisture Content Jar Sample
B4	MS04	2	Moisture Content Jar Sample
B5	MS05	2	Moisture Content Jar Sample
B6	MS06	2	Moisture Content Jar Sample

Table 8 - Samples to be Shipped to the
FHWA-LTPP Testing Contractor Laboratory (continued)

Sample Location Number	Sample Number	Lab Test Number	Type of Sample
Embankment $\geq$ 1.2 m (4 ft) - If thin wall tubes are not available			
B1	BS01	2	136 kg (300 lb) Bulk Sample[1]
B2	BS02	2	136 kg (300 lb) Bulk Sample[1]
B3	BS03	2	136 kg (300 lb) Bulk Sample[1]
B4	BS04	2	136 kg (300 lb) Bulk Sample[1]
B5	BS05	2	136 kg (300 lb) Bulk Sample[1]
B6	BS06	2	136 kg (300 lb) Bulk Sample[1]
B1	MS01	2	Moisture Content Jar Sample
B2	MS02	2	Moisture Content Jar Sample
B3	MS03	2	Moisture Content Jar Sample
B4	MS04	2	Moisture Content Jar Sample
B5	MS05	2	Moisture Content Jar Sample
B6	MS06	2	Moisture Content Jar Sample

Note 1: The bulk sample shall be obtained from the participating agency.

SECTION 4
LABORATORY MATERIALS TESTING

4. LABORATORY MATERIALS TESTING

4.1 GENERAL

The following sections contain general guidelines to be used by laboratories participating in the SPS-1 laboratory materials testing program. All of the protocols, test data reporting sheets, definitions, etc. referenced in this document can be found in the document, "SHRP-LTPP Interim Guide for Laboratory Material Handling and Testing," Revised and Amended July, 1993. The purpose of the protocols and the materials testing guide is to minimize the variability of materials test data attributable to laboratory material testing and handling techniques by standardizing these techniques as much as possible. The general instructions included in this SPS-1 materials sampling and testing document are to be used as guidelines by the laboratories. However, the laboratory chief/manager should use his or her own judgement when using the guidelines.

It should be noted that all those laboratories wishing to participate in the laboratory material testing program for the SPS projects must maintain either a current AASHTO certification or satisfactory current participation in AMRL/CCRL certification programs combined with the direct supervision of the laboratory by a registered professional engineer.

When implementing the field sampling plan for a SPS-1 site, it is imperative that a sufficient type and amount of samples be obtained to ensure completion of all test procedures. Therefore, a laboratory testing plan shall always be developed in conjunction with the field material drilling and sampling plan. The plan shall list the tests to be performed and the samples to be used for each test in a format similar to that shown later in this document. In addition to the laboratory tests required to characterize the materials used in the SPS test sections, other tests may be required to characterize the properties of materials used on the supplemental test sections constructed at the test site. The laboratory and field test plan should address the testing requirements for both the primary SPS experiment test sections and other supplemental test sections.

The laboratory materials testing plan presented herein assumes that only two laboratories will be involved with the testing of each SPS-1 test section; the state/provincial agency laboratory (or their designee) and the FHWA-LTPP Laboratory Materials Testing Contractor. Because more than one laboratory is involved with the testing of these materials, enhanced coordination is essential between the FHWA-LTPP Regional Coordination Office (RCO), the state/provincial field sampling forces, the state/provincial laboratory and the FHWA-LTPP Laboratory Materials Testing Contractor. The FHWA-LTPP Regional Coordination Office must take the lead role in providing this coordination which should include detailing the laboratory

test assignments for each laboratory, making sure the layer numbers assigned to the various samples are correct and consistent and compiling the laboratory test data generated by all parties.

The guidelines in this section are divided by material type. Throughout the remainder of this section, sample numbering and layer numbers, etc. are based on the idealized general test section layout presented in Section 3 and in more detail in Appendix A. Additionally, the "Sample Tracking Tables" are also based on the idealized sampling plan. These guidelines and specifications must be modified and a site specific plan developed for each SPS-1 project.

4.2 LABORATORY TESTING OF SUBGRADE MATERIALS

The following sections are to be used as a guide for the completion of the laboratory material testing program for subgrade materials retrieved from the SPS-1 projects. Generally, a 136 kg (300 lb) bulk sample and thin-wall tube samples used for resilient modulus testing will be shipped to the FHWA-LTPP Laboratory Materials Testing Contractor. A 45 kg (100 lb) bulk sample and all other thin-wall tube samples will be used by the state/province agency laboratory (or their designee).

In the event that acceptable (undamaged) thin-wall tube samples are <u>not</u> available, then the following tests will <u>not</u> be conducted:

Resilient Modulus	Protocol P46 (the test will be conducted on the bulk samples)
Classification	Protocol P52 (the test will still be conducted on the bulk samples)
Unit Weight	Protocol P56
Unconfined Compressive Strength	Protocol P54
Permeability	Protocol P57 (Protocol P48 will be conducted on the bulk sample instead)

4.2.1 Testing to be Conducted by the State/Province Laboratory (or Their Designee)

If testable thin-wall tube samples are available, the state/provincial laboratory will perform the following tests:

1.	Unit Weight	Protocol P56
2.	Unconfined Compressive Strength	Protocol P54
3.	Permeability	Protocol P57
4.	Classification	Protocol P52

Generally, the same six thin-wall tube samples shall be used to perform the classification, unit weight test, and the unconfined compressive strength test (in that order). Subsequently, three thin-wall tube samples shall be used to perform the classification and permeability test series. In an ideal project, three thin-wall tube samples will be left over as back-ups for the other specimens. If these extra tube samples are not used for any other tests, then only the classification test will be performed on these tubes. In general, all thin-wall tubes shall have the visual-manual classification test performed prior to any other testing.

If twelve testable tube samples are not available for this testing, then a revised testing plan must be developed. For example, if twelve thin-wall tubes are retrieved from the field, but after extrusion only six are testable, then the testing plan could be revised to perform only three of the classification, unit weight, and unconfined compressive strength testing series and three tube samples could be used for the classification and permeability test series. The testing plan should be coordinated between the laboratory and the FHWA-LTPP Regional Coordination Office. See the laboratory tracking tables for an example of the order of testing of the thin-wall tubes. After completion of all of the testing on thin-wall tubes the samples may be disposed of in an appropriate manner.

If testable thin-wall tube samples are not obtained from a subgrade layer, the Permeability test will be conducted using Protocol P48, "Permeability of Unbound Base and Subbase Materials Under Constant Head Using A Rigid Wall Permeameter." After completion of this test, the sample may be disposed of in a suitable manner.

4.2.2 Testing to be Conducted by the FHWA-LTPP Materials Testing Contractor

The following remaining tests shall be conducted by the FHWA-LTPP Materials Testing Contractor in the following order:

1.	Natural Moisture Content	Protocol P49
2.	Sieve Analysis	Protocol P51
3.	Hydrometer	Protocol P42
4.	Atterberg Limits	Protocol P43
5.	Classification	Protocol P52
6.	Moisture-Density Relations	Protocol P55
7.	Resilient Modulus	Protocol P46

The following general procedures shall be used to perform the testing on the subgrade soils:

- Perform moisture content testing (Protocol P49) on all jar samples provided with the bulk samples.
- Combine the bulk samples (with the same sample number - do not combine bulk samples of materials obtained from different locations in the SPS-1 project) if contained in more than one bag or container.
- Thoroughly mix the combined bulk sample and then dry the sample in accordance with the procedure described in Section 4.1 of AASHTO T87-86, "Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test."
- The mixed and dried sample is to be reduced to the appropriate test size using the procedures described in AASHTO T248. The test samples shall be representative of the total bulk sample.
- Perform all other tests in accordance with the appropriate protocols. Table 9 contains approximate test sample sizes for each test procedure.

It is likely that a substantial amount of material may be left over after testing of the subgrade soil. This extra material ensures that an adequate amount of sample was available to run all of the required characterization tests. This extra material shall not be disposed of until all testing has been completed and the results appear acceptable.

If the thin-wall tube samples are available and acceptable for resilient modulus testing, the "undisturbed" thin-wall tube shall be used for resilient modulus testing instead of the bulk sample. If the thin-wall tube is not available or acceptable for testing, then use bulk samples to reconstitute the test specimens for the resilient modulus test.

It is very important that the subgrade layer be adequately tested for resilient modulus. If the full complement of six thin-wall tubes dedicated for resilient modulus are not obtained from the field, or after extrusion, are not suitable for resilient modulus testing, then the bulk samples shall be used. In any case, a minimum of six resilient modulus tests shall be performed on the subgrade layer.

Table 9 - Approximate Weight of Test Samples for Subgrade Soil Testing

Protocol Name	Protocol No.	Approximate Sample Size kg (lb)		
		Maximum Aggregate Size		
		25 mm (1 in.)	51 mm (2 in.)	76 mm (3 in.)
Particle Size Analysis, Hydrometer	P51 P42	5 (11)	18 (40)	60 (133)
Atterberg Limits	P43	1.8 (4)	4.1 (9)	5 (11)
Classification	P47	Based on P41 and P43 Results		
Moisture-Density Relations	P44	9 (20)	14 (30)	14 (30)
Resilient Modulus (if no thin-wall tube)	P46	29 (65)	29 (65)	29 (65)
TOTAL		45 (100)	65 (144)	108 (239)

4.3 LABORATORY TESTING OF EMBANKMENT MATERIALS (≥ 1.2 m [4 ft] thick)

Embankment materials greater than or equal to 1.2 m (4 ft) thick shall be tested in accordance with section 4.2 (Laboratory Testing of Subgrade Soils). These types of pavement layers are to be considered as the subgrade material.

4.4 LABORATORY TESTING OF EMBANKMENT MATERIALS (< 1.2 m [4 ft] thick)

Embankment materials less than 1.2 m (4 ft) thick shall be tested in accordance with section 4.2 (Laboratory Testing of Subgrade Material). These types of pavement layers are to be considered a subbase but tested using the subgrade material tests due to the position in the pavement structure and because they are soils.

4.5 LABORATORY TESTING OF UNBOUND GRANULAR BASE/SUBBASE MATERIAL

The following sections are to be used as a guide for the completion of the laboratory material testing program for the unbound granular base layer for the SPS-1 projects. The state/province agency laboratory (or their designee) should receive the entire 181 kg (400 lb) sample from the field. This laboratory shall then split and quarter the sample according to AASHTO T248, "Reducing Field Samples of Aggregate to Testing Size," (without rejecting any material). Subsequently, the participating laboratory shall retain their portion (45 kg [100 lb]) and ship the remainder (136 kg [300 lb]) of the material to the appropriate FHWA-LTPP Materials Testing Contractor. The bulk sample sent to the state/province agency laboratory (or their designee) will be used to perform the Permeability test (LTPP Protocol P48).

4.5.1 Conducting the Permeability Test

The Permeability test shall be conducted utilizing LTPP Protocol P48, "Permeability of Unbound Base and Subbase Materials Under Constant Head Using a Rigid Wall Permeameter." This protocol can be found in Appendix E.2 of the "SHRP-LTPP Interim Guide for Laboratory Material Handling and Testing," dated July 1993. After completion of the test, the sample may be disposed of in an appropriate manner.

4.5.2 Other Unbound Base/Subbase Materials Testing

The following remaining tests shall be conducted by the FHWA-LTPP Materials Testing Contractor in the following order:

1.	Natural Moisture Content	Protocol P49
2.	Particle Size Analysis	Protocol P41
3.	Sieve Analysis (washed)	Protocol P41
4.	Atterberg Limits	Protocol P43
5.	Classification	Protocol P47
6.	Moisture-Density Relations	Protocol P44
7.	Resilient Modulus	Protocol P46

The following general procedures shall be used to perform the testing on the unbound granular base/subbase.

- Perform moisture content testing (Protocol P49) on all jar samples provided with the bulk samples.
- Combine the bulk samples (only those with the same sample number - do not combine bulk samples of materials obtained from different locations in the SPS-1 project) if contained in more than one bag or container.
- Thoroughly mix the combined bulk sample and then dry the sample in accordance with the procedure described in Section 4.1 of AASHTO T87-86, "Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test."
- The mixed and dried sample is to be reduced to the appropriate test size using the procedures described in AASHTO T248. The test samples shall be representative of the total bulk sample.
- Perform all other tests in accordance with the appropriate protocols. Table 10 contains approximate test sample sizes for each test procedure.

It is likely that a substantial amount of material may be left over after testing of the unbound granular base/subbase layer. This extra material ensures that an adequate amount of sample was available to run all of the required characterization tests. This extra material shall not be disposed of until all testing has been completed and the results appear acceptable.

Table 10 - Approximate Weight of Test Samples for Unbound Granular Base/Subbase Testing

Protocol Name	Protocol No.	Approximate Sample Size kg (lb)		
		Maximum Aggregate Size		
		25 mm (1 in.)	51 mm (2 in.)	76 mm (3 in.)
Particle Size Analysis Sieve Analysis (washed)	P41	5 (11)	18 (40)	60 (133)
Atterberg Limits	P43	1.8 (4)	4.1 (9)	5 (11)
Classification	P47	Based on P41 and P43 Results		
Moisture-Density Relations	P44	9.1 (20)	13.6 (30)	13.6 (30)
Resilient Modulus	P46	29 (65)	29 (65)	29 (65)
TOTAL		45 (100)	65 (144)	108 (239)

4.6 LABORATORY TESTING OF PERMEABLE ASPHALT TREATED BASE

The following section is to be used as a guide for the completion of the laboratory testing program for the permeable asphalt treated base (PATB) course. Generally, 45 kg (100 lb) bulk samples of the PATB mixture will be retrieved from the SPS-1 project. These bulk samples will subsequently be shipped to the state/province agency laboratory (or their designee). Approximately 18 kg (40 lb) of the PATB will be used for the characterization of the material. The remaining portion (approximately 27 kg [60 lbs]) shall be saved until further notice.

To obtain sufficient material to complete the gradation test, approximately four asphalt content tests (Protocol P04) need to be run per 18 kg (40 lb) sample. The asphalt content tests shall be run as per LTPP Protocol P04, "Asphalt Content of Asphaltic Concrete." In reporting the test results, the average of the four asphalt content tests shall be used on the data sheet.

After the asphalt cement has been extracted from the samples, the remaining aggregate may be tested using LTPP Protocol P14, "Gradation of Aggregate Extracted from Asphalt Concrete." After the gradation test is performed, the "NAA Test for Fine Aggregate Particle Shape," (LTPP Protocol P14A) does not have to be performed on the sample as indicated in Protocol P14.

After performing all of the tests on the PATB material, the tested samples may be disposed of in an appropriate manner.

4.7 LABORATORY TESTING OF ASPHALTIC CONCRETE

The following sections are to be used as a guide for the completion of the laboratory material testing program for asphaltic concrete (AC), including both the asphaltic surface and binder courses.

4.7.1 Core Orientation and Handling of AC Cores Bonded with Other Layers

AC cores that are received by the laboratory from the field should be marked with an arrow to show the direction of traffic. It is important that this orientation mark be transferred to all layers within an AC core (surface, binder and dense graded asphalt treated base) when these layers are separated by sawing. After sawing, the asphalt concrete core layers below the surface that will be used for testing will no longer contain the arrow that was marked during the drilling operations. Therefore, if any asphalt concrete layer requires sawing to separate two independent materials, the laboratory technician shall paint the same arrow to designate traffic direction on the sawed surface of the lower asphalt layer(s). This arrow shall be placed along the same axis to designate the direction of traffic on the pavement surface. The face to be

marked shall be the one closest to the pavement surface. The marking of the direction of traffic is required for all cores.

4.7.2 Thickness Measurements of Cores with Bonded Layers

The laboratory will receive cores from the project which will contain one or more bonded layers. The laboratory is required to identify different layers, assign layer numbers and measure the layer thickness of each layer prior to sawing. The procedure described in Section 3.3 of Attachment "B" to Protocol P01 (Appendix E.2 of the SHRP-LTPP Interim Guide for Laboratory Material Handling and Testing) shall be used to measure the thickness of the bonded layers. It shall be noted and emphasized that multiple lifts within an asphalt concrete layer shall not be separated by sawing. All of the lifts will be treated as a single homogeneous layer and tested as such. It should also be noted that in no case shall two or more layers within an AC core sample be combined for any specified test.

Different layers within an AC core shall be separated by carefully sawing the sample. Special care shall be taken for sawing AC cores so as to provide minimum disturbance. The sawing operation on the interface of the layer to be separated shall be performed so that the asphaltic concrete will not be weakened by shock or by heating. The sawed surfaces of cores shall be smooth, plane, parallel and free from steps, ridges, and grooves. Care should be taken to avoid chipping or cracking. Always saw and separate the bottom layer first, followed by the next layer in ascending order until reaching the top layer. After sawing, proper identification, etc. shall be attached to the core to facilitate identification.

4.7.3 Laboratory Test Procedure for Asphaltic Concrete Cores

The AC Core Examination and Thickness Test (LTPP Test Designation AC01) will be the first test performed on all AC cores prior to sawing. LTPP Protocol P01 will be used for the performance of this test. Protocol P01 covers the visual examination of the entire asphaltic concrete core and the measurement of the length of the entire asphalt concrete core. It also covers the identification and determination of thickness of the individual layers within the core.

The bulk specific gravity test (LTPP Test Designation AC02) will be the second test performed on all AC layers after the sawing of individual layers. LTPP Protocol P02 will be used for the performance of this test. After the completion of the bulk specific gravity test, some of the cores will be placed in long-term storage, some will be tested for resilient modulus (LTPP Protocol P07), and some cores will be tested for creep compliance (LTPP Protocol P05) as indicated in the Laboratory Tracking Tables presented later.

Resilient modulus testing will be conducted using LTPP Protocol P07. Generally, a sample group of four cores are retrieved from the same general location on the SPS project. Of these four cores, one is tested in indirect tension to determine the stress levels to be used for resilient modulus testing of the other three cores. Then, after completion of the resilient modulus testing, an indirect tensile strength test shall be performed on each core. After the completion of all tests on these samples, the cores may be disposed of in an appropriate manner.

Creep compliance testing will be conducted using LTPP Protocol P06. Generally, three cores will be tested per SPS-1 project. After the completion of the testing, the cores may be disposed of in an appropriate manner.

4.7.4 Laboratory Test Procedures for Bulk Samples of Asphaltic Concrete

Bulk samples will be obtained from various locations throughout the SPS project. These bulk samples will contain approximately 90.7 kg (200 lb) of mixed uncompacted asphalt concrete. The bulk sample shall be split into two equal portions. One portion will be used to mold samples for moisture susceptibility testing and one portion will be used for maximum specific gravity, asphalt extraction tests and subsequently, tests on the asphalt cement and aggregates.

Note: Prior to the January, 1994 version of this document, only 45 kg (100 lb) of asphalt concrete was retrieved from the field. Usually, three 45 kg (100 lb) samples are retrieved from an entire project. In cases such as this, the laboratory, at their option, can use two of the three 45 kg (100 lb) samples to perform the extraction and subsequent asphalt cement/aggregate tests and use the remaining 45 kg (100 lb) sample to remold samples for moisture susceptibility testing.

4.7.4.1 Moisture Susceptibility Testing - Using the 45 kg (100 lb) sample of uncompacted asphalt concrete, the moisture susceptibility test shall be conducted as per LTPP Protocol P05, "Moisture Susceptibility of Asphaltic Concrete." After completion of the test, the samples may be disposed of in an appropriate manner.

4.7.4.2 Other Uncompacted Asphalt Concrete Testing - Using the second 45 kg (100 lb) sample of uncompacted asphalt concrete, the remaining asphalt concrete extracted aggregate and asphalt cement tests may be performed. Approximately 4.5 kg (10 lb) will be used for maximum specific gravity testing and approximately 27 kg (60 lb) will be used for the asphalt content testing. Any excess material shall be saved until further notice.

4.7.4.2.1 To obtain sufficient material to complete all of the asphalt cement tests, approximately six asphalt content tests need to be run per 27 kg (60 lb) sample. The

asphalt content test shall be run as per LTPP Protocol P04, "Asphalt Content of Asphaltic Concrete." In reporting the test results, the average of the six asphalt content tests shall be used on the data sheet.

After the aggregate has been removed from the sample, the aggregate sample shall be split into two equal portions. One portion shall be used for conducting the aggregate gradation test using LTPP Protocol P14, "Gradation of Aggregate Extracted from Asphalt Concrete." After the gradation test is performed the "NAA Test for Fine Aggregate Particle Shape," (Protocol P14A) shall be conducted on the appropriate sample. The other portion shall be used to conduct the specific gravity tests on the aggregates using LTPP Protocol P11, "Specific Gravity and Absorption of Extracted Coarse Aggregate," and Protocol P12, "Specific Gravity and Absorption of Extracted Fine Aggregates." After completion of all tests on the extracted aggregate, the sample may be disposed of in appropriate fashion. Any extra material not used for testing shall be saved until further notice.

4.7.4.2.2 The abson recovery test shall be performed on each extracted asphalt solution sample. Subsequently, the recovered asphalt cement samples shall be combined and used to perform the remaining asphalt cement tests. The following approximate volume of material is needed for each test:

LTPP Protocol	Name	Approximate Volume of Material
P22	Penetration at 25°C, 46°C	200 ml
P23	Specific Gravity at 16°C	25 ml
P24	Viscosity at 25°C	200 ml
P25	Viscosity at 60°C, 135°C	40 ml
TOTAL		465 ml

After performing the asphalt cement tests, the samples may be disposed of in an appropriate manner. Figure 10 illustrates the flow of materials for the testing of the bulk asphalt concrete samples.

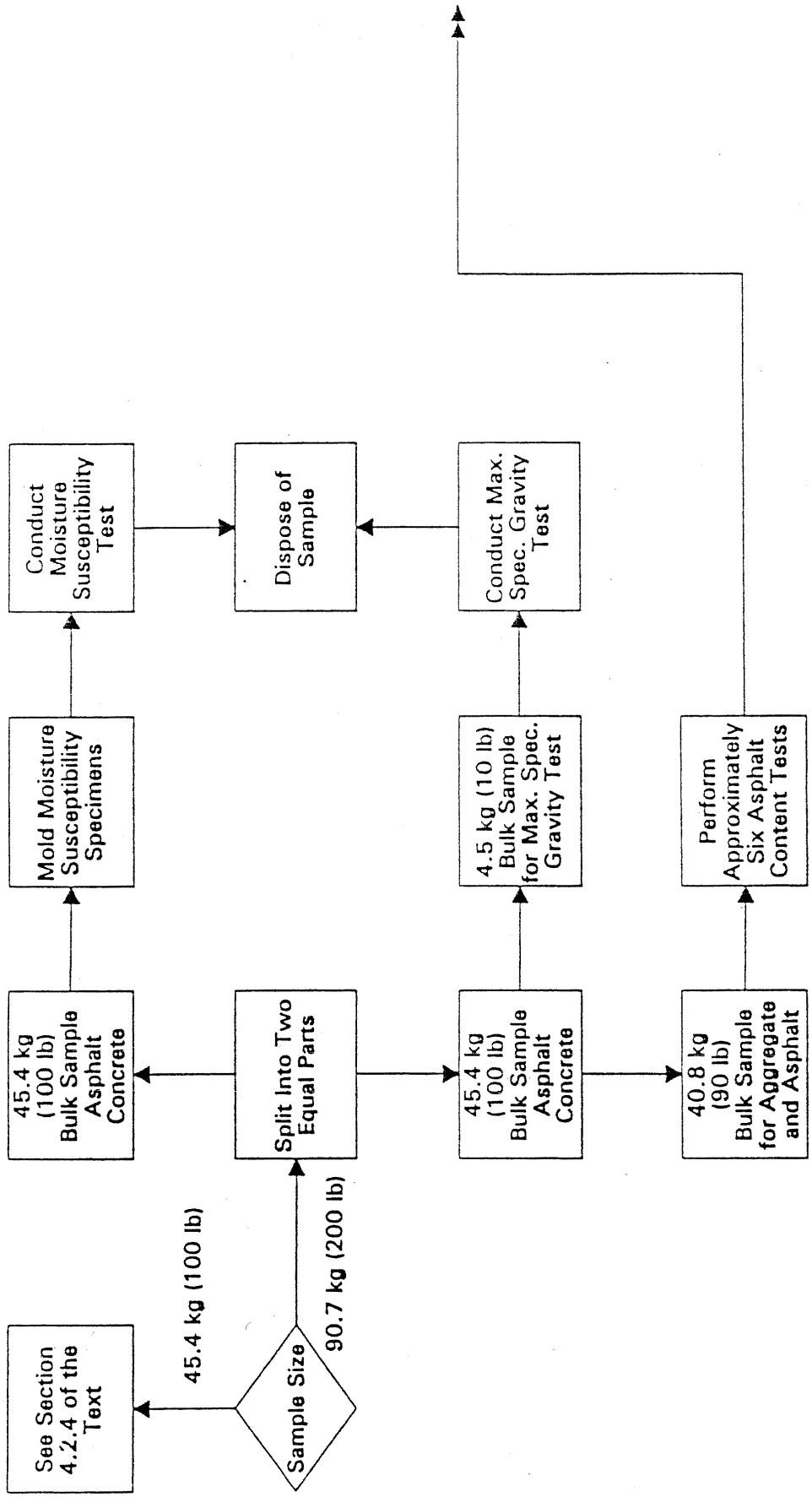


Figure 10. Flowchart for Asph Concrete Bulk Samples

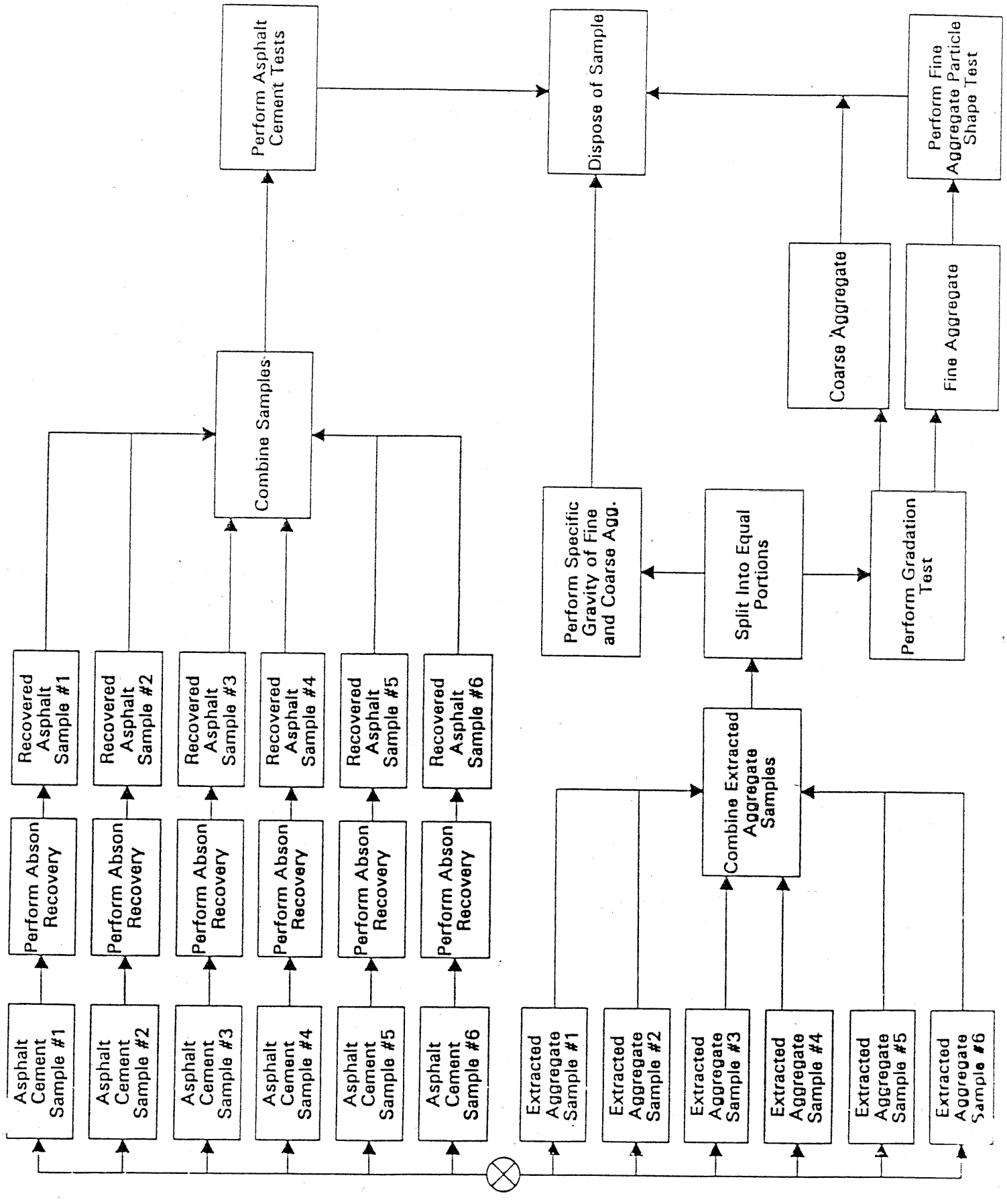


Figure 10. Flowchart for Asphalt Concrete Bulk Samples, Continued.

4.8 SAMPLE IDENTIFICATION AND MARKING

It is imperative that there be strict adherence to the sample identification and marking procedures used initially in the field (see Sections 3.3.7, 3.3.8, and 3.3.9 of this document). The sample numbers, core/sample location numbers, etc. shall follow each sample throughout the laboratory materials testing process and it is extremely important to keep sample tags and labels on samples during storage.

4.9 SAMPLE RECORD KEEPING

The laboratories conducting the testing for the SPS-1 projects are required to keep in close coordination with the LTPP Regional Engineer and the FHWA-LTPP Regional Coordination Office from the time of receiving the samples from the field to the disposal of the material samples. Timely transmission of information between the laboratory and the RCO should be maintained using the standard guidelines and forms discussed in this section. The forms discussed herein may be found in Appendix C.2 of the "SHRP-LTPP Interim Guide for Laboratory Material Handling and Testing."

4.9.1 Sample Receipt Procedures

The field material samples will be shipped to the participating laboratory by the drilling and sampling crew. The drilling and sampling crew or others, as designated by the state/provincial agency, will also mail a complete packet of field data sheets for the corresponding SPS project. Field Operations Information Form 1 provides an inventory of material samples shipped to the laboratory. Field Operations Information Form 2-1 also provides pavement layer numbers assigned in the field.

Upon receipt of the samples, the samples shall be inspected by the laboratory manager (or their designee) for completeness of the shipment (as compared to the data shown on Field Operation Forms 1 and 2-1), damage, contamination, sufficient quantity, proper identification and properly completed field forms. Regardless of the condition and size of the samples, they must be logged in by using the information from Field Operation Forms 1 and 2-1 as well as individual sample tags and markings.

The laboratory shall then use Forms L01, L02, and L03 to prepare the sample receipt report for each project. It is imperative that the sample identification and any unique laboratory control number (assigned by the participating laboratory) remain attached to the sample/sample container at all times. In the event that it becomes necessary to remove the identification label or tag during sample processing or testing, steps shall be taken to ensure that the relationship

between the sample and its identification is not lost but the identification is restored to the sample at the end of each step of processing or testing.

After completing the sample receipt process, these forms should be transmitted to the appropriate personnel. As a minimum, this should include the state/provincial agency contact person, the RCO, and the FHWA-LTPP Regional Engineer.

After preparing the sample receipt report, the laboratory manager shall make laboratory test assignments using Form L04 (Appendix C.2 of the Laboratory Testing Guide). On this form, the first three columns from the left provide the following information about the pavement layers:

a. Column 1 - Layer Number - Layer number is assigned on Column 1 of Form L04 starting with layer number 1. Layer number 1 is always assigned for the subgrade and the last layer number is always assigned to the pavement surface layer. Example of layer numbers for a five-layer pavement structure is:

Subgrade	1
Subbase	2
Base	3
AC Binder Course . . .	4
AC Surface Course . . .	5

b. Column 2 - Layer Description - Layer description is provided on Column 2 of this form, using the following codes:

Overlay	01	Subgrade	07
Seal Coat	02	Interlayer	08
Surface Layer	03	Friction Course	09
AC Layer below Surface .	04	Surface Treatment . . .	10
Base Layer	05	Embankment (Fill) . .	11
Subbase Layer	06		

c. Column 3 - Layer Type - Layer type code is assigned in Column 3 from the left on Form L04 using:

AC - for asphaltic concrete (bituminous concrete) layer,
TB - for bound (treated) base,
TS - for bound (treated) subbase,
GB - for unbound (granular) base,
GS - for unbound (granular) subbase,

SS - for subgrade (untreated), and
ST - for subgrade (treated).

Multiple sheets can be used for the laboratory designated test assignments on the samples from a SPS project. Appendix C.2 of the Laboratory Materials Testing Guide contains further instructions on the use of Forms L01-L04. The FHWA-LTPP Regional Engineer (or their designee) shall approve all test data reporting forms.

4.9.2 Test Data Reporting

The participating laboratory is required to use the LTPP standard data reporting forms for recording test results. These data reporting forms are contained in Appendix C.2 of the, "SHRP-LTPP Interim Guide for Laboratory Material Handling and Testing." All of these forms provide space to record sample identification information and test data as well as comments and notes relevant to each test. These forms are also contained at the end of each LTPP Protocol contained in Appendix E.2 of the Laboratory Material Testing Guide. All data entry sheets should be forwarded to the FHWA-LTPP Regional Engineer for processing and approval.

4.9.3 Sample Disposition Reporting

At the completion of all testing for a SPS project, Form L06 (Appendix C.2 of the Laboratory Materials Testing Guide) is used by the participating laboratory to provide the LTPP RCO with a record status of all material samples. This form includes entries for recording whether a particular sample/specimen was stored, disposed of, etc. After completion of this form, it should be transmitted to the appropriate personnel. As a minimum, this should include the state/province agency contact personnel, the RCO and the FHWA-LTPP Regional Engineer.

4.10 SAMPLE STORAGE

Due to the volume of work and the likelihood of delays in testing, proper storage conditions must be maintained for all specimens obtained from the Long Term Pavement Performance (LTPP) program Specific Pavement Studies experiments. This includes samples and specimens that will be tested by the state highway agency laboratories or their agents and the materials which will subsequently tested by the FHWA contracted laboratories. The storage requirements presented herein are critical to ensuring the integrity of the sample/specimen for future testing and materials characterization. Specifically, requirements for adequate storage and temperature conditions have been detailed for the specimens to ensure that the samples are not compromised while intending not to make the storage requirements burdensome on the

participating laboratory. Identification assigned to the materials shall be retained on tested samples, untested samples and extra samples at all times.

The term "Environmentally Protected Storage" as used in this document means that the storage area shall be fully enclosed and not subjected to the natural elements. This type of area shall provide protection against contact with water (rain or wet floor) and exposure to direct sunlight. Also, the storage area shall be capable of maintaining each sample in the required temperature range as specified below. Samples shall be marked to indicate their status; such as "hold material - do not use."

The following guidelines shall be followed for storage of materials from the LTPP experiments:

4.10.1 Asphaltic Concrete Cores

Asphaltic concrete cores should be stored flat side down, fully supported and at between 5°C (40°F) and 21°C (70°F) in an environmentally protected storeroom.

4.10.2 Asphalt Treated Materials

Asphalt Treated Base/Subbase and Treated Subgrade cores and materials should be stored flat side down, fully supported and at between 5°C (40°F) and 21°C (70°F) in an environmentally protected storeroom.

4.10.3 Other Than Asphalt Treated Materials

Other than asphalt treated base/subbase and subbase cores and materials should be stored in a fully supported condition and at between 5°C (40°F) and 38°C (100°F) in an environmentally protected storeroom.

4.10.4 Thin-Walled Tube Samples

Thin-walled tube samples of the subgrade should be stored in a fully supported condition and at temperatures between 5°C (40°F) and 21°C (70°F) in an environmentally protected storeroom. They shall be stored on their ends and shall always be stored in a vertical position with respect to the longitudinal axis of the tube in the same orientation as that retrieved from the field.

4.10.5 Bulk/Moisture Samples

Bulk and moisture samples of base, subbase and subgrade material should be kept in an environmentally protected storage area at temperatures between 5°C (40°F) and 38°C (100°F).

4.11 SAMPLE HANDLING AND SHIPPING

All samples sent to other laboratories for testing shall, as a minimum, be prepared and shipped using the following guidelines.

4.11.1 Packaging

1. Each sample shall have a label or tag attached that clearly identifies the material, the project number/test section from which it was recovered, and the sample number.

2. Each core shall be surrounded by "bubble-wrap" or other acceptable cushioning material on all sides within the shipping box.

3. Bulk samples shall be marked with the two samples or tags. One shall be placed inside the bag and one attached to the outside. Pieces from treated layers not suitable for testing as cores shall be packaged and shipped as bulk samples.

4. Thin-walled tube samples and jar samples shall be packaged in boxes with cushioning such as "bubble-wrap" or other similar material.

5. Shipping boxes shall be made of wood of suitable grade and construction to withstand shipping and subsequent moving without breakage of the box or damaging of the samples.

6. All boxes shall be adequately secured by nails or screws prior to shipping.

7. All necessary documentation related to the samples being shipped shall also be included in the shipment. A duplicate set of all necessary documentation shall be sent in a separate package to the laboratory to confirm the box inventory.

4.11.2 Shipping

Each box shall be labeled to include the project identification number, type(s) of samples, box number (for each series of boxes). The boxes shall be labeled "Handle with Care" or similar wording as specified by the transporting organization to reasonably insure careful handling and protection from freezing and overheating.

It is recommended that each shipment be insured for an amount to cover at least twice the cost of the field work performed at the site to obtain the samples.

A copy of the bill of lading clearly showing the boxes being shipped and a receipt signed by the shipping organization shall be sent to the appropriate FHWA LTPP Regional Coordination Office.

4.11.3 Summary

The sample preparation and shipping guidelines provided herein are designed to protect the integrity of the materials samples to the highest degree possible within economic limits. These materials are very important to the success of the LTPP program and should be treated with as much care as possible. Cooperation from all participants is needed to insure that these specimens are shipped between laboratories with a minimum of damage.

4.12 LABORATORY TESTING PLAN

Using all of the information presented previously, the laboratory testing plan can be established for each project. Table 11 presents this plan for the SPS-1 materials laboratory testing.

4.13 LABORATORY TRACKING OF SAMPLES

This section contains Laboratory Sample Tracking Tables which contain instructions for sample handling and tracking throughout the laboratory testing process. Tables 12 to 17 detail the sample handling and testing for the state/ provincial agency laboratory (or their designee) and Tables 18 to 23b detail the sample handling and testing for the FHWA-LTPP Laboratory Materials Testing Contractor.

Table 11 - Samples to be Used for Laboratory Materials Testing

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Sampling Location	Test Conducted by: Agency	Test Conducted by: FHWA
SUBGRADE (when embankment ≥ 1.2 m [4 ft])						
No Testing						
SUBGRADE						
Sieve Analysis	SS01	P51	6	B1-B6		✓
Hydrometer to 0.001 mm	SS02	P42	6	B1-B6		✓
Atterberg Limits	SS03	P43	6	B1-B6		✓
Classification	SS04	P52	6	B1-B6		✓
(visual-manual only on thin-wall tubes)			18	A1-A18	✓	✓
Moisture-Density Relations	SS05	P55	6	B1-B6		✓
Resilient Modulus	SS07	P46	6	A2, A5, A9, A11, A14, A17		✓
(if thin-wall tube is not available)			6	B1-B6		✓
Unit Weight (if thin-wall tube is not available, test is not conducted)	SS08	P56	6	A1, A4, A8, A10, A13, A16	✓	
Natural Moisture Content	SS09	P49	6	B1-B6		✓
Unconfined Comp. Strength (if thin-wall tube is not available, test is not conducted)	SS10	P54	6	A1, A4, A8, A10, A13, A16	✓	
Permeability	SS11	P57	3	A3, A7, A18	✓	
Permeability	UG09	P48	6	B1-B6	✓	
EMBANKMENT < 1.2 m (4 ft) Thick						
Sieve Analysis	SS01	P51	6	B7-B12		✓
Hydrometer to 0.001 mm	SS02	P42	6	B7-B12		✓
Atterberg Limits	SS03	P43	6	B7-B12		✓
Classification	SS04	P52	6	B7-B12		✓
Moisture-Density Relations	SS05	P55	6	B7-B12		✓
Resilient Modulus	SS07	P46	6	B7-B12		✓
Natural Moisture Content	SS09	P49	6	B7-B12		✓
Permeability	UG09	P48	6	B7-B12	✓	

Table 11 - Samples to be Used for Laboratory Materials Testing

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Sampling Location	Test Conducted by: Agency	FHWA
EMBANKMENT ≥ 1.2 m (4 ft) Thick						
Sieve Analysis	SS01	P51	6	B1-B6		✓
Hydrometer to 0.001 mm	SS02	P42	6	B1-B6		✓
Atterberg Limits	SS03	P43	6	B1-B6		✓
Classification	SS04	P52	6	B1-B6		✓
(visual-manual only on thin wall tube)			18	A1-A18	✓	✓
Moisture-Density Relations	SS05	P55	6	B1-B6		✓
Resilient Modulus	SS07	P46	6	A2, A5, A9, A11, A14, A17		✓
(if thin-wall tube is not available)			6	B1-B6		✓
Unit Weight (if thin-wall tube is not available, test is not conducted)	SS08	P56	6	A1, A4, A8, A10, A13, A16	✓	
Natural Moisture Content	SS09	P49	6	B1-B6		✓
Unconfined Comp. Strength (if thin-wall tube is not available, test is not conducted)	SS10	P54	6	A1, A4, A8, A10, A13, A16	✓	
Permeability	SS11	P57	3	A3, A7, A18	✓	
Permeability	UG09	P48	6	B1-B6	✓	
UNBOUND GRANULAR BASE						
Particle Size Analysis	UG01	P41	3	B13-B15		✓
Sieve Analysis (washed)	UG02	P41	3	B13-B15		✓
Atterberg Limits	UG04	P43	3	B13-B15		✓
Moisture-Density Relations	UG05	P44	3	B13-B15		✓
Resilient Modulus	UG07	P46	3	B13-B15		✓
Classification	UG08	P47	3	B13-B15		✓
Permeability	UG09	P48	3	B13-B15	✓	
Natural Moisture Content	UG10	P49	3	B13-B15		✓
PERMEABLE TREATED ASPHALT BASE						
Asphalt Content (Extraction)	AC04	P04	3	B16-B18 from paver	✓	
Extracted Aggregate:						
Gradation of Aggregate	AG04	P14	3	B16-B18 from paver	✓	

Table 11 - Samples to be Used for Laboratory Materials Testing

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Sampling Location	Test Conducted by: Agency	FHWA
ASPHALT TREATED BASE						
Core Examination/Thickness	AC01	P01	34	C1-C10, C21-C34, C47-C56	✓	✓
Bulk Specific Gravity	AC02	P02	34	C1-C10, C21-C34, C47-C56	✓	✓
Maximum Specific Gravity	AC03	P03	3	B19-B21 from paver	✓	
Asphalt Content (Extraction)	AC04	P04	3	B19-B21 from paver	✓	
Moisture Susceptibility	AC05	P05	3	B19-B21 from paver	✓	
Resilient Modulus	AC07	P07	9	C5-C7, C25-C27, C51-C53		✓
Tensile Strength	AC07	P07	12	C5-C8, C25-C28, C51-C54		✓
Extracted Aggregate:						
Specific Gravity:						
Coarse Aggregate	AG01	P11	3	B19-B21 from paver	✓	
Fine Aggregate	AG02	P12	3	B19-B21 from paver	✓	
Gradation of Aggregate	AG04	P14	3	B19-B21 from paver	✓	
NAA Test for Fine Aggregate Particle Shape	AG05	P14A	3	B19-B21 from paver	✓	
Asphalt Cement:						
Absorn Recovery	AE01	P21	3	B19-B21 from paver	✓	
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	B19-B21 from paver	✓	
Specific Gravity 16°C (60°F)	AE03	P23	3	B19-B21 from paver	✓	
Viscosity at 25°C (77°F)	AE04	P24	3	B19-B21 from paver	✓	
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	B19-B21 from paver	✓	
Asphalt Cement: (From Tanker or Plant)						
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	B22-B24 from plant	✓	
Specific Gravity 16°C (60°F)	AE03	P23	3	B22-B24 from plant	✓	
Viscosity at 25°C (77°F)	AE04	P24	3	B22-B24 from plant	✓	
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	B22-B24 from plant	✓	

Table 11 - Samples to be Used for Laboratory Materials Testing

Material Type and Properties	LTPP Designation	LTPP Protocol	Minimum No. of Tests per Layer	Sampling Location	Test Conducted by: Agency	Test Conducted by: FHWA
ASPHALTIC CONCRETE SURFACE AND BINDER						
Core Examination/Thickness	AC01	P01	60	C1-C60	✓	✓
Bulk Specific Gravity	AC02	P02	60	C1-C60	✓	✓
Maximum Specific Gravity	AC03	P03	3	B25-B27 from paver	✓	
Asphalt Content (Extraction)	AC04	P04	3	B25-B27 from paver	✓	
Moisture Susceptibility	AC05	P05	3	B25-B27 from paver	✓	
Creep Compliance	AC06	P06	3	C3, C23, C47		✓
Resilient Modulus	AC07	P07	18	C5-C7, C15-C18, C25-C28, C35-C37, C41-C43, C51-C54		✓
Tensile Strength	AC07	P07	24	C5-C8, C15-C18, C25-C28, C35-C38, C41-C44, C51-C54		✓
Extracted Aggregate:						
Specific Gravity:						
Coarse Aggregate	AG01	P11	3	B25-B27 from paver	✓	
Fine Aggregate	AG02	P12	3	B25-B27 from paver	✓	
Gradation of Aggregate	AG04	P14	3	B25-B27 from paver	✓	
NAA Test for Fine Aggregate Particle Shape	AG05	P14A	3	B25-B27 from paver	✓	
Asphalt Cement:						
Abson Recovery	AE01	P21	3	B25-B27 from paver	✓	
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	B25-B27 from paver	✓	
Specific Gravity 16°C (60°F)	AE03	P23	3	B25-B27 from paver	✓	
Viscosity at 25°C (77°F)	AE04	P24	3	B25-B27 from paver	✓	
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	B25-B27 from paver	✓	
Asphalt Cement: (From Tanker)						
Penetration at 25°C, 46°C (77°F, 115°F)	AE02	P22	3	B28-B30 from plant	✓	
Specific Gravity 16°C (60°F)	AE03	P23	3	B28-B30 from plant	✓	
Viscosity at 25°C (77°F)	AE04	P24	3	B28-B30 from plant	✓	
Viscosity at 60°C, 135°C (140°F, 275°F)	AE05	P25	3	B28-B30 from plant	✓	

Table 12 - Tracking Table of Asphaltic Concrete Testing
in the State/Province Laboratory (or their designee)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
C1	CA01	1	AC01/P01	AC02/P02			Yes	(a)	No
C2	CA02	1	AC01/P01	AC02/P02			Yes	(a)	No
C4	CA04	2	AC01/P01	AC02/P02			Yes	(a)	No
C9	CA09	2	AC01/P01	AC02/P02			Yes	(a)	No
C10	CA10	2	AC01/P01	AC02/P02			Yes	(a)	No
C11	CA11	1	AC01/P01	AC02/P02			Yes	(a)	No
C12	CA12	1	AC01/P01	AC02/P02			Yes	(a)	No
C13	CA13	2	AC01/P01	AC02/P02			Yes	(a)	No
C14	CA14	2	AC01/P01	AC02/P02			Yes	(a)	No
C19	CA19	2	AC01/P01	AC02/P02			Yes	(a)	No
C20	CA20	2	AC01/P01	AC02/P02			Yes	(a)	No
C21	CA21	1	AC01/P01	AC02/P02			Yes	(a)	No
C22	CA22	1	AC01/P01	AC02/P02			Yes	(a)	No
C24	CA24	2	AC01/P01	AC02/P02			Yes	(a)	No
C29	CA29	2	AC01/P01	AC02/P02			Yes	(a)	No
C30	CA30	2	AC01/P01	AC02/P02			Yes	(a)	No
C31	CA31	1	AC01/P01	AC02/P02			Yes	(a)	No
C32	CA32	1	AC01/P01	AC02/P02			Yes	(a)	No
C33	CA33	2	AC01/P01	AC02/P02			Yes	(a)	No
C34	CA34	2	AC01/P01	AC02/P02			Yes	(a)	No
C39	CA39	2	AC01/P01	AC02/P02			Yes	(a)	No
C40	CA40	2	AC01/P01	AC02/P02			Yes	(a)	No
C45	CA45	2	AC01/P01	AC02/P02			Yes	(a)	No
C46	CA46	2	AC01/P01	AC02/P02			Yes	(a)	No
C48	CA48	1	AC01/P01	AC02/P02			Yes	(a)	No
C49	CA49	2	AC01/P01	AC02/P02			Yes	(a)	No
C50	CA50	2	AC01/P01	AC02/P02			Yes	(a)	No
C55	CA55	2	AC01/P01	AC02/P02			Yes	(a)	No

Table 12 - Tracking Table of Asphaltic Concrete Testing
in the State/Province Laboratory (or their designee) (Continued)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
C56	CA56	2	AC01/P01	AC02/P02			Yes	(a)	No
C57	CA57	1	AC01/P01	AC02/P02			Yes	(a)	No
C58	CA58	1	AC01/P01	AC02/P02			Yes	(a)	No
C59	CA59	2	AC01/P01	AC02/P02			Yes	(a)	No
C60	CA60	2	AC01/P01	AC02/P02			Yes	(a)	No
B25	BA01	3	See Figure 10				No	(a)	Yes
B26	BA02	3	See Figure 10				No	(a)	Yes
B27	BA03	3	See Figure 10				No	(a)	Yes
B28	BC04	3	AE02/P22	AE03/P23	AE04/P24	AE05/P25	No	(a)	Yes
B29	BC05	3	AE02/P22	AE03/P23	AE04/P24	AE05/P25	No	(a)	Yes
B30	BC06	3	AE02/P22	AE03/P23	AE04/P24	AE05/P25	No	(a)	Yes

Note: all of the core specimens noted herein shall be stored for possible future use. In the future, these specimens may be used to evaluate test procedures for the SuperPave program.

Table 13 - Tracking Table of Asphalt Treated Base Testing in the State/Province Laboratory (or their designee)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
C1	CT01	1	AC01/P01	AC02/P02			Yes	(a)	No
C2	CT02	1	AC01/P01	AC02/P02			Yes	(a)	No
C3	CT03	2	AC01/P01	AC02/P02			Yes	(a)	No
C4	CT04	2	AC01/P01	AC02/P02			Yes	(a)	No
C9	CT09	2	AC01/P01	AC02/P02			Yes	(a)	No
C10	CT10	2	AC01/P01	AC02/P02			Yes	(a)	No
C21	CT21	1	AC01/P01	AC02/P02			Yes	(a)	No
C22	CT22	1	AC01/P01	AC02/P02			Yes	(a)	No
C23	CT23	2	AC01/P01	AC02/P02			Yes	(a)	No
C24	CT24	2	AC01/P01	AC02/P02			Yes	(a)	No
C29	CT29	2	AC01/P01	AC02/P02			Yes	(a)	No
C30	CT30	2	AC01/P01	AC02/P02			Yes	(a)	No
C31	CT31	1	AC01/P01	AC02/P02			Yes	(a)	No
C32	CT32	1	AC01/P01	AC02/P02			Yes	(a)	No
C33	CT33	2	AC01/P01	AC02/P02			Yes	(a)	No
C34	CT34	2	AC01/P01	AC02/P02			Yes	(a)	No
C47	CT47	1	AC01/P01	AC02/P02			Yes	(a)	No
C48	CT48	1	AC01/P01	AC02/P02			Yes	(a)	No
C49	CT49	2	AC01/P01	AC02/P02			Yes	(a)	No
C50	CT50	2	AC01/P01	AC02/P02			Yes	(a)	No
C55	CT55	2	AC01/P01	AC02/P02			Yes	(a)	No
C56	CT56	2	AC01/P01	AC02/P02			Yes	(a)	No
B19	BT20	3	See Figure 10				No	(a)	Yes
B20	BT21	3	See Figure 10				No	(a)	Yes
B21	BT22	3	See Figure 10				No	(a)	Yes
B22	BC01	3	AE02/P22	AE03/P23	AE04/P24	AE05/P25	No	(a)	Yes
B23	BC02	3	AE02/P22	AE03/P23	AE04/P24	AE05/P25	No	(a)	Yes
B24	BC03	3	AE02/P22	AE03/P23	AE04/P24	AE05/P25	No	(a)	Yes

Table 14 - Tracking Table of Permeable Asphalt Treated Base Testing in the State/Province Laboratory (or their designee)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
B16	BT01	3	AC04/P04	AG04/P14			No	(a)	Yes
B17	BT02	3	AC04/P04	AG04/P14			No	(a)	Yes
B18	BT03	3	AC04/P04	AG04/P14			No	(a)	Yes

Table 15 - Tracking Table of Unbound Granular Base Testing
in the State/Province Laboratory (or their designee)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
B13	BG07	1	UG09/P48				No	(b)	Yes
B14	BG08	1	UG09/P48				No	(b)	Yes
B15	BG09	1	UG09/P48				No	(b)	Yes

Table 16 - Tracking Table of Embankment < 1.2 m (4 ft) Testing
in the State/Province Laboratory (or their designee)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
B7	BG01	2	UG09/P48				No	(b)	Yes
B8	BG02	2	UG09/P48				No	(b)	Yes
B9	BG03	2	UG09/P48				No	(b)	Yes
B10	BG04	2	UG09/P48				No	(b)	Yes
B11	BG05	2	UG09/P48				No	(b)	Yes
B12	BG06	2	UG09/P48				No	(b)	Yes

Table 17a - Tracking Table of Subgrade (Embankment ≥ 1.2 m [4 ft]) Testing in the State/Province Laboratory (or their designee) (If Thin-Wall Tubes are Available)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
B1	BS01	2	No testing - samples stored				Yes	(b)	No
B2	BS02	2	No testing - samples stored				Yes	(b)	No
B3	BS03	2	No testing - samples stored				Yes	(b)	No
B4	BS04	2	No testing - samples stored				Yes	(b)	No
B5	BS05	2	No testing - samples stored				Yes	(b)	No
B6	BS06	2	No testing - samples stored				Yes	(b)	No
A1	TS01	3	SS04/P52	SS08/P56	SS10/P54		No	(c)	Yes
A3	TS05	3	SS04/P52	SS11/P57			No	(c)	Yes
A4	TS07	3	SS04/P52	SS08/P56	SS10/P54		No	(c)	Yes
A6	TS11	3	SS04/P52				No	(c)	Yes
A7	TS13	3	SS04/P52	SS11/P57			No	(c)	Yes
A8	TS15	3	SS04/P52	SS08/P56	SS10/P54		No	(c)	Yes
A10	TS19	3	SS04/P52	SS08/P56	SS10/P54		No	(c)	Yes
A12	TS23	3	SS04/P52				No	(c)	Yes
A13	TS25	3	SS04/P52	SS08/P56	SS10/P54		No	(c)	Yes
A15	TS29	3	SS04/P52				No	(c)	Yes
A16	TS31	3	SS04/P52	SS08/P56	SS10/P54		No	(c)	Yes
A18	TS35	3	SS04/P52	SS11/P57			No	(c)	Yes
A3	TS06	3					Yes	(c)	No
A4	TS08	3					Yes	(c)	No
A6	TS12	3					Yes	(c)	No
A7	TS14	3					Yes	(c)	No
A8	TS16	3					Yes	(c)	No
A10	TS20	3					Yes	(c)	No
A12	TS24	3					Yes	(c)	No
A13	TS26	3					Yes	(c)	No
A15	TS30	3					Yes	(c)	No
A16	TS32	3					Yes	(c)	No
A18	TS36	3					Yes	(c)	No

Table 17b - Tracking Table of Subgrade (Embankment ≥ 1.2 m [4 ft]) Testing in the State/Province Laboratory (or their designee) (If Thin-Wall Tubes are not Available)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
B1	BS01	2	SS11/P57				No	(b)	Yes
B2	BS02	2	SS11/P57				No	(b)	Yes
B3	BS03	2	SS11/P57				No	(b)	Yes
B4	BS04	2	SS11/P57				No	(b)	Yes
B5	BS05	2	SS11/P57				No	(b)	Yes
B6	BS06	2	SS11/P57				No	(b)	Yes

Table 18 - Tracking Table of Asphaltic Concrete Testing
in the FHWA-LTPP Testing Contractor Laboratory

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
C3	CA03	2	AC01/P01	AC02/P02	AC06/P06		No	(a)	Yes
C5	CA05	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C6	CA06	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C7	CA07	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C8	CA08	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C15	CA15	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C16	CA16	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C17	CA17	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C18	CA18	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C23	CA23	2	AC01/P01	AC02/P02	AC06/P06		No	(a)	Yes
C25	CA25	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C26	CA26	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C27	CA27	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C28	CA28	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C35	CA35	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C36	CA36	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C37	CA37	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C38	CA38	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C41	CA41	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C42	CA42	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C43	CA43	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C44	CA44	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C47	CA47	1	AC01/P01	AC02/P02	AC06/P06		No	(a)	Yes
C51	CA51	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C52	CA52	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C53	CA53	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C54	CA54	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes

Table 19 - Tracking Table of Asphalt Treated Base Testing
in the FHWA-LTPP Testing Contractor Laboratory

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			
C5	CT05	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C6	CT06	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C7	CT07	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C8	CT08	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C25	CT25	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C26	CT26	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C27	CT27	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C28	CT28	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C51	CT51	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C52	CT52	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C53	CT53	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes
C54	CT54	1	AC01/P01	AC02/P02	AC07/P07	AC07/P07 (ITS)	No	(a)	Yes

Table 20 - Tracking Table of Permeable Asphalt Treated Base Testing in the FHWA-LTPP Testing Contractor Laboratory

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence						
			Required Laboratory Tests Per Layer (4)				Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth			

No permable asphalt treated base testing will be conducted by the FWHA-LTPP Testing Contractor

Table 21 - Tracking Table of Unbound Granular Base Testing in the FHWA-LTPP Testing Contractor Laboratory

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence								
			Required Laboratory Tests Per Layer						Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth	Fifth	Sixth			
B13	BG07	1	UG01/P41	UG02/P41	UG04/P43	UG08/P47	UG05/P44	UG07/P46	No	(b)	Yes
B14	BG08	1	UG01/P41	UG02/P41	UG04/P43	UG08/P47	UG05/P44	UG07/P46	No	(b)	Yes
B15	BG09	1	UG01/P41	UG02/P41	UG04/P43	UG08/P47	UG05/P44	UG07/P46	No	(b)	Yes
B13	MG07	1	UG10/P49						No	(b)	Yes
B14	MG08	1	UG10/P49						No	(b)	Yes
B15	MG09	1	UG10/P49						No	(b)	Yes

Table 22 - Tracking Table of Embankment < 1.2 m (4 ft.) Testing in the FHWA-LTPP Testing Contractor Laboratory

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence								
			Required Laboratory Tests Per Layer						Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth	Fifth	Sixth			
B7	BG01	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B8	BG02	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B9	BG03	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B10	BG04	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B11	BG05	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B12	BG06	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B7	MG01	2	SS09/P49						No	(b)	Yes
B8	MG02	2	SS09/P49						No	(b)	Yes
B9	MG03	2	SS09/P49						No	(b)	Yes
B10	MG04	2	SS09/P49						No	(b)	Yes
B11	MG05	2	SS09/P49						No	(b)	Yes
B12	MG06	2	SS09/P49						No	(b)	Yes

Table 23a - Tracking Table of Subgrade (Embankment ≥ 1.2 m [4 ft]) Testing in the FHWA-LTPP Testing Contractor Laboratory (If Thin-Wall Tubes are Available)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence								
			Required Laboratory Tests Per Layer						Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth	Fifth	Sixth			
B1	BS01	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55		No	(b)	Yes
B2	BS02	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55		No	(b)	Yes
B3	BS03	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55		No	(b)	Yes
B4	BS04	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55		No	(b)	Yes
B5	BS05	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55		No	(b)	Yes
B6	BS06	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55		No	(b)	Yes
A2	TS03	3	SS04/P52	SS07/P46					No	(c)	Yes
A5	TS09	3	SS04/P52	SS07/P46					No	(c)	Yes
A9	TS17	3	SS04/P52	SS07/P46					No	(c)	Yes
A11	TS21	3	SS04/P52	SS07/P46					No	(c)	Yes
A14	TS27	3	SS04/P52	SS07/P46					No	(c)	Yes
A17	TS33	3	SS04/P52	SS07/P46					No	(c)	Yes
B1	MS01	2	SS09/P49						No	(b)	Yes
B2	MS02	2	SS09/P49						No	(b)	Yes
B3	MS03	2	SS09/P49						No	(b)	Yes
B4	MS04	2	SS09/P49						No	(b)	Yes
B5	MS05	2	SS09/P49						No	(b)	Yes
B6	MS06	2	SS09/P49						No	(b)	Yes
A2	TS04	3							Yes	(c)	No
A5	TS10	3							Yes	(c)	No
A9	TS18	3							Yes	(c)	No
A11	TS22	3							Yes	(c)	No
A14	TS28	3							Yes	(c)	No
A17	TS34	3							Yes	(c)	No

Table 23b - Tracking Table of Subgrade (Embankment ≥ 1.2 m [4 ft]) Testing in the FHWA-LTPP Laboratory Testing Contractor Laboratory (If Thin-Wall Tubes are not Available)

Sample Location Number	Sample Number	Lab Test Number	Steps Involved in Laboratory Handling and Testing Sequence								
			Required Laboratory Tests Per Layer						Extra Sample	Sample Storage	Sample Disposed?
			First	Second	Third	Fourth	Fifth	Sixth			
B1	BS01	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B2	BS02	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B3	BS03	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B4	BS04	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B5	BS05	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B6	BS06	2	SS01/P51	SS02/P42	SS03/P43	SS04/P52	SS05/P55	SS07/P46	No	(b)	Yes
B1	MS01	2	SS09/P49						No	(b)	Yes
B2	MS02	2	SS09/P49						No	(b)	Yes
B3	MS03	2	SS09/P49						No	(b)	Yes
B4	MS04	2	SS09/P49						No	(b)	Yes
B5	MS05	2	SS09/P49						No	(b)	Yes
B6	MS06	2	SS09/P49						No	(b)	Yes

These tables provide the laboratories with the following information and directions:

- tracking of samples as they are taken for the field and tested in the laboratory,
- laboratory test sequences for each pavement material type,
- dedicated sample(s) for each test,
- designation of extra samples for future use,
- instructions for sample storage, and
- special instructions and other remarks.

As mentioned previously, these tables are based on the idealized sampling plan presented in Section 3 and Appendix A of this document. Using these tracking tables, each laboratory shall be able to plan and track each sample through the laboratory materials testing program for the SPS-1 experiment in a step-by-step manner.

The following is a description of the column headings used for the tracking table:

Sample Location Number - as described previously in Section 3 and as shown on sample tags and labels.

Sample Number - as described previously in Section 3 and as shown on sample tags and labels.

Lab Test Number - shall be assigned as per the following:

a. Beginning of the Section (Station 0-): samples of each layer that are retrieved from areas in the approach end of the test section (stations preceding 0+00) shall be assigned Laboratory Test Number '1'.

b. End of the Section (Stations 5+): samples of each layer that are retrieved from areas in the leave end of the test section (stations after 5+00) shall be assigned Laboratory Test Number '2'.

c. Middle of the Section (Stations 0+00 to 5+00): samples of each layer that are retrieved from areas in the middle of the test section (from the paver) shall be assigned Laboratory Test Number '3'.

Required Laboratory Tests Per Layer - order in which testing shall proceed.

Extra Sample - is the sample to be saved as a backup for other tests? A "yes" in this column implies that this is a dedicated extra sample saved for future use. A "no" indicates that a sample can be discarded after use.

Sample Storage - the following codes are used to specify the sample storage conditions for samples.

a. environmentally protected and controlled storeroom at 5-21°C (40-70°F).

b. environmentally protected and controlled storeroom at 5-38°C (40-100°F).

c. Thin-walled tube samples of the subgrade that should be stored in a fully supported condition and at temperatures between 5°C (40°F) and 21°C (70°F) in an environmentally protected storeroom. They shall be stored on their ends and shall always be stored in a vertical position with respect to the longitudinal axis of the tube in the same orientation as that retrieved from the field.

Sample Disposal? - indicates whether or not a sample can be disposed of after testing. Generally all samples, or portions of samples that are not tested are saved until further notice.

APPENDIX A

EXAMPLE OF SAMPLING PLAN LAYOUT

APPENDIX A - EXAMPLE OF SAMPLING PLAN LAYOUT

This appendix contains an example of a field sampling layout plan for a SPS-1 test site which provides the minimum requirements for materials characterization considered essential for the experiment. The plan should be adjusted with consideration to the condition and details of the specific test site and supplemental test sections desired by the participating highway agency.

A schematic layout of a test section illustrating the location of the sampling areas relative to the monitoring length is shown in Figure A.1. This figure highlights the importance of constructing 183 m (600 ft) long test sections with similar pavement structure and materials to allow for representative sampling areas (15 m [50 ft]) at each end of the 152 m [500 ft] long monitoring length).

Subgrade sampling depends on variations in subgrade material along the test site and is not necessarily dependent on test section details. A sampling plan for subgrade is illustrated in Figure A.2 for an example test site. The subgrade sampling plan presented herein may be used for other test sites regardless of test section ordering at the site.

A sampling plan for the example site is illustrated in Figures A.3 through A.14 for the twelve test sections to be constructed at each site. The plans shown in Figures A.3 through A.14, including the sampling locations, stations, offsets, number of cores, etc. should be used for the corresponding test sections at each SPS-1 test site regardless of the test section location within the test site.

LIST OF FIGURES

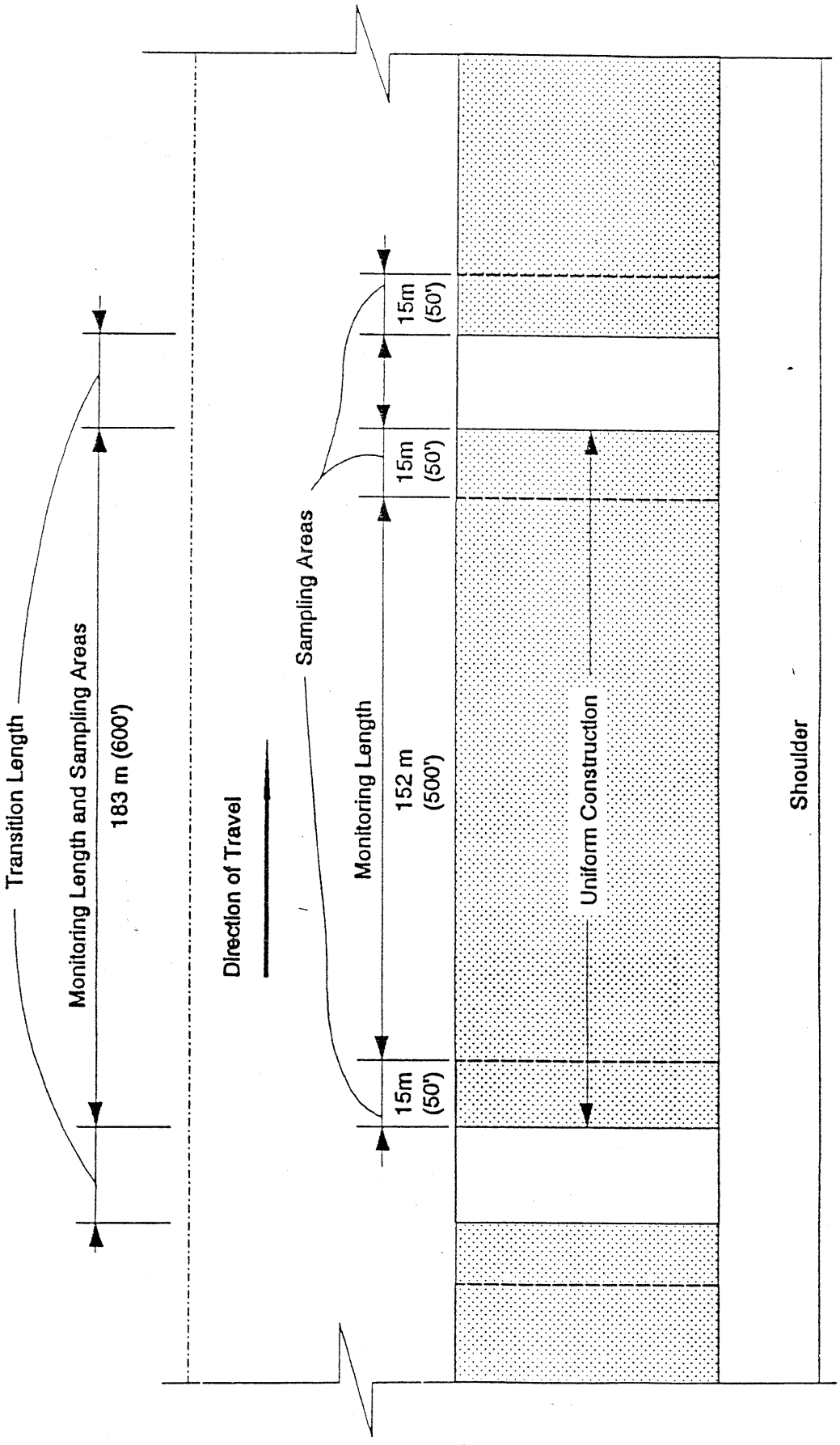
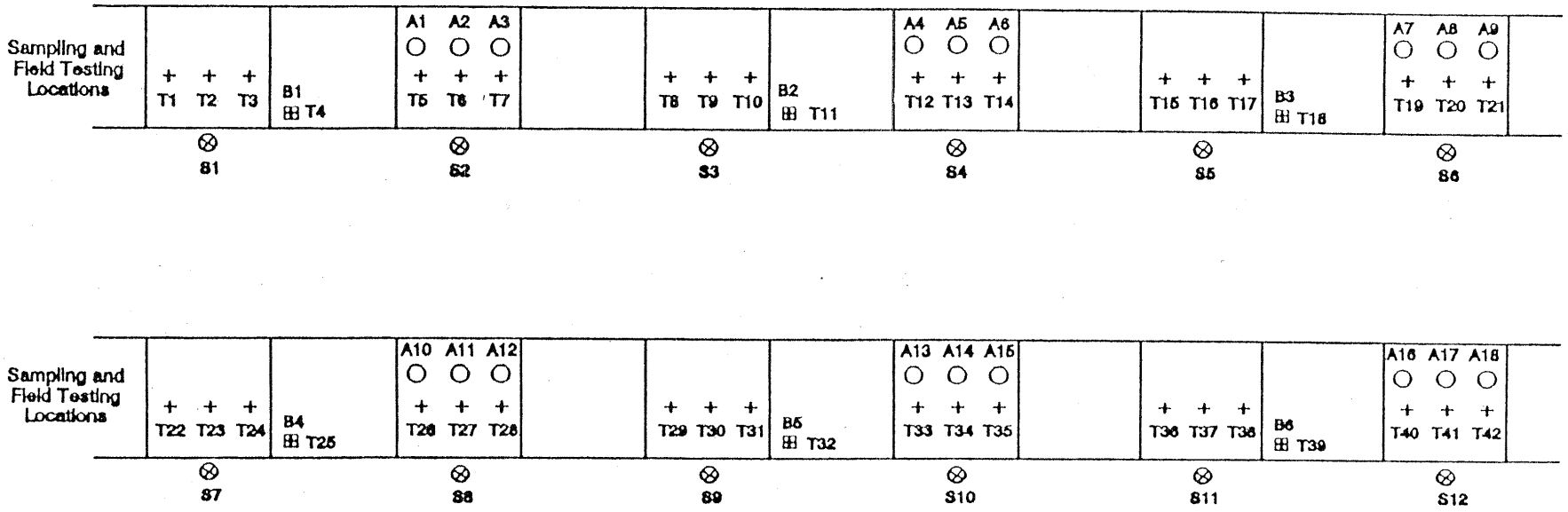


Figure A.1 Typical Section Layout

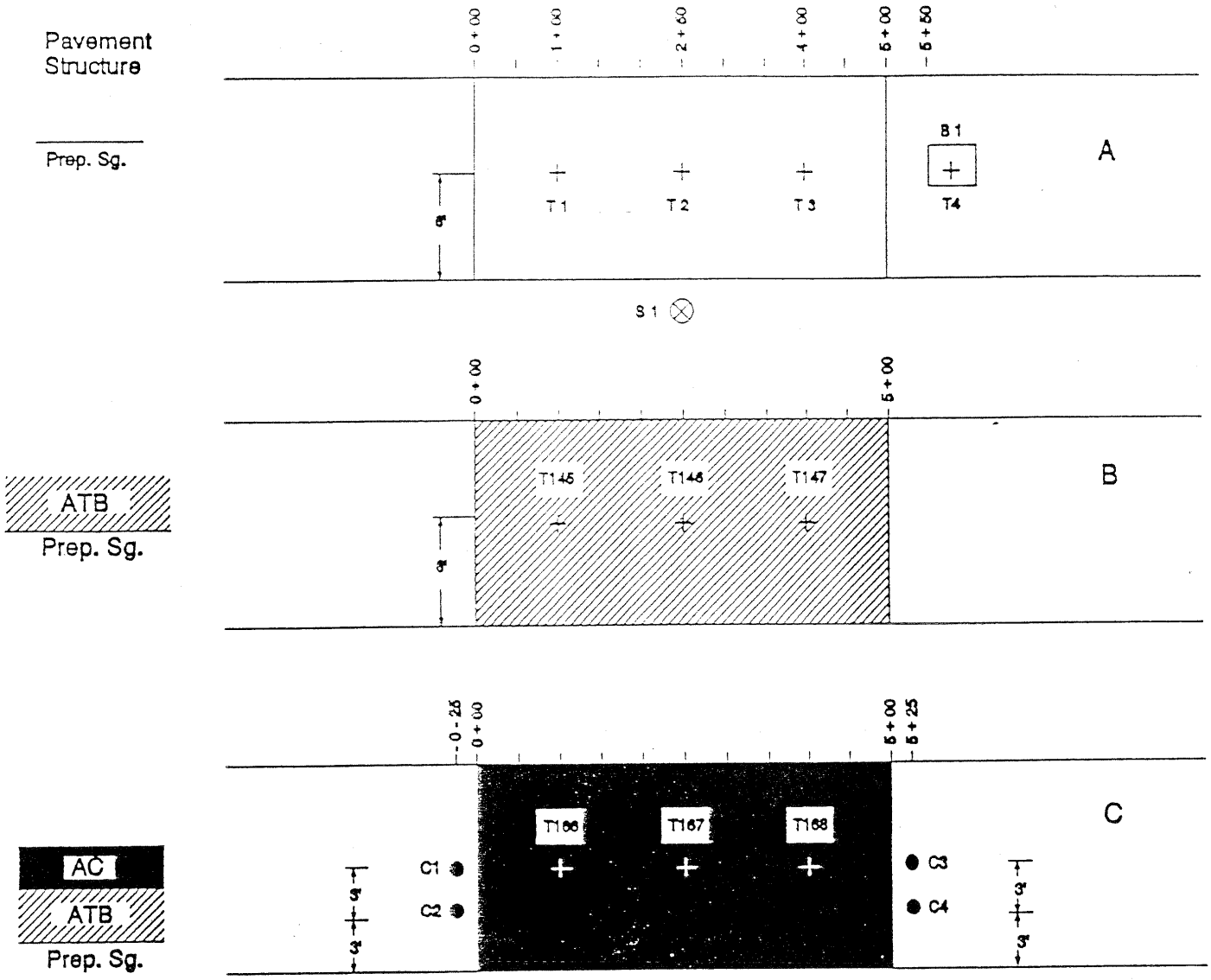


LEGEND

- □ 0.6 m x 0.6 m (2' x 2') bulk sampling location (B1 - B6) to 305 mm (12") below top of subgrade/embankment
- ○ Thin wall tube/splitspoon sampling to 102 mm (4") below top of subgrade (A1 - A18)
- ⊗ Shoulder probe (S1 - S12)
- \+ Location of field nuclear moisture/density testing (T1 - T42)

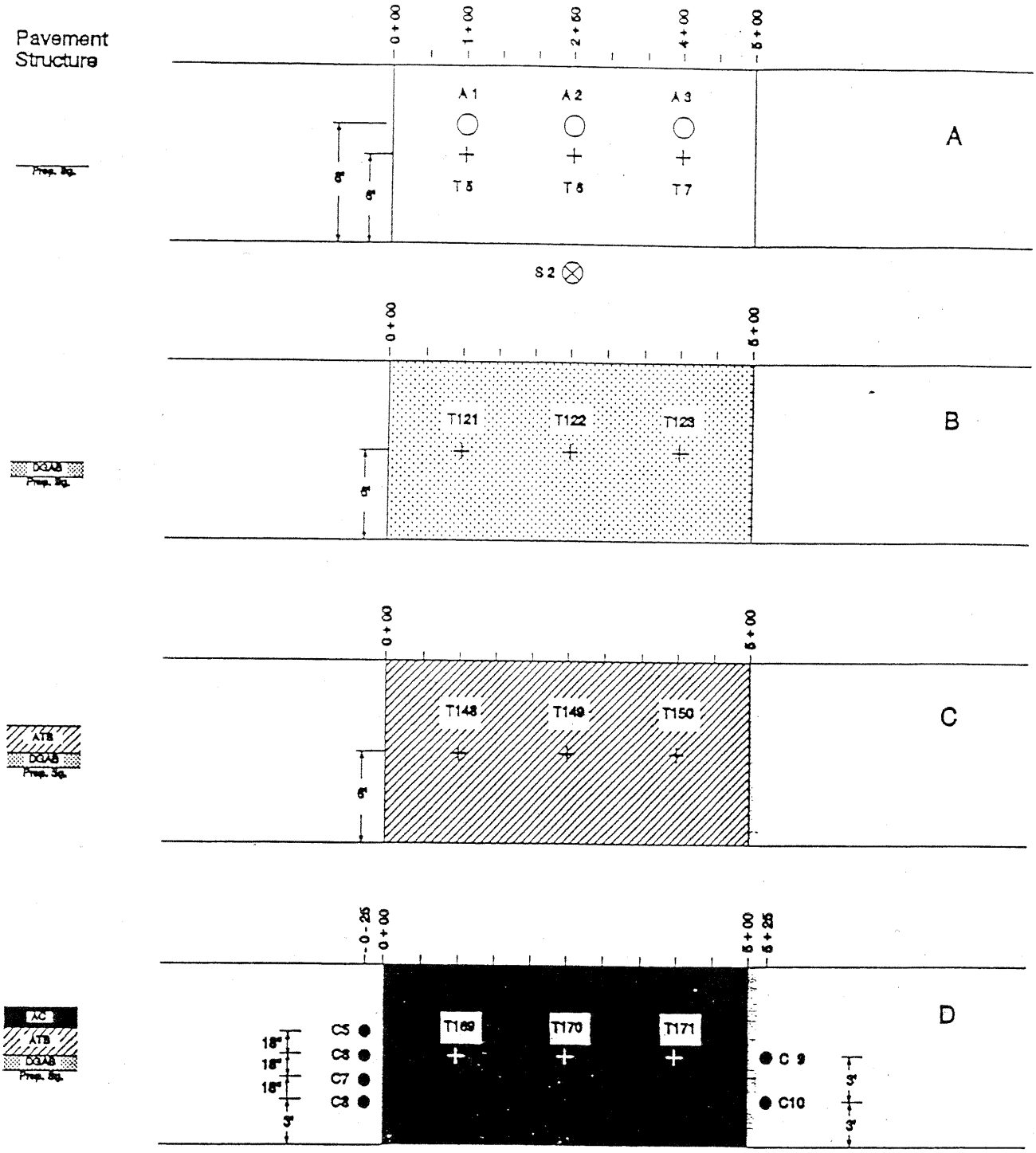
Note: Nuclear moisture/density testing must be conducted at bulk sampling location prior to excavation.

Figure A.2 Sampling and Testing Locations for Subgrade (and Embankment Layers≥ 1.2 m [4 ft])



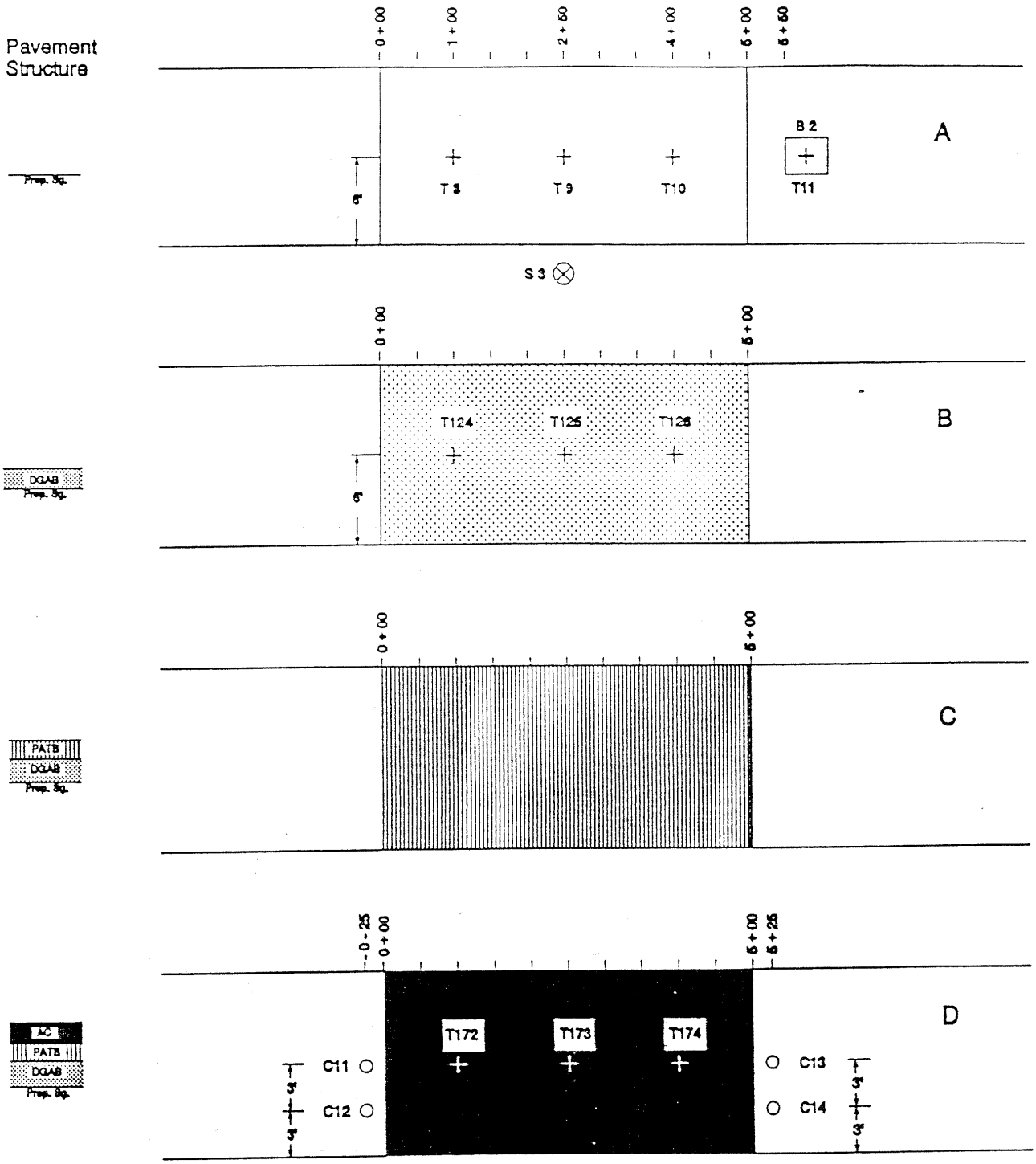
A Testing on prepared Subgrade (T1 - T4, B1 , S1)
B Testing on compacted ATB (T145 - T147)
C Testing on finished AC Surface (T166 - T168)
Coring AC Surface and bound layers (C1 - C4)

Figure A.3 Sampling and Testing Plan for Test Sections 4 and 16



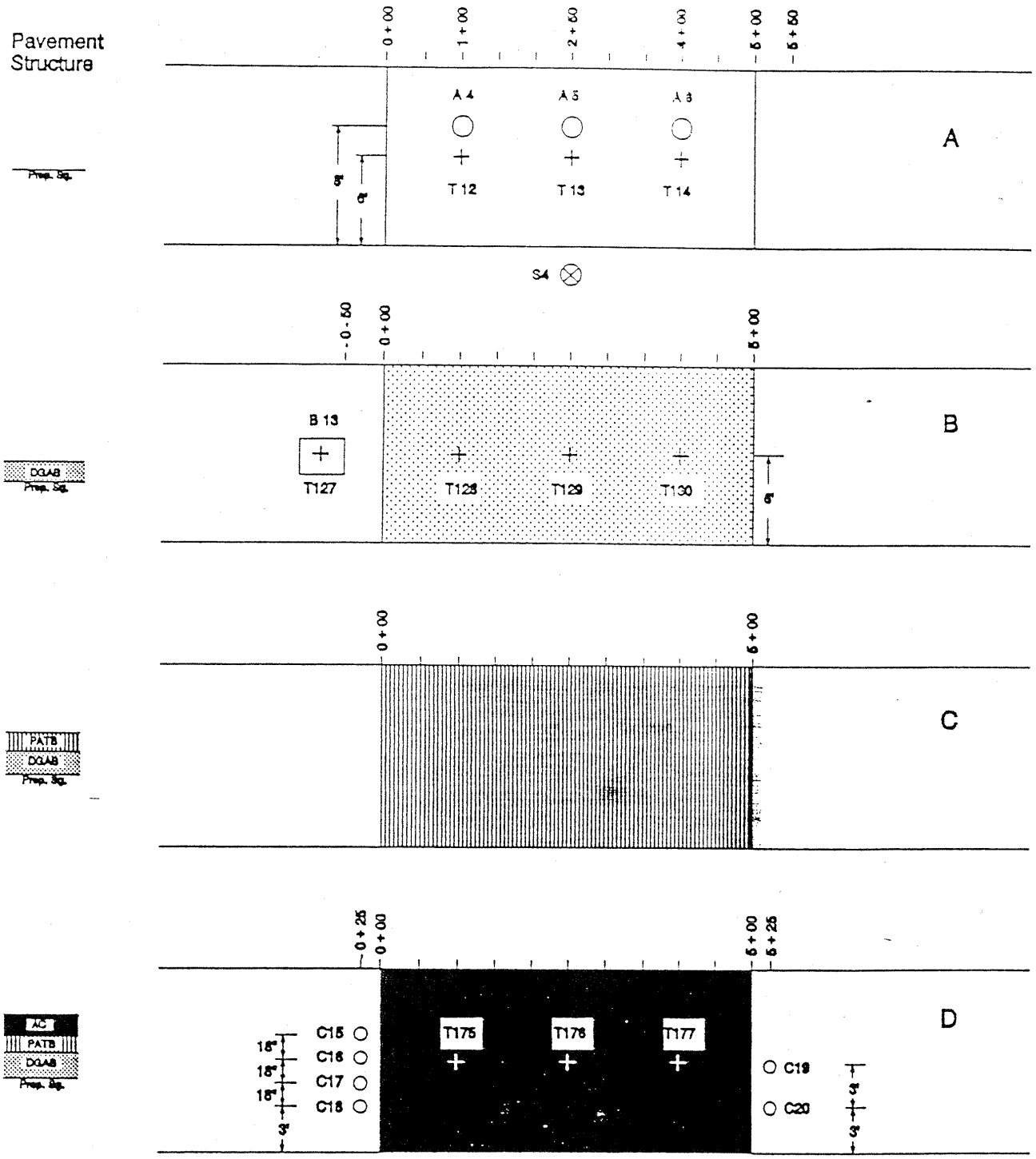
A Testing on prepared Subgrade (T5 - T7, A1 - A3, S2)
B Testing on compacted DGAB (T121 - T123)
C Testing on compacted ATB (T148 - T150)
D Testing on finished AC Surface (T169 - T171)
Coring AC Surface and bound layers (C5 - C10)

Figure A.4 Sampling and Testing Plan for Test Sections 6 and 18



A Testing on prepared Subgrade (T8 - T11, B2 , S3)
B Testing on compacted DGAB (T124 - T126)
C No Testing on compacted PATB
D Testing on finished AC Surface (T172 - T174)
Coring AC Surface Only (C11 - C14)

Figure A.5 Sampling and Testing Plan for Test Sections 9 and 21



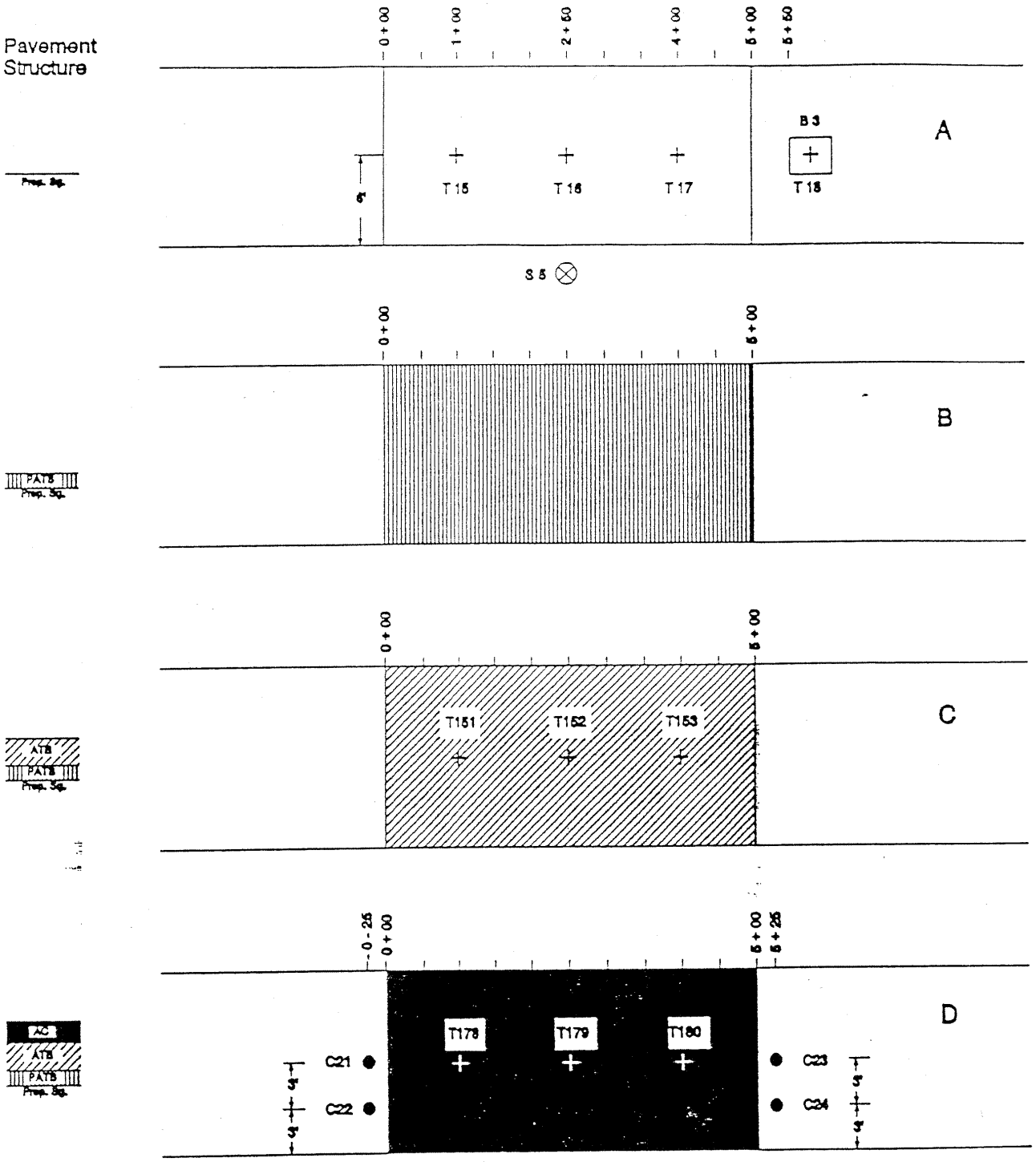
A Testing on prepared Subgrade (T12 - T14, A4 - A6, S4)

B Testing on compacted DGAB (T127 - T130, B13)

C No testing on compacted PATB

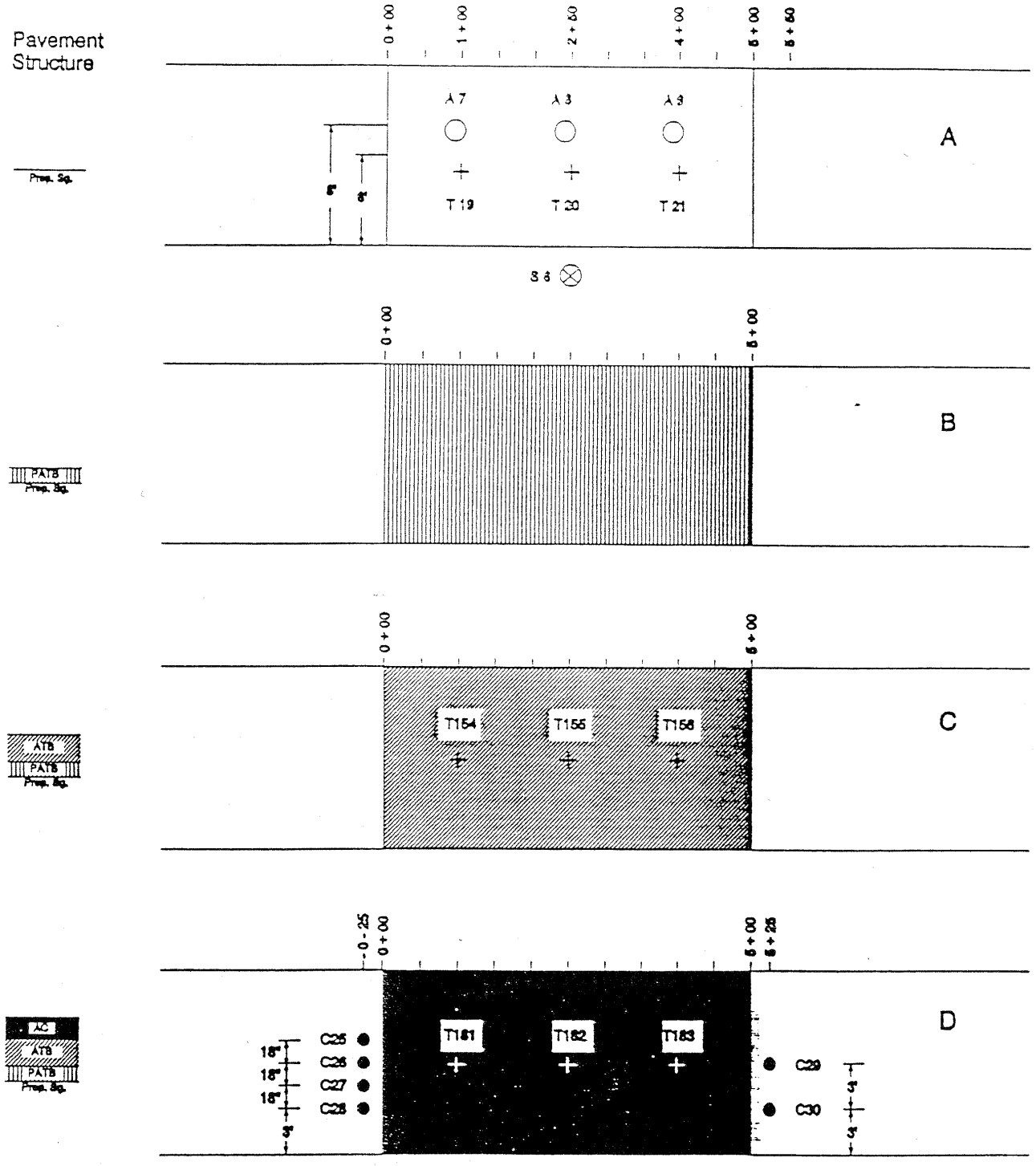
D Testing on finished AC Surface (T175 - T177)
Coring AC Surface Only (C15 - C20)

Figure A.6 Sampling and Testing Plan for Test Sections 8 and 20



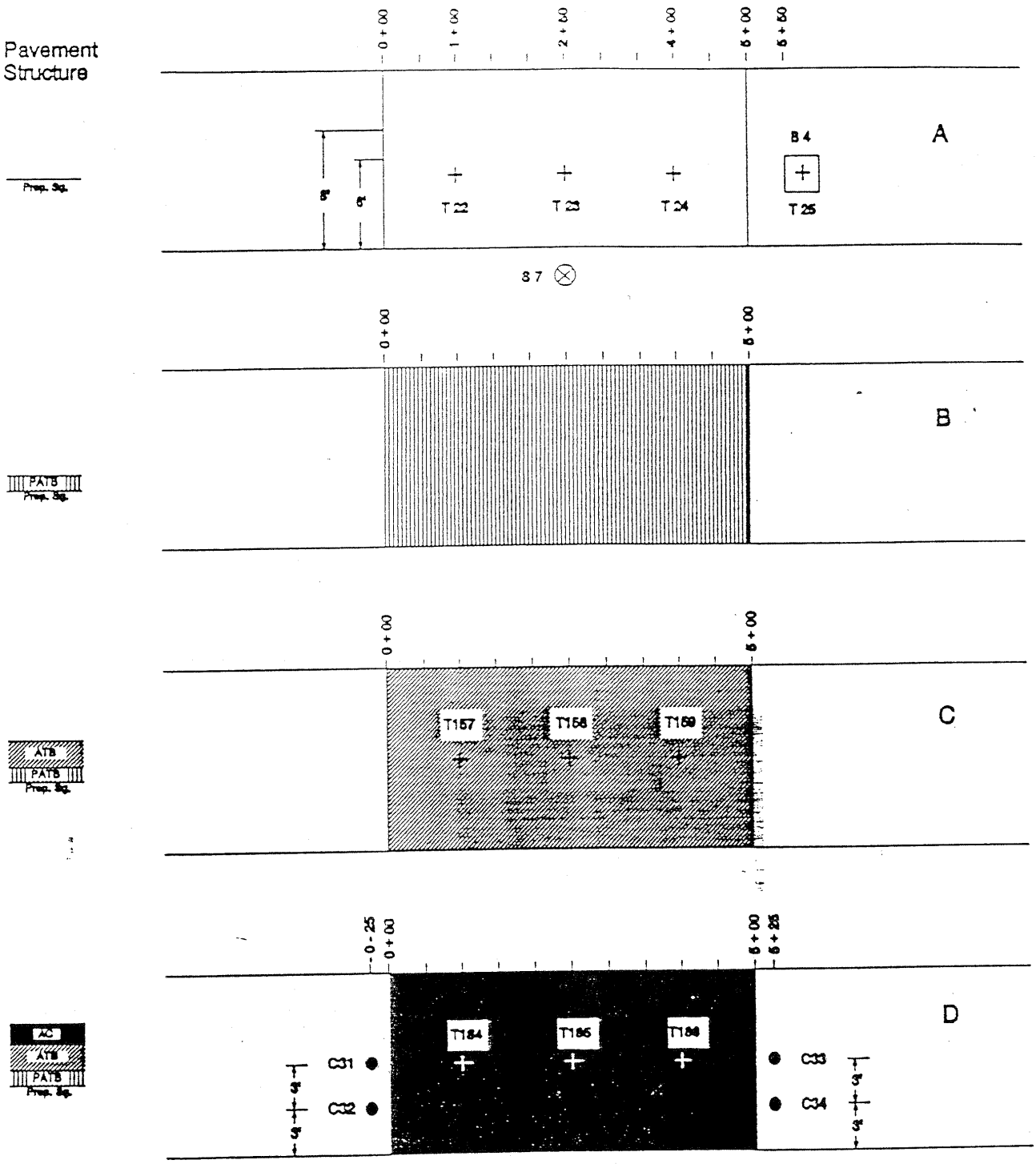
A Testing on prepared Subgrade (T15 - T18, B3, S5)
B No testing on compacted PATB
C Testing on compacted ATB (T151 - T153)
D Testing on finished AC Surface (T178 - T180)
Coring AC Surface and bound layers (C21 - C24)

Figure A.7 Sampling and Testing Plan for Test Sections 10 and 22



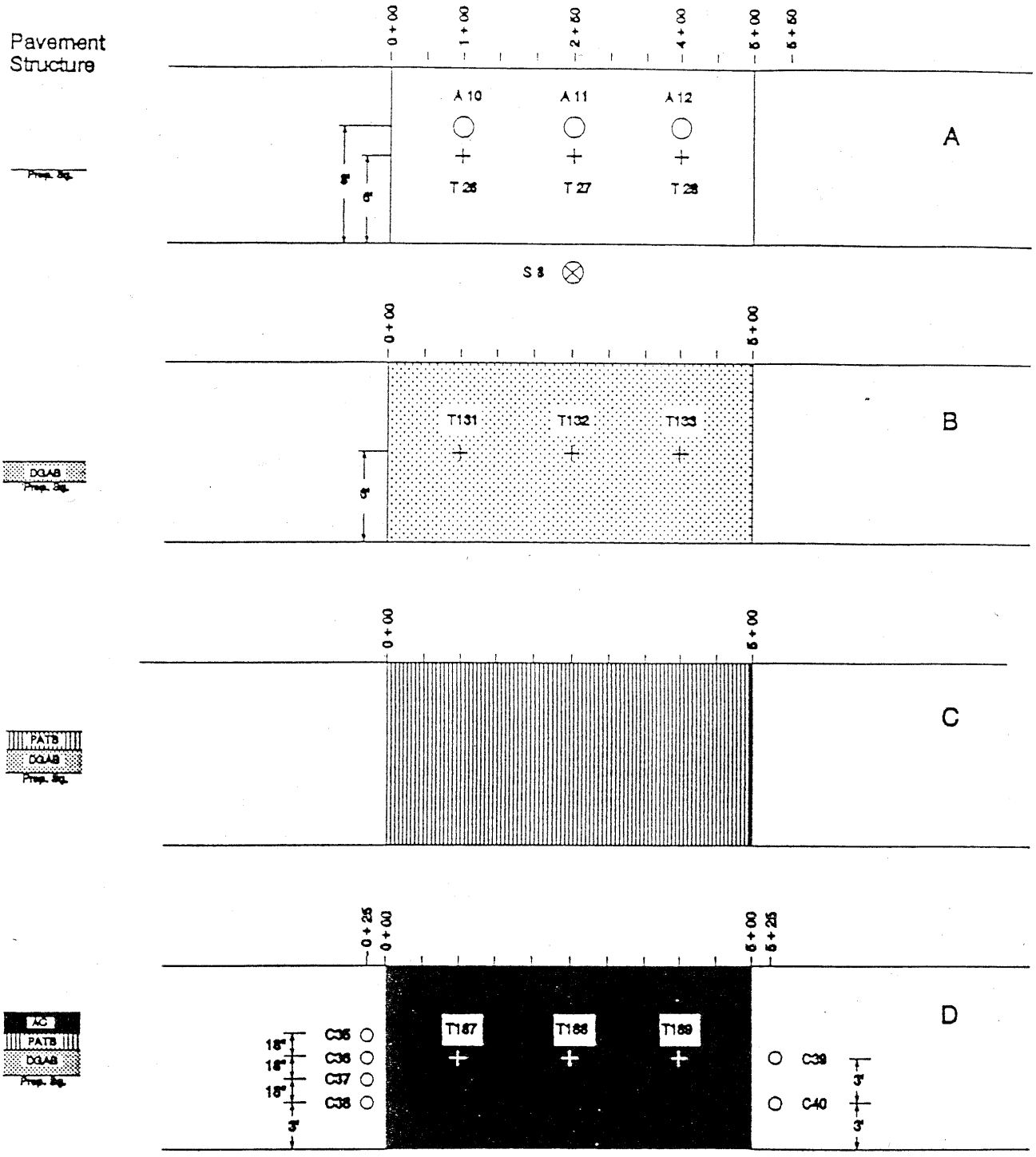
A Testing on prepared Subgrade (T19 - T21, A7 - A9, S6)
B No testing on compacted PATB
C Testing on compacted ATB (T154 - T156)
D Testing on finished AC Surface (T181 - T183)
Coring AC Surface and bound layers (C25 - 30)

Figure A.8 Sampling and Testing Plan for Test Sections 12 and 24



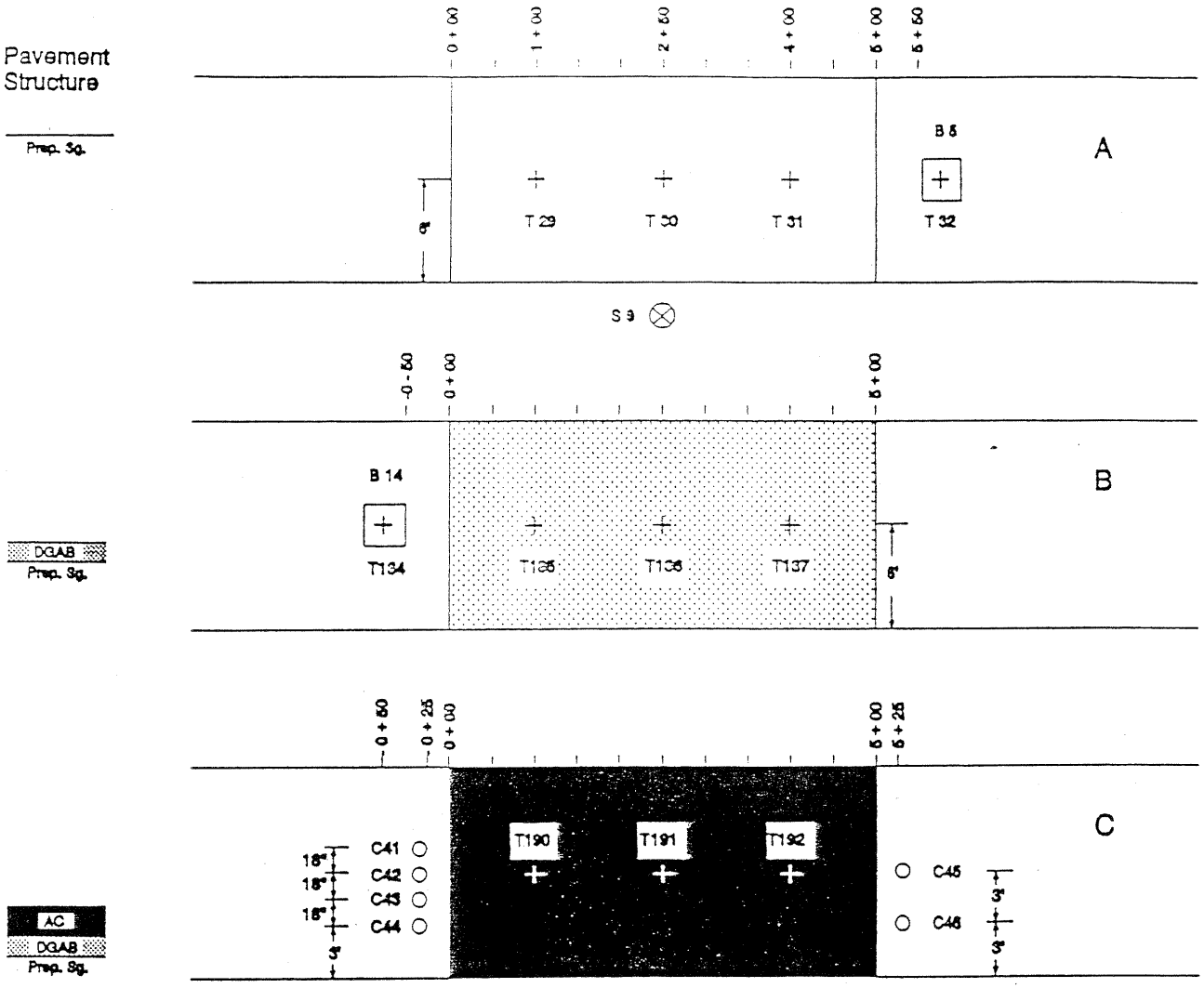
A Testing on prepared Subgrade (T22 - T25, B4, S7)
B No testing on compacted PATB
C Testing on compacted ATB (T157 - T159)
D Testing on finished AC Surface (T184 - T186)
Coring AC Surface and bound layers (C31 - C34)

Figure A.9 Sampling and Testing Plan for Test Sections 11 and 23



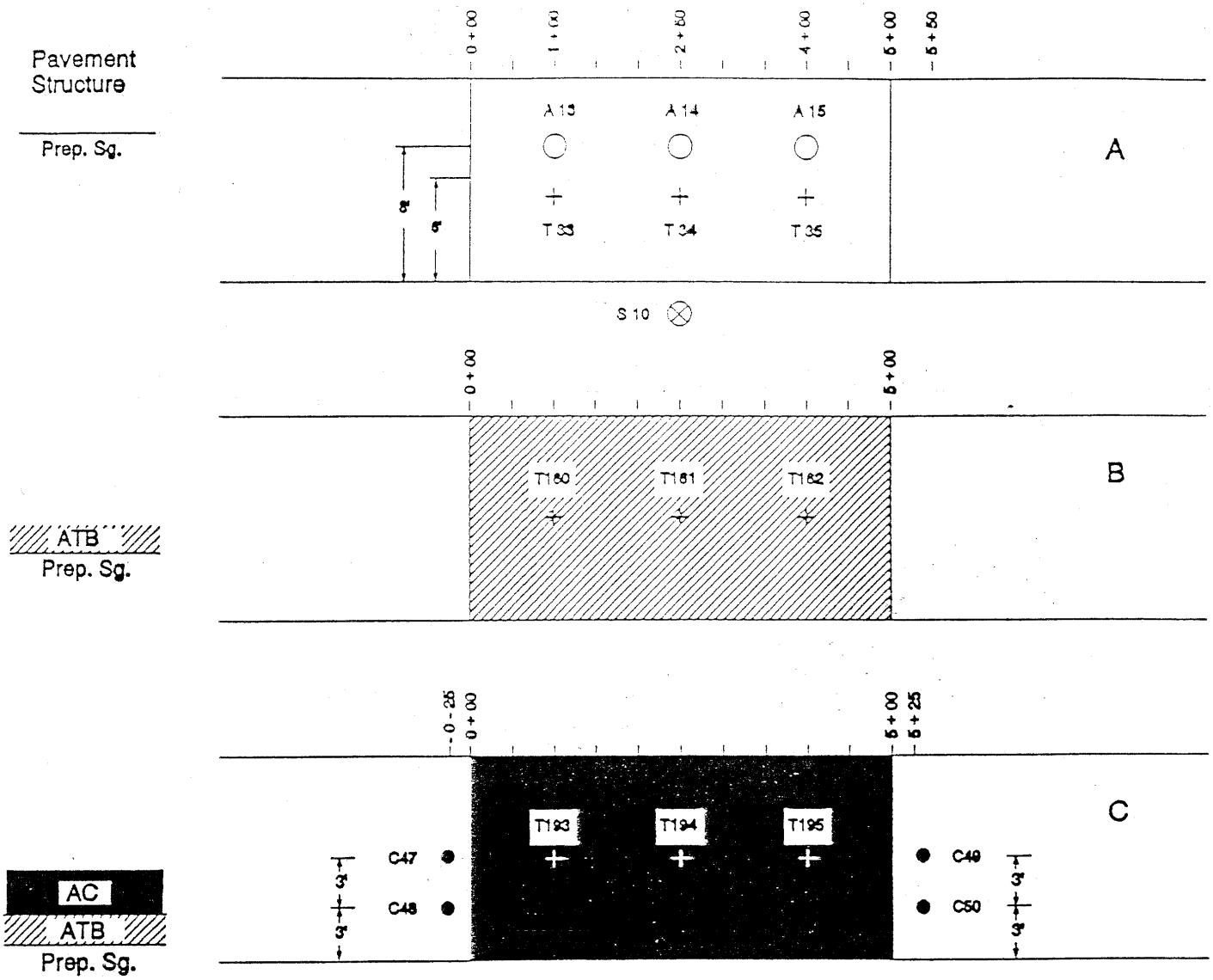
A Testing on prepared Subgrade (T26 - T28, A10 - A12, S8)
B Testing on compacted DGAB (T131 - T133)
C No testing on compacted PATB
D Testing on finished AC Surface (T187 - T189)
Coring AC Surface Only (C35 - C40)

Figure A.10 Sampling and Testing Plan for Test Sections 7 and 19



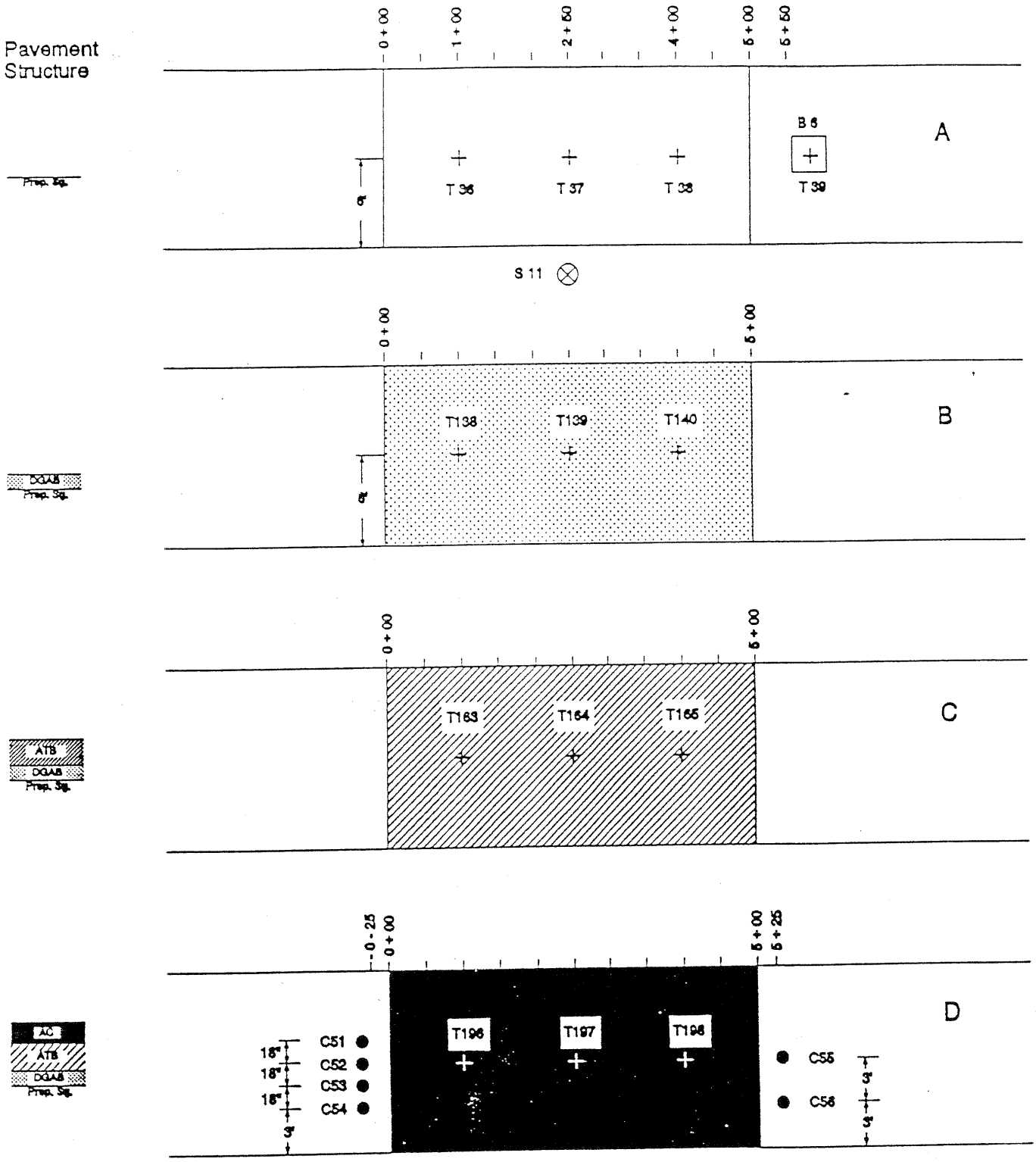
A Testing on prepared Subgrade (T29 - T32, B5 , S9)
B Testing on compacted DGAB (T134 - T137, B14)
C Testing on finished AC Surface (T190 - T192)
Coring AC Surface Only (C41 - C46)

Figure A.11 Sampling and Testing Plan for Test Sections 1 and 13



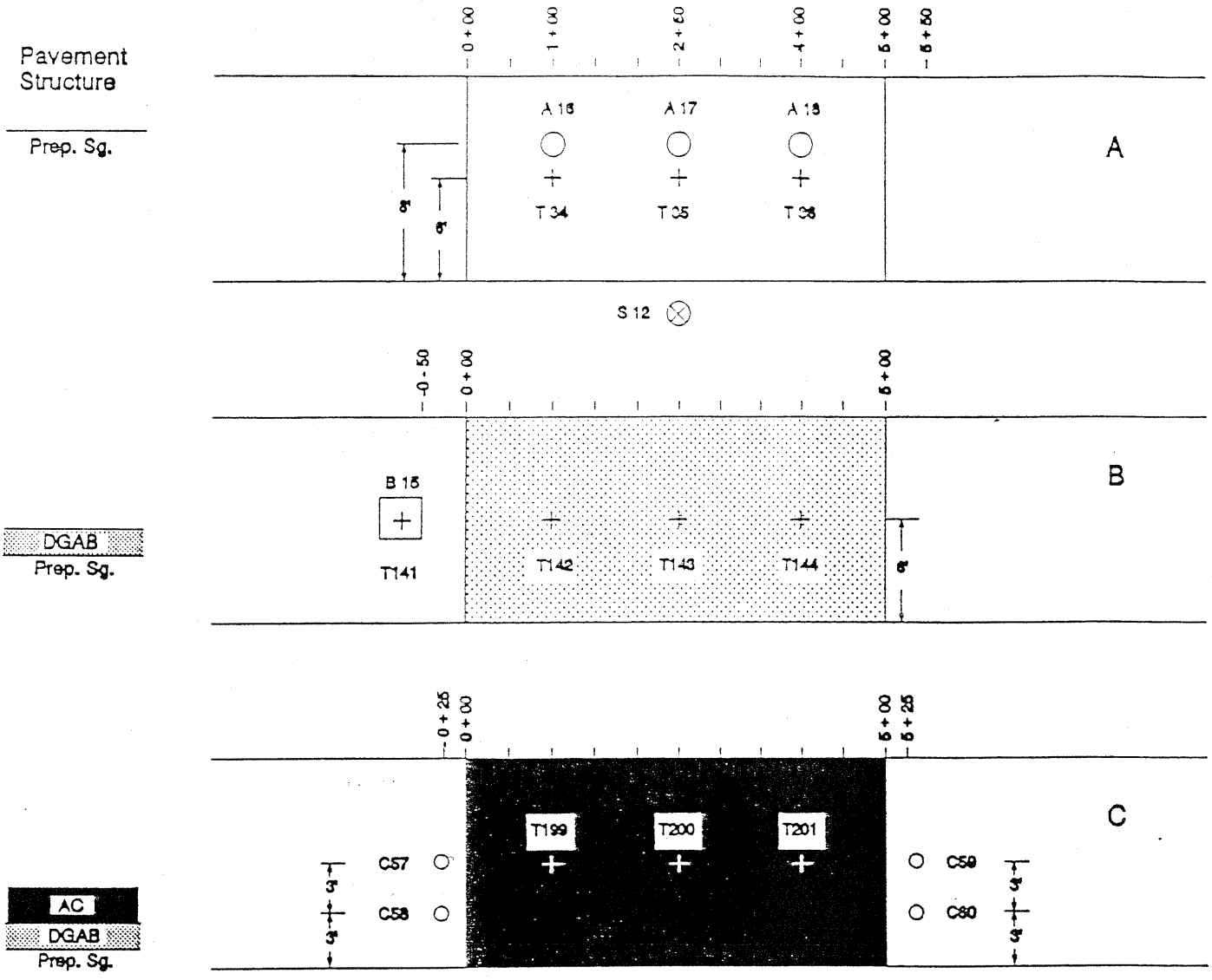
A **Testing on** prepared Subgrade (T33 - T35, **A13 - A15 , S10)**
B **Testing on** compacted ATB (T160 - T162)
C **Testing on** finished AC Surface (T193 - T195)
Coring AC Surface and bound layers (C47 - C50)

Figure A.12 Sampling and Testing Plan for Test Sections 3 and 15



A Testing on prepared Subgrade (T36 - T39, B6 , S11)
B Testing on compacted DGAB (T138 - T140)
C Testing on compacted ATB (T163 - T165)
D Testing on finished AC Surface (T196 - T198)
Coring AC Surface and bound layers (C51 - C56)

Figure A.13 Sampling and Testing Plan for Test Sections 5 and 17



A Testing on prepared Subgrade (T40 - T42, A16 - A18 , S12)
B Testing on compacted DGAB (T141 - T144, B15)
C Testing on finished AC Surface (T199 - T201)
Coring AC Surface Only (C57 - C60)

Figure A.14 Sampling and Testing Plan for Test Sections 2 and 14

APPENDIX B

FIELD MATERIAL SAMPLING AND TESTING DATA FORMS

APPENDIX B - FIELD MATERIALS SAMPLING AND TESTING DATA FORMS

In general, the field materials sampling and testing should be performed following the guidelines provided in Operational Guide No. SHRP-LTPP-OG-006, "SHRP-LTPP Guide for Field Materials Sampling, Testing, and Handling", May 1990. However, field data forms have been revised and data sheets have been included to report data for bulk sampling of subgrade, granular material, and asphalt concrete materials performed during construction. These changes and/or additions have been made to accommodate the specific needs of the experiment.

REVISED FIELD DATA FORMS

Due to differences between the sampling requirements for GPS and SPS projects, the field materials sampling and testing data forms used in the GPS program were modified. The primary changes common to each form relate to test section number and sample location referencing.

The six digit test section identification numbers on the data forms have been subdivided into three, two digit fields representing the state code, SPS project code, and test section number. The structure of this number is described under SPS Test Section Numbering Scheme in this document.

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING DATA SHEETS

Material sampling and field testing data sheets used in the SPS experiments include Sampling Data Sheets and Field Operations Information Forms. The SPS-1 experiment requires completion of the following sheets and forms:

Sampling Data Sheet No.	Description
2	Pavement Core Log at C-Type Core Locations
4-1	A-Type Bore Hole Log
8-1	In-Situ Density and Moisture Tests
9	Shoulder Probe Log
10-1	Sampling Uncompacted Bituminous Paving Mixtures
12	Bulk Sampling of Subgrade and Unbound Granular Materials

Field Operations Information Form No.	Description
1	Laboratory Shipment Samples Inventory
2-1	Summary of Material Samples Sent to Each Laboratory

Most of the LTPP-SPS Material Sampling and Field Testing data sheets (Sampling Data Sheets and Field Operations Information Forms) use the same top block of information related to the test section and project.

SHEET NUMBER. Since multiple data sheets will be required for the samples and tests from the multiple sampling areas on the project, room is provided on all data forms to sequentially order the data sheets. The first field is the sequential number of the data sheet and the second field is the total number of data sheets submitted.

SHRP REGION. Indicate the SHRP-LTPP region in which the state or province is located: North Atlantic, North Central, Southern, or Western.

STATE. Indicate the name of the state, District of Columbia, Puerto Rico, or the Canadian Province the project is located.

STATE CODE. Enter the two-digit numeric code corresponding to the state or province as shown in Table C.1 of the SHRP-LTPP Guide for Field Materials Sampling, Testing and Handling.

SPS PROJECT CODE. The two digit SPS project code. The first digit (from the left) of this code should either be a 0 (zero), for the first project constructed in a state and province, or a letter starting with A, B, etc. for the second, third, etc. projects of the same SPS experiment constructed in the same state and province. The second digit corresponds to the SPS experiment number i.e. for SPS-1 experiment.

TEST SECTION NO. The two digit number assigned to the test section. If a GPS project is co-located on the SPS project and the GPS data sheets are used for the material sampling and field testing, the four digit SHRP SECTION ID should be divided into two-two digit fields and the first two digits (from the left) should be entered as the SPS PROJECT CODE

and the last two digits entered as the TEST SECTION NO. Enter the test section number marked on the project in the field.

SPS EXPERIMENT NO. The SPS experiment number for the project (i.e. "SPS-1" for projects in the SPS-1 experiment, Strategic Study of Structural Factors for Flexible Pavements").

ROUTE/HIGHWAY. Record the signed designation for the route or highway where the project is located.

Lane. Drilling and sampling shall always occur on the outside lane for the SPS program. Record a "1" for sampling occurring on the outside lane and a "2" for sampling on the inside lane.

Direction. Record the direction of travel at the project site. Use the following abbreviations:

E for eastbound traffic direction
W for westbound traffic direction
N for northbound traffic direction
S for southbound traffic direction

SAMPLE/TEST LOCATION. Check "Before Section" if the sampling location is before the beginning of the test section indicated under TEST SECTION NUMBER on the form (station 0-). Check "After Section" if the sampling location is after the end of the test section indicated on the form (station 5+). Check "Within Section" if the sampling is performed within the boundaries of the monitoring length.

FIELD SET NO. The field set number is a sequentially assigned number to indicate the different time periods in which material samples and field testing were conducted on the project. These time periods usually refer to different stages in the pavement construction or life, such as prior to overlay construction, after overlay construction, etc. A field set number can apply to more than one day since sampling of SPS test sections may require more than one day. As a general rule, the same field set number should be applied to all material samples and field tests conducted in a continuous 30 day period, unless a construction event occurs between the two sampling sessions. Enter 1 for the first time that material sampling and field testing conducted on the prepared subgrade and base during construction on the project. Enter 2, 3, etc. for the second, third and subsequent sampling and field testing on this project.

SAMPLING DATA SHEET 2. PAVEMENT CORE LOG AT C-TYPE CORE LOCATIONS

This form is similar to Form S01A used for GPS test sections and is used to log data from the 4-inch diameter pavement cores extracted from C-Type core locations. Each sheet can be used to record data for cores taken from six different core hole locations. Space is provided in each column to record data for up to 4 layers from one core hole. The pavement surface layer core should be recorded first, followed by other layers in the column. The first column from the left should always start with the lowest numbered core hole.

OPERATOR. Record the coring equipment operator's name.

EQUIPMENT USED. Indicate the generic type of the coring equipment used.

CORING DATE. Record the month, date, and year the core was taken.

CORE BARREL SIZE. Record the rated inside diameter of the core barrel to the nearest tenth of an inch.

COOLING MEDIUM. Record the material used for cooling during the coring operation.

CORE HOLE NO. Enter the core hole sample code number following the sample coding system as specified in the materials sampling plan developed for the project.

LOCATION: STATION. This is the station number of the core, relative to the test section specified under TEST SECTION NO. on the form. This number should be greater than 5+00 for sampling locations that occur after the test section specified, and less than 0+00 for sampling locations which occur before the test section specified.

LOCATION: OFFSET. This is the distance from the interface of the pavement lane and the outside shoulder to the core location (generally measured from the outside edge of the white pavement edge stripe). This distance should be indicated to the nearest tenth of a foot.

CORE RECOVERED. Circle the appropriate response to indicate if an intact and suitable core was recovered from the indicated core hole.

REPLACEMENT CORE HOLE NO. Record the sample number of the core that will replace a core which was deemed unacceptable during field sampling operations. This entry should only be used when a "No" was recorded in the "Core Recovered" data entry space of this form.

CORE SAMPLE NO. Record the core sample number for the recovered core. Separate sample numbers should be assigned to HMAC and bound base layers from the same core hole, even if the bound base adheres to the HMAC surface layer.

DEPTH. Depth should be measured from the pavement surface to the bottom of the material interface in the core and expressed to the nearest tenth of an inch.

MATERIAL DESCRIPTION. Enter the appropriate material description based on the generic material type. These material descriptions are contained in Table C.2, Appendix C, of the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing.

MATERIAL CODE. Enter the appropriate material code number from Table C.2 in the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing corresponding to the described type of material.

SAMPLING DATA SHEET 4-1. A-TYPE BORE HOLE LOG

This form is similar to Form S02A used for GPS test sections and is designed to record logs of A-Type Shelby tube and splitspoon sampling. The following data is recorded on this form.

OPERATOR. Record the boring equipment operator's name.

EQUIPMENT USED. Indicate the generic type of the drilling equipment used.

BORING DATE. Record the month, date, and year the operation was performed.

LOCATION: STATION. This is the station number of the bore, relative to the test section specified under TEST SECTION NO. on the form. This number should be greater than 5+00 for sampling locations that occur after the test section specified, and less than 0+00 for sampling locations which occur before the test section specified.

LOCATION: OFFSET. This is the distance from the interface of the pavement lane and the outside shoulder to the bore location (generally measured from the outside edge of the white pavement edge stripe). This distance should be indicated to the nearest tenth of a foot.

BORE HOLE NO. Enter the core hole sample code number following the sample coding system specified in the material sampling plan developed for the project.

BORE HOLE SIZE. Record the borehole size (diameter) in inches to the nearest inch.

STRATA CHANGE. Record the depth of strata changes to the nearest tenth of an inch. The depth of strata changes should always be measured from the top of the pavement surface. Draw a horizontal line across the form which indicates the depth of each strata change.

Also, record the depth of sampling for each sample taken. For example, if a thin-walled tube sample was obtained at a depth from 18 inches to 36 inches, a line should be drawn at the 18 inch mark and the 36 inch mark along with the appropriate sample code number, material description, etc. See example data sheets in the SHRP-LTPP Guide for Field Materials Sampling, Testing and Handling for further clarification.

SAMPLE NUMBER. Record the sample number for splitspoon or thin-walled tube samples obtained from the subgrade.

BLOWS. **The next four columns (*# Blows, Refusal?, DLR (Driving Length to refusal, IOP (Inches of Penetration)*) shall be used only if a splitspoon sample recovery was attempted.** Standard practice for recording the blow count for splitspoon samples requires the following format: A - B - C, where:

A = number of blows for first 6 inches of penetration by the splitspoon sampler. This is considered a seating drive.

B = number of blows for second 6 inches of penetration by the splitspoon sampler.

C = number of blows for third 6 inches of penetration by the splitspoon sampler.

Record the blow count from the first 6 inches of seating penetration by the splitspoon sampler in the left most column under number of blows. ("A" from above example of blow count record). Record the blow count from the second 6 inches of penetration by the splitspoon

sampler in the middle column under number of blows ("B" from above example of blow count record). Record the blow count from the third 6 inches of penetration by the splitspoon sampler in the right most column under number of blows. ("C" from above example of blow count record).

Refusal of the splitspoon sampler is defined as having advanced less than one inch with 100 blows (or no observed advance of the sampler during the application of 10 blows) or the test is aborted at the discretion of the SHRP Representative to avoid damage to the splitspoon sampler.

If the splitspoon sampler is "refused" in the first 6 inches indicate the blow count to refusal in the left most column, place a "Y" in the *Refusal?* column and indicate in the *DLR* (Driving Length to Refusal) column, the distance, measured to the nearest tenth of an inch, from the top of the pavement surface to refusal. Also, record the penetration depth of the splitspoon sampler in the *IOP* column (distance penetrated in "A").

If the splitspoon is refused during the second 6 inches of penetration, indicate the blow count to refusal in the middle column, place a "Y" in the *Refusal?* column and indicate in the *DLR* column the distance, measured to the nearest tenth of an inch, from the top of the pavement surface to refusal. Also, record the penetration depth of the splitspoon sampler in the *IOP* column (distance penetrated in "A" + "B").

If the total blow count ("A" + "B") reaches 100 before penetrating deeper than 12 inches, the splitspoon sampling procedure should be stopped and the blow count for the second 6 inch increment should be recorded in the middle column and the total depth of penetration recorded under the *IOP* column (the depth of penetration shall be measured from the beginning of penetration of the splitspoon sampler.)

In the case of refusal during the third 6 inch increment, the same instructions outlined previously for the left and middle columns will be followed. The penetration depth of the splitspoon sampler will be recorded in the *IOP* column (distance penetrated in "B" + "C").

If the second and third 6 inch increment blow count ("B" + "C" only) reaches 100 before prior to penetrating 18 inches, the splitspoon sampling procedure should be stopped and the blow count for the third 6 inch increment recorded in under number of blows. The total depth of penetration ("B" + "C" only) should be recorded under the *IOP* column (measured from the beginning of penetration of the splitspoon sampler minus the 6 inch seating drive).

(REF)USAL. Record a "Y" if splitspoon sampler is refused (see explanation under *# Blows* above). Record a "N" if the full 18 inch sample is recovered and the splitspoon is not refused. This column is only used if a splitspoon sampler is utilized.

Refusal is defined as occurring when the splitspoon sampler advances less than one inch in 100 blows (or no observed advance of the sampler during the application of 10 blows) or when the test is aborted at the discretion of the SHRP Representative to avoid damage to the splitspoon sampler.

DLR. Driving Length to Refusal - Record the penetration of the splitspoon sampler to refusal to the nearest tenth of an inch. This value is measured from the top of the pavement surface. This column is only used if a splitspoon sampler is utilized and refused. In the case of refusal, an entry is made in the *DLR* and *IOP* columns.

IOP. Inches of Penetration - Record the distance of penetration of the splitspoon sampler after 100 blows is reached in the first 6 inches ("A"), the first and second 6 inches of penetration ("A" and "B") or the second and third 6 inches of penetration ("B" and "C") (See explanation under # Blows above). This column is only used if a splitspoon sampler is utilized.

MATERIAL DESCRIPTION. Enter the appropriate material description for each strata based on the generic material type. These material descriptions are contained in Table C.2, Appendix C, of the SHRP-LTPP Guide for Field Materials Sampling, Testing and Handling.

MATERIAL CODE. Enter the appropriate material code number for each strata from Table C.2 in the SHRP-LTPP Guide for Field Materials Sampling, Testing and Handling corresponding to the described type of material.

SAMPLING DATA SHEET 8-1. IN SITU DENSITY AND MOISTURE TESTS

This sheet is similar to Form S04 used for GPS test sections and is designed to record data from the in situ density and moisture tests performed on all unbound layers and density tests performed on bound layers with a nuclear moisture and density gauge. The following data is recorded on this form.

OPERATOR. Record nuclear density gauge operator's name.

NUCLEAR DENSITY GAUGE I.D.. Record the identification number of the nuclear density gauge.

TEST DATE. Record the month, date, and year the test was performed.

LOCATION: STATION. This is the station number of the sampling area, relative to the test section specified under TEST SECTION NO. on the form. This number should be greater than 5+00 for sampling locations that occur after the test section specified, and less than 0+00 for sampling locations which occur before the test section specified.

LOCATION: OFFSET. This is the distance from the edge of the pavement lane and the outside shoulder to the location the test was performed (generally measured from the edge of the white pavement edge stripe). This distance should be indicated to the nearest tenth of a foot.

SAMPLING LOCATION NUMBER. Enter the sampling location number shown in the material sampling plan developed for the project.

DATE OF LAST MAJOR CALIBRATION. Record the date of the last major calibration of the nuclear density gauge. All dates should be recorded as mm-dd-yy. A major calibration is defined as that calibration/verification performed as directed in Section 4 of the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing. Daily calibrations performed in the field do not constitute a major calibration.

DEPTH FROM SURFACE TO THE TOP OF THE LAYER. This information is obtained from Sampling Data Sheet 5 for each unbound granular layer. Record to the nearest tenth of an inch and measure from the top of the pavement surface for each test performed.

LAYER NUMBER. Write in the project specified layer number for the layer being tested.

MATERIAL TYPE. Report a "G" if the material is unbound (granular); record "T" if the material is other than unbound (treated). In practice, all entries should be a "G" since nuclear density testing is not required on bound materials.

IN SITU DENSITY. For each unbound layer, record four nuclear density gauge results. These measurements should be taken at the top of each unbound layer using the direct

transmission test method if possible. Record to one decimal place in pounds per cubic foot (pcf).

AVERAGE. Calculate and record the average in situ densities for each unbound layer. Record to one decimal place.

METHOD (A,B,or C). Record the test method used to perform the in situ density test as per AASHTO T238-86, "A" - Backscatter, "B" - Direct Transmission, or "C" - Air Gap. The direct transmission method ("B") should almost always be used. However, there may be some extenuating circumstances necessitating the use of methods "A" or "C".

ROD DEPTH. Record the depth of the nuclear density gauge probe to the nearest inch.

IN SITU MOISTURE CONTENT. For each unbound layer, record four in situ moisture content test results. These tests should be conducted at the top of each layer. Record as a percentage moisture content to one decimal place. The backscatter method should always be used for this measurement.

AVERAGE. Calculate and record the average of the four in situ moisture content test results for each unbound layer. Record to one decimal place.

SAMPLING DATA SHEET 9. SHOULDER PROBE LOG

This data sheet is similar to Form S05 used for the GPS test sections and is used to record the results of the shoulder auger probe to determine the depth to a rigid layer.

OPERATOR. Record the auger equipment operator's name.

EQUIPMENT USED. Indicate the generic type of the auguring equipment used.

AUGURING DATE. Record the month, date, and year the operation was performed.

LOCATION: STATION. This is the station number of the bore, relative to the test section specified under TEST SECTION NO. on the form. This number should be greater than 5+00 for probes located after the test section, less than 0+00 for probes located before the test section, and between 0+00 and 5+00 for probe locations within the monitoring length.

LOCATION: OFFSET. This is the distance from the edge of the pavement lane and the outside shoulder to the auger location (generally measured form the outside edge of the white pavement edge stripe. For shoulder probes, this distance will be measured toward the outside edge of the shoulder. This distance should be indicated to the nearest tenth of a foot.

AUGER PROBE NUMBER. Record the auger probe number; an S1 for the first auger and increasing numbers for subsequent auger probes.

TOP OF ROCK BASED ON. Enter "Auger Refusal" if auger is refused. If the top of rock is based on some other observation, indicate the type of observation.

DEPTH FROM SURFACE. Record the depths of strata changes to the nearest tenth of a foot.

MATERIAL DESCRIPTION. Enter the appropriate material description for each strata based on the generic material type. These material descriptions are contained in Table C.2, Appendix C, of the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing.

MATERIAL CODE. Enter the appropriate material code number for each strata from Table C.2 in the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing corresponding to described type of material.

REFUSAL WITHIN 20 FEET (Y/N). Record a "yes" or a "no" as appropriate to indicate if a rigid layer was encountered within 20 feet from the pavement surface.

DEPTH TO REFUSAL. Record the depth to refusal to the nearest tenth of a foot if the auger refused.

SAMPLING DATA SHEET 10-1. SAMPLING UNCOMPACTED BITUMINOUS PAVING MIXTURES

This data sheet is used to record information concerning sampling of uncompacted bituminous paving mixtures (asphalt concrete and asphalt-treated materials) for LTPP material testing purposes. Sampling shall be performed according to AASHTO T-168, except that a 100-lb sample should be used.

PERSON PERFORMING SAMPLING. Record the name, title and affiliation of the person performing the sampling.

PLANT NAME. Record the common name or operator of the mix plant facility which produced the sampled material.

PLANT LOCATION. Record the location of the mix plant, including street address, town, and state.

PLANT TYPE. Indicate the general type of mix plant used to produce the mix. If a plant other than a batch or drum plant was used, indicate other and provide a description of the plant on the next line.

DESCRIPTION OF MIX PLANT. Provide a brief description of the type of mix plant noting any special features of traditional types of batch or drum plants, or a description of other mix plant types.

MANUFACTURER OF MIX PLANT. Enter the name of the mix plant manufacturer.

MODEL NUMBER. Enter the model number or model designation of the mix plant.

BATCH SIZE. Record the size of the batch the sample from which the sample was obtained.

SAMPLING LOCATION. Enter the code number shown on the data form corresponding to the location from which the sample was taken. If the sample was taken from the roadway prior to compaction, indicate the station and offset of the sample and the respective test section number.

MIX TYPE. Enter the code number corresponding to the generic type of material (virgin asphalt concrete, recycled asphalt concrete, asphalt dense graded or permeable asphalt treated).

LAYER TYPE. Enter the code number, as shown on the form, which corresponds to the type of layer in which the material is used.

SAMPLE TYPE DESIGNATOR. Enter the sample type designation for the sample. This is a 4 digit code which signifies the generic type of material, virgin or recycled, and a sequential

number for each sample of each material type obtained. For materials incorporating all virgin materials, the sample type designation shall begin with the letters BV (Bulk Virgin). For materials incorporating recycled materials, the designator shall begin with BR (Bulk Recycled). These letter designations are followed with a two digit number sequentially assigned to each sample, for each type of material.

SAMPLE NUMBER. This is a 4 digit code starting with the letters BA (Bulk Asphalt Concrete) or BT (Bulk Asphalt Treated material) and followed with a sequentially assigned two digit number, which uniquely designates each bulk asphalt concrete sample.

APPROXIMATE SAMPLE SIZE. Enter the approximate weight of the sample obtained, to the nearest pound.

DATE SAMPLED. Enter the date the material sample was obtained.

LOCATION SAMPLE SHIPPED TO. Record the location the sample was shipped to from the field. In many cases this should be the laboratory which will perform the testing.

DATE SHIPPED. Enter the date the material was shipped to the location indicated on the form.

GENERAL REMARKS. Provide any general remarks concerning the representativeness of the obtained sample, comments concerning the quality or uniformity of the mix, or any other pertinent miscellaneous comments.

SAMPLING DATA SHEET 12. BULK SAMPLING OF SUBGRADE AND UNBOUND GRANULAR MATERIALS

This form is similar to Form S03 used for GPS test sections and is designed to record data from the field sampling of materials from shallow excavations made in prepared subgrade and uncompacted graded layers during construction. The following data is recorded on this form:

TECHNICIAN. Record the name of the technician who retrieved the samples and recorded the information on the data form.

EQUIPMENT USED. Indicate the generic type of the equipment used to excavate the material.

EXPLORATION DATE. Record the month, date, and year the operation was performed.

LOCATION: STATION. This is the station number of the sampling area, relative to the test section specified under TEST SECTION NO. on the form. This number should be greater than 5+00 for sampling locations that occur after the test section specified, and less than 0+00 for sampling locations which occur before the test section specified.

LOCATION: OFFSET. This is the distance from the edge of the pavement lane and the outside shoulder to the outside edge of the sampling area (generally measured from the outside edge of the white pavement edge stripe). This distance should be indicated to the nearest tenth of a foot.

SAMPLING LOCATION NUMBER. Enter the sampling location number shown in the material sampling plan developed for the project.

EXCAVATION SIZE. Record the length and width of the excavation to the nearest half foot.

STRATA CHANGE. Record the depth of strata changes to the nearest tenth of an inch. The depth of strata changes should always be measured from the top of the pavement surface. Draw a line across the form to indicate strata changes.

MOISTURE SAMPLE NUMBER. Record sample numbers for samples taken from unbound base, subbase and subgrade for moisture content testing.

BULK SAMPLE NUMBER. Record the sample number for bulk samples taken from the unbound pavement layers and the subgrade.

MATERIAL DESCRIPTION. Enter the appropriate material description for each strata based on the generic material type. These material descriptions are contained in Table C.2, Appendix C, of the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing.

MATERIAL CODE. Enter the appropriate material code number for each strata from Table C.2 in the SHRP-LTPP Guide for Field Materials Sampling, Handling and Testing corresponding to the described type of material.

FIELD OPERATION INFORMATION FORM 1. LABORATORY SHIPMENT SAMPLES INVENTORY

This form is intended to provide a record of field activity and no information from this form will be included in the data base. This form is similar to Form S06 used for GPS test sections and provides the necessary information on where each sample was shipped for testing. Also, it provides a detailed inventory of material samples shipped to each materials testing laboratory. The inventory should be made in the following sequence of sample location numbers, starting from the pavement surface layer in each case:

1. Samples from C-Type locations, starting from cores of pavement surface layers.
2. Samples from A-Type bore holes and any additional similar bore holes.
3. Samples from shallow excavations.

Sample location numbers and sample numbers should be obtained from the appropriate Sampling Data Sheets. "Sample size" should be used to record the number of bags of bulk samples or the number of jar samples bearing a single sample number in each case. The bulk sample from one layer can be placed in more than one bag, if necessary. However, the sample number should be the same on all of these bags with an indication of the number of bags on the labels and in the column of the "Sample size." For core samples, record only diameter of the core in the "Sample size" column in inches.

Enter core, bulk, moisture, tube or splitspoon in the "Sample type" column as appropriate. Enter AC, PCC, Base, Subbase or Subgrade in the "Sample material" column as appropriate. The "Sample condition" should indicate a brief description as to the overall quality of the sample - cores: good, poor, fractured; bulk samples: satisfactory, wet, insufficient quantity, contaminated.

Since more than one laboratory may be used to test samples in the SPS program, room is provided on this form to indicate up to three laboratories to receive samples. Enter the laboratory number, as noted at the bottom of the form, each sample is sent to under the LAB column.

Typically, samples will include:

- All AC cores from C-Type locations.
- Bulk samples and jar samples of granular (untreated) layers and subgrade from BA-Type locations and test pits.
- Thin-walled tube samples and splitspoon samples from the subgrade.

FIELD OPERATION INFORMATION FORM 2-1. SUMMARY OF MATERIAL SAMPLES SENT TO EACH LABORATORY

This form provides a summary of the information provided on Field Operations Information Form 1 by testing laboratory. It is similar to Form S06A used for GPS test sections. A separate form should be completed for each set of samples sent to each separate laboratory.

This form requires the samples to be aggregated into layers designated with a layer number. The layer number assigned to each layer (1 for subgrade, 2 for subbase, 3 for unbound base, etc.) is shown in the left hand column. A description of the pavement layer material and sample type is provided in the next column on the right, followed by the total number of samples by sample type.

OTHER GPS DATA FORMS

Other Field Materials Sampling and Testing data forms used for GPS test sections not referenced in this report should not be completed for the SPS activity. These forms include S07, S08, S09, S10, S11, S12, S13, S14A, S14B, S15A, S15B, S16A, and S16B.

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING

PAVEMENT CORE LOG AT C-TYPE CORE LOCATIONS

SAMPLING DATA SHEET 2

SHEET NUMBER _____ OF _____

SHRP REGION _____ STATE _____ *STATE CODE* __ __

SPS EXPERIMENT NO _____ *SPS PROJECT CODE* __ __

ROUTE/HIGHWAY_____ Lane_____ Direction_____ *TEST SECTION NO.* __ __

SAMPLE/TEST LOCATION: ☐ Before Section ☐ After Section *FIELD SET NO.* __

OPERATOR_____ EQUIPMENT USED_____ *CORING DATE* ___-___-___

CORE BARREL: Tip Type_____ Cooling Medium_____

Note: Record information for all cores extracted from each core hole in one column in the table below. Use a separate sheet for each test section. "Depth" should be measured from the pavement surface to the bottom of the core and recorded to the nearest tenth of an inch.

CORE HOLE NUMBER						
LOCATION: (a) STATION						
(b) OFFSET (Feet, O/S)						
Core Recovered?	*YES/NO*	*YES/NO*	*YES/NO*	*YES/NO*	*YES/NO*	*YES/NO*
Replacement Core Hole No.						
Core Size (inch Diam.)	4	4	4	4	4	4
Core Sample No.						
Depth (Inches)						
Material Description						
Material Code						
Core Size (inch Diam)	4	4	4	4	4	4
Core Sample No.						
Depth (Inches)						
Material Description						
Material Code						
Core Size (inch Diam.)	4	4	4	4	4	4
Core Sample No.						
Depth (Inches)						
Material Description						
Material Code						
Core Size (inch Diam.)	4	4	4	4	4	4
Core Sample No.						
Depth (Inches)						
Material Description						
Material Code						
Remarks						

GENERAL REMARKS: _____

CERTIFIED VERIFIED AND APPROVED DATE

_____ _____ _____-____-19___

Field Crew Chief SHRP Representative Month- Day- Year

Affiliation:_____ Affiliation:_____

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING

A-TYPE BORE HOLE LOG

SAMPLING DATA SHEET 4

SHEET NUMBER _____ OF _____

SHRP REGION _____ STATE _____ *STATE CODE* __ __

SPS EXPERIMENT NO _____ *SPS PROJECT CODE* __ __

ROUTE/HIGHWAY_____ Lane_____ Direction_____ *TEST SECTION NO.* __ __

SAMPLE/TEST LOCATION: ☐ Before Section ☐ After Section *FIELD SET NO.* __

OPERATOR_____ EQUIPMENT USED_____ *BORING DATE*___-___-___

*LOCATION: STATION*_____ *OFFSET*_____ *feet from °/s*

*BORE HOLE NUMBER:*_____ *BORE HOLE SIZE:* _____ (inch Diam.)

Scale (Inches)	*Strata Change (Inches)*	*Sample Number* (1)	*#Blows*(2) 6"	6"	6"	*Ref? Y/N* (3)	*DLR (Inches)* (4)	*IOP* (5)	*Material Description*	*Material Code*
_____ _10.0__ _____ _20.0__ _____ _30.0__ _____ _40.0__ _____ _50.0__										

1. Record sample numbers for splitspoon/thin-walled tube samples taken from the subgrade.

2. For splitspoon samples, record the number of blows for the first, second and third 6 inches of penetration.

3. *Refused* - If the splitspoon is refused, place a Y in the *REFUSAL* column and complete *Driving Length To Refusal* column. Refusal is defined as less than 1 inch of penetration with 100 blows.

4. *Driving Length To Refusal* - Record penetration to refusal of splitspoon from the top of the pavement surface.

5. *Inches Of Penetration* - Record from start of splitspoon sampling procedure if 100 blows is reached before one foot of penetration. If penetration exceeds 12 inches before 100 blows is reached, enter middle 6 inches plus depth of penetration into the last 6 inches when 100 blows was reached (not including seating drive); record to nearest tenth of an inch.

GENERAL REMARKS:_____

CERTIFIED

_____

Field Crew Chief

Affiliation:_____

VERIFIED AND APPROVED

_____

SHRP Representative

Affiliation:_____

DATE

____-____-19___

Month- Day- Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING SHEET NUMBER _____ OF _____

IN SITU DENSITY AND MOISTURE TESTS

SAMPLING DATA SHEET 8-1

SHRP REGION _____ STATE _____ *STATE CODE* ___ ___
SPS EXPERIMENT NO _____ *SPS PROJECT CODE* ___ ___
ROUTE/HIGHWAY _____ Lane _____ Direction _____ *TEST SECTION NO.* ___ ___
SAMPLE/TEST LOCATION: **9** Before Section **9** After Section *FIELD SET NO.* ___
9 Within Section
OPERATOR _____ *NUCLEAR DENSITY GAUGE I.D.* _____ *TEST DATE* ___-___-___
SAMPLING AREA NO: SA-_____ *LOCATION: STATION* _____ *OFFSET* _____ *feet from E/s*
LOCATION NO: _____ DATE OF LAST MAJOR CALIBRATION ___-___-___
Note: Use additional sheets if necessary

DEPTH FROM SURFACE TO THE TOP OF THE LAYER, INCHES (From Plans)							
LAYER NUMBER							
MATERIAL TYPE: (Unbound=G Other=T)							
	1						
IN SITU	**2**						
DENSITY, pcf	**3**						
(AASHTO T238-86)	**4**						
AVERAGE							
Method (A,B,or C)							
Rod Depth, inches							
	1						
IN SITU	**2**						
MOISTURE CONTENT, %	**3**						
(AASHTO T239-86)	**4**						
AVERAGE							

GENERAL REMARKS: _____
_____

CERTIFIED VERIFIED AND APPROVED DATE
_____ _____ ___ - ___ -19 __
Field Crew Chief SHRP Representative Month - Day - Year
Affiliation: _____ Affiliation: _____

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING SHEET NUMBER _____ OF _____

SHOULDER PROBE LOG

SAMPLING DATA SHEET 9

SHRP REGION _____ STATE _____ *STATE CODE* __ __

SPS EXPERIMENT NO _____ *SPS PROJECT CODE* __ __

ROUTE/HIGHWAY_____ Lane_____ Direction_____ *TEST SECTION NO.* __ __

SAMPLE/TEST LOCATION: ☐ Before Section ☐ After Section *FIELD SET NO.* __

☐ Within Section

OPERATOR_____ EQUIPMENT USED_____ *AUGERING DATE*___-____-____

*AUGER PROBE NUMBER*_____ *LOCATION STATION*:_____ *OFFSET*:_____*feet from °/s*

TOP OF ROCK BASED ON:_____

Scale (feet)	*Depth from Surface (Feet)*	*Material Description*	*Material Code*
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

REFUSAL WITHIN 20 FEET (Y/N):_____ *DEPTH TO REFUSAL*:_____*(FEET)*

GENERAL REMARKS:_____

CERTIFIED _____ VERIFIED AND APPROVED _____ DATE _____-____-19___

Field Crew Chief SHRP Representative Month- Day- Year

Affiliation:_____ Affiliation·_____

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING

SHEET NUMBER _____ OF _____

SAMPLING UNCOMPACTED BITUMINOUS PAVING MIXTURES

SAMPLING DATA SHEET 10

SHRP REGION _____ STATE _____ *STATE CODE* __ __

SPS EXPERIMENT NUMBER _____ *SPS PROJECT CODE* __ __

ROUTE/HIGHWAY_____ Lane_____ Direction_____ *TEST SECTION NO.* __ __

FIELD SET NO. __

PERSON PERFORMING SAMPLING

NAME _____ EMPLOYER _____

TITLE _____

MIX PLANT

PLANT NAME _____

PLANT LOCATION _____

PLANT TYPE Batch..... 1 Drum..... 2 Other (Specify)..... 3 [__]

DESCRIPTION OF MIX PLANT _____

MANUFACTURER OF ASPHALT PLANT _____

MODEL NUMBER _____

BATCH SIZE _____

SAMPLING LOCATION [___]

Conveyor Belt..... 1 Stockpile..... 2 Haul Truck..... 3 Funnel Device..... 4
Roadway Prior to Compaction ..... 5 Station __ + __ __ Offset ____ (feet from O/S)
Other..... 6 (specify) _____

MIX TYPE "Virgin" Asphalt Concrete ..... 1 Recycled Asphalt Concrete..... 2 [___]

LAYER TYPE [___]

Rut Level-Up..... 1 Mill Replacement..... 2 Binder Course..... 3
Surface Course..... 4 Surface Friction Layer..... 5

SAMPLE TYPE DESIGNATION [___ ___ ___ ___]

SAMPLE NUMBER [___ ___ ___ ___]

APPROXIMATE SAMPLE SIZE (lbs) ___ ___ ___

DATE SAMPLED (Month - Day - Year) [__ __ - __ __ - __ __]

LOCATION SAMPLE SHIPPED TO _____

DATE SHIPPED (Month-Day-Year) [__ __ - __ __ - __ __]

GENERAL REMARKS: _____

_____

_____

CERTIFIED _____ Field Crew Chief
Affiliation:_____

VERIFIED AND APPROVED _____ SHRP Representative
Affiliation:_____

DATE ____-____-19__ Month- Day- Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING SHEET NUMBER _____ OF _____

BULK SAMPLING OF SUBGRADE AND UNBOUND GRANULAR MATERIALS

SAMPLING DATA SHEET 12

SHRP REGION _____ STATE _____ *STATE CODE* __ __

SPS EXPERIMENT NO _____ *SPS PROJECT CODE* __ __

ROUTE/HIGHWAY_____ Lane_____ Direction_____ *TEST SECTION NO.* __ __

SAMPLE/TEST LOCATION: ☐ Before Section ☐ After Section *FIELD SET NO.* 1

TECHNICIAN_____ EQUIPMENT _____ *EXPLORATION DATE*___-___-___

*LOCATION: STATION*_____ *OFFSET*_____*feet from °/s*

*SAMPLING LOCATION NUMBER*_____

PIT SIZE: (a) *Length*_____feet (b) *Width*_____feet

LAYER NUMBER:_____ (SUBGRADE _____ GRADED AGGREGATE BASE _____)

Scale (Inches)	*Strata Change (Inches)*	*Moisture Sample No.*	*Bulk Sample No.*	*Material Description*	*Material Code*
4					
8					
12					
16					

GENERAL REMARKS:_____

_____

CERTIFIED

_____

Field Crew Chief

Affiliation:_____

VERIFIED AND APPROVED

_____

SHRP Representative

Affiliation:_____

DATE

_____-_____-19___

Month- Day- Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING

LABORATORY SHIPMENT SAMPLES INVENTORY

FIELD OPERATIONS INFORMATION FORM 1

FOR EXPERIMENT SPS-1

SHEET NUMBER _____ OF _____

SHRP REGION _____ STATE _____

SPS EXPERIMENT NO 1

ROUTE/HIGHWAY_____ Lane_____ Direction_____

SAMPLE/TEST LOCATION: ☐ Before Section ☐ After Section
☐ Within Section

STATE CODE __
SPS PROJECT CODE __
TEST SECTION NO. __
FIELD SET NO. _

FIELD WORK COMPLETED ON ____-____-____

Note: Use additional sheets if necessary. Include summary information (Field Operations Information Form 2) and "as actual" sampling location plan sheets with this material samples inventory.

SAMPLE LOCATION	SAMPLE NUMBER	SAMPLE SIZE	SAMPLE TYPE	SAMPLE MATERIAL	SAMPLE - CONDITION	LAB*

* Enter number of laboratory, as specified below, each sample was sent to:

Lab No.(1) _____
Lab No.(2) _____
Lab No.(3) _____

GENERAL REMARKS: _____

CERTIFIED

_____
Field Crew Chief
Affiliation:_____

VERIFIED AND APPROVED

_____
SHRP Representative
Affiliation:_____

DATE

____-____-19__
Month- Day- Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING SHEET NUMBER _____ OF _____

SUMMARY OF MATERIAL SAMPLES SENT TO EACH LABORATORY

FIELD OPERATIONS INFORMATION FORM 2

FOR EXPERIMENT SPS-1

SHRP REGION _____ STATE _____ *STATE CODE* __ __

SPS EXPERIMENT NO _____ *SPS PROJECT CODE* __ __

ROUTE/HIGHWAY_____ Lane_____ Direction_____ *TEST SECTION NO.* __ __

SAMPLE/TEST LOCATION: ☐ Before Section ☐ After Section *FIELD SET NO.* __

LABORATORY _____ WORK COMPLETED ON ____-____-____

NOTE: This is a summary of material samples sent to each laboratory based on the information from Field Operations Information Form 1. Complete one form for each laboratory that material samples were sent.

LAYER NO. (From Subgrade)	MATERIAL/SAMPLE TYPE		TOTAL NUMBER OF SAMPLES
_____	AC CORES (surface)	4" Diameter	_____
_____	AC MIX BULK SAMPLES:	200 pound bulk samples	_____
		5 gallon pail asphalt cement	_____
_____	AC CORES (binder)	4" Diameter	_____
_____	AC MIX BULK SAMPLES:	200 pound bulk samples	_____
		5 gallon pail asphalt cement	_____
_____	ATB CORES:	4" Diameter	_____
_____	AC Treated BULK SAMPLES:	200 pound sample - ATB	_____
		5 gallon pail asphalt cement	_____
_____	AC Treated BULK SAMPLES:	100 pound sample - PATB	_____
		5 gallon pail asphalt cement	_____
_____	UNBOUND BASE SAMPLES:	(a) BAGS (BULK)_____ (b) JARS (MOISTURE)_____	
_____	UNBOUND SUBBASE SAMPLES:	(a) BAGS (BULK)_____ (b) JARS (MOISTURE)_____	
1	SUBGRADE SAMPLES:	(a) BAGS (BULK)_____ (b) JARS (MOISTURE)_____	
		(c) THIN-WALLED TUBES_____	

GENERAL REMARKS:_____

_____

CERTIFIED

_____

Field Crew Chief

Affiliation:_____

VERIFIED AND APPROVED

_____

SHRP Representative

Affiliation:_____

DATE

____-____-19___

Month- Day- Year

APPENDIX C

REPRINT OF PROTOCOL P59

SHRP PROTOCOL: P59
For SHRP Test Designation: SS13
DEFLECTION TESTING OF SUBGRADE AND BASE LAYERS

This SHRP protocol covers the test method for measuring the surface deflection of subgrade and base layers. The test shall be performed during test section construction for Specific Pavement Studies experiments SPS-1, SPS-2 and SPS-8. This protocol is based on ASTM D 4694-87 (Standard Test Method for Deflections with a Falling-Weight-Type Impulse Load Device). The test shall be performed in accordance with this standard (ASTM D 4694-87), as modified herein. Those sections of the ASTM standard included in this protocol by reference and without modification shall be strictly followed. All other sections of this protocol shall be followed as written herein.

1. Scope

1.1 This test method covers the measurement of deflections of paved and unpaved surfaces with a falling weight-type impulse load device. These devices are commonly referred to as falling weight deflectometers (FWD).

1.2 This test method describes the measurement of vertical deflection response of the surface to an impulse load applied to the pavement surface. Vertical deflections are measured on the load axis and at points spaced radially outward from the load axis. An impulse load more nearly represents the moving vehicle load-pulse applied to prototype pavements than does a static load.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* A specific hazard statement is given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*
D 4695 Guide for General Pavement Deflection Measurements.

2.2. SHRP-LTPP Manual for FWD Testing, November 1992.

3. Summary of Test Method

3.1 This test method is a type of plate-bearing test. The load is a force pulse generated by a weight dropped on a spring system and is transmitted through a plate resting on the pavement surface. The test apparatus is mounted in a vehicle or on a suitable trailer towed by a vehicle.

3.2 The load plate of the test apparatus is brought to a stop over the desired test location. The plate and deflection sensors are lowered to the pavement. The weight is raised to the height that, when dropped, will impart the desired force to the pavement. The weight is dropped and the resulting vertical movement or deflection of the pavement surface is measured using suitable instrumentation. Multiple tests may be performed before the apparatus is then raised and moved to the next test site.

3.3 Peak pavement deflections at each measured location resulting from the first force impulse is recorded in microns, millimeters, mils, or inches, as appropriate. In addition to the peak value, the deflection pulse shall be sampled at a number of intervals sufficient to completely define its shape (a minimum of 2 samples per millisecond per deflection sensor), beginning approximately 30 milliseconds (ms) before the peak deflection and ending approximately 30 ms after the peak deflection.

3.4 The peak force imparted by the falling weight is measured by a load cell and recorded, as force in kN or lbf, or mean stress (the load divided by the plate area) in kN/m^2 or psi as appropriate. In addition to the peak value, the load pulse shall be sampled at a number of intervals sufficient to completely define its shape (a minimum of 2 samples per millisecond), beginning approximately 30 milliseconds (ms) before the peak load and ending approximately 30 ms after the peak load.

4. **Significance and Use**

4.1 This test method covers the determination of pavement surface deflections as a result of the application of an impulse load to the pavement surface. The resulting deflections, measured at the center of the applied load, and at distances away from the load, are used to estimate the in-situ material properties and to evaluate construction uniformity.

5. **Apparatus**

5.1 *Instrumentation System* - conforming to the following general requirements:

5.1.1 *Instruments Exposed to the Elements* (outside the vehicle) shall be operable in the temperature range of -10 to -50°C (10 to 120°F) and shall tolerate relatively high humidity, rain or spray, and all other adverse conditions such as dust, shock, vibrations that may normally be encountered.

5.1.2 *Instruments Not Exposed to the Elements* (inside the vehicle) shall be operable in the temperature range of 5 to 40°C (40 to 105°F).

5.2 *Force-Generating Device* (falling weight), with a guide system. The force-generating device shall be capable of being raised to four predetermined heights and dropped. The device shall generate a force pulse approximating the shape of a haversine or half-sine wave while achieving a peak force of at least 50 kN (11,000 lbf). Specific load levels and drop heights are defined in 11.4.

5.2.1 *Guide System*, designed to operate with negligible friction or resistance and designed so the weight falls perpendicular to the pavement surface.

5.3 *Loading Plates*, capable of distributing an approximate uniform load to the pavement surface. The load plate shall be 11.8 inches (300 mm) in diameter for subgrade and base course testing. The plate shall be open in the center to allow a deflection measuring sensor to be installed and the plates shall be swivel suspended to tilt in any direction a minimum of 5° from the horizontal plane.

5.4 *Deflection Transducers*, capable of measuring the maximum vertical deflection of the pavement surface and mounted in such a manner as to minimize angular rotation with respect to its measuring plane at the maximum expected movement. The number and spacing of the transducers is defined in 11.3. Transducers may be of several types such as seismometers (absolute measurement transducers), velocity transducers, or accelerometers.

5.5 *Data Processing and Storage System* - A magnetic storage device shall be used to store the measured load, surface deflection data, and supporting information such as air temperature, pavement surface temperature, distance measurements, and identification data for each test point.

5.6 *Load Cell*, to measure the applied load on each impact shall be placed in a position to minimize inertial effects. The load cell shall be capable of deflection measurements at the center of the load, shall be water resistant, and shall be resistant to mechanical shocks from road impacts.

6. Signal Conditioning and Recorder System

6.1 All signal conditioning and recording equipment shall allow data reading resolution to meet the following requirements:

6.1.1 Load measurements shall be displayed and stored at a resolution of 200 N (50 lbf) or less.

6.1.2 Deflection measurements shall be displayed and stored with a resolution of 1 μm (0.04 mils).

6.1.3 The load and deflection measurements shall be recorded as specified under 6.1.1 and 6.1.2, respectively, within a time period or measurement window of at least 60 ms, to an absolute accuracy at the time of peak load and deflection, of ±2% and a random accuracy for deflections of ±2 μm (0.08 mils).

7. Hazards

7.1 The test vehicle, as well as all attachments to it, shall comply with all applicable state and federal laws. All necessary precautions shall be taken beyond those imposed by laws and regulations to ensure maximum safety of operating personnel and other traffic.

8. Calibration

8.1 *Calibration* - Follow the recommendations for deflection sensor relative calibration and for deflection and load cell reference calibration specified in the SHRP-LTPP Manual for FWD Testing. Reference calibration shall be performed annually and after repairs to the sensors or the load cell. Relative calibration shall be performed monthly and immediately after reference calibration.

8.2 DELETE

8.3 DELETE

9. Procedure

9.1 Bring the device to the test location and locate the test plate over the desired test point. The test location shall be as clean as possible of rocks and debris to ensure that the loading plate will be properly seated. Gravel or soil surfaces shall be as smooth as possible and all loose material removed. (See ASTM D 4695)

9.2 Lower the loading plate and the transducers and ensure they are resting on a firm and stable surface.

9.3 Raise the force generator to the desired height and drop. Record the resulting peak surface deflections and peak loads.

9.4 Perform two loading sequences at each drop height and compare the results. If the difference is greater than that specified in the SHRP-LTPP Manual for FWD Testing (for deflections, ± 2 μm (± 0.08 mils) ± 1 percent, and for load, ± 2.6 kPa (± 0.38 psi) ± 2 percent), it shall be noted in the report.

NOTE 1 - If the deflections indicate poor subgrade or base compaction, then this should be brought to the attention of the construction inspector.

10. Precision and Bias

10.1 *Precision* - At this time, no precision from a statistically designed series of tests with different devices has been obtained for testing unbound materials.

10.2 *Bias* - No statement is being made as to the bias of this test method at the present time.

11. Test Plan (see Table 1)

11.1 *Test Location* - Deflection tests shall be performed along the test section at the following two transverse locations in order of preference; (Note: Before performing the second pass, the influence of tow vehicle/trailer wheel rutting of the surface must be assessed. The second pass shall be omitted if rutting indicates some additional compaction or shearing of the subgrade and/or unbound materials has occurred.)

(1) Outer Wheel Path - located 0.76 m ± 0.15 m (2.5 ft ± 0.5 ft) from lane edge. (Denoted as pass "3" for consistency with SHRP procedures)

(2) Mid-Lane - located 1.8 m ± 0.15 m (6.0 ft ± 0.5 ft) from the lane edge. (Denoted as pass "1" for consistency with SHRP procedures)

11.2 *Test Interval* - A 15 m (50 ft) longitudinal test spacing shall be used for both passes. The starting station for the first pass shall be 0+00 and the second pass shall start at 0+7.5 m (0+25 ft), resulting in a staggered test pattern.

11.3 *Sensor Configuration* - A deflection sensor shall be placed directly beneath the center of the load plate and at radial offsets of 203, 305, 457, 610, 915, and 1524 mm (8, 12, 18, 24, 36, and 60 inches) from the center of the load plate.

11.4 *Load Levels/Number of Drops* - For subgrade testing, four drop heights shall be used as follows. The lowest load level shall be achieved by using the lowest possible physical drop height. The highest load level shall be achieved by determining the drop height required to obtain a maximum deflection of approximately 1524 μm (60 mils). The two intermediate load levels shall be achieved by setting the drop heights to positions that will produce evenly spaced load levels. For testing permeable asphalt treated, unbound granular base and lean concrete base courses the SHRP standard mass package and target load levels for flexible pavement testing shall be used. In all cases where excessive deflection measurements occur (greater than 1524 μm (60 mils)), only load levels that cause these high measurements shall be omitted.

11.5 *Drop Sequence* - At each test location, one seating drop at the lowest load level shall be applied prior to testing. Following the seating drop, two drops will be applied at each load level, starting with the lowest load level.

11.6 *Other Considerations* - Provision shall be made with the construction contractor for timely site access. Testing of subgrade shall be performed after completion of fine grading and prior to placement of base course materials. Unbound granular base testing shall be performed after completion of compaction and fine grading. Testing of permeable asphalt treated base course shall be performed after the material has been in place for a minimum of 48 hours and the prohibition of construction traffic on this material does not apply to the test vehicle and trailer. Lean concrete base material shall be tested no earlier than 7 days after placement. The prohibition of construction traffic does not apply to the test vehicle and trailer. Testing shall only be performed in the absence of standing water.

12. Report

12.1 *Test Identification Information* - Test Agency, SHRP Region, State Code, SPS Experiment Number, SPS Project Code, Test Section Number, Field Set Number, Roadway Name and Route Number, Test Designation, SHRP Protocol Number, Technician Name, and Test Date.

12.2 *Load and Deflection Data* - Load and deflection data shall be recorded in ASCII format and may be stored in compressed form on 3-1/2 inch computer diskettes. File names will consist of eight

characters; characters 1-6 shall be the SHRP Section ID of the SPS section, character 7 shall be a digit between 1 and 9, signifying the number of times that this section has been tested under this protocol. The first instance of testing will be denoted with a "1", whether the first testing occurs on the subgrade, a subbase course, or a base course. Character 8 shall be a number denoting the test location (1 - mid-lane, 3 - outer wheel path). A three character extension ".FWD" shall follow the eight character file name. Example: 29B32013.FWD represents the file name for the first deflection testing of this section along the outer wheel path. A paper copy printout of the load and deflection data shall also be provided along with the computer file for each section.

12.3 *Additional Data* - In addition to the load and deflection data, the air temperature, and time of testing shall be recorded for each test location. Lane specifications shall also be recorded. All lane specification codes are two character codes where the first character indicates material information and the second character indicates test location; "1" for mid-lane testing and "3" for outer wheelpath testing.

Material codes are as follows:

S - Subgrade,
G - Granular Aggregate Base,
P - Permeable Asphalt Treated Base, and
L - Lean Concrete Base.

An example of a lane specification, "G3", denotes testing of the granular aggregate base course in the outer wheel path.

Pavement temperature profiles are not required for any of the listed materials.

Table 1. Test Plan Summary for Deflection Testing of SPS 1, 2, and 8 Subgrade and Base Layers

Test Location	Mid-Lane Outer Wheel Path
Test Interval	15 m (50 ft)
Sensor Configuration	0, 203, 305, 457, 610, 915, 1524 mm (0, 8, 12, 18, 24, 36, 60 in.)
Load Plate	300 mm (11.8 in.) Diameter
Load Levels:	
Subgrade Testing	Non-SHRP mass package to achieve target loads: Height 1 - lowest possible (1,600 lbs.) Height 4 - to achieve 5,000 lbs. (maximum 1524 μm (60 mils)) Height 2, 3 - evenly spaced between heights 1 and 4
Base Course Testing	SHRP standard mass package and drop heights for target loads: Height 1 - 6,000 lbs. Height 2 - 9,000 lbs.(maximum 1524 μm (60 mils)) Height 3 - 12,000 lbs.(maximum 1524 μm (60 mils)) Height 4 - 16,000 lbs.(maximum 1524 μm (60 mils))
Drop Sequence	1 seating drop 2 drops at each load level (record peaks for each drop and whole history for the second drop at each height)

********** SPS TESTING DATA SHEET **********

SHEET _____ OF _____

SHRP-LTPP LABORATORY MATERIAL TESTING
DEFLECTION TESTING OF SUBGRADE AND BASE LAYERS
FIELD DATA SHEET T59
SUBGRADE AND BASE LAYERS
SHRP TEST DESIGNATION: SS13/SHRP PROTOCOL P59

AGENCY PERFORMING TEST: _____

SHRP REGION: _____ STATE: _____ STATE CODE: [__ __]

SPS PROJECT CODE: [__ __]

ROADWAY: _____ TEST SECTION NO.: [__ __]

FWD Manufacturer: _____

Model: _____

S/N: _____

TESTED BY: _____

DATE TESTED: __ __ - __ __ - 19__ __

1. PAVEMENT LAYER TESTED _____

2. LAYER NUMBER [__]

3. COMPUTER FILE NAMES __ __ __ __ __ __ __ __.FWD

__ __ __ __ __ __ __ __.FWD

GENERAL REMARKS:

_____

_____

CERTIFIED BY, DATE

_____

Participating Agency
Affiliation: _____

VERIFIED AND APPROVED BY, DATE

_____

SHRP Representative
Affiliation: _____