Long-Term Pavement Performance (LTPP) Program Specific Pavement Studies (SPS)

Development of Experiment Design: SPS-11 Asphalt Concrete Pavement Preservation Study

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Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

FOREWORD

Pavement preservation represents a proactive approach to maintaining and extending the lives of existing highways. Until recently, limited rigorous performance research existed on the effects of pavement preservation treatments, and consequently there was a reliance on anecdotal information. However, research findings over the past few years are proving that preservation can be an effective approach to extend pavement's effective service life, improve safety and service condition, and is cost-efficient.

The purpose of this report is to document the recommended experimental design for the Long-Term Pavement Performance (LTPP) SPS-11 Asphalt Concrete (AC) Pavement Preservation Study. This study has been designed to establish the impact of selected preservation treatments on pavement performance under different loading and environmental conditions through a field study of in-service pavements starting from construction of the preservation treatments under consideration. The underlying concept of this experiment is to apply the same preservation treatment, at different times, on the same pavement structure to determine the effectiveness of a single application of a treatment as a function of pavement condition and time. This experiment is designed to answer the question on when is the best time to apply a preservation treatment on AC pavements. It will also enable development and implementation of important pavement preservation products and tools, such as addition of pavement preservation considerations to the AASHTO Mechanistic-Empirical Pavement Design Guide and associated software. Although the recommended experiment will not be implemented under the LTPP program, the experiment and this project report can be adopted and adapted by interested highway agencies to achieve the stated benefits.

Cheryl Allen Richter, Ph.D., P.E.
Director, Office of Infrastructure
Research and Development

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16. Abstract

Pavement preservation represents a proactive approach to maintaining and extending the lives of existing highway pavements. At the heart of the preservation decision-making process is pavement performance. This report documents the recommended experimental design for the LTPP SPS-11 Asphalt Concrete (AC) Pavement Preservation Study as well as the various elements required for its successful implementation. However, the recommended experiment will not be implemented under the LTPP program, but the experiment and this project report can be adopted and adapted by interested highway agencies to achieve the stated benefits, and consequently the impetus for publication of the report. The underlying concept of the experiment is to apply the same preservation treatment, at different times, on the same pavement structure to determine the effectiveness of a single application of a treatment as a function of pavement condition and time. This experiment is designed to answer the question on when is the best time to apply a preservation treatment on AC pavements. It will also enable development and implementation of important pavement preservation products and tools, such as addition of pavement preservation considerations to the AASHTO Mechanistic-Empirical Pavement Design Guide and associated software.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ACRONYMS AND ABBREVIATIONS

AADT	—	annual average daily traffic
AASHTO	—	American Association of State Highway and Transportation Officials
AC	—	Asphalt Concrete
AC/ACP	—	AC overlay of AC pavement
AC/PCCP	—	Asphalt Concrete Overlay of Portland Cement Concrete Pavement
ACI	—	American Concrete Institute
ADT	—	Average Daily Traffic
AMPT	—	Asphalt Mixture Performance Test
AWS	—	automated weather station
BBR	—	Bending Beam Rheometer
CBR	—	California Bearing Ratio
CPR	—	concrete pavement restoration
CRCP	—	Continuously Reinforced Concrete Pavement
CRG	—	Communication Reference Guide
DCP	—	Dynamic Cone Penetrometer
DIM	—	Distress Identification Manual
DOT	—	Department of Transportation
DSR	—	Dynamic Shear Rheometer
ESAL	—	Equivalent Single Axle Load

ETF	—	Expert Task Force
ETG	—	Expert Task Group
FHWA	—	Federal Highway Administration
FWD	—	Falling Weight Deflectometer
GPR	—	Ground Penetrating Radar
GPS	—	Global Positioning System
GPS	—	General Pavement Studies
HMA	—	Hot Mix Asphalt
HOT	—	high occupancy toll
HOV	—	high occupancy vehicle
HPMS	—	Highway Performance Monitoring System
IMS	—	Information Management System
IRI	—	International Roughness Index
ISSA	—	International Slurry Surfacing Association
ISTEA	—	Intermodal Surface Transportation Efficiency Act
JITT	—	just in time training
JPCC	—	Jointed Portland Cement Concrete
JPCP	—	Jointed Plain Concrete Pavement
JRCP	—	Jointed Reinforced Concrete Pavement
LL	—	Liquid Limit

LSPEC	—	TRB LTPP Special Activities Committee
LTE	—	load transfer efficiency
LTPP	—	Long-Term Pavement Performance
MERRA	—	Modern-Era Retrospective Analysis for Research and Applications
MRL	—	Materials Reference Library
MS&T	—	materials sampling and testing
MTS	—	Materials tracking system
NAPA	—	National Asphalt Pavement Association
NASA	—	National Aeronautics and Space Administration
NCAT	—	National Center for Asphalt Technology
NCHRP	—	National Cooperative Highway Research Program
PCC	—	Portland Cement Concrete
PCI	—	Pavement Condition Index
PG	—	performance grade
PI	—	Plasticity Index
PL	—	Plastic Limit
PMS	—	Pavement Management System
PPDB	—	Pavement Performance Database
QC	—	quality control
RAP	—	reclaimed asphalt pavement

RAS	—	recycled asphalt shingles
RCO	—	Regional Coordination Office
RSCs	—	Regional Support Contractors
SAMI	—	stress-absorbing member interlayer
SHA	—	State Highway Agency
SHRP	—	Strategic Highway Research Program
SPS	—	Specific Pavement Studies
TFHRC	—	Turner-Fairbank Highway Research Center
TRB	—	Transportation Research Board
TSSC	—	Technical Support Services Contractor
VMA	—	voids in mineral aggregate
vpd	—	vehicles per day
WIM	—	Weigh-in-Motion
WMA	—	warm mix asphalt
WRI	—	Western Research Institute
WTAT	—	wet track abrasion test

CHAPTER 1. INTRODUCTION

The objective of the project documented in this report was to design an asphalt concrete (AC) pavement preservation experiment for the Federal Highway Administration (FHWA) Long-Term Pavement Performance (LTPP) program. The original intent of this project report was to provide, under a single document, the complete set of requirements and supporting information needed for implementation of an AC pavement preservation experiment under the LTPP program to capture information on the short- and long-term performance of AC pavements subjected to preservation treatments. The resulting data would allow both user-agencies and researchers a better understanding of the potential benefits of pavement preservation and they would also enable development and implementation of important pavement preservation products and tools. The recommended experiment will not be implemented under the LTPP program, but the experiment and this project report can be adopted and adapted by interested highway agencies to achieve the stated benefits, and consequently the impetus for publication of the report. The language of this project report also reflects this – a proposed experiment.

LTPP BACKGROUND

The LTPP program was formally established by the U.S. Congress in the Surface Transportation and Uniform Relocation Assistance Act of 1987 as part of the first Strategic Highway Research Program (SHRP). While most of the SHRP initiatives ended after the first five-year SHRP effort, the FHWA was formally authorized by Congress in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 to continue management of the LTPP program to complete the mission of performance observations over full pavement construction (new or rehabilitation) cycles. [(1)]

In 1992, the FHWA assumed management and administrative responsibilities to continue LTPP and complete the planned pavement performance monitoring in partnership with the State transportation agencies that own the LTPP test sections, the Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB). With the 2018 data collection cycle underway, a data set reflecting nearly three decades of data collection will soon be available. The mission of the LTPP program is to promote increased pavement life through: [(1)]

- Collecting and storing performance data from a large number of in-service highways in the United States and Canada over an extended period to support analysis and product development.
- Analyzing these data to describe how pavements perform and to explain why they perform as they do.
- Translating these insights into knowledge and usable engineering products related to pavement design, construction, rehabilitation, maintenance, preservation, and management.

The program's goal is to understand how and why pavements perform as they do. As highway agencies transition to a performance-based approach to managing highway investments this goal is, if anything, more important than ever.

To accomplish the stated mission and goal, the following six objectives were established for the LTPP program in 1985: [(1)]

1. Evaluate existing design methods.
2. Develop improved design methods and strategies for pavement rehabilitation.
3. Develop improved design equations for new and reconstructed pavements.
4. Determine the effects of (1) loading, (2) environment, (3) material properties and variability, (4) construction quality, and (5) maintenance levels on pavement distress and performance.
5. Determine the effects of specific design features on pavement performance.
6. Establish a national long-term pavement database to support SHRP objectives and future needs.

To meet these six objectives, data characterizing about 2,500 in-service pavement test sections throughout North America and documenting their performance over a time period of up to 25 years have been collected, processed and made publicly available—figure 1 shows their geographical distribution. These pavement test sections studied are organized in 18 scientifically designed field experiments within two broad sets of studies: General Pavement Studies (GPS) and Specific Pavement Studies (SPS)—see table 1 and table 2. The GPS are a series of studies on selected existing pavement structures. These studies are restricted to pavements having materials and designs representing good engineering practices and having strategic future importance due to widespread use throughout North America. The SPS are studies of specially constructed, maintained, or rehabilitated pavement sections incorporating a controlled set of experimental design and construction features. The SPS experiments were designed to provide a broader range of pavement factors than those available from pavements designed to meet local conditions.

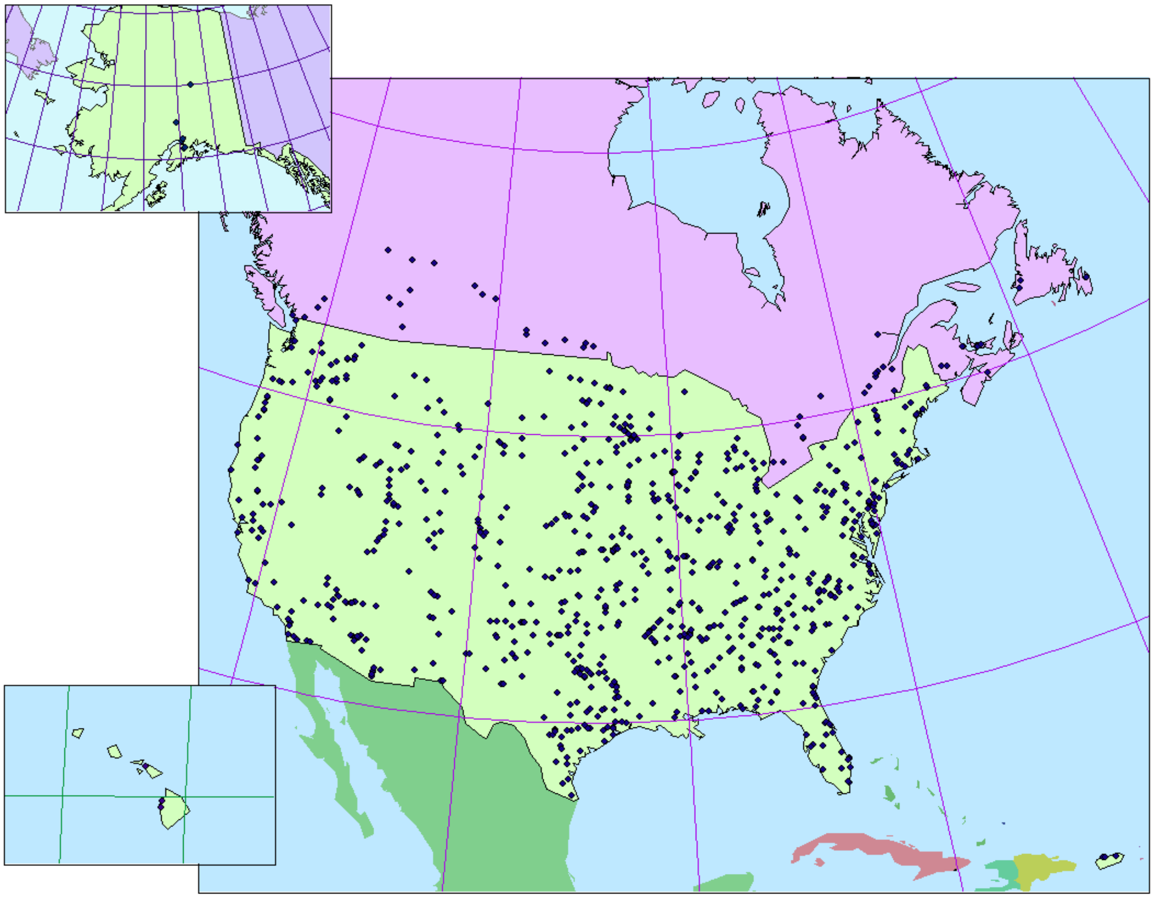

Figure 1. Map. Geographic distribution of LTPP test sections. [(1)]

Table 1. List of General Pavement Study (GPS) experiments.

Experiment	Experiment Title	Total No. of Sections
GPS-1	Asphalt Concrete (AC) Pavement on Granular Base	106
GPS-2	AC Pavement on Bound Base	65
GPS-3	Jointed Plain Concrete Pavement (JPCP)	113
GPS-4	Jointed Reinforced Concrete Pavement (JRCP)	49
GPS-5	Continuously Reinforced Concrete Pavement (CRCP)	55
GPS-6	AC Overlay of AC Pavement	421
GPS-7	AC Overlay on Portland Cement Concrete (PCC) Pavement	142
GPS-9	Unbonded PCC Overlay on PCC Pavement	25
Total:		976

Table 2. List of Specific Pavement Study (SPS) experiments by category.

Experiment	Experiment Title	Total No. of Sections
SPS-1	Strategic Study of Structural Factors for Flexible Pavements	147
SPS-2	Strategic Study of Structural Factors for Rigid Pavements	207
SPS-3	Preventive Maintenance Effectiveness of Flexible Pavements	445
SPS-4	Preventive Maintenance Effectiveness of Rigid Pavements	220
SPS-5	Rehabilitation of AC Pavements	166
SPS-6	Rehabilitation of Jointed Portland Cement Concrete (JPCC) Pavements	150
SPS-7	Bonded PCC Overlays on Concrete Pavements	39
SPS-8	Study of Environmental Effects in the Absence of Heavy Loads	50
SPS-9P/ SPS-9A	Validation and Refinements of SuperPave®Asphalt Specifications and Mix Design Process/SuperPave Asphalt Binder Study	109
SPS-10	Warm Mix Asphalt Study	72
Total:		1,605

Many insights have emerged from the LTPP program since its inception, but the continual update of existing pavement engineering tools and development of new are needed to stay abreast of new and emerging technological advances. To effectively design and manage pavements constructed using new emerging materials and technologies requires prediction of the long-term performance of the resulting structure under actual traffic loads and varied climate conditions; it has become apparent that long-term field observations are required to calibrate mechanistic-based pavement models.

The critical requirement in the development of any type of performance prediction model is availability of quality long-term performance data. The data have to be collected following a uniform methodology, must span the length of time between construction cycles, include measurements of significant parameters, and have measures of data quality. The recognition of these data requirement is what initially led to the development of the LTPP program in the 1980s, as such data would enable development of needed pavement engineering tools based on knowledge obtained from long-term performance observations, engineering structural measurements, climate measurements, and traffic loadings on in-service pavements.

Pavement technology has changed and it will continue to evolve. The topics from the 1980s that the LTPP program was designed to address—e.g., maintenance and rehabilitation treatments and strategies, use of recycled materials, concrete strength, base type, asphalt grade, pre-overlay treatments, layer thickness, and in-pavement drainage structures—have, in some cases, been supplemented with new questions. Although many of the topics are still relevant today and will continue to be into the future, new pavement materials, technologies and strategies have evolved and they too must be addressed within the context of long-term performance monitoring.

LTPP PAVEMENT PRESERVATION EXPERIMENTS

Pavement preservation is a technology that has been around for many decades, but there are limited data and information relating to the impact of preservations treatments on pavement performance, service life extensions and life-cycle costs. Except for a few state highway agencies (SHAs), the introduction and usage of pavement preservation treatments within the pavement management system (PMS) decision-making process has been based mostly on anecdotal information, if considered at all. Moreover, without long-term pavement performance data, the "application of the right preservation treatment, on the right pavement, at the right time" adage, will remain an abstract concept rather than an achievable goal.

In light of the above stated problem, FHWA undertook a project that had as its main objective to design and implement a pavement preservation experiment for the LTPP program. The provision of long-term performance data on in-service pavement test sections where controlled application of preservation treatments are monitored is the motivation for the LTPP experiment addressed in this document: the SPS-11 AC Pavement Preservation Study.

In the design of the LTPP SPS-11 preservation experiment, it was beneficial to start with a definition of pavement preservation, as it provided needed background and a measuring yardstick. The definition adopted by the LTPP program (based on 2005 FHWA memorandum titled "ACTION Pavement Preservation Definitions") is as follows: [(2)]

> *Pavement preservation is a planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity). The ultimate goal of pavement preservation is the application of the right preservation treatment, on the right pavement, at the right time.*

Key postulates associated with the above definition include:

- *Typically applied to pavements in good condition having significant remaining service life.*
- *A strategy of extending service life by applying cost effective treatments to the surface or near-surface of structurally sound pavements.*
- *Preventive treatments include asphalt crack sealing, chip sealing, slurry or micro-surfacing, thin and ultra-thin hot-mix asphalt (HMA) overlays.*

Albeit mostly anecdotally, pavement preservation has been proven to be a cost-effective approach to extend pavement's effective service life, improve safety and service condition. Moreover, given the current economic environment, most SHAs (as well as local highway agencies) are now embracing the pavement preservation philosophy to utilize more cost-effective pavement preservation techniques to better serve the public. There is, however, a clear need to demonstrate through field performance data collected under different loading and environmental conditions that this technology does indeed provide an effective approach in support of pavement decisions. Pavement performance is at the heart of the preservation decision-making process.

As stated earlier, pavement preservation treatments have been around for decades, but SHAs have not been able to use and/or optimize them appropriately due to the lack of data relating to their impact on performance, service life extensions, and life-cycle costs. However, given the budget constraints faced by SHAs, including limitations on rehabilitation and reconstruction funds, the use of preservation technology as a means to make pavements last longer has taken on a greater significance.

In addition, there are a few new pavement preservation treatments and improved technologies in the market today that were not available in the 1980s, when the SPS-3 Preventive Maintenance Effectiveness of Flexible Pavements experiment was designed. [(3)] Fortunately, there is also a larger agency/industry information base as well as improved industry experience. Nonetheless, issues such as treatment selection, traffic loadings and climatic conditions must be considered in the development of the SPS-11 Pavement Preservation Study.

PROJECT APPROACH

Overview

The objective of the project documented in this report was to design an AC pavement preservation experiment for the LTPP program. To accomplish this objective, the following five tasks were completed:

- Formulation of experimental design.
- Development of construction guidelines and requirements.
- Definition of materials sampling and testing requirements.
- Definition of pavement performance monitoring requirements.
- Identification of other data collection needs.

The project commenced in September 2014. The first three tasks were performed as part of Phase I, which was completed in June 2015, while the remaining tasks were done in Phase II, which commenced in July 2015 and was completed in March 2017. This document describes the approaches and outcomes all of the above tasks performed on this project. This report also provides the guidelines that resulted from the project.

Expert Task Group (ETG)

The formation of an Expert Task Group (ETG) was vital to the success of the project, and hence it was the first project activity. The ETG was formed to review and to provide feedback during the development of the LTPP pavement preservation experiment. In selecting members to the

ETG, careful consideration was given to information each member brought to the project to ensure the key elements of the LTPP pavement preservation studies were covered—LTPP program and pavement preservation technology. It was expected that the members of the ETG would have specific areas of expertise as well as a sound understanding of both the LTPP program and pavement preservation technology, and indeed this was ultimately the case.

The ETG was to consist of eight members. Working with FHWA, the project team identified eight candidate ETG members and four potential alternatives. Candidate members were identified from the TRB LTPP committees and TRB Pavement Preservation Committees (AHD18 and AHD20), as the members of these groups are committed to the goals of their respective technology. The ETG members were to represent the full range of LTPP stakeholders as well as the diverse geographic/climate regions of the country. The final list is presented in table 3; there were six DOT, two industry and one academia representatives. Vendors were not invited to join as it was felt there were too many pavement preservation technologies and only a limited space for ETG membership.

Two methods were used throughout the project to solicit input from the ETG. The first method of input was via webinars / teleconferences, which allowed the project team to present the progress and/or key technical issues and the ETG to provide feedback. Secondly, the ETG participated in two direct face-to-face meetings with FHWA and the project team to review and to discuss draft and final project deliverables. Table 4 provides a summary of the ETG meetings, including date, type and purpose of each.

Table 3. Project ETG membership.

ETG member	Affiliation	Expertise
Anita Bush	Nevada DOT	Pavement preservation and chair TRB pavement preservation comm.
Colin Franco	Rhode Island DOT	LTPP and pavement preservation
Morgan Kessler	FHWA	Pavement preservation and materials
David Luhr	Washington State DOT Transportation	LTPP and pavement preservation
Magdy Mikael	Texas DOT	Pavement preservation and materials
Larry Scofield	International Grooving and Grinding Association	LTPP and concrete pavement preservation
Jim Moulthrop	Foundation for Pavement Preservation	Asphalt pavement preservation and materials
Roger Smith	Texas A&M (retired)	LTPP, pavement preservation and management
Ben Worel	Minnesota DOT	LTPP and pavement preservation

Table 4. Summary of ETG meetings.

Date	Meeting Type	Purpose
January 22, 2015	Webinar / teleconference	ETG, FHWA and project team member introductions; project overview, and review and discuss experimental design and materials sampling and testing frameworks
April 23, 2015	Face-to-face (Reno, NV)	Review and discuss draft experimental design and materials sampling and testing
July 28, 2015	Webinar / teleconference	Finalize experiment design and materials and sampling plans, discuss marketing of experiments, and review upcoming activities and schedule
September 14, 2015	Webinar / teleconference	Review and discuss adjustments to the experiment design
May 2, 2016	Webinar / teleconference	Review and discuss framework for construction guidelines, data construction requirements, performance monitoring guidelines and other data collection requirements as well as review and discuss outreach activities
July 26, 2016	Face-to-face (Reno, NV)	Review and discuss completed set of experiment draft documents

Prior to each meeting, ETG members were provided with the meeting presentation as well as the reference material (i.e., draft and final documents). The project team also prepared minutes for each meeting to capture the guidance provided by the ETG members. The minutes were distributed to the ETG members for their review and comment and they were revised as appropriate. These minutes are considered an important record of the ETG input.

REPORT PURPOSE AND ORGANIZATION

The purpose of this report is to provide, under a single document, the complete set of requirements and supporting information needed for implementation of the LTPP SPS-11 AC Pavement Preservation Study. As with other LTPP experiments, this experiment is designed to capture information on the short- and long-term performance of AC pavements subjected to preservation treatments as well as other relevant data, which will allow both user-agencies and researchers a better understanding of the potential benefits of pavement preservation. Data collected as part of the study will also enable development and implementation of important products and tools, such as AASHTO standard specifications for the preservation treatments.

With the above in mind, this report has been organized into the following chapters:

1. Introduction—provides background information about the LTPP program and the LTPP pavement preservations studies, summarizes the approach taken to achieve the project objective, and presents the report purpose and organization.

2. Experimental Design—presents the approach established for development of the experiment, summarizes the key factors considered in the formulation of the experiment, details the resulting experiment matrices and recommended project layouts, and summarizes the project nomination and acceptance process.

3. Construction Requirements—provides recommendations on construction guidelines, checklists and just in time training (JITT) considered critical in minimizing variability over time and from project to project, summarizes the general construction data requirements (in terms of data sheets), and provides guidelines for the preparation of individual project construction reports.

4. Materials Sampling and Testing Plans—provides an overview of the MS&T process, summarizes the MS&T requirements including layers to test, sampling plans and testing protocols, and details other MS&T considerations such as the LTPP Materials Tracking System (MTS) and LTPP Materials Reference Library (MRL).

5. Performance Monitoring Requirements—lists the performance monitoring data elements (both required and desired), provides the monitoring frequency requirements, presents the required monitoring protocols (including deviations, if any), and summarizes the monitoring data collection requirements.

6. Other Data Collection Needs—lists the remaining required data elements (both required and desired), provides the data collection frequency requirements, presents the required data collection protocols (including deviations, if any), and summarizes the data collection requirements.

In addition, appendix A contains the data forms (and associated instructions) that require completion as part of the SPS-11 experiment documentation requirements, while appendix B contains new materials sampling and testing protocols not presently in use by the LTPP program.

CHAPTER 2. EXPERIMENTAL DESIGN

This chapter documents the recommended experimental design for the LTPP SPS-11 AC Pavement Preservation Study. As with other LTPP experiments, this experiment is designed to capture information on the long-term performance of pavement preservation treatments on AC. This is important because the monitoring of performance over time will permit verification of the purported benefits of the more common pavement preservation treatments and hence the technology. The understanding of how pavements where preservation treatments have been applied perform and why they perform as they do will also enable the development and implementation of numerous important products and tools, such as AASHTO standard specifications for the preservation treatments under consideration.

The SPS-11 experiment has been structured to ensure consistency and compatibility with the LTPP program objectives and database, while addressing information gaps regarding pavement preservation. The studies will capture not only field performance, but also laboratory test data that will allow both user-agencies and researchers a better understanding of the potential benefits of AC pavement preservation. Collectively, this information will be used to establish the impact of preservation treatments on AC pavement distress propagation rates, which will enable determination of their impact on pavement life extension and performance. In turn, this information and understanding will enable determination of the optimal timing, cost-effectiveness and benefits of preservation treatments.

The experimental design described in this chapter is intended for test sections not previously in the LTPP program. Projects nominated into the SPS-11 study will be classified into cells within the experimental matrix for project selection purposes. They should also adhere to the guidelines contained in this report. Because these sections will be nominated into the program prior to construction of the preservation treatments, all preservation construction activities, materials properties, and sampling will be documented to provide complete data sets.

OVERVIEW OF EXPERIMENT APPROACH

An innovative approach that segregates treatment types and project locations into discrete groups was adopted for this LTPP pavement preservation experiment. The underlying concept is to apply the same preservation treatment, at different times, on the same pavement structure to determine the effectiveness of a single application of a treatment as a function of pavement condition and time. This concept is designed to try and capture the most appropriate time to perform a treatment and to identify factors related to treatment timing. The vision of the experimental design is to choose pavements that have recently been constructed, reconstructed, or received a structural overlay. Starting with relatively new pavement structures at each project site, six test sections are established along a uniform road segment before any other preservation or maintenance treatments are applied. Over time (and hence change in pavement condition), the same preservation treatment is applied to different test sections. The length of the treatment application time span is intended to start before preservation treatments would normally be placed, and extend past the time use of preservation treatments is considered appropriate.

For example, a typical "thin AC overlay of an AC pavement" project in the SPS-11 experiment will contain six test sections at the same site—one control test sections (located near the middle of the project) and five treatment test sections, where the same thin overlay treatment is applied at different times. The thin overlay will be applied at the five treatment test sections 0, 2, 4, 6 and 8 years after inclusion of the project into the SPS-11 experiment. The untreated "control" test section will be used to normalize distress propagation rates along the project. Moreover, the remaining project sections can serve this purpose until the thin overlay treatment is applied. In year 3, for example, there would be two test sections with an applied thin overlay treatment and three test sections without the treatment, which can serve as additional untreated sections.

Motivations for the suggested experimental design approach include the following:

- Each pavement has a unique distress propagation rate based on the combination of pavement structure, material properties, traffic loadings and environment effects on materials used to construct the pavement. Performing a series of treatments over time on test sections at the same site provides a better indication of treatment effect versus condition/time as opposed to including pavement structures at different levels of condition in different climate, traffic load, and pavement structures.

- Only one treatment is specified for each project location in order to reduce the number of test sections required. If multiple treatments were specified at each location, this would increase the number of test sections by a multiple of two for each treatment (i.e., 12 versus 6 at each site for two treatments).

- One treatment type for test sections at the same site also offers the benefit of tailoring the timing of treatments for each specific treatment type. This avoids the issue of treatment timing when multiple types of treatments are applied to the same project location.

- One treatment per project location should enhance implementation since SHAs with experience with a specific type of preservation treatment may be more willing to participate in a treatment that they routinely use. However, SHAs are not limited to one treatment—agencies can implement multiple projects at a given site, each having six (6) test sections, but using different treatments. Indeed, it would be ideal if agencies could implement multiple projects at a single site, but it is recognized that to accomplish this, there are important issues and or limitations to address such as agency commitment, ability to find uniform location that can accommodate 18 test sections or more, etc.

- This type of approach offers significant results for each pavement test site that is meaningful to each participating agency without reliance on other SPS-11 project sites. Some of the other national pavement experiments required a global analysis of results between sites to provide data points to influence current agency practice.

- While the underlying concept is to determine the effectiveness of a single pavement preservation treatment as a function of pavement condition/time, the practicalities of this approach allow for consideration of some multiple treatments. For example, a test section that receives an early time-based treatment that returns to essentially the same condition as the control untreated section, allows the opportunity to apply a second treatment. This is an opportunity to extend the results, but is not included in the experimental design because it becomes an uncontrolled covariate in the overall scheme.

- The do nothing control test sections plus interim control test sections allow assessment of distress propagation within the limits of a project.

The suggested approach will also enable determination of the effect of the existing pavement condition on treatment life. Sometimes preservation treatments are placed on pavements in fair or poor condition and skepticism is created as to the effectiveness of these treatments when they do not perform well. Moreover, the approach also provides the baseline data needed to achieve an understanding of pavement distress propagation rates, and hence enable determination of the impact of preservation treatments on pavement life extension and performance.

It is recognized that there are issues associated with the suggested approach; e.g., for application of thin AC overlays at a given project, it is possible that the aggregate source, binder type, and contractor responsible for its placement may vary from one year to another. Other issues include:

- Staff turnover.

- Sections failing before application of treatment.

- Application of maintenance treatments by highway agency personnel other than the one under consideration at the site.

- Cost of mobilizing to project site every two years to apply treatment to a small area.

These issues introduce variability that is real and that is the same as that encountered by highway agency practitioners. As such, the LTPP data collection plans are designed to capture as much of that variability in the construction process as possible. Moreover, regardless of the above referenced issues, the benefits of the suggested approach far outweigh the potential negatives.

KEY EXPERIMENT CONSIDERATIONS

The SPS-11 experiment has been designed to establish the impact of the timing of preservation treatments through a field study of in-service pavements starting from construction of the preservation treatment being studied. A fundamental analysis concept of the experiment is to examine the effect of preservation treatments on pavement distress propagation rates, which will enable determination of their impact on pavement life extension and performance. In turn, this information and understanding will enable determination of the optimal timing, cost-effectiveness and benefits of preservation treatments.

This section describes the key considerations addressed in the development of the experimental design. A large number of factors were considered in formulating the experimental designs. However, given the practical constraints of financial resources and size of the experiment matrix required to adequately represent all factors, the resulting experimental design reflects the prioritization of factors within a statistically sound study, as described later in the chapter.

Pavement Preservation Treatments

A significant number of preservation treatments exist today, well beyond that which can realistically be considered as part of the SPS-11 experiment. Three treatments were selected as the most appropriate number of treatments that could reasonably be implemented within the LTPP program and its associated budget. In deciding what treatments to incorporate, the findings from various studies were considered, including the National Cooperative Highway Research Program (NCHRP) Project 14-33: Pavement Performance Measures that Consider the Contributions of Preservation Treatments. (4) Based on these studies, the most common treatments for AC pavements in order of frequency (listed in order from most to least frequent) were found to be:

- Thin AC overlays.
- Chip seals.
- Micro-surfacing.
- Crack seals.
- Fog seals.
- Slurry seals.
- Other seals.
- Mill and fill.
- Patching.
- Bonded wearing course (Nova chip).

Thin AC overlay, chip seals, and micro-surfacing are the three most common AC pavement preservation treatments, and hence the logical treatment choices for the SPS-11 experiment. These three treatments, if applied in time, preserve the pavement by protecting the AC surface layer from the aging effects as well as preventing the intrusion of moisture into the pavement system. Key issues considered in terms of these treatments included:

- How do treatments affect the aging of the AC surface layer and moisture conditions within the pavement, and hence pavement performance?
- How does treatment placement timing (and existing pavement condition) affect pavement performance?
- What is the optimal timing for these treatments as a function of age, traffic and climatic conditions?

Given the large number of SHAs using crack sealing of AC pavements (fourth most common treatment), this treatment was also considered. Typically, this is the first treatment agencies apply in terms of maintenance and preservation, but they do not know the impact on pavement life extension. Accordingly, it would make sense for this treatment to be included in the SPS-11 experiment. However, it is difficult to find sites to manage within the context of the experiment and sites considered will need continuous maintenance (i.e., application of crack sealing) to properly study the impact of the treatment of pavement performance. Accordingly, crack sealing was not included as a core SPS-11 experiment treatment.

Consideration was also given to multi-step preservation treatments such as a cape seal and double-chip with cape as well as including a fiber-modified process, such as metered cut fiber that is introduced at the pug mill on a slurry/micro setup. Most of these, however, are used by local and county highway agencies, not SHAs, and hence were not considered sufficiently strong candidates for inclusion in the experiment.

In summary, the following pavement preservation treatments were selected for inclusion in the SPS-11 experiment:

- Thin AC overlay (up to 1.0-inch thick).
- Chip seal.
- Micro-surfacing.

It is anticipated that other AC preservation treatments could potentially be included in the list of supplemental preservations treatments (discussed later in this chapter), which are strongly encouraged for implementation by the interested SHAs.

For those treatments that will be included in the SPS-11 experiment, a combination of national and local specifications was established. National specifications address general construction and workmanship requirements—e.g., thickness of thin AC overlays cannot exceed 1.0 inch and the aggregates used for these thin AC overlay should have a 3/8-inch nominal maximum size. Local specifications, on the other hand, pertain to specific construction and workmanship requirements—e.g., locally available asphalt and aggregates will be used for the thin AC overlays and agencies will control, as much as possible, material sources to reduce variability. To the extent possible, both national and local specifications should remain the same over time. These national and local specifications are reflected in the construction guidelines for the experiment presented in the next chapter. These guidelines address the many issues related to construction, workmanship, and construction specifications that can affect the outcome of the experiment.

Pavement Type and Age

A measure of the success of the SPS-11 experiment will be its contribution to the understanding of the performance of pavements that have been subjected to preservation treatments. Four sets of factors have been chosen to serve as main effects in the factorial pavement selection matrix: (1) pavement structure (including pavement type and pavement layer thicknesses and materials),

(2) subgrade soil, (3) traffic, and (4) drainage and environmental conditions. The first two factors are addressed in this section.

In formulating the SPS-11 experiment, pavements were grouped into the following pavement structure families:

- Original AC construction pavement (AC).
- AC overlay of AC pavement (AC/ACP).
- AC overlay of PCC pavement (AC/PCCP).

The following thought process was used in the selection of the pavement structure family to include in the experiment:

- Original AC construction pavement families were initially given the highest priority, as they are more likely to provide reasonable and clear outcomes.
- The use of AC overlays introduces additional variables such as underlying pavement condition prior to AC overlay, overlay thickness, and overlay materials, which complicate attainment of reasonable and clear outcomes.
- The AC overlay of AC pavement family represents a large component of the pavement network in the U.S., plus finding an adequate number of original AC pavement construction projects meeting the experiment requirements could prove difficult.
- The AC overlay of PCC pavement family were not considered as it introduces yet additional factors (e.g., PCC distress mechanisms versus AC distresses prior to placement of AC overlay) beyond those noted above for AC overlays in general.

Accordingly, based on the above, the AC overlay of AC pavement family was selected for inclusion in the SPS-11 experiment, with preference given to pavements with a single AC overlay. Original AC construction may be considered at a later time if the available LTPP program budget permits it.

The pavement family selection was made without consideration of the structural factors associated with the pavements, such as surface layer thickness, base layer type and thicknesses, subgrade soil and drainage. While important, these structural factors are not directly addressed in the experiment. Rather, the overarching assumption has been made that pavements incorporated into the experiment will have been appropriately designed for the given traffic and climate conditions, and as such the influence of the preservation treatments on the performance of the pavements will be accurately reflected. Properties of the test sections included in the study will be verified through falling weight deflectometer (FWD), cores, material tests and ground penetrating radar (GPR) testing. LTPP contractors and participating highway agencies will perform the FWD, cores and materials tests, while a specialty contractor will perform the GPR surveys, which will have a wide-ranging scope.

In addition, because the concept of preservation is premised on the assumption that the pavement receiving the treatment is in good condition, the following construction age requirement is stipulated: placement of AC overlay on existing AC pavement must have been completed within the past 4 years. Consideration will be given to older overlays if they are in good condition.

Detailed criteria for establishing whether a pavement meets the condition requirements is provided as part of the Project Nomination Guidelines detailed later in this chapter. They include:

- Desired pavement structure is a structural AC overlay—defined as a new overlay layer that is greater than 2 inches thick and represents more than 30 percent of the thickness of the bound AC layers—of AC pavement constructed within the past 4 years, but consideration will be given to older overlays if they are in good condition. Also, preference will be given to pavements with a single AC overlay.

- No interlayers within the internal asphalt concrete layer structure are allowed. Interlayers include geotextiles, fabrics, stress absorbing membranes, and sub-surface open graded asphalt cement layers.

- The pavement surface should be in good condition. It should have no visible surfaces distresses, such as cracks or ruts, and no patches. In addition, ride quality, as measured by the International Roughness Index (IRI), should be less than 80 inches/mi.

- The construction project must be of sufficient length to accommodate all of the experimental test sections. An ideal test section is 1,250 ft long, whereas a practical minimum is 800 ft long. Thus, the six cores test sections require a segment length between 1 to 1.5 mi, where the properties of the pavement along that length are as similar as possible in terms of layer types, layer thicknesses, drainage features, and subgrade. A longer length is needed if supplemental test sections are proposed.

- The surface of the project site pavement must be dense graded AC appropriate for the application of the preservation treatment. Open graded friction courses, chip seals, micro-surfacing, and other such treatments, which would need to be removed prior to application of the experimental treatment, are not appropriate. Such treatments would need to be removed for inclusion consideration in the experiment.

- Traffic flow should be uniform over the length of the project. All sections should carry the same traffic stream and be located in the same direction of traffic. Intersections, rest stops, on-off ramps, weaving areas, quarry entrances, etc., should be avoided on and between test sections on a project.

- Test sections should be located on portions of the project that are relatively straight and have a uniform vertical grade. Horizontal curves greater than 3 degrees and vertical grades greater than 4 percent should be avoided.

- All test sections should be located on shallow fills. The entire length of each test section, however, should be located completely on either a cut or a fill. Cut-fill transitions or side hill fills should be avoided within the monitoring portion of each test section.

- Culverts, pipes and other substructures beneath the pavement should be avoided, but if required they should not be within the limits of the monitoring portion of a test section.

- Road sections with added lanes, added shoulders, or that have been widened are not desirable for the SPS-11 experiment.

- The project pavement must not have curb and gutter within 6 feet from the outside edge of the pavement adjacent to the test lane.

- The test sections must be located in the outside lane of the travel direction.

These criteria will help identify projects in which the relative performance of the pavement is due to the timing of the placement of the preservation treatments, and the influence of other factors such as changes in the existing pavement structure, subgrade, traffic patterns, and drainage characteristics is minimized.

Climate

A key factor affecting pavement performance is climate and consequently, it must be a key consideration in the formulation of the SPS-11 experiment. The four general climatic zone designations that have been used in the prior LTPP experiment designs will be used for the experiment in question. They are:

- Wet-Freeze.

- Dry-Freeze.

- Wet-No Freeze.

- Dry-No Freeze.

Annual precipitation will be used to define dry and wet. Climates with an average annual precipitation of less than 20 inches/year from 1990 to 2010 will be considered “Dry,” while those receiving more than 20 inches of precipitation per year will be considered ‘Wet.”

Freezing Index will be used to define the Freeze and No Freeze climates from the average annual freeze index from 1990 to 2010. A site located where the annual Freezing Index is greater than 150°F-days will be considered to be in the Freeze zone, while one located where the annual Freezing Index is less than 150°F-days will be considered to be in the No Freeze zone.

The experiment design is based on the same number of SPS-11 preservation treatments being constructed in in all four climatic zones. The experiment will rely on data obtained from a climate source developed by the National Aeronautics and Space Administration (NASA), the Modern-Era Retrospective Analysis for Research and Applications (MERRA), which provides continuous hourly weather data starting in 1979 on a relatively fine-grained uniform grid and also traditional virtual weather stations from nearby operating weather stations. Installation of an automated weather station (AWS) at each project site is not required.

Traffic

Traffic factors, both in terms of loads and volumes, are a primary consideration in the performance of preservation treatments. Historically, the LTPP program has used annual application rate of equivalent single axle loads (ESALs) to characterize traffic in the formulation of the experiments as well as in the project/test section nomination/acceptance and experimental cell grouping process. Typically, a high and low level of the traffic load classification factor has been used.

The approach that will be used for the SPS-11 experiment is based on both traffic volume and ESALs. Traffic characterized in terms of ESALs alone does not accurately reflect the impact on some preservation treatments placed on “high volume” routes. Traffic volume is also considered an important variable in the experiment because the performance of some treatments is not necessarily related to structural issues.

The findings and recommendations from the SHRP 2 Report No. R26-RR-2 “Guidelines for the Preservation of High-Traffic-Volume Roadways” were used to establish a traffic threshold value based on the route’s average daily traffic (ADT). (5) In this report, high volume is defined as 5,000 or more vehicles per day (vpd) for rural roads, and 10,000 or more vehicles for urban roads. Since the preponderance of LTPP test sections have been established in rural areas, the traffic volume threshold for AC pavements was set at 5,000 vpd. Sites receiving less than 5,000 vpd are considered low traffic, while those sites with traffic volumes greater than 5,000 vpd are considered high traffic for purposes of the experiment.

In terms of ESALs, the same approach and threshold value used in the SPS-10 Experiment: Warm Mix Asphalt (WMA) Overlay of Asphalt Pavement Study will be used for the SPS-11 experiment. Sites receiving less than 500,000 ESALs per year are considered low traffic, while those sites with traffic greater than 500,000 ESALs per year are considered high traffic. The basis for the 500,000 ESAL threshold values, as directly extracted from the SPS-10 Experimental Design and Research Plan, is provided below: (6)

> *To ensure that the experiment captured a range of loading conditions, two categories were established by evaluating measured loading at the existing LTPP sites. The distribution of average annual ESALs per year is provided in figure 2, while summary statistics are provided in table 5. These data were assembled from all LTPP locations where monitored traffic data are available and represent the annual average of all years collected for each location—the ESAL values reported are for one lane in one direction of travel (i.e., design ESALs). As shown, the mean for the data set is 338 kESALs per year; however, the distribution is skewed with approximately 60 percent of the sites receiving less than 250 kESALs per year. In addition, traffic loads continue to grow thereby increasing ESAL levels. Some of the data included in figure 2 was captured in the early to the mid-1990s and they have not been adjusted for growth. Based on this distribution and considering the difficulties in obtaining lane closure in high traffic*

areas, the low traffic category was defined as sites receiving less than 500,000 ESALs per year. A site with traffic greater than or equal to 500,000 ESALs per year will fall into the high traffic category for purposes of this experiment.

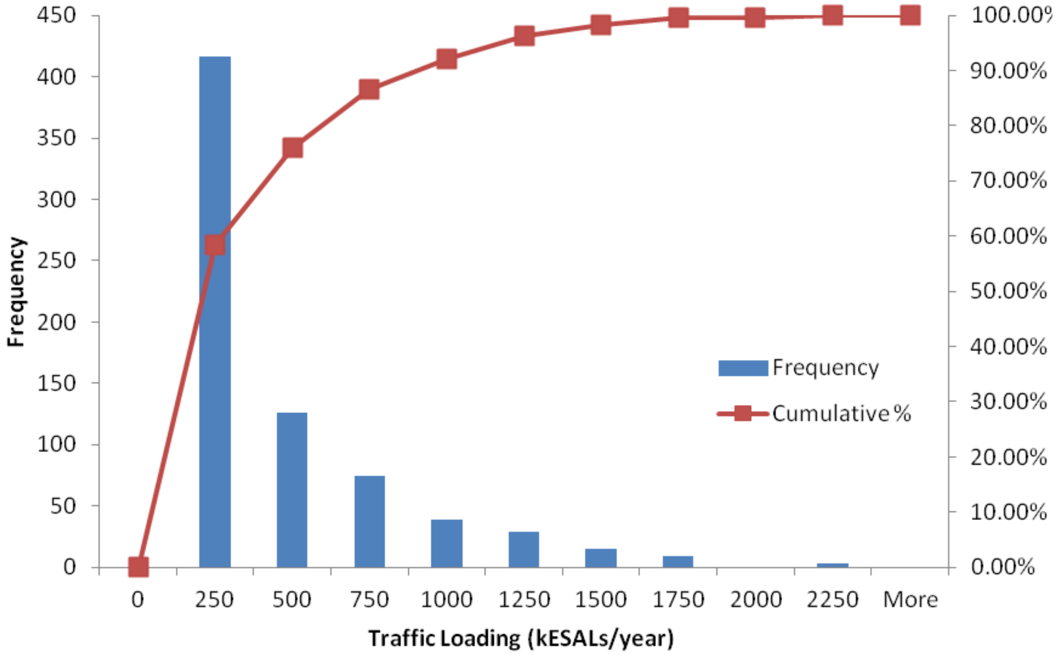

Figure 2. Graph. Distribution of annual traffic loading at LTPP sites.

Table 5. Summary of statistics of annual traffic loading at LTPP sites.

Statistic	Average Annual Traffic Loading (kESALs/yr)
Mean	338
Median	195
Standard Deviation	377
Minimum	2
Maximum	2172

Furthermore, to limit the size of the experimental matrix and hence number of required projects, the two referenced traffic parameters were used to develop the chart presented in figure 3 for establishing traffic levels at a given project site as high or low. In the preparation of this chart, the thresholds of 500,000 annual ESALs and 5,000 vpd were used as the starting point; they generated four quadrants—high-high, low-low, high-low and low-high. The next step was to decide how to assign part or all of the high-low and low-high quadrants to either the high or low traffic level. Various options were considered, including looking at the number of ESALs per vehicle and vice-versa. In the end, the decision was made to give equal weight to ESALs and volume, and hence the high-low and low-high quadrants were each separated along the rising (increasing ESALs and decreasing volume) diagonal—above the diagonal was considered low and below high.

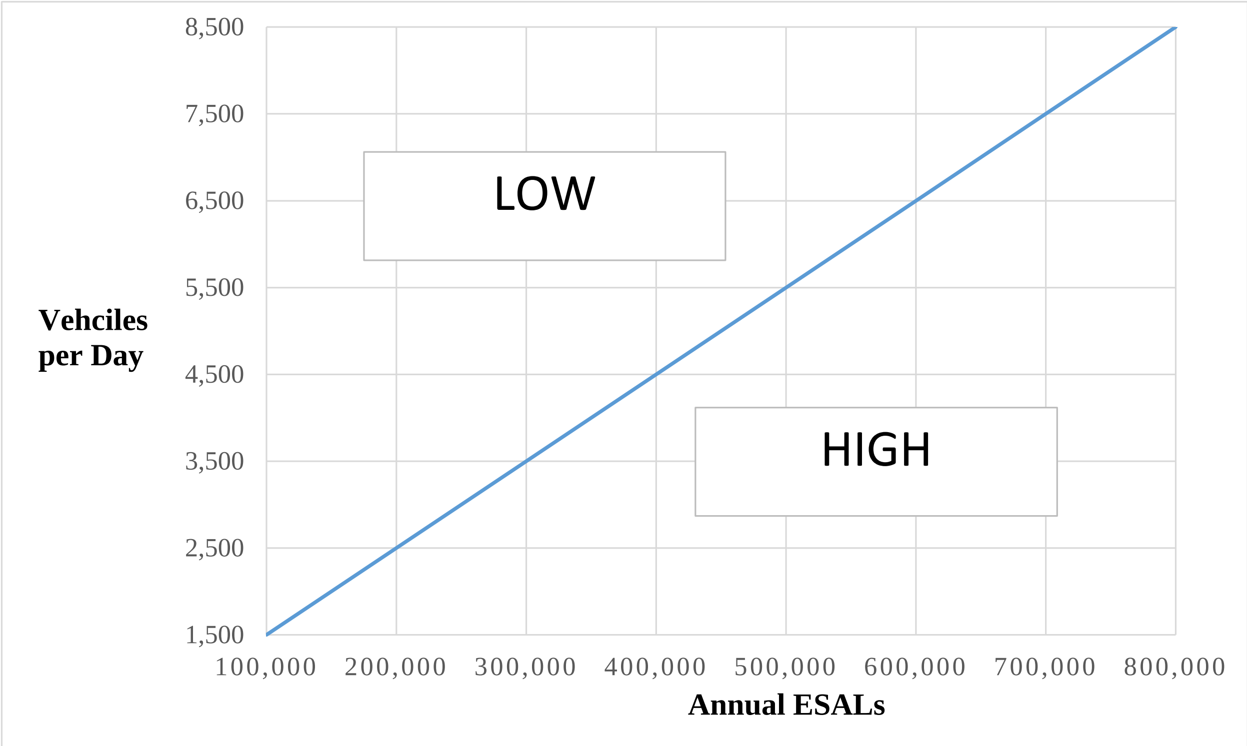

Figure 3. Graph. Chart for definition of SPS-11 traffic level.

In summary, the approach that will be used to characterize traffic in the SPS-11 experiment makes use of both traffic volume and annual ESALs to establish the traffic level at a given project as High or Low. However, these traffic parameters will be only be used for purposes of project recruitment and population of the experiments. Once incorporated into the LTPP program, traffic information will be collected at each project site as part of the monitoring data requirements. Priority will be given to continuously operating permanent Weigh-in-Motion (WIM) devices for the collection of classification and weight data because they provide:

- Accurate traffic loading measurements required to develop mechanistic and mechanistic/empirical design models.

- The base data necessary to understand the intricacies of the interactions among pavement, traffic load, and environment.

More specifically, a minimum of three years of WIM data and thereafter continuous classification data collection for the remainder of the time the project remains in the LTPP program is recommended. Collection of WIM data provides information on loading and vehicle classification at a site, while continuous classification provides the basis to expand loading data for later years in the study by correctly weighting the various loading distributions.

The three-year minimum for WIM data collection should allow capture of major variations due to economic cycles. The LTPP SPS traffic validation (pooled-fund) study used five years to fully cover high and low periods of economic activity since economic cycles typically last three years.

It was found in that study that weight patterns by vehicle class tend to be stable over time. A three-year requirement also recognizes that site calibration and validation required at periodic intervals is a resource demand. The quartz piezo sensor is one of the possible WIM sensors that has minimal temperature sensitivity. An installation with quartz piezo sensors would require only one validation during the expected sensor life. The calibration typically holds with a bias that will not affect pavement design evaluations for 18 to 24 months. The typical minimum life of a correctly installed sensor in good pavement is three years. An initial data collection period, where an agency could use the site to supplement an existing weight group or test a hypothesis about weight group selection would allow the data to be used for other purposes. At the end of the period, an agency decision on reinstallation would not significantly affect the availability of loading information for the SPS-11 experiment.

The purpose of the on-going classification data collection requirement is to track truck growth (up or down) and to look for potential shifts in the distribution between classes. The shift in truck distributions can impact expansion of prior year loading information. This limits the utility of volume counts for on-going data collection. Vehicle distribution changes may be a function of route utilization or agency changes in classification trees. LTPP research has found that about a quarter of all locations will have a significant shift in distribution within a five-year period, an interval shorter than the length of the experiment.

It is recognized that the ability to achieve the recommended traffic data collection will depend on the availability of funds within the LTPP program. Should funds not be sufficient, consideration will be given to more attainable data collection requirements, but which would still provide reliable traffic data.

Replicate and Repeat Test Sections

The use of replicates in the SPS-11 experiment is highly desirable for a number of reasons. However, it is first important to describe the difference between “replicate” and “repeat” test sections. Both words suggest response measurements collected from multiple test sections with the same (or very similar) combination of design factor settings.

The most essential distinction is that replicate sections are constructed at different sites, whereas repeat sections are constructed at the same site, such as the control sections. This description implies a “replicate” is the smallest experimental unit to which the experiment factors can be independently applied. Random assignment of design, environmental, or traffic load factors is not possible here since they are fixed by climate and demographic characteristics of the country. However, they form the basis of the design that should strive to achieve a wide numerical range of these factors and also combinations of low and high values with other factors.

Maximizing numerical properties of the design matrix is important to obtaining results related to their effects on pavement performance. In the experiment design, these factors are defined as the “between” site factors, which have the important characteristic that pavement design, environmental, and traffic conditions (which can only have one specified level for each factor for all 6 sections within each site) apply to all test sections built at the site. In this case, the location of the test site case becomes the experimental unit.

A “repeat” (identical test sections built within the same site) is known as pseudo-replication. Although it could be useful for evaluating measurement error, an all too common mistake is to incorrectly consider two or more identical test sections from one location as if they were multiple experimental units. Statistical computations from data obtained through pseudo-replication typically underestimate the error term and inflate the denominator degrees of freedom for statistical tests. The impact is that confidence intervals are too narrow and p-values are smaller than they should be, resulting in an increased chance of making Type I errors (i.e., falsely rejecting a true null hypothesis) or detecting treatment differences as false positives.

The control test section at each project site plus those test sections that have not yet received treatment (number will decrease with time) are considered as repeats in these experimental designs and they will be used to measure within-site variation, which for some sites may be substantial over a cumulative length of several miles. Sections repeated within a site that specify different treatments as a within-site factor would be ideal, though practical time and resource limitations of this study prevent this type of design. Within site comparisons will then be limited only to what occurs with one treatment over time, that is, the effect of accumulated environmental factors and traffic on pavement performance over time.

Replication of environmental and traffic conditions at two or more locations permits more accurate estimation of the variability for effects of the between section factors. Proper estimation of experimental error to include differences due to location makes the results relevant to a wider inference space. This feature is crucial in inferential statistics in order to compare both main and interaction effects and to estimate standard errors and their resulting confidence intervals and p-values for differences in factor means.

The recommended SPS-11 experimental design matrices discussed later in this chapter include replication of the primary tier factorials. Replication here implies obtaining two locations with similar characteristics of pavement design, traffic, and environmental conditions; however, the actual numerical values may vary between them to an unknown extent. A minimum of two projects will be recruited for each combination of primary tier factorials of climate and traffic, but more than two replicate projects will be considered for inclusion LTPP program. The matrices indicate balance of the overall experiment with the factors represented, but does not prevent or limit additional replicates from being included in the program.

The ability to include replicates within the SPS-11 experiment will depend on the required time and resources, which is beyond the scope of this report to define. They will be based on the LTPP program budget in the coming years as well as the interest demonstrated by the SHAs in support of the experiment.

Supplemental Test Sections

LTPP SPS experiments to date have encouraged the use of supplemental test sections by sponsoring SHAs. The SPS-11 experiment is no exception, but given its approach, the incorporation of supplemental test sections will not be as straightforward as with other experiments. Nonetheless, the use of supplemental test sections to expand the experiment to address items of interest and/or concern as well as incorporate other preservation technologies is highly encouraged. This is especially true in light of the focus of the core experiments in terms of pavement types and treatments. As with the core experiment test sections, responsibility for construction of the supplemental test sections will fall on the sponsoring SHAs. However, this enables participating highway agencies to conduct field research of interest to them.

Various examples of supplemental test sections that could be included in the SPS-11 experiment are listed below:

- Addition of Supplemental Test Sections (Option 1)—At core projects that have been accepted for inclusion into the SPS-11 experiment, agencies can incorporate supplemental test sections that consider the exact same factors addressed by the core test sections for the single treatment under consideration at that project, but the treatment for the supplemental test sections is placed at different times as those for the core test sections. For example, if the thin AC overlay is applied to the core test sections in years 0, 2, 4, 6 and 8 after inclusion of the project in the LTPP program, then the agency could opt for the application of the same thin AC overlay at supplemental test sections in years 1, 3, 5 and/or 7.

- Addition of Supplemental Test Sections (Option 2)—At projects that have been accepted for inclusion into the SPS-11 experiment, agencies can incorporate supplemental test sections that consider factors not addressed by the core test sections for the single treatment under consideration at that project. For example, at thin AC overlay projects, the thickness of the overlay for the core test sections must be less than 1.0 inch. The agency could choose to include supplemental test sections placed at the same times as the core test sections, but where the thickness of the overlay is thinner (say ½ inch) or thicker (say 1.5 inches). Similarly, the agency could consider alternate materials and/or construction techniques as compared to those used for the core test sections. Other examples include:
    - Different treatments:
        - Scrub seals used as a chip seal or prior to an HMA overlay
        - Cape seals using micros or slurries
        - Thin bonded wearing courses (Nova chip)
    - Same treatment, but modified
        - Thin HMA overlay using different overlay thickness or using different aggregate sizes
        - Chip seal and/or micro-surfacing projects using different materials or using different technologies

- Addition of Supplemental Projects (Option 3)—Adjacent to projects that have been accepted for inclusion into the SPS-11 experiment or new sites, interested agencies could set-up supplemental projects that consider alternate preservation treatments or technologies enabling performance comparisons between treatments under the given site conditions. For example, an agency interested in comparing the performance of fog seals (supplemental study) versus that of chip seals (core study), could establish a fog seal project adjacent to the chip seal project, where treatments in the two projects are applied at the same time.

- Addition of Supplemental Sub-Experiments (Option 4)—If multiple agencies are interested in the same treatment (whether part of the core experiment but using different materials/ techniques or not), the establishment of one or more additional (supplemental) treatments could be considered. For example, a group of highway agencies may be interested in considering a preservation treatment not included in the core experimental treatments, such as Nova chip for AC pavements.

- Other examples (albeit more appropriately core experiment options) include:

    - Build the three core projects sections at one site; i.e., thin AC overlays, chip seals and micro-surfacing projects.

    - Build time series of LTPP core test sections and build mirrored site using same time schedule, but alternative treatment to determine best treatment timing.

    - Add shadow set of core test sections that allow multiple treatments to be placed over time; e.g., place two treatments (one core test section and one supplemental test section) of the same type on two different test sections and at future time, place second treatment on supplemental test section so that multiple combinations over time can be used to extend study results

In addition to the above supplemental test section options, it is important to highlight the following two considerations:

- If so desired, SHAs participating in the experiment will be afforded the opportunity to place more than one preservation treatment at one location. As such, these agencies are able to construct SPS-3 style projects, with multiple treatments monitored over time.

- Following-up on above bullet item, treatments that are going to be applied at a project on a given year must be constructed within a short period of time, preferably one week, to optimize LTPP resources.

In summary, a wide range of options exist for interested SHAs to incorporate supplemental test sections into the SPS-11 experiment, ranging from individual test sections to projects to full experiments. Moreover, these test sections can address the full spectrum of factors associated with preservations treatments, including materials, techniques, and timing.

Lessons Learned from Other LTPP Experiments

Another important set of considerations in the development of the SPS-11 experiment was the lessons learned from the SPS-3, SPS-4 and other LTPP experiments. These lessons addressed in the development of the experiment design include:

- An experimental design for preservations treatments, where a core set of the same treatments were placed at each site has an issue with not being able to apply a specific treatment. In the SPS-3 experimental design, one of the core treatments was crack sealing. If the location designated for the cracking sealing section has no cracks to seal, which happened on SPS-3 sites, then the crack seal section becomes an anomaly. The lesson learned is that consideration of treatments appropriate to the pavement condition for pavement preservation activities must be considered in the experimental design.

- After initial construction of experimental treatments, it was difficult to get agencies to use a prescribed regimen on follow-up treatments. In the case of the crack sealing sections on SPS-3 sites, getting an agency to seal only the cracks on the crack sealing section and not any of the other sections at the site was nearly impossible because of the way maintenance type of activities are administered. The lesson learned is not to get too complex with prescribed treatments that are outside of normal agency practices.

- One often reported observation from previous preventive maintenance experiments was that chip seals worked well in states that regularly use chip seals and slurry seals worked well in states that regularly use slurry seals, etc. This is perhaps a reflection of the knowledge based on construction techniques developed by agencies, experience of pavement contractors in those states, and understanding what works well given available materials, climate, and traffic loadings. The lesson learned was that while development of national models has various planning applications, the desired outcomes of these types of studies are findings that State and districts within a State can use to improve their practice—i.e., Texas is not interested in what works well in Alaska.

- The standard 500-ft long LTPP test section was based on needs for mechanistic based structural analysis of pavement performance. This length can be too short for pavement preservation investigations. The exception to this rule is the 1,000-ft long Concrete Pavement Restoration (CPR) included in the LTPP SPS-6 experiment. These sections were designated to be double the length of normal LTPP test sections since they consisted of a mixture of preventive/preservation treatments to address specific distress condition at each site. The lesson learned was that test section must be based on how the resulting data will be interpreted. Accordingly, while 500-ft long test sections were selected for the experiment, the lesson learned was considered when establishing test section lengths.

- The materials sampling and testing plan for the existing pavement structure at LTPP SPS-3 and -4 experiments relied exclusively on the associated LTPP test section. This meant that no cores were taken to document the thickness or structural properties of each individual preventive maintenance test section. All of the existing structural properties have to be inferred from the existing LTPP test section. There was one site in the SPS-4 experiment that had no associated LTPP test section; as a result there were no measured layer structure or material properties in LTPP database and the test section was released from the program. The lesson learned from this experience was that every field pavement test section, including those located on the same construction project site, must have a rudimentary set of field cores taken at each end of the test section, if only to visually classify the material and measure layer thicknesses.

- When the performance of field test sections was analyzed within the context of formal statistical experiments, it was easy to miss the significance of outliers, which do not follow trends. Case in point is the SPS-3 chip seal sections placed in Arizona. These chip seal sections exhibited advanced rutting whereas the adjacent sections with slurry seals and thin overlays experienced little to no rutting under the same traffic conditions. The lesson learned from these observations is that it is not possible to determine from statistical analysis of empirical observations of pavement condition time histories alone, why pavements behave as observed. This type of observation supports the need for supplemental monitoring studies to aid in the engineering interpretation of the performance of test sections that cannot be directly determined through statistical analysis techniques that are the underpinning of all statistical experiment designs.

- Recent findings in pavement preservation research related to slurry seals indicate that optimum levels of preservation were achieved from application of multiple treatments at distinct time intervals from initial construction date. To design a field experiment to discover optimal timing of single treatments, multiple applications of a single treatment, multiple applications of different treatments, and sequence of multiple treatments types to obtain optimum performance requires an impossible number of field test sections to cover the factor space.

- In the early LTPP SPS experiments, participating agencies were asked to fund materials testing on SPS sites and aid in collection of construction data. This resulted in a mixture of varying level of data completeness, availability, comparability, accuracy, and uniformity. The lesson learned from this experience was that the best way to promote data uniformity is for LTPP to fund and perform these activities using contractors subject to LTPP quality control and assurance requirements.

- One of the more unique activities performed on the LTPP SPS-3 and -4 experiments were tours of the active test sections by active national, federal and State agency engineers. While these groups were not supposed to compare the performance of different preventive maintenance treatments against other preventive maintenance treatments, this was about impossible to do since the main concern was what treatment works best. The lesson learned from this experience was that one of the fastest routes to implementation of research findings is to engage key State practitioners in the research process.

- Past LTPP field experiments were based on construction of the same pavement structures at a site, which appeared to rely on an analysis of between test section performance at each site. What has been shown in analysis of these types of field experiments is that when differences are observed between the different treatments between different project sites, more information is needed to explain between site differences in performance. The lesson learned from this observation was that when more than one site is included in a field study, then measurement of factors such as traffic loading is required to explain possible site to site variations in performance.

- The thrust of the national LTPP experiments in the past was designed to discover universal effects such as climate, traffic load, materials, and soil type on pavement performance. In practice, SHAs have a limited set of these factors that are of concern to their business practices and engineering decisions. A lesson learned from past LTPP research was that while agencies can in some cases be persuaded to participate in national studies, they are more interested in participating in studies that lead to improvement in their practice.

EXPERIMENT DESIGNS

The objective of the SPS-11 experiment is to provide long-term performance data on in-service pavement test sections where controlled application of preservation treatments is monitored. The underlying concept is to apply the same treatment, at different times, on the same pavement structure to determine the effectiveness of a single application of a treatment as a function of pavement condition and time. This concept is designed to establish the impact of preservation treatments on pavement distress propagation rates, which in turn will enable identification of the most appropriate time to perform a treatment as well as the factors related to treatment timing.

To accomplish the stated objective, the experimental design consists of multiple experiments, where each experiment addresses a specific treatment. Those treatments or experiments, are:

- SPS-11T—thin AC overlay of AC overlay (over AC pavement).
- SPS-11C—chip seal of existing AC overlay (over AC pavement).
- SPS-11M—micro-surfacing of AC overlay (over AC pavement).

Placement of the AC overlay should have been completed within the past 4 years and preference will be given to pavements with a single AC overlay. However, consideration will also be given to older overlays if overlay is in good condition.

The generic SPS-11 experiment project selection matrices are presented in figure 4 through figure 6. These matrices identify how to select project site characteristics with a design based on categorization that will be numerical data. To the extent possible, it is essential to select project sites with these characteristics that are substantially below or above the indicated numerical break-point for each factor. This will provide variability among the design factors, which in turn will help ensure that the available data will efficiently achieve the experiment objective. In addition, it is highly desirable that at least one project be nominated and constructed per cell and that there be replicate projects for each cell.

Each of the SPS-11 experiment projects will be located across North America, such that the appropriate range and distribution of climate (moisture and temperature) and traffic conditions are captured; these site factors are identified across the top of the matrix in figure 4 through figure 6. Besides these site factors, the other major factor incorporated into the experiment design was timing of treatment, which relates to both age and condition of the pavement structure.

	Wet				**Dry**				**Annual Precipitation**
	Freeze		**No Freeze**		**Freeze**		**No Freeze**		**Average Annual Freezing Index**
Treatment	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**Daily Volume & Annual ESALs**
Thin AC Overlay									

Figure 4. Illustration. SPS-11T experiment matrix: thin AC overlay experiment.

	Wet				**Dry**				**Annual Precipitation**
	Freeze		**No Freeze**		**Freeze**		**No Freeze**		**Average Annual Freezing Index**
Treatment	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**Daily Volume & Annual ESALs**
Chip Seal									

Figure 5. Illustration. SPS-11C experiment matrix: chip seal experiment.

	Wet				**Dry**				**Annual Precipitation**
	Freeze		**No Freeze**		**Freeze**		**No Freeze**		**Average Annual Freezing Index**
Treatment	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**Daily Volume & Annual ESALs**
Micro-Surfacing									

Figure 6. Illustration. SPS-11M experiment matrix: micro-surfacing experiment.

Within each of the SPS-11 experiment projects, there will be six (6) core test sections. Of those, one (1) control test section (no treatment) and five (5) treatment test sections (same treatment, but applied at different times). Four of the treatment test sections will also serve as repeat test sections, at least for portions of the monitoring period. The timing of each treatment test section, in years from inclusion of project into the LTPP program (where inclusion is defined as date of project's formal acceptance into LTPP program), is as follows:

- Treatment Section 1—0 years from inclusion.
- Treatment Section 2—2 years from inclusion.
- Treatment Section 3—4 years from inclusion.
- Treatment Section 4—6 years from inclusion.
- Treatment Section 5—8 years from inclusion.

It is possible that the above timing schedule could change based on observed pavement conditions. For example, the timing schedule could be accelerated (e.g., 0, 2, 3, 4 and 5 years from inclusion) if deterioration rate is higher than anticipated. Alternatively, the timing interval between treatments could be increased (e.g., 0, 2, 5, 9 and 12 years from inclusion) if the condition of pavement remains stable. The need for change to the timing schedule will be identified by the LTPP Regional Support Contractors (RSCs). The RSCs will also address the associated changes in data collection and monitoring schedules.

The layout of the SPS-11 test sections within each core project is discussed in the next section. In addition to the core test sections, it is important to recognize that supplemental test sections are highly encouraged, and hence there may be more than the six SPS-11 core test sections at a given project site.

PROJECT LAYOUT

Uniformity along the length of the SPS-11 projects is critical to the success of the experiment; i.e., same traffic, pavement structure, subgrade, and drainage conditions. Lane widening projects with traffic entry/exit points within its length are not suitable for the experiment. An ideal LTPP test section is illustrated in figure 7. Each test section is 1,250 ft long, with a 500-ft lead in, 500-ft monitoring section, and 250-ft leave zones. Directly next to each end of the monitoring section are two 50-ft buffer zones where destructive material tests, such as cores and test pits, and traffic monitoring scales are prohibited. Next to the buffer zones are material sampling areas where destructive samples are allowed. The treatments applied to each test section must cover the entire designated test section length.

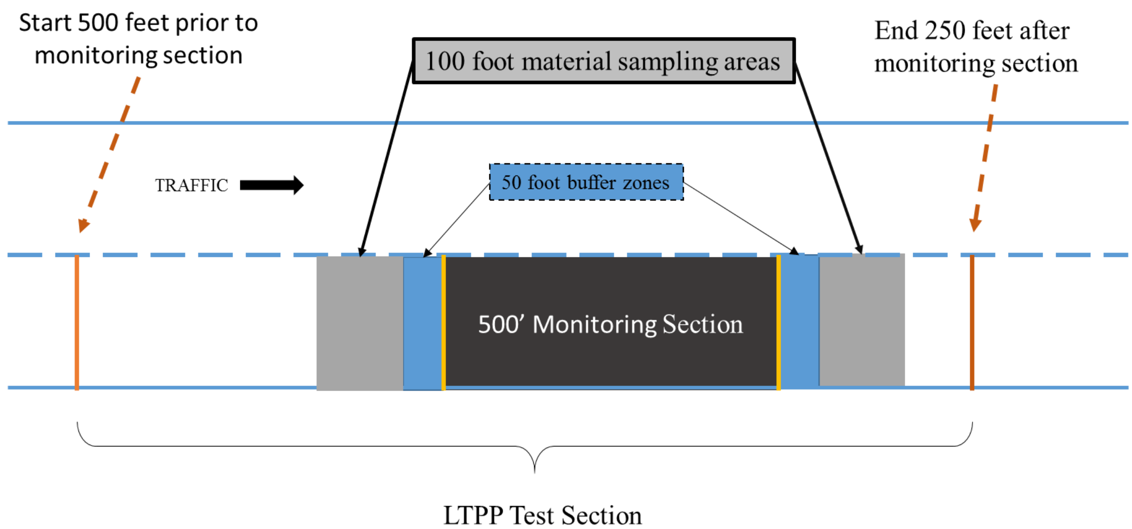

Figure 7. Illustration. Typical SPS-11 test section.

While the layout of test sections on a project site must be adjusted to site conditions, the rule of thumb is that about 1.5 mi of a relatively consistent pavement structure with little to no intersections, driveways, sharp horizontal curves, subsurface drainage features, bridges, speed limit changes, cut/fill transitions, vertical grades, or other features that could influence the performance of the test sections being studies is desired. This length could increase if agency specified supplemental test sections are proposed. In all cases, test sections are established in the outside lane for practical and safety reasons. A typical SPS-11 project layout (applies to all experiments) is shown in figure 8. This is labeled as a typical layout because the order of the test sections can be altered on a project, but the number of core test sections must remain the same.

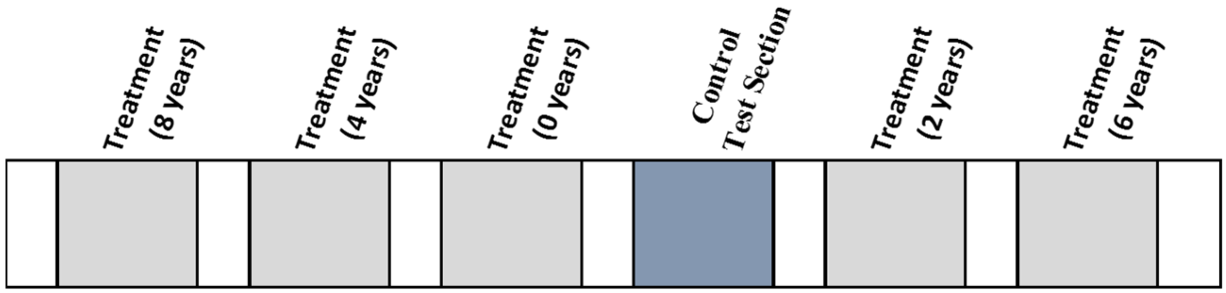

Figure 8. Illustration. Typical SPS-11T/11C/11M project layout: all experiments.

OTHER EXPERIMENTAL CONSIDERATIONS

Benefits to Participating Highway Agencies

The SPS-11 experiment, while being coordinated through the FHWA LTPP team, is to be conducted for SHAs. Therefore, the details of the experiment have been selected to address the needs of the highway community. However, the experimental rigor necessary to achieve the desired results requires that participating agencies agree to the same experimental factors and to construct the required test sections in a consistent manner. The statistical aspects of this experiment make the full cooperation of participating agencies crucial to its success. While all agencies will benefit from the information, knowledge and products that result from this research, participating agencies will accrue additional direct benefits. Since a portion of this research will be conducted in an agency's jurisdiction on test sections constructed using materials, specifications, and techniques employed by that agency and exposed to local climate and traffic loadings, participating agencies will be able to make direct use of the results.

The SPS-11 experiments will also allow SHAs the opportunity to quantify the performance differences associated with a given preservation treatment that depends on the timing of the application of the treatment, therefore addressing critical issues such as the right timing for the treatment and its associated benefits. In addition to these direct benefits, participating agencies will also receive ancillary benefits as a result of direct involvement in the experiment process including valuable insights and exchange of ideas through interaction with the FHWA team, researchers and highway personnel from other agencies.

Project Responsibilities

Participating Highway Agency

Participating highway agencies play a key role in the development and implementation of the SPS-11 experiment, including the following activities:

- Participation in experiment and implementation plans.
- Nomination of test sites.
- Provide inventory data for existing pavements.

- Preparation of plans and specifications.
- Selection of construction contractors.
- Materials sampling assistance, including coring and auguring activities.
- Conduct of JITT prior to construction of test sections.
- Construction of test sections.
- Construction control, inspection, and quality management.
- Installation of moisture tube for subgrade moisture measurements.
- Collection and submission of traffic data.
- Provide snow removal and deicing information.
- Provide traffic control for test site data collection.
- Assistance with collecting and reporting as-built construction data.
- Conducting and reporting of maintenance and rehabilitation activities.
- Test section signs and markings and maintenance of those signs and markings.

A more detailed description of the agency participation requirements is provided in the Project Nomination Guidelines presented in the next section. In addition, the long-term commitment required of participating highway agencies cannot be emphasized enough.

FHWA LTPP Team Responsibilities

The primary role of the FHWA LTPP team is to provide coordination and technical assistance to participating highway agencies to help ensure uniformity and consistency in construction and data collection to achieve the desired study results. Some of the activities the FHWA team will be responsible for include:

- Development of experimental designs.
- Coordination among participating agencies.
- Validation of in situ conditions at site, including GPR surveys that will be performed by a specialty contractor.
- Final acceptance of nominated test sites.
- Development of uniform data collection guidelines and forms.

- Coordinating and conducting of materials sampling and testing.
- Collecting and time-series reporting of as-built construction data.
- Periodic monitoring of pavement performance, including surface distress surveys, deflection testing and surface profile and texture surveys.
- Monitoring of subgrade moisture conditions.
- Collecting snow removal and deicing information from participating highway agencies.
- Support of SHA traffic data collection activities, including technical support and data quality reviews.
- Development and operation of comprehensive database and data entry platform.
- Control of data quality.
- Data analysis and reporting.

PROJECT NOMINATION AND ACCEPTANCE PROCESS

A comprehensive set of guidelines and accompanying forms were developed to support the SPS-11 project nomination process and that information is detailed in this section. The project nomination and acceptance process is coordinated between FHWA, the SHAs, the RSCs, and the Technical Support Services Contractor (TSSC). The project nomination and acceptance process for each SPS-11 project site consists of the following steps:

1. Highway agency reviews project requirements and nominates project site for inclusion in the study. Highway agencies are encouraged to contact LTPP RSC personnel to assist in the site selection process.
2. Highway agency fills out and submits project nomination form to FHWA LTPP staff; see appendix A.1 to this report.
3. FHWA LTPP staff reviews project site nomination and, if needed, contacts highway agency to resolve questions and issues. LTPP staff submits project site nomination and recommendation on acceptability of proposed project site to FHWA staff.
4. FHWA staff provides preliminary approval of project site and informs interested state highway agency.
5. On-site review and pre-acceptance testing (distress survey, deflection testing, profile survey, and GPR survey) are performed by LTPP staff (with traffic control support from highway agency) on project site that has received preliminary approval.
6. Adjustments to project site location details and final acceptability recommendation are made by FHWA LTPP staff.

7. FHWA staff make final decision on acceptance of project site and informs highway agency as to acceptability of project site.

Highway Agency Participation requirements

Highway agencies considering participating in the SPS-11 experiment must be willing to perform the following activities:

- Prepare plans, specifications, quantities, and all other documents necessary as part of the agency's contracting procedure. The agency must also provide construction control, inspection and management in accordance with their standard quality control and assurance procedures. LTPP RSC staff will be on-site during construction to collect construction documentation required by LTPP.

- Construct the test sections described in the SPS-11 experimental design document detailed in this chapter. This includes placing the same pavement preservation treatments at different times on test sections located at a project site. The treatments should also be applied across all adjacent lanes over the length of each test section in the direction of travel.

- Provide and maintain signing and marking of project site.

- Assist LTPP RSC staff with collecting and reporting project site information and construction data.

- Perform and/or provide for time-series drilling, coring and sampling of in-place pavement materials used in the test sections. Costs for this work are to be borne by the participating agency. LTPP RSC staff will be on site to perform sample logging and sample shipment. Testing of material samples will be performed by FHWA or its contractors.

- Provide traffic information. For an SPS-11 project site, a continuously operating permanent device for classification and weight data is required. This level of data collection is desired for two reasons: (1) to provide the accurate traffic loading measurements required to develop mechanistic and mechanistic/empirical design models and (2) to provide the base data necessary to understand the intricacies of the interactions among pavement, traffic load, and environment.

- Three years of continuous WIM traffic measurements followed by on-going vehicle classification measurements is required. The minimum recommended traffic data collection effort for each site is two weeks of continuous classification data, four times per year (a total of eight weeks of classification data per year). It is the agency's responsibility to ensure representative data is collected that accounts for seasonal variation, weekday/weekend differences, and inconsistent truck loading patterns throughout the year.

- When nominating a project location, consideration should be given to the location of existing WIM equipment. Sites where existing WIM equipment can be used to capture the traffic loading would allow for traffic data to be captured without the installation of additional equipment.

- Provide periodic traffic control for on-site data collection activities performed by agency and LTPP RSC staff, such as drilling and materials sampling, distress surveys, deflection testing, and other monitoring activities.

- Coordinate maintenance activities on the test sections to prevent application of premature treatments that alter the characteristics of the test sections and limit their use in the study.

- Notify LTPP RSC prior to the application of overlays or other such treatments when any of the test section reach an unsafe condition or become a candidate for rehabilitation. As much lead time as possible is needed to allow recording of the terminal condition of the test sections.

If highway agency personnel would like to discuss the details of these participation requirements, they should contact the LTPP RSC for their region. Again, the long-term commitment required of participating highway agencies cannot be emphasized enough.

Project Selection Criteria

The following criteria will be considered in evaluating candidate projects for inclusion in the SPS-11 experiment:

- Desired pavement structure is a structural AC overlay—defined as a new overlay layer that is greater than 2 inches thick and represents more than 30 percent of the thickness of the bound AC layers—of AC pavement constructed within the past 4 years, but consideration will be given to older overlays if they are in good condition. Also, preference will be given to pavements with a single AC overlay.

- No interlayers within the internal asphalt concrete layer structure are allowed. Interlayers include geotextiles, fabrics, stress absorbing membranes, and sub-surface open graded asphalt cement layers.

- The pavement surface should be in good condition. It should have no visible surfaces distresses, such as cracks or ruts, and no patches. In addition, ride quality, as measured by the IRI index, should be less than 80 inches/mi.

- The construction project must be of sufficient length to accommodate all of the experimental test sections. An ideal test section is 1,250 ft long, whereas a practical minimum is 800 ft long. Thus, the six cores test sections require a segment length between 1 to 1.5 mi, where the properties of the pavement along that length are as similar as possible in terms of layers types, layer thicknesses, drainage features, and subgrade. A longer length is needed if supplemental test sections are proposed.

- The surface of the project site pavement must be dense graded AC appropriate for the application of the experimental preservation treatment. Open graded friction courses, chip seals, micro-surfacing, and other such treatments, which would need to be removed prior to application of the experimental preservation treatment, are not appropriate. Such treatments would need to be removed for inclusion consideration in the SPS-11 experiment.

- Traffic flow should be uniform over the length of the project. All sections should carry the same traffic stream and be located in the same direction of traffic. Intersections, rest stops, on-off ramps, weaving areas, quarry entrances, etc., should be avoided on and between test sections on a project.

- Test sections should be located on portions of the project that are relatively straight and have a uniform vertical grade. Horizontal curves greater than 3 degrees and vertical grades greater than 4 percent should be avoided.

- The entire length of each test section should be located completely on either a cut or a fill. Cut-fill transitions or side hill fills should be avoided within the monitoring portion of each test section.

- Culverts, pipes and other substructures beneath the pavement should be avoided, but if required they should not be within the limits of the monitoring portion of a test section.

- Road sections with added lanes, added shoulders, or that have been widened are not desirable for the SPS-11 experiment.

- The project pavement must not have curb and gutter.

- The test sections must be located in the outside lane of the travel direction.

These criteria will help identify projects in which the relative performance of the test sections is due to the timing of the placement of the preservation treatments, and the influence of other factors such as changes in the existing pavement structure, subgrade, traffic patterns, and drainage characteristics is minimized.

Test section homogeneity is important to the success of the experiment. Construction history records, while valuable, often do not fully reflect the variability of in-service pavements. It is requested that the agency evaluate the homogeneity of potential projects prior to nominating them, and include the evaluation results with their submission. Tools to evaluate homogeneity include distress surveys, FWD testing, and GPR testing. As noted earlier, LTPP will also perform preconstruction tests on proposed sites to aid in determining test section locations and assessing the uniformity of the proposed site.

It is recognized that projects containing all of the desirable characteristics are not always readily available. Each candidate project site will be evaluated individually to determine the extent of compliance with the desired criteria and usefulness to the experiment. Deviations from the desired project characteristics may be necessary in order to obtain sufficient projects for the experiment. For example, projects will be considered where it is not possible to locate all of the test sections completely in either cuts or fills. In this case, it may be necessary to locate some test sections in cuts and others in fills. Also, on a project in rolling terrain, with limited distance between intersections, it may be necessary to locate a test section over a shallow cut-fill transition (less than 10 ft difference). Generally, engineering judgment will be used to evaluate the impact of such non-uniformities on test section performance.

The criteria presented in this section will be used to evaluate and rank candidate projects in cases where more than the required number of projects are available. They can also be used as a guide by a highway agency to identify candidate projects in their jurisdiction that are most suitable for nomination.

Special consideration will be given to projects sites that include test sections that are located near existing or previous LTPP projects or test sections as well as to those project sites that incorporate more than one SPS-11 experimental treatment treatments.

Candidate Project Nomination Forms

The forms and instructions provided in appendix A.1 should be used to complete a set of SPS-11 candidate project nomination forms. One set of forms is required for each SPS-11 project site being nominated.

CHAPTER 3. CONSTRUCTION REQUIREMENTS

This chapter addresses construction-related elements critical to the success of the SPS-11 experiment. The first of those elements is construction guidelines, checklists and JITT, which are critical to minimizing variability associated with the application of preservation treatments at a given project site over time as well as from one project to another, which could otherwise make analyses of the data more difficult and complex.

The second element addresses the construction-related data requirements, including those prior to construction, during construction, and after construction. The third and last element addresses the requirements associated with the construction reports for each SPS-11 project, which provide valuable information to users of the LTPP data.

CONSTRUCTION GUIDELINES

For those treatments included in the SPS-11 experiment, a combination of national and local specifications have been established. National specifications address general construction and workmanship requirements—e.g., thickness of thin AC overlays cannot exceed 1.0 inch and the aggregates used for these thin AC overlay should have a 3/8-inch nominal maximum size. Local specifications, on the other hand, pertain to specific construction and workmanship requirements—e.g., locally available asphalt and aggregates will be used for the thin AC overlays and agencies will control, as much as possible, material sources.

This section discusses the guidelines and specifications recommended for placement of the SPS-11 treatments. The guidelines address the many issues related to construction, workmanship, and construction specifications that can affect the outcome of the experiment. It includes not only the types of guidelines available, but also other considerations to minimize the variability of the treatments, which will be placed over time. To the extent possible, the guidelines and specifications presented in this chapter should remain the same over time.

Thin AC Overlays

Guidelines for construction of thin AC overlays will rely on the work by AASHTO, National Asphalt Pavement Association (NAPA) and NCHRP. [7, 8, 9] Thin AC overlays are the most commonly used preservation treatment for asphalt pavements. It is important that the SPS-11T experiment limit the number of variables as much as possible. Some of the factors to consider are listed below:

- Thin AC overlay generally consist of a layer that is up to 1.0 inch in thickness, but they could include conventional asphalt binder, polymer modified binder, rubberized asphalt binder or more. It will be important to limit the types of binders in the study to those normally used by the State in which they are placed.

- The aggregates used in the thin AC layers should be 3/8-inches nominal maximum size and meet the minimum agency requirements. Thin AC overlays at a given project will be placed at different times (approximately zero to 10 years after inclusion of project in LTPP program), which will introduce potential changes in binder and aggregate types, the paving contractor who places the product, and other factors. As such, it is important that the participating highway agency control the aggregate source, but it is unlikely that the agency will be able to use the same binder or contractor for subsequent applications of the thin AC overlay treatment.

- Tack coat used as well as type and extent of milling, if used, and effect of milling on surface texture.

It is anticipated that most agencies will use their own specifications for construction of the SPS-11T project test sections, but there are guidelines and sources of information that can be used to provide uniformity in the placement of this treatment. Table 6 summarizes some of these sources for guidelines and/or best practices. It is recommended that the agencies use Section 401 of the AASHTO Guide Specifications for Highway Construction and the FHWA Pavement Preservation check list, which can be found via the link provided in the referenced table. (10) It is critical to minimize the variability in the materials and the construction process to the extent possible.

Section 401 of the AASHTO Guide Specifications includes requirements for smoothness using either a straightedge or a profilograph. These specifications can be waived if the IRI is used in lieu of these requirements. Also, the price adjustment for smoothness in the AASHTO specifications can be waived.

Table 6. Summary of guidelines and/or best practices for thin AC overlays.

Agency	Title	Reference
AASHTO	Construction Specifications for Thin HMA, Section 401	2008 "Guide Specifications for Highway Construction," American Association of State Highway and Transportation Officials. AASHTO Construction Specification for hot mix asphalt, latest version (7)
NAPA	Thin HMA Overlays for Pavement Preservation	IS-135, National Asphalt Paving Association, 2009 (8)
NCHRP	Thin HMA Overlays	NCHRP Synthesis 464, Transportation Research Board, 2014 (9)
FHWA	Pavement Preservation Check List (PPC 103) for Thin HMA	FHWA/FP2, https://www.fhwa.dot.gov/pavement/preservation/ppcl00.cfm(10)

Chip seals

Chip seals (sometimes referred to as surface treatments or seal coats) can be use in a single treatment or double treatments. (See references 11 through 14.) The SPS-11C experiment will focus on the following:

- Single surface treatments of chip seal. Introducing other types of surface treatments will confound the experiment, unless they are project supplemental test sections adjacent to the core chip seal project test sections.

- A variety of binders can be used with these chip seals including conventional emulsions, polymer modified emulsions, rubberized asphalt, and asphalt rubber. The emulsions recommend for use in this experiment are those meeting the AASHTO specification for emulsified asphalt (AASHTO M140-16), cationic emulsified asphalt (AASHTO M-208-16), or polymer modified emulsified asphalt (AASHTO M-316-16). [15, 16, 17]

- A variety of aggregates can also be used in this experiment. Again, it is important to use aggregates meeting the AASHTO Materials Specifications for Chip Seals, which is scheduled to be published in the near future.

- The design of the chip seals should follow the AASHTO design practice which is scheduled to be published in the near future.

- A draft construction guide for chip seals was developed by the FHWA Expert Task Force (ETF) and is provided in appendix A.1. This guide will be updated as a part of NCHRP Project 14-37 Guide Specifications for the Construction of Chip Seals and Micro-surfacing, which began in 2016. It will not be available until 2018 or later. As a result, the construction guide in appendix A.1 is recommended for projects that are constructed before publication of the NCHRP Project 14-37 final report.

- To minimize the variability in the aggregates to be used in subsequent chip seal applications, the highway agency is encouraged to stockpile sufficient aggregate for the subsequent applications. It is likely that the same emulsion will not be used, but every attempt should be made to characterize the properties of the liquid emulsion and the residue from the emulsion to understand how the properties change during the subsequent treatments.

- It will be difficult to guarantee that the same contractor will perform subsequent applications of the chip seals. As such, highway agencies will need to ensure that the contractors are qualified and/or certified to perform work for the agency. JITT using qualified instructors will also be required prior to the placement of the treatments.

Most highway agencies will use their own specifications to construct the SPS-11C chip seal project test sections, but there are guidelines and/or sources of information that can be used to provide some uniformity in the placement of these treatments. Table 7 summarizes some of these sources for guidelines and/or best practices. The AASHTO specifications for materials and design should be defined as the minimum requirements for all chip seals. The FHWA ETF draft construction guidelines that are contained in appendix A.1 should also be used as minimum requirements. In addition, the FHWA pavement preservation checklist for chip seals should be used as the primary resource for the inspection by the agencies. [18] A link to this checklist is provided in the referenced table.

Table 7. Summary of guidelines and/or best practices for chip seals (aka surface treatments or seal coats).

Agency	**Title**	**Reference**
FHWA ETG	Draft Construction Specifications for Chip Seals	See appendix A.1
NCHRP	Best Practices for Chip Seals Guidelines for Construction Specification for Chip Seals and Micro-surfacing	NCHRP Synthesis 342, Transportation Research Board, 2005 [12]
Arizona Chapter of AGC	Chip Seal Guide for Application and Construction	Arizona Chapter AGC Pavement Preservation Series, December 2013 [13]
WSDOT	WSDOT-RD-841.1, Chip Seal Performance Measures-Best Practices	WA-RD 841, WSDOT, March 2015 [14]
FHWA	Pavement Preservation Check List (PPC 102) on Chip Seals	FHWA /FP2, https://www.fhwa.dot.gov/pavement/preservation/ppcl00.cfm [18]

Micro-surfacings

Micro-surfacing is normally used in a single treatment that is 1/4 to 3/8 inch thick. (See references 19 through 22.) The SPS-11M experiment will focus on the following:

- Single layer treatments. Introducing other applications of micro-surfacings, such as part of a cape seal, could confound the study. Cape seals or other treatments could be used as a part of the project supplemental test sections.
- The emulsions recommend for this experiment should meet the 2016 AASHTO specification for emulsified asphalt (AASHTO Designation M140-16), cationic

emulsified asphalt (AASHTO Designation M208-16), or polymer modified emulsified asphalt (AASHTO Designation M318-14). [15, 16, 17]

- A variety of aggregates could be used in this experiment. Again, it is important to use aggregates meeting the 2016 Materials Specifications for Micro-surfacings (to be published in the near future).

- The mix design procedure to be used should conform to the procedure outlined in the AASHTO Design Practice for micro-surfacing (to be published in the near future).

- To minimize the variability in the aggregates to be used in subsequent applications, interested highway agencies will be encouraged to stockpile sufficient aggregate for the subsequent applications. It is likely that the same emulsion will not be used, but every attempt should be made to characterize the properties of the liquid emulsion and residue from the emulsion to understand how properties change during subsequent treatments.

- It will be difficult to guarantee that the same contractor will perform the subsequent applications of the micro-surfacing, so the agency will have to ensure that the contractors are qualified or certified to perform work for the agency.

Most highway agencies will use their own specifications to construct the SPS-11M project test sections, but there are guidelines and/or sources of information that can be used to provide some uniformity in the placement of these treatments. Table 8 summarizes some of these sources for guidelines and/or best practices. The new AASHTO specifications for materials and design should be the minimum requirement for all micro-surfacings. The FHWA ETF draft construction guidelines that are contained in appendix A.2 should also be used as minimum requirements. The FHWA Pavement Preservation check list given in the link in the referenced table should be followed as a minimum for inspection guides. [18]

JUST IN TIME TRAINING (JITT)

Contractor and Highway Agency Training

Training on the construction of the various treatments is essential to the success of the SPS-11 experiment. While many of the treatments have been placed for many years, the quality of the finished product depends on good construction practices and having good quality control programs for the contractors as well as a well-defined inspection program for agency personnel.

Where available, AASHTO guidelines for construction should be used in the JITT program and the FHWA inspection checklists should be used as training guides for the agency personnel to ensure that the products are placed in the most appropriate manner.

Quality contractors are also a must to ensure the placement of good treatments. Low bid contracts can result in contractors that do not place quality treatment. Every effort should be made to ensure that the contractors that are placing the treatments over time are certified and can place a quality product. If possible, all contractors should be certified in placing these treatments.

Table 8. Summary of guidelines and/or best practices for micro-surfacing.

Agency	Title	Reference
FHWA ETF	Construction Specifications for Micro-Surfacings, Section 401 (pending)	See appendix A.2
NCHRP	NCHRP project 14-37, Guidelines for Construction Specification for Chip Seals and Micro-surfacing	NCHRP Synthesis 411, Transportation Research Board, 2005 (19)
ISSA	Inspectors Manual for Slurry Systems	ISSA, 2010 (20)
Arizona Chapter of AGC	Micro Surface and Slurry Seal Guide for Application and Construction	Arizona Chapter AGC Pavement Preservation Series, December 2013 (21)
FHWA	Pavement Preservation Check List (PPC 005) on Micro-Surfacing	FHWA/FP2 https://www.fhwa.dot.gov/pavement/preservation/ppcl00.cfm (22)

The training will be the responsibility of the participating agencies and it should be included in the contract price for placing each of the treatments. This will be the simplest and best approach for including the cost of the training.

Delivery

All training should be conducted by a qualified instructor or instructors just prior to the construction of the treatments. The contractor and highway agency inspectors should attend this training. It is recommended that the training take place over a period of 2 to 4 hours for each treatment.

It is important that the instructor or instructors be qualified to deliver training for each of the treatments. It may involve someone from a highway agency and/or a contractor who has been qualified prior to the training. The approval of the training staff will have to be discussed at more length before a recommendation can be made as to their selection.

CONSTRUCTION DATA REQUIREMENTS

A key component of achieving the objectives of the SPS-11 experiment is to develop and execute a construction monitoring plan capable of tracking and collecting the construction data for the selected pavement preservation treatments. The guidelines for collecting construction data and the periodic collection of monitoring data are described in this section. Detailed construction information (in text as well as tables and figures) are to be collected including, at a minimum, the following elements:

- Construction documents pertaining to the project. This will include the following (if available):
    - Plans, Specifications, and Special Provisions.
    - Strip charts during production.
    - Mix designs for all SPS-11 treatments.
- Work activity dates, including pre-overlay work such as patching, crack sealing, and mill work, and any overlay work.
- Description of hot mix equipment on site (and at plant) used for thin AC overlays. Information should be included for the hot mix plant and the pavement equipment. Hot mix plant information should include the type of plant used, description, and the location, along with hauling distance and haulers. Information for the paving equipment should include the paver used, the pick-up machine, and the rollers and number of passes. For the chip seal and micro-surfacing projects, the equipment used such as the boot trucks, aggregate applicators, rollers, sweepers, along with the hauling distance and haulers as well as the paving equipment for the micro-surfacing.
- Detailed materials information should include the aggregate source, aggregate properties, as well as the number of stock piles used.
- Field QC test results performed by the agency or contractor. This should also include:
    - Daily log of activities/equipment/weather.
    - Daily field notes from personnel on-site.
    - Section by section details including lift thickness for the treatments, paving widths, density, detailed temperature information at plant and laydown, ambient temperature, temperatures during paving, compaction effort and any construction issues or problems.
    - For the chip seal and micro-surfacing projects, application rates need to be document at the end of each day.

- Copies of the layouts from the MS&T Plan. This will include a copy of the "as-sampled" layout from the MS&T Plan used in the field and the original designed MS&T Plan, with any differences noted between the two plans.

Much of the construction data collected will be recorded by the LTPP RSCs with support from the participating agencies in the construction data sheets provided in appendix B.2. The remaining construction data collected will be included in construction reports to be prepared by the LTPP RSCs in accordance to the guidelines provided in the next section. Again, construction data are important information to assess the effectiveness of pavement maintenance. [(3)]

The SPS-11 data sheets include items for identifying general project and section specific attributes, as well as many layer and material specific items. The construction data sheets listed in table 9 were developed for the SPS-11 experiment. These data sheets and the instructions for completing them are included in appendix B.2. Supplemental sections may contain treatment types for which the SPS-11 data sheets are not adequate to record the necessary information about these treatments. For these sections, additional data sheets from the "LTPP Maintenance and Rehabilitation Guide," addressed under LTPP directive, should be used to supplement the SPS-11 data sheets. This guide contains further information on which sheets are appropriate for each construction event type.

SPS-11T Thin AC Overlay

The construction related data required for the SPS-11T thin AC overlays projects are presented in table 10. Multiple references could be utilized when developing thin AC overlay projects. (See references 3 and 7 through 10.) The collected data are grouped in three categories: before construction, during construction, and after construction.

SPS-11C Chip Seals

The construction related data required for SPS-11C chip seal projects are presented in table 11. Multiple guidelines or references could be utilized when developing chip seal projects. (See references 3, 11 through 14 and 18.) The collected data are grouped in three categories: before construction, during construction, and after construction.

SPS-11M Micro-surfacing

The construction related data required for the SPS-11M micro-surfacing projects are presented in table 12. Multiple references could be utilized when developing a micro-surfacing project. (See references 3 and 19 through 22.) The collected data are grouped in three categories including before construction, during construction, and after construction.

Table 9. List of LTPP SPS-11 data sheets and titles.

LTPP SPS-11 Construction Data Sheet Number	LTPP SPS-11 Construction Data Sheet Title
LTPP SPS-11 Data Sheet 1	Project Identification
LTPP SPS-11 Data Sheet 2	Project Stations
LTPP SPS-11 Data Sheet 3	General Information
LTPP SPS-11 Data Sheet 4	Layer
LTPP SPS-11 Data Sheet 5	Age and Major Improvements
LTPP SPS-11 Data Sheet 6	Snow Removal/Deicing
LTPP SPS-11 Data Sheet 7-8	HPMS Data Items
LTPP SPS-11 Data Sheets 9-11	AC Aggregate Properties
LTPP SPS-11 Data Sheet 12	AC Binder
LTPP SPS-11 Data Sheet 13	AC Binder Aged
LTPP SPS-11 Data Sheet 14	AC, DSR, BBR, Direct Tension
LTPP SPS-11 Data Sheet 15	Reclaimed Asphalt Pavement (RAP)
LTPP SPS-11 Data Sheets 16-17	PMA Lab Mix Design
LTPP SPS-11 Data Sheet 18	PMA Lab Mix Design Warm Mix
LTPP SPS-11 Data Sheets 19-20	PMA Mix Properties
LTPP SPS-11 Data Sheet 21	Superpave Mixture Properties
LTPP SPS-11 Data Sheets 22-23	PMA Construction
LTPP SPS-11 Data Sheets 24-25	Unbound
LTPP SPS-11 Data Sheets 26-27	Subgrade
LTPP SPS-11 Data Sheet 28	QC Measurements
LTPP SPS-11 Data Sheet 29	Field Thickness
LTPP SPS-11 Data Sheet 30	Notes and Comments
LTPP SPS-11 Data Sheet 31	Improvement Listing
LTPP SPS-11 Data Sheet 32-33	Chip Seal Application
LTPP SPS-11 Data Sheet 34-35	Micro-surfacing Application

Table 10. Construction data collection for thin AC overlay.

Before Construction	During Construction	After Construction
• Plans, Specifications, Special Provisions • Pre-overlay conditions • Pre-overlay surface preparation sketch • Mix design • Mix properties • Aggregate type, gradation, and other properties • Asphalt binder grade and properties • Asphalt modifiers • MSDS sheets • Construction schedule	• Daily construction logs from the contractor and engineer • Surface preparation work • Daily construction log from contractor and engineer • Weather data • Equipment log • Field QC results • Construction issues • Type of plant, hauling distance, haulers • Road surface moisture condition • Construction process, tack coat, compaction effort • Mix temperatures • Longitudinal and transverse joints • Surface smoothness	• Surface smoothness • Annual precipitation information • Any snow removal/deicing information

Table 11. Construction data collection for chip seals.

Before Construction	During Construction	After Construction
• Plans, Specifications, Special Provisions • Pre-treatment conditions • Surface preparation sketch • Chip seal design (emulsion, aggregate application rates) • Emulsion type and properties • Aggregate type and properties (gradation, quality, cleanliness) • Embedment depth • Rock retention using the Vialet test • Equipment calibrations • MSDS sheets • Construction schedule	• Daily construction logs from the contractor and engineer • Weather condition - temperature, humidity, wind, cloud • Surface condition—clean, moisture, pavement temperature, initial existing surface preparation • Binder/emulsion application rates, temperature • Uniformity of binder application, any streaking • Curing time • Aggregate spreading rate o Uniformity of aggregate application o Aggregate cleanliness o Moisture condition of aggregate o Roller type, operation speed, number of coverages • Finished surface- condition, rock loss, embedment depth • Any construction issues	• Surface smoothness • Annual snow removal/deicing information • Annual precipitation information • Pavement condition assessment • Chip rock loss

Table 12. Construction data collection for micro-surfacing.

Before Construction	During Construction	After Construction

• Plans, Specifications, Special Provisions
• Surface condition prior to application
• Surface preparation prior to treatment
• Mix design (emulsion, aggregate, mineral fillers, chemicals, etc.)
• Emulsion type and properties
• Residual asphalt content
• Aggregate properties (Type, gradation quality, cleanliness)
• Equipment calibrations
• MSDS sheets
• Construction Schedule
	• Daily construction logs from the contractor and engineer
	• Weather condition - temperature, humidity, wind, cloud
	• Surface condition—clean, moisture, pavement temperature, initial existing surface preparation
	• Aggregate condition—cleanliness, moisture
	• Tack coat—type and application rate
	• Proper emulsion temperature
	• Mixing quality
	• Any construction issues
	• Application rates of mix
	• Residual asphalt content and field wet track abrasion test (WTAT)
	• Surface conditions
	  ○ Mix is even and consistent
	  ○ Surface has an even and uniform texture
	• Times between spreading, foot traffic, and opening to traffic
	• If roller is used, the type, weight, and speed of roller
	• Brooming should not dislodge the micro-surfacing
		• Surface smoothness
		• Annual snow removal/deicing information
		• Annual precipitation information
		• Pavement condition assessment
		• Amount of shedding of rock

CONSTRUCTION REPORTS

A lesson learned from construction of the SPS-1 through -10 experiment projects is the importance of having project-specific construction reports. Further, having standardized report elements helps the entire pavement community in comparing projects to one another and to the original experiment design. Accordingly, guidelines for what should be included in each SPS-11 construction report were developed.

Construction reports for all projects accepted into the SPS-11 study will be prepared by the LTPP RSCs following the guidelines contained in this chapter. Because of the time-based approach to the experiment, an initial construction report will be completed after the initial application of a preservation treatment, in accordance with the guidelines presented in this chapter. The report will then be updated, as appropriate and as needed, each time a project test section receives application of the preservation treatment under investigation at the site. Special attention will be given to ensuring that test section specific information is clear for all test sections in the project. Both the original and updated construction reports will be provided to FHWA for review and comment.

Report Specifications

All reports will be prepared in accordance with the FHWA Communications Reference Guide (CRG). These documents are considered as research reports and will follow the guidelines contained in chapter 5 of the CRG for Research Reports. A Times New Roman 12-point font will be used for all text. Contractors' names may not appear in the report, except in block 9 of the Technical Report Documentation Page (form DOT F 1700.7). Contractor logos should not appear at all, and paid consultants should not be acknowledged anywhere else in publication.

The following list provides the required elements for each SPS-11 Construction Report:

- Front Cover.
  - Front cover.
  - Inside front cover (R&D Foreword and Disclaimer Notice).
- Front Matter.
  - Technical Report Documentation Page (Form DOT F 1700.7).
  - SI/Metric Conversion Chart.
  - Table of Contents (preferably auto-generated using the MS Word Style feature).
  - List of Figures (preferably auto-generated using the MS Word Style feature).
  - List of Tables (preferably auto-generated using the MS Word Style feature).
  - List of Abbreviations and Symbols.
- Body of Report.
  - Chapter 1: Introduction.
  - Chapter 2: Project Description.
  - Chapter 3: Construction Details.
  - Chapter 4: Summary.
  - Chapter 5: Key Observations.
- Back Matter.
  - Appendix A: Construction Photographs.
  - Appendix B: Mix Designs.

  - Appendix C: Materials Sampling and Testing Layouts.
  - Appendix D: Other Construction Documents.
  - Appendix E: Complete Set of SPS-11 Construction Forms.
  - Appendix F: Deviation Report (if any).
- Back Cover (blank).

The minimum contents for each element of the report are described next.

Front Cover

The front cover page will use the current LTPP research report cover design. RSCs will obtain the current cover format from their LTPP Contract Officer Representative at the start of creation of each construction report. The title of the construction report will include the official reference and title of the SPS-11 study, name of participating highway agency, short name for project location and other elements required by the FHWA CRG.

Front Matter

The front matter will include the latest Technical Report Documentation Page (Form DOT F 1700.7), SI/metric conversion chart, table of contents, list of figures, list of tables, and abbreviations and symbols.

Body of Report

The body of the report will contain the following chapters, in the specified order, whose content will include the following elements as a minimum, but can also include other information of significance based on the RSC's judgment.

Chapter 1: Introduction

The following overview will be included in the introduction of each SPS-11 Construction report.

General Overview of SPS-11 Study

Pavement preservation is a technology that has been around for many decades and it has been proven, mostly anecdotally, to be an effective approach to extend pavement's effective service life, improve safety and service condition, and is cost-efficient. Given the current economic environment, most highway agencies are embracing pavement preservation, which utilize more cost-effective techniques to better serve the public.

Because pavement performance is at the heart of the pavement preservation decision-making process, provision of long-term performance data on in-service pavement test sections where controlled application of pavement preservation treatments are monitored is the motivation for the LTPP experiment titled the SPS-11: AC Pavement Preservation Study. The objective of the

SPS-11 experiment is to establish the impact of timing of preservation treatments on pavement distress propagation rates, which will enable determination of their impact on pavement life extension and performance. In turn, this information and understanding will enable determination of the right timing and cost-effectiveness of preservation treatments.

The SPS-11 experiment is intended for test sections not previously in the LTPP program. As such, all construction activities, materials properties, and sampling over the entire history of the roadway on which the test sections are located will be documented in this report.

Specific Project Summary Overview

Included in the introduction of the construction report will be a summary overview description of the project that includes, as a minimum, the following basic information:

- Location details that include route designation, direction of travel, and Highway Performance Monitoring System (HPMS) functional classification.
- Existing pavement structure and history of pavement construction events at the site.
- Total number of experimental test sections constructed.
- Types of preservation treatment(s) used.
- Agencies standard preservation treatment specifications for the project site.

Report Organization

A brief description of the report organization will be included to provide a summary of the report sections/chapters and their respective contents. For example:

- Chapter 2 of this report gives the project location, description, and other attributes of the project.
- Chapter 3 describes the materials and construction procedures for each layer and then continues to the detailed construction sequence and operations.
- Chapter 4 provides a summary of the test section construction.
- Chapter 5 contains a documentation of the key observations.
- Appendix A contains a collection of construction photographs from the project.
- Appendix B contains the treatment requirements for each section.
- Appendix C contains the materials sampling and testing layouts.
- Appendix D contains construction documents including the plans, specifications, mix designs and special provisions of the project; strip charts during production; project

related correspondence; and daily logs and field notes of activities, equipment, and weather.

- Appendix E contains the SPS-11 Construction Forms.
- Appendix F contains the Deviation Report (if any).

Chapter 2: Project Description

The project description will include basic information on the project with the use of text as well as tables and figures. It will serve as an introduction to the specific SPS-11 experiment. Project information will contain, at a minimum, the following:

Test Section Layout

Include one or more figures that show the test section layout, stationing, transition areas, pavement layers, intersections, ramps, driveways, bridges, subsurface drainage features, nearby bodies of water, etc.

Physical Attributes

The report should include the physical attributes of the project (i.e. project location, surrounding terrain, road geometry, existing pavement condition, etc.). The highway, interstate or state route, the nearest township/city, and the Global Positioning System (GPS) coordinates will be described. A figure of the location of the project on a map will be included. Also included should be the immediate terrain (rolling hills, flat, etc.), embankments, cuts, side-slope cut/fill, cut/fill transitions, etc. The description of the pavement should include structure, layers, maintenance and rehabilitation history, shoulder types, lane and shoulder width, horizontal curves, pavement cross slope, super-elevation transitions, vertical grades, and condition. The existing pavement condition should also be included; condition will be presented in terms of distresses, transverse profile, longitudinal profile, and texture at each test section location.

Climate

Summary climate statistics will be presented for the project location that include as a minimum:

- Average annual precipitation.
- Average annual freeze index.
- Annual hours of sunshine.
- Average annual relative humidity.
- By month, average daily high air temperature, average daily low air temperature, average precipitation, average snowfall, average relative humidity and hours of sunshine.
- The location of the climate statistics.

Traffic

To provide a brief overview of the traffic conditions of the project, a table should be used to describe the AADT of the project site in each direction. The table should also include the percent of heavy trucks and combination vehicles in the LTPP test lane. Finally, the table should include the estimated cumulative 18,000 ESALs and the design traffic data for the project, which may include 18K ESAL applications, traffic load spectra, assumed growth rates, etc. If load spectra traffic data are available, they will be described in this section and included in an appendix.

The traffic monitoring measurement plan during the performance observation period will be described in as much detail as possible. The plan should indicate the type of monitoring equipment, equipment location, sampling time intervals, calibration details, and other information that will assist in proper interpretation of the resulting traffic monitoring data.

Supplemental Test Sections

Sponsoring agencies have the opportunity to expand the experiment to address their own interests and concerns as well as to incorporate innovative technology through the construction of supplemental test sections. If supplemental test sections are included in the project, a brief overview will be included that includes all of the information noted for the core test sections.

Project Personnel

The project personnel involved should be noted, including personnel from the governing agency and construction contractor(s). The agency should be noted along with the personnel from the project including the resident engineer for the project, the assistant resident engineer, the inspector(s) and their responsibilities, the field sampling and testing crew, and others involved with the coordination and execution of the project. The prime contractor should be noted along with the project manager and construction superintendent. Also included with the prime contractor should be the subcontractors, if used, and the aspects of the project they were tasked with, respectively. When possible, include pictures of project personnel in a report appendix, but only with the permission from the personnel involved. The figure title will identify people in each picture.

Project Timeline

A project timeline will be presented, which documents the date and time of significant events in the implementation of the project site. Such events include as a minimum:

- Dates of preconstruction distress, profile, and deflection measurements.
- Date of start of associated construction activities as it relates to each test section.
- Traffic closure.
- Pre-treatment construction activities including patching, shoulder restoration, maintenance actions, etc.

- Quality control tests.
- Start and finish of treatment application activities.
- Traffic opening date/time.
- Dates and time of material sampling including cores, bulk materials from mix plant, etc.

Chapter 3: Construction Details

Detailed construction information—in text as well as tables, figures, and pictures—will be provided including, at a minimum:

- Work activity dates, including pre-treatment work such as patching and crack sealing.
- Description of equipment on-site (and at plant). Information should be included for the hot mix asphalt plant and the pavement equipment. Hot mix asphalt plant information should include the type of plant used, description, and the location, along with hauling distance and haulers. Information for the paving equipment should include the paver used, the pick-up machine, and the rollers and number of passes.
- Detailed materials information (full mix designs should be included in appendix B) should include the aggregate source and the number of stockpiles used.
- Field QC test results performed by the contractor.
- Acceptance testing performed by the agency.
- Section by section construction details including construction issues or problems.

All pictures will include global coordinates and timestamps in the electronic metadata stored in the electronic picture file.

Chapter 4: Summary

The summary chapter will be an overview of key project details and construction activities. It will note the number of LTPP test sections within the project, the highway, interstate or state route number, and the nearest city where the project was located. A brief recap of each section's attributes will also be included. Attributes to include will be pavement thicknesses, preservation treatment used, and pre-treatment preparation activities performed. Also included will be the project's beginning construction date and ending construction date. Finally, any construction issues encountered will be included, with a more detailed description included in chapter 5.

Chapter 5: Key Observations

This chapter will capture noteworthy observations by test section. It will also document issues encountered during construction, including, but not limited to equipment breakdowns, weather and/or material variability, experiment deviations, or other details that may be important to understanding the resulting performance of the experimental test sections.

Back Matter

This part of the report includes the appendices.

Appendix A: Construction Photographs

Appendix A will contain photos of each section before, during, and after application of treatment. Photographs of the treatment application operation will also be contained in this appendix. All pictures will include GPS coordinates and timestamps in the electronic metadata stored in the picture file.

Appendix B: Treatment Requirements

Appendix B will contain complete treatment information and requirements for the project (core and supplemental).

Appendix C: Materials Sampling and Testing Layouts

Appendix C will contain copies of the layouts from the MS&T plan. This will include a copy of the "as-sampled" layout from the MS&T plan used in the field and the original/design MS&T plan, with any differences noted between the two plans.

Appendix D: Other Construction Documents

Appendix D will contain other construction documents pertaining to the project. This will include the following (if available):

- Plans, specifications, mix designs, and special provisions.
- Strip charts during production.
- Project related correspondence.
- Daily log of activities/equipment/weather.
- Other available construction information.
- Daily field notes from personnel on-site.

Appendix E: SPS-11 Construction Forms

Construction data for the SPS-11 experiment include primarily items related to the preservation treatment technologies and their application. Copies of the construction data forms and notes collected for the project will be contained in this appendix.

Appendix F: Deviation Report

Include the deviation report, if applicable.

CHAPTER 4. MATERIALS SAMPLING AND TESTING PLANS

A material sampling and testing plan must be developed for each project to characterize the unique engineering properties of the paving materials and the pavement structure on all experimental test sections constructed. The materials sampling and testing plan must be designed to quantify material variations between test sections. The criteria for selecting test section locations requires that all test sections at each site have the same structural cross section and be constructed of the same materials under the same contract. To accommodate likely deviations from this and other established criteria, the test plan must be devised so that all known or suspected variations can be properly characterized. Generally, variability of the subgrade will be determined during the site selection process and should be a prime consideration in development of the final sampling and testing plan for the site. Plan and profile sheets and other soils information can help determine the location of cut/fill sections and possible variations in subgrade materials.

Detailed instructions and guidelines for developing and implementing MS&T plans are provided in this chapter. The chapter also addresses new MS&T protocols that are not presently in use by the LTPP program, but which are important to the success of the SPS-11 experiment.

MATERIALS SAMPLING AND TESTING OVERVIEW

The following is the general process to be used to obtain and report the necessary materials information from SPS-11 projects:

- Review of project site layout and soil profile logs. Variations in the subgrade material, embankments, or other materials related pavement features should be identified.

- Formulation of a field materials sampling and test plan. This plan should take into account site conditions and the laboratory material testing requirements. An adequate number of samples must be obtained to assure that all laboratory material characterization tests can be performed, as well as to provide additional samples for storage in the MRL.

- Development of a field sampling plan report. This report should specify sampling area locations, type and number of material samples from each location, and include a tracking table that specifies all tests and testing sequence to be performed on each sample. This report should be submitted to the FHWA for review prior to implementation.

- Development of field sampling and testing protocols for all materials. All field tests and sampling must be performed in accordance with LTPP standard protocols and reported on standard LTPP data forms, which are contained in appendix B.3.

- Testing of material samples in the laboratory. All tests must be performed in accordance with LTPP test protocols and reported on standard LTPP data forms. Because the SPS-11 experiment involves new materials tests or protocols, these protocols are included in appendix C of this report.

- Compilation and storage of data. This will include compilation of field sampling, field testing and laboratory material test data and entry of this data into a LTPP database.

The primary objective of the materials and sampling and testing plans is to identify the sample needs and tests to support the LTPP SPS-11 pavement preservation effort. As such, it includes materials and sampling and testing for the following SPS-11 experiment situations:

- Prior to construction.
- During/post construction of the treatments.

It also includes information dealing with the requirements for sampling for the MRL, including the necessary labeling and shipping requirements for the samples.

Finally, information describing the laboratory sampling and testing of the existing pavement materials and the preservation treatments used for the SPS-11 experiment is also described. The remainder of this chapter covers the following:

- Sampling requirements.
- Test methods including LTPP protocols.
- Identification of new tests to be used as a part of this study.
- Sample handling, labeling and storage procedures.

MATERIALS SAMPLING AND TESTING REQUIREMENTS

The SPS-11 test sections will consist of pavement preservation projects on existing asphalt pavements. Coring and auguring must be used to obtain samples of the existing materials. Sampling of existing pavement materials can be performed prior to placement of the preservation treatments. Sampling of the preservation treatments will take place during the construction of the treatments, and additional testing will occur at various time periods after construction.

Preconstruction

The objective of the preconstruction sampling and testing is to characterize the material properties and subsurface condition of the existing pavement structure prior to application of the experimental treatments. The scope of the existing field material sampling and testing to be performed on SPS-11 projects includes the following:

- Layers to test.
- Sampling plan.
- Testing protocols.

Layers to Test

This section discusses the layers of the existing pavements to test for the SPS-11 projects.

Subgrade/Embankment

- Bulk sampling of the subgrade for material classification tests.
- Dynamic Cone Penetrometer (DCP) testing.
- Shoulder auger probe for sampling.

Base Layers

- Visual material classification.
- Bulk sampling for material classification tests.
- Layer thickness measurements.
    - From cores of bound base.
    - From auger holes in unbound base.
- DCP testing.

Existing AC Layers

- Cores for thickness measurements.
- Cores for laboratory testing.

Overall Pavement Structure

- FWD/GPR to establish the structural condition of the pavement sections.
- Drainage survey to determine if water could be a problem within the sections.

The specifics of the location and amount of samples, field tests, and laboratory tests to be performed, are presented in the remaining portion of this chapter.

Sampling Plan

In developing the field sampling plan for a SPS-11 site, it is imperative that a sufficient type and amount of samples be obtained to ensure completion of all test procedures as well as to provide additional samples for storage in the MRL. Therefore, a laboratory testing plan always needs to be tailored for specific site conditions in concert with the field material drilling and sampling plan. The plan needs to 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 chapter. 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 the supplemental test sections.

The site-specific field material sampling, field testing, and laboratory testing plan for each SPS-11 site should include the following elements:

- Project layout plan.
- Detailed material sampling layout.
- Detailed field testing layout.
- Laboratory testing plan.

The field sampling plan is 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 for each material layer, layouts must be developed for each layer (i.e., prepared subgrade, base course, surface course, and/or overlay).

Figure 9 illustrates an overview of the sampling areas to be used in developing a site-specific plan. This figure shows an ideal project location where all six defined test sections in the core SPS-11 experiment plan are located on a site that has uniform geomorphic characteristics along the entire test site. In this ideal example, all test sections are located on a consistent cut or fill, no cut/fill transitions occur between or within test sections, and no significant subsurface drainage structures exist. In this idyllic project overview, three types of sampling areas are identified:

- Type 1 sample areas. These are basic sample areas within the pavement test lane, where a minimum number of cores are obtained in order to measure the thickness of bound layers, perform bulk specific gravity tests on AC layer samples, and perform DCP test at selected locations.
- Type 2 sample areas. These are the sample areas designated for sampling of enough materials from the existing pavement structure to allow pavement materials characterization tests to be performed. This is in addition to the tests specified for the Type 1 sampling areas. On an idyllic project with relative uniform site characteristics, only three Type 2 sampling areas are required for the six core test sections.
- Shoulder probes. The intent of the shoulder probe is to auger down to approximately 20 ft below the surface to discover near surface rigid layers, water tables, and locations to obtain sufficient subgrade samples to minimize repair requirements for subgrade samples obtained from cores through the pavement surface. Where a project location includes both cut and fill test sections, adequate samples of the underlying subsurface pavement structure and documentation of subsurface features will be obtained.

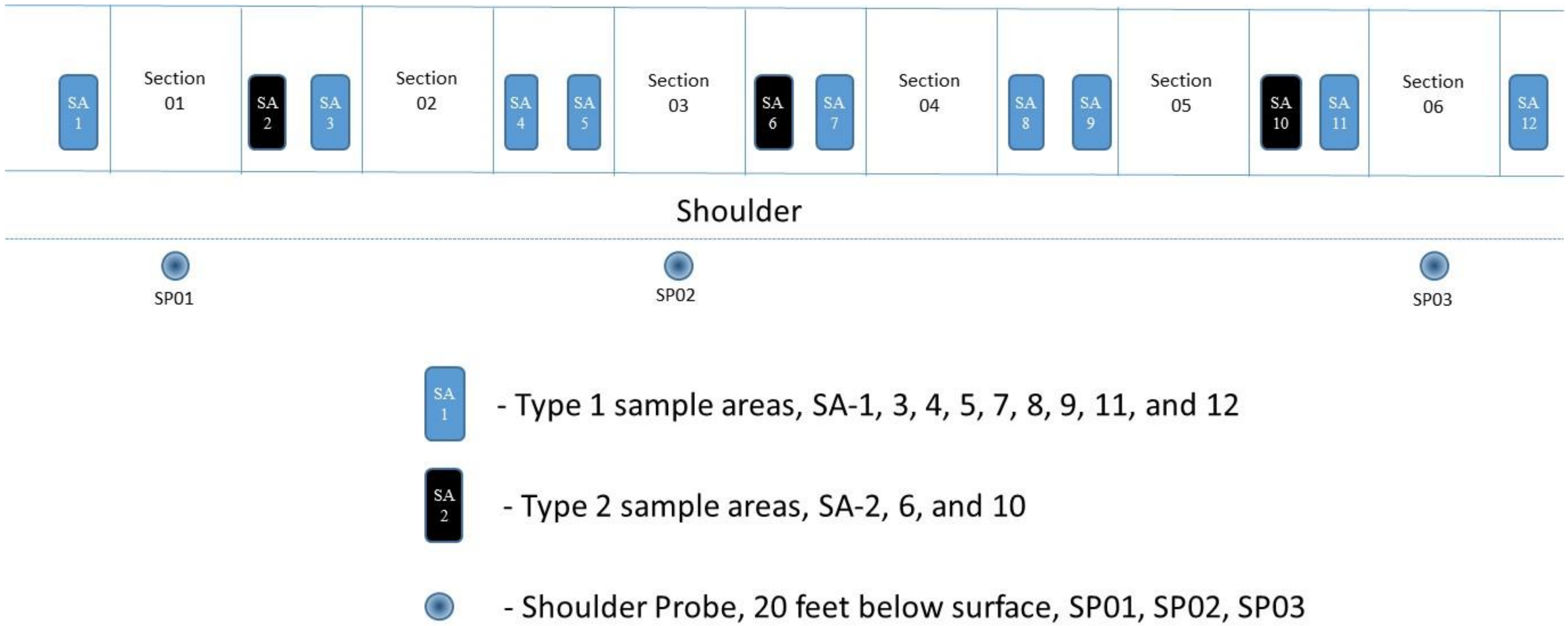

Figure 9. Illustration. Overview of SPS-11 project level sampling areas.

In situations where the idyllic situation of uniformity along the project site does not exist, more samples should be taken to provide a proper representation of the project site for intensive pavement performance research analysis.

Figure 10 and figure 11 illustrate the sampling requirements on the existing pavement structure at Type 1 sampling areas on the approach and leave side of a test section, respectively. Only two 4-inch nominal diameter cores are required in Type 1 sample areas prior to construction in order to provide basic information on bound layer thicknesses, bulk specific gravity measurements on AC layers, and access to unbound layers for DCP testing. If needed, 6-inch cores for DCP test locations may be used if the DCP test equipment requires a core hole greater than 4-inch diameter. In these figures, example LOC_NO locations are specified that link to tables showing material test requirements for each sample. Example sample numbers are not included in these tables since more than one testable sample of an AC layer can be obtained from a single core location.

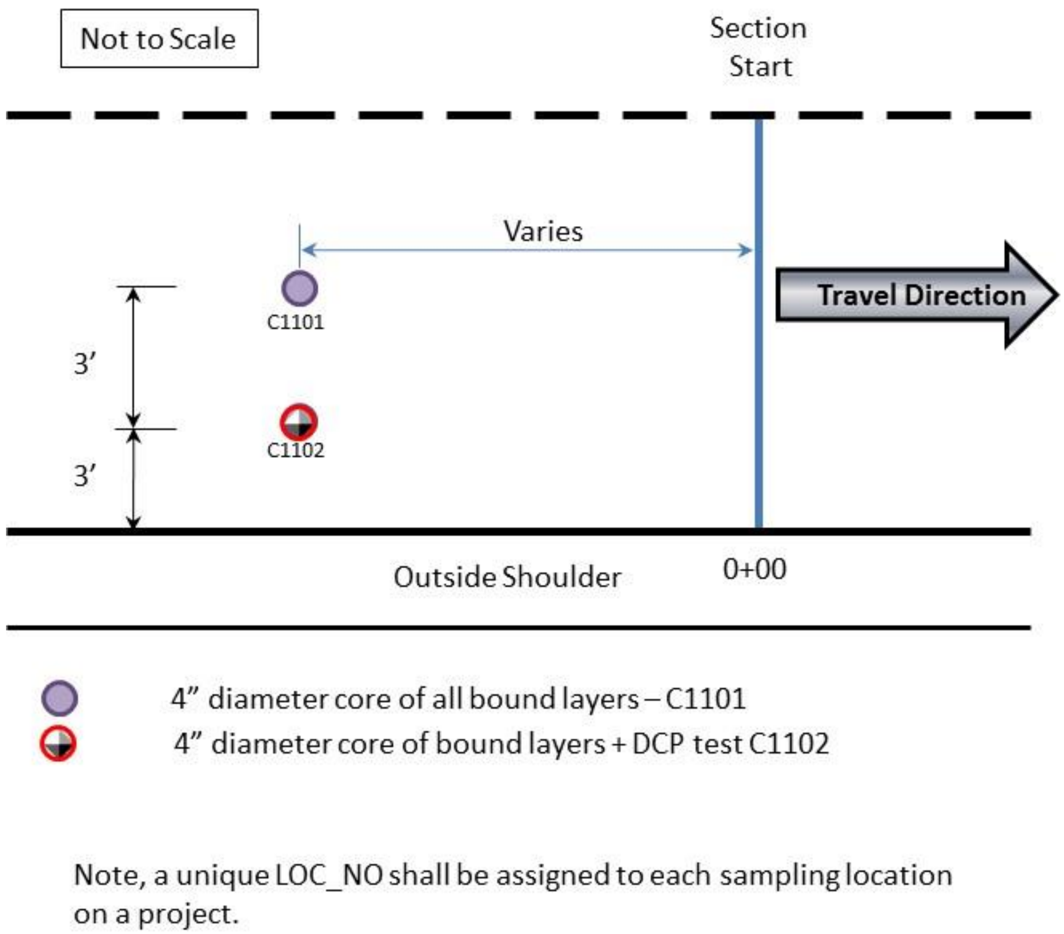

Figure 10. Illustration. Example sampling locations on approach side of test sections in Type 1 sampling areas.

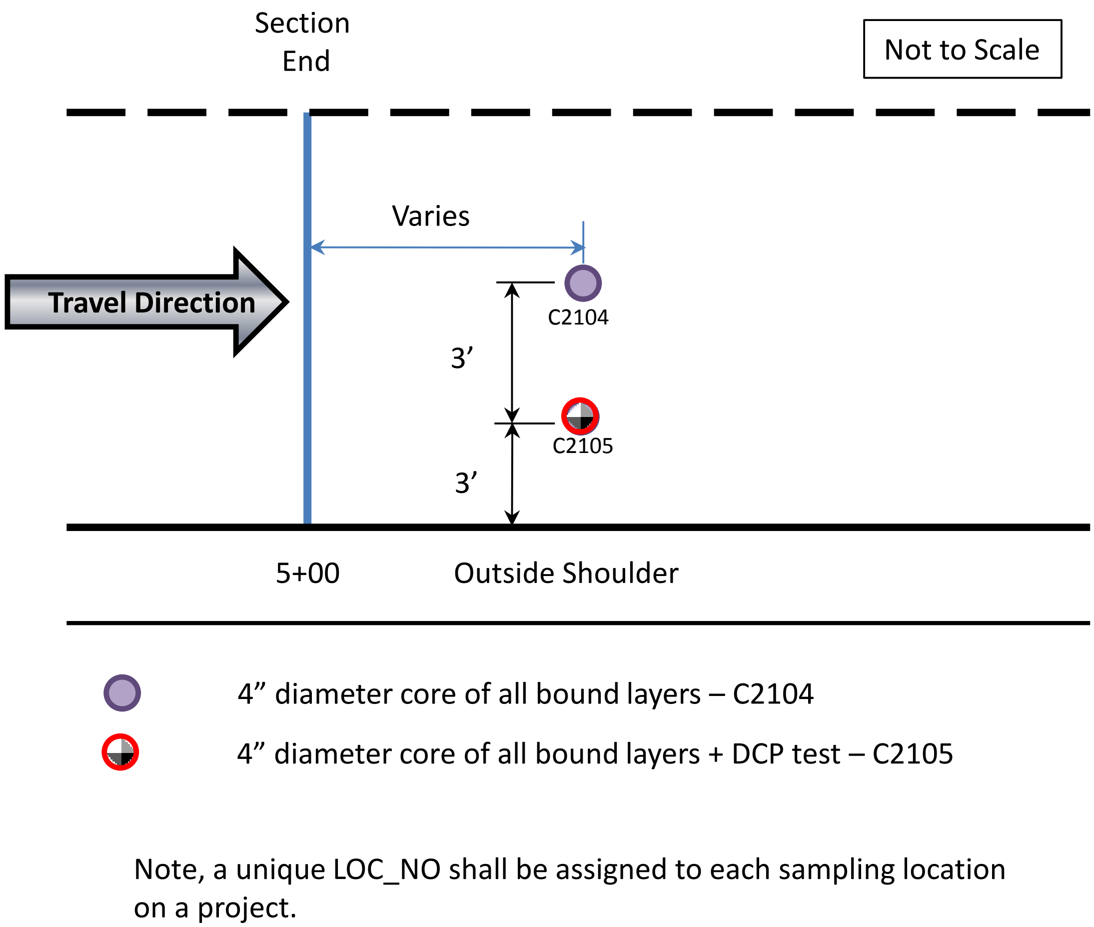

Figure 11. Illustration. Example sampling locations on leave side of test sections in Type 1 sampling areas.

Figure 12 illustrates the typical sampling requirements at Type 2 sample areas. Type 2 sample areas are purposefully designated on the leave side of a test section in order to lessen the impact of destructive core locations on longitudinal profile measurements and to reduce possible induced dynamic loads from heavy trucks on the monitoring portion of the test section. In figure 12, the three 6-inch diameter cores are specified for Asphalt Mixture Performance Test (AMPT). While it is possible to obtain two AMPT samples from each 6-inch diameter core, three cores are being specified at this time in order to allow for contingencies related to acquisition of unsuitable cores for this lab test. The extra material left over from the 6-inch diameter cores that are not suitable for AMPT testing can be used in the extraction process to obtain a large enough sample of asphalt cement. Aggregates extracted from the 6-inch diameter cores used for AMPT testing will not be mixed with those from other core samples, since the AMPT sample extraction process results in further aggregate size reduction that can influence the results of the aggregate size analysis.

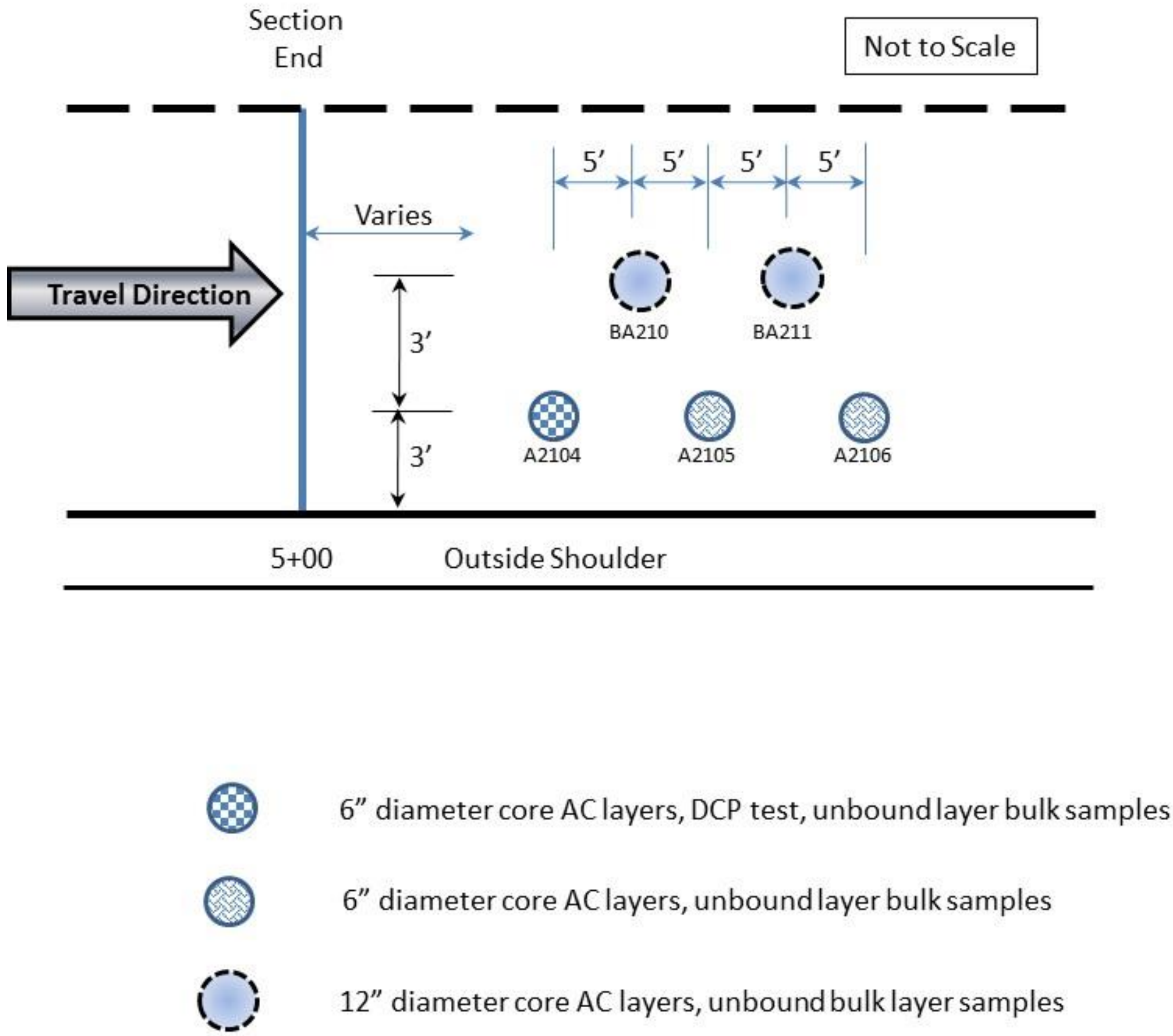

Figure 12. Illustration. Example sampling locations for Type 2 sampling areas.

In addition, sample tracking tables specifying the sequence of tests to be performed on each material sample are needed. Other items that may be included with the 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 FHWA prior to implementation.

To ensure consistency in data reporting, a detailed pavement 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. These layer structures may need to be revised based on information gained through sampling and testing. The RSC will have personnel on site during sampling activities who are familiar with the development of the plan, and who can make changes to the plan and data collection forms as well as to the layer numbering based on their observations. This will limit the need to re-sample any materials and allow assignment of

LAYER NO while in the field. An example project level layer numbering is shown in table 13 for a newly constructed SPS-11 project.

Table 13. Example project layer numbering scheme.

Project Material Code	Layer Code	Material Description
A	104	Natural Soil
B	107	Embankment
C	303	Dense Graded Aggregate Base
D	319	Dense Graded Asphalt Treated Base
E	01	HMA Existing Binder Course
F	01	HMA Overlay Surface Course

The first issue in developing a layer numbering scheme is the designation of subgrade and embankment material. If a project or test section is located on fill material, then the project layer numbering will contain an embankment layer. It must be noted that if a fill (embankment) layer is present and is greater than 4 ft in thickness, the natural subgrade will NOT be sampled or tested. Only the fill (embankment) layer will be sampled and tested as if it were the natural subgrade. Since this can vary over the extent of a test site, the sampling plan will also be tailored to site conditions based on an initial site inspection visit prior to developing the sampling and testing plan. Shoulder augur probes are used to supplement samples of subgrade materials obtained through core holes in the existing pavement and to investigate subsurface conditions such as rigid layers and near surface water table depths.

The layering for the bound and unbound bases and subbases is rather straight forward. However, if any test section is located on a treated subgrade layer, this is considered a treated subbase layer in the project layering table. Sampling in the transition areas at the beginning and end of the test section, along a project site, should be done to establish the variability in these materials.

The AC 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 AC layer is comprised of a surface and binder course which has different mix composition (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 in AC layers will not be identified as separate layers.

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 of the proper procedures to be used to perform this layering activity can be found in chapter 5 of the latest version of the *Long-Term Pavement Performance Project*: *Laboratory Material Testing and Handling Guide*.[23]

Material Sampling and Test Requirements

All testing will follow the LTPP test protocols for testing the various layers in the pavement structure. This section identifies the types of tests to be used for the various layers in the SPS-11 experiment. Subsurface layers are all layers in the pavement structure beneath the existing pavement surface prior to placement of the experimental treatment layers. Subsurface layers will be sampled and tested according to their material type.

Subgrade

The subgrade is the natural soil under the pavement structure. This is always designated as Layer 1. An embankment is fill material placed on top of the naturally occurring subgrade. If the embankment layer is greater than 4 ft thick, the embankment material should be sampled and tested in accordance with the instructions contained in this document for subgrade. In this situation, samples or tests are not required to be performed on the subgrade beneath the embankment layer. If the thickness of the embankment varies beneath the test section, engineering judgment of the regional engineers must be used to decide if sample material classification tests should be performed on samples from both the subgrade and embankment layers. Treated subgrade should be classified and treated as a subbase layer for materials sampling and testing purposes.

Bulk Samples

Bulk samples should be obtained for each project subgrade layer. If the subgrade layer is uniform throughout the project, only three subgrade samples are required. If the subgrade layer is found to be different for each section, additional samples will be needed. Bulk samples of the subgrade should be obtained by auguring through six, 12-inch core holes in type 2 sampling areas, or shoulder augur probe locations, depending on conditions at each test site.

If these locations are impractical, an alternate location within the sampling area should be selected, taking care not to disturb areas designated for subsequent sampling. The depth of auguring should be 4 ft below the top of the natural subgrade or fill embankment material directly beneath the base and/or subbase layers. If rock, boulders or other forms of dense material are encountered within 4 ft of the top of natural subgrade or fill, another attempt for sampling the subgrade will be made at a different location with a longitudinal offset at least 2 ft. If rock, boulders or refusal is encountered at the second location, sampling will be terminated. The sampling operation should be performed following the procedures contained in the *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. [23] Each subgrade bulk sample should consist of a minimum of 150 lb of material. The bag will include a jar sample of the material for moisture content measurements. The jar sample will be placed in the bulk sample bag prior to the bag being tied shut.

Laboratory Testing

Laboratory tests to be performed on subgrade materials are shown in table 14, which includes the size of sample needed. All tests are to be performed using the indicated LTPP test protocol.

Dynamic Cone Penetrometer

DCP testing must be performed on the unbound layers of each test section. DCP testing is to be performed starting on the surface of the uppermost unbound layer. As a minimum, DCP test should be performed at one location per test section, using one of the cores in the outer wheelpath. Testing is performed in accordance to LTPP Protocol P72 of the *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. (23)

Table 14. Subgrade testing.

Sample Type / No. of Samples per Test	Sample Location	Test Type	LTPP Designation	Min. No. of Tests for each project layer[1]
150 lb Sample	All A, BA and SP locations as appropriate	Sieve Analysis	SS01	3
		Atterberg Limits	SS03	3
		Classification	SS04	3
		Standard Proctor	SS05	3
		Resilient Modulus[2]	SS07	3
1 qt. Mason Jar		Natural Moisture Content	SS09	3

Note 1: Minimum number of tests per project layer.
Note 2: If Resilient Modulus cannot be run, an alternate method such as using back calculation can be used.

Unbound Base Layers

Base and subbase layers composed of unbound materials should be sampled and tested following similar guidelines as those used for subgrade. These samples will be obtained from similar locations as subgrade samples. In the field, the thicknesses of these layers need to be determined in-situ, preferable through direct measurement from large diameter augur holes. The material tests are those required for classification, moisture density tests, and resilient modulus.

Bulk Sample

Bulk samples should be obtained for each project base and/or subbase layer. If the layer is uniform throughout the project, only three samples are required. If the layer composition is found to be different for each section, additional samples will be obtained by auguring through the 12-inch or 6-inch core holes. Sample combination may be needed to acquire the minimum of 150 lb of material for each of the three sampling areas.

Laboratory Testing

Laboratory testing to be performed on unbound base/subbase layers is shown in table 15. All of these tests are LTPP standards.

Thickness Measurement

The thickness of base layers must be obtained from inspection and measurement of the auger borings from A-type or BA-type auger sampling locations.

Table 15. Base/subbase testing

Sample Type / No. of Samples per test	Location Number	Test Type	LTPP Designation	Min. No. of Tests per project layer[1]
150 lb Sample	BG010XX	Sieve Analysis	UG03	3
		Classification	UG08	3
		Atterberg Limits	UG04	3
		Standard Proctor	UG05	3
		Resilient Modulus[2]	UG07	3

Note 1: Minimum number of tests per project layer.
Note 2. In lieu of Resilient modulus test, back calculated modulus for these layers could be considered if regional contractor performs satisfactory backcalculation from FWD test results.

Bound (Treated) Base Layers

Cores of bound base layers should be obtained. Depending on the type of bound material, the laboratory test will either be AC01 and AC08 (AMPT) for high quality asphalt concrete base material, or TB01 for other types of bound bases. At least three tests should be performed per project layer; however more are desired to capture thickness variations. Laboratory testing requirements are shown in table 16.

Table 16. Bound base testing.

Sample Type	No. of Samples per Test	Sample Location	Test Type	LTPP Designation	Min. No. of Tests per project layer[1]
6” Core	1	All 6-inch diameter cores	Examination & Classification	TB01 or AC01	3
6” Core	3	All 6-inch diameter cores used for AMPT testing	AMPT Dynamic Modulus	AC08	3

Note 1: Minimum number of tests per project layer.

Existing HMA Layers

The required laboratory testing for each AC type layer is shown in table 17. Additional cores may be necessary to obtain sufficient quantities of existing AC layers to perform required tests.

During and Post Treatment Construction

The during/post construction phase of material sampling is defined as the time starting with placement of each pavement preservation treatment and ending one month after placement of each treatment. The post treatment sampling extending one month beyond the day of construction is limited to test sites receiving thin AC overlays, where it is not practical to obtain cores the same day after final compaction of the overlay has been completed. All other material sampling and field tests will be performed on the day each experimental treatment is placed on a test section site.

Table 17. AC layer testing at Types 1 and 2 sampling areas.

<table>
<tr><th colspan="2">Sample Type / No. of Samples per test</th><th>Sample Location</th><th colspan="2">Test Type</th><th>LTPP Designation</th><th>Min. No. of Tests by project layer[1]</th></tr>
<tr><td rowspan="3">6-inch Core</td><td rowspan="3">3</td><td rowspan="3">All cores</td><td colspan="2">Core Exam. and Thickness</td><td>AC01</td><td>9</td></tr>
<tr><td colspan="2">Bulk Specific Gravity</td><td>AC02</td><td>9</td></tr>
<tr><td colspan="2">AMPT Dynamic Modulus (requires 3 cores per sample location)</td><td>AC08</td><td>3</td></tr>
<tr><td colspan="2" rowspan="8">12-inch Cores (or 4 x 6” Cores)</td><td rowspan="8">All cores</td><td rowspan="4">Mix</td><td>Core Exam. and Thickness</td><td>AC01</td><td>6</td></tr>
<tr><td>Max Specific Gravity</td><td>AC03</td><td>3</td></tr>
<tr><td>Extraction[2]</td><td>AC04</td><td>3</td></tr>
<tr><td>Abson Recovery</td><td>AE01</td><td>3</td></tr>
<tr><td rowspan="3">Extracted Binder</td><td>Dynamic Shear Rheometer (DSR)</td><td>AE07</td><td>3</td></tr>
<tr><td>Bending Beam Rheometer</td><td>AE08</td><td>3</td></tr>
<tr><td>Multiple Stress Creep Recovery</td><td>AE10</td><td>3</td></tr>
<tr><td>Extracted Aggregate</td><td>Gradation</td><td>AG04</td><td>3</td></tr>
</table>

Note 1: Minimum number of tests per project layer.
Note 2: Left over materials from 6-inch cores used for AMPT test can be used to create test samples on extracted binder.

Types of Tests and Sampling Plan

Thin AC Overlay (1-inch thick)

The types of tests to be included in this study include those on:

- Mixes.
- Binders.
- Aggregates.

For the mixes, in-situ density testing should be conducted on the finished bituminous surface layer. This testing is to be performed at the specified locations as shown in figure 13 using AASHTO T310-11, backscatter method. (24) Each testing location will have four readings with the density instrument rotated 90 degrees between each reading.

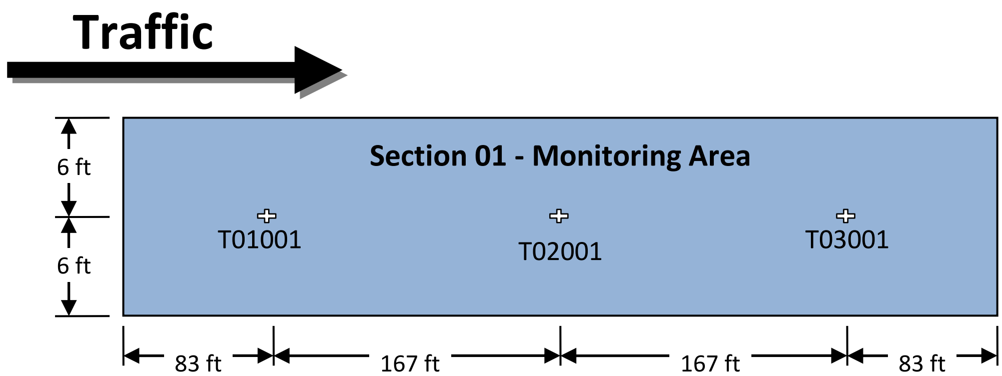

Figure 13. Illustration. In situ density/moisture measurements using nuclear density/moisture gauge for a typical section.

It is also recommended that two nuclear gauges be available at the test site. One will serve as a stand-by in the event the primary test gauge becomes inoperative or is of questionable accuracy. Nuclear testing will 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 will be followed.

Cores from each thin experimental overlay AC surface layer mixture used on the SPS-11 projects will be needed for layer thickness, bulk specific gravity and aging tests on underlying AC layer. For the test section receiving the thin overlay treatment during each construction event, two 4-inch cores from each end of the test section are required as shown in figure 14. These 4-inch cores should be obtained, preferably on the day of placement, after final compaction has been completed, or within 30 days of placement.

The coring operations will be carried out in accordance with AASHTO T 24M/ T 24-15. (25) 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. The cores will be dried before packaging. The pavement may be cooled by dry-ice or other means prior to coring if necessary to obtain cores of suitable quality. Full depth cores may be broken in the field to retrieve only the layer of interest as long as the sample is not unduly disturbed. Otherwise, cores of multiple layers will be wrapped and shipped as a single core.

Bulk samples of binder, aggregate and AC mix used for the thin overlay will be used to perform binder, aggregate, and mix characterization tests. These samples will be collected separately each time a new thin overlay is placed. Tests to be performed on the virgin AC binder are shown in table 18. Tests to be performed on unmixed aggregate are shown in table 19. Tests on uncompacted bulk sample of AC mix are shown in table 20. The quantities of the binder are also included in the table 18. It is also recommended that tests be performed on the aggregate used in the mix as shown in table 19.

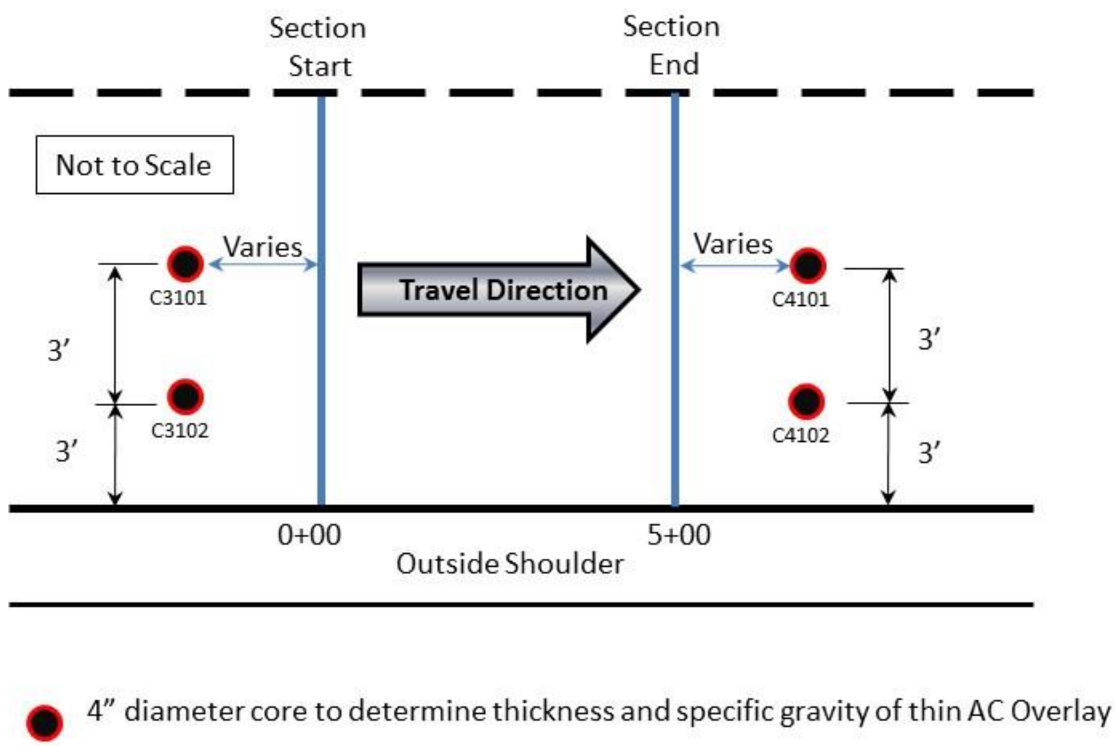

Figure 14. Illustration. Location of 4-inch cores of thin overlay on test section receiving thin overlay during each construction treatment.

Table 18. Virgin AC binder tests for thin HMA.

Sample Type	Test Type		Test Designation	Min. Number of Tests
1 gallon can	Original	Specific Gravity	AE03	1
		Dynamic Shear Rheometer	AE07	1
	Original + RTFO[1]	Dynamic Shear Rheometer	AE07	1
		Multiple Stress Creep Recovery	AE10	1
	Original + RTFO + PAV[2]	Dynamic Shear Rheometer	AE07	1
		Bending Beam Rheometer	AE08	1

Note 1: RTFO—Rolling thin film oven
Note 2: PAV—Pressure aging vessel

Table 19. Aggregate tests for thin HMA.

Sample Type	Test Type	AASHTO Test Designation	Min. Number of Tests
5 gallons	Gradation	T 27	1
	Sand Equivalent	T 176	1
	Micro-Deval Abrasion Test	T 327	1
	Durability	T 96	1
		T 104	1

Table 20. Tests on uncompacted AC mix sample.

Sample Type	Test Type		Test Designation	Min. Number of Tests
5-gallon bucket of uncompacted mix	Mix	Max Specific Gravity	AC03	1
		Extraction	AC04	1
		Abson Recovery	AE01	1
	Extracted Binder	Dynamic Shear Rheometer	AE07	1
		Bending Beam Rheometer	AE08	1
		Multiple Stress Creep Recovery	AE10	1
	Extracted Aggregate	Gradation	AG04	1

For the thin AC overlay sections on an SPS-11 project, table 21 summarizes the bulk samples to be taken during construction and for shipment to the MRL or FHWA. If the project includes supplemental sections, the sampling and testing plan will need to be modified by the RSC.

Table 21. Samples to be taken during thin overlay construction.

Sample type	Quantity	Sampling method	Destination of the sample	Comments
Bulk samples of the uncompacted AC mix	Four 5-gal buckets	AASHTO T 168	MRL	Sampled on site
Bulk samples of the combined aggregate	Three 5-gal buckets	AASHTO T 002	MRL	Sample obtained from the plant
Bulk virgin AC binder	Five 1-gal cans	AASHTO T 40	MRL	Sampled from the plant
Bulk virgin AC binder	Two 1-qt cans	AASHTO T 40	FHWA-TFHRC	For AE-11 testing

Chip Seal

The same tests used for the SPS-3 experiment will be used in the SPS-11 chip seal projects. They include tests for application rates, tests on the emulsions, and tests on the aggregates.

The RSC will collect samples of the materials during construction. These will be marked, packaged, and sent express mail to the Regional testing lab and the MRL. The emulsions will have to be tested within 21 days, otherwise their properties will change. Sampling of the materials for chip seals are summarized in table 22.

Table 22. Sampling and testing for chip seal materials.

Materials/Tests	ASTM Test Method	AASHTO Test Method	Quantity of Materials Needed
Emulsion tests	D 2397	T 59	1 gal
Emulsion residue	D 244	T 59	
Softening point	D 36	T 53	
Penetration at 77°F (25°C)	D 2397	T 49	
Aggregate sand equivalent	D 2419	T 176	5 gal
Aggregate soundness	C 88	T104	
Aggregate abrasion resistance	C 131	T 96	
Aggregate gradation	C 136 or C 117	T 27 or T 11	
Application rates	Not a standard	Not a standard	In field

Micro-surfacing

Since micro-surfacings were not used in the SPS-3 experiment, it is recommended that the International Slurry Surfacing Association (ISSA) tests be used for the SPS-11 experiment including tests on the emulsions, tests on aggregates, and tests for application rates of emulsions, additives, and aggregates.

The sampling and testing plan is summarized in table 23; however, the emulsions need to be tested within 21 days of construction or the results will not be meaningful.

Table 23. Sampling and testing requirements for the micro-surfacing experiment.

Materials/Tests	ASTM Test Method	AASHTO Test Method	Quantity of Materials Needed
Emulsion tests	D 2397	T 59	1 gal
Emulsion residue	D 244	T 59	
Softening point	D 36	T 53	
Penetration at 77°F (25°C)	D 2397	T 49	
Aggregate sand equivalent	D 2419	T 176	5 gal
Aggregate soundness	C 88	T104	
Aggregate abrasion resistance	C 131	T 96	
Aggregate gradation	C 136 or C 117	T 27 or T 11	
Application rates	Not a standard	Not a standard	In field

New Tests Needed

New test methods to be used in the SPS-11 experiment are identified in this section. These new test protocols are included in appendix C to this report.

Chip Seal

For the SPS-11 test sections involving chip seals, the tests described in the 2016 AASHTO chip seal materials specifications and the design practice will be used. These procedures had not been published at the time of preparation of this report, but it is expected they will be published in the near future. The materials specifications include the tests recommended for the emulsions, while the design practice includes tests to design the application rates to be used for the chip seals.

For construction monitoring, the tests recommended include measures of application rates, embedment depth, and field Vialit. [26, 27] Though the Vialit test is more appropriate for hot applied chip seals, it has also been used with emulsion chip seals and should be used in SPS-11 supplemental test sections. The test procedure is given in appendix C.3; the RSCs will be responsible for conducting the field Vialit test.

Micro-surfacing

For the SPS-11 test sections involving micro-surfacings, the tests described in the 2016 AASHTO micro-surfacing materials specifications and the design practice will be used. These procures will be published in the near future. The materials specifications include the tests recommended for the emulsions, while the design practice includes tests to design the application rates to be used for the micro-surfacings.

For construction monitoring, it is important to test behind the paver for residual asphalt and at the end of each test section for application rates, including emulsion, aggregate, cement, and additives. Procedures for doing this are given in the ISSA publication. [20]

AC Aging—All SPS-11 Projects

Since two of the beneficial mechanisms thought to be provided by thin overlays, chip seals, and micro-surfacing are retardation of aging in the structural AC layer and reduction of moisture infiltration to unbound layers, it is desired to test these two factors over time.

To test aging of the existing structural AC layer, a new micro sampling approach developed at the Western Research Institute (WRI) will be used which requires small samples of the surface of the existing AC pavement structure that can be obtained using a hammer drill outfitted with a vacuum sample retrieval apparatus. The sample is then tested in the DSR to determine how much aging has taken place.

During each construction event, one sample, from each end of all test sections located on a project should be obtained from the sampling areas. For the treated sections, small holes can be made with hammer drill to expose the underlying pavement surface. For the thin overlay sections, small cores may be needed to access the underlying pavement surface. The extracted asphalt from the top of the underlying asphalt will be used to assess the effect of the aging of the existing pavement. [28] This test method is discussed in more detail later in appendix C.1.

FIELD MATERIALS SAMPLING

This section describes procedures and guidelines for field materials sampling, field testing and 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 sampling and handling techniques.

Personnel Requirements

The scope, intensity and time constraints imposed on the field coring 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, completing the necessary data sheets and forms, and performing the necessary testing. It is recommended that the field crew include a qualified and experienced on-site project supervisor who is experienced with LTPP sampling procedures and data collection and reporting requirements. This supervisor should be a senior technician, geologist, or engineer with experience in subsurface explorations and pavement field sampling and testing. This person must be familiar with all aspects of the LTPP drilling and sampling program, field coring and sampling techniques and the timing of all field activities.

Field Operations

Field operations at each SPS-11 project site will include the following activities:

- Prior to construction, the LTPP RSC should establish a joint field team with the participating highway agency to coordinate the conduct of the activities involved in the coring and sampling operations. RSC personnel will be assigned to assist the participating highway agency and contractors to ensure that field operations are performed in accordance with the proper procedures and the field sampling and testing plan, and to perform all necessary written documentation.

- The joint field team will lay out the project site, mark initial sample locations and perform the sampling and testing operations. It is important to follow the sequence of boring as specified in the sampling plan to reduce the risk of mixing the samples at the site. Core or auger locations that are considered unacceptable should be replaced with alternate locations and marked on an as-sampled layout plan.

- The LTPP field representative will record, report, and resolve problems encountered during the field operations.

- Test samples will be prepared for shipping together with complete logs and other records.

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 samples be packaged carefully. The samples will be packaged and preserved in accordance with Group B of ASTM D4220 - 95(2007). [(29)] Extreme care must be taken in packaging and shipping of test samples to eliminate damage to the samples or modification of 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 will be used for marking labels.
- Labels and tags will be of high quality moisture resistant material. It is recommended that labels be color coded to indicate the destination of the sample (e.g., contract Lab, FHWA Lab, MRL, etc.).
- Samples of portions of auger and bulk samples of materials to be used for laboratory moisture content determination will be plastic lined cloth or heavy plastic and sealable against moisture loss or gain by wire-ties. Mason jars adequately sealed against moisture loss or gain may also be used for this purpose.
- Bags for large bulk samples will be heavy cloth, plastic lined with wire-ties for closing.
- Cores will 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 2 inches wide).

Sampling Location Designations

Sample locations for every sample taken must be unique throughout project. Sampling locations are designated on the LTPP forms and materials sampling plans with the following code format:

S-LL-XX

Where,

S = Sample location type:
A—6-inch diameter core and/or auger locations
C—4- or 6-inch diameter core locations
BA—12-inch diameter core and/or auger locations
B—Bulk sample location
F—field bulk HMA sample (uncompacted bulk mix obtained on site)
T—nuclear density/moisture gage
H—Samples obtained from the HMA plant
AD—Distributor or applicator equipment
TR—Delivery Truck

LL = Sample location number: two-digit sample number assigned sequentially to each location of the same type. Only a single location number is necessary for on-site, non-roadway bulk sampling locations (AD, TR).

XX = Section number: two-digit designation for test section number (e.g., 01, 02, and 03). This makes the sample location unique to that test section. For bulk samples not collected on site, use the first section number to which the materials apply.

Examples of valid sample location numbers are provided in table 24.

Table 24. Examples of valid sample location numbers.

Code	Detail
A0203	A-type core location 02 from Test Section 03.
C1003	C-type core location 10 from Test Section 03.
TR0101	Delivery truck for Test Section 01.
H0101	HMA Plant 1 used for the project for Test Section 01.

The samples from each sample location are assigned a sample number as described in the next section.

Sample Code Number

Each sample (core, bulk, moisture, compacted) will be assigned a sample code designation that must be recorded on the appropriate data forms. Sample numbers for every sample taken must be unique throughout the project. The sample number will consist of the following format:

S-M-##-XX

Where,

S = Sample type:

C—core sample
B—bulk sample
M—moisture sample

M = Material type:

A—Asphalt concrete
C—Portland cement concrete
T—Treated, bound, or stabilized base/subbase
G—Untreated, unbound granular base/subbase
S—Subgrade soil or fill material
U—Aggregate
E—Emulsified asphalt

= Sample number: up to a two-digit sample number assigned sequentially to each sample with the same sample type and material type.

XX = Section number: two-digit designation for test section number (e.g., 01, 02, and 03). This makes the sample location unique to that test section. For bulk samples not collected on site, use the first section number to which the materials apply.

Examples of valid sample location numbers are provided in table 25.

Table 25. Examples of valid samples code numbers.

Code	**Detail**
CA2402	Asphalt concrete core number 24 obtained from Test Section 02
CA0101	Asphalt concrete core number 01 taken from Test Section 01
CT0203	Treated base core number 02 from Test Section 03
BG0101	Bulk sample number 01 of granular base from Test Section 01. Assign numbers consecutively as samples are obtained from each test section, BG0101, BG0201, etc.
BA0102	Bulk sample number 01 of uncompacted AC from Test Section 02. Assign numbers consecutively as samples are obtained from each test section, BA0102, BA0202, etc.
BS0102	Bulk subgrade sample of material from Test Section 02. Assign sample numbers consecutively for multiple samples from the same test section.
MS0102	Subgrade moisture content sample number 01 obtained from bulk sampling location on Test Section 02.

Materials Tracking System—Hole ID and Specimen ID

The LTPP MTS is based on the use of a single, unique specimen identification number (SPECIMEN ID) for each test specimen. This identification will be directly written on the specimen (in the case of cores), or on the bag, bucket or can that contain the specimen in the case of bulk samples. While other identifying information, such as STATE_CODE, SHRP_ID, LAYER_NO, etc. may be transmitted along with the specimen, the SPECIMEN ID is intended to be the primary means of identifying the specimen in communications between RSC, lab and other stakeholders. The SPECIMEN ID will be assigned by the RSC. The first character of the SPECIMEN ID will indicate the RSC that assigned the SPECIMEN ID, in accordance with table 26.

Table 26. Specimen ID RSC codes.

Code	**Detail**
A	North Atlantic
C	North Central
S	Southern
W	Western

This RSC identifier will be followed by five alphanumeric characters that form a unique sequence for the sampling location. It is not required that any specific information be encoded in this sequence, and it is up to the RSC to develop a system that ensures that this sequence be unique. This combination of the RSC code and five-character unique sequence is called the HOLE ID for specimens obtained by coring/boring. The final three characters of the SPECIMEN

ID will be ‘L’ and the layer number corresponding to the specimen. An example is shown in figure 15.

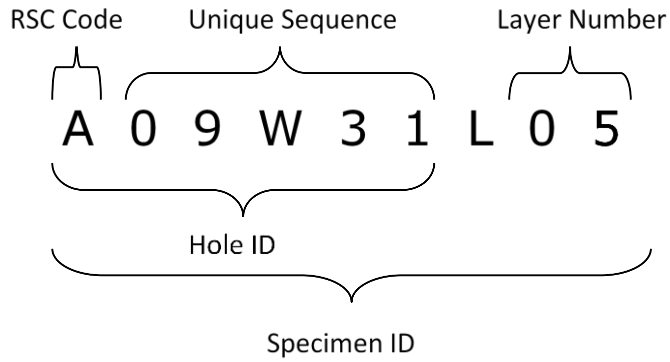

Figure 15. Illustration. SPECIMEN ID diagram.

Plant specimens, such as stockpile materials or bulk asphalt cement, may represent more than one test section, and it is possible that the layer numbering for these sections may be different. However, the sampling information will be keyed to a single test section, and the layer number encoded in the SPECIMEN ID will be the layer number appropriate for that test section. An example “A” type core/boring location, “C” type core and bulk AC sample from the same hypothetical test section, along with example SPECIMEN IDs are shown in figure 16.

Labels and Tags

Each sample will be labeled before packing in boxes and cartons. As a minimum, the following information will be included on a tag or label attached to the specimen:

- SPECIMEN ID.
- STATE CODE.
- SHRP ID.
- LOCATION DESIGNATION.
- SAMPLE NUMBER.
- DATE (mm-dd-yy, sampling date).
- FIELD SET (one digit number which will be 1 for the first round of sampling).

For cores, the HOLE ID will be written directly on the core. If the core contains more than one layer, layer boundaries will be clearly marked, and each layer numbered. For bulk samples, the SPECIMEN ID will be written directly on the bag, bucket or can that contain the sample.

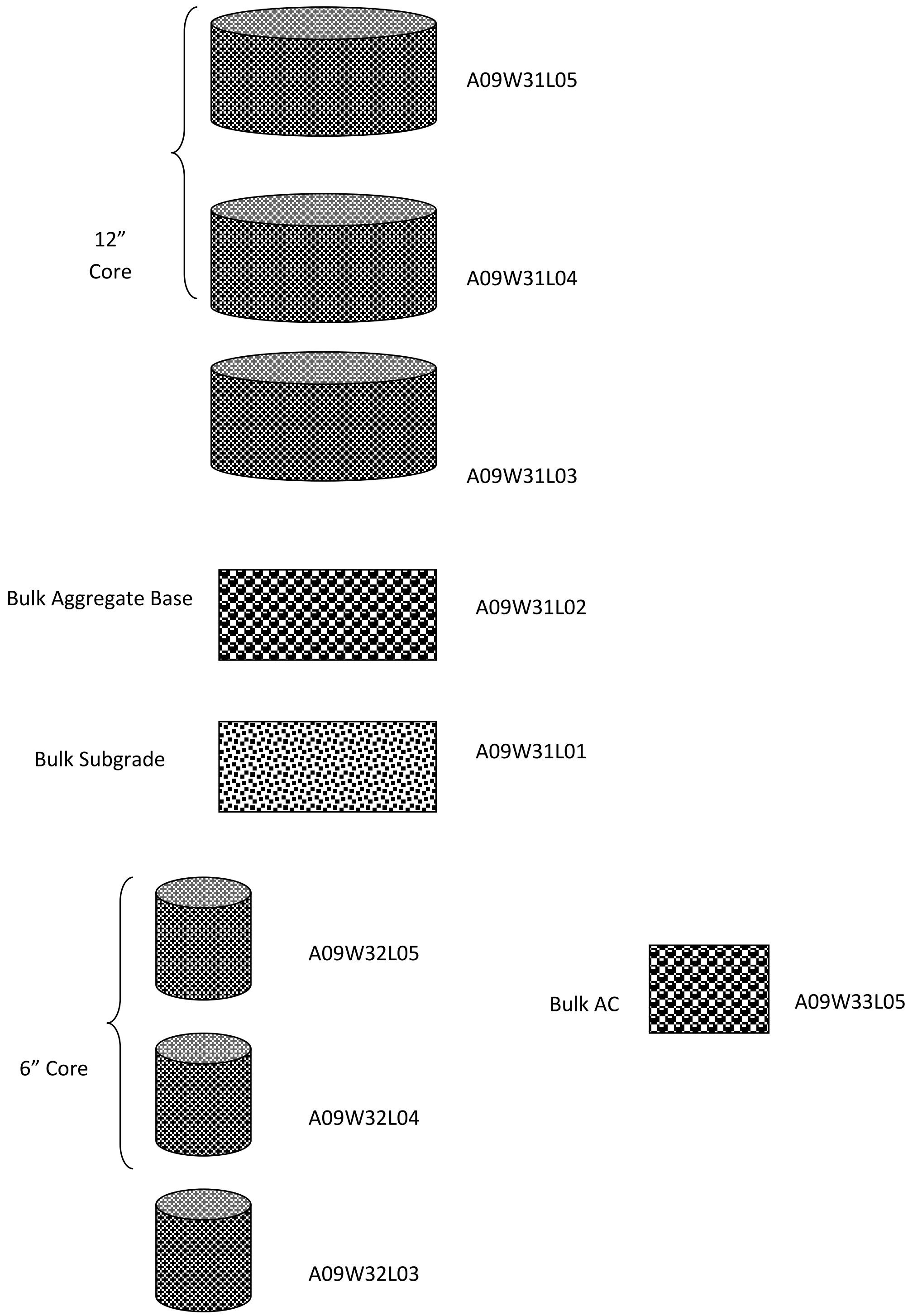

Figure 16. Illustration. Example SPECIMEN IDs.

Packaging

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

1. All samples of like material (e.g., asphalt concrete surface and binder) will be placed in separate boxes or separate compartments of one box.
2. Each sample will have a label or tag attached that clearly identifies the material. It is recommended that the label be color-coded by destination (e.g., contract Lab, FHWA lab, MRL, etc.).
3. Each core will be surrounded with "bubble-wrap" or other acceptable cushioning material on all sides within the shipping box.
4. All bulk samples will be marked with two labels or tags. One will be placed inside the bag and one attached to the outside. A jar sample for moisture testing of each bulk sample will be placed inside the bulk sample bag.
5. 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.
6. All boxes should be adequately secured by nails or screws prior to shipping.

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

Shipping

All samples should be shipped within five days to the laboratory designated by FHWA. Each box will be labeled to include the State Code, SHRP ID, 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 will be protected against freezing and overheating.

A copy of the bill of lading clearly showing the boxes being shipped and a receipt signed by the shipping organization will be sent to the appropriate RSC.

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.

Patching and Clean-up

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

Logs and Reports

Accurate and detailed record keeping is essential for the materials sampling and testing program. All forms and paperwork are to be compiled by LTPP RSC personnel. 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, to insure the accuracy and integrity of the collected data, and to forward the data sheets to the appropriate personnel. This person must 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.

GPS Coordinates

A GPS measurement will be taken at each static sampling location. This includes cores, bulk samples of uncompacted mixture, bulk samples of asphalt cement, and in-situ density measurements. GPS coordinates are not necessary for locations that are mobile such as a haul truck or distributor. Sampling Data Sheets 2, 4, 8, 10, 10A, and 21 include fields for recording GPS measurements. The GPS measurement will be taken using a receiver that meets all of the following requirements:

1. Has a Wide Area Augmentation System (WAAS) capability or a potential location accuracy of less than 3 meters.
2. Displays measure latitude and longitude coordinates to a resolution of 0.00001 degrees.
3. Provides an estimate of measurement accuracy in meters.
4. Has 12 parallel channel tracking capability.

All GPS measurements will be obtained using the World Geodetic System 84 (WGS 84) datum.

Field Set Number

The field set number is a sequentially assigned number used to indicate the different time periods in which material sampling and field testing were conducted on the project. A field set number can apply to more than one date since sampling of test sections may require more than one day.

All sampling that occurs during or immediately after construction of the overlay should be designated field set number 1. All sampling performed during the next construction cycle will be designated field set number 2, etc.

Cores

A separate log will be completed for each core hole. The depth of penetration of each coring operation and the average length of the recovered core will be recorded to the nearest 0.1 inch.

Data sheets for these logs are included in appendix B.3. Sampling Data Sheet 2 will be used to record pavement cores from C-type sampling areas. These logs will show the general type of material in accordance with terminology described in appendix B.3. The general code 001 will be used to identify dense graded HMA, and 091 will be used to identify dense graded WMA. Remarks will 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.

A-Type Sampling

Data for each A-type sampling hole will be recorded on Sampling Data Sheet 4. This includes auguring used to obtain subgrade bulk samples and to perform material classification and layer thickness measurements on base and subbase layers. This data should include descriptions of the subgrade layers, samples depths, 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 *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. (23)
2. Thickness of each layer encountered in the hole to the nearest 0.1 inch.
3. Presence and levels of any water encountered.

Bulk Sampling of Subgrade

Observations and measurements performed during subgrade sampling will be logged as the excavation progresses and will be reported on Sampling Data Sheet 4. The record will include description of the exposed subgrade and thickness of any layers to the nearest 0.1 inch, sample numbers and number of bags per sample, test numbers, any water seepage, sloughing, voids and other pertinent items.

Bulk AC Materials Sampling

Data for bulk HMA mix, asphalt and asphalt emulsions, and aggregates should be recorded on Sampling Data Sheets 10, 10A, and 21, respectively. The record will include information on when and where the sample was obtained, as well as the size and other basic characteristics of the sample.

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-11 test site. The forms will appear in the final assembled data packet in the order provided in appendix B. The title page will always be the first (top) sheet of the data packet and it will include the following information.

1. State.
2. State Code.

3. SHRP ID.

4. Date(s) of Field Materials Sampling and Field Testing.

5. Submitting Contractor/Agency.

6. Total Sheets, including the Title Page.

To determine the number of sheets (item 6 above) all of the pages in the packet should be counted. The pages should then be numbered 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.

After the packet has been assembled and numbered, an appropriate number of duplicates should be made. The original will be stored at the RSC office.

MRL Samples

Scheduling information should be furnished to the LTPP MRL contractor as soon as this information is available. This information should, at the minimum, contain: (1) sampling date, (2) highway agency contact name, (3) shipping address, and (4) telephone number. The contact name information for the MRL is as follows:

Program Manager
FHWA Materials Reference Library
1625 Crane Way
Sparks, NV 89431
Phone: 775-329-4955
Fax: 775-329-5098
Website: www.ncenet.com/ltpp/mrl

Shipping of samples to the MRL will be performed by a common carrier and the costs borne by FHWA. The RSC should contact the MRL office for coordination and sample shipping details.

Prior to shipping samples to the MRL, the specimens will be logged into the MTS, along with the appropriate shipment information. A copy of LTPP Field Operations Information Form 1 should be completed and attached to all MRL shipments.

If necessary, cores for the SPS-11 projects can also be shipped and stored at the MRL if the LTPP Testing Contractor is not yet able to test or store the material designated for it to test. The MRL should be contacted for shipping containers and instructions.

LABORATORY MATERIALS TESTING

This section contains general guidelines to be used by laboratories participating in the SPS-11 laboratory materials testing program. All of the protocols, test data reporting sheets, definitions, etc. referenced in this section can be found in the document *Long-Term Pavement Performance*

Project: Laboratory Material Testing and Handling Guide. [23] 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. They also provide a common format for reporting test results so they can be stored in the LTPP Pavement Performance Database portion of the LTPP Information Management System (IMS) for dissemination. The general instructions included in this SPS-11 materials sampling and testing chapter are to be used as general guidelines by the laboratory. However, the laboratory chief/manager must exercise judgment when using these guidelines. If problems or discrepancies are found, the RSC should be contacted.

Subgrade Materials Testing

The LTPP central laboratory contractor will be responsible for performing the sieve analysis, Atterberg limits, material classification and natural moisture content tests on the subgrade materials obtained from the SPS-11 test sections. The LTPP protocols containing the test procedure, reporting requirements and data forms for these tests are:

- Natural Moisture Content Protocol P49
- Sieve Analysis Protocol P51
- Atterberg Limits Protocol P43
- Material Classification Protocol P52
- Resilient Modulus Protocol P46

The following general procedures will 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. Make sure the jar samples do not break.
- Combine the bulk samples with the same sample number if contained in more than one bag or container. Do not combine bulk samples of materials obtained from different locations on the SPS-11 projects.
- Thoroughly mix the combined bulk sample and then dry the sample in accordance with the procedure described in AASHTO R058-11. [30]
- The mixed and dried sample is to be reduced to the appropriate test size using the procedures described in AASHTO T248-14. [31] The test samples will be representative of the total bulk sample.
- Perform all other tests including the resilient modulus in accordance with the appropriate protocols.

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 is available to run all of the required characterization tests. This extra material will not be disposed of until all testing has been completed and all results have been received by the RSC and passed quality control checks.

Laboratory Testing of Embankment Materials

Materials from embankment layers greater than or equal to 4 ft thick will be treated as subgrade materials and tested in accordance with Laboratory Testing of Subgrade Materials discussed above. Materials from embankment layers less than 4 ft thick will be considered as a subbase but tested as a subgrade material.

Laboratory Testing of Unbound Granular Base/Subbase Material

All testing will be performed by the LTPP central laboratory contractor. These tests will be conducted in the following order:

- Particle Size Analysis (Protocol P41).
- Atterberg Limits (Protocol P43).
- Classification of Granular Base/Subbase Materials (Protocol P47).
- Resilient Modulus (Protocol P46).

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

- Combine the bulk samples with the same sample number if contained in more than one bag or container. Do not combine bulk samples of materials obtained from different locations on the SPS-11 projects.
- Thoroughly mix the combined bulk sample and then dry the sample in accordance with the procedure described in AASHTO R058-11.(30)
- The mixed and dried sample is to be reduced to the appropriate test size using the procedures described in AASHTO T248-14. (31) The test samples will be representative of the total bulk sample.
- Perform all other tests in accordance with the appropriate protocols.

Extra material will not be disposed of until all testing has been completed and all results have been received by the RSC and passed quality control checks.

Laboratory Testing of Existing HMA Materials

The following sections are to be used as a guide for the completion of the laboratory material testing program for the existing HMA layers, including asphalt cement, RAP stockpile material and HMA cores. All tests will be performed by the LTPP central laboratory contractor except:

- AC01 will be performed by the RSCs. Each RSC is responsible for performing AC01 on every core drilled within its region. AC01 should be completed and the results verified before the core is shipped to the LTPP central laboratory contractor.

- AE11 will be performed by FHWA Turner-Fairbank Highway Research Center (TFHRC).

Bulk Samples of AC Binder

The following tests will be performed on each asphalt cement used in the SPS-11 experiment HMA mixtures. Normally this will only be for the binder used in the control section; however, these tests will apply to binder used in the supplemental sections if the binder specification is different than for the core sections.

The central laboratory contractor will perform the following tests in the following order:

- Binder specific gravity (P23).

- Dynamic Shear Rheometer, Unaged (P27).

- Dynamic Shear Rheometer, RTFO (P27).

- Multiple stress creep recovery, RTFO (P73).

- Dynamic Shear Rheometer, RTFO+PAV (P27).

- Bending Beam Rheometer, RTFO+PAV (P28).

AC Layers other than Surface Layer

The following tests will be performed on each AC layer other than the experimental surface layers. For overlay projects, these correspond to the existing AC layers. These tests will only be done for cores sampled at the time of construction. All testing will be performed by the central laboratory contractor, with the exception of AC01 which will be performed by the RSC.

- **Mix Stiffness** - Three 6-inch cores per section required, except supplemental sections:

    - Examination and thickness, performed on each core (P01).

    - Bulk specific gravity, performed on each core (P02).

    - Dynamic modulus, performed on specimens prepared from one of the three cores (P74).

- **Maximum Specific Gravity and Component Properties -** Two 12-inch cores per section required, except supplemental sections. Multiple 6-inch cores may be substituted to achieve same volume of material:

- Examination and thickness (P01).
- Maximum specific gravity (P03).
- Extraction, asphalt content (P04).
- Abson Recovery (P21).
- Dynamic Shear Rheometer, unaged (P27).
- Bending Beam Rheometer, unaged (P28).
- Multiple stress creep recovery, unaged (P73).
- Aggregate gradation (P14).

Treated Base/Subbase/Subgrade Materials

If a treated base, subbase or subgrade is present, it will be examined using protocol P31. This examination can be performed on 4-inch diameter or greater cores. One test will be performed for each section. Testing will be performed by the RSCs.

Laboratory Testing for Asphalt Preservation Treatments

For preservation treatments applied to asphalt pavements, laboratory testing of the hot mix asphalt can be done as discussed earlier. However, tests for chip seals and micro-surfacing will be more difficult since emulsions have a limited shelf life. This section discusses the types of tests that are being considered for the various preservation treatments.

Thin AC Overlay

The following tests will be performed on the experimental AC surface layer. These layers correspond to the HMA control layers placed as part of this experiment. All testing will be performed by the central laboratory contractor, with the exception of AC01 which will be performed by the RSC. Because of the thin HMA some of the tests such as those for mix stiffness may not be run.

- **Mix Stiffness** - Three 6-inch cores per section required, including supplemental sections:
  - Examination and thickness, performed on each core (P01).
  - Bulk specific gravity, performed on each core (P02).
  - Two Dynamic modulus tests, performed on different specimens prepared from the three cores (P74).
- **Maximum Specific Gravity and Component Properties** - One 12-inch core per section required, including supplemental sections. Multiple smaller cores may be substituted to achieve same volume of material:

  - Examination and thickness (P01).
  - Maximum specific gravity (P03).
  - Extraction, asphalt content (P04).
  - Abson recovery (P21).
  - Binder specific gravity (P23).
  - Dynamic Shear Rheometer, unaged (P27).
  - Multiple Stress Creep Recovery, unaged (P73).
  - Dynamic Shear Rheometer, PAV (P27).
  - Bending Beam Rheometer, PAV (P28).
  - Aggregate gradation (P14).
- **Binder Properties** - One 12-inch core per section required, including supplemental sections. Multiple 6-inch cores may be substituted to achieve same volume of material:
  - Examination and thickness (P01).
  - Extraction, asphalt content (P04).
  - Abson recovery (P21).
  - Dynamic Shear Rheometer, unaged (P27).
  - Bending Beam Rheometer, unaged (P28).
  - Multiple Stress Creep Recovery, unaged (P73).

Chip Seals

Tests for chip seals should be in conformance with the new AASHTO specification which is scheduled to be published in the near future. They would include tests on:

- Emulsions.
- Aggregates.
- Mix tests (Embedment, Sweep and Vialit).

Tests on emulsions may not be possible unless they are completed within 21 days or if the same emulsion were produced at a later date. Similarly, if mix tests are used, they would have to be performed with the construction materials within 21 days or use a different emulsion.

Micro-surfacing

Tests for micro-surfacings should be in conformance with the new AASHTO specification which is scheduled to be published in the near future. They would include tests on:

- Emulsions.
- Aggregates.
- Mix tests (residual asphalt content and wet track abrasion).

Tests on emulsions may not be possible unless they are completed within 21 days or if the same emulsion were produced at a later date. Similarly, mix tests would have to be performed with the construction materials within 21 days or use a different emulsion. An alternative would be to collect the base stock and the chemicals used in the production of the emulsions.

Sample Record Keeping

The laboratories conducting the testing for the SPS-11 projects are required to keep in close coordination with the RSC 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 RSC should be maintained using the MTS.

Sample Receipt Procedures

Upon receipt of the samples, the samples will be inspected by the laboratory manager (or their designee) for completeness of the shipment (as compared to the MTS), damage, contamination, sufficient quantity, and proper identification. Regardless of the condition and size of the samples, they must be logged in using the MTS. If testing cannot be performed on a given specimen, the reason will be entered in the MTS.

Test Data Reporting

The participating laboratory is required to use electronic data formats for recording test results. Electronic data formats will be verified and agreed to by FHWA before testing is performed. At a minimum, the electronic record will contain the SPECIMEN ID of the sample, and all data fields included on the paper data reporting forms contained in Chapter 3.1 of the *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. [23] For each test performed, the lab will update the MTS with the name of the electronic data file containing the test results. Data file shipments will also be tracked using the MTS.

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 SPS-11 projects. 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 will 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 will be fully enclosed and not subjected to the natural elements. This type of area will provide protection against contact with water (rain or wet floor) and exposure to direct sunlight. Also, the storage area will be capable of maintaining each sample in the required temperature range as specified below. Samples will be marked to indicate their status; such as “hold material - do not use.”

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

Asphalt Concrete Materials

Asphalt materials will be stored between 40°F and 80°F in an environmentally protected storeroom. Cores should be stored flat-side down, fully supported.

Asphalt Treated Materials

Asphalt Treated Base/Subbase and Treated Subgrade cores and materials should be stored flat side down, fully supported and at a temperature between 40°F and 80°F in an environmentally protected storeroom.

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 a temperature between 40°F and 100°F in an environmentally protected storeroom.

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 40°F and 100°F.

Emulsions

Emulsions used in the chip seals and micro-surfacings do not store well. They should be tested during or shortly after construction. If the samples are tested after 21 days, the results will not be reliable.

Sample Handling and Shipping

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

Packaging

1. Each sample will 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 will be wrapped in 'bubble-wrap' or other acceptable cushioning material on all sides within the shipping box.
3. Bulk samples will be marked with two labels or tags. One will be placed inside the bag and one attached to the outside. Pieces from treated layers not suitable for testing as cores will be packaged and shipped as bulk samples.
4. Shipping boxes will 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.
5. All boxes will be adequately secured by nails or screws prior to shipping.
6. All necessary documentation related to the samples being shipped will also be included in the shipment. A duplicate set of all necessary documentation will be sent in a separate package to the laboratory to confirm the box inventory.

Shipping

Each box will be labeled to include the project identification number, type(s) of samples, and box number (for each series of boxes). The boxes will 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.

A copy of the bill of lading clearly showing the boxes being shipped and a receipt signed by the shipping organization will be sent to the appropriate RSC.

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 ensure that these specimens are shipped between entities with a minimum of damage.

CHAPTER 5. PERFORMANCE MONITORING REQUIREMENTS

OVERVIEW

A key component to achieving the objectives of the SPS-11 experiment is to develop and execute a performance monitoring plan capable of tracking and collecting the short- and long-term data for the selected pavement preservation treatments. The guidelines for the periodic collection of monitoring data are described in this chapter.

The performance monitoring requirements include data elements that are part of the standard LTPP performance monitoring activities as well as a new, additional monitoring data element. They are:

- Standard LTPP monitoring.
    - Deflection testing.
    - Distress surveys.
    - Profile and texture surveys.
- Additional monitoring.
    - Surface friction surveys.

The first three data elements—deflection testing, distress surveys and profile and texture surveys—are considered required (i.e., mandatory). The fourth data element—surface friction surveys—is considered desirable (i.e., not mandatory) because these surveys have not been performed in a controlled basis within the LTPP program (but they could be expanded to other LTPP test sections). In addition, they introduce program expenses (retaining the services of specialty data collection contractor) that may not be available within the LTPP budget.

The monitoring frequency requirements for the performance measures in question are summarized in table 27. As shown, the following three monitoring time frames are specified:

- Pre-treatment monitoring—these are measurements taken prior to (within one month) application of the treatment to capture the condition of pavement with respect to the measure in question prior to the treatment.
- Post-treatment monitoring—these are measurements taken immediately (within one month) after application of the treatment to capture the initial impact of the treatment on the measure in question. In the case of the distress surveys, a second survey will be performed between three and six months after application of the treatment to capture the short-term impact of the treatment on the measure in question.
- Routine monitoring—these are measurements taken over the life of the project test sections, at approximately (but within three months) the same date and time as the initial

after treatment measurements, while active within the LTPP program to capture the short- and long-term performance of the pavements.

Table 27. Performance monitoring guidelines: frequency requirements.

Monitoring Type	Data Element	Monitoring Frequency		
		Pre-Treatment	Post-Treatment	Routine Monitoring
Standard LTPP Monitoring	Deflection Testing	Within 1 month prior to treatment application	Not Required	Approximately every 3 years, but not to exceed 5-year intervals within 3 months of the anniversary date of initial after treatment testing
	Distress Surveys	Within 1 month prior to treatment application	Within 1 month and between 3 and 6 months after treatment application	Annual basis within 3 months of the anniversary date of initial after treatment survey
	Profile and Texture Surveys	Within 1 month prior to treatment application	Within 1 month after treatment application	Annual basis within 3 months of the anniversary date of initial after treatment survey
Additional Monitoring	Surface Friction Surveys	Within 1 month prior to treatment application	Within 1 month after treatment application	Annual basis within 3 months of the anniversary date of initial after treatment survey

The pre- and post-treatment measurements are to be performed on those project test sections receiving the treatment in a given year. Performance measurements will be conducted on all test sections at a site any time a performance measurement is scheduled for any test sections at the project site.

As shown in table 28, deflection testing, distress surveys and profile and texture surveys are to be conducted in accordance with existing LTPP protocols, except as follows: [32, 33, 34]

- Deflection testing on SPS-11 projects will be performed using the SPS-1 Flexible Test Plan 4, which provides adequate deflection data, while reducing time and hence traffic control requirements. [32]

- Distress surveys of SPS-11 projects receiving the chip seal or micro-surfacing treatment will be conducted per the latest version of the "Distress Identification Manual for the Long-Term Pavement Performance Program" or DIM. [33] However, the following changes to the DIM will be required:

    - Bleeding and raveling on SPS-11C chip seal and SPS-11M micro-surfacing project test sections will be determined in the same manner as for HMA surfaced pavements that have not received a chip seal or micro-surfacing.

    - Addition of chip rock loss for use at the SPS-11C chip seal project test sections.

- Addition of shedding of rock for use at the SPS-11M micro-surfacing project test sections.
- Addition of delamination for use at the SPS-11T thin overlay and SPS-11M micro-surfacing project test sections.

Table 28. Performance monitoring guidelines: protocols.

Monitoring Type	Data Element	Protocols/References	Protocol(s) Changes/Deviations
Standard LTPP Monitoring	Deflection Testing	LTPP Manual For Falling Weight Deflectometer Measurements Version 4.1 (FHWA-HRT-06-132) or latest version and applicable directives [32]	Deflection testing on SPS-11 projects will be performed using the SPS-1 Flexible Test Plan 4
	Distress Surveys	Distress Identification Manual for the Long-Term Pavement Performance Program—May 2014 (FHWA-RD-13-092) or later version and applicable directives [33]	Revisions to bleeding and raveling for SPS-11C and SPS-11M test sections, addition of chip rock loss for SPS-11C test sections, addition of shedding of rock for SPS-11M test sections, and addition of delamination for SPS-11T and SPS-11M test sections
	Profile and Texture Surveys	LTPP Manual for Profile Measurements and Processing December 2013 - Revised Appendix B or later version and applicable directives [34]	No changes or deviations to referenced protocols
Additional Monitoring	Surface Friction Surveys	ASTM E2340, Standard Test Method for Measuring the Skid Resistance of Pavements and Other Trafficked Surfaces Using a Continuous Reading, Fixed-Slip Technique [35]	No changes or deviations to referenced protocols

For the surface friction surveys, the latest version of the ASTM standard is to be used. [35] In addition, highway agencies are encouraged to perform parallel friction measurements using one or more other devices such as the ASTM E274 skid trailers and the GripTester. [36]

Responsibility for the collection of the required performance measure data elements is summarized in table 29. As shown, the LTPP RSCs are responsible for all data collection activities except for the surface friction surveys, which will be performed by a specialty data collection contractor.

Table 29. Performance monitoring guidelines: data collection responsibilities.

Monitoring Type	Data Element	Responsible Data Collection Party
Standard LTPP Monitoring	Deflection Testing	LTPP Regional Support Contractors
	Distress Surveys	LTPP Regional Support Contractors
	Profile and Texture Surveys	LTPP Regional Support Contractors
Additional Monitoring	Surface Friction Surveys	Specialty Data Collection Contractor

Each of the recommended performance measures is discussed in greater detail next, including objectives, hypotheses, monitoring frequency, and testing protocols.

STANDARD LTPP MONITORING

Deflection Testing

The objective for carrying out deflection testing (using FWDs) on the pavement preservation project test sections is to estimate the stiffness of the individual pavement layers as well as the overall pavement structure for all SPS-11 project test sections.

Without exception, the SPS-11 treatments are intended to prevent moisture from entering the pavement structure and to protect the HMA surface layer from the aging effects. They are not expected to have an immediate impact on the structural capacity of the pavements, but as long as these treatments remain in good condition, it is hypothesized that:

- The subgrade foundation, as measured in terms of its elastic modulus, will remain stable (higher moduli values for given material type).
- In terms of the remaining pavement layers, changes in moduli are expected to remain relatively stable over time (for same moisture and temperature conditions), until structural condition of the pavement begins to deteriorate, as manifested by cracking, rutting and/or other distresses.

Deflection testing is to be conducted at least one month prior to application of the treatment at a given project test section (as well as at project control test section) to not only establish the pre-treatment structural condition of the pavement, but to also confirm whether or not the test section meets the structural condition criteria stipulated in the SPS-11 project nomination guidelines.

Deflection testing immediately after application of a treatment at a given project test sections is not required, as none of the SPS-11 treatments in question are expected to significantly affect the structural condition of the pavement, as determined by the pre-treatment testing. Accordingly, only routine monitoring—testing every 3 years but not to exceed 5 years—is required after the pre-treatment testing to monitor change in structural capacity, if any, over time. These routine testing should be performed at approximately (but within three months) the same date and time as the initial after treatment testing for each project.

All deflection testing is to be performed by the LTPP RSCs in accordance with the LTPP Manual for Falling Weight Deflectometer Measurements, Version 4.1, or latest version and applicable directives. (32) Testing will be done in accordance with the SPS-1 Plan 4 specification—i.e., SPS-1 Flexible Test Plan 4. This test plan provides adequate deflection data to determine the structural condition of the pavements, while reducing testing time and hence traffic control requirements.

Distress Surveys

The objective of the pavement surface distress surveys on the SPS-11 project test sections is to identify the distress types present at those test sections as well as to quantify their extent and severity and, by doing so, capture the impact of preservation treatments on the life and performance of the pavements. The project test sections to be included in the SPS-11 experiment are to be in good condition, as detailed in the project nomination guidelines. Consequently, it is anticipated that limited pavement surface distress will be present on these project test sections when introduced into the LTPP program.

As noted in the previous section, the SPS-11 treatments are intended to prevent moisture from entering the pavement structure and to protect the HMA surface layer from the aging effects. Accordingly, it is hypothesized that these treatments will affect pavement surface distresses as follows:

- All three treatments in question are expected to conceal cracks visible on the pavement surface, if any, and that in the case of the chip seal and micro-surfacing treatments, those cracks will re-appear in a short period of time (weeks or months), whereas for thin HMA overlays, it is possible that a longer period of time (months or years) may pass before the cracks re-appear.

- If no cracking is present on the SPS-11 project test sections, it is anticipated that cracking will appear first and propagate faster on the project control test section when compared to the first treatment project test section. For later treatment project test sections, cracking on those test sections yet to be treated should be similar to that at the control test section, but once treated, cracking propagation rates could potentially slow down.

- Only thin HMA overlays are anticipated to have an impact on rutting immediately after application of the treatment. However, all three treatments could potentially slow down the rate of rutting.

Distress surveys will be conducted on all SPS-11 project test sections at least one month prior to application of the treatment at a given project test section as well as within one month after application of the treatment. These surveys are intended to establish pavement surface distress conditions immediately prior to and after application of the treatments. In addition, distress surveys will be conducted between three and six months after application of the treatment, as some pre-existing distresses, such as cracking, are expected to re-appear not long after application of the treatments, especially in the case of the chip seals and micro-surfacing. These three surveys—immediately prior to, immediately after and between three and six months after application of treatment—are only applicable to those project test sections being treated as well as the project control test section.

In addition, distress surveys will be performed on all project test sections on an annual basis, at approximately (but within three months) the same date and time as the initial after treatment survey, to monitor the progression of distresses over time.

All distress surveys are to be performed by the LTPP RSCs in accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program, May 2014 or latest version and applicable directives. [33] Deviations and additions to the requirements stipulated in this manual include:

- Bleeding and raveling on the SPS-11C chip seal and SPS-11M micro-surfacing project test sections will be determined in the same manner as for HMA surfaced pavements that have not received a chip seal or micro-surfacing.
- Addition of chip rock loss for use at the SPS-11C chip seal project test sections.
- Addition of shedding of rock for use at the SPS-11M micro-surfacing project test sections.
- Addition of delamination for use at the SPS-11T thin overlay and SPS-11M micro-surfacing project test sections.

Profile and Texture Surveys

The objectives of the pavement surface profile and texture surveys are to:

- Collect longitudinal profile data along the wheel paths to evaluate the roughness of the pavement at a given point in time as well as the change in roughness over time, which is an important indicator of pavement performance.
- Collect texture data along the wheel paths to evaluate the texture characteristic of the pavement surface at a given point in time as well as the change in texture over time, both of which related to pavement surface friction characteristics.

Directly related to the above objectives, it is hypothesized that the SPS-11 treatments will affect pavement roughness and texture as follows:

- Application of the thin HMA overlay treatment will have a significant impact on pavement surface roughness (and potentially texture), with the most significant impact being smoother pavement surfaces.
- Application of the remaining treatments are not expected to significantly affect pavement surface roughness, if at all, but the chip seal and thin HMA overlays will likely impact pavement surface texture characteristics both negatively and positively.

Profile and texture surveys will be conducted on all SPS-11 project test sections at least one month prior to application of the treatment at a given project test section as well as within one month after application of the treatment. These surveys are intended to establish pavement surface roughness and texture conditions immediately prior to and after application of the treatments. While these surveys are only intended for those project test sections being treated as well as the project control test section, it is just as easy to collect profile and texture data over the entire project, hence the RSCs have the option to conduct the surveys on the two required test sections or over the entire project length.

In addition, profile and texture surveys will be performed on all project test sections on an annual basis, at approximately (but within three months) the same date and time as the initial after treatment survey, to monitor the progression of roughness and texture over time.

All profile and texture surveys are to be performed by the LTPP RSCs in accordance with the LTPP Manual for Profile Measurements and Processing, November 2008 (plus Revised Appendix B, December 2013) or latest version and applicable directives. [(34)] No deviations or changes to the requirements stipulated in the manual are required for purposes of the SPS-11 experiment.

ADDITIONAL MONITORING

Surface Friction Surveys

The objective of the surface friction surveys is to establish the skid characteristics of the SPS-11 project test sections at a given point in time as well over time, which is another important pavement performance indicator. Towards achieving this objective, the texture surveys discussed in the previous section will supplement and complement the data gathered by the surface friction surveys.

Unlike the performance measures detailed up to this point, surface friction surveys are desired, but not required, for the SPS-11 experiment. One reason these surveys are not required is because they have not been performed in a control basis within the LTPP program (but they could be expanded to other LTPP test sections). Another reason is that they introduce program expenses (to retain the services of specialty data collection contractor) that may not be available within the LTPP budget.

Directly relating to the stated objective for the performance measure in question, it is hypothesized that the SPS-11 treatments will affect the pavement surface friction characteristics of the existing pavement prior to application of treatment. In the case of chip seals, those characteristics are expected to improve, in the case of micro-surfacings they are expected to worsen, and in the case of thon overlays the impact could range from improve, worsen or no change.

Surface friction surveys will be conducted on all SPS-11 project test sections. The surveys will be conducted at least one month prior to application of the treatment at the referenced project test section as well as within one month after application of the treatment. These surveys are intended to establish pavement surface friction characteristics immediately prior to and after application of the treatments.

As was the case with the profile and texture surveys, the pre-treatment surface friction surveys are only intended for those project test sections being treated as well as the project control test section; however, consideration may be given to performing survey over entire project if this does not introduce significant additional expenses. In addition to the pre-treatment surveys, surface friction surveys will be performed on all project test sections on an annual basis, at approximately (but within three months) the same date and time as the initial after treatment survey, to monitor the change in surface friction characteristics over time.

All friction surveys are to be performed by a specialized and experienced contractor in accordance with ASTM E2340 Standard Test Method for Measuring the Skid Resistance of Pavements and Other Trafficked Surfaces using a Continuous Reading, Fixed-Slip Technique or latest version of the standard. [35] No deviations or changes to the requirements stipulated in the standard are required for purposes of the SPS-11 experiment.

In addition to the ASTM E2340 continuous friction measurements, highway agencies are encouraged to perform parallel friction measurements using one or more other devices such as the ASTM E274 skid trailers and the GripTester. [36] Such measurements will be planned, coordinated and executed with the support of the respective LTPP RSC to ensure the data are stored in the LTPP database.

CHAPTER 6. OTHER DATA COLLECTION

OVERVIEW

Another important element of the SPS-11 experiment is to develop and execute a plan for collecting those data necessary for understanding the short- and long-term performance of pavements subjected to preservation treatments, which have not been addressed by the MS&T plans and the performance monitoring guidelines addressed in earlier chapters. Guidelines for the collection of those data are described in this chapter, while guidelines for the collection of maintenance and rehabilitation data are provided under separate LTPP directive.

The additional SPS-11 data collection requirements include data elements that are part of the standard LTPP data collection processes as well as new data elements. These data elements can be grouped into pre-treatment testing and monitoring data:

- Standard LTPP data.
    - Traffic data.
    - Climate data.
    - Maintenance and rehabilitation data.
- Additional data collection.
    - Pre-Treatment testing data.
        - GPR data.
    - Monitoring data.
        - Subgrade moisture data.
        - Snow removal and deicing data (freeze areas only).

All of the above data elements are considered required (i.e., mandatory), without exception. It is recognized that GPR data will require the LTPP program to retain the services of specialty data collection contractors, which introduces expenses that could potentially be beyond the available program funding. However, GPR data is considered mandatory for the SPS-11 experiment because it yields information critical to understanding the performance of pavements subjected to preservation treatments. Without these data, the usefulness of the proposed data collection effort is handicapped.

The data collection frequency requirements for the data elements in question are summarized in table 30. As shown, the following two data collection time frames are specified:

- Pre-treatment data collection—these are measurements taken within three months prior to the application of a treatment to capture the preconstruction pavement condition. GPR and subgrade moisture measurements should be performed within the pre-treatment time frame. These measurements should be performed on all test sections at a project site. As indicated in the SPS-11 project nomination guidelines, projects must meet minimum specified structural capacity and condition requirements for inclusion in the experiments.

Table 30. Other data collection needs: frequency requirements.

Monitoring Type	Data Element	Data Collection Frequency	
		Pre-Treatment	Routine Data Collection
Standard LTPP Data	Traffic	Not Required	3 years of continuous WIM and thereafter continuous classification data collection for remainder of time project remains in LTPP program
	Climate	Not Required	MERRA data will be updated at intervals of 1 year or less, while virtual weather station data will be generated for the project when it enters LTPP and then updated at intervals not to exceed 5 years
Additional Data Collection	Ground Penetrating Radar (GPR)	Within 3 months prior to treatment application	Not Required
	Subgrade Moisture	Within one week prior to treatment application.	Quarterly, but not to exceed 6 months, measurements
	Snow Removal and Deicing	Not Required	RSCs will work with highway agencies to establish frequency for providing required information, but in no case, should it exceed 1 month during winter

- Routine data collection—these are measurements taken over the life of the project test sections while active within the LTPP program to enable understanding of the short- and long-term performance of the pavements where preservation treatments have been applied. Routine data collection is to be performed on all project test sections, whether they are control or treatment test sections and, if a treatment test section, whether or not it has received the treatment.

As shown in table 30, “other” post-treatment data collection measurements taken within one week to six months after application of the treatment to capture the initial impact of the treatment only includes subgrade moisture.

Also, as shown in table 31, traffic and climate data are to be collected in accordance with existing LTPP protocols and/or practices, except as follows: (See references 37 through 43.)

- The traffic data collection effort will entail 3 years of WIM data collected using piezo quarts or better quality sensors and thereafter continuous classification data for the remainder of the time the project remains in the LTPP program.

Data for the remaining data elements—subgrade moisture, snow removal and deicing and GPR—are to be collected using procedures that are new to the LTPP program:

- Snow removal and deicing—rather than a protocol, a data sheet detailing the information required from the highway agencies at SPS-11 projects is included under appendix B.4. The LTPP RSCs will work with the agencies to collect these information on a routine basis.

- GPR—the primary protocol for the collection of GPR data is AASHTO R-37-04 Standard Practice for Application of Ground Penetrating Radar (GPR) to Highways, supplemented by ASTM D4718-10 Standard Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar, ASTM D6432-11 Standard Guide for Using Ground Penetrating Radar for Subsurface Investigation, and Research Report FHWA/ TX-92/1233-1 Implementation of the Texas Ground Penetrating System. (See references 44 through 47.) Given the nature of GPR data collection and interpretation, it is envisioned that the surveys and subsequent data analyses will be carried out by one or more specialized GPR contractors in accordance with the stated protocols.

- Subgrade moisture—data will be collected at SPS-11 project test sections in accordance with ASTM D5220-02 Test Method for Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method, as adapted by NCAT at the University of Auburn, which makes use of permanently installed moisture sealed tubes positioned such that the tip is embedded two inches into the subgrade. [48] A probe that contains both a nuclear source and a detector is lowered into these tubes for determining moisture at the top of the subgrade.

Responsibility for the collection of the required data elements is summarized in table 32. These responsibilities were based on FHWA committing to the leadership role in implementation of this experiment. These responsibilities could change if these experiments are implemented outside the existing LTPP program structure. As shown, the LTPP RSCs are responsible for all data collection activities except as follows:

- Traffic data will be collected by the State DOTs with support from the LTPP program.

- GPR surveys will be performed by a specialty data collection contractor.

Each of the additional data collection elements required is discussed in greater detail next, including objectives, hypotheses, monitoring frequency, and testing protocols.

Table 31. Other data collection needs: protocols.

Monitoring Type		Data Element	Protocols/References	Protocol(s) Changes/Deviations
Standard LTPP Data		Traffic	SPS traffic pooled fund protocols for load data and FHWA Traffic Monitoring Guide (September 2013) for classification data (See references 37 through 41.)	3 years instead of 5 years of WIM data will be collected using piezo quartz sensors
		Climate	Current LTPP MERRA and virtual weather station approaches or updated version will be used to generate climatic data [42, 43]	No changes or deviations to referenced protocols
Additional Data Collection	Pre-Treatment Testing Data	Ground Penetrating Radar (GPR)	AASHTO R-37-04 Standard Practice for Application of Ground Penetrating Radar (GPR) to Highways [44]	Supplemented by ASTM D4718-10 Standard Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar, ASTM D6432-11 Standard Guide for Using Ground Penetrating Radar for Subsurface Investigation, Research Report FHWA/ TX-92/1233-1 Implementation of the Texas Ground Penetrating System [45, 46, 47]
	Monitoring Data	Subgrade Moisture	ASTM D5220-02 Test Method for Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method [48]	Use of National Center for Asphalt Technology (NCAT) moisture sealed tubes
		Snow Removal and Deicing	Not required; data sheet for information required from agencies has been prepared	Not applicable

STANDARD LTPP DATA

Traffic

Traffic is one of four key factors that influence the performance of pavements—the other three factors are climate, foundation subgrade soil and pavement structure. As such, the objective of this data collection effort is to obtain high-quality traffic data, both in terms of loads and volumes. It is hypothesized that, all other factors being the same, the performance of pavement is inversely proportional to traffic. The greater the loads and/or volumes, the greater the reduction in performance.

Table 32. Other data collection needs: data collection responsibilities.

Monitoring Type		Data Element	Responsible Data Collection Party
Standard LTPP Data		Traffic	State DOTs and LTPP Regional Support Contractors
		Climate	LTPP Technical Support Services Contractor
Additional Data Collection	Pre-Treatment Testing Data	Ground Penetrating Radar (GPR)	Specialty Data Collection Contractor
	Monitoring Data	Subgrade Moisture	State DOTs (installation) and LTPP Regional Support Contractors (monitoring)
		Snow Removal and Deicing	LTPP Regional Support Contractors

Traffic information will be collected by the participating State DOTs (with LTPP support) at all SPS-11 project sites using existing LTPP SPS traffic validation (pooled-fund) protocols. (See references 37 through 40). However, instead of 5 years of WIM data, a minimum of 3 years' worth of collected using a quartz piezo sensor will be required. Once completed, continuous classification data will be collected for the remainder of the time the project remains in the LTPP program. The FHWA Traffic Monitoring Guide will be used for purposes of the continuous classification data collection. (41) The WIM data will provide information on loading and vehicle classification at each site, while continuous classification will provide the basis to expand loading data for later years by correctly weighting the various loading distributions.

The 3-year minimum for WIM data collection should allow capture of major variations due to economic cycles. The LTPP SPS traffic validation (pooled-fund) study used 5 years to fully cover high and low periods of economic activity since economic cycles typically last 3 years. It was found in this study that weight patterns by vehicle class tend to be stable over time. A 3-year requirement also recognizes that site calibration and validation required at periodic intervals is a resource demand. The quartz piezo sensor is one of the possible WIM sensors that has minimal temperature sensitivity. An installation with quartz piezo sensors, based on LTPP data studies would require only one validation during the expected sensor life. The calibration of a quartz piezo sensor typically holds with a bias that will not affect pavement design evaluations for 18 to 24 months. The typical minimum life of a correctly installed sensor in good pavement is 3 years. An initial data collection period, where an agency could use the site to supplement an existing weight group or test a hypothesis about weight group selection would allow the data to be used for other purposes. At the end of the period, an agency decision on reinstallation would not significantly affect the availability of loading information for the SPS-11 experiments.

The purpose of the on-going classification data collection requirement is to track truck growth (up or down) and to look for potential shifts in the distribution between classes. The shift in truck distributions can impact expansion of prior year loading information. This limits the utility of volume counts for ongoing data collection. Vehicle distribution changes may be a function of route utilization or agency changes in classification trees. LTPP research has found that about a quarter of all locations will have a significant shift in distribution within a 5-year period, an interval shorter than the length of the experiment.

All SPS-11 traffic data will be handled via electronic files and hence, data sheets are not required for this data element.

Climate

Like traffic, climate is one of four key factors that influence the performance of pavements—the other two factors are foundation subgrade soil and pavement structure. Accordingly, the objective of this data collection effort is to obtain climatic data, including moisture and temperature related information. It is hypothesized that, all other factors being the same, the performance of pavement is inversely proportional to moisture. The higher the moisture content in the pavement layers, the greater the performance reduction. In the case of temperature, the impacts on performance will depend on the specific pavement type and the metric used to measure performance. For example, the likelihood of rutting in asphalt pavement will increase as temperature increases.

The SPS-11 experiments do not require the installation of an AWS at each project site. Instead, climate data will be collected using two existing LTPP approaches. [42,43] One of them relies on climate data obtained from a new emerging climate data source developed by the NASA, MERRA, which provides continuous hourly weather data starting in 1979 on a relatively fine-grained uniform grid. The second approach relies on the traditional LTPP virtual weather stations from nearby operating weather stations. Both of these approaches are well established within the LTPP program and, as a result, no deviations are planned.

For purposes of the SPS-11 experiments, MERRA data will updated at 1-year intervals or less, while virtual station data will be generated for the project when it enters the LTPP program and then updated at intervals not to exceed 5 years. Both of these activities will be carried out by the LTPP TSSC. Like the traffic data, climatic data will be handled via electronic files and hence, data sheets are not required for this data element.

ADDITIONAL DATA COLLECTION

Pre-Treatment Testing

Ground Penetrating Radar

The objective of the GPR surveys is to clearly establish the condition of the pavement prior to and as part of the inclusion of a project into the SPS-11 experiments. Specific data elements to be pursued include:

- Determination of layer thickness information.
- Conduct of quality control.
- Presence of moisture within the pavement structure.
- Detection of voids within the pavement structure.
- Level of bonding, if any, between the pavement layers.

- Evaluation of granular base material.
- Detection of asphalt stripping and/or segregation.
- Presence of construction defects.
- Other pavement structure information that may affect pavement performance.

The project nomination guidelines specify pavement condition requirements that must be met in order for the project to be included in the SPS-11 experiments. This is important because the experiments assume that the project pavement will be in good condition and that preservation treatments will be applied to sections within the project at different points in time, starting when the pavement is in good condition and then at later times when the pavement has deteriorated to various levels.

As noted earlier, the GPR surveys will be conducted in accordance with AASHTO R-37-04 Standard Practice for Application of Ground Penetrating Radar (GPR) to Highways, as supplemented by ASTM D4718-10 Standard Test Method for Determining the Thickness of Bound Pavement Layers Using Short-Pulse Radar, ASTM D6432-11 Standard Guide for Using Ground Penetrating Radar for Subsurface Investigation, and Research Report FHWA/ TX-92/1233-1 Implementation of the Texas Ground Penetrating System. (See references 44 through 47.)

Unlike previous data collection efforts in this document, it is envisioned that the GPR surveys and subsequent data analyses will be carried out by a specialized GPR contractor (in accordance with the stated protocols) due to the highly specialized nature of GPR technology.

GPR surveys will only be conducted once at the SPS-11 projects, within 3 months prior to the application of the first preservation treatment at the project to enable determination that the project pavements meet the minimum condition requirements stipulated in the experiment nomination guidelines. All GPR data will be handled via electronic files and hence, data sheets are not required for this data element.

Monitoring Data

Subgrade Moisture

The objective of the subgrade moisture measurements is to monitor the impact of the preservation treatments at the SPS-11 project test sections on moisture conditions at the top of the subgrade. Without exception, the SPS-11 treatments are intended to prevent moisture from entering the pavement structure (as well as to protect the asphalt surface layer from the aging effects). Accordingly, it is hypothesized that moisture conditions will remain stable and not approach critical saturation conditions as a result of precipitation events, which could significantly affect the subgrade soil load carrying capabilities—these will be measured as part of the deflection testing to be conducted as part of the performance monitoring requirements addressed in chapter 5.

Subgrade moisture measurements are to be taken at all SPS-11 project test sections in accordance with ASTM D5220-02 Test Method for Water Content of Soil and Rock In-Place by the Neutron Depth Probe Method, as adapted by NCAT at the University of Auburn, which makes use of permanently installed moisture sealed tubes positioned such that the tip is embedded two inches into the subgrade. (48) A probe that contains both a nuclear source and a detector is then lowered into these tube for determining moisture at the top of the subgrade.

The moisture sealed tubes will be installed at both ends of the SPS-11 project and near the middle, in the mid-lane and in the buffer zone, at approximately 25 ft from the monitoring area. The moisture tubes are to be installed at least 3 months prior to the application of the first treatment at project site. Moisture measurements will be taken at the three locations within 1 week of treatment application.

In addition to the pre-treatment measurements, subgrade moisture will be routinely monitored at all SPS-11 projects on a quarterly, but not to exceed 6 months, basis for as long as the test section remains active within the LTPP program. The data sheet to be used for recording the subgrade moisture measurements and supporting information is contained in appendix B.4.

Snow Removal and Deicing

The collection of data on snow removal and deicing is another important data requirement for those SPS-11 projects in freeze areas. The objective is to collect information on snow removal and deicing equipment and materials as well as their frequency of use and history. It is hypothesized that all other factors being the same, snow removal equipment such as plows and snow blowers and/or material such as salt brine or deicers as well as their increased frequency will adversely affect the performance of pavements that have been subjected to preservation treatments.

Information on the snow removal and deicing practices used by the state highway agencies at the SPS-11 projects is detailed in the data sheet contained in appendix B.4. Individual data elements for each SPS-11 project include:

- Type(s) of snow removal equipment used.
- Frequency of snow removal on a monthly basis.
- Type(s) of deicing chemicals used.
- Frequency of application of deicing chemicals on a monthly basis.

It is recommended that the LTPP RSCs work with the SHAs so that the data sheet is:

- Completed on a monthly (or more frequent) basis during the winter months in freeze areas by participating State DOTs.
- Submitted by the SHAs to the LTPP RSCs within 2 weeks after the end of the reporting period.

As long as the project stays within the LTPP program, completion and submission of the data sheet is desired for those SPS-11 projects where snow removal and/or deicing are used, even if not a routine activity, but only for those months where actual snow removal and/or deicing was required. As stated earlier, the data sheet to be used for recording snow removal and deicing information and supporting information is contained in appendix B.4.

CHAPTER 7. SUMMARY AND CONCLUSIONS

The objective of the project documented in this report, as stated in the introductory chapter, was to design and implement a pavement preservation experiment within the LTPP program operational structure. Working closely with FHWA staff and the project ETG, the SPS-11 experiment design was formulated. This experiment was designed to capture information necessary to establish the impact of the timing of preservation treatments through a field study of in-service pavements starting from construction of the preservation treatment being studied. One of the analysis concepts for development of the experiment is to examine the effect of preservation treatments on pavement distress propagation rates, which will enable determination of their impact on pavement life extension and performance. In turn, this information and understanding will enable determination of the right timing, cost-effectiveness and benefits of preservation treatments.

An innovative experimental approach that segregates treatment types and project locations into discrete groups was adopted for the LTPP pavement preservation studies. The underlying concept is to apply the same preservation treatment, at different times, on the same pavement structure to determine the effectiveness of a single application of a treatment as a function of pavement condition and time. This concept is designed to try and capture the most appropriate time to perform a treatment and discover factors related to treatment timing. The vision of the experimental design is to choose pavements that have recently been constructed, reconstructed, or received a structural overlay. Starting with relatively new pavement structures at each project site, six test sections are established along a uniform road segment before any other preservation or maintenance treatments are applied. Over time (and hence change in pavement condition), the same preservation treatment is applied to different test sections. The length of the treatment application time span is intended to start before preservation treatments would normally be placed, and extend past the time they would normally be placed.

On completion of the experimental design, a series of guidelines were developed to facilitate the deployment of the experiments. They include:

- Construction guidelines, construction data collection guidelines, and construction report preparation guidelines.

- Guidelines or preparation of material sampling and testing plans, including new sampling and testing protocols.

- Performance monitoring guidelines.

- Guidelines for the collection of other data elements.

It is anticipated that the data collected using the above guidelines will help gain an understanding of how pavement preservation impacts the performance of pavements and why. In turn, this information and understanding will enable accomplishment of the stated objective for the LTPP pavement preservation experiments—determination of the right timing and cost-effectiveness of preservation treatments.

In addition to the various guidelines detailed above, dozens of presentations were prepared and delivered at conferences and meeting throughout the country, technical articles were also prepared and published in relevant magazines, and other technical materials were prepared in support of the SPS-11 experiment. Technical support to FHWA, State DOTS and other LTPP stakeholders was also provided.

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APPENDIX A. NEW CONSTRUCTION GUIDELINES

A.1 FHWA-ETF CONSTRUCTION GUIDES FOR CHIP SEALS

Final draft
Emulsified Asphalt Chip Seal

40x.01 **Description.** Construct a chip seal on a prepared surface. A chip seal is the application of emulsified asphalt, followed immediately by an application of a single layer of cover aggregate. A fog seal application may be used over the completed chip seal.

40x.02 **Material.**

A. Emulsified asphalt for chip seal shall meet the requirements of AASHTO M140 Standard Specification for Emulsified Asphalt, M208 Standard Specification for Cationic Emulsified Asphalt, or M316 Standard Specification for Polymer-Modified Cationic Emulsified Asphalt M 316 as applicable.

B. An emulsified asphalt fog seal may be applied to the surface of the completed chip seal. Fog seal emulsified asphalt shall be a SS-1h or CSS-1h, emulsified asphalt. The fog seal emulsified asphalt shall be diluted prior to application such that the residue of the diluted emulsion is not less than 28 percent.

C. Aggregate for chip seal shall conform to the requirements of the 2016 AASHTO Materials for Emulsified Asphalt Chip Seal (to be published in the near future).

D. Design the chip seal using a design method contained in the 2016 AASHTO Design Practice for Chip Seals to be published in the near future.

402x.03 **Equipment.**

A. Pressure Distributor**.** The pressure distributor shall have a ground speed control device interconnected with the emulsified asphalt pump such that the specified application rate will be supplied at any speed. The pressure distributor shall be capable of maintaining the emulsified asphalt at the specified temperature. The spray bar nozzles shall produce a uniform triple lap application fan spray, and the shutoff shall be instantaneous, with no dripping. All nozzles shall be oriented at the same angle between 15° and 30° using the wrench supplied by the distributor manufacturer. Each pressure distributor shall be capable of maintaining the specified application rate within +/- 0.015 gal/yd^2 for each load.

B. Aggregate Spreader**.** Use a self-propelled mechanical type aggregate spreader with a computerized spread control, capable of distributing the aggregate uniformly to the required width and at the designed rate. Use a self-propelled type mounted on pneumatic-tired wheels.

C. Pneumatic-Tired Rollers. Provide a minimum of three (3) self- propelled pneumatic-tired rollers. Pneumatic rollers capable of ballast loading, either with water or sand, which allows the weight of the machine to be varied from 6 to 8 tons to achieve the specified minimum contact pressure of 80 lbs/in^2. The alignment of the axles is such that the rear axle tires, when inflated to the proper pressure, can compact the voids untouched by the front-axle tire. All tires shall be as supplied by the roller manufacturer.

D. Brooms. Provide motorized brooms with a positive means of controlling vertical pressure and capable of cleaning the road surface prior to spraying emulsified asphalt material. Plastic bristle brooms are required to remove loose aggregate after chip sealing.

40x.04 Construction

A. Weather Limitations. Construct chip seal and fog sealing according to the following:

1. Ambient or pavement surface temperatures shall be 50F and rising.
2. Application of the chip seal should be only during daylight hours.
3. Suspend chip sealing if the pavement surface temperature exceeds 140°F.
4. The road surface shall be dry to damp.
5. Chip seal only when the chance for precipitation is zero or very low.

B. Road Surface Preparations**.** Clean the roadway surface on the same day before chip seal operations begin. Sweep the pavement with a motorized broom to remove loose material. Clean depressions not reached by the motorized broom with a hand broom. Clean the outer edges of the pavement to be sealed including an adjacent paved shoulder.

Cover utility castings (manholes, gate valve covers, catch basins, sensors, etc.) to prevent coating with emulsified asphalt. Suitable covering includes plywood disks, Kraft paper, roofing felt or other approved methods. Remove the protective coverings before opening the road to traffic.

Any hot mix asphalt patches that have been placed within six months of the chip seal shall have a fog seal applied prior to chip seal operations. The fog seal must be completely cured prior to chip seal application.

C. Application of Emulsified Asphalt. Prior to construction, calibrate the pressure distributor by applying a minimum of 500 gallons of emulsified asphalt to the roadway. Measure the volume of emulsified asphalt in the distributor using the dipstick supplied with the distributor. Compare the volume in the distributor before and after the minimum of 500 gallons is applied and divide this value by the area of emulsified asphalt applied. The actual rate applied should be within +/-5% of the target rate determined from the chip seal design. After applying the emulsified asphalt, place the cover aggregate at the design application rate. Make adjustments to the rate of application, if necessary, so that some emulsified asphalt can be seen between the aggregate chips, but not so much that aggregate chips adhere to the pneumatic rollers. Inspect the aggregate in the wheel paths for proper embedment. Embedment should be 50 to 60 percent after rolling. Make additional adjustments to the rate of application during the project, if needed.

The temperature of the emulsified asphalt at the time of application shall be above 120F.

Longitudinal construction joint for a single course chip seal must coincide with the painted lane line or at the outside edge of shoulder. The longitudinal construction joint for a double course chip seal shall have the first course overlap the painted lane line 6 inches and the second course shall coincide with the original lane line location. There shall be no overlap of the longitudinal construction joint for a single application chip seal.

D. Application of Cover Aggregate**.** Prior to construction, evaluate the lateral spread uniformity by visually observing the flow of aggregate as it exits the spreader box. Stop the spreader and adjust the gate openings if any non-uniformity is observed. Then, if coarse adjustment is needed, adjust the appropriate gates and determine the flow of aggregate using ASTM D5624 Determining the Transverse Aggregate Spread Rate for Surface Treatment Applications. Adjustment of the spreader shall be completed when the actual spread rate matches the target design spread rate by +/- 10%. The longitudinal spread rate shall be measured by the same procedure by placing one measuring pad directly in front of the spreader at 500 foot intervals for 1500 feet.

Provide uniformly moistened aggregates, which are damp at the time of placement. Immediately (within one minute) after the emulsified asphalt has been sprayed, apply the aggregates. The speed of the spreader shall be restricted to avoid the aggregates from rolling, and starting and stopping of the spreader is minimized. The edges of the aggregate applications shall be sharply defined. Previously used aggregates from sweeping may not be returned to the stockpile or the spreader for reuse.

E. Transverse Paper Joints**.** When beginning a new application of the chip seal abutting the previously placed chip seal a transverse paper joint shall be used so excess asphalt and chips are not placed at the joint. The transverse paper joint shall be formed by placing 36 inch wide Kraft paper on top of the previously applied chip seal so the edge of the paper aligns with the joint that will be formed when the previously placed chip seal meets the newly applied chip seal. The asphalt distributor shall begin applying asphalt emulsion by starting the application on top of the Kraft paper. As the distributor moves forward and over the joint the paper shall be removed.

E. Rolling Operations**.** Complete the first roller pass as soon as possible but not longer than two minutes after applying the aggregate. Proceed in a longitudinal direction at a speed less than or equal to three miles per hour. Three complete roller passes of the aggregate chips are required. One pass is defined as the roller moving over the aggregates in either direction. Ensure the rolling is completed quickly enough to embed the aggregate, before the emulsified asphalt breaks and no longer than 15 minutes. Position the rollers in echelon so the entire width of the pavement lane is covered in one pass of the rollers. The total compacting width of each pneumatic-tired roller shall exceed 5 feet.

F. Sweeping**.** Excess cover aggregate shall be removed from the pavement surface by sweeping no later than the morning after placement of the seal coat.

Exercise care to not disturb aggregate that has set. Re-sweep prior to opening to unrestricted traffic. The Contractor will dispose of the surplus cover aggregate in a manner satisfactory to the Department.

G**.** Protection of the Surface. Traffic may be allowed onto the fresh chip seal after rolling is completed and before sweeping. The seal coat shall be protected by keeping traffic off of the freshly sealed surface or by controlling traffic speeds with pilot vehicles or other approved methods such that traffic does not displace imbedded aggregate.

A pilot car shall be used on 2-lane roadways during construction and until the roadway and shoulders have been swept free of loose aggregate.

H. Protection of Motor Vehicles**.** The Contractor is responsible for claims of damage to vehicles until the roadways and shoulders have been swept free of loose aggregate and permanent pavement markings have been applied. If permanent pavement markings are to be applied by Agency forces, the Contractor's responsibility ends after completion of the fog seal and placement of temporary pavement markings.

I. Application of Emulsified Asphalt for Fog Sealing**.** Fog seal all chip seal areas after sweeping and before placement of permanent pavement markings, but not sooner than 24 hours after final rolling. Diluted emulsified asphalt should be initially applied at an application rate of from 0.06 to 0.12 gal/yd^2. Construct a 100 foot test strip for a fog seal and adjust the application rate as needed and assure that a uniform application of the fog seal emulsion is applied with no streaking. Apply the fog seal to minimize the amount of overspray and do not allow traffic on the fog seal until it has cured.

J. Sequence of Work**.** Construct the chip seal so that adjacent lanes are sealed on the same day when possible. If the adjacent lane(s) has not been sealed sweep all loose chips from the unsealed lane(s) before traffic is allowed on the surface without traffic control.

The chip seal will usually cure within 24 hours under dry conditions and temperatures above 60°F. The fog seal can be applied after the chip seal coat is cured. The fog seal will usually cure within 2 hours under dry conditions and temperatures above 60°F. Interim pavement markings can be placed after the fog seal cures. The permanent pavement markings shall not be placed for three days after placing the fog seal for water borne pavement marking or ten days for other types.

40x.05 Quality Control. The Contractor is responsible for quality control (QC) sampling and testing and shall submit a QC plan including materials and procedures.

A. Chip Seal Aggregate

1. Stockpile. The gradation testing rate is a minimum of one per day, or one per 1500 tons, whichever is greater. If the material is hauled from the production site to a temporary stockpile, test at the temporary stockpile.

2. Construction. Provide aggregate gradation and quality test results from samples taken from the hopper of the chip spreader. The testing rate for gradation is a minimum of one per day, or one per 1500 tons, whichever is greater. The testing rate for quality values in table 6.1 is once per source.

B. Emulsified Asphalt**.** Only emulsified asphalt from certified or approved source is allowed for use.

Verify the application rate of the emulsified asphalt by dividing the volume of emulsified asphalt used by the area chip sealed each day. Allowable variation is +/- 5% of the application rate adjusted from the design quantity. Provide material certification and quality control test results for each batch of emulsified asphalt used on the project. Include the supplier name, plant location, emulsion grade, and batch number on all reports.

40x.06 **Agency Acceptance.** The Agency is responsible for acceptance sampling and testing. Samples must be taken randomly by the Agency.

1. Chip Seal Aggregate**.** Sample aggregate taken from the chip spreader hopper once per day. Samples will be stored and tested for gradation at the discretion of the Agency. If the results vary from the requirements of table 6.1, a price reduction will be applied.
   a. Price Reduction for Failing Gradations
      i. The Contract bid price for chip seal will be reduced 2 percent, for each 1 percent passing outside of the requirements for any sieve, except the 75 µm (# 200) sieve.
      ii. The 75 µm (# 200) sieve will have 2 percent price reduction for each 0.1 percent outside of the specification.
      iii. All failing results will be added together. The deductions apply to the specification range only. If any gradations fall outside of the quality

control range but within specifications, stop construction and a new design will be required.

2. Emulsified Asphalt. Sample every tanker supplying the distributor on the project. Testing of emulsions shall be in accordance with AASHTO M140 Standard Specification for Emulsified Asphalt, M208 Standard Specification for Cationic Emulsified Asphalt, or M316 Standard Specification for Polymer-Modified Cationic Emulsified Asphalt, as applicable.

40x.07 Method of Measurement

1. Emulsified Asphalt
   a. Measure the emulsified asphalt for chip seal by volume, at 60°F.
   b. Measure the diluted emulsified asphalt for fog seal by volume, at 60°F.

2. Aggregate Chips
   a. Aggregate chips will be paid for by the area of pavement surfaced.

40x.08 Basis of Payment

1. Payment for diluted emulsified asphalt for fog seal is compensation in full for all costs of furnishing and applying the material.

2. Payment for the applied and accepted quantity of emulsified asphalt for chip seal (including any required additives) at the Contract bid price of measure is compensation in full for all costs of furnishing and applying the material as specified.

3. Payment for the accepted quantity of seal coat at the Contract bid unit price of measure is compensation in full for all costs of furnishing and applying the material as specified, including cleaning the existing pavement, stationing, purchase of aggregate, delivery of aggregate, all labor, equipment, and materials necessary for the placement of the chip seal for full lane coverage, sweeping of any loose aggregate after construction and other requirements as specified.

4. Payment will be made in accordance with the schedule set forth below at the Contract bid price for the specified unit of measure. Such payment, in each instance, is compensation in full for all costs incidental thereto.

Item No.	Item	Unit
State ##	Emulsified asphalt for Chip Seal Gallon	
State ##	Diluted Emulsified asphalt for Fog Seal Gallon	
State ##	Aggregate used in the Chip Seal Square Yard	

A.2 FHWA-ETF CONSTRUCTION GUIDELINES FOR MICRO-SURFACING

Final draft
Micro-surfacing

408.01 Description. Construct micro-surfacing on a prepared surface.

408.02 Material.

A. Use polymer modified emulsified asphalt meeting requirements for CQS-1hp or CQS-1p in AASHTO M 316.

B. Use aggregate that meets the requirements of 2016 AASHTO specs for Materials for Emulsified Asphalt Micro-surfacing.

C. Use mineral filler that meets the requirements of 2016 AASHTO specs for Materials for Emulsified Asphalt Micro-surfacing.

D. Use water that meets the requirements of 2016 AASHTO specs for Emulsified Asphalt Micro-surfacing.

E. Use additives that meet the requirements of 2016 AASHTO Materials for Emulsified Asphalt Micro-surfacing.

408.03 Mix Design

A. Develop a job-mix formula conforming to the 2016 AASHTO Design practice for Micro-surfacing. Submit the job-mix formula for approval at least 14 days before production. Report all laboratory test results from 2016 AASHTO Design practice for Micro-surfacing.

408.04 Equipment

A. Mixing Equipment

Mix materials in a specifically designed paver, either truck mounted or continuous run machines, to be determined by the Agency. Use a paver with a continuous-flow mixing unit able to accurately proportion and deliver the aggregate, emulsified asphalt, mineral filler, water, and additives, to a continuous flow mixing chamber. Use a paver with sufficient storage capacity for all the mixture ingredients to maintain an adequate supply to the mixing chamber.

If a continuous run machine is required by the Agency to reduce construction joints, use a machine capable of loading materials while continuing to apply micro-surfacing.

B. Proportioning Devices

Provide and identify individual volume or weight controls for proportioning each material.

C. Spreading Equipment

Use a spreader box equipped with spiral augers permanently fixed to the box. Provide a front seal to eliminate any loss of the mixture and an adjustable rear seal to control the application rate of the material. Design the spreader box and rear seal so that a uniform mixture is delivered to the secondary strike-off. Provide a box capable of shifting laterally to compensate for variability in the geometry of the pavement.

D. Secondary Strike-off

Equip the spreading equipment with a secondary strike-off with the same leveling adjustment capabilities as the spreader box to provide a satisfactory surface texture.

E. Rut Box

Provide a rut box specifically designed and manufactured to fill ruts. Provide a rut box for each designated wheel track. Use a 5-6 feet (1.5-1.8 meters) wide rut box with a dual chamber and an inner “V” configuration of augers to channel the large aggregate toward the center of the rut and the fines to the edges of the rut fill pass. Equip the box with a dual strike-off plate to control the width and depth of the rut fill.

F. Brooms

Provide motorized brooms with a positive means of controlling vertical pressure and capable of cleaning the road surface prior to placing micro-surfacing.

G. Rolling

Where required by the Agency, use a self-propelled, 10 ton (maximum) pneumatic tire roller equipped with a water spray system. All tires should be inflated per the manufacture’s specifications.

408.05 Construction

A. Weather Limitations

Do not apply micro-surfacing if either the pavement temperature or the air temperature is below 50°F (10°C) and falling. Do not apply micro-surfacing when rain is expected before the mix is cured. Do not apply micro-surfacing when temperatures below 32°F (0°C) are expected within 24 hours.

B. Mix Paver Calibration

Calibrate the mix paver to be used for the placement of micro-surfacing in the presence of the engineer according to ISSA A143 Recommended Performance Guidelines for Micro-Surfacing or a method recommended by the mix paver manufacturer.

C. Preconstruction Meeting

Coordinate a preconstruction meeting prior to construction with the engineer to discuss the following topics:

-the construction process
-mix design
-materials control
-materials measurement
-equipment calibration
-traffic control plan
-quality control plan
-equipment/process overview
-inspection
-test strip
-unique project conditions
-project documentation

D. Pavement Surface Preparation

Clean the pavement surface of all loose material, vegetation, and other objectionable materials immediately before applying the micro-surfacing. Allow all pavement surface cracks to dry thoroughly, if water is used, before applying the micro-surfacing mixture. Cover service entrances (i.e., manhole covers, valve boxes) with an approved method. Eliminate dry aggregate, either spilled from the mixing machine or existing on the pavement surface.

Allow crack sealant material to cure for a minimum of 7 days on pavement surfaces that have been crack sealed before application of the micro-surfacing.

Apply a tack coat, if required by the Agency, according to Section 404 using an emulsified asphalt meeting the requirements of AASHTO M140 Standard Specification for Emulsified Asphalt, M208 Standard Specification for Cationic Emulsified Asphalt, or M316 Standard Specification for Polymer-Modified Cationic Emulsified Asphalt. Dilute the emulsified asphalt one part emulsion to one part water, or as approved by the engineer. Apply the diluted tack coat at the rate of 0.05 to 0.10 gallons/yd^2 (0.16 to 0.32 liters/m^2). Allow the tack to cure sufficiently before the application of the micro-surfacing.

E. Test Strip

Coordinate with the Agency for a test strip to be constructed on or near the project site. Construct the test strip under similar placement conditions of time of day, temperature, and humidity as expected for the duration of the project. Construct the test strip a minimum of 300 feet in length with the job mix proportions, materials, and equipment to be used on the project. Adjust the mixture formula if necessary for localized roadway conditions but do not exceed the tolerances stated in the mix design. Cease production after construction of the test strip until the test strip is evaluated and accepted by the Agency. Repeat the test strip process until an acceptable test strip is produced at no additional cost to the Agency. Correct unacceptable test strips, if necessary, at no additional cost to the Agency.

F. Application of Mixture

For mix consistency and performance, adjustments to the job mix formula are allowed and must remain within the tolerances set forth in the mix design.

Wet the surface of the pavement by fogging ahead of the spreader box. The rate of application shall not result in pooling of water on the surface to be paved.

In areas not accessible to the spreader box, use hand tools to provide a complete and uniform coverage. Clean and lightly dampen these areas before placing the mix. Produce a finished texture that is uniform and neat in appearance.

Where required in the plans, use the rut box to fill ruts and depressions equal to or greater than 0.5 inch. For ruts of less than 0.5 inch, a full width scratch course using the conventional spreader box is acceptable. Where ruts exceed 1.5 inches, multiple passes with the rut box are necessary.

Cure rut filled areas under traffic for at least 24 hours before the final surface course is placed. Use a Type III gradation for rut filling as specified in table 6.2 of 2016 AASHTO Materials Specifications for Micro-surfacing Meet the longitudinal and transverse profile as described in Section 408.04(G).

When required, roll pavement surfaces with a minimum of two full coverage passes after the mixture has cured to the point where it will not be damaged by the roller.

Clean all areas including service entrances, gutters, and intersection debris associated with the placement of the micro-surfacing on a daily basis. At the direction of the engineer, sweep raveled aggregate.

G. Workmanship

Produce longitudinal and transverse joints uniform and neat in appearance with no material build-up or uncovered areas. Construct longitudinal joints on lane lines, edge lines, or shoulder lines with a maximum overlap of 3 inches. Product longitudinal joints straight in appearance along the centerline, lane lines, shoulder lines, curbs, intersections and edge lines.

Produce longitudinal edge lines that do not vary by more than ± 2 inches (± 51 mm) in 100 linear edge feet.

Produce a finished surface with a uniform texture free from excessive surface defects, ripples, or drag marks. A single drag mark exceeding 0.5 inch in width and 6 inches in length or a total of four drag marks within 100 linear feet in a single pass are considered to be excessive when they exhibit the following criteria:

- 0.5 inch wide or wider
- 6 inches or more long

Construct transverse joints as butt-type joints. Joints are acceptable if there is no more than 0.25 inch vertical space for longitudinal joints, and no more than 0.125 inches for a transverse joint between the pavement surface and a 10 foot straightedge placed perpendicular to the joint.

H. Opening to Traffic.

Open the pavement to rolling traffic within one hour after placement. Do not allow traffic on newly completed surface course until mix has set sufficiently to prevent pick-up. Stopping and starting traffic may require additional curing time. Construct the micro-surfacing so that adjacent lanes are placed on the same day when possible.

Place temporary pavement markings after the micro-surfacing cures. Do not place permanent pavement markings for 3-5 days for water borne pavement markings or per manufacturer’s recommendations for other types.

408.06 Quality Control.

The contractor is responsible for QC sampling and testing and shall submit a QC plan including materials and procedures.

A. Aggregate

1. Sample and test the aggregate a minimum of once per day of production of the screening operation at the project stockpile site with a sample consisting of three test portions tested in accordance with AASHTO T2 Standard Practice for Sampling Aggregates, T11 Standard Method of Test for Materials Finer Than 75-

micro m (No. 200) Sieve in Mineral Aggregates by Washing, T27 Sieve Analysis of Fine and Coarse Aggregates, and T255 Standard Method of Test for Total Evaporable Moisture Content of Aggregate by Drying.

2. Verify the application rate of aggregate using the paver's calibration records.

B. Emulsified Asphalt

1. Only emulsified asphalt from certified or approved sources is allowed.

2. Verify the application rate of the emulsified asphalt using the paver's calibration records. Provide material certification and quality control test results for each load of emulsified asphalt used on the project. Include the supplier name, plant location, emulsion grade, and batch number on all reports.

C. Project Documentation

Supply daily documentation to the Agency that includes the following:

1. Aggregate used, tons (dry)
2. Micro-surfacing emulsified asphalt used, tons
3. Emulsified asphalt for tack coat used, if specified, tons
4. Mineral filler used, pounds
5. Water used in mixture, gallons
6. Additive used in mixture, gallons
7. Surface area completed, square yards
8. Surface area application rate, dry pounds of aggregate per square yard
9. Percentage of emulsified asphalt based on dry aggregate

408.07 Acceptance.

The Agency is responsible for acceptance sampling and testing. Samples must be taken randomly by the Agency.

A. Aggregate.

The engineer will sample aggregate from the stockpile at least once per day. Samples will be stored and tested for gradation. The contractor may be allowed to request split samples from the Agency.

B. Emulsified Asphalt.

The engineer will sample the first tanker load from a certified manufacturer supplying the project and every 50,000 gallons thereafter. Every tanker shall be sampled when supplied by a non-certified supplier. Testing of emulsified asphalt shall be in accordance with AASHTO M-316. The contractor is permitted to request a split sample of the emulsified asphalt.

408.08 Method of Measurement

The engineer will measure work acceptably completed as specified in Subsection 109.01 and as follows:

A. The engineer will not measure mix water or water used to pre-wet the pavement surface.

408.09 BASIS OF PAYMENT

The Agency will pay for accepted quantities at the contract unit price as follows:

Pay Item	Pay Unit
A. Aggregate for micro-surfacing	ton (Mg)
B. Emulsified asphalt (polymer)	ton (Mg), gal (L)
C. Filler	ton (Mg)

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

APPENDIX B. DATA SHEETS

B.1 PROJECT NOMINATION FORMS

The purpose of this section of appendix B is to provide information, guidelines and forms for nominating candidate projects for acceptance in the LTPP SPS-11experiment. The following instructions should be used to complete a set of three SPS-11 candidate project nomination forms. They are:

- Sheet A. General Project Information
- Sheet B. Existing Pavement Structure Information
- Sheet C. Test Sections

One set of forms is required for each SPS-11 project site being nominated. Tables containing layer material class codes, which are required for completion of Sheet B, are included at the end of this appendix section.

Sheet A. General Project Information

This sheet includes information on project location, significant dates, a general project description, and design traffic.

State/Province. State or province in which the project is located. Enter either the two-digit LTPP STATE_CODE for the agency, or two character postal designation.

SHRP ID. This four-digit SHRP ID will be assigned by FHWA if the project is selected for inclusion in the SPS-11 experiment, and it will be used as a project reference number.

Date. Enter the date the form was filled out or submitted.

Project Location

This portion of the form provides information on the location of the candidate project. In this document, a project refers to the overall construction project. Test sections refer to 1,250 ft portions of the project in which the experimental pavement structures are constructed.

Route Designation. This is the general higher level route designation used on highway maps assigned to the route on which the project is located. Please indicate the most common designation for routes with multiple designations.

Coordinates. This is the location of the start of the project on the side of the road in the direction of travel. The latitude and longitude as determined from a convenient mapping source, such as the Google Earth or other mapping software is sufficient. The coordinates will be designated in fractions of a degree to at least 5 decimal places.

Location Description. This is a written description of the location of the start of the project referenced to a permanent landmark, such as mileposts/milepoints, signed highway intersections, road intersections, signed or labeled bridges, underpasses, overpasses, rest areas and railroad crossings. The objective is to provide a reference for field crews to easily locate the section in the field. Distances from a landmark located prior to the section, in the direction of travel and a landmark located past the start of the section should be specified. For example, "The start of the project is 1.5 mi north of overpass 20-45-43; the intersection with I-71 is located 2.1 mi north of the start of the project" (assuming the direction of travel in northbound).

Direction of Travel. Check the box that describes the direction of travel of the lane proposed for the project. The direction of travel should be as the route is signed. For example, if the lane is on I-71, only northbound or southbound should be chosen, even if route trends mostly east-west within the project limits.

Facility Type. Check the box divided if there is a median, curb, or other permanent barrier between the directions of traffic.

Number of Lanes. For an undivided road, enter the total number of lanes in both directions. For a divided road, enter the number of lanes in the project direction.

County. This is the county or county-level governmental jurisdiction unit in which the project is located. If the project is located in more than one county, indicate the county first encountered in the direction of travel.

Highway Agency District. Enter the highway agency's district, division or region designation in which the project is located.

Experiment Type

Check the box which indicates the SPS-11 experiment type being proposed for the location. Check more than one box if the intention is to collocate multiple experiments on the same site. Note that each experiment requires 6 separate test sections to be established.

Significant Dates

Original Pavement Construction. This is the date the original pavement was constructed. Estimate to the nearest year.

Last Overlay or Reconstruction. This is the date of the placement of the most recent AC overlay.

Traffic

AADT (in project lane). This is the estimate of the annual average daily traffic (AADT) volume of all vehicles in the project lane only.

Percent Heavy Trucks and Combinations. This is the ratio of trucks and heavy combinations to total vehicles (AADT) expressed to the nearest percent. This excludes all pickups, panels, other two axle, and four tire trucks. This is for the traffic in the project lane only.

Annual 18-kip ESALs (in project lane). Provide an estimate of the current average application rate of heavy truck loadings, in 18-Kip ESAL applications, in the study lane of the proposed project. This should be the design number of ESAL applications divided by the duration of the design period.

Traffic Equipment

Permanent WIM installed that can be applied to test sections? (Y or N). Indicate if an existing permanent WIM is installed within close proximity to the proposed location. The WIM needs to be on the same route, in the same direction of travel, and have the same traffic loadings/patterns as the site location.

WIM Location. Provide the location of the existing WIM (Lat/Long).

WIM Type/Manufacturer. Provide information on the type of WIM equipment installed.

Last Calibration Date of WIM. Provide the date of the last known calibration of the WIM equipment. Leave blank if unknown.

Does Agency agree to provide a minimum of 3 years of WIM data? If a permanent, full time WIM is not currently available for the proposed location, please indicate if the agency is willing to install one.

Sheet B. Existing Pavement Structure Information

The purpose of this sheet is to provide information on the existing pavement structure at the project site.

State/Province. State or province in which the project is located. Enter either the two digit LTPP STATE_CODE for the agency, or two character postal designation.

SHRP ID. Assigned by LTPP staff.

Pavement IRI. Provide an average or most representative IRI for the existing pavement at the project site.

Pavement Condition. Provide a description of the general pavement condition using the most recent agency information. When available include Pavement Condition Index (PCI), or other condition index (or indices) used by the highway agency from the most recent survey. Note that pavements suitable for inclusion in the experiment should be in like new condition with no to minor surface distresses.

Existing Layer Structure. This is a general description of the pavement layer structure existing at the project location.

Layer No. This layer number convention starts with the naturally occurring subgrade as layer 1 and progresses to the pavement surface as the highest numbered layer. Each unique material above the subgrade is assigned a layer number, layer description, and corresponding material type code. Multiple lifts of the same material can be combined into a single layer. Fabrics, surface treatments and other thin layers should be included.

Layer Description. Describe the layer in general terms. Examples include “Select fill”, “Aggregate Base”, and “Hot-Mix”. Please use generic terms such as embankment, subbase, base, original AC layer, overlay, and avoid agency-specific descriptions.

Material Type Class Code. The two digit codes identifying the type of material in each layer of the pavement structure are shown in table 33 through table 36. The purpose of this information is to provide a general identification of materials for classification and project selection.

Thickness (inches). This is the nominal thickness of each existing layer, in inches. Enter a thickness of 0.1 for very thin layers.

Sheet C. Test Sections

This sheet includes general information on the number of proposed test sections and details on planned supplemental sections.

Number of Core Test Sections. This is the number of core test sections planned for the project. If the proposed number of test sections does not equal 6 for each experiment proposed for the project site, please provide an explanation under the site deviation comments.

Number of Planned Supplemental Test Sections. This is the number of planned supplemental test sections an agency proposes to construct on the project site in addition to the core test sections. The number of core and supplemental sections will be used to assess the suitability of the length and characteristics of the proposed site location.

Description of Supplemental Sections. Describe the general nature of the planned supplemental test sections including type(s) of preservation treatment and placement timing considerations.

Site Deviations Comments. Provide brief comments describing significant deviations from the desired site location criteria presented in this document. Include in these comments items such as traffic pattern interruptions, intersections between test sections, substructures, cut-fill changes, less than required number of core test sections, traffic control limitations, planned future construction events, etc.

Please attach additional agency documentation to these nomination forms in order to provide information that will help LTPP evaluate the suitability of the proposed project site.

Sheet A. SPS-11 Candidate Project Nomination and Information

STATE/PROVINCE ________________ Date _____________________
SHRP ID ________________ DD/MMM/YYYY

General Project Information

Project Location

Route Designation ______________
GPS Coordinates Latitude ° _ _ . _ _ _ _ _ Longitude ° -_ _ _._ _ _ _
Project Length (miles) ____
Location Description ____
____
____

Direction of Travel [ ] Northbound [ ] Southbound [ ] Westbound [ ] Eastbound
Facility Type [ ] Divided [ ] Undivided
Number of Lanes (in both directions if undivided) ______________
County ______________
Highway Agency District ______________

Experiment Type(s)

[ ] Thin overlay [ ] Chip Seal [ ] Micro-Surfacing

Significant Dates

Original Pavement Construction/Reconstruction ______________________
Last Overlay ______________________

Traffic
AADT (**in project lane**) ________________
Percent Heavy Trucks and Combinations
on project lane ________________
Annual 18-kip ESALs (**in project lane**) ________________

Traffic Equipment
Permanent WIM installed that can be applied to test sections? (Y or N) ____________________
WIM Location Latitude ° _ _ . _ _ _ _ _ Longitude ° -_ _ _._ _ _ _
WIM Type/Manufacturer ____
Last Calibration Date of WIM ________________
Does Agency agree to provide a minimum of three years of continuous
WIM data? (Y or N) ____________________

Sheet B. SPS-11 Candidate Project Nomination and Information

STATE/PROVINCE ____________________
SHRP ID ____________________

Existing Pavement Structure Information

Pavement IRI (in/mile) ____
Pavement Condition ____
____
____

Existing Layer Structure

Layer No.[1]	Layer Description	Material Code[2]	Thickness (in)
1	**Subgrade**		
2			
3			
4			
5			
6			
7			
8			
9			

Notes:

1. Layer 1 is the naturally occurring subgrade soil. The pavement surface will have the largest assigned layer number.
2. Refer to table 33 through table 36 for material class codes.

Sheet C. SPS-11 Candidate Project Nomination and Information

STATE/PROVINCE ____________________
SHRP ID ____________________

Test Sections

Number of Core Test Sections ________________
Number of Planned Supplemental Test Sections ________________
Describe Proposed Supplemental Test Sections ________________________________

____
____
____
____
____
____
____

Site Deviation Comments ________________________________

____
____
____
____
____
____

Table 33. Pavement surface material type classification codes.

Hot Mixed, Hot Laid, Asphalt Concrete, Dense graded	01
Hot Mixed, Hot Laid, Asphalt Concrete, Open Graded (Porous Friction Course)	02
Sand Asphalt	03
Jointed Plain Portland Cement Concrete	04
Jointed Reinforced Portland Cement Concrete…	05
Continuously Reinforced Portland Cement Concrete	06
Prestressed Portland Cement Concrete	07
Fiber Reinforced Portland Cement Concrete	08
Plant Mix, Cold Laid, Emulsified Asphalt Material	09
Plant Mix, Cold Laid, Cutback Asphalt Material	10
Single Surface Treatment	11
Double Surface Treatment…	12
Hot Recycled, Central Plant Mix, Asphalt Concrete	13
Central Plant Mix, Cold Laid, Recycled Asphalt Concrete…	14
Mixed-in-place, Cold Laid, Recycled Asphalt Concrete	15
Heater Scarification/Recompaction, Recycled Asphalt Concrete	16
Jointed Plain Recycled Portland Cement Concrete	17
Jointed Reinforced Recycled Portland Cement Concrete	18
Other	19
Warm Mix Asphalt Concrete, Dense Graded	91
Warm Mix Asphalt Concrete, Open Graded	92
Warm Mix Asphalt Concrete, Gap Graded	93

Table 34. Base and subbase material type classification codes.

No Base (Pavement Directly on Subgrade)	21
Uncrushed Gravel	22
Crushed Stone, Gravel or Slag	23
Sand	24
Soil-Aggregate Mixture, Predominately Fine-Grained Soil	25
Soil-Aggregate Mixture, Predominately Coarse-Grained Soil	26
Soil Cement	27
Bituminous Dense Graded, Hot Laid, Central Plant Mix	28
Bituminous Dense Graded, Cold Laid, Central Plant Mix	29
Bituminous Dense Graded, Cold Laid Mixed-in-place	30
Bituminous Open Graded, Hot Laid, Central Plant Mix	31
Bituminous Open Graded, Cold Laid, Central Plant Mix	32
Bituminous Open Graded, Cold Laid, Mixed-in-place	33
Recycled Asphalt Concrete, Plant Mix, Hot Laid	34
Recycled Asphalt Concrete, Plant Mix, Cold Laid	35
Recycled Asphalt Concrete, Mixed-in-place	36
Sand Asphalt	46
Cement Aggregate Mixture	37
Lean Concrete (< 3 sacks/cy)	38
Recycled Portland Cement Concrete	39
Sand-Shell Mixture	40
Limerock, Caliche (Soft Carbonate Rock)	41
Lime-Treated Subgrade Soil	42
Cement Treated Subgrade Soil	43
Pozzolanic-Aggregate Mixture	44

Table 35. Subgrade soil description codes.

FINE-GRAINED SUBGRADE SOILS

Clay (Liquid Limit > 50)	51
Sandy Clay	52
Silty Clay	53
Silt	54
Sandy Silt	55
Clayey Silt	56

COARSE-GRAINED SOILS

Sand	57
Poorly Graded Sand	58
Silty Sand	59
Clayey Sand	60
Gravel	61
Poorly Graded Gravel	62
Clayey Gravel	63
Shale	64
Rock	65

Table 36. Material type classification codes for thin seals and interlayers.

Chip Seal Coat	71
Slurry Seal Coat	72
Fog Seal Coat	73
Woven Geotextile	74
Nonwoven Geotextile	75
Stress Absorbing Membrane Interlayer	77
Dense Grades Asphalt Concrete Interlayer	78
Aggregate Interlayer	79
Open Graded Asphalt Concrete Interlayer	80
Chip Seal with Modified Binder (Excluding Absorbing Membrane)	81
Sand Seal	82
Asphalt Rubber Seal Coat (Stress Absorbing Membrane)	83
Sand Asphalt	84
Other	85

B.2 CONSTRUCTION DATA SHEETS

The purpose of this section of appendix B is to detail the construction data collection requirements for test sections in the LTPP SPS-11 experiment. These requirements are to be completed by the LTPP RSCs, through the use of LTPP-developed data sheets, with support from the participating highway agencies in order to develop complete construction data suites for each SPS-11 project.

A set of tables containing definitions or codes, which are required for completion of several of the SPS-11 construction data sheets, are included at the end of this appendix section.

Supplemental sections may contain treatment types for which the SPS-11 data sheets are not adequate to record the necessary information about these treatments. For these sections, additional data sheets from the LTPP Maintenance and Rehabilitation Guide, issued under separate directive, should be used to supplement the SPS-11 data sheets. The Guide contains further information on which sheets are appropriate for each construction event type.

SPS-11 DATA SHEETS

SPS-11 data sheets for the SPS-11 experiment include items for identifying general project and section specific attributes, as well as many layer and material specific items. Under the section Data Collection and Recording there is a complete set of SPS-11 Data Sheets, along with descriptions of each data sheet.

The LTPP SPS construction data sheets listed in table 37 were developed for the SPS-11 experiment.

Table 37. List of LTPP data sheets and titles.

LTPP SPS-11 Construction Data Sheet Number	LTPP SPS-11 Construction Data Sheet Title
LTPP SPS-11 Data Sheet 1	Project Identification
LTPP SPS-11 Data Sheet 2	Project Stations
LTPP SPS-11 Data Sheet 3	General Information
LTPP SPS-11 Data Sheet 4	Layer
LTPP SPS-11 Data Sheet 5	Age and Major Improvements
LTPP SPS-11 Data Sheet 6	Snow Removal/Deicing
LTPP SPS-11 Data Sheet 7-8	HPMS Data Items
LTPP SPS-11 Data Sheets 9-11	AC Aggregate Properties
LTPP SPS-11 Data Sheet 12	AC Binder
LTPP SPS-11 Data Sheet 13	AC Binder Aged
LTPP SPS-11 Data Sheet 14	AC, DSR, BBR, Direct Tension
LTPP SPS-11 Data Sheet 15	RAP
LTPP SPS-11 Data Sheets 16-17	PMA Lab Mix Design
LTPP SPS-11 Data Sheet 18	PMA Lab Mix Design Warm Mix
LTPP SPS-11 Data Sheets 19-20	PMA Mix Prop
LTPP SPS-11 Data Sheet 21	SUPERPAVE MIXTURE PROPERTIES
LTPP SPS-11 Data Sheets 22-23	PMA CONSTRUCTION
LTPP SPS-11 Data Sheets 24-25	UNBOUND
LTPP SPS-11 Data Sheets 26-27	SUBGRADE
LTPP SPS-11 Data Sheet 28	QC MEASUREMENTS
LTPP SPS-11 Data Sheet 29	FIELD THICKNESS
LTPP SPS-11 Data Sheet 30	NOTES AND COMMENTS
LTPP SPS-11 Data Sheet 31	IMPROVEMENT LISTING
LTPP SPS-11 Data Sheet 32-33	CHIP SEAL APPLICATION
LTPP SPS-11 Data Sheet 34-35	MICRO-SURFACING APPLICATION

The following table should be used to complete the SPS-11 Data Sheets for the SPS-11 project and sections.

Table 38. List of LTPP data sheets to be completed for each section.

Construction Data Sheets	Thin Overlay Sections	Chip Seal Sections	Micro-surfacing Sections	Project Level
1				X
2				X
3				X
4	X	X	X	
5				X
6				X
7	X	X	X	
8	X	X	X	
9-11	1*	1*,2	1*,3	
12	1*	1*,2	1*,3	
13	1	1	1	
14	1	1	1	
15	1	1	1	
16-17	1*	1*	1*	
18	1*	1*	1*	
19-20	1*	1*	1*	
21	1*	1*	1*	
22-23	1*	1*	1*	
24-25	4	4	4	
26-27	5	5	5	
28	X	X	X	
29	X	X	X	
30	X	X	X	
31	X	X	X	
32-33		2		
34-35			3	

Legend:
X Always complete this data sheet.
1 Complete data sheet for each AC layer (including existing layers and new thin overlay layers constructed for SPS-11T).
2 Complete data sheet for each new Chip Seal layer constructed for SPS-11C
3 Complete data sheet for each new Micro-surfacing layer constructed for SPS-11M
4 Complete data sheet for each existing unbound layer.
5 Complete data sheet for each existing subgrade layer.
* Also complete data sheet for each asphalt treated base.

DATA COLLECTION AND RECORDING

Record Data

These guidelines contain the SPS-11 Data Sheets necessary for recording data activities during the construction.

While spaces are provided in the data sheets for a broad array of data elements, it is recognized that much of the data will not be available. When the data element is not applicable to or represents something that does not exist on the test section enter an "N" to indicate that the data element is not applicable. If the data element is applicable, but the value is unknown (i.e., not available in project records), enter a "U" to indicate that the value is unknown. Many data items will require codes to be entered. Unless otherwise noted in the following instructions, the codes are listed or referenced on the data sheets.

Some construction data items may apply to more than one test section. However, a large portion of the data elements will be specific to each test section. Data items common to all test sections will be referred to as “project level data” while data items specific to each test section will be referred to as “section specific data.”

Data Common for all LTPP SPS-11 Data Sheets

A common set of project identification data appears in the upper right-hand corner of every data sheet. These data items are described below.

> *State Code:* The State code is a number used to identify the state or Canadian province in which the pavement section is located (see table 39 in Standard Codes Tables section).
>
> *SHRP Section ID:* The section ID is a four-digit identification number assigned by LTPP. This number is used to facilitate the computer filing of the projects and will identify the section in the field.

SHRP ID

The SHRP section ID is a four-digit identification number assigned by LTPP. This number is used to facilitate the computer filing of the projects and will identify the section in the field.

SPS-11 sections have a six-digit identifier. The first two digits represent the State Code and the next four digits represent the SHRP ID. The first digit is a designator to differentiate between multiple projects for a specific SPS experiment in the same agency. An A, B, C, etc. is assigned to the first, second, third, etc. projects selected for a SPS-11 experiment in the same agency. The second digit of the SHRP ID identifies the section is a SPS-11 experiment. This digit will always be a B. The remaining two digits identify the individual test section. The test section number is specific to the experiment design. Project level data are specified using 00 as the test section number. For SPS projects, the inventory data are expected to apply to the entire project length. Therefore, the data should be entered for the project level section ID of 00.

Example: 04AB01

Where

04 is the state code for Arizona
A is the first SPS-11 experiment assigned in Arizona
B is the designation for a SPS-11 experiment
01 is the first section at this site

Description of LTPP SPS-11 Data Sheets

The following provides a description of each data sheet used in the collection of SPS-11 data.

Project ID (SPS-11 Data Sheet 1)

A project and section identification data sheet needs to be completed for each project. This data is to be filled out from project records on SPS-11 Data Sheet 1.

Individual data elements are as follows:

Date of Data Collection or Update (Item 1): The month and year in which the "as-built" construction inventory data was collected. The number to identify the month is in numerical sequence of the months as they occur during the year (enter 03 for March, etc.). The year is identified using four digits.

Highway Agency (HA) District Number (Item 2): The number identifying the SHA district in which the pavement test section is located.

County or Parish (Item 3): Code for the county or parish where the pavement section is located. County codes come from Federal Information Processing Standards Publication 6, "Counties of the States of the United States."

Functional Class (Item 4): The number identifying the functional classification of highway for which the pavement section is a sample (see table 40 in Standard Codes Tables section).

Route Number (Item 5): The signed route number (leading zeros should not be used). E.g., Interstate 81 should be coded as '81', Interstate 35W should be coded as '35'. This should be the same route number that is identified for the route in Data Items 4 and 5 (Route Signing and Route Qualifier).

Route Signing (Item 6): The type of route signing. These codes appear in table 40 of Standard Codes Tables section.

Route Qualifier (Item 7): The type of route signing. Codes for route signing are provided on SPS-11 Data Sheet 8.

Alternate Route Name (Item 8): A familiar, non-number designation for a route. This data item is optional and can be left null if it is unknown.

Number of Through Lanes (Item 9): The number indicating the total number of through lanes in the direction of travel.

Date Open to Traffic (Item 10): The year and month the project was opened to traffic.

Construction Costs per Lane Mile (In $1000) (Item 11): The total average construction cost (in thousands) per lane mile for the test section.

Milepoint (Item 12): The milepoint at which the project is located.

Elevation (Item 13): The elevation of the project.

Additional Location Information (Item 14): Text describing any additional location information such as landmarks. This type of information will be useful for field crews locating the project during monitoring activities.

Project Stations (SPS -11 Data Sheet 2)

A reference project station system must be established for each project. While a majority of the construction data sheets are completed in English units, this data sheet will be completed in metric. This station referencing system starts with station 0+00 assigned to the starting point of the first test section encountered on the project. The station number of the beginning and end of all test sections on the project will be referenced to this point to provide a relative distance measure of the beginning, end, and distance between test sections on the site. This continuous system is used to avoid compounding measurement. This information will be used to process profile data collected from continuous measurements over the test sections and to identify the locations of the materials sampling and testing operations on the test sections for the entire site. Additionally, this information will indicate the ordering and distance between test sections.

Field measurements should be used to locate the start and end point of each test section with an accuracy of ± 1 meters (0.328 ft) using a steel tape. Ideally, these measurements should be made prior to overlay construction, e.g. when the test section locations are initially marked on the pavement. This data can then be used as a check against the repositioning of the start and end of the test sections following overlay construction. Otherwise, these measurements should be performed on the as-marked sections following construction.

This data is to be filled out from project records on SPS-11 Data Sheet 2.

Individual data elements are as follows:

Test Section ID (Item 1): The four-digit test section ID number should be entered for each SPS section.

Start Station Number (Item 2): The station number of the starting point of the test section relative to the starting point of the first test section on the project, to the nearest 0.1 meter.

End Station Number (Item 3): The station number of the ending point of the test section relative to the starting point of the first test section on the project, to the nearest 0.1 meter.

Subgrade Structure Type (Item 4): Enter the code number shown under note 1 on the data sheet to indicate if the test section is located entirely on fill, cut, at-grade or is located on both cut and fill. If the test section is located on both cut and fill, the approximate location of the cut-fill transition within the test section should be entered using a test section relative station number (0+00 to 1+52.4).

Direction of Travel (Item 5): Code for signed direction of traffic flow along the entire route, which includes the test section.

Intersections Between Test Sections on the Project (Item 6): If any intersections occur between any of the test sections on the project, indicate the number or name of the intersection route, the reference project station number (referenced to the start of the first test section on the project), and check whether it is an entrance or exit ramp, or an intersection with a stop sign, traffic signal, or is un-signalized.

General Information (SPS -11 Data Sheet 3)

This data sheet provides geometric, drainage and general information on the sections throughout the entire project length. This data is to be filled out from project records on SPS-11 Data Sheet 3.

Individual data elements are as follows:

Lane Width (Item 1): The width of the lane to be monitored, to the nearest whole number of feet.

Monitoring Site Lane Number (Item 2): A number that identifies which lane is to be monitored. The lane numbering methodology is identified on the data sheet. Lanes should be numbered starting with the outside lane as lane 1 and increasing toward the centerline of the roadway.

Direction of Travel (Item 3): Code for signed direction of traffic flow along the entire route, which includes the test section.

Speed Limit (Item 4): The posted speed limit for the given section of the road.

Median Type (Item 5): The type of median. Codes for the type of median are provided on SPS-11 Data Sheet 9.

Median Width (Item 6): The existing median width.

Drainage Data (Items 7-10): Spaces are provided to enter data describing subsurface drainage features. If there is not drainage, enter "N" for those spaces pertaining to drainage.

Subsurface Drainage Location (Item 7): A code indicating whether the subsurface drainage is continuous along the section or is provided at intermittent locations. Codes are provided on Data Sheet 3.

Subsurface Drainage Type (Item 8): A code indicating the type of system used to provide subsurface drainage from no subsurface drainage provided to a well system or a drainage blanket with longitudinal drains. Codes for each type of subsurface drainage are provided on Data Sheet 3. A code and space are provided for describing another type of subsurface drainage if different from those provided on Data Sheet 3.

Diameter of Longitudinal Drainpipes (Item 9): The inside diameter to the nearest tenth of an inch (0.1 inch) of the longitudinal drainpipes used for subsurface drainage. If there is no longitudinal drainage, enter "N."

Spacing of Laterals (Item 10): The average spacing in feet between lateral drains from the pavement subdrainage system. Enter "N" if there are no subdrainage laterals.

Shoulder Data (Items 11-16): Spaces are provided to enter data describing both the outside and inside shoulder. If there are no shoulders, enter "N" for those spaces pertaining to shoulders.

Shoulder Surface Type (Item 11): A code indicating the type of material used for the surface of the shoulder for the outside and inside shoulders. Codes are provided on Data Sheet 3. If the full width of the shoulder is only partially paved, enter the code for the material used in the paved portion of the shoulder.

Total Width (Item 12): The total paved and unpaved width of the outside shoulder. A separate space is provided for the total paved and unpaved width of the inside shoulder to the nearest whole number of feet.

Paved Width (Item 13): The paved widths of the outside and inside shoulders to the nearest whole number of feet.

Shoulder Base Type (Item 14): Codes identifying the types of material used as the base of the pavement structure on the shoulders. See table 44 in Standard Codes Tables section.

Shoulder Surface Thickness (Item 15): The average thicknesses of the inside and outside shoulder surfaces to the nearest tenth of an inch (0.1 inch).

Shoulder Base Thickness (Item 16): The average base thicknesses along the shoulders to the nearest tenth of an inch (0.1 inch).

Layer (SPS -11 Data Sheet 4)

The data on this data sheet provide key information as to the structure of the pavement when it is open to traffic under the LTPP study. This data is to be filled out from project records on SPS-11 Data Sheet 4. As all subsequent data sheets refer back to this one, special care should be taken in establishing the layering.

Individual data elements are as follows:

> *Layer Number (Item 1)*: Space is provided for up to 9 layers. If more than 9 layers are needed, please use an additional SPS-11 Data Sheet 4. Layer numbering begins at the bottom of the structure and increases moving to the top of the structure. Therefore, the subgrade is always layer number 1 and the last (and largest) number identifies the surface layer.
>
> *Layer Description (Item 2)*: A layer description code identifying the function of the layer within the pavement structure is to be entered for each of the layers in the system. Codes are provided on SPS-11 Data Sheet 4. For AC layers, separate lifts of the same mixture are not to be identified as separate layers.
>
> Many highway agencies cover poor subgrade soils with one to three feet of select material. Such an embankment should be reported as a subbase with a layer description code 06.
>
> *Material Type Classification (Item3)*: A code identifying the type of material used in each layer of the pavement structure, including the subgrade should be entered for material type classification. Codes for surfacing materials, base and subbase materials, subgrade soils, and thin seals and interlayers are identified in table 43 through table 46 of Standard Codes Tables section, respectively.
>
> *Layer Thickness (Item 4)*: Four numbers can be provided to indicate the Mean, Minimum, Maximum, and Standard Deviation of thickness for each specific layer in inches (enter to the nearest tenth of an inch (0.1 inch). If only a single specified design value for thickness is available from project records, enter it as the "mean value."

Age and Major Improvements (SPS -11 Data Sheet 5)

This data sheet provides information regarding dates of construction for the primary pavement structure and any major improvements or rehabilitation that has occurred since that construction. Data should be provided for any improvement events on the existing pavement structure up to the SPS-11 construction. This data is to be filled out from project records on SPS-11 Data Sheet 4 for which long-term monitoring is planned.

Individual data elements are as follows:

> *Date of Latest (Re)Construction (Item 1)*: Month and year in which construction or reconstruction (if any, not including overlay or mill and overlay, have been performed) of

the pavement to be monitored has been completed. The first two digits represent the numerical sequence of the month as it occurs during the year and the remaining four digits are the year.

Date Subsequently Opened to Traffic (Item 2): The month and year that the pavement was originally opened to traffic (not the date when the project was accepted). The first two digits represent the numerical sequence of the month as it occurs during the year and the remaining four digits are the year.

Latest (Re)Construction Cost Per Lane Mile (Item 3): The total average original construction or reconstruction cost in thousands of dollars per lane-mile for the project that includes the test section, exclusive of non-pavement costs such as bridges, culverts, lighting, and guard rails. This cost is to be reported as a cost indexed to the year reported in the data entry for "Date of Latest (Re)Construction."

Major Improvements Since Latest (Re)Construction (Items 4-8): Space is provided for identifying six major improvement activities by year in which they have been accomplished. This does not include bridges, culverts, lighting, etc. Major improvements do include overlays and associated pretreatments (patching, milling, joint repair, etc.), and inlays (mill and fill).

Year (Item 4): The year in which the major improvement was constructed.

Work Type Code (Item 5): A code to identify the type of activity performed. Codes are provided in table 55 of Standard Codes Tables section.

Work Quantity (Item 6): The quantity of work applied to the section in appropriate units (refer to table 55 of Standard Codes Tables section for determining appropriate units).

Thickness (Item 7): For improvements that increase the thickness of the pavement structure (such as "surface treatment, single layer" or "surface treatment, double layer," etc.), enter the thickness of the improvement to the nearest tenth of an inch (0.1 inch).

Major Improvement Type Other (Item 8): Type of improvement performed if other than those specified.

Additional Roadway Widening Information (Items 9-12): The following data items are applicable only if the roadway has been widened.

Year When Roadway Widened (Item 9): The year when the roadway was widened. If the roadway has not been widened, enter “N.”

Original Number of Lanes (Item 10): The original number of lanes in the survey direction prior to roadway widening. If the roadway has not been widened, enter “N.”

Final Number of Lanes (Item 11): The final number of lanes after the roadway has been widened. If the roadway has not been widened, enter “N.”

Lane Number of Lane Added (Item 12): Lane number added when roadway has been widened. The outside lane is Lane 1; the next lane is Lane 2, etc. If the roadway has not been widened, enter “N.”

Snow Removal/Deicing (SPS -11 Data Sheet 6)

This data sheet provides information on the snow removal and deicing practices used by the SHA at the test section location. This data is to be filled out from project records on SPS-11 Data Sheet 6.

Individual data elements are as follows:

Are Snow Plows Used on the Section (Item 1): A yes/no code indicating whether the section is subject to snow plow use or not. No may be used on sections that may occasionally get plowed, but do not have activity in a normal year (i.e. item 3 is zero)

Snow Plow Edge Type (*Item 2*): For sections that typically are plowed, indicate the most common blade edge type. Codes are provided on the data sheet.

Typical Number of Passes per Year (Item 3): Indicate the number of times in a typical year that the section is plowed—each pass of the plow should be counted individually. When Item 1 is ‘N’, this should be zero.

Typical Speed of Plowing Operation (Item 4): For sections that are typically plowed, indicate the common travel speed of the plow while plowing, in MPH.

Are Pre-Treatments Used on the Section (Item 5): A yes/no code indicating whether the section is subject to anti-icing pre-treatments. No may be used on sections that may occasionally get treated, but do not have activity in a normal year (i.e. item 7 is zero).

Type of Pre-Treatment Used (*Item 6*): For sections that typically are treated, indicate the most common treatment type. Codes are provided on the data sheet.

Typical Number of Applications per Year (Item 7): Indicate the number of times in a typical year that the section is treated. When Item 5 is ‘N’, this should be zero.

Are De-Icers Used on the Section (Item 8): A yes/no code indicating whether the section is subject to application of de-icing chemicals. No may be used on sections that may occasionally get treated, but do not have activity in a normal year (i.e. item 10 is zero).

Type of De-Icers Used (*Item 9*): For sections that typically receive de-icing, indicate the most common treatment type. Codes are provided on the data sheet.

Typical Number of Applications per Year (Item 10): Indicate the number of times in a typical year that de-icing agents are applied. When Item 8 is ‘N’, this should be zero.

Is the Section Subject to Chain Controls (Item 11): A yes/no code indicating whether the section is subject to chain controls If the agency has provisions for chain controls on the section, regardless of how often they are applied, then this item should be ‘Y.’

Typical Number of Applications per Year (Item 12): Indicate the number of times in a typical year that the section is subject to some type of chain requirement. When Item 11 is ‘N’, this should be zero.

HPMS Data Items (Project Level) (SPS -11 Data Sheet 7)

This data sheet provides project level HPMS data item information on the entire project length. This data is to be filled out from project records on SPS-11 Data Sheet 7.

Individual data elements are as follows:

HPMS Sample Number (Item 1): 12 digit “Section/Grouped Data Identification” assigned to any section of highway in the HPMS.

HPMS Section Subdivision (Item 2): Code used to identify a further subdivision of an original HPMS section. This code is generally included as a 13th digit of the HPMS sample number.

Urban Code (Item 3): The U.S. Census Urban Area Code. Enter up to five digits. Leading zeros are not required. Default codes for Urban Code are provided on SPS-11 Data Sheet 7.

Facility Type (Item 4): The operational characteristic of the roadway. Codes for each type of facility are provided on SPS-11 Data Sheet 7.

Access Control (Item 5): The degree of access control for the given section of the road. Codes for each type of access control are provided on SPS-11 Data Sheet 7.

Ownership (Item 6): The entity that has legal ownership of a roadway. If more than one code applies, code the lowest numerical value. These codes appear in table 62 of Standard Codes Tables section.

HOV Type (Item 7): The type of HOV (High Occupancy Vehicle Operations Type) operations. Codes for each type of HOV are provided on SPS-11 Data Sheet 7.

HOV Lanes (Item 8): The maximum number of lanes in both directions designated for HOV operations.

Peak Lanes (Item 9): The number of lanes in the peak direction of flow during the peak period.

Counter Peak Lanes (Item 10): The number of lanes in the counter-peak direction of flow during the peak period.

Right Turn Lanes (Item 11): The presence of right turn lanes at a typical intersection. These codes appear in table 63 of Standard Codes Tables section.

Left Turn Lanes (Item 12): The presence of right turn lanes at a typical intersection. These codes appear in table 63 of Standard Codes Tables section.

HPMS Data Items (Project Level) (Continued) (SPS -11 Data Sheet 8)

The data on this data sheet is a continuation of the information from SPS-11 Data Sheet 7.

Individual data elements are as follows:

Toll Charged (Item 1): Identify if the site is a toll facility regardless of whether or not a toll is charged. Codes for each type of toll charge are provided on SPS-11 Data Sheet 8.

Toll Type (Item 2): Indicate if this site has the presence of special tolls (i.e. High Occupancy Toll (HOT) or other managed lanes. Codes for each type of toll charge are provided on SPS-11 Data Sheet 8.

Widening Obstacles (Item 3): Obstacles that prevent widening of the existing roadway for additional through lanes. Code all conditions that apply in either direction on either side of the section and leave blank for unreported data. Enter any combination of the codes (e.g. if there are Historic and Dense development obstacles, code “EA” or “AE” for this Data Item). There is no requirement for the ordering of the codes; a code should not be used more than once in a sequence of codes (e.g. “AEA”). Code “X” cannot be used with other codes (e.g. “XE”). This item provides for the coding of obstacles which may prevent or limit the ability to widen the roadway surface within approximately 100 ft of the outer edge of the through lanes that are present in either direction of the section. Codes for widening obstacles are provided in table 64 of Standard Codes Tables section.

Widening Potential (Item 4): The number of through lanes that could be potentially added. Code the number of lanes (0-9) for which it is feasible to widen the existing road, in both directions. Code a ‘9,’ if it is possible to add nine or more lanes. Code this item based on how feasible it is to widen the existing road based on the presence of obstacles as identified in Data Item 13 (Widening Obstacles), and the proximity of the obstacle to the roadway.

Terrain Type (Item 5): The type of terrain. Codes for the type of terrain are provided on Data Sheet 8.

Curve Classification (Item 6): The curve classification data, using the degree of curvature ranges provided on SPS-11 Data Sheet 8.

Grade Classification (Item 7): The grade classification, using the percent grade ranges provided on SPS-11 Data Sheet 8.

Percent Passing Sight Distance (Item 8): The percent of the section length that is striped for passing.

AC Aggregate Properties (SPS -11 Data Sheet 9)

This data sheet provides information regarding asphalt aggregate properties. This data is to be filled out from project records on SPS-11 Data Sheets 9, 11 and 11. For existing AC layers, agency records should be used to complete this data sheet. For AC layers constructed specifically for the SPS-11 project, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this sheet is being provided (from SPS-11 Data Sheet 4).

Type of Aggregate (Item 2): The type of aggregate used as identified by one of the codes appearing on SPS-11 Data Sheet 9.

Composition of Coarse Aggregate (Items 3, 4 and 5): When more than one coarse aggregate is used, the type code as provided on the data sheet and percentage by total weight of coarse aggregate should be indicated for each coarse aggregate. Space is provided for up to three different types of coarse aggregate. If only one type of coarse aggregate is used, enter its type and 100 percent in the top set of the data spaces, leaving the others blank. Space is provided for identifying another type of material if one was used other than those for which codes are provided. Coarse aggregate is considered to be that portion retained on the No. 8 (2.36-mm) sieve.

Geologic Classification of Coarse Aggregate (Item 6): The geologic classification of the natural stone used as coarse aggregate in the concrete. These codes appear in table 47 of Standard Codes Tables section and provide identification as to which of the three major classes of rock the coarse aggregate belongs to and the type of rock within those classes. If a "blend" was used, enter the code for the geologic classification for the material representing the majority of the coarse aggregate. If a "crushed slag", "manufactured lightweight", or "recycled concrete" was used, enter "N."

Composition of Fine Aggregate (Items 7, 8, and 9): When more than one fine aggregate is used, the type code as provided on the data sheet and percentage by total weight of fine aggregate should be indicated for each fine aggregate. Fine aggregate is defined as that passing the No. 8 (2.36-mm) sieve and retained on the No. 200 (75-µm) sieve. Space is provided for up to three different fine aggregate types. If only one type of fine aggregate is used, enter its type code and 100 percent in the top set of the data spaces, leaving the others blank.

Type of Mineral Filler (Item 10): The type of mineral filler used as identified by one of the codes appearing on SPS-11 Data Sheet 9.

Aggregate Durability Test Results (Items 11-14): The type of tests used to evaluate the durability of the aggregate used in the mix and the results in thousandths (0.001) recorded in units specified for the test. Three of these sets are for coarse (Items 11, 12, and 13) and one (Item 14) for the combination of coarse and fine aggregates. The durability test type codes appear in table 51 of Standard Codes Tables section.

AC Aggregate Properties (Continued) (SPS -11 Data Sheet 10)

This data sheet is a continuation of the data on SPS-11 Data Sheet 9.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Aggregate (Item 2): The type of aggregate used as identified by one of the codes appearing on SPS-11 Data Sheet 10.

Polish Value of Coarse Aggregates (Item 3): The accelerated polish value of the coarse aggregates used in the surface layer, as determined by AASHTO T279 (ASTM D3319).

Angularity Coarse One Face (Item 4): The coarse aggregate angularity for aggregates with one or more faces.

Angularity Coarse Two Faces (Item 5): The coarse aggregate angularity for aggregates with two or more faces.

Angularity Fine (Item 6): The angularity for fine aggregate.

Soundness Coarse (Item 7): The coarse aggregate soundness.

Soundness Fine (Item 8): The fine aggregate soundness.

Coarse Aggregate Toughness (Item 9): The toughness of coarse aggregate.

Deleterious Materials (Item 10): The estimate of percentage of deleterious materials.

Clay Content (Item 11): The clay content determined by the use of the Sand Equivalent.

Thin Elongated Particles (Item 12): The percentage by weight of aggregate that have a maximum to minimum dimension of greater than 5.

Gradation of Combined Aggregates (Item 13): The percent passing (of coarse and fine aggregates) on various standard sieve sizes to the nearest one percent. It is not expected that values will be available for all eighteen sieve sizes; the objective is to provide a sufficient number of sieve sizes to accommodate testing and specification practice for most highway agencies.

AC Aggregate Properties (Continued) (SPS -11 Data Sheet 11)

This data sheet is a continuation of the data on SPS-11 Data Sheets 9 and 10.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Aggregate (Item 2): The type of aggregate used as identified by one of the codes appearing on the data sheet.

Absorption of Aggregate (Items 3 and 4): The absorption of aggregates (to the nearest thousandth (0.001)) for coarse aggregate (Item 3) and fine aggregate (Item 4). The absorption of aggregates can be determined using AASHTO T85 and ASTM C127 (coarse aggregate) or AASHTO T84 and ASTM C128 (fine aggregate).

Bulk Specific Gravities (Items 5-8): The bulk specific gravities (to the nearest thousandth (0.001)) for coarse aggregate (Item 5), fine aggregate (Item 6), mineral filler (Item 7), and the aggregate combination (Item 8). The bulk specific gravities for the aggregate fractions are measured using the laboratory procedures indicated on the data sheet. The bulk specific gravity for the aggregate combination (usually called "bulk specific gravity of aggregate") is calculated as follows:

$$G_{sb} = \frac{P_1 + P_2 + P_3}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \frac{P_3}{G_3}}$$

Figure 17. Equation. Bulk specific gravity of total aggregate.

where:

G_{sb}	=	Bulk specific gravity for the total aggregate
P_1,P_2,P_3	=	Percentages by weight of coarse aggregate, fine aggregate, and mineral filler
G_1,G_2,G_3	=	Specific gravities of coarse aggregates, fine aggregates, and mineral filler

Effective Specific Gravity of Aggregate Combination (Item 9): The calculated effective specific gravity to the nearest thousandth (0.001). This calculation requires the maximum specific gravity (no air voids) of the paving mixture, which is obtained by Test Method AASHTO T209 or ASTM D2041. The effective specific gravity of the aggregate is calculated as follows:

$$G_{se} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}}$$

Figure 18. Equation. Effective specific gravity of aggregate.

where:

G_{se}	=	Effective specific gravity of aggregate
P_b	=	Asphalt cement, percent by total weight of mixture
G_b	=	Specific gravity of asphalt
G_{mm}	=	Maximum specific gravity of paving mixtures (no air voids)

Theoretical Maximum Specific Gravity of the RAP/Recycled Asphalt Shingles (RAS) (Item 10): The theoretical maximum specific gravity for the aggregate combination of the reclaimed asphalt shingles.

AC Binder (SPS -11 Data Sheet 12)

A new data sheet should be filled out for each type of binder that is used in the layer (Virgin, RAP, RAS and Combined.) Additionally, a new data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Binder (Item 2): The type of binder used as identified by one of the codes appearing on SPS-11 Data Sheet 12.

Asphalt Grade (Item 3): The Performance Grade (PG) of performance graded binders. If a PG Binder was not used, enter "N."

Asphalt Grade (Item 4): The grade of asphalt cement used (see table 54 of Standard Codes Tables section) prior to addition of WMA technology. Space is provided on the data sheet for identifying another grade of asphalt cement not appearing in table 54.

Source (Item 5): The refinery that produced the asphalt cement used in the WMAC layer being described. If PG Grading was not used, leave this field null. A list of asphalt refiners and processors is provided in table 53 of Standard Codes Tables section. Space is provided to specify other sources which may not be included in the table provided.

Specific Gravity of Asphalt Cement (Item 6): The specific gravity of the asphalt cement (to the nearest thousandth (0.001)) when it is available. If unavailable, a typical specific gravity for asphalt cements produced at the source refinery may be entered. This specific gravity is measured as specified by AASHTO T228 (ASTM D70).

Viscosity of Asphalt at 140°F (Item 7): The result in poises from absolute viscosity testing using Test Method AASHTO T202 (ASTM D2171) on samples of the original asphalt cement prior to its use in construction of the pavement section and prior to addition of WMA technology.

Viscosity of Asphalt at 275°F (Item 8): The results in centistokes (to the nearest hundredth (0.01)) from kinematic viscosity testing using Test Method AASHTO T201 (ASTM D2170) on samples of the original asphalt cement and prior to addition of WMA technology.

Penetration at 77°F (Item 9): The penetration (in tenths of a millimeter (0.1 mm)) at 77°F (25°C) with a 100-gram load and a five-second load duration using Test Method AASHTO T49 (ASTM D5) on the original asphalt cement in the mixture and prior to addition of WMA technology.

Asphalt Modifiers (Items 10 and 11): Space is provided to list the type and quantity of up to two modifiers added to the asphalt cement for whatever purpose. A list of possible asphalt cement modifiers and codes for data entry are provided in table 53 of Standard Codes Tables section. The quantities of modifier should be provided in percent of asphalt cement weight. Some modifiers (such as lime) may be specified in terms of "percent of aggregate weight," but they must be converted to percent of asphalt cement weight for uniformity. WMA technologies are not to be considered modifiers.

Ductility at 77°F (Item 12): The ductility in centimeters at 77°F (25°C) using Test Method AASHTO T51 (ASTM D113) and prior to addition of WMA technology.

Ductility at 39.2°F (Item 13): The ductility in centimeters at 39.2°F (4°C), using the procedures of Test Method AASHTO T51 (ASTM D113) and prior to addition of WMA technology.

Test Rate for Ductility Measurement at 39.2°F (Item 14): The test speed in centimeters per minute for the ductility measurement taken at 39.2°F (4°C) and prior to addition of WMA technology.

Penetration at 39.2°F (Item 15): The penetrating (in tenths of a millimeter (0.1 mm)) at 39.2°F (4°C), with a 200-gram load and a 60-second load duration using Test Method AASHTO T49 (ASTM D5) on samples of the original asphalt cement, prior to its use as a construction material and prior to addition of WMA technology.

Ring and Ball Softening Point (Item 16): The softening point of the asphalt cement in degrees Fahrenheit as measured with the ring-and-ball apparatus used in Test Method AASHTO T53 (ASTM D36), on samples of the original asphalt cement prior to its use as a construction material and prior to addition of WMA technology.

AC Binder Aged (SPS -11 Data Sheet 13)

This data sheet provides information regarding asphalt binder aged properties for each layer. This data sheet can be filled out multiple times for a single layer when binder properties were captured at more than one aging condition. This data is to be filled out from project records on SPS-11 Data Sheet 13 for which long-term monitoring is planned.

For existing PMA layers, agency records should be used to complete this data sheet. For new SPS-11 construction layers, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

> *Layer Number (Item 1)*: The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).
>
> *Type of Binder (Item 2)*: The type of binder used as identified by one of the codes appearing on the data sheet.
>
> *Test Procedure Used to Measure Aging Effects (Item 3)*: The test procedure used to "age" the asphalt cement in the laboratory and to measure the effects of the aging. Codes are provided on the data sheet, along with space to identify a process used other than those for which codes are provided.
>
> *Specific Gravity of Asphalt Cement (Item 4)*: The specific gravity of the asphalt cement (to the nearest thousandth (0.001)) when it is available. If unavailable, a typical specific gravity for asphalt cements produced at the source refinery may be entered. This specific gravity is measured as specified by AASHTO T228 (ASTM D70).
>
> *Viscosity of Asphalt at 140°F (Item 5)*: The result in poises from absolute viscosity testing using Test Method AASHTO T202 (ASTM D2171) on samples of the original asphalt cement prior to its use in construction of the pavement section and prior to addition of WMA technology.
>
> *Viscosity of Asphalt at 275°F (Item 6)*: The results in centistokes (to the nearest hundredth (0.01)) from kinematic viscosity testing using Test Method AASHTO T201 (ASTM D2170) on samples of the original asphalt cement and prior to addition of WMA technology.
>
> *Ductility at 77°F (Item 7)*: The ductility in centimeters at 77°F (25°C) using Test Method AASHTO T51 (ASTM D113) and prior to addition of WMA technology.
>
> *Ductility at 39.2°F (Item 8)*: The ductility in centimeters at 39.2°F (4°C), using the procedures of Test Method AASHTO T51 (ASTM D113) and prior to addition of WMA technology.

Test Rate for Ductility Measurement at 39.2°F (Item 9): The test speed in centimeters per minute for the ductility measurement taken at 39.2°F (4°C) and prior to addition of WMA technology.

Penetration at 77°F (Item 10): The penetration (in tenths of a millimeter (0.1 mm)) at 77°F (25°C) with a 100-gram load and a five-second load duration using Test Method AASHTO T49 (ASTM D5) on the original asphalt cement in the mixture and prior to addition of WMA technology.

Penetration at 39.2°F (Item 11): The penetrating (in tenths of a millimeter (0.1 mm)) at 39.2°F (4°C), with a 200-gram load and a 60-second load duration using Test Method AASHTO T49 (ASTM D5) on samples of the original asphalt cement, prior to its use as a construction material and prior to addition of WMA technology.

Ring and Ball Softening Point (Item 12): The softening point of the asphalt cement in degrees Fahrenheit as measured with the ring-and-ball apparatus used in Test Method AASHTO T53 (ASTM D36), on samples of the original asphalt cement prior to its use as a construction material and prior to addition of WMA technology.

Weight Loss (Item 13): The weight loss resulting from the laboratory aging process to the nearest one-tenth of one percent (0.1 percent).

AC DSR, BBR, Direct Tension (SPS -11 Data Sheet 14)

This data sheet provides information for Dynamic Shear Rheometer, Bending Beam Rheometer, and Direction Tension properties for each layer. This data sheet can be filled out multiple times for a single layer for binder from different sources. This data is to be filled out from project records on SPS-11 Data Sheet 14 for which long-term monitoring is planned.

For existing PMA layers, agency records should be used to complete this data sheet. For new SPS-11 construction layers, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Binder (Item 2): The type of binder used as identified by one of the codes appearing on SPS-11 Data Sheet 14.

Dynamic Shear Rheometer Complex Modulus and Phase Angle (Item 3): The dynamic shear complex modulus reported to the nearest hundredth kilopascal (0.01 kPa) for the tank processed asphalts and the phase angle reported to the nearest degree.

Dynamic Shear Rheometer Complex Modulus and Phase Angle (Item 4): The dynamic shear complex modulus reported to the nearest hundredth kilopascal (0.01 kPa) for the rolling thinned film of RTFO-processed asphalts and the phase angle reported to the nearest degree.

Dynamic Shear Rheometer Complex Modulus and Phase Angle (Item 5): The dynamic shear complex modulus reported to the nearest hundredth kilopascal (0.01 kPa) for the pressure aged vessel processed asphalts and the phase angle reported to the nearest degree.

Bending Beam Rheometer Stiffness Modulus and Slope (Item 6): The stiffness modulus reported to the nearest megapascal and the slope reported to the nearest thousandth (0.001).

Direct Tension Tensile Strength and Tensile Strain (Item 7): The tensile stress reported to the nearest tenth of kilopascal (0.1 kPa) and the percent strain to the nearest hundredth percent (0.01 percent).

RAP (SPS -11 Data Sheet 15)

This data sheet provides information regarding recycled asphalt pavements and reclaimed asphalt shingles. A new sheet should be filled out for each plant mix asphalt. If RAP (1) is included in the mix, items 3, 4, 6 and 7 should be completed. If the mix includes RAS (2), items 5, 6 and 7 should be completed. This data is to be filled out from project records on SPS-11 Data Sheet 15.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Aggregate (Item 2): The type of aggregate used as identified by one of the codes appearing on the data sheet. If RAP or RAS were not used, enter an ‘N’ in this field.

Procedure Used to Break Up and/or Remove the RAP (Item 3): A code to indicate the procedure used for removal of the asphalt pavement to be recycled. Codes are provided on the data sheet. Additionally, space is provided to describe a different type of procedure if none of those for which codes are provided was used.

RAP Processing (Item 4): A code, as provided on the data sheet, to indicate how the pavement material was processed after removal.

Type of RAS (Item 5): Type of reclaimed asphalt shingles used in the mixture.

Percent of Binder in the RAP/RAS by Mass (%) (Item 6): The percent of binder in the RAP.

RAP Additive (Item 7): A yes or no field to indicate whether an additive was added to the RAP stockpile to maintain workability. If an additive was added, what quantity in percentage by mass. Also enter the type of additive that was used.

PMA Laboratory Mix Design (SPS -11 Data Sheet 16)

This data sheet provides information regarding laboratory mixture design. This data is to be filled out from project records on SPS-11 Data Sheets 16, 17 and 18 for which long-term monitoring is planned.

For existing PMA layers, agency records should be used to complete this data sheet. For new SPS-11 construction layers, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Maximum Specific Gravity (Item 2): The maximum specific gravity (to the nearest thousandth (0.001)), calculated using figure 18 and figure 19.

$$G_{mm} = \frac{100}{\frac{P_s}{G_{se}} + \frac{P_b}{G_b}}$$

Figure 19. Equation. Maximum specific gravity of paving mixture.

where:

G_{mm} = Maximum specific gravity of paving mixture (no air voids)
P_s = Aggregate, percent by total weight of mixture
G_{se} = Effective specific gravity of aggregate
P_b = Asphalt, percent by total weight of mixture
G_b = Specific gravity of asphalt

Bulk Specific Gravity (Item 3): The bulk specific gravity (to the nearest thousandth (0.001)) of the recycled mixture compacted in the laboratory at the optimum asphalt content selected and by appropriate procedures for Marshall or Hveem stability. Test Method ASTM D1188 is to be used for establishing the bulk specific gravity.

Optimum Asphalt Content (Item 4): The optimum amount of asphalt cement as obtained from Marshall or Hveem Stability testing that is added to the recycled mixture to the nearest one-tenth of a percent (0.1 percent).

Percent Air Voids (Item 5): The calculated air voids (to the nearest tenth of a percent (0.1 percent)) in the recycled mixture, compacted in the laboratory to the optimum asphalt content and by appropriate procedures for Marshall or Hveem stability. Figure 20 may be used for calculating the percent air voids.

$$P_a = 100\,\frac{G_{mm} - G_{mb}}{G_{mm}}$$

Figure 20. Equation. Air voids in compacted mixture.

where:

P_a	=	Air voids in compacted mixture, percent of total volume
G_{mm}	=	Maximum specific gravity of paving mixture (zero air voids) as determined by ASTM D2041
G_{mb}	=	Bulk specific gravity of compacted mixture

Marshall Stability (Item 6): The Marshall Stability (Test Method AASHTO T245, (ASTM D1559)) of the mixture at optimum asphalt content in pounds.

Number of Blows (Item 7): The number of blows of the compaction hammer that were applied to each end of the specimen to compact it for Marshall Stability and flow testing.

Marshall Flow (Item 8): The Marshall Flow (Test Method AASHTO T245 (ASTM D1559)) of the mixture at optimum asphalt content. This item is to be entered as the whole number of the measured hundredth of an inch (i.e., if 0.15 is measured, enter "15").

Hveem Stability (Item 9): The Hveem Stability or "stabilometer value" of the mixture at optimum asphalt content as measured with the Hveem apparatus using Test Method AASHTO T246 (ASTM D1560).

Hveem Cohesiometer Value (Item 10): The cohesiometer value of the mixture at optimum asphalt content, in grams per 25-mm (1-inch) width (or diameter) of specimen, obtained by Test Method AASHTO T246 (ASTM D1560).

Voids in Mineral Aggregate (Item 11): Enter the design void space between the aggregate particles of a compacted AC mixture, which includes the air voids and the effective asphalt content, to the nearest tenth of a percent (0.1 percent). Percent of voids in mineral aggregate (VMA) is calculated as follows:

$$VMA = 100 - \frac{G_{mb}\,P_s}{G_{sb}}$$

Figure 21. Equation. Voids in mineral aggregate.

where:

VMA	=	Voids in mineral aggregate (percent of bulk volume)
G_{sb}	=	Bulk specific gravity of aggregate
G_{mb}	=	Bulk specific gravity of compacted mixture (ASTM D2726)
P_s	=	Aggregate, percent by total weight of mixture
	=	100 - (percent of asphalt cement by total weight of mixture)

Effective Asphalt Content (Item 12): The design effective asphalt content (total asphalt content of the paving mixture minus the portion of asphalt that is lost by absorption onto the aggregate particles as a percentage of the total mixture, to the nearest tenth of a percent (0.1 percent). The asphalt absorption may be calculated as a percent of total weight of mixture as follows:

$$P_{ab} = P_{ba} P_s = \frac{G_{se} - G_{sb}}{G_{sb} G_{se}} G_b P_s$$

Figure 22. Equation. Percent absorbed asphalt.

where:

P_{ab}	=	Absorbed asphalt, percent by weight of total mixture
P_{ba}	=	Absorbed asphalt, percent by weight of aggregate
P_s	=	Aggregate, percent by total weight of mixture
G_{se}	=	Effective specific gravity of aggregate
G_{sb}	=	Bulk specific gravity of aggregate
G_b	=	Specific gravity of asphalt

Superpave Gyratory Compaction N_{DESIGN} (Item 13): Enter the number of revolutions of the Superpave gyratory compactor to achieve 4 percent air voids.

Gyration Ratio: (Item 14): The gyration ratio measured. The recommended compactability criterion is the gyration ratio should be less than or equal to 1.25. The gyration ratio is calculated as follows:

$$Ratio = \frac{(N_{92})_{T-30}}{(N_{92})_T}$$

Figure 23. Equation. Gyration ratio.

where:

Ratio	=	Gyration ratio
$(N_{92})_{T-30}$	=	Gyrations to 92 percent relative density at 30ºC below the planned field compaction temperature
$(N_{92})_T$	=	Gyrations to 92 percent relative density at the planned field compaction temperature

Asphalt Grade (Item 15): Enter the code for the asphalt grade used in asphalt mixtures, if available. (See asphalt code sheet table 54 of Standard Codes Tables section).

Hamburg Wheel Tracking Test Conditioning (Item 16): The condition of the Hamburg Wheel Tracking Test.

Deformation at 20,000 passes (Item 17): The deformation measurement at 20,000 passes during the Hamburg Wheel Tracking Test measured in inches.

Test Temperature (Item 18): The temperature used during the Hamburg Wheel Tracking Test in degrees of Fahrenheit.

Tensile Strength Ratio (AASHTO T283) (Item 19): Percentage of Tensile Strength Ratio using AASHTO T283.

PMA Laboratory Mix Design (Continued) (SPS -11 Data Sheet 17)

The data on this data sheet is a continuation of the information from SPS-11 Data Sheet 16.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Flow Number (AASHTO TP-79) (Item 2): The number of cycles corresponding to the minimum rate of change.

Flow Number Temperature (Item 3): The flow number temperature in degrees Fahrenheit.

Planned Production Temperature (Item 4): The planned production temperature of the asphalt mixture in degrees Fahrenheit.

Planned Field Compaction Temperature (Item 5): The planned field compaction temperature in degrees Fahrenheit.

Design Asphalt Binder Content of Mix Without RAS/RAP (Item 6): The percentage of asphalt binder content without RAS or RAP.

Percent RAS in Mixture (Item 7): The percentage of reclaimed asphalt shingles in the mixture.

Percent Shingle Asphalt Binder in RAS (Item 8): The percentage of shingle asphalt binder in the reclaimed asphalt shingles.

Percent RAP in Mixture (Item 9): The percentage recycled asphalt cement in the mixture.

Percent Asphalt in RAP (Item 10): The percentage of asphalt in the recycled asphalt cement mixture.

Percent of RAP/RAS Binder in the Mix by Mass (Binder Replacement) (Item 11): The amount of binder from RAP/RAS as a percentage of total binder in the mixture (from the mix design).

Amount of New Untreated Aggregate Added (Item 12): The amount of new untreated aggregate added, to the nearest tenth of a percent (0.1 percent) of the combined weight of the aggregates in the recycled mixture.

Recycling Agent (Item 13): Codes to identify the Type and Quantity of recycling agent used. The codes for type appear in table 58 of Standard Codes Tables section. The amount of recycling agent should be provided by weight added to the reclaimed (aged) asphalt, to the nearest tenth of a percent (0.1 percent) of the reclaimed asphalt cement weight. As an example, if the weight of the recycling agent to be added to the aged asphalt cement was 41.5 percent of the weight of the aged asphalt in the reclaimed mixture, "41.5" would be entered on the data sheet.

Amount of New Asphalt Cement Added (Item 14): The quantity of new asphalt cement to the nearest tenth of a percent (0.1 percent) of total recycled mixture weight (includes reclaimed AC and untreated aggregate and asphalt cement/recycling agent added).

PMA Laboratory Mix Design (Warm Mix) (SPS -11 Data Sheet 18)

The data on this data sheet is a continuation of the information from SPS-11 Data Sheets 16 and 17. The sheet only needs to be filled out for sections that use warm mix asphalt.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Warm Mix Technology (Item 2): The type of warm mix technology that was used. If a technology other than those provided is used, space is provided to specify technology used and a brand name. If the mix is HMA, enter the code for none.

Form of WMA Additive (Item 3): The type of WMA technology, as identified on the data sheet, used in the mixture. If the mix is HMA, enter the code for none.

Dosage Rate (Item 4): The percent by total weight of the binder. If the binder is HMA, leave this field null.

Method of Introducing Additive to the Mix (Item 5): The method used to introduce the WMA technology to the mix. If a method other than those provided is used, space is provided to specify the method used. If the mix is HMA, enter the code for none.

PMA Mix Prop (SPS -11 Data Sheet 19)

This data sheet provides information regarding mixture properties as placed. This data is to be filled out from project records on SPS-11 Data Sheets 19 and 20 for which long-term monitoring is planned.

For existing PMA layers, agency records should be used to complete this data sheet. For new SPS-11 construction layers, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Samples (Item 2): Whether the test samples were sampled in the field and compacted in the laboratory, or removed from the compacted pavement. The codes appear on the data sheet.

Maximum Specific Gravity (Item 3): The Maximum Specific Gravity (no air voids) of a mixture sampled during or soon after construction according to AASHTO T209 or ASTM D2041. Where possible, several samples should be tested and the average entered. Use the resulting maximum specific gravity and the design asphalt content for the mixture to calculate the effective specific gravity of the aggregate using figure 18. Once the effective specific gravity of the aggregate is established, it may be used to calculate other maximum specific gravities for the mixture at other measured asphalt contents using figure 19.

Bulk Specific Gravity (Item 4): The Number of Tests and the Mean, Minimum, Maximum, and Standard Deviation of bulk specific gravities (to the nearest thousandth (0.001)) of compacted mixtures measured on cores removed from the pavement during or right after construction. While the test method specified in ASTM D1188 is preferable, the results from nuclear density tests (ASTM D2950), appropriately calibrated to measurements on cores, may also be used.

Asphalt Content (Item 5): The Number of Tests and the Mean, Minimum, Maximum, and Standard Deviation of percentages by weight of the total asphalt cement (including that absorbed by the aggregate) in the asphalt mixture to the nearest one-tenth of a percent (0.1 percent). Asphalt contents measured by extraction tests (AASHTO T164 (ASTM D2172)) on field samples are preferred, but results from nuclear test methods may also be used. If no such test results are available, enter the specified asphalt content as the mean, and leave the other spaces blank.

Percent Air Voids (Item 6): The Number of Tests and the Mean, Minimum, Maximum, and Standard Deviation of calculated air voids (to the nearest tenth of a percent (0.1 percent)) as a percent of the material volume. These data are frequently not available, but can be calculated using other available data from reports on mix design and density measurements on samples from the pavement. Percent air voids is calculated as shown in figure 20.

Voids in Mineral Aggregate (Item 7): The Number of Tests and the Mean, Minimum, Maximum, and Standard Deviation of mean void space between the aggregate particles of a compacted mixture, which includes air voids and the effective asphalt content, to the nearest one-tenth of one percent (0.1 percent). Percent of VMA is calculated as shown in figure 21.

Effective Asphalt Content (Item 8): The Number of Tests and the Mean, Minimum, Maximum, and Standard Deviation of effective asphalt content (total asphalt content of the paving mixture minus the portion of asphalt that is lost by absorption into the aggregate particles), expressed by weight of total mixture to the nearest tenth of a percent (0.1 percent). The asphalt absorption may be calculated as a percent of total weight of mixture as shown in figure 22.

PMA Mix Prop (Continued) (SPS -11 Data Sheet 20)

The data on this data sheet is a continuation of the data from SPS-11 Data Sheet 19.

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Samples (Item 2): Whether the test samples were sampled in the field and compacted in the laboratory, or removed from the compacted pavement. The codes appear on SPS-11 Data Sheet 20.

Type of Asphalt Plant (Item 3): The type of plant that produced the asphalt concrete mixture. Codes are provided on SPS-11 Data Sheet 20.

Type of Antistripping Agent (Item 4): The type of antistripping agent used in the mixture. The codes are provided in table 59 of Standard Codes Tables section.

Antistripping Agent Liquid or Solid Code (Item 5): A code to indicate whether the antistripping agent used is a liquid or solid. Codes are provided on SPS-11 Data Sheet 20.

Amount of Antistripping Agent (Item 6): The amount of antistripping agent used in the mixture by weight to the nearest tenth of a percent of weight of asphalt if the agent is liquid and weight of aggregate if it is solid.

Moisture Susceptibility Test Type (Item 7): The type of test used to evaluate the moisture susceptibility of the asphalt mixture. Codes are provided on SPS-11 Data Sheet 20.

Moisture Susceptibility Test Results (Item 8): Space is provided to record the Hveem Stability Number or Percent Stripped and the Tensile Strength Ratio or Index of Retained Strength, depending on the test procedure used.

Superpave Mixture Properties (SPS -11 Data Sheet 21)

This data sheet provides information regarding Superpave properties of the mixture as placed. This data is to be filled out from project records on SPS-11 Data Sheet 21 for which long-term monitoring is planned.

For existing PMA layers, agency records should be used to complete this data sheet. For new SPS-11 construction layers, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Type of Samples (Item 2): Whether the test samples were sampled in the field and compacted in the laboratory, or removed from the compacted pavement. The codes appear on SPS-11 Data Sheet 21.

Frequency Sweep (Item 3): The mean Complex Modulus and Phase SHRP Designation M-002 in PSI and to the nearest tenth of a degree (0.1°) for Phase Angle for each of the three temperatures (39.2°F, 68°F, 104°F (4°C, 20°C, and 40°C, respectively)). (Test method ASTM D7312).

Uniaxial Strain (Item 4): The Axial Stress and percent Strain (SHRP Designation M-003) for each of the three temperatures (39°F, 68°F and 104°F) in kPa and the nearest hundredth of a percent strain (0.01 percent).

Volumetric Strain (Item 5): The Confining Pressure and percent Strain (SHRP Designation M-003) for each of the three temperatures (39°F, 68°F and 104°F) in kPa and the nearest hundredth of a percent strain (0.01 percent).

Simple Shear (Item 6): The Axial Stress, Shear Stress and percent Strain (SHRP Designation M-003) for each of three temperatures (preferred 39°F, 68°F and 104°F in PSI and the nearest hundredth of a percent strain (0.01 percent).

PMA Construction (SPS -11 Data Sheet 22)

This data sheet provides information regarding construction, roller and compaction data. This data is to be filled out from project records on SPS-11 Data Sheets 23 and 24.

For existing PMA layers, agency records should be used to complete this data sheet. For new SPS-11 construction layers, this data sheet should be filled out during construction activities. Additionally, this data sheet should be completed for all asphalt treated base layers.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Date Operations Began (Item 2): The date paving operations began.

Date Paving Complete (Item 3): The date paving was completed.

Mixing Plant Type (Item 4): The type of mixing plant used. Codes are provided on SPS-11 Data Sheet 22.

Mixing Plant Name (Item 5): Name of the mix plant.

Type of Materials Transfer Equipment Used (Item 6): A code to indicate the type of materials transfer equipment used. Space is also provided to describe some other type of equipment used if none of those for which codes are provided are used. Additionally, there is a space provided to list the brand name of the equipment used.

Tack Coat (Y/N) (Item 7): A yes or no field indicating whether a tack coat was applied.

Tack Coat Type (Item 8): The type of tack coat that was applied. The codes appear in table 54 of Standard Codes Tables section. Space is provided on the data sheet for identifying another type of tack coat if the types identified in table 54 are not applicable.

Tack Coat Dilution (Item 9): The dilution of the tack coat in percent asphalt as part of the total.

Application Rate (Item 10): The number to record the gallons per square yard(gal/yd^2) of the application rate.

Haul Distance and Time (Item 11): The distance from the plant to the site in miles, and the time from the plant to site in minutes.

Single Pass Laydown Width (Item 12): With of pavement (in ft) the paver lays down in a single pass.

Transverse Joint Location (Item 13): Location in meters from the start of the section to a transverse paving joint.

Longitudinal Surface Joint (Item 14): Code indicating whether the longitudinal surface joint is between lanes (1) or within the LTPP test lane (2).

Longitudinal Joint Offset (Item 15): Location (in ft) of the longitudinal joint from the outside shoulder.

Significant Events (Item 16): Note any significant events that may have impacted the paving operations. Include information such as disruptions, weather events, equipment issues, etc.

PMA Construction (Continued) (SPS -11 Data Sheet 23)

The data on this data sheet is a continuation of the data from SPS-11 Data Sheet 23.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Mixing Temperature (Item 2): The temperature of the mixture during mixing at the plant (i.e., the mix as discharged) in degrees Fahrenheit.

Plant Exhaust Temperature (Item 3): The plant exhaust temperature in degrees Fahrenheit.

Mean Delivery Temperature (Item 4): The average temperature of mixture during delivery to the site in degrees Fahrenheit.

Laydown Temperatures (Item 5): The Number of Tests taken and the Mean, Minimum, Maximum, and Standard Deviation of temperatures measured. The temperature should be measured just behind the screed. Three to five measurements should be made.

Roller Data (Items 6-22): Codes appear on the data sheet for steel-wheeled tandem, pneumatic-tired, single-drum vibratory, and double-drum vibratory rollers. For each type of roller, spaces are provided to describe significant characteristics for up to four different rollers. Steel-wheeled tandem rollers are described by their gross weights to the nearest tenth of a ton (0.1 ton). Pneumatic-tired rollers are described by their gross weight and tire pressure in psi. Vibratory rollers are described by their gross weight in tons to the nearest tenth (0.1 ton), frequency in vibrations per minute, amplitude in inches to the nearest thousandth (0.001 inch), and roller speed in miles per hour to the nearest tenth (0.1 mph).

Compaction Data (Items 23-31): Spaces are provided to enter the compaction data up to four lifts.

Description of the Roller (Items 23-28): Descriptive data to identify the type of roller used (code from data sheet) and Number of Coverages for breakdown, intermediate, and final compactions for up to four lifts. A "coverage" in this case is defined as one trip of the roller across the pavement.

Air Temperature (Item 29): The ambient temperature measured in degrees Fahrenheit while compaction is accomplished.

Compacted Thickness (Item 30): The thickness of the compacted mat measured in inches to the nearest tenth (0.1 inch). If coring is not performed, the planned thickness should be recorded.

Curing Period (Item 31): Enter the number of days before a new lift is placed or the layer is opened to traffic.

Unbound (SPS -11 Data Sheet 24)

This data sheet provides information regarding the unbound or stabilized base or subbase material and should be filled out for each unbound base layer. This data is to be filled out from project records on SPS-11 Data Sheets 24 and 25 for which long-term monitoring is planned.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

AASHTO Soil Classification (Item 2): The AASHTO soil classification for the base or subbase material (prior to any stabilization). The code numbers appear in table 48 of Standard Codes Tables section for the various AASHTO classifications.

Atterberg Limits (Item 3): The plasticity index (PI), liquid limit (LL), and plastic limit (PL) determined by AASHTO T90 and T89 or ASTM D4318.

Maximum Lab Dry Density (Item 4): The maximum laboratory dry density in pounds per cubic foot for the base or subbase material in the layer of interest.

Optimum Lab Moisture Content (Item 5): The optimum moisture content obtained in the laboratory to the nearest one-tenth of a percent (0.1 percent) for the base or subbase layer.

Test Used to Measure Maximum Dry Density (Item 6): The test method used to establish the maximum dry density and optimum moisture content. Codes are provided on Data Sheet 20 for the most commonly used test methods. Space is also provided for identifying another test method used, if different from the test methods listed.

Compactive Energy for "Other" Method (Item 7): The compactive energy in foot-pounds per cubic inch applied if some test method was used other than those for which codes were provided under Item 6. If the test method used already had a code under Item 6, this space is to be left blank.

In Situ Dry Density (Item 8): The Number of Samples tested, and the Mean, Minimum, Maximum, and Standard Deviation of field measurements of the in-place dry density in pounds per cubic foot for the base or subbase layer.

In Situ Moisture Content (Item 9): The Number of Samples tested, and the Mean, Minimum, Maximum, and Standard Deviation of field measurements of the base or subbase in-place moisture content in percent of dry weight of the material. This moisture content data is to be based on the same tests as the dry density data in Item 8.

Compressive Strength (Item 10): The Number of Tests performed and the Mean, Minimum, Maximum, and Standard Deviation of the compressive strength in psi of the stabilized or un-stabilized material.

Type of Compression Test (Item 11): The type of test used to evaluate the compressive strength of the material. Codes are provided on the data sheet along with space to identify the test type if the appropriate type is not listed.

Confining Pressure (Item 12): The confining pressure applied during the compressive strength testing. If the test was unconfined, enter "0.0."

Calcium Carbonate Content (Item 13): The percent by weight of the base or subbase material that is composed of calcium carbonate, as determined by ASTM D4373.

Unbound (Continued) (SPS -11 Data Sheet 25)

The data on this data sheet is a continuation of the information from SPS-11 Data Sheet 24.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

California Bearing Ratio (CBR) (Item 2): The mean CBR-value of the material as determined by Test Method AASHTO T193 or ASTM D1883.

Resistance (R-Value) (Item 3): The mean R-Value as determined by Test Method AASHTO 190 (ASTM D2844).

Modulus of Subgrade Reaction (k-Value) (Item 4): The mean k-Value in pci (pounds per square inch per inch of deflection) measured at the top of the base or subbase after it is compacted in place.

Type of Test (Item 5): The Type of Test used. Either the repeated load test (AASHTO T221 (ASTM D1195)) or the static load test (AASHTO T222 or ASTM D1196) may be used and codes for these are provided on SPS-11 Data Sheet 25.

Type and Percent Stabilizing Agent (for Stabilized Layers Only) (Items 6 and 7): The types of stabilizing agents and the average percent of each by dry weight of soil mixed into the base or subbase material in the layer of interest. Codes are provided on the data sheet for stabilizing agents commonly in use and space is provided to identify an agent not listed. An average of measured percentages is used whenever available. If percentages have not been measured, the specified percentage should be entered. If neither measured nor specified data are available, but the layer is known to have been stabilized, a percentage should be estimated based on practice at the time the stabilized base or subbase layer was constructed. If only one stabilizing agent is used, leave the spaces for "Stabilizing Agent 2" blank. If the base or subbase material is not stabilized, enter "N."

Gradation of Base or Subbase Material (Coarse and Fine Aggregates) (Item 8): The percentage of material passing various standard sieve sizes to the nearest one percent. It is not expected that values will be available for all seventeen sieve sizes; the objective is to provide space for a sufficient number of sieve sizes to accommodate testing practices for most agencies.

Subgrade (SPS -11 Data Sheet 26)

The properties of the predominant subgrade type encountered on the project should be entered on this data sheet. In cases where a known variation in the subgrade occurs along the project, SPS-11 Data Sheets 26 and 27 should be completed for each test section.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

AASHTO Soil Classification (Item 2): The AASHTO Soil Classification for the subgrade material. These codes are provided in table 48 of Standard Codes Tables section.

California Bearing Ratio (Item 3): The CBR for the subgrade soil (Test Method AASHTO T193 or ASTM D1883).

Resistance (R-Value) (Item 4): The mean resistance R-value as determined by test method AASHTO T190 (ASTM D2844).

Modulus of Subgrade Reaction (k-Value) (Items 5 and 6): The mean modulus of subgrade reaction in pci (pounds per square inch per inch of deflection) for the in situ subgrade, and the Type of Test used. Either the repeated load test (AASHTO T221 (ASTM D1195)) or the static load test (AASHTO T222 or ASTM D1196) may be used as coded on SPS-11 Data Sheet 26.

Plasticity Index (Item 7): The average of plasticity indices measured for samples from the first five feet (1.5 m) of the subgrade (Test Methods AASHTO T90 or ASTM D4318).

Liquid Limit (Item 8): The average of the liquid limits measured for samples from the first five feet (1.5 m) of subgrade (Test Methods AASHTO T89 or ASTM D4318).

Maximum Laboratory Dry Density (Item 9): The maximum laboratory dry density in pounds per cubic foot for the subgrade material.

Optimum Laboratory Moisture Content (Item 10): The optimum moisture content obtained in the laboratory to the nearest tenth of a percent for the subgrade (0.1 percent).

Test Used to Measure Maximum Dry Density (Item 11): A code, provided on Data Sheet 22, to indicate whether standard AASHTO, modified AASHTO, or some other test method is used to establish the maximum dry density and optimum moisture content.

Compactive Energy for "Other" Method (Item 12): The compactive energy in foot-pounds per cubic inch applied if some test method is used other than the standard AASHTO or modified AASHTO. If standard or modified AASHTO is used, leave this space blank.

In Situ Dry Density (Percent of Optimum) (Item 13): The Number of Tests conducted, and the Mean, Minimum, Maximum, and Standard Deviation of field measurements of in-place dry density for the subgrade as a percentage of the maximum lab dry density. In situ dry density may be measured successfully by several procedures; including the "rubber-balloon method" (AASHTO T205 (ASTM D2167)), the "sand cone method" (AASHTO T191 (ASTM D1556)), or "nuclear methods" (AASHTO T238).

In Situ Moisture Content (Percent of Optimum) (Item 14): The Number of Tests conducted, and the Mean, Minimum, Maximum, and Standard Deviation of field measurements of in-place subgrade moisture content as a percent of the optimum moisture content obtained in the laboratory. This moisture content data is to be based on the same tests as for the dry density data above. Values should be recorded to the nearest tenth of a percent (0.1 percent).

In Situ Dry Density (pcf) (Item 15): The Number of Tests conducted, and the Mean, Minimum, Maximum, and Standard Deviation of field measurements of in-place dry density in pounds per cubic foot for the subgrade. This data item need not be entered if both the maximum laboratory dry density and the in situ dry density as a percent of maximum have been reported.

In Situ Moisture Content (Item 16): The Number of Tests conducted, and the Mean, Minimum, Maximum, and Standard Deviation of field measurements of in-place subgrade moisture in percent of dry weight of the material. This moisture content data is to be based on the same tests as for the dry density data above, and need not be entered if the optimum laboratory moisture content and the in situ moisture content as a percent of optimum have been reported. Values should be recorded to the nearest tenth of a percent (0.1 percent).

Subgrade (Continued) (SPS -11 Data Sheet 27)

The data on this data sheet is a continuation of the data from SPS-11 Data Sheet 26.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Relative Density of Cohesionless Free-Draining Soil (Items 2 and 3): For cohesionless free-draining soils only. If the subgrade soil has more than 12 percent by weight passing the No. 200 (75-µm) sieve or is otherwise known to not be free-draining, enter "N" in these spaces. Otherwise, the following values are requested: 1) minimum and maximum densities in pcf (to the nearest tenth (0.1 pcf)) as determined by Test Method ASTM

D2049 (Measured Density), 2) mean relative density in percent (to the nearest tenth (0.1 percent)) and number of tests conducted, 3) minimum and maximum mean relative densities in percent (to the nearest tenth (0.1 percent)) and 4) standard deviation of relative density in percent (to the nearest tenth (0.1 percent)). The calculated relative densities and standard deviation of relative density are related to the "in situ dry densities" in pcf recorded on SPS-11 Data Sheet 21, and are calculated using those field densities and the minimum and maximum densities from Test Method D2049.

Soil Suction (Item 4): A value for soil suction (negative pore water pressure) to the nearest tenth of a ton per square foot (0.1 tsf) determined by AASHTO T273.

Expansion Index (Item 5): The Expansion Index as determined by ASTM Test Method D4829. The "Expansion Index" has been included as a data element as it appears to offer high potential for "explaining" the effects of expansive soils on pavement performance in future predictive models.

Swell Pressure (Items 6 and 7): A value to the nearest pound per square inch for swell pressure, and a code to identify the test used. Codes are provided on Data Sheet 27.

Percent by Weight Finer Than 0.02mm (Item 8): The percent by weight (to the nearest tenth (0.1 percent)) of the subgrade sample having soil "grains" finer in size than 0.02 millimeters. This value is generally obtained by hydrometer analysis (ASTM Test Method D422). This data item is only required in "Freeze Zones" where frost is expected to penetrate into the subgrade.

Average Rate of Heave During Standard Laboratory Freezing Test (Item 9): The average rate of heave in millimeters per day to the nearest tenth (0.1 mm/day) of the subgrade soil as measured by a standard laboratory freeze test (reference not available used by U.S. Army Corps of Engineers). This data item is only required in "Freeze Zones" where frost is expected to penetrate into the subgrade.

Frost Susceptibility Classification Code (Item 10): The frost susceptibility classification of the subgrade soil. The codes appear on the data sheet. A value for the "Average Rate of Heave" is required for the classification, although "Percent by Weight Finer Than 0.02 mm" is indicative and significant to the heave rate. This data item is only required in "Freeze Zones" where frost is expected to penetrate into the subgrade.

QC Measurements (SPS -11 Data Sheet 28)

The purpose of this data sheet is to record the results of nuclear density tests or surface profile measurements if used for construction control or acceptance by the participating agency. For nuclear density tests, it is desired that the test section be treated as the sampling union if a random sampling technique is used. Reported Profilograph readings should be based on measurements on the test section and prorated to units of inches per mile. Measurements over 500 feet (0.1 of a mile) centered on the test section may also be used.

Individual data elements are as follows:

Nuclear Density Measurements (Item 1): Space is provided for entry of the results of nuclear density tests on the binder course and surface course layers. Enter information only for the layers on the test sections that were tested. For each layer tested, enter the measurement method (backscatter, direct transmission, air gap), the number of measurements, the average, maximum, minimum and standard deviation of the density measurements (pounds per cubic foot), and the corresponding layer number from SPS-11 Data Sheet 4.

Manufacturer of Nuclear Density Gauge (Item 2): Indicate the name of the manufacturer of the nuclear density gauge used for the reported measurements.

Nuclear Density Gauge Model Number (Item 3): Enter the manufacturer's model designation of the gauge used.

Nuclear Density Gauge Identification Number (Item 4): Enter the identification number of the nuclear density gauge used.

Nuclear Gauge Count Rate for Standardization (Item 5): Enter the gauge count rate used for standardization.

Profilograph Measurements (Item 6): Report the results of any Profilograph measurements performed on the overlay finished surface layer. For each measurement performed, report the type of Profilograph (Rainhard or California), profile index, interpretation method (manual, mechanical or computer), height of blanking band and cutoff height. Note that mechanical interpretation method refers to readings from mechanical counters located on some devices. Enter mechanical computer reading only if the profilograms are not interpreted either by manual or computer methods.

Surface Profile Used as Basis of Incentive Payment (Item 7): This is a yes or no field to indicate if the surface profile was or was not used as a contractual basis for incentive payments to the construction contractor.

Field Thickness (SPS -11 Data Sheet 29)

This data sheet is used to record the results of the layer thickness measurements within the test section from before and after elevation measurements. Results of these measurements should be provided for five offset points at every station along the project which was measured. The station number should be entered as the test section relative station number. Offset distance should be entered in inches and measured from the outside shoulder lane edge joint or edge stripe. Space is provided to enter elevation for four layers within the test section. If individual layer thicknesses are not measured, enter the layer thicknesses for the layer for which after placement surface elevation was measured. For example, if surface elevation was only measured for the surface course, then the layer thickness should be entered for the layer number corresponding to the surface. Enter the layer number of any layer for which layer thickness is shown. Use more than one data sheet as required.

Notes and Comments (SPS -11 Data Sheet 30)

This data sheet is provided for reporting miscellaneous notes and comments, further descriptions of entries on other data sheets, or construction related data that are not covered on other data sheets. Comments on this data sheet should address features or occurrences which may influence the performance of the test section. For example, comments from the site asphalt concrete inspector concerning marginal or questionable batches that were either rejected or used on the test sections may be included.

Also, this data sheet may be used to provide additional comments on items included in other data sheets. In these cases, the items and data sheet number pertaining to these comments should be indicated on this data sheet.

In addition, this data sheet can be used to report other types of quality control measurements performed on the test section which are not covered in the construction data sheets. For example, if profile or ride quality acceptance procedures are not based on Profilograph measurements, this information could be provided on this data sheet. In this case, specify the type, manufacture, model number of measurement equipment used, and a reference to the standard test procedure employed (such as ASTM, AASHTO, or Agency's test method).

Improvement Listing (SPS -11 Data Sheet 31)

This data sheet is to be completed each time construction activities are performed on a test section.

Individual data elements are as follows:

> *Date Completed (Item 1)*: The month, day, and year that the pavement improvements were finished and the project was subsequently opened to traffic (not the date when the project was accepted).
>
> *Work Type Code (Item 2)*: A code to identify the type of maintenance work accomplished (Table 57 of Standard Codes Tales section).
>
> *Work Quantity (Item 3)*: The quantity of work applied to the section in appropriate units (Table 57 of Standard Codes Tales section).
>
> *Thickness (Item 4)*: For improvements that alter the thickness of the pavement structure (such as overlays, etc.), enter the thickness of the rehabilitation activity to the nearest tenth of an inch. For items that do not alter the thickness of the pavement structure, enter 'N' to indicate the data element is not applicable.
>
> *Cost (Item 5)*: The cost of the improvement is reported in thousands of dollars per lane-mile. The cost includes only pavement structure cost. Non-pavement costs such as cut and fill work, work on bridges, culverts, lighting, and guardrails should be excluded.

Chip Seal Application Data (SPS -11 Data Sheet 32)

SPS-11 Data Sheets 32 and 33 are for recording data on chip seal applications. This includes data specific to the design and construction of the layer. Material specific information for the binder and aggregates is recorded on sheets 12 and 9-11 respectively.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Date Sealing Began (Item 2): The month, day and year the maintenance operation began.

Date Sealing Complete (Item 3): The month, day and year the maintenance operation began.

Application Rate for Bituminous Material (Item 4): The design amount of bituminous material, to the nearest hundredth of a gallon, to be placed per square yard (0.01 gal/yd^2) of pavement.

Application Temperature for Bituminous Material (Item 5): The design application temperature of the bituminous material in degrees Fahrenheit.

Application Rate for Aggregate (Item 6): The design amount by weight of aggregate, to the nearest tenth of a pound (0.1 lb) including mineral filler, to be placed per square yard of pavement (0.1 lb/yd^2).

Design Embedment Depth (Item 7): The designed depth of aggregate embedment, to the nearest hundredth of an inch (0.01 inch).

Vialet Test Lab Results (Item 8): The percent of aggregate retained, to the nearest one percent, as determined by the Vialet test using lab prepared samples.

Condition of Existing Pavement Surface (Item 9): A code entered to indicate the general condition of the surface prior to application of the treatment. The codes appear on the data sheet.

Initial Preparation of Existing Pavement Surface (Item 10): A code entered to indicate the method of initial preparation for the existing pavement surface. The codes appear on the data sheet, and space is provided to describe a method not coded, where applicable. Attach a separate piece of paper if more space is needed.

Final Preparation of Existing Pavement Surface (Item 11): A code entered to record the final surface preparation used on the existing AC surface prior to seal coat application. The codes for various surface preparation methods appear on the data sheet.

Surface Cleanliness Prior to Placement (Item 12): A code entered to indicate whether the surface of the existing pavement was clean, moderately clean, or dirty when the seal coat was placed.

Surface Moisture at Placement (Item 13): A code entered to indicate whether the surface of the existing pavement was wet or dry when the seal coat was placed.

Air Temperature (Item 14): The ambient temperature measured in degrees Fahrenheit while the seal coat was placed.

Surface Temperature (Item 15): The temperature of the existing pavement surface measured in degrees Fahrenheit just prior to the seal coat placement.

Relative Humidity (Item 16): The relative humidity, in percent, at the time of seal coat placement.

Cloud Cover (Item 17): The approximate cloud coverage, in percent, at the time of seal coat placement.

Wind Speed (Item 18): The approximate typical wind speed, in miles per hour, at the time of seal coat placement.

Chip Seal Application Data, Continued (SPS -11 Data Sheet 33)

This data sheet is a continuation of the seal coat data recorded on SPS-11 Data Sheet 32.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Asphalt Distributor Manufacturer/Model (Item 2): The manufacturer name and the manufacturer model designation for the asphalt distribution vehicle.

Nozzle Angle (Item 3): The angle, in degrees from vertical, of the spray bar nozzles on the asphalt distribution vehicle.

Spray Bar Height (Item 4): The height, in inches, of the spray bar from the pavement surface, to the nearest tenth of an inch (0.1 inch).

Nozzle Spacing (Item 5): The distance, in inches, between the spray bar nozzles, to the nearest tenth of an inch (0.1 inch).

Nozzle Brand/Model (Item 6): The brand and model number of the spray bar nozzles.

Aggregate Distributor Manufacturer/Model (Item 7): The manufacturer name and the manufacturer model designation for the aggregate distribution equipment.

Roller Data (Items 8-11): Codes appear on the data sheet for pneumatic-tired rollers only. Spaces are provided to describe significant characteristics for up to four different rollers. Rollers are described by their gross weight in tons, tire pressure in psi, and roller speed in miles per hour to the nearest tenth (0.1 mph). Space is also provided for the coverage information. A "coverage" in this case is defined as one trip of the roller across the pavement.

Power Broom Manufacturer/Model (Item 12): The manufacturer name and the manufacturer model designation for the equipment used to sweep the surface after rolling.

Passes (Item 13): Number of passes made by the power broom.

Bituminous Material Application Rate (Item 14): The amount of bituminous material, to the nearest hundredth of a gallon, placed per square yard (0.01 gal/yd^2) of pavement (water added to emulsified asphalt is included).

Bituminous Material Application Temperature (Item 15): The temperature of the bituminous material, as applied, in degrees Fahrenheit.

Appearance of Non-Uniform Bituminous Material Application (Item 16): The length of the section, in feet, that received non-uniform (streaking or areas not adequately covered) transverse application of bituminous material.

Aggregate Precoated (Item 17): A Y/N code entered to indicate whether or not the aggregate used in the seal coat was coated with bituminous material prior to placement.

Aggregate Application Rate (Item 18): The amount by weight of aggregate, to the nearest tenth of a pound (0.1 lb) including mineral filler, placed per square yard of pavement (0.1 lb/yd^2).

Appearance of Non-Uniform Aggregate Application (Item 19): The length of the section, in feet, that received non-uniform transverse application of bituminous material

Aggregate Cleanliness (Item 20): A code entered to indicate the general level of cleanliness of the applied aggregate. Codes are supplied on the data sheet.

Aggregate Wetness (Item 21): A code entered to indicate the general level of wetness of the applied aggregate. Codes are supplied on the data sheet.

Aggregate Moisture Content (Item 22): The moisture content of the applied aggregate, in percent by weight of the aggregate.

Estimated Time Allowed for Seal Coat to Cure (Item 23): The approximate length of time, in hours, between the completion of rolling or seating the aggregate and opening the section to vehicular traffic.

Approximate Finished Surface Treatment Thickness (Item 24): The approximate thickness of the applied seal coat, to the nearest tenth of an inch (0.1 inch).

Measured Embedment Depth (Item 25): The depth of aggregate embedment measured in the finished layer, to the nearest hundredth of an inch (0.01 inch).

Vialet Test Field Results (Item 26): The percent of aggregate retained as determined by the Vialet test using field collected samples to the nearest one percent.

Micro-surfacing Application Data (SPS -11 Data Sheet 34)

SPS-11 Data Sheets 34 and 35 are for recording data on micro-surfacing applications. This includes data specific to the design and construction of the layer. Material specific information for the binder and aggregates is recorded on sheets 12 and 9-11 respectively.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Date Sealing Began (Item 2): The month, day and year the maintenance operation began.

Date Sealing Complete (Item 3): The month, day and year the maintenance operation began.

Application Rate for Bituminous Material (Item 4): The design amount of bituminous material, to the nearest hundredth of a gallon, to be placed per square yard (0.01 gal/yd^2) of pavement.

Application Rate for Aggregate (Item 5): The design amount by weight of aggregate, to the nearest tenth of a pound (0.1 lb), to be placed per square yard of pavement (0.1 lb/yd^2).

Application Rate for Mineral Filler (Item 6): The design amount by weight of filler, to the nearest tenth of a pound (0.1 lb), to be placed per square yard of pavement (0.1 lb/yd^2).

Application Rate for Mixture (Item 7): The design amount by weight of micro-surfacing mixture, to the nearest tenth of a pound (0.1 lb), to be placed per square yard of pavement (0.1 lb/yd^2).

Residual Asphalt Content (Item 8): The design amount by weight of residual asphalt, to the nearest tenth of a pound (0.1 lb), per square yard of pavement (0.1 lb/yd^2).

Wear Value (WTAT Loss) (Item 9): The design wear value in grams per square foot (g/ft^2). This value is also known as abrasion loss or WTAT (Wet Track Abrasion Test) loss.

Condition of Existing Pavement Surface (Item 10): A code entered to indicate the general condition of the surface prior to application of the treatment. The codes appear on the data sheet.

Initial Preparation of Existing Pavement Surface (Item 11): A code entered to indicate the method of initial preparation for the existing pavement surface. The codes appear on the data sheet, and space is provided to describe a method not coded, where applicable. Attach a separate piece of paper if more space is needed.

Final Preparation of Existing Pavement Surface (Item 12): A code entered to record the final surface preparation used on the existing AC surface prior to seal coat application. The codes for various surface preparation methods appear on the data sheet.

Surface Cleanliness Prior to Placement (Item 13): A code entered to indicate whether the surface of the existing pavement was clean, moderately clean, or dirty when the seal coat was placed.

Surface Moisture at Placement (Item 14): A code entered to indicate whether the surface of the existing pavement was wet or dry when the seal coat was placed.

Air Temperature (Item 15): The ambient temperature measured in degrees Fahrenheit while the seal coat was placed.

Surface Temperature (Item 16): The temperature of the existing pavement surface measured in degrees Fahrenheit just prior to the seal coat placement.

Relative Humidity (Item 17): The relative humidity, in percent, at the time of seal coat placement.

Cloud Cover (Item 18): The approximate cloud coverage, in percent, at the time of seal coat placement.

Wind Speed (Item 19): The approximate typical wind speed, in miles per hour, at the time of seal coat placement.

Micro-surfacing Application Data, Continued (SPS -11 Data Sheet 35)

This data sheet is a continuation of the micro-surfacing data recorded on SPS-11 Data Sheet 34.

Individual data elements are as follows:

Layer Number (Item 1): The number of the layer for which the data on this data sheet is being provided (from SPS-11 Data Sheet 4).

Mixer/Distributor Manufacturer/Model (Item 2): The manufacturer name and the manufacturer model designation for the micro-surfacing mixer/distributor vehicle.

Spreader Box Width (Item 3): The width of the spreader box, to the nearest inch.

Type of Drag Used (Item 4): A code indicating what type of drag, if any, was used. Codes are provided on the form.

Roller Data (Items 5-9): Codes appear on the data sheet for pneumatic-tired rollers, and also for a different roller type if necessary. Spaces are provided to describe significant characteristics for up to five different rollers. Rollers are described by their gross weight in tons, tire pressure in psi, and roller speed in miles per hour to the nearest tenth (0.1 mph). Space is also provided for the coverage information. A "coverage" in this case is defined as one trip of the roller across the pavement.

Tack Coat Material (Item 10): A code used to indicate the material used for the tack coat applied prior to application of the micro-surfacing. The codes are available in table 54 of Standard Codes Tables section. A space is provided to indicate the type of material used if other than those provided.

Tack Coat Application Rate (Item 11): The amount of bituminous material, to the nearest hundredth of a gallon, placed per square yard (0.01 gal/yd^2) of pavement.

Bituminous Material Application Rate (Item 12): The amount of bituminous material, to the nearest hundredth of a gallon, placed per square yard (0.01 gal/yd^2) of pavement.

Aggregate Application Rate (Item 13): The amount by weight of aggregate, to the nearest tenth of a pound (0.1 lb), placed per square yard of pavement (0.1 lb/yd^2).

Mineral Filler Application Rate (Item 14): The amount by weight of mineral filler, to the nearest tenth of a pound (0.1 lb), placed per square yard of pavement (0.1 lb/yd^2).

Water Added to Mix (Item 15): The amount of bituminous water, to the nearest hundredth of a gallon, placed per square yard (0.01 gal/yd^2) of pavement.

Micro-surfacing Application Rate (Item 16): The amount by weight of micro-surfacing, to the nearest tenth of a pound (0.1 lb), placed per square yard of pavement (0.1 lb/yd^2).

Bituminous Material Application Temperature (Item 17): The temperature of the bituminous material, at the time of mixing, in degrees Fahrenheit.

Appearance of Non-Uniform Application (Item 18): The length of the section, in feet, that received non-uniform (excessive surface defects, ripples, or drag marks) transverse application of micro-surfacing.

Wear Value (WTAT Loss)—As Placed (Item 19): The wear value in grams per square foot (g/ft^2) of the as placed micro-surfacing mixture. This value is also known as abrasion loss or WTAT (Wet Track Abrasion Test) loss.

Aggregate Cleanliness (Item 20): A code entered to indicate the general level of cleanliness of the applied aggregate. Codes are supplied on the data sheet.

Aggregate Wetness (Item 21): A code entered to indicate the general level of wetness of the applied aggregate. Codes are supplied on the data sheet.

Aggregate Moisture Content (Item 22): The moisture content of the applied aggregate, in percent by weight of the aggregate.

Estimated Time Between Spreading and Foot Traffic (Item 23): The approximate length of time, in hours, between the completion of spreading of the surface and opening the section to foot traffic.

Estimated Time Between Spreading and Vehicle Traffic (Item 24): The approximate length of time, in hours, between the completion of spreading of the surface and opening the section to vehicular traffic.

Approximate Finished Surface Treatment Thickness (Item 25): The approximate thickness of the applied seal coat, to the nearest tenth of an inch (0.1 inch).

Surface Texture Provided (Item 26): A code entered to record the texture of the finished micro-surfacing layer. The codes appear on the data sheet.

Does Brooming Dislodge Surface (Item 27): A Y/N code indicating whether the finished micro-surfacing is easily dislodged by a broom or not.

LTPP SPS-11 DATA **SHEET 1** **PROJECT IDENTIFICATION**	STATE CODE [__ __] PROJECT ID [__ __ __ __]

1. DATE OF DATA COLLECTION OR UPDATE (Month/Year) [__ __ / __ __ __ __]

2. HIGHWAY AGENCY (HA) DISTRICT NUMBER [__ __]

3. COUNTY OR PARISH [__ __ __]

4. FUNCTIONAL CLASS (See Table 40) [__ __]

5. ROUTE NUMBER [__ __ __ __ __]

6. ROUTE SIGNING (See Route Signing Codes, Table 61) [__ __]

7. ROUTE QUALIFIER [__ __]

No Qualifier or Not Signed.... 1	Alternate................. 2
Business Route................ 3	Bypass Business........... 4
Spur.......................... 5	Loop...................... 6
Proposed...................... 7	Temporary................. 8
Truck Route................... 9	None of the Above........ 10

8. ALTERNATE ROUTE NAME
(Specify)[____]

9. NUMBER OF THROUGH LANES (One direction) [__]

10. DATE OPEN TO TRAFFIC [__ __ / __ __ __ __]

11. CONSTRUCTION COSTS PER LANE MILE (In $1000) [__ __ __ __ __]

12. MILEPOINT (project start) [__ __ __ __ __ . __ __]

13. ELEVATION (feet) [__ __ __ __ __ __]

14. ADDITIONAL LOCATION INFORMATION (significant landmarks): [______________
____
____]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 2 PROJECT STATIONS	STATE CODE [__ __] PROJECT ID [__ __ __ __]

ORDER	(1)TEST SECTION ID NO	REFERENCE PROJECT STATION NUMBER		(4) CUT-FILL TYPE[1]
		(2) START	(3) END	
1	__ __ __ __	0+ 0 0. 0	__ __ __+__ __.__	__
2	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
3	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
4	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
5	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
6	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
7	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
8	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
9	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
10	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
11	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
12	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
13	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
14	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
15	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
16	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
17	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
18	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
19	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__
20	__ __ __ __	__ __ __+__ __.__	__ __ __+__ __.__	__

5. DIRECTION OF TRAVEL [__]
East..... 1 West..... 2 North..... 3 South..... 4

Note 1. Indicate the type of subgrade section the test section is located on:
Cut..... 1 Fill..... 2 At-Grade..... 3 Cut and Fill..... 4
If cut-fill transition is located in a test section, enter test section station of the cut-fill transition location.

6. INTERSECTION BETWEEN TEST SECTION ON THE PROJECT

ROUTE	PROJECT STATION NO.	RAMPS EXIT	RAMPS ENT	INTERSECTION STOP	INTERSECTION SIGNAL	INTERSECTION UNSIG
_______________________	__ __ __ __+__ __	___	___	___	___	___
_______________________	__ __ __ __+__ __	___	___	___	___	___
_______________________	__ __ __ __+__ __	___	___	___	___	___
_______________________	__ __ __ __+__ __	___	___	___	___	___

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 3** **GENERAL INFORMATION**	STATE CODE [__ __] SHRP ID [__ __ __ __]

LAYOUT

1. LANE WIDTH (**feet**) [__ __]

2. LANE NUMBER MONITORED (outside lane = 1) [__]

3. DIRECTION OF TRAVEL [__]
East Bound.... 1 West Bound..... 2
North Bound... 3 South Bound.... 4 Both Directions.... 5

4. SPEED LIMIT (MPH) [__ __]

MEDIAN

5. MEDIAN TYPE [__]
None......................... 1 Unprotected..................... 2
Curbed....................... 3 Positive Barrier—Unspecified... 4
Positive Barrier—Flexible... 5 Positive Barrier—Semi-Rigid.... 6
Positive Barrier—Rigid...... 7

6. MEDIAN WIDTH (feet) [__ __]

DRAINAGE

7. SUBSURFACE DRAINAGE LOCATION [__]
Continuous Along Test Section...........1
Intermittent...........................2

8. SUBSURFACE DRAINAGE TYPE [__]
No Subsurface Drainage ..1 Well System............5
Longitudinal Drains .....2 Drainage Blanket with
Transverse Drains ....3 Longitudinal Drains....6
Drainage Blanket 4
Other (Specify)____________________________________ 7

9. DIAMETER OF LONGITUDINAL DRAINPIPES (inches) [__ __ __.__]

10. SPACING OF LATERALS (feet) [__ __ __]

SHOULDER

INSIDE OUTSIDE
SHOULDER SHOULDER
11. SURFACE TYPE [__] [__]
Turf................ 1 Concrete.................. 4
Granular............ 2 Surface Treatment......... 5
Asphalt Concrete.... 3 Other(Specify)_______________________ 6
12. TOTAL WIDTH (feet) [__ __] [__ __]
13. PAVED WIDTH (feet) [__ __] [__ __]
14. SHOULDER BASE TYPE (table 44) [__ __] [__ __]
15. SHOULDER SURFACE THICKNESS (inches) [__ __ __.__] [__ __ __.__]
16. SHOULDER BASE THICKNESS (inches) [__ __ __.__] [__ __ __.__]

PREPARER___________________EMPLOYER____________________DATE__________________

LTPP SPS-11 DATA **SHEET 4** **LAYER**	STATE CODE [__ __] SHRP ID [__ __ __ __]

LAYER DESCRIPTIONS

LAYER NUMBER[1]	LAYER DESCRIPTION[2]	MATERIAL TYPE[3]	LAYER THICKNESSES[4] (**inch**)			
			MEAN	MIN.	MAX.	STD. DEV.
1	SUBGRADE(7)	[__ __]				
2	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
3	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
4	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
5	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
6	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
7	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
8	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
9	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
10	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
11	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
12	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
13	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
14	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]
15	[__ __]	[__ __]	[_ _ _._]	[_ _ _._]	[_ _ _._]	[_ _ _._]

5. DEPTH BELOW SURFACE TO 'RIGID' LAYER (ft) [__ __.__]
(Rock, Stone, Dense Shale)

NOTES:

1. Layer 1 is subgrade soil. The highest numbered layer is the pavement surface.

2. Layer description codes:

Overlay	01	Subbase Layer	06
Seal Coat	02	Subgrade	07
Original Surface	03	Interlayer	08
HMAC Layer (Below Surface Layer)	04	Porous Friction Course	09
		Surface Treatment	10
Base Layer	05	Embankment (Fill)	11

3. The material type classification codes for surface, base or subbase, subgrade, and seal coat or interlayer materials appear in table 43 through table 46, respectively.

4. Enter the average thickness of each layer and the minimum, maximum, and standard deviation of the thickness measurements, if known.

PREPARER____________________EMPLOYER_____________________DATE___________________

LTPP SPS-11 DATA **SHEET 5** **AGE AND MAJOR IMPROVEMENTS**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. DATE OF LATEST (RE)CONSTRUCTION (month/year) [__ __/__ __ __ __]

2. DATE SUBSEQUENTLY OPENED TO TRAFFIC (month/year) [__ __/__ __ __ __]

3. LATEST (RE)CONSTRUCTION COST PER LANE MILE (thousands of dollars)[1] [__ __ __ __ __]

MAJOR IMPROVEMENTS SINCE LATEST (RE)CONSTRUCTION (Items 4 through 8)

4.	5.	6.	7.
YEAR	WORK TYPE CODE (Table 55)	WORK QUANTITY (Table 55 for units)	THICKNESS (inches)
[__ __ __ __]	[__ __]	[__ __ __ __ __]	[__ __.__]
[__ __ __ __]	[__ __]	[__ __ __ __ __]	[__ __.__]
[__ __ __ __]	[__ __]	[__ __ __ __ __]	[__ __.__]
[__ __ __ __]	[__ __]	[__ __ __ __ __]	[__ __.__]
[__ __ __ __]	[__ __]	[__ __ __ __ __]	[__ __.__]

8. MAJOR IMPROVEMENT TYPE OTHER
[____]

ADDITIONAL ROADWAY WIDENING INFORMATION (Items 9 through 12)

9. YEAR WHEN ROADWAY WIDENED[2] [__ __ __ __]

10. ORIGINAL NUMBER OF LANES (One Direction) [__]

11. FINAL NUMBER OF LANES (One Direction) [__]

12. LANE NUMBER OF LANE ADDED [__]

NOTES 1. Cost is to represent pavement structure cost. Non-pavement costs such as cut and fill work, work on bridges, culverts, lighting, and guard rails are to be excluded.

2. A lane created by roadway widening should not be used for LTPP unless the pavement structure under the entire lane was constructed at the same time and is uniform.

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 6 SNOW REMOVAL / DEICING	STATE CODE [__ __] SHRP ID [__ __ __ __]

SNOW PLOW

1. ARE SNOW PLOWS USED ON THE SECTION? (Y/N) [__]

2. MOST COMMON SNOW PLOW EDGE TYPE [__]
   - Steel.................... 1 Rubber 3
   - Carbide.................. 2 Polyurethane...........4
   - Other (Specify) [____________________________________] 5

3. TYPICAL NUMBER OF PASSES PER YEAR [__ __ __]

4. TYPICAL SPEED OF PLOWING OPERATION (mph) [__ __]

PRE-TREATMENT

5. ARE PRE-TREATMENTS USED ON THE SECTION? (Y/N) [__]

6. TYPE OF PRE-TREATMENT USED [__]
   - NaCl.................... 1 $CaCl_2$..................2
   - NaCl + $CaCl_2$ .... 3 CMA 4
   - Other (Specify) [______________________________________] 5
   - KCl..................... 6 $MgCl_2$..................7
   - Urea.................... 8

7. TYPICAL NUMBER OF APPLICATIONS PER YEAR [__ __ __]

DE-ICING

8. ARE DE-ICERS USED ON THE SECTION? (Y/N) [__]

9. TYPE OF DE-ICER USED [__]
   - NaCl.................... 1 $CaCl_2$..................2
   - NaCl + $CaCl_2$ .... 3 CMA 4
   - Other (Specify) [______________________________________] 5
   - KCl..................... 6 $MgCl_2$..................7
   - Urea.................... 8

10. TYPICAL NUMBER OF APPLICATIONS PER YEAR [__ __ __]

CHAIN CONTROLS

11. IS THE SECTION SUBJECT TO CHAIN CONTROLS? (Y/N) [__]

12. TYPICAL NUMBER OF CONTROL EVENTS PER YEAR [__ __ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 7** **HPMS DATA ITEMS**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. HPMS SAMPLE NUMBER [__ __ __ __ __ __ __ __ __ __ __ __]

2. HPMS SECTION SUBDIVISION [__]

3. URBAN CODE [__ __ __ __ __]
   Small Urban Sections 99998
   Rural Area Sections 99999

4. FACILITY TYPE [__]
   One-Way Roadway......... 1
   Two-Way Roadway......... 2

5. ACCESS CONTROL [__]
   Full Access Control..... 1
   Partial Access Control.. 2
   No Access Control....... 3

6. OWNERSHIP (See Ownership Codes, Table 62) [__]

7. HOV TYPE (High Occupancy Vehicle Operations Type) [__]
Full-Time HOV........... 1
(Site has 24-hour exclusive HOV lanes, no other use permitted)
Part-Time HOV........... 2
(Normal through lanes used for exclusive HOV during specified time periods)
Part-Time HOV........... 3
(Shoulder/parking lanes used for exclusive HOV during specified time periods)

8. HOV LANES [__]

9. PEAK LANES [__]

10. COUNTER PEAK LANES [__]

11. RIGHT TURN LANES (See Turn Lane Codes, Table 63) [__]

12. LEFT TURN LANES (See Turn Lane Codes, Table 63) [__]

PREPARER____________________ EMPLOYER______________________DATE_________________

LTPP SPS-11 DATA **SHEET 8** **HPMS DATA ITEMS (Continued)**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. TOLL CHARGED [__]
   - Toll charged in one direction only.................. 1
   - Toll charged in both directions..................... 2
   - No toll charged..................................... 3

2. TOLL TYPE [__]
   - Toll lanes but no special tolls (e.g. HOT lanes).... 1
   - HOT lanes... 2
   - Other special tolls................................. 3

3. WIDENING OBSTACLES (See Widening Obstacles Codes, Table 64) [__ __ __]

4. WIDENING POTENTIAL [__]

5. TERRAIN TYPE [__]
   - Level.................. 1
   - Rolling................ 2
   - Mountainous............ 3

6. CURVE CLASSIFICATION [__]

Under 3.5 Degrees....... A	8.5—13.9 Degrees..... D
3.5—5.4 Degrees....... B	14.0—27.9 Degrees.... E
5.5—8.4 Degrees....... C	28 Degrees or More..... F

7. GRADE CLASSIFICATION [__]

0.0—0.4............... A	4.5—6.4.............. D
0.5—2.4............... B	6.5—8.4.............. E
2.5—4.4............... C	8.5 or Greater......... F

8. PERCENT PASSING SIGHT DISTANCE [__ __ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 9 AC AGGREGATE PROPERTIES	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF AGGREGATE [__]
Untreated....... 1 RAP....................... 2
RAS............. 3 Combined.................. 4

COMPOSITION OF COARSE AGGREGATE (Items 3, 4, and 5)
TYPE PERCENT
Crushed Stone... 1 Crushed Slag.............. 4 3.[__][__ __ __]
Gravel.......... 2 Manufactured Lightweight... 5 4.[__][__ __ __]
Crushed Gravel.. 3 5.[__][__ __ __]
Other (Specify)[______________________________]6

6. GEOLOGIC CLASSIFICATION OF COARSE AGGREGATE [__ __]
(See Geologic Classification Codes, Table 47)

COMPOSITION OF FINE AGGREGATE (Items 7, 8, and 9)
TYPE PERCENT
Natural Sand................................... 1 7.[__][__ __ __]
Manufactured Sand (From 8.[__][__ __ __]
Crushed Gravel or Stone)....................... 2 9.[__][__ __ __]
Recycled Concrete.............................. 3
Other (Specify)[________________________________]4

10. TYPE OF MINERAL FILLER [__]
Stone Dust..... 1 Portland Cement........... 3
Hydrated Lime.. 2 Fly Ash................... 4
None........... 5
Other (Specify)[______________________________]6

AGGREGATE DURABILITY TEST RESULTS (Items 13 through 16)
(See Durability Test Type Codes, Table 51)

TYPE OF AGGREGATE TYPE OF TEST RESULTS
11. COARSE [__ __] [__ __ __.__ __ __]
12. COARSE [__ __] [__ __ __.__ __ __]
13. COARSE [__ __] [__ __ __.__ __ __]
14. COMBINED COARSE AND FINE [__ __] [__ __ __.__ __ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 10 AC AGGREGATE PROPERTIES (Continued)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]
2. TYPE OF AGGREGATE [__]

Untreated....... 1 RAP....................... 2
RAS............. 3 Combined.................. 4

3. POLISH VALUE OF COARSE AGGREGATES [__ __]
(Surface Layer Only) (AASHTO T279, ASTM D3319)

4. ANGULARITY COARSE ONE FACE [__ __ __.__]

5. ANGULARITY COARSE TWO FACES [__ __ __.__]

6. ANGULARITY FINE [__ __ __.__]

7. SOUNDNESS COARSE [__ __ __.__]

8. SOUNDNESS FINE [__ __ __.__]

9. COARSE AGGREGATE TOUGHNESS [__ __ __.__]

10. DELETERIOUS MATERIALS [__ __ __.__]

11. CLAY CONTENT [__ __ __.__]

12. THIN ELONGATED PARTICLES [__ __.__]

13. GRADATION OF COMBINED AGGREGATES

Sieve Size or No.	% Passing	Sieve Size or No.	% Passing
2″...........	[__ __ __]	No. 4.........	[__ __]
1 1/2″.......	[__ __ __]	No. 8.........	[__ __]
1″...........	[__ __ __]	No. 10........	[__ __]
7/8″.........	[__ __ __]	No. 16........	[__ __]
3/4″.........	[__ __ __]	No. 30........	[__ __]
5/8″.........	[__ __ __]	No. 40........	[__ __]
1/2″.........	[__ __ __]	No. 50........	[__ __]
3/8″.........	[__ __ __]	No. 80........	[__ __]
No. 100.......	[__ __]		
No. 200.......	[__ __]		

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 11 AC AGGREGATE PROPERTIES (Continued)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]
2. TYPE OF AGGREGATE [__]
Untreated....... 1 RAP....................... 2
RAS............. 3 Combined.................. 4

ABSORPTION OF AGGREGATE (Items 2 and 3)

3. COARSE AGGREGATE (AASHTO T85 OR ASTM C127) [__.__ __ __]

4. FINE AGGREGATE (AASHTO T84 OR ASTM C128) [__.__ __ __]

BULK SPECIFIC GRAVITIES (Items 4 through 7)

5. COARSE AGGREGATE (AASHTO T85 OR ASTM C127) [__.__ __ __]

6. FINE AGGREGATE (AASHTO T84 OR ASTM C127) [__.__ __ __]

7. MINERAL FILLER (AASHTO T100 OR ASTM D854) [__.__ __ __]

8. AGGREGATE COMBINATION [__.__ __ __]

9. EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE
COMBINATION [__.__ __ __]

10. THEORETICAL MAXIMUM SPECIFIC GRAVITY OF THE RAP/RAS [__.__ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 12 AC BINDER	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF BINDER [__]
Untreated....... 1 RAP....................... 2
RAS............. 3 Combined.................. 4

3. ASPHALT GRADE (Specify Design SUPERPave PG Grading) PG[__ __]-[__ __]

4. ASPHALT GRADE (If not PG grade)
(See Asphalt Code Sheet, Table 54) [__ __]
Other (Specify) [_________________________________]

5. SOURCE (See Supply Code Sheet, Table 52) [__ __]
Other (Specify) [_________________________________]

6. SPECIFIC GRAVITY OF ASPHALT CEMENT [__.__ __ __]
(AASHTO T228, ASTM D70)

7. VISCOSITY OF ASPHALT AT 140°F (poises) [__ __ __ __ __ __]
(AASHTO T202, ASTM D2171)

8. VISCOSITY OF ASPHALT AT 275°F (centistokes) [__ __ __ __.__ __]
(AASHTO T201, ASTM D2170)

9. PENETRATION AT 77°F, 100 g, 5 sec. (tenths of a mm) [__ __ __]
(AASHTO T49, ASTM D5)

ASPHALT MODIFIERS (See Type Code, Table 53) (Items 11 and 12)
TYPE QUANTITY(%)
10. MODIFIER #1 [__ __] [__ __.__]
11. MODIFIER #2 [__ __] [__ __.__]
Other (Specify) [_________________________________]

12. DUCTILITY AT 77°F (cm) [__ __ __]
(AASHTO T51, ASTM D113

13. DUCTILITY AT 39.2°F (cm) [__ __ __]
(AASHTO T51, ASTM D113

14. TEST RATE FOR DUCTILITY MEASUREMENT AT 39.2°F (cm/min) [__ __ __]

15. PENETRATION AT 39.2°F, 200 g, 60 sec. (tenths of a mm) [__ __ __]
(AASHTO T49, ASTM D5)

16. RING AND BALL SOFTENING POINT (°F) [__ __ __]
(AASHTO T53, ASTM D36)

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 13 AC BINDER AGED	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF BINDER [__]
Untreated....... 1 RAP....................... 2
RAS............. 3 Combined.................. 4

3. TEST PROCEDURE USED TO MEASURE AGING EFFECTS [__]
ASTM D1754 - Thin Film Oven Test.............................. 1
ASTM D2872 - Rolling Thin Film Oven Test...................... 2
Other (Specify)[____] 3
Field Aged—For Binder Extracted From Cores Taken in the Field 4

4. SPECIFIC GRAVITY OF ASPHALT CEMENT [__.__ __ __]
(AASHTO T228, ASTM D70)

5. VISCOSITY OF ASPHALT AT 140°F (poises) [__ __ __ __ __ __]
(AASHTO T202, ASTM D2171)

6. VISCOSITY OF ASPHALT AT 275°F (centistokes) [__ __ __ __.__ __]
(AASHTO T201, ASTM D2170)

7. DUCTILITY AT 77°F (cm) [__ __ __]
(AASHTO T51, ASTM D113

8. DUCTILITY AT 39.2°F (cm) [__ __ __]
(AASHTO T51, ASTM D113

9. TEST RATE FOR DUCTILITY MEASUREMENT AT 39.2°F (cm/min) [__ __ __]

10. PENETRATION AT 77°F, 100 g, 5 sec. (tenths of a mm) [__ __ __]
(AASHTO T49, ASTM D5)

11. PENETRATION AT 39.2°F, 200 g, 60 sec. (tenths of a mm) [__ __ __]
(AASHTO T49, ASTM D5)

12. RING AND BALL SOFTENING POINT (°F) [__ __ __]
(AASHTO T53, ASTM D36)

13. WEIGHT LOSS (percent) [__.__]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 14** **AC DSR, BBR, DIRECT TENSION**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

2. TYPE OF BINDER [__]
Untreated....... 1 RAP....................... 2
RAS............. 3 Combined.................. 4

3. DYNAMIC SHEAR RHEOMETER COMPLEX MODULUS AND PHASE ANGLE (kPa, deg)
(Tank Asphalt) (AASHTO TP5) [__ __ __ __.__ __] [__ __]

4. DYNAMIC SHEAR RHEOMETER COMPLEX MODULUS AND PHASE ANGLE (kPa, deg)
(RTFO Asphalt) (AASHTO TP5) [__ __ __ __.__ __] [__ __]

5. DYNAMIC SHEAR RHEOMETER COMPLEX MODULUS AND PHASE ANGLE (kPa, deg)
(PAV Asphalt)(AASHTO TP5) [__ __ __ __ __.__ __] [__ __]

6. BENDING BEAM RHEOMETER STIFFNESS MODULUS AND SLOPE (MPa, ratio)
(PAV Asphalt)(AASHTO TP5) [__ __ __ __] [__ __ __ __.__ __ __]

7. DIRECT TENSION TENSILE STRENGTH AND TENSILE STRAIN (kPa, ratio)
(PAV Asphalt)(AASHTO TP5) [__ __ __ __ __.__] [__ __ __.__ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 15 RAP	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF AGGREGATE [__]
   RAP................... 1 RAS.................... 2

RAP

3. PROCEDURE USED TO BREAK UP AND/OR REMOVE THE RAP [__]
Scarifying............ 1 Ripping................ 3
Grid Rolling........... 2 Cold Milling........... 4
Other (Specify)[___________________________________] 5

4. RAP PROCESSING [__]
None.. 1
Crushed and Screened................................ 2
Pulverized by Hammermill............................ 3
Pulverized by Grid or V-Cleated Roller.............. 4
Other (Specify)[__________________________________] 5

RAS

5. TYPE OF RAS [__]
Manufactured Shingle Waste.......................... 1
Post-Consumer Asphalt Shingles...................... 2
None 3

BOTH

6. PERCENT OF BINDER IN THE RAP/RAS BY MASS (%) [__.__ __]

7. WAS AN ADDITIVE ADDED TO THE STOCKPILE TO MAINTAIN WORKABILITY(Y/N)[__]

If yes, what quantity? (% by mass) [__.__ __]

Provide type of additive [____]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 16** **PMA LABORATORY MIX DESIGN**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. MAXIMUM SPECIFIC GRAVITY (No Air Voids) [__.__ __ __]

3. BULK SPECIFIC GRAVITY (ASTM D1188) [__.__ __ __]

4. OPTIMUM ASPHALT CONTENT (**% by weight of total mix**) [__ __.__]

5. PERCENT AIR VOIDS [__ __ __.__]

6. MARSHALL STABILITY (**pounds**) (AASHTO T245, ASTM D1559) [__ __ __ __]

7. NUMBER OF BLOWS [__ __]

8. MARSHALL FLOW (hundredths of an inch) [__ __ __ __]
(AASHTO T245, ASTM D1559)

9. HVEEM STABILITY (AASHTO T246, ASTM D1560) [__ __ __]

10. HVEEM COHESIOMETER VALUE (**grams/25 mm of width**) [__ __ __ __]
(AASHTO T246, ASTM D1560)

11. VOIDS IN MINERAL AGGREGATE (%) [__ __.__]

12. EFFECTIVE ASPHALT CONTENT (%) [__ __.__]

13. SUPERPAVE GYRATORY COMPACTION N_{DESIGN} [__ __ __]

14. GYRATION RATIO [__.__ __]

15. ASPHALT GRADE (Specify Design SUPERPave PG Grading) PG[__ __]-[__ __]
Other (Specify)[________________________________]

HAMBURG WHEEL TRACKING TEST

16. CONDITIONING (AASHTO T324) Wet... 1 Dry... 2 [__]

17. DEFORMATION AT 20,000 PASSES (**inches**) [__.__ __ __]

18. TEST TEMPERATURE [__ __.__]

19. TENSILE STRENGTH RATIO (AASHTO T283) [__ __.__]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 17 PMA LABORATORY MIX DESIGN (Continued)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. FLOW NUMBER (AASHTO TP79) [__.__ __]

3. FLOW NUMBER TEMPERATURE [__ __ __]

4. PLANNED PRODUCTION TEMPERATURE [__ __ __.__]

5. PLANNED FIELD COMPACTION TEMPERATURE [__ __ __.__]

RECYCLED DESIGN INFORMATION

6. DESIGN ASPHALT BINDER CONTENT OF MIX WITHOUT RAS/RAP (%) [__ __.__]

7. PERCENT RAS IN MIXTURE (%) [__ __.__]

8. PERCENT OF SHINGLE ASPHALT BINDER IN THE RAS BY MASS (%) [__.__ __]

9. PERCENT RAP IN MIXTURE (%) [__ __.__]

10. PERCENT ASPHALT IN RAP BY MASS (%) [__ __.__]

11. PERCENT OF RAP/RAS BINDER IN THE MIX BY MASS (%) [__.__ __]
(binder replacement)

12. AMOUNT OF NEW UNTREATED AGGREGATE ADDED (%) [__ __.__]
(percent by weight of combined aggregate in recycled mix)

TYPE QUANTITY(%)
13. RECYCLING AGENT (See Type Code, Table 58) [__ __] [__ __]
Other (Specify)[____________________________________]

14. AMOUNT OF NEW ASPHALT CEMENT ADDED (%) [__ __.__]
(percent by weight of recycled mixture)

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 18 PMA LABORATORY MIX DESIGN WARM MIX	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF WARM MIX TECHNOLOGY [__]
Foaming Process.................................... 1
Foaming Additive................................... 2
Chemical Additive.................................. 3
Organic Additive................................... 4
None... 5
Other (Specify)[_________________________________] 6

Name Brand (Specify)[____]

3. FORM OF WMA ADDITIVE [__]
Liquid............... 1 Water Injection........... 3
Solid................ 2 None...................... 4
Other (Specify)[_________________________________] 5

4. DOSAGE RATE (Percent by total weight of binder) [__ __]

5. METHOD OF INTRODUCING ADDITIVE TO THE MIX [__]
Terminal... 1
Storage Tank at Plant.............................. 2
In-Line.. 3
Conveyor/Vane/Collar Feed System................... 4
Water Injection.................................... 5
None... 6
Other (Specify)[_________________________________] 7

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 19 PMA MIX PROP	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF SAMPLES [__]
   Mixed in Field, Compacted in Laboratory 1
   Mixed and Compacted in Field 2

3. MAXIMUM SPECIFIC GRAVITY (No Air Voids) [__.__ __ __]

4. BULK SPECIFIC GRAVITY (ASTM D1188)

MEAN	[__.__ __ __]	NUMBER OF TESTS	[__ __]
MINIMUM	[__.__ __ __]	MAXIMUM	[__.__ __ __]
STD. DEV.	[__.__ __ __]		

5. ASPHALT CONTENT (% by weight of total mix)
   (AASHTO T164, ASTM D2172)

MEAN	[__ __.__]	NUMBER OF TESTS	[__ __]
MINIMUM	[__ __.__]	MAXIMUM	[__ __.__]
STD. DEV.	[__ __.__]		

6. PERCENT AIR VOIDS

MEAN	[__ __.__]	NUMBER OF TESTS	[__ __]
MINIMUM	[__ __.__]	MAXIMUM	[__ __.__]
STD. DEV.	[__ __.__]		

7. VOIDS IN MINERAL AGGREGATE (%)

MEAN	[__ __.__]	NUMBER OF TESTS	[__ __]
MINIMUM	[__ __.__]	MAXIMUM	[__ __.__]
STD. DEV.	[__ __.__]		

8. EFFECTIVE ASPHALT CONTENT (%)

MEAN	[__ __.__]	NUMBER OF TESTS	[__ __]
MINIMUM	[__ __.__]	MAXIMUM	[__ __.__]
STD. DEV.	[__ __.__]		

PREPARER____________________ EMPLOYER______________________DATE__________________

LTPP SPS-11 DATA SHEET 20 PMA MIX PROP (Continued)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF SAMPLES [__]
   Mixed in Field, Compacted in Laboratory 1
   Mixed and Compacted in Field 2

3. TYPE ASPHALT PLANT [__]
   Batch Plant............ 1 Drum Mix Plant.......... 2
   Other (Specify) [_________________________________]3

4. TYPE OF ANTISTRIPPING AGENT (See Type Codes, Table 59) [__ __]
   Other (Specify) [__________________________________]

5. ANTISTRIPPING AGENT LIQUID OR SOLID CODE [__]
   Liquid.................. 1 Solid 2

6. AMOUNT OF ANTI-STRIPPING AGENT [__ __ __.__]
   (If liquid, enter amount as percent of asphalt cement weight. If solid, enter amount as percent of aggregate weight.)

7. MOISTURE SUSCEPTIBILITY TEST TYPE [__]
   AASHTO T165 (ASTM D1075)............................1
   Texas Freeze-Thaw Pedestal Test (Ref 21).............2
   Texas Boiling Test (Ref 22)..........................3
   Revised Lottman Procedure (AASHTO T283)..............4
   Other (Specify)[_________________________________] 5

8. MOISTURE SUSCEPTIBILITY TEST RESULTS
   HVEEM STABILITY NO. [__ __]
   PERCENT STRIPPED [__ __]
   TENSILE STRENGTH RATIO (AASHTO T283) [__.__ __]
   INDEX OF RETAINED STRENGTH (AASHTO T165) [__ __ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 21** **SUPERPAVE MIXUTRE PROPERTIES**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__ __]

2. TYPE OF SAMPLES [__]
   Mixed in Field, Compacted in Laboratory 1
   Mixed and Compacted in Field 2

3. FREQUENCY SWEEP (COMPLEX MODULUS, MPa % PHASE ANGLE, δ)
   4°C[__ __ __][__ __.__] 20°C[__ __ __][__ __.__] 40°C[__ __ __][__ __.__]

4. UNIAXIAL STRAIN (AXIAL STRESS, kPa & STRAIN, mm/mm)
   4°C[__ __ __][__.__ __] 20°C[__ __ __][__.__ __] 40°C[__ __ __][__.__ __]

5. VOLUMETRIC STRAIN (CONFINING PRESSURE, kPa & AXIAL STRAIN, mm/mm)
   4°C[__ __ __][__.__ __] 20°C[__ __ __][__.__ __] 40°C[__ __ __][__.__ __]

6. SIMPLE SHEAR

	4°C	20°C	40°C
AXIAL STRESS, kPa	[__ __ __]	[__ __ __]	[__ __ __]
SHEAR STRESS, kPa	[__ __ __]	[__ __ __]	[__ __ __]

PREPARER____________________ EMPLOYER______________________ DATE_________________

LTPP SPS-11 DATA SHEET 22 PMA CONSTRUCTION	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

2. DATE OPERATIONS BEGAN(dd/mmm/yyyy) [__ __ /__ __ __ /__ __ __ __]

3. DATE PAVING COMPLETE(dd/mmm/yyyy) [__ __ /__ __ __ /__ __ __ __]

EQUIPMENT

4. MIXING PLANT TYPE [__]
   Batch... 1 Drum Mix... 2 Other... (specify)[________________________]

5. MIXING PLANT NAME [____]

6. TYPE OF MATERIALS TRANSFER EQUIPMENT USED [__]
   None... 1
   Windrow Elevator................................. 2
   Surge Volume/Remixing MTV........................ 3
   Other (Specify) [__________________________________] 4
   BRAND [____]

TACK COAT

7. TACK COAT USED (Y/N) [__]

8. TACK COAT TYPE (See Table 54) [__ __]
   Other (Specify) [__________________________________]

9. TACK COAT DILUTION (%) [__ __]

10. APPLICATION RATE (gal/yd²) [__.__ __]

PLACEMENT INFO

11. HAUL DISTANCE (miles)[__ __ __] HAUL TIME (minutes)[__ __ __]

12. SINGLE PASS LAYDOWN WIDTH (ft) [__ __.__]

13. TRANSVERSE JOINT LOCATION (station in meters) [__+__ __.__]

14. LONGITUDINAL SURFACE JOINT LOCATION [__]
    Between Lanes.... 1 Within Lane.... 2

15. LONGITUDINAL JOINT OFFSET FROM OUTSIDE SHOULDER (ft) [__ __.__]

16. SIGNIFICANT EVENTS (disruptions, rain, equipment problems, etc.)
    [____]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 23 PMA CONSTRUCTION (Continued)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

TEMPERATURE DATA (Items 2. to 5.)

2. MIXING TEMPERATURE (°F) [__ __ __]
3. PLANT EXHAUST TEMPERATURE (°F) [__ __ __]
4. MEAN DELIVERY TEMPERATURE (°F) [__ __ __]
5. LAYDOWN TEMPERATURES (°F)

MEAN [__ __ __] NUMBER OF TESTS [__ __ __]
MINIMUM [__ __ __] MAXIMUM [__ __ __]
STD. DEV. [__ __ __. __]

ROLLER DATA (Items 6. to 22.)

ROLLER CODE	ROLLER DESCRIPTION	GROSS WGT (tons)	TIRE PRES. (psi)	FREQ. (vibr/min)	AMPLITUDE (in)	SPEED (mph)
6. A	STEEL-WHL TANDEM	__ __.__				
7. B	STEEL-WHL TANDEM	__ __.__				
8. C	STEEL-WHL TANDEM	__ __.__				
9. D	STEEL-WHL TANDEM	__ __.__				
10. E	PNEUMATIC-TIRED	__ __.__	__ __ __.			
11. F	PNEUMATIC-TIRED	__ __.__	__ __ __.			
12. G	PNEUMATIC-TIRED	__ __.__	__ __ __.			
13. H	PNEUMATIC-TIRED	__ __.__	__ __ __.			
14. I	SINGLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
15. J	SINGLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
16. K	SINGLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
17. L	SINGLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
18. M	DOUBLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
19. N	DOUBLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
20. O	DOUBLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
21. P	DOUBLE-DRUM VIBR.	__ __.__		__ __ __ __.	.__ __ __	__ __.__
22. Q	OTHER ______________________________________					

COMPACTION DATA (Items 23. to 31.)

BREAKDOWN:	FIRST LIFT	SECOND LIFT	THIRD LIFT	FOURTH LIFT
23. ROLLER CODE # (A-Q)	[__]	[__]	[__]	[__]
24. COVERAGES	[__ __]	[__ __]	[__ __]	[__ __]
INTERMEDIATE:				
25. ROLLER CODE # (A-Q)	[__]	[__]	[__]	[__]
26. COVERAGES	[__ __]	[__ __]	[__ __]	[__ __]
FINAL:				
27. ROLLER CODE # (A-Q)	[__]	[__]	[__]	[__]
28. COVERAGES	[__ __]	[__ __]	[__ __]	[__ __]
29. AIR TEMPERATURE (°F)	[__ __ __]	[__ __ __]	[__ __ __]	[__ __ __]
30. COMPACTED THICKNESS (in.)	[__.__]	[__.__]	[__.__]	[__.__]
31. CURING PERIOD (days)	[__ __]	[__ __]	[__ __]	[__ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 24 UNBOUND	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

2. AASHTO SOIL CLASSIFICATION (See Codes, Table 48) [__ __]

3. ATTERBERG LIMITS (AASHTO T90 or ASTM D4318)
   PI [__ __] LL [__ __] PL [__ __]

4. MAXIMUM LAB DRY DENSITY (pcf) [__ __ __]

5. OPTIMUM LAB MOISTURE CONTENT (percent) [__ __.__]

6. TEST USED TO MEASURE MAXIMUM DRY DENSITY [__]
   Standard AASHTO T99 ....1 ASTM D558....................4
   Modified AASHTO T180 ....2 ASTM D4223...................5
   AASHTO T134 (Soil-Cement) ..3
   Other (Specify) [____] 6

7. COMPACTIVE ENERGY FOR "OTHER" METHOD
   (foot-pounds/cubic inch) [__ __.__]

8. IN SITU DRY DENSITY (pcf)
   MEAN [__ __ __ __.__] NUMBER OF SAMPLES [__ __ __]
   MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
   STANDARD DEVIATION [__ __ __ __.__]

9. IN SITU MOISTURE CONTENT (% of dry weight)
   MEAN [__ __ __ __.__] NUMBER OF SAMPLES [__ __ __]
   MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
   STANDARD DEVIATION [__ __ __ __.__]

10. COMPRESSIVE STRENGTH (psi)
   MEAN [__ __ __ __.__] NUMBER OF TESTS [__ __ __]
   MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
   STANDARD DEVIATION [__ __ __ __.__]

11. TYPE OF COMPRESSION TEST [__]
   AASHTO T167 (ASTM D1074) . 1 AASHTO T220 3
   AASHTO T24 (ASTM D1633) .. 2 AASHTO T234 (ASTM D2850) . 4
   Other (Specify) [___________________________________] 5

12. CONFINING PRESSURE (psi)[1] [__ __.__]

13. CALCIUM CARBONATE CONTENT (%) (ASTM D4373) [__ __ __]

Note 1: If the test is unconfined, enter "0.0"

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 25** **UNBOUND (Continued)**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

2. CALIFORNIA BEARING RATIO (CBR) [__ __ __]
   (AASHTO T193 OR ASTM D3668)

3. RESISTANCE (R-VALUE) (AASTHO T190 (ASTM D2844)) [__ __ __]

4. MODULUS OF SUBGRADE REACTION (K-VALUE) (psi/sq.in.) [__ __ __]

5. TYPE OF TEST [__]
   AASHTO T221 (ASTM D1195) .... 1 AASHTO T222 2

6. STABILIZING AGENT 1 TYPE CODE [__] PERCENT [__ __.__]

7. STABILIZING AGENT 2 TYPE CODE [__] PERCENT [__ __.__]

STABILIZING AGENT TYPE CODES

Asphalt Cement .... 1 Lime 5
Emulsified Asphalt .... 2 Fly Ash, Class C 6
Cutback Asphalt .... 3 Fly Ash, Class N 7
Portland Cement 4
Other (Specify) [____________________________________]8

8. GRADATION OF COMBINED AGGREGATES

Sieve Size or No.	% Passing	Sieve Size or No.	% Passing
2″...........	[__ __ __]	No. 4.........	[__ __]
1 1/2″.......	[__ __ __]	No. 8.........	[__ __]
1″...........	[__ __ __]	No. 10........	[__ __]
7/8″.........	[__ __ __]	No. 16........	[__ __]
3/4″.........	[__ __ __]	No. 30........	[__ __]
5/8″.........	[__ __ __]	No. 40........	[__ __]
1/2″.........	[__ __ __]	No. 50........	[__ __]
3/8″.........	[__ __ __]	No. 80........	[__ __]
No. 100.......	[__ __]		
No. 200.......	[__ __]		

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 26 SUBGRADE	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

2. AASHTO SOIL CLASSIFICATION (See Table 48) [__ __]

3. CALIFORNIA BEARING RATIO (CBR) (AASHTO T193 or ASTM D1883) [__ __ __]

4. RESISTANCE (R-VALUE) (AASHTO T190 (ASTM D2844)) [__ __ __]

5. MODULUS OF SUBGRADE REACTION (K-VALUE) (psi/sq. in.) [__ __ __]

6. TYPE OF TEST [__]
   AASHTO T221 (ASTM D1195) ...1 AASHTO T222 or ASTM D1196.. 2

7. PLASTICITY INDEX (AASHTO T90 or ASTM D4318) [__ __]

8. LIQUID LIMIT (AASHTO T89 or ASTM D4318) [__ __]

9. MAXIMUM LABORATORY DRY DENSITY (pcf) [__ __ __]

10. OPTIMUM LABORATORY MOISTURE CONTENT (%) [__ __.__]

11. TEST USED TO MEASURE MAXIMUM DRY DENSITY [__]
    Standard AASHTO (T-99) ... 1 Modified AASHTO (T-180) .. 2
    Other (Specify)____3

12. COMPACTIVE ENERGY FOR "OTHER" METHOD (ft.-lbs./cu. in.) [__ __.__]

13. IN SITU DRY DENSITY (% of optimum)
    MEAN [__ __ __ __.__] NUMBER OF TESTS [__ __ __]
    MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
    STANDARD DEVIATION[__ __ __ __.__]

14. IN SITU MOISTURE CONTENT (% of optimum)
    MEAN [__ __ __ __.__] NUMBER OF TESTS [__ __ __]
    MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
    STANDARD DEVIATION[__ __ __ __.__]

15. IN SITU DRY DENSITY (pcf)
    MEAN [__ __ __ __.__] NUMBER OF TESTS [__ __ __]
    MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
    STANDARD DEVIATION[__ __ __ __.__]

16. IN SITU MOISTURE CONTENT (% of dry weight)
    MEAN [__ __ __ __.__] NUMBER OF TESTS [__ __ __]
    MINIMUM [__ __ __ __.__] MAXIMUM [__ __ __ __.__]
    STANDARD DEVIATION[__ __ __ __.__]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA **SHEET 27** **SUBGRADE (Continued)**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

RELATIVE DENSITY OF COHESIONLESS FREE-DRAINING SOILS (ASTM D2049)

2. MEASURED DENSITIES FROM LABORATORY TESTS (pcf):

MINIMUM [__ __ __ __.__]
MAXIMUM [__ __ __ __.__]

3. RELATIVE DENSITIES (percent):

MEAN [__ __ __ __.__]
MINIMUM [__ __ __ __.__]
NUMBER OF TESTS [__ __ __]
MAXIMUM [__ __ __ __.__]
STANDARD DEVIATION [__ __ __ __.__]

4. SOIL SUCTION (tons/sf) (AASHTO T273) [__ __ __ __.__]

5. EXPANSION INDEX (ASTM D4829) [__ __ __]

SWELL PRESSURE (psi)

6. TEST VALUE [__ __ __]

7. TEST CODE [__]
AASHTO T190 or ASTM D2844 ..1   AASHTO T258, Method 1... 2
Other ____3

8. PERCENT BY WEIGHT FINER THAN 0.02 MM[1] [__ __ __.__]

9. AVERAGE RATE OF HEAVE DURING STANDARD LABORATORY FREEZING TEST (mm/day)[1] [__ __ __.__]

10. FROST SUSCEPTIBILITY CLASSIFICATION CODE[1] [__]

Negligible 1   Medium 4
Very Low 2   High 5
Low 3   Very High 6

NOTE 1: This data is only required in "Freeze Zones" where frost may be expected to penetrate into the subgrade.

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS-11 DATA SHEET 28 QC MEASUREMENTS	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. NUCLEAR DENSITY MEASUREMENTS

Layer Type	Binder Course	Surface Course
Measurement Method (A, B, C)[1]	[__]	[__]
Number of Measurements	[__ __]	[__ __]
Average (pcf)	[__ __ __ __.__]	[__ __ __ __.__]
Maximum (pcf)	[__ __ __ __.__]	[__ __ __ __.__]
Minimum (pcf)	[__ __ __ __.__]	[__ __ __ __.__]
Standard Deviation (pcf)	[__ __ __ __.__]	[__ __ __ __.__]
Layer Number	[__ __]	[__ __]

[1]Measurement Method Backscatter.. A Direct Transmission.. B Air Gap.. C

2. MANUFACTURER OF NUCLEAR DENSITY GAUGE [____________________________]

3. NUCLEAR DENSITY GAUGE MODEL NUMBER [____________________________]

4. NUCLEAR DENSITY GAUGE IDENTIFICATION NUMBER [_____

5. NUCLEAR GAUGE COUNT RATE FOR STANDARDIZATION [__ __ __ __ __]

6. PROFILOGRAPH MEASUREMENTS

Measured Layer Number [__ __]
Profilograph Type California...... 1 Rainhard...... 2 [__]
Profile Index (Inches/Mile) [__ __ __.__]
Interpretation Method Manual.. 1 Mechanical.. 2 Computer.. 3 [__]
Height of Blanking Band (Inches) [__.__ __]
Cutoff Height (Inches) [__.__ __]

7. SURFACE PROFILE USED AS BASIS OF INCENTIVE PAYMENT (Y/N) [__]

PREPARER___________________ EMPLOYER_____________________DATE________________

LTPP SPS-11 DATA **SHEET 29** **FIELD THICKNESS**	STATE CODE [__ __] SHRP ID [__ __ __ __]

LAYER THICKNESS MEASUREMENTS (Inches) SHEET __ OF __

		LAYER NUMBER (From LTPP Data Sheet 4)			
STATION NUMBER	OFFSET (Inches)	[__ __]	[__ __]	[__ __]	[__ __]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]
[__+__ __]	[__ __ __] [__ __ __] [__ __ __] [__ __ __] [__ __ __]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]	[__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__] [__ __ __.__]

PREPARER____________________ EMPLOYER______________________DATE________________

LTPP SPS-11 DATA SHEET 30 NOTES AND COMMENTS	STATE CODE [__ __] SHRP ID [__ __ __ __]

Provide any miscellaneous comments and notes concerning construction operations which may have an influence on the ultimate performance of the test sections or which may cause undesired performance differences to occur between test sections. Also include any quality control measurements or data for which space is not provided on other data sheets. Provide an indication of the basis for such measurements, such as an ASTM, AASHTO, or Agency standard test designation.

PREPARER__________________ EMPLOYER____________________DATE_______________

LTPP SPS-11 DATA SHEET 31 IMPROVEMENT LISTING	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. DATE COMPLETE (dd/mmm/yyyy)	2. WORK TYPE CODE (Table 55)	3. WORK QUANTITY (units from table 55)	4. THICKNESS (inches)	5. COST (thousands of dollars per lane mile)
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]
[__ __/__ __ __ /__ __ __ __]	[__ __]	[__ __ __.__]	[__ __.__]	[__ __ __]

PREPARER__________________ EMPLOYER____________________DATE_______________

LTPP SPS-11 DATA SHEET 32 CHIP SEAL APPLICATION DATA	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

2. DATE SEALING BEGAN (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]
3. DATE SEALING COMPLETE (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]

DESIGN INFORMATION

4. APPLICATION RATE FOR BITUMINOUS MATERIAL (gallons/sq. yard) [__.__ __]
5. APPLICATION TEMPERATURE FOR BITUMINOUS MATERIAL (°F) [__ __ __]
6. APPLICATION RATE FOR AGGREGATE (pounds/sq. yard) [__ __.__]
7. DESIGN EMBEDMENT DEPTH (inches) [__.__ __]
8. VIALET TEST LAB RESULTS (percent retained) [__ __ __]

GENERAL CONDITION INFORMATION

9. CONDITION OF EXISTING PAVEMENT SURFACE [__]
   - Flushed-bleeding.................................... 1
   - Smooth, non-porous.................................. 2
   - Slightly porous, slightly oxidized 3
   - Slightly pocked, porous, oxidized 4
   - Badly pocked, porous, oxidized 5

10. INITIAL PREPERATION OF EXISTING PAVEMENT SURFACE [__]
    - None.................... 1 Cold Mill 3
    - Sweep Clean Only......... 2 Shot Blast 4
    - Other (Specify) [____________________________________] 5

11. FINAL PREPARATION OF EXISTING PAVEMENT SURFACE [__]
    - None (Other Than Identified Above) 1
    - Primarily Air Blast................................. 2
    - Primarily Water Blast............................... 3
    - Primarily Sand Blast................................ 4
    - Sand Blast and Air Blast............................ 5
    - Other (Specify) [____________________________________] 6

12. SURFACE CLEANLINESS PRIOR TO PLACEMENT
    Clean....1 Moderately Clean....2 Dirty....3 [__]

13. SURFACE MOISTURE AT PLACEMENT—Dry.....1 Wet......2 [__]

AMBIENT CONDITIONS AT TIME SEAL COAT APPLIED

14. AIR TEMPERATURE (°F) [__ __ __]
15. SURFACE TEMPERATURE (°F) [__ __ __]
16. RELATIVE HUMIDITY (percent) [__ __ __]
17. CLOUD COVER (percent) [__ __ __]
18. WIND SPEED (mph) [__ __ __]

PREPARER__________________ EMPLOYER____________________DATE______________

LTPP SPS-11 DATA SHEET 33 CHIP SEAL APPLICATION DATA (CONTINUED)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

EQUIPMENT INFORMATION

ASPHALT DISTRIBUTOR
2. MANUFACTURER/MODEL [________________________]
3. NOZZLE ANGLE (degrees) [__ __]
4. SPRAY BAR HEIGHT (inches) [__ __.__]
5. NOZZLE SPACING (inches) [__ __.__]
6. NOZZLE BRAND/MODEL [________________________]

AGGREGATE DISTRIBUTOR
7. MANUFACTURER/MODEL [________________________]

ROLLERS

	ROLLER CODE	ROLLER DESCRIPTION	GROSS WGT (tons)	TIRE PRES. (psi)	SPEED (mph)	COVERAGES (number of passes)
8.	E	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __.__	__ __
9.	F	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __.__	__ __
11.	G	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __.__	__ __
11.	H	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __.__	__ __

POWER BROOM
12. MANUFACTURER/MODEL [________________________]
13. PASSES [__ __]

CONSTRUCTION INFORMATION

14. BITUMINOUS MATERIAL APPLICATION RATE (gallons/sq. yard) [__.__]
15. BITUMINOUS MATERIAL APPLICATION TEMPERATURE (°F) [__ __ __]
16. APPEARANCE OF NON-UNIFORM BITUMINOUS MATERIAL APPLICATION (ft) [__ __ __]
17. AGGREGATE PRECOATED? (Y/N) [__]
18. AGGREGATE APPLICATION RATE (pounds/sq. yard) [__ __.__]
19. APPEARANCE OF NON-UNIFORM AGGREAGATE APPLICATION (ft) [__ __ __]

AGGREGATE CONDITION PRIOR TO USE
20. CLEANLINESS - Clean...1 Moderately Clean...2 Dirty...3 [__]
21. WETNESS—Very Dry..1 Only Slightly Damp..3 Slightly Wet..5 [__]
Dry.......2 Somewhat Damp.......4 Wet...........6
22. MOISTURE CONTENT (percent by weight) [__ __.__]

23. ESTIMATED TIME ALLOWED FOR SEAL COAT TO CURE (hours) [__]

FINISHED SURFACE INFORMATION

24. APPROXIMATE FINISHED SURFACE TREATMENT THICKNESS (inches) [__.__]
25. MEASURED EMBEDMENT DEPTH (inches) [__.__ __]
26. VIALET TEST FIELD RESULTS (percent retained) [__ __ __]

PREPARER__________________ EMPLOYER____________________DATE______________

LTPP SPS-11 DATA SHEET 34 MICRO-SURFACING APPLICATION DATA	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]
2. DATE SEALING BEGAN (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]
3. DATE SEALING COMPLETE (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]

DESIGN INFORMATION

4. APPLICATION RATE FOR BITUMINOUS MATERIAL (gallons/sq. yard) [__.__ __]
5. APPLICATION RATE FOR AGGREGATE (pounds/sq. yard) [__ __.__]
6. APPLICATION RATE FOR MINERAL FILLER (pounds/sq. yard) [__ __.__]
7. APPLICATION RATE FOR MIXTURE (pounds/sq. yard) [__ __.__]
8. RESIDUAL ASPHALT CONTENT (pounds /sq. yard) [__.__ __]
9. WEAR VALUE (WTAT loss) (g/sq. ft) (ASTM D3910) [__ __ __]

GENERAL CONDITION INFORMATION

10. CONDITION OF EXISTING PAVEMENT SURFACE [__]
    - Flushed-bleeding 1
    - Smooth, non-porous 2
    - Slightly porous, slightly oxidized 3
    - Slightly pocked, porous, oxidized 4
    - Badly pocked, porous, oxidized 5

11. INITIAL PREPERATION OF EXISTING PAVEMENT SURFACE [__]
    - None 1
    - Cold Mill 3
    - Sweep Clean Only 2
    - Shot Blast 4
    - Other (Specify) [____________________________________] 5

12. FINAL PREPARATION OF EXISTING PAVEMENT SURFACE [__]
    - None (Other Than Identified Above) 1
    - Primarily Air Blast 2
    - Primarily Water Blast 3
    - Primarily Sand Blast 4
    - Sand Blast and Air Blast 5
    - Other (Specify) [____________________________________] 6

13. SURFACE CLEANLINESS PRIOR TO PLACEMENT
    Clean....1 Moderately Clean....2 Dirty....3 [__]

14. SURFACE MOISTURE AT PLACEMENT—Dry.....1 Wet......2 [__]

AMBIENT CONDITIONS AT TIME OF APPLICATION

15. AIR TEMPERATURE (°F) [__ __ __]
16. SURFACE TEMPERATURE (°F) [__ __ __]
17. RELATIVE HUMIDITY (percent) [__ __ __]
18. CLOUD COVER (percent) [__ __ __]
19. WIND SPEED (mph) [__ __ __]

PREPARER___________________ EMPLOYER_____________________DATE______________

LTPP SPS-11 DATA SHEET 35 MICRO-SURFACING APPLICATION DATA (CONTINUED)	STATE CODE [__ __] SHRP ID [__ __ __ __]

1. LAYER NUMBER (From LTPP Data Sheet 4) [__]

EQUIPMENT INFORMATION

MIXING MACHINE

2. MANUFACTURER/MODEL [____]
3. SPREADER BOX WIDTH (inches) [__ __ __]
4. TYPE OF DRAG USED [__]
   None.................... 1 Burlap 2
   Other (Specify) [____________________________________] 3

ROLLERS

ROLLER CODE	ROLLER DESCRIPTION	GROSS WGT (tons)	TIRE PRES. (psi)	SPEED (mph)	COVERAGES (number of passes)
5. E	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __	__.__ __ __
6. F	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __	__.__ __ __
7. G	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __	__.__ __ __
8. H	PNEUMATIC-TIRED	__ __.__	__ __ __	__ __	__.__ __ __
9. Q	OTHER ________________________________	__ __.__ __ __			

CONSTRUCTION INFORMATION

10. TACK COAT MATERIAL (See Table 54) [__ __]
    Other (Specify) [____]
11. TACK COAT APPLICATION RATE (gallons/sq. yard) [__.__ __]
12. BITUMINOUS MATERIAL APPLICATION RATE (gallons/sq. yard) [__.__ __]
13. AGGREGATE APPLICATION RATE (pounds/sq. yard) [__ __.__]
14. MINERAL FILLER APPLICATION RATE (pounds/sq. yard) [__ __.__]
15. WATER ADDED TO MIX (gallons/sq. yard) [__.__ __]
16. MICRO-SURFACING APPLICATION RATE (pounds/sq. yard) [__ __.__]
17. BITUMINOUS MATERIAL TEMPERATURE (°F) [__ __ __]
18. APPEARANCE OF NON-UNIFORM APPLICATION (ft) [__ __ __]
19. WEAR VALUE (WTAT loss)—AS PLACED (g/sq. ft) (ASTM D3910) [__ __ __]

AGGREGATE CONDITION PRIOR TO USE

20. CLEANLINESS - Clean...1 Moderately Clean...2 Dirty...3 [__]
21. WETNESS—Very Dry..1 Only Slightly Damp..3 Slightly Wet..5 [__]
    Dry.......2 Somewhat Damp.......4 Wet...........6
22. MOISTURE CONTENT (percent by weight) [__ __.__]

23. ESTIMATED TIME BETWEEN SPREADING AND FOOT TRAFFIC (hours) [__.__]
24. ESTIMATED TIME BETWEEN SPREADING AND VEHICLE TRAFFIC (hours) [__ __.__]

FINISHED SURFACE INFORMATION

25. APPROXIMATE FINISHED SURFACE TREATMENT THICKNESS (inches) [__.__]
26. SURFACE TEXTURE PROVIDED [__]
    Rough and Open ....1 Somewhat Smooth and Tight.3
    Somewhat Rough and Open .2 Smooth and Tight..........4
27. DOES BROOMING DISLODGE SURFACE (Y/N) [__]

PREPARER__________________ EMPLOYER____________________DATE______________

STANDARD CODES TABLES

Table 39. Standard codes for States, District of Columbia, Puerto Rico, American Protectorates, and Canadian Provinces.

State	Code
Alabama	01
Alaska	02
Arizona	04
Arkansas	05
California	06
Colorado	08
Connecticut	09
Delaware	10
District of Columbia	11
Florida	12
Georgia	13
Hawaii	15
Idaho	16
Illinois	17
Indiana	18
Iowa	19
Kansas	20
Kentucky	21
Louisiana	22
Maine	23
Maryland	24
Massachusetts	25
Michigan	26
Minnesota	27
Mississippi	28
Missouri	29
Montana	30
Nebraska	31
Nevada	32
New Hampshire	33
New Jersey	34
New Mexico	35
New York	36
North Carolina	37
North Dakota	38
Ohio	39
Oklahoma	40
Oregon	41
Pennsylvania	42

State	**Code**
Rhode Island	44
South Carolina	45
South Dakota	46
Tennessee	47
Texas	48
Utah	49
Vermont	50
Virginia	51
Washington	53
West Virginia	54
Wisconsin	55
Wyoming	56
American Samoa	60
Guam	66
Puerto Rico	72
Virgin Islands	78
Alberta	81
British Columbia	82
Manitoba	83
New Brunswick	84
Newfoundland	85
Nova Scotia	86
Ontario	87
Prince Edward Island	88
Quebec	89
Saskatchewan	90

Table 40. Functional class codes.

Rural Principal Arterial—Interstate	01
Rural Principal Arterial—Other	02
Rural Minor Arterial	06
Rural Major Collector	07
Rural Minor Collector	08
Rural Local Collector	09
Urban Principal Arterial—Interstate	11
Urban Principal Arterial—Other Freeways or Expressways	12
Urban Other Principal Arterial	14
Urban Minor Arterial	16
Urban Collector	17
Urban Local	19

Table 41. Experiment type definitions.

General Pavement Studies

(01) Asphalt Concrete Pavement with Granular Base

Acceptable pavements for this study include a dense-graded HMAC surface layer, with or without other HMAC layers, placed over untreated granular base. One or more subbase layers may also be present, but are not required. A treated subgrade is classified as a subbase layer. "Full depth" AC pavements, defined as an HMAC surface layer combined with one or more subsurface HMAC layers beneath the surface layer with a minimum total HMAC thickness of 152 mm (6 inches) placed directly upon a treated or untreated subgrade, are also allowed in this study. Two or more consecutive lifts of the same mixture design are to be treated as one layer.

Seal coats or porous friction courses are allowed on the surface, but not in combination, i.e., a porous friction course placed over a seal coat is not acceptable. Seal coats are permissible on top of granular layers. At least one layer of dense-graded HMAC is required, regardless of the existence of seal coats or porous friction courses.

(02) Asphalt Concrete Pavement with Bound Base

Acceptable pavements for this study include a dense-graded HMAC surface layer with or without other HMAC layers, placed over a bound base layer. To properly account for a variety of bound base types in the sampling design, two classifications of binder types, bituminous and non-bituminous, are defined as factor levels. Bituminous binders include asphalt cements, cutbacks, emulsions, and road tars. Non-bituminous binders include all hydraulic cements (those which harden by a chemical reaction with water and are capable of hardening under water), lime, fly ashes, and natural pozzolans, or combinations thereof. Stabilized bases with lower quality materials such as sand asphalt or soil cement are also allowed. Stabilization practices of primary concern for this study are those in which the structural characteristics of the material are improved due to the cementing action of the stabilizing agent. Thus, the description of the study actually refers to treatments improving the structural properties of the base materials. Two or more consecutive lifts of the same mixture design are to be treated as one layer. One or more subbase layers may be present but are not required.

Seal coats or porous friction courses are permitted on the surface but not in combination, i.e., a porous friction course placed over a seal coat is not acceptable. Project selection is often to those constructed on both fine and coarse subgrades.

(03) Jointed Plain Concrete Pavement—JPCP

Acceptable jointed, unreinforced PCC slab placed over untreated granular base, HMAC, or stabilized base. One or more subbase layers may also be present, but are not required. The joints may have either no load transfer devices or smooth dowel bars. A seal coat is permissible above a granular base layer. Jointed slabs with load transfer devices other than dowel bars and pavements placed directly upon a treated or untreated subgrade are also not acceptable.

Table 41. Experiment type definitions (continued).

(04) Jointed Reinforced Concrete Pavement—JRCP

Acceptable projects include jointed reinforced PCC pavements with doweled joints spaced between 20 and 65 feet (66 and 213 m). The slab may rest directly upon a base layer or upon unstabilized coarse-grained subgrade. A base layer and one or more subbase layers may exist, but are not required. A seal coat is also permissible over a granular base layer. JRCP placed directly upon a fine-grained soil/aggregate layer or a fine-grained subgrade will not be considered for this study. JRCP's without load transfer devices or using devices other than smooth dowel bars at the joints are not acceptable.

(05) Continuously Reinforced Concrete Pavement—CRCP

Acceptable projects include continuously reinforced PCC pavements placed directly upon a base layer or upon unstabilized coarse-grained subgrade. One or more subbase layers can exist but are not required. A seal coat (prime coat) is permissible just above a granular base layer. CRCP's placed directly upon a fine-grained soil/aggregate layer or a fine-grained subgrade is not acceptable for this study.

(06) AC Overlay of AC Pavement

Pavements in the GPS-6A, 6B, 6C, 6D, and 6S experiments include a dense-graded HMAC surface layer with or without other HMAC layers placed over an existing AC pavement.

The designation 6A refers to those sections, which were overlaid prior to acceptance in the GPS program.

The 6B, 6C, 6D, and 6S designation refers to LTPP sections on which an overlay was placed after the section had been accepted into the LTPP program.

Seal coats or porous friction courses are allowed but not in combination. Fabric interlayers and SAMIs are permitted between the original surface and the overlay. The total thickness of HMAC used in the overlay is required to be at least 25.4 mm (1.0 inch).

The 6W designates WMA mixtures as follows:

Chemical Additives are defined as water-free (non-aqueous) chemistry packages that modify the AC binder properties to enhance coating, adhesion, and workability at reduced temperatures. This includes surfactants, fatty-acid chemical additives, cationic surface-active agents, and rheology modifiers.

Organic Additives are plant-based, wax-based, or sulfur-extended materials designed to provide viscosity reduction, aid in asphaltenes dispersion, and act as a lubricant at mixing temperatures below that of standard HMA.

Table 41. Experiment type definitions (continued).

Foaming Additives are defined as water-containing materials added to the mixture to foam the asphalt. The most common foaming additive is synthetic zeolite. Zeolite contains 20-30 percent water that is released at temperatures above the boiling point of water. The water from the zeolite foams the asphalt binder.

The ***Foaming Process*** category includes all WMA types that utilize assemblies/modifications to the plant to foam AC binder without additives. This includes foaming nozzles, expansion chambers, vortex mixers, and shearing devices. While the other categories may be added to the mix using some type of nozzle or other addition, the key distinction between the Foaming Process category and others is the absence of additives. WMA technologies that fall into the Foaming Process category only utilize water.

(07) AC Overlay of Concrete Pavement

Pavements classified in the GPS-7A, 7B, 7C, 7D, 7F, 7R, and 7S experiments primarily consist of JPCP, JRCP, and CRCP pavements in which a dense-graded HMAC surface layer with or without other HMAC surface layers was constructed.

The exception is the 7R classification that was added to account for PCC pavement test sections rehabilitated using CPR techniques. (To date, no test sections have been classified in the 7R category.)

The designation 7A refers to sections that were overlaid prior to acceptance in the GPS program. The 7B, 7C, 7D, 7F, and 7S designation refers to those test sections on which an overlay was placed after the section had been accepted into the LTPP program.

The PCC slab may rest upon a combination of the base and/or subbase layers. The existing concrete slab can also be placed directly on lime or cement-treated fine or coarse-grained subbase or on untreated coarse-grained subgrade soil. Slabs placed directly on untreated fine-grained subgrade are not acceptable.

Seal coats or porous friction courses are permissible but not allowed in combination. Fabric interlayers and SAMIs are acceptable when placed between the original surface (concrete) and the overlay. Overlaid pavements involving aggregate interlayers and open-graded AC interlayers are not included in this study. The total thickness of HMAC used in the overlay is required to be at least 38 mm (1.5 inches).

The 6W designates WMA mixtures as follows:

Chemical Additives are defined as water-free (non-aqueous) chemistry packages that modify the AC binder properties to enhance coating, adhesion, and workability at reduced temperatures. This includes surfactants, fatty-acid chemical additives, cationic surface-active agents, and rheology modifiers.

Table 41. Experiment type definitions (continued).

Organic Additives are plant-based, wax-based, or sulfur-extended materials designed to provide viscosity reduction, aid in asphaltenes dispersion, and act as a lubricant at mixing temperatures below that of standard HMA.

Foaming Additives are defined as water-containing materials added to the mixture to foam the asphalt. The most common foaming additive is synthetic zeolite. Zeolite contains 20-30 percent water that is released at temperatures above the boiling point of water. The water from the zeolite foams the asphalt binder.

The ***Foaming Process*** category includes all WMA types that utilize assemblies/modifications to the plant to foam AC binder without additives. This includes foaming nozzles, expansion chambers, vortex mixers, and shearing devices. While the other categories may be added to the mix using some type of nozzle or other addition, the key distinction between the Foaming Process category and others is the absence of additives. WMA technologies that fall into the Foaming Process category only utilize water.

(09) Unbonded JCP Overlays of Concrete Pavement

Acceptable projects for this study include unbonded JPCP, JRCP, or CRCP overlays with a thickness of 129 mm (5 inches) or more placed over an existing JPCP, JRCP, or CRCP pavement. An interlayer used to prevent bonding of the existing and the overlay slabs is required. The overlaid concrete pavement can rest on a base and/or a subbase or directly upon the subgrade.

Specific Pavement Studies

(01) Structural Factors for Flexible Pavements

The experiment on Strategic Study of Structural Factors for Flexible Pavements (SPS-1) examines the performance of specific HMAC-surfaced pavement structural factors under different environmental conditions. Pavements within SPS-1 must start with the original construction of the entire pavement structure or removal and complete reconstruction of an existing pavement. The pavement structural factors included in this experiment are in-pavement drainage layer, surface thickness, base type, and base thickness. The experiment design stipulates a traffic loading level in the study lane in excess of 100,000—80-kN (18-kip) ESAL per year. The combination of the study factors in this experiment result in 24 different pavement structures. The experiment is designed using a fractional factorial approach to enhance implementation practicality; permitting the construction of twelve test sections at one site with the complementary twelve test sections to be constructed at another site within the same climatic region on a similar subgrade type.

Table 41. Experiment type definitions (continued).

(02) Structural Factors for Rigid Pavements

The experiment on Strategic Study of Structural Factors for Rigid Pavements (SPS-2) examines the performance of specific JPCP structural factors under different environmental conditions. Pavements within SPS-2 must start with the original construction of the entire pavement structure or removal and complete reconstruction of an existing pavement. The pavement structural factors included in this experiment are in-pavement drainage layer, PCC surface thickness, base type, PCC flexural strength, and lane width. The experiment requires that all test sections be constructed with perpendicular doweled joints at 4.9-m (15-ft) spacing and stipulate a traffic loading level in the lane in excess of 200,000 ESAL/year. The experiment is designed using a fractional factorial approach to enhance implementation practicality; permitting construction of twelve test sections at one site with the complementary twelve test sections to be constructed at another site within the same climatic region on a similar subgrade type.

(03) Preventive Maintenance Effectiveness of Flexible Pavements

The experiment on Preventive Maintenance Effectiveness of Flexible Pavements (SPS-3) examines the performance of 4 preventive maintenance treatments (cracking seal, chip seal, slurry seal, and thin overlay) on AC surfaced pavement sections within the four climatic regions, on the two classes of subgrade soil. The experimental design stipulates that the effectiveness of each of the four treatments be evaluated independently. The effectiveness of combinations of treatments is not considered. Therefore, each site includes four treated test sections in addition to a control section. In most cases the control, or do nothing section, is classified as a GPS test section.

(04) Preventive Maintenance Effectiveness of Jointed Concrete Pavements

The experiment on Preventive Maintenance Effectiveness of Jointed Concrete Pavements (SPS-4) was designed to study the effects of crack/joint sealing and undersealing on jointed PCC pavement structures. Both JRCP and JPCP are included in the study. Undersealing is included as an optional factor and is only performed on a section in which the need for undersealing is indicated. The experiment design stipulates that the effectiveness of each of the two treatments be evaluated independently. The effectiveness of combinations of treatments is not considered. Each test site includes two treated test sections in addition to a control section. The treatment sections on joint/crack seal test sites consists of one section in which all joints have no sealant, and one in which a water tight seal is maintained on all cracks and joints.

(05) Rehabilitation of Asphalt Concrete Pavements

The experiment on Rehabilitation of Asphalt Concrete Pavements (SPS-5) examines the performance of 8 combinations of AC overlays on existing AC-surfaced pavements. The rehabilitation treatment factors included in the study are intensity of surface preparation, recycled vs. virgin AC overlay mixture, and overlay thickness. The experiment design includes all four climatic regions and conditions of existing pavement. The experiment design stipulates a traffic loading level in the study lane in excess of 100,000 ESALs/year.

Table 41. Experiment type definitions (continued).

(06) Rehabilitation of Jointed Portland Cement Concrete Pavements

The experiment on Rehabilitation of Jointed Portland Cement Concrete Pavements (SPS-6) examines the performance of 7 rehabilitation treatment options as a function of climatic region, type of pavement (plain and reinforced), and condition of existing pavement. The rehabilitation methods include surface preparation (a limited preparation and full CPR) with a 102 mm (4 inches) thick AC overlay or without an overlay, crack/break and seat with two AC overlay thicknesses (102 and 203 mm [4 and 8 inches]), and limited surface preparation with a 102 mm (4 inches) thick AC overlay with sawed and sealed joints.

(07) Bonded Concrete Overlays of Concrete Pavements

The experiment on Bonded Concrete Overlays on Concrete Pavements (SPS-7) examines the performance of 8 combinations of bonded PCC treatment alternatives as a function of climatic region, pavement type (jointed and continuously reinforced), and condition of existing pavement. The rehabilitation treatment factors include combinations of surface preparation methods (cold milling plus sand blasting and shot blasting), bonding agents (neat cement grout or none), and overlay thickness (76 and 127 mm [3 and 5 in.]). The experiment design stipulates a traffic loading level in the study lane in excess of 200,000 ESAL/year.

(08) Environmental Effects in the Absence of Heavy Loads

The experiment on Environmental Effects in the Absence of Heavy Loads (SPS-8) examines the effect of climatic factors in the four environmental regions, subgrade type (frost-susceptible, expansive, fine, and coarse) on pavement sections incorporating flexible and rigid pavement designs that are subjected to limited traffic loading. The experiment design requires either 2 flexible pavement structures or 2 rigid pavement structures to be constructed at each site. The 2 flexible pavement sections consist of 102-mm (4-inch) AC surface on 102-mm (8-inch) thick untreated granular base, and 178-mm (7-inch) AC surface over a 305-mm (12-inch) thick granular base. Rigid pavement test sections consist of doweled JPCP with 203-mm (8-inch) and 279-mm (11-inch) PCC surface thickness on 152-mm (6-inch) thick dense-graded granular base. The pavement structures included in this study match pavement structures included in the SPS-1 and 2 experiments. The experiment design stipulates that traffic volume in the study lane be at least 100 vehicles per day but not more than 10,000 ESALs/year. The flexible and rigid pavement sections may be constructed at the same site or at different sites.

(09) Validation of SHRP Asphalt Specifications and Mix Design

The SPS-9P pilot effort started at the end of the SHRP program in order to get some experience in implementing the SuperPave™ specifications. Test sections classified as SPS-9P were constructed using a very limited set of guidelines. In some instances, specifications were based on interim SuperPave™ specifications that were changed at a later date. Many of the test sections were constructed before material sampling and testing guidelines were established.

Table 41. Experiment type definitions (continued).

The SPS-9A experiment, SuperPave™ Asphalt Binder Study, requires construction of a minimum of two test sections at each project site. Construction can include new construction, reconstruction, or overlay. The minimum test sections consist of (1) Highway agencies' standard mix, (2) SuperPave™ Level 1 designed standard mix, and (3) SuperPave™ mix with alternate binder grade either higher or lower than the specified SuperPave™ binder. The minimum two test sections at some sites results from the agency's declaration that the SuperPave™ test section is the same as the standard agency mixture. This will provide the opportunity to evaluate and improve the practical aspects of implementing SuperPave™ mix design through a hands-on field trial by interested highway agencies, comparison of the performance of the SuperPave™ mixes against mixes designed with current highway agencies' asphalt specifications, asphalt-aggregate specifications, and mix design procedures, and to test the sensitivity of the SuperPave™ asphalt binder specifications relative to low temperature cracking, fatigue, or permanent deformation distress factors.

(10) Warm Mix Asphalt (WMA)

The experiment on WMA was designed to study the effects of warm mix asphalt layers on existing and newly constructed pavements. The experiment design includes all four climatic regions. The experiment design stipulates a mixture produced at or below 275^{o}F or a mixture produced at temperatures at least 30^{o}F below the production temperature of the HMA control.

The WMA mixture is as follows:

Chemical Additives are defined as water-free (non-aqueous) chemistry packages that modify the AC binder properties to enhance coating, adhesion, and workability at reduced temperatures. This includes surfactants, fatty-acid chemical additives, cationic surface-active agents, and rheology modifiers.

Organic Additives are plant-based, wax-based, or sulfur-extended materials designed to provide viscosity reduction, aid in asphaltenes dispersion, and act as a lubricant at mixing temperatures below that of standard HMA.

Foaming Additives are defined as water-containing materials added to the mixture to foam the asphalt. The most common foaming additive is synthetic zeolite. Zeolite contains 20-30 percent water that is released at temperatures above the boiling point of water. The water from the zeolite foams the asphalt binder.

The *Foaming Process* category includes all WMA types that utilize assemblies/modifications to the plant to foam AC binder without additives. This includes foaming nozzles, expansion chambers, vortex mixers, and shearing devices. While the other categories may be added to the mix using some type of nozzle or other addition, the key distinction between the Foaming Process category and others is the absence of additives. WMA technologies that fall into the Foaming Process category only utilize water.

Table 41. Experiment type definitions (continued).

(11) AC Preservation

The SPS-11 experiment examines the effectiveness of a single application of an AC preservation treatment as a function of pavement condition and time through application of the same preservation treatment, at different times, on the same pavement structure. Three different treatments are part of the experiment, each with a different designation. SPS-11T is used for thin AC overlays, SPS-11C for chip seals, and SPS-11M for micro-surfacing. The treatments should be applied to roadways with a recent (<4 years) overlay, with no visible distress and a smooth (IRI<80) surface.

(12) PCC Preservation

The SPS-12 experiment examines the effectiveness of a single application of a PCC preservation treatment as a function of pavement condition and time through application of the same preservation treatment, at different times, on the same pavement structure. Three different treatments are part of the experiment, each with a different designation. SPS-12G is used for diamond grinding, SPS-12S for joint sealing, and SPS-12P for penetrating sealers. The treatments should be applied to recently constructed (<4 years for sealers, <10 years for grinding), dowelled JPCC surfaces in good condition.

Table 42. Pavement type codes.

Asphalt Concrete (AC) Surfaced Pavements

AC With Granular Base	01
AC With Bituminous Treated Base	02
AC With Non-Bituminous Treated Base	07
AC Overlay on AC Pavement	03
AC Overlay on JPCP Pavement	28
AC Overlay on JRCP Pavement	29
AC Overlay on CRCP Pavement	30
Other	10

Portland Cement Concrete Surfaced Pavements

JPCP—Placed directly on Untreated Subgrade	11
JRCP—Placed directly on Untreated Subgrade	12
CRCP—Placed directly on Untreated Subgrade	13
JPCP—Placed directly on Treated Subgrade	14
JRCP—Placed directly on Treated Subgrade	15
CRCP—Placed directly on Treated Subgrade	16
JPCP Over Unbound Base	17
JRCP Over Unbound Base	18
CRCP Over Unbound Base	19
JPCP Over Bituminous Treated Base	20
JRCP Over Bituminous Treated Base	21
CRCP Over Bituminous Treated Base	22
JPCP Over Non-Bituminous Treated Base	23
JRCP Over Non-Bituminous Treated Base	24
CRCP Over Non-Bituminous Treated Base	25
JPCP Overlay on JPCP Pavement	31
JPCP Overlay on JRCP Pavement	33
JPCP Overlay on CRCP Pavement	35
JRCP Overlay on JPCP Pavement	32
JRCP Overlay on JRCP Pavement	34
JRCP Overlay on CRCP Pavement	36
CRCP Overlay on JPCP Pavement	38
CRCP Overlay on JRCP Pavement	39
CRCP Overlay on CRCP Pavement	37
JPCP Overlay on AC Pavement	04
JRCP Overlay on AC Pavement	05
CRCP Overlay on AC Pavement	06
Prestressed Concrete Pavement	40
Other	49

Table 43. Pavement type codes (continued).

***Composite Pavements (Wearing Surface Included in Initial Construction**

JPCP With Asphalt Concrete Wearing Surface	51
JRCP With Asphalt Concrete Wearing Surface	52
CRCP With Asphalt Concrete Wearing Surface	53
Other	59

Definitions

JPCP—Jointed Plain Concrete Pavement
JRCP—Jointed Reinforced Concrete Pavement
CRCP—Continuously Reinforced Concrete Pavement

* "Composite Pavements" are pavements originally constructed with an AC wearing surface over a PCC slab (1986 "AASHTO Guide for Design of Pavement Structures").

Table 43. Pavement surface material type classification codes.

Hot Mixed, Hot Laid Asphalt Concrete, Dense Graded	01
Hot Mixed, Hot Laid Asphalt Concrete, Open Graded (Porous Friction Course)	02
Sand Asphalt	03
Portland Cement Concrete (JPCP)	04
Portland Cement Concrete (JRCP)	05
Portland Cement Concrete (CRCP)	06
Portland Cement Concrete (Prestressed)	07
Portland Cement Concrete (Fiber Reinforced)	08
Plain Portland Cement Concrete (Only used for SPS-7 overlays of CRCP)	90
Plant Mix (Emulsified Asphalt) Material, Cold Laid	09
Plant Mix (Cutback Asphalt) Material, Cold Laid	10
Single Surface Treatment	11
Double Surface Treatment	12
Recycled Asphalt Concrete, Hot, Central Plant Mix	13
Recycled Asphalt Concrete, Cold Laid, Central Plant Mix	14
Recycled Asphalt Concrete, Cold Laid, Mixed-In-Place	15
Recycled Asphalt Concrete, Heater Scarification/Recompaction	16
Recycled Portland Cement Concrete, JPCP	17
Recycled Portland Cement Concrete, JRCP	18
Recycled Portland Cement Concrete, CRCP	19
Other	20
Warm Mix Dense Graded	91
Warm Mix Open Graded	92
Warm Mix Gap Graded	93

Table 44. Base and subbase material type classification codes.

Gravel (Uncrushed)	22
Crushed Stone, Gravel or Slag	23
Sand	24
Soil-Aggregate Mixture (Predominantly Fine-Grained Soil)	25
Soil-Aggregate Mixture (Predominantly Coarse-Grained Soil)	26
Soil Cement	27
Asphalt Bound Base or Subbase Materials, Dense Graded, Hot Laid, Central Plant Mix	28
Asphalt Bound Base or Subbase Materials, Dense Graded, Cold Laid, Central Plant Mix	29
Asphalt Bound Base or Subbase Materials, Dense Graded, Cold Laid, Mixed-In-Place	30
Asphalt Bound Base or Subbase Materials, Open Graded, Hot Laid, Central Plant Mix	31
Asphalt Bound Base or Subbase Materials, Open Graded, Cold Laid, Central Plant Mix	32
Asphalt Bound Base or Subbase Materials, Open Graded, Cold Laid, Mixed-In-Place	33
Asphalt Bound Base or Subbase Materials, Recycled Asphalt Concrete, Plant Mix, Hot Laid	34
Asphalt Bound Base or Subbase Materials, Recycled Asphalt Concrete, Plant Mix, Cold Laid	35
Asphalt Bound Base or Subbase Materials, Recycled Asphalt Concrete, Mixed-In-Place	36
Asphalt Bound Base or Subbase Materials, Sand Asphalt	46
Cement-Aggregate Mixture	37
Lean Concrete (<3 sacks cement/cy)	38
Recycled Portland Cement Concrete	39
Sand-Shell Mixture	40
Limerock, Caliche (Soft Carbonate Rock)	41
Lime-Treated Subgrade Soil	42
Cement-Treated Subgrade Soil	43
Pozzolanic-Aggregate Mixture	44
Cracked and Seated PCC Layer	45
Other	49

Table 45. Subgrade soil description codes.

Fine-Grained Subgrade Soils

Clay (Liquid Limit > 50)	51
Sandy Clay	52
Silty Clay	53
Silt	54
Sandy Silt	55
Clayey Silt	56

Coarse-Grained Subgrade Soils

Sand	57
Poorly Graded Sand	58
Silty Sand	59
Clayey Sand	60
Gravel	61
Poorly Graded Gravel	62
Clayey Gravel	63
Shale	64
Rock	65

Table 46. Material type codes for thin seals and interlayers.

Grout	70
Chip Seal Coat	71
Slurry Seal Coat	72
Fog Seal Coat	73
Woven Geotextile	74
Nonwoven Geotextile	75
Stress Absorbing Membrane Interlayer	77
Dense Graded Asphalt Concrete Interlayer	78
Aggregate Interlayer	79
Open Graded Asphalt Concrete Interlayer	80
Chip Seal with Modified Binder (Does Not Include Crumb Rubber)	81
Sand Seal	82
Asphalt-Rubber Seal Coat (Stress Absorbing Membrane)	83
Sand Asphalt	84
Other	85
Thin Seal Interlayer	86
Micro-surfacing	87
Plain Portland Cement Concrete (only used for SPS-7)	90

Table 47. Geologic classification codes.

Igneous

Granite	01
Syenite	02
Diorite	03
Gabbro	04
Peridotite	05
Felsite	06
Basalt	07
Diabase	08

Sedimentary

Limestone	09
Dolomite	10
Shale	11
Sandstone	12
Chert	13
Conglomerate	14
Breccia	15

Metamorphic

Gneiss	16
Schist	17
Amphibolite	18
Slate	19
Quartzite	20
Marble	21
Serpentine	22

Other Rock Type (Specify if Possible or Unknown) 30

Glacial Soils

Glacial Soils	31
Boulder Clay	32
Glacial Sands and Gravels	33
Laminated Silts and Laminated Clays	34
Varved Clays	35
Ground Moraine	36
Fluvio-glacial Sands and Gravels	37
Other Glacial Soils	38

Table 47. Geologic classification codes (continued).

Residual Soils	Code
Plateau Gravels	40
River Gravels	41
Alluvium	42
Alluvial Clays and / or Peat	43
Alluvial Silt	44
Other Alluvial Soils	45
Coastal Shingle and Beach Deposits	46
Wind-blown Sand	47
Loess (collapsible soil)	48
Shale, siltstone, mudstone, claystone	49
Expansive Soils	50
Residual Soils	51
Residual Soils derived from granites, gneisses, and schists	52
Residual Soils derived from limestone, sandstone, and shale	53
Other Residual Soils	54
Coquina	55
Shell	56
Marl	58
Caliche	59
Other	60

Table 48. Soil and soil-aggregate mixture type codes, AASHTO classification.

A-1-a	01
A-1-b	02
A-3	03
A-2-4	04
A-2-5	05
A-2-6	06
A-2-7	07
A-4	08
A-5	09
A-6	10
A-7-5	11
A-7-6	12

Table 49. Portland cement type codes.

Type I	41
Type II	42
Type III	43
Type IV	44
Type V	45
Type IS	46
Type ISA	47
Type IA	48
Type IIA	49
Type IIIA	50
Type IP	51
Type IPA	52
Type N	53
Type NA	54
Other	55

Table 50. Portland cement concrete admixture codes.

Water-Reducing (AASHTO M194, Type A)	01
Retarding (AASHTO M194, Type B)	02
Accelerating (AASHTO M194, Type C)	03
Water-Reducing and Retarding (AASHTO M194, Type D)	04
Water-Reducing and Accelerating (AASHTO M194, Type E)	05
Water-Reducing, High Range (AASHTO M194, Type F)	06
Water-Reducing, High Range and Retarding (AASHTO M194, Type G)	07
Air-Entraining Admixture (AASHTO M154)	08
Natural Pozzolans (AASHTO M295, Class N)	09
Fly Ash, Class F (AASHTO M295)	10
Fly Ash, Class C (AASHTO M295)	11
Other (Chemical)	12
Other (Mineral)	13

Table 51. Aggregate durability test type codes.

Description	AASHTO	ASTM	Code
Resistance to Abrasion of Small Size Coarse Aggregate by Use of Los Angeles Machine (Percent Weight Loss)	T96	C131	01
Soundness of Aggregate by Freezing and Thawing (Percent Weight Loss)	T103	--	02
Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate (Percent Weight Loss)	T104	C88	03
Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine (Percent Weight Loss)	--	C535	04
Potential Volume Change of Cement-Aggregate Combinations (Percent Expansion)	--	C342	05
Evaluation of Frost Resistance of Coarse Aggregates in Air-Entrained Concrete by Critical Dilution Procedures (Number of Weeks of Frost Immunity)	--	C682	06
Potential Alkali Reactivity of Cement Aggregate Combinations (Average Percent Expansion)	--	C227	07
Potential Reactivity of Aggregates (Reduction in Alkalinity-mmol/L)	--	C289	08
Test for Clay Lumps and Friable Particles in Aggregates (Percent by Weight)	T112	C142	09
Test for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Percent Change in Specimen Length)	--	C586	11

Table 52. Codes for asphalt refiners and processors in the United States*.

Belcher Refining Co., Mobile Bay, Alabama	78
Hunt Refining Co., Tuscaloosa, Alabama	01
Chevron USA, Inc., Kenai, Alaska	02
Mapco Alaska Petroleum, North Pole, Alaska	03
Intermountain Refining Cl., Fredonia, Arizona	04
Berry Petroleum Company, Stevens, Arizona	05
Cross Oil and Refining Company, Smackover, Arizona	06
Lion Oil Company, El Dorado, Arizona	07
McMillan Ring, Free Oil Cl., Norphlet, Arizona	08
Chevron USA, Inc., Richmond, California	09
Conoco, Inc., Santa Maria, California	10
Edgington Oil Co., Inc., Long Beach, California	11
Golden Bear Division, Witco Chemical Corp., Oildate, California	12
Golden West Refining, Co., Santa Fe Springs, California	13
Huntway Refining Co., Benicia, California	14
Huntway Refining Co., Wilmington, California	15
Lunday-Thagard Co., South Gate, California	79
Newhall Refining Co., Inc., Newhall, California	16
Oxnard Refining, Oxnard, California	17
Paramount Petroleum Corp., Paramount, California	80
Powerline Oil Co., Martinez, California	81
San Joaquin Refining Cl., Bakersfield, California	18
Shell Oil Co., Martinez, California	19
Superior Processing Co., Santa Fe Springs, California	20
Colorado Refining Co., Commerce City, Colorado	82
Conoco, Inc., Commerce City, Colorado	21
Amoco Oil, Inc., Savannah, Georgia	22
Young Refining Corp., Douglasville, Georgia	23
Chevron USA, Inc., Barber's Point, Hawaii	24
Clark Oil and Refining Corp., Blue Island, Illinois	25
Shell Oil Co., Wood River, Illinois	26
Unacol Corp., Lemont, Illinois	27
Amoco Oil, Co., Whiting, Indiana	28
Laketon Refining Corp., Laketon, Indiana	83
Young Refining Corp., Laketon, Indiana	29
Derby Refining Co., El Dorado, Kansas	30
Total Petroleum, Inc., Arkansas City, Kansas	31
Ashland Petroleum Co., Catlettsburg, Kentucky	32
Atlas Processing Co., Shreveport, Louisiana	33
Calumet Refining Co., Princeton, Louisiana	34
Exxon Co., Baton Rouge, Louisiana	35
Marathon Petroleum Co.—Garyville, Louisiana	36
Marathon Petroleum Co.—Detroit, Michigan	37
Ashland Petroleum Co.—St. Paul, Minnesota	38
Koch Refining Co.—Rosemount, Minnesota	39

Table 52. Codes for asphalt refiners and processors in the United States* (continued).

Chevron USA, Inc.—Pascagoula, Mississippi	40
Ergon Refining Inc.—Vicksburg, Mississippi	41
Southland Oil Co.—Lumberton, Mississippi	42
Southland Oil Co.—Sanderson, Mississippi	43
Cenex—Laurel, Montana	44
Conoco, Inc.—Billings, Montana	45
Exxon Co.—Billings, Montana	46
Chevron USA, Inc.—Perth Amboy, New Jersey	47
Exxon Co.—Linden, New Jersey	48
Giant Industries, Inc.—Gallup, New Mexico	85
Navahoe Refining Co.—Artesia, New Mexico	49
Cibro Petroleum Products Co.—Albany, New York	86
Ashland Petroleum Co.—Canton, Ohio	50
Standard Oil Co.—Toledo, Ohio	51
Sohio Oil Co. (BP America)—Toledo, Ohio	87
Kerr-McGee Refining Co.—Wynnewood, Oklahoma	52
Sinclair Oil Corp.—Tulsa, Oklahoma	53
Sun Co.—Tulsa, Oklahoma	54
Total Petroleum Inc.—Ardmore, Oklahoma	55
Chevron USA, Inc.—Portland, Oregon	56
Atlantic Refining & Marketing Corp.—Philadelphia, Pennsylvania	57
United Refining Co.—Warren, Pennsylvania	58
Mapco Petroleum, Inc.—Memphis, Tennessee	59
Charter International Oil Co.—Houston, Texas	60
Chevron USA, Inc.—El Paso, Texas	61
Coastal Refining & Marketing, Inc.—Corpus Christi, Texas	88
Coastal States Petroleum Co.—Corpus Christi, Texas	62
Diamond Shamrock Corp.—Sunray, Texas	63
Exxon Co. USA—Baytown, Texas	64
Fina Oil and Chemical Co.—Big Spring, Texas	65
Fina Oil and Chemical Co.—Port Arthur, Texas	89
Hill Petroleum Co.—Houston, Texas	90
Shell Oil Co.—Deer Park, Texas	66
Star Enterprise—Port Arthur & Port Neches, Texas	91
Texaco Refining & Marketing, Inc.—Port Arthur & Port Neches, Texas	67
Trifinery—Corpus Christi, Texas	92
Unocal Corp.—Nederland, Texas	68
Valero Refining Co.—Corpus Christi, Texas	69
Phillips 66 Co.—Woods Cross, Utah	70
Chevron USA Inc.—Seattle, Washington	71
Sound Refining, Inc.—Tacoma, Washington	72
US Oil and Refining Co.—Tacoma, Washington	73
Murphy Oil USA, Inc.—Superior, Wisconsin	74
Big West Oil Co.—Cheyenne, Wyoming	75
Little America Refining Co.—Casper, Wyoming	93

Table 52. Codes for asphalt refiners and processors in the United States* (continued).

Sinclair Oil Corp.—Sinclair, Wyoming	76
Other	77
Alon Israel Oil Company LTD—Bakersfield, California	94
Alon Israel Oil Company LTD—Krotz Springs, Louisiana	95
Alon Israel Oil Company LTD—Big Spring, Texas	96
American Refining Group Inc.—Bradford, Pennsylvania	97
FJ Management Inc.—North Salt Lake, Utah	98
BP PLC—Prudhoe Bay, Alaska	99
BP PLC—Whiting, Indiana	100
BP PLC—Texas City, Texas	101
BP PLC—Los Angeles, California	102
BP PLC—Ferndale, Washington	103
BP Husky Refining LLC, Toledo, Ohio	104
Transworld Oil USA, Inc.—Lake Charles, Louisiana	105
Calumet Lubricants, Co—Cotton Valley, Louisiana	106
Calumet Lubricants, Co—Princeton, Louisiana	107
Calumet Lubricants, Co—Superior, Wisconsin	108
Calumet Lubricants, Co - Shreveport, Louisiana	109
CHS, Inc.—Laurel, Montana	110
Chalmette Refining LLC = Chalmette, Louisiana	111
Chevron Corp—El Segundo, California	112
Chevron Corp—Honolulu, Hawaii	113
Chevron Corp—Salt Lake City, Utah	114
PDV America Inc.—Lake Charles, Louisiana	115
PDV American Inc.—Corpus Christi, Texas	116
CVR Energy—Coffeyville, Kansas	117
ConocoPhillips—Prudhoe Bay, Alaska	118
ConocoPhillips—Rodeo, California	119
ConocoPhillips—Wilmington, California	120
ConocoPhillips—Belle Chasse, Louisiana	121
ConocoPhillips—Westlake, Louisiana	122
ConocoPhillips—Linden, New Jersey	123
ConocoPhillips—Ponca City, Oklahoma	124
ConocoPhillips—Sweeny, Texas	125
ConocoPhillips—Ferndale, Washington	126
Continental Refining Co. LLC—Somerset, Kentucky	127
Countrymark Coop Inc.—Mount Vernon, Indiana	128
Deer Park Refining LTD PTNRSHP—Delaware City, Delaware	129
Delek Group LTD—Tyler, Texas	130
Access Industries - Channelview, Texas	131
Ergon Inc.—Newell, West Virginia	132
Excel Paralubes—Westlake, Louisiana	133
Exxon Mobil Corp—Torrance, California	134
Exxon Mobil Corp—Joliet, Illinois	135
Exxon Mobil Corp—Beaumont, Texas	136

Table 52. Codes for asphalt refiners and processors in the United States* (continued).

Koch Industries Inc.—North Pole, Alaska	137
Koch Industries Inc.—Saint Paul, Minnesota	138
Koch Industries Inc.—Corpus Christi, Texas	139
Foreland Refining Corp—Ely, Nevada	140
Hollyfrontier Corp—El Dorado, Kansas	141
Hollyfrontier Corp—Woods Cross, Utah	142
Access Industries—Houston, Texas	143
Hovensa LLC—Kingshill, Virgin Islands	144
Hunt Consld Inc.—Tuscaloosa, Alabama	145
Hunt Consld Inc.—Sandersville, Mississippi	146
Kern Oil & Refining Co.—Bakersfield, California	147
Blue Dolphin Energy Co—Nixon, Texas	148
Husky Energy Inc.—Lima, Ohio	149
Delek Group LTD—El Dorado, Arkansas	150
Sinclair Oil Corp—Evansville, Wyoming	151
World Oil Co—South Gate, California	152
Marathon Petroleum Corp—Robinson, Illinois	153
Marathon Petroleum Corp—Catlettsburg, Kentucky	154
Marathon Petroleum Corp—Canton, Ohio	155
Marathon Petroleum Corp—Texas City, Texas	156
Martin Resource Management Grp—Smackover, Arkansas	156
Connacher Oil & Gas LTD—Great Falls, Montana	157
Motiva Enterprises LLC—Convent, Louisiana	158
Motiva Enterprises LLC—Norco, Louisiana	159
Motiva Enterprises LLC—Port Arthur, Texas	160
Hollyfrontier Corp—Artesia, New Mexico	161
CHS Inc.—McPherson, Kansas	162
Nustar Energy LP—Savanna, Georgia	163
Nustar Energy LP—Paulsboro, New Jersey	164
Nustar Energy LP—San Antonio, Texas	165
Alon Israel Oil Company LTD—Paramount, California	166
Petroleo Brasileiro SA—Pasadena, California	167
PBF Energy Co LLC—Paulsboro, New Jersey	168
PDV American Inc.—Lemont, Illinois	169
Pelican Refining Co. LLC—Lake Charles, Louisiana	170
Arctic Slope regional Corp—North Pole, Alaska	171
Arctic Slope regional Corp—Valdez, Alaska	172
Placid Oil Co—Port Allen, Louisiana	173
Vallero Energy Corp—Memphis, Tennessee	174
Vallero Energy Corp—Port Arthur, Texas	175
Greka Energy—Santa Maria, California	176
Royal Dutch/Shell Group—Saraland, Alabama	177
Royal Dutch/Shell Group—Martinez, California	178
Royal Dutch/Shell Group—Saint Rose, Louisiana	179
Royal Dutch/Shell Group—Anacortes, Washington	180

Table 52. Codes for asphalt refiners and processors in the United States* (continued).

Silver Eagle Refining Inc.—Woods Cross, Utah	181
Silver Eagle Refining Inc.—Evanston, Wyoming	182
Texas Oil & Chemical Co. –Silsbee, Texas	183
Northern Tier Energy LLC—Saint Paul, Minnesota	184
Suncor Energy Inc.—Commerce City East, Colorado	185
Sunoco Inc.—Philadelphia, Pennsylvania	186
Tesoro Corp—Kenai, Alaska	187
Tesoro Corp—Ewa Beach, Hawaii	188
Tesoro Corp—Martinez, California	189
Tesoro Corp—Wilmington, California	190
Tesoro Corp—Mandan, North Dakota	191
Tesoro Corp—Salt Lake City, Utah	192
Tesoro Corp—Anacortes, Washington	193
PBF Energy Co. LLC—Toledo, Ohio	194
Total SA—Port Arthur, Texas	195
BTB Refining LLC—Corpus Christi, Texas	196
Compagnie Nationale A Portefeuilli—Tacoma, Washington	197
Valero Energy Corp—Meraux, Louisiana	198
Valero Energy Corp—Sunray, Texas	199
Valero Energy Corp—Three Rivers, Texas	200
Valero Energy Corp—Benicia, California	201
Valero Energy Corp—Wilmington Asphalt Plant, California	202
Valero Energy Corp—Wilmington Refinery, California	203
Valero Energy Corp—Ardmore, Oklahoma	204
Valero Energy Corp—Houston, Texas	205
Valero Energy Corp—Texas City, Texas	206
Valero Energy Corp—Norco, Louisiana	207
Ventura Refining and Transmission LLC—Thomas, Oklahoma	208
Western Refining Inc.—El Paso, Texas	209
Western Refining Inc.—Bloomfield, New Mexico	210
Western Refining Inc.—Gallup, New Mexico	211
WRB Refining LP—Wood River, Illinois	212
WRB Refining LP—Borger, Texas	213
CVR Energy—Wynnewood, Oklahoma	214
Black Elk Refining LLC—New Castle, Wyoming	215

* Codes 1-93 Originally taken from Oil and Gas Journal, March 20, 1989, pp. 72-89 and updated October 1993.

Codes 94-215 taken from Energy Information Administration (EIA), Form EIA-820, "Annual Refinery Report" as of January 1, 2012.

Table 53. Asphalt cement modifier codes.

Stone Dust	01
Lime	02
Portland Cement	03
Carbon Black	04
Sulfur	05
Lignin	06
Natural Latex	07
Synthetic Latex	08
Block Copolymer	09
Reclaimed Rubber	10
Polyethylene	11
Polypropylene	12
Ethylene-Vinyl Acetate	13
Polyvinyl Chloride	14
Asbestos	15
Rock Wool	16
Polyester	17
Manganese	18
Other Mineral Salts	19
Lead Compounds	20
Carbon	21
Calcium Salts	22
Recycling Agents	23
Rejuvenating Oils	24
Amines	25
Fly Ash	26
Other	27

Table 54. Grades of asphalt, emulsified asphalt, and cutback asphalt codes.

Asphalt Cements

AC-2.5	01
AC-5	02
AC-10	03
AC-20	04
AC-30	05
AC-40	06
AR-1000 (AR-10 by AASHTO Designation)	07
AR-2000 (AR-20 by AASHTO Designation)	08
AR-4000 (AR-40 by AASHTO Designation)	09
AR-8000 (AR-80 by AASHTO Designation)	10
AR-16000 (AR-160 by AASHTO Designation)	11
200-300 pen	12
120-150 pen	13
85-100 pen	14
60-70 pen	15
40-50 pen	16
Other Asphalt Cement Grade	17

Emulsified Asphalts

RS-1	18
RS-2	19
MS-1	20
MS-2	21
MS-2h	22
HFMS-1	23
HFMS-2	24
HFMS-2h	25
HFMS-2s	26
SS-1	27
SS-1h	28
CRS-1	29
CRS-2	30
CMS-2	31
CMS-2h	32
CSS-1	33
CSS-1h	34
Other Emulsified Asphalt Grades	35

Cutback Asphalts (RC, MC, SC)

30 (MC only)	36

Table 54. Grades of asphalt, emulsified asphalt, and cutback asphalt codes (continued).

70	37
250	38
800	39
3000	40
Other Cutback Asphalt Grade	99

Taken from Manual Series No. 5 (MS-5), “A Brief Introduction to Asphalt,” and Specification Series No. 2 (SS-2), “Specifications for Paving and Industrial Asphalts,” both publications by the Asphalt Institute.

Table 55. Maintenance and rehabilitation work type codes.

Crack Sealing (linear ft)	01
Transverse Joint Sealing (linear ft)	02
Lane-Shoulder, Longitudinal Joint Sealing (linear ft)	03
Full Depth Joint Repair Patching of PCC (sq. yards)	04
Full Depth Patching of PCC Pavement Other than at Joint (sq. yards)	05
Partial Depth Patching of PCC Pavement Other than at Joint (sq. yards)	06
PCC Slab Replacement (sq. yards)	07
PCC Shoulder Restoration (sq. yards)	08
PCC Shoulder Replacement (sq. yards)	09
AC Shoulder Restoration (sq. yards)	10
AC Shoulder Replacement (sq. yards)	11
Grinding/Milling Surface (sq. yards)	12
Grooving Surface (sq. yards)	13
Pressure Grout Subsealing (no. of holes)	14
Slab Jacking Depressions (no. of depressions)	15
Asphalt Subsealing (no. of holes)	16
Spreading of Sand or Aggregate (sq. yards)	17
Reconstruction (Removal and Replacement) (sq. yards)	18
Asphalt Concrete Overlay (sq. yards)	19
Portland Cement Concrete Overlay (sq. yards)	20
Mechanical Premix Patch (using motor grader and roller) (sq. yards)	21
Manual Premix Spot Patch (hand spreading and compacting with roller) (sq. yards)	22
Machine Premix Patch (placing premix with paver, compacting with roller) (sq. yards)	23
Full Depth Patch of AC Pavement (removing damaged material, repairing supporting material, and repairing) (sq. yards)	24
Patch Pot Holes—Hand Spread, Compacted with Truck (no. of holes)	25
Skin Patching (hand tools / hot pot to apply liquid asphalt and aggregate) (sq. yards)	26
Strip Patching (using spreader and distributor to apply hot liquid asphalt and aggregate) (sq. yards)	27
Surface Treatment, single layer (sq. yards)	28
Surface Treatment, double layer (sq. yards)	29
Surface Treatment, three or more layers (sq. yards)	30
Aggregate Seal Coat (sq. yards)	31
Sand Seal Coat (sq. yards)	32
Slurry Seal Coat (sq. yards)	33
Fog Seal Coat (sq. yards)	34
Prime Coat (sq. yards)	35
Tack Coat (sq. yards)	36
Dust Layering (sq. yards)	37
Longitudinal Subdrains (linear ft)	38
Transverse Subdrainage (linear ft)	39
Drainage Blanket (sq. yards)	40
Well System	41
Drainage Blankets with Longitudinal Drains	42
Hot-Mix Recycled Asphalt Concrete (sq. yards)	43

Table 55. Maintenance and rehabilitation work type codes (continued).

Cold-Mix Recycled Asphalt Concrete (sq. yards)	44
Heater Scarification, Surface Recycled Asphalt Concrete (sq. yards)	45
Fracture Treatment of PCC Pavement as Base for New AC Surface (sq. yards)	46
Fracture Treatment of PCC Pavement as Base for New PCC Surface (sq. yards)	47
Recycled Portland Cement Concrete (sq. yards)	48
Pressure Relief Joints in PCC Pavements (linear feet)	49
Joint Load Transfer Restoration in PCC Pavements (linear ft)	50
Mill Off Existing AC Pavement and Overlay with AC (sq. yards)	51
Mill Off Existing AC Pavement and Overlay with PCC (sq. yards)	52
Other	53
Partial Depth Patching of PCC Pavement at Joints (sq. yards)	54
Mill Existing Pavement and Overlay with Hot-Mix Recycled Asphalt Concrete (sq. yards)	55
Mill Existing Pavement and Overlay with Cold-Mix Recycled Asphalt Concrete (sq. yards)	56
Saw and Seal (linear ft)	57
Mill Existing Pavement and Overlay with Warm Mix AC (sq. yards)	58
Warm Mix AC Overlay (sq. yards)	59
Warm Mix AC Overlay with RAP and/or RAS (sq. yards)	60
Mill Existing Pavement and Overlay with Warm Mix Recycled AC (sq. yards)	61
Micro-surfacing (sq. yards)	62
PCC Penetrating Sealant (sq. yards)	63

Table 56. Maintenance location codes.

Outside Lane (Number 1)	01
Inside Lane (Number 2)	02
Inside Lane (Number 3)	03
All Lanes	09
Shoulder	04
All Lanes Plus Shoulder	10
Curb and Gutter	05
Side Ditch	06
Culvert	07
Other	08

Note: LTPP only studies outside lanes.

Table 57. Maintenance materials type codes.

Preformed Joint Fillers	01
Hot-Poured Joint and Crack Sealer	02
Cold-Poured Joint and Crack Sealer	03
Open Graded Asphalt Concrete	04
Hot Mix Asphalt Concrete Laid Hot	05
Hot Mix Asphalt Concrete Laid Cold	06
Sand Asphalt	07
Portland Cement Concrete (overlay replacement), Joint Plain (JPCP)	08
Portland Cement Concrete (overlay replacement), Joint Reinforced (JRCP)	09
Portland Cement Concrete (overlay replacement) ,Continuously Reinforced (CRCP)	10
Portland Cement Concrete (Patches)	11
Hot Liquid Asphalt and Aggregate (Seal Coat)	12
Hot Liquid Asphalt and Mineral Aggregate	13
Hot Liquid Asphalt and Sand	14
Emulsified Asphalt and Aggregate (Seal Coat)	15
Emulsified Asphalt and Mineral Aggregate	16
Emulsified Asphalt and Sand	17
Hot Liquid Asphalt	18
Emulsified Asphalt	19
Sand Cement (Using Portland Cement)	20
Lime Treated or Stabilized Materials	21
Cement Treated or Stabilized Materials	22
Cement Grout	23
Aggregate (Gravel, Crushed Stone, or Slag)	24
Sand	25
Mineral Dust	26
Mineral Filler	27
Other	28

Table 58. Recycling agent type codes.

RA 1	42
RA 5	43
RA 25	44
RA 75	45
RA 250	46
RA 500	47
Other	48

Note: The recycling agent groups shown in this table are defined in ASTM D4552.

Table 59. Anti-stripping agent type codes.

Permatac	01
Permatac Plus	02
Betascan Roads	03
Pavebond	04
Pavebond Special	05
Pavebond Plus	06
BA 2000	07
BA 2001	08
Unichem “A”	09
Unichem “B”	10
Unichem “C”	11
Aquashield AS4115	12
Aquashield AS4112	13
Aquashield AS4113	14
Portland Cement	15
Hydrated Lime, Mixed Dry with Asphalt Cement	16
Hydrated Lime, Mixed Dry with Dry Aggregate	17
Hydrated Lime, Mixed Dry with Wet Aggregate	18
Hydrated Lime, Slurried Lime Mixed with Aggregate	19
Hydrated Lime, Hot Lime Slurry (Quick Lime Slaked and Slurried at Job Site)	20
Nostrip Chemicals A-500	21
No Strip Chemical Works ACRA RP-A	22
No Strip Chemical Works ACRA Super Conc.	23
No Strip Chemical Works ACRA 200	24
No Strip Chemical Works ACRA 300	25
No Strip Chemical Works ACRA 400	26
No Strip Chemical Works ACRA 500	27
No Strip Chemical Works ACRA 512	28
No Strip Chemical Works ACRA 600	29
Darakote	30
De Hydro H86C	31
Emery 17065	32
Emery 17319	33
Emery 17319—6880	34
Emery 17320	35
Emery 17321	36
Emery 17322	37
Emery 17339	38
Emery 1765—6860	39
Emery 6886B	40
Husky Anti-Strip	41
Indulin AS-Special	42
Indulin AS-1	43
Jetco AD-8	44
Kling	45

Table 59. Anti-stripping agent type codes (continued).

Kling-Beta ZP-251	46
Kling-Beta L-75	47
Kling-Beta LV	48
Kling-Beta 1000	49
Kling-Beta 200	50
Nacco Anti-Strip	51
No Strip	52
No Strip Concentrate	53
Redi-Coat 80-S	54
Redi-Coat 82-S	55
Silicone	56
Super AD-50	57
Tap Co 206	58
Techni H1B7175	59
Techni H1B7173	60
Techni H1B7176	61
Techni H1B7177	62
Tretolite DH-8	63
Tretolite H-86	64
Tretolite H-86C	65
Tyfo A-45	66
Tyfo A-65	67
Tyfo A-40	68
Edoco 7003	69
Other	70
No Antistripping Agent Used	00

Table 60. Distress types.

Asphalt Concrete Pavement

Alligator Cracking	01
Block Cracking	02
Edge Cracking	03
Longitudinal Cracking	04
Reflection Cracking	05
Transverse Cracking	06
Patch Deterioration	07
Potholes	08
Rutting	09
Shoving	10
Bleeding	11
Polished Aggregate	12
Raveling and Weathering	13
Lane Shoulder Dropoff	14
Water Bleeding	15
Pumping	16
Other	17

Portland Cement Concrete Pavement

Corner Breaks	20
Durability Cracking	21
Longitudinal Cracking	22
Transverse Cracking	23
Joint Seal Damage	24
Spalling	25
Map Cracking / Scaling	26
Polished Aggregate	27
Popouts	28
Punchouts	29
Blowouts	30
Faulting	31
Lane / Shoulder Dropoff	32
Lane / Shoulder Separation	33
Patch Deterioration	34
Water Bleeding / Pumping	35
Slab Settlement	36
Slab Upheaval	37
Other	38

Table 61. Route signing codes.

Not Signed	1
Interstate	2
U.S.	3
State	4
Off-Interstate Business Marker	5
County	6
Township	7
Municipal	8
Parkway Marker or Forest Route Marker	9
None of the Above	10

Table 62. Ownership codes.

State Highway Agency	1
County Highway Agency	2
Town or Township Highway Agency	3
City or Municipal Highway Agency	4
State Park, Forest, or Reservation Agency	11
Local Park, Forest or Reservation Agency	12
Other State Agency	21
Other Local Agency	25
Private (other than Railroad)	26
Railroad	27
State Toll Road	31
Local Toll Authority	32
Other Public Instrumentality (i.e., Airport)	40
Indian Tribe Nation	50
Other Federal Agency	60
Bureau of Indian Affairs	62
Bureau of Fish and Wildlife	63
U.S. Forest Service	64
National Park Service	66
Tennessee Valley Authority	67
Bureau of Land Management	68
Bureau of Reclamation	69
Corps of Engineers	70
Air Force	72
Navy/Marines	73
Army	74
Other	80

Table 63. Turn lane codes.

No intersection where a right turning movement is permitted exists on the section	1
Turns permitted; multiple exclusive right turning lanes exist. Through movements are prohibited in these lanes. Multiple turning lanes allow for simultaneous turns from all turning lanes	2
Turns permitted; a continuous exclusive right turning lane exists from intersection to intersection. Through movements are prohibited in this lane	3
Turns permitted; a single exclusive right turning lane exists	4
Turns permitted; no exclusive right turning lanes exist	5
No right turns are permitted during the peak period	6

Table 64. Widening obstacles codes.

No obstacles	X
Dense development	A
Major transportation facilities	B
Other public facilities	C
Terrain restrictions	D
Historic and archaeological sites	E
Environmentally sensitive areas	F
Parkland	G

No obstacles - No obstacles to widening.

Dense development - Refers to the density and size of buildings to be acquired, the number of people that would need to be relocated, and the number of businesses that would need to be acquired. (Realizing dense development may be higher in urban areas; this should not be used as on obstacle for all urban areas and should be evaluated relative to the conditions in the area where the section is located).

Major transportation facilities - Includes major rail lines, canals, airports, major natural gas and oil pipe lines whose location relative to the roadway section would limit expansion of the existing roadway.

Other public facilities - Includes hospitals, museums, libraries, major public office buildings, schools, and universities.

Terrain restrictions - Relates to geographic features that would make it very difficult to add lanes, requiring significant excavation, fill, or tunneling. This applies to both horizontal and vertical terrain restrictions.

Historic and archaeological sites - Includes such things as historic buildings, historic land, large monuments, cemeteries, and known archaeological sites.

Environmentally sensitive areas - Includes such areas as scenic landmarks, wetlands, bodies of water, areas inhabited or used by protected species. Scenic routes and byways are included in the category and are those national and State routes that have been identified and listed as official designations.

Parkland - Includes National, State, and local parks.

B.3 FIELD MATERIALS SAMPLING AND TESTING DATA FORMS

The SPS-11 field materials sampling and testing should be performed following the guidelines in the *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. (20) Field data forms and data sheets have been revised to report SPS-11 data for bulk sampling of subgrade, granular material, and asphalt concrete materials performed during construction; they are included in this section of appendix B. The changes and/or additions have been made to accommodate the specific needs of the SPS-11 experiment.

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-11 experiment requires completion of the following sheets and forms:

Table 65. Sampling data sheets.

Sampling Data Sheet No.	Description
2	Pavement Core Log at C-Type Core Locations
4	A-Type Bore Hole Log
8	In-Situ Density and Moisture Tests
10	Sampling Uncompacted Bituminous Paving Mixtures
10-A	Sampling Asphalt Cement and Emulsion
21	Sampling Bulk Aggregate

Table 66. Field operations information sheets.

Field Operations Information Form No.	Description
1	Laboratory Shipment Samples Inventory

Most of the LTPP SPS-11 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 NO. Because 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.

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.

SHRP ID. Enter the four character SHRP_ID assigned to the test section.

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 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 project. Enter 2, 3, etc. for the second, third and subsequent sampling and field testing on this project.

SAMPLE/TEST LOCATION. Check "Before Section" if the sampling location is before the beginning of the test section indicated 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+).

Sampling Data Sheet 2. Pavement Core Log at C-Type Core Locations

This is used to log data from the pavement cores extracted from C-Type core locations. Each sheet can be used to record data for cores taken from three different core hole locations. Space is provided in each column to record data for up to four 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 ID. Enter the core HOLE ID as specified in the materials sampling plan developed for the project.

CORE HOLE NUMBER. Enter the core hole sample code number following the sample coding system as specified in the materials sampling plan developed for the project.

STATION. This is the station number of the sampling area, relative to the test section specified 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 that occur before the test section specified.

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.

LATITUDE. Record the latitude of the center of the core location in degrees (North).

LONGITUDE. Record the longitude of the center of the core location in degrees (West).

CORE SIZE. Circle the appropriate response to indicate the diameter of recovered core.

CORE RECOVERED. Circle the appropriate response to indicate if an intact and suitable core was recovered from the indicated core ho1e.

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 NUMBER. Record the core sample number for the recovered core. Separate sample numbers should be assigned to AC surface layers and bound base layers from the same core hole, even if the bound base adheres to the AC surface layer.

LAYER NUMBER. Record the layer number for the layer identified in the core. Layer numbers are referenced to the materials sampling plan developed for the project, and start at 1 for the subgrade and increase towards the surface.

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 *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. (2)

MATERIAL CODE. Enter the appropriate material code number from table C.2 in the *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide* corresponding to the described type of material. (20)

Sampling Data Sheet 4. Pavement Bore Hole Log at A-Type Auger Locations

This is designed to record logs of A-Type auger 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 sampling area, relative to the test section specified 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 that 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.

LATITUDE. Record the latitude of the center of the sampling location in degrees (North).

LONGITUDE. Record the longitude of the center of the sampling location in degrees (West).

BORE HOLE NUMBER. Enter the core hole sample code number following the sample coding system specified in the material sampling plan developed for the project.

BORE HOLE ID. Enter the core HOLE ID as specified in the materials 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 bulk samples obtained from the subgrade.

LAYER NUMBER. Record the layer number for the identified layer. Layer numbers are referenced to the materials sampling plan developed for the project, and start at 1 for the subgrade and increase towards the surface.

MOISTURE SAMPLE NO. Record the sample number for moisture samples obtained from the unbound base or 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 *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide*. [20] .

MATERIAL CODE. Enter the appropriate material code number for each strata from table C.2 in the *Long-Term Pavement Performance Project: Laboratory Material Testing and Handling Guide* corresponding to the described type of material. [20]

Sampling Data Sheet 8. In Situ Density and Moisture Tests

This sheet 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.

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

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

DATE OF LAST MAJOR CALIBRATION. Record the date of the last major calibration of the nuclear density gauge. 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.

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

STATION. This is the station number of the sampling area, relative to the test section specified 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 that occur before the test section specified.

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.

LATITUDE. Record the latitude of the center of the sampling location in degrees (North).

LONGITUDE. Record the longitude of the center of the sampling location in degrees (West).

DEPTH FROM SURFACE TO THE TOP OF THE LAYER. This information is obtained from Sampling Data Sheet 4 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 T310-11*, "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 10. 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.

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

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.

LATITUDE. Record the latitude of the sampling location in degrees (North).

LONGITUDE. Record the longitude of the sampling location in degrees (West).

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

LAYER NUMBER Write in the project specified layer number for which the sampled bulk material is applicable.

LOCATION NUMBER. Enter the sampling location number as specified in the materials sampling plan developed for the project.

SAMPLE NUMBER. Enter the sample number as specified in the materials sampling plan developed for the project.

SPECIMEN ID. Enter the SPECIMEN ID as specified in the materials sampling plan developed for the project.

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 10-A. Sampling Asphalt Cement or Emulsion

This data sheet is used to record information concerning sampling of asphalt cement or emulsions for LTPP material testing purposes.

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

SAMPLING LOCATION. Enter the code number shown on the data form corresponding to the location from which the sample was taken.

LATITUDE. Record the latitude of the sampling location in degrees (North).

LONGITUDE. Record the longitude of the sampling location in degrees (West).

LAYER NUMBER Write in the project specified layer number for which the sampled bulk material is applicable.

LOCATION NUMBER. Enter the sampling location number as specified in the materials sampling plan developed for the project.

SAMPLE NUMBER. Enter the sample number as specified in the materials sampling plan developed for the project.

SPECIMEN ID. Enter the SPECIMEN ID as specified in the materials sampling plan developed for the project.

SAMPLE VOLUME. Enter the approximate volume of the sample obtained, to the nearest gallon.

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.

COMMENTS: Provide any comments concerning the representativeness of the obtained sample, comments concerning the quality or uniformity of the mix, or any other pertinent miscellaneous comments, that may be of use to the data users.

GENERAL REMARKS. Provide any general remarks that may be of use to the office data handler, or be otherwise of use during the data entry and QC processes.

Sampling Data Sheet 21. Sampling Bulk Aggregate

This data sheet is used to record information concerning sampling of bulk aggregate used in AC mixes, thin seal coats, and other bound layers.

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

SAMPLING LOCATION. Enter the code number shown on the data form corresponding to the location from which the sample was taken.

LATITUDE. Record the latitude of the sampling location in degrees (North).

LONGITUDE. Record the longitude of the sampling location in degrees (West).

LAYER NUMBER Write in the project specified layer number for which the sampled bulk material is applicable.

LOCATION NUMBER. Enter the sampling location number as specified in the materials sampling plan developed for the project.

SAMPLE NUMBER. Enter the sample number as specified in the materials sampling plan developed for the project.

SPECIMEN ID. Enter the SPECIMEN ID as specified in the materials sampling plan developed for the project.

SAMPLE VOLUME. Enter the approximate volume of the sample obtained, to the nearest gallon.

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 that may be of use to the office data handler, or be otherwise of use during the data entry and QC processes.

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 database. This form provides the necessary information for the RSC to perform test assignments. 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.

1. Samples from A-Type bore holes and any additional similar bore holes.

2. Samples from shallow excavations.

3. Bulk Samples of constituent materials.

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 or moisture 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-11 experiment, 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.

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
PAVEMENT CORE LOG AT C-TYPE CORE LOCATIONS
SAMPLING DATA SHEET 2

SHEET NO. _____ **OF** _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]
SAMPLE/TEST LOCATION:
☐ **Before Section**
☐ **After Section**

OPERATOR __________________________
CORING DATE __ __ -__ __ __-__ __ __ __
(dd-mmm-yyyy)

EQUIPMENT USED ___________________
CORE BARREL:
Size ____________________________
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 layer strata and recorded to the nearest tenth of an inch.

CORE HOLE ID			
CORE HOLE NUMBER			
STATION (feet)			
OFFSET (feet from O/S)	__ __ . __	__ __ . __	__ __ . __
Latitude (degrees North)	__ __.__ __ __ __ __	__ __.__ __ __ __ __	__ __.__ __ __ __ __
Longitude (degrees West	__ __ __.__ __ __ __ __	__ __ __.__ __ __ __ __	__ __ __.__ __ __ __ __
Core Size (inch diameter)	4" / 6"	4" / 6"	4" / 6"
Core Recovered?	Yes / No	Yes / No	Yes / No
Replacement Core Hole No.			
Core Sample Number			
Layer Number			
Depth (inch)	__ __ . __	__ __ . __	__ __ . __
Material Description			
Material Code			
Core Sample Number			
Layer Number			
Depth (inch)	__ __ . __	__ __ . __	__ __ . __
Material Description			
Material Code			
Core Sample Number			
Layer Number			
Depth (inch)	__ __ . __	__ __ . __	__ __ . __
Material Description			
Material Code			
Core Sample Number			
Layer Number			
Depth (inch)	__ __ . __	__ __ . __	__ __ . __
Material Description			
Material Code			

GENERAL REMARKS ____
____
____

CERTIFIED
____
Field Crew Chief
Affiliation_________________________

VERIFIED AND APPROVED
____
RSC Personnel
Affiliation _________________________

DATE
_______ – _______ – _______
Month – Day – Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
PAVEMENT BORE HOLE LOG AT A-TYPE AUGER LOCATIONS
SAMPLING DATA SHEET 4

SHEET NO. _____ OF _____
STATE _________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]
SAMPLE/TEST LOCATION:
☐ **Before Section**
☐ **After Section**

OPERATOR ___________________________
BORING DATE __ __-__ __ __- __ __ __ __
(dd-mmm-yyyy)
LOCATION:
STATION ________________________
OFFSET _____________ feet from O/S

EQUIPMENT USED ___________________
BORE HOLE NUMBER: ________________
BORE HOLE ID: ______________________
BORE HOLE SIZE: __________ inch diameter
LATTITUDE: __ __ . __ __ __ __ __ ° N
LONGITUDE: __ __ __ . __ __ __ __ __ ° W

Scale (inches)	Strata Change (inches)	Layer Number	Sample Number	Moisture Sample No.	Material Description	Material Code
____						
5.0____						
____						
10.0____						
____						
15.0____						
____						
20.0____						
____						
25.0____						
____						
30.0____						
____						
35.0____						
____						
40.0____						
____						
45.0____						
____						
50.0____						
____						
55.0____						
____						
60.0____						

GENERAL REMARKS ____
____
____

CERTIFIED ____________________
Field Crew Chief
Affiliation ____________________

VERIFIED AND APPROVED ____________________
RSC Personnel
Affiliation ____________________

DATE ______ – ______ – ______
Month – Day – Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
IN SITU DENSITY AND MOISTURE TEST
SAMPLING DATA SHEET 8

SHEET NO. _____ **OF** _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]
SAMPLE/TEST LOCATION:
☐ **Before Section**
☐ **Within Section**
☐ **After Section**

OPERATOR __________________________
TEST DATE __ __-__ __ __-__ __ __ __ (dd-mmm-yyyy)
NUCLEAR DENSITY GAUGE I.D.__________________
DATE OF LAST MAJOR CALIBRATION __ __-__ __ __-__ __ __ __ (dd-mmm-yyyy)

Note: Use additional sheets if necessary

LOCATION NUMBER				
STATION				
OFFSET(feet from O/S)				
LATTITUDE ° N		__ __.__ __ __ __ __	__ __.__ __ __ __ __	__ __.__ __ __ __ __
LONGITUDE ° W		__ __ __.__ __ __ __ __	__ __ __.__ __ __ __ __	__ __ __.__ __ __ __ __
DEPTH FROM SURFACE TO THE TOP OF THE LAYER (inches from plans)				
LAYER NUMBER				
MATERIAL TYPE: (Unbound=G and Other=T)				
IN SITU DENSITY (pcf) (*AASHTO T310-11*)	1			
	2			
	3			
	4			
AVERAGE				
METHOD (A, B, or C)				
ROD DEPTH (inches)				
IN SITU MOISTURE CONTENT (%) (*AASHTO T310-11*)	1			
	2			
	3			
	4			
AVERAGE				

GENERAL REMARKS ____
____
____

CERTIFIED

____
Field Crew Chief
Affiliation ______________________

VERIFIED AND APPROVED

____
RSC Personnel
Affiliation ______________________

DATE

_______ – _____ – _______
Month – Day – Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
SAMPLING UNCOMPACTED BITUMINOUS PAVING MIXTURES
SAMPLING DATA SHEET 10

SHEET NO. _____ OF _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]

PERSON PERFORMING SAMPLING
NAME________________________________ AFFILIATION____

SAMPLING LOCATION .... [ ]
Conveyor Belt = 1, Stockpile = 2, Haul Truck = 3, Funnel Device = 4,
Roadway Prior to Compaction = 5 (Specify: Station ________________ Offset_______________ feet from O/S),
Other = 6 (Specify:____),
Bins = 7, RAP Stockpile = 8.
Latitude .... [ ][ ].[ ][ ][ ][ ][ ] **° N**
Longitude .... [ ][ ][ ].[ ][ ][ ][ ][ ] **° W**

LAYER NUMBER .... [ ] [ ]
LOCATION NUMBER .... [ ][ ][ ][ ][ ][ ][ ]
SAMPLE NUMBER .... [ ][ ][ ][ ][ ][ ][ ]
SPECIMEN ID .... [ ] [ ][ ][ ][ ][ ] **L** [ ][ ]
APPROXIMATE SAMPLE SIZE (lbs) .... [ ][ ][ ]
DATE SAMPLED (dd-mmm-yyyy) .... [ ][ ]-[ ][ ][ ]-[ ][ ] [ ][ ]
LOCATION SAMPLE SHIPPED TO: ____
DATE SHIPPED (dd-mmm-yyyy) .... [ ][ ]-[ ][ ][ ]-[ ][ ] [ ][ ]

GENERAL REMARKS ____
____
____

CERTIFIED	VERIFIED AND APPROVED	DATE
____________________	____________________	_______ – _____ – _______
Field Crew Chief	RSC Personnel	Month – Day – Year
Affiliation ______________________	Affiliation ______________________	

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
SAMPLING ASPHALT CEMENT OR EMULSION
SAMPLING DATA SHEET 10-A

SHEET NO. _____ **OF** _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]

PERSON PERFORMING SAMPLING
NAME________________________________ AFFILIATION____

SAMPLING LOCATION .... [ ]
Storage Tank = 1, Feedline = 2, Other = 3 (Specify: ____)
Distributor = 4, Delivery Truck = 5
Latitude ....[ ][ ].[ ][ ][ ][ ][ ] **° N**
Longitude .... [ ][ ][ ].[ ][ ][ ][ ][ ] **° W**

LAYER NUMBER.. [ ][ ]
LOCATION NUMBER .... [ ][ ][ ][ ][ ][ ]
SAMPLE NUMBER.. [ ][ ][ ][ ][ ][ ][ ]
SPECIMEN ID.. [ ] [ ][ ][ ][ ][ ] **L** [ ][ ]
SAMPLE VOLUME (gal) .... [ ][ ]
DATE SAMPLED (dd-mmm-yyyy).. [ ][ ]-[ ][ ][ ]-[ ][ ] [ ][ ]
LOCATION SAMPLE SHIPPED TO: ____
DATE SHIPPED (dd-mmm-yyyy).. [ ][ ]-[ ][ ][ ]-[ ][ ] [ ][ ]

COMMENTS: ____
____

GENERAL REMARKS ____
____
____

CERTIFIED	VERIFIED AND APPROVED	DATE
___________________________	___________________________	______ – _____ – ______
Field Crew Chief	RSC Personnel	Month – Day – Year
Affiliation ____________________	Affiliation ____________________	

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
SAMPLING BULK AGGREGATE
SAMPLING DATA SHEET 21

SHEET NO. _____ **OF** _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]

PERSON PERFORMING SAMPLING
NAME________________________________ AFFILIATION____

SAMPLING LOCATION .... [ ]
Conveyor Belt = 1, Stockpile = 2, Haul Truck = 3, Funnel Device = 4,
Other = 6 (Specify:____),
Bins = 7, Distributor = 9
Latitude ....[ ][ ].[ ][ ][ ][ ][ ] **° N**
Longitude .... [ ][ ][ ].[ ][ ][ ][ ][ ] **° W**

LAYER NUMBER..[ ][ ]
LOCATION NUMBER...[ ][ ][ ][ ][ ][ ]
SAMPLE NUMBER.. [ ][ ][ ][ ][ ][ ][ ]
SPECIMEN ID..[ ] [ ][ ][ ][ ][ ] **L** [ ][ ]
APPROXIMATE SAMPLE SIZE (lbs).. [ ][ ][ ]
DATE SAMPLED (dd-mmm-yyyy)... [ ][ ]-[ ][ ][ ]-[ ][ ] [ ][ ]
LOCATION SAMPLE SHIPPED TO: ____
DATE SHIPPED (dd-mmm-yyyy)... [ ][ ]-[ ][ ][ ]-[ ][ ] [ ][ ]

GENERAL REMARKS ____
____
____

CERTIFIED	VERIFIED AND APPROVED	DATE
_______________________	_______________________	______ – ______ – ______
Field Crew Chief	RSC Personnel	Month – Day – Year
Affiliation ________________	Affiliation ________________	

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING
LABORATORY SHIPMENT SAMPLE INVENTORY
FIELD OPERATION INFORMATION FORM 1

SHEET NO. _____ OF _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]
FIELD SET NO. [ ][ ]
SAMPLE/TEST LOCATION:
☐ **Before Section**
☐ **Within Section**
☐ **After Section**

FIELD WORK COMPLETED ON: __ __-__ __-__ __ __ __ (MM-DD-YYYY)

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.

SPECIMEN ID	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
____
RSC Personnel
Affiliation ______________________

DATE
______ – ______ – ______
Month – Day – Year

LTPP-SPS MATERIAL SAMPLING AND FIELD TESTING FOR EXPERIMENT SPS-10
ROD AND LEVEL ELEVATION SURVEY
ELEVATION MEASUREMENTS FORM EM-1

SHEET NO. _____ OF _____
STATE ________________
STATE CODE [ ][ ]
SHRP ID. [ ][ ][ ][ ]

SURVEYOR ________________________

SURVEY DATE __ __-__ __ __-__ __ __ __ (dd-mmm-yyyy)

REFERENCE DESCRIPTION ____ REFERENCE ELEVATION __ __.__ __ __

LAYER NUMBER (use additional sheets as necessary) .... [ ]

	STATION 0+00		**STATION 50+00**		**STATION 100+00**	
	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)
OLE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
OWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ML	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
IWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ILE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __

	STATION 150+00		**STATION 200+00**		**STATION 250+00**	
	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)
OLE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
OWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ML	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
IWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ILE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __

	STATION 300+00		**STATION 350+00**		**STATION 400+00**	
	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)
OLE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
OWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ML	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
IWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ILE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __

	STATION 450+00		**STATION 500+00**	
	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)	TRANSVERSE OFFSET (ft)	ELVEVATION (ft)
OLE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
OWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ML	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
IWP	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __
ILE	__ __.__	__ __.__ __ __	__ __.__	__ __.__ __ __

For nominal 12-ft lane use the following transverse offsets:

OLE = 0 ft
OWP = 3 ft
ML = 6 ft
IWP = 9 ft
ILE = 12 ft

*OLE = Outside Lane Edge, OWP = Outside Wheel Path, ML = Mid Lane, IWP = Inside Wheel Path, ILE = Inside Lane Edge

GENERAL REMARKS ____
____
____

CERTIFIED ______________________
Field Crew Chief
Affiliation ______________________

VERIFIED AND APPROVED ______________________
RSC Personnel
Affiliation ______________________

DATE ________ – ______ – ________
Month – Day – Year

B.4 OTHER REQUIRED DATA SHEETS

The purpose of this section of appendix B is to provide a couple of data sheets (and associated completion instructions) for the collection of data not covered elsewhere in the report. They include a data sheet for the recording of subsurface moisture measurements and another data sheet for the collection of information on the snow removal and deicing practices used by the SHA at SPS-11 project locations.

SUBSURFACE MOISTURE (Data Sheet 1)

This data sheet provides information for the measurement of subsurface moisture by means of a neutron probe device.

Individual data elements are as follows:

> *Measurement Date (Item 1)*: The day, month, and year of the measurement.
>
> *Manufacturer/Model* (*Item 2*): Indicate the manufacturer name and model of the device used for the moisture measurement
>
> *Serial Number* (*Item 3*): Indicate the serial number of the device used for the moisture measurement
>
> *Date of Last Calibration (Item 4)*: The day, month, and year of the most recent calibration.
>
> *Station (Item 5)*: The location of the test hole, in meters, relative to the start of the section. Holes located prior to the section start should be identified with negative stationing.
>
> *Offset (Item 6)*: The location of the test hole, in meters, relative to the outside edge of the test section. Locations to the left (centerline side) of the outside edge are positive, and holes to the right (shoulder side) are negative.
>
> *Depth (Item 7)*: Indicate the depth, in meters, of the measurement.
>
> *Measurement Count (Item 8)*: The number of counts recorded during the measurement period.
>
> *Type of De-Icers Used* (*Item 9*): The moisture content determined by the measurement, in kilograms of water per cubic meter of the material being tested.
>
> *Operator (Item 10)*: Include the initials of the individual performing the test.

SNOW REMOVAL/DEICING (Data Sheet 2)

This data sheet provides information on the snow removal and deicing practices used by the SHA at the test section location. The form should be filled out and submitted monthly (or more frequently) during the periods where applications occurred.

Individual data elements are as follows:

Were Snow Plows Used on the Section (Item 1): A yes/no code indicating whether the section was subject to snow plow use or not.

Snow Plow Edge Type (*Item 2*): For sections that have been plowed, indicate the most common blade edge type. Codes are provided on the data sheet.

Number of Passes in Period (Item 3): Indicate the number of times in the observation period that the section was plowed—each pass of the plow should be counted individually. When Item 1 is 'N', this should be zero.

Typical Speed of Plowing Operation (Item 4): For sections that were plowed, indicate the common travel speed of the plow while plowing, in MPH.

Were Pre-Treatments Used on the Section (Item 5): A yes/no code indicating whether the section was subject to anti-icing pre-treatments.

Type of Pre-Treatment Used (*Item 6*): For sections that received treatment, indicate the most common treatment type. Codes are provided on the data sheet.

Number of Applications in Period (Item 7): Indicate the number of times during the observation period that the section was treated. When Item 5 is 'N', this should be zero.

Were De-Icers Used on the Section (Item 8): A yes/no code indicating whether the section was subject to application of de-icing chemicals.

Type of De-Icers Used (*Item 9*): For sections that received treatment, indicate the most common treatment type. Codes are provided on the data sheet.

Typical Number of Applications per Year (Item 10): Indicate the number of times in the observation period that de-icing agents were applied. When Item 8 is 'N', this should be zero.

Is the Section Subject to Chain Controls (Item 11): A yes/no code indicating whether the section is subject to chain controls If the agency has provisions for chain controls on the section, regardless of how often they are applied, then this item should be 'Y'

Number of Control Events in Period (Item 12): Indicate the number of times during the observation period that the section was subject to some type of chain requirement. When Item 11 is 'N', this should be zero.

LTPP SPS PERFORMANCE MONITORING **DATA SHEET 2** **SUBSURFACE MOISTURE**	STATE CODE [__ __] SHRP ID [__ __ __ __]

1 MEASUREMENT DATE (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]

MEASUREMENT DEVICE

2. MANUFACTURER/MODEL [______________________________________]

3. SERIAL NUMBER [______________________________________]

4. DATE OF LAST CALIBRATION (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]

TEST HOLE

5. STATION (meters) [__ __ __.__]

6. OFFSET (meters) [__.__]

MEASUREMENT

7. DEPTH (meters) [__.__ __]

8. MEASUREMENT COUNT [__ __ __ __ __]

9. WATER MASS PER UNIT VOLUME (kilograms per cubic meter) [__ __ __.__]

9. OPERATOR (initials) [__ __ __]

PREPARER__________________ EMPLOYER____________________DATE________________

LTPP SPS PERFORMANCE MONITORING DATA SHEET 1 SNOW REMOVAL / DEICING	STATE CODE [__ __] SHRP ID [__ __ __ __]

OBSERVATION PERIOD

FROM (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]
TO (dd/mmm/yyyy) [__ __/__ __ __/__ __ __ __]

SNOW PLOW

1. WERE SNOW PLOWS USED ON THE SECTION? (Y/N) [__]

2. MOST COMMON SNOW PLOW EDGE TYPE [__]
   - Steel.................... 1   Rubber 3
   - Carbide................. 2   Polyurethane..........4
   - Other (Specify) [____________________] 5

3. NUMBER OF PASSES IN PERIOD [__ __ __]

4. TYPICAL SPEED OF PLOWING OPERATION (mph) [__ __]

PRE-TREATMENT

5. WERE PRE-TREATMENTS USED ON THE SECTION? (Y/N) [__]

6. TYPE OF PRE-TREATMENT USED [__]
   - NaCl.................... 1 $CaCl_2$.................2
   - NaCl + $CaCl_2$............ 3   CMA 4
   - Other (Specify) [____________________] 5
   - KCl..................... 6 $MgCl_2$.................7
   - Urea.................... 8

7. NUMBER OF APPLICATIONS IN PERIOD [__ __ __]

DE-ICING

8. WERE DE-ICERS USED ON THE SECTION? (Y/N) [__]

9. TYPE OF DE-ICER USED [__]
   - NaCl.................... 1 $CaCl_2$.................2
   - NaCl + $CaCl_2$............ 3   CMA 4
   - Other (Specify) [____________________] 5
   - KCl..................... 6 $MgCl_2$.................7
   - Urea.................... 8

10. NUMBER OF APPLICATIONS IN PERIOD [__ __ __]

CHAIN CONTROLS

11. IS THE SECTION SUBJECT TO CHAIN CONTROLS? (Y/N) [__]

12. NUMBER OF CONTROL EVENTS IN PERIOD [__ __ __]

PREPARER__________________ EMPLOYER____________________ DATE________________

APPENDIX C. NEW MATERIALS TEST PROTOCOLS

C.1 STANDARD METHOD OF TEST FOR STANDARD PRACTICE FOR MICRO-SAMPLING ASPHALT PAVEMENT - AASHTO DESIGNATION: T XXX-13

1. SCOPE

1.1. This practice describes a procedure for removal of a micro-sample (200 ± 20 g) of pulverized asphalt pavement for extraction and recovery of the binder for laboratory testing. It is intended for use when the physical or chemical properties of the recovered asphalt are to be determined. It is not intended to determine the quantity of asphalt binder or the gradation of the recovered aggregate. This method is applicable to HMA or WMA pavement.
1.2. The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.
1.3. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. AASHTO Standards:
- 2.1.1. AASHTO T XXX-12 Standard Method of Test for Determining the Low Temperature Rheological Properties of Asphalt Binder Using a DSR.
- 2.1.2. AASHTO TXXXX-13 Standard Method of Test for Qualitative Micro-Extraction and Recovery of Asphalt Binder from Asphalt Mixtures.

2.2. ASTM Standards
- 2.2.1. ASTM D3665—12 Standard Practice for Random Sampling of Construction Materials.

3. TERMINOLOGY

3.1. Definitions:
3.1.1. Micro-sample ― Pulverized asphalt pavement, sample of ~ 200 g or less.
3.1.2. Micro-extraction―Extraction and recovery of asphalt binder from a micro sample.

Note 1―Typically, 200 g of pulverized asphalt pavement will produce about 10 g of asphalt depending on the percent asphalt in the mixture. Dense graded HMA or WMA is typically between 4.5 and 6.5% asphalt.

4. SIGNIFICANCE AND USE

4.1. The Samples obtained in accordance with the procedure given in this practice may be used to extract and recover the asphalt binder for further testing such as the low, intermediate, and high temperature SHRP Performance Grade specification parameters m-value, creep stiffness, $G^* \sin \delta$, and $G^*/ \sin \delta$ as well as chemical composition by e.g. infrared absorption (IR) analyses.

5. APPARATUS

5.1. 25-mm (1 inch) diameter masonry bit
5.2. Hammer drill with vacuum attachment
5.3. 300-mL (10 oz) metal tins with lids—for sample storage
5.4. Cooler—for storing samples
5.5. Freezer—for long term sample storage

6. MATERIALS

6.1. Dry ice or other cooling material

7. HAZARDS

7.1. Eye protection should be worn when operating the hammer drill.

8. PROCEDURE

8.1. Select the location on the pavement to be sampled and the sampling depth. Brush the surface with a stiff paint brush to remove dust and other debris. Avoid areas with obvious contamination.
8.2. Determine the number of drills required. For example if the selected sampling depth is 50-mm (~ 2") then four drill holes to a depth of 50-mm (2") will be required to obtain roughly 200 g ± of pulverized pavement (assuming an approximate in-place density of 2-g/cm3).
8.3. After drilling the required number of holes to obtain a 200 g ± sample remove the pulverized material from the vacuum storage on the drill to a metal tin with lid. Or in accordance with Note 3, when collecting surface samples i.e. ~10-mm (3/8") depth simply sweep the pulverized material onto a small dust pan (or a stiff paper) and transfer into a metal tin.

> Note 2—When removing the pulverized material from the vacuum storage on the drill it is necessary to remove the filter and brush out the material between the filter baffles. Use a small (1" wide) nylon brush. Typically about 80% of the pulverized material is visible in the container and about 20% is on the filter.
>
> Note 3—When sampling the surface to a depth of approximately 10-mm (3/8"), it is not necessary to use the vacuum to collect the sample, instead the pulverized material can simply be swept up using a small (1" wide) nylon brush, and then placed in the tin.

8.4. Place the metal tin in a cooler with dry ice or other suitable cooling material. Ice is not suitable due to the possibility of contaminating the samples with water from the melting ice. The purpose of keeping the sample cool is to prevent further oxidation of the asphalt during transport.
8.5. After transporting the samples back to the laboratory, place the samples in a freezer until solvent extraction.

9. REPORT

9.1. Report the detailed location where the pavement sampling occurred.

C.2 STANDARD METHOD OF TEST FOR QUALITATIVE MICRO-EXTRACTION AND RECOVERY OF ASPHALT BINDER FROM ASPHALT MIXTURES, AASHTO - DESIGNATION: T XXX-13

1. SCOPE

1.1. This test method describes a procedure for the extraction and recovery of asphalt binder from a small amount of asphalt mixture (< 200 g). It is intended for use when the physical or chemical properties of the recovered asphalt are to be determined. It is not intended to determine the quantity of asphalt binder or the gradation of the recovered aggregate because the samples are too small and do not represent the aggregate gradation. This method is applicable to HMA sampled from the pavement, RAP sampled from the pavement or stockpile, HMA plant production, or laboratory fabricated HMA, and RAS.
1.2. The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.
1.3. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1. AASHTO Standards:
- 2.2.1. AASHTO T XXX-12 Standard Method of Test for Determining the Low Temperature Rheological Properties of Asphalt Binder Using a DSR

2.2. ASTM Standards:
- 2.2.1. ASTM D92 - 12b Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

3. TERMINOLOGY

3.1. Definitions:
- 3.1.1. Micro-sample—Asphalt mixture sample less than 200 g.
- 3.1.2. Micro-extraction—Extraction and recovery of asphalt binder from a microsample.
  - Note 1—In general, 200 g of asphalt mixture will produce about 10 g of asphalt depending on the percent asphalt in the mixture. Dense graded HMA is typically between 4.5 and 6.5% asphalt.
- 3.1.3. Rotary Evaporator—also referred to as a "rotovap" is used to remove solvent from mixtures. The solvent is removed under vacuum and is trapped by a condenser. The flask is rotated during the evaporation process to increase the exposed surface area which increases the evaporation rate.
- 3.1.4. Bumping—occurs during rotary evaporation when the contents of the rotary evaporator flask are drawn up into the condenser.

4. SIGNIFICANCE AND USE

4.1. The paving mixture is extracted with a mixture of toluene and ethanol, or trichloroethylene. The intent of this standard is to extract and recover asphalt binder from an asphalt mixture sample without significantly changing the rheological properties of the recovered binder. The asphalt mixture sample size is limited to a maximum of 200 g (referred to as a micro-sample) which greatly reduces the solvent requirements and exposure of laboratory technicians to harmful organic vapors. The method only recovers about 10 g of asphalt binder. However recent development of 4-mm Dynamic Shear Rheometry (AASHTO T XXX-12), which allows low temperature rheological testing to determine Bending Beam Rheometer (BBR) m-value and creep stiffness, dramatically reduces the amount of binder required. Four-mm DSR only requires about 25 mg of asphalt unlike the BBR which requires about 15 g per beam, and several beams are required.

5. APPARATUS

5.1. Erlenmeyer flask —500 mL
5.2. Round Bottom Recovery Flask—1000 mL
5.3. Amber glass bottle—120 mL, wide-mouth
5.4. Flow meter—Gas flow meter, capable of indicating a gas flow up to 1000 mL/min.
5.5. Manometer or Vacuum Gage, suitable for measuring the specified vacuum.
5.6. Rotary Evaporator—Although the solvent removal can be accomplished with one rotary evaporator (rotovap) equipped with an oil heating bath, two rotovaps are recommended to reduce the time it takes to perform an extraction: (1) a rotovap equipped with an oil heating bath capable of maintaining a temperature of 170°C ±; and (2) a rotovap equipped with a water bath capable of maintaining a temperature of 100°C. The rotovap should be equipped with a distillation flask, a variable speed motor capable of rotating the distillation flask at a rate of at least 50 rpm, condenser, solvent recovery flask, and heated bath. The rotovap should be capable of holding a recovery flask at a 15° angle. The rotovap setup should include a trap (with dry-ice) placed between the vacuum source and the condenser unit.
5.7. Centrifuge—Batch unit capable of exerting a minimum centrifugal force of 770 times gravity.
5.8. Centrifuge Bottles—wide mouth glass centrifuge bottles, 100 mL.
5.9. Thermometric Device—A built-in temperature measurement device capable of displaying the oil temperatures to the nearest 1°C [2°F].
5.10. Utilities

5.10.1. Vacuum System, capable of maintaining a vacuum of to within 60.7 kPa [65 mm of Hg] of the desired level up to and including 80 kPa [600 mm of Hg].
5.10.2. Cooling water source.

5.11. Balance, of suitable capacity meeting the requirements of AASHTO M231, class G2.
5.12. Glass syringe—50 mL, 6-inch long 12 gauge flat needle.
5.13. N-EVAP—Nitrogen evaporator with water bath.

6. REAGENTS AND MATERIALS

6.1. Solvents:
6.1.2. Trichloroethylene, reagent grade.
6.1.3. Toluene/Ethanol—85:15 (v/v) mixture of toluene (reagent grade) and 95% ethanol.
6.2. Nitrogen, Argon, or Carbon Dioxide Gas—at least 99.95 % pure, in a pressurized tank, with a pressure-reducing regulator valve.

> Note 2—Different flow rates may be required depending on which gas is used. 6.3. Oil—the oil for the heated oil bath should be USP White Oil or Silicone Fluid SWS-101 with flash point above 215°C [420°F] or an equivalent. The flash point is determined in accordance with Test Method D92.

7. HAZARDS

7.1. Caution—the solvents listed in Section 6 should be used only under a hood or with an effective surface exhaust system in a well-ventilated area, since they are toxic to various degrees. Consult the current Threshold Limit Concentration Committee of the American Conference of Governmental Industrial Hygienists6 for the current threshold limit values. Wear nitrile gloves and safety glasses.
7.2. Exposure of these solvents or their vapors to high temperatures such as contact with flames, hot glowing surfaces, or electric arcs can produce decomposition products such as hydrogen chloride. Steel drums containing these solvents should be stored in a cool, dry location, kept tightly sealed and opened as infrequently as possible. The hydrogen chloride in decomposed solvent may harden an asphalt during the extraction and recovery test.

8. PROCEDURE

8.1. Place the test sample (maximum 200 g) in the 500 mL Erlenmeyer flask.

> Note 3—if necessary, for example when working with a core slice, break the sample into smaller irregular pieces.

8.2. Add sufficient solvent to cover the sample (typically several hundred mL). Stir the solvent/mix for several minutes. Cover the flask with aluminum foil and allow to stand overnight. The next day remove the bulk of the solvent/asphalt solution by decanting into another 500 mL Erlenmeyer flask. Try not to disturb the sediment while decanting.
8.3. Using a glass syringe, place approximately 100 mL aliquots of the solvent/asphalt solution into glass centrifuge tubes, and centrifuge for 30 minutes at 2,200 rpm.

> Note 4—it is important to balance the amounts of solution in each tube in the centrifuge to avoid damage to the centrifuge or injury to the operator.
>
> Note 5—the sediment at the bottom of the centrifuge tube after centrifuging can be left in place until after the last centrifuge operation. The sediment can then be removed by adding several mL of solvent to the tube and inserting a thin metal rod into the sediment to loosen it.

8.4. Using a glass syringe, carefully remove the bulk of the solution from the centrifuge tubes and transfer to a 1000 mL round bottom recovery flask.

> Note 6—When using a syringe to remove the asphalt/solvent solution where there is sediment in the bottom of the centrifuge tube, position the tip of the syringe needle 1 to 2

mm above the surface of the sediment and slowly draw the solution into the syringe so as not to disturb the sediment.

8.5. Evaporate the solvent in a rotary evaporator (water bath set at 70 °C) until the solution is visually dry. Increase nitrogen, argon or carbon dioxide flow to approximately 600 mL/min to eliminate the exposure of the asphalt material to oxygen during solvent removal. Set the rotational speed to about 45 RPM.

Note 7—To prevent bumping slowly lower the round bottom evaporative flask approximately 40 mm into the water bath, and slowly apply a vacuum of 80.0 ± 0.7 kPa [600 ±5 mm of Hg] below atmospheric pressure.

8.6. Repeat the procedure described in steps 8.2 to thru 8.5, except it is not necessary for the solution in step 8.2 to stand overnight. Instead, allow the solution to stand for approximately 30 minutes, occasionally swirl to agitate, and allow to settle before removing the solvent/asphalt solution. Repeat steps 8.2 to 8.5 until the extraction solvent is slightly yellow or straw colored.

8.7. After the last rotovap is performed in step 8.5, pour approximately 30 mL of solvent into the rotary evaporator flask, swirl to agitate, and transfer the solution to a 120 mL amber colored glass bottle. Continue rinsing using small amounts of solvent ~5 mL each time to remove all the remaining asphalt from the round bottom flask.

Note 8—Typically, it requires roughly 70 mL of solvent to remove the asphalt from the rotary evaporator flask to the glass bottle.

8.8. Place the glass bottle under an N-EVAP and reduce the amount solvent to about 30 mL.

Note 9—Instead of using an N-EVAP to reduce the solvent to approximately 30 mL, a rotovap with a water bath set at 70°C can be used, but care has to be exercised to prevent the solution from bumping. Recommend slowly lowering the bottle into the water bath and slowly increasing the vacuum.

8.9. Evaporate the remaining solvent in a rotary evaporator (oil bath set at 170 °C). Increase nitrogen, argon or carbon dioxide flow to approximately 600 mL/min to eliminate the exposure of the asphalt material to oxygen during solvent removal. To prevent bumping slowly lower the bottle approximately 25 mm into the oil bath, and slowly apply a vacuum of 80.0 ± 0.7 kPa [600 ±5 mm of Hg] below atmospheric pressure. Set the rotational speed to 25 RPM.

Note 10—the maximum depth of the bottle in the oil bath is set at 25 mm to help prevent the bath oil from contaminating the sample by climbing up the side of the bottle while it is rotating.

8.10. Perform the rotary evaporation for a minimum of 1 hour. After 1 hour, if no obvious condensation is occurring on the condenser, maintain the evaporative process for an additional10 minutes.

Note 11—In general, if the rotary evaporative process in 8.10 is followed, the concentration of the solvent remaining will not affect the asphalt rheology. To insure the level of solvent is below the threshold that could affect the asphalt's viscoelastic properties evaluate the solvent concentration using infrared spectroscopy. If the solvent is above the detection threshold of the infrared instrument repeat step 8.10 for 30 minutes. The infrared method is optional.

Note 12—Ash contents of recovered asphalts greater than 1 % may affect the accuracy of rheological test such as DSR.

9. PRECISION AND BIAS

9.1. Repeatability and reproducibility tests have not been established in accordance with standard AASHTO practice.

10. REPORT

10.1. Report source of test sample.

C.3 FIELD VIALIT TEST: DETERMINING THE AGGREAGATE RETENTION FOR CHIP SEALS

SUMMARY OF METHOD

Hot asphalt cement is applied to standard size stainless-steel pans in the field. The aggregates is applied and rolled in the field. The plate with the sample is recovered from the field to cure under specified conditions. Following this cure, the trays are conditioned at -22° C for 30 minutes. Then a 500 g ball is dropped 3 times from a distance of 50 cm onto the inverted plates. The results are recorded as percent aggregate retention.

APPARATUS

Vialit Stand - See drawing in figure 24.

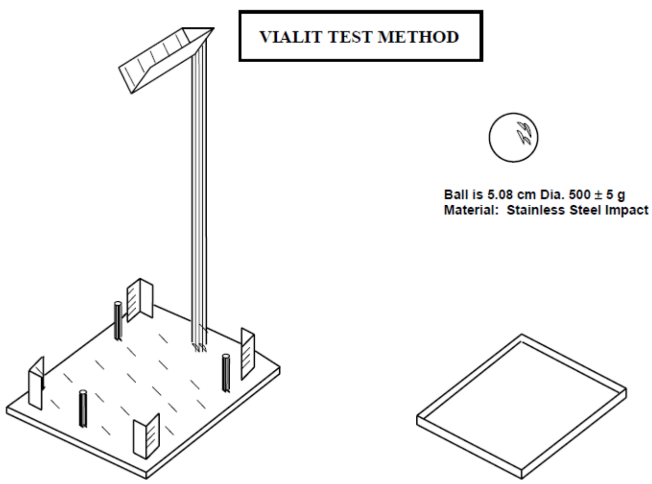

Figure 24. Illustration. Vialit testing apparatus.

Pans - the pans are constructed of 304 stainless-steel 2 mm thick. The pans shall be 20 X 20 cm with a lip around the entire edge. The lip shall be high enough to prevent the emulsion or cement from over flowing, and no higher than 75% of the smallest aggregate sieve size.

Vialit drop test unit - see attached drawing.

Ball - the ball shall be stainless-steel and weigh 500 ± 5 g.

Oven - the oven shall be a forced recirculating oven capable of regulating temperature within ± 2° C.

Freezer - for test below 0° C, a freezer capable of regulating temperature within ± 1.0° C is required.

PREPARATION OF TEST SPECIMENS

For field testing seal coat chip retention the Field Modified Vialit Test Method for Aggregate in Chip seals, French Chip is revised as follows:
Use a 20 cm x 20 cm galvanized plate 2.0 mm thick and determine the tare weight of the galvanized plate.

Place the plate on the existing pavement surface before placing chip seal. After finish rolling the seal coat and initial surface sweeping, remove the specimen. Place the specimen in a plastic bag.

CURE OF SPECIMENS

Cure the specimen, except cure at 100 ºF for the first 2 hours.

SAMPLE CONDITIONING

The pan is removed from the oven, and allowed to cool for 30 minutes at 25 ± 5° C. The pan is then placed in a freezer at the specified temperature -22ºC for 30 minutes. Sample conditioning is then completed.

Weigh the test specimen and any loose chips in the sample bag.

Perform the Vialit test and reweight the test specimen.

Remove the pan from the freezer and place it in an inverted position in the test apparatus. Place the ball in the V-holder and let it free-fall. Repeat the procedure until the ball has been dropped a total of three times. The entire sequence must be completed in 10 seconds for the test to be valid.

Calculate the binder weight as follows:

BW = Binder weight = BAR (gallons/sq yd) X 0.0478 (sq yd) X SG (lbs/gal)

Figure 25. Equation. Binder weight calculation.

Where:

BAR = seal coat binder application rate in gal/sq yd
Plate dimension = 20 cm X 20 cm = 0.0478 sq yd
SG = specific gravity of seal coat binder determined under ASSHTO T 228

Calculate the chip retention by weight as follows:

$$Percent\ Retention = \frac{SW_{Final} - (BW + TW)}{SW_{Initial} - (BW + TW)}$$

Figure 26. Equation. Percent retention.

Where:

SWinitial = initial specimen weight
SWfinal = final specimen weight
BW = seal coat binder weight
TW = tare weight of plate