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DEVELOPMENT OF SPS-2 PAVEMENT PRESERVATION EXPERIMENT

FINAL REPORT
June 27, 2016

Washington State Department of Transportation
310 Maple Park Ave., SE
Olympia, Washington 98504

Development of SPS-2 Pavement Preservation Experiment
Final Phase I Report

Pooled fund TPF -5(291)

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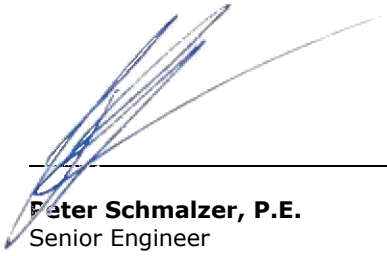

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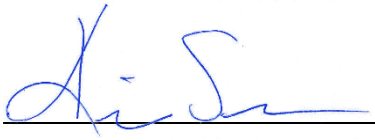

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<tr><td colspan="5">16. Abstract
This report outlines the current availability of the Long Term Pavement Performance (LTPP) SPS-2 experiment – strategic study for structural factors for rigid pavements – and proposes several options for potential future experiments that could be completed with the existing data for a comprehensive study of concrete pavement preservation techniques. The original core experiment sections were utilized in an experiment design comparing multiple maintenance treatments while the supplemental sections were included in a dowel bar retrofit study. Additionally, the proposed experiment could likely be expanded to include using the wealth of existing pavement performance data from the SPS-2 experiment to potentially use the predicted performance curves from AASHTOWARE PavementME as the control sections and thus eliminating the need for paired sections and allowing for doubling of the experimental sections that could be used. This report for Phase I summarizes the work completed thus far evaluating and recommending possible experiments based on existing data.</td></tr>
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EXECUTIVE SUMMARY

The Long Term Pavement Performance (LTPP) SPS-2 experiment - strategic study of structural factors for rigid pavements - is the most comprehensive on-going concrete pavement research effort undertaken since the AASHO Road Test. Spanning fourteen states, the study begin in 1992 and eleven of the original fourteen sections remain in service with current years of service ranging between 14 and 22 years as of 2015. Given this unparalleled resource of well documented and monitored aged concrete pavements, the sections currently in study provide the ideal opportunity to develop a second experiment to compare the effectiveness of concrete pavement preservation strategies to extend pavement service life. Recognizing the opportunity, this pooled fund study (TPF-5(291)) was initiated to develop and implement a continuation experiment focused on pavement preservation. As a precursor to the full experiment, the evaluation and assessment of the existing SPS-2 sections with current data limitations and availability must be analyzed and discussed in order to proceed with the development of a robust experimental plan.

This report outlines the current availability of LTPP data, including sections remaining in study, and of those, which have received maintenance or rehabilitation treatments that may limit the options of inclusion in further study. Pavement preservation techniques are evaluated and discussed, including limitations that should be considered due to site specific factors or test section history. The available test sections were considered with the respective potential limitations based on the investigated pavement preservation methods. Multiple options of pairing the test sections for evaluating a control and a testing section are presented and several potential experiments are identified to investigate the performance of spall repairs, joint sealing, diamond grinding, crack sealing, and the combination maintenance of joint sealing and diamond grinding.

Additionally, an experiment to investigate the effectiveness of dowel bar retrofit is presented that utilizes the original supplemental sections, some of which were originally undoweled. This would allow for comparing the variation in load transfer efficiency and difference in faulting between a previously undoweled section receiving a dowel bar retrofit and sections with dowels that will receive diamond grinding for maintenance.

The proposed experiment could be expanded to include using the wealth of existing pavement performance data from the SPS-2 experiment to utilize the predicted performance curves produced from AASHTOWARE PavementME as the “control” sections. If successful, this would eliminate paired sections and allow for doubling of the experimental sections. Additional work will be necessary to establish the validity of this approach before revising the experimental plan.

This report for Phase I summarizes the work completed thus far evaluating and recommending possible experiments based on existing data and the pooled fund panel will be evaluating and guiding the future direction of the project.

BACKGROUND

The Long Term Pavement Performance (LTPP) SPS-2 experiment, strategic study of structural factors for rigid pavements, is the most comprehensive on-going concrete pavement research effort undertaken since the AASHO Road Test. Spanning fourteen states, the study begin in 1992 and eleven of the original fourteen sections remain in service with life spans ranging between 14 and 22 years as of 2015. Given this unparalleled resource of well documented and monitored aged concrete pavements, the sections currently in study provide the ideal opportunity to develop a second experiment to compare the effectiveness of concrete pavement preservation strategies to extend pavement service life. Due to the age of the sections, the timeframe of establishing this continuation experiment is critical before the sections in study will require any additional maintenance to maintain adequate serviceability. To begin addressing this project, the pooled fund study (TPF-5(291)) was initiated to develop and implement this continuation experiment. As a precursor to the full experimentation, the evaluation and assessment of the existing SPS-2 sections with current data limitations and availability must be analyzed and discussed in order to proceed with the development of a robust experimental plan.

This work was completely funded by the Transportation Pooled Fund study program, initiated by the FWHA. Washington served as the lead state for this project and supporting states included in the pooled fund included Arizona, California, Colorado, Georgia, Kansas, and North Carolina. The first project initiation meeting occurred on January 6, 2014, and the first panel meeting was held on March 11, 2016.

INTRODUCTION

The SPS-2 experiments were designed to investigate the effect of several key factors on the performance of doweled jointed plain concrete pavement. These factors were selected based on input provided from participating state and provincial highway agencies and used to develop the core experiment, which will be discussed in more detail below. The core experiment construction requirements were held consistent across all participating states. States were then given the option to include supplemental test sections of interest to the State Highway Agency (SHA). The original intent was to develop a robust secondary experiment with the supplemental test sections. However, states indicated a preference toward designing individualized, state-specific experiments. The supplemental sections were not held consistent across the participating SHAs but contained some similar factors across different states, including testing dowel bar effectiveness, joint spacing and skew. The organization and implementation of the supplemental test sections will also be discussed in more detail in this section.

Core Experiment

As previously discussed, the SPS-2 core experiment was comprised of both site specific and structural factors that were based on the interest and input of participating agencies. The factors considered are summarized in Table 1 below. Factors were divided between site related factors (environmental) and structural factors. There were three site-specific factors that were originally considered experimentally significant: traffic, climate, and subgrade. However, traffic was not included in the experimental design matrix and rather, a minimum level of traffic was required for sites to be considered eligible for participation. This lead to varying traffic levels across test sites that will be discussed later in the report. The other site related factors included climate, which was divided into four levels based on climatic zones: wet-freeze, wet-no freeze, dry-freeze, and dry-no freeze, and two subgrade factor levels of either fine or coarse subgrade. There were five structural factors: base type, drainage type, concrete thickness, concrete flexural strength, and lane width. The levels considered in the experiment are also presented in Table 1 below. It should be noted that some states were unable to achieve the exact requirements and some variation does exist between some required factors in the test sections.

Table 1. Experimental factors considered in the original SPS-2 experiment

Type of Experimental factor	Variables affected	Experimental factor	Number of levels	Levels
Environmental	Site-specific	Traffic	0	N/A
		Climate	4	Wet-Freeze
				Wet-No Freeze
				Dry-Freeze
				Dry-No Freeze
		Subgrade	2	Fine
				Coarse
Structural	Base/Subbase	Base type	3	Dense-graded untreated unbound aggregate (DGAB)
				Lean concrete (LCB)
				Open graded permeable asphalt stabilized base (PATB)
		Drainage type	2	Open graded permeable asphalt drainage layer (PATB)
				No drainage layer
	Pavement surface	PCC thickness	2	8 inch
				11 inch
		PCC flexural strength	2	550 psi
				900 psi
		Lane width	2	12 ft
				14 ft

These factors were then compiled into a factorial experiment which, between the eight environmentally related factors and 24 pavement related structural factors, resulted in 192 factor level combinations that would require 24 test sections constructed at each site for a full factorial experiment. Due to the financial and energy intensity of this endeavor for participating agencies, the resulting constructed experiment was a half-factorial experiment that coupled the full factorial design based on climatic sub-zone. This resulted in only 12 test sections to be constructed at each site. The initial ideal experimental design table is shown in Table 2 below based on the finalized half-factorial experiment. Then the actual construction matrix based on available agencies is given in Table 3 to reflect actual SPS-2 construction.

Table 2. Experimental matrix for half-factorial experiment design for SPS-2 experiment.

Pavement Structure					Climate zones, subgrade site															
					Wet								Dry							
					Freeze				No Freeze				Freeze				No Freeze			
Drainage	Base Type	PCC		Lane Width	Fine		Coarse		Fine		Coarse		Fine		Coarse		Fine		Coarse	
		Thick, in	Strength, psi		J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
No	DGAB	8	550	12	J1		L1		N1		P1		R1		T1		V1		X1	
				14		K13		M13		O13		Q13		S13		U13		W13		Y13
			900	12		K14		M14		O14		Q14		S14		U14		W14		Y14
				14	J2		L2		N2		P2		R2		T2		V2		X2	
		11	550	12		K15		M15		O15		Q15		S15		U15		W15		Y15
				14	J3		L3		N3		P3		R3		T3		V3		X3	
			900	12	J4		L4		N4		P4		R4		T4		V4		X4	
				14		K16		M16		O16		Q16		S16		U16		W16		Y16
No	LCB	8	550	12	J5		L5		N5		P5		R5		T5		V5		X5	
				14		K17		M17		O17		Q17		S17		U17		W17		Y17
			900	12		K18		M18		O18		Q18		S18		U18		W18		Y18
				14	J6		L6		N6		P6		R6		T6		V6		X6	
		11	550	12		K19		M19		O19		Q19		S19		U19		W19		Y19
				14	J7		L7		N7		P7		R7		T7		V7		X7	
			900	12	J8		L8		N8		P8		R8		T8		V8		X8	
				14		K20		M20		O20		Q20		S20		U20		W20		Y20
Yes	PATB/ DGAB	8	550	12	J9		L9		N9		P9		R9		T9		V9		X9	
				14		K21		M21		O21		Q21		S21		U21		W21		Y21
			900	12		K22		M22		O22		Q22		S22		U22		W22		Y22
				14	J10		L10		N10		P10		R10		T10		V10		X10	
		11	550	12		K23		M23		O23		Q23		S23		U23		W23		Y23
				14	J11		L11		N11		P11		R11		T11		V11		X11	
			900	12	J12		L12		N12		P12		R12		T12		V12		X12	
				14		K24		M24		O24		Q24		S24		U24		W24		Y24

Table 3. As-Constructed experimental matrix for half-factorial experiment design for SPS-2 experiment.

Pavement Structure					Climatic Conditions and Subgrade															
					Wet								Dry							
					Freeze						No-Freeze		Freeze					No-Freeze		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width, ft	Fine			Coarse			Fine	Coarse	Fine				Coarse	Fine	Coarse	
					OH	IA	MI	DE	AR	WI	NC		KS	WA	ND	CO	NV		CA	AZ
No	DGAB	8	550	12	1			1			1		1	1			1		1	
				14		13	13		13	13					13	13				13
			900	12		14	14		14	14					14	14				14
				14	2			2			2		2	2			2		2	
		11	550	12		15	15		15	15					15	15				15
				14	3			3			3		3	3			3		3	
			900	12	4			4			4		4	4			4		4	
				14		16	16		16	16					16	16				16
No	LCB	8	550	12	5			5			5		5	5			5		5	
				14		17	17		17	17					17	17				17
			900	12		18	18		18	18					18	18				18
				14	6			6			6		6	6			6		6	
		11	550	12		19	19		19	19					19	19				19
				14	7			7			7		7	7			7		7	
			900	12	8			8			8		8	8			8		8	
				14		20	20		20	20					20	20				20
Yes	PATB	8	550	12	9			9			9		9	9			9		9	
				14		21	21		21	21					21	21				21
			900	12		22	22		22	22					22	22				22
				14	10			10			10		10	10			10		10	
		11	550	12		23	23		23	23					23	23				23
				14	11			11			11		11	11			11		11	
			900	12	12			12			12		12	12			12		12	
				14		24	24		24	24					24	24				24

It can be seen from Table 3 that the experiment as constructed resulted in the matrix being unable to be exactly filled due to agency availability and participation. For example, there were no experiments with fine subgrade in a no-freeze dry climate and no experiments with a coarse subgrade in a no-freeze wet climate. Only a single, non-coupled experiment exists for fine soil in a no-freeze wet climate and likewise only one single, non-coupled experiment was constructed for coarse soil in a dry freeze climate. Also again due to agency participation, some cells from the matrix can be seen as replicates.

Supplemental Experiments

Originally, the supplemental sections were intended to formally create several robust, secondary experiments regarding several additional factors of interest as determined by state agencies including the use of dowel bars, joint spacing, and joint skew. However, during development, it was determined that states preferred more agency-specific supplemental experiment options. This resulted in some variation of experiments by state, including some states that did not have any supplemental sections or constructed only a single supplemental section, which was often constructed with the standard concrete paving mix and structure for the agency.

Arizona

The supplemental sections in Arizona were divided into three smaller experiments that were designed to investigate random skew joints, slab thickness, and project variability, respectively. To investigate random, skew joints, the concrete mix design was held consistent across this experiment, and the lower strength mix (550 psi flexural strength) used in the core experiments was also used in this supplemental experiment. The joints for all slabs were skewed by two feet across the width with the pattern 13, 15, 17, 15 ft and all slabs were undoweled. This experiment also utilized a half-factorial design and investigated three factors: slab width, base type, and slab thickness. The base types considered included dense graded aggregate base (DGAB) and permeable bituminous treated base (PBTB).

The second state experiment varied the concrete slab thickness and was constructed over a Bituminous Treated Base (BTB) mix and all sections were doweled with 15 ft joint spacing. Again, the lower strength mix used in the core experiments (550 psi) was used consistently across these supplemental sections.

Finally, the third smaller experiment investigated site-based variability and the two identical AC test sections were constructed on either end of the site. This allowed for comparison across the site to ensure consistency across all of the sites. Site-specific information is given in Table 4 below.

Table 4. Supplemental sections constructed for the Arizona SPS-2 experiment.

SHRP ID	Sub-experiment	Lane width, ft	Base type	PCC thickness, in	Dowels
040262	1	14	DGAB	8	No
040263		14	PBTB	8	No
040264		12	PBTB	11	No
040265		12	DGAB	11	No
040266	2	14	BTB	12.5	Yes
040267		14	BTB	11	Yes
040268		14	BTB	8	Yes
040260	3	(intentionally identical and on either end of the project; asphalt surface)			
040261					

Delaware

Delaware constructed two supplemental test sections to investigate the effect of different dowel bars on concrete pavement performance. The two sections, whose properties are given in Table 5 below, are identical except for the type of dowel used.

Table 5. Supplemental sections constructed for the Delaware SPS-2 experiment.

SHRP ID	Lane width, ft	Compressive strength, psi	DGAB thickness, in	PCC thickness, in	Dowel type
100259	12	3000	8	10	steel
100260	12	3000	8	10	plastic

North Dakota

North Dakota constructed six supplemental sections for the SPS-2 experiment. This included one control section, constructed to the standard methods of practice for NDOT (380259) and five additional experimental sections. These sections investigated several factors: the inclusion of dowels (only 380260 was doweled), the use of skewed joints at varying lengths (380261, 380262, and 380263 are all spaced with variable joint spacing alternating on the same pattern of 12, 15, 13, and 14 ft) and finally, base type was also varied across sections. The details of all supplemental sections constructed in North Dakota are given in Table 6 below.

Table 6. Supplemental sections constructed for the North Dakota SPS-2 experiment.

SHRP ID	PCC Pavement Thickness (in)	Joint orientation	Strength	PCC Pavement width, ft	Base Type	Dowels	Joint spacing
380260	11	Skewed	***	38	DGAB	Yes	15 ft
380261	11	Skewed	550	24	DGAB	No	Variable**
380262	11	Skewed	550	28	LCB	No	Variable**
380263	11	Skewed	550	24	PASB	No	Variable**
380264	11	Skewed	***	38	PASB	No	15 ft
380259*	10	Skewed	***	24	8” Salve	Yes	15 ft

* indicates state control section which used the standard state mix design

** “variable” indicates joint spacing varying from 12, 15, 13, and 14 ft

*** considered Class AE concrete as per NDDOT specifications

Ohio

The Ohio supplemental sections were constructed to test several factors including base type and thickness, AB thickness, and the mix design as shown in Table 7 below. Two different base types were compared: permeable asphalt treated base (PATB) and cement treated free draining base (CTFDB). Sections 390259, 390263, and 390264 were not constructed on an unbound aggregate base, but constructed on 6 inches of asphalt base, while sections 390260 and 390265 were both constructed on PATB and sections 390261 and 390262 were constructed on CTFDB. The PCC thickness was held constant across all supplemental sections. The supplemental sections were alternated between low and high strength mix designs. Details of the construction of the Ohio supplemental sections are given in Table 7 below while details of the two mix designs used are given in Table 8.

Table 7. Supplemental sections constructed for the Ohio SPS-2 experiment.

SHRP ID	PCC thickness	AB, in	Base type	Base thickness, in	Mix design
390259	11	6		0	A
390260	11	4	PATB	4	B
390261	11	4	CTFDB	4	A
390262	11	4	CTFDB	4	B
390263	11	6		0	A
390264	11	6		0	B
390265	11	4	PATB	4	A

Table 8. Mix design detail for supplemental sections constructed for the Ohio SPS-2 experiment.

	Mix design, lbs/CY	
	Mix A	Mix B
Coarse Aggregate	1680	1850
Fine Aggregate	1260	950
Cement	510	750
Water	240	270
Fly Ash	90	113
Air entrainer	7.2-9.6 oz	8-12.7 oz
Water reducer	18 oz	26.3-36.8 oz

Wisconsin

Wisconsin constructed eight supplemental sections, including two identical control sections of 550259 and 550260. Several factors were varied across the other test sections including lane width, subbase thickness, rock base thickness, embankment fill thickness, and PCC strength. The details of the differentiation between all test sections is given in Table 9 below.

Table 9. Supplemental sections constructed for the Wisconsin SPS-2 experiment.

SHRP ID	Lane width, ft	Subbase thick., in	Rock base thick., in	Embankment fill thick., in	DGAB thick., in	CSOGB thick., in	PCC thick., in	PCC strength, psi
550259*	14			24	6		11	550
550260*	14			24	6		11	550
550261	12			24	4	4	8	550
550262	12	10	3		6		8	900
550263	14			24	6		10	550
550264	14			24	6		11	550
550265	14	10			6	4	11	550
550266	14			24	6		11	

(*) indicates control section

States with control sections only

Seven additional states constructed only a “control” section in addition to the core experiment, rather than a series of supplemental sections. These control sections were constructed in accordance

with each state's specific pavement construction requirements. Certain aspects of the construction varied across the control sections and pertinent construction and material details as given by each agency are compiled in Table 10 below.

Table 10. Control sections constructed by state.

SHRP	State	Lane width, ft	PCC thickness, in	Base type	Base thickness, in	PCC Strength, psi	Notes
080259	CO	12	11	None	0	650	
190259	IA	14	11	Granular base	6		
200259	KS	12	12	Stabilized base/modified fly ash	6	600	
260259	MI	12	11	Granular base, treated base	4, 4	550	Has tied concrete shoulders and neoprene transverse joints and hot poured rubberized sealant longitudinal joints
32059	NV		11	Treated base	1.5		
370259	NC	12	10	Permeable Asphalt Treated Base	5		
530259	WA	14	10	ATB/crushed surfacing base course (CSBC)	3, ATB 2, CSBC	650	

CURRENT DATA AVAILABILITY

The availability of specific test data was evaluated as part of Tasks 1 and 2, in the original project description. The existing data was evaluated to discern which sites remained in service and have been compiled and presented in Table 11. The shaded cells indicate sites that have been removed from study. No sites from the SPS-2 experiment were reassigned to a different experiment; therefore, sites removed from study indicate that data is no longer being actively collected. Table 11 presents the updated original experiment matrix indicating which sites remain in study of the core experimental sections.

Table 11. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections.

Pavement Structure					Climatic Conditions and Subgrade							
					Wet							
					Freeze						No Freeze	
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Fine			Coarse			Fine	Coarse
					OH	IA	MI	DE	AR	WI	NC	
No	DGAB	8	550	12	390201			100201			370201	
				14		190213	260213		050213	550213		
			900	12		190214	260214		050214	550214		
				14	390202			100202			370202	
		11	550	12		190215	260215		050215	550215		
				14	390203			100203			370203	
			900	12	390204			100204			370204	
				14		190216	260216		050216	550216		
No	LCB	8	550	12	390205			100205			370205	
				14		190217	260217		050217	550217		
			900	12		190218	260218		050218	550218		
				14	390206			100206			370206	
		11	550	12		190219	260219		050219	550219		
				14	390207			100207			370207	
			900	12	390208			100208			370208	
				14		190220	260220		050220	550220		
Yes	PATB	8	550	12	390209			100209			370209	
				14		190221	260221		050221	550221		
			900	12		190222	260222		050222	550222		
				14	390210			100210			370210	
		11	550	12		190223	260223		050223	550223		
				14	390211			100211			370211	
			900	12	390212			100212			370212	
				14		190224	260224		050224	550224		

Table 11. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections (continued)

Pavement Structure					Climatic Conditions and Subgrade							
					Dry							
					Freeze					No Freeze		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Fine				Coarse	Fine	Coarse	
					KS	WA	ND	CO	NV		CA	AZ
No	DGAB	8	550	12	200201	530201			320201		060201	
				14			380213	080213				040213
			900	12			380214	080214				040214
				14	200202	530202			320202		060202	
		11	550	12			380215	080215				040215
				14	200203	530203			320203		060203	
			900	12	200204	530204			320204		060204	
				14			380216	080216				040216
No	LCB	8	550	12	200205	530205			320205		060205	
				14			380217	080217				040217
			900	12			380218	080218				040218
				14	200206	530206			320206		060206	
		11	550	12			380219	080219				040219
				14	200207	530207			320207		060207	
			900	12	200208	530208			320208		060208	
				14			380220	080220				040220
Yes	PATB	8	550	12	200209	530209			320209		060209	
				14			380221	080221				040221
			900	12			380222	080222*				040222
				14	200210	530210			320210		060210	
		11	550	12			380223	080223				040223
				14	200211	530211			320211		060211	
			900	12	200212	530212			320212		060212	
				14			380224	080224				040224

It can be seen from Table 11 that of the original fourteen states participating in the SPS-2 study, each with twelve test sections, eight remain completely intact (Arizona, California, Delaware, Iowa, Kansas, North Dakota, Washington, and Wisconsin) with all twelve original sections still in study. Two of the original fourteen sites (Arkansas and Colorado) have only one out of the original twelve test sections removed from study resulting in eleven monitored test sections. Two of the original fourteen sites (North Carolina and Ohio) have half of the original test sections removed from study resulting in six test sections remaining in study in each state. Finally, all test sections from two of the original fourteen sites (Michigan and Nevada) have been removed from study.

The supplemental sections were also evaluated for current status. Table 12 below is a listing of the state and SHRP ID only with shaded cells indicating sites that are no longer in study. Please reference the previous section's discussion for the specific details regarding experiment design considerations for the supplemental sections.

Table 12. Summary of current status of SPS-2 experiment supplemental sections.

State	SHRP ID
Arizona	040260
	040261
	040262
	040263
	040264
	040265
	040266
	040267
	040268
Colorado	080259
Delaware	100259
	100260
Iowa	190259
Kansas	200259
Michigan	260259
Nevada	320259
North Carolina	370259
North Dakota	380259
	380260
	380261
	380262
	380263
	380264
Ohio	390259
	390260
	390261
	390262
	390263
	390264
	390265
Washington	530259
Wisconsin	550259
	550260
	550261
	550262
	550263
	550264
	550265
	550266

It can be seen that most of the state supplemental sections remain in study. Only four of the forty total constructed supplemental sections have been removed from study since construction. This

provides ample possible testing sections; however, the widely varying design and construction parameters as discussed in the previous section makes the inclusion of these sections in the proposed study challenging with regards to providing appropriate means of comparison.

PREVENTIVE MAINTENANCE METHODS

Methods of pavement preservation are of utmost importance to highway agencies in order to extend the effective life of constructed pavement for economic, sustainability, and logistical reasons. Previously, the LTPP SPS-4 experiment, Preventive Maintenance Effectiveness of Rigid Pavements, was designed to address this concern, albeit more than 20 years ago. Preventive maintenance strategies, technologies, and materials have advanced greatly since then indicating a need for a more robust and updated research approach. Increasingly, the implementation of pavement preservation and maintenance has shifted from addressing existing distresses to a proactive, preventive approach. The terms preservation, rehabilitation, and preventative maintenance are best illustrated visually in Figure 1 below, reproduced from Smith et al (2014).

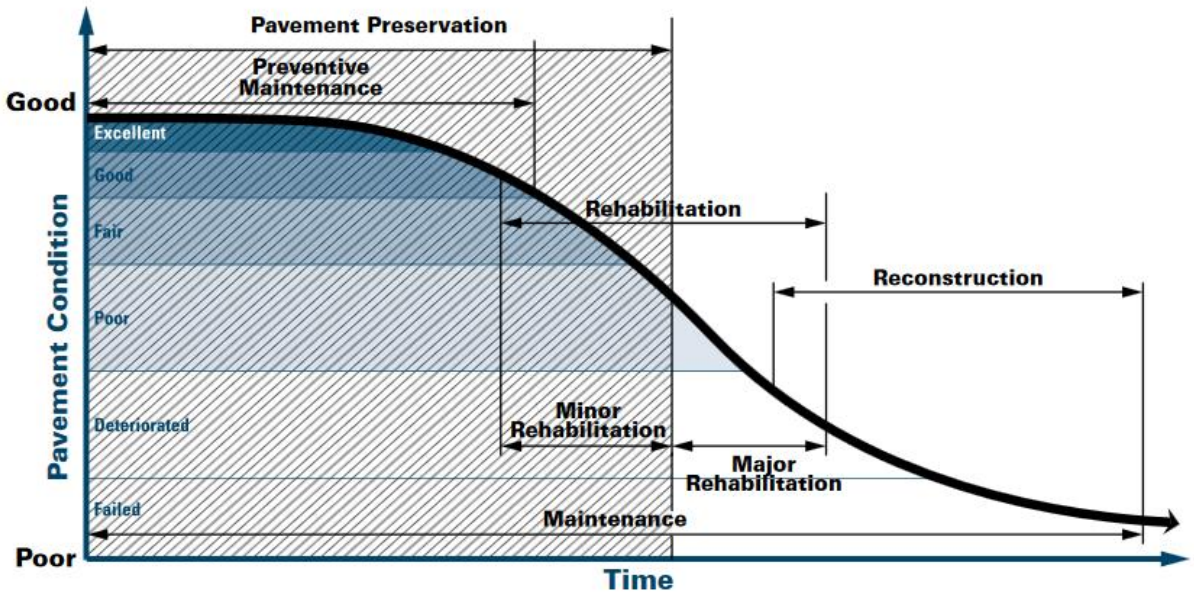

Figure 1. Visual representation of pavement preservation, maintenance, and reconstruction. Reproduced from Figure 2.1 of Smith et al (2014).

By compiling agency input as well as considering the experimental feasibility of some techniques, the following pavement preservation techniques for rigid pavements were selected to be included in the study.

- Partial depth patching (including spall repair)
- Dowel bar retrofit
- Joint sealing
- Diamond grinding

Partial depth repairs are a pavement preservation technique that involve removing and replacing areas of the pavement between ½ and 1/3 the full depth of the pavement slab. This can be an extremely effective method of repair for myriad distresses and are roughly divided into three categories based on the targeted areas of distress: joint repairs, non-joint repairs, and bottom half repairs. Joint repairs include removing the top portion of the joint and are ideally used for spalled joints or otherwise damaged joints. Repairs that occur away from the joint can also be due to spalling or cracking. Finally, bottom-half repairs are most commonly used for corner breaks or other corner-concentrated deterioration. For any of these repairs, the type of repair material used is extremely important to the effectiveness of this repair type and therefore a high quality concrete is often used (Smith et al 2014).

Dowel bar retrofits involve inserting dowel bars into existing joints to increase the load transfer efficiency across slabs. Since all sections in the core experiment contain dowel bars, this would only be effective to compare performance between undoweled supplemental sections and doweled sections. While aggregate interlock can provide some level of load transfer across joints, as joints age and widen, the effectiveness of aggregate interlock decreases which can merit the use of a dowel bar retrofit. Ultimately, improving the load transfer efficiency across joints can reduce the occurrence of pumping, faulting, and corner breaks.

Joint sealing is arguably the most truly preventive of all the maintenance options and includes removing the existing joint seal and replacing it. This prevents distresses related to the infiltration of incompressible materials, which can lead to joint or crack deterioration. The sealing does require maintenance, however, as the joint or crack can widen with age, which can stretch the joint filling material more than the crack width.

Diamond grinding is a technique utilizing diamond saw blades to remove a predetermined amount of surface to improve surface texture and smoothness. Grinding is used to reduce faulting, rutting, built in slab curl or warp, and to improve texture on polished aggregate surfaces.

Each of these potential repairs can treat one or several distresses as shown in Table 13 below, reproduced from Hall et al (2001) which details the types of distresses that can be addressed from each of these rehabilitation and maintenance treatments.

Table 13. Concrete pavement distresses addressed by rehabilitation and maintenance techniques.

Concrete pavement distresses	Concrete pavement rehabilitation techniques								
	Full depth repair/slab replacement	Partial depth repair	Slab jacking	Dowel bar retrofit	Joint resealing	Diamond grinding	Grooving	Pressure relief joints	Crack sealing
Corner break	×								
Linear cracking	×								×
Punchout	×								
Durability cracking	×								
Alkali-aggregate reaction	×							×	
Map cracking, crazing, scaling		×							
Joint seal damage					×				
Joint spalling	×	×							
Blowup	×								
Pumping			×	×					
Faulting				×		×			
Bumps, settlements, heaves	×					×			
Polishing						×	×		

DATA LIMITATIONS

The available data (including both in service and out of service test sections) present some challenges for conducting an experiment that can account for different methods of pavement preservation in a similarly robust and controlled manner to the originally designed half-factorial experiment. There are several limitations of what experiments could be conducted using the existing SPS-2 experimental sections as well as several variations that must be considered before further analysis is completed. These limitations primarily include variability across the different test sites and within in the maintenance and rehabilitation history that each section has received. These sources of variability will be discussed in the following section as well as the potential effect of these variabilities on the interpretation of proposed data, based on the selected maintenance treatments of interest.

Intra-test site variation

During the initial design of the SPS-2 experiment, traffic was not considered as a variable to be controlled or included in the experimental design or matrix. Therefore, the anticipated traffic levels at each test site varied and were not further categorized into levels based on volume. The only site requirement for acceptance into the SPS-2 experiment was that the sections receive at least 200 kESALs annually. Over the approximate 20 years of service of the projects thus far, the traffic volumes have varied widely across the sections. Despite designing the experiment as a coupled experiment, this produces a level of difficulty when pairing the test sites and attempting to draw comparisons directly across test sections. Traffic loading as kESALs was averaged on an annual basis and presented in Table 14 below. It can be seen that traffic loading varies from as low as 248 kESALs in Delaware to as high as 3584 kESALs in Arkansas. This indicates that limiting future experiments to being within test sites may allow for drawing more valid conclusions regarding preservation treatment effectiveness.

Table 14. Comparison of average traffic loading, in kESALs, of SPS-2 test sections.

Climatic Conditions		Subgrade	State Code	State	kESALs per year
Wet	Freeze	Fine	39	Ohio	617
			19	Iowa	572
			26	Michigan	1924
		Coarse	10	Delaware	248
			5	Arkansas	3584
			55	Wisconsin	275
	No Freeze	Fine	37	North Carolina	764
		Coarse			
Dry	Freeze	Fine	20	Kansas	719
			53	Washington	425
			8	Colorado	383
			38	North Dakota	476
		Coarse	32	Nevada	739
	No Freeze	Fine			
		Coarse	6	California	1961
			4	Arizona	1713

Additionally, though without as much variance, the current age of the test sections varies by test site. Table 15 below shows the age in years for the SPS-2 test sections remaining in study. The age varies between 17 years (in California) and 24 years (in Kansas and Delaware) across all test sites.

Table 15. Comparison of age, in years, of SPS-2 test sections.

Climatic Conditions		Subgrade	State Code	State	Age, years
Wet	Freeze	Fine	39	Ohio	22
			19	Idaho	22
			26	Michigan	23
		Coarse	10	Delaware	24
			5	Arkansas	22
			55	Wisconsin	19
	No Freeze	Fine	37	North Carolina	23
		Coarse			
Dry	Freeze	Fine	20	Kansas	24
			53	Washington	23
			8	Colorado	23
			38	North Dakota	21
		Coarse	32	Nevada	23
	No Freeze	Fine			
		Coarse	6	California	17
			4	Arizona	23

It should be noted that while the variation in age and traffic levels can be easily quantified and presented, the variation of potentially more subtle differences must also be considered, such as the exact behavior and composition of the subgrade. Despite the organization of the initial experimental matrix, the real possibility exists that a fine subgrade soil in Washington State could behave very differently than a fine subgrade soil in North Dakota, despite both being categorized by the experimental design as Dry-Freeze climates with fine subgrade soil. This becomes especially important when considering possible pavement preservation techniques given the susceptibility of soils to infiltrate cracks and joints, as well as soil susceptibility to freeze/thaw swelling can greatly impact the performance of certain maintenance activities.

Maintenance history variation

Potentially most limiting, many test sections have received different maintenance and rehabilitation treatments at different intervals during their lifetimes. In accordance with LTPP procedures, the activities were administered as deemed necessary by the SHA and were documented with as much detail as given by the supporting agencies. Sites remained in study unless completely overlaid or changed in a similarly fundamental capacity, and therefore, sections remaining in study have received different amounts and types of maintenance treatments at varying timing intervals. The level that previous maintenance and rehabilitation activities complicate upcoming experiments is highly dependent on the amount, timing, and variation of maintenance treatments across each of the test sections. From this information, there are several courses of action that could be taken in order to account for this variability, such as including only sections that have not received any maintenance treatments during their lifetimes, or ensuring that sections were comparably maintained (for example, a single maintenance treatment such as diamond grinding that affected all test sections equally in a single site). Additionally, preservation behaviors that are deemed extremely intrusive, such as full depth repairs, could be excluded from study.

In order to determine the extent of historical maintenance and rehabilitation treatments and their possible effect on the proposed experiment, historical maintenance and rehabilitation records were analyzed and a complete set of tables outlining the maintenance procedure and the age of the pavement during that treatment for the core experiment sections in years are given in Appendix A. These tables list the type of maintenance or rehabilitation treatments completed on each test section within a site and the age (relative to the initial pavement construction in years) of each test section during the application of that rehabilitation treatment.

This data could additionally be used as previously described to evaluate previous maintenance treatments and eliminate sections receiving treatments deemed limiting, such as full depth repairs. However, this wealth of previous maintenance treatment data could also be used in conjunction with the current experiment to provide either more data to validate experimental observations with or to provide a means of estimating and establishing performance curves based on MEPDG prediction models.

To evaluate the present condition of the sites, the maintenance treatments were divided in terms of intrusiveness to be organized into Table 16 below. This table lists sites still in study and how many of those have or have not received any maintenance treatments. Sections are then further subdivided based on maintenance activities such that any sections receiving full depth patching, partial depth patching, or slab replacement were only counted for those maintenance actions. For example, a slab receiving both grinding and slab stabilization would be counted only under slab stabilization as that was considered the most limiting previous maintenance activity.

Table 16. Previous maintenance activities on test sections still in study.

State	In study	Number of test sections still in study receiving this type of maintenance								
		None	Only joint or crack sealing	Only grinding	Grinding and sealing	Partial depth patching	Only skin patching	Full depth patching	Slab replacement	Only pothole patching
AZ	12	8				4				
AR	0		8			3				
CA	12	0	9		1	2				
CO	11	6				5				
DE	12	2		1		4	1	3	1	
IA	12	5	1			4	1		1	
KS	12	0	3					7	2	
MI	0									
NV	0									
NC	6	6								
ND	12				5	6			1	
OH	6	2		1					3	
WA	12	12								
WI	12	11								1

Effect of limitations on pavement preservation techniques

These previously discussed limitations can potentially affect the direction of future analysis of SPS-2 data. The section-level variation, specifically traffic and age differences, will more greatly affect how the sections could be compared between test sections. A large difference in traffic will obviously affect any sections paired across project boundaries, such that a fair comparison may not be made. It can be seen from Table 14 that some pairings across the original half-factorial experiment are still close; for example, California and Arizona retain comparable levels of traffic (1961 and 1713 kESALs, respectively) and could be paired for a full experiment matrix. However, extrapolating results should be exercised with caution when comparing data from, for example, Michigan (1924 kESALs) with Iowa (572 kESALs) or Wisconsin (275 kESALs) with Arkansas (3584 kESALs)

Similarly, the variation in previous maintenance events can also affect the future data analysis in several ways. First, previous maintenance treatments, especially inconsistent treatments, could cause different pavement conditions between the compared sections; thus not allowing for controlled comparisons to be made. Additionally, some maintenance treatments, such as crack sealing or joint spalling repairs, will be contingent on existing distresses. Therefore, the pre-existing maintenance treatments could affect the design of the experiment, such that specific planned maintenance treatments could only exist on sections with prescribed distresses.

However, an assumption could be made that any maintenance treatments, especially limiting, aggressive treatments, were completed only to bring the condition of the entire roadway within a passable range, and therefore maintenance such as full depth repairs or slab stabilization was only completed on sections as deemed completely necessary and would create a standard road condition for the entire current existing pavement.

The previous maintenance data, which includes the extent of the maintenance activity and time, despite creating a potential discrepancy for future experimental design, does create the opportunity of a wealth of existing data that can be used for MEPDG calibration for section performance following specific maintenance treatments. This could then be used to evaluate the future performance as measured in this proposed experiment and will be discussed in more detail later.

RECOMMENDED EXPERIMENTS

Pairing options

Pairing sections for analysis is required for testing a preventive maintenance measure directly against a comparable section that is not improved as a control section. This will allow for further experimental design of more robust experiments. Four options for choosing paired sections across test sites will now be discussed.

Pairing option 1: Selecting exact experiment pairs based on experimental design

This pairing option assumes that the lane width has a negligible effect on experiment components. Logically, the lane width would only reasonably affect the performance of a dowel bar retrofit and should not affect the performance of spall repairs, partial depth repairs, or diamond grinding. Note that in Table 17 below, states with no sections left in study were completely removed for clarity and states that did not have an appropriate pair could not be included. Pairing these sections across projects does ignore the aforementioned potential variation, such as traffic levels. Sections that have been paired are outlined in bold. This method of pairing would provide 53 experimental pairs.

Table 17. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	OH	IA	DE	WI	NC
No	DGAB	8	550	12	390201		100201		370201
				14		190213		550213	
			900	12		190214		550214	
				14	390202		100202		370202
		11	550	12		190215		550215	
				14	390203		100203		370203
			900	12	390204		100204		370204
				14		190216		550216	
No	LCB	8	550	12	390205		100205		370205
				14		190217		550217	
			900	12		190218		550218	
				14	390206		100206		370206
		11	550	12		190219		550219	
				14	390207		100207		370207
			900	12	390208		100208		370208
				14		190220		550220	
Yes	PATB	8	550	12	390209		100209		370209
				14		190221		550221	
			900	12		190222		550222	
				14	390210		100210		370210
		11	550	12		190223		550223	
				14	390211		100211		370211
			900	12	390212		100212		370212
				14		190224		550224	

Table17. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections (continued)

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
No	DGAB	8	550	12	200201		530201		060201	
				14		080213		380213		040213
			900	12		080214		380214		040214
				14	200202		530202		060202	
		11	550	12		080215		380215		040215
				14	200203		530203		060203	
			900	12	200204		530204		060204	
				14		080216		380216		040216
No	LCB	8	550	12	200205		530205		060205	
				14		080217		380217		040217
			900	12		080218		380218		040218
				14	200206		530206		060206	
		11	550	12		080219		380219		040219
				14	200207		530207		060207	
			900	12	200208		530208		060208	
				14		080220		380220		040220
Yes	PATB	8	550	12	200209		530209		060209	
				14		080221		380221		040221
			900	12		080222*		380222		040222
				14	200210		530210		060210	
		11	550	12		080223		380223		040223
				14	200211		530211		060211	
			900	12	200212		530212		060212	
				14		080224		380224		040224

Pairing option 2: Site specific ignoring base layer effects

The second pairing option identifies pairs within projects rather than across projects due to the aforementioned potential differences between traffic level, age and any other differences between sites. Because these experiments are no longer paired across sites to complete the full factorial experimental matrix, several assumptions must be made. These include:

- Unlike PCC thickness and PCC strength, the type of base layer used would not greatly affect the performance of preventive maintenance.
- The types of base layer that provide no drainage, the dense graded aggregate base and the lean concrete base were deemed sufficiently comparable to pair sites within a test section across these different base types.
- The permeable asphalt treated base, which provided drainage, was deemed sufficiently different to not be included in the pairing across base types.

The inclusion of drainage could potentially affect the type of distress or reaction to maintenance treatments and therefore should not be included in the pairings. This could be especially true for distress mechanisms which can be aggravated by inadequate subsurface drainage, such as pumping, or for increasing the level of potentially damaging incompressible materials which could infiltrate cracks or joints.

Pairs are indicated with a bold outline in Table 18. This method of pairing provides 40 experimental pairs.

Table 18. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	PCC Thickness, in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	WI	NC
No	8	550	DGAB	12	390201		100201		370201
				14		190213		550213	
			LCB	12	390205		100205		370205
				14		190217		550217	
		900	DGAB	12		190214		550214	
				14	390202		100202		370202
			LCB	12		190218		550218	
				14	390206		100206		370206
	11	550	DGAB	12		190215		550215	
				14	390203		100203		370203
			LCB	12		190219		550219	
				14	390207		100207		370207
		900	DGAB	12	390204		100204		370204
				14		190216		550216	
			LCB	12	390208		100208		370208
				14		190220		550220	
Yes	8	550	PATB	12	390209		100209		370209
				14		190221		550221	
		900		12		190222		550222	
				14	390210		100210		370210
	11	550		12		190223		550223	
				14	390211		100211		370211
		900		12	390212		100212		370212
				14		190224		550224	

Table 18. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections (continued)

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	PCC Thickness, in	Flexural strength, 14-d (psi)	Base Type	Lane width	KS	ND	WA	CO	CA	AZ
No	8	550	DGAB	12	200201		530201		060201	
				14		080213		380213		040213
			LCB	12	200205		530205		060205	
				14		080217		380217		040217
		900	DGAB	12		080214		380214		040214
				14	200202		530202		060202	
			LCB	12		080218		380218		040218
				14	200206		530206		060206	
	11	550	DGAB	12		080215		380215		040215
				14	200203		530203		060203	
			LCB	12		080219		380219		040219
				14	200207		530207		060207	
		900	DGAB	12	200204		530204		060204	
				14		080216		380216		040216
			LCB	12	200208		530208		060208	
				14		080220		380220		040220
Yes	8	550	PATB	12	200209		530209		060209	
				14		080221		380221		040221
		900	PATB	12		080222*		380222		040222
				14	200210		530210		060210	
	11	550	PATB	12		080223		380223		040223
				14	200211		530211		060211	
		900	PATB	12	200212		530212		060212	
				14		080224		380224		040224

Pairing option 3: Selecting exact experiment pairs based on experimental design and discounting sections with limiting previous maintenance activity

Similar to the first pairing option, this method assumes that the lane width has a negligible effect on experiment components and, therefore, pairs were selected across projects. Again, it was assumed that the lane width would only reasonably affect the performance of a dowel bar retrofit and should not affect the performance of spall repairs, partial depth repairs, or diamond grinding. Note that in Table 19 below, states with no sections left in study were completely removed for clarity and states that did not have an appropriate pair could not be included. Additionally, this pairing option did not include any sections that received what was considered limiting previous maintenance activity. This included full depth repairs and slab stabilization, which were deemed to have changed the original sections too much for adequate data collection. Sections that have received these limiting maintenance activities are highlighted in gray and again, sections removed from study are highlighted in orange, in Table 19 below and are excluded from the paired sampling. Pairing these sections across projects does ignore the aforementioned potential variation, such as traffic levels. Sections that have been paired are outlined in bold. This method of pairing would provide 40 experimental pairs.

Table 19. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	OH	IA	DE	WI	NC
No	DGAB	8	550	12	390201		100201		370201
				14		190213		550213	
			900	12		190214		550214	
				14	390202		100202		370202
		11	550	12		190215		550215	
				14	390203		100203		370203
			900	12	390204		100204		370204
				14		190216		550216	
No	LCB	8	550	12	390205		100205		370205
				14		190217		550217	
			900	12		190218		550218	
				14	390206		100206		370206
		11	550	12		190219		550219	
				14	390207		100207		370207
			900	12	390208		100208		370208
				14		190220		550220	
Yes	PATB	8	550	12	390209		100209		370209
				14		190221		550221	
			900	12		190222		550222	
				14	390210		100210		370210
		11	550	12		190223		550223	
				14	390211		100211		370211
			900	12	390212		100212		370212
				14		190224		550224	

Table 19. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections (continued)

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
No	DGAB	8	550	12	200201		530201		060201	
				14		080213		380213		040213
			900	12		080214		380214		040214
				14	200202		530202		060202	
		11	550	12		080215		380215		040215
				14	200203		530203		060203	
			900	12	200204		530204		060204	
				14		080216		380216		040216
No	LCB	8	550	12	200205		530205		060205	
				14		080217		380217		040217
			900	12		080218		380218		040218
				14	200206		530206		060206	
		11	550	12		080219		380219		040219
				14	200207		530207		060207	
			900	12	200208		530208		060208	
				14		080220		380220		040220
Yes	PATB	8	550	12	200209		530209		060209	
				14		080221		380221		040221
			900	12		080222*		380222		040222
				14	200210		530210		060210	
		11	550	12		080223		380223		040223
				14	200211		530211		060211	
			900	12	200212		530212		060212	
				14		080224		380224		040224

Pairing option 4: Site specific ignoring base layer effects and discounting sections with limiting previous maintenance activity

Similar to pairing option 2, pairs were matched within test sites rather than across sites due to the aforementioned potential differences between traffic level and age and any potentially unquantifiable differences between sites. Because these experiments are no longer paired, several assumptions must be made. These include:

- Unlike PCC thickness and PCC strength, the type of base layer used would not greatly affect the performance of preventive maintenance.
- The types of base layer that provide no drainage, the dense graded aggregate base and the lean concrete base were deemed sufficiently comparable to pair sites within a test section across these different base types.
- The permeable asphalt treated base, which provided drainage, was deemed sufficiently different to not be included in the pairing across base types.

The inclusion of drainage could potentially affect the type of distress or reaction to maintenance treatments and therefore should not be included in the pairings.

Additionally, this pairing option did not include any sections that received what was considered to be limiting previous maintenance activity. This included full depth repairs and slab stabilization which were deemed to have changed the original sections too much for adequate data collection. Sections that have received these limiting maintenance activities are highlighted in gray in Table 20 below and are excluded from the paired sampling. Sections that have been paired are outlined in bold. This method of pairing is considered the most conservative and produced 18 experimental pairs.

Table 20. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	PCC Thickness, in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	WI	NC
No	8	550	DGAB	12	390201		100201		370201
				14		190213		550213	
			LCB	12	390205		100205		370205
				14		190217		550217	
		900	DGAB	12		190214		550214	
				14	390202		100202		370202
			LCB	12		190218		550218	
				14	390206		100206		370206
	11	550	DGAB	12		190215		550215	
				14	390203		100203		370203
			LCB	12		190219		550219	
				14	390207		100207		370207
		900	DGAB	12	390204		100204		370204
				14		190216		550216	
			LCB	12	390208		100208		370208
				14		190220		550220	
Yes	8	550	PATB	12	390209		100209		370209
				14		190221		550221	
		900		12		190222		550222	
				14	390210		100210		370210
	11	550		12		190223		550223	
				14	390211		100211		370211
		900		12	390212		100212		370212
				14		190224		550224	

Table20. Summary table of status of current SPS-2 test sections and experiment design for core experiment sections (continued)

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	PCC Thickness, in	Flexural strength, 14-d (psi)	Base Type	Lane width	Dry					
					Freeze				No Freeze	
					Fine				Coarse	
					KS	ND	WA	CO	CA	AZ
No	8	550	DGAB	12	200201		530201		060201	
				14		080213		380213		040213
			LCB	12	200205		530205		060205	
				14		080217		380217		040217
		900	DGAB	12		080214		380214		040214
				14	200202		530202		060202	
			LCB	12		080218		380218		040218
				14	200206		530206		060206	
	11	550	DGAB	12		080215		380215		040215
				14	200203		530203		060203	
			LCB	12		080219		380219		040219
				14	200207		530207		060207	
		900	DGAB	12	200204		530204		060204	
				14		080216		380216		040216
			LCB	12	200208		530208		060208	
				14		080220		380220		040220
Yes	8	550	PATB	12	200209		530209		060209	
				14		080221		380221		040221
		900	PATB	12		080222*		380222		040222
				14	200210		530210		060210	
	11	550	PATB	12		080223		380223		040223
				14	200211		530211		060211	
		900	PATB	12	200212		530212		060212	
				14		080224		380224		040224

Experiment options for the core experiment sections

As previously discussed, several popular preventive maintenance options were selected to be included for further experimentation as follows:

- Partial depth patching (including spall repair)
- Joint sealing and/or crack sealing
- Diamond grinding
- Dowel bar retrofit

An experiment suggested for dowel bar retrofit using only the supplemental sections will be discussed in more detail later; however, the remaining four maintenance options can be used for an experiment utilizing the existing core sections. However, crack sealing, spall repair, and partial depth patching (also used for spall repair) require that specific distresses exist on the sections which will be assigned those specific methods of rehabilitation. Joint sealing and diamond grinding could be used on any section as a means of general preventive maintenance.

Only crack sealing and spall repair were distress-specific maintenance techniques and diamond grinding and joint sealing could be completed for any section, regardless of current distress. Table 21 below presents the results of the most recent distress survey that varied by site but was conducted in either 2014 or 2015. A complete list of the distresses exhibited by each core section is also given in Appendix B. The purple-shaded squares indicate sites in study that have noted spalling in the most recent distress survey and would therefore be candidates for spall repairs. In Table 22, the purple shaded squares indicate sites in study that have noted either transverse or longitudinal cracking and would therefore be candidates for crack sealing. As mentioned previously, diamond grinding and joint sealing could be compared on any other section. In both tables, cells shaded in orange indicate sections that are no longer in the study.

Table 21. Summary table of current SPS-2 test sections and experiment design for core experiment sections with spalling

Pavement Structure					Climatic Conditions and Subgrade							
					Wet							
					Freeze						No Freeze	
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Fine			Coarse			Fine	Coarse
					OH	IA	MI	DE	AR	WI	NC	
No	DGAB	8	550	12	390201			100201			370201	
				14		190213	260213		050213	550213		
			900	12		190214	260214		050214	550214		
				14	390202			100202			370202	
		11	550	12		190215	260215		050215	550215		
				14	390203			100203			370203	
			900	12	390204			100204			370204	
				14		190216	260216		050216	550216		
No	LCB	8	550	12	390205			100205			370205	
				14		190217	260217		050217	550217		
			900	12		190218	260218		050218	550218		
				14	390206			100206			370206	
		11	550	12		190219	260219		050219	550219		
				14	390207			100207			370207	
			900	12	390208			100208			370208	
				14		190220	260220		050220	550220		
Yes	PATB	8	550	12	390209			100209			370209	
				14		190221	260221		050221	550221		
			900	12		190222	260222		050222	550222		
				14	390210			100210			370210	
		11	550	12		190223	260223		050223	550223		
				14	390211			100211			370211	
			900	12	390212			100212			370212	
				14		190224	260224		050224	550224		

Table21. Summary table of current SPS-2 test sections and experiment design for core experiment sections with spalling (continued)

Pavement Structure					Climatic Conditions and Subgrade							
					Dry							
					Freeze					No Freeze		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Fine				Coarse	Fine	Coarse	
					KS	WA	CO	ND	NV		CA	AZ
No	DGAB	8	550	12	200201	530201			320201		060201	
				14			380213	080213				040213
			900	12			380214	080214				040214
				14	200202	530202			320202		060202	
		11	550	12			380215	080215				040215
				14	200203	530203			320203		060203	
			900	12	200204	530204			320204		060204	
				14			380216	080216				040216
No	LCB	8	550	12	200205	530205			320205		060205	
				14			380217	080217				040217
			900	12			380218	080218				040218
				14	200206	530206			320206		060206	
		11	550	12			380219	080219				040219
				14	200207	530207			320207		060207	
			900	12	200208	530208			320208		060208	
				14			380220	080220				040220
Yes	PATB	8	550	12	200209	530209			320209		060209	
				14			380221	080221				040221
			900	12			380222	080222*				040222
				14	200210	530210			320210		060210	
		11	550	12			380223	080223				040223
				14	200211	530211			320211		060211	
			900	12	200212	530212			320212		060212	
				14			380224	080224				040224

Table 22. Summary table of current SPS-2 test sections and experiment design for core experiment sections with cracking

Pavement Structure					Climatic Conditions and Subgrade							
					Wet							
					Freeze						No Freeze	
					Fine			Coarse			Fine	Coarse
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	OH	IA	MI	DE	AR	WI	NC	
No	DGAB	8	550	12	390201			100201			370201	
				14		190213	260213		050213	550213		
			900	12		190214	260214		050214	550214		
				14	390202			100202			370202	
		11	550	12		190215	260215		050215	550215		
				14	390203			100203			370203	
			900	12	390204			100204			370204	
				14		190216	260216		050216	550216		
No	LCB	8	550	12	390205			100205			370205	
				14		190217	260217		050217	550217		
			900	12		190218	260218		050218	550218		
				14	390206			100206			370206	
		11	550	12		190219	260219		050219	550219		
				14	390207			100207			370207	
			900	12	390208			100208			370208	
				14		190220	260220		050220	550220		
Yes	PATB	8	550	12	390209			100209			370209	
				14		190221	260221		050221	550221		
			900	12		190222	260222		050222	550222		
				14	390210			100210			370210	
		11	550	12		190223	260223		050223	550223		
				14	390211			100211			370211	
			900	12	390212			100212			370212	
				14		190224	260224		050224	550224		

Table 22. Summary table of current SPS-2 test sections and experiment design for core experiment sections with cracking (continued)

Pavement Structure					Climatic Conditions and Subgrade							
					Dry							
					Freeze					No Freeze		
					Fine				Coarse	Fine	Coarse	
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	KS	WA	CO	ND	NV		CA	AZ
No	DGAB	8	550	12	200201	530201			320201		060201	
				14			380213	080213				040213
			900	12			380214	080214				040214
				14	200202	530202			320202		060202	
		11	550	12			380215	080215				040215
				14	200203	530203			320203		060203	
			900	12	200204	530204			320204		060204	
				14			380216	080216				040216
No	LCB	8	550	12	200205	530205			320205		060205	
				14			380217	080217				040217
			900	12			380218	080218				040218
				14	200206	530206			320206		060206	
		11	550	12			380219	080219				040219
				14	200207	530207			320207		060207	
			900	12	200208	530208			320208		060208	
				14			380220	080220				040220
Yes	PATB	8	550	12	200209	530209			320209		060209	
				14			380221	080221				040221
			900	12			380222	080222*				040222
				14	200210	530210			320210		060210	
		11	550	12			380223	080223				040223
				14	200211	530211			320211		060211	
			900	12	200212	530212			320212		060212	
				14			380224	080224				040224

Considering these factors, several experimental designs can now be fully proposed.

Option 1: All divisions of treatment, only sections without limiting previous maintenance

In this option, sections with limiting previous maintenance, namely slab stabilization or full depth repairs, are excluded from future study and therefore either pairing option three or four could be used to pair comparable test sections (each with its own control section and excluding sections receiving limiting maintenance treatments). Each maintenance activity, including spall repair, diamond grinding, crack sealing, joint sealing, and partial depth repairs would be used within each test section. Several test sections do not have enough pairs to fulfill the criteria but the suggested experiment based on pairing option three is given in Table 23 below, and the suggested experiment design based on pairing option four is given in Table 24 below. The bold squares indicate paired test sections, and gray shaded cells indicate sections that have received a limiting maintenance treatment (excluded from experimentation) and the orange shaded cells indicate test sections that are no longer in study. The recommended compared treatment for each experimental pair in this experimental option is written in the bold square. One section should be a control section that will not receive the maintenance treatment and one section will receive the experimental maintenance treatment. The general intent was to have at least two replicate testing pairs within each similar climate block. There were some limitations based on existing distresses and some similar climate divisions had more than ten experimental pairs. In this case, additional testing replicates were based on existing distresses as applicable.

Table 23. Proposed experimental option 1 using pairing option 3.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	OH	IA	DE	WI	NC
No	DGAB	8	550	12	390201		100201		370201
				14	Crack and joint seal	190213		550213	
			900	12		190214		550214	
				14	390202		100202	Crack and joint sealing	370202
		11	550	12	Spall repair	190215		550215	
				14	390203		100203	Spall repair	370203
			900	12	390204		100204	Diamond grind and joint seal	370204
				14		190216		550216	
No	LCB	8	550	12	390205		100205	Crack and joint sealing	370205
				14		190217		550217	
			900	12		190218		550218	
				14	390206		100206	Joint seal	370206
		11	550	12		190219		550219	
				14	390207		100207	Spall repair	370207
			900	12	390208		100208	Diamond grinding	370208
				14		190220		550220	
Yes	PATB	8	550	12	390209		100209	Diamond grind and joint seal	370209
				14		190221		550221	
			900	12		190222		550222	
				14	390210		100210	Diamond grind and joint seal	370210
		11	550	12	Diamond grinding	190223		550223	
				14	390211		100211	Diamond grind	370211
			900	12	390212		100212	Joint seal	370212
				14		190224		550224	

Table23. Proposed experimental option 1 using pairing option 3 (continued)

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
No	DGAB	8	550	12	200201		530201		060201	Diamond grind and joint sealing
				14		080213	Diamond grind and joint seal	380213		040213
			900	12		080214	Diamond grinding	380214		040214
				14	200202		530202		060202	Diamond grinding
		11	550	12	Diamond grinding	080215	Crack and joint sealing	380215		040215
				14	200203		530203		060203	Crack and joint sealing
			900	12	200204		530204		060204	Spall repair
				14		080216	Joint sealing only	380216		040216
No	LCB	8	550	12	200205		530205		060205	Crack and joint sealing
				14		080217		380217		040217
			900	12		080218	Spall repair	380218		040218
				14	200206		530206		060206	Crack and joint sealing
		11	550	12		080219	Spall repair	380219		040219
				14	200207		530207		060207	Spall repair
			900	12	200208		530208		060208	Joint sealing only
				14	Spall repair	080220	Crack and joint sealing	380220		040220

Table23. Proposed experimental option 1 using pairing option 3 (continued)

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	Dry					
					Freeze				No Freeze	
					Fine				Coarse	
					KS	ND	WA	CO	CA	AZ
Yes	PATB	8	550	12	200209		530209		060209	Joint sealing only
				14		080221	Diamond grinding and joint seal	380221		040221
			900	12		080222*	Diamond grinding	380222		040222
				14	200210		530210		060210	Diamond grinding
		11	550	12		080223	Joint sealing only	380223		040223
				14	200211		530211		060211	Diamond grinding and joint sealing
			900	12	200212		530212		060212	Spall repair
				14	Joint and crack sealing	080224	Diamond grinding and joint sealing	380224		040224

Table 24. Proposed experimental option 1 using pairing option 4.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	WI	NC
No	8	550	DGAB	12	390201		100201		370201
				14		190213		550213	
			LCB	12	390205	Diamond grinding	100205	Spall repair	370205
				14		190217		550217	
		900	DGAB	12		190214		550214	
				14	390202	Crack and joint sealing	100202	Crack and joint sealing	370202
			LCB	12		190218	Spall repair	550218	
				14	390206		100206		370206
	11	550	DGAB	12		190215		550215	
				14	390203	Spall repair	100203	Diamond grinding	370203
			LCB	12		190219	Crack and joint sealing	550219	Spall repair
				14	390207		100207		370207
		900	DGAB	12	390204		100204		370204
				14		190216	Diamond grinding only	550216	Diamond grinding and joint sealing
			LCB	12	390208	Diamond grinding and joint sealing	100208	Diamond grinding and joint sealing	370208
				14		190220		550220	

Table 25. Proposed experimental option 1 using pairing option 4 (continued).

Pavement Structure					Climatic Conditions and Subgrade				
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
					OH	IA	DE	WI	NC
Yes	8	550	PATB	12	390209		100209		370209
				14		190221		550221	
		900		12		190222		550222	
				14	390210		100210		370210
	11	550		12		190223		550223	
				14	390211		100211		370211
		900		12	390212		100212		370212
				14		190224		550224	

Table 24. Proposed experimental option 1 using pairing option 4 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Dry					
					Freeze				No Freeze	
					Fine				Coarse	
					KS	ND	WA	CO	CA	AZ
No	8	550	DGAB	12	200201		530201		060201	
				14		080213	Spall repair	380213	Spall repair	040213
			LCB	12	200205		530205		060205	Diamond grinding and joint sealing
				14		080217		380217		040217
		900	DGAB	12		080214		380214		040214
				14	200202	Joint and crack sealing	530202	Diamond grinding	060202	Diamond grinding
			LCB	12		080218	Joint and crack sealing	380218	Joint and crack sealing	040218
				14	200206		530206		060206	
	11	550	DGAB	12		080215		380215		040215
				14	200203	Spall repair	530203	Joint and crack sealing	060203	Joint and crack sealing
			LCB	12		080219	Diamond grinding	380219	Diamond grinding only	040219
				14	200207		530207		060207	
		900	DGAB	12	200204		530204		060204	
				14	Diamond grinding and joint sealing	080216	Diamond grinding and joint sealing	380216	Diamond grinding and joint sealing	040216
			LCB	12	200208		530208	Spall repair	060208	Spall repair
				14		080220		380220		040220

Table 24. Proposed experimental option 1 using pairing option 4 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Dry					
					Freeze				No Freeze	
					Fine				Coarse	
					KS	ND	WA	CO	CA	AZ
Yes	8	550	PATB	12	200209		530209		060209	
				14		080221		380221		040221
		900	PATB	12		080222*		380222		040222
				14	200210		530210		060210	
	11	550	PATB	12		080223		380223		040223
				14	200211		530211		060211	
		900	PATB	12	200212		530212		060212	
				14		080224		380224		040224

Option 2: All treatments types, ignoring previous maintenance

In this testing option, sections with limiting previous maintenance, namely slab stabilization or full depth repairs, are included in the current experiment and therefore either pairing option one or two could be used to pair comparable test sections each with its own control section. Each maintenance activity including spall repair, diamond grinding, crack sealing, joint sealing, and partial depth repairs would be used within each test section, as possible. Several test sections do not have enough pairs to fulfill the criteria. The suggested experiment based on pairing option one is given in Table 26 below and the suggested experiment design based on pairing option two is given in Table 27 below. The bold squares indicate paired test sections and the orange shaded cells indicate test sections that are no longer in study. The recommended compared treatment for each experimental pair in this experimental option is written in the bold square. One section should be a control section that will not receive the maintenance treatment and one section will receive the experimental maintenance treatment. The general intent was to have at least two replicate testing pairs within each similar climate block. There were some limitations based on existing distresses and some similar climate divisions had more than ten experimental pairs. In this case, additional testing replicates were based on existing distresses as applicable.

Table 26. Proposed experimental option 2 using pairing option 1.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	OH	IA	DE	WI	NC
No	DGAB	8	550	12	390201		100201	Joint sealing	370201
				14	Crack and joint sealing	190213		550213	
			900	12		190214		550214	
				14	390202		100202	Crack and joint sealing	370202
		11	550	12	Spall repair	190215		550215	
				14	390203		100203	Spall repair	370203
			900	12	390204		100204	Diamond grinding and joint sealing	370204
				14		190216		550216	
No	LCB	8	550	12	390205		100205	Crack and joint sealing	370205
				14		190217		550217	
			900	12		190218		550218	
				14	390206		100206	Spall repair	370206
		11	550	12	Diamond grinding and joint sealing	190219		550219	
				14	390207		100207	Diamond grinding	370207
			900	12	390208		100208	Diamond grind and joint sealing	370208
				14	Joint sealing	190220		550220	
Yes	PATB	8	550	12	390209		100209	Spall repair	370209
				14		190221		550221	
			900	12		190222		550222	
				14	390210		100210	Diamond grind and joint seal	370210
		11	550	12	Diamond grinding	190223		550223	
				14	390211		100211	Diamond grinding	370211
			900	12	390212		100212	Joint sealing	370212
				14	Spall repair	190224		550224	

Table 25. Proposed experimental option 2 using pairing option 1 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
No	DGAB	8	550	12	200201		530201		060201	
				14	Joint and crack sealing	080213	Diamond grind and joint sealing	380213	Diamond grind and joint sealing	040213
			900	12	Spall repair	080214	Diamond grinding	380214	Diamond grinding	040214
				14	200202		530202		060202	
		11	550	12	Diamond grinding	080215	Crack and joint sealing	380215	Crack and joint sealing	040215
				14	200203		530203		060203	
			900	12	200204		530204		060204	
				14	Diamond grinding and joint sealing	080216	Joint sealing	380216	Spall repair	040216
No	LCB	8	550	12	200205		530205		060205	
				14		080217	Crack and joint sealing	380217	Crack and joint sealing	040217
			900	12	Spall repair	080218	Spall repair	380218	Joint sealing	040218
				14	200206		530206		060206	
		11	550	12	Joint sealing	080219	Spall repair	380219	Spall repair	040219
				14	200207		530207		060207	
			900	12	200208		530208		060208	
				14	Diamond grinding	080220	Crack and joint sealing	380220	Spall repair	040220

Table 25. Proposed experimental option 2 using pairing option 1 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
Yes	PATB	8	550	12	200209		530209		060209	
				14	Joint sealing	080221	Diamond grinding and joint sealing	380221	Joint sealing	040221
			900	12	Diamond grinding and joint sealing	080222*	Diamond grinding	380222	Diamond grinding	040222
				14	200210		530210		060210	
		11	550	12	Diamond grinding	080223	Joint sealing	380223	Diamond grinding and joint sealing	040223
				14	200211		530211		060211	
			900	12	200212		530212		060212	
				14	Joint and crack sealing	080224	Diamond grinding and joint sealing	380224	Crack and joint sealing	040224

Table 27. Proposed experimental option 2 using pairing option 2.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	WI	NC
No	8	550	DGAB	12	390201		100201		370201
				14		190213		550213	
			LCB	12	390205	Diamond grinding	100205	Spall repair	370205
				14		190217		550217	
		900	DGAB	12		190214		550214	
				14	390202	Crack and joint sealing	100202	Crack and joint sealing	370202
			LCB	12		190218	Spall repair	550218	
				14	390206		100206		370206
	11	550	DGAB	12		190215		550215	
				14	390203	Spall repair	100203	Diamond grinding	370203
			LCB	12	Crack and joint sealing	190219	Crack and joint sealing	550219	Spall repair
				14	390207		100207		370207
		900	DGAB	12	390204		100204		370204
				14		190216	Diamond grinding	550216	Diamond grinding and joint sealing
			LCB	12	390208	Diamond grinding and joint sealing	100208	Diamond grinding and joint sealing	370208
				14		190220		550220	

Table 26. Proposed experimental option 2 using pairing option 2 (continued).

Pavement Structure					Climatic Conditions and Subgrade				
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
					OH	IA	DE	WI	NC
Yes	8	550	PATB	12	390209		100209		370209
				14		190221		550221	
		900		12		190222		550222	
				14	390210		100210		370210
	11	550		12		190223		550223	
				14	390211		100211		370211
		900		12	390212		100212		370212
				14		190224		550224	

Table 26. Proposed experimental option 2 using pairing option 2 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	KS	ND	WA	CO	CA	AZ
No	8	550	DGAB	12	200201		530201		060201	
				14	Spall repair	080213	Spall repair	380213	Spall repair	040213
			LCB	12	200205		530205		060205	Diamond grinding and joint sealing
				14		080217		380217		040217
		900	DGAB	12		080214		380214		040214
				14	200202	Joint and crack sealing	530202	Diamond grinding only	060202	Diamond grinding
			LCB	12	Joint and crack sealing	080218	Joint and crack sealing	380218	Joint and crack sealing	040218
				14	200206		530206		060206	
	11	550	DGAB	12		080215		380215		040215
				14	200203	Spall repair	530203	Joint and crack sealing	060203	Joint and crack sealing
			LCB	12	Diamond grinding	080219	Diamond grinding	380219	Diamond grinding	040219
				14	200207		530207		060207	
		900	DGAB	12	200204		530204		060204	
				14	Diamond grinding and joint sealing	080216	Diamond grinding and joint sealing	380216	Diamond grinding and joint sealing	040216
			LCB	12	200208		530208		060208	
				14		080220		380220		040220

Table 26. Proposed experimental option 2 using pairing option 2 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Dry					
					Freeze				No Freeze	
					Fine				Coarse	
					KS	ND	WA	CO	CA	AZ
Yes	8	550	PATB	12	200209		530209		060209	
				14		080221		380221		040221
		900	PATB	12		080222*		380222		040222
				14	200210		530210		060210	
	11	550	PATB	12		080223		380223		040223
				14	200211		530211		060211	
		900	PATB	12	200212		530212		060212	
				14		080224		380224		040224

Option 3: Isolating one type of preventive maintenance per test site ignoring all previous maintenance treatments

In this experimental option, a single type of preventive maintenance would be selected for each test site, all previous maintenance treatments would be ignored and all test sections remaining in study would be included in this experiment. Isolating a single type of preventive maintenance for each test site would allow for robust replication and allow for a larger sample size for future statistical analyses of the performance data. Since previous limiting maintenance will have no effect on the inclusion of sites in this experiment section, either pairing option one or two would be used with its own control section. Each maintenance activity including spall repair, diamond grinding, crack sealing and joint sealing will be used across the different test sections. The suggested experiment using pairing option one is given in Table 28 below whereas the suggested experiment design based on pairing option two is given in Table 29 below. The bold squares indicate paired test sections and the orange shaded cells indicate test sections that are no longer in study. The recommended compared treatment for each experimental pair in this option is written in the bold square. One section should be a control section that will not receive the maintenance treatment and one section will receive the experimental maintenance treatment.

Table 28. Proposed experimental option 3 using pairing option 1.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	OH	IA	DE	WI	NC
No	DGAB	8	550	12	390201		100201	Spall repair	370201
				14	Diamond grinding and joint sealing	190213		550213	
			900	12		190214		550214	
				14	390202		100202	Spall repair	370202
		11	550	12	Diamond grinding and joint sealing	190215		550215	
				14	390203		100203	Spall repair	370203
			900	12	390204		100204	Spall repair	370204
				14		190216		550216	
No	LCB	8	550	12	390205		100205	Spall repair	370205
				14		190217		550217	
			900	12		190218		550218	
				14	390206		100206	Spall repair	370206
		11	550	12	Diamond grinding and joint sealing	190219		550219	
				14	390207		100207	Spall repair	370207
			900	12	390208		100208	Spall repair	370208
				14	Diamond grinding and joint sealing	190220		550220	
Yes	PATB	8	550	12	390209		100209	Spall repair	370209
				14		190221		550221	
			900	12		190222		550222	
				14	390210		100210	Spall repair	370210
		11	550	12	Diamond grinding and joint sealing	190223		550223	
				14	390211		100211	Spall repair	370211
			900	12	390212		100212	Spall repair	370212
				14	Diamond grinding and joint sealing	190224		550224	

Table 27. Proposed experimental option 3 using pairing option 1 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
No	DGAB	8	550	12	200201		530201		060201	
				14	Joint sealing	080213	Diamond grinding	380213	Crack and joint sealing	040213
			900	12	Joint sealing	080214	Diamond grinding	380214	Crack and joint sealing	040214
				14	200202		530202		060202	
		11	550	12	Joint sealing	080215	Diamond grinding	380215	Crack and joint sealing	040215
				14	200203		530203		060203	
			900	12	200204		530204		060204	
				14	Joint sealing	080216	Diamond grinding	380216	Crack and joint sealing	040216
No	LCB	8	550	12	200205		530205		060205	
				14		080217	Diamond grinding	380217	Crack and joint sealing	040217
			900	12	Joint sealing	080218	Diamond grinding	380218	Crack and joint sealing	040218
				14	200206		530206		060206	
		11	550	12	Joint sealing	080219	Diamond grinding	380219	Crack and joint sealing	040219
				14	200207		530207		060207	
			900	12	200208		530208		060208	
				14	Joint sealing	080220	Diamond grinding	380220	Crack and joint sealing	040220
Yes	PATB	8	550	12	200209		530209		060209	
				14	Joint sealing	080221	Diamond grinding	380221	Crack and joint sealing	040221
			900	12	Joint sealing	080222*	Diamond grinding	380222	Crack and joint sealing	040222
				14	200210		530210		060210	
		11	550	12	Joint sealing	080223	Diamond grinding	380223	Crack and joint sealing	040223
				14	200211		530211		060211	
			900	12	200212		530212		060212	
				14	Joint sealing	080224	Diamond grinding	380224	Crack and joint sealing	040224

Table 29. Proposed experimental option 3 using pairing option 2.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	WI	NC
No	8	550	DGAB	12	390201		100201		370201
				14		190213	Spall repair	550213	
			LCB	12	390205	Diamond grinding and joint sealing	100205	Diamond grinding	370205
				14		190217		550217	
		900	DGAB	12		190214		550214	
				14	390202	Diamond grinding and joint sealing	100202	Diamond grinding	370202
			LCB	12		190218	Spall repair	550218	
				14	390206		100206		370206
	11	550	DGAB	12		190215		550215	
				14	390203	Diamond grinding and joint sealing	100203	Diamond grinding	370203
			LCB	12	Crack and joint sealing	190219	Spall repair	550219	Joint sealing
				14	390207		100207		370207
		900	DGAB	12	390204		100204		370204
				14		190216	Spall repair	550216	Joint sealing
			LCB	12	390208	Diamond grinding and joint sealing	100208	Diamond grinding	370208
				14		190220		550220	

Table 28. Proposed experimental option 3 using pairing option 2 (continued).

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	WI	NC
Yes	8	550	PATB	12	390209		100209		370209
				14		190221		550221	
		900		12		190222		550222	
				14	390210		100210		370210
	11	550		12		190223		550223	
				14	390211		100211		370211
		900		12	390212		100212		370212
				14		190224		550224	

Table 28. Proposed experimental option 3 using pairing option 2 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	KS	ND	WA	CO	CA	AZ
No	8	550	DGAB	12	200201		530201		060201	
				14	Diamond grinding and joint sealing	080213	Joint sealing	380213	Joint and crack sealing	040213
			LCB	12	200205		530205	Diamond grinding	060205	Spall repair
				14		080217		380217		040217
		900	DGAB	12		080214		380214		040214
				14	200202	Crack and joint sealing	530202	Diamond grinding	060202	Spall repair
			LCB	12	Diamond grinding and joint sealing	080218	Joint sealing	380218	Joint and crack sealing	040218
				14	200206		530206		060206	
	11	550	DGAB	12		080215		380215		040215
				14	200203	Crack and joint sealing	530203	Diamond grinding	060203	Spall repair
			LCB	12	Diamond grinding and joint sealing	080219	Joint sealing	380219	Joint and crack sealing	040219
				14	200207		530207		060207	
		900	DGAB	12	200204		530204		060204	
				14	Diamond grinding and joint sealing	080216	Joint sealing	380216	Joint and crack sealing	040216
			LCB	12	200208		530208	Diamond grinding	060208	Spall repair
				14		080220		380220		040220

Table 28. Proposed experimental option 3 using pairing option 2 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	KS	ND	WA	CO	CA	AZ
Yes	8	550	PATB	12	200209		530209		060209	
				14		080221		380221		040221
		900	PATB	12		080222*		380222		040222
				14	200210		530210		060210	
	11	550	PATB	12		080223		380223		040223
				14	200211		530211		060211	
		900	PATB	12	200212		530212		060212	
				14		080224		380224		040224

Option 4: Isolating one type of preventive maintenance per test site discounting sections receiving limiting previous maintenance activities

Similar to the previous experimental option, a single type of preventive maintenance is selected for each test site; however, all previous maintenance treatments are considered and test sections that have received a limiting previous maintenance treatment would not be included in further study. Isolating a single type of preventive maintenance for each test site would allow for robust replication and allow for a larger sample size for future statistical analyses of the performance data. Since test sites with limiting maintenance will be excluded from the study, either pairing option three or four would be used with its own control section. Each maintenance activity including spall repair, diamond grinding, crack sealing and joint sealing will be used across the different test sections. The suggested experiment using pairing option three is given in Table 30 below whereas the suggested experiment design based on pairing option four is given in Table 32 below. The bold squares indicate paired test sections, the orange shaded cells indicate test sections that are no longer in study and the cells shaded gray will not be included due to the limiting maintenance treatments. The recommended compared treatment for each experimental pair in this experimental option is written in the bold square. One section should be a control section that will not receive the maintenance treatment and one section will receive the experimental maintenance treatment.

Table 30. Proposed experimental option 4 using pairing option 3.

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
					Fine		Coarse		Fine
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	OH	IA	DE	WI	NC
No	DGAB	8	550	12	390201		100201		370201
				14	Diamond grinding and joint sealing	190213		550213	
			900	12		190214		550214	
				14	390202		100202	Spall repair	370202
		11	550	12	Diamond grinding and joint sealing	190215		550215	
				14	390203		100203	Spall repair	370203
			900	12	390204		100204	Spall repair	370204
				14		190216		550216	
No	LCB	8	550	12	390205		100205		370205
				14		190217		550217	
			900	12		190218		550218	
				14	390206		100206	Spall repair	370206
		11	550	12		190219		550219	
				14	390207		100207	Spall repair	370207
			900	12	390208		100208	Spall repair	370208
				14		190220		550220	

Table 31. Proposed experimental option 4 using pairing option 3 (continued).

Pavement Structure					Climatic Conditions and Subgrade				
					Wet				
					Freeze				No Freeze
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Fine		Coarse		Fine
					OH	IA	DE	WI	NC
Yes	PATB	8	550	12	390209		100209		370209
				14		190221		550221	
			900	12		190222		550222	
				14	390210		100210		370210
		11	550	12	Diamond grinding and joint sealing	190223		550223	
				14	390211		100211	Spall repair	370211
			900	12	390212		100212	Spall repair	370212
				14		190224		550224	

Table 29. Proposed experimental option 4 using pairing option 3 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	Base Type	PCC Thick., in	Flexural strength, 14-d (psi)	Lane width	KS	ND	WA	CO	CA	AZ
No	DGAB	8	550	12	200201		530201		060201	
				14		080213	Diamond grinding	380213	Crack and joint sealing	040213
			900	12		080214	Diamond grinding	380214		040214
				14	200202		530202		060202	
		11	550	12	Joint sealing	080215	Diamond grinding	380215	Crack and joint sealing	040215
				14	200203		530203		060203	
			900	12	200204		530204		060204	
				14		080216	Diamond grinding	380216	Crack and joint sealing	040216
No	LCB	8	550	12	200205		530205		060205	
				14		080217		380217	Crack and joint sealing	040217
			900	12		080218	Diamond grinding	380218	Crack and joint sealing	040218
				14	200206		530206		060206	
		11	550	12		080219	Diamond grinding	380219	Crack and joint sealing	040219
				14	200207		530207		060207	
			900	12	200208		530208		060208	
				14	Joint sealing	080220	Diamond grinding	380220	Crack and joint sealing	040220
Yes	PATB	8	550	12	200209		530209		060209	
				14		080221	Diamond grinding	380221	Crack and joint sealing	040221
			900	12		080222*	Diamond grinding	380222	Crack and joint sealing	040222
				14	200210		530210		060210	
		11	550	12		080223	Diamond grinding	380223	Crack and joint sealing	040223
				14	200211		530211		060211	
			900	12	200212		530212		060212	
				14	Joint sealing	080224	Diamond grinding	380224	Crack and joint sealing	040224

Table 32. Proposed experimental option 4 using pairing option 4.

Pavement Structure					Climatic Conditions and Subgrade					
					Wet					
					Freeze					No Freeze
					Fine		Coarse			Fine
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	OH	IA	DE	AR	WI	NC
No	8	550	DGAB	12	390201		100201			370201
				14		190213		050213	550213	
			LCB	12	390205	Diamond grinding and joint sealing	100205		Joint sealing	370205
				14		190217		050217	550217	
		900	DGAB	12		190214		050214	550214	
				14	390202	Diamond grinding and joint sealing	100202	Diamond grinding	Joint sealing	370202
			LCB	12		190218	Spall repair	050218	550218	
				14	390206		100206			370206
	11	550	DGAB	12		190215		050215	550215	
				14	390203	Diamond grinding and joint sealing	100203	Diamond grinding	Joint sealing	370203
			LCB	12		190219	Spall repair	050219	550219	Spall repair
				14	390207		100207			370207
		900	DGAB	12	390204		100204			370204
				14		190216	Spall repair	050216	550216	Spall repair
			LCB	12	390208	Diamond grinding and joint sealing	100208	Diamond grinding	Joint sealing	370208
				14		190220		050220	550220	

Table 30. Proposed experimental option 4 using pairing option 4 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Wet					
					Freeze					No Freeze
					Fine		Coarse			Fine
					OH	IA	DE	AR	WI	NC
Yes	8	550	PATB	12	390209		100209			370209
				14		190221		050221	550221	
		900		12		190222		050222	550222	
				14	390210		100210			370210
	11	550		12		190223		050223	550223	
				14	390211		100211			370211
		900		12	390212		100212			370212
				14		190224		050224	550224	

Table 30. Proposed experimental option 4 using pairing option 4 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
					Dry					
					Freeze				No Freeze	
					Fine				Coarse	
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	KS	ND	WA	CO	CA	AZ
No	8	550	DGAB	12	200201		530201		060201	
				14		080213	Spall repair	380213	Spall repair	040213
			LCB	12	200205		530205		060205	Diamond grinding and joint sealing
				14		080217		380217		040217
		900	DGAB	12		080214		380214		040214
				14	200202	Joint and crack sealing	530202	Diamond grinding	060202	Diamond grinding
			LCB	12		080218	Joint and crack sealing	380218	Joint and crack sealing	040218
				14	200206		530206		060206	
	11	550	DGAB	12		080215		380215		040215
				14	200203	Spall repair	530203	Joint and crack sealing	060203	Joint and crack sealing
			LCB	12		080219	Diamond grinding	380219	Diamond grinding	040219
				14	200207		530207		060207	
		900	DGAB	12	200204		530204		060204	
				14	Diamond grinding and joint sealing	080216	Diamond grinding and joint sealing	380216	Diamond grinding and joint sealing	040216
			LCB	12	200208		530208	Spall repair	060208	Spall repair
				14		080220		380220		040220

Table 30. Proposed experimental option 4 using pairing option 4 (continued).

Pavement Structure					Climatic Conditions and Subgrade					
Drainage	PCC Thick., in	Flexural strength, 14-d (psi)	Base Type	Lane width	Dry					
					Freeze				No Freeze	
					Fine				Coarse	
					KS	ND	WA	CO	CA	AZ
Yes	8	550	PATB	12	200209		530209		060209	
				14		080221		380221		040221
		900	PATB	12		080222		380222		040222
				14	200210		530210		060210	
	11	550	PATB	12		080223		380223		040223
				14	200211		530211		060211	
		900	PATB	12	200212		530212		060212	
				14		080224		380224		040224

Experiment possibilities for the supplemental experiment sections

As previously discussed, the supplemental sections remaining in study would provide an ideal opportunity to investigate the effects of a dowel bar retrofit as a preventive maintenance strategy for the currently undoweled sections. These supplemental sections that are currently doweled could be further divided to isolate the effects of diamond grinding only on load transfer performance, which could also be compared then to the undoweled sections. All test sections in the core experiment were required to contain specified dowel bars. Therefore, the supplemental sections that were not constructed without dowel bars would provide an excellent opportunity to investigate the impact on load transfer for undoweled sections.

The inherent difficulty of designing an experiment with the supplemental sections from the SPS-2 experiment is the lack of consistency between the test sections. As mentioned previously, the original intent of the supplemental experiment of the SPS-2 sections was to provide a robust secondary experiment to investigate dowel bar effects. However, states were more receptive to the flexibility of designing their own experiments based on issues and interest specific to that state. Many states opted to construct only a control section that was constructed with the state standard paving mix design and pavement structure. Therefore, the ability to use the sites as replicate experiments decreases substantially.

This dowel bar based experiment for the supplemental sections will have two categories of experiment: either doweled sections will be diamond ground and compared to a comparable controlled section, or undoweled sections will undergo a dowel bar retrofit and also be compared to comparable control section. Ideally, load transfer efficiency performance could be compared between both experiments. Unfortunately, states with only a control section were eliminated from this experiment because it would require at least pairs in order to match each treatment section with a control section. States with more than a single control section will now be considered individually to outline experiments suited for each state with supplemental sections. To keep cohesion across sections and to allow for broader trend interpretation, the type of dowel bar used in retrofitting should be kept consistent across all test sections while the size may vary due to variances in pavement thickness.

Arizona

The supplemental sections in Arizona were divided into several sub-experiments as shown in Table 33 below. Due to the variety of the inclusion of dowel bars, these test sites are ideally suited for a dowel bar retrofit experiment. The test sections without dowel bars are paired into a control section and a section that will receive dowel bars. Of the three sections with dowel bars, one will remain as a

control while two will receive diamond grinding. These sections do have different PCC thicknesses and while PCC thickness should have a negligible effect on the performance of diamond grinding, it could possibly have an effect on the PCC joint faulting. However, caution should be exercised when comparing these specimens. The recommended experiment pairings are then given in Table 34. The asphalt sections were not included in this experiment.

Table 33. Supplemental sections constructed for the Arizona SPS-2 experiment.

SHRP ID	Sub-experiment	Lane width, ft	Base type	PCC thickness, in	Dowels
040262	1	14	DGAB	8	No
040263		14	PBTB	8	No
040264		12	PBTB	11	No
040265		12	DGAB	11	No
040266	2	14	BTB	12.5	Yes
040267		14	BTB	11	Yes
040268		14	BTB	8	Yes
040260	3	(intentionally identical and on either end of the project; asphalt surface)			
040261					

Table 34. Supplemental sections constructed for the Arizona SPS-2 experiment.

SHRP ID	Lane width, ft	Base type	PCC thickness, in	Dowels	New experiment type	Treatment
040262	14	DGAB	8	No	Control	None
040263	14	PBTB	8	No	Testing	Dowels
040264	12	PBTB	11	No	Control	None
040265	12	DGAB	11	No	Testing	Dowels
040266	14	BTB	12.5	Yes	Testing	Diamond grinding
040267	14	BTB	11	Yes	Control	None
040268	14	BTB	8	Yes	Testing	Diamond grinding

Delaware

In Delaware, the original supplemental test sections were kept consistent with the exception of the type of dowel bar used as seen in Table 35 below. Unfortunately, these sections could not be compared directly due to the different dowel bars used which would not create a replicate experiment.

Table 35. Supplemental sections constructed for the Delaware SPS-2 experiment.

SHRP ID	Lane width, ft	Compressive strength, psi	DGAB thickness, in	PCC thickness, in	Dowel type
100259	12	3000	8	10	steel
100260	12	3000	8	10	plastic

North Dakota

The supplemental sections of North Dakota create some level of difficulty in finding exactly matching pairs for a robust experiment. Some assumptions will have to be made. Most significantly, the joint spacing is variable for most sections due to the nature of the experiment which could affect the performance of a dowel bar retrofit. However, the same procedure is still used to create testing pairs for the recommended experiment. The experimental sections and recommendations for testing are given in Table 36 below. Due to the variability, especially of joint spacing and the pavement width, not all sections could be included in the final recommended experiment.

Table 36. Supplemental sections constructed for the North Dakota SPS-2 experiment.

SHRP ID	PCC Pavement Thickness (in)	Strength	PCC Pavement width, ft	Base Type	Dowels	Joint spacing	New Experiment type	Treatment
380260	11	***	38	DGAB	Yes	15 ft	Testing	Diamond grinding
380259*	10	***	24	8” salvaged layer (unknown material)	Yes	15 ft	Control	None
380261	11	550	24	DGAB	No	Variable **	Control	None
380262	11	550	28	LCB	No	Variable **	Testing	Dowels
380263	11	550	24	PASB	No	Variable **	Testing	Dowels
380264	11	***	38	PASB	No	15 ft		

* indicates state control section

** “variable” indicates joint spacing varying from 12, 15, 13, and 14 ft

*** considered Class AE concrete as per NDDOT specifications

Ohio

The Ohio test sections can only be paired based on mix design and base thickness; however, the effects of base type would have to be ignored for the sake of pairing sections for a dowel bar retrofit experiment. The supplementary sections in Ohio are given in Table 37 below. The detail of the specific mix designs A and B were given previously in Table 8. All test sections in Ohio were doweled so in this experimental case in Ohio, only the effect of diamond grinding can be tested for sections, rather than introducing dowel bars into an undoweled section. Section 390264 would not be included in the experiment.

Table 37. Supplemental sections constructed for the Ohio SPS-2 experiment.

SHRP ID	PCC thickness	AB, in	Base type	Base thickness, in	Mix design	New Experiment Type	Treatment
390259	11	6		0	A	Control	None
390263	11	6		0	A	Testing	Diamond grinding
390261	11	4	CTFDB	4	A	Control	None
390265	11	4	PATB	4	A	Testing	Diamond grinding
390260	11	4	PATB	4	B	Control	None
390262	11	4	CTFDB	4	B	Testing	Diamond grinding
390264	11	6		0	B		

Wisconsin

The Wisconsin supplemental test sections, like Ohio, were all doweled sections and therefore only a comparison of the effects of diamond grinding can be compared. The experimental sections, paired as recommended for this experiment, are given in Table 38 below. Not all sections were sufficiently replicable, such as section 550262, which was the only section with 900 psi strength concrete.

Table 38. Supplemental sections constructed for the Wisconsin SPS-2 experiment.

SHRP ID	Lane width, ft	Subbase thick., in	Rock base thick., in	Embankment fill thick., in	DGAB thick., in	CSOGB thick., in	PCC thick., in	PCC strength, psi	New experiment section
550259*	14			24	6		11	550	Control
550260*	14			24	6		11	550	Testing
550261	12			24	4	4	8	550	
550262	12	10	3		6		8	900	

550263	14			24	6		10	550	Control
550264	14			24	6		11	550	Testing
550265	14	10			6	4	11	550	
550266	14			24	6		11		

(*) indicates control section

Data and suggested analysis

These possible experiments allow for several data analysis options. The nature of the experimental framework: namely, including a single control section matched with each test section, should allow for more robust statistical analysis than prior experiments. This would allow for data comparisons across different treatment methods to be normalized to a control and this normalized value could be used to compare treatments across the different treatment methods.

The outlined experiments were presented such that many replicates exist across different sections, although the ultimate number of sections included varies based on selected pairing option, which will have an effect on the robustness of possible statistical analysis. While a higher number of sections could potentially produce a more rigorous statistical comparison due to the higher degree of freedom, the more conservative pairing options could allow for more distinct trends to emerge. For example, despite pairing options one and two producing many more possible experimental pairings, there could be effects from ignoring previous maintenance treatments that could possibly skew observed trends which might be eliminated if using pairing options three or four.

The experimental options two and four that recommended multiple replications of the same experiment across a single project provide the opportunity for two outlets of analysis. Either the experiment could remain as recommended which would allow for more single replicates for robust statistical analysis, or the replication could allow for the opportunity to incorporate timing effects into the experiment. The options for including timing considerations could vary widely but should be held consistent across the experiments for the sake of later data analysis. A sample of testing timing across four experimental pairs for a treatment type is given in Table 39 below where time X, Y, and Z fall chronologically.

Table 39. Suggested time-based maintenance experiment for experiment options 2 or 4.

Test section	Time 0	Time X	Time Y	Time Z
Test section 1	Receives initial maintenance treatment	No treatment	No treatment	No treatment
Test section 2	Receives initial maintenance treatment	Receives diamond grinding and joint sealing as a proactive follow up treatment	No treatment	No treatment
Test section 3	Receives initial maintenance treatment	Receives diamond grinding and joint sealing as a proactive follow up treatment	Receives diamond grinding and joint sealing as a proactive follow up treatment	No treatment
Test section 4	Receives initial maintenance treatment	Receives diamond grinding and joint sealing as a proactive follow up treatment	Receives diamond grinding and joint sealing as a proactive follow up treatment	Receives diamond grinding and joint sealing as a proactive follow up treatment

A limitation of the experiment design that affects the possible analysis is certainly the need to pair each site with a comparable section as a control section. As mentioned before, for many sites, this requires some assumptions regarding which pavement structure or mix design variables have a negligible effect on the tested pavement preservation techniques. The possibility exists that pavement performance could be adequately simulated by the AASHTOWARE PavementME such that the simulated performance could be used as a control section, thus effectively doubling the amount of experimental sections that would be required to complete the experiment.

In order to use the results of AASHTOWARE PavementME predictions to replace the planned control sections, the historic data taken over the life of the pavement to date would be used to establish the current performance curve with respect to time. At this point, the predicted performance curves could be constructed from the original constructed data and the predicted, based on PavementME, could be compared with the actual. If the two are comparable, it could be reasonably assumed that PavementME could be used to simulate control sections from these existing sections before receiving any treatment. Then, all of the eligible test sections could be used for experimental treatment testing without requiring a control section for each experimental pair. However, this calibration could only be

completed if it shown that the predicted and actual performance curves from PavementME are sufficiently close. It would be recommended that if the performance curves align such that the control section can be removed from the study, thus effectively doubling the amount of testing sections, that this course of action be taken.

The calibration of the PavementME performance curves from the historical data available for the SPS-2 experiment would provide the opportunity to calibrate the performance curves considering maintenance treatments and timing received by the test sections. This would provide very valuable insight into the effect of maintenance treatments and timing and how they relate to the calculated performance curves from PavementME.

CONCLUSION

The Long Term Pavement Performance (LTPP) SPS-2 experiment - strategic study of structural factors for rigid pavements - is the most comprehensive on-going concrete pavement research effort undertaken since the AASHO Road Test. Spanning fourteen states, the study begin in 1992 and eleven of the original fourteen sections remain in service with current years of service ranging between 14 and 22 years as of 2015. Given this unparalleled resource of well documented and monitored aged concrete pavements, the sections currently in study provide the ideal opportunity to develop a second experiment to compare the effectiveness of concrete pavement preservation strategies to extend pavement service life. Recognizing the opportunity, this pooled fund study (TPF-5(291)) was initiated to develop and implement a continuation experiment focused on pavement preservation. As a precursor to the full experiment, the evaluation and assessment of the existing SPS-2 sections with current data limitations and availability must be analyzed and discussed in order to proceed with the development of a robust experimental plan.

This report outlines the current availability of LTPP data, including sections remaining in study, and of those, which have received maintenance or rehabilitation treatments that may limit the options of inclusion in further study. Pavement preservation techniques are evaluated and discussed, including limitations that should be considered due to site specific factors or test section history. The available test sections were considered with the respective potential limitations based on the investigated pavement preservation methods. Multiple options of pairing the test sections for evaluating a control and a testing section were presented and several potential experiments were identified to investigate the performance of spall repairs, joint sealing, diamond grinding, crack sealing, and the combination maintenance of joint sealing and diamond grinding.

Additionally, an experiment to investigate the effectiveness of dowel bar retrofit is presented that utilizes the original supplemental sections, some of which were originally undoweled. This could allow for comparing the variation in load transfer efficiency and difference in faulting between a previously undoweled section receiving a dowel bar retrofit and sections with dowels that will receive diamond grinding for maintenance.

The research team believes the proposed experiment could be expanded using the wealth of existing pavement performance data from the SPS-2 experiment to utilize the predicted performance curves produced from AASHTOWARE PavementME as the “control” sections. If successful, this would eliminate paired sections and allow for doubling of the experimental sections that could be used.

Additional work will be necessary to establish the validity of this approach and revise the experimental plan.

Each pairing and experimental options, with complete discussions of analytical strengths and weaknesses of each, is given in much more detail in the accompanying report. This supplement serves to summarize the findings presented and to seek input from the panel for direction of the project. A pairing and experimental option could be chosen for further progress, or the experiment could be expanded to investigate the feasibility of utilizing AASTHOWARE PavementME curves as control sections.

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Appendix A. Tables of Test Section Rehabilitation and Maintenance

Table A-1.Maintenance and Rehabilitation for sites in Arizona.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	040213	
					Partial depth patching, not joint	16.6
					Partial depth patching, joints	16.6
	LCB				040217	
					Partial depth patching, not joint	16.6
					Partial depth patching, joints	16.6
Yes	PATB				040221	
					Partial depth patching, joints	14.5
					Partial depth patching, not joint	16.6
					Partial depth patching, joints	16.6
No	DGAB		900	12	040214	
	LCB				040218	
					Partial depth patching, joints	14.5
Yes	PATB				040222	
No	DGAB	11	550		040215	
	LCB				040219	
Yes	PATB				040223	
No	DGAB		900	14	040216	
	LCB				040220	
Yes	PATB				040224	

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-2.Maintenance and Rehabilitation for sites in Arkansas.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	050213	
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Crack sealing	9.3
					Partial depth patching, not joint	10.2
					Partial depth patching, not joint	13.1
	LCB				050217	
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Crack sealing	9.3
					Partial depth patching, joints	9.3
					Partial depth patching, joints	12.8
Yes	PATB				050221	
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Transverse joint sealing	9.3
					Lane-Shoulder, Longitudinal joint sealing	9.3
No	DGAB		900	12	050214	
					Lane-Shoulder, Longitudinal joint sealing	3.4
	LCB				050218	
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Crack sealing	9.3
					Transverse joint sealing	9.3
					Partial depth patching, joints	12.8
Yes	PATB				050222	
					Lane-Shoulder, Longitudinal joint sealing	3.4
No	DGAB	11	550		050215	
					Lane-Shoulder, Longitudinal joint sealing	3.4
	LCB				050219	
					Lane-Shoulder, Longitudinal joint sealing	3.4
Yes	PATB				050223	
					Lane-Shoulder, Longitudinal joint sealing	3.4
No	DGAB		900	14	050216	
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Transverse joint sealing	9.3
					Lane-Shoulder, Longitudinal joint sealing	9.3
	LCB				050220	
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Transverse joint sealing	9.3
					Lane-Shoulder, Longitudinal joint sealing	3.4

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-2. Maintenance and Rehabilitation for sites in Arkansas (continued).

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	
Yes	PATB	11	900	14	050224	
					Partial depth patching, joints	2.8
					Lane-Shoulder, Longitudinal joint sealing	3.4
					Partial depth patching, joints	7.8
					Transverse joint sealing	9.3

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-3.Maintenance and Rehabilitation for sites in California.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	060201	
					Lane-Shoulder, Longitudinal joint sealing	2.3
					Partial depth patching, not joint	8.0
					Partial depth patching, not joint	13.3
	LCB				060205	
					Lane-Shoulder, Longitudinal joint sealing	2.3
Yes	PATB				060209	
					Lane-Shoulder, Longitudinal joint sealing	2.3
					Partial depth patching, joints	13.3
No	DGAB		900	14	060202	
					Lane-Shoulder, Longitudinal joint sealing	5.3
	LCB				060206	
					Transverse joint sealing	8.0
					Lane-Shoulder, Longitudinal joint sealing	8.0
Yes	PATB				060210	
					Lane-Shoulder, Longitudinal joint sealing	5.3
					Transverse joint sealing	8.0
					Lane-Shoulder, Longitudinal joint sealing	8.0
No	DGAB	11	550		060203	
					Transverse joint sealing	2.3
					Lane-Shoulder, Longitudinal joint sealing	2.3
					Grinding/Milling surface	5.3
					Grinding/Milling surface	9.0
	LCB				060207	
					Transverse joint sealing	8.0
					Lane-Shoulder, Longitudinal joint sealing	8.0
Yes	PATB				060211	
					Transverse joint sealing	2.3
					Lane-Shoulder, Longitudinal joint sealing	2.3
No	DGAB		900	12	060204	
					Lane-Shoulder, Longitudinal joint sealing	5.3
					Transverse joint sealing	8.0
					Lane-Shoulder, Longitudinal joint sealing	8.0
	LCB				060208	
					Lane-Shoulder, Longitudinal joint sealing	2.3
					Lane-Shoulder, Longitudinal joint sealing	5.3
					Lane-Shoulder, Longitudinal joint sealing	8.0

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-3. Maintenance and Rehabilitation for sites in California (continued).

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
Yes	PATB	11	900	12	060212	
					Lane-Shoulder, Longitudinal joint sealing	5.3

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-4.Maintenance and Rehabilitation for sites in Colorado.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	080213	
	LCB				080217	
					Partial depth patching, joints	12.4
					Partial depth patching, not joint	17.5
Yes	PATB				080221	
No	DGAB		900	12	080214	
	LCB				080218	
					Partial depth patching, joints	12.4
					Partial depth patching, joints	15.4
Yes	PATB				080222	
					Partial depth patching, joints	6.4
					Partial depth patching, joints	11.4
					Partial depth patching, joints	12.4
No	DGAB	11	550		080215	
					Partial depth patching, joints	11.4
					Partial depth patching, joints	13.4
	LCB				080219	
Yes	PATB				080223	
No	DGAB		900	14	080216	
					Partial depth patching, not joint	12.4
	LCB				080220	
					80224	
	PATB				Partial depth patching, joints	11.3

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-5.Maintenance and Rehabilitation for sites in Delaware.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	100201	
					Full Depth joint repair patching	4.3
					Grinding/Milling surface	8.4
	LCB				100205	
					Full Depth joint repair patching	4.3
					PCC Slab replacement	4.3
					Grinding/Milling surface	8.4
					Transverse joint sealing	15.4
					Lane-Shoulder, Longitudinal joint sealing	15.4
					Full Depth joint repair patching	20.2
					Skin patching	22.4
Yes	PATB				100209	
					Full Depth joint repair patching	4.3
					Grinding/Milling surface	8.4
No	DGAB		900	14	100202	
	LCB				100206	
Yes	PATB				100210	
					Full Depth joint repair patching	4.3
					Grinding/Milling surface	8.4
					Transverse joint sealing	10.4
					Lane-Shoulder, Longitudinal joint sealing	10.4
					Skin patching	22.4
No	DGAB	11	550		100203	
					Skin patching	22.4
	LCB				100207	
					Lane-Shoulder, Longitudinal joint sealing	14.4
					Crack sealing	16.4
					Other	16.4
					Crack sealing	19.2
					Partial depth patching, not joint	19.2
					Patch potholes, by hand	19.2
					Skin patching	22.4
Yes	PATB				100211	
					Lane-Shoulder, Longitudinal joint sealing	14.4
					Partial depth patching, not joint	19.2
					Skin patching	22.4

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-5. Maintenance and Rehabilitation for sites in Delaware (continued)

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	11	900	12	100204	
					Grinding/Milling surface	8.4
					Partial depth patching, joints	19.4
					Skin patching	22.4
	LCB				100208	
					Grinding/Milling surface	8.4
					Lane-Shoulder, Longitudinal joint sealing	14.4
					Patch potholes, by hand	19.2
					Partial depth patching, not joint	20.3
					Partial depth patching, joints	20.3
					Skin patching	22.4
Yes	PATB				100212	
					Grinding/Milling surface	8.4
					Skin patching	22.4

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-6.Maintenance and Rehabilitation for sites in Iowa.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	190213	
	LCB				190217	
					PCC Slab replacement	11.4
					Transverse joint sealing	12.4
					Lane-Shoulder, Longitudinal joint sealing	12.4
					Full Depth patching, not joint	12.4
					PCC Slab replacement	12.4
					PCC Slab replacement	19.4
					Partial depth patching, joints	19.4
					Skin patching	20.4
Yes	PATB				190221	
No	DGAB		900	12	190214	
					Crack sealing	19.4
	LCB				190218	
					Partial depth patching, not joint	19.4
					Partial depth patching, joints	19.4
					Skin patching	20.4
Yes	PATB				190222	
					Partial depth patching, joints	19.4
					Skin patching	20.4
No	DGAB	11	550	12	190215	
	LCB				190219	
Yes	PATB				190223	
No	DGAB		900	14	190216	
					Skin patching	20.4
	LCB				190220	
					Partial depth patching, joints	19.4
					Skin patching	20.4
Yes	PATB				190224	
					Partial depth patching, joints	19.4
					Partial depth patching, not joint	19.4
					Skin patching	20.4

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-7.Maintenance and Rehabilitation for sites in Kansas.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	200201	
					Partial depth patching, joints	3.9
					PCC Slab replacement	3.9
					PCC Slab replacement	10.4
					PCC Slab replacement	12.7
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Full Depth joint repair patching	19.4
					Full Depth patching, not joint	19.4
	LCB				200205	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Partial depth patching, joints	16.4
					Partial depth patching, joints	18.4
					Full Depth joint repair patching	19.4
					Full Depth patching, not joint	19.4
					Partial depth patching, joints	22.4
Yes	PATB				200209	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Full Depth joint repair patching	19.4
					Full Depth patching, not joint	19.4
No	DGAB		900	14	200202	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Full Depth joint repair patching	19.4
					Full Depth patching, not joint	19.4
	LCB				200206	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					PCC Slab replacement	19.4
Yes	PATB				200210	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Full Depth joint repair patching	19.4

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-7. Maintenance and Rehabilitation for sites in Kansas (continued).

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	11	550	14	200203	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
	LCB				200207	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Partial depth patching, joints	16.4
					Full Depth joint repair patching	19.4
					Full Depth patching, not joint	19.4
Yes	PATB				200211	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Full Depth joint repair patching	19.4
No	DGAB		900	12	200204	
					Partial depth patching, joints	3.4
					Partial depth patching, joints	5.3
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
					Full Depth joint repair patching	19.4
	LCB				200208	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3
Yes	PATB				200212	
					Transverse joint sealing	13.3
					Lane-Shoulder, Longitudinal joint sealing	13.3

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-8.Maintenance and Rehabilitation for sites in Michigan.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	260213	
	LCB				260217	
Yes	PATB				260221	
					Lane-Shoulder, Longitudinal joint sealing	9.8
					Partial depth patching, joints	15.4
No	DGAB		900	12	260214	
					PCC Slab replacement	9.4
					Lane-Shoulder, Longitudinal joint sealing	9.4
					Full Depth joint repair patching	10.8
					Partial depth patching, joints	10.8
	LCB				260218	
Yes	PATB				260222	
					Lane-Shoulder, Longitudinal joint sealing	9.8
No	DGAB	11	550		260215	
	LCB				260219	
					Partial depth patching, joints	10.7
					Partial depth patching, joints	13.4
Yes	PATB				260223	
					Lane-Shoulder, Longitudinal joint sealing	9.8
					Partial depth patching, joints	15.4
No	DGAB		900	14	260216	
					Lane-Shoulder, Longitudinal joint sealing	9.8
					Partial depth patching, joints	15.4
	LCB				260220	
					Lane-Shoulder, Longitudinal joint sealing	9.8
					Partial depth patching, joints	15.4
Yes	PATB				260224	
					Lane-Shoulder, Longitudinal joint sealing	9.8

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-9.Maintenance and Rehabilitation for sites in Nevada.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	320201	
					Full Depth patching, not joint	4.3
					Crack sealing	4.7
					Full Depth patching, not joint	6.8
					Full Depth patching, not joint	7.3
					Full Depth patching, not joint	10.4
	LCB				320205	
					Crack sealing	2.7
					Crack sealing	4.7
Yes	PATB				320209	
No	DGAB		900	14	320202	
					Crack sealing	4.3
					Partial depth patching, not joint	4.3
	LCB				320206	
					Partial depth patching, not joint	4.3
Yes	PATB				320210	
					Crack sealing	4.7
No	DGAB	11	550		320203	
					Crack sealing	2.7
					Crack sealing	4.7
	LCB				320207	
					Partial depth patching, joints	4.3
					Crack sealing	4.7
Yes	PATB				320211	
					Crack sealing	2.7
					Crack sealing	4.7
No	DGAB		900	12	320204	
					Partial depth patching, not joint	2.7
					Partial depth patching, not joint	3.3
					Crack sealing	4.3
					Partial depth patching, joints	4.3
					Crack sealing	4.7
	LCB				320208	
					Partial depth patching, not joint	2.7
					Crack sealing	4.7
					Partial depth patching, not joint	9.3
Yes	PATB				320212	

Notes: • Shaded cells are no longer in study

- Sections with nothing listed have not received any maintenance or rehabilitation

Table A-10. Maintenance and Rehabilitation for sites in North Carolina

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	370201	
	LCB				370205	
Yes	PATB				370209	
No	DGAB		900	14	370202	
	LCB				370206	
Yes	PATB				370210	
					Partial depth patching, joints	2.9
No	DGAB	11	550		370203	
	LCB				370207	
Yes	PATB				370211	
No	DGAB		900	12	370204	
	LCB				370208	
Yes	PATB				370212	

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-11.Maintenance and Rehabilitation for sites in North Dakota.

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	380213	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Transverse joint sealing	14.9
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Partial depth patching, joints	14.9
					Grinding/Milling surface	16.5
	LCB				380217	
					Partial depth patching, joints	3.7
					Crack sealing	3.7
					Partial depth patching, joints	4.8
					Crack sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Crack sealing	7.8
					Lane-Shoulder, Longitudinal joint sealing	7.8
					Crack sealing	10.8
					Lane-Shoulder, Longitudinal joint sealing	10.8
					Partial depth patching, not joint	10.8
					Partial depth patching, joints	10.8
					Crack sealing	14.9
					Transverse joint sealing	14.9
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Full Depth joint repair patching	14.9
					PCC Slab replacement	14.9
					Partial depth patching, joints	14.9
					Grinding/Milling surface	16.5
Yes	PATB				380221	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Grinding/Milling surface	16.5

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-11. Maintenance and Rehabilitation for sites in North Dakota (continued).

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	11	900	12	380214	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Transverse joint sealing	14.9
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Partial depth patching, joints	14.9
					Grinding/Milling surface	16.5
	LCB				380218	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Transverse joint sealing	14.9
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Partial depth patching, joints	14.9
					Grinding/Milling surface	16.5
Yes	PATB				380222	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Transverse joint sealing	14.9
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Partial depth patching, joints	14.9
					Grinding/Milling surface	16.5
No	DGAB	8	550		380215	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Transverse joint sealing	14.9
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Partial depth patching, joints	14.9
					Grinding/Milling surface	16.5
					Skin patching	20.6
	LCB				380219	
					Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Grinding/Milling surface	16.5

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-11. Maintenance and Rehabilitation for sites in North Dakota (continued).

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
					380223	
Yes	PATB	8	550	12	Lane-Shoulder, Longitudinal joint sealing	6.8
					Lane-Shoulder, Longitudinal joint sealing	11.6
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Grinding/Milling surface	16.5
					380216	
					Partial depth patching, joints	4.8
					Partial depth patching, joints	5.8
					Lane-Shoulder, Longitudinal joint sealing	6.8
	DGAB				Lane-Shoulder, Longitudinal joint sealing	11.6
					Partial depth patching, joints	11.6
					Transverse joint sealing	14.9
No					Lane-Shoulder, Longitudinal joint sealing	14.9
					Partial depth patching, joints	14.9
		11	900	14	Grinding/Milling surface	16.5
					380220	
					Lane-Shoulder, Longitudinal joint sealing	6.8
	LCB				Lane-Shoulder, Longitudinal joint sealing	11.6
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Grinding/Milling surface	16.5
					380224	
					Lane-Shoulder, Longitudinal joint sealing	6.8
Yes	PATB				Lane-Shoulder, Longitudinal joint sealing	11.6
					Lane-Shoulder, Longitudinal joint sealing	14.9
					Grinding/Milling surface	16.5

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-12. Maintenance and Rehabilitation for sites in Ohio

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	390201	
	LCB				390205	
Yes	PATB				390209	
					Full Depth joint repair patching	13.5
No	DGAB		900	14	390202	
	LCB				390206	
Yes	PATB				390210	
No	DGAB	11	550		390203	
					Grinding/Milling surface	19.4
	LCB				390207	
					Full Depth joint repair patching	18.6
					Full Depth patching, not joint	18.6
					PCC Slab replacement	19.4
					Other	19.4
Yes	PATB				390211	
No	DGAB		900	12	390204	
	LCB				390208	
					Full Depth joint repair patching	13.5
					Full Depth joint repair patching	18.6
					Full Depth patching, not joint	18.6
					Full Depth patching, not joint	19.4
					PCC Slab replacement	19.4
					Other	19.4
Yes	PATB				390212	
					Full Depth joint repair patching	13.5
					Partial depth patching, not joint	16.4
					Partial depth patching, not joint	18.4
					Full Depth joint repair patching	18.6
					Full Depth patching, not joint	18.6
					PCC Slab replacement	19.4
					Other	19.4

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-13. Maintenance and Rehabilitation for sites in Washington

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	12	530201	
	LCB				530205	
Yes	PATB				530209	
No	DGAB		900	14	530202	
	LCB				530206	
Yes	PATB				530210	
No	DGAB	11	550		530203	
	LCB				530207	
Yes	PATB				530211	
No	DGAB		900	12	530204	
	LCB				530208	
Yes	PATB				530212	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table A-14. Maintenance and Rehabilitation for sites in Wisconsin

Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Code	Age
No	DGAB	8	550	14	550213	
	LCB				550217	
					Patch potholes, by hand	14.4
Yes	PATB				550221	
No	DGAB		900	12	550214	
	LCB				550218	
Yes	PATB				550222	
No	DGAB	11	550		550215	
	LCB				550219	
Yes	PATB				550223	
No	DGAB		900	14	550216	
	LCB				550220	
Yes	PATB				550224	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Appendix B. Tables of Test Section Rehabilitation and Maintenance and Recent Distress Survey Results

Table B-1. Maintenance, Rehabilitation, and Distresses for sites in Arizona.

					Arizona		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14	040213		
					Partial depth patching, not joint	16.6	Pumping
					Partial depth patching, joints	16.6	Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Flexible patches
							Transverse spalling
							Scaling
							Map cracking
	LCB				040217		
					Partial depth patching, not joint	16.6	Transverse spalling
					Partial depth patching, joints	16.6	Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Scaling
							Map cracking
Yes	PATB				040221		
					Partial depth patching, joints	14.5	Transverse spalling
					Partial depth patching, not joint	16.6	Longitudinal cracking
					Partial depth patching, joints	16.6	Transverse cracking
							Longitudinal spalling
							Flexible patches
							Scaling
							Map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-2. Maintenance, Rehabilitation, and Distresses for sites in Arizona (continued).

					Arizona		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	900	12	040214		Longitudinal cracking Transverse cracking Longitudinal spalling Transverse spalling Scaling Map cracking
	LCB				040218 Partial depth patching, joints	14.5	Transverse spalling Corner breaks Longitudinal cracking Transverse cracking Longitudinal spalling Map cracking
Yes	PATB				040222		Longitudinal cracking Transverse cracking Longitudinal spalling Transverse spalling Map cracking
No	DGAB	11	550		040215		Longitudinal cracking Longitudinal spalling Transverse spalling Map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-2. Maintenance, Rehabilitation, and Distresses for sites in Arizona (continued).

					Arizona		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	LCB	11	550	12	040219		Longitudinal cracking Transverse cracking Transverse spalling Map cracking
Yes	PATB				040223		Longitudinal spalling Transverse spalling
No	DGAB		900	14	040216		Longitudinal cracking Longitudinal spalling Map cracking
	LCB				040220		Longitudinal cracking Longitudinal spalling
Yes	PATB				040224		Map cracking Longitudinal cracking Longitudinal spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-2. Maintenance, Rehabilitation, and Distresses for sites in Arkansas.

					Arkansas		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14	050213		
					Lane-Shoulder, Longitudinal joint sealing	3.4	
					Crack sealing	9.3	
					Partial depth patching, not joint	10.2	
					Partial depth patching, not joint	13.1	
	LCB				050217		
					Lane-Shoulder, Longitudinal joint sealing	3.4	Corner breaks
					Crack sealing	9.3	Longitudinal cracking
					Partial depth patching, joints	9.3	Transverse cracking
					Partial depth patching, joints	12.8	Longitudinal spalling
							Flexible patches
							polished aggregate
							pumping
Yes	PATB				050221		
					Lane-Shoulder, Longitudinal joint sealing	3.4	polished aggregate
					Transverse joint sealing	9.3	Corner breaks
					Lane-Shoulder, Longitudinal joint sealing	9.3	Transverse cracking
							Longitudinal spalling
No	DGAB		900	12	050214		
					Lane-Shoulder, Longitudinal joint sealing	3.4	polished aggregate
							Transverse cracking
							Longitudinal spalling
							Transverse spalling
							pumping

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-2. Maintenance, Rehabilitation, and Distresses for sites in Arkansas (continued).

					Arkansas		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	LCB	8	900	12	050218		
					Lane-Shoulder, Longitudinal joint sealing	3.4	pumping
					Crack sealing	9.3	Corner breaks
					Transverse joint sealing	9.3	Longitudinal cracking
					Partial depth patching, joints	12.8	Transverse cracking
							Longitudinal spalling
							Flexible patches
Yes	PATB				050222		
					Lane-Shoulder, Longitudinal joint sealing	3.4	pumping
							Longitudinal spalling
							Transverse spalling
							pumping
No	DGAB	11	550		050215		
					Lane-Shoulder, Longitudinal joint sealing	3.4	polished aggregate
							Longitudinal spalling
							Transverse spalling
							pumping
	LCB				050219		
					Lane-Shoulder, Longitudinal joint sealing	3.4	polished aggregate
							Longitudinal spalling
							Transverse spalling
							pumping
Yes	PATB				050223		
					Lane-Shoulder, Longitudinal joint sealing	3.4	polished aggregate
							Longitudinal spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-2. Maintenance, Rehabilitation, and Distresses for sites in Arkansas (continued).

					Arkansas		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	14	050216		
					Lane-Shoulder, Longitudinal joint sealing	3.4	polished aggregate
					Transverse joint sealing	9.3	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	9.3	Transverse spalling
							pumping
	LCB				050220		
					Lane-Shoulder, Longitudinal joint sealing	3.4	Transverse spalling
					Transverse joint sealing	9.3	Corner breaks
					Lane-Shoulder, Longitudinal joint sealing	3.4	Longitudinal spalling
							Flexible patches
							pumping
Yes	PATB				050224		
					Partial depth patching, joints	2.8	polished aggregate
					Lane-Shoulder, Longitudinal joint sealing	3.4	Longitudinal spalling
					Partial depth patching, joints	7.8	Transverse spalling
					Transverse joint sealing	9.3	Flexible patches
							pumping

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-3. Maintenance, Rehabilitation, and Distresses for sites in California.

					California		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	060201		
					Lane-Shoulder, Longitudinal joint sealing	2.3	Transverse spalling
					Partial depth patching, not joint	8.0	Corner breaks
					Partial depth patching, not joint	13.3	Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Flexible patching
							pumping
							map cracking
	LCB				060205		
					Lane-Shoulder, Longitudinal joint sealing	2.3	Transverse spalling
							Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Flexible patching
							map cracking
Yes	PATB				060209		
					Lane-Shoulder, Longitudinal joint sealing	2.3	Transverse spalling
					Partial depth patching, joints	13.3	Scaling
							Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-3. Maintenance, Rehabilitation, and Distresses for sites in California (continued).

					California		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	900	14	060202		
					Lane-Shoulder, Longitudinal joint sealing	5.3	Longitudinal cracking Transverse cracking Longitudinal spalling map cracking
	LCB				060206		
					Transverse joint sealing	8.0	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	8.0	Corner breaks Longitudinal cracking Transverse cracking Longitudinal spalling map cracking
Yes	PATB				060210		
					Lane-Shoulder, Longitudinal joint sealing	5.3	Longitudinal spalling
					Transverse joint sealing	8.0	map cracking
					Lane-Shoulder, Longitudinal joint sealing	8.0	
No	DGAB	11	550		060203		
					Transverse joint sealing	2.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	2.3	Longitudinal cracking
					Grinding/Milling surface	5.3	Transverse cracking
					Grinding/Milling surface	9.0	Longitudinal spalling Scaling map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-3. Maintenance, Rehabilitation, and Distresses for sites in California (continued).

					California		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	LCB	11	550	14	060207		
					Transverse joint sealing	8.0	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	8.0	Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Scaling
							polished aggregate
							map cracking
Yes	PATB				060211		
					Transverse joint sealing	2.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	2.3	Longitudinal spalling
							Scaling
							map cracking
No	DGAB		900	12	060204		
					Lane-Shoulder, Longitudinal joint sealing	5.3	Transverse spalling
					Transverse joint sealing	8.0	Transverse cracking
					Lane-Shoulder, Longitudinal joint sealing	8.0	Longitudinal spalling
							map cracking
	LCB				060208		
					Lane-Shoulder, Longitudinal joint sealing	2.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	5.3	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	8.0	Transverse cracking
							Longitudinal spalling
							map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-3. Maintenance, Rehabilitation, and Distresses for sites in California (continued).

					California		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
					060212		
Yes	PATB	11	900	12	Lane-Shoulder, Longitudinal joint sealing	5.3	Corner breaks Longitudinal spalling map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-4. Maintenance, Rehabilitation, and Distresses for sites in Colorado.

					Colorado		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14	080213		Longitudinal cracking Longitudinal spalling transverse spalling scaling polished aggregate map cracking
	LCB				080217		
					Partial depth patching, joints	12.4	
					Partial depth patching, not joint	17.5	
Yes	PATB				080221		Longitudinal cracking Longitudinal spalling transverse spalling scaling polished aggregate map cracking
No	DGAB		900	12	080214		Longitudinal cracking Transverse cracking Longitudinal spalling transverse spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-4. Maintenance, Rehabilitation, and Distresses for sites in Colorado (continued).

					Colorado		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	LCB	8	900	12	080218		
					Partial depth patching, joints	12.4	polished aggregate
					Partial depth patching, joints	15.4	Durability cracking
							Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Rigid patching
							Flexible patching
							transverse spalling
							map cracking
Yes	PATB				080222		
					Partial depth patching, joints	6.4	Longitudinal cracking
					Partial depth patching, joints	11.4	Longitudinal spalling
					Partial depth patching, joints	12.4	transverse spalling
							map cracking
No	DGAB	11	550		080215		
					Partial depth patching, joints	11.4	transverse spalling
					Partial depth patching, joints	13.4	Corner breaks
							Longitudinal spalling
							Flexible patching
							polished aggregate
							map cracking
	LCB				080219		
							Longitudinal cracking
							scaling
							polished aggregate

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-4. Maintenance, Rehabilitation, and Distresses for sites in Colorado (continued).

					Colorado		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
Yes	PATB	11	550	12	080223		map cracking Transverse cracking Longitudinal spalling transverse spalling scaling polished aggregate map cracking transverse spalling
No	DGAB		900	14	080216 Partial depth patching, not joint	12.4	Longitudinal cracking Transverse cracking Longitudinal spalling Flexible patching transverse spalling map cracking
	LCB				080220		Flexible patching polished aggregate transverse spalling map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-4. Maintenance, Rehabilitation, and Distresses for sites in Colorado (continued).

					Colorado		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
					80224		
No	PATB	11	900	14	Partial depth patching, joints	11.3	Longitudinal spalling Longitudinal cracking Flexible patching transverse spalling scaling polished aggregate map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-5. Maintenance, Rehabilitation, and Distresses for sites in Delaware.

					Delaware		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	100201		
					Full Depth joint repair patching	4.3	Transverse spalling
					Grinding/Milling surface	8.4	Longitudinal spalling
							Rigid patching
							polished aggregate
							map cracking
	LCB				100205		
					Full Depth joint repair patching	4.3	Longitudinal cracking
					PCC Slab replacement	4.3	Transverse cracking
					Grinding/Milling surface	8.4	Longitudinal spalling
					Transverse joint sealing	15.4	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	15.4	Transverse spalling
					Full Depth joint repair patching	20.2	polished aggregate
					Skin patching	22.4	map cracking
Yes	PATB				100209		
					Full Depth joint repair patching	4.3	Transverse spalling
					Grinding/Milling surface	8.4	Longitudinal spalling
							Rigid patching
							polished aggregate
No	DGAB		900	14	100202		
							Longitudinal cracking
							Longitudinal spalling
							Transverse spalling
							polished aggregate

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-5. Maintenance, Rehabilitation, and Distresses for sites in Delaware (continued).

					Delaware		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	LCB	8	900	14	100206		Transverse spalling polished aggregate map cracking
Yes	PATB				100210		
					Full Depth joint repair patching	4.3	scaling
					Grinding/Milling surface	8.4	Longitudinal cracking
					Transverse joint sealing	10.4	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	10.4	Rigid patching
					Skin patching	22.4	Flexible patching Transverse spalling polished aggregate map cracking
No	DGAB	11	550		100203		
					Skin patching	22.4	Transverse spalling Longitudinal cracking Longitudinal spalling Flexible patching map cracking
	LCB				100207		
					Lane-Shoulder, Longitudinal joint sealing	14.4	Longitudinal cracking
					Crack sealing	16.4	Sealed longitudinal cracks
					Other	16.4	Longitudinal spalling
					Crack sealing	19.2	Flexible patching
					Partial depth patching, not joint	19.2	map cracking
					Patch potholes, by hand	19.2	Transverse spalling

					Skin patching	22.4	polished aggregate

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-5. Maintenance, Rehabilitation, and Distresses for sites in Delaware (continued).

					Delaware		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
Yes	PATB	11	550	14	100211		
					Lane-Shoulder, Longitudinal joint sealing	14.4	Longitudinal spalling
					Partial depth patching, not joint	19.2	Flexible patching
					Skin patching	22.4	polished aggregate
							map cracking
No	DGAB		900	12	100204		
					Grinding/Milling surface	8.4	Longitudinal spalling
					Partial depth patching, joints	19.4	Flexible patching
					Skin patching	22.4	Transverse spalling
							map cracking
	LCB				100208		
					Grinding/Milling surface	8.4	polished aggregate
					Lane-Shoulder, Longitudinal joint sealing	14.4	Corner breaks
					Patch potholes, by hand	19.2	Longitudinal spalling
					Partial depth patching, not joint	20.3	Rigid patching
					Partial depth patching, joints	20.3	Flexible patching
					Skin patching	22.4	Transverse spalling
							scaling
							pumping
							map cracking
Yes	PATB				100212		
					Grinding/Milling surface	8.4	Longitudinal spalling
					Skin patching	22.4	Flexible patching

						map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-6. Maintenance, Rehabilitation, and Distresses for sites in Iowa.

					Iowa		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14	190213		
	LCB				190217		
					PCC Slab replacement	11.4	Longitudinal cracking
					Transverse joint sealing	12.4	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	12.4	Rigid patching
					Full Depth patching, not joint	12.4	Flexible patching
					PCC Slab replacement	12.4	
					PCC Slab replacement	19.4	
					Partial depth patching, joints	19.4	
					Skin patching	20.4	
Yes	PATB				190221		
							Longitudinal spalling
No	DGAB		900	12	190214		
					Crack sealing	19.4	Transverse spalling
							Transverse cracking
							Longitudinal spalling
	LCB				190218		
					Partial depth patching, not joint	19.4	Transverse spalling
					Partial depth patching, joints	19.4	Corner break
					Skin patching	20.4	Longitudinal cracking
							Transverse cracking
							Longitudinal spalling
							Flexible patching

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-6. Maintenance, Rehabilitation, and Distresses for sites in Iowa (continued).

					Iowa		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
Yes	PATB	8	900	12	190222		
					Partial depth patching, joints	19.4	Transverse spalling
					Skin patching	20.4	Longitudinal spalling
							Flexible patching
No	DGAB	11	550		190215		
							Longitudinal spalling
							Transverse spalling
	LCB				190219		
							Longitudinal spalling
							polished aggregate
							Transverse spalling
Yes	PATB				190223		
							Transverse spalling
No	DGAB		900	14	190216		
					Skin patching	20.4	Longitudinal spalling
							Transverse spalling
							Longitudinal cracking
							Transverse cracking
							Flexible patching
	LCB				190220		
					Partial depth patching, joints	19.4	Transverse spalling
					Skin patching	20.4	Longitudinal spalling
Yes	PATB				190224		
					Partial depth patching, joints	19.4	Longitudinal spalling
					Partial depth patching, not joint	19.4	Flexible patching
					Skin patching	20.4	Transverse spalling

Notes: • Shaded cells are no longer in study

• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-7. Maintenance, Rehabilitation, and Distresses for sites in Kansas.

					Kansas		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	200201		
					Partial depth patching, joints	3.9	Longitudinal cracking
					PCC Slab replacement	3.9	Transverse cracking
					PCC Slab replacement	10.4	Longitudinal spalling
					PCC Slab replacement	12.7	Rigid patching
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	
					Full Depth joint repair patching	19.4	
					Full Depth patching, not joint	19.4	
	LCB				200205		
					Transverse joint sealing	13.3	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Rigid patching
					Partial depth patching, joints	16.4	Flexible patching
					Partial depth patching, joints	18.4	Transverse spalling
					Full Depth joint repair patching	19.4	map cracking
					Full Depth patching, not joint	19.4	
					Partial depth patching, joints	22.4	
Yes	PATB				200209		
					Transverse joint sealing	13.3	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	13.3	Longitudinal spalling
					Full Depth joint repair patching	19.4	Rigid patching
					Full Depth patching, not joint	19.4	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-7. Maintenance, Rehabilitation, and Distresses for sites in Kansas.

					Kansas		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	900	14	200202		
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Longitudinal cracking
					Full Depth joint repair patching	19.4	Transverse cracking
					Full Depth patching, not joint	19.4	Longitudinal spalling
							Rigid patching
	LCB				200206		
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Longitudinal cracking
					PCC Slab replacement	19.4	Rigid patching
							map cracking
Yes	PATB				200210		
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Longitudinal cracking
					Full Depth joint repair patching	19.4	Longitudinal spalling
							Rigid patching
No	DGAB	11	550		200203		
					Transverse joint sealing	13.3	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	13.3	
	LCB				200207		
					Transverse joint sealing	13.3	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Rigid patching
					Partial depth patching, joints	16.4	Transverse spalling
					Full Depth joint repair patching	19.4	map cracking
					Full Depth patching, not joint	19.4	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-7. Maintenance, Rehabilitation, and Distresses for sites in Kansas.

					Kansas		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
Yes	PATB	11	550	14	200211		
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Longitudinal cracking
					Full Depth joint repair patching	19.4	Longitudinal spalling
							Rigid patching
							map cracking
No	DGAB		900	12	200204		
					Partial depth patching, joints	3.4	Longitudinal spalling
					Partial depth patching, joints	5.3	Rigid patching
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	map cracking
					Full Depth joint repair patching	19.4	
	LCB				200208		
					Transverse joint sealing	13.3	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	map cracking
Yes	PATB				200212		
					Transverse joint sealing	13.3	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	13.3	Longitudinal cracking
							Longitudinal spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-8. Maintenance, Rehabilitation, and Distresses for sites in Michigan.

					Michigan		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14	260213		
	LCB				260217		
Yes	PATB				260221		
					Lane-Shoulder, Longitudinal joint sealing	9.8	
					Partial depth patching, joints	15.4	
No	DGAB		900	12	260214		
					PCC Slab replacement	9.4	
					Lane-Shoulder, Longitudinal joint sealing	9.4	
					Full Depth joint repair patching	10.8	
					Partial depth patching, joints	10.8	
	LCB				260218		
Yes	PATB				260222		
					Lane-Shoulder, Longitudinal joint sealing	9.8	
No	DGAB	11	550		260215		
	LCB				260219		
					Partial depth patching, joints	10.7	
					Partial depth patching, joints	13.4	
Yes	PATB				260223		
					Lane-Shoulder, Longitudinal joint sealing	9.8	
					Partial depth patching, joints	15.4	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-8. Maintenance, Rehabilitation, and Distresses for sites in Michigan (continued).

					Michigan		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	14	260216		
					Lane-Shoulder, Longitudinal joint sealing	9.8	
					Partial depth patching, joints	15.4	
	LCB				260220		
					Lane-Shoulder, Longitudinal joint sealing	9.8	
					Partial depth patching, joints	15.4	
Yes	PATB				260224		
					Lane-Shoulder, Longitudinal joint sealing	9.8	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-9. Maintenance, Rehabilitation, and Distresses for sites in Nevada.

					Nevada		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	320201		
					Full Depth patching, not joint	4.3	
					Crack sealing	4.7	
					Full Depth patching, not joint	6.8	
					Full Depth patching, not joint	7.3	
					Full Depth patching, not joint	10.4	
	LCB				320205		
					Crack sealing	2.7	
					Crack sealing	4.7	
Yes	PATB				320209		
No	DGAB		900	14	320202		
					Crack sealing	4.3	
					Partial depth patching, not joint	4.3	
	LCB				320206		
					Partial depth patching, not joint	4.3	
Yes	PATB				320210		
					Crack sealing	4.7	
No	DGAB	11	550		320203		
					Crack sealing	2.7	
					Crack sealing	4.7	
	LCB				320207		
					Partial depth patching, joints	4.3	
					Crack sealing	4.7	
Yes	PATB				320211		
					Crack sealing	2.7	
					Crack sealing	4.7	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-9. Maintenance, Rehabilitation, and Distresses for sites in Nevada (continued).

					Nevada		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	12	320204		
					Partial depth patching, not joint	2.7	
					Partial depth patching, not joint	3.3	
					Crack sealing	4.3	
					Partial depth patching, joints	4.3	
					Crack sealing	4.7	
	LCB				320208		
					Partial depth patching, not joint	2.7	
					Crack sealing	4.7	
					Partial depth patching, not joint	9.3	
Yes	PATB				320212		

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-10. Maintenance, Rehabilitation, and Distresses for sites in North Carolina.

					North Carolina		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	370201		
	LCB				370205		
Yes	PATB				370209		
No	DGAB		900	14	370202		
	LCB				370206		
Yes	PATB				370210		
					Partial depth patching, joints	2.9	
No	DGAB	11	550		370203		Longitudinal spalling Transverse spalling map cracking polished aggregate
	LCB				370207		Longitudinal spalling Transverse spalling polished aggregate map cracking
Yes	PATB				370211		Longitudinal spalling map cracking scaling polished aggregate

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-10. Maintenance, Rehabilitation, and Distresses for sites in North Carolina (continued).

					North Carolina		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	12	370204		Longitudinal spalling scaling
	LCB				370208		Longitudinal spalling scaling Transverse spalling
Yes	PATB				370212		Longitudinal spalling Flexible patching Transverse spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-11. Maintenance, Rehabilitation, and Distresses for sites in North Dakota.

					North Dakota		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14	380213		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	Rigid patching
					Transverse joint sealing	14.9	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	14.9	polished aggregate
					Partial depth patching, joints	14.9	
					Grinding/Milling surface	16.5	
	LCB				380217		
					Partial depth patching, joints	3.7	Longitudinal cracking
					Crack sealing	3.7	Sealed longitudinal cracks
					Partial depth patching, joints	4.8	Transverse cracking
					Crack sealing	6.8	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	6.8	Rigid patching
					Crack sealing	7.8	polished aggregate
					Lane-Shoulder, Longitudinal joint sealing	7.8	
					Crack sealing	10.8	
					Lane-Shoulder, Longitudinal joint sealing	10.8	
					Partial depth patching, not joint	10.8	
					Partial depth patching, joints	10.8	
					Crack sealing	14.9	
					Transverse joint sealing	14.9	
					Lane-Shoulder, Longitudinal joint sealing	14.9	
					Full Depth joint repair patching	14.9	
					PCC Slab replacement	14.9	
					Partial depth patching, joints	14.9	
					Grinding/Milling surface	16.5	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-11. Maintenance, Rehabilitation, and Distresses for sites in North Dakota (continued).

					North Dakota		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
Yes	PATB	8	550	14	380221		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	14.9	Transverse spalling
					Grinding/Milling surface	16.5	polished aggregate
No	DGAB		900	12	380214		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal spalling
					Transverse joint sealing	14.9	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	14.9	Transverse spalling
					Partial depth patching, joints	14.9	polished aggregate
					Grinding/Milling surface	16.5	
	LCB				380218		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal spalling
					Transverse joint sealing	14.9	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	14.9	Flexible patching
					Partial depth patching, joints	14.9	Transverse spalling
					Grinding/Milling surface	16.5	polished aggregate
Yes	PATB				380222		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal spalling
					Transverse joint sealing	14.9	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	14.9	Transverse spalling
					Partial depth patching, joints	14.9	
					Grinding/Milling surface	16.5	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-11. Maintenance, Rehabilitation, and Distresses for sites in North Dakota (continued).

					North Dakota		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	550	12	380215		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal spalling
					Transverse joint sealing	14.9	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	14.9	Flexible patching
					Partial depth patching, joints	14.9	Transverse spalling
					Grinding/Milling surface	16.5	polished aggregate
					Skin patching	20.6	
	LCB				380219		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	14.9	Longitudinal spalling
					Grinding/Milling surface	16.5	Rigid patching
							Flexible patching
							polished aggregate
Yes	PATB				380223		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	14.9	polished aggregate
					Grinding/Milling surface	16.5	

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-11. Maintenance, Rehabilitation, and Distresses for sites in North Dakota (continued).

					North Dakota		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	14	380216		
					Partial depth patching, joints	4.8	Longitudinal spalling
					Partial depth patching, joints	5.8	Rigid patching
					Lane-Shoulder, Longitudinal joint sealing	6.8	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	
					Partial depth patching, joints	11.6	
					Transverse joint sealing	14.9	
					Lane-Shoulder, Longitudinal joint sealing	14.9	
					Partial depth patching, joints	14.9	
					Grinding/Milling surface	16.5	
	LCB				380220		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal cracking
					Lane-Shoulder, Longitudinal joint sealing	14.9	Transverse cracking
					Grinding/Milling surface	16.5	Longitudinal spalling polished aggregate
Yes	PATB				380224		
					Lane-Shoulder, Longitudinal joint sealing	6.8	Transverse spalling
					Lane-Shoulder, Longitudinal joint sealing	11.6	Longitudinal spalling
					Lane-Shoulder, Longitudinal joint sealing	14.9	Rigid patching
					Grinding/Milling surface	16.5	Flexible patching

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-12. Maintenance, Rehabilitation, and Distresses for sites in Ohio.

					Ohio		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	390201		
	LCB				390205		
Yes	PATB				390209		
					Full Depth joint repair patching	13.5	
No	DGAB		900	14	390202		
	LCB				390206		
Yes	PATB				390210		
No	DGAB	11	550		390203		
					Grinding/Milling surface	19.4	Transverse spalling
							Longitudinal spalling
							Transverse cracking
	LCB				390207		
					Full Depth joint repair patching	18.6	Transverse cracking
					Full Depth patching, not joint	18.6	Longitudinal spalling
					PCC Slab replacement	19.4	Rigid patching
					Other	19.4	Transverse spalling
Yes	PATB				390211		
							Transverse cracking
							Longitudinal spalling
							Transverse spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-12. Maintenance, Rehabilitation, and Distresses for sites in Ohio (continued).

					Ohio		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	12	390204		
	LCB				390208		
					Full Depth joint repair patching	13.5	Longitudinal cracking
					Full Depth joint repair patching	18.6	Transverse cracking
					Full Depth patching, not joint	18.6	Longitudinal spalling
					Full Depth patching, not joint	19.4	Rigid patching
					PCC Slab replacement	19.4	Transverse spalling
					Other	19.4	map cracking
Yes	PATB				390212		
					Full Depth joint repair patching	13.5	Corner break
					Partial depth patching, not joint	16.4	Longitudinal cracking
					Partial depth patching, not joint	18.4	Transverse cracking
					Full Depth joint repair patching	18.6	Longitudinal spalling
					Full Depth patching, not joint	18.6	Rigid patching
					PCC Slab replacement	19.4	Transverse spalling
					Other	19.4	map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-13. Maintenance, Rehabilitation, and Distresses for sites in Washington.

					Washington		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	12	530201		Corner break Longitudinal cracking Sealed longitudinal cracks Transverse cracking Sealed transverse cracks map cracking
	LCB				530205		Corner break Sealed longitudinal cracks Transverse cracking Sealed transverse cracks Transverse spalling map cracking
Yes	PATB				530209		Corner break Sealed longitudinal cracks Transverse cracking map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-13. Maintenance, Rehabilitation, and Distresses for sites in Washington (continued).

					Washington		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	900	14	530202		Corner break Longitudinal cracking Durability cracking Sealed longitudinal cracks Transverse cracking
	LCB				530206		Corner break Longitudinal cracking Durability cracking Sealed longitudinal cracks Transverse cracking Sealed transverse cracks Longitudinal spalling Transverse spalling Pumping map cracking
Yes	PATB				530210		Corner break Durability cracking Longitudinal cracking Sealed longitudinal cracks Transverse cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-13. Maintenance, Rehabilitation, and Distresses for sites in Washington (continued).

					Washington		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	550	14	530203		Corner break Sealed longitudinal cracks Transverse cracking map cracking
	LCB				530207		Corner break Durability cracking Sealed longitudinal cracks Transverse cracking Sealed transverse cracks Transverse spalling map cracking
Yes	PATB				530211		Corner break Sealed longitudinal cracks Transverse cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-13. Maintenance, Rehabilitation, and Distresses for sites in Washington (continued).

					Washington		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	900	12	530204		Corner break Sealed longitudinal cracks Transverse cracking Rigid patching
	LCB				530208		Corner break Longitudinal cracking Durability cracking Sealed longitudinal cracks Transverse cracking map cracking
Yes	PATB				530212		Corner break Longitudinal cracking Durability cracking Sealed longitudinal cracks Transverse cracking map cracking

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-14. Maintenance, Rehabilitation, and Distresses for sites in Wisconsin.

					Wisconsin		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	8	550	14		550213	Longitudinal spalling Flexible patching Transverse spalling
	LCB				Patch potholes, by hand	550217 14.4	Longitudinal spalling Transverse spalling
Yes	PATB					550221	Longitudinal spalling Transverse spalling
No	DGAB		900	12		550214	Longitudinal spalling Transverse spalling
	LCB					550218	Longitudinal cracking Longitudinal spalling Transverse spalling
Yes	PATB					550222	Longitudinal cracking Longitudinal spalling Transverse spalling scaling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation

Table B-14. Maintenance, Rehabilitation, and Distresses for sites in Wisconsin (continued).

					Wisconsin		
Drainage	Base Type	PCC Thickness, in	Flexural strength, 14-d (psi)	Lane width	Maintenance Activity	Age	2014/2015 Distress
No	DGAB	11	550	12	550215		Longitudinal spalling Transverse spalling
	LCB				550219		Longitudinal spalling Transverse spalling
Yes	PATB				550223		Longitudinal spalling Transverse spalling
No	DGAB		900	14	550216		Longitudinal spalling Transverse spalling
	LCB				550220		Longitudinal spalling
Yes	PATB				550224		Longitudinal spalling Transverse spalling

Notes: • Shaded cells are no longer in study
• Sections with nothing listed have not received any maintenance or rehabilitation