PRR 165 – Performance of Mechanistically-Designed Pavements

2012 – 2015 Data

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Agenda

- History
- Data Collection Process
- Life-Cycle Models
- Current Analysis
- Future Efforts
- Questions

Background and History

- First mechanistically-designed sections were constructed in 1986 on Routes FA 401 and 409 (US 20 and US 50).
- Physical Research Report (PRR) 112 was the first report to evaluate and analyze the performance of these four different design sections.
- An internal report written in 1994 documented the performance of the original four sections plus an additional four new sections constructed between 1986 and 1992.
- Additional internal reports were written in 1997 and 2000 reporting on 88 different structural sections.

FA 401 and 409 Locations

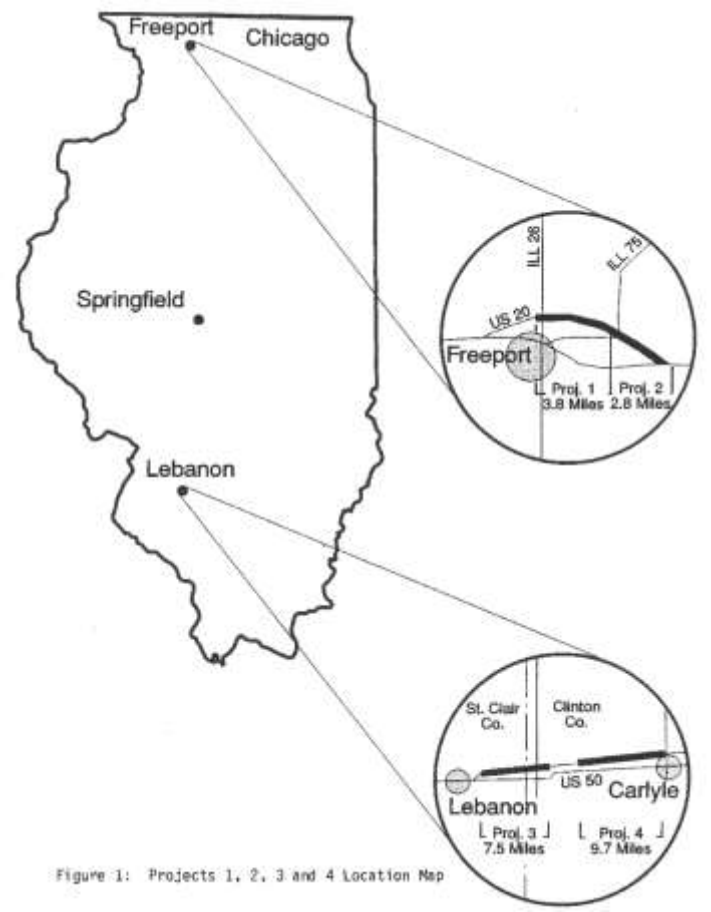


Figure 1: Projects 1, 2, 3 and 4 Location Map

Figure 1 from PRR 112

FA 401 (US 20)

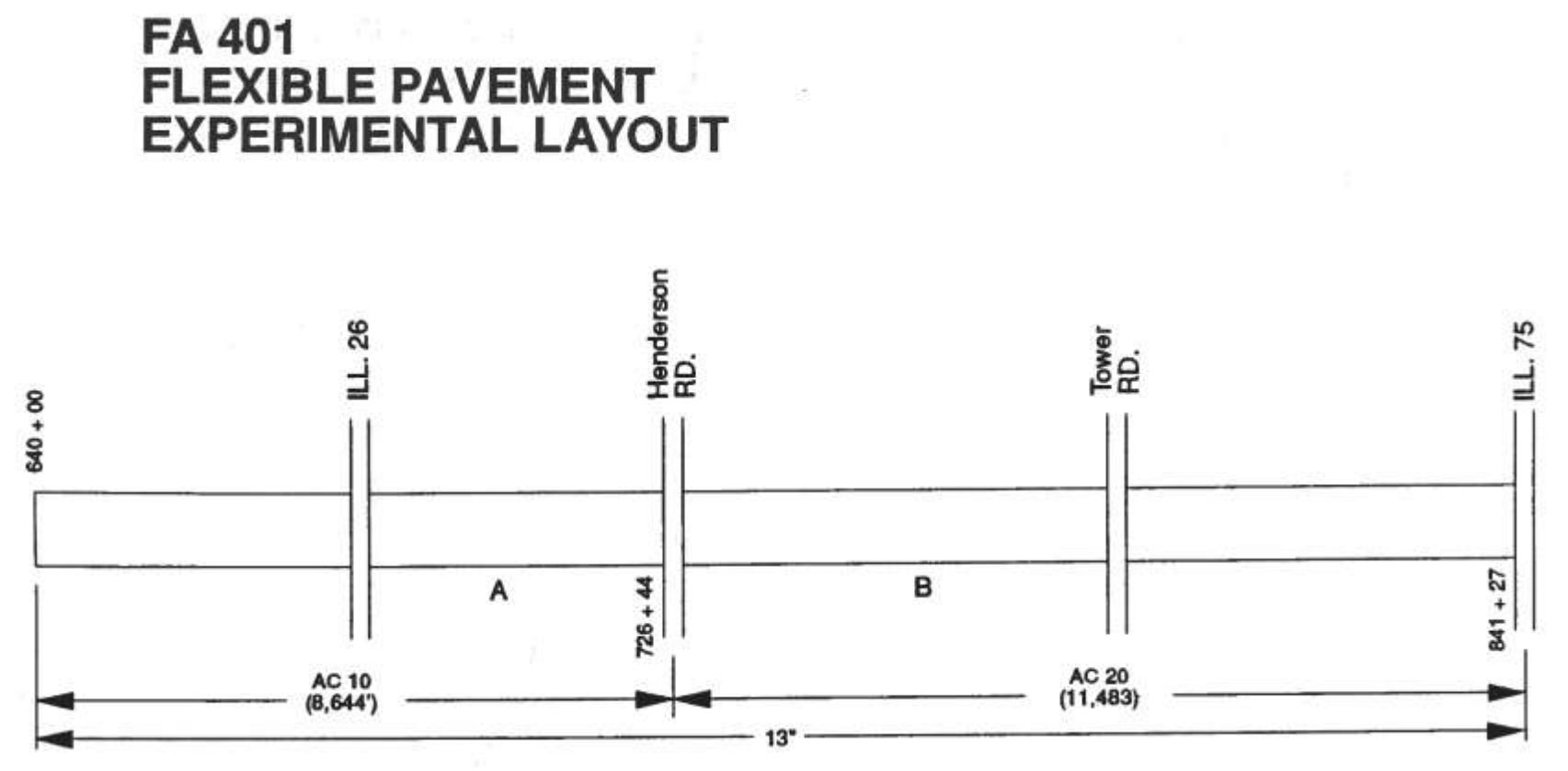


Figure 2 from PRR 112

FA 409 (US XX)

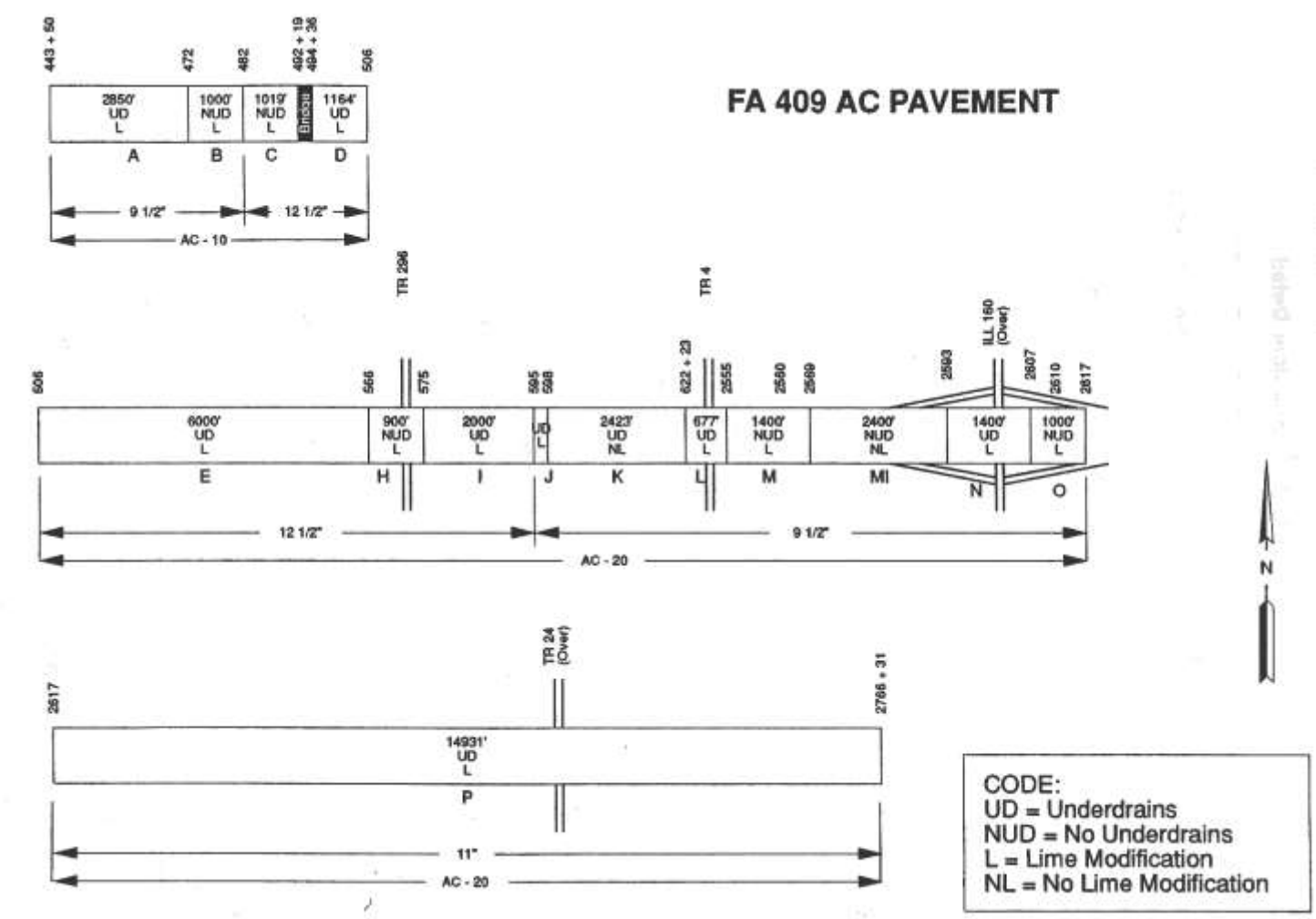


Figure 3 from PRR 112

Recent History

- PRR 159 was published in March of 2011.
  - Analysis period from 1986 to 2010.
  - 105 contracts (55 HMA, 24 JPCP, and 26 CRCP contracts)
- PRR 165 was published in October of 2016.
  - Analysis period from 1986-2015.
  - Contained the same 105 contracts as PRR 159.
- In April of 2016 the Bureau of Research added 80 new mechanistic sections that will be monitored and added to the next report.

Data Collection

- Performance data on these sections comes from manual pavement distress surveys (PDS).
- Traffic and condition (IRI, Rut, etc.) information are downloaded from the Illinois Roadway Information System (IRIS).
- A database was created specifically for this effort to capture all of the data and project details due to the limitations of IRIS.
- Each section will receive a PDS the year opposite of the scheduled video van collection, so that some level of survey is performed every year.

Data Collection Cont.

- Before 2014, the entire length of each section was surveyed.

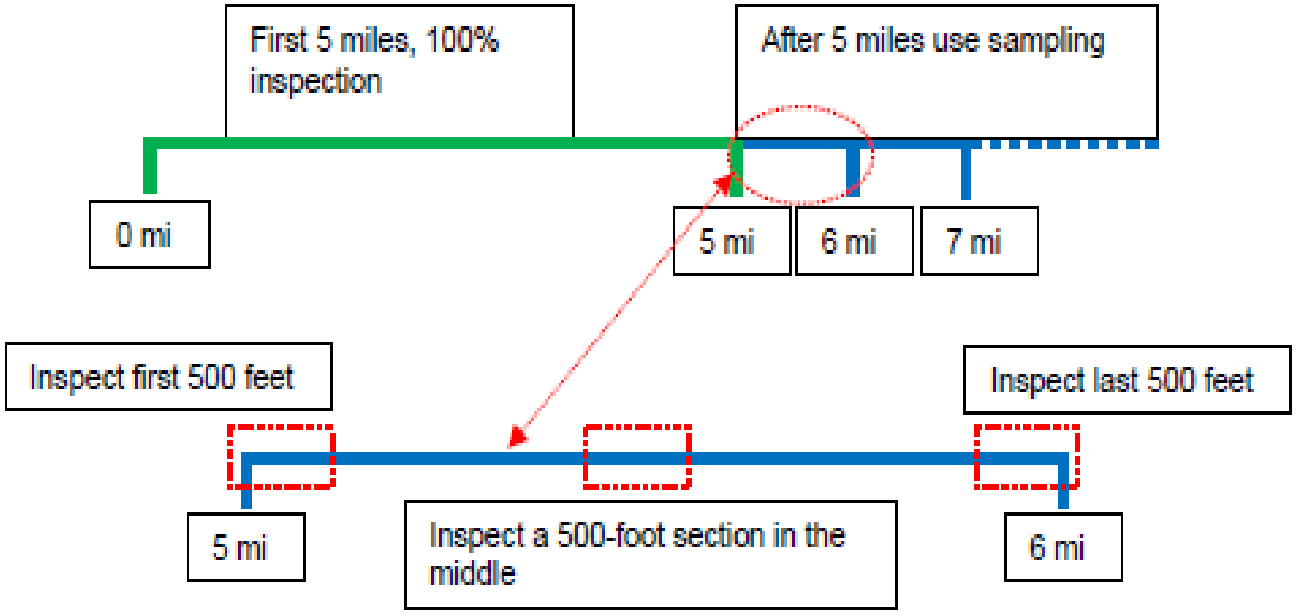


Figure 1. Sampling Method for Pavement Distress Surveys

Figure 1 from PRR 165

HMA Matrix of Contracts

Location	T_{HMA}, inches	8.0-8.99	9.0-9.99	10.0-10.99	11.0-11.99	12.0-12.99	13.0-13.99	14.0-14.99	15.0-15.99	16.0-16.99	17.0-17.99	18.0-18.99	19.0-19.99	20.0-20.99
NORTH	1	82125		80169	80497		80315	80482	80742					
	2				84199	84167 84161 84125 84200	40463 84659 84220							
CENTRAL NORTH	3													
	4					68159	88067★ 88261 86068 88624	88067★	88051 88048	88031 88047				
CENTRAL SOUTH	5				40662			86602			90046/ 90049/ 90123 90023/ 90122			
	6	92339				92328	92434	92228 92108	92109 92230					
	7				94859*		94037	90278	90281		70059*			
SOUTH	8		96625		40448• 40315•		96232	96397	96737/ 96739 96484					96349
	9							98119 98290 98420		40406♦				

NOTE: ★Contract contains 2 pavement thicknesses
• denotes contract partially removed
♦ denotes contract completely removed for historical design features
* denotes contract completely removed for supplemental design

Table 1: Selected Performance Monitoring Sections – Full-Depth HMA Matrix

Table 1 from PRR 165

Splitting Contracts into sub-sections

- The original project is not always completely rehabilitated at the same time.
- There have been a number of sections that have received partial overlays.
- < 25% of contract was overlaid, overlaid portion was truncated.
- 25%-75% was overlaid, the contract was split into sub-sections
- > 75% of contract was overlaid, the remaining portion was truncated.

Survey Results

Survey Section Information

District: 4 County: Tazewell

Key Route: FAI 155 Marked Route: I 155

Contract Number: 88031A Year of Construction: 1991

Pavement Type: HMA Pavement Thickness: 16.75

Survey Section Limits

Beginning: 15.62 Ending: 17.21

Surveyed Lanes: 2 of 4 Direction Surveyed: SB

Overlay: 2000 2012

Traffic Year: 2013 AADT: 17768 PV: 15221 SU: 854 MU: 1693

CRS Year: 2014 CRS Value: 8.4 Average IRI: 31 Average Rut: 0.1

2015 Summary Of Distresses

Lane	Passing Lane			Driving Lane		
Distress	Low	Medium	High	Low	Medium	High
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	13126	0	0
9	0	0	0	0	0	0
13	7	0	0	0	0	0
14	0	0	0	0	0	0
16	0	0	0	0	0	0
18	0	0	0	0	0	0
21	13126	0	0	13126	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	0
27	0	0	0	0	0	0
30	8	0	0	9	0	0
31	0	0	0	0	0	0

Survey Results (cont.)

Survey Section Information

District: 4 County: Woodford

Key Route: FAP 317 Marked Route: US 24

Contract Number: 88067A_2 Year of Construction: 1995

Pavement Type: HMA Pavement Thickness: 13

Survey Section Limits

Beginning: 0.00 Ending: 1.5

Surveyed Lanes: 2 of 2 Direction Surveyed: EB/WB

Overlay: 2010

Traffic Year: 2015 AADT: 6537 PV: 6128 SU: 149 MU: 260

CRS Year: 2014 CRS Value: 6.6 Average IRI: 69 Average Rut: 0.1

2015 Summary Of Distresses

Lane	Passing Lane			Driving Lane		
Distress	Low	Medium	High	Low	Medium	High
1	1948	0	0	716	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	82	0	0
5	0	0	0	0	0	0
6	7344	0	0	0	0	0
9	0	0	0	0	0	0
13	0	0	0	18	0	0
14	0	0	0	0	0	0
16	0	0	0	0	0	0
18	0	0	0	0	0	0
21	7524	0	0	7524	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	0
27	0	0	0	0	0	0
30	54	2	0	32	1	0
31	0	0	0	0	0	0

Distresses Collected

1. ALLIGATOR OR FATIGUE CRACKING
2. ASPHALT BLEEDING
3. BELT CRACKING
4. BLOCK CRACKING
5. CENTER OF LANE CRACKING
6. CENTERLINE CRACKING
9. REFLECTIVE D-CRACKING
13. LONGITUDINAL CRACKING
14. OVERLAID PATCH DETERIORATION
16. PERMANENT PATCH DETERIORATION

Distresses Collected (cont.)

18. POTHOLE & LOCALIZED DISTRESS

21. RAVELING & WEATHERING

22. REFLECTED PATCH JOINT CRACKING

23. REFLECTION CRACKING OF TRANS. JOINTS

24. REFLECTIVE WIDENING CRACKING

25. RUTTING

27. SHOVING/CORRUGATION

30. TRANSVERSE CRACKING

31. PUMPING & WATER BLEEDING

Alligator or Fatigue Cracking

Block Cracking

Centerline Cracking

Raveling and Weathering

Image from NAPA website

Rutting

Historical and Current Design Sections

- The Bureau of Research decided to focus the analysis on pavement designs that are relevant today.
- Research removed various contracts that had design features that are no longer part of IDOT standards.

Table 4 – PRR 165

Table 4 - Historical Sections Removed

Contract Number	Year of Construction	Pavement Thickness	Marked Route	Reason
40315M	1986	9.5	US 50	Pavement 1.5" thinner than design
40315MI	1986	9.5	US 50	Pavement 1.5" thinner than design
40315N	1986	9.5	US 50	Pavement 1.5" thinner than design
40315O	1986	9.5	US 50	Pavement 1.5" thinner than design
40406	1986	16	I 57	HMA does not contain anti-strip
40442	1986	10	I 57	CRCP has recycled aggregates and untied shoulders
40448A	1986	9.5	US 50	Pavement 1.5" thinner than design

Table 5 - Supplemental Designs Removed

Contract Number	Year of Construction	Pavement Thickness	Marked Route	Reason
70059	2003	17.5	I 70	HMA Overlay of Rubblized PCC Pavement
70044	2002	12	I 70	Unboned Concrete Overlay
94859	2004	11.25	I 57	HMA Overlay of Rubblized PCC Pavement

Full-Depth Hot-Mix Asphalt (HMA) Maintenance and Rehabilitation Model

- Found on page 54-7.5 of Bureau of Design and Environment Manual
- This model represents the anticipated maintenance that this pavement will receive over a set length of time and is basis for the life-cycle cost analysis used for pavement type selection.

Full-Depth Hot Mix Asphalt (HMA) Maintenance and Rehabilitation Model

Illinois PAVEMENT DESIGN March 2013

ACTIVITY 1 — YEAR 5
- 100% Longitudinal Shoulder Joint Routing & Sealing
- 100% Centerline Joint Routing & Sealing
- 50% Random/Thermal Crack Routing & Sealing (see Note)
- 0.10% Partial-Depth Pavement Patching (Mill & Fill Surface)

ACTIVITY 2 — YEAR 10
- 100% Longitudinal Shoulder Joint Routing & Sealing
- 100% Centerline Joint Routing & Sealing
- 50% Random/Thermal Crack Routing & Sealing (see Note)
- 0.50% Partial-Depth Pavement Patching (Mill & Fill Surface)

ACTIVITY 3 — YEAR 15
- 2.00 in. Milling - Pavement & Shoulder
- 1.0% Partial-Depth Pavement Patching (Mill & Fill Additional 2.00 in.)
- 2.00 in. HMA Overlay - Pavement & Shoulder

ACTIVITY 4 — YEAR 20
- 100% Longitudinal Shoulder Joint Routing & Sealing
- 100% Centerline Joint Routing & Sealing
- 50% Random/Thermal Crack Routing & Sealing (see Note)
- 0.10% Partial-Depth Pavement Patching (Mill & Fill Surface)

ACTIVITY 5 — YEAR 25
- 100% Longitudinal Shoulder Joint Routing & Sealing
- 100% Centerline Joint Routing & Sealing
- 50% Random/Thermal Crack Routing & Sealing (see Note)
- 0.50% Partial-Depth Pavement Patching (Mill & Fill Surface)

ACTIVITY 6 — YEAR 30

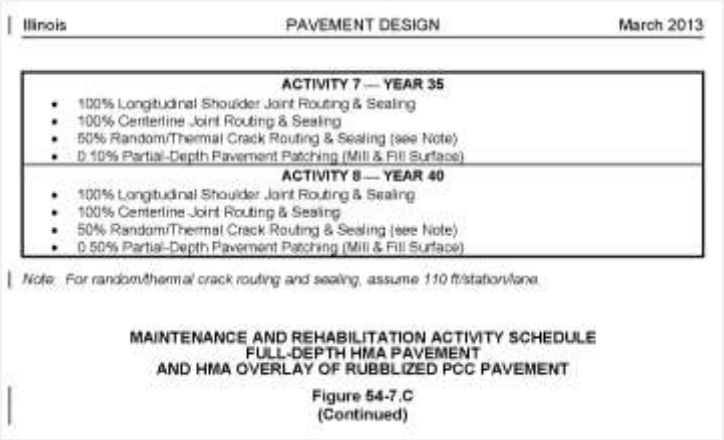
Interstate Standard Design:
- 2.00 in. Milling - Pavement Only
- 2.0% Partial-Depth Pavement Patching (Mill & Fill Additional 2.00 in.)
- 1.0% Partial-Depth Shoulder Patching (Mill & Fill Surface)
- 3.75 in. HMA Overlay Pavement
- 1.75 in. HMA Overlay Shoulder

Other State Maintained Route Standard Design:
- 2.00 in. Milling - Pavement & Shoulder
- 2.0% Partial-Depth Pavement Patching (Mill & Fill Additional 2.00 in.)
- 1.0% Partial-Depth Shoulder Patching (Mill & Fill Additional 2.00 in.)
- 2.25 in. HMA Overlay Pavement & Shoulder

All Limiting Strain Criterion Designs:
- 2.00 in. Milling - Pavement & Shoulder
- 2.0% Partial-Depth Pavement Patching (Mill & Fill Additional 2.00 in.)
- 1.0% Partial-Depth Shoulder Patching (Mill & Fill Additional 2.00 in.)
- 2.00 in. HMA Overlay - Pavement & Shoulder

MAINTENANCE AND REHABILITATION ACTIVITY SCHEDULE
FULL-DEPTH HMA PAVEMENT
AND HMA OVERLAY OF RUBBLIZED PCC PAVEMENT

Figure 54-7.C



Illinois PAVEMENT DESIGN March 2013

ACTIVITY 7 — YEAR 35
- 100% Longitudinal Shoulder Joint Routing & Sealing
- 100% Centerline Joint Routing & Sealing
- 50% Random/Thermal Crack Routing & Sealing (see Note)
- 0.10% Partial-Depth Pavement Patching (Mill & Fill Surface)

ACTIVITY 8 — YEAR 40
- 100% Longitudinal Shoulder Joint Routing & Sealing
- 100% Centerline Joint Routing & Sealing
- 50% Random/Thermal Crack Routing & Sealing (see Note)
- 0.50% Partial-Depth Pavement Patching (Mill & Fill Surface)

Note: For random/thermal crack routing and sealing, assume 110 ft/station/lane.

MAINTENANCE AND REHABILITATION ACTIVITY SCHEDULE
FULL-DEPTH HMA PAVEMENT
AND HMA OVERLAY OF RUBBLIZED PCC PAVEMENT

Figure 54-7.C
(Continued)

Pages 54-7.5 – 54-7.6 of Bureau of Design and Environment Manual

Figure 2 – PRR 165 Percent Patching

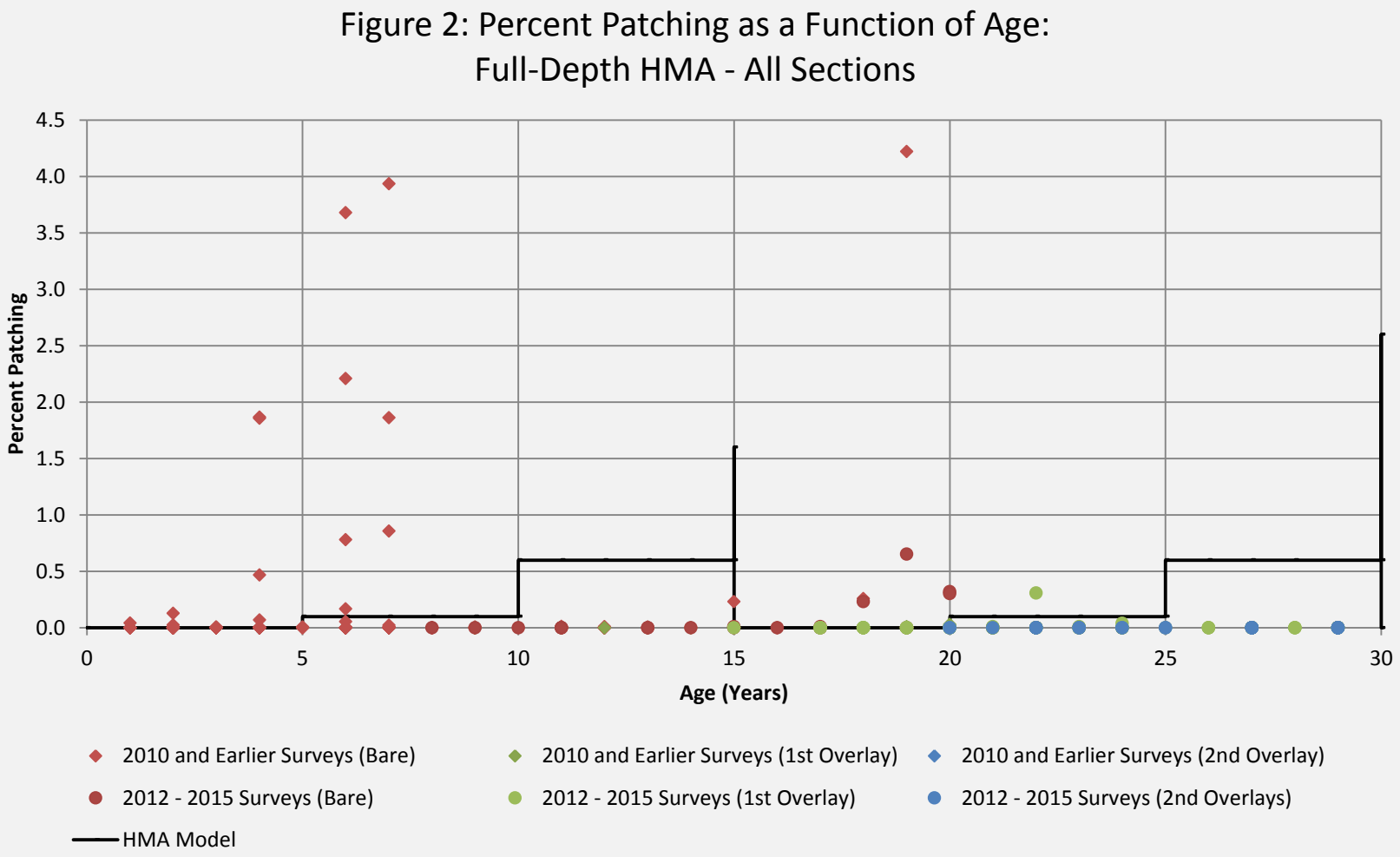


Figure 3a – PRR 165 Current Design Percent Patching

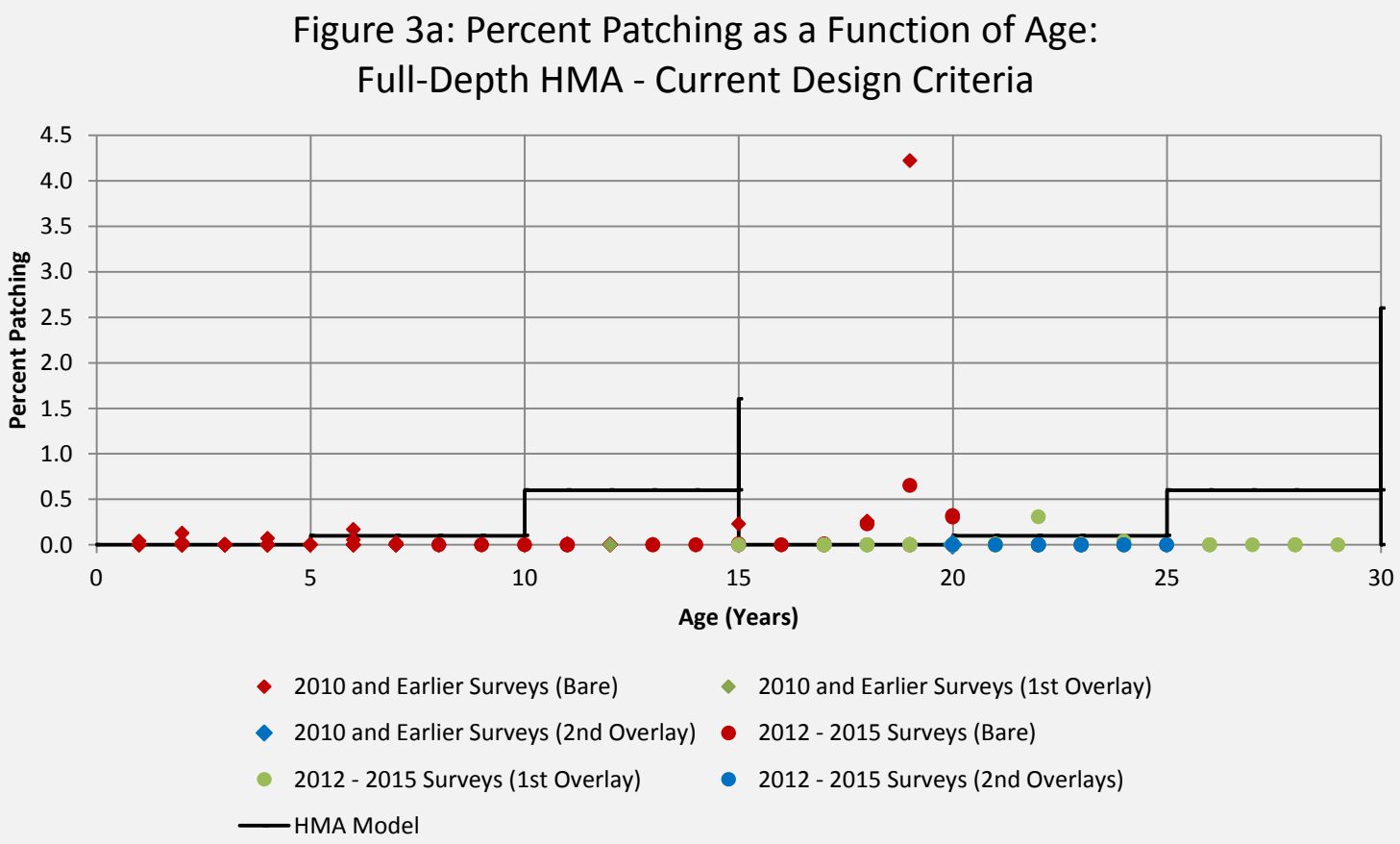


Figure 3b – PRR 165 Current Design Percent Patching

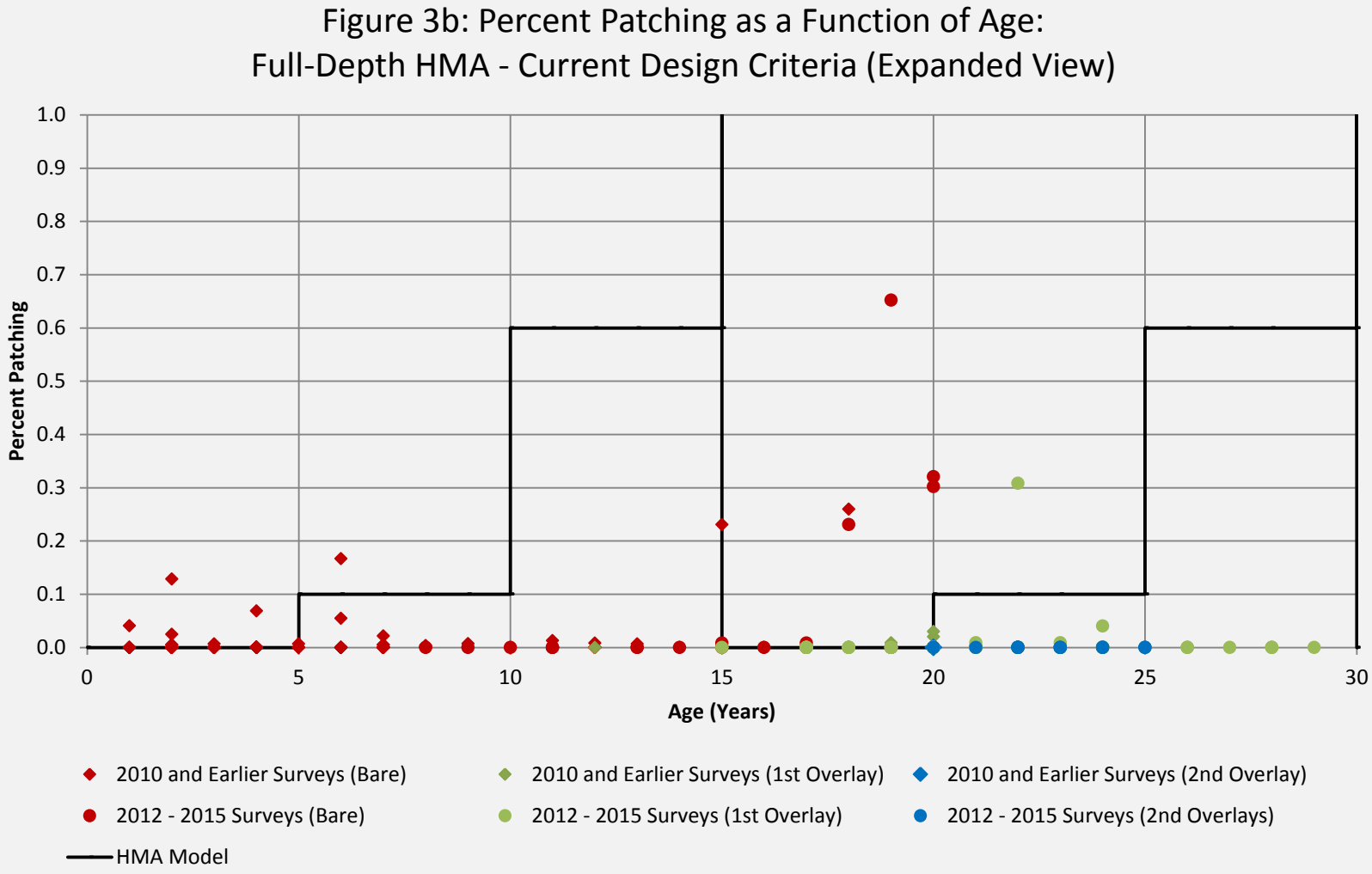


Figure 11 – PRR 165

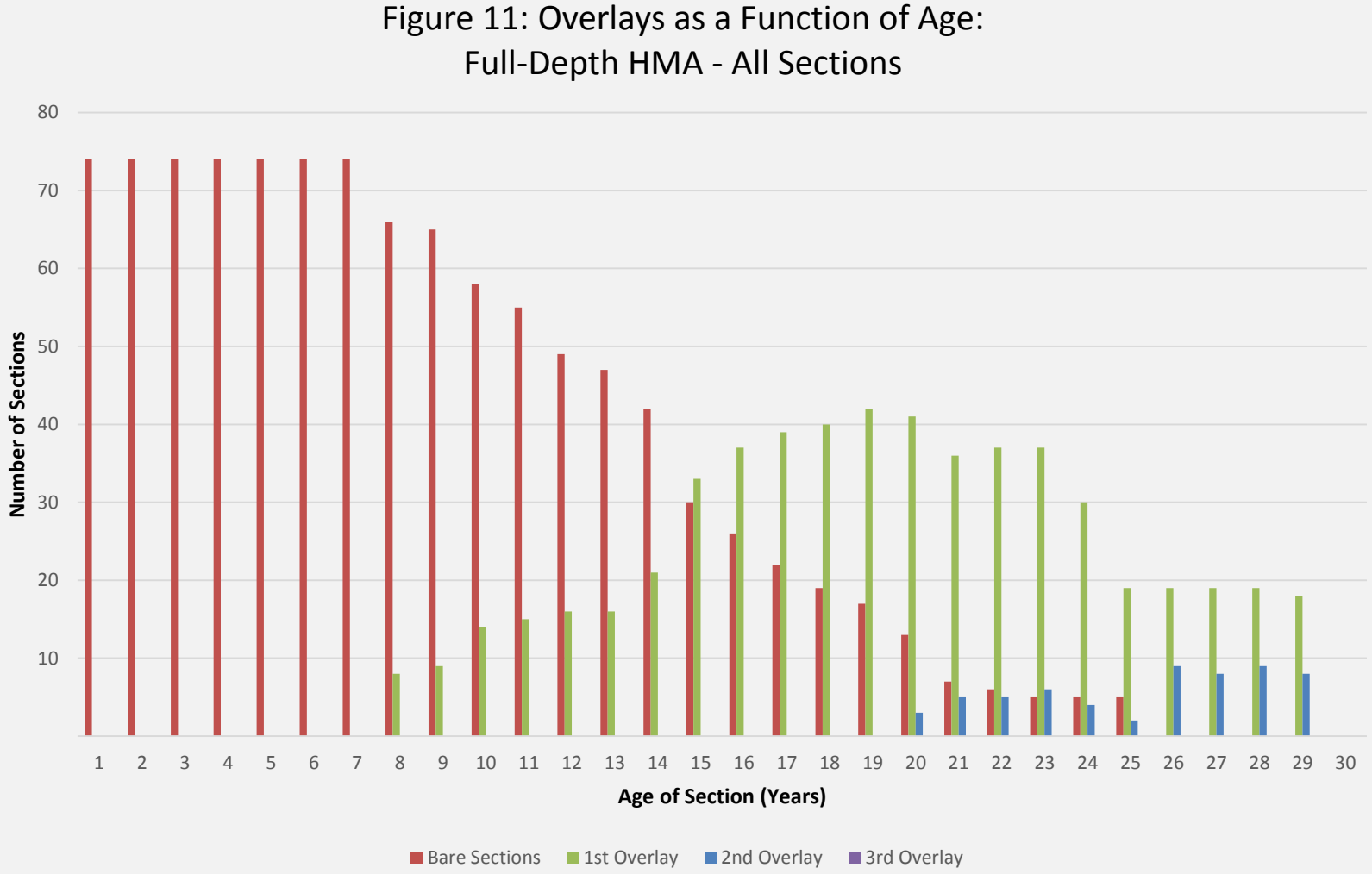
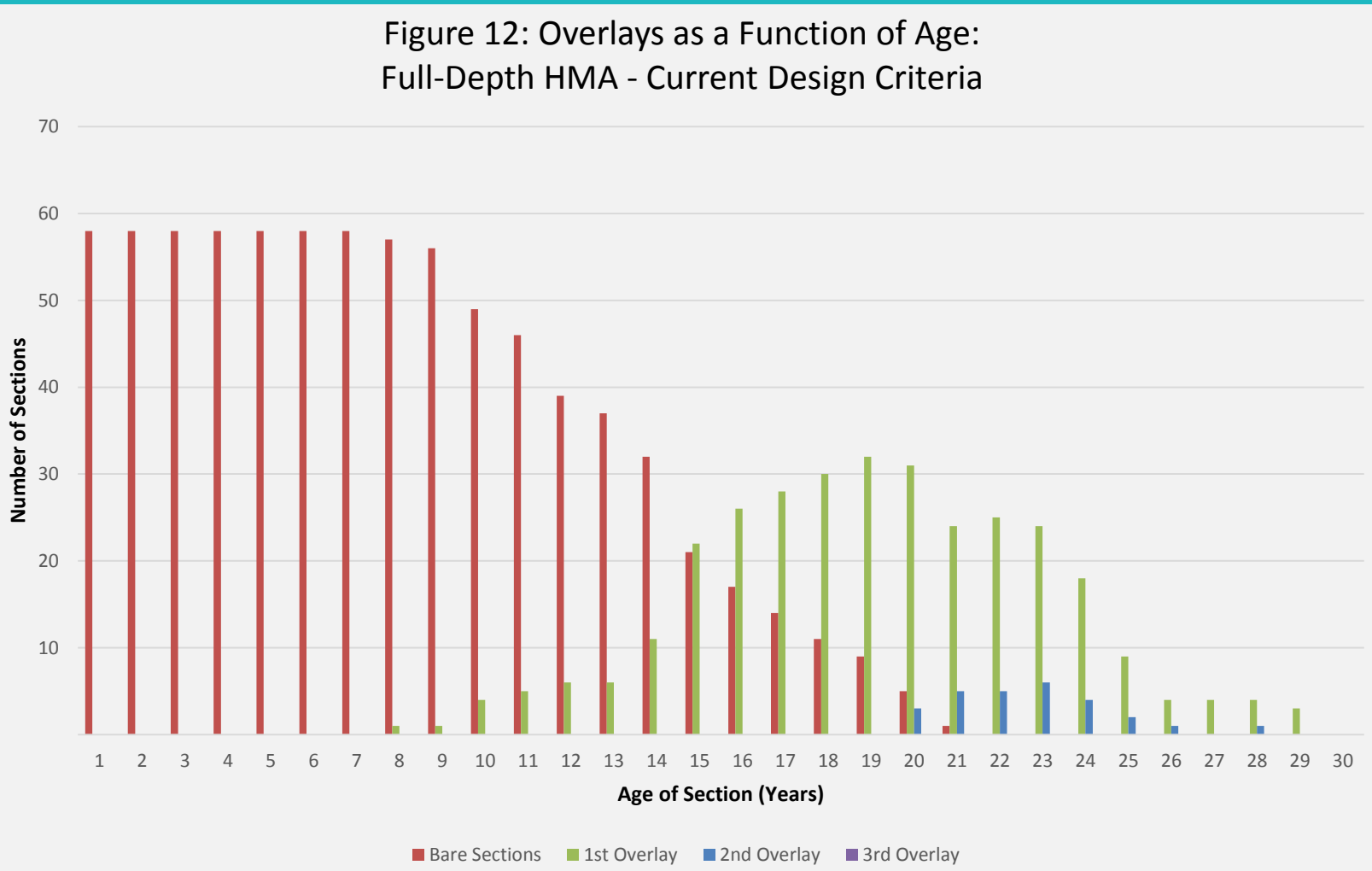


Figure 12 – PRR 165



Service Life of Initial HMA Wearing Surface

Figure 13: Age of Sections: Full-Depth HMA Sections - Current Design Criteria

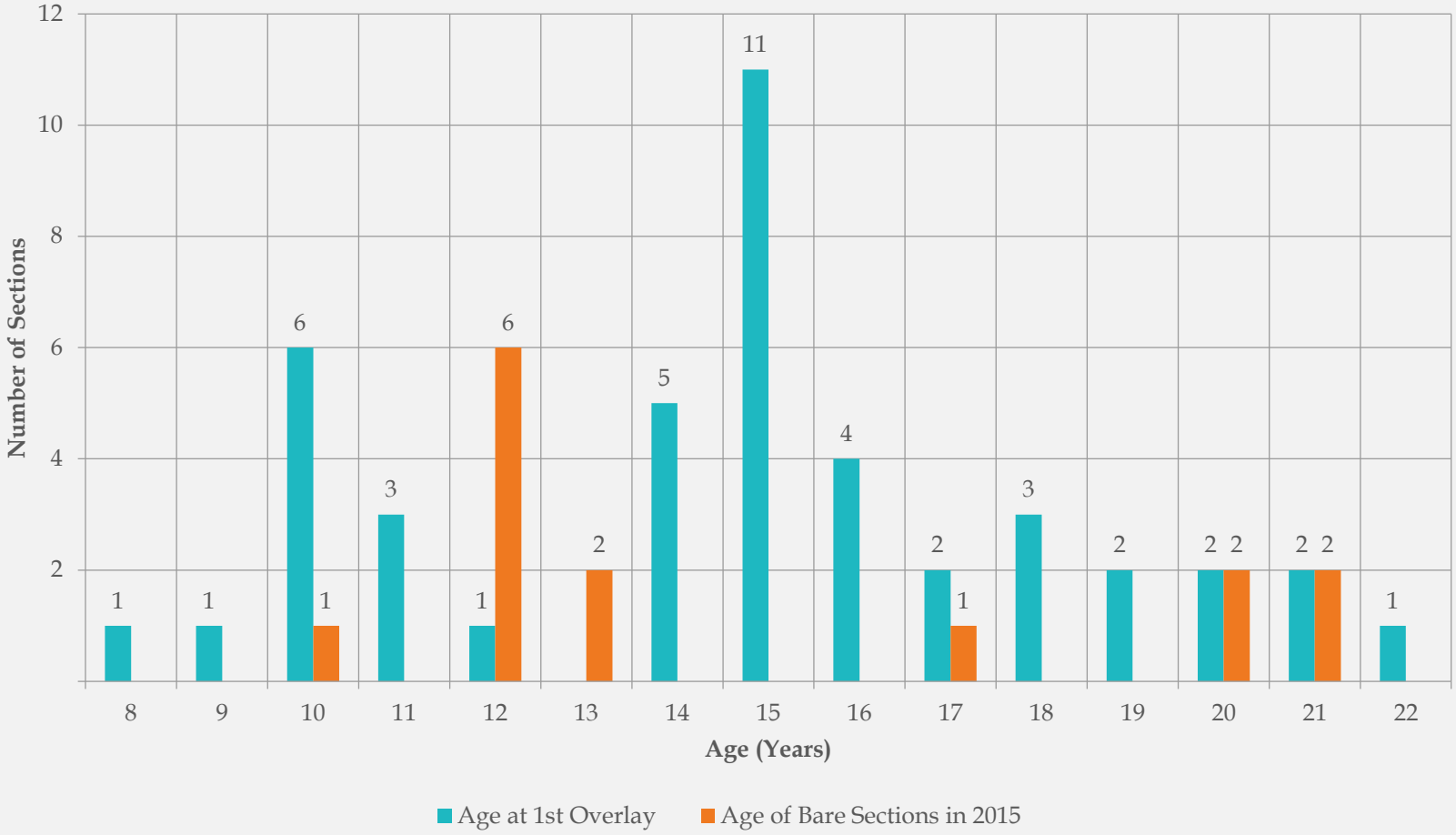


Figure 24 – PRR 165 ESALs

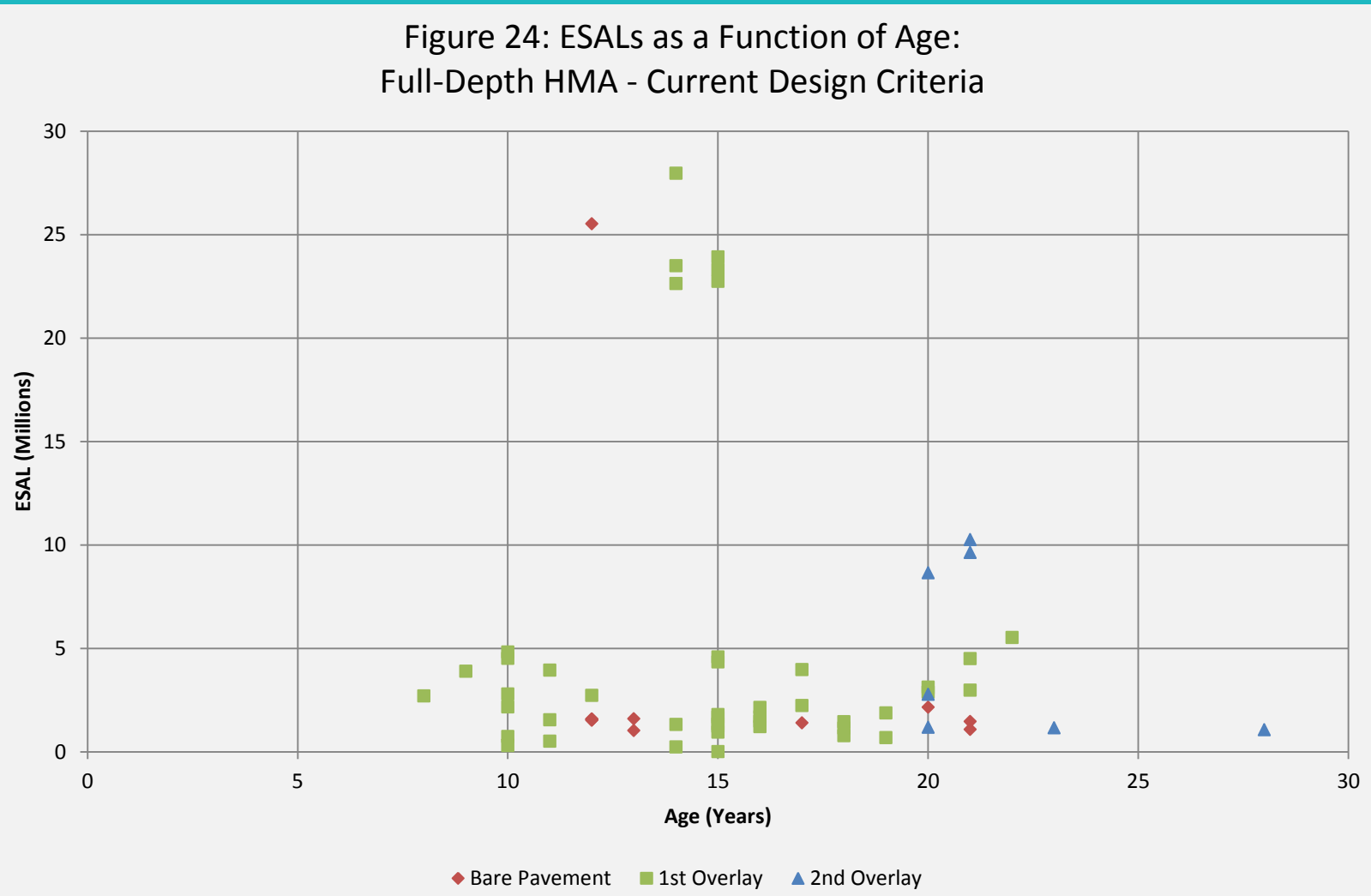
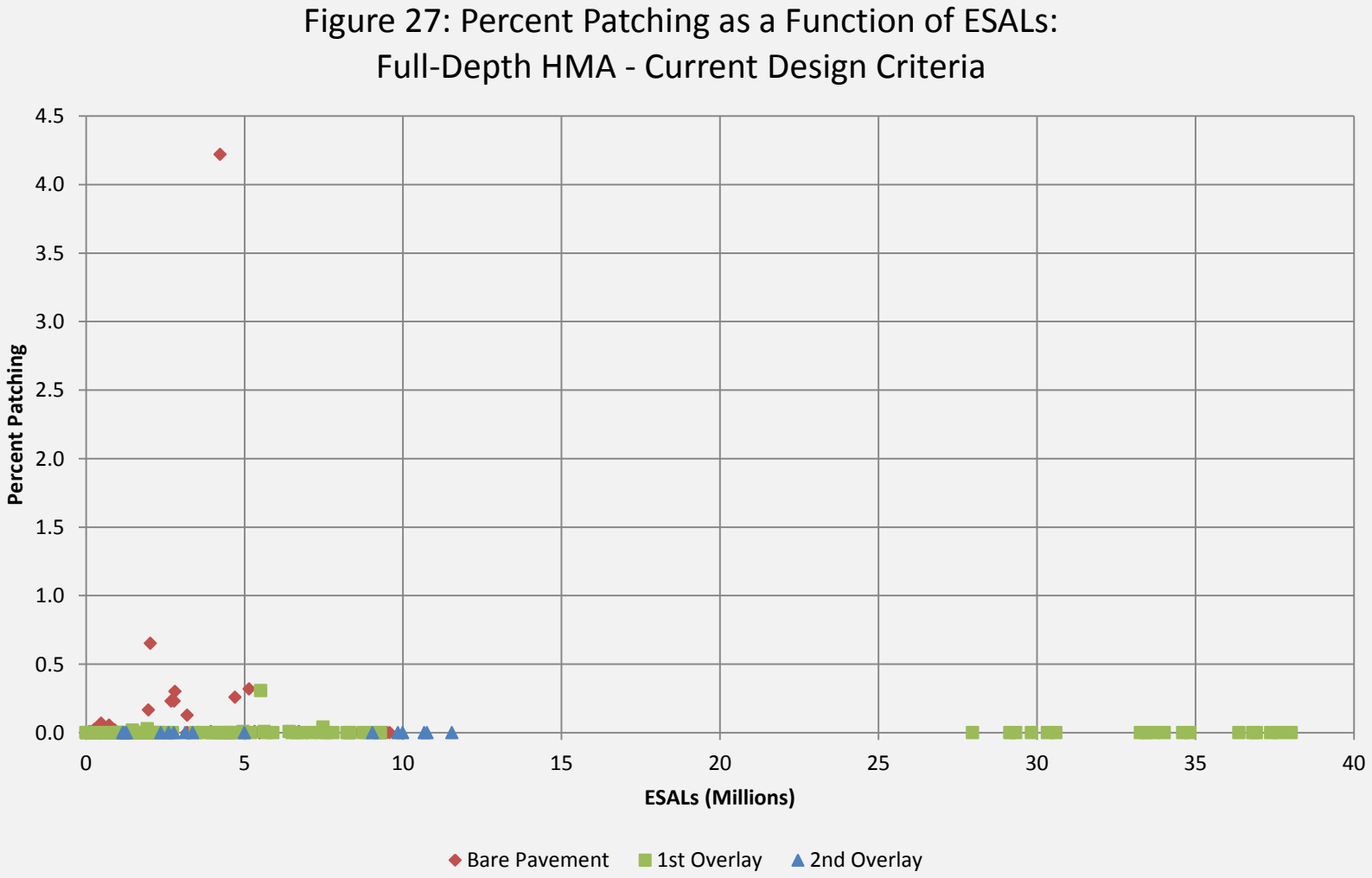


Figure 27 – PRR 165 ESALs and Patching



What is Next? Future Monitoring Efforts

- Bureau of Research added 80 new sections to the monitoring effort this year.
- Supplemental designs (unbonded concrete overlays and HMA over rubblized concrete) added to monitoring list.
- Continued monitoring of sections with pavement preservation treatments to determine their roll in the life cycle models.
- Continue to collect data to fill in the gaps: Communication with the districts about overlays, patching quantities before an overlay, and preservation treatments will be critical.

Questions

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