The Mechanics of Thin Asphalt Overlays

Northwest Pavement Management Association

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AN MDU RESOURCES COMPANY

Why Thin Overlays?

For *preservation* of well-constructed thick asphalt pavements:

- Additional structure may not be critical
- Functional improvements to provide smoothness and safety.

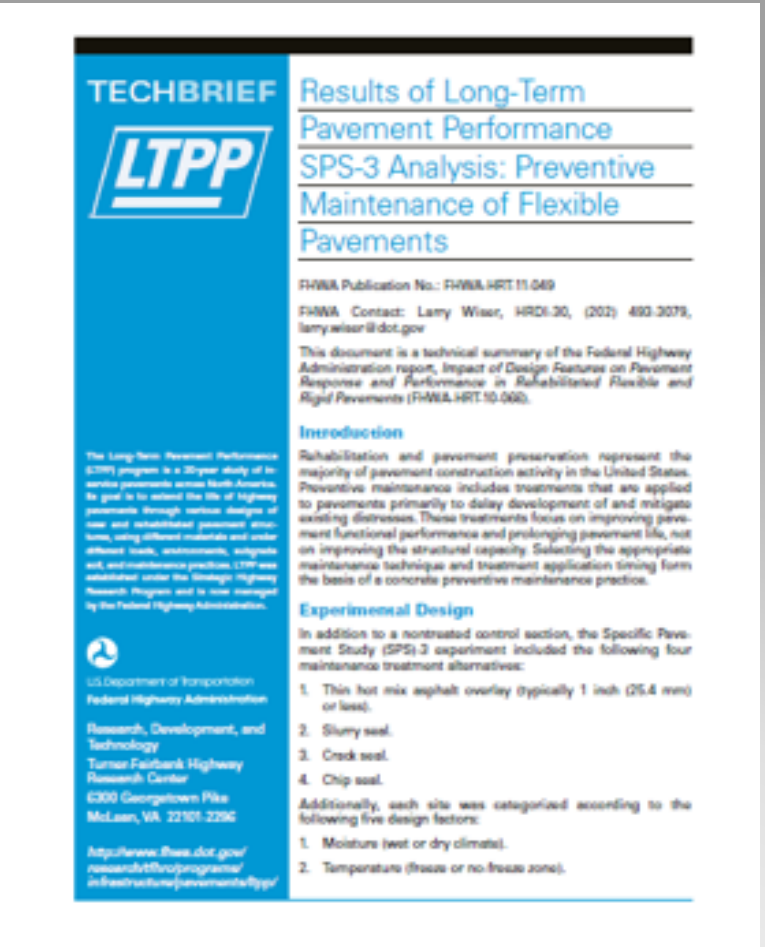
Thin Overlays:

- Cost effective preservation treatment for mitigating distresses confined to the upper layer

- Thin Lift Asphalt Overlays (1½” or less…, commonly 1”) are a proven preservation method of extending pavement life.

How Thin Are We Talking?

Thin Lift Overlay (1½” or Less)



TECHBRIEF

LTPP

Results of Long-Term Pavement Performance SPS-3 Analysis: Preventive Maintenance of Flexible Pavements

FHWA Publication No.: FHWA-HRT-11-049

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This document is a technical summary of the Federal Highway Administration report, *Impact of Design Features on Pavement Response and Performance in Rehabilitated Flexible and Rigid Pavements* (FHWA-HRT-10-066).

The Long-Term Pavement Performance (LTPP) program is a 20-year study of in-service pavements across North America. Its goal is to extend the life of highway pavements through various designs of new and rehabilitated pavement structures, using different materials and under different loads, environments, subgrade soil, and maintenance practices. LTPP was established under the Strategic Highway Research Program and is now managed by the Federal Highway Administration.

U.S. Department of Transportation
Federal Highway Administration

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

http://www.fhwa.dot.gov/research/tfhrc/programs/infrastructure/pavements/ltpp/

Introduction

Rehabilitation and pavement preservation represent the majority of pavement construction activity in the United States. Preventive maintenance includes treatments that are applied to pavements primarily to delay development of and mitigate existing distresses. These treatments focus on improving pavement functional performance and prolonging pavement life, not on improving the structural capacity. Selecting the appropriate maintenance technique and treatment application timing form the basis of a concrete preventive maintenance practice.

Experimental Design

In addition to a nontreated control section, the Specific Pavement Study (SPS)-3 experiment included the following four maintenance treatment alternatives:

1. Thin hot mix asphalt overlay (typically 1 inch (25.4 mm) or less).
2. Slurry seal.
3. Crack seal.
4. Chip seal.

Additionally, each site was categorized according to the following five design factors:

1. Moisture (wet or dry climate).
2. Temperature (freeze or no-freeze zone).

FHWA LTPP SPS–3 (2011)

Preventive Maintenance of Flexible Pavements

Four Treatments Evaluated:

- Thin Lift Overlay (typically 1”)
- Slurry Seal
- Crack Seal
- Chip Seal

Three Pavement Performance Criteria:

- Fatigue
- Rutting
- Roughness

FHWA LTPP SPS–3

Preventive Maintenance of Flexible Pavements

Conclusions:

- Fatigue: "Thin overlay and chip seal were more effective than slurry seal and crack seal treatments and performed better than the control section for fatigue."
- Rutting: "Thin overlay mitigated and slowed the progression of rutting under all circumstances."
- Roughness: "Only thin overlay was effective in mitigating and delaying the progression of roughness."

FHWA LTPP SPS-3

Preventive Maintenance of Flexible Pavements

Advantages of Thin Overlays

Thin Lift Overlays:

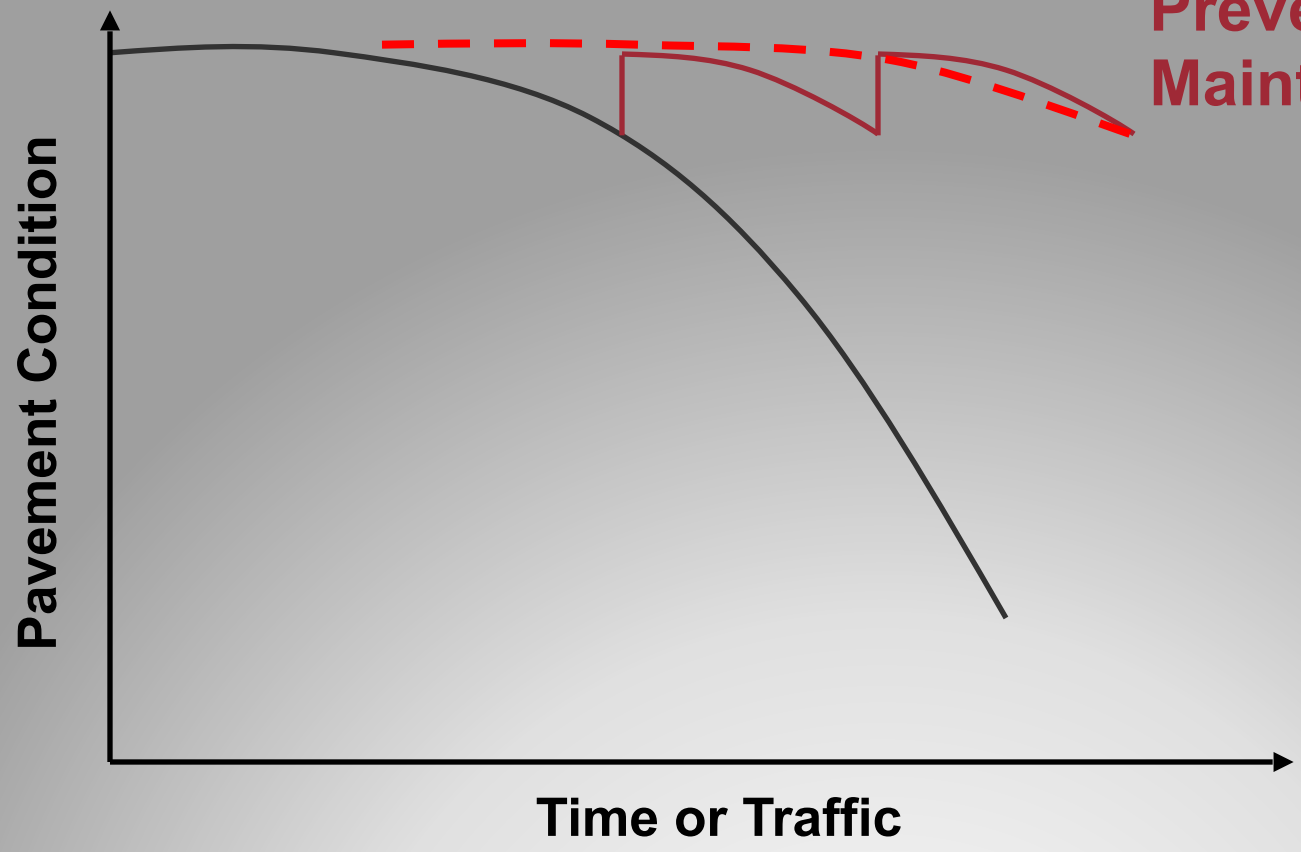
- Maintain grade and slope with minimal drainage impacts
- Withstand heavy traffic and high shear stresses
- Smoothness
- No dust or loose rock issues (think chip seal)
- No fugitive binder (think chip seal)
- No curing time (think chip seal)
- Ability to use recycled material
- Low Life Cycle cost when used appropriately

Appropriate Application

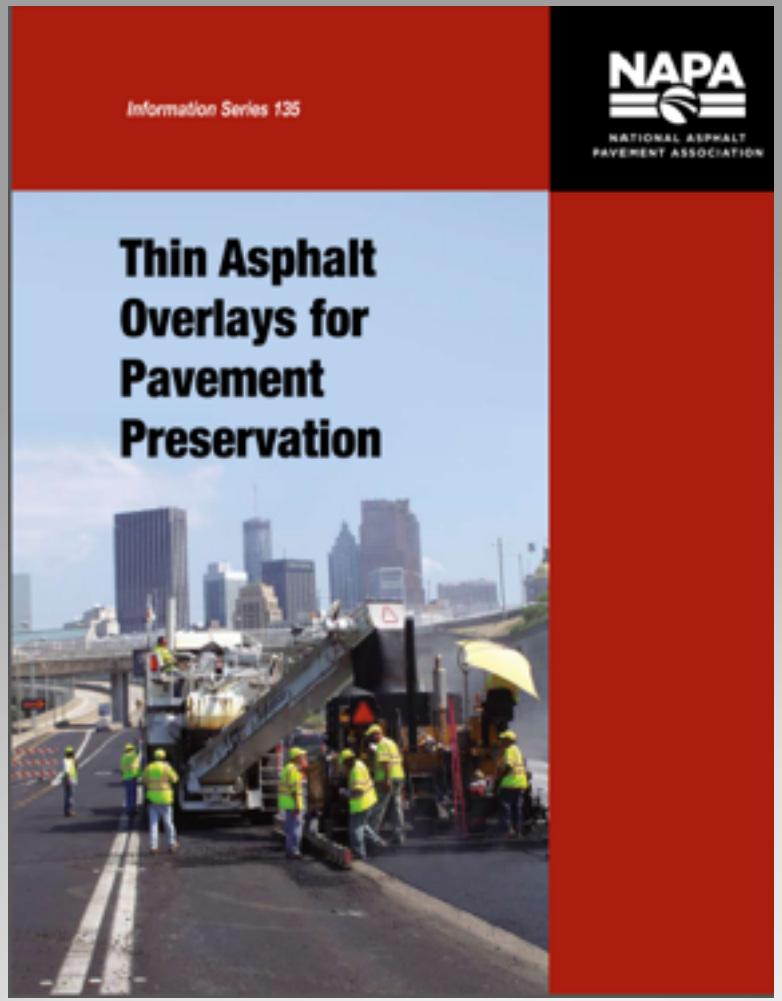
Thin Lift Overlays:

- Should be placed on reasonably sound pavement structures that ***do not*** require a structural rehabilitation.
- Properly constructed can be expected to last 10+ years on asphalt roadways.

Thin Overlays *are not* for Pavements Needing Structural Rehabilitation!!!



Preventive Maintenance



NAPA Info Series 135

Project Selection

- Thin Overlays may be used to:
  - Mitigate Raveling (Studded tire damage)
  - Mitigate *topdown* cracking:
    - Longitudinal cracking not in the wheelpath
    - Transverse cracking
    - Verify depth of topdown cracking by coring
  - Mitigate Rutting
    - Investigate Shoving
  - Milling is generally recommended for topdown cracking and/or rutting or shoving confined to the surface layer

Structural Design

- AASHTO MEPDG …. Not so much…
  (Issues with lifts 1” and thinner…)
- 1993 AASHTO Pavement Design Guide
- Asphalt Institute Asphalt Pavement Thickness Design Guide

Materials for Thin Overlays

- Binder (Asphalt Cement)
- Aggregates
- Recycled Asphalt Material

Binder (Asphalt Cement)

- Use the appropriate PG grade for the climate and traffic.
  - LTPP Bind Software
  - Adjust accordingly if using RAP/RAS
- Polymers should be considered for very high traffic applications. ("ER", Kraton, etc.)

Aggregate Size

- Logic dictates that smaller nominal maximum aggregate size (NMAS) will be required for thin lift overlays.
  - NCHRP Report 531 recommends the NMAS to be 1/3 to 1/4 the lift thickness
  - For a 1” thin overlay, the NMAS should be 3/8” or smaller.
  - For ultra-thin overlays: NMAS No. 4

Aggregate Quality

- Routine production QC testing by a Certified Aggregate Technician:
  - Sieve Analysis
  - Sand Equivalent (Methylene Blue)
  - Fracture
- Product compliance testing:
  - Sodium Sulfate Soundness
  - Plasticity Index

Blend Sand

- NCAT recommended additional research to study the impacts of natural sand.
  - The mixes studied by NCAT had very high VMA's (15.8 – 24.2% with resultant asphalt contents 6.2 – 11.8%)
  - Recommendation: Allow blend sand up to 10% for traffic levels < 10 million ESALs with no slow or standing loads.

Recycled Asphalt Materials

- Recycled Asphalt Materials (RAM):
  - RAP
  - RAS (Shingles)
  - RAP/RAS Blends (SuperRAP)
  - Process all RAM to a size comparable to the nominal maximum aggregate size of your mix
  - Use AASHTO/DOT recommendations on RAM quantities and require AASHTO Blending Procedure for higher amounts

Mix Design

- Require a qualified laboratory prepare the design
- Use AASHTO/DOT Standard Specs for 1/2” and 3/8” mixtures
- Follow NCAT Report 11–01 for No. 4 mixtures

NCAT Report 11–01: No. 4 Mixes

- NCAT has refined the guidelines for the 4.75mm (No. 4) size mix listed in SuperPave™
- They looked at mixes from 12 states and performed both laboratory and field studies

- Allows a design void range of 4.0 – 6.0%
- Replaces VMA and VFA with V_{be}

Calculated as follows: $V_{be} = VMA - V_a$

- Dust to Effective Range:
  - 1.0 – 2.0 for < 3 mil ESALs
  - 1.5 – 2.0 for > 3 mil ESALs
- Control Points:
  - No. 16: 30 – 55%
  - No. 200: 6.0 – 13.0%

NCAT Report 11-01

- Recommendation for Ideal Targets
  - Developed from the VMA vs. Blend data for NCAT's twelve 50 gyration mixes and six 75 gyration mixes, and Oregon's one 80 gyration mix

No. 4 Mix
Ideal Gradation Targets

Sieve	%Passing	Control
3/8”	100	100
No. 4	95	90 – 100
No. 8	70	90 max
No. 16	45	30 - 55
No. 30	30	
No. 50	20	
No. 100	15	
No. 200	8.5	6.0 – 13.0

No. 4 Ideal Targets

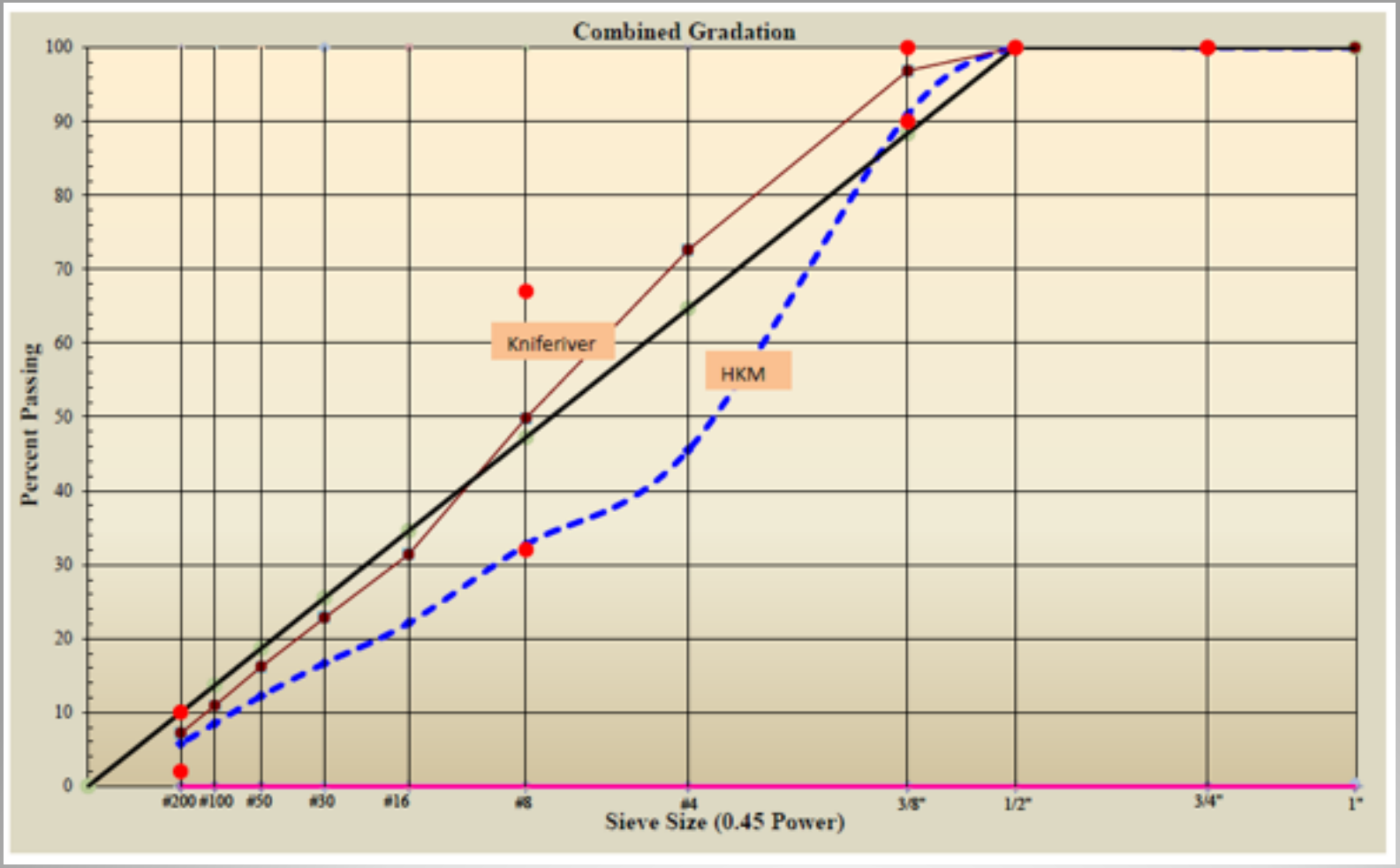
Performance Testing

- AASHTO T 283 Tensile Strength Testing : All mixtures
- Rut Testing : Traffic > 3 million ESALs

Hamburg Wheel-Track Device

Hamburg Wheel-Track Device

- Typical Rut Criteria:
  - WsDOT: 10 mm max @ 15,000 passes
  - MDT: 13 mm max @ 15,000 passes
  - UDOT: 10 mm max @ 20,000 passes
- Relatively severe test…. (uses steel wheel)
- Known to intimidate mix designers into gap-grading mixes……



Hamburg Wheel-Track Testing

Hamburg Wheel-Track Testing

Operator	A. Ford	Run Date	1/14/2014
Test Sample			
Date Compacted	1/13/2014		
Project Number	DOWL HKM	Binder Content, %	5.50%
Project Name	Bozeman District	Binder Grade	CHS PG 70-28
Lab Sample No.	HKM Blend	Sample Type	Information
Other	Tested for information purposes only.		
Total Passes	15,000		
Final Impression @ Middle of Track	5.3 mm	**Average Final Impression**	5.2 mm
Maximum Final Impression	5.7 mm		

Operator	A. Ford	Run Date	1/15/2014
Test Sample			
Date Compacted	1/14/2014		
Project Number	DOWL HKM	Binder Content, %	5.50%
Project Name	Bozeman District	Binder Grade	CHS PG 70-28
Lab Sample No.	Knife River Blend	Sample Type	Information
Other	Tested for information purposes only.		
Total Passes	15,000		
Final Impression @ Middle of Track	6.5 mm	**Average Final Impression**	6.6 mm
Maximum Final Impression	6.8 mm		

Hamburg Wheel-Track Testing

Main St. Bozeman, MT (3/8” Mix)

Gap-Graded 3/8”

Construction

- Plant Production
- Laydown
- Quality Control

Plant Production

Plant Production

- Moisture:
  - Fine Aggregates tend to have the most moisture
  - May require additional drying time
  - Will create a heavier veil in the drum
- Mixing:
  - More surface area to coat may require additional time for mixing

Laydown

Laydown

- Bonding is critical
  - Milling is preferred
  - Heavier Tack Shot Rate: (0.10 - 0.15 gal/yd^2)
- Mat cooling is greatly accelerated
  - 1” mat cools twice as fast as a 1½” mat
    - Don’t let the paver outrun the rollers
- Generally Static Compaction

Quality Control

- Require a qualified Asphalt Technician at the plant to measure mixture properties
- Density measurement is not normally performed.
- Establish a roller pattern and stick to it…

15th Street – Dalton Gardens, ID

- 1” Thin Overlay
- Primary distress was transverse cracks
- 3/8” Mix
- 50 Gyration Design (< 1 million ESALs)

15th Street – Dalton Gardens, ID

- Cost of Paving:

$3.93/SY

- Cost of Paving Including Mobilization, Minor Pavement Repair, Pavement Markings, and Traffic Control:

$4.63/SY

15th Street – Dalton Gardens, ID

Thin Lift Program - Hayden, ID

2014

- 2500 tons
- 3/8” mix
- 50 gyrations
- PG 58-28 &
  PG 64-28 Binder
- Multiple Streets

Thin Lift Program - Hayden, ID

- Placed by City Forces
- 1” and 1 ½” Lifts
- Used STE -1 Quick Set Tack
- FOB Price $47.27/ton

Thin Lift Program - Hayden, ID

- 8600 lineal ft.
- 2 & 4 Lane Sections
- Delaminating Slurry Seal
- Original Design:
  - 1” Micro Mill
  - Single Chip Seal with ½” Rock & Fog Coat
- Contractor Proposed:
  - 1” Micro Mill
  - 1” Thin Overlay

Walnut Blvd – Corvallis, OR

Walnut Blvd

Walnut Blvd

2008 NAPA Survey of State Asphalt Associations

Treatment	Expected Life, yrs	Range	Cost, $/ SY	Range	Annual Cost, $/lane-mile
Chip Seal	*4.08*	*2.5 - 5*	*2.06*	*0.50 – 4.25*	*3,554.51*
Slurry Seal	*3.25*	*2 - 4*	*1.78*	*1.00 – 2.20*	*3,855.75*
Micro-surfacing	*4.67*	*4 - 6*	*3.31*	*2.30 – 6.75*	*4,989.81*
Thin Surfacing	*10.69*	*7 - 14*	*4.52*	*2.40 – 6.75*	*2,976.69*
Walnut Blvd	*10.00*	*n/a*	*3.93*	*n/a*	*2,075.00*

Life Cycle Costs

Conclusions

- Thin Overlays had better performance.
- Thin Overlays had lower life cycle cost.
- Thin Overlays offer Owner/Agencies a viable preventive maintenance tool.

Questions?