



Pavement Evaluation 2014
September 15-18, 2014 ▼ Blacksburg, Virginia

Pavement Evaluation 2014

Virginia Tech

September 15 – 18, 2014
Resource International, Inc.



Presented by:
Todd Majidzadeh
Julie Miller, PE
Cherif Amer-Yahia, PhD, PE

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

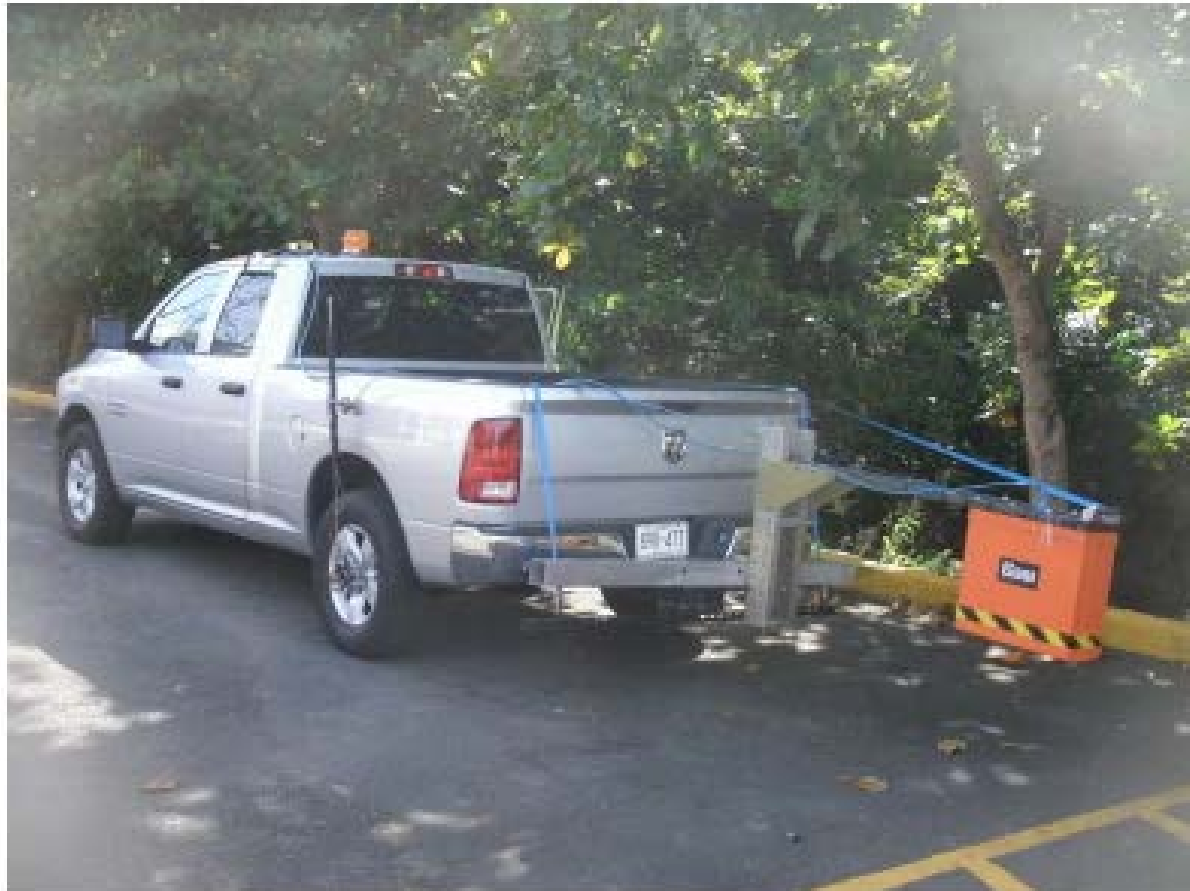
GPR for Pavement Rehabilitation

- Rii was retained by the Client to perform GPR scans for use in pavement rehabilitation program on major toll road (AADT = 250,000)
 - Locate areas of high moisture content
 - Determine thickness of existing layers
 - Identify/locate voids
 - Detect areas of stripping
- Used non-contact horn antenna with center frequency of 1 GHz
- Data collected from right wheel path of each lane
- Project included 44.71 Km of toll road with up to 8 to 10 lanes of traffic

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

GPR System Used During Data Collection



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

GPR Findings

- Rii determined that the existing asphalt was severely stripped in many areas indicated by out-of-phase reflection peak
 - Radar wave travels from higher to lower dielectric material
 - Low dielectric a function of low density of the stripped material

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

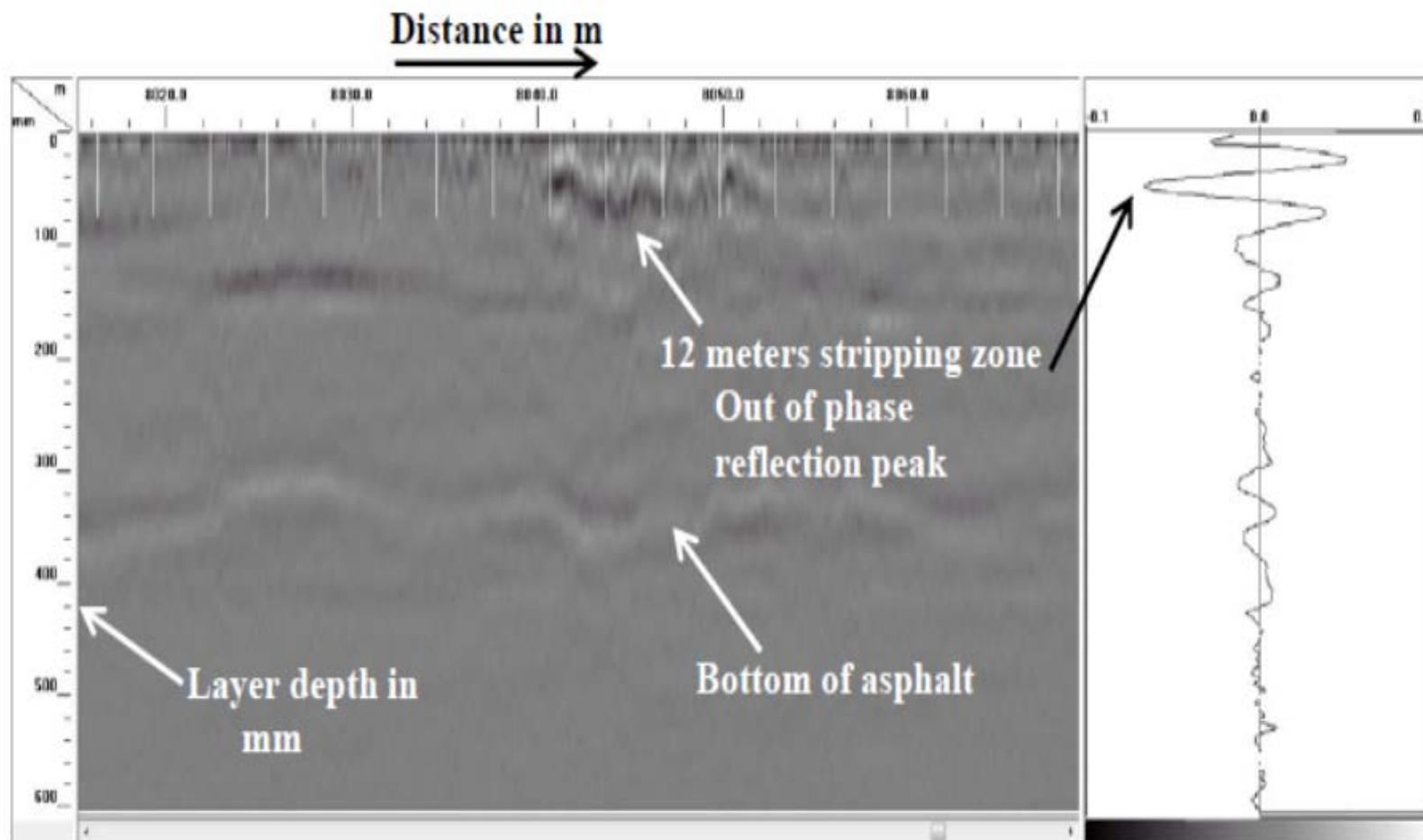


Figure 1. Detection of stripping

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Premature Pavement Failure

- As a result of the GPR findings, the Client further retained Rii to evaluate premature pavement failure of recent rehabilitation

Toll Road	Section (Km)		Section Total (Km)	# of Lanes	Pavement Type
	From	To			
PR-22	1.00	7.61	6.61	8-10	Flexible
PR-22	13.60	22.60	9.00	6	Flexible
PR-5	5.75	9.75	4.00	5-6	Flexible
PR-22	71.00	72.00	1.00	4	Flexible
PR-22	83.40	85.00	1.60	4	Flexible
PR-22	33.00	45.00	12.00	4	Rigid
PR-22	64.00	71.00	7.00	4	Rigid
PR-22	80.00	83.50	3.50	4	Rigid

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

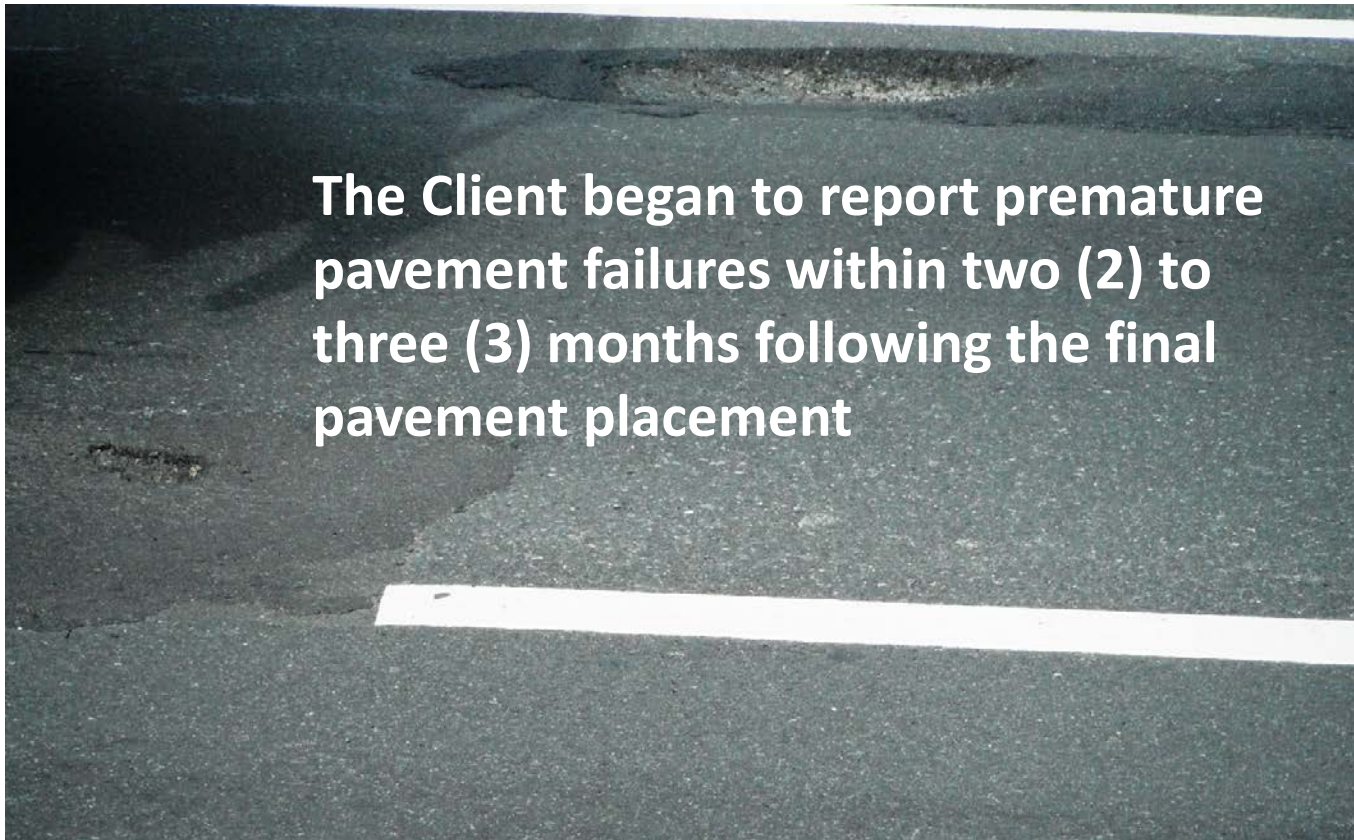
Premature Pavement Failure

- The Client began to report premature pavement failures within two (2) to three (3) months following the final pavement placement
- Potholes, delamination, and staining reported
- Failures continued to occur

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Premature Pavement Failure



The Client began to report premature pavement failures within two (2) to three (3) months following the final pavement placement

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Premature Pavement Failure



**Potholes, delamination,
and staining reported**

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Pavement Staining



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii's Investigative Approach

- Review construction, materials, and testing records
- Site visit and interviews with owner and consultants
- Obtain pavement cores and test for specific parameters
 - Conformance to mix design
 - Potential for stripping

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Construction Review

- Three types of treatments
 - Cold milling and overlay (2") – used most extensively throughout the project
 - Cold milling and overlay with geogrid (3")
 - Full depth repair and overlay
- Most work performed at night
- Tropical climate (rain, high temps, humidity)
- Warm Mix Asphalt
 - Rediset[®] WMX with anti-stripping agent
- Construction August 2012 – March 2013

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Construction Review

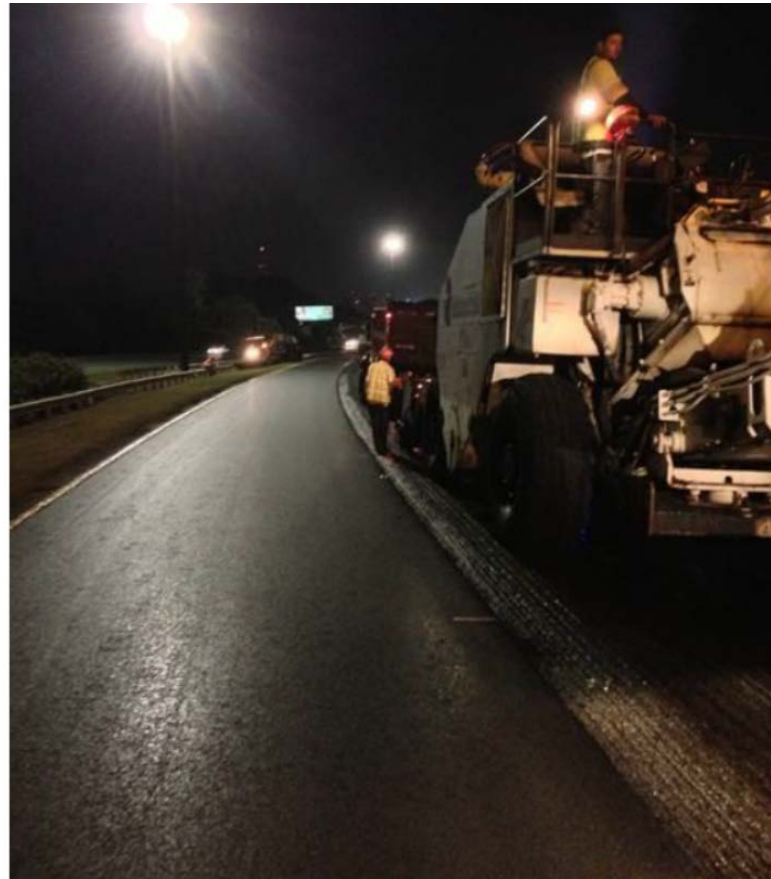
- Construction records indicate there were areas of unsound pavement after cold milling
 - These were addressed by additional milling
- Milled pavement left open to traffic for up to 25 days (3 to 5 typical)
- Surface cleaned and tacked prior to paving – tack pick up noted in project photos
- MTV used with standard paver- most work at night
- Mix temps were within specification
- Rain reported in 10 of 41 paving lots

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia



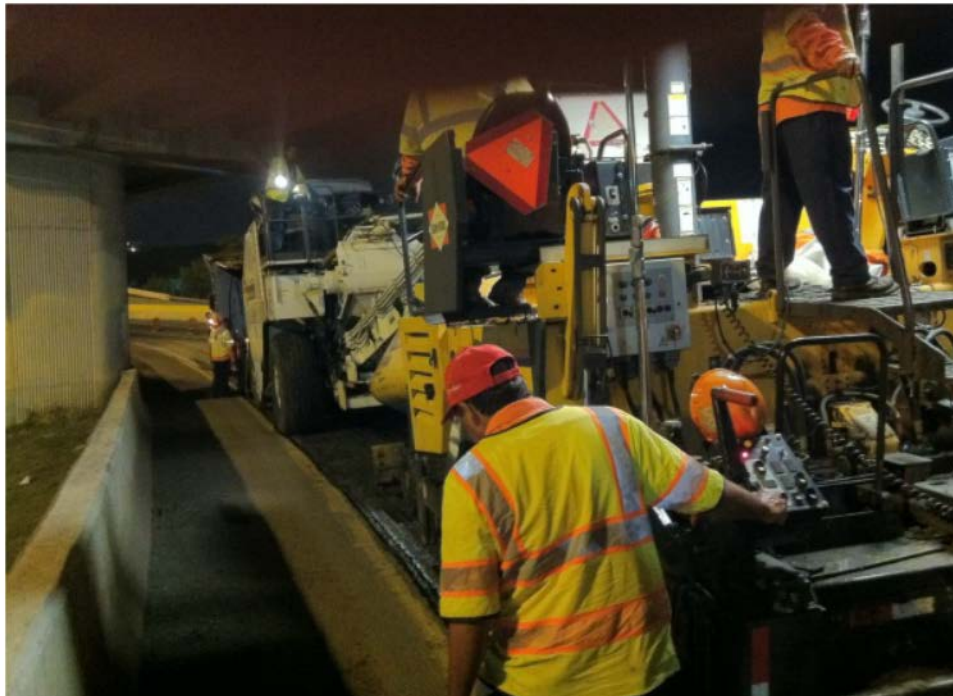
Suspect area after milling



Typical night paving operation – note the paver tire track pick up

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia



Pavement Evaluation 2014

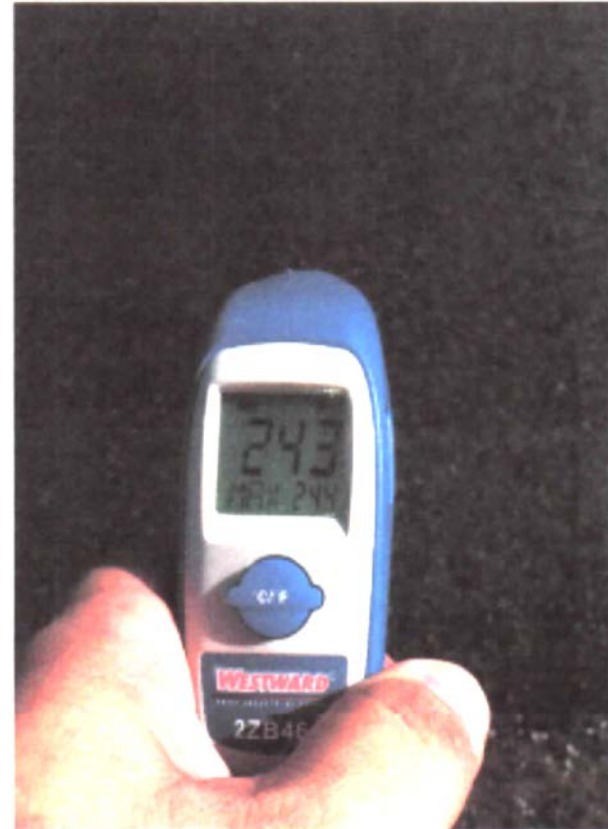
September 15-18, 2014 ▼ Blacksburg, Virginia

Construction Review

- Generally the mix was reported as acceptable in field
- Air voids were reported to generally be in specification
 - Ave. in-place compaction of 92 to 97% met in all but 2 lots
 - Some individual in-place compaction less than spec

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Post Construction Testing Review

- Contractor performed testing of pavement cores
- Determined:
 - Permeability of overlay was very low
 - Saturation of cores 58 to 75% in new surface and existing asphalt in distressed areas
 - Potential for stripping based on TSR was low (AASHTO T-283) in new overlay with no distress; but high in areas of distress

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Post Construction Testing Review

- Contractor in-situ moisture (% Saturation) was inconsistent with the results of the GPR testing performed by Rii
- Rii evaluated the dielectric constants in two (2) distressed areas to assess moisture conditions in the asphalt layers

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Post Construction Testing Review

- Overall the GPR test data indicated that the asphalt material (new and existing) generally had low moisture content and the aggregate base material was generally dry

Location	Lane	LPN	Average Dielectric Constant - Surface	Average Dielectric Constant – Existing Base Asphalt
Km 3.389 – 3.438 EB	3	14	6.02	6.53
	4	14	6.22	6.63
Km 4.478 – 4.438 EB	5	6	6.83	7.31
	Ramp Lane	6	6.70	7.10

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Post Construction Testing Review

- Contractor determined:
 - Water was infiltrating up through base material from bottom or sides and through cracks in the old asphalt
 - Temperature fluctuations and traffic action caused pore water pressure in old damaged asphalt to fracture the asphalt-aggregate bond in the new overlay

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Site Visit - Observations

- Potholes were observed in lower elevation areas and at higher elevations such as on ramp embankments
- Many potholes appeared in wheel paths
- Potholes appeared to be depth of overlay
 - Overlay material appeared delaminated from the milled surface with loose material in the associated pothole
 - Distresses appeared consistent with stripping, either a cohesion failure between the aggregate surface and asphalt binder; or an adhesion failure within the asphalt binder itself.
- Project area is in coastal plane
- During rainfall event lower elevation areas showed evidence of ponding water in ditches.

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing

- Cores obtained from 1 production lot represented distressed and non-distressed areas:
 - Area A with visible distress at a relatively low pavement elevation area.
 - Area B with visible distress at a relatively higher pavement elevation area.
 - Area C without visible distress.

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing

- Gradation & Percent passing sieve #200
- Percent binder (asphalt) content
- In-place air void content
- Moisture susceptibility testing (AASHTO T 283), Tensile Splitting Ratio (TSR)

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia



Pavement Evaluation 2014

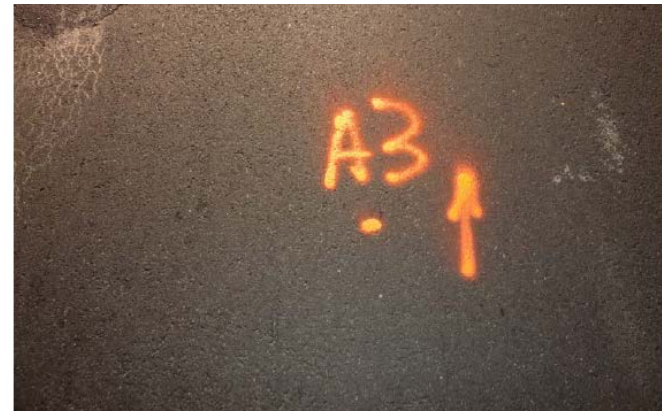
September 15-18, 2014 ▼ Blacksburg, Virginia

A-3



A. Area with visible distress at a relatively low pavement elevation area.

Cold mill to ~3" inches; ~1-inch WMA leveling course; geogrid; and ~2" inches of WMA surface course.



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

A-4



A. Area with visible distress at a relatively low pavement elevation area.

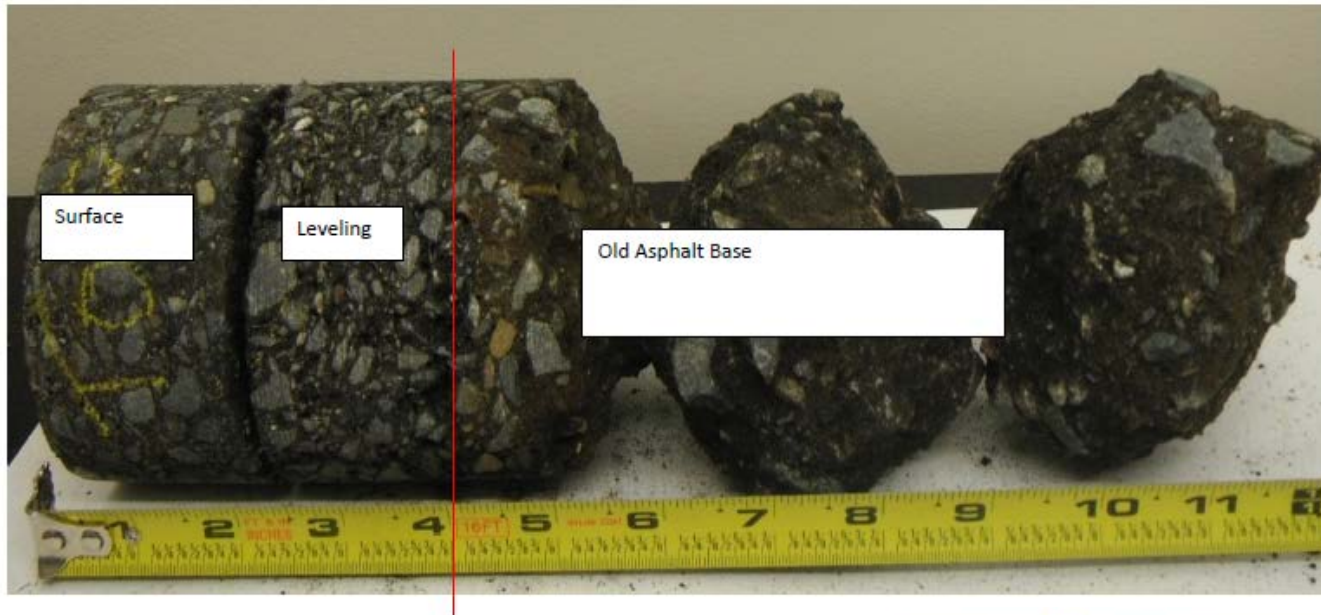
Cold mill to ~3" inches; ~1-inch WMA leveling course; geogrid; and ~2" inches of WMA surface course.



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

B-2



B. Area with visible distress at a relatively higher pavement elevation area.

Cold mill to ~3" inches; ~1-inch WMA leveling course; geogrid; and ~2" inches of WMA surface course.



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

B-1



B. Area with visible distress at a relatively higher pavement elevation area.

Cold mill to ~3" inches; ~1-inch WMA leveling course; geogrid; ~2" inches of WMA surface course.



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia



C. Area without visible distress.

Cold mill and place ~2" of WMA surface course.

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

C-3



C. Area without visible distress.

Cold mill and place ~2" of WMA surface course.



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing - Gradation

- Gradation tests indicated that the mixes in all three areas (A, B and C) had similar gradation characteristics with little or no variability
- There was not excessive material passing the #200 sieve

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing – Binder Content

- Percent Binder (Asphalt) Content of the new surface mix ranged from 5.9 to 6.7 as compared to the JMF of 5.52

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing – In place AVs – New Surface Course

- Average percent air voids ranged from 4.823 to 6.421
 - Area A with visible failures and relatively low elevation had lowest average air voids (highest average in-place compaction of 95.2%)
 - Area C with no visible failures had the highest average air voids (lowest average in-place compaction of 93.6%)
 - All within specification and not statistically different

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing – In place AVs – Existing Asphalt Base Course

- Average percent air voids ranged from 10.125 to 6.284 (89.9 % to 93.7% average in-place compaction)
 - Area A with visible failures had the lowest average in-place compaction of 89.9%
 - Area C with no visible failures had the highest average in-place compaction of 93.7%.

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Testing - TSR

Test Area	Average Strength, Unconditioned (Dry) Samples, psi	Average Strength, Conditioned (Wet) Samples, psi	Strength Ratio
A-Top	120.5	105.1	0.87
B-Top	104.5	77.5	0.74
C-Top	104.2	87.5	0.84
JMF	130.9	130.7	0.969
Spec	80	80	0.75
A-Bottom	126.6	71.55	0.56
B- Bottom	121.3	77.44	0.64
C- Bottom	153.4	102.97	0.67

Contractor's testing of new surface had TSR results of 0.33 to 0.51 in distressed area; and 0.96 to 1.05 in non-distressed area; and TSR of 0.75 of existing asphalt for both distressed and non-distressed areas



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Determination

- Mix was not the issue; the new asphalt overlay
 - was within specification for gradation, binder content, TSR
 - Field compaction was within specification
- Existing asphalt had areas of stripping
 - Evidenced using GPR and confirmed with cores

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Determination

- Construction practices suspect
 - Cold milled surface left open to rain and traffic
 - LPN 15 left open from 6 to 11 days

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Determination

- Water entered old stripped asphalt matrix and was trapped when overlay was placed
- Trapped water can condense causing pressure in matrix in turn causing potholes in new asphalt course

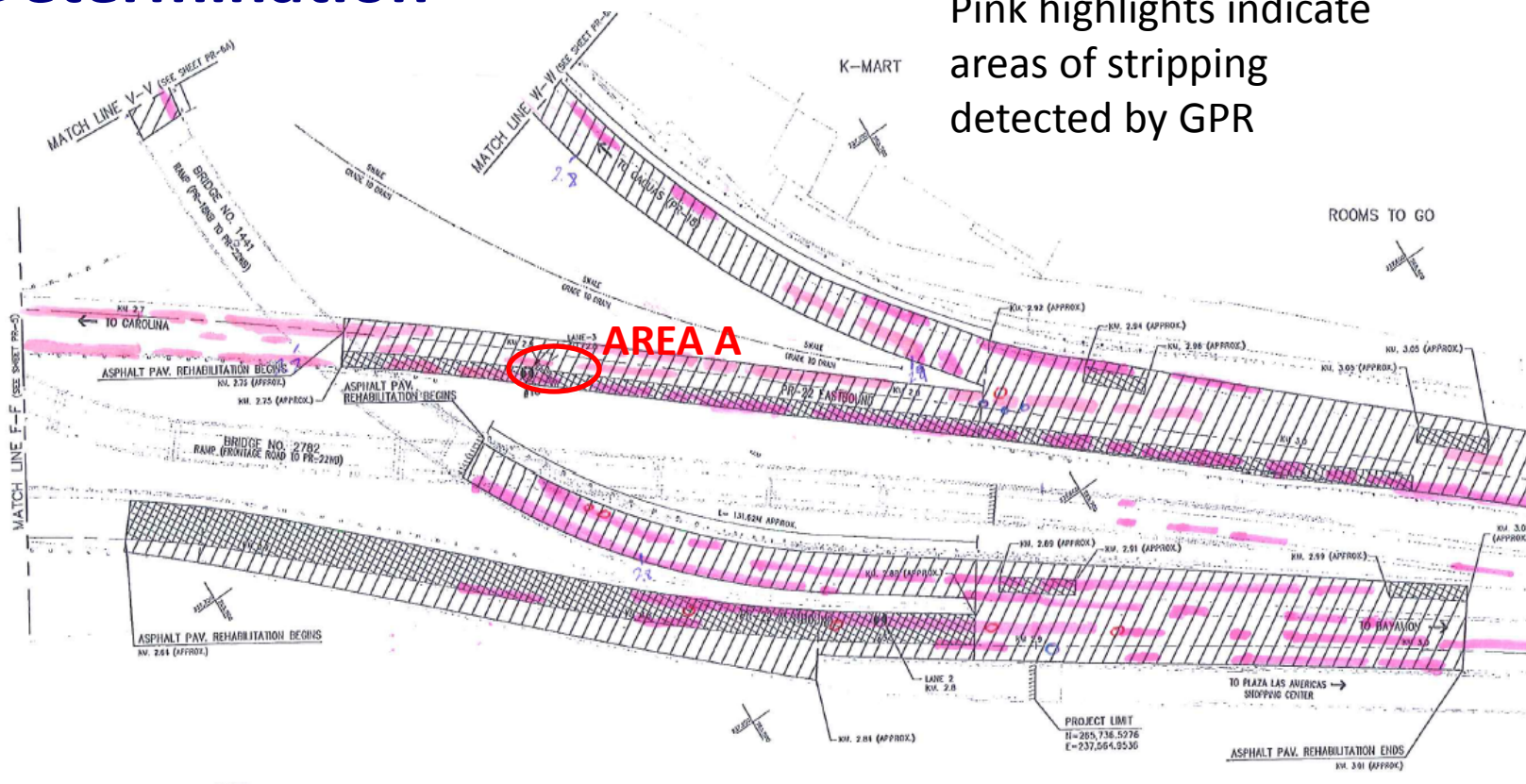


Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Determination

Pink highlights indicate areas of stripping detected by GPR

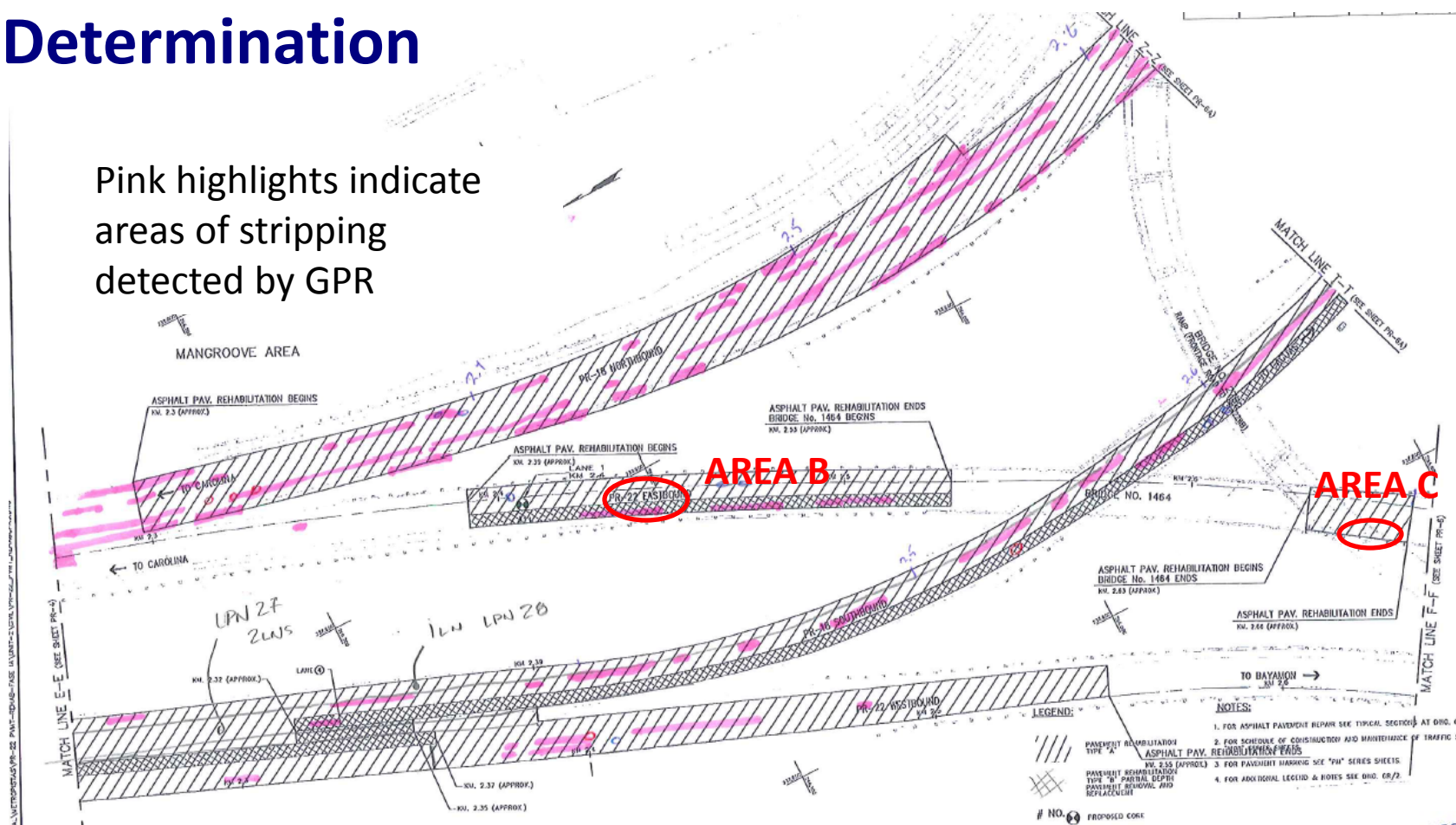


Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Determination

Pink highlights indicate areas of stripping detected by GPR



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Rii Determination

- Tack pick up during paving operation can contribute to pavement delamination



Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Summary

- Rii determined mechanisms of premature failure were:
 - Milled surface open to rain and traffic for long periods coupled with questionable structural integrity of existing asphalt
 - Additional Delamination/de-bonding due to tack placement issues
 - Could not corroborate that moisture was coming from subgrade
 - The use of GPR was very effective in determining stripped areas that likely contributed to premature failure

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Thank You

Todd Majidzadeh

Executive Vice President

ToddM@resourceinternational.com

Cherif Amer-Yahia, PhD, PE

Director – NDE & Technology Division

CherifA@resourceinternational.com

Julia Miller, PE

Director – CM of

Infrastructure Services

JuliaM@resourceinternational.com

www.ResourceInternational.com

