Comparing Repave with Kentucky's Method For Determining Flexible Pavement Thickness and Rigid Pavement Replacement Thickness

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I. INTRODUCTION

Kentucky uses "in-house" design tools to determine the required asphalt overlay thickness for flexible and rigid pavements. Full depth replacement of both flexible and rigid pavements are designed based off of the Kentucky Transportation Cabinet's (KYTC) *Pavement Design Guide 2007 Revision*. Both design methods are based off of Kentucky's mechanistic-empirical pavement design strategies which were developed over 30 years ago.

Another tool available to engineers for determining flexible and rigid overlay thicknesses and full depth replacement of pavement structures is the SHRP2 Solutions RePave Pavement Renewal Program developed under the SHRP 2 project *R23 Using Existing Pavements in Place and Achieving Long L*ife. The RePave program is a scoping tool designed to take in account the condition of the existing pavement structure and provide renewal options that can be cost effective and provide a service life of up to 50 years.

The purpose of this project is to compare Kentucky's method of determining flexible pavement thicknesses and rigid replacement thickness with those from the RePave pavement renewal scoping tool. Five KYTC pavement rehabilitation projects were selected for the comparison, three flexible pavements and two rigid pavements (see Table 1).

Table 1: Selected Rehabilitation Projects

	1	2	3	4	5
County	Perry	Perry	Hardin	Christian	Hardin
Route	KY80	KY15	I-65	KY9004	KY9002
MP	7.9 – 8.4	13.25 – 14.75	91.1 – 97.6	16.5 – 22.48	0.0 – 5.8
Existing Pavement	Rigid	Flexible	Flexible	Rigid	Flexible

II. METHODOLOGY

The methodology used to compare RePave with the Kentucky method of pavement design consists of six steps. 1. Forensic investigation to determine the physical and engineering properties of the existing pavement block, 2. Determine the anticipated traffic loading, 3. Develop KYTC pavement distress equivalencies for RePave, 4. RePave pavement design method, 5. Kentucky pavement design method, 6. Comparison of pavement thicknesses.

Forensic investigations were conducted on each of the pavements to determine the properties of the existing pavements. Ground Penetrating Radar (GPR) was used to determine the thickness of the pavement and subbase. The results from Falling Weight Deflectometer (FWD) tests were used to approximate the pavement, subbase, and subgrade moduli along with the California Bearing Ratio (CBR) of the subgrade. Field cores of the pavement block were taken to calibrate the layer thicknesses in the GPR analysis and provide confirmation of the subbase and subgrade material types from the historical design documentation. The forensic results for each project can be found in Appendix C-G.

The Kentucky Transportation Center (KTC) online ESAL forecasting database was used to determine the design ESALs used for both RePave and the Kentucky method. The database uses 2012 traffic data and 2008 WIM data to develop the ESAL's for a specified design year. The 20 and 40-year design years were used for the Kentucky method. The minimum 30-year ESAL

forecast was used for RePave. If there were multiple traffic sections within the project limits, the section with the most ESAL's was used for the design to simplify the number of designs required for a particular roadway.

KYTC determines which pavements require rehabilitation based on the pavement condition evaluations performed during the service life of the pavement. In order for RePave to provide a renewal option for a pavement the existing condition of the pavement is required. Pavement evaluations, provided by KYTC, were used to determine the distress conditions for input into RePave. Since KYTC pavement distress condition categories and extent/severity indices do not align with the distress conditions required in RePave, KYTC distress equivalencies were developed for use in RePave.

The results from the pavement investigation were input into RePave. The average layer thicknesses from the GPR results were used to establish the pavement cross section entered into RePave. The subgrade modulus in RePave is limited to three choices, 5,000, 10,000, and 20,000 psi with CBR values of 3, 7 and 13 respectively. The FWD results were used to establish the existing CBR of the subgrade by dividing the FWD subgrade modulus by five. The subgrade modulus chosen in RePave needed to be less than or equal to the modulus in the FWD results. The growth rate within RePave was set to zero and the design ESAL's were divided by 30 to establish the required ESAL's per year. The renewal type was based on the existing pavement. If the existing pavement was flexible then the renewal option chosen was flexible. The recommended option for flexible was always chosen to be removal of the existing pavement where needed and placement of an overlay. The subbase modulus was approximated to be composite modulus of the subgrade and the granular base that were calculated from the FWD results. However, dual credit for the subgrade modulus and subbase modulus was not given. Rigid renewal was chosen when the existing pavement was rigid and the recommended action chosen was always replacement of the rigid pavement with rigid pavement. The RePave pavement design results and the inputs used for this project can be found in Appendix A.

The same pavement cross sections established in RePave were used in Kentucky's pavement design process. For flexible pavements with an overlay, structural credit of the existing pavement and granular base was based on 75% of the original design credit. The remaining structural number required was used to back calculate the required asphalt base and surface required to meet the required structure number. The required structure number of the flexible pavement was established using Kentucky's 50% curves along with the design ESAL's. The CBR value was estimated from the subgrade modulus that was calculated in the FWD analysis. If the particular design ESAL was above 20,000,000, then the SN was extrapolated from the 50% curve using a power rule trend line which best fits the data. Kentucky's JPC pavement curves (with drainage blanket) were used for estimating the thickness required for the rigid pavements. The rigid pavement thickness required is based off of the design ESAL's and the CBR value similar to the flexible pavement design. The Kentucky pavement design results and the inputs used can be found in Appendix B.

III. RESULTS

After performing the design calculations using both RePave and the Kentucky method for pavement design, the results were compared to the existing design. The summary of those results are in Table 2 below. The net change from existing to proposed is in parentheses. It should be

noted, based off of the forensic investigation, the I-65 pavement was separated into two cross sections and the KY9002 project was separated into three cross sections because of the varying pavement designs.

Results are split when the existing design is compared with the proposed designs for a rigid replacement. Both RePave 30-Year and KY 20-Year designs call for less PCC on the KY 80 project, but on the KY9004 project both RePave 30-Year and KY 20-Year designs are very close to the existing pavement design thickness. Looking at the proposed designs for the flexible pavements, five of the six RePave 30-Year designs call for less pavement than the existing, with an average net difference of -4.10 inches. The remaining RePave 30-Year flexible design calls for an extra 1.00 inch. The KY 20-Year designs show three of the six designs calling for less pavement than the existing, with an average net difference of -1.25 inches. The three KY-20 Year designs that call for additional pavement show an average net difference of 6.58 inches. The KY 40-Year designs were included only for informational purposes.

Table 2: Summary of Pavement Thicknesses Designs and Net Change from Existing

	Existing	RePave 30-Year	KY 20-Year	KY 40-Year
KY 80 (Rigid)	13.00"	9.00" (-4.00")	9.00" (-4.00")	11.00" (-2.00")
KY9004 (Rigid)	9.00"	9.50" (0.50")	9.00" (0.00")	11.00" (2.00")
KY 15 (Flexible)	12.75"	8.00" (-4.75")	10.75" (-2.00")	16.25" (3.50")
I-65 Section 1 (Flexible)	11.25"	7.50" (-3.75")	18.50" (7.25")	22.00" (10.75")
I-65 Section 2 (Flexible)	16.00"	14.00" (-2.00")	24.00" (8.00")	27.50" (11.50")
KY9002 Section 1 (Flexible)	10.00"	11.00" (1.00")	14.50" (4.50")	16.75" (6.75")
KY9002 Section 2 (Flexible)	17.00"	11.00" (-6.00")	15.50" (-1.50")	17.75" (0.75")
KY9002 Section 3 (Flexible)	15.00"	11.00" (-4.00")	14.75" (-0.25")	17.25" (2.25")

Table 3 below shows the difference between KY design thickness and the results obtained from RePave. The rigid pavement thickness calculated by RePave compare well to the KY 20-Year design thicknesses. KY 20-Year designs for flexible pavements are thicker than the same designs in RePave. With the minimum difference of 2.75 inches up to a maximum difference of 11.00 inches. The average difference for all six flexible designs is 6.00 inches.

Table 3: Difference between KY Design Thickness and RePave

	RePave 30-Year Total Pavement Thickness	KY 20-Year	KY 40-Year
KY 80 (Rigid)	9.00"	0.00"	2.00"
KY9004 (Rigid)	9.50"	-0.50"	1.50"
KY 15 (Flexible)	8.00"	2.75”	8.25"
I-65 Section 1 (Flexible)	7.50"	11.00"	14.50"
I-65 Section 2 (Flexible)	14.00"	10.00"	13.50"
KY9002 Section 1 (Flexible)	11.00"	3.50"	5.75"
KY9002 Section 2 (Flexible)	11.00"	4.50"	6.75"
KY9002 Section 3 (Flexible)	11.00"	3.75"	6.25"

IV. SUMMARY AND CONCLUSIONS

The Kentucky design thickness for rigid pavement and the RePave design thickness for rigid pavement are approximately the same for both the KY80 and the KY9004 project. However, Kentucky's flexible pavement thicknesses are more conservative when compared to RePave.

Though both the Kentucky method and RePave called for similar thicknesses when designing for rigid pavement, the two methods yielded substantially different thicknesses when designing for flexible pavement. The Kentucky method designs presented in the report assume no removal of the existing asphalt surface. If removal of the existing surface is required then all the thicknesses reported will increase by approximately one inch or more depending on the amount of existing pavement removed.

There are several likely reasons the results using Kentucky's method for flexible pavement design are more conservative than the results from RePave. Kentucky's pavement design methodology differs from that of RePave. Kentucky's required structural numbers are based off of Kentucky's mechanistic-empirical pavement design procedure. Kentucky has their own method for determining CBR and Kentucky's load equivalency factors for ESAL calculation are different. The Kentucky overlay method also assumes the existing pavement has a structural layer coefficient equal to 75% of a new design coefficient unless a forensic investigation shows otherwise. All of these factors can contribute to the differences between the RePave results and Kentucky's results.

APPENDIX A

REPAVE DESIGN RESULTS

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KY80

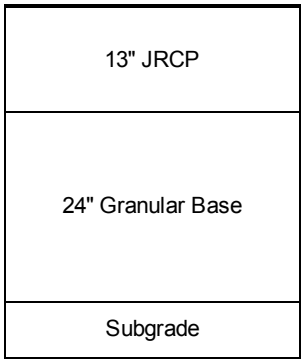
Created: 2016-10-24
Updated: 2016-10-26

Project Information

Project Title	KY80
Project Location	KY

Existing Pavement

Lanes	2
Type	rigid



Existing Distress

Materials Distress: Light D-Cracking
Joint Faulting

- Deflection: 0"
- Depth: .333"

Desired Pavement

Design Period	30 years	Current ADT	6000
Subgrade MR	10,000 psi	Lanes Added	0
Current ESALs	.533 million per year	Height Restriction	N/A
Design ESALs	15.99 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed
13" JRCP	9"New Pavement
	4" HMA Base
24" Granular Base	24" Granular Base
Subgrade	Subgrade

Renewal Type Rigid
Design Period 30 years
Design ESALs 15.99 million
Subgrade MR 10,000 psi
Pre-existing Pavement or Base Modulus not applicable
Actions Replace existing pavement with JPCP or CRCP over a 4 inch HMA base.
Pavement Removed 13"
Existing Pavement 24"
Estimated Design Thickness 9"
New Pavement 13"
Added Elevation 0"

Best Practices

Rigid Best Practices
The quest for long-life concrete pavements necessitates an improved understanding of design and construction factors that affect both short-term and long-term concrete pavement performance. Essentially, this requires that there would be a better understanding of how concrete pavements deteriorate and fail. Concrete pavements deteriorate over a period of time as a result of distresses that develop from a combination of traffic and environmental loading. These best practices provide insight into design and construction options that will have achieve the long-life goal.

Guidespecs

Guide Specification
The guide specifications developed by the SHRP2 R23 team are contained in this document. They are organized into three sections which are: (1) guide specifications for pavement components that are not contained within the AASHTO Guide Specifications, (2) elements that can be added to or otherwise modify existing AASHTO Guide Specifications, and (3) summaries for relevant State DOT and AASHTO specifications that were used to produce the “elements” in item 2.

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KY9004

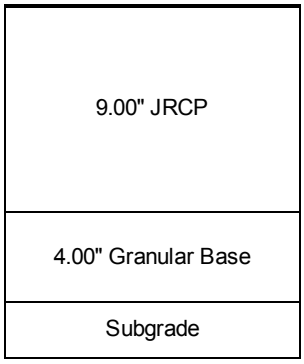
Created: 2016-10-24
Updated: 2016-10-25

Project Information

Project Title	KY9004
Project Location	KY

Existing Pavement

Lanes	2
Type	rigid



Existing Distress

Materials Distress: Severe D-Cracking
Pavement Cracking
- Cracked Panels: 75%

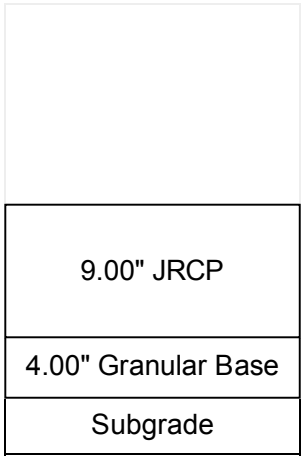
Joint Faulting
- Deflection: .0078"
- Depth: 0.67"

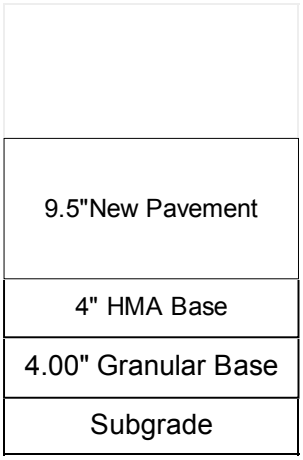
Desired Pavement

Design Period	30 years	Current ADT	5750
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	.437 million per year	Height Restriction	N/A
Design ESALs	13.11 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design





Renewal Type Rigid
Design Period 30 years
Design ESALs 13.11 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus not applicable
Actions Replace existing pavement with JPCP or CRCP over a 4 inch HMA base.
Pavement Removed 9"
Existing Pavement 4"
Estimated Design Thickness 9.5"
New Pavement 13.5"
Added Elevation 4.5"

Best Practices

Rigid Best Practices
The quest for long-life concrete pavements necessitates an improved understanding of design and construction factors that affect both short-term and long-term concrete pavement performance. Essentially, this requires that there would be a better understanding of how concrete pavements deteriorate and fail. Concrete pavements deteriorate over a period of time as a result of distresses that develop from a combination of traffic and environmental loading. These best practices provide insight into design and construction options that will have achieve the long-life goal.

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KY15

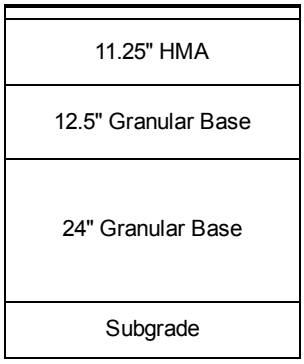
Created: 2016-10-24
Updated: 2016-10-25

Project Information

Project Title	KY15
Project Location	KY

Existing Pavement

Lanes	2
Type	flexible



Existing Distress

Fatigue Cracking
- Type: Top Down
- Low: %
- Medium: 33%
- High: %

Patching
- Cracking Type: Surface
- Area Patched: 15%

Transverse Cracking
- 4 per 100ft

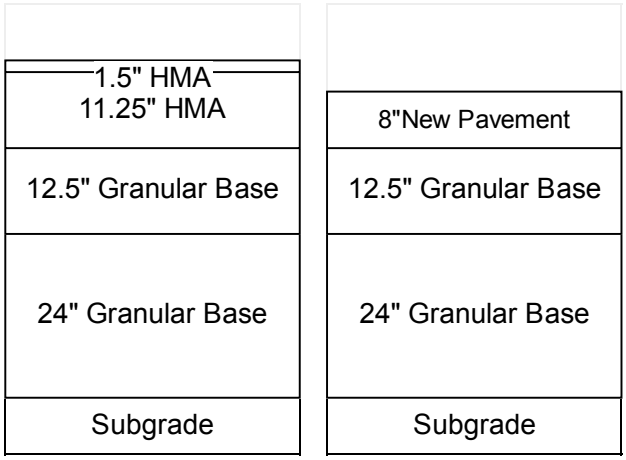
Stripping Present

Desired Pavement

Design Period	30 years	Current ADT	12750
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	.300 million per year	Height Restriction	N/A
Design ESALs	9 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design



Renewal Type Flexible
Design Period 30 years
Design ESALs 9 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus 75000 psi
Actions Remove and replace existing HMA because of stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
Pavement Removed 12.8"
Existing Pavement 36.5"
Estimated Design Thickness 8"
New Pavement 8"
Added Elevation -4.7"

Best Practices

Flexible Best Practices
The intention of the long-life pavement concept is to significantly extend current pavement design life by restricting distress, such as cracking and rutting, to the pavement surface. Common distress mechanisms such as bottom-up fatigue cracking and rutting in the unbound layers should be, in principle, completely eliminated. These best practices provide insight into design and construction options that will have achieve the long-life goal.

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I65-1

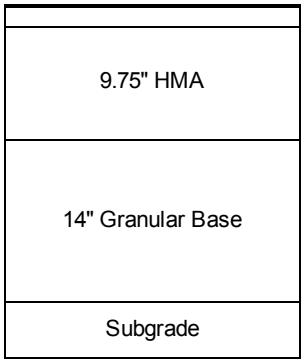
Created: 2016-10-24
Updated: 2016-10-25

Project Information

Project Title	I65-1
Project Location	KY

Existing Pavement

Lanes	3
Type	flexible



Existing Distress

Fatigue Cracking
- Type: Top Down
- Low: %
- Medium: 17%
- High: %

Patching
- Cracking Type: Surface
- Area Patched: 10%

Transverse Cracking
- 1 per 100ft

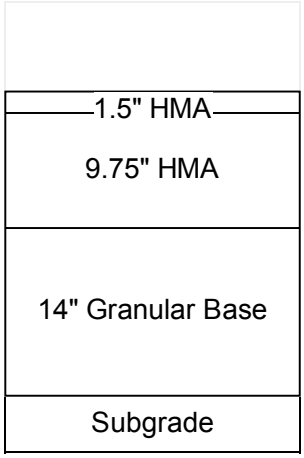
Stripping Present

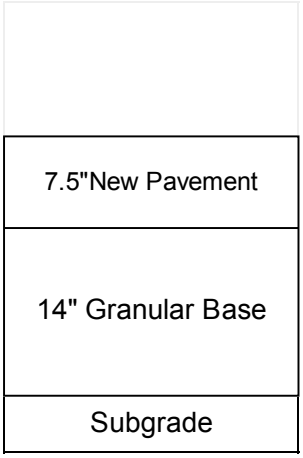
Desired Pavement

Design Period	30 years	Current ADT	27000
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	5 million per year	Height Restriction	N/A
Design ESALs	150 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design





Renewal Type Flexible
Design Period 30 years
Design ESALs 150 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus 100000 psi
Actions Remove and replace existing HMA because of stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
Pavement Removed 11.3"
Existing Pavement 14"
Estimated Design Thickness 7.5"
New Pavement 7.5"
Added Elevation -3.7"

Best Practices

Flexible Best Practices
The intention of the long-life pavement concept is to significantly extend current pavement design life by restricting distress, such as cracking and rutting, to the pavement surface. Common distress mechanisms such as bottom-up fatigue cracking and rutting in the unbound layers should be, in principle, completely eliminated. These best practices provide insight into design and construction options that will have achieve the long-life goal.

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I65-2

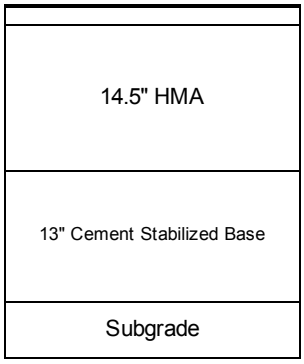
Created: 2016-10-24
Updated: 2016-10-24

Project Information

Project Title	I65-1
Project Location	KY

Existing Pavement

Lanes	3
Type	flexible



Existing Distress

Patching
- Cracking Type: Full Depth
- Area Patched: 15%

Transverse Cracking
- 1 per 100ft

Stripping Present

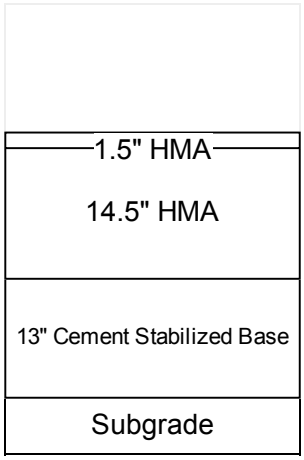
Fatigue Cracking
- Type: Top Down
- Low: %
- Medium: %
- High: 17%

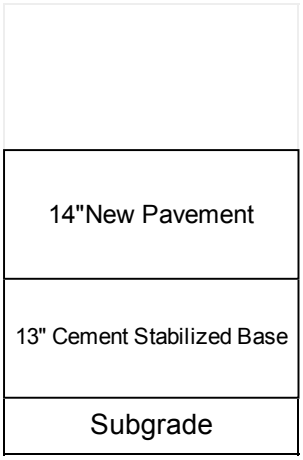
Desired Pavement

Design Period	30 years	Current ADT	27000
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	5 million per year	Height Restriction	N/A
Design ESALs	150 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design





Renewal Type Flexible
Design Period 30 years
Design ESALs 150 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus 30000 psi
Actions Remove and replace existing HMA because of stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
Pavement Removed 16"
Existing Pavement 13"
Estimated Design Thickness 14"
New Pavement 14"
Added Elevation -2"

Best Practices

Flexible Best Practices
The intention of the long-life pavement concept is to significantly extend current pavement design life by restricting distress, such as cracking and rutting, to the pavement surface. Common distress mechanisms such as bottom-up fatigue cracking and rutting in the unbound layers should be, in principle, completely eliminated. These best practices provide insight into design and construction options that will have achieve the long-life goal.

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KY9002

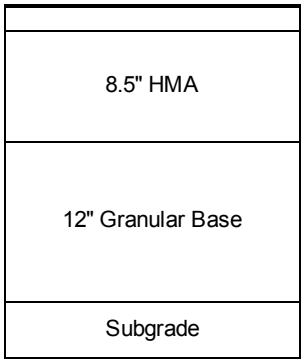
Created: 2016-10-24
Updated: 2016-10-24

Project Information

Project Title	KY9002-1
Project Location	KY

Existing Pavement

Lanes	2
Type	flexible



Existing Distress

Fatigue Cracking
- Type: Top Down
- Low: %
- Medium: %
- High: 75%

Patching
- Cracking Type: Surface
- Area Patched: 20%

Transverse Cracking
- 4 per 100ft

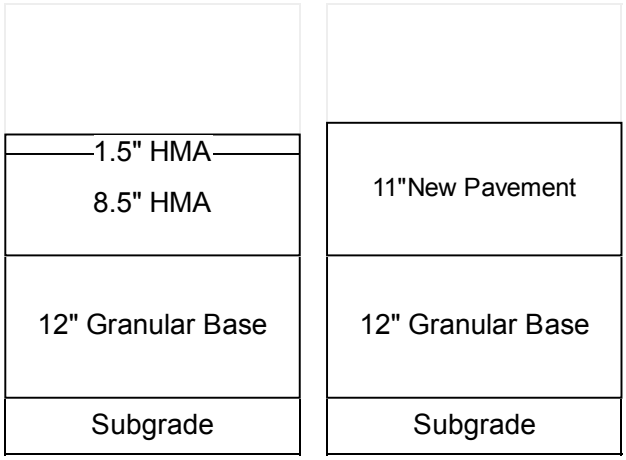
Stripping Present

Desired Pavement

Design Period	30 years	Current ADT	6600
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	.700 million per year	Height Restriction	N/A
Design ESALs	21 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design



Renewal Type Flexible
Design Period 30 years
Design ESALs 21 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus 30000 psi
Actions Remove and replace existing HMA because of stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
Pavement Removed 10"
Existing Pavement 12"
Estimated Design Thickness 11"
New Pavement 11"
Added Elevation 1"

Best Practices

Flexible Best Practices
The intention of the long-life pavement concept is to significantly extend current pavement design life by restricting distress, such as cracking and rutting, to the pavement surface. Common distress mechanisms such as bottom-up fatigue cracking and rutting in the unbound layers should be, in principle, completely eliminated. These best practices provide insight into design and construction options that will have achieve the long-life goal.

Guidespecs

Guide Specification
The guide specifications developed by the SHRP2 R23 team are contained in this document. They are organized into three sections which are: (1) guide specifications for pavement components that are not contained within the AASHTO Guide Specifications, (2) elements that can be added to or otherwise modify existing AASHTO Guide Specifications, and (3) summaries for relevant State DOT and AASHTO specifications that were used to produce the “elements” in item 2.

For scoping purposes only – this is not an official design

KY9002-2

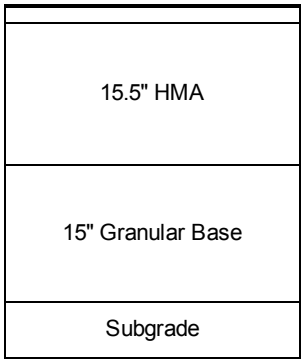
Created: 2016-10-24
Updated: 2016-10-24

Project Information

Project Title	KY9002-2
Project Location	KY

Existing Pavement

Lanes	2
Type	flexible



Existing Distress

Fatigue Cracking
- Type: Top Down
- Low: %
- Medium: %
- High: 75%

Patching
- Cracking Type: Surface
- Area Patched: 20%

Transverse Cracking
- 4 per 100ft

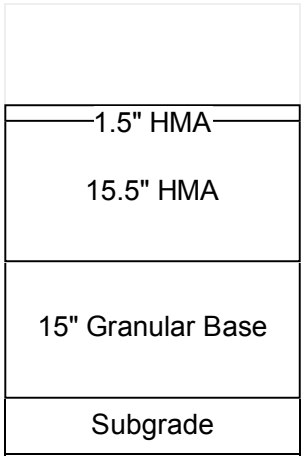
Stripping Present

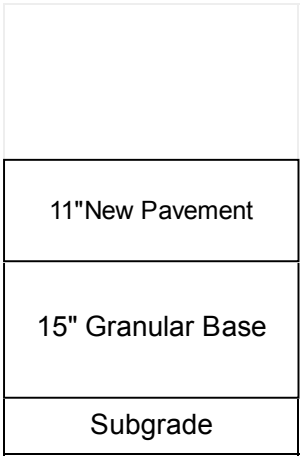
Desired Pavement

Design Period	30 years	Current ADT	6600
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	.700 million per year	Height Restriction	N/A
Design ESALs	21 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design





Renewal Type Flexible
Design Period 30 years
Design ESALs 21 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus 30000 psi
Actions Remove and replace existing HMA because of stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
Pavement Removed 17"
Existing Pavement 15"
Estimated Design Thickness 11"
New Pavement 11"
Added Elevation -6"

Best Practices

Flexible Best Practices
The intention of the long-life pavement concept is to significantly extend current pavement design life by restricting distress, such as cracking and rutting, to the pavement surface. Common distress mechanisms such as bottom-up fatigue cracking and rutting in the unbound layers should be, in principle, completely eliminated. These best practices provide insight into design and construction options that will have achieve the long-life goal.

Guidespecs

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For scoping purposes only – this is not an official design

KY9002-3

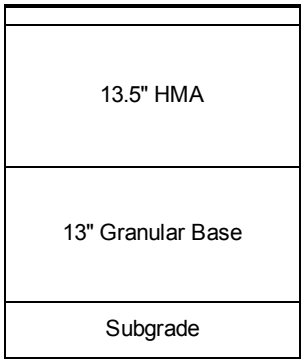
Created: 2016-10-24
Updated: 2016-10-25

Project Information

Project Title	KY9002-3
Project Location	KY

Existing Pavement

Lanes	2
Type	flexible



Existing Distress

Fatigue Cracking
- Type: Top Down
- Low: %
- Medium: %
- High: 75%

Patching
- Cracking Type: Surface
- Area Patched: 20%

Transverse Cracking
- 4 per 100ft

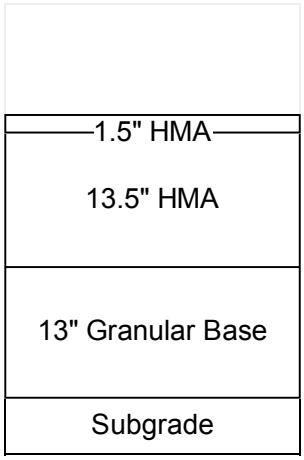
Stripping Present

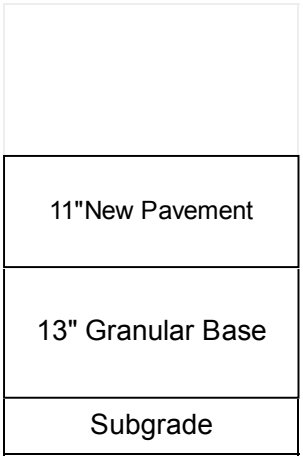
Desired Pavement

Design Period	30 years	Current ADT	6600
Subgrade MR	5,000 psi	Lanes Added	0
Current ESALs	.700 million per year	Height Restriction	N/A
Design ESALs	21 million		
Growth Rate	0%		

Renewal Design

Existing	Proposed	Recommended Design





Renewal Type Flexible
Design Period 30 years
Design ESALs 21 million
Subgrade MR 5,000 psi
Pre-existing Pavement or Base Modulus 30000 psi
Actions Remove and replace existing HMA because of stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
Pavement Removed 15"
Existing Pavement 13"
Estimated Design Thickness 11"
New Pavement 11"
Added Elevation -4"

Best Practices

Flexible Best Practices
The intention of the long-life pavement concept is to significantly extend current pavement design life by restricting distress, such as cracking and rutting, to the pavement surface. Common distress mechanisms such as bottom-up fatigue cracking and rutting in the unbound layers should be, in principle, completely eliminated. These best practices provide insight into design and construction options that will have achieve the long-life goal.

Guidespecs

Guide Specification
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APPENDIX B1

KENTUCKY DESIGN RESULTS

Table B1. 1: KY80 and KY 9004 Rigid Pavement Design Thickness

Project	CBR	20-Year ESAL	40-Year ESAL	KY 20-Year	KY 40-Year
KY80	11	10,000,000	23,000,000	9.00”	11.00”
KY9004	4	8,000,000	20,000,000	9.00”	11.00”

Table B1. 2: KY 15 Perry County 20-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:				Required SN if New Asphalt:	4.50			
County:	Perry			Asphalt Surface Thickness:	1.50 in.			
Route:	KY15			Asphalt Binder Thickness:	0.00 in.			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	5,500,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	20			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	11			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	12.50 in.	DGA		Asphalt Base Thickness:	-1.49 in.	-3.40 in.	-5.31 in.	-7.53 in.
Existing Asphalt Depth:	12.75 in.	Asphalt		Total Asphalt Overlay using SN:	0.01 in.	-1.90 in.	-3.81 in.	-6.03 in.

Table B1. 3: KY 15 Perry County 40-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:	0			Required SN if New Asphalt:	6.62			
County:	Perry			Asphalt Surface Thickness:	1.50			
Route:	KY15			Asphalt Binder Thickness:	0.00			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	13,100,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	40			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	11			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	12.50	DGA		Asphalt Base Thickness:	3.81 in.	1.90 in.	-0.01 in.	-2.23 in.
Existing Asphalt Depth:	12.75	Asphalt		Total Asph Overlay using SN:	5.31 in.	3.40 in.	1.49 in.	-0.73 in.

Table B1. 4: I65-1 Hardin County 20-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:				Required SN if New Asphalt:	7.92			
County:	Hardin			Asphalt Surface Thickness:	1.50 in.			
Route:	I65-1			Asphalt Binder Thickness:	0.00 in.			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	87,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	20			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	6			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	14.00 in.	DGA		Asphalt Base Thickness:	7.62 in.	5.86 in.	4.11 in.	2.00 in.
Existing Asphalt Depth:	11.25 in.	Asphalt		Total Asphalt Overlay using SN:	9.12 in.	7.36 in.	5.61 in.	3.50 in.

Table B1. 5: I65-1 Hardin County 40-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses						Date:	11/29/2016	
blue -	Calculated Overlay Thickness								
				Kentucky Methods					
Item No.:	0			Required SN if New Asphalt:	9.26				
County:	Hardin			Asphalt Surface Thickness:	1.50				
Route:	I65-1			Asphalt Binder Thickness:	0.00				
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New	
ESALs:	258,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14	
No. of Years:	40			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40	
CBR:	6			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.	
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.	
Existing DGA:	14.00	DGA		Asphalt Base Thickness:	10.97 in.	9.21 in.	7.46 in.	5.35 in.	
Existing Asphalt Depth:	11.25	Asphalt		Total Asph Overlay using SN:	12.47 in.	10.71 in.	8.96 in.	6.85 in.	

Table B1. 6: I65-2 Hardin County 20-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses						Date:	11/29/2016	
blue -	Calculated Overlay Thickness								
				Kentucky Methods					
Item No.:				Required SN if New Asphalt:	9.48				
County:	Hardin			Asphalt Surface Thickness:	1.50 in.				
Route:	I65-2			Asphalt Binder Thickness:	0.00 in.				
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New	
ESALs:	87,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14	
No. of Years:	20			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40	
CBR:	2			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.	
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.	
Existing DGA:	13.00 in.	RB		Asphalt Base Thickness:	8.80 in.	6.48 in.	4.15 in.	1.50 in.	
Existing Asphalt Depth:	16.00 in.	Asphalt		Total Asphalt Overlay using SN:	10.30 in.	7.98 in.	5.65 in.	3.00 in.	

Table B1. 7: I65-2 Hardin County 40-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses						Date:	11/29/2016	
blue -	Calculated Overlay Thickness								
				Kentucky Methods					
Item No.:	0			Required SN if New Asphalt:	10.94				
County:	Hardin			Asphalt Surface Thickness:	1.50				
Route:	I65-2			Asphalt Binder Thickness:	0.00				
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New	
ESALs:	258,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14	
No. of Years:	40			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40	
CBR:	2			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.	
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.	
Existing DGA:	13.00	RB		Asphalt Base Thickness:	12.45 in.	10.13 in.	7.80 in.	5.15 in.	
Existing Asphalt Depth:	16.00	Asphalt		Total Asph Overlay using SN:	13.95 in.	11.63 in.	9.30 in.	6.65 in.	

Table B1. 8: KY9002-1 Hardin County 20-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:				Required SN if New Asphalt:	6.18			
County:	Hardin			Asphalt Surface Thickness:	1.50 in.			
Route:	KY9002-1			Asphalt Binder Thickness:	0.00 in.			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	12,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	20			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	5			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	12.00 in.	DGA		Asphalt Base Thickness:	4.55 in.	3.00 in.	1.45 in.	-0.40 in.
Existing Asphalt Depth:	10.00 in.	Asphalt		Total Asphalt Overlay using SN:	6.05 in.	4.50 in.	2.95 in.	1.10 in.

Table B1. 9: KY9002-1 Hardin County 40-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:	0			Required SN if New Asphalt:	7.13			
County:	Hardin			Asphalt Surface Thickness:	1.50			
Route:	KY9002-1			Asphalt Binder Thickness:	0.00			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	32,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	40			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	5			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	12.00	DGA		Asphalt Base Thickness:	6.93 in.	5.38 in.	3.83 in.	1.98 in.
Existing Asphalt Depth:	10.00	Asphalt		Total Asph Overlay using SN:	8.43 in.	6.88 in.	5.33 in.	3.48 in.

Table B1. 10: KY9002-2 Hardin County 20-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:				Required SN if New Asphalt:	6.18			
County:	Hardin			Asphalt Surface Thickness:	1.50 in.			
Route:	KY9002-2			Asphalt Binder Thickness:	0.00 in.			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	12,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	20			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	5			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	15.00 in.	DGA		Asphalt Base Thickness:	-0.58 in.	-3.08 in.	-5.58 in.	-8.45 in.
Existing Asphalt Depth:	17.00 in.	Asphalt		Total Asphalt Overlay using SN:	0.92 in.	-1.58 in.	-4.08 in.	-6.95 in.

Table B1. 11: KY9002-2 Hardin County 40-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:	0			Required SN if New Asphalt:	7.13			
County:	Hardin			Asphalt Surface Thickness:	1.50			
Route:	KY9002-2			Asphalt Binder Thickness:	0.00			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	32,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	40			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	5			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	15.00	DGA		Asphalt Base Thickness:	1.80 in.	-0.70 in.	-3.20 in.	-6.08 in.
Existing Asphalt Depth:	17.00	Asphalt		Total Asph Overlay using SN:	3.30 in.	0.80 in.	-1.70 in.	-4.58 in.

Table B1. 12: KY9002-3 Hardin County 20-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:				Required SN if New Asphalt:	5.91			
County:	Hardin			Asphalt Surface Thickness:	1.50 in.			
Route:	KY9002-3			Asphalt Binder Thickness:	0.00 in.			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	12,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	20			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	6			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	13.00 in.	DGA		Asphalt Base Thickness:	0.50 in.	-1.70 in.	-3.90 in.	-6.43 in.
Existing Asphalt Depth:	15.00 in.	Asphalt		Total Asphalt Overlay using SN:	2.00 in.	-0.20 in.	-2.40 in.	-4.93 in.

Table B1. 13: KY9002-3 Hardin County 40-Year Flexible Design Thickness

pink -	Required to find Overlay Thicknesses					Date:	11/29/2016	
blue -	Calculated Overlay Thickness							
				Kentucky Methods				
Item No.:	0			Required SN if New Asphalt:	6.86			
County:	Hardin			Asphalt Surface Thickness:	1.50			
Route:	KY9002-3			Asphalt Binder Thickness:	0.00			
				Condition of Existing Asphalt:	Bad	Mediocre	Good	New
ESALs:	32,000,000			Existing DGA a-coefficient:	0.10	0.11	0.12	0.14
No. of Years:	40			Existing Asphalt a-coefficient:	0.25	0.30	0.35	0.40
CBR:	6			Asphalt Surface Thickness:	1.50 in.	1.50 in.	1.50 in.	1.50 in.
				Asphalt Binder Thickness:	0.00 in.	0.00 in.	0.00 in.	0.00 in.
Existing DGA:	13.00	DGA		Asphalt Base Thickness:	2.88 in.	0.68 in.	-1.53 in.	-4.05 in.
Existing Asphalt Depth:	15.00	Asphalt		Total Asph Overlay using SN:	4.38 in.	2.18 in.	-0.02 in.	-2.55 in.

APPENDIX B2

KYTC RIGID PAVEMENT CURVES
&
KYTC ASPHALT CURVES

Table B2. 1: KYTC Rigid Pavement Curves

JPC Pavement Curves (With Cement Treated Drainage Blanket)											
ESAL					CBR						
	1	2	3	4	5	6	7	8	9	10	11
1,000,000	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
2,000,000	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
3,000,000	9.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
4,000,000	9.0	9.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
5,000,000	9.0	9.0	9.0	9.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
6,000,000	10.0	9.0	9.0	9.0	9.0	9.0	8.0	8.0	8.0	8.0	8.0
7,000,000	10.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	8.0	8.0	8.0
8,000,000	10.0	10.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.0
9,000,000	10.0	10.0	10.0	10.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
10,000,000	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	9.0	9.0	9.0
11,000,000	11.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	9.0
12,000,000	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0	9.0
13,000,000	11.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0
14,000,000	11.0	11.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
15,000,000	11.0	11.0	11.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0	10.0
16,000,000	11.0	11.0	11.0	11.0	11.0	11.0	10.0	10.0	10.0	10.0	10.0
17,000,000	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.0	10.0	10.0	10.0
18,000,000	12.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.0	10.0	10.0
19,000,000	12.0	12.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.0	10.0
20,000,000	12.0	12.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.0	10.0

Table B2. 2: KYTC Flexible Pavement Curves

50% Asphalt Curves											
ESAL'S					CBR						
	1	2	3	4	5	6	7	8	9	10	11
10,000	2.73	2.62	2.48	2.32	2.16	2.00	1.84	1.68	1.54	1.40	1.27
25,000	3.44	3.19	2.97	2.77	2.58	2.41	2.25	2.11	1.97	1.85	1.74
50,000	3.93	3.61	3.34	3.10	2.89	2.71	2.56	2.42	2.29	2.18	2.08
75,000	4.20	3.85	3.55	3.30	3.09	2.90	2.74	2.60	2.48	2.37	2.27
100,000	4.38	4.02	3.71	3.45	3.23	3.04	2.88	2.74	2.62	2.51	2.41
250,000	4.95	4.55	4.22	3.94	3.70	3.50	3.33	3.19	3.06	2.95	2.85
500,000	5.36	4.97	4.63	4.34	4.09	3.88	3.70	3.55	3.41	3.29	3.19
750,000	5.61	5.21	4.87	4.58	4.33	4.11	3.93	3.76	3.62	3.50	3.39
1,000,000	5.79	5.40	5.05	4.76	4.50	4.28	4.09	3.92	3.78	3.65	3.54
2,000,000	6.26	5.85	5.50	5.20	4.93	4.70	4.49	4.32	4.16	4.03	3.91
3,000,000	6.55	6.14	5.78	5.46	5.19	4.95	4.74	4.56	4.40	4.26	4.14
4,000,000	6.77	6.35	5.98	5.66	5.38	5.13	4.92	4.73	4.57	4.43	4.31
5,000,000	6.96	6.52	6.15	5.82	5.53	5.28	5.06	4.87	4.71	4.57	4.44
6,000,000	7.11	6.67	6.28	5.95	5.66	5.40	5.18	4.99	4.83	4.68	4.56
7,000,000	7.24	6.79	6.40	6.06	5.77	5.51	5.29	5.10	4.93	4.79	4.66
8,000,000	7.36	6.91	6.51	6.16	5.87	5.61	5.38	5.19	5.02	4.88	4.75
9,000,000	7.47	7.01	6.60	6.25	5.95	5.69	5.47	5.27	5.10	4.96	4.83
10,000,000	7.57	7.10	6.69	6.34	6.03	5.77	5.54	5.35	5.18	5.03	4.91
11,000,000	7.66	7.18	6.77	6.41	6.11	5.84	5.62	5.42	5.25	5.10	4.97
12,000,000	7.74	7.26	6.84	6.49	6.18	5.91	5.68	5.48	5.31	5.17	5.04
13,000,000	7.82	7.33	6.91	6.55	6.24	5.97	5.74	5.55	5.38	5.23	5.10
14,000,000	7.89	7.40	6.98	6.61	6.30	6.03	5.80	5.60	5.43	5.28	5.15
15,000,000	7.96	7.46	7.04	6.67	6.36	6.09	5.86	5.66	5.49	5.34	5.21
16,000,000	8.02	7.53	7.10	6.73	6.41	6.14	5.91	5.71	5.54	5.39	5.26
17,000,000	8.08	7.58	7.15	6.78	6.47	6.19	5.96	5.76	5.59	5.44	5.31
18,000,000	8.14	7.64	7.21	6.83	6.52	6.24	6.01	5.81	5.64	5.49	5.35
19,000,000	8.20	7.69	7.26	6.88	6.56	6.29	6.06	5.86	5.68	5.53	5.40
20,000,000	8.25	7.74	7.30	6.93	6.61	6.34	6.10	5.90	5.73	5.57	5.44

APPENDIX C

FIELD RESULTS

GROUND PENETRATING RADAR
FALLING WEIGHT DEFLECTOMETER
CORING AND MATERIALS SAMPLING

KY 80, PERRY COUNTY

Perry County KY 80

A team from the Kentucky Transportation Center's Pavement, Materials, Geotechnical and Infrastructure Assessment evaluated KY 80 from Mile Point 8.0 to 8.6 at the request of the Kentucky Transportation Cabinet. This road segment is a Portland cement concrete (PCC) pavement that extends from a bridge over KY 15 eastward toward Justice Drive. All data collected on KY 80 are presented herein.

The work was performed on 10 and 11 March 2016 and included:

- Ground Penetrating Radar (GPR) – using 2-900 MHz ground-coupled antennas with 6-foot separation, ground penetrating data were collected in each wheel path in both lanes in both directions. Data obtained through GPR scans are presented in Figures C1 through C4.
- Falling Weight Deflectometer (FWD) – deflection testing was performed only at the mid-panel in both lanes in both directions. Back-calculated moduli values for the PCC pavement and underlying layers are presented in Table C1 and graphically in Figures C5 through C16.
- Coring, sampling, and Dynamic Cone Penetrometer (DCP) tests – multiple cores were obtained in the field, samples of crushed sandstone obtained, and a limited number of DCP tests were attempted. Coring and sampling results are presented in Table C2 and in Figure C17.

Traffic control was expertly provided by the Perry County maintenance crew for both days of data collection activities.

The PCC pavement averaged just over 13 inches in thickness (this number does not include a core measuring 11.50 inches obtained in a patched area). All cores, with the exception of the core obtained in the patched area, contained reinforcing mesh at varying depths. The reinforcing mesh interfered with the KTC's GPR scans. The roadway base materials were comprised of crushed sandstone, predominately gray and brown in color. The moisture content of the crushed sandstone base ranged from 7.5 to 9.6% and averaged 8.3%. Moisture contents were slightly higher in the samples obtained from the westbound lanes. The crushed stone base generally averaged six (6) inches in thickness and was underlain by additional crushed sandstone subgrade materials. There was no evidence that the subbase or subgrade material had been stabilized.

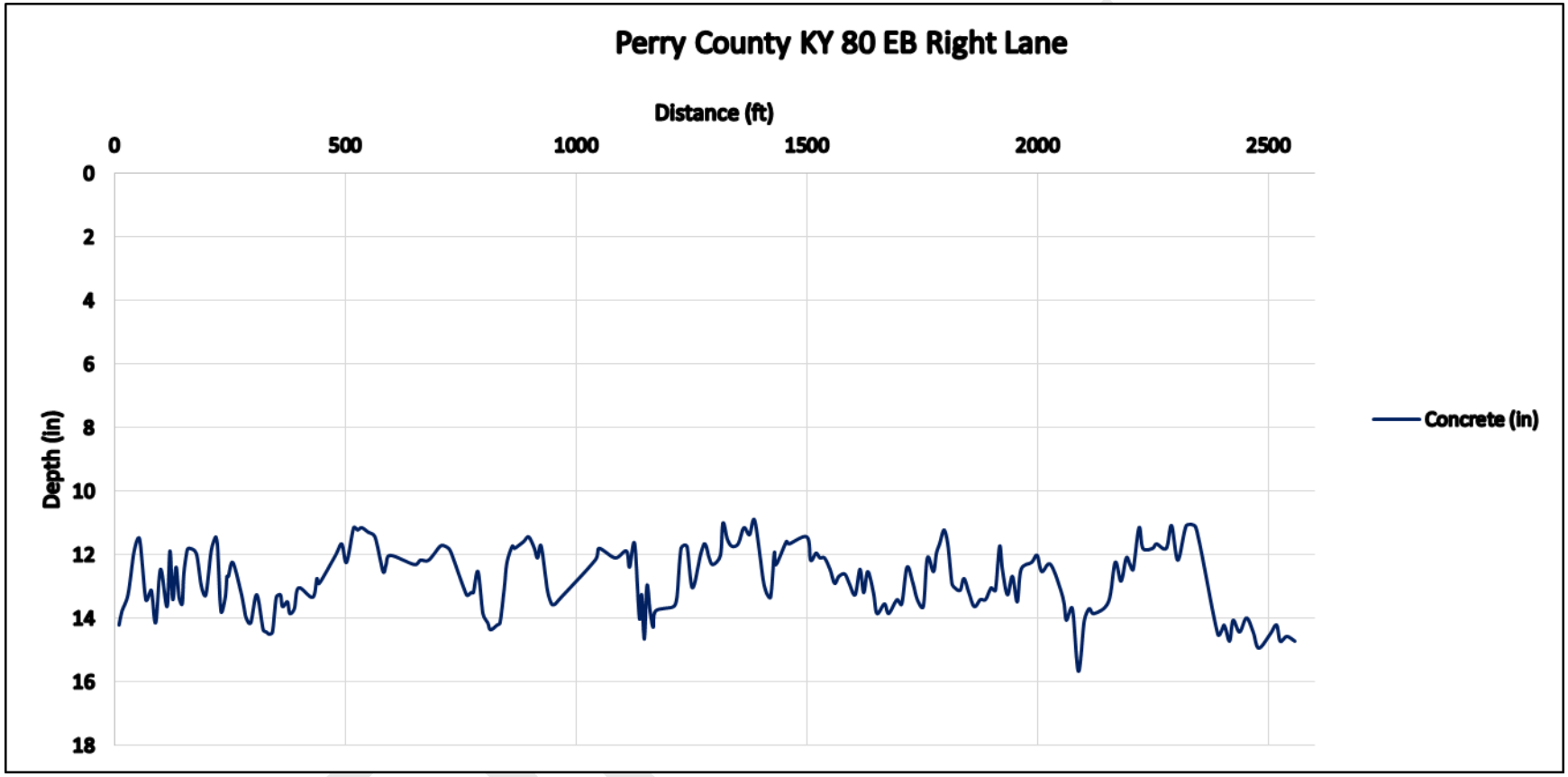


Figure C1. GPR scan results for east bound right lane, KY 80 Mile Point 8.0 - 8.6.

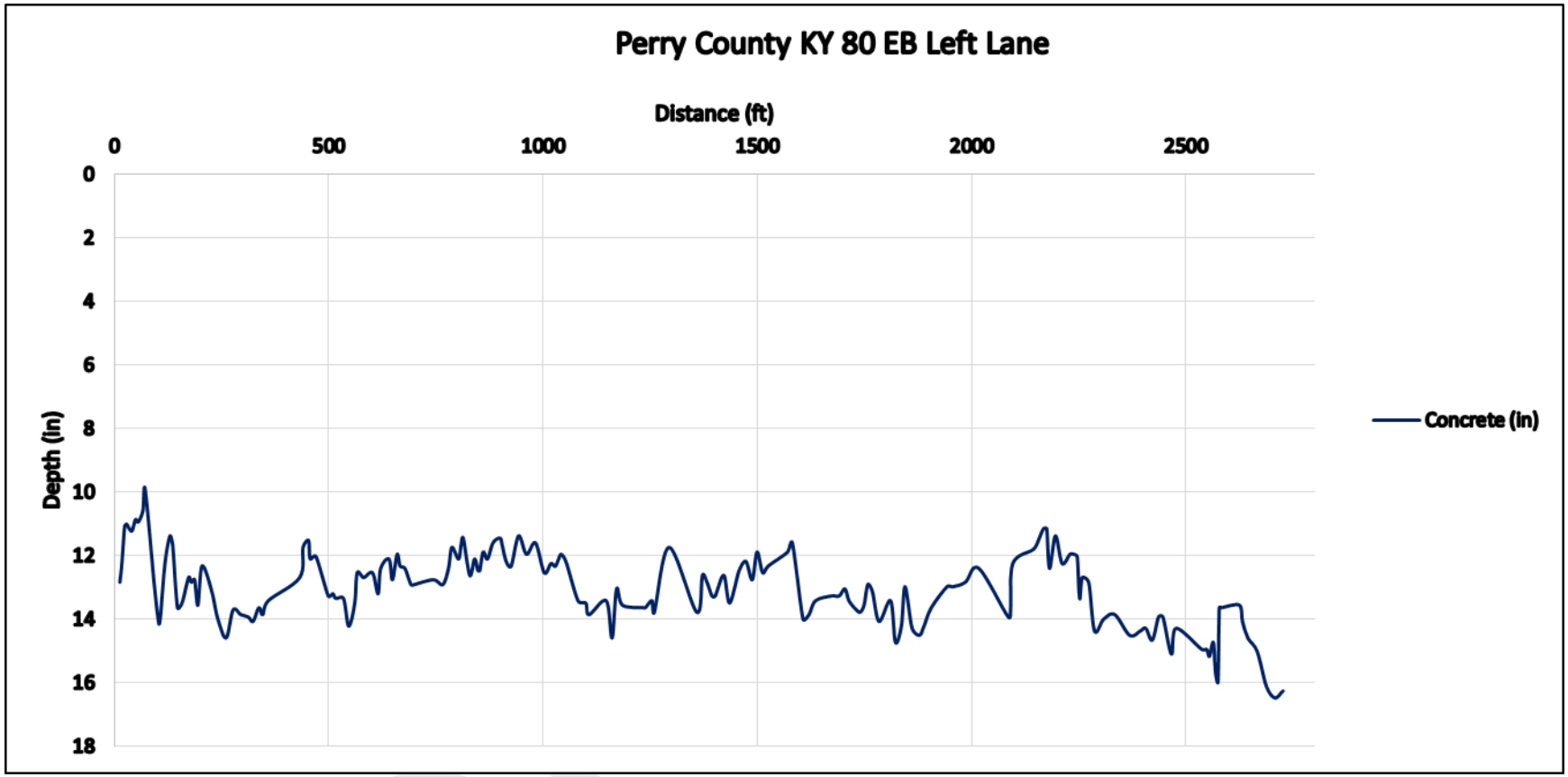


Figure C2. GPR scan results for east bound left lane, KY 80 Mile Point 8.0 - 8.6.

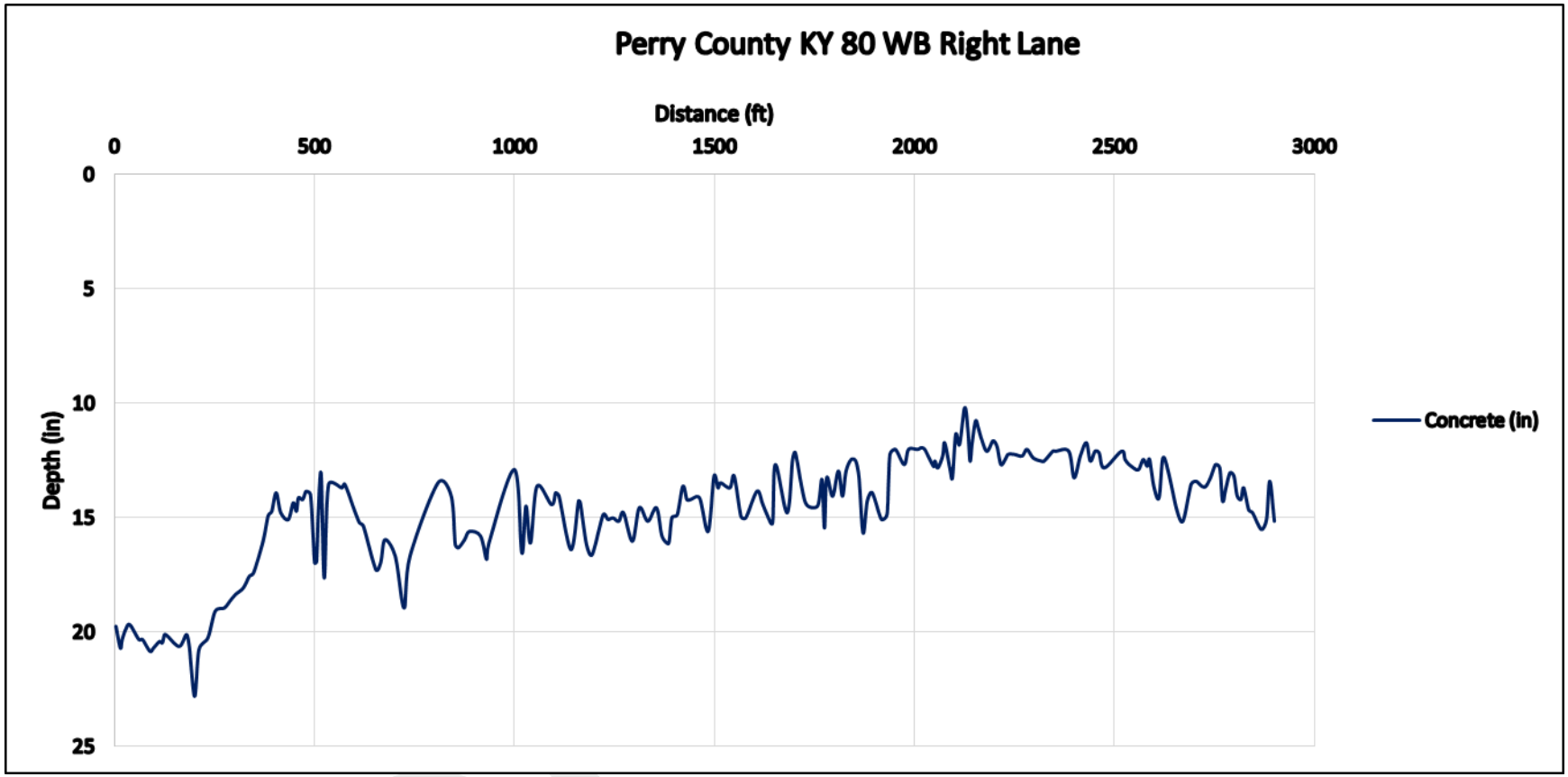


Figure C3. GPR scan results for west bound right lane, KY 80 Mile Point 8.0 - 8.6.

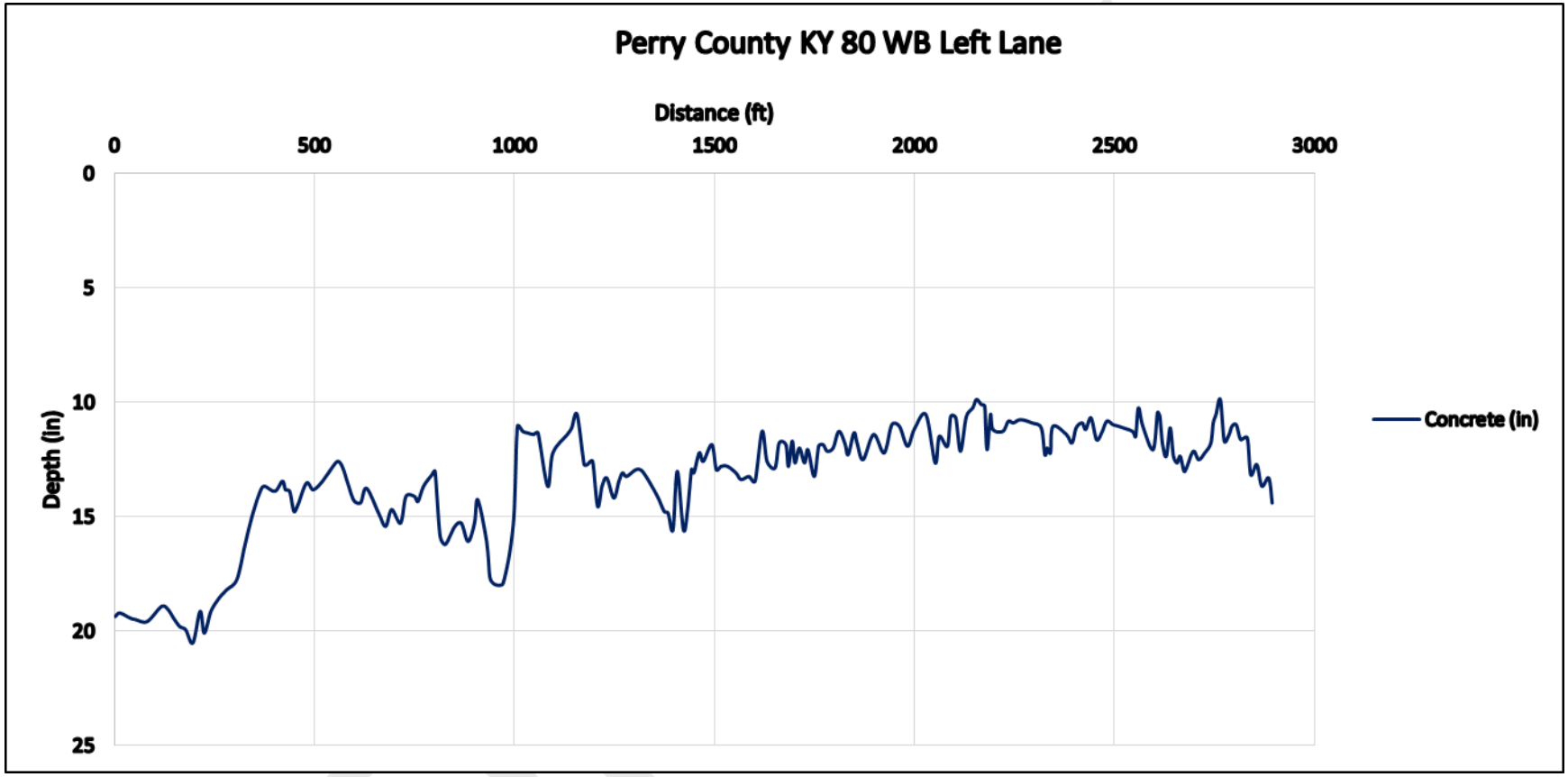


Figure C4. GPR scan results for west bound left lane, KY 80 Mile Point 8.0 - 8.6.

TABLE C1. KY 80, Perry County Structural Assessment

Analysis Scenario	PCC Modulus (KSI)	Subbase Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
Eastbound Inside Lane - 13.0" PCC / 24" Crushed Sandstone Subbase				
MAX Value	7,000	205	27	5
AVG Value	5,200	93	8	2
MIN Value	2,047	50	2	0
Eastbound Outside Lane - 13.0" PCC / 24" Crushed Sandstone Subbase				
MAX Value	7,000	145	27	5
AVG Value	5,889	70	3	8
MIN Value	2,410	50	4	2
Westbound Inside Lane - 13.0" PCC / 24" Crushed Sandstone Subbase				
MAX Value	7,000	300	23	5
AVG Value	5,827	134	11	2
MIN Value	3,063	50	4	1
Westbound Outside Lane - 13.0" PCC / 24" Crushed Sandstone Subbase				
MAX Value	7,000	260	45	9
AVG Value	5,828	109	5	24
MIN Value	2,518	50	2	8

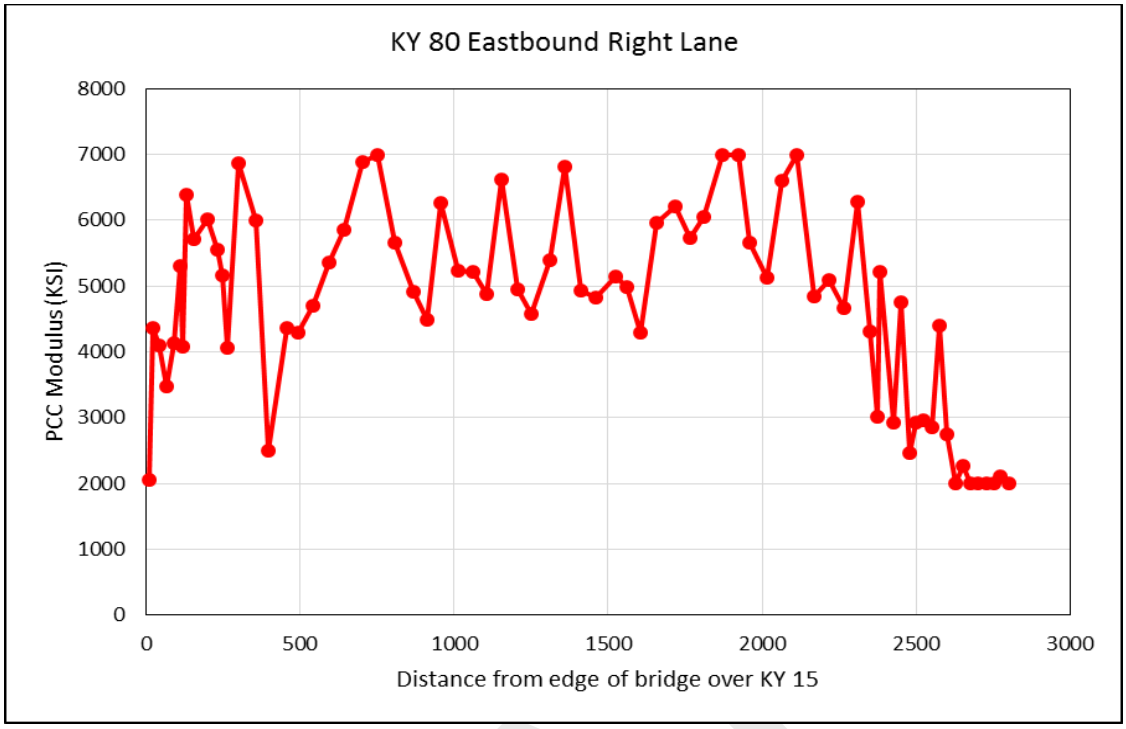


Figure C5. Back-calculated PCC Moduli for eastbound right lane, KY 80, Mile Point 8.0 - 8.6.

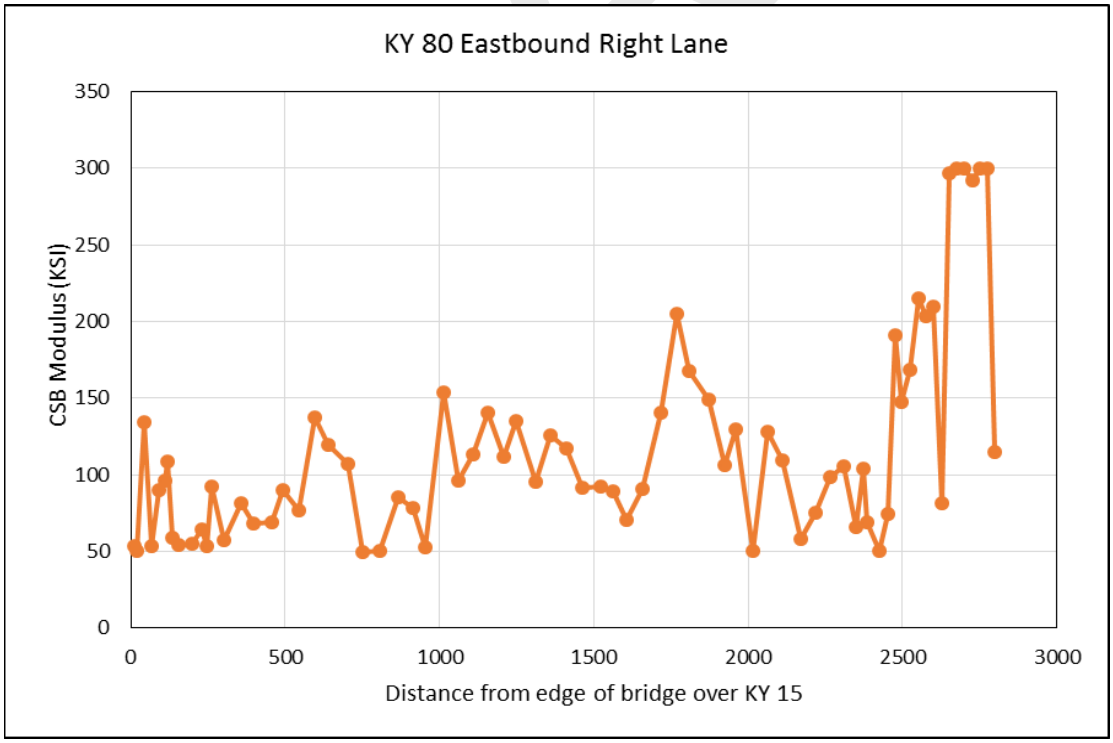


Figure C6. Back-calculated CSB Moduli for eastbound right lane, KY 80, Mile Point 8.0 - 8.6.

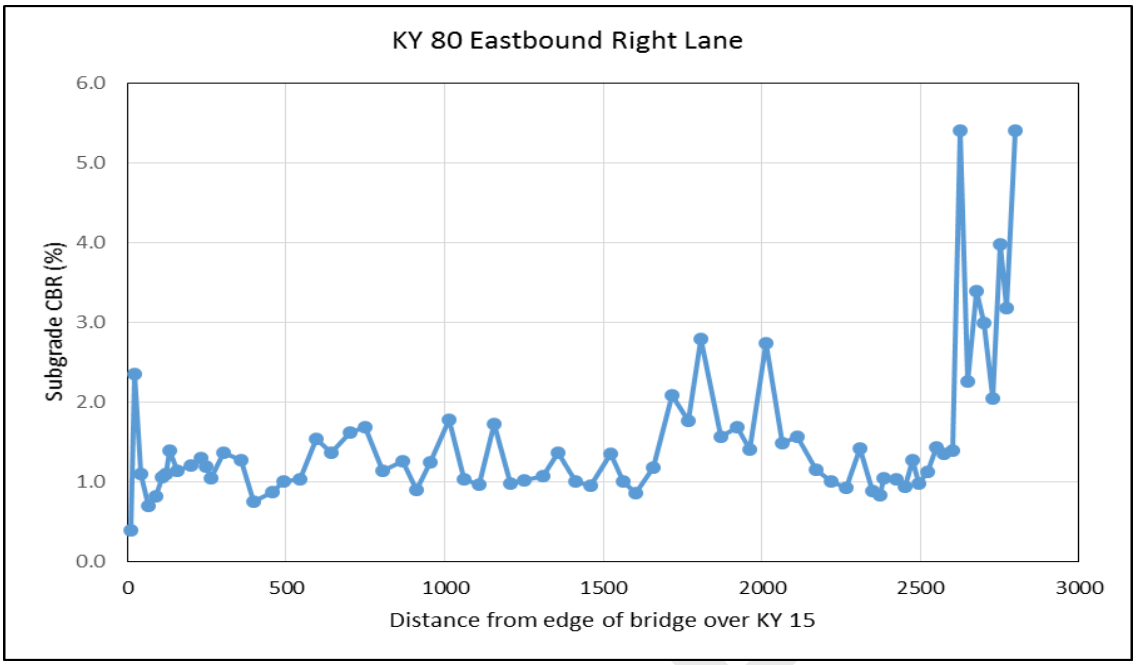


Figure C7. Back-calculated subgrade CBR values for eastbound right lane, KY 80 Mile Point 8.0 - 8.6.

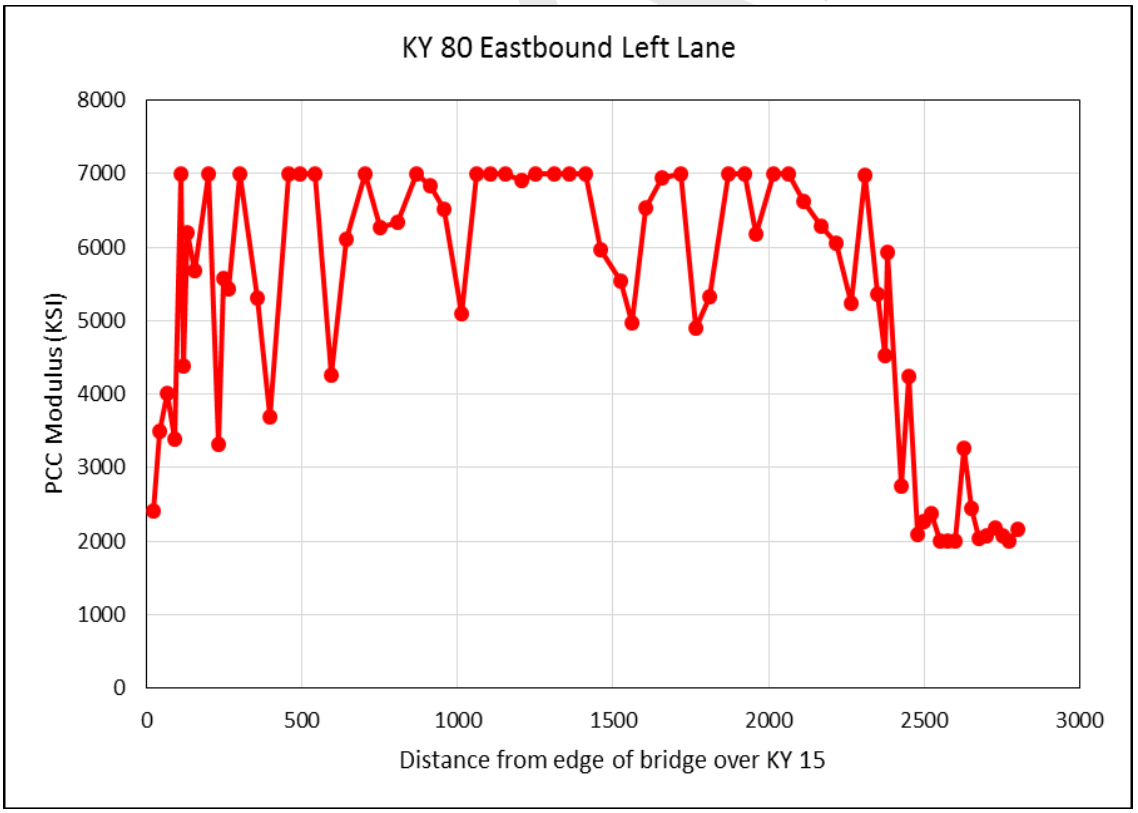


Figure C8. Back-calculated PCC Moduli for eastbound left lane, KY 80 Mile Point 8.0 - 8.6.

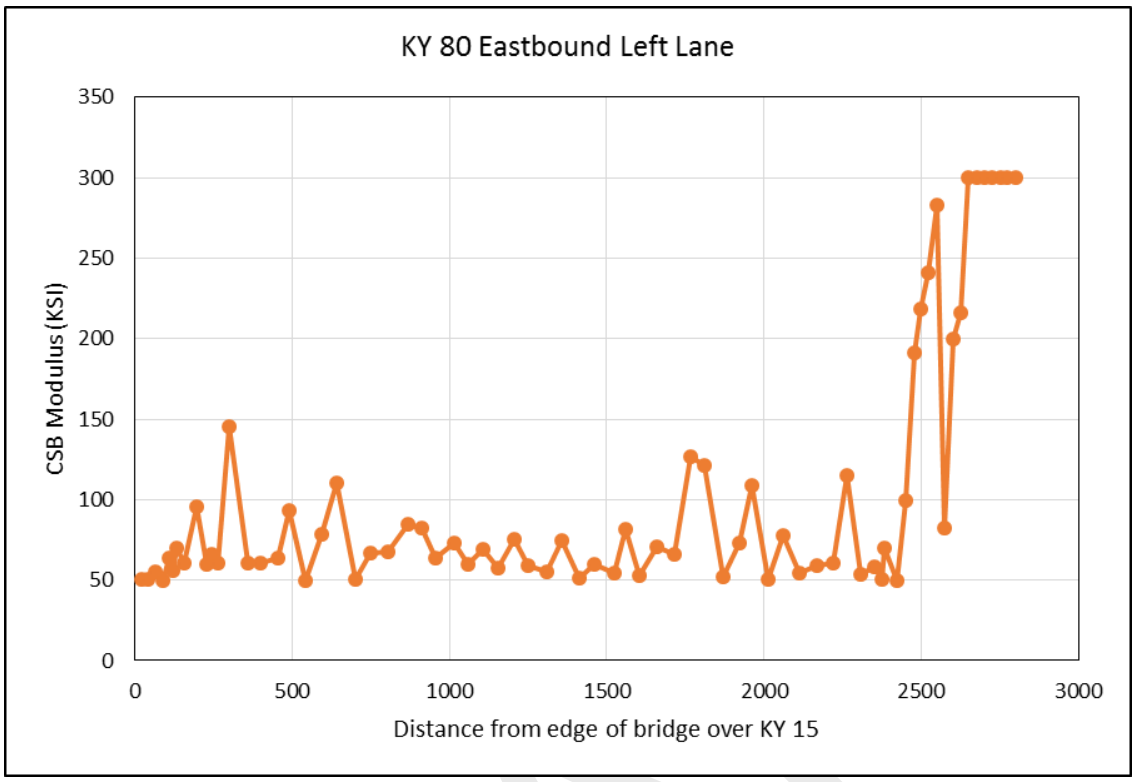


Figure C9. Back-calculated CSB Moduli for eastbound left lane, KY 80 Mile Point 8.0 - 8.6.

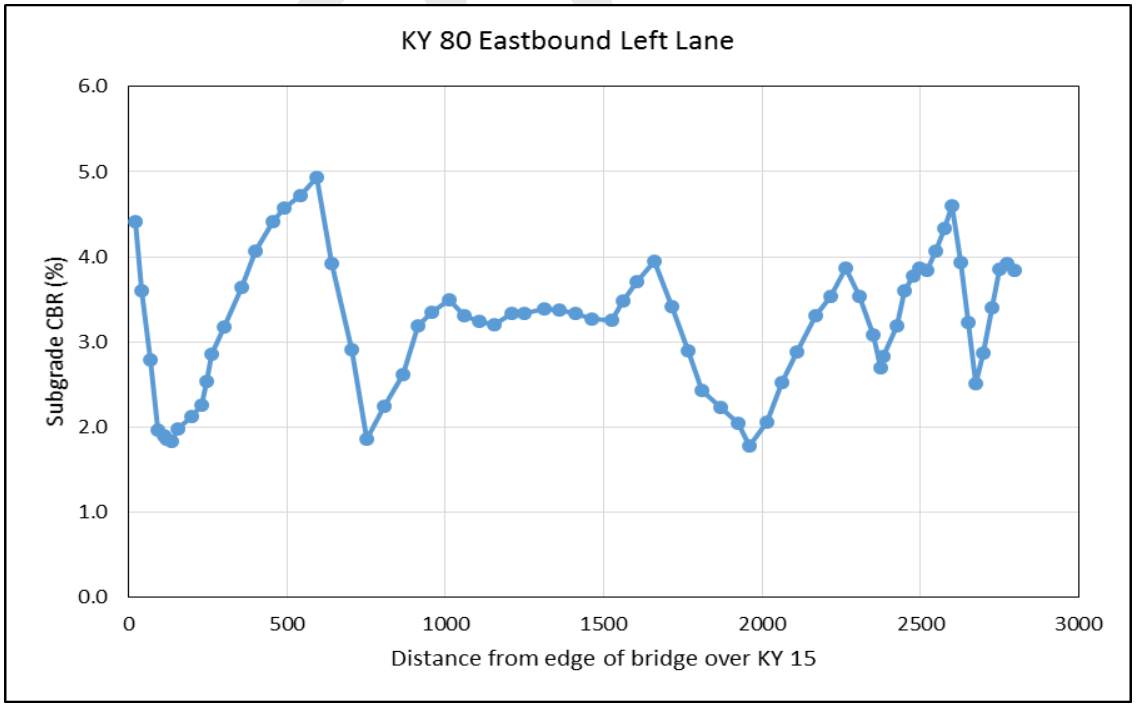


Figure C10. Back-calculated subgrade CBR values for eastbound left lane, KY 80 Mile Point 8.0 - 8.6.

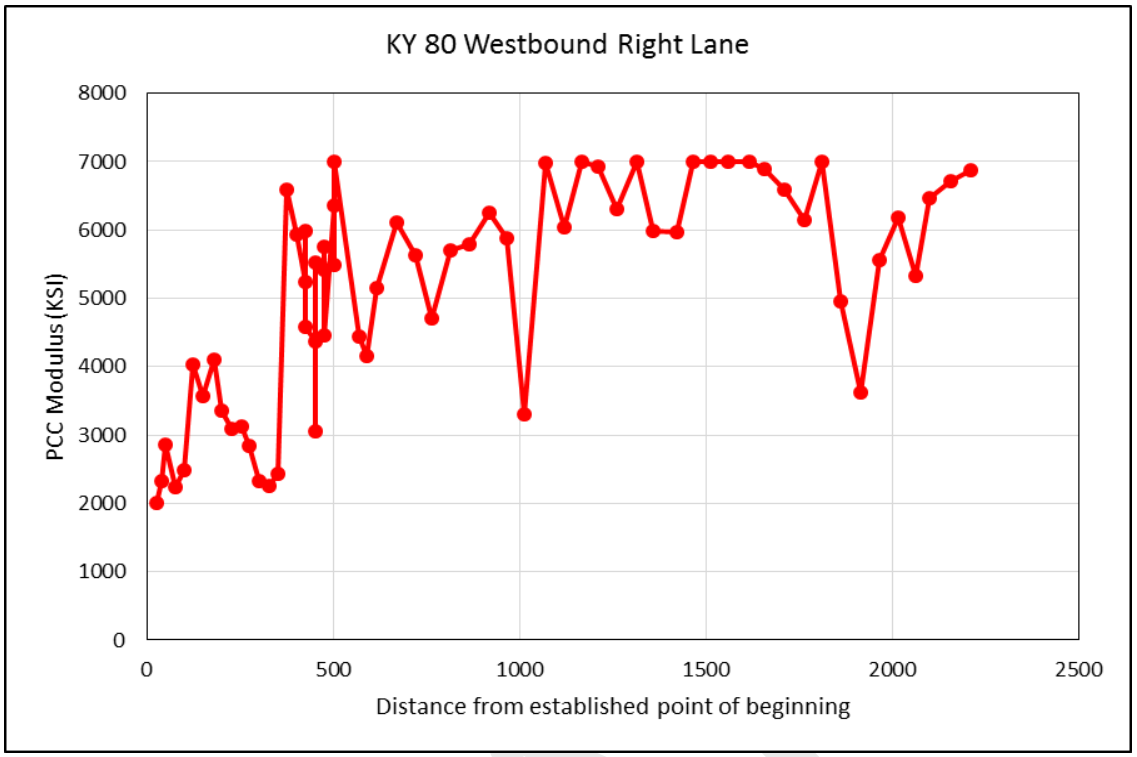


Figure C11. Back-calculated PCC Moduli for westbound right lane, KY 80 Mile Point 8.0 - 8.6.

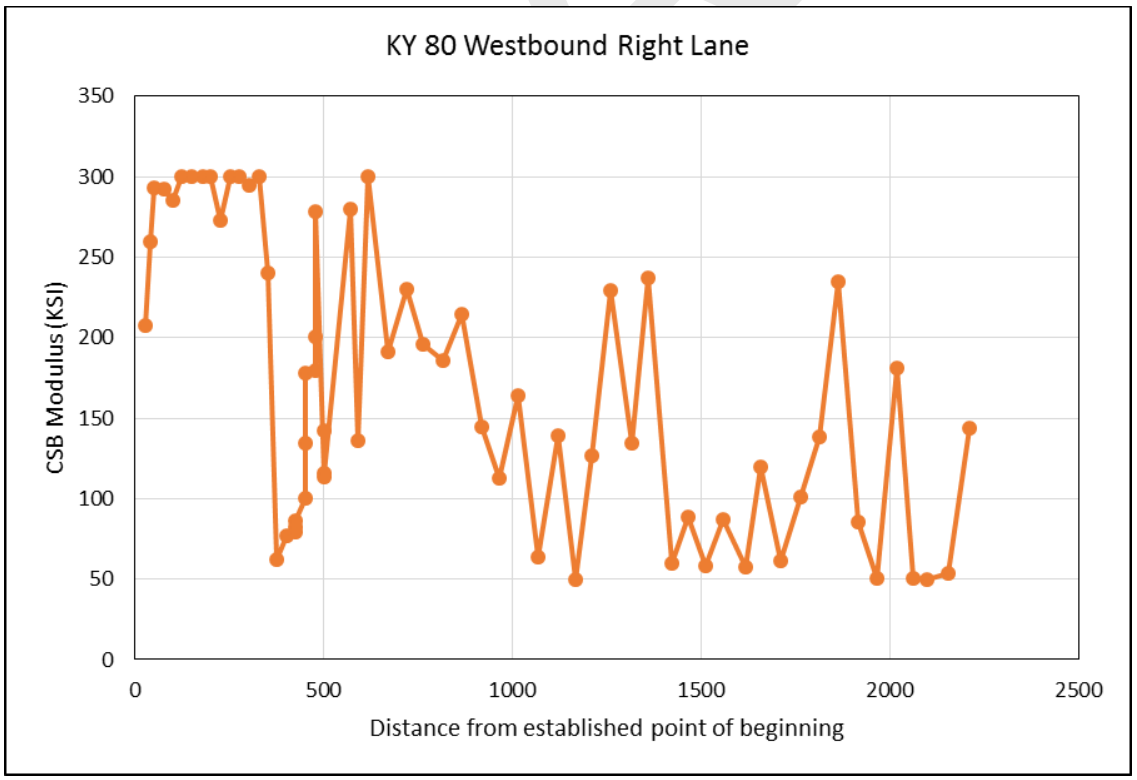


Figure C12. Back calculated CSB Moduli for westbound right lane, KY 80 Mile Point 8.0 - 8.6.

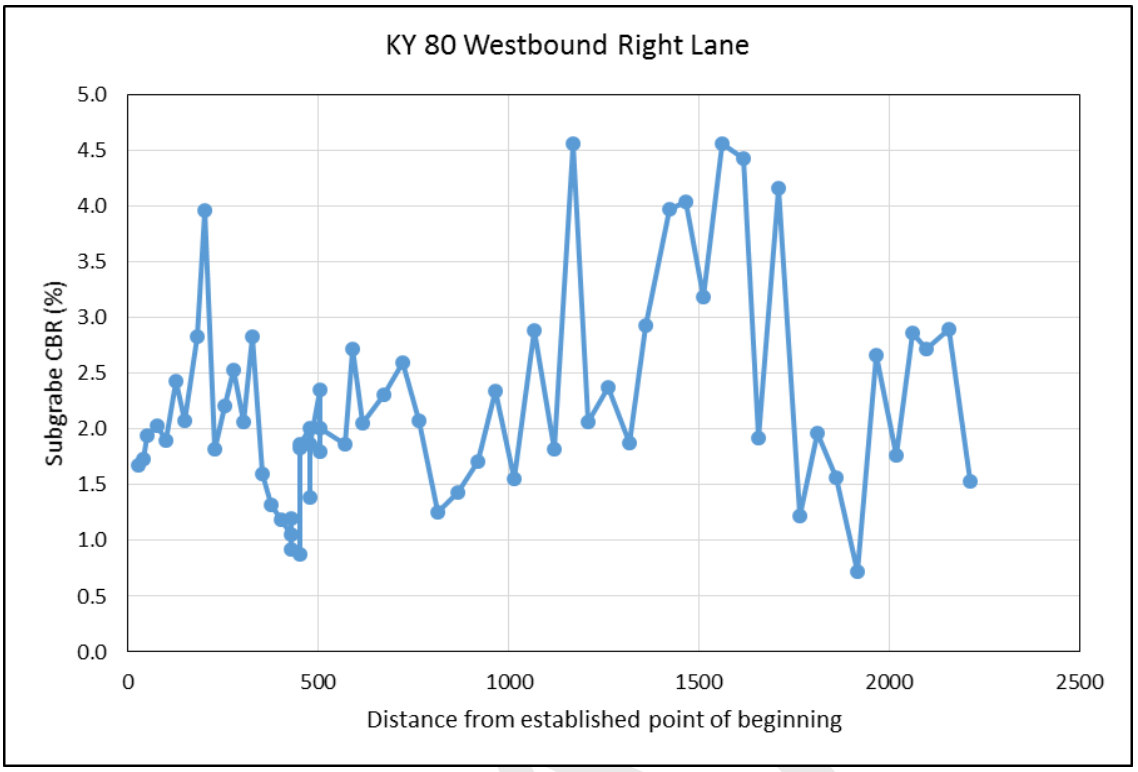


Figure C13. Back-calculated subgrade CBR values for westbound right lane, KY 80 Mile Point 8.0 - 8.6.

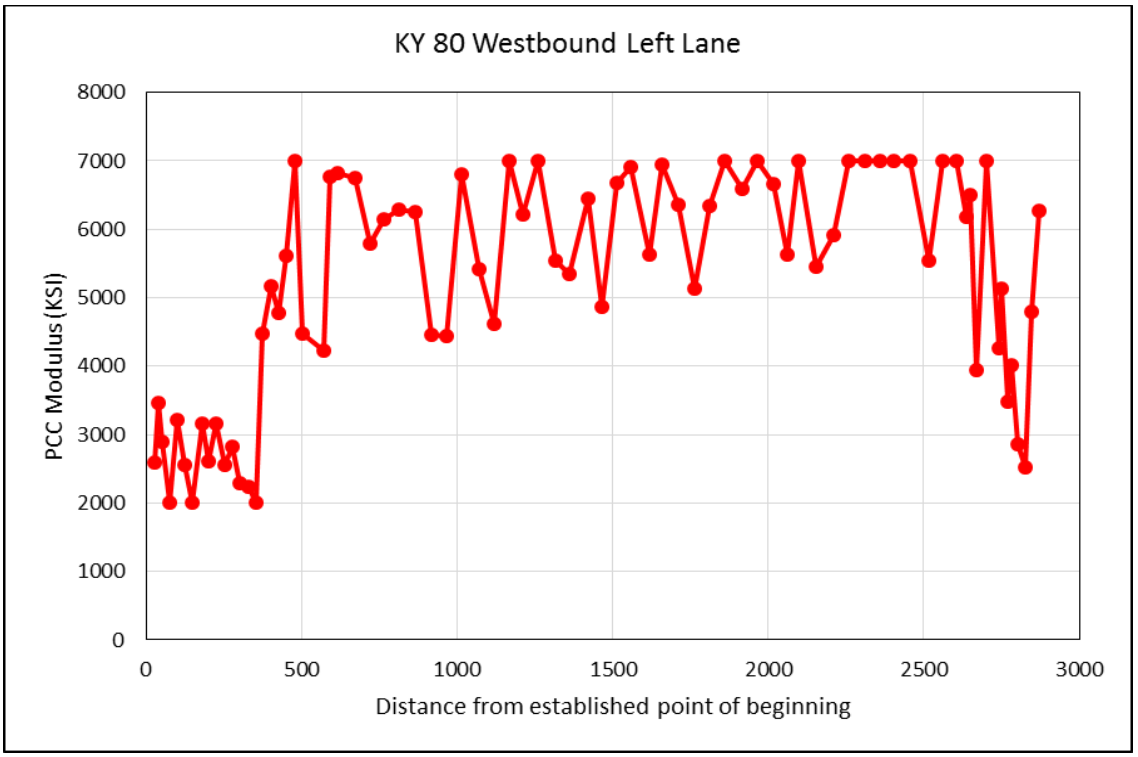


Figure C14. Back-calculated PCC Moduli for westbound left lane, KY 80 Mile Point 8.0 - 8.6

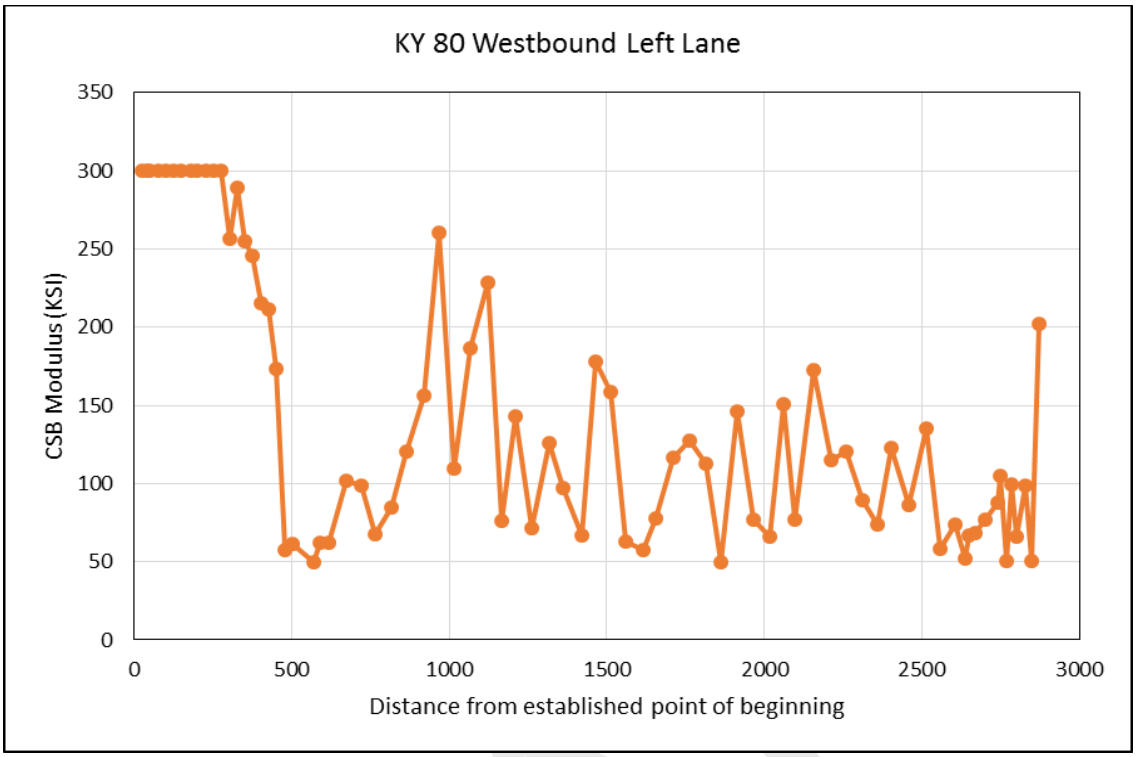


Figure C15. Back calculated CSB Moduli for westbound left lane, KY 80 Mile Point 8.0 - 8.6.

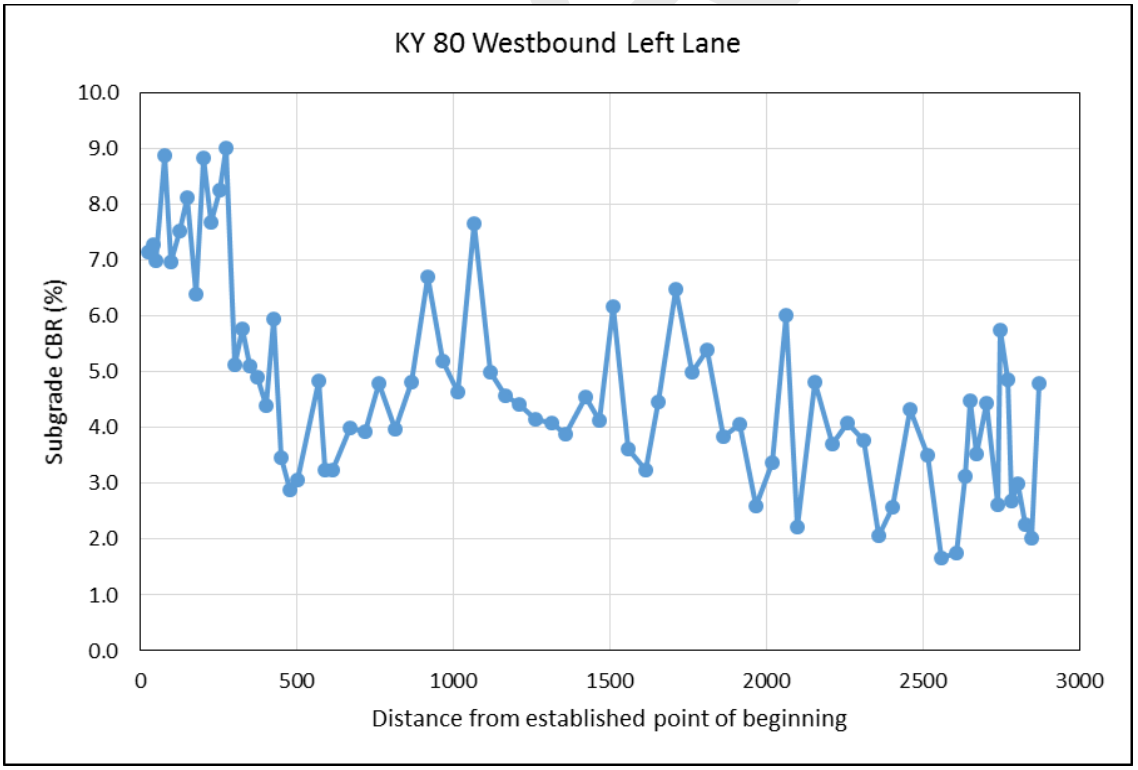


Figure C16. Back-calculated subgrade CBR values for westbound left lane, KY 80 Mile Point 8.0 - 8.6.

TABLE C2. Core Extractions and Related Information – KY 80, Perry County

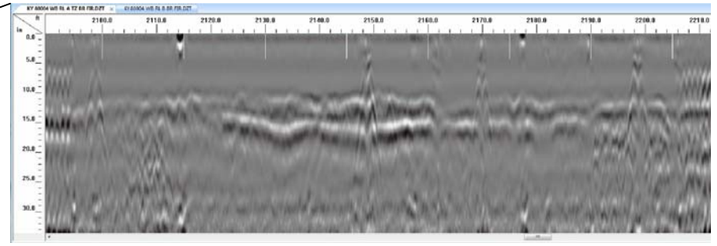
Core Site	Lane	Core Location[a] (Ft.)	Core Purpose	Field Core Length (in.)	Crushed Sandstone Thickness (in.)	Depth of Moisture Content Sample (in.)	Subgrade Moisture Content (%)
EB1	Outside	+240 RWP	Moving Slab	12-3/4	10-1/4+	19	7.7
EB2	Outside	+1,940 LWP	Wet Area	13-1/4	9-3/4+	NA	NA
EB3	Inside	+505 Center	Random	13	6+	18	9.3
EB4	Inside	+1,165	Wet Area	13-1/2	6+	17	7.5
WB1	Outside	+1,835	Wet Area	13-3/8	6+	17	8.4
WB2	Outside	+2,110	Settlement	11-1/2[c]	8+	19-1/2	9.6
WB3	Inside	+740	Random	13-1/2	6+	17-3/4	8.5
WB4	Inside	+1,440	Wet Area	13-1/2	6+	17	7.5

Notes: a = Locations of cores in eastbound lanes based on distance from armored edge on east end of bridge over KY 15.

b = Locations of cores in westbound lanes based on distance from established point of beginning located 528 feet east of concrete pavement /asphalt pavement interface.

c = Core WB2 located in a patched area that exhibited settlement and surface staining. A 5-inch layer of compacted dense-graded aggregate was found below the concrete patch.

CORE 2 WB RL
PCC 11.5"
DGA 11.5" TO 16.5"
CSB AT 16.5"



GPR SHOWING SUBGRADE LAYERS
BENEATH PCC PATCH

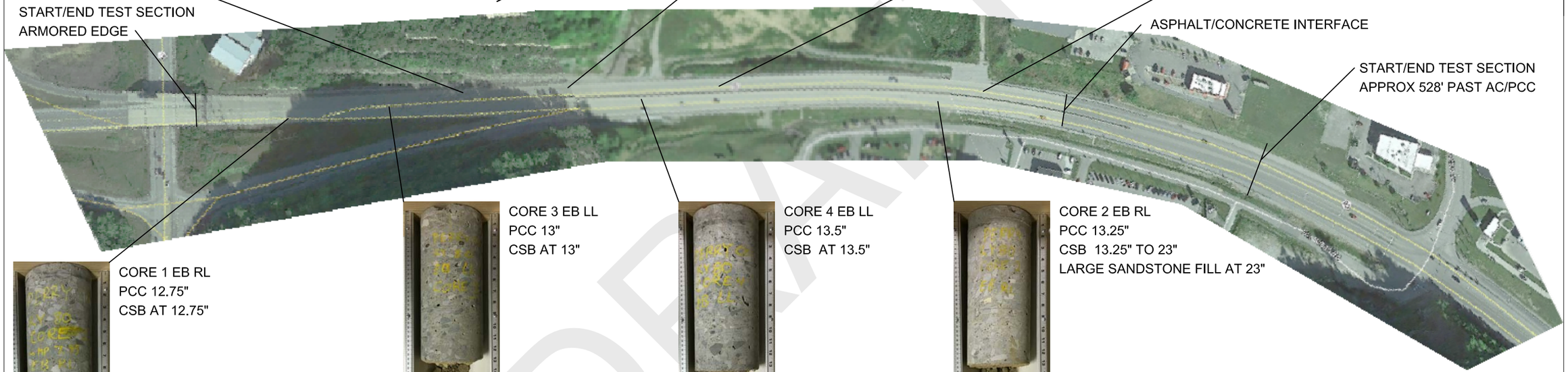
CORE 1 WB RL
PCC 13.75"
CSB AT 13.75"

CORE 4 WB LL
PCC 13.5"
CSB AT 13.5"

CORE 3 WB LL
PCC 13.375"
CSB AT 13.375"

NORTH

START/END TEST SECTION
ARMORED EDGE



ASPHALT/CONCRETE INTERFACE

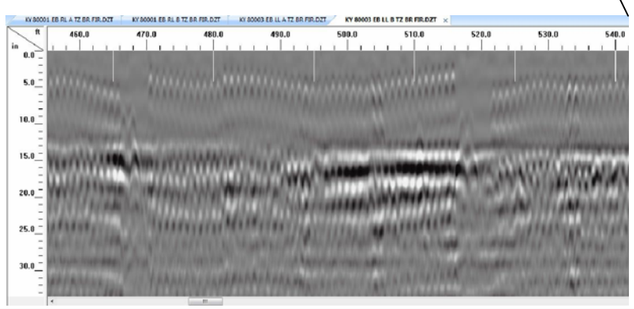
START/END TEST SECTION
APPROX 528' PAST AC/PCC

CORE 1 EB RL
PCC 12.75"
CSB AT 12.75"

CORE 3 EB LL
PCC 13"
CSB AT 13"

CORE 4 EB LL
PCC 13.5"
CSB AT 13.5"

CORE 2 EB RL
PCC 13.25"
CSB 13.25" TO 23"
LARGE SANDSTONE FILL AT 23"



GPR SHOWING CONCRETE
REINFORCED WITH WIRE MESH
DEPTH APPROX. 13"

NOT TO SCALE

*CSB = CRUSHED SANDSTONE BASE

Figure C17. Core locations and results.

PERRY CO. KY 80 SUBSURFACE INVESTIGATION, ~MP 8-8.6	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 1 OF 1 DATE 4/4/16 DRAFTED TAJ

APPENDIX D

FIELD RESULTS

GROUND PENETRATING RADAR
FALLING WEIGHT DEFLECTOMETER
CORING AND MATERIALS SAMPLING

KY 15, PERRY COUNTY

Perry County KY 15

A team from the Kentucky Transportation Center's Pavement, Materials, Geotechnical and Infrastructure Assessment performed work for the Kentucky Transportation Cabinet to structurally assess KY 15 in Perry County. The section tested extended from the intersection of Johnny Cox All American Drive (Hazard Bypass KY 15) northward through Combs, KY to the intersection with Boone Ridge Road, Mile Point 13.25 to 14.95. The roadway is comprised of three and four-lane sections with turn lanes. Project information provided through Palmer Engineering was used to guide the KY 15 investigation. All data collected on KY 15 are presented herein.

Initial field work was performed on Friday, 15 April 2016 and involved performing a scan with ground-penetrating radar (GPR) using an air-launched, 1.0 GHz antenna. Remaining field work was performed on 25 and 26 April 2016 and included:

- Ground Penetrating Radar (GPR) – 2-900 MHz ground-coupled antennas with 6-foot separation were used to scan the left and right wheel paths of the outer lane. Data obtained through GPR scans are presented in Figures D1 through D6.
- Falling Weight Deflectometer (FWD) – deflection testing was performed at 250-foot intervals in the right-wheel path of the outer lane. Back-calculated moduli values for the HMA pavement and underlying layers are presented in Tables D1 and D2 for northbound and southbound directions, respectively, and graphically in Figures D7 through D30.
- Coring, sampling, and Dynamic Cone Penetrometer (DCP) tests were performed at sites predetermined in concert with Palmer Engineering. Coring and sampling results are presented in Tables D3 and D4. Additional core-related information is presented in Figures D31 through D33.

Traffic control was expertly provided by the Perry County maintenance crew both days.

The GPR data indicated significant variations in the thickness of the hot mix asphalt (HMA) and dense-graded aggregate (DGA) layers throughout the project limits. Those values ranged from 10 to 15 inches for the HMA layers and eight (8) to 16 inches for the DGA layer. Moisture contents of the shale/rock/soil subgrade ranged from four (4) percent to 14 %.

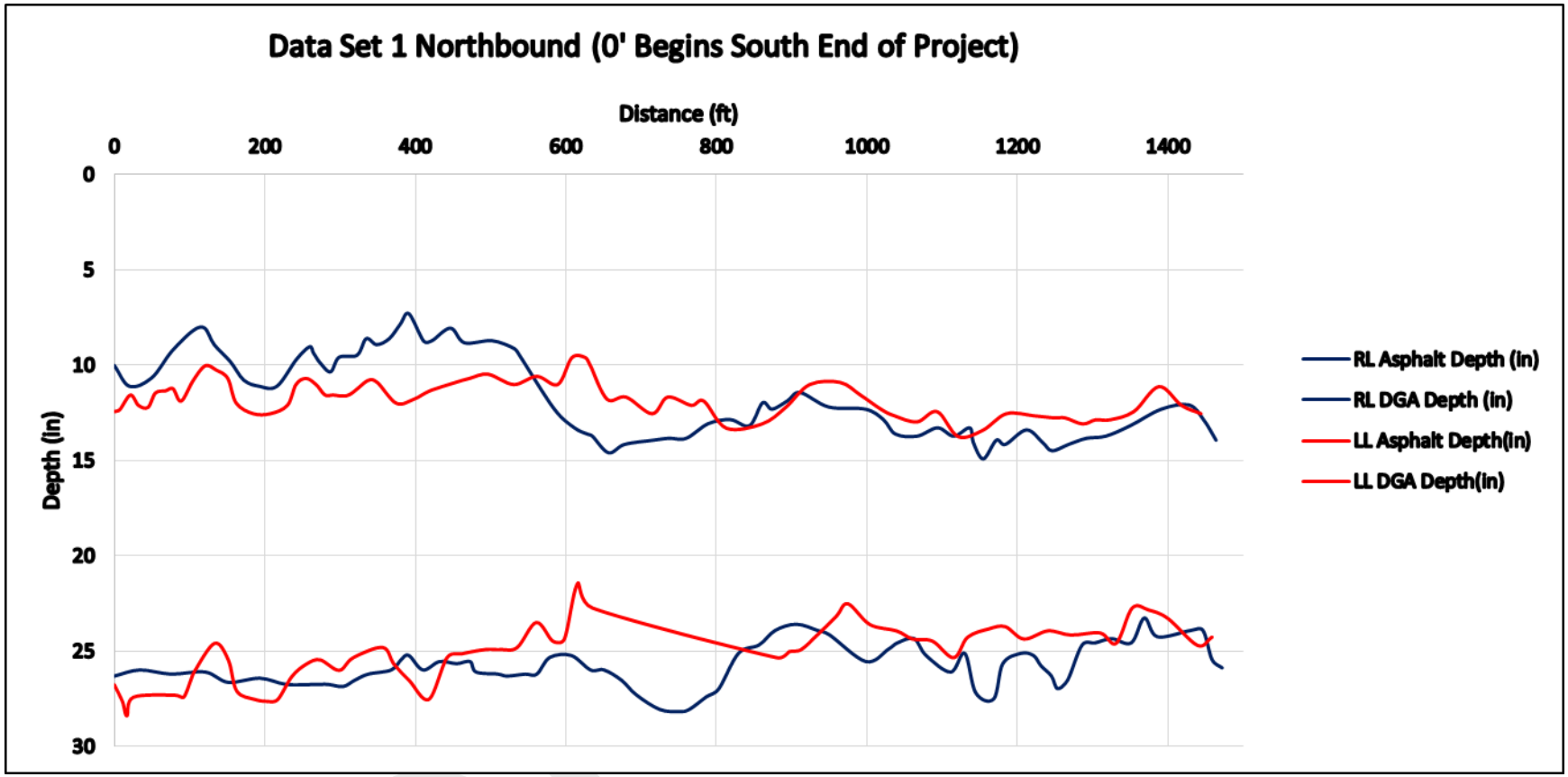


Figure D1. Northbound KY 15, Perry County, Station 303+07.49 to 317+07.49.

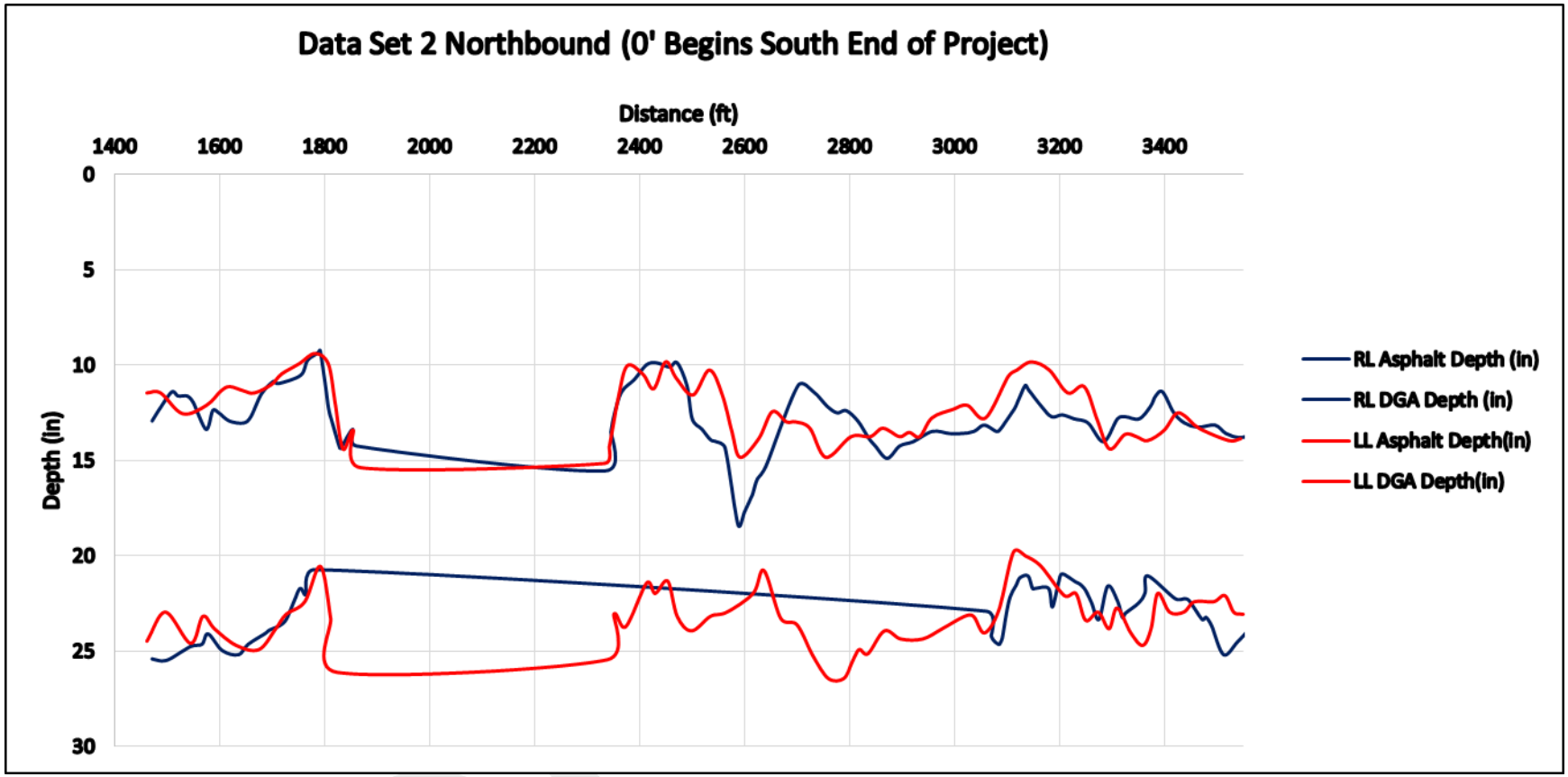


Figure D2. Northbound KY 15, Perry County, Station 317+07.49 to Station 337+07.49.

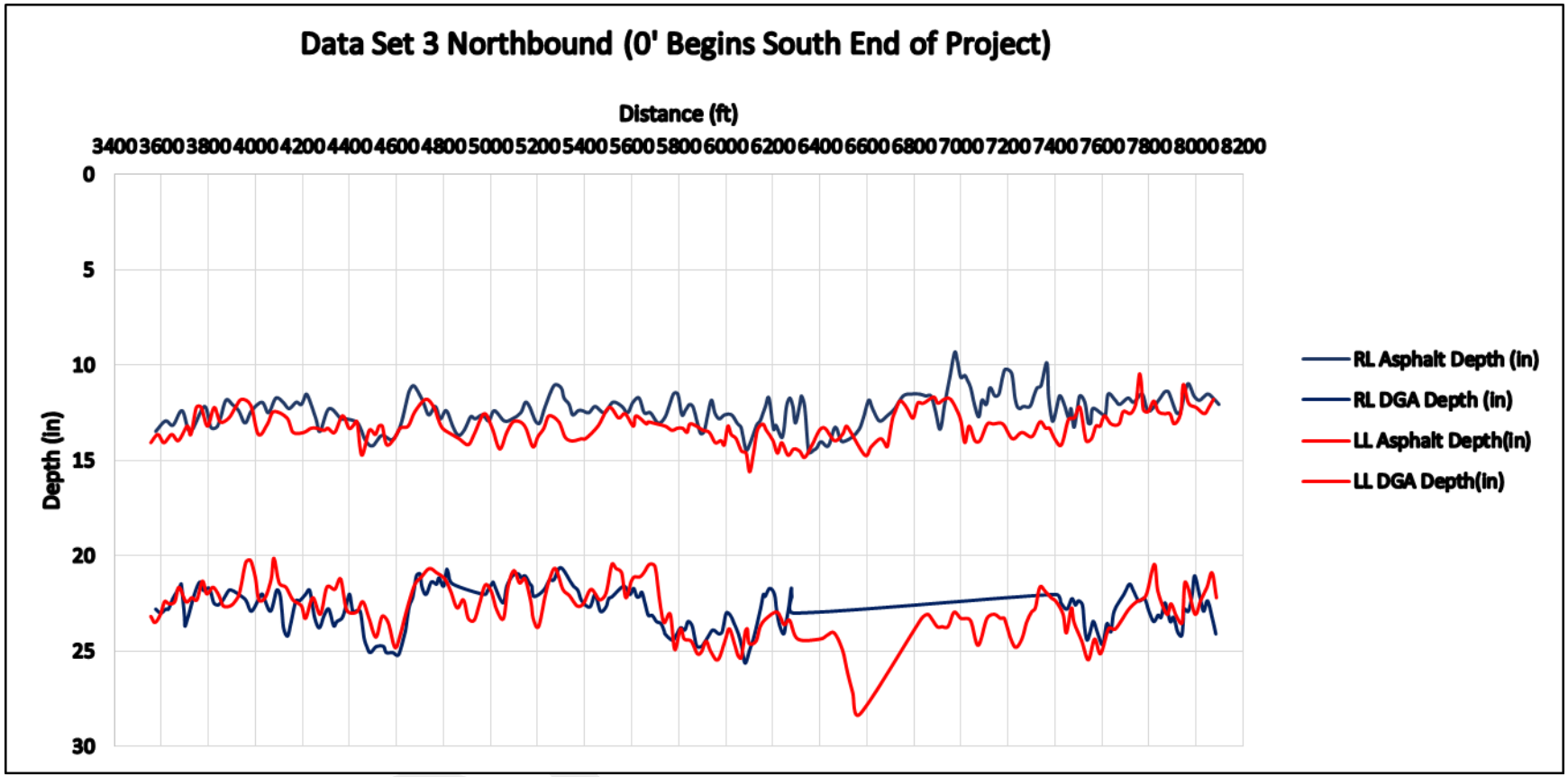


Figure D3. Northbound KY 15, Perry County, Station 337+07.49 to Station 393+14.58.

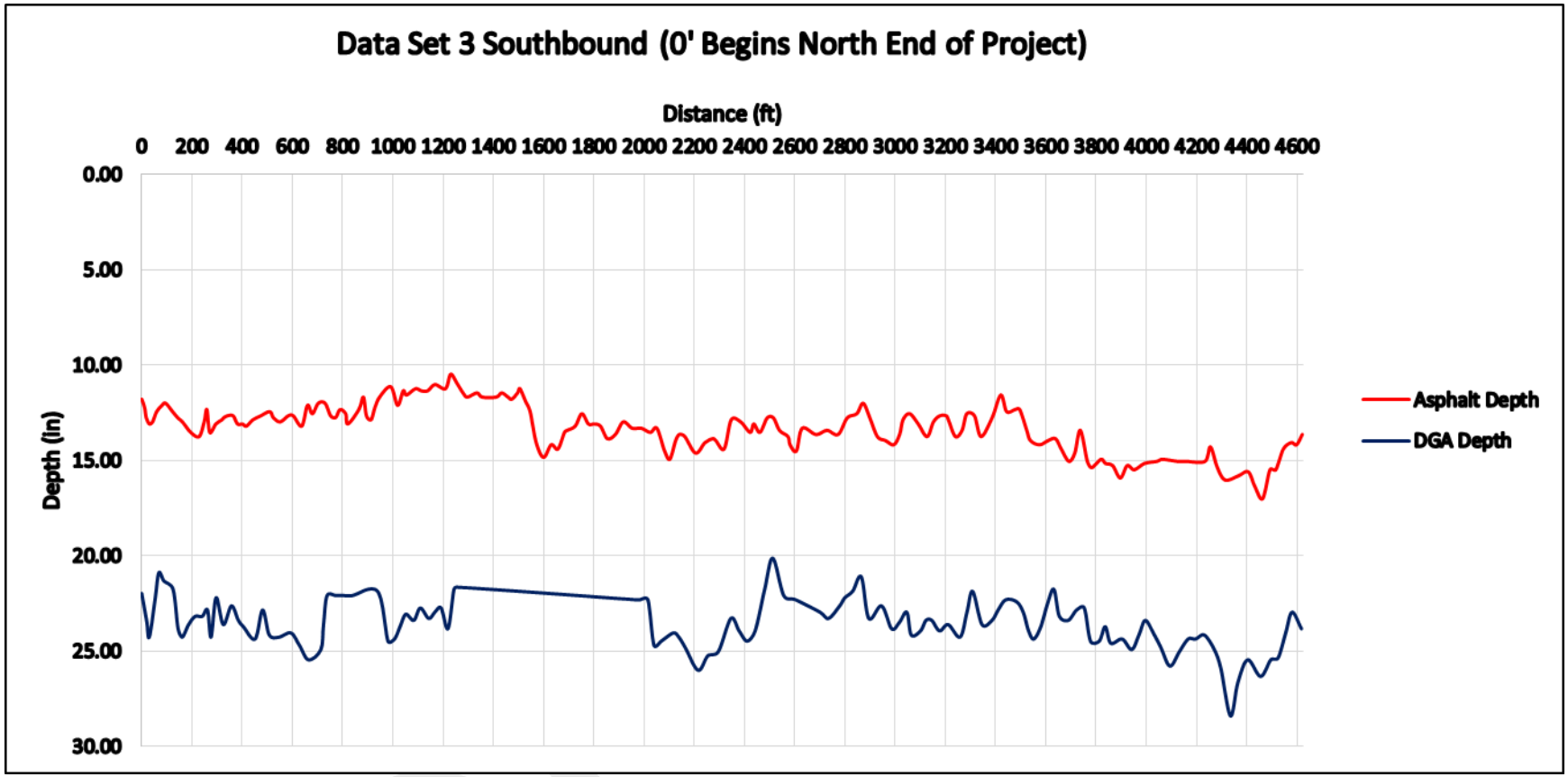


Figure D4. Southbound KY 15, Perry County, Station 393+14.58 to Station 343+14.58.

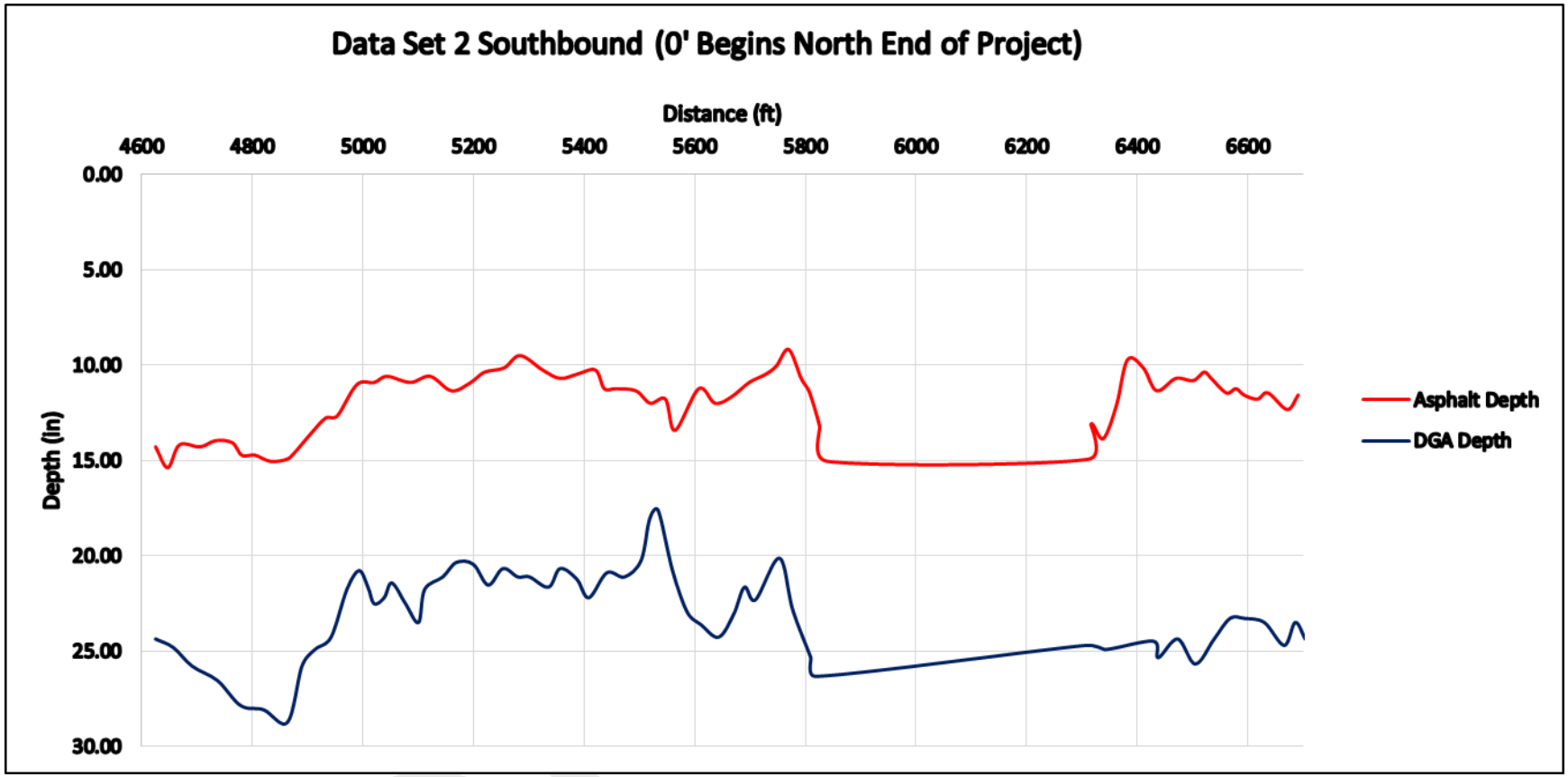


Figure D5. Southbound KY 15, Perry County, Station 343+14.58 to Station 323+14.58.

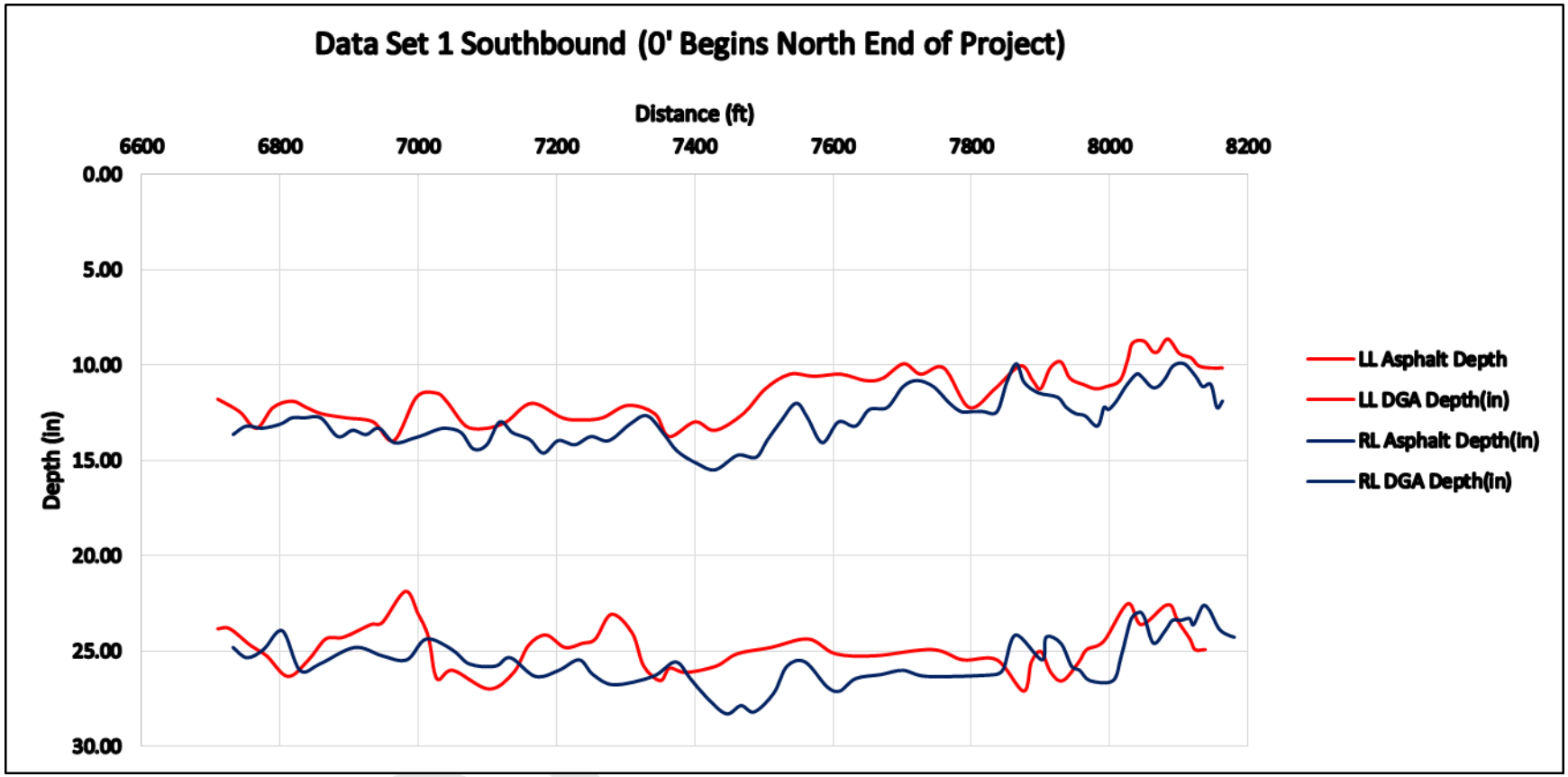


Figure D6. Southbound KY 15, Perry County, Station 323+14.58 to Station 303+07.49.

TABLE D1. Northbound KY 15 Structural Assessment

Analysis Scenario	AC Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
12.5” AC / 11.0” DGA – Average Thickness throughout				
MAX Value	2072	100	48	10
AVG Value	1204	79	18	4
MIN Value	516	23	8	2
10.5” AC / 8.5” DGA – Minimum Thickness throughout				
MAX Value	2420	100	51	10
AVG Value	1604	82	22	4
MIN Value	553	49	10	2
15.0” AC / 16.0” DGA – Maximum Thickness throughout				
MAX Value	1504	100	45	9
AVG Value	951	46	17	3
MIN Value	393	25	6	1
12.2” AC / 11.3” DGA – Average Thickness Northbound only				
MAX Value	2263	100	48	10
AVG Value	1271	81	20	4
MIN Value	521	30	7	1

TABLE D2. Southbound KY 15 Structural Assessment

Analysis Scenario	AC Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
12.5” AC / 11.0” DGA – Average Thickness throughout				
MAX Value	1894	100	33	7
AVG Value	1386	70	9	2
MIN Value	737	25	4	1
10.5” AC / 8.5” DGA – Minimum Thickness throughout				
MAX Value	2340	100	42	8
AVG Value	1916	68	14	3
MIN Value	910	25	6	1
15.0” AC / 16.0” DGA – Maximum Thickness throughout				
MAX Value	1416	100	25	5
AVG Value	954	60	6	1
MIN Value	606	25	2	1
13.3” AC / 14.3” DGA – Average Thickness Southbound only				
MAX Value	1629	100	27	6
AVG Value	1111	79	7	1
MIN Value	645	25	3	1

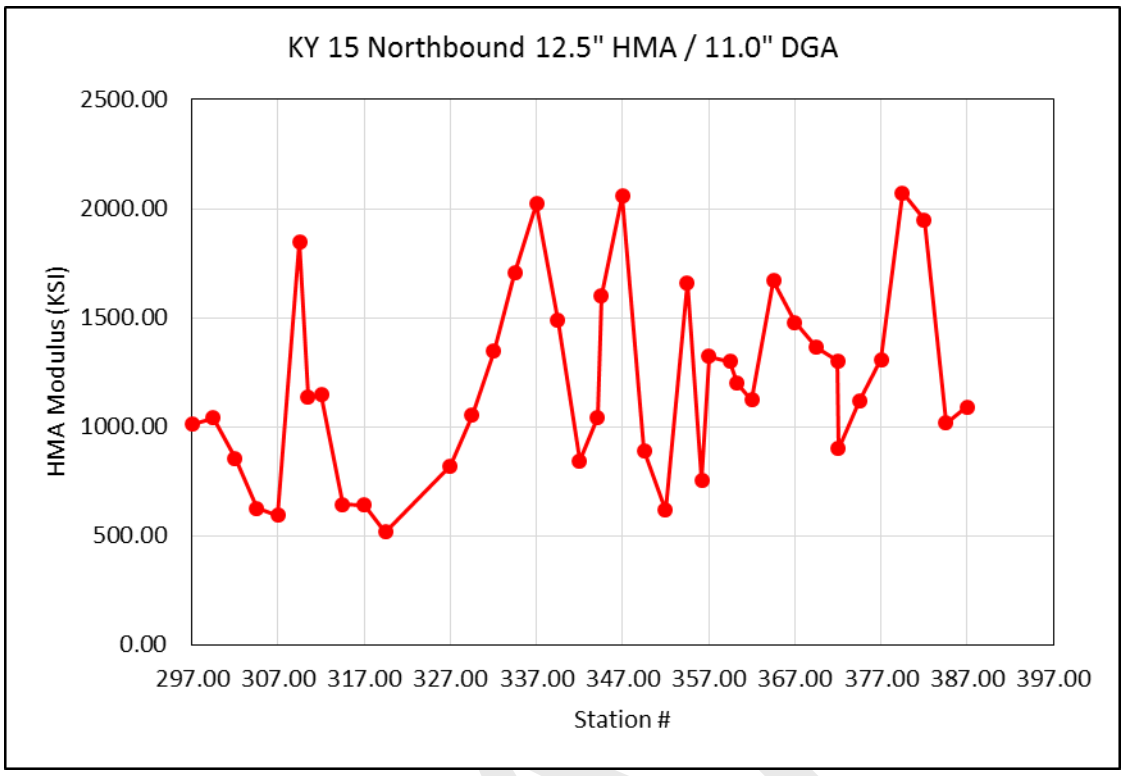


Figure D7. Back-calculated HMA moduli values for northbound right lane, KY 15 Mile Point 13.25 – 14.95.

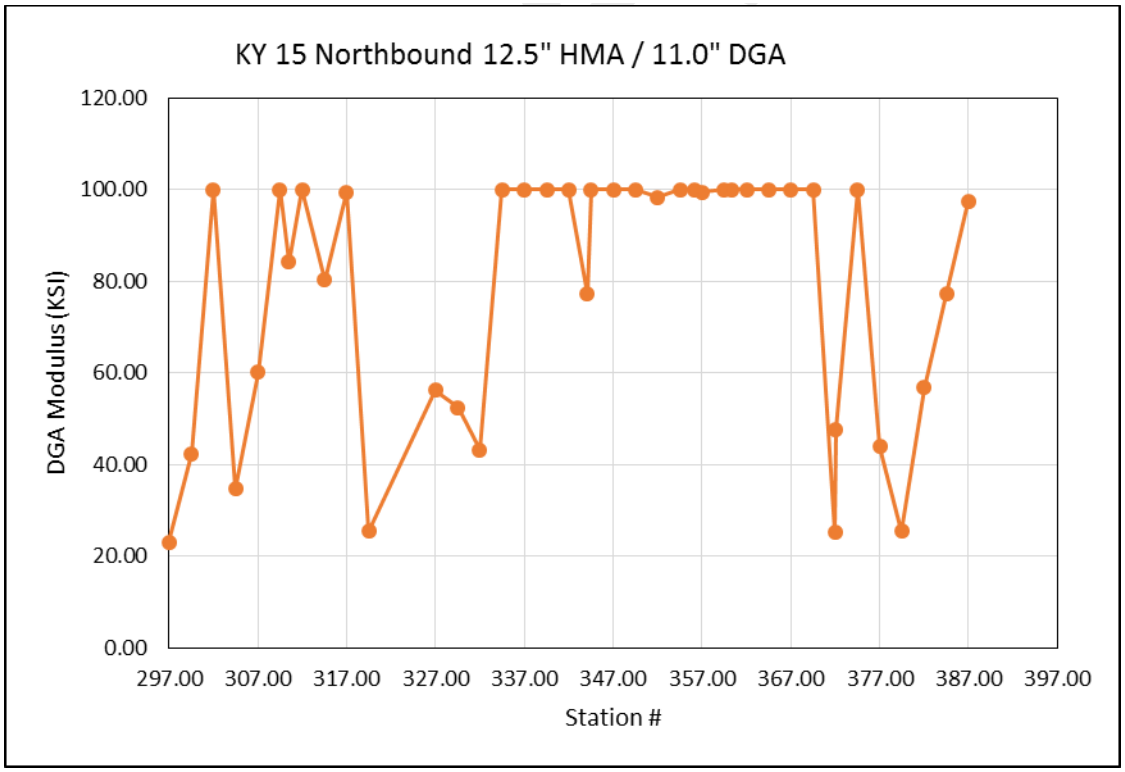


Figure D8. Back-calculated DGA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

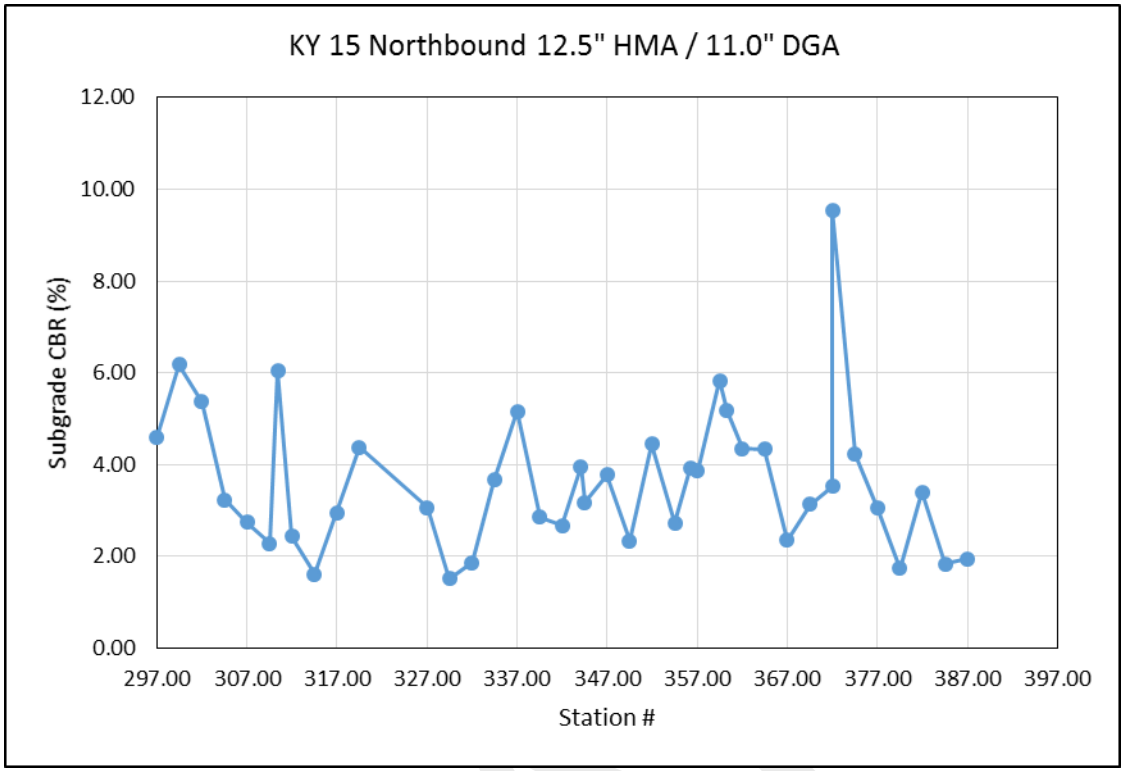


Figure D9. Back-calculated subgrade CBR values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

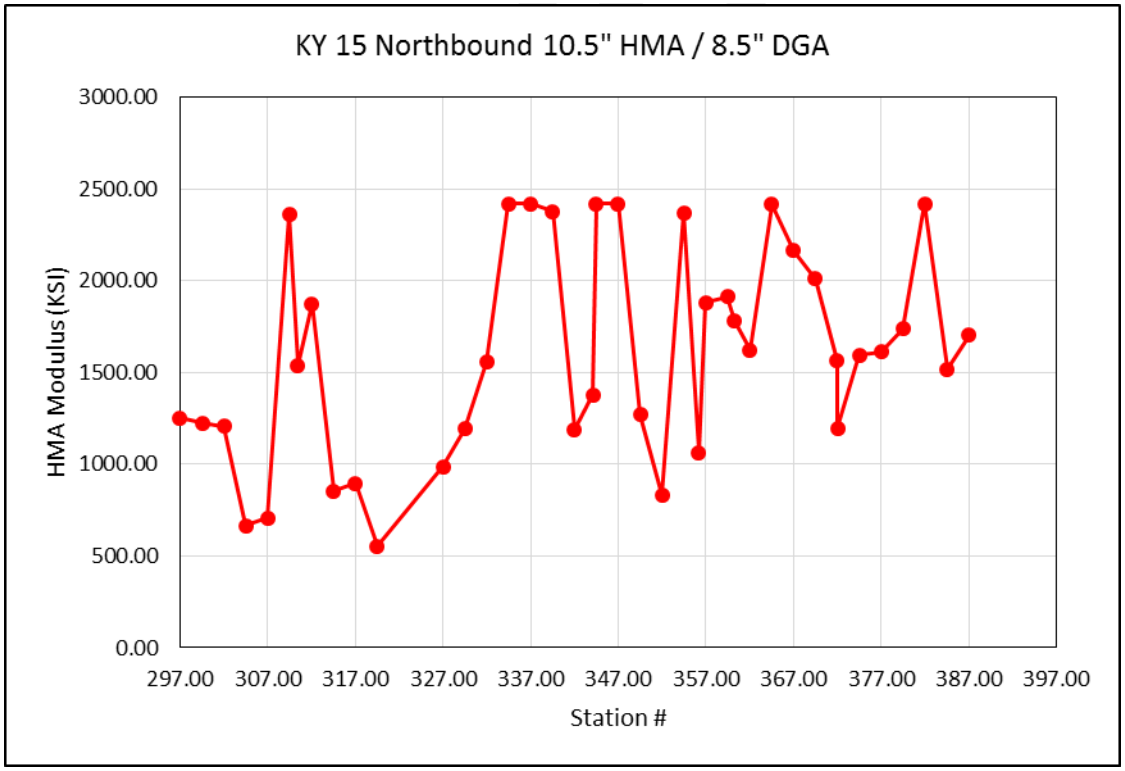


Figure D10. Back-calculated HMA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

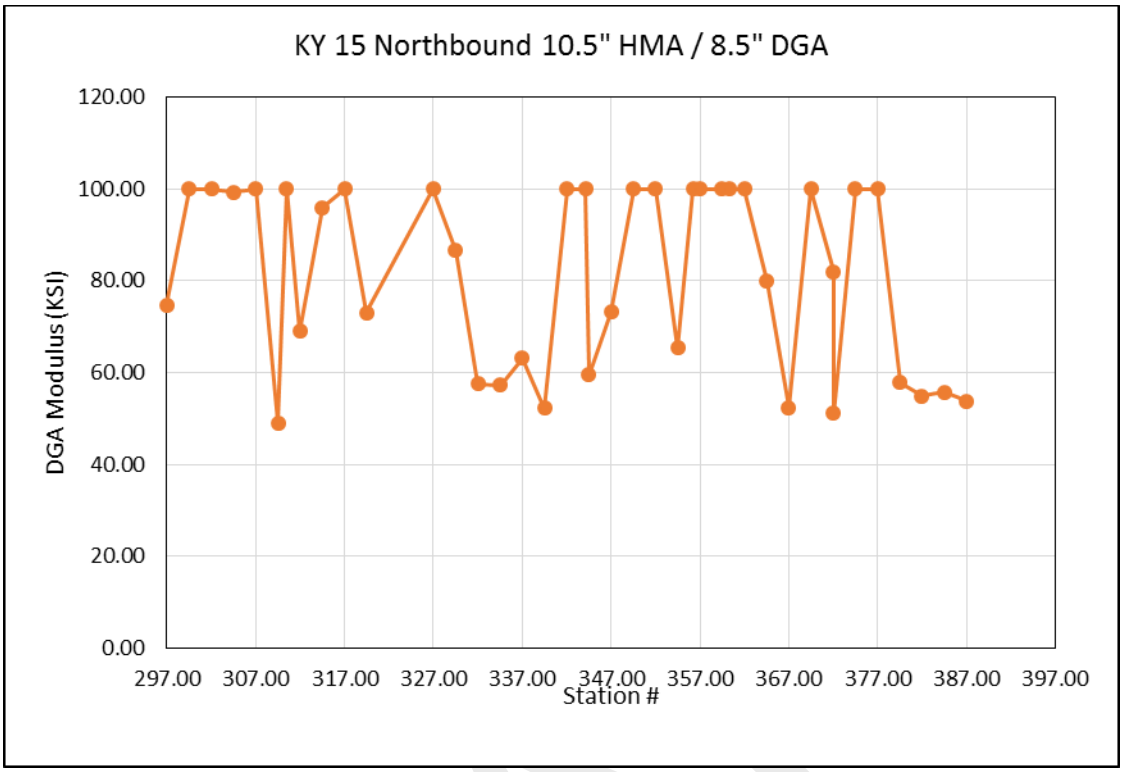


Figure D11. Back-calculated DGA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

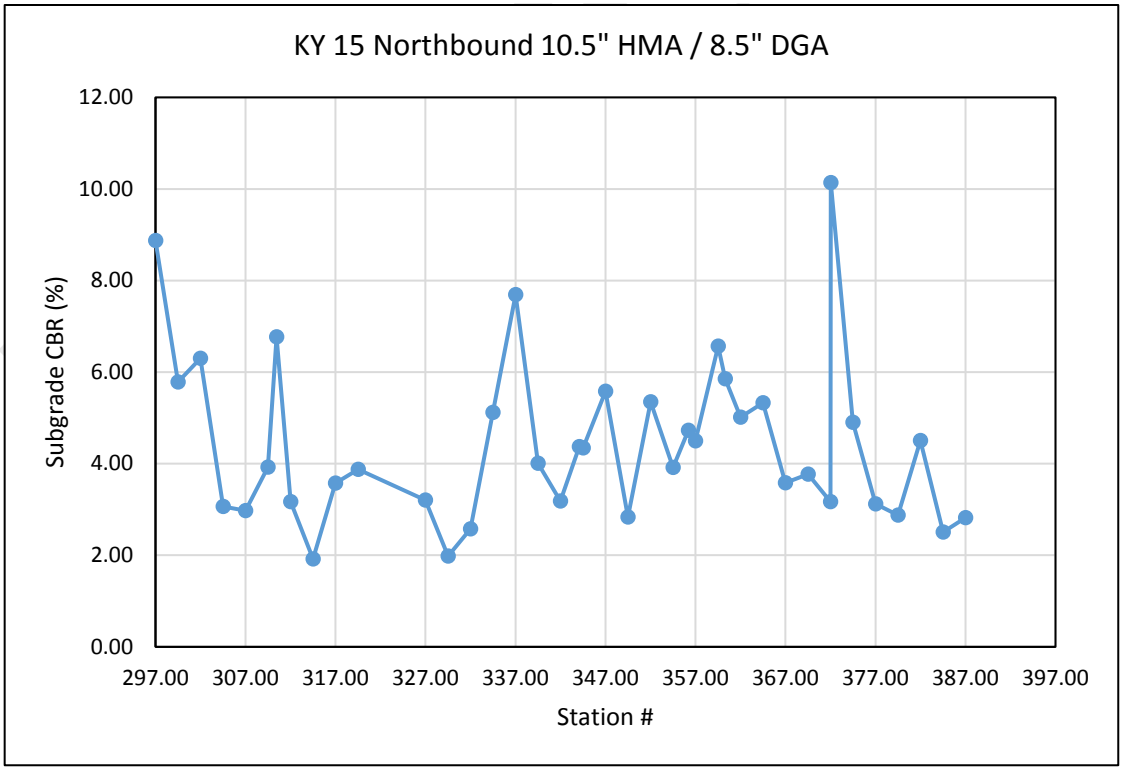


Figure D12. Back-calculated subgrade CBR values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

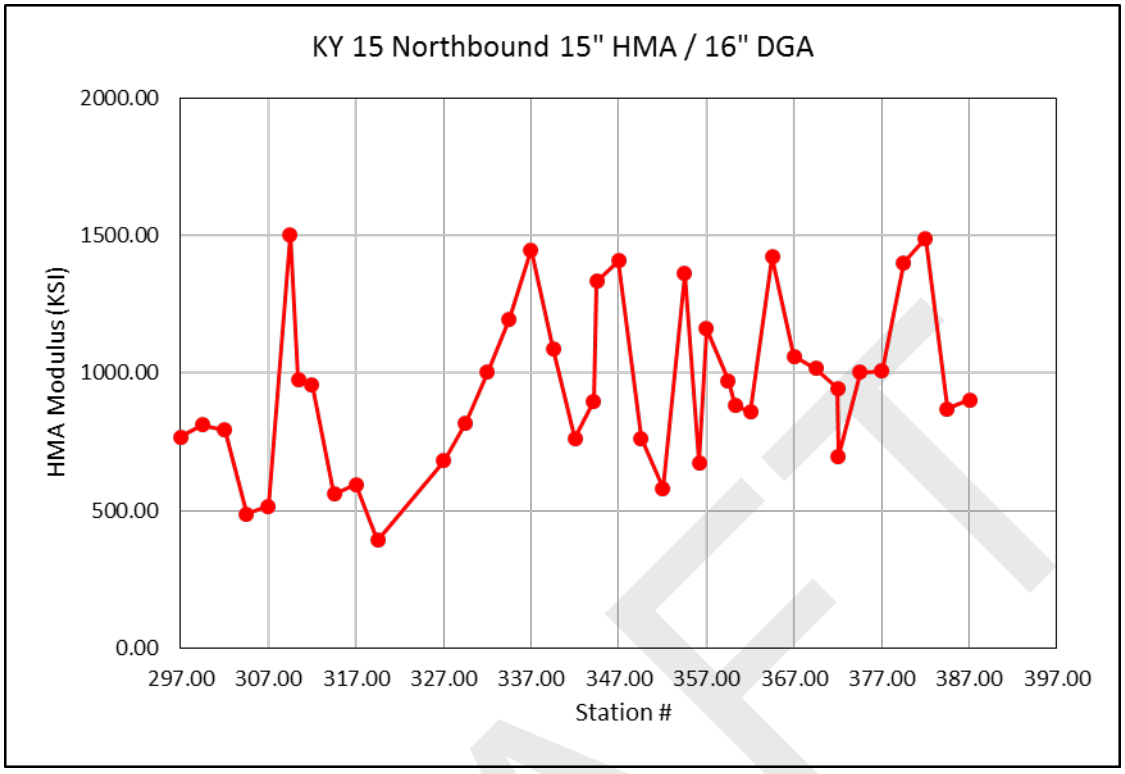


Figure D13. Back-calculated HMA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

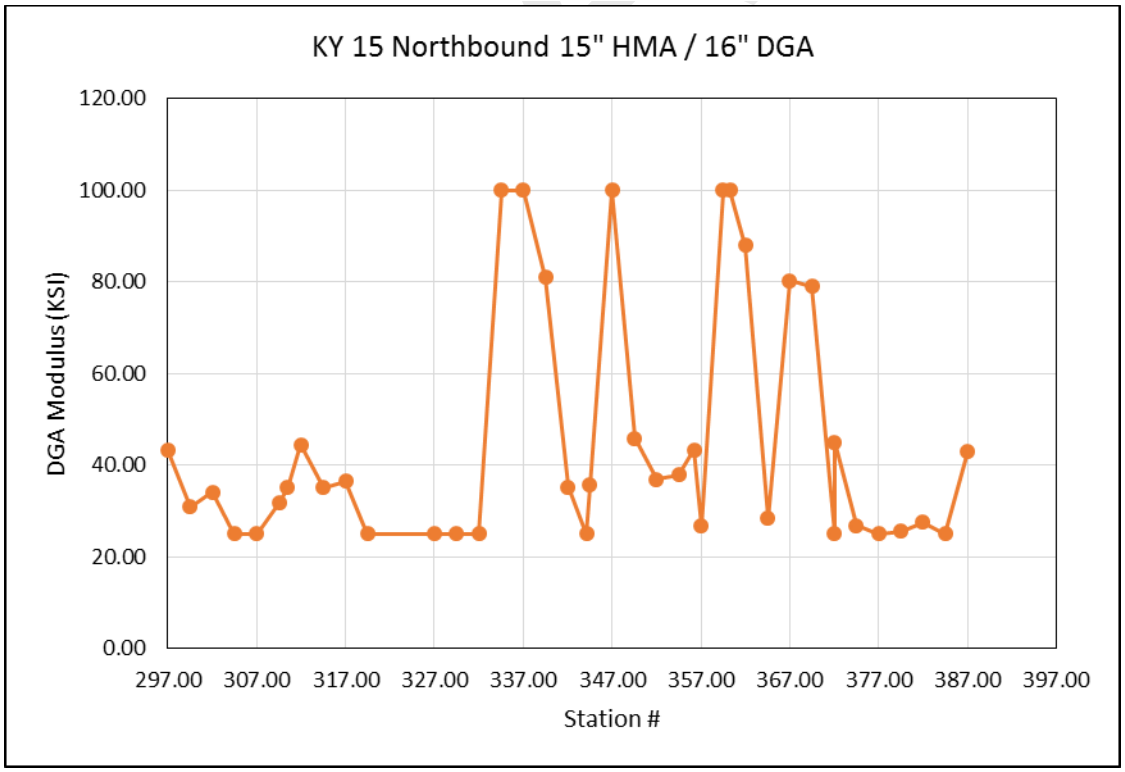


Figure D14. Back-calculated DGA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

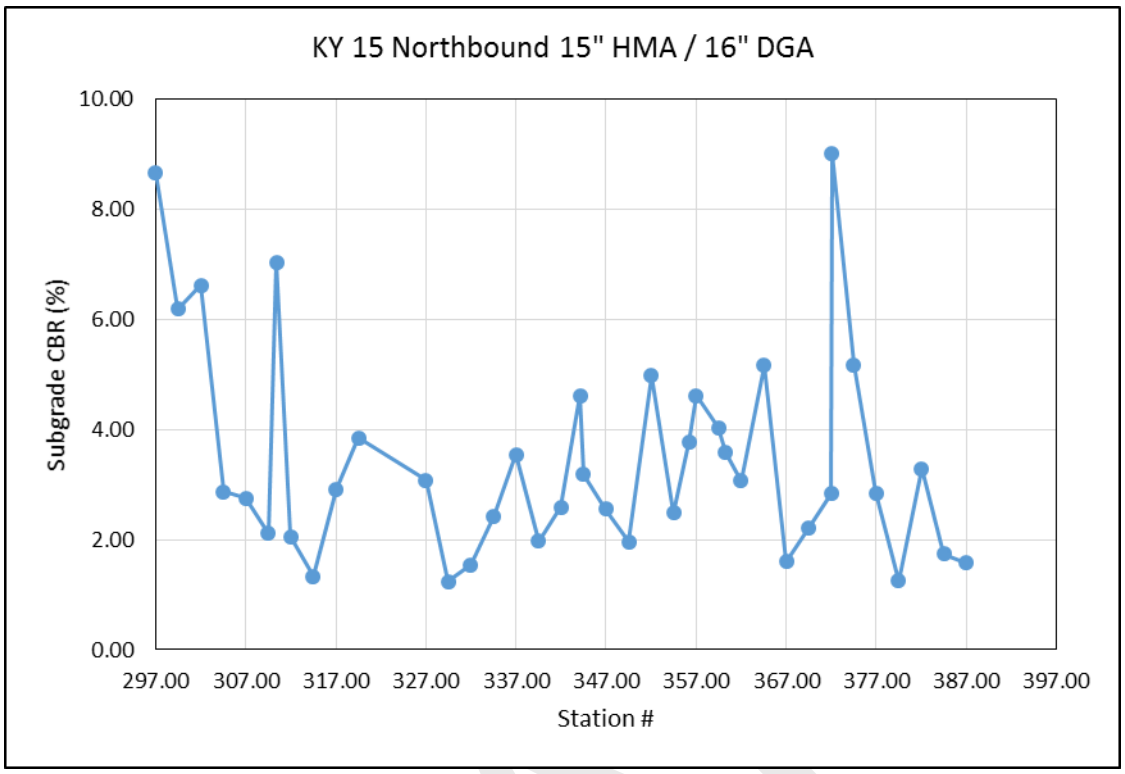


Figure D15. Back-calculated subgrade CBR values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

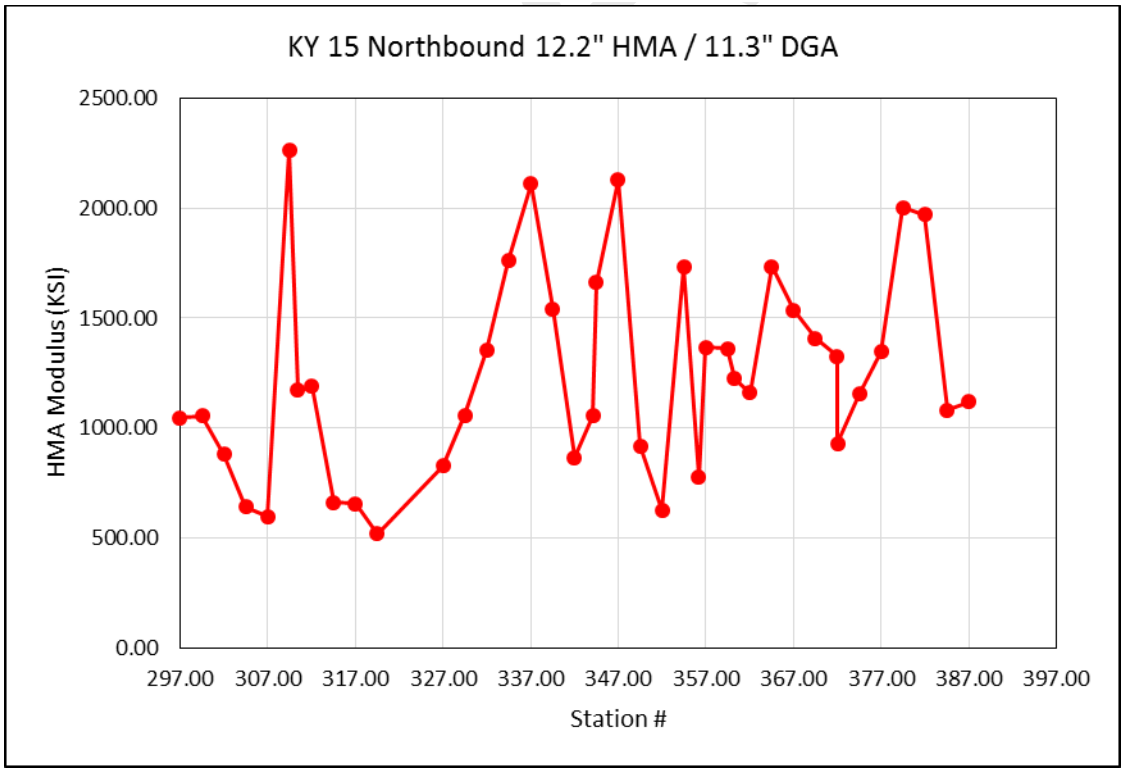


Figure D16. Back-calculated HMA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

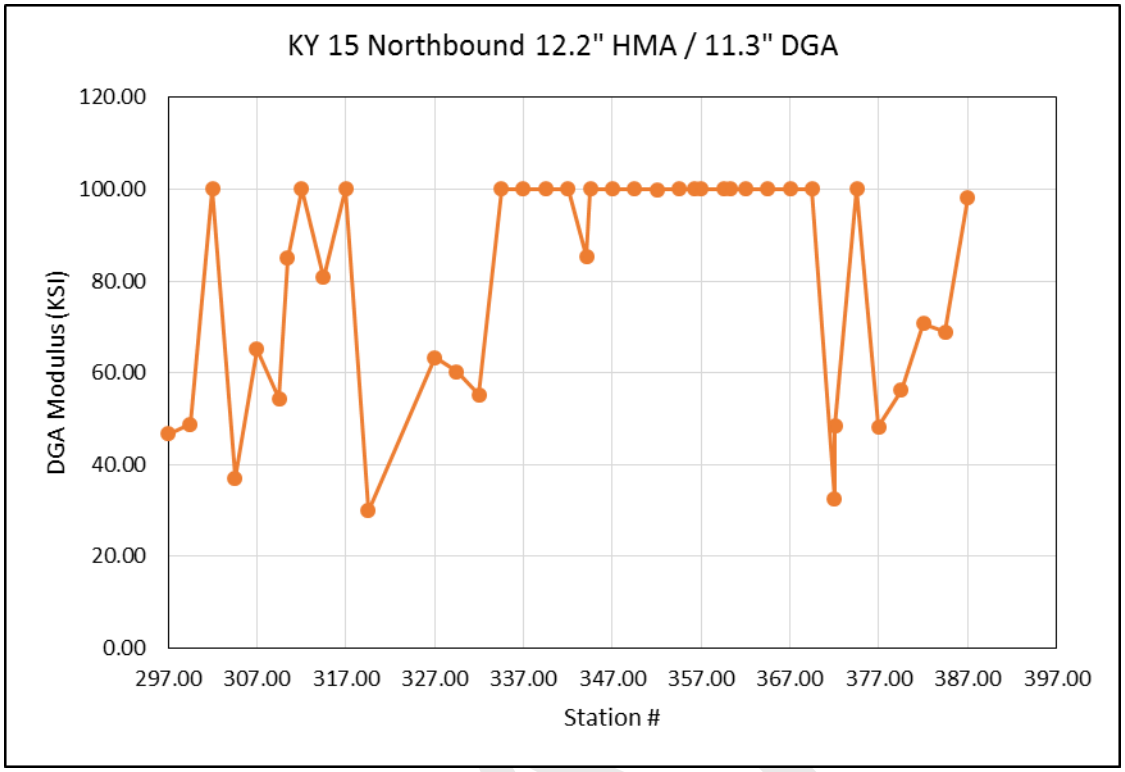


Figure D17. Back-calculated DGA moduli values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

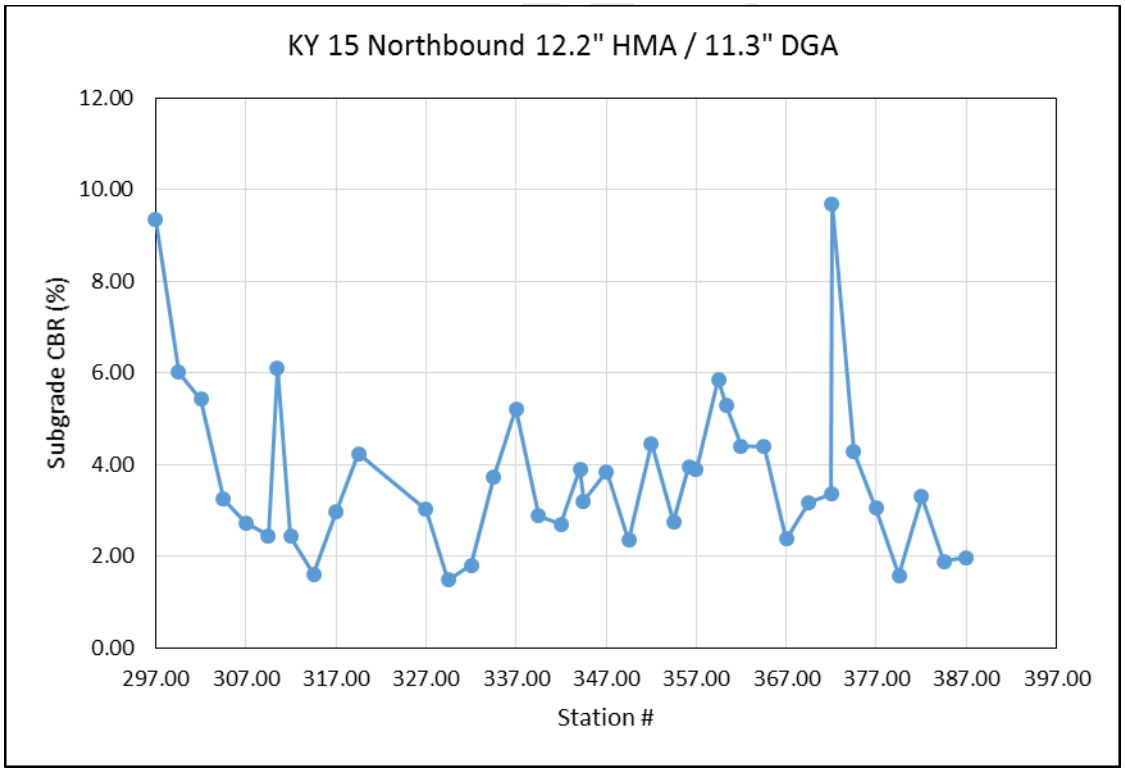


Figure D18. Back-calculated subgrade CBR values for northbound right lane, KY 15 Mile Point 13.25 - 14.95.

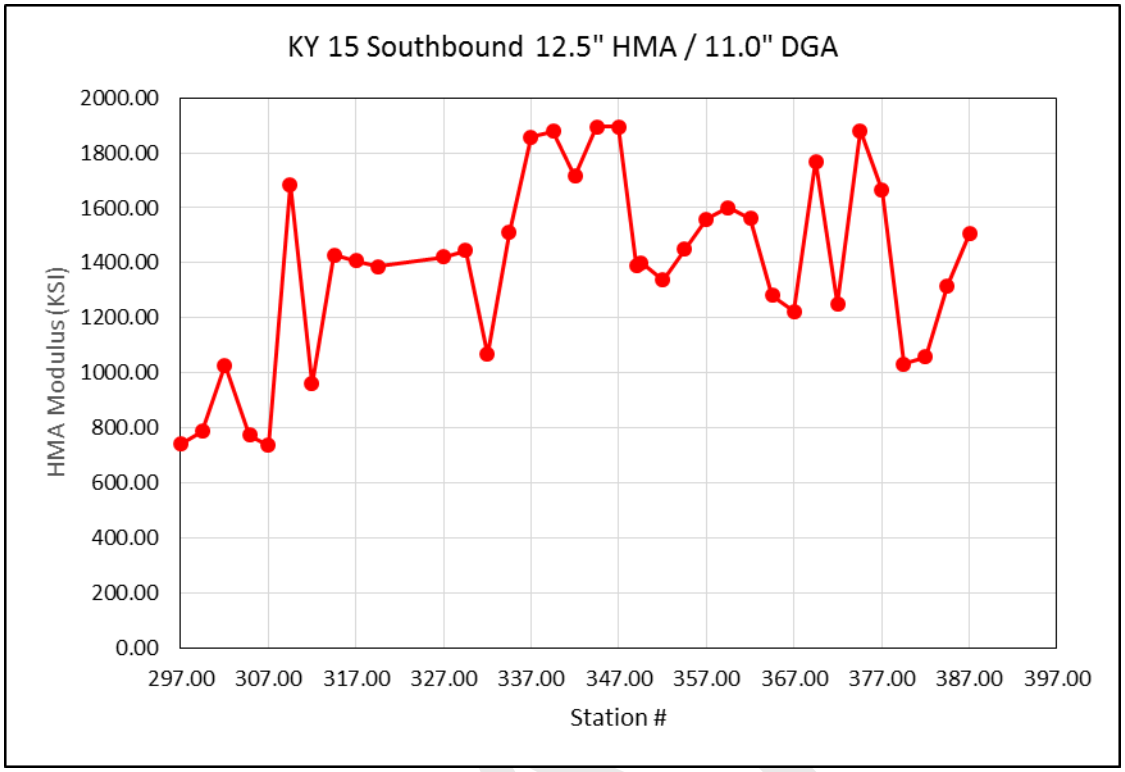


Figure D19. Back-calculated HMA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

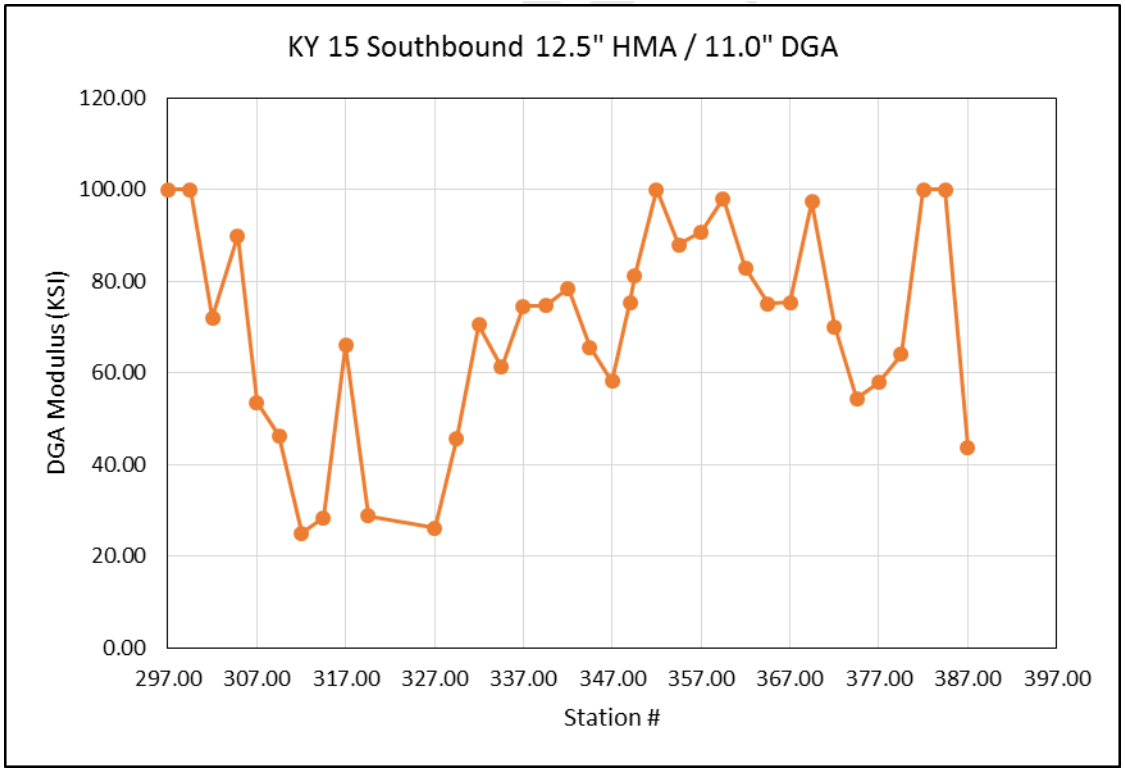


Figure D20. Back-calculated DGA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

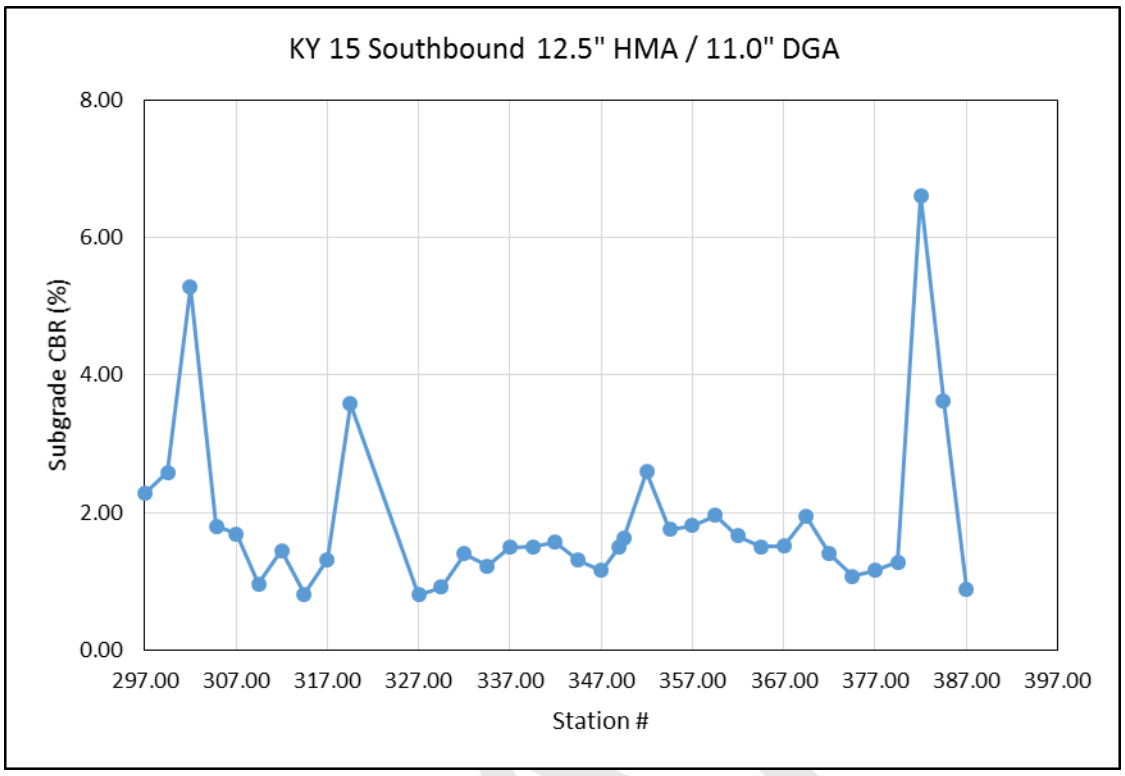


Figure D21. Back-calculated subgrade CBR values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

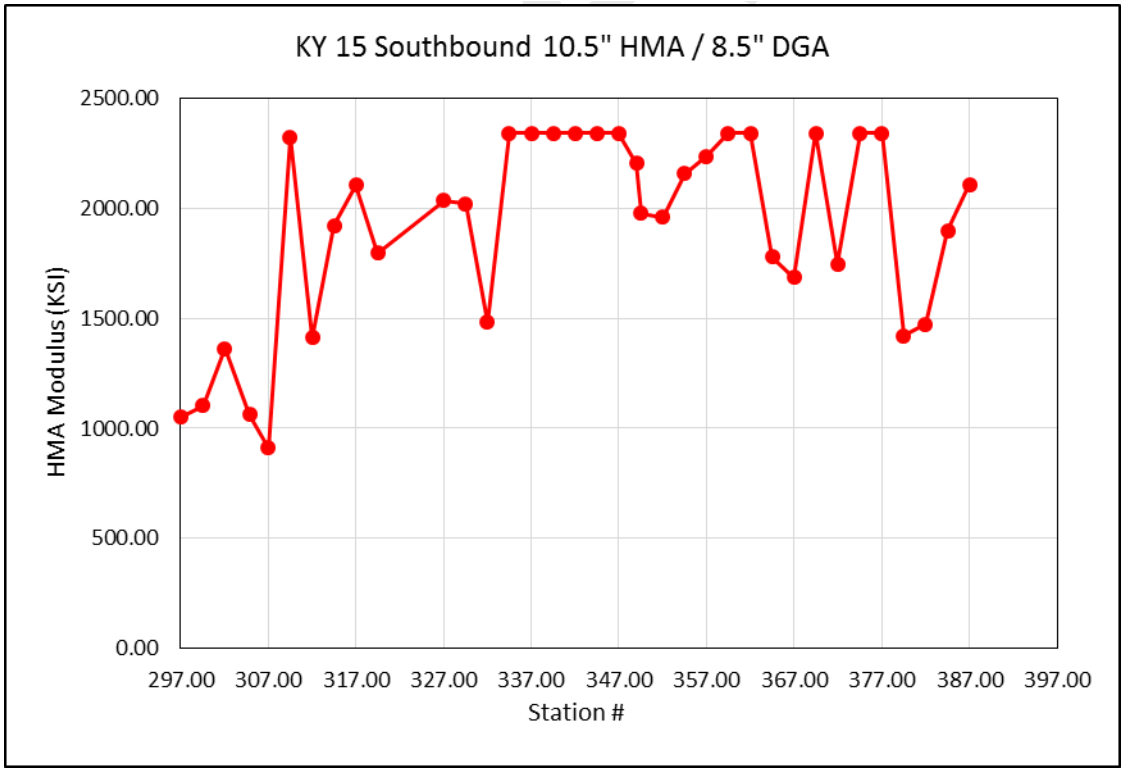


Figure D22. Back-calculated HMA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

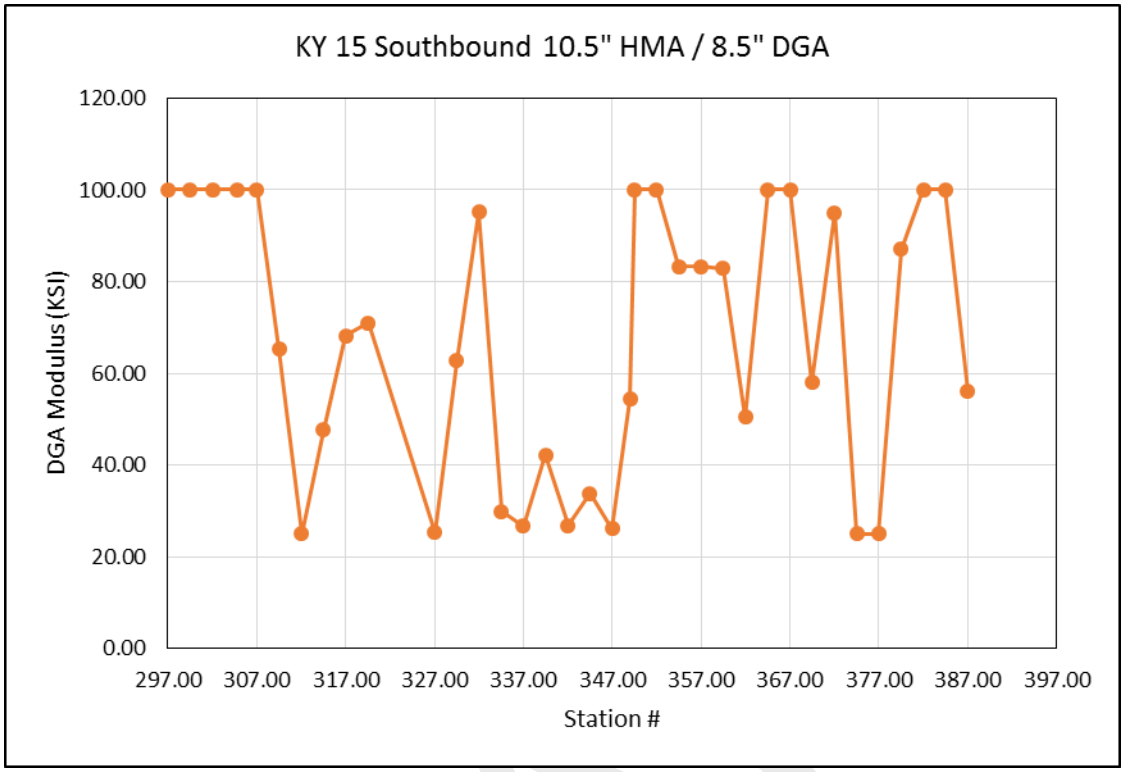


Figure D23. Back-calculated DGA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

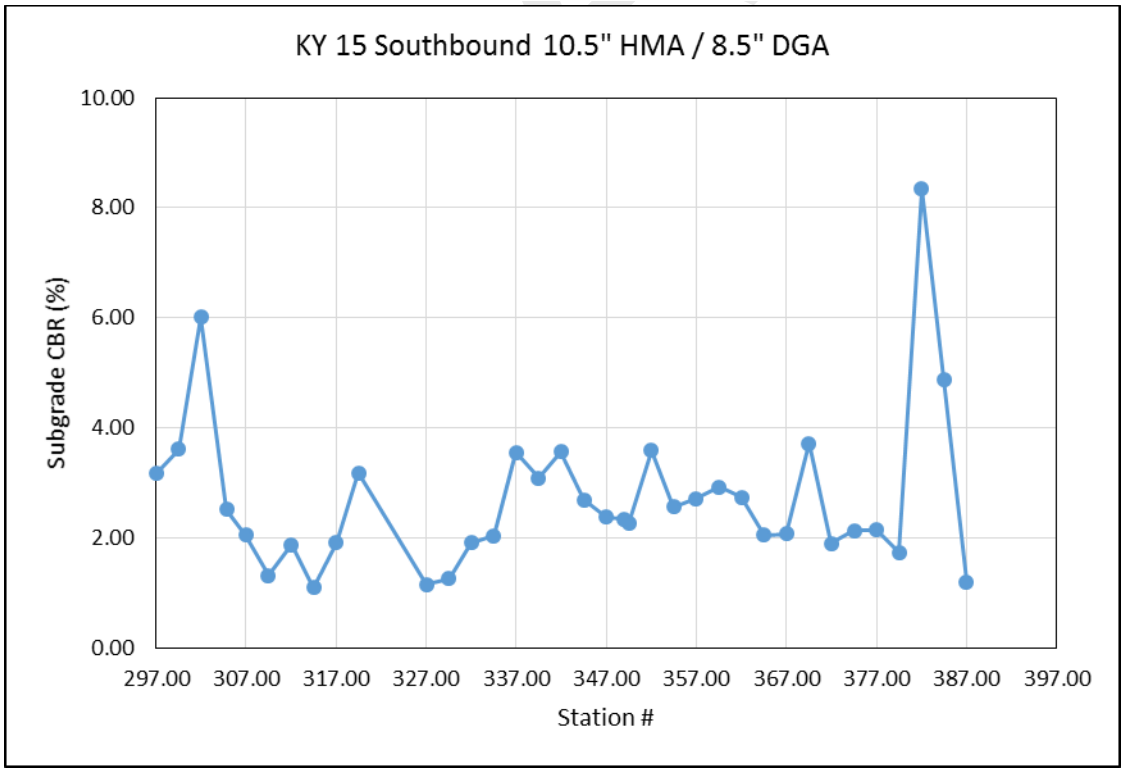


Figure D24. Back-calculated subgrade CBR values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

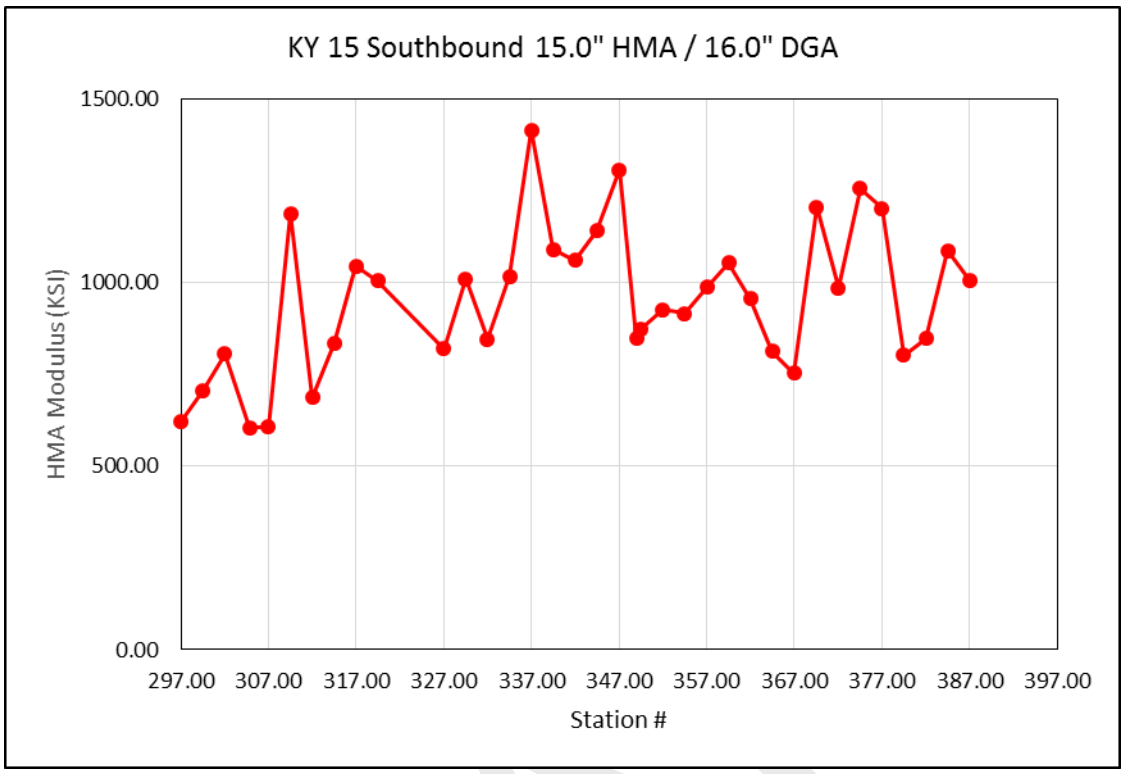


Figure D25. Back-calculated HMA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

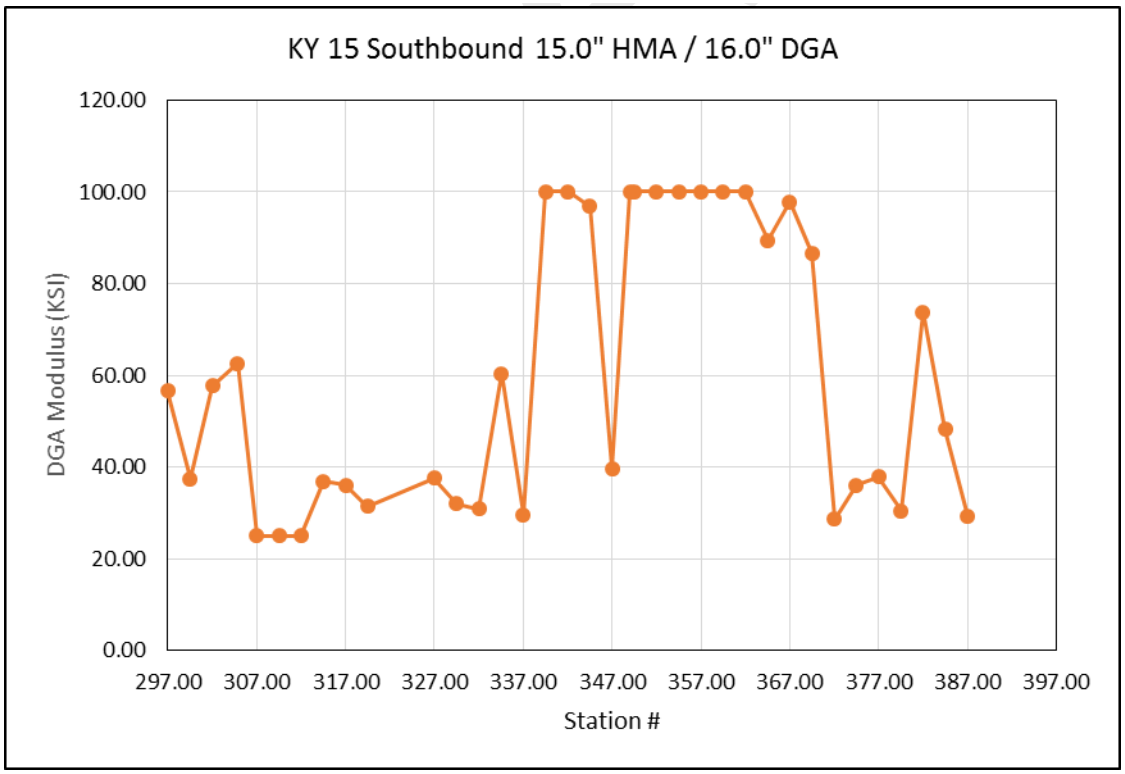


Figure D26. Back-calculated DGA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

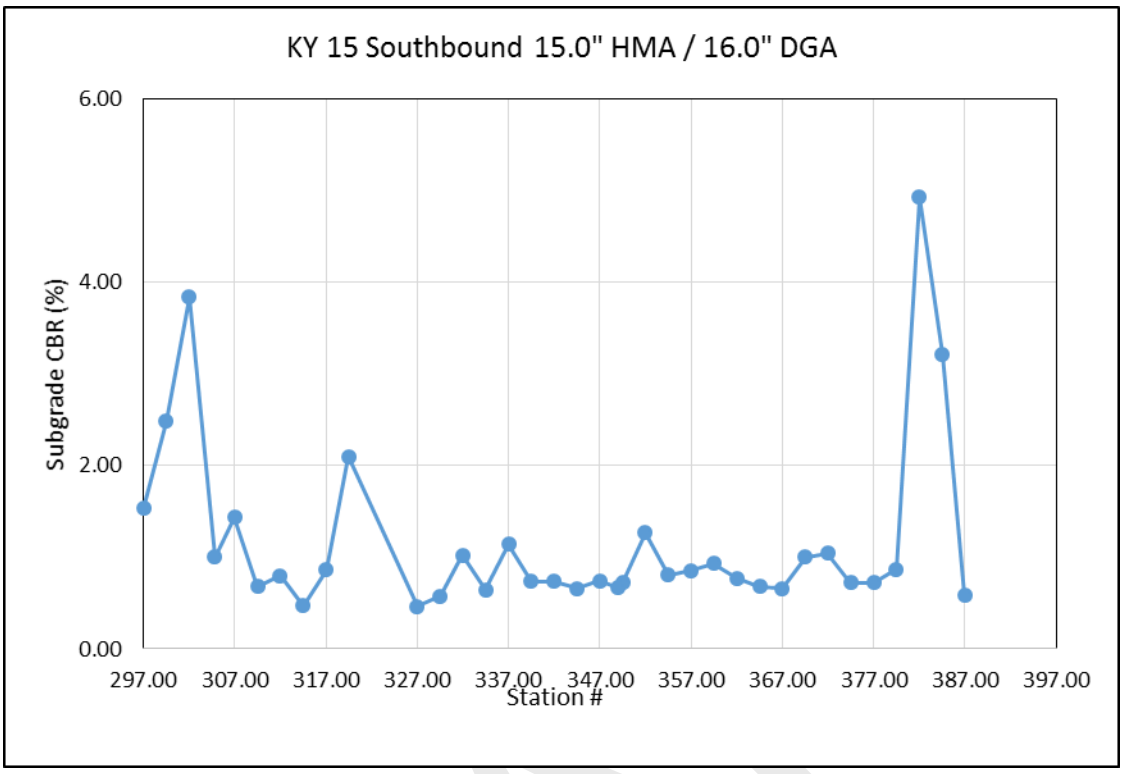


Figure D27. Back-calculated subgrade CBR values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

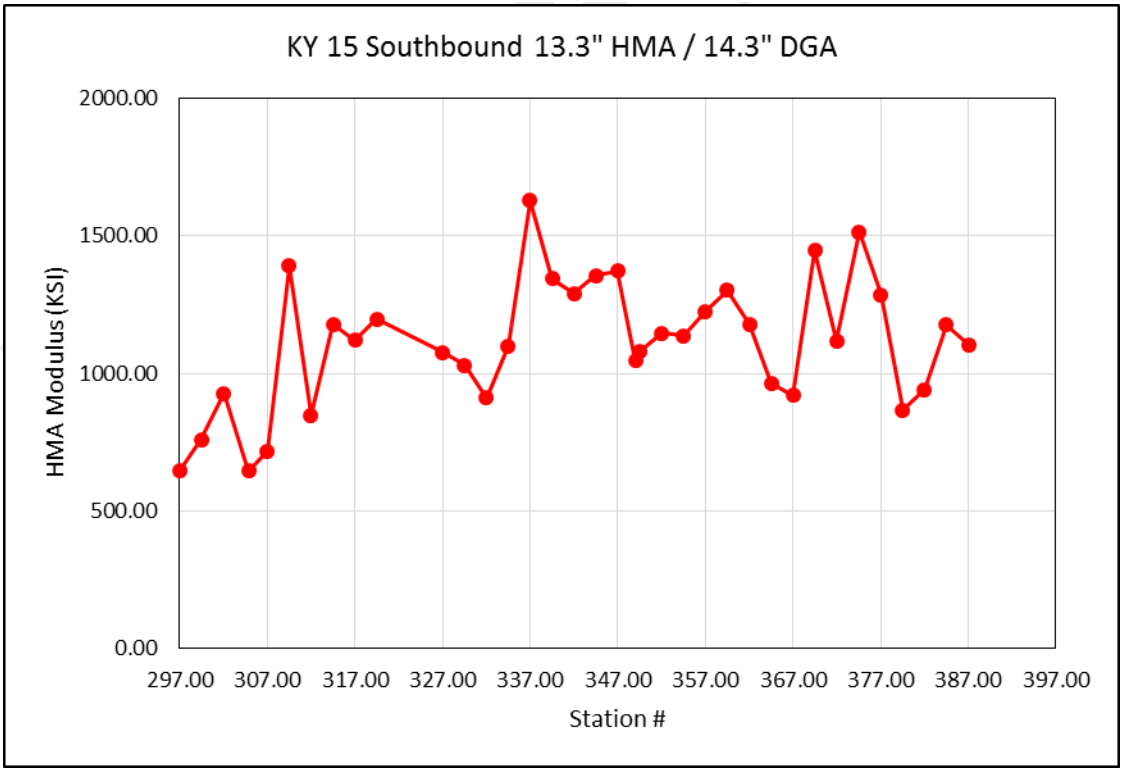


Figure D28. Back-calculated HMA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

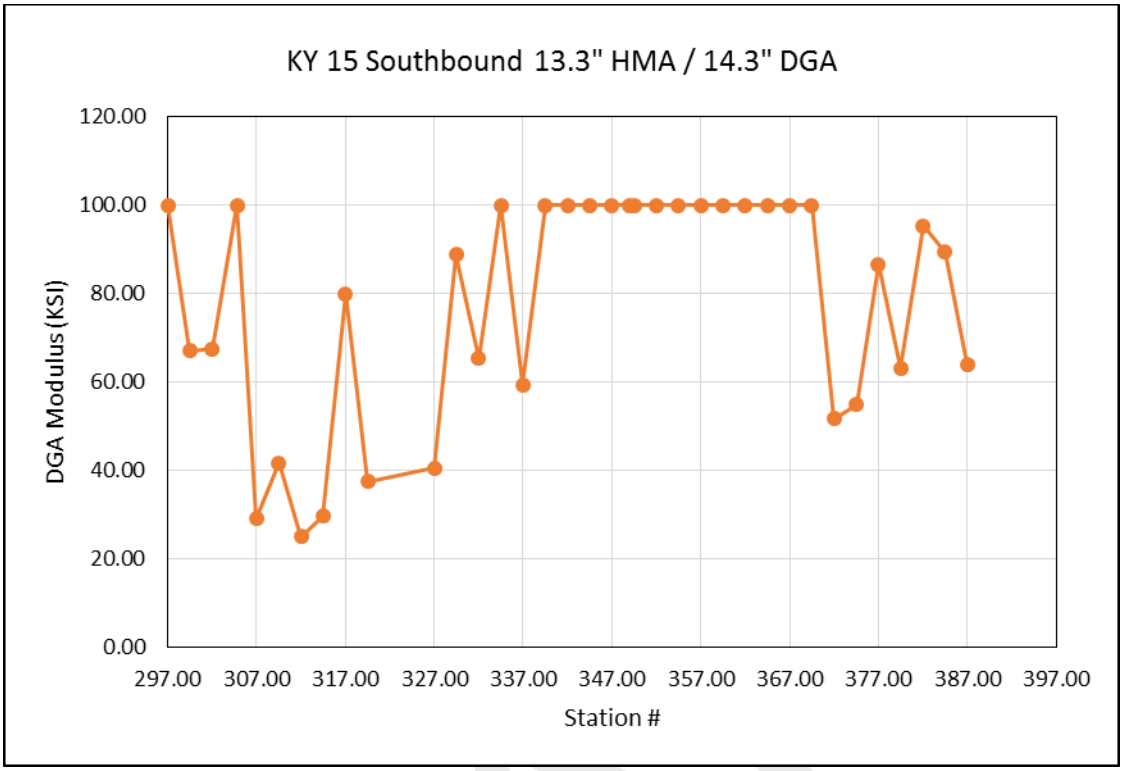


Figure D29. Back-calculated DGA moduli values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

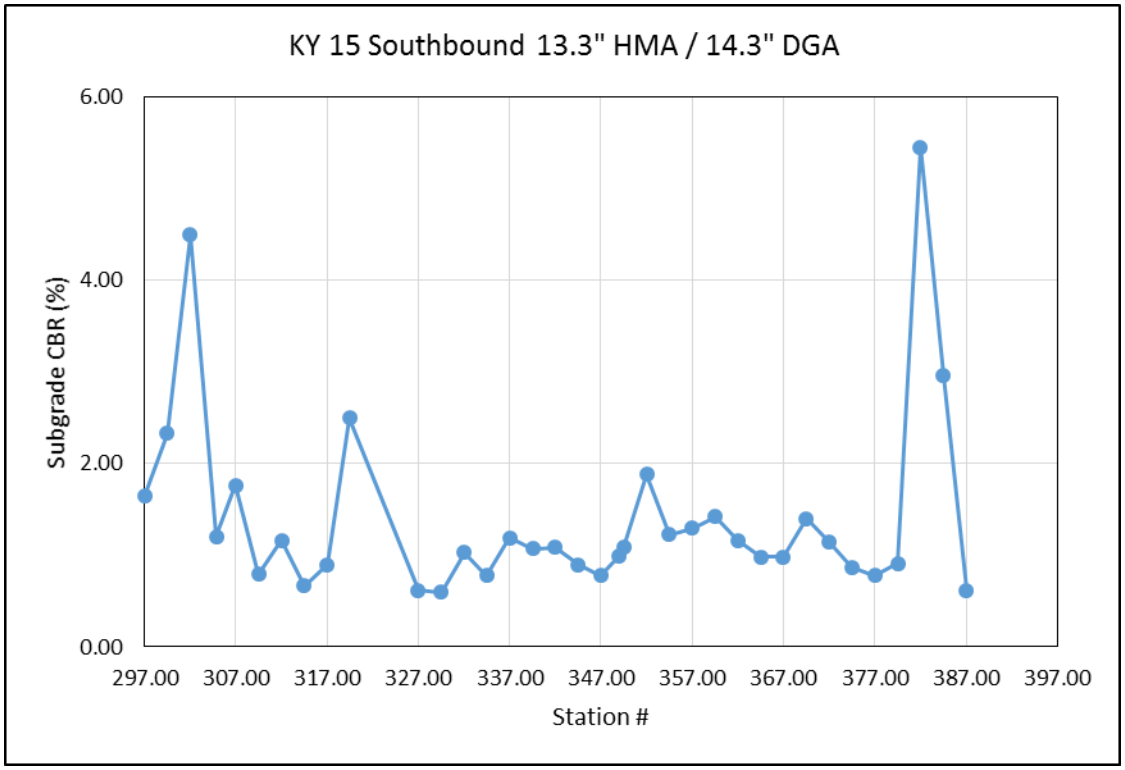


Figure 30. Back-calculated subgrade CBR values for southbound right lane, KY 15 Mile Point 13.25 - 14.95.

TABLE D3. Test Locations – KY 15 Perry County

Core Site	Station	Wheel Path	Latitude	Longitude
1	305+00	LT	37^15’59.92	83^12’09.26
2	311+00	RT	37^16’04.93	83^12’13.19
3	340+00	LT	37^16’25.59	83^12’38.99
4	344+00	RT	37^16’27.87	83^12’41.83
5	349+00	LT	37^16’31.24	83^12’46.40
6	356+00	RT	37^16’36.38	83^12’52.22
7	360+00	RT	37^16’39.19	83^12’55.70
8	367+00	LT	37^16’44.98	83^12’59.87
9	372+00	RT	37^16’49.79	83^12’58.80

TABLE D4. Core Extractions and Related Information – KY 15 Perry County

Core Site	Field Core Length (in.)	DGA Thickness (in.)	Depth of Moisture Content Sample (in.)	Subgrade Moisture Content (%)
1	12.25	11.50	23.75	14.45
2	13.25	10.75	24.00	11.23
3	13.00	12.00	27.50	4.20
4	11.25	12.75	24.00	5.70
5	14.00	16.00	36.00	7.10
6	12.50	12.00	25.50	7.39
7	12.50	11.50	24.00	7.12
8	15.00	14.00	30.00	8.49
9	10.50	8.50*	X*	X*

* At Site # 9, hard rock was encountered after augering out the DGA to a depth of 19 inches. No moisture content sample was obtained.

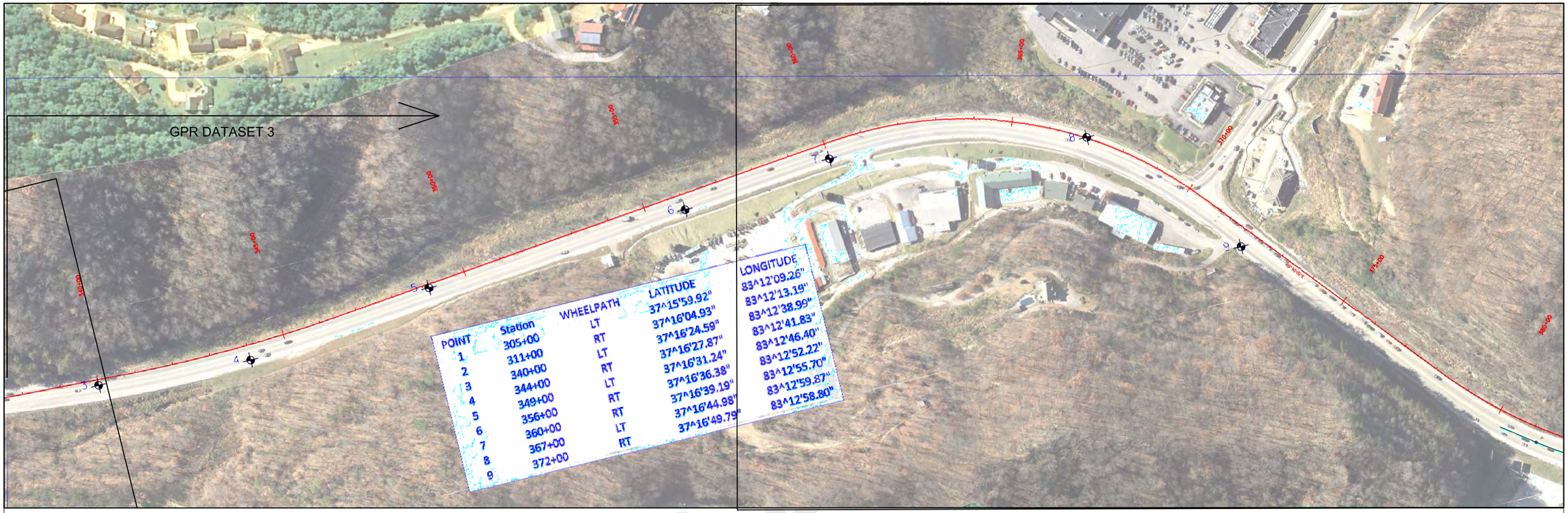
CORE 1 SB LWP
ACC 12.25"
DGA 11.5"
CLAY SHALE SUBGRADE

CORE 2 NB RWP
ACC 13.25"
DGA 10.75"
CLAY SHALE SUBGRADE

NOT TO SCALE

PERRY CO. KY 15 SUBSURFACE INVESTIGATION	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 1 OF 3 DATE 5/1/16 DRAFTED TAJ

Figure D31. Core locations and results.



POINT	Station	WHEELPATH	LATITUDE	LONGITUDE
1	305+00	LT	37^15'59.92"	83^12'09.26"
2	311+00	RT	37^16'04.93"	83^12'13.19"
3	340+00	LT	37^16'24.59"	83^12'38.99"
4	344+00	RT	37^16'27.87"	83^12'41.83"
5	349+00	LT	37^16'31.24"	83^12'46.40"
6	356+00	RT	37^16'36.38"	83^12'52.22"
7	360+00	RT	37^16'39.19"	83^12'55.70"
8	367+00	LT	37^16'44.98"	83^12'59.87"
9	372+00	RT	37^16'49.79"	83^12'58.80"

CORE 3 NB LWP
ACC 13"
DGA 12"
SHALE SUBGRADE

CORE 4 NB RWP
ACC 11.25"
DGA 12.75"
SHALE SUBGRADE

CORE 5 SB LWP
ACC 14"
DGA 16"
SHALE SUBGRADE

CORE 6 NB RWP
ACC 12.5"
DGA 12"
SHALE SUBGRADE

NOT TO SCALE

PERRY CO. KY 15 SUBSURFACE INVESTIGATION	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 2 OF 3 DATE 5/1/16 DRAFTED TAJ

Figure D32. Core locations and results.

CORE 7 NB RWP
ACC 12.5"
DGA 11.5"
SHALE SUBGRADE

CORE 8 SB LWP
ACC 15"
DGA 14"
SHALE SUBGRADE

CORE 9 NB RWP
ACC 10.5"
DGA 8.5"
ROCK REFUSAL AT 19"

NOT TO SCALE

Figure D33. Core locations and results.

PERRY CO. KY 15 SUBSURFACE INVESTIGATION	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 3 OF 3 DATE 5/1/16 DRAFTED TAJ

APPENDIX E

FIELD RESULTS

GROUND PENETRATING RADAR
FALLING WEIGHT DEFLECTOMETER
CORING AND MATERIALS SAMPLING

I-65, HARDIN COUNTY

Hardin County I-65

A team from the Kentucky Transportation Center's Pavement, Materials, Geotechnical and Infrastructure Assessment Section performed work for the Kentucky Transportation Cabinet (KYTC) to structurally assess I-65 in Hardin County. KTC utilized Ground Penetrating Radar (GPR), Falling Weight Deflectometer (FWD), and coring to characterize the pavement structure within the test section. The section tested extended from MP 91.1 (Western Kentucky Parkway Interchange) to MP 97.6 (start of Portland Cement Concrete pavement) and included both the northbound and southbound directions. The northbound section is comprised of three lanes. The southbound section is comprised of three lanes from MP 91.1 to MP 95.2 and four lanes from MP 95.2 to MP 97.6, with the fourth lane being a truck climbing lane. Fieldwork was performed during the evenings of Monday, 20 June 2016 and Tuesday, 21 June 2016. Traffic control was expertly provided by the Hardin County maintenance crew from 8:00 PM to 6:00 AM.

The scope of work included the following:

- GPR testing of the slow lanes in the northbound and southbound directions to determine pavement and subbase thickness.
- GPR testing of the southbound truck climbing lane to identify wet areas below the pavement.
- GPR testing of the northbound and southbound shoulders to determine pavement thickness.
- FWD testing, at 250-foot intervals, of the slow lanes in the northbound and southbound directions to determine subgrade, subbase and pavement layer modulus values.
- Core pavement structure and dig through subbase material for verification of thickness in northbound and southbound directions.
- Core pavement layer in northbound and southbound shoulders to verify asphalt pavement thickness.
- Core wet areas in the truck climbing lane observed in the GPR results.
- Locate longitudinal cracking in the wheel paths and core to determine mode of cracking.

All data collected on Interstate 65 in Hardin County are presented herein. Table E1 contains estimated layer thickness information derived from the GPR scans while Figures E1 through E9 present this information graphically. Tables E2 and E3 present structural analysis scenarios for the northbound and southbound directions. Figures E10 through E15 are graphic representations of back-calculated layer modulus or subgrade values. Tables E4 through E6 contain core-related information. Figures E16 through E18 present additional core-related information.

The study area along I-65 included a wide range of pavement designs and remedial actions performed over the years that made this structural investigation challenging. The north and southbound directions of I-65 between the Bluegrass Parkway interchange and the off ramp to the Western Kentucky Parkway were the most variable, showing significant variations in HMA and DGA thickness. KTC determined that a layer of cement treated DGA was constructed within this area to offset the poor, unstable subgrade and provide a construction platform. This layer was likely encountered on the first night's work when the drill crew failed to reach the subgrade at three of the four randomly selected core locations. Additional investigation, including coring,

would provide more detail on the variability KTC observed. Furthermore, this investigation was limited to the slow lane of I-65. Given the significant variability of HMA and DGA thicknesses, in addition to a layer of cement-treated DGA located in the section between the Bluegrass Parkway interchange and the off ramp exiting to the Western Kentucky Parkway, a plan to scan the middle and fast lanes may be necessary to fully determine the appropriate rehabilitative pavement design.

In the northbound slow lane, beginning at MP 95.1 and extending north to MP 97.6, the pavement design was full-depth asphalt on a subgrade of native soil and shot rock/shale. HMA thickness was fairly consistent throughout this area (approximately 17 inches). A cement-treated soil/aggregate mixture of varying thickness was found below the HMA layer in the southbound truck lane and adjacent slow lane. The extent of the cement-stabilized soil/aggregate mixture was not determined and will require additional investigation. The soil/rock layer below the stabilized layer exhibited high moisture content.

Table E1: Pavement Structure Defined by Ground Penetrating Radar Results

Northbound Slow Lane	
MP 91.10 to MP 94.15	7-in. to 17-in. HMA over 10-in. to 24-in. of subbase
MP 94.15 to MP 95.10	8-in. to 12-in. of HMA over 8-in. to 12-in. of subbase
MP 95.10 to MP 97.60	15-in. to 18-in. of HMA over subgrade
Northbound Shoulder	
MP 91.10 to MP 95.10	8-in. to 15-in. of HMA
MP 95.10 to MP 97.60	6-in. to 10-in. of HMA
Southbound Slow Lane	
MP 91.10 to MP 92.00	7-in. to 16.5-in. HMA over 12-in. to 26-in. subbase
MP 92.00 to MP 93.75	7-in to 14-in. HMA over 13-in. to 25-in. subbase
MP 93.00 to MP 94.40	11.5-in. to 15.5-in. HMA over 10-in. to 19-in. subbase
MP 94.40 to MP 95.50	9-in. to 11-in. of HMA over 6-in. to 10-in. of subbase
MP 95.50 to MP 97.60	16-in. to 21-in. of HMA over subgrade or stabilized subgrade
Southbound Truck Lane	
MP 95.30 to MP 97.60	16-in. to 19-in. of HMA over subgrade or stabilized subgrade
Southbound Shoulder	
MP 91.10 to MP 93.80	6-in. to 17-in. of HMA
MP 94.05 to MP 95.15	8-in. to 12-in. of HMA
MP 95.15 to MP 97.60	5-in. to 8-in. of HMA

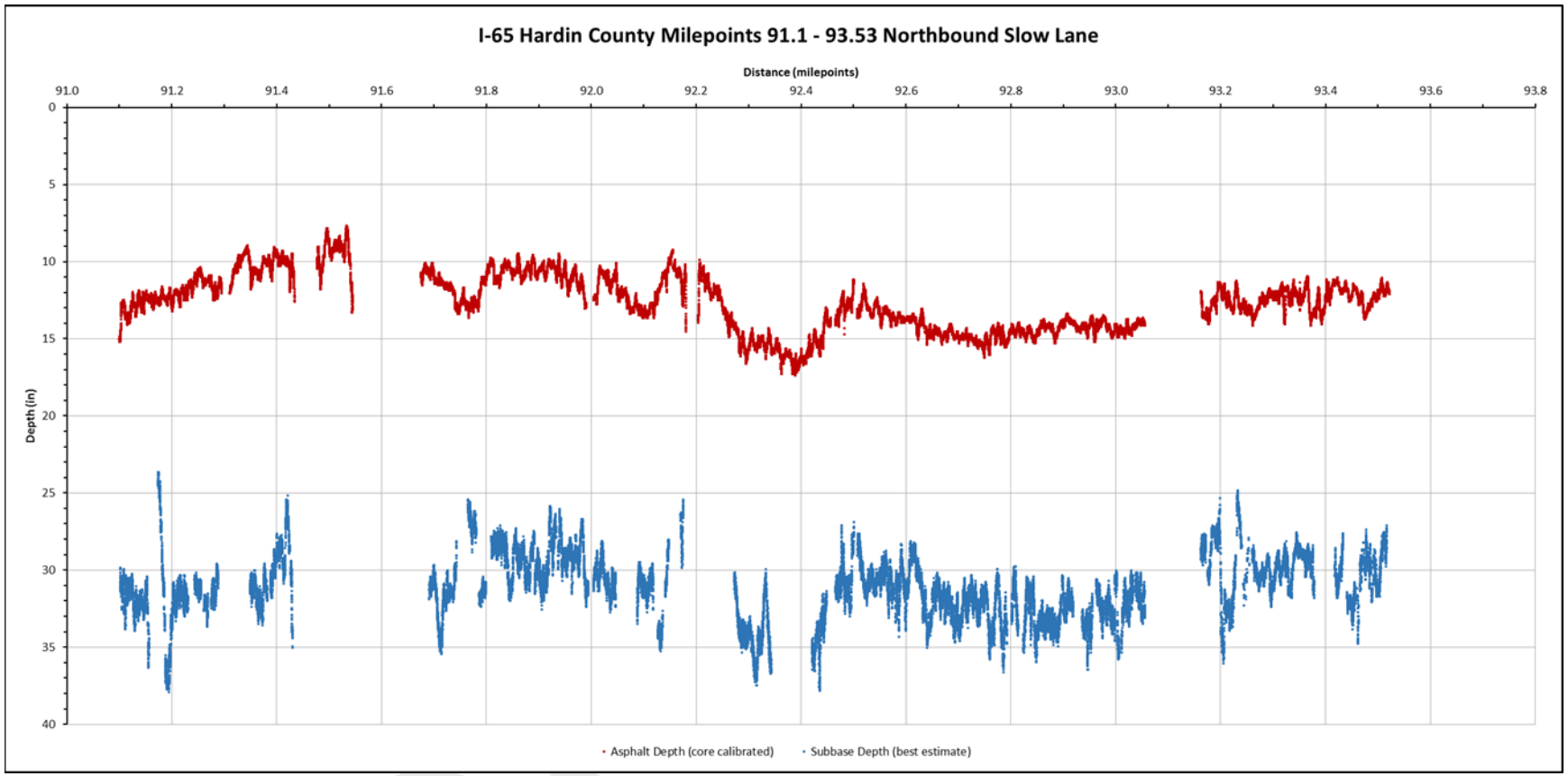


Figure E1. Results of GPR Scan, I-65 Northbound Slow Lane, MP 91.1 - 93.53.

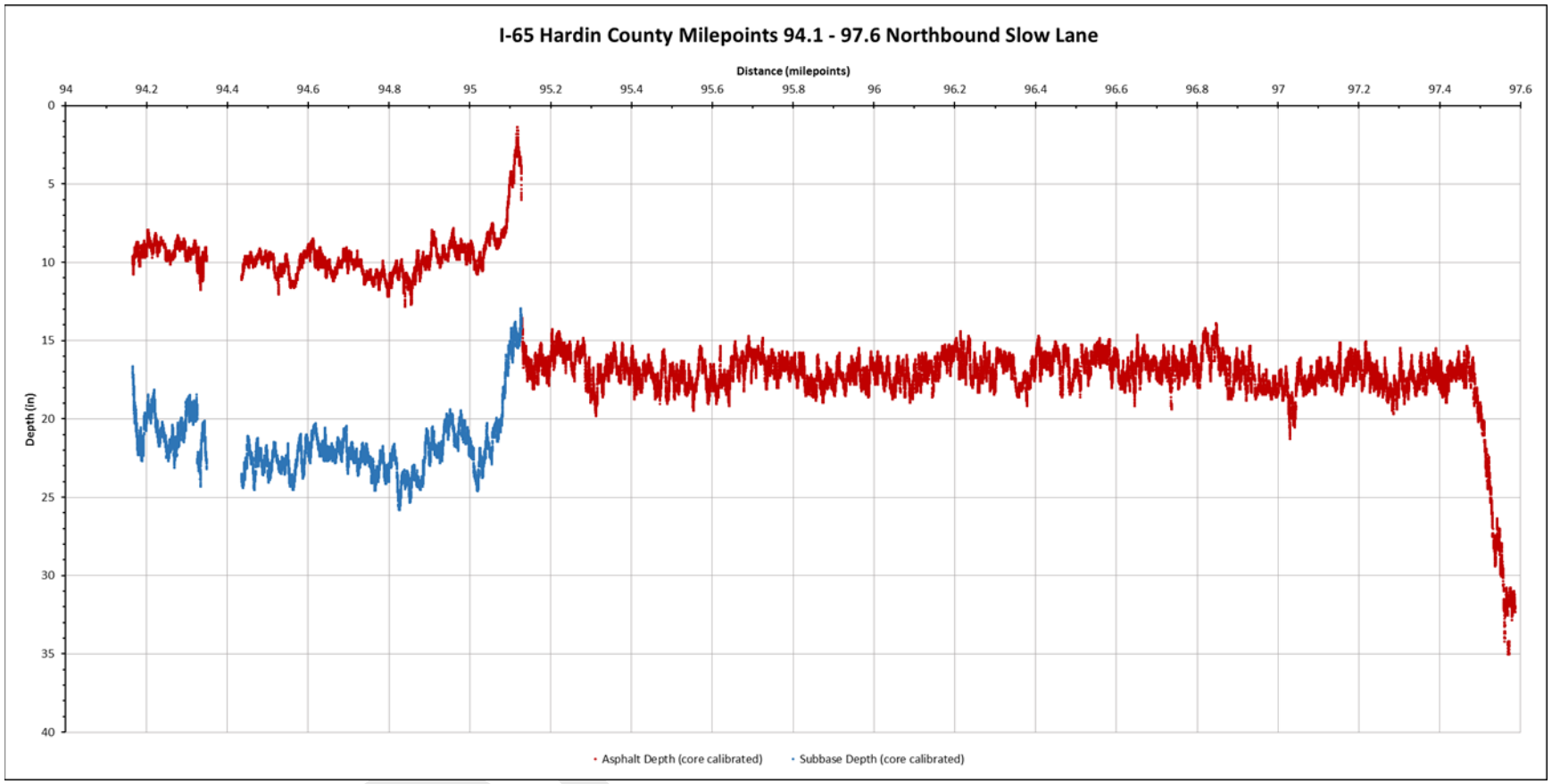


Figure E2. Results of GPR Scan, I-65 Northbound Slow Lane, MP 94.1 - 97.6.

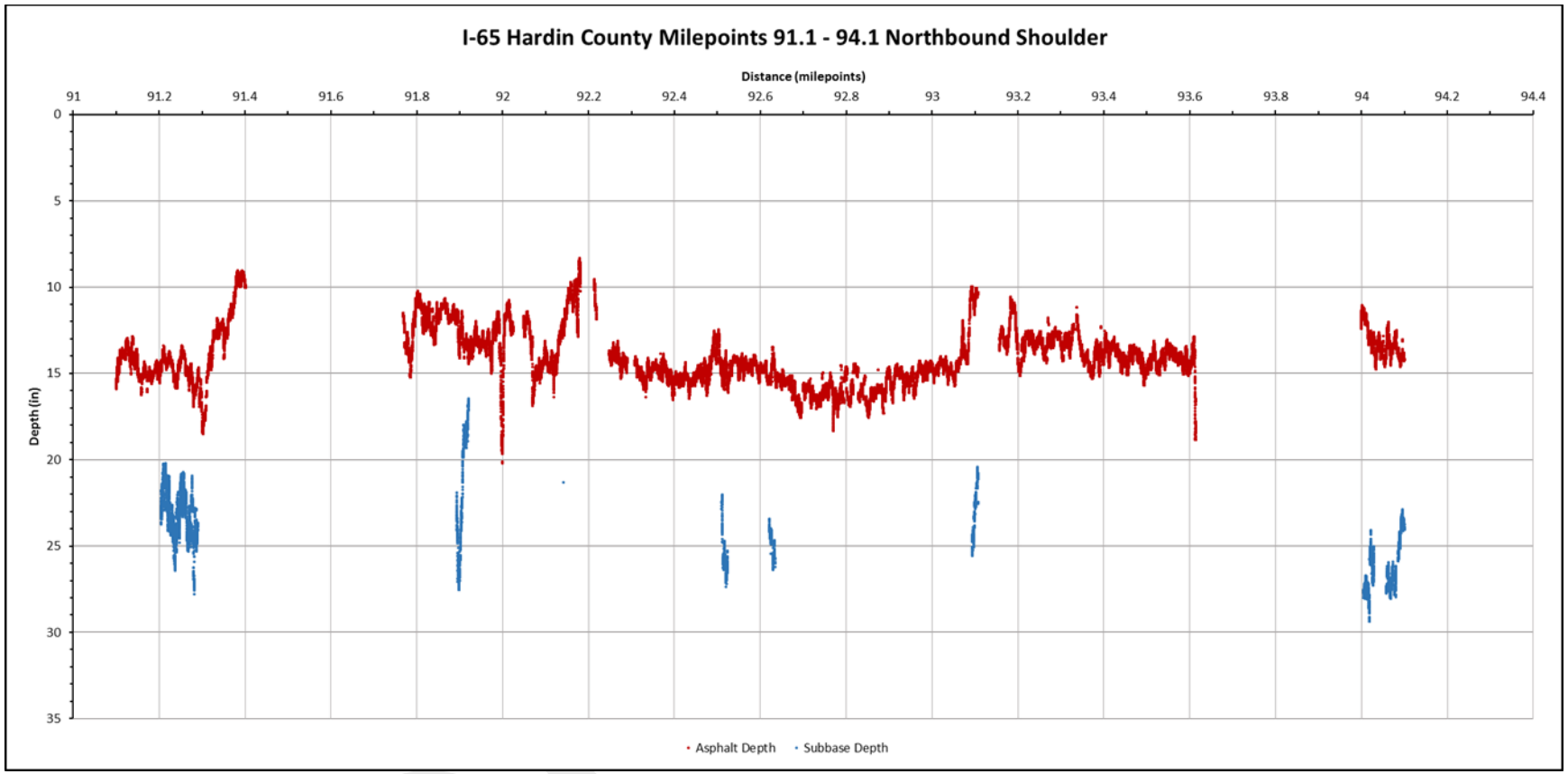


Figure E3. Results of GPR Scan, I-65 Northbound Shoulder MP 91.1 - 94.1.

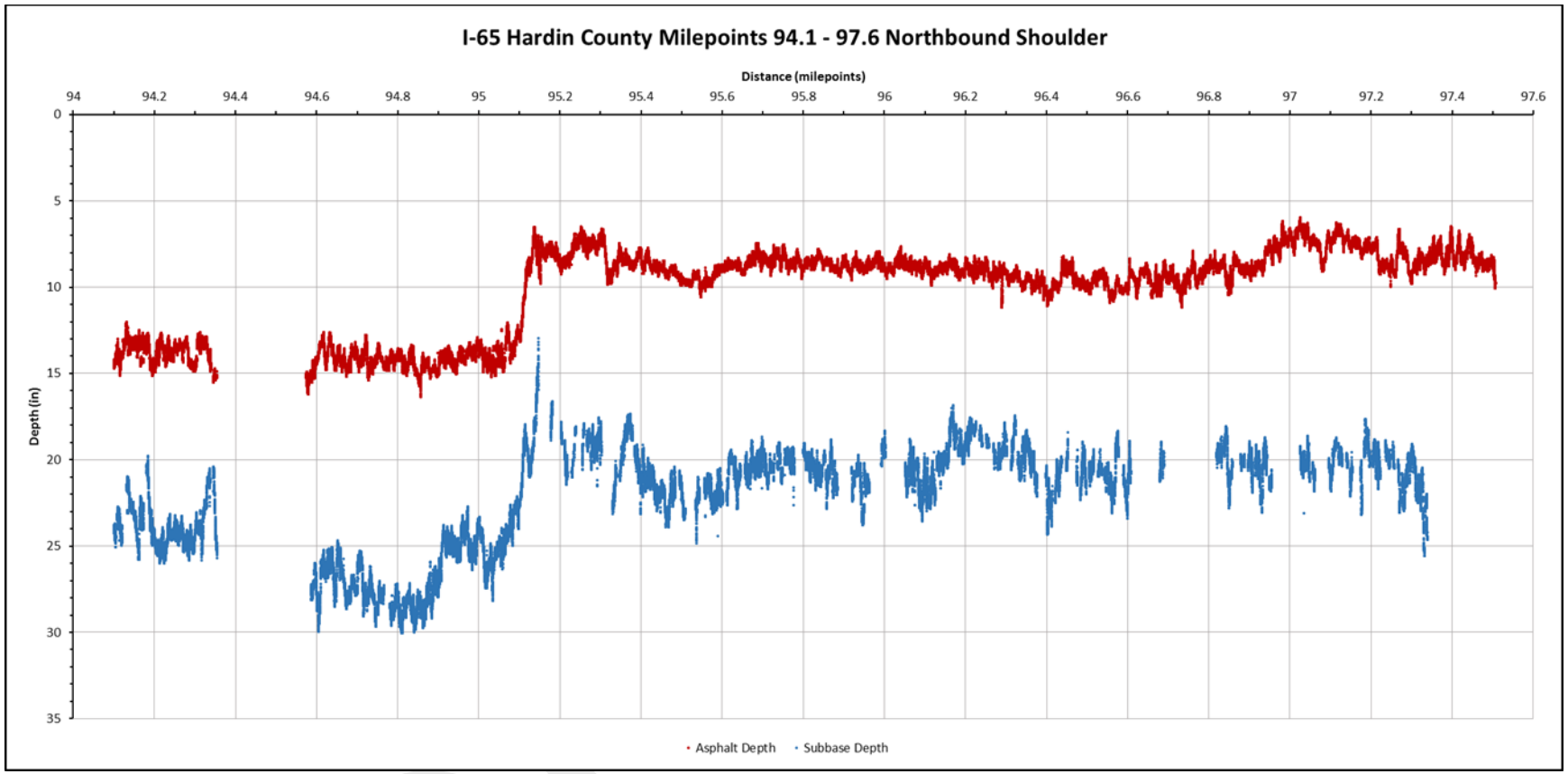


Figure E4. Results of GPR Scan, I-65 Northbound Shoulder MP 94.1 to MP 97.6.

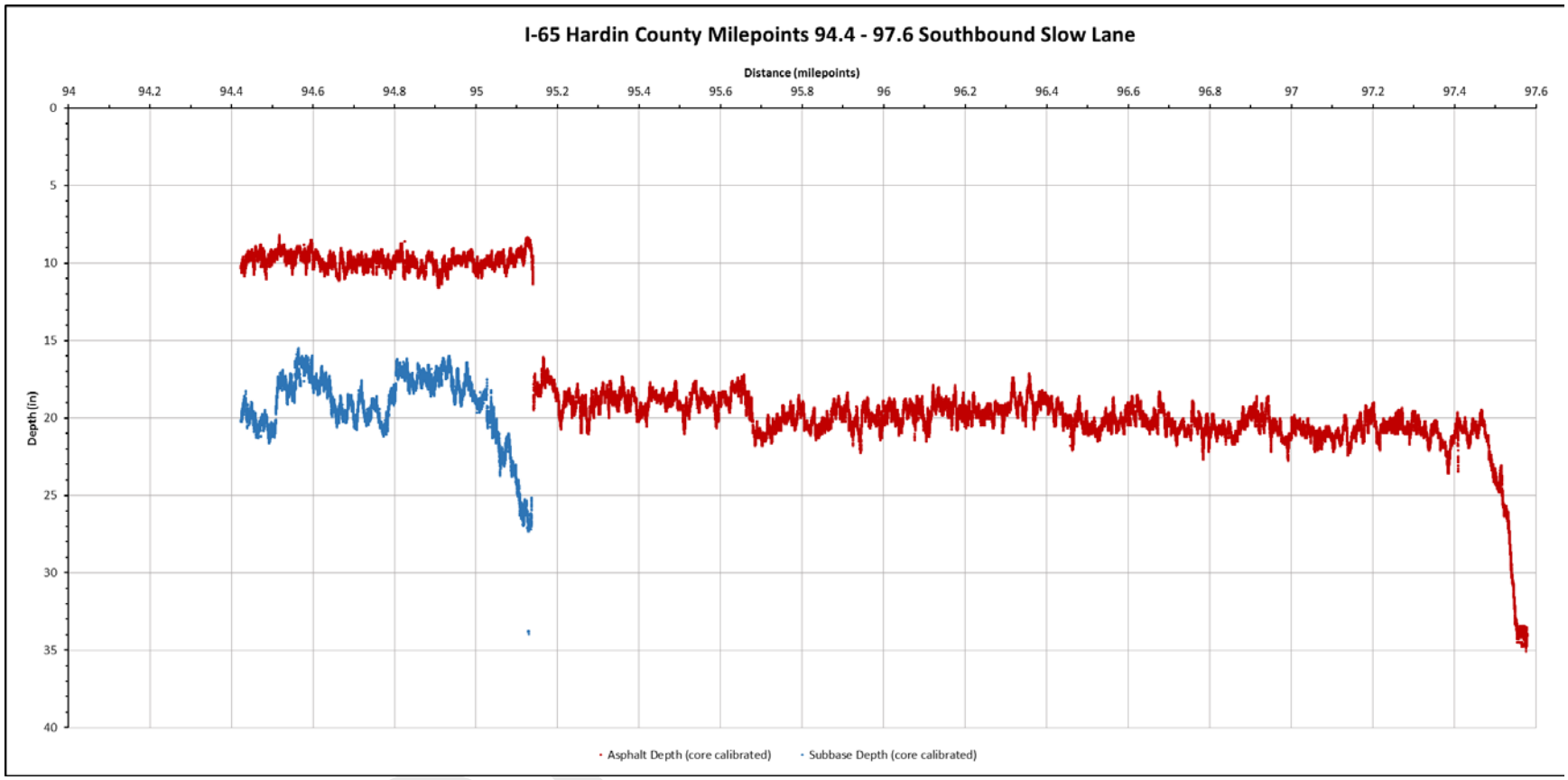


Figure E5. Results of GPR Scan, I-65 Southbound Slow Lane MP 94.4 to MP 97.6.

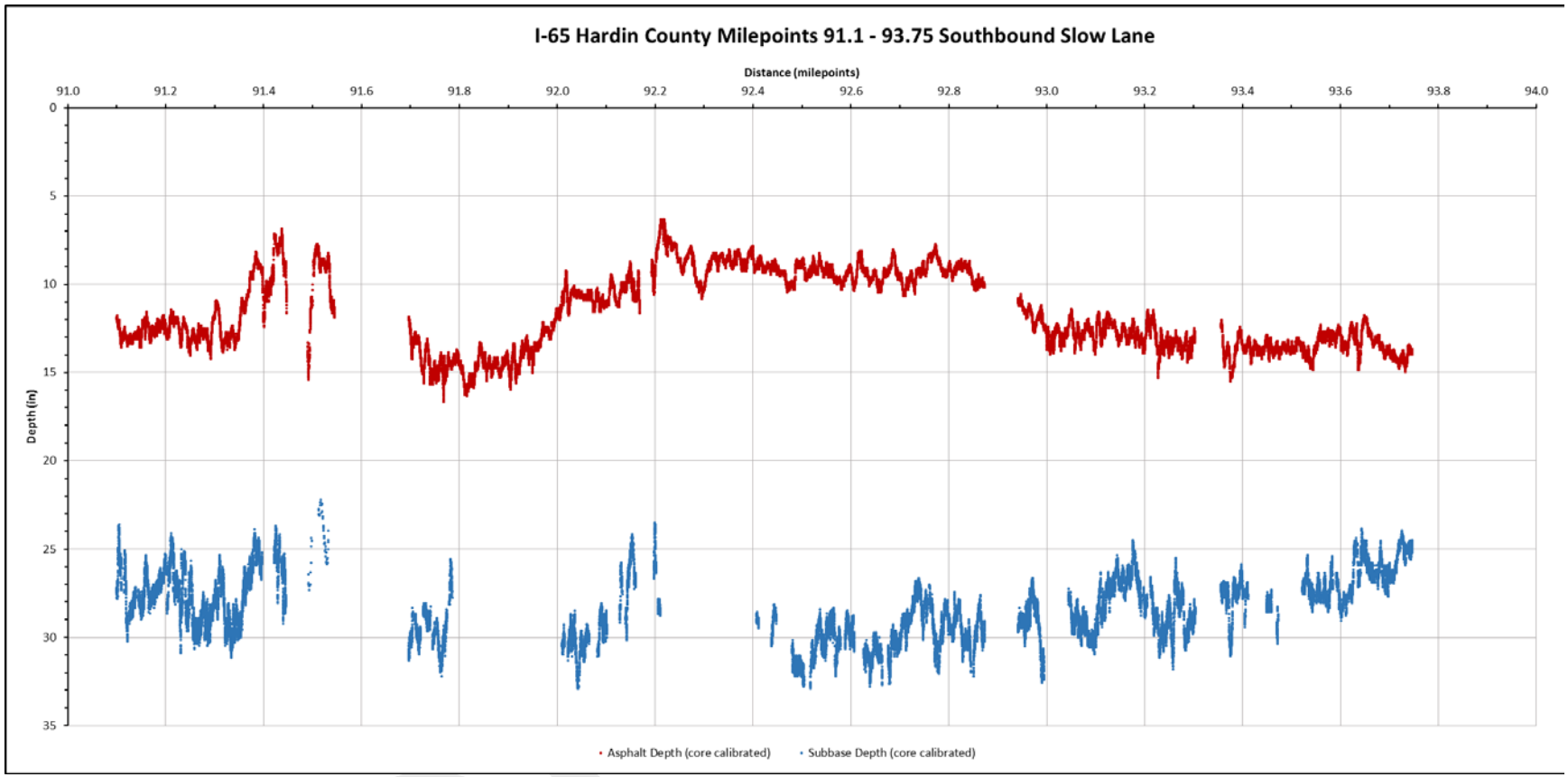


Figure E6. Results of GPR Scan, I-65 Southbound Slow Lane MP 91.1 - 93.75.

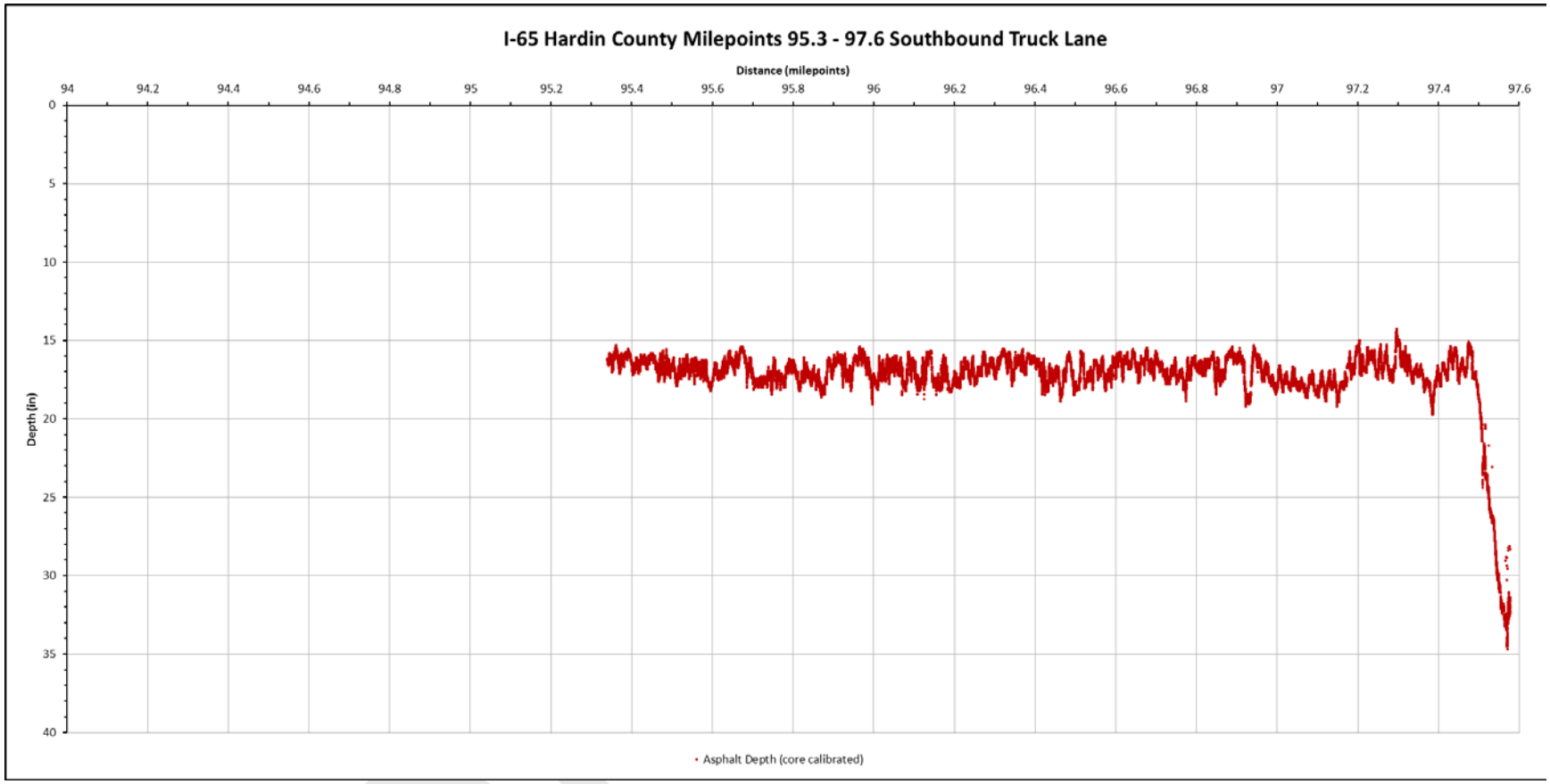


Figure E7. Results of GPR Scan, I-65 Southbound Truck Lane MP 95.3 – 97.6.

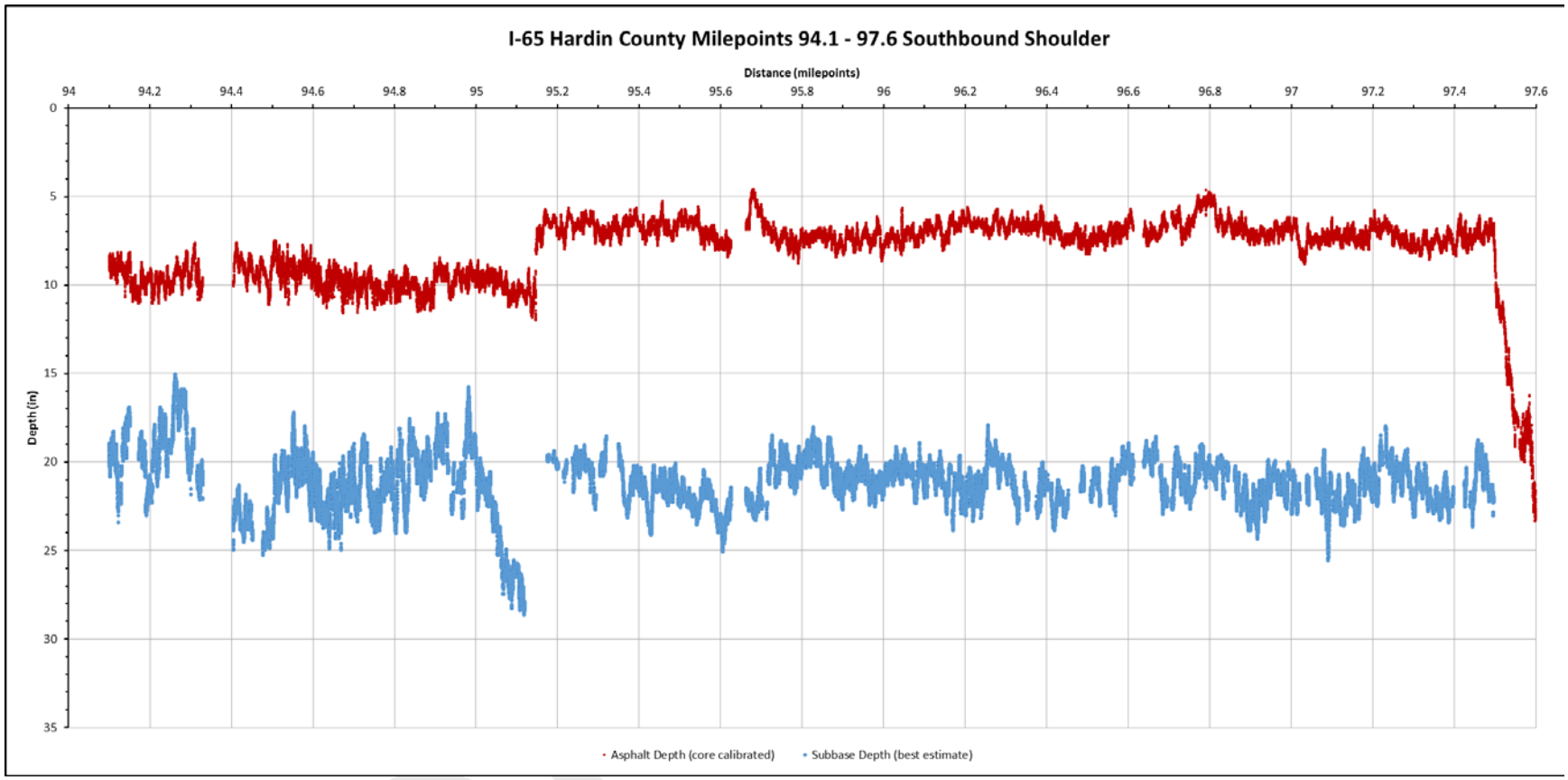


Figure E8. Results of GPR Scan, I-65 Southbound Shoulder MP 95.3 – 97.6.

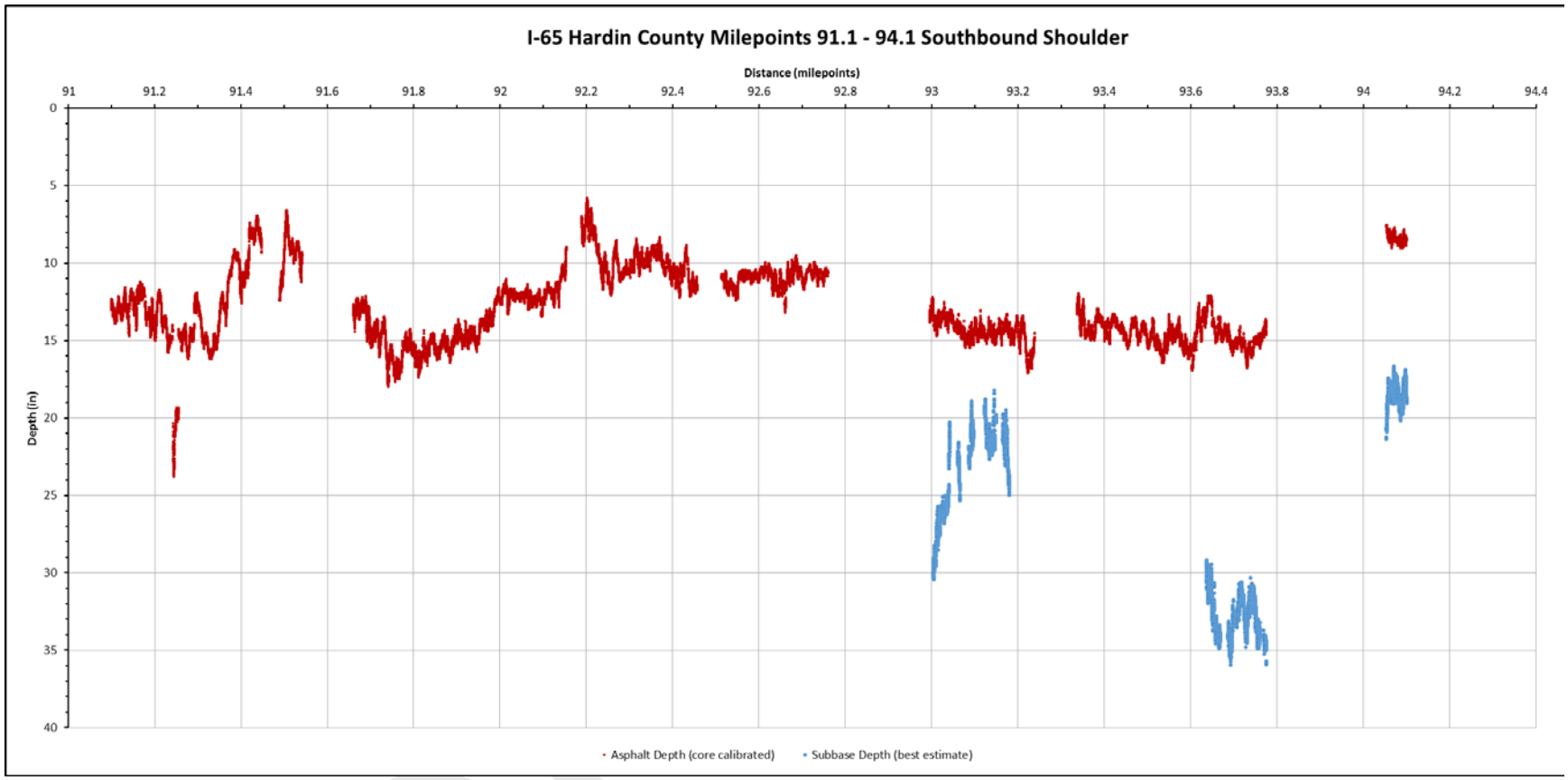


Figure E9. Results of GPR Scan, I-65 Southbound Shoulder MP 91.1 – 94.1.

TABLE E2. Northbound I-65 Structural Assessment

Area Included	HMA Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
MP 91 – 94: 13-in. HMA / 19-in. DGA - Thickness throughout				
MAX Value	816	100	34	7
AVG Value	593	51	20	4
MIN Value	401	25	9	2
MP 94 – 95: 9-in. HMA / 11-in. DGA – Thickness throughout				
MAX Value	2502	100	44	9
AVG Value	1558	100	29	6
MIN Value	972	100	15	3
MP 95 – 98: 16-in. HMA / 0-in. DGA – Thickness throughout				
MAX Value	1613		25	5
AVG Value	877		7	1
MIN Value	442		2	0

TABLE E3. Southbound I-65 Structural Assessment

Area Included	HMA Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
MP 91 – 92: 13-in. HMA / 16-in. DGA - Thickness throughout				
MAX Value	1184	100	67	13
AVG Value	668	57	24	5
MIN Value	383	25	12	2
MP 92 – 93: 10-in. HMA / 22-in. DGA - Thickness throughout				
MAX Value	1859	100	78	16
AVG Value	1041	91	40	8
MIN Value	656	48	25	5
MP 93 – 94: 13-in. HMA / 14-in. DGA - Thickness throughout				
MAX Value	842	100	53	11
AVG Value	677	72	35	7
MIN Value	485	30	19	4
MP 94 – 95: 9-in. HMA / 11-in. DGA – Thickness throughout				
MAX Value	1140	100	32	6
AVG Value	782	99	24	5
MIN Value	426	86	13	3
MP 95 – 98: 16-in. HMA / 0-in. DGA – Thickness throughout				
MAX Value	1643		86	17
AVG Value	584		15	3
MIN Value	382		2	0

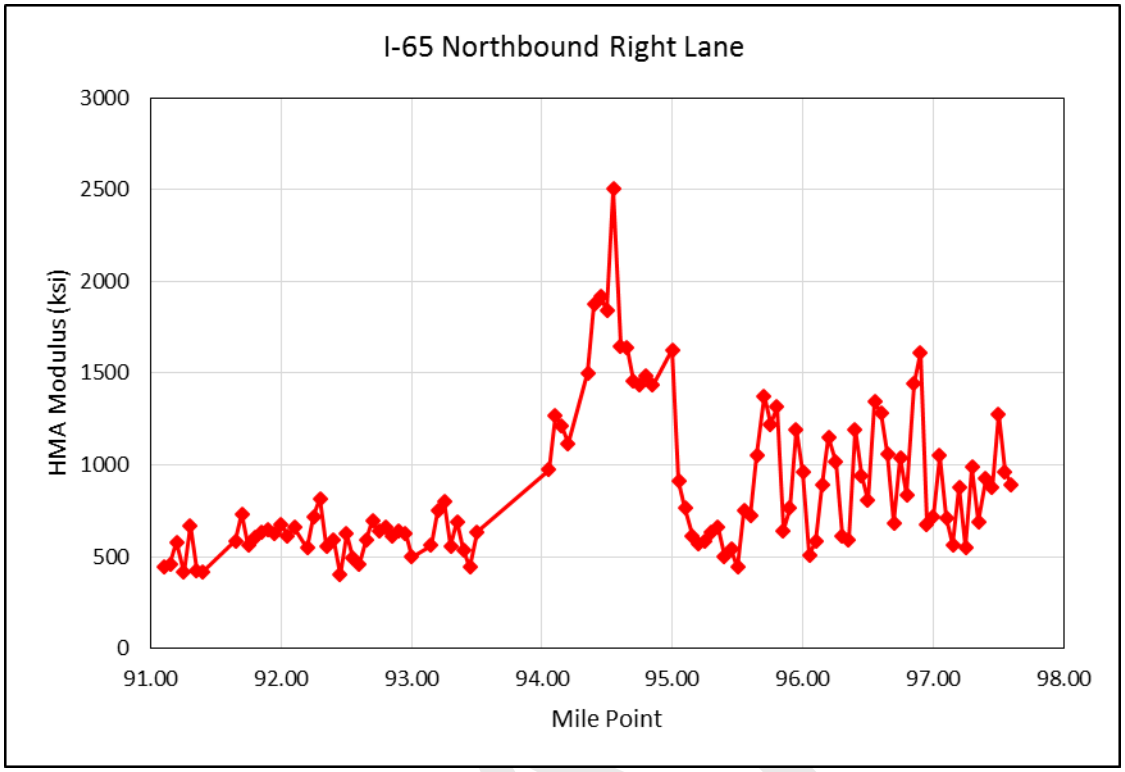


Figure E10. Back-calculated HMA Moduli values for northbound right lane, I-65 Mile Point 91.1 – 97.6.

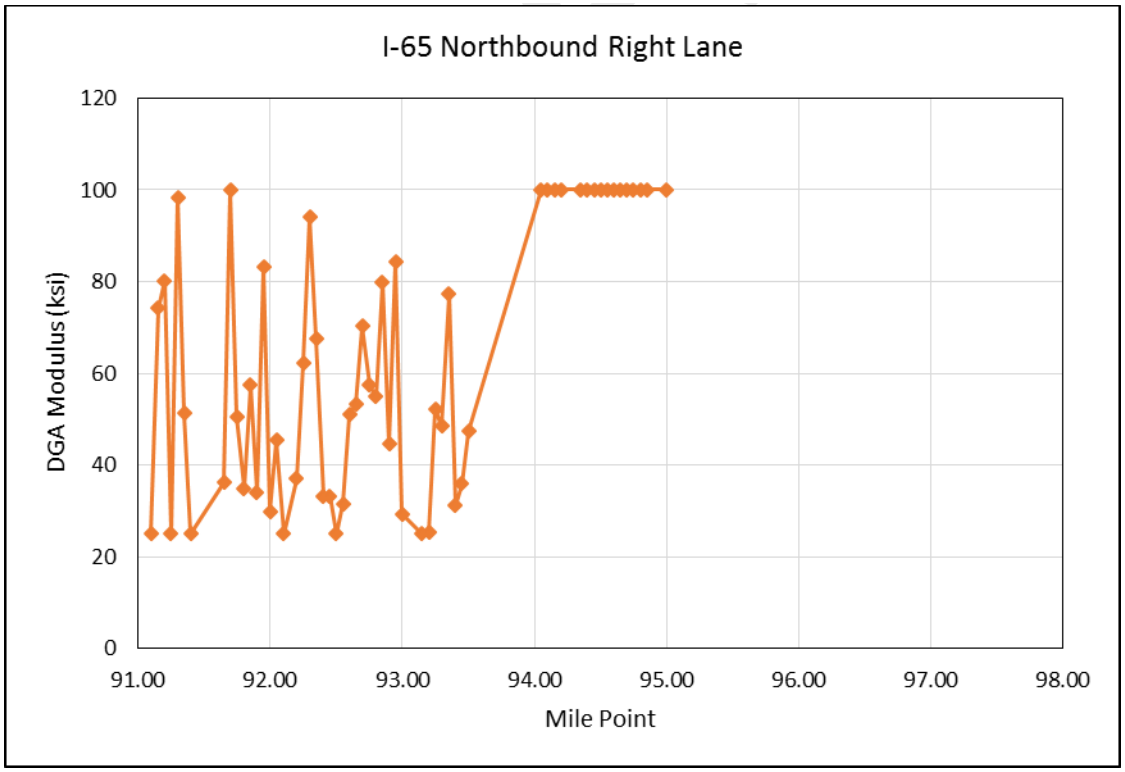


Figure E11. Back-calculated DGA moduli values for northbound right lane, I-65 Mile Point 91.1 - 97.6.

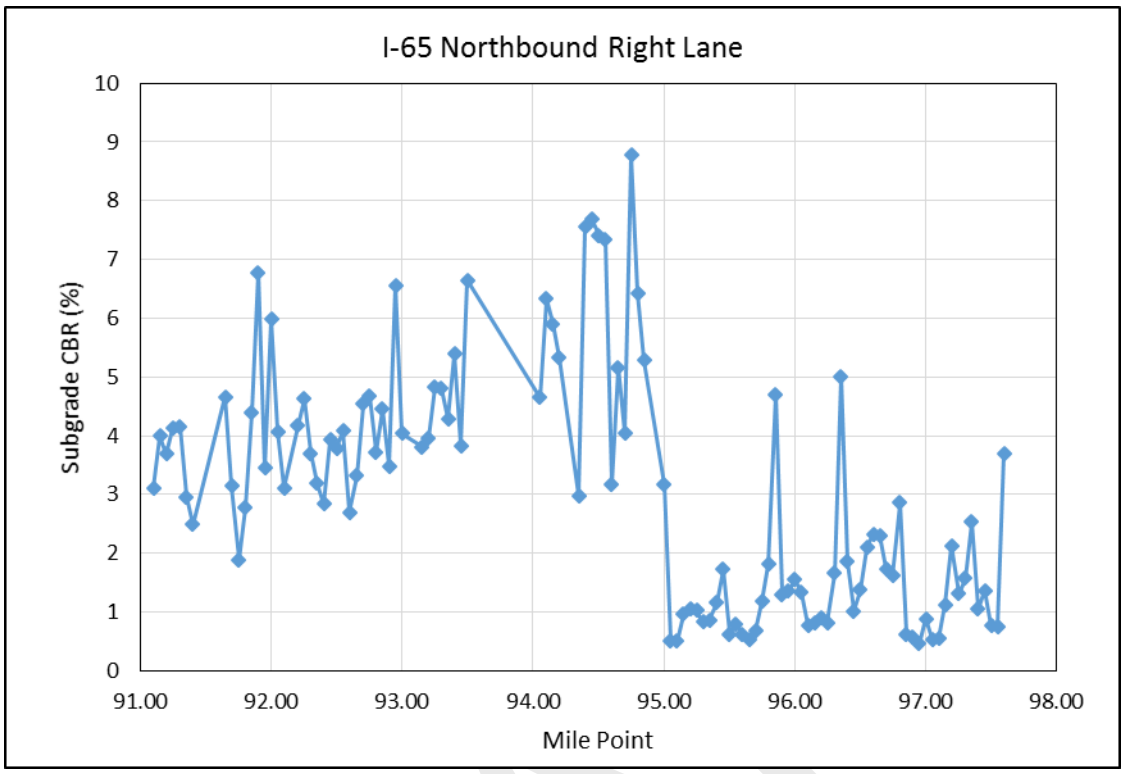


Figure E12. Back-calculated subgrade CBR values for northbound right lane, I-65 Mile Point 91.1 - 97.6.

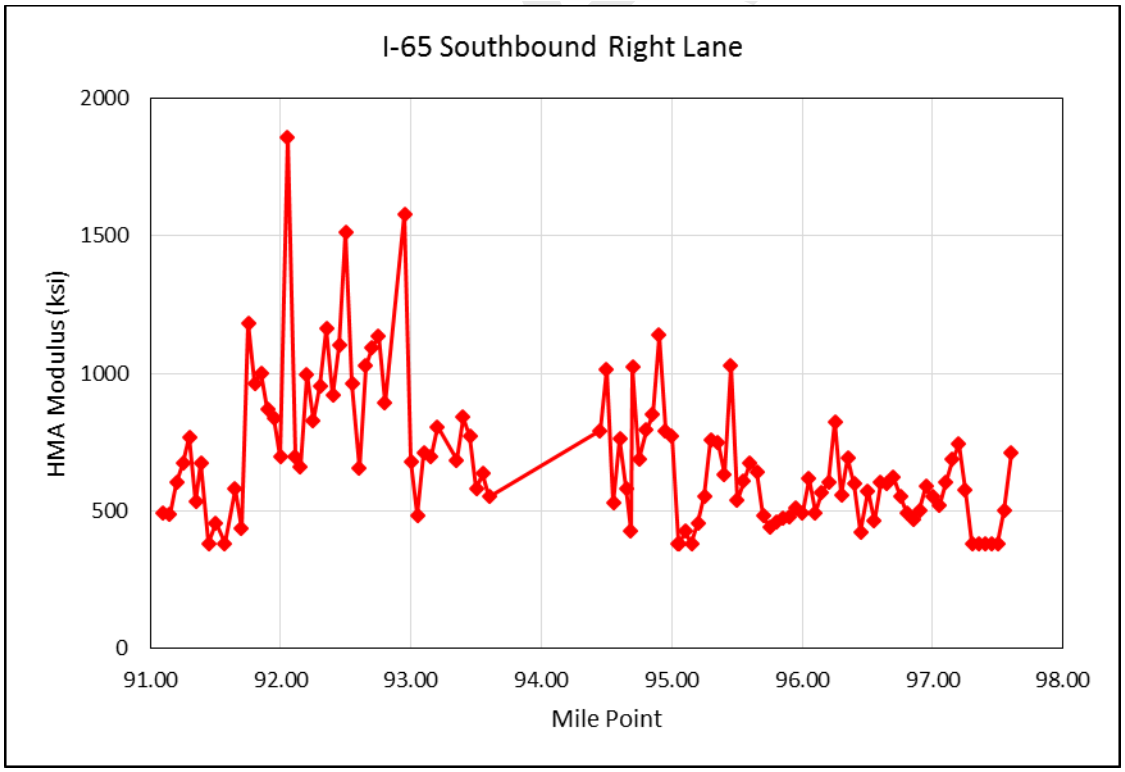


Figure E13. Back-calculated HMA Moduli values for southbound right lane, I-65 Mile Point 91.1 – 97.6.

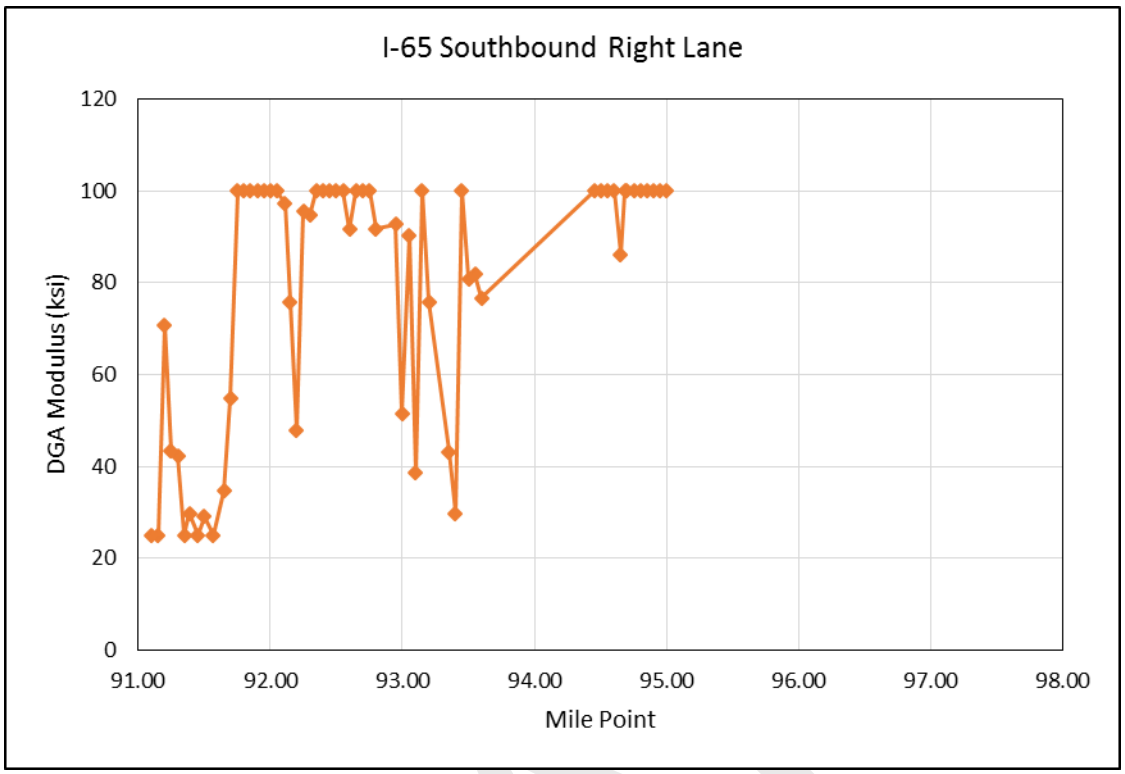


Figure E14. Back-calculated DGA moduli values for southbound right lane, I-65 Mile Point 91.1 - 97.6.

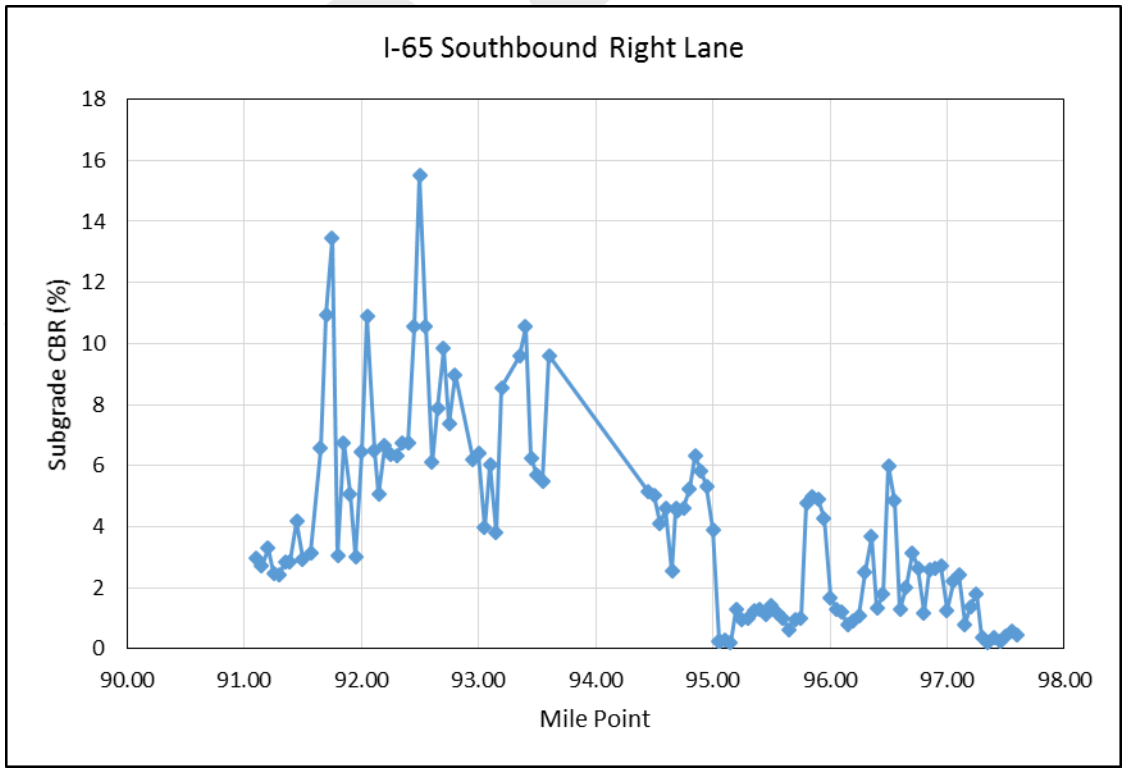


Figure E15. Back-calculated subgrade CBR values for southbound right lane, I-65 Mile Point 91.1 - 97.6.

Table E4. Northbound Mainline Core Information Table

Core	Lane	MP	Purpose of Core	HMA (in.)	Subbase (in.)	Stabilized Base (in.)	Total Depth of Investigation (in.)	Subbase Type	MC	Notes
1	SL	91.337	Cal	9.5	6.75		16.25	CSB		Could not remove any more material below subbase already extracted, evidence of HMA loss/stripping.
3	SL	92.973	Cal	13.75	5.75		19.5	DGA		Could not remove any more material below subbase already extracted, evidence of HMA loss/stripping.
8	SL	95.415	Cal	17.375			21.0			Core came out in 2 pieces (13.75-in. and 3.625-in.), mud/shot rock mix below HMA, no DGA found, evidence of HMA loss/stripping.
9	SL	96.453	Crack	17.0			25.0			Core came out in 2 pieces (13.75-in. and 3.25-in.), mud/shot rock mix below HMA, no DGA found, evidence of HMA loss/stripping.
10	SL	96.529	Crack	18.0			21.0		12.32%	Core broke during extraction, mud/shot rock mix below HMA, no DGA found, obtained moisture content sample, evidence of HMA loss/stripping.

SL = Slow Lane, TL = Truck Lane, Cal = Core used for GPR calibration, Crack = Core at longitudinal crack, Wet = Core at wet area as defined using GPR

Table E5. Southbound Mainline and Truck Lane Core Information Table

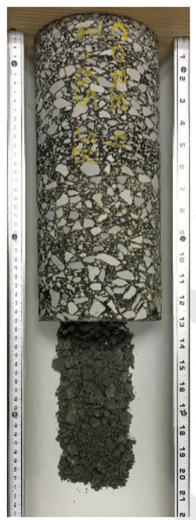
Core	Lane	MP	Purpose of Core	HMA (in.)	Subbase (in.)	Stabilized Base (in.)	Total Depth of Investigation (in.)	Subbase Type	MC	Notes
4	SL	91.324	Cal	13.0	8.25		21.25	DGA		Could not remove any more material below subbase already extracted, evidence of HMA loss/stripping.
2	SL	93.108	Cal	13.5	16.5		30.0	DGA	19.15%	Red clay found below DGA, obtained moisture content sample, evidence of HMA loss/stripping.
14	SL	94.648	Cal	9.625	8.375.		18.5	DGA	14.89%	Obtained moisture content sample, evidence of HMA loss/stripping.
17	SL	96.391	Wet	16.5		16.0.	32.5			Stabilized subgrade below asphalt was cement treated soil/aggregate mixture. Too deep to get sample for moisture content, evidence of HMA loss/stripping.
16	TL	96.891	Wet	16.0		10.0	32.5		25.30%	Stabilized subgrade below asphalt was cement treated soil/aggregate mixture. HMA core came out in 2 pieces (9.00-in. and 7.00-in.), evidence of HMA loss/stripping.
15	TL	97.456	Wet	16.5			20.5		26.74%	Obtained moisture content sample, evidence of HMA loss/stripping.

SL = Slow Lane, TL = Truck Lane, Cal = Core used for GPR calibration, Crack = Core at longitudinal crack, Wet = Core at wet area as defined using GPR

Table E6. Shoulder Core Information Table

Core	Direction	MP	HMA Thickness (in.)	Notes
5	NB	95.174	7.625	Evidence of HMA loss/stripping.
6	NB	96.164	8.625	Evidence of HMA loss/stripping.
7	NB	97.151	7.875	Evidence of HMA loss/stripping.
13	SB	94.600	9.5	Evidence of HMA loss/stripping.
12	SB	95.626	7.5	Core came out in 2 pieces (2.25-in. to 4.25-in. and 2.875-in.), Evidence of HMA loss/stripping.
11	SB	96.613	6.625	Core came out in 3 pieces (1.75-in., 2.5-in., and 2.375-in.), Evidence of HMA loss/stripping.

CORE 1
MP 91.337
NB SL
AC 9.5"
CSB 6.75"



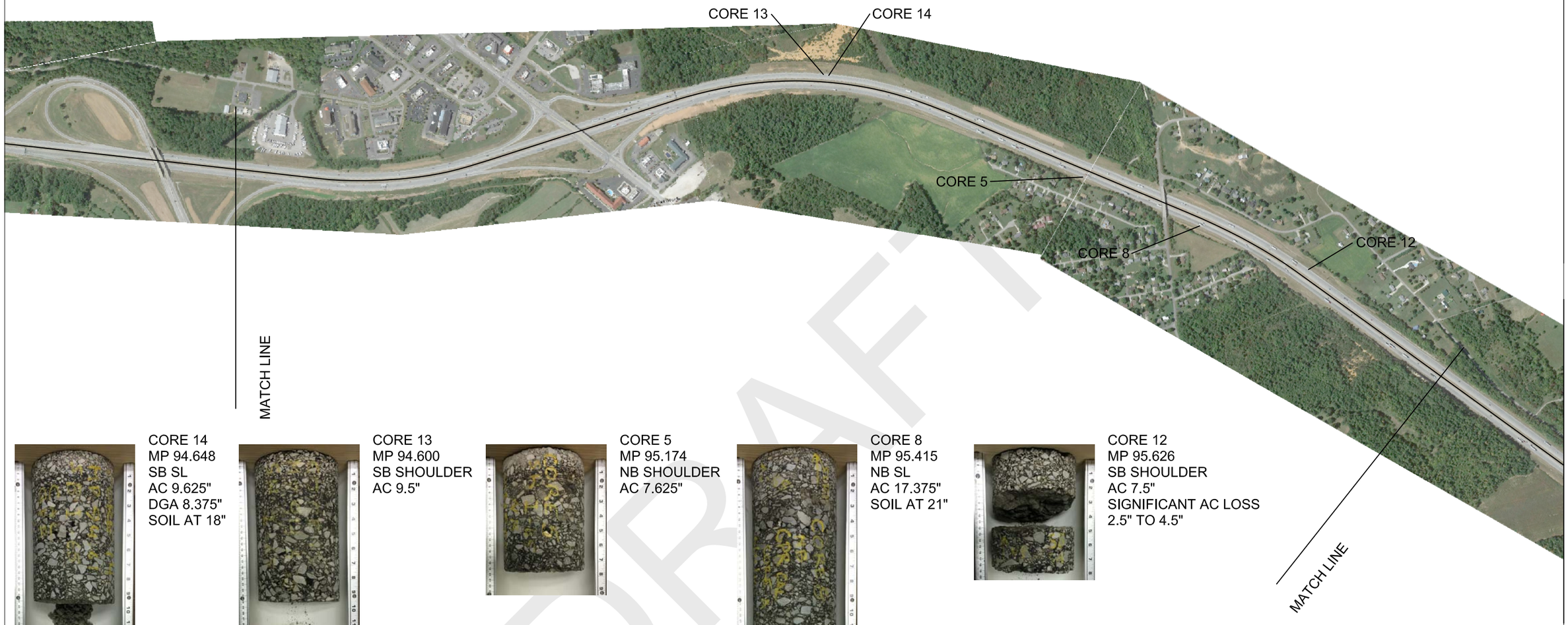
CORE 4
MP 91.324
SB SL
AC 13"
DGA 8.25"

CORE 3
MP 92.973
NB SL
AC 13.75"
DGA 5.75"

CORE 2
MP 93.108
SB SL
AC 13.5"
DGA 16.5"
SOIL AT 30"

Figure E16. Core locations and results.

NOT TO SCALE	I-65 HARDIN CO. FORENSIC EVALUATION APPROX MP 91.1 TO 97.6	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 1 OF 3 DATE 7/7/16 DRAFTED TAJ



CORE 14
MP 94.648
SB SL
AC 9.625"
DGA 8.375"
SOIL AT 18"

CORE 13
MP 94.600
SB SHOULDER
AC 9.5"

CORE 5
MP 95.174
NB SHOULDER
AC 7.625"

CORE 8
MP 95.415
NB SL
AC 17.375"
SOIL AT 21"

CORE 12
MP 95.626
SB SHOULDER
AC 7.5"
SIGNIFICANT AC LOSS
2.5" TO 4.5"

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I-65 HARDIN CO. FORENSIC EVALUATION
APPROX MP 91.1 TO 97.6

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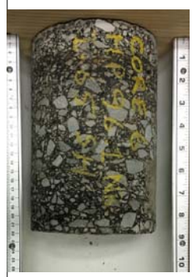
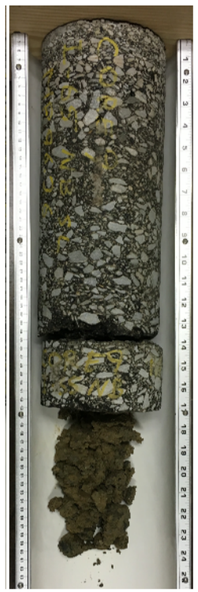
Figure E17. Core locations and results.

CORE 16
MP 96.891
SB TRUCK LN
AC 16"
STABILIZED 10"
SOIL AT 26"

CORE 17
MP 96.391
SB SL
AC 16.5"
STABILIZED 16"



CORE 6
MP 96.164
NB SHOULDER
AC 8.625"



CORE 9
MP 96.453
NB SL
AC 17"
SOIL AT 25"

CORE 10
MP 96.529
NB SL
AC 18"
SOIL AT 21"

CORE 11
MP 96.613
SB SHOULDER
AC 6.625"
AC STRIPPING AT
2"-4.25"

CORE 7
MP 97.151
NB SHOULDER
AC 7.875"

CORE 15
MP 97.456
SB TRUCK LN
AC 16.5"
SOIL AT 16.5"

NOT
TO
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Figure E18. Core locations and results.

I-65 HARDIN CO. FORENSIC EVALUATION
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APPENDIX F

FIELD RESULTS

GROUND PENETRATING RADAR
FALLING WEIGHT DEFLECTOMETER
CORING AND MATERIALS SAMPLING

KY 9004, PENNYRILE PARKWAY, CHRISTIAN COUNTY

Christian County Pennyrile Parkway

A team from the Kentucky Transportation Center's Pavement, Materials, Geotechnical and Infrastructure Assessment program area evaluated a section of the Edward T. Breathitt Pennyrile Parkway, KY 9004, from Mile Point 16.50 to 22.48 at the request of the Kentucky Transportation Cabinet. This road segment extends northward from Mile Point 16.50, where the pavement type transitions from a flexible to rigid pavement, to the Crofton interchange.

Initial work for this project was accomplished on 28 July 2016 and included scanning the outside lanes in both directions of the roadway section using ground penetrating radar (GPR). Two (2) 900 MHz ground-coupled antennas with six-foot separation and a SIR 30 data collection unit were used to collect GPR scanning data. Ground Penetrating Radar data were collected at the rate of six (6) scans per foot. The separation between the antennas permitted simultaneous scanning of each wheel path of the outside lane. Data obtained through GPR scans are presented in Figures F1 and F2 for the northbound and southbound directions, respectively.

Additional data for this investigation were collected on 08 and 09 August 2016 and included:

- Falling Weight Deflectometer (FWD) — deflection testing was performed at 0.1 mile intervals at the mid-panel of the concrete pavement slab and the adjacent transverse pavement joint. Back-calculated moduli values for the PCC pavement and underlying layers are presented in Table F1 and graphically in Figures F3 through F8.
- Coring, materials sampling, and Dynamic Cone Penetrometer (DCP) tests were performed at locations established through GPR and FWD testing. Tables F3 and F4 contain core-related information. Figures F9 through F11 contain additional core-related information.

Traffic control was provided by the Christian County maintenance crew for all data collection activities. The results of data collection activities performed for the forensic investigation of KY 9004 are presented herein.

The GPR data collection and analysis indicated a pavement structure consisting of a 9-inch PCC pavement overlying a four-inch layer of DGA. Falling Weight Deflectometer measurements were obtained at 0.1 mile intervals at the mid slab and across the adjacent transverse joint. Data obtained with the FWD were analyzed to determine back-calculated moduli values of the PCC and DGA pavement layers using the average values for PCC and DGA thickness throughout. Subgrade CBR values were determined from the back-calculated subgrade layer moduli. Moisture contents ranged from a high of 36.4% for the clay subgrade to a low of 8.0% for the sandy subgrade material. All clay-type subgrade soils had moisture contents above 20%.

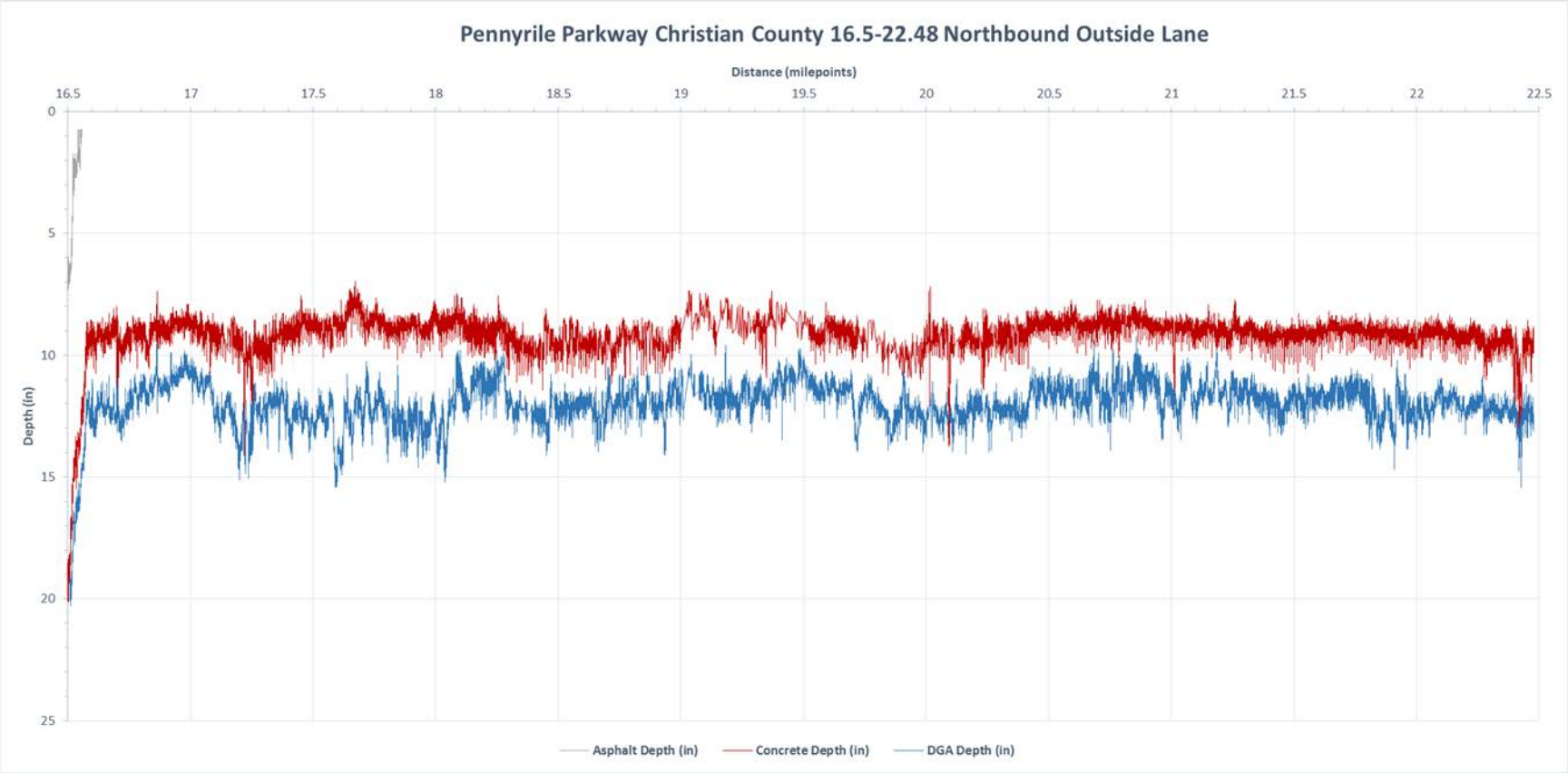

Figure F2. GPR results for northbound outside lane of Pennyrile Parkway, Mile Point 16.50 to 22.48.

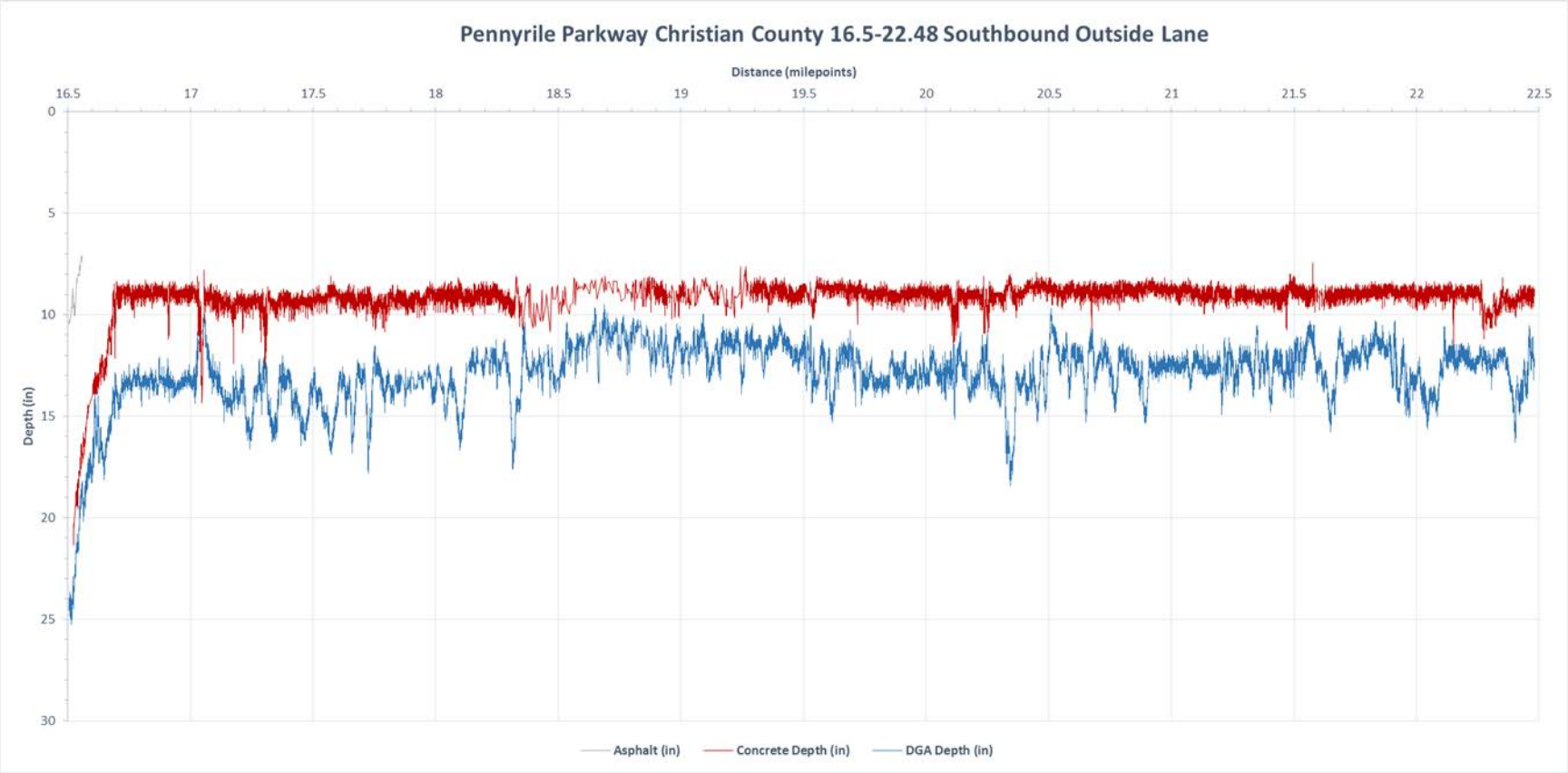

Figure F3. GPR results for southbound outside lane of Pennyrile Parkway, Mile Point 16.5 to 22.48.

TABLE F1. Northbound KY 9004, Christian County Structural Assessment

Analysis Scenario	PCC Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
9.0" PCC / 4.0" DGA – Average Thickness throughout				
MAX Value	8000	100	61	12
AVG Value	7231	63	19	4
MIN Value	4761	26	8	2

TABLE F2. Southbound KY 9004, Christian County Structural Assessment

Analysis Scenario	AC Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
9.0" PCC / 4.0" DGA – Average Thickness throughout				
MAX Value	8000	100	49	10
AVG Value	7018	56	21	4
MIN Value	4865	25	6	1

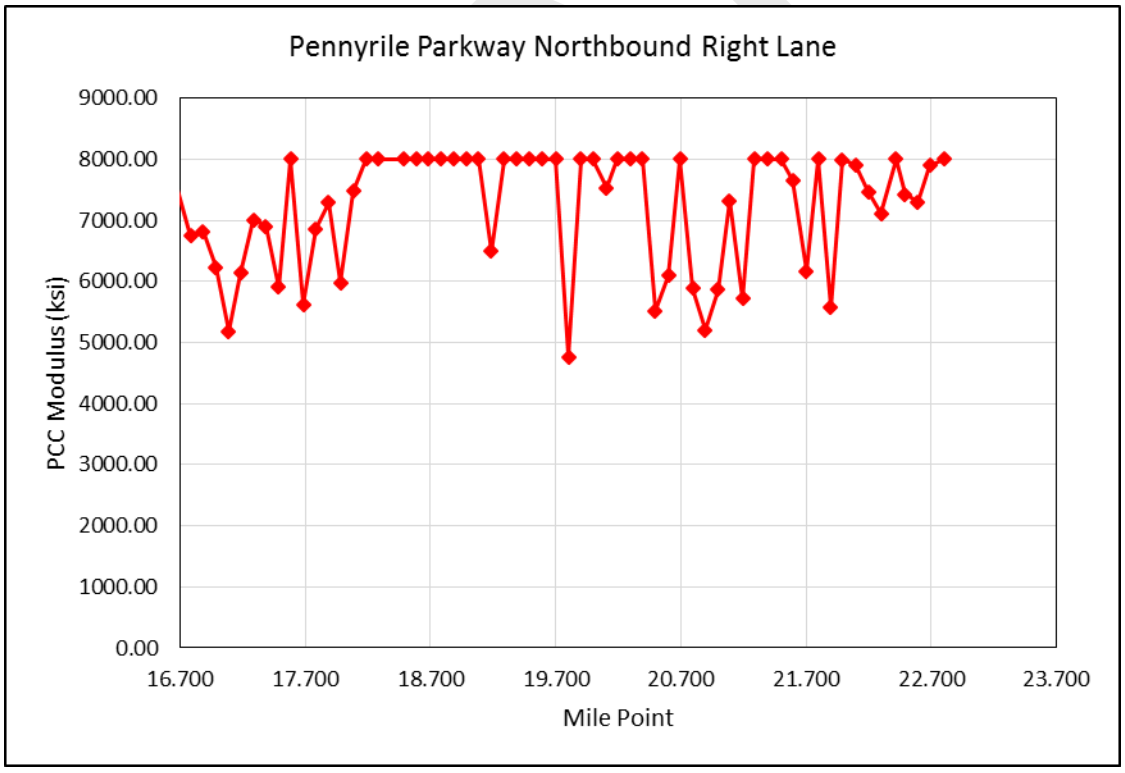

Figure F3. Back-calculated PCC moduli values for northbound right lane, Pennyrile Parkway, Mile Point 16.50 - 22.48.

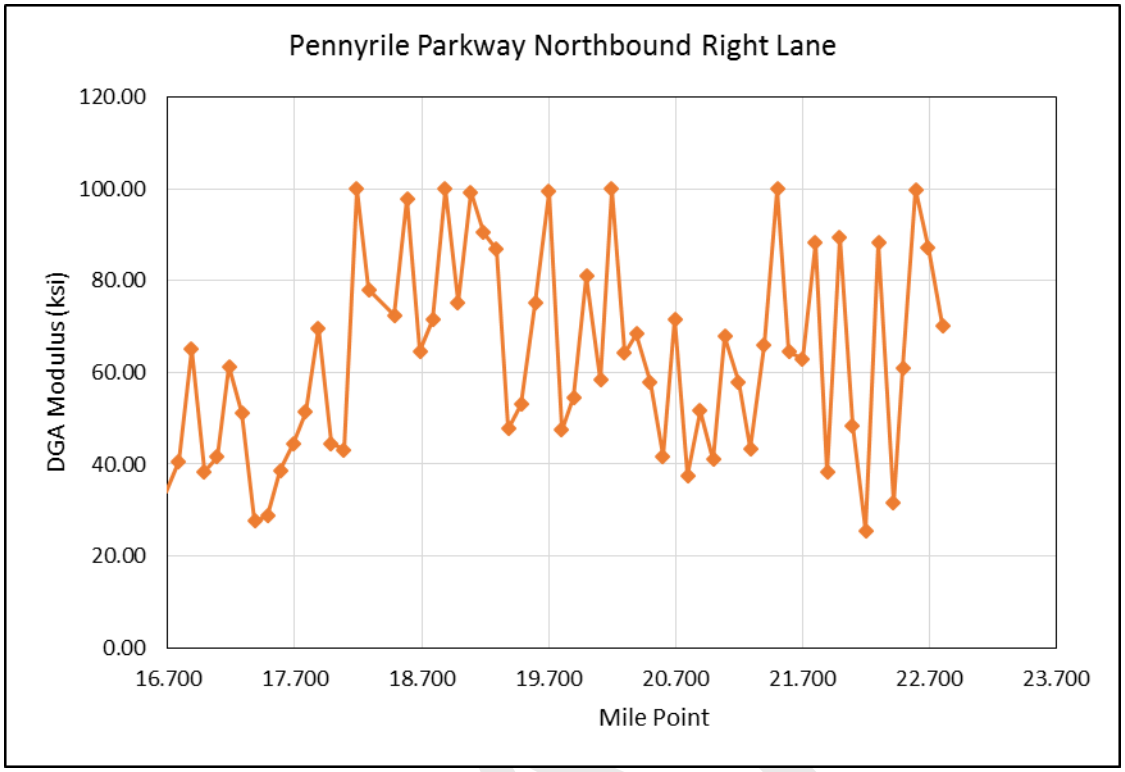

Figure F4. Back-calculated DGA moduli values for northbound right lane, Pennyrile Parkway, Mile Point 16.50 - 22.48.

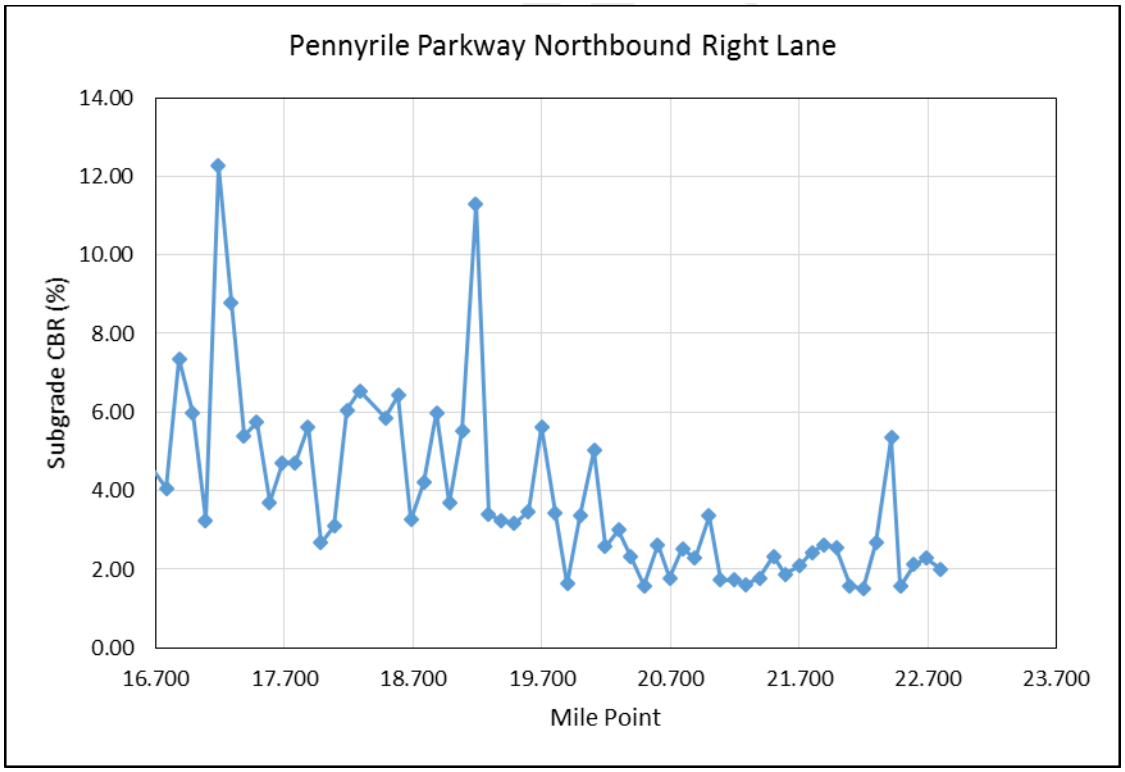

Figure F5. Back-calculated subgrade CBR values for northbound right lane, Pennyrile Parkway, Mile Point 16.50 - 22.48.

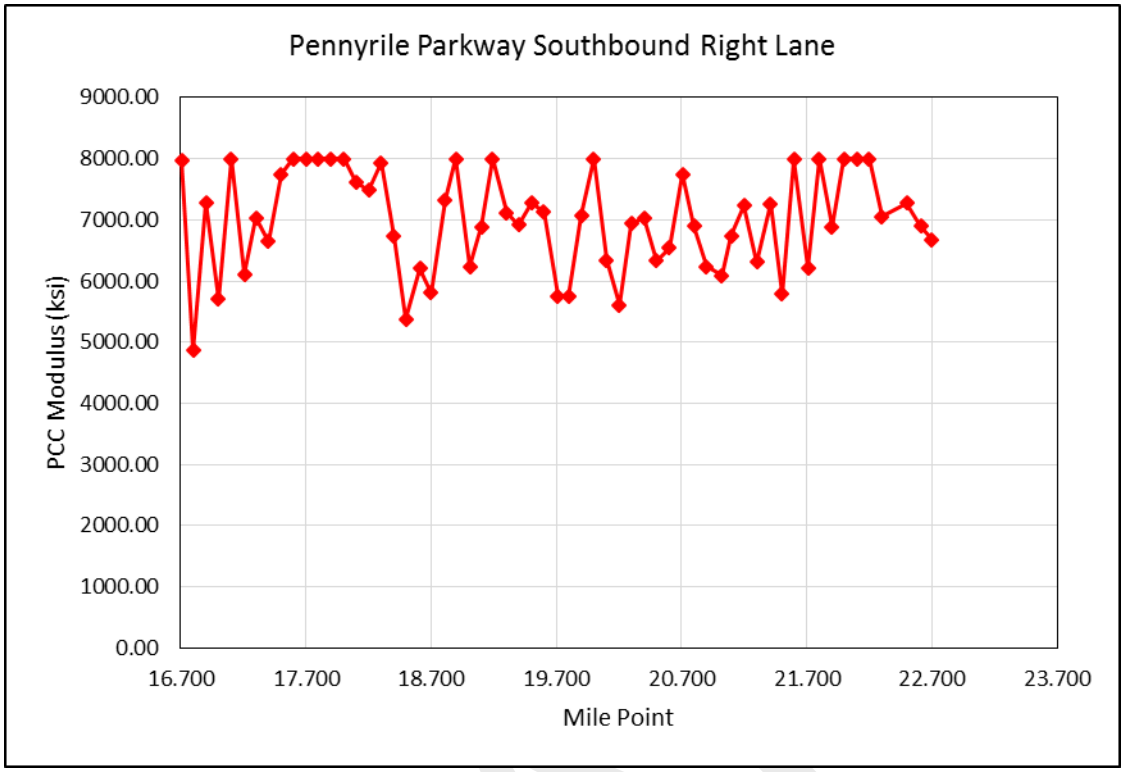

Figure F6. Back-calculated PCC moduli values for southbound right lane, Pennyrile Parkway, Mile Point 16.50 - 22.48.

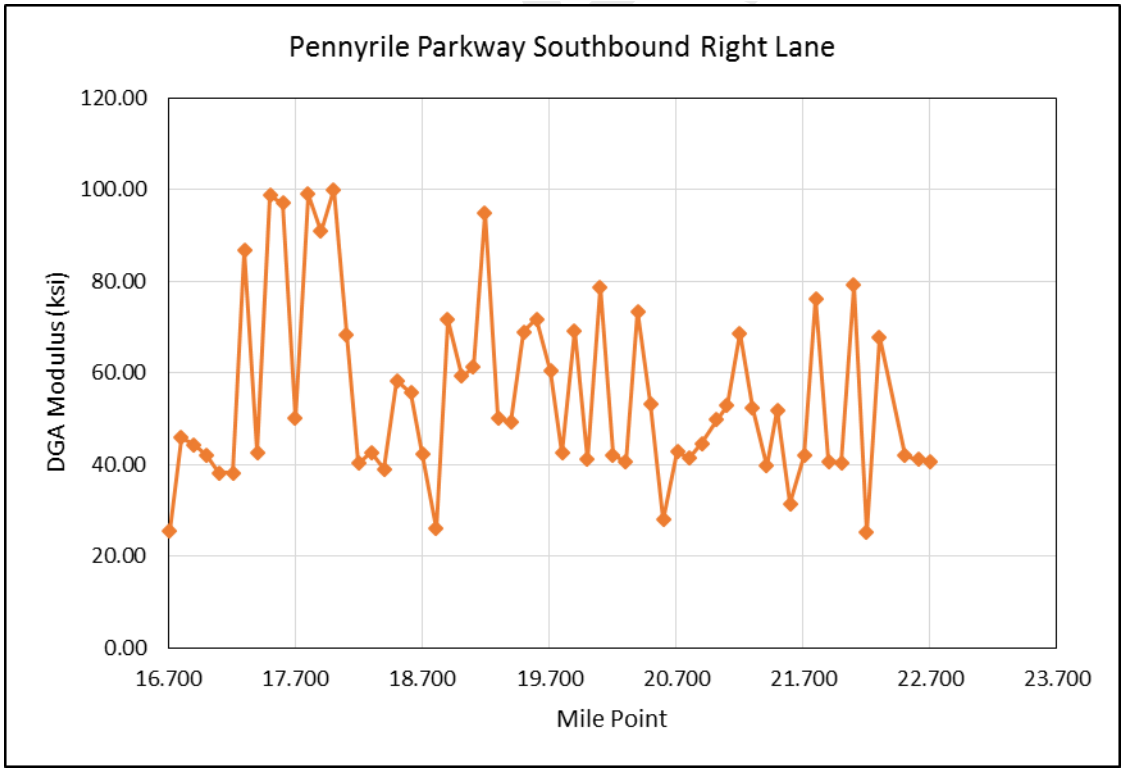

Figure F7. Back-calculated DGA moduli values for southbound right lane, Pennyrile Parkway, Mile Point 16.50 - 22.48.

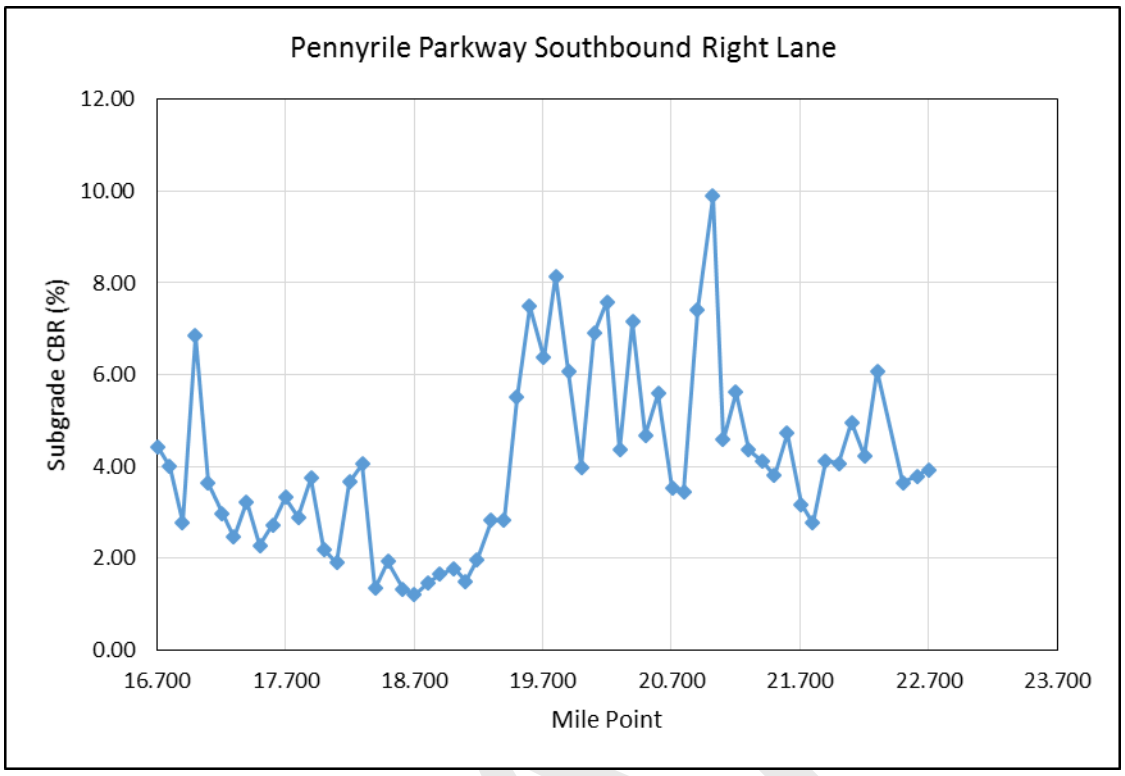

Figure F8. Back-calculated subgrade CBR values for southbound right lane, Pennyrile Parkway, Mile Point 16.50 - 22.48.

TABLE F3. Core Extractions and Related Information – KY 9004 Northbound, Christian County

Core Site	Core Location	Core Purpose	Field Core Length (in.)	DGA Thickness (in.)	Depth of Moisture Content Sample (in.)	Subgrade Moisture Content (%)
1	MP 17.51	Thick DGA	9-1/2	6-1/4	22	21.9
2	MP 19.02	Dry Area	8-3/4	3-3/4	17-1/2	10.7
3	MP 20.86	Thin DGA	8-3/8	3-1/8	15-3/4	29.7
4	MP 21.84	Wet Area	8-3/4	4-1/2	16-1/2	26.0
NOTES: Core locations for the northbound section were selected for the purpose shown. Investigation of the subgrade at Core Site 2 revealed a layer of sand below the DGA layer. The moisture content sample for Core Site 2 was sand. The presence of water was confirmed in the subgrade beneath the DGA at Core Site 4.						

TABLE F4. Core Extractions and Related Information – KY 9004 Southbound, Christian County

Core Site	Core Location	Core Purpose	Field Core Length (in.)	DGA Thickness (in.)	Depth of Moisture Content Sample (in.)	Subgrade Moisture Content (%)
5	MP 21.00	Calibration	8-3/4	3-1/4	17-3/4	28.2
6	MP 20.90	Thick DGA	8-5/8	6-3/8	17-1/2	36.4
7	MP 19.18	Thin DGA	8-3/4	3-1/2	28-1/2	15.0
8	MP 19.09	FWD	8-7/8	3-7/8	28-1/2	8.0
9	MP 17.97	Dry Area	8-1/2	4-1/4	13	11.5

NOTES: Core locations for the southbound section were selected for the purpose shown. Core Site 8 was selected based on higher deflections in this area. Investigation of the subgrade at Core Sites 7 and 8 revealed a layer of sand below the DGA layer. Material below Core Site 9 was mixture of shale and rock.

CORE 1
MP 17.597 NB
PCC 9.5"
DGA 6.25"
SOIL AT 15.75"

CORE 9
MP 17.973 SB
PCC 8.5"
DGA 4.25"
SOIL AT 12.75"

Figure F9. Core Locations and Results.

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SCALE

KY 9004 PENNYRILE PARKWAY
FORENSIC EVALUATION
APPROX MP 16.5 TO 22.5

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CORE 2
MP 19.016 NB
PCC 8.75"
DGA 3.75"
SOIL AT 12.5"

CORE 3
MP 20.856 NB
PCC 8.375"
DGA 3.125"
SOIL AT 11.5"

CORE 6
MP 20.890 SB
PCC 8.625"
DGA 6.375"
SOIL AT 15"

CORE 7
MP 19.18 SB
PCC 8.75"
DGA 3.5"
SAND 10"

CORE 8
MP 19.197 SB
PCC 8.875"
DGA 3.875"
SAND 15.75"

Figure F10. Core Locations and Results

NOT
TO
SCALE

KY 9004 PENNYRILE PARKWAY
FORENSIC EVALUATION
APPROX MP 16.5 TO 22.5

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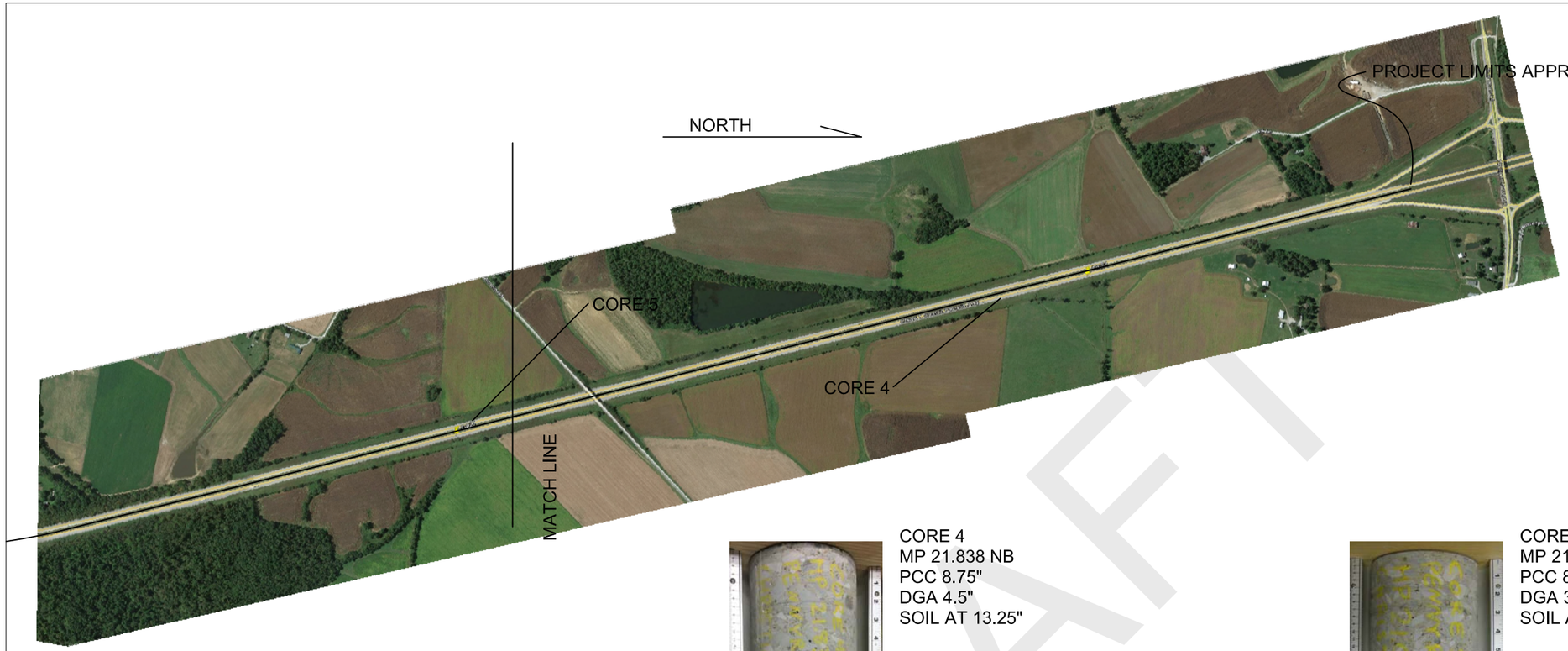


CORE 4
MP 21.838 NB
PCC 8.75"
DGA 4.5"
SOIL AT 13.25"

CORE 5
MP 21.030 SB
PCC 8.75"
DGA 3.25"
SOIL AT 12"

Figure F11. Core Locations and Results.

NOT TO SCALE	KY 9004 PENNYRILE PARKWAY FORENSIC EVALUATION APPROX MP 16.5 TO 22.5	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 3 OF 3 DATE 8/15/16 DRAFTED TAJ

APPENDIX G

FIELD RESULTS

GROUND PENETRATING RADAR
FALLING WEIGHT DEFLECTOMETER
CORING AND MATERIALS SAMPLING

KY 9002, BLUEGRASS PARKWAY,
HARDIN COUNTY

Hardin County Bluegrass Parkway

A team from the Kentucky Transportation Center's Pavement, Materials, Geotechnical and Infrastructure Assessment program area evaluated a section of the Martha Layne Collins Bluegrass Parkway, KY 9002, from the intersection with I-65 (Mile Point 0.0) to Mile Point 5.82 at the request of the Kentucky Transportation Cabinet. The road segment extends eastward from Mile Point 0.0 to an obvious change in the age of the pavement surface at Mile Point 5.82.

Initial work for this project was accomplished on 19 September 2016 and included scanning the outside lanes in both directions of the roadway section using ground penetrating radar (GPR). Two (2) 900 MHz ground-coupled antennas with six-foot separation and a SIR 30 data collection unit were used to collect GPR scanning data. Ground Penetrating Radar data were collected at the rate of three (3) scans per foot. The separation between the antennas permitted simultaneous scanning of each wheel path of the outside lane.

Additional data for this investigation were collected on 26 and 27 September 2016 and included:

- Falling Weight Deflectometer (FWD) — deflection testing was performed at 250-feet intervals using a JILS-20 FWD. Back-calculated moduli values for the HMA pavement and underlying layers are presented in Table G1 and graphically in Figures G3 through G20.
- Coring, materials sampling, and Dynamic Cone Penetrometer (DCP) tests were performed at locations established through GPR and/or FWD testing. Tables G3 and G4 contain core-related information. Figures G21 through G23 contain additional core-related information.

Traffic control was expertly provided by the Hardin County maintenance crew for all data collection activities. The results of data collection activities performed for the forensic investigation of KY 9002 are presented herein.

The pavement thickness of this section of the Bluegrass Parkway varied due to maintenance operations performed in the fall of 2006. The maintenance activity attempted to reinforce the pavement from mile point 4.8 to 5.8 to eliminate or minimize surface block cracking. Specifically, the maintenance activity incorporated a layer of woven steel mesh (identified as PaveTrac® from mile point 4.8 to 5.3, and GlasGrid® from mile point 5.3 to 5.8), to reinforce the HMA layers. The application of these materials resulted in a thicker pavement section between mile points 4.8 and 5.8 in each direction. The average thickness of the HMA layer and DGA layer for the different sections determined through analysis of the GPR scans are presented in Appendix E. Moisture contents ranged from 14.4% to 20.9% for the clay subgrade and averaged 16.8%.

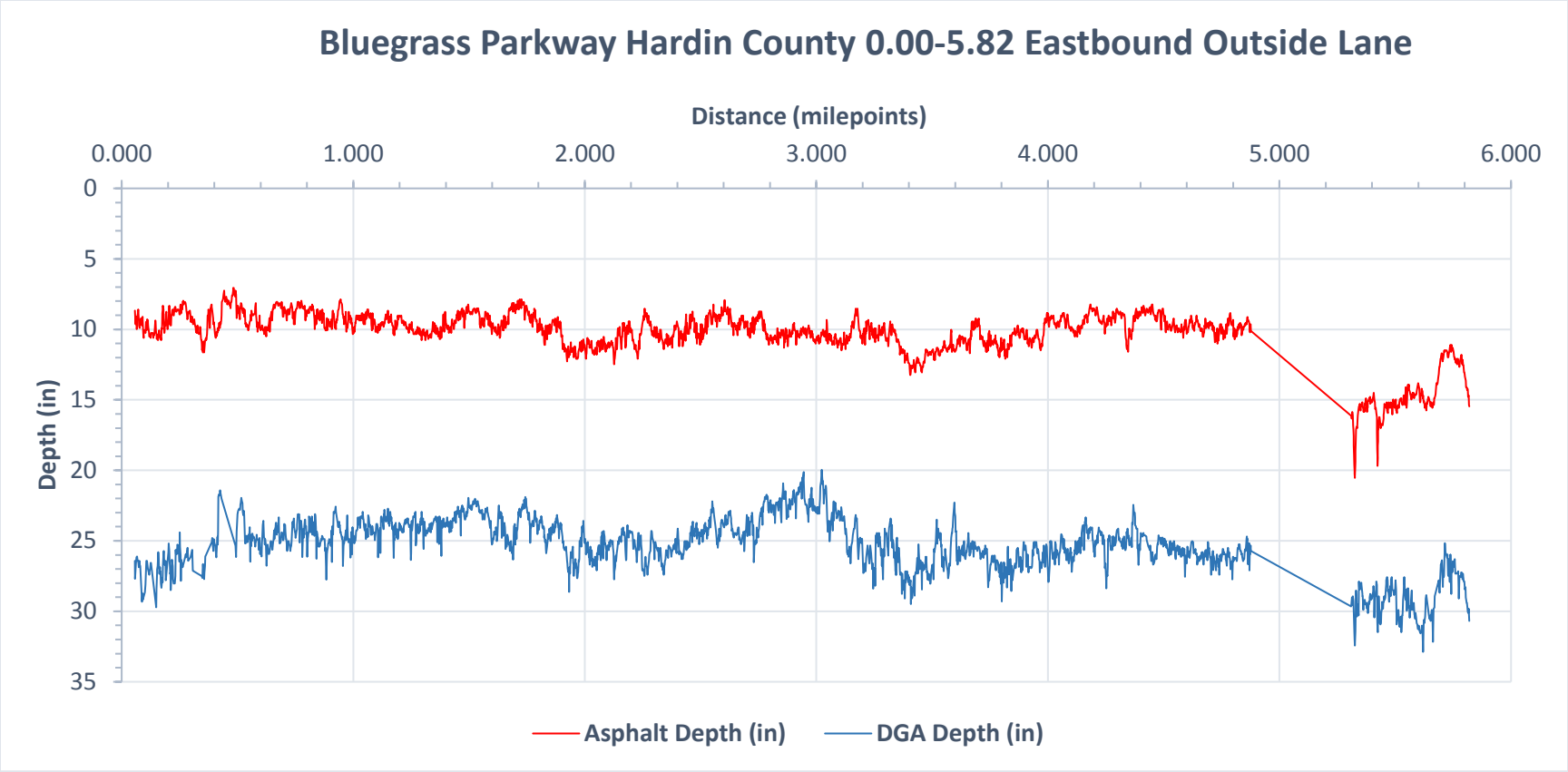


Figure G1. GPR results for Eastbound outside lane of Bluegrass Parkway, Mile Point 0.00 to 5.82.

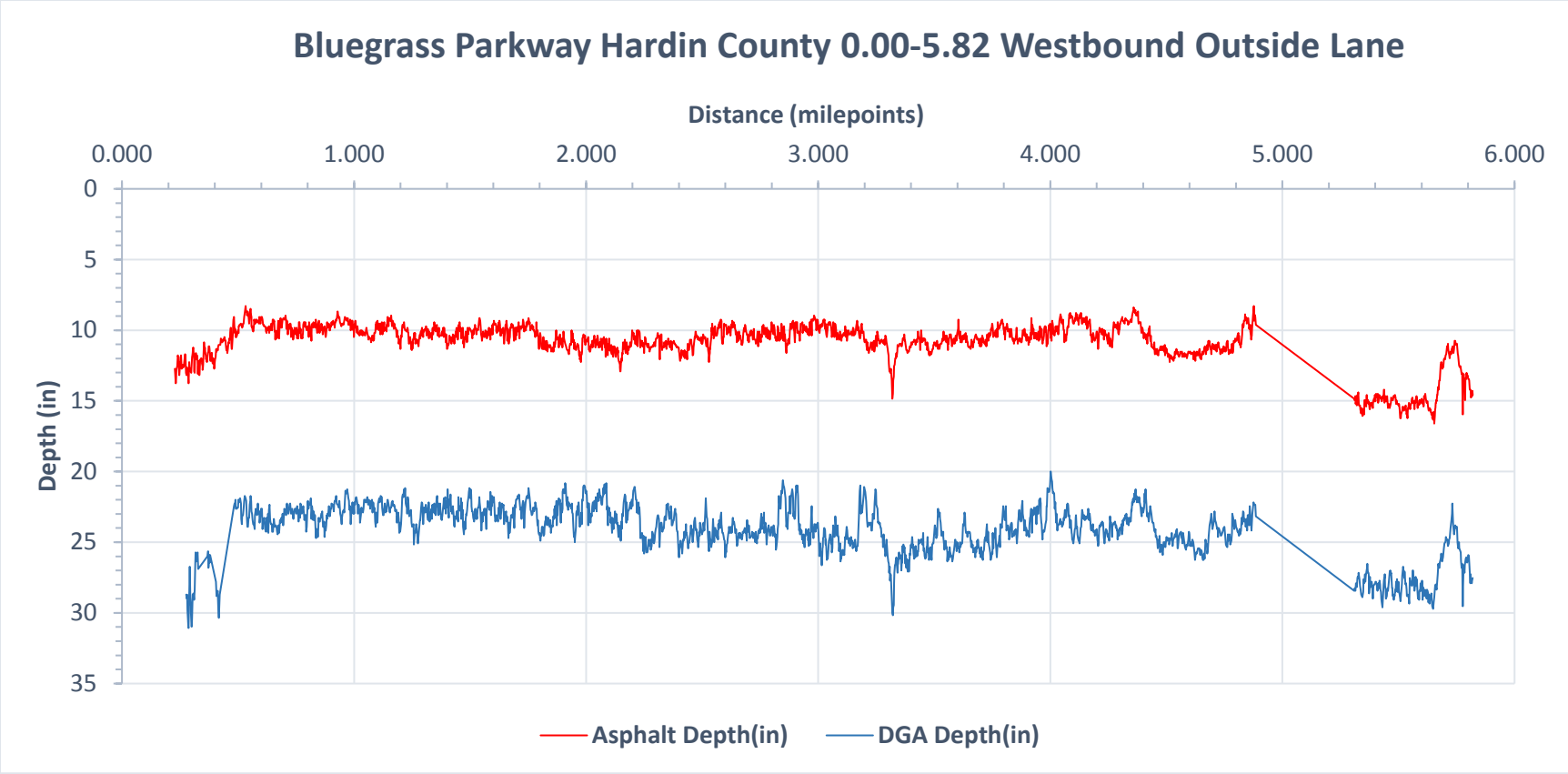


Figure G2. GPR results for Westbound outside lane of Bluegrass Parkway, Mile Point 0.00 to 5.82.

TABLE G1. Eastbound KY 9002, Hardin County Structural Assessment with FWD

Analysis Scenario	HMA Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
Mile Point 0.0 to 4.8, 10" HMA / 12" DGA				
MAX Value	2624	98	57	11
AVG Value	663	39	24	5
MIN Value	267	25	7	1
Mile Point 4.8 to 5.3, 17" HMA / 15" DGA – PaveTrac® Steel Reinforcement				
MAX Value	568	26	26	5
AVG Value	410	25	19	4
MIN Value	263	25	9	2
Mile Point 5.3 to 5.9, 15" HMA / 13" DGA – GlasGrid® Reinforcement				
MAX Value	498	50	81	16
AVG Value	429	28	30	6
MIN Value	334	25	16	3

TABLE G2. Westbound KY 9002, Hardin County Structural Assessment with FWD

Analysis Scenario	HMA Modulus (KSI)	DGA Modulus (KSI)	Subgrade Modulus (KSI)	Subgrade CBR (%)
Mile Point 5.9 to 5.3, 15" HMA / 13" DGA – GlasGrid® Reinforcement				
MAX Value	688	86	39	8
AVG Value	561	38	24	5
MIN Value	320	25	14	3
Mile Point 5.3 to 4.8, 17" HMA / 15" DGA – PaveTrac® Steel Reinforcement				
MAX Value	797	36	32	6
AVG Value	540	26	26	5
MIN Value	226	25	19	4
Mile Point 4.8 to 0.0, 10" HMA / 12" DGA				
MAX Value	1310	100	60	12
AVG Value	563	41	25	5
MIN Value	239	25	10	2

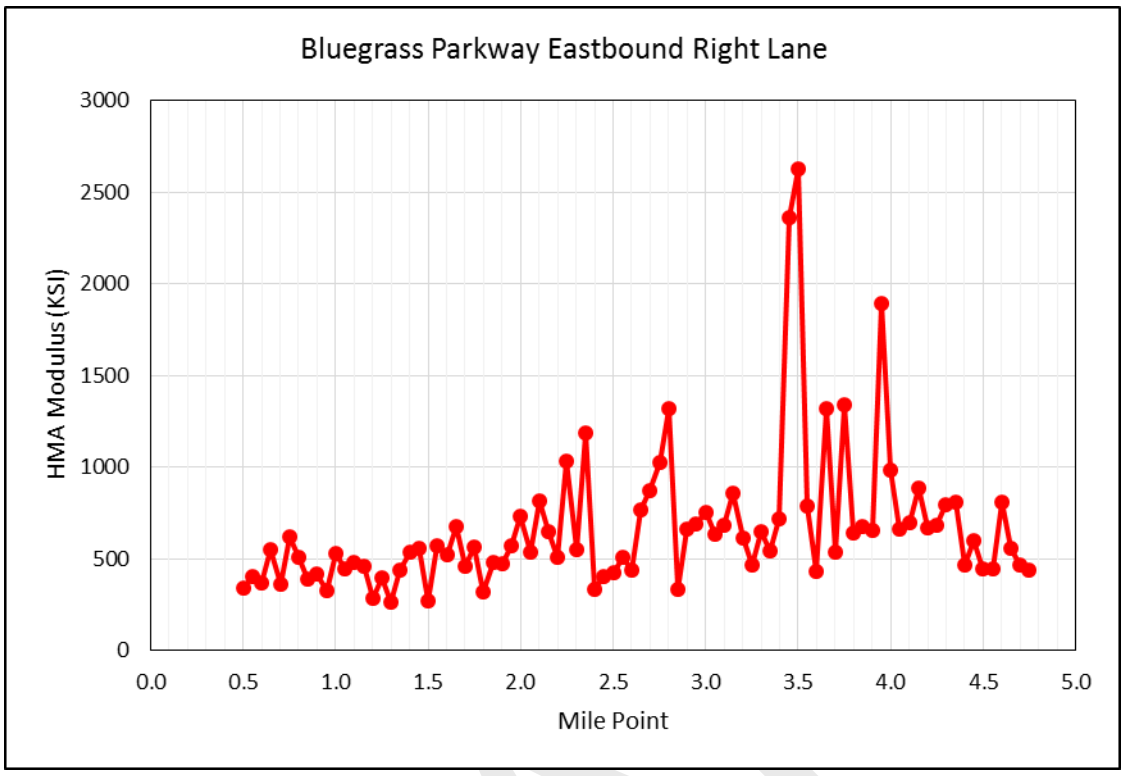


Figure G3. Back-calculated HMA moduli values for eastbound right lane, Bluegrass Parkway Mile Point 0.0 – 4.8.

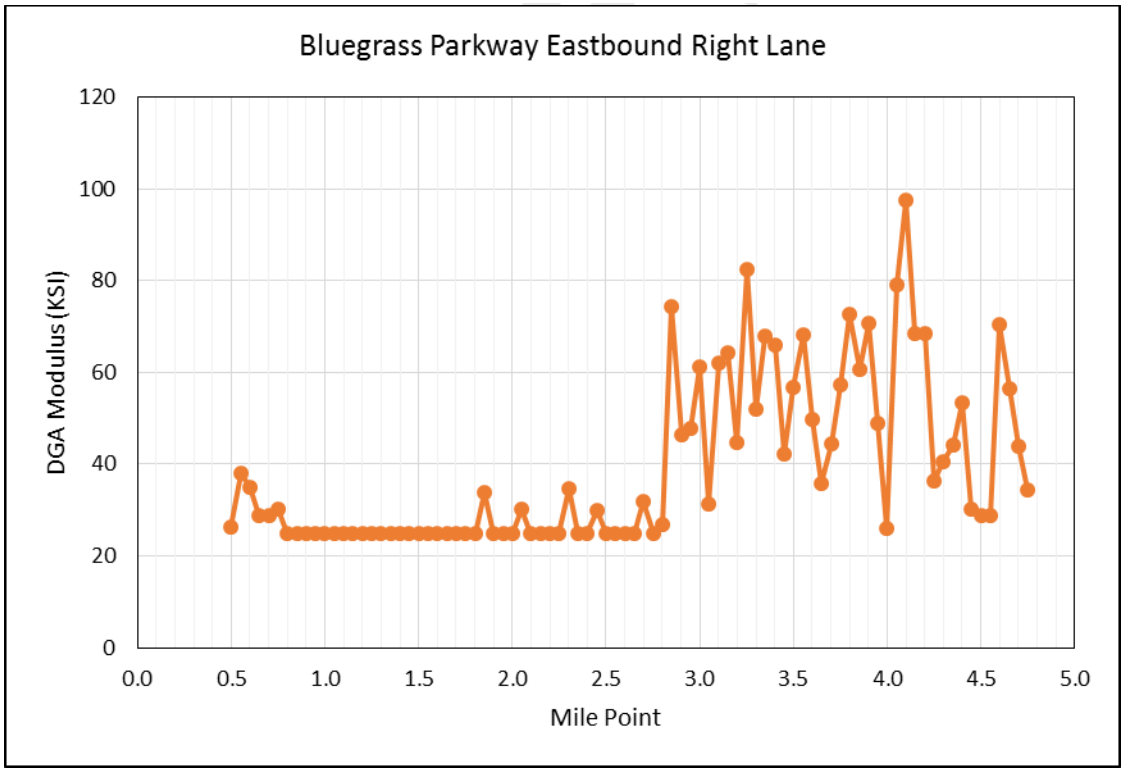


Figure G4. Back-calculated DGA moduli values for eastbound right lane, Bluegrass Parkway Mile Point 0.0 – 4.8.

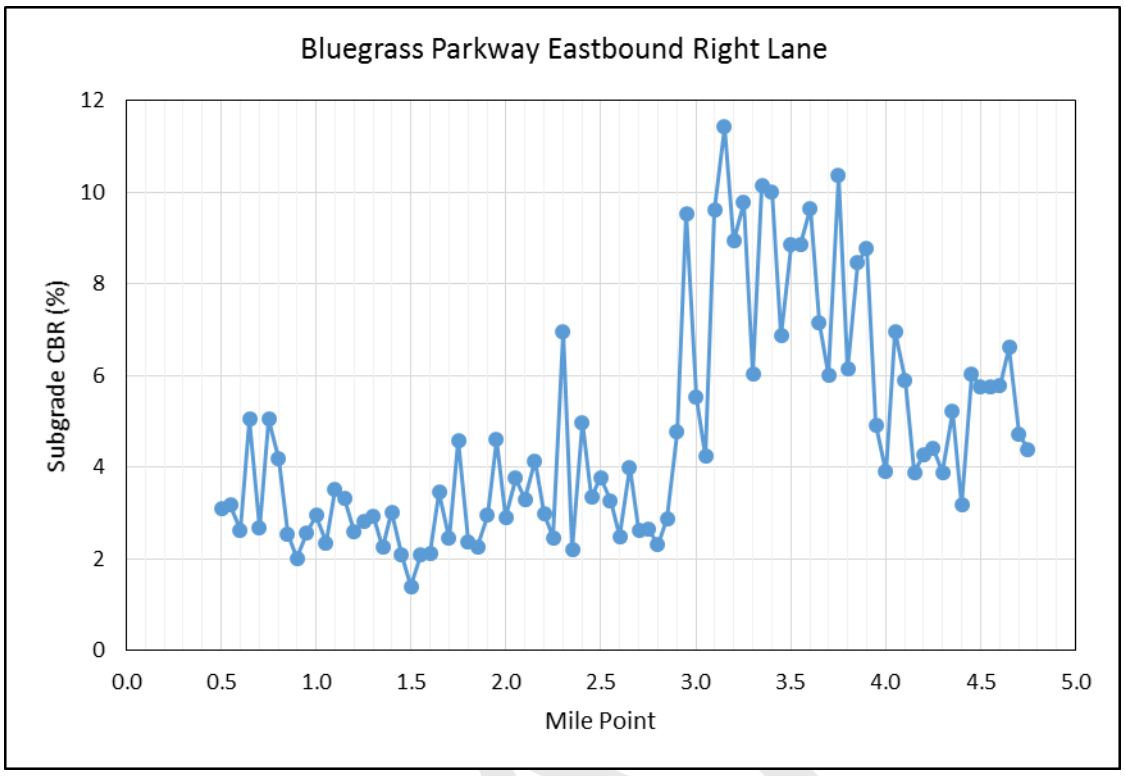


Figure G5. Back-calculated subgrade CBR values for eastbound right lane, Bluegrass Parkway Mile Point 0.0 – 4.8.

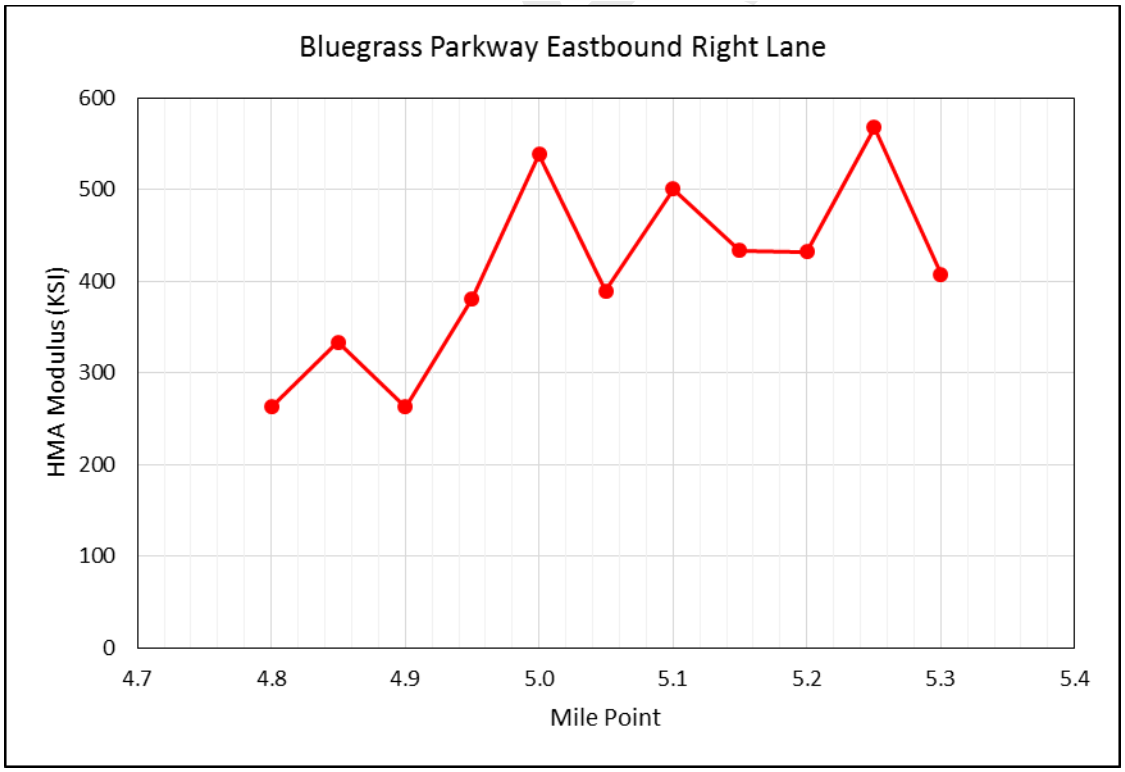


Figure G6. Back-calculated HMA moduli values for eastbound right lane, Bluegrass Parkway Mile Point 4.8 – 5.3.

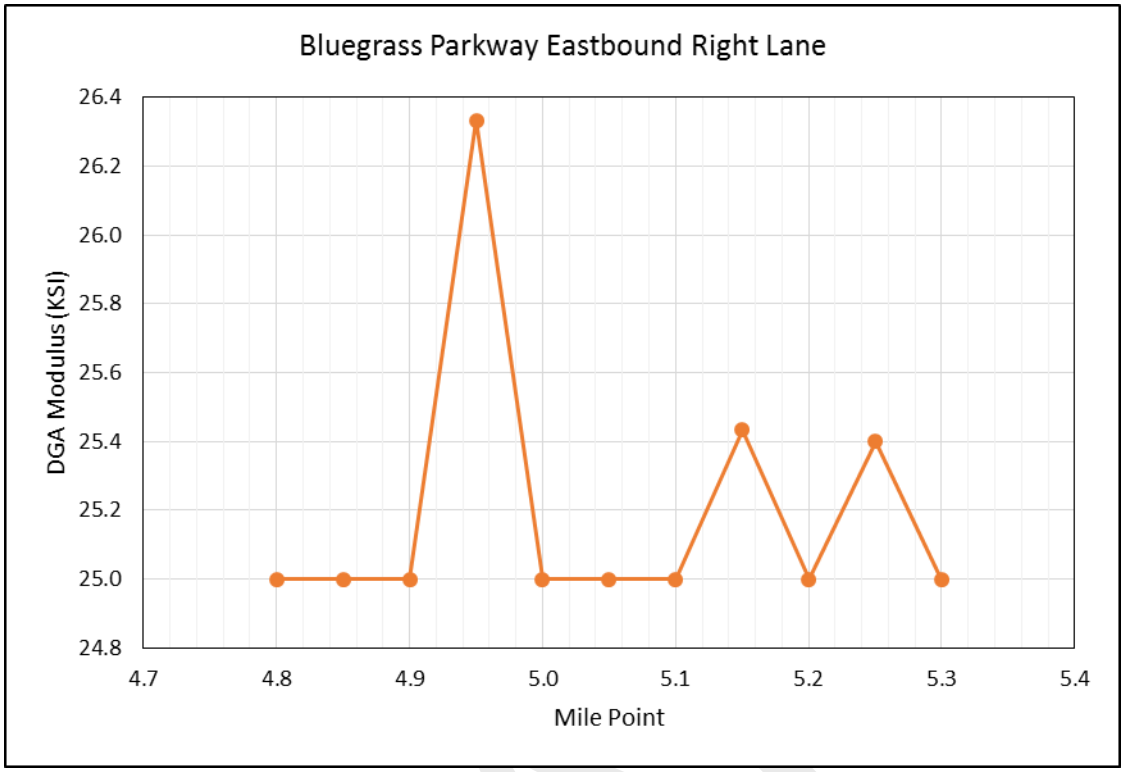


Figure G7. Back-calculated DGA moduli values for eastbound right lane, Bluegrass Parkway Mile Point 4.8 – 5.3.

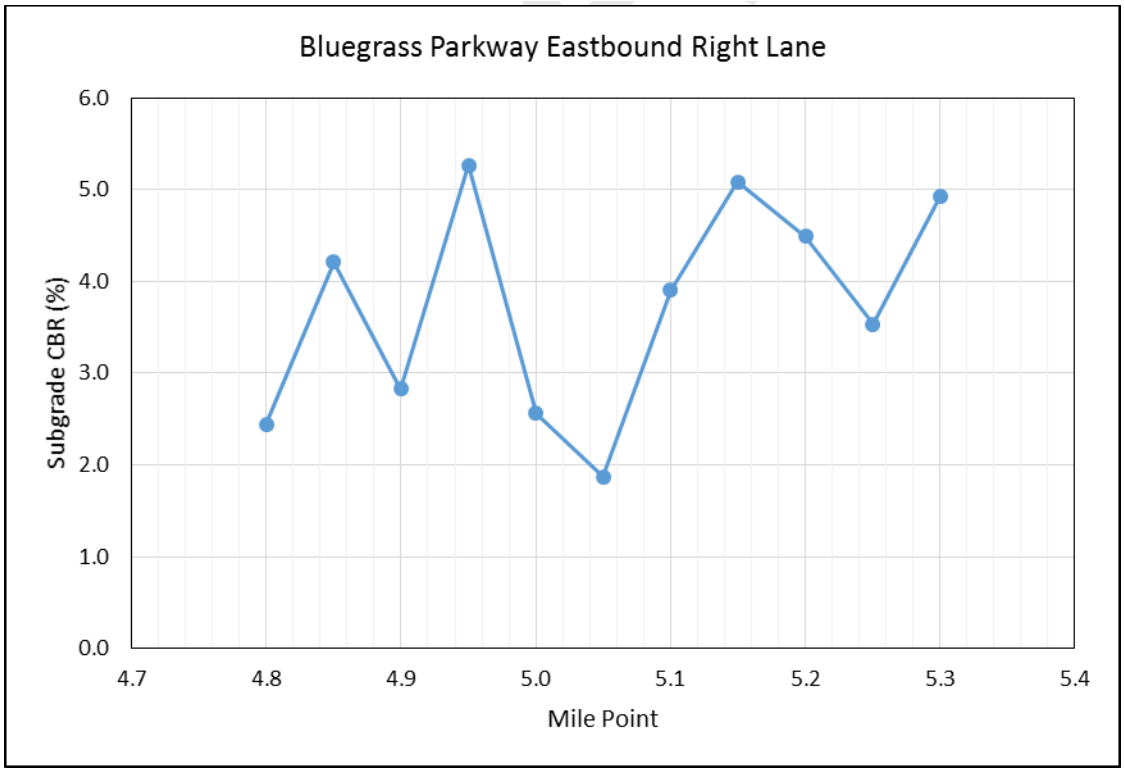


Figure G8. Back-calculated subgrade CBR values for eastbound right lane, Bluegrass Parkway Mile Point 4.8 – 5.3.

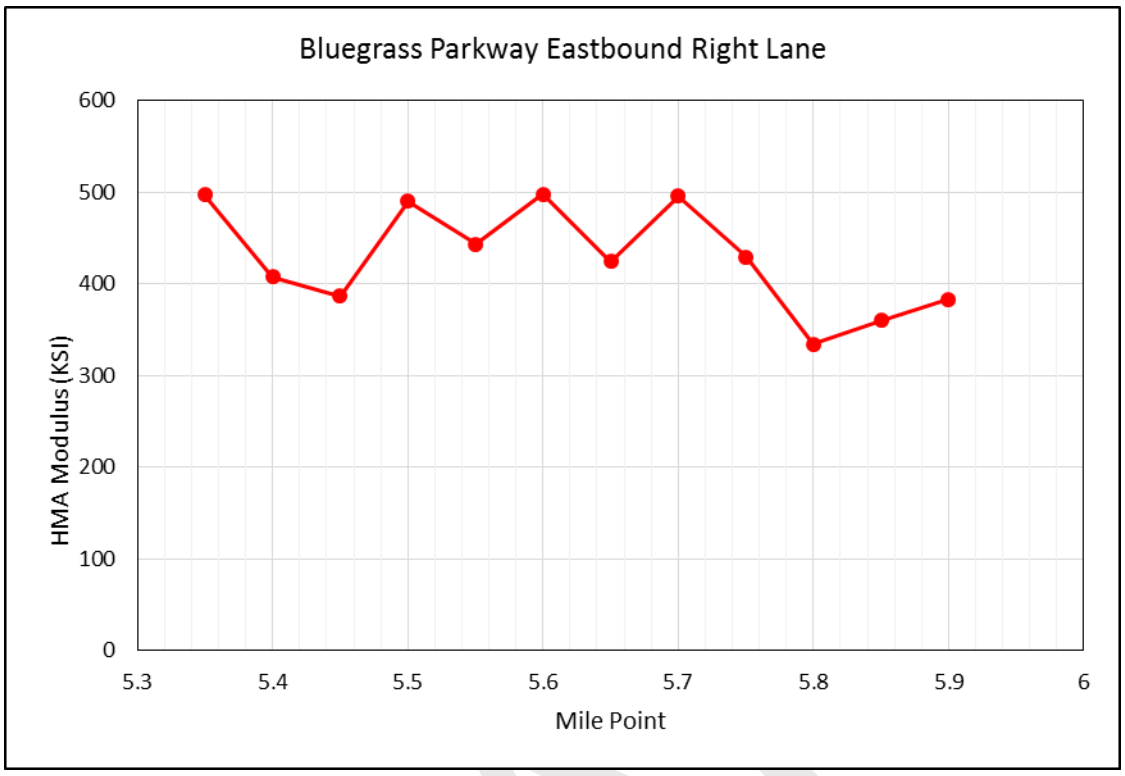


Figure G9. Back-calculated HMA moduli values for eastbound right lane, Bluegrass Parkway Mile Point 5.3 – 5.9.

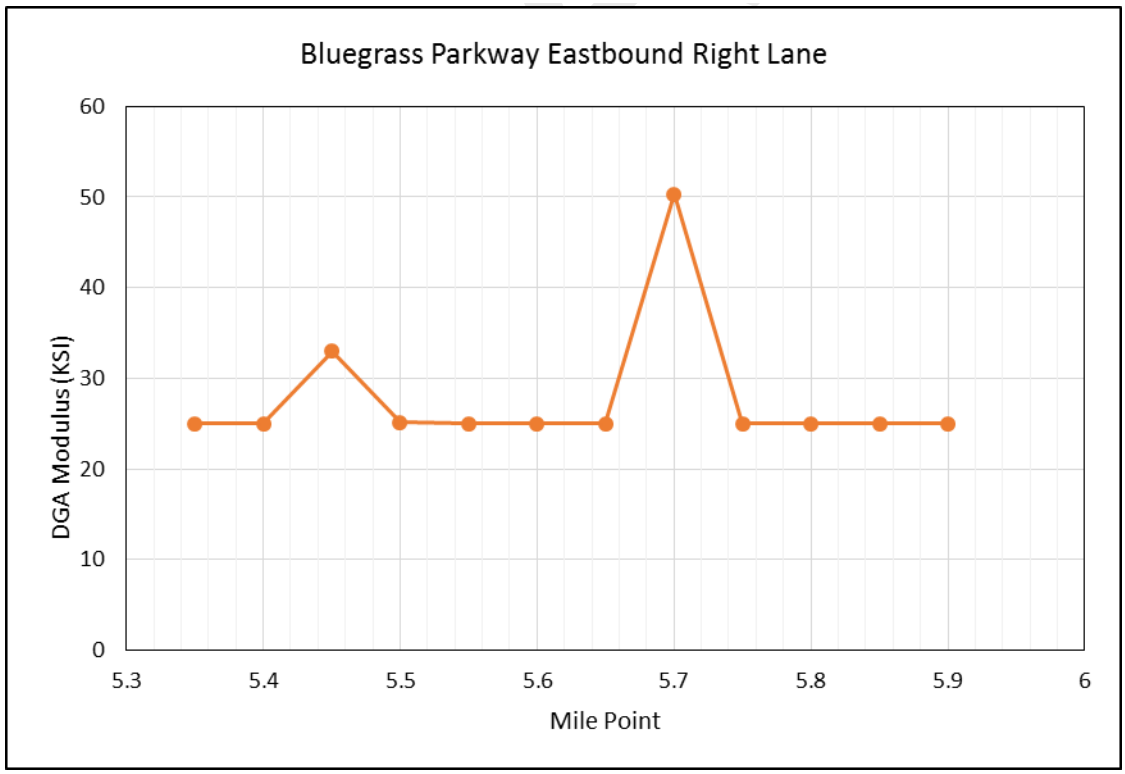


Figure G10. Back-calculated DGA moduli values for eastbound right lane, Bluegrass Parkway Mile Point 5.3 - 5.9.

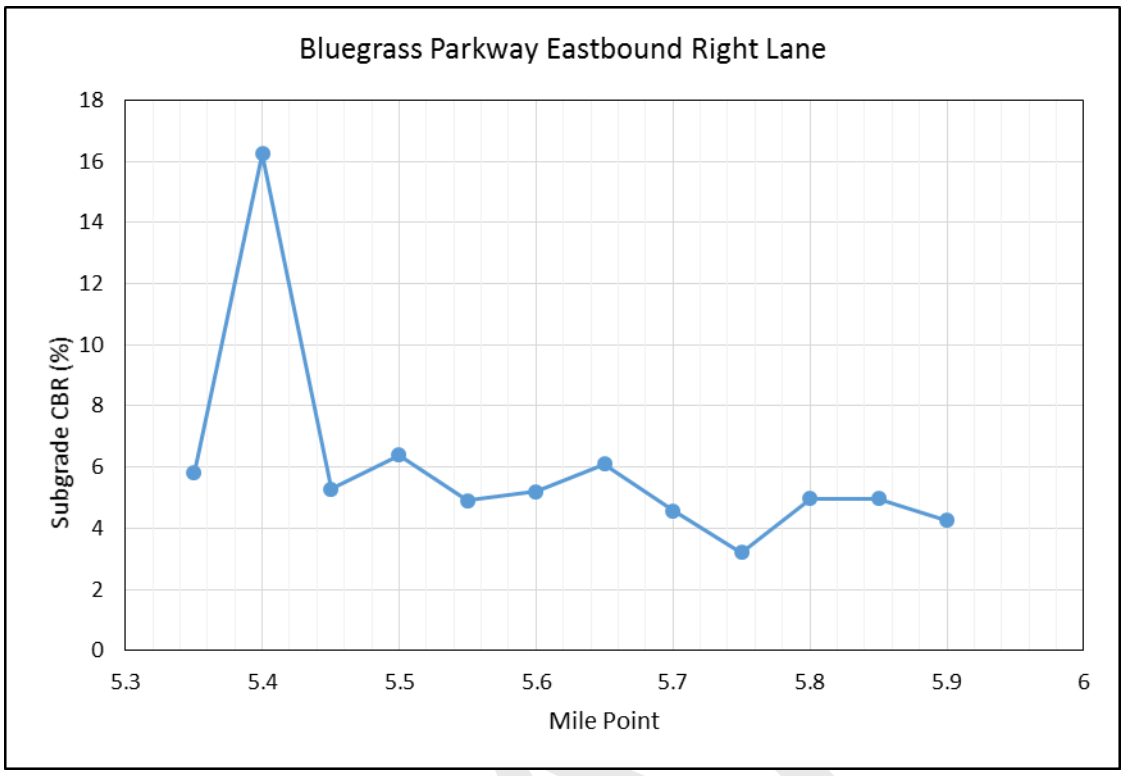


Figure G11. Back-calculated subgrade CBR values for eastbound right lane, Bluegrass Parkway Mile Point 5.3 - 5.9.

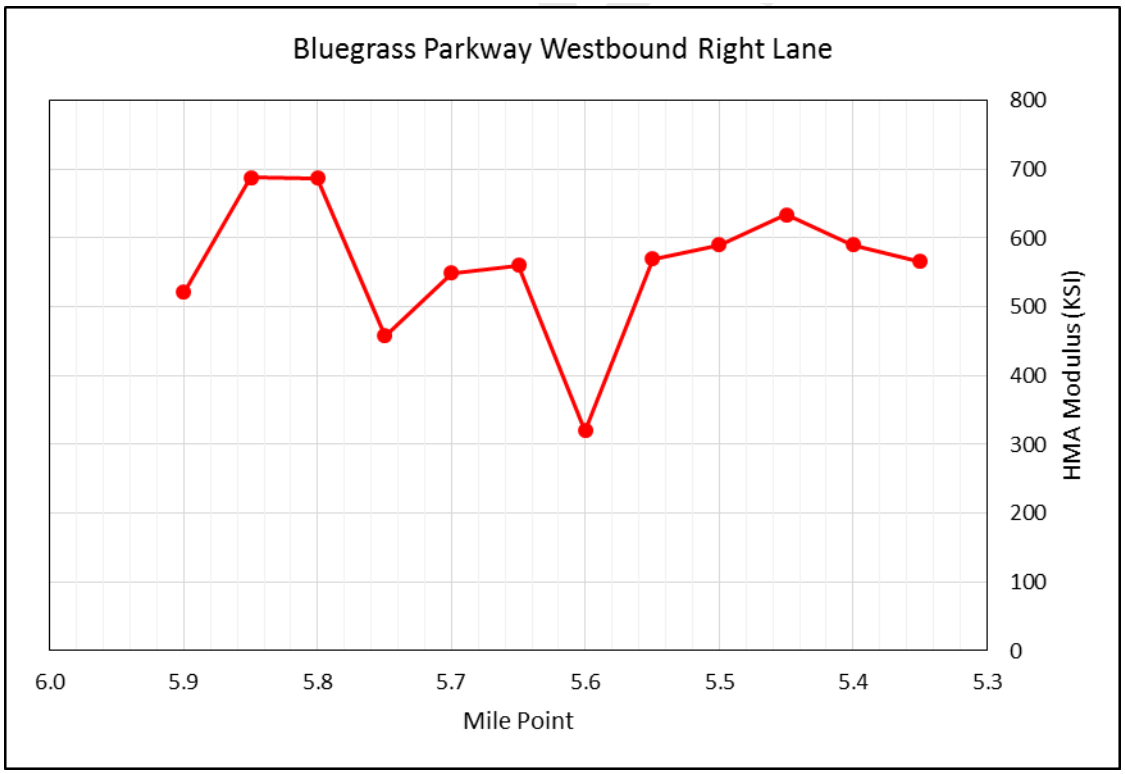


Figure G12. Back-calculated HMA moduli values for westbound right lane, Bluegrass Parkway Mile Point 5.9 - 5.3.

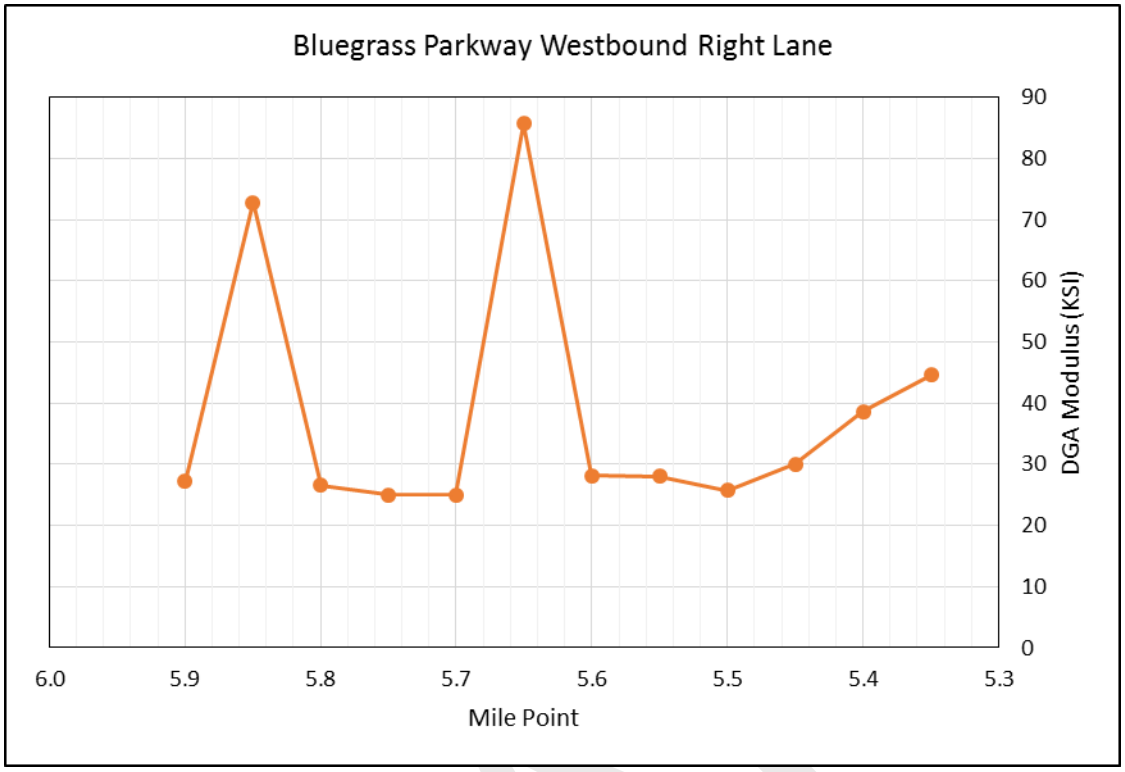


Figure G13. Back-calculated DGA moduli values for westbound right lane, Bluegrass Parkway Mile Point 5.9 - 5.3.

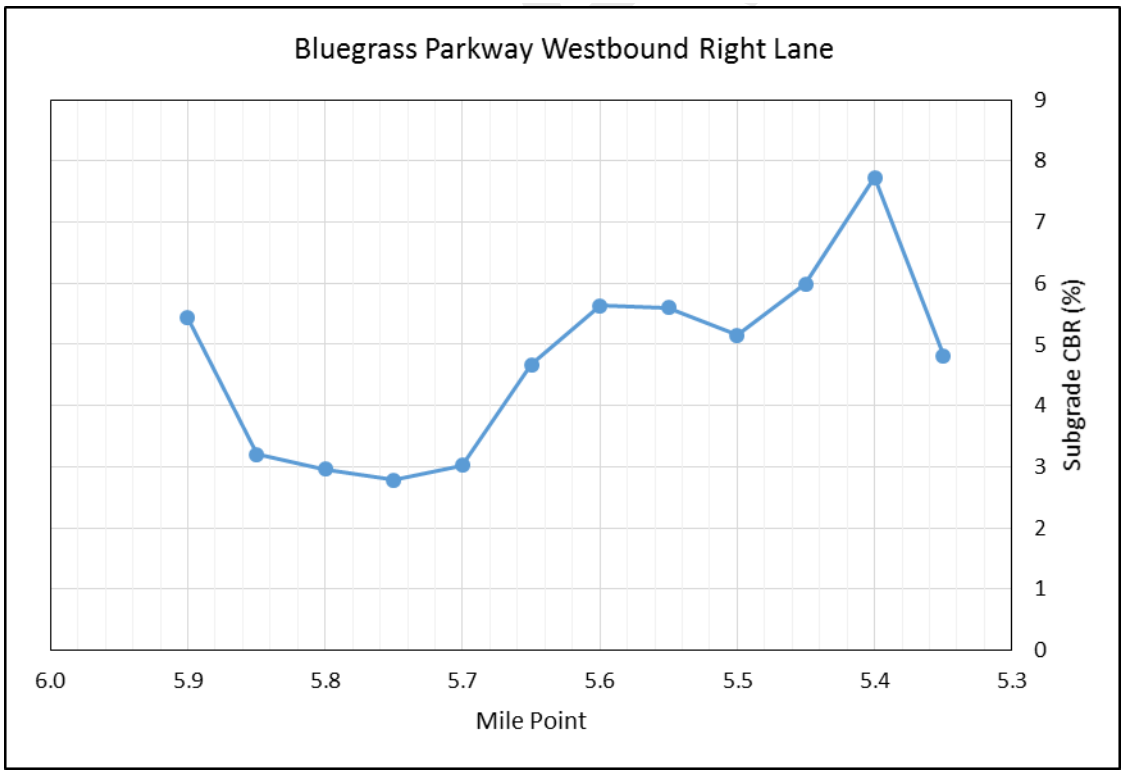


Figure G14. Back-calculated subgrade CBR values for westbound right lane, Bluegrass Parkway Mile Point 5.9 - 5.3.

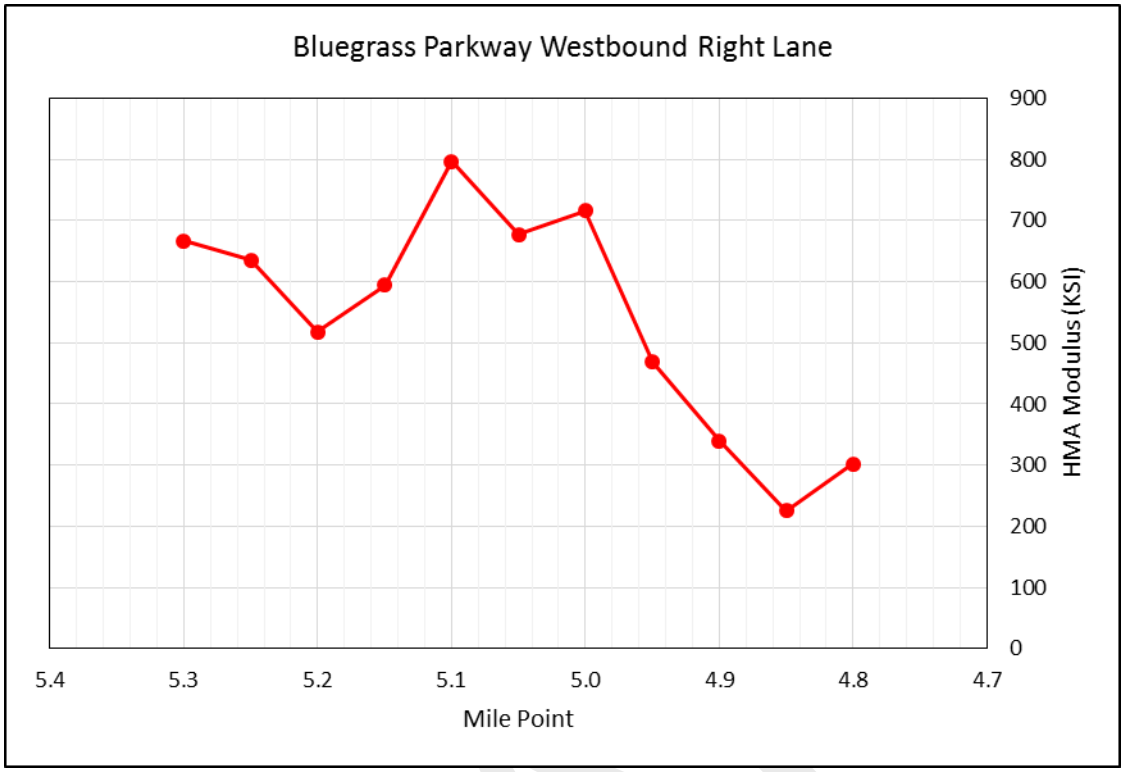


Figure G15. Back-calculated HMA moduli values for westbound right lane, Bluegrass Parkway Mile Point 5.3 – 4.8.

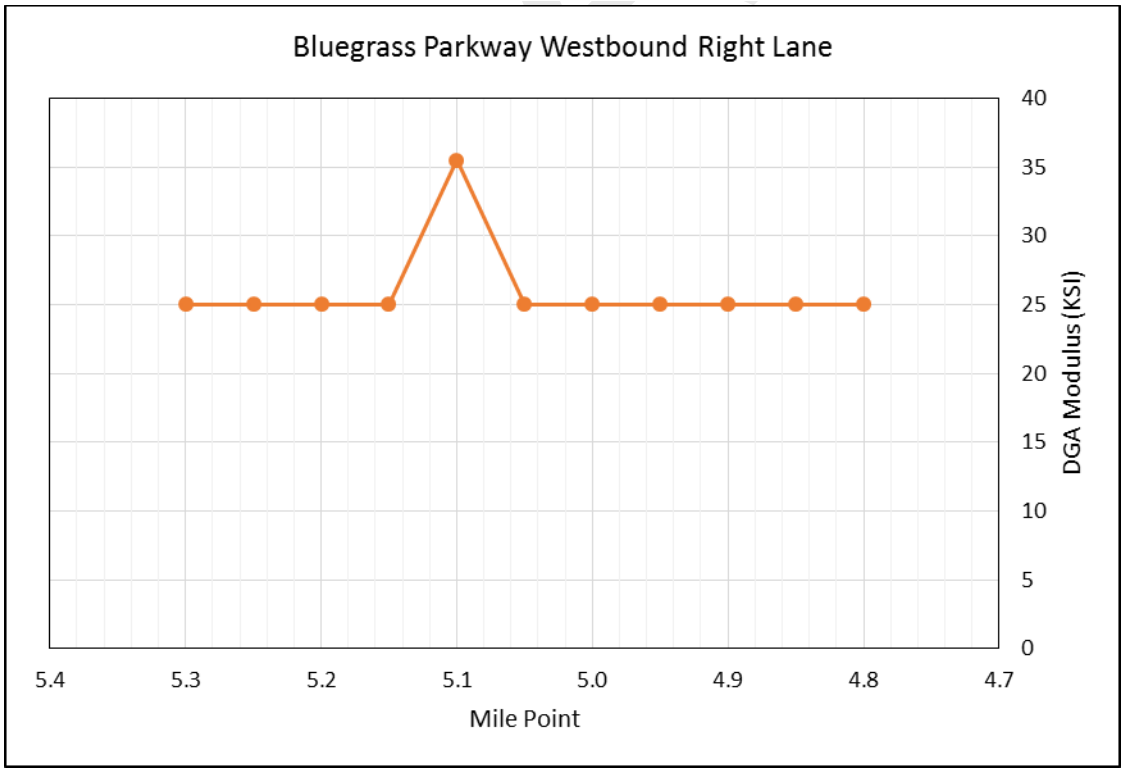


Figure G16. Back-calculated DGA moduli values for westbound right lane, Bluegrass Parkway Mile Point 5.3 - 4.8.

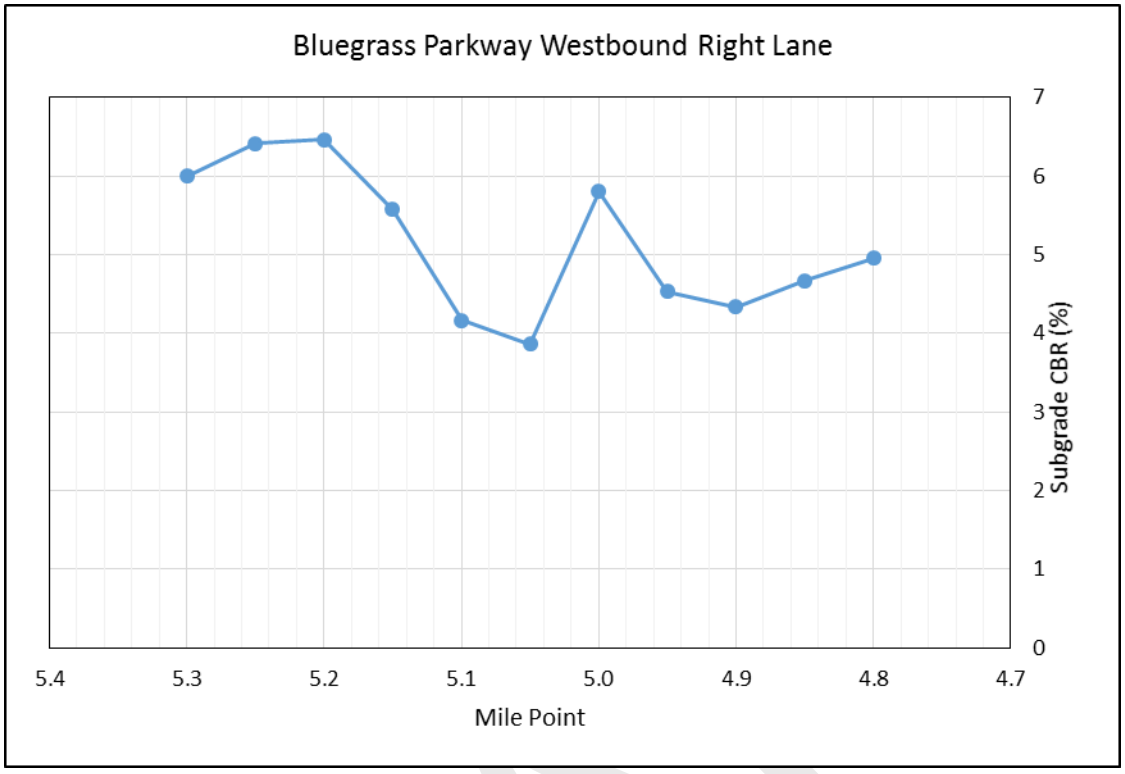


Figure G17. Back-calculated subgrade CBR values for westbound right lane, Bluegrass Parkway Mile Point 5.3 - 4.8.

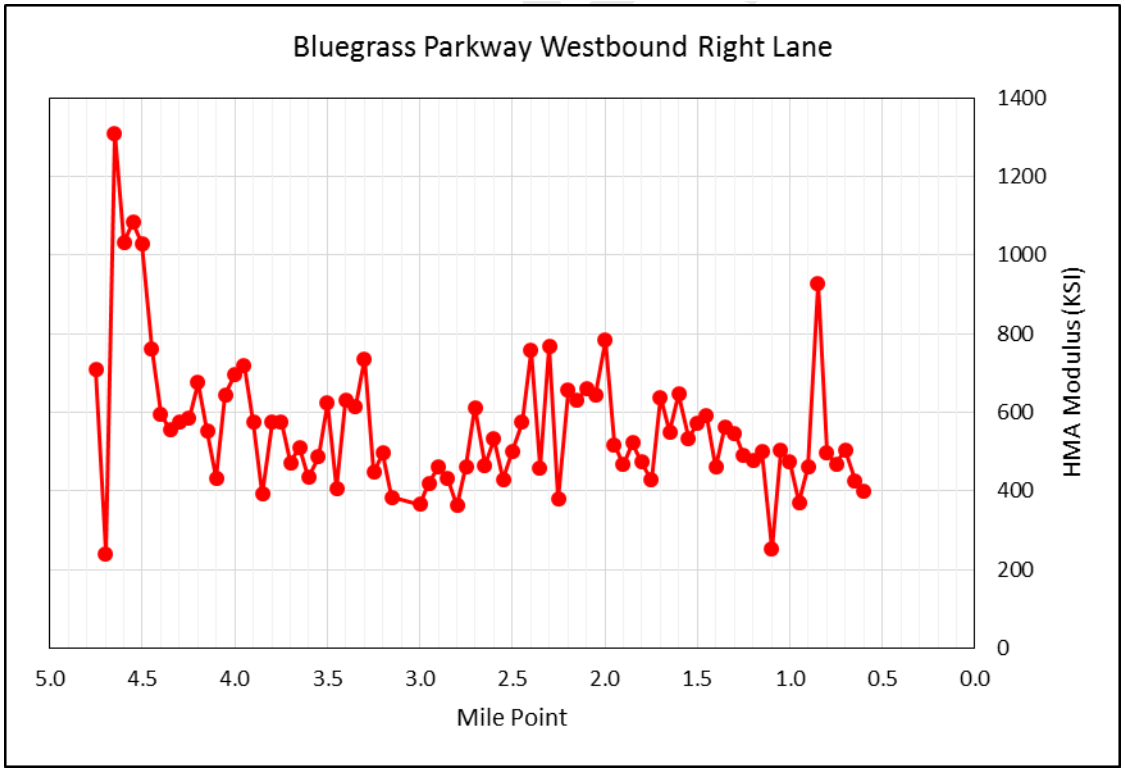


Figure G18. Back-calculated HMA moduli values for westbound right lane, Bluegrass Parkway Mile Point 4.8 - 0.0.

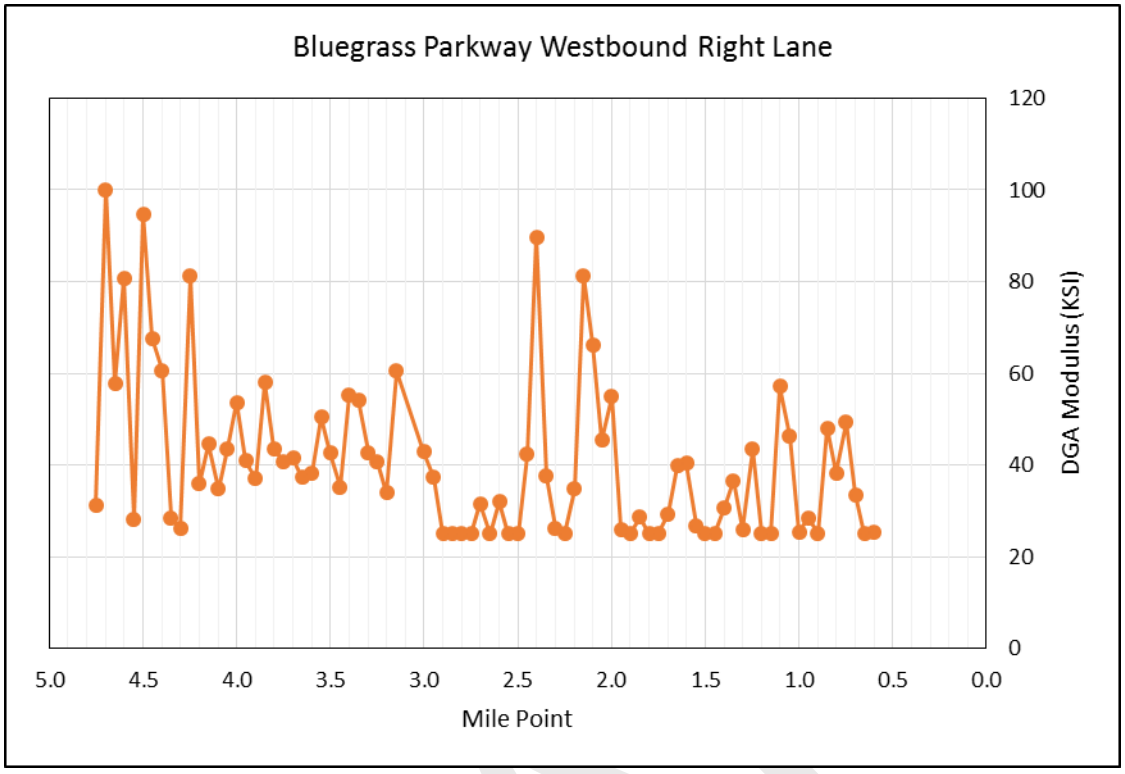


Figure G19. Back-calculated DGA moduli values for westbound right lane, Bluegrass Parkway Mile Point 4.8 - 0.0.

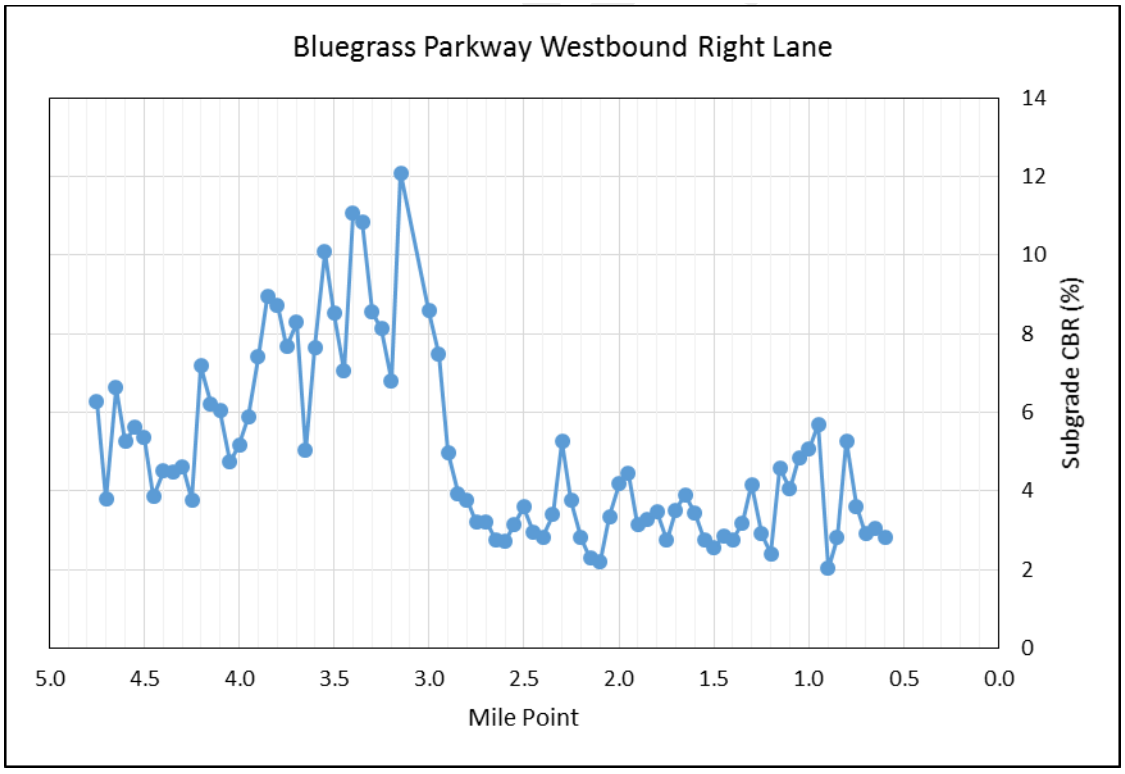


Figure G20. Back-calculated subgrade CBR values for westbound right lane, Bluegrass Parkway Mile Point 4.8 - 0.0.

TABLE G3. Core Extractions and Related Information – KY 9002 Eastbound, Hardin County

Core Site	Core Location	Core Purpose	Field Core Length (in.)	DGA Thickness (in.)	Depth of Moisture Content Sample (in.)	Subgrade Moisture Content (%)
EB1	MP 1.32	Wet/Calibration	10-3/4	13-3/4	28-1/4	20.9
EB2	MP 3.03	Thin Pavement	10-5/8	10-5/8	23-1/2	14.4
EB3	MP 3.46	Deep Layers	13	13-1/2	NA	NA
EB4	MP 4.51	Many Layers	10-1/8	14-7/8	27-1/4	16.1
EB5	MP 5.44	Thick HMA	15-1/2	10-1/2	27-1/2	17.7
Site EB3 had only 1-1/4 inch layer of subgrade soil before reaching rock material and no moisture content sample was collected.						

TABLE G4. Core Extractions and Related Information – KY 9002 Westbound, Hardin County

Core Site	Core Location	Core Purpose	Field Core Length (in.)	DGA Thickness (in.)	Depth of Moisture Content Sample (in.)	Subgrade Moisture Content (%)
WB1	MP 5.64	Deep Layers	15-1/2	11-1/2	30	14.8
WB2	MP 5.00	Pavetrac	17-3/8	15-5/8	34	14.6
WB3	MP 2.78	Dry Area	9-7/8	12-1/8	24	13.5
WB4	MP 2.10	Wet/Calibration	11	14	26-1/2	19.3
WB5	MP 0.70	Calibration	9-7/8	14-5/8	26	20.2
NOTES: Core locations for the westbound section were selected for the purpose shown. Core Site WB1 was selected based layer thickness. GlasGrid® was found ~ 4 inches from surface. Core Site WB2 was selected to investigate the presence of PaveTrac® metal reinforcement in the pavement structure.						

EB CORE 1
MP 1.32
AC 10 3/4"
DGA 13 3/4"
SOIL AT 24 1/2"

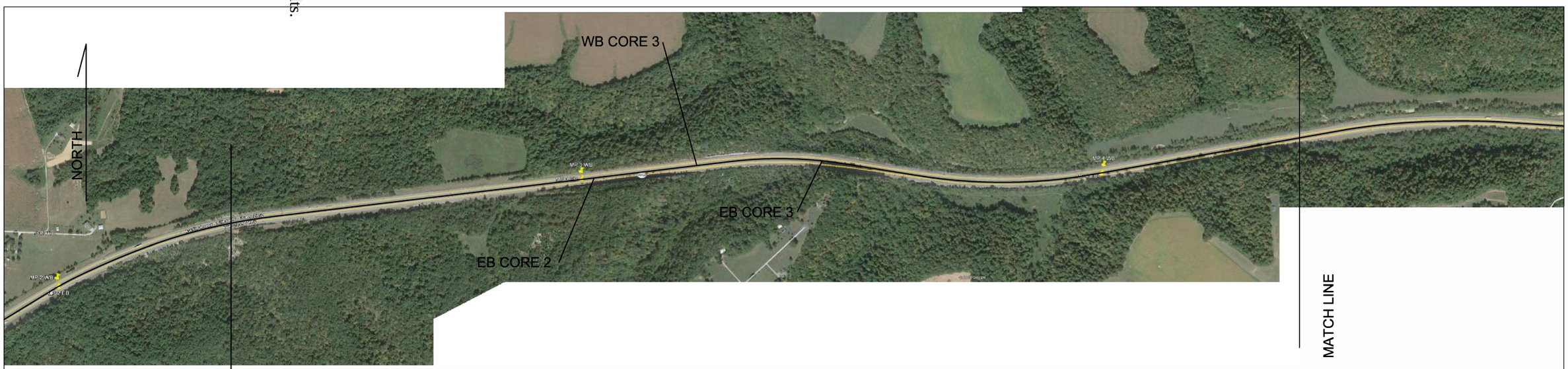
WB CORE 4
MP 2.10
AC 11"
DGA 14"
SOIL AT 25"

WB CORE 5
MP 0.70
AC 9 7/8"
DGA 14 5/8"
SOIL AT 24 1/2"

Figure G21. Core locations and results.

NOT TO SCALE	KY 9002 BLUEGRASS PARKWAY FORENSIC EVALUATION APPROX MP 0.0 TO 5.82	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 1 OF 3 DATE 10/24/16 DRAFTED TAJ

d results.

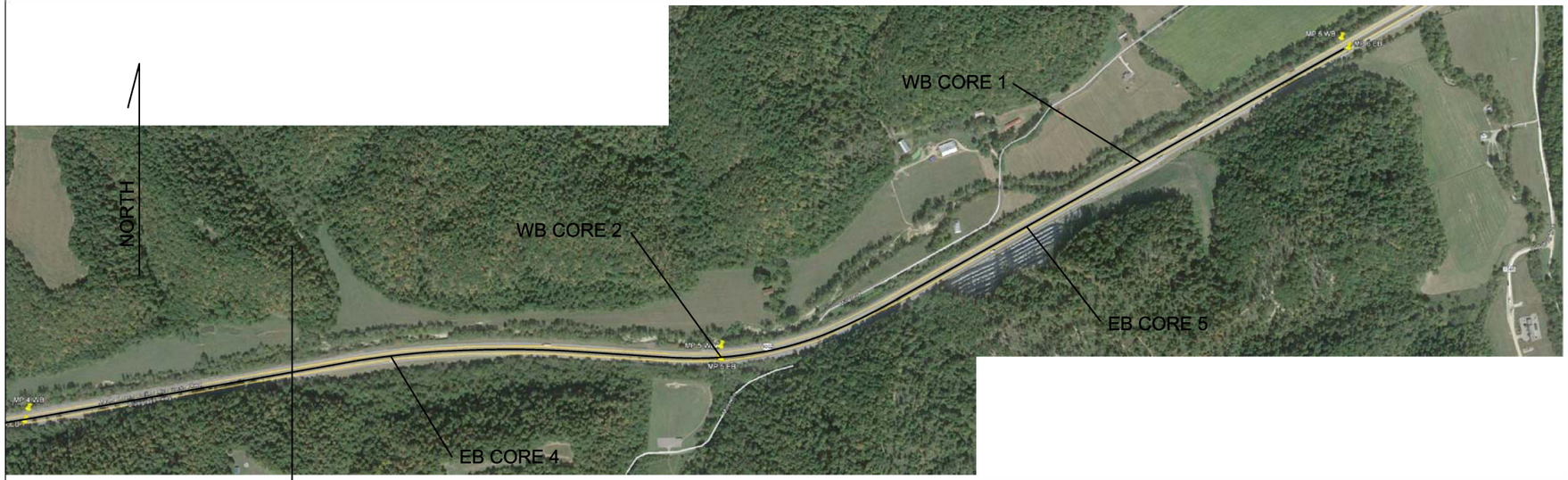


EB CORE 2
MP 3.03
AC 10 5/8"
DGA 10 5/8"
SOIL AT 21 1/4"

EB CORE 3
MP 3.46
AC 13"
DGA 13 1/2"
SOIL AT 26 1/2"

WB CORE 3
MP 2.78
AC 9 7/8"
DGA 12 1/8"
SOIL AT 22"

NOT TO SCALE	KY 9002 BLUEGRASS PARKWAY FORENSIC EVALUATION APPROX MP 0.0 TO 5.82	KENTUCKY TRANSPORTATION CENTER 176 RAYMOND BLDG LEXINGTON, KY 40505 859-257-4513	SHEET 2 OF 3 DATE 10/24/16 DRAFTED TAJ



MATCH LINE

EB CORE 4
MP 4.51
AC 10 1/8"
DGA 14 7/8"
SOIL AT 27 1/4"

EB CORE 5
MP 5.44
AC 15 1/2"
DGA 14 7/8"
SOIL AT 12.75"

WB CORE 1
MP 5.64
AC 15 1/2"
DGA 11 1/2"
SOIL AT 27"

WB CORE 2
MP 5.00
AC 17 3/8"
DGA 15 5/8"
SOIL AT 33"

NOT
TO
SCALE

KY 9002 BLUEGRASS PARKWAY
FORENSIC EVALUATION
APPROX MP 0.0 TO 5.82

KENTUCKY TRANSPORTATION CENTER
176 RAYMOND BLDG
LEXINGTON, KY 40505
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SHEET 3 OF 3
DATE 10/24/16
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