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Department Memorandum

Idaho Transportation Department

ITD 0500 (Rev. 07-17)
itd.idaho.gov

DATE: January 17, 2023

Program Number(s) A022(210)

&TO: JESSE BARRUS, P.E
DE 4

Key Number(s) 22210

FROM: LYNN WHITE, P.E.
MTLS E4

Program ID, County, Etc. US-93, MAIN ST,
KETCHUM, BLAINE CO
WA P204360

RE: FINAL ROADWAY MATERIALS REPORT (Materials Phases I(R)-II-III)

Your approval of the Final Roadway Materials Reports report is requested.

The scope of this project is the rehabilitation of SH-75 from MP 128.2 to MP 129.7. This report was prepared before the project was funded and assigned an official name. Therefore, the key number and project name on the report cover is different.

The report was prepared by Shannon Wilson (Formerly "*American Geotechnics*"), and is dated November 27, 2019.

Approval Recommended by

District Materials Engineer	1-17-2023 Date

Report Approved by:

Scott Malone Digitally signed by Scott Malone
Date: 2023.01.26 13:18:06 -07'00'

District Engineer	Date

Roadway Materials Report

(Materials Reports Phases I(R)-II-III)

State, FY19 D4 Materials Reconnaissance

(SH-75, River St to Clubhouse Dr)

Ketchum, Blaine Co., Idaho

ITD Key No. 18815

Prepared for:

Idaho Transportation Department

November 27, 2019

03224

November 27, 2019
File No 03224

Idaho Transportation Department, District 4
216 South Date St.
Shoshone, ID 83352

Attention: Lynn White, P.E.

Roadway Materials Report

Materials Reports Phases I(R)-II-III

State, FY19 D4 Materials Reconnaissance

(SH-75, River St to Clubhouse Dr)

Ketchum, Blaine Co., Idaho

ITD Key No. 18815

Prepared by:

American Geotechnics

PROFESSIONAL ENGINEER REGISTERED 4/27/2019 7042 STATE OF IDAHO REX WILLIAM HANSEN

Rex W. Hansen, P.E.
Geotechnical Engineer

Mart E. Earl, WAQTC
Sr. Geotechnical Technician

November 27, 2019

Table of Contents

Appendices

November 27, 2019

100.00 SUMMARY

100.01 Pavement Report

This pavement report includes the following sections prepared in general accordance with the *Idaho Transportation Department (ITD) Materials Manual* (ITD 2019).

- **Section 100 Summary**, offering an overview of the investigation
- **Section 540 Pavement Structure Analysis**, covering detailed engineering and economic considerations for the roadway rehabilitation
- **Section 230 Soils**, covering soil and rock conditions along the length of the project and geotechnical recommendations that may affect the project development
- **Section 240 Pavement Estimating**, identifying materials and providing estimating data necessary to develop plan quantities and cost estimates

This report covers the essential roadway components of the ITD Phase I(R), II, and III materials investigations process for development of a pavement rehabilitation strategy.

100.02 Purpose and Scope

This Pavement Investigation Report describes American Geotechnics' observations, field explorations, laboratory testing, and materials recommendations for about 1.5 miles of SH-75 from River St (Mile Post (MP) 128.2) to Clubhouse Dr (MP 129.7) in Ketchum, Idaho. Appendix A includes a vicinity map, site photographs, pavement condition survey, and a geologic map.

ITD classifies this segment of SH-75 as a rural minor arterial. The posted speed limit is 25 mph within the City limits and up to 65 mph beyond the City limits. The roadway consists of two to four lanes with intermittent curb, gutter, guardrail, parking, sidewalks, and residential approaches, which are mostly within the City of Ketchum. The existing lanes are 12 feet wide and are asphalt concrete (AC). Additionally, there are existing 8-foot wide parallel parking adjacent to the existing curb between River St and 10th St. The shoulder widths vary throughout the project.

Due to the resort culture demanding minimal construction duration and minimal impact to the public, CRABS unacceptable rehabilitation alternative. Portland Cement Concrete replacement reconstruction is also unacceptable because of long cure time, poor detour route, and white concrete taking longer for snow to melt.

100.03 Summary of Recommendations

The project was divided into two segments because the existing FWD was only collected in SH-75 from River St to Saddle St. Thus, this SH-75 project was separated into Segment 1: River St (MP 128.2) to Saddle Rd (MP 129.3) and Segment 2: Saddle Rd (MP 129.3) to Clubhouse Dr (MP 129.7) where FWD was not collected. The design alternatives evaluated for each segment include:

- Full-Depth Asphalt Concrete Removal and Replacement
- Flexible Reconstruction

Based on the benefits listed in Section 540.05 Recommendations, American Geotechnics recommends ***Full-Depth AC Removal and Replacement*** for this project. This alternative includes the full removal of the existing AC, supplementing the existing base layer with new untreated aggregate base material as needed, and then tight grading and compacting to the required final base layer lines and grades, and placement of the new HMA surface course. Based on the analyses using AASHTOWare Pavement ME software, the anticipated service interval for this design alternative is 20 years. The following tables summarizes the design recommendations for this alternative.

Recommended Full-Depth AC Removal and Replacement (River St to Saddle Rd) Design (20-Year Analysis)	
Pavement Design Element	**Thickness (feet)**
Remove Existing AC (Average)	0.57
HMA (PG 70-34)	0.50
¾" Untreated Aggregate Base, Type "B" (leveling course)	0.07 (1)
Average Undisturbed Existing Base/Subbase	0.71
Estimated Rise in Existing Roadway Profile	0.00
[1] 0.07 is the average leveling course thickness. The leveling course thickness may range from 0.00 feet to 0.50 feet thick.	

Recommended Full-Depth AC Removal and Replacement (Saddle Rd to Clubhouse Dr) Design (20-Year Analysis)	
Pavement Design Element	**Thickness (feet)**
Remove Existing AC (Average)	0.79
HMA (PG 70-34)	0.50
¾" Untreated Aggregate Base, Type "B" (leveling course)	0.29 (1)
Average Undisturbed Existing Base/Subbase	1.06
Estimated Rise in Existing Roadway Profile	0.00
[1] 0.29 is the average leveling course thickness. The leveling course thickness may range from 0.07 feet to 0.64 feet thick.	

November 27, 2019

540.00 PAVEMENT STRUCTURE ANALYSIS

540.01 Introduction

See Section 100.02 Purpose and Scope.

540.02 Methodology

Mechanistic-Empirical (ME) analyses and ITD design methodology (ITD 2014, 2015) were used to evaluate the existing pavement layers and design the rehabilitation recommendations.

The ME approach for this project was coupled with pavement borings, pavement deflection measurements from a falling weight deflectometer (FWD) and ground imaging from ground-penetrating radar (GPR).

540.03 Existing Pavement Conditions

Site Geology

The project area lies within the alluvial gravel deposits mapped as “Gravel terrace deposits of Big Wood River (Pleistocene)” and “Gravel deposits of side streams (Pleistocene)” in 2006 by the Idaho Geological Survey (Breckenridge and Othberg). The fluvial channel gravels are described as pebbly and cobbly, sandy gravels, sub angular to rounded clasts, deposited as glacial outwash. Finer surface material deposited from slope processes and smaller tributaries need to be identified. Appendix A contains a geological map for the area.

Construction History

According to ITD records, this segment of SH-75 was originally constructed in 1934. This project’s roadway segment was overlaid in 1975 and 1992. A minor widening project was also done in 1992. There have been multiple maintenance interventions done on the roadway, with the last seal coat applied in 2011.

Visual Pavement Distress Survey

American Geotechnics performed a pavement distress survey for the project in July 2019, to identify pavement distresses in general accordance with the FHWA *Distress Identification Manual for the Long-Term Pavement*

Performance Program (FHWA 2014). The following table presents the dominant distresses observed during the visual pavement distress survey.

2019 Dominant Pavement Distresses		
Distress Type	**Severity**	**Notes**
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	Low to Med	10 to 90% of wheel path length; open and sealed cracks
Longitudinal Cracking – Non Wheel Path	Low to Med	10 to 90% of line length; open and sealed cracks
Transverse Cracking	Low to High	Spaced at 20- to 100-foot intervals; open and sealed cracks
Surface Deformation		
Bleeding	Med	In the wheel path
Rutting	Med to High	Depths from ½" up to 2"
Patching	Low to Med	Up to 15% of the wheel path

ITD Pavement Condition Survey

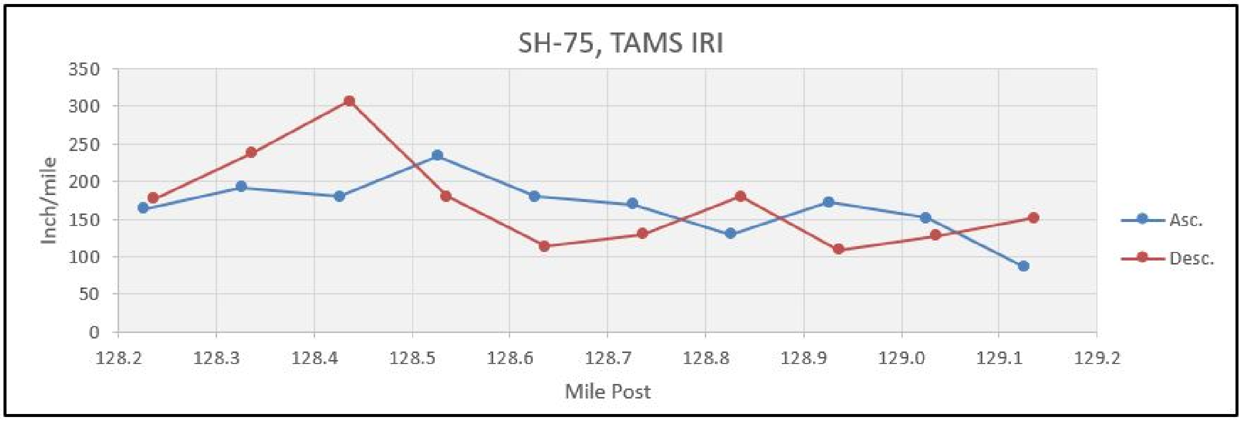
Standardized pavement surface condition indices are routinely recorded along Idaho roadways describing pavement cracking, roughness, and rutting (ITD 2012), as part of ITD's Transportation Asset Management System (TAMS). The indices provide evidence to pavement engineers as to possible underlying causes of pavement failure. The tables below list ITD index threshold values (ITD 2017, *Pavement Performance Report*) for highway roads and the 2018 ITD TAMS data.

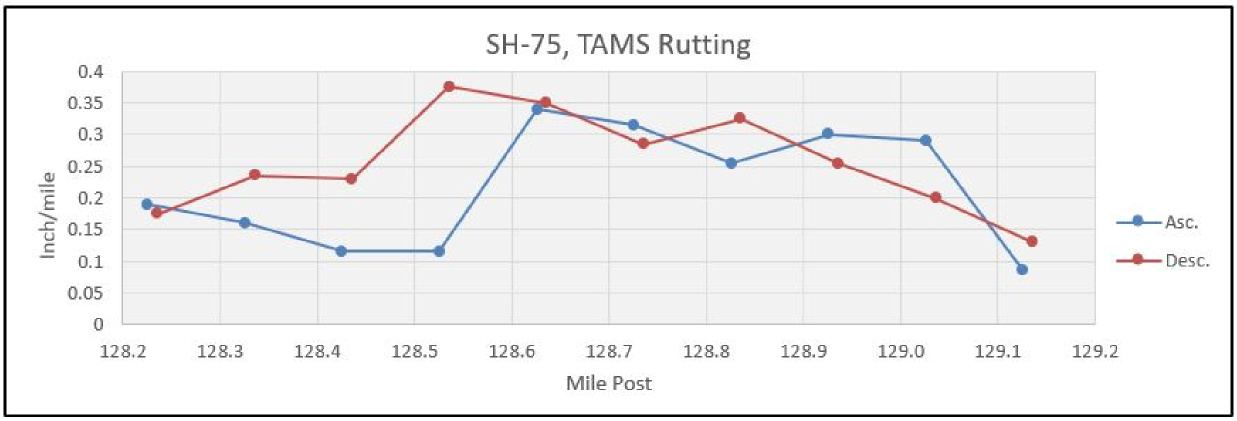
The ITD index threshold values indicate the project roadways have good to poor cracking, roughness is poor, and rutting is fair in the left wheel path and good in the right wheel path.

Pavement Condition Thresholds for ITD Highways (Flexible Pavement)			
Pavement Condition	Thresholds		
	Cracking Index	Roughness Index	Rutting
Good	> 3.0	> 3.0	0.00" to 0.24"
Fair	2.5 to 3.0	2.5 to 3.0	0.25" to 0.49"
Poor	2.0 to 2.49	2.0 to 2.49	0.50" to 0.74"
Very Poor	< 2.0	< 2.0	≥0.75"

2018 TAMS Data				
Roadway Segment	Cracking Index (CI)	Roughness Index [1] (RI)	Rutting (in.)	
			Left WP	Right WP
MP 128.22 to 128.54	3.50	2.19	0.32 in.	0.11 in.
MP 128.54 to 129.12	2.00	2.14	0.39 in.	0.12 in.
MP 129.12 to 132.00	2.00	2.95	0.20	0.06

[1] The following equation was used to convert International Roughness Index (IRI) data to ITD Roughness Indices (RI): RI=0.8722 e^(0.3863*5.075e^(-0.00455*IRI).





Based on the above thresholds values and the TAMS data, the existing pavement surface classifies as “Poor.”

Borings

Seven roadway borings spaced from 500 feet to about 2,300-foot apart in the southbound lane were advanced to a depth of about 6 feet using the American Geotechnics drill rig. The purposes of the borings were twofold:

1. Provide an opportunity to examine the condition and quality of the buried materials and the nature of the native subgrade
2. Identify the near-surface bedrock or ground water, if encountered

Appendix B contains an Exploration Location Map, together with the boring logs and AC core photographs.

Bedrock was not encountered in any of the borings and groundwater was not encountered at the time of drilling.

The boring logs were updated to include laboratory ASTM classification information. Laboratory test reports are in Appendix C.

Project Segmentation

The project roadway was divided into two segments because FWD was only collected in SH-75 from River St to Saddle St. Thus, this SH-75 project was separated into Segment 1: River St (MP 128.2) to Saddle Rd (MP 129.3) where FWD was collected and Segment 2: Saddle Rd (MP 129.3) to Clubhouse Dr (MP 129.7) where FWD was not collected.

GPR Pavement Structure Layer Imaging

American Geotechnics collected ground penetrating radar (GPR) images on June 6, 2019, to supplement boring explorations. A short-pulse GPR imaging system was used in general accordance with ASTM D4748 (2006). The components of the American Geotechnics GPR system include a controller and two antennas. The 2 GHz antenna is especially suited for collecting detailed data in the upper 24 inches of the pavement structure. The 400 MHz antenna was set to collect data to 5 feet below the pavement surface for project-level design.

To assess pavement layer thicknesses and variability in the project roadway segment, the GPR data, when tied to the subsurface boring measurements, enabled a substantial understanding of the variability of the roadway pavement structure layers. Pavement structure layer data was evaluated from scans obtained at 4-inch intervals along the length of the roadway, with 512 samples per scan. As a result, this investigation provided over 12.1 million sample data points for this project. The following table summarizes the GPR results.

Pavement Layer Statistics using GPR				
Layer	Thickness (feet)			
	Minimum	Mean	Maximum	Standard Deviation
Segment 1. SH-75, River St to Saddle Rd (MP 128.2 to MP 129.3)				
AC	0.25	0.57	1.07	0.13
Base	0.02	0.18	0.60	0.08
Subbase	0.01	0.52	1.33	0.18

Pavement Layer Statistics using GPR				
Layer	Thickness (feet)			
	Minimum	Mean	Maximum	Standard Deviation
Segment 2. SH-75, Saddle Rd to Clubhouse Dr (MP 129.3 to MP 129.7)				
AC	0.57	0.79	1.14	0.11
Base	0.03	0.16	0.43	0.04
Subbase	0.05	0.90	1.38	0.25

Appendix D contains the GPR results for the existing pavement structure profile and statistics.

The GPR layer thicknesses were used as part of ME based analyses to backcalculate pavement structure layer moduli or stiffness at each FWD test location.

FWD Deflections and Layer Moduli

ITD provided the project's FWD deflection data with tests performed at approximately 250-feet intervals in both the ascending (northbound) and the descending (southbound) travel lanes' outside wheel path on September 5, 2019. After reviewing the deflection data and anticipated truck load limits, American Geotechnics selected the 12,000-lb drop load from each test sequence for analyses. All deflections were normalized to the 12,000-lb target load.

ELMOD6 software was used to facilitate the backcalculation of elastic moduli for the existing pavement layers. The following table shows the backcalculated moduli of the existing pavement structure. Appendix D includes the ELMOD backcalculation results.

Backcalculated Layer Elastic Moduli for Existing Pavement Layers				
Layer	Ascending. Mean (ksi)	Descending Mean (ksi)	Average (ksi)	Average Standard Deviation
AC (1)	334.7	385.8	360.3	190.4
Base/Subbase	32.4	34.8	33.6	17.9
Subgrade	18.6	21.2	19.9	7.7
[1] Adjusted to Reference Condition (70º F).				

In all, the backcalculation results appeared to be plausible and had reasonable root mean square (RMS – quality check) error values.

Design C-Value

If the layer design resilient (or elastic) modulus values are backcalculated from FWD deflection basin tests, AASHTO guidelines require those values to be adjusted to laboratory conditions (AASHTO 2015). A ratio of the laboratory tested resilient modulus, M_r, to the backcalculated elastic modulus, E_{FWD}, or C-Value (M_r/E_{FWD}), is used to adjust the backcalculated moduli obtained from FWD deflection data for base and subgrade materials. The following table presents default, or input Level 3, C-Values applicable to the project to be used with layer elastic modulus values obtained from backcalculated FWD data. These values are also direct input values in the AASHTOWare Pavement ME software for design when FWD testing is performed.

Summary of Default C-Values for Use with Backcalculated Moduli (1)		
Layer Type	Location	C-Value or M_r/E_{FWD} Ratio
Aggregate Base/Subbase	Below an HMA Layer	0.62
Subgrade/Embankment	Below an Unbound Aggregate Base Layer	0.35
[1] Manual of Practice, Table 10-8 (AASHTO 2015)		

As shown above, the default C-Values suggested for design for some materials, especially subgrade soils below an unbound aggregate base, significantly reduce the E_{FWD} values. Some evidence shows these default C-Values to be overconservative (Baladi 2009).

To obtain a basic knowledge of the engineering properties of the materials that will affect the design, undisturbed samples (such as those obtained with thin wall samplers) should be taken, if possible (Von Quintas 1997). American Geotechnics collected thin-walled, subgrade samples adjacent to Borings AG-04. The purpose in collecting the subgrade sample was to investigate an opportunity to site calibrate the design C-Value for this roadway segment by testing an in-situ sample.

American Geotechnics performed resilient modulus testing in general accordance with AASHTO T307 procedures to represent the project subgrade. The testing included a series of 15 sequences of dynamic triaxial loading applications at various stress states per the AASHTO T307 procedure (AASHTO 1999). Linear regression analyses of the measured data determined the nonlinear elastic parameters (k_1, k_2, and k_3) used for the generalized resilient modulus model (AASHTO 2015).

To determine the in-situ resilient (or elastic) modulus from laboratory test results, the actual lateral and vertical stresses must be known and include the at-rest earth pressures (Von Quintas 1997). WinJULEA, a layered elastic analysis software, enabled evaluation of these stress values, and estimated stress states were evaluated for the subgrade condition. These values were then applied to the generalized resilient modulus model to determine a representative resilient modulus value for the subgrade soil.

To evaluate a project specific C-Value for design, the calculated subgrade resilient modulus value was compared to the backcalculated elastic value at the sample location. The following table summarizes the results from this analysis. Appendix C contains a C-Value summary report.

Summary of Design C-Value Evaluation Results			
Average Backcalculated Elastic Modulus at AG-04 E_{FWD} (ksi)	Subgrade Resilient Modulus, Mr (ksi)	C-Value or M_r/E_{FWD} Ratio	Design Resilient Moduli (ksi)
19.9	13.8	0.84	16.7

Based on our analyses, the design C-Value for the project increased through use of project samples for resilient modulus evaluation.

540.04 Analyses and Design

American Geotechnics used the AASHTOWare Pavement ME Design version 2.5.4 software for the pavement analysis and design (AASHTO 2019). The ME methodology uses physical material properties and theoretical models to predict stresses and strains from measurements obtained using a FWD.

Traffic Load

ITD planning provided traffic data in terms of ESALs (ITD 2019). The 20-year calculated flexible equivalent single axle loads (ESALs) of 11,717,490. American Geotechnics installed traffic counters and collected traffic data from July 1st to July 17th 2019 to determine vehicle class distribution. The annual growth rate was adjusted to achieve the 20-year calculated ESALs in the ME analyses.

Appendix E contains the traffic data, truck class percentages, together with the traffic data summary.

Axle load distribution data was obtained from the Primary Loaded Truck Group (ITD 2014).

The standard deviation for design lane wander is +/- 10 inches (ITD 2012). Design truck tire pressure is 120 psi (ITD 2012). For the various strategies, detailed traffic input is contained within each of the ME output summaries in the appendices. Traffic inputs are based on the Idaho AASHTOWare Pavement ME Design User's Guide Version 1.1 (ITD 2014).

Climate

The project is situated at Latitude 43.68 and Longitude -114.36, with an elevation of about 5850 feet.

For ME analyses, multiple local weather stations with similar elevations were selected using the Pavement ME software and provided detailed climate data to predict influence of local climate on the pavement structure.

For the various strategies, climate input is summarized within each of the ME analysis report summaries in the appendices.

Frost

Project subgrade soils generally classified as A-1-b Silty Soils and as A-2 and A-6 Clayey Soils. The subgrade has F4 frost susceptibility characteristics, as classified by the United States Army Corps of Engineers (US DOD 2001). Typical frost penetration is about 30 inches BGS at the project location. For partial-frost design over frost susceptible subgrades, US DOD recommends the total pavement structure be at least 70 percent of the typical frost penetration depth which is 21 inches.

Pavement Layer Design Elastic Moduli

The following table summarizes the elastic moduli for each pavement structure layer used in the AASHTOWare Pavement ME.

Pavement Layer Design Moduli

Layer	Design Elastic Moduli (ksi)
Untreated Aggregate Base	35.0
Granular Subbase	25.0
Existing Aggregate Base/Subbase	23.3[(1)]
Subgrade	16.7[(2)]

[1] Existing base and subbase moduli were adjusted using a C-Value of 0.62 X (1.15 Base stiffening) in the AASHTOWare Pavement ME analyses, per AASHTO guidelines (AASHTO 2015).

[2] Backcalculated modulus values for existing subgrade soils were adjusted using C-Value of 0.84 in the AASHTOWare Pavement ME analyses.

The pavement design alternatives evaluated for this report included the following:

- **Alternative 1** – Full-Depth AC Removal and Replacement Rehabilitation (20-year analysis)

- **Alternative 2** - Flexible Reconstruction (20-year analysis)

Appendix F contains the design results for each alternative.

Alternative 1 – Full-Depth AC Removal and Replacement

River St to Saddle Rd (MP 128.2 to MP 129.3)

This strategy includes the following activities:

- Fully remove the existing 0.57 feet (6.9 inches) of existing AC.
- Restore the base layer by supplementing the existing base layer with 0.07 feet (0.8 inches) leveling course of new untreated aggregate base material as needed, and then tight grade and compact to the required final base layer lines and grades.
- Compact the exposed base with at least 8 passes of a minimum 45,000-lb vibratory compactor.
- Place 0.50 ft HMA layer.

Analyses show this alternative will provide 20 years of service. The following pavement structure conforms to ITD's performance criteria and reliability levels.

SH-75 AC Removal and Replacement (River to Saddle)

File Name: C:\Users\MEarl\Desktop\SH-75 AC Removal and Replacement (River to Saddle).dgpx

Design Inputs

Design Life:	20 years	Base construction:	June, 2024	Climate Data Sources (Lat/Lon)	43.5, -114.375
Design Type:	FLEXIBLE	Pavement construction:	July, 2024		43.5, -113.75
		Traffic opening:	August, 2024		44, -113.75

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	New HMA (PG 70-34)	6.0
NonStabilized	New & Existing Base/Subbase	9.4
Subgrade	Subgrade	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	11.6
Air voids (%)	7.5

Traffic

Age (year)	Heavy Trucks (cumulative)
2024 (initial)	1,560
2034 (10 years)	4,047,120
2044 (20 years)	10,515,000

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	175.00	113.74	90.00	99.99	Pass
Permanent deformation - total pavement (in)	0.50	0.07	90.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	15.00	14.36	90.00	94.39	Pass
AC thermal cracking (ft/mile)	1000.00	216.30	90.00	100.00	Pass
Permanent deformation - AC only (in)	0.20	0.03	90.00	100.00	Pass

This strategy includes removal of existing materials and importing new materials to maintain the current profile. A maintenance event including a micro-mill and seal coat is assumed in 2034.

Saddle Rd to Clubhouse Dr (MP 129.3 to MP 129.7)

This strategy includes the following activities:

- Fully remove the existing 0.79 feet (9.5 inches) of existing AC.
- Restore the base layer by supplementing the existing base layer with 0.29 feet (3.5 inches) of new untreated aggregate base material as needed, and then tight grade and compact to the required final base layer lines and grades.

- Compact the exposed base with at least 8 passes of a minimum 45,000-lb vibratory compactor.
- Place 0.50 ft HMA.

Analyses show this alternative will provide 20 years of service. The following pavement structure conforms to ITD's performance criteria and reliability levels.

SH-75 AC Removal and Replacement (Saddle to Clubhouse)

File Name: C:\Users\MEarl\Desktop\SH-75 AC Removal and Replacement (Saddle to Clubhouse).dgpx

Design Inputs

Design Life:	20 years	Base construction:	June, 2024	Climate Data Sources (Lat/Lon)	43.5, -114.375
Design Type:	FLEXIBLE	Pavement construction:	July, 2024		43.5, -113.75
		Traffic opening:	August, 2024		44, -113.75

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	New HMA (PG 70-34)	6.0
NonStabilized	New & Existing Base/Subbase	16.3
Subgrade	Subgrade	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	11.6
Air voids (%)	7.5

Traffic

Age (year)	Heavy Trucks (cumulative)
2024 (initial)	1,560
2034 (10 years)	4,047,120
2044 (20 years)	10,515,000

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	175.00	113.64	90.00	99.99	Pass
Permanent deformation - total pavement (in)	0.50	0.07	90.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	15.00	12.30	90.00	99.95	Pass
AC thermal cracking (ft/mile)	1000.00	216.30	90.00	100.00	Pass
Permanent deformation - AC only (in)	0.20	0.03	90.00	100.00	Pass

This strategy includes removal of existing materials and importing new materials to maintain the current profile. A maintenance event including a micro-mill and seal coat is assumed in 2034.

Alternative 2 - Flexible Reconstruction (20-Year Analysis)

This alternative includes removing the existing roadway and constructing a new flexible pavement section. A single reconstruction design was used for both roadway segments as they have the same traffic and subgrade resistance values. The following tables shows the proposed pavement layer structure and results.

SH-75 Reconstruct (River to Clubhouse)

File Name: C:\Users\MEarl\Desktop\SH-75 Reconstruct (River to Clubhouse).dgpx

Design Inputs

Design Life:	20 years	Base construction:	June, 2024	Climate Data Sources (Lat/Lon)	43.5, -114.375
Design Type:	FLEXIBLE	Pavement construction:	July, 2024		43.5, -113.75
		Traffic opening:	August, 2024		44, -113.75

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	New HMA (PG 70-34)	6.0
NonStabilized	Untreated Aggregate Base	7.0
NonStabilized	Granular Subbase	8.0
Subgrade	Subgrade	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	11.6
Air voids (%)	7.5

Traffic

Age (year)	Heavy Trucks (cumulative)
2024 (initial)	1,560
2034 (10 years)	4,047,120
2044 (20 years)	10,515,000

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	175.00	112.99	90.00	100.00	Pass
Permanent deformation - total pavement (in)	0.50	0.07	90.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	15.00	11.32	90.00	100.00	Pass
AC thermal cracking (ft/mile)	1000.00	216.30	90.00	100.00	Pass
Permanent deformation - AC only (in)	0.20	0.03	90.00	100.00	Pass

This strategy includes removal of existing materials and importing new materials to maintain the current profile. After 10 years, a micro-mill and seal coat is assumed in 2034.

540.05 Recommendations

The **Full-Depth AC Removal & Replacement Rehabilitation (Alternative 1)** is the preferred strategy. This recommendation is based on the preceding pavement design analyses, the use of recycled materials and anticipated lower impact to traffic and surrounding businesses. It is anticipated this alternative will provide the following benefits:

- Replace the old, deteriorated AC with new HMA and eliminate the potential for reflective cracking through the new HMA surface

- Retain and reuse the existing base material in the proposed pavement structure
- Provide an opportunity to densify and recompact the existing base layer prior to placing the new HMA surface course
- Maintain the existing roadway surface profile

Summary of Recommended Design Strategies	
Roadway Segment	Recommended Design
- SH-75 - River St to Saddle Rd	• Remove all the existing AC (0.57 feet) • Restore the base layer by supplementing the existing base layer with average of 0.07 feet leveling course of new Untreated Aggregate Base • tight grade and compact to the required final base layer lines and grades • Compact the exposed base with at least 8 passes of a minimum 45,000-lb vibratory compactor. • Prime coat base if base is to temporary support traffic. • Overlay with 0.50 ft HMA
- SH-75 – Saddle Rd to Clubhouse Dr	• Remove all the existing AC (0.79 feet) • Restore the base layer by supplementing the existing base layer with average of 0.29 feet leveling course of new Untreated Aggregate Base • tight grade and compact to the required final base layer lines and grades • Compact the exposed base with at least 8 passes of a minimum 45,000-lb vibratory compactor. • Prime coat base if base is to temporary support traffic. • Overlay with 0.50 ft HMA

540.06 References

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End of Phase I Report

230.00 SOILS

230.01 Introduction

See Section 100.02 Purpose and Scope.

230.02 Vicinity Map

A vicinity map is in Appendix A.

230.03 Soils Profile

See Section 540.03 Existing Pavement Conditions for a discussion of the subsurface drilling program and a generalized description of the pavement structure layers and subgrade conditions encountered.

This is a pavement rehabilitation project. A soils profile drawing was not prepared. Detailed boring logs are in Appendix B.

The following table summarizes the subgrade soil characteristics.

Sample		Moisture (%)	Atterberg Limits			Particle-Size			AASHTO Class.
Location	Depth (ft)		LL (%)	PL (%)	PI	Gravel (%)	Sand (%)	Fines (%)	
AG-01	2.0’-4.0’	16.1	40	20	20	11	50	39.2	A-6
AG-01	4.0’-6.0’	17.4	45	21	24	7	51	42.5	A-7-6
AG-02	2.0’-4.0’	---	---	---	---	27	57	15.6	A-1-b
AG-04	4.0’-5.0’	4.4	24	17	7	56	30	13.9	A-2-4
AG-07	2.0’-4.0’	---	---	---	---	40	39	20.9	A-1-b

230.04 Borrow Source Data

Approved contractor-furnished sources are specified.

230.05 Aggregate Inventory Report

Approved contractor-furnished sources are specified.

230.06 Borrow and Aggregate Source Plats

Approved contractor-furnished sources are specified.

230.07 Soil Report Summary

A soil report summary is not necessary for rehabilitation projects.

230.08 Total Design Pavement Section

See Section 540.04 Analyses and Design for the preferred rehabilitation strategy.

230.09 Sub-subgrading

Sub-subgrading is not anticipated.

230.10 Grade Pointing

Grade pointing is not anticipated.

230.11 Special Placement

Special placement of materials is not anticipated.

The Contractor should anticipate that soft and moisture-sensitive subgrade soils could occur through the project. Soft and moisture-sensitive subgrade soils are prone to rutting or pumping under construction equipment, especially if these soils become wetter than their optimum moisture content at the time of construction. Therefore, the Contractor should protect these soils during construction activities and determine how best to achieve compaction. The Department will not pay for any excavation or replacement of excavated material below subgrade elevation made necessary from construction activities.

Additionally, during seasonally wet construction periods, the Contractor should take care to prevent proof rolling operations from excessively disturbing the moisture-sensitive subgrade.

230.12 Compaction

Class A compaction requirements should be specified.

230.13 Slope Design Summary

The roadway will maintain the current grade elevation.

230.14 Slope Design

Soil cut or fill slopes on this project are not planned.

230.15 Embankment Foundation

Embankment foundations are not planned.

230.16 Surface and Subsurface Water

Surface water along the project is generally from precipitation runoff.

Groundwater was not encountered in the roadway borings.

230.17 Drainage

Any drainage ditches along the roadway should extend a minimum of 1 foot or the diameter of any pipe size below the bottom of the pavement structure section and maintain positive drainage as shown on ITD standard drawing A-2.

230.18 Retaining Walls

Roadside retaining walls are not planned.

230.19 Blanket Course or Filter Material

Blanket courses or filter materials are not anticipated.

230.20 Existing Roadway Material

Reuse of existing roadway base materials is recommended.

230.21 Abutment Embankment Material

Abutment embankment material is not planned.

230.22 Rock Subgrade

Rock subgrade or rock cuts are not planned.

230.23 Topsoil

Topsoil, if required, will have to be imported.

230.24 Pipe

A pipe condition survey was not conducted for this investigation.

230.25 Riprap

Riprap is not planned.

230.26 Staged Construction

Staged embankment construction for settlement control is not anticipated.

230.27 Dust Abatement

The estimated volume of water for dust abatement is about 1,400 MG (1MG = 1,000 gallons), assuming 6 inches of water per square foot of disturbed area estimated for the project.

230.28 Seismic Design

Seismic design parameters are not needed for rehabilitation projects.

230.29 References

See Section 540.06 References.

End of Phase II Report

240.00 PAVEMENT ESTIMATING

240.01 Pavement Type and Smoothness Determination

Pavement type is Superpave HMA, Class SP-5.

We recommend constructing the project using a Schedule II Surface Smoothness (405.P).

240.02 Typical Section

The following table summarizes the typical section for the project.

Typical Section for Full-Depth AC Removal and Replacement (River St MP 128.2 to Saddle Rd MP 129.3)			
	Thickness	Layer	Materials
	0.50 feet	Superpave Hot Mix Asphalt, Class SP-5; two equal lifts	Aggregate for Superpave HMA Pavement, ½-inch (703.05) Asphalt, PG 70-34 (702.01)
	0.07 Feet (average) (1)	Aggregate Base (303) Leveling Course	Aggregate for Untreated Base, ¾-inch Type B (703.04)
	0.71 feet	Average Undisturbed Existing Base	
[1] 0.07 is the average leveling course thickness. The leveling course thickness may range from 0 feet to 0.5 feet thick.			

Typical Section for Full-Depth AC Removal and Replacement (Saddle Rd MP 129.3 to Clubhouse Dr MP 129.7)			
	Thickness	Layer	Materials
	0.50 feet	Superpave Hot Mix Asphalt, Class SP-5; two lifts	Aggregate for Superpave HMA Pavement, ½-inch (703.05) Asphalt, PG 70-34 (702.01)
	0.29 feet (average) (1)	Aggregate Base (303) Leveling Course	Aggregate for Untreated Base, ¾-inch Type B (703.04)
	1.07 feet	Average Undisturbed Existing Base	
[1] 0.29 is the average leveling course thickness needed. The leveling course thickness may range from 0.07 feet to 0.64 feet thick.			

PG grade is based on LTPPBind software (version 3.1) (2005) and a 98 percent desired reliability value. Appendix F includes the LTPPBind output.

240.03 Bases

Aggregate Base (303)

Aggregate for Untreated Base, ¾-inch Type B (703.04)

Excavation and Repair of Soft Spot (205.03.D)

Combined areas of soft spot repair may total about 1,700 sy with 2 feet of sub-excavation.

Granular Borrow (205.02.B)

Subgrade Separation Geotextile, Type III (718.07)

240.04 Pavement

Tack Coat (401) on New HMA

Emulsified Asphalt, CSS-1 or CSS-1h (702.03) diluted (1:1 ratio) asphalt applied at a rate of 0.08 gal/sy (residual rate of 0.03 gal/sy estimated)

Prime Coat (402) for Untreated Aggregate Base (If temporary traffic allowed)

Emulsified Asphalt, CSS-1h (702.03) at 0.27 gal/sy (residual rate of 0.9 gal/sy estimated)

Superpave Hot Mix Asphalt, Class SP-5 (405)

Aggregate for Superpave HMA Pavement, ½-inch (703.05)

Asphalt, PG 70-34 (702.01) at 5.5% by weight of mix (estimated)

Anti-Stripping Additive (702.04) at 0.5% by weight of asphalt binder (estimated)

240.05 Surface Treatment

A surface treatment is not planned.

240.06 Aggregate Estimating Data

Superpave Hot Mix Asphalt (405)

Aggregate for Superpave HMA Pavement at 146 lb/cf, including asphalt (estimated)

Aggregate for Untreated Base (303)

Aggregate for Untreated Base at 135 lb/cf, including 7% water (estimated)

Granular Borrow (205.02.B)

Aggregate for Granular Borrow at 125 lb/cf, including 7% water (estimated)

Disclaimer

The unit weights in this estimating basis are provided to the designer for developing approximate project quantities. The actual quantities will vary dependent on the contractor-provided source, crushing operation, and mix designs. The contractor is solely responsible for determining actual unit weights based on the methods of production and providing adequate materials for the project plus any losses due to stockpile operations, out of specification (rejected) materials or other wastes.

240.07 Aggregate Sources

Approved contractor-furnished sources are specified for all aggregates.

End of Phase III Report

Appendix A

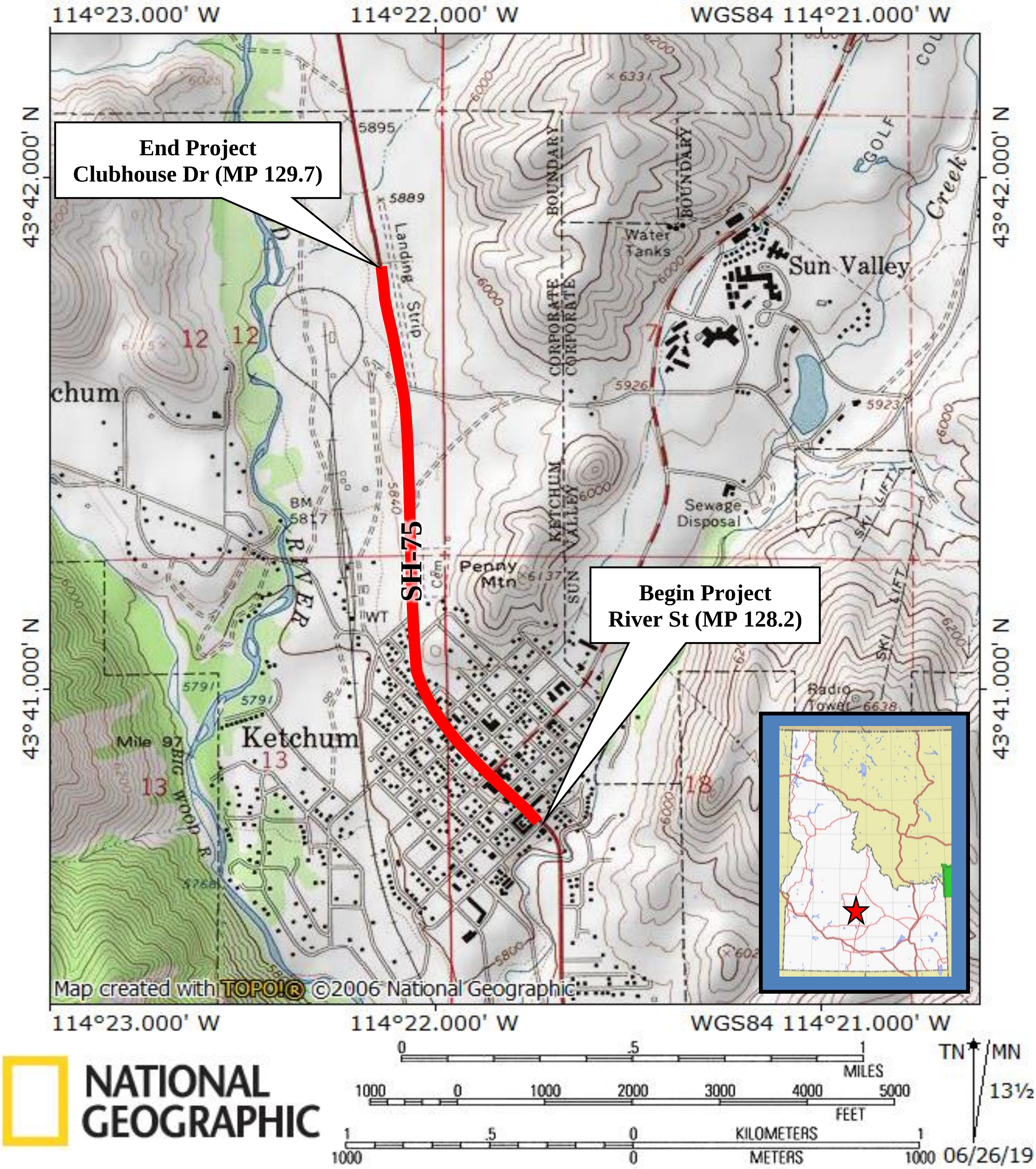
Vicinity Map

Site Photographs

Pavement Condition Survey

Geological Map

American Geotechnics



Vicinity Map State FY19 D4 Materials Reconnaissance SH-75, River St to Clubhouse Dr Ketchum, Blaine County, ID		Figure 1
File No. 03224	July 11, 2019	AMERICAN GEO TECHNICS

Site and Pavement Distress Photographs

Photo 1: Looking north west on SH-75, from River St.
Photo taken on 7/8/2019.

Photo 2: Looking north west on SH-75, from Saddle Rd.
Photo taken on 7/8/2019.

Photo 3: Looking south east on SH-75, from Saddle Rd.
Photo taken on 7/8/2019.

Photo 4: Looking south east on SH-75, from Clubhouse Dr.
Photo taken on 7/8/2019.

Boring AG-01	**Observed Pavement Distress (1)**	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	Med	> ¼" in, 75% of length - Open and sealed cracks
Longitudinal Cracking – Non-Wheel Path	Low	< ¼" in, 75% of length - Open and sealed cracks
Transverse Cracking	High	50'-100' intervals – Open and sealed cracks
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	None	
Potholes	None	
Surface Deformation		
Rutting	Depth up to 1/2"	
Miscellaneous		
Bleeding	Medium, in both wheel paths	
Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).		

Boring AG-02	**Observed Pavement Distress (1)**	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	Med	> ¼" in, 90% of length - Open and sealed cracks
Longitudinal Cracking – Non-Wheel Path	Low	< ¼" in, 90% of length - Open and sealed cracks
Transverse Cracking	High	50'-100' intervals – Open and sealed cracks
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	Med	15% in the study area, NB lane
Potholes	None	
Surface Deformation		
Rutting	Depth up to 1"	
Miscellaneous		
Bleeding	Medium, localized areas mainly in the wheel paths.	
Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).		

Boring AG-03	**Observed Pavement Distress (1)**	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	Med	> ¼” in, 90% of length - Open and sealed cracks
Longitudinal Cracking – Non-Wheel Path	Med	> ¼” in, 90% of length - Open and sealed cracks
Transverse Cracking	High	50’-100’ intervals – Open and sealed cracks
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	Med	2% in the study area
Potholes	None	
Surface Deformation		
Rutting	Depth up to 1”	
Miscellaneous		
Bleeding	Medium, localized areas mainly in the wheel paths.	
Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).		

Boring AG-04	**Observed Pavement Distress (1)**	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	Low	< ¼” in, 10% of length - Open and sealed cracks
Longitudinal Cracking – Non-Wheel Path	Low	< ¼” in, 10% of length - Open and sealed cracks
Transverse Cracking	High	20’-50’ intervals – Open and sealed cracks
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	Med	10% in the study area
Potholes	None	
Surface Deformation		
Rutting	Depth up to 1/2”	
Miscellaneous		
Bleeding	Medium, localized areas mainly in the wheel paths.	
Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).		

Boring AG-05	Observed Pavement Distress (1)	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	None	
Longitudinal Cracking – Non-Wheel Path	None	
Transverse Cracking	None	
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	None	
Potholes	None	
Surface Deformation		
Rutting	Depth up to 2”	
Miscellaneous		
Bleeding	Medium, localized areas mainly in the wheel paths.	
Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).		

Boring AG-06	Observed Pavement Distress (1)	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	None	
Longitudinal Cracking – Non-Wheel Path	None	
Transverse Cracking	Low	20’-50’ intervals – Open and sealed cracks
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	None	
Potholes	None	
Surface Deformation		
Rutting	Depth up to 2”	
Miscellaneous		
Bleeding	Medium, localized areas mainly in the wheel paths.	
Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).		

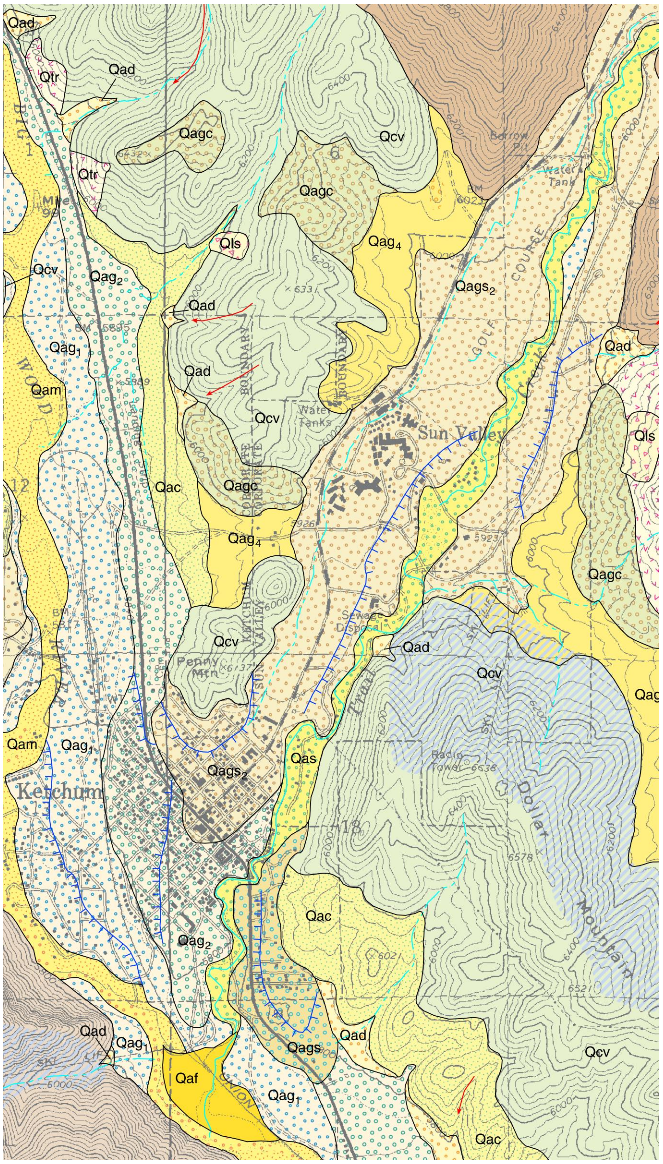
Boring AG-07	Observed Pavement Distress [1]	
Distress Type	**Severity**	**Notes**
Cracking		
Fatigue (Alligator) Cracking	None	
Longitudinal Cracking – Wheel Path	None	
Longitudinal Cracking – Non-Wheel Path	None	
Transverse Cracking	Low	50'-75' intervals – Open and sealed cracks
Edge Cracking	None	
Block Cracking	None	
Patching and Potholes		
Patch/Patch Deterioration	None	
Potholes	None	
Surface Deformation		
Rutting	Depth up to 1"	
Miscellaneous		
Bleeding	Medium, localized areas mainly in the wheel paths.	

Note: (1) Distress observations were made and recorded in general accordance with the Distress Identification Manual for the Long-Term Pavement Performance Program (FHWA, 2003).

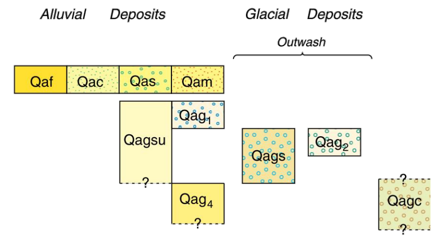
Surficial Geologic Map of the Sun Valley Quadrangle, Blaine County, Idaho

Roy M. Breckenridge and Kurt L. Othberg

2006



CORRELATION OF MAP UNITS



ALLUVIAL GRAVEL DEPOSITS

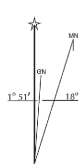
Qag$_1$ **Gravel terrace deposits of Big Wood River (Holocene-Pleistocene?)**—Mostly sorted and coarsely bedded fluvial channel gravel. Cobbly and pebbly sandy gravel with sandy matrix. Forms a post-glacial cut-in-fill terrace 10-20 feet above present flood plain. Soil series include the Adamson and Balaam.

Qag$_2$ **Gravel terrace deposits of Big Wood River (Pleistocene)**—Pebble and cobble gravel, and some boulders. Poor to moderate sorting. Subangular to rounded clasts, mostly thick bedded with some cross-bedding. Glacial outwash gravels from late Wisconsin alpine glaciers in headwaters of adjacent Boulder and Pioneer mountains. Equivalent to the Pinedale gravels of Schmidt (1962) and the Boulder Creek outwash gravels of Pearce and others (1988). Forms terrace 30-50 feet above present flood plain. Soils series in terrace gravels include the Gimlett and Little Wood. The Hutton series developed where smaller tributaries and slope processes contribute finer material.

Qag$_4$ **Older gravel deposits (Pleistocene-Pliocene?)**—Older gravel deposits deposited in the Wood River graben. Well-rounded mature cobble and pebble gravels. Predominantly quartzite clasts. Remnant surfaces, graded to a base level that is a hundred or more feet above the present stream level, are shown by pattern only (see *Symbols*). Mainly underlain by volcanic rocks in the Wood River graben. Most common in the drainage of Elkhorn Creek. Probably represents paleodrainage of ancestral Big Wood River defined by saddles between drainages along the Sun Valley fault which defines the eastern margin of the graben. Soil series include Smelter.

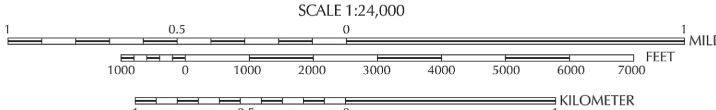
Qagc **Gravel deposits in colluvium (Pleistocene-Pliocene?)**—Silty gravel colluvium. Derived from remnant gravel deposits of older gravel deposits (*Qag$_4$*) incorporated into colluvial slopes. Includes well-rounded clasts of resistant quartzite. Probably represents eroded remnants of *Qag$_4$*. Soil series include the Peevywell, Smelter, and Starhope.

Qags **Gravel deposits of sidestreams (Pleistocene)**—Poorly sorted and coarsely bedded fluvial channel gravels. Cobbly and pebbly sandy gravels. Generally finer, less sorted, and more angular than mainstream gravels. Soil series include the Drage.



UTM Grid and 1967 Magnetic North Declination at Center of Map

SCALE 1:24,000



Contour interval 40 feet

QUADRANGLE LOCATION

Drawing2.dwg

9/17/2019 9:43 AM

H. Ross

Geology Map State FY19 D4 Materials Reconnaissance (SH-75, River St to Clubhouse Dr) Ketchum, Idaho		Figure 2
File No. 03224	September 17, 2019	AMERICAN GEO TECHNICS

Appendix B

Exploration Location Map

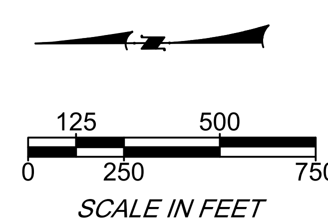
Boring Logs

Core Photographs

American Geotechnics

LEGEND

AG-01 BORING LOCATION



Exploration Location Map

State FY19 D4 Materials Reconnaissance
(SH-75, River St to Clubhouse Dr)
Ketchum, Idaho

Figure 3

AMERICAN GEOTECHNICS

File No. 03224	July 11, 2019

03224 River St to Clubhouse Dr Exploration Map Prep 7-3-2019.dwg 7/3/2019 B. Alvarado

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

BORING NO. AG-01

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

GROUNDWATER:

Groundwater not encountered on 6/30/2019

LATITUDE: 43.69650518°
LONGITUDE: -114.3689842°

DEPTH (ft)	TYPE - No.	TYPE - No.	RECOVERY %	LITHOLOGY	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
0.5		CR-01			Asphalt Concrete- Dense; Interfaces at 0.16', 0.27', 0.42', 0.53'; Core recovery=0.72'.	0.74	0.74	Boring in the southbound lane just north of Boulder View Rd. An approx. one-foot gently downward sloped embankment to the east and west.
1.0		GB-02			Base (crushed)- Silty Gravel with Sand (GM)- About 45% hard, subangular to subrounded gravel to 1/2"; about 40% hard, fine to coarse, angular to subrounded sand; about 15% non-plastic fines; moist; dark brown.	0.23	0.97	
1.5		GB-03			Subbase (uncrushed)- Silty Gravel with Sand (GM)- About 50% hard, subangular to subrounded gravel to 1 1/2"; about 25% hard, fine to coarse, angular to subrounded sand; about 15% non-plastic to low plasticity fines; moist; dark brown.	0.94	1.91	
2.0 2.5 3.0		SS-04	100		Clayey Sand (SC)- 50% hard, fine to coarse, angular to subrounded sand; 39% fines; LL=40, PL=20, PI=20; 11% hard, subangular gravel to 3/4"; ω= 16.1%; brown.			
3.5 4.0 4.5 5.0 5.5 6.0	BK-06	SS-05	68		51% hard, fine to coarse, subangular to subrounded sand; 42% fines; LL=45, PL=21, PI=24; 7% hard, subangular to subrounded gravel to 3/4"; ω= 17.4%; brown.	4.09	6.00	

Bottom of Boring at 6.0 ft on 6/30/2019.

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

LATITUDE: 43.68993651°
LONGITUDE: -114.3679053°

BORING NO. AG-02

AMERICAN GEO TECHNICS

GROUNDWATER:

Groundwater not encountered on 6/30/2019

DEPTH (ft)	TYPE - No.	RECOVERY %	LITHOLOGY	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
0.5	CR-07			Asphalt Concrete- Dense; Interfaces at 0.1', 0.25', 0.37', stripped below 0.52'; core recovery=0.52'.	0.57	0.57	Located in the southbound lane. An approx. five-foot gently downward sloping embankment to the west. An approx. four-foot gently downward sloping grassy embankment to the east.
	GB-08			Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; dark brown; moist.	0.27	0.84	
1.0 / 1.5 / 2.0	GB-09, GB-10			Subbase (uncrushed)- Clayey Sand with Gravel (SC)- About 45% hard, fine to coarse, subangular to subround sand; about 40% hard, subangular to subrounded gravel to 3/4"; about 15% non-plastic to low plasticity fines; dark brown; moist.	1.16	2.00	
2.5 / 3.0 / 3.5 / 4.0	SS-11	100		Silty Sand with Gravel (SM)- 57% hard, fine to coarse, angular to subrounded sand; 27% hard, angular to subrounded gravel to 1"; 16% low to medium plasticity fines; brown; moist.	2.00	4.00	Gravel is redish-brown in color
4.5 / 5.0 / 5.5 / 6.0	SS-12	40		Clayey Gravel with Sand (GC)- About 45% hard, angular to subangular gravel to 1"; about 35% hard, fine to coarse, subangular to subrounded sand; about 20% low to medium plasticity fines; dark brown; moist.	2.00	6.00	0.1' layer of broken rock at 4.4'.

Bottom of Boring at 6.0 ft on 6/30/2019.

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

BORING NO. AG-03

AMERICAN GEOTECHNICS

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

GROUNDWATER:

Groundwater not encountered on 6/30/2019

LATITUDE: 43.68614006°
LONGITUDE: -114.367595°

DEPTH (ft)	TYPE - No.	TYPE - No.	RECOVERY %	LITHOLOGY	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
		CR-13			Asphalt Concrete- Dense; Interfaces at 0.1', 0.21'and 0.36'; core recovery= 0.52'.	0.57	0.57	Boring in the southbound lane. Toward east, level for approx. 15 feet then slopes downward about four-feet. Toward west, level shoulder then upward slopes into driveway.
0.5		GB-14			Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; dark brown; moist.	0.23	0.80	
1.0		GB-15			Subbase (uncrushed)- Clayey Sand with Gravel (SC)- About 45% hard, fine to coarse, subangular to subround sand; about 40% hard, subangular to subrounded gravel to 3/4"; about 15% non-plastic to low plasticity fines; dark brown; moist.	1.50	2.30	
1.5								
2.0								
2.5					Poorly Graded Gravel with Silt and Sand (GP-GM)- About 65% hard, subrounded to subangular gravel to 1"; about 25% hard, fine to coarse, subrounded to subangular sand; about 10% non-plastic fines; brown; moist.	1.70	4.00	Weathered basalt.
3.0		SS-17	48					
3.5								
4.0					Poorly Graded Gravel with Clay and Sand (GP-GC)- About 50% hard, angular to subangular gravel to 1 1/2"; about 40% hard, fine to coarse, angular to subangular sand; about 10% low plasticity fines; dark brown; moist.	1.15	5.15	
4.5	BK-16							
5.0		SS-18	68					
5.5					Clayey Sand with Gravel (SC)- About 55% hard, fine to coarse, angular to subangular sand; about 25% hard, subangular to subrounded gravel to 1"; about 20% low plasticity fines; brown; moist.	0.85	6.00	
6.0								

Bottom of Boring at 6.0 ft on 6/30/2019.

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

BORING NO. AG-04

AMERICAN GEO TECHNICS

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

GROUNDWATER:

Groundwater not encountered on 6/30/2019

LATITUDE: 43.68198978°
LONGITUDE: -114.3661838°

DEPTH (ft)	TYPE - No.	TYPE - No.	RECOVERY %	LITHOLOGY	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
0.0–0.42	BK-22 (0.0–1.5)	CR-19			Asphalt Concrete- Dense; Interfaces at 0.1', and 0.24'; core recovery=0.42'.	0.42	0.42	Boring in southbound lane. In-town with curb, gutter and sidwalks.
0.42–0.57		GB-20			Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; tan; moist.	0.15	0.57	
0.57–0.89		GB-21			Subbase (uncrushed)- Poorly Graded Gravel with Clay and Sand (GP-GC)- About 65% hard, angular to subangular gravel to 1/2"; about 25% hard, fine to coarse, subangular to subrounded sand; about 10% non-plastic to low plasticity fines; gray; dry.	0.32	0.89	
0.89–4.0	BK-22 (1.5–4.0)	SS-23 (2.0–4.0)	0		Silty Clayey Gravel with Sand (GC-GM)- 56% hard, subrounded to angular gravel to 1 1/2; 30% hard, fine to coarse, subrounded to angular sand; 14% fines; LL=24, PL=17, PI=7; ω= 4.4%; brown.	3.11	4.00	
4.0–4.3		SS-24	68		Clayey Sand with Gravel (SC)- About 50% hard, fine to coarse , subrounded to angular sand; about 30% hard, subangular to angular gravel to 1"; about 20% low plasticity fines; dark brown; moist.	0.30	4.30	
4.3–6.0		SS-24	68		Poorly Graded Gravel with Sand (GP)- About 55% hard, angular to subangular gravel to 1 1/2"; about 40% hard, fine to coarse, angular to subangular sand; about 5% non-plastic fines; brown; moist. Poorly Graded Gravel with Sand (GP)- About 60% hard, angular to subangular gravel to 1 1/2"; about 35% hard, fine to coarse, angular to subangular sand; about 5% non-plastic fines; gray; moist.	1.70	6.00	Driving split spoon beyond 4.5' becomes more difficult.

Bottom of Boring at 6.0 ft on 6/30/2019.

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

BORING NO. AG-05

AMERICAN GEO TECHNICS

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

GROUNDWATER:

Groundwater not encountered on 6/30/2019

LATITUDE: 43.68102242°
LONGITUDE: -114.3648536°

DEPTH (ft)	TYPE - No.	TYPE - No.	RECOVERY %	LITHOLOGY	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
		CR-25			Asphalt Concrete- Dense, Interfaces at 0.21' and 0.31'; core recovery= 0.42'; bottom lift delaminated.	0.43	0.43	Boring in southbound lane. In-town with curb, gutter and sidwalks.
0.5		GB-26			Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; dark brown; moist.	0.39	0.82	
1.0		GB-27a			Subbase (uncrushed)- Poorly Graded Sand with Silt and Gravel (SP-SM)- About 55% hard, fine to coarse, subangular to angular sand; about 35% hard, angular to subrounded gravel to 5/8"; about 10% low plasticity fines; brown; moist. As above except with coarser gravel to 1" below 1'.	1.68	2.50	
1.5–2.5	GB-27b							
2.5					As above except with coarser gravel to 1 1/2".			
3.0		SS-28	43					
4.5						3.50		
5.0		SS-29	70					
6.0							6.00	

Bottom of Boring at 6.0 ft on 6/30/2019.

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

BORING NO. AG-06

AMERICAN GEO TECHNICS

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

GROUNDWATER:

Groundwater not encountered on 6/30/2019

LATITUDE: 43.67996725°
LONGITUDE: -114.363432°

DEPTH (ft)	TYPE - No.	RECOVERY %	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
0.0–0.5	CR-30		Asphalt Concrete- Dense; Interfaces at 0.18' and 0.25'; striped below 0.25'; core recovery=0.40'.	0.48	0.48	Boring in southbound lane. In-town with curb, gutter and sidwalks.
0.5	GB-31		Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; dark brown; moist.	0.11	0.59	
				0.26	0.85	No recovery, augered through.
1.0	GB-32			0.20	1.05	
			Old Asphalt Concrete-			
1.5			Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; dark brown; moist.	0.49	1.54	
2.0			Subbase- Poorly Graded Gravel with Clay and Sand (GP-GC)- About 55% hard, angular to subangular, hard gravel to 1"; about 35% hard, fine to coarse, subrounded to angular sand; about 10% low plasticity fines; brown; moist.			Bulk sample got contaminated, therefore not collected.
2.5–4.0	SS-34	67	Poorly Graded Sand with Silt and Gravel (SP-SM)- About 55% hard, fine to coarse, subangular to angular sand; about 35% hard, angular to subrounded gravel to 1"; about 10% low plasticity fines; brown; moist.	2.46	4.00	
4.0–4.5	SS-35	45	Clayey Sand with Gravel (SC)- About 45% hard, fine to coarse, subrounded to angular sand, about 30% hard, angular to subangular gravel to 1/2"; about 25% low plasticity clay; brown; moist.	0.35	4.35	Augered to 5.5' to recover split spoon (broken rod). Organics (wood chips) present in sample from depth of 4' and below. Basalt fragments present in sample.
4.5–6.0			Poorly Graded Sand with Silt and Gravel (SP-SM)- About 50% hard, fine to coarse, angular to subangular sand; about 40% hard, angular to subangular gravel to 1 1/2"; about 25% non-plastic fines; brown; moist	1.65	6.00	

Depth scale (ft): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0

Bottom of Boring at 6.0 ft on 6/30/2019.

PROJECT: State FY19 D4 Materials Reconnaissance
LOCATION: Blaine County, Idaho

BORING NO. AG-07

AMERICAN GEO TECHNICS

METHOD: Hollow-Stem Auger/ HQ Diamond Core
DATE LOGGED: 6/30/2019
LOGGED BY: David Wadley

GROUNDWATER:

Groundwater not encountered on 6/30/2019

LATITUDE: 43.67927502°
LONGITUDE: -114.3624867°

DEPTH (ft)	TYPE - No.	TYPE - No.	RECOVERY %	LITHOLOGY	MATERIAL DESCRIPTION (Stratification lines represent approximate boundaries between materials)	LAYER THICKNESS (ft.)	DEPTH (ft)	REMARKS
0.5		CR-36			Asphalt Concrete- Dense; Interface at 0.23'; delamination at 0.29'; core recovery=0.51'.	0.59	0.59	Boring in southbound lane. In-town with curb, gutter and sidwalks.
		GB-37			Base (crushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 60% hard, subangular to subrounded gravel to 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% non-plastic fines; dark brown; moist.	0.26	0.85	Oily smell
1.0		GB-38			Subbase (uncrushed)- Poorly Graded Gravel with Silt and Sand (GP-GM)- About 55% hard, subangular to angular gravel to 1 1/2"; about 35% hard, fine to coarse, angular to subrounded sand; about 10% low plasticity fines; dark brown; moist.	0.63	1.48	
1.5 2.0 2.5 3.0 3.5	BK-39	SS-40	83		Silty Gravel with Sand (GM)- 40% hard, angular to subrounded gravel to 1 1/2"; 39% hard, fine to coarse, angular to subrounded sand; 21% non-plastic fines; brown; moist.	2.52	4.00	
4.0 4.5 5.0 5.5 6.0		SS-41	25		Poorly Graded Gravel with Clay and Sand (GP-GC)- About 60% hard, angular to subangular gravel to 1 1/2"; about 30% hard, fine to coarse, angular to subrounded sand; about 10% low plasticity fines; rusty brown; moist.	2.00	6.00	

Bottom of Boring at 6.0 ft on 6/30/2019.

Core Photos

Scale in Feet

Scale in Inches

Photo 1: AG-01; CR-01; 0.0'- 0.72'.

Photo 2: AG-02; CR-07; 0.0’- 0.52’.

Photo 3: AG-03; CR-13; 0.0’- 0.52’.

Photo 4: AG-04; CR-19; 0.0'- 0.42'.

Photo 5: AG-05; CR-25; 0.0'- 0.42'.

Scale in Feet

Scale in Inches

Photo 6: AG-06; CR-30; 0.0'- 0.40'.

Scale in Feet

Scale in Inches

Photo 7: AG-07; CR-36; 0.0'- 0.51'.

Appendix C

Laboratory Test Reports

Mr Test Results & Mr Design Spreadsheet

Project Information

Report to: ITD District 4
Project: State, FY19 D4 Materials Reconnaissance
Report Date: 9-9-19
File No.: 03224

Material Information

Date Sampled: 6-30-19
Sampled By: David Wadley
Date Received: 8-1-19
Date Tested: 8-1 to 9-2-19

SUMMARY OF LABORATORY RESULTS

Lab Number	Borehole	Sample Type	Depth (ft)	Water Content (%)	% Passing #200 Sieve	Liquid Limit (%)	Plasticity Index	Soil Type	Remarks
19-0448	AG-01	SS-04	2.0'-4.0'	16.1	39.2	40	20	SC	A-6
19-0449	AG-01	SS-05	4.0'-6.0'	17.4	42.5	45	24	SC	A-7-6
19-0450	AG-02	SS-11	2.0'-4.0'	--	15.6	--	--	SM	A-1-b
19-0452	AG-04	BK-22	4.0'-5.0'	4.4	13.9	24	7	GC-GM	A-2-4
19-0451	AG-07	BK-39	2.0'-4.0'	--	20.9	--	--	GM	A-1-b

Prepared By: Travis Thomsen

American Geotechnics
5260 Chinden Blvd.
Boise, Idaho 83714
Phone:(208) 658-8700
Fax: (208) 658-8703

Report to: Idaho Transportation Department, District 4
Project: State FY19D4 Material Reconnaissance KN18697
Report Date: 9/9/2019
File No.: 03224

Material Information

Date Sampled: 6/30/2019
Sampled By: American Geotechnics
Date Received: 8/1/2019
Date Tested: 8/1 to 9/2/19

Test Results

Remolded Density and Moisture Content

Lab Number	Location	Depth (ft)	Dry Density (pcf)	Moisture (%)	Soil Type
19-0452	Composite	2'-5'	110.4	7.8	GC-GM

Reviewed By: Travis Thomsen

American Geotechnics
5260 Chinden Blvd.
Boise, Idaho 83714
Phone:(208) 658-8700
Fax: (208) 658-8703

Report to: Idaho Transportation Department, District 4
Report Date: 9/9/2019
Project No.: 03224
Project: State FY19D4 Material Reconnaissance KN18697

Material Information

Date Sampled: 6/30/2019
Sampled By: American Geotechnics
Date Received: 8/1/2019
Date Tested: 8/1 to 9/2/19

AASHTO CLASSIFICATION

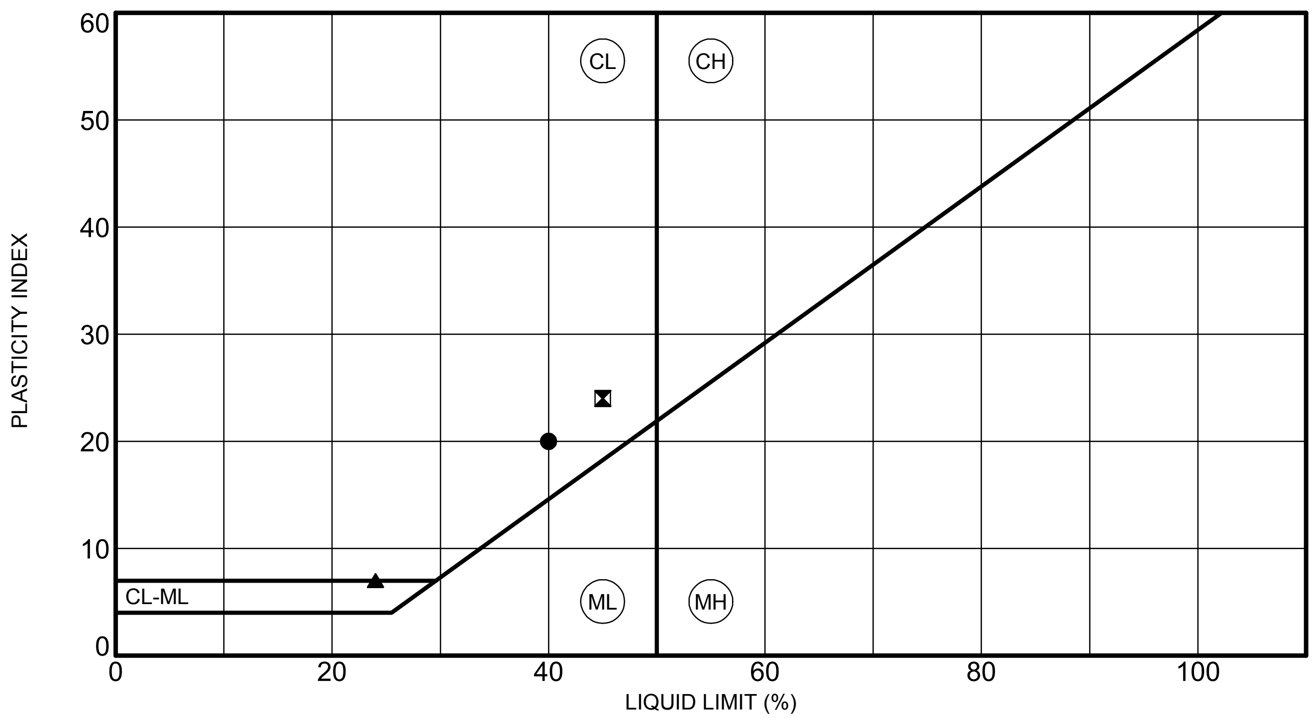
Lab Number	Boring/Pit	Sample ID	Depth	AASHTO Classification	
19-0448	AG-01	SS-04	2'-4'	A-6	Clayey Soils
19-0449	AG-01	SS-05	4'-6'	A-7-6	Clayey Soils
19-0450	AG-02	SS-11	2'-4'	A-1-b	Stone Fragments, Gravel and Sand
19-0451	AG-07	BK-39	2'-4'	A-1-b	Stone Fragments, Gravel and Sand
19-0452	AG-04	BK-22	4'-5'	A-2-4	Silty or Clayey Gravel and Sand
19-0452	AG-07	BK-39	1.5'-4'	A-2-4	Silty or Clayey Gravel and Sand

Reviewed By: *Travis Thomsen*

ATTERBERG LIMITS REPORT

CLIENT: ITD District 4
FILE NUMBER: 03224

PROJECT NAME: State, FY19 D4 Materials Reconnaissance
PROJECT LOCATION: Blaine County



	Specimen Identification			MC	LL	PL	PI	Fines	Classification
●	AG-01	SS-04	2.0	16.1	40	20	20	39	CLAYEY SAND (SC)
⊠	AG-01	SS-05	4.0	17.4	45	21	24	43	CLAYEY SAND (SC)
▲	AG-04	BK-22	4.0	4.4	24	17	7	14	SILTY, CLAYEY GRAVEL with SAND (GC-GM)
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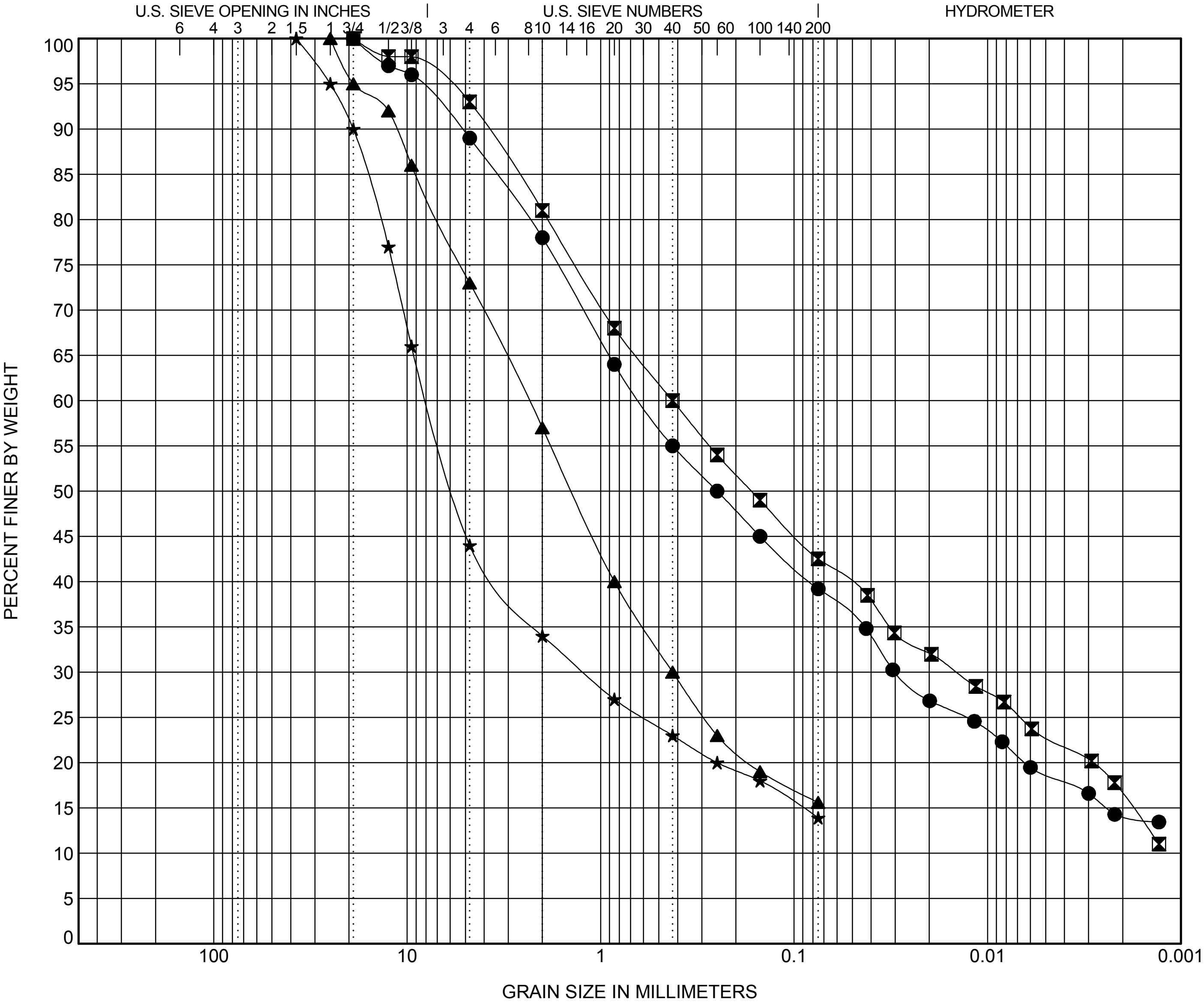
Prepared By: Travis Thomsen

PARTICLE-SIZE DISTRIBUTION REPORT

AMERICAN GEO TECHNICS

CLIENT: ITD District 4
FILE NUMBER: 03224

PROJECT NAME: State, FY19 D4 Materials Reconnaissance
PROJECT LOCATION: Blaine County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification			Classification	D10	D30	D60
●	AG-01	SS-04	2.0	CLAYEY SAND (SC)	--	0.03	0.625
⊠	AG-01	SS-05	4.0	CLAYEY SAND (SC)	--	0.015	0.425
▲	AG-02	SS-11	2.0	SILTY SAND with GRAVEL (SM)	--	0.425	2.352
★	AG-04	BK-22	4.0	SILTY, CLAYEY GRAVEL with SAND (GC-GM)	--	1.227	7.864

	Specimen Identification			%Gravel	%Sand	%Fines	D15	D50	D85	Cc	Cu	MC	LL	PI
●	AG-01	SS-04	2.0	11.0	49.8	39.2	0.002	0.25	3.468	--	--	16.1	40	20
⊠	AG-01	SS-05	4.0	7.0	50.5	42.5	0.002	0.166	2.668	--	--	17.4	45	24
▲	AG-02	SS-11	2.0	27.0	57.4	15.6	--	1.406	9.007	--	--	--	--	--
★	AG-04	BK-22	4.0	56.0	30.1	13.9	0.09	5.738	16.174	--	--	4.4	24	7

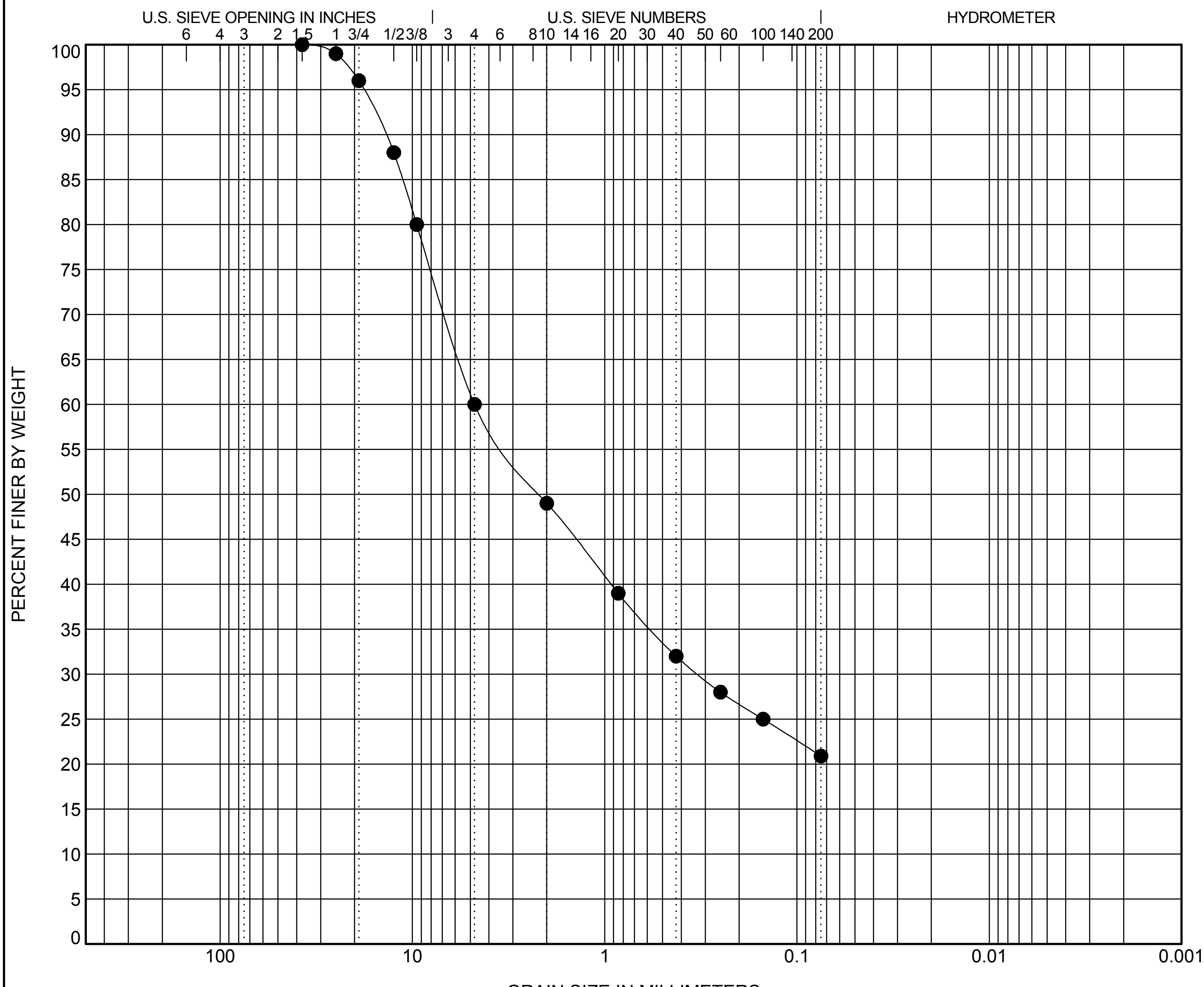
Prepared By: Travis Thomsen

American Geotechnics

PARTICLE-SIZE DISTRIBUTION REPORT

CLIENT: ITD District 4
FILE NUMBER: 03224

PROJECT NAME: State, FY19 D4 Materials Reconnaissance
PROJECT LOCATION: Blaine County



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

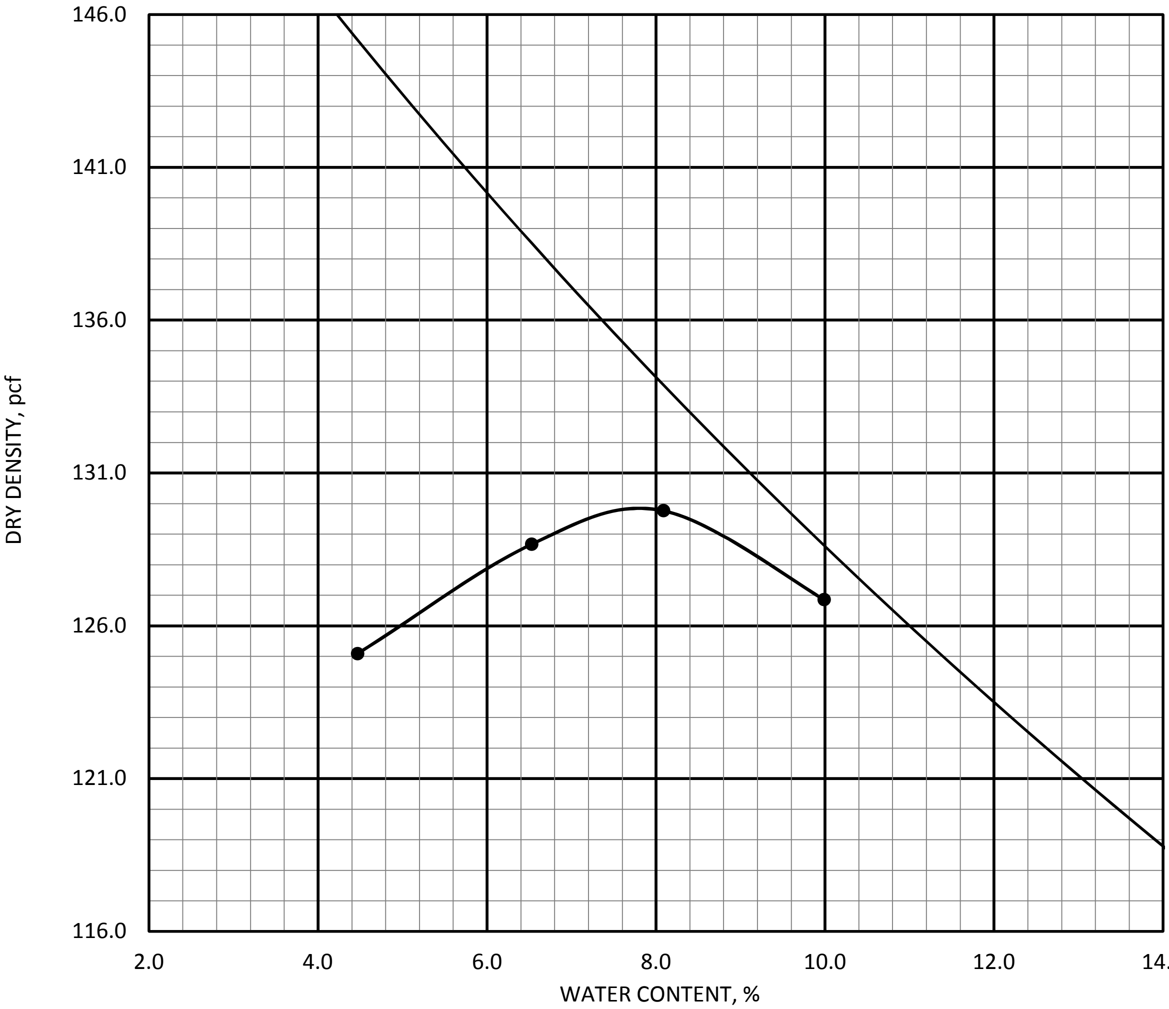
	Specimen Identification	Classification	D10	D30	D60
●	AG-07 BK-39 2.0	SILTY GRAVEL with SAND (GM)	--	0.326	4.75

	Specimen Identification	%Gravel	%Sand	%Fines	D15	D50	D85	Cc	Cu	MC	LL	PI
●	AG-07 BK-39 2.0	40.0	39.1	20.9	--	2.164	11.278	--	--	--	--	--

Prepared By: Travis Thomsen

American Geotechnics

COMPACTION TEST REPORT



Sp.G. for ZAV = 2.6

Project Number:	03224
Project Name:	State FY19D4 Material Reconnaissance
Client:	ITD D4
Sample Location:	AG-04,07 BK-22,39
Sample Description:	Silty, Clayey Gravel with Sand (GC-GM)
Lab Number:	19-0452
Date Sampled:	6/30/2019
Sampled By:	AGEO
Date Tested:	8/7/2019
Tested By:	Holly Lockett
	Remarks:

AASHTO T-180, Method C	
Maximum Dry Density, pcf	**129.9**
Optimum Moisture, %	**7.8**
Percent of Aggregate > 3/4"	0

Reviewed By: Travis Thomsen

Client Name: ITD District 4
Project Name: State, FY19 D4 Materials Reconnaissance
Project No: 03224
Report Date: 9/Sep/19

Material Information

Boring/Sample ID: AG-04&07 / BK-22&39
Material Type: Type-2 (Subgrade)
Type of Sample: 4" Dia Remolded
Dry Density (pcf): 110.4 95% Mod
Specimen WC (%) 7.8 OMC

Lab Number: 19-0446
AASHTO Clasification: A-2-4
Depth of Specimen (ft.): 3.50
Date Sampled: 20/Jun/19
Date Tested: 3/Sep/19

Test Results

Resilient Modulus Test (AASHTO T-307)

Sequence No	Confining Stress	Total Axial Stress	Bulk Stress	Octahedral Shear Stress	Measured Resilient Modulus	Predicted Resilient Modulus
	σ_3	σ_d	θ	τ_{oct}	M_r	Pred. M_r
	psi	psi	psi	psi	psi	psi
1	6.00	2.04	20.06	0.96	32288	25942
2	6.00	4.03	22.05	1.90	21522	22971
3	6.00	6.18	24.20	2.91	18852	20235
4	6.00	8.30	26.31	3.91	17756	17944
5	6.00	10.24	28.25	4.83	17128	16130
6	4.00	2.01	14.02	0.95	20123	18919
7	4.00	4.04	16.05	1.90	15250	17305
8	4.00	6.15	18.16	2.90	14124	15712
9	4.00	8.18	20.19	3.86	13816	14320
10	4.00	10.18	22.19	4.80	13982	13068
11	2.00	2.01	8.02	0.95	12407	11498
12	2.00	4.06	10.06	1.91	10542	11391
13	2.00	6.12	12.12	2.88	10360	10990
14	2.00	8.13	14.14	3.83	10619	10476
15	2.00	10.11	16.11	4.77	11061	9887

Resilient Modulus Equation

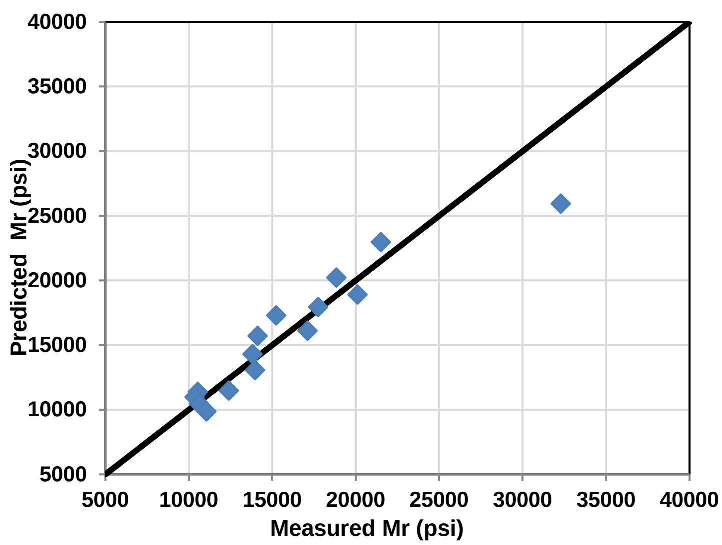
$$Mr = k_1 * Pa * \left(\frac{\theta}{Pa}\right)^{k_2} * \left(\frac{\zeta oct}{Pa} + 1\right)^{k_3}$$

Resilient Modulus Model Parameters

k_1 = **1675.333**

k_2 = **0.891**

k_3 = **-3.539**



Tested By: Travis Thomsen

Reviewed By: Tamim

American Geotechnics

Client Name: ITD District 4
Project Name: State FY19 D4 Materials Reconnaissance
Project No: 03224
Report Date: 9/Sep/19
Boring/Sample ID: AG-04&07 / BK-22&39

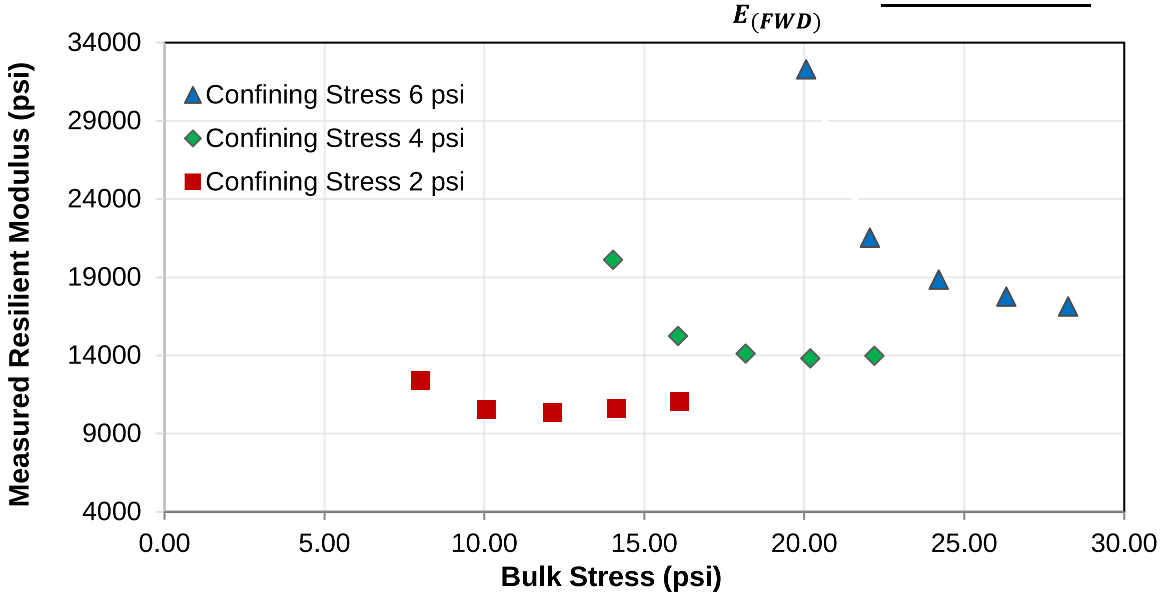
Design Resilient Modulus and C-Value for Subgrade Soil

Pavement Structure Details

Layer Number	Material Type	Layer Thickness (in)	Density (pcf)	Vertical Stress (psi)	Remarks
1	Asphalt Concrete	6.9	145	0.58	
2	Base	2.3	143	0.19	
3	Subbase	6.2	135	0.48	
4	Subgrade	21.84	119	1.50	

At-Rest Vertical Stress (psi)	2.76
At-Rest Earth Pressure Coefficient	0.85
At-Rest Lateral Stress (psi)	2.34
At-Rest Bulk Stress (psi)	7.45
Load-Related Bulk Stress (psi)	1.05
Total Bulk Stress (psi)	8.50
At-Rest Octahedral Shear Stress (psi)	0.20
Load-Related Octahedral Shear Stress (psi)	0.10
Total Octahedral Shear Stress (psi)	0.29
Atmospheric Pressure (psi)	14.70
Resilient Modulus from M_r Equation (psi)	14090
Design Subgrade Resilient Modulus, M_r (psi)	13,800
Elastic Modulus from FWD Back Calculation, $E_{(FWD)}$ (psi)	16,400

C-Value = $\frac{M_r}{E_{(FWD)}}$ = **0.84**



Reviewed By: MEE

Appendix D

GPR Pavement Structure Layers Thickness Profile

ITD FWD Data & Elmod Back-Calculation Results

Pavement Structure Layers Statistics

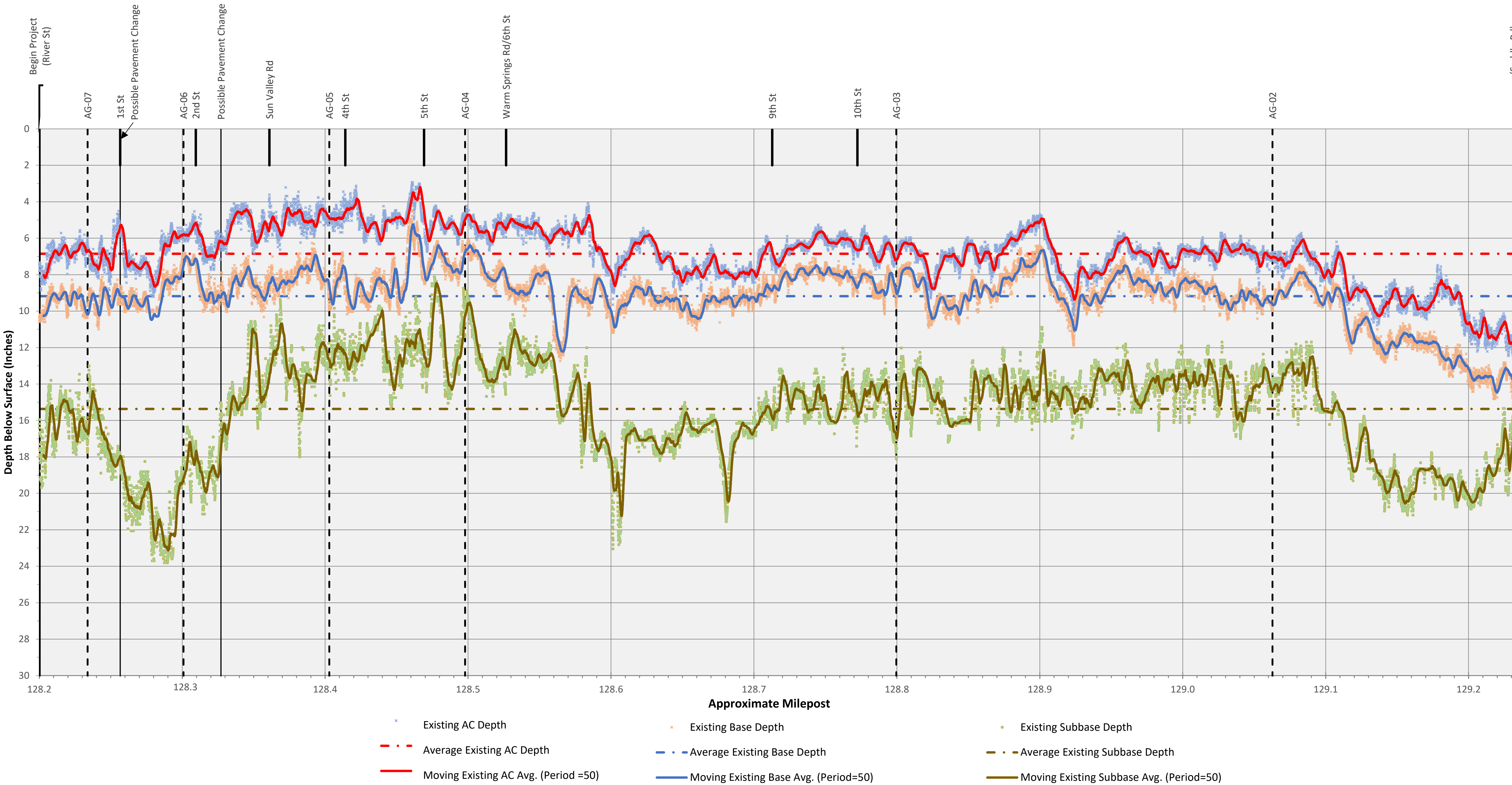
File No: 03224
ITD Key No. 18697
Scan Date: 6/21/2019

Existing Pavement Layer Depths

State FY19D4 Materials Reconnaissance (SH-75, River St to Saddle Rd, Ketchum)

SH-75, MP 128.2 to MP-129.23

(South Bound, Lane 0, Right Wheel Path)



Note: GPR distance scale along the x-axis may not corespond exactly with project stationing.

File No: 03224

ITD Key No: 18697

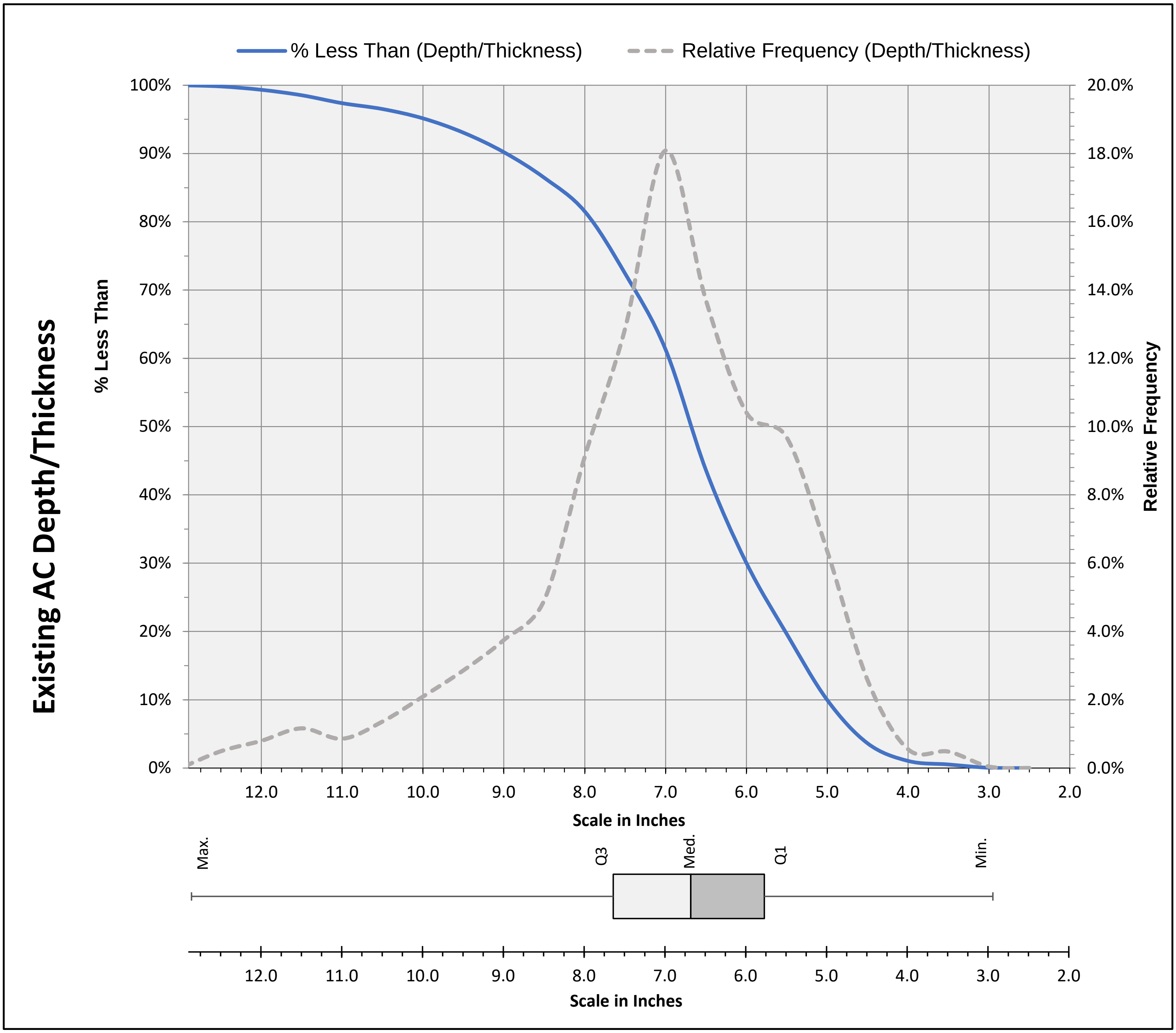
Scan Date: 6/21/2019

Existing AC Depth/Thickness Statistics

State FY19D4 Materials Reconnaissance (SH-75, River St to Saddle Rd, Ketchum)

SH-75, MP 128.2 to MP-129.23

(South Bound, Lane 0, Right Wheel Path)



Existing AC Depth/Thickness Statistics

Average=	6.9 in.	(0.57 ft.)
Max=	12.9 in.	(1.07 ft.)
Min=	2.9 in.	(0.25 ft.)
SD=	1.6 in.	(0.13 ft.)
Median=	6.7 in.	(0.56 ft.)
Q1=	5.8 in.	(0.48 ft.)
Q3=	7.6 in.	(0.64 ft.)
Total Number of Scans=	16421	

File No: 03224

ITD Key No: 18697

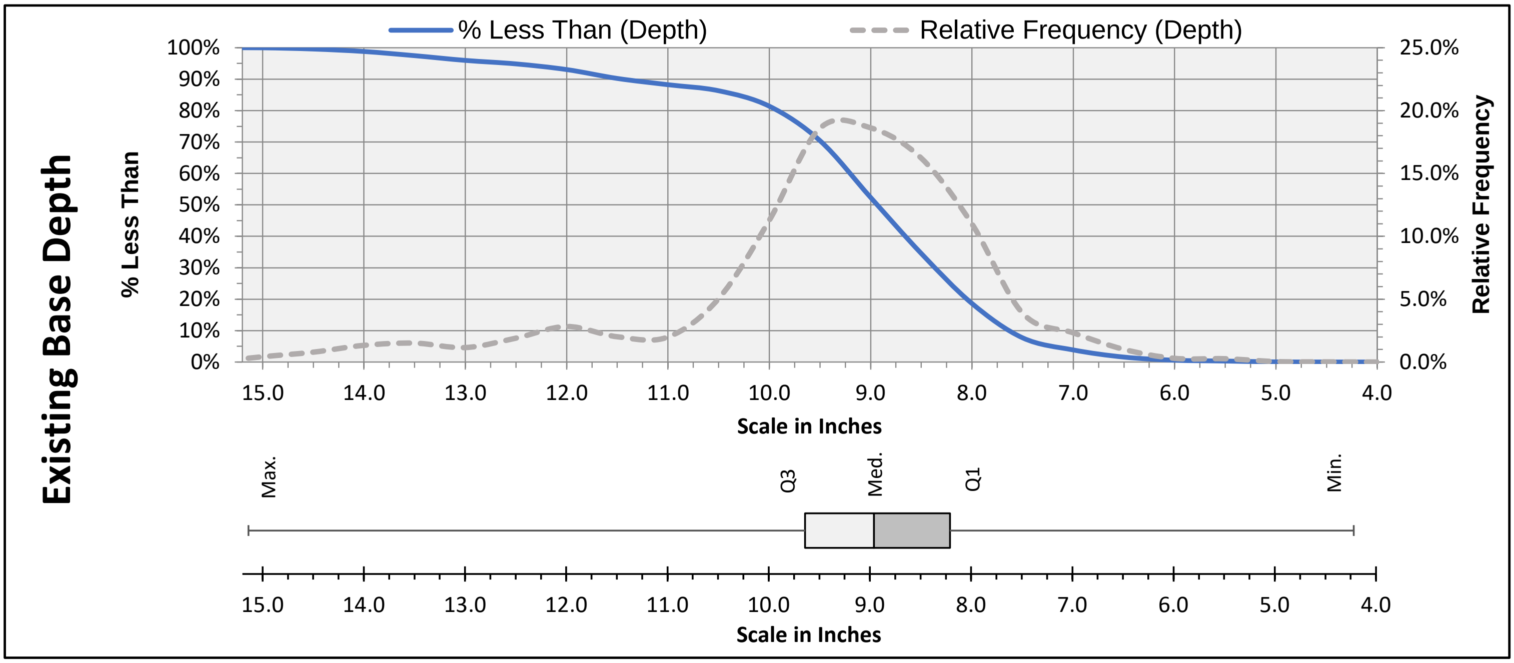
Scan Date: 6/21/2019

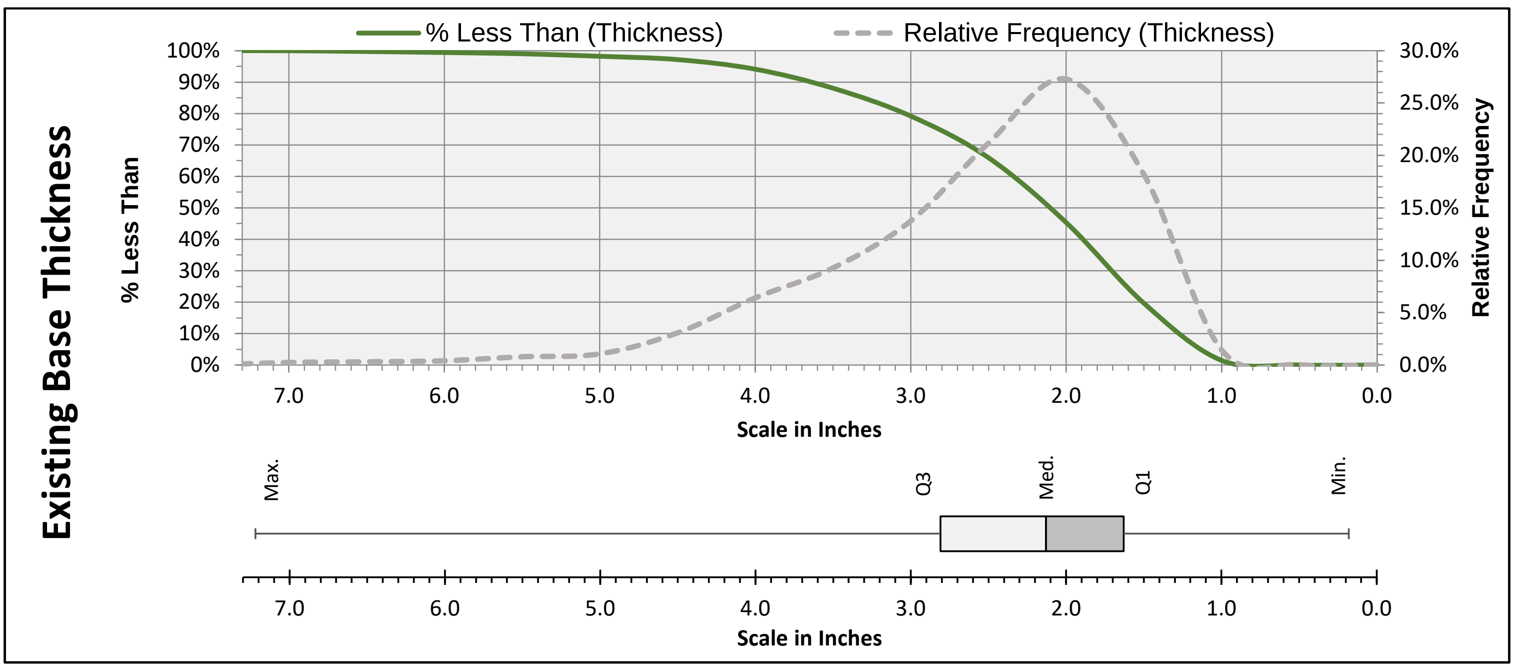
Existing Base Depth And Thickness Statistics

State FY19D4 Materials Reconnaissance (SH-75, River St to Saddle Rd, Ketchum)

SH-75, MP 128.2 to MP-129.23

(South Bound, Lane 0, Right Wheel Path)





Existing Base Depth Statistics		
Average=	9.2 in.	(0.76 ft.)
Max=	15.1 in.	(1.26 ft.)
Min=	4.2 in.	(0.35 ft.)
SD=	1.5 in.	(0.13 ft.)
Median=	9 in.	(0.75 ft.)
Q1=	8.2 in.	(0.68 ft.)
Q3=	9.6 in.	(0.8 ft.)
Total Number of Scans=	16421	

Existing Base Thickness Statistics		
Average=	2.3 in.	(0.19 ft.)
Max=	7.2 in.	(0.6 ft.)
Min=	0.2 in.	(0.02 ft.)
SD=	1 in.	(0.08 ft.)
Median=	2.1 in.	(0.18 ft.)
Q1=	1.6 in.	(0.14 ft.)
Q3=	2.8 in.	(0.23 ft.)

File No:	03224
ITD Key No:	18697
Scan Date:	6/21/2019

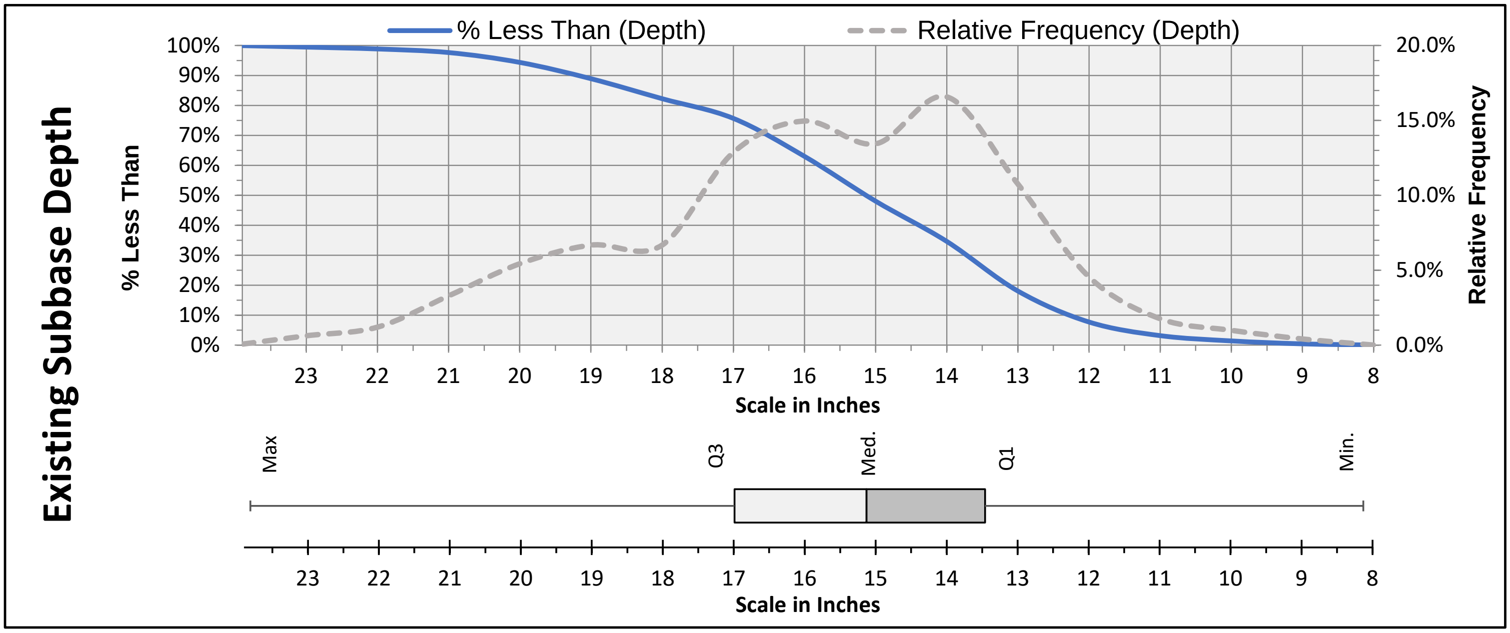
Existing Subbase Depth And Thickness Statistics

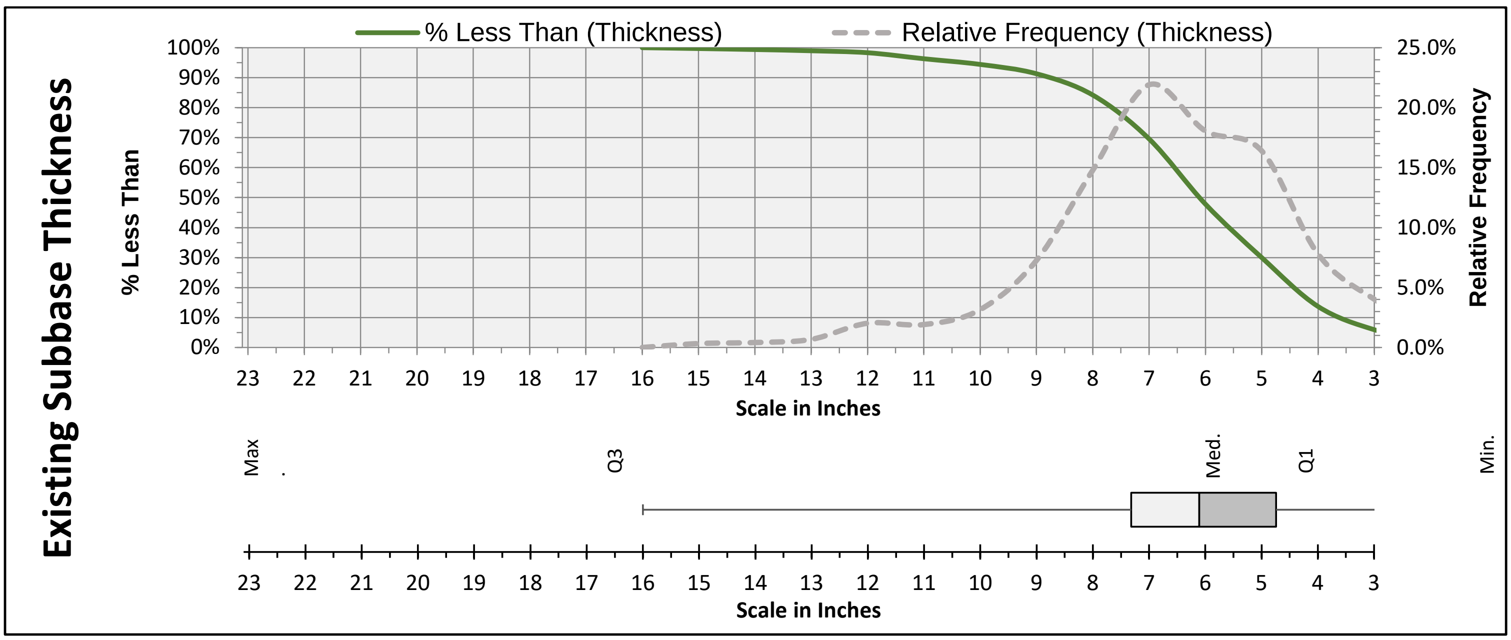
State FY19D4 Materials Reconnaissance (SH-75, River St to Saddle Rd, Ketchum)

SH-75, MP 128.2 to MP-129.23

(South Bound, Lane 0, Right Wheel Path)

AMERICAN GEO TECHNICS





Existing Subbase Depth Statistics

Average=	15.4 in.	(1.28 ft.)
Max=	23.8 in.	(1.98 ft.)
Min=	8.1 in.	(0.68 ft.)
SD=	2.7 in.	(0.22 ft.)
Median=	15.1 in.	(1.26 ft.)
Q1=	13.5 in.	(1.12 ft.)
Q3=	17 in.	(1.42 ft.)
Total Number of Scans=	16421	

Existing Subbase Thickness Statistics

Average=	6.2 in.	(0.52 ft.)
Max=	16 in.	(1.33 ft.)
Min=	0.2 in.	(0.01 ft.)
SD=	2.2 in.	(0.18 ft.)
Median=	6.1 in.	(0.51 ft.)
Q1=	4.7 in.	(0.4 ft.)
Q3=	7.3 in.	(0.61 ft.)

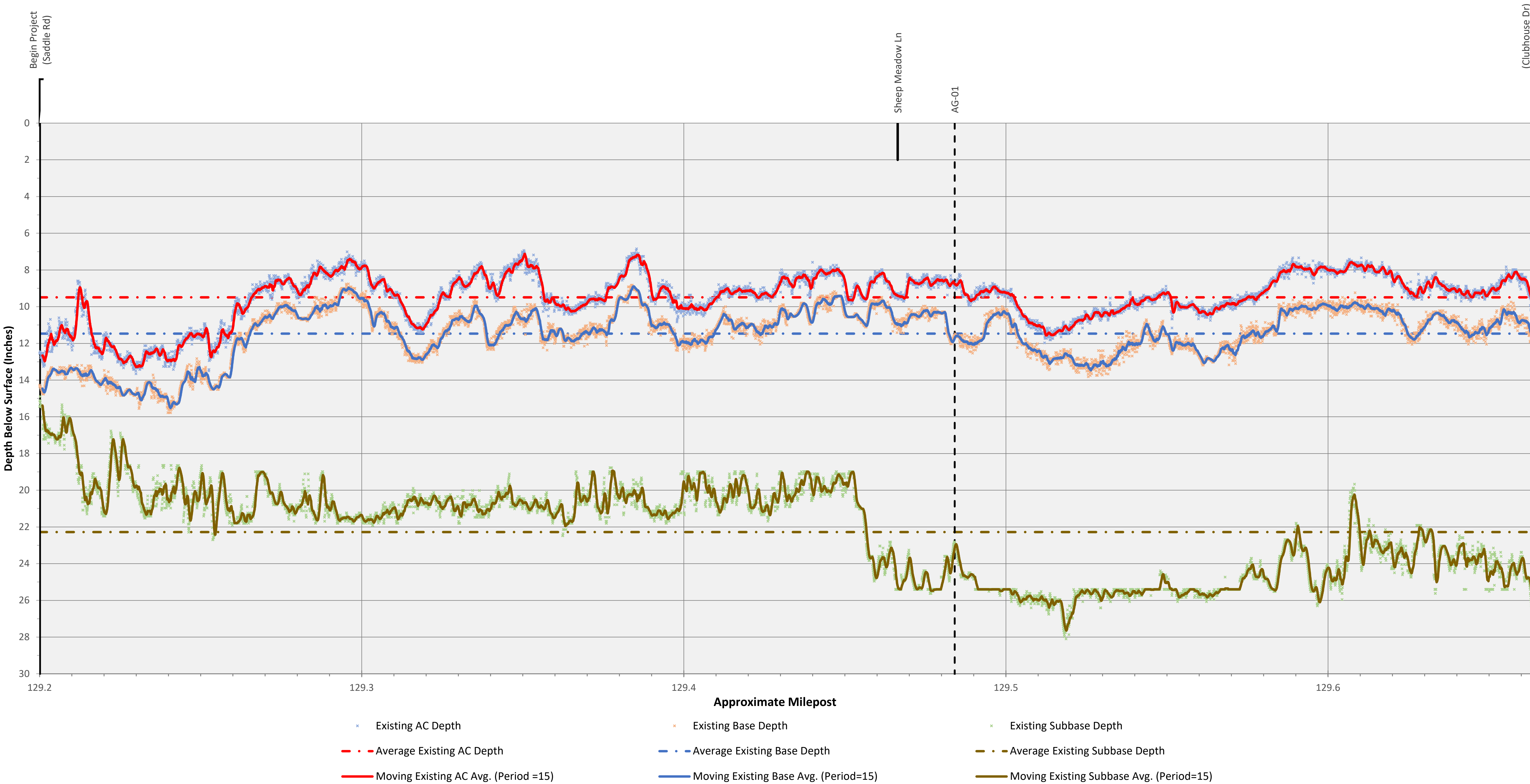
File No:	03224
ITD Key No.	18697
Scan Date:	6/21/2019

Existing Pavement Layer Depths

State FY19D4 Materials Reconnaissance (SH-75, Saddle Rd to Clubhouse Dr, Ketchum)

SH-75, MP 129.23 to MP-129.7

(South Bound, Lane 0, Right Wheel Path)



Note: GPR distance scale along the x-axis may not corespond exactly with project stationing.

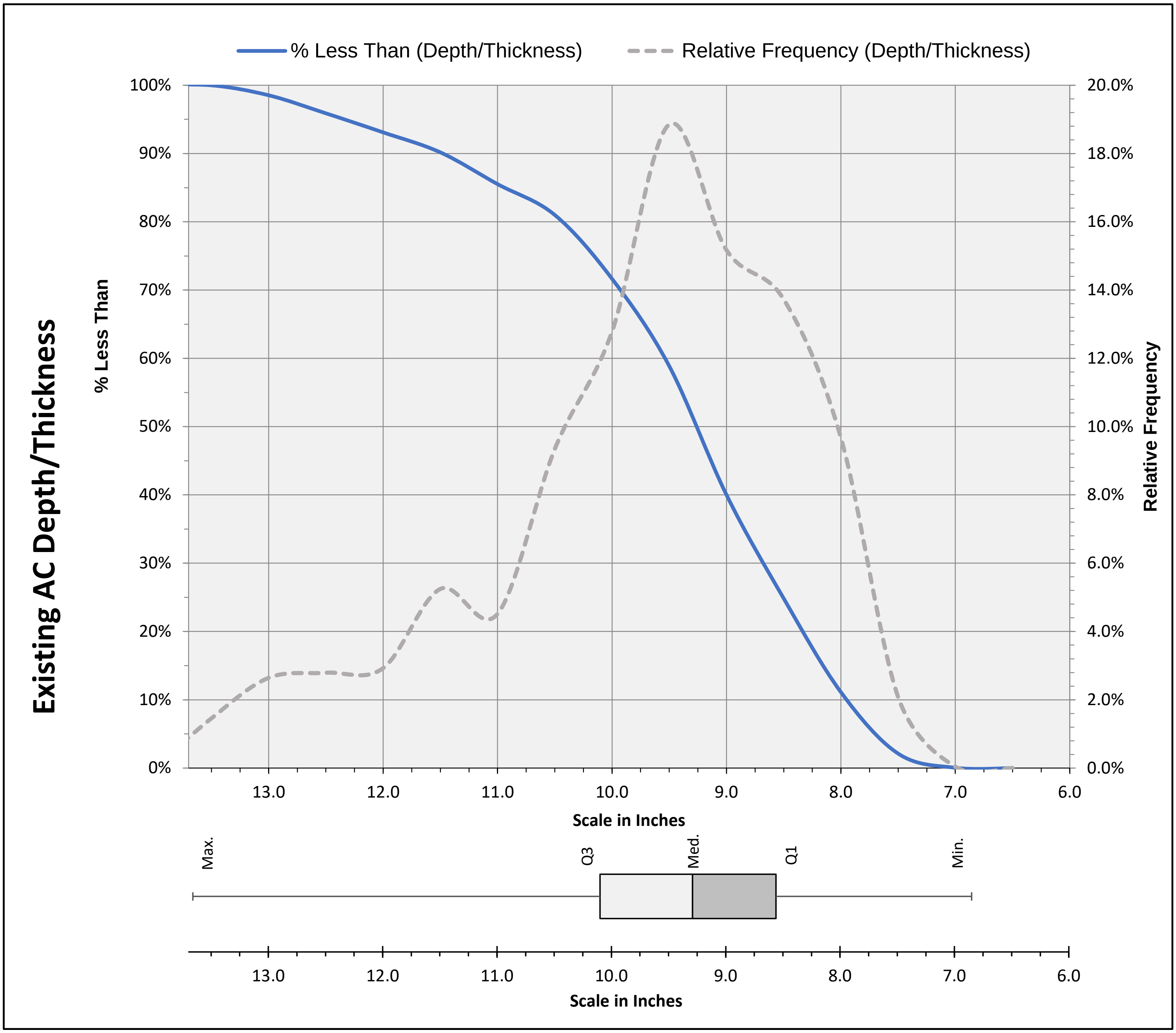
Existing AC Depth/Thickness Statistics

File No: 03224
ITD Key No: 18697
Scan Date: 6/21/2019

State FY19D4 Materials Reconnaissance (SH-75, Saddle Rd to Clubhouse Dr, Ketchum)

SH-75, MP 129.23 to MP-129.7

(South Bound, Lane 0, Right Wheel Path)



Existing AC Depth/Thickness Statistics		
Average=	9.5 in.	(0.79 ft.)
Max=	13.7 in.	(1.14 ft.)
Min=	6.9 in.	(0.57 ft.)
SD=	1.3 in.	(0.11 ft.)
Median=	9.3 in.	(0.77 ft.)
Q1=	8.6 in.	(0.71 ft.)
Q3=	10.1 in.	(0.84 ft.)
Total Number of Scans=	7415	

Existing Base Depth And Thickness Statistics

File No: 03224

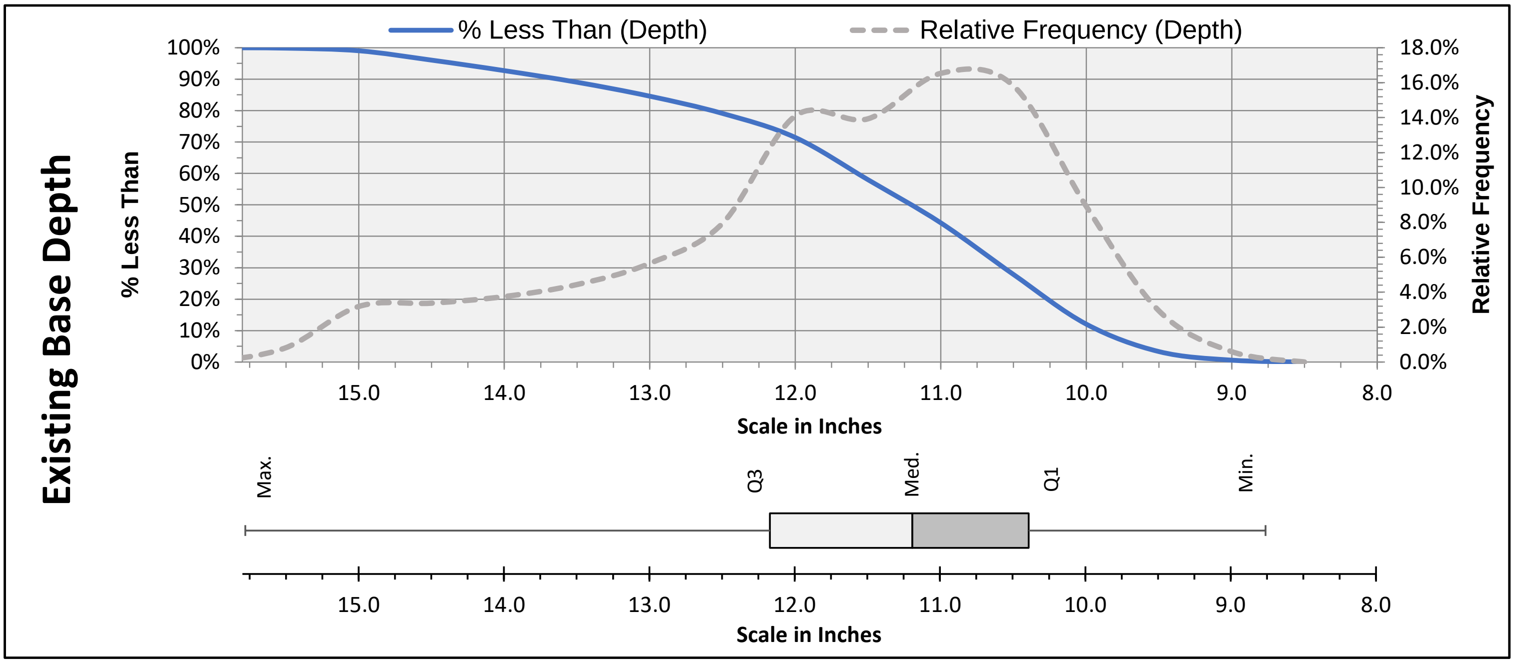
ITD Key No: 18697

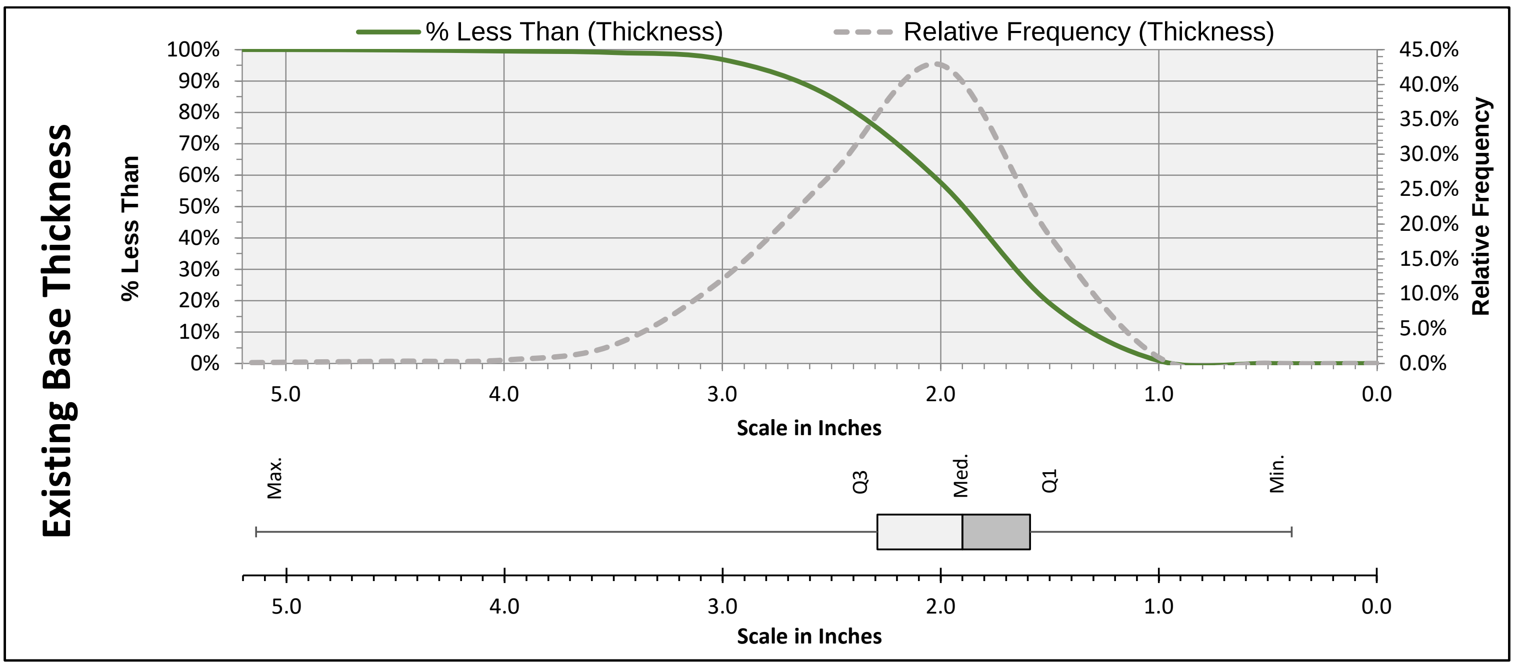
Scan Date: 6/21/2019

State FY19D4 Materials Reconnaissance (SH-75, Saddle Rd to Clubhouse Dr, Ketchum)

SH-75, MP 129.23 to MP-129.7

(South Bound, Lane 0, Right Wheel Path)





Existing Base Depth Statistics		
Average=	11.5 in.	(0.96 ft.)
Max=	15.8 in.	(1.32 ft.)
Min=	8.8 in.	(0.73 ft.)
SD=	1.4 in.	(0.12 ft.)
Median=	11.2 in.	(0.93 ft.)
Q1=	10.4 in.	(0.87 ft.)
Q3=	12.2 in.	(1.01 ft.)
Total Number of Scans=	7415	

Existing Base Thickness Statistics		
Average=	2 in.	(0.16 ft.)
Max=	5.1 in.	(0.43 ft.)
Min=	0.4 in.	(0.03 ft.)
SD=	0.5 in.	(0.04 ft.)
Median=	1.9 in.	(0.16 ft.)
Q1=	1.6 in.	(0.13 ft.)
Q3=	2.3 in.	(0.19 ft.)

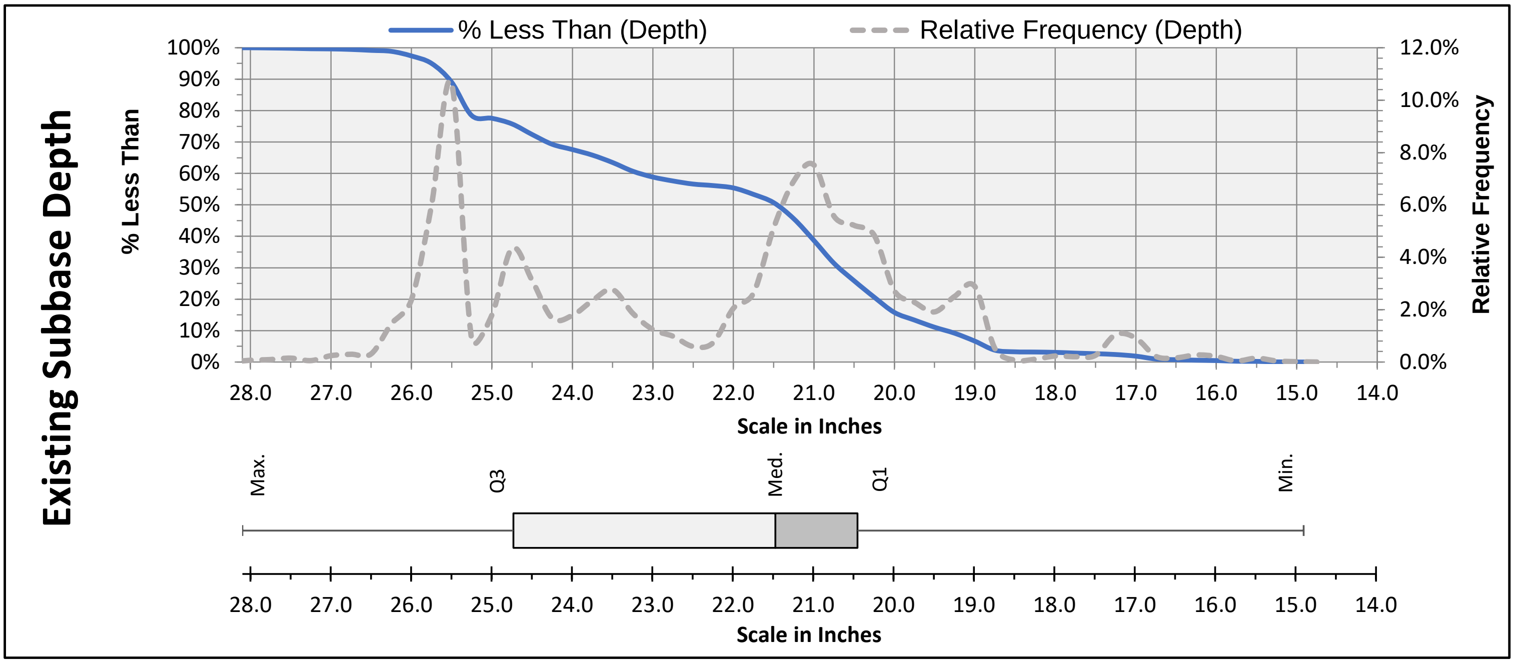
File No:	03224
ITD Key No:	18697
Scan Date:	6/21/2019

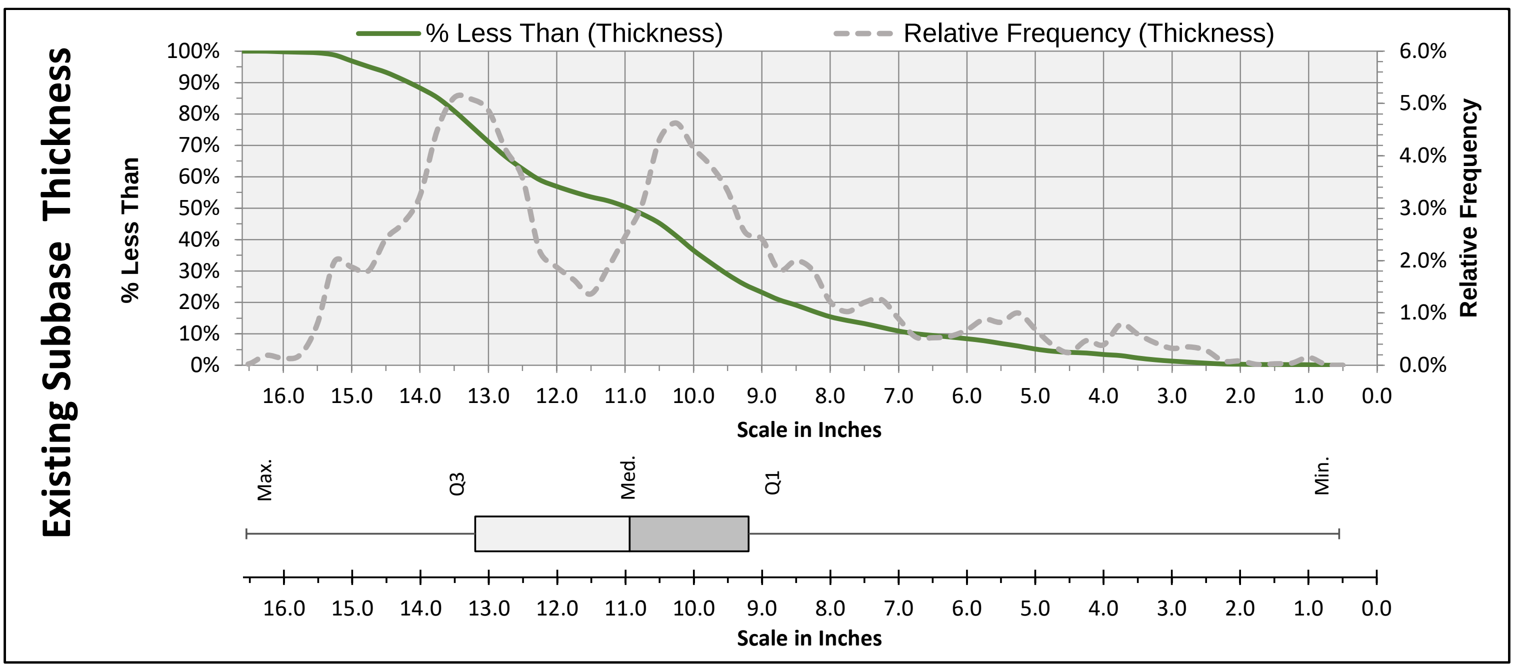
Existing Subbase Depth And Thickness Statistics

State FY19D4 Materials Reconnaissance (SH-75, Saddle Rd to Clubhouse Dr, Ketchum)

SH-75, MP 129.23 to MP-129.7

(South Bound, Lane 0, Right Wheel Path)





Existing Subbase Depth Statistics

Average=	22.3 in.	(1.86 ft.)
Max=	28.1 in.	(2.34 ft.)
Min=	14.9 in.	(1.24 ft.)
SD=	2.5 in.	(0.21 ft.)
Median=	21.5 in.	(1.79 ft.)
Q1=	20.5 in.	(1.7 ft.)
Q3=	24.7 in.	(2.06 ft.)
Total Number of Scans=	7415	

Existing Subbase Thickness Statistics

Average=	10.8 in.	(0.9 ft.)
Max=	16.6 in.	(1.38 ft.)
Min=	0.6 in.	(0.05 ft.)
SD=	3 in.	(0.25 ft.)
Median=	10.9 in.	(0.91 ft.)
Q1=	9.2 in.	(0.77 ft.)
Q3=	13.2 in.	(1.1 ft.)

Summary of FWD Data and Backcalculation Results

(ELMOD6 version 6.1.86)

Project Name: **State FY19 D4 Materials Reconnaissance**
Segment: **SH-75, River to Saddle (MP128.2 to 129.2)**
Direction: **Asc.**

Calc. Date: **10/9/2019**
File No.: **03224**

Summary of Input Data

Date of FWD Testing: **September 5, 2019**
PDAT used for Backcalculation (BELLS): **66**
FWD Plate Radius: **5.905"**

	Summary of Backcalulated Moduli (ksi)				
	AC (70°F)	Base	Subbase	Subgrade	RMS (%)
Mean:	334.7	32.4	--	18.6	2.1
Standard Deviation:	196.5	13.2	--	6.3	2.1

Distance (Miles)	FWD Normalized Load (lbs)	Pavement Deflections in Mils (inches from load plate)							Temperatures (Deg. F)			Layer Thickness (inches)			Backcalculated Elastic Modulus, E_{FWD} (ksi)				
		D(0)	D(8)	D(12)	D(18)	D(24)	D(36)	D(60)	Asphalt BELLS	Asphalt Surface	Air	AC	Base	Subbase	AC (70°F)	Base	Subbase	Subgrade	RMS (%)
0.000	12000	13.43	10.64	9.11	7.28	5.71	3.36	1.40	71.2	78.8	57.2	6.9	5.5	--	669.4	35.3	--	20.9	2.8
0.051	12000	26.22	20.38	16.12	11.07	6.02	3.73	1.93	71.2	78.8	55.4	6.9	5.5	--	191.5	20.5	--	10.1	7.8
0.100	12000	20.74	15.30	11.91	8.48	6.13	3.61	1.74	72.2	80.6	55.4	6.9	5.5	--	225.0	31.9	--	17.6	0.7
0.157	12000	18.52	12.65	9.70	7.13	5.52	3.52	1.61	72.2	80.6	55.4	6.9	5.5	--	162.9	62.5	--	26.5	1.3
0.200	12000	18.94	13.70	10.71	7.24	4.77	2.51	1.13	70.3	77.0	55.4	6.9	5.5	--	254.5	28.9	--	15.8	1.2
0.239	12000	14.89	11.76	9.67	7.01	5.01	2.96	1.35	72.2	80.6	55.4	6.9	5.5	--	444.7	29.3	--	21.6	0.8
0.300	12000	11.52	9.04	7.22	5.09	3.70	1.96	1.17	72.2	80.6	55.4	6.9	5.5	--	612.9	33.7	--	25.1	1.0
0.400	12000	23.17	18.49	15.44	11.83	8.87	3.35	1.90	72.2	80.6	55.4	6.9	5.5	--	545.3	11.8	--	6.3	6.4
0.600	12000	19.91	13.54	10.44	7.56	5.72	3.58	1.75	71.2	78.8	55.4	6.9	5.5	--	193.2	39.5	--	25.0	0.4
0.600	12000	18.90	13.39	10.35	7.45	5.55	3.48	1.89	71.2	78.8	55.4	6.9	5.5	--	167.1	34.7	--	28.6	1.2
0.701	12000	23.07	16.62	11.93	7.98	5.75	3.55	1.80	71.2	78.8	55.4	6.9	5.5	--	146.5	27.6	--	20.7	2.6
0.801	12000	18.72	13.50	10.89	8.06	6.01	3.57	1.52	71.2	78.8	55.4	6.9	5.5	--	209.0	58.2	--	18.5	0.7
0.900	12000	25.37	19.28	14.91	10.63	7.68	4.41	1.90	70.3	77.0	55.4	6.9	5.5	--	189.4	22.9	--	13.6	0.9
1.000	12000	16.30	13.22	11.60	9.18	6.98	3.78	1.67	71.2	78.8	55.4	6.9	5.5	--	659.3	25.0	--	13.0	2.9
1.044	12000	19.25	15.20	12.29	9.16	6.74	3.83	1.76	71.2	78.8	55.4	6.9	5.5	--	350.2	24.2	--	15.9	1.2

Summary of FWD Data and Backcalculation Results

(ELMOD6 version 6.1.86)

Project Name: **State FY19 D4 Materials Reconnaissance**
Segment: **SH-75, River to Saddle (MP 129.2 to 129.7)**
Direction: **Dsc.**

Calc. Date: 10/9/2019
File No.: 03224

Summary of Input Data

Date of FWD Testing: **September 5, 2019**
PDAT used for Backcalculation (BELLS): **66**
FWD Plate Radius: **5.905"**

Summary of Backcalulated Moduli (ksi)	AC (70°F)	Base	Subbase	Subgrade	RMS (%)
Mean:	385.8	34.8	--	21.2	1.4
Standard Deviation:	184.3	22.5	--	9.0	1.3

Distance (Miles)	FWD Normalized Load (lbs)	Pavement Deflections in Mils (inches from load plate)							Temperatures (Deg. F)			Layer Thickness (inches)			Backcalculated Elastic Modulus, E_{FWD} (ksi)				
		D(0)	D(8)	D(12)	D(18)	D(24)	D(36)	D(60)	Asphalt BELLS	Asphalt Surface	Air	AC	Base	Subbase	AC (70°F)	Base	Subbase	Subgrade	RMS (%)
-1.050	12000	14.08	12.33	10.45	8.09	6.34	3.85	1.53	71.2	78.8	55.4	6.9	5.5	--	727.6	14.4	--	23.5	1.2
-1.004	12000	15.00	11.27	8.51	5.75	4.17	2.68	1.54	71.2	78.8	55.4	6.9	5.5	--	282.2	19.1	--	45.7	1.2
-0.958	12000	18.28	14.43	11.63	8.13	5.73	3.06	1.36	71.2	78.8	55.4	6.9	5.5	--	372.1	20.6	--	15.6	0.0
-0.905	12000	19.61	14.54	11.10	7.36	4.89	2.69	1.32	71.2	78.8	55.4	6.9	5.5	--	245.9	26.3	--	16.4	1.4
-0.850	12000	21.80	15.40	11.56	7.50	5.12	3.00	1.24	71.2	78.8	55.4	6.9	5.5	--	177.0	27.6	--	17.9	1.7
-0.798	12000	42.81	30.28	20.21	11.19	7.19	3.86	1.80	71.2	78.8	55.4	6.9	5.5	--	72.3	18.4	--	7.1	5.8
-0.749	12000	12.22	9.93	8.29	6.43	4.96	3.02	1.55	71.2	78.8	55.4	6.9	5.5	--	657.3	24.6	--	30.8	1.8
-0.700	12000	12.22	9.70	8.04	6.13	4.65	2.83	1.30	71.2	78.8	55.4	6.9	5.5	--	586.8	28.6	--	31.3	1.6
-0.601	12000	18.86	14.41	12.12	9.25	7.09	4.41	1.89	71.2	78.8	55.4	6.9	5.5	--	293.6	36.7	--	19.3	1.2
-0.501	12000	18.11	13.15	10.36	7.40	5.40	3.18	1.57	71.2	78.8	55.4	6.9	5.5	--	236.4	40.4	--	20.4	0.7
-0.400	12000	15.29	12.48	10.69	8.41	6.53	3.94	1.66	71.2	78.8	53.6	6.9	5.5	--	521.1	42.4	--	17.0	1.2
-0.301	12000	16.93	14.17	12.11	9.27	7.09	4.24	2.01	71.2	78.8	53.6	6.9	5.5	--	528.4	15.1	--	19.7	0.8
-0.200	12000	14.96	11.98	10.32	8.31	6.65	4.29	1.97	71.2	78.8	53.6	6.9	5.5	--	385.6	84.1	--	19.6	0.9
-0.100	12000	18.37	14.56	12.07	9.23	7.17	4.29	1.88	71.2	78.8	53.6	6.9	5.5	--	354.3	35.7	--	16.6	1.2
0.000	12000	16.94	13.90	12.01	9.94	8.18	5.63	2.99	71.2	78.8	53.6	6.9	5.5	--	346.2	87.6	--	17.9	0.6

Appendix E

Traffic Data

Traffic Projection worksheet

Traffic Data Summary

Projected commercial and 18,000 Equivalent Single Axle Loadings (ESALS)

Project number: Key number: Location: River St to Clubhouse Dr

Route: SH-75 RouteID:)2230ASH075 From Measure: 54.053 To Measure: 54.762

Truck Density = 2 Medium Last year with data: 2018 Cumulating ESALs up to: 2044 Starting to Cumulate in: 2024

Year	ADTS			Rigid Pavement ESALs (In 1000s)				Flexible Pavement ESALs (In 1000s)			
				Both Directions		50% Dir of Travel		Both Directions		50% Dir of Travel	
	Total	Pass	Comm	Year Value	Cumulative	50% Year	50% Cum	Year Value	Cumulative	50% Year	50% Cum
2018	14000	12800	1200								
2024	17430	15870	1560	1203	1203	601	601	650	650	325	325
2025	18000	16380	1620	1261	2463	630	1232	681	1331	341	666
2026	18580	16900	1680	1326	3789	663	1895	719	2050	359	1025
2027	19150	17410	1740	1392	5181	696	2591	751	2801	375	1400
2028	19720	17920	1800	1453	6634	727	3317	783	3584	392	1792
2029	20290	18430	1860	1522	8157	761	4078	816	4400	408	2200
2030	20860	18940	1920	1592	9749	796	4874	856	5256	428	2628
2031	21440	19460	1980	1656	11405	828	5703	890	6147	445	3073
2032	22010	19970	2040	1729	13134	864	6567	925	7071	462	3536
2033	22580	20480	2100	1795	14929	898	7465	960	8031	480	4016
2034	23150	20990	2160	1870	16799	935	8400	1003	9034	501	4517
2035	23720	21500	2220	1946	18745	973	9373	1039	10073	519	5036
2036	24300	22020	2280	2016	20761	1008	10381	1075	11148	538	5574
2037	24870	22530	2340	2094	22855	1047	11428	1112	12260	556	6130
2038	25440	23040	2400	2174	25029	1087	12515	1158	13418	579	6709
2039	26010	23550	2460	2246	27276	1123	13638	1196	14614	598	7307
2040	26580	24060	2520	2329	29605	1164	14802	1234	15848	617	7924
2041	27160	24580	2580	2403	32008	1202	16004	1273	17121	637	8561
2042	27730	25090	2640	2488	34496	1244	17248	1322	18443	661	9222
2043	28300	25600	2700	2574	37070	1287	18535	1362	19805	681	9902
2044	28870	26110	2760	2651	39721	1326	19861	1402	21207	701	10604

Traffic Projection Worksheet

Project: **SH-75, River St to Clubhouse Dr.** Date: **August 5, 2019**

	Beginning Year:		Ending Year:		Analysis Period: (Years)
Flexible Pavement -->	Beginning Year:	2024	Ending Year:	2044	20
Rigid Pavement -->	Beginning Year:		Ending Year:		NA

	Roadway Segment					
	SH-75					
Lane Information						
No. of Lanes in Design Direction	**1**					
% Split of Trucks in Design Direction	**57%**					
% of Trucks in Design Lane	**100%**					
From ITD's AADT Projection Report (Flexible)						
Total Traffic - Both Directions						
2024 AADT						
2044 AADT						
AADT for the Analysis Period						
Truck Traffic - Both Directions						
% Truck Traffic						
AADTT						
Truck Density (H, M, L)						
Design Lane						
AADTT						
Traffic Index, TI						
Flexible Design ESALs						
Compound Annual Growth Rate						
From ITD's ESAL Projection Report (Flexible)						
Flexible ESAL Projections - Both Directions						
2024 Yearly and Cummulative ESALs	**650,000**					
2044 Yearly ESALs	**1,402,000**					
2044 Cummulative ESALs	**21,207,000**					
Design Lane						
Flexible Design ESALs	**11,717,490**					
Traffic Index, TI	**12.1**					
Compound Annual Growth Rate						
From ITD's ESAL Projection Report (Rigid)						
Rigid ESAL Projections - Both Directions						
Yearly and Cummulative ESALs						
Yearly ESALs						
Cummulative ESALs						
Design Lane						
Rigid Design ESALs						
Compound Annual Growth Rate						

Traffic Data Summary (by Vehicle Classification)

Project Name: State FY19 D4 Materials Reconnaissance
Client: ITD
File No.: 03224
Date Prepared: 10/7/2019

Segment: SH-75, River St to Clubhouse Dr **Traffic Count Duration:** 14 days

Northbound

		Trips Per FHWA Vehicle Class													
		1	2	3	4	5	6	7	8	9	10	11	12	13	
Date	Time	Motorcycle	Cars and Trailers	2-axle	Buses	2-axle 6-tire	3-axle single	4 axle single	<5-axle double	5 axle double	>6 axle double	<6 axle multi	6 axle multi	>6 axle multi	Total
7/4/2019	24 Hrs	24	1924	784	12	502	3	0	83	6	0	1	0	0	3,339
7/5/2019	24 Hrs	28	2521	1104	19	680	5	0	106	3	0	1	0	0	4,467
7/6/2019	24 Hrs	43	2200	932	23	575	7	0	61	3	0	1	0	0	3,845
7/7/2019	24 Hrs	24	1571	638	28	367	3	0	57	1	0	2	0	0	2,691
7/8/2019	24 Hrs	27	1971	890	36	555	23	7	81	11	3	1	0	2	3,607
7/9/2019	24 Hrs	27	2127	991	31	635	19	16	75	11	1	3	0	0	3,936
7/10/2019	24 Hrs	39	2133	1050	49	638	4	9	111	13	3	2	0	1	4,052
7/11/2019	24 Hrs	23	2175	1126	36	695	14	4	139	14	2	1	0	0	4,229
7/12/2019	24 Hrs	32	2281	1203	44	727	11	6	144	5	4	0	0	0	4,457
7/13/2019	24 Hrs	27	2192	880	21	504	4	0	72	2	1	1	0	0	3,704
7/14/2019	24 Hrs	29	1636	697	25	414	2	0	54	3	0	1	0	0	2,861
7/15/2019	24 Hrs	27	1991	939	26	620	7	5	90	13	2	1	0	0	3,721
7/16/2019	24 Hrs	62	2135	938	37	656	51	9	90	11	0	5	0	0	3,994
7/17/2019	24 Hrs	37	2136	964	34	655	40	10	119	17	3	0	0	1	4,016
	TOTAL	449	28993	13136	421	8223	193	66	1282	113	19	20	0	4	52,919

Southbound

		Trips Per FHWA Vehicle Class													
		1	2	3	4	5	6	7	8	9	10	11	12	13	
Date	Time	Motorcycle	Cars and Trailers	2-axle	Buses	2-axle 6-tire	3-axle single	4 axle single	<5-axle double	5 axle double	>6 axle double	<6 axle multi	6 axle multi	>6 axle multi	Total
7/4/2019	24 Hrs	15	1849	705	1	290	3	0	23	9	0	0	0	0	2,895
7/5/2019	24 Hrs	10	2638	1171	10	440	8	0	85	6	0	5	0	1	4,374
7/6/2019	24 Hrs	16	2505	1146	14	375	4	0	111	8	0	3	0	0	4,182
7/7/2019	24 Hrs	28	2182	1059	22	371	1	0	251	1	0	3	0	0	3,918
7/8/2019	24 Hrs	9	1999	1026	9	403	22	0	75	18	4	0	0	0	3,565
7/9/2019	24 Hrs	10	2195	1143	10	463	25	0	56	14	1	1	0	0	3,918
7/10/2019	24 Hrs	8	2082	1165	29	473	20	3	78	13	3	0	0	0	3,874
7/11/2019	24 Hrs	3	2186	1249	36	493	16	2	69	19	3	1	0	0	4,077
7/12/2019	24 Hrs	9	2183	1292	22	449	21	0	80	7	3	3	0	0	4,069
7/13/2019	24 Hrs	19	2087	980	8	316	4	0	97	2	1	2	0	0	3,516
7/14/2019	24 Hrs	11	2021	1007	14	344	2	0	170	2	0	0	0	0	3,571
7/15/2019	24 Hrs	10	2060	1082	8	446	15	0	75	20	2	1	0	0	3,719
7/16/2019	24 Hrs	5	2214	1027	13	473	41	6	84	14	1	2	0	0	3,880
7/17/2019	24 Hrs	8	2180	1126	8	501	32	0	68	18	3	0	0	2	3,946
	TOTAL	161	30381	15178	204	5837	214	11	1322	151	21	21	0	3	53,504

TOTAL Both Directions:	610	59374	28314	625	14060	407	77	2604	264	40	41	0	7	106,423
% of Total NB & SB:	0.57%	55.79%	26.61%	0.59%	13.21%	0.38%	0.07%	2.45%	0.25%	0.04%	0.04%	0.00%	0.01%	100%
Average Daily Traffic (ADT)(14 days):	44	4241	2022	45	1004	29	6	186	19	3	3	0	1	7,602
Directional Distribution Factors:	74%	51%	54%	67%	58%	53%	86%	51%	57%	53%	51%	50%	57%	
Percent Traffic in Design Direction:	50%													

Commerical Average Daily Traffic (ADTT):				45	1,004	29	6	186	19	3	3	0	1	1295
Commercial Vehicle Class Distribution:				3.45%	77.57%	2.25%	0.42%	14.37%	1.46%	0.22%	0.23%	0.00%	0.04%	100%
Directional Distribution Factors:				67%	58%	53%	86%	51%	57%	53%	51%	50%	57%	
Percent Trucks in Design Direction:	57%													

Appendix F

AASHTOWare Pavement ME Results:

- Asphalt Removal and Replacement
- Flexible Reconstruction

LTPPBind output

SH-75 AC Removal and Replacement (River to Saddle)

File Name: C:\Users\MEarl\Desktop\SH-75 AC Removal and Replacement (River to Saddle).dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: June, 2024
Pavement construction: July, 2024
Traffic opening: August, 2024

Climate Data Sources (Lat/Lon): 43.5, -114.375; 43.5, -113.75; 44, -113.75

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	New HMA (PG 70-34)	6.0
NonStabilized	New & Existing Base/Subbase	9.4
Subgrade	Subgrade	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	11.6
Air voids (%)	7.5

Traffic

Age (year)	Heavy Trucks (cumulative)
2024 (initial)	1,560
2034 (10 years)	4,047,120
2044 (20 years)	10,515,000

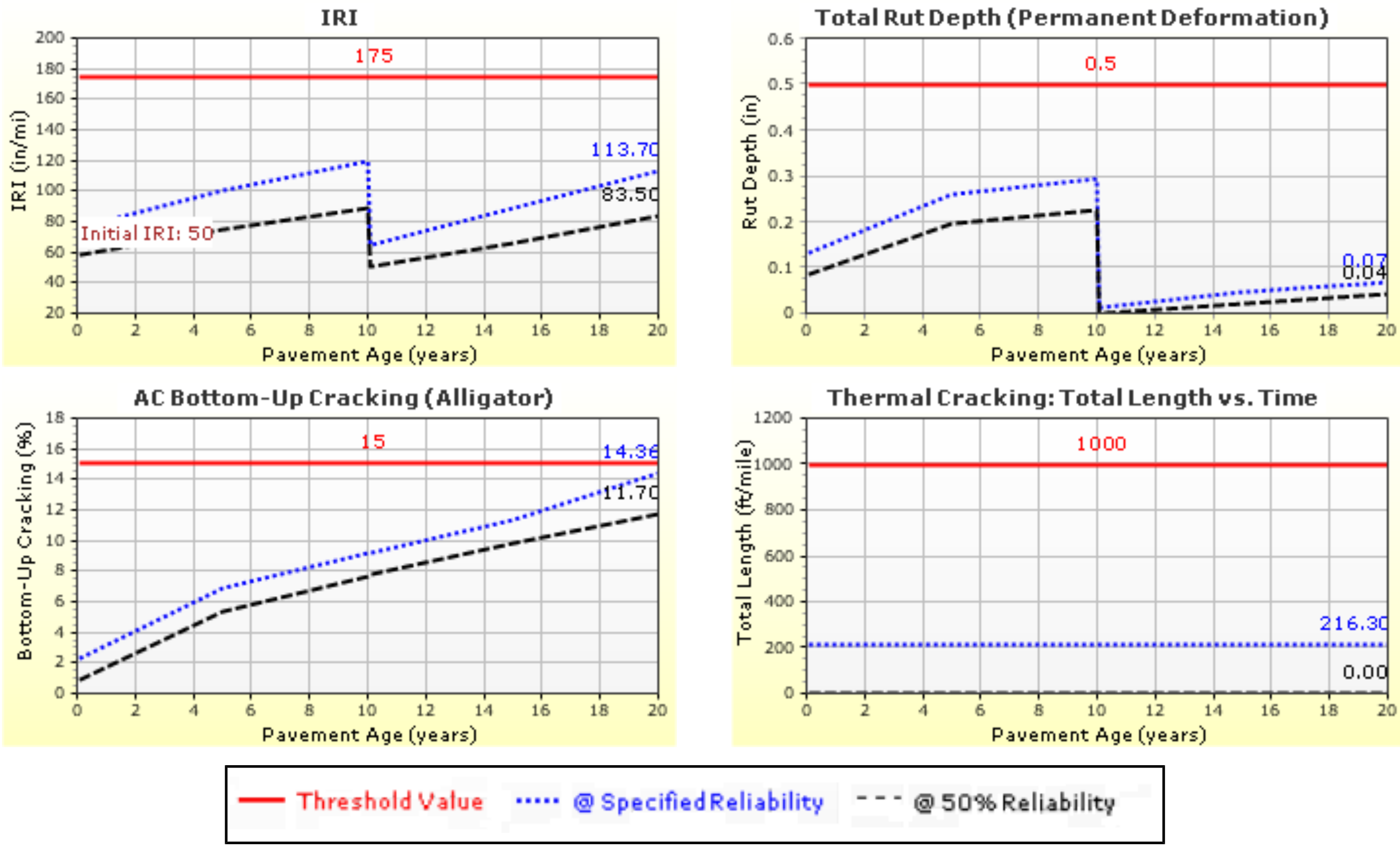
Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	175.00	113.74	90.00	99.99	Pass
Permanent deformation - total pavement (in)	0.50	0.07	90.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	15.00	14.36	90.00	94.39	Pass
AC thermal cracking (ft/mile)	1000.00	216.30	90.00	100.00	Pass
Permanent deformation - AC only (in)	0.20	0.03	90.00	100.00	Pass

Design traffic (flexible pavements) = 11.68 million ESALs

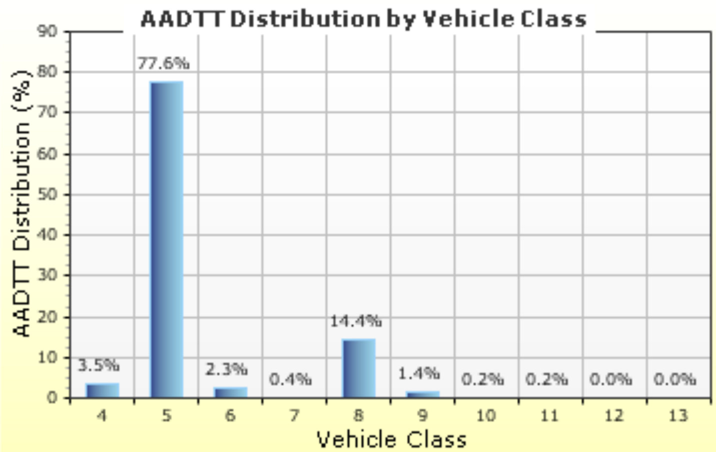
Distress Charts

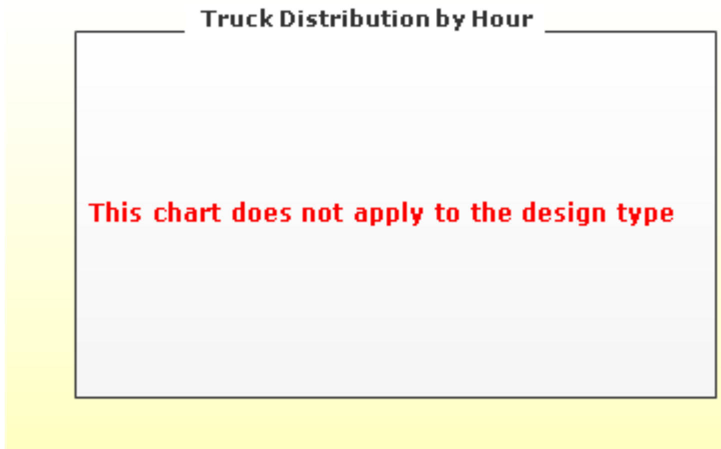


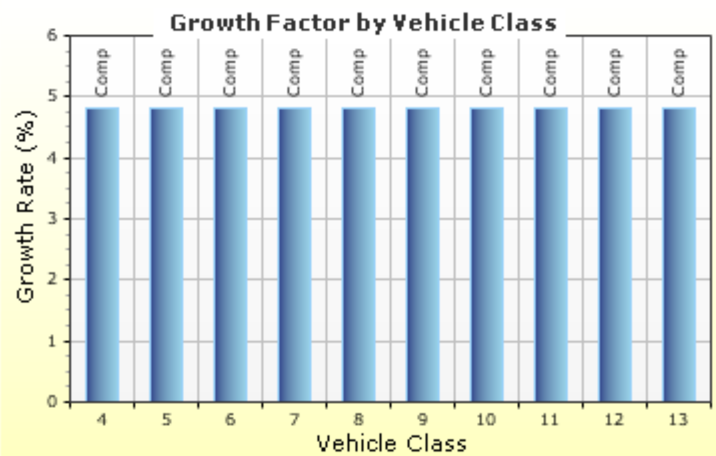
Traffic Inputs

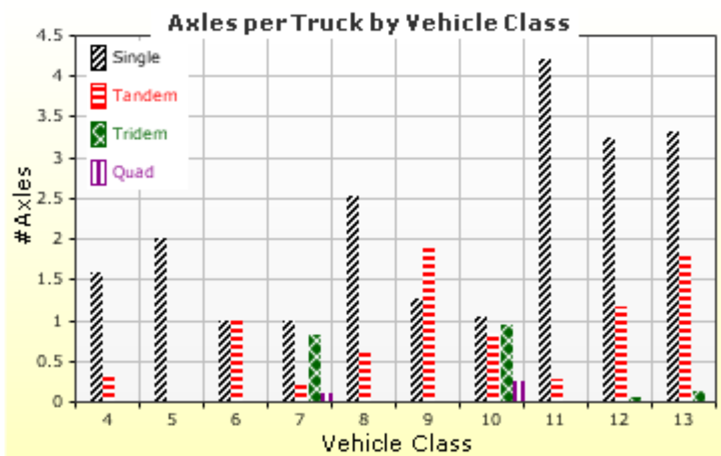
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	1,560	Percent of trucks in design direction (%):	57.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	25.0

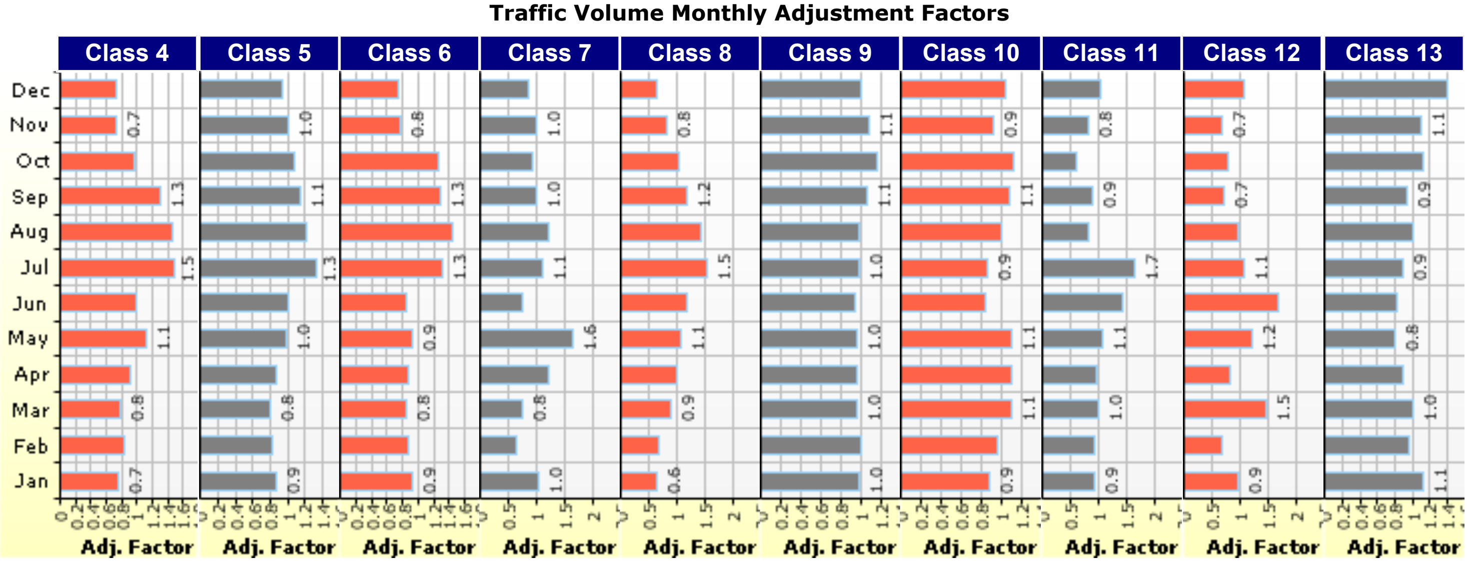








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.7	0.9	0.9	1.0	0.6	1.0	0.9	0.9	0.9	1.1
February	0.8	0.8	0.9	0.6	0.7	1.0	1.0	0.9	0.7	1.0
March	0.8	0.8	0.8	0.8	0.9	1.0	1.1	1.0	1.5	1.0
April	0.9	0.9	0.9	1.2	1.0	1.0	1.1	0.9	0.8	0.9
May	1.1	1.0	0.9	1.6	1.1	1.0	1.1	1.1	1.2	0.8
June	1.0	1.0	0.8	0.7	1.2	0.9	0.8	1.4	1.7	0.8
July	1.5	1.3	1.3	1.1	1.5	1.0	0.9	1.7	1.1	0.9
August	1.5	1.2	1.5	1.2	1.4	1.0	1.0	0.8	1.0	1.0
September	1.3	1.1	1.3	1.0	1.2	1.1	1.1	0.9	0.7	0.9
October	0.9	1.1	1.3	0.9	1.0	1.2	1.1	0.6	0.8	1.1
November	0.7	1.0	0.8	1.0	0.8	1.1	0.9	0.8	0.7	1.1
December	0.7	0.9	0.7	0.9	0.6	1.0	1.0	1.0	1.1	1.4

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	3.5%	4.8%	Compound
Class 5	77.6%	4.8%	Compound
Class 6	2.3%	4.8%	Compound
Class 7	0.4%	4.8%	Compound
Class 8	14.4%	4.8%	Compound
Class 9	1.4%	4.8%	Compound
Class 10	0.2%	4.8%	Compound
Class 11	0.2%	4.8%	Compound
Class 12	0%	4.8%	Compound
Class 13	0%	4.8%	Compound

Truck Distribution by Hour does not apply

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

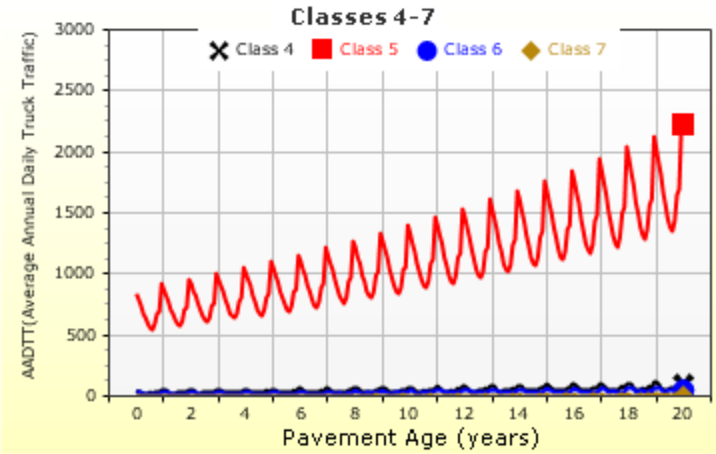
Wheelbase does not apply

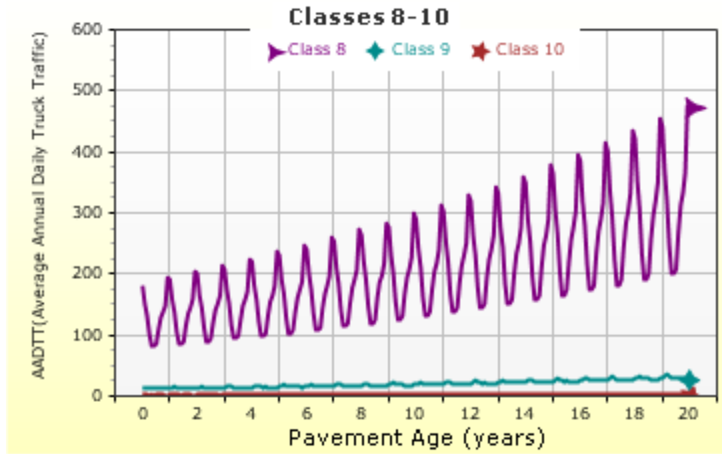
Number of Axles per Truck

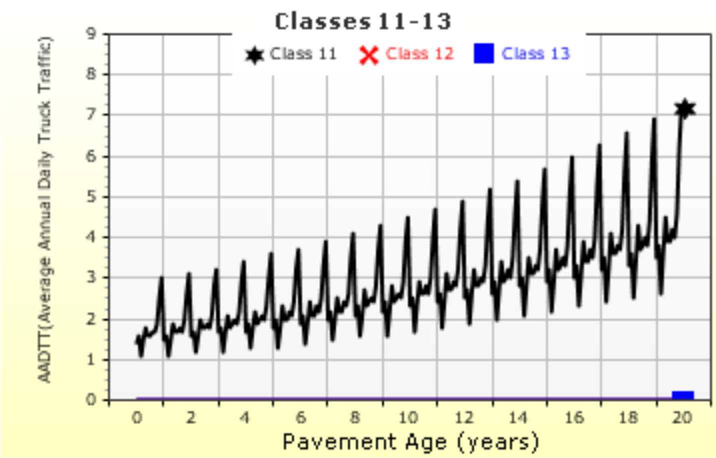
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.59	0.34	0	0
Class 5	2	0	0	0
Class 6	1	1	0	0
Class 7	1	0.22	0.83	0.1
Class 8	2.52	0.6	0	0
Class 9	1.25	1.87	0	0
Class 10	1.03	0.85	0.95	0.26
Class 11	4.21	0.29	0.01	0
Class 12	3.24	1.16	0.07	0.01
Class 13	3.32	1.79	0.14	0.02

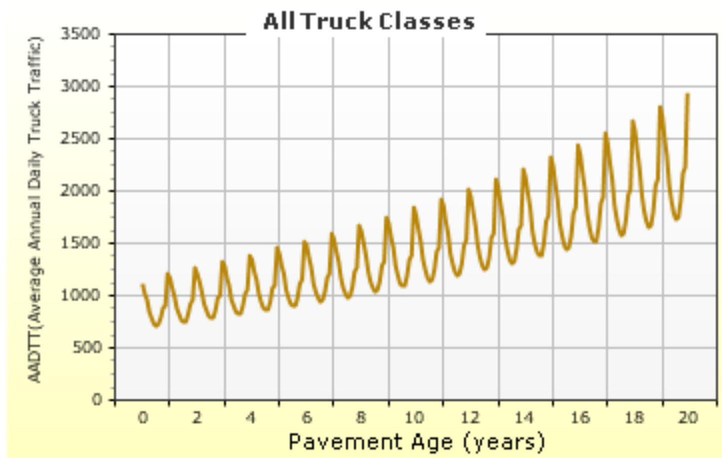
AADTT (Average Annual Daily Truck Traffic) Growth

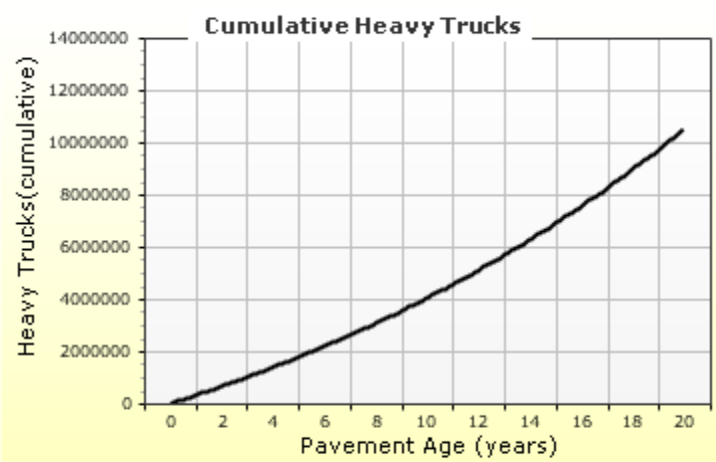
*** Traffic cap is not enforced**







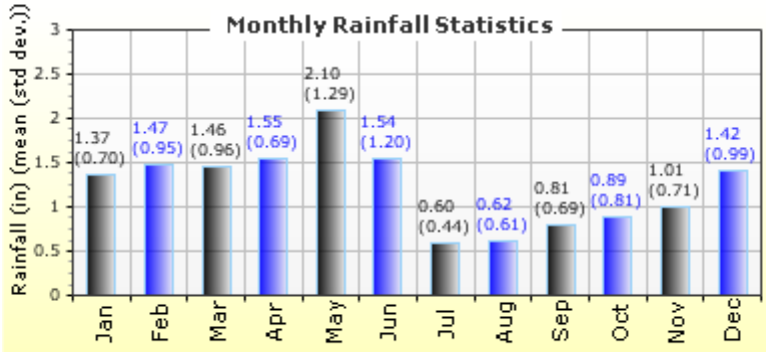




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
US, ID	43.50000 -114.37500 5697
US, ID	43.50000 -113.75000 6658
US, ID	44.00000 -113.75000 6344

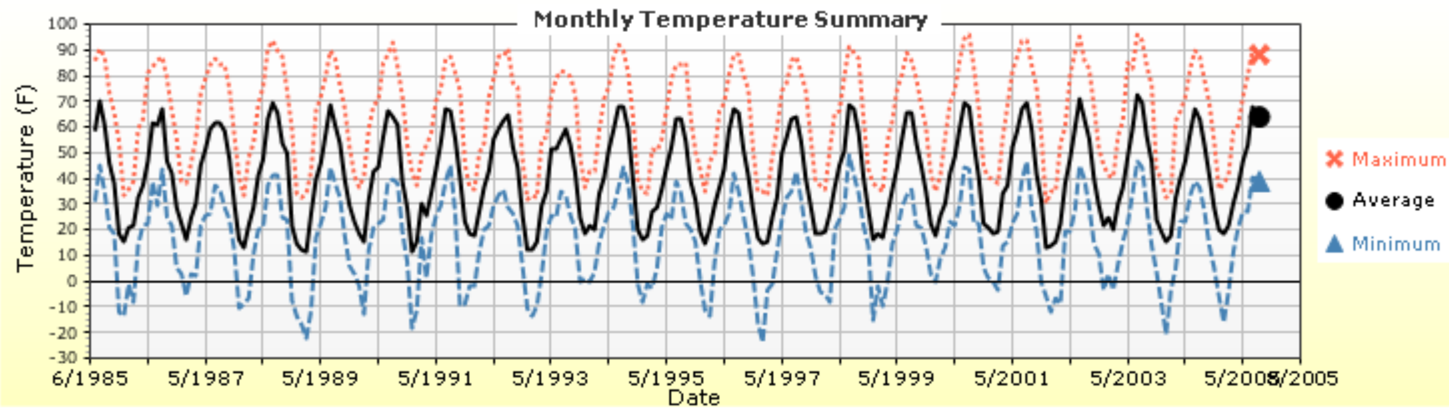


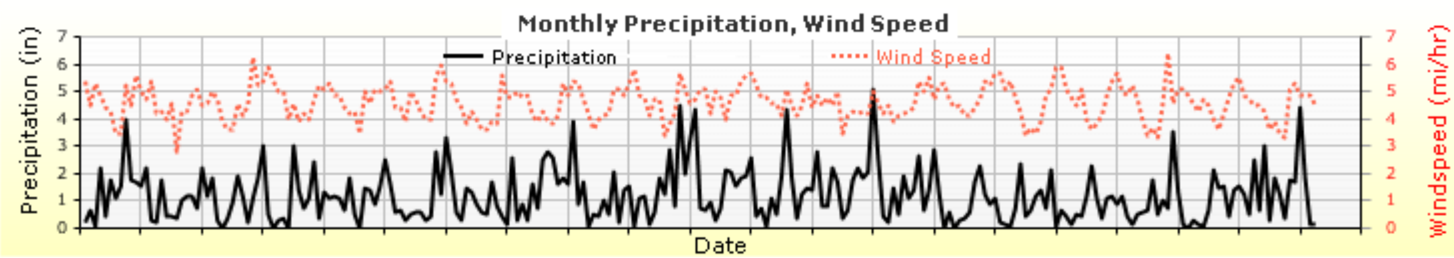
Annual Statistics:

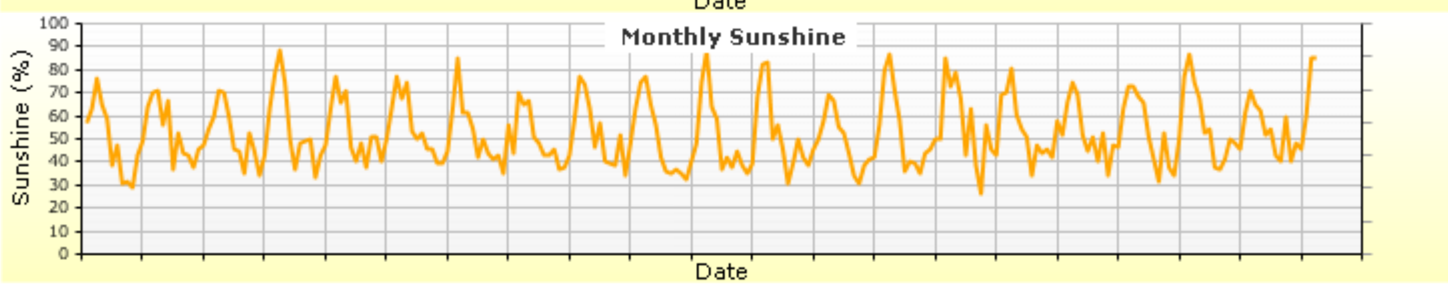
Mean annual air temperature (ºF)	40.86
Mean annual precipitation (in)	14.79
Freezing index (ºF - days)	1430.72
Average annual number of freeze/thaw cycles:	116.08

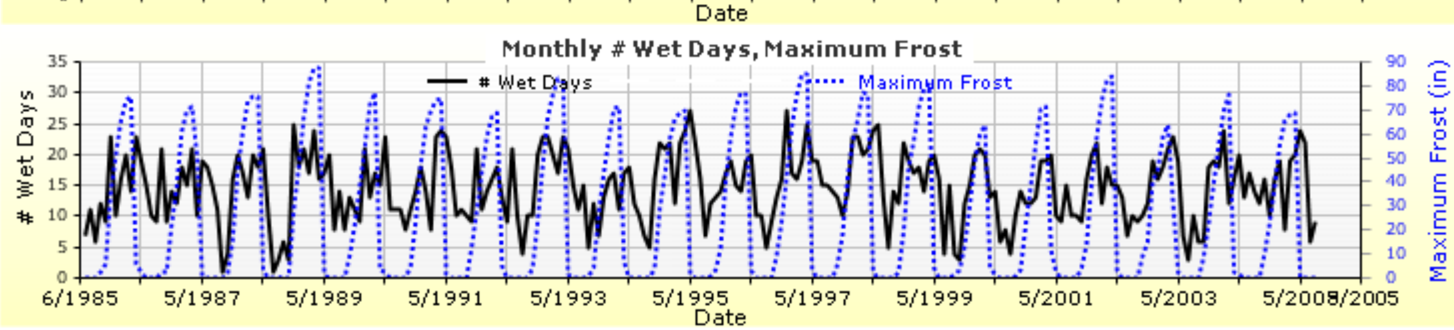
Water table depth (ft)	10.00

Monthly Climate Summary:

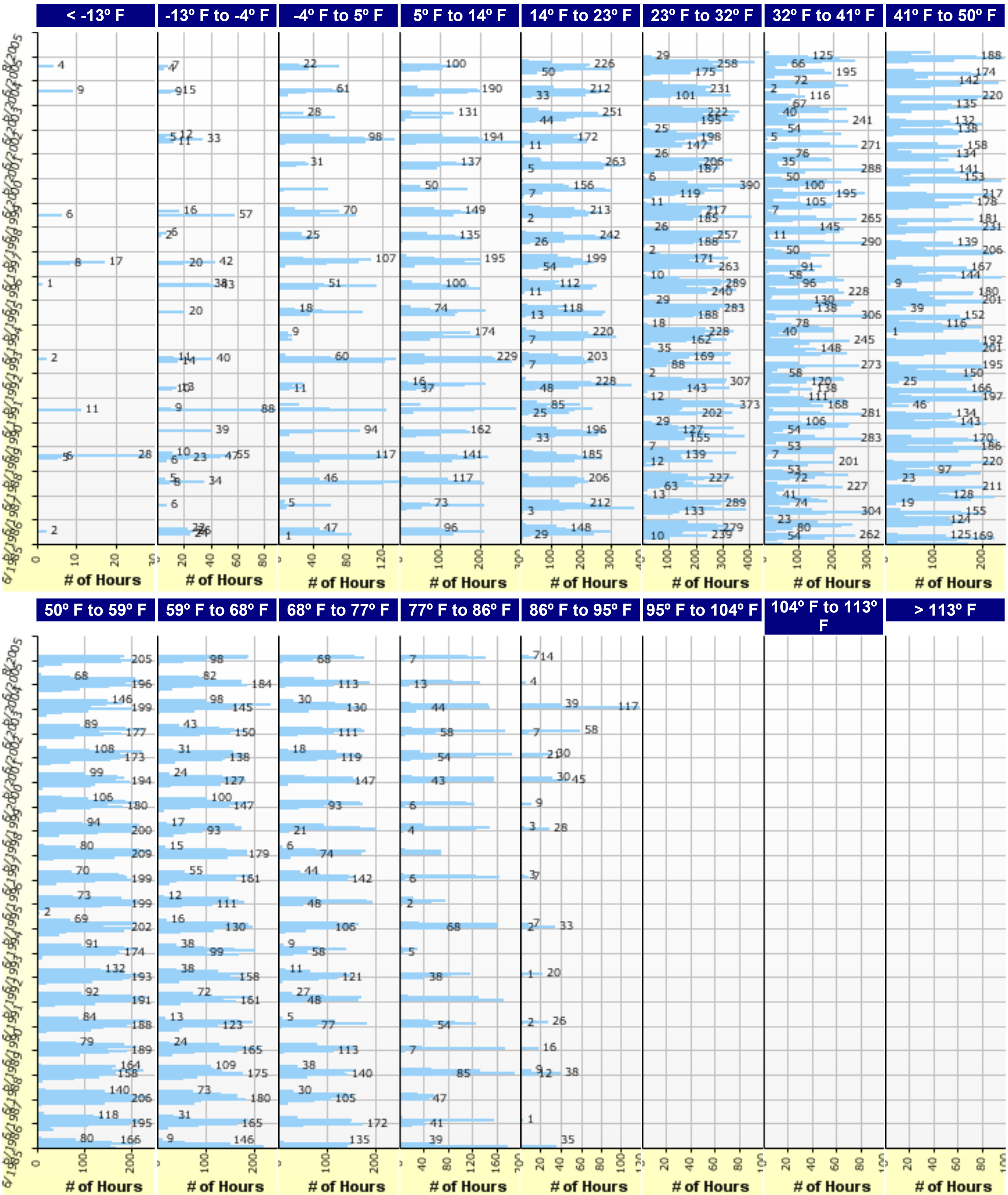








Hourly Air Temperature Distribution by Month:



Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : New HMA (PG 70-34)	Flexible (1)	1.00
Layer 2 Non-stabilized Base : New & Existing Base/Subbase	Non-stabilized Base (4)	1.00
Layer 3 Subgrade : Subgrade	Subgrade (5)	-

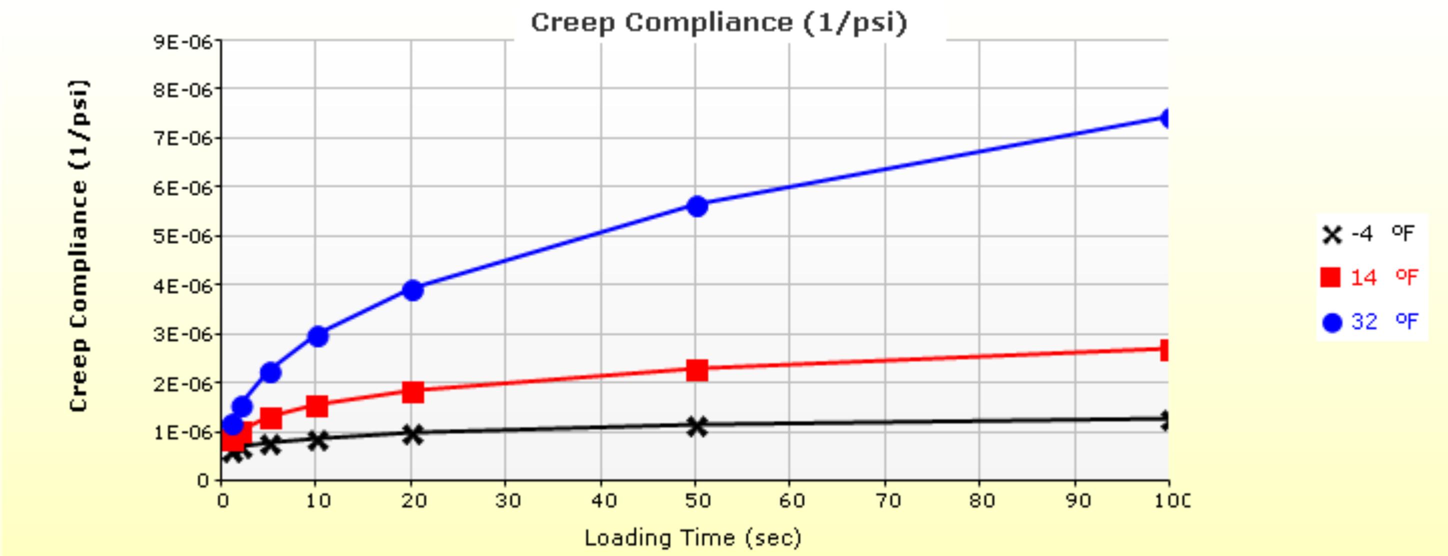
Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

Thermal Cracking

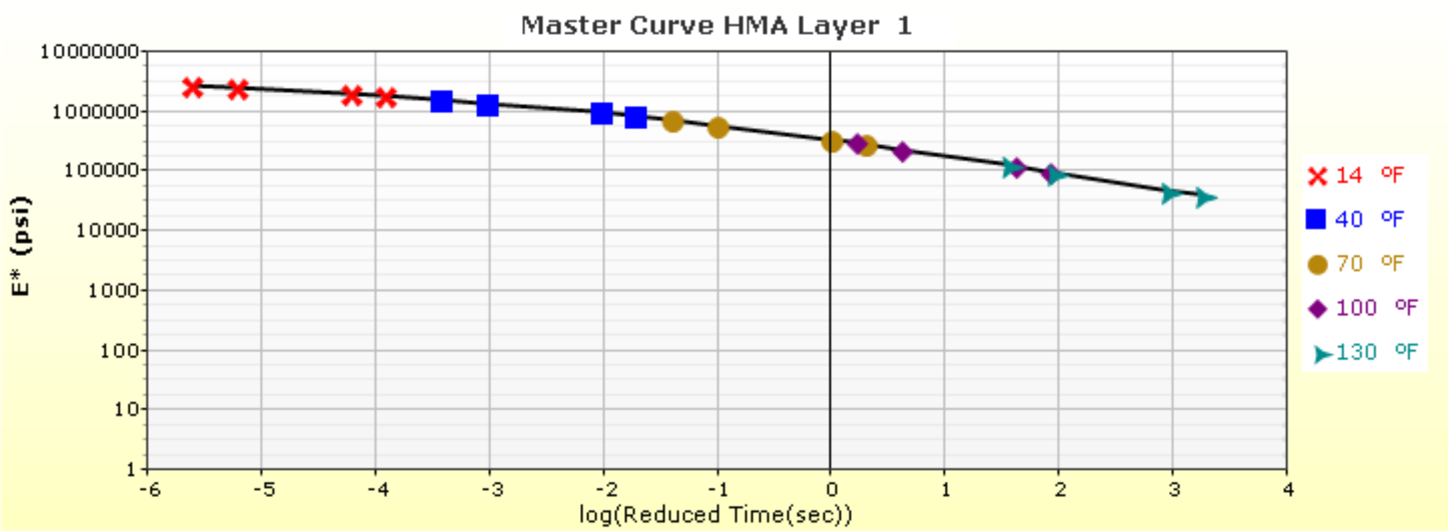
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	19.1

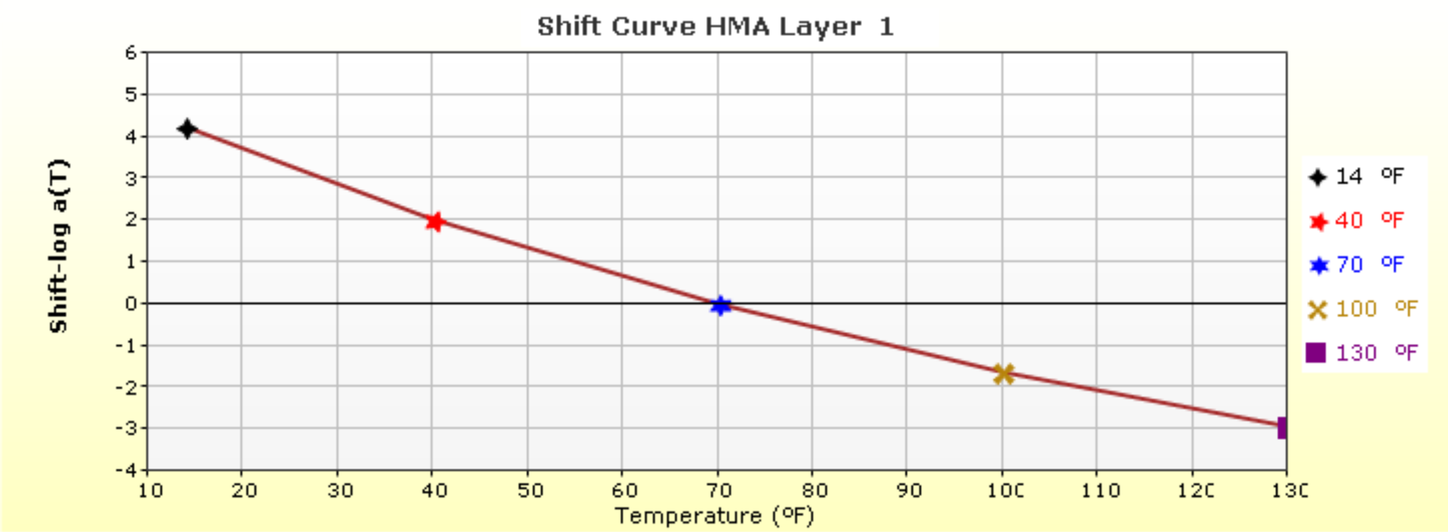
Indirect Tensile Strength (Input Level: 3)	
Test Temperature (ºF)	Indirect Tensilte Strength (psi)
14.0	490.85

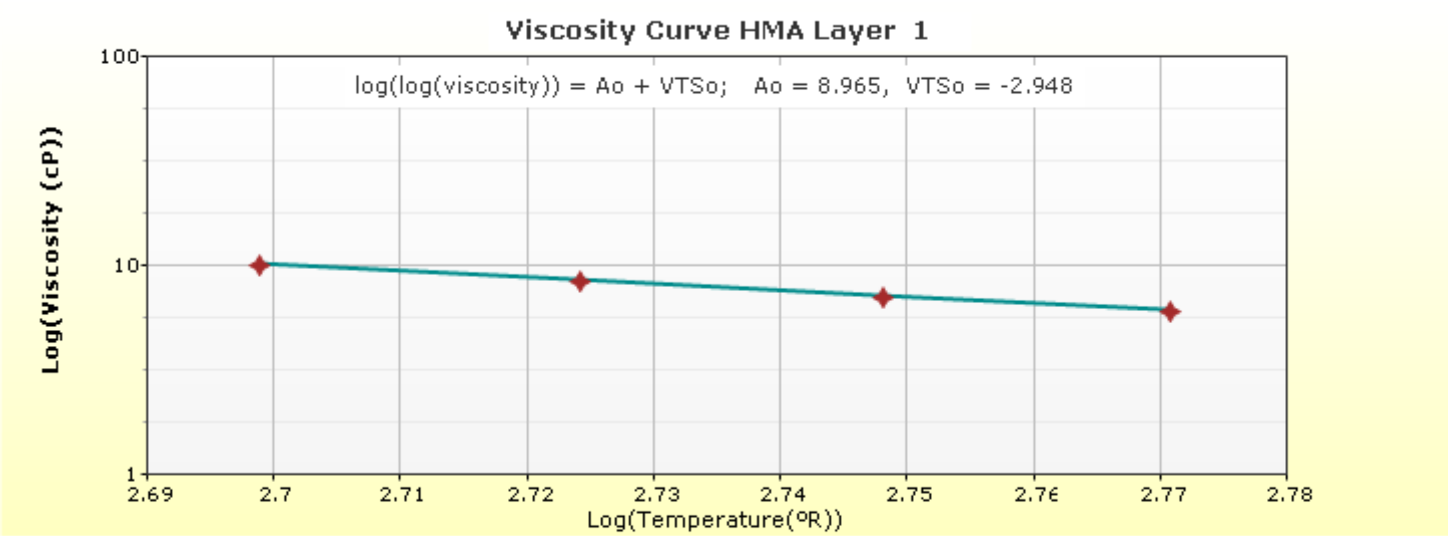
Creep Compliance (1/psi) (Input Level: 3)			
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	6.27e-007	8.90e-007	1.21e-006
2	6.98e-007	1.05e-006	1.59e-006
5	8.05e-007	1.32e-006	2.28e-006
10	8.96e-007	1.56e-006	3.00e-006
20	9.97e-007	1.84e-006	3.95e-006
50	1.15e-006	2.30e-006	5.67e-006
100	1.28e-006	2.73e-006	7.46e-006



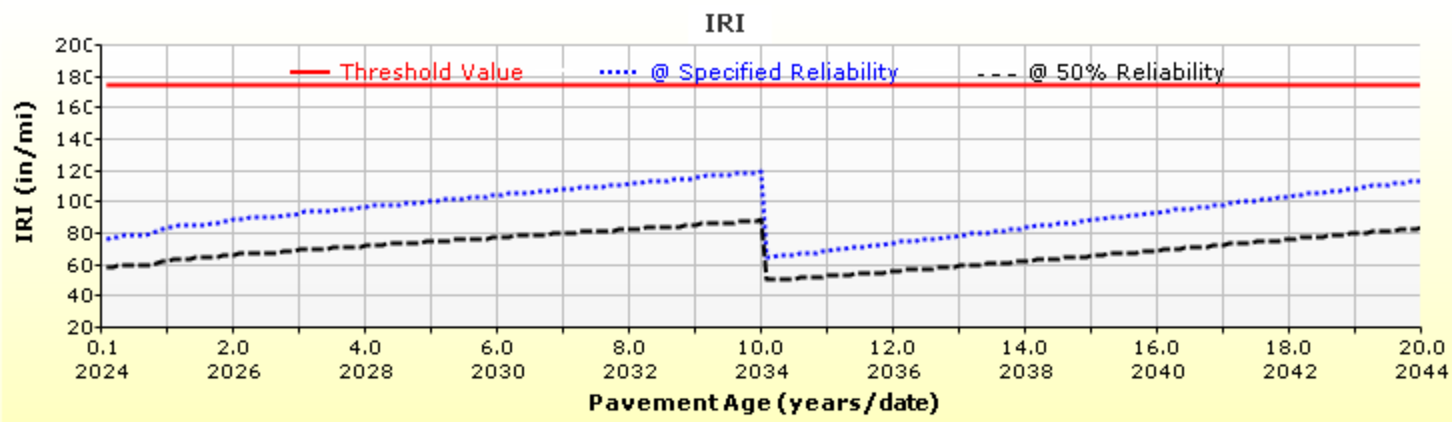
HMA Layer 1: Layer 1 Flexible : New HMA (PG 70-34)

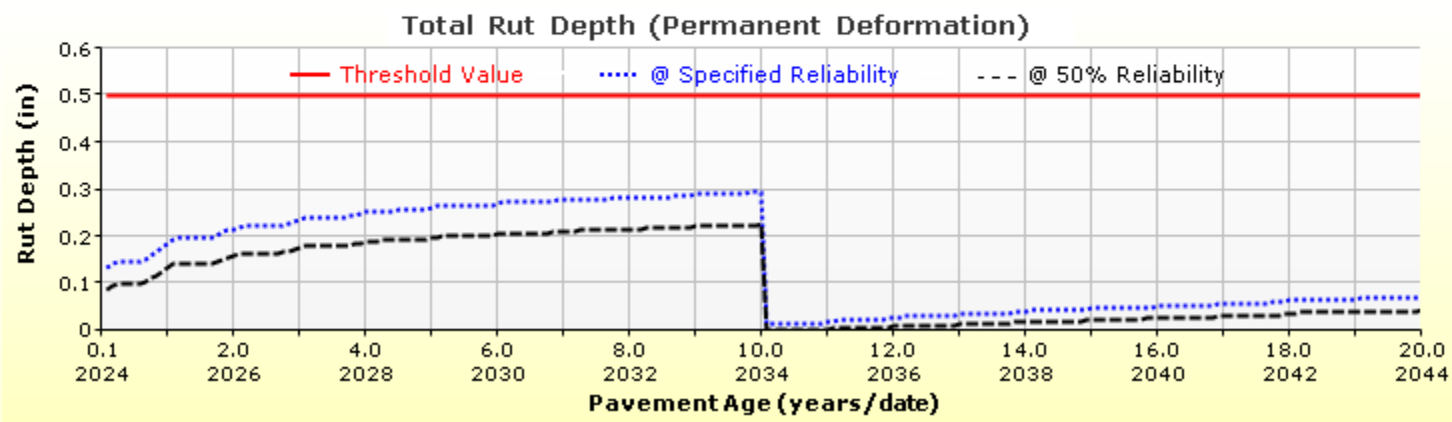


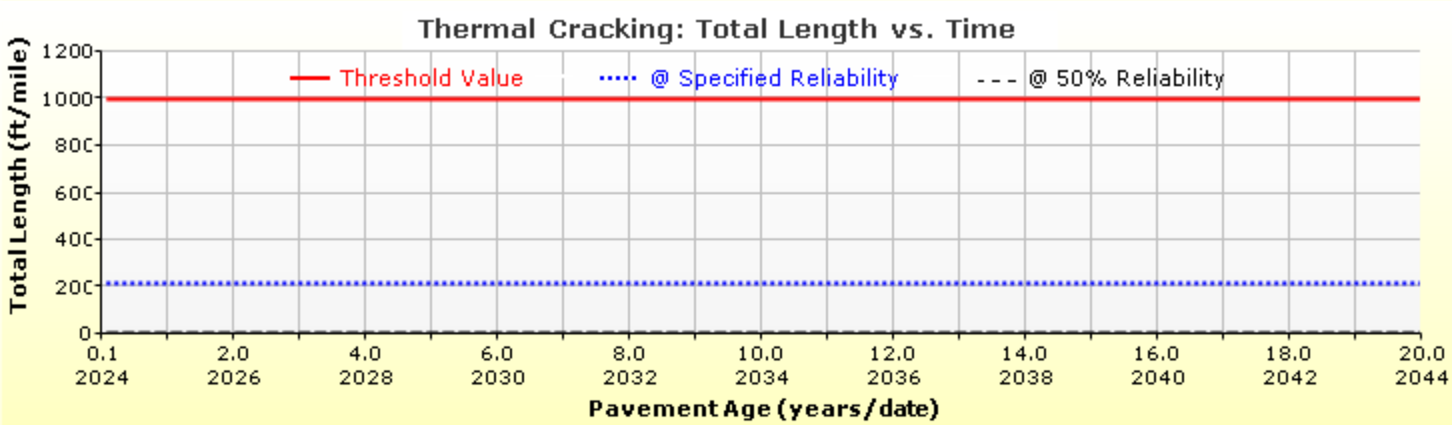


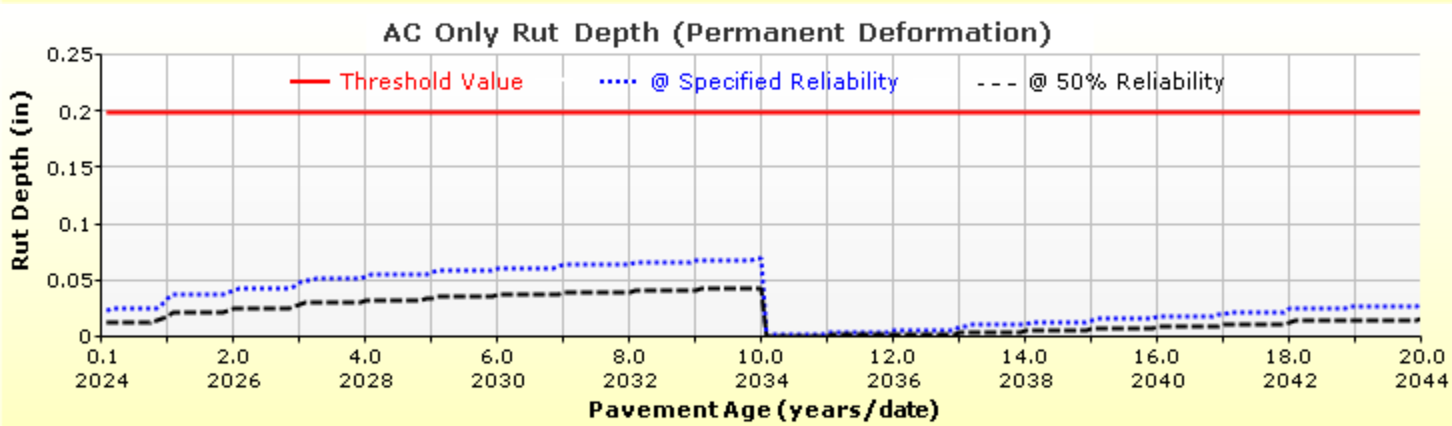


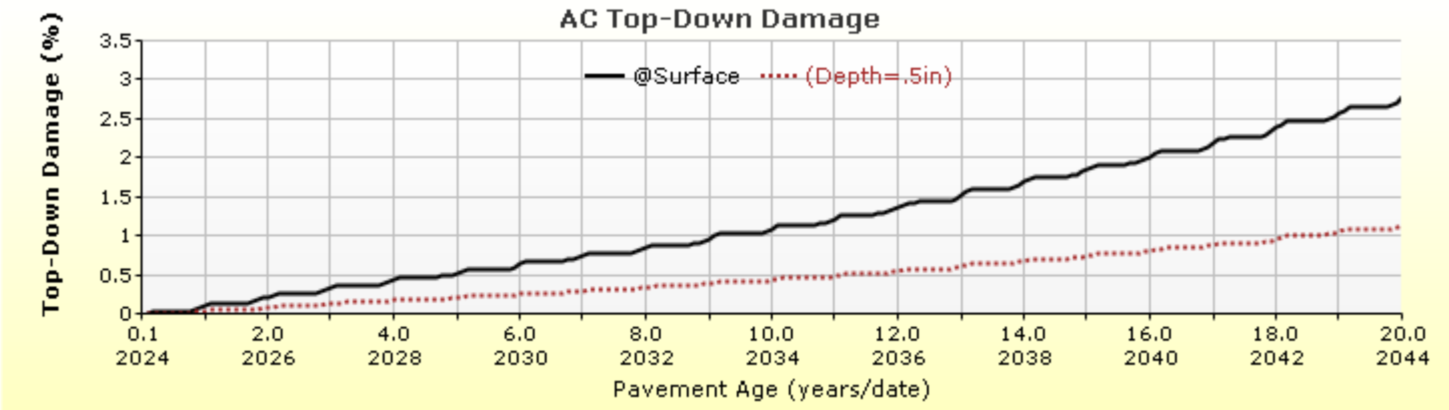
Analysis Output Charts



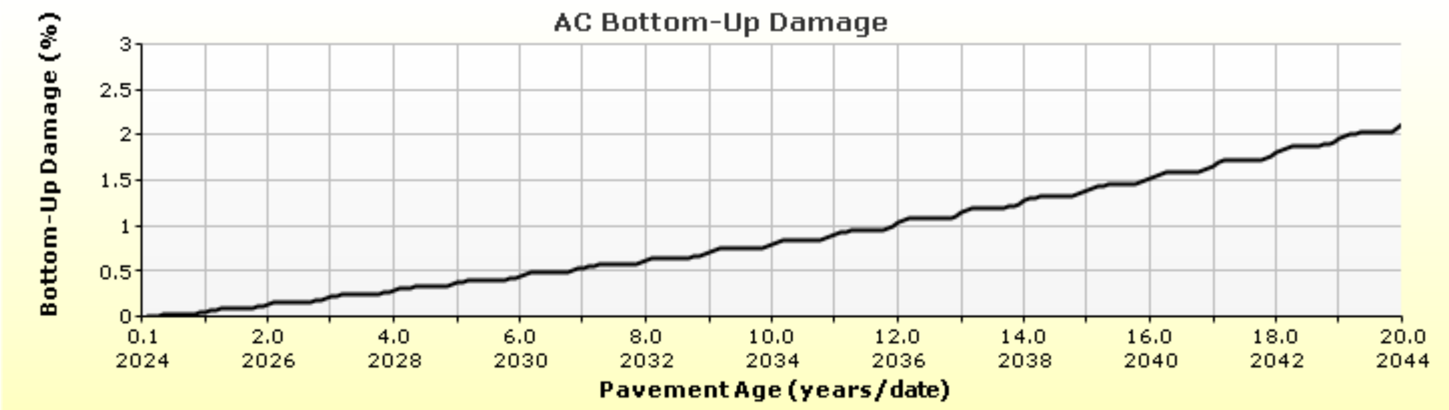




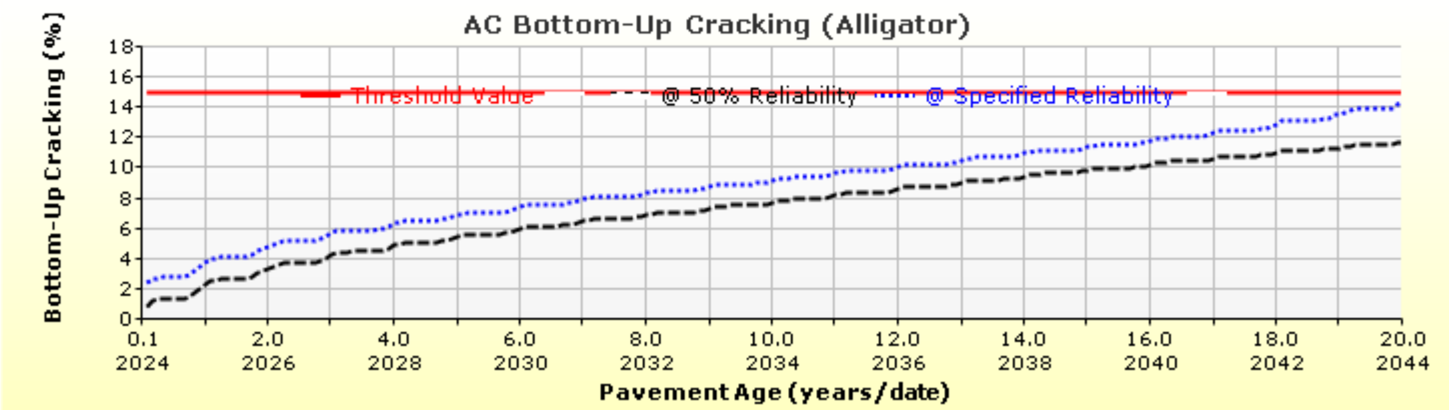




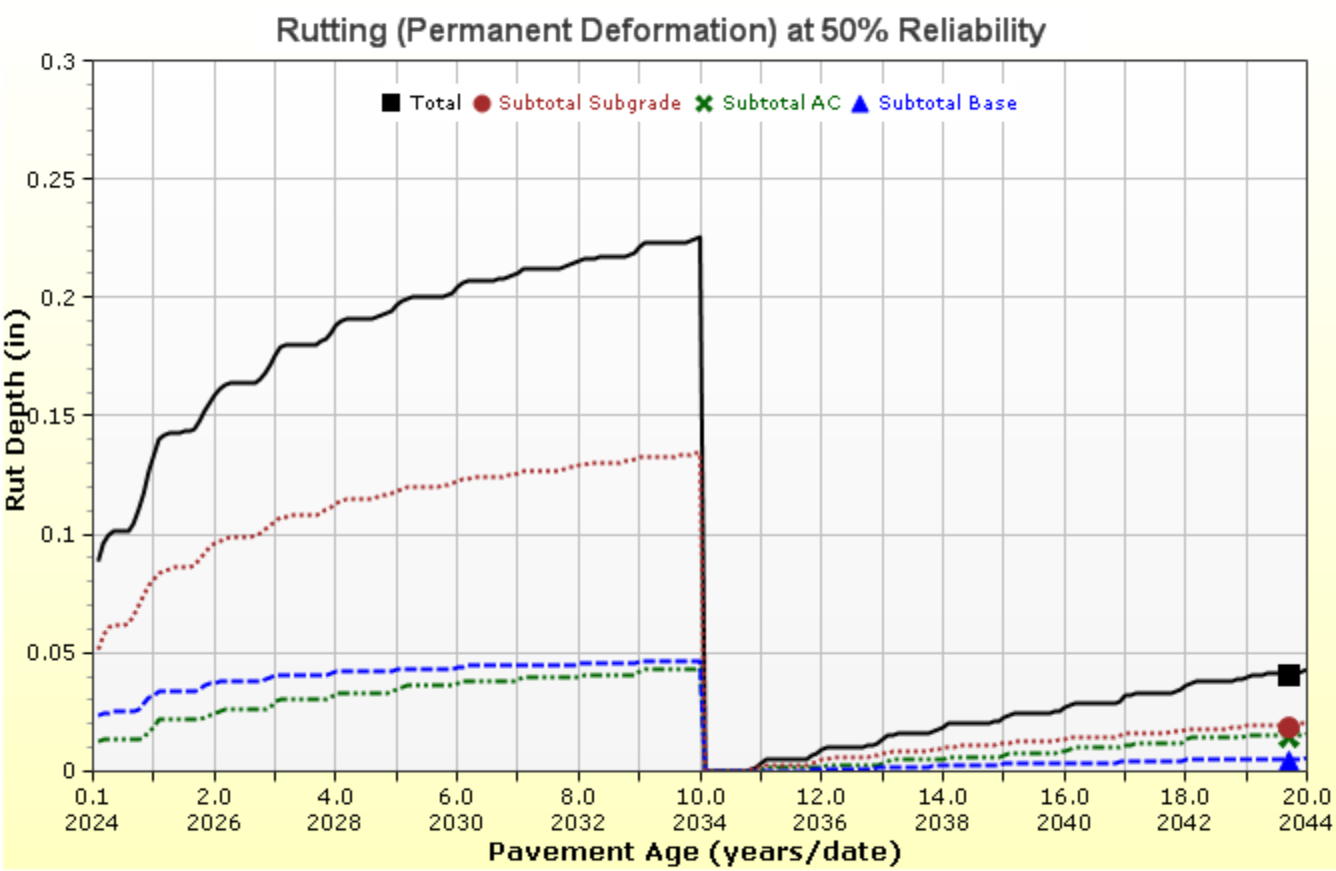
AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
Pavement Age (years/date)



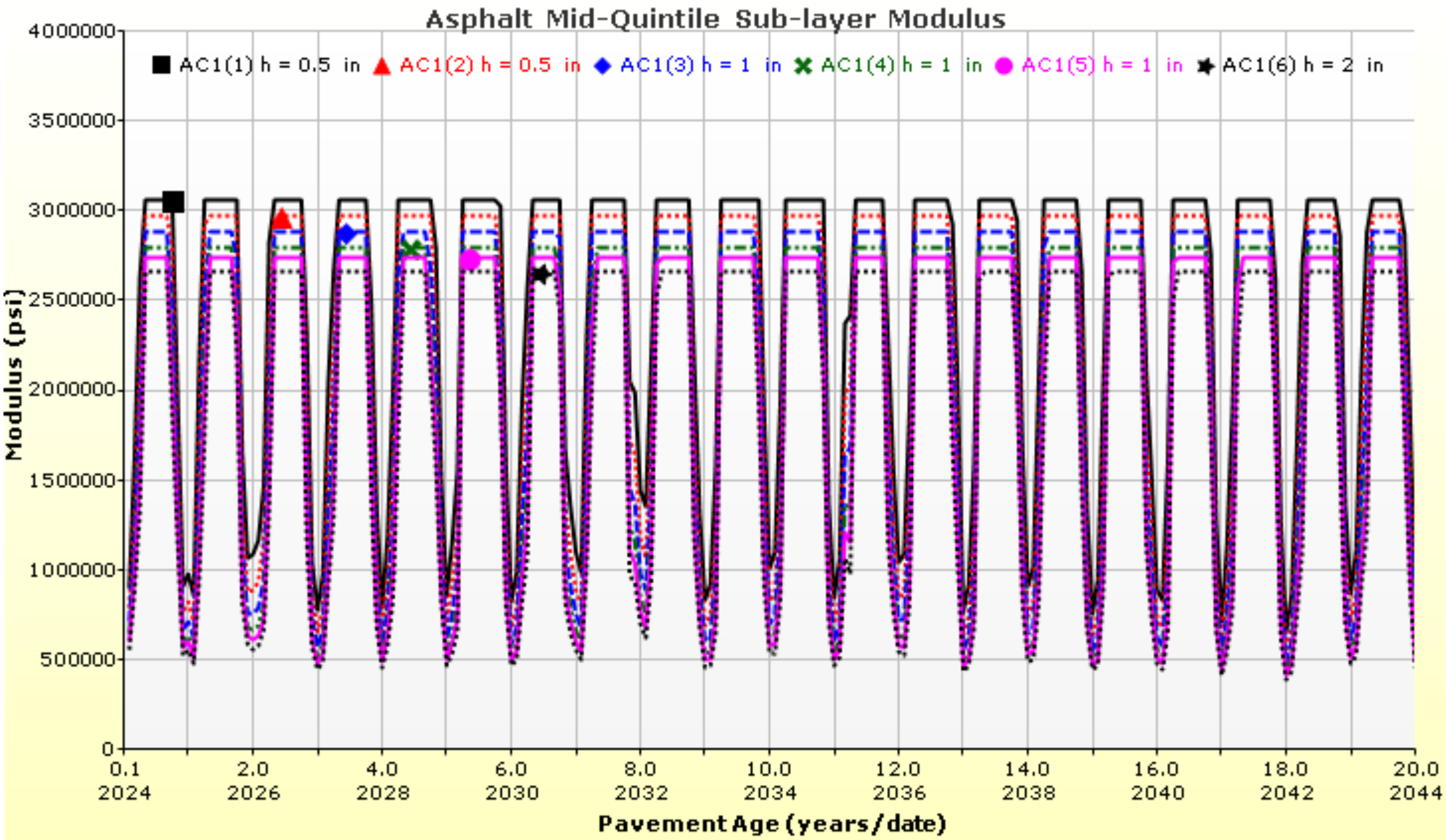
AC Bottom-Up Damage
Bottom-Up Damage (%)
Pavement Age (years/date)



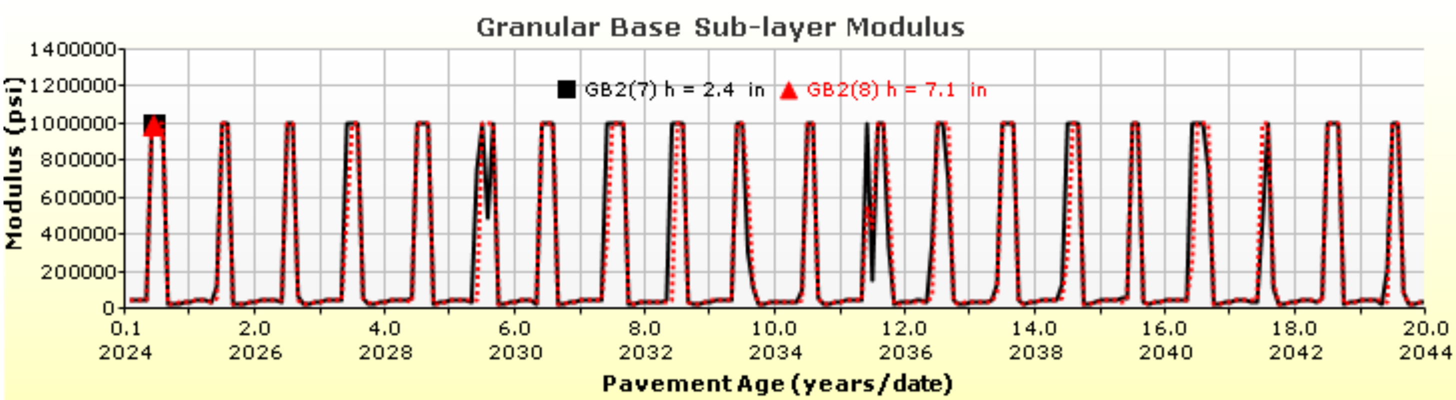
AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
Pavement Age (years/date)



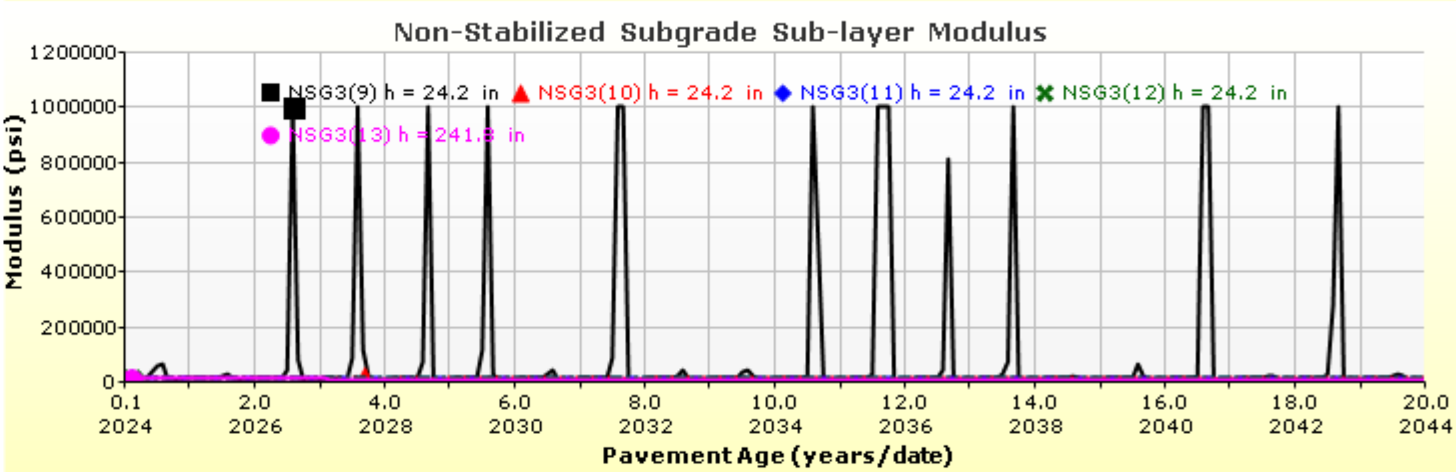
Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal Subgrade
Subtotal AC
Subtotal Base
Rut Depth (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC1(4) h = 1 in
AC1(5) h = 1 in
AC1(6) h = 2 in
Modulus (psi)
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
4000000
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Granular Base Sub-layer Modulus
GB2(7) h = 2.4 in
GB2(8) h = 7.1 in
Modulus (psi)
0
200000
400000
600000
800000
1000000
1200000
1400000
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Non-Stabilized Subgrade Sub-layer Modulus
NSG3(9) h = 24.2 in
NSG3(10) h = 24.2 in
NSG3(11) h = 24.2 in
NSG3(12) h = 24.2 in
NSG3(13) h = 241.8 in
Modulus (psi)
0
200000
400000
600000
800000
1000000
1200000
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : New HMA (PG 70-34)

Asphalt		
Thickness (in)	6.0	
Unit weight (pcf)	144.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 3)

Gradation	Percent Passing
3/4-inch sieve	100
3/8-inch sieve	77
No.4 sieve	60
No.200 sieve	6

Asphalt Binder

Parameter	Value
Grade	Superpave Performance Grade
Binder Type	70-34
A	8.965
VTS	-2.948

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.6
Air voids (%)	7.5
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	New HMA (PG 70-34)
Description of object	New Superpave Hot Mix Asphalt
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : New & Existing Base/Subbase

Unbound	
Layer thickness (in)	9.4
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
23345.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	New & Existing Base/Subbase
Description of object	Existing Untreated Aggregate Base
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	6.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.5
Saturated hydraulic conductivity (ft/hr)	False	5.57e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.5

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.3826
bf	2.0948
cf	0.7783
hr	115.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	7.5
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	52.5
#4	
3/8-in.	
1/2-in.	95.0
3/4-in.	
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : Subgrade

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
17300.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Subgrade
Description of object	Default material
Author	AASHTO
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	40.0
Plasticity Index	20.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	115.8
Saturated hydraulic conductivity (ft/hr)	False	8.941e-06
Specific gravity of solids	False	2.7
Water Content (%)	False	13.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	99.8852
bf	0.7387
cf	0.2720
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	39.0
#100	
#80	
#60	
#50	
#40	55.0
#30	
#20	
#16	
#10	78.0
#8	
#4	89.0
3/8-in.	96.0
1/2-in.	97.0
3/4-in.	100.0
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Calibration Coefficients

AC Fatigue	
$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2 \beta_{f2}} \left(\frac{1}{E}\right)^{k_3 \beta_{f3}}$	k1: 3.75
	k2: 2.87
$C = 10^M$	k3: 1.46
	Bf1: (5.014 * Pow(hac,-3.416)) * 1 + 0
$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$	Bf2: 1.38
	Bf3: 0.88

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_a^2 + 2.4868 * H_a - 17.342$$

$$C_2 = 0.0172 * H_a^2 - 1.7331 * H_a + 27.428$$

Where:

$H_{ac} = total\ AC\ thickness(in)$

$\varepsilon_p = plastic\ strain(in/in)$

$\varepsilon_r = resilient\ strain(in/in)$

$T = layer\ temperature(°F)$

$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.24 * Pow(RUT,0.8026) + 0.001	
AC Layer 1	K1:-2.45 K2:3.01 K3:0.22	Br1:0.3 Br2:0.52 Br3:1.36

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

C_f = observed amount of thermal cracking(ft/500ft)
k = refression coefficient determined through field calibration
$N()$ = standard normal distribution evaluated at()
σ = standard deviation of the log of the depth of cracks in the pavments
C = crack depth(in)
h_{ac} = thickness of asphalt layer(in)
ΔC = Change in the crack depth due to a cooling cycle
ΔK = Change in the stress intensity factor due to a cooling cycle
A, n = Fracture parameters for the asphalt mixture
E = mixture stiffness
σ_M = Undamaged mixture tensile strength
β_t = Calibration parameter

Level 1 K: ((3 * Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 1 Standard Deviation: 0.14 * THERMAL + 168
Level 2 K: ((2.591* Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 2 Standard Deviation: 0.20 * THERMAL + 168
Level 3 K: ((3 * Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 3 Standard Deviation: 0.289 * THERMAL + 168

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1}\left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

N_f = number of repetitions to fatigue cracking
σ_s = Tensile stress(psi)
M_r = modulus of rupture(psi)

k1: 0.972	k2: 0.0825	Bc1: 1	Bc2:1

Unbound Layer Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^{\beta}} \right|$$

δ_a = permanent deformation for the layer
N = number of repetitions
ε_v = average veritcal strain(in/in)
$\varepsilon_0, \beta, \rho$ = material properties
ε_r = resilient strain(in/in)

Base Rutting		Subgrade Rutting	
k1: 0.965	Bs1: 0.86	k1: 0.965	Bs1: 0.736
Standard Deviation (BASERUT) 0.1477 * Pow(BASERUT,0.6711) + 0.001		Standard Deviation (BASERUT) 0.1235 * Pow(SUBRUT,0.5012) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 3.3	c2: 0.825	c3: 0	c4: 1000

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D*100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.31	c2: (0.867 + 0.2583 * hac) * 0.2 + 0	c3: 3000

Top down AC Cracking Standard Deviation	Bottom up AC Cracking Standard Deviation
200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))	1.13 + 13/(1+exp(7.57-15.5*LOG10(BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4 * log_{10}(Damage)}}$$

C1: 0	C2: 75	C3: 2	C4: 2

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 80	C2: 0.6	C3: 0.008	C4: 0.02

SH-75 AC Removal and Replacement (Saddle to Clubhouse)

File Name: C:\Users\MEarl\Desktop\SH-75 AC Removal and Replacement (Saddle to Clubhouse).dgpx

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: June, 2024
Pavement construction: July, 2024
Traffic opening: August, 2024

Climate Data Sources (Lat/Lon): 43.5, -114.375; 43.5, -113.75; 44, -113.75

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	New HMA (PG 70-34)	6.0
NonStabilized	New & Existing Base/Subbase	16.3
Subgrade	Subgrade	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	11.6
Air voids (%)	7.5

Traffic

Age (year)	Heavy Trucks (cumulative)
2024 (initial)	1,560
2034 (10 years)	4,047,120
2044 (20 years)	10,515,000

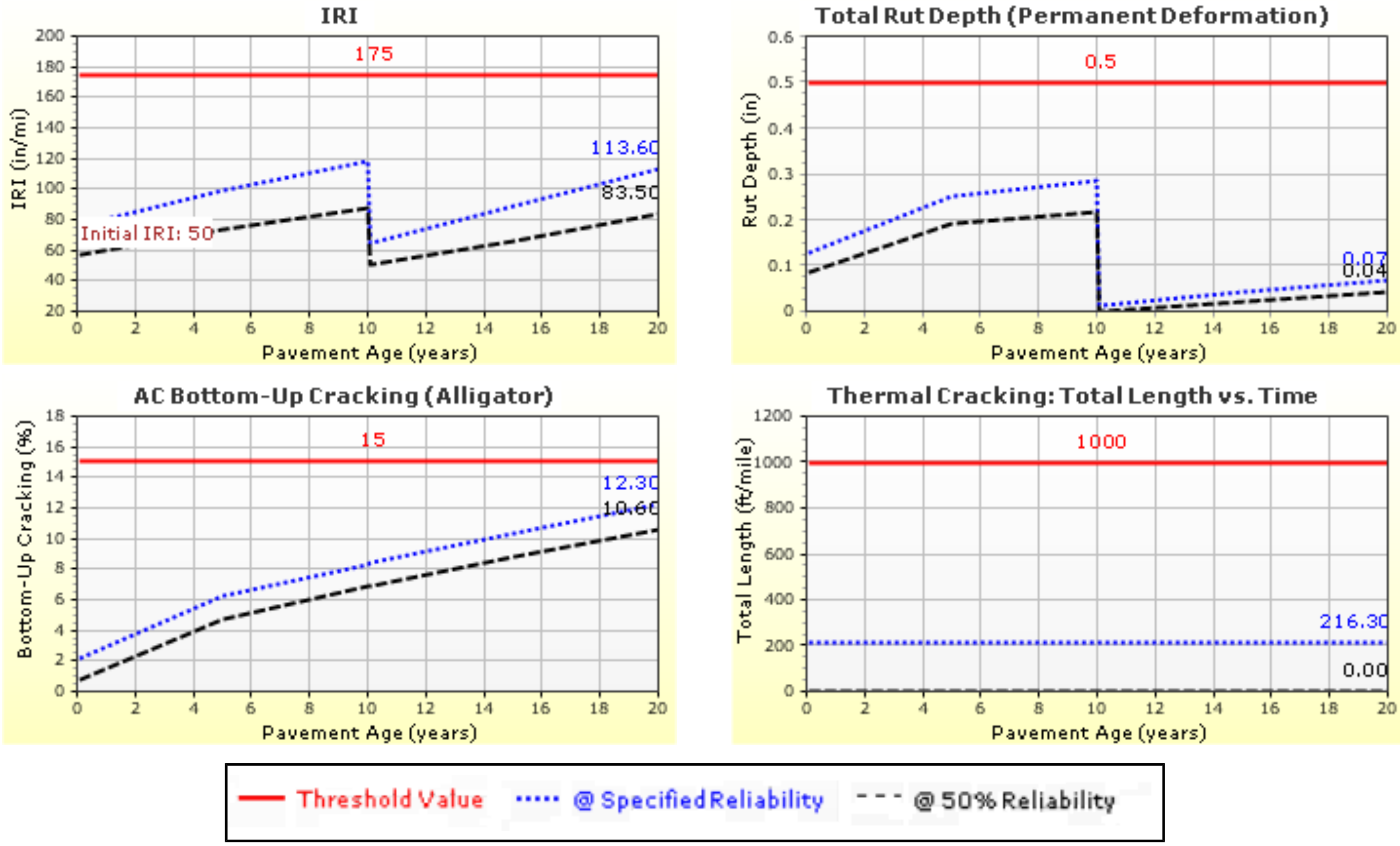
Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	175.00	113.64	90.00	99.99	Pass
Permanent deformation - total pavement (in)	0.50	0.07	90.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	15.00	12.30	90.00	99.95	Pass
AC thermal cracking (ft/mile)	1000.00	216.30	90.00	100.00	Pass
Permanent deformation - AC only (in)	0.20	0.03	90.00	100.00	Pass

Design traffic (flexible pavements) = 11.68 million ESALs

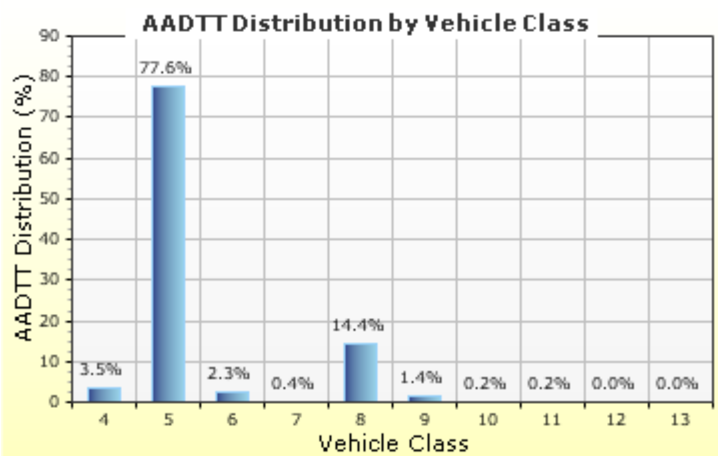
Distress Charts

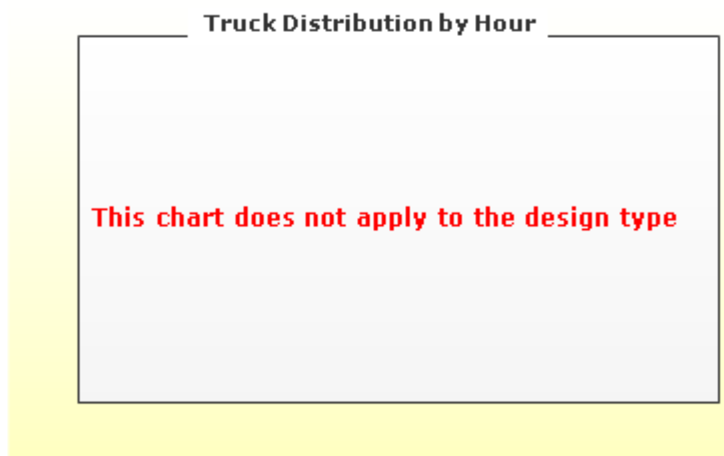


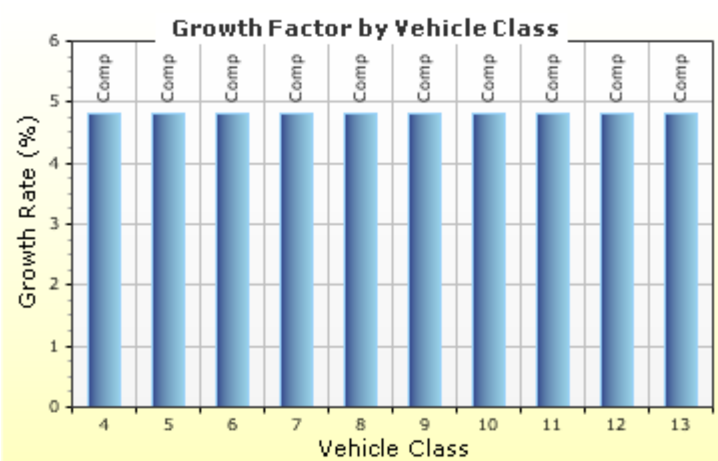
Traffic Inputs

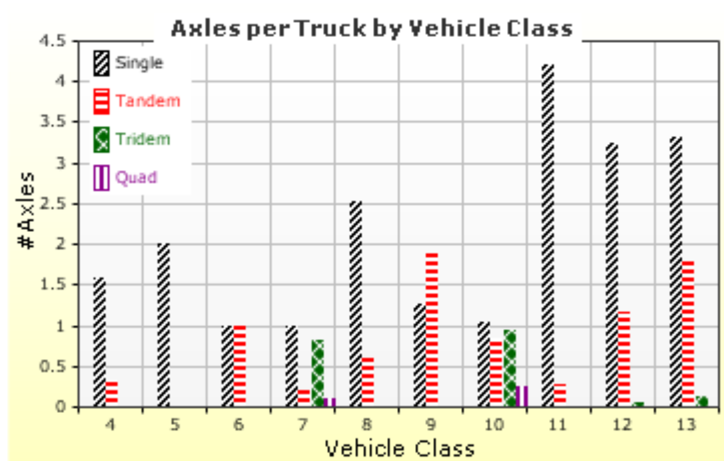
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	1,560	Percent of trucks in design direction (%):	57.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	25.0

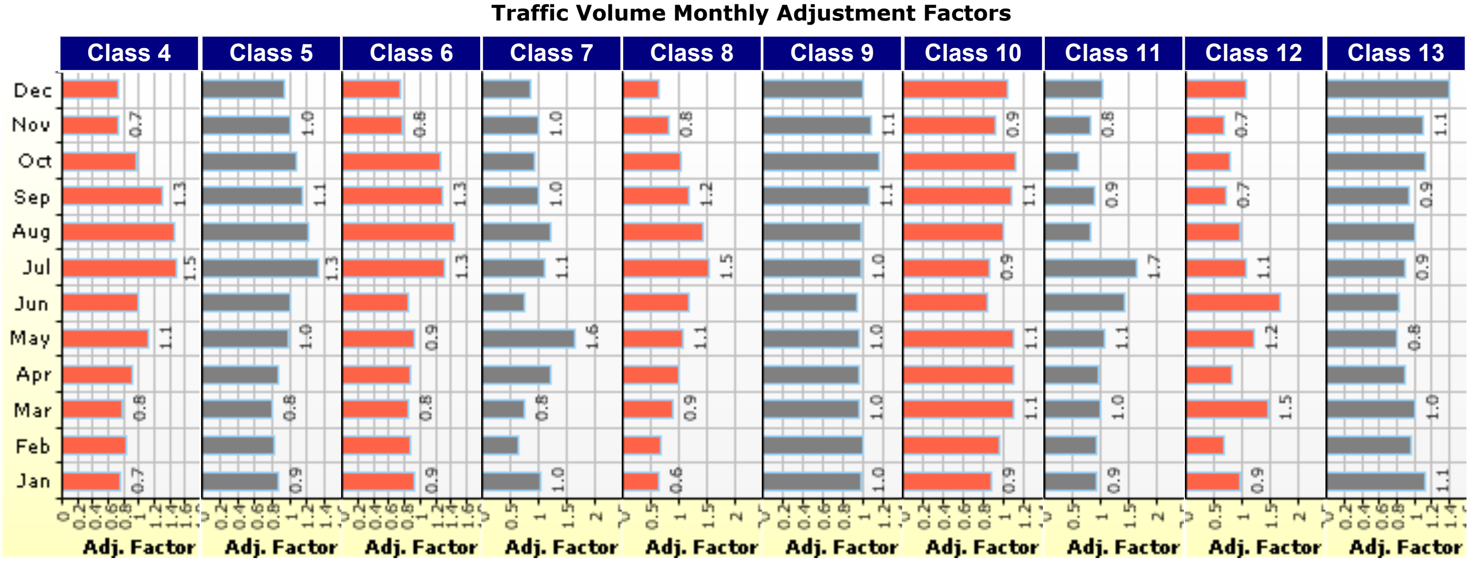








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.7	0.9	0.9	1.0	0.6	1.0	0.9	0.9	0.9	1.1
February	0.8	0.8	0.9	0.6	0.7	1.0	1.0	0.9	0.7	1.0
March	0.8	0.8	0.8	0.8	0.9	1.0	1.1	1.0	1.5	1.0
April	0.9	0.9	0.9	1.2	1.0	1.0	1.1	0.9	0.8	0.9
May	1.1	1.0	0.9	1.6	1.1	1.0	1.1	1.1	1.2	0.8
June	1.0	1.0	0.8	0.7	1.2	0.9	0.8	1.4	1.7	0.8
July	1.5	1.3	1.3	1.1	1.5	1.0	0.9	1.7	1.1	0.9
August	1.5	1.2	1.5	1.2	1.4	1.0	1.0	0.8	1.0	1.0
September	1.3	1.1	1.3	1.0	1.2	1.1	1.1	0.9	0.7	0.9
October	0.9	1.1	1.3	0.9	1.0	1.2	1.1	0.6	0.8	1.1
November	0.7	1.0	0.8	1.0	0.8	1.1	0.9	0.8	0.7	1.1
December	0.7	0.9	0.7	0.9	0.6	1.0	1.0	1.0	1.1	1.4

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	3.5%	4.8%	Compound
Class 5	77.6%	4.8%	Compound
Class 6	2.3%	4.8%	Compound
Class 7	0.4%	4.8%	Compound
Class 8	14.4%	4.8%	Compound
Class 9	1.4%	4.8%	Compound
Class 10	0.2%	4.8%	Compound
Class 11	0.2%	4.8%	Compound
Class 12	0%	4.8%	Compound
Class 13	0%	4.8%	Compound

Truck Distribution by Hour does not apply

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

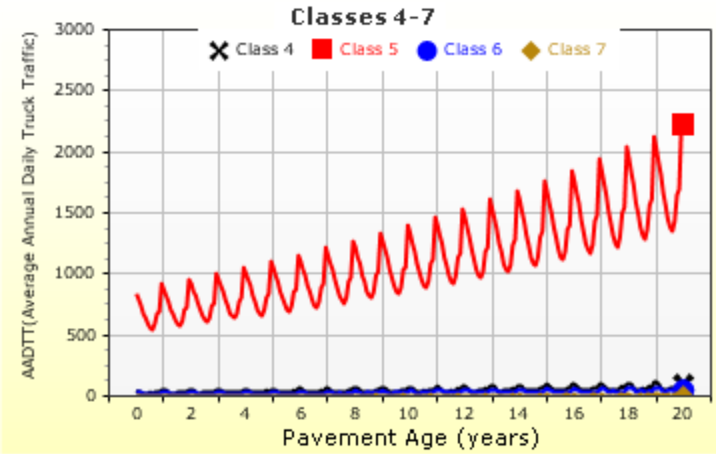
Wheelbase does not apply

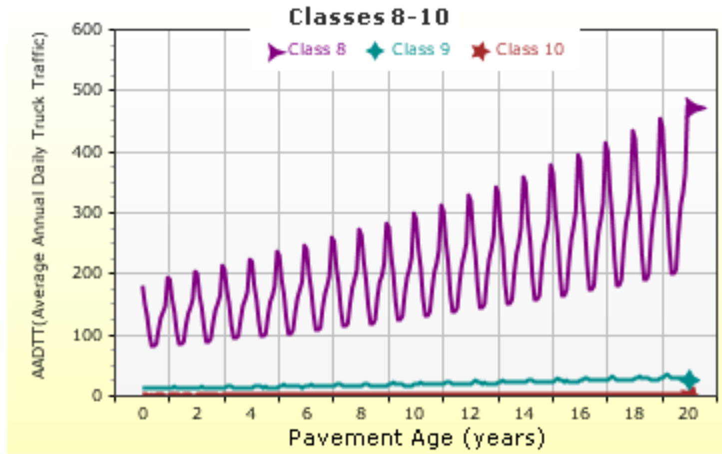
Number of Axles per Truck

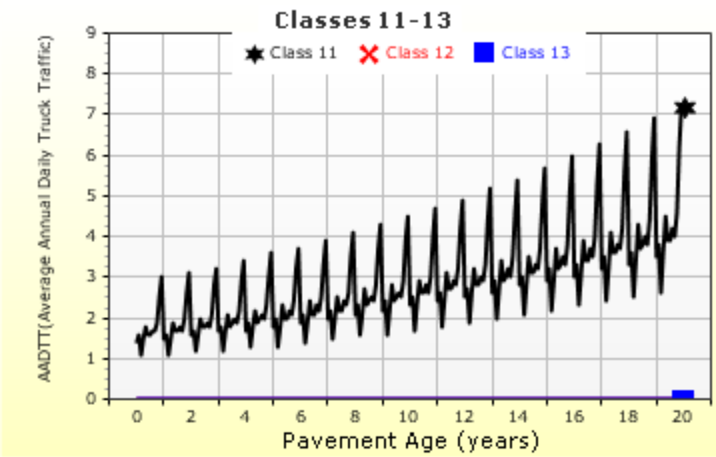
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.59	0.34	0	0
Class 5	2	0	0	0
Class 6	1	1	0	0
Class 7	1	0.22	0.83	0.1
Class 8	2.52	0.6	0	0
Class 9	1.25	1.87	0	0
Class 10	1.03	0.85	0.95	0.26
Class 11	4.21	0.29	0.01	0
Class 12	3.24	1.16	0.07	0.01
Class 13	3.32	1.79	0.14	0.02

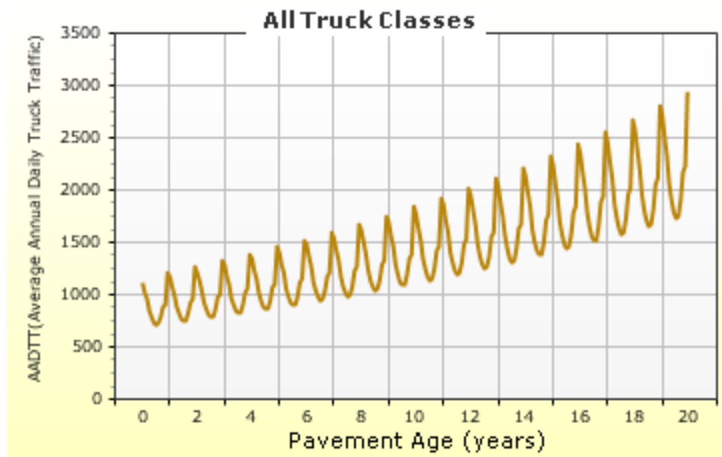
AADTT (Average Annual Daily Truck Traffic) Growth

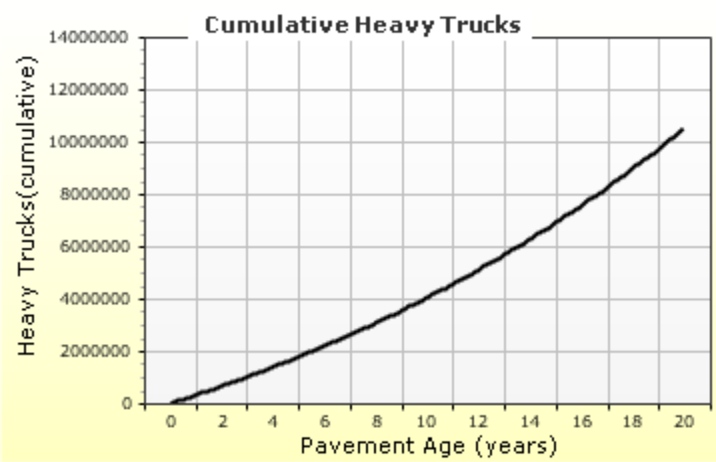
*** Traffic cap is not enforced**











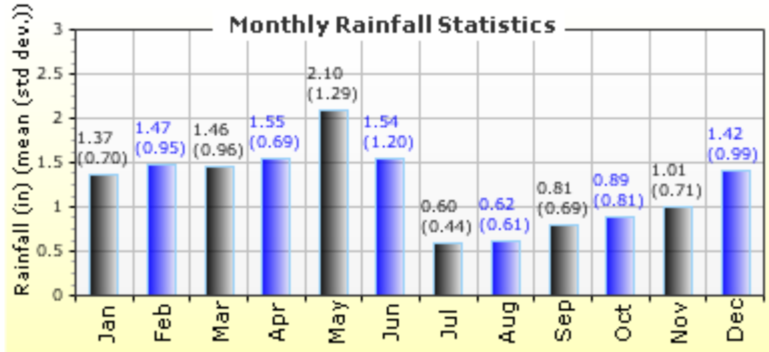
Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
US, ID	43.50000 -114.37500 5697
US, ID	43.50000 -113.75000 6658
US, ID	44.00000 -113.75000 6344

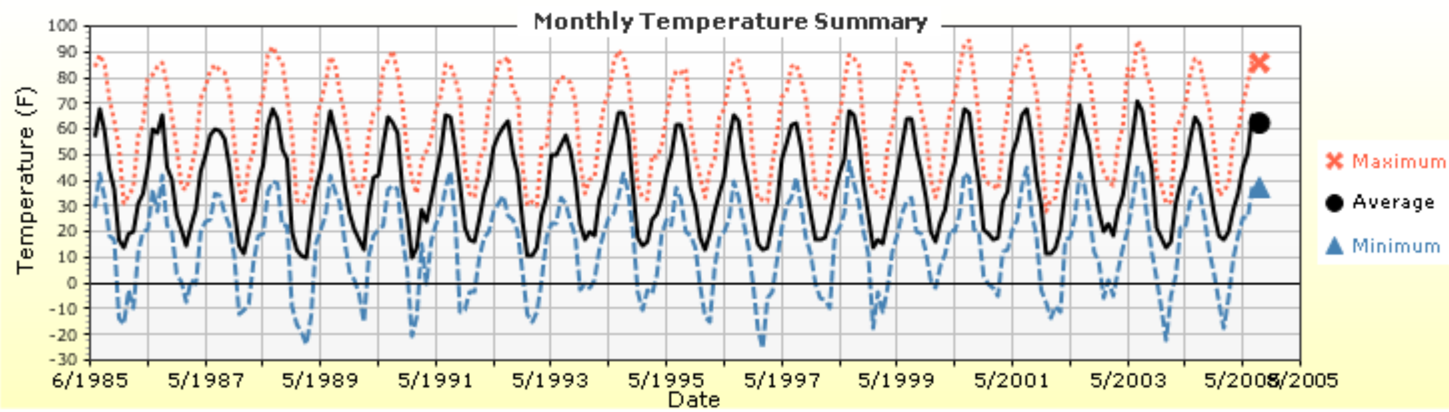
Annual Statistics:

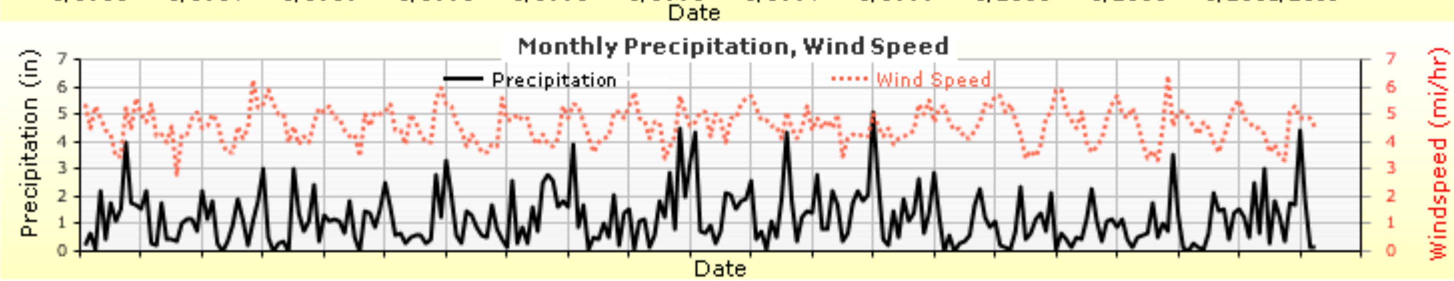
Mean annual air temperature (ºF)	39.08
Mean annual precipitation (in)	14.79
Freezing index (ºF - days)	1670.83
Average annual number of freeze/thaw cycles:	113.87

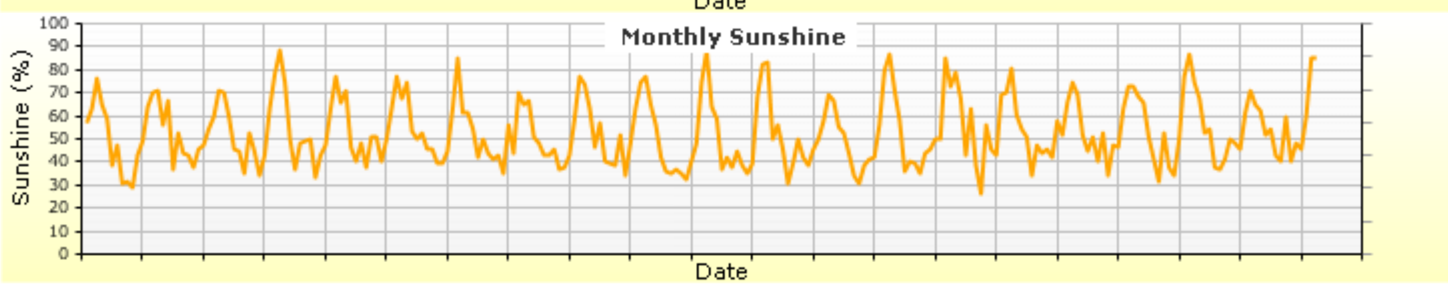


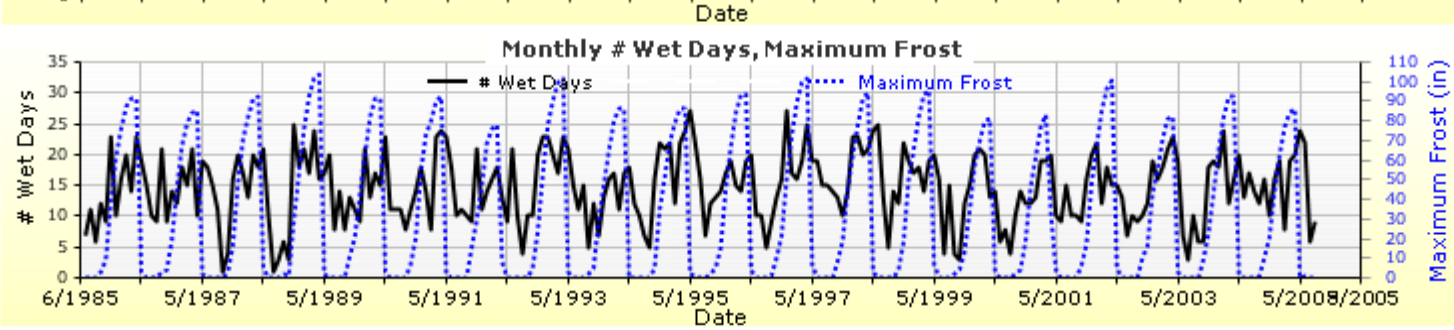
Water table depth (ft)	10.00

Monthly Climate Summary:

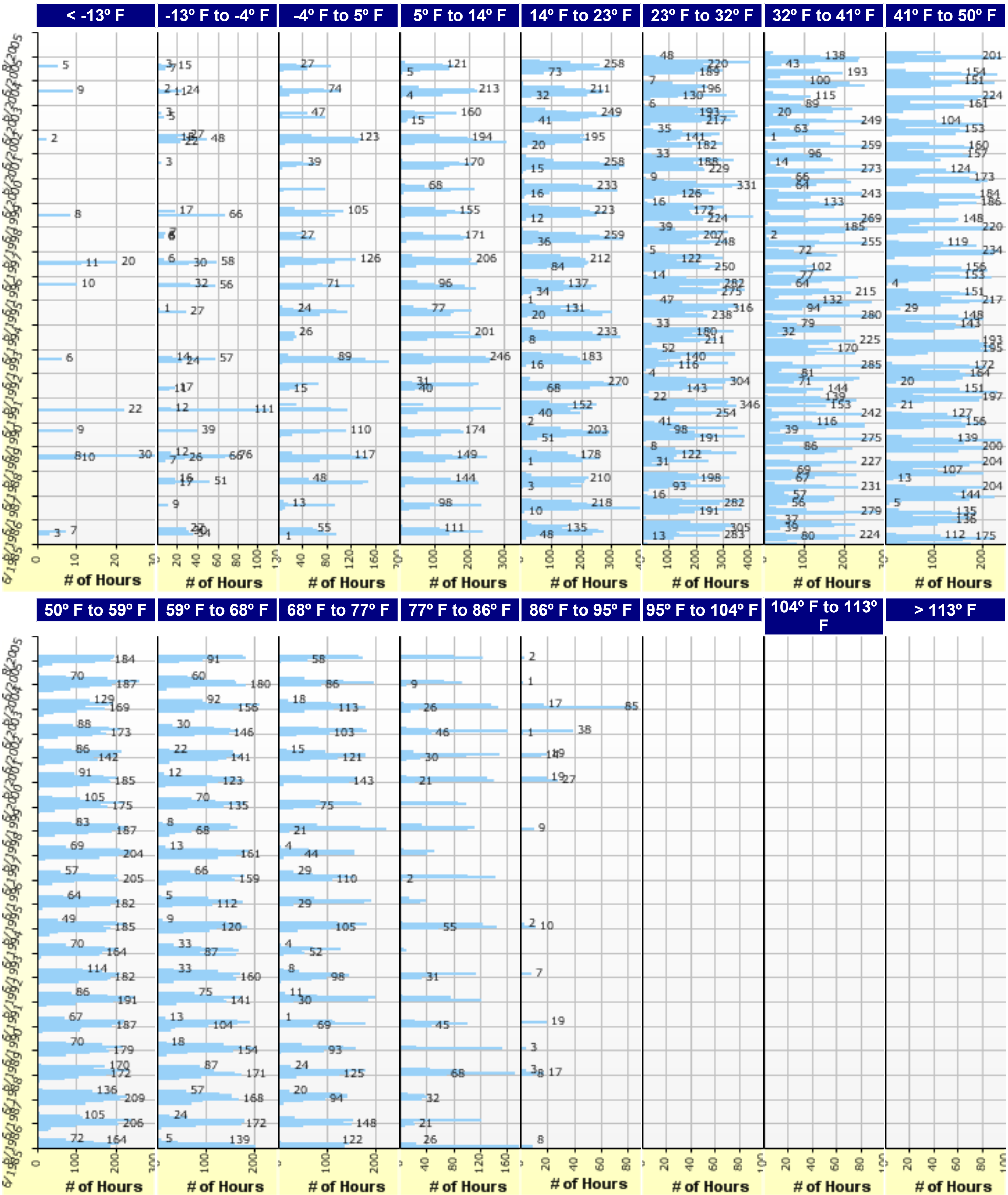








Hourly Air Temperature Distribution by Month:



Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Layer Name	**Layer Type**	**Interface Friction**
Layer 1 Flexible : New HMA (PG 70-34)	Flexible (1)	1.00
Layer 2 Non-stabilized Base : New & Existing Base/Subbase	Non-stabilized Base (4)	1.00
Layer 3 Subgrade : Subgrade	Subgrade (5)	-

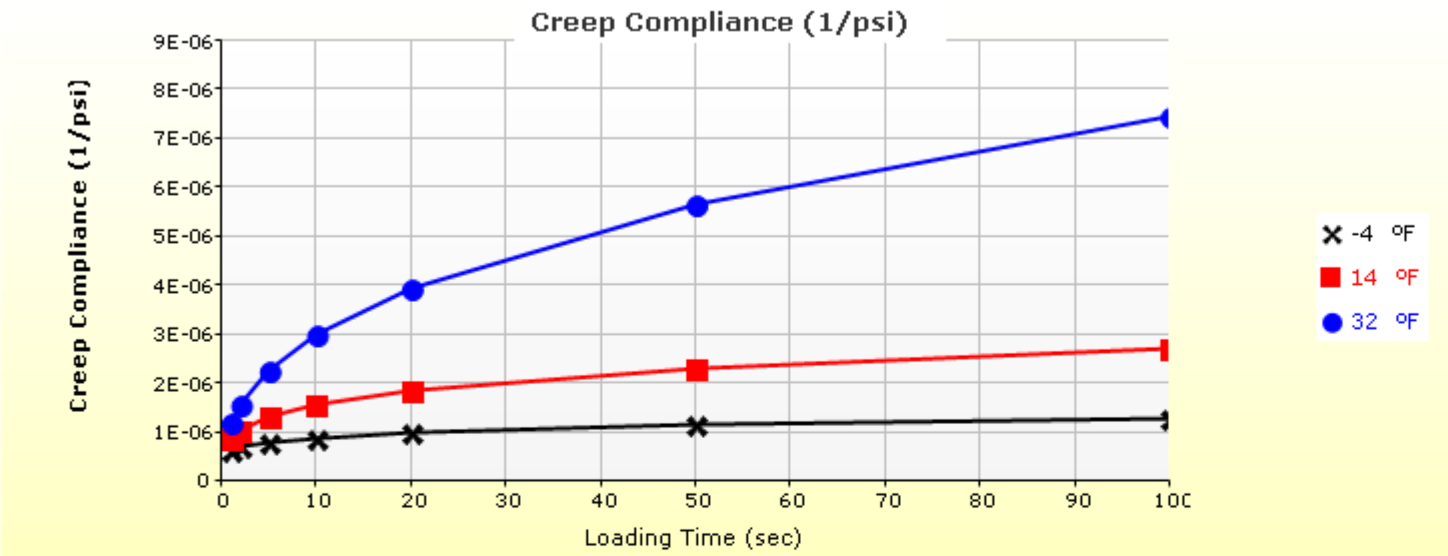
Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

Thermal Cracking

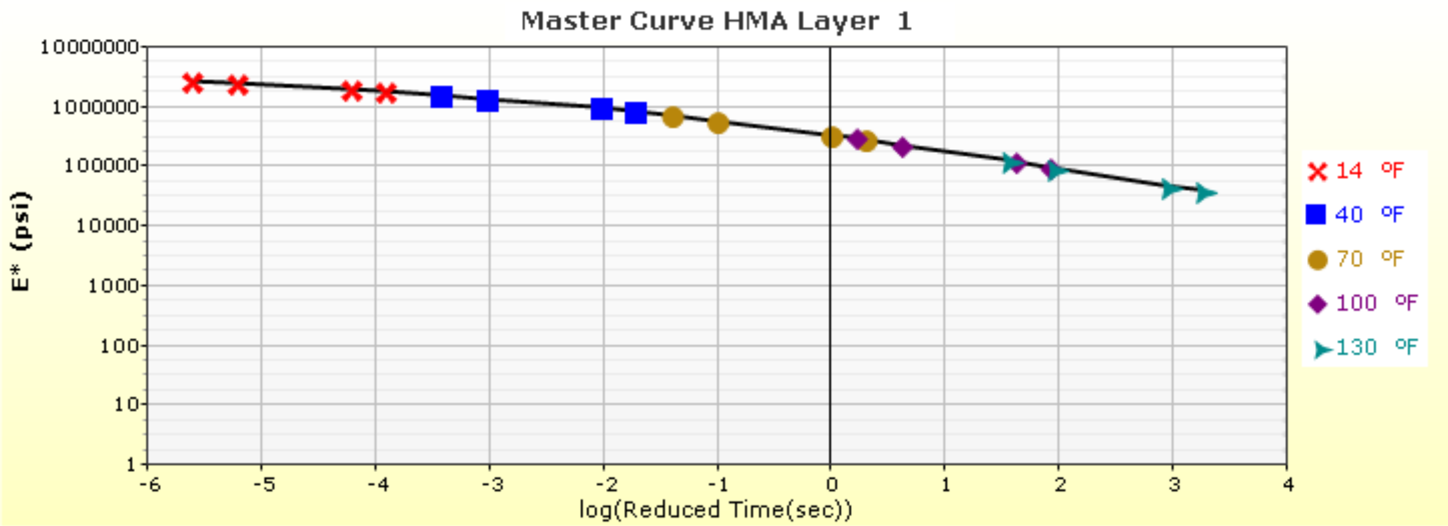
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	19.1

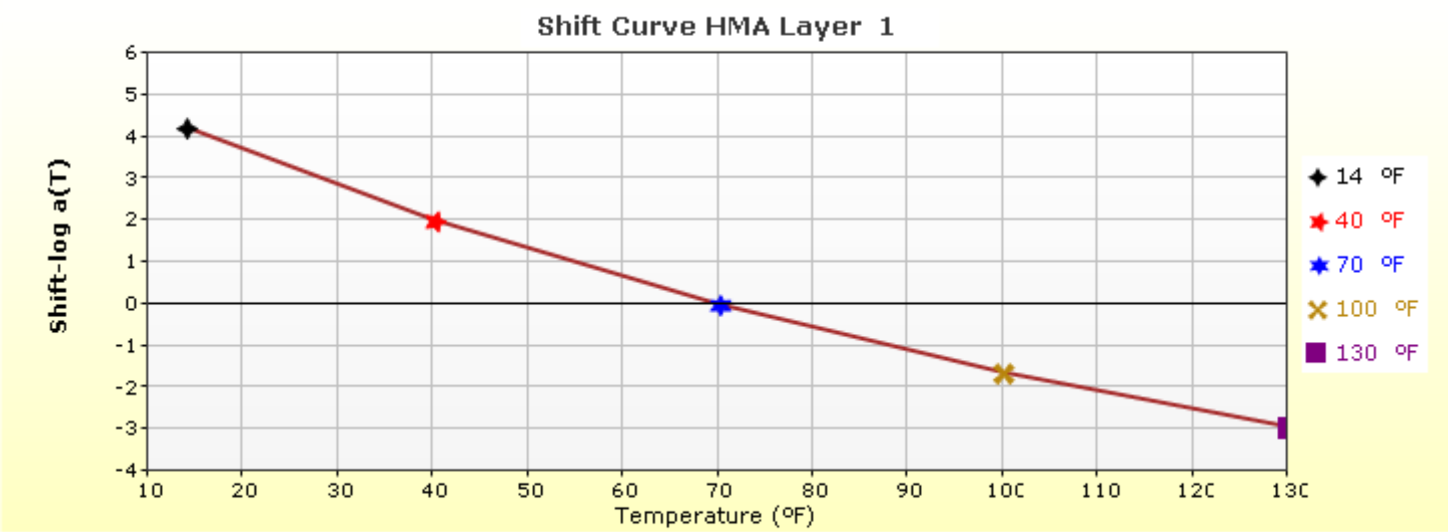
Indirect Tensile Strength (Input Level: 3)	
Test Temperature (ºF)	Indirect Tensilte Strength (psi)
14.0	490.85

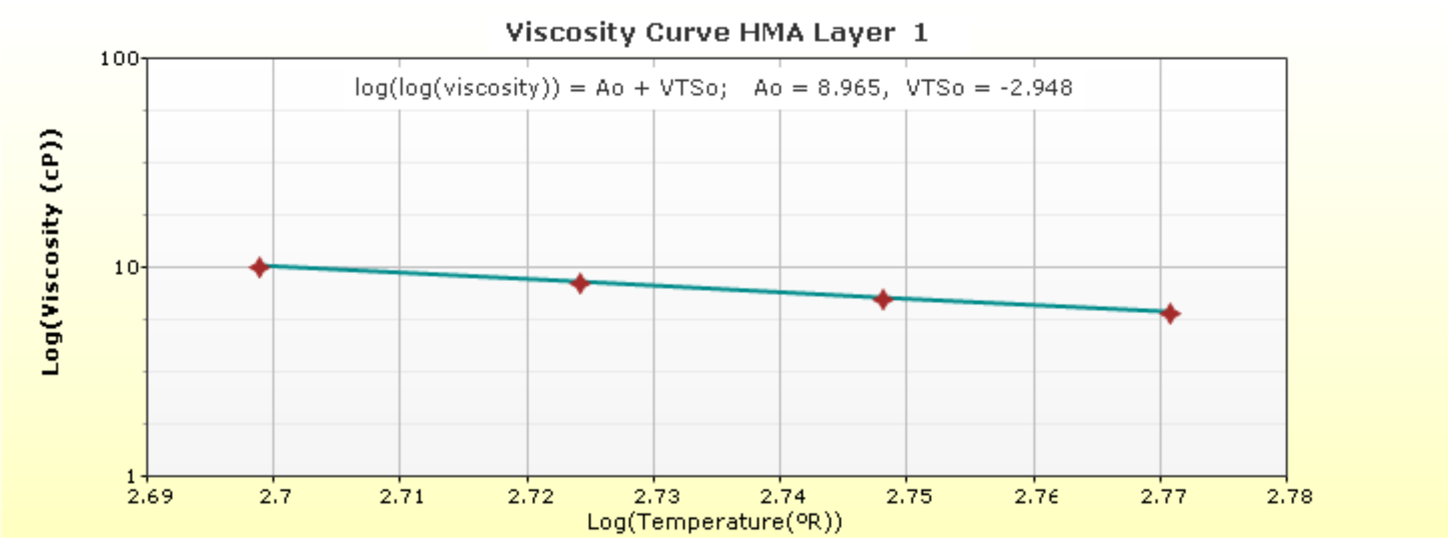
Creep Compliance (1/psi) (Input Level: 3)			
Loading time (sec)	-4 ºF	14 ºF	32 ºF
1	6.27e-007	8.90e-007	1.21e-006
2	6.98e-007	1.05e-006	1.59e-006
5	8.05e-007	1.32e-006	2.28e-006
10	8.96e-007	1.56e-006	3.00e-006
20	9.97e-007	1.84e-006	3.95e-006
50	1.15e-006	2.30e-006	5.67e-006
100	1.28e-006	2.73e-006	7.46e-006



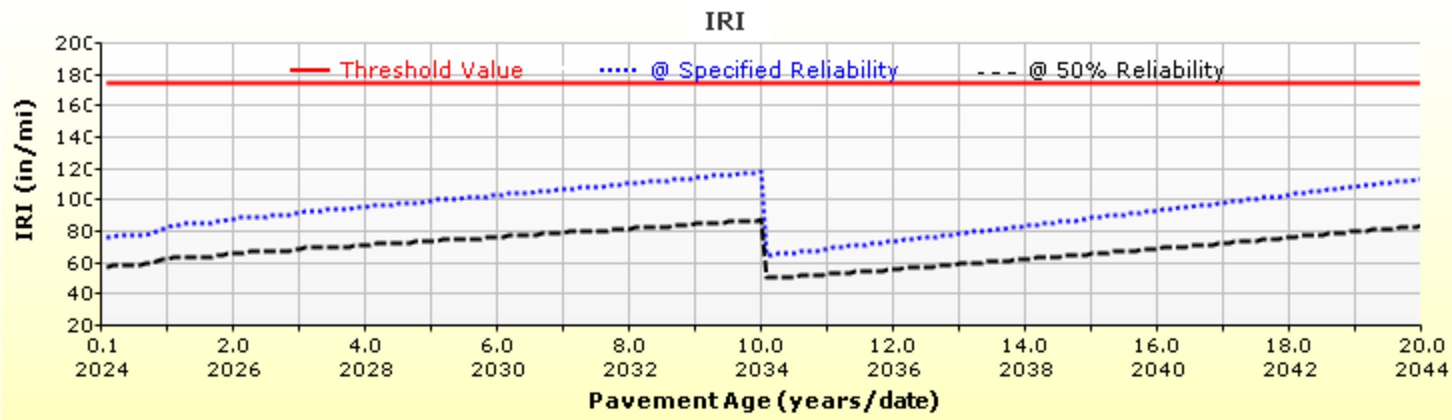
HMA Layer 1: Layer 1 Flexible : New HMA (PG 70-34)

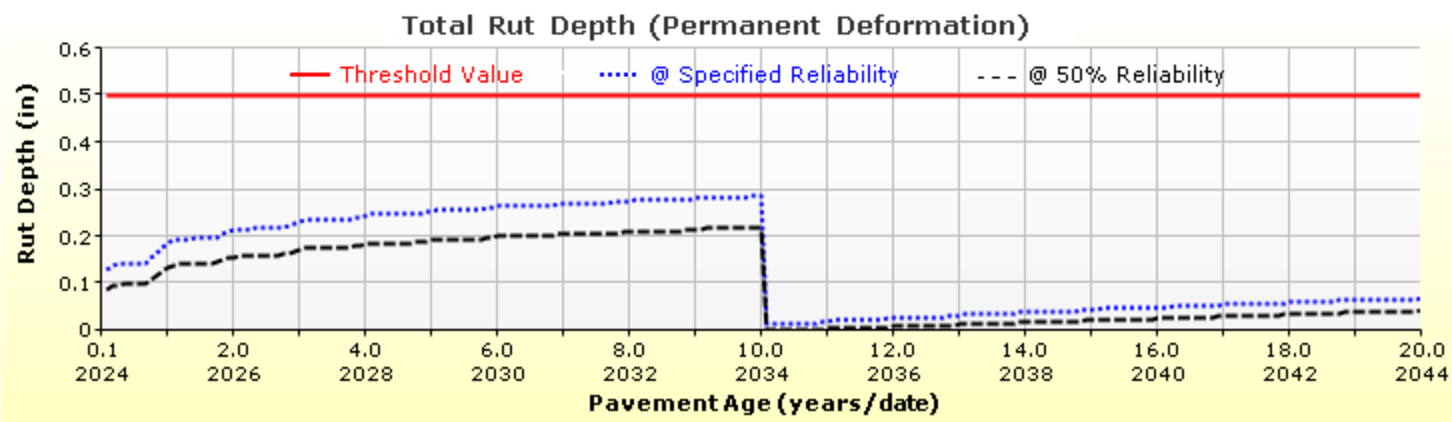


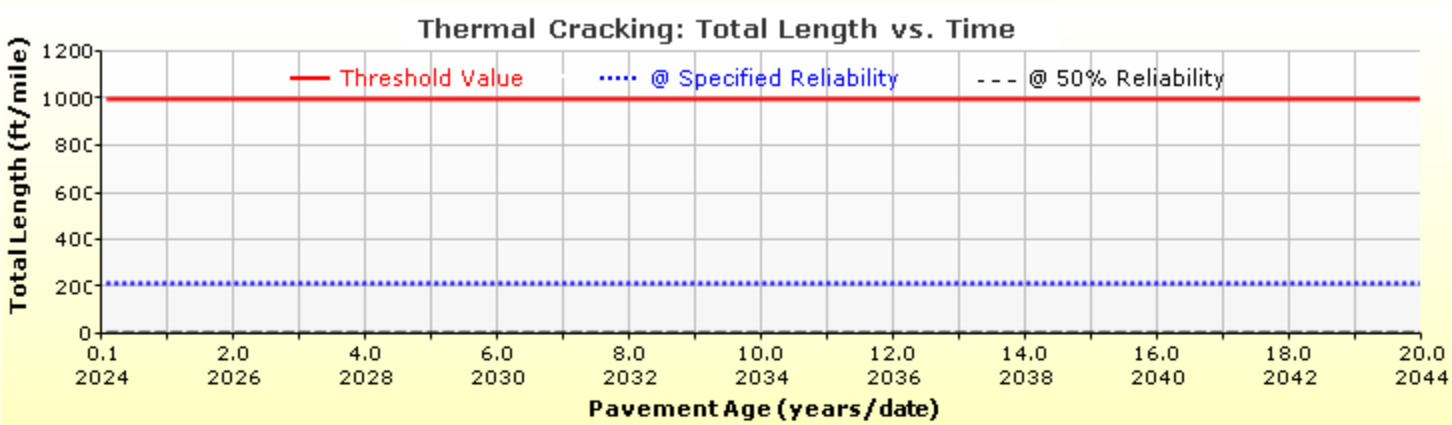


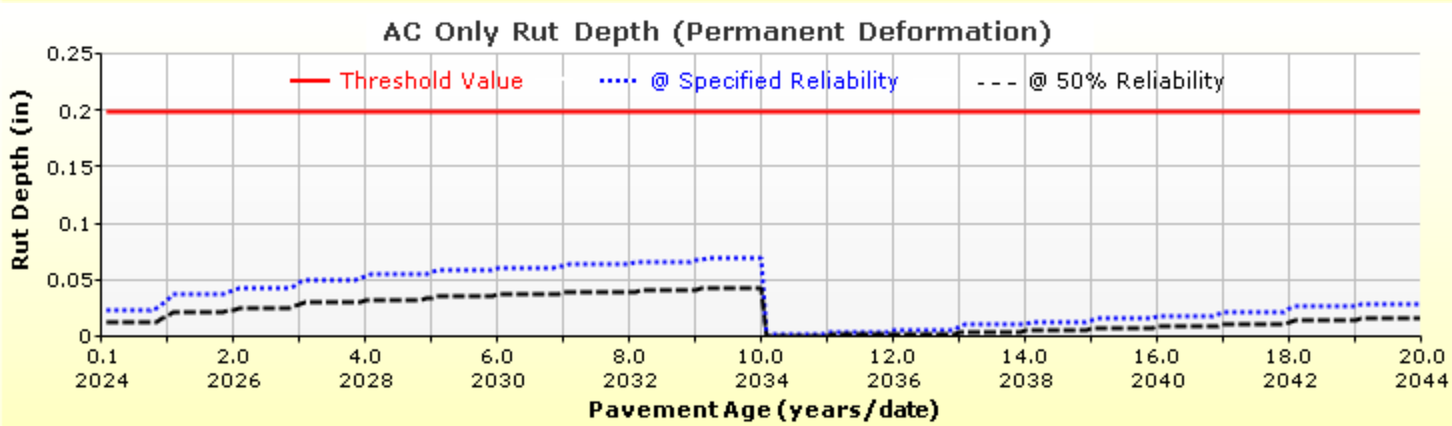


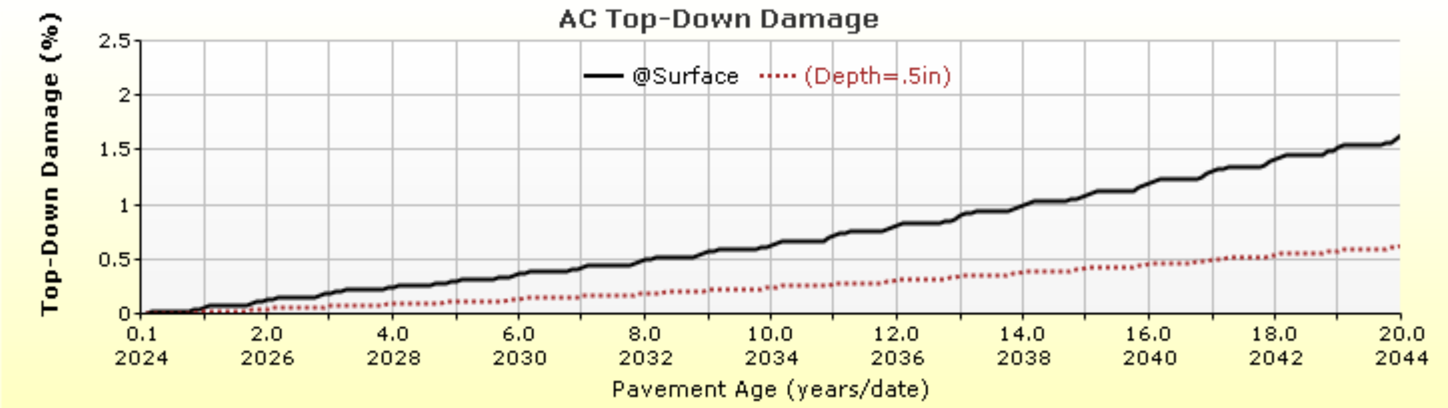
Analysis Output Charts

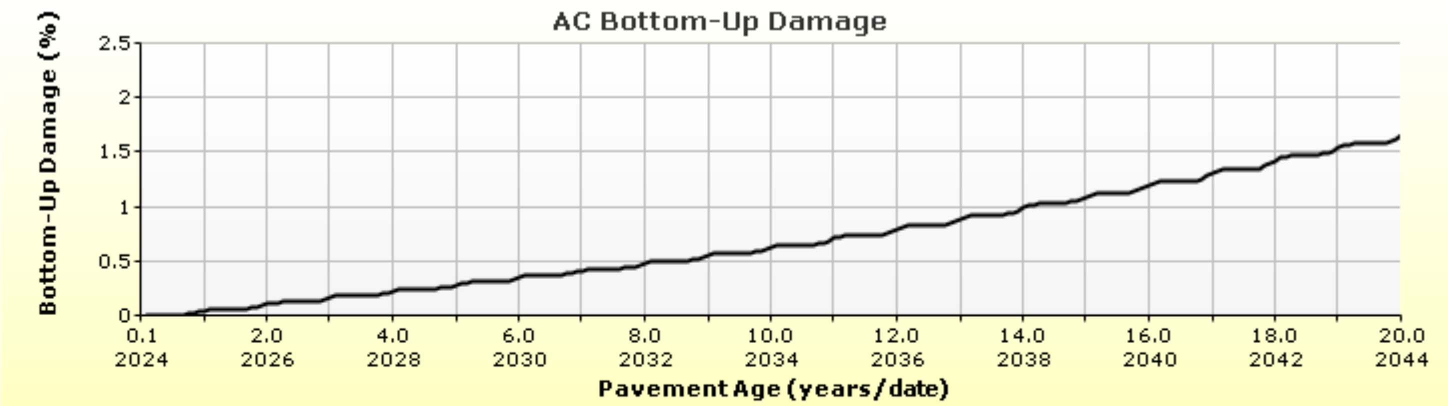


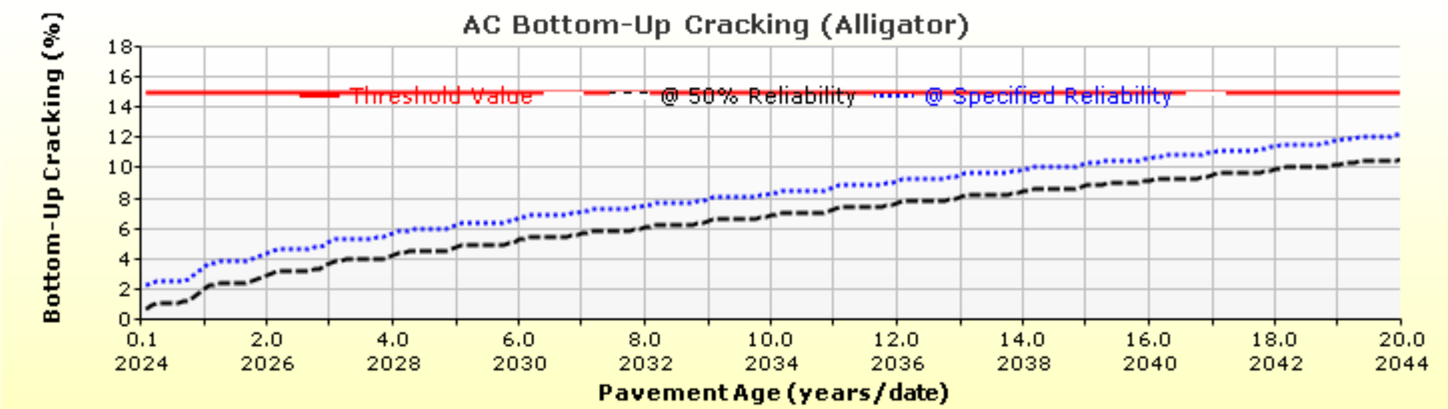


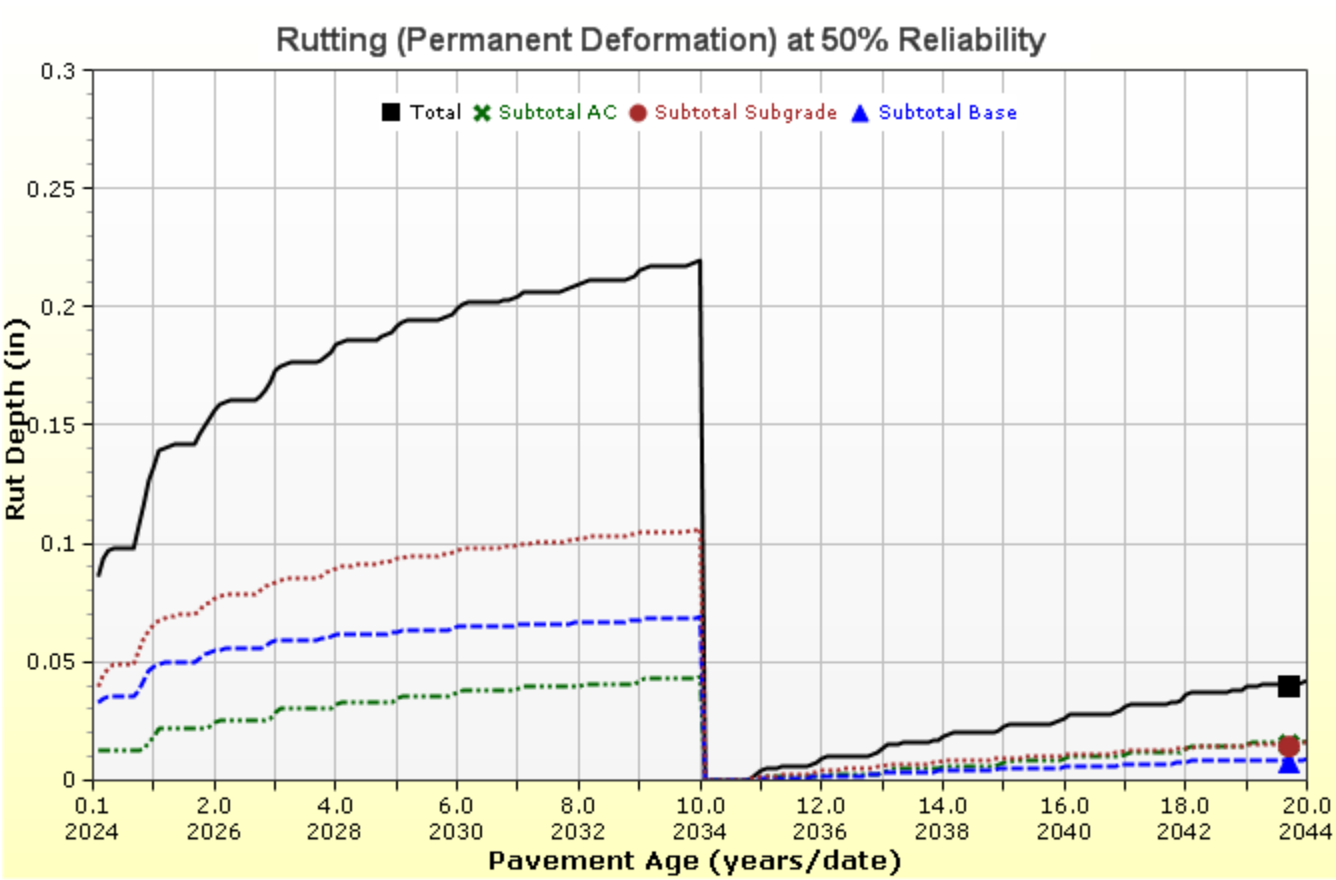


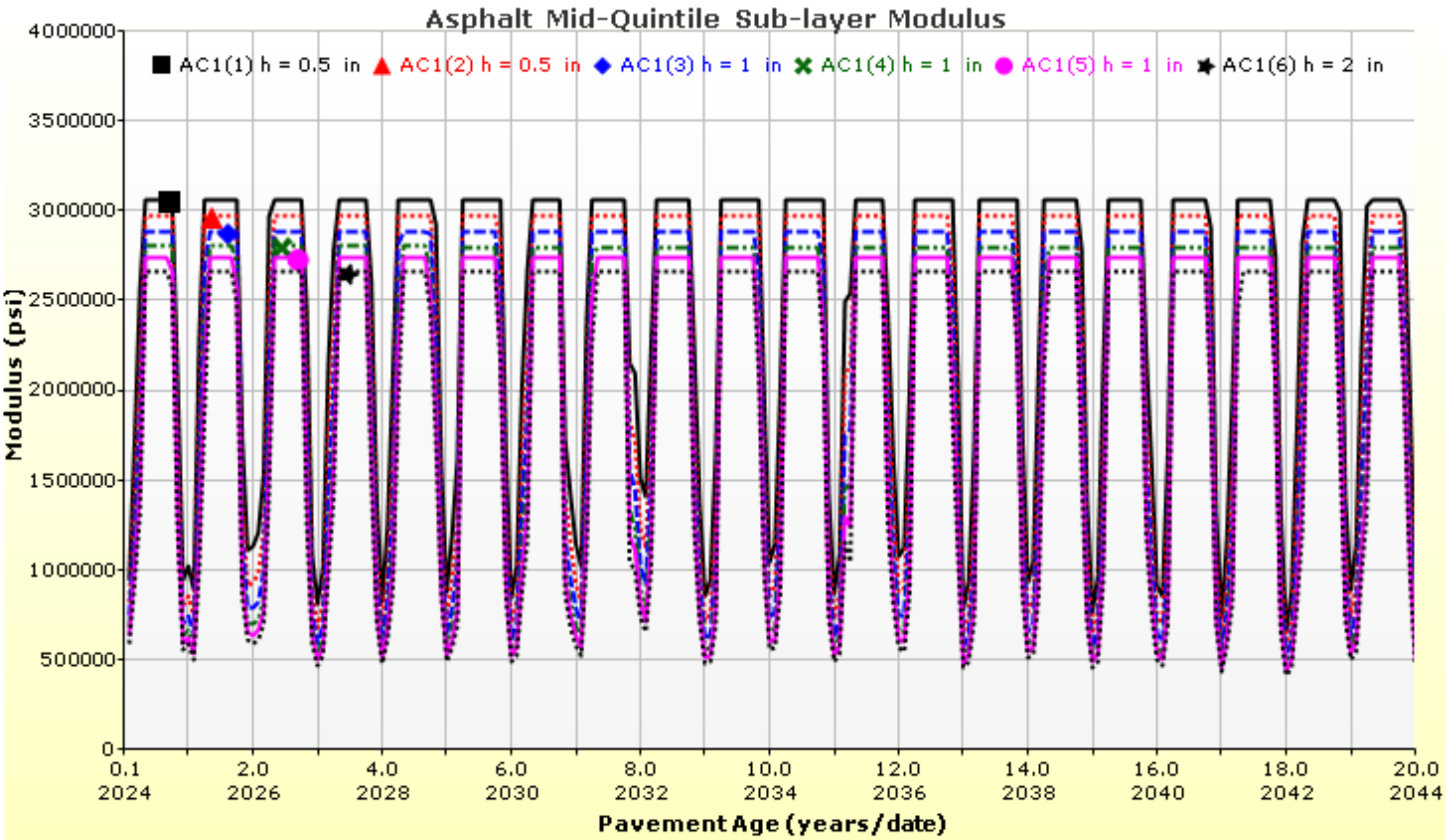



AC Top-Down Damage
@Surface
(Depth=.5in)
Top-Down Damage (%)
Pavement Age (years/date)

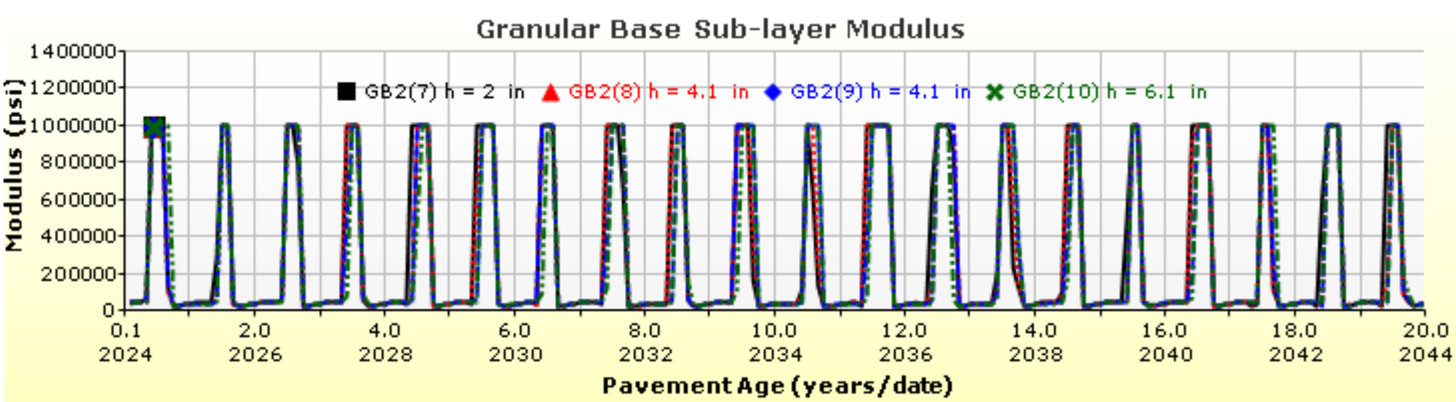

AC Bottom-Up Damage
Bottom-Up Damage (%)
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Threshold Value
@ 50% Reliability
@ Specified Reliability
Bottom-Up Cracking (%)
Pavement Age (years/date)

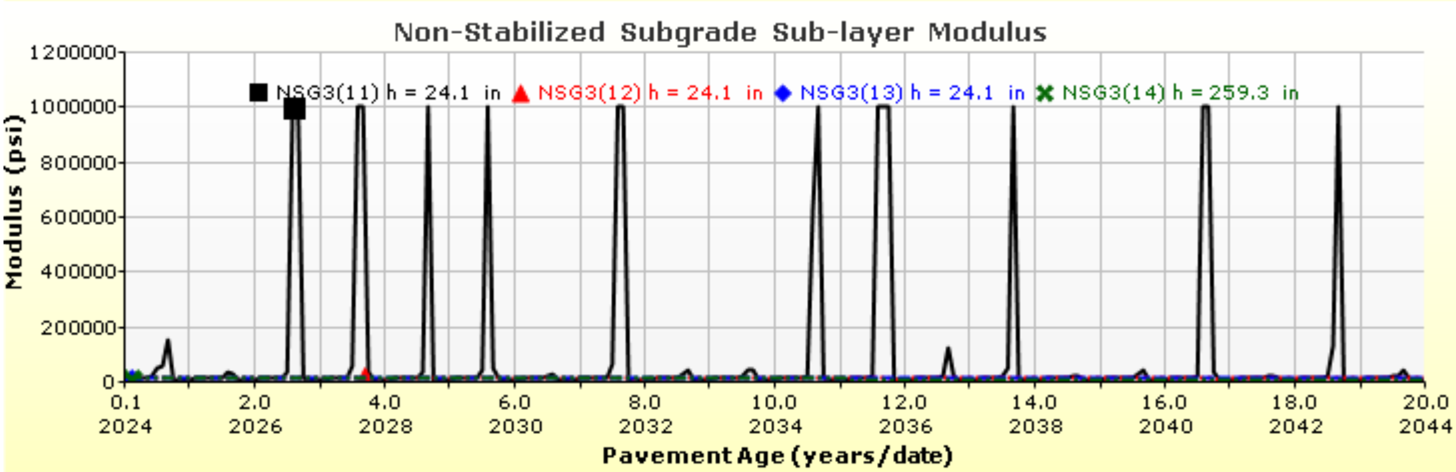

Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1
2024
2.0
2026
4.0
2028
6.0
2030
8.0
2032
10.0
2034
12.0
2036
14.0
2038
16.0
2040
18.0
2042
20.0
2044
Pavement Age (years/date)



Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC1(4) h = 1 in
AC1(5) h = 1 in
AC1(6) h = 2 in
Modulus (psi)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Granular Base Sub-layer Modulus
GB2(7) h = 2 in
GB2(8) h = 4.1 in
GB2(9) h = 4.1 in
GB2(10) h = 6.1 in
Modulus (psi)
1400000
1200000
1000000
800000
600000
400000
200000
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Non-Stabilized Subgrade Sub-layer Modulus
NSG3(11) h = 24.1 in
NSG3(12) h = 24.1 in
NSG3(13) h = 24.1 in
NSG3(14) h = 259.3 in
Modulus (psi)
1200000
1000000
800000
600000
400000
200000
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : New HMA (PG 70-34)

Asphalt		
Thickness (in)	6.0	
Unit weight (pcf)	144.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 3)

Gradation	Percent Passing
3/4-inch sieve	100
3/8-inch sieve	77
No.4 sieve	60
No.200 sieve	6

Asphalt Binder

Parameter	Value
Grade	Superpave Performance Grade
Binder Type	70-34
A	8.965
VTS	-2.948

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.6
Air voids (%)	7.5
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	New HMA (PG 70-34)
Description of object	New Superpave Hot Mix Asphalt
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : New & Existing Base/Subbase

Unbound	
Layer thickness (in)	16.3
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
23345.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	New & Existing Base/Subbase
Description of object	
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	6.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	125.5
Saturated hydraulic conductivity (ft/hr)	False	5.57e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.5

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.3826
bf	2.0948
cf	0.7783
hr	115.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	7.5
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	52.5
#4	
3/8-in.	
1/2-in.	95.0
3/4-in.	
1-in.	100.0
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Subgrade : Subgrade

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
17300.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Subgrade
Description of object	Default material
Author	AASHTO
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	40.0
Plasticity Index	20.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	115.8
Saturated hydraulic conductivity (ft/hr)	False	8.941e-06
Specific gravity of solids	False	2.7
Water Content (%)	False	13.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	99.8852
bf	0.7387
cf	0.2720
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	39.0
#100	
#80	
#60	
#50	
#40	55.0
#30	
#20	
#16	
#10	78.0
#8	
#4	89.0
3/8-in.	96.0
1/2-in.	97.0
3/4-in.	100.0
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2 \beta_{f2}} \left(\frac{1}{E}\right)^{k_3 \beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

AC Fatigue
k1: 3.75
k2: 2.87
k3: 1.46
Bf1: (5.014 * Pow(hac,-3.416)) * 1 + 0
Bf2: 1.38
Bf3: 0.88

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_a^2 + 2.4868 * H_a - 17.342$$

$$C_2 = 0.0172 * H_a^2 - 1.7331 * H_a + 27.428$$

Where:

$H_{ac} = total\ AC\ thickness(in)$

$\varepsilon_p = plastic\ strain(in/in)$

$\varepsilon_r = resilient\ strain(in/in)$

$T = layer\ temperature(°F)$

$N = number\ of\ load\ repetitions$

AC Rutting Standard Deviation	0.24 * Pow(RUT,0.8026) + 0.001	
AC Layer 1	K1:-2.45 K2:3.01 K3:0.22	Br1:0.3 Br2:0.52 Br3:1.36

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

$C_f = observed\ amount\ of\ thermal\ cracking(ft/500ft)$
$k = refression\ coefficient\ determined\ through\ field\ calibration$
$N(\,) = standard\ normal\ distribution\ evaluated\ at(\,)$
$\sigma = standard\ deviation\ of\ the\ \log\ of\ the\ depth\ of\ cracks\ in\ the\ pavments$
$C = crack\ depth(in)$
$h_{ac} = thickness\ of\ asphalt\ layer(in)$
$\Delta C = Change\ in\ the\ crack\ depth\ due\ to\ a\ cooling\ cycle$
$\Delta K = Change\ in\ the\ stress\ intensity\ factor\ due\ to\ a\ cooling\ cycle$
$A, n = Fracture\ parameters\ for\ the\ asphalt\ mixture$
$E = mixture\ stiffness$
$\sigma_M = Undamaged\ mixture\ tensile\ strength$
$\beta_t = Calibration\ parameter$

Level 1 K: ((3 * Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 1 Standard Deviation: 0.14 * THERMAL + 168
Level 2 K: ((2.591* Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 2 Standard Deviation: 0.20 * THERMAL + 168
Level 3 K: ((3 * Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 3 Standard Deviation: 0.289 * THERMAL + 168

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1} \left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

$N_f = number\ of\ repetitions\ to\ fatigue\ cracking$
$\sigma_s = Tensile\ stress(psi)$
$M_r = modulus\ of\ rupture(psi)$

k1: 0.972	k2: 0.0825	Bc1: 1	Bc2:1

Unbound Layer Rutting

$$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left| e^{-\left(\frac{\rho}{N}\right)^\beta} \right|$$

δ_a = permanent deformation for the layer
N = number of repetitions
ε_v = average veritcal strain(in/in)
$\varepsilon_0, \beta, \rho$ = material properties
ε_r = resilient strain(in/in)

Base Rutting		Subgrade Rutting	
k1: 0.965	Bs1: 0.86	k1: 0.965	Bs1: 0.736
Standard Deviation (BASERUT) 0.1477 * Pow(BASERUT,0.6711) + 0.001		Standard Deviation (BASERUT) 0.1235 * Pow(SUBRUT,0.5012) + 0.001	

AC Cracking

AC Top Down Cracking

$$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$$

c1: 3.3	c2: 0.825	c3: 0	c4: 1000

AC Bottom Up Cracking

$$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D*100))}}\right) * \left(\frac{1}{60}\right)$$

$$C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$$

$$C_1' = -2 * C_2'$$

c1: 0.31	c2: (0.867 + 0.2583 * hac) * 0.2 + 0	c3: 3000

Top down AC Cracking Standard Deviation	Bottom up AC Cracking Standard Deviation
200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))	1.13 + 13/(1+exp(7.57-15.5*LOG10(BOTTOM+0.0001)))

CSM Cracking

$$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4 * log_{10}(Damage)}}$$

C1: 0	C2: 75	C3: 2	C4: 2

CSM Standard Deviation

CTB*1

IRI Flexible Pavements

C1 - Rutting
C2 - Fatigue Crack
C3 - Transverse Crack
C4 - Site Factors

C1: 80	C2: 0.6	C3: 0.008	C4: 0.02

Design Inputs

Design Life: 20 years
Design Type: FLEXIBLE

Base construction: June, 2024
Pavement construction: July, 2024
Traffic opening: August, 2024

Climate Data Sources (Lat/Lon): 43.5, -114.375; 43.5, -113.75; 44, -113.75

Design Structure

Layer type	Material Type	Thickness (in)
Flexible	New HMA (PG 70-34)	6.0
NonStabilized	Untreated Aggregate Base	7.0
NonStabilized	Granular Subbase	8.0
Subgrade	Subgrade	Semi-infinite

Volumetric at Construction:	
Effective binder content (%)	11.6
Air voids (%)	7.5

Traffic

Age (year)	Heavy Trucks (cumulative)
2024 (initial)	1,560
2034 (10 years)	4,047,120
2044 (20 years)	10,515,000

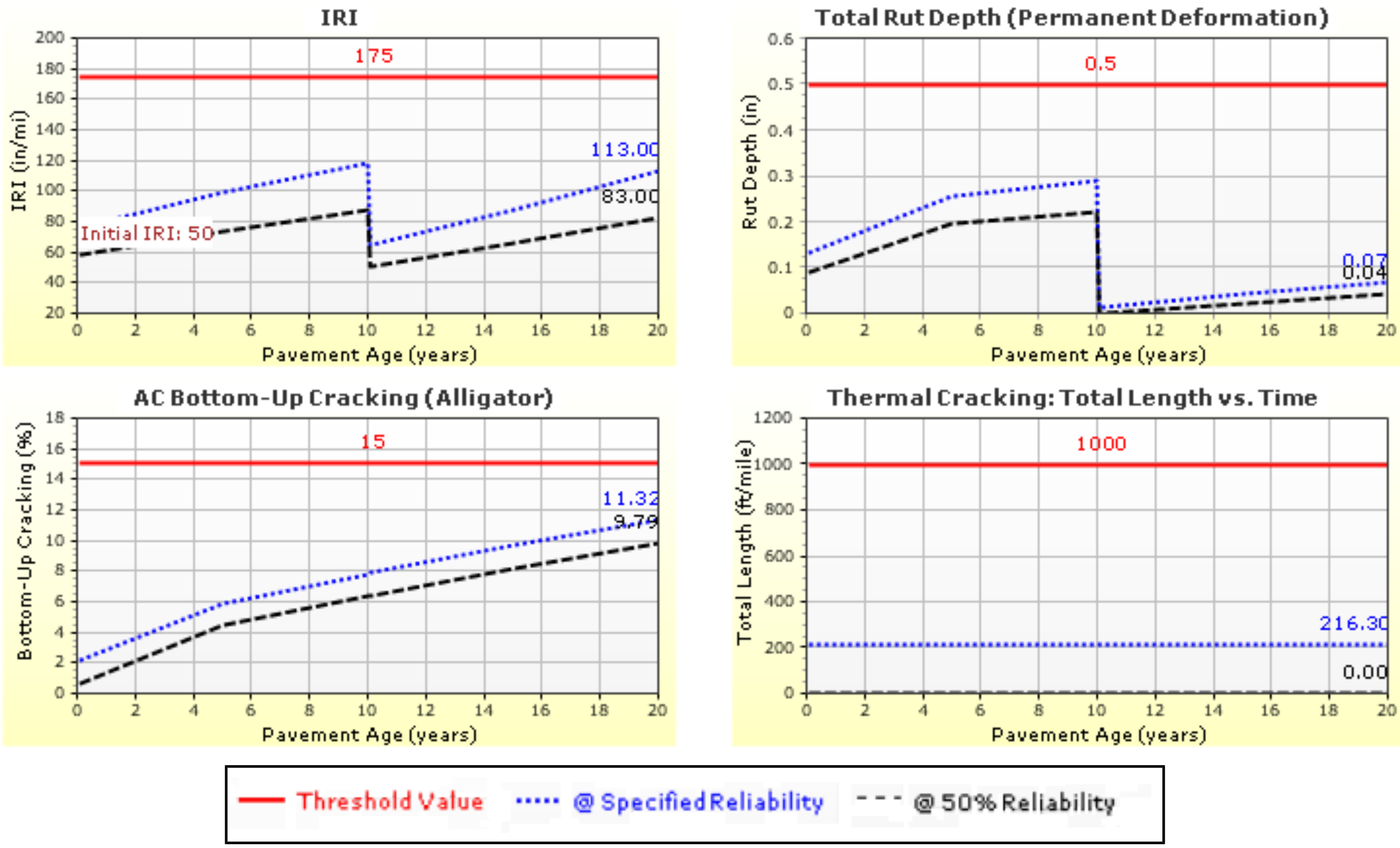
Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in/mile)	175.00	112.99	90.00	100.00	Pass
Permanent deformation - total pavement (in)	0.50	0.07	90.00	100.00	Pass
AC bottom-up fatigue cracking (% lane area)	15.00	11.32	90.00	100.00	Pass
AC thermal cracking (ft/mile)	1000.00	216.30	90.00	100.00	Pass
Permanent deformation - AC only (in)	0.20	0.03	90.00	100.00	Pass

Design traffic (flexible pavements) = 11.68 million ESALs

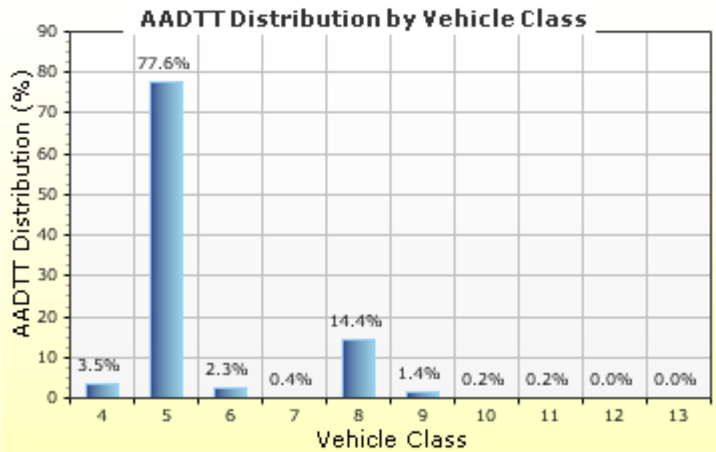
Distress Charts

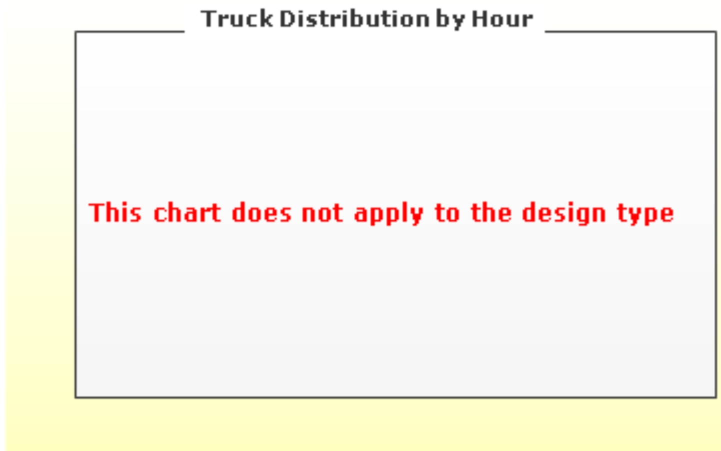


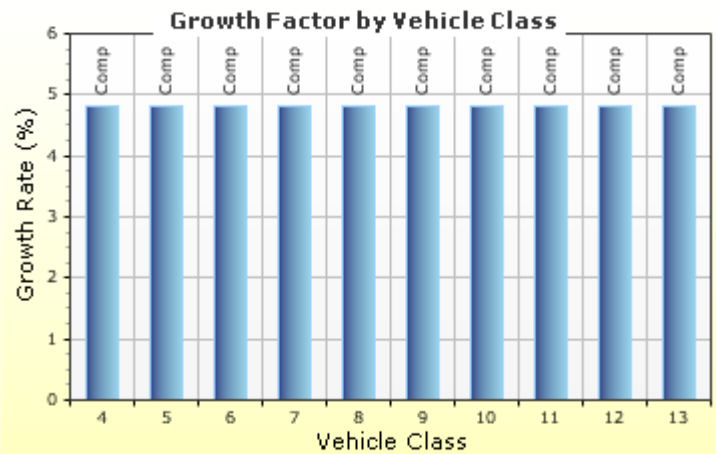
Traffic Inputs

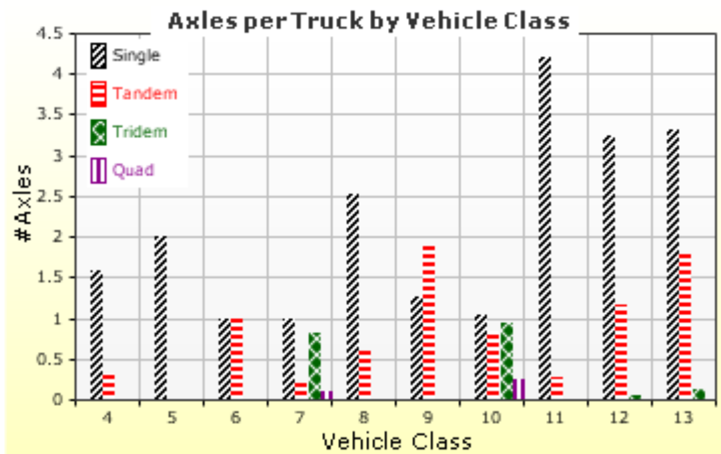
Graphical Representation of Traffic Inputs

Initial two-way AADTT:	1,560	Percent of trucks in design direction (%):	57.0
Number of lanes in design direction:	1	Percent of trucks in design lane (%):	100.0
		Operational speed (mph)	25.0

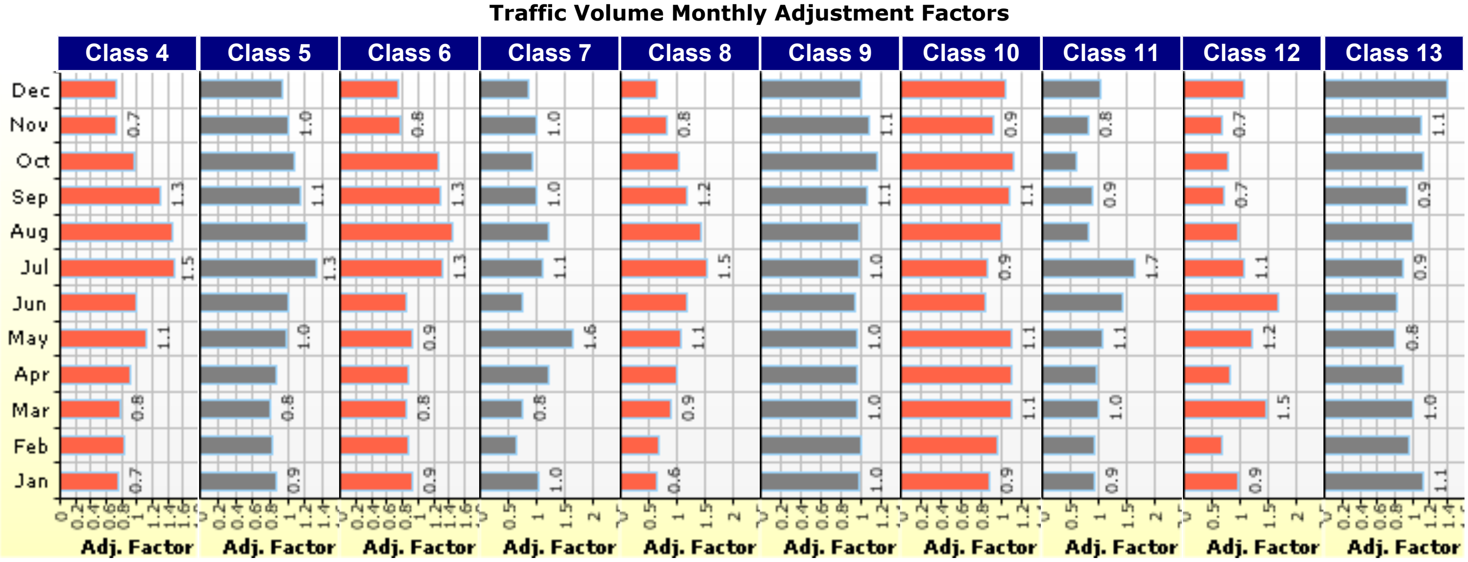








Traffic Volume Monthly Adjustment Factors



Tabular Representation of Traffic Inputs

Volume Monthly Adjustment Factors

Level 3: Default MAF

Month	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
January	0.7	0.9	0.9	1.0	0.6	1.0	0.9	0.9	0.9	1.1
February	0.8	0.8	0.9	0.6	0.7	1.0	1.0	0.9	0.7	1.0
March	0.8	0.8	0.8	0.8	0.9	1.0	1.1	1.0	1.5	1.0
April	0.9	0.9	0.9	1.2	1.0	1.0	1.1	0.9	0.8	0.9
May	1.1	1.0	0.9	1.6	1.1	1.0	1.1	1.1	1.2	0.8
June	1.0	1.0	0.8	0.7	1.2	0.9	0.8	1.4	1.7	0.8
July	1.5	1.3	1.3	1.1	1.5	1.0	0.9	1.7	1.1	0.9
August	1.5	1.2	1.5	1.2	1.4	1.0	1.0	0.8	1.0	1.0
September	1.3	1.1	1.3	1.0	1.2	1.1	1.1	0.9	0.7	0.9
October	0.9	1.1	1.3	0.9	1.0	1.2	1.1	0.6	0.8	1.1
November	0.7	1.0	0.8	1.0	0.8	1.1	0.9	0.8	0.7	1.1
December	0.7	0.9	0.7	0.9	0.6	1.0	1.0	1.0	1.1	1.4

Distributions by Vehicle Class

Vehicle Class	AADTT Distribution (%) (Level 3)	Growth Factor	
		Rate (%)	Function
Class 4	3.5%	4.8%	Compound
Class 5	77.6%	4.8%	Compound
Class 6	2.3%	4.8%	Compound
Class 7	0.4%	4.8%	Compound
Class 8	14.4%	4.8%	Compound
Class 9	1.4%	4.8%	Compound
Class 10	0.2%	4.8%	Compound
Class 11	0.2%	4.8%	Compound
Class 12	0%	4.8%	Compound
Class 13	0%	4.8%	Compound

Truck Distribution by Hour does not apply

Axle Configuration

Traffic Wander	
Mean wheel location (in)	18.0
Traffic wander standard deviation (in)	10.0
Design lane width (ft)	12.0

Axle Configuration	
Average axle width (ft)	8.5
Dual tire spacing (in)	12.0
Tire pressure (psi)	120.0

Average Axle Spacing	
Tandem axle spacing (in)	51.6
Tridem axle spacing (in)	49.2
Quad axle spacing (in)	49.2

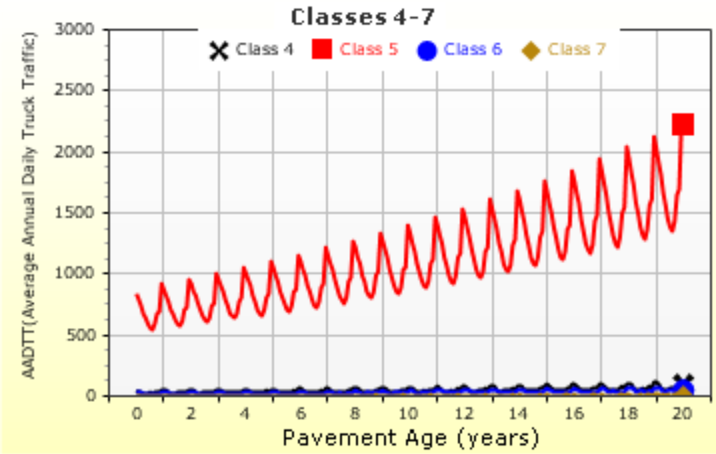
Wheelbase does not apply

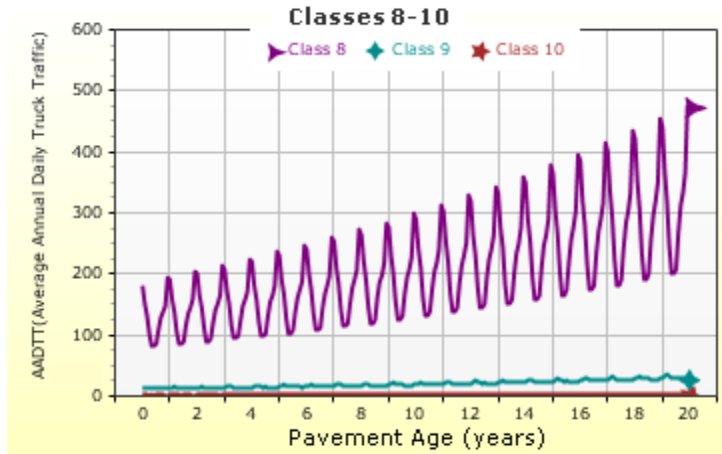
Number of Axles per Truck

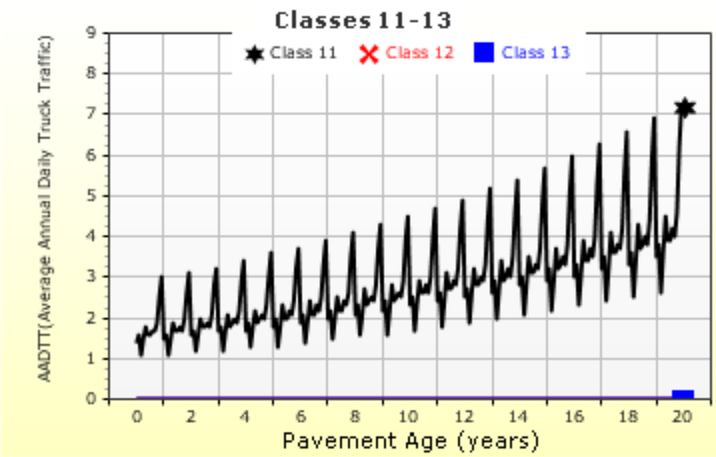
Vehicle Class	Single Axle	Tandem Axle	Tridem Axle	Quad Axle
Class 4	1.59	0.34	0	0
Class 5	2	0	0	0
Class 6	1	1	0	0
Class 7	1	0.22	0.83	0.1
Class 8	2.52	0.6	0	0
Class 9	1.25	1.87	0	0
Class 10	1.03	0.85	0.95	0.26
Class 11	4.21	0.29	0.01	0
Class 12	3.24	1.16	0.07	0.01
Class 13	3.32	1.79	0.14	0.02

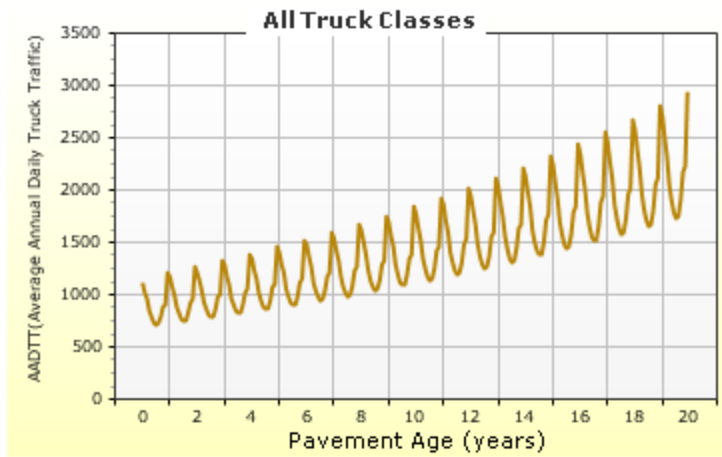
AADTT (Average Annual Daily Truck Traffic) Growth

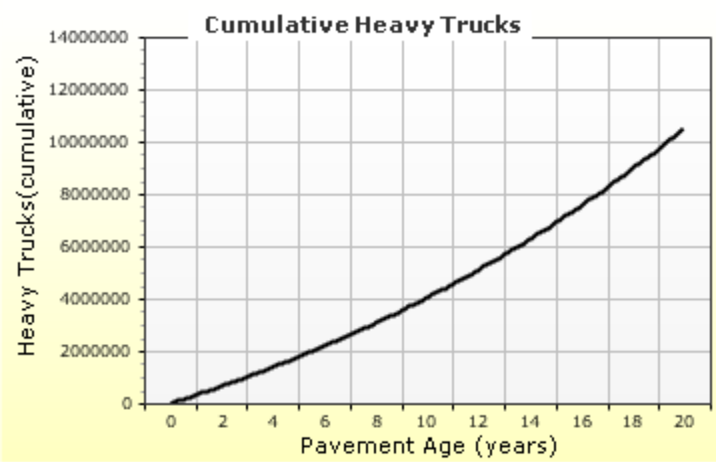
*** Traffic cap is not enforced**







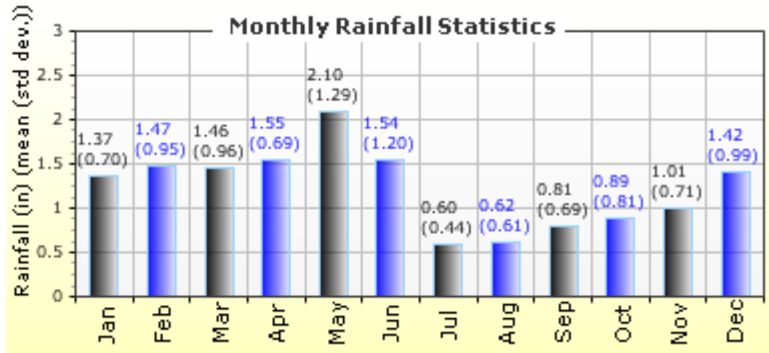




Climate Inputs

Climate Data Sources:

Climate Station Cities:	Location (lat lon elevation(ft))
US, ID	43.50000 -114.37500 5697
US, ID	43.50000 -113.75000 6658
US, ID	44.00000 -113.75000 6344

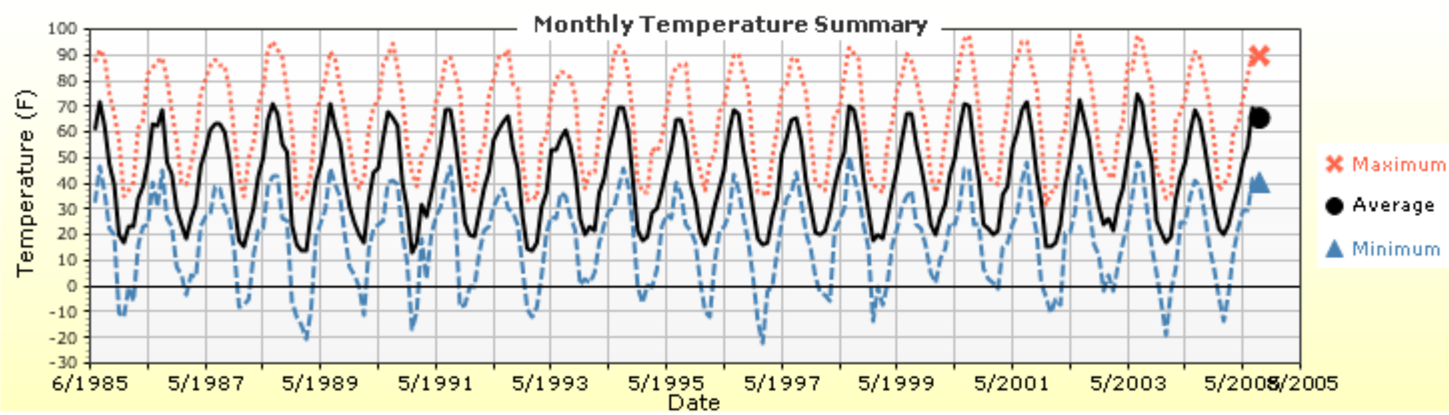


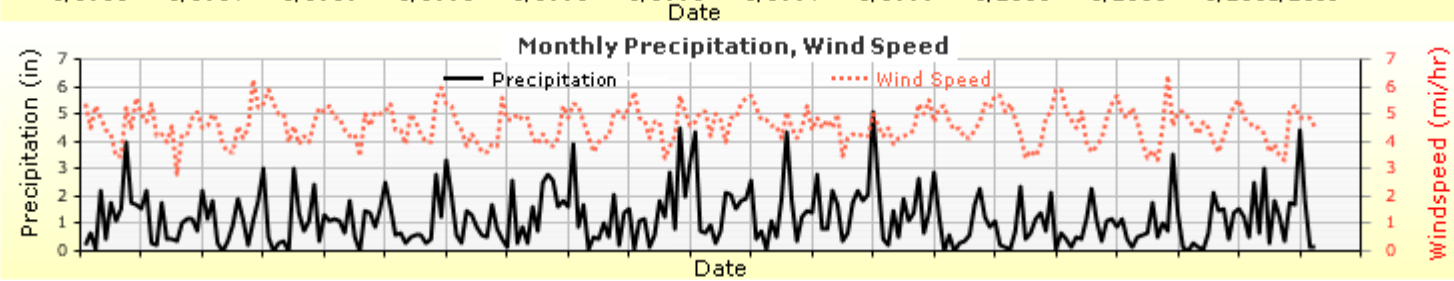
Annual Statistics:

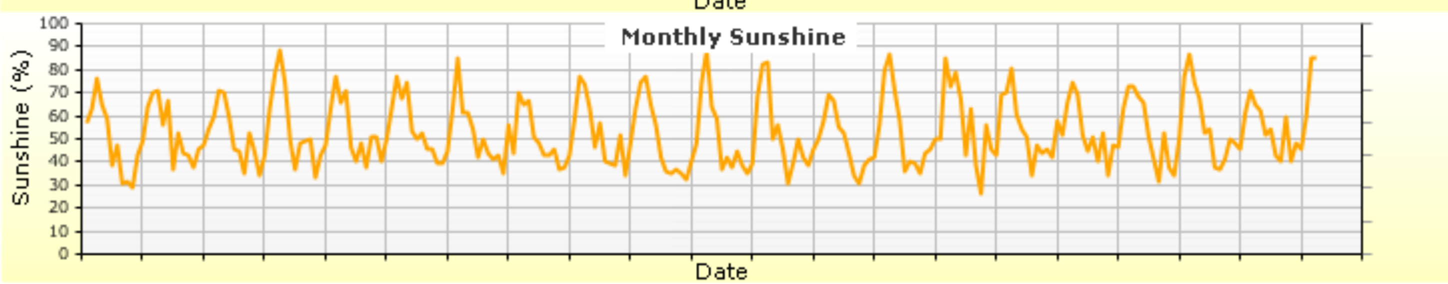
Mean annual air temperature (ºF)	42.54
Mean annual precipitation (in)	14.79
Freezing index (ºF - days)	1223.03
Average annual number of freeze/thaw cycles:	118.83

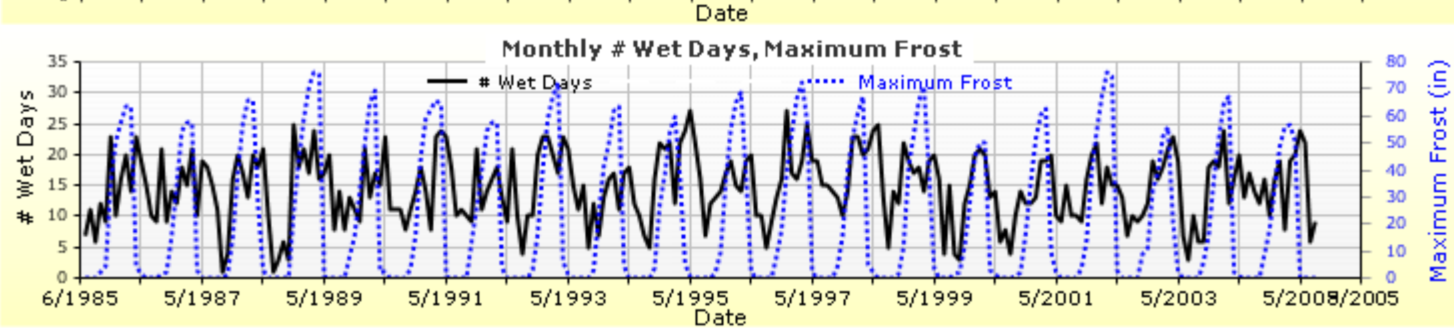
Water table depth (ft) 10.00

Monthly Climate Summary:

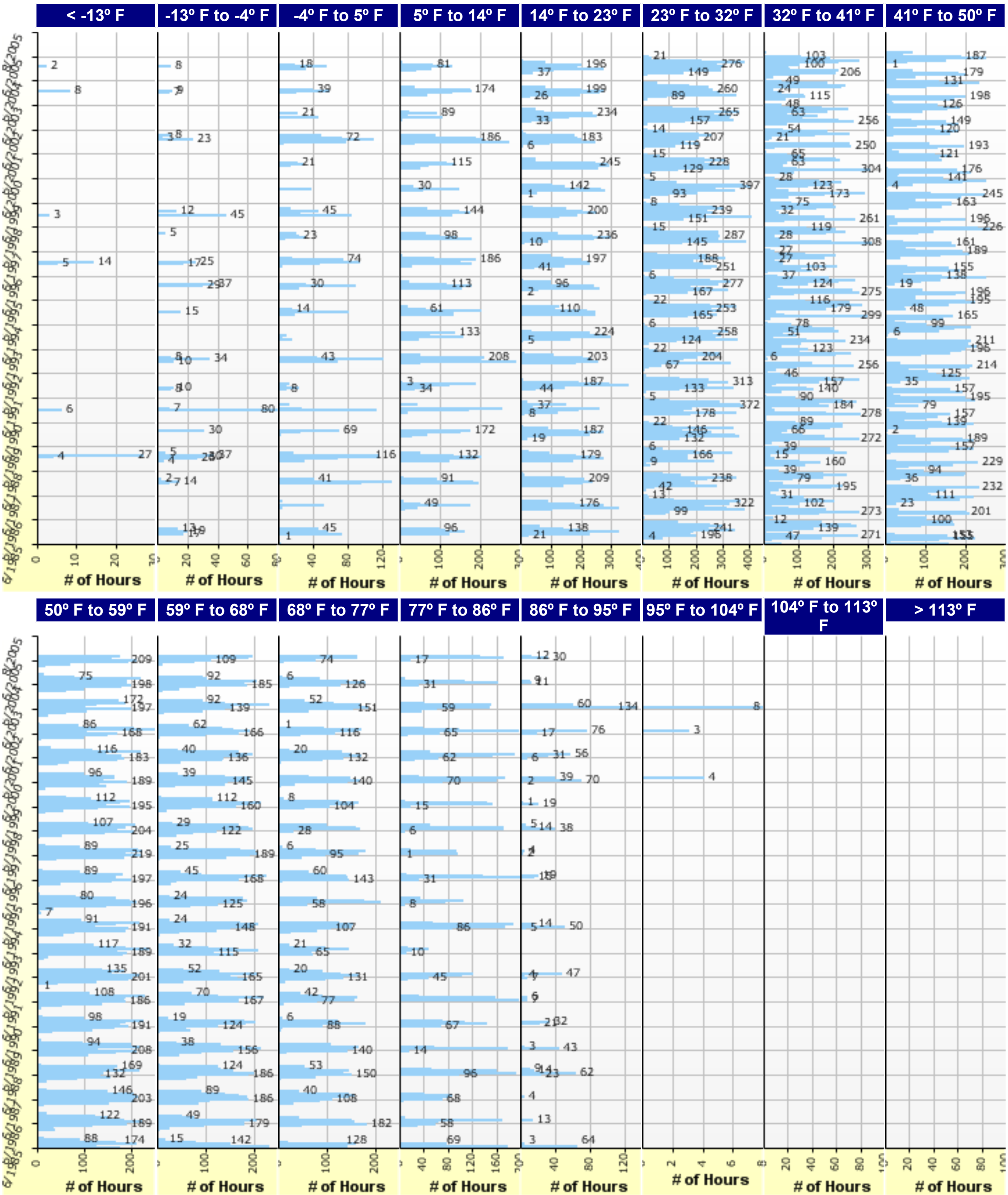








Hourly Air Temperature Distribution by Month:



Design Properties

HMA Design Properties

Use Multilayer Rutting Model	False
Using G* based model (not nationally calibrated)	False
Is NCHRP 1-37A HMA Rutting Model Coefficients	True
Endurance Limit	-
Use Reflective Cracking	True

Structure - ICM Properties	
AC surface shortwave absorptivity	0.85

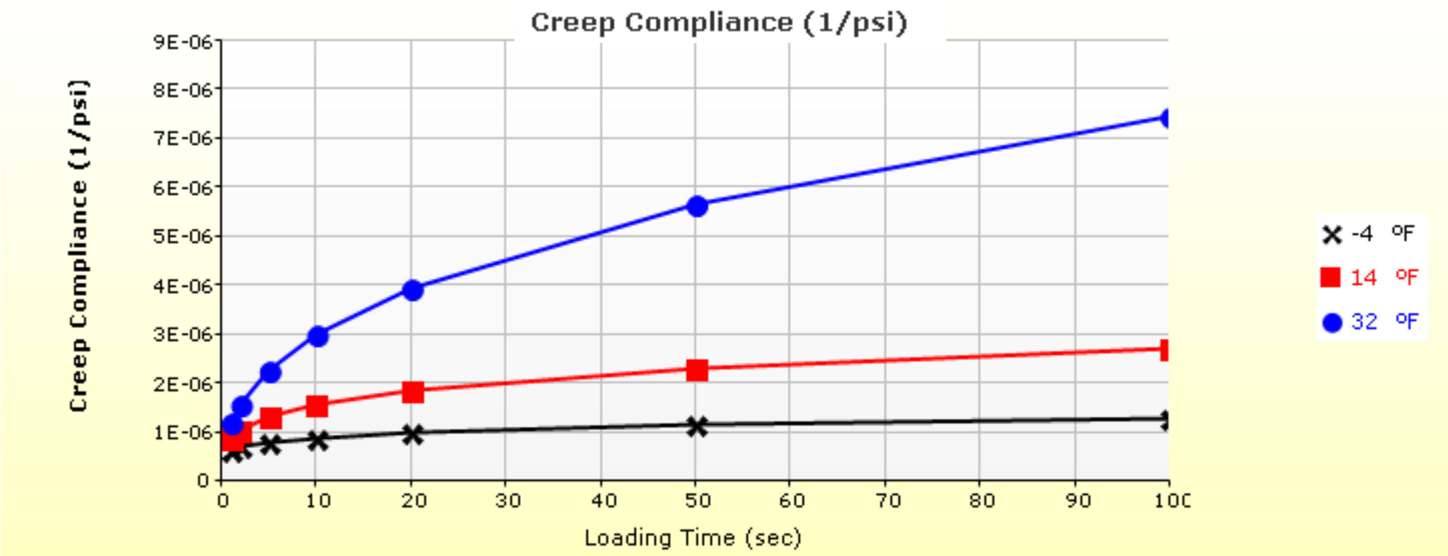
Layer Name	Layer Type	Interface Friction
Layer 1 Flexible : New HMA (PG 70-34)	Flexible (1)	1.00
Layer 2 Non-stabilized Base : Untreated Aggregate Base	Non-stabilized Base (4)	1.00
Layer 3 Non-stabilized Base : Granular Subbase	Non-stabilized Base (4)	1.00
Layer 4 Subgrade : Subgrade	Subgrade (5)	-

Thermal Cracking

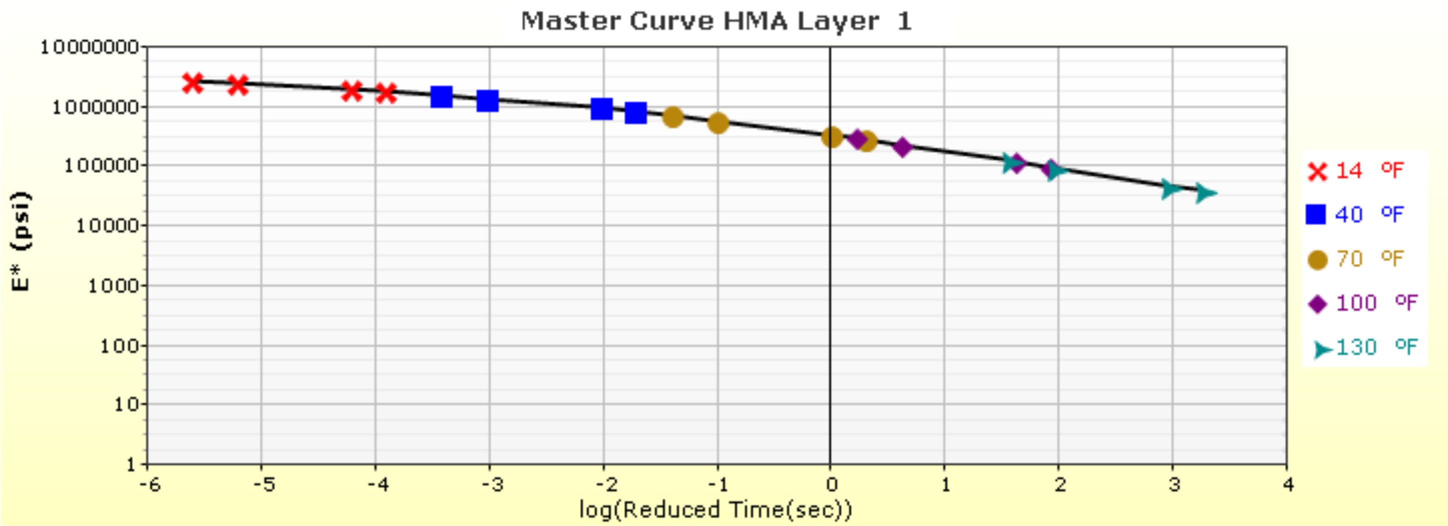
Thermal Contraction	
Is thermal contraction calculated?	True
Mix coefficient of thermal contraction (in/in/ºF)	-
Aggregate coefficient of thermal contraction (in/in/ºF)	5.0e-006
Voids in Mineral Aggregate (%)	19.1

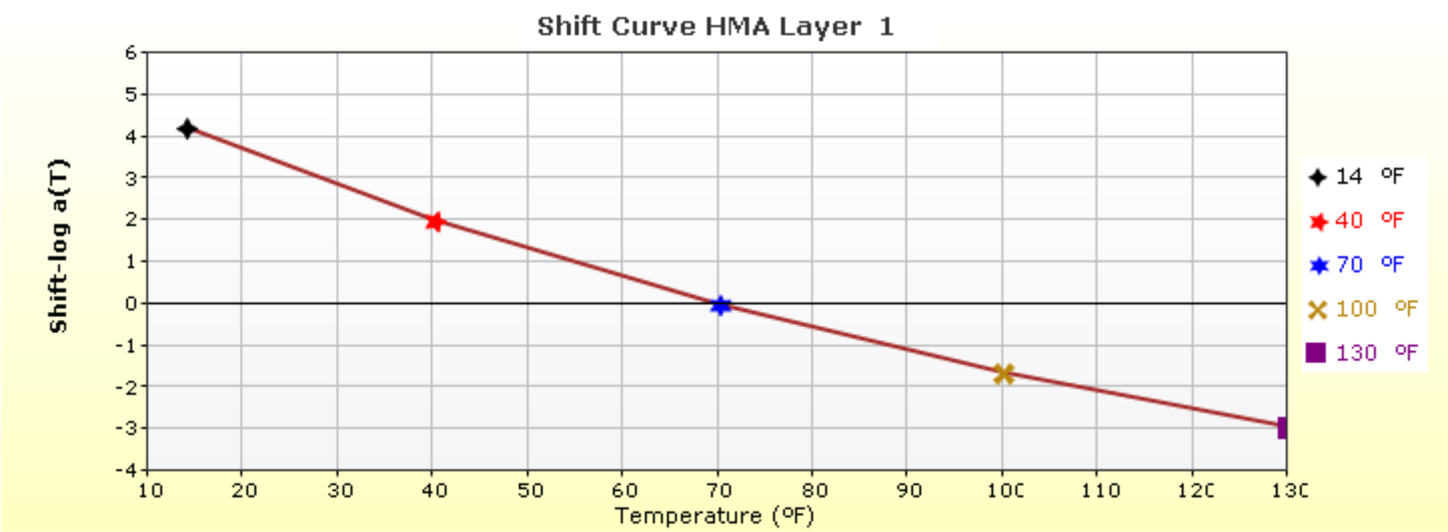
Indirect Tensile Strength (Input Level: 3)	
Test Temperature (ºF)	**Indirect Tensilte Strength (psi)**
14.0	490.85

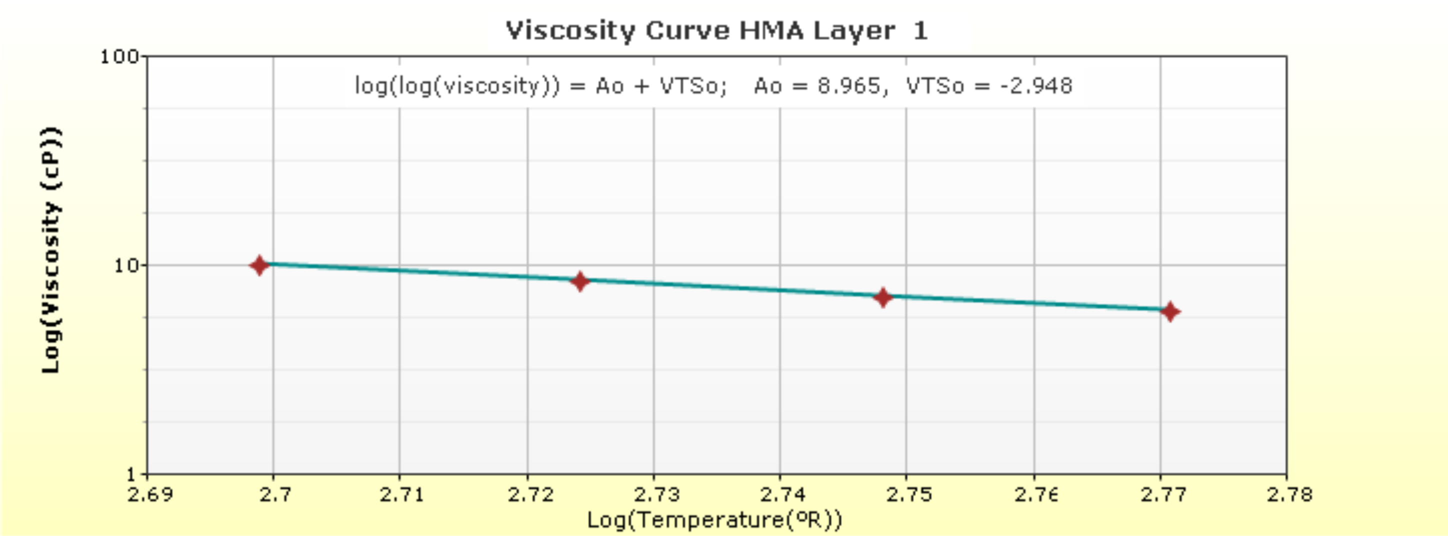
Creep Compliance (1/psi) (Input Level: 3)			
Loading time (sec)	**-4 ºF**	**14 ºF**	**32 ºF**
1	6.27e-007	8.90e-007	1.21e-006
2	6.98e-007	1.05e-006	1.59e-006
5	8.05e-007	1.32e-006	2.28e-006
10	8.96e-007	1.56e-006	3.00e-006
20	9.97e-007	1.84e-006	3.95e-006
50	1.15e-006	2.30e-006	5.67e-006
100	1.28e-006	2.73e-006	7.46e-006



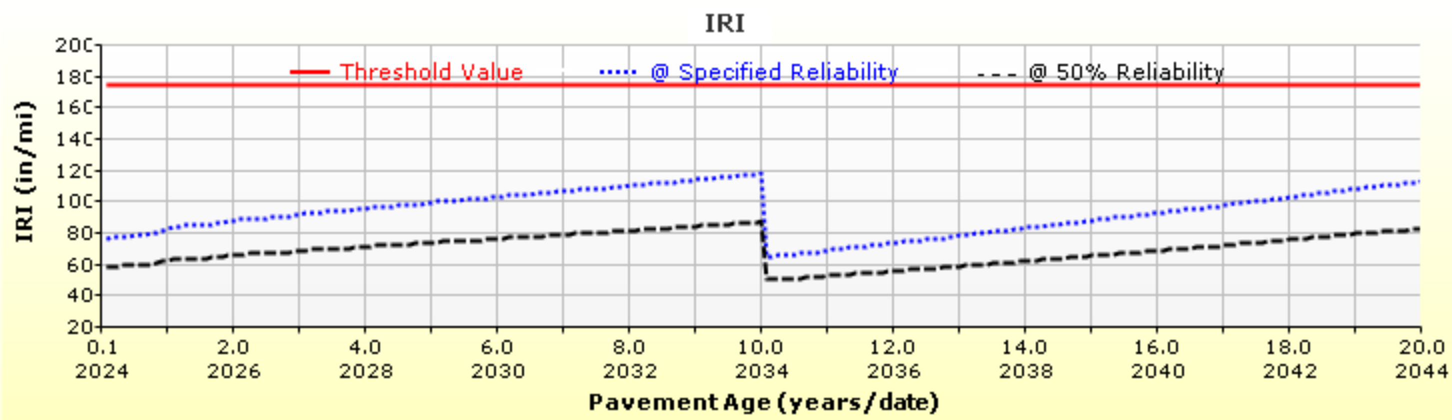
HMA Layer 1: Layer 1 Flexible : New HMA (PG 70-34)

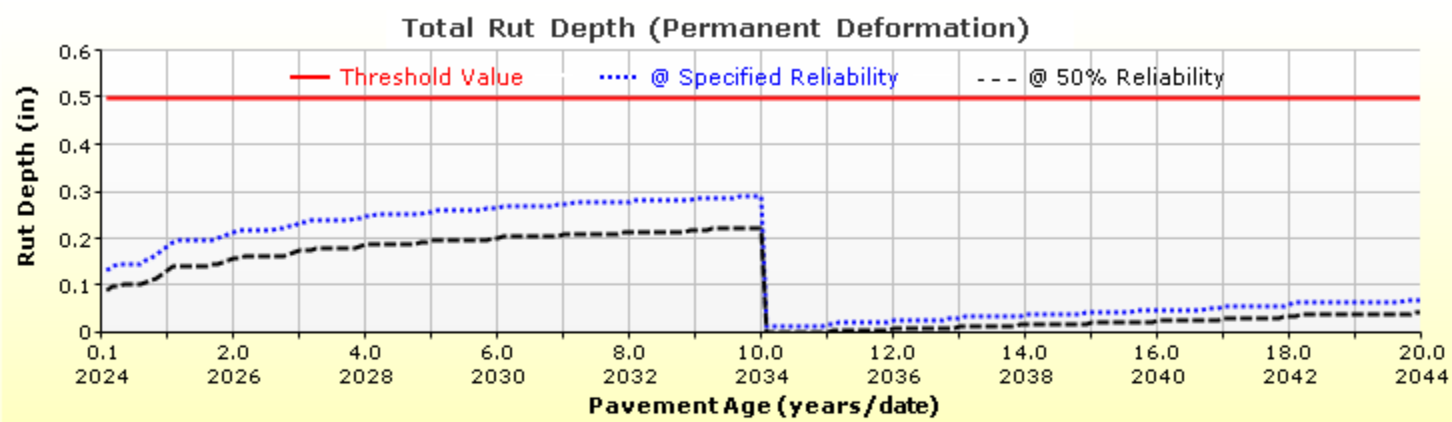


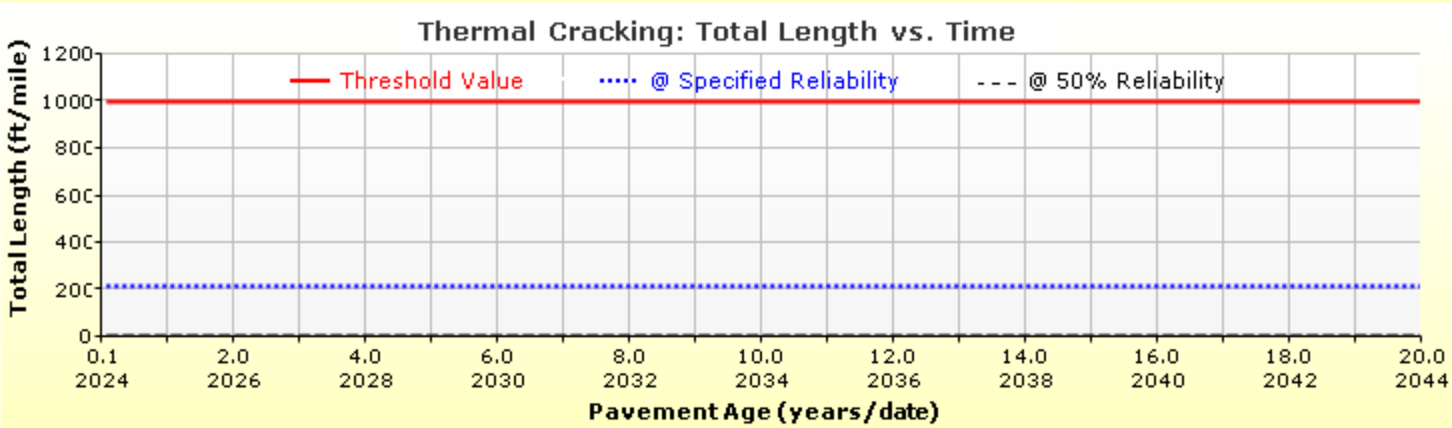


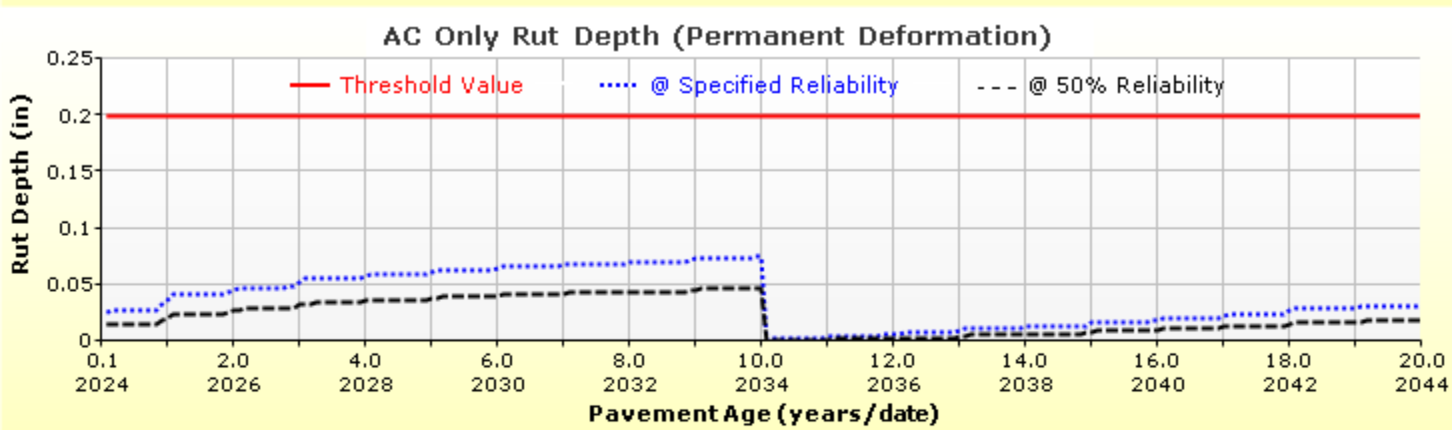


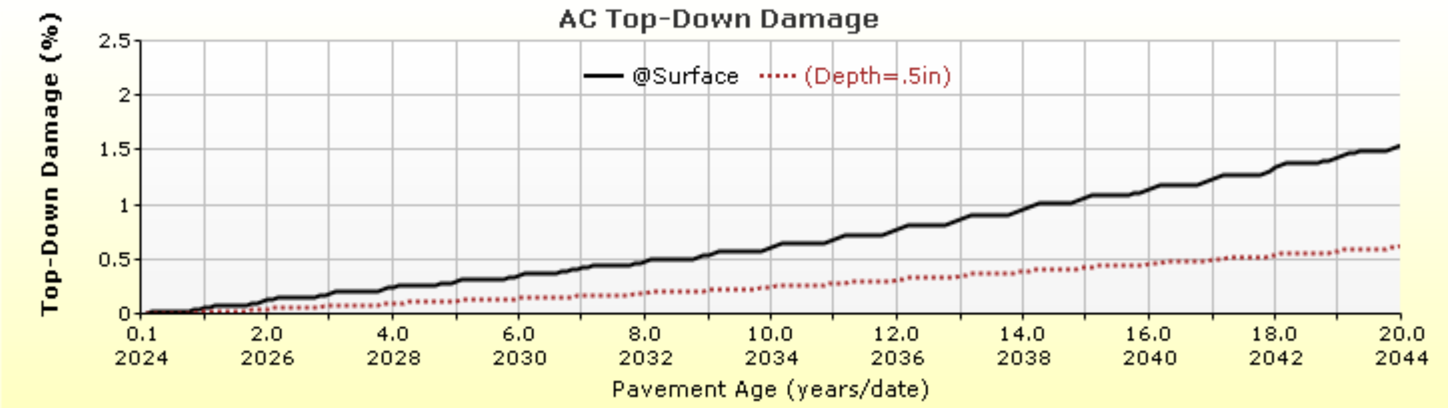
Analysis Output Charts

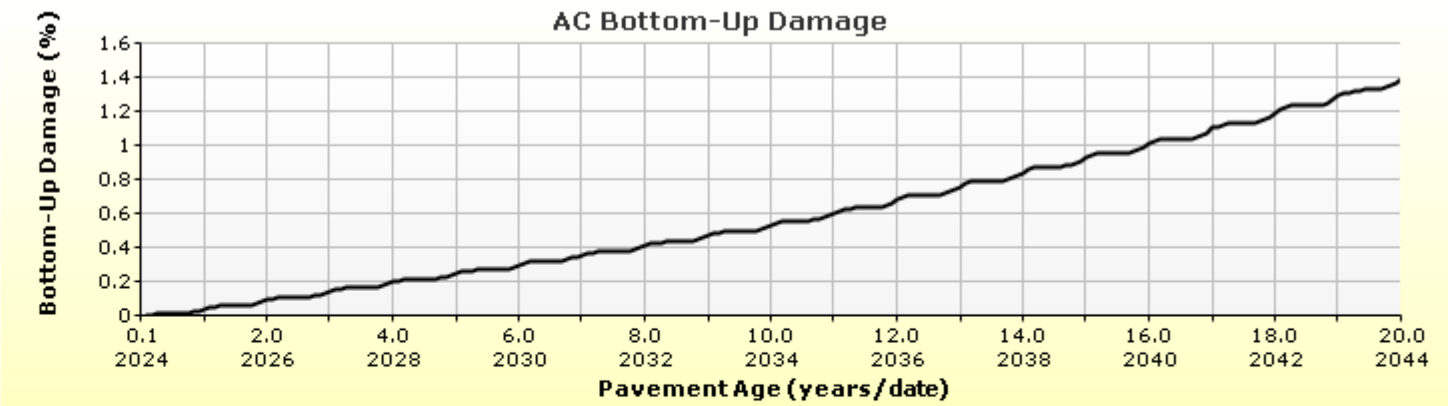


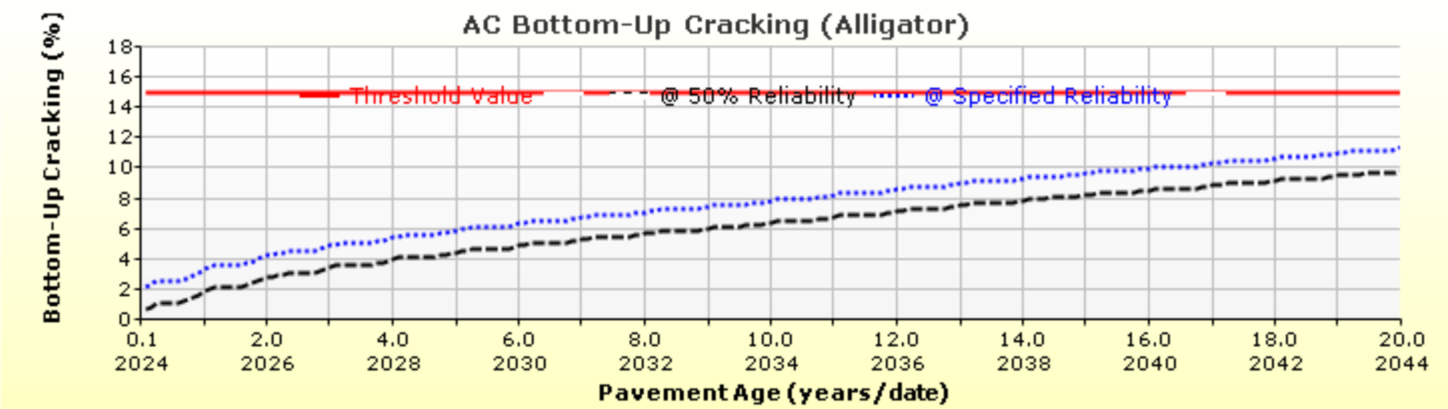


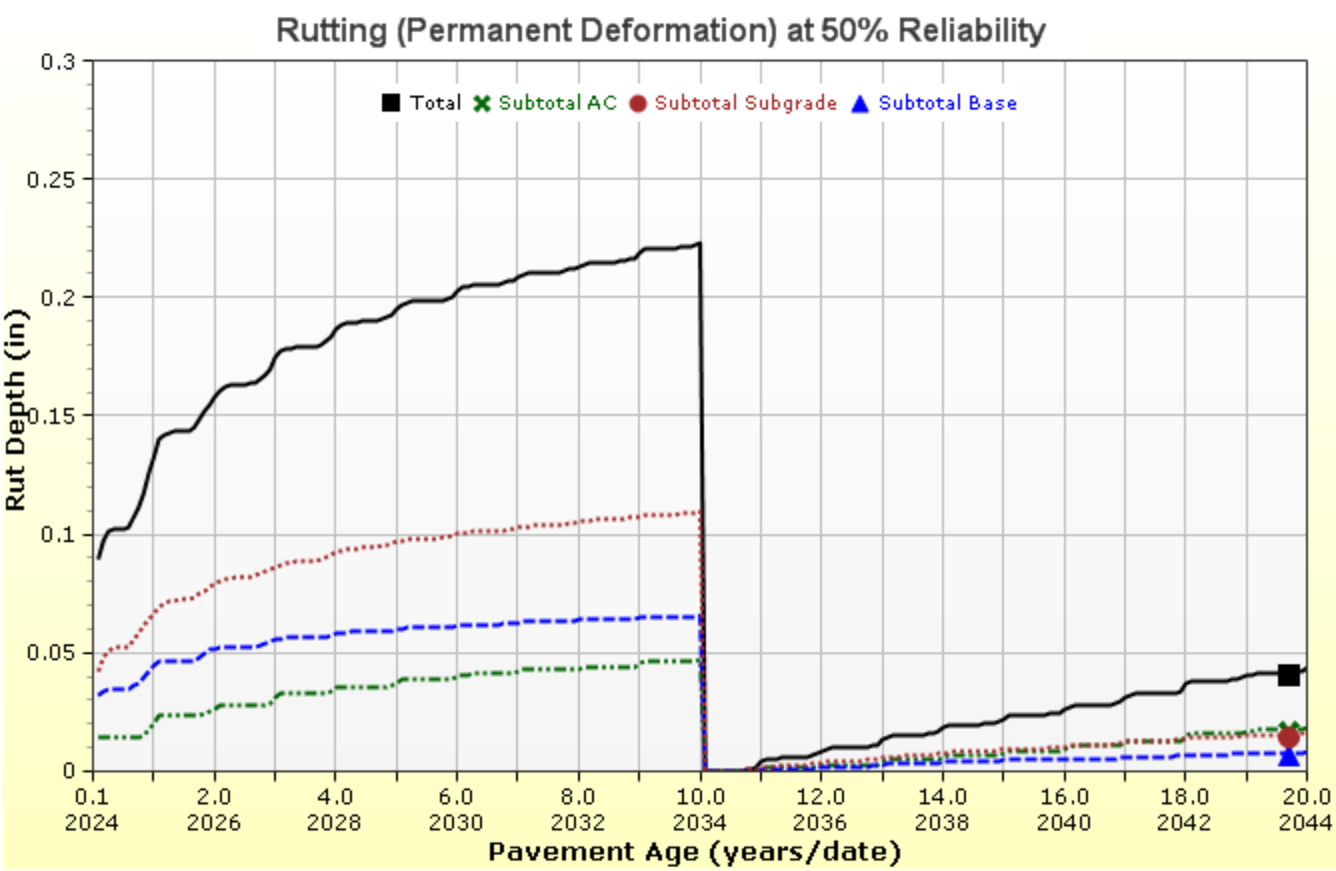


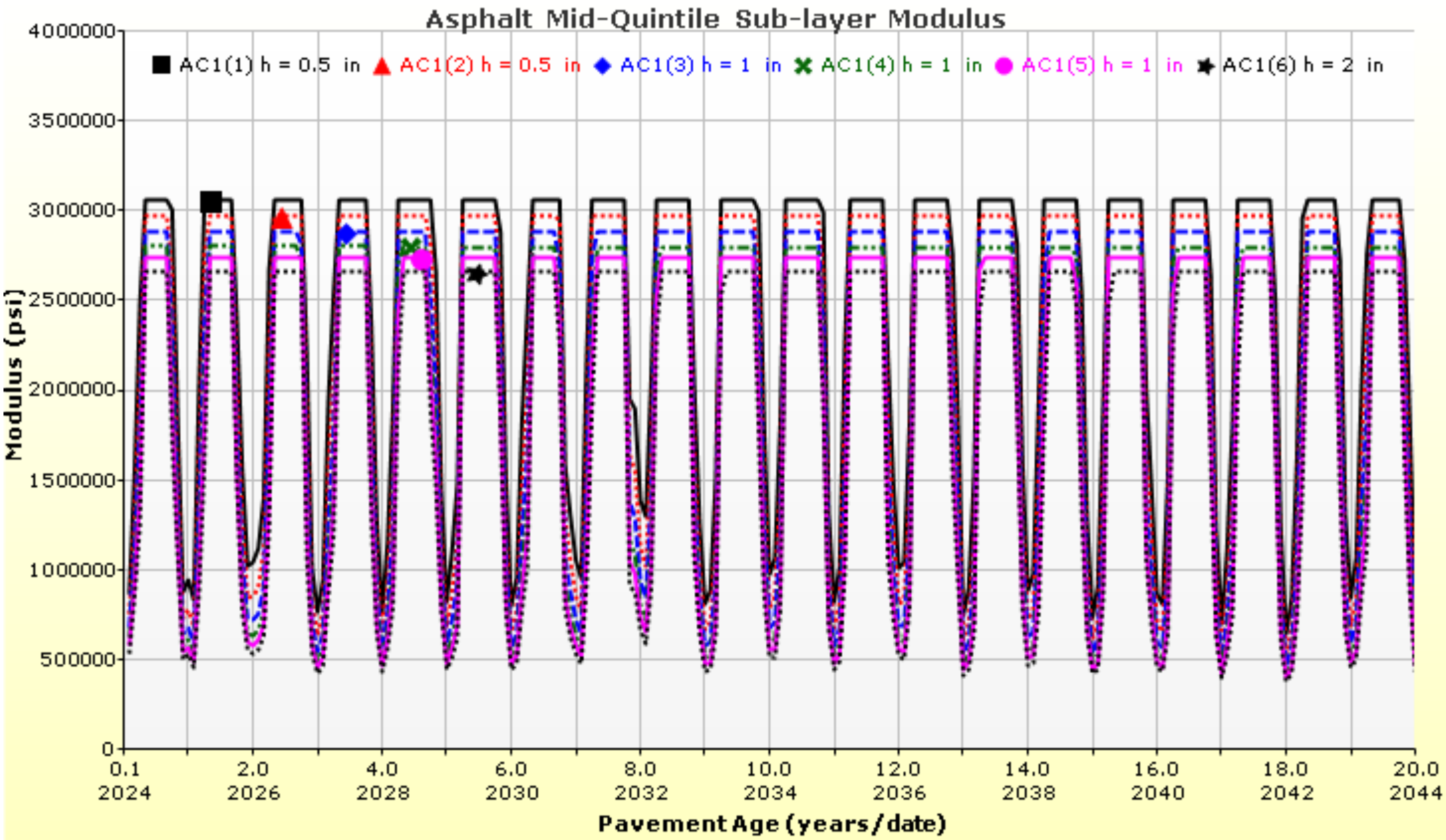



AC Top-Down Damage
Top-Down Damage (%)
@Surface
(Depth=.5in)
Pavement Age (years/date)

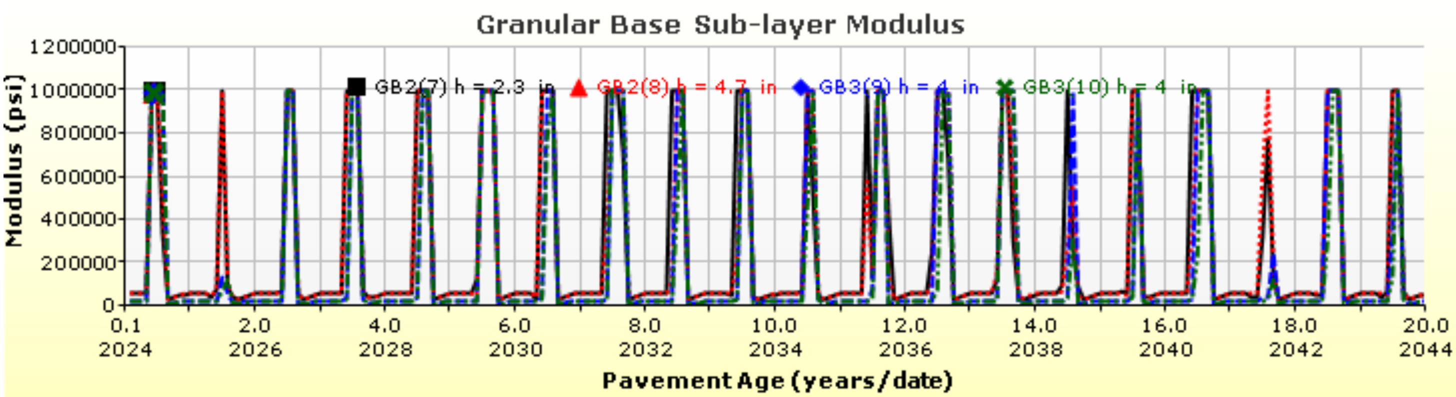

AC Bottom-Up Damage
Bottom-Up Damage (%)
Pavement Age (years/date)


AC Bottom-Up Cracking (Alligator)
Bottom-Up Cracking (%)
Threshold Value
@ 50% Reliability
@ Specified Reliability
Pavement Age (years/date)

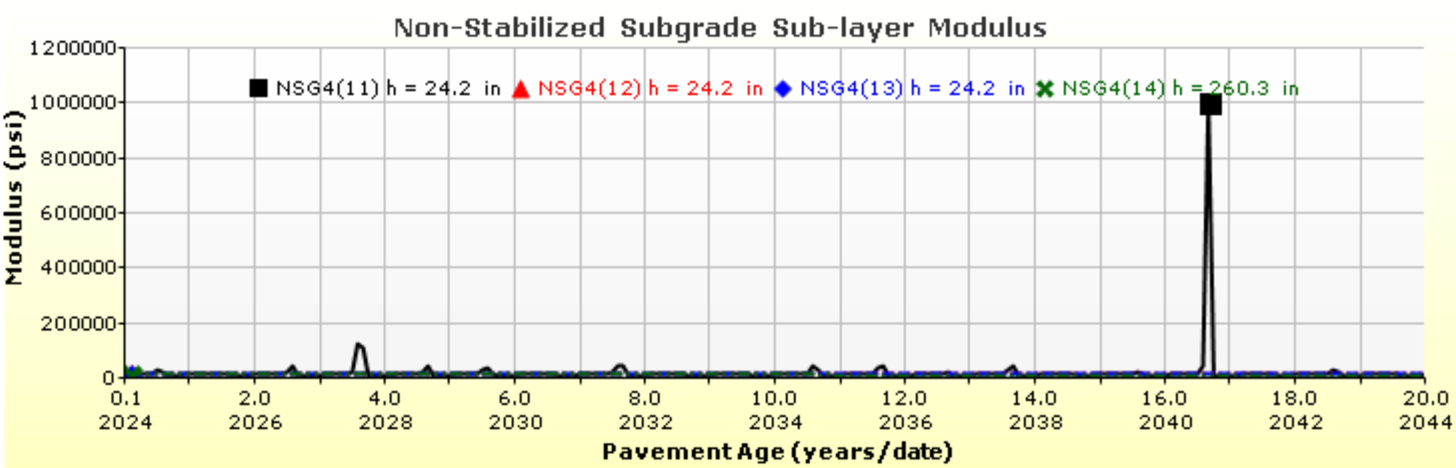

Rutting (Permanent Deformation) at 50% Reliability
Total
Subtotal AC
Subtotal Subgrade
Subtotal Base
Rut Depth (in)
0.3
0.25
0.2
0.15
0.1
0.05
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Asphalt Mid-Quintile Sub-layer Modulus
AC1(1) h = 0.5 in
AC1(2) h = 0.5 in
AC1(3) h = 1 in
AC1(4) h = 1 in
AC1(5) h = 1 in
AC1(6) h = 2 in
Modulus (psi)
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Granular Base Sub-layer Modulus
GB2(7) h = 2.3 in
GB2(8) h = 4.7 in
GB3(9) h = 4 in
GB3(10) h = 4 in
Modulus (psi)
1200000
1000000
800000
600000
400000
200000
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)



Non-Stabilized Subgrade Sub-layer Modulus
NSG4(11) h = 24.2 in
NSG4(12) h = 24.2 in
NSG4(13) h = 24.2 in
NSG4(14) h = 260.3 in
Modulus (psi)
1200000
1000000
800000
600000
400000
200000
0
0.1 2024
2.0 2026
4.0 2028
6.0 2030
8.0 2032
10.0 2034
12.0 2036
14.0 2038
16.0 2040
18.0 2042
20.0 2044
Pavement Age (years/date)

Layer Information

Layer 1 Flexible : New HMA (PG 70-34)

Asphalt		
Thickness (in)	6.0	
Unit weight (pcf)	144.0	
Poisson's ratio	Is Calculated?	True
	Ratio	-
	Parameter A	-1.63
	Parameter B	3.84E-06

Asphalt Dynamic Modulus (Input Level: 3)

Gradation	Percent Passing
3/4-inch sieve	100
3/8-inch sieve	77
No.4 sieve	60
No.200 sieve	6

Asphalt Binder

Parameter	Value
Grade	Superpave Performance Grade
Binder Type	70-34
A	8.965
VTS	-2.948

General Info

Name	Value
Reference temperature (ºF)	70
Effective binder content (%)	11.6
Air voids (%)	7.5
Thermal conductivity (BTU/hr-ft-ºF)	0.67
Heat capacity (BTU/lb-ºF)	0.23

Identifiers

Field	Value
Display name/identifier	New HMA (PG 70-34)
Description of object	New Superpave Hot Mix Asphalt
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Layer 2 Non-stabilized Base : Untreated Aggregate Base

Unbound	
Layer thickness (in)	7.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
35000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Untreated Aggregate Base
Description of object	Existing Untreated Aggregate Base
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	6.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	126
Saturated hydraulic conductivity (ft/hr)	False	8.77e-03
Specific gravity of solids	False	2.7
Water Content (%)	False	8.2

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	1.7748
bf	2.2297
cf	0.6927
hr	116.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	8.0
#100	
#80	
#60	
#50	
#40	
#30	20.0
#20	
#16	
#10	
#8	40.0
#4	60.0
3/8-in.	
1/2-in.	95.0
3/4-in.	100.0
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 3 Non-stabilized Base : Granular Subbase

Unbound	
Layer thickness (in)	8.0
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
25000.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Granular Subbase
Description of object	New Granular Subbase
Author	
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	6.0
Plasticity Index	1.0
Is layer compacted?	True

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	127.7
Saturated hydraulic conductivity (ft/hr)	False	1.504e-02
Specific gravity of solids	False	2.7
Water Content (%)	False	7.3

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	5.6397
bf	1.9907
cf	0.7543
hr	115.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	7.5
#100	
#80	
#60	
#50	
#40	
#30	
#20	
#16	
#10	
#8	
#4	52.5
3/8-in.	
1/2-in.	
3/4-in.	95.0
1-in.	
1 1/2-in.	100.0
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Layer 4 Subgrade : Subgrade

Unbound	
Layer thickness (in)	Semi-infinite
Poisson's ratio	0.35
Coefficient of lateral earth pressure (k0)	0.5

Modulus (Input Level: 3)

Analysis Type:	Modify input values by temperature/moisture
Method:	Resilient Modulus (psi)

Resilient Modulus (psi)
17300.0

Use Correction factor for NDT modulus?	-
NDT Correction Factor:	-

Identifiers

Field	Value
Display name/identifier	Subgrade
Description of object	Default material
Author	AASHTO
Date Created	10/10/2019 12:00:00 AM
Approver	
Date approved	1/1/0001 12:00:00 AM
State	
District	
County	
Highway	
Direction of Travel	
From station (miles)	
To station (miles)	
Province	
User defined field 1	
User defined field 2	
User defined field 3	
Revision Number	0

Sieve

Liquid Limit	40.0
Plasticity Index	20.0
Is layer compacted?	False

	Is User Defined?	Value
Maximum dry unit weight (pcf)	False	115.8
Saturated hydraulic conductivity (ft/hr)	False	8.941e-06
Specific gravity of solids	False	2.7
Water Content (%)	False	13.1

User-defined Soil Water Characteristic Curve (SWCC)	
Is User Defined?	False
af	99.8852
bf	0.7387
cf	0.2720
hr	500.0000

Sieve Size	% Passing
0.001mm	
0.002mm	
0.020mm	
#200	39.0
#100	
#80	
#60	
#50	
#40	55.0
#30	
#20	
#16	
#10	78.0
#8	
#4	89.0
3/8-in.	96.0
1/2-in.	97.0
3/4-in.	100.0
1-in.	
1 1/2-in.	
2-in.	
2 1/2-in.	
3-in.	
3 1/2-in.	

Calibration Coefficients

AC Fatigue

$$N_f = 0.00432 * C * \beta_{f1} k_1 \left(\frac{1}{\varepsilon_1}\right)^{k_2 \beta_{f2}} \left(\frac{1}{E}\right)^{k_3 \beta_{f3}}$$

$$C = 10^M$$

$$M = 4.84\left(\frac{V_b}{V_a + V_b} - 0.69\right)$$

k1: 3.75	
k2: 2.87	
k3: 1.46	
Bf1: (5.014 * Pow(hac,-3.416)) * 1 + 0	
Bf2: 1.38	
Bf3: 0.88	

AC Rutting

$$\frac{\varepsilon_p}{\varepsilon_r} = k_z \beta_{r1} 10^{k_1} T^{k_2 \beta_{r2}} N^{k_3 \beta_{r3}}$$

$$k_z = (C_1 + C_2 * depth) * 0.328196^{depth}$$

$$C_1 = -0.1039 * H_\alpha^2 + 2.4868 * H_\alpha - 17.342$$

$$C_2 = 0.0172 * H_\alpha^2 - 1.7331 * H_\alpha + 27.428$$

Where:

H_{ac} = total AC thickness(in)

ε_p = plastic strain(in/in)

ε_r = resilient strain(in/in)

T = layer temperature(°F)

N = number of load repetitions

AC Rutting Standard Deviation	0.24 * Pow(RUT,0.8026) + 0.001	
AC Layer 1	K1:-2.45 K2:3.01 K3:0.22	Br1:0.3 Br2:0.52 Br3:1.36

Thermal Fracture

$$C_f = 400 * N\left(\frac{\log C / h_{ac}}{\sigma}\right)$$

$$\Delta C = (k * \beta t)^{n+1} * A * \Delta K^n$$

$$A = 10^{(4.389 - 2.52 * \log(E * \sigma_m * n))}$$

C_f = observed amount of thermal cracking(ft/500ft)
k = refression coefficient determined through field calibration
$N()$ = standard normal distribution evaluated at()
σ = standard deviation of the log of the depth of cracks in the pavments
C = crack depth(in)
h_{ac} = thickness of asphalt layer(in)
ΔC = Change in the crack depth due to a cooling cycle
ΔK = Change in the stress intensity factor due to a cooling cycle
A, n = Fracture parameters for the asphalt mixture
E = mixture stiffness
σ_M = Undamaged mixture tensile strength
β_t = Calibration parameter

Level 1 K: ((3 * Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 1 Standard Deviation: 0.14 * THERMAL + 168
Level 2 K: ((2.591* Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 2 Standard Deviation: 0.20 * THERMAL + 168
Level 3 K: ((3 * Pow(10,-7)) * Pow(MAAT,4.0319)) * 1 + 0	Level 3 Standard Deviation: 0.289 * THERMAL + 168

CSM Fatigue

$$N_f = 10^{\left(\frac{k_1 \beta_{c1}\left(\frac{\sigma_s}{M_r}\right)}{k_2 \beta_{c2}}\right)}$$

N_f = number of repetitions to fatigue cracking
σ_s = Tensile stress(psi)
M_r = modulus of rupture(psi)

k1: 0.972	k2: 0.0825	Bc1: 1	Bc2:1

Unbound Layer Rutting			
$\delta_a(N) = \beta_{s_1} k_1 \varepsilon_v h \left(\frac{\varepsilon_0}{\varepsilon_r}\right) \left\| e^{-\left(\frac{\rho}{N}\right)^\beta} \right\|$		δ_a = permanent deformation for the layer N = number of repetitions ε_v = average veritcal strain(in/in) $\varepsilon_0, \beta, \rho$ = material properties ε_r = resilient strain(in/in)	
Base Rutting		**Subgrade Rutting**	
k1: 0.965	Bs1: 0.86	k1: 0.965	Bs1: 0.736
Standard Deviation (BASERUT) 0.1477 * Pow(BASERUT,0.6711) + 0.001		Standard Deviation (BASERUT) 0.1235 * Pow(SUBRUT,0.5012) + 0.001	

AC Cracking						
AC Top Down Cracking				**AC Bottom Up Cracking**		
$FC_{top} = \left(\frac{C_4}{1 + e^{(C_1 - C_2 * log_{10}(Damage))}}\right) * 10.56$				$FC = \left(\frac{6000}{1 + e^{(C_1 * C_1' + C_2 * C_2' log_{10}(D*100))}}\right) * \left(\frac{1}{60}\right)$ $C_2' = -2.40874 - 39.748 * (1 + h_{ac})^{-2.856}$ $C_1' = -2 * C_2'$		
c1: 3.3	c2: 0.825	c3: 0	c4: 1000	c1: 0.31	c2: (0.867 + 0.2583 * hac) * 0.2 + 0	c3: 3000
Top down AC Cracking Standard Deviation				**Bottom up AC Cracking Standard Deviation**		
200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))				1.13 + 13/(1+exp(7.57-15.5*LOG10(BOTTOM+0.0001)))		

CSM Cracking				IRI Flexible Pavements			
$FC_{ctb} = C_1 + \frac{C_2}{1 + e^{C_3 - C_4 * log_{10}(Damage)}}$				C1 - Rutting C2 - Fatigue Crack		C3 - Transverse Crack C4 - Site Factors	
C1: 0	C2: 75	C3: 2	C4: 2	C1: 80	C2: 0.6	C3: 0.008	C4: 0.02
CSM Standard Deviation							
CTB*1							

State FY19 D4 Materials Reconnaissance

SH-75, River St to Clubhouse Dr

LTPPBind V3.1 PG Binder Selection Report (Date: 10/10/2019)

Parameter	A=4 km	B=29 km	C=50 km	D=51 km	E=52 km
Station ID	ID4845	ID3417	ID3108	ID3110	ID7040
Elevation, m	5472	6781	4705	4663	4487
Degree-Days >10 C	2010	1687	2479	2315	2500
Low Air Temperature, C	-27.8	-30	-31.5	-35.3	-28.4
Low Air Temp. Std Dev	4.3	4.2	4.1	5.2	4.1

Input Data

Latitude, Degree	43.68
Yearly Degree-Days>10C	2198
Lowest Yearly Air Temp., Deg. C	-30.6
Low Temp. Std. Dev., Deg. C	4.4
Base HT PG	52

Traffic Adjustments for HT

Desired Reliability, Percent	98
Traffic Loading, Million ESAL	10 to 30 M. ESAL
Traffic Speed	Slow
High Temp. Adjustment	15.5

PG Temperature	HIGH	LOW
PG Temp. at 50% Reliability	49.3	-22.5
PG Temp. at Desired Reliability	52.4	-30.3
Adjustments for Traffic	15.5	
Adjustments for Depth	0.0	0.0
Adjusted PG Temperature	67.9	-30.3
Selected PG Binder Grade	70	-34