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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

February 28, 2022

Mr. Cory Beasley, PE
HDR Engineering Inc.
5555 Tech Center Dr, Suite 310
Colorado Springs, CO 80919

RE: HIGHWAY 105 PROJECT A, PAVEMENT ADENDUM REVISION 1, EL PASO COUNTY, COLORADO

Dear Mr. Beasley:

This letter supersedes pavement design sections for Highway 105 Project A. Updated traffic loading was incorporated into the analysis, as well as adding a full depth reclamation (FDR) section option. The geotechnical investigation of the project site is summarized in our 2017 Geotechnical and Pavement Design Report[1].

INTRODUCTION

Our pavement design analysis along the Highway 105 corridor was updated for the current design standards provided in the 2016 El Paso County Engineering Criteria Manual[2], as well as revised traffic data and projections for the corridor. The updated pavement design is for Highway 105 from the CDOT right-of-way near Interstate 25 (I-25) to Lake Woodmoor Drive. For our analysis, we assumed the final roadway configuration will consist of two eastbound (EB) and two westbound (WB) travel lanes.

Based on discussions with HDR and the County, the roadway classification for Project A is an urban, principal arterial. We subdivided the alignment into two segments, split at Knollwood Drive, based on the anticipated traffic projections provided by HDR. The subgrade strength and treatment recommendations remain unchanged from our 2017 report.

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[1] Shannon & Wilson, Inc., 2017, Geotechnical and Pavement Design Report, Highway 105, Full Corridor Design, El Paso County, Colorado; prepared by Shannon & Wilson, Inc. of Denver, Colorado for HDR Engineering, Inc.; job no. 23-1-01311-002; dated July 6, 2017.

[2] El Paso County, 2016, Engineering Criteria Manual.

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TRAFFIC LOADING

To estimate an 18-kip Equivalent Single-Axle Loading (ESAL) value for the roadways, updated assumptions were made regarding traffic distributions. Traffic loading for Highway 105 was determined based on discussion with HDR. Refer to Exhibit 1 for traffic loading data used for design. We assumed 8% truck traffic in accordance with El Paso County (2016)[2] criteria for urban principal arterials. The El Paso County minimum design ESALs were used in our pavement analysis.

Exhibit 1: Project A Traffic Loading

Roadway Segment	Design ADT	Annually Compounded Growth Rate	Calculated ESAL	County Minimum ESAL
I-25 to Knollwood Dr	16,700 vpd	2.2%	4,079,000	5,256,000
Knollwood Dr to Lake Woodmoor Dr	15,500 vpd	1.7%	3,550,000	

NOTES:
ADT = average daily traffic; ESAL = equivalent single axle load; vpd = vehicles per day

FULL DEPTH RECLAMATION (FDR)

We understand that a pulverized FDR section is being considered for rehabilitation of the existing Project A roadway pavement. The process involves pulverizing and mixing the existing asphalt with the underlying layers to create a uniformly blended, homogeneous material that will be incorporated into the proposed pavement section as a base course. The benefit of the FDR process is that it allows the existing material to be recycled in place and eliminates the expense to export the material offsite.

In our experience, the pulverized FDR process can accommodate approximately up to 2 feet of roadway shoulder widening. Areas where the roadway is anticipated to be widened greater than 2 feet will require import ABC. Import material should be mixed with the reclaimed FDR material and processed across the entire roadway section to provide the specified minimum FDR thickness below the HMA. In addition, cement can be added to chemically stabilize the FDR.

CEMENT TREATED SUBGRADE AND CEMENT TREATED BASE

Cement treated subgrade (CTS) (also referred as cement-modified soil) involves thoroughly mixing a soil and cement and then adding water so that the mix is near the optimum

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moisture content. The CTS is then compacted to 95 percent maximum dry density and allowed to cure. Pavement sections are based on a 7-day unconfined compressive strength of 125 pounds per square inch (psi). A mix design would be required to determine the cement content to achieve this strength.

Cement treated base (CTB) involves thoroughly mixing aggregate materials with cement and then adding water. Pavement sections are based on a 7-day unconfined compressive strength of 650 psi. A mix design would be required to determine the cement content to achieve this strength. Refer to El Paso County Engineering Criteria Manual (2016) Section D.5.7.

RECOMMENDED PAVEMENT SECTIONS

Using the AASHTO[3] procedures and the parameters outlined in the enclosed worksheets, we recommend the following pavement section alternatives:

- Alternative 1: 9.5 inches of HMA over 8 inches of ABC
- Alternative 2: 8.5 inches of HMA over 12 inches of ABC
- Alternative 3: 9.5 inches of HMA over 12 inches FDR
- Alternative 4: 8.5 inches of HMA over 8 inches FDR with Cement
- Alternative 5: 8.5 inches of HMA over 12 inches CTS
- Alternative 6: 7.5 inches of HMA over 8 inches CTB

We understand that existing grades will remain relatively unchanged; therefore, any FDR (Alternatives 3 and 4) would need to be pulverized in place, stockpiled, and then placed as part of a pavement section to match existing grades. Import ABC is anticipated to be used in areas with insufficient FDR material. Alternatives 5 and 6 would require the existing pavement section to be removed prior to importing new paving material.

[3] American Association of State Highway and Transportation Officials (AASHTO), 1993, AASHTO guide for design of pavement structures: Washington, D.C., AASHTO, 2 v.

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PAVING MATERIALS

All pavement material recommendations provided in our 2017 are applicable for the updated Project A pavements.

Sincerely,

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Joseph C Goode III, PE
Senior Engineer

JCG:DAA:GRF/jcg

Enc. Flexible Pavement 18-kip ESAL Worksheet (2 Sheets)
Flexible Pavement Design Worksheet (6 Sheets)

Flexible Pavement 18-kip Equivalent Single-Axle Loading (ESAL) Worksheet

Project No: 23-1-01311-102

Location: SH 105, I-25 to Knollwood Drive, four lanes

Comment: Analysis based on Table D.21 of the 1993 AASHTO Guide for the Design of Pavement Structures

Assume an urban, 4-lane principal arterial.

Traffic Study Year:	2020	
Paving Year:	2023	
Pavement Design Life (D):	20	years
2020 Two-way Average Daily Traffic (ADT):	16,700	vehicles per day (vpd)
2023 ADT:	17,827	vpd = 2020 ADT (1+r/100)^3
Estimated 2043 ADT:	27,548	vpd = 2020 ADT (1+r/100)^23
Growth Rate (r) :	2.20	%

Equations

b = 2023 ADT * (a/100)

c = b * 365

d = [(1+r/100)^20-1]/(r/100)

e = c * d

g = e * f

j = g * h * i

Vehicle Classification and Description	a Traffic Percentage	b 2023 ADT	c 2023 Total Traffic	d Growth Factors	e 20 yr Design Traffic Volume (total two-way volume)	f Flexible Pavement Equivalency Factor	g Roadway Design 18k ESAL	h Directional Distribution Factor	i Traffic Lane Factor	j Design Lane 18k ESAL
Passenger Cars	92.0	16,400	5,986,181	24.79	148,380,610	0.003	445,142	0.50	0.90	200,314
Single Unit Trucks	4.0	713	260,269	24.79	6,451,331	0.249	1,606,381	0.50	0.90	722,871
Combination Trucks	4.0	713	260,269	24.79	6,451,331	1.087	7,012,597	0.50	0.90	3,155,669
Total	100	17,827	6,506,719		161,283,272		9,064,120			**4,078,854**

Calculated ESAL	4,079,000
Design ESAL	**5,256,000**

Notes

1. The current and projected ADT provided by HDR. Percentage of truck traffic is based on El Paso County minimum criteria.
2. The flexible pavement equivalency factors, directional distribution factor, and traffic lane factor is based on Appendix H of the 2021 CDOT Pavement Design Manual. Shannon & Wilson assumed a 50:50 ratio of single unit trucks and combination trucks.
3. The El Paso County minimum design ESAL for an urban, 4-lane pricipal arterial is 5,256,000.

Flexible Pavement 18-kip Equivalent Single-Axle Loading (ESAL) Worksheet

Project No: 23-1-01311-102

Location: SH 105, Knollwood Drive to Furrow Road, four lanes

Comment: Analysis based on Table D.21 of the 1993 AASHTO Guide for the Design of Pavement Structures

Assume an urban, 4-lane principal arterial.

Traffic Study Year:	2020	
Paving Year:	2023	
Pavement Design Life (D):	20	years
2020 Two-way Average Daily Traffic (ADT):	15,500	vehicles per day (vpd)
2023 ADT:	16,304	vpd = 2020 ADT (1+r/100)^3
Estimated 2043 ADT:	22,841	vpd = 2020 ADT (1+r/100)^23
Growth Rate (r) :	1.70	%

Equations

b = 2023 ADT * (a/100)

c = b * 365

d = [(1+r/100)^20-1]/(r/100)

e = c * d

g = e * f

j = g * h * i

	a	b	c	d	e	f	g	h	i	j
Vehicle Classification and Description	**Traffic Percentage**	**2023 ADT**	**2023 Total Traffic**	**Growth Factors**	**20 yr Design Traffic Volume (total two-way volume)**	**Flexible Pavement Equivalency Factor**	**Roadway Design 18k ESAL**	**Directional Distribution Factor**	**Traffic Lane Factor**	**Design Lane 18k ESAL**
Passenger Cars	92.0	15,000	5,474,888	23.58	129,123,130	0.003	387,369	0.50	0.90	174,316
Single Unit Trucks	4.0	652	238,039	23.58	5,614,049	0.249	1,397,898	0.50	0.90	629,054
Combination Trucks	4.0	652	238,039	23.58	5,614,049	1.087	6,102,471	0.50	0.90	2,746,112
Total	100	16,304	5,950,965		140,351,229		7,887,738			**3,549,482**

Calculated ESAL	3,550,000
Design ESAL	**5,256,000**

Notes

1. The current and projected ADT provided by HDR. Percentage of truck traffic is based on El Paso County minimum criteria.
2. The flexible pavement equivalency factors, directional distribution factor, and traffic lane factor is based on Appendix H of the 2021 CDOT Pavement Design Manual. Shannon & Wilson assumed a 50:50 ratio of single unit trucks and combination trucks.
3. The El Paso County minimum design ESAL for an urban, 4-lane pricipal arterial is 5,256,000.

Flexible Pavement Design Worksheet

Location: Hwy 105, Urban Principal Arterial, 4-lane
Comment: I-25 Ramps to Lake Woodmoor Dr.
Alt. 1: HMA over ABC (min)

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): 18k ESALs: 5,256,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS
p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R):

R-value: 22.7

Section D.4.1 (C)

M_R: 5,400 psi

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,400 psi

5. Reliability:

R: 90 % D.4.1 - C

Z_R: -1.282

6. Design Standard Deviation (S_o):

S_o: 0.45 D.4.1 - C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R		
32,883	SN_1:	**2.591**
5,400	SN_2:	**5.044**
-NA-	SN_3:	**-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	9.5 inches	4.180	2.591
2	ABC	8.0 inches	5.060	5.044
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Hwy 105, Urban Principal Arterial, 4-lane
Comment: I-25 Ramps to Lake Woodmoor Dr.
Alt. 2: HMA over 12 in. ABC

1. Pavement Design Life: 20.0 years

   Traffic Loading (W_{18}): 18k ESALs: 5,256,000 per lane

3. Serviceability:

   p_0: 4.2 Value assumed based on 1993 AGDPS

   p_t: 2.5 Table D-1 based on roadway classification

   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R):

   R-value: 22.7

   Section D.4.1 (C)

   S_1 = [(R-value - 5) / 11.29] + 3

   $M_R = 10^{[(S_1 + 18.72)/6.24]}$ = 5,400 psi

   M_R: 5,400 psi

5. Reliability:

   R: 90 % D.4.1 - C

   Z_R: -1.282

6. Design Standard Deviation (S_o):

   S_o: 0.45 D.4.1 - C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
32,883	SN_1: **2.591**
5,400	SN_2: **5.044**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	ABC	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

   $SN^*_1 = a_1 D^*_1 >= SN_1$

   $SN^*_2 = a_1 D^*_1 + a_2 D^*_2 m_2 >= SN_2$

   $SN^*_3 = a_1 D^*_1 + a_2 D^*_2 m_2 + a_3 D^*_3 m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	8.5 inches	3.740	2.591
2	ABC	12.0 inches	5.060	5.044
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Hwy 105, Urban Principal Arterial, 4-lane
Comment: I-25 Ramps to Lake Woodmoor Dr.
Alt. 3: HMA over FDR
Assume the FDR was pulverizated, stockpiled, and placed below proposed pavement section.

1. Pavement Design Life: 20.0 years

Traffic Loading (W_{18}): 18k ESALs: 5,256,000 per lane

3. Serviceability:

p_0: 4.2 Value assumed based on 1993 AGDPS

p_t: 2.5 Table D-1 based on roadway classification

ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R):

R-value: 22.7

Section D.4.1 (C)

M_R: 5,400 psi

S_1 = [(R-value - 5) / 11.29] + 3

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,400 psi

5. Reliability:

R: 90 % D.4.1 - C

Z_R: -1.282

6. Design Standard Deviation (S_o):

S_o: 0.45 D.4.1 - C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
25,000	SN_1: **2.880**
5,400	SN_2: **5.044**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	FDR (Double Worked)	a_2: 0.08	m_2: 1.00	25,000
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1D^*_1 >= SN_1$

$SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

$SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	9.5 inches	4.180	2.880
2	FDR (Double Worked)	12.0 inches	5.140	5.044
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Hwy 105, Urban Principal Arterial, 4-lane

Comment: I-25 Ramps to Lake Woodmoor Dr.

Alt. 4: HMA over FDR with Cement

Assume the FDR was pulverizated, stockpiled, mixed with cement, and placed below proposed pavement section.

1. Pavement Design Life: 20.0 years

   Traffic Loading (W_{18}): 18k ESALs: 5,256,000 per lane

3. Serviceability:

   p_0: 4.2 Value assumed based on 1993 AGDPS

   p_t: 2.5 Table D-1 based on roadway classification

   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R):

   R-value: 22.7

   Section D.4.1 (C)

   M_R: 5,400 psi

   S_1 = [(R-value - 5) / 11.29] + 3

   $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ = 5,400 psi

5. Reliability:

   R: 90 % D.4.1 - C

   Z_R: -1.282

6. Design Standard Deviation (S_o):

   S_o: 0.45 D.4.1 - C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
100,000	SN_1: **2.591**
5,400	SN_2: **5.044**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\, S_o + 9.36\, \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\, \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	FDR - Cement	a_2: 0.17	m_2: 1.00	100,000
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

$SN^*_1 = a_1 D^*_1 >= SN_1$

$SN^*_2 = a_1 D^*_1 + a_2 D^*_2 m_2 >= SN_2$

$SN^*_3 = a_1 D^*_1 + a_2 D^*_2 m_2 + a_3 D^*_3 m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	8.5 inches	3.740	2.591
2	FDR - Cement	8.0 inches	5.100	5.044
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Hwy 105, Urban Principal Arterial, 4-lane
Comment: I-25 Ramps to Lake Woodmoor Dr.
Alt. 5: HMA over Cement Treated Subgrade (CTS)

1. Pavement Design Life: 20.0 years

   Traffic Loading (W_{18}): 18k ESALs: 5,256,000 per lane

3. Serviceability:

   p_0: 4.2 Value assumed based on 1993 AGDPS

   p_t: 2.5 Table D-1 based on roadway classification

   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R):

   R-value: 22.7

   Section D.4.1 (C)

   S_1 = [(R-value - 5) / 11.29] + 3

   $M_R = 10^{[(S_1 + 18.72)/6.24]}$ = 5,400 psi

   M_R: 5,400 psi

5. Reliability:

   R: 90 % D.4.1 - C

   Z_R: -1.282

6. Design Standard Deviation (S_o):

   S_o: 0.45 D.4.1 - C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
32,883	SN_1: **2.591**
5,400	SN_2: **5.044**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\ S_o + 9.36\ \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\ \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	CTS	a_2: 0.11	m_2: 1.00	32,883
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

   $SN^*_1 = a_1D^*_1 >= SN_1$

   $SN^*_2 = a_1D^*_1 + a_2D^*_2m_2 >= SN_2$

   $SN^*_3 = a_1D^*_1 + a_2D^*_2m_2 + a_3D^*_3m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	8.5 inches	3.740	2.591
2	CTS	12.0 inches	5.060	5.044
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Hwy 105, Urban Principal Arterial, 4-lane
Comment: I-25 Ramps to Lake Woodmoor Dr.
Alt. 6: HMA over Cement Treated Base (CTB)

1. Pavement Design Life: 20.0 years

   Traffic Loading (W_{18}): 18k ESALs: 5,256,000 per lane

3. Serviceability:

   p_0: 4.2 Value assumed based on 1993 AGDPS

   p_t: 2.5 Table D-1 based on roadway classification

   ΔPSI: 1.7

4. Subgrade Resilient Modulus (M_R):

   R-value: 22.7

   Section D.4.1 (C)

   $S_1 = [(\text{R-value} - 5) / 11.29] + 3$

   $M_R = 10^{[(S_1 + 18.72)/6.24]}$ = 5,400 psi

   M_R: 5,400 psi

5. Reliability:

   R: 90 % D.4.1 - C

   Z_R: -1.282

6. Design Standard Deviation (S_o):

   S_o: 0.45 D.4.1 - C

7. Requred Structural Numbers (SN_i): [Fig. D-1]

Analysis M_R	
100,000	SN_1: **2.591**
5,400	SN_2: **5.044**
-NA-	SN_3: **-NA-**

$$\log_{10}(W_{18}) = Z_R\, S_o + 9.36\, \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\, \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization: Table D-3

Layer	Material	Structural Layer Coefficients	Drainage Coefficients	Layer Modulus (psi)
1	HMA	a_1: 0.44	-	-
2	CTB	a_2: 0.23	m_2: 1.00	100,000
3		a_3:	m_3:	

9. Solutions for thicknesses: [Figure 3.2, Part II of 1993 AASHTO]

   $SN^*_1 = a_1 D^*_1 >= SN_1$

   $SN^*_2 = a_1 D^*_1 + a_2 D^*_2 m_2 >= SN_2$

   $SN^*_3 = a_1 D^*_1 + a_2 D^*_2 m_2 + a_3 D^*_3 m_3 >= SN_3$

Recommended Thicknesses				
Layer	Material	Thickness (D^*_i)	SN^*_i	SN_i
1	HMA	7.5 inches	3.300	2.591
2	CTB	8.0 inches	5.140	5.044
3		inches		

Note: Required SN <= Pavement SN, Design is Acceptable