To: Kevin Marchek
Attn: Wayne Phillips
From: Maureen M. Addis
Subject: Pavement Design Approval
Date: October 28, 2017

Route: I-55
Job No.: P-93-025-14
Section: (53-5) R&I
Contract No.: 66B64
County: Livingston
Target Letting: FY 2018
Limits: 1.7 miles South of IL 116 to 0.6 miles North of IL 23 (around Pontiac)

We have reviewed the two pavement designs for the above referenced project which were submitted on August 8, 2017. The scope of the project involves replacing and reconstructing the existing pavement; as well as removing the mainline structures carrying I-55 over an abandoned railroad and lowering the grade of the roadway. The cross-section of I-55 will be two 12' lanes in each direction with 10' outside shoulders and 8' inside shoulders (6' paved, 2' aggregate).

Removal & Replacement: The design for the three segments to be removed and replaced (total 2.5 miles in length) resulted in two pavement options: 11" PCC and 15.25" Full-Depth HMA. The life-cycle cost analysis of these options resulted in the PCC pavement being 11.9% less expensive ($218,768 per mile compared to HMA at $244,701 per mile) and thus the preferred option.

Reconstruction: In the remainder of the project without vertical profile restrictions (total 3.7 miles in length), the design resulted in three pavement options: 11" PCC, 15.25" Full-Depth HMA, and an 11" HMA overlay of rubblized CRCP. The life-cycle cost analysis of these options resulted in the rubblization option being 52.8% less expensive than the next closest option ($142,388 per mile compared to PCC at $217,552 per mile) and thus the preferred option.

In summary, the approved pavement designs are as follows:

**Removal & Replacement**
- 11" PCC Pavement
- Tied PCC Shoulders
- 4" HMA Stabilized Subbase
- 12" Improved Subgrade

**Reconstruction**
- 11" HMA overlay of Rubblized CRC
- HMA Shoulders

If you have any questions, please contact Mike Brand at (217) 782-7651.
To: Maureen Addis  
From: Kevin Marchek  
Subject: Pavement Design  
Date: August 8, 2017

FAI 55 (I-55)  
Section (53-5) R&I  
Livingston County  
Job No. P-93-025-14  
Contract No. 66B64

Attached for approval are two pavement designs for I-55 from 1.7 miles south of IL 116 to 0.6 mile north of IL 23 with a total length of approximately 6.2 miles. Project construction is currently programmed for FY 2018.

The first design (total 2.5 miles) considered only Jointed Plain Concrete Pavement (JPCP) and full depth HMA pavement options at three locations: the IL 116 and IL 23 interchanges and the I-55 Vermilion River Bridge and adjacent CH 27 overhead structure (SN 053-0130). These options are the most practical in order to:

- Maintain a minimum 16' clearance under overhead structures.
- Match interchange ramps.
- Transition pavements at existing I-55 mainline Vermilion River structures.
- Remove an I-55 structure over an abandoned railroad and lower the I-55 vertical curve north of the IL 116 interchange.

Eleven inches of JPCP with an annual life-cycle cost per mile of $218,768 is the preferred pavement type based on life-cycle cost in the attached mechanistic pavement design analysis. The annual life-cycle cost per mile for the JPCP option is 11.9 percent less than 15.25" of full depth HMA pavement ($244,701). This proposed design includes removing the existing pavement and constructing a 12" improved subgrade, 4" stabilized sub-base, underdrains and 11" of JPCP. The design is for four lanes and the estimated new pavement quantity is 70,400 square yards.

The second design (total 3.7 miles) considered JPC, full depth HMA, and HMA overlay of rubblized CRC pavements. An 11" HMA overlay of rubblized CRC with an annual life-cycle cost per mile of $142,388 is the preferred pavement type based on life-cycle cost in the attached mechanistic pavement design.
analysis. The annual life-cycle cost per mile for the rubblization option is 52.8 percent less than 11" of JPCP ($217,552) and 72.5 percent less than 15.25" of full depth HMA pavement ($245,553). The design is for four lanes and the estimated new pavement quantity is 104,192 square yards.

This project is not suitable for the alternative pavement bidding process because the life cycle cost difference for both the designs is more than 10 percent. Calculations to determine pavement thicknesses and life-cycle costs and the Roadway Geotechnical Report Pavement Rubblization Study are attached. Electronic files have also been emailed for review. For the full depth options, the potential cost savings of recycling the existing pavement was not considered in the unit prices due to the existing pavement showing signs of D-cracking. Based on the overall costs of the various options, potential recycling savings were not considered to be significant to the design.

The pavements were designed using Chapter 54 of the Bureau of Design and Environment Manual, current as of August 2017. The following facts and assumptions were used in the design:

- Jointed Plain Concrete Pavement constructed with tied shoulder.
- Design traffic was based on 2038 projections.
- Design period of 20 years.
- Poor subgrade.
- PG 76-28 for the top lift of binder and the surface course.
- PG 64-22 for the lower binder lifts.
- Unbonded overlay was not considered due to the age and condition of the existing hot-mix asphalt overlay and the existence of D-cracking in the existing CRCP.

If you have any questions, please contact Mr. Ted Fultz at 815-434-8469.

JO: jw
Project Location Map
FAI 55 (I-55)
Section (53-5)R&I
Livingston County
Rubblization
1.7 miles south of IL 116 to
0.6 mile north of IL 23
Phase I Job No: P-93-025-14
Contract No.66B64

Project Area = ★

SN 053-0115
IL 23

SN 053-0128 SB
SN 053-0129 NB
Vermilion River

SN 053-0126 SB
SN 053-0127 NB
Abandoned RR

SN 053-0116
IL 115

SN 053-2504
Culvert/Stream

SN 053-2505
Culvert over stream

SN 053-0130
CH 27 (FAS 2056)

Project Begin

Project End

D3# 3254
PROJECT AND TRAFFIC INPUTS

<table>
<thead>
<tr>
<th>Route</th>
<th>Comments</th>
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<tbody>
<tr>
<td>FAI 55</td>
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<table>
<thead>
<tr>
<th>Section</th>
<th>(53-5)R&amp;I</th>
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<th>LIVINGSTON</th>
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<table>
<thead>
<tr>
<th>Location</th>
<th>1.7 MI N OF IL 116 TO 0.6 MI N \ OF \ IL 23</th>
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<table>
<thead>
<tr>
<th>Facility Type</th>
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<tr>
<th># of Lanes</th>
<th>4</th>
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<th>Road Class</th>
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<tr>
<th>Subgrade Support Rating (SSR)</th>
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<tr>
<th>Construction Year</th>
<th>2018</th>
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<table>
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<tr>
<th>Design Period (DP)</th>
<th>20 years</th>
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### TRAFFIC FACTOR CALCULATION

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<thead>
<tr>
<th>Flexible Pavement</th>
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<tr>
<td>$C_{pv}$</td>
<td>0.15</td>
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<tr>
<td>$C_{su}$</td>
<td>132.5</td>
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<tr>
<td>$C_{mu}$</td>
<td>482.53</td>
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<table>
<thead>
<tr>
<th>TF Flexible (Actual)</th>
<th>30.85</th>
<th>(Actual ADT)</th>
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<tr>
<td>TF Rigid (Actual)</td>
<td>44.09</td>
<td>(Actual ADT)</td>
</tr>
<tr>
<td>TF Flexible (Min)</td>
<td>7.11</td>
<td>(Min ADT)</td>
</tr>
<tr>
<td>TF Rigid (Min)</td>
<td>10.05</td>
<td>(Min ADT)</td>
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</tbody>
</table>

### NEW CONSTRUCTION / RECONSTRUCTION PAVEMENT DESIGN CALCULATIONS

#### Full-Depth HMA Pavement

- Use TF flexible = 30.85
- PG Grade Lower Binder Lifts = PG 76-28 (Fig. 53-4.R)
- Design HMA Mixture Temp. = 76.5 °C (Fig. 54-5.C)
- Design HMA Mixture Modulus ($E_{max}$) = 650 kpsi (Fig. 54-5.D)
- Design HMA Strain ($E_{max}$) = 4.5 (Fig. 54-5.E)
- Full Depth HMA Design Thickness = 15.50 in. (Fig. 54-5.F)
- Limiting Strain Criterion Thickness = 15.25 in. (Fig. 54-5.I)

#### JPC Pavement

- Use TF rigid = 44.09
- Edge Support = Tied Shoulder or C.&G.

#### CRC Pavement

- Use TF rigid = 44.09
- IBR value = 3

#### HMA Overlay of Rubblized PCC

- Use TF flexible = 30.85
- Design HMA Overlay Thickness = 12.75 in. (Fig. 54-5.U)
- Limiting Strain Criterion Thickness = 11.00 in. (Fig. 54-5.V)

#### Unbonded Concrete Overlay

- Review 54-4.03 for limitations and special considerations.

### DESIGN TABLES FROM BDE MANUAL CHAPTER 54 - PAVEMENT DESIGN

#### Class I Roads

<table>
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<tr>
<th>4 lanes or more</th>
<th>Part of a future 4 lanes or more</th>
<th>One-way Streets with ADT &gt; 3500</th>
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<td>Min. Str. Design Traffic (Fig. 54-2.C)</td>
<td>2 lanes with ADT &gt; 2000</td>
<td>One way Street with ADT &lt;= 3500</td>
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<tr>
<td>ADT</td>
<td>Class</td>
<td>ADT</td>
</tr>
<tr>
<td>0 - 750</td>
<td>I</td>
<td>750 - 2000</td>
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<tr>
<td>&gt;750</td>
<td>II</td>
<td>&gt;2000</td>
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#### Traffic Factor ESAL Coefficients

<table>
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<th>Class</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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<td>$C_{su}$</td>
<td>143.81</td>
<td>135.78</td>
<td>129.58</td>
<td>129.58</td>
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<td>$C_{mu}$</td>
<td>696.42</td>
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<td>562.47</td>
<td>562.47</td>
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<tr>
<td>$C_{su}$</td>
<td>132.50</td>
<td>112.06</td>
<td>109.14</td>
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<tr>
<td>$C_{mu}$</td>
<td>482.53</td>
<td>385.44</td>
<td>384.35</td>
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#### Design Lane Distribution Factors For Structural Design Traffic (Fig. 54-2.B)

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<th>Number of Lanes</th>
<th>Rural</th>
<th>Urban</th>
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<tr>
<td>1 Lane Ramp</td>
<td>P 100%</td>
<td>S 100%</td>
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<tr>
<td>2 or 3</td>
<td>P 50%</td>
<td>S 50%</td>
</tr>
<tr>
<td>6 or more</td>
<td>P 32%</td>
<td>S 45%</td>
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<tr>
<td>Rural</td>
<td>8%</td>
<td>37%</td>
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<tr>
<td>Urban</td>
<td>37%</td>
<td>37%</td>
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**LIFE-CYCLE COST ANALYSIS: NEW CONSTRUCTION / RECONSTRUCTION**

**FULL-DEPTH HMA PAVEMENT**

<table>
<thead>
<tr>
<th>FACILITY</th>
<th>LENGTH</th>
<th># OF CENTERLINES</th>
<th># OF LANES</th>
<th># OF EDGES</th>
<th>LANE WIDTH - AVERAGE</th>
<th>SHOULDER WIDTH</th>
<th>TOTAL WIDTH OF PAVED SHOULDERS</th>
</tr>
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<tr>
<td>PROJECT</td>
<td>13200 FT = = &gt; 2.50 Miles</td>
<td>2 CL</td>
<td>4 LANES</td>
<td>4 EP</td>
<td>12 FT</td>
<td>6 FT</td>
<td>32 FT</td>
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<table>
<thead>
<tr>
<th>PAVEMENT THICKNESS (FLEXIBLE)</th>
<th>MINIMUM</th>
<th>15.25 IN</th>
<th>MAX</th>
<th>15.25 IN</th>
<th>LSC Design</th>
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</table>

| POLICY OVERLAY THICKNESS | 2.00 IN |

<table>
<thead>
<tr>
<th>FLEX PAVEMENT TRAFFIC FACTORS</th>
<th>MINIMUM</th>
<th>ACTUAL</th>
<th>USE</th>
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<tr>
<td>HMA COST PER TON</td>
<td>UNIT PRICE</td>
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<tr>
<td>HMA SURFACE</td>
<td>$101.00 / TON</td>
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<td></td>
</tr>
<tr>
<td>HMA TOP BINDER</td>
<td>$87.28 / TON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMA LOWER BINDER</td>
<td>$75.17 / TON</td>
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<tr>
<td>HMA BINDER (LEVELING)</td>
<td>$87.28 / TON</td>
<td></td>
<td></td>
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<tr>
<td>HMA SHOULDER</td>
<td>$81.12 / TON</td>
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**INITIAL COSTS**

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<th>ITEM</th>
<th>THICKNESS</th>
<th>100% QUANTITY</th>
<th>UNIT</th>
<th>UNIT PRICE</th>
<th>COST</th>
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<tr>
<td>HMA PAVEMENT (FULL-DEPTH)</td>
<td>(15.25&quot;)</td>
<td>70,400 SQ YD</td>
<td>$72.07 / SQ YD</td>
<td>$5,073,476</td>
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<tr>
<td>HMA SURFACE COURSE</td>
<td>(2.00&quot;)</td>
<td>7,940 TONS</td>
<td>$101.00 / TON</td>
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<tr>
<td>HMA TOP BINDER COURSE</td>
<td>(2.25&quot;)</td>
<td>9,063 TONS</td>
<td>$87.28 / TON</td>
<td>$0</td>
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<tr>
<td>HMA LOWER BINDER COURSE</td>
<td>(11.00&quot;)</td>
<td>46,303 TONS</td>
<td>$75.17 / TON</td>
<td>$0</td>
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<tr>
<td>HMA SHOULDER</td>
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<td>40,081 TONS</td>
<td>$81.12 / TON</td>
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<td>$30.00 / LIN FT</td>
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<td>SUBBASE GRAN MATL TY C (TONS)</td>
<td>Aggregate Width = 87.1'</td>
<td>127,722 SQ YD</td>
<td>$13.03 / SQ YD</td>
<td>$1,664,218</td>
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<tr>
<td>IMPROVED SUBGRADE</td>
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<td>$20.71 / TON</td>
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<tr>
<td>Earthexcavation</td>
<td>49,276 CU YD</td>
<td>$17.83 / CU YD</td>
<td>$878,590</td>
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<td>$0.00 / UNITS</td>
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<td>PAVEMENT REMOVAL</td>
<td>70,400 SQ YD</td>
<td>$10.90 / SQ YD</td>
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<td>SHOULDER REMOVAL</td>
<td>46,933 SQ YD</td>
<td>$10.81 / SQ YD</td>
<td>$507,346</td>
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**MILLING**

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<th>UNIT</th>
<th>UNIT PRICE</th>
<th>COST</th>
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</table>
| PARTIAL DEPTH PVMT PATCH | (2.00") | 2.00 | $2.75 / SQ YD | }

**MAINTENANCE COSTS:**

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<thead>
<tr>
<th>ITEM</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
<th>UNIT BILL</th>
<th>UNIT COST</th>
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<tbody>
<tr>
<td>ROUTINE MAINTENANCE ACTIVITY</td>
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<td>LANE-MILE / YEAR</td>
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<td>HMA OVERLAY PVMT SURF</td>
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<td>Surface Mix</td>
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<td>Surface Mix</td>
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<td>$11.39 / SQ YD</td>
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<td>HMA SURFACE MIX</td>
<td>(2.00&quot;)</td>
<td>Shoulder Mix</td>
<td>2.00</td>
<td>$9.09 / SQ YD</td>
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<tr>
<td>HMA BINDER MIX</td>
<td>(0.00&quot;)</td>
<td>Should Mix</td>
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<td>$0.00 / SQ YD</td>
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<tr>
<td>HMA OVERLAY SHLD</td>
<td>(Year 30)</td>
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<td>$9.09 / SQ YD</td>
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<td>MILLING</td>
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<td>Surface Mix</td>
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<tr>
<td>Description</td>
<td>Mix</td>
<td>Cost</td>
<td>Unit</td>
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</tr>
<tr>
<td>--------------------------------------------------</td>
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<td>-------</td>
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<tr>
<td>PARTIAL DEPTH SHLD PATCH (Mill &amp; Fill Surf)</td>
<td>Shoulder Mix</td>
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<td>$78.84 / SQ YD</td>
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<td>Leveling Binder Mix</td>
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<tr>
<td>PARTIAL DEPTH SHLD PATCH (Mill &amp; Fill +2.00&quot;)</td>
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<td>2.00</td>
<td>$78.84 / SQ YD</td>
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<td>LONGITUDINAL SHOULDER JOINT ROUT &amp; SEAL</td>
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<td>$3.00 / LIN FT</td>
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<tr>
<td>CENTERLINE JOINT ROUT &amp; SEAL</td>
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<td>$3.00 / LIN FT</td>
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<tr>
<td>RANDOM / THERMAL CRACK ROUT &amp; SEAL</td>
<td>(100% Rehab = 110.00’ / Station / Lane)</td>
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<td>$3.00 / LIN FT</td>
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FLEXIBLE TOTAL LIFE-CYCLE COST $14,999,365
FLEXIBLE TOTAL ANNUAL COST PER MILE $244,701
PCC PAVEMENT

ROUTE: FAI 55
SECTION: (53-5)R&I
COUNTY: LIVINGSTON
LOCATION: 1.7 MI S OF IL 116 TO 0.6 MI N OF IL 23

FACILITY TYPE: INTERSTATE

PROJECT LENGTH: 13200 FT = 2.50 Miles

# OF CENTERLINES: 2 CL
# OF LANES: 4 LANES
# OF EDGES: 4 EP
LANE WIDTH - AVERAGE: 12 FT
SHOULDER WIDTH: PCC Inside 6 FT, PCC Outside 10 FT
Total Width of Paved Shoulders: 32 FT

PAVEMENT THICKNESS (RIGID): JPCP 11.00 IN
SHOULDER THICKNESS: 11.00 IN

POLICY OVERLAY THICKNESS: 3.75 IN

RIGID PAVEMENT TRAFFIC FACTORS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
<th>T</th>
<th>UNIT COST</th>
</tr>
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<tbody>
<tr>
<td>JPC PAVEMENT</td>
<td>(11.00&quot;)</td>
<td>70,400 SQ YD</td>
<td>$58.84 / SQ YD</td>
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<td>STABILIZED SUBBASE</td>
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<td>$2,065,052</td>
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<tr>
<td>CURB &amp; GUTTER</td>
<td>0 LIN FT</td>
<td>$30.00 / LIN FT</td>
<td>$0</td>
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<tr>
<td>SUBBASE GRAN MATL TY C</td>
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<td>5,522 TONS</td>
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<td>IMPROVED SUBGRADE: Aggregate Width = 82.0'</td>
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<td>$0.00 / UNITS</td>
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Note: * Denotes User Supplied Quantity

RIGID CONSTRUCTION INITIAL COST: $11,539,568
RIGID CONSTRUCTION ANNUAL COST PER MILE: $188,257

MAINTENANCE COSTS:

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RIGID TOTAL LIFE-CYCLE COST: $13,409,799
RIGID TOTAL ANNUAL COST PER MILE: $218,768
**LIFE-CYCLE COST ANALYSIS: NEW DESIGN**

Calculated / Revised: 7/10/17 3:35 PM

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**LIFE-CYCLE COST ANALYSIS: FINAL SUMMARY**

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S:\Studies\Writers\Oyier\I-55 66B64 Livingston County 12-31-16\Pavement Design\[1-66B64- Pavement Design JPCP -.xlsm]\PDFSheets
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<th>UNIT</th>
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<td>LIN FT</td>
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<tr>
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**Routine Maintenance Activity**

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**Maintenance Life-Cycle Cost**

$2,856,999
### JOINTED PLAIN CONCRETE PAVEMENT

#### UNBONDED JOINTED PLAIN CONCRETE OVERLAY

Figure 54-7.A

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<th>UNIT</th>
<th>UNIT COST</th>
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<td>PD PVMT PATCH M&amp;F HMA SURF 1.50&quot;</td>
<td>0.10%</td>
<td>70 SQ YD</td>
<td>$78.23</td>
<td>$5,476</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PWFn = 0.4776</td>
<td>PW = 0.4776 X</td>
<td></td>
<td>$185,261</td>
<td></td>
</tr>
<tr>
<td>YEAR 30</td>
<td>PAVEMENT PATCH CLASS B</td>
<td>4.00%</td>
<td>2,816 SQ YD</td>
<td>$144.16</td>
<td>$405,955</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SHOULDER PATCH CLASS C</td>
<td>1.50%</td>
<td>704 SQ YD</td>
<td>$177.89</td>
<td>$125,235</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HMA POLICY OVERLAY 3.75&quot; ( PVMT )</td>
<td>100.00%</td>
<td>70,400 SQ YD</td>
<td>$19.73</td>
<td>$1,388,706</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HMA POLICY OVERLAY 3.75&quot; ( SHLD )</td>
<td>100.00%</td>
<td>46,933 SQ YD</td>
<td>$17.04</td>
<td>$799,519</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PWFn = 0.4120</td>
<td>PW = 0.4120 X</td>
<td></td>
<td>$1,120,363</td>
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</tr>
<tr>
<td>YEAR 35</td>
<td>INTERSTATE</td>
<td>LONGITUDINAL SHLD JT R&amp;S</td>
<td>100.00%</td>
<td>52,800 LIN FT</td>
<td>$3.00</td>
<td>$158,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CENTERLINE JT R&amp;S</td>
<td>100.00%</td>
<td>26,400 LIN FT</td>
<td>$3.00</td>
<td>$79,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RANDOM CRACK R&amp;S</td>
<td>50.00%</td>
<td>26,400 LIN FT</td>
<td>$3.00</td>
<td>$79,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>REFLECTIVE TRANSVERSE CRACK R&amp;S</td>
<td>40.00%</td>
<td>16,896 LIN FT</td>
<td>$3.00</td>
<td>$50,688</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>PD PVMT PATCH M&amp;F HMA SURF 1.50&quot;</td>
<td>0.10%</td>
<td>70 SQ YD</td>
<td>$78.23</td>
<td>$5,476</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PWFn = 0.3554</td>
<td>PW = 0.3554 X</td>
<td></td>
<td>$132,545</td>
<td></td>
</tr>
<tr>
<td>YEAR 40</td>
<td>INTERSTATE</td>
<td>PAVEMENT PATCH CLASS B</td>
<td>0.50%</td>
<td>352 SQ YD</td>
<td>$144.16</td>
<td>$50,744</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LONGITUDINAL SHLD JT R&amp;S</td>
<td>100.00%</td>
<td>52,800 LIN FT</td>
<td>$3.00</td>
<td>$158,400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CENTERLINE JT R&amp;S</td>
<td>100.00%</td>
<td>26,400 LIN FT</td>
<td>$3.00</td>
<td>$79,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>REFLECTIVE TRANSVERSE CRACK R&amp;S</td>
<td>60.00%</td>
<td>25,344 LIN FT</td>
<td>$3.00</td>
<td>$76,032</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RANDOM CRACK R&amp;S</td>
<td>50.00%</td>
<td>26,400 LIN FT</td>
<td>$3.00</td>
<td>$79,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PD PVMT PATCH M&amp;F HMA SURF 1.50&quot;</td>
<td>0.50%</td>
<td>352 SQ YD</td>
<td>$78.23</td>
<td>$27,538</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PWFn = 0.3066</td>
<td>PW = 0.3066 X</td>
<td></td>
<td>$144,423</td>
<td></td>
</tr>
<tr>
<td>ROUTINE MAINTENANCE ACTIVITY</td>
<td>10.00 Lane Miles</td>
<td>$0.00</td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### MAINTENANCE LIFE-CYCLE COST:

- **CRFn = 0.0407852**
- **MAINTENANCE ANNUAL COST PER MILE** $30,511

**MAINTENANCE LIFE-CYCLE COST** $1,870,231

**RAILWAY MAINTENANCE COST** $30,511

**TOTAL MAINTENANCE COST** $1,870,231
**PROJECT AND TRAFFIC INPUTS**

(Enter Data in Gray Shaded Cells)

<table>
<thead>
<tr>
<th>Route: FAI 55</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section: (53-5)R&amp;I</td>
<td></td>
</tr>
<tr>
<td>County: LIVINGSTON</td>
<td>Design Date: 07/10/2017 J. OYER</td>
</tr>
<tr>
<td>Location: 1.7 MI S OF IL 116 TO 0.6 MI N OF IL 23</td>
<td>Modify Date:</td>
</tr>
<tr>
<td>Facility Type: Interstate or Freeway</td>
<td># of Lanes = 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Road Class:</th>
<th>PV = 0</th>
<th>SU = 500</th>
<th>MU = 1500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgrade Support Rating (SSR): Poor</td>
<td>17,436</td>
<td>1,011</td>
<td>6,823</td>
</tr>
<tr>
<td>Construction Year: 2018</td>
<td>ADT &gt;= 32%</td>
<td>S = 45%</td>
<td></td>
</tr>
<tr>
<td>Design Period (DP) = 20 years</td>
<td>23,061</td>
<td>4.0%</td>
<td>27,479</td>
</tr>
</tbody>
</table>

### Traffic Factor Calculation

<table>
<thead>
<tr>
<th>Flexible Pavement</th>
<th>Cpv = 0.15</th>
<th>Csu = 132.5</th>
<th>Cmu = 482.53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid Pavement</td>
<td>Cpv = 0.15</td>
<td>Csu = 143.81</td>
<td>Cmu = 696.42</td>
</tr>
<tr>
<td></td>
<td>SSU = 132.5</td>
<td>M = 45%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MU = 1500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| TF Flexible (Actual) = 30.85 | TF Rigid (Actual) = 44.09 |
| TF Flexible (Min) = 7.11 | TF Rigid (Min) = 10.05 |

### New Construction / Reconstruction Pavement Design Calculations

<table>
<thead>
<tr>
<th>Full-Depth HMA Pavement</th>
<th>JPC Pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use TF flexible = 30.85</td>
<td>Use TF rigid = 44.09</td>
</tr>
<tr>
<td>PG Grade Lower Binder Lifts = PG 76-28 (Fig. 54-4.R)</td>
<td>Edge Support = Tied Shoulder or C.&amp;G.</td>
</tr>
<tr>
<td>HMA Mixture Temp. = 76.5 deg. F (Fig. 54-4.C)</td>
<td>Rigid Pavt Thick. = 11.00 in. (Fig. 54-4.E)</td>
</tr>
<tr>
<td>Design HMA Mixture Modulus (E_{f,99}) = 650 ksi (Fig. 54-4.D)</td>
<td></td>
</tr>
<tr>
<td>Design HMA Strain (E_{f,99}) = 45 (Fig. 54-4.E)</td>
<td></td>
</tr>
<tr>
<td>Full Depth HMA Design Thickness = 15.50 in. (Fig. 54-4.F)</td>
<td></td>
</tr>
<tr>
<td>Limiting Strain Criterion Thickness = 15.25 in. (Fig. 54-4.I)</td>
<td></td>
</tr>
<tr>
<td>Use Full-Depth HMA Thickness = 15.25 inches</td>
<td></td>
</tr>
</tbody>
</table>

### Reconstruction Only (Supplemental) Pavement Design Calculations

<table>
<thead>
<tr>
<th>HMA Overlay of Rubblized PCC</th>
<th>Unbonded Concrete Overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use TF flexible = 30.85</td>
<td>Use TF rigid = 44.09</td>
</tr>
<tr>
<td>HMA Overlay Design Thickness = 12.75 in. (Fig. 54-4.U)</td>
<td>Edge Support = Tied Shoulder or C.&amp;G.</td>
</tr>
<tr>
<td>Limiting Strain Criterion Thickness = 11.00 in. (Fig. 54-4.V)</td>
<td>Rigid Pavt Thick. = 11.00 in. (Fig. 54-4.E)</td>
</tr>
<tr>
<td>Use HMA Overlay Thickness = 11.00 inches</td>
<td></td>
</tr>
</tbody>
</table>

### Design Tables from BDE Manual Chapter 54 - Pavement Design

<table>
<thead>
<tr>
<th>Class I Roads</th>
<th>Class II Roads</th>
<th>Class III Roads</th>
<th>Class IV Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 lanes or more</td>
<td>2 lanes with ADT &gt; 2000</td>
<td>2 lanes (ADT 750 - 2000)</td>
<td>2 lanes (ADT &lt; 750)</td>
</tr>
<tr>
<td>Part of a future 4 lanes or more</td>
<td>One way Street with ADT &lt;= 3500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-way Streets with ADT &gt; 3500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Traffic Factor ESAL Coefficients | Flexible (Fig. 54-5.B) | Rigid (Fig. 54-4.C) |
| Class | Csu | Cmu | Csu | Cmu |
| I     | 143.81 | 696.42 | 132.50 | 482.53 |
| II    | 135.78 | 657.21 | 112.06 | 385.44 |
| III   | 129.58 | 612.47 | 109.14 | 384.35 |
| IV    | 129.58 | 612.47 | 109.14 | 384.35 |

<table>
<thead>
<tr>
<th>Number of Lanes</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Lane Ramp</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2 or 3</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>6 or more</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>
# LIFE-CYCLE COST ANALYSIS: NEW CONSTRUCTION / RECONSTRUCTION

## FULL-DEPTH HMA PAVEMENT

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>LSC Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
<td>FAI 55</td>
</tr>
<tr>
<td>Section</td>
<td>(53)-R&amp;I</td>
</tr>
<tr>
<td>County</td>
<td>LIVINGSTON</td>
</tr>
<tr>
<td>Location</td>
<td>1.7 MI S OF IL 116 TO 0.6 MI N OF IL 23</td>
</tr>
<tr>
<td>Facility Type</td>
<td>INTERSTATE</td>
</tr>
</tbody>
</table>

## Project Details

- **Project Length:** 19536 FT = 3.70 Miles
- **# of Centerlines:** 2 CL
- **# of Lanes:** 4 LANES
- **# of Edges:** 4 EP
- **Lane Width - Average:** HMA Inside 6 FT, HMA Outside 10 FT
- **Shoulder Width:** HMA Inside 6 FT, HMA Outside 10 FT
- **Total Width of Paved Shoulders:** 32 FT

## Pavement Thickness

- **Flexible:** 15.25 IN, 15.25 IN MAX
- **Shoulder:** 15.25 IN
- **Policy Overlay Thickness:** 2.00 IN

## Traffic Factors

<table>
<thead>
<tr>
<th>Flexible Pavement Traffic Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>7.11</td>
</tr>
</tbody>
</table>

## Cost Analysis

### HMA Cost Per Ton

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness</th>
<th>100% Quantity</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA Surface</td>
<td>(15.25&quot;)</td>
<td>104,192 SQ YD</td>
<td>$71.21</td>
<td>$7,419,408</td>
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</tr>
<tr>
<td>HMA Top Binder</td>
<td>(15.25&quot;)</td>
<td>11,751 TONS</td>
<td>$101.66</td>
<td>$0</td>
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</tr>
<tr>
<td>HMA Lower Binder</td>
<td>(11.00&quot;)</td>
<td>68,528 TONS</td>
<td>$73.99</td>
<td>$0</td>
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</tr>
<tr>
<td>HMA Binder (Leveling)</td>
<td>(0.00&quot;)</td>
<td>1.0139 UNITS</td>
<td>$0.00</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>HMA Shoulder (Year 30)</td>
<td>(2.00&quot;)</td>
<td>59,320 TONS</td>
<td>$9.09</td>
<td>$531,217</td>
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</tr>
<tr>
<td>Curb &amp; Gutter</td>
<td>(15.25&quot;)</td>
<td>59,320 TONS</td>
<td>$81.20</td>
<td>$4,816,782</td>
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</tbody>
</table>

### Reserved For User Supplied Item

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness</th>
<th>100% Quantity</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Width 67.1&quot;</td>
<td>189,029 SQ YD</td>
<td>$13.03/ SQ YD</td>
<td>$2,463,048</td>
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</tr>
</tbody>
</table>

### Earthwork

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness</th>
<th>100% Quantity</th>
<th>Unit</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Removal</td>
<td>104,192 SQ YD</td>
<td>$10.90/ SQ YD</td>
<td>$1,135,693</td>
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<tr>
<td>Shoulder Removal</td>
<td>69,461 SQ YD</td>
<td>$10.81/ SQ YD</td>
<td>$750,873</td>
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### Maintenance Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness</th>
<th>Material</th>
<th>T</th>
<th>Unit Cost</th>
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</thead>
<tbody>
<tr>
<td>ROUTINE MAINTENANCE ACTIVITY</td>
<td>(15.25&quot;)</td>
<td>Surface Mix</td>
<td>2.00</td>
<td>$11.46/ SQ YD</td>
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<tr>
<td>HMA Overlay Pavement Surf</td>
<td>(0.00&quot;)</td>
<td>Shoulder Mix</td>
<td>2.00</td>
<td>$9.09/ SQ YD</td>
</tr>
</tbody>
</table>

### Milling

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness</th>
<th>Unit Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial Depth Pavement Patch (Milling)</td>
<td>2.00&quot;</td>
<td>$81.39/ SQ YD</td>
<td>$198,305</td>
</tr>
</tbody>
</table>

Note: * Denotes User Supplied Quantity

FLEXIBLE CONSTRUCTION INITIAL COST: **$17,990,377**

FLEXIBLE CONSTRUCTION ANNUAL COST PER MILE: **$198,305**
<table>
<thead>
<tr>
<th>Description</th>
<th>Mix Type</th>
<th>Mix Quantity</th>
<th>Cost per SQ YD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARTIAL DEPTH SHLD PATCH</td>
<td>Shoulder Mix</td>
<td>2.00</td>
<td>$79.09</td>
</tr>
<tr>
<td>PARTIAL DEPTH PVMT PATCH</td>
<td>Leveling Binder Mix</td>
<td>2.00</td>
<td>$81.39</td>
</tr>
<tr>
<td>PARTIAL DEPTH SHLD PATCH</td>
<td>Shoulder Mix</td>
<td>2.00</td>
<td>$79.09</td>
</tr>
<tr>
<td>LONGITUDINAL SHOULDER JOINT ROUT &amp; SEAL</td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
<tr>
<td>CENTERLINE JOINT ROUT &amp; SEAL</td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
<tr>
<td>RANDOM / THERMAL CRACK ROUT &amp; SEAL</td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
</tbody>
</table>

- **FLEXIBLE TOTAL LIFE-CYCLE COST**: $22,276,347
- **FLEXIBLE TOTAL ANNUAL COST PER MILE**: $245,553
PCC PAVEMENT

ROUTE: FAI 55
SECTION: (53-5)R&I
COUNTY: LIVINGSTON
LOCATION: 1.7 MI S OF IL 116 TO 0.6 MI N OF IL 23

FACILITY TYPE: INTERSTATE

PROJECT LENGTH: 19536 FT = 3.70 Miles
# OF CENTERLINES: 2 CL
# OF LANES: 4 LANES
# OF EDGES: 4 EP
LANE WIDTH - AVERAGE: 12 FT
SHOULDER WIDTH:
  PCC Inside: 6 FT
  PCC Outside: 10 FT
Total Width of Paved Shoulders: 32 FT

PAVEMENT THICKNESS (RIGID) - JPCP: 11.00 IN
SHOULDER THICKNESS - JPCP: 11.00 IN

POLICY OVERLAY THICKNESS - JPCP: 3.75 IN

RIGID PAVEMENT TRAFFIC FACTORS

Worksheet Construction Type is: Reconstruction
The Pavement Type is: JPCP

INITIAL COSTS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>THICKNESS</th>
<th>100% QUANTITY</th>
<th>UNIT</th>
<th>UNIT PRICE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>JPC PAVEMENT</td>
<td>( 11.00&quot; )</td>
<td>104,192 SQ YD</td>
<td>$58.85 / SQ YD</td>
<td>$6,131,699</td>
<td></td>
</tr>
<tr>
<td>PAVEMENT REINFORCEMENT</td>
<td>( 0&quot; )</td>
<td>0 SQ YD</td>
<td>$22.00 / SQ YD</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>STABILIZED SUBBASE</td>
<td>( 4.00&quot; )</td>
<td>117,216 SQ YD</td>
<td>$18.00 / SQ YD</td>
<td>$2,109,899</td>
<td></td>
</tr>
<tr>
<td>PCC SHOULDERS</td>
<td></td>
<td>69,461 SQ YD</td>
<td>$44.00 / SQ YD</td>
<td>$3,056,284</td>
<td></td>
</tr>
<tr>
<td>CURB &amp; GUTTER</td>
<td></td>
<td>0 LIN FT</td>
<td>$30.00 / LIN FT</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>SUBBASE GRAN MATL TY C</td>
<td>( ~ 3.48&quot; )</td>
<td>8,173 TONS</td>
<td>$21.00 / TON</td>
<td>$171,633</td>
<td></td>
</tr>
<tr>
<td>IMPROVED SUBGRADE: Aggregate</td>
<td>Width = 82.0'</td>
<td>177,995 SQ YD</td>
<td>$13.03 / SQ YD</td>
<td>$2,319,275</td>
<td></td>
</tr>
<tr>
<td>Earthwork</td>
<td></td>
<td>72,928 UNITS</td>
<td>$17.83 / UNITS</td>
<td>$1,300,313</td>
<td></td>
</tr>
<tr>
<td>Reserved For User Supplied Item</td>
<td></td>
<td>0 UNITS</td>
<td>$0.00 / UNITS</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>PAVEMENT REMOVAL</td>
<td></td>
<td>104,192 SQ YD</td>
<td>$10.90 / SQ YD</td>
<td>$1,135,693</td>
<td></td>
</tr>
<tr>
<td>SHOULDER REMOVAL</td>
<td></td>
<td>69,461 SQ YD</td>
<td>$10.81 / SQ YD</td>
<td>$750,873</td>
<td></td>
</tr>
</tbody>
</table>

Note: * Denotes User Supplied Quantity

RIGID CONSTRUCTION INITIAL COST: $16,975,658
RIGID CONSTRUCTION ANNUAL COST PER MILE: $187,123

MAINTENANCE COSTS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>THICKNESS</th>
<th>MATERIAL</th>
<th>T</th>
<th>UNIT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROUTINE MAINTENANCE ACTIVITY</td>
<td></td>
<td></td>
<td></td>
<td>$0.00 / LANE-MILE / YEAR</td>
</tr>
<tr>
<td>HMA POLICY OVERLAY</td>
<td>( 3.75&quot; )</td>
<td>3.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMA POLICY OVERLAY PVMT</td>
<td>( 3.75&quot; )</td>
<td>1.0130</td>
<td>3.75</td>
<td>$19.63 / SQ YD</td>
</tr>
<tr>
<td>HMA SURFACE MIX</td>
<td>( 1.50&quot; )</td>
<td>1.0002</td>
<td>Surface Mix</td>
<td>$8.58 / SQ YD</td>
</tr>
<tr>
<td>HMA BINDER MIX</td>
<td>( 2.25&quot; )</td>
<td>1.0182</td>
<td>Top Binder Mix</td>
<td>$11.04 / SQ YD</td>
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<tr>
<td>HMA POLICY OVERLAY SHLD</td>
<td>( 3.75&quot; )</td>
<td>3.75</td>
<td>Shoulder Mix</td>
<td>$17.05 / SQ YD</td>
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<tr>
<td>CLASS A PAVEMENT PATCHING</td>
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<td>$195.00 / SQ YD</td>
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<tr>
<td>CLASS B PAVEMENT PATCHING</td>
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<td></td>
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<td>$150.00 / SQ YD</td>
</tr>
<tr>
<td>CLASS C SHOULDER PATCHING</td>
<td></td>
<td></td>
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<td>$145.00 / SQ YD</td>
</tr>
<tr>
<td>PARTIAL DEPTH PVMT PATCH</td>
<td></td>
<td></td>
<td>Surface Mix</td>
<td>$78.54 / SQ YD</td>
</tr>
<tr>
<td>PARTIAL DEPTH PVMT PATCH</td>
<td></td>
<td></td>
<td>Surface Mix</td>
<td>$78.54 / SQ YD</td>
</tr>
<tr>
<td>LONGITUDINAL SHOULDER JOINT RUT &amp; SEAL</td>
<td></td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
<tr>
<td>CENTERLINE JOINT RUT &amp; SEAL</td>
<td></td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
<tr>
<td>REFLECTIVE TRANSVERSE CRACK RUT &amp; SEAL</td>
<td></td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
<tr>
<td>RANDOM CRACK RUT &amp; SEAL</td>
<td>(100% Rehab = 100.00' / Station / Lane)</td>
<td></td>
<td></td>
<td>$3.00 / LIN FT</td>
</tr>
</tbody>
</table>

RIGID TOTAL LIFE-CYCLE COST: $19,736,190
RIGID TOTAL ANNUAL COST PER MILE: $217,552
### RECONSTRUCTION - HMA OVER RUBBLIZED PAVEMENT

**PAVEMENT OVERLAY THICKNESS (FLEXIBLE)**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>THICKNESS</th>
<th>100% QUANTITY</th>
<th>UNIT PRICE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA OVERLAY REMOVAL</td>
<td>3.25</td>
<td>104,192 SQ YD</td>
<td>$4.23 / SQ YD</td>
<td>$440,732</td>
</tr>
<tr>
<td>RUBBLIZING PCC PAVEMENT</td>
<td></td>
<td>104,192 SQ YD</td>
<td>$2.50 / SQ YD</td>
<td>$260,480</td>
</tr>
<tr>
<td>HMA OVERLAY (TOTAL)</td>
<td>11.00</td>
<td>104,192 SQ YD</td>
<td>$51.99 / SQ YD</td>
<td>$5,417,394</td>
</tr>
<tr>
<td>HMA SURFACE COURSE</td>
<td>2.00</td>
<td>104,192 SQ YD</td>
<td>$11.46 / SQ YD</td>
<td>$0</td>
</tr>
<tr>
<td>HMA TOP BINDER COURSE</td>
<td>2.25</td>
<td>104,192 SQ YD</td>
<td>$11.08 / SQ YD</td>
<td>$0</td>
</tr>
<tr>
<td>HMA LOWER BINDER COURSE</td>
<td>6.75</td>
<td>104,192 SQ YD</td>
<td>$29.45 / SQ YD</td>
<td>$0</td>
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</tbody>
</table>

**SHOULDER OVERLAY THICKNESS**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>THICKNESS</th>
<th>100% QUANTITY</th>
<th>UNIT PRICE</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA OVERLAY REMOVAL</td>
<td>3.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMA OVERLAY (TOTAL)</td>
<td>7.75</td>
<td>30,146 TONS</td>
<td>$81.20 / TON</td>
<td>$2,447,873</td>
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</tbody>
</table>

**Reserved For User Supplied Item**

- **Earthwork**
  - 3,622 CU YD *
  - $17.83 / CU YD
  - $64,572

**Note:** * Denotes User Supplied Quantity

---

**RECONSTRUCTION - PCC UNBONDED OVERLAY**

- **RUBBLIZED CONSTRUCTION INITIAL COST**: $8,631,051
- **RUBBLIZED CONSTRUCTION ANNUAL COST PER MILE**: $95,140
- **RUBBLIZED MAINTENANCE LIFE-CYCLE COST**: $4,286,270
- **RUBBLIZED MAINTENANCE ANNUAL COST PER MILE**: $47,248
- **RUBBLIZED TOTAL LIFE-CYCLE COST**: $12,917,321
- **RUBBLIZED TOTAL ANNUAL COST PER MILE**: $142,388
## LIFE-CYCLE COST ANALYSIS: NEW DESIGN

**CONSTRUCTION**
- **INITIAL COST**
  - **PRESENT WORTH**
    - **JPCP**: $16,975,658
    - **HMA**: $17,990,077
  - **ANNUAL COST PER MILE**
    - **JPCP**: $187,123
    - **HMA**: $198,305

**MAINTENANCE**
- **LIFE-CYCLE COST**
  - **PRESENT WORTH**
    - **JPCP**: $2,760,532
    - **HMA**: $4,286,270
  - **ANNUAL COST PER MILE**
    - **JPCP**: $30,429
    - **HMA**: $47,248

**TOTAL**
- **LIFE-CYCLE COST**
  - **PRESENT WORTH**
    - **JPCP**: $19,736,190
    - **HMA**: $22,276,347
  - **ANNUAL COST PER MILE**
    - **JPCP**: $217,552
    - **HMA**: $245,553

## LIFE-CYCLE COST ANALYSIS: SUPPLEMENTAL DESIGNS

**CONSTRUCTION**
- **INITIAL COST**
  - **PRESENT WORTH**
    - **PCC Unbonded**: $8,960,496
    - **Rubblized**: $8,631,051
  - **ANNUAL COST PER MILE**
    - **PCC Unbonded**: $98,772
    - **Rubblized**: $95,140

**MAINTENANCE**
- **LIFE-CYCLE COST**
  - **PRESENT WORTH**
    - **PCC Unbonded**: $2,760,532
    - **Rubblized**: $4,286,270
  - **ANNUAL COST PER MILE**
    - **PCC Unbonded**: $30,429
    - **Rubblized**: $47,248

**TOTAL**
- **LIFE-CYCLE COST**
  - **PRESENT WORTH**
    - **PCC Unbonded**: $11,721,028
    - **Rubblized**: $12,917,321
  - **ANNUAL COST PER MILE**
    - **PCC Unbonded**: $99,999,999
    - **Rubblized**: $142,388

## LIFE-CYCLE COST ANALYSIS: FINAL SUMMARY

**LOWEST COST OPTION**
- Rubblized: $142,388

**OTHER OPTIONS (LOWEST TO HIGHEST):**
- **TYPE / PERCENTAGE**
  - **JPCP**: $217,552  52.8%
  - **HMA**: $245,553  72.5%
### FULL-DEPTH HMA PAVEMENT

**HMA OVERLAY OF RUBBLIZED PCC PAVEMENT**

Figure 54-7.C

LIMITING STRAIN CRITERION DESIGN

**PRESENT MAINTENANCE COSTS:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>UNIT COST</th>
<th>COST</th>
<th>WORTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>LONG SHLD JT R&amp;S</td>
<td>78,144</td>
<td>LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
<td></td>
</tr>
<tr>
<td>CNTR LINE JOINT R&amp;S</td>
<td>39,072</td>
<td>LIN FT</td>
<td>$3.00</td>
<td>$171,216</td>
<td></td>
</tr>
<tr>
<td>RNDM / THRM CRACK R&amp;S</td>
<td>42,979</td>
<td>LIN FT</td>
<td>$3.00</td>
<td>$128,937</td>
<td></td>
</tr>
<tr>
<td>PD PVMT PATCH M&amp;F SURF</td>
<td>104 SQ YD</td>
<td>$81.39</td>
<td>$8,464</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**YEAR 5**

PWFn = 0.8626
PW = 0.8626 X $489,049 = $421,858

**YEAR 10**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>UNIT COST</th>
<th>COST</th>
<th>WORTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>LONG SHLD JT R&amp;S</td>
<td>78,144</td>
<td>LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
<td></td>
</tr>
<tr>
<td>CNTR LINE JOINT R&amp;S</td>
<td>39,072</td>
<td>LIN FT</td>
<td>$3.00</td>
<td>$171,216</td>
<td></td>
</tr>
<tr>
<td>RNDM / THRM CRACK R&amp;S</td>
<td>42,979</td>
<td>LIN FT</td>
<td>$3.00</td>
<td>$128,937</td>
<td></td>
</tr>
<tr>
<td>PD PVMT PATCH M&amp;F SURF</td>
<td>521 SQ YD</td>
<td>$81.39</td>
<td>$42,402</td>
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<td></td>
</tr>
</tbody>
</table>

**YEAR 15**

PWFn = 0.7441
PW = 0.7441 X $522,987 = $389,151

**YEAR 20**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>UNIT COST</th>
<th>COST</th>
<th>WORTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILL PVMT &amp; SHLD 2.00&quot;</td>
<td>173,653</td>
<td>SQ YD</td>
<td>$3.00</td>
<td>$520,959</td>
<td></td>
</tr>
<tr>
<td>PD PVMT PATCH M&amp;F ADD'L 2.00&quot;</td>
<td>1,042 SQ YD</td>
<td>$81.39</td>
<td>$84,804</td>
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<tr>
<td>HMA OVERLAY PVMT 2.00&quot;</td>
<td>104,192</td>
<td>SQ YD</td>
<td>$11.46</td>
<td>$1,194,560</td>
<td></td>
</tr>
<tr>
<td>HMA OVERLAY SHLD 2.00&quot;</td>
<td>69,461</td>
<td>SQ YD</td>
<td>$9.09</td>
<td>$631,709</td>
<td></td>
</tr>
</tbody>
</table>

**YEAR 25**

PWFn = 0.5537
PW = 0.5537 X $522,987 = $270,775

**YEAR 30**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>UNIT</th>
<th>UNIT COST</th>
<th>COST</th>
<th>WORTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILL PVMT &amp; SHLD 2.00&quot;</td>
<td>173,653</td>
<td>SQ YD</td>
<td>$3.00</td>
<td>$520,959</td>
<td></td>
</tr>
<tr>
<td>PD PVMT PATCH M&amp;F ADD'L 2.00&quot;</td>
<td>2,084 SQ YD</td>
<td>$81.39</td>
<td>$169,608</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PD SHLD PATCH M&amp;F ADD'L 2.00&quot;</td>
<td>695 SQ YD</td>
<td>$81.39</td>
<td>$54,971</td>
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<td></td>
</tr>
<tr>
<td>HMA OVERLAY PVMT 2.00&quot;</td>
<td>104,192</td>
<td>SQ YD</td>
<td>$11.46</td>
<td>$1,194,560</td>
<td></td>
</tr>
<tr>
<td>HMA OVERLAY SHLD 2.00&quot;</td>
<td>69,461</td>
<td>SQ YD</td>
<td>$9.09</td>
<td>$631,709</td>
<td></td>
</tr>
</tbody>
</table>

**YEAR 35**

PWFn = 0.3554
PW = 0.3554 X $522,987 = $160,325

**YEAR 40**

**ROUTINE MAINTENANCE ACTIVITY**

14.80 Lane Miles 0.00 0 $0

MAINTENANCE LIFE-CYCLE COST $4,286,270

**CRFn = 0.0407852**

MAINTENANCE ANNUAL COST PER MILE $47,248
### Maintenance Costs:

<table>
<thead>
<tr>
<th>Year</th>
<th>Item Description</th>
<th>%</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Cost</th>
<th>Present Worth</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>YEAR 10</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>0.10%</td>
<td>104 SQ YD</td>
<td>$150.00</td>
<td>$15,600</td>
<td>$11,608</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shoulder Patch Class C</td>
<td>0.50%</td>
<td>347 SQ YD</td>
<td>$145.00</td>
<td>$50,315</td>
<td>$50,315</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Shld JT R&amp;S</td>
<td>100.00%</td>
<td>78,144 LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Centerline JT R&amp;S</td>
<td>100.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
<td>$117,216</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>YEAR 15</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>0.20%</td>
<td>208 SQ YD</td>
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<td>$31,200</td>
<td>$20,026</td>
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<tr>
<td></td>
<td>Shoulder Patch Class C</td>
<td>0.50%</td>
<td>347 SQ YD</td>
<td>$145.00</td>
<td>$50,315</td>
<td>$50,315</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Shld JT R&amp;S</td>
<td>100.00%</td>
<td>78,144 LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
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<td></td>
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<tr>
<td></td>
<td>Centerline JT R&amp;S</td>
<td>100.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
<td>$117,216</td>
<td></td>
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<tr>
<td></td>
<td><strong>YEAR 20</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>2.00%</td>
<td>2,084 SQ YD</td>
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<td>$312,600</td>
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<tr>
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<td>0.50%</td>
<td>347 SQ YD</td>
<td>$145.00</td>
<td>$50,315</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Shld JT R&amp;S</td>
<td>100.00%</td>
<td>78,144 LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Centerline JT R&amp;S</td>
<td>100.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
<td>$117,216</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>YEAR 25</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>3.00%</td>
<td>3,126 SQ YD</td>
<td>$150.00</td>
<td>$468,900</td>
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<tr>
<td></td>
<td>Shoulder Patch Class C</td>
<td>1.00%</td>
<td>695 SQ YD</td>
<td>$145.00</td>
<td>$100,775</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Shld JT R&amp;S</td>
<td>100.00%</td>
<td>78,144 LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Centerline JT R&amp;S</td>
<td>100.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
<td>$117,216</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reflective Transverse Crack R&amp;S</td>
<td>40.00%</td>
<td>24,998 LIN FT</td>
<td>$3.00</td>
<td>$74,994</td>
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</tr>
<tr>
<td></td>
<td>Random Crack R&amp;S</td>
<td>50.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PD/PMT Patch M&amp;F HMA Surf 1.50&quot;</td>
<td>0.10%</td>
<td>104 SQ YD</td>
<td>$78.54</td>
<td>$8,168</td>
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</tr>
<tr>
<td></td>
<td><strong>YEAR 30</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>4.00%</td>
<td>4,168 SQ YD</td>
<td>$150.00</td>
<td>$625,200</td>
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</tr>
<tr>
<td></td>
<td>Shoulder Patch Class C</td>
<td>1.50%</td>
<td>1,042 SQ YD</td>
<td>$145.00</td>
<td>$151,090</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>HMA Policy Overlay 3.75&quot; (PVMT)</td>
<td>100.00%</td>
<td>104,192 SQ YD</td>
<td>$19.63</td>
<td>$2,044,917</td>
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</tr>
<tr>
<td></td>
<td>HMA Policy Overlay 3.75&quot; (SHLD)</td>
<td>100.00%</td>
<td>69,461 SQ YD</td>
<td>$3.00</td>
<td>$1,184,455</td>
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<tr>
<td></td>
<td><strong>YEAR 35</strong></td>
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<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>6.00%</td>
<td>6,276 SQ YD</td>
<td>$150.00</td>
<td>$941,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shoulder Patch Class C</td>
<td>1.50%</td>
<td>1,042 SQ YD</td>
<td>$145.00</td>
<td>$151,090</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HMA Policy Overlay 3.75&quot; (PVMT)</td>
<td>100.00%</td>
<td>104,192 SQ YD</td>
<td>$19.63</td>
<td>$2,044,917</td>
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<tr>
<td></td>
<td>HMA Policy Overlay 3.75&quot; (SHLD)</td>
<td>100.00%</td>
<td>69,461 SQ YD</td>
<td>$3.00</td>
<td>$1,184,455</td>
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<tr>
<td></td>
<td><strong>YEAR 40</strong></td>
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<tr>
<td></td>
<td>Pavement Patch Class B</td>
<td>6.00%</td>
<td>6,276 SQ YD</td>
<td>$150.00</td>
<td>$941,400</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shoulder Patch Class C</td>
<td>1.50%</td>
<td>1,042 SQ YD</td>
<td>$145.00</td>
<td>$151,090</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Longitudinal Shld JT R&amp;S</td>
<td>100.00%</td>
<td>78,144 LIN FT</td>
<td>$3.00</td>
<td>$234,432</td>
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<tr>
<td></td>
<td>Centerline JT R&amp;S</td>
<td>100.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
<td>$117,216</td>
<td></td>
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<tr>
<td></td>
<td>Reflective Transverse Crack R&amp;S</td>
<td>40.00%</td>
<td>24,998 LIN FT</td>
<td>$3.00</td>
<td>$74,994</td>
<td></td>
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<tr>
<td></td>
<td>Random Crack R&amp;S</td>
<td>50.00%</td>
<td>39,072 LIN FT</td>
<td>$3.00</td>
<td>$117,216</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>PD/PMT Patch M&amp;F HMA Surf 1.50&quot;</td>
<td>0.10%</td>
<td>104 SQ YD</td>
<td>$78.54</td>
<td>$8,168</td>
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</tr>
</tbody>
</table>

**Routine Maintenance Activity**

| Lane Miles | $0.00 | $0.00 | $941,400 |

**Maintenance Life-Cycle Cost**

$2,760,532

**Maintenance Annual Cost per Mile**

$30,429
EXISTING / PROPOSED TYPICAL SECTION

STA 20+43 to STA 84+40

EXISTING AGGREGATE WEDGE
1. EXISTING STABILIZED SHOULDER, 8"
2. EXISTING HMA SURFACE SHOULDER, 3/4"
3. STABILIZED SUB-BASE, 4"
4. EXISTING HMA SURFACE, 3/4"
5. EXISTING HMA PAVEMENT, 9"

NORTH BOUND

STA 199+50 TO STA 296+40

MEDIAN SYMMETRICAL

EXISTING / PROPOSED SUPERELEVATION TYPICAL SECTION

STA 20+75.38 TO STA 51+68.43

EXISTING
1. EXISTING AGGREGATE WEDGE
2. EXISTING STABILIZED SHOULDER, 8"
3. EXISTING HMA SURFACE SHOULDER, 3/4"
4. STABILIZED SUB-BASE, 4"
5. EXISTING HMA SURFACE, 3/4"
6. EXISTING HMA PAVEMENT, 9"

EXISTING / PROPOSED TYPICAL SECTION

STA 152+465 TO STA 181+428.15

PROPOSED

7. RUBBLIZED CRC PAVEMENT (METHOD I RECOMMENDED)
8. HOT-MIX ASPHALT BINDER COURSE, N90, IL-19, 1"
   (4" BOTTOM LIFT, 3" TOP LIFT)
9. POLYMERIZED HOT-MIX ASPHALT BINDER COURSE, N90, IL-19, 2/4"
10. POLYMERIZED HOT-MIX ASPHALT SURFACE COURSE, N80 SMA SURFACE, 2"
11. PIPE UNDERDRAINS SPECIAL, 4" (TYP)
12. HOT-MIX ASPHALT BINDER COURSE, 100, IL-10, 3/4"
   (4" BOTTOM LIFT, 1/2" TOP LIFT)
13. HOT MIX ASPHALT SURFACE MIX C, N50 1/4"
14. SHOULDER RUMBLE STRIP
15. AGGREGATE SHOULDER (GRADING AND SHAPING SHOULders)

~ MEDIAN SYMMETRICAL~

EXISTING / PROPOSED SUPER ELEVATION TYPICAL SECTION

7. RUBBLIZED CRC PAVEMENT (METHOD I RECOMMENDED)
8. HOT-MIX ASPHALT BINDER COURSE, N90, IL-19, 1"
   (4" BOTTOM LIFT, 3" TOP LIFT)
9. POLYMERIZED HOT-MIX ASPHALT BINDER COURSE, N90, IL-19, 2/4"
10. POLYMERIZED HOT-MIX ASPHALT SURFACE COURSE, N80 SMA SURFACE, 2"
11. PIPE UNDERDRAINS SPECIAL, 4" (TYP)
12. HOT-MIX ASPHALT BINDER COURSE, N50, IL-19, 3/4"
   (4" BOTTOM LIFT, 1/2" TOP LIFT)
13. HOT MIX ASPHALT SURFACE MIX C, N50 1/4"
14. SHOULDER RUMBLE STRIP
15. AGGREGATE SHOULDER (GRADING AND SHAPING SHOULders)
EXISTING

1. **EXISTING AGGREGATE WEDGE**
2. **EXISTING STABILIZED SHOULDER, 8"**
3. **EXISTING HMA SURFACE SHOULDER, 3/4"**
4. **STABILIZED SUB-BASE, 4"**
5. **EXISTING HMA SURFACE, 3/4"**
6. **EXISTING CWC PAVEMENT, 9"**

PROPOSED

- **1.5% PAVEMENT CROSS SLOPE**
- **4.0% SHOULDER CROSS SLOPE**
- **GRADING TO MATCH EXISTING FORESLOPE (1% AND Varies)**

EXISTING / PROPOSED TYPICAL SECTION

STA 84400 TO STA 152465
STA 181+28.15 TO STA 199+00
STA 396+50 TO STA 348+00

SOUTH BOUND

NORTH BOUND