Performance Measures for Making Pavement Preservation Decisions

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Performance Measures as Tools

- Project Decision Support
  - Where, When, and How for pavement decisions
- Accountability & Communication
  - achieving standards, reports to legislature & public
  - stewardship, protecting infrastructure investment
- Forecasting Needs & Risks
  - funding needs, evaluation of risk
- Learning
  - continual improvement of methods & procedures

Performance Measures within what Context?

- Historical?
- Future Projection?

- Project Level?
- Network Level?

- Agency Perspective?
- User Perspective?

Pavement Performance Measures

What is current physical condition of pavement?

- Distress (cracking, rutting, raveling, faulting, etc.)
- Profile - Roughness (IRI)
- Friction (Skid Number, macrotexture)
- Structure (deflection, seismic response)

Pavement Performance Measures

How is road performing for users?

- Roughness (IRI)
- User cost (user delay, user operating cost)
- Freight damage
- Safety (pavement related)

Performance Management in MAP-21

Title 23, U.S.C.

§150. National goals and performance management measures

(a) DECLARATION OF POLICY.—Performance management will transform the Federal-aid highway program and provide a means to the most efficient investment of Federal transportation funds by refocusing on national transportation goals, increasing the accountability and transparency of the Federal-aid highway program, and improving project decisionmaking through performance-based planning and programming.

Cost-Effectiveness

- Evaluates the cost of acceptable pavement performance ($/lane-mile/year)

- Simpler than Benefit/Cost analysis, since difficult to express benefit of pavement performance in terms of dollars

Cost-Effectiveness

"…the most efficient investment…"

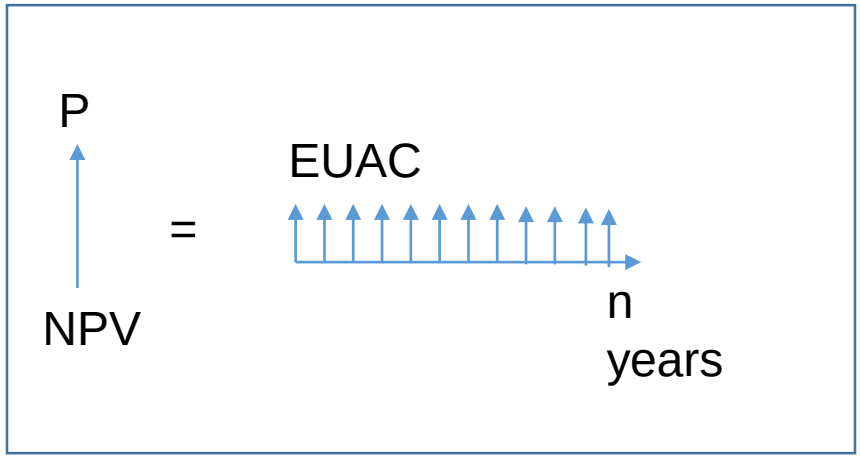
- Annual Cost ($ / lane-mile / year of life)

- Historical Cost of Acceptable Pavement Performance
  - Actual historical cost ($/LMY)

- Expected Cost of Future Pavement Rehab
  - Projected LCCA ($ /LMY)

Equivalent Uniform Annual Cost (EUAC)

$$EUAC = P \frac{i(1+i)^n}{(1+i)^n - 1}$$



where

P = Present Value of all costs
i = Discount Rate
n = number of years

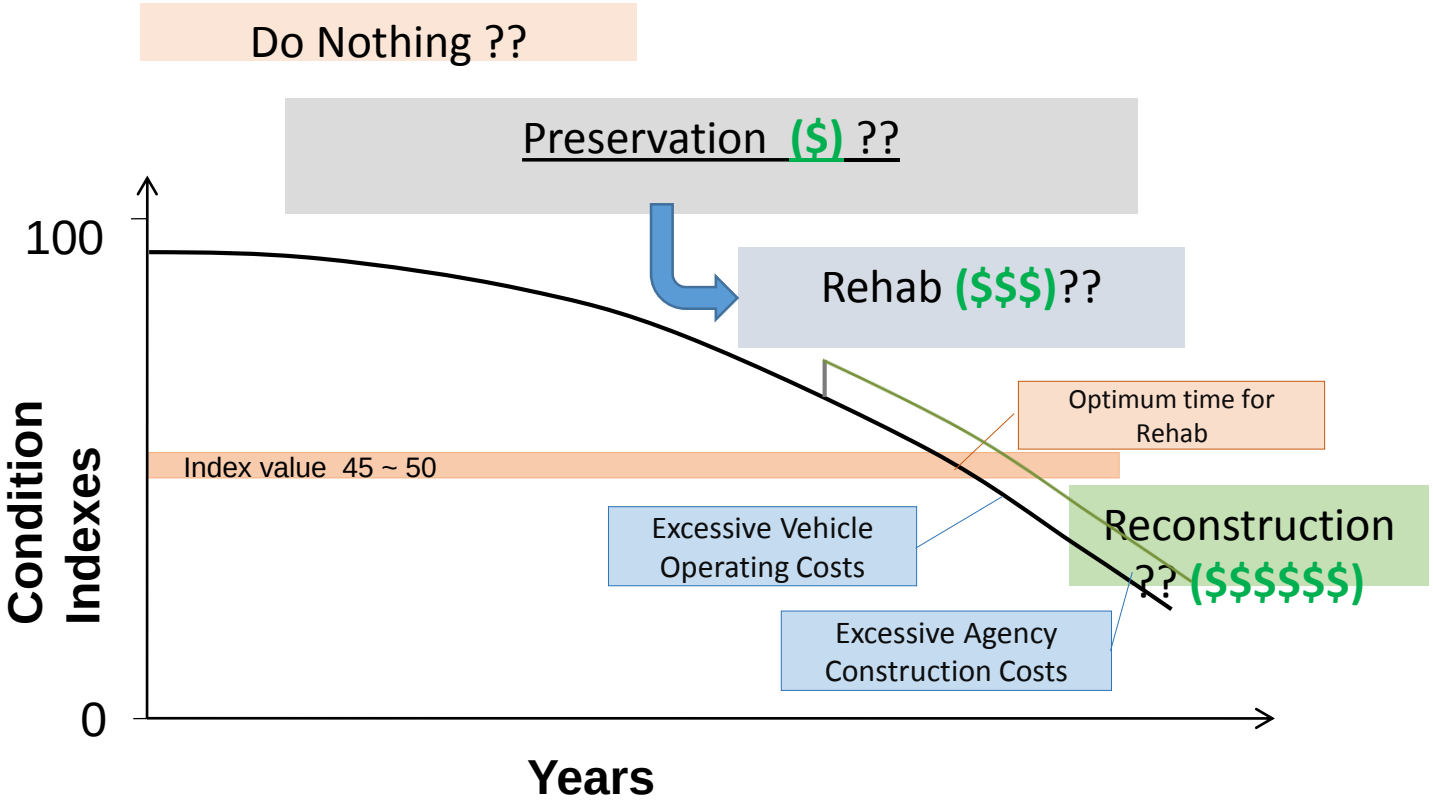
Advantages of EUAC

1) A simple measure that can be directly compared with a different project, or statewide average
2) Easier to calculate (no need to add multiple performance periods)
3) Salvage Value does not need to be considered

Typical Cost-Effectiveness Comparison

Pavement Type	Treatment Category	Treatments	Agency Cost ($/LM)	Life Extension (years)	$EUAC_{0\%}$ ($/LMY)	$EUAC_{4\%}$ ($/LMY)
Chip Seal	Maint.	Crack sealing, patching	$2,500	2	$1,250	$1,325
	Rehab	Resurfacing	$45,000	9	$5,000	$6,052
	Reconst.	Rebuild	$200,000	14	$14,286	$18,934
Asphalt	Maint.	Crack sealing, patching	$5,000	3	$1,667	$1,802
	Rehab	Resurfacing	$225,000	15	$15,000	$20,237
	Reconst.	Remove & Replace	$1,000,000	20	$50,000	$73,582
Concrete	Rehab	Grinding, slab replacement	$400,000	15	$26,667	$35,976
	Reconst.	Remove & Replace	$2,500,000	50	$50,000	$116,376

LCCA: Asphalt and Chip Seal

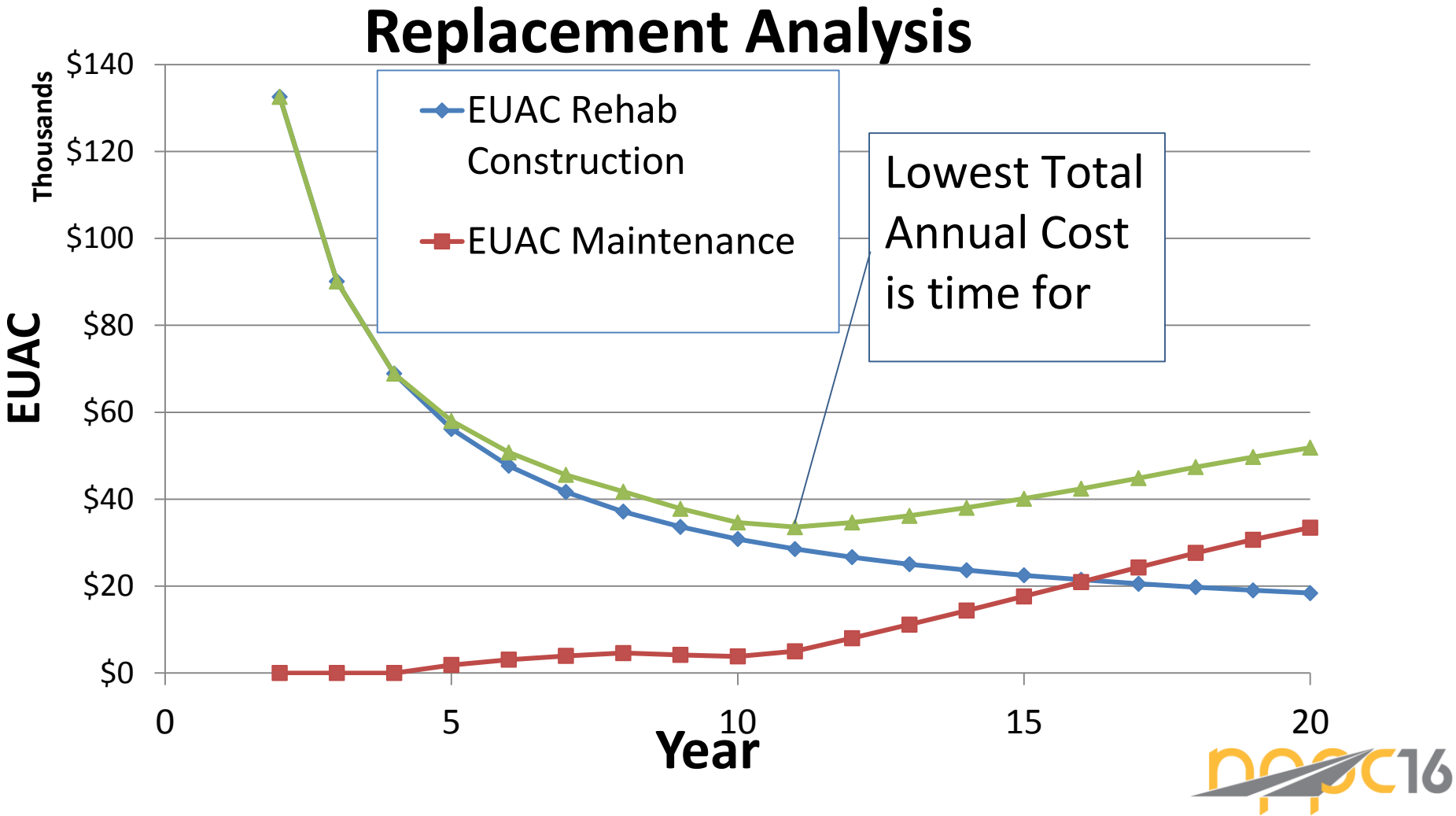


Replacement Analysis

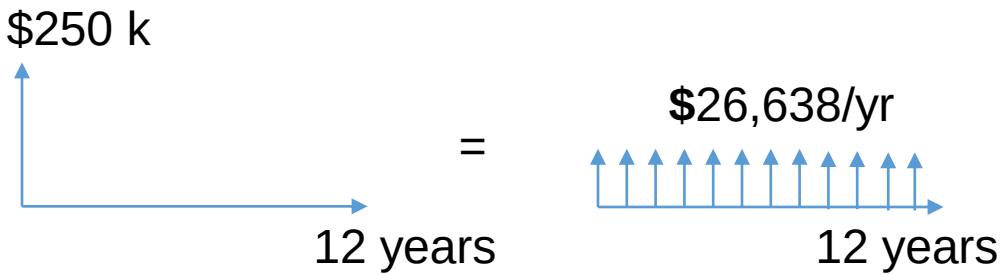
Decision Analysis to consider:

- Do Nothing (no replacement)
- Maintenance
- Rehabilitation
- Reconstruction

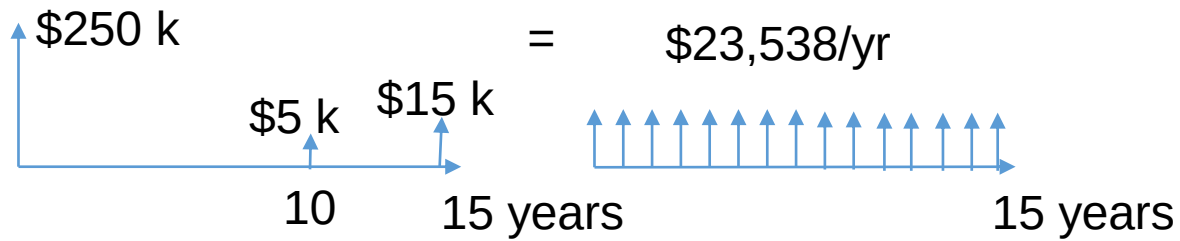
If proposed alternative results in lower annual cost, then make decision for replacement


Replacement Analysis
EUAC
Thousands
$140
$120
$100
$80
$60
$40
$20
$0
0
5
10
15
20
Year
EUAC Rehab Construction
EUAC Maintenance
Lowest Total Annual Cost is time for

Analysis of Alternatives

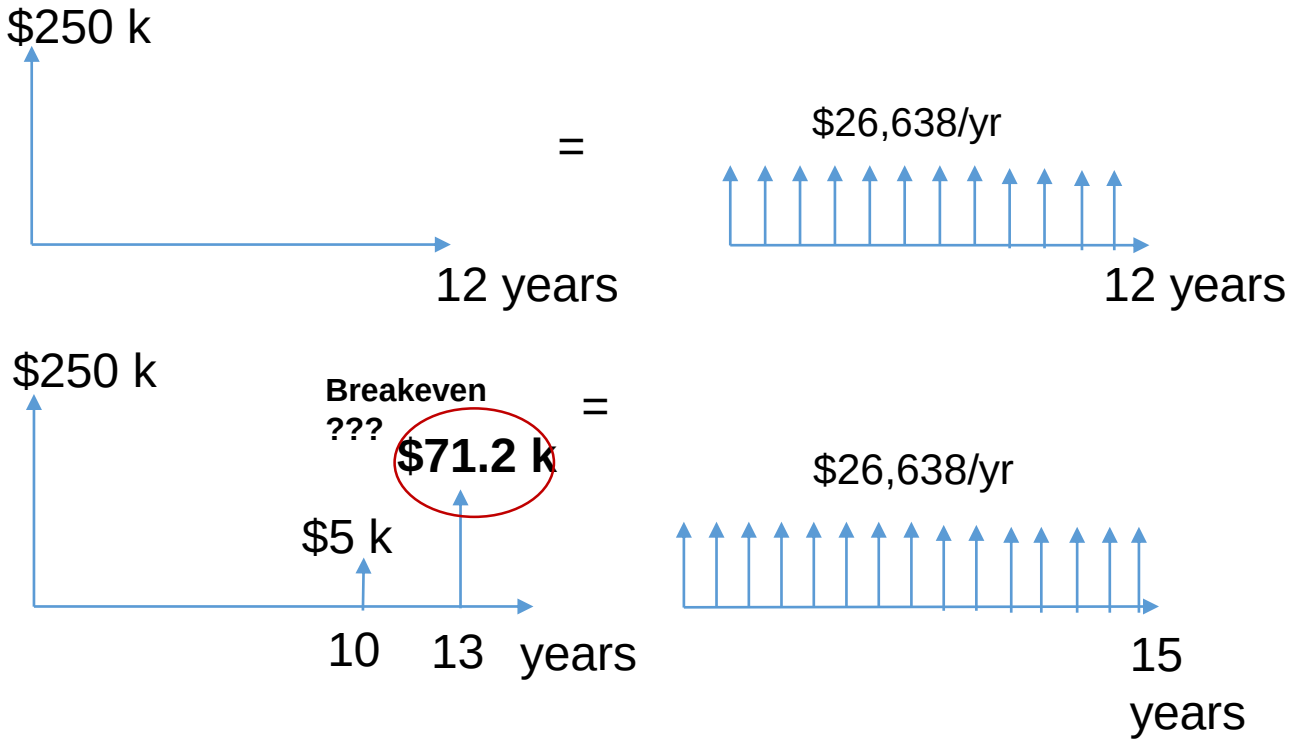


Calculation of EUAC for an asphalt pavement resurfacing ($250k for 12 year period).



Spending additional $5k on maintenance in year 10 and $15k in year 15 results in EUAC that is $3.1k less (12% reduction in annual cost).
(Assumed Discount Rate 4%)

Breakeven Analysis



Spending $5k on maintenance in year 10 and $71.2k in year 13 to achieve a 15 year life is equivalent to EUAC of $26,638/yr. (Assumed Discount Rate 4%)

Performance Measures as tools in Pavement Management

- Decision Support
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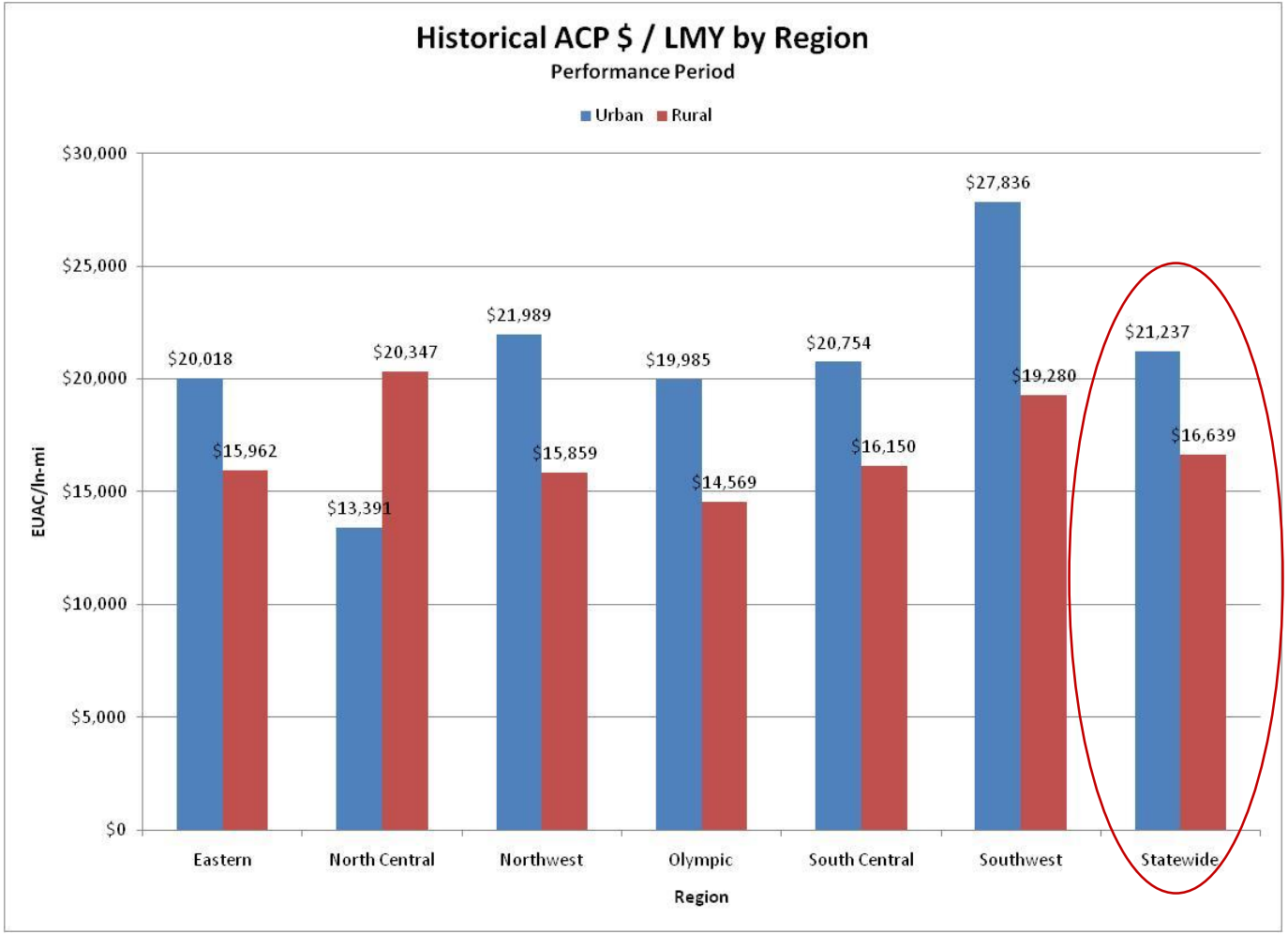
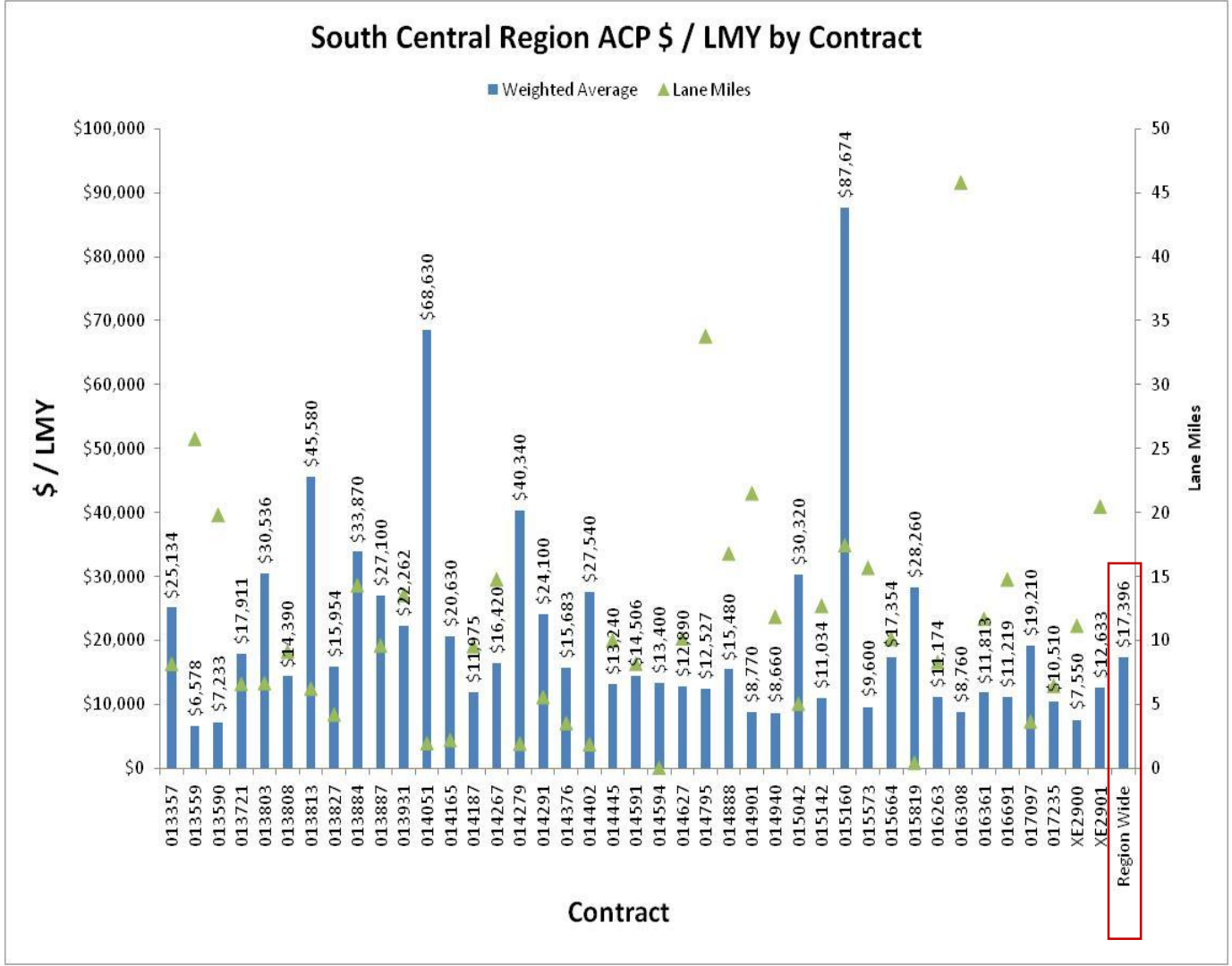

Historical ACP $ / LMY by Region
Performance Period
Urban
Rural
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
EUAC/ln-mi
$20,018
$15,962
$13,391
$20,347
$21,989
$15,859
$19,985
$14,569
$20,754
$16,150
$27,836
$19,280
$21,237
$16,639
Eastern
North Central
Northwest
Olympic
South Central
Southwest
Statewide
Region


South Central Region ACP $ / LMY by Contract
Weighted Average
Lane Miles
$ / LMY
Lane Miles
Contract
$100,000
$90,000
$80,000
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
50
45
40
35
30
25
20
15
10
5
0
$25,134
$6,578
$7,233
$17,911
$30,536
$14,390
$45,580
$15,954
$33,870
$27,100
$22,262
$68,630
$20,630
$11,975
$16,420
$40,340
$24,100
$15,683
$27,540
$13,240
$14,506
$13,400
$12,890
$12,527
$15,480
$8,770
$8,660
$30,320
$11,034
$87,674
$9,600
$17,354
$28,260
$11,174
$8,760
$11,813
$11,219
$19,210
$10,510
$7,550
$12,633
$17,396
013357
013559
013590
013721
013803
013808
013813
013827
013884
013887
013931
014051
014165
014187
014267
014279
014291
014376
014402
014445
014591
014594
014627
014795
014888
014901
014940
015042
015142
015160
015573
015664
015819
016263
016308
016361
016691
017097
017235
XE2900
XE2901
Region Wide

Search | Route: 002 | Direction: I D B | SRMPs: 24.00 - 29.00 | ARMs: 24.08 - 29.08 | Length: 5

Select Location | Manage Data Components | Hide Slider

24.00 24.50 25.00 25.50 26.00 26.50 27.00 27.50 28.00 28.50 29.00

24.08 24.58 25.08 25.58 26.08 26.58 27.08 27.58 28.08 28.58 29.08

1 mi | Auto Refresh | SRMP: 24.00 - 29.00 | ARM: 24.08 - 29.08 | Go

Search Data Dictionary:

Economic Performance

Hide | Close

Visual | Hide Visual

Fit/Fixed

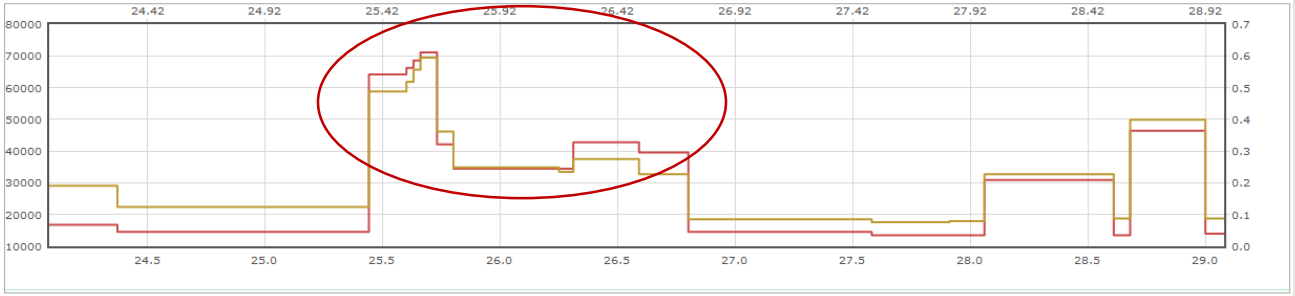
Left Y Axis

Lane Mile Costs | Left Y Axis Fields

Right Y Axis

Right Y Axis Fields | Dollars Per Mile Per ESAL

EUAC Per Lane Mile | Dollars Per Mile Per ESAL

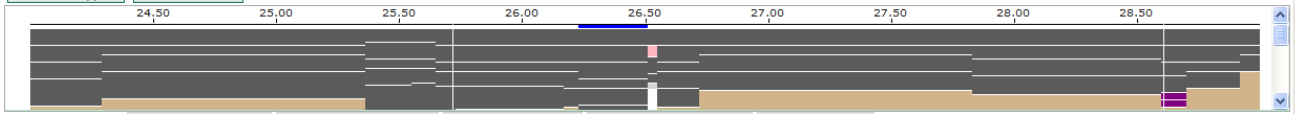


Cross Section

Hide | Export to Excel | Close

Visual | Hide Visual

Axis Type | Fit/Fixed



Contract Detail | Hide Contract Detail | Previous Contract Area | Next Contract Area | Show All Contract Info | Scroll Into View

SRMP: 26.23 - 26.51

ARM: 26.31 - 26.59

Construction End Date	Contract	Thickness	Surface	Exception
6/21/2002	016187	0.15	ACP CLASS B PG58-22	
8/29/2000	015668	0.15	ACP CLASS B PG58-22	
12/10/1996	014847	0.15	ACP CLASS B AR4000W	
9/30/1988	013313	0.08	ACP CLASS B AR4000W	

Done | Local intranet | 100%

Pavement Performance Measures - Network Level

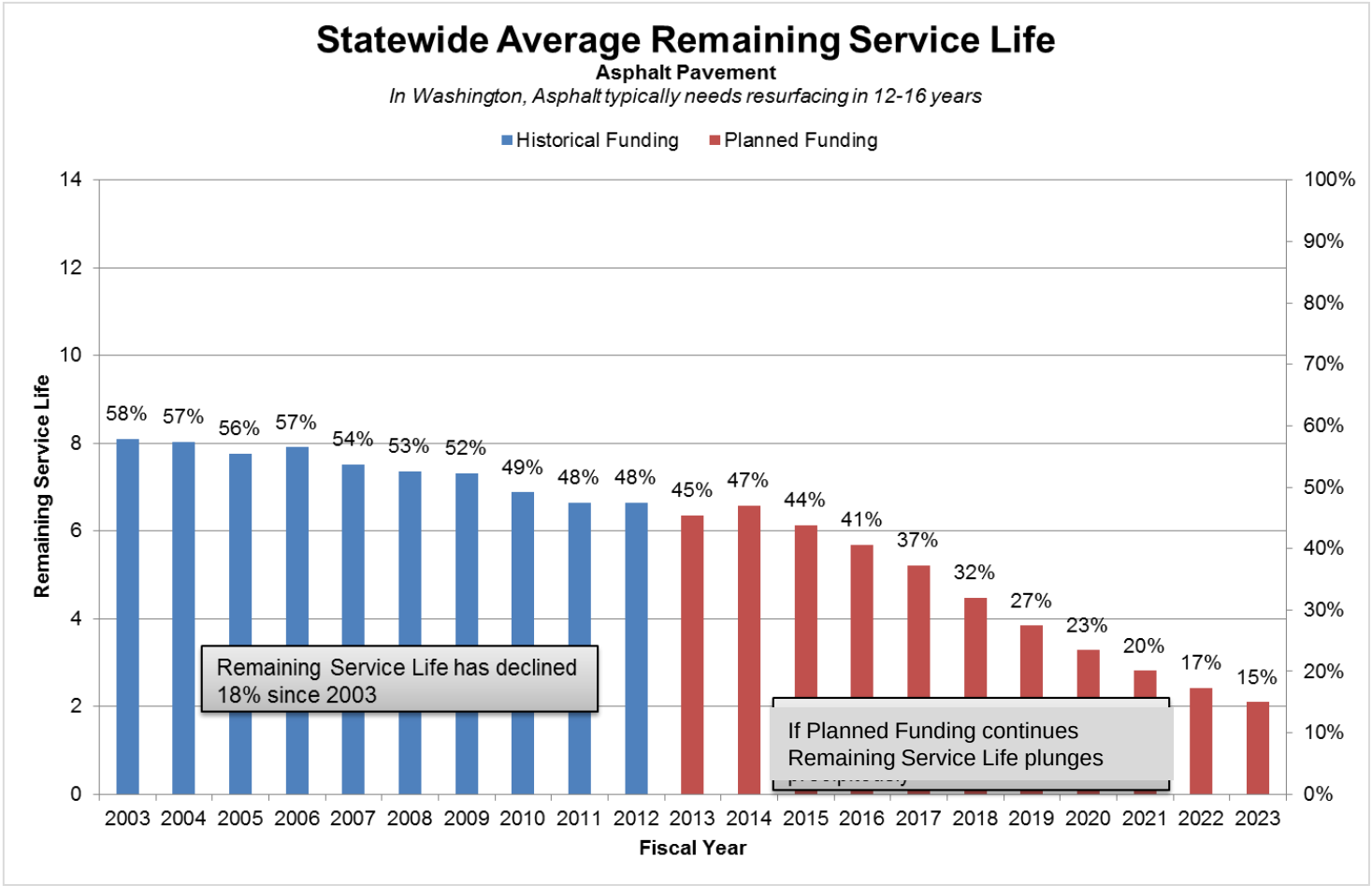
How well is infrastructure being managed (past and future)?

- Remaining Service Life (RSL)
- Asset Sustainability Ratio
- Accrued cost of deferred maintenance/rehabilitation (Deferred Preservation Liability)

Remaining Service Life (RSL)

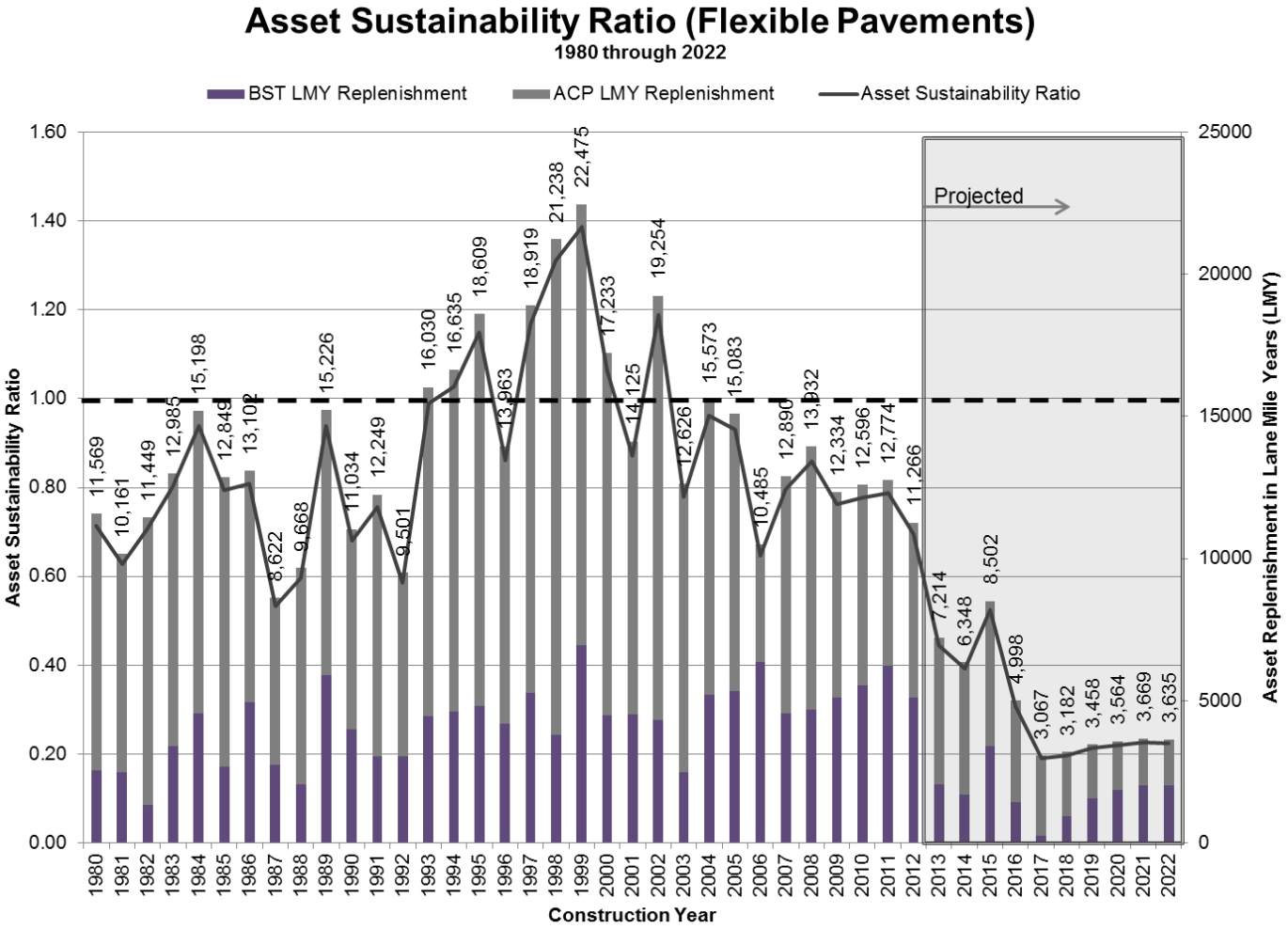
- Measures the pavement life (years until due for rehabilitation) of each section over the entire network (expressed as % of typical pavement life)

- Healthy system has remaining service life of 40 – 60 percent
  - In an ideal system, the entire system would have an average remaining service life equal to 50% of the total average pavement life


Statewide Average Remaining Service Life
Asphalt Pavement
In Washington, Asphalt typically needs resurfacing in 12-16 years
Historical Funding
Planned Funding
Remaining Service Life
Fiscal Year
58% 57% 56% 57% 54% 53% 52% 49% 48% 48% 45% 47% 44% 41% 37% 32% 27% 23% 20% 17% 15%
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023
Remaining Service Life has declined 18% since 2003
If Planned Funding continues Remaining Service Life plunges

Asset Sustainability Ratio

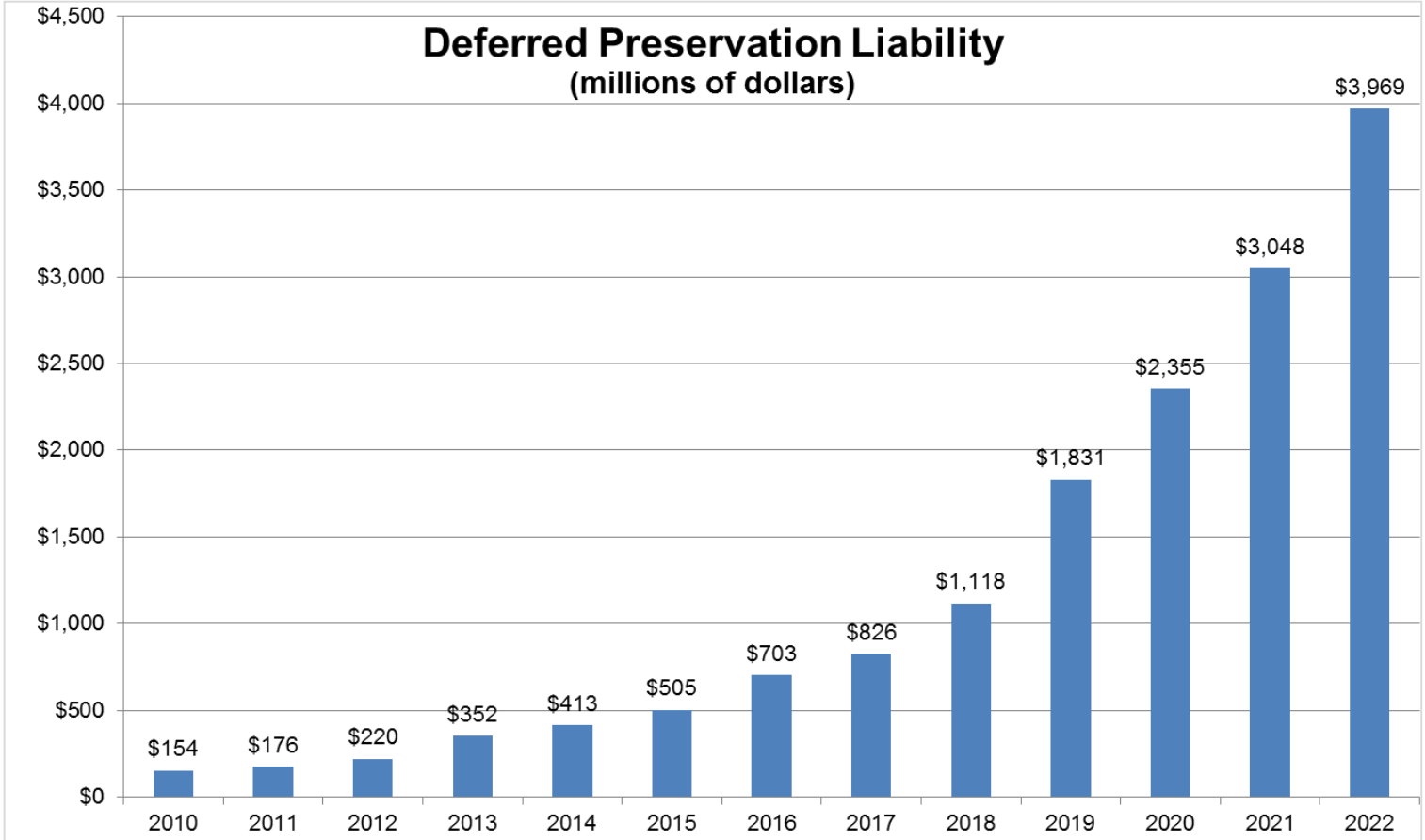
- Measures how well WSDOT's pavement replenishment is keeping up with pavement wear.
- Illustrates how much life was put back into the pavement system verses how much was consumed in a given year (units of lane-mile years).
- Consumption (for WSDOT flexible pavements) is 16,000 lane-mile years (per year)
- Target is Ratio of 1.0


Asset Sustainability Ratio (Flexible Pavements)
1980 through 2022
BST LMY Replenishment
ACP LMY Replenishment
Asset Sustainability Ratio
Projected
Asset Sustainability Ratio
Asset Replenishment in Lane Mile Years (LMY)
Construction Year
11,569
10,161
11,449
12,985
15,198
12,849
13,108
8,622
9,668
15,226
11,034
12,249
9,501
16,030
16,635
18,609
13,963
18,919
21,238
22,475
17,233
14,125
19,254
12,626
15,573
15,083
10,485
12,890
13,332
12,334
12,596
12,774
11,266
7,214
6,348
8,502
4,998
3,067
3,182
3,458
3,564
3,669
3,635

Deferred Preservation Liability

- Is an estimate of the funding necessary to address the backlog of deferred pavement rehabilitation

- Takes into consideration higher costs as pavement condition gets worse (and needs more extensive repair)


Deferred Preservation Liability
(millions of dollars)
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
$154
$176
$220
$352
$413
$505
$703
$826
$1,118
$1,831
$2,355
$3,048
$3,969
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

Decision Support
- Pavement Condition
- Cost-Effectiveness
- Remaining Service Life

Forecast Needs & Risks
- Pavement Condition
- Remaining Service Life
- Deferred Preservation Liability

Accountability & Communication
- Pavement Condition
- Asset Sustainability Ratio
- Cost-Effectiveness

Learning
- Cost-Effectiveness
- Remaining Service Life
- Pavement Condition

Future	Historic	Project Level	Network Level
✓		✓	
✓			✓
	✓	✓	✓
	✓	✓	✓

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