Economic Evaluation of Pavement Management Decisions

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Outline

- Long Term and Operational LCCA
- Cost Effectiveness
- Comparing Alternatives: Replacement Analysis and Breakeven Analysis
- Performance Measures and Their Application
- Conclusions

MAP-21 Policy

Established in Title 23, U.S.C.

Sec. 150. National goals and performance measures

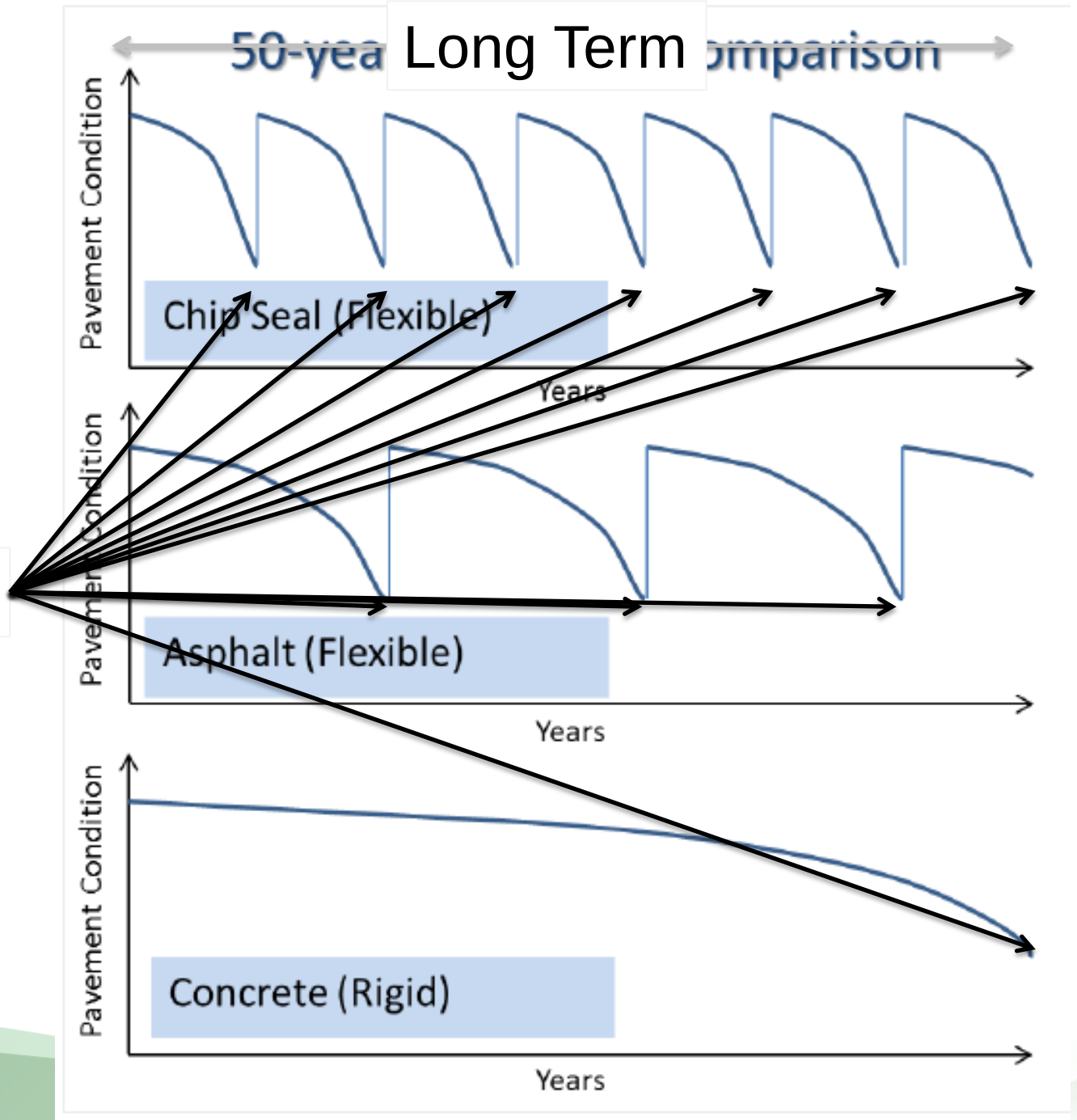
(a) Declaration of Policy – *Performance management* will transform the Federal-aid highway and provide a means to the *most efficient investment* of Federal transportation funds by refocusing on national transportation goals, increasing the accountability and transparency of the Federal-aid highway program, and improving project decision making through performance-based planning and programming.

Comparing LCCA

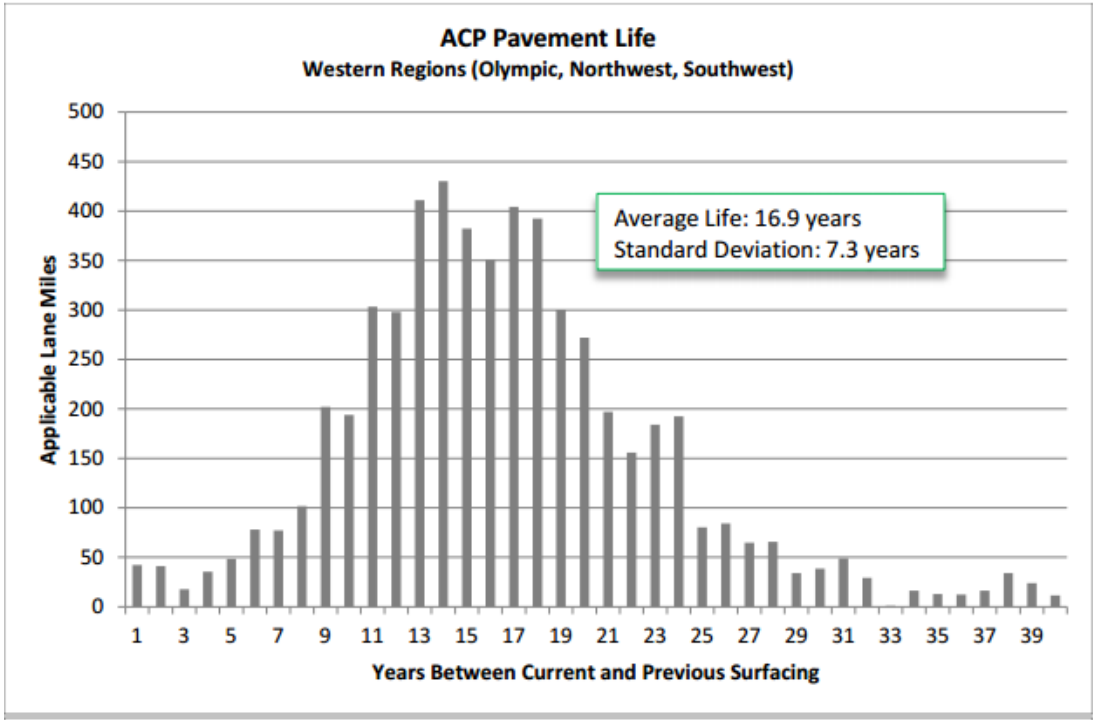
- Long Term
  - Evaluating Pavement Design Strategies over many performance periods
  - Assumed performance
  - FHWA RealCost
- Operational (Year-to-Year)
  - Historical performance is known
  - Evaluation of single performance period
  - Decisions involve maintenance/preservation and rehabilitation/reconstruction

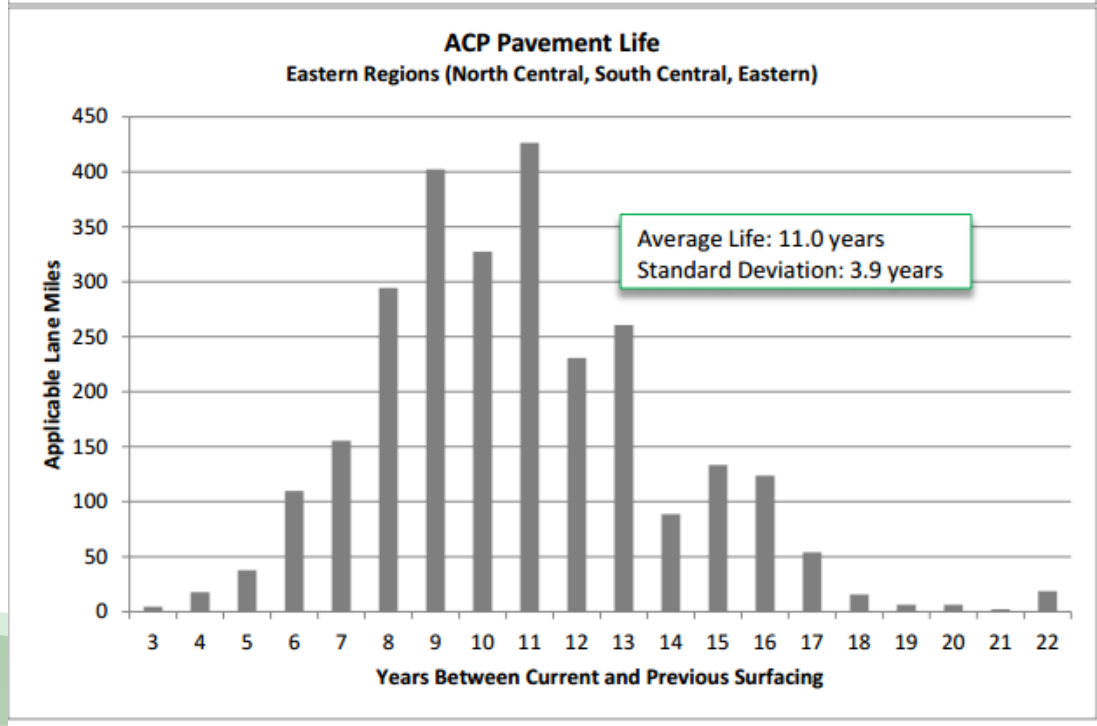
Example Performance Periods for LCCA

Operational



Pavement Performance Variability





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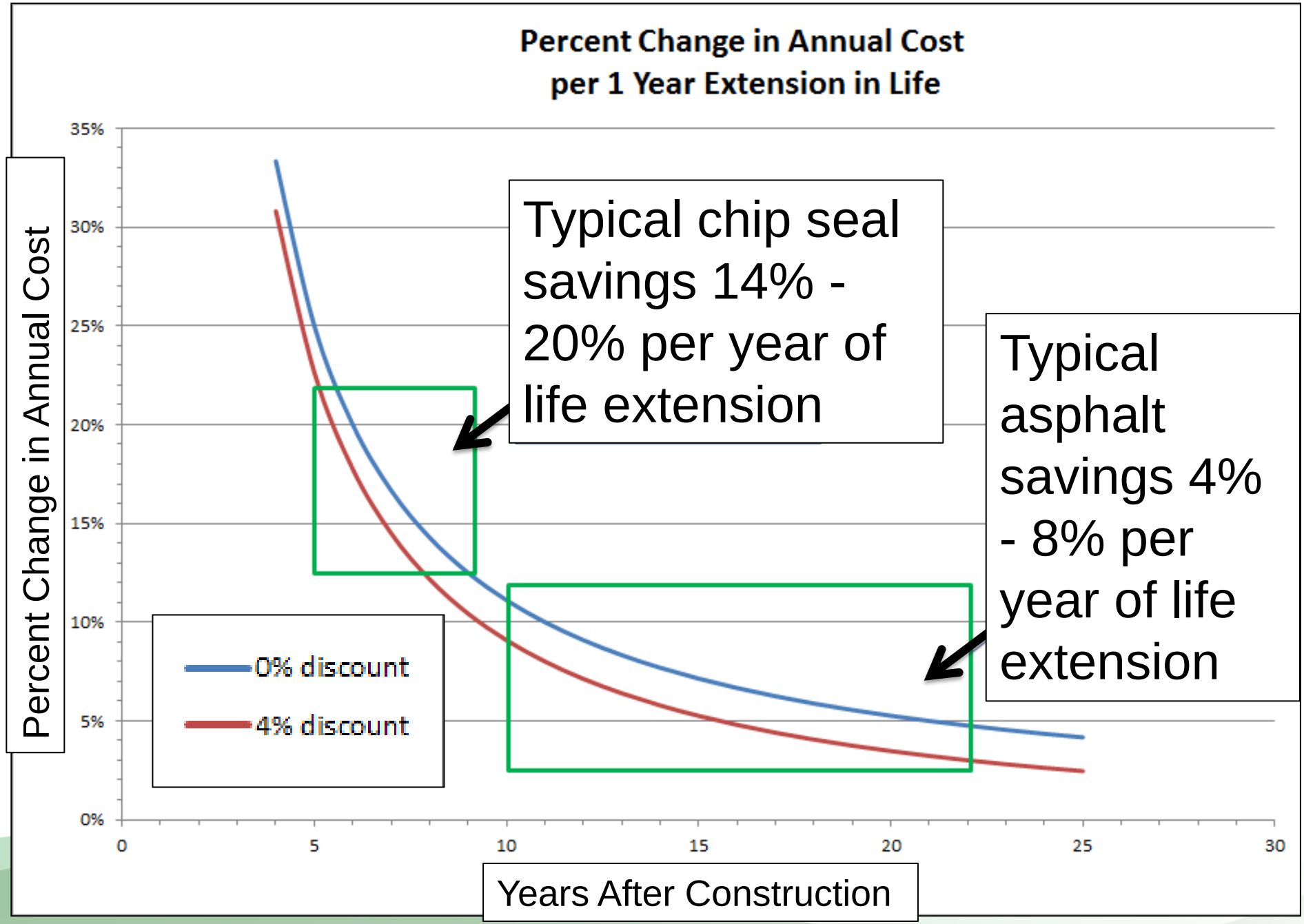

Percent Change in Annual Cost
per 1 Year Extension in Life
Percent Change in Annual Cost
35%
30%
25%
20%
15%
10%
5%
0%
0
5
10
15
20
25
30
Years After Construction
0% discount
4% discount
Typical chip seal savings 14% - 20% per year of life extension
Typical asphalt savings 4% - 8% per year of life extension

Operational LCCA is Critical

1) Numerous opportunities for application
2) Variability in pavement life
3) Substantial opportunity for cost savings

Cost-Effectiveness

- Evaluates the cost of managing pavement performance at or above a standard

- Simpler than Benefit/Cost analysis, since difficult to express benefit, in dollars, of pavement performance differences in fair or better conditions

Equivalent Uniform Annual Cost (EUAC)

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

where

P = Present Value of all costs

i = Discount Rate

n = number of years

Advantages of EUAC

1) A simple number 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 no need to be considered

Cost Effectiveness Examples

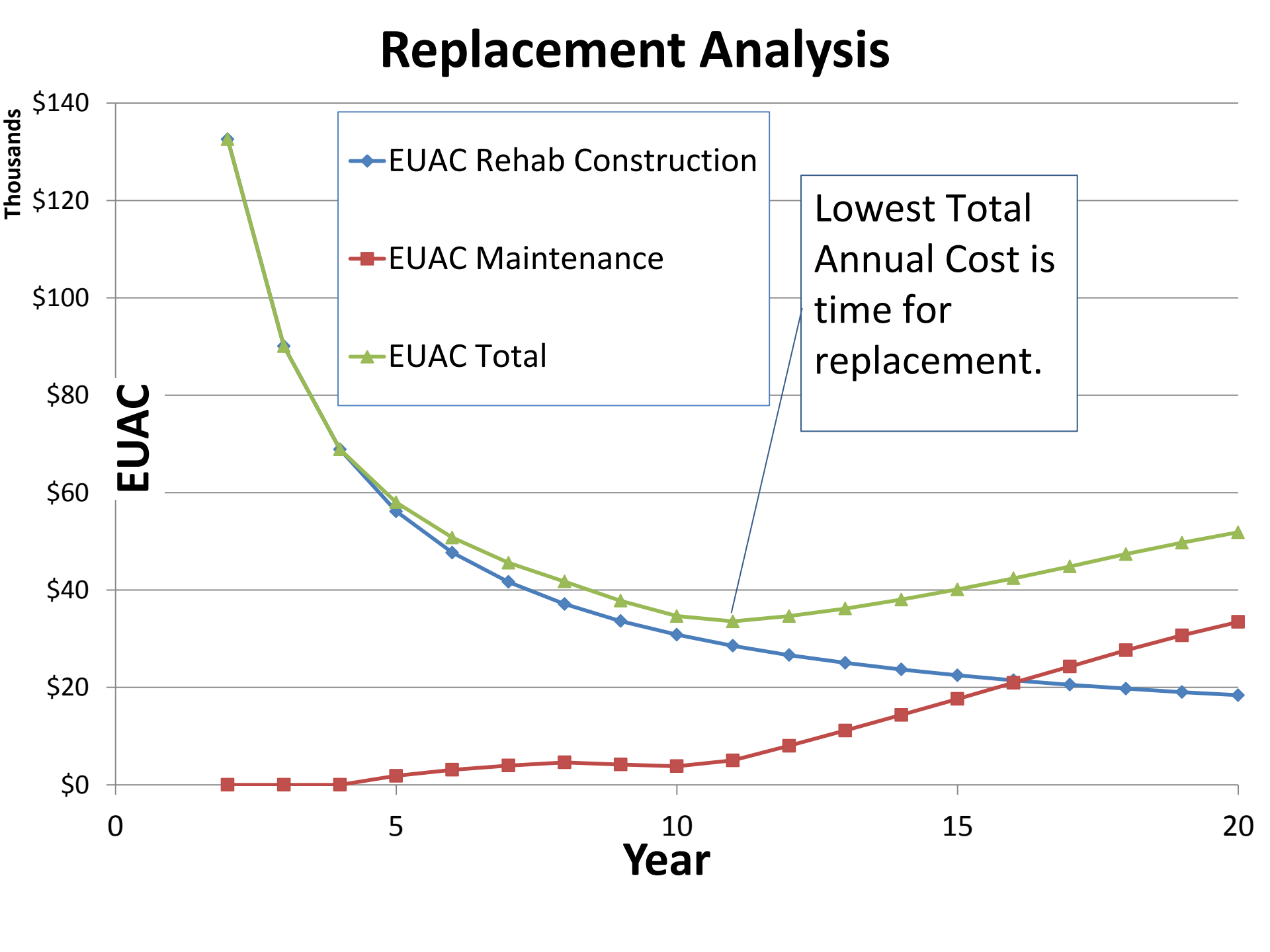
Project Type	Const. Cost($/LM)	LMY gained
Reconst (ACP)	$900,000	20
Rehab (ACP)	$250,000	14
Chip Seal	$45,000	7
Crack Seal	$5,000	3
Reconst (PCCP)	$2,500,000	50
Grinding (PCCP)	$150,000	15

* includes 4% Discount Rate

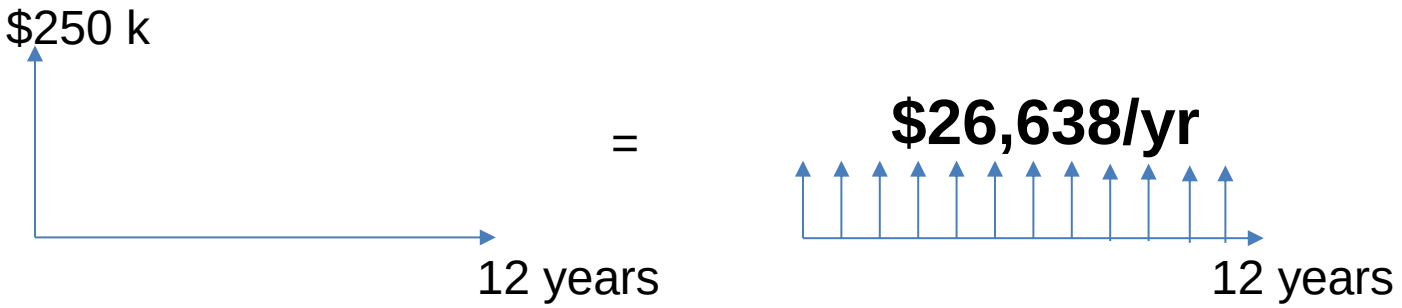
Replacement Analysis

- Decision Analysis to consider:
  - Do Nothing (no replacement)
  - Maintenance / Preservation
  - Rehabilitation / Reconstruction

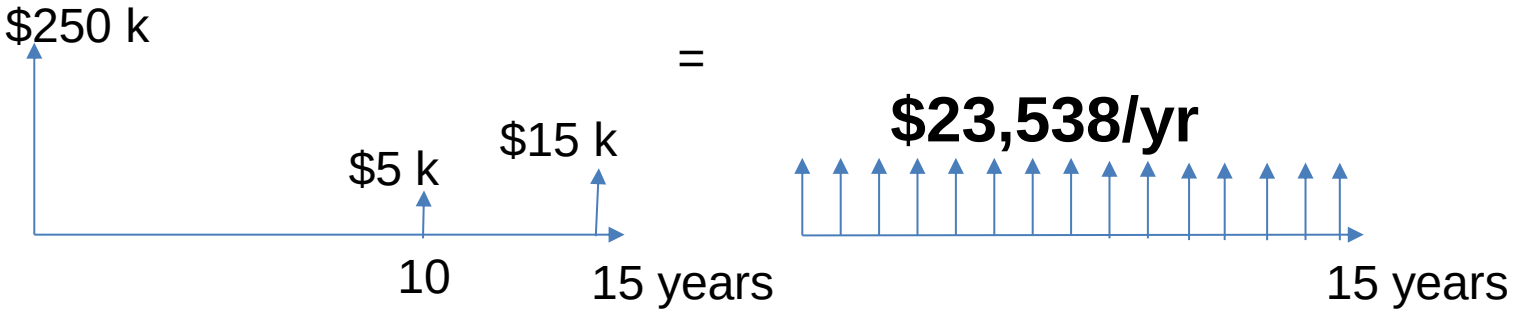
- If proposed alternative results in lower annual cost, then make decision for replacement


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

Analysis of Alternatives

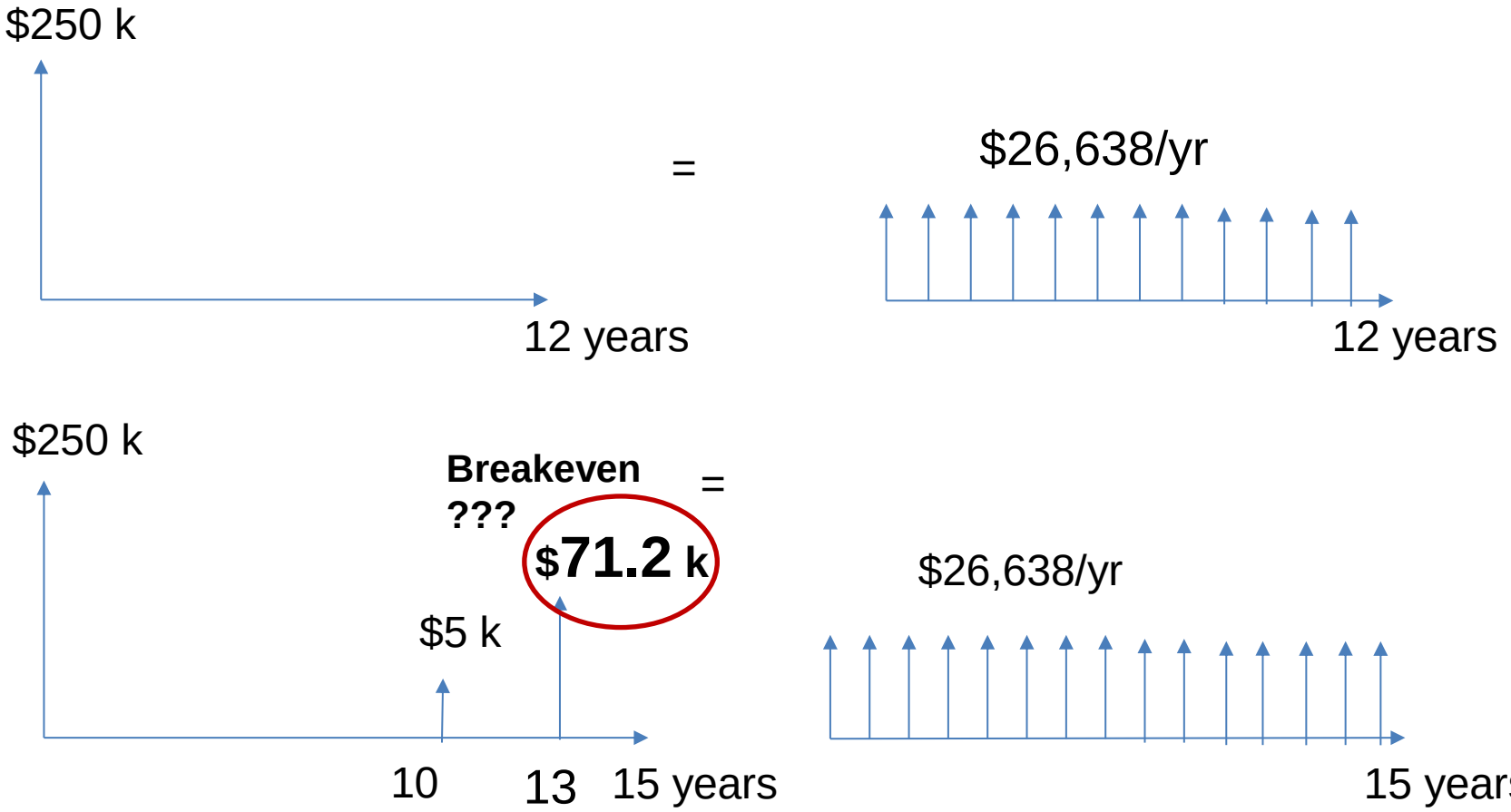


Calculation of EUAC for an asphalt pavement resurfacing ($250k for 12 year period).



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%)

Economic Performance Measures

- Asset Measurement
  - EUAC divided by lane-miles
  - Dollars per lane mile per year ($/LMY)
- ESAL (Service) Measurement
  - EUAC divided by ESALs divided by miles
  - Dollars per ESAL Mile Traveled ($/ESAL)
- Historical Perspective
  - Actual cost and actual life
- Future Cost Efficiency
  - Expected cost and expected life

Uses for Economic Performance Measures

- Evaluation of Pavement Management
  - How efficiently are pavements performing?
  - Are the most cost-effective decisions being implemented?
- Evaluation of Pavement Design
  - Is pavement structure over designed or under designed?
- Setting Targets for Managing Pavement Assets
  - Establish targets for cost-effectiveness

Search | Route: 002 | Direction: I ○ D ○ B ◉ | SRMPs: 198.08 - 238.06 | ARMs: 190 - 230 | Length: 40

Select Location | Manage Data Components | Hide Slider

198.08 202.08 206.08 210.05 214.05 218.05 222.06 226.06 230.06 234.06 238.06

190.00 194.00 198.00 202.00 206.00 210.00 214.00 218.00 222.00 226.00 230.00

1 mi | Auto Refresh

SRMP: 198.08 - 238.06 | ARM: 190.00 - 230.00 | Go

Search Data Dictionary:

Data | Show Data | Filter:

Lane Configuration

Hide | Export to Excel | Close

Visual | Hide Visual

Total Lane Miles: 80

Axis Type | Fit/Fixed | Show Extra Information?

202.08 206.08 210.05 214.05 218.05 222.06 226.06 230.06 234.06

Data | Show Data | Filter:

Economic Performance

Hide | Close

Visual | Hide Visual

Fit/Fixed

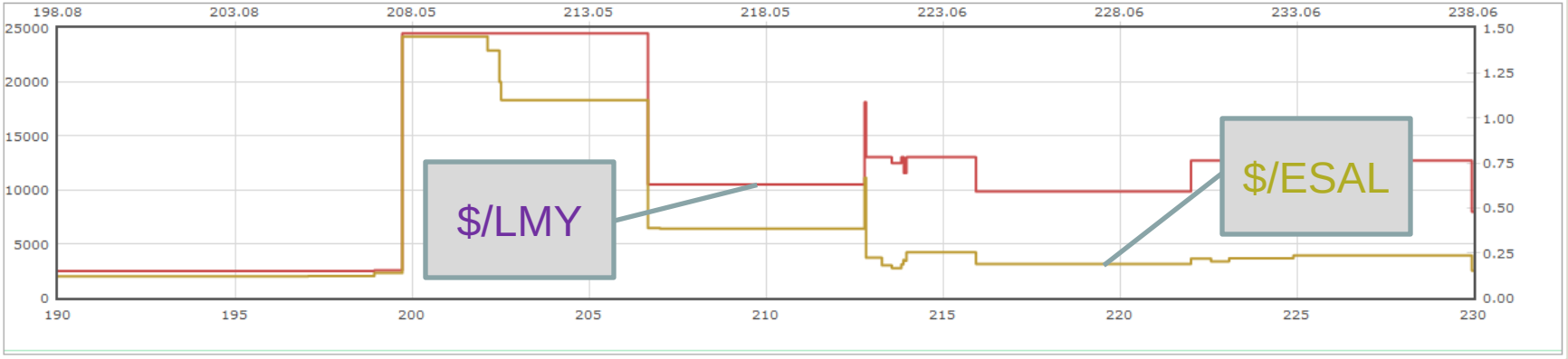
Left Y Axis

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



Economic Performance

Visual | Hide Visual

Fit/Fixed

Left Y Axis

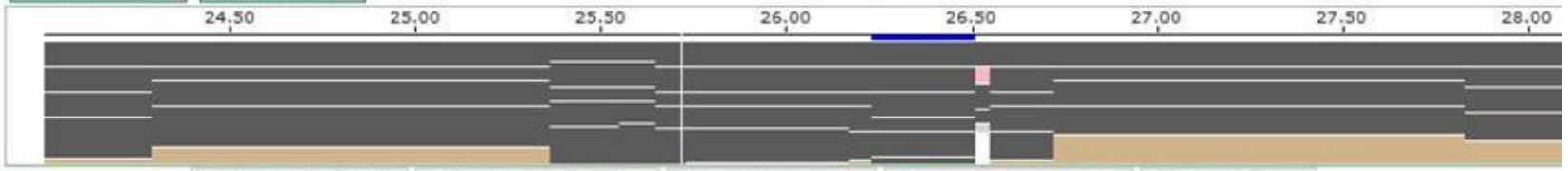
Lane Mile Costs | Left Y Axis Fields | Right Y Axis Fi

EUAC Per Lane Mile Dollars Per Mile Per ESAL

Cross Section

Visual | Hide Visual

Axis Type | Fit/Fixed



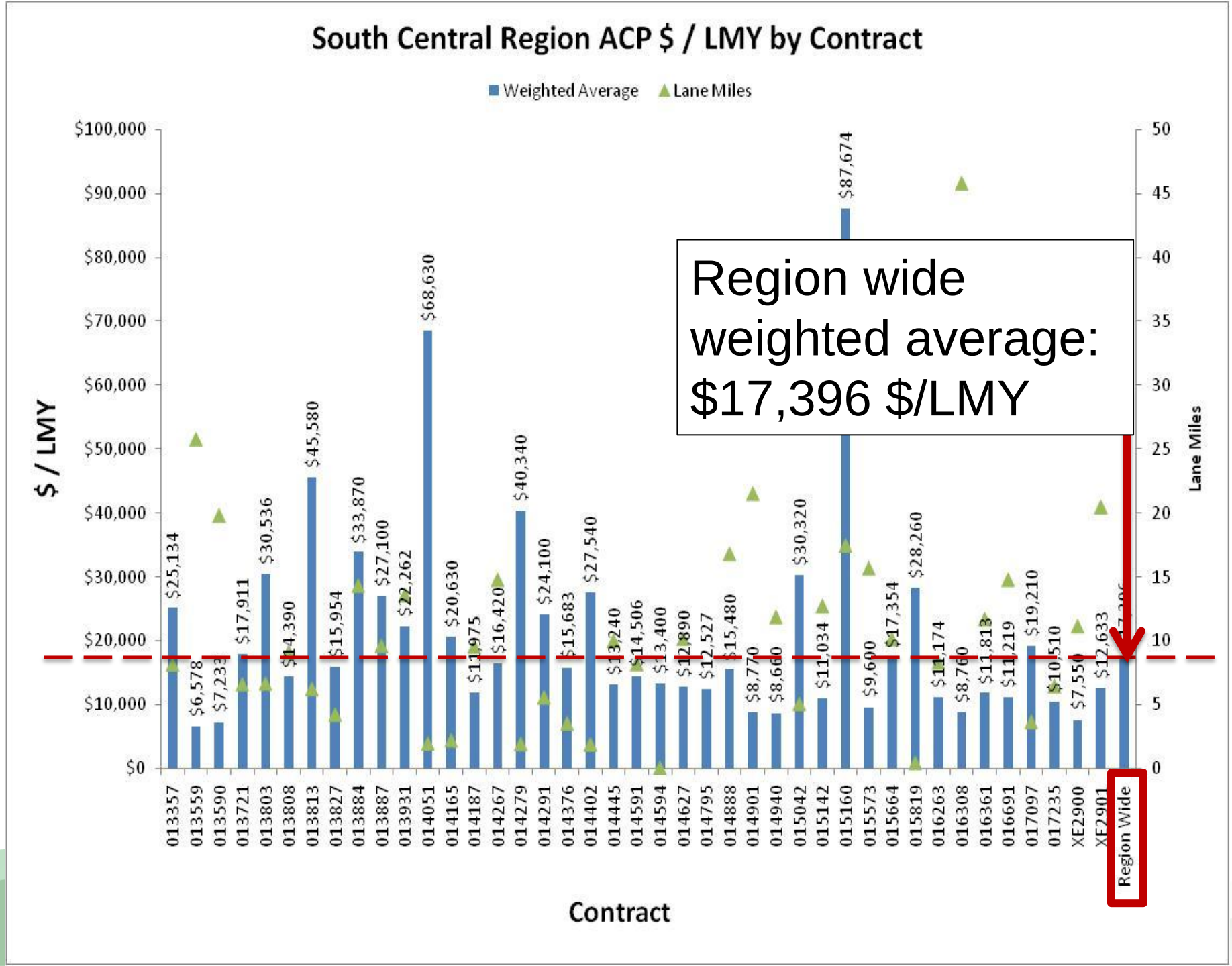
Contract Detail | Hide Contract Detail | Previous Contract Area | Next Contract Area | Show All Contract Info | Scroll Into View

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


South Central Region ACP $ / LMY by Contract
Weighted Average
Lane Miles
$ / LMY
Lane Miles
Contract
Region wide weighted average: $17,396 $/LMY
$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
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

Conclusions

- Potential for Substantial Savings by Leveraging Operational LCCA
- Judicious use of the EUAC is a key to operational LCCA allows for comparison across time frames, projects and region averages
- The EUAC can be normalized and leveraged for several decision analyses

Questions?