

# Issues with Pavement Type Selection



NEAUPG - October 2004

Carlos Rosenberger

**16 22 \$99 16,000 88**  
**333 66 \$12 56**

**You are going to see a lot of numbers, don't worry about specific numbers, it is the concept**

**27 2,500 \$3 500**

**2 300 105 \$1,000,000**

**18 \$23 500,000 1**

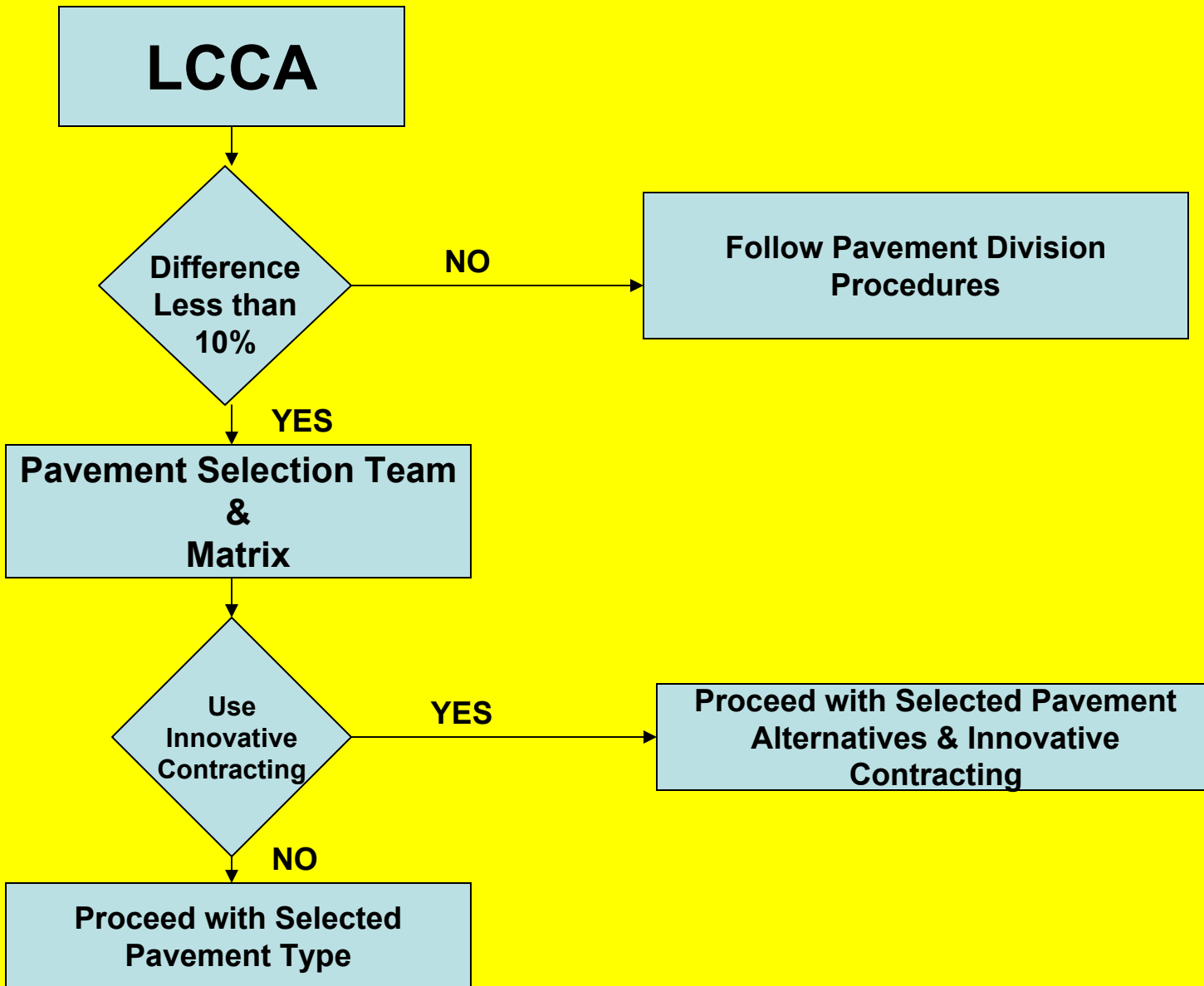
# Pavement Type Selection Team

## Final Report

### Maryland State Highway Administration



# Pavement Selection Flow Chart



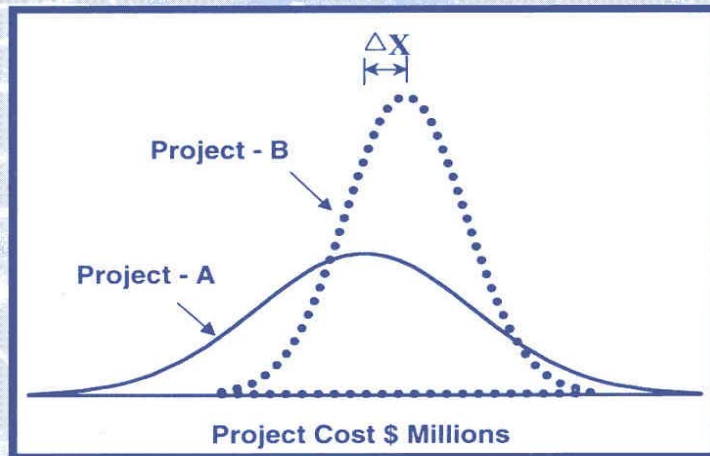


U.S. Department  
of Transportation  
**Federal Highway  
Administration**

# Publication No. FHWA -SA-98-079

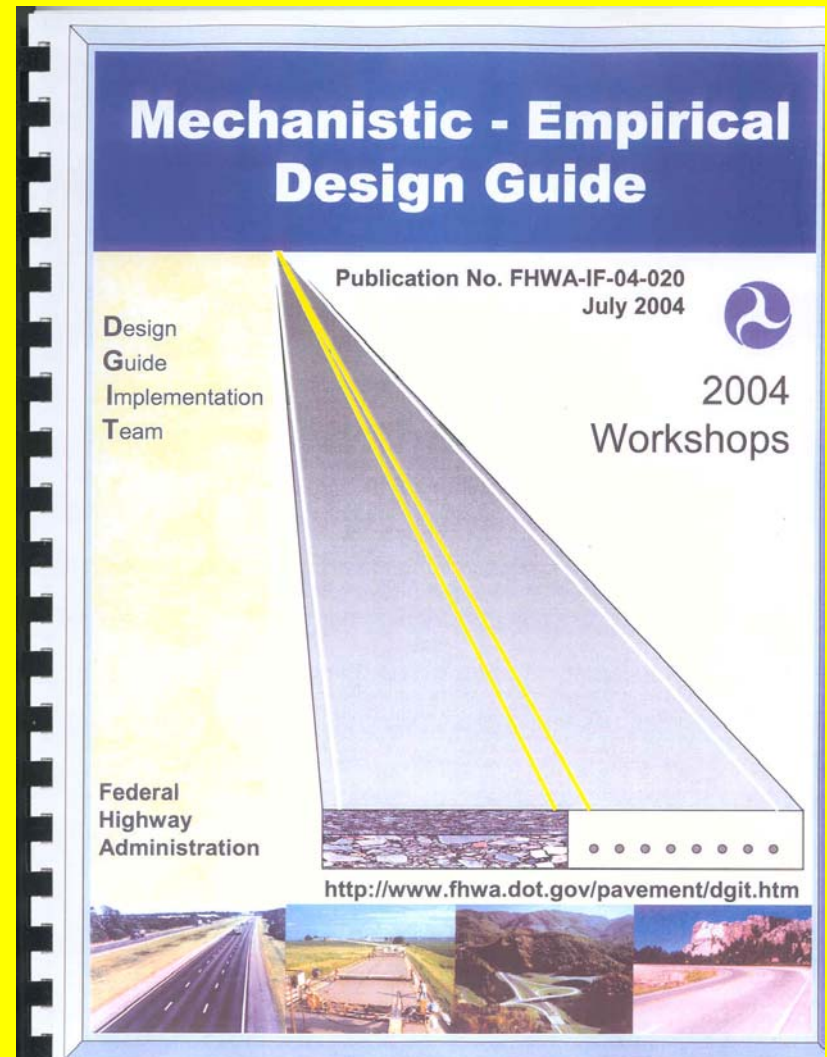
## Life-Cycle Cost Analysis in Pavement Design

- In Search of Better Investment Decisions -

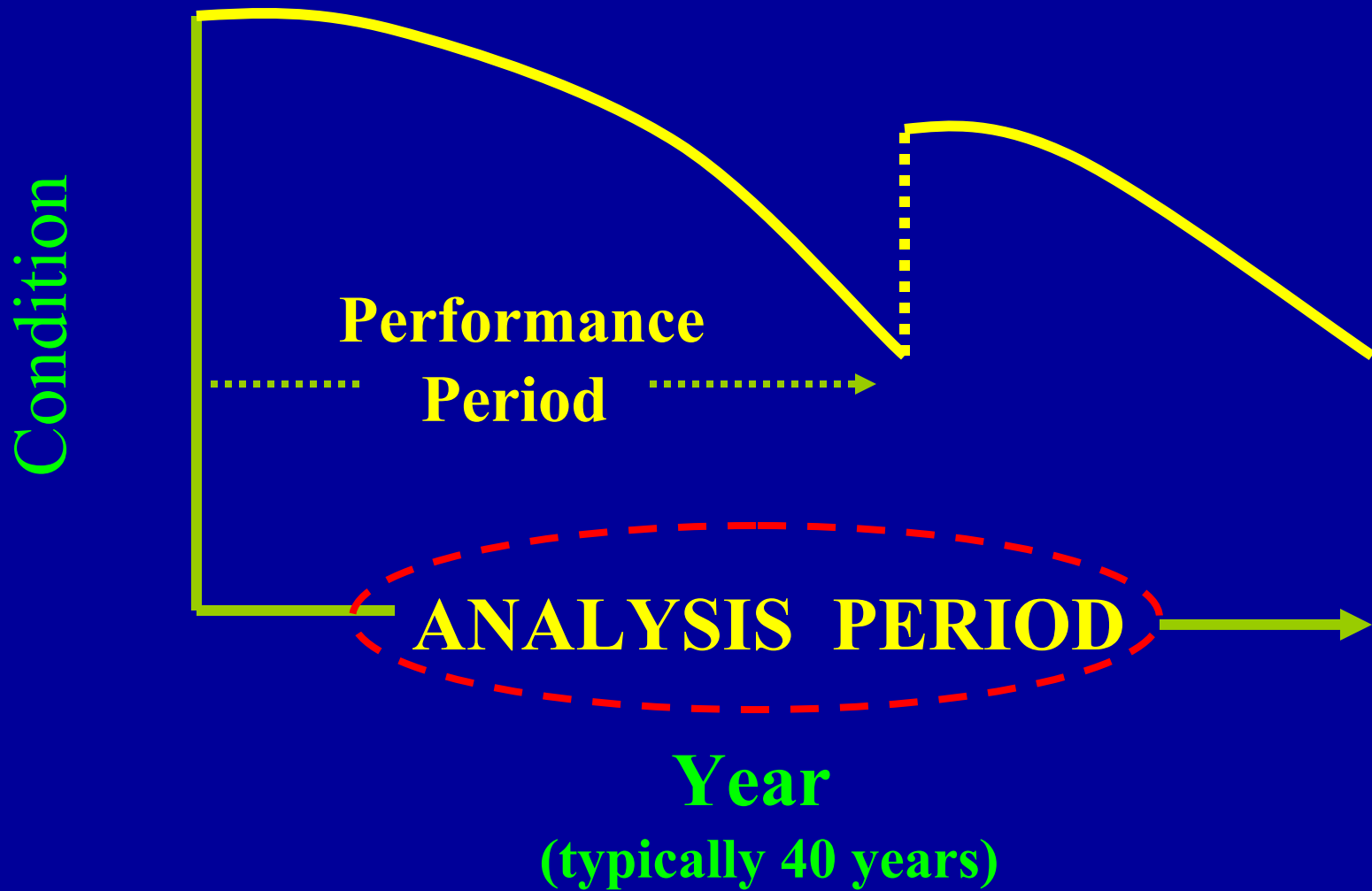


Pavement Division Interim Technical Bulletin  
September 1998

# Equivalent Initial Pavement Thickness Designs

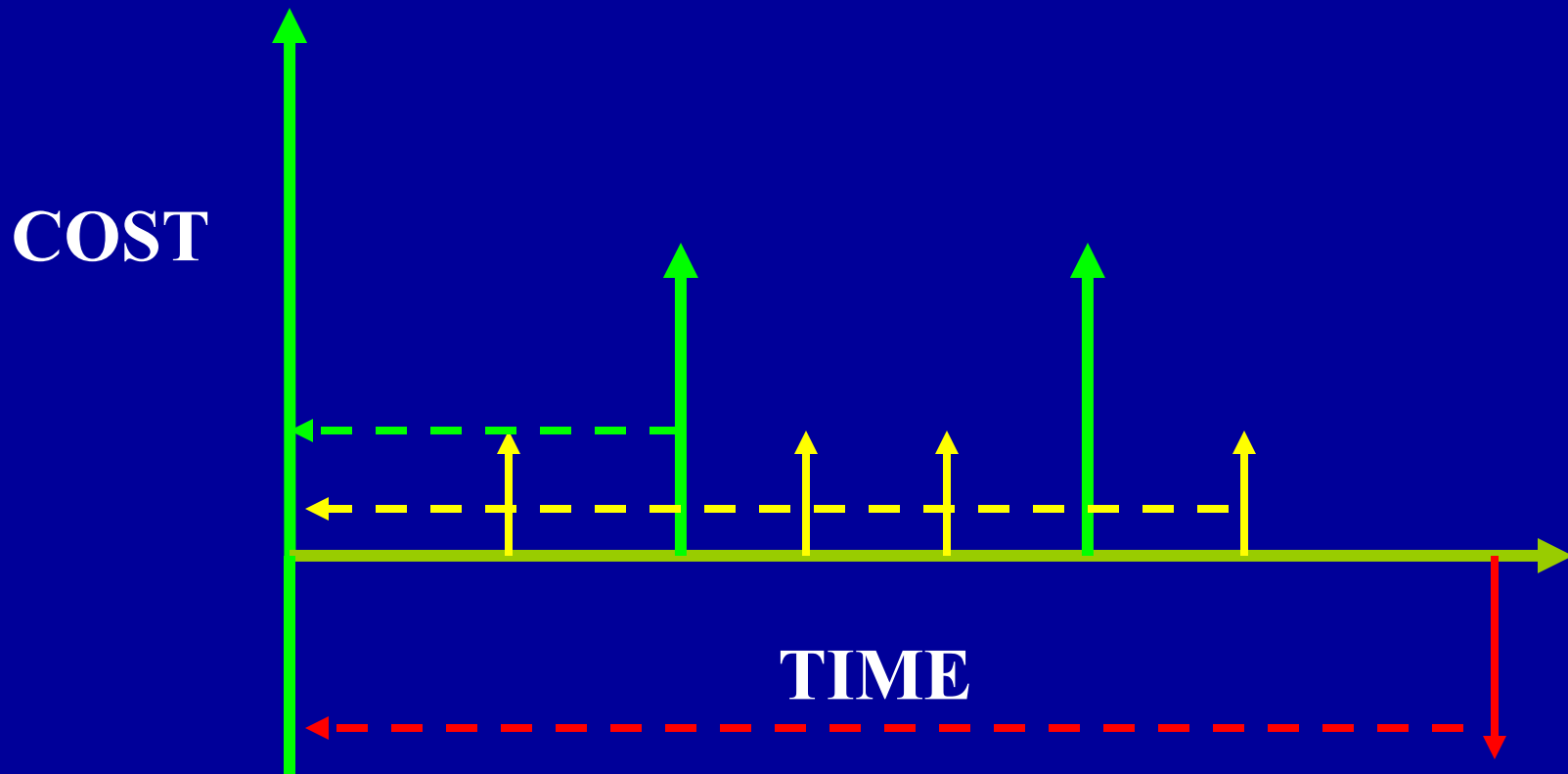


# LIFE CYCLE ANALYSIS



# NET PRESENT VALUE

**Invested Interest Rate - Inflation Rate = Discount rate**





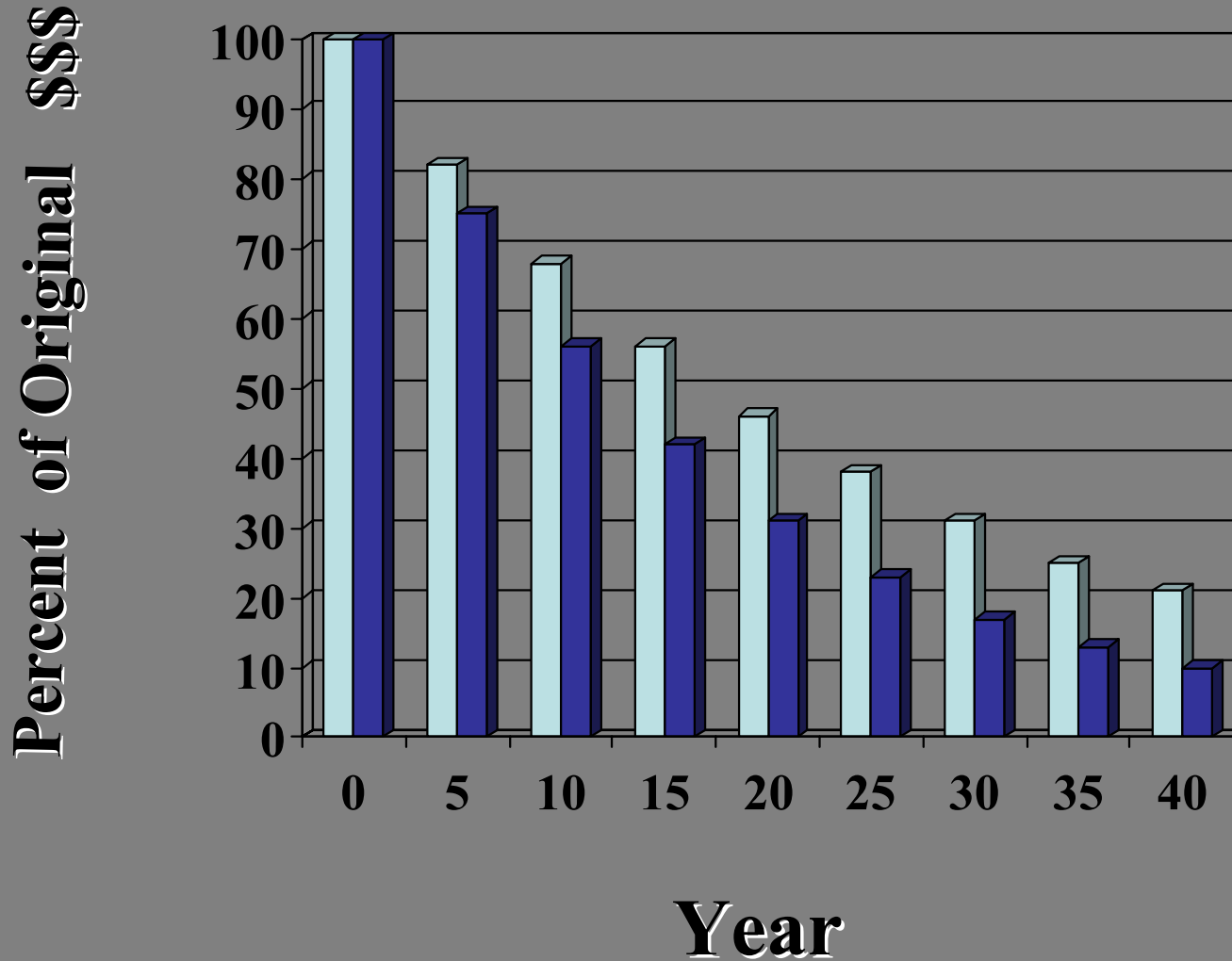
**Table 2.16. Present value discount factors: single future payment.**

Year	Discount Factor			Year	Discount Factor		
	3%	4%	5%		3%	4%	5%
1	0.9709	0.9615	0.9524	21	0.5375	0.4388	0.3589
2	0.9426	0.9246	0.9070	22	0.5219	0.4220	0.3418
3	0.9151	0.8890	0.8638	23	0.5067	0.4057	0.3256
4	0.8885	0.8548	0.8227	24	0.4919	0.3901	0.3101
5	0.8626	0.8219	0.7835	25	0.4776	0.3751	0.2953
6	0.8375	0.7903	0.7462	26	0.4637	0.3607	0.2812
7	0.8131	0.7599	0.7107	27	0.4502	0.3468	0.2678
8	0.7894	0.7307	0.6768	28	0.4371	0.3335	0.2551
9	0.7664	0.7026	0.6446	29	0.4243	0.3207	0.2429
10	0.7441	0.6756	0.6139	30	0.4120	0.3083	0.2314
11	0.7224	0.6496	0.5847	31	0.4000	0.2965	0.2204
12	0.7014	0.6246	0.5568	32	0.3883	0.2851	0.2099
13	0.6810	0.6006	0.5303	33	0.3770	0.2741	0.1999
14	0.6611	0.5775	0.5051	34	0.3660	0.2636	0.1904
15	0.6419	0.5553	0.4810	35	0.3554	0.2534	0.1813
16	0.6232	0.5339	0.4581	36	0.3450	0.2437	0.1727
17	0.6050	0.5134	0.4363	37	0.3350	0.2343	0.1644
18	0.5874	0.4936	0.4155	38	0.3252	0.2253	0.1566
19	0.5703	0.4746	0.3957	39	0.3158	0.2166	0.1491
20	0.5537	0.4564	0.3769	40	0.3066	0.2083	0.1420

**50 cents**  
**\$1** ←

4% Discount Rate

6% Discount Rate



# Material Cost Information – Large Quantities (also Small, Med. & All)

Item Classification	Generic Item	Unit Cost	Standard Deviation
Other	Excavation (CY)	\$9.80	\$4.30
	GAB (SY)	\$5.60	\$1.20
	Borrow (CY)	\$4.60	2.90
HMA	Surface (Ton)	\$36.00	\$5.00
	Gap Graded (Ton)	\$48.00	\$7.00
	Base (Ton)	\$35.00	\$5.00
	Wedge/Level (Ton)	\$36.00	\$6.00
	Patching (SY)	\$30.00	\$15.00
	Patching (Ton)	\$56.00	\$18.00
	Grinding (SY)	\$1.40	\$0.60
PCC	Diamond Grinding (SY)	\$5.60	\$1.60
	Surface (SY)	\$44.00	\$11.00
	Patching (SY)	\$123.00	\$49.00

Cycle	Flexible Pavement	Rigid Pavement	Composite Pavement
Initial	14.8	20.0	
1 <sup>st</sup> Rehabilitation	11.9	10.0	
2 <sup>nd</sup> Rehabilitation	11.1		9.8
3 <sup>rd</sup> Rehabilitation	12.0		8.1

**Average Service Lives for LCCA  
(historical data)**

**Service Lives Standard  
Deviation for LCCA**

Cycle	Flexible Pavement	Rigid Pavement	Composite Pavement
Initial	5.8	5.7	
1 <sup>st</sup> Rehabilitation	4.7	2.8	
2 <sup>nd</sup> Rehabilitation	4.4		3.0
3 <sup>rd</sup> Rehabilitation	4.5		1.9

# Future Rehabilitation Estimates

Cycle	Flexible Pavement	Rigid Pavement	Composite Pavement
1 <sup>st</sup> Rehabilitation	<ul style="list-style-type: none"> <li>- 2" Grind</li> <li>- 2" HMA OL</li> <li>- 1% HMA patching</li> </ul>	<ul style="list-style-type: none"> <li>- 5% patching</li> <li>- 100 % clean/seal joints</li> <li>- Diamond Grind</li> </ul>	
2 <sup>nd</sup> Rehabilitation	<ul style="list-style-type: none"> <li>- 2" Grind</li> <li>- 3" HMA OL</li> <li>- 3% HMA patching</li> </ul>		<ul style="list-style-type: none"> <li>- min. 4" HMA OL</li> <li>- 5% PCC patching</li> </ul>
3 <sup>rd</sup> Rehabilitation	<ul style="list-style-type: none"> <li>- 2" Grind</li> <li>- 3" HMA OL</li> <li>- 5% HMA patching</li> </ul>		<ul style="list-style-type: none"> <li>- 2" Grind</li> <li>- 2" HMA OL</li> <li>- 3% HMA/PCC patching</li> </ul>





# 40 YEAR LIFE CYCLE

## Agency Costs

<b>10 Year Life for HMA</b>	<b>\$ 433,462</b>
<b>15 Year Life for HMA</b>	<b>\$ 403,138</b>

**Difference of \$ 30,324 per Lane/Mile     $\Delta$     7.5 %**

**@ 6% discount rate**



# Life Cycle Costs Difference to 1<sup>st</sup> Overlay



	8	\$ 453,000	+ 4.6 %
1 <sup>st</sup> Overlay @ Year	10	433,000	- - -
	12	421,000	- 2.8 %
	15	403,138	- 7.5 %
	17	397,000	- 8.3 %
	20	390,000	- 9.9 %

@ 6% discount rate

# Construction Duration Estimates \*

Construction Operation	Rehab OR Under MOT	New Construction OR few MOT
HMA Placement	1,400 – 1,500 tons/day	1,500 - 2,500 tons/day
HMA Grinding	8,000 – 10,000 SY/day	
HMA Base Widening & HMA Wedge/Level HMA Patching	800 – 1,000 tons/day 200 – 250 tons/day	
PCC Placement	3,000 - 4,000 SY/day	4,000 - 5,000 SY/day
PCC Patching	200 – 250 SY/day	
PCC Grinding	5,600 – 7,000 SY/day	
Clean and Seal Joints	5,000 – 6,000 LF/day	
Graded Aggregate Base Placement	3,000 - 4,000 SY/day	6,000 – 8,000 SY/day
Class 1-A Excavation	1,600 - 2,400 SY/day	4,000 - 6,000 CY/day
Remove and Replace Concrete Curb and Gutter	300 LF/day for forming or slipforming	

# 40 Life Cycle Analysis

	10	15
<b>Original</b>	<b>\$433,462</b>	<b>\$403,138</b>
<b>- Salvage Value</b>	<b>\$426,215</b>	<b>\$395,891</b>
<b>- Salvage Value + User Delay*</b>	<b>\$459,607</b>	<b>\$414,800</b>

**11% difference**

**\* 35 second delay**

**\* Speed change 65MPH to 45 MPH  
for 1 mile (100k ADT @ 10% trucks for 5 days)**

# 40 Life Cycle Analysis

	10 YEAR	15
<b>Original</b>	<b>\$433,462</b>	<b>\$403,138</b>
<b>- Salvage Value</b>	<b>\$426,215</b>	<b>\$395,891</b>
<b>- Salvage Value + User Delay*</b>	<b>\$526,391</b>	<b>\$452,618</b>

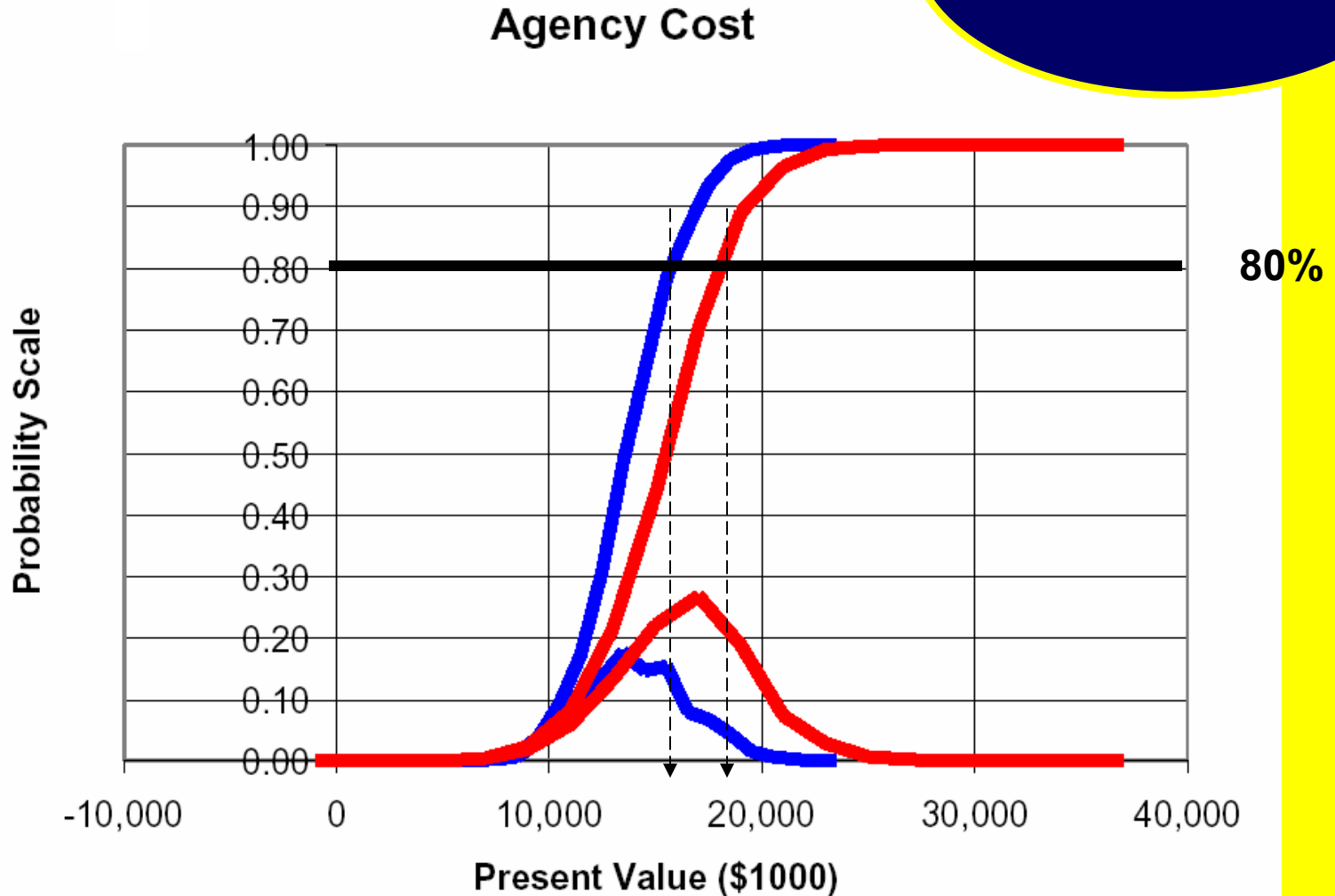
**16% difference**

**\* 95 second delay**

# Life Cycle Analysis

40 year analysis @ 3% discount rate

When the difference is  
+ 10% Decision Made



# Life Cycle Activities

Using the APA software we, the industry, evaluated effects of Maryland's Pavement Selection Process.

- a) Equivalent subgrade and aggregate base:  
HMA approximately 24% more economical
- b) 4" increased subgrade and aggregate base for HMA:

Maryland's first project differential 16% in favor of HMA

Critical issue is that when the difference is  $\leq 10\%$ , then other pavement selection factors kick in.

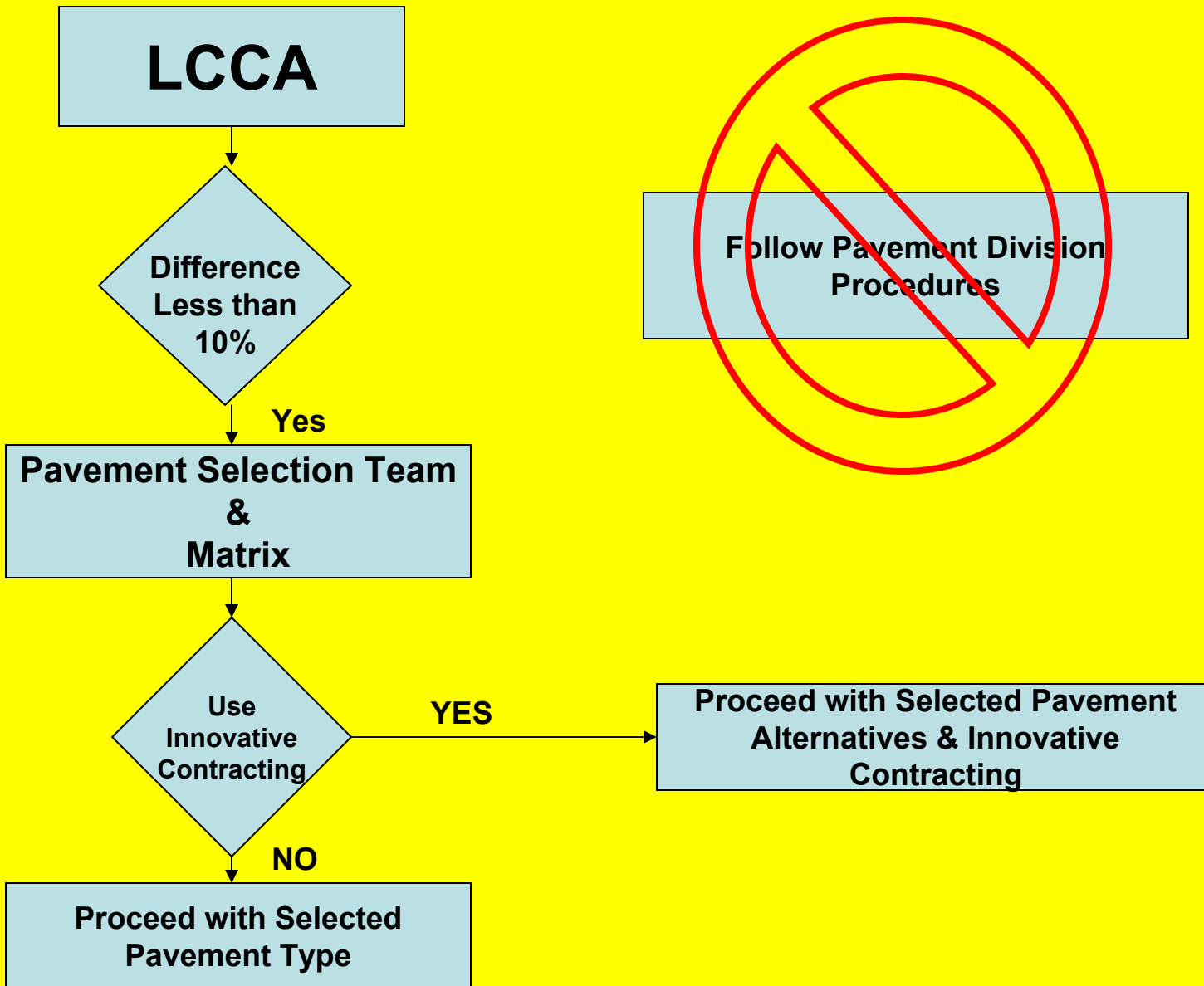
# What if the difference had been $< 10\%$

<b>Bush</b>	<b>46%</b>
<b>Kerry</b>	<b>44%</b>
<b>Nader</b>	<b>3%</b>
<b>Undecided</b>	<b>7%</b>

**Margin of Error  $\pm 4\%$**

**Like the presidential race pavement type selection is too close to call  $< 10\%$**

# Pavement Selection Flow Chart





# Pavement Selection Team



**Matrix Inputs & Importance to Project**

**Rural**



**Matrix Inputs May Be Different**

**Urban**



# EXAMPLE

## Matrix Scoring Criteria

Component	Factor	Factor Weight	Component Weight	Final Weight
<b>Cost</b>			<b>45%</b>	
	Agency Cost Present Worth	<b>65%</b>		<b>29%</b>
	User Delay Present Worth	<b>35%</b>		<b>16%</b>
	*LCCA			
<b>Construction</b>			<b>30%</b>	
	Duration of Contract	<b>20%</b>		<b>6%</b>
	Utilities & Future Maintenance	<b>20%</b>		<b>6%</b>
	Maintenance of Traffic	<b>40%</b>		<b>12%</b>
	Maintenance of Access	<b>20%</b>		<b>6%</b>
	*Material Sources			
	*Reliability of Construction			

## Matrix Scoring Criteria

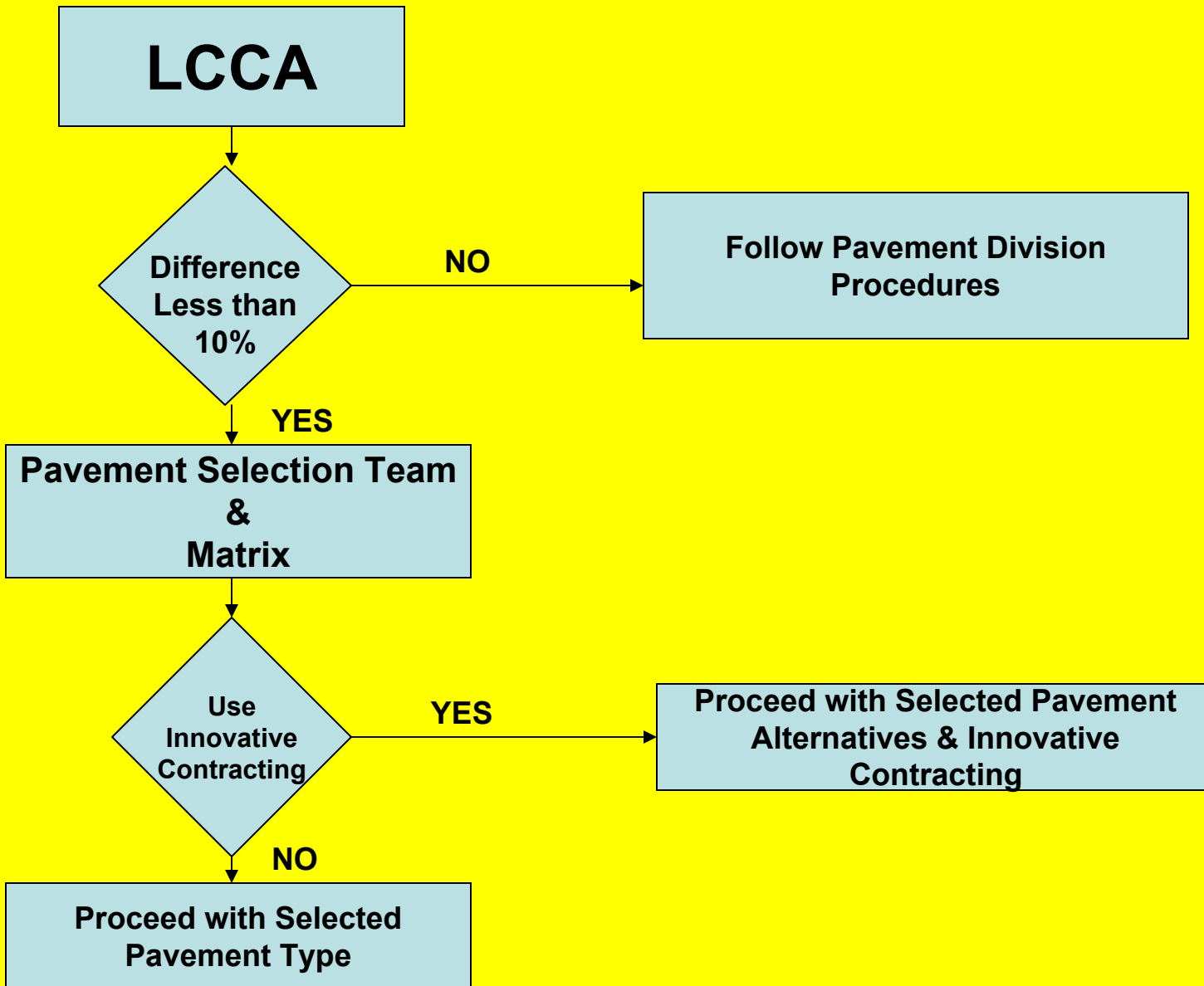
<b>Design &amp; Environment</b>			<b>25%</b>	
	<b>Traffic &amp; Geometry</b>	<b>55%</b>		<b>14%</b>
	<b>Adjacent Pavement &amp; Structures</b>	<b>25%</b>		<b>6%</b>
	<b>Environmental Impact</b>	<b>20%</b>		<b>5%</b>
	<b>*Community Concerns</b>			
	<b>*Future Planning</b>			
<b>* non-scoring elements</b>				

**Total = cost 45% + construction 30% + Design & Environment 25% = 100%**

## Matrix Scoring - Example

Component / Factor	Weight	Ratings		
		Alt #1	Alt #2	Alt #3
<u>Overall Rating</u>		<u>4.6</u>	<u>5.2</u>	<u>5.5</u>
<u>Cost</u>	<u>45%</u>	<u>5.1</u>	<u>5.4</u>	<u>6.3</u>
Agency Cost – PW costs	65%	4.0	5.0	8.0
User Delay – PW costs	35%	7.0	6.0	3.0
<u>Construction</u>	<u>30%</u>	<u>4.0</u>	<u>4.8</u>	<u>4.8</u>
Duration of Construction (Climate)	25%	4.0	6.0	5.0
Maintenance of Traffic	50%	4.0	4.0	5.0
Maintenance of Access	25%	4.0	5.0	4.0
<u>Design &amp; Environment</u>	<u>25%</u>	<u>4.5</u>	<u>5.6</u>	<u>5.1</u>
Traffic & Geometry	55%	4.0	6.0	6.0
Adjacent Pavement & Structures	25%	5.0	5.0	3.0
Environmental Impact	20%	5.0	5.0	5.0

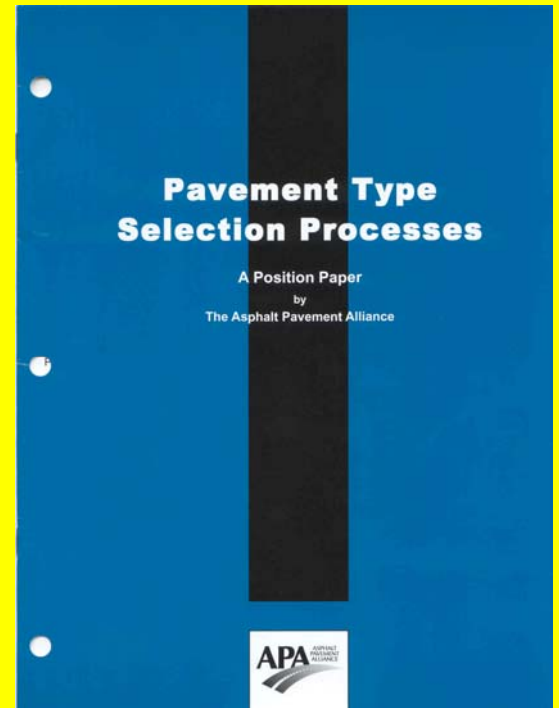
# Pavement Selection Flow Chart



# Issues with Pavement Type Selection

- ❑ **Equivalent Pavement Sections**
- ❑ **Life Cycle Analysis**
  - ✓ **Analysis Period**
  - ✓ **Discount Rate**
  - ✓ **Performance Periods**
  - ✓ **Material Prices**
  - ✓ **Variability of Performance & Prices**
  - ✓ **Rehabilitation Strategies**
  - ✓ **Construction Duration**
- ❑ **Matrix**
  - ✓ **Primary Inputs**
  - ✓ **Secondary Inputs**

- **Primarily based on Economics**
- **Be based on Historical Facts**
- **Provide the Best Value for the Taxpayers and Road Users**
- **Be Rational, Objective, Understandable and Defensible**







**Thank You**

**Questions, Comments**

**Carlos Rosenberger  
Asphalt Institute**