



Life-Cycle Cost Analysis



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Agenda

1. Pavement Preservation
2. FHWA Updates
3. LCCA Program Status
4. State Example





Pavement Preservation

Keeping Good Roads Good



Without Pavement, We Would Be Stuck In The Mud!



Washington-Richmond road, 1919

NMAH, Archives Center, API Collection



Less Than 100 Years Ago...



We've Come a Long Way ...





Society Depends on Infrastructure

SOCIAL INTERACTIONS

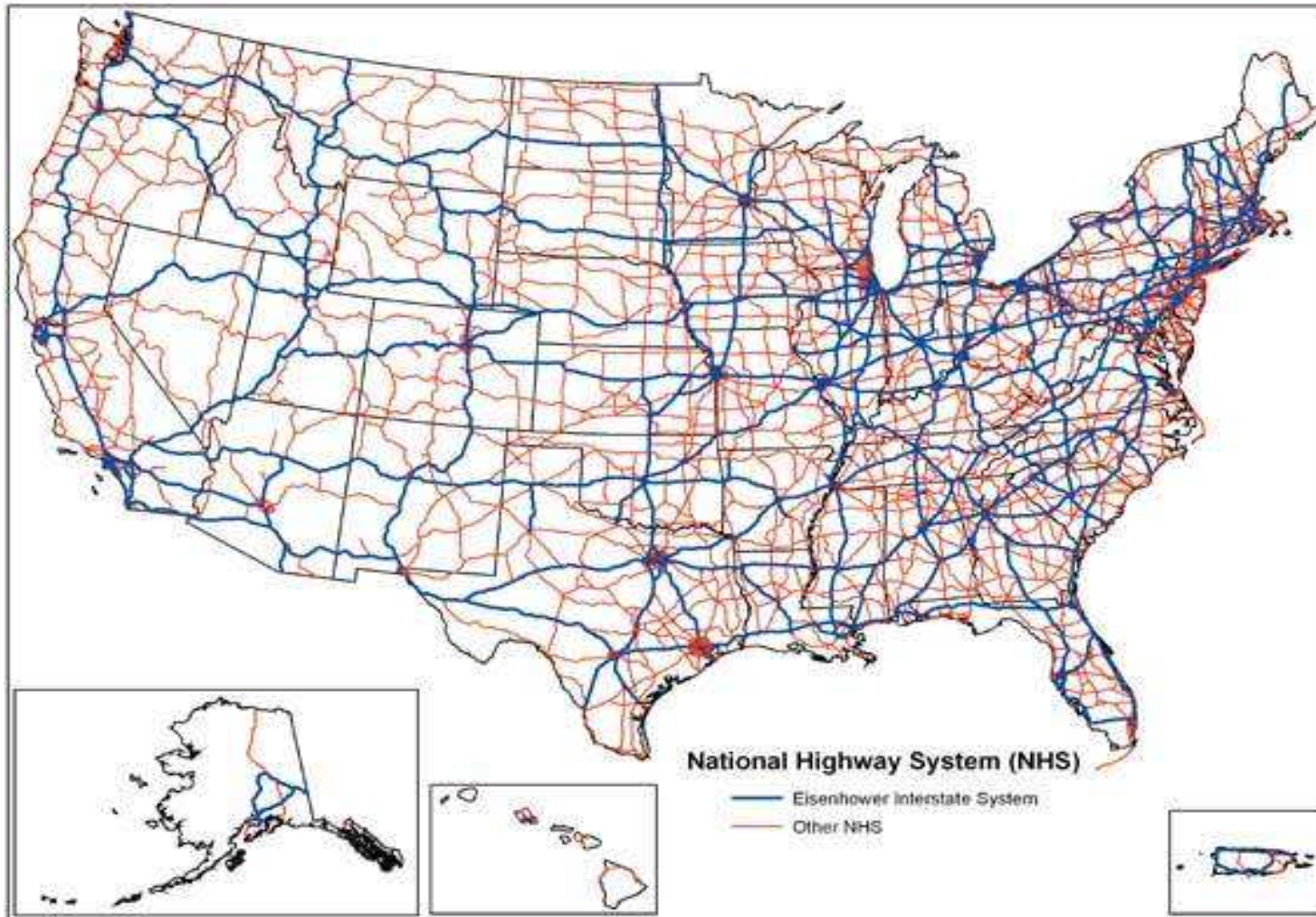
ECONOMIC TRANSACTIONS

INFRASTRUCTURE

Roads, Bridges, Airports, Water Systems, Wastewater Systems,
Gas, Electric, Telephones, Waterways, Coastal Facilities, Parks, Etc.



4 Million Miles of Roads & 600,000 Bridges





Statistics We Should Know:

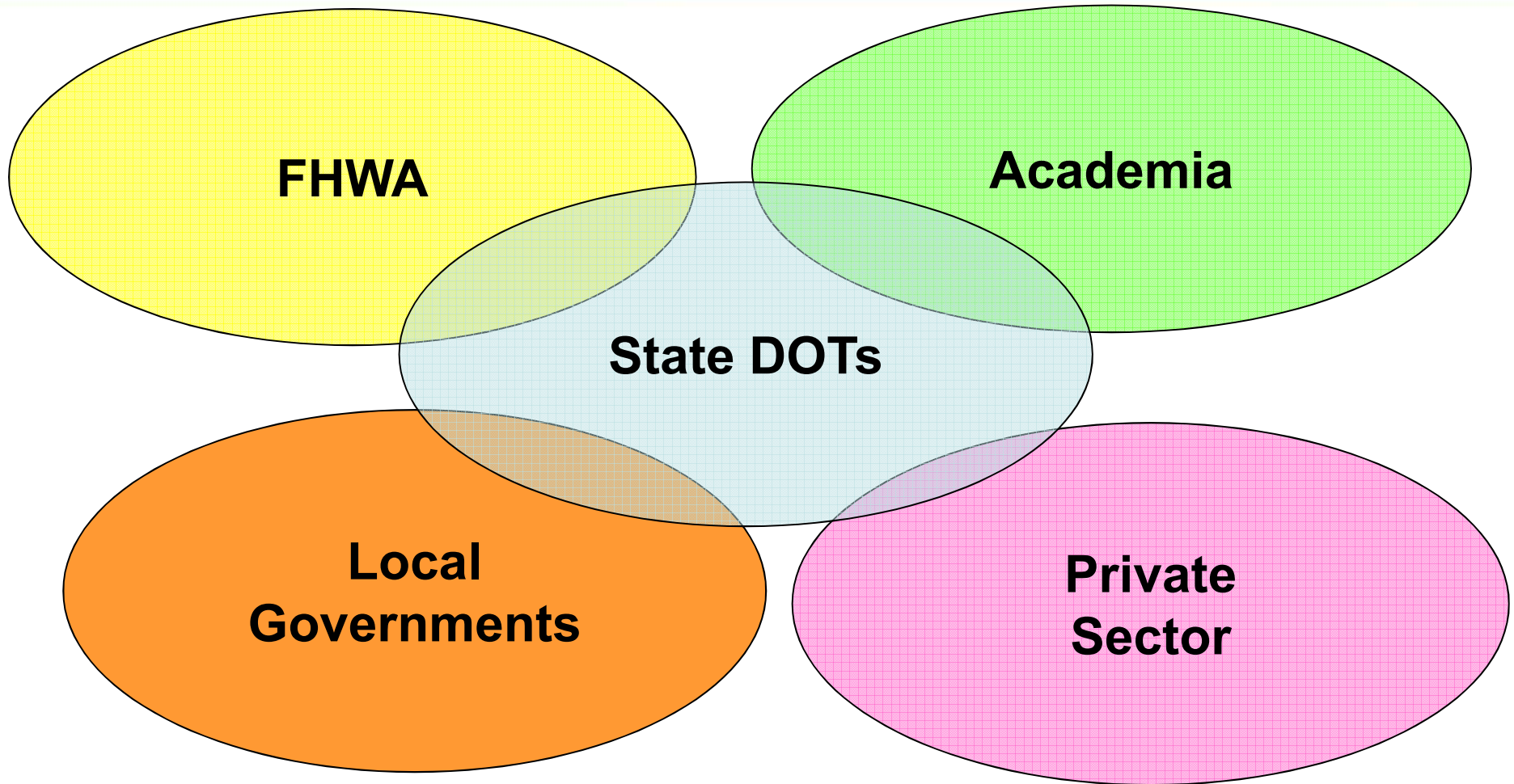
Federal	= 3%
State	= 20%
Local	= 77%

2/3 are Paved (1/3 Unpaved)

94% of Paved have an Asphalt Surface

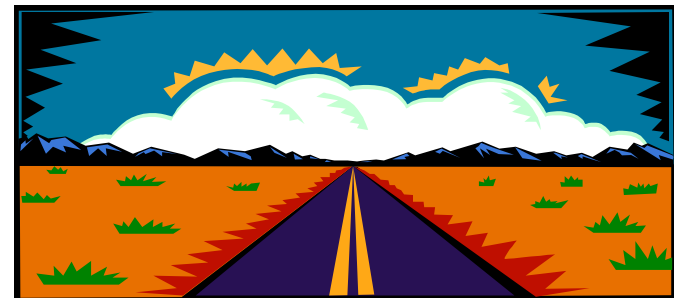


Partnerships Are Required



Pavement Preservation and Asset Management

Three FHWA Asset Management Teams:
Systems Management and Monitoring
Engineering and Economic Investment
Construction and System Preservation





Construction and System Preservation

BRYAN CAWLEY





Pavement Preservation

Doing the *right* thing...

...to the *right* pavement.

...at the *right* time...

TO KEEP THE “GOOD” ROADS GOOD!



Keeping Good Roads Good

Corridor assessment

- I-95 corridor
- What data are states using to manage “conditions” of I-95
- Common performance indicators
- Good, Fair or Poor
- MD-DE-VA
- “Evaluation of Highway Performance Measures for a Multi-Study Corridor - A Pilot Study”

<http://www.fhwa.dot.gov/asset/hif10015/>



Keeping Good Roads Good

Infrastructure Health Project

- 2 objectives
 1. Identify performance indicators
 - Good, fair & poor
 - Condition Data needed
 - Reported
 2. Identify pavement health indicators
 - What do we need to measure



Maintenance Leadership Academy

- Four-week training, blended learning
- Target audience: state and local maintenance supervisors
- Strong emphasis on preservation and performance improvement



Maintenance Leadership Academy

Six Modules

- ✓ Maintenance Management
- ✓ System Preservation
- ✓ Roadsides and Drainage
- ✓ Weather-related Operations
- ✓ Safety and Workzones



Life-Cycle Cost Analysis



LCCA Program Status

Distance Learning Course

Onsite RealCost LCCA Workshop

RealCost User Manual

Technical Bulletin

Bridge LCCA





Life-Cycle Cost Analysis Definition

- Life-Cycle Cost Analysis is a **process** for evaluating the total economic worth of a usable project segment by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project segment.

Source: Transportation Equity Act for the 21st Century



Pavement Preservation vs. Reconstruction

State Examples

Arizona State DOT

Washington State DOT



Pavement Preservation vs. Reconstruction

Arizona Department of Transportation

- Continuous weakening of substructure material
- Cost & performance
- **Sponsored a Study** - *Cost-Benefit Analysis of Continuous Pavement Preservation Design Strategies Versus Reconstruction Final Report 491*

Prepared by: K.L. Smith, L. Titus-Glover, M.I. Darter, H.L. Von Quintus, R.N. Stubstad, and J.P. Hallin

Arizona Department of Transportation

- Break-even
- Continuous preservation
- Rehabilitation treatments



Arizona Department of Transportation

Life-Cycle cost Analysis (LCCA)

- Probabilistic approach
- FHWA's LCCA spreadsheet program
- RealCost, Version 2.1 (FHWA, 2004)





Input Analysis

- ✓ Pavement performance
- ✓ Service life estimates
- ✓ Best estimates of unit costs
- ✓ Work zone-related user cost
- ✓ Discount rates
- ✓ Analysis period





Alternative Strategies

- Life Cycle Cost
 - 4 strategies
 - 15 commonly occurring pavement scenarios

Traffic Info Used in LCCA

Project ID	AADT, veh/day ^a	Cars as Percentage of AADT, %	Percent Single Trucks ^b	Percent Combo Unit Trucks ^b	Annual Growth of Traffic, %	Speed Limit, mi/hr	Lanes Open ^c	Free Flow Capacity, vphpl	Rural or Urban? ^d	Queue Dissipation Capacity, vphpl	Maximum AADT, veh/day ^e	Maximum Queue Length, mi
Cell 1	10,000	77	13	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 2	18,000	72	18	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 3	13,000	85	5	10	2.5	55	1	2,200	Rural	1,800	100,000	4
Cell 4	6,000	84	6	10	2.5	55	2	2,200	Rural	1,800	100,000	4
Cell 5	7,500	83	7	10	2.5	55	2	2,200	Rural	1,800	100,000	4
Cell 6	17,000	66	24	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 7	23,000	75	15	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 8	9,000	79	11	10	2.5	55	2	2,200	Rural	1,800	100,000	4
Cell 9	14,000	80	10	10	2.5	55	1	2,200	Rural	1,800	100,000	4
Cell 10	1,400	83	7	10	2.5	55	1	2,200	Rural	1,800	100,000	4
Cell 11	17,000	66	24	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 12	80,000	85	5	10	2.5	55	3	2,200	Urban	1,800	100,000	4
Cell 13	25,000	75	15	10	2.5	70	2	2,200	Rural	1,800	100,000	4
Cell 14	240,000	81	9	10	2.5	55	5	2,200	Urban	1,800	100,000	4
Cell 15	75,000	86	4	10	2.5	55	3	2,200	Urban	1,800	100,000	4

Agency Construction Cost

Bid Item	Unit	Description Bid Item Components	Unit Price	Quantity Per Day
Asphalt Concrete Friction Course (FC)	ton	Asphalt Concrete Friction Course	\$28.13	2,000
	ton	Asphalt Cement for ACFC	\$154.03	
	ton	Mineral Admixture for ACFC	\$97.42	
Asphalt Rubber AC Friction Course (FR)	ton	Asphalt Rubber AC Friction Course	\$29.44	2,000
	ton	Asphalt Cement for AR-ACFC	\$274.99	
	ton	Mineral Admixture for AR-ACFC	\$97.42	
Asphalt Concrete (AC)	ton	Asphalt Concrete (3/4" Mix)	\$22.09	2,000
	ton	Asphalt Cement for AC (3/4" Mix)	\$154.03	
	ton	Mineral Admixture for AC (3/4" Mix)	\$97.42	
Asphalt Rubber AC (AR)	ton	Asphalt Rubber AC	\$25.65	2,000
	ton	Asphalt Cement for AR-AC	\$260.48	
	ton	Mineral Admixture for AR-AC	\$97.42	
Continued....				



Agency Construction Cost

Bid Item	Unit	Description Bid Item Components	Unit Price	Quantity Per Day
Bituminous Pavement (milling)	yd ²	Milling depth = 0.5"	\$0.54	20,000
	yd ²	Milling depth = 1.0"	\$0.76	18,000
	yd ²	Milling depth = 2.0"	\$1.10	16,000
	yd ²	Milling depth = 2.5"	\$1.25	15,000
	yd ²	Milling depth = 3.0"	\$1.35	14,000
	yd ²	Milling depth = 3.5"	\$1.40	13,500
	yd ²	Milling depth = 4.0"	\$1.50	13,000
	yd ²	Milling depth = 4.5"	\$1.60	12,500
	yd ²	Milling depth = 5.0"	\$1.70	12,000
JPC (nondoweled PCC)	yd ²	11.0-in PCC	\$27.00	2,500
	yd ²	12.0-in PCC	\$29.00	
	yd ²	12.5-in PCC	\$30.00	
	yd ²	13.0-in PCC	\$31.00	
	yd ²	13.5-in PCC	\$32.00	
Continued...				



Value of Time

Parameter	Cost
Value of Time for Passenger Cars (\$/hour)	\$3.08
Value of Time for Single Unit Trucks (\$/hour)	\$20.95
Value of Time for Combination Trucks (\$/hour)	\$25.21



Final results

- Reduction in total LCC
- Increase (from 0 to 2) in the number of rehabs between original construction and the first reconstruction events
- 9 of the 15 scenarios
- Break-even point
 - Occurs after 2 to 3 cycles of rehab



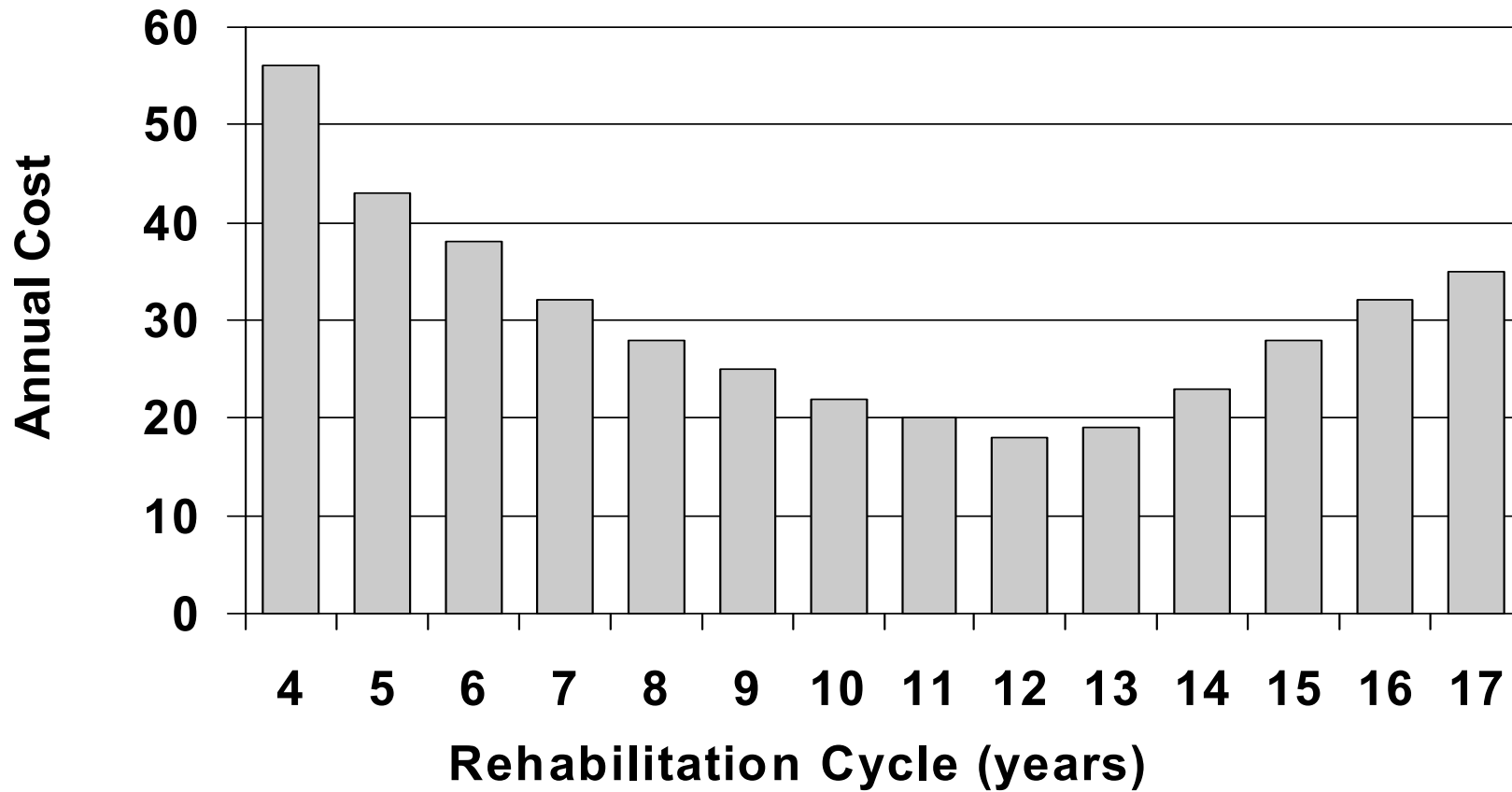
Pavement Preservation vs. Reconstruction

Washington State DOT

- 1993 Revised Code WA
 - Required project selection be based on the lowest life cycle cost concept
 - Optimal timing (opportunity window) 2 to 3 yrs



Washington State DOT





Washington State DOT

Network level Economic Analysis

- Design life yielded the most benefits
- Pavement Management System (PMS)
 - Pavements
 - Anticipated deterioration curves
 - Rehabilitation activity cycles
 - Anticipated costs in the year the activity would occur



Washington State DOT

- “worst first” to “ a needs based approach”.
- 3 performance measures of pavement distress.
 1. Pavement Structural Condition (PSC)
 2. International Roughness Index (IRI)
 3. Rutting



Washington State DOT

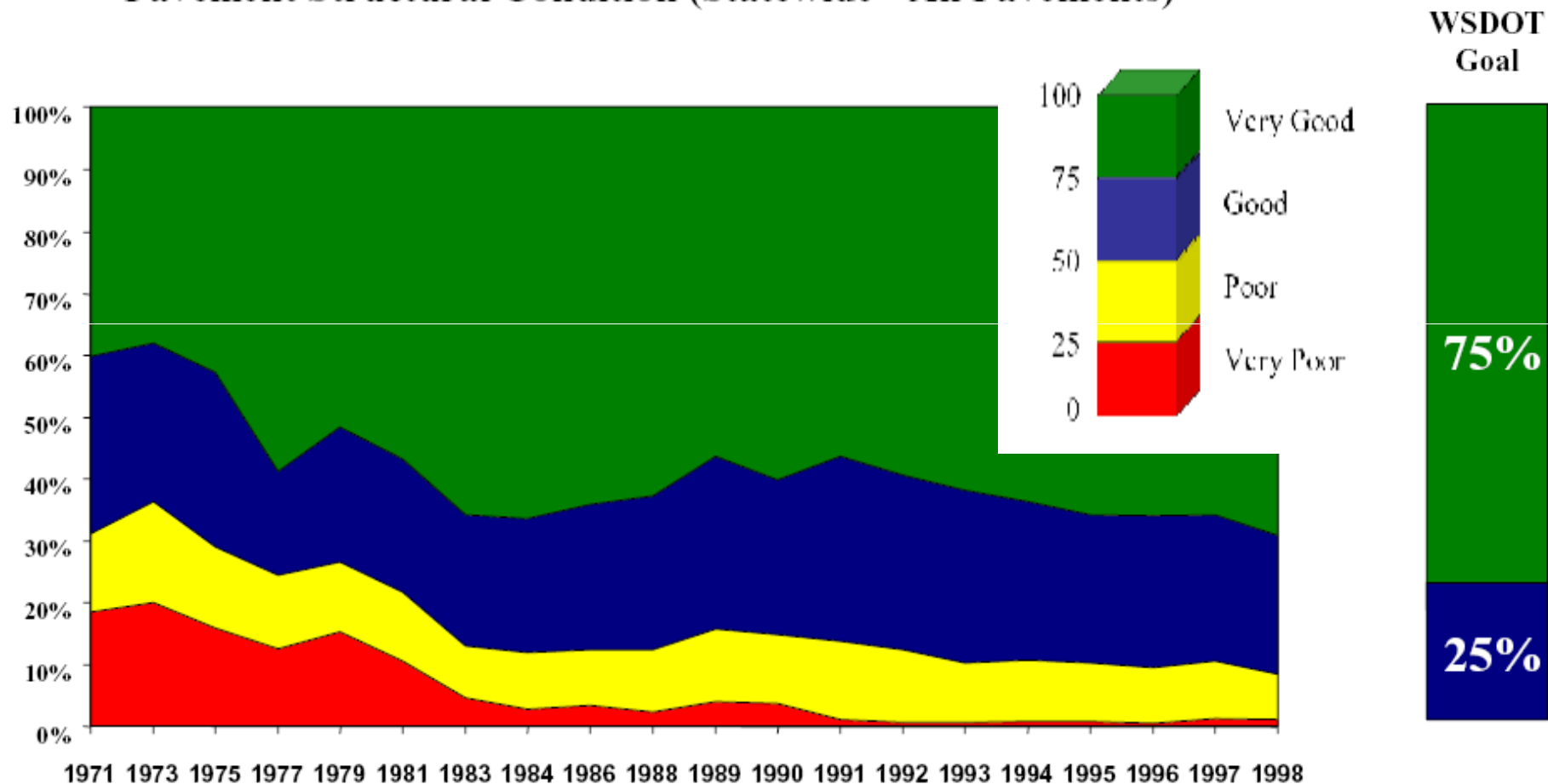
Minimum Rating

- 50 for PSC
- 220 inches/mile for IRI
- 10 mm (.4 in) for rutting

- The LCCA validation process was conducted again in 2000

Washington State DOT

Pavement Structural Condition (Statewide - All Pavements)





Washington State DOT

- Lowest LCC by conducting preservation activities
 - Early stages of deterioration to prolong their life
 - Need for major rehabilitation



Washington State DOT

- Success is measured by network condition of their pavements
- In 1971
 - 50% poor conditions
- Today
 - Less 10% are in poor condition



Resource Documentation

- **Arizona report**

*Cost-Benefit Analysis of Continuous Pavement
Preservation Design Strategies Versus Reconstruction*

<http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm>

- **FHWA Case Study**

Pavement Management Systems

The Washington State Experience

http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=626



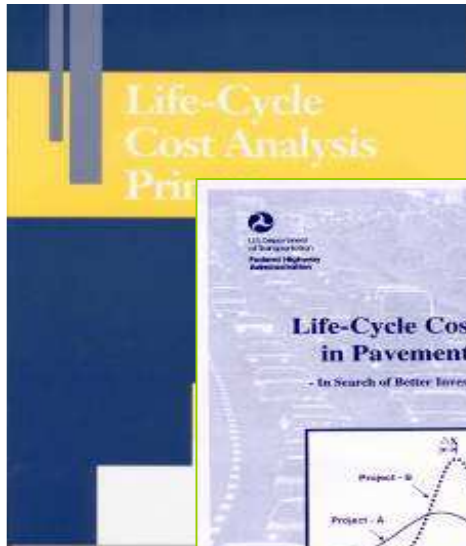
Resources

Training

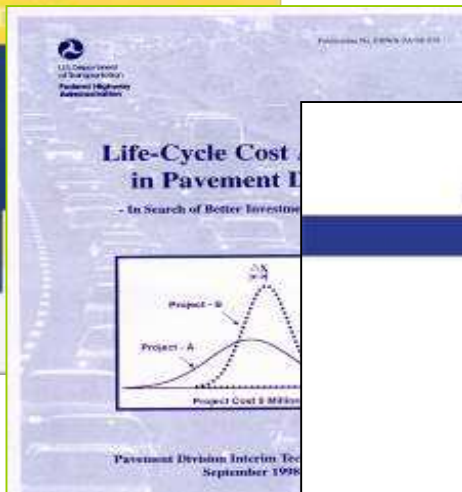
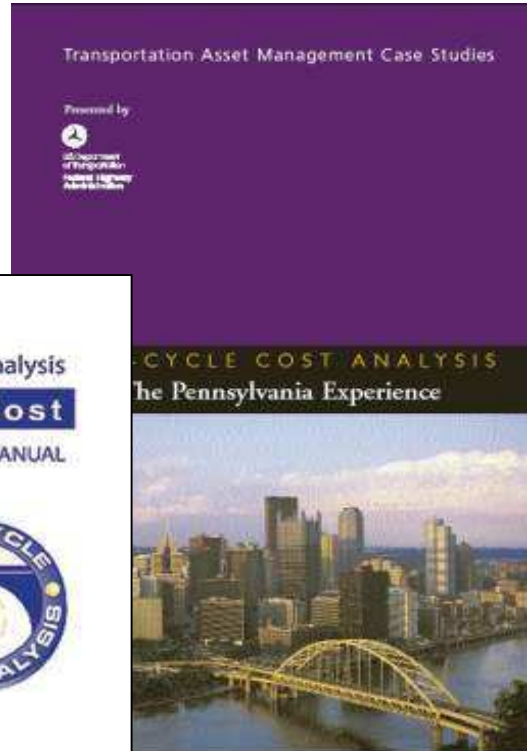
Fundamentals of Life Cycle Cost Analysis Live Instructor Led Distance Learning Course

Onsite RealCost Life-Cycle Cost Analysis (LCCA) Software Workshop

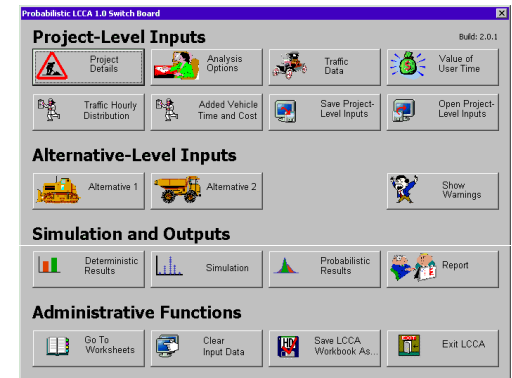
Resources



LCCA Primer
FHWA-IF-02-047



Technical Bulletin
FHWA-SA-98-079



LCCA Software
RealCost 2.5
and
User Manual



Summary and Closing Remarks

- Pavement Preservation
- Keeping Good Roads Good
- LCCA/RealCost
- State Examples

<http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm>

Thank you

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<http://www.fhwa.dot.gov/infrastructure/asstmgt/lcca.htm>