Cold In Place Recycling In Washington State

Jeff Uhlmeyer
Pavement Design Engineer

State Materials Laboratory
Washington State Department of Transportation

First Western States Regional In-Place Recycling Conference
June 3-5, 2008

Experiences with CIR

SR/Project	Mile Posts	Construction Year
395/Valley to Chewelah	202.76 to 207.80	1982
221/County Well Road to Jct. SR 22	17.13 to 23.24	1982
97/Brewster Airport to SR 17	262.83 to 265.09	1983
12/Clarkston Vicinity Paving	413.82 to 416.89	1992
17/Leahy to East Foster Creek	119.87 to 127.94	1993
395/Loon Lake to SR 231	193.95 to 196.79	1995
221/SR 22 to Prosser Hill	23.01 to 26.06	1998
211/ Vicinity Four Lanes to SR 20	0.00 to 15.19	1999
270/Pullman to Idaho State Line	4.02 to 9.89	2000
395/SR 17 to Adams County Line	55.08 to 61.24	2001
124/Railroad Bridge to County Road	22.62 to 28.56	2002
904/Tyler to Cheney	0.00 to 9.09	2002
221/SR 14 to Prosser Hill	0.03 to 23.01	2002
127/Church Hill Road to Dusty	18.98 to 22.40	2002
24/Fire Station to Taylor Ranch Road	15.66 to 23.07	2004
28/Davenport to Harrington	117.73 to 131.16	2004

CIR Selection

Basically two requirements:

- 2.5 to 3 inches of existing HMA
- Functional pavement distress not related to base or subgrade failure
- Other qualifiers including an experienced Contractor

Pavement Distress

Pavement Distress

Recommended CIR Projects

- Warm and dry climate – Eastern Washington
- Weathered/oxidized pavements
- Sites with limited aggregate supplies
- Potential to eliminate reflective cracking full depth (HMA only) recycling
- Improvement of the profile and cross slope
- Rutted roadways not containing excessive fines or oils

Recommended CIR Projects (cont)

- Roadways with generally uniform materials
- Pavements that appear to be distress driven as a result of stripping
- Roadways that need more structure

CIR Projects Recycling - Not Recommended

- High ADT – delay concerns
- Urban environments
- Wet and cooler weather conditions (western Washington)
- Structural problem in subgrade
- Excessively inconsistent pavement width and depth
- Flushing or bleeding pavement
- Pavement with excessive fines
- Multiple pavement types
- Multiple physical obstructions

CIR Structural Design

Table 4. Example AASHTO overlay thickness determination.

Material	Layer Coefficient	Thickness (mm)		Structural Number
		Existing Depths	New Depths	
AASHTO required SN = 2.64				
New HMA	0.44	n/a	45	0.79
CIR	0.30	n/a	85	1.01
Existing HMA	0.30	85	0	0.00
Existing Base	0.12	610	610	2.88
Total Structural Number				4.68

CIR Structural Design

Table 2. WSDOT layer coefficients.

Material Description	Layer Coefficient
HMA pavement – new	0.44
HMA – existing	0.25 to 0.35
CIR pavement	0.30
Untreated base – new	0.14
Untreated base – existing	0.08 to 0.14

Table 3. State DOT CIR layer coefficients.

State	Layer Coefficient
Nevada	0.26
New Mexico	0.30
Oregon	0.30
Pennsylvania	0.30

CIR Performance

CIR Performance

Table 7. Rehabilitated CIR projects.

Project	Original Construction			Rehabilitation		
	Year	CIR Depth (mm)	HMA Wearing Depth (mm)	Year	Surface Type	PSC[1] prior to rehabilitation
SR-395	1982	107	45	1993	HMA	67
SR-221	1982	60	60	2002	HMA	53-75
SR-97	1983	107	45	1994	HMA	78
SR-12	1992	76	45	2003	HMA	98[2]
SR-17	1993	76	45-60	1998 2006	Chip seal Chip seal	83 37[3]

1. Pavement structural condition (PSC) is a rating based on distresses related to the pavement's structural ability to carry traffic loading and refers to cracking and patching.
2. Project rehabilitated to match paving cycles on adjacent roadway.
3. Project rehabilitated to preserve the deteriorating HMA wearing surface.

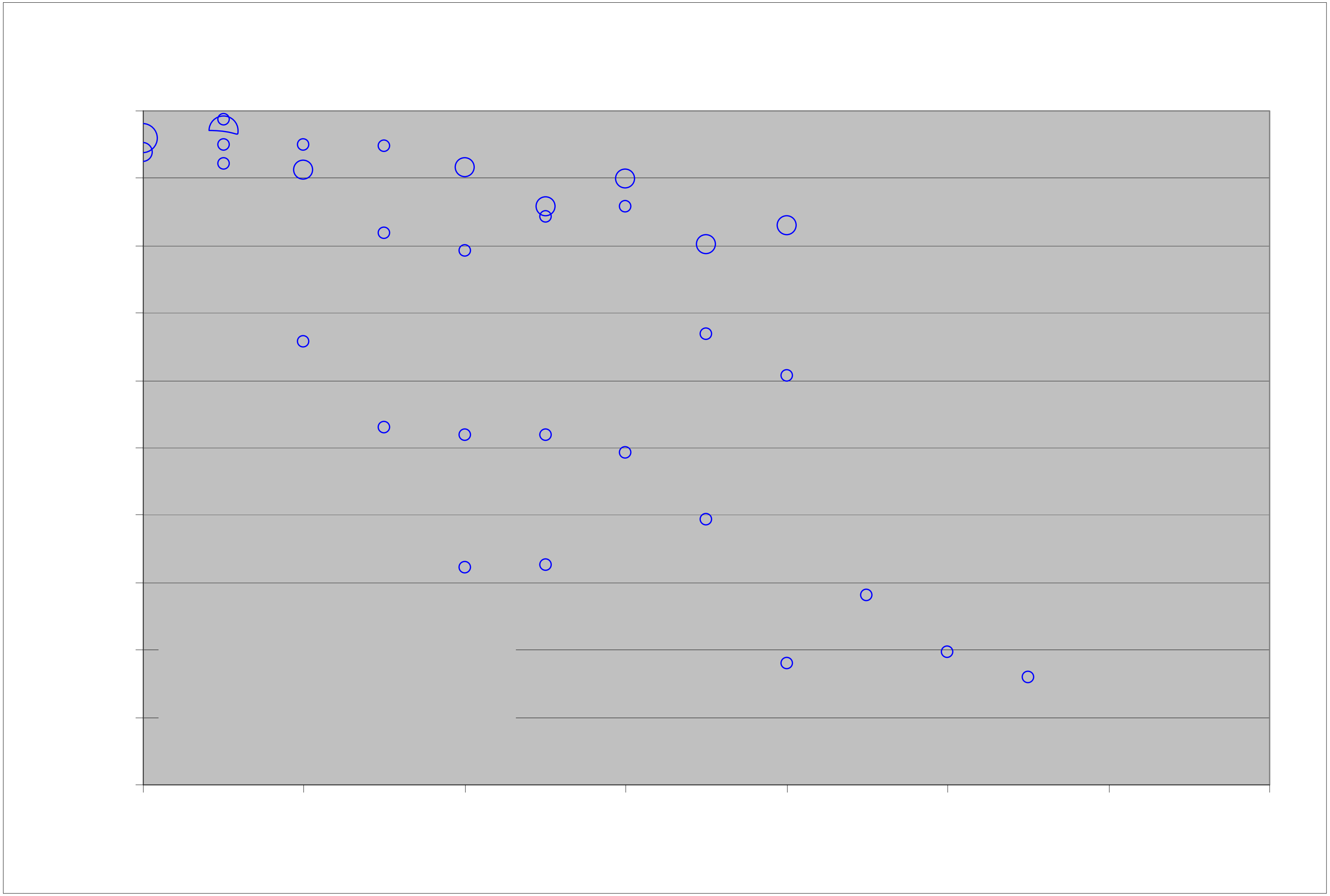
CIR Performance

Table 8. Performance of non-rehabilitated CIR projects.

Project	Original CIR Construction		2006 PSC
	Year	HMA Depth (mm)	
SR-395	1995	60	79
SR-221	1998	45	43
SR-211	1999	60	98
SR-270	2000	45	83
SR-395	2001	60	95
SR-124	2002	45	94
SR-904	2002	Chip Seal	88
SR-221	2002	60	99
SR-127	2002	45	100
SR-28	2004	Chip Seal	98
SR-24	2004	45	100

The SR-221 section has the lowest PSC (43) of any of the CIR projects. The

CIR Performance



CIR Life Cycle Costs

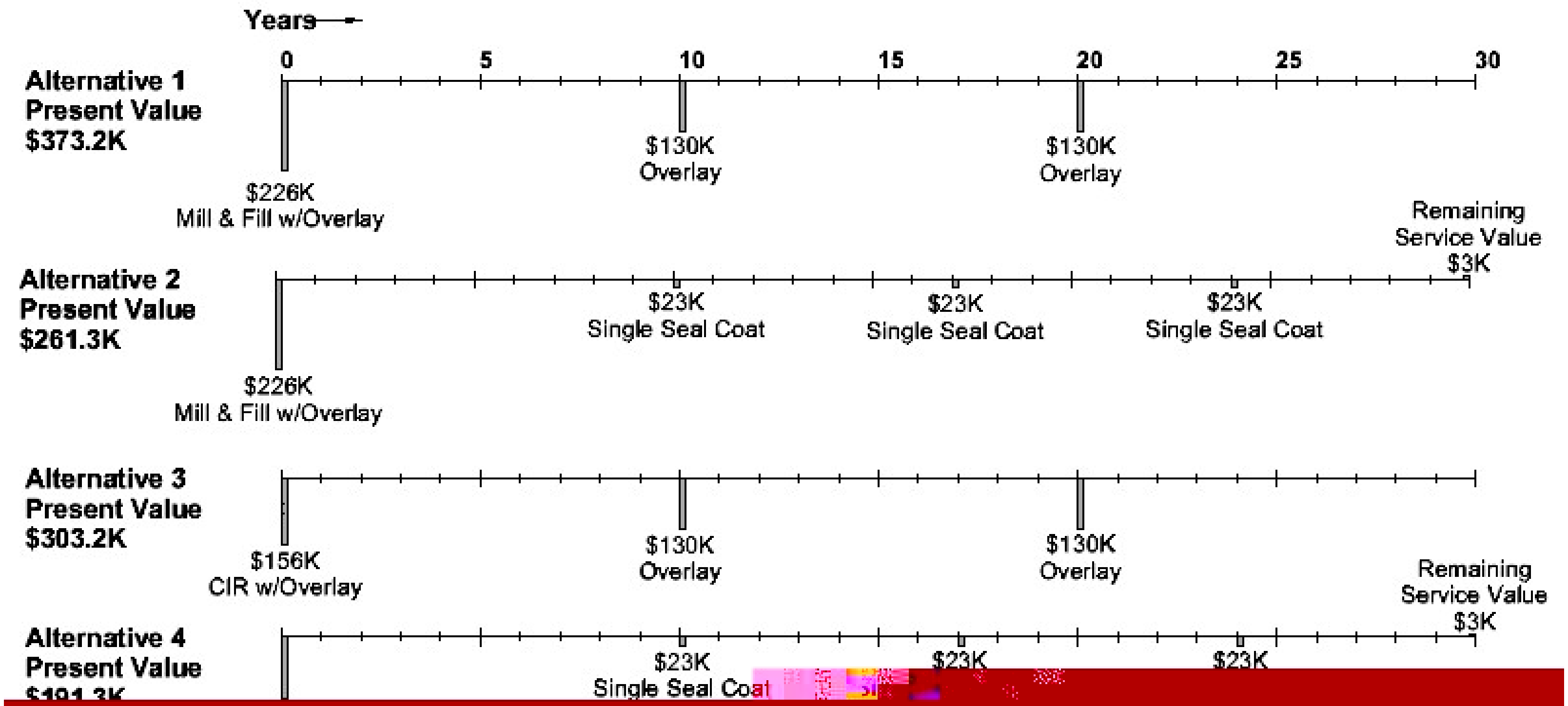
Table 9. WSDOT rehabilitation strategies

Option	Rehabilitation
1	Remove 60 mm of the existing structure and inlay with 60 mm of dense-graded HMA followed by a 45 mm dense-graded HMA overlay. Future overlays are applied every 10 years.
2	Remove 60 mm of the existing structure and inlay with 60 mm of dense graded HMA followed by a 45 mm dense-graded HMA overlay. Future chip seals are applied every seven years following ten years of initial HMA performance.
3	CIR to a depth of 90 mm followed by a 45 mm dense-graded HMA. Future dense-graded HMA overlays are applied every 10 years.
4	CIR to a depth of 90 mm followed by a 45 mm dense-graded HMA. Future chip seals are applied at seven year intervals following ten years of initial HMA performance.
5	CIR to a depth of 90 mm followed by a double chip seal application. Future chip seals are applied at seven year intervals following the initial chip seal application.

CIR Life Cycle Costs

Option	Initial Cost (per ln-mi)	Number of Future Rehabs	Rehab. Cost[1] (per ln-mi)	Residual Value (per ln-mi)	Net Present Value (per ln-mi)
1	$226,000	2	$130,000		$373,200
2	$226,000	3	$23,000	($3,200)	$261,400
3	$155,900	2	$130,000		$303,200
4	$155,900	3	$23,000	($3,200)	$191,400
5	$118,000	4	$23,000	($16,400)	$161,400

Life Cycle Cost



CIR Challenges for Decision Makers/Construction

Construction

Table 5. WSDOT project challenges.

Challenge	No. of Projects	Challenge	No. of Projects
Controlling emulsion rate	2	Rainstorm	3
Curing emulsion	3	Compaction	1
Incorporating base	2	Raveling	5
Saturated sub layers	1	Traffic control	1


EAST
28

Mix Design/Calibration

Issues

- What Mix design?
- Mix calibration is always a “discussion”
- Inspectors/decision makers feel very uncomfortable for a process in which they have little control
- Emulsion contents have historically been 1.5 to 1.8 percent with 1.5 percent lime slurry
- One major failure will stunt future CIR work in Washington

What is working for emulsion based CIR . . . .

- Adjustments made for variability
- Adjustment recommendation by Contractor’s staff
- Adjustments are monitor and documented
- If raveling or rutting occurs…Contractor is responsible for corrective action

Mix Calibration

Mix Calibration

Mix Calibration

Mix Calibration

Mix Calibration

Use of Engineered Oils

- Mix design as assurance that the CIR mix will work
- Provide a comfort level to project staff the CIR is a technically sound process
- Future WSDOT projects will likely us this improvement to CIR

Contact Information:

Jeff Uhlmeyer, P.E.

Pavement Design Engineer

Washington State Department of Transportation

360-709-5485

uhlmeyj@wsdot.wa.gov