Cold Recycling in Montana

Montana Department of Transportation

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Surfacing Design Unit

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Table of Contents

Chapter 1: Executive Summary

The purpose of this report is to compile all past CIR documents created by the Montana Department of Transportation (MDT) into one complete resource. The goal of this report is to inform and educate people that are unfamiliar with cold recycling processes and provide a reference to the Surfacing Design unit as well as all MDT employees working with cold recycling.

This report integrates all past and present information and data from cold recycled projects completed in Montana. An overview of cold in-place recycling (CIR) and cold central plant recycling (CCPR) is included in this paper. Analyses of rut and ride data from 2004 to 2013 for past CIR roadways are incorporated into this report along with performance summaries of these CIR roadways. Cost analysis was implemented on CIR projects and compared to other pavement preservation treatments constructed around Montana. Images of CIR roadways, which can be used to evaluate each roadway visually, were obtained from previous years using PathWeb, MDT's pavement analysis and condition software.

A total of 23 CIR projects were constructed in Montana. So far, 17 projects performed well, 5 performed poorly, and 1 was recently constructed and needs additional time to be evaluated. Determining the performance of the roadway was done by analyzing rut and ride data as well as reviewing construction review reports and past MDT documents containing summaries of CIR projects. Possible reasons for poor roadway performance include the following:

- Poor construction practices.
- Poor project selection.
- Heavy traffic load.
- Recycling inadequate surface material

With correct project selection, CIR matches the performance of other pavement preservation techniques with a significant cost savings. Listed below are cost savings based on CIR with a single chip seal.

- 10% savings over CIR with an overlay.
- 16% savings over CIR with a double chip seal.
- 151% savings over an isolation lift and overlay.
- 176% savings over a mill and fill.

When considering CIR, it is imperative to look at climate, traffic, and availability of aggregate in selected areas. CIR without an overlay usually does not perform well in mountainous climates and is more prone to moisture damage given high void content. CIR performs relatively better when an overlay of hot mix asphalt is placed on top of the CIR surface as opposed to a single or double chip seal.

Some limitations existed while creating this report. Rut and ride data was not available before the year of 2004. Rut and ride data before and after CIR construction could not be obtained and analyzed if a project was completed before 2004. Also, other pavement treatments were applied to many of these roadways since CIR construction. When evaluating the rut and ride data, it is difficult to accurately rate the performance of the roadway because the existing surface does not consist of CIR.

Chapter 2: Introduction

2.1 Cold In-Place Recycling (CIR)

Cold in-place recycling (CIR) is a pavement preservation technique that can be a cost effective alternative to asphalt overlays and mill and fill treatments. Traditional treatments require placing virgin plant-mixed material, whereas CIR processes remove and recycle the road surface in-place. An overlay and/or chip seal is placed on the roadway after CIR soon after CIR construction.

The CIR process involves milling the existing pavement to a specified depth, generally 2.5 to 5 inches. The milled material is then crushed and screened to meet design specifications. Emulsion, water, and lime/cement are added to rejuvenate the existing plant mix, after which the mixture is placed and compacted. This is all done in one pass of the recycling train. The CIR production rate is about 2 lane miles per day.

Selecting the right projects for CIR is very important. MDT experience has shown that CIR is well suited for low traffic roadways in dry climates. With proper project selection, the life expectancy of CIR pavement should be similar to other pavement preservation techniques.

2.2 Cold Central Plant Recycling (CCPR)

Cold central plant recycling (CCPR) is another cold recycled method used in place of traditional bituminous surfacing techniques. Although CCPR has never been performed in Montana, it could be a more economical option in specific locations around the state.

CCPR involves milling the existing pavement surface to a desired depth and transporting these millings to be stockpiled for immediate or future use. After millings are treated at the central plant with asphalt emulsion, water, and lime, they are immediately hauled from the central plant back to any construction site and placed on the roadway for paving and compaction.

CCPR is used in different types of situations. First, the road surface can be milled at a partial depth and cold millings can be stockpiled, treated at any time, and used on any project. Cold millings from one road surface can be recycled and placed on either the same or different roadway. Second, CCPR can be used in reconstruction or new construction projects. The road surface is milled at full depth and underlying base material can be reconstructed while still being able to cold recycle the existing bituminous surfacing. It is recommended that a CCPR surface be overlaid with a layer of hot mix asphalt (HMA), although some low traffic roadways can perform well with a single or double chip seal. CCPR allows better control of mix properties and quality control testing as opposed to CIR. CCPR also allows for a more fluid paving process considering paving does not rely on material milling and other operations associated with CIR. CCPR pavements can match life expectancies of traditional pavement projects with correct project selection.

Chapter 3: Cold Recycling Equipment

3.1 Cold In-Place Recycling

Equipment used in the CIR process is often called the "train" which should be capable of the following:

- Milling the existing asphalt pavement to the desired depth stated in design plans.
- Separating and breaking larger millings using a screening and crushing unit.
- Mixing cold millings, emulsion, water, and lime/cement.
- Reapplying the cold recycled material to the roadway surface.
- Paving and compacting the newly placed CIR material.


Image 1: Milling Machine


Image 2: Screening and Crushing Unit

3.1.1 Milling Machine

The milling machine, shown in Image 1, mills the existing asphalt pavement to a specified depth. The milling head can operate in a down cutting direction or up cutting direction resulting in a fine gradation or coarse gradation. Roadways can be milled at various widths and depths. 12.5',14', and 4' mills were used on the most recent CIR project, Box Elder – North.

3.1.2 Screening and Crushing Unit

Material is moved to the screening and crushing unit after milling. Millings are required to pass a 1.25 inch screen before being mixed with CIR additives. Any oversized material is resized in the crushing unit. The screening and crushing unit is displayed in Image 2.

3.1.3 Pugmill Mixer

Millings are fed to the pugmill mixer from the screening and crushing unit. Recycling additives, water, asphalt emulsion and lime/cement are added to the millings. The pugmill blends the millings and additives together to make a homogeneous mixture. After mixing, the cold recycled material is deposited in a windrow.

3.1.4 Paver

The windrow is gathered by the windrow elevator and placed and compacted by conventional paving equipment. This process is shown in Image 3. It is estimated that the maximum amount of material that can be paved is comparable to a 17’ wide roadway by a 0.30’ thickness. Because of this, the paver limits how much roadway can be milled.

Image 3: Windrow Elevator and Paver

3.1.5 Rollers

Compaction is carried out by double drum steel rollers and pneumatic rollers. Images 4 and 5 display the different rollers.

Image 4: Pneumatic Roller

Image 5: Double Drum Steel Roller

For more information about the different CIR processes as well as the equipment used for these processes, see the following link: CIR Processes and Equipment.

3.2 CCPR Equipment

Equipment used for CCPR should be capable of the following:

- Milling the existing pavement to the desired design depth.
- Loading and transporting the milled surface to a central plant.
- Screening and crushing millings.
- Blending asphalt emulsion, recycling agents, and cold millings.
- Loading and transporting the new CCPR mix to the construction site and placing it on the roadway.
- Paving and compacting the newly placed CCPR material.

Equipment for different cold recycling processes does not vary much. However, some additional equipment is required for CCPR. The following equipment along with their tasks are described below:

- Dump trucks are needed to transport CCPR mix and millings to and from construction sites.
- Other heavy equipment is needed to transport stock piled millings to the central plant for recycling.

Contractors operating in Montana that have equipment to produce cement treated base (CTB) may be able to produce CCPR with small equipment modifications or additional components such as emulsion injection.

For more information about the CCPR processes as well as the equipment used for these processes, see the following link: CCPR Processes and Equipment.

Chapter 4: Guidelines for CIR Projects

4.1 Pavements Characteristics

Existing PMS thickness should exceed 0.35’. This thickness allows 0.25’ of material to be recycled, and leaves 0.10’ of PMS for equipment operation. Collect PMS cores prior to the project, to determine existing PMS thickness.

If PMS thickness is inadequate, cold millings may be placed over existing pavement before CIR to provide additional thickness. Cold millings can also be used to level pavements prior to CIR. If pavements are underlain by soft or saturated subgrades, verify that adequate pavement structure exists to prevent CIR equipment from breaking through remaining pavement. Typically, 0.10’ of PMS and 0.66’ of base course will provide enough structure to prevent equipment breakthrough. A CIR candidate must be in good structural condition, and should exhibit less than 10% base failure.

4.2 Recommended CIR Depth

Recommended CIR depth is 0.25’ but can be increased to 0.40’ if needed. Increasing the thickness of the CIR will delay the onset of reflective cracking. If CIR thickness is 0.25’ or greater, CIR will have a similar design life to a mill and fill treatment.

4.3 Typical Section Consideration

Ideally, milling equipment mills 12 to 14’ of the roadway with one pass of the recycling train. It is recommended that 6”-12” of existing surface should be left on the shoulders of the roadway to prevent rollout during paving and compaction. With regards to shoulder width, recycling to the edge of the rumble strip can improve economy by requiring only one pass of the recycling train. It is estimated that 10% to 15% of the total CIR cost can be eliminated if 6” or more of the shoulders are left on the roadway.

4.4 Traffic

CIR projects followed by a chip seal should carry less than 50 daily equivalent single axle loadings (ESALs) and less than 2,000 average daily traffic (ADT). CIR can be performed on roadways with more than 2,000 ADT and/or 50 ESALs provided an overlay is placed over the CIR material. CIR should not be placed on high traffic roadways given it is more susceptible to rutting.

4.5 Environmental Aspects (Temperature and Precipitation)

<u>During Construction</u>: During CIR, daytime temperatures should exceed 55ºF with nighttime temperatures exceeding 35ºF. Curing problems may occur if work proceeds during cold, damp conditions that typically occur during early spring, late fall or at higher elevations in Montana.

<u>After Construction</u>: In most circumstances, CIR placed without an overlay is not recommended in wet environments or in locations where snowplow damage occurs. CIR material has a high air void content (8 to 14% by volume) causing the material to be more prone to moisture damage. There are some instances where CIR will work adequately in wet environments. One example is on very low traffic roadways. CIR projects in wet environments should be looked at on a case-by-case basis.

4.6 Project Length

Project length should be at least 5 miles. If possible, tie two or more CIR projects together for bid letting. Since CIR requires special equipment, mobilization costs may make small projects non-cost effective.

4.7 Time Constraints

Cold recycled material should be placed between the dates of May 15 to August 1 when surface treatments consist of a seal and cover. The seal and cover should be applied twenty five to thirty calendar days after CIR construction.

When surface treatments consist of an overlay, CIR material should be placed between the dates of May 15 to October 1. The overlay should be applied twelve to fifteen calendar days after the CIR construction.

4.8 Lack of Locally Available Materials

Cold in-place recycling can be more cost effective when aggregates are not available locally.

Chapter 5: Advantages and Disadvantages of Cold Recycling

5.1 Cold In-Place Recycling

Advantages

- Cost effective in areas lacking aggregate or when the cost of road oil is high
- Eliminates hauling of asphalt to a project location resulting in lower fuel costs
- Reduces wear and tear on haul routes
- Ease of construction
- High production rate
- Environmentally friendly

Disadvantages

- Lack of MDT expertise
- Lack of local contractors
- Contractor unfamiliarity
- Additional design time
- Ride specification for CIR with a chip seal do not exist
- Lack of control of CIR mix properties and densities
- Millings are unavailable to counties or cities

The disadvantages regarding contractors should be alleviated as more CIR projects are built in Montana. Another advantage is CIR does not raise the existing grade substantially making the process ideal for secondary roads that cannot be narrowed.

5.2 Cold Central Plant Recycling

Advantages

- Millings and CCPR mix can be stockpiled in any central location to use on any project.
- Gradation can be controlled and improved. Virgin aggregate can be combined with millings if desired.
- Cost effective in areas lacking aggregate
- Cost effective on roadways that require reconstruction of base material. Plant mix can be milled off and transported to a central plant. Millings can then be reapplied after reconstruction of the base material.
- CCPR can completely eliminate cracking when the base is pulverized and reconstructed.

Disadvantages

- Lack of MDT expertise
- Lack of local contractors
- Contractor unfamiliarity
- Additional design time
- Millings are unavailable to counties or cities

Chapter 6: Cost of Cold In-Place Recycling vs. Traditional Pavement Preservation Treatments

Cost analysis implemented on CIR and traditional pavement preservation alternatives are listed in Table 1 below. These costs are based on a PMS unit cost of $80.82/ton, a 0.20’ thick CIR unit cost of $4.49/yd^2, a 0.30’ thick CIR unit cost of $5.30/yd^2, a milling unit cost of $1.75/yd^2, a double chip seal unit cost of $2.75/yd^2, and a single chip seal unit cost of $1.75/yd^2. All options consist of a 0.30’ surface thickness, 32’ surface width, and a total project length of 1 mile.

Pavement Preservation Options	Cost/mile
0.30' Mill and Fill	$333,197
0.10' Isolation Lift with a 0.20' Overlay	$303,423
0.20' CIR with 0.10' Overlay	$169,839
0.30' CIR with Double Chip Seal	$139,694
0.30' CIR with Single Chip Seal	$120,921

Table 1: Pavement Preservation Comparison

CIR with a single chip seal is the most economical pavement preservation option. Cost savings include the following:

- 16% savings over CIR with a double chip seal.
- 40% savings over CIR with an overlay.
- 151% savings over an isolation lift and overlay.
- 176% savings over a mill and fill.

Full cost analysis for each option can be found in Appendix E.

The tables below show cost comparisons between the most recent CIR projects and other pavement rehabilitation treatments. As displayed by Tables 2-8, CIR projects have a significantly lower cost/yd^2 than those of other pavement treatments.

Letting Date	Project	Area (yd^2)	Total Cost	Cost/yd^2
2/12/2015	Box Elder - North	437,901	$6,383,125	$14.58
3/22/2012	East Glacier - Browning	216,438	$5,064,922	$23.40
7/29/2010	East of Conrad - East	104,974	$1,020,963	$9.73
6/10/2010	Colstrip - North	235,736	$4,125,124	$17.50
7/29/2010	Mehmke Hill	156,329	$2,769,384	$17.72
5/14/2009	North of Lame Deer - North	142,560	$1,510,075	$10.59
3/27/2008	Jct - MT 16 - Northwest	141,727	$1,582,327	$11.16
5/26/2008	Lodge Grass - North	347,776	$8,523,540	$24.51
5/26/2008	West of Lodge Grass - Southwest	124,667	$1,484,494	$11.91
3/27/2008	Hebgen Lake - East and West	289,950	$2,234,953	$7.71
3/29/2007	Lewistown - North	70,281	$657,482	$9.36

Table 2: A comparison of costs between each CIR project

Letting Date	Project Type	Project	Area (yd^2)	Total Cost	Cost/yd^2
3/29/2007	0.15' CIR	Lewistown - North	70,281	$657,482	$9.36
12/7/2006	0.15' Overlay	Wibaux - South	372,181	$4,154,345	$11.16
3/29/2007	0.15' Mill/Fill	Shelby - North	20,037	$294,372	$14.69

Table 3: Comparison of different projects in 2007

Letting Date	Project Type	Project	Area (yd^2)	Total Cost	Cost/yd^2
3/27/2008	0.20' CIR	Hebgen Lake - East and West	289,950	$2,234,953	$7.71
3/27/2008	CIR	Jct - MT 16 - Northwest	141,727	$1,582,327	$11.16
5/26/2008	CIR	West of Lodge Grass - Southwest	124,667	$1,484,494	$11.91
5/26/2008	0.33' CIR w/ 0.23' Overlay	Lodge Grass - North	347,776	$8,523,540	$24.51
3/27/2008	0.25' Overlay	St. Xavier - North and South	98,560	$2,131,971	$21.63
3/27/2008	0.15' Mill/Fill	Hardin - South	27,079	$444,605	$16.42

Table 4: Comparison of different projects in 2008

Letting Date	Project Type	Project	Area (yd^2)	Total Cost	Cost/yd^2
5/14/2009	0.25' CIR	North of Lame Deer	142,560	$1,510,075	$10.59
6/25/2009	0.25' Mill/0.20' Fill	Busby - Northeast	119,093	$2,078,708	$17.45
5/28/2009	0.15' Mill/Fill and 0.35' Overlay	Laurel - Northeast	106,086	$1,686,423	$15.90

Table 5: Comparison of different projects in 2009

Letting Date	Project Type	Project	Area (yd^2)	Total Cost	Cost/yd^2
7/29/2010	0.25' CIR	East of Conrad	104,974	$1,020,963	$9.73
6/10/2010	0.25' CIR w/0.15' Overlay	Colstrip - North	235,736	$4,125,124	$17.50
7/29/2010	0.25' CIR w/0.15' Overlay	Mehmke Hill	156,329	$2,769,384	$17.72
8/12/2010	0.98' Pulverize/0.33' Overlay	Bridger - South	292,741	$7,908,625	$27.02
6/10/2010	0.30' PMS and 1.0' CAC	Redstone East and West	153,301	$7,420,695	$48.41

Table 6: Comparison of different projects in 2010

Letting Date	Project Type	Project	Area (yd^2)	Total Cost	Cost/yd^2
3/22/2012	0.20' CIR w/ 0.20' Overlay	East Glacier - Browning	216,438	$5,064,922	$23.40
12/1/2011	0.66' Pulverize/.3' Overlay	Forsyth - Northwest	210,167	$6,389,829	$30.40
4/26/2012	0.40' Overlay	Saltese - East	340,156	$10,817,104	$31.80

Table 7: Comparison of different projects in 2012

Letting Date	Project Type	Project	Area (yd^2)	Total Cost	Cost/yd^2
2/12/2015	0.30' CIR w/0.15' Overlay	Box Elder - North	437,901	$6,383,125	$14.58
4/30/2015	0.20' Mill/Fill	Big Timber - East	421,251	$7,707,784	$18.30
2/26/2015	0.20' Mill/Fill and 0.15' Overlay	Decker - North and South	117,783	$2,941,778	$24.98

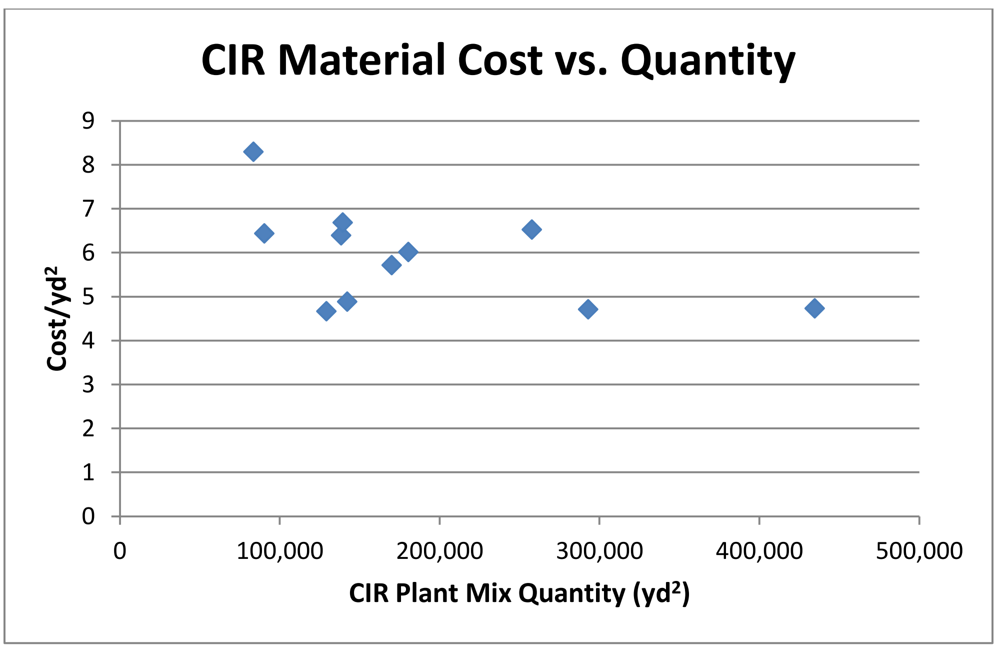
Table 8: Comparison of different projects in 2015

Costs in Tables 1-8 are strictly calculated from pavement materials of each project, not total costs of entire projects. Cost analysis of pavement materials for CIR projects from 2007 to 2015 can be accessed by selecting any hyperlinked project in Tables 2-8. Costs of separate items as well as total cost of each project from years 2002 through 2015 can be found using the following link: Bid Tabs. Once the 'Bid Tabs' link is selected, a year and a letting date will need to be chosen for a preferred project. The letting dates are also displayed above in Tables 2-8.

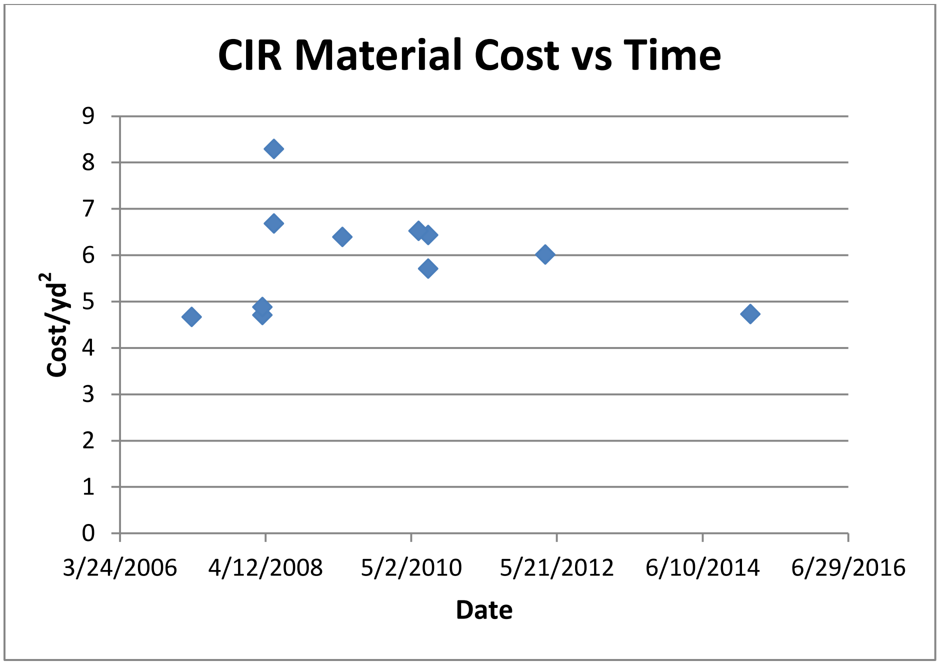
Most CIR projects listed above have additional typical sections that do not contain CIR. Those pavement treatments are included in the total cost and cost/yd^2 in Tables 1-8 above. To see comparisons of CIR material costs alone refer to Graphs 1-4 and Tables 9-11 below and on the following pages.

Project	Letting Date	Cold Recycled Plant Mix Quantity (yd^2)	Cold Recycled Plant Mix Unit Price	Mineral Filler Quantity (ton)	Mineral Filler Unit Price	Recycling Agent Quantity (ton)	Recycling Agent Unit Price	Total Cost	Total Cost/yd^2
Box Elder - North	2/12/2015	434,751	$2.30	839	$156	1674	$553	2,056,478.00	4.73
East Glacier - Browning	3/22/2012	180,498	$2.50	325	$225	795	$705	1,084,915.50	6.01
East of Conrad	7/29/2010	90,379	$2.75	203	$205	419	$695	581,501.25	6.43
Colstrip North	6/10/2010	257,697	$2.90	578	$202	1242	$657	1,680,308.80	6.52
Mehmke Hill	7/29/2010	170,137	$2.50	369	$200	788	$600	971,662.50	5.71
North of Lame Deer	5/14/2009	138,541	$2.65	312	$130	667	$717	885,827.61	6.39
Hebgen Lake - East and West	3/27/2008	292,984	$2.50	527	$210	1128	$475	1,378,703.50	4.71
Jct MT 16 - Northwest	3/27/2008	142,200	$2.90	254	$140	547	$450	693,989.00	4.88
Lodge Grass - North	5/26/2008	83,659	$3.10	283	$264	608	$592	693,686.90	8.29
West of Lodge Grass	5/26/2008	139,527	$3.10	346	$264	691	$592	932,604.20	6.68
Lewistown - North	3/29/2007	129,354	$2.75	223	$185	479	$430	603,157.50	4.66

Table 9: Total costs based on cold recycled plant mix, mineral filler, and recycling agent



Graph 1: Cost vs Quantity – CIR Materials

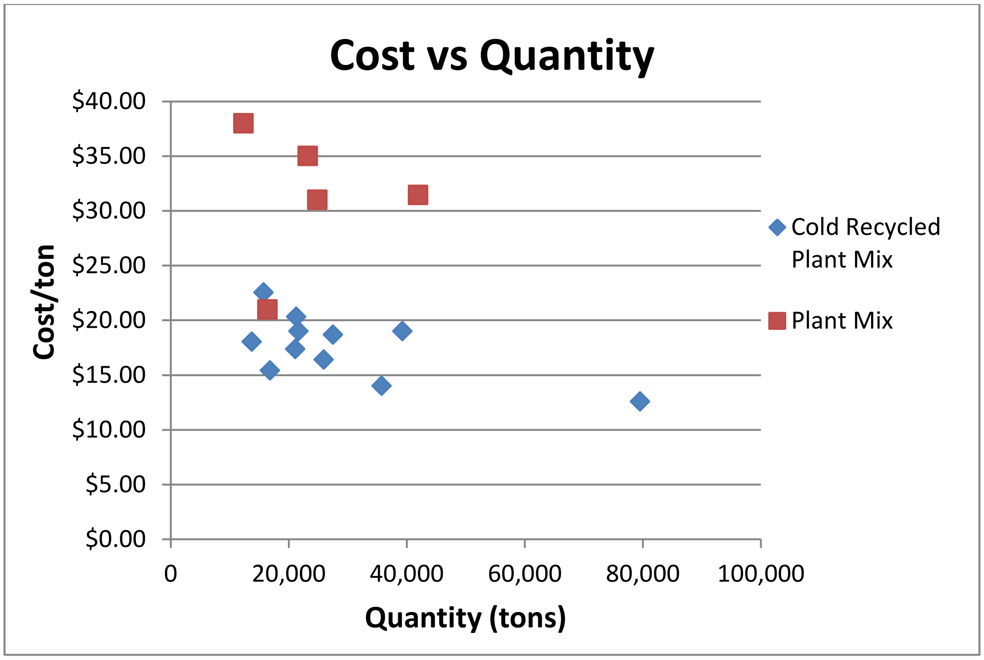


Graph 2: Cost vs. Time – CIR Materials

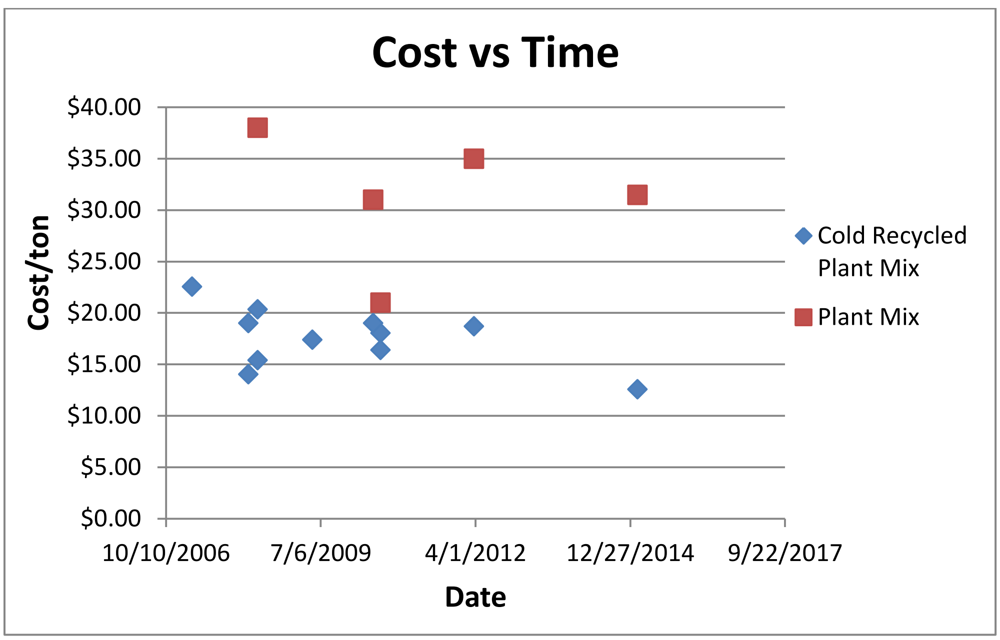
Graphs 1 and 2 display cost vs quantity and cost vs time of CIR materials for projects from 2007 to 2015. CIR materials used to calculate total costs included cold recycled plant mix, recycling agent, and mineral filler which can be seen in Table 9 on the previous page.

Project	Letting Date	Cold Recycled Plant Mix Quantity (ton)	Plant Mix Quanitity (tons)	Total Cost Cold Recycled Plant Mix	Total Cost Plant Mix	Cold Recycled Plant Mix (Cost/ton)	Plant Mix (Cost/ton)
Box Elder - North	2/12/2015	79,559	41,953	$999,927	$1,319,856	$12.57	$31.46
East Glacier - Browning	3/22/2012	27,526	23,224	$514,419	$812,843	$18.69	$35.00
East of Conrad	7/29/2010	13,783	-	$248,542	-	$18.03	-
Colstrip North	6/10/2010	39,299	24,868	$747,321	$770,901	$19.02	$31.00
Mehmke Hill	7/29/2010	25,946	16,418	$425,343	$344,783	$16.39	$21.00
North of Lame Deer	5/14/2009	21,128	-	$367,134	-	$17.38	-
Hebgen Lake - East and West	3/27/2008	35,744	-	$501,003	-	$14.02	-
Jct MT 16 - Northwest	3/27/2008	21,686	-	$412,380	-	$19.02	-
Lodge Grass - North	5/26/2008	16,841	12,379	$259,418	$470,392	$15.40	$38.00
West of Lodge Grass	5/26/2008	21,278	-	$432,534	-	$20.33	-
Lewistown - North	3/29/2007	15,781	-	$355,724	-	$22.54	-

Table 10: Comparison between cold recycled plant mix and plant mix



Graph 3: Cost vs Quantity – CIR Plant Mix and Plant Mix



Graph 4: Cost vs Time – CIR Plant Mix and Plant Mix

Refer to Table 10 to see comparisons between cold recycled plant mix and plant mix. Graphs 3 and 4 display cost vs. quantity and cost vs. time comparisons between cold recycled plant mix and plant mix. Cost of cold recycled plant mix is considerably lower than plant mix and appears to be decreasing with time.

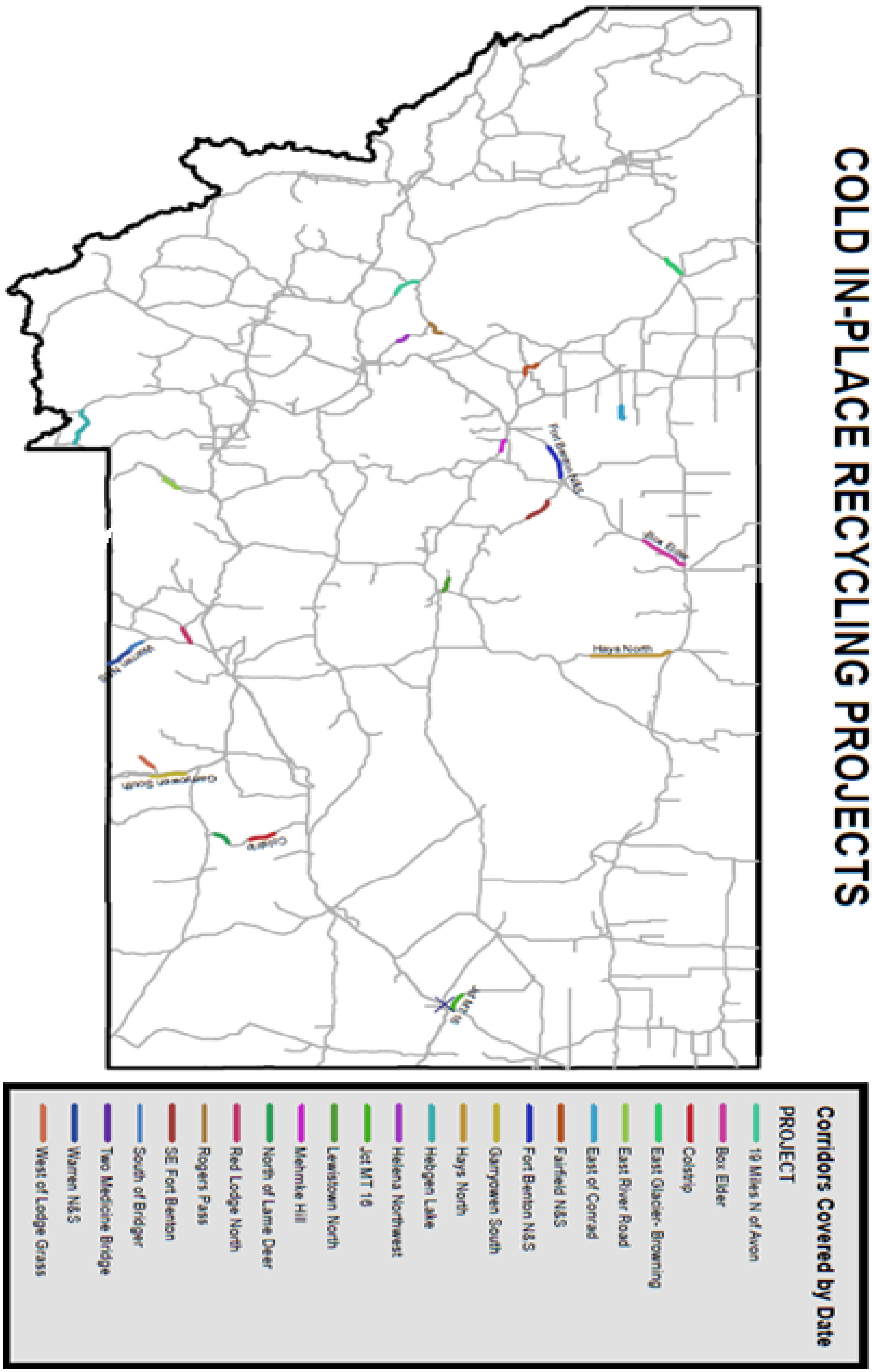
Project	Letting Date	CIR-EE Quantity (tons)	CIR-EE Unit Price (Cost/ton)	CRS-2P Quantity (tons)	CRS-2P Unit Price (Cost/ton)	Cost/yd^2 CIR-EE	Cost/yd^2 CRS-2P
Box Elder - North	2/12/2015	1674	$553	790	$555	$2.13	$2.91
East Glacier - Browning	3/22/2012	795	$705	389	$625	$3.11	$2.86
East of Conrad	7/29/2010	419	$695	177	$505	$3.22	$4.28
Colstrip North	6/10/2010	1242	$657	425	$531	$3.17	$2.57
Mehmke Hill	7/29/2010	788	$600	276	$495	$2.78	$2.19
Lodge Grass - North	5/26/2008	608	$592	627	$480	$4.30	$1.99

Table 11: Comparison between different emulsions

Shown in Table 11 are relative costs of emulsions used on CIR projects in Montana. CIR-EE is used for cold recycled plant mix whereas CRS-2P is used for chip seals. These prices can be used to estimate cost of emulsions in certain locations in Montana.

Appendix G includes the following bid price reports for mineral filler, lime slurry, cold recycled plant mix, and recycling agent. Some CIR projects are not included in the bid price reports. Refer to Appendix F if CIR materials cannot be found in the bid price reports.

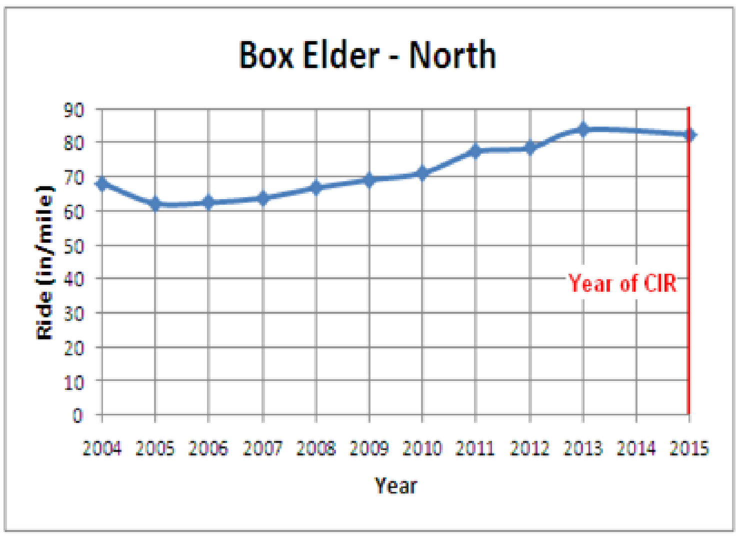
Chapter 7: Montana's Past CIR Projects



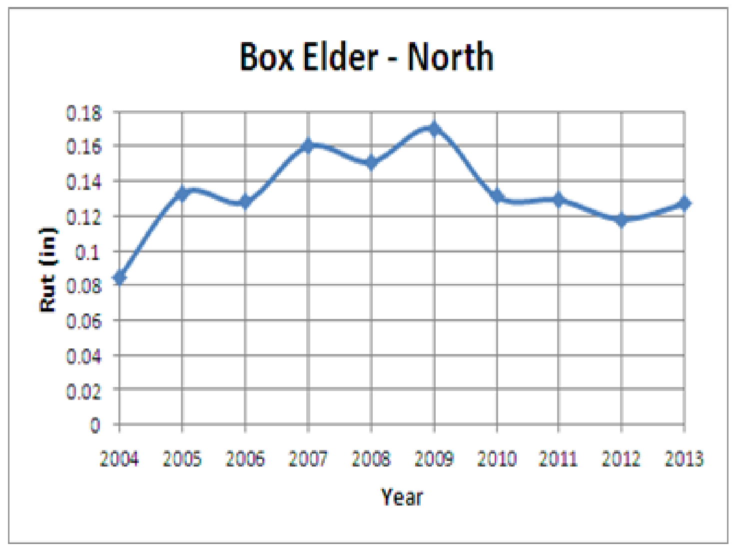
Chapter 8: Performance of Past CIR Projects

8.1 Box Elder – North NH 10-3(19)89 CN 6814000

Roadway: US 87, RP 89.0 to RP 111.1
Corridor: C000010
Construction Date: June 2015
Traffic: 92 daily ESALs
Treatment: 0.30' CIR w/ 0.15' PMS overlay
Total Cost: $6,383,124
Cost/yd^2: $14.58/yd^2



Graph 5: Ride vs Year: Box Elder – North



Graph 6: Rut vs Year: Box Elder – North

Note: The 2015 ride data was collected prior to the overlay which was placed on the CIR surface. The 2015 ride displays the ride performance of the CIR surface.

For a full summary of the project and past images of the roadway select the following link: Box Elder - North.

8.2 East Glacier – Browning CBI 1-3(65)209

Roadway: US 2, RP 208.9 to RP 219.2

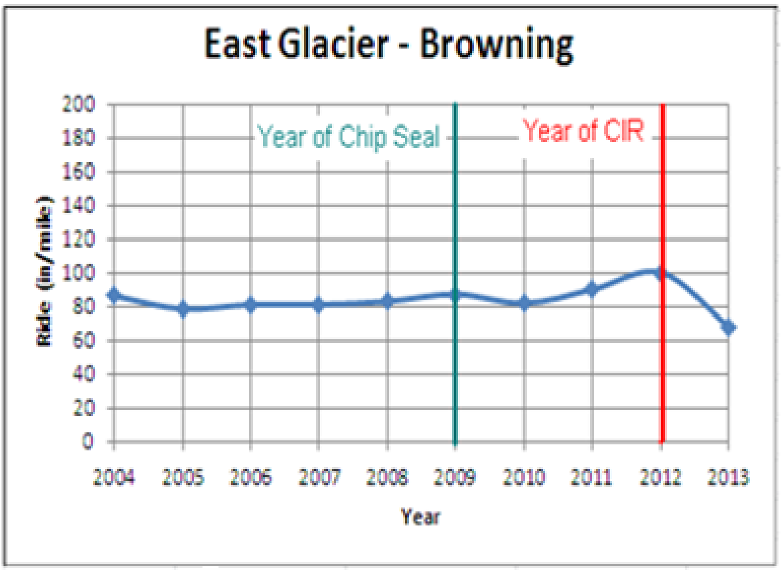
Construction Date: July 2012

Traffic: 78 daily ESALs

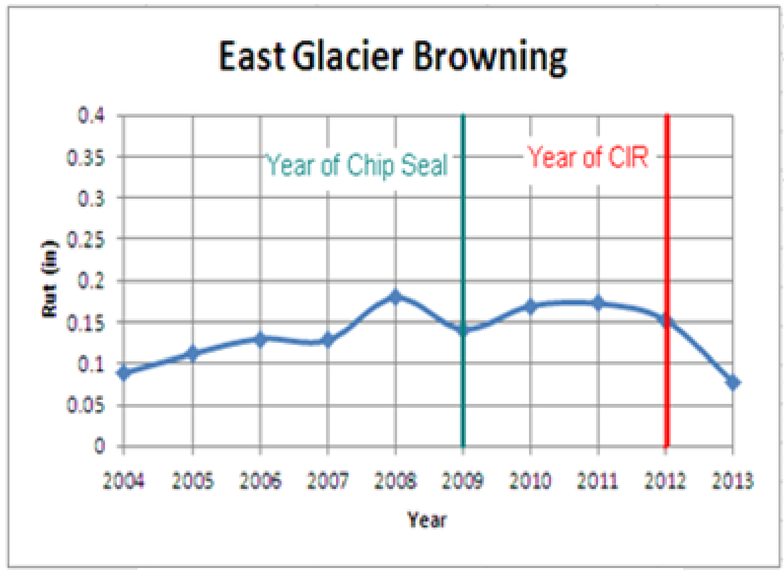
Treatment: 0.20' CIR w/ 0.20' PMS overlay

Total Cost: $5,064,922

Cost/yd^2: $23.40/yd^2



Graph 7: Ride vs. Year – East Glacier - Browning



Graph 8: Rut vs. Year – East Glacier - Browning

Distress	PVMS Distress Score		
	2009	2011 (Before CIR)	2013 (After CIR)
Rut Index	71	65	80
Ride Index	77	77	83
ACI	91	85	100
MCI	79	97	100

Table 14: Distress Scores – East Glacier - Browning

For a full summary of the project and past images of the roadway select the following link: East Glacier-Browning.

8.3 East of Conrad STPS 218-1(10)19

Roadway: S-218, RP 18.8 to RP 25.9

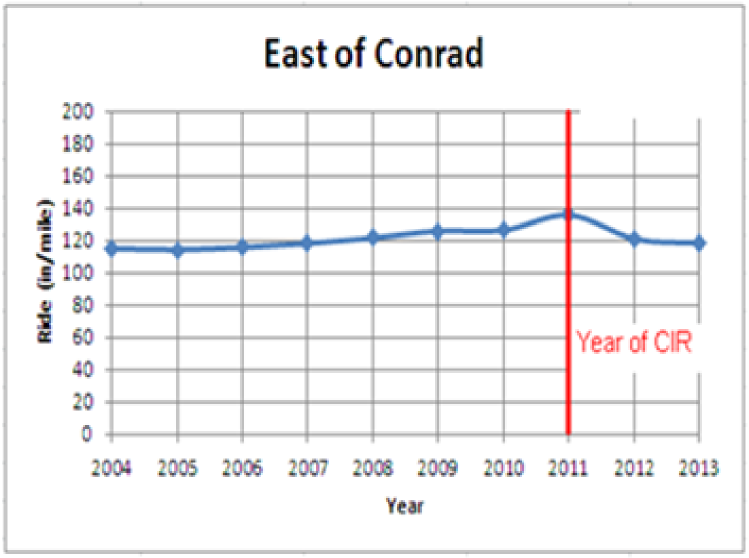
Construction Date: June 2011

Traffic: 3 daily ESALs

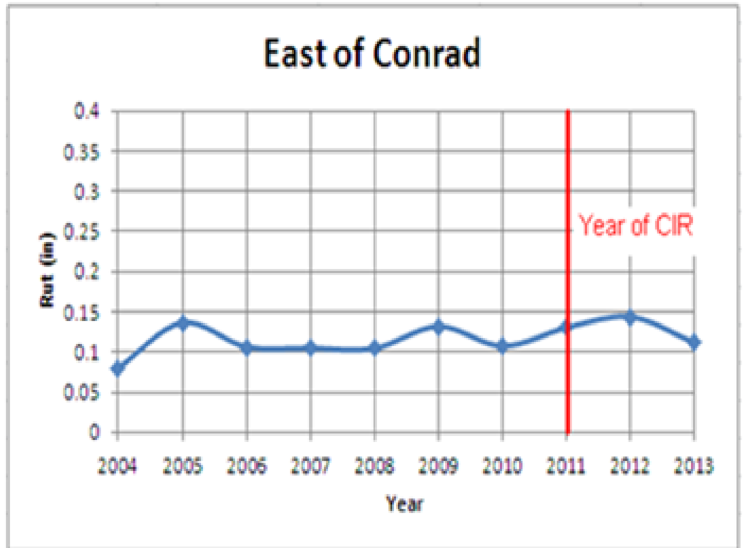
Treatment: 0.25' CIR w/ Chip Seal

Total Cost: $1,020,963

Cost/yd^2: $9.73/yd^2



Graph 9: Ride vs. Year – East of Conrad



Graph 10: Rut vs. Year – East of Conrad

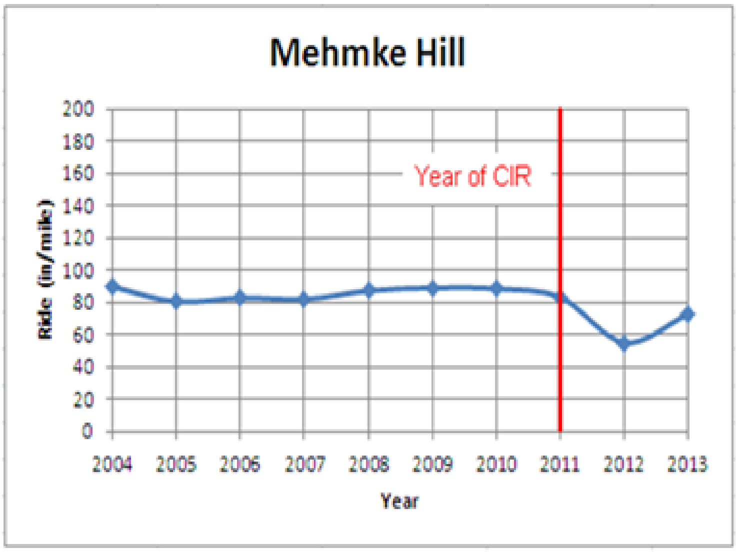
Distress	PVMS Distress Score		
	2010 (Before CIR)	2012 (After CIR)	2013
Rut (in)	0.11	0.14	0.11
Ride (in/mile)	124	121	118

Table 15: Distress Scores – East of Conrad

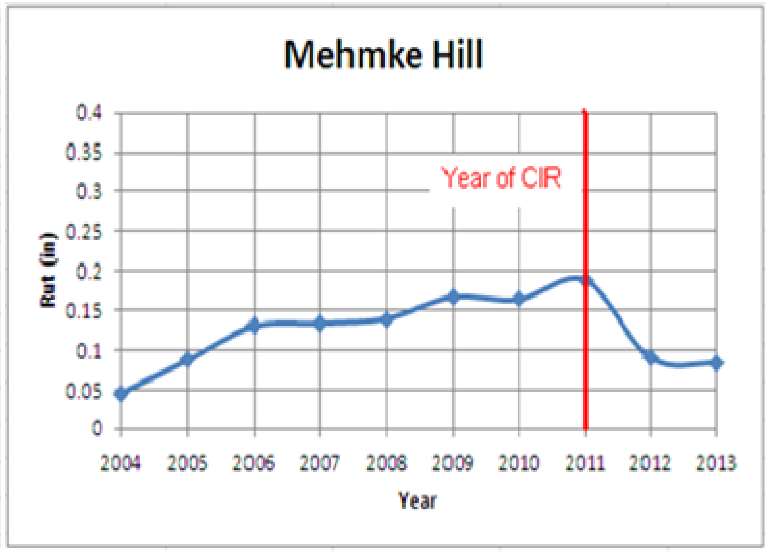
For a full summary of the project and past images of the roadway select the following link: East of Conrad.

8.4 Mehmke Hill NH 60-2(90)82

Roadway: US 87, RP 81.5 to RP 87.3
Construction Date: June 2011
Traffic: 252 daily ESALs
Treatment: 0.25' CIR w/ 0.15' PMS overlay
Total Cost: $2,769,384
Cost/yd^2: $17.72/yd^2



Graph 11: Ride vs. Year – Mehmke Hill



Graph 12: Rut vs. Year – Mehmke Hill

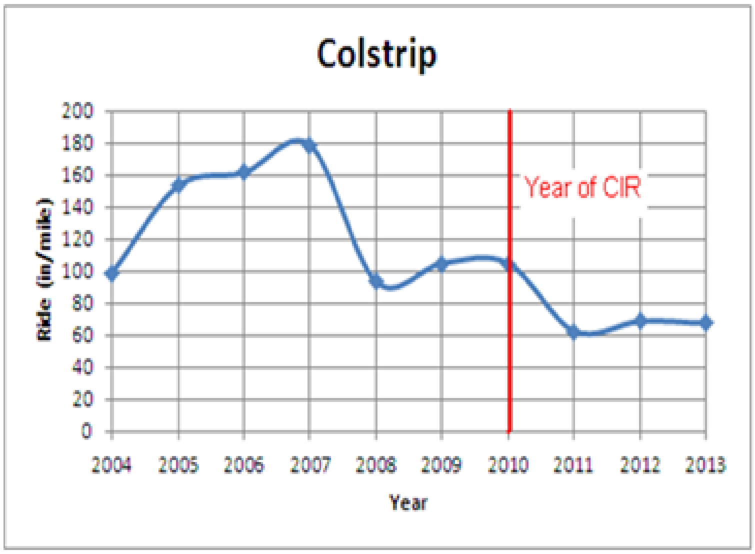
Distress	PVMS Distress Score		
	2010 (Before CIR)	2012 (After CIR)	2013
Rut (in)	0.16	0.09	0.08
Ride (in/mile)	89	55	73

Table 16: Distress Scores – Mehmke Hill

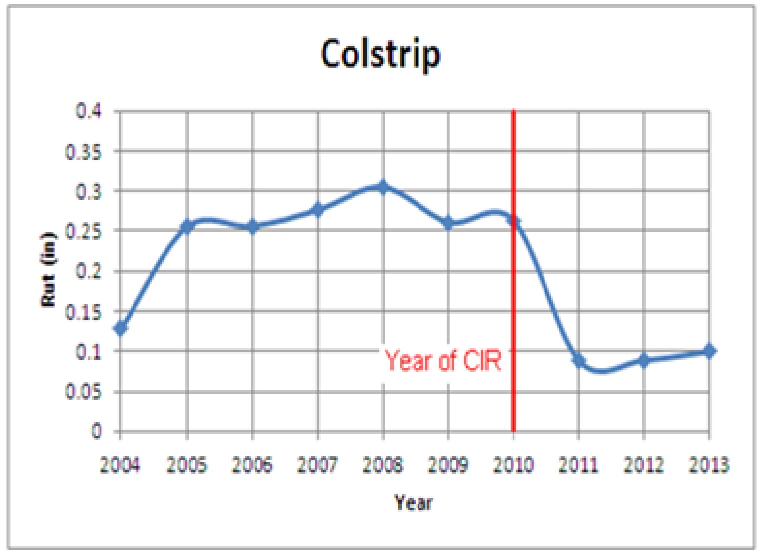
For a full summary of the project and past images of the roadway select the following link: Mehmke Hill.

8.5 Colstrip STPP 39-1(41)24

Roadway: P-39, RP 23.6 to RP 35.0
Construction Date: 2011
Traffic: 73 daily ESALs
Treatment: 0.25' CIR w/ 0.15' PMS overlay
Total Cost: $4,125,124
Cost/yd^2: $17.50/yd^2



Graph 13: Ride vs. Year – Colstrip



Graph 14: Rut vs. Year – Colstrip

Distress	PVMS Distress Score		
	2009 (Before CIR)	2011 (After CIR)	2013
Rut (in)	0.26	0.09	0.1
Ride (in/mile)	108	63	68

Table 17: Distress Scores – Colstrip

For a full summary of the project and past images of the roadway select the following link: Colstrip.

8.6 North of Lame Deer ARRA 39-1(39)4

Roadway: P-39, RP 4.2 to RP 12.3

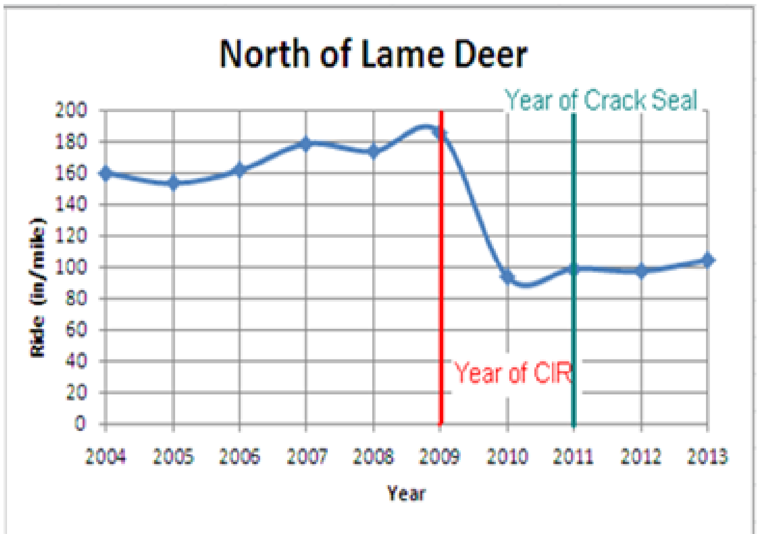
Construction Date: 2009

Traffic: 23 daily ESALs

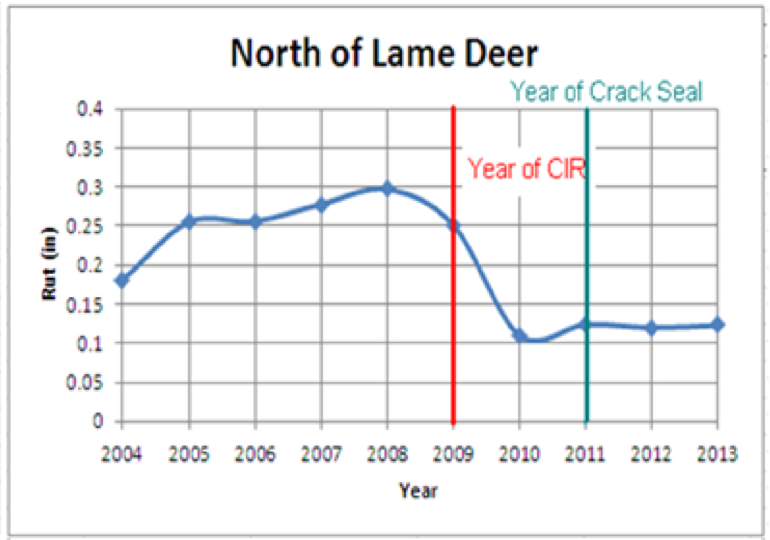
Treatment: 0.25' CIR w/ Chip Seal

Total Cost: $1,510,075

Cost/yd^2: $10.59/yd^2



Graph 15: Ride vs. Year – North of Lame Deer



Graph 16: Rut vs. Year – North of Lame Deer

Distress	PVMS Distress Score		
	2008 (Before CIR)	2010 (After CIR)	2013
Rut (in)	0.30	0.11	0.12
Ride (in/mile)	174	94	105

Table 18: Distress Scores – North of Lame Deer

For a full summary of the project and past images of the roadway select the following link: North of Lame Deer.

8.7 Hebgen Lake E&W STPP 87-1(9)0

Roadway: US 287, RP 0 to RP 22.4

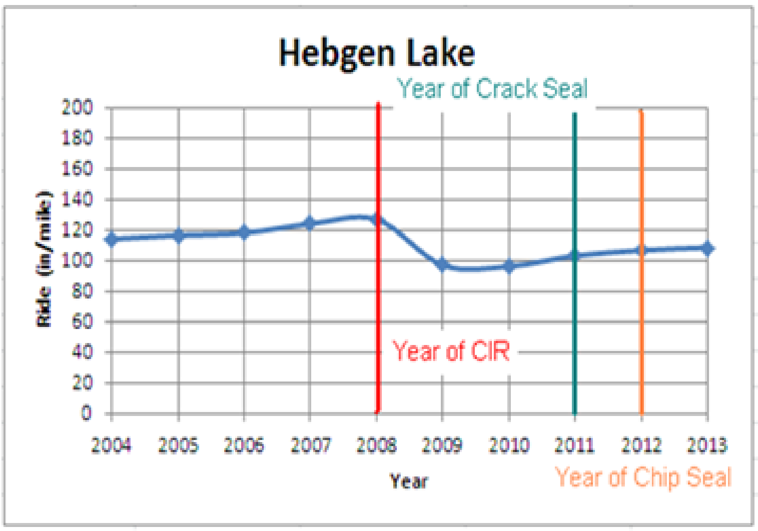
Construction Date: October 2008

Traffic: 22 daily ESALs

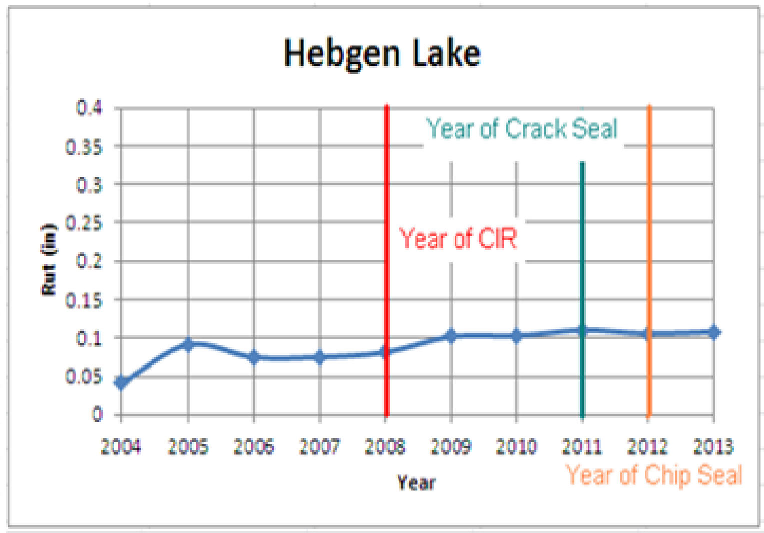
Treatment: 0.20' CIPR w/ Chip Seal

Total Cost: $2,234,953

Cost/yd^2: $7.71/yd^2



Graph 17: Ride vs. Year – Hebgen Lake



Graph 18: Rut vs. Year – Hebgen Lake

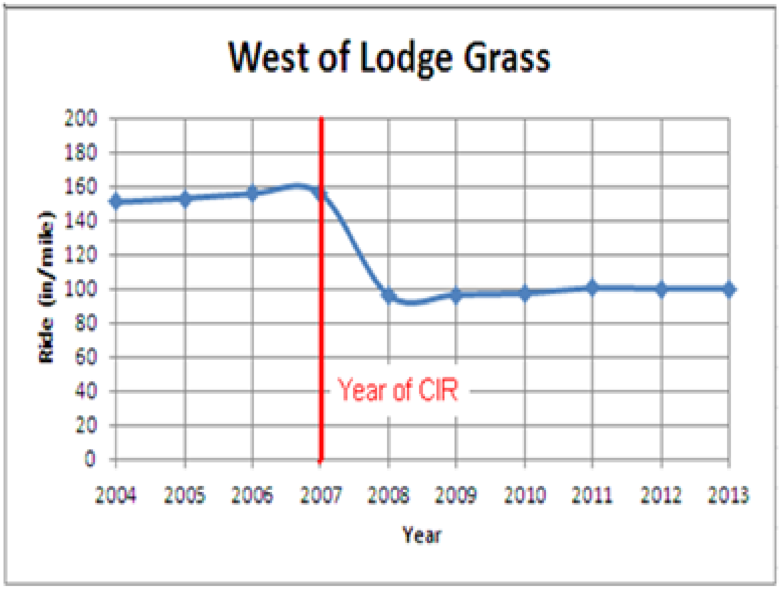
Distress	PVMS Distress Score		
	2007 (Before CIPR)	2009 (After CIPR)	2013
Rut Index	88	85	67
Ride Index	72	70	76
ACI	90	99	97
MCI	65	99	97

Table 19: Distress Scores – Hebgen Lake

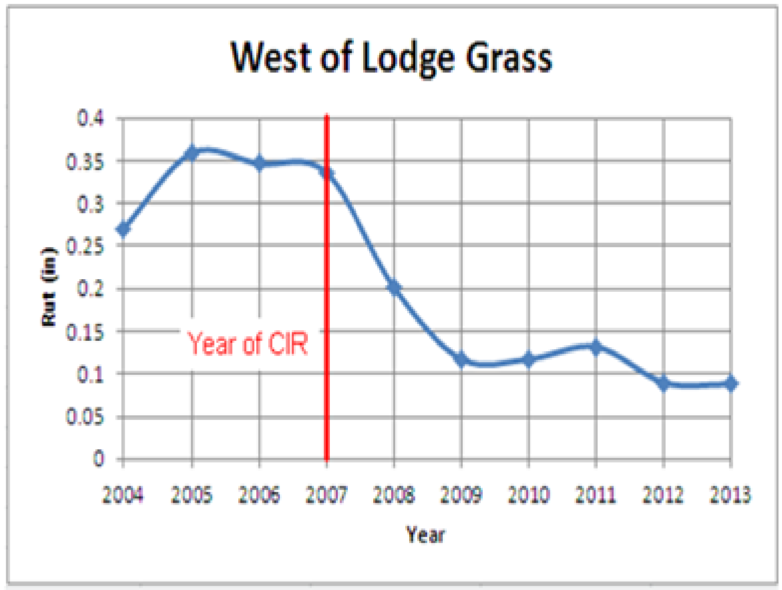
For a full summary of the project and past images of the roadway select the following link: Hebgen Lake.

8.8 West of Lodge Grass SFCS 463-1(5)6

Roadway: S-463, RP 5.7 to RP 14.2
Construction Date: 2008
Treatment: CIR w/ Chip Seal
Total Cost: $1,484,494
Cost/yd^2: $11.91/yd^2



Graph 19: Ride vs. Year – West of Lodge Grass



Graph 20: Rut vs. Year – West of Lodge Grass

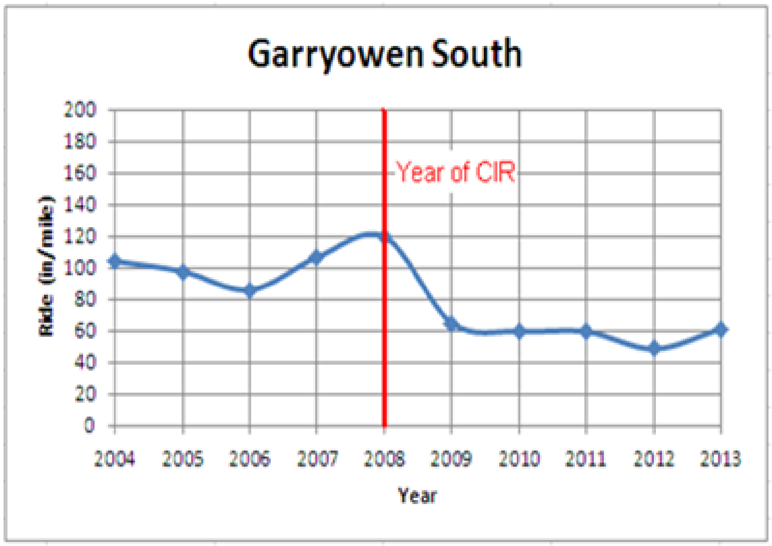
Distress	PVMS Distress Score		
	2008 (Before CIR)	2010 (After CIR)	2013
Rut (in)	0.20	0.12	0.09
Ride (in/mile)	96	97	100

Table 20: Distress Scores – West of Lodge Grass

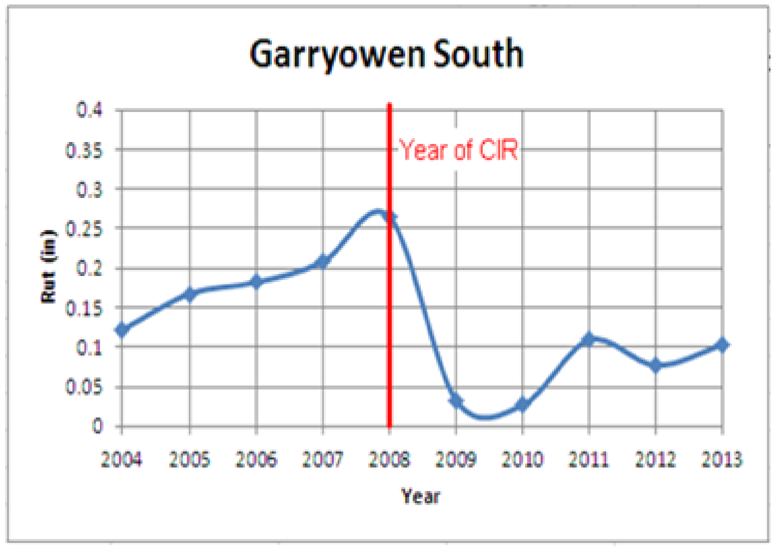
For a full summary of the project and past images of the roadway select the following link: West of Lodge Grass.

8.9 Garryowen South IM 90-9(100)517 & Lodge Grass North IM 90-9(102)510

Roadway: Interstate 90, RP 516.6 to RP 531.8
Construction Date: 2008
Traffic: 894 daily ESALs
Treatment: 0.33' CIR w/ 0.23 PMS Overlay
Total Cost: $8,523,540
Cost/yd^2: $24.51/yd^2



Graph 21: Ride vs. Year – Garryowen South



Graph 22: Rut vs. Year – Garryowen South

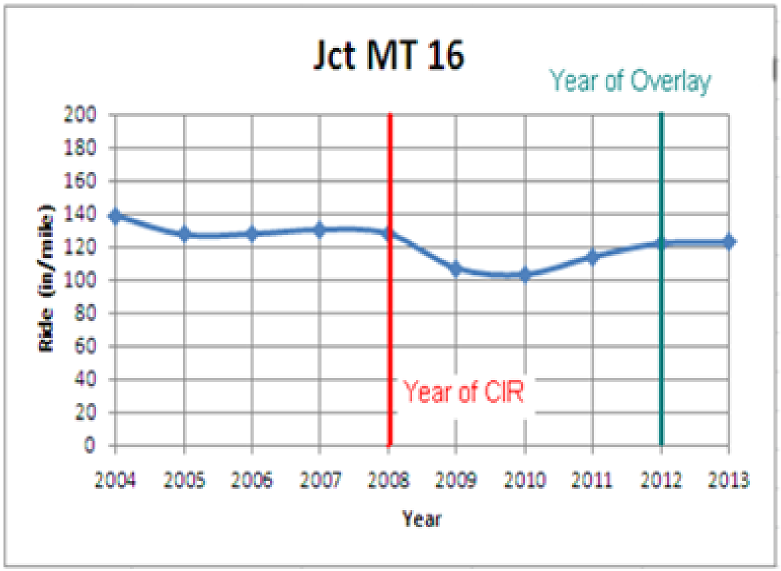
Distress	PVMS Distress Score		
	2008 (Before CIR)	2010 (After CIR)	2013
Rut Index	59	94	74
Ride Index	73	85	83
ACI	100	100	93
MCI	97	99	96

Table 21: Distress Scores – Garryowen South

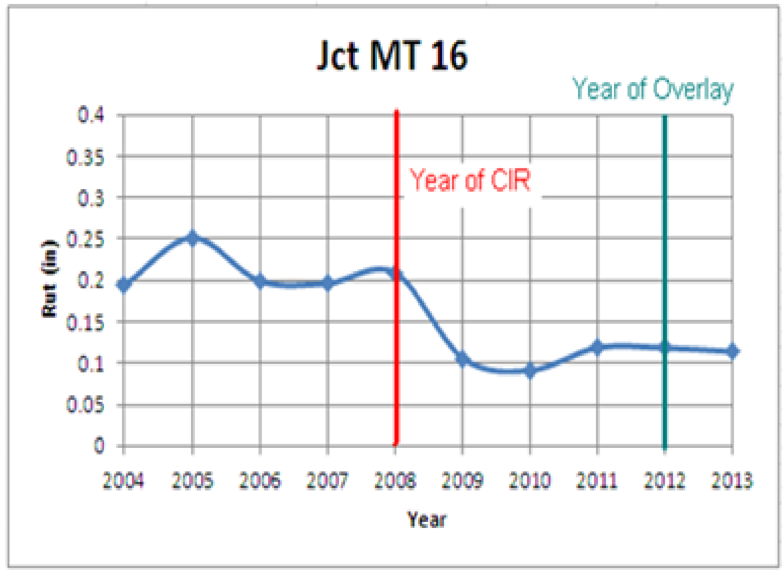
For a full summary of the project and past images of the roadway select the following link: Garryowen South.

8.10 JCT MT 16- Northwest STPS 254-1(23)0

Roadway: S-254, RP 0 to RP 9.4
Construction Date: August 2008
Traffic: 24 daily ESALs
Treatment: CIR w/ Chip Seal
Total Cost: $1,582,327
Cost/yd^2: $11.16/yd^2



Graph 23: Ride vs. Year – Jct MT 16



Graph 24: Rut vs. Year – Jct MT 16

Distress	**PVMS Distress Score**		
	2007 (Before CIR)	2009 (After CIR)	2013
Rut (in)	0.20	0.11	0.11
Ride (in/mile)	130	107	123

Table 22: Distress Scores – Jct MT 16

For a full summary of the project and past images of the roadway select the following link: Jct MT 16.

8.11 Lewistown – North STPS 426-2(9)19, Jct. Us 191 - West, CN 5976000

Roadway: Secondary 426, RP 26.9 to RP 19.0

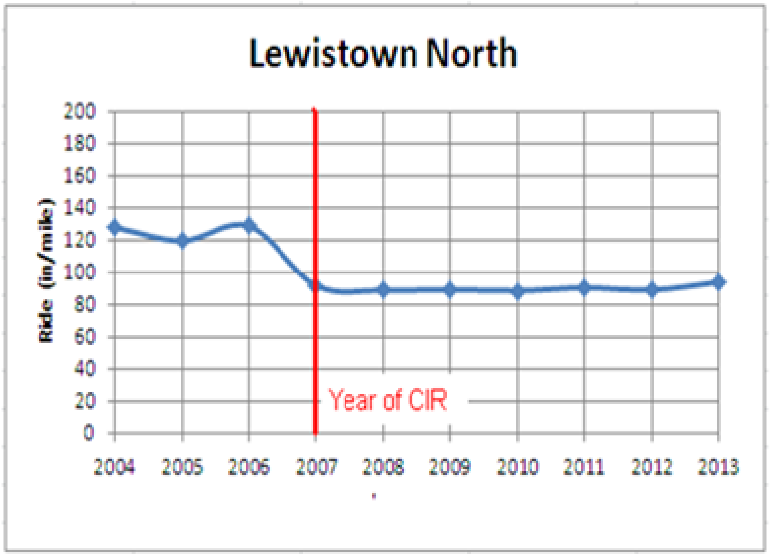
Construction Date: July 2007

Traffic: 7 to 19 daily ESALs

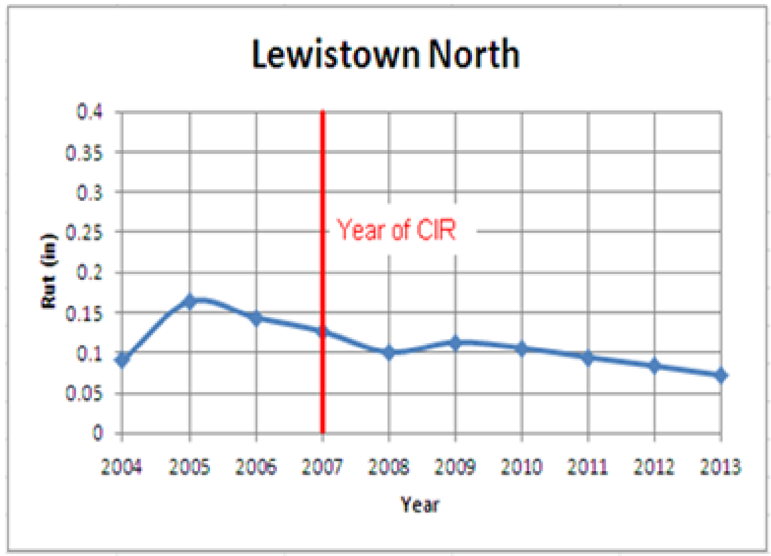
Treatment: 0.20' CIR w/ Chip Seal

Total Cost: $657,482

Cost/yd²: $9.36/yd²



Graph 25: Ride vs. Year – Lewistown North



Graph 26: Rut vs. Year – Lewistown North

Distress	PVMS Distress Score		
	2006 (Before CIPR)	2008 (After CIPR)	2013
IRI (in/mile)	0.14	0.10	0.07
Rut Depth (in)	128	88	94

Table 23: Distress Scores – Lewistown North

For a full summary of the project and past images of the roadway select the following link: Lewistown North.

8.12 South of Bridger

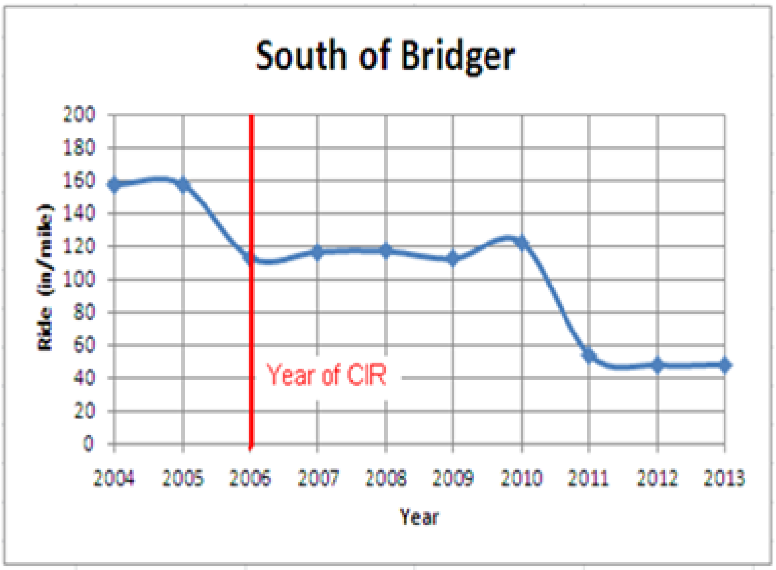
Roadway: US 310, RP 12.8 to RP 20.0

Treatment: 0.25' CIR w/ Chip Seal

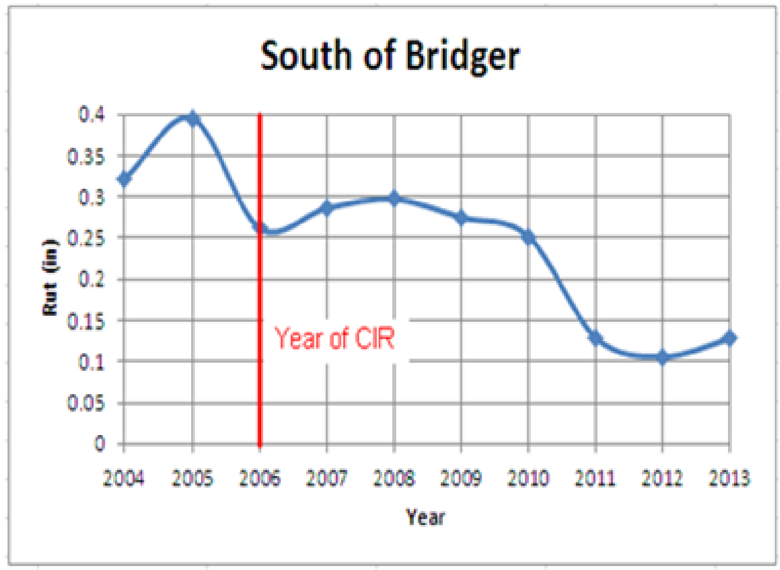
Traffic: **156 daily ESALs**

Construction Date: 2006

This is was a **Maintenance Project**.



Graph 27: Ride vs. Year – South of Bridger



Graph 28: Rut vs. Year – South of Bridger

Distress	PVMS Distress Score		
	2005 (Before CIPR)	2006 (months After CIPR)	2014
Rut Index	46	57	80
Ride Index	58	69	83
IRI (in/mile)	158	113	61
Rut Depth (in)	0.40	0.26	0.09

Table 24: Distress Scores – South of Bridger

For a full summary of the project and past images of the roadway select the following link: South of Bridger.

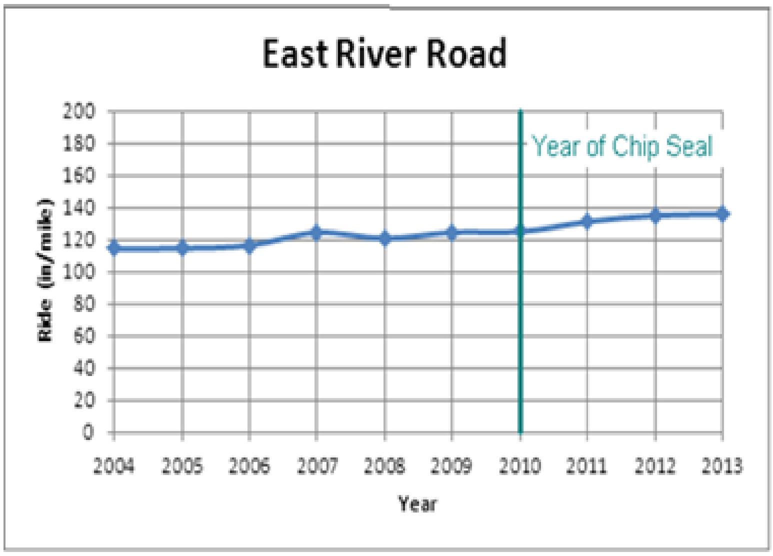
8.13 East River Road

Roadway: S-540, RP 10.5 to RP 20.0,

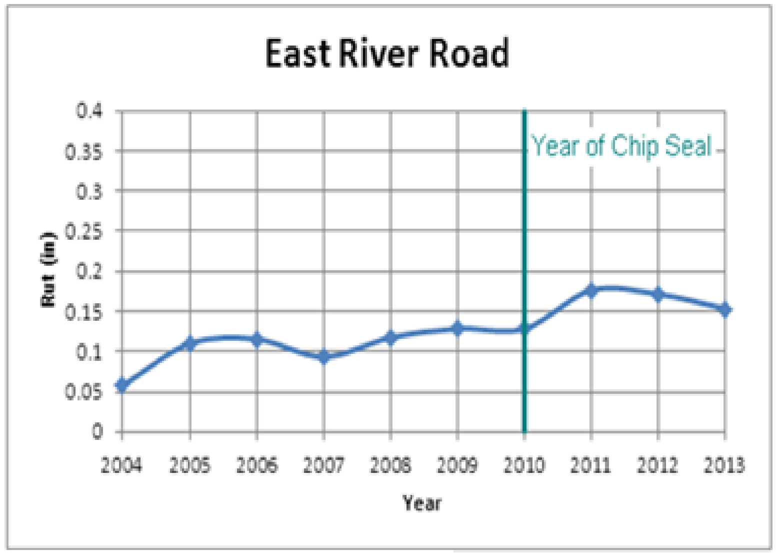
Treatment: 0.35' CIR w/ Chip Seal

Construction Date: 2003

This is was a **Maintenance Project**.



Graph 29: Ride vs. Year – East River Road



Graph 30: Rut vs. Year – East River Road

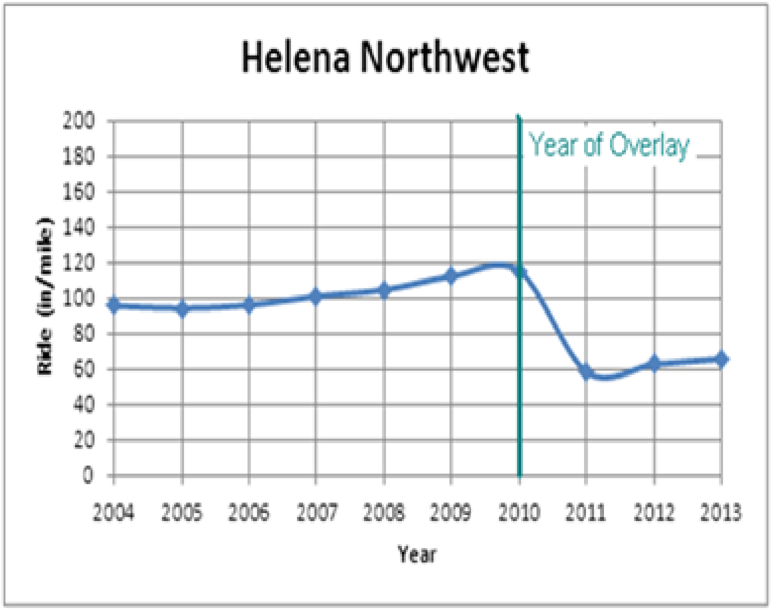
Distress	PVMS Distress Score				
	2003 (Before CIPR)	2004 (After CIPR)	2006	2009	2013
Rut Index	56	86	76	63	68
Ride Index	56	70	69	57	65
ACI	N/A	100	100	97	99
MCI	N/A	100	98	85	98

Table 25: Distress Scores – East River Road

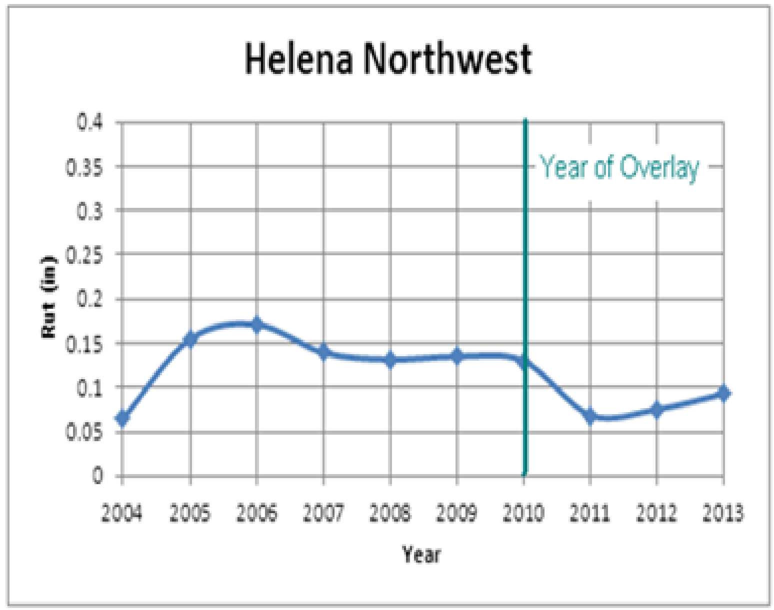
For a full summary of the project and past images of the roadway select the following link: East River Road.

8.14 Helena Northwest

Roadway: S-279, RP 16.1 to RP 22.0,
Treatment: 0.35' CIR w/ Chip Seal
Construction Date: 2003



Graph 31: Ride vs. Year – Helena Northwest



Graph 32: Rut vs. Year – Helena Northwest

This is was a **Maintenance Project**.

Distress	PVMS Distress Score				
	2003 (Before CIPR)	2004 (After CIPR)	2005	2006	2014
Rut Index	82	84	75	66	80
Ride Index	65	75	68	74	80
IRI (in/mile)	133	96	94	96	72
Rut Depth (in)	0.07	0.06	0.15	0.17	0.09

Table 26: Distress Scores – Helena Northwest

For a full summary of the project and past images of the roadway select the following link: Helena Northwest.

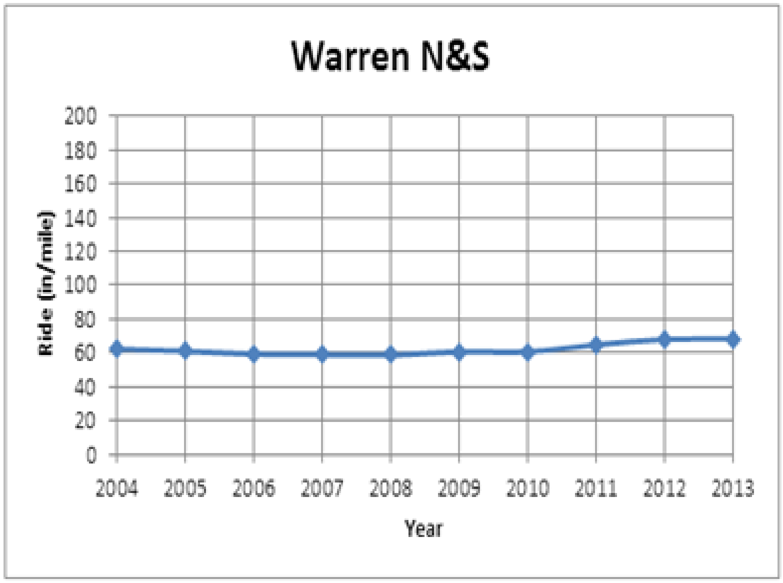
8.15 Warren N&S NH 4-1(23)0 F CN 1423

Roadway: US Highway 310, RP 0 to RP 12.8

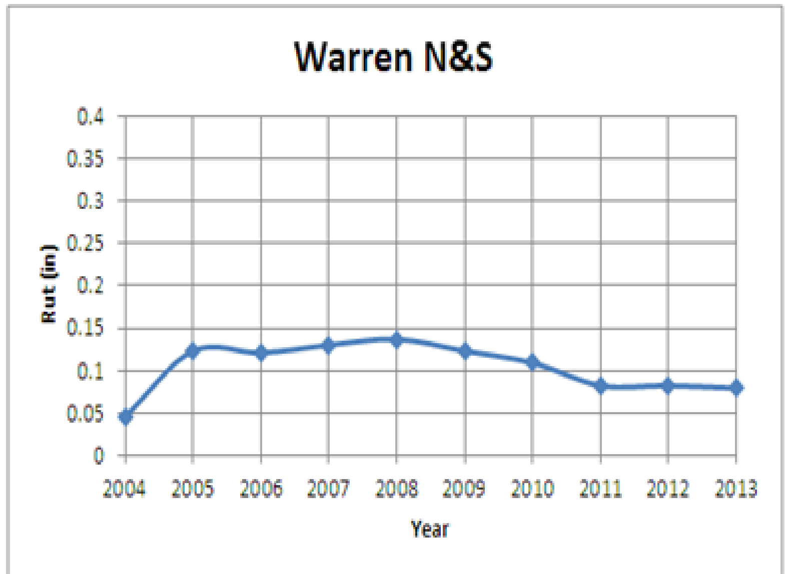
CIPR done from RP 0.6 to 10.4 (+/-)

Project Description: 0.16' CIR Overlaid w/ 0.15' PMS

Construction Date: 2002



Graph 33: Ride vs. Year – Warren N&S



Graph 34: Rut vs. Year – Warren N&S

Distress	PVMS Distress Score				
	2001 (Before CIPR/Overlay)	2003 (After CIPR/Overlay)	2006	2009	2013
Rut Index	60	74	73	74	79
Ride Index	48	82	84	84	81
ACI	47	100	100	100	100
MCI	47	100	93	99	100

Table 27: Distress Scores – Warren N&S

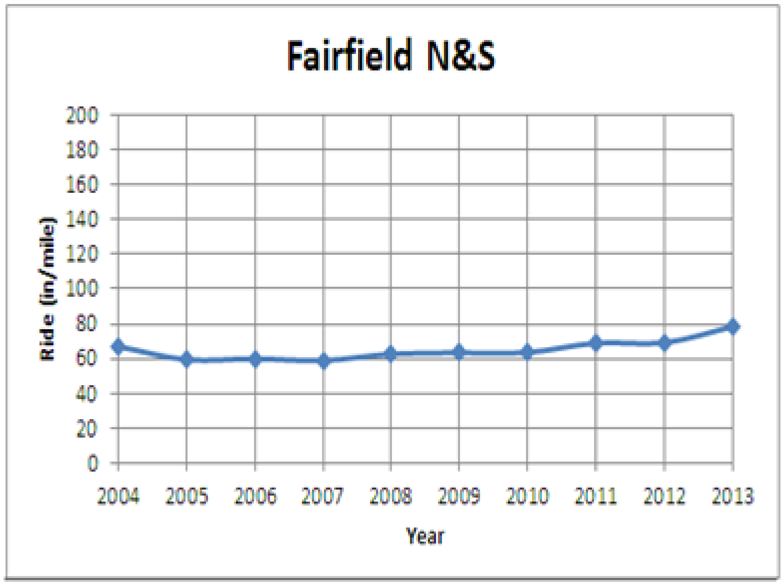
For a full summary of the project and past images of the roadway select the following link: Warren N&S.

8.16 Fairfield N&S STPP 3-1(11)18 CN 3129

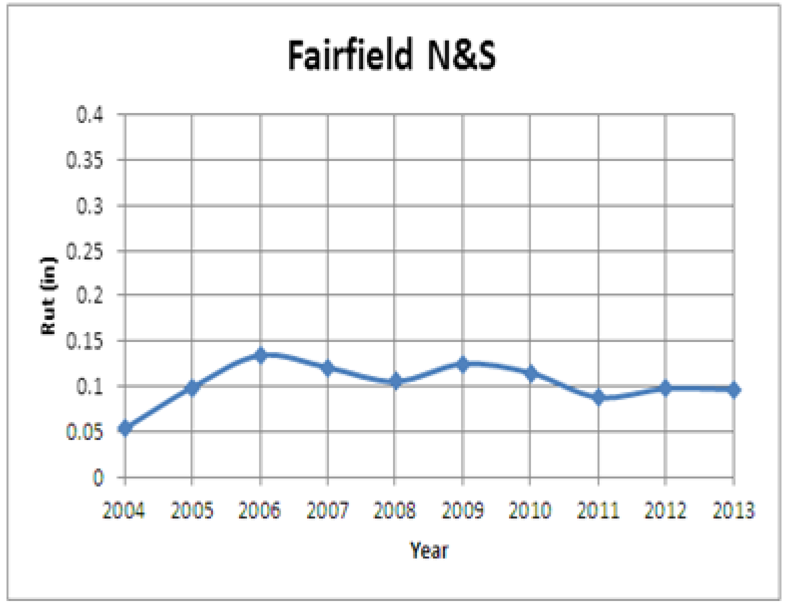
Roadway: Highway 89, RP 18.0 to RP 28.0

Project Description: 0.20’ CIR Overlaid w/ 0.20’ PMS

Construction Date: fall 2001



Graph 35: Ride vs. Year – Fairfield N&S



Graph 36: Rut vs. Year – Fairfield N&S

Distress	PVMS Distress Score				
	2001 (Before CIPR/Overlay)	2002 (After CIPR/Overlay)	2006	2009	2013
Rut Index	60	81	71	72	75
Ride Index	71	84	84	83	82
ACI	N/A	N/A	99	100	98
MCI	N/A	N/A	97	84	97

Table 28: Distress Scores – Fairfield N&S

For a full summary of the project and past images of the roadway select the following link: Fairfield N&S.

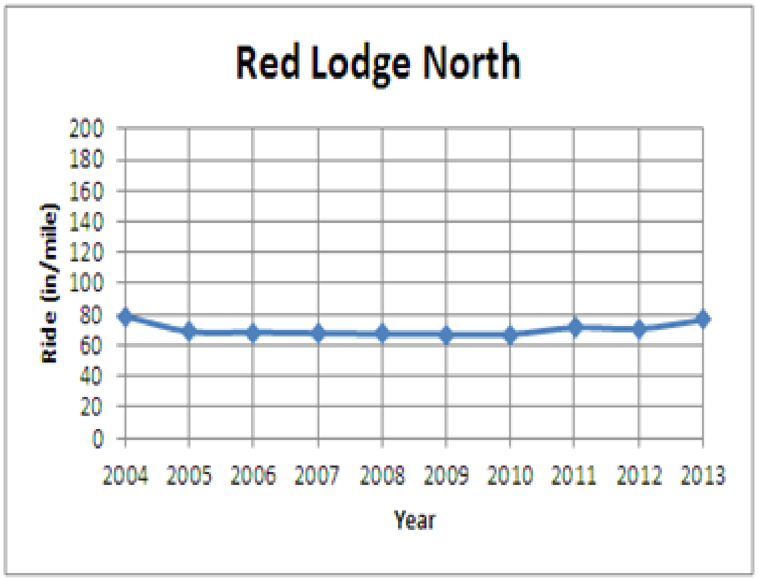
8.17 Red Lodge North STPP 28-2(14)70 CN 2409

Roadway: Highway 212, RP 91.0 to 101.5

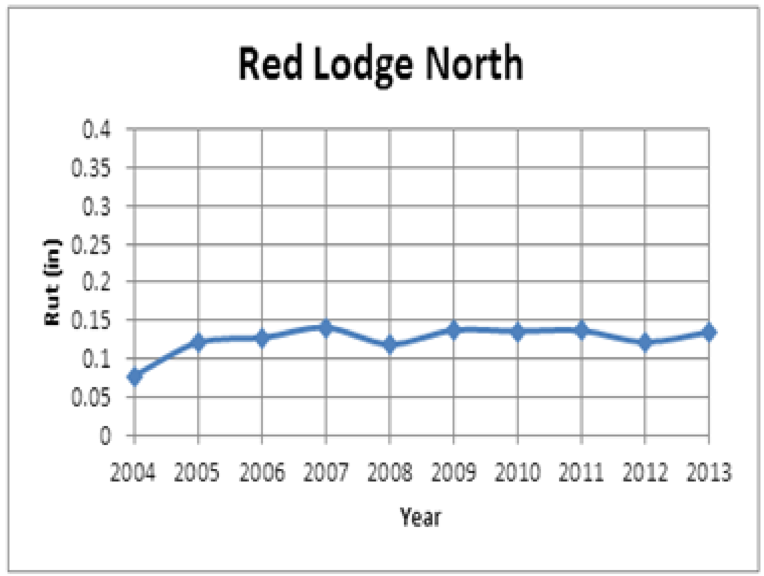
Date of Construction: July, 2001

Treatment:

- **Section 1**: RP 89.0- RP 91.0, 0.30' Cold Mill, 0.34' PMS
- **Section 2**: RP 91.0-RP 94.3, 0.25' Recycle with 0.15' PMS Overlay
- **Section 3**: RP 94.3-RP 95.4, 0.25' Recycle with Seal and Cover
- **Section 4**: RP 95.4-RP 96.3, 0.25' Mill and Fill
- **Section 5**: RP 96.3-RP 98.0, 0.25' Recycle with Seal and Cover
- **Section 6**: RP 98.0-RP 101.6, 0.25' Recycle with Two 0.30' Lifts of PMS



Graph 37: Ride vs. Year – Red Lodge North



Graph 38: Rut vs. Year – Red Lodge North

Distress	PVMS Distress Score		
	2005	2009	2013
Rut Index	80	78	76
Ride Index	81	81	80
ACI Index	100	100	98
MCI Index	99	99	97

Table 29: Distress Scores – Red Lodge North

For a full summary of the project and past images of the roadway select the following link: Red Lodge North.

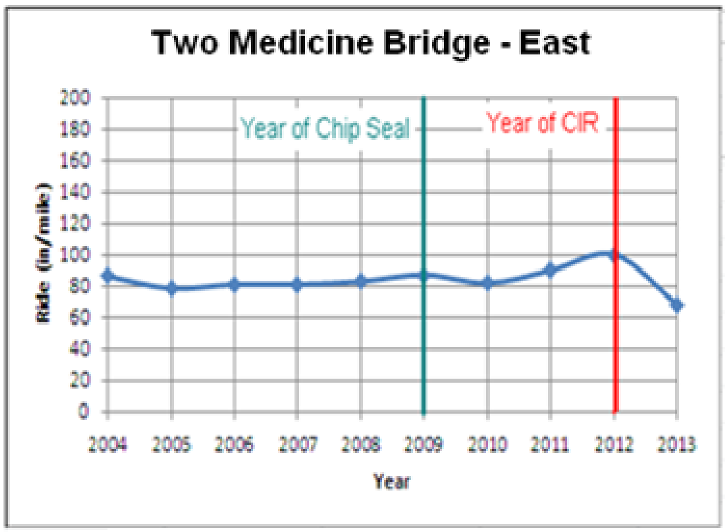
8.18 Two Medicine Bridge - East, NH 1-3(34)210F CN 1814

Roadway: US-2, RP 211.0 to RP 217.5

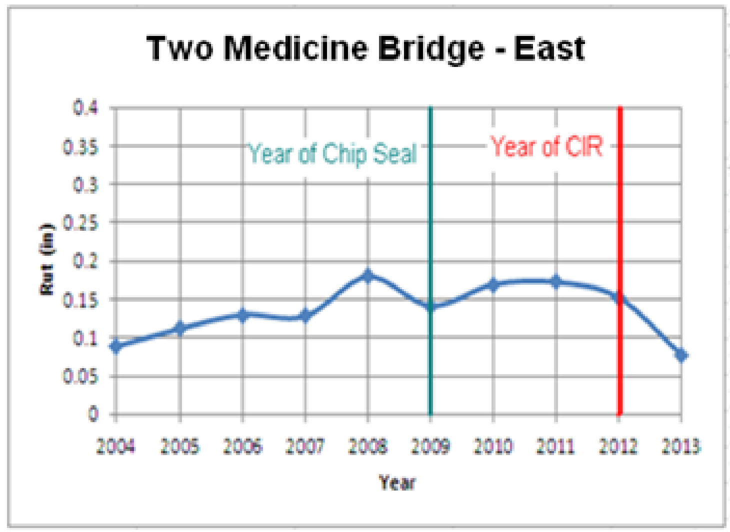
Treatment:

- RP 211 to RP 213: 0.25' CIR w/ 0.20' Grade D Overlay
- RP 214-217.5: 0.20' CIR w/ 0.20' Grade D Overlay

Construction Date: June 1998



Graph 39: Ride vs. Year – Two Medicine Bridge



Graph 40: Rut vs. Year – Two Medicine Bridge

Distress		PVMS Distress Score		
	2006	2008 (After widening and overlay)	2011	2012
Rut Index	73	65	65	67
Ride Index	79	78	77	77
ACI Index	100	100	85	99
MCI Index	86.7	94	97	94

Table 30: Distress Scores – Two Medicine Bridge – East

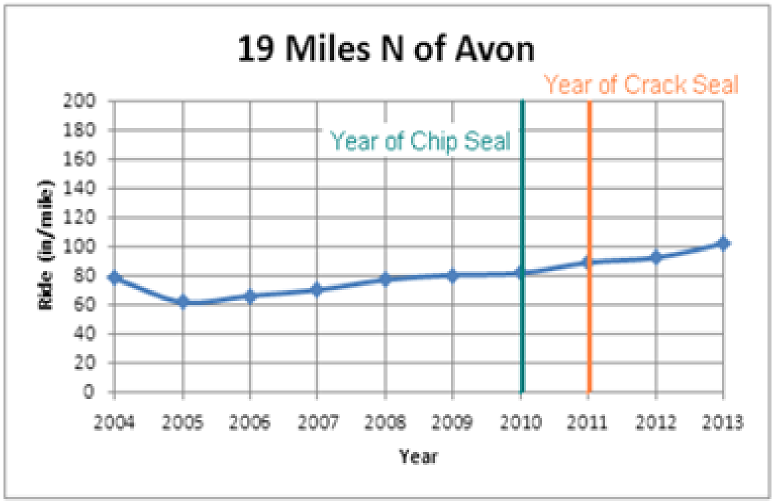
For a full summary of the project and past images of the roadway select the following link: Two Medicine Bridge.

8.19 19 Miles N. of Avon RTF 41-1(12)19 CN 2406, Devil's Dip N&S STPP 41-1(10)28 CN 2345

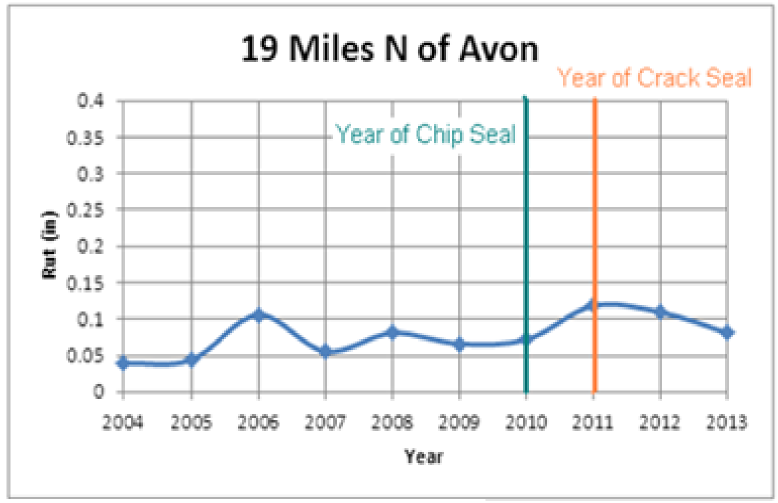
Roadway: Montana 141, RP 19.5 to RP 32.5

Treatment: 0.20' and 0.30' CIR w/ Chip Seal

Construction Date: July 1996



Graph 41: Ride vs. Year – 19 Miles N of Avon



Graph 42: Rut vs. Year – 19 Miles N of Avon

Distress	PVMS Distress Scores			
	1996 (Before CIR)	1997 (After CIR)	2001 (Before Overlay)	2014
Rut Index	N/A	N/A	54	71
Ride Index	N/A	N/A	70	74
IRI (in/mile)	171	121	113	N/A
Rut Depth (in)	0.21	0.03	0.29	N/A

Table 31: Distress Scores – 19 Miles N of Avon

For a full summary of the project and past images of the roadway select the following link: 19 Miles N of Avon.

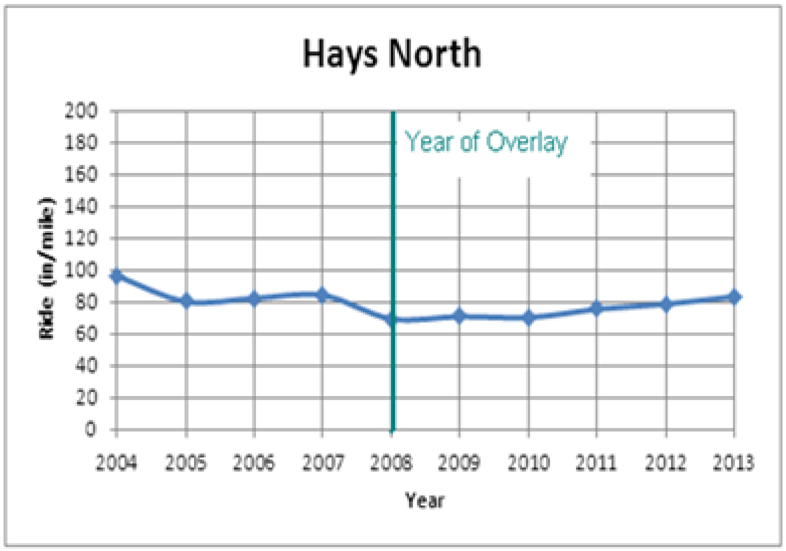
8.20 Hays North, RTF 66-2(1)16 CN 2694

Roadway: State Highway 66, RP 16.0 to RP 49.0

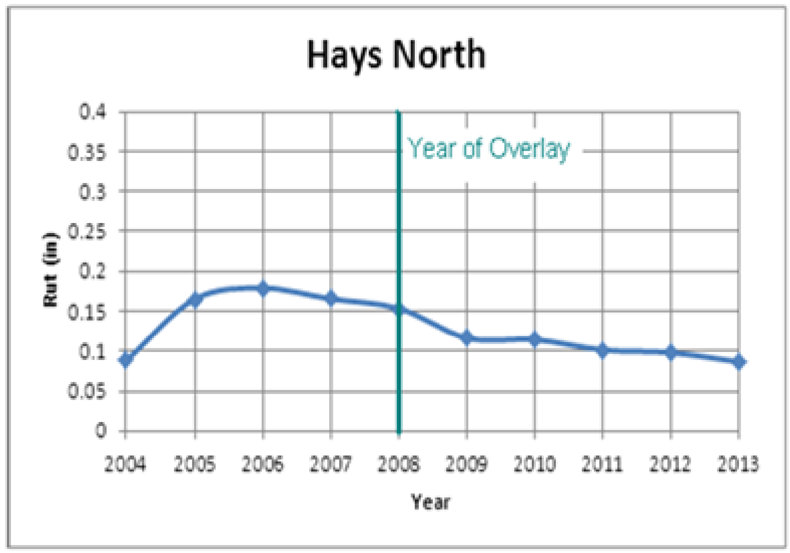
Treatment:

- Treatment 1: 0.20' CIR w/ 0.15' Grade B Overlay
- Treatment 2: 0.20' CIR

Construction Date: 1995



Graph 43: Ride vs. Year – Hays North



Graph 44: Rut vs. Year – Hays North

Distress	PVMS Distress Score		
	2007 (Before Overlay)	2008 (After Overlay)	2013
Ride Index	78	79	73
Rut Index	72	81	79
ACI	96	100	100
MCI	80	99	99

Table 32: Distress Scores – Hays North

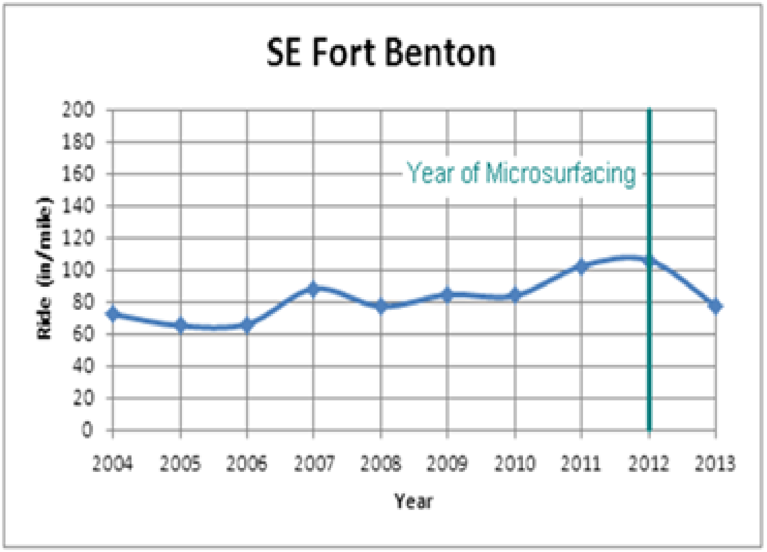
For a full summary of the project and past images of the roadway select the following link: Hays North.

8.21 SE Fort Benton - Geraldine, STPP 80-1(10)15, CN 2405

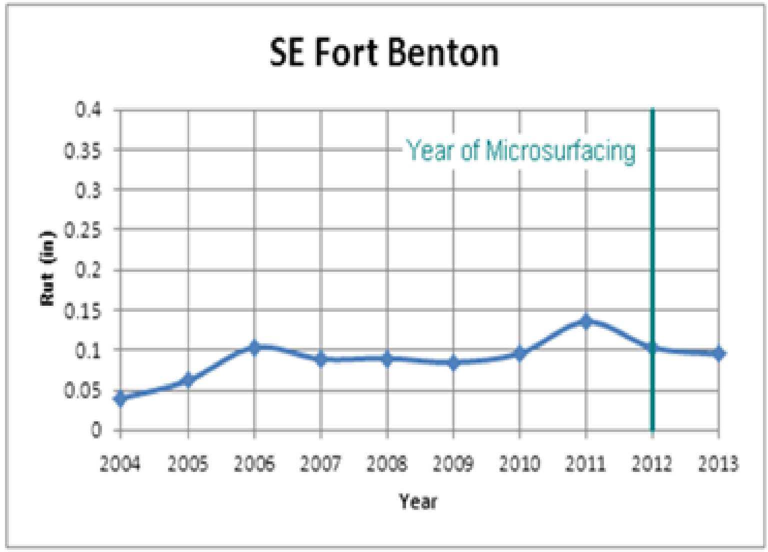
Roadway: MT-80, RP 14.7 to RP 28.0

Treatment: 0.20' CIPR with 0.15' Overlay

Construction Date: 1995



Graph 45: Ride vs. Year – SE Fort Benton



Graph 46: Rut vs. Year – SE Fort Benton

Distress	PVMS Distress Score			
	1997 (2-years after CIPR/Overlay)	2006	2011 (Before Microsurfacing)	2013 (After Microsurfacing)
Rut Index	79	76	71	77
Ride Index	85	82	74	80
ACI Index	N/A	100	79	100
MCI Index	N/A	86	96	99

Table 33: Distress Scores – SE Fort Benton

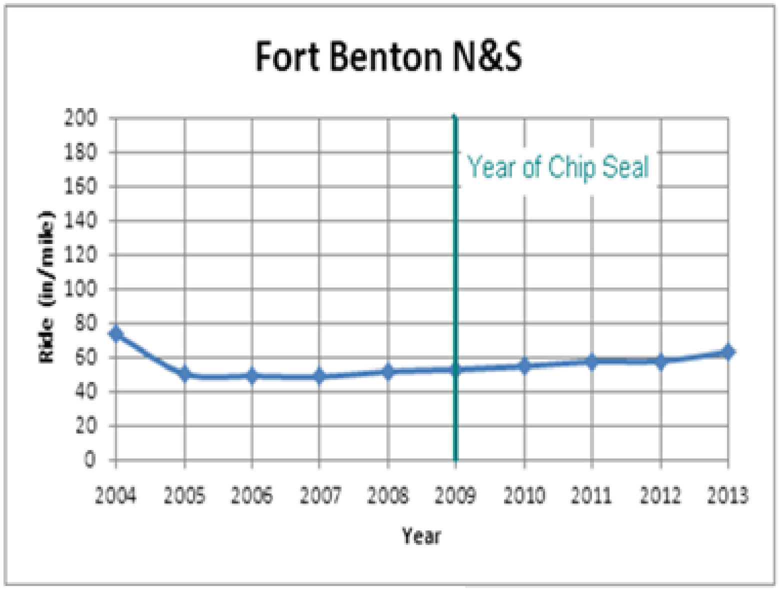
For a full summary of the project and past images of the roadway select the following link: SE Fort Benton.

8.22 Fort Benton N & S, NH 10-2(19)20 CN 1403

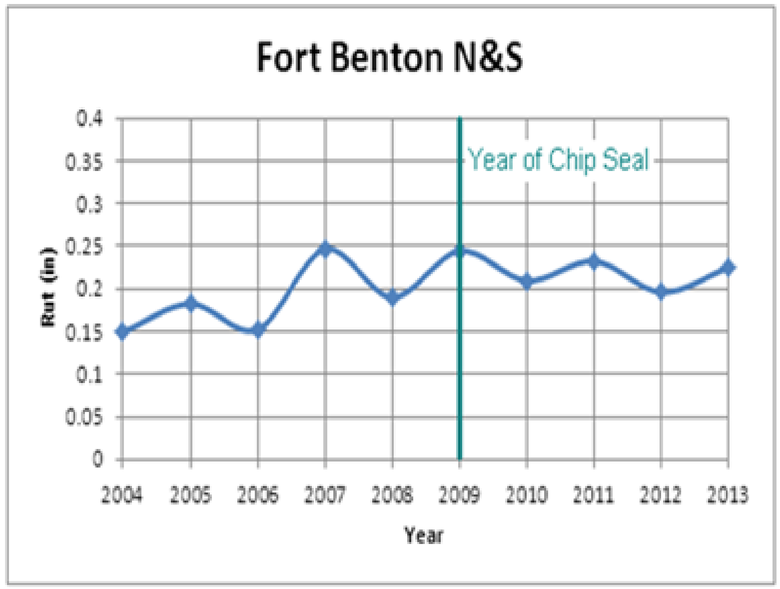
Roadway: US-89, RP 19.9 to RP 37.5

Treatment: 0.25' CIR w/ 0.35' Grade D Overlay

Construction Date: August 1994



Graph 47: Ride vs. Year – Fort Benton N&S



Graph 48: Rut vs. Year – Fort Benton N&S

Distress	PVMS Distress Score			
	1997 (3-years after CIR/Overlay)	2006	2010 (after Chip Seal)	2013
Rut Index	79	72	62	59
Ride Index	85	87	85	83
ACI Index	N/A	100	100	100
MCI Index	N/A	99	98	100

Table 34: Distress Scores – Fort Benton N&S

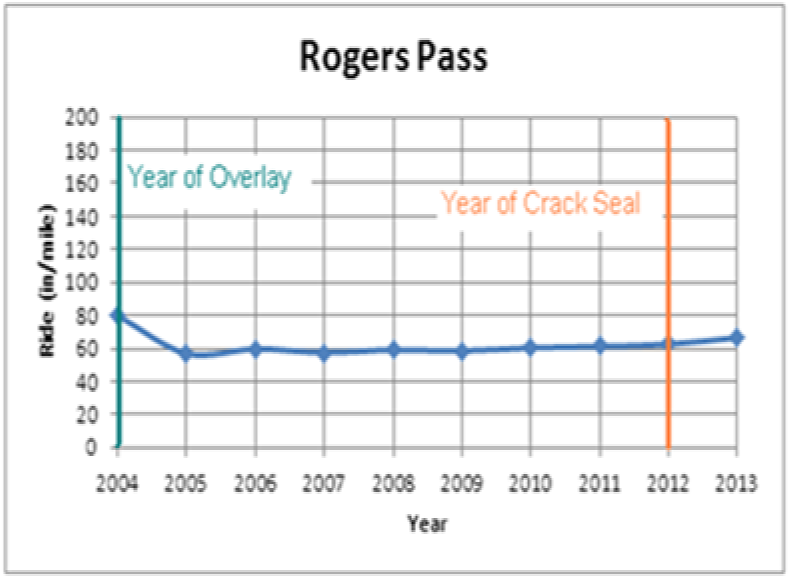
For a full summary of the project and past images of the roadway select the following link: Fort Benton N&S.

8.23 Rogers Pass – West, F-HES 24-3(11)83

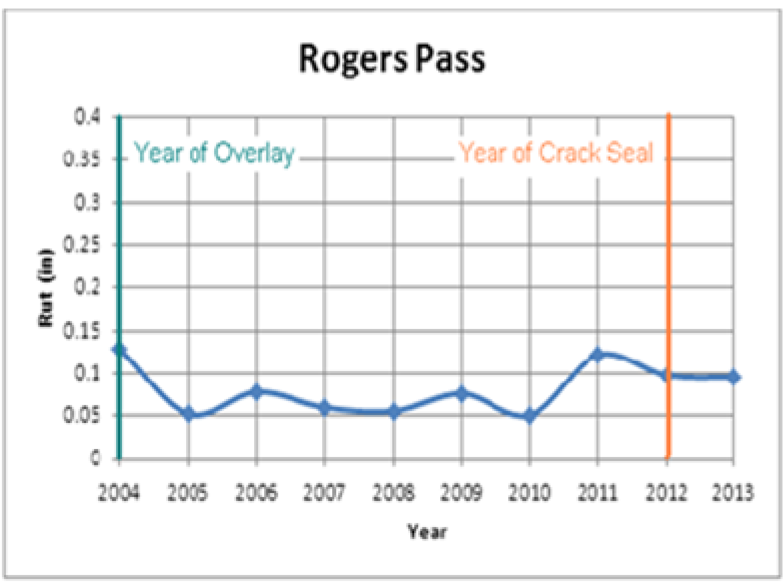
Roadway: MT-200, RP 83.0 to RP 91.0

Treatment: 0.25' Cold Recycled w/ 0.20' PMS Overlay

Construction Date: 1985



Graph 49: Ride vs. Year – Rogers Pass



Graph 50: Rut vs. Year – Rogers Pass

For a full summary of the project and past images of the roadway select the following link: Rogers Pass.

Chapter 9: Conclusion

CIR can be a cost effective treatment that can be utilized in specific locations throughout Montana. Table 12 provides estimated costs for CIR and conventional plant mix options. These costs are based on a PMS unit cost of $80.82/ton, a 0.20' thick CIR unit cost of $4.49/yd^2, a 0.30' thick CIR unit cost of $5.30/yd^2, a milling unit cost of $1.75/yd^2, a double chip seal unit cost of $2.75/yd^2, and a single chip seal unit cost of $1.75/yd^2. As indicated by Table 12, all three CIR options have a significant cost savings when compared to traditional treatments (mill/fill and overlay) with the most economical option being CIR with a single chip seal. All options in Table 12 consist of a 32' road width, a 0.30' surface thickness, and a total project length of 1 mile.

Pavement Preservation Options	$/yd^2	$/ton
0.30' Mill and Fill	17.75	92.09
0.10' Isolation Lift with a 0.20' Overlay	16.16	83.85
0.20' CIR with 0.10' Overlay	9.05	48.64
0.30' CIR with Double Chip Seal	7.44	40.75
0.30' CIR with Single Chip Seal	6.44	35.27

Table 12: Comparison of Pavement Treatment Options (Cost/yd^2)

A total of 23 CIR projects were constructed in Montana. So far, 17 projects performed well, 5 performed poorly, and 1 was recently constructed and needs additional time to be evaluated. Determining the performance of the roadway was done by analyzing rut and ride data as well as reviewing construction review reports and past MDT documents containing summaries of CIR projects. The following bullets consist of the 5 projects that performed poorly and factors that led to below average performances.

- **Hebgen Lake E&W STPP 87-1(9)0, CN 5960:** Shallow depressions in the newly placed CIR occurred due to static loading from parked traffic and equipment. Emulsions seemed to adhere to equipment tires causing these indentations. Placing blotter on the fog sealed surface would have prevented this problem. This project was a poor CIR candidate due to the long and extreme winter climate experienced in this area.
- **South of Bridger:** Heavy volumes of traffic existed on this roadway which led to increased rutting. This roadway experienced 156 daily ESALs in 2006, the year of CIR construction.
- **19 Miles N. of Avon RTF 41-1(12)19, CN 2406:** Poor performance was also the result of heavy traffic on the roadway. This roadway experienced 60 daily ESALs in 1996, the year of CIR construction.
- **East of Conrad STPS 218-1(10)19, CN 6977:** A centerline soil survey was not conducted during preconstruction. The roadway failed due to cracking which was attributed to subgrade instability. This roadway experienced 3 daily ESALs in 2011, the year of CIR construction.
- **Rogers Pass – West F-HES 24-3(11)83:** The CIR surface was overlaid wet which resulted in cracking and rutting of the roadway.

Out of the 23 total CIR projects 13 were overlaid and 10 were chip sealed. Rogers Pass was the only roadway with an overlay that resulted in a poor performance. In short, 6 out of 10 or 60% of the chip sealed projects performed well whereas 11 out of 12 or 92% of the overlaid projects performed well.

CIR should continue to be utilized more in Montana, although some precautions should be taken. CIR has high void content when compared to conventional plant mix and is more susceptible to moisture damage. Because of this, CIR can perform poorly in cold, wet climates such as high elevation mountain passes. CIR should always be overlaid if constructed on a high traffic roadway (>50 ESALs). Rutting will result from the high volume traffic if an overlay is not applied. Also, cold in-place recycling PMS with poor binder and marginal aggregate will likely result in poor performance of the roadway.

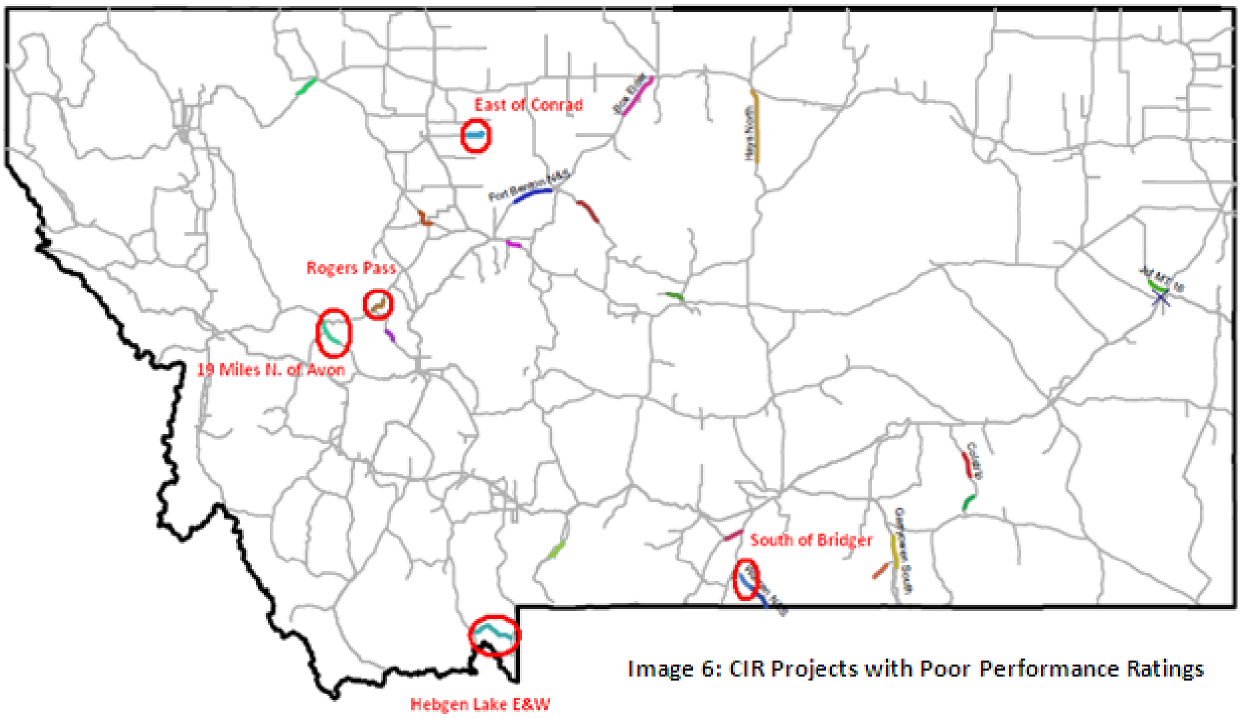


Image 6: CIR Projects with Poor Performance Ratings

As displayed by Image above, past CIR projects are spread throughout the state. Projects with poor performances are circled in red in the image. CIR projects that have performed well extend throughout the state indicating that CIR can perform well in all districts in Montana. CIR without an overlay may not be suitable in much of the Missoula district due to the increased freeze thaw cycles in the winter and spring months and also in certain locations in the Butte district where roadways travel through cold and wet climates.

Appendix A: Summary of the Performance of Past CIR Projects in Montana

A.1 Box Elder – North NH 10-3(19)89 CN 6814000

Roadway: US 87, RP 89.0 to RP 111.1
Corridor: C000010
Construction Date: June 2015
Traffic: 92 daily ESALs
Treatment: 0.30' CIR w/ 0.15' PMS Overlay

This project was the longest CIR in Montana to date and utilized the use of cement in lieu of lime slurry. Pictures displayed below were taken during CIR construction on June 24, 2015.


Transverse cracking through milled and existing pavement


Cement used as mineral filler in CIR mix is spread on the roadway

Severe cracking was present in this stretch of roadway. As seen by pictures above, cracking occurred deep in the mat and milling could not eliminate all of the cracks. Reflective cracking through the CIR and overlay should be expected in the future.

Pictures below provide an accurate representation of the CIR surface. The material was very loose around the edges and crumbled when any load was applied around the outer margins of the mat.


Loose material near the edge of the mat


Vehicle loading is observed near the edge of the mat

Surface after CIR was overlaid

CIR surface

Another visit was taken to Box Elder – North on July 29, 2015. CIR construction was finished and the CIR was being overlaid with HMA. A picture of the overlay is displayed above.

Additional photos of Box Elder – North taken during construction can be accessed by the following link: Box Elder – North Construction Photos. A construction review report of Box Elder – North can also be obtained by selecting the specified link: Box Elder – North: Construction Review.

**Treatment recommendations for the future:

- Thin overlay in 2017 from RP 89.68 to RP 104.30.

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 95 taken before the CIR project were acquired from PathWeb and are presented on the following page. More images can be found using the following link: Box Elder - North.

2014 Image: One year before the CIR project

2012 Image: Three years before the CIR project

A.2 East Glacier – Browning CBI 1-3(65)209 CN 6961

Roadway: US 2, RP 208.9 to RP 219.2

Corridor: C000001

Construction Date: July 2012

Traffic: 78 daily ESALs

Treatment: 0.20' CIR w/ 0.20' PMS Overlay

It was indicated by soils tests that subgrade in this project was sensitive to moisture and could be weak in certain areas. Soils reaching plastic limits in this stretch of roadway could cause construction difficulties, although, no construction problems were stated in the construction review report.

This road has performed well. The ride has improved from 100 in/mile in 2012 to around 65 in/mile in 2013. The rut has improved from 0.15 inches in 2012 to around 0.08 inches in 2013.

The construction review report of East Glacier – Browning can be accessed using the following link: East Glacier – Browning: Construction Review.

Images from mile post 216 taken before and after the CIR project were obtained from PathWeb and are presented below. More images can be found using the following link: East Glacier - Browning Images.

2012 Image: Months before the CIR project

2014 Image: Two years after the CIR project

A.3 East of Conrad STPS 218-1(10)19, CN 6977

Roadway: S-218, RP 18.8 to RP 25.9

Corridor: C000218

Construction Date: June 2011

Traffic: 3 daily ESALs

Treatment: 0.25' CIR w/ Chip Seal

Small areas of newly recycled material were breaking and cracking during construction. Design called for 3.0% emulsion, but this was modified during construction to 2.0% due to field conditions. Density tests indicated that the mat material met the minimum control target density of 97%. Upon further research, the reviewer learned that centerline soil survey was not conducted to determine stability of subgrade and therefore, cracking and breaking of the mat was blamed on poor subgrade material.

The contractor submitted a proposal for milling only 25' of the existing surface leaving about 6 inches of existing material on the shoulders of the road. This would minimize any shoving or rollout during the compaction process. This may also lead to sympathy cracking in the future.

There was not a significant improvement in the performance of this roadway. Ride did have a small improvement from 140 in/mile in 2011 to 120 in/mile in 2012. Rut worsened from 0.13 inches in 2011 to 0.15 inches in 2012. The increase in rut is attributed to the poor subgrade.

A construction review report for East of Conrad can be accessed using the following link: East of Conrad: Construction Review.

**Treatment recommendations for the future:

- Thin overlay in 2015 and 2017 from RP 18.8 to RP 25.7

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 20 taken before and after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: East of Conrad Images.

2008 Image: Three years before the CIR project

2013 Image: One year after the CIR project

2015 Image: Recent photo of East of Conrad project

A trip was taken to the East of Conrad project location on June 24, 2015. The roadway was severely cracked as seen by the 2015 image above. To see more pictures of the June 24, 2015 trip select the following link: East of Conrad Photos – June 24, 2015.

A.4 Mehmke Hill NH 60-2(90)82, CN 6958

Roadway: US 87, RP 81.5 to RP 87.3

Corridor: C000060

Construction Date: June 2011

Traffic: 252 daily ESALs

Treatment: 0.25' CIR w/ 0.15' PMS Overlay

The contractor proposed a change to leave 6 to 12 inches of existing plant mix on the shoulders of the road to compensate for any roll out and shoving during the compaction process. This may lead to sympathy cracking in the future.

This road has performed well with ride improving from 80 in/mile in 2011 to 55 in/mile in 2012. The rut improved from 0.19 inches in 2011 to 0.09 inches in 2012. The ride and rut in 2013 measured 75 in/mile and 0.09 inches.

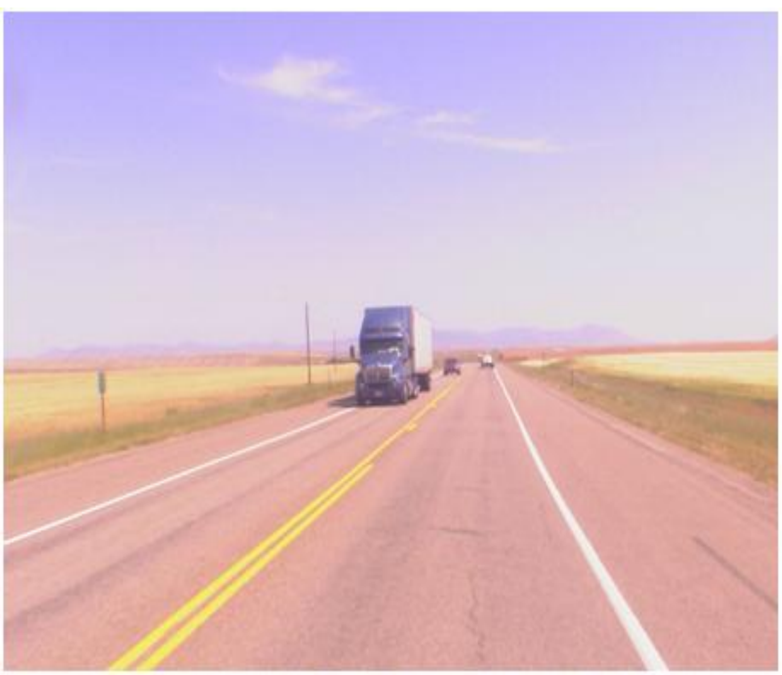
A construction review report for Mehmke Hill can be accessed using the following link: Mehmke Hill: Construction Review.

**Treatment recommendations for the future:

- Thin overlay in 2017 from RP 19.5 to RP 32.5

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 25 taken before and after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Mehmke Hill Images.



2009 Image: Two years before the CIR project

2012 Image: One year after the CIR project

A.5 Colstrip STPP 39-1(41)24, CN 6973

Roadway: P-39, RP 23.6 to RP 35.0

Corridor: C000039

Construction Date: 2011

Traffic: 73 daily ESALs

Treatment: 0.25' CIR w/ 0.15' PMS Overlay

This roadway has performed well with ride improving from 100 in/mile in 2009 to 60 in/mile in 2010. The rut also improved from 0.26 inches to 0.09 inches from 2009 to 2010. Rut and ride in 2013 measured 65 in/mile and 0.10 inches.

**Treatment recommendations for the future:

- Thin overlay in 2017 from RP 19.5 to RP 32.5

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 25 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Colstrip Images.

2011 Image: One year after the CIR project

2014 Image: Three years after the CIR project

A.6 North of Lame Deer ARRA 39-1(39)4, CN 5917

Roadway: P-39, RP 4.2 to RP 12.3

Corridor: C000039

Construction Date: 2009

Traffic: 23 daily ESALs

Treatment: 0.25' CIR w/ Chip Seal

This road has performed well. Ride measured 180 in/mile in 2009 and improved to 95 in/mile in 2010. Rut measured 0.25 inches in 2009 and was significantly better in 2010 measuring 0.10 inches. In 2013, rut and ride measured 0.13 inches and 100 in/mile.

*Projects on roadway after CIR project:

- Crack seal in 2011 from RP 4.2 to RP 12.3

**Treatment recommendations for the future:

- Thin overlay in 2017 from RP 4.2 to RP 12.4

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 8 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: North of Lame Deer Images.


2011 Image: Two years after the CIR project


2014 Image: Five years after the CIR project

A.7 Hebgen Lake E&W STPP 87-1(9)0, CN 5960

Roadway: US 287, RP 0 to RP 22.4
Corridor: C000087
Construction Date: October 2008
Traffic: 22 daily ESALs
Treatment: 0.20' CIPR w/ Chip Seal
Emulsion: 2.5% CIR-EE

This project consisted of a 0.20' CIR with a chip and fog seal. The mineral filler (lime slurry) and emulsion (CIR-EE) in the mix measured 1.4% and 2.5% by mix weight.

Fog seal was applied and allowed to cure each day before traffic was opened to the road surface. The contractor found that without the fog seal the CIR raveled under traffic. The contractor did not have a spreader available during CIR operations and therefore, blotter could not be applied to the fog sealed surface. In certain areas throughout the project, equipment was parked on the fog sealed surface resulting in shallow depressions in the roadway.

The CIR treatment improved the ride from 125 in/mile in 2008 to 100 in/mile in 2009. The ride measured approximately 110 in/mile in 2013. The rut increased after the CIR project measuring 0.08 inches in 2008 and 0.10 inches in 2009. The rut remained 0.10 inches in 2013.

A construction review report for Hebgen Lake can be accessed using the following link: Hebgen Lake: Construction Review.

Photos were also taken during the CIR process. They can be accessed through the following link: Hebgen Lake Construction Photos.

*Projects on roadway after CIR project:

- Crack sealed in 2011 from RP 6.9 to RP 22.4
- Chip sealed in 2012 from RP 6.9 to RP 22.4

**Treatment recommendations for the future:

- Thin overlay in 2015 and 2017 from RP 0 to RP 7.1
- Crack seal and cover in 2015 from RP 7.1 to RP 22.4
- Thin overlay in 2017 from RP 7.1 to RP 22.4

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 12 taken before and after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: Hebgen Lake Images.


2006 Image: Two years before the CIR project


2012 Image: Four years after the CIR project


2014 Image: Six years after the CIR project

A.8 Garryowen South IM 90-9(100)517, CN 5177

Roadway: Interstate 90, RP 516.6 to RP 531.8

Corridor: C000090

Construction Date: 2008

Traffic: 894 daily ESALs

Treatment: 0.33' CIR w/ 0.23 PMS Overlay

This roadway has performed well. The ride has improved from 120 in/mile to 60 in/mile from 2008 to 2009. The rut also improved drastically from 0.26 inches in 2008 to 0.05 inches in 2009. The ride and rut was 60 in/mile and 0.10 inches in 2013.

A construction review report for Garryowen South can be accessed using the following link: Garryowen South: Construction Review.

**Treatment recommendations for the future:

- Crack seal and cover in 2017 from RP 516.6 to RP 531.7

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 523 taken before and after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Garryowen South Images.

2008 Image: Months before the CIR project

2011 Image: Three years after the CIR project

A.9 JCT MT 16- Northwest STPS 254-1(23)0, CN 6242

Roadway: S-254, RP 0 to RP 9.4
Corridor: C000254
Construction Date: August 2008
Traffic: 24 daily ESALs
Treatment: CIR w/ Chip Seal

This project consisted of CIR with a chip seal and fog seal. Based on gradations at the start of the operation, percentage of CIR-EE was 1% by dry weight of RAP. Virgin aggregate and quick lime were added to the mix at 15% and 1.4% by dry weight.

Small pieces of crack sealant milled from the existing roadway were passing through the 1.25 inch screen. The crack sealant was then dispersed throughout the newly recycled mat. Crack sealant does not bind with the cold recycled mat and will eventually loosen and create voids in the road surface. After discussion, it was decided that the crack sealant would be left in the mat and that a chip seal would seal voids created by the crack sealant.

This CIR project has performed well. The rut dropped from 0.20 inches in 2008 to 0.11 inches in 2009 and remained 0.11 inches in 2013. The ride measured around 130 in/mile in 2008 and improved to around 100 in/mile in 2009. The ride has increased to 120 in/mile from 2009 to 2013. An overlay was placed on this roadway in 2012 from RP 2.33 to RP 12.20. Rut and Ride has remained about the same before and after the overlay.

The construction review report for Jct MT 16 can be accessed using the following link: Jct MT 16: Construction Review.

**Treatment recommendations for the future:

- Thin overlay in 2015 and 2017 from RP 0 to RP 9.4

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 5 taken before and after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: Jct MT 16 Images.

2007 Image: One year before the CIR project

2011 Image: Three years after the CIR project

2014 Image: Six years after the CIR project

A.10 Lewistown – North STPS 426-2(9)19, Jct. Us 191 - West, CN 5976000

Roadway: Secondary 426, RP 26.9 to RP 19.0
Corridor: C000426
Construction Date: July 2007
Traffic: 7 to 19 daily ESALs
Treatment: 0.20' CIR w/ Chip Seal
Emulsion: 2% CIR-EE

Crack Sealant was present on the road surface. Normally, crack sealant mills up in strips and is easily removed from the 1.25 inch screen before it is included in the CIR mixture. On this project, the sealant broke into small pieces, fell through the screen, and was incorporated into the CIR mixture. The sealant did not adhere well to the surface of the mat, and resulted in a void the size of a golf ball when removed. After paving 3 +/- lane, the Contractor learned how to remove the majority of the sealant by switching screens and used two laborers to remove the remaining sealant from the mat surface. This project will be monitored to determine if the sealant incorporated into the CIR affects road performance.

The 0.20 ft CIR depth was determined to be too thin to mitigate the extensive reflective cracking. The surfacing design unit will strive to CIR 0.30 ft deep in the future to mitigate reflective cracking and improve ride.

It was determined during that the CIR material does not cure fast enough to support parked traffic until 2 days after it is placed. Roughness was observed where traffic stopped to wait for the pilot car. The cars were parked on the previous day's work and the tires left indentations in the CIR mat. A statement was written in the special provision stating vehicles cannot park on the CIR mat for 2 days after placement.

The westbound lane IRI improved from 128 to 87 in/mile and the eastbound lane improved from 122 to 98 in/mile in 2008 after the CIR. There is a gravel pit located at the west end of this project and loaded trucks traveling from the gravel pit use the eastbound lanes. The loaded trucks parked on the new mat (as described above) may be a reason for the poorer IRI in the eastbound lane.

The construction review report for Lewistown North can be accessed using the following link: Lewistown North Construction Review.

**Treatment recommendations for the future:

- Thin overlay in 2015 and 2017 from RP 19.0 to RP 26.9

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 23 taken before and after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: Lewistown North Images.

2006 Image: One year before the CIR project

2009 Image: Two years after the CIR project

2011 Image: Four years after the CIR project

A.11 West of Lodge Grass SFCS 463-1(5)6, CN 5977

Roadway: S-463, RP 5.7 to RP 14.2

Corridor: C000463

Construction Date: 2008

Treatment: CIR w/ Chip Seal

This road is performing well. Ride has improved from 160 in/mile in 2007 to 100 in/mile in 2008. Rut has also improved from 0.34 inches in 2007 to 0.20 inches in 2008. Ride has stayed the same from 2008 to 2013. Rut has improved from 2008 to 2013 measuring 0.09 inches in 2013.

**Treatment recommendations for the future:

- Thin overlay in 2017 from RP 19.5 to RP 32.5

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 10 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: West of Lodge Grass Images.

2007 Image: Months before the CIR project

2011 Image: Four years after the CIR project

A.12 South of Bridger

This was a **Maintenance Project** built with SemMaterials CIR-EE emulsion.

Roadway: US 310, RP 12.8 to RP 20.0

Corridor: C000004

Treatment: 0.25’ CIR w/ Chip Seal

Traffic: **156 daily ESALs**

Construction Date: 2006

Emulsion Type/Content: CIR-EE,

This stretch of road was badly deteriorated and in need of major rehabilitation. Maintenance used CIR to hold the road together until the funds for rehabilitation were available.

This road carries approximately 156 daily ESALs and serves as a truck corridor. Typically, CIPR should be done on low volume roads (<30 daily ESALs) when it is placed without an overlay. Also, it was learned on this roadway that CIR should only be placed when the ambient air temperature is greater than 65 ºF and the low temperature at night is not below freezing. CIR has improved the ride but is showing premature rutting. The rutting is believed to be caused by the heavy truck traffic.

Images from mile post 15 taken before and after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: South of Bridger Images.

2003 Image: Three years before the CIR project

2009 Image: Three years after the CIR project

A.13 East River Road

This was a **Maintenance Project**.
Corridor: C000540
Roadway: S-540, RP 10.5 to RP 20.0,
Treatment: 0.35' CIR w/ Chip Seal
Construction Date: 2003
Emulsion Type/Content: CIR-EE, 3.0% by weight

This road was severely deteriorated and had been patched and chip sealed extensively for years. Coring revealed evidence of stripping. The PMS thickness ranged from 1.5 to 9 in., so RAP millings were spread on road during construction to provide sufficient depth for CIR. Due to the variety of different PMS types, the emulsion content was adjusted to account for different existing AC contents.

**Treatment recommendations for the future:

- Thin overlay in 2015 from RP 10.8 to RP 15.0
- Thin overlay in 2017 from RP 10.8 to RP 25.5

**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 15 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: East River Road Images.

2003 Image: Months before the CIR project

2006 Image: Three years after the CIR project

2009 Image: Six years after the CIR project

2014 Image: Eleven years after the CIR project

A.14 Helena Northwest:

This was a **Maintenance Project**.
Roadway: S-279, RP 16.1 to RP 22.0,
Corridor: C000279
Treatment: 0.35’ CIR w/ Chip Seal
Construction Date: 2003
Traffic: 9 daily ESALs
Emulsion Type/Content: CIR-EE, 2.3% by weight

Secondary 279 travels from flat farmland to heavily treed alpine conditions. The roadway has extensive changes in elevation and sharp curves. Before CIR, the road had extensive thermal cracking and longitudinal cracking. Several of the cores came out stripped and broken. The PMS thickness ranges from 4.5 to 11 in.

After CIR, the thermal cracking came back within 2 years. It is believed that this happened because 1-ft. of the shoulder was left on both sides of the roads, and the cracks on the shoulder propagated across the road (“sympathy” cracking). In the future, CIPR will be specified full-width, to address the sympathy cracking.

Based on the data below, CIR appears to have improved the ride. **In 2005, a natural gas drilling rig was hauled over this road** and set up on Flesher Pass. These heavy vehicles are believed to have caused the accelerated rutting.

*Projects on roadway after CIR project:

- Chip seal and overlay in 2009 from RP 22.5 to RP 30.4

**Treatment recommendations for the future:

- Crack seal in 2017 from RP 15.2 to RP 22.4

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 19 taken before and after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: Helena Northwest Images.

2002 Image: One year before the CIR project

2005 Image: Two years after the CIR project

2008 Image: Five years after the CIR project

2014 Image: Eleven years after the CIR project

A.15 Warren N&S NH 4-1(23)0 F CN 1423

Roadway: US Highway 310, RP 0 to RP 12.8

- *CIR done from RP 0.6 to 10.4 (+/-)*

Corridor: C000004
Project Description: 0.16' CIR Overlaid w/ 0.15' PMS
Construction Date: 2002
Traffic: 156 daily ESALs
Emulsion Type / Content: CMS-2

This road was CIR and overlaid in 2002. Considering the relatively thin thickness of the rehabilitation, this road is performing well on this truck corridor.

Images from mile post 5 taken before and after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Warren N&S Images.

2000 Image: Two years before the CIR project

2003 Image: One year after the CIR project

2011 Image: Nine years after the CIR project

2014 Image: Twelve year after the CIR project

A.16 Fairfield N&S STPP 3-1(11)18 CN 3129

Roadway: Highway 89, RP 18-28
Corridor: C000003
Roadway: Highway 89, RP 18.0 to RP 28.0
Project Description: 0.20' CIR Overlaid w/ 0.20' PMS
Construction Date: fall 2001
Traffic: ~60 daily ESALs
Emulsion Type: CMS-2

In fall 2001, this road was CIR and overlaid. This minor rehabilitation has worked very well on this moderately traveled roadway.

**Treatment recommendations for the future:

- Crack seal and cover in 2017 from RP 23.4 to RP 28.2

****Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 25 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Fairfield N&S Images.


2002 Image: One year after the CIR project


2008 Image: Seven years after the CIR project

A.17 Red Lodge North STPP 28-2(14)70 CN 2409

Roadway: Highway 212, RP 91.0 to 101.5

Corridor: C000028

Construction Date: July 2001

Treatment:

- **Section 1**: RP 89.0- RP 91.0, 0.30’ Cold Mill, 0.34’ PMS
- **Section 2**: RP 91.0-RP 94.3, 0.25’ Recycle with 0.15’ PMS Overlay
- **Section 3**: RP 94.3-RP 95.4, 0.25’ Recycle with Seal and Cover
- **Section 4**: RP 95.4-RP 96.3, 0.25’ Mill and Fill
- **Section 5**: RP 96.3-RP 98.0, 0.25’ Recycle with Seal and Cover
- **Section 6**: RP 98.0-RP 101.6, 0.25’ Recycle with Two 0.30’ Lifts of PMS

2006 Traffic: ~30 daily ESALs

Emulsion Type: CIR-EE

Before CIR, Highway 212 suffered from rutting, plastic deformation and transverse cracking. MDT decided to conduct an experimental CIR project using the Koch Pavement Solutions™ CIR-EE process. The length of the project allowed the installation of various treatments with adequate control sections.

The Research Section has done annual evaluations of this pavement. The 2006 evaluation is summarized below:

The chart below is the averaged 2006 wheel-path rutting for all treatments.

TREATMENTS	AVERAGE RUT DATA (IN INCHES)			
	NORTHBOUND		SOUTHBOUND	
	OWP	IWP	IWP	OWP
(1) 0.30’ Cold Mill, 0.34’ PMS	0.20	0.16	0.20	0.16
(2) 0.25’ Recycle, 0.15’ PMS	0.16	0.12	0.08	0.12
(3) 0.25’ Recycle	0.16	0.20	0.28	0.20
(4) 0.25’ Mill and Fill	0.24	0.20	0.12	0.20
(5) 0.25’ Recycle	0.16	0.16	0.31	0.24
(6) 0.25’ Recycle, 0.30’ PMS	0.28	0.16	0.16	0.20

The following is the individual breakout on cracks-per-mile (CPM) in order as listed above.

Treatment	Cracks per Mile
Section 1	0
Section 2	18
Section 3	88
Section 4	73
***Section 5**	**170**
Section 6	0

*This is the 0.25' recycle site. This report will note that initially with the first annual inspection, there was an abnormally high transverse cracking within the 300' data site.

**Treatment recommendations for the future:

- Crack seal and cover in 2017 from RP 91.0 to RP 95.3

****Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 95 taken before and after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Red Lodge North Images.

2000 Image: One year before the CIR project

2003 Image: Two years after the CIR project

2009 Image: Eight years after the CIR project

2013 Image: Twelve years after the CIR project

A.18 Two Medicine Bridge - East, NH 1-3(34)210F CN 1814

Roadway: US-2, RP 211.0 to RP 217.5

Corridor: C000001

Treatment:

- RP 211 to RP 213: 0.25’ CIR w/ 0.20’ Grade D Overlay
- RP 214-217.5: 0.20’ CIR w/ 0.20’ Grade D Overlay

Construction Date: June 1998

2006 Traffic: 52 Daily ESALs

Emulsion Type / Content: CMS-2P

This experimental project involved the comparison of two CIPR treatments of two depths: 0.20’ vs. 0.25’.

In 2002, the final research report indicated the following differences in performance between the two treatments:

TREATMENTS	RUTTING DATA (IN INCHES)			
	EASTBOUND		WESTBOUND	
	OWP	**IWP**	**IWP**	**OWP**
0.20’ CIR	0.27	0.22	0.13	0.26
0.25’ CIR	0.20	0.17	0.13	0.25

Maintenance crack sealed and chip sealed this road in 2003.

*Projects on roadway after CIR project:

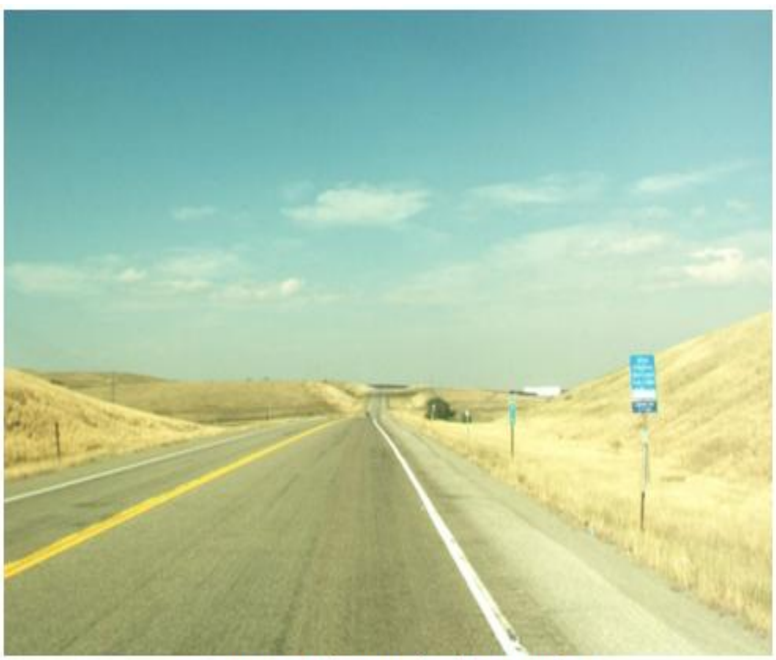
- Widening and overlay in 2007 from RP 204.3 to RP 208.9
- Chip seal in 2009 from RP 219.2 to RP 224.7
- Cold in place recycling in 2012 from RP 208.9 to RP 219.2 (can be seen later in the report – East Glacier Browning project)

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**

Images from mile post 215 taken before and after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: Two Medicine Bridge Images.

1997 Image: One year before the CIR project

2001 Image: Three years after the CIR project



2007 Image: Nine years after the CIR project

2014 Image: Sixteen years after the CIR project

A.19 19 Miles N. of Avon RTF 41-1(12)19 CN 2406, Devil's Dip N&S STPP 41-1(10)28 CN 2345

Roadway: Montana 141, RP 19.5 to RP 32.5

Corridor: C000041

Treatment: 0.20' and 0.30' CIR w/ Chip Seal

Construction Date: July 1996

2006 Traffic: ~60 daily ESALs

Emulsion Type/Content: CMS-2P, Design Asphalt content = 2.2% by weight, actual construction emulsion content = 1.1 to 1.3% by weight

The 0.30' CIPR section extends from RP 19.5 to 27.0. The 0.20' CIR section extends from RP 28.0 to 32.0. Generally speaking, the CIR did not perform well. After 5 years in service, the average thermal crack spacing was approximately 47 ft. The rutting along the 0.30' portion averaged 0.30 inches with a maximum of 0.40 inches. The rutting along the 0.20' portion averaged 0.25 inches with a maximum of 0.50 inches. The ride generally stayed satisfactory.

This project was overlaid by maintenance in May 2001, after 5 years in-service. The overlay has performed well.

The poor performance after the CIPR in 1996 may have been a result of using low emulsion content (1.3% by weight).

*Projects on roadway after CIR project:

- Chip sealed in 2010 from RP 19.6 to RP 32.5
- Crack sealed in 2011 from RP 19.6 to RP 32.5

**Treatment recommendations for the future:

- Thin overlay in 2017 from RP 19.5 to RP 32.5

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 25 taken after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: 19 Miles N of Avon Images.

2002 Image: Six years after the CIR project

2012 Image: Sixteen years after the CIR project

2014 Image: Eighteen years after the CIR project

A.20 Hays North, RTF 66-2(1)16 CN 2694

Roadway: State Highway 66, RP 16.0 to RP 49.0

Corridor: C000066

Treatment:

- Treatment 1: 0.20' CIR w/ 0.15' Grade B Overlay
- Treatment 2: 0.20' CIR

Construction Date: 1995

2006 Traffic: ~40 daily ESALs

Emulsion Type: CMS-2P

This was a formal research project. The project included two control sections to compare the performance of the CIR to virgin PMS (shown below). In general, the CIR road has performed well and is still in service.

The following cracking was measured in 2001:

Treatment Type	Cracks per Mile
0.20' 85/100 grade B	132
0.20' CIR, 0.15' 85/100 grade B	217
0.20' CIR	318
0.10' HMA	376

The following rut depths were measured in 2001:

Treatment Type - Accumulated Rut (in)	NB Lanes		SB Lanes	
	OWP	IWP	OWP	IWP
0.20' Grade B	0.11	0.18	0.15	0.13
0.20 CIR w/ 0.15' Grade B	0.09	0.11	0.09	0.10
0.20' CIR	0.21	0.22	0.23	0.13
0.10' HMA	0.14	0.18	0.15	0.13

*Projects on roadway after CIR project:

- Chip sealed in 2002 from RP 40.0 to RP 50.0.
- Crack sealed in 2003 from RP 15.7 to RP 40.0.
- Overlaid in 2008 from RP 15.7 to RP 35.0.

**Treatment Recommendations for the future:

- Thin overlay in 2017 from RP 15.7 to RP 36.0
- Crack seal and cover in 2015 and 2017 from RP 36.0 to RP 50.0

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 30 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Hays North Images.

2003 Image: Eight years after the CIR project

2009 Image: Fourteen years after the CIR project

2014 Image: Nineteen years after the CIR project

A.21 SE Fort Benton - Geraldine, STPP 80-1(10)15, CN 2405

Roadway: MT-80, RP 14.7 to RP 28.0
Corridor: C000080
Treatment: 0.20’ CIR w/ 0.15’ Overlay
Construction Date: 1995
2006 Traffic: ~39 daily ESALs
Emulsion Type: CMS-2P @ 1.8% by weight

There is no research construction report available. This project was a minor rehabilitation project with a 20-year design life. CMS-2 emulsion was used at a rate of 1.9% by weight.

In 2001, the transverse cracks averaged 161 cracks per mile, or 33 ft. crack spacing.

*Projects on roadway after CIR project:

- Microsurfacing in 2012 from RP 14.7 to 24.3

**Treatment Recommendations for the future:

- Crack seal in 2017 from RP 14.7 to RP 24.3

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images from mile post 20 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: SE Fort Benton Images.

2003 Image: Eight years after the CIR project

2012 Image: Seventeen years after the CIR project

A.22 Fort Benton N & S, NH 10-2(19)20 CN 1403

Roadway: US-89, RP 19.9 to RP 37.5
Corridor: C000010
Treatment: 0.25' CIR w/ 0.35' Grade D Overlay
Construction Date: August 1994
2006 Traffic: ~105 daily ESALs
Emulsion Type: CMS-2P

This minor rehabilitation was designed to provide a 20-year design life. Before construction in 1991, the Pavement Management Section indicated that 30% of the project had alligator cracking and 57% of the project had rut depths ranging from 0.50 to 0.75 inches.

In 2001, the transverse cracks averaged 121 cracks per mile, or 44 ft crack spacing.

Maintenance crack sealed this roadway in 2001 and 2002.

*Projects on roadway after CIR project:

- Crack seal in 2003 from RP 20.0 to RP 41.0
- Chip seal in 2009 from RP 19.9 to RP 43.4

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**

Images from mile post 25 taken after the CIR project were obtained from PathWeb and are displayed below. More images can be found using the following link: Fort Benton N&S Images.

1997 Image: Three years after the CIR project

2003 Image: Nine years after the CIR project

2009 Image: Fifteen years after the CIR project

2014 Image: Twenty years after the CIR project

A visit was taken to Fort Benton N&S on June 24, 2015 to evaluate the performance of the roadway. The road was analyzed at RP 20.4. Spacing of transverse cracks measured approximately 65 to 85 feet apart propagating across both lanes. Chip seal delamination was present along the shoulders of the roadway as well as along the centerline most likely due to snowplows. The following pictures show cracking and chip seal delamination in the roadway.

Transverse cracking across both lanes of the highway

Transverse cracking and delamination

Delamination on the shoulders of the highway

To access more images from June 25, 2015 select the following link: Fort Benton N&S.

A.23 Rogers Pass – West, F-HES 24-3(11)83

Roadway: MT-200, RP 83.0 to RP 91.0
Corridor: C000024
Treatment: 0.25' CIR w/ 0.20' PMS Overlay
Construction Date: 1985
2006 Traffic: 126 daily ESALs
Emulsion Type/Content: Cyclogen @ 2.5% by weight

This roadway did not perform well. In 1991, it was overlaid with 0.35' Grade B PMS. The Surfacing Design Unit believes there were a number of correctable reasons that this project failed. The current special provision addresses the problems encountered in 1985.

A 1990 PFR report indicated the following:
Cores taken along the project were not holding together, causing the top lift to alligator crack. Transverse cracking and rutting were also noted. Factors that may have led to the premature failure included:

1) In 1989, cores from the CIR mixture were tested using the Modified Lottman procedure. The tests resulted in 26.7% retained strength, indicating the material was moisture susceptible.

2) Gradation testing of the cores taken in 1989 showed there was 10.5% passing the No. 200 screen. The emulsion content used was 2.5%. This was not enough emulsion for the fine gradation.

3) The specification required that the CIR material be overlaid after it had "dried" to a moisture content of 2% or less. This was not possible because of the wet weather, and the CIR was overlaid "wet."

*Projects on roadway after CIR project:

- Crack seal in 1991 from RP 82.9 to RP 99.2
- Overlay in 1999 from RP 87.7 to RP 90.0
- Overlay in 2004 from RP 83.1 to RP 91.2
- Crack seal in 2012 from RP 83.1 to RP 100.2

**Treatment Recommendations for the future:

- Crack seal and cover in 2015 and 2017 from RP 82.4 to RP 91.3

*** Looked up in Agile Assets. These projects may not fit with summaries in some of the older CIR projects.**
**** Looked up in 2014 Pavement Performance and Conditions Manual**

Images taken from mile post 87 after the CIR project were obtained from PathWeb and are displayed on the following page. More images can be found using the following link: Rodgers Pass Images.

2005 Image: Twenty years after the CIR project

2008 Image: Twenty-three years after the CIR project

2014 Image: Twenty-nine years after the CIR project

Appendix B: CIR Specifications

405-1 Cold In-Place Recycling (Partial Depth) (Revised 2-12-15)

COLD IN-PLACE RECYCLING (PARTIAL DEPTH) [405] (REVISED 2-12-15)

Description. This work is the partial depth pulverizing, crushing, and screening of the in-place bituminous materials to the dimensions shown on the plans and incorporating emulsified asphalt binder agent, water and mineral filler into the pulverized material. The work also includes paving the cold in-place recycled (CIR) material to the dimensions shown on the plans.

Materials.

Mixture Design. Perform the mixture design using the procedure in the special provision for Cold In-place Recycling (Partial Depth) Mixture Design found elsewhere in the proposal. Include all costs associated with the mixture design in the pay item, “Cold Recycled Plant Mix”.

Asphalt Emulsion. Use an asphalt emulsion with the properties listed in Table 405-2 and the mixture design properties listed in Table 405-3, found elsewhere in the proposal. The target asphalt emulsion content will be determined from the mixture design. Adjust the asphalt emulsion rate, with concurrence from the Project Manager, to improve coating or to adjust breaking properties. Do not reduce asphalt emulsion content below 2% without concurrence from the Materials Bureau.

Pulverized Bituminous Material. Meet the following gradation before adding asphalt emulsion:

Sieve Size	Percent Passing
1.25-inch (31.5 mm)	100

Mineral Filler. Furnish 1.0% mineral filler by dry weight of cold recycled material. Obtain written approval by the Project Manager to increase the application rate of mineral filler prior to production changes. Furnish mineral filler as specified elsewhere in the contract.

Reclaimed Asphalt Pavement (RAP). If available, RAP may be added as approved by the Project Manager if it meets the requirements in Table 405-1. Ensure that when RAP is added to the cold recycled material, the resulting material meets the specifications in Table 405-3.

Table 405-1

Additional Crushed RAP

Tests	Method	Limit
Deleterious Materials: Clay Lumps and Friable Particles in Aggregate, % max	AASHTO T 112	0.2 recommended
Maximum size, 100% Passing	AASHTO T 27	1.25-inch (31.5 mm) sieve

Water. Provide water free of organics or deleterious materials that does not cause an adverse reaction with the asphalt emulsion or mineral filler.

Construction Requirements.

Seasonal and Weather Limitations. Place cold recycled material between the dates of May 15 and August 1 when surface treatment will consist of seal and cover. Place cold recycled material between the dates of May 15 and October 1 when surface treatment will consist of an overlay.

The National Weather Service weather forecast will be used for the following items c) and d). Do not perform recycling operations when:

The ambient temperature measured in the shade and not influenced by artificial heat is lower than 55 °F.

During foggy or rainy weather regardless of temperature.

When the weather forecast for the project site includes a probability of precipitation greater than 45 percent during the intended schedule of operations for that day.

When the weather forecast for the project site predicts the temperature will be below 35 °F (1.7 °C) within 24 hours after placement of any portion of the project.

When the surface treatment consists of an overlay, begin placing overlay between twelve and fifteen calendar days after the completion of cold recycling. An overlay can be placed earlier provided the CIR meets the water content specifications under Construction Requirements part 3) of this provision.

When the surface treatment consists of a seal and cover, begin placing seal and cover between twenty-five and thirty calendar days after the completion of cold recycling. A seal and cover can be placed earlier provided the CIR meets the water content specifications under Construction Requirements part 3) of this provision.

Equipment. Meet the following equipment requirements.

Use a self-propelled cold milling machine capable of pulverizing the existing bituminous material in a single pass to the plan depth and a minimum 12.5-foot (3.6 m) width. Ensure the machine has automatic depth control to maintain cutting depth to within plus or minus 0.25-inch (6 mm) of the plan depth. The machine must have positive means to control cross slope elevations. Heating devices to soften the pavement are prohibited.

The Contractor will be required to cold recycle the full pavement width, as shown on the plans. If the primary milling machine is unable to process one half of the road in one pass, multiple passes with a milling machine will be necessary to process the pavement remaining along shoulder. A smaller milling machine may be used to mill shoulders and miscellaneous areas.

Submit a milling plan for Project Manager's approval 10 business days before starting the cold recycling operation.

Use a mixing unit equipped with a belt scale to continuously weigh the pulverized material. A coupled/interlocked computer controlled liquid metering device is required. Ensure the liquid metering device can automatically adjust the asphalt emulsion flow to compensate for variations in the weight and water content of pulverized material introduced into the mixer. Ensure the metering device delivers the asphalt emulsion to within plus or minus 0.2 percent of the required amount, based upon dry weight of pulverized material. Ensure the asphalt emulsion pump is capable of emulsion contents up to 3.5 percent by weight of pulverized material. Ensure automatic digital readings are displayed for both the emulsion and pulverized material flow rates. Use a pugmill with interlocked water metering system capable of adding water at a rate between 0.5 and 5.0 percent by weight of pulverized material.

Prior to beginning work, provide Project Manager with documentation of calibration and certification of flow meters and internal scales required to achieve the required control of mixing rates.

Use a self-propelled bituminous paver equipped with electronic grade and cross slope control for the screed. Ensure the paver is capable of spreading and laying cold recycled material during one continuous pass to the specified dimensions.

Use at least one 20-ton (18.1 MT) minimum pneumatic roller and at least two 10-ton (9.07 MT) minimum steel wheel static/vibratory rollers. Ensure scrapers and water-spraying systems are in working order.

Use a self-propelled power broom to remove loose particles and other materials from the cold recycled surface prior to overlay or seal and cover.

Construction Methods and Procedures. Remove dirt, vegetation, standing water, combustible materials, oils, and thermoplastic markings from the entire roadway width.

Complete recycling operations through initial compaction and open the roadway to two-lane traffic at the end of each day's work. Maintain traffic through the project at all times. Close one lane only as necessary to permit recycling and compaction operations.

Mill to required depth and width as indicated on the plans. Do not disturb the material underlying the bituminous pavement. Make adjustments to milling depth as directed by the Project Manager. Process pulverized material so 100 percent passes the 1.25-inch (31.5 mm) sieve. Ensure that the screening and crushing unit includes a closed circuit system capable of continuously returning oversized material to the crusher. Remove oversized crack filler and fabric within the pulverized material from the crusher screens. Oversized crack filler is crack filler not passing the 1.25-inch (31.5 mm) screen. Waste oversized crack sealer as directed by the Project Manager.

Produce cold recycled material using a mixing unit that processes the pulverized material, asphalt emulsion, and mineral filler into a homogeneous mixture. Introduce asphalt emulsion and mineral filler into the pulverized material at the rate shown in the mix design(s). Do not deviate from asphalt emulsion or mineral filler rates shown in the mix design without Project Manager approval.

Do not heat paver screed. Use a pick-up machine to transfer the windrowed material into the paver hopper. Ensure the pickup machine is within 50 yards (46 m) of the mixing unit during the work.

Begin rolling within 30 minutes after paving. Use double drum steel rollers for final rolling to remove pneumatic tire marks. Complete finish rolling within 1 hour after paving is completed. Do not start, stop or park rollers on the un-compacted mat. Discontinue rolling if cracking is observed or if material is being displaced.

After compaction, do not permit traffic, including that of the Contractor, on the cold recycled material for 2 hours. Do not allow stopped or standing traffic, including that of the Contractor, on the cold recycled material for 36 hours after placement. Place traffic control at the beginning of the previous day's work so vehicles waiting in queue park on cold recycled material more than 36 hours old. After compaction and before placing the overlay or seal and cover, maintain the recycled pavement surface in a condition suitable for the safe movement of traffic.

The method for determining the moisture content is to divide each paver pass into 3000 foot (915 m) sections. At one location selected and witnessed by Department personnel, remove a 2.2 lb. (1000 g) sample withdrawn from a uniform section representing the full depth of the compacted cold recycled material. Extract using a dry method such as a pick or a diamond saw. Immediately place samples in a previously weighed moisture proof container. Fill sample hole by placing and compacting cold recycled, hot, or cold mix asphalt pavement in 2 inch (50 mm) lifts to the finished surface. Furnish samples to the Department. The Department will determine moisture content using MT 312. Each location must have moisture contents less than 2.0 percent before an overlay or seal and cover is placed on the section.

Quality Assurance/ Quality Control. Be responsible for sampling, testing and control of the cold recycled material and cold recycling process.

Milled Bituminous Material Sizing. Provide equipment needed to collect a representative sample from the belt conveyer before introducing emulsion. Sample each 0.5 mile (0.8 km) and test using a 1.25-inch (31.5 mm) sieve to determine compliance with the particle size requirement. Use ASTM D979 or AASHTO T 168.

Asphalt Emulsion. Ensure the asphalt emulsion arrives on the project not exceeding 120ºF. For all asphalt emulsion delivered to the project, provide supplier's documentation that asphalt emulsion meets the requirements of Table 405-2. Asphalt Emulsion not meeting these requirements will be rejected. When requested by the Department, obtain samples for verification testing in accordance with Subsection 402.03.2. Obtain samples from shipping trailers before transferring emulsion into the Contractor's storage units for verification testing.

Table 405-2

Asphalt Emulsion Requirements

Test		Minimum	Maximum
Residue from distillation, %	AASHTO T 59	63.0	
Oil distillate by distillation, %	AASHTO T 59		1.0
Sieve Test, %	AASHTO T 59		0.3
Penetration range (TBD[1]), 77ºF (25°C), in (mm)	AASHTO T 49	-25%	+25%

Notes:

1. To be determined by the CIR mixture design before manufacturing emulsion for project. Submit penetration range to Project Manager for approval before project start.

Asphalt Emulsion Content. Use asphalt emulsion content required by the mixture design, or as allowed by Project Manager. Do not reduce asphalt emulsion content below 2% without concurrence from the Materials Bureau. Check and record emulsion content for each segment where the percentage is changed. Record emulsion content from the belt scale and asphalt pump totalizers.

Mixture Testing. When instructed by the Project Manager, submit representative samples of loose cold recycled material from windrow for testing and review. Samples may be tested by the Department to verify the material meets the properties in Table 405-3, found elsewhere in the proposal. Take samples from the windrow following MT 303. Seal samples in a waterproof bag.

If mixture properties do not meet the properties in Table 405-3, work may be suspended until proper corrective actions or adjustments can be made. This may include but not be limited to changing production rate and the amount or type of recycling agent or other additives.

Milling Depth. Check and record the nominal depth on both outside vertical faces of the cut at 700 feet (210 m) intervals.

Compaction and Density Requirements. Compaction and Density requirements will be determined using the test strip method. Compact cold recycled material to a minimum of 97 percent of the target density obtained from test strip.

Construct test strip, establish target density, and monitor density during construction in accordance with MT 219, *Control-Strip B – Plant Mix Paving* with the following exceptions:

Construct test strip when pavement temperature is 68ºF (20ºC) or higher;

Construct test strip at a depth representative of the project; and

Construct test strip using rollers specified in Construction Requirements, part 2) f).

If mix proportions, weather conditions or other controlling factors change, the Department may require construction of additional test strip(s) to establish a new target density.

Cold Recycled Surface Cross Slope / Smoothness. Use a level to check the cold recycled surface cross slope regularly during placement. Ensure the smoothness varies less than 0.25-inch (6 mm) from the lower edge of a 10-foot (3 m) straight edge placed on the surface parallel and transversely to the centerline after rolling is completed.

Conditions of Acceptance and Corrective Actions for Cold Recycled Material. Acceptance for payment of the cold recycled material will be determined by visual inspection of the mixture on the roadway. Before proceeding to other work or surfacing treatments, correct deficient cold recycled material to the satisfaction of the Project Manager as follows:

Reprocess or repair any area showing an excess or deficiency of asphalt emulsion.

Reprocess or repair any area that ravels.

If rutting occurs before the surface treatment is placed, re-compact to remove ruts.

Reprocess or repair areas not meeting smoothness criteria.

Measurement. Work as described will be measured by the square yard of the completed sections for the depth specified. Asphalt emulsion will be measured by the ton (metric ton). Water used in this operation will not be measured for payment.

Basis of Payment. Payment for completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Cold Recycled Plant Mix	Square Yard (square meter)
Cold Recycling Emulsion	Ton (metric ton)

Mineral filler will be paid for as described elsewhere in the contract.

Reprocess and/or repair Cold Recycled Material not meeting specifications at no cost to the Department.

Payment at the contract unit price is full compensation for all necessary resources necessary to complete the contract work items.

405-2 Cold In-Place Recycling (Partial Depth) Mixture Design (Revised 2-12-15)

COLD IN-PLACE RECYCLING (PARTIAL DEPTH) MIXTURE DESIGN [405] (REVISED 2-12-15)

Description. This procedure is used to determine the asphalt emulsion content for cold in-place recycled (CIR) plant mix surfacing. Use this procedure when specifying cold in-place recycling - engineered emulsion (CIR-EE).

Mixture Design. Submit a mix design for approval 10 business days before starting the CIR operation. Perform the mixture design in accordance with this special provision. Use asphalt emulsion meeting the requirements presented in Table 405-2. Ensure the job mix formula meets Table 405-3 requirements at the design asphalt emulsion content.

TABLE 405-3

JOB MIX FORMULA CRITERIA

PROPERTY	CRITERIA	PURPOSE
Compaction effort, Superpave Gyratory Compactor 4” (100 mm) diameter specimens	1.25° angle, 87 psi (600 kPa) stress, 30 gyrations	Density Indicator
Density, MT 314	Report	Compaction Indicator
Gradation for Design Millings, AASHTO T 11	Report	
Marshall stability, AASHTO T 124	1,250 pound (6.7 kN) minimum	Strength Indicator
Retained stability based on cured stability, AASHTO T 283, modified in Part f)	70 percent minimum	Moisture susceptibility
Indirect Tensile Test, AASHTO T 322, Modified in Part g)	Critical Cracking Temperature is -24ºF (-31 ºC).	Thermal Cracking
Raveling Test, ASTM D 7196, Ambient or 50 ^{0}F (10 ºC)	2 percent maximum	Raveling Resistance

Sampling and Processing. Collect cores from the area to be recycled. If cores show significant differences over the project length, such as different types of plant mix surfacing, perform separate mix designs for each of these pavement segments. Take cores at regular intervals within the project limits, calculated as follows:

Core Interval, ft. (m) = (Length of Project, ft. (m))/(No. of Cores needed for Mix Design).

Use only the portion of the core that will be recycled for the mix design. Crush cores in the laboratory. Perform a mixture design for each gradation shown in Table 405-4, for a total of two mixture designs.

Table 405-4

Mix Design Gradation Requirements

Sieve	Medium	Coarse
	Percent Passing	
1.25-inch (31.5 mm)	100	100
No. 4 (4.75 mm)	40-50	28-38
No. 30 (0.6 mm)	7-12	4-10
No. 200 (0.075mm)	> 1	> 1

After crushing determine the millings gradation using AASHTO T 11 and T 27 (dried at no greater than 104 °F (40 °C)).

A minimum of 150 pounds (68 kg) of usable millings is required for each mix design. The estimated quantities for one mix design is:

50 – 4-inch (100 mm) cores, or

30 – 6-inch (150 mm) cores

Prepare samples with a sample splitter. An alternative method is to dry, screen and recombine millings in the laboratory to target gradation. The following screen sizes are recommended: ½-inch (12.5 mm), ⅜-inch (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 30 (0.600 mm), and pan.

Scalp oversize aggregate with a 1-inch (25 mm) screen when using 4-inch (100 mm) diameter compaction molds.

Mixing. Mix material for a 4-inch (100 mm) diameter, 2.4-inch to 2.6-inch (61.0 mm to 66.0 mm) tall specimen. Determine sample size for Rice specific gravity testing using MT 321.

Number of specimens:

Quantity	Test To Be Performed	Total Number
2	Moisture Susceptibility @ 3 emulsion contents	6
2	Rice Specific Gravity on highest emulsion content	2
2	Marshall Stability @ 3 emulsion contents	6

Choose three emulsion contents bracketing the estimated design emulsion content. Recommended emulsion contents: 1, 2, and 3 percent.

Add 1.0% mineral filler.

Mix test specimens in a mechanical bucket mixer. At ambient temperature, mix the millings thoroughly with mineral filler first, then mix with emulsion. Mix one specimen at a time. Do not mix with emulsion more than 60 seconds.

Compaction. Compact specimens immediately after mixing.

Compact specimens as specified in Table 405-3. Do not heat the mold.

Curing after compaction. Extrude specimens from molds immediately after compaction. Place specimens in 140 °F (60 °C) forced draft oven with side and top ventilation. Place each specimen in a small container to account for material loss from specimens.

Cure Rice specific gravity specimens to constant weight (less than 0.05% weight loss in two hours). Do not over-dry the specimens.

Cure compacted Marshall and moisture susceptibility specimens to constant weight (less than 0.05 percent change in weight in two hours) for 16 to 48 hours. After curing, cool specimens at ambient temperature for 12 to 24 hours.

Marshall Stability and Air Voids. Determine bulk specific gravity of each specimen according to MT 314 with one exception. Record the mass of the specimen in water after 1-minute submersion.

Determine specimen heights according to ASTM D3549 or from the SGC readout.

Determine Rice specific gravity, MT 321, except do not break any agglomerates which will not easily reduce with a flexible spatula. Normally the supplemental dry-back procedure is performed to adjust for uncoated particles.

Determine air voids at each emulsion content.

Determine corrected Marshall stability by AASHTO T 124 at 104 °F (40 °C) after 2-hour temperature conditioning in a forced draft oven.

Moisture Susceptibility. Perform moisture susceptibility (AASHTO T 283) with the following changes to the procedure. Vacuum saturate to 55 to 75 percent, soak in a 77 °F (25 C) water bath for 23 hours, followed by a 1-hour soak at 104 °F (40°C). Determine corrected Marshall stability and retained stability.

Procedure for performing AASHTO T 322 for CIR Design Specimens. The critical cold temperature cracking temperature must be equal to or colder than the temperature shown in Table 405-3.

Perform the indirect tensile testing (IDT) meeting AASHTO T 322, except as follows:

Prepare two specimens 6-inch (150 mm) in diameter and at least 4.5 inch (115 mm) in height, compacted to the design air voids (±1%) at the design emulsion content. Cure test specimens at 60 ºC between 48 and 72 hours. After curing 48 hours, ensure that specimen mass changes no more than a 0.05 percent in 2 hours. After curing, cut two 2-inch (50 mm) specimens from each cured specimen from the center of the specimen (i.e. discard top and bottom of specimen). Perform the bulk specific gravity test after cutting.

A minimum of 2 specimens are required at each of 2 temperatures.

Select two testing temperatures at an 18 ºF (10 ºC) interval bracketing the critical cold cracking temperature For example, if the required temperature is -13 ºF (-25 ºC), then select testing temperatures of -4 ºF (-20 ºC) and -22 ºF (-30 ºC).

Perform IDT tensile strength test immediately after the IDT tensile creep test at the same temperature as the creep test.

Ensure the environmental chamber can reach -40 ºF (-40 ºC).

The critical cracking temperature is defined as the intersection of the calculated pavement thermal stress curve, derived from creep data, and the tensile strength line. The tensile strength line connects the average tensile strength at the two test temperatures.

Procedures for Performing the Raveling Test on CIR Specimens. Use a modified A-120 Hobart mixer (or equivalent) and abrasion head (including hose) to perform the raveling test (ASTM D 7196 exceptions stated below). Remove the ring weight from the abrasion head while performing the raveling test. The weight of the abrasion head and hose in contact with the specimen is 1.32 lbs (600 g) ± 0.5 ounces (15 g).

Split two 6 lb. (2700 g) recycled asphalt samples from the medium gradation or field sample. Place sample in a mechanical bucket mixer.

Add water required to reach field or design moisture content and mix for 60 seconds.

Add the design emulsion content and mix for 60 seconds.

Immediately place the samples into a 6-inch (150 mm) gyratory. compaction mold and compact to 20 gyrations. If the sample height is not 2.75-in. (70 mm) ±0.2 inches (5 mm), adjust the recycled asphalt weight and prepare a new specimen.

After compaction, remove the specimen from the compaction mold and place on a flat pan to cure at ambient temperature (65-75ºF) for 4 hours ±5 minutes.

Weigh specimen after the curing and immediately before testing.

Place specimen on the raveling test apparatus. Ensure the specimen is secured and centered under the abrasion head allowing for free vertical movement of the abrasion head. Provide at least 0.4 in (10 mm) of vertical hose movement for abrasion. For the sample to fit properly for abrasion, it may be necessary to adjust the abrasion head height or sample height. The portion of the hose in contact with the specimen must be unused. It is allowable to rotate the hose to an unworn section for testing.

Abrade sample for 15 minutes. Remove abraded material and weigh sample immediately after testing.

Determine the percent raveling loss as follows:

(Mass Prior to test – Mass After test)/(Mass Prior to test) * 100.

Report the average results of two specimens as the percent raveling loss. Repeat the test if a difference in raveling loss between the two specimens is greater than 0.5 percent. If both samples have a Raveling Loss greater than 10 percent, waive the 0.5 percent requirement and report results.

Emulsion Content Selection. The design emulsion content is the lowest emulsion content meeting the requirements in Table 405-3.

Report. Include the following minimum information in the mix design report:

RAP Gradation

The amount and gradation of virgin aggregate or RAP added to the cold milled material (if required)

Recommended water content range as percentage of dry RAP

Optimum emulsion content as a percentage of dry RAP

Rice and bulk specific gravity, density, air void level, and absorbed water at optimum emulsion content

Marshall stability and retained stability at design moisture and emulsion content.

The emulsion product name, manufacturer's name, and plant location. Report the following asphalt properties:

-Residue from distillation, % (AASHTO T 59)

-Oil distillate by distillation, % (AASHTO T 59)

-Sieve Test, % (AASHTO T 59)

-Penetration Range @ 77ºF (25°C), in (mm) (AASHTO T 49)

Provide the type of mineral filler used and furnish a manufacturer's certificate of compliance.

Appendix C: Mineral Filler Specifications

1. MINERAL FILLER FOR COLD IN-PLACE RECYCLED PAVEMENT [713] (REVISED 2-12-15)

A. Description. This work includes furnishing and incorporating mineral filler into cold in-place recycled pavement.

B. Materials. Use either lime slurry or cement for mineral filler

1) Cement. Furnish Type I or II portland cement listed on the QPL, in accordance with Subsection 551.02.

2) Lime Slurry. Lime slurry consists of either hydrated lime or quicklime mixed with water. The purpose of the lime slurry is to introduce hydrated lime to the milled recycled asphalt pavement. If quicklime is used to produce lime slurry, proportion quicklime to meet the required hydrated lime application rate after slaking.

a) Quicklime. Provide granular or pelletized quicklime conforming to the following requirements.

Provide certification that quicklime meets the following gradation under AASHTO T 27:

Sieve Size	Percent Passing (by weight)
⅜ inch (9.5 mm)	100
No. 10 (2.0 mm)	25 maximum

Provide certification that quicklime contains 90% minimum calcium oxide (CaO) content as determined by ASTM C25.

b) Hydrated lime. Provide hydrated lime conforming to the following requirements.

Provide certification that hydrated lime meets the following gradation under AASHTO M 303:

Sieve Size	Percent Passing (by weight)
⅜ inch (9.5 mm)	99
No. 30 (0.600 mm)	95-100
No. 200 (0.075 mm)	75-100

Provide certification that hydrated lime contains 85% minimum calcium hydroxide, $Ca(OH)_2$, as determined by AASHTO T 219 for Type I lime or ASTM C 25 for type II lime.

C. Construction.

1) Storage Facility. Store mineral filler in weatherproof containers.

2) Lime Slurry.

a) Slurry Equipment. Prepare hydrated lime slurry in either a central mixing tank or tank trucks with agitation provided for mixing. Prepare quicklime slurry in mixing equipment designed for quicklime slurry production. The Project Manager may approve other slurrying methods. Equip mixing equipment with scales and meters to accurately proportion lime and water within 0.5% by weight. Provide consistent pumpable lime slurry with the specified percentage of quicklime or hydrated lime. Use a metering device to accurately measure the amount of lime solids required within plus or minus 0.2 percent. Keep batch logs and solids content for each mixed load and submit to the Project Manager at the end of each day. Equipment or methods that result in excessive loss or displacement of lime are prohibited. Prevent injuries to persons and livestock. Immediately pick up or slake any spilled quicklime to eliminate the hazard. Do not perform Dry Lime treatment work when wind or other weather conditions are able to move quicklime from the intended location.

b) Lime Slurry Transport and Feed Tank(s). Provide agitation to keep lime slurry in suspension while held in the lime slurry feed transport and cold in-place recycle feed tank(s).

c) Addition of Lime Slurry. Incorporate hydrated lime or quicklime as lime slurry having a minimum dry solids content of 35 percent by weight. Add lime slurry to the pulverized material with a spray bar located on the milling head. Use a metering device to accurately measure the amount of lime slurry required to within ±10%.

3) Cement. Submit a sequence of operations to the Project Manager for the introduction of cement into the Cold In-Place Recycling 20 calendar days prior to production. Include a description of equipment that will be used for cement introduction.

a) Equipment. Use equipment capable of milling and mixing road sections to the depths shown in the plans. The equipment must be able to utilize a water spray or injection system capable of uniformly mixing the water, recycled plant mix and portland cement together. Equip spreading and mixing equipment with scales and meters to accurately proportion cement and water within 0.5% by weight. Equipment or methods that result in excessive loss or displacement of cement are prohibited. Prevent injuries to persons and livestock. Immediately pick up or remove any spilled cement to eliminate hazards. Do not perform work involving cement placement or mixing when wind or other weather conditions are able to move the cement from the intended location.

b) Immediately suspend operations due to detrimental weather conditions (e.g. wind and/or rain).

c) Spread portland cement uniformly on top of the pavement to be recycled. Do not spread cement in excess of 1000 feet (300 m) ahead of the CIR operation.

d) Uniformly mix portland cement and milled plant mix surfacing with recycling equipment.

D. Method of Measurement. Mineral Filler is measured by the dry ton (metric ton). If hydrated lime is used to produce Lime Slurry, the dry ton of Lime Slurry will be equivalent to the tons of hydrated lime added. If quick lime is used to produce the Lime Slurry, the dry ton of Lime Slurry will be the tons of quick lime added multiplied by 1.32.

E. Basis of Payment. Payment for completed and accepted quantities is made under the following:

Pay Item	Pay Unit
Mineral Filler – CIR	Dry Ton (metric ton)

Replace mineral filler that does not meet specification or is lost or displaced by blowing, washing, or other causes at no cost to the Department.

Payment at the contract unit price is full compensation for all necessary resources necessary to complete the contract work items.

Appendix D: Quality Control

- Ensure milled material passes the 1.25” screen. Probably only needs to be checked once to ensure the contractor has the 1.25” screen installed on the train.
- Ensure Contractor has quicklime production tanks on-site. This includes a quicklime slurry being applied at the milling head.
- Ensure Contractor has calibrated the quicklime pumping equipment at 1.4% by dry weight of CIR material. Ask Contractor for certification that CaO meets the special provision requirements. Collect lime batch logs daily for patment at end of each day.

Ensure the following climate restrictions are met.

Do not perform recycling operations when:

a) The ambient temperature measured in the shade and not influenced by artificial heat is lower than 55 ^{o}F (18.3 °C).
b) During foggy or rainy weather regardless of temperature.
c) When the weather forecast for the project site includes a probability of precipitation greater than 45 percent during the intended schedule of operations for that day.
d) When the weather forecast for the project site predicts the temperature will be below 35 ^{o}F (1.7 °C) within 24 hours after placement of any portion of the project.

- Contractor needs to submit a milling plan 10 days before starting CIR work.
- Ensure the Contractor provides calibration and certification of flow meters and internal scales required to achieve required control of mixing rates.
- Chip Seal should be placed within 2 weeks of the mixtures moisture content initially dropping to 1.5% or less. This is determined as follows:
  - The method for determining the moisture content is to divide each paver pass into 2000 foot (610 m) sections. At two locations selected and witnessed by Department personnel, remove a 4.4 lb. (2000 g) sample withdrawn from a uniform section representing the full depth of the compacted cold recycled material. Extract using a dry method such as a pick or a diamond saw. Immediately place samples in a previously weighed moisture proof container. Fill sample hole by placing and compacting cold recycled asphalt pavement in 2 inch (50 mm) lifts to the finished surface. Furnish samples to the Department. The Department will determine moisture content using MT 312. Each of the two locations must have moisture contents less than 1.5 percent before a surface treatment is placed on the section.

The Contractor is responsible for the following QC:

1) Submitting a copy of the QC plan before starting CIR process.
2) A gradation every 0.5 miles to ensure that 100% of material passes the 1.25” sieve.
3) Provide asphalt emulsion suppliers documentation that the emulsion meet the following requirements:

Asphalt Emulsion Requirements

Test		Minimum	Maximum
Residue from distillation, %	ASTM D244[1]	63.0	
Oil distillate by distillation, %	ASTM D244[1]		1.0
Sieve Test, %	ASTM D244[1]		0.3
Penetration range (TBD[2]), 77ºF (25°C), in (mm)	ASTM D5	-25%	+25%

4) If needed, require Contractor to submit a representative sample for verification of the mix design properties. Take samples from the windrow following ASTM D3665 and D979. Seal samples in a waterproof bag.
5) Check and record the nominal depth on both outside vertical faces of the cut at 700 feet (210 m) intervals.
6) Compaction and Density Requirements. Compaction and Density requirements will be determined using the test strip method.
   a) Test Strip Method. Compact cold recycled material to a minimum of 97 percent of the target density obtained from test strip. Construct test strip, establish target density, and monitor density during construction in accordance with MT 219-04, *Control-Strip B – Plant Mix Paving* with the following exceptions:
      - Construct test strip when pavement temperature is 68 ºF (20 ºC) or higher.
      - Construct test strip at a depth representative of the project.
      - Construct test strip using rollers specified in Construction Requirements

7) Cold Recycled Surface Cross Slope / Smoothness. Use a level to check the cold recycled surface cross slope regularly during placement. Ensure the smoothness varies less than 0.25 inch (6 mm) from the lower edge of a 10-foot (3 m) straight edge placed on the surface parallel and transversely to the centerline after rolling is completed.

8) Conditions of Acceptance and Corrective Actions for Cold Recycled Material. Acceptance for payment of the cold recycled material will be determined by visual inspection of the mixture on the roadway. Before proceeding to other work, correct the deficient cold recycled material as follows:

a) Reprocess or repair any area showing an excess or deficiency of asphalt emulsion.
b) Reprocess or repair any area that ravels.
c) If rutting occurs before the surface treatment is placed, recompact to remove ruts.
d) Reprocess or repair areas not meeting smoothness criteria

Reprocess or repair as directed by the Engineer, at Contractor’s expense. Reprocess or repair any damage before placing surface treatment.

Reprocess and/or repair Cold Recycled Material not meeting specifications at no cost to the Department.

Appendix E: Pavement Preservation Cost Comparison

Line		Surfacing Alternatives		Option 1 ISO/Overlay	Option 2 Mill/Fill	Option 3 CIR/Overlay	Option 4 CIR/Double Chip	Option 5 CIR/Single Chip	Notes:
1	Length	MILES		*1*	*1*	*1*	*1*	*1*	
2	Length	FT		5,280	5,280	5,280	5,280	5,280	
3	**PMS Thickness**	**FT**		**0.30**	**0.30**	**0.10**	**0.00**	**0.00**	
4	PMS Inslope	:1		**4**	**4**	**4**	**4**	**4**	
5	PMS Top Width	FT		**32**	32	32	32	32	
6	PMS Bot Width	FT		34.4	34.4	32.8	32	32	
7	PMS Top Area	SY		18,773	18,773	18,773	18,773	18,773	
8	PMS Weight/Volume	Ton/CY	3855	1.93	1.93	1.93	1.93	1.93	
9	PMS QTY	CU YD		1,948	1,948	634	-	-	
10	PMS QTY	TONS		3,754	3,754	1,221	-	-	
11	MILLING WIDTH	FT		**0.00**	**29.00**	**0.00**	**0.00**	**0.00**	
12	MILLING QTY	SY		-	17,013	-	-	-	
13	**CIR Thickness**	FT		**0.00**	**0.00**	**0.20**	**0.30**	**0.30**	
14	CIR Inslope			0.001	0.001	0.001	0.001	0.001	
15	CIR Top Width	FT		**0.0**	**0.0**	**27.0**	**28.0**	**28.0**	
16	CIR QTY	SY		0	0	15840	16427	16427	
17	Additional Chip Seal	SY		18773	18773	18773	18773	18773	
18	CIR Weight/Volume	Ton/CY	3652	1.83	1.83	1.83	1.83	1.83	
19	PMS Unit $	$/TON	Below	80.82	80.82	80.82	80.82	80.82	
20	CIR Unit $	$/SY	Below	4.49	4.49	4.49	5.36	5.36	
21	MILLING UNIT $	$/SY		**1.75**	1.75	1.75	1.75	1.75	
22	Additional Chip Seal $	$/SY		0.00	0.00	0.00	**2.75**	**1.75**	
23	PMS Cost	$		303,423	303,423	98,704	-	-	
24	CIR Cost	$		-	-	71,135	88,068	88,068	
25	Milling Cost	$		-	29,773	-	-	-	
26	Additional Chip Seal	$		-	-	-	51,627	32,853	
27	"Surfacing Option Total"	$		303,423	333,197	169,839	139,694	120,921	
28	$$$$$ More than least expensive alternative	$		182,503	212,276	48,918	18,773	-	
29	% More than least expensive alternative	%		251%	276%	140%	116%	100%	
30	Total "New" Surfacing Thickness	FT		0.30	0.30	0.30	0.30	0.30	
31	Treated Mat thickness (existing)	FT		0	0.30	0.20	0.30	0.30	
32									
33	**PMS COST BASIS**	**%**	**$/TON**	**$/Ton**	**Notes:**				
34	3/4" Grade S	n/a	**40**	**40.00**	2014 Average Prices = $33.15/TON				
35	PG 64-28	**5.4**	**697.91**	37.69	2014 Average Prices = $697.91/TON				
36	Hydrated Lime	**1.4**	**223.86**	3.13	2014 Average Prices = $223.86/TON				
37	**PMS Total**			**80.82**					
38									
39	**CIR COST BASIS**	**%**	**$/TON**	**$/SY of CIR (0.20')**	**$/SY of CIR (0.30')**	**Notes:**			
40	CIR Processing/Placement	n/a	n/a	**2.75**	**2.75**	Estimate based on economy of scale and past prices.			
41	CIR Emulsion	**2.0**	**675**	1.64	2.47	Use the same Estimate cost of CRS-2P (or to 115% of CRS-2P cost)			
42	CIR Mineral Filler	**0.5**	**160**	0.10	0.15	Use 70% of the cost of Hydrated Lime (Cement is cheaper than Lime!!!)			
43	**CIR Total**			**4.49**	5.36				

CIR has 10-15% voids while PMS has 5% Voids

Appendix F: Cost Analysis of CIR Projects from 2007 - 2015

F.1 Box Elder – North

	Box Elder - North				Great Falls - 3		
Item Number	Quantities	Description	Unit	Bid Prices: Unit Prices	Bid Prices: Amount	District Unit Prices: Unit Prices	District Unit Prices: Amount
				Dollars	Dollars	Dollars	Dollars
104030010	30,000.00	MISCELLANEOUS WORK	UNIT	$1.00	$30,000.00		
109200005	1.00	MOBILIZATION	L SUM	$1,064,358.76	$1,064,358.76		
210020170	20.00	TEST TRAILER-TRANSPORT SET-UP	MI	$97.29	$1,945.80		
409000010	441,421.00	COVER MATERIAL TYPE 1	SY	$0.73	$322,237.33		
301020735		COVER MATERIAL TYPE 2	SY		$0.00		
401020042		PLANT MIX BIT SURF GR D - COMMERCIAL	TON		$0.00		
401020045	43,536.00	PLANT MIX BIT SURF GR S - 3/4IN	TON	$31.46	$1,369,642.56		
401020048		PLANT MIX BIT SURF GR S - 1/2IN	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4 IN	TON		$0.00		
401020300	609.00	HYDRATED LIME	TON	$226.61	$138,005.49		
402020092	2,353.50	ASPHALT CEMENT PG 64-28	TON	$650.00	$1,529,775.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	790.40	EMULSIFIED ASPHALT CRS-2P	TON	$555.00	$438,672.00		
402020476	1,673.90	RECYCLING AGENT CIR-EE	TON	$553.00	$925,666.70		
409000000	22.00	FINAL SWEEP AND BROOM	MILE	$425.00	$9,350.00		
411010000	22,977.00	COLD MILLING	SY	$1.57	$36,073.89		
411011135	39.50	RUMBLE STRIPS	MILE	$829.76	$32,775.52		
618030005	425,000.00	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.79	$335,750.00		
620011105	28.00	WORDS AND SYMBOLS-WHITE PAINT	GAL	$95.00	$2,660.00		
620011110	56.00	WORDS AND SYMBOLS-YELLOW PAINT	GAL	$95.00	$5,320.00		
620011260	18.00	WORDS AND SYMBOLS-WHITE EPOXY	GAL	$275.00	$4,950.00		
620011265	37.00	WORDS AND SYMBOLS-YELLOW EPOXY	GAL	$275.00	$10,175.00		
620012950	44.20	TEMPORARY STRIPING	MILE	$375.00	$16,575.00		
620017000		TEMPORARY PAVEMENT MARKINGS	MI		$0.00		
620013000	1,620.00	STRIPING-WHITE PAINT	GAL	$21.95	$35,559.00		
620013960	1,079.00	STRIPING-WHITE EPOXY	GAL	$47.50	$51,252.50		
620014000	418.00	STRIPING-YELLOW PAINT	GAL	$21.95	$9,175.10		
620014960	278.00	STRIPING-YELLOW EPOXY	GAL	$47.50	$13,205.00		
							English
				TOTAL	$6,383,124.65	LENGTH(mile)	22.081
						WIDTH(f)	33.8037906
			length	116587.68	feet		
			width	33.80	feet		
			Area	3941105.52	Sq Feet		
				437900.61	SqYards		
				14.58	Cost/yard Sq		

F.2 Decker – North and South

Decker N&S						Billings - 5	
				Average Bid Prices		District Unit Prices	
Item Number	Quantities	Description	Unit	Unit Prices Dollars	Amount Dollars	Unit Prices Dollars	Amount Dollars
104030010	20,000.00	MISCELLANEOUS WORK	UNIT	$1.00	$20,000.00		
109200005	1.00	MOBILIZATION	L SUM	$158,545.00	$158,545.00		
210020170	258.00	TEST TRAILER-TRANSPORT SET-UP	MI	$20.00	$5,160.00		
409000010	117,691.00	COVER MATERIAL TYPE 1	SY	$0.68	$80,029.88		
301020735		COVER MATERIAL TYPE 2	SY		$0.00		
401020042		PLANT MIX BIT SURF GR D - COMMERCIAL	TON		$0.00		
401020045	22,455.00	PLANT MIX BIT SURF GR S - 3/4IN	TON	$39.22	$880,685.10		
401020048		PLANT MIX BIT SURF GR S - 1/2IN	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4 IN	TON		$0.00		
401020300	326.00	HYDRATED LIME	TON	$146.70	$47,824.20		
402020092	1,212.20	ASPHALT CEMENT PG 64-28	TON	$649.31	$787,093.58		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	209.20	EMULSIFIED ASPHALT CRS-2P	TON	$598.08	$125,118.34		
403010245	14,140.00	CRACK FILLING	LNFT	$4.25	$60,095.00		
409000000	6.80	FINAL SWEEP AND BROOM	MILE	$800.00	$5,440.00		
411010000	69,753.00	COLD MILLING	SY	$1.54	$107,419.62		
411011135	687.50	RUMBLE STRIPS	MILE	$687.50	$472,656.25		
618030005	180,000.00	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.76	$136,800.00		
620011105	4.00	WORDS AND SYMBOLS-WHITE PAINT	GAL	$70.00	$280.00		
620011260	2.00	WORDS AND SYMBOLS-WHITE EPOXY	GAL	$229.00	$458.00		
620017000		TEMPORARY PAVEMENT MARKINGS	MI		$0.00		
620012950	13.60	TEMPORARY STRIPING	MILE	$840.45	$11,430.12		
620013000	492.00	STRIPING-WHITE PAINT	GAL	$23.55	$11,586.60		
620013960	328.00	STRIPING-WHITE EPOXY	GAL	$50.85	$16,678.80		
620014000	252.00	STRIPING-YELLOW PAINT	GAL	$23.55	$5,934.60		
620014960	168.00	STRIPING-YELLOW EPOXY	GAL	$50.85	$8,542.80		
							English
				TOTAL	$2,941,777.89	LENGTH(mile)	6.76856061
						WIDTH(f)	29.6615025
			length	35738	feet		
			width	29.66	feet		
			Area	1060042.78	Sq Feet		
				117782.53	SqYards		
				24.98	Cost/yard Sq		

F.3 Big Timber – East

		Big Timber - East				Billings - 5	
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	50,000.00	MISCELLANEOUS WORK	UNIT	$1.00	$50,000.00		
109200005	1.00	MOBILIZATION	L SUM	$1,180,000.24	$1,180,000.24		
210020170	126.00	TEST TRAILER-TRANSPORT SET-UP	MI	$16.00	$2,016.00		
301020735		COVER MATERIAL TYPE 2	SY		$0.00		
401020042		PLANT MIX BIT SURF GR D - COMMERCIAL	TON		$0.00		
401020045		PLANT MIX BIT SURF GR S - 3/4IN	TON		$0.00		
401020047	58,764.00	PLANT MIX SURF GR S-3/4 IN-RAP	TON	$28.50	$1,674,774.00		
401020048		PLANT MIX BIT SURF GR S - 1/2IN	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4 IN	TON		$0.00		
401020300	993.00	HYDRATED LIME	TON	$170.20	$169,008.60		
402020092		ASPHALT CEMENT PG 64-28	TON		$0.00		
402020095	2,877.60	ASPHALT CEMENT PG 70-28	TON	$629.00	$1,810,010.40		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	2,271.80	EMULSIFIED ASPHALT CRS-2P	TON	$526.50	$1,196,102.70		
409000000	64.80	FINAL SWEEP AND BROOM	MILE	$250.00	$16,200.00		
409000020	1,278,255.00	COVER MATERIAL TYPE 2	SY	$0.39	$498,519.45		
411010000	635,168.00	COLD MILLING	SY	$1.15	$730,443.20		
411011135		RUMBLE STRIPS	MILE		$0.00		
618030005	850,000.00	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.10	$85,000.00		
620011105	19.00	WORDS AND SYMBOLS-WHITE PAINT	GAL	$200.00	$3,800.00		
620011110		WORDS AND SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	13.00	WORDS AND SYMBOLS-WHITE EPOXY	GAL	$250.00	$3,250.00		
620011265		WORDS AND SYMBOLS-YELLOW EPOXY	GAL		$0.00		
620012950	64.80	TEMPORARY STRIPING	MILE	$250.00	$16,200.00		
620013000	3,036.00	STRIPING-WHITE PAINT	GAL	$20.50	$62,238.00		
620013960	2,024.00	STRIPING-WHITE EPOXY	GAL	$47.95	$97,050.80		
620014000	2,157.00	STRIPING-YELLOW PAINT	GAL	$20.50	$44,218.50		
620014960	1,438.00	STRIPING-YELLOW EPOXY	GAL	$47.95	$68,952.10		
							English
				TOTAL	$7,707,783.99	LENGTH(mile)	28.7216856
						WIDTH(f)	25
			length	151650.5	feet		
			width	25.00	feet		
			Area	3791262.50	Sq Feet		
				421251.39	SqYards		
				18.30	Cost/yard Sq		

F.4 East Glacier – Browning

		East Glacier- Browning			District 3		
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	25,000.00	MISCELLANEOUS WORK	UNIT	$1.00	$25,000.00		
109200005	1.00	MOBILIZATION	L SUM	$500,000.00	$500,000.00		
203020310		SPECIAL BORROW - NEAT LINE	CY		$0.00		
203020278	20,907.00	EXCAVATION-DIGOUTS	CY	$6.25	$130,668.75		
203020375	600.00	EMBANKMENT IN PLACE	CY	$5.00	$3,000.00		
203020376		CRACK AND SEAT	SY		$0.00		
203080100	2,340.00	TOPSOIL SALVAGING & PLACING	CY	$4.00	$9,360.00		
207010200		BEDDING MATERIAL	CY		$0.00		
207010300		FOUNDATION MATERIAL	CY		$0.00		
210020170	270.00	TEST TRAILER-TRANSPORT SET-UP	MI	$5.00	$1,350.00		
301020340	4,263.00	CRUSHED AGGREGATE COURSE	CY	$17.00	$72,471.00		
301020450	14,560.00	SPECIAL BACKFILL	CY	$12.00	$174,720.00		
301020718	218,212.00	COVER MATERIAL TYPE 1	SY	$0.45	$98,195.40		
401020045	32,734.00	PLANT MIX BIT SURF GR S - 3/4in	TON	$29.00	$949,286.00		
401020049		PLANT MIX BIT SURF GR S NV -3/4in	TON		$0.00		
401020300	458.00	HYDRATED LIME	TON	$210.00	$96,180.00		
401020301	325.00	LIME SLURRY	TON	$225.00	$73,125.00		
401020325	180,498.00	COLD RECYCLED PLANT MIX	SY	$2.50	$451,245.00		
402020092	1,800.30	ASPHALT CEMENT PG 64-28	TON	$680.00	$1,224,204.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020105	23.10	LIQUID ASPHALT MC-70	TON	$800.00	$18,480.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	388.70	EMULSIFIED ASPHALT CRS-2P	TON	$625.00	$242,937.50		
402020476	795.10	RECYCLING AGENT CIR-EE	TON	$705.00	$560,545.50		
402020369		CONCRETE PAVEMENT GRINDING	SY		$0.00		
411010000	18,066.00	COLD MILLING	SY	$2.25	$40,648.50		
606010030		GUARD RAIL - STEEL	LNFT		$0.00		
606010385		REMOVE GUARD RAIL	LNFT		$0.00		
618030005	300,000.00	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.87	$261,000.00		
620011105	25.00	WORDS & SYMBOLS-WHITE PAINT	GAL	$75.00	$1,875.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	17.00	WORDS & SYMBOLS-WHITE EPOXY	GAL	$300.00	$5,100.00		
620013000	613.00	STRIPING-WHITE PAINT	GAL	$19.00	$11,647.00		
620013960	411.00	STRIPING-WHITE EPOXY	GAL	$65.00	$26,715.00		
620014000	384.00	STRIPING-YELLOW PAINT	GAL	$18.50	$7,104.00		
620014960	255.00	STRIPING-YELLOW EPOXY	GAL	$60.50	$15,427.50		
620017000	22.30	TEMPORARY PAVEMENT MARKINGS	MI	$600.00	$13,380.00		
622011084	24,228.00	GEOTEXTILE STABILIZATION	SY	$1.50	$36,342.00		
623000000	15.70	RUMBLE STRIPS	MI	$950.00	$14,915.00		
							ENGLISH
				TOTAL	$5,064,922.15	LENGTH(mile)	8.72283902
						WIDTH(f)	42.2945201
			length	46056.59	feet		
			width	42.29	feet		
			Area	1947941.37	Sq Feet		
				216437.93	SqYards		
				23.40	Cost/yard Sq		

F.5 Saltese – East

Item Number	Quantities	Description	Unit	Bid Prices: Unit Prices (Dollars)	Bid Prices: Amount (Dollars)	District Unit Prices: Unit Prices (Dollars)	District Unit Prices: Amount (Dollars)
		Saltese-East & Deborgia-West			District 1		
104030010	25,000.00	MISCELLANEOUS WORK	UNIT	$1.00	$25,000.00		
109200005	1.00	MOBILIZATION	L SUM	$510,000.00	$510,000.00		
203020310		SPECIAL BORROW - NEAT LINE	CY		$0.00		
203020375		EMBANKMENT IN PLACE	CY		$0.00		
203020376	328,381.00	CRACK AND SEAT	SY	$0.58	$190,460.98		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
207010200		BEDDING MATERIAL	CY		$0.00		
207010300		FOUNDATION MATERIAL	CY		$0.00		
210020170	180.00	TEST TRAILER-TRANSPORT SET-UP	MI	$6.50	$1,170.00		
301020340		CRUSHED AGGREGATE COURSE	CY		$0.00		
301020416	10,637.00	SHOULDER GRAVEL	CY	$8.00	$85,096.00		
301020718		COVER MATERIAL TYPE 1	SY		$0.00		
301020735	376,105.00	COVER MATERIAL TYPE 2	SY	$0.50	$188,052.50		
401020045	107,317.00	PLANT MIX BIT SURF GR S - 3/4in	TON	$23.00	$2,468,291.00		
401020049		PLANT MIX BIT SURF GR S NV -3/4in	TON		$0.00		
401020300	1,502.00	HYDRATED LIME	TON	$190.00	$285,380.00		
402020092		ASPHALT CEMENT PG 64-28	TON		$0.00		
402020095	5,689.40	ASPHALT CEMENT PG 70-28	TON	$755.00	$4,295,497.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	670.60	EMULSIFIED ASPHALT CRS-2P	TON	$580.00	$388,948.00		
402020369	1,308.00	CONCRETE PAVEMENT GRINDING	SY	$9.00	$11,772.00		
411010000	6,477.00	COLD MILLING	SY	$5.00	$32,385.00		
606010030	26,237.50	GUARD RAIL - STEEL	LNFT	$14.50	$380,443.75		
606010385	27,787.50	REMOVE GUARD RAIL	LNFT	$1.80	$50,017.50		
606011150	2,245.00	REMOVE CONC BARRIER RAIL	EA	$100.00	$224,500.00		
606011215	918.00	TALL CONCRETE BARRIER RAIL	EA	$750.00	$688,500.00		
606011244	1,327.00	CONCRETE BARRIER RAIL	EA	$500.00	$663,500.00		
618030005	300,000.00	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.72	$216,000.00		
620011105	6.00	WORDS & SYMBOLS-WHITE PAINT	GAL	$100.00	$600.00		
620011260	4.00	WORDS & SYMBOLS-WHITE EPOXY	GAL	$250.00	$1,000.00		
620013000	794.00	STRIPING-WHITE PAINT	GAL	$27.00	$21,438.00		
620013960	529.00	STRIPING-WHITE EPOXY	GAL	$61.00	$32,269.00		
620014000	607.00	STRIPING-YELLOW PAINT	GAL	$37.00	$22,459.00		
620014960	404.00	STRIPING-YELLOW EPOXY	GAL	$61.00	$24,644.00		
620017000		TEMPORARY PAVEMENT MARKINGS	MI		$0.00		
623000000	8.80	RUMBLE STRIPS	MI	$1,100.00	$9,680.00		
							ENGLISH
				TOTAL	$10,817,103.73	LENGTH(mile)	
						WIDTH(f)	
			length	0	feet		
			width	0.00	feet		
			Area	0.00	Sq Feet		
				340156.36	SqYards		
				31.80	Cost/yard Sq		

F.6 Forsyth – Northwest

		FORSYTH - NORTHWEST				DISTRICT 4	
Item Number	Quantities	Description	Unit	Bid Prices: Unit Prices Dollars	Bid Prices: Amount Dollars	District Unit Prices: Unit Prices Dollars	District Unit Prices: Amount Dollars
104100000	45,000.00	MISCELLANEOUS WORK	UNIT	$1.00	$45,000.00		
109200000	1.00	MOBILIZATION	L SUM	$1,165,000.00	$1,165,000.00		
203220000		SPECIAL BORROW-NEAT LINE	M3		$0.00		
203300000		EMBANKMENT IN PLACE	M3		$0.00		
204600000		CRACK AND SEAT	M2		$0.00		
203500000	42,616.00	TOPSOIL SALVAGING & PLACING	M3	$3.25	$138,502.00		
207300000	761.20	BEDDING MATERIAL	M3	$30.00	$22,836.00		
207310000	1,136.70	FOUNDATION MATERIAL	M3	$20.00	$22,734.00		
210300000	150.00	TEST TRAILER-TRANSPORT SET-UP	KM	$10.00	$1,500.00		
301270000	79,071.00	CRUSHED AGGREGATE COURSE	M3	$21.50	$1,700,026.50		
301440000	173,769.00	COVER MATERIAL TYPE 1	M2	$0.40	$69,507.60		
401080000	36,640.00	PLANT MIX BIT SURF GR S-19MM	MT	$24.00	$879,360.00		
401200000	536.00	HYDRATED LIME	MT	$165.00	$88,440.00		
401320000	130,063.00	PAVEMENT PULVERIZATION	M2	$1.00	$130,063.00		
402088000	1,978.40	ASPHALT CEMENT PG 64-28	MT	$720.00	$1,424,448.00		
402097000		ASPHALT CEMENT PG 70-28	MT		$0.00		
402200000		EMULSIFIED ASPHALT SS-1	L		$0.00		
402225000	336.40	EMULSIFIED ASPHALT CRS-2P	MT	$665.00	$223,706.00		
411000000	2,293.00	COLD MILLING	M2	$5.50	$12,611.50		
501540000		CONCRETE PAVEMENT GRINDING	M2		$0.00		
606000000	266.70	GUARD RAIL - STEEL	M	$68.00	$18,135.60		
606800000	425.00	REMOVE GUARD RAIL	M	$8.00	$3,400.00		
618010000	550,000.00	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.70	$385,000.00		
618030000	29.60	TEMPORARY PAVEMENT MARKINGS	KM	$450.00	$13,320.00		
620010000	1,819.00	STRIPING-WHITE PAINT	KM	$6.50	$11,823.50		
620020000	227.00	STRIPING-YELLOW PAINT	KM	$6.50	$1,475.50		
620110000	2,169.00	STRIPING-WHITE PAINT EPOXY	L	$13.50	$29,281.50		
620120000	271.00	STRIPING-YELLOW PAINT EPOXY	L	$13.50	$3,658.50		
620130000		WORDS & SYMBOLS-WHITE EPOXY	L		$0.00		
620135000		WORDS & SYMBOLS-YELLOW EPOXY	L		$0.00		
800080000		RUMBLE STRIPS	KM		$0.00		
							metric
				TOTAL	$6,389,829.20	LENGTH(km)	19.1
						WIDTH(m)	9.2
			length	62663.28	feet		
			width	30.19	feet		
			Area	1891503.64	Sq Feet		
				210167.07	SqYards		
				30.40	Cost/yard Sq		

F.7 East of Conrad

		EAST OF CONRAD - EAST				DISTRICT 3	
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	15,000	MISCELLANEOUS WORK	UNIT	$1.00	$15,000.00		
109200005	1	MOBILIZATION	L SUM	$110,000.00	$110,000.00		
203020310		SPECIAL BORROW - NEAT LINE	CY		$0.00		
203020375		EMBANKMENT IN PLACE	CY		$0.00		
203020376		CRACK AND SEAT	SY		$0.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
207010200		BEDDING MATERIAL	CY		$0.00		
207010300		FOUNDATION MATERIAL	CY		$0.00		
210020170	150	TEST TRAILER-TRANSPORT SET-UP	MI	$16.00	$2,400.00		
301020340		CRUSHED AGGREGATE COURSE	CY		$0.00		
301020718	98,444	COVER MATERIAL TYPE 1	SY	$0.53	$52,175.32		
401020045		PLANT MIX BIT SURF GR S - 3/4in	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV -3/4in	TON		$0.00		
401020300		HYDRATED LIME	TON		$0.00		
401020023	198	COMMERCIAL MIX - PG 58-28	TON	$116.00	$22,968.00		
401020301	203	LIME SLURRY	TON	$205.00	$41,615.00		
401020325	90,379	COLD RECYCLED PLANT MIX	SY	$2.75	$248,542.25		
401020328	200	LEVELING MATERIAL	TON	$15.00	$3,000.00		
402020092		ASPHALT CEMENT PG 64-28	TON		$0.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	4,064	EMULSIFIED ASPHALT SS-1	GAL	$2.50	$10,160.00		
402020368	177	EMULSIFIED ASPHALT CRS-2P	TON	$505.00	$89,435.50		
402020369		CONCRETE PAVEMENT GRINDING	SY		$0.00		
402020476	419	RECYCLING AGENT CIR-EE	TON	$695.00	$291,344.00		
411010000	1,783	COLD MILLING	SY	$3.00	$5,349.00		
606010030		GUARD RAIL - STEEL	LNFT		$0.00		
606010385	675	REMOVE GUARD RAIL	LNFT	$2.10	$1,417.50		
618030005	110,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.78	$85,800.00		
620011105		WORDS & SYMBOLS-WHITE PAINT	GAL		$0.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620013000	497	STRIPING-WHITE PAINT	GAL	$15.50	$7,703.50		
620013960	332	STRIPING-WHITE EPOXY	GAL	$60.50	$20,086.00		
620014000	188	STRIPING-YELLOW PAINT	GAL	$16.25	$3,055.00		
620014960	125	STRIPING-YELLOW EPOXY	GAL	$62.75	$7,843.75		
620017000	6	TEMPORARY PAVEMENT MARKINGS	MI	$520.00	$3,068.00		
623000000		RUMBLE STRIPS	MI		$0.00		
							ENGLISH
				TOTAL	$1,020,962.82	LENGTH(mile)	6.9
						WIDTH(f)	26
			length	36432	feet		
			width	26.00	feet		
			Area	947232.00	Sq Feet		
				104973.61	SqYards	Additional Area Added	
				9.73	Cost/yard Sq		

F.8 Mehmke Hill

	JCT S-227/228 - MEHMKE HILL				DISTRICT 3		
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	15,000	MISCELLANEOUS WORK	UNIT	$1.00	$15,000.00		
109200005	1	MOBILIZATION	L SUM	$365,500.00	$365,500.00		
203020310		SPECIAL BORROW - NEAT LINE	CY		$0.00		
203020375		EMBANKMENT IN PLACE	CY		$0.00		
203020376		CRACK AND SEAT	SY		$0.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
207010200		BEDDING MATERIAL	CY		$0.00		
207010300		FOUNDATION MATERIAL	CY		$0.00		
210020170	10	TEST TRAILER-TRANSPORT SET-UP	MI	$40.00	$400.00		
301020340	491	CRUSHED AGGREGATE COURSE	CY	$35.00	$17,185.00		
301020718	154,768	COVER MATERIAL TYPE 1	SY	$0.28	$43,335.04		
401020045	18,010	PLANT MIX BIT SURF GR S - 3/4in	TON	$21.00	$378,210.00		
401020049		PLANT MIX BIT SURF GR S NV -3/4in	TON		$0.00		
401020300	252	HYDRATED LIME	TON	$170.00	$42,840.00		
401020301	369	LIME SLURRY	TON	$200.00	$73,700.00		
401020325	170,137	COLD RECYLCED PLANT MIX	SY	$2.50	$425,342.50		
402020092	973	ASPHALT CEMENT PG 64-28	TON	$590.00	$573,893.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	7,922	EMULSIFIED ASPHALT SS-1	GAL	$2.20	$17,428.40		
402020368	276	EMULSIFIED ASPHALT CRS-2P	TON	$495.00	$136,372.50		
402020369		CONCRETE PAVEMENT GRINDING	SY		$0.00		
402020476	788	RECYCLING AGENT CIR-EE	TON	$600.00	$472,620.00		
411010000	7,944	COLD MILLING	SY	$2.75	$21,846.00		
606010030	875	GUARD RAIL - STEEL	LNFT	$18.75	$16,406.25		
606010385	675	REMOVE GUARD RAIL	LNFT	$2.00	$1,350.00		
618030005	150,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.80	$120,000.00		
620011105	22	WORDS & SYMBOLS-WHITE PAINT	GAL	$58.50	$1,287.00		
620011110	22	WORDS & SYMBOLS-YELLOW PAINT	GAL	$60.50	$1,331.00		
620013000	419	STRIPING-WHITE PAINT	GAL	$15.25	$6,389.75		
620013960	279	STRIPING-WHITE EPOXY	GAL	$57.00	$15,903.00		
620014000	210	STRIPING-YELLOW PAINT	GAL	$15.25	$3,202.50		
620014960	140	STRIPING-YELLOW EPOXY	GAL	$58.50	$8,190.00		
620017000	12	TEMPORARY PAVEMENT MARKINGS	MI	$315.00	$3,622.50		
623000000	11	RUMBLE STRIPS	MI	$730.00	$8,030.00		
							ENGLISH
				TOTAL	$2,769,384.44	LENGTH(mile)	5.8
						WIDTH(f)	43
			length	30624	feet		
			width	43.00	feet		
			Area	1316832.00	Sq Feet		
				156328.71	SqYards	Additional Area Added	
				17.72	Cost/yard Sq		

F.9 Colstrip – North

	COLSTRIP - N				DISTRICT 4		
				Bid Prices		District Unit Prices	
Item Number	Quantities	Description	Unit	Unit Prices Dollars	Amount Dollars	Unit Prices Dollars	Amount Dollars
104030010	5,000	MISCELLANEOUS WORK	UNIT	$1.00	$5,000.00		
109200005	1	MOBILIZATION	L SUM	$382,000.00	$382,000.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170	150	TEST TRAILER-TRANSPORT SET-UP	MI	$1.00	$150.00		
301020718	236,705	COVER MATERIAL TYPE 1	SY	$0.55	$130,187.75		
301020735		COVER MATERIAL TYPE 2	SY		$0.00		
401020042		PLANT MIX GR D - COMMERCIAL	TON		$0.00		
401020045	25,352	PLANT MIX BIT SURF GR S - 3/4in	TON	$31.00	$785,912.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4in	TON		$0.00		
401020300	355	HYDRATED LIME	TON	$135.00	$47,925.00		
401020325	257,697	COLD RECYCLED PLANT MIX	SY	$2.90	$747,321.30		
402020092	1,370	ASPHALT CEMENT PG 64-28	TON	$500.00	$684,800.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	12,305	EMULSIFIED ASPHALT SS-1	GAL	$1.20	$14,766.00		
402020368	425	EMULSIFIED ASPHALT CRS-2P	TON	$531.00	$225,675.00		
402020476	1,242	RECYCLING AGENT CIR-EE	TON	$657.00	$815,994.00		
411010000	4,746	COLD MILLING	SY	$4.00	$18,984.00		
618030005	225,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.80	$180,000.00		
620011105	18	WORDS & SYMBOLS-WHITE PAINT	GAL	$49.00	$882.00		
620011110	46	WORDS & SYMBOLS-YELLOW PAINT	GAL	$49.00	$2,254.00		
620011260	12	WORDS & SYMBOLS-WHITE EPOXY	GAL	$160.00	$1,920.00		
620011265	31	WORDS & SYMBOLS-YELLOW EPOXY	GAL	$160.00	$4,960.00		
620013000	846	STRIPING-WHITE PAINT	GAL	$17.00	$14,382.00		
620013960	564	STRIPING-WHITE EPOXY	GAL	$44.00	$24,816.00		
620014000	352	STRIPING-YELLOW PAINT	GAL	$17.00	$5,984.00		
620014960	234	STRIPING-YELLOW EPOXY	GAL	$44.00	$10,296.00		
620017000	23	TEMPORARY PAVEMENT MARKINGS	MI	$475.00	$10,925.00		
623000000	22	RUMBLE STRIPS	MI	$450.00	$9,990.00		
							ENGLISH
				TOTAL	$4,125,124.05	*LENGTH(mile)*	11.4
						WIDTH(feet)	34.6
			length	60192.00	feet		
			width	34.60	feet		
			Area	2082643.20	Sq Feet		
				235735.96	SqYards	Additional Area Added	
				17.50	Cost/yard Sq		

F.10 Bridger – South

		BRIDGER - SOUTH				DISTRICT 5	
				Bid Prices		District Unit Prices	
Item Number	Quantities	Description	Unit	Unit Prices Dollars	Amount Dollars	Unit Prices Dollars	Amount Dollars
104100000	25,000	MISCELLANEOUS WORK	UNIT	$1.00	$25,000.00		
109200000	1	MOBILIZATION	L SUM	$1,080,989.28	$1,080,989.28		
203100000	165,745	EXCAVATION-UNCLASSIFIED	M3	$4.45	$737,565.25		
203200000	69,541	EXCAVATION-UNCLASSIFIED BORROW	M3	$5.00	$347,705.00		
203220000		SPECIAL BORROW-NEAT LINE	M3		$0.00		
203300000		EMBANKMENT IN PLACE	M3		$0.00		
204600000		CRACK AND SEAT	M2		$0.00		
203500000	46,261	TOPSOIL SALVAGING & PLACING	M3	$3.75	$173,478.75		
207300000	445	BEDDING MATERIAL	M3	$29.00	$12,899.20		
207310000		FOUNDATION MATERIAL	M3		$0.00		
210300000	147	TEST TRAILER-TRANSPORT SET-UP	KM	$15.00	$2,205.00		
301270000	61,095	CRUSHED AGGREGATE COURSE	M3	$23.00	$1,405,185.00		
301440000	202,535	COVER MATERIAL TYPE 1	M2	$0.40	$81,014.00		
401080000	49,491	PLANT MIX BIT SURF GR S-19MM	MT	$27.40	$1,356,053.40		
401200000	693	HYDRATED LIME	MT	$145.00	$100,485.00		
401320000	183,330	PAVEMENT, PULVERIZATION	M2	$1.35	$247,495.50		
402088000	2,672	ASPHALT CEMENT PG 64-28	MT	$550.00	$1,469,600.00		
402097000		ASPHALT CEMENT PG 70-28	MT		$0.00		
402100000	330	LIQUID ASPHALT	MT	$760.00	$250,952.00		
402200000	372	EMULSIFIED ASPHALT SS-1	L	$570.00	$211,983.00		
402225000		EMULSIFIED ASPHALT CRS-2P	MT		$0.00		
411000000		COLD MILLING	M2		$0.00		
501540000		CONCRETE PAVEMENT GRINDING	M2		$0.00		
606000000		GUARD RAIL - STEEL	M		$0.00		
606800000	120	REMOVE GUARD RAIL	M	$5.00	$600.00		
618010000	450,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.75	$337,500.00		
618030000	35	TEMPORARY PAVEMENT MARKINGS	KM	$210.00	$7,329.00		
620010000	2,772	STRIPING-WHITE PAINT	KM	$5.00	$13,860.00		
620020000	928	STRIPING-YELLOW PAINT	KM	$5.00	$4,640.00		
620110000	1,849	STRIPING-WHITE PAINT EPOXY	L	$11.00	$20,339.00		
620120000	619	STRIPING-YELLOW PAINT EPOXY	L	$11.00	$6,809.00		
620130000		WORDS & SYMBOLS-WHITE EPOXY	L		$0.00		
620135000		WORDS & SYMBOLS-YELLOW EPOXY	L		$0.00		
800080000	39	RUMBLE STRIPS	KM	$385.00	$14,938.00		
							metric
				TOTAL	$7,908,625.38	LENGTH(km)	21.1
						WIDTH(m)	11.6
			length	69224.88	feet		
			width	38.06	feet		
			Area	2634671.24	Sq Feet		
				292741.25	SqYards		
				27.02	Cost/yard Sq		

F.11 Redstone – East and West

	REDSTONE - E & W					DISTRICT 4	
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	100,000	MISCELLANEOUS WORK	UNIT	$1.00	$100,000.00		
109200005	1	MOBILIZATION	L SUM	$802,771.28	$802,771.28		
203020100	871,728	EXCAVATION - UNCLASSIFIED	CY	$2.57	$2,240,340.96		
203020310	24,733	SPECIAL BORROW - NEAT LINE	CY	$8.50	$210,230.50		
203020375		EMBANKMENT IN PLACE	CY		$0.00		
203020376		CRACK AND SEAT	SY		$0.00		
203080100	45,385	TOPSOIL SALVAGING & PLACING	CY	$2.40	$108,924.00		
207010200	463	BEDDING MATERIAL	CY	$13.95	$6,458.85		
207010300	903	FOUNDATION MATERIAL	CY	$13.95	$12,596.85		
210020170	144	TEST TRAILER-TRANSPORT SET-UP	MI	$20.00	$2,880.00		
301020340	76,798	CRUSHED AGGREGATE COURSE	CY	$13.95	$1,071,332.10		
301020718	159,268	COVER MATERIAL TYPE 1	SY	$0.37	$58,929.16		
401020045	33,982	PLANT MIX BIT SURF GR S - 3/4in	TON	$20.57	$699,009.74		
401020049		PLANT MIX BIT SURF GR S NV -3/4in	TON		$0.00		
401020300	476	HYDRATED LIME	TON	$177.50	$84,490.00		
401020330	79,199	PAVEMENT PULVERIZATION	SY	$0.77	$60,983.23		
402020092	1,836	ASPHALT CEMENT PG 64-28	TON	$641.55	$1,177,885.80		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020105	239	LIQUID ASPHALT MC-70	TON	$755.00	$180,218.50		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	292	EMULSIFIED ASPHALT CRS-2P	TON	$581.13	$169,515.62		
402020369		CONCRETE PAVEMENT GRINDING	SY		$0.00		
411010000		COLD MILLING	SY		$0.00		
606010030		GUARD RAIL - STEEL	LNFT		$0.00		
606010385		REMOVE GUARD RAIL	LNFT		$0.00		
618030005	700,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.51	$357,000.00		
620011105	5	WORDS & SYMBOLS-WHITE PAINT	GAL	$100.00	$500.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620013000	664	STRIPING-WHITE PAINT	GAL	$22.00	$14,608.00		
620013960	444	STRIPING-WHITE EPOXY	GAL	$46.00	$20,424.00		
620014000	342	STRIPING-YELLOW PAINT	GAL	$22.00	$7,524.00		
620014960	227	STRIPING-YELLOW EPOXY	GAL	$46.00	$10,442.00		
620017000	19	TEMPORARY PAVEMENT MARKINGS	MI	$500.00	$9,550.00		
623000000	18	RUMBLE STRIPS	MI	$800.00	$14,080.00		
							ENGLISH
				TOTAL	$7,420,694.59	LENGTH(mile)	9.3
						WIDTH(f)	28
			length	49104	feet		
			width	28.00	feet		
			Area	1374912.00	Sq Feet		
				153301.48	SqYards	Additional Area Added	
				48.41	Cost/yard Sq		

F.12 North of Lame Deer

	NORTH OF LAME DEER - NORTH					DISTRICT 5	
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	20,000	MISCELLANEOUS WORK	UNIT	$1.00	$20,000.00		
109200005	1	MOBILIZATION	L SUM	$222,126.42	$222,126.42		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170		TEST TRAILER-TRANSPORT SET-UP	MI		$0.00		
301020718	133,808	COVER MATERIAL TYPE 1	SY	$0.51	$68,242.08		
301020735		COVER MATERIAL TYPE 2	SY		$0.00		
311010235	312	QUICK LIME	TON	$130.00	$40,560.00		
401020042		PLANT MIX GR D - COMMERCIAL	TON		$0.00		
401020045		PLANT MIX BIT SURF GR S - 3/4in	TON		$0.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4in	TON		$0.00		
401020300		HYDRATED LIME	TON		$0.00		
401020325	138,541	COLD RECYCLED PLANT MIX	SY	$2.65	$367,133.65		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	6,884	EMULSIFIED ASPHALT SS-1	GAL	$1.00	$6,884.00		
402020368	228	EMULSIFIED ASPHALT CRS-2P	TON	$551.95	$125,844.60		
402020476	667	RECYCLING AGENT CIR-EE	TON	$716.95	$478,133.96		
411010000		COLD MILLING	SY		$0.00		
618030005	250,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.55	$137,500.00		
620011105		WORDS & SYMBOLS-WHITE PAINT	GAL		$0.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260		WORDS & SYMBOLS-WHITE EPOXY	GAL		$0.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
620013000	588	STRIPING-WHITE PAINT	GAL	$15.29	$8,990.52		
620013960	392	STRIPING-WHITE EPOXY	GAL	$40.08	$15,711.36		
620014000	358	STRIPING-YELLOW PAINT	GAL	$15.29	$5,473.82		
620014960	239	STRIPING-YELLOW EPOXY	GAL	$40.08	$9,579.12		
620017000	16	TEMPORARY PAVEMENT MARKINGS	MI	$239.00	$3,895.70		
							ENGLISH
				TOTAL	$1,510,075.23	LENGTH(mile)	8.1
						WIDTH(feet)	30
			length	42768.00	feet		
			width	30.00	feet		
			Area	1283040.00	Sq Feet		
				142560.00	SqYards		
				10.59	Cost/yard Sq		

F.13 Laurel – Northeast

	LAUREL - NORTHEAST				DISTRICT 5			
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	30,000	MISCELLANEOUS WORK	UNIT	$1.00	$30,000.00		
109200005	1	MOBILIZATION	L SUM	$190,000.00	$190,000.00		
203080100	1,730	TOPSOIL SALVAGING & PLACING	CY	$9.50	$16,435.00		
210020170		TEST TRAILER-TRANSPORT SET-UP	MI		$0.00		
301020625	49,125	AGGREGATE TREATMENT	SY	$0.15	$7,368.75		
301020718		COVER MATERIAL TYPE 1	SY		$0.00		
301020735	104,886	COVER MATERIAL TYPE 2	SY	$0.25	$26,221.50		
401020042		PLANT MIX GR D - COMMERCIAL	TON		$0.00		
401020045	17,658	PLANT MIX BIT SURF GR S - 3/4in	TON	$28.50	$503,253.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4in	TON		$0.00		
401020300	246	HYDRATED LIME	TON	$130.00	$31,980.00		
402020092	950	ASPHALT CEMENT PG 64-28	TON	$500.00	$475,150.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	179	EMULSIFIED ASPHALT CRS-2P	TON	$550.00	$98,340.00		
411010000	57,072	COLD MILLING	SY	$1.15	$65,632.80		
618030005	225,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.85	$191,250.00		
620011105	118	WORDS & SYMBOLS-WHITE PAINT	GAL	$59.00	$6,962.00		
620011110	6	WORDS & SYMBOLS-YELLOW PAINT	GAL	$59.00	$354.00		
620011260	77	WORDS & SYMBOLS-WHITE EPOXY	GAL	$150.00	$11,550.00		
620011265	3	WORDS & SYMBOLS-YELLOW EPOXY	GAL	$150.00	$450.00		
620013000	296	STRIPING-WHITE PAINT	GAL	$20.00	$5,920.00		
620013960	197	STRIPING-WHITE EPOXY	GAL	$45.50	$8,963.50		
620014000	308	STRIPING-YELLOW PAINT	GAL	$20.00	$6,160.00		
620014960	153	STRIPING-YELLOW EPOXY	GAL	$45.50	$6,961.50		
620017000	8	TEMPORARY PAVEMENT MARKINGS	MI	$445.00	$3,471.00		
							ENGLISH
				TOTAL	$1,686,423.05	LENGTH(mile)	3.8
						WIDTH(feet)	39
			length	20064.00	feet		
			width	39.00	feet		
			Area	782496.00	Sq Feet		
				106085.59	SqYards	Additional area added	
				15.90	Cost/yard Sq		

F.14 Busby – Northeast

		BUSBY - NE				DISTRICT 4	
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	10,000	MISCELLANEOUS WORK	UNIT	$1.00	$10,000.00		
109200005	1	MOBILIZATION	L SUM	$480,000.00	$480,000.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170	90	TEST TRAILER-TRANSPORT SET-UP	MI	$17.00	$1,530.00		
301020718	120,019	COVER MATERIAL TYPE 1	SY	$0.55	$66,010.45		
301020735		COVER MATERIAL TYPE 2	SY		$0.00		
401020042		PLANT MIX GR D - COMMERCIAL	TON		$0.00		
401020045	16,244	PLANT MIX BIT SURF GR S - 3/4in	TON	$33.00	$536,052.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020049		PLANT MIX BIT SURF GR S NV - 3/4in	TON		$0.00		
401020300	225	HYDRATED LIME	TON	$135.00	$30,375.00		
402020092	878	ASPHALT CEMENT PG 64-28	TON	$575.00	$504,735.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	213	EMULSIFIED ASPHALT CRS-2P	TON	$555.00	$118,159.50		
402020493	9,330	CRACK FILLING	LNFT	$4.50	$41,985.00		
411010000	129,584	COLD MILLING	SY	$1.25	$161,980.00		
618030005	125,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.75	$93,750.00		
620011105		WORDS & SYMBOLS-WHITE PAINT	GAL		$0.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260		WORDS & SYMBOLS-WHITE EPOXY	GAL		$0.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
620013000	438	STRIPING-WHITE PAINT	GAL	$24.00	$10,512.00		
620013960	291	STRIPING-WHITE EPOXY	GAL	$48.00	$13,968.00		
620014000	58	STRIPING-YELLOW PAINT	GAL	$24.00	$1,392.00		
620014960	38	STRIPING-YELLOW EPOXY	GAL	$48.00	$1,824.00		
620017000	12	TEMPORARY PAVEMENT MARKINGS	MI	$550.00	$6,435.00		
							ENGLISH
				TOTAL	$2,078,707.95	LENGTH(mile)	5.8
						WIDTH(feet)	35
			length	30624.00	feet		
			width	35.00	feet		
			Area	1071840.00	Sq Feet		
				119093.33	SqYards		
				17.45	Cost/yard Sq		

F.15 Hebgen Lake – East and West

	HEBGEN LAKE - EAST & WEST				DISTRICT 2		
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	17,500	MISCELLANEOUS WORK	UNIT	$1.00	$17,500.00		
109200005	1	MOBILIZATION	L SUM	$316,000.00	$221,200.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170	126	TEST TRAILER-TRANSPORT SET-UP	MI	$16.00	$2,016.00		
301020340	1,044	CRUSHED AGGREGATE COURSE	CY	$51.50	$53,766.00		
301020718	308,981	COVER MATERIAL TYPE 1	SY	$0.55	$169,939.55		
311010235	527	QUICK LIME	TON	$172.00	$90,575.20		
402020502	42,564	CRACK SEALING	LB	$1.71	$72,784.44		
401020042	989	PLANT MIX BIT SURF GR D - COMMERCIAL	TON	$120.00	$118,680.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020300		HYDRATED LIME	TON		$0.00		
401020325	292,984	COLD RECYCLED PLANT MIX	SY	$1.71	$501,002.64		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	13,725	EMULSIFIED ASPHALT SS-1	GAL	$2.00	$27,450.00		
402020368	527	EMULSIFIED ASPHALT CRS-2P	TON	$400.00	$210,672.00		
402020476	1,128	RECYCLING AGENT CIR-EE	TON	$457.00	$515,358.90		
411010000	3,797	COLD MILLING	SY	$3.75	$14,238.75		
618030005	210,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.60	$126,000.00		
620017000	31	TEMPORARY PAVEMENT MARKINGS	MI	$475.00	$14,725.00		
620013960	702	STRIPING-WHITE EPOXY	GAL	$40.00	$28,084.00		
620014960	428	STRIPING-YELLOW EPOXY	GAL	$40.00	$17,136.00		
620014000	567	STRIPING-YELLOW PAINT	GAL	$18.00	$10,206.00		
620013000	972	STRIPING-WHITE PAINT	GAL	$18.00	$17,488.80		
620011105	12	WORDS & SYMBOLS-WHITE PAINT	GAL	$45.00	$540.00		
620011110	22	WORDS & SYMBOLS-YELLOW PAINT	GAL	$45.00	$990.00		
620011260	7	WORDS & SYMBOLS-WHITE EPOXY	GAL	$200.00	$1,400.00		
620011265	16	WORDS & SYMBOLS-YELLOW EPOXY	GAL	$200.00	$3,200.00		
							ENGLISH
				TOTAL	$2,234,953.28	LENGTH(mile)	15.7
						WIDTH(feet)	30
			length	82896.00	feet		
			width	30.00	feet		
			Area	2486880.00	Sq Feet		
				289949.93	SqYards	Additional area added	
				7.71	Cost/yard Sq		

F.16 Jct MT 16 – Northwest

	JCT MT 16 - NORTHWEST				DISTRICT 4		
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	20,000	MISCELLANEOUS WORK	UNIT	$1.00	$20,000.00		
109200005	1	MOBILIZATION	L SUM	$163,600.00	$163,600.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170		TEST TRAILER-TRANSPORT SET-UP	MI		$0.00		
301020340	6,575	CRUSHED AGGREGATE COURSE	CY	$18.00	$118,350.00		
301020718	142,319	COVER MATERIAL TYPE 1	SY	$0.55	$78,275.45		
311010235	254	QUICK LIME	TON	$140.00	$35,504.00		
401020042	1,362	PLANT MIX BIT SURF GR D - COMMERCIAL	TON	$100.00	$136,200.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020300		HYDRATED LIME	TON		$0.00		
401020325	142,200	COLD RECYCLED PLANT MIX	SY	$2.90	$412,380.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	6,961	EMULSIFIED ASPHALT SS-1	GAL	$2.05	$14,270.05		
402020368	244	EMULSIFIED ASPHALT CRS-2P	TON	$415.00	$101,177.00		
402020476	547	RECYCLING AGENT CIR-EE	TON	$450.00	$246,105.00		
411010000		COLD MILLING	SY		$0.00		
618030005	250,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.78	$195,000.00		
620017000	19	TEMPORARY PAVEMENT MARKINGS	MI	$365.00	$6,862.00		
620013960	454	STRIPING-WHITE EPOXY	GAL	$51.00	$23,154.00		
620014960	186	STRIPING-YELLOW EPOXY	GAL	$19.00	$3,534.00		
620014000	280	STRIPING-YELLOW PAINT	GAL	$51.00	$14,280.00		
620013000	680	STRIPING-WHITE PAINT	GAL	$19.00	$12,920.00		
620011105	2	WORDS & SYMBOLS-WHITE PAINT	GAL	$200.00	$400.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	1	WORDS & SYMBOLS-WHITE EPOXY	GAL	$315.00	$315.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
							ENGLISH
				TOTAL	$1,582,326.50	LENGTH(mile)	9.4
						WIDTH(feet)	25.7
			length	49632.00	feet		
			width	25.70	feet		
			Area	1275542.40	Sq Feet		
				141726.93	SqYards		
				11.16	Cost/yard Sq		

F.17 West of Lodge Grass

	WEST OF LODGE GRASS - SW				DISTRICT 5		
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	2,500	MISCELLANEOUS WORK	UNIT	$1.00	$2,500.00		
109200005	1	MOBILIZATION	L SUM	$202,500.00	$202,500.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170		TEST TRAILER-TRANSPORT SET-UP	MI		$0.00		
301020718	124,722	COVER MATERIAL TYPE 1	SY	$0.85	$106,013.70		
311010235	346	QUICK LIME	TON	$264.00	$91,212.00		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020300		HYDRATED LIME	TON		$0.00		
401020325	139,527	COLD RECYCLED PLANT MIX	SY	$3.10	$432,533.70		
401020328	2,677	LEVELING MATERIAL	TON	$8.00	$21,416.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	6,281	EMULSIFIED ASPHALT SS-1	GAL	$1.50	$9,421.50		
402020368	211	EMULSIFIED ASPHALT CRS-2P	TON	$480.00	$101,232.00		
402020476	691	RECYCLING AGENT CIR-EE	TON	$591.50	$408,667.35		
411010000		COLD MILLING	SY		$0.00		
618030005	50,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$1.00	$50,000.00		
620017000	17	TEMPORARY PAVEMENT MARKINGS	MI	$500.00	$8,500.00		
620013960	410	STRIPING-WHITE EPOXY	GAL	$51.00	$20,910.00		
620014960	186	STRIPING-YELLOW EPOXY	GAL	$51.00	$9,486.00		
620014000	278	STRIPING-YELLOW PAINT	GAL	$22.00	$6,116.00		
620013000	616	STRIPING-WHITE PAINT	GAL	$22.00	$13,552.00		
620011105	2	WORDS & SYMBOLS-WHITE PAINT	GAL	$92.00	$184.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	1	WORDS & SYMBOLS-WHITE EPOXY	GAL	$250.00	$250.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
							ENGLISH
				TOTAL	$1,484,494.25	LENGTH(mile)	8.5
						WIDTH(feet)	25
			length	44880.00	feet		
			width	25.00	feet		
			Area	1122000.00	Sq Feet		
				124666.67	SqYards		
				11.91	Cost/yard Sq		

F.18 Lodge Grass – North

		LODGE GRASS - NORTH				DISTRICT 5	
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	32,000	MISCELLANEOUS WORK	UNIT	$1.00	$32,000.00		
109200005	1	MOBILIZATION	L SUM	$1,147,500.00	$1,147,500.00		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
203020278	15,674	EXCAVATION - DIGOUTS	CY	$25.00	$391,850.00		
203020310	20,750	SPECIAL BORROW - NEAT LINE	CY	$20.00	$415,000.00		
210020170	100	TEST TRAILER-TRANSPORT SET-UP	MI	$37.00	$3,700.00		
301020718	367,141	COVER MATERIAL TYPE 1	SY	$0.85	$312,069.85		
311010235	283	QUICK LIME	TON	$264.00	$74,685.60		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020045	67,170	PLANT MIX BIT SURF GR S 3/4in	TON	$38.00	$2,552,460.00		
401020300	940	HYDRATED LIME	TON	$165.00	$155,100.00		
401020325	83,659	COLD RECYCLED PLANT MIX	SY	$3.10	$259,342.90		
402020095	3,625	ASPHALT CEMENT PG 70-28	TON	$585.80	$2,123,407.84		
402020305	19,044	EMULSIFIED ASPHALT SS-1	GAL	$1.50	$28,566.00		
402020368	627	EMULSIFIED ASPHALT CRS-2P	TON	$480.00	$300,768.00		
402020476	608	RECYCLING AGENT CIR-EE	TON	$591.50	$359,454.55		
402020483	9,840	CRACK FILLING	LF	$5.50	$54,120.00		
411010000	40,636	COLD MILLING	SY	$3.25	$132,067.00		
618030005	100,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$1.00	$100,000.00		
620017000	14	TEMPORARY PAVEMENT MARKINGS	MI	$500.00	$6,800.00		
620013960	489	STRIPING-WHITE EPOXY	GAL	$51.00	$24,939.00		
620014960	379	STRIPING-YELLOW EPOXY	GAL	$51.00	$19,329.00		
620014000	570	STRIPING-YELLOW PAINT	GAL	$22.00	$12,540.00		
620013000	732	STRIPING-WHITE PAINT	GAL	$22.00	$16,104.00		
620011105	8	WORDS & SYMBOLS-WHITE PAINT	GAL	$92.00	$736.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	4	WORDS & SYMBOLS-WHITE EPOXY	GAL	$250.00	$1,000.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
							ENGLISH
				TOTAL	$8,523,539.74	LENGTH(mile)	7.8
						WIDTH(feet)	76
			length	41184.00	feet		
			width	76.00	feet		
			Area	3129984.00	Sq Feet		
				347776.00	SqYards		
				24.51	Cost/yard Sq		

F.19 Hardin – South

	HARDIN - S				DISTRICT 5		
Item Number	Quantities	Description	Unit	Average Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	8,000	MISCELLANEOUS WORK	UNIT	$1.00	$8,000.00		
109200005	1	MOBILIZATION	L SUM	$54,075.81	$54,075.81		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170	42	TEST TRAILER-TRANSPORT SET-UP	MI	$10.00	$420.00		
301020718		COVER MATERIAL TYPE 1	SY		$0.00		
301020735	26,401	COVER MATERIAL TYPE 2	SY	$1.03	$27,193.03		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020045	2,582	PLANT MIX BIT SURF GR S 3/4in	TON	$35.90	$92,693.80		
401020300	36	HYDRATED LIME	TON	$170.00	$6,120.00		
402020092	139	ASPHALT CEMENT PG 64-28	TON	$470.00	$65,424.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305	1,320	EMULSIFIED ASPHALT SS-1	GAL	$1.80	$2,376.00		
402020368	45	EMULSIFIED ASPHALT CRS-2P	TON	$480.00	$21,552.00		
411010000	27,119	COLD MILLING	SY	$2.40	$65,085.60		
618030005	105,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.82	$86,100.00		
620017000	3	TEMPORARY PAVEMENT MARKINGS	MI	$310.00	$868.00		
620013960	90	STRIPING-WHITE EPOXY	GAL	$48.00	$4,320.00		
620014960	60	STRIPING-YELLOW EPOXY	GAL	$48.00	$2,880.00		
620014000	90	STRIPING-YELLOW PAINT	GAL	$20.00	$1,800.00		
620013000	90	STRIPING-WHITE PAINT	GAL	$20.00	$1,800.00		
620011105	40	WORDS & SYMBOLS-WHITE PAINT	GAL	$36.00	$1,440.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	27	WORDS & SYMBOLS-WHITE EPOXY	GAL	$91.00	$2,457.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
							ENGLISH
				TOTAL	$444,605.24	LENGTH(mile)	1.4
						WIDTH(feet)	28
			length	7392.00	feet		
			width	28.00	feet		
			Area	206976.00	Sq Feet		
				27079.03	SqYards	Additional area added	
				16.42	Cost/yard Sq		

F.20 St. Xavier – North and South

	ST. XAVIER - N & S				DISTRICT 5		
Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	17,000	MISCELLANEOUS WORK	UNIT	$1.00	$17,000.00		
109200005	1	MOBILIZATION	L SUM	$250,100.61	$250,100.61		
203080100		TOPSOIL SALVAGING & PLACING	CY		$0.00		
210020170	42	TEST TRAILER-TRANSPORT SET-UP	MI	$10.00	$420.00		
301020718	133,574	COVER MATERIAL TYPE 1	SY	$0.65	$86,823.10		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020045	23,647	PLANT MIX BIT SURF GR S 3/4in	TON	$35.90	$848,927.30		
401020300	331	HYDRATED LIME	TON	$170.00	$56,270.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020092	1,275	ASPHALT CEMENT PG 70-28	TON	$470.00	$599,250.00		
402020305	6,693	EMULSIFIED ASPHALT SS-1	GAL	$1.80	$12,047.40		
402020368	226	EMULSIFIED ASPHALT CRS-2P	TON	$480.00	$108,480.00		
411010000	3,211	COLD MILLING	SY	$2.40	$7,706.40		
618030005	120,000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.82	$98,400.00		
620017000	7	TEMPORARY PAVEMENT MARKINGS	MI	$310.00	$2,170.00		
620013960	516	STRIPING-WHITE EPOXY	GAL	$20.00	$10,320.00		
620014960	344	STRIPING-YELLOW EPOXY	GAL	$48.00	$16,512.00		
620014000	336	STRIPING-YELLOW PAINT	GAL	$20.00	$6,720.00		
620013000	224	STRIPING-WHITE PAINT	GAL	$48.00	$10,752.00		
620011105	2	WORDS & SYMBOLS-WHITE PAINT	GAL	$36.00	$72.00		
620011110		WORDS & SYMBOLS-YELLOW PAINT	GAL		$0.00		
620011260	1	WORDS & SYMBOLS-WHITE EPOXY	GAL	$91.00	$91.00		
620011265		WORDS & SYMBOLS-YELLOW EPOXY	GAL		$0.00		
							ENGLISH
				TOTAL	$2,131,970.81	LENGTH(mile)	7
						WIDTH(feet)	24
			length	36960.00	feet		
			width	24.00	feet		
			Area	887040.00	Sq Feet		
				98560.00	SqYards		
				21.63	Cost/yard Sq		

F.21 Lewistown – North

	LEWISTOWN - NORTH				DISTRICT 5		
				Bid Prices		District Unit Prices	
Item Number	Quantities	Description	Unit	Unit Prices Dollars	Amount Dollars	Unit Prices Dollars	Amount Dollars
104030010	5100	MISCELLANEOUS WORK	UNIT	$1.00	$5,100.00		
109200005	0.255	MOBILIZATION	L SUM	$222,895.00	$56,838.23		
210020170		TEST TRAILER-TRANSPORT SET-UP	MI		$0.00		
301020718	48910.53	COVER MATERIAL TYPE 1	SY	$0.40	$19,564.21		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020049	1864.05	PLANT MIX BIT SURF GR S 3/4in	TON	$28.00	$52,193.40		
401020300	26.01	HYDRATED LIME	TON	$150.00	$3,901.50		
402020092	381.4	ASPHALT CEMENT PG 64-28	TON	$500.00	$190,700.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	325.4	EMULSIFIED ASPHALT CRS-2P	TON	$450.00	$146,430.00		
411010000	75898	COLD MILLING	SY	$1.75	$132,821.50		
618030005	30600	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.95	$29,070.00		
620017000	4.69	TEMPORARY PAVEMENT MARKINGS	MI	$600.00	$2,814.00		
620013960	138.72	STRIPING-WHITE EPOXY	GAL	$50.00	$6,936.00		
620014960	86.7	STRIPING-YELLOW EPOXY	GAL	$50.00	$4,335.00		
620014000	130.31	STRIPING-YELLOW PAINT	GAL	$20.00	$2,606.20		
620013000	208.59	STRIPING-WHITE PAINT	GAL	$20.00	$4,171.80		
							ENGLISH
				TOTAL	$657,481.84	LENGTH(mile)	2.7
						WIDTH(feet)	42
			length	14256.00	feet		
			width	42.00	feet		
			Area	598752.00	Sq Feet		
				70280.67	SqYards	Additional area added	
				9.36	Cost/yard Sq		

F.22 Wibaux – South

THIN OVERLAY (English)

WIBAUX - SOUTH | DISTRICT 4

Item Number	Quantities	Description	Unit	Bid Prices Unit Prices Dollars	Bid Prices Amount Dollars	District Unit Prices Unit Prices Dollars	District Unit Prices Amount Dollars
104030010	20000	MISCELLANEOUS WORK	UNIT	$1.00	$20,000.00		
109200005	1	MOBILIZATION	L SUM	$338,079.51	$338,079.51		
210020170	80	TEST TRAILER-TRANSPORT SET-UP	MI	$20.00	$1,600.00		
301020718	372080	COVER MATERIAL TYPE I	SY	$0.47	$174,877.60		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020045	58564	PLANT MIX BIT SURF GR S 3/4in	TON	$25.05	$1,467,028.20		
401020300	820	HYDRATED LIME	TON	$128.45	$105,329.00		
402020092	3162.9	ASPHALT CEMENT PG 64-28	TON	$453.78	$1,435,260.76		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	630.9	EMULSIFIED ASPHALT CRS-2P	TON	$434.62	$274,201.76		
618030005	250000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.80	$200,000.00		
620017000	24.4	TEMPORARY PAVEMENT MARKINGS	MI	$494.50	$12,065.80		
620013000	1764	STRIPING-WHITE PAINT	GAL	$17.47	$30,817.08		
620013960	1177	STRIPING-WHITE EPOXY	GAL	$49.61	$58,390.97		
620014000	726	STRIPING-YELLOW PAINT	GAL	$17.47	$12,683.22		
620014960	484	STRIPING-YELLOW EPOXY	GAL	$49.61	$24,011.24		
							English
				TOTAL	$4,154,345.14	LENGTH(mile)	24.4
						WIDTH(f)	26
			length	128832	feet		
			width	26.00	feet		
			Area	3349632.00	Sq Feet		
				372181.33	SqYards		
				11.16	Cost/yard Sq		

F.23 Shelby – North

	SHELBY NORTH				DISTRICT 3		
Item Number	Quantities	Description	Unit	Bid Prices		District Unit Prices	
				Unit Prices	Amount	Unit Prices	Amount
				Dollars	Dollars	Dollars	Dollars
104030010	5000	MISCELLANEOUS WORK	UNIT	$1.00	$5,000.00		
109200005	1	MOBILIZATION	L SUM	$56,192.24	$56,192.24		
210020170	60	TEST TRAILER-TRANSPORT SET-UP	MI	$5.00	$300.00		
301020718	21391	COVER MATERIAL TYPE I	SY	$0.56	$11,978.96		
401020048		PLANT MIX BIT SURF GR S 1/2in	TON		$0.00		
401020049	2183	PLANT MIX BIT SURF GR S 3/4in	TON	$31.60	$68,982.80		
401020300	31	HYDRATED LIME	TON	$135.00	$4,185.00		
402020092	118.4	ASPHALT CEMENT PG 64-28	TON	$410.00	$48,544.00		
402020095		ASPHALT CEMENT PG 70-28	TON		$0.00		
402020305		EMULSIFIED ASPHALT SS-1	GAL		$0.00		
402020368	36.6	EMULSIFIED ASPHALT CRS-2P	TON	$410.00	$15,006.00		
411010000	22440	COLD MILLING	TON	$1.75	$39,270.00		
618030005	36000	TRAFFIC CONTROL-DEVICES CB	UNIT	$0.95	$34,200.00		
620017000	1.3	TEMPORARY PAVEMENT MARKINGS	MI	$575.00	$747.50		
620013000	90	STRIPING-WHITE PAINT	GAL	$23.50	$2,115.00		
620013960	59	STRIPING-WHITE EPOXY	GAL	$55.00	$3,245.00		
620014000	74	STRIPING-YELLOW PAINT	GAL	$23.50	$1,739.00		
620014960	49	STRIPING-YELLOW EPOXY	GAL	$58.50	$2,866.50		
							English
				TOTAL	$294,372.00	LENGTH(mile)	1.3
						WIDTH(f)	24
			length	6864	feet		
			width	24.00	feet		
			Area	164736.00	Sq Feet		
				20037.02	SqYards	Additional area added	
				14.69	**Cost/yard Sq**		

Appendix G: Bid Price Reports

G.1 Mineral Filler

29-APR-15

MONTANA DEPARTMENT OF TRANSPORTATION

Page 1 of 1

BID PRICES REPORT

STMR0217

ITEM BID HISTORY ENG/ BEGIN END
ITEM NUMBER 401020250 MET/ E QTY PCT 100 AWARD
NEUTRAL

DESCRIPTION MINERAL FILLER-CIR UNIT OF MEASURE TON OBS N

QUANTITY	UNIT PRC	ALT	AVG PRC	UNIT	YR	LET DATE	DIST	LOCAL DESCRIPTION
839.000	156.000		158.000	E	14	02/12/2015	3	BOX ELDER - NORTH 2/12/15

ITEM BID HISTORY ENG/ BEGIN END
ITEM NUMBER 401020250 MET/ QTY PCT 100 AWARD
NEUTRAL

DESCRIPTION MINERAL FILLER-CIR UNIT OF MEASURE TON OBS N

QUANTITY	UNIT PRC	ALT	AVG PRC	UNIT	YR	LET DATE	DIST	LOCAL DESCRIPTION
1,000.000	36.950		44.730	E	87	08/23/1990	1	DRUMMOND- E & W 8/90
335.000	275.000		279.333	E	87	04/21/1988	1	LOOKOUT PASS-DREXEL 4/88

G.2 Lime Slurry

06-JAN-15

MONTANA DEPARTMENT OF TRANSPORTATION

Page 1 of 1

BID PRICES REPORT

STMR0217

ITEM BID HISTORY ENG/ BEGIN END
ITEM NUMBER 401020301 MET/ E QTY PCT 100 AWARD
NEUTRAL

DESCRIPTION LIME SLURRY UNIT OF MEASURE TON OBS N

QUANTITY	UNIT PRC	ALT	AVG PRC	UNIT	YR	LET DATE	DIST	LOCAL DESCRIPTION
325.000	225.000		262.542	E	06	03/22/2012	3	EAST GLACIER - BROWNING 3/22/12
203.000	205.000	OP1	225.000	E	06	07/29/2010	3	EAST OF CONRAD - EAST 7/29/10
368.500	200.000		211.250	E	06	07/29/2010	3	JCT S-227/228 - MEHMKE HILL 7/29/10
578.200	202.000		204.000	E	06	06/10/2010	4	COLSTRIP - NORTH 6/10/10

G.3 Cold Recycled Plant Mix

29-APR-15 | MONTANA DEPARTMENT OF TRANSPORTATION | Page 1 of 1

BID PRICES REPORT | STMR0217

ITEM BID HISTORY | ENG/ MET/ NEUTRAL E | BEGIN | END

ITEM NUMBER 401020325 | QTY | PCT 100 | AWARD

DESCRIPTION COLD RECYCLED PLANT MIX | UNIT OF MEASURE SQYD | OBS N

QUANTITY	UNIT PRC	ALT	AVG PRC	UNIT	YR	LET DATE	DIST	LOCAL DESCRIPTION
434,751.000	2.300		2.410	E	14	02/12/2015	3	BOX ELDER - NORTH 2/12/15
180,498.000	2.500		2.634	E	06	03/22/2012	3	EAST GLACIER - BROWNING 3/22/12
170,137.000	2.500		2.788	E	06	07/29/2010	3	JCT S-227/228 - MEHMKE HILL 7/29/10
90,379.000	2.750	OP1	3.150	E	06	07/29/2010	3	EAST OF CONRAD - EAST 7/29/10
257,697.000	2.900		3.133	E	06	06/10/2010	4	COLSTRIP - NORTH 6/10/10
138,541.000	2.650		2.660	E	06	05/14/2009	4	NORTH OF LAME DEER - NORTH 5/14/09
223,186.000	3.100		3.100	E	06	05/29/2008	5	LODGE GRASS - NORTH, W OF LODGE GRAS
292,984.000	1.710	OP2	2.003	E	06	03/27/2008	2	HEBGEN LAKE - EAST & WEST 3/08
142,200.000	2.900		2.843	E	06	03/27/2008	4	JCT. MT. 16-NORTHWEST 3/08
129,354.000	2.750		2.750	E	06	03/29/2007	5	LEWISTOWN - NORTH, JCT US 191 - WEST

G.4 Recycling Agent

29-APR-15 | MONTANA DEPARTMENT OF TRANSPORTATION | Page 1 of 1

BID PRICES REPORT | STMR0217

ITEM BID HISTORY | ENG/ MET/ NEUTRAL E | BEGIN | END

ITEM NUMBER 402020476 | QTY | PCT 100 | AWARD

DESCRIPTION RECYCLING AGENT CIR-EE | UNIT OF MEASURE TON | OBS N

QUANTITY	UNIT PRC	ALT	AVG PRC	UNIT	YR	LET DATE	DIST	LOCAL DESCRIPTION
1,673.900	553.000		552.750	E	14	02/12/2015	3	BOX ELDER - NORTH 2/12/15
795.100	705.000		761.000	E	06	03/22/2012	3	EAST GLACIER - BROWNING 3/22/12
787.700	600.000		598.750	E	06	07/29/2010	3	JCT S-227/228 - MEHMKE HILL 7/29/10
419.200	695.000	OP1	641.250	E	06	07/29/2010	3	EAST OF CONRAD - EAST 7/29/10
1,242.300	657.000		649.000	E	06	06/10/2010	4	COLSTRIP - NORTH 6/10/10
666.900	716.950		722.317	E	06	05/14/2009	4	NORTH OF LAME DEER - NORTH 5/14/09
1,298.600	591.500		591.500	E	06	05/29/2008	5	LODGE GRASS - NORTH, W OF LODGE GRAS
546.900	450.000		489.000	E	06	03/27/2008	4	JCT. MT. 16-NORTHWEST 3/08
1,127.700	457.000	OP2	501.750	E	06	03/27/2008	2	HEBGEN LAKE - EAST & WEST 3/08
479.400	430.000		430.000	E	06	03/29/2007	5	LEWISTOWN - NORTH, JCT US 191 - WEST

Chapter 8: Works Cited

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MDT. (2007). *An Overview of Cold In-Place Recycling in Montana.* Helena: MDT.

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MDT. (2015). *405-2 Cold In-Place Recycling.* Helena : MDT.

MDT. (2015). *713-1 Mineral Filler for Cold In-Place Recycled Pavement.* Helena: MDT.

Links

- CIR Processes and Equipment
- CCPR Processes and Equipment
- Bid Tabs
- PathWeb

Construction Review Reports

- Box Elder – North Construction Review
- East Glacier – Browning: Construction Review
- East of Conrad: Construction Review
- Mehmke Hill: Construction Review
- Hebgen Lake: Construction Review
- Garryowen South: Construction Review
- Jct MT 16: Construction Review
- Lewistown North Construction Review

PathWeb Images

- Box Elder – North Images
- East Glacier - Browning Images
- East of Conrad Images
- Mehmke Hill Images
- Colstrip Images
- North of Lame Deer Images
- Hebgen Lake Images
- Garryowen South Images
- Jct MT 16 Images
- Lewistown North Images
- West of Lodge Grass Images
- South of Bridger Images
- East River Road Images
- Helena Northwest Images
- Warren N&S Images
- Fairfield N&S Images
- Red Lodge North Images
- Two Medicine Bridge Images
- 19 Miles N of Avon Images
- Hays North Images
- SE Fort Benton Images
- Fort Benton N&S Images
- Rogers Pass Images

Construction Photos

- Hebgen Lake Construction Photos
- Box Elder – North Construction Photos