Northeastern Montana Oil Boom Study: Pavement Impacts

Prepared by Montana Department of Transportation's Pavement Analysis Section

Introduction:

Within the past five years there has been increasing oil and natural gas extraction activities in northeastern Montana. These activities have resulted in more oil truck traffic, and has and will accelerate pavement damage on MDT's road system.

This oil boom is expected to last for a long time and additional road construction will be needed to keep the roads in today's condition. The purpose of this report is to predict the amount of additional road construction projects and funding that will be needed during the next 20 years (2013-2032) due to the increased oil truck traffic.

This report contains the following items:

- Summary of the oil traffic increase.
- Discussion regarding the increased construction costs that are occurring within the oil impact area.
- Overview of the method used to predict future construction projects and costs.
- Estimate of the additional funding that will be needed to keep the roads in today's condition.

Four different scenarios were analyzed predicting the pavement impacts that will occur if 0, 20, 40 or 80 oil well drilling rigs are active in Montana. The 0 drill rig scenario is the baseline scenario where no oil boom has or will occur in Montana. For report brevity, this report will place emphasis on the baseline and 20-rig scenarios.

Study Area:

The portion of Montana included in this study includes Valley, Daniels, Sheridan, Roosevelt, McCone, Richland, Dawson, and Wibaux counties. A map of these counties is shown in Figure 1. This area is included within MDT's Glendive District.

Roads Included in Pavement Study:

This study includes the roadways shown in Figure 2 including 1,401 centerline miles of roadways. These roads include Montana's Interstate (60 miles), National Highway System (NHS) (394 miles), and Montana State Primary (458 miles) and secondary systems (490 miles).

Predicted Oil Traffic Increase:

In November 2012, Upper Great Plains Transportation Institute (UGPTI) (UGPTI, 2012) provided a report entitled *Oil Boom Study: Draft Final Report.* The UGPTI report includes predictions of the oil boom traffic levels that will occur from 2013 through 2032. The report includes truck traffic that will occur if 20, 40, or 80 drill rigs operate in Montana. For reference, currently there are about 22 drill rigs operating in Montana. The truck traffic is measured in equivalent single axle loadings (ESALs). ESALs are commonly used by pavement engineers to quantify truck traffic. As a rule of thumb, 1 ESAL is about equal to 1.33 truck loadings.

Figure 3 shows the Daily ESALs for the baseline and 20-rig scenarios. A summary of the ESAL increase for each highway system is presented in Table 1. **Appendix A** presents more detailed traffic information including the ESAL increase between the baseline and 20-rig scenarios arranged by7 corridor and sign route.

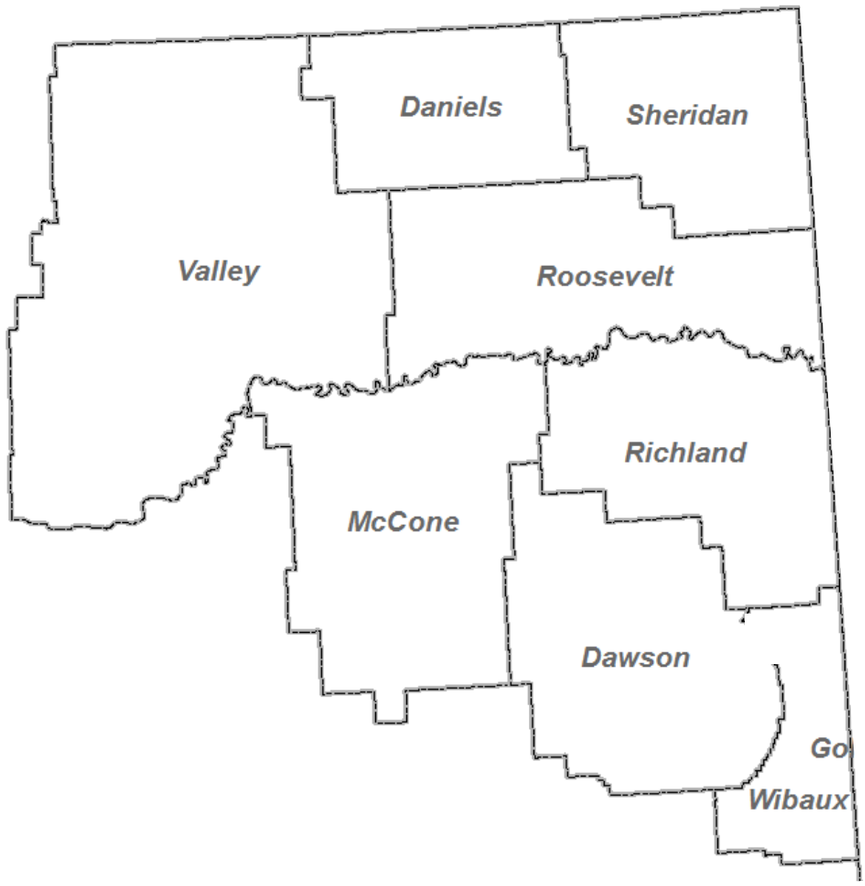

Figure 1: Counties included in Pavement Study

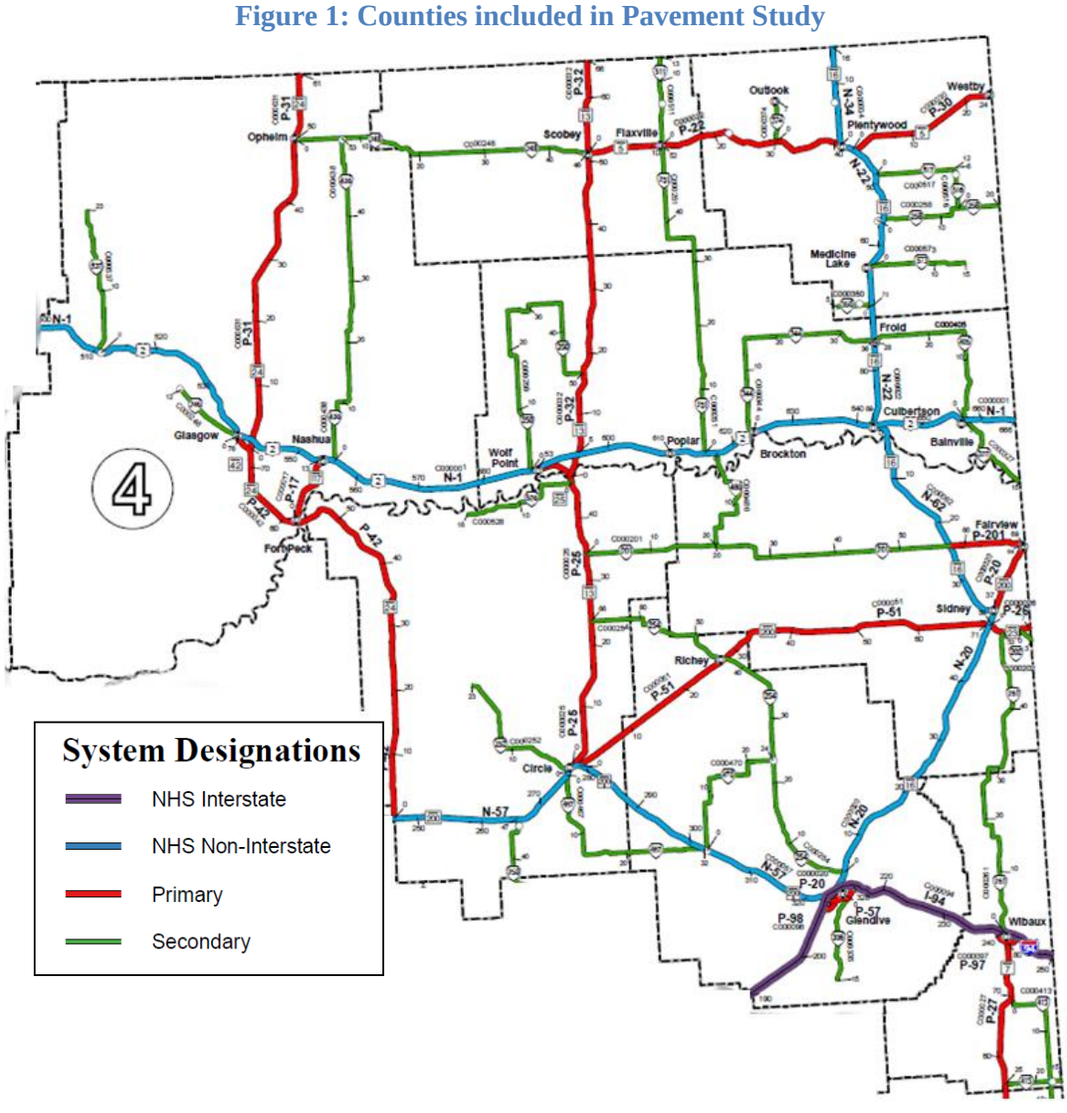

Figure 2: Roads Included in Pavement Study

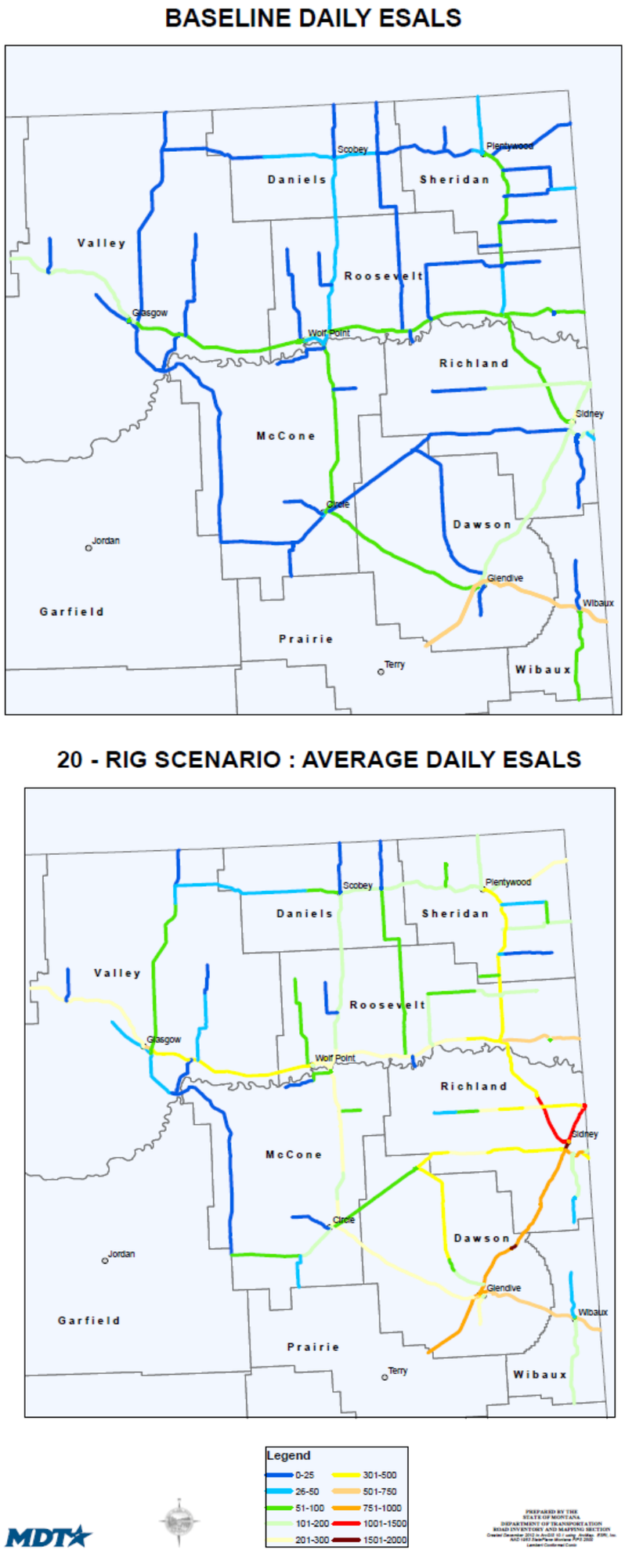

Figure 3: Baseline and 20 – Rig Scenarios: Daily ESALs

Table 1: 20-Rig Scenario: Daily ESAL Increase

Road System	Average Baseline (2009) Daily ESALs	Average 20-Rig Daily ESALs	Percent Increase
Total	91	307	238%
Interstate	604	697	15%
NHS	89	396	344%
Primary	33	168	408%
Secondary	20	104	413%

Construction Cost Increases within the Oil Impact Area

There have been indications that MDT pavement construction costs are increasing within the oil-impact area. This may be a result of both scarcity of road building materials and competition with the oil industry for labor and materials. The purpose of this report section is to estimate construction costs to use for future construction projects in the oil-impact area.

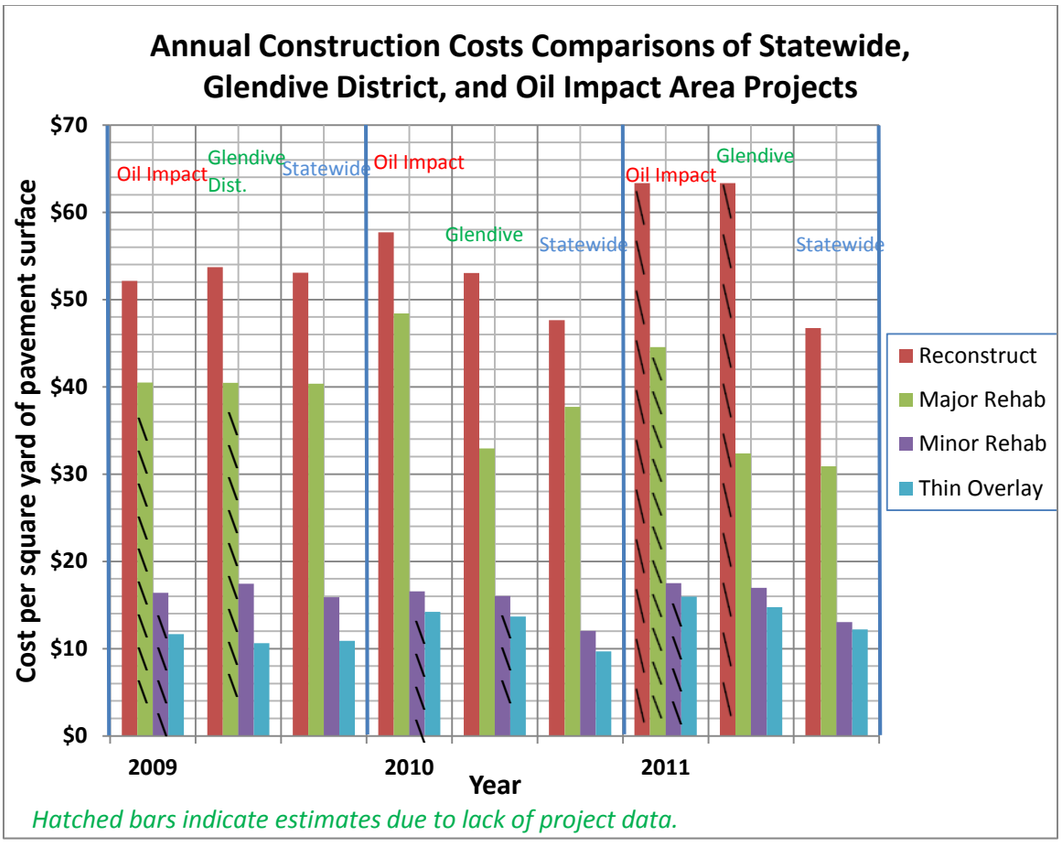

Figure 4: 2009 through 2011 Annual Pavement Construction Costs

The pavement construction costs used within this report are calculated using the "Cost Trends for Pavement Treatments" that are published annually by MDT's Pavement Analysis Section (MDT, 2011). These costs are calculated annually using the bid tabulations for all pavement-related projects during the subject year. Only the statewide averages are published, so the bid tabulations were revisited to gather the project costs within the Glendive District and Oil Impact Area. Note that these costs only include pavement-related construction costs, and do not include items such as right-of-way, preconstruction (design or PE), construction oversight (CE), and ICAP (incidental costs and overhead).

Figure 4 shows that in 2009 construction costs are relatively uniform across the state. However, in 2010 and 2011 projects in both the Glendive District and Oil-Impact Area are greater than the statewide averages. At the time of this report, 2012 construction costs are not available.

The costs to be used in the Pavement Construction Cost Prediction model are presented in Table 2 and Table 3. Note that 2009 costs are assumed to be the baseline, or no oil boom, scenario, while 2011 costs are used for the 20, 40, and 80-rig scenarios.

Table 2: Baseline Scenario: Construction Costs

2009 Construction Costs (Baseline Scenario)		
Treatment Type	**Cost/yd2**	**How was the cost Calculated?**
Driving Lane Mill/Fill with Full Width Chip Seal (Interstate Only)	7.22	2009 Oil-Boom Area
Overlay	10.63	2009 Oil-Boom Area
Minor Rehab	15.9	2009 Statewide Average
Major Rehab	40.36	2009 Statewide Average
Reconstruct	52.14	2009 Oil-Boom Area

Table 3: 20, 40, and 80 Rig Scenarios: Construction Costs

2011 Construction Costs (20, 40, and 80 Rig Scenarios)		
Treatment Type	**Cost/yd2**	**How was the cost Calculated?**
Driving Lane Mill/Fill with Full Width Chip Seal (Interstate Only)	8.2	2011 Oil-Boom Area
Overlay	15.97	2011 Oil-Boom Area
Minor Rehab	17.49	110% of 2009 Statewide Average
Major Rehab	44.55	110% of 2009 Statewide Average
Reconstruct	63.34	2011 Oil-Boom Area

Pavement Construction Cost Prediction Model

The goal of this analysis is to determine what additional funding will be needed above what is currently being spent to keep roads in the oil-impact area in today's condition. To accomplish this, a pavement performance prediction model was built to predict future pavement construction projects that will occur during the 20-year span from 2013 to 2032.

Four different scenarios were modeled:

- A baseline scenario to predict the pavement costs MDT would incur if there was no-oil boom.
- Three oil-boom scenarios to predict pavement costs MDT will incur during an oil boom with 20, 40, or 80 drill rigs operating in Montana. For comparison, there are currently about 22 and 200 drill rigs currently operating in Montana and North Dakota, respectively.

The following bullets describe the four scenarios in more detail:

- **Baseline Scenario:** This scenario assumes that the oil boom hasn't and won't occur. Based on traffic information, 2009 appears to be the year before the oil-boom began since truck traffic starts to increase in 2010. The model is based on 2009 traffic levels (ESALs) and assumes a 1% annual traffic growth rate. The pavement construction costs are 2009 construction costs incurred on projects within the oil-impact area (Table 2).

  It is important to note that the Baseline Scenario is calibrated so its predicted construction expenditures will be similar to current MDT construction expenditures. The purpose of this is to provide an "apples-to-apples" comparison with current construction expenditures.

- **20-Rig Scenario:** This scenario assumes that the oil boom is occurring and that 20 drill rigs will be active in Montana. Based on current oil activity, this scenario may be the best prediction of what will occur. This scenario uses UGPTI's 20-rig traffic data, and construction costs are based on construction projects let in the oil-impact area during 2011.

- **40-rig Scenario:** This scenario assumes that the oil-boom to 40 drill rigs operating in Montana. This scenario uses UGPTI's 40-rig traffic data, and construction costs are based on construction projects let in the oil-impact area during 2011.

- **80-rig Scenario:** This scenario assumes that the oil-boom significantly expands to 80 drill rigs operating in Montana. This scenario uses UGPTI's 80-rig traffic data, and construction costs are based on construction projects let in the oil-impact area during 2011.

Pavement Analysis Results

Total and annual highway expenditures for MDT's highway systems are shown in Table 4 through

Table 7. Table 8 is a summary of the increased construction funding that will be needed under all three oil-boom scenarios.

The additional construction costs include both costs due to construction price escalation and increased truck loading. Overall, about 30% is due to price escalation, while the other 70% is due to increased truck loading.

Note that the 20, 40, and 80 rig scenarios construction costs are relatively the same. This may mean that the size of the oil boom doesn't matter: Only the presence of the oil boom is needed to increase construction expenditures.

Figure 5 presents a map showing additional construction expenditures for the 20-rig scenario. **Appendix B** has more detailed information and presents construction costs for both baseline and 20-rig scenarios arranged by corridor and sign route.

Table 4: Baseline Scenario: Predicted Construction Costs

Baseline Scenario		
Interstate	20-year Total	$50,306,687
	Annual	$2,515,334
NHS-non interstate	20-year Total	$361,253,133
	Annual	$18,062,657
State Primary	20-year Total	$112,814,271
	Annual	$5,640,714
State Secondary	20-year Total	$39,132,104
	Annual	$1,956,605
Total	20-year Total	$563,506,194
	Annual	$28,175,310

Table 5: 20-Rig Scenario: Predicted Construction Costs

20 Rig Scenario		
Interstate	20-year Total	$58,884,441
	Annual	$2,944,222
NHS-non interstate	20-year Total	$804,147,925
	Annual	$40,207,396
State Primary	20-year Total	$535,840,359
	Annual	$26,792,018
State Secondary	20-year Total	$186,985,524
	Annual	$9,349,276
Total	20-year Total	$1,585,858,249
	Annual	$79,292,912

Table 6: 40-Rig Scenario: Predicted Construction Costs

40 Rig Scenario		
Interstate	20-year Total	$59,242,153
	Annual	$2,962,108
NHS-non interstate	20-year Total	$813,603,255
	Annual	$40,680,163
State Primary	20-year Total	$558,994,884
	Annual	$27,949,744
State Secondary	20-year Total	$192,227,138
	Annual	$9,611,357
Total	20-year Total	$1,624,067,429
	Annual	$81,203,371

Table 7: 80-Rig Scenario: Predicted Construction Costs

80 Rig Scenario		
Interstate	20-year Total	$59,242,153
	Annual	$2,962,108
NHS-non interstate	20-year Total	$849,020,094
	Annual	$42,451,005
State Primary	20-year Total	$586,597,569
	Annual	$29,329,878
State Secondary	20-year Total	$222,065,033
	Annual	$11,103,252
Total	20-year Total	$1,716,924,849
	Annual	$85,846,242

Table 8: Increase in Construction Funding Needed due to the Oil Boom

		20-Rig Scenario	40-Rig Scenario	80-Rig Scenario
Interstate	20-year Total	$8,577,754	$8,935,466	$8,935,466
	Annual	$428,888	$446,773	$446,773
NHS-non interstate	20-year Total	$442,894,792	$452,350,122	$487,766,961
	Annual	$22,144,740	$22,617,506	$24,388,348
State Primary	20-year Total	$423,026,088	$446,180,613	$473,783,298
	Annual	$21,151,304	$22,309,031	$23,689,165
State Secondary	20-year Total	$147,853,420	$153,095,034	$182,932,929
	Annual	$7,392,671	$7,654,752	$9,146,646
Total	20-year Total	$1,022,352,055	$1,060,561,235	$1,153,418,654
	Annual	$51,117,603	$53,028,062	$57,670,933

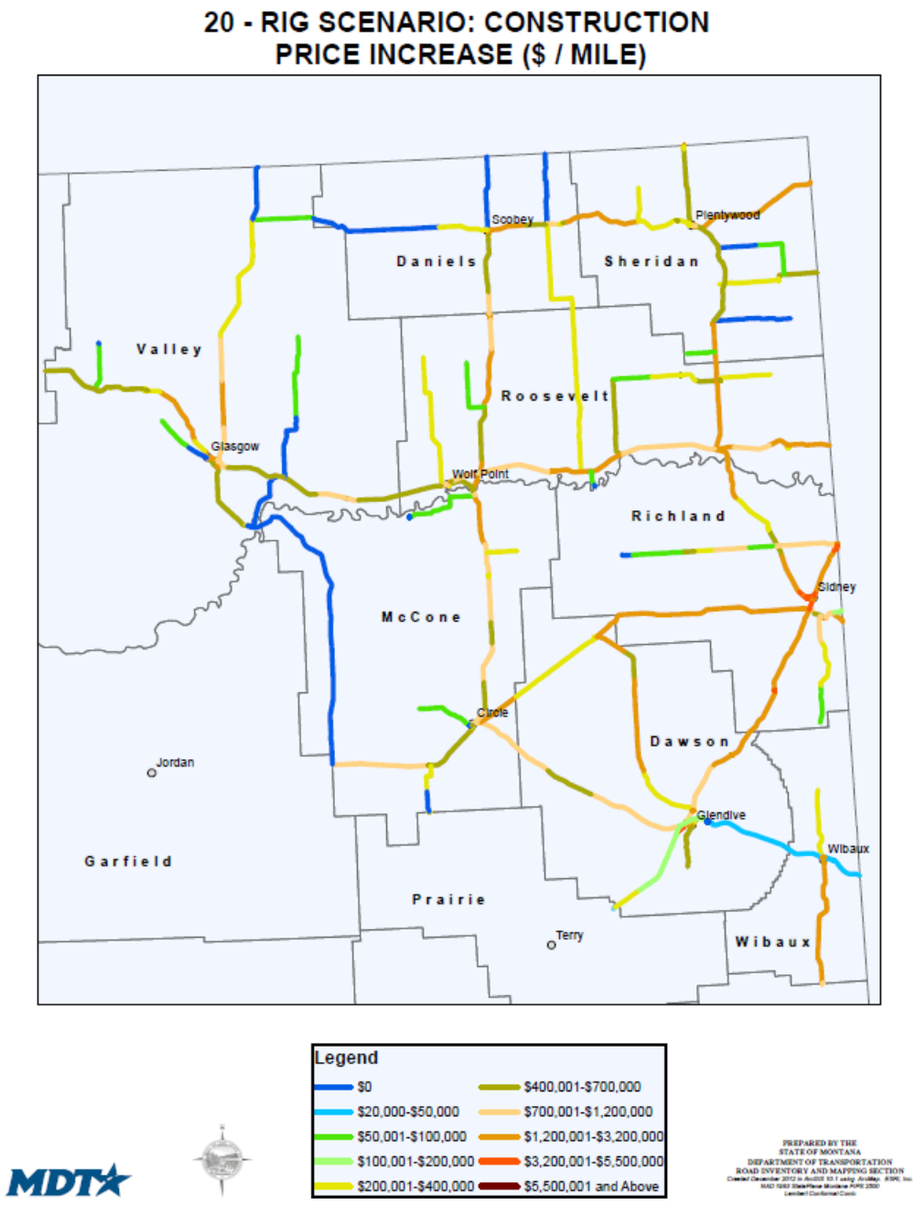

Figure 5: 20-Rig Scenario: Total Construction Cost Increase from 2013-2032

Works Cited

MDT. (2011). *2011 Pavement Conditions, 2012 and 2014 Recommended Treatments.* Helena, MT: Montana Department of Transportation.

UGPTI. (2012). *Oil Boom Study: Draft Final Report.* Fargo: North Dakota State University.

Appendix A

Table 9: 20-Rig Scenario: ESAL Increases per Corridor and Sign Route

System, Corridor, Sign Route	Baseline (2009) Daily ESALs	20-rig scenario: Average Daily ESALs	ESAL increase (%)
Interstate			
C000094W			
INTERSTATE 94	601	692	15%
C000094E			
INTERSTATE 94	601	701	17%
NHS			
C000062S			
MONTANA 16	78	739	820%
C000022E			
MONTANA 16	58	380	592%
MONTANA 5	83	381	358%
C000020N			
MONTANA 16	179	979	440%
C000001E			
US 2	94	339	282%
C000034N			
MONTANA 16	46	172	277%
C000057E			
MONTANA 200	32	120	287%
MONTANA 200S	80	252	214%
Primary			
C000051E			
MONTANA 200	16	228	1319%
C000030E			
MONTANA 5	18	209	1050%
C000097N			
P-97 through Wibaux	57	621	995%
C000020N			
MONTANA 16	141	832	492%
MONTANA 200	194	1,288	564%
C000032N			
MONTANA 13	23	98	373%
C000098E			
P-98 west of Glendive	53	245	364%
C000022E			
MONTANA 5	26	118	356%
C000025N			
MONTANA 13	68	228	234%
MONTANA 25	43	226	468%
C000026E			
MONTANA 23	192	701	263%
C000057E			
MONTANA 200S	72	286	297%
P-57 through Glendive	127	413	227%
C000125E			

System, Corridor, Sign Route	Baseline (2009) Daily ESALs	20-rig scenario: Average Daily ESALs	ESAL increase (%)
Secondary			
C000335S			
SECONDARY 335	10	196	4493%
C000350W			
SECONDARY 350	2	61	2573%
C000254W			
SECONDARY 254	12	273	2231%
C000374N			
SECONDARY 374	3	67	1882%
C000261N			
SECONDARY 261	5	73	1780%
C000537N			
SECONDARY 537	3	51	1461%
C000327S			
SECONDARY 327	12	169	1233%
C000253N			
SECONDARY 253	4	35	1064%
C000528W			
SECONDARY 528	5	50	996%
C000202E			
SECONDARY 202	39	323	736%
C000344E			
SECONDARY 344	17	116	584%
C000405N			
SECONDARY 405	17	111	565%
C000250N			
SECONDARY 250	8	48	520%
C000258E			
SECONDARY 258	22	132	503%
C000516N			
SECONDARY 516	15	79	438%
C000511N			
SECONDARY 511	2	11	434%
C000252W			
SECONDARY 252	7	31	333%
C000246W			
SECONDARY 246	17	47	312%
C000251N			
SECONDARY 251	18	73	303%
C000438N			
SECONDARY 438	8	32	288%
C000573N			
SECONDARY 573	6	22	282%
C000201E			
SECONDARY 201	113	320	253%

MONTANA 25	44	137	210%
C000031N			
MONTANA 24	13	47	209%
C000027N			
MONTANA 7	59	180	202%
C000042N			
MONTANA 24	8	23	181%
MONTANA 42	14	34	155%
C000017N			
MONTANA 117	12	17	41%

C000248E			
SECONDARY 248	17	48	192%
C000517E			
SECONDARY 517	16	44	178%
C000480S			
SECONDARY 480	6	14	152%

Appendix B

Table 10: 20-Rig Scenario: Cost Increase by Corridor and Sign Route

Corridor	SIGN ROUTE	20-year Total Construction Spending		
		Baseline Construction Costs	20-Rig Scenario Construction Costs	Cost Increase between Baseline and 20-Rig Scenario
		Interstate		
C000094E				
	INTERSTATE 94	$24,487,156	$28,767,286	$4,280,130
C000094W				
	INTERSTATE 94	$25,819,531	$30,117,155	$4,297,624
		NHS		
C000001E				
	US 2	$186,337,510	$353,679,997	$167,342,486
C000020N				
	MONTANA 16	$73,696,335	$155,656,441	$81,960,106
C000057E				
	MONTANA 200	$4,021,319	$34,446,392	$30,425,074
	MONTANA 200S	$48,309,293	$81,250,051	$32,940,758
C000022E				
	MONTANA 16	$17,687,385	$77,804,135	$60,116,749
	MONTANA 5	$1,143,042	$2,523,024	$1,379,983
C000062S				
	MONTANA 16	$24,388,619	$85,169,339	$60,780,720
C000034N				
	MONTANA 16	$5,669,630	$13,618,546	$7,948,916
		Primary		
C000051E				
	MONTANA 200	$2,114,469	$100,858,950	$98,744,481
C000032N				
	MONTANA 13	$10,919,729	$65,666,469	$54,746,739
C000025N				
	MONTANA 13	$30,578,261	$74,438,080	$43,859,818
	MONTANA 25	$3,661,570	$7,706,091	$4,044,521
C000022E				
	MONTANA 5	$2,919,837	$48,124,731	$45,204,894
C000031N				
	MONTANA 24	$4,306,728	$42,861,208	$38,554,479
C000027N				
	MONTANA 7	$6,884,931	$45,253,082	$38,368,151
C000030E				
	MONTANA 5	$0	$37,266,587	$37,266,587
C000020N				
	MONTANA 16	$1,218,576	$1,828,897	$610,321
	MONTANA 200	$25,502,839	$58,750,975	$33,248,136
C000098E				
	P-98 west of Glendive	$1,224,524	$9,100,635	$7,876,111
C000042N				
	MONTANA 24	$2,749,321	$8,379,088	$5,629,767
	MONTANA 42	$594,333	$1,669,803	$1,075,470
C000057E				
	MONTANA 200S	$1,265,545	$2,312,521	$1,046,976

	P-57 through Glendive	$10,384,434	$16,008,788	$5,624,353
C000026E				
	MONTANA 23	$8,052,018	$14,435,580	$6,383,562
C000097N				
	P-97 through Wibaux	$279,645	$876,382	$596,737
C000125E				
	MONTANA 25	$157,510	$302,494	$144,983
C000017N				
	MONTANA 117	$0	$0	$0
		Secondary		
C000254W				
	SECONDARY 254	$0	$42,296,083	$42,296,083
C000201E				
	SECONDARY 201	$15,992,162	$42,366,696	$26,374,534
C000251N				
	SECONDARY 251	$0	$13,280,269	$13,280,269
C000344E				
	SECONDARY 344	$1,214,775	$13,896,604	$12,681,829
C000261N				
	SECONDARY 261	$3,861,309	$15,620,744	$11,759,435
C000250N				
	SECONDARY 250	$2,172,279	$9,704,929	$7,532,650
C000258E				
	SECONDARY 258	$0	$7,379,136	$7,379,136
C000335S				
	SECONDARY 335	$0	$5,278,753	$5,278,753
C000202E				
	SECONDARY 202	$431,624	$4,526,169	$4,094,545
C000248E				
	SECONDARY 248	$2,269,047	$5,737,288	$3,468,241
C000405N				
	SECONDARY 405	$0	$3,306,604	$3,306,604
C000374N				
	SECONDARY 374	$0	$1,601,424	$1,601,424
C000438N				
	SECONDARY 438	$3,016,470	$4,531,799	$1,515,329
C000528W				
	SECONDARY 528	$2,659,306	$3,995,214	$1,335,907
C000253N				
	SECONDARY 253	$0	$1,313,393	$1,313,393
C000537N				
	SECONDARY 537	$1,683,468	$2,626,146	$942,678
C000252W				
	SECONDARY 252	$1,627,965	$2,543,746	$915,781
C000246W				
	SECONDARY 246	$1,218,641	$1,910,971	$692,330
C000327S				
	SECONDARY 327	$0	$584,949	$584,949
C000516N				
	SECONDARY 516	$940,498	$1,412,958	$472,461
C000350W				
	SECONDARY 350	$821,241	$1,233,794	$412,552
C000517E				
	SECONDARY 517	$810,228	$1,217,248	$407,020
C000480S				

	SECONDARY 480	$413,090	$620,607	$207,517
C000573N				
	SECONDARY 573	$0	$0	$0
C000511N				
	SECONDARY 511	$0	$0	$0
	TOTAL	**$563,506,194**	**$1,585,858,249**	**$1,022,352,055**