State Highway System: Eastern Montana Impacts from Oil Exploration & Production: Summary of MDT's Efforts

Executive Summary

In the past 5 years there have been increasing oil and natural gas extraction activities in eastern Montana. This oil-related activity has resulted in more commercial vehicle traffic and has accelerated infrastructure deterioration road network that MDT maintains. To better understand and respond to the impacts of oil exploration in eastern Montana, MDT has conducted seven distinct studies—two corridor studies, one safety audit, three traffic estimations studies and one pavement analysis. Based on these analyses, the estimated transportation impacts attributable to energy extraction activities are:

- $52 million dollars per year for twenty years to address pavement needs.
- On some oil region highways, AADT will almost double in the next 15 years.
- While commercial vehicle traffic trends were nearly flat historically, increases of 130% in oil region counties since 2007 are noted. This growth is projected to continue in the next 15 years.
- Population may increase by 30,000 in MDT's Glendive District by 2035, with most of the growth in the northeast portion of the district.[1]
- 20 ±10 oil drilling rigs are estimated to be active in the region over the next 15 years.

To date, MDT has made the following improvements and adjustments in designs and policies to meet the evolving needs in the region.

- MDT had expended $5.2 million in project change orders to specifically increase the base depth and to increase asphalt thickness on projects let to contract.
- MDT has added passing lanes, increased shoulder widths and added centerline rumble strips on Montana Highway 16 north of Glendive.
- MDT has added a grade-separated crossing to the Fort Peck Northeast project scope—at a cost of $7.8 million—to address the effect of increased train traffic to and from the oil region.
- MDT has examined capacity along the major oil region corridors (both Culbertson and MT16 corridor studies identify potential capacity issues along these corridors) and REMI analysis forecasts Montana Highway 200 from Sidney to Fairview may have potential capacity issues.
- MDT Motor Carrier Services (MCS) has increased truck weight enforcement in the region.
- MDT has assisted the Governor's office in workforce development and retention in the area.
- Projected peak traffic through 2025 will not exceed two lane projected capacity (1200 vehicles/lane during peak hour)

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[1] It is assumed that most of the growth will be in Daniels, Dawson, , Roosevelt, Richland, Sheridan, and Wibaux Counties

Oil exploration and extraction in Montana has created a strain on the road network in eastern Montana. MDT is currently taking steps to ensure the infrastructure needs are addressed in the region. Additionally, MDT has conducted several studies to estimate the infrastructure impact in the oil region.

Introduction

A recent boom in energy extraction is generating significant freight traffic in the region of the Bakken oil formation, the main body of which is in North Dakota, Montana, and Saskatchewan. North Dakota's recent research on the topic suggests that the roadway impact of this oil activity is in the hundreds of millions of dollars. Energy exploration and extraction is growing in parts of Montana as well, and research may provide insights into potential transportation impacts of freight growth and changes throughout the state.

Several efforts are underway or have been recently completed to assist MDT in traffic forecasting – both freight and personal vehicles – which has given MDT staff a way to estimate the future impact of the oil extraction activity in this region, beyond historical trend line methods.

The purpose of this briefing is to briefly discuss the background, history, nature, and extent of oil extraction in the Bakken region of eastern Montana, and its relative impact on the state transportation system.

Background

The Bakken formation is a rock unit from the Late Devonian to Early Mississippian age occupying about 200,000 square miles (520,000 km^2) of the subsurface of the Williston Basin, and underlying areas of North Dakota, Montana and Saskatchewan.

The formation contains significant producible oil reserves. In April 2008, a USGS report estimated the amount of recoverable oil within the Bakken Formation at 3.0 to 4.3 billion barrels. Due to the rapid advancement and field deployment of technology, various other estimates now place total recoverable and non-recoverable reserves at up to 24 billion barrels. Current consensus places the estimate at over 18 billion barrels.

Oil was first discovered within the Bakken formation in 1951, but exploration and extraction was limited due to the lack of today's readily-implementable technology and available working capital. The new technology driving improved resource recovery is a process of hydraulic rock fracturing (very high-pressure fluid pumped thousands of feet below Earth's surface) made economically viable in 2008. By the end of 2010, Bakken oil production rates reached 458,000 barrels (72,800 m^3) per day, demanding greater outbound shipping capacity to transport Bakken crude to US markets, much of which must be accomplished in the last-mile scenario over Montana highways.

Impact to Montana's Highways

Area of Influence: Bakken energy exploration and extraction is occurring mostly in North Dakota. This is due primarily to the geophysics of the North Dakota oil-bearing shale, resulting in roughly double the thickness of the ND Bakken as compared to the Montana formation.

Figure One: Study Area and Wells

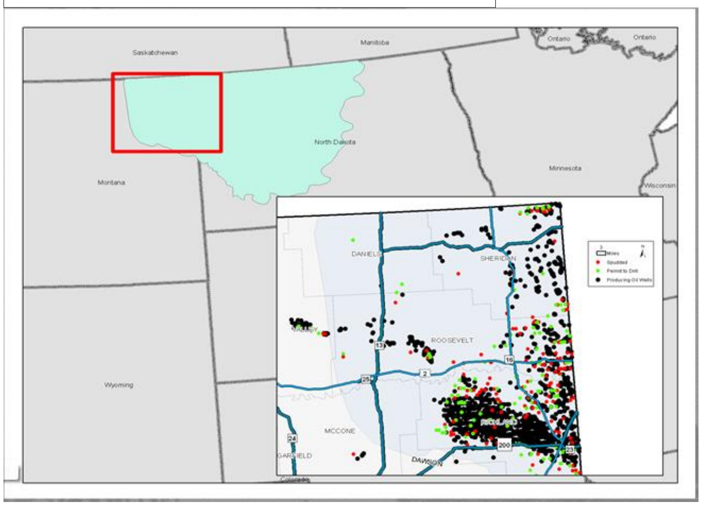
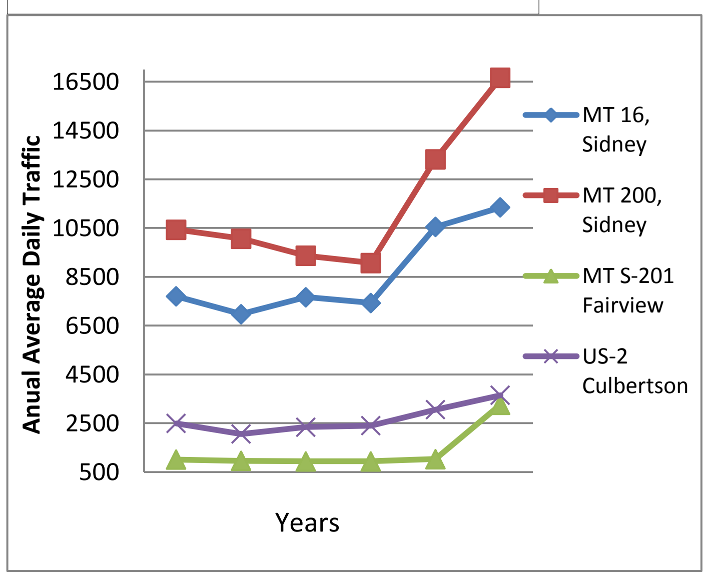


Figure One shows the Bakken region in North Dakota and Montana. The inset map shows the location of the producing wells (black circles), the permitted wells (green circles) and spudded wells (red circles). It is important to note that the Montana Bakken surface area is roughly 20% of the total Bakken, while North Dakota Bakken surface area comprises the remaining 80%. Noting the depth and breadth of the Montana Bakken, it is a reasonable assumption that Montana will not have the same oil impact magnitude as compared to North Dakota. However, Montana infrastructure is impacted from both oil activity in Montana and drilling and exploration activities in North Dakota.

Traffic Changes: Evidence of oil exploration in eastern Montana and western North Dakota can be seen in the increase in traffic volume and vehicle mix values over time. Historic year-over-year traffic trends for the region once ranged from 0% to 1% growth. From 2010 to 2012 the annual average daily traffic (AADT) increased from 30% to as much as 500% on low volume roads. Figure Two shows the increase in AADT on major routes at specific locations within the oil region. In many cases throughout the oil region, similar traffic volume increases are seen.

Figure Two: AADT Increases by Highway



Traffic volume increases generated from oil exploration in both North Dakota and Montana impact roads which were originally designed to carry relatively low volume, single-digit percent commercial vehicle traffic. Oil-related increases in traffic volumes and vehicle mix will have a significant impact.

Commercial vehicle traffic has also increased and this is important because this vehicle class brings with it accelerated pavement degradation and other safety considerations. Table one shows the percent change in commercial vehicle traffic by county and highway system between 2010 and

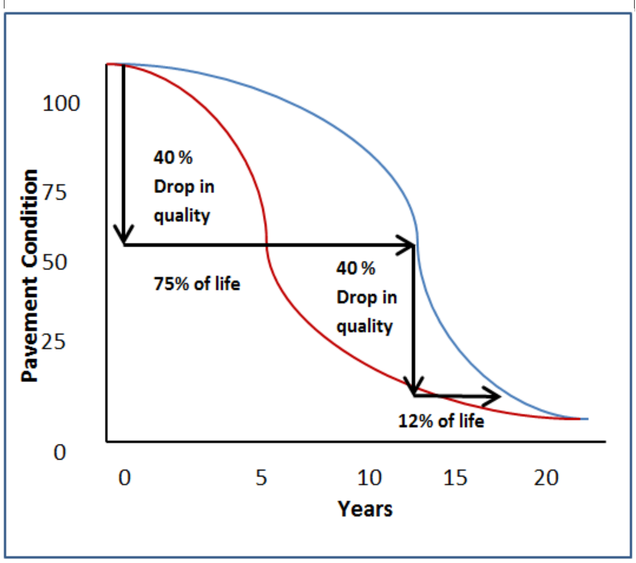
2011.

Table one: Weighted Commercial Annual Average Daily Traffic (AADT) by County

Interstate	**2010**	**2011**	**Percent Change**
Dawson	3,599	4,039	+12.2%
Wibaux	2,748	2,882	+4.9%
Non-Interstate National Highway System	**2010**	**2011**	**Percent Change**
Dawson	1,501	1,652	+10.1%
Richland	2,150	2,739	+27.4%
Roosevelt	1,623	1,987	+23.4%
Sheridan	722	1,035	+34.1%
Primary	**2010**	**2011**	**Percent Change**
Daniels	476	521	+9.5%
Dawson	1,279	1,515	+18.5%
Richland	1,304	2,138	+64.0%
Roosevelt	497	686	+38.0%
Sheridan	405	566	+39.8%
Wibaux	753	837	+11.2%

Pavement Life Cycle: Typically, MDT designs highways to last between 20 and 25 years or longer, depending on traffic design volume and vehicle mix. With regular pavement maintenance, the highway will remain in good condition over its lifetime. Roads deteriorate quickly, however, if the road is under-designed or if maintenance is not performed regularly. Figure Three shows a typical pavement degradation curve (blue). Note that for over 75% of the highway lifecycle there is a corresponding 40% drop in pavement condition (quality). The next 40% decrease in pavement condition occurs in the last 12% of its lifecycle, a very sharp decline. In the oil impacted region, the degradation curve (denoted in red) could be accelerated dramatically due to increased traffic, particularly from commercial vehicles. In other words, an initial 40% drop in pavement quality could occur in the first 5 years, as compared to 15 years in a typical curve.

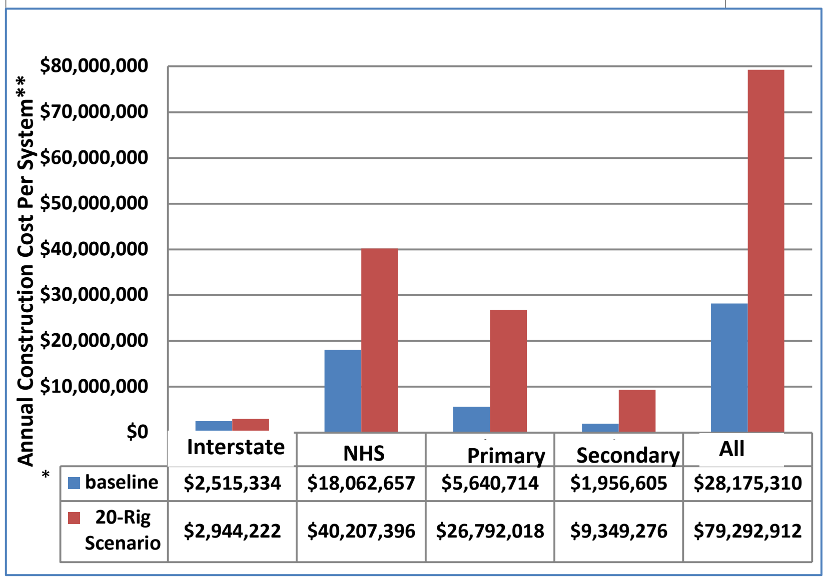
Figure Three: Pavement Degradation curve



This increase in traffic and the potential pavement degradation has prompted MDT to conduct a series of studies, described later, from which MDT's Pavement Engineer has evaluated the roads and associated cost to keep the oil region highways at an acceptable level of service (LOS). LOS is an objective measure of performance to determine the effectiveness of the transportation infrastructure.

Projected Needs: Data and analysis from the Upper Great Plains Transportation Institute (UGPTI) were used to further refine traffic projections in the oil region. Traffic projections from oil development scenarios were used to forecast the cost to keep the pavement in good condition.

Figure Four: Annual Cost Increase in Oil Impact Region



* 2009 Base line data

** Costs are based on construction only.

Figure Four shows the comparison of construction project expenditures by highway system using 2009 as the baseline year and comparing that to the projected traffic forecasts from UGPTI. Baseline expenditure need for all highway systems was about $30 million (in 2009) to keep the pavement in good condition. The average increase in estimated construction costs would be about $52 million per year for the life of the oil boom. It is important to note that this increase is only in the region which the oil boom is occurring and not in Glendive district as a whole. The biggest cost increases are projected for the National Highway System (NHS) and State Primary highways. The Interstate (I-94) cost estimate demonstrates a nominal increase. It is important to note these expenditures do not address capacity enhancement, design, right of way acquisition, or any environmental analysis – only the cost of materials and labor to address pavement condition.

Figure Five: Annual Cost Increase in the Oil Region by Scenario

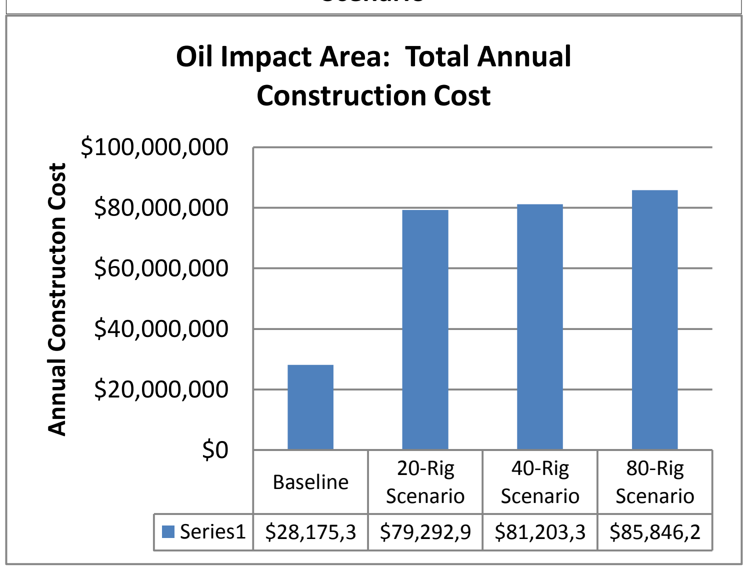
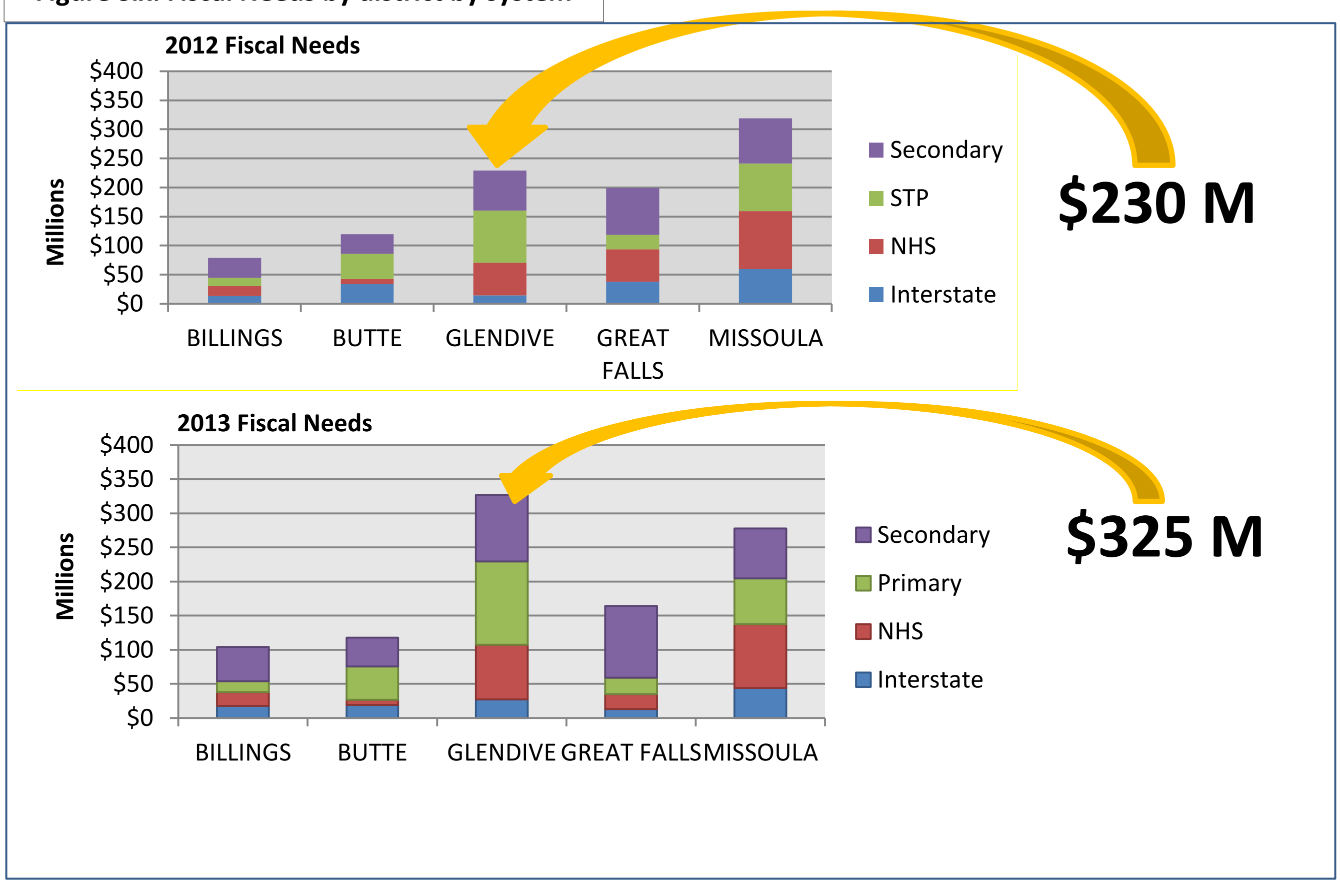


Figure Five shows annual highway construction costs for several different oil drilling rig scenarios. The number of new wells is dependent on the number of drilling rigs in Montana. The more drilling rigs, the more new wells and the greater the commercial vehicle traffic impacting the roads. It is important to note that it is highly unlikely that there will be more than about 20 ±10 drilling rigs in Montana. What is interesting is that the annual construction cost is essentially the same for 20 drilling rigs as it is for 80 drilling rigs. This is because most pavement treatments prescribed are reconstruction projects which would be built to handle the increase traffic regardless of the volume.

Figure Six shows the pavement needs in dollars by MDT transportation district and by highway system. MDT spends about $230 million per year in all districts. MDT project selection is based on providing the right treatment at the right time, in this case a pavement treatment. Under current funding levels, Montana's transportation needs will always be greater than the funding available. As seen in Figure Six, although the needs in the Glendive district have increased by about $100 million from fiscal year 2012 to 2013, the needs in the other districts are also substantial as well. This increase encompasses the entire district with current pavement needs.

Figure Six: Fiscal Needs by district by system



Any solution that simply diverts available statewide funding from other MDT districts to the Glendive district would dramatically increase the pavement needs in those districts within a short time.

Although the above analysis demonstrates the need for funding in the oil impacted region, it does not encompass the entire issue fiscally or programmatically. Adding to the fiscal impact of the above scenario are other costs such as increased capacity needs, bridge and safety considerations and other typical construction costs not captured. In addition, there are other considerations such as the workforce retention. There is great demand upon a relatively small, skilled workforce and turnover is high due to employees being drawn to the oil industry which typically pays more. MDT is currently studying these issues and working with other agencies.

Additional MDT Efforts to Date

In an effort to better understand the Bakken oil boom, MDT has made several research and planning efforts.

Initial impact estimate

In 2010, MDT Planning conducted an analysis to estimate the impact of increased traffic on Montana roads and highways. By looking at the well density in each township of an identified "hotspot area" we were able to identify potential commercial vehicle increases into low, medium, medium high and high projections.

Figure Seven: Example of a "hot spot" Area

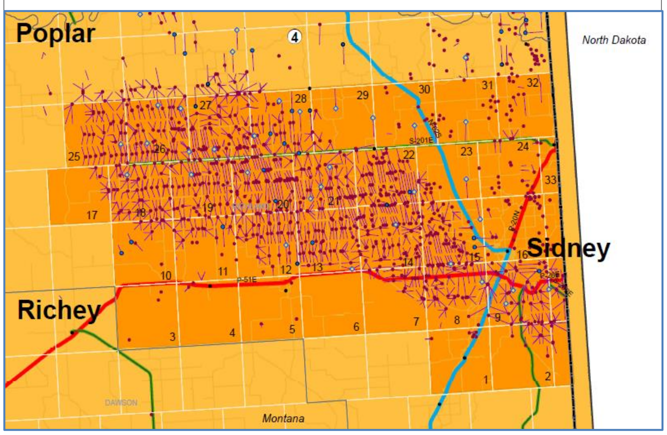
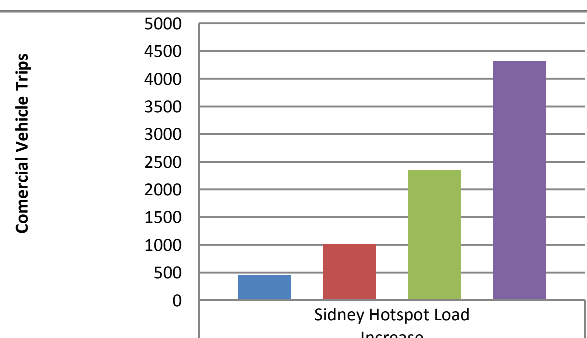


Figure Seven shows a hotspot area around Sidney. This area encompasses 32 townships. The number of wells in each township was identified and the townships were placed in rank order based on the number of wells. A quartile analysis was conducted to identify the low, medium, medium high and high oil well densities. Then the number of possible new oil wells was calculated for each township, based on the analysis. If the township had more wells than the projection, no new wells were added. New wells were assigned until the number of wells matched each quartile density for low, medium, medium high and high.

Based on the calculation of 2,300 commercial vehicle trips per new well, the number of additional commercial vehicles per well was calculated for each of the four quartile-density calculations.

Figure Eight: Initial Traffic Projections



	Sidney Hotspot Load Increase
Low Projection	454
Med Projection	1006
Med-high Projection	2350
High Projection	4315

Figure Eight shows the calculated commercial vehicle trip increases based on the analysis. Our initial estimate is based on the medium-high projection.

Although this effort generated the potential truck traffic increase in a specific area, it did not give projected increases by system, route, or reference location. The UGPTI was contracted to analyze and develop a routable highway system, conduct an origin destination study for inbound/outbound products and assign the truck movements to the highway system.

UPGTI study

The Upper Great Plains Transpiration Institute is conducting a study for MDT which predicts the increase in traffic for oil-related activities. The UPGTI was tasked to develop a Geospatial Information System (GIS) database, which could be used to project commercial vehicle traffic increases along specific routes and highway segments. This task included mapping major inputs to the oil extraction industry such as fresh water sources, water disposal sites, gravel and scoria pits, frac sand facilities and outputs such as oil, salt water, natural gas and natural gas liquids.

These were then used to develop trip origin and destinations and calculated projected traffic growth. These inputs were then used by the MDT pavement engineer to calculate the pavement costs described above. It is important to note that both the pavement engineer analysis and the UGPTI analysis only identify impacts due to the increase in commercial traffic from oil activity.

In summary the UGPTI study calculated the impact of the commercial vehicles resulting from the increased oil exploration in eastern Montana and North Dakota. This study did not address capacity expansion, only the impact of increased commercial vehicle traffic on existing pavements.

Here is a link to the completed UGPTI report:

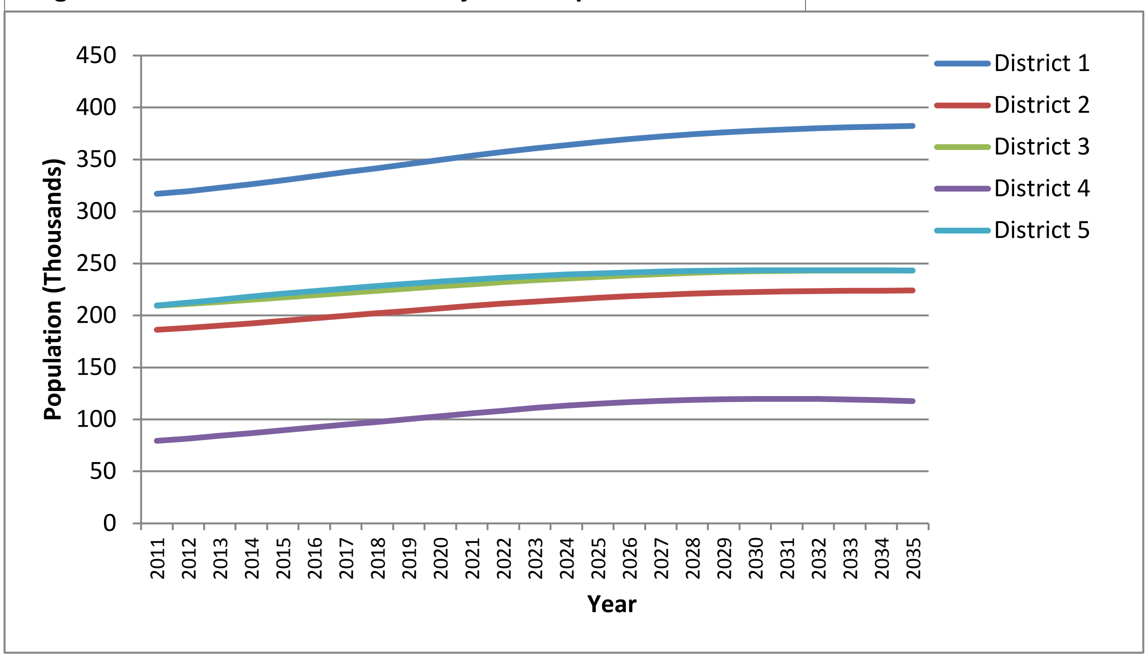
http://www.mdt.mt.gov/other/research/external/docs/research_proj/oil_boom/final_report.pdf

REMI

It is clear that with the oil boom a population increase is also likely, thus increasing the personal vehicle traffic which may also affect highway capacity in the oil region. In order to understand the impact of traffic growth, a study was conducted using MDT's licensed software – Regional Economic Model Inc. (REMI).

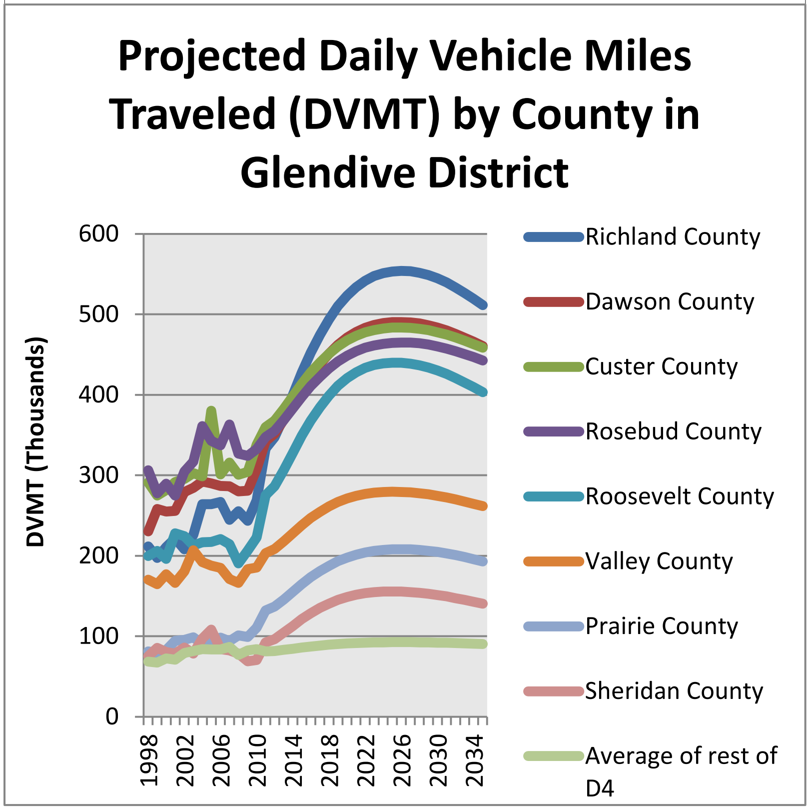
A REMI model was developed to estimate population growth in the oil region. Figure Nine shows population growth when the model is adjusted for the oil boom in eastern Montana. Although the Glendive district (District 4 in the figure) sees substantial growth, both the growth rate and the population are still significantly less than the other MDT districts.

Figure Nine: Initial REMI Model Projected Population Growth



Because vehicle miles travelled can be closely correlated to population growth, oil region growth in vehicle miles traveled can be calculated from the REMI population forecast. Figure Ten shows the projected VMT growth in each of the counties in District 4. Interestingly, the five counties with the greatest growth are the ones in the oil region or are associated with the interstate corridor supplying the region.

Figure Ten: VMT Increase by County



From the percent change in VMT and knowledge of existing highway mileage in the District, a percent change in Annual Average Daily Traffic (AADT) can be calculated. This allows the calculation of the total traffic increase in the region over the forecasted period, allowing for design calculations for capacity and surfacing.

Using MDT's TRED study, as a rule peak hour capacity for a rural 2-3 lane highway is 1500 vehicles/hour/lane. Put simply, if traffic volume in the peak hour exceeds 1500 vehicles per lane then the demand for increased capacity (additional lanes) is possible. From the UGPTI study there are five routes that could see a dramatic increase in traffic. Table two shows these routes, the peak forecasted AADT in the peak year along the entire corridor, as well as traffic volume in the peak hour. As can be seen in Table Two, no route rises to the peak hour threshold level, though this is a conservative estimate using the percent change in VMT. The Highway 200 to Sidney should be monitored closely during the peak period of oil extraction in the area.

Table Two: Projected (year 2025) Traffic by Route

Route	Peak AADT	Peak Hour Traffic Volume
Highway 16: Glendive to Sidney	5,900	483
Highway 16: Sidney to Culbertson	2,758	285
Highway 200: Sidney to Fairview	10,202	511
Highway 2: Culberson to ND boarder	3,514	184

The REMI analysis affords MDT the ability to forecast traffic increases based on population. Although there is a significant increase in AADT associated with the population increase, no routes are forecasted to encounter capacity issues at this time.

MT 16 Safety Audit

Corridor safety improvement recommendations were identified based on the MT 16 / MT 200 corridor safety audit workshop and crash analysis. The recommendations are both behavioral- and engineering-focused and are intended to mitigate safety trends and concerns identified during the audit process.

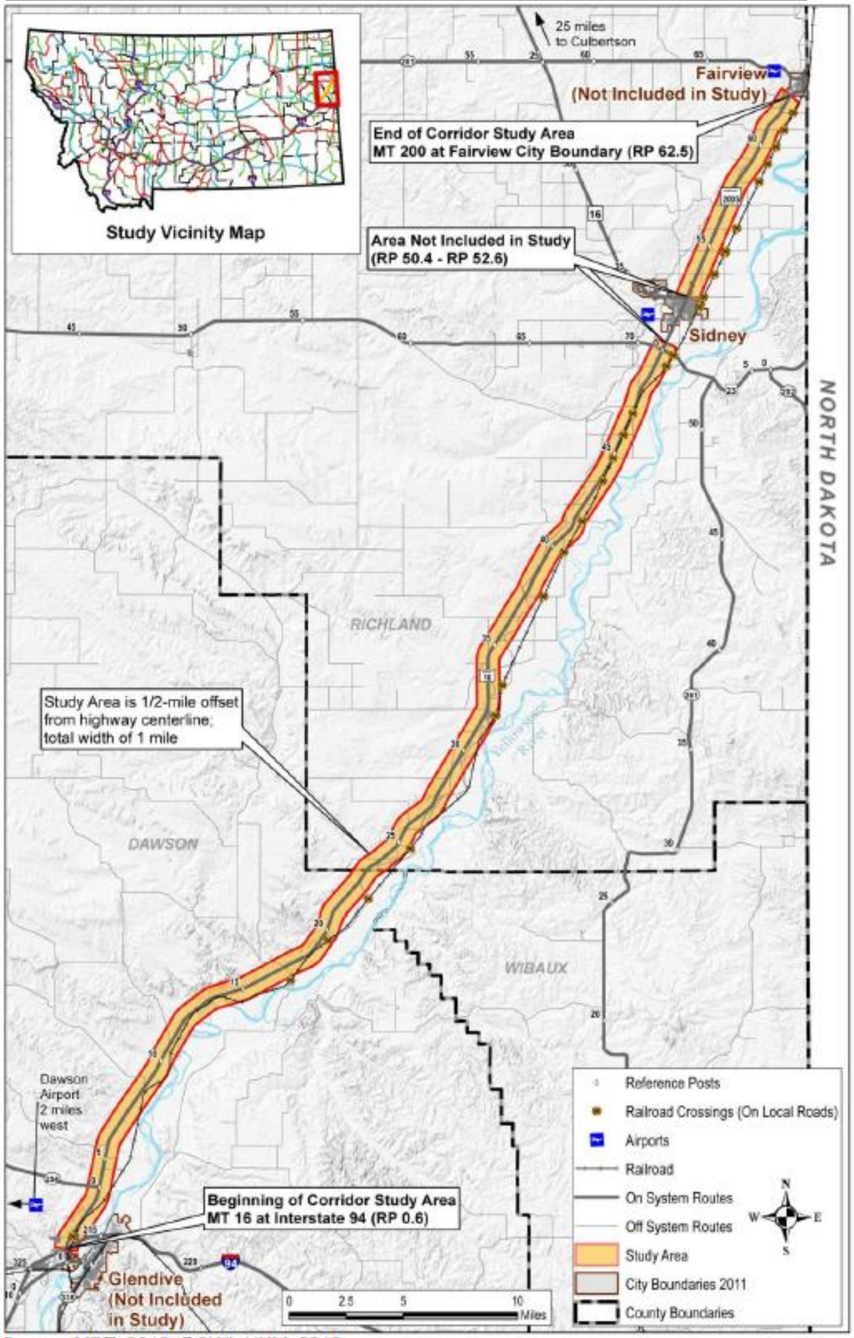
Three engineering studies are recommended to occur immediately: 1) a corridor wide speed zone study; (this has been completed and the results were presented at a public meeting) 2) evaluation of left turn phasing and overall signal operations at the signalized intersections in Sidney; and 3) evaluation of passing zones throughout the corridor (there is a project scoped for which will consider passing and turn lanes). The speed zone study recommendation is to assess the concern expressed regarding the differential in speed between the commercial vehicles and passenger vehicles resulting in large vehicle queues. The evaluation of left-turn phasing at signalized intersections is to address concerns of insufficient gaps in the traffic stream for left-turning vehicles. The passing zone evaluation is recommended to determine if additional passing opportunities at appropriate locations are justified given the volume of traffic and safety concerns identified. In addition to the engineering studies, additional engineering recommendations include updated signs; continuous centerline rumble strips and other improvements.

Education and enforcement are behavioral tools that are also relevant when discussing ways to mitigate safety concerns. Behavioral recommendations can consist of enhanced traffic safety education targeting high risk groups or actions, or increased enforcement activities among other things. Although the majority of the recommendations in this report revolve around engineering or infrastructure improvements, there is an opportunity to enhance current educational efforts. These enhancements would primarily be targeted to younger drivers, safely operating around large vehicles, and reducing impaired, fatigued, and aggressive driving.

MT 16 Corridor Study

The Montana 16 Corridor study area includes approximately 60 miles of the MT 16 / MT 200 corridor beginning just north of the I-94 Interchange in ends about at the Fairview city limits. The study excludes areas within the city limits of Glendive, Sidney, and Fairview and extends one-half mile on each side of the highway centerline throughout the corridor. Figure eleven shows the areas studied. Under this study the MT 16 safety audit—discussed above—were considered while conducting the corridor study.

Figure Eleven: MT 16 Corridor Study



This study concludes that:

1) Safety and operational conditions within the MT 16 / MT 200 corridor are rapidly changing as oil development continues throughout the region.
2) Corridor safety and operational concerns are best addressed through combined implementation of education, enforcement, and engineering solutions.
3) In addition to the improvement options, MDT will provide passing lanes and shoulder / centerline rumble strips as part of two programmed projects (30 km NE of Glendive – NE and SF 119 – Glendive Rumble Strips). Completion of these projects was completed in August 2012 and fall 2012, respectively.
4) If improvements are forwarded from this study, anticipated next steps may include conducting project level analysis, including studies to address access management, safety, signing and striping, speed, turn lanes, and passing lanes as funding and program priorities allow.

Improvement options were identified to address the corridor needs and objectives options include corridor-wide and location specific improvements to address; access management, roadway capacity, passing opportunities, traffic control devices and safety features, and turn lanes to name a few. Planning level costs estimate range from $500 for new signage to $177 million to provide a four-lane facility throughout the corridor.

Culbertson Corridor Study

Rapid growth in the oil industry has substantially increased commercial vehicle traffic through the Town of Culbertson and surrounding area. The purpose of this study was to identify cost-effective ways to address both transportation needs and safety concerns within the Study area. Figure Twelve shows the Culbertson study area.

Figure Twelve: Culbertson Corridor Study

The improvement options ranged from major reconstruction projects along US 2 and MT 16 to small spot improvement projects to address safety and operational issues. Based on implementation timeframes from short-term to long-term, thirteen improvement options on the existing networks of US 2 and MT 16 were recommended to be carried forward for further consideration.

Additionally, a single alternate truck route improvement option was advanced for future consideration, which would alleviate truck traffic through downtown Culbertson.

The cost estimate for these improvements ranged from installing traffic warning/detection devises from $10,000 to $20, 000 to create a four-lane on the east edge of the Culbertson Area.

Other Impacts

In addition to asset considerations, there are other impacts to MDT. In the Glendive District, MDT has experienced significant problems with employee recruitment and retention, specifically in the oil counties. Along with other state agencies MDT is playing an active role in pursuing and developing a statewide policy in response. The policy went into effect on 11/26/2012 and can be found at: https://montana.policytech.com/dotNet/documents/?docid=256&mode=view

Conclusion

Montana has seen the beginning of the oil impact and the Glendive District will likely continue to bear the brunt of development from oil exploration and extraction in North Dakota and Montana. From the REMI analysis and UGPTI study, MDT projects to see traffic increases by corridor, in the range of 5-200%. This will require MDT to sustain current funding and potentially demand additional focused capital investment of $1.7 billion over the next 20 years. Preventative maintenance efforts, adequate pavement designs, safety considerations and the challenge of retaining key staff will remain top priorities.

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