RAIL TO TRUCK MODAL SHIFT: IMPACT OF INCREASED FREIGHT TRAFFIC ON PAVEMENT MAINTENANCE COSTS

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16. Abstract
The loss of rail network infrastructure and rail service throughout the US has in most instances resulted in the modal shift of rail freight to truck. Rail freight converted to truck may have significant impact on pavement maintenance costs and activities due to the increased highway traffic volumes. This study investigated three short-line rail routes in Minnesota, Wisconsin, and the Upper Peninsula of Michigan, and determined the potential impact of diverting rail freight flows to truck. A freight flow analysis was undertaken to illustrate the new truck flows by highway classification and usage. The highway route current conditions and asset management techniques were documented. A pavement maintenance model was created to determine the incremental maintenance cost per ton-mile if additional freight moved over various classes of highway and the resulting impact on highway funding.

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3. EXECUTIVE SUMMARY

Considerable support in completing this report was provided by the regional railroads, shippers, and state government agencies. The railroad shippers were contacted by surveys and by telephone for data needed to determine freight flows. Traffic volumes, commodity characteristics, rail car type, route condition and average travel times were collected, along with probable rerouting if a rail connection was no longer available. The data represents cargo volume for 2004 and it should be noted that volumes vary annually and by commodity and volume. This study used freight volumes before a new Ethanol plant came on line in Minnesota. Future volumes for these short line segments may be different in the future.

The States of Michigan, Minnesota and Wisconsin were selected for this research project given the rural nature and regional profile of the area. One shortline railroad within each state was identified for in-depth analysis. The shortline carriers represented connections to all the Class 1 railroad connections in the Upper Midwest. The Escanaba Lake Superior Railroad, Wisconsin Southern Railroad, and the Twin Cities Western Railroad each participated in this hypothetical mode diversion analysis.

The three states use different maintenance strategies for pavements in the same condition and thus the maintenance costs vary by state. The states were surveyed for pavement conditions and maintenance activities that are typically employed. The unit maintenance costs were also collected for analytical purposes. States were surveyed on the expected service life for their respective maintenance activities on all types of pavements. Given increased volumes, in some cases, the best economic option may be to forgo maintenance on a particular pavement, as the incremental benefit for maintenance is not justified. In some cases rehabilitation may be the best economic option. The factors that were considered in the analysis include:

- Pavement conditions
- Design methods employed with associated assumptions
- Commonly used maintenance activities
- Maintenance costs
- Added life with a maintenance activity
- Interest rate in life cycle cost analysis

The economic analysis employed was the equivalent uniform annual cost (EUAC) for perpetuity. The EUAC method is the established economic analysis method for life-cycle cost analysis (LCCA) that the Federal Highway Administration recommends. The LCCA also included a sensitivity analysis of the variables such as costs, extended life expectancy of maintenance activities, and the discount rate. The LCCA employed a risk analysis approach due to uncertainty of roadway conditions and thus its life as well as maintenance unit costs.

The three case studies illustrated that in each location there would be a decrease in pavement life on sections of the highway that rail diverted truck traffic traveled. In addition, on the highways of Case Study (MN) it was found that existing highways may need structural improvements just to handle the increased weight.

- In Case Study (WI), a branch line of the Wisconsin and Southern railroad, it was found that 12 of 32 (37.5%) pavement sections studied will experience a shorter lifespan due to the increased truck traffic.
- In Case Study (MI) a branch line of the Escanaba and Lake Superior Railroad, it was found that 18 of 48 (37.5%) pavement sections studied will experience a shorter lifespan due to the increased truck traffic.
- In Case Study (MN), on the Minnesota Prairie Line a subdivision line of the Twin Cities and Western Railroad it was found that 10 of 14 (71.4%) pavement sections may need structural improvements and will experience a shorter lifespan due to the increased truck traffic.

Because of the varied and disparate methods used by the three state agencies in allocating funds for pavement maintenance and/or improvements, a common dollar amount was not computed. However, it was evident that expenditures would increase. State DOTs as a group believed that the increased pavement costs would not be substantial enough to take new or different actions. However along two of the three rail properties studied new ethanol facilities have been established and have substantially increased traffic density since the 2004 data time line. The ethanol shippers were adamant that they must have rail service to survive. Each facility consciously located on a short line railroad to assure connection to at least one Class 1 railroad.

Asset Management is an efficient and cost effective way of strategically targeting resources. The guide on asset management prepared by Cambridge Systematics for the National Cooperative Highway Research Program (NCHRP) defines transportation Asset Management as a strategic approach to managing transportation infrastructure.

In Case Study # 1 of a branch line of the Wisconsin and Southern railroad it was found the Wisconsin DOT has not integrated maintenance expenditures into the programming and planning process for Asset Management. They use data based tools to make decisions, but only to a limited extent. Their maintenance program is centered on maintaining a safe and serviceable roadway. When presented with the estimated increase in truck traffic that might occur with the rail closure the WisDOT agency concerned with Asset Management concluded that no additional maintenance expenditures would be required to maintain each of these road segments cited in the study at the level these roads are maintained today.

In Case Study # 2 of a branch line of the Escanaba and Lake Superior Railroad, Michigan Department of Transportation (MDOT) under Act 499, written into law in 2002, mandates the practice of Asset Management and established the 11-member Transportation Asset Management Council (TAMC), which reports directly to the State Transportation Commission. The MDOT representatives believed that there would be no impact on the Asset Management program due to the shift in traffic from truck to rail for the following reasons. All Michigan routes cited in the study have 164,000 lbs weight limit with 7 axle trucks. The axle loading is much lower that the US average. They felt that the additional amount of trucks on the rural road, while significant and nearly double the current volume, would not be significant enough to affect the maintenance budget as these roads are not near capacity. If the trucks are going to/through Wisconsin, then they would be hauling lighter loads. They would split the loads before entering Wisconsin to two 80,000 pound loads. The total increase in truck traffic would be about 2% which would have minimal effect.

In Case Study # 3 of the Minnesota Prairie Line, a subdivision line of the Twin Cities and Western Railroad, the research team was unable to obtain viable information on how Asset Management by Minnesota DOT (Mn/DOT) would be impacted by the pavement damage. However, Mn/DOT has some of the best freight metrics in the spectrum of State DOTs and changes in pavement condition are tracked locally.

The study found that the additional truck traffic generated by the closing short line railroads cited would result in shortened pavement life. The DOT Asset Management process in current use would not reflect this shortened pavement life.

This study was not tasked with examining the potential impact of increased truck traffic on bridges due to the specialized nature of bridge construction and funding levels for this study. Bridges may be the weak link in a highway system, especially on rural roads. A total impact analysis should include the potential impact on bridges on the selected routes.

Asset Management programs are responsive to changes in traffic growth and tonnage. Yet no mechanism exists to inform or consult with State asset management program managers when short line investment or disinvestment strategies are developed. Most asset management programs at the State level have no means to monitor new plant or facility site developments until after the traffic patterns change.

Additional costs beyond pavement damage can occur from the increased truck traffic including: air pollution, increased congestion, additional hazardous cargo on highways, higher freight rates, and adverse economic impacts to businesses and communities. This study was not tasked with capturing that impact but it can be assumed that there would be impacts in these areas of concern. This is an area that merits further research, as the costs of these factors may exceed the cost of pavement damage.

The economic reality is that transportation costs for low value agricultural products greatly influence market share and market reach. Low transportation costs allow a wider market penetration and often allow products to be marketed in more populated areas. High transportation costs will limit, or in some cases prohibit, entry into new or potentially more lucrative markets. An increase in total logistics costs, which includes transportation, handling, storage, inventory in transit, insurance, repositioning of trucks, and higher freight rates could divert lower value products to entirely new markets where profit margins may be lower. If the truck transportation rates become a significant portion of the total product cost, grain moved to this market or the ethanol being shipped out, may not be competitive with other regions where transportation is less expensive. Ultimately a loss of rail access could lead to plant closures or businesses failures. While not measured in this study, the economic impact of market shifts or loss of market share for the regions served by the short lines could be significant.

The three state DOTs represented in this study focused on the State owned roads in their state. Most rural roads which serve the study areas, were not at capacity. Therefore impact analysis was somewhat inconclusive. The roads analyzed had sufficient capacity to handle more truck traffic. Pavement maintenance will increase as the truck traffic increases. The state viewpoint is frequently mandated by state law. In actual practice the greatest adverse impact of congestion will occur in urban areas (such as Minneapolis and Madison) as the diverted freight moves from origin to destination through these regional hubs. One of the drawbacks to state focused data is the inability to capture the entire impact along the complete route of diverted freight from short line railroads.

Researchers also observed that infrastructure improvement in rural areas often breeds additional growth and market success. In Minnesota, a rail improvement program helped fund track improvements for an ethanol plant. As a result of this infrastructure improvement, other businesses on the same rail segment began to use more rail transportation. As freight traffic grew, service improved. Short lines can be an important incubator for new businesses with transportation cost constraints.

4. INTRODUCTION AND METHODOLOGY

4.1. Background

This research project focused on Rail to Truck Modal Shifts and the impact these changes have on pavement structures. A parallel study entitled Evaluation of Shipper Requirements and Rail Service for Northern Wisconsin and the Upper Peninsula of Michigan was conducted during the same study window. The second study, which was federally funded, focused on helping rural users preserve existing rail services. Researchers from UW-Superior and Michigan Tech were involved in this study. The researchers in the study engaged shippers, State DOTs, and railroads in the data collection and traffic flow documentation process.

During the period of the study there were twelve freight railroads in Wisconsin, twenty-five railroads in Michigan, and eleven short-line, five regional, and four Class 1 railroads in Minnesota that provided key transportation services to agriculture, manufacturing, and other business customers. Michigan, Minnesota, and Wisconsin recognize the importance of preserving short line rail service. Line abandonments, railroad upgrades and track sales were all in process during this research project, which provided a rich background for the study team.

The question this study attempts to quantify is: *How is the highway "damaged" as a result of mode diversion, as a result of the loss of short line railroad service?* Without adequate investments in railroad infrastructure, more freight will move by truck, resulting in increased pavement damage and highway maintenance costs. Many rural roads are not designed to accommodate the volume of traffic which currently moves by rail to and from the area the roads also service. Additional costs beyond pavement damage occur from the increased truck traffic including: air pollution, increased congestion, additional hazardous cargo on highways, higher freight rates and adverse economic impacts to businesses and communities. These costs may be considerable, but will not be addressed in this study.

Short line and Regional railroads are defined by Federal Railway Administration guidelines. Regional railroads operate at least 350 miles and generate a minimum of $40 million dollars gross revenue. There are two classifications of a Short Line railroad. A short line may be a local carrier that operates 350 miles or less. A second category of Short Line Railroad is defined as a Switching or Terminal railroad that typically shuttles or transfer cars between Class 1 connections and local shippers. Frequently short line railroads are created when a Class 1 railroad sells a segment of track. This rationalization is often made because a rail line segment may no longer meet the Class 1 carriers' minimum volume threshold, business plan or network strategy. Today's short segments can be tomorrow's short line railroads. Recent changes to certain short line routes and terminals make the question even more pressing. Additional rail freight demand, coupled with a decrease in line capacity could significantly impact the pavement in many rural and urban settings.

This study identified the additional incremental pavement maintenance costs that could be expected as a result of additional freight traffic that shifted from rail moving over the highways in these three states.

4.2. Overview of the Research

The research team conducted three case studies of representative short line rail segments in Wisconsin, Michigan's Upper Peninsula, and Minnesota and assessed impacts based on those case studies. The researchers identified freight volumes from 2004 which moved on the rail segments and estimated the corresponding trucking volumes if this rail traffic were diverted to nearby roads. The team worked in conjunction with the rail study Evaluation of Shipper Requirements and Rail Service for Northern Wisconsin and the Upper Peninsula of Michigan which was completed in 2006, as well as with rail and state DOT representatives. A logistical freight flow analysis documented the increased truck movements by route if a rail line were lost. The condition of the highway segments which would be impacted by potential line abandonment, were documented. The research team assessed where significance warranted, the asset management implications and impacts of these modal shifts from those states actively using asset management. State DOT pavement maintenance models were used in determining the incremental pavement maintenance cost per ton-mile when additional rail freight is diverted to highway. The analysis investigated pavement maintenance implications across various classes of highways.

4.3. Determine Case Study Rail Routes

The researchers reviewed literature, State DOT traffic and volume flow data, and Transearch freight data, shipper associations input, and prior studies to prepare a suggested list of rail lines for case studies. The team then met with railroad representatives and public agencies from Michigan, Wisconsin, and Minnesota to determine which three railroads were best suited for case studies. Factors that were important to line selection included availability of data, willingness of participants, regional freight flows, commodity mix, and state regulations. Parameters used in the selection process included: volume, traffic flows, regional diversity, product mix, population density and potential impact on state, county, local and interstate highways. Efforts were made to include examples in all three states with potential multi-state freight flows. The cross border flows were done to gain an idea of the impact on trucking flow because the difference in state truck weight limits. Seven preliminary rail routes were suggested (see Table 4.1) and sent to state DOT personnel for review. Rail companies were contacted to ensure active participation. The list was then narrowed to three based on the input from state DOT representative, rail company participation, and traffic.

Table 4.1 - Initial Suggested Case Studies

Case Study	Route	Owner	States Impacted
#1	Channing, MI to Green Bay, WI	Escanaba and Lake Superior	MI and WI
#2	Saulkville, WI to Kiel, WI	Wisconsin Southern Railroad	WI
#3	Hutchison, MN to Wayzata, MN	Hennepin County Regional Railroad	MN
#4	Hoot Lake, MN to Moorhead, MN	Otter Tail Valley RR	MN
#5	North Branch, MN to Hinckley, MN	St. Croix Valley Line	MN
#6	Janesville, WI to Monroe, WI	Wisconsin & Southern Railroad Co	WI
#7	Madison, WI to Watertown, WI	Wisconsin & Southern Railroad Co	WI

4.4. Final Case Study Selection

In spring of 2006, research team members met with relevant state Department of Transportation representatives and rail company representatives. Based on the input received, the research team selected three short line railroads for the case studies (see Table 4.2), including one route that was not considered in the original list of suggested rail routes.

The rail lines were selected based on input from DOT members, the review committee, and the availability of data. The routes were selected because they included parallel truck routes on interstate highways, crossed state borders and served a wide variety of products which expanded truck types need to replace rail cars. One of the significant developing issues was the increased rail traffic due to the expansion of Ethanol production in rural areas. A rail line was selected that served grain and Ethanol producers.

Table 4.2 – Final Case Study Selection

Case Study	Route	Owner	States Impacted
#1	Channing, MI to Green Bay, WI	Escanaba and Lake Superior	MI and WI
#2	Janesville, WI to Monroe, WI	Wisconsin & Southern Railroad Co.	WI
#3	Appleton & Granite Falls, MN to Hopkins, MN	Twin Cities and Western Railroad & Minnesota Prairie Line	MN

4.5. Data Collection

The research team gathered relevant traffic flow data for the selected carriers. Data from shippers, railroads, and DOTs was used, including, but not limited to, data on types of traffic (local, interline, overhead and/or international origins and destinations). Traffic volumes, commodity characteristics, rail car type, route condition, and average travel times were collected. Data is critical to the success of the study, yet is often difficult to capture with enough detail to make simple conclusions. Shippers are often hesitant to share shipping data if it will compromise competitive trade intelligence. Railroads are careful when they discuss route closure decisions in order to not compromise their political position if line abandonment is a consideration. Transearch data and other national databases often undercount rail shipments, and are even less accurate when it comes to short haul movements. Yet for this study we were able to gather enough sample data to accurately identify primary routes and lanes for the dominant products. Key shippers were very helpful but were unable to disclose certain competitive data elements.

Part of the solution utilized by the researchers to capturing the elusive nature of rail and traffic volumes was to use a hands-on approach with site visits to short line rail offices. The team felt that the most accurate method of determining rail flows was to go to the rail company and obtain the traffic data from them. The researchers followed up with phone interviews with the larger shippers using that railroad in order to get an idea of the shippers' logistics activities and preferences. Phone interviews were also conducted to supplement and clarify data collected from visits with the short lines. Class 1 and State DOT rail samples were used to validate the primary research effort. A survey instrument was carefully constructed to ensure accurate and specific information could be collected. In support of this goal, a sample survey was constructed for a pilot distribution. The test survey was successful and adequately captured variations in shipper types and business patterns. The final survey was designed with the specific intention to capture consistently reported data elements. Emphasis was placed on using clearly understood terms and highway conditions when looking at specific track and road conditions in different states and geographic regions. Members of the team have used this approach successfully in a variety of research projects, including the MRUTC project on Strategic Planning and Asset Management and the MRUTC project Twin Ports Intermodal Freight Terminal Study.
In addition, the road network and condition of each of the roads that would be used as an alternative to rail were obtained from each of the State DOTs. This data included average speeds on the roads, speed limits, grades, weight limits, seasonal restrictions, and other elements suggested by the MRUTC oversight committee and state department of transportation staff.

4.6. Logistical Flow of New Truck Freight

Class 1 railroad carriers are optimizing methods to handle growing global trade volumes, and are focusing on taking full advantage of their network capacity by running high utilization unit train blocks moving end to end across their network. The changes the Class 1 carriers are implementing are having adverse impacts on short line and rural shippers in many areas nationally. In the study region, shippers have seen a reduction in services in many areas served by secondary railroads (short lines). Rural shippers, faced with limited options due to declining rail service and limited car availability, have taken their case to their government representatives. The need to ship the former rail freight (such as logs) on highways, has resulted in the introduction of new state truck size and weight legislation, throughout the Upper Midwest. On March 22, 2006, Wisconsin passed into law 2005 Assembly Bill 678 which raised truck gross vehicle weight (GVW) to 98,000 lbs for forest products traditionally carried by short line railroads. This new legislation may have significant impact on highway pavement conditions. This law limits distance to travel and type of product, is not valid on interstate highways or highways or bridges with posted weight limits, and does not come into effect until 2011. It may have limited future impact on a few Wisconsin roads in the case study. Because of the five year time frame until enactment, it was not evaluated or applied in this research.

In each case study, the team determined the least cost alternative highway routes for the logistical movement of regional freight if a modal shift were to take place. Truck routing decisions were based on origin destination pairs, travel time, truck operation parameters, truck size and weight laws, and other truck user costs. Data available from prior regional and national studies, along with data gathered from ongoing research, provided the benchmarks for logistical analysis. Modal conversion of freight and routing models were developed by team members for the MRUTC Twin Ports Intermodal Terminal Study (Project 02-06) and elements of that methodology were used in this research.

Freight modes may be influenced by a number of factors such as transportation cost, service, terms of payment, availability of trucks and drivers, quality, condition and availability of rail cars and trucks, highway weight limits, length of haul and physical freight characteristics. Packaging requirements, physical plant/distribution center characteristics, origin and destination loading and unload characteristics are also often significant factors in mode selection. These factors were included in the cost section of our modal shift design and influence the decision on how and when freight will move.

Cost historically has been the primary factor which influences mode selection. For raw materials, transportation cost can represent a large percentage of the final cost of goods sold. In the past five years, with escalating fuel prices, soaring insurance rates and new engine emission standards, trucking costs have increased substantially while carrier availability and driver shortages have reduced trucking capacity. In a soft economy, many companies have looked to rail and intermodal shipping as a way to reduce overall transportation costs. Service and reliability, however, are often just as important as freight rates and many of these shippers are concerned about the rail companies service levels.

Service is a complex term which has different meanings and which relates to the availability of equipment, speed of shipments, and consistency of performance. The term service may be used generally to indicate whether a “service offering exists”; in this situation we sought shippers who currently use rail service. It is typical to find rail shippers who have three day per week switching service. The word “service” used by buyers and receivers often refers to consistent performance and reliability. Service considerations were included in our modal shift decision process

State DOT designated truck routes and highway weight limitations often dictate routes freight carriers must travel. Roads which parallel the short line rail route may not be feasible if a heavy load does not meet the truck size and weight restrictions. During the research process, Wisconsin changed its weight limits and Minnesota actively considered changing weight limits. Out of route and shipment circuitry were noted in our modal shift decision process. When data on highway user speeds, costs, etc. are limited, we supplemented the data with information from a variety of sources concerning highway user costs including those in the list of references.

In this research effort the team used the data collected in the survey and company interview process to map new truck freight flows. The flows identified in this exercise were used in determining the highways for the new truck traffic so that highway impact could be evaluated.

4.7. Determine Incremental Pavement Damage

The objective of this research was to assess the incremental pavement damage due to modal shift from rail to truck in the selected case studies. The estimated damage was based on the impact of the freight flows generated in the rerouting process. It is important to note that the three states use different pavement design methods and the routes have pavements at varying stages of their design lives. The Wisconsin DOT uses the 1972 AASHTO Design Guide for New and Rehabilitated Pavements, while the Michigan DOT and Minnesota DOT use the subsequent AASHTO updates of 1986 and 1993, respectively. Utilization of pavement design practice, currently in place in the selected states, was employed in this study. In some instances, the diversion of freight may occur over multiple routes and could include pavements in multiple condition states. The impacts of the additional loading and vehicle miles traveled (VMT) were considered over the range in pavement conditions.

The three states may use different maintenance strategies for pavements in the same condition and thus the maintenance costs vary by state. The states were surveyed for pavement conditions and maintenance activities that are typically employed and the associated maintenance unit costs. States were also surveyed on the expected added service life for their respective maintenance activities on all types of pavements. Bausano et al (2004) recently completed research work determining the life extension of certain maintenance activities on flexible and composite pavements. The survey results for extended life were compared to the research findings of Bausano et al for consistency. In some cases, the most economical option may be to forgo maintenance costs for a particular pavement, as the incremental benefit for maintenance does not exist, and rehabilitation may be the best economic option. The factors that were considered in the analysis include:

- Existing pavement conditions
- Design methods employed with associated assumptions
- Commonly used maintenance activities
- Maintenance costs
- Added life with a maintenance activity
- Interest rate in life cycle cost analysis

The economic analysis employed was the equivalent uniform annual cost (EUAC) for perpetuity. The EUAC method is the established economic analysis method for life-cycle cost analysis (LCCA) that the Federal Highway Administration recommends. The LCCA also included a sensitivity analysis of the variables such as costs, extended life expectancy of maintenance activities, and the discount rate. The LCCA employed a risk analysis approach as there will be some uncertainty of the roadway conditions and thus its life as well as maintenance unit costs.

4.8. Application of Asset Management Techniques

The guide on asset management prepared by Cambridge Systematics for the National Cooperative Highway Research Program (NCHRP) defines transportation asset management as *"a systematic and strategic approach to managing transportation infrastructure."* The concept of asset management covers a very broad range of activities and functions. It includes investment decisions, prioritization, and relationships with different stakeholders and partners, long range transportation planning, capital project development, etc. States and counties which have an Asset Management plan in place may be able to mitigate some of the costs of increased highway damage through careful planning and targeting of investment resources.

The research team held discussions with each DOT about the utilization of their current Asset Management techniques. The objective was to determine how DOTs impacted by the modal shifts predicted in the case studies, would deal with forecasted increased pavement damage using Asset Management techniques employed by that state. With this information, an estimate of potential impact on maintenance costs was made.

A portion of the increased truck traffic might occur on county roads. This posed an additional complication, since county maintenance personnel may not be using Asset Management to schedule maintenance activities. However, it turned out that county roads were not part of the proposed logistical routing to the degree to justify discussions with county officials.

Whether on state, county, or locally maintained roads, several outcomes needed to be considered. One is that increased maintenance costs are added to the highway budget and are used to keep the roads at a satisfactory level of performance. Another is that the maintenance budget is fixed and decisions have to be made on allocating scarce maintenance funds. Maintenance funds could be shifted from other roads, leading to an overall deterioration of the road system in the area. Alternatively, the level of maintenance on the roads affected by increased traffic could stay the same, leading to an accelerated deterioration of those roads. Thus, the impact on the road system may be different than estimates based solely on increased maintenance costs.

4.9. A Decision Process for State DOTs and Regional Planners

Based on the results of the case studies, estimates of the amount of highway damage and incremental maintenance costs and overall system performance, levels were made to determine the true total cost of a modal freight shift from rail to truck. In addition, we analyzed the results of the three case studies to better understand how re-route options might be arrived at. There are five freight diversion outcomes that can affect the impact on highway maintenance costs and other environmental impacts. Shippers could decide to:

1. Remain with rail, where abandonment does not occur
2. Divert shipments to truck
3. Seek new customers and/or markets
4. Move or relocate their business to a rail served facility
5. Investigate a rail transload option

Each outcome has an impact on highway maintenance costs, as well as the route selected within a region. Our decision process shows the various inputs and associated outcomes of modal shifts on State DOT highway maintenance budgets.

Scenario 1 – Remain with rail. This situation usually requires additional investment to upgrade or maintain the short line. It may be a situation where the connecting carrier changes service or minimum business thresholds. The result is that funding for infrastructure must be increased and users must increase volume or perhaps change shipping protocols.

Scenario 2 – Shipments are diverted to truck. This often increases total transportation costs and impacts shipping network and customers.

Scenario 3 – If rail service is interrupted, shippers may have to identify new markets and customers. This often results in lower margins because of the volume and availability of locally competitive sources of raw materials.

Scenario 4 – For shippers who base their manufacturing model on rail transportation, these users are often forced to relocate to an area with rail service.

Scenario 5 – Transload or trans-shipment models are becoming more widely used by shippers who do not have rail service. This often results in more handling and additional costs if product has to be taken to another shipping location to access rail service.

5. RAIL ROUTES CASE STUDIES

5.1. Wisconsin and Southern Railroad (WSOR)

5.1.1. Case Study 1

The rail line selected for this case study is considered a subdivision or a line segment connecting Janesville to Monroe, WI which is currently served by the Wisconsin and Southern Railroad (WSOR). The identification of current freight volumes on this rail segment were identified and the corresponding trucking volumes were estimated. This railroad is unique because the state of Wisconsin owns the rail line and has hired WSOR to be the railroad operator. A freight flow analysis documents the increased truck movements by route if this rail line was lost and freight moved to the same destinations by truck. The current condition of the highway segments, which would be impacted by the potential line abandonment, is documented in terms of rutting, roughness, faulting, and cracking, (alligator, transverse, and longitudinal). The pavement design method currently used by the Wisconsin Department of Transportation, "WisPave" a software utility comprised of pavement design and life cycle-cost analysis, was used to measure the pavement's ability to handle the additional trucks on the highway in terms of structural number for flexible pavements and thickness for concrete pavements.

5.1.2. Background

Twelve freight railroads in Wisconsin offer key transportation services for agriculture, manufacturing, and other rail based customers. The state of Wisconsin recognizes the importance of preserving short line railroads. Without adequate investments in railroad infrastructure, a greater amount of freight will move by truck, taking a toll on pavements that were not designed to accommodate this traffic and weight. Additional costs beyond pavement damage occur from the increased truck traffic including: air pollution, increased congestion, additional hazardous cargo on highways, higher freight rates, and adverse economic impacts to businesses and communities.

This case study identifies the impact on pavements that could be expected as a result of additional freight traffic moving over the highways in the state of Wisconsin. This information is needed to help State DOTs evaluate how and where to support rail preservation. This research identifies current freight volumes on the rail segment(s) and the corresponding trucking volumes if this rail traffic were diverted to nearby roads. A logistical flow analysis was done and documents the increased truck movements by route if the subdivision of the WSOR rail line was lost. A comparison of the pavement structural design is included taking into account the increased traffic volumes.

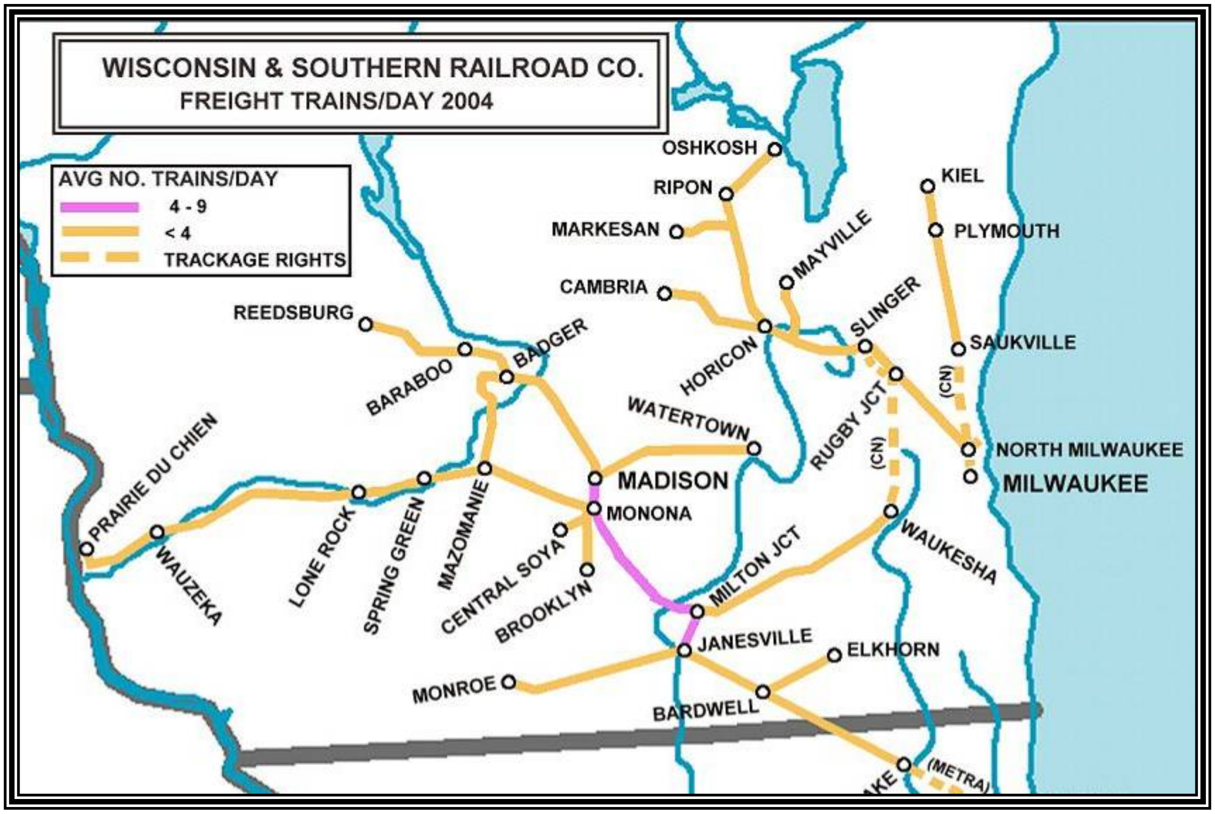
Wisconsin has recently seen a dramatic change in rail service since the Wisconsin Central Railroad was sold to the Canadian National. The Wisconsin Central gathered traffic from Wisconsin customers, and delivered this freight to larger railroads that serve Chicago to be delivered nationwide. The Canadian National purchase of the Wisconsin Central created a network which links deep water ports in British Columbia to Chicago and other Midwestern cities. This has resulted in both increased market access and also much more rail congestion and competition for rail assets for shippers in Wisconsin. The rail business model in Wisconsin shifted from one of gathering traffic for hand off to other larger carriers, to a new model where Wisconsin has become a traffic bridge between British Columbia and Chicago. This traffic bridge is reaching capacity and the long haul traffic is pushing the short line traffic off the network.

Map 5.1.1 – Wisconsin DOT Railroad Map

5.1.3. Case Study 1 Route Selection

This case study considered the closure of a subdivision of the short line Wisconsin and Southern Railroad which operates in the southeastern section of southern Wisconsin, as shown in Map 5.1.2. This railroad serves farming communities and medium sized urban areas. The rail route runs near interstate highways as well as state highways. The Monroe subdivision of the WSOR rail road connects to the Class 1 railroad Union Pacific in Janesville, Wisconsin. This subdivision was selected in part, because it serves an outlying area of southern Wisconsin where the closure of the subdivision would not provide rail users on the route with other rail options. Janesville, Wisconsin is also home to an auto assembly plant.

Map 5.1.2 – Wisconsin & Southern Railroad



In this scenario, three specific WSOR railroad routes were considered: Monroe to Madison (see Map 5.1.4), Monroe to Milwaukee (see Map 5.1.5), and Monroe to the Illinois border (see Map 5.1.6). If this short-line railroad were to cease operating along these routes, a modal shift from rail to highway would occur, thus resulting in an increase in truck traffic on the noted highways. Maps 5.1.7 through 5.1.11 represent five primary routes that were identified based on surveys of shippers. Map 5.1.7 illustrates the route identified from surveying shippers from Monroe to Madison, Wisconsin. Map 5.1.8 shows the trucking route from Monroe to Milwaukee, Wisconsin. Map 5.1.9 shows the truck route from Monroe to the Illinois border. Maps 5.1.10 and 5.1.11 show two alternative truck routes from Janesville to Madison.

5.1.4. Data Collection

Relevant traffic flow data for the selected carriers was gathered. Data from shippers, railroads, and DOTs was used, including, but not limited to; data on types of traffic (local, interline, overhead, and/or international origins and destinations). Data related to pavements such as pavement thicknesses, hot mix asphalt (HMA), concrete, base, subbase, material characterization, subgrade soil type, existing truck traffic, and the existing condition of the pavement were collected from the Wisconsin Department of Transportation. Typical subgrade modulus values (subgrade support value or modulus of subgrade reaction) were selected based on the American Association of State Highway and Transportation Officials (AASHTO) classification of the subgrade soil type. The subgrade soil support values used were from a previous WisDOT research project (Testing Wisconsin Asphalt Mixtures for the AASHTO 2002 Mechanistic Design Procedure) in which the AASHTO soil designation was known. The subgrade support value was used in the WisPave pavement design guide simulations for flexible pavements and the modulus of subgrade reaction was used for rigid pavement design.

Table 5.1.1 - Wisconsin Southern Railroad Stations

Wisconsin Southern Railroad Stations Case Study 5.1	Distance Between Stations*
Janesville, WI	0
Hanover, WI	17 miles
Orfordville, WI	4.6 miles
Brodhead, WI	6.3 miles
Juda, WI	6.5 miles
Monroe, WI	9 miles
End of Track	1.5 miles
Total Miles of Track	**44.9 miles**

5.1.5. Logistical Flow of New Truck Freight

The largest user on the line, an ethanol shipper, was interviewed to determine how the loss of rail service would impact this company. The ethanol plant is a high volume facility and the consideration of a transload operation was out of the question due to the volumes produced here and the recent development of this facility. The option to move or relocate was not feasible given the recent capital expense to build this plant. This shipper indicated that ethanol users on the east and west coast, in heavily populated areas, pay the most for ethanol. If rail service were lost, the shipper would be forced to find new markets that were not served by rail. The top three “new markets” accessible to this plant would include Madison, Milwaukee, and Rockford, IL. Freight flows on this highway network are already high, with many competitive ethanol producers in the region. It was noted that these markets pay a much lower rate for ethanol than the current East and West Coast customer mix for this shipper (currently served by rail). These three destinations are not far from the ethanol plant. Truck routes to these new markets were mapped to identify the routes which this product would likely move.

5.1.6. Pavement Design

The objective was to assess the incremental pavement structural design due to modal shift from rail to truck in the selected case study. The design was based upon the flows generated in Maps 5.1.7 through 5.1.11. The diversion of freight is anticipated to occur over multiple routes and includes 32 pavement cross-sections (designs). One assumption inherent when using the WisPave pavement design software is that it does not take into account the current condition of the pavement structure; it assumes that it is a new pavement structure. The WisPave software does not take into account reliability and the change in present serviceability index which is used to trigger rehabilitation and maintenance activities.

To determine the additional number of trucks, the total tonnage during the most recent year of shipping on the railroad was measured and then divided by 48,000 lbs. While gross vehicle weight is limited to 80,000 lbs on the interstate system, it is assumed that the tare weight of the truck and trailer equipment averages 32,000 lbs. The number of trucks was estimated based on a straight tonnage conversion methodology. Actual shipments may be somewhat higher based on specific order quantities or production limitations. It was calculated that there would be an annual increase of 19,077 trucks on the five routes described in section 5.1.3., listed above. However, the trucks were distributed along the routes according to the conversations with the various shippers and the use of reasonable assumptions when needed. It was assumed that the additional trucks would be type 3S-2 trucks (Class 10 trucks). The expansion of the ethanol plant in Monroe, Wisconsin, would likely in the future significantly increase cargo movement for this case study.

Table 5.1.2 summarizes the traffic data in terms of average annual daily traffic (AADT), growth factor, AADT at design life, percent of trucks for each route, and in some cases the county where the traffic level changed. Included in Table 5.1.2 is the new traffic if the short line railroad were to close. Two simulations for each route were performed for the existing traffic and the new traffic if the short rail lines closes.

Typical (default) values for layer coefficients were selected when using the WisPave pavement design guide for the surface, base, subbase 1, and subbase 2 layers. Tables 5.1.3 through 5.1.7 show the simulations for each route and pavement structure on that route. On the average, the new structural number (SN) is 0.021 units greater than the existing SN for flexible and composite pavements. For rigid pavements the new pavement thickness 0.044 inches greater than the existing pavement thickness. There is a tendency for the as built SN or pavement thickness to be over-designed providing a much greater as built design versus the as designed. For the flexible and composite pavements, the average SN for the as built versus the required SN is 0.493 units greater than the required SN. For rigid pavements the average as built pavement thickness is 0.183 inches greater than required pavement thickness. Since the majority of the pavements are over-designed, an increase in traffic may not affect the pavement in term of rutting, cracking, or faulting.

However, for those pavements that are under-designed or designed at optimum, an increase in traffic may accelerate the damage to the pavements in terms of rutting and cracking for flexible pavements and cracking and faulting for rigid pavements. Nonetheless, 12 of the 32 pavement sections will experience a shorter life with the additional modal shift freight than their as-built life, primarily on two of the five routes.

5.1.7. Summary

Rural shippers are facing limited options when rail service declines and/or railcars are no longer available. To help minimize the truck cost impact, many shippers are lobbying for increased truck size and weight laws. This new legislation may have significant impact on highway pavement conditions in these rural areas. It was calculated that there would be an annual increase of 19,077 trucks added to the highway system if the Monroe subdivision of the WSOR was closed.

The pavement conditions considered in Case Study 1 are the changes in SN and concrete pavement thickness due to the increase of truck traffic in the highway system in the state of Wisconsin. The results show that there is an increase in SN and concrete pavement thickness due to the increase in traffic on these routes; however, these pavements have as built SNs or concrete pavement thicknesses greater than the existing and potential future SNs or concrete pavement thicknesses. Twelve of the thirty-two pavement sections, primarily on two of the five routes, will experience a shorter life with the additional modal shift of freight than their as built life. For those pavements that are built at the optimum design, they should be monitored closely to determine if they will deteriorate quickly due to the increase in truck traffic. Furthermore, the greatest impact on reduced as built service life will occur on lower volume roadways.

5.1.8. Wisconsin DOT Asset Management Process

A questionnaire was developed for professionals who are responsible for highway maintenance and may use Asset Management techniques in programming maintenance. The department was sent the questionnaire which was Internet based and answered online.

5.1.8.1 Asset Overview

The state of Wisconsin is responsible for maintenance of highways, streets and bridges; maintains airports in the state; and is also responsible for rail and harbor facilities management and rail crossing maintenance. WisDOT is responsible for the planning, programming, design, construction, operation, and maintenance of the state highway system. They are also involved in the planning and funding of rail, airport, and harbor facilities. In addition to these facility management functions, the department manages the State Patrol and Motor Vehicles operations.

5.1.8.2 Asset Management

The department has not integrated maintenance expenditures into the programming and planning process. They use data based tools to make decisions, but only to a limited extent. Their maintenance program is centered on maintaining a safe and serviceable roadway. Typical activities include seal coats, crack sealing, shoulder grading, patching and minor overlays. Maintenance work and funding is prioritized on a worst-first basis. They do not use metrics or performance measures to prioritize maintenance expenditures. Instead, conflicting priorities or trade offs are resolved through committee consensus and/or peer review.

Department personnel were asked about the type of performance data collected. They responded that the department collects a full battery of observable pavement distress as well as ride measurements. The data is collected on the entire state trunk network every other year. Targets are set for distress (PDI), ride (IRI) and rutting. The performance data is used directly to evaluate options and future performance of the system. When asked about how trade-offs between priorities are reconciled, the department stated that, historically, the distress index level overrides other concerns.

5.1.8.3 Additional Trucks on the Road System

The questionnaire then discussed that the project involves assessing the impact on the road system if the WSOR went out of business sending additional trucks on the road. Information was also provided about the roads that would most likely be affected by a modal shift of freight from rail to truck:

- Monroe to Madison
- Monroe to Milwaukee
- Monroe to the Illinois border
- Janesville to Madison

According to WisDOT, the maintenance process for each of these road segments involved simple routine maintenance such as crack filling. For each of the highways specified, WisDOT typically spends less than $20,000 per mile for maintenance over the course of the pavement's life for maintenance.

WisDOT was also given estimates of the additional truck traffic that would travel on these roads if WSOR ceased to exist. They were asked: Given your use of Asset Management techniques, or other approaches to maintenance, how would the department deal with the increased damage to these roads caused by the estimated truck traffic? They responded that the increase in trucking is trivial and would have no impact on the maintenance of this roadway, contrary to findings of pavement models. Nor would there be any impact on the roads for replacing the existing facility in the future. They concluded that no additional maintenance expenditures would be required to maintain each of these road segments at the level these are maintained today.

5.1.8.4 Conclusion

It is clear from the results of the questionnaire that Wisconsin DOT does not use Asset Management techniques in the planning and programming of maintenance expenditures. The question that remains is what will be the ultimate impact on the road system of a possible shift of traffic from rail to truck.

Since the maintenance budget seems fixed, decisions have to eventually be made as to how to allocate scarce maintenance funds. Two outcomes need to be considered. Maintenance funds could be shifted from other roads, leading to an overall deterioration of the road system in the area. Alternatively, the level of maintenance on the roads affected by increased traffic could stay the same, which is what the department is suggesting, leading to an accelerated deterioration of those roads.

5.1.9. Tables and Maps

Table 5.1.2 - Summary of Traffic Data

			Current % Heavy Trucks									% Heavy Trucks with Closure of Short Rail Line										
Case Studies	Route	County	$AADT_0$	$AADT_{20}$	Growth Factor	% Heavy Vehicles (>Class 4)	2D	3-SU	2S-1 + 2S-2	3S-2	2-S1-2	# of Truck Increase per year	$AADT_0$	$AADT_{20}$	% Increase	% Heavy Vehicles (>Class 4)	Growth Factor	2D	3-SU	2S-1 + 2S-2	3S-2	2-S1-2
							6	7	9	10	12							6	7	9	10	12
Route 1	HWY 69 NB & SB Monroe to Verona	Green	3000	4458	2%	13.0	25.4	4.6	12.3	56.2	1.5	3633	3010	4473	0.3	13.3	2%	24.8	4.5	12	57.2	1.5
	HWY 69 NB & SB Monroe to Verona	Dane	2000	2972	2%	13.0	25.4	4.6	12.3	56.2	1.5	3633	2009	2985	0.5	13.5	2%	24.5	4.5	11.9	57.6	1.5
	HWY 18 EB & WB from HWY 69 to HWY 14	Dane	20400	30313	2%	13.0	25.4	4.6	12.3	56.2	1.5	3633	20410	30328	0.0	13.0	2%	25.3	4.6	12.2	56.3	1.5
	HWY 14 EB & WB from HWY 18 to HWY 12	Dane	53500	79498	2%	4.8	37.5	10.4	14.6	35.4	2.1	3633	53510	79513	0.02	4.82	2%	37.4	10.4	14.6	35.7	2.1
Route 2	HWY 11 EB & WB from Monroe to HWY 81	Green	3700	5498	2%	13.0	25.4	4.6	12.3	56.2	1.5	11761	3732	5546	0.9	13.9	2%	23.8	4.3	11.5	58.9	1.4
	HWY 81 EB & WB from HWY 11 to I-39	Green	6900	10253	2%	13.0	25.4	4.6	12.3	56.2	1.5	11761	6932	10301	0.5	13.5	2%	24.5	4.5	11.9	57.7	1.5
	HWY 81 EB & WB from HWY 11 to I-39	Rock	2700	4012	2%	13.0	25.4	4.6	12.3	56.2	1.5	11761	2732	4060	1.2	14.2	2%	23.3	4.2	11.3	59.8	1.4
	I-43 NB & SB from Beloit to STH 140	Rock	7300	10847	2%	13.0	25.4	4.6	12.3	56.2	1.5	3652	7310	10862	0.1	13.1	2%	25.1	4.6	12.2	56.6	1.5
Route 3	HWY 69 SB & NB Monroe, WI to Illinois Boarder	Green	4700	6984	2%	13.0	25.4	4.6	12.3	56.2	1.5	1816	4705	6991	0.1	13.1	2%	25.2	4.6	12.2	56.5	1.5
Route 4	HWY 14 EB & WB from HWY 51 to HWY 138	Rock	5800	8618	2%	3.6	47.2	8.3	13.9	30.6	0	934	5803	8622	0.0	3.6	2%	46.7	8.2	13.7	31.4	0.0
	HWY 14 EB & WB from HWY 51 to WI 138	Dane	7300	10847	2%	3.6	47.2	8.3	13.9	30.6	0	934	7303	10851	0.0	3.6	2%	46.8	8.3	13.8	31.2	0.0
Route 5	I-39 NB & SB from HWY 26 to HWY 12 Interchange	Rock	14900	22141	2%	16.0	17.5	5.6	16.9	59.4	0.6	934	14903	22144	0.0	16.0	2%	17.5	5.6	16.8	59.4	0.6
	I-39 NB & SB from HWY 26 to HWY 12 Interchange	Dane	21400	31799	2%	16.0	17.5	5.6	16.9	59.4	0.6	934	21403	31803	0.0	16.0	2%	17.5	5.6	16.8	59.4	0.6

Table 5.1.3 - Truck Route 1 Simulations

Case Study	Route	Pavement Section	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN	Calculated Pavement Thickness (in)	As Built Pavement Thickness (in)
Route 1	HWY 69 Monroe to Verona	1	2,000,000	Green	JPCP w/dowels	Existing Traffic	N/A	N/A	7.7	9.0
	HWY 69 Monroe to Verona	1	2,100,000	Green	JPCP w/dowels	New Traffic	N/A	N/A	7.8	9.0
	HWY 69 Monroe to Verona	2	1,300,000	Green	HMA	Existing Traffic	4.84	4.77	N/A	N/A
	HWY 69 Monroe to Verona	2	1,300,000	Green	HMA	New Traffic	4.86	4.77	N/A	N/A
	HWY 69 Monroe to Verona	3	1,300,000	Green	HMA	Existing Traffic	4.84	5.29	N/A	N/A
	HWY 69 Monroe to Verona	3	1,300,000	Green	HMA	New Traffic	4.86	5.29	N/A	N/A
	HWY 69 Monroe to Verona	4	1,000,000	Dane	HMA	Existing Traffic	4.04	5.05	N/A	N/A
	HWY 69 Monroe to Verona	4	1,000,000	Dane	HMA	New Traffic	4.07	5.05	N/A	N/A
	HWY 69 Monroe to Verona	5	1,000,000	Dane	HMA	Existing Traffic	4.04	4.84	N/A	N/A
	HWY 69 Monroe to Verona	5	1,000,000	Dane	HMA	New Traffic	4.07	4.84	N/A	N/A
	HWY 69 Monroe to Verona	6	1,000,000	Dane	COMPOSITE	Existing Traffic	4.04	4.86	N/A	N/A
	HWY 69 Monroe to Verona	6	1,000,000	Dane	COMPOSITE	New Traffic	4.07	4.86	N/A	N/A
	HWY 69 Monroe to Verona	7	1,000,000	Dane	COMPOSITE	Existing Traffic	4.04	6.18	N/A	N/A
	HWY 69 Monroe to Verona	7	1,000,000	Dane	COMPOSITE	New Traffic	4.07	6.18	N/A	N/A
	HWY 69 Monroe to Verona	8	1,300,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	7.2	9.0
	HWY 69 Monroe to Verona	8	1,400,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	7.2	9.0
	HWY 18 from HWY 69 to HWY 14	9	14,000,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.4	9.0
	HWY 18 from HWY 69 to HWY 14	9	14,100,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.4	9.0
	HWY 18 from HWY 69 to HWY 14	10	14,000,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.4	10.0
	HWY 18 from HWY 69 to HWY 14	10	14,100,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.4	10.0
	HWY 18 from HWY 69 to HWY 14	11	14,000,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.4	10.0
	HWY 18 from HWY 69 to HWY 14	11	14,100,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.4	10.0
	HWY 18 from HWY 69 to HWY 14	12	14,000,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.4	9.0
	HWY 18 from HWY 69 to HWY 14	12	14,100,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.4	9.0
	HWY 14 from HWY 18 to HWY 12	13	11,000,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.0	9.0
	HWY 14 from HWY 18 to HWY 12	13	11,000,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.0	9.0

Table 5.1.4 - Truck Route 2 Simulations

Case Study	Route	Pavement Section	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN	Calculated Pavement Thickness (in)	As Built Pavement Thickness (in)
Route 2	HWY 11 From Monroe to HWY 81	14	2,500,000	Green	JPCP	Existing Traffic	N/A	N/A	8.0	8.0
	HWY 11 From Monroe to HWY 81	14	2,800,000	Green	JPCP	New Traffic	N/A	N/A	8.2	8.0
	HWY 11 From Monroe to HWY 81	15	2,500,000	Green	JRCP	Existing Traffic	N/A	N/A	8.0	9.0
	HWY 11 From Monroe to HWY 81	15	2,800,000	Green	JRCP	New Traffic	N/A	N/A	8.2	9.0
	HWY 11 From Monroe to HWY 81	16	1,600,000	Green	COMPOSITE	Existing Traffic	3.84	5.02	N/A	N/A
	HWY 11 From Monroe to HWY 81	16	1,700,000	Green	COMPOSITE	New Traffic	3.90	5.02	N/A	N/A
	HWY 11 From Monroe to HWY 81	17	2,500,000	Green	JPCP	Existing Traffic	N/A	N/A	7.7	8.0
	HWY 11 From Monroe to HWY 81	17	2,700,000	Green	JPCP	New Traffic	N/A	N/A	7.8	8.0
	HWY 81 from HWY 11 to I-39	18	1,800,000	Rock	JPCP	Existing Traffic	N/A	N/A	7.6	8.0
	HWY 81 from HWY 11 to I-39	18	2,000,000	Rock	JPCP	New Traffic	N/A	N/A	7.7	8.0
	HWY 81 from HWY 11 to I-39	19	1,200,000	Rock	COMPOSITE	Existing Traffic	4.76	6.06	N/A	N/A
	HWY 81 from HWY 11 to I-39	19	1,300,000	Rock	COMPOSITE	New Traffic	4.84	6.06	N/A	N/A
	I-43 from Beloit to STH 140	20	4,900,000	Rock	JPCP	Existing Traffic	N/A	N/A	8.9	10.0
	I-43 from Beloit to STH 140	20	5,000,000	Rock	JPCP	New Traffic	N/A	N/A	9.0	10.0

Table 5.1.5 - Truck Route 3 Simulations

Case Study	Route	Pavement Section	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN	Calculated Pavement Thickness (in)	As Built Pavement Thickness (in)
Route 3	HWY 69 SB to Illinois	21	3,200,000	Green	JPCP	Existing Traffic	N/A	N/A	8.2	8.0
	HWY 69 SB to Illinois	21	3,200,000	Green	JPCP	New Traffic	N/A	N/A	8.2	8.0
	HWY 69 SB to Illinois	22	2,000,000	Green	HMA	Existing Traffic	4.61	3.30	N/A	N/A
	HWY 69 SB to Illinois	22	2,000,000	Green	HMA	New Traffic	4.61	3.30	N/A	N/A

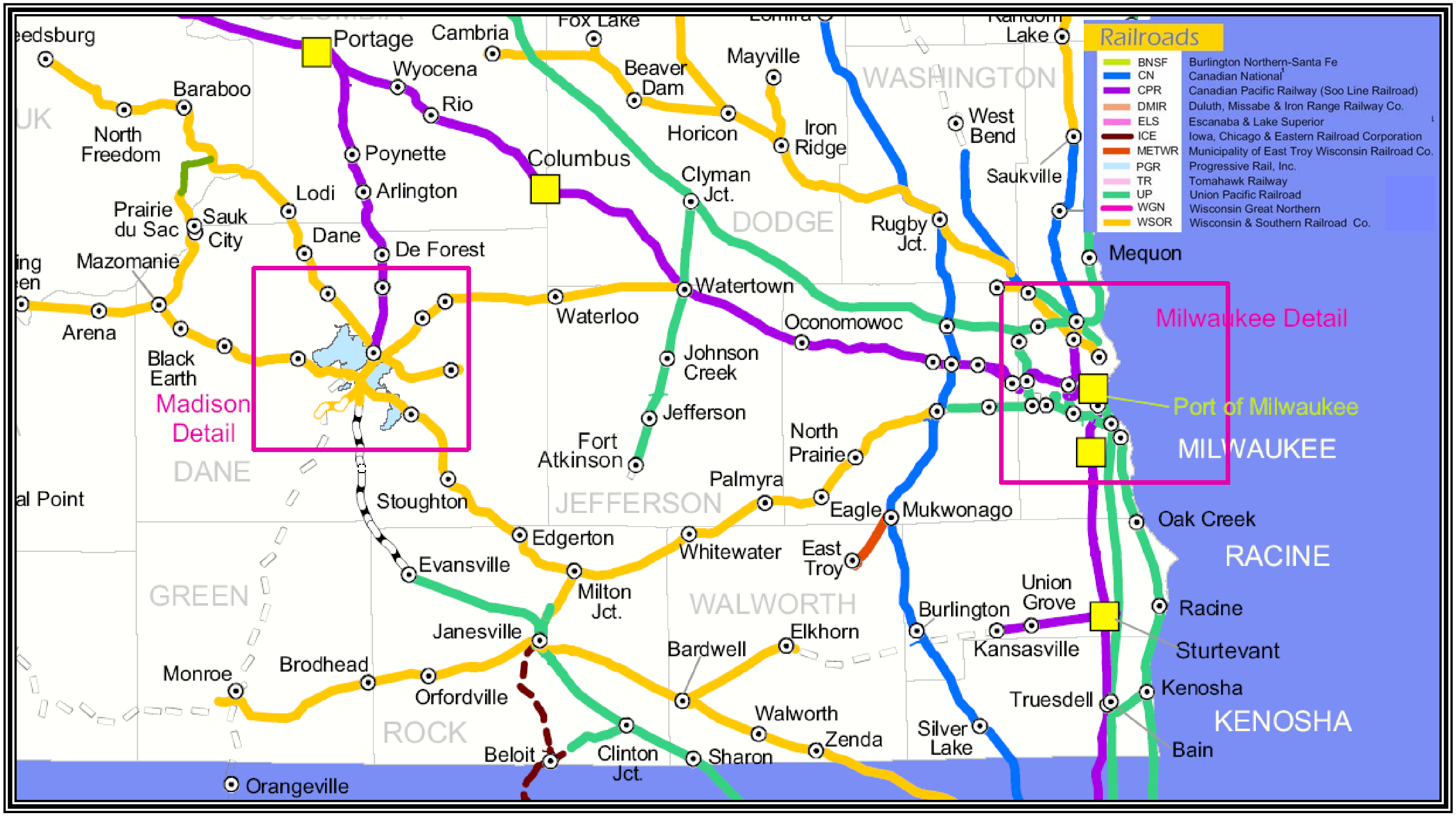
Table 5.1.6 - Route 4 Simulations

Case Study	Route	Pavement Section	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN	Calculated Pavement Thickness (in)	As Built Pavement Thickness (in)
Route 4	HWY 14 from HWY 51 to HWY 138	23	1,000,000	Dane	JPCP	Existing Traffic	N/A	N/A	6.6	8.0
	HWY 14 from HWY 51 to HWY 138	23	1,000,000	Dane	JPCP	New Traffic	N/A	N/A	6.6	8.0
	HWY 14 from HWY 51 to HWY 138	24	700,000	Dane	HMA	Existing Traffic	3.90	4.94	N/A	N/A
	HWY 14 from HWY 51 to HWY 138	24	700,000	Dane	HMA	New Traffic	3.90	4.94	N/A	N/A
	HWY 14 from HWY 51 to HWY 138	25	600,000	Rock	HMA	Existing Traffic	4.24	3.33	N/A	N/A
	HWY 14 from HWY 51 to HWY 138	25	600,000	Rock	HMA	New Traffic	4.24	3.33	N/A	N/A
	HWY 14 from HWY 51 to HWY 138	26	600,000	Rock	COMPOSITE	Existing Traffic	4.24	5.87	N/A	N/A
	HWY 14 from HWY 51 to HWY 138	26	600,000	Rock	COMPOSITE	New Traffic	4.24	5.87	N/A	N/A

Table 5.1.7 - Truck Route 5 Simulations

Case Study	Route	Pavement Section	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN	Calculated Pavement Thickness (in)	As Built Pavement Thickness (in)
Route 5	I-39 from HWY 26 to HWY 12	27	8,000,000	Rock	HMA	Existing Traffic	6.22	5.78	N/A	N/A
	I-39 from HWY 26 to HWY 12	27	8,000,000	Rock	HMA	New Traffic	6.22	5.78	N/A	N/A
	I-39 from HWY 26 to HWY 12	28	13,000,000	Rock/Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.3	11.0
	I-39 from HWY 26 to HWY 12	28	13,000,000	Rock/Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.3	11.0
	I-39 from HWY 26 to HWY 12	29	18,500,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.9	11.0
	I-39 from HWY 26 to HWY 12	29	18,500,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.9	11.0
	I-39 from HWY 26 to HWY 12	30	8,000,000	Rock	HMA	Existing Traffic	6.22	5.78	N/A	N/A
	I-39 from HWY 26 to HWY 12	30	8,000,000	Rock	HMA	New Traffic	6.22	5.78	N/A	N/A
	I-39 from HWY 26 to HWY 12	31	13,000,000	Rock/Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.3	11.0
	I-39 from HWY 26 to HWY 12	31	13,000,000	Rock/Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.3	11.0
	I-39 from HWY 26 to HWY 12	32	18,500,000	Dane	JPCP w/dowels	Existing Traffic	N/A	N/A	10.9	11.0
	I-39 from HWY 26 to HWY 12	32	18,500,000	Dane	JPCP w/dowels	New Traffic	N/A	N/A	10.9	11.0

Map 5.1.3 – Railroads in Southern Wisconsin



Map 5.1.4 – Rail Route 1, Monroe to Madison

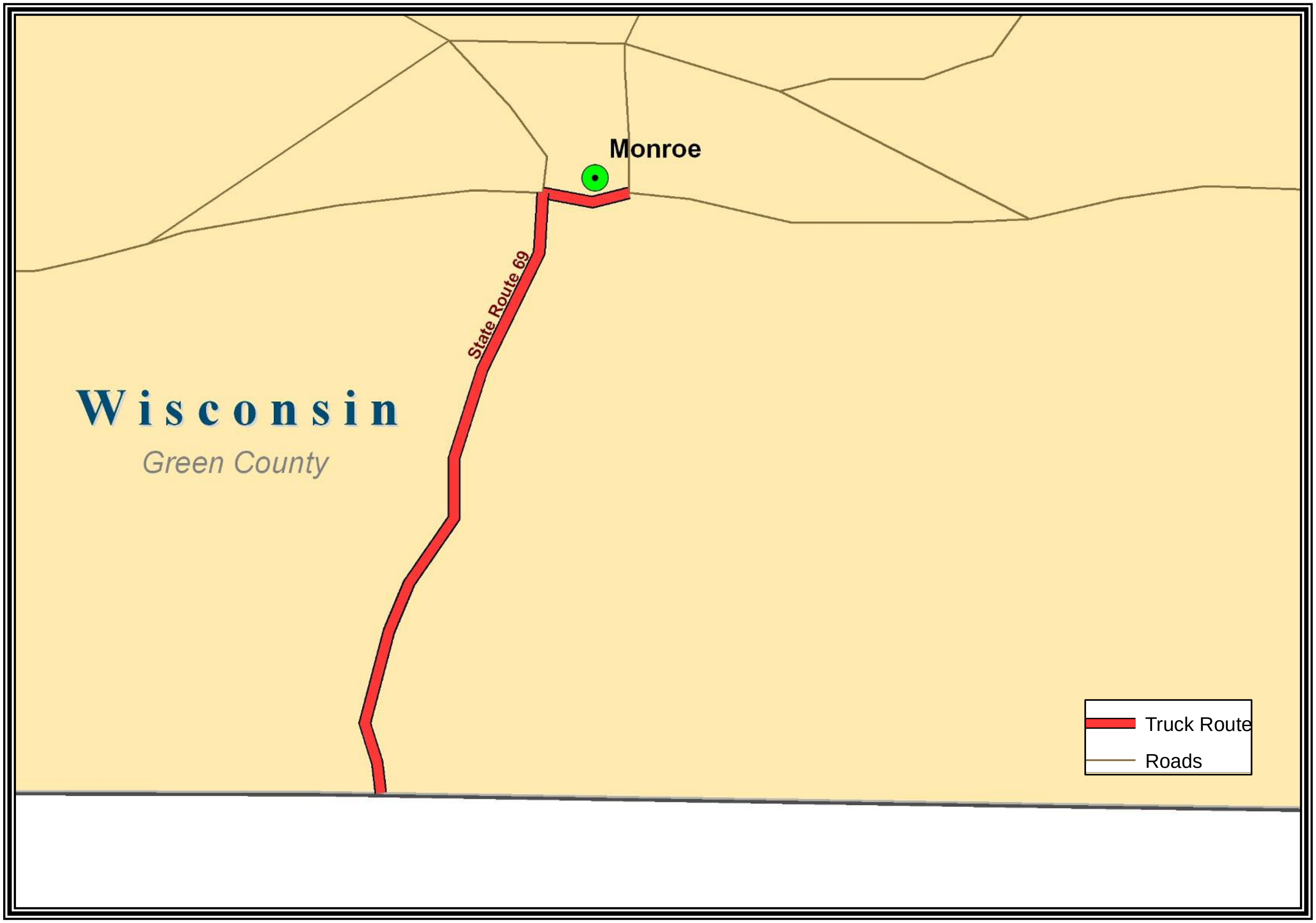
Map 5.1.5 - Rail Route 2, Monroe to Milwaukee

Map 5.1.6 – Rail Route 3, Monroe to Illinois Border

Map 5.1.7 - Truck Route 1, Monroe to Madison

Map 5.1.8 – Truck Route 2, Monroe to Milwaukee

Map 5.1.9 - Truck Route 3, Monroe to Illinois Border



Map 5.1.10 – Truck Route 4, Janesville to Madison

Map 5.1.11 - Truck Route 5, Janesville to Madison

5.2. Escanaba Lake Superior Railroad (ELS)

5.2.1. Case Study 2

The area selected for Case Study 2 considers a short line connecting Ontonagon, Escanaba, and Rousseau, Michigan, which is currently served by the Escanaba Lake Superior Railroad (ELS). This line connects Michigan cities to paper manufactures in the Green Bay, Wisconsin area (see Map 5.2.2). It is anticipated rail traffic will be diverted from Michigan to Green Bay, Wisconsin. This is one of the longer short line railroads in the region and also the only one of the case studies where the railroad selected crosses state lines. This is a significant issue for shippers if they lose rail service because of the difference in each state's truck size and weight laws.

Current freight volumes and corresponding trucking volumes are estimated, assuming this rail traffic was diverted to nearby roads. A logistical flow analysis documents the increased truck movements by route if this rail line is lost. The current condition of the highway segments, which would be impacted by the potential line abandonment, is documented in terms of rutting, roughness, faulting, and cracking (alligator, transverse, and longitudinal). The pavement design method currently used by the Michigan Department of Transportation is the 1994 AASHTO Pavement Design Guide and the Wisconsin Department of Transportation uses "WisPave". These pavement design guides were used to measure the pavements' ability to handle the additional trucks on the highway in terms of structural number for flexible pavements and thickness for concrete pavements.

5.2.2. Background

Twenty-seven freight railroads in Michigan offer key transportation services to customers in agriculture, manufacturing, and other industries. The Escanaba Lake Superior Railroad serves the largest geographical area of all three case studies considered. Roads in the Upper Peninsula of Michigan are predominantly rural and are not approaching designed capacity thresholds.

5.2.3. Case Study Route Selection

The Escanaba to Lake Superior railroad is connected to the Class 1 railroad CN in Green Bay, WI, and Iron Mountain and Marinette, MI (See Map 5.2.1). The ELS has short branch lines running to Oconto Falls, WI, and to Marinette and Republic, MI. There is the possibility that the CN railroad may take some of the traffic in Marinette and Iron Mountain but that traffic has not shifted to CN in the past. And in talking to shippers it was found that in many instances they would prefer shifting to truck rather than moving it on a Class 1 railroad because the cost of direct access to a Class 1 railroad is lower than the cost of a joint line move. A modal shift from rail to highway would then occur, resulting in an increase in truck traffic on the highways. Maps 5.2.3 through 5.2.5 represent three primary truck routes that were identified based on surveys of shippers. Map 5.2.3 illustrates the route identified from surveying shippers from Menominee, Michigan to Green Bay, Wisconsin. Map 5.2.4 shows the route from Ontonagon, Michigan to Green Bay, Wisconsin. Map 5.2.5 shows the route from Rousseau, Michigan to Green Bay, Wisconsin.

Map 5.2.1 – Michigan DOT Railroad Map

5.2.4. Data Collection

Relevant traffic flow data for the selected carriers were gathered from shippers, railroads, and DOTs. Data included, but was not limited to, types of traffic: local, interline, overhead, and international origins and destinations. Data related to pavements was collected from state DOTs (MDOT and WisDOT). Data fields included pavement thicknesses, hot mix asphalt (HMA), concrete, base, subbase, material characterization data, subgrade soil type, existing truck traffic, and the existing condition of the pavement Typical subgrade modulus values (subgrade support value or modulus of subgrade reaction) were selected based on the American Association of State Highway and Transportation Officials (AASHTO) classification of the subgrade soil type. The subgrade soil support values used were from a previous WisDOT research project (Testing Wisconsin Asphalt Mixtures for the AASHTO 2002 Mechanistic Design Procedure) in which the AASHTO soil designation was known. The subgrade support value was used in the WisPave pavement design guide simulations for flexible pavements and the modulus of subgrade reaction was used for rigid pavement design. Resilient modulus and modulus of subgrade reaction was used in the 1993 AASHTO pavement design guide for flexible and rigid pavements.

5.2.5. Logistical Flow of New Truck Freight

The ELS Railroad's three largest product groups are lumber, scrap, and chemicals. Many of these users are in the upper northwestern portion of the Upper Peninsula of Michigan. While Michigan trucks are allowed to haul overweight loads, when these trucks get to Wisconsin, the load limits are more restrictive than intrastate Michigan, so trucking to transload centers in Northern Wisconsin is the only viable option, yet more costly.

Wisconsin law limits a truck's steering axle to 13,000 pounds with a maximum Gross Vehicle Weight (GVW) of 80,000 pounds. Class B highways are 60% of Class A highways, according to WisDOT classifications In Michigan, steering axle weights can be up to 18,000 pounds with high pressure tires; up to 16,000 pounds per axle with a nine foot distance between axles; and up to 32,000 pounds for tandem axles. Maximum GVW cannot exceed 700 pounds per inch of tire or tire weight rating as stated on the tire, for a maximum GVW of 164,000 pounds. Frost law restrictions set by MDOT are 25% on rigid base and 35% on flexible base.

Wisconsin recently introduced higher truck load limits during certain months of the year to accommodate the forest products industry, but these limits are still well below the Michigan statutes. It was noted that if the ELS service was lost, the lumber and scrap traffic would nearly double current traffic volumes on certain northern highways. Several mills are located on rural routes which are not part of the state highway system. These shippers have few alternatives other than trucking if rail service was lost.

5.2.6. Pavement Design

The objective was to assess the incremental pavement structural design due to modal shift from rail to truck in the selected case study. The design was based upon the flows generated in Maps 5.2.3 through 5.2.5. The diversion of freight is anticipated to occur over multiple routes and includes 48 pavement cross-sections (designs). One assumption inherent when using the WisPave pavement design software is that it does not take into account the current condition of the pavement structure; it assumes that it is a new pavement structure. The WisPave software does not take into account reliability and the change in present serviceability index, which is used to trigger rehabilitation and maintenance activities. However, the pavement sections in Michigan, since they were designed using the 1993 AASHTO pavement design guide, use reliability and present serviceability index in the equations for structural number and concrete pavement thickness.

The total tonnage during the most recent year of shipping via railroad was measured and then divided by 48,000 lbs to determine the additional number of trucks that would be on the highway routes. While gross vehicle weight is limited to 80,000 lbs, it is assumed that the tare weight of the truck and trailer equipment averages 32,000 lbs. The number of trucks was estimated based on a straight tonnage conversion methodology. Actual shipments may be somewhat higher based on specific order quantities or production limitations. It was calculated that there would be an annual increase of 25,678 trucks on the three routes listed above. However, the trucks will be distributed along the routes according to the conversations with the various shippers and some assumptions when needed. It was assumed that the additional trucks would be 3S-2 trucks (class 10 trucks). Table 5.2.2 Summary of Traffic Data summarizes the traffic data in terms of average annual daily traffic (AADT), growth factor, AADT at design life, and percent trucks for each route and in some cases the county where the traffic level changed. Included in Table 5.2.2 is the new traffic if the short rail closes. Two simulations for each route were performed for the existing traffic and the new traffic if the short line railroad closes.

Typical (default) values for layer coefficients were selected when using the WisPave and AASHTO 1993 pavement design guide for the surface, base, subbase 1, and subbase 2 layers. Tables 5.2.3 through 5.2.5 show the simulations for each route and pavement structure on that route. On average the new structural number (SN) is 0.07 units greater than the existing SN for flexible and composite pavements. For rigid pavements the new pavement thickness is 0.17 inches greater than the existing pavement thickness. There is a tendency for the as built SN or pavement thickness to be over designed providing a much greater as built design versus the as designed. For the flexible and composite pavements, the average SN for the as built versus the required SN is 0.28 units greater than the required SN. For rigid pavements the average as built pavement thickness is 0.43 inches greater than required pavement thickness. Since the majority of the pavements are over-designed, an increase in traffic may not affect the pavement in terms of rutting, cracking, or faulting. However, for those pavements that are under-designed or designed at optimum, an increase in traffic may accelerate the damage to the pavements in terms of rutting and cracking for flexible pavements and cracking and faulting for rigid pavements. Nonetheless, 18 of the 48 pavement sections primarily on two of the five routes will experience a shorter life with the additional modal shift in freight than their as-built life.

5.2.7. Summary

It was calculated that if the Escanaba and Lake Superior rail line was closed, there would be an annual increase of 25,678 trucks on the three routes listed. The pavement conditions considered in this paper are the changes in SN and concrete pavement thickness due to the increase of truck traffic in the highway system in the state of Michigan and

Wisconsin. The results show that there is an increase in SN and concrete pavement thickness due to the increase in traffic on these routes. However, these pavements have as built SNs or concrete pavement thicknesses greater than the existing and potential future SNs or concrete pavement thicknesses. Eighteen of the forty-eight pavement sections, primarily on two of the five routes, will experience a shorter life with the additional modal shift freight than their as-built life. Those pavements that are built at the optimum design should be monitored closely to determine if they will deteriorate quickly due to the increase in truck traffic. Furthermore, the greatest impact on reduced as built service life will occur on lower volume roadways.

5.2.8. Michigan DOT Asset Management

5.2.8.1 Asset Overview

While Michigan DOT (MDOT) is responsible for a variety of assets, the focus of this study was on assets maintained by the Superior Region office in Escanaba. The office is responsible for maintenance of highways, streets, bridges, roadside facilities, scenic overlooks, snowmobile crossings, and freeway crossovers.

5.2.8.2 Asset Management – State Legislation

Act 499, written into law in 2002, mandates the practice of Asset Management and established the 11-member Transportation Asset Management Council (TAMC), which reports directly to the State Transportation Commission. The TAMC, comprised of transportation professionals from various levels of government, is responsible for the administration of the asset management process, including areas of training, data storage and collection, reporting, developing a multi-year program, budgeting, and funding.

5.2.8.3 Asset Management Process

MDOTs Asset Management literature outlines what they see as the major elements of an asset management system:

- Establishing goals and objectives through development of a strategic plan
- Collecting data to measure progress toward achieving the established goals and objectives
- Using management systems to control the various processes
- Developing appropriate performance measures
- Identifying standards and benchmarks
- Developing alternative analyses procedures
- Making decisions based on these results and developing an appropriate program
- Implementing the program
- Monitoring and reporting results of actions taken

MDOT lists the following as its key elements in asset management:

- Establishing goals and objectives in a strategic plan
- Data collection and storage
- Transportation Management Systems
- Setting performance measures and standards
- Alternatives analysis, e.g. life cycle cost analysis and a prioritization process
- Decision-making and program development
- Plan implementation
- Monitoring and reporting

MDOT has established various programs in its Transportation Management Systems, as listed below:

- Bridge Management System
  - PONTIS and Michigan-specific interface
- Congestion Management System
- Intermodal Management System
- Pavement Management System
  - PASER rating system
  - Annual "Windshield Survey"-A sufficiency rating system which is a subjective measurement of ride smoothness, cracking, rutting. The regional offices do a physical features inventory. They produce annual plans based on the inventory.
- Public Transportation Management System
- Safety Management System

5.2.8.4 Metrics in Place

In the State Long Range Plan, it is stated that over 100 performance measures are used by MDOT and have been incorporated into the Transportation Management Systems database. The following performance measures relate to asset management:

- Bridge Condition
  - Each bridge is evaluated every two years to determine maintenance, rehabilitation, or replacement requirements. Larger bridges are evaluated once a year.
- Customer Satisfaction Survey
  - Provides feedback on how MDOT is meeting customer demands and measures customer perceptions about system condition and service
- Pavement Condition
  - Evaluation based on ride quality, crack severity and average depth of wheel path ruts

MDOT has also put in place a Road Quality Forecasting System, in which future pavement condition is estimated using the measure Remaining Service Life (RSL). The appropriate level of pavement maintenance is determined by this system. Pavements are grouped into six categories:

- I 0-2 years
- II 3-7 years
- III 8-12 years
- IV 13-17 years
- V 18-22 years
- VI 23-25 years

The department uses network pavement strategies that are a collection of fixes that will extend the life of the road. There are three basic types of fixes:

1. Reconstruction and Rehabilitation
2. Capital Preventive Maintenance
3. Reactive Maintenance

The MDOT Strategic Plan states that the concept of Asset Management applies to all of the state long range plan goals, but that the process is most directly related to the plan goal of preservation. MDOT has formulated specific strategies in the area of asset management and preservation, including:

- Strategy for Repairing and Rebuilding Roads
- Trucks
- Winter Maintenance Strategy (this is the number one priority in the UP of Michigan, because of the severe winters)
- Bridge Preservation Strategy
- Bridge Widening and Lengthening Strategy

Most data is sent to MDOT headquarters, which performs the actual programming, and has the ability to access the databases and move funding around to more equally distribute spending.

5.2.8.5 Additional Trucks on the Road System

The questionnaire then discussed the project which involves assessing the impact on the road system if the ESLS went out of business, sending additional trucks on the road. We then provided information on the roads would be affected by a shift from rail to truck:

- Route 2, Ontonagon, MI to Green Bay, WI
- Route 3, Rousseau, MI to Green Bay, WI

The Department explained that these are lower priority roads. Because of logging in the area, the weight limits are 164,000 lbs on state roads. Route 2 is 130 miles, and MDOT spends $2 million per year on this road. It spends $1 million per year Route 3. All routes have 164,000 lbs. weight limit with 7 axle trucks. The axle loading is much lower that the US average.

Estimates of the additional truck traffic that would travel on these roads, if the ESL railroad ceased to exist, were also shown to MDOT. They were asked: Given your use of Asset Management techniques, or other approaches to maintenance, how would the department deal with the increased damage to these roads caused by the estimated truck traffic?

The department responded that they have two priorities: safety and mobility. The roads are already designed for heavier weights. The additional amount of trucks on the road would be so small that it would not affect the maintenance budget. If the trucks are going to Wisconsin, then they would be hauling lighter loads. They would split the loads before entering Wisconsin to two, 80,000 pound loads. The total increase in truck traffic would be about 2%, which would not have much of an effect. The roads currently are not near capacity.

5.2.9. Tables and Maps

Table 5.2.1 - ELS Stations

Escanaba and Lake Superior Stations	Distance Between Rail Stations
Green Bay, WI	0
Sobieski, WI	8 miles
Lena, WI	17 miles
Coleman, WI	12 miles
Crivitz, WI	15 miles
Pembine, WI	29 miles
Iron Mountain, MI	14 miles
Channing, MI	24 miles
Amasa, MI	20 miles
Sindaw, MI	26 miles
Ontonagon, MI	47 miles
Total Miles of track	**212 miles**

Table 5.2.2 - Summary of Traffic Data

			Current % Heavy Trucks										% Heavy Trucks with Closure of Short Rail Line										
Case Studies	Route	County	$AADT_0$	$AADT_{20}$	Growth Factor	% Heavy	2D 6	3-SU 7	2S-1 + 2S-2 9	3S-2 10	2-S1-2 12	# of Truck Increase	$AADT_0$	$AADT_{20}$	% Increase	% Heavy Vehicles	Growth Factor	2D 6	3-SU 7	2S-1 + 2S-2 9	3S-2 10	2-S1-2 12
ELS Route 1	Menominee to WI Border	Menominee	23500	34920	2%	3.6	47.2	8.3	13.9	30.6	0	256	23501	34921	0.003	3.6	2%	47.2	8.3	13.9	30.6	0
	In City of Marinette	Marinette	14300	21249	2%	13	25.4	4.6	12.3	56.2	1.5	256	14301	21250	0.005	13.0	2%	25.4	4.6	12.3	56.2	1.5
	US-41 SB to Green Bay	Marinette	8400	12482	2%	13	25.4	4.6	12.3	56.2	1.5	256	8401	12483	0.008	13.0	2%	25.4	4.6	12.3	56.2	1.5
	US-41/US-141 SB to Green Bay	Oconto	7600	11293	2%	13	25.4	4.6	12.3	56.2	1.5	25678	7670	11398	0.926	13.9	2%	23.7	4.3	11.5	59.1	1.4
	US-41/US-141 SB to Green Bay	Brown	16900	25113	2%	13	25.4	4.6	12.3	56.2	1.5	25678	16970	25217	0.416	13.4	2%	24.6	4.5	11.9	57.5	1.5
ELS Route 2	Ontonagon to Green Bay, US-45 SB	Ontonagon	1100	1635	2%	16	17.5	5.6	16.9	59.4	0.6	10056	1128	1675	2.505	18.5	2%	15.1	4.9	14.6	64.9	0.5
	US-45 SB	Gogebic	2900	4309	2%	13	25.4	4.6	12.3	56.2	1.5	10056	2928	4350	0.950	14.0	2%	23.7	4.3	11.4	59.1	1.4
	US-2 EB	Gogebic	3200	4755	2%	13	25.4	4.6	12.3	56.2	1.5	10056	3228	4796	0.861	13.9	2%	23.8	4.3	11.5	58.9	1.4
	US-2 EB	Iron	1400	2080	2%	16	17.5	5.6	16.9	59.4	0.6	10056	1428	2121	1.968	18.0	2%	15.6	5	15.1	63.8	0.6
	US-141 SB	Iron	1400	2080	2%	16	17.5	5.6	16.9	59.4	0.6	10056	1428	2121	1.968	18.0	2%	15.6	5	15.1	63.8	0.6
	US-2 EB	Florence	1400	2080	2%	16	17.5	5.6	16.9	59.4	0.6	10056	1428	2121	1.968	18.0	2%	15.6	5	15.1	63.8	0.6
	US-2/US-141 SB	Dickinson	8400	12482	2%	13	25.4	4.6	12.3	56.2	1.5	17739	8449	12554	0.579	13.6	2%	24.3	4.4	11.8	58	1.5
	US-141 SB	Marinette	4200	6241	2%	13	25.4	4.6	12.3	56.2	1.5	17739	4249	6313	1.157	14.2	2%	23.3	4.2	11.3	59.7	1.4
	US-141/US-41 SB	Oconto	7600	11293	2%	13	25.4	4.6	12.3	56.2	1.5	25678	7670	11398	0.926	13.9	2%	23.7	4.3	11.5	59.1	1.4
	US-141/US-41 SB	Brown	16900	25113	2%	13	25.4	4.6	12.3	56.2	1.5	25678	16970	25217	0.416	13.4	2%	24.6	4.5	11.9	57.5	1.5
ELS Route 3	Rousseau to Green Bay, M-38 EB	Houghton	590	877	2%	13	25.4	4.6	12.3	56.2	1.5	2393	597	886	1.111	14.1	2%	23.4	4.3	11.3	59.6	1.4
	NF-16 SB	Ontonagon	900	1337	2%	16	17.5	5.6	16.9	59.4	0.6	2751	908	1349	0.837	16.8	2%	16.6	5.3	16	61.4	0.6
	NF-16 SB	Houghton	900	1337	2%	16	17.5	5.6	16.9	59.4	0.6	2751	908	1349	0.837	16.8	2%	16.6	5.3	16	61.4	0.6
	M-28 EB	Houghton	1700	2526	2%	16	17.5	5.6	16.9	59.4	0.6	4951	1714	2546	0.798	16.8	2%	16.7	5.4	16.1	61.3	0.6
	M-28 EB	Baraga	1700	2526	2%	16	17.5	5.6	16.9	59.4	0.6	4951	1714	2546	0.798	16.8	2%	16.7	5.4	16.1	61.3	0.6
	US-141 SB	Baraga	1100	1635	2%	16	17.5	5.6	16.9	59.4	0.6	4951	1114	1655	1.233	17.2	2%	16.2	5.2	15.7	62.3	0.6
	US-141 SB	Iron	1100	1635	2%	16	17.5	5.6	16.9	59.4	0.6	4951	1114	1655	1.233	17.2	2%	16.2	5.2	15.7	62.3	0.6
	US-2 EB	Florence	1400	2080	2%	16	17.5	5.6	16.9	59.4	0.6	4951	1414	2100	0.969	17.0	2%	16.5	5.3	15.9	61.7	0.6
	US-2/US-141 SB	Dickinson	8400	12482	2%	13	25.4	4.6	12.3	56.2	1.5	17739	8449	12554	0.579	13.6	2%	24.3	4.4	11.8	58	1.5
	US-141 SB	Marinette	4200	6241	2%	13	25.4	4.6	12.3	56.2	1.5	17739	4249	6313	1.157	14.2	2%	23.3	4.2	11.3	59.7	1.4
	US-141/US-41 SB	Oconto	7600	11293	2%	13	25.4	4.6	12.3	56.2	1.5	25678	7670	11398	0.926	13.9	2%	23.7	4.3	11.5	59.1	1.4
	US-141/US-41 SB	Brown	16900	25113	2%	13	25.4	4.6	12.3	56.2	1.5	25678	16970	25217	0.416	13.4	2%	24.6	4.5	11.9	57.5	1.5

Table 5.2.3 - Truck Route 1 Simulations

Case Study	Route	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN
Route 1	US-41 SB	3,131,700	Menominee	HMA	Existing Traffic	4.77	5.88
	US-41 SB	3,131,700	Menominee	HMA	New Traffic	4.77	5.88
	US-41 SB	3,518,600	Marinette	HMA	Existing Traffic	4.37	4.44
	US-41 SB	3,525,900	Marinette	HMA	New Traffic	4.37	4.44
	US-41 SB	3,730,300	Oconto	HMA	Existing Traffic	5.06	4.94
	US-41 SB	3,730,300	Oconto	HMA	New Traffic	5.06	4.94
	US-41/US-141 SB	3,175,500	Oconto	HMA	Existing Traffic	4.94	6.08
	US-41/US-141 SB	3,511,300	Oconto	HMA	New Traffic	5.01	6.08
	US-41/US-141 SB	7,095,600	Brown	HMA	Existing Traffic	5.47	5.63
	US-41/US-141 SB	7,394,900	Brown	HMA	New Traffic	5.50	5.63

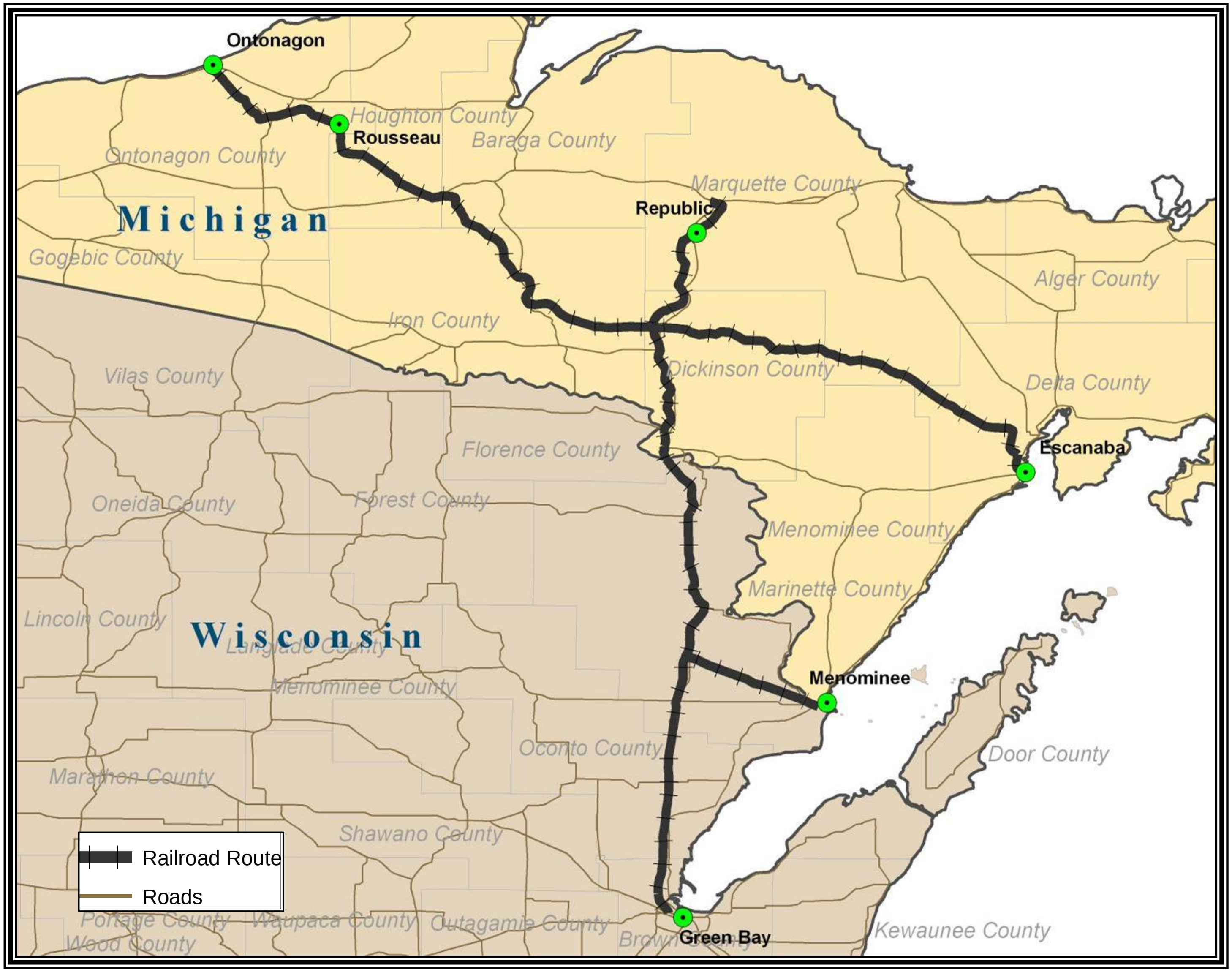
Table 5.2.4 - Truck Route 2 Simulations

Case Study	Route	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN
Route 2	US-45 SB	584,000	Ontonagon	HMA	Existing Traffic	4.03	10.62
	US-45 SB	722,700	Ontonagon	HMA	New Traffic	4.16	10.62
	US-45 SB	584,000	Ontonagon	HMA	Existing Traffic	4.51	5.26
	US-45 SB	722,700	Ontonagon	HMA	New Traffic	4.65	5.26
	US-45 SB	584,000	Ontonagon	HMA	Existing Traffic	4.03	5.02
	US-45 SB	722,700	Ontonagon	HMA	New Traffic	4.16	5.02
	US-45 SB	1,226,400	Gogebic	HMA	Existing Traffic	4.49	4.78
	US-45 SB	1,343,400	Gogebic	HMA	New Traffic	4.55	4.78
	US-2 EB	1,343,200	Gogebic	HMA	Existing Traffic	4.55	5.11
	US-2 EB	1,474,600	Gogebic	HMA	New Traffic	4.61	5.11
	US-2 EB	1,343,200	Gogebic	HMA	Existing Traffic	4.55	6.10
	US-2 EB	1,474,600	Gogebic	HMA	New Traffic	4.61	6.10
	US-2 EB	744,600	Iron	HMA	Existing Traffic	4.18	5.11
	US-2 EB	876,000	Iron	HMA	New Traffic	4.28	5.11
	US-2 EB	744,600	Iron	HMA	Existing Traffic	4.18	6.54
	US-2 EB	876,000	Iron	HMA	New Traffic	4.28	6.54
	US-141	744,600	Iron	HMA	Existing Traffic	4.18	4.36
	US-141	876,000	Iron	HMA	New Traffic	4.28	4.36
	US-2 EB	744,600	Florence	HMA	Existing Traffic	3.92	4.54
	US-2 EB	876,000	Florence	HMA	New Traffic	4.02	4.54
	US-2/US-141	3,518,600	Dickinson	HMA	Existing Traffic	5.20	4.88
	US-2/US-141	3,759,500	Dickinson	HMA	New Traffic	5.25	4.88
	US-2/US-141	3,518,600	Dickinson	HMA	Existing Traffic	5.20	4.33
	US-2/US-141	3,759,500	Dickinson	HMA	New Traffic	5.25	4.33
	US-2/US-141	3,518,600	Dickinson	HMA	Existing Traffic	5.20	1.98
	US-2/US-141	3,759,500	Dickinson	HMA	New Traffic	5.25	1.98
	US-8 SB	1,766,600	Marinette	JRCP	Existing Traffic	N/A	N/A
	US-8 SB	3,197,400	Marinette	JRCP	New Traffic	N/A	N/A
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	4.55
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	4.55
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	3.08
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	3.08
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	3.14
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	3.14
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	3.20
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	3.20
	US-141 SB	1,766,600	Marinette	JPCP w/dowels	Existing Traffic	N/A	N/A
	US-141 SB	3,197,400	Marinette	JPCP w/dowels	New Traffic	N/A	N/A
	US-141 SB	5,095,400	Oconto	JPCP w/dowels	Existing Traffic	N/A	N/A
	US-141 SB	5,664,600	Oconto	JPCP w/dowels	New Traffic	N/A	N/A
	US-41/US-141 SB	3,175,500	Oconto	HMA	Existing Traffic	4.94	6.08
	US-41/US-141 SB	3,511,300	Oconto	HMA	New Traffic	5.01	6.08
	US-41/US-141 SB	7,095,600	Brown	HMA	Existing Traffic	5.47	5.63
	US-41/US-141 SB	7,394,900	Brown	HMA	New Traffic	5.50	5.63

Table 5.2.5 - Truck Route 3 Simulations

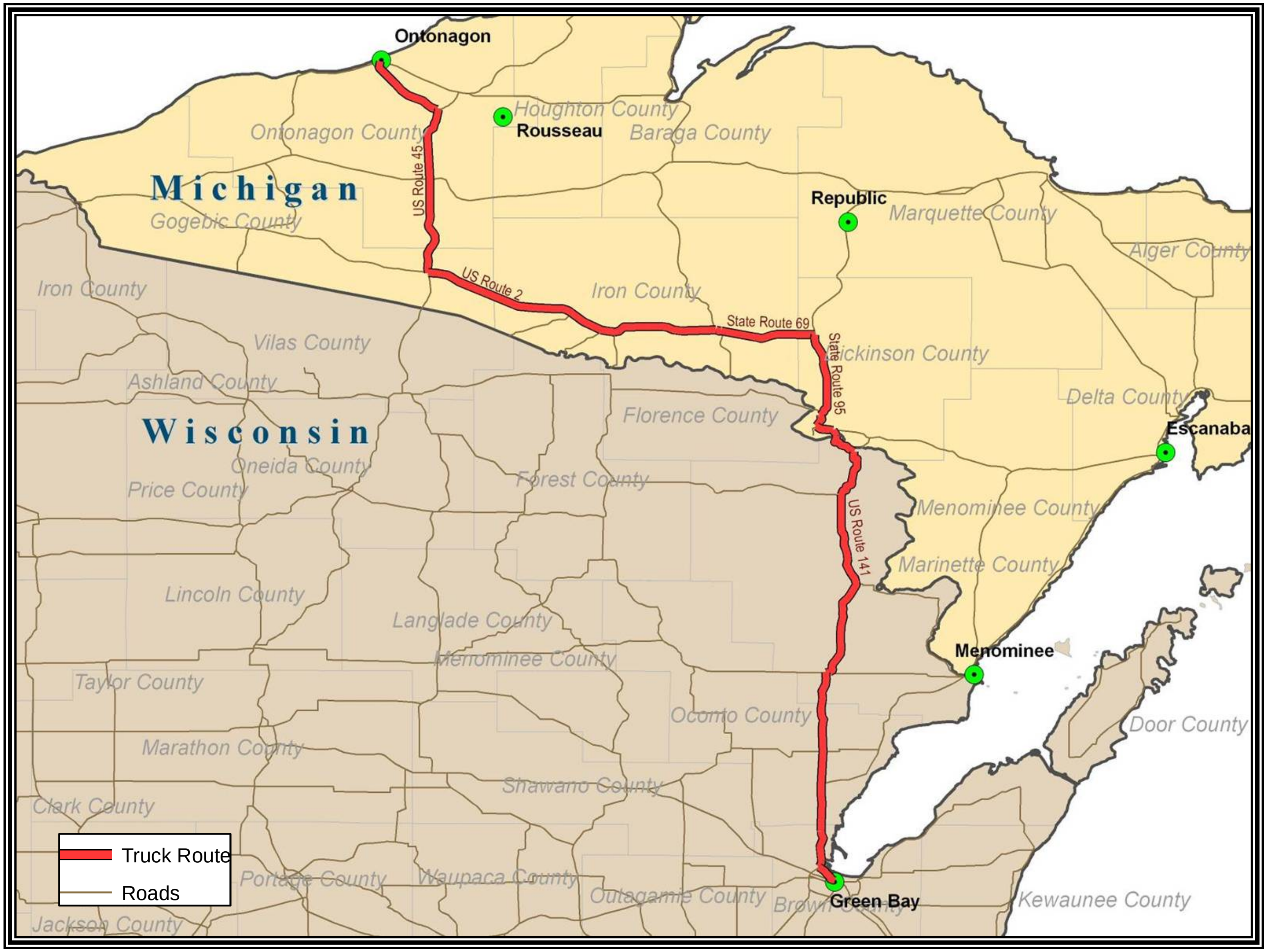
Case Study	Route	Calculated ESAL's	County	Pavement Type	Simulation	Required SN	As Built SN
Route 3	M-38 EB	255,500	Houghton	HMA	Existing Traffic	3.56	4.71
	M-38 EB	292,000	Houghton	HMA	New Traffic	3.64	4.71
	NF-16 SB	489,100	Ontonagon	HMA	Existing Traffic	3.41	4.45
	NF-16 SB	518,300	Ontonagon	HMA	New Traffic	3.44	4.45
	NF-16 SB	489,100	Houghton	HMA	Existing Traffic	3.41	4.45
	NF-16 SB	518,300	Houghton	HMA	New Traffic	3.44	4.45
	M-28 EB	897,900	Houghton	HMA	Existing Traffic	4.79	3.91
	M-28 EB	934,400	Houghton	HMA	New Traffic	4.82	3.91
	M-28 EB	897,900	Baraga	HMA	Existing Traffic	4.79	4.30
	M-28 EB	934,400	Baraga	HMA	New Traffic	4.82	4.30
	US-141 SB	584,000	Baraga	HMA	Existing Traffic	3.74	5.54
	US-141 SB	657,000	Baraga	HMA	New Traffic	3.80	5.54
	US-141 SB	584,000	Iron	HMA	Existing Traffic	4.03	3.56
	US-141 SB	657,000	Iron	HMA	New Traffic	4.11	3.56
	US-141 SB	584,000	Iron	HMA	Existing Traffic	4.03	4.62
	US-141 SB	657,000	Iron	HMA	New Traffic	4.11	4.62
	US-2 EB	744600	Florence	HMA	Existing Traffic	3.92	4.54
	US-2 EB	876000	Florence	HMA	New Traffic	4.02	4.54
	US-2/US-141	3,518,600	Dickinson	HMA	Existing Traffic	5.20	4.88
	US-2/US-141	3,759,500	Dickinson	HMA	New Traffic	5.25	4.88
	US-2/US-141	3,518,600	Dickinson	HMA	Existing Traffic	5.20	4.33
	US-2/US-141	3,759,500	Dickinson	HMA	New Traffic	5.25	4.33
	US-2/US-141	3,518,600	Dickinson	HMA	Existing Traffic	5.20	1.98
	US-2/US-141	3,759,500	Dickinson	HMA	New Traffic	5.25	1.98
	US-8 SB	1,766,600	Marinette	JRCP	Existing Traffic	N/A	N/A
	US-8 SB	3,197,400	Marinette	JRCP	New Traffic	N/A	N/A
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	4.55
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	4.55
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	3.08
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	3.08
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	3.14
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	3.14
	US-141 SB	1,766,600	Marinette	HMA	Existing Traffic	3.92	3.20
	US-141 SB	1,985,600	Marinette	HMA	New Traffic	4.00	3.20
	US-141 SB	1,766,600	Marinette	JPCP w/dowels	Existing Traffic	N/A	N/A
	US-141 SB	3,197,400	Marinette	JPCP w/dowels	New Traffic	N/A	N/A
	US-141 SB	5,095,400	Oconto	JPCP w/dowels	Existing Traffic	N/A	N/A
	US-141 SB	5,664,600	Oconto	JPCP w/dowels	New Traffic	N/A	N/A
	US-41/US-141 SB	3,175,500	Oconto	HMA	Existing Traffic	4.94	6.08
	US-41/US-141 SB	3,511,300	Oconto	HMA	New Traffic	5.01	6.08
	US-41/US-141 SB	7,095,600	Brown	HMA	Existing Traffic	5.47	5.63
	US-41/US-141 SB	7,394,900	Brown	HMA	New Traffic	5.50	5.63

Map 5.2.2 - Case Study 2 Overview of Rail Routes

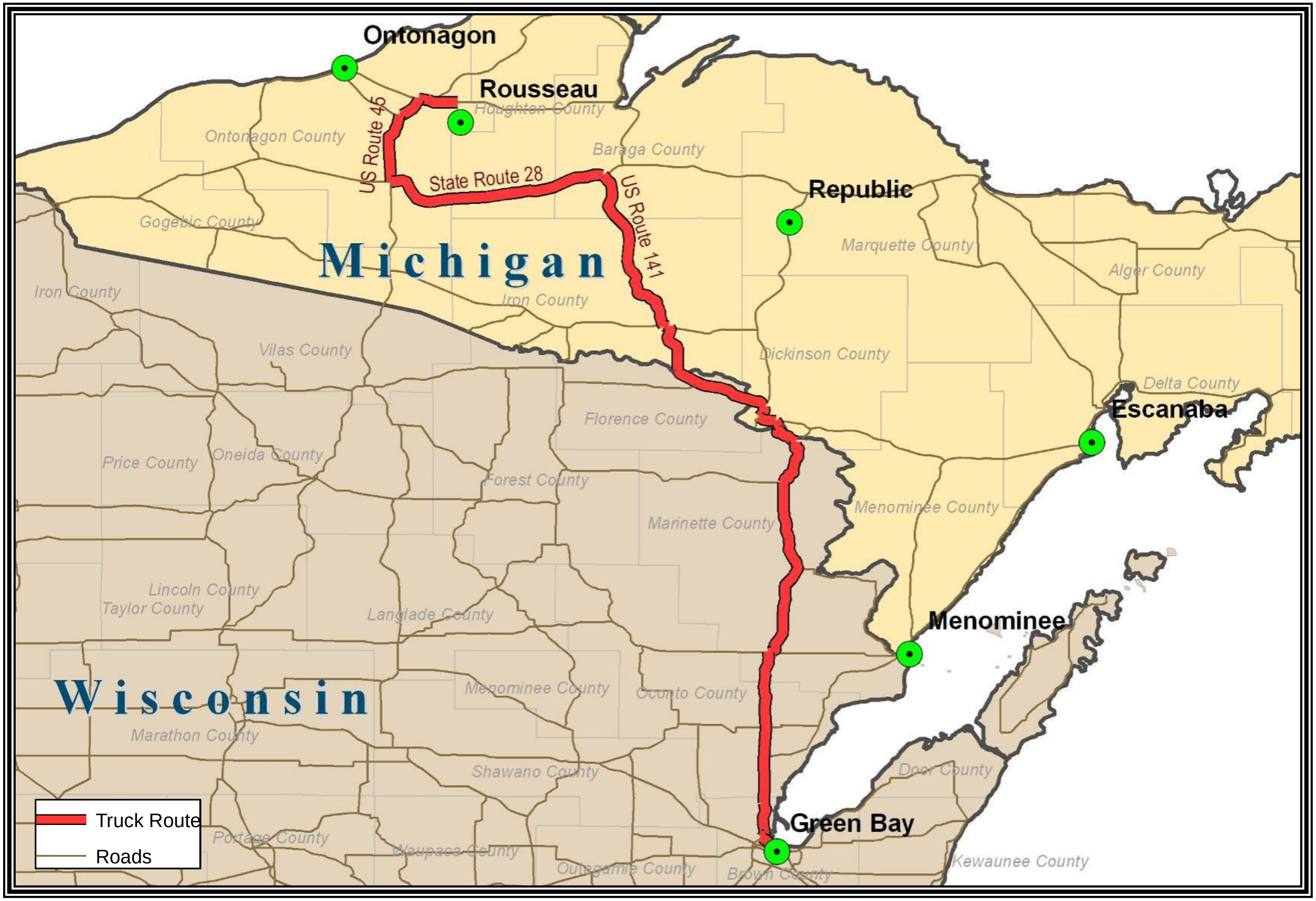


Map 5.2.3 - Truck Route 1, Menominee, MI to Green Bay, WI

Map 5.2.4 - Truck Route 2, Ontonagon, MI to Green Bay, WI



Map 5.2.5 - Truck Route 3, Rousseau, MI to Green Bay, WI

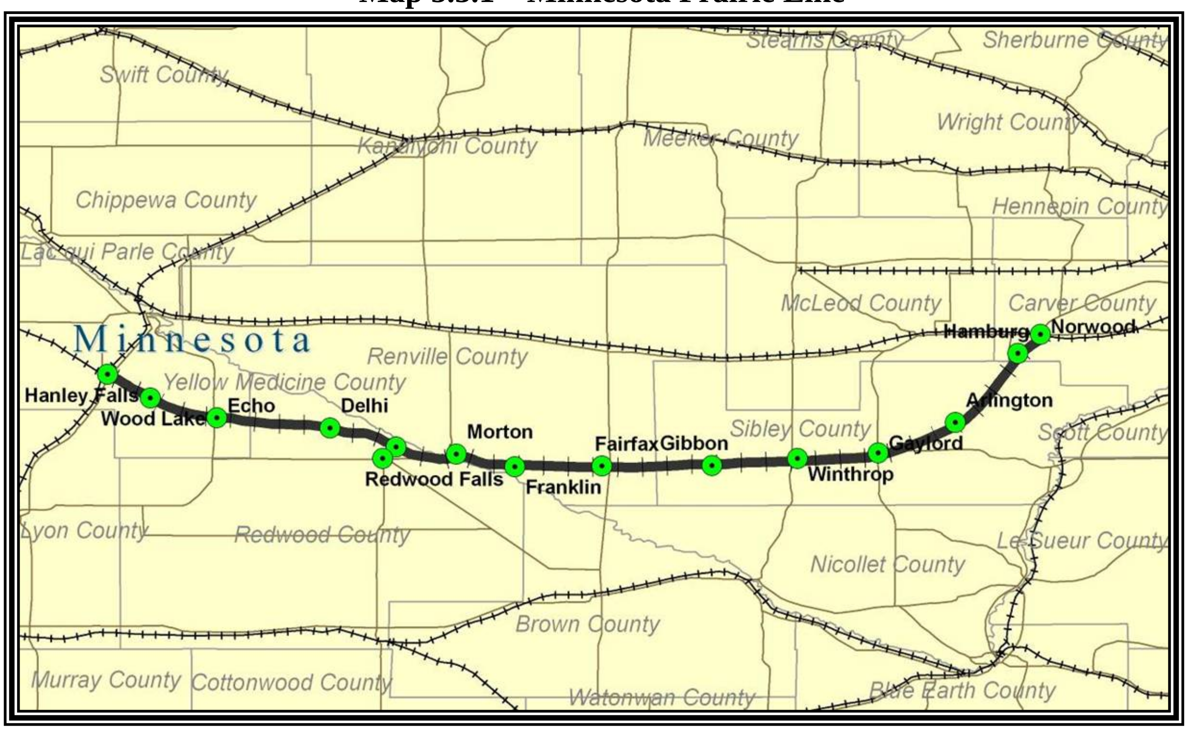


5.3. Minnesota Prairie Line (MPLI)

5.3.1. Case Study Route Selection

The Minnesota Prairie Line (MPLI) is a subdivision of the Twin Cities Western Railroad, and is shown in Maps 5.3.1 and 5.3.3. The traffic on this line was analyzed from Hamburg, MN on the eastern side of the line to Hanley Falls, MN on the western end of this rail segment. There are 19 shippers identified on this segment of track. Some shippers have several locations along this line. The primary activity along this line is agricultural in nature. Trucks bring grain to farm co-ops located along this line, which in turn load railcars for shipment to markets beyond. Some fertilizer comes inbound to farms that grow for these co-ops. There are several manufactures located on this line; some using rail service, some using intermodal service, and some who truck all of their products. Door manufacturers bring inbound product from overseas origins via container, over the Twin Cities intermodal terminals. These containers are then trucked to Gaylord, MN. Ethanol is another product, which has grown rapidly in the past few years. An ethanol plant was built on this line before the study began but had not come online with freight volumes during the data evaluation phase of the project.

Map 5.3.1 – Minnesota Prairie Line



5.3.2. Background

The Minnesota Department of Transportation lists four classes of railroads based on the Federal Railway Administration's criteria that serve the state. There are four Class I railroads (Annual Gross Operating Revenue over $261.9 million) which operate across 2821 miles of track. There are 5 Class II (Annual Gross Operating Revenue between $21.0 million & $261.9 million) with 861 miles of track. There are 15 Class III carriers operating 775 miles of railroad in Minnesota. The MPLI is a Class III railroad (Annual Gross Operating Revenue below $21.0 million) with a total of 94 miles of track including sidings. Finally, there are 3 privately held railroads which operate across 57 miles.

The State of Minnesota is critically aware of their rail resources and has been a strong advocate for shipper access and rail preservation. The Minnesota Statewide Freight Plan completed in 2005 identifies the importance of infrastructure condition, connectivity and capacity for statewide, national and international freight networks. Many of these national and international freight corridors rely heavily upon freight railroads to move goods to and from global sources.

The State of Minnesota supports a rail line rehabilitation program which provides loans to railroads if they can raise 30% of the project funds for track upgrades provided specific conditions can be met.

5.3.3. Data Collection

Table 5.3.2 Minnesota Prairie Line 2004 Annual Volumes illustrates the MN Prairie Line stations and the freight reported by the TCW railroad for all twelve months of 2004. The primary commodities moving by rail in the corridor are agricultural. Legal size and weight rules allow trucks to have a gross weight of 80,000 pounds. Based on typical tractor and trailer equipment, an assumption was made that each truck could carry 48,000 pounds given the bulk nature of the products. It is important to note that the volumes inbound and outbound are not balanced. This will result in empty trucks coming to the region to pick up freight which is moving to destinations beyond the local area. Some trucking equipment can allow for heavier payloads, yet given standard equipment configurations and industry averages, for the purpose of this study a trucking unit is estimated to weigh 48,000 lbs. Grain shippers were asked about truck weight and confirmed this assumption.

Initial customer interviews identified that intermodal service was used for import and export products. These shipments move by truck to and from intermodal terminals in the Twin Cities. These freight volumes were not captured in the rail tonnage identified in this table. This table lists only freight moving in carload quantities as reported by the Twin Cities Western Railroad. If the Minnesota Prairie Line no longer existed it would result in approximately 5,104 more fully loaded trucks on the local roads annually. It is assumed that for every load originated, an empty truck move would have to be made to pick up the load.

5.3.4. Logistical Flow of New Truck Freight

The research team approached modal conversion in two ways. The first approach was to take the existing freight movements and assume that the flows would stay in place but the mode or means of transport might change. Rail tonnage was converted to truck equivalents and the same traffic lanes were assumed to remain intact.

The second method of mode conversion estimation was included in the shipper interviews. Users were asked how the loss of the rail service would impact their logistics flows. There were three potential outcomes:

a) mode shift yet lane remained constant
b) mode shift to an intermediate transfer point (alternate shuttle train site)
c) mode shift resulted in market shift

The shipper population along this short line was small. In general high value products would remain in the same lanes, bulk or agricultural shipments (primarily outbound) were likely move to other shuttle train loading facilities generally within 75-100 miles of the production point (Minnesota Statewide Freight Plan May 2005). These movements to intermediate loading points generally followed the route to final long haul rail destinations, therefore truck lane estimates were the same within the first +/-100 miles of the facilities. On routes over 100 miles away from the point of shipment, fewer trucks maybe realized. Map 5.3.9 illustrates that freight moving to or from Pacific Northwestern states would still move westbound to shuttle facilities.

In the case of ethanol, which showed no tonnage in the 2004 data set, producers indicated that end user markets would dramatically shift. Today ethanol moves to the East and West coasts, where ethanol prices are higher than in the Midwest. Ethanol is not a product easily transferred or transloaded due to the nature of the product. Producers indicated that if they lost rail service their entire customer base would change. Because ethanol was not included in the 2004 data this dramatic conversion was not calculated.

The primary focus of this study was on state and county road impact if freight converted from rail to truck. It was evident in the data analysis and after validation in the shipper interview process, that many factors influence freight modes and lanes. While end use markets may change, the first miles from the point of origin to either a transload point or a regional market remained the same. Therefore, the truck impact within the first 100 miles surrounding the infrastructure loss would remain constant.

Transload centers are located on the same rail network that MPLI would eventually interchange with, as shown in Map 5.3.11. The truck movement to these centers would generally follow the same three interstate corridors to access a transload or shuttle facility. The mode conversion from rail to truck may not equal the same total highway miles to final destination, but the “first mile” regional impact would be the same.

The economic reality is that the price sensitivity of relatively low value agricultural products means that transportation costs greatly influence their markets. Low transportation costs allow a wider market range and high transportation costs will limit or, in some cases, prohibit entry into markets. A rise in transportation costs, which include, handling, storage, invoicing, insurance, repositioning of trucks, and freight rates, could also divert low value products to entirely new markets where they are price competitive. If the truck transportation costs are raised too high for this grain moved to this market or the ethanol being shipped out, the potential end result may be a closure of businesses dependent on the agricultural products.

Map 5.3.4 illustrates the stations served by the MPLI. The eastern most stations on this line are in Hamburg and Arlington, MN, and are located on MN Highway 5. MN Highway 5 meets MN Highway 19 at Gaylord, MN. The MPLI stations of Gaylord, Winthrop, Gibbon, Fairfax, Franklin, Morton, and Redwood are on Highway 19. The stations of Delhi, Echo and Wood Lake are small volume locations. Delhi is on a paved secondary State Road 6, Echo is served by MN State Highway 67 and Wood Lake is on MN State Highway 274.

Inbound and outbound freight lanes were identified for each station served by the MPLI. Routes were mapped for each of the 10 stations which generated freight in 2004 along the MPLI line. While each station had a unique set of origin and/or destination pairs, freight generally traveled to one of three highway corridors: I-90, I-94 or I-35, as shown in Maps 5.3.5 and 5.3.6. A smaller segment of freight moved to and/or from St. Paul, MN which would move along the same route that eastbound tonnage to I-94.

Freight moving to and from the western states of Washington, Oregon, Idaho, Montana, and North Dakota, and Canadian provinces of British Columbia and Alberta, would find local routes to Interstate 94 westbound. If freight was pushed to another shuttle train point, these locations are all west of the MPLI which means trucks would move along the same initial routes. Freight moving to southern destinations would find secondary highways to Interstate 35 southbound. Freight moving to St Paul, Minnesota; Wisconsin; Illinois; and points east of the Mississippi would find routes to Interstate 94 eastbound. Freight moving to Utah, Arizona, and California would travel to Interstate 90. If freight would be suitable to use a transload facility these sites would be found along these same routes.

Freight which would move to and from businesses located near MPLI along route MN 19 would move on US 212 on to I-494 and on to I-94 to points in the Twin Cities, Wisconsin, Illinois, New York, Tennessee, and the eastern United states. Freight to and from St. Paul would move via this same corridor. Intermodal freight moves along this route but was not captured in the tonnage data.

Freight which would move to Texas and Gulf Coast States from MPLI locations would travel on MN 19 to I-35. Freight which moved westbound from MPLI stations took CR 9 to CR 15 to CR 13 to CR 2 to MN 22 to MN 15 to I-94. Intrastate MN movements from Delhi, MN to Mankato took CR 6 to MN 19 to MN 4 to US 14 to US 169. Freight moving to St Paul took MN 19 to MN 212 to I-494.

Stations in Winthrop and Wood Lake generated freight to/from Utah, Arizona, California and the Southwestern United States. This traffic, if it would move via truck, would find local roads to I-90. Table 5.3.3 Minnesota Prairie Line 2004 Annual Regional Volumes summarizes truck equivalents by destination region. Map 5.3.7 shows routes for eastbound and intrastate traffic; Map 5.3.8 shows traffic moving to or from southwestern locations; and Map 5.3.9 shows routes for traffic going to or from Pacific Northwestern locations. These illustrate the actual routing for the largest station volume.

During the interview process, the research team identified that additional capacity has been added to an ethanol plant in Winthrop, MN, as of November 2006. Ten years ago this site generated about 10 million gallons of ethanol per year; with the new expansion in 2006 this plant now produces 95-100 million gallons per year. This volume is not reflected in the charts or truck equivalent estimates. This has resulted in increased volume along the line. This plant now ships 90-100 car unit trains. In 2004, traffic moved primarily to western destinations but with new capacity, the shippers feel that the market is larger in the eastern cities and current volumes are now going east via rail.

The second largest freight volumes generated on this short line are driven by grain shippers. Map 5.3.9 also illustrates the route for grain diversions to BNSF Loading Facility. These shippers bring inbound fertilizer and ship outbound wheat crops. This traffic moves to and from the elevators in Winthrop and Arlington, where shuttle trains of 25 cars are loaded three times per week. If the MPLI short line was no longer viable, the crops would be loaded at other mills in the region either located on the BNSF line or on the DME line. Freight would not move over the road to final destination but instead would find the next closest elevator. This would mean that 4,804 trucks would find the elevators in Springfield, MN instead of coming to Winthrop or Arlington, MN. The local impact is somewhat difficult to judge since these trucks move from local farms today to Winthrop and Arlington.

5.3.5. Pavement Design

The pavement design was based upon the flows generated in Section 5.3.3. The diversion of freight is anticipated to occur over three routes, and includes 14 pavement cross-sections (designs). The pavement design procedures used by the Minnesota DOT are mechanistic-empirical ones calibrated for use in Minnesota. The design process is encapsulated in the software program MnPAVE for flexible pavements, but a similar approach does not exist for concrete pavements. Thus the 1993 AASHTO Pavement Design Guide was utilized to examine the pavement structures and the impact of the diverted freight.

The total tonnage during the most recent year of shipping on the railroad was measured and then divided by 48,000 lbs. to determine the additional number of trucks that would be on the highway routes. While gross vehicle weight is limited to 80,000 lbs., it is assumed that the tare weight of the truck and trailer equipment averages 32,000 lbs. The number of trucks was estimated based on a straight tonnage conversion methodology. Actual shipments may be somewhat higher based on specific order quantities or production limitations. It was calculated that there would be an annual increase of 5,104 trucks on the three routes listed above. However, the trucks will be distributed along the routes according to the conversations with the various shippers and some assumptions when needed. It was assumed that the additional trucks would be type 3S-2 trucks (Class 10 trucks). Two simulations for each route were performed for the existing traffic and the new traffic if the short line railroad closes. It was determined that there would be no impact on any of the 14 pavement sections in terms of required structural number for the three different routes based upon the 2004 data. It is important to point out that the structural adequacy of 11 of the 14 pavement sections were found to be inadequate. The recent installation of a 100 million gallon per year ethanol plant on the shortline in 2006 has substantially increased the freight on the shortline and this impact was examined too. The estimated increase in freight is: 100,000,000gallons X 8.6lbs/gallon X 1ton/2000lbs X 1 Truck/24Tons = 17,917 Trucks. This assumes all ethanol produced is shipped from the ethanol plant by rail and does not include incoming rail freight nor ethanol co-product shipment such as distillers grains by rail. A conservative estimate of total freight including the ethanol components is equivalent to 25,520 trucks (80,000lb gross vehicle weight). The impact of the diverted freight on the 3 routes consisting of the 14 pavement sections was reassessed and assumed the same proportional distribution of trucks on the routes based upon the 2004 shipper data.

Table 5.3.1 summarizes the simulations of the existing loading on the 14 pavement sections and the added truck traffic on the sections with the diverted freight. The addition of the ethanol plant does increase the need for improved structural adequacy from the previous year when the plant was not operational, but did not move the remaining three pavement sections from being adequate to inadequate. The diverted freight from the short line would increase the structural needs of 10 of the 14 pavement sections if adequately designed for the current loading. All three routes would be impacted if the short line freight was diverted to trucks, with the segment from Winthrop to the intersection of Highway 15 with I-94 being impacted the most.

5.3.6. Minnesota Asset Management

Due to the light volume of truck traffic foreseen from modal shift based on the 2004 data the Asset Management research team did not contact Minnesota DOTs Asset Management division. The addition of what is projected to be considerably increased traffic from the Ethanol plant, that is not part of the 2004 data set, would mean that any future evaluation should include an evaluation of the impact on MNDOTs asset management planning.

5.3.7. Summary

If the Minnesota Prairie Line subdivision of the Twin Cities and Western Railroad no longer existed it would result in approximately 5,104 more trucks on the local roads. This figure does not take into account the additional ethanol production from a plant expansion that became operational in the middle of the study. It is estimated that the number of trucks has increased by over 400 percent with this addition to the ethanol plant, thus resulting in more than 25,000 trucks on the local roads if the short line were closed. Current users were optimistic that this increased activity would be justification to increase levels of service and maintenance along the line. Some shippers located on the MPLI line had rail sidings and had previously used rail service but due to increased rail rates and car shortages found that truck shipment was a preferred mode given the ease of doing business. Other users along the line feel that rail service may be an option for them in the future if truck rates increase and rail service and frequency improves.

When users were asked about alternatives to rail, the ethanol facility felt that there were no other viable transportation alternatives to rail given the volume and the volatile nature of the finished product. This facility was specifically located on the available short line to gain access to multiple Class 1 railroads. They consciously did not locate on a Class 1 rail carrier in order to improve their competitive transportation position.

A conservative approach was taken to estimating the added freight from the ethanol plant and its impact on the three routes. The increased freight from the ethanol plant is substantial with structural aspects of 10 of the 14 pavement sections being increased. However, 11 of the 14 pavement sections are already structurally inadequate.

5.3.8. Tables and Maps

Table 5.3.1 - Pavement Design Simulations for the Minnesota Prairie Line Truck Routes

Case Study	Route	Pavement Section	Calculated ESAL's	Pavement Type	County	Simulation	Required SN	As Built SN	Calculated Pavement Thickness (in)	As Build Pavement Thickness (in)
Route 1	HWY 212 from HWY 41 to HW	1	181,100	Composite	Mcleod	Existing Traffic	5.49	4.54	N/A	N/A
	HWY 212 from HWY 41 to HW	1	193,220	Composite	Mcleod	New Traffic	5.54	4.54	N/A	N/A
	HWY 212 fromHWY 494 to HW	2	781,800	JPCP	Carver	Existing Traffic	N/A	N/A	11.74	13.50
	HWY 212 fromHWY 494 to HW	2	793,920	JPCP	Carver	New Traffic	N/A	N/A	11.74	13.50
	HWY 494 from HWY 77 to HW	3	828,600	Composite	Dakota	Existing Traffic	5.06	4.35	N/A	N/A
	HWY 494 from HWY 77 to HW	3	840,720	Composite	Dakota	New Traffic	5.07	4.35	N/A	N/A
	HWY 494 from HWY 13 to HW	4	884,900	HMA	Dakota	Existing Traffic	4.82	5.19	N/A	N/A
	HWY 494 from HWY 13 to HW	4	897,020	HMA	Dakota	New Traffic	4.82	5.19	N/A	N/A
	HWY 494 from HWY 94 to WI	5	1,417,600	JPCP	Washington	Existing Traffic	N/A	N/A	12.84	9.00
	HWY 494 from HWY 94 to WI	5	1,429,720	JPCP	Washington	New Traffic	N/A	N/A	12.86	9.00
Route 2	15 E of New Ulm	6	86,600	JPCP	Nicollet	Existing Traffic	N/A	N/A	8.18	7.50
	15 E of New Ulm	6	90,515	JPCP	Nicollet	New Traffic	N/A	N/A	8.25	7.50
	15 S of New Ulm	7	88,823	HMA	Brown	Existing Traffic	3.43	4.09	N/A	N/A
	15 S of New Ulm	7	92,738	HMA	Brown	New Traffic	3.46	4.09	N/A	N/A
	60 at St. James	8	166,600	JPCP	Watonwan	Existing Traffic	N/A	N/A	9.15	9.00
	60 at St. James	8	170,515	JPCP	Watonwan	New Traffic	N/A	N/A	9.18	9.00
Route 3	On Th15 just N of Winthrop	9	58,114	JPCP	Sibley	Existing Traffic	N/A	N/A	7.62	7.50
	On Th15 just N of Winthrop	9	67,599	JPCP	Sibley	New Traffic	N/A	N/A	7.83	7.50
	HWY 15 from HWY 212 to Hutc	10	136,200	HMA	Mcleod	Existing Traffic	5.29	3.16	N/A	N/A
	HWY 15 from HWY 212 to Hutc	10	145,685	HMA	Mcleod	New Traffic	5.33	3.16	N/A	N/A
	On Th15 just N of Hutchinson	11	94,034	JPCP	Meeker	Existing Traffic	N/A	N/A	8.30	8.00
	On Th15 just N of Hutchinson	11	103,519	JPCP	Meeker	New Traffic	N/A	N/A	8.44	8.00
	On Th15 just S of Jct 15/12	12	53,500	Bit. Aggregate	Wright	Existing Traffic	4.65	1.01	N/A	N/A
	On Th15 just S of Jct 15/12	12	62,985	Bit. Aggregate	Wright	New Traffic	4.75	1.01	N/A	N/A
	On Th 15 just N of Jct 15/12	13	54,200	Bit. Aggregate	Meeker	Existing Traffic	4.66	1.01	N/A	N/A
	On Th 15 just N of Jct 15/12	13	63,685	Bit. Aggregate	Meeker	New Traffic	4.76	1.01	N/A	N/A
	On Th15 just S of Jct 15/94	14	139,417	HMA	Sherber	Existing Traffic	5.30	4.84	N/A	N/A
	On Th15 just S of Jct 15/94	14	148,902	HMA	Sherber	New Traffic	5.35	4.84	N/A	N/A

Map 5.3.2 – Minnesota DOT Rail Map

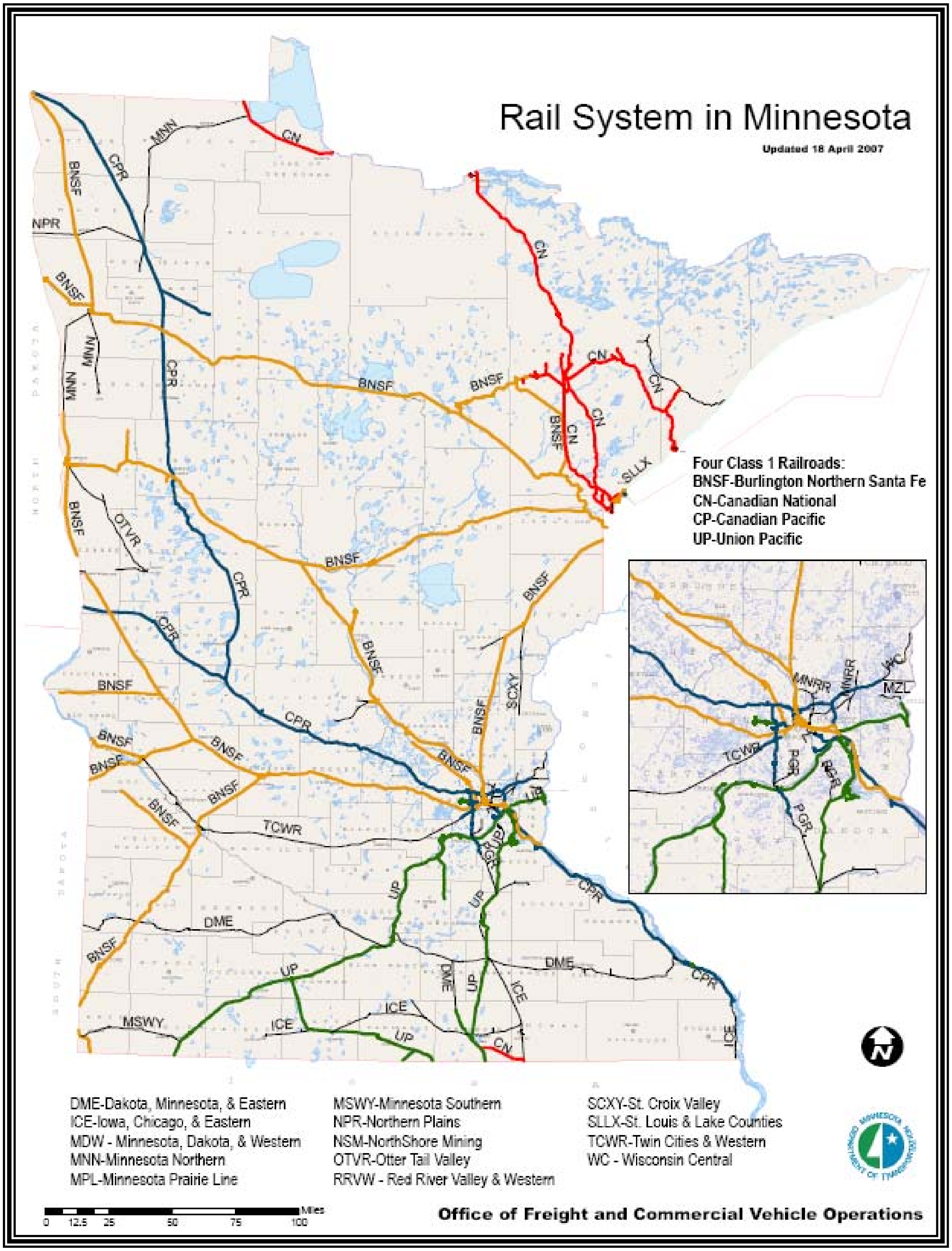


Table 5.3.2 - Minnesota Prairie Line 2004 Annual Volumes

Minnesota Prairie Line 2004 Annual Volumes					
Station	**Outbound Pounds (000)**	**Outbound Truck Equivalents**		**Inbound Pounds (000)**	**Inbound Truck Equivalents**
Hamburg	0	0		0	0
Greendale	0	0		0	0
Arlington	18,996	396		0	0
Gaylord	0	0		3,315	69
Winthrop	34,199	712		0	0
Gibson	0	0		0	0
Fairfax	45,170	941		6,040	126
Franklin	0	0		8,318	173
Morton	1,019	21		192	4
Redwood Falls	324	7		0	0
Delhi	91,588	1,908		0	0
Belview	0	0		0	0
Echo	2,000	42		7,421	155
Wood Lake	13,952	291		12,474	260
Henley Falls	0	0		0	0
TOTAL	207,248	4,318		37,760	787

Table 5.3.3 - Minnesota Prairie Line 2004 Annual Regional Volumes

Minnesota Prairie Line 2004 Annual Regional Volumes			
Route	**Highway Segments**	**Pounds (000)**	**Truck Equivalents**
East	Local I494 - I94 E	86,853	1,809
South	Local to I 90 W	18,388	383
West	Local to I 94W	91,054	1,897
Southwest	Local to I 35 S	19,208	400
MN	St Paul Area	29,504	615
Total		***245,007***	***5,104***

Map 5.3.3 - Twin Cities and Western Railroad Company

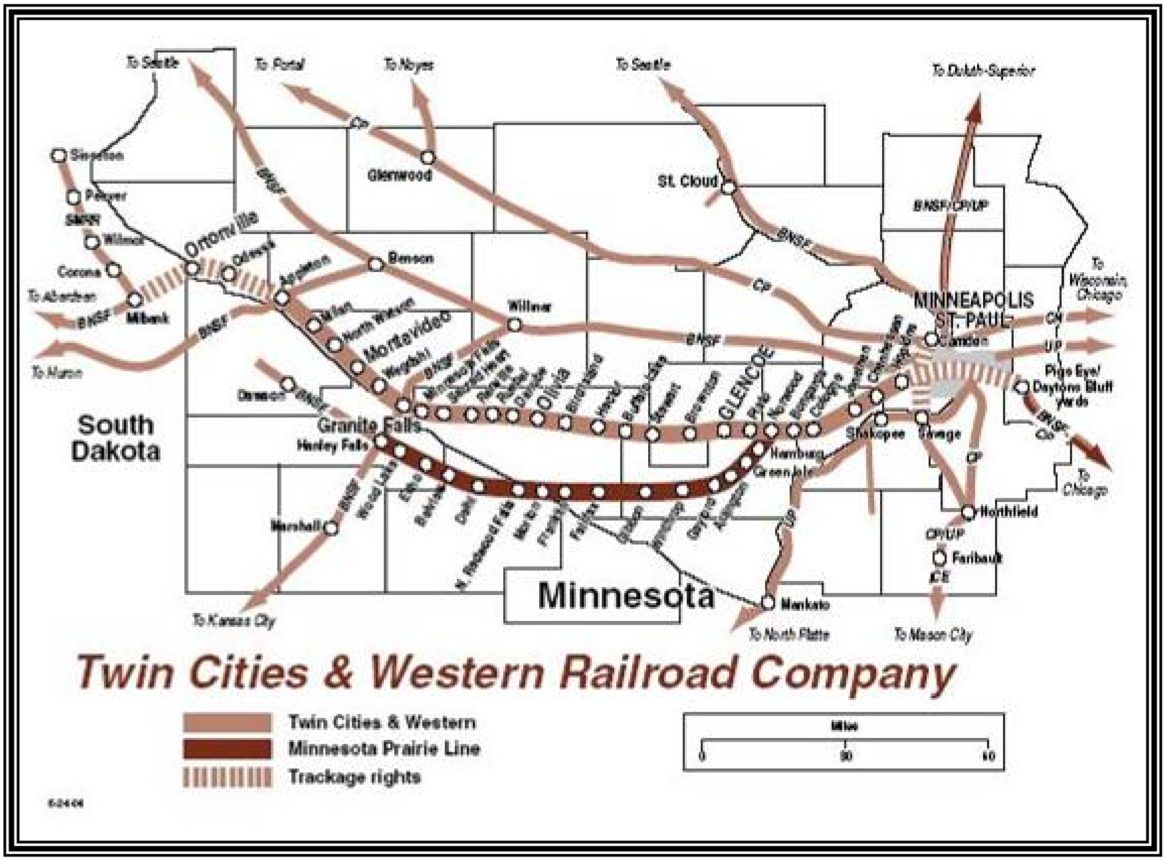
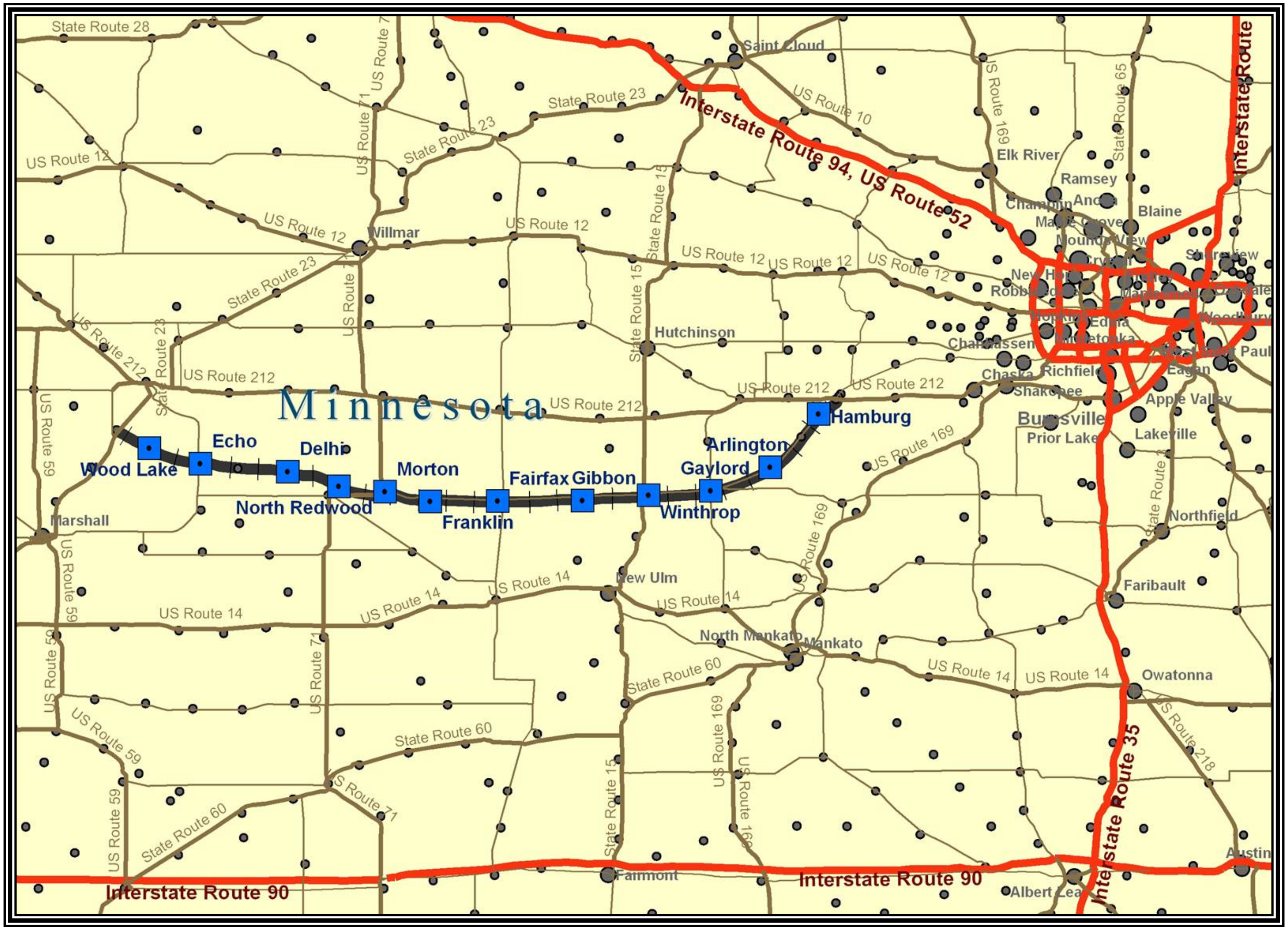


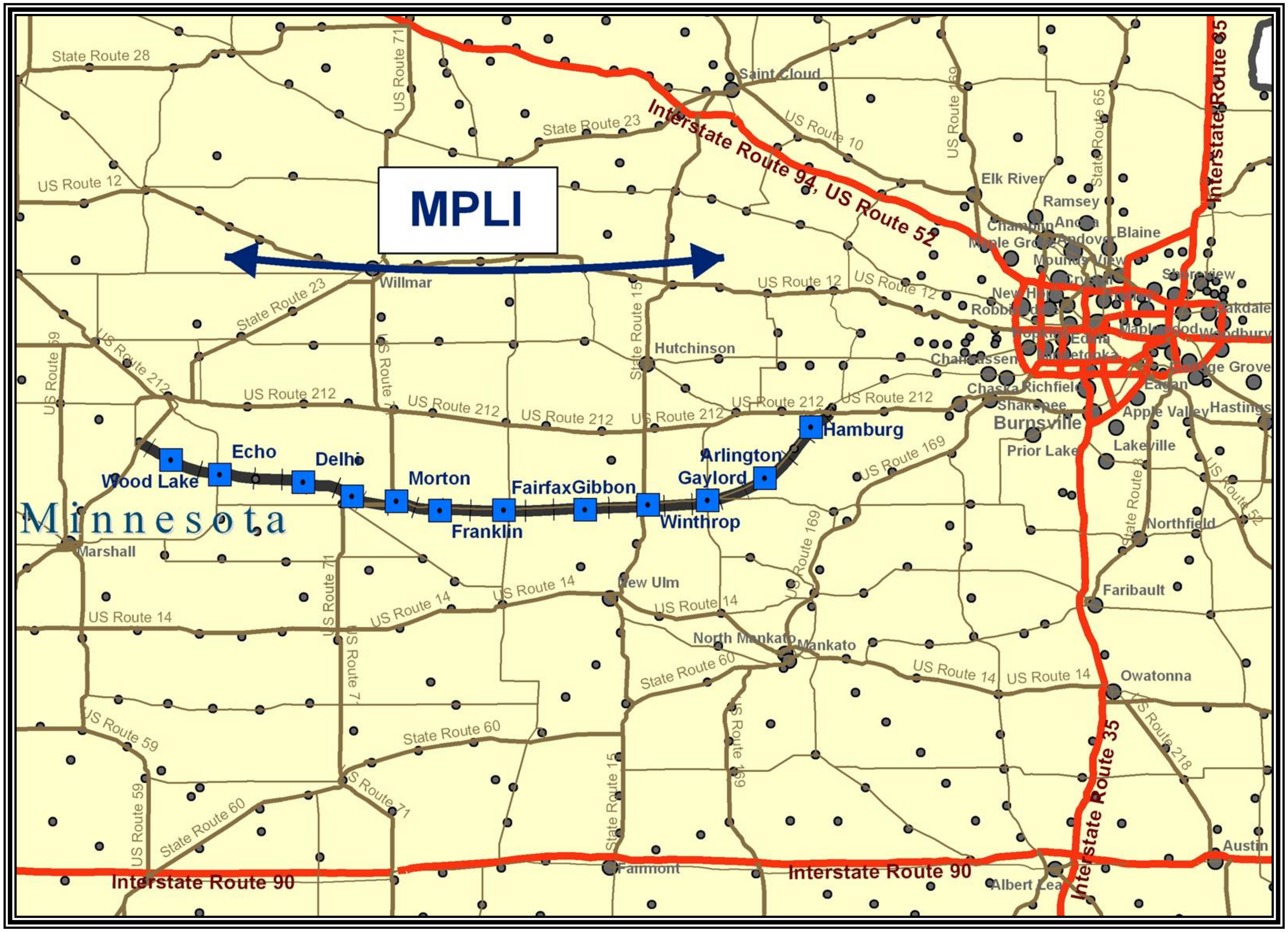
Table 5.3.4 - Minnesota Prairie Line Stations

Twin Cities and Western Railroad Stations Case Study 5.3	Distance Between Rail Stations
Norwood, MN	0
Glenco, MN	11 miles
Olivia, MN	42 miles
Granite Falls, MN	27 miles
Total Miles of track	**80 miles**

Map 5.3.4 - MN Truckers Highway Map

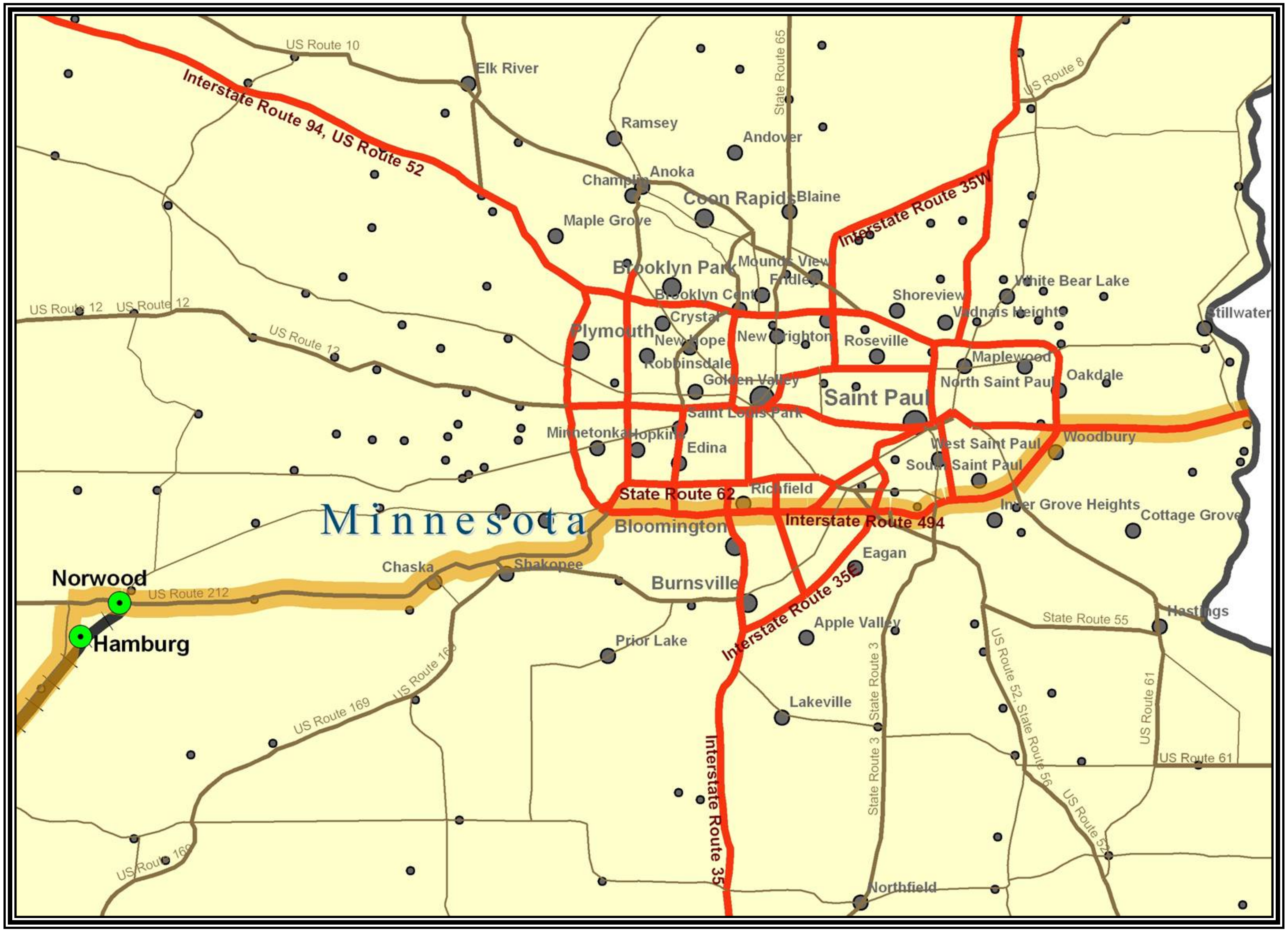


Map 5.3.5 - MN Truckers Highway Map



Map 5.3.6 – MPLI Flow

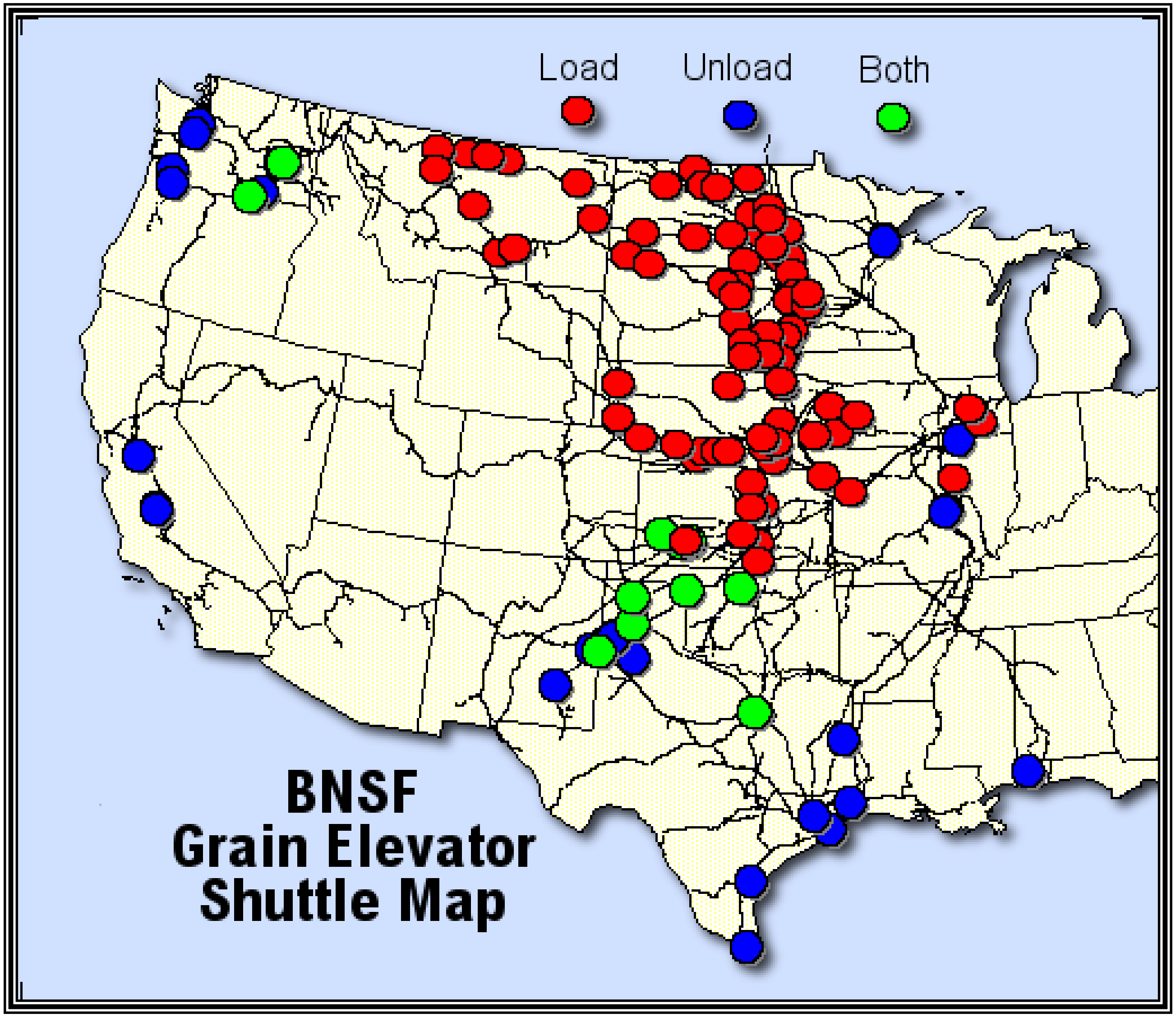
Map 5.3.7 - Routes for Eastbound and Intrastate Minnesota Traffic



Map 5.3.8 - Routes for Traffic Moving To/From Southwestern Locations

Map 5.3.9 - Routes for Traffic Going To/From Pacific Northwestern Locations

Map 5.3.10 - BNSF Grain Elevator Shuttle Map



Map 5.3.11 - Transload Distribution Association – Transload Locations

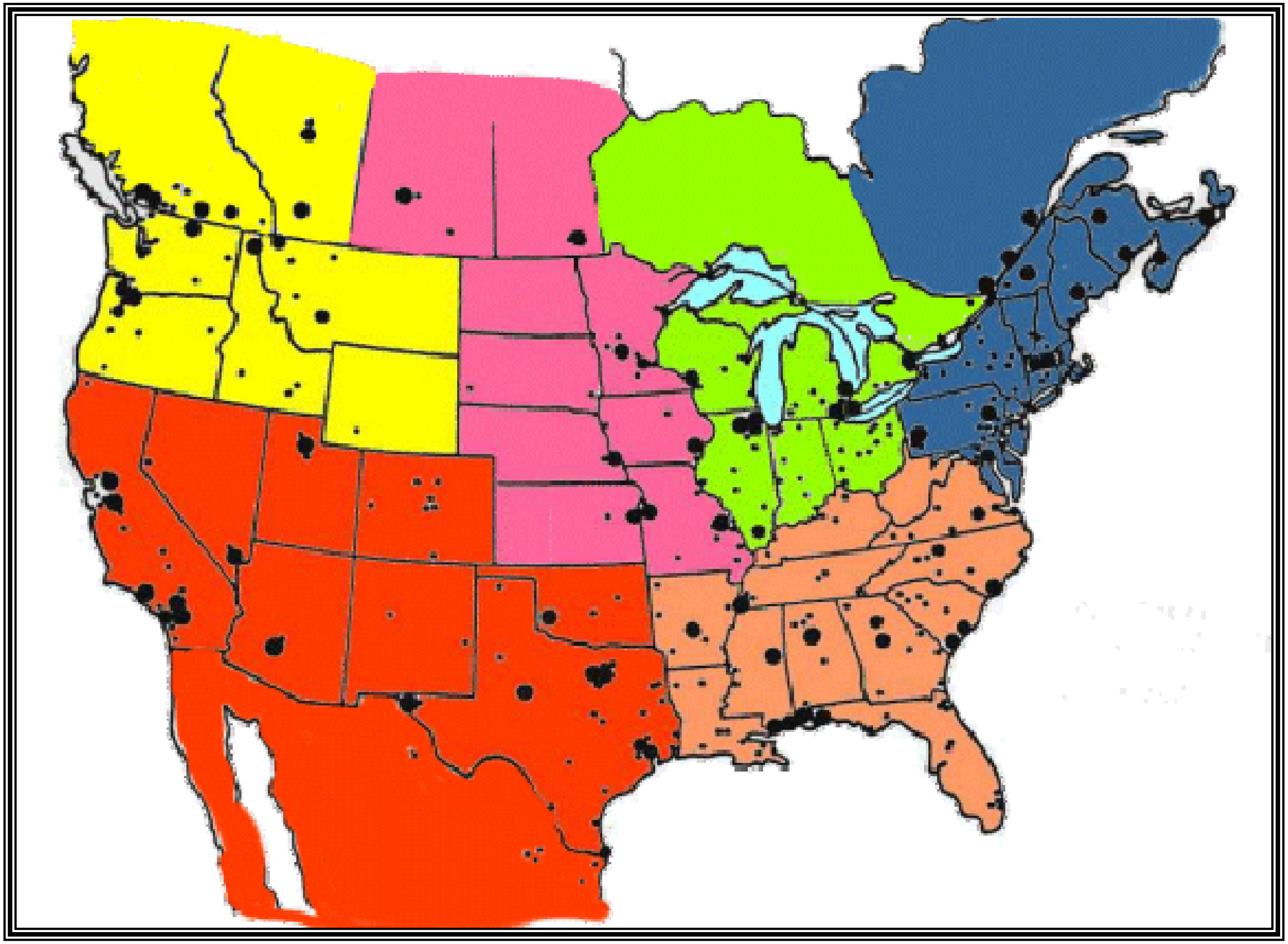


Table 5.3.5 – Commodity Volumes

Commodity	Truck Equivalent	Pct of Total 2004
Fertilizer	486	9.52%
Salt	231	4.53%
Lumber	69	1.35%
Wheat	4318	84.60%
Total:	5104	

6. GLOSSARY / LIST OF ACRONYMS

WORD OR ACRONYM	***DEFINITION***
3S2 truck (FHWA Class 9)	A 3-axle tractor with a 2-axle semi-trailer
3S3 truck (FHWA Class 10)	A 3-axle tractor with a 2-axle semi-trailer
AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
Asset Management	Systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines engineering principles with sound business practices and economic theory, to facilitate a more organized and logical approach to decision-making.
BNSF	Burlington Northern Santa Fe railroad company; a large Class I carrier that operates over 32,000 route-miles in the U.S., primarily west of the Mississippi River.
Class I or Class 1 railroad	U.S. line haul freight railroads with operating revenue in excess of $319.3 million.
Class II or Class 2 railroad	U.S. line haul freight railroads with annual operating revenues of less than $319.3 million but more than $25.5 million. Generally, Class II carriers are referred to as regional railroads.
Class III or Class 3 railroad	U.S. line haul freight railroads with annual operating revenues of $25.5 million or less; and all switching and terminal companies regardless of operating revenues. Generally, Class III carriers are called short line railroads.
CN	Canadian National railroad company; a large Class I railroad that operates in many parts of Canada, the US, and Mexico.
Composite pavements	Pavement materials that are a combination of hot mix asphalt (HMA) and Portland cement concrete (PCC).
DME or DM&E	Dakota, Minnesota, and Eastern railroad company; one of the largest regional (Class II) railroads in the United States, with 1,103 miles of track located principally in South Dakota and Minnesota.
DOT	Department of Transportation
ELS or E&LS	Escanaba and Lake Superior Railroad; a privately owned short line railroad company operating in Northeastern Wisconsin and the Upper Peninsula of Michigan. Headquartered in Wells, MI, it had over 235 miles of operating railroad as of 2005.

ESAL	Equivalent Single Axle Load
Ethanol	A flammable, colorless, slightly toxic chemical compound that can be used as a motor fuel or fuel additive, mainly as a biofuel alternative to gasoline. Also known as ethyl alcohol, or grain alcohol.
EUAC	Equivalent Uniform Annual Cost
Flexible pavements	Asphalt pavements used where the total pavement structure bends or flexes to accommodate traffic loads.
FHWA	Federal Highway Administration
FRA	Federal Railway Administration
HMA	Hot Mix Asphalt; a combination of aggregate and asphalt binder that forms a pavement material; also known as "asphalt concrete" (AC or ACP), "asphalt", "blacktop" or "bitumen".
Intermodal	Refers to the transportation of freight in a container or vehicle, using multiple modes of transportation (ship, rail, and truck).
IRI	International Roughness Index; a method for estimating roughness of a pavement section.
LCCA	Life-Cycle Cost Analysis
MDOT	Michigan Department of Transportation
Mn/DOT	Minnesota Department of Transportation
MnPAVE	Computer software program that combines known empirical relationships with a representation of the physics and mechanics behind flexible pavement behavior. Developed by researchers at Mn/DOT, in conjunction with the University of Minnesota.
MPLI	Minnesota Prairie Line, Inc; a wholly owned subsidiary of the Twin Cities & Western Railroad. MPLI operates 94 miles of track between Norwood and Hanley Falls, MN.
MRUTC	Midwest Regional University Transportation Center; based at the University of Wisconsin-Madison. MRUTC focuses on research, outreach, and education in asset optimization and management techniques for transportation facilities.
NCHRP	National Cooperative Highway Research Program; conducts research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide. Administered by the Transportation Research Board (TRB).

O&D or Origins and Destinations	As used in the transportation industry, this refers to the point of origin and the final destination of a freight shipment. O&D data can be used to analyze particular freight traffic and other transportation related variables.
PASER	Pavement Surface Evaluation and Rating; a road rating system developed by the University of Wisconsin-Madison Transportation Information Center to be used as the State of Wisconsin's standard road rating system.
PCC	Portland cement concrete, as used as a pavement material.
PDI	Pavement Distress Index; a value that suggests overall pavement distress (i.e. cracking, rutting, raveling, etc.) based on visual inspections of the roadway.
PONTIS	Pontis is a comprehensive bridge management software product for bridge management used by more than forty states; developed by the firm AASHTOWare.
Reebie data	Reebie Associates was a firm that collected and organized unique county-level freight movement databases to provide extensive data and analysis of intra-U.S. commercial freight traffic for Government agencies and transportation providers. In 2005 Reebie Associates was acquired by worldwide forecasting company Global Insight.
Regional railroad	U.S. line haul freight railroads with at least 350 route-miles and operating revenue in excess of $40 million but less than the Class I threshold. Generally, regional railroad carriers are in the Class II category.
Rigid pavements	Portland cement concrete (PCC) pavements that do not flex appreciably under traffic loads.
Short-line or shortline railroad	Local U.S. line haul railroads that fall below the Class II criteria, with annual carrier operating revenues of $25.5 million or less; and includes all switching and terminal railroad companies regardless of operating revenues. Generally, short line railroads are Class III.
SN or Structural Number	A concept developed by AASHTO as a design parameter and an indicator of pavement strength, for both rigid and flexible pavements. The structural design of a pavement using the Structural Number (SN) has become a common practice in the U.S. and many other countries.
TAMC	Transportation Asset Management Council; a council of the Michigan Department of Transportation, also know as the Asset Management Council. Their mission is to expand the practice of asset management statewide to enhance the productivity of investing in Michigan's roads and bridges through coordination and collaboration among state and local transportation agencies.

TC&W	Twin Cities and Western Railroad; a short line railroad company based in Glencoe, Minnesota.
Transload	Transloading is the storage and transfer of cargo at an intermediate facility for the purposes of continuing the movement of the cargo in commerce; and usually includes switching from one transportation mode to another.
TRB	Transportation Research Board; a division of the National Research Council, which serves as an independent adviser to the federal government and others on scientific and technical questions of national importance. The mission of the Transportation Research Board is to promote innovation and progress in transportation through research.
Unit train	A freight train composed of cars carrying a single type of commodity all bound for the same destination. A unit train does not need to switch cars at intermediate junctions, allowing for nonstop runs between two terminals, which reduces the shipping time and cost.
WC or Wisconsin Central	Wisconsin Central Ltd. railroad company; a regional railroad that operated over 2,850 miles of track in the Great Lakes region. In 2001 it was purchased by Canadian National and became integrated into the CN system.
WisDOT	Wisconsin Department of Transportation
WisPave	A software package comprised of pavement design and life cycle-cost-analysis, used by the Wisconsin Department of Transportation and other agencies.
WSOR	Wisconsin and Southern Railroad; a privately owned regional railroad company operating in the southern half of Wisconsin and northeastern Illinois. Headquartered in Milwaukee, WSOR operates 700 miles of track.

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