TITLE PAGE

Upper Midwest Freight Corridor Study

Final Report
March 31, 2005

Performing Organization:
Midwest Regional University Transportation Center
University of Wisconsin-Madison
1415 Engineering Drive, Rm 2205
Madison, Wisconsin 53706
USDOT Region 5

Principal Investigator:
Teresa M. Adams, University of Wisconsin-Madison

Report Authors:
Teresa M. Adams, University of Wisconsin-Madison
Travis J. Gordon, University of Wisconsin-Madison
Ernie F. Wittwer, University of Wisconsin-Madison
Jiwan Gupta, University of Toledo
Peter Lindquist, University of Toledo
Mark Vonderembse, University of Toledo
Kazuya Kawamura, University of Illinois-Chicago
Sue McNeil, University of Illinois-Chicago

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16. Abstract This study was undertaken in order to establish a regional approach to improving freight transportation through the Upper Midwest corridor. Improving freight flows through the region can improve reliability and enhance competitiveness. This study examines several aspects of regional freight transportation including, capacity, performance measures, administrative issues, demand/usage and best practices. The project was funded by, six states in the region, through their Departments of Transportation, have contributed to a pooled fund to finance the majority of the work. These states include Illinois, Indiana, Iowa, Minnesota, Ohio, and Wisconsin.			
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Introduction

The Upper Midwest states are the economic and geographic cross roads of the nation. All major U.S. and Canadian railroads converge in Chicago. Major East-West (I-80, I-90, and I-94) and North-South (such as I-35, I-69, I-71, and I-75) roadways link the states to each other and to the nation. Ports on the Great Lakes and the Illinois, Ohio, Mississippi, and Missouri Rivers carry goods around the nation and to the world. Substantial freight moves through the region's busy airports. In addition, the Upper Midwest is influenced by a strong and growing economy in Ontario. Demand on the region's transportation system is stretching infrastructure to, and in many cases beyond, capacity. While estimates vary, by 2020 the freight moving across this network is expected to increase by about 50 percent. To improve regional, national, and global competitiveness, it is essential that system-wide efficiency and intermodal connectivity are developed to help suppliers, manufacturers, distributors, and retailers. Because the transportation system does not stop at state or provincial boundaries, improvements must be sought at a regional level.

Phase One of the study was largely concerned with the collection of data and a description of the scope of freight issues across the region. Analysis was expressly given a secondary role. Despite this focus, the data makes some findings inescapable:

- The free and efficient movement of freight is critical to the economy of the region. Gross Domestic Product and Employment track the movement of freight closely. This link is even tighter for the region because it is more dependent on manufacturing than the rest of the nation.

- While the numbers vary depending upon the measures used, something in the range of one-third of the freight movements in the country have an origin or a destination within the region, illustrating the importance of freight and the region to the nation's economy.

- The states of the region are very important in their mutual economies. Trade flows within the region far outweigh trade with other states of the nation or with foreign partners.

- While overhead, that is freight moving through the region that has neither an origin nor a destination in the region, is significant, it is typically less than thirty percent, depending upon the location and the measure used.

- Congestion in all modes is significant. Particularly in urban areas, the infrastructure is operating at or beyond design capacity. In rural areas, both highway and rail links are operating in a state of marginal capacity at many locations. As growth continues, the degree of operating congestion can be expected to grow to intolerable levels.

- Regulatory issues are generally not a major concern for freight movements within or through the region. US federal standards preempt state regulation and thus provide uniformity.

- The region could benefit from greater cooperation in implementing performance measures, traffic management, and information and regulatory systems related to commercial vehicles.

- The region could also benefit from greater efforts to collect freight related data and greater efforts at communication among public agencies and between public agencies and the private sector.

- The region could benefit from a cooperative approach to addressing the challenges of freight. The interdependence of the states in economic activity and trade make such actions critical.

These findings lead to a dire outlook for a no-action scenario. While projections of future travel demand are not part of this study, some simple and conservative assumptions give us a perspective on what happens if nothing is done. Waits at waterway locks will grow longer, congestion at major airports will increase substantially, and rail lines, which offer opportunities for intermodal links from truck to rail, will have more congestion at terminals and transfer points as well as at key main line routes. If by 2020, highway freight grows by 50 percent, which is less than previously projected, and if passenger travel increases by about 25 percent, which is slower than the past twenty years, highways that are already congested will become less safe and less efficient. As congestion increases, the region will become less attractive to businesses because they will be further away from both markets and suppliers in terms of time and because the costs of doing of business will increase.

Background

Several regions in the U.S. began to examine freight movements in the 1990s with studies like the Latin American Trade and Transportation Study and the I-35 Trade Corridor Study. In April of 2002, the Midwest Regional University Transportation Center (MRUTC) convened a statewide meeting that focused on freight and the need for a regional approach for the Upper Midwest states. In July 2002 at the American Association of State Highway and Transportation Officials (AASHTO) Mississippi Valley meeting, the research team (MRUTC, University of Wisconsin at Madison, University of Illinois at Chicago, and University of Toledo) was assembled and initial discussions began with the state Departments of Transportation (DOT). Working in cooperation with the DOTs, the research team developed a study proposal that defined four phases.

- Phase 1: Inventory/Data Collection – Assess the corridor and proposed study area for freight flows, physical infrastructure, and administrative issues.
- Phase 2: Needs Analysis – Identify infrastructure and administrative needs.
- Phase 3: Action Plans – Develop and recommend action items to address needs.
- Phase 4: Implementation and Ongoing Efforts – Develop strategies for implementing these action plans and for continuing regional cooperation.

In January 2003, six states agreed to complete Phase 1. Phases 2 through 4 were put on hold pending the outcome of the first phase. A meeting to kickoff Phase 1 was held the following June, and the pooled fund study began in August 2003. The objective of Phase 1 was to establish a regional approach for freight transportation in the Upper Midwest states based on a multi-state, multi-jurisdictional partnership of public and private sector stakeholders. This partnership considers and addresses short- and long-term issues surrounding anticipated increases in freight movement that use the transportation assets in the region and the likely impacts on the region's infrastructure, economic health, and quality of life.

Funding for the study was provided by the state DOTs in Illinois, Indiana, Iowa, Ohio, Minnesota, and Wisconsin (total $360,000) using State Planning and Research (SPR) funds obtained from Federal Highway Association (FHWA). The study region, which is shown in Figure ES.1, includes these states plus Michigan and the adjoining Canadian provinces. The MRUTC and the participating universities provided a cost share in excess of $200,000.

The study area is defined by I-80, 90, and 94, major North-South connecting routes, and important parallel routes. The study considers highway, rail, air, and water shipments, and recognizes that freight transportation should be mode agnostic. The administrative structure includes a steering committee and an advisory committee in addition to the research team. The steering committee has one representative from each state DOT in the region, plus the provinces of Manitoba and Ontario. Federal officials from both the U.S. and Canada have also been regular participants in the steering committee. The steering committee's role is to provide direction and oversight for Phase 1. The advisory committee includes all members of the steering committee plus representatives from metropolitan planning organizations, port authorities, private sector firms and associations, and other interested groups. The advisory committee provides perspective, expertise, and ideas on the direction and outcome of the study.

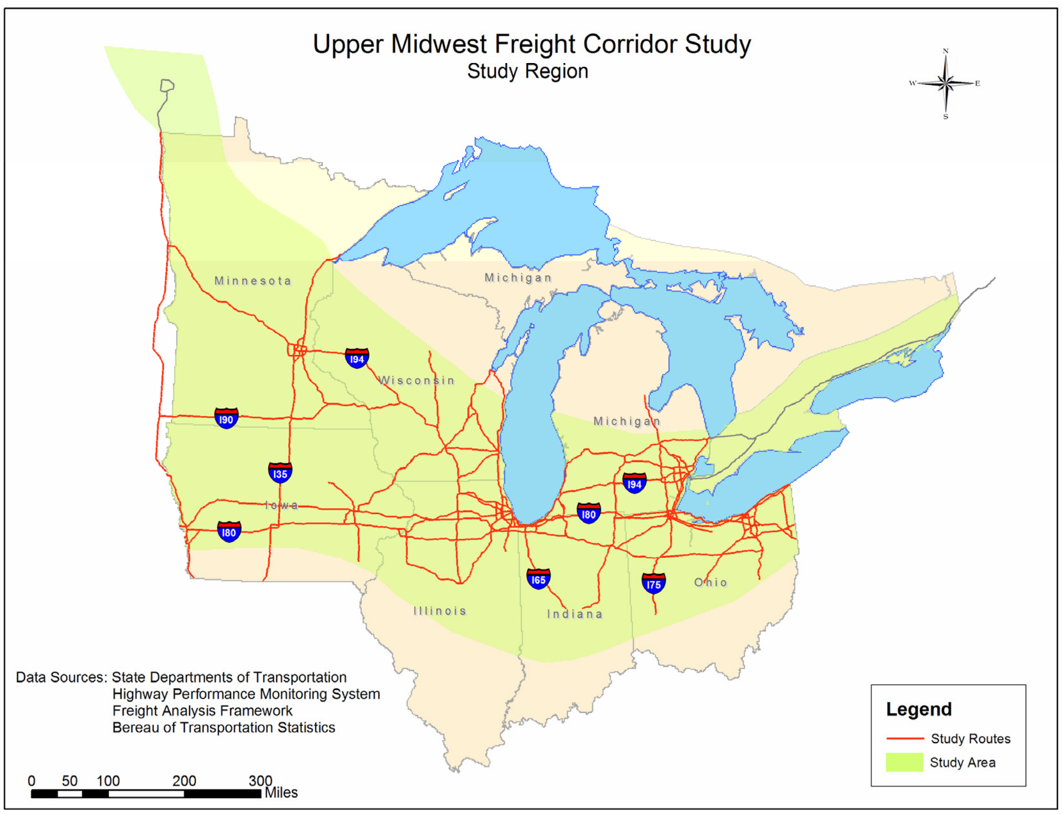


Figure ES.1 Upper Midwest Freight Corridor Study Area

Results

This report focuses on Phase 1, Data Collection, for the comprehensive effort to understand and improve freight flows in the Upper Midwest. The following sub-sections document the tasks as defined by the Phase I pooled-fund study:

- Examine *performance metrics* that may help assess the effectiveness of the transportation system
- Discuss and synthesize the components of *best practices* used by other regions to examine freight movement and to access federal support for projects
- Measure *usage and capacities* across the various modes to identify system level bottlenecks
- Understand *administrative issues* that may act as impediments to effective freight movement
- Create a *data reporting site* that provides access to study data and results
- Determine next steps to create a successful coalition of private and public sector partners to address transportation as a tool to increase economic development and improve quality of life.

At the end of each sub-section, specific recommendations are provided. In addition, overall recommendations are given at the end of the report.

Performance Metrics

Communication, understanding, and an ability to focus regional efforts are essential for improving the flows of freight in the Upper Midwest. Agreeing on and reporting a common set of metrics can play a significant role in unifying regional efforts by helping to guide action and direct resources. Because metrics influence the direction of the region on freight-related issues, they must be carefully selected to reflect accurately the items (e.g., speed, efficiency, and safety) that are important to the region.

The first part of a process to select a common set of metrics should be a structured planning session that would bring the stakeholders together to agree on the key regional performance parameters for freight. Measures should flow directly from those parameters. Implementation of metrics requires an organizational entity that spans the states. Several possibilities for this role exist, including the MRUTC and its partners in this study. Because much of the information currently available through transportation agencies does not deal with the topic of freight or the details needed for measurement, additional work will be required to develop dependable data sources.

Previous efforts at defining freight-related performance measures and the results of surveys generally point to the following broad areas for measurement:

- Safety of both employees of the transportation firms and of the general traveling public.
- Economic development that might be fostered by freight movement.
- Economic efficiency, as measured by larger economic trends.
- Economic efficiency, as measured by the costs of moving freight.
- Environmental quality.
- Congestion, reliability and time.

Recommendation for additional work in the area of performance metrics include:

- Facilitate a planning process that leads to the development of regional measures.
- Find or create data to support these measures.
- Define an administrative structure to collect and report the measures.

Synthesis of Practices

Many other regions of the country, such as the I-35 and I-95 corridors, have worked together on transportation planning and enhancements. Much can be learned from their efforts at regional cooperation. Areas for consideration include funding, organizational structure, decision-making processes, identification of catalysts and private sector involvement.

Different objectives bring states, local agencies and private firms together for various reasons. In some regions, organizations sought to better utilize their limited resources to efficiently address issues that crossed jurisdictional boundaries. The states along I-35 and I-29 coordinated deployment of intelligent transportation systems (ITS) for commercial vehicle operations. Other regions emphasized the need for regional thinking and freight planning to increase economic vitality. The southeastern portion of the U.S. realized the importance of Latin American markets to its economy.

The I-95 Corridor Coalition, encompassing the entire east coast of the U.S., set high standards for cooperation across boundaries and modes. This coalition has successfully attracted federal dollars to support regional transportation projects. With a small staff and a relatively small budget, the I-95 group has attempted to coordinate electronic toll payments, develop traveler information systems, and involve private freight carriers in their efforts. Concepts and programs developed by this coalition are transferable to the Upper Midwest region such as ideas for funding, organizing, and decision-making.

Recommendation for additional work in the area of synthesis include:

- Create an administrative structure for an ongoing effort. A policy-making committee should lead the coalition, with action plans developed by a steering committee. Specific projects would be administered through subcommittees formed as needed around specific issues.
- Share resources to improve efficiency. Agencies should jointly define problems, pool resources to solve them and share the results of these efforts. This could be applied to training, data collection, and working with the federal government.
- Increase communication among the personnel who work with freight issues. The freight industry is complex, changes rapidly and could benefit from advances in technology. The states will benefit from sharing ideas and by learning about different perspectives in freight.
- Improve coordination with other freight related groups in the corridor to take advantage of the work already done by groups such as the Gary-Chicago-Milwaukee ITS Priority Corridor and not duplicate these efforts.

Usage and Capacity

The study area accounts for roughly one-third of the total freight activities that occur in the U.S., and roughly 19% of the U.S. employment, so it is fair to claim that regional economic activities are "freight intensive." In fact, the study area has about 27% of the manufacturing jobs in the U.S. Furthermore, the region is at the heart of the transportation network that connects the economic engines on the East, West, and Gulf coasts of the U.S. as well as the adjoining Canadian provinces. Figure ES.2, which depicts the tons of freight transported by water, highway, and rail, clearly illustrates the critical significance of the Upper Midwest region to the nation's freight transportation network.

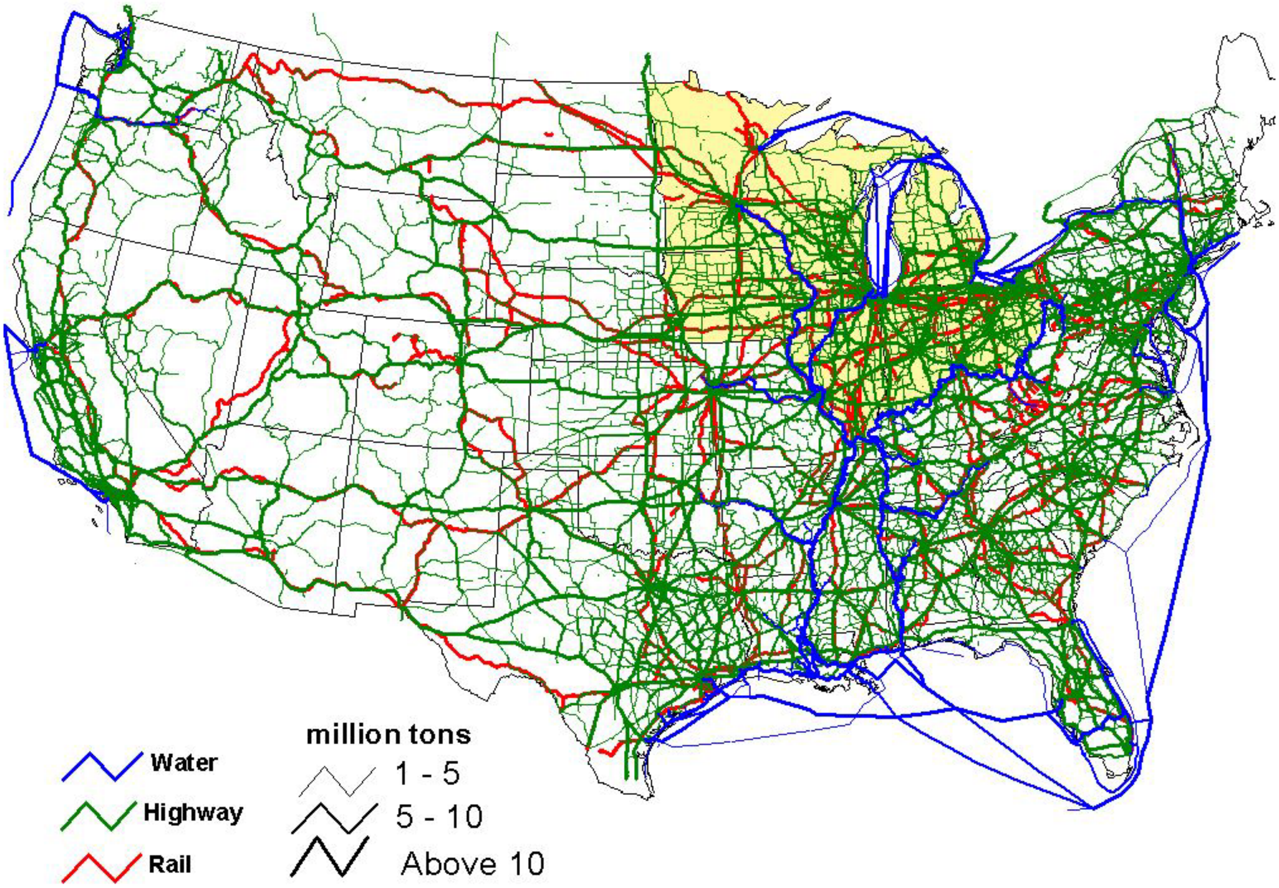


Figure ES.2 Link Tonnages, 1998

Source: FHWA, GeoFreight

Key Usage characteristics: Chart ES.1 looks at freight shipments that have at least one trip-end within the study area. It shows the region's share of the total U.S. freight shipments by ton, value, and ton-mile for the different modes. These data show the importance of the region to the country across all modes of transportation. Water plays a significant role when the parameter, ton-miles, is considered.

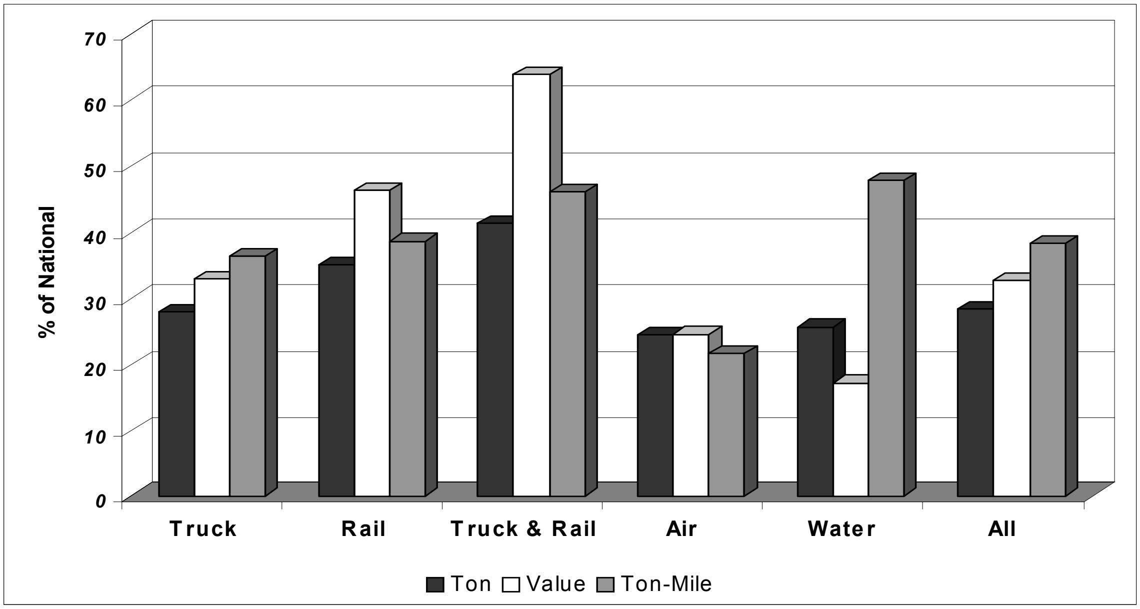


Chart ES.1 Share of the U.S. freight shipments - shipments with at least one trip end within the study area.

Source: Woods & Poole, 2003

Table ES.1 shows shipment by ton, value, and ton-mile that are intrastate (S-S), interstate within the region (S-R), and interstate outside the region (S-E). By tonnage, the freight activity in the Upper Midwest is dominated by the intrastate truck shipments (64%). However, low-value shipments such as gravel and non-metallic minerals account for about 30% of all the intrastate truck freight movements. Also, the trip lengths for those commodities tend to be very short. Consequently, the analyses of other indicators of freight activity, such as value of shipments and ton-miles, are more useful. When value is considered, intrastate shipments by truck are still substantial (38%), but regional moves (S-R) and external moves (S-E) are also substantial. This supports the claim that the states in the region are their own best trading partners. When ton-miles are considered, as expected, rail and water shipments carry a larger portion of the total shipments.

Table ES.1 Breakdown of Freight Shipments with One or both Trip-Ends in the Study Area

	Freight Tons %			Freight Value %			Freight Ton-Mile %		
	IS	Reg	Ext	IS	Reg	Ext	IS	Reg	Ext
Total	***70.3***	***13.5***	***16.2***	***39.6***	***23.4***	***36.9***	***15.0***	***17.0***	***68.0***
Truck	64.3	10.4	9.2	38.4	21.9	30.3	12.2	11.9	29.5
Rail	5.1	2.4	4.4	1.0	1.1	4.0	2.2	3.9	22.1
Truck and Rail	0.0	0.0	0.2	0.0	0.0	1.4	0.0	0.0	2.1
Air	0.0	0.0	0.0	0.1	0.4	0.7	0.0	0.0	0.1
Water	0.9	0.7	2.4	0.1	0.0	0.5	0.6	1.2	14.2

IS=Intrastate; Reg=Regional; Ext=External; Total does not include all modes, only the five major modes specified in the table.

Intrastate shipments typically account for less than 20% of the total truck tonnage transported on any given link. The remainder is attributed to regional, external and pass-through freight traffic. All freight modes cater to fairly specific market niches that are defined by the origin-destination pairs and commodities. For example, a considerable portion of the freight moved by water transportation involves low-value bulk goods such as coal and grain between the Upper Midwest and Louisiana ports. Intermodal competes against truck and air for certain high-value commodities such as automobile parts, electronics and other machinery. California is a major origin and destination location for those modes. Consequently, the flow of freight is driven largely by a limited number of origin-destination and commodity combinations. Typically about one-third of the freight flow can be attributed to the top 15 origin-destination pairs. Truck is by far the most versatile in terms of the types of commodities transported. All other modes are narrowly focused on only a few commodities that typically account for over 80% of total freight transported.

Although gravel and crushed stone accounted for over 23% of truck freight movements in terms of weight, its economic significance is negligible (0.3% of total value). Meanwhile, finished goods and machines account for a significant percentage, approximately 25%, of the total value of the shipments moved by trucks.

Five out of the ten largest traffic generators of rail freight, in the U.S. are either within or in close proximity of the study area, underscoring the importance of the study corridor for the movement of freight by rail. The Chicago region ranks third and first as origin and destination, respectively. In terms of weight, bulk commodities account for most of the rail shipments. Roughly 70% of the rail shipments that originate or terminate in the study area are coal, metallic ores, or cereal grains.

Intermodal transport (i.e. truck and rail combination) is used mostly for long-distance shipments of high-value commodities. California is by far the most important destination for the intermodal shipments originating from the study area.

The type of commodities and also origin-destination pairs served by air transportation are similar to intermodal movements. California appears to be an important trade partner for airfreight. Approximately 60 to 70 % of the total value of all the shipments can be attributed to precision machinery such as electronic equipment and instruments, suggesting a narrow market niche for the airfreight industry.

The Great Lakes and the inland waterway system provide an extensive network for the movement of freight by water. The movement is predominately north-to-south taking advantage of the Mississippi River system. Freight movement from Illinois to Louisiana account for almost a third of all movements in terms of tonnage and over 50% by value.

Most highway segments in the urban areas are congested and operating at capacity. This congestion is extending into some of the rural parts of the highway system. As other factors such as interchange geometry, toll plazas, and incidents are included, the overall operating capacity deteriorates beyond what is shown in Figure ES.3.

Rail capacity is similar to that of highways. While many railway segments have the ability to handle additional traffic flow, key rail segments are at capacity. Additional constraints on the system are rail yards and terminals. The number of sidings and signals also negatively impact rail segment capacity.

Although excess runway capacity exists at many of the airports in the region, other factors such as air traffic control systems, weather, and landside capacity may constrain airport capacity. A detailed study will expand the analysis of airport capacity.

River locks are bottlenecks in the regional waterways navigational system, causing inefficiency in the movement of barges and bulk goods. If these bottlenecks were addressed, excess line-haul capacity is available in the navigational system.

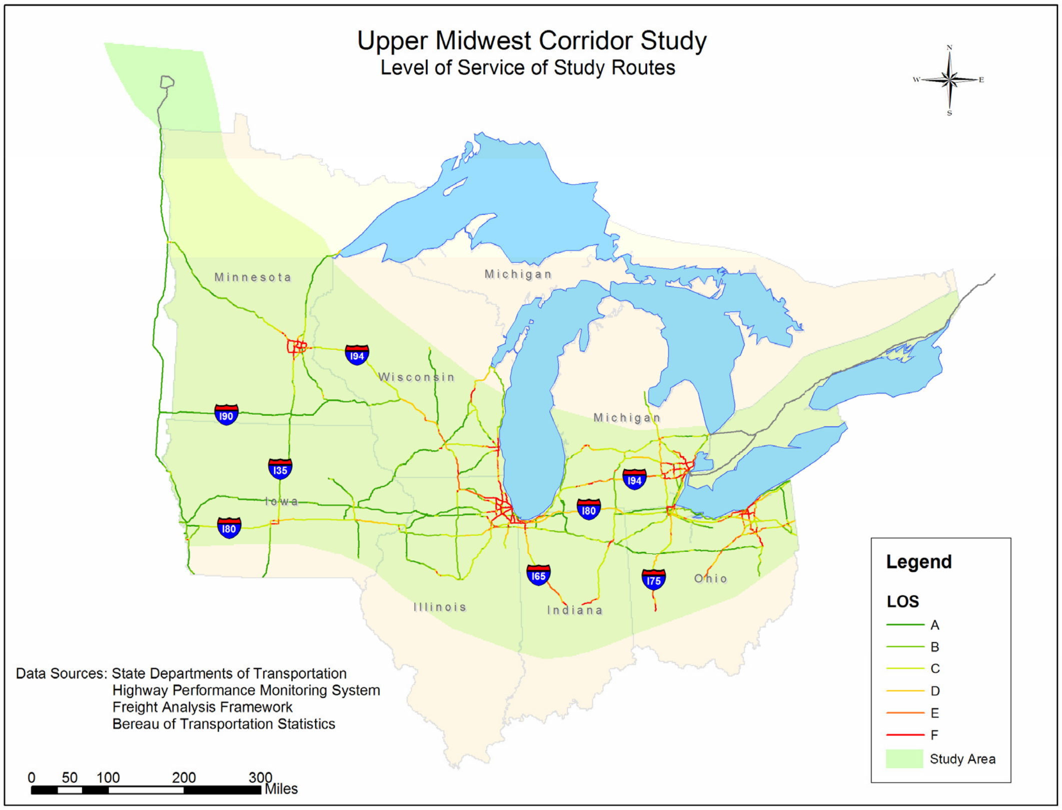


Figure ES.3 Thematic Map showing Level of Service for the Study Region Highway Network

Recommendation for additional work in the area of usage and capacity include:

- Develop a regional approach to transportation planning. The average trip length of all the freight shipments that are destined for the study area is over 250 miles. Although the data are not available, similar figures should apply for the outbound shipments. The overwhelming majority of the freight traffic that originates or terminates in the study region crosses at least one state boundary. Thus, any changes in the flow of freight, favorable or unfavorable, will likely cause impacts that extend beyond state lines.
- Use existing transportation infrastructure in all modes to address the needs to move freight. While more detailed network-level analysis must be conducted to determine the actual impacts on the study corridor, it is unlikely that highway expansion alone can address the current and growing congestion problem.

- Investigate policy and technical options to make intermodal (truck on rail) transportation efficient and reliable enough to compete in the market for medium and short shipments, which account for approximately 70% of the freight tonnage in the study area. Analysis indicates it is unlikely that intermodal alone will make a significant dent on the road congestion at the network level.

Administrative Issues

This area of study focused on the impacts of regulatory inconsistencies for freight transport on highways because freight transported by the other modes is privately controlled (rail), federally regulated (air and water ports), or determined by limitations specific to the locations (water ports). Even on federally funded highways, federal regulations govern freight vehicle equipment, maintenance, and operators. As a result, regulatory inconsistencies impact freight movement when the freight shipment's origin or destination is located within a certain region. The inconsistencies have no effect on freight movement that passes through the region because of the uniformity of federal regulations. U.S. federal regulations are generally more restrictive than Canadian guidelines, thus trucks that meet size and weight rules to travel in the U.S. comply with Canadian regulations. Regulatory inconsistencies in the region include:

- Minnesota and Wisconsin do not allow STAA doubles (twin 28.5 foot trailers with max gross vehicle weight (GVW) of 40 tons) on non-designated state highways as do other jurisdictions.
- The adjoining Indiana East-West Toll Road and Ohio James W. Shocknessey Turnpike accommodate longer combination vehicles (doubles and triples). However, the maximum allowable GVW and cargo size for long combination vehicles are different for Indiana and Ohio.
- A standard five-axle truck and trailer that complies with U.S. Federal weight regulations cannot legally travel on non-designated state routes in Minnesota and on some state roads in Illinois.
- Indiana, Illinois, Ohio, and Michigan enforce a speed differential for trucks that is up to 15 mph lower than for cars.
- The fee structure for commercial driver's licenses and required participation in the International Fuel Tax Agreement and Single State Registration System vary among jurisdictions in the region.

Regulatory inconsistencies may impact the efficiency of freight movement within the region. Trucks that must comply with multiple regulations must comply with the most restrictive, leading to more trucks and higher transport costs. For example, if a fully loaded truck in Wisconsin reaches its weight capacity before its volume capacity is full, it carries the equivalent of 1.09 fully loaded trucks in Minnesota (operating off of the federally designated system) because the gross vehicle weight limit is higher in Wisconsin.

In another case, some states have differential speed limits (DSL) for trucks. The logic is to improve highway safety. DSL may impact the efficiency of freight transport across the region and impose an added enforcement burden for highway patrol with little impact on highway safety.

Recommendation for additional work in the area of administrative regulation include:

- Collaborate to deploy electronic screening facilities at critical locations. Even with regulatory differences, jurisdictions should collaborate to build a regional network of electronic sites for better enforcement, time saving-benefits to carriers and increased safety and efficiency of commercial vehicle operations.
- Upgrade all weigh stations to handle electronic screening. Ohio and Illinois have employed this technology, but other states have only recently begun deployment. A regional perspective builds on what the states are doing to solve regulatory compliance and safety problems.
- Examine regulatory inconsistency and consider change. For example, allowing STAA doubles, adopting a single regional weight package, or removing speed differentials are likely to increase the efficiency for freight transport and may impact safety.
- Redesign fee structures and administrative procedures to make them uniform.

Data Reporting Site

Early in the study a decision was made to create a database structured within an internet-based GIS delivery system to provide continuous, seamless coverage of the regional transportation system. The system serves as a mechanism for reporting on the condition of regional infrastructure and for the on-going study of freight movements. This approach was intentionally adopted to underscore the importance of the study's regional perspective and to enable stakeholders and public officials to gain a view of freight movements that extends beyond their counties, states, or provinces. The database and the delivery system were designed to bring together transportation professionals from a variety of organizations including State/Provincial Departments of Transportation, Metropolitan Planning Organizations, Economic Development Organizations, Private Sector Participants and Research Organizations.

A second major element in the development of the regional freight database deals with the internet-based data delivery system. This system, dubbed ***Midwest FreightView***, enables users from these organizations to access the database through a specialized ***Citrix*** Metaframe server located at the University of Toledo (UT). Users are given a set of permissions and can access data using a standard web browser with no additional software needed. Users operate the delivery system entirely on the UT server and screen images, not data, are transferred to users. All data are stored at the Toledo site to maintain data quality and security. A full range of mapping and query functions are available on the site.

Considerable effort has been expended to gather and manage data from a wide range of sources including highways, rail lines, waterways, airports, ports and intermodal terminals. Additional data dealing with usage, capacity and administrative policies have been tied to these components of the network. The network contains data sets from the Bureau of Transportation Statistics (BTS), the Federal Railroad Administration (FRA), FHWA and state DOT databases as a way to provide as detailed a description of the network as possible. In addition, the database contains comprehensive regional economic data including employment figures, number and locations of establishments, and the types of commodities produced within each portion of the region. As a result, the database serves as a resource for the research team, transportation professionals, and economic development authorities to draw the essential link between economic activity and the capacity of the freight infrastructure.

Recommendation for additional work in the area of the data reporting site include:

- Extend the ***Midwest FreightView*** to simulate travel time on the highway network. Detailed data pertaining to the interplay between travel time, traffic volume and capacity, and travel at specific times of day can be developed to simulate truck movements over the highway network. Figure ES.4 illustrates the travel time from Moline, Illinois to the rest of the lower 48 states. This simulation is based on assumed congested conditions over the network on truck trips.
- Add social and economic data to ***Midwest FreightView***. This would allow the study team and others to examine the relationship between these data and freight movement.

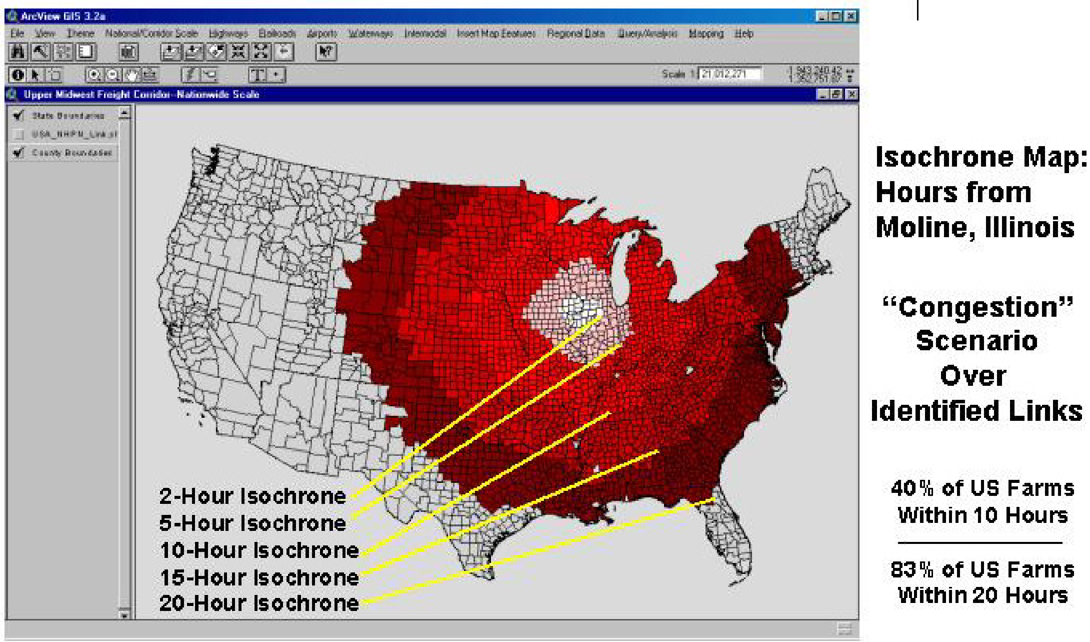


Figure ES.4 Sample isochrone map showing travel times from Moline, Illinois to the national market

Overall Recommendations

If the transportation network in the Upper Midwest is to keep pace with the demands of businesses that move freight to meet consumer demand, achieve economic growth and development that lead to jobs, and meet the leisure and recreational needs that enhance quality of life, it must be developed and managed as a regional asset. The process for implementing these efforts requires the development of mechanisms for interstate cooperation at the policy, planning, implementation, and operating levels. It is a process that requires the commitment, support, and involvement of the CAO/Director in the state DOTs. Commitment implies authority to move ahead; support implies resources to do the work; and involvement implies an active role in driving the concept throughout the DOT and participation in regional policy making.

Important outcomes should be:

- Continued communication among freight transportation stakeholders in the region

- Processes for reviewing and investing in promising ideas and technologies that boost the safety, reliability and efficiency of the transportation network
- Efforts to seek federal support for projects that are important to the region and the nation
- Resource sharing in design, planning and implementation expertise as well as the planning and execution of transportation research

- Establish regional cooperation. Before these innovations can be implemented challenges must be overcome to assure efficient, timely and accurate information exchange within the region. The first of these issues deals with regional interest, dialog and participation among the players.

To accomplish these outcomes, it is necessary that regional transportation leaders create a vision for the future of transportation in the Upper Midwest and define a structure and process that leads us to that vision through broad-based participation and intense interaction, free and open idea exchange, and frank evaluation and feedback. The study implies that the vision should involve transportation as the means to the ends of better economic development and enhanced quality of life. Key factors include the development, application and use of technology both transportation and information systems related. Creating a vision involves cooperative efforts in planning, implementation and operations, supported by sharing resources, information and ideas. A process for turning this vision into reality requires a multi-state, multi-jurisdictional partnership of public and private sector stakeholders that can transform the vision to specific goals, action plans, and projects.

The study team, with the support of the steering committee and the advisory committee, is making the following recommendations.

1. Continue efforts to build a regional coalition to improve freight transportation. This should become an ongoing activity that is supported by the seven states and the Canadian provinces, private sector and public sector stakeholders, the Midwest Regional University Transportation Center and the University of Wisconsin at Madison, University of Illinois at Chicago, and University of Toledo. The essence of this partnership is to:

- Define regional goals, objectives, and metrics
- Examine commodity flows into and out of the region
- Discuss and resolve public policy issues
    a. National and regional freight policy
    b. Level of cooperation among the states

c. Role of the public sector in freight
d. Level of investment in research and new technology
e. Appropriate strategies to influence behavior
f. Value of public and private sector partnerships

- Develop and execute transportation plans
    a. Compatible approaches to design and planning
    b. Develop a regional planning process
    c. Jointly plan and fund research
    d. Share information/data dissemination
- Identify issues on the ground
    a. Bottlenecks of regional importance
    b. Identify intermodal opportunities
    c. Enhance infrastructure utilization
    d. Examine administrative fees and procedures
    e. Cooperative management efforts—ITS

2. Form a policy committee for the Upper Midwest states that would include the CAO or their designated representative from all the seven state DOTs. This group should quickly determine the role and level of participation of the adjoining Canadian provinces. The purpose of this group would be to provide direction and oversight for building a regional coalition. The initial tasks for this group are to:

    - Develop a vision statement for the region that considers economic development, the quality of life, the role of technology, regional planning and cooperation.
    - Create a process that can transform the vision into specific goals, action plans and projects. A starting point for the process is shown in Figure ES.5.

3. Provide short-term funding support for the Upper Midwest Freight Corridor Study until July 2005. This funding would support the following efforts

    - Define a regional agenda for freight
    - Investigate opportunities to secure federal dollars to continue funding future study phases
    - Investigate funding sources for the corridor and the impact of participation on ongoing federal aids received in the region. During this process the research team would review the reauthorization bill, identify the provisions that would benefit the corridor, and provide a "white

paper" with advice and reasoning that the state DOTs can pass on to their AASTHO representatives.

- Develop applications for participation as deemed appropriate by the states.

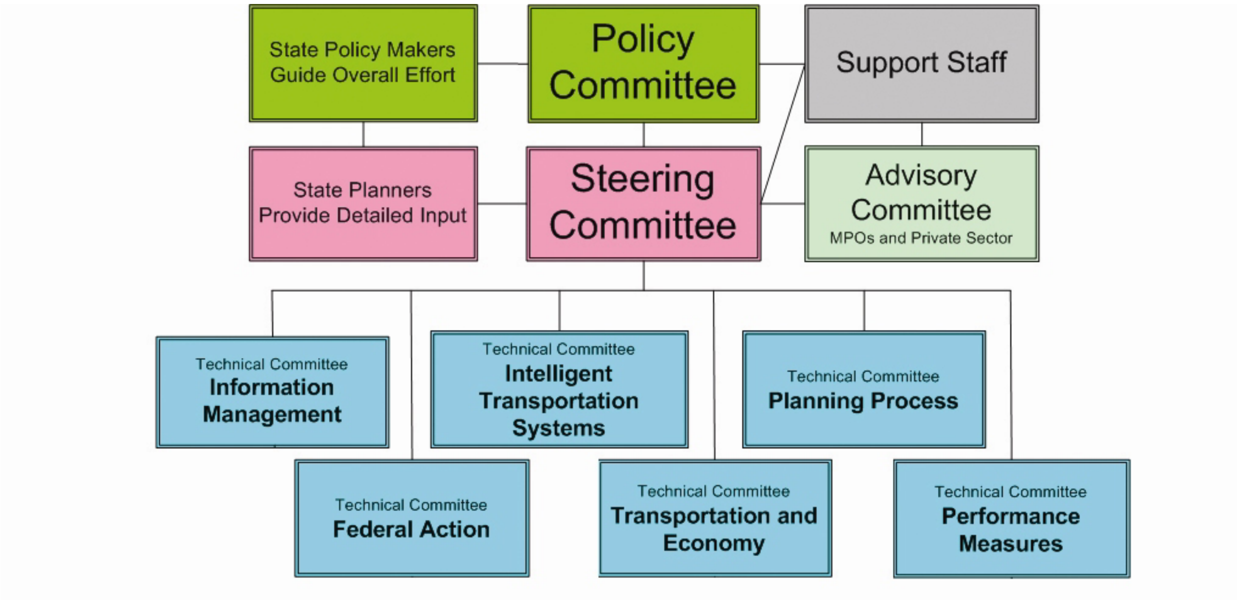


Figure ES.5 Proposed structure of regional freight coalition

- Coordinate a regional dialog to reach agreement on a regional position on freight issues for the federal arena.
- Seek AASHTO and FHWA – Freight Office endorsement and co-sponsorship of the corridor study, the study's recommendations, and future efforts. Seek their advice and direction for next steps.
- Offer to use the corridor as a new initiative or test case study corridor. For example, the region would welcome the development and testing of new technologies that could reduce congestion and increase system capacity.
- Continue outreach and education work in support of the regional agenda.
- Continuing information management and enhancement efforts
- Facilitate an initial effort in Commercial Vehicle Operation – Intelligent Transportation Systems (ITS)

1 INTRODUCTION

Safe, reliable, and efficient transportation systems are essential to the economic viability and strength of our nation and region. The demand on our nation's transportation system is stretching infrastructure to, and in many cases beyond, capacity. Continued growth in the demand for freight transportation cannot be met by increased capacity. Ideas and methods are needed that increase the utilization of existing assets through the application of technology and innovative management practices. This report documents the methodology used by and the findings of the Upper Midwest Freight Corridor Study.

This chapter introduces the Upper Midwest Freight Corridor Study. The chapter begins by defining the problem and motivation for the study. The remainder of the chapter provides some background, describes the objectives of the study and the components, summarizes key findings and presents an outline of the remainder of the report.

1.1 Problem Statement and Motivation

The Upper Midwest serves as a critical corridor for domestic and international freight moving in all directions. Freight movements in this corridor are currently increasing and are projected to continue to grow. While both the private and the public sectors agree that this important issue must be addressed, neither sector is prepared to deal with the anticipated impacts of this projected increase. Current state-by-state practices, with the public and private sectors acting independently, will no longer be sufficient to meet the increased demands on the infrastructure and/or increased costs associated with freight transport.

Shifts in public agency policy relative to infrastructure management and expansion, budgeting decisions and staff resource allocations have and will impact the safe and efficient movement of goods within the region. At the same time, private sector interests insist on an approach that is equitable for all modes and allows industry to remain competitive in the region. Without proper collaboration and communication between the two sectors, and between the states and planning agencies of the region, the impacts of projected freight growth could be intolerable.

The Upper Midwest freight corridor, the focus of the study, stretches from Manitoba, Minnesota, and Iowa in the west to Ontario and Ohio in the east. Interstate highways 94, 90, and 80 generally define the study corridor as shown as in Figure 1.1. Although the corridor is defined by highways, the freight transportation system in the region is multi-modal, including not only major highways roads, but also the rail network, inland waterways, the Great Lakes, intermodal facilities, and major cargo-handling airports.

This corridor is crucial for the movement of freight for the region, nation, and continent. Not only does the corridor handle the major east-west movements of freight; it is also important in the north-south movements of freight in the region and continent. The corridor, like freight shipments, transcends state and national boundaries. The relationship of the states in the region to the two Canadian provinces to the north, Manitoba and Ontario, is important for both parties. About thirty-five percent of Ontario's merchandise trade with the United States in 2001 either went to or came from the seven states of the region. (Rob Tardif, personal communication, 2003)

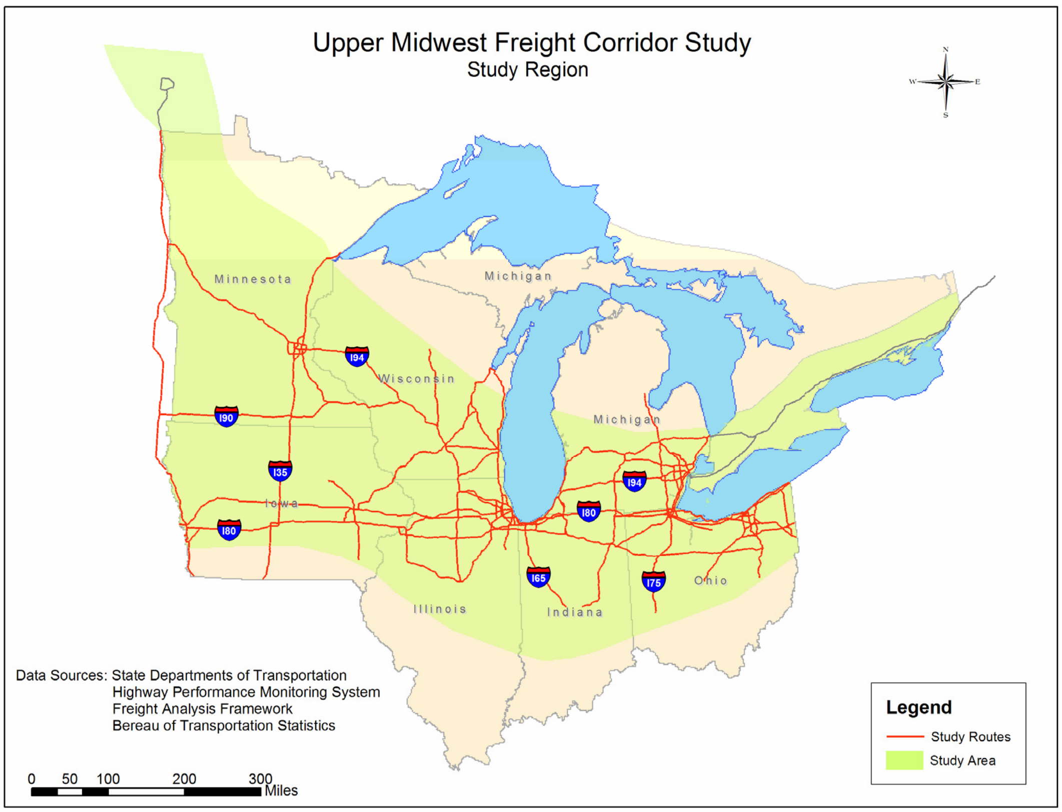


Figure 1.1 Upper Midwest Freight Study Corridor

A regional perspective, such has been done in other regions of the nation and around the world, is an effective way to consider and address short- and long-term issues surrounding anticipated increases in freight movements. This study is the first critical step in establishing a regional approach to improving freight transportation in the Upper Midwest and Great Lakes region. It will be the foundation for future cooperative efforts by documenting and analyzing the current condition of the freight transportation system in the region.

1.2 Audience for this Report

The primary audience for this report is the freight transportation stakeholders in the Upper Midwest region. These include state transportation agencies, local transportation agencies, state economic development agencies, and freight shippers and carriers. Project steering and advisory committees, comprising stakeholders, have been involved throughout the research project. The key meetings and workshops were as follows:

- Steering and Advisory Committee workshop, June 3, 2003. Toledo
- Research team meeting and Steering Committee meeting, December 7 and 8, 2003. Chicago
- Steering and Advisory Committee meetings, March 29 and 30, 2004. Milwaukee
- Steering and Advisory Committee meetings, August 10 and 11, 2004. Chicago

1.3 Background

In April 2002, the Midwest Regional University Transportation Center (MRUTC) hosted a meeting of approximately 75 stakeholders in Chicago. For two days, the participants discussed the needs of the region and looked at different ways to begin working together to address freight transportation. One idea, supported by the participants, was the creation of a regional effort on the model of others around the country, such as the I-95 Corridor Coalition, the National I-10 Freight Corridor Study, and the Latin American Trade and Transportation Study. (Switzer 2002) The result of this discussion was the Upper Midwest Freight Corridor Study. Funding was secured by mid-2003 in the form of a transportation pooled fund. Six states in the region each contributed $60,000 to support the study. Those states are Indiana, Illinois, Iowa, Minnesota, Ohio, and Wisconsin. Ohio is the lead state of the pooled fund. Additional funding came from the Midwest Regional University Transportation Center at the University of Wisconsin, the Urban Transportation Center at the University of Illinois at Chicago, and the University of Toledo. In August 2003, study work officially began when Ohio and the participating universities signed a contract.

1.4 Study Objectives

The objective of the research is to provide documentation and analysis of the freight transportation system in the corridor described above, including work in closely related areas of performance measures and synthesis of practices. This study is part of an ongoing effort to establish a regional approach for improving freight transportation in the Upper Midwest based on a multi-state, multi-jurisdictional partnership of public and private sector stakeholder interests.

Goals of the research are to:

- Compile and synthesize existing plans and efforts
- Create a setting for coalition building through regular communication and data sharing
- Identify and document the conditions and needs across all modes of freight transportation for the identified corridor in the region
- Analyze the non-physical capacity issues that may be an impediment to the efficient movement of freight in the region.

The Upper Midwest Freight Corridor Study has six components: performance metrics, synthesis of practices, demand/usage, capacity, and administrative issues.

Performance Metrics. The study identifies potential performance measures that could be used to evaluate operations and infrastructure performance. It also suggests a method for evaluating potential measures and possible sources of data to support measurement.

The objective of the research as it relates to performance measures is to define a menu of measures that might be used by all stakeholders to monitor the performance of the freight transportation system and focus efforts for improvement. Such measures should improve communication between the private and public sectors and between public agencies and improve the understanding of the functioning of the region's transportation system as a mover of freight. These objectives will be attained through several products: (1) a clear statements of what the private and public sectors perceive to be important aspects of system performance for the movement of freight; (2) a useable framework to evaluate potential issues for measurement; (3) a menu of potential measures; (4) a review of the sources of data that might make the measures real; and (5) suggestions on who would maintain measures and how they would be maintained and reported.

Synthesis of Practices. Many multi-jurisdictional projects related to freight transportation are now underway. A review of those experiences is necessary to capitalize on those experiences, replicating successes and avoiding failures. Other freight transportation projects, plans, or studies are underway within the corridor region. As a part of defining a true base of experience these other studies will be compiled and made available to the participants.

This area of the study is divided into two major parts and both have specific objectives. The first is a clearinghouse that contains two sets of information in a web-accessible database: Cooperative efforts in freight transportation that involve the public agencies in the region and research of relevance to this region in freight transportation. The objective of this is to support the goal of coalition building by communicating to the stakeholders the freight transportation initiatives within the region.

The second part is an analysis of multi-jurisdictional cooperation and the details of several groups that have worked together on transportation issues (best practices). Areas of interest include funding, organizational structure, decision making processes, identification of catalysts, and private sector involvement. The objective is to have the analysis be a tool for the study's stakeholders as they discuss future steps in this regional effort.

Demand/Usage. A key question is how the transportation system is being used. To examine this, the research team collected and analyzed demand or usage data collected from a variety of sources, including state, federal, regional, and local agencies. The objective of the analysis is to give the stakeholders of the study useful information on how goods move to, from and within the region.

Capacity. Demand management and usage decisions depend on a clear understanding of the freight capacity on all modes of transportation along and feeding into the corridor. Demand and Usage data enable the calculation of a usage to capacity ration that can provide stakeholders with a list potential bottlenecks that can be addressed.

Administrative Issues. Inconsistencies in the governing regulations and administrative processes lead to duplication of efforts and reduced travel efficiencies. Identification of inconsistencies and qualifying their impacts can lead regional participants to money saving opportunities for cooperation that do not sacrifice travel safety or overstress the physical infrastructure.

The objectives for this research component are to identify regulatory inconsistencies and administrative bottlenecks in the region, to provide reference information for quantifying the impacts of regulatory inconsistencies, and finally to identify opportunities for improving administrative effectiveness through use of ITS technology and regional cooperation.

1.5 Overview of Methodology

The study focused on inventorying and characterizing existing freight movements and the freight transportation system in the Upper Midwest region, including performance metrics, capacity, administrative issues and usage. The research was conducted through a series of workshops, interactions with the participants, interviews and surveys of freight stakeholders, a review and synthesis of the literature and available data, and data analysis and interpretation. The study also developed infrastructure in the form of websites, an information clearinghouse, data catalogues, databases, and mapping and data manipulation tools to support research and investigation.

The study participants include researchers and representatives of the public and private sectors. Throughout the study, participants collaborated in workshops, conference calls, and meetings. Three primary groups involved. The members of the groups are listed in Appendix B and each group is described as follows:

- The steering committee is made up of representatives from funding organizations, which are all state DOTs. Each funding state has a representative from the DOT and their divisional Federal Highway Administration office. In addition, invitations were extended to other states and provinces in the region. Manitoba and Ontario accepted this invitation and have a non-voting seat on the steering committee. This committee is ultimately responsible for the direction of the study.
- An advisory committee is also part of this study. The charge of this committee is to give the steering committee different perspectives and insight on regional freight transportation issues. This committee is made up of representatives from other public agencies, private freight carriers, and freight shippers.
- A multi-disciplinary research team representing three university transportation centers: the Midwest Regional University Transportation Center at the University of Wisconsin-Madison, the Intermodal Transportation Institute at the University of Toledo and the Urban Transportation Center at the University of Illinois at Chicago. The disciplines of the researchers include engineering, geography, planning, and business.

The study is defined by seventeen tasks that were undertaken by the research team. These tasks are:

Task 1 Collect data from public and private agencies. Conduct a literature review for performance measures and administrative issues.

Task 2 Design and implement a database of freight information for optimal organization and easy access.

Task 3 Define, organize and layout the highway and rail networks that will be part of the study.

Task 4 Identify and map the significant airports, seaports and intermodal facilities in the study area.

Task 5 Release survey for planning agencies across the county the country, compile results of performance measures questions and administrative issues questions.

Task 6 Design and launch study website.

Task 7 Conduct State DOT and other stakeholders' visits and interviews.

Task 8 Determine the capacity of the infrastructure identified in tasks 3 and 4.

Task 9 Research freight transportation planning activities in the region, including ITS CVISN plans.

Task 10 Research best practices for multi-jurisdictional cooperation.

Task 11 Identify system level bottlenecks that inhibit the flow of freight on the transportation network, including administrative impediments.

Task 12 Document data characteristics.

Task 13 Analyze freight demand data.

Task 14 Plan and execute second steering / advisory committee meeting.

Task 15 Identify next steps for demand data such as forecasting.

Task 16 Plan and execute concluding workshop for the study.

1.6 Key Findings

This section provides a preview of the key findings in terms of the five components of the study.

Performance Metrics. Several points were discovered that are important for the region's decision makers:

- Little work has been done to develop regional performance measures for freight.
- Current public sector data collection efforts are generally not geared toward meaningful measures of freight activity or performance.
- Much of the information that might be useful for performance measures resides in private companies, who are reluctant to share information without strong safeguards.
- Most stakeholders in both the private and public sectors seem to agree that measurement could be a useful tool for the improvement of freight planning and management.

- Many of those same stakeholders are apprehensive about how measures could be misused, fearing that they might become report cards or sources for faultfinding.
- Whatever measures are ultimately developed, they should be a natural outgrowth of regionally developed strategic goals and objectives.
- Responsibility for data collection, analysis and measurement maintenance and reporting must be assigned to a single regional entity.

Synthesis of Practices. There is strong evidence that a regional perspective in freight transportation issues would complement local, state, and federal efforts. Benefits of regional cooperation were identified from numerous studies, reports, and selected case studies. Some of those benefits include the following.

- Create a geographically larger agency pool for resources and staffing.
- Develop effective policy programs that target technology, training, research, and data sharing.
- Mitigate administrative boundary barriers for commercial vehicles at state lines throughout the region. This is consistent with the findings in the administrative issues part of this study.
- Create options in regional funding structures for future transportation related improvements that include multiple states leveraging funds through existing transportation programs.
- Encourage private sector involvement with policies designed to improve freight flows resulting in improved economic conditions.

Other findings to note include the fact that federal funding for such regional efforts help overcome the challenge of "burden sharing." This term describes the fact that benefits of freight transportation improvement projects usually go beyond the jurisdiction where the improvement is made. Consistent communication and involvement of the interested parties, including private sector stakeholders, is also important to maintain momentum of regional efforts.

Administrative Issues. Inconsistent regulation has no effect on freight movement that passes through the region because of federal regulations for unlisted highways are uniform. Regulatory inconsistencies in the region occur on non-designated state roadways and consequently, may impact freight movement having origin or destination within the region requiring travel on non designated roads. Major regulatory inconsistencies in non-designated roads include the following

- Minnesota and Wisconsin do not allow STAA doubles (two 28-28.5 foot trailers with max gross vehicle weight (GVW) of 40 tons) on non-designated state highways as do other jurisdictions in the Upper Midwest Region.
- A standard five-axle truck tractor semi-trailer that complies with U.S. federal maximum weight regulations can legally travel on non-designated state highways in all Upper Midwest jurisdictions except in Minnesota and on some state roads in Illinois where lower weight limits are enforced.
- U.S. federal regulations are generally more restrictive than Canadian guidelines, thus trucks that are sized and weighted to travel in the U.S. will comply with the Canadian regulations.
- The adjoining Indiana East-West Toll Road and Ohio James W. Shocknessy Turnpike that accommodate longer combination vehicles (LCVs) are regarded as a freight travel enhancement for the region. However, the benefits of the enhancement might be increased by resolving the inconsistency in maximum allowable GVW and cargo size between these adjoining roadways.
- Most jurisdictions allow trucks to travel at the same speed as passenger vehicles on rural highways. Illinois, Indiana, Michigan, and Ohio enforce a differential speed limit (DSL) where the speed limit for trucks is up to 15 mph lower than for cars on rural highways.

The fee structure for commercial driver's licenses (CDLs) and for required participation in the International Fuel Tax Agreement (IFTA) and Single State Registration System (SSRS) vary widely among the jurisdictions in the region.

Demand/Usage. Some of the key observations from the analysis of usage are the following.

- The Upper Midwest region plays a very important role in the nation's freight transportation, accounting for roughly one-third of the total freight activities that occur in the U.S. For some modes, such as Intermodal, the share is considerably higher.
- In terms of tonnage, the freight activity in the seven states included in the study region (IA, IL, IN, MI, MN, OH, WI) is dominated by the intrastate truck shipments, which is trucks hauling low volume commodities such as stone and sand short distances are examined. However, when value of shipments and ton-miles medium-distance trucking (i.e. interstate movements within the study area), long-distance trucking (external or through movements), rail, and water play a critical role in the efficacy of region's freight system and economy.

- The preceding point underscores the importance of regional framework for addressing freight issues.
- In general, all freight modes cater to fairly specific market niches that are defined by the origin-destination pairs and commodities. Consequently, the flow of freight is driven largely by a limited number of origin-destination and commodity combinations. Therefore, the efforts to expand the use of non-highway modes need to focus on specific niches in the market.

Capacity. Practical capacity for each mode was calculated using mode specific parameters. Capacity is compared with the current traffic flows to generate the level of service for a mode. This comparison reveals several points about the freight transport system in the region:

- In highways most of the segments in the urban areas perform at capacity or at a LOS F, which indicates congestion during peak usage. In rural areas a small but growing number of highway segments were operating at capacity. For the smooth operation of traffic flows on urban expressways innovative solutions are needed to move freight.
- Many railway segments have surplus capacity to handle additional traffic flows. Some key segments are already congested. Studying and improving the parameters that have negative impact on segment capacity can improve railway segments efficiency. The analysis points out those segment that need immediate attention.
- Surplus runways' capacity exists at most of the airports in the region. In studying and analyzing the airport capacity, it was found that most of the constraints were due to landside capacity. The improvement in landside capacity will improve airport capacity.
- Although locks are bottlenecks in most navigable waterways, there is surplus capacity available in the line haul portion of the navigational system.

1.7 Report Outline

The report is organized as follows. Chapter 2 describes the methodology used. Chapters 3 through 7 document the research conducted for each component of the study. Future research and overall conclusions of the research team, along with a list of references, completes the report.

Separate appendices support the work documented in the individual chapters. APPENDIX A is a list of acronyms. APPENDIX B lists the study participants including the research team, steering committee and advisory committee. APPENDIX C documents the methodology used to define the highway links included in the study corridor. APPENDIX D describes the data structures developed to support data access, while APPENDIX E documents the data reconciliation procedures used to ensure data compatibility. APPENDIX F summarizes our interviews with major regional planning organizations in the study corridor. APPENDIX G includes the surveys undertaken as part of the study and documents survey results. Finally, APPENDIX H through APPENDIX J provide the data and information to support the Administrative Issues, Demand/Usage, and Capacity chapters respectively.

2 STUDY METHODOLOGY

The Upper Midwest Freight Corridor study methodology evolved from a workshop on freight issues in April 2002. The methods were refined during further meetings and workshops that defined issues and products for the participating state DOTs. This chapter documents the methodology, the organizational structure developed to complete the study, the definition of the study corridor, data sources, and data reporting practices.

2.1 Methodology

As stated in Section 1.4, the objective of the study was to establish a regional approach for improving freight transportation in the Upper Midwest based on a multi-state, multi-jurisdictional partnership of public and private sector stakeholder interests. This partnership considered and addressed short- and long-term issues surrounding anticipated increases in freight movement within the region and the likely impacts on the region's infrastructure and economic health.

2.1.1 Overview

The study focuses on developing an inventory of the existing transportation system including performance metrics, capacity, administrative issues, and usage. Through a series of workshops, interactions with the participants, and a review and synthesis of the literature and available data, the research team accomplished the following:

- Compiled and synthesized existing plans and efforts
- Created a setting for coalition building through regular communication and data sharing
- Identified and documented the conditions and needs across all modes of freight transportation for the identified corridors
- Understood the market activities that generate goods for shipping that impact this region
- Identified the regulatory inconsistencies and associated bottlenecks across the region.
- Taking a regional perspective, looked at possibilities for streamlining administrative practices through regional cooperation, ITS/CVO technology, and standardization of key infrastructure.

2.1.2 Data Collection and Study Resources

The study heavily depends on data to represent the existing freight facilities, usage, flows and value of goods moved. Data were requested from the study advisory committee members using a "wish list" and then with follow up telephone calls and mail. State representatives provided data in a variety of forms –

electronic and printed. National data available from US Department of Transportation and the Bureau of Transportation Statistics were identified.

The researchers requested segment specific data for all the expressway segments of I-90/94/80 in the study area and any major alternative routes and modes that can be used to move freight. The data fields requests are listed in Table 2.1. Table 2.1 also identifies potential data sources. The study team asked for recent data (within the last 7 years) and time series data.

Table 2.1 Segment Specific Data Requested.

Data Types	Specifics	Potential Sources
Demand/ Usage	Hourly/daily/monthly/yearly vehicular volumes including: traffic counts (in order of preference: classification counts, car vs. heavy vehicle counts, heavy vehicle percentages, total volumes), train frequencies, cargo flight volume, counts at toll gates, and any other information that can be used to estimate freight movement and bottlenecks.	Traffic counts HPMS External trip surveys (e.g. data used to calibrate travel demand forecasting models) Weigh station counts Corridor studies, traffic impact studies, market analysis Lock monitoring report Weigh station counts Engineering studies (interchanges or freeways segment improvement projects)
	AADT, average peak hour volumes, seasonal variation factors, day of the week variation factors, time of day factors	
	Weight or volume of goods moved (e.g. tonnage, TEU, carloads, etc.) in daily/monthly/yearly averages and peak	
	Value of goods moved	
	Type of goods moved (e.g. empty, HAZMAT, commodity classified by Standard Transportation Commodity Codes (STCC) or by Standard Classification of Transported Goods (SCTG) or by more generic categorization)	
Segment Specific Infrastructure Data	Physical characteristics of segments (number of lanes, capacity, weight limit, truck restrictions, drafts, etc.)	HPMS Accident studies Accident records Rail line grade crossing/accident studies
	Accidents at interchanges	
	Physical characteristics of segments (number of lanes, capacity, weight limit, truck restrictions, drafts, etc.)	
	Location and characteristics (e.g. land area, lifts, truck volumes, train volumes, TEU, airplane landing/departure, berthing, cargo handling capacity, etc.) of inter modal and intra modal transfer points such as intermodal rail yards, classification yards, ports, distribution centers, etc	
	Known bottlenecks in the system	
Origin- Destinatio n Data	Origin-destination of shipments (weight, value, commodity type, transfer points, mode, and route) including any shipment that originates or terminates in any of the seven states	Special generator studies for demand forecasting model Reebie Transearch
Administrative Process	Legal loads weights	
	Legal load size	
	Requirements for transporting Hazardous materials permits and licenses	
	Toll and toll collections	
	Permit process	
	Credentials requirements	
Freight Planning activities	Who interfaces with rail, air, and water transport?	Airport master plan Market analysis Port master plan Freight planning studies (state-wide, regional, local)
	When is a traffic impacts study required?	
	Who does freight planning?	
	Agencies' plans for freight.	
	Hazardous Materials transport permits requirements for air, water, and rail modes	

At the national level, publicly available resources for the project include:

- Commodity Flow Survey
- Freight Analysis Framework
- Geofreight
- Lock Performance Monitoring System
- Highway Performance Monitoring System (HPMS)
- National Highway Planning Network (NHPN)
- Waybill Sample

As data were collected a data catalog was used to identify the data source, and document a description, contact, attributes, attribute definitions, year, type, area, form and source of original data. For example, the "Wisconsin State Airport System Plan 2020" includes a description of future plans for public use airport improvements. Contact person is a Program and Planning Analyst at Wisconsin DOT. Attributes are the number and classification of airports for 2000 for the state of Wisconsin. The data catalog is currently available in hard copy only.

2.1.2.1 National Highway Planning Network

The National Highway Planning Network (NHPN) is a geospatial dataset for planning that is consistent with other datasets such as the Highway Performance Monitoring System. The NHPN is a 1:100,000 scale network database that contains line features representing just over 450,000 miles of current and planned highways in the U.S. The NHPN consists of interstates, principal arterials, and rural minor arterials. (FHWA 2004c)

2.1.2.2 Commodity Flow Survey

The Commodity Flow Survey (CFS) provides data on goods movement in the US. The survey is undertaken through a partnership between the Bureau of the Census, U.S. Department of Commerce, the Bureau of Transportation Statistics, and the U.S. Department of Transportation. The 2002 CFS covers business establishments in mining, manufacturing, wholesale trade, and selected retail industries. The survey warehouses for the covered industries but not farms, forestry, fisheries, governments, construction, transportation, foreign establishments, services, and most establishments in retail. (U.S. Census 2004a)

The CFS captures data on shipments originating from selected types of business establishments located in the 50 states and the District of Columbia. Establishments were mailed a survey requesting the respondent to provide the following information about their establishment's shipments over a one week period in each quarter of the year: domestic destination or port of exit, commodity, value, weight, mode(s) of transportation, the date on which the shipment was made, and an indication of whether the shipment was an export, or hazardous material. For shipments that include more than one commodity, respondents are instructed to report the commodity that makes up the greatest percentage of the shipment's weight. For exports, the mode of export and the foreign destination city and country was also requested. Complete data from 1997 is available and preliminary data for 2002 was released in December of 2003.

2.1.2.3 GeoFreight

GeoFreight is an intermodal freight decision support and display tool developed by the Oak Ridge National Laboratory and the Bureau of Transportation Statistics for intermodal freight planning and policymaking. It is widely available on CD. The tool uses a routing model to assign freight flows to the transportation network. (ORNL 2004)

2.1.2.4 Highway Performance Monitoring System

The HPMS is a national level highway information system was developed by the Federal Highway Administration in 1978 to support decision-making within FHWA, US Department of Transportation and Congress (FHWA 2004b). The database includes data on the extent, condition, performance, use, and operating characteristics of the Nation's highways. The data are reported to FHWA by state DOTs and include comprehensive data for the National Highway Systems and sample data for arterial and collector systems. Data fields appropriate for use in this study included AADT and percentage trucks.

2.1.2.5 Lock Performance Monitoring System

The Lock Performance Monitoring System (LPMS) provides data for all locks owned and operated by the US Army Corps of Engineers. The lock characteristics report includes information on the physical characteristics of each lock chamber, usage and closure data. The closure data was added in 1995. Usage data identifies direction but not commodity. Historical data are available. (USACE 1999)

2.1.2.6 Waybill Sample

The Waybill Sample is a 2.5-3% of all railroad waybills. Data includes origin, destination, intermediate railroads and junctions, commodity, type of car, number of cars, tons, and revenue. A public use file is available for download but with support from the state DOTs participating in the study we were able to obtain the Waybill sample from the Surface Transportation Board. The 2002 data includes over 590,000 waybills, which have 62 files include Bureau of Economic Analysis codes for origins and destinations and STCC codes (5 digit codes except for series 19, which are only two digit) to indicate commodities.

2.1.2.7 Freight Analysis Framework

The Freight Analysis Framework (FAF) integrates data from a variety of sources to estimate commodity flows and related freight transportation activity among states, regions, and major international gateways (FHWA 2004a). FAF estimates and forecasts are available for 1998, 2010, and 2020. The FAF's main products are (FHWA 2004a):

- Freight Origin-Destination Database of commodity flows among and within the 106 CFS regions, benchmarked every 5-years and updated annually with provisional estimates.
- Freight Network Flow Database of commodity movements assigned to corridors centered on major transportation facilities connecting the 106 CFS regions, with forecasts and updates corresponding to the Freight Origin-Destination Database.
- Commodity Flow Disaggregation Tool: a method for disaggregating the Freight Origin-Destination Database to more detailed geography. We did not use the tool as part of the study.

2.1.2.8 Supporting Tools

The main support tools for the analysis, storage and management, and display of the data compiled and analyzed in the study can be summarized as follows:

- ArcGIS 8.3: Data collection, formatting, management
- ArcIMS and ArcSDE: Data display on data reporting page
- Network segmentation tools for combining network attributes from diverse sources
- HTML Development tools for on-line data documentation site
- Secure FTP (file transfer protocol) server at Geographic Information Science and Applied Geographics (GISAG) Center at the Toledo Site.

These tools and their application are described in detail in APPENDIX D and APPENDIX E.

2.1.3 Synthesis

There are two parts to this area of the study, and even though related, the methodologies used were different. The clearinghouse of freight efforts in this region documents relevant research and cooperative projects. The research team developed a database that is web-accessible to compile and store data related to each study. These items were gathered from different sources throughout the span of the study. One source was the research team members themselves; most of the documents used in the literature searches for the different parts of the study are recorded in the database. The steering committee also served as an excellent resource, as state and provincial representatives pointed out relevant projects, studies, and plans in their respective agencies.

In comparison, the other part of this area of the study involved more analysis. It reports on the issue of multi-jurisdictional cooperation and the details of several groups that have worked together on transportation issues. It was important to take the necessary time to develop a scope for this report carefully, meaning both what elements of multi-jurisdictional cooperation and what case studies were examined. The research team selected these elements using a quantitative and qualitative approach. For example, opinions and feedback were sought from the steering and advisory committees of the study at this stage. Comprehensive research was then done in this area, including interviews and site visits for the selected case studies. The final report synthesizes this information in a manner that makes it a tool for the study's stakeholders as they discuss future steps in the regional effort.

2.1.4 Performance Measures

The research team began with five basic questions: 1) What is the current state of the art in performance measurement? 2) Which aspects of freight movement are most important for the success of the region? 3) What opinions are held in the freight stakeholder community on measurement? 4) What is the experience of transportation organizations in performance measurement related to freight? And 5) What sources of data might be found to support performance measures?

To answer these questions, several actions were taken:

- A focus group session was held with the project's steering and advisory committees.
- The literature on performance measurement generally, in transportation and in freight was reviewed.

- Surveys were sent to all state departments of transportation and to major metropolitan planning organizations. Surveys were also sent to shippers and carriers. (See APPENDIX G)
- The experience of other regional freight planning efforts was reviewed.
- The experience of some state departments of transportation was reviewed in more depth.
- Selected interviews were held with departments of transportation and private sector organizations.
- State and federal databases and data collection systems were reviewed for applicable data sources.
- Data from all of these efforts was analyzed and synthesized.

2.1.5 Administrative Issues

Administrative issues relate to the effectiveness of administrative practices and impacts of regulatory inconsistencies. The scope of issues include: highway infrastructure, safety, traffic operations, environment, economic productivity and modal competitiveness, finance and energy, compliance and enforcement, and intergovernmental cooperation. The research team concentrated on identifying and understanding regulatory inconsistencies and administrative practices in the Upper Midwest Corridor Region. Then taking a regional perspective, the team identified potential impacts of inconsistencies including travel bottlenecks and opportunities for regional cooperation including ITS/CVO technology. This part of the research was accomplished by several tasks.

1. Literature review to provide information for understanding the regulatory environment that governs freight movement, to identify documented inconsistencies in regulations and impacts of inconsistencies. The scope of the literature review includes previous studies and reports dealing with administrative issues and freight regulations.
2. Survey questions regarding regulatory inconsistencies and impacts were sent to all state departments of transportation, major metropolitan planning organizations, and selected shippers and carriers. (See APPENDIX G)
3. The research team interviewed the stakeholders. Representatives of motor carrier and rail industries provided perspectives on regulations governing the trucking, rail, and shipping industries and the impacts of regulations on shippers, carriers, and intermodal users. Highway state patrol officers provided perspectives on hazardous materials regulations. Highway operations engineers provided perspectives on ITS/CVO applications by states. In addition, focus group sessions were held with the project's steering and advisory committees.

4. The research team cataloged the CVISN deployment status and plans in the corridor states and performed a regional GIS analysis to identify potential deployment sites to improve administrative effectiveness.

2.1.6 Usage

The analysis of usage focused on two areas:

- Collect existing freight flow data from various sources, such as state DOTs or the federal government. Data to be used should be reliable and accurate. If there are gaps in the data for parts of the corridor, this will be noted to the Steering Committee before analysis.
- Analyze the data collected from sources. The objective of the analysis is to give the stakeholders useful information on how goods move to, from and within the region. If resources and existing data allow, an analysis of future growth in freight movements will be conducted.

Specific tasks include:

Task 0. Develop a list of data and data sources. Prior to the official start of the project, states were provided with a "data wish list." This is intended to identify the nature and type of useful data. While many states participating in the study have acquired the Reebie Transearch data, this is just one of many possible sources. UIC will identify the data need for the study and develop the data wish list with assistance from other project members.

Task 1. Solicit data. The data wish list was distributed to the participating states and Ontario. UIC served as the coordinator of the data collection effort.

Task 2. Acquire data from state, national and public sources. Data came from many sources. Data acquisition does not necessarily mean the physical acquisition of the data but ensuring access to the data either through electronic access or physical media.

Task 3. Documentation of data characteristics and data analysis. As the data were collected, the variables and other pertinent characteristics of each data set were inventoried and documented. Acquired data was analyzed for data quality. If necessary, data cleaning was performed to ensure correctness and integrity to the extent possible. This also includes evaluating and setting the standards for time frame and sources of the data.

In the next step, the completeness of the data is assessed in terms of geographic, modal, and industry coverage. If necessary, procedures for data imputation were developed. Issues are documented and compiled data analyzed to provide a picture of the freight demand in the region.

Task 4. Identify next steps. Because this phase provides only a snapshot of current demand, crude procedures for forecasting demand, strategies for acquiring additional data and opportunities for enhancing the available data were identified.

2.1.7 Capacity

In Upper Midwest Corridor study region, there are four different types of modes used in freight movement. These are: Highway, Railways, Waterways and Airports. A capacity analysis of each mode provides the stakeholders with an understanding of the systems attributes and their impact on capacities. The capacity information is useful and important in economic analysis as recurring congestion or constraint capacity increase the transportation costs of commodities.

As physical and traffic characteristics of modes are different so in the capacity analysis each mode is treated separately. For the capacity analysis a mode specific network is selected and then link or uniform segment capacity is estimated. The estimated practical capacity is compared with the usage (demand) of the facility to determine the congestion or constraint parameters

2.1.8 Interpretation

Each of the study areas was responsible for developing conclusions and recommendations. Team meetings and meetings with the steering committee and the workshops with stakeholders provided opportunities for synthesis of the results and the identification of future directions. The focus is on "what have we learned" and "how do we move forward."

2.2 Study Team and Organization

The Midwest Regional University Transportation Center (MRUTC) at the University of Wisconsin-Madison, Intermodal Transportation Institute at the University of Toledo, and the Urban Transportation Center (UTC) at the University of Illinois at Chicago (UIC) conducted the Upper Midwest Freight Corridor Study. The study was led by the MRUTC and funded through a transportation pooled fund. Participating states in the pooled fund were Illinois, Indiana, Iowa, Minnesota, Ohio and Wisconsin. Dr. Teresa Adams of the University of Wisconsin-Madison was the Principal Investigator. MRUTC staff was responsible for the overall functioning of the project, assembling the pooled funds and reporting on the progress of the study to the pooled fund administrator.

Three primary groups are involved with the study. The steering committee is made up of representatives from funding organizations, which are all state DOTs. Each funding state has a representative from the DOT and their divisional Federal Highway Administration office. In addition, invitations were extended to other states and provinces in the region. Manitoba and Ontario accepted this invitation and have a non-voting seat on the steering committee, which is responsible for the direction of the study.

An advisory committee is also part of this study. The charge of this committee is to give the steering committee different perspectives and insight on regional freight transportation issues. This committee is made up of representatives from other public agencies, private freight carriers, and freight shippers. Examples of members on this committee include representatives from the Chicago Area Transportation Study, Ports of Indiana, American Transportation Research Institute, Canadian Pacific Railway, and Iowa Corn Growers Association.

The final group is the multi-disciplinary research team, which includes three university transportation centers. The disciplines of the researchers include engineering, geography, planning, and business.

Members of the research team took responsibility for specific study components as follows:

- Performance measures – Ernie Wittwer, MRUTC
- Administrative issues – Teresa Adams, MRUTC
- Synthesis – Travis Gordon, MRUTC
- Demand/Usage – Kazuya Kawamara, University of Illinois
- Capacity – Jiwan Gupta, University of Toledo
- Catalogue the data and identify the gaps – Kazuya Kawamura, University of Illinois at Chicago
- Data assembly and mapping, Peter Lindquest, University of Toledo

2.3 Corridor Definition

Researchers from the University of Illinois-Chicago, University of Toledo and University of Wisconsin-Madison, along with graduate research assistants worked together to define the highway network to be studied. Central to the corridor are interstates 80, 90 and 94. To identify other critical roads in the corridor's highway network, the research team started by listing parallel, connecting, and intersecting roads that were complimentary freight routes to these main corridor roads (I-80/90/94). This list was circulated among the project steering committee members including representatives from each participating state for validation and revisions. It was explained to these representatives that while states have designated state freight corridors, they were being asked to take a regional perspective and realize that research resources were limited.

The research team used the National Highway Planning Network (NHPN) (FHWA 2004c) to map the corridor roads in order to evaluate consistency and connectivity across the region. The NHPN was selected as the base map for the study because all of the states report spatial data to the federal level for the NHPN. A process for identifying the appropriate NHPN roadway links was developed based on rational rules, criteria, and guidelines. These are documented in APPENDIX C.

These guidelines were applied with enough flexibility to allow for the unique circumstances that may exist in each sub-area within the study area. In most cases, not meeting one of the guideline did not determine the fate of a route. Rather, the routes that were excluded usually suffered from a combination of shortcomings.

2.4 Data Sources

The amount of freight data available from state and regional agencies has proven to be more than expected. However, the lack of consistency between data sets raised considerable challenges.

The freight corridor study did not include a budget for collecting new data. Existing data held by the federal government, the states and provinces, and the metropolitan planning organizations (MPOs) would be utilized to construct an overall view of freight movement and the operational characteristics of the freight transportation system in the region. Accordingly, the first task was to identify available data and sources from which it might be obtained. Primary sources were identified for information concerning freight traffic in the corridor. These organizations are:

- United States Department of Transportation
- Ontario and Manitoba Ministries of Transportation
- State Departments of Transportation
- Association of American Railroads
- Ohio Turnpike Authority

- United States Customs
- Bureau of Labor Statistics
- American Trucking Association
- AASHTO
- U.S. Chamber of Commerce
- National Governor's Association
- Great Lakes Carrier Association
- St. Lawrence Seaway Development Corporation
- National Association of Manufacturing
- Army Corps of Engineers
- Intermodal Association of North America

At the state, regional, and local levels, there are no consistent formats for collecting or reporting freight usage data as shown in Table 2.2.

Table 2.2 Types of Data Held in the Region

Data Type	Ont	Ohio	Mntb	Iowa	Mich	Wis	MPOs
Roadside survey of carriers	X						
Truck counts		X	X	X	X	X	X
Commodity flow data	X	X		X	X	X	X
Link volume data		X		X	X	X	
Crash records		X		X	X	X	
Transearch data		X		X	X	X	
Port studies and plans		X		X	X	X	
Turnpike gate-to gate flows		X					
Major shippers survey		X					
Border Crossing data			X				
Weight data	X	X	X	X	X	X	
Railroad waybill data				X		X	
Economic value of freight	X						

2.5 Data Reporting and Documentation

All of the data collected, organized and analyzed by the research team are stored in a centralized repository maintained on a server at the Toledo site. The members of the research team have secured ftp access to this repository as a means to facilitate exchange among the three sites. In addition, complete documentation of the data is posted on a web site for easy access to research team members as well as to stakeholders and decision makers in the region. Documentation of the data includes such descriptors as source, contents, location in the database, data modifications made by the research team, and restrictions and limitations. Details regarding the storage and documentation of the database are provided in APPENDIX D and APPENDIX E.

Considerable effort has also been devoted to the creation of an internet-based data reporting and mapping system. This system enables shippers, carriers, public agencies and policymakers to conveniently visualize the transportation infrastructure within the corridor region and prepare maps that can incorporate a wide range of variables documented within the database. Users of the data reporting system can use their web browsers to generate maps that incorporate any desired component of the transportation system: highways, railroads, intermodal facilities, ports, airports and waterways. In addition, any attribute associated with features in the database can be displayed in a variety of thematic mapping functions. Another feature of this map-based data reporting system includes detailed data documenting population distribution, economic activity driving freight movements, and socioeconomic data. These additional components of the database enable users to not only display freight movements and traffic volumes in the map, but can also spatially relate these movements to economic activities in the region as displayed in Figure 2.1. Users can also download their map compositions from the site.

The user interface for this data reporting system was designed to be as logical and intuitive as possible. A number of automated scaling and display options were built into the system so that users can concentrate on the selection of desired features and variables and not on learning how to display them. It is anticipated, however, that this reporting site will be expanded to incorporate a wider variety of query functions and analysis tools that can assist in decision support efforts for shippers, carriers, public officials and policymakers.

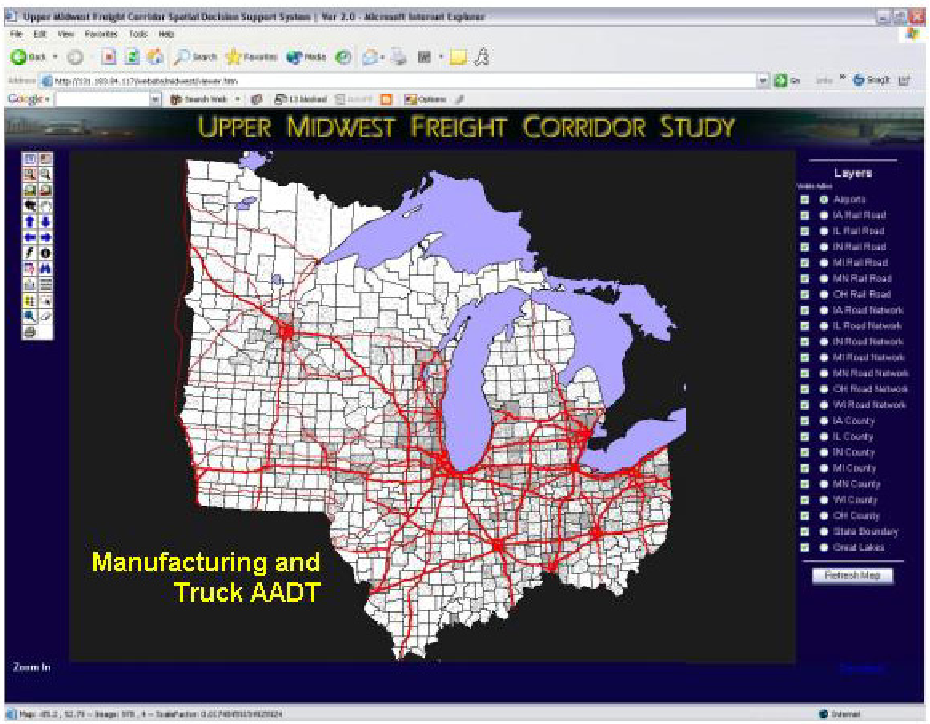


Figure 2.1. A Sample of the Data Reporting Site.

3 SYNTHESIS OF PRACTICES

When the study's objectives were being drafted, the stakeholders knew that it was important to gather information on current practices in the area of public-sector participation in freight transportation. What evolved from this are two study areas that are related and reported here under the heading of Synthesis of Practices. The first is a clearinghouse of public freight transportation efforts. This tool allows freight stakeholders to look at projects in neighboring jurisdictions or at emerging research projects of interest. The second area is a report on multi-jurisdictional efforts from around the nation that address freight transportation, with a particular emphasis on groups involving multiple states. This report draws out the groups' successes and challenges and translates them into a strategy for the Upper Midwest region.

3.1 Clearinghouse

3.1.1 Objective

The objective of this is to support the goal of coalition building by communicating to the stakeholders the freight transportation initiatives in the region. The clearinghouse is a synthesis of efforts that compiles two sets of information into a web-accessible database: Cooperative efforts in freight transportation that involve the public agencies in the region and research of relevance to this region.

While only the research team is able to access the interface to enter items into the database, the website that shows the contents of the database is globally accessible. One benefit of the categories was the ability to give users of the database easier access to groups of related items. The search function allows users to narrow their scope even further by matching submitted terms to the title, author, or abstract areas.

3.1.2 Methodology

These items were gathered from different sources throughout the span of the study. One source was the research team themselves; most of the documents used in the literature reviews for the different parts of the study are recorded in the database. The steering committee also provided an excellent resource, as state and provincial representatives pointed out relevant projects, studies, and plans in their respective agencies.

The items to be entered into the database came in all forms. Email messages with links to documents on websites were common, as were the hard copies of the materials themselves. One researcher served as the main collector of these items. The process for deciding which items to enter into the database was informal. Compilations of projects were favored over entries of multiple projects. For example, instead of entering all of the freight research projects done by a specific research center, only the link to the research center was entered, and if possible, a link to the listing of these specific projects.

Once an item was ready to be entered into the database, the researchers used a web interface to enter the item's information into the database. The interface was developed by the research team and is shown in Figure 3.1. One feature of this database was the assignment of each item to a specific category. The categories were created to group similar items in the database. The categories include each state and province in the region, as well as specific areas of research.

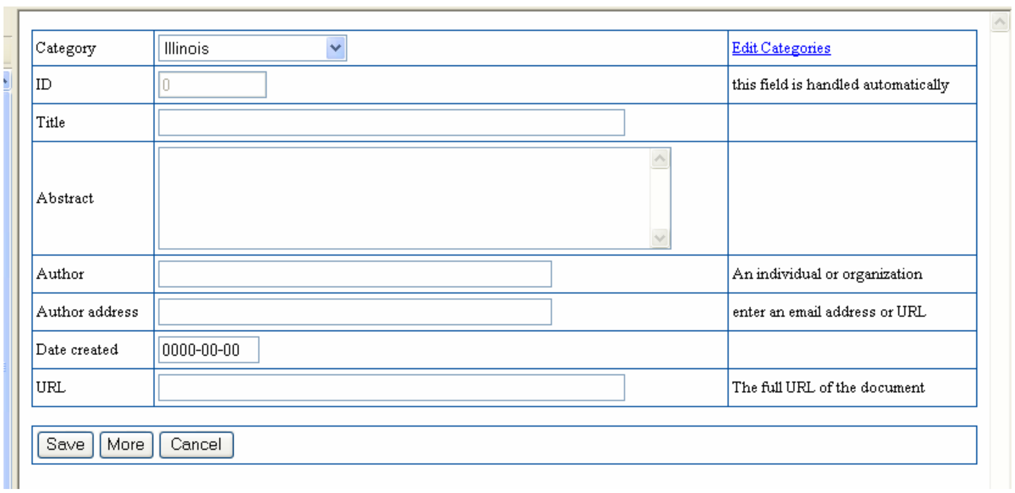


Figure 3.1 Web interface for entering items into clearinghouse database.

3.1.3 Future Directions

The clearinghouse is a worthwhile effort to continue for the region. Many other freight stakeholders agreed with this view, as long as the clearinghouse was updated on a regular basis. There was also a recommendation to have a system where users could sign-up for notifications when new items are entered into the database. However, questions remain regarding this responsibility beyond the end of the study. It is certain that future efforts on the clearinghouse would require resources. One idea is to minimize those resources required by teaming with other organizations working on similar efforts. FHWA has an on-going initiative called Freight Professional Development. One of the products of this initiative is a library of freight resources (see http://www.ops.fhwa.dot.gov/freight/FPD/library.asp). The idea of this resource is very similar to the clearinghouse done for the study, except on a national scale. Future efforts for a regional clearinghouse could be combined with future work on FHWA's freight resource library. One section of the FHWA library could be dedicated to the Upper Midwest region, allowing regional users easier access to national resources and users from other regions easier access to this region's efforts.

3.2 Best Practices

Findings from this report show that freight movements are expected to grow at rates that could cause major capacity issues in the future. The region's existing transportation terminals and links will be exposed to greater usage rates to cope with these increasing movements. In the past, stakeholders in the freight transportation field have found ways to effectively manage increases in freight movements. Advances in technology have dramatically decreased freight delivery times. In addition, deregulation, consolidation, vast distribution networks, changes in administrative policy, and "just in time" freight have produced both solutions and challenges for freight transportation. An approach in successfully meeting these demands is to plan and manage a freight transportation system regionally. Regional planning is used as a management tool for preparing programs and objectives of public policies, such as freight transportation, that have a regional scope. Regions provide an excellent basis for governments to create policies and programs for the solution of problems that cross state boundries. The creation of regional, multi-agency coalitions can serve to further state and national interests on a centralized or decentralized basis, respectively. (ACIR 1972)

This area of the study begins with a look at multiple jurisdictions working together, primarily with a multi-state scope. The authors identify the benefits and challenges of cooperation across agency boundaries in a variety of settings. The case for taking a regional perspective for freight transportation is then discussed. Then, with many multi-jurisdictional projects related to freight transportation now underway, the authors analyze several of these efforts. A review of those efforts is necessary to capitalize on those experiences, replicating successes and avoiding failures. Areas of interest in this analysis include funding, organizational structure, decision making processes, identification of catalysts, and private sector involvement. The objective is to have the analysis be a tool for the study's stakeholders as they discuss future steps in this regional effort.

3.2.1 Ideas, Concepts, and Obstacles

According to Katz (1999) many people, from academics to corporate leaders to political activists, argue that the regional perspective is relevant. They insist that regions are critical, functional units in a worldwide economy. Perhaps as important, regions are critical functional units in individual American lives. Broadcast and print media rely on a regional marketplace. There is an ever-increasing amount of travel across city, county, and state borders in terms of daily commutes. Businesses, large and small, depend on suppliers, workers, and customers who rarely reside in a single jurisdiction. Freight movement follows suit in this dynamic process.

The various multi-state political entities, created by diverse compacts and legislation, are a clear indication that governments at different levels find it both necessary and desirable to accommodate regional tendencies politically and to satisfy multi-jurisdictional needs within regional structure. (ACIR 1972) Multi-agency cooperation has occurred through voluntary coordination of certain federally supported projects. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), combined with the Clean Air Act amendments adopted in 1990, and the Transportation Equity Act for the Twenty-First Century (TEA-21) have provided opportunities through funding for regional decision making. It should be kept in mind that the role of state and federal policies "is not to override localities in the name of regional collaboration, but to enable all of them to compete on a level playing field." (Katz 1999)

Multi-agency relationships develop in different forms. Cooperative efforts may be in the public or private sector, or in forums where both sectors work together. They may take the shape of public-private/city-county economic development relationships, multi-county sewer district affiliations, or multi-jurisdictional wildlife refuge partnerships. More generally, because many problems that cannot be ignored involve large areas that include a number of independent governmental jurisdictions, regional agencies have been established to perform a single operational function within the district covered by its activities. (Branch 1988)

Many articles and case studies analyzing multi-agency cooperation have been published. What is often found to be an underlying motivation in working together is that administrative decisions regarding a particular issue in one jurisdiction has an effect in other jurisdictions. For example, without regional, multi-agency cooperation, regional development is likely to be compromised by problems such as pollution control. Land use controversies, water quality issues, and the difficulties of planning for the region's transportation and communication infrastructure (Nunn and Rosentraub 1997; Glick and Clark 1998), are all illustrations of the types of issues generated when cooperation is limited or averted.

Even though it is very useful to recognize the potential for cooperation, more is involved in determining whether a cooperative arrangement will succeed. Challenges exist because cooperating organizations may have goals, objectives, and policies that conflict. (Glick and Clark 1998) Challenges are overcome when the organizations are able to see the long-term benefits from regional cooperation.

"A popular misconception is that people cooperate primarily for altruistic reasons: that is, they do so to make others feel good or to promote the common good. In fact, most cooperative efforts develop and endure because of strong, self-interested motives that can be achieved only through cooperation. The diverse groups involved in pushing for environmental protection of the Big Cypress Swamp did not join hands and walk into the sunset because they wanted to make each other feel good, or they were all trying to "do good things" for the environment. Instead, they formed a coalition of interests because collectively they had a chance to protect their own individual interests, whereas individually, they were likely to fail." (Yaffe 1998)

Another challenge is that regional cooperation will have no impact if it does not address its challenges head-on. To be significant, regional multi-agency cooperation must be involved in the governance process, that is, the network of political units which will always govern the region. (Cassella 1983) This is easier said than done, because regional organizations are often seen as a threat from both the federal and state perspectives. (ACIR 1972)

Finally, sometimes groups have incentive to work together, but cannot because of past relationships, ineffective procedures for communication, laws, or institutional norms that inhibit involvement. These obstacles affect how the groups' self-interest is seen. As a result, people will hold on to past positions and behaviors even when they understand that their own interests would stand to gain through other means. (Glick and Clark 1998; Yaffee 1998)

While the challenges seem immense, successful cooperation can address truly regional issues, benefiting the region at large. The analysis of selected case studies later in this chapter and the conclusion of the literature review will provide some strategies to overcome the challenges and reap the benefits of regional cooperation.

3.2.2 Benefits

Regional, multi-agency cooperation can result in coordinated policy programs that advance a broad range of public interests. Some of those interests include: improving the quality of land use decisions; saving money on infrastructure and maintenance through more efficient use of resources; guiding future growth and investment to achieve sustainable economic growth; conserving renewable resources; protecting sensitive natural resources; achieving a balanced tax base, rate of growth, revenue stream, and public service costs; and generally promoting what is best in the public interest. (APA 1993)

One example that outlines the potential benefits of cooperation among states and provinces, although on a smaller scale, is a council of governments (COG). Issues that a local communities face will not all be solved by a single city or county. Problems of a regional nature require cooperative action by all local governments. The objective of a COG is to make possible a cooperative approach to regional problem solving and programs of a regional nature. As local governments become more complex with increasing multi-jurisdictional relationships, COGs across the country have seen significant increases in responsibility and a shift to greater regional decision-making. (BFCG 2004) Councils of governments provide benefits of participation similar to the following. Notice how all of them could easily be translated to apply to a multi-state group.

- A seat at the table and a voice in key regional decisions
- Opportunities to resolve growth, economic development, and transportation issues that cross jurisdictional boundaries
- Information and technical assistance for obtaining federal and state transportation funds
- Workshops, training, and other educational opportunities to learn about important issues for local jurisdictions
- Employment, population and travel data needed to meet special requirements for day-to-day planning needs
- Access to an extensive range of technical expertise in areas such as transit and transportation planning, economics and economic development, growth management, demographics and use of geographic information systems

Agencies can take advantage of scale, an inherent benefit of cooperating as a region. As a result of cooperative efforts, a larger geographic pool of resources and staffing is available. Because state and local governments usually do not have sufficient resources to solve all of the problems they face, this is an important benefit of cooperating on issues they have in common regionally. (Mercer 1991)

This approach, which works well for MPOs, can also be applied across states and provinces to coordinate action and satisfy the intents of individual jurisdiction.

3.2.3 Freight Cooperation

Freight transportation is one of those issues that the states in the Upper Midwest and Great Lakes region have in common. By its very nature, most freight shipments cross jurisdictional boundaries. Trucks and railroads cross state borders, ships cross international boundaries, and airplanes carrying cargo criss-cross the world. As reported in the FHWA case study of freight efforts in Southern California, freight “doesn’t respect” political boundaries and can’t be captured in a project’s study area. (FHWA 2002b) It is truly a global issue, where “no one truly understands or manages the whole system.” (Asariotis et al. 1999)

While a multi-state approach can't and doesn't attempt to address all freight transportation issues, it is an important scope that can capture the benefits of cooperation stated above and more. It is justified by the fact that in the Upper Midwest region, trade from one state to another is a very important part of every state's economy. Work done by the Regional Economics Applications Laboratory at the University of Illinois and the Federal Reserve Bank of Chicago exemplifies this fact.

> *"In Illinois it was shown that the state's foreign trade with its major international partners, although very large, was dwarfed by its trade with its regional partners. Exports to the smallest regional partner are on the order of three times that of the largest foreign trade partner. If a "most favored nation" status were to be conferred by states, Illinois should confer that status on its state partners." (AASHTO 1998)*

The region that the Federal Reserve looked at included Illinois, Indiana, Michigan, Ohio, and Wisconsin. On average, about 35% of each of those states' outbound freight movements (by value) go to the other states in the region.

Findings from this study (the Upper Midwest Freight Corridor Study) support this claim. Using data provided by FHWA, analysis showed that 40% of the average freight traffic (by weight) on I-75, just north of Toledo, Ohio, is going to or from Ohio from or to other states in this study's region (excluding Canadian provinces). On I-94, south of Milwaukee, that figure is 36% for traffic going to or from Wisconsin from or to other states in the region.

The multi-state, regional approach to addressing freight transportation issues has been widely discussed in the past decade. Momentum continues from various stakeholders that recommend this approach. Most recently, a report by the U.S. General Accountability Office (GAO) highlighted the shortcomings of freight transportation planning when done within one jurisdiction, whether it is a city, a metropolitan region, or a state. Freight movements and their needs along corridors (such as Minneapolis/Chicago or Toledo/Detroit) demand cooperation across borders. When local entities approach freight issues alone, two challenges can arise. One is the issue of "burden sharing" where the local agency and their constituents will not favor a project when the majority of the benefits are dispersed along trade corridors that extend beyond their jurisdiction. The other challenge is when an agency finds that improvements to help their businesses actually fall out of their jurisdiction. Bottlenecks that are in a neighboring city or state cannot be easily addressed by that agency alone. The GAO report recommends a multi-jurisdictional approach in their strategies. (GAO 2003; FHWA 2002b) Multi-state corridor efforts for freight transportation are also recommended by AASHTO and provisions for them are included in the

Administration's 2003 Surface Transportation Reauthorization Proposal (SAFETEA). (AASHTO 2002; GAO 2003)

Many cases of successful multi-state, regional cooperation in transportation issues exist. Stakeholders in Intelligent Transportation Systems (ITS) implementation efforts realized early that working together across city, county, and state borders improved efficiency of the deployment dramatically. For example, toll agencies in several states along the east coast have cooperated to implement the E-ZPass electronic toll collection system. Having one system in a large region, instead of 10 different systems, saves time and money for the users. (Deblasio 2000) In freight, regions have cooperated with varying degrees of success. Several of those efforts are identified and analyzed in the following section.

3.2.4 Case Studies

Over the past decade, several groups have formed across jurisdictional boundaries to address the issue of freight transportation. These groups were aware, for a variety of reasons, that working together could produce better results than continuing to address the issue separately. Most of these efforts have involved multiple governmental agencies, including DOTs and MPOs. Some have also had participation from the users of the freight system, such as motor carriers or industrial shippers. The case studies presented in this report were selected based on a number of elements, but the focus was on those that involved multiple state DOTs, similar to the effort that is responsible for the Upper Midwest Freight Corridor Study.

After an overview of the selection criteria, each case study is summarized and key points are listed. The final two sections of the chapter offer strategies based on the case studies to overcome common challenges in a regional freight effort.

3.2.4.1 Selection Criteria

The selection was done using both quantitative and qualitative methods. The research team had first developed a quantitative scoring method that used differing weights on the selection elements. However, the steering committee was concerned that the scoring system would overlook some efforts that were important to the group. It was then decided to use the scoring system just as an initial evaluation tool, followed by feedback from the group to make the final selections. The quantitative scoring system is shown in Table 3.1 and the selected case studies with their scores are shown in Table 3.2.

Table 3.1 Quantitative evaluation method used to evaluate possible case study alternatives.

Element	Scoring
Involves state governments	0 = no state governments 1 = one state 2 = two states 4 = multiple states
Involves multiple countries	0 = one nation 2 = multi-national
Addresses freight transportation issues	0 = no 3 = yes
Current stage	0 = forming, study underway 1 = study completed 3 = next steps taken
Information on effort that is readily available	0 = hard to find 1 2 3 = several sources
Located in region	0 = no 2 = yes
Multi-modal consideration	0 = no 2 = yes

Table 3.2 Scoring results of final case studies selected.

Element	CREATE	NAITC	I-95
Involves state governments	1	4	4
Involves multiple countries	0	2	2
Addresses freight transportation issues	3	3	3
Current stage	3	3	3
Information on effort that is readily available	3	1	3
Located in region	2	2	0
Multi-modal consideration	2	0	2
TOTAL (out of possiblel 19)	14	15	17

CREATE=Chicago Region Environmental and Transportation Efficiency Project; NAITC=North American International Trade Corridor (I-35 Corridor); I-95=I-95 Corridor Coalition;

3.2.4.2 CREATE Program

Chicago is a unique setting for railroad operations in North America. It is the one place where all of the major U.S. and Canadian railroads converge. These railroads use Chicago as one of the largest rail freight processing centers in the world. On an average day, the Chicago area handles more than 37,500 rail freight cars. (AAR 2003) Chicago has also been the recent setting of several initiatives that have brought together the public sector and the private railroads. An infrastructure improvement plan released in the summer of 2003, dubbed the CREATE program, is one of those efforts. It is a plan to upgrade track, bridges, signaling and switches that in some places are well over 100 years old. In addition, the program includes seven rail over rail flyovers and 25 rail-highway grade separations. This program is supported by the railroads, as well as the state and local transportation agencies. Several factors helped to unite the different stakeholders.

In the 1990s, rail service concerns in the Chicago area prompted action by two groups. The first was the railroads themselves and their operations-level representatives who formed the Chicago Planning Group. This group formed soon after the severe winter storm that snarled rail traffic for months in 1998-99. One of their first actions was to establish an office that coordinates rail operations in the area. The Chicago Transportation Coordination Office (CTCO) was created one year later. Each major railroad has representatives at the CTCO who work together to collectively operate the Chicago rail system. The goal of this office is to improve the efficiency of the system. It has done this by developing contingency plans for weather problems or track outages, coordinating track maintenance, and making changes to railroad operations that will improve the system as a whole. (Blaszak 2003)

The other group to address rail issues in the Chicago area was formed by a multitude of stakeholders. According to representatives of the Chicago Department of Transportation (CDOT), Mayor Richard M. Daley has had an interest in rail transportation issues for many years. The industry is important for the city's economic health, but there was growing concern with the negative effects of the railroads. At railroad merger hearings at the Surface Transportation Board (STB) in 1999, the concerns of the city were presented. A moratorium on mergers was enacted as a result of issues raised at the hearing. Subsequently, Mayor Daley asked the director of the STB to facilitate discussion between the parties involved. He was able to get top management of the railroads to the table. Another motivating factor was that the railroads realized that they had growing problems in Chicago, as demonstrated in the service problems of the previous winter. All of these factors combined to establish the Chicago Rail Task Force. The task force is made up of the leaders of the freight railroads servicing Chicago, Amtrak, METRA, Illinois DOT, and CDOT. The representatives from the participating organizations are from the top levels of management. The group first met in the spring of 2001, when the city outlined six concerns they had with the industry. Over the next year, the railroads worked together to put together a plan to improve the efficiency of rail operations in the Chicago area. The proposed plan would allow the industry to better serve existing and projected rail traffic.

By the fall of 2002, the railroads submitted their plan to the Illinois DOT and CDOT. The different sectors entered into almost a year of negotiations over the proposed infrastructure plan. The parties involved worked with engineers, lawyers, and consultants. With a commitment to the goals and open lines of communication, the railroads and government agencies were able to release a plan that benefited all parties by the summer of 2003. As of the summer of 2004, preliminary engineering consultants had been selected for key projects with funding from the state of Illinois and the railroads. Funding for the majority of the program is still not determined, although federal funding is being sought through the reauthorization of the Transportation Equity Act for the 21st Century.

Some of the key points to highlight from this multi-jurisdictional and public/private sector partnership are:

- Commitment from the organizations involved was critical. The railroads and government agencies assigned senior personnel to this project. Attendance and cooperation from the railroads and the government agencies was exceptional.
- All parties involved recognized the importance of improving the rail situation in the Chicago area.
- Communication was key in overcoming the challenges during negotiations.
- Each organization absorbed the costs incurred in developing the plans and completing negotiations.

3.2.4.3 North American International Trade Corridor (I-35 Corridor)

Since 1994, private and public sector organizations have worked together to transfer a vision of a high-tech transportation corridor in the center of the U.S. into a reality. The corridor traces I-35 from Mexico, north into Minnesota and follows I-29 into the Dakotas and Manitoba. A not-for-profit corporation named North America's Supercorridor Coalition, Inc. (NASCO) has been involved in most of the efforts along this corridor. It is a unique organization that represents several major companies and jurisdictions. Jurisdictions that are members link the corridor from Mexico to Canada, although some states are only represented by a county or city. There is a diverse mix of members from the private sector, including banks, industrial and retail shippers, and transportation associations. Organizations to note are the Ambassador Bridge, Frozen Foods Express Industries, chambers of commerce from many different points along the corridor, Kansas City SmartPort, and Daktronics. From these members, officers are elected to fill the roles of President, Vice-President, Secretary, and Treasurer. The membership of NASCO is assisted by two staff members (executive director, marketing director) located in a Dallas, Texas office. (NASCO 2003; NASCO 2004)

Their efforts have helped produce multi-state cooperation. Specifically, these efforts are the I-35 Trade Corridor Study which highlighted infrastructure data from the corridor and two recent studies that look at ITS applications for commercial vehicle operations along the corridor.

In 1995, the I-35 corridor was listed as High Priority Corridor #23 (Section 1105(c) of ISTEA (P.L. 102-240), as amended through P.L. 108-199 Division F Section 111). Shortly after this designation, the states along the corridor and FHWA began work on the I-35 Trade Corridor Study. It began with an analysis of existing conditions of the corridor's infrastructure and the current demand. Next, forecasting of future demand was done and the corridor's infrastructure was evaluated on its ability to handle future demand. The research team, working with stakeholders in the region through public meetings, developed a set of strategies to address the future demand. Finally, the study recommended a set of improvements. (TxDOT 1999)

The findings of the Trade Corridor Study spurred additional action by the stakeholders along the corridor, supported by two grants from the National Corridor Planning and Development Program in FY99 ($800,000) and FY00 ($600,000). (This program has generally been limited to funding projects along High Priority Corridors, such as I-35. (FHWA 2003)) The states, first led by the Missouri DOT, focused the next stage of work on comprehensive ITS implementation. The purpose was "to develop a coordinated approach to improving information processes for commercial vehicle operations along the Interstate corridors traversed by I-35, I-29, and I-80/I-94." (BAH 2001a) The report outlined a comprehensive system architecture to support ITS projects for commercial vehicle operations, providing details that would benefit any region in the U.S. It also gave the stakeholders several options of projects and plans to move forward. (BAH 2001b)

The next study/effort, led by the Iowa DOT, focused on the development of an Advanced Traveler Information System (ATIS) including a minimum one year deployment and field operations test of the ATIS. (D. VanderSchaaf, personal communication, September 20, 2002; IaDOT 2002)

The work of the stakeholders along this corridor goes beyond these studies. NASCO lobbies for project funding from different sources. For example, NASCO supported the Central Texas Turnpike Project. This project secured over $900 million in loans from FHWA and the Transportation Finance and Innovation

Act (TIFIA), a provision of TEA-21. Congressional earmarks have also financed projects along the corridor. (NASCO 2002) Yet the organization faces the problem of appearing to favor one section of the corridor over another. To balance their efforts along the entire corridor, a board of members and officers approves support for all projects. (NASCO 2004)

Some of the key points to highlight from this multi-state effort are the following.

- Both the North American International Trade Corridor and NASCO identify interstate roads 80 and 94 from Des Moines to Detroit within the corridor's scope. Coordination with these groups, especially with activities that have been done on these roads, is recommended for future efforts that result from this study.
- Strong NASCO leadership coincided with cooperative freight activities by the corridor, such as the pooled fund studies.
- NASCO works with other corridor groups to create new federal programs that assist regional efforts, even though they realize that those groups will be competing with them for that funding at a later date. (NASCO 2004)
- Academic institutions have been involved with the corridor's cooperative efforts, including the Kentucky Transportation Center at the University of Kentucky and the Center for Transportation Research and Education (CTRE) at Iowa State University.

3.2.4.4 I-95 Corridor Coalition

The I-95 Corridor Coalition is a well-documented effort to address transportation issues across jurisdictional boundaries. It is not a governing body, yet the work of the Coalition has had a positive impact on transportation operations for the east coast region and beyond. Among their accomplishments are numerous projects delivered that would not have been possible without the Coalition, such as an information network that connects the transportation agencies in the region with information on critical incidents on I-95.

The I-95 Corridor Coalition developed out of informal relationships involving operations representatives of the transportation agencies of the Northeast region. It took work by members of FHWA and upper management of the corridor states to bring all twelve states of the Northeast region together, from Maine to Virginia, to work on transportation operations issues. Another factor was the emerging topic of Intelligent Transportation Systems (ITS) during the time that the Coalition was forming. The Northeast region was seen as a good testing ground for ITS provisions that were introduced in ISTEA, especially if there was a mechanism that coordinated the states' efforts. Being a testing ground held the promise of federal funds. By the end of 1992, the I-95 Corridor Coalition was formalized, encompassing the 12-state region of the Northeast from Maine to Virginia. The first objective of this group, managing critical incidents on I-95 beyond state borders, was simple yet provided immediate benefits at a low-cost. Over the next several years, the organizational structure evolved with the creation of an Executive Board and Steering Committee. The Coalition also acquired dedicated full-time staffers, who had all been employees from member agencies "on-loan" to the Coalition. (Baniak 2002; Baniak and Ross 2000)

Today, the Coalition has expanded its scope of work, covers the transportation system along the entire east coast, uses four full-time staff positions, and procures several million dollars each year for projects to benefit the region. It is helping to improve the multi-jurisdictional analysis of proposed capacity-enhancing and operational improvements by sponsoring the development of information systems that assist member agencies in analyzing the movement of people and freight across jurisdictions. (Baniak 2002)

Having membership roles and a defined organizational framework have become more important as the Coalition has grown in scope of work and number of states represented. Most transportation agencies owning or operating a major regional system are *Full Members*. Transportation associations (ATA or AAR) and planning agencies (MPOs) make up the *Affiliates Membership*. Smaller transportation agencies and other governmental agencies with a role in transportation operations (state patrols) fall under the *Associate Membership* group. Finally, any other organization or interested party can be a *Friend of the Coalition*. All of these members are organized under a set of committees and program tracks. The Executive Board is made up of the top administrators of the full members. This group provides policy direction and approves the annual plan of projects to be funded. The Steering Committee gets involved with more of the details of the Coalition's work and has representation from the full and affiliate members of the Coalition. People who serve on this committee are usually the leaders and experts of transportation operations and management in their agencies. Finally, Program Track Committees are used to oversee a particular area of work in the Coalition, such as freight transportation. (I-95 2001) These committees manage the approved projects in its subject area, providing a critical link between the organizations conducting the work and the Coalition. These organizational bodies work together in a cyclical process that is constructive, yet simple.

> *"The Executive Board establishes broad program priorities that guide the Steering Committee and the Program Track Committees. After receiving Executive guidance, the Program Track Committees review their objectives, refine them as needed, establish the activities and projects to meet those objectives, and follow up with detailed plans and budgets. From this input, an annual work plan is compiled. The Steering Committee and Executive Board then adopt the Business Plan update and approve the annual work plan. This annual cycle results in a continuous flow of planning and implementation." (Baniak and Ross 2000)*

Administrative duties of setting up contracts for projects, producing newsletters, and arranging Coalition meetings have been done increasingly by Coalition staff. These four people are "on-loan" from member agencies, an arrangement that has worked well since the first full-time staffer started work with the Coalition over a decade ago. Consultants, which were used for these tasks in the past, are now utilized for specific projects. The University of Maryland's Maryland Center for Advanced Transportation Technology works extensively on the Coalition's website and also currently serves on behalf of the Maryland Department of Transportation to receive, account for, and disburse the funds for specific Coalition projects. (I-95 2004)

Funding for the operation of the Coalition and its projects has benefited directly from FHWA's ITS program. In TEA-21, these federal funds were "set aside" for the Coalition. While this funding has been critical, it does not make up the entire budget of the Coalition. Using those federal funds has required matching funds from the member organizations. The Coalition has excelled in securing this match by making it an important part of the project selection process. By the time a proposed project has made it to an annual business plan for approval by the Coalition's committees, the matching funds are locked in. These funds are not a suggestion; they are a requirement for each proposed project. (I-95 2004)

Some of the key points to highlight from this multi-state effort are the following.

- The Coalition gained early momentum by delivering benefits that were relatively low-cost.
- The Coalition has benefited from the executive level support and participation of its member organizations.
- Outside of the committee structure, the Coalition has informal groups that meet regularly via conference call. It is a challenge that these groups don't undermine the committee structure, but rather they make the organization more efficient by dealing with the mundane issues and letting the larger committees tackle the major issues.
- Minority owned business participation in support consultants' contracts has been encouraged by the Coalition and they note this in their work.

3.2.5 Analysis and Recommendations

3.2.5.1 Funding

Federal funds have been key to the work of most regional efforts. It is a necessary component for success because even at a regional level, the benefits of cooperative improvements to the freight transportation system go beyond those states directly involved. Federal funds can overcome this challenge of burden-sharing. However, while reports and studies have touted the benefits of working regionally on freight issues and recommendations have been made to make it easier for regions to obtain funds, the options are still limited. (GAO 2003; AASHTO 1998) The I-95 Corridor Coalition has made use of "set asides" and earmarks. The National Corridor Planning and Development Program is the program that could assist regional efforts. However, this program's funding level is relatively low and even more problematic is the fact that the program is largely earmarked in Congress. All projects awarded through this program were congressionally designated in FY02, FY03, and FY04. Even the discretionary awards that supported the ITS efforts along the I-35 corridor were based on the fact that the corridor was designated High Priority, a political decision. (FHWA 2003)

The U.S. Senate's version of re-authorization would develop a Multistate International Corridor Development Program, which would fund activities benefiting a corridor that traverses *at least three states*. This would in essence force multi-state cooperation to access funds from this proposed program. (FHWA 2004d)

While federal funds are important for regional activities, the agencies within the region must also share in the financial burdens. In most cases, using federal funds will require a local match. This local match does help in giving the local agencies and states a sense of continued ownership of these efforts. This element is important in the case studies detailed above. The I-95 Corridor Coalition is very successful in securing funding from their member agencies. The studies completed for the North American International Trade Corridor also required match from the participating states.

3.2.5.2 Organization

Effective regional, multi-agency cooperation, rather than a single jurisdictional agency providing oversight, has the potential to efficiently and effectively address some of the challenges caused by the complex freight system. Other regions in this nation have begun this effort. Their approaches to organizing have differed, just as the regions they represent differ. Many unique elements of organization were pointed out in the case studies and those should be noted for future efforts of the region represented in the Upper Midwest Freight Corridor Study.

Common ties can be found among the case studies and the literature regarding regional organization. In his work on regional cooperation, Yaffee (1998) makes it clear that, "critical to the success of these and other cooperative efforts is effective participation by all parties." This is apparent in all three of the cases. For the CREATE program and I-95 Corridor Coalition, consistent and well-attended meetings have sustained their efforts and produced deliverables. This point is more evident in the North American International Trade Corridor. The momentum of the group coincided with the involvement of all of the states along the corridor. As fewer states participated in the projects and a real champion was missing, many feel that the efforts have stalled.

Staffing to handle the day-to-day operations of a regional effort is also important. These tasks include contract administration, facilitating communication among the stakeholders, planning meetings, and coordinating an on-going outreach effort, among others. The use of "on-loan" employees from member agencies of the I-95 Corridor Coalition has worked well for that group, but it is only one option. It is also possible that a regional system can succeed even if some of these functions are carried out by agencies, municipalities, counties, states, or private sector interests (Wachs and Dill 1997) as is the case with the International Mobility and Trade Corridor (IMTC). The IMTC is a coalition of government and business entities, led by the Whatcom Council of Governments (WCOG). It was formed to jointly identify and pursue improvements to cross-border mobility between Washington State and British Columbia. (WCOG 2004) The work by WCOG for IMTC has proven successful as member agencies and businesses benefit from the cross-boundary, multi-agency organizational structure.

3.2.5.3 Private Sector involvement

The private sector should have an interest in the regional efforts. It is a challenge to turn this interest into participation. Several studies cite the differences in culture between public and private sector organizations, such as drastically different planning horizons, as a deterrent. There can be frustration on both sides caused by the other's processes and organizational structure. (GAO 2003)

A strategy to note from the case studies comes from the CREATE program. Communication and understanding of the different organizations was important in bringing the two sectors together to seek a common goal. This process cannot be rushed, nor can its value be underrated. The work by NASCO shows how it is important for the private sector to see the value of a regional effort. This group truly believed in the benefits of regional cooperation and has led much of the work to secure funding for corridor-wide projects. Finally, the I-95 Corridor Coalition has capitalized on the participation of private sector associations.

3.2.6 Conclusion

The participating states in the Upper Midwest Freight Corridor Study area have been given an overview of regional cooperation, with a focus on multi-jurisdictional groups. The case was made for addressing freight transportation from a regional perspective, including the identification of supporting documentation and benefits specific to freight. Next, a series of case studies were detailed to observe other group's successes and challenges. The last section of the chapter grouped strategies based on these case studies into three categories: funding, organization, and private sector involvement. Those recommendations by the researchers are summarized here.

- Support the expansion of federal programs that fund multi-state initiatives that address freight transportation issues.
- Be aware of the political landscape in terms of federal funding.
- Coordinate efforts with those of intersecting or overlapping groups, especially the North American International Trade Corridor and NASCO.
- Make the multi-state regional perspective a complimentary part of a state DOT's freight agenda. Continue to elevate freight issues within the agencies using facts from this report, BTS, FHWA, or internal studies and documents. State resources are going to be an important part of any regional effort, especially in the initial stages.
- Involve the executive level administrators of the state agencies either through a committee or periodic communications that are brief and punctual.
- Have a consistent meeting schedule for the states and other stakeholders to maintain momentum. Not all meetings need to be face-to-face. Periodic conference calls or other remote technologies can be utilized.
- Find a way to keep a person or organization to handle day-to-day operations in order to help maintain momentum of the group. Other regions have used staff from transportation agencies or outside support.
- Communicate the benefits of addressing freight transportation from a regional perspective so that all parties recognize the importance of cooperation.

- Continue to understand the viewpoints of all the stakeholders in the effort. Take time to share the processes and programs of the different organizations involved.
- Focus recruitment more on private sector associations instead of individual companies. This is particularly important for the trucking industry and shipping representatives.

4 PERFORMANCE MEASURES

4.1 Introduction/Summary

Communication, understanding and an ability to focus efforts are keys to improving the flows of freight in the upper Midwest. Agreeing to and reporting on selected measures of performance can play a significant role in bringing these conditions about. The first part of the effort should be a structured planning process that would bring the stakeholders together to agree on the core mission and vision for freight in the region. Measures should flow directly from those core issues.

Actual implementation of measures will require that some organization be appointed and supported to fulfill this role. Several possibilities exist for this role. Among them are the Midwest Regional University Transportation Center and its partners in this study. Some additional work will be required to develop dependable data sources for the measures. Some existing sources such as the Bureau of Labor Statistics, the Bureau of Transportation Statistics and the Federal Highway Administration's *Transportation Statistics* can be used, but they do not provide all of the information needed at the regional level. They also tend to lag significantly in reporting. Other existing sources, such as automatic traffic counters, freeway monitoring systems, and heavy vehicle transponders, could be mined to provide some additional information. Finally, other sources from private firms will have to be explored.

The process of measuring and reporting on measures should be started and allowed to evolve overtime. It may grow in complexity and frequency as stakeholders become more comfortable with the process and as information sources become more defined.

4.2 About performance measures

Performance measures are becoming more widely used in transportation, but a great deal of confusion still exists as to why and how they should be used. Hal Kassoff, Vice President of Highway Programs at Parsons Brinckerhoff, attempted to answer some of these questions when he quoted the authors of *Reinventing Government*: (Kassoff 1999)

- If you don't measure results, you can't tell success from failure
- If you can't see success, you can't reward it
- If you can't see failure, you can't correct it

A key first step in the performance measurement process, Kassoff went on to suggest, is to ask what it is the performance measure is intended to address? Who is interested in the results? How will the results be used? For example:

- Front line people asking for better tools to achieve consistent quality in the products and services they provide
- First level supervisors searching for ways to evaluate the productivity of their units
- Middle managers seeking ways to gauge the efficiency of their programs
- Senior managers seeking to assess the effectiveness of their policies and strategies
- Elected officials evaluating the impacts of budgets and legislation.
- The press investigating how well an agency is fulfilling its obligations to the public
- The customer wanting to know if their getting their money's worth as taxpayers

With this perspective, performance measures are simply tools to be used to improve communications, understanding of process and performance, and to improve performance. They can be very powerful positive forces when defined and used appropriately. They can be dangerously destructive when used and defined inappropriately.

4.2.1 Definitions

Performance measurement systems are basically a way of focusing attention on the goals that an organization has defined and monitoring whether those goals are being attained. The National Cooperative Highway Research Program (NCHRP) in its report 8-32(02) arrives at a similar, albeit more subtle, definition when it defines performance measurement as:

> *"The use of statistical evidence to determine progress toward specific defined organizational objectives. This includes both evidence of actual fact, such as measurements of pavement surface smoothness, and measurement of customer perception such as would be accomplished through a customer satisfaction survey. In a service industry such as transportation, the performance measurement process starts by defining precisely the services the organization promises to provide, including the quality or level of service (LOS) (e.g., timeliness, reliability, etc.) that is to be delivered. There are often good opportunities for collecting feedback from system users in "real time," since the transportation service is often "consumed" at the same time it is "produced." Performance measures provide information to managers about how well that bundle of services is being provided. Performance measures should reflect the satisfaction of the transportation service user in addition to those concerns of the system owner or operator." (NCHRP 2003a)*

This definition has a number of important and useful subtleties.

- Measures may be quantitative or hard, but they can also capture the perception of the customer. In a service industry, customer perceptions may be as important as quantitative measures.
- Effective measurement requires that the services to be provided and the level of acceptable service be clearly defined.
- Some balance must be found between the concerns of the provider (in the case of a transportation agency this might reflect concerns over the preservation of a facility) and of the user (which might reflect the desire for unhindered access to or use of the facility).
- Measures may be of many aspects of a system or service. For example, reliability may be important, but so might speed, safety, or the travel experience. Neglecting an aspect of the system or service that is important to a key stakeholder could undermine the credibility of the measurement system and the success of the organization.
- Finally, transportation services lend themselves to timely, often real-time, reporting of performance. A traveler is probably much less interested in what the travel experience was last month, last year or five years ago, than what it was like today or will be like tomorrow.

All of these ideas imbedded in the NCHRP definition are important as we consider the use of measurement.

4.2.2 Benefits

So why do performance measurement? In particular, why do it in an open, public manner? In short, what's in it for the person or agency ultimately being measured? The writings on performance measurement suggest a large number of benefits, along with some of the concerns already noted. Tom Barry, the former Secretary of the Florida DOT, explained his agency's reasons for using measures:

> *"We measure ourselves for two reasons - to make sure we are spending the taxpayers' money as efficiently as possible and to try to improve how we provide transportation to the people of Florida." (Florida DOT 1998)*

The authors of the NCHRP Report 8-32(02) offered a similar, but more complete answer in their six reasons for adopting performance measures (NCHRP 2003a):

- Accountability – Performance measurement provides a means of determining whether resources are being allocated to the priority needs that have been identified, through reporting on performance and results to external or higher-level entities.

- Efficiency – Performance measurement focuses actions and resources on organizational outputs and the process of delivery; in essence, in this context, performance measurement becomes an internal management process.
- Effectiveness – Related primarily to planning and goals achievement, performance measurement in this case provides a linkage between ultimate outcomes of policy decisions and the more immediate actions of transportation agencies.
- Communications – Performance measurement provides better information to customers and stakeholders on the progress being made toward desired goals and objectives, or deterioration of performance, in some cases.
- Clarity – By focusing on desired ultimate outcomes of decisions, performance measures can lend clarity to the purpose of an agency's actions and expenditures.
- Improvement – Performance measurement allows periodic refinement of programs and service delivery given more intermediate results of system monitoring.

Finally, through surveys, the public and private sectors involved in freight were asked about the benefits of using measures. While few of the public agencies responding to the survey actually used performance measures, those who did reported a number of benefits as shown in Figure 4.1:

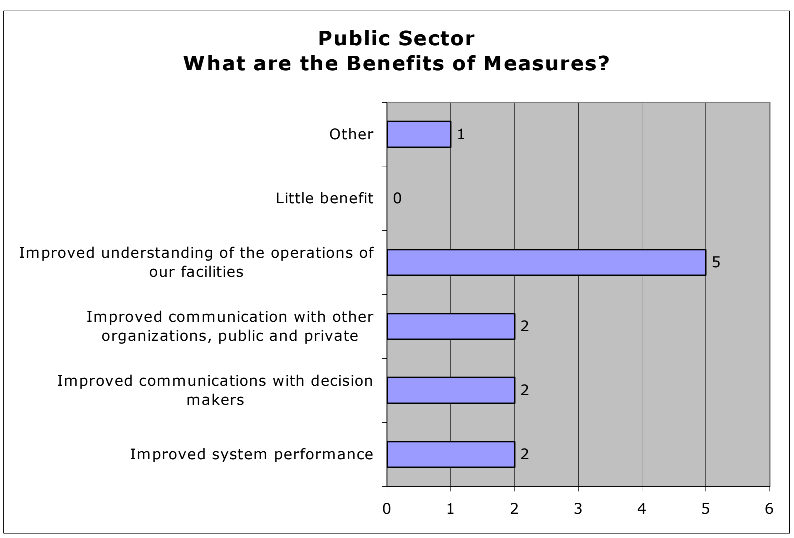


Figure 4.1 Benefits of Measures in Public Agencies.

Public agencies were also asked what the greatest needs were for improving freight transportation. As shown in Figure 4.2, improved communication was the by far the most important ingredient cited.

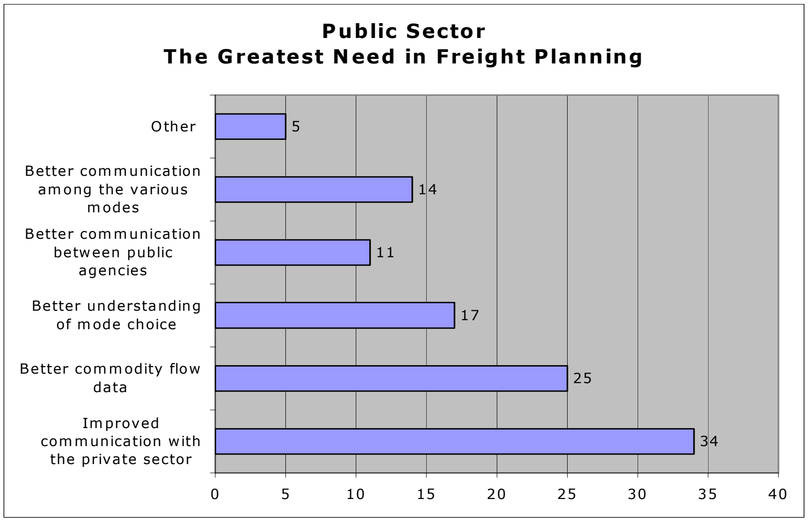


Figure 4.2 Greatest Need in Freight Planning, Public Sector.

A similar question was put to private sector organizations. Once again, the majority of the respondents answered that better communication, at many levels was needed. The other major response dealt with understanding of the freight industry, as shown in Figure 4.3.

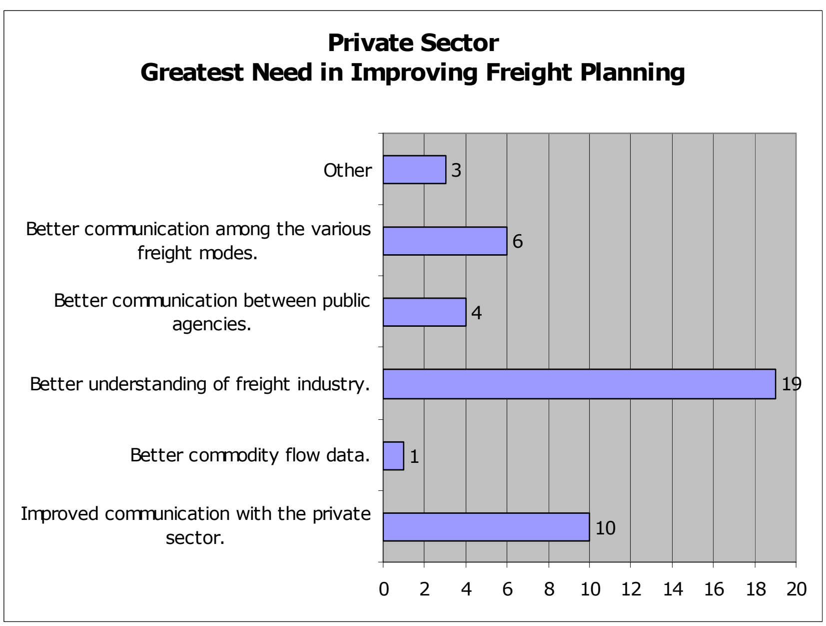


Figure 4.3 Greatest Need in Freight Planning, Private Sector.

So the answer to the question that began this section, why do performance measurement, is to: (a) provide focus, (b) foster communication, (c) improve decision making, (d) ensure accountability, and (e) promote improvement.

As will be discussed, all of these are essential for a regional effort to improve the flow of freight.

4.2.3 Concerns

The key to useful measurement is that measures be carefully crafted and used appropriately. Measures that are not well thought out can produce blurred views of reality and distort the actions of people in all involved organizations. They can be counterproductive. Measures that are used inappropriately become nothing more than threats to all involved, causing further confusion and gaming. One private sector freight provider put it bluntly when he said: "We've got all kinds of performance measurements, but I don't want you (indicating public sector) to use them to beat me over the head."

Crafting useful performance measures means understanding some basics about your organization. The State of Maine offered some guidance to its managers involved in performance measurement. It listed several questions to be answered (State of Maine 2004):

- Are the performance measures consistent with statutory direction?
- Are the priorities reflected by the performance measures appropriate?
- What is an acceptable level of performance?
- Is a shift/change in policy or resources warranted?

Kaplan and Norton (2000) used much of the same logic in suggesting a balanced approach to measurement, as shown in Figure 4.4.

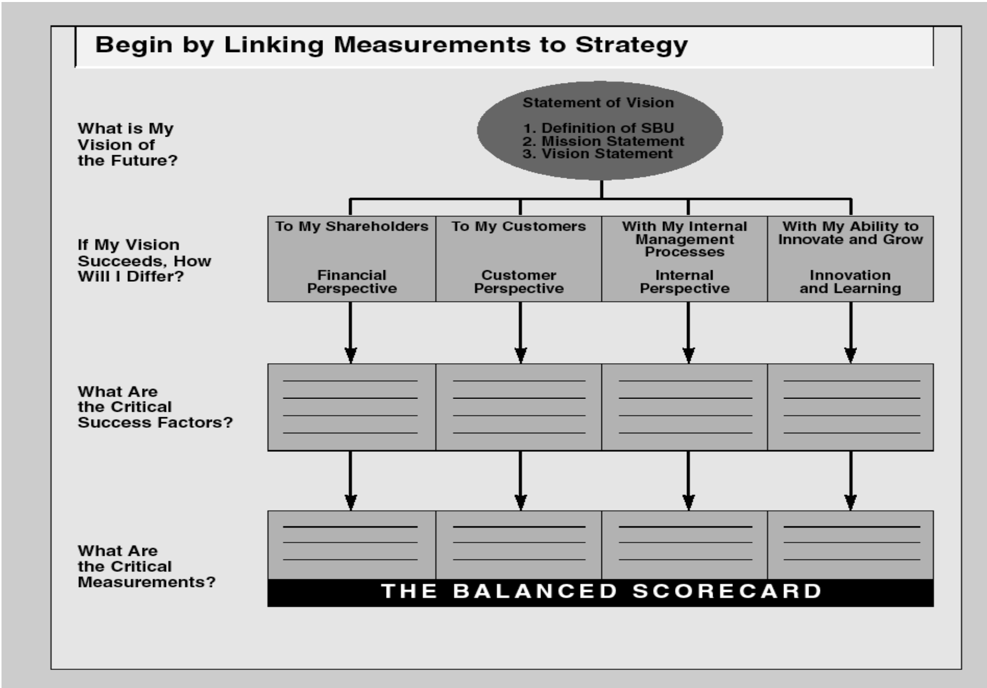


Figure 4.4 Linking Measurements to Strategy.

Source: Kaplan and Norton

This balanced scorecard approach emphasizes that measures must flow from an agency's mission and vision, that they must measure items that are critical to the organization and they must be broad enough to consider a range of perspectives, both within the agency and from its stakeholders.

4.2.4 A model of measurement

The challenge for those who might employ measures is to develop them in such a way that they are thoughtful, tie to what is important in the organization and are understood and used appropriately. Figure 4.5 is an attempt to map the major issues that should be covered. The horizontal flow illustrates the tie of measures to the core issues of an organization. The vertical flow lists questions that should logically be asked as the top elements are defined.

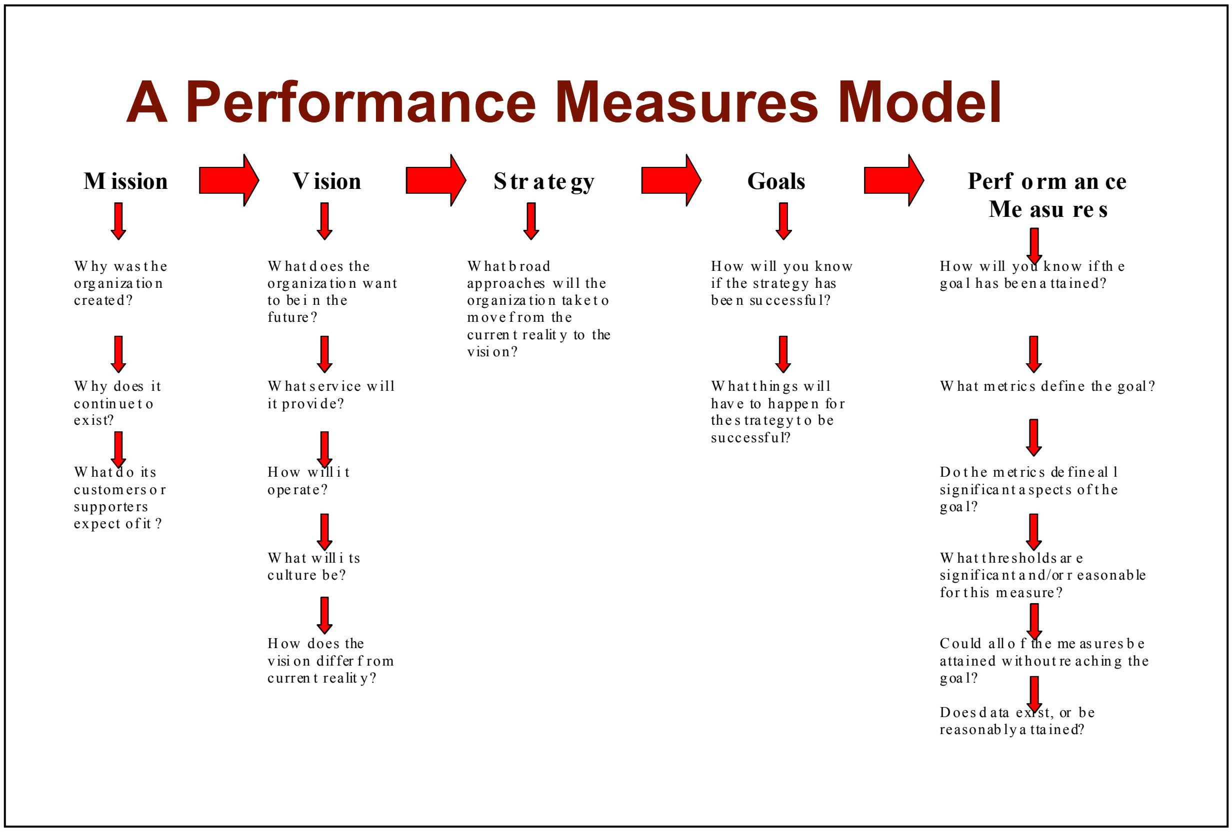


Figure 4.5 A Performance Measures Model.

An organization's mission should be its conceptual foundation. It should answer three very basic questions: Why was it created? Why does it continue to exist? What is expected of it? If the answers to these three questions are not apparent to and agreed upon by all participants, internal and external to the organization, any effort to define future directions or measures will likely be futile.

A vision is a different sort of thing. It is future oriented. It deals not only with the businesses that the organization wants to be involved with, but also with how it will operate, the values that it will follow and the culture that it will strive to have. It should suggest a desire for change or improvement, a need to strive for something better.

A strategy is the broad approach that the organization will take to move from the current reality to the defined vision of the future. How will it change its service and product offerings? How will it change how it operates? Its values? Its culture? Or how it interacts with its stakeholders? To be truly useful, strategies must deal not only with areas of major change, but also with how core, ongoing activities will be maintained. For example, a highway agency might define its vision as including an expansion into modes other than highways, of becoming a full-service transportation agency. Logically, it should have strategies on how it will move in this new direction. At the same time, it also must have strategies on how it will maintain and improve its highway activities. Those strategies might deal with issues like efficiency, the quality of the service provided, or the cost of maintaining the facilities. Without specifically defined strategies that deal with these core programs, a manager or a stakeholder might neglect activities that are ongoing, but of vital importance to the success of the agency.

A goal, or set of goals, moves to greater specificity. In the above example, the agency may have goals of developing programs and expertise in transit. It might also have goals of improving the public's perception of the quality of pavements, or of reducing the cost of delivering construction projects. These goals should lend themselves to measurement, either qualitatively or quantitatively, but a single measure may not capture all aspects of a particular goal.

Finally, performance measures define aspects of the goal that will allow the organization to determine if it has been reasonably achieved. As Figure 4.5 outlines, a number of key questions should be used to determine if the measures are complete or appropriate:

- How will the agency know if a goal has been attained?
- What measures best define the goal? For example, pavement quality might be defined by a number of objective measures. Some might focus on smoothness, others on structural integrity. Pavement quality might also be measured by the perception of the user. The key question is how the goal has been defined. Does it focus on users? Or is it primarily concerned with professional issues like structural integrity?
- Do the chosen metrics define all significant aspects of the goal? As outlined in Figure 4.4, a goal may have several significant aspects. They may deal with the internal performance of the organization, issues of cost, or stakeholder perception. The failure to reflect any significant aspect of a goal in a set of measures could distort organizational actions or cause gaming of the measures.
- What is/are reasonable thresholds for the measure? It is usually not sufficient to do a simple yes or no, the measure was achieved or not. What degree of attainment is desired? And, of equal importance, what degree of attainment can be afforded. For example, an agency might set a goal of reducing the number of structurally deficient bridges. A reasonable threshold for a measure of

structurally deficiency might be to have no deficient bridges, but if that goal requires a massive increase in budget, it is probably not a realistic or meaningful measure.

- Could the measure (and established threshold) be attained without the goal being attained? For example, an agency might have a goal of reducing fatal highway crashes. If the measures and thresholds are defined as the rate of fatal crashes, the rate might well decline or hold constant while the absolute number of fatalities go up.
- Finally, does the data exist, or can it reasonably be obtained, to actually calculate the measure? Data collection, storage and analysis are very costly. If a significant investment is required to obtain new data, does the measure warrant that cost?

Following the logic of this model will not guarantee success in performance measurement, but it will help to avoid many of the major problems associated with measurement.

4.3 Performance measures in freight

No one has done a really good or complete job of developing and using performance measurements for freight, but input can be found from a number of sources that could influence the direction taken.

4.3.1 Freight Advisory Committee

On June 3, 2003, fifteen participants from the Steering and Advisory committees of the Upper Midwest Freight Corridor Study shared their ideas and experiences on the topic of measuring the performance of the freight infrastructure system. Participants represented rail and trucking companies, state and federal transportation agencies, metropolitan planning agencies, universities, and transportation advocacy groups. Over a ninety minute period, they addressed three basic questions: 1) What factors are important in the movement of freight? 2) How can we measure those important factors? and 3) Where can the data be found to complete the measurement?

The group, in a roundtable discussion, identified a large number of factors that are important in the operation of freight systems. These factors can be grouped in five categories: 1) Efficiency; 2) Environmental Impacts; 3) Reliability; 4) Safety; and 5) Security. Each of these, in turn has one or more specific factors, many measures and some data sources.

Efficiency: Under the broad heading of efficiency are grouped several diverse concepts. The broadest of these is the cost of transportation as a proportion of GDP. It was argued that this is the most basic measure of the performance of the freight system since it defines the cost to the entire economy of transportation. For the past twenty years, transportation and warehousing as a percent of GDP has fallen dramatically and consistently. Arguably, reduced transportation costs have fueled the economic boom of the 1980's and 90's. In recent years, the trend-line has become flat. Transportation costs are no longer falling relative to other components in the economy. The group surmised that the impacts of deregulation, transportation investments of the 1960's, and changes in warehousing strategies had all been maximized. Therefore, a goal for the transportation sector should be to find similar strategies or key investments that will at least hold the relative cost of transportation constant.

Several other items in this category related to potential sources of delay: 1) Throughput at rail yards; 2) Inspection times at border crossing; 3) Time lost to blocked highway-rail crossings; and 4) Problems with the connectivity between modes. For nearly all of the measures suggested for these factors, problems of data availability exist. In a few cases, data may be available in the records of rail companies, but it probably will not be available to the public sector and almost certainly not in a form from which generalizations can be made.

Another factor noted in this category is the impact of poorly maintained highways on the operational costs of trucks. It is generally agreed that smoother, flatter, and straighter roads produce less wear on trucks and increase fuel efficiency. While data is available for things like pavement smoothness and other roadway characteristics, it seems very unlikely that these factors can be correlated with real costs incurred by truckers.

The final element in this category deals with the value of a transportation asset as it relates to it utilization. The argument is that if an asset is under utilized relative to other assets, its value could be increased and the efficiency of the system could be increased, if utilization rates are increased. While this logic seems strong, once again finding the data sources and developing the analytic methods that would allow it to become operational as a performance measure seem remote.

Environmental Impacts: Air quality is the single environmental impact cited. Many measures were suggested for it including the impacts of alternative modes, of speed and congestion changes, of idling times, of border crossing and terminal waiting times, and of traffic bottlenecks. With the exception of EPA modeling capabilities, data sources are difficult to find.

Reliability: Congestion is the single factor identified as a reliability issue, although many measures were suggested that define various dimensions of the problem. Three of those relate to specific modeling capabilities that exist and are used in some places. Other measures deal with delivery time issues: as promised, consistent, and on time. Data sources might be available from those companies and communities that use models regularly. Other measures would require surveys of shippers or carriers.

Safety: Three aspects of safety are listed: employee safety, vehicle safety and vehicle road-worthiness. The measures relating to these factors respectively are: personal injuries per mile of travel, severity of crashes, and out-of-service citations. Data sources are available for all of these measures either from private companies or public agencies.

Security: Participants discussed two aspects of security. The first is the efficiency impact of security inspections, especially at border crossings. This was the subject of much concern and reported on in the above discussion of efficiency. The second aspect, which was little discussed, is the reason for inspections: the potential security incident. The only measure suggested is the number of such incidents. It is unclear whether data is readily available for this measure.

4.3.2 Survey of public sector agencies

As part of the study, a survey was sent to over 100 public transportation agencies, all 50 states, major Metropolitan Planning Agencies across the country and some major cities and port authorities. As shown in Figure 4.6, 29 state DOTs responded as did 26 MPOs.

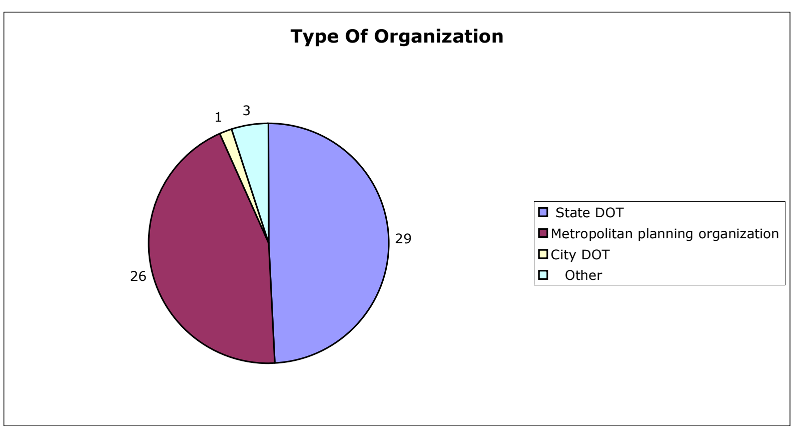


Figure 4.6 Type of Public Agencies Responding.

This survey indicated a fairly embryonic effort in freight planning, monitoring and measurement. Figure 4.7 outlines how facilities are monitored relative to freight movement. While multiple choices were possible, only sixteen of the 59 respondents suggested any more than an ad hoc approach to monitoring.

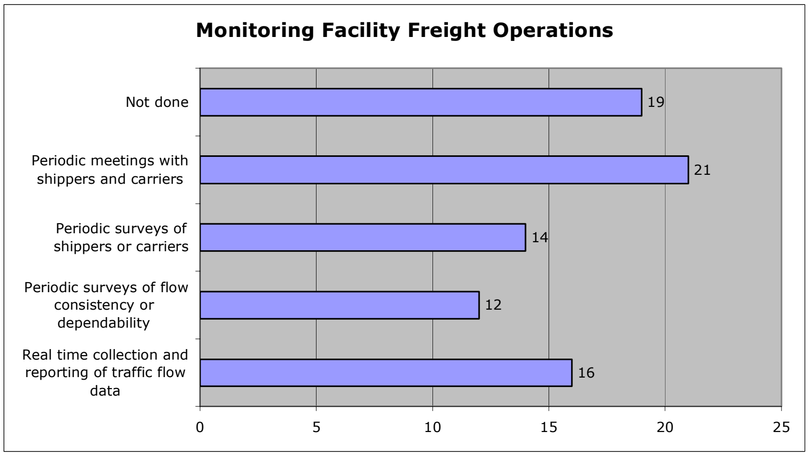


Figure 4.7 Monitoring Facility Freight Operations.

Figure 4.8 outlines the answer to the basic question of whether measures are used. Only seven of the 59 said yes.

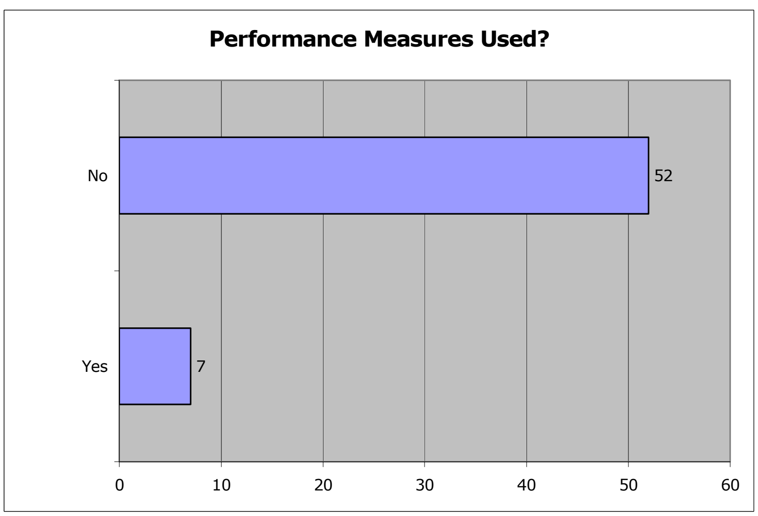


Figure 4.8 Performance Measures Used?

Another basic question dealt with how those seven developed measures. Again, multiple responses were possible, but, as shown in Figure 4.9, few seemed to follow a process that might be considered careful or thoughtful, that is little public involvement seemed to take place and a heavy reliance was placed on existing data sources.

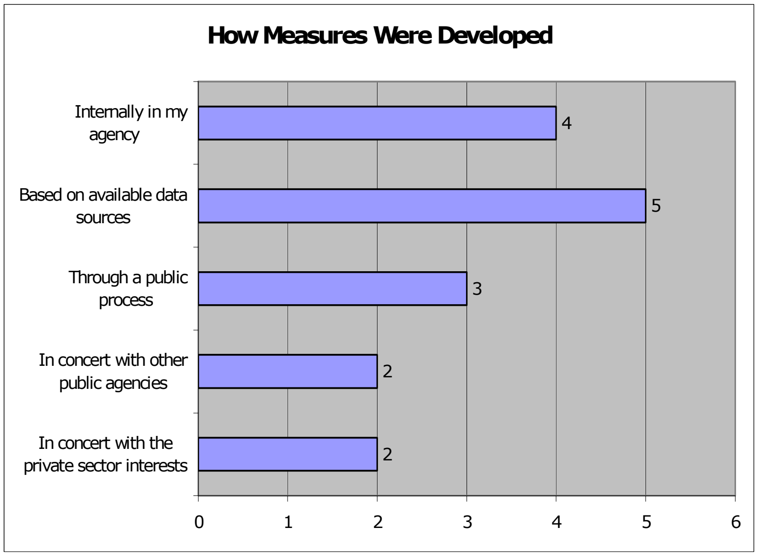


Figure 4.9 How Measures Were Developed.

Reporting seems to be equally sporadic. Only three of the seven reported that they regularly share information with private organizations, see Figure 4.10.

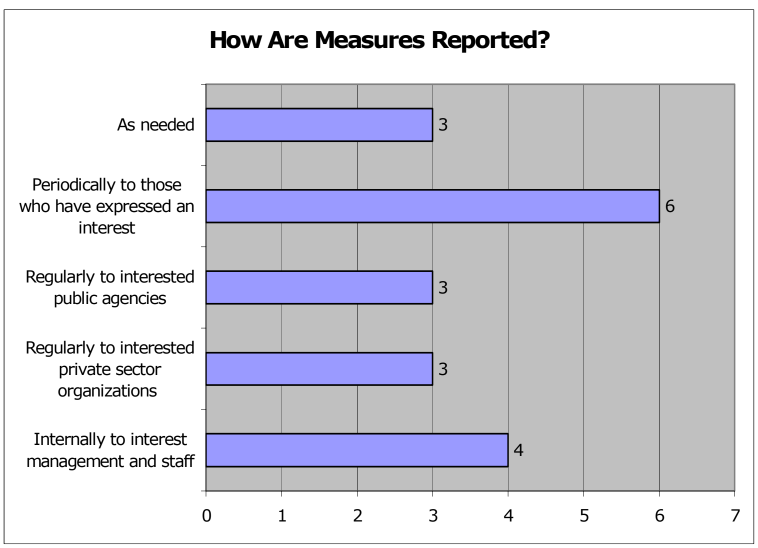


Figure 4.10 How are Measures Reported?

While the public sector did not report the wide use of measures, their sense of what is important in the movement of freight provides an insight into what they might see as critical, and, therefore, important for measurement. Figure 4.11 contains their response to that question. Somewhat surprisingly, management of existing facilities got the highest marks. This would suggest some measures related to the operational characteristics of the facilities might be appropriate.

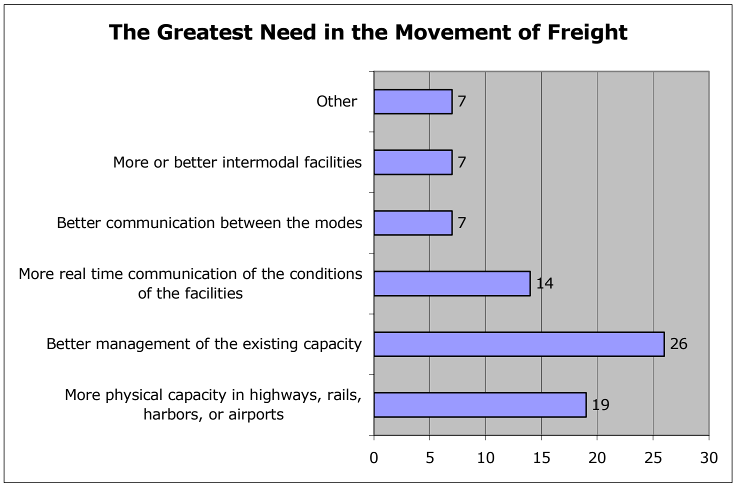


Figure 4.11 The Greatest Need in the Movement of Freight.

4.3.3 Survey of private sector

A similar survey was done of private sector companies involved in freight activities. The response rate to this survey was much smaller, with only about ten percent responding. Figure 4.12 outlines the type of companies that responded. The weighting was very heavily toward trucking and rail companies, with very few shippers.

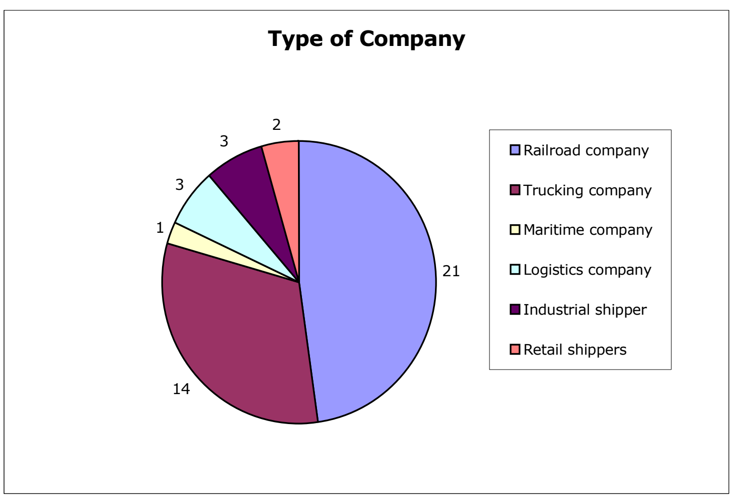


Figure 4.12 Type of Company Responding.

Because our interest was primarily on measures that might be useful in guiding public decisions and in fostering communications, the private companies were not asked specifically about their use of measurement. Rather the focus was on what they considered to be most important in the movement of freight and what the appropriate focus of government should be. Figure 4.13 illustrates the private sector's view of the appropriate areas of government involvement in freight. Economic efficiency, operational efficiency and reliability are three related issues that rated very high. Employee safety was the other highly rated issue. All suggest fertile areas for measurement.

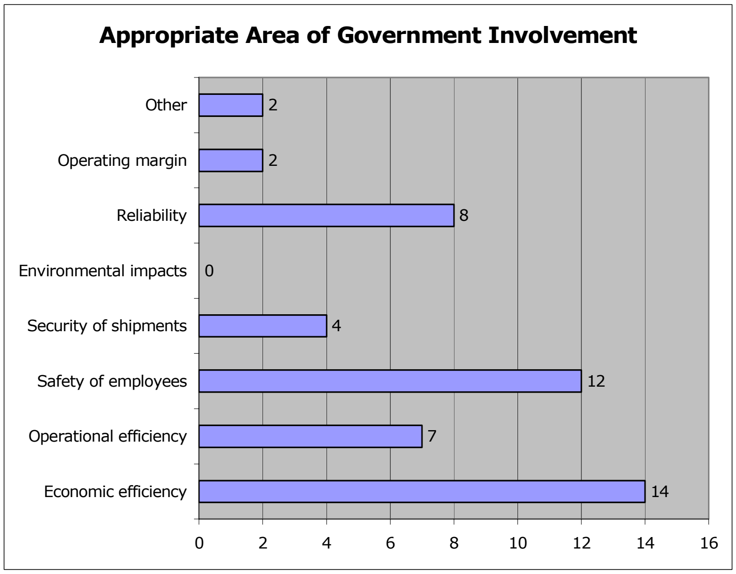


Figure 4.13 Appropriate Area of Government Involvement.

Another somewhat different question dealt with what they saw as the appropriate government role. Figure 4.14 provides a summary of the answers to this question. Facilitating planning scored highest, followed by managing highways and improving intermodal facilities.

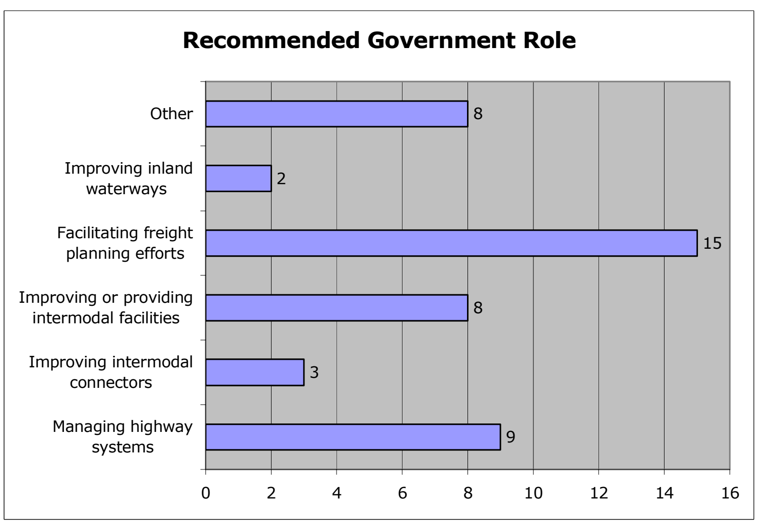


Figure 4.14 Recommended Government Role.

4.3.4 Examples from the literature

A number of studies have been done exploring various aspects of performance measurement for freight.

FHWA issued a report that outlined its conclusions after reviewing a number of previous efforts in freight measurement. Its recommended measures are (FHWA 2004e):

- Cost of highway freight per ton-mile
- Cargo insurance rates
- Point-to-point travel times on selected freight-significant highways
- Hours of delay per 1,000 vehicle miles on selected freight-significant highways
- Crossing times at international borders
- Condition of connectors between NHS and intermodal terminals
- Customer satisfaction

Jack Faucett Associates, working for the Southern California Association of Governments in 1996 suggested a number of potential freight measures (Faucett 1996):

- Link/Corridor Mobility Index
- Truck Link/Corridor Hrs. of Delay
- Delay Costs for Trucking
- Value Added, Employment/Ton
- Emission Factors
- Energy Consumption Rates
- Acres Sensitive Habitat Removed
- All Accessibility Indicators
- Injury Accidents/TEU-Mile (Ton-Mile)
- Avg. Truck Route Time
- Rail Link/Corridor Hrs. of Delay
- Transfer Facility V/C
- Processing Facility Hrs. of Delay
- Cost Per Ton
- Delay Costs
- Public Costs
- Capacity Expansion Factor

Minnesota, in its State Transportation Plan, outlined an aggressive set of measures for many aspects of its transportation system and services. A number of those measures are relevant to freight (Minnesota DOT 2002).

- Travel Time Reliability: Average clearance time, from detection to total clearance, for incidents on the instrumented portion of the Twin Cities metropolitan area urban freeway system that occur between 6:00 a.m. and 7:00 p.m. on weekdays.
- Travel Time Reliability: Number of hours it takes to achieve bare lanes after a weather event ends.
- Travel and Flow Management: Percent of Principal Arterial corridor-miles in Regional Trade Centers 0 and 1 that are highly, moderately or minimally managed.
- Access between Ports/Terminals/Major Generators and Transportation Corridors: Percent of airports with scheduled service that have appropriately designed access to interregional Corridors.
- Access between Ports/Terminals/Major Generators and Transportation Corridors: Percent of major freight generators with appropriately designed roadway connections to Interregional Corridors and other major rail and water corridors. Major freight generators include commercial water ports and terminals, rail terminals, truck terminals, intermodal facilities, and other major freight generating facilities and transfer points.
- Travel Speed: Percent of Interregional Corridor miles that meet minimum speed targets.
- Travel Time Reliability: Percent of peak period travel that takes no longer than an acceptable travel time. That is, no longer than an "expected" travel time plus some additional buffer.
- Travel Time: Twin Cities ranking among metropolitan areas for peak to off-peak travel times as reported by the Texas Transportation Institute’s Travel Rate Index. This measure applies only to the Twin Cities metropolitan area.
- Travel Time Reliability Percent of peak weekday travel that takes no longer than an acceptable travel time. That is, no longer than an “expected” travel time plus some additional buffer time.
- Duration and Extent of Congestion: Percent of directional urban freeway miles in Regional Trade Centers 0 and 1 that are congested or severely congested.
- Crash Rate: Annual crash rate on state trunk highways using three-year averages.
- Total Crashes: Average total crashes occurring at at-grade railroad crossings as reported by the Department of Public Safety.
- Total Fatalities: Annual roadway-related fatalities using three-year averages.

- Air Pollutants: Outdoor levels of ozone, nitrogen dioxide, carbon monoxide and particulate matter as a percent of the National Ambient Air Quality Standards (NAAQS).
- Carbon Dioxide Emissions: Estimated carbon dioxide emissions from motor vehicles in Minnesota.

All of these sources seem to converge on a few broad topics:

- Safety of both employees of the transportation firms and of the general traveling public.
- Economic development that might be fostered by freight movement.
- Economic efficiency, as measured by larger economic trends.
- Economic efficiency, as measured by the costs of moving freight.
- Environmental degradation.
- Congestion, reliability and time.

While none of the measures suggested from the literature have been fully implemented, they are instructive to our effort. In the following sections, each area will be addressed by applying the model in Figure 4.5.

4.4 Applying the model to the Region

Applying the model outlined in Figure 4.5 would most appropriately be done through a strategic planning process involving representatives of all of the freight stakeholders of the region. This would be a somewhat intensive process that would require a commitment of time from many people. Because this is not going to happen in the short run, some assumptions have to be applied to illustrate the workings of the model and to hone in on some measures, from the plethora of possibilities.

To define some of these assumptions, assume that a regional group exists dedicated to the improvement of freight flows in the region. What follows are assumptions of what that group might conclude through such a planning process.

4.4.1 Our mission

The foundation plank of the effort is the mission statement. Most transportation agencies have a mission that reads something like the following:

> *Provide safe and efficient transportation facilities and services.*

4.4.2 Our vision

Focusing on a possible regional effort, our view of what we hope be and accomplish could be summarized in this statement:

> *Keep industries of the Upper Midwest competitive by facilitating the safe, efficient, and reliable movement of freight.*

4.4.3 Our strategy

Maintaining this regional perspective, we might attempt to attain our vision with this strategy:

> *Work cooperatively across the region to identify and implement tools, programs and procedures, acceptable to each state, which will facilitate the movement of freight.*

4.4.4 Related goals

Goals, which might be defined for this strategy closely, parallel those found in the literature and suggested by the Advisory Committee:

- Cost-competitive freight
- A network that is safe for workers and other travelers
- A system that is environmentally sound
- Timely delivery of goods
- Reliable delivery of goods

4.4.5 Related reasonable measures

Each of the goals can be related to possible measures. These measures can be defined in a wide-variety of ways.

4.4.5.1 Cost-competitive

Cost-competitive can be defined in two fundamentally different ways. The first is economic performance. One way of measuring this is to look at freight-related costs as a part of the national and regional economies. Figure 4.15 summarizes how this would look at both the national and regional level for the past 15 years.

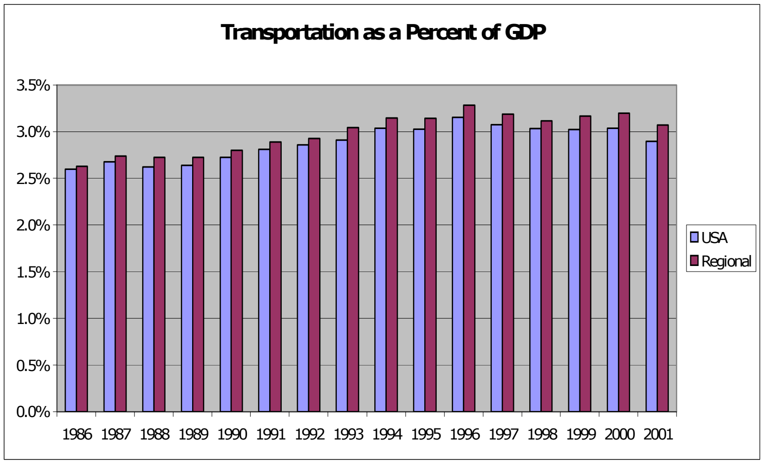


Figure 4.15 Transportation as a percent of GDP.

(Source: BLS)

It should be pointed out that the numbers shown reflect only freight-related transportation costs and do not include warehousing. They are, therefore, significantly lower and show a different trend than transportation and warehousing numbers that are frequently quoted.

Another approach to economic performance might be to develop a regional transportation index, similar to an index recently introduced by the USDOT. Unfortunately, that effort would require a significant dedication of resources. The major challenges would include reaching agreement on which elements accurately define our regional transportation network and finding the data to support such a statistic. For example, even the federal index uses information voluntarily reported by the trucking industry as a primary input. That source would have to be developed for regional information.

Costs are the second way that this broad measurement area might be defined. Collecting freight cost could be made very complex, given that the published rates and the experienced rates can vary widely. However, if it is the overall trend that is most important, rather than the specific numbers, the published trucking, rail and package rates could be collected and published over time to produce a meaningful measure.

4.4.5.2 Safe for workers and other travelers

Safety can be defined in many ways. The following suggestions rely on data that is normally collected by the states or the industry. The figures that are included use national data to illustrate the measures since some effort would be required to collect the regional information from the states.

Regional truck crash numbers are an obvious measure. Figure 4.16 outlines the trends in large truck crashes using information from the entire nation.

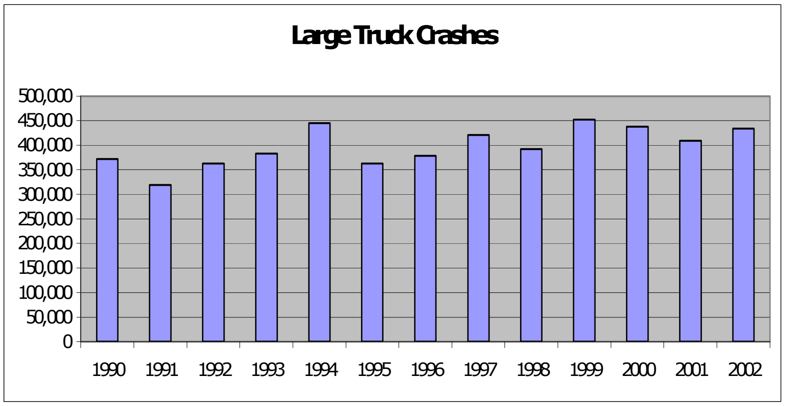


Figure 4.16 Large Truck Crashes.

Source: BTS

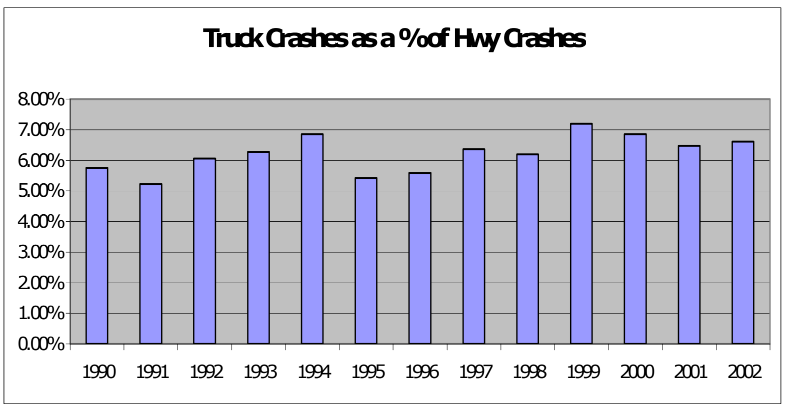


Figure 4.17 Truck Crashes as a percent of Highway Crashes.

Source: BTS

Figure 4.17 offers another view of truck crashes. This relates truck crashes to overall crashes. Essentially, it attempts to answer the question: Are trucks becoming more of a safety problem than the overall fleet?

Fatal crashes are always of interest. In this case, it is difficult to determine overall fatalities involved in truck crashes. It requires an attribution of cause that may or may not be made consistently across the states. Another view, however, is to look at truck occupants who died in crashes. Figure 4.18 outlines the trend in this information from a national perspective.

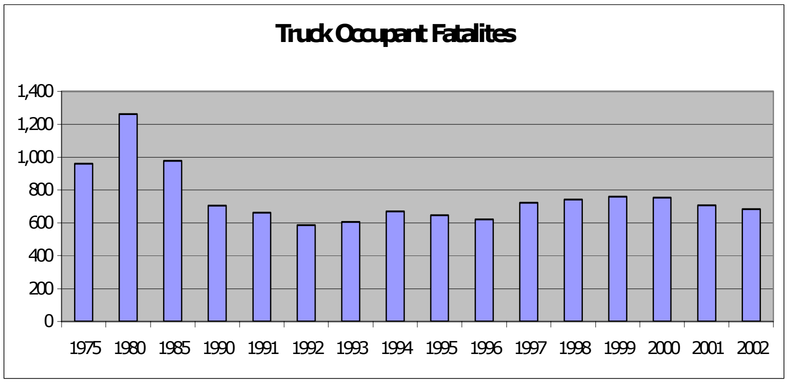


Figure 4.18 Truck Occupant Fatalities.

Source: BTS

Railroad/Highway Crossing crashes in the region could be another significant measure of the safety of both the rail and highway systems. Figure 4.19 outlines the data for this measure, using available national information.

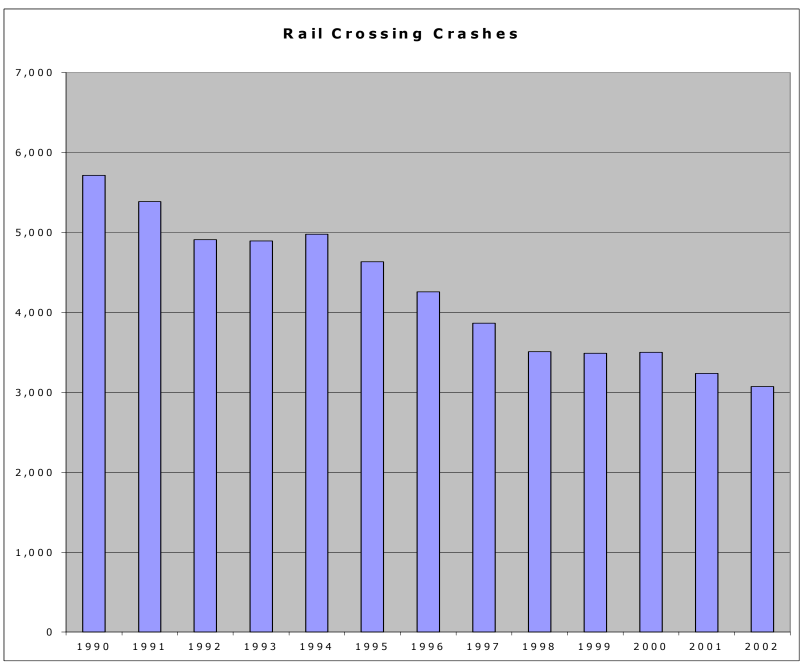


Figure 4.19 Rail Crossing Crashes.

Source: BTS

Another possible safety measure is the number of rail employee injuries over time. Figure 4.20 outlines those national trends.

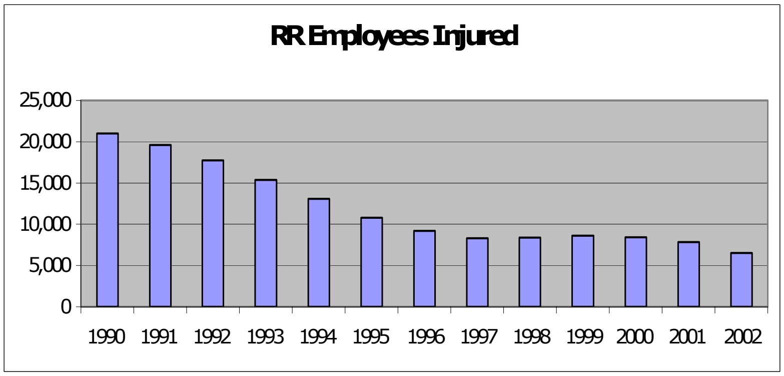


Figure 4.20 RR Employee Injuries.

Source: BTS

Rail crashes are another way safety might be measured. Figure 4.21 provides a national view of rail crashes over the last twelve years.

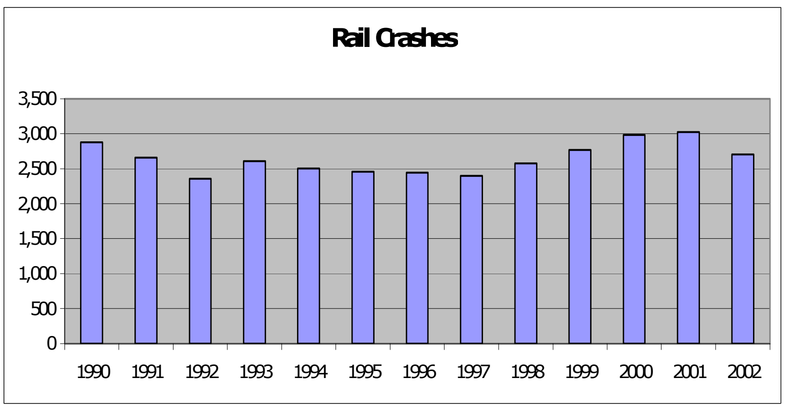


Figure 4.21 Rail Crashes.

Source: BTS

Other possible measures include the rates and numbers of crashes and severity by major regional rail links and class one derailments in region. For each of these measures new data reporting conduits would have to be defined or existing national data would have to be disaggregated.

4.4.5.3 Environmentally sound

Since most of the elements of environmental degradation that are thought of when discussing freight deal with the consumption of fuel, measures related to fuel seem logical. However, the consumption of fuel in freight also closely correlates to economic activity. Therefore, a simple measure of fuel used is not reasonable. Fuel consumption could fall, with disastrous impacts for the economy. A more reasonable measure is shown in Figure 4.22, diesel fuel consumed per million dollars of GDP. Diesel fuel remains a good approximation of trucking activity since most taxed diesel is used in trucks.

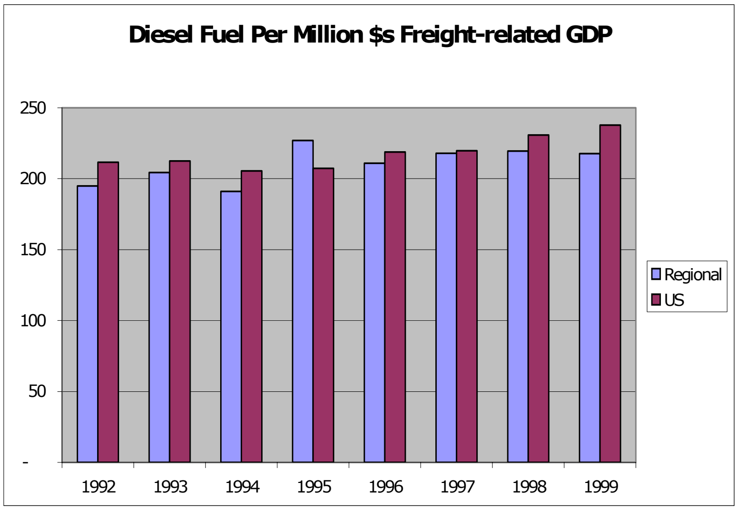


Figure 4.22 Diesel fuel consumed relative to GDP.

Source: Highway Statistics, BLS

4.4.5.4 Timely

Timeliness is important for freight, but the concept requires that major points to defined for which timeliness can be measured. Major links within the corridor would seem to be the most likely sets of points. For example, the following points might be used:

- Twin Cities to Chicago
- Des Moines to Chicago
- Indianapolis to Chicago
- Chicago to Detroit
- Chicago to Toledo

With agreement upon these points, published delivery times for class one railroads and parcel deliveries by land could be used as a reasonable estimate of timeliness over time. These measures could be combined with on-time statistics, which are available from parcel carriers, to yield a fairly complete picture of this measure.

4.4.5.5 Reliable

Expected versus actual travel time on major rural and urban links at various times of the week and the day and with defined confidence levels is the only real measure of reliability. It is captured in the following equation:

X=Expected travel times

Y=Acceptable variation

Standard=X+/-Y, with Z confidence

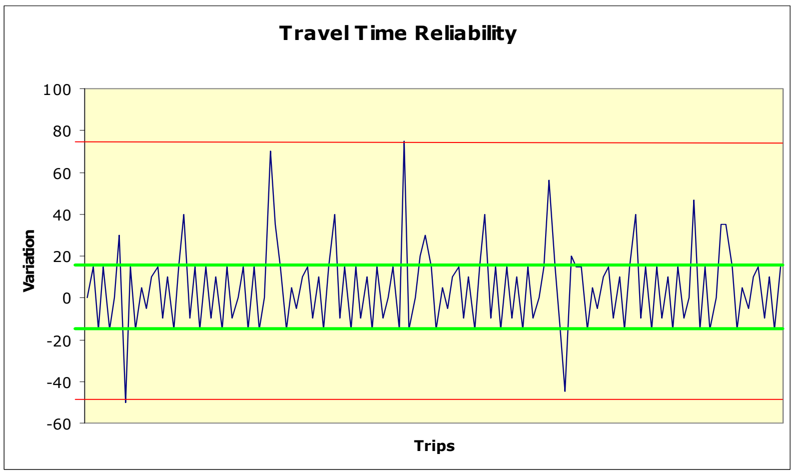


Figure 4.23 Travel time reliability.

The same links as defined in the previous section would be used here. The measure is illustrated with hypothetical data in Figure 4.23. As this illustrates, variability is inevitable. The major question is how much variability can be tolerated. In reality, of course, the world is not this simple. Variability will be determined in large part by time of travel. Some hours, days, weeks and months will have different patterns than others. Figure 4.24 illustrates this point from the perspective of time of day. Obviously, as an effort is made to narrow the lines of acceptability, the impact and the cost will become major considerations.

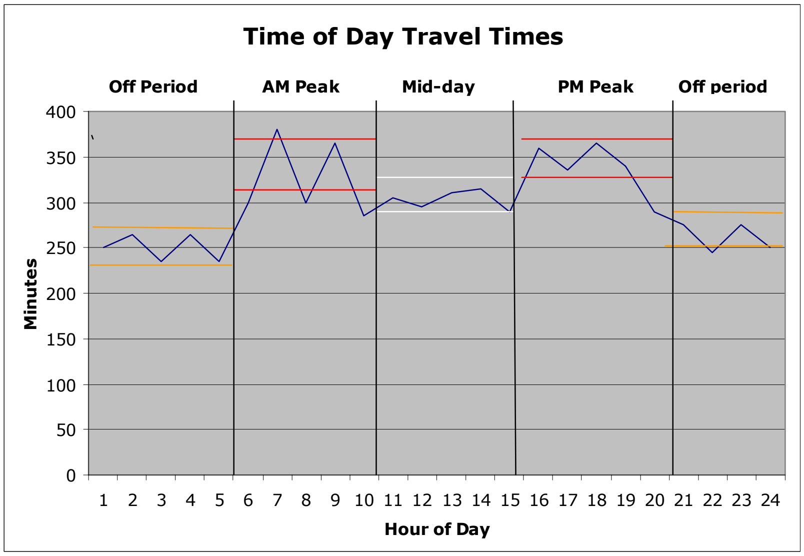


Figure 4.24 Time of day travel times

Another approach that might be taken relative to reliability is to consider the hours of delay experienced in each of the major urban areas. These data are available, and while the data deal with all vehicles, it can be assumed that trucks and autos are stuck in the same congestion and that as hours of overall delay mount so do hours of freight delay. Figure 4.25 outlines the past twenty years of experience for some of the major cities in the region.

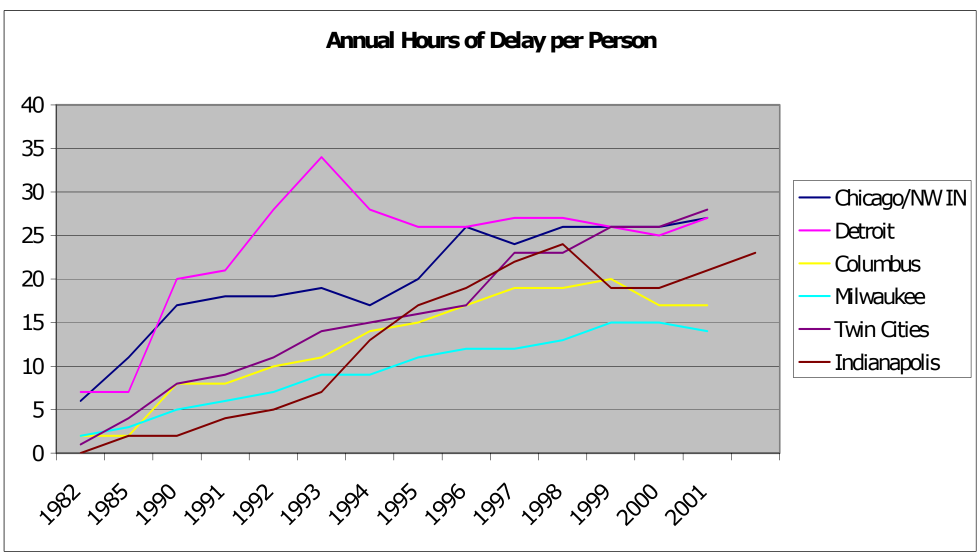


Figure 4.25 Annual hours of delay

Source: BTS

This group of suggested measures would provide an excellent starting point for the region to gauge the success of its transportation network in freight. But the measures should be further developed and refined by the stakeholders of the region.

4.4.6 Data sources

Existing data sources do not lend themselves to the type of measurement that would be desirable for freight. Most state and federal sources deal more with the movement of vehicles rather than of people or goods. In addition, many federal sources are not easily disaggregated for state or regional level analysis. With this said, some potential sources are available, or might be available with additional effort:

The Bureau of Labor Statistics (BLS) reports nearly all of the economic information that is needed for measurement. The major drawback of this source is that it tends to lag in reporting times by about two years. This will tend to make such things as freight as a portion of GDP a very late indicator of performance.

The Bureau of Transportation Statistics (BTS) reports on many of the factors discussed. It tends not to report at a state level for many of the needed data. Therefore, an effort would be required to either break apart some reported information into state-level sources, or to replicate those sources in the states themselves. This is particularly true for safety-related information related to highways. For similar information related to rails, the source for data is the railroads themselves.

The Federal Highway Administration's *Federal Highway Statistics* is a good source for some safety, operational and environmental information. Its major drawback is the timeliness of the data. Like BLS, it typically has about a two-year lag-time.

Existing on-line sources from package carriers and class one railroads provide information on rates, delivery times and on-time rates. The challenge will be to agree on the travel points between which this information is most relevant.

Reliability information is perhaps the most important and challenging from a data source perspective. No information on this subject is currently available for highways, but a number of possibilities do exist:

- Trucking companies could be periodically surveyed. The information would have to be made anonymous; and given the collection method, it may not be timely nor will it likely reflect all for the time of day and year differentiation that would be most useful.

- For major pairs of destinations, as suggested in section 4.4.5.4, automatic traffic count information, which usually includes speed, could be collected from each of the states along a link. With this information, the average travel times at various hours and times of the year could be calculated for the rural segments of the system.
- Similar to the above, information could be gathered from heavy vehicle transponder readers, which identify specific vehicles. These e-screening sites will be discussed later in the report. Locations of the sites within the study's region are shown in Figure 5.7. With the identification of specific vehicles and the times they passed certain points, travel speeds could be calculated as needed. A short-coming of this source is that the coverage is not complete with this technology. A strength of using this source is that it could be used for both rural and urban segments.
- Finally, for the urban links, another data source might be the traffic management systems. Without question, those systems in the major urban areas all contain the information that would be needed to calculate reliability in moving through those areas. Unfortunately, it has never been used for this purpose. Researchers who have tried to collect the needed information have usually been frustrated.

Overall, meeting the data challenge will require additional effort. Data has been one of the downfalls of all previous efforts to measure freight performance. It is, however, a challenge that can be overcome.

4.5 About doing regional measures

No existing organization is uniquely situated to collect and report on performance measures for the region. Indeed, the region is at best a natural geographic area. It is not a natural political or jurisdictional area. Therefore, the states of the region will have to consider exactly how they will pursue measurement.

4.5.1 Who?

Because no natural organization exists, one must be invented or ordained to carry out this role. Two possibilities come to mind. First, if the states agreed to remain active in a regional coalition on freight, they could agree to either employ staff to, among other things, collect the needed data and report on measures or to assign the responsibility for all or apart of the effort to specific state DOTs or MPOs. Another option is to ordain the Midwest Regional University Transportation Center and its academic partners in the current study to do the performance measurement reporting. With support from the states for the staff needed to do the work and a commitment from the states to share data, this could be made to work fairly well.

4.5.2 How?

As stated previously, the key to how is significant stakeholder involvement in the planning effort needed to specifically define measures (see Figure 4.5). This could be accomplished through a structured process and over a time frame that would make participation possible. Once this effort is complete, the decisions should be firm on what is to be reported and in what format. The next step is a research effort to define the specific data sources and the form for reporting. Then the task is to begin and maintain a reporting effort.

4.5.3 How often?

The timing of reporting could vary both by topic and over time. To begin, an annual report of all measures in a consistent format over time would be useful and would begin the process of understanding and communication. As the system develops, those measures that lend themselves to more frequent, or even real-time, reporting might be moved to that basis with some web-facilitate process. Regardless of the timing, the key is to start and to maintain the data trail.

5 ADMINISTRATIVE

5.1 Introduction

Freight transportation, by road, rail, water, and air is governed by federal, state, and local regulations, industry standards for the equipment and infrastructure, cost, and technology limitations. For example, maximum rail car size and weight are limited to the specification of the existing rail. Water transportation is limited by harbor depth and lock length. Federal regulations govern freight transport on federally funded roads, however state and local agencies may impose or exempt size and weight regulations on state roads.

Freight transport by rail, water, air and highways can be managed by either the private or public sector; and are subject to a wide range of administrative issues. For example, rail is managed by the private sector and operates in an exclusive right-of-way that is separated from the general public. Rail transportation is standardized by the car size and weight that can be supported on the standard rail lines. On the other hand, freight transport by water is mostly a private sector undertaking regulated by public actions. Barges and self-propelled vessels, if registered with the United States, must comply with U.S. laws and regulations. Ports and marine facilities are both publicly and privately owned (EPA 1997). Water vessels must be able to fit in any lock size and draft depth of ports. The Federal Aviation Administration (FAA) heavily regulates freight transport by air. The FAA regulates airplane design and maintenance, the flight personnel, and maintenance crew. Airports are owned or controlled by a public entity, whether it is a local jurisdiction or a public body, like an airport authority (EPA 1998).

This chapter focuses on administrative issues associated with freight transport on highways. Most freight is moved by trucks on highways. The public sector owns, operates, and maintains the highway transportation network. Regional collaboration to identify and address administrative issues associated with freight transportation can have an impact on the overall effectiveness of freight transportation.

The United States Department of Transportation (U.S. DOT) regulates transportation in the U.S. The two agencies within the U.S. DOT that oversee the trucking industry are the Federal Highway Administration (FHWA) and the Federal Motor Carrier Safety Administration (FMCSA). Several federal regulatory acts affect the trucking industry. The Motor Carrier Regulatory Reform and Modernization Act of 1980 deregulated much of the trucking industry making it easier for new carriers to start a business and to set their own prices and routes. The Surface Transportation Assistance Act (STAA) of 1982 outlined federal limits on truck size and weight, such as a maximum width of 102 inches. The STAA also established a National Network (NN) of highways where federal limits on truck size and weight would apply. The Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 enacted a freeze on longer combination vehicles (LCVs). Any state that currently allowed LCVs could continue operation, but no new LCV configurations or states without LCVs could commence operation. The North American Free Trade Agreement (NAFTA), passed in 1993, is still impacting truck size and weight regulations today because NAFTA required a harmonization of truck size and weights between the member countries. That goal has yet to be realized. The Transportation Equity Act of the 21st Century (TEA-21) was signed into law in 1998. TEA-21 provided funds for motor carrier safety programs.

International agreements also impact trucking industry regulations. The International Fuel Tax Agreement (IFTA) streamlines procedures for interstate/international motor carriers to pay fuel taxes. The International Registration Plan (IRP) made it easier for interstate/international motor carriers to register and obtain authority to operate.

5.1.1 Statement of the Problem

Administrative issues relate to inconsistencies in state, provincial, and federal regulations. While some consistency on federally designated highways exists, size and weight regulations on non-designated state highways vary from state to state. Each jurisdiction separately controls truck size, weight, configuration, commodities exemptions, insurance requirements, hours of service, and commercial driver's licenses, to name a few.

Studying administrative issues is important because with freight infrastructure reaching capacity with few infrastructure expansion possibilities, other means are necessary to alleviate congestion and make the industry more efficient. Reducing or eliminating administrative bottlenecks or other redundant regulations and increasing cooperation within the region are ways to reach industry goals of better use of infrastructure and high safety standards. Describing the impacts of the administrative issues gives administrators an idea of how they can reduce costs and increase efficiency.

Administrative issues arise because many different federal, state and local agencies administer the various programs needed to comply with regulations. To obtain operating authority and to comply with regulations, trucking firms must contact Departments of Transportation, Departments of Revenue, Commerce Commissions, Bureaus of Motor Vehicles, and Public Service Commissions, among others. Inconsistencies in the governing regulations and administrative processes lead to duplication of efforts and reduced travel efficiencies. Identification of inconsistencies and describing their impacts can lead regional participants to money saving opportunities for cooperation that do not sacrifice travel safety or overstress the physical infrastructure.

5.1.2 Objectives

The objectives for this research component are:

- To identify regulatory inconsistencies and associated administrative bottlenecks in the region,
- To provide reference information for quantifying the impacts of regulatory inconsistencies, and
- To take a regional perspective while identifying opportunities for improving administrative effectiveness through regional cooperation, use of ITS/CVO technology, and standardization of key infrastructure.

5.1.3 Scope

Focus on the highway mode clearly dominates discussions on administration issues of freight transport both in literature and with industry and agency stakeholders. Administrative issues relate to size and weight of vehicles and loads as well as commodities, operating authority, and speed limits. Issues include the effectiveness of administrative practices and impacts of regulatory inconsistencies. Some of the inconsistencies in trucking regulations concern length and width of trailers, gross vehicle weight, axle weight, axle configuration, and number of trailers. Height is less of a concern as all states in the region have the same height maximum, due to standard bridge clearances. The scope of issues include: highway infrastructure, motor carrier safety, traffic congestion, economic productivity, trucking industry and modal competitiveness, environment, finance and energy, and compliance and enforcement.

The scope of this research includes the Commercial Vehicle Information Systems and Networks (CVISN) for electronic credentialing, electronic screening, and safety information exchange. CVISN refers to the collection of information systems and communications networks that support commercial vehicle operations (CVO) (CVISN 2004). The CVISN program provides a way for existing and newly designed systems to exchange information though the use of standards and available communication systems. These include information systems owned and operated by governments, motor carriers, and other stakeholders (Richeson 2000).

5.1.4 Methodology

The research team concentrated on identifying and understanding regulatory inconsistencies and administrative practices at each individual jurisdiction within the Upper Midwest Corridor Region. Taking a regional perspective, the team identified potential impacts of inconsistencies including travel bottlenecks and opportunities for regional cooperation including ITS/CVO technology. The research was accomplished by several tasks.

5. Literature review to provide information for understanding the regulatory environment that governs freight movement, and to identify documented inconsistencies in regulations and their impacts. The scope of the literature review includes previous studies and reports dealing with administrative issues and freight regulations.
6. Survey questions regarding regulatory inconsistencies and impacts were sent to all state departments of transportation, major metropolitan planning organizations, and shippers and carriers. (See APPENDIX G)
7. The research team interviewed the stakeholders. Representatives of motor carrier and rail industries provided perspectives on regulations governing the trucking, rail, and shipping industries and the impacts of regulations on shippers, carriers, and intermodal users. Highway state patrol officers provided perspectives on hazardous materials regulations. Highway operations engineers provided perspectives on ITS/CVO applications by states. In addition, focus group sessions were held with the project's steering and advisory committees.
8. The research team created a GIS map of administrative facilities on the corridor highways including current CVISN deployment sites. Then, taking a regional perspective performed a GIS analysis to identify potential deployment sites for fixed and mobile electronic screening sites to improve travel safety and the administration of regulatory compliance.
9. The research team used GIS analysis to identify locations of administrative bottlenecks on the Upper Midwest study corridor as roadway sections having inconsistencies in truck size and weight regulations. Then taking a regional perspective, the research team described the qualitative and quantitative impacts of regulatory inconsistencies on the Upper Midwest Freight Corridor.

5.2 Regulations Governing Highway Freight Transport

Commercial trucking firms need to comply with various regulations before they can legally operate on United States and Canadian highways. Regulations govern taxes and fees required of the motor carriers and shippers, motor vehicle operators, and truck size and weight. Regulations are administered by multi-jurisdictional agreements and federal and state agencies. Multi-jurisdictional agreements include the International Registration Plan (IRP), the International Fuel Tax Agreement (IFTA), and the Single State Registration System (SSRS). U.S. federal regulations include registration numbers for trucks, the Heavy Vehicle Use Tax (HVUT), the Commercial Driver's License (CDL) program, and Hours of Service (HOS) requirements. The Federal Motor Carrier Safety Administration (FMCSA) regulates all safety requirements in the United States and regulates the CDL program and the HOS requirements. The Internal Revenue Service (IRS) administers the HVUT. Canadian regulations are administered by the provinces. The Canadian National Safety Code implemented standards for the provinces to follow and governs articles such as safety ratings, HOS, drivers licensing, etc. Jurisdiction regulations apply to truck size and weight.

5.2.1 International Registration Plan (IRP)

All trucks must be registered in each jurisdiction that they travel through. The International Registration Plan (IRP) was created to simplify the registration process for interjurisdictional carriers. In the past, motor carriers traveling across jurisdictions had to be registered and carry a license plate from each jurisdiction for every truck. The paperwork process was tedious and by the late 1960s the American Association of Motor Vehicle Administrators (AAMVA) bargained to create an agreement between all jurisdictions in the U.S. and Canada that would allow for reciprocity in registration and fees. In 1973, the IRP was implemented. As of 2001, 59 jurisdictions had joined IRP (History@ 2001).

The IRP allows motor carriers to choose a base jurisdiction, complete one registration form, and receive one set of plates for each vehicle. Each vehicle receives a cab card that allows it to travel in any jurisdiction where it has operating authority. A truck carrier pays a fee to its base jurisdiction dependent upon the mileage accrued in each jurisdiction and the fees levied by each jurisdiction. The base jurisdiction distributes the registration fees collected from the carrier to the other jurisdictions that the carrier operated in. Registration is renewed annually.

5.2.2 Motor Carrier Fuel Taxes and the International Fuel Tax Agreement (IFTA)

After the 1980 trucking industry deregulation when thousands of new trucking firms entered the industry the diverse set of fuel taxes became quite an issue. Operators of heavy vehicles are required to pay fuel tax at the pump, on the purchase of bulk fuel, and an additional fuel tax to each jurisdiction based on the amount fuel used during travel there. Taxed motor fuels include gasoline, diesel, propane, blended fuels (gasohol and ethanol), compressed natural gas, liquid petroleum, and kerosene. Motor carriers were required to register, apply for permits, and file fuel tax returns with each jurisdiction they traveled through. To complicate the process, each jurisdiction had separate paperwork requirements and different due dates. Motor carriers called on the U.S. DOT to simplify how fuel tax is collected. In response, IFTA was created. Currently fifty-eight North American jurisdictions are in IFTA, not including Alaska, Hawaii, the District of Columbia, Mexico, the Yukon Territory, Nunavut, and the Northwest Territories.

The International Fuel Tax Agreement (IFTA) was created to reduce the fuel tax paperwork for motor carriers operating in more than one jurisdiction. IFTA was modeled heavily after the IRP and works by allowing a motor carrier to register and file quarterly tax reports with its base jurisdiction only. This allows a motor carrier to satisfy their fuel tax reporting requirements for travel in all other IFTA member jurisdictions with only one form (*International* 2004). In addition to submitting quarterly tax reports, the motor carriers are required to display IFTA decals for each truck registered in the program. These decals allow a truck to travel to any other IFTA jurisdiction.

The quarterly tax report outlines the mileage each carrier traveled in each jurisdiction, the fuel economy of the carrier's vehicles, and the amount of fuel purchased in each jurisdiction. Motor carrier firms are also required to keep fuel receipts for fuel purchases made at the pump or from bulk purchases. Using the information in the quarterly report, it determines if the carrier overpaid or underpaid fuel taxes to that jurisdiction. If the carrier owes taxes to other jurisdictions, it pays its base jurisdiction and the base jurisdiction distributes the taxes to the designated jurisdictions. If the carrier overpaid, then the base jurisdiction collects the money and refunds the carrier (Runde 2003).

States may impose fees on motor carriers for participation in IFTA. Fees for the Upper Midwest jurisdictions are listed in Table 5.1. For example, a motor carrier based in Iowa pays a one time fee of $10.00 then $0.50 annually for each set of decals. Ohio, on the other hand, does not charge anything to be a member of IFTA. Indiana does not charge for the decals, but requires an annual fee of $25.00 from the trucking firms based there (The International@ 2001).

Table 5.1 International Fuel Tax Agreement (IFTA) Fees.

State/ Province	Fees		
	Annual License	Annual Decals	New Registrants
Illinois	None	$3.75/set	None
Indiana	$25	None	None
Iowa	$10 (permanent license)	$0.50/set	None
Michigan	None	None	None
Minnesota	$28	$1.00/set	None
Ohio	None	None	None
Wisconsin	$3	$2.00/set	$3 + $15 application fee
Manitoba	$64	$4.00/set	None
Ontario	None	$10/set	None

Source: Trucking Permit Guide. J.J. Keller & Associates, Inc. 2003

5.2.3 Heavy Vehicle Use Tax (HVUT)

The Internal Revenue Service (IRS) collects the Heavy Vehicle Use Tax (HVUT) annually on heavy vehicles weighing 55,000 lbs or more and traveling on US public roads. The federal government then distributes the revenues to the states for highway maintenance and construction projects (HVUT@ 2004).

5.2.4 Single State Registration System (SSRS)

The FMCSA requires for-hire carriers operating in the United States to register with the Single State Registration System (SSRS), which validates their insurance coverage. Each jurisdiction wants assurance that for-hire carriers traveling within its boundaries are covered by insurance. The SSRS is the way for-hire carriers to register with only one state but provide proof of insurance coverage to multiple jurisdictions. This results in less paperwork for states and motor carriers because there is only one form and one proof of insurance, instead of contacting each state separately.

Currently, 38 states participate in the SSRS program including all states in the Upper Midwest Corridor region. Motor carriers pay per-vehicle fee for each jurisdiction. The fees are paid to the base state that handles all disbursements of fees and issues a receipt indicating in which states travel is allowed. From Table 5.2, there are a wide range of SSRS fees within the Midwest region. Clearly some states in the Upper Midwest have reciprocal agreements on SSRS fees. The principle place of business corresponds to the primary location (base state) of the motor carrier. The travel state corresponds to the jurisdiction a firm's trucks may travel. For example, a Michigan trucking firm pays $5.00 per truck annually to travel in Wisconsin. A Wisconsin trucking firm pays $10.00 per truck annually to travel in Michigan.

Table 5.2 Annual Single State Registration System (SSRS) Fees Per Vehicle.

		Principle Place of Business (Base State)								
		IL	IN	IA	MI	MN	OH	WI	MB	ON
Travel State	IL	$7.00	$0.00	$1.00	$0.00	$0.00	$5.00	$3.00	$10.00	$7.00
	IN	$0.00	$10.00	$1.00	$0.00	$1.00	$1.00	$5.00	$10.00	$10.00
	IA	$1.00	$1.00	$1.00	$1.00	$0.00	$1.00	$1.00	$1.00	$1.00
	MI	$0.00	$0.00	$10.00	$10.00*	$0.00	$10.00	$10.00	$0.00	$0.00
	MN	$0.45	$0.45	$0.45	$0.45	$5.45	$5.45	$5.45	$0.45	$5.45
	OH	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00
	WI	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00
	MB	NA	NA	NA	NA	NA	NA	NA	NA	NA
	ON	NA	NA	NA	NA	NA	NA	NA	NA	NA

* Vehicles base-plated in Michigan require the $100 MPSC (Michigan Public Service Commission) decal, and need not register for "Michigan" on the SSRS application. Michigan based interstate carriers with vehicles based outside of Michigan must register those vehicles on the SSRS application at a fee of $10.00 per vehicle.

NA - Not applicable. The SSRS is a U.S. program.

Source: Trucking Permit Guide. J.J. Keller & Associates, Inc. 2003

5.2.5 Motor Carrier Operator Requirements

Motor carrier operators are required to comply with federal regulations regarding commercial driver's licenses (CDL) and hours of service (HOS) requirements. The CDL is a federal program administered by the FMCSA, which oversees the states' CDL programs to make sure that they meet or exceed the minimum federal guidelines. This program also ensures that truck operators only have one CDL from one state. The states still administer the CDL; they make sure that truck operators are qualified to receive a license (CDL@ 2003). Canadian provinces administer CDLs. Table 5.3 shows the CDL fees for each jurisdiction in the Upper Midwest and amount of time the licenses are valid.

Table 5.3 Commercial Driver's License (CDL) Fees.

State/Province	Fee	Number of Years Valid
Illinois	$60.00	4
Indiana	$30.00	4
Iowa	$40.00	5
Michigan	$25.00	4
Minnesota	$37.50	4
Ohio - First CDL	$42.00	4
- Renewal	$43.00	4
Wisconsin	$64.00	8
Manitoba	$65.00	1
Ontario	$10.00	5

Sources: http://www.sos.state.il.us/departments/drivers/cdl/cdl.html, http://www.in.gov/bmv/platesandtitles/feechart2003html.htm, http://www.dot.state.ia.us/mvd/ods/cdl/cdlnut.pdf, http://www.michigan.gov/sos/0,1607,7-127-1627_8669_9040-75992--,00.html, *http://www.dted.state.mn.us/01x03x02x05.asp?LicenseID=5004, http://bmv.ohio.gov/01012004_BMV_Fees.htm, http://www.dot.wisconsin.gov/drivers/drivers/driver-fees.htm, http://www.gov.mb.ca/tgs/ddvl/LICFEE, http://www.mto.gov.on.ca/english/dandv/driver/index.html*

Hours of service regulations are federal requirements that truck drivers must comply with concerning the number of consecutive hours that drivers are allowed to drive. The United States rules were first implemented in 1939 and have just been revised by the FMCSA. Backed by scientific studies on fatigue and sleep disorders, the new rules are designed to allow drivers to get enough sleep and reduce fatigue related truck crashes. Canadian HOS rules are similar. A logbook must be kept by each driver detailing their time on-duty, off-duty, or sleeping. State inspectors enforce the HOS rules (HOS@ 2004).

5.2.6 Truck Size and Weight Regulations

Uniform federal size and weight regulations apply on the NN and have been in effect since 1982. (Non-Interstate NN roads are listed in the Code of Federal Regulations Chapter 23, Section 658 Appendix A.) States cannot restrict vehicle size and weight to less than the following:

- 20,000 pounds single axle weight,
- 34,000 pounds tandem axle weight,
- 80,000 pounds gross vehicle weight,
- 102 inches width,
- 48 foot trailer length, and
- 28 foot trailer length for trailers used in twin-trailer combinations.

State roads and supplemental highways make up the rest of the national trucking road system. These roads are subject to the size and weight regulations of the states which may be more or less restrictive than the federal limits. Illinois and Minnesota, for example, have a more restrictive GVW off of the NN.

Despite federal regulations, there are inconsistencies in truck size and weight limits on the NN. When federal regulations were put into effect, Congress allowed for grandfathering of semitrailer length limits higher than the federal standard. Any semitrailer length that was lawfully operating in that state when the federal regulations were put into effect can continue to operate in that state without any penalties. This provision is applicable to both new and old semitrailers.

The Canadian federal government has little input into truck size and weight regulations. The provinces and territories determine the maximum size and weight of trucks on the road; therefore there are many differences in regulations between the jurisdictions. To help alleviate regulatory inconsistencies the

Council of Ministers of Transportation and Highway Safety endorsed a Memorandum of Understanding in 1988. This agreement is designed to improve consistency in truck size and weight regulations on the national highway system (Heavy Truck@ 1999).

Because of their importance to a jurisdiction's economy, certain commodities such as wood and farm products have exemptions to size and weight limits. These commodities may be totally exempt from size and weight regulations or allowed to be hauled in loads up to a certain percentage more than the maximum weight limit without a permit. For example, Wisconsin regulation allows a 41% increase in width for carrying hay in bales or Christmas trees. A complete list of exempt commodities can be found in APPENDIX H.

Longer Combination Vehicles (LCVs) are truck tractors pulling two or three trailers with a GVW greater than 80,000 lb. LCVs were also grandfathered in when the U.S. federal regulations were put in effect. There are three types of LCVs: Rocky Mountain doubles, turnpike doubles, and triple trailers. Rocky Mountain doubles consist of a truck tractor, a 40-48 ft trailer, and a 20-28 ft trailer. Turnpike doubles have a truck tractor and two 48-53 ft trailers. Triple trailers have a truck tractor and three 28-28.5 ft trailers. LCVs are not to be confused with STAA doubles, which were created in the STAA of 1982. STAA doubles have a truck tractor pulling two 28 ft trailers with a maximum GVW of 80,000 lb. All states allow STAA doubles on the NN. Federal regulation imposed a freeze on LCV operations in the 1991 ISTEA and extended the freeze in TEA-21. The freeze specified that states allowing LCV operations can not expand the operations or change the configuration of allowable LCVs. It also meant that states without LCV operations could not start allowing them. In the Upper Midwest region, only the Ohio and Indiana turnpikes allow LCVs (U.S. DOT 2000). The Canadian provinces of Manitoba and Ontario do not allow LCVs on their roads.

Considering federal and jurisdictional regulations, grandfather exemptions, commodity exemptions, and LCV operations, a diverse and varied truck size and weight regulatory environment emerges. Table 5.4 lists the truck size and weight regulations for the states and provinces in the Upper Midwest Region.

5.2.7 Regulatory Enforcement

All jurisdictions have weigh stations, where trucks are inspected for oversize/overweight or safety violations. At a typical weigh station, trucks slow down or stop at a scale that weighs each axle and total vehicle gross weight. The proper credentialing for fuel tax, registration, operating authority, and insurance are also checked by inspectors. Inspectors can also ask to see Hours of Service (HOS) logbooks to check HOS compliance.

Table 5.4 Truck Size and Weight Regulations for the Upper Midwest Region including U.S. Federal Regulations.

Administrative Unit	Length (Feet)										Height (Feet)	Width (Inches)		Weight (1,000 lbs)					
	Interstate and Desig Hwys. (Des.)*					State and Supp. Hwys. (Other)								Single Axle		Tandem Axle		Gross Vehicle	
	Straight Truck	Combinations		Trailing Units		Straight Truck	Combinations		Trailing Units										
		Tractor Semi-Trailer	Tractor Twin Trailers	Semi-Trailer	Trailer		Tractor Semi-Trailer	Tractor Twin Trailers	Semi-Trailer	Trailer		Des	Other	Des	Other	Des	Other	Des	Other
US Federal	N	Ø	Ø	>48	>28	N	N	N	N	N	N	102	N	20	N	34	N	80	N
Illinois †	42	Ø	Ø	53A	28.5	42	B	B	53B	28.5	13.5	102	96	20	18	34	32	80	73.28
Indiana	40			53C		40	Ø	Ø	53C				102		20		34		80
Iowa				53					53										
Michigan			D	53E				59	50	F			96	G	G	G	G	G	G
Minnesota			Ø	53H			75	J	53H	28.5			102	20	18	34	34	80	73.28
Ohio				53			Ø	Ø	53						20				80
Wisconsin				53I			65	J	48										
Manitoba	41	75	82	53	NS	41	65.6	75	N	N	13.6	102	102	20	20	37.5	35.3	137.8	117.9
Ontario							75	82	53	NS				22	22	39.7	39.7	140	140

Des. - Interstates and federally designated state highways. These designated state highways are listed in 23 CFR 658.

Other - All other highways and supplemental routes.

Combinations - Only tractor-semitrailer and tractor-twin-trailer combinations are considered here. For other combinations, contact the state/province agency.

Trailing Units - Semitrailer in tractor-semitrailer combination, and trailer in tractor-twin-trailer combination.

Ø - No overall length restrictions imposed, but must not exceed trailer length.

A - Kingpin to center of rear axle cannot exceed 45.5 ft if trailer is longer than 48ft.

B - Maximum tractor/semitrailer wheelbase is 55 ft. or 65 ft. overall length. Maximum tractor twin-trailer overall length is 60 ft. Kingpin to rearmost axle cannot exceed 42.5 ft if trailer is longer than 48ft.

C - Kingpin to rearmost axle cannot exceed 43 ft.; if the semitrailer is longer than 48.5 ft.

D - No overall length restrictions imposed, but overall length of trailers must not exceed 58 ft., measured from front of first trailer to rear of second trailer.

E - Semitrailer can only have two axles. Kingpin to center of tandem axle cannot exceed 40.5 ft. +/- 0.5 ft. and can only operate on designated routes.

F - Overall length of truck tractor, semi-trailer, and trailer, or truck tractor and two semi-trailers is 59 ft.

G - Variable, contact the Michigan Department of Transportation at 1-800-682-4682.

H - If over 48 ft., kingpin to center of rear axle cannot exceed 43 ft.

I - 53 ft. trailers only allowed on interstate and maximum distance from kingpin to center of rearmost axle not to exceed 43 ft.

J - Not allowed (unless have a permit.)

N - No limit imposed

NS – Not specified, but must meet box length of 65.6 ft. Box length is the length from the front of the first trailer to the rear of the second trailer.

* - In Manitoba, Interstate is designated as RTAC, heavy vehicle roads (Roads and Transportation Association of Canada).

† - Class I and Class II apply to Interstate and Designated Highways. Class III applies to State and Supplemental Highways.

Sources: 23 CFR 685.13, 658.15, 658.17
“Highway Traffic Act” R.S.O. 1990, Chapter H.8 http://www.e-laws.gov.on.ca/DBLaws/Statutes/English/90h08_e.htm
“Truck Driver’s Guidebook” Michigan Center for Truck Safety, Seventh Edition Revised
“Vehicle Sizes & Weights Chart” J. J. Keller & Associates, Inc. 2002
“Vehicle Weights and Dimensions on Classes of Highways Regulation” The Highway Traffic Act, Regulation 575/88 Registered December 19, 1988
(625 ILCS 5/) Illinois Vehicle Code, Minnesota Statues 2003 Chapter 169

5.3 Deployment of CVISN Technology

Commercial Vehicle Information Systems and Networks (CVISN) program is changing the environment in which commercial vehicles operate by coordinating nationwide deployment of capabilities to improve safety and efficiency of commercial vehicle operations. Many states have worked together in studying, planning, testing, and deploying CVISN technology. The section provides an overview of CVISN technology deployment in the region.

5.3.1 Introduction to CVISN

As defined earlier, CVISN refers to the collection of information systems and communications networks that support commercial vehicle operations (CVO). The CVISN program does not create new information systems; rather it integrates the existing systems with communication technology and standards.

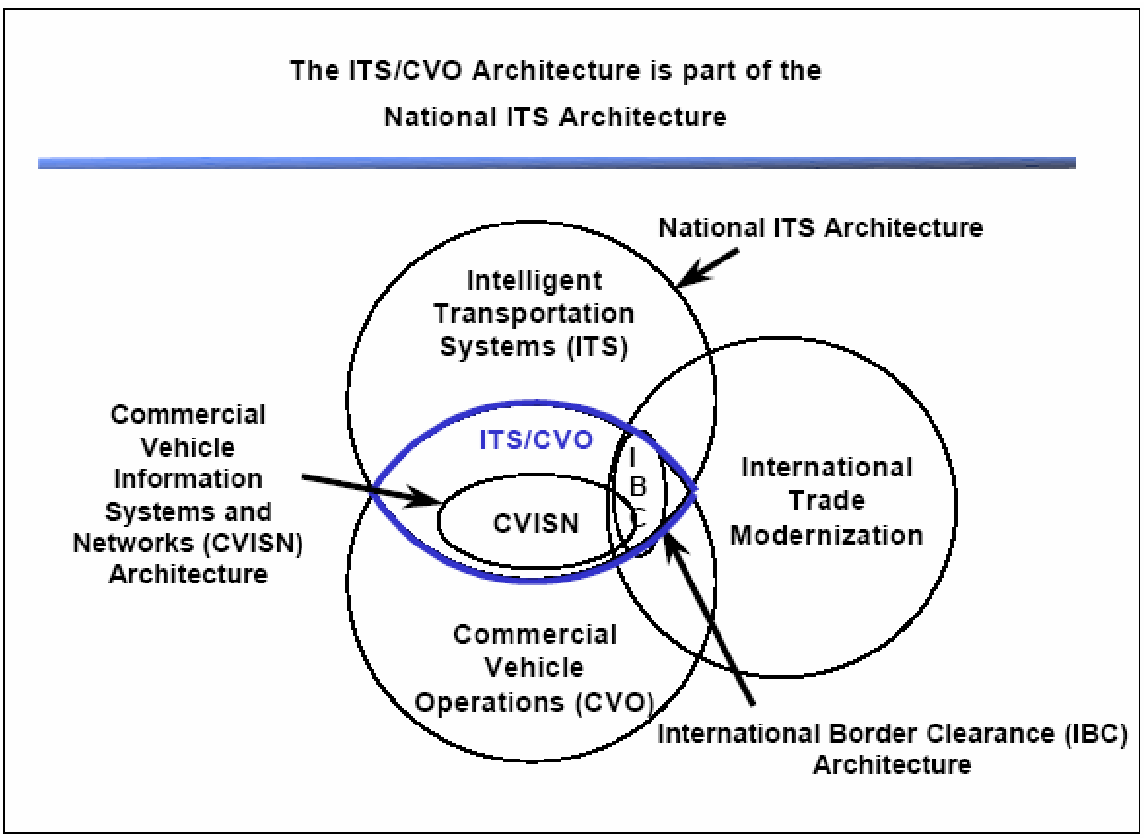


Figure 5.1 Scope of CVISN (Richeson 2000)

The diagram in Figure 5.1 defines the scope of CVISN. Intelligent Transportation System (ITS) refers to electronics, communications, or information processing used to improve safety or efficiency of a surface transportation system. While the operations and regulatory activities associated with commercial vehicles are known as Commercial Vehicles Operation (CVO). CVISN falls within the areas of overlap between ITS and CVO. CVISN also includes elements from International Border Clearance (IBC) program.

5.3.2 IFTA and Electronic Credentialing

CVISN aims to provide end-to-end automation of the credentialing processes. “Credentialing” comprises a variety of business processes including registering operators, registering and titling vehicles, checking insurance, collecting and distributing fuel taxes, issuing oversize / overweight (OS/OW) permits, issuing licenses and permits to haul hazardous materials, collecting federal heavy vehicle use tax. The states process the applications using a combination of manual and automated systems. Motor carriers use some type of credentialing system software on their computer to prepare and submit applications electronically. The state agency’s system then processes the data. The processing includes error checking, crosschecks with other databases, fee calculations, invoicing, payment, and issuance of the appropriate decal, sticker, plate, or paper document.

Table 5.5 lists the expected benefits of deploying CVISN systems for Electronic Credentialing. CVISN incorporates systems called IRP Clearinghouse and IFTA Clearinghouse. IFTA Clearinghouse allows the states and provinces to exchange data and fees electronically rather than via paper reports by calculating fees and transferring of funds among states’ banks. Deployment of Electronic Credentialing results in time and cost savings for both states and carriers (Richeson 2000).

Table 5.5 Benefits of Electronic Credentialing Deployment.

Key Features	Benefits
End-to-end electronic application and processing of credentials	Time and cost savings and increased customer satisfaction for both carriers and states Fewer delays to carriers for obtaining credentials Reduced tax evasion
Use of PC-based and web-based software to submit applications for credentials	Time and cost savings and increased satisfaction for both carriers and states
Printing of permanent or temporary credentials in carrier offices	Avoids delays in getting vehicle on the road
Interface with IRP and IFTA clearinghouses	Cost savings to states

Source: Battelle 2000a

State’s CVISN system design conforms to the national CVISN architecture and can evolve to include new technology and capabilities. As part of the deployment plan, a set of capabilities known as ‘Level 1’ have been defined. Capabilities for Levels 2 and 3 are now being defined. Milestones in the process of Level 1 deployment are defined as: Step 1 Planning, Step 2 Design, and Step 3 Implementation and Deployment The following defines Level 1 deployment for Electronic Credentialing (JHU-APL 2000):

- Automated processing (application, state processing, issuance, tax filing) of at least International Registration Plan (IRP) and International Fuel Tax Agreement (IFTA) credentials; readiness to extend to other credentials (intrastate, titling, oversize/ overweight carrier registration, and hazardous material)
- Connection to IRP and IFTA clearinghouses
- At least 10 percent of transaction volume handled electronically; readiness to sign up more carriers; readiness to extend to branch offices where applicable

Table 5.6 lists the deployment status for Electronic Credentialing in the Upper Midwest region. Although most states are committed to deploying electronic credentialing, these systems have not yet achieved the same level of widespread deployment as have the systems in other areas of CVISN such as safety information exchange. The major challenge in deployment of electronic screening is establishing interfaces between new and legacy, or archival, databases and software systems.

Table 5.6 Electronic Credentialing Deployment Status.

State	CVISN Deployment Status	End-to-End IRP	IRP Clearinghouse	End to End IFTA	IFTA Clearinghouse
MN	Level 1 in FY '02	P	I	I	
MI	Level 1 in FY '03				I
IA	Step 3				
IN	Step 3				I
OH	Step 3		I		I
WI	Step 3				I
IL	Step 2				
I = Implemented					
P = Partially Implemented					

Source: Battelle 2000a

5.3.3 Safety Enforcement Exchange and Electronic Screening

Safety Information Exchange and Electronic Screening are two other components of the CVISN program that support the administration of safety regulations. These systems enable near real-time update and dissemination of information in the Federal Motor Carrier Safety Administration (FMCSA) central Motor Carrier Management Information System (MCMIS). Without the CVISN Safety Information Exchange, MCMIS inputs are entered from paper forms and outputs are made available as printed reports. With CVISN, results of vehicle inspections (including out-of-service orders) are entered, updated and available nationwide in less than an hour.

Vehicle and driver inspections are collected automatically over a network, dial-up, or wireless cellular data link via a system called ASPEN. In a typical state configuration, the inspection reports are relayed from ASPEN via a Commercial Vehicle Information Exchange Window (CVIEW) system at the state level to the Safety and Fitness Electronic Records System (SAFER) at the national level. SAFER relays them to MCMIS and makes them available to the CVIEW systems in all states. The SAFER system makes the safety data available online to safety analysts and law enforcement personnel.

Table 5.7 Benefits of Safety Information Exchange and Electronic Screening Deployment.

KEY FEATURES	ANTICIPATED BENEFITS
Mainline screening with weigh-in-motion (WIM) capability	Time and cost savings and increased customer satisfaction for registered carriers Improved targeting of high-risk carriers
Timeliness of the screening data used in the inspection units	Increased compliance with safety regulations. Identification of and reduction in number of OOS order violators
Facilities for screening on bypass routes	Increased safety through identification of violators of safety regulations

Source: Battelle 2000a

Table 5.7 lists the benefits resulting from Safety Information Exchange and Electronic Screening deployment. The Electronic Screening component automatically screens vehicles as they approach weigh stations and allows those that are safe and legal to bypass without slowing down or stopping. This system uses the safety data provided by the Safety Information Exchange. This capability has WIM scales in the main highway to measure the weight of trucks while they are moving at highway speeds. The trucks are equipped with transponders that are interrogated by roadside readers just before the vehicle goes over the scale. A reader obtains identifying information equivalent to the license plate number from the transponder. A computer in the weigh station uses this identifier to check the safety rating and registration of the vehicle and associated carrier using information provided by SAFER. If the weight and other checks are good, the reader sends back a message to the transponder that says the truck is cleared and does not need to pull into the static scale ramp. The transponder is mounted on the dashboard and has red and green indicators. The green light signals the driver to proceed; the red light to pull into the scale. Enforcement personnel can set up the system to pull in a certain number of vehicles for random safety inspections, just as they do with manual systems. This technology could save up to five minutes of time per bypass for the weighing process. It also saves waiting time for inspection at the weigh station due to shorter queues that result due to electronic screening (Orban J.E. 2000). Hence there is considerable incentive for carriers to participate in the electronic screening program.

Table 5.8 shows the deployment status of Safety Information Exchange and Electronic Screening in the states of Upper Midwest region. The following defines Level 1 deployment for Safety Information Exchange (Richeson 2000):

- Use of Aspen (or equivalent software for access to safety data) at all major inspection sites
- Connection to the SAFER system so that states can exchange “snapshots” of information on interstate carriers and individual vehicles
- Implementation of the CVIEW (or equivalent) system for exchange of intrastate snapshots and for integration of SAFER and other national/interstate data.

The following defines Level 1 deployment for Electronic Screening (Richeson 2000):

- Electronic screening at one or more fixed or mobile inspection sites
- Readiness to replicate electronic screening capability at other sites

Milestones in the process of Level 1 deployment are defined in three steps: Step 1 Planning, Step 2 Design and Step 3 Implementation and Deployment (JHU-APL 2000). It should be noted that most states are using Aspen and Safer for safety information exchange and also have active E-screening program. None of the states in our region have implemented SAFER/CVIEW snapshots.

Table 5.8 Safety Information Exchange and Electronic Screening Deployment Status.

STATE	CVISN Deployment	PRISM	Safety Info Exchange			Electronic Screening	
			ASPEN	SAFER	CVIEW	Fixed/ Mobile Sites	SAFER/CVIEW Snapshots
MN	Level 1 FY ‘02	Yes	I	A	I	Norpass	
MI	Level 1 FY ‘03		I	E	I		
IA	Step 3	Yes	Q	E		Prepass	
IN	Step 3	Yes	I	A		Prepass	
OH	Step 3		I	E		Prepass	
WI	Step 3		I	E	P	Prepass	
IL	Step 2		I	E		Prepass	
I = Implemented							
P = Partially Implemented							
A= Active User							
E = Enrolled User							
Q = Equivalent System							

Source: Battelle 2002a

5.3.4 Regional Collaboration for CVO/CVISN Deployment

Table 5.9 lists various collaborative efforts among states and agencies for deploying CVISN technology and systems for Commercial Vehicle Operations (CVO) in the Upper Midwest region (ITS in Your State, 2004). The most striking example of a regional collaboration is the Gary-Chicago-Milwaukee (GCM) Intelligent Transportation Systems (ITS) Priority Corridor. Since 1993, Illinois, Indiana, and Wisconsin have worked together on solutions to transportation problems in this 130-mile-long, 16-county corridor with a population of more than 10 million. GCM coalition's Commercial Vehicle Operations (CVO) group meets on a regular basis to improve efficiency and effectiveness of the corridor's infrastructure through planning, design, deployment, and evaluation of ITS/CVO applications. The CVO group is currently working on CVISN and Virtual Weigh Station projects (GCM Corridor Website, 2004).

Advantage CVO, formerly Advantage I-75, represents a multi-state partnership of public and private sector interests along the I-75 corridor (CTRE 1998). Advantage I-75 was one the first collaborative efforts for electronic screening deployment. Six states and Ontario, including Ohio and Michigan from Upper Midwest region, conducted an operational test on the I-75 corridor. All the weigh stations along the corridor were equipped with electronic screening capability. The project enabled transponder-equipped and properly documented trucks to travel along the entire length of I-75 at mainline speeds with minimal stopping at weigh/inspection stations. This test was successful in demonstrating perceived benefits of electronic clearance system. Advantage I-75 corridor coalition later formed an organization named North American Electronic Screening System (NORPASS).

Midwest State One-Stop Shopping project was conceived to test a one-stop electronic system that would allow motor carriers to apply, pay for, and receive all necessary credentials or permits electronically. Agencies from several Midwestern states entered into a partnership with FHWA to cooperatively develop and test such an Electronic Credentialing system (BAH 1999). The test demonstrated feasibility of such a system and potential benefits.

The North American International Trade Corridor (NAITC)—which comprises I-35, I-29, and I-80/I-94—is a critical trade route for goods traveling between North American Free Trade Agreement (NAFTA) countries and to and from destinations across the United States. Eight corridor states (Iowa, Kansas, Minnesota, Missouri, North Dakota, Oklahoma, South Dakota, Texas), the Province of Manitoba, North America's Superhighway Coalition (NASCO), and the Ambassador Bridge have established a formal agreement to support the integration of freight services to reduce regulatory and administrative burdens and support carriers operating along the corridor (BAH 2001b). NAITC envisions comprehensive and coordinated Intelligent Transportation Systems for Commercial Vehicle Operations (ITS/CVO) throughout the corridor. The project plan includes pilot projects in the area of credential administration, electronic screening, safety and security. The CVISN projects for implementation are

- Corridor-wide electronic one-stop system
- Coordination of State Commercial Vehicle Inspection Activities
- Electronic Data Exchange Platform for Freight Management

Table 5.9 Major CVO Projects in Upper Midwest Region and Participants

	GCM ITS Corridor			**Advantage CVO (I-75)**			**Midwest state One-stop Shopping**			**North America's Superhighway Coalition (NAITC, I-35 corridor)**		
	SIE	ES	EC	SIE	ES	EC	SIE	ES	EC	SIE	ES	EC
WI	X	X	X		X				X			
MI												
IA									X	X	X	X
IN	X	X	X		X							
OH									X			
MN										X	X	X
IL	X	X	X						X	X	X	X
FHWA					X				X	X	X	X
Ontario												
Manitoba										X	X	X
Other States					FL, GA TN, KY				MO, KS, NE, SD	KS, MO TX, OK	KS, MO TX, OK	KS, MO TX, OK
SIE = Safety Information Exchange ES = Electronic Screening EC = Electronic Credentialing												

5.4 Identification of Potential Locations for Fixed and Mobile E-Screening Facilities in the Upper Midwest Freight Corridor

Studies suggest that CVISN planning based on regional cooperation are more effective than national planning (Tinklenberg 2003). This is because 80% of all trucks travel short distances (i.e. less than 250 miles). Consequently, it is important to consider regional trade in planning and deploying CVISN technology. Consequently, a regional effort to identify location of new electronic screening facilities in the Upper Midwest Freight Corridor would ensure maximum regional benefits. The result of this analysis would be a list of high priority locations for deploying fixed and mobile electronic screening devices.

The FMCSA's CVISN guide to deployment of on electronic screening offers guidance to states on critical issues in planning, design and deployment (JHU-APL, 2002). The guide lists some factors that may influence the selection of first deployment site for electronic screening in the state but no guidelines or a process for selecting the multiple locations for electronic screening sites. There are also no guidelines on working with other states in the region on selecting the location such that it would maximize the benefits for entire region. As seen in the previous section, no past collaboration in the Upper Midwest has taken a regional perspective for selecting locations for electronic screening facilities.

As part of this Upper Midwest Freight Corridor Study, researchers investigated opportunities for regional collaboration in the future deployment of electronic screening facilities. The objective is to suggest an approach that would help different state agencies to collaborate on electronic screening deployment in the region and maximize benefits for the entire region. An approach for identifying potential sites for deployment of electronic screening is inherently a spatial problem. Geographic Information System (GIS) provides powerful tools to spatially combine several data layers and perform analysis to get the results.

The GIS based approach used in analysis builds on existing data created by the states. Data from various state agencies was combined to create a regional dataset that would enable analysis from a regional perspective. The approach tries to incorporate all traditional factors that states would analyze for deployment of such a system, like state policies and preferences, congestion, safety and available resources. An effort has been made here to integrate all these factors into a logical quantitative approach.

The objective of the methodology was to recommend locations for new electronic screening sites such that it would maximize the benefits for the entire Upper Midwest region. Thus the approach was based on benefit-cost analysis. An evaluation of CVISN deployment was used to develop the evaluation criteria. Typically the benefit-cost ratios for electronic screening range from 2 to 5 (Bapna et al 1998). This justifies the economic feasibility of deploying electronic screening at a location. Given this as a base, we try to identify sites that are most beneficial. We assume that the cost for deployment at every site is equal and hence the higher the benefits, the higher the deployment preference.

Table 5.10 Evaluation criteria related to electronic screening benefits

Evaluation criterion	Electronic screening benefit	Data requirement
Traffic volume	Travel time savings for carriers and increase screening capacity at weigh station	Commercial average daily traffic
Number of commercial vehicle crashes	Reduction in number of crashes through identification of high risk and overweight carriers	Commercial vehicle crashes
Proximity to border	Better enforcement of regulations	Locations of weigh stations

Table 5.10 relates the expected benefits of electronic screening system with evaluation criteria. The first and most important benefit of electronic screening is to increase the capacity of a weigh station by enabling it to handle large volume of traffic by pre-clearing legal and safe vehicles and allowing them then to bypass the weigh station without stopping. The result is the ability to process more vehicles and to increase the likelihood of finding violations. A related benefit to operators is the reduction in overall travel time. These benefits are directly related to the number of motor carriers in the traffic volume.

The second benefit of electronic screening is reduction in number of crashes. If an electronic screening facility is deployed near locations having high occurrence of crashes involving commercial vehicles, it may help reduce these crashes.. The sites located in high crash zones are given higher priority when making deployment decisions.

The third criterion ‘proximity to state border’ was included because of the institutional environment. State agencies are particularly inclined to establish facilities for screening the inbound traffic to ensure that vehicles entering their jurisdiction are safe and legal (WisDOT 1998). This is particularly true if neighboring states have different size and weight regulations. Therefore the weigh stations near the state border serving the inbound traffic in the state should be given priority over sites that are away from the state border. Indirectly, this relates to better enforcement benefits of the electronic screening technology.

Any weigh stations that are located on major freight routes in the region were included in the analysis. The aim of the analysis is to prioritize the locations to maximize the benefits with minimum investment. The weigh stations were evaluated using the criteria described above and ranked in order of expected benefits from deployment of electronic screening.

5.4.1 Methodology

A two-stage methodology is suggested. The first stage is to identify a subset of all possible locations where electronic screening could be deployed. The second stage is to rank and prioritize these locations based on ranking criteria. Figure 5.2 shows the flow chart of the proposed methodology to identify and rank potential locations for deployment of electronic screening.

Certain data are needed to model the selection criteria. Table 5.10 lists the data required for each of the evaluation criteria. Since electronic screening would only deal with commercial vehicles, traffic and crash data involving only commercial vehicle are used. Location of existing weigh stations and existing electronic screening facilities is required to select only those weigh stations that are on major freight routes and do not have electronic screening facility. Also the distance from state border would be derived from the location of a weigh station. In addition to the data requirements in Table 5.10, the roadway network in the Upper Midwest is required to perform the routing analysis and find major freight routes using major freight origin-destination data. All these data layers are spatially overlaid in different stages and analyzed to find the potential locations for deployment of electronic screening.

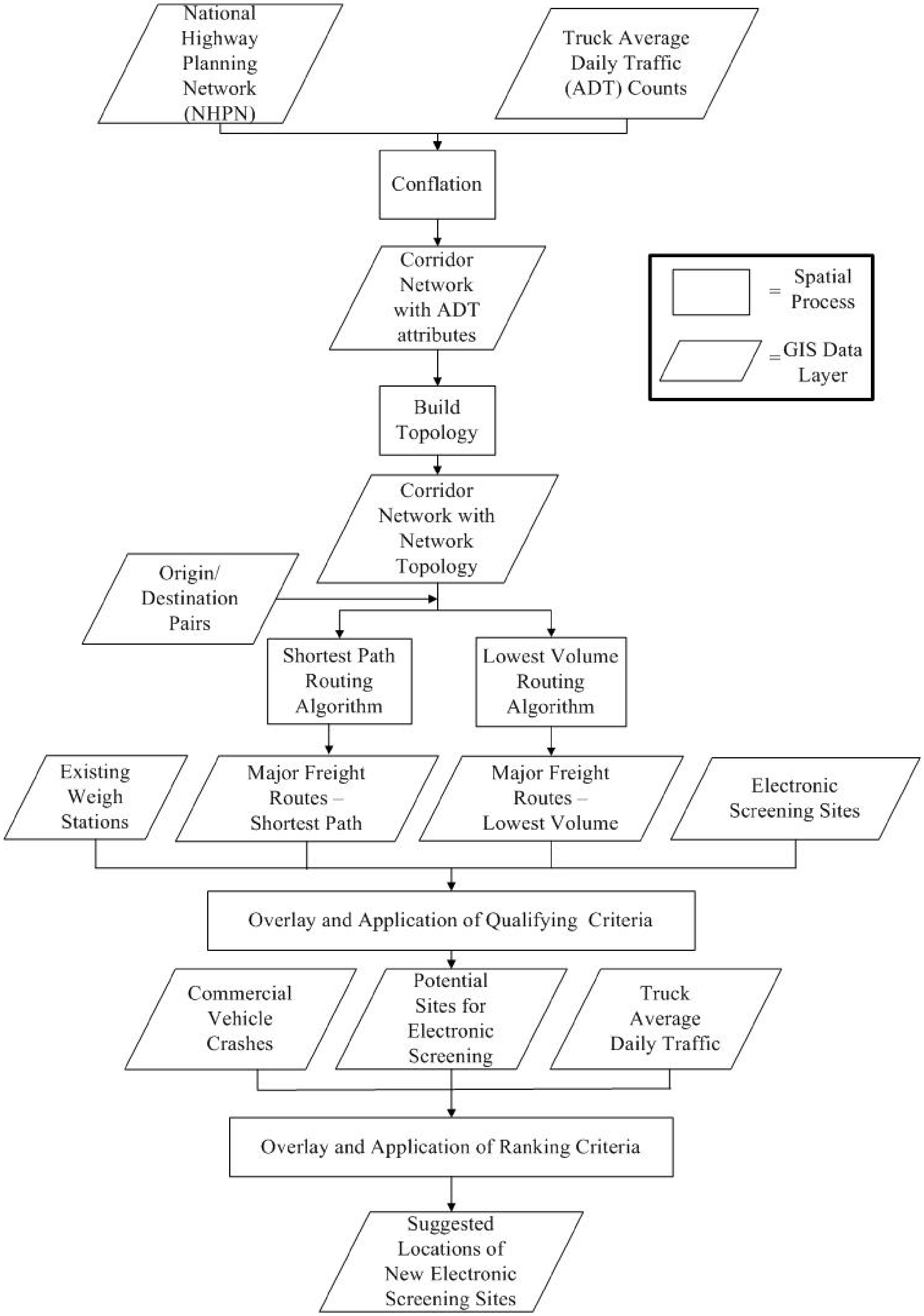


Figure 5.2 Process flow chart for identifying candidate sites for Electronic Screening Technology Investment in the Upper Midwest Freight Corridor

5.4.2 Analysis of Data Sources

Several data layers were used in the analysis: some in digital spatial form others only in tabular format. . Table 5.11 lists the data layers used in the methodology and their original sources. Following is a brief analysis of data sources and description of technique used to edit or create the required data layer.

Table 5.11 Data Sources.

Spatial Data Layer	**Original Data Source**		**Spatial data edited or created from original data?**
Corridor Network	National highway Planning Network v4.0		Edited
Commercial Average Daily Traffic	WI	Wisconsin DOT	Edited
	IL	FHWA	
	OH	Ohio DOT	
	MN	Minnesota DOT	
	IA	Iowa DOT	
	MI	SEMCOG	
Origin/Destination Pairs	FHWA Freight analysis Framework		Created
Weigh Stations	State DOTs		Created
Existing Electronic Screening Sites	PrePass, HELP Inc.		Created
Commercial Vehicle Crashes	State DOTs		Created

Commercial Average Daily Traffic: Commercial Average Daily Traffic (ADT) data was obtained from sources other than the base corridor network. A spatial process called ‘conflation’ was used to transfer the ADT data to the corridor network. Figure 5.3 shows the dataset classified to show the distribution of commercial vehicle traffic in the Upper Midwest. Figure 5.3 shows a pattern of concentration of truck traffic near metropolitan areas and that the interstates 90, 94, 80 and 75 experience much larger truck volumes than any other highway in the region.

Origin/Destination Pairs: The major freight origin and destination pairs were derived from freight analysis framework’s (FAF) freight flow maps (FAF 2004). Origin/destination pairs with more than 500,000 tons of freight flows between them were considered as major freight origin/destinations. Figure 5.4 lists the major origin/destination pairs and shows the routes between them.

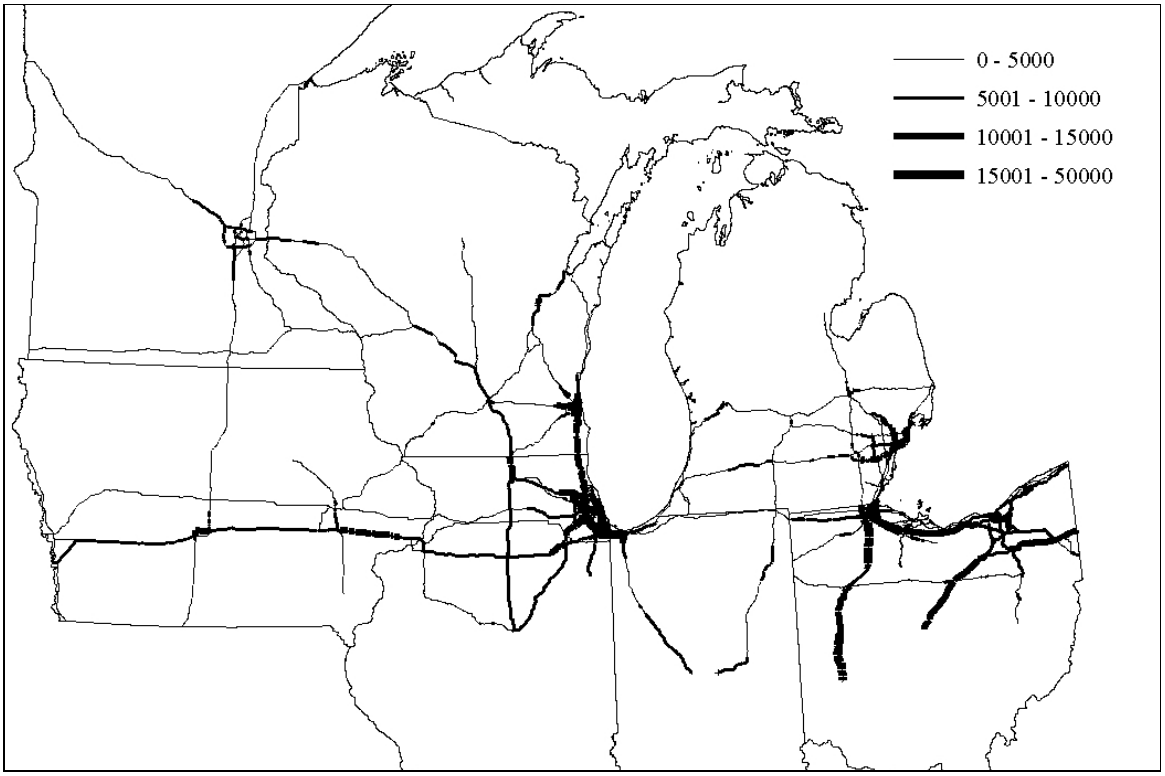


Figure 5.3 Commercial Average Daily Traffic data layer

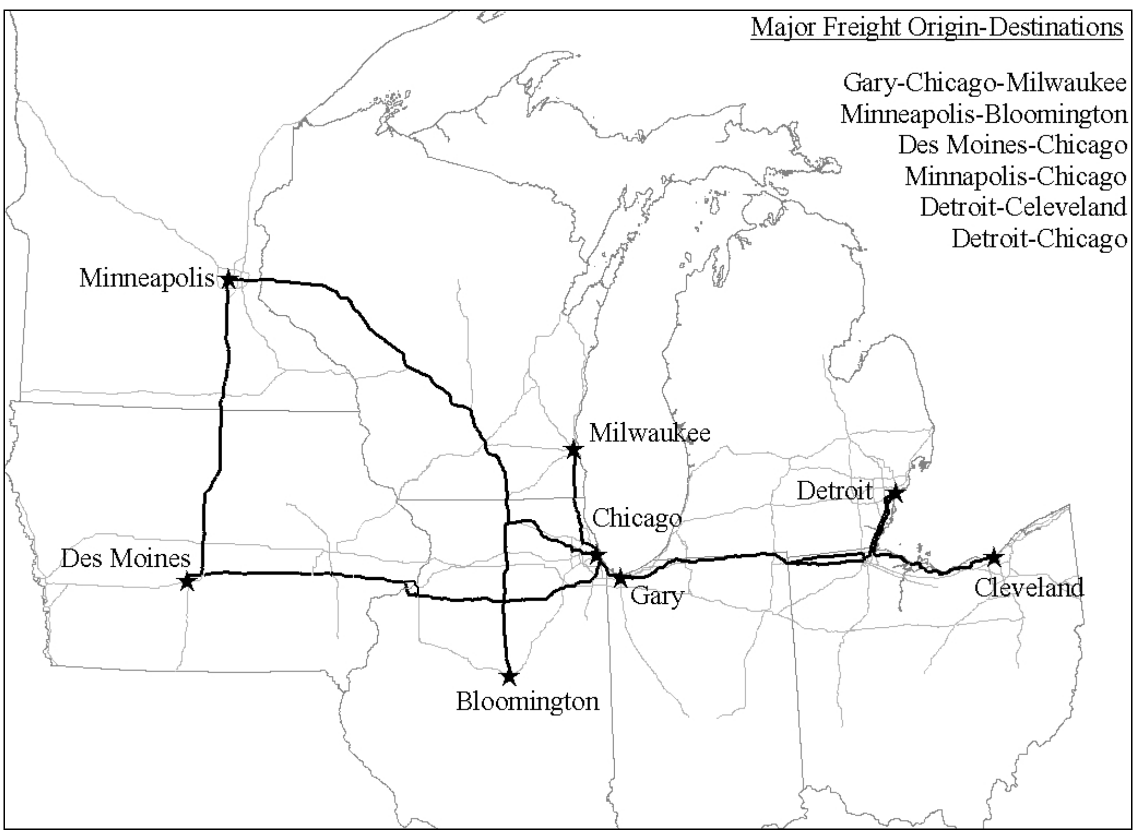


Figure 5.4 Major freight routes

Commercial Vehicle Crashes: Commercial vehicle crash data was the most difficult to obtain in a form that could be used in the analysis directly. For the purpose of the analysis, the location of crashes was needed. States publish the crash data categorized by vehicle type, severity, reason, county, etc. But high volumes of data make it impossible to publish the location of each crash. Therefore an indirect approach was used to create the crash dataset from available published data. Figure 5.5 illustrates the process. Crash data categorized by vehicle type, county, and roadway type was obtained. A county was considered the smallest unit of analysis. Using the GIS tools available, the roadway lengths of, interstate, U.S. trunk highway, and state highway in a given county were calculated. For a county roadway segment, the total commercial vehicles crashes were distributed in the proportion to the length of that segment to total length of that type to roadway.

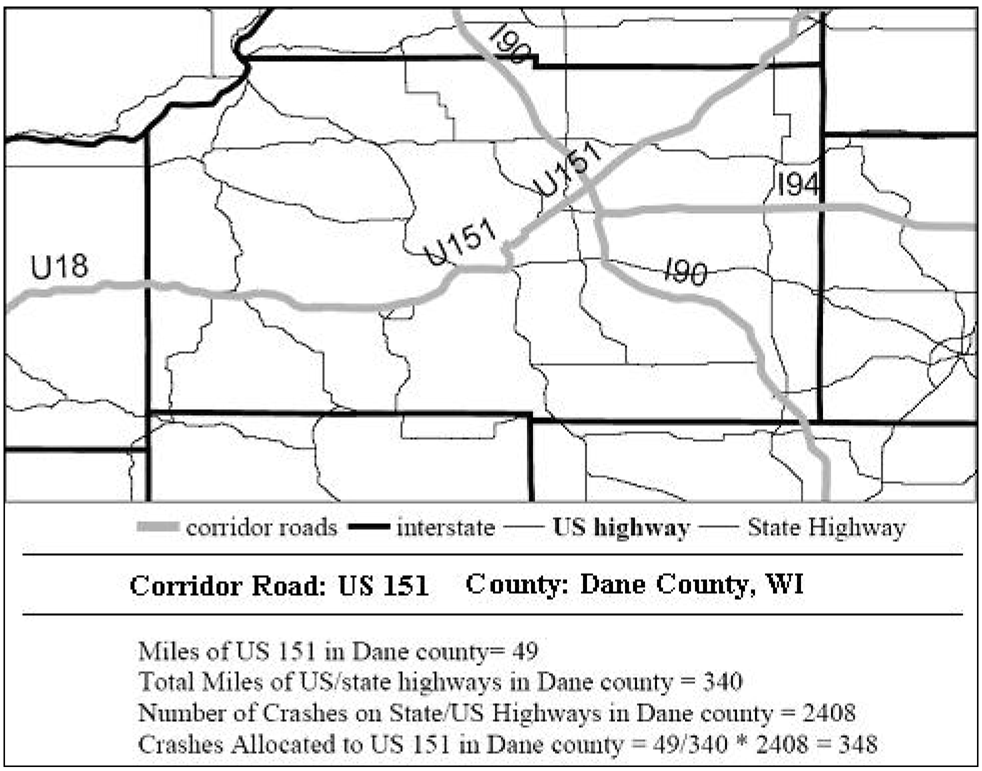


Figure 5.5 Process used for creating Crash Dataset.

Though the accuracy of data created by such method is limited, for the application in consideration, the low resolution of the data does not pose limitations. Figure 5.6 shows the distribution of crashes involving heavy trucks in the Upper Midwest. Chicago, Minneapolis, and Detroit metropolitan areas are clearly the hotspots for commercial vehicle crashes.

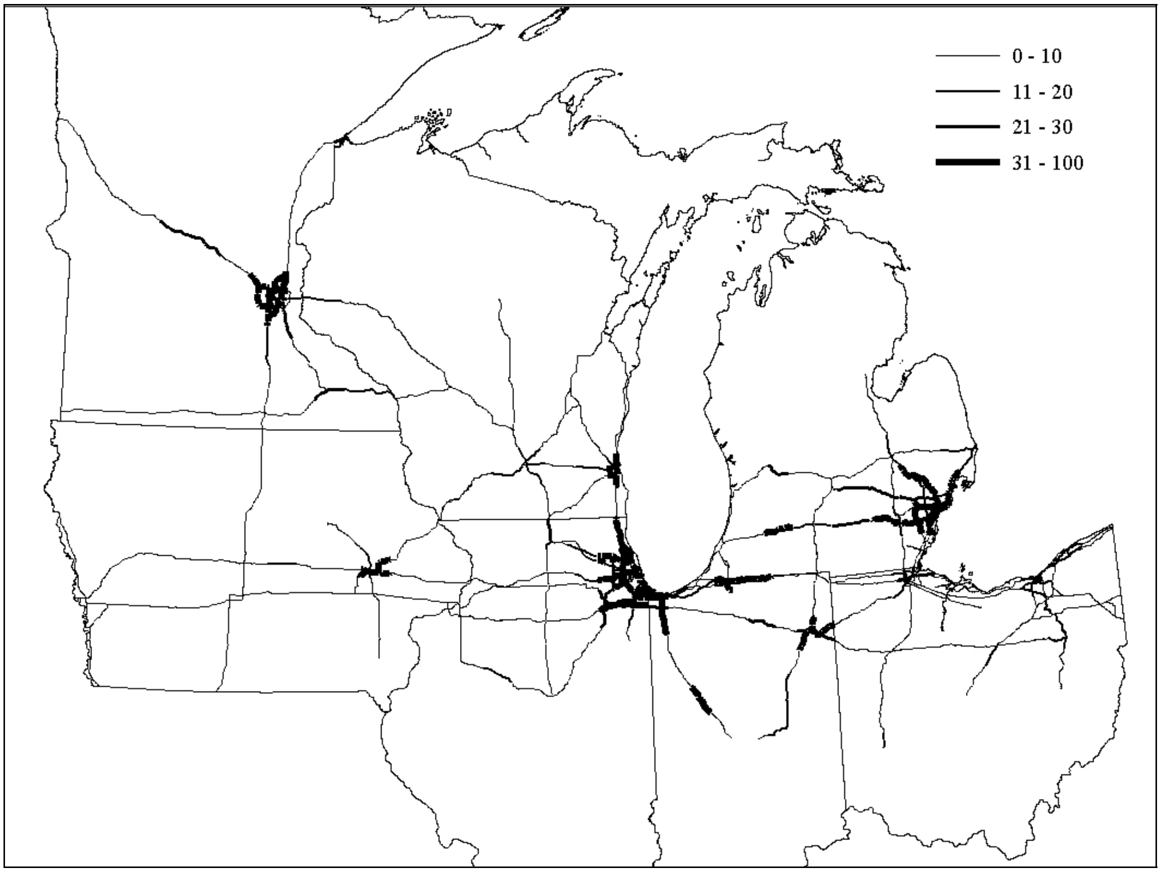


Figure 5.6 Commercial vehicle crashes in Upper Midwest

Weigh Stations and Electronic Screening Facilities: Other important data layers for the analysis were existing weigh station and electronic screening facilities. The electronic screening facilities are generally located at an existing weigh station. Five states of the region participate in the Prepass electronic screening program and many weigh station sites in the region are already equipped with this technology. Because interest has not been expressed by the trucking industry, Minnesota does not have pre-screening sites. No data was available for Michigan.

The data for existing weigh stations and Prepass electronic screening facilities in the region was available in the form of location descriptions. APPENDIX H lists the weigh stations and their location descriptions. The locations were described in different forms depending on the source and included route and milepoint, nearest exit, and intersection of highways. Using this information, the locations were plotted on the corridor network and a spatial dataset was created. Figure 5.7 shows a regional map indicating the weigh stations and electronic screening facilities in the Upper Midwest freight corridor.

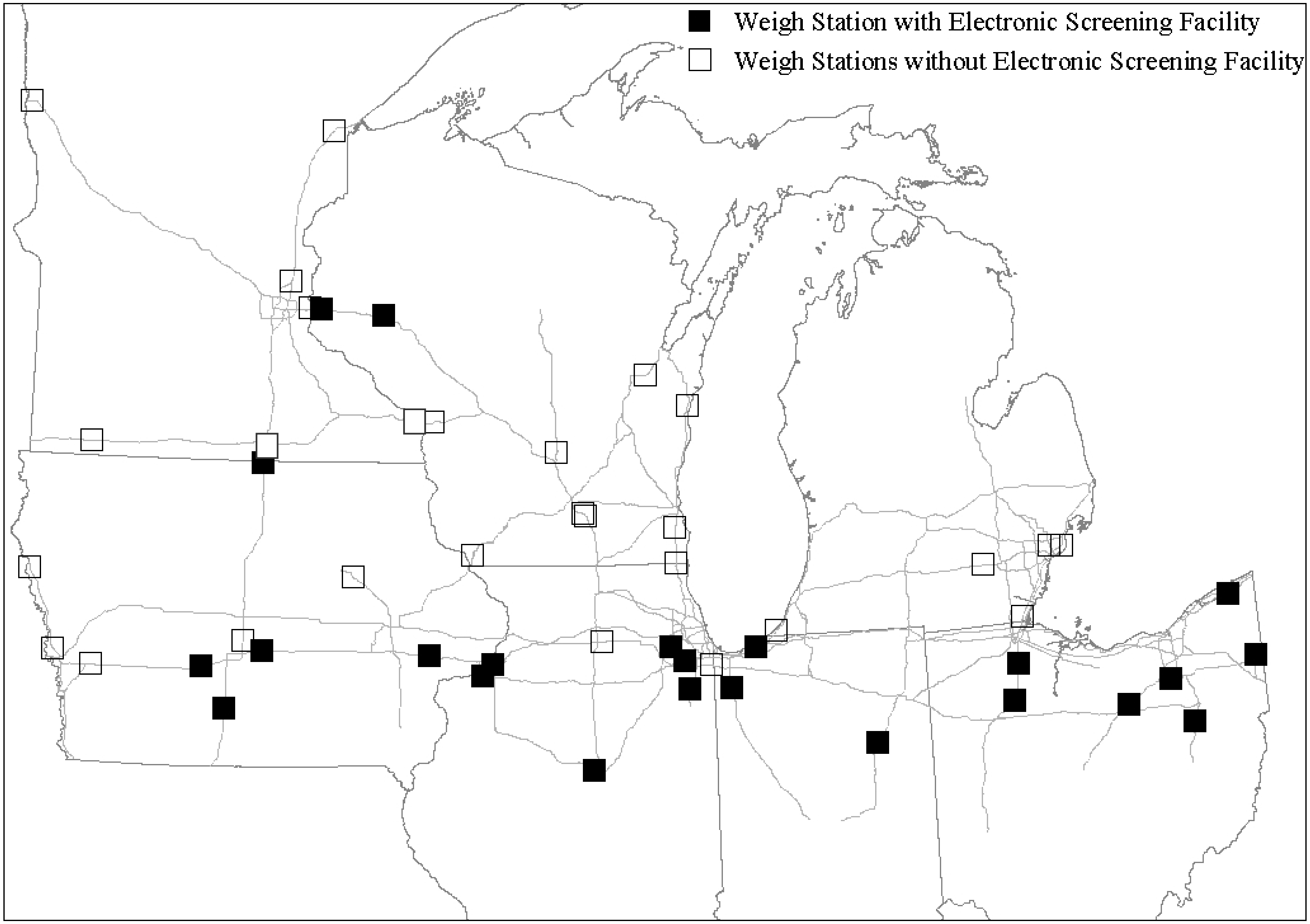


Figure 5.7 Weight Enforcement Facilities in Upper Midwest Region Study Corridor

5.4.3 Analysis

Two steps were applied to find the sites where deployment of electronic screening would maximize the benefits for the entire region. The first qualifying criterion is to select all possible sites where electronic screening could be deployed. Next, rank the sites according to potential benefits from deployment.

Qualifying Criteria: The analysis looked at existing weigh stations without electronic screening as potential new locations for fixed electronic screening sites. To qualify as a potential site,

- A weigh station exists at the site. No electronic screening currently exists at the site
- The weigh station is located on a major freight route

Using the weigh station and electronic screening sites data layers, the first criterion was applied and a subset of weigh stations was selected. To apply the second criterion a routing analysis was carried out on the subset.

Two routing algorithms were used to find major freight routes between the origin/destination pairs. The shortest path algorithm finds the shortest route from the origin to the destination. This would be the preferred route for most carriers as it would be, in most cases, the most economical route. But for some carriers operating under time-sensitive schedules, a path that takes lowest time would be preferred. The lowest volume algorithm was used to model this condition. The average annual daily traffic (AADT) attribute was used as weight for routing analysis. The weigh stations from the subset located at any of the above major freight routes were selected as potential sites for electronic screening deployment.

Ranking Criteria: The selected potential sites were ranked based on following three criteria:

- Volume of commercial traffic
- Number of crashes
- Proximity to state border

<u>Volume of Commercial Traffic</u>: Electronic screening improves the efficiency of commercial vehicle operations. It is especially effective at sites that experience large volume of trucks by screening a large number of vehicles and accurately identifying potential safety violators. The benefits are linearly proportional to the number of vehicles screened. Therefore, by deploying electronic screening at high volume sites, maximum efficiency benefits could be obtained. For quantification of this criterion, the corridor network was classified into four categories. Each category was assigned a numerical factor ranging from 1 to 4. Table 5.12 lists the categories and associated value of the volume factor.

Table 5.12 Traffic volume categories and associated volume factors

Category	Commercial Traffic Volume (vehicles/day)	Volume Factor (fv)
Low	0 – 5000	1
Medium	5001 – 10000	2
High	10001 – 15000	3
Very High	15001 and above	4

Number of Crashes: A site located in a high crash zone would result in higher safety benefits than a site where fewer crashes occur. A crash zone was defined as roadway segment of 20 miles around a weigh station. The crash dataset was developed from countywide statistics and hence the resolution of the data was limited to county boundaries. Typical length of roadway segment in a county being around 20 miles, this number was chosen to define a crash zone. Table 5.13 shows the crash factor assigned to each category of crash zone.

Table 5.13 Commercial vehicle crashes categories and associated crash factors

Category	Commercial vehicle crashes (crashes/year)	Crash Factor (fc)
Low	0 – 10	1
Medium	11 – 20	2
High	21 – 30	3
Very High	31 and above	4

Proximity to State Border: The weigh stations near the state border serving the inbound traffic in the state were given priority over sites that are away from the state border. Table 5.14 shows the categories for this criterion and numerical values assigned for the border factor.

Table 5.14 Categories for proximity to state border and associated border factors

Proximity to state border	Distance to the border (miles)	Border factor (f_b)
Far	More than 50	1
Near	10 – 50	2
On the border	0 – 10	3

Evaluation Function: The three criteria selected for evaluation do not contribute equally to the benefits that result from electronic screening. As a result weight factors were used in the evaluation function. Weight factors are assigned in proportion of the expected benefits. The evaluation function used for ranking the potential sites can be written as follows:

$$F = w_v * f_v + w_c * f_c + w_b * f_b$$

Where,

f_v, f_c and f_b = crash, volume, and border factors

w_v, w_c and w_b = weight factors

It is estimated that the benefits from travel time saving are at least three times more than the safety benefits (Bapna et al. 1998). For that reason the volume factor (f_v) should be given more weight in the evaluation function. As a base case, w_v =3, w_c =1 and w_b =1 were used. Later a sensitivity analysis was performed to evaluate the sensitivity of results to these weight factors.

5.4.4 Results and Recommendations

Table 5.15 lists the potential sites for deployment of electronic screening ranked in order of expected benefits using the evaluation function. Higher rank represents larger benefits at the same level of investment. Hence it is recommended that the sites with higher rank value should be given higher priority. Figure 5.8 shows the location of the recommended deployment sites.

Table 5.15 Potential Weigh Stations and Corresponding Rank Value.

Station ID	Route	State	Truck Crashes per year	Truck ADT per year	Miles to Border	f_V	f_C	f_b	Rank Value (F)
8	Gary-Chicago-Milwaukee (I-94)	WI	32	15050	28	4	4	2	18
6	Gary-Chicago-Milwaukee (I-94)	WI	25	10800	1	3	3	3	15
13	Gary-Chicago-Milwaukee (I-94)	IL	25	10800	1	3	3	3	15
50	Minneapolis-Chicago (I-94)	MN	13	7020	1	2	2	3	11
3	Minneapolis-Chicago (I-90)	WI	17	7400	40	2	2	2	10
5	Minneapolis-Chicago (I-90)	WI	17	7400	38	2	2	2	10
31	Minneapolis-Des Moines (I-35)	IA	10	5250	120	2	2	1	9
48	Detroit-Chicago (US 24)	MI	12	360	3.5	1	2	3	8

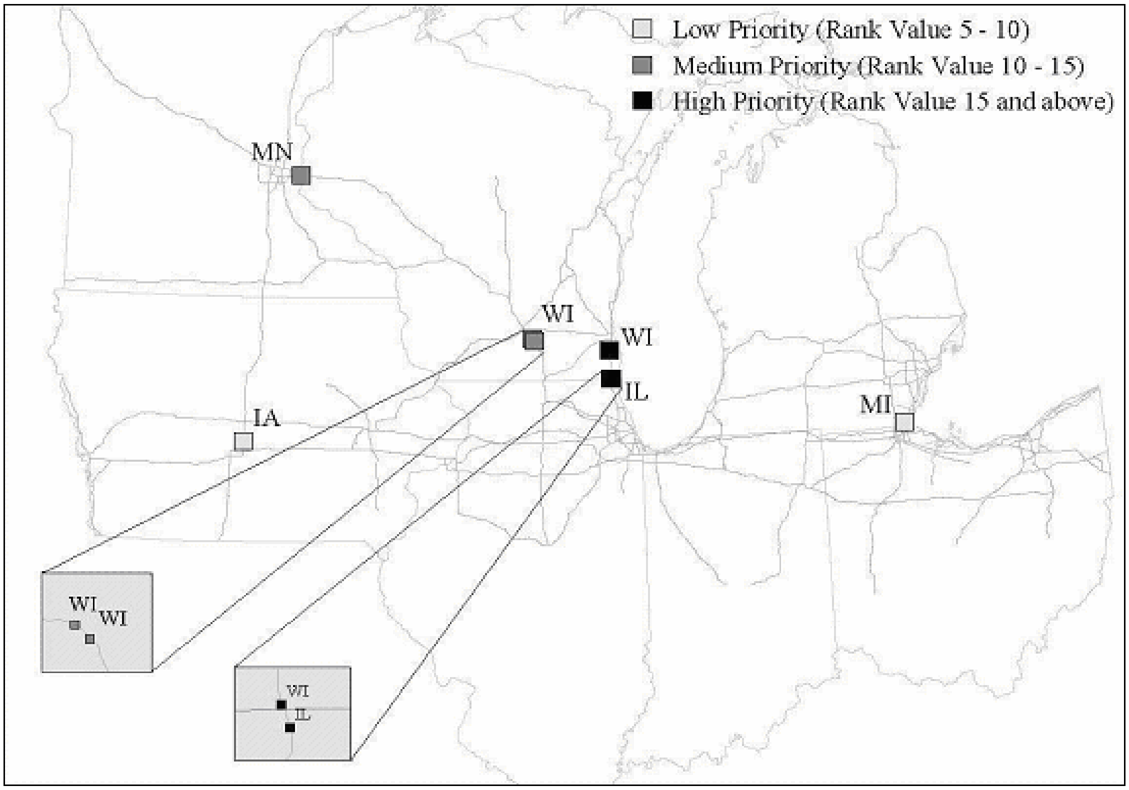


Figure 5.8 Recommended priorities for deployment of electronic screening

Sensitivity Analyses: The weight factors used in the evaluation were derived from a benefit-cost analysis of a deployment in the state of Maryland. The relationship might be different in other states or regions. Table 5.16 lists the combinations and result of the sensitivity analyses of the three weight factors. Rank value (F) was calculated for each combination of factors.

Table 5.16 Sensitivity Analyses

Weigh Station ID	Rank Value (F)						
	Base Case	Sensitivity of w_v		Sensitivity of w_c		Sensitivity of w_b	
	$w_v = 3$	$w_v = 2$	$w_v = 1$	$w_v = 2.25$	$w_v = 1.5$	$w_v = 2.25$	$w_v = 1.5$
	$w_c = 1$	$w_c = 1.5$	$w_c = 2$	$w_c = 2$	$w_c = 3$	$w_c = 0.75$	$w_c = 0.5$
	$w_b = 1$	$w_b = 1.5$	$w_b = 2$	$w_b = 0.75$	$w_b = 0.5$	$w_b = 2$	$w_b = 3$
8	18	17	16	18.5	19	16	14
6	15	15	15	15	15	15	15
13	15	15	15	15	15	15	15
50	11	11.5	12	10.75	10.5	12	13
3	10	10	10	10	10	10	10
5	10	10	10	10	10	10	10
31	9	8.5	8	9.25	9.5	8	7
48	8	10	10	8.75	7.5	11.25	12.5

Conclusion/Observations: It can be seen that most of the recommended higher priority sites are located in Wisconsin and surrounding area. Several reasons can be cited for this. It must be noted that each state has achieved a different level of electronic screening deployment. States like Ohio and Illinois have upgraded almost all weigh stations to handle electronic screening whereas other states have just recently begun deployment process. Many weigh stations in the region would have ranked higher if there had not already been electronic screening capability at that site. The results of this research provide an excellent opportunity for states that are in an early stage of deployment to expedite deployment of electronic screening facilities at critical locations in the region that would maximize benefits for individual states as well as the entire region.

The sensitivity analysis shows that the results do not vary significantly by varying the volume and crash weight factors. But it was found that large changes in the border factor do alter the rankings. The planning agencies should be aware of this and all stakeholders must agree on appropriate weight adjustment for this factor.

The research provides a setting for regional collaboration among the states of Upper Midwest for cooperating on deployment of electronic screening facilities at critical locations. Other collaborative efforts in the Upper Midwest region or elsewhere can also adopt a similar methodology for a regional analysis. This study can also serve as input to the future version of FMCSA's CVISN guidelines for electronic screening deployment, so other states and regions can incorporate the methodology in CVISN planning and utilize the limited resources for maximum benefits.

5.5 Impacts of Regulatory Inconsistencies

In a previous section, Table 5.4 shows the full details of the regulatory limits in each jurisdiction. This section discusses the differences in those regulations on the Upper Midwest corridor. Also, the concept of "weight packages" is introduced, showing how jurisdictions allow different combinations of allowed truck weights on their roads. Administrative bottlenecks, locations on the corridor roads that are non-designated, are identified and discussed. Differential speed limit regulations are analyzed. Finally, the impacts of the inconsistent truck size and weight regulations are examined.

5.5.1 Regulatory Inconsistencies in the Upper Midwest Region

Size and weight regulations on highways are organized by roadway designation. There are two main networks of roads that truck size and weight regulations apply: federal (designated) roads and state (non-designated) roads. The designated roads include the National Network (NN), Interstates, and any other federal road. All other roads are considered to be non-designated, and include roads classified as supplemental truck routes, state roads that are not federally funded, and roads not on the NN.

Federal guidelines and regulations are uniform on designated roads, and there are very few differences in size and weight maximums from state to state. These differences are minor and are mostly concerned with Illinois and Michigan regulations. Table 5.17 shows the inconsistencies found on designated roads in the Upper Midwest. Most inconsistencies arise when traveling on non-designated roads. It is there that jurisdictions are allowed to regulate truck size and weight as they see fit. Lengths, trailer combinations, widths, and axle weights vary from jurisdiction to jurisdiction. A complete list of inconsistencies found on non-designated roads is shown in Table 5.18. These two tables demonstrate inconsistencies by identifying the most shared regulation in the region and listing the deviation for each regulation by jurisdiction. By complying within the common limits, carriers can legally travel within the region.

Illinois and Michigan regulations are more involved than the other jurisdictions. Illinois's highways are divided into classes. Class I and II highways are Interstates and designated routes. Class III highways are state and supplemental highways. Michigan is the only state in the region that allows higher truck gross vehicle weights (GVWs) than the federal maximum of 80,000 lbs on its roads, dependent upon the number of axles of the vehicle. Michigan, just like every other state, has to allow five axle semi-trailers with a gross weight of 80,000 lbs, a single axle weight of 20,000 lbs, a tandem axle weight of 34,000 lbs, and a trailer length of at least 48 feet on its Interstate highways because of the federal regulations and the federal bridge formula. However, this federal rule is an exemption to Michigan's state regulations. Michigan also allows vehicles to travel on its highways with a GVW greater than 80,000 lbs. In those cases, the allowable single axle weight is 18,000 lbs and the allowable tandem axle weight is 32,000 lbs. The heaviest vehicle that can travel on Michigan highways without a permit is 164,000 lbs on 11 axles. Because of these regulations, trucks traveling on Michigan's highways that follow Michigan regulations and have a GVW greater than 80,000 lbs cannot leave Michigan roads, unless they have an oversize/overweight permit to the states they want to travel through (*Truck* 2003).

A single truck loaded to travel in one state or province may not be legal in other jurisdictions in the Upper Midwest. When on designated roads, as long as a truck follows federal weight and size standards, it can travel from state to state. However, by leaving federally designated roads or by traveling across international borders, different truck regulations apply.

Table 5.17 Regulatory Inconsistencies on Designated Highways in the Upper Midwest Region

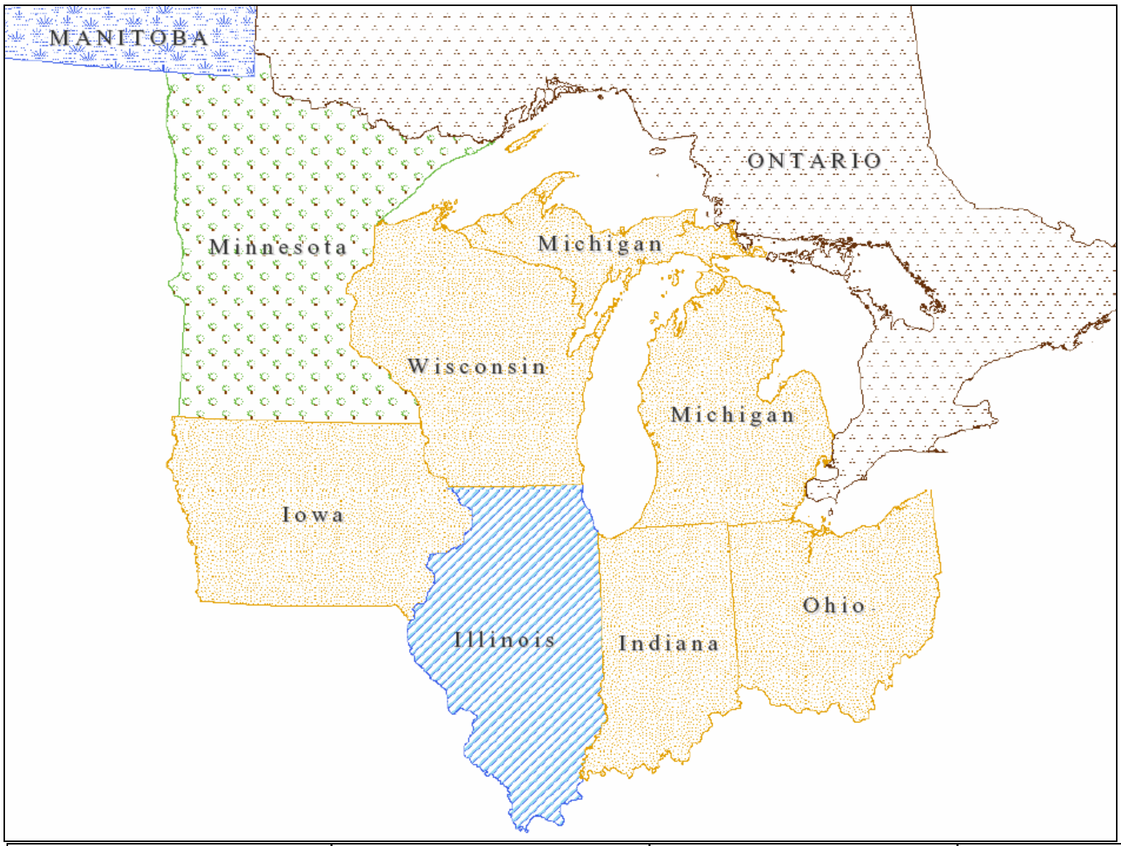
Dimension	Most Common Allowable Limit	Deviation (+/-)	Regulatory Deviation
Straight Truck Length	40 ft	+	IL allows 42 ft
		+	MB allows 41 ft
		+	ON allows 41 ft
Tractor Semi-Trailer Length	No overall length limit specified - must meet trailer length limit	-	MB specifies 75 ft overall length
		-	ON specifies 75 ft overall length
Tractor Twin Trailers Length	No overall length limit specified - must meet trailer length limit	-	MI no overall length limit imposed, but overall length of trailers must not exceed 58 ft
		-	MB restricts to 82 ft overall length
		-	ON restricts to 82 ft overall length
Semi-Trailer Length	53 ft with kingpin to center of rear axle length of 43 ft	+	IL specifies kingpin to center of rear axle length of 45.5 ft
		-	MI specifies kingpin to center of rear axle length of 40.5 ft +/- 0.5 ft
Trailer Length	28.5 ft	-	MB limit is not specified, but must meet box length of 65.5 ft
		-	ON limit is not specified, but must meet box length of 65.5 ft
Height	13.5 ft	+	MB allows 13.6 ft
		+	ON allows 13.6 ft
Width	102 in		None
Single Axle Weight	20,000 lbs	-	MI specifies 18,000 lbs on vehicles weighing greater than 80,000 lbs
		+	ON allows 22,000 lbs
Tandem Axle Weight	34,000 lbs	-	MI specifies 32,000 lbs on vehicles weighing greater than 80,000 lbs
		+	MB allows 37,500 lbs
		+	ON allows 39,700 lbs
Gross Vehicle Weight	80,000 lbs	+	MI allows 151,400 lbs on 11 axles
		+	MB allows 137,800 lbs
		+	ON allows 140,000 lbs

Table 5.18 Regulatory Inconsistencies on Non-Designated Highways in the Upper Midwest Region

Dimension	Most Common Allowable Limit	Deviation (+/-)	Regulatory Deviation
Straight Truck Length	40 ft	+	IL allows 42 ft
		+	MB allows 41 ft
		+	ON allows 41 ft
Tractor Semi-Trailer Length	No overall length limit specified - must meet trailer length limit	-	IL specifies a max tractor/semitrailer wheelbase of 55 ft or 65 ft overall length
		-	MN specifies 75 ft overall length limit
		-	WI specifies 65 ft overall length limit
		-	MB specifies 65.6 ft overall length limit
		-	ON specifies 75 ft overall length limit
Tractor Twin Trailers Length	No overall length limit specified - must meet trailer length limit	-	IL specifies 60 ft overall length limit
		-	MI specifies 59 ft overall length limit
		-	MN does not allow
		-	WI does not allow
		-	MB specifies 75 ft overall length limit
		-	ON specifies 82 ft overall length limit
Semi-Trailer Length	53 ft with kingpin to center of rear axle length of 43 ft	-	IL specifies a kingpin to center of rear axle length of 42.5 ft
		-	MI specifies 50 ft length limit
		-	WI specifies 48 ft length limit
		+	MB has no limit imposed
Trailer Length	28.5 ft	-	MI specifies 59 ft overall length limit
		+	MB has no limit imposed
		-	ON limit is not specified, but must meet box length of 65.5 ft
Height	13.5 ft	+	MB allows 13.6 ft
		+	ON allows 13.6 ft
Width	102 in	-	IL specifies 96 in width limit
		-	MI specifies 96 in width limit
Single Axle Weight	20,000 lbs	-	IL specifies 18,000 lb limit
		-	MI specifies 18,000 lbs on vehicles weighing greater than 80,000 lbs
		-	MN specifies 18,000 lb limit
		+	ON allows 22,000 lbs
Tandem Axle Weight	34,000 lbs	-	IL specifies 32,000 lbs limit
		-	MI specifies 32,000 lbs on vehicles weighing greater than 80,000 lbs
		+	MB allows 35,300 lbs
		+	ON allows 39,700 lbs
Gross Vehicle Weight	80,000 lbs	-	IL specifies 73,280 lbs limit
		+	MI allows 151,400 lbs on 11 axles
		-	MN specifies 73,280 lbs
		+	MB allows 117,900 lbs
		+	ON allows 140,000 lbs

Within the seven states and two provinces there are several truck "weight packages", or combinations of allowed vehicle weights, as shown in Figure 5.9. Five of the seven states apply the federal limits statewide. Both provinces allow GVW and tandem axle weight higher than U.S. limits except for in Michigan. Two states limit GVW and single axle weight below the federal standard off of designated roads. One state limits the tandem axle weight below the federal standard off of designated roads. One province allows a single axle weight limit higher than U.S. limits.

Figure 5.9 Weight Packages in Upper Midwest Region.



State(s), Province	Gross Vehicle Weight (1,000 lbs)		Single Axle Weight (1,000 lbs)		Tandem Axle Weight (1,000 lbs)	
	Federal	**State**	**Federal**	**State**	**Federal**	**State**
IL	80	73.28	20	18	34	32
MN	80	73.28	20	18	34	34
MI	164	164	18	18	32	32
IN, IA, MI*, OH, WI	80	80	20	20	34	34
MB	87.1	82.7	20	20	37.5	35.3
ON	104.1	104.1	22	22	42.1	42.1
*Five axle truck tractor semitrailer						

Sources: DOT Comprehensive Truck Size and Weight Study, Summary Report, Table 2; Manitoba Transportation Regulation http://www.gov.mb.ca/tgs/transreg/index.html; Ontario Highway Traffic Act http://www.e-laws.gov.on.ca/DBLaws/Statutes/English/90h08_e.htm

5.5.2 Regulatory Bottlenecks on the Upper Midwest Freight Corridor

The truck size and weight limits in the Upper Midwest Freight corridor were plotted in Figure 5.10 to examine the regulatory inconsistencies in an effort to identify bottlenecks on the study corridor. Geographic Information System (GIS) analysis was used to assess route connectivity. The map is based on the National Highway Planning Network (NHPN). The effort involved translating written descriptions of the regulations to a corridor map locations (FHWA 2004f). Six areas were identified as being potential regulatory bottlenecks because they are non-designated segments of the Upper Midwest Freight Corridor. (Figure 5.11 and Figure 5.12 show zoom-in views.) However, most of these potential bottlenecks are not significant since there are designated alternative routes. The result is the identification of essential route segments to be added to the Upper Midwest Freight corridor.

1. In Madison Wisconsin, US 51 and US 12/18, that bypass the non-designated segment of US 151 from I-90/94 to US 14.

2. In Milwaukee Wisconsin, US 45 and state highway 145 that provide alternative routes to the non-designated segment of US 41 from W. North Avenue to US 45.

3. In Rock Falls, Illinois, a portion of US 30 is non-designated between I-88 and Lincoln Highway. Trucks traveling east to west, must head west on I-88 at the intersection of US 30 and then take Lincoln Highway to connect back to US 30.

4. In the Chicago, Illinois I-294 runs parallel to the non-designated segments of US 20 in the suburbs of Northlake and Countryside.

5. US 30 through Joliet, Illinois has a non-designated portion. Heading from east to west on US30, trucks must take I-80 where it intersects with US 30 at New Lenox. Trucks would then take I-55 heading north and connect back to designated US 30 at Plainfield, Illinois.

6. The Detroit-Windsor Tunnel and Ambassador Bridge that connect the two cities are bottlenecks. The Detroit-Windsor crossings have no alternative routes, but there are plans in place to help alleviate the congestion and the non-designated truck route connections (Canada-Ontario 2002, MDOT 2004).

Figure 5.13 illustrates the inconsistencies of Straight Truck Length Regulation in the Upper Midwest Region. The Straight Truck Length Regulation has a different inconsistency pattern from other regulations as its inconsistencies are caused by various regulations imposed by states rather than the federally non-designated bottleneck constraints.

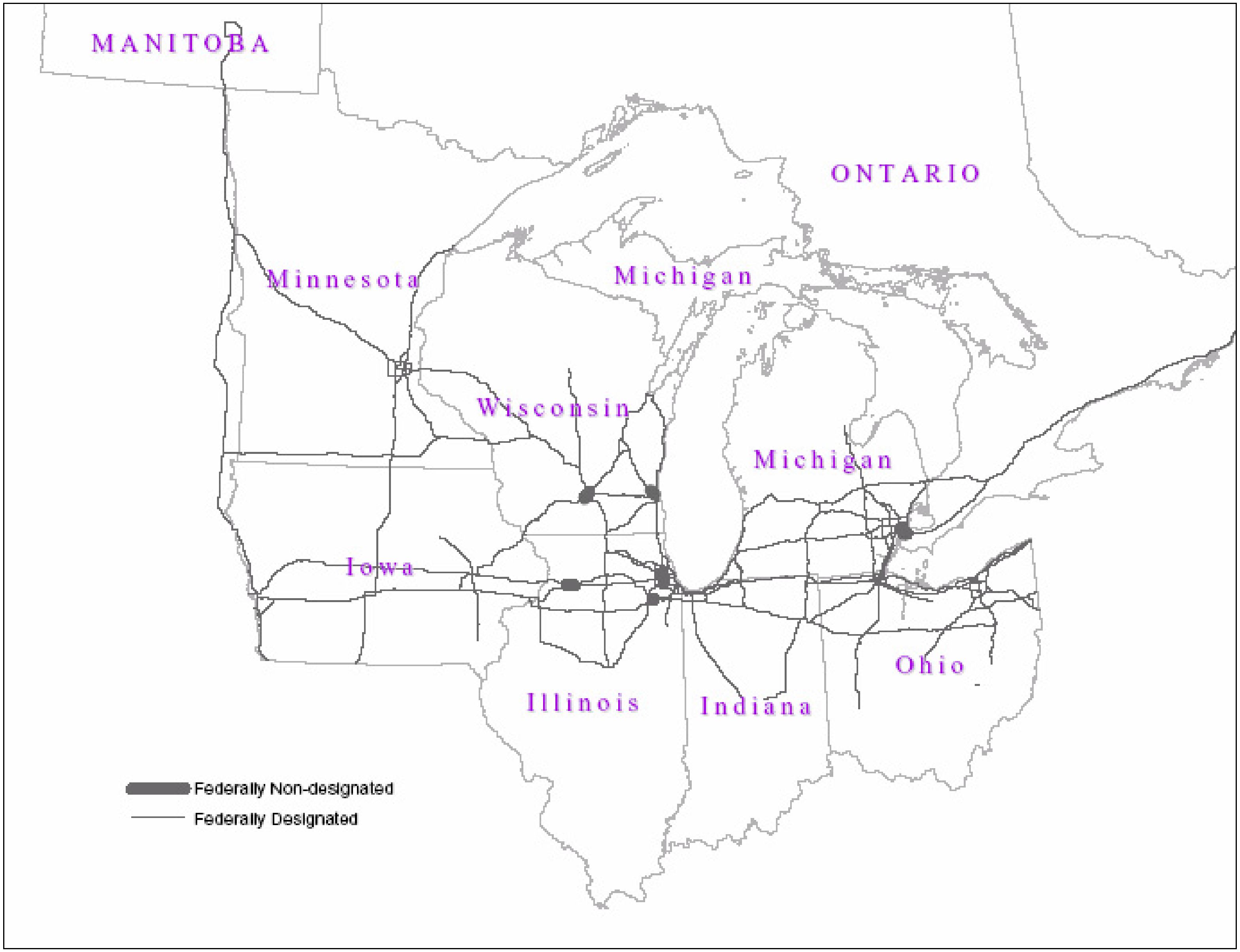


Figure 5.10 Federally Designated Status of the Selected Corridor Highways.

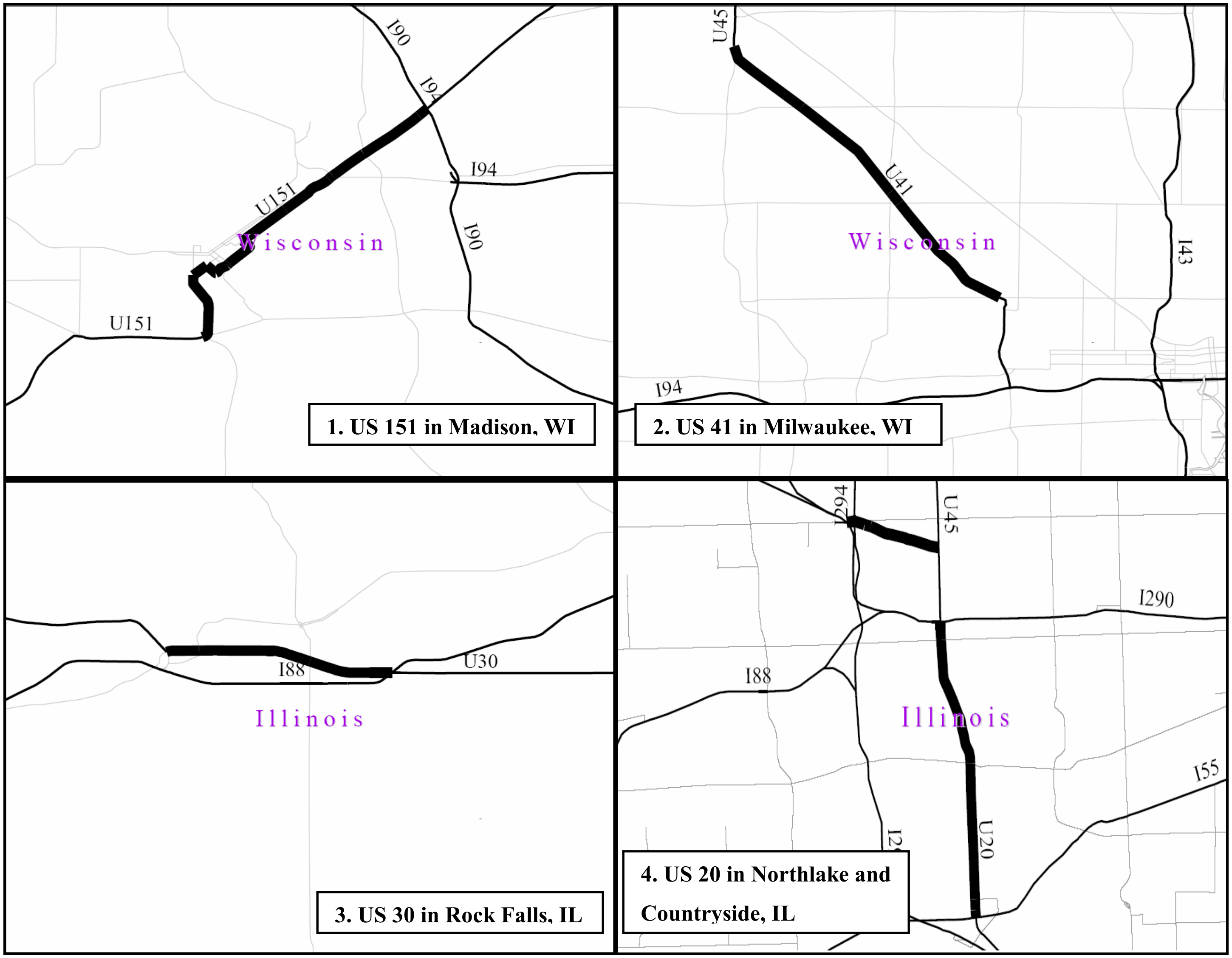


Figure 5.11 Zoom-in Views of Federally Non-designated Roadway Links on Study Corridor.

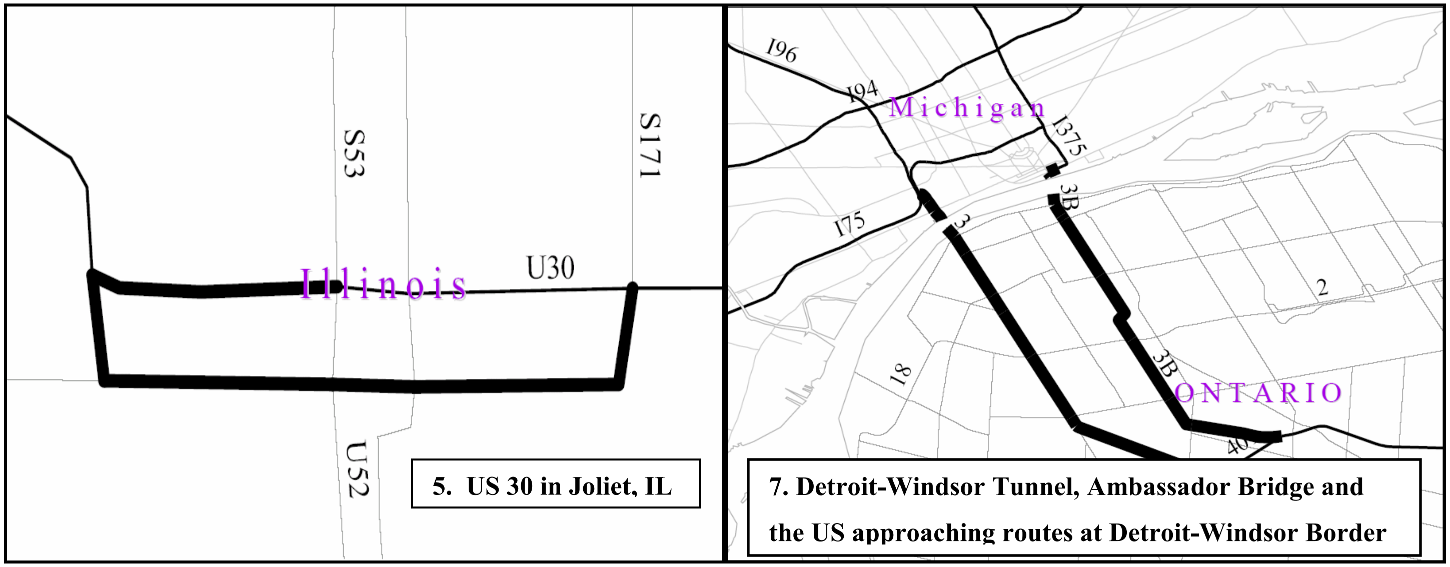


Figure 5.12 Zoom-in Views of Federally Non-designated Roadway Links on Study Corridor (continued)

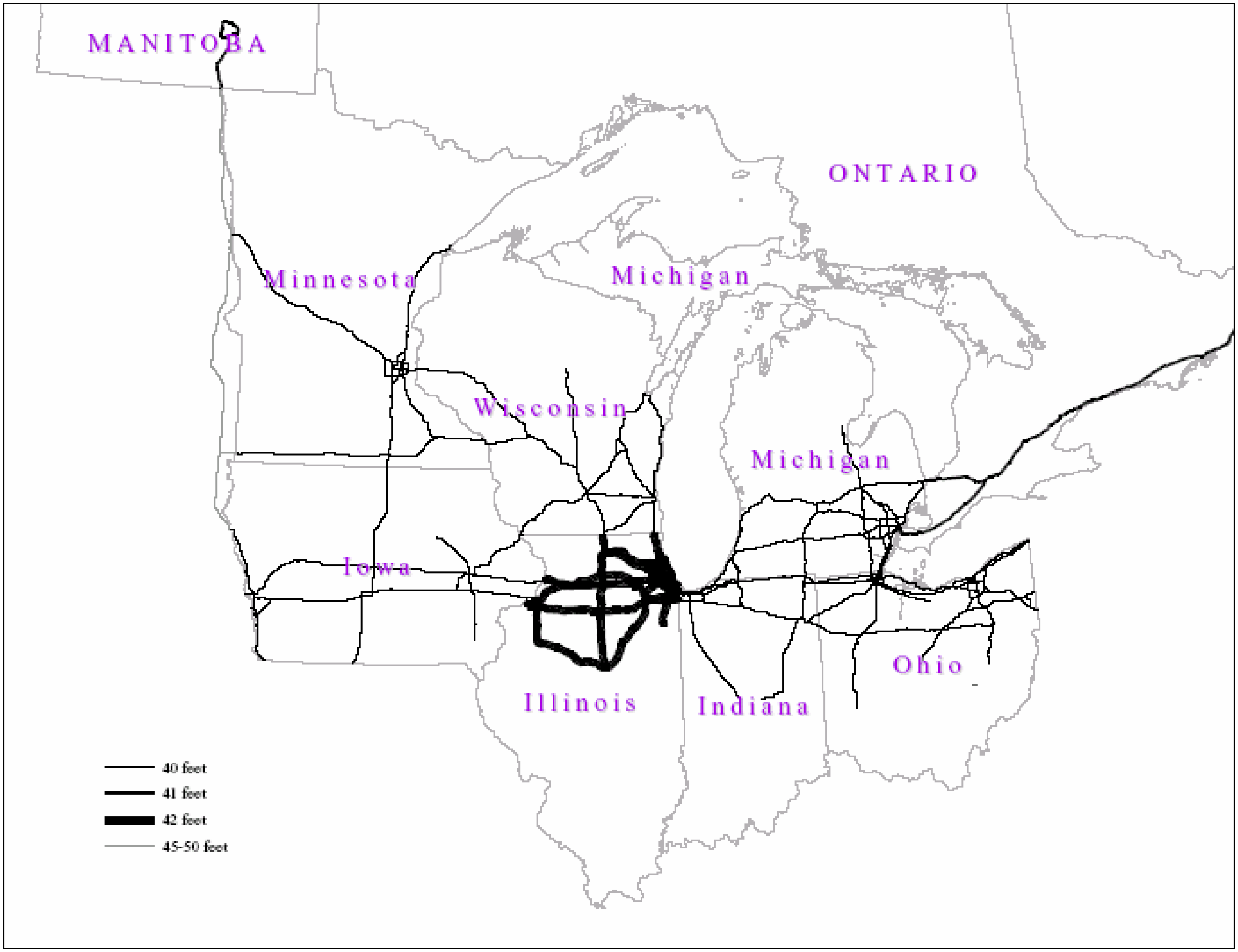


Figure 5.13 Straight Truck Length Regulation Map.

5.5.3 Maximum Speed Limits

Until the fuel crisis of the 1970s, states regulated the speed limits on highways. In response to the crisis, the federal government mandated a 55 mph maximum speed limit. The Surface Transportation and Uniform Relocation Assistance Act of 1987, allowed states to raise the maximum speed limits on their rural interstate highways from 55 mph to 65 mph. Rural interstates are defined by the FHWA as segments located outside areas with populations greater than 50,000 (Harkey and Mera 1994). Many states raised the maximum speed limits; some raised the limit for passenger cars but not for trucks (Garber et al. 2003).

In 1995, the federal government returned authority to the states to designate maximum speed limit. Since then, debate continues over Differential Speed Limit (DSL) for large trucks. Only 10 states have a DSL; four are in the Upper Midwest (Table 5.19) Figure 5.14 shows the maximum truck speed limits allowed on rural interstates and the speed limit differential for all states in the Upper Midwest.

Table 5.19 Speed Limits in the Upper Midwest Region.

Jurisdiction	Urban Auto and Truck (mph)	Rural (mph)		
		Auto	Truck	Speed Differential
Indiana	55	65	60	5
Illinois	55	65	55	10
Ohio	65	65	55	10
Michigan	65	70	55	15

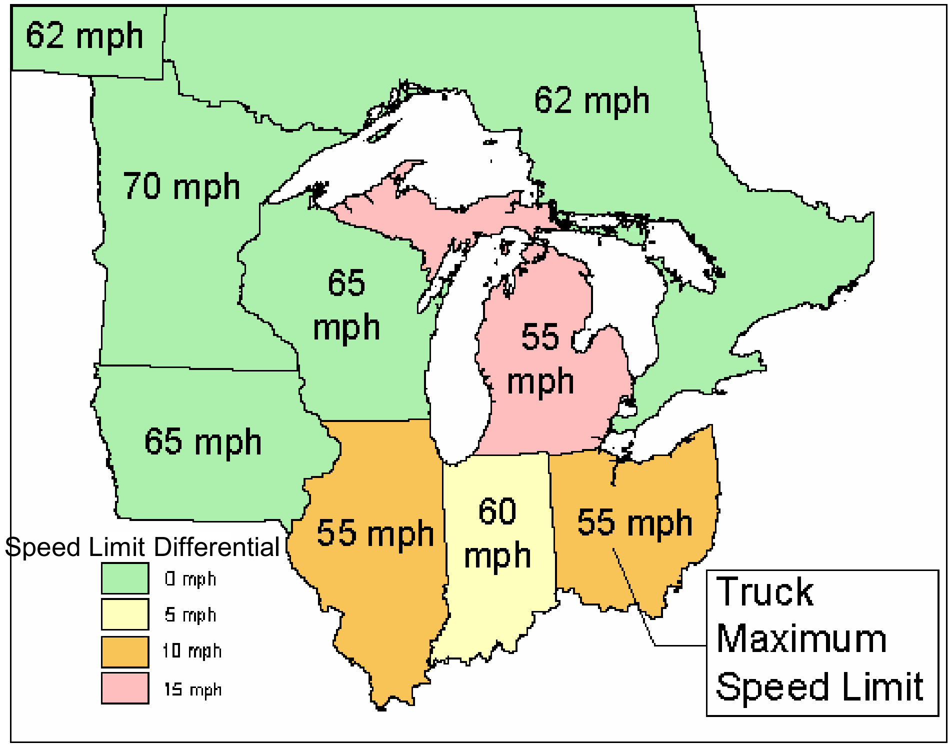


Figure 5.14 Maximum Speed Limits and Rural Interstate Differential Speed Limits.

The main argument supporting DSL is that large trucks are heavier than passenger cars and take longer to stop. Requiring that trucks travel at a slower speed will reduce the distance needed for large trucks to decelerate and completely stop thus crash risk will be reduced,(Garber et al. 2003). Also, with trucks traveling slower it is easier for smaller vehicle to pass them (Q&A@ 2004). Proponents of USL raise several other arguments. One is that the driver of the truck sits higher than a passenger car driver and sees a greater distance. The truck drivers therefore can see an object in the road and react sooner than passenger car drivers. Another argument is that DSL creates speed variances in vehicle speed, which increases the number of vehicles interactions and potential conflicts (Harkey and Mera 1994). A final argument for USL is that enforcement of DSL can be problematic (Reich et al. 2002).

Studies were conducted to determine the impacts of DSL and USL on speeding and accidents. One study showed that the 5 mph speed differential was not effective (Harkey and Mera 1994). The 65 mph speed limit for cars and 55 mph speed limit for trucks did show that the mean speed for trucks was lower with this 10 mph differential; however, the difference between the higher and lower speed groups was only 3 mph. The 10 mph speed differential also resulted in fewer trucks traveling above 70 mph. The same study found that states with a USL had a higher occurrence of truck into car accidents, such as sideswipe and rear-end collisions. Another study found that imposing a DSL of 10 mph did not reduce (Garber and

Gadiraju 1993) but rather could potentially increase accidents, especially on roads with a high percentage of trucks and a high Annual Average Daily Traffic (AADT).

The results are inconclusive over whether DSL or USL is safer. Both sides present compelling arguments in their favor, but there is insufficient evidence to make a definite conclusion.

5.5.4 Impacts of Truck Size and Weight Regulatory Inconsistencies

Regulatory inconsistencies impact freight movement when the freight shipment origin or destination is located within the region. The inconsistencies have no effect on freight movement that only passes through the region due to the uniformity of federal regulations on the interstate or designated roads. The inconsistencies may penalize regional trade movement, contribute to congestion, affect the efficiency of freight movement, and inhibit the ability of states to collaborate on regulatory enforcement, and pressure states to change their size and weight regulations. Regional trade shipments, however, could begin and end in locations where the roads are not designated. In that case, trucks must comply with jurisdictional size and weight standards, and cannot take advantage of the higher sizes and weights that the designated road system allows.

Congestion is another potential impact caused by inconsistencies. When non-designated portions of major highway freight routes appear, trucks are forced to find bypasses or routes that support designated loadings. This causes increased congestion on the alternative routes. Highway planners should consider these locations as potential sites of congestion abatement.

Efficiency of freight movement is measured three ways: equivalent truck loads, travel time, and operator cost. Equivalent truck loads compare the non-designated maximum of GVW, single axle weight, and tandem axle weight for each jurisdiction. Figure 5.15 graphically shows the non-designated maximum GVW weight equivalents. For example, a fully loaded truck in Wisconsin carries the equivalent of 1.09 fully loaded trucks in Minnesota because the GVW is higher in Wisconsin. As can be seen from Figure 5.15, travel across the region can be inefficient due to the mosaic of equivalent truck loads. Travel time is affected by trucks traveling on alternative routes or bypasses to avoid non-designated areas. In many cases, the alternative routes or bypasses are longer to travel and add time to the total trip. This in turn affects operator costs because the longer travel distance means increased motor fuel costs. In addition, operator cost increases whenever traveling to jurisdictions with lower GVW limits. Since less weight is hauled per truck compared to travel in jurisdictions with higher GVW limits, more trucks and truck operators are needed to haul the difference in weight, and that increases costs.

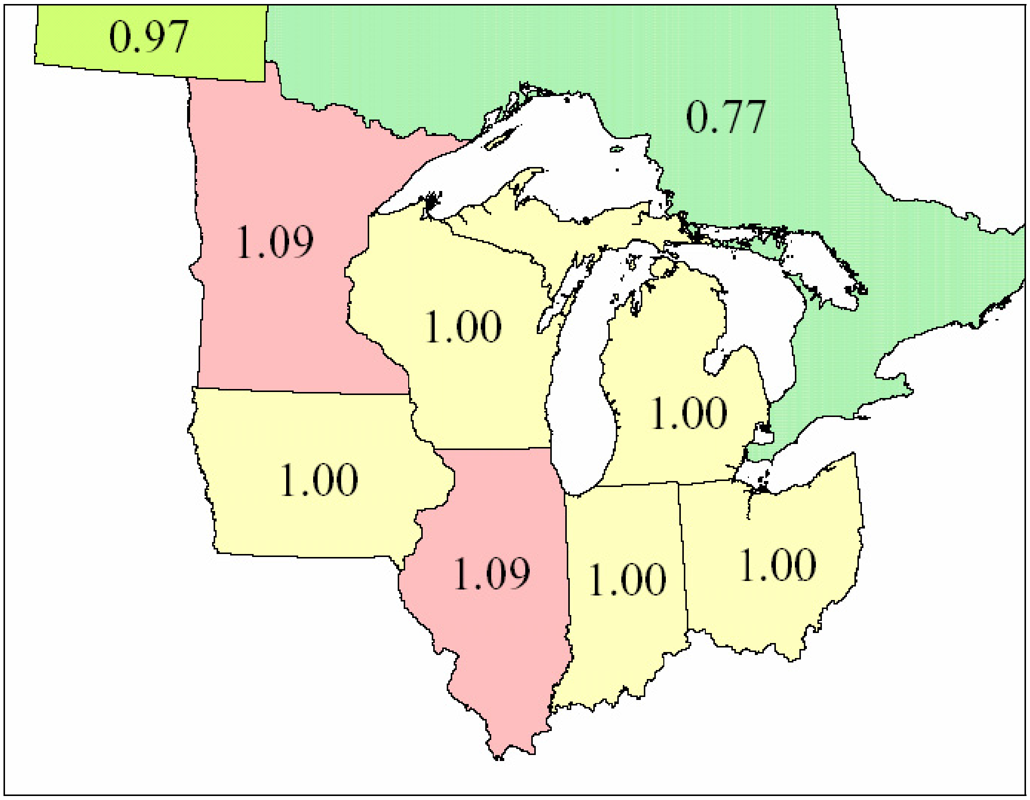


Figure 5.15 GVW Weight Equivalent.

Regulatory inconsistencies can inhibit the ability of states to cooperate on enforcement because an oversize or overweight truck in one jurisdiction could be legal in another. Motor carriers who abuse the size and weight regulations cannot be flagged in other jurisdictions for regulatory illegality when the regulations are different. States with lower limits are likely to have more violators who could potentially damage the highway infrastructure. A report published by AASHTO found that heavier truck weights incurred increased costs for pavement rehabilitation and maintenance (AASHTO 1995).

Another impact of regulatory inconsistencies is pressure to ratchet up weight limits. The higher regulatory limits in one jurisdiction tend to have an escalating effect on neighboring jurisdictions. The practice of maintaining grandfathered exemptions has the same effect. States are allowed to have their own size and weight regulations for their state funded roads. A semitrailer length that is grandfathered in one state may create pressure driven by trucking interests in adjoining states to allow the grandfathered length on their state roads. If enough surrounding states have a higher truck size and weight limit, truck interests may pressure the hold-out state to keep up and change their regulations for uniformity purposes. This scenario can be fairly common. A study completed in western Minnesota documented the effect of how neighboring states with higher weight limits were bypassing Minnesota interstates in order to avoid being weighed and caught (Hurley and Monson 2001). This study also outlined another opportunity for cooperation by streamlining weight enforcement strategies and overcoming inconsistencies in weight regulations.

5.6 Impacts of Regulatory Change

Changing the size and weight regulations to make them more consistent is one way to reduce inefficiencies in highway freight transport. Changing the regulations impact several different areas such as the highway infrastructure, motor carrier safety, traffic congestion, economic productivity, trucking industry and modal competitiveness, the environment, finance and energy, and compliance and enforcement. Table 5.20 lists the potential impacts of regulatory changes. These impacts can be measured quantitatively and associated costs can be estimated. Several studies were found that examined the potential impacts of changing truck size and weight limits. The scope of these studies include identifying federal and state regulations on truck sizes and weights; identifying current truck configurations; predicting future truck configurations, weights, and sizes dependent upon regulation changes; and identifying possible social, environmental, and economic outcomes dependent upon regulation changes. Most of these studies had recommendations as to how truck regulations should be changed.

Table 5.20 Impact Areas and Measures.

Impact Area	Impacts	Impact Measures	
		Quantitative	Cost
Highway Infrastructure	• Bridges • Pavement • Roadway geometry	• Bridge overstress • Load equivalency factors • Interchange and intersection improvement needs	• Bridge costs • Highway maintenance costs • Cost of geometric improvements • User costs due to delay for improvements
Motor Carrier Safety	• Vehicle stability • Rearward amplification • Off-tracking • Perceived safety	• Number of accidents: • Fatal • Personal injury • Property damage	• Accident costs
Traffic Congestion	• Passing • Speed maintenance • Differential speed limits • Lane changes	• Passenger car equivalents	• Congestion costs
Economic Productivity	• Commodity exemptions • LCV expansion	• Benefits to commodity and LCV industries	• Enforcement costs
Trucking Industry and Modal Competitiveness	• Effects on rail and waterborne modes • Truck VMT • Containers • Logistics	• Change in payload ton-miles for truck and rail • Change in truck VMT • Truck configuration, size, and weight	• Loss of future rail revenue • Truck logistics costs • Truck operating costs
Environment	• Air quality • Noise	• Pollutant emission burden	• Air pollution costs • Noise costs
Finance and Energy	• Energy use	• Change in truck fuel consumption	• Fuel tax revenue
Compliance and Enforcement	• State administration and enforcement requirements	• Permit issuance needs • Vehicle inspections needs	• State administrative and enforcement costs

Source: DOT Comprehensive Truck Size and Weight Study, 2000

Relating impacts of regulatory changes to the Upper Midwest Freight Corridor is very difficult. Data describing impacts of regulatory changes was usually given for the entire country and not for individual states. Finding and matching similar data from the Canadian provinces and the U.S. states was next to impossible due to the different agencies involved. Collecting the necessary data to determine, quantitatively, the impacts of regulatory changes is beyond the scope of this study and could be another study in itself.

5.6.1 Previous Studies

Truck size and weight regulations have been imposed since the 1950s. They have gone through many changes through the years and a number of studies, especially within the past 20 years, have been published concerning the various components of United States federal and state truck size and weight regulations. Various agencies have commissioned studies to identify and quantify impacts of truck size and weight regulations. These agencies include federal agencies such as FHWA, TRB, U.S. DOT, and state agencies such as state Departments of Transportation. Universities and other academia are also included. The scope of these studies include identifying federal and state regulations on truck sizes and weights; identifying current truck configurations; predicting future truck configurations, weights, and sizes dependent upon regulation changes; and identifying possible social, environmental, and economic outcomes dependent upon regulation changes. Most of these studies had recommendations as to how truck regulations should be changed in the future.

Longer Combination Trucks: Potential Infrastructure Impacts, Productivity Benefits, and Safety Concerns, a General Accounting Office (GAO) study, focused on Longer Combination Vehicles (LCVs), and determined the impacts of LCVs on highway infrastructure, safety, and the economy (GAO 1994).

The Productivity Effects of Truck Size and Weight Policies study focused on the theoretical increased use of LCVs and how it might impact logistics costs of the shippers. The researchers sent a survey to logistics shippers and used the findings to model the costs incurred by the shippers when using LCVs (Middendorf and Bronzini 1994).

The American Association of State Highway Transportation Officials (AASHTO) *Report of the Subcommittee on Truck Size and Weight* outlines truck size and weight policy recommendations. The report details the stakeholders, the major background topics in truck size and weight policy, the impacts from changes in truck size and weight, and the alternative proposals for future truck regulations (AASHTO 1995).

The North America Free Trade Agreement (NAFTA) Land Transportation Standards Subcommittee (LTSS) published the *Highway Safety Performance Criteria In Support of Vehicle Weight and Dimension Regulations: Candidate Criteria & Recommended Thresholds*. This draft report focuses on the differences in truck size and weight regulations between the three NAFTA countries and also discusses safety implications of changing truck size, weight, and configuration (NAFTA 1999).

The U.S. DOT *Comprehensive Truck Size and Weight Study* presented six illustrative scenarios of changing truck size, weight, and configuration. The impacts of implementing each of the scenarios on nine areas of interest were analyzed and discussed (U.S. DOT 2000).

The *Effects of Truck Size and Weight on Highway Infrastructure and Operations: A Synthesis Report* looks at the implications of harmonizing truck sizes, weights, and configurations between the U.S., Mexico, and Canada, and how liberalization of truck size and weight would affect infrastructure and safety (Luskin and Walton 2001).

The *Truck Weight Sub-Committee Final Report* of the West Central Minnesota Transportation Advisory Committee highlighted the problems of having limited truck size and weight enforcement and the damage caused to infrastructure by oversize and overweight trucks. The main objective was to formulate solutions to the problem of truck weight damage by focusing on the three E's: engineering, education, and enforcement (Hurley and Monson 2001).

The TRB Special Report 267 titled *Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles* evaluated and summarized previous truck size and weight studies. Options were offered as to how new truck size and weight regulations could be implemented as well as mitigation of these new regulations. The report developed six recommendations to make truck freight transportation more efficient and outlined ways regulations could be improved (Poirot 2002).

The National Cooperative Highway Research Program (NCHRP) Report 495, *Effect of Truck Weight on Bridge Network Costs* described the types of damage done to bridges and developed a methodology and algorithm to predict how bridge network costs would be impacted due to increased truck weights (Fu 2004).

5.6.2 Highway Infrastructure

Highway infrastructure includes bridges, pavement, and roadway geometry. These three main infrastructure components are what would be most affected by any change in truck size and weight regulations.

The Interstate system has been mostly completed and very few new roads and infrastructure will be added. New construction is taking the form of redesigning interchanges to incorporate new design standards or reconstructing worn out infrastructure. Changing truck size and weight regulations by introducing heavier and larger trucks could necessitate infrastructure reconstruction much sooner than design had called for. The cost to upgrade the infrastructure to accommodate heavier loads and larger size trucks is prohibitive. Several studies found an increase in truck weight would be detrimental to the existing highway infrastructure. "If heavier trucks are introduced, highway agencies will incur costs for replacement of bridges, more intensive bridge management and maintenance, and lost useful life of some structures. Construction necessitated by bridge deficiencies will cause highway user delay costs" (Poirot, et al. 2002).

Increased axle weight limits would also negatively affect highway infrastructure. "Increasing axle weight limits will generally result in higher pavement costs, since pavement costs increase sharply with axle weight" (U.S. DOT 2000). The AASHTO study found that bridge costs will increase with increased truck weights. "Many bridges on non-Interstate highways would become deficient if the maximum weights of vehicles operating on these highways are increased" (AASHTO 1995). Table 5.21 shows the bridge assets of the Upper Midwest Region. Most truck traffic uses the interstate bridges. However, most states show that almost a quarter of their total bridges are structurally deficient and functionally obsolete. This number could possibly increase if truck size and weight limits were raised.

Table 5.21 Highway Bridge Condition: 2002.

State	Total interstate bridges	Total bridges	Structurally deficient	Functionally obsolete	Total, structurally deficient and functionally obsolete	
Illinois	2,242	25,610	2,609	2,039	4,648	18.1%
Indiana	1,490	18,087	2,197	1,975	4,172	23.1%
Iowa	386	24,955	5,069	1,958	7,027	28.2%
Michigan	1,191	10,799	1,990	1,328	3,318	30.7%
Minnesota	697	12,845	1,208	575	1,783	13.9%
Ohio	2,292	27,988	3,273	3,799	7,072	25.3%
Wisconsin	1,117	13,563	1,713	888	2,601	19.2%
Total	9,415	133,847	18,059	12,562	30,621	22.9%

Source: BTS Summary State Transportation Profile, December 2003

5.6.3 Motor Carrier Safety

Changing truck size and weight regulations could affect vehicle stability resulting in unsafe highway conditions. Two common measures of vehicle stability are rearward amplification and off-tracking. Rearward amplification, a "crack the whip" effect, occurs when a LCV makes a sharp or sudden maneuver. The rearward trailer or axle will travel a greater distance from the middle of a lane in response to smaller steering movements made by the driver. This is very dangerous if another vehicle is present or the trailer moves into an adjacent lane. Off-tracking occurs during high or low speed turns where the rearmost axle of a trailer travels outside of its lane into an adjacent one. Longer trailers or allowing double or triple trailers could increase rearward amplification and off-tracking occurrences. The U.S. DOT study also found risk with weight increases. "Increases in the gross weight of a given multi-articulated truck combination will result in a modest increase in the rearward amplification level" (U.S. DOT 2000).

LCVs include vehicles such as triple trailers and turnpike doubles and are only allowed on certain roads in the Upper Midwest region. Figure 5.16 shows the roads that LCVs are currently allowed on. In order to operate a LCV, the driver must hold a Commercial Driver's License (CDL) and must take supplemental exams certifying their ability to operate LCVs. Because of the driver experience required to safely operate a LCV, an expansion of routes or number of LCVs in operation would require that the driver work force be able to support the experience needed for LCV operation.

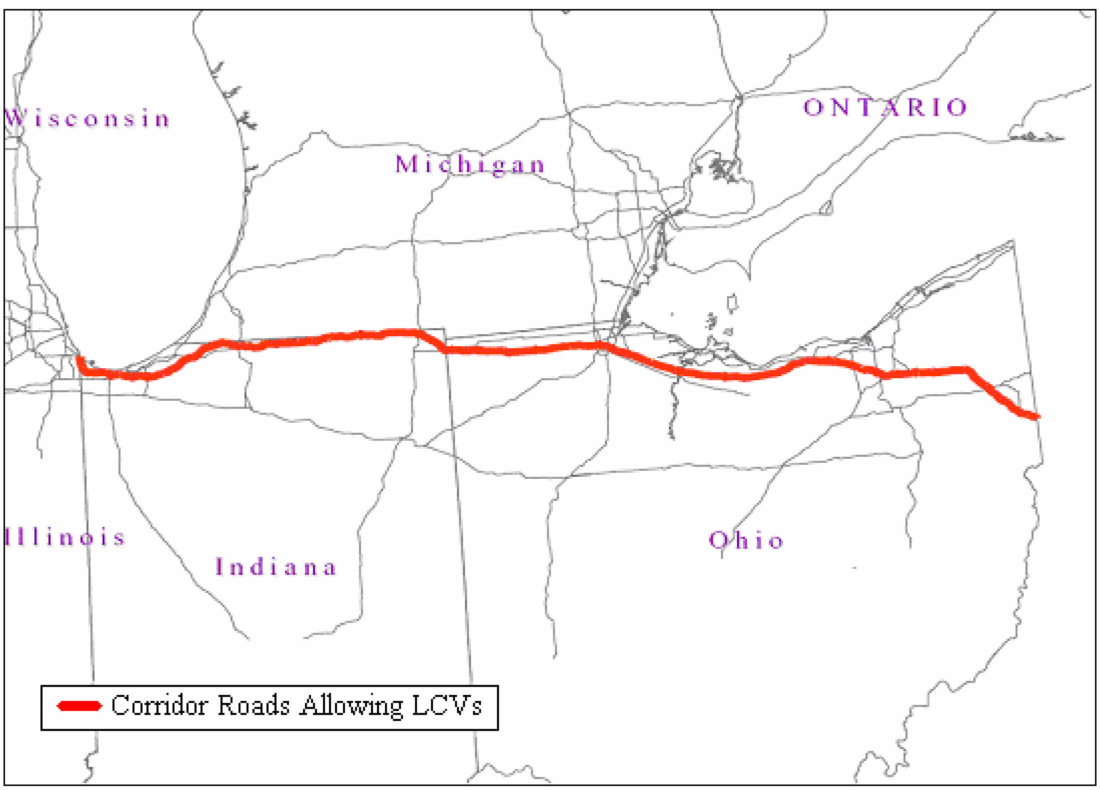


Figure 5.16   Upper Midwest Freight Corridor Roads Allowing LCVs

Another important aspect is the perceived safety concerns of automobile motorists sharing the road with large trucks. The AASHTO report shared this conclusion. "The most publicized impact is the perceived danger to small automobiles traveling in the traffic stream with the large and heavy truck" (AASHTO 1995).

Table 5.22 shows the statistics for accidents and fatalities involving large trucks in the Upper Midwest region. Increasing truck size and weight is presumed to impact the number of accidents and thus increase overall accident costs.

Table 5.22 2001 Highway Fatalities involving Large Trucks in the Upper Midwest Region.

State	Total	Percent of All State Highway Fatalities
Illinois	200	14.1%
Indiana	135	14.9%
Iowa	83	18.6%
Michigan	122	9.2%
Minnesota	64	11.3%
Ohio	166	12.0%
Wisconsin	108	14.2%

Source: FHWA http://www.nhtsa.dot.gov/people/Crash/crashstatistics/2001StateDateFatalities.htm

5.6.4 Traffic Congestion

Traffic operations include all aspects of the daily movement of freight on the highways. Changing truck size and weight regulations could affect traffic operations in passing maneuvers, truck speed maintenance, and truck lane changes. Truck speed maintenance is how well trucks can maintain their speed, especially on grades. The higher the GVW, the more difficult it is for the truck to accelerate and stop. This could become problematic in passing situations. What is the safest length and GVW for a truck to not cause congestion or have problems passing? These impacts can be measured in passenger car equivalents, meaning how many passenger car lengths equate to the length of the truck. Congestion costs are the main outcome.

The GAO study found that slower speeds for trucks pose a safety hazard. "Turnpike doubles, with their longer wheelbase trailers and fewer connecting joints, are more stable than triples, but these heavier LCVs are slower to accelerate and move with traffic. Unless tractor power is significantly increased, speed differentials can present a hazard in traffic, especially on grades" (GAO 1994).

Larger GVW or size will allow more freight to be carried per truck, thus reducing the number of trucks using the system. On the other hand, these larger or heavier trucks could have a more difficult time maintaining speed, accelerating, and decelerating, thereby causing congestion.

5.6.5 Economic Productivity

LCV expansion, while currently frozen by ISTEA, is desired by some trucking companies. Changing truck size and weight regulations to include LCVs would benefit the regional economy. With more LCVs on the highways, fewer truck tractors and drivers would be needed. This could be translated into savings for motor carriers. Trucking firms also would have a decreased logistics costs by switching to LCVs. “Given sufficient flows of a company's product in a lane, LCVs would generally have a positive impact on the total logistics cost of firms that currently ship in single trailer truckload quantities” (Middendorf and Bronzini 1994).

5.6.6 Trucking Industry and Modal Competitiveness

Generally, high weight and low value cargo is hauled by rail while low weight, time sensitive, and high value cargo is hauled by truck. By changing the truck size and weight maximums in the region, trucks could potentially haul heavier freight that traditionally was sent via rail. Factoring in the flexibility and faster movement of truck, the trucking industry could affect the number of rail operators in business or the length of rail in operation. Table 5.23 shows the number of railroads and miles operated in the Upper Midwest region. As of 2001 there were 125 freight railroads in the Upper Midwest region operating 41,619 miles of rail. These numbers could be affected by increasing truck maximum weight regulations. The rail industry is a major opponent to increasing truck weights because of research that suggests they will lose freight to the trucking industry. “If the gross vehicle weight limit is lifted, railroads will have the potential of losing 2.2 percent of their total traffic” (AASHTO 1995).

Table 5.23 Number of Freight Railroads by Class and Miles Operated: 2001.

State	Class I		Regional		Local		Total	
	Number	Miles	Number	Miles	Number	Miles	Number	Miles
Illinois	8	7,762	6	928	11	648	25	9,338
Indiana	5	3,816	2	56	17	924	24	4,796
Iowa	3	2,643	4	1,514	7	390	14	4,547
Michigan	4	2,228	3	783	9	1,101	16	4,112
Minnesota	3	6,646	6	1,072	8	704	17	8,422
Ohio	3	4,526	3	929	12	771	18	6,226
Wisconsin	3	1,832	4	1,833	4	513	11	4,178
Total	29	29,453	28	7,115	68	5,051	125	41,619

Source: BTS Summary State Transportation Profile, December 2003

5.6.7 Environment

The two main environmental impacts of changing truck size and weight regulations are noise pollution and air pollution. Noise pollution is caused by engine and tire noise. Table 5.24 shows the noise passenger car equivalents for large trucks. As can be seen at 60 mph, trucks are 14.16 times as loud as one passenger car. Or stated another way, it would take 14.16 passenger cars to make as much noise as one truck. Table 5.25 shows the amount of pollutants emitted for each jurisdiction based on truck VMT. Each year, large trucks emit over 1000 million pounds of air pollutants in the states of the Upper Midwest. The heavier the truck and the greater the VMT traveled, the more pollutants that are emitted.

Changing truck size and weight regulations could affect air pollution and two studies give examples of how. "It is easily understood that reducing the number of trucks on the highways (either by diverting freight to another mode or by increasing truck loads/decreasing vehicle trips) is a means to achieve air quality goals" (AASHTO 1995). "As the size and weight of trucks is increased, there will be a shift in the amount of freight carried from rail onto trucks. Since trucks are typically less fuel efficient (ton miles/gallon) and emit more pollutants (pounds/ton-mile) than rail shipments, this shift will tend to have a negative impact on the environment. Conversely, as size and weight limits are reduced, freight would shift from trucks onto rail having a positive environmental impact" (Battelle 1995).

Table 5.24 Noise Passenger Car Equivalents for Trucks.

Vehicle Type	Speed (mph)				
	20	30	40	50	60
Passenger Car	1.00	1.00	1.00	1.00	1.00
Truck	84.85	43.82	27.42	19.06	14.16

Source: DOT Comprehensive Truck Size and Weight Study, 2000

Table 5.25 Annual Air Pollutant Emission.

State	Total VMT (millions)	Annual Air Pollutant Emission (million pounds)			
		Nitrogen Oxides[1]	Particulate Matter (10)[2]	Volatile Organic Compounds (VOC)[3]	Sulfur Oxides[4]
Illinois	7,423	207.10	12.91	16.85	8.53
Indiana	6,401	178.59	11.14	14.53	7.36
Iowa	2,841	79.26	4.94	6.45	3.27
Michigan	4,461	124.46	7.76	10.13	5.13
Minnesota	2,327	64.92	4.05	5.28	2.68
Ohio	8,116	226.44	14.12	18.42	9.33
Wisconsin	3,094	86.32	5.38	7.02	3.56
Total	34,663	967.10	60.31	78.69	39.86
Large trucks emit: [1]0.0279 lb/VMT, [2]0.00174 lb/VMT, [3]0.00227 lb/VMT, [4]0.00115 lb/VMT					

Source: FAF, Truck ADT, 1998; DOT Comprehensive Truck Size and Weight Study, 2000

5.6.8 Finance and Energy

Financing highway departments is directly related to fuel consumption. Three ways that fuel consumption may be impacted are through more efficient vehicles, changes in the truck size and weight regulations, and changes in environmental pollution standards. The fuel tax is a major source of funds for transportation. Fuel tax is assessed per gallon, so more efficient vehicles that get more miles to the gallon pay less fuel tax than less efficient vehicles. Table 5.26 shows fuel tax rates of the jurisdictions in the region.

Table 5.27 gives a ballpark figure of how much jurisdictions earn from large truck fuel taxes. These numbers were found by multiplying the tax rate by the VMT, and then dividing by the fuel economy.

Changing truck size and weight will impact the energy use and fuel economy of the truck. These impacts can be measured through changes in truck fuel consumption and in fuel tax revenue. If increased truck size and weight regulations are introduced, there is the chance that fewer vehicles will be needed on the road to haul the same amount of freight. Fewer trucks means less VMT and less fuel tax revenue.

Environmental groups are lobbying for increased environmental standards that will force truck manufacturers to introduce trucks that use alternative fuels, and these fuels are currently not taxed by the government. Alternative fuels emit fewer pollutants than current diesel fuels. "If alternate fuels are required for air quality attainment, revenue from the current fuel-based user fees would erode" (AASHTO 1995).

Table 5.26 Motor-Fuel Tax Rates: 2001 (Cents per gallon).

State/Province	Gasoline	Diesel	Liquefied Petroleum Gas	Gasohol
Illinois	19.00	21.50	19.00	19.00
Indiana	15.00	27.00	0.00	15.00
Iowa	20.00	22.50	20.00	19.00
Michigan	19.00	15.00	15.00	19.00
Minnesota	20.00	20.00	15.00	20.00
Ohio	20.00	22.00	22.00	22.00
Wisconsin	27.30	27.30	20.00	27.30
Federal tax	18.40	24.40	13.60	13.10
Manitoba	27.75	26.30	13.75	21.72
Ontario	35.47	34.51	10.38	35.47

Sources: BTS Summary State Transportation Profile, December 2003, IFTA website, http://www.iftach.org/index50.htm

Table 5.27 Large Truck Fuel Tax Revenue from Diesel Sales.

State	Total VMT (millions)	Total Tax (Millions of dollars)[1]
Illinois	7,423	223.2
Indiana	6,401	143.2
Iowa	2,841	89.4
Michigan	4,461	93.6
Minnesota	2,327	65.1
Ohio	8,116	249.7
Wisconsin	3,094	118.1
Total	34,663	982.3
[1]Fuel Economy is 7.15 miles per gallon		

Source: FAF, Truck ADT, 1998; BTS Summary State Transportation Profile, December 2003; IFTA website http://www.iftach.org/index50.htm, Office of Energy Efficiency (2000)

5.6.9 Compliance and Enforcement

Enforcement of size and weight regulations is essential for safety reasons and to protect the investment in highway infrastructure. Heavy trucks are a large component of infrastructure degradation, which is why enforcement of axle and gross vehicle weights is so important. Overweight trucks without permits are illegal and cause infrastructure damage that everyone ends up paying for. Changing truck size and weight regulations could impact state administrative and enforcement requirements. This impact can be measured by tallying the permits and vehicle inspections needed. The state administrative and enforcement costs could also be used as a measure.

Table 5.28 and Table 5.29 indicate the number of vehicles weighed, the permits issued for overweight trucks, and fines for overweight violations in the Upper Midwest region. Increasing truck size and weight regulations could impact how many vehicles are weighed to check compliance. Overweight permits may no longer be as necessary.

Enforcement of truck weights is a problem. Changing truck size and weight is an added burden to state enforcers who must learn the new rules. There are also costs associated with illegal loadings. "According to the TRB *Truck Weight Limits* study, if all illegally overweight axle loads were eliminated and the volume of truck freight carried remained unchanged, highway agency pavement costs would decrease by $160 million to $670 million annually" (Poirot, et al. 2002). State fines could potentially make up the costs associated with illegal overweight vehicles. However, the amount of state fines for overweight violations does not account for infrastructure damage.

Table 5.28 Number of Vehicles Weighed and Citations Issued, and a Sample Fine: 2001.

State	Number Weighted	Citations Issued	Citations Issued (%)	Fine for a 4,000 lb overweight vehicle
Illinois	2,436,249	19,279	0.79	$347 in Cook Co., $365 everywhere else
Indiana	1,285,948	7,416	0.58	$1 - $1,000
Iowa	750,319	10,225	1.36	$130
Michigan	557,548	2,692	0.48	$360
Minnesota	465,183	3,159	0.68	$510
Ohio	6,330,496	23,931	0.38	$140
Wisconsin	383,300	4,138	1.08	$170
Total	15,209,043	70,843	0.47	-

Source: State Comparison of Enforcement http://www.ops.fhwa.dot.gov/freight/size_weight.htm, FHWA http://www.ops.fhwa.dot.gov/freight/freight_analysis/state_info/98fines.htm

Table 5.29 Permits Issued for Overweight Vehicles for Fiscal Year 2001.

State	Nondivisible Single Trip	Nondivisible Multiple Trip	Divisible Single Trip	Divisible Multiple Trip	Divisible Overwidth	Total
Illinois	131,776	0	0	0	0	131,776
Indiana	0	0	79,264	14,460	0	93,724
Iowa	44,277	561	0	121	0	44,959
Michigan	116,871	14,790	0	180	0	131,841
Minnesota	12,532	1,531	0	4,180	257	18,500
Ohio	96,738	4,313	2,367	18,366	0	121,784
Wisconsin	10,648	3,294	0	4,743	0	18,685
Total	412,842	24,489	81,631	42,050	257	561,269

Source: FHWA http://www.ops.fhwa.dot.gov/freight/freight_analysis/tables/table8.htm

5.7 Conclusions and Next Steps

Freight transportation, by road, rail, water, and air is governed by federal, state, and local regulations; cost; and technology and/or industry standards for the equipment and infrastructure.

Most freight in the Upper Midwest Region, like elsewhere in North America, is moved by trucks on highways. U.S. federal regulations govern freight vehicle equipment, maintenance, and operators on federally funded highways. U.S. federal regulations were enacted to promote efficient movement of freight on federally designated roads. Accordingly, freight trucks that pass through the Upper Midwest region can do so without regulatory problems by complying with the federal regulations and staying on the interstate or designated roads.

Regulatory inconsistencies in the region occur on non-designated state roadways and consequently, impact interstate freight movement within the region. Non-designated roads are subject to regulations imposed by state and local governments, which can vary from jurisdiction to jurisdiction and tend to be more restrictive than the federal regulations. Regulatory inconsistencies impact freight movement when the freight shipment origin or destination is located within the region. This may penalize the efficiencies of regional highway freight movement because trucks must comply with the lowest maximum limits and thus cannot take advantage of the slightly higher size and weight allowed on the designated roadway system.

Canadian provinces control truck size and weight regulations on Canadian roads. U.S. federal regulations are generally more restrictive than Canadian guidelines, thus trucks that are sized and weighted to travel in the U.S. will comply with the Canadian regulations.

Major regulatory inconsistencies in the region include the following:

- Minnesota and Wisconsin do not allow STAA doubles (two 28-28.5 foot trailers with max gross vehicle weight (GVW) of 40 tons) on non-designated state highways as do other jurisdictions in the Upper Midwest Region.
- The adjoining Indiana East-West Toll Road and Ohio James W. Shocknessy Turnpike accommodate longer combination vehicles (LCVs). This may be regarded as a freight travel enhancement for the region. However, the benefits of the enhancement might be increased by resolving the inconsistency in maximum allowable GVW and cargo size between these adjoining roadways.
- A standard five-axle truck tractor semi-trailer that complies with U.S. federal maximum weight regulations can legally travel on non-designated state highways in all Upper Midwest jurisdictions except in Minnesota and on some state roads in Illinois where lower weight limits are enforced.
- Most jurisdictions allow trucks to travel at the same speed as passenger vehicles on rural highways. Illinois, Indiana, Michigan, and Ohio enforce a differential speed limit (DSL) where the speed limit for trucks is up to 15 mph lower than for cars on rural highways.

- The fee structure for commercial driver's licenses (CDLs) and for required participation in the International Fuel Tax Agreement (IFTA) and Single State Registration System (SSRS) vary widely among the jurisdictions in the region.

The inconsistencies have no effect on freight movement that only passes through the region due to the uniformity of federal regulations.

Much research on impacts of regulatory inconsistencies focuses on highway freight transport. There is much literature that describes how changes in size and weight limits will impact physical, operational, safety, modal, environmental, and economic aspects of freight movement and highway travel. The Upper Midwest Freight Corridor Study looks specifically at identifying impacts of regulatory inconsistencies from a regional perspective by using the analysis of regulatory discontinuities and results of policy studies regarding impacts of regulatory change. Knowing the locations and impacts of the regulatory discontinuities within the region can help facilitate regional freight planning and help reduce inefficiencies, and thus costs, in the freight system.

Impacts of regulatory inconsistency are offset by regulatory change that will impact the performance of freight transport. Accordingly, the next step in further study of regulatory inconsistencies may focus on how regulatory changes affect freight performance. For example, allowing STAA doubles, adopting a single regional weight package, and removing speed limit differentials may increase the efficiency for freight transport and may impact safety.

Findings from a literature review suggest that differential speed limits (DSL) may impact the efficiency of freight transport across the region and impose an added enforcement burden for highway patrol with little impact on highway safety. Arguments in favor of DSL state that the distance needed for large heavy trucks to decelerate and completely stop is reduced and it is easier for cars to pass trucks on the highway. Arguments against DSL are that the driver of the truck sits higher than a passenger car driver and sees a greater distance. Eliminating DSL may reduce the need for cars to pass trucks and thus reduces vehicle interaction and potential collisions.

Each jurisdiction has a unique fee structure for covering administrative costs. Next steps should include a round table discussion for sharing information regarding administration processes. The jurisdictions may benefit from process improvement and the identification of opportunities for collaborative administration and enforcement.

Finally, the researchers recommend regional collaboration among the states of the Upper Midwest for deployment of CVISN/CVO technology such as electronic screening facilities at critical locations. States like Ohio and Illinois have upgraded almost all weigh stations to handle electronic screening whereas other states have just recently begun deployment process. Taking a regional perspective is an effective way to build upon what the states are doing to solve problems of regulatory compliance and safety in the region. States in the region should build a regional consortium for collaboration across current and emerging ITS/CVO project.

6 USAGE

This chapter documents the usage of existing facilities and the flow of freight within, through and between the states in the study area. The chapter begins with some definitions. It then goes on to discuss findings from the analyses of freight movements through the region as a whole, and by mode in terms of origins and destinations, commodities and facility usage. Additional usage data are provided in APPENDIX I.

6.1 Definitions

6.1.1 Usage versus Demand

Precisely speaking, the data presented in this report are classified as usage rather than demand. The theory of demand is derived from the economic theory of consumer choice (Morlok 1978). That is, we are distinguishing between the observed behavior (usage) and underlying potential with respect to the cost (demand) in terms of how and when goods are moved. Methodologically, this distinction is significant because while the data on usage can be obtained from the field data, the quantification of demand generally involves mathematical models that capture the relationships between the transportation and the socioeconomic system. While we are interested in understanding and predicting the underlying demand for freight transportation, it is beyond the scope of the study.

6.1.2 Measures of Usage

The usage data can be divided into two broad types according to how the data are collected and organized spatially. Segment or link specific data measure freight movements on specific links of the transportation network within the study area. Origin-destination data measure the totals flow between sources and destinations -- origins and destinations.

6.1.2.1 Link data

The link data are used as inputs to the capacity analysis and also the GIS database discussed in APPENDIX D. Ideally, this type of data captures all the freight volumes that travel on a particular link. The most common measure of link usage is the truck volume. The definition of trucks may vary among the data sources but mostly based on the gross weight and/or the number of axles. Most DOTs use FHWA's vehicle classification scheme (FHWA 2004g). Typically, classes 4 through 13 are included in the truck volume counts. In rare cases, tons or even the aggregated value of shipments transported on a particular link are reported. Such data are usually generated by the travel demand forecasting model.

6.1.2.2 Origin-Destination data

Origin-destination data are usually obtained from surveys of shippers, such as the Commodity Flow Survey (CFS), or carriers, such as the Railroad Waybill Sample. The survey data are expanded using statistically derived weights to produce the origin-destination information for the population (i.e. all freight movements). For this type of data, freight flow can be measured in weight, value, or vehicle trips. Following definitions are based on those used in the CFS (BTS 2004d):

- Value: The dollar value of the entire shipment. This is defined as the net selling value exclusive of freight charges, and excise taxes.
- Weight: The total weight of an entire shipment. Respondents reported the weight in pounds. Aggregated pounds were converted to short-tons (2,000 pounds).
- Ton-miles: The weight times the mileage for a shipment. For the CFS, the respondents reported shipment weight in pounds, and mileage was calculated as the distance between the shipment origin and destination ZIP Codes estimated by the computer model developed by the Oak Ridge National Laboratory. For shipments by truck, rail, or shallow draft vessels, the mileage excludes international segments. Aggregated pound-miles were converted to ton-miles (based on short tons).

These definitions apply throughout this chapter unless otherwise noted.

One of the difficulties associated with the collection and analysis of freight data is that there is no standard format for recording or reporting usage information. There are several reasons for that. To a large extent, the unit of measurement depends on the mode. For example, one of the common measures of freight movement on a highway link is the volume of trucks because it can be observed and measured directly while the information on the tons or values of shipments need to be collected from a roadside survey. Meanwhile, for a rail link, tons of freight is probably more widely available than the number of rail cars. In addition to the unit of measurement, the geographical boundaries used for data aggregation are often inconsistent. For example, the Commodity Flow Survey (CFS) aggregates the data by states and selected Metropolitan Statistical Areas (MSA) while the Waybill Sample uses the Economic Areas (EAs) defined by the Bureau of Economic Analysis (BEA 1995).

From the capacity standpoint, measures based on vehicles, including trucks, railcars, vessels, and airplanes, are usually more informative. On the other hand, for planning purposes, it may be more useful to know the weight or value of shipments. In spite of these inconsistencies, this study strived to gather as much usage data as possible regardless of the format and the unit of measurement because one of the main goals of this study was to catalogue all existing data and data sources. However, for the analysis of usage, tons, ton-miles, and value of shipments were the main units of measurement used for both link and origin-destination data. Those measures enabled us to make comparisons across different modes and also determine the aggregate flow of freight. States were used as the standard geographical level of aggregation for the analysis since it was the most commonly used boundary.

Based on the origin and destination, each trip can be classified into three types; intrastate, intra-regional, and external (Figure 6.1). In this study, these three types are used in a mutually exclusive manner.

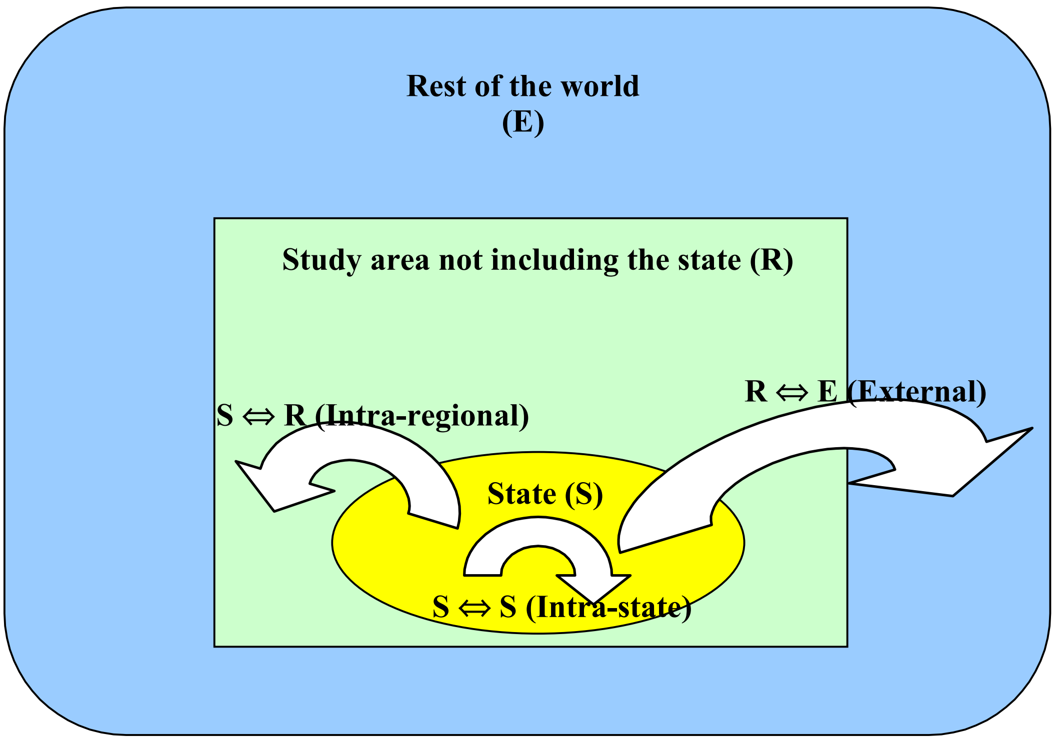


Figure 6.1 Trip Types Based on Origin-Destination.

It is possible to obtain the information on the origins and destinations of the vehicles that are traveling on a particular link. The information typically comes from a roadside intercept survey. However, most commercial demand forecasting software has the capability to extract such data on any link in the model. This type of information is commonly referred to as "select link" analysis. For the select link analysis, the origin and destination of each shipment can be categorized into one of the six types. Figure 6.2 represents the concepts used to define the groupings used in this study. It is possible to further aggregate the six types into three from a planning standpoint. The shipments that cross at least one state border but remains within the study area is defined as "Regional" type since addressing the freight traffic generated by those types of movements requires regional efforts. As shown in Figure 6.2, four of the six types are considered regional.

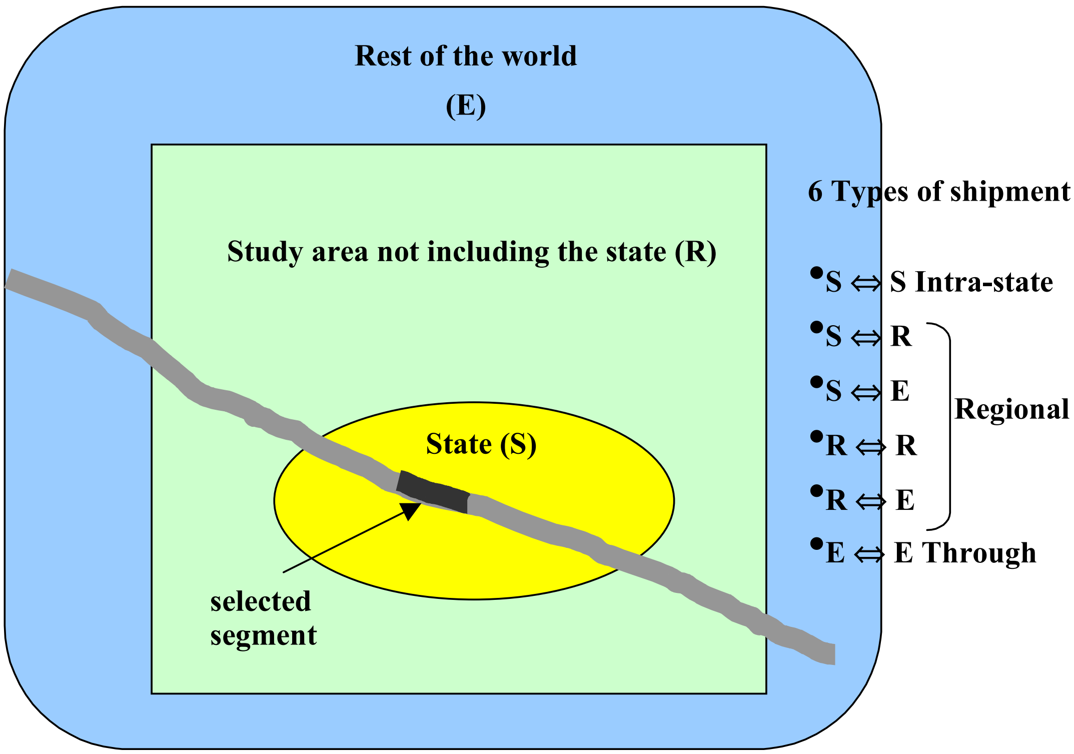


Figure 6.2 Trip Types Based on Origin-Destination - Select Link Analysis.

6.1.3 Commodities

Knowing which commodities move where and by what mode is essential for effective freight planning. To simplify the process, commodity codes are used. The number of digits used in a code represents the degree of specificity. Two types of commodity codes are used in this study.

For transportation data, the Standard Transportation Commodity Code (STCC) is commonly used to categorize the commodity transported. This classification code was developed in the early 1960s by the American Association of Railroads (AAR) to analyze commodity movements by rail only. (BTS 2004c)

The STCC code is a seven digit numeric code representing 38 commodity groupings. Most freight data either reports the 2, 3 or 4 digit STCC (RAILINC 2002). Both the FAF and Railroad Waybill Sample are based on the STCC classification.

The CFS uses another classification system called the Standard Classification of Transported Goods (SCTG). SCTG was jointly developed by agencies of the United States and Canadian governments (BTS 2004c). Prior to 1997, CFS data were collected and reported using the STCC code. CFS defines commodities as "products that an establishment produces, sells, or distributes. This does not include items that are considered as excess or byproducts of the establishment's operation. For the Commodity Flow Survey, respondents reported the description and the five-digit Standard Classification of Transported Goods (SCTG) code for the major commodity contained in the shipment, defined as the commodity with the greatest weight in the total shipment" (BTS 2004e).

In this study, SCTG at the 2-digit level of classification is mainly used. When FAF or Waybill Sample is examined, STCC classification, also at the 2-digit level, is used. The descriptions of SCTG and STCC codes are included in APPENDIX I.

It should be noted that there are some discrepancies among the data tables provided by the 1997 CFS. For example, the table that contains the types of commodity transported does not necessarily match exactly with the table for origin-destination information. Thus, the percentages given by the tables in this chapter may not match perfectly in some cases. However, the observations and insights are sufficiently robust and are not affected by those minor inconsistencies.

6.1.4 Modes

For the analysis of usage data, this study focused on five major modes; truck, rail, Intermodal (truck and rail), air and water. According to the 1997 CFS, these modes account for 86% of weight and 78% of value of all the shipments that either originate or terminate in the seven-state study area (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin). However, for some of the modes, such as air and Intermodal, a statistically adequate amount of data does not exist at greater levels of disaggregation.

Table 6.1 shows the definition for each mode as defined by the Bureau of Transportation Statistics (BTS). The total, as defined by the BTS, includes the shipments transported by the five aforementioned modes and also other modes such as pipeline, parcel, US Postal Service or courier (except for those transported by air or rail and truck combination), a combination of two or more modes (other than truck and rail), and other miscellaneous modes.

Table 6.1 Mode definition.

Mode	Description
Truck	Shipments using for-hire truck only, private truck only, or a combination of for-hire truck and private truck.
Rail	Includes common carriers and private railroads .
Truck and rail	Shipments using a combination of truck and rail
Air	Air service for shipments that typically weigh more than 100 pounds using commercial or private aircraft. Includes air freight and air express.
Water	Shipments using shallow draft vessel only, deep draft vessel only, or Great Lakes vessel only. Combinations of these modes, such as shallow draft vessel and Great Lakes vessel are included as Other multiple modes.
All	Shipments by the modes listed above and also pipeline, truck and water, rail and water, parcel, U.S. Postal Service, and other miscellaneous modes

Source: BTS 2004d

6.2 Data Sources

The study of usage began with the collection of the secondary data from various sources including state DOTs, regional planning agencies, municipalities, and the federal government. Because the main focus of the study is the assessment of the existing conditions, very little resources have been devoted to the prediction or estimation of the usage data.

6.2.1 Link Data

There are two common ways to obtain the link specific data. One is simply to collect the data from the field, either manually or using automated machines such as traffic recording devices. As discussed in Chapter 2, state departments of transportation, planning agencies, and municipalities are the main sources of the field data. Another approach used to obtain link specific data is to rely on the demand forecasting model or other estimation methods. For example, popular data sources such as Freight Analysis Framework (FAF), Transearch, and GeoFreight derive the link specific data by filling the gaps in the field data using a predefined algorithm (Battelle 2002b) or performing traffic assignment on the origin-destination data that were generated from the surveys and economic data (ORNL 2004). One advantage of this approach is the consistency between the origin-destination data and link data.

The data collection efforts for this study pursued both types of link data with a greater emphasis on the field counts. This is because for the existing condition, the validity of the field counts is superior to the data that were estimated by models. Also it was found that a considerable amount of field data were available from each of the participating states and provinces, and a single database to store those data under a common format would be extremely valuable for future planning efforts. Such databases already exist for FAF and GeoFreight.

Field counts on the study corridor roads were obtained in ArcView GIS format from all seven participating states. The data from Ontario were originally in TransCAD software, but were converted to the ArcView shapefile. As noted previously, the main source for the link data was the field data that were supplied by the DOTs. The alternative source of data was the FAF, which reports 1998 truck Average Daily Traffic (ADT) for the major roadways in the nation. However, for many segments, the FAF volumes are synthetic as they were derived from the volumes on the neighboring segments. Figure 6.3 depicts the difference between the truck ADT reported by the Illinois Department of Transportation and the 1998 truck ADT provided by the FAF. Although the DOT volumes are for 2000 and the FAF data are for 1998, the differences between the two data sets are substantial at many locations. In most cases, the FAF volumes exceed the DOT volumes.

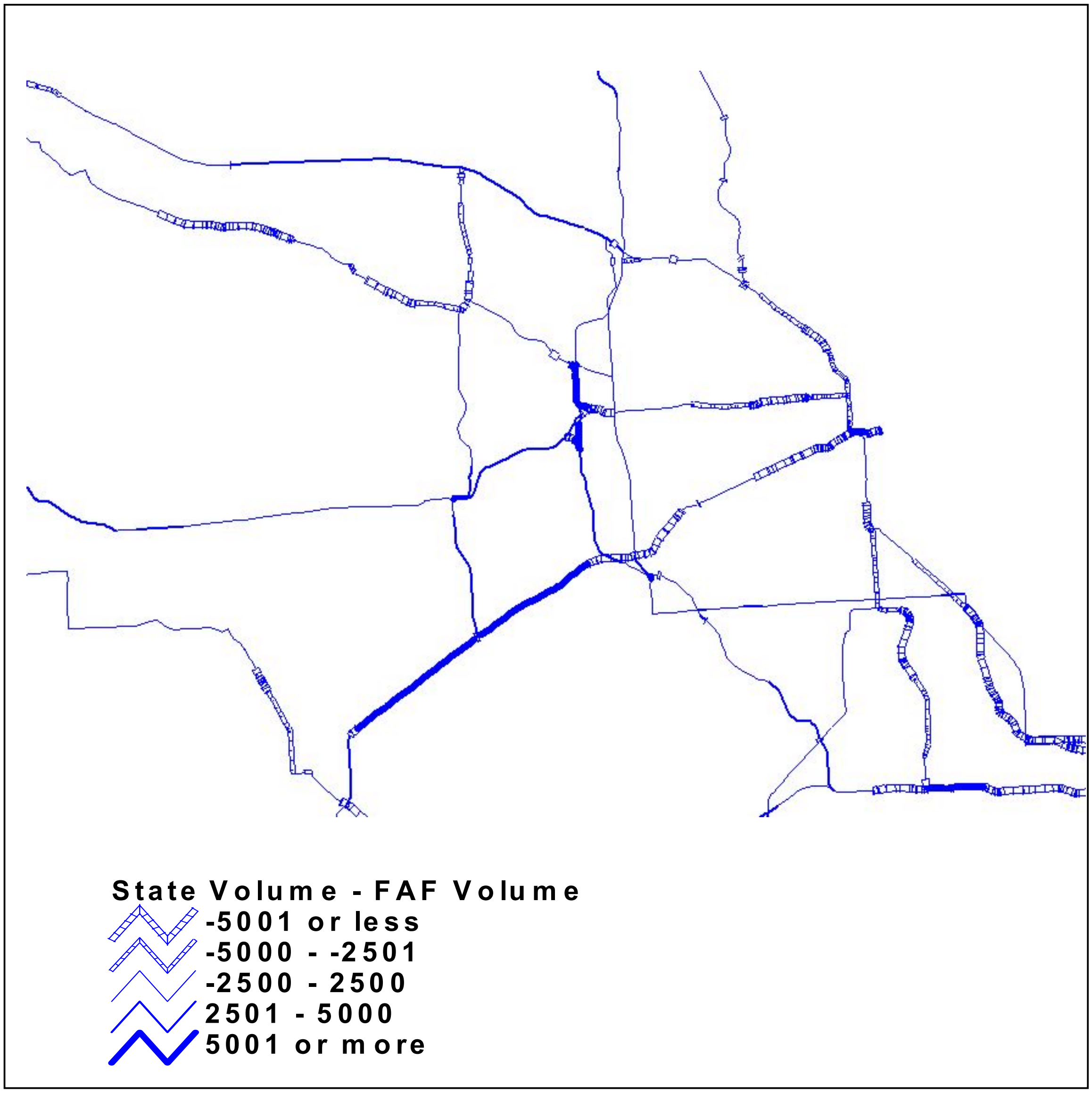


Figure 6.3 Comparison of Field Counted Truck Volumes VS. 1998 FAF Volumes - Chicago Region.

6.2.2 Origin-Destination Data

For the origin-destination data, the 1997 CFS served as the main data source, complemented by FAF, Railroad Waybill Sample (2002), 1999 Canadian National Roadside Study, Ontario Commercial Vehicle Survey, 2002 CFS, and US Army Corps of Engineers Inland Waterway database. At the present time only the preliminary data have been released for the 2002 CFS. The state-level data from the 2002 CFS are scheduled for release in December 2004.

When possible, the data from two different sources were cross-checked to assess the consistency and reliability. The comparisons between 1997 CFS and Waybill Sample data and also between 1997 CFS and FAF are detailed in APPENDIX I. The cross-checks indicated that while Waybill Sample and 1997 CFS match very closely, FAF and 1997 CFS showed a high degree of inconsistencies. The comparison revealed that the FAF reports, for each state, greater tonnage than the CFS. The differences also vary by state. For example, the CFS tonnage is 86% of that reported by the FAF for Illinois while it is 57% for Wisconsin and 66% for Iowa. The inconsistency can be explained by the fact that the FAF and CFS cover different populations. The FAF coverage is broader than that of CFS in the areas such as agricultural products and import from abroad.

The analysis of the Waybill Sample for the internal consistency, however, revealed problems associated with some of the variables including interchange location and the mode choice for Intermodal shipments. It was found that when the shipments between the EAs in the Northeastern part of the nation and those in California were extracted for a close examination, 83% of the records indicated no interchange (i.e. transfer of cargo between railroads) occurred. Since no railroad owns a contiguous route through the continent to make a rail shipment between the East and West coasts without an interchange, this indicates an inaccuracy in the data set. In addition, the examination of the mode choice between Intermodal and rail revealed that Intermodal accounted for only 0.3% of the total revenue and tons. According to the data published by the Association of American Railroads, Intermodal accounted for on average 22% of the total revenue of Class I railroads (AAR 2004). Also, 52% of the records were missing the mode choice information. These findings suggest a high rate of "item non-response" in the Waybill Sample. Even though almost all the records in the sample contain the information on some of the basic variables such as origin-destination, and commodity, many of the variables related to the mode choice and the locations and frequencies of interchange and transit of shipments are missing. Therefore, this study utilized Waybill Sample data in carefully selected situations for which the detailed geographical aggregation of the Waybill Sample relative to the CFS were required.

6.3 Role of the Upper Midwest Region

Freight either originating from or destined for the Upper Midwest region represents a significant portion of all freight movement in the United States. Chart 6.1 underscore the critical role the Upper Midwest region plays in the U.S. economy and also the movement of freight. While the figures vary depending on the measures used, the shipments with at least one of the trip ends within the seven-state study area account for roughly one-third of the total freight activity that occur in the U.S. Detailed data are provided in APPENDIX I. In terms of ton-miles, the share is 38.4%, which is considerably higher than one-third. Since approximately 19 % of the U.S. employment is located within the study area, the economic activities within the study area can be characterized as "freight intensive" compared against other regions. In fact, 27% of the manufacturing jobs in the U.S. are located within the study area (Woods & Poole 2003). Also, the shares of the national total vary significantly for each mode. For example, the study area accounts for a relatively lower share of air freight. However, for rail and especially Intermodal (truck and rail), the percentages are very high, reflecting the fact that most of the rail shipments that travel between the West Coast and East Coast must go through at least one interchange, most likely in the study area, because none of the railroads owns a contiguous rail network that covers the entire country.

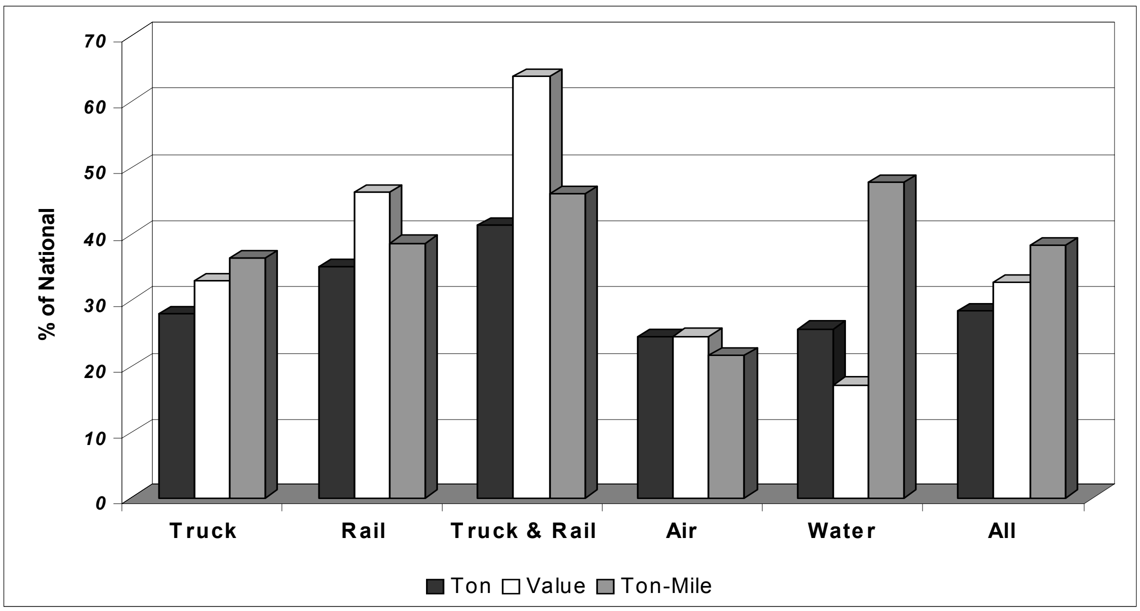


Chart 6.1 Share of the US freight shipments - shipments with at least one trip end within the study area.

Source: Woods & Poole 2003

Furthermore, as shown in Figure 6.4 and Figure 6.5, the unique geographical setting of this region, at the heart of the transportation network that connects the economic engines on the East, West and Gulf coasts of the U.S. and also the Eastern provinces of Canada, makes it critical to sustain the efficient movement of freight along the study corridor. It is no surprise that Figure 6.6, which depicts the tons of freight transported by water, highway and rail links, clearly illustrates the critical significance of the Upper Midwest region and also the study corridor for this nation's freight transportation network.

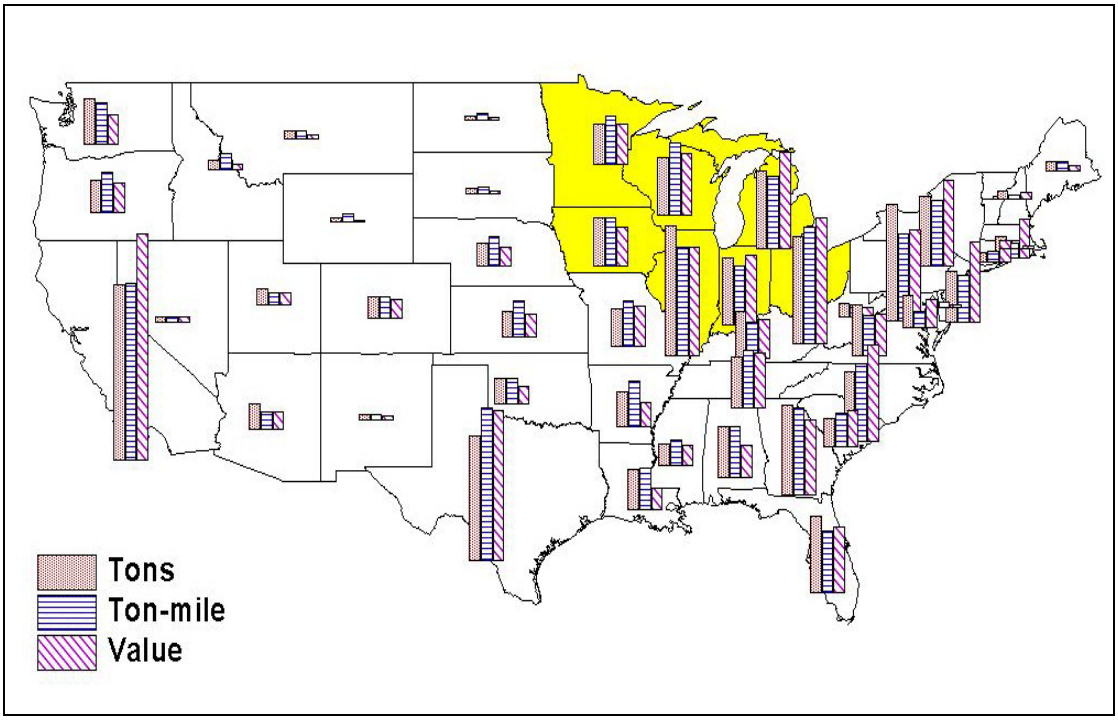


Figure 6.4 Freight Shipments Originating within Each State (percent of U.S. Total).

Source: 1997 CFS

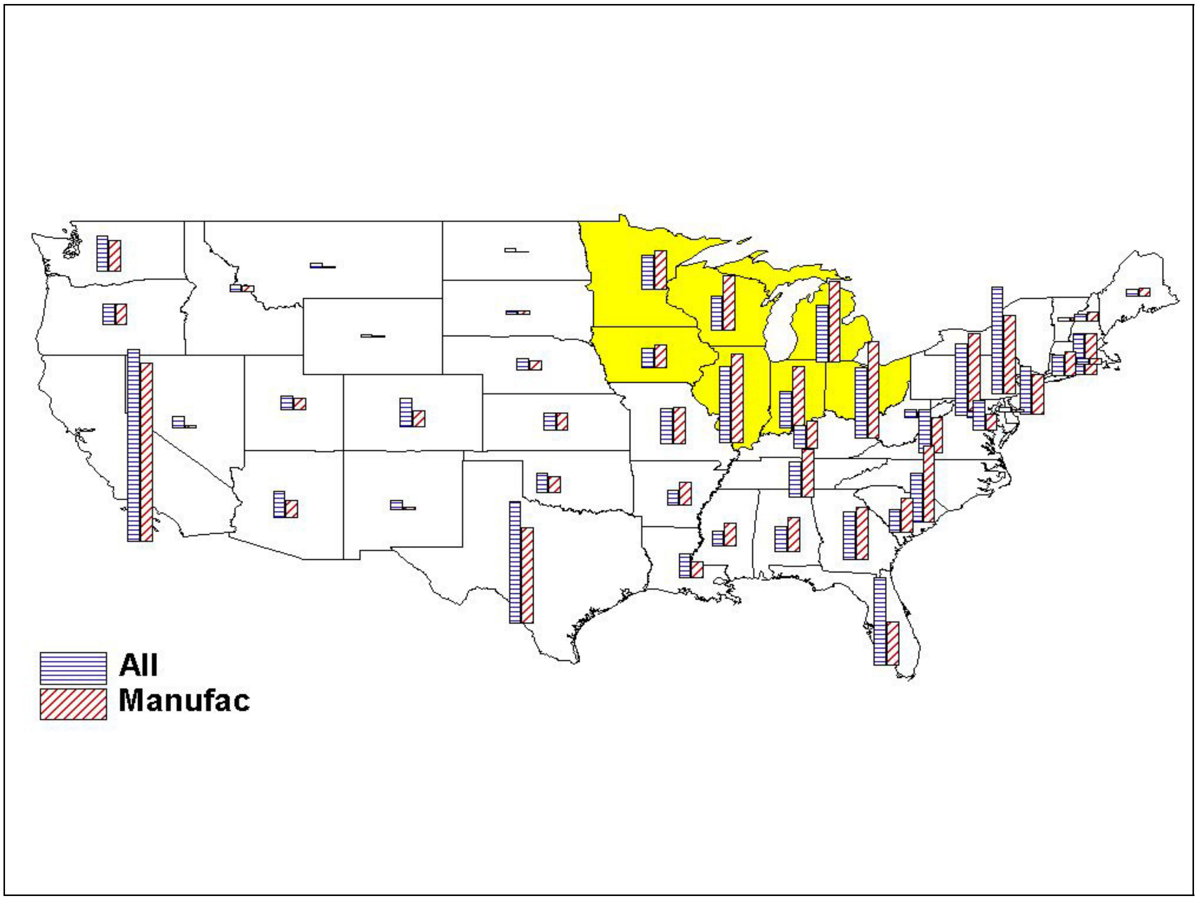


Figure 6.5 Employment in Each State (Percent of U.S. Total).

Source: Woods & Poole 2003

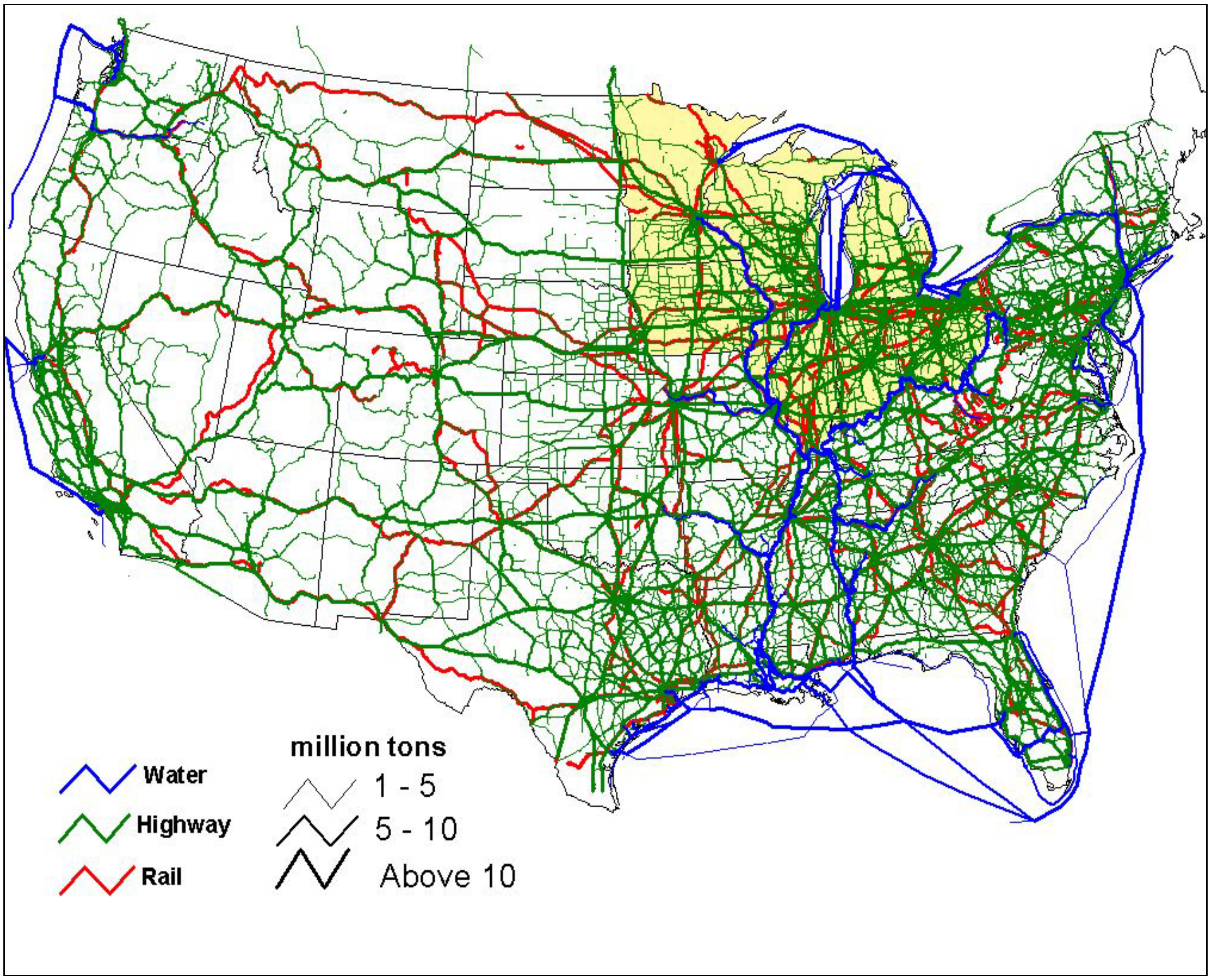


Figure 6.6 Link Tonnages - 1998.

Data Source: ORNL 2004

6.4 Link Data

As noted previously, the main application of the link data is the capacity analysis, which is discussed in Chapter 7. In addition, the massive number of traffic counts provided by the participating states were reconciled into a single GIS database by the University of Toledo team. The resulting database, which contains all the link volumes for the study corridor, is accessible over a dedicated Internet web site as described in APPENDIX D.

6.5 Analysis of Origin-Destination Data

In this section, the key findings from the analyses of the origin-destination data are discussed. The section begins with the analysis across all modes, then the trends within each of the five major modes are discussed.

6.5.1 Total Freight Activity and Modal Comparison

To understand how freight moves through the region this section explores the total freight activities in terms of tons, value and ton-miles of freight with destination and/or origin within the study area. Also, modal comparisons are made to understand the similarities and differences among the major freight modes. We also explore the types of commodities shipped and the relative value of commodities shipped. Additional data are included within APPENDIX I.

6.5.1.1 Mode Share

Table 6.2 and Table 6.3 show the shares of five major freight modes in terms of ton, value of shipment, and ton-mile. Table 6.2 looks at the shipments that originate within the study area, and Table 6.3 looks at the shipments that terminate within the study area. Since the figures for "All" modes include modes other than those listed in the table (e.g. pipeline, water and rail, etc.), the sum of the mode shares does not add up to 100%. The mode shares are generally similar to the U.S. figures that are included in the appendix with a few notable differences. The shares of the truck are slightly higher and the shares of water are lower for the study area. Surprisingly, the shares of the rail in Table 6.2 are lower than the national figures.

Comparing Table 6.2 with Table 6.3 reveals that except for the truck shipments, the flow of the freight for the study area is not symmetrical. For example, both ton and ton-miles of rail shipments that terminate within the study area are considerably greater than the shipments that originate within the study area. However, the values of shipments are almost identical in both tables. Different patterns of imbalance are observed for each mode except for the truck, which shows approximately symmetrical flow in both directions.

In both tables, truck is dominant in terms of weight and value of shipments transported. However, truck is responsible for less than half of the ton-miles. This suggests that truck trips are relatively short compared against other modes such as rail.

Table 6.2 Freight shipments with origin within study area - breakdown by mode.

Mode	Ton (Mode Share)	Value (Mode Share)	Ton-mile (Mode Share)
All	2,607 Million (100%)	$1,720 Billion (100%)	560 Billion (100%)
Truck	1,951 Million (74.8%)	$1,275 Billion (74.1%)	248 Billion (44.2%)
Rail	277 Million (10.6%)	$85 Billion (4.9%)	130 Billion (23.2%)
Truck & Rail	6.3 Million (0.2%)	$21.5 Billion (1.3%)	10 Billion (1.8%)
Air	0.3 Million (0.0%)	$17.1 Billion (1.0%)	0.3 Billion (0.0%)
Water	92.7 Million (3.6%)	$8.4 Billion (0.5%)	74.6 Billion (13.3%)

Source: 1997 CFS

Table 6.3 Freight shipments with destination within the study area - breakdown by mode.

Mode	Ton (Mode Share)	Value (Mode Share)	Ton-mile (Mode Share)
All	2,604 Million (100%)	$1,547 Billion (100%)	541 Billion (100%)
Truck	1,900 Million (73.0%)	$1,202 Billion (77.7%)	228 Billion (42.1%)
Rail	430 Million (16.2%)	$81.2 Billion (5.2%)	257 Billion (47.5%)
Truck & Rail	2.7 Million (0.1%)	$4.5 Billion (0.3%)	3.4 Billion (0.6%)
Air	0.3 Million (0.0%)	$20.3 Billion (1.3%)	0.3 Billion (0.1%)
Water	51.5 Million (1.9%)	$1.9 Billion (0.1%)	16.2 Billion (3.0%)

Source: 1997 CFS

6.5.1.2 Combined Analysis of Mode and Trip Type

In this section, the freight flow is analyzed in terms of both mode and trip types that were presented in Figure 6.1. Fifteen categories, representing the tons, value and ton-miles of shipments in Chart 6.2 through Chart 6.4 respectively are derived from five modes (truck, rail, truck & rail, air and water) and three trip types (S-S, intrastate; S-R, inter-regional; and S-E, external). As shown in Chart 6.2, intrastate truck shipments are by far the most important mode in terms of the weight of commodity transported, followed by regional and external truck shipments. As a whole, intrastate trip types account for roughly 70% of the total tons of shipments originating within the study area. However, as shown in the subsequent sections, low-value shipments such as gravel and non-metallic minerals account for about 30% of all the intrastate truck freight movements. Also, the trip lengths for those commodities tend to be very short (less than 50 miles on average). Consequently, the share of the intrastate trucking decreases considerably for the value of shipments (Chart 6.3). On the other hand, the longer truck shipments, such as regional and external, become critical. In fact, regional and external truck shipments account for about 52% of the total value of shipments. In terms of value, the intrastate shipments account for only 40% of the total. For ton-miles, shown in, external trips by rail, truck, and water play a dominant role, accounting for over 65% of the total.

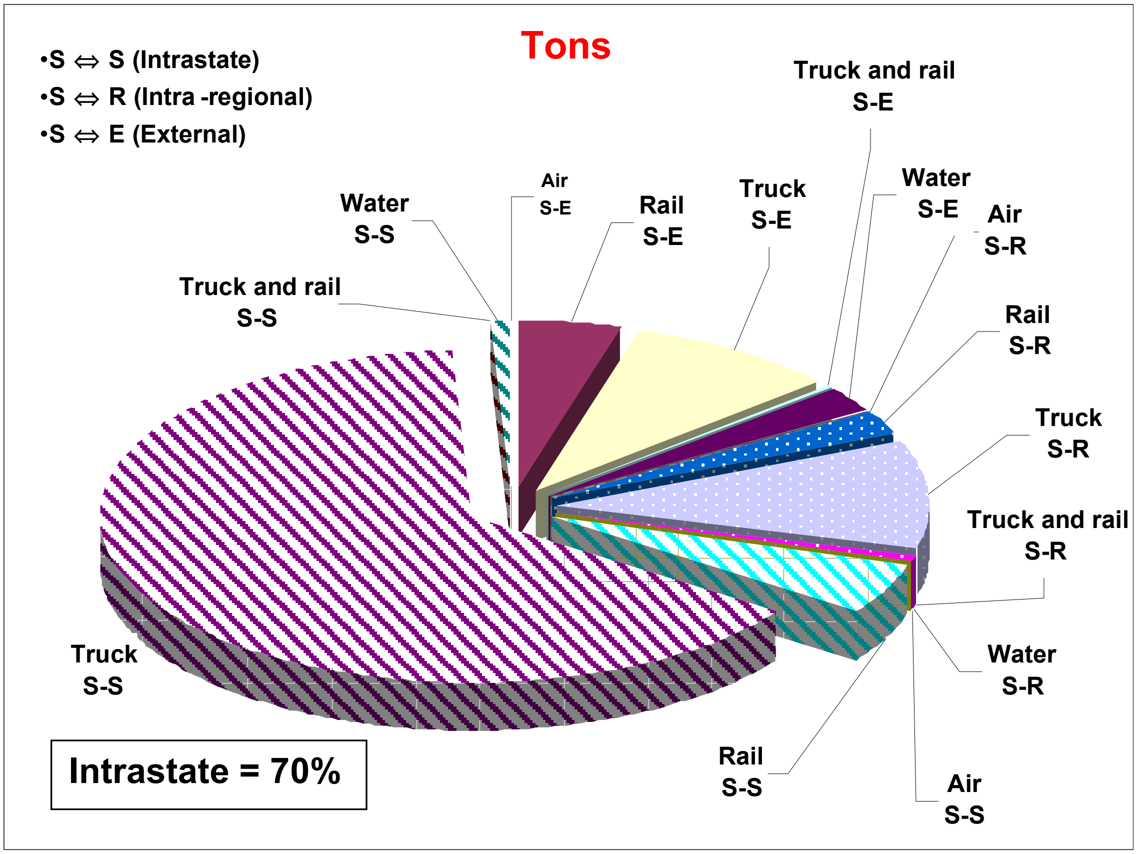


Chart 6.2 Breakdown of Freight Shipments with Origin within the Study area - by Tons.

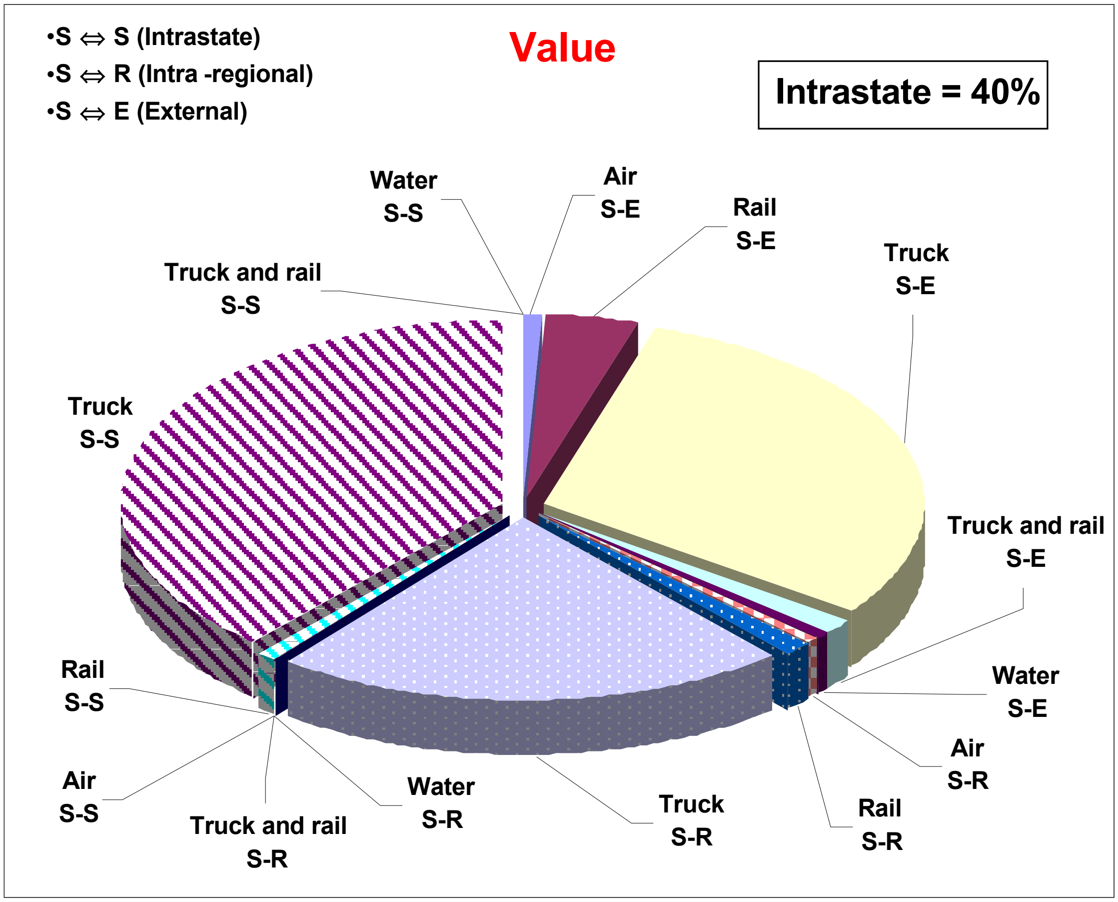


Chart 6.3 Breakdown of Freight Shipments with Origin within the Study area - by Value.

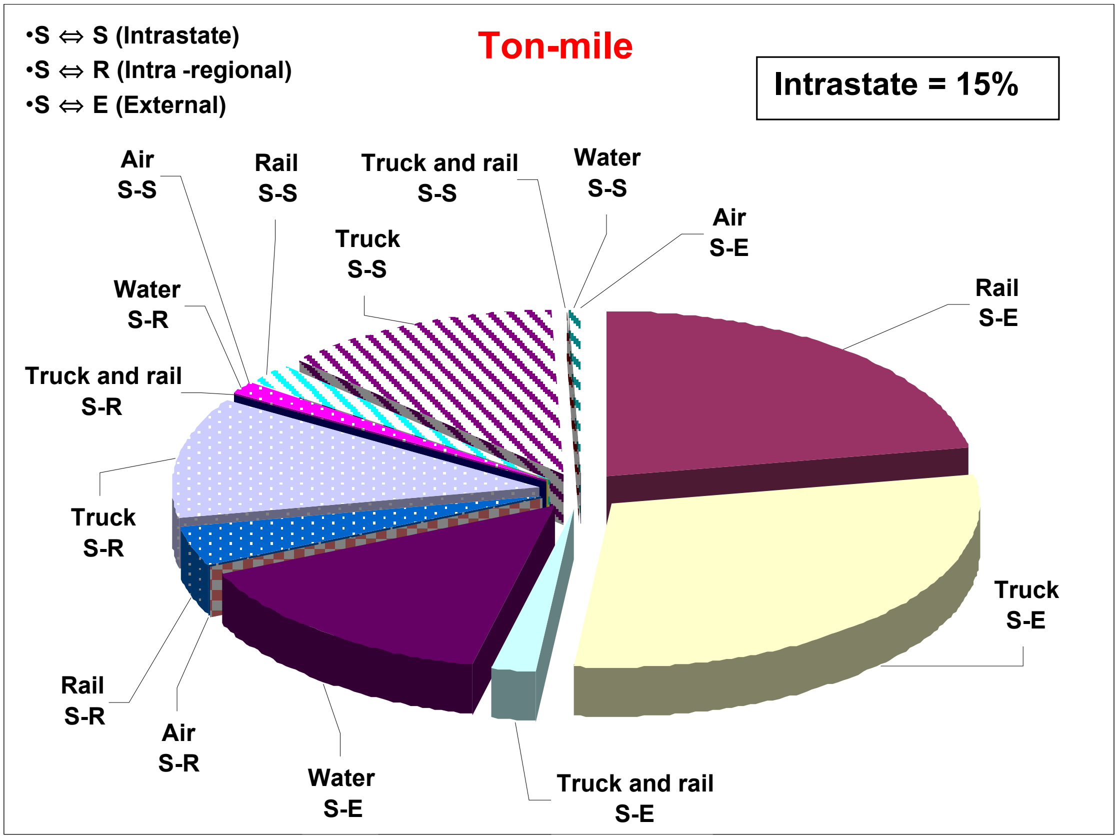


Chart 6.4 Breakdown of Freight Shipments with Origin within the Study area - by Ton-Mile.

6.5.1.3 Commodity Types

An analysis of the commodities commonly shipped from the study area provides some insight into the role transportation plays in supporting various industries and how the transportation system is used. Table 6.4 through Table 6.6 list top ten commodities for the shipments that originate within the study area by weight, value, and ton-miles, respectively. The most striking observation is that gravel and crushed stone, which accounts for over 21 % of total weight, does not even appear in the list for value. Since gravel and crushed stone is a low value commodity and the shipment distance tend to be short, this is consistent with the findings discussed in the preceding section. Table 6.5 shows that heavy industries, automotive in particular, are very important to the regional economy. According to the 1997 CFS, nationally, the commodity group "electronic and other electrical equipment and components and office equipment" account for the greatest share, at 12.7 % of the total value of shipments, and motorized and other vehicles (including parts) is second at 8.4%. The ton-miles, shown in Table 6.6, is the most relevant measure for determining the intensity of the usage of the transportation system. Cereal grains are the most prevalent commodity, followed by food products and metal products. The top three commodities account for over one-third, 34.3%, and the top ten commodities account for 68.3% of the ton-miles.

Table 6.4 Total freight flow with origin within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	458,007	21.83%
Base metal in primary or semifinished forms and in finished basic shapes	160,199	7.64%
Gasoline and aviation turbine fuel	155,249	7.40%
Cereal grains	146,443	6.98%
Nonmetallic mineral products	118,961	5.67%
Coal	117,426	5.60%
Other prepared foodstuffs and fats and oils	109,883	5.24%
Fuel oils	72,766	3.47%
Other agricultural products	69,661	3.32%
Coal and petroleum products	69,644	3.32%

Source: 1997 CFS

Table 6.5 Total freight flow with origin within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	261,114	17.19%
Machinery	143,239	9.43%
Electronic and other electrical equipment and components and office equipment	123,859	8.15%
Base metal in primary or semifinished forms and in finished basic shapes	108,724	7.16%
Other prepared foodstuffs and fats and oils	93,695	6.17%
Miscellaneous manufactured products	90,663	5.97%
Plastics and rubber	73,320	4.83%
Articles of base metal	66,638	4.39%
Chemical products and preparations	49,670	3.27%
Printed products	48,301	3.18%

Source: 1997 CFS

Table 6.6 Total freight flow with origin within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Cereal grains	64,941	15.9%
Other prepared foodstuffs and fats and oils	38,268	9.3%
Base metal in primary or semifinished forms and in finished basic shapes	37,128	9.1%
Metallic ores and concentrates	28,340	6.9%
Gravel and crushed stone	22,544	5.5%
Other agricultural products	21,664	5.3%
Motorized and other vehicles (including parts)	20,340	5.0%
Coal	19,793	4.8%
Animal feed and products of animal origin	13,976	3.4%
Milled grain products and preparations, and bakery products	12,790	3.1%

Source: 1997 CFS

6.6 Highway

In this section, the usage data related to trucking is presented. First, selected origin-destination data are discussed. Then, the findings from the link-based analyses conducted using the GeoFreight data (ORNL 2004) are presented. Additional data are provided in section four of APPENDIX I.

6.6.1 Origin-Destination Data

Table 6.7 and Table 6.8 show the top fifteen origin-destination pairs for the shipments that originate or terminate within the study area by weight and value, respectively. Not surprisingly, the data largely reflect the trends observed for the total freight movement, with even greater shares for the intrastate movements. The truck freight movements within Michigan and Ohio seem to be higher in value per ton than that in Illinois because the latter ranks only third in value while ranking first in weight. The top fifteen origin-destination pairs account for a considerable portion of the total truck freight, 76.6 % of tons and 42.2% of values. Thus, in general the market for trucks seems to be the short to medium distance shipments between relatively limited number of origin-destination combinations. Table 6.9 through Table 6.11 show the top 10 commodities originating in the study area based on weight, value and ton-miles. The data show that although gravel and crushed stone accounts for a considerable percentage of truck freight movements in terms of weight, its economic significance is negligible (0.3% of total value). Also, the comparison of Table 6.9 and Table 6.11 reveals that the trip length for the shipments of gravel and crushed stone is short because the share of the ton-miles is considerably lower than that for the weight. In general, the market for trucks, in terms of commodities, is surprisingly focused. Combined, the top ten commodities account for 60% to 70% of the tons, values, and ton-miles of the total truck shipments. Finished goods and machines account for a significant percentage of the freight flow in terms of value. Two commodities, metal products and food products account for over one-quarter of the total truck ton-miles.

Table 6.7 Truck freight flow with origin or destination within the study area - Top 15 origin-destination pairs by weight.

Origin	Destination	Weight (1000 tons)	% of Total
Illinois	Illinois	379,354	17.9%
Ohio	Ohio	284,135	13.4%
Michigan	Michigan	234,503	11.1%
Indiana	Indiana	176,,021	8.3%
Wisconsin	Wisconsin	165307	7.8%
Iowa	Iowa	139,062	6.6%
Minnesota	Minnesota	117,045	5.5%
Indiana	Illinois	20,543	1.0%
Illinois	Indiana	17,586	0.8%
Ohio	Michigan	17,015	0.8%
Michigan	Ohio	16,273	0.8%
Ohio	Pennsylvania	15,219	0.7%
Ohio	Kentucky	13,957	0.7%
Ohio	Indiana	13,433	0.6%
Indiana	Ohio	11,526	0.5%

Source: 1997 CFS

Table 6.8 Truck freight flow with origin or destination within the study area - Top 15 origin-destination pairs by value.

Origin	Destination	Value (in $million)	% of Total
Michigan	Michigan	129,165	8.0%
Ohio	Ohio	116,486	7.2%
Illinois	Illinois	108,199	6.7%
Wisconsin	Wisconsin	53,635	3.3%
Indiana	Indiana	49,115	3.1%
Minnesota	Minnesota	46,911	2.9%
Iowa	Iowa	36,746	2.3%
Ohio	Michigan	28,800	1.8%
Michigan	Ohio	19,241	1.2%
Indiana	Michigan	18,353	1.1%
Wisconsin	Illinois	15,065	0.9%
Indiana	Illinois	14,713	0.9%
Ohio	Indiana	14,556	0.9%
Illinois	Indiana	14,107	0.9%
Ohio	Illinois	14,086	0.9%

Source: 1997 CFS

Table 6.9 Truck freight flow with origin within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	404,525	26.1%
Base metal in primary or semifinished forms and in finished basic shapes	127,601	8.2%
Nonmetallic mineral products	112,114	7.2%
Gasoline and aviation turbine fuel	104,928	6.8%
Other prepared foodstuffs and fats and oils	90,434	5.8%
Cereal grains	73,906	4.8%
Coal and petroleum products	52,966	3.4%
Animal feed and products of animal origin	48,421	3.1%
Natural sands	46,817	3.0%
Fuel oils	45,244	2.9%

Source: 1997 CFS

Table 6.10 Truck freight flow with origin within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	152,567	14.1%
Machinery	111,346	10.3%
Base metal in primary or semifinished forms and in finished basic shapes	95,425	8.8%
Other prepared foodstuffs and fats and oils	83,909	7.7%
Electronic and other electrical equipment and components and office equipment	72,452	6.7%
Plastics and rubber	60,821	5.6%
Miscellaneous manufactured products	58,071	5.4%
Articles of base metal	50,932	4.7%
Chemical products and preparations	41,604	3.8%
Meat, fish, seafood, and their preparations	33,029	3.0%

Source: 1997 CFS

Table 6.11 Truck freight flow with origin within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Base metal in primary or semifinished forms and in finished basic shapes	23,506	13.4%
Other prepared foodstuffs and fats and oils	20,952	12.0%
Gravel and crushed stone	10,409	5.9%
Motorized and other vehicles (including parts)	10,064	5.7%
Nonmetallic mineral products	9,908	5.7%
Chemical products and preparations, n.e.c.	8,435	4.8%
Plastics and rubber	8,073	4.6%
Milled grain products and preparations, and bakery products	6,903	3.9%
Machinery	6,832	3.9%
Articles of base metal	6,814	3.9%

Source: 1997 CFS

6.6.2 Select link analysis

Select link analysis show, for any selected link of a roadway, the origins and destinations of the freight shipments that are transported on that link. The Geofreight package, developed by the Oak Ridge National Laboratory for the U.S. Department of Transportation in 2001 (ORNL 2004) is a graphical data interface and also a decision support tool for freight planning. The select link analysis capability of Geofreight was used to derive the data presented in this section. The data in Geofreight come from the freight traffic assignment model developed by the Oak Ridge National Laboratory.

Figure 6.7 and Table 6.12 shows the locations of the links for which the analyses were performed. All the locations, except for location K, a section of I-75 at the Michigan and Ohio border, are on I-90, I-94, or I-80 within the study area. The locations were chosen to give a uniform coverage of the key locations along the study corridor. Detailed analysis results for each location are included in the section A.5. of the Appendix J.

Figure 6.8 and Figure 6.9 show the breakdown of shipments by three types of movement (regional, intrastate and through traffic), discussed in Subsection 6.1.2.2, based on weight and value. Both figures generally share the same trends. At the points along I-90, I-94, and I-80, typically 15% to 30% of the truck shipments are through movements. Also, the shares of the intrastate shipments are typically less than 10%, except at I-94 near Minneapolis, where the intrastate shipments account for 18% of value and weight. The remaining share at each location, which typically ranges from 60% to 80%, is regional in nature.

At individual locations, however, some unique characteristics can be observed. For example, not surprisingly, the segment of I-94 between Chicago and Milwaukee mostly carries regional and intrastate movements. The low percentages of through movement at the locations in Michigan, C and K, can be explained by how the destination or origin are recorded for the international shipments. In Geofreight, the origin and/or destination for the international shipments is recorded as the US state where the shipment entered or left the country. Thus, the origins for the shipments that enter the study area from Ontario are likely to be recorded as Michigan.

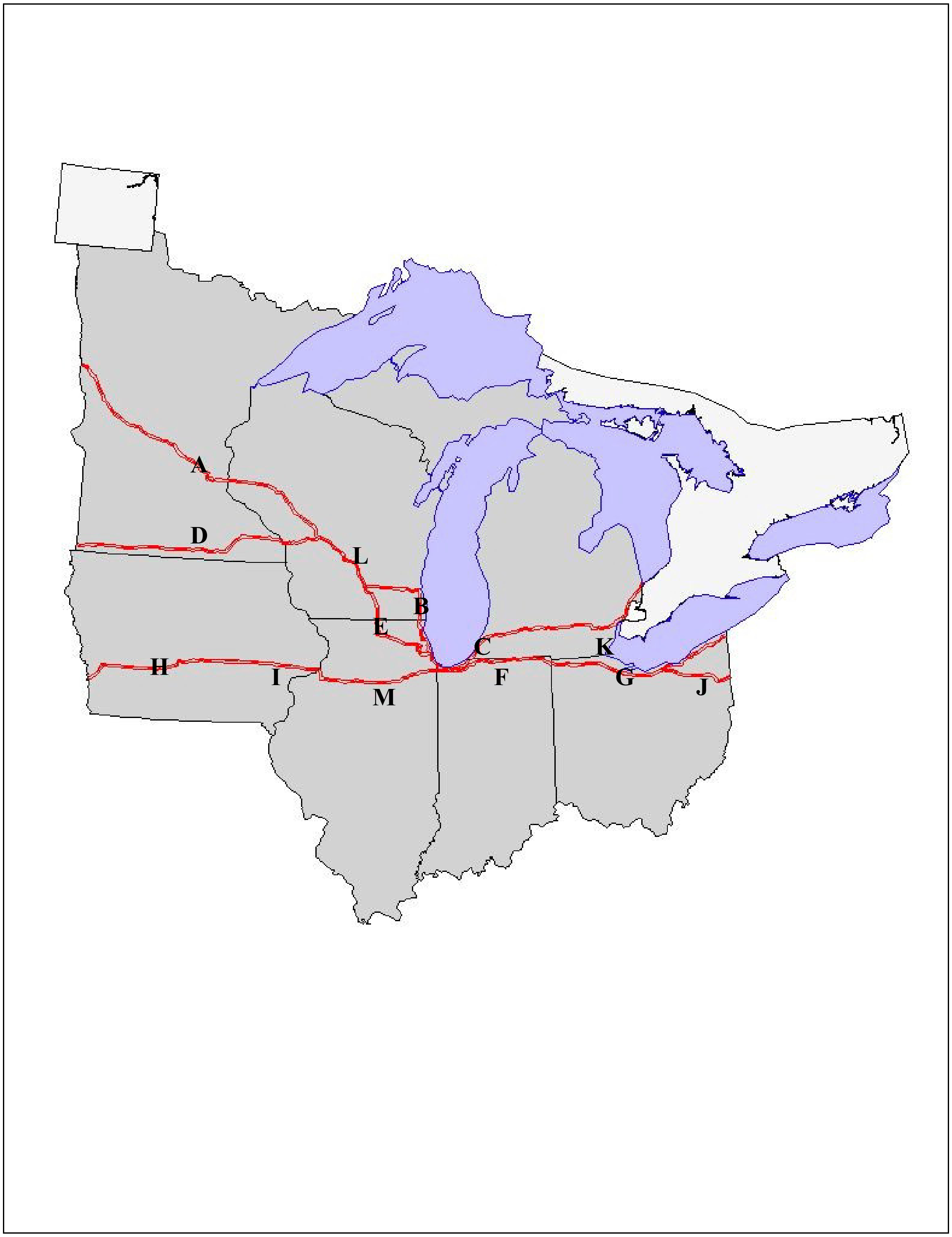


Figure 6.7   Locations of select link analysis.

Table 6.12 Description of select link analysis locations.

Analysis location	Description	State
A	I-94 West of Minneapolis	MN
B	I-94 South of Milwaukee	WI
C	I-94 at South of Benton Harbor	MI
D	I-90 West of I-35 Interchange	MN
E	I-90 at South of Madison	WI
F	I-80/90 East of South Bend	IN
G	I-80/90 Near Norwalk	OH
H	I-80 West of Des Moines	IA
I	I-80 West of Davenport	IA
J	I-80 North of I-76 Interchange	OH
K	I-75 North of Toledo	MI
L	I-90/94 East of 90/94 Split	WI
M	I-80 East of I-39 Interchange	IL

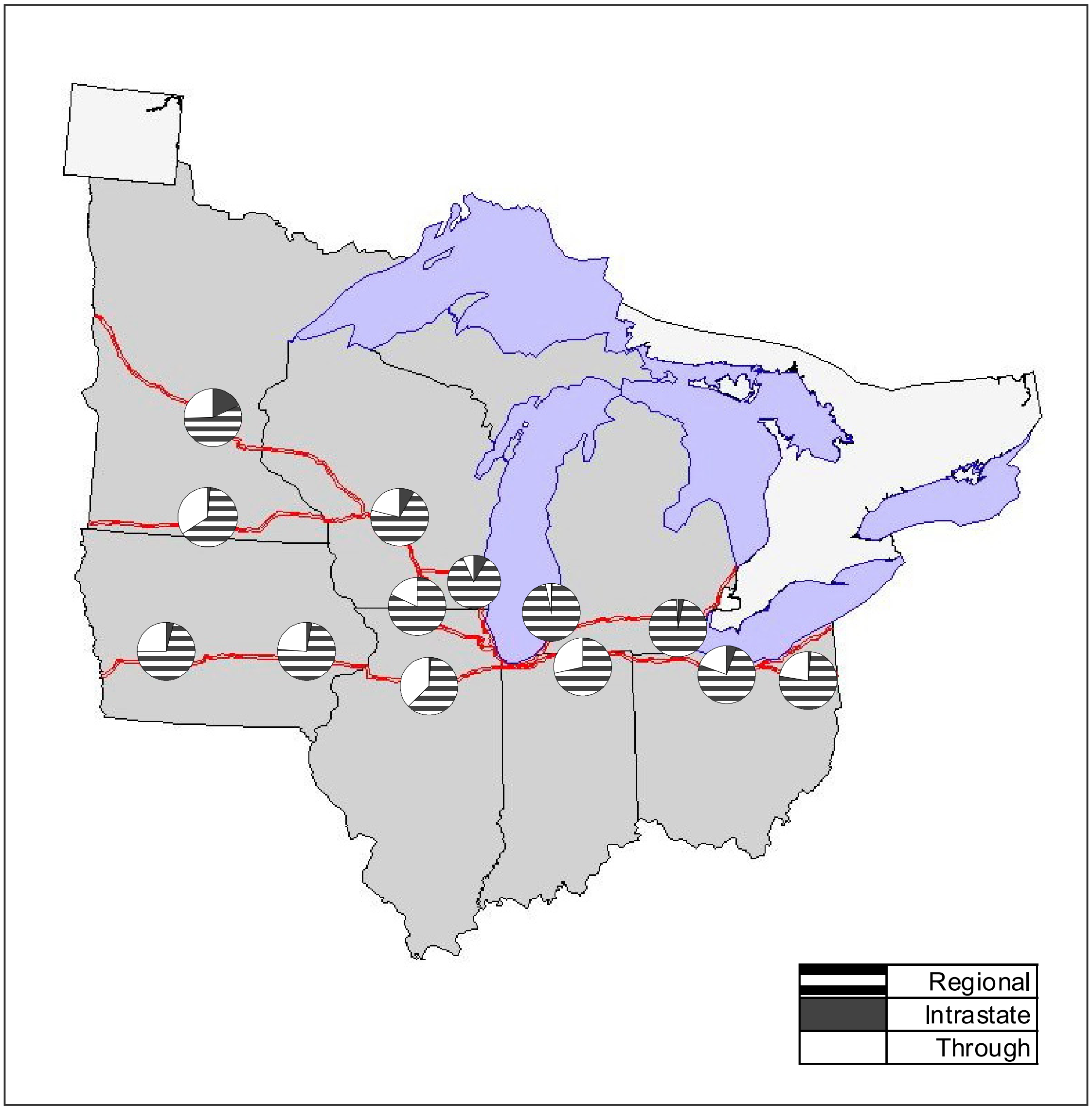


Figure 6.8 Breakdown of truck shipment value by movement types - select link analysis.

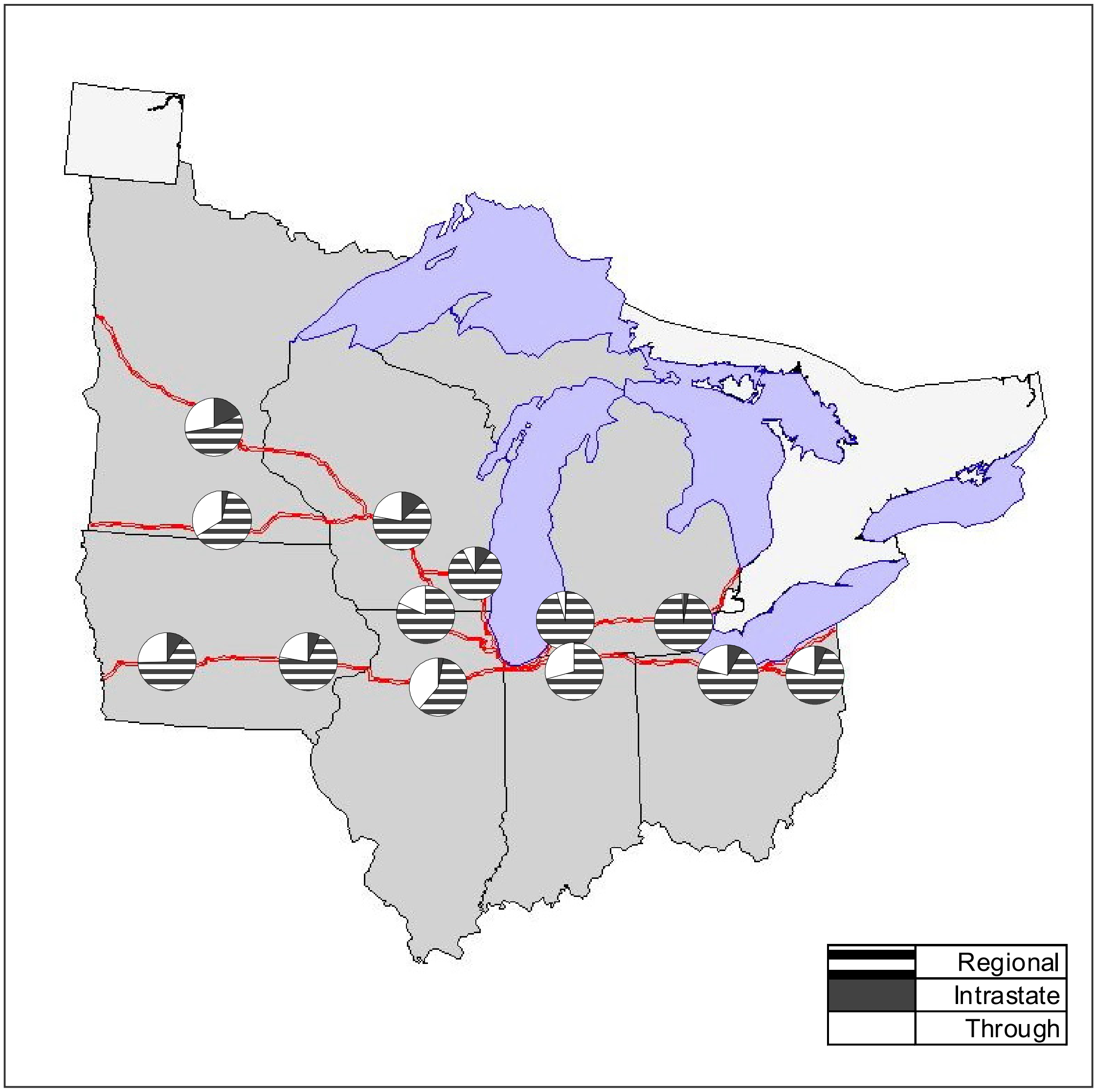


Figure 6.9 Breakdown of truck shipment weight by movement types - select link analysis.

6.7 Rail

Section 6.6 presents an analysis of origin destination and a select link analysis for highways, In the case of rail, we present the analysis of origin destination data but the data are not available to support a select link analysis.

Figure 6.10 and Figure 6.11 show the top ten regions for rail shipments by weight, using the Economic Areas (EAs) defined by the Bureau of Economic Analysis. (BEA 1995) For both origin and destination, five out of ten areas are either within or in the close proximity of the study area, underscoring the importance of the study corridor for the movement of freight by rail. It should be mentioned that most of the shipments that travel between the western part and eastern part of the country must go through at least one interchange since none of the railroads owns a contiguous rail network that covers the entire country. Such interchanges, most of which happen in Chicago, are not reflected in the figures presented. Unfortunately, the poor quality of data in the Waybill Sample for the interchange makes it impossible to extract the information related to interchange.

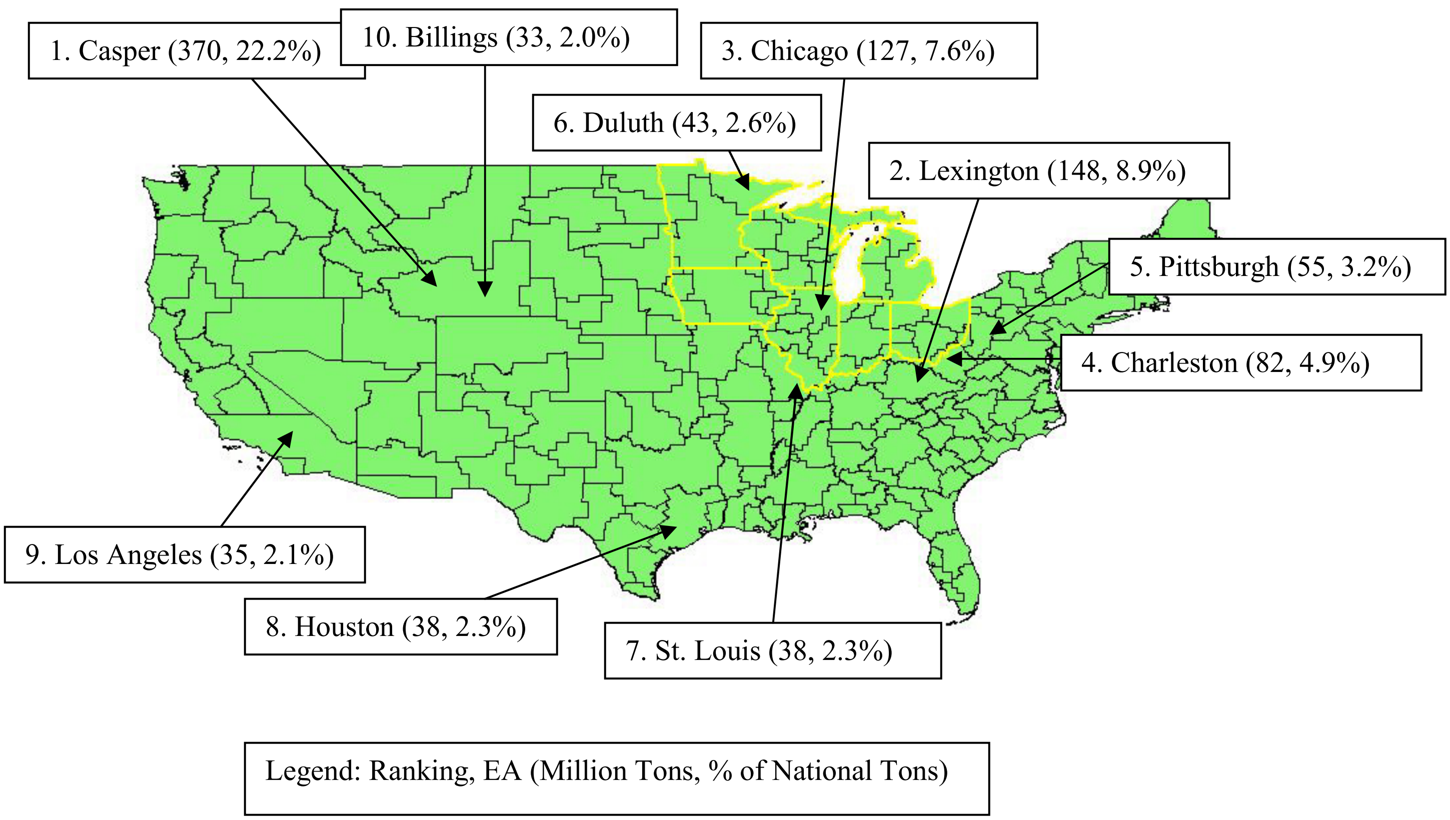


Figure 6.10 Top 10 origin EAs in the nation by weight.

Data Source: 2001 Rail Waybill Sample

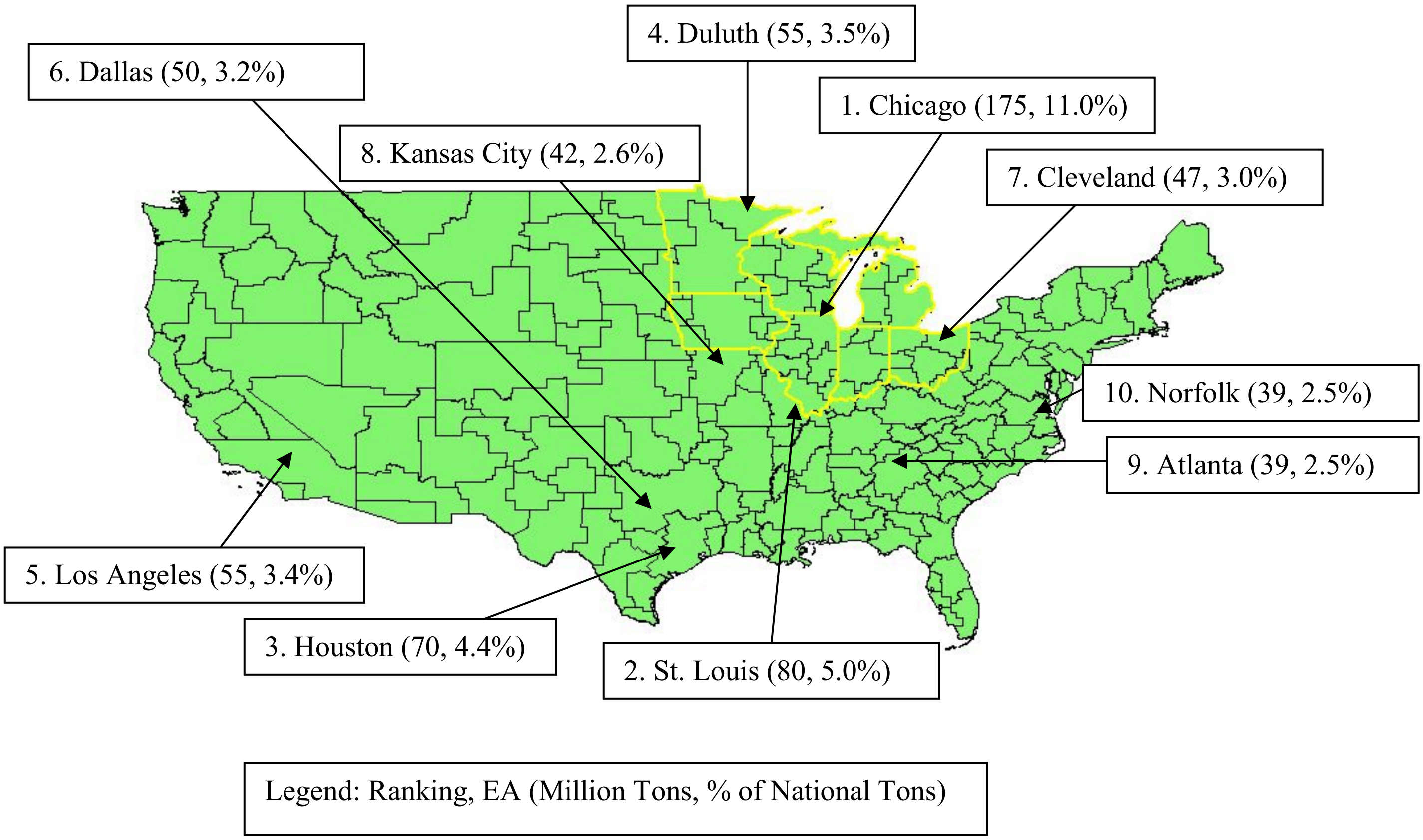


Figure 6.11 Top 10 destination EAs in the nation by weight.

Data Source: 2001 Rail Waybill Sample

Compared with trucking, the top fifteen origin-destination pairs for rail freight flow by weight and value, shown in Table 6.13 and Table 6.14, paint a different picture. A much smaller share of the freight flow is intrastate both in terms of weight and value. The data in Table 6.13 indicate that Wyoming is a significant generator of rail freight traffic that is destined for the study area. This can be attributed to the high volume of coal shipped from Wyoming. In terms of value, however, the states such as Texas, Missouri, and California are critical trading partners to the study area states. It should be noted that, compared with trucking, the movement of rail freight is geographically less concentrated. Top fifteen origin-destination pairs account for only 49.4% and 30.9% of tons and values, respectively. Even the shipments from Michigan to Missouri, which ranks first in value, account for only 3.3% of the total.

Table 6.13 Rail freight flow with origin or destination within the study area - top 15 origin-destination pairs by weight.

Origin	Destination	Weight (1000 tons)	% of Total
Illinois	Illinois	31,818	7.4%
Indiana	Indiana	31,124	7.2%
Minnesota	Minnesota	21,462	5.0%
Wyoming	Iowa	16,236	3.8%
Wyoming	Wisconsin	15,463	3.6%
Montana	Wisconsin	14,737	3.4%
Michigan	Michigan	12,378	2.9%
Wyoming	Illinois	11,656	2.7%
Ohio	Ohio	10,544	2.4%
Wyoming	Minnesota	10,092	2.3%
Wyoming	Indiana	9,493	2.2%
Iowa	Illinois	7,416	1.7%
Pennsylvania	Ohio	7,392	1.7%
Illinois	Indiana	7,292	1.7%
Ohio	North Carolina	6,720	1.6%

Source: 1997 CFS

Table 6.14 Rail freight flow with origin or destination within the study area - Top 15 origin-destination pairs by value.

Origin	Destination	Value ($million)	% of Total
Michigan	Missouri	3,707	3.3%
Michigan	Michigan	3,652	3.3%
Michigan	Texas	3,343	3.0%
Indiana	Indiana	2,607	2.3%
Illinois	California	2,561	2.3%
Illinois	Illinois	2,406	2.2%
Texas	Illinois	2,216	2.0%
Michigan	California	2,152	1.9%
Ohio	Texas	1,965	1.8%
Ohio	Ohio	1,893	1.7%
Michigan	Florida	1,740	1.6%
Illinois	Texas	1,580	1.4%
Michigan	Maryland	1,566	1.4%
Michigan	Georgia	1,548	1.4%
Minnesota	Minnesota	1,528	1.4%

Source: 1997 CFS

Table 6.15 through Table 6.17 show the top ten commodities in terms of weight, value, and ton-mile, respectively. Although the rail freight movement is relatively dispersed geographically, it is highly concentrated in terms of the commodities being transported. The top ten commodities account for 92.6% of total tons, 91.2% of total values, and 67.7% of total ton-miles. The data also show that the weight of the shipments has very little relationship with the value. For example, coal, which is 63.2% of the total weights of the inbound shipments, accounts for only 8.0% in value. On the other hand, motorized and other vehicles and parts is the most economically important commodity transported by rail, with 53.4% of the total value, even though it accounts for only a small percentage in weight.

Table 6.15 Rail freight flow with origin within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Coal	51,934	32.9%
Cereal grains	25,042	15.9%
Metallic ores and concentrates	21,096	13.4%
Base metal in primary or semifinished forms and in finished basic shapes	12,395	7.9%
Waste and scrap	10,524	6.7%
Other prepared foodstuffs and fats and oils	8,763	5.6%
Motorized and other vehicles (including parts)	4,985	3.2%
Animal feed and products of animal origin	4,831	3.1%
Milled grain products and preparations, and bakery products	3,673	2.3%
Other agricultural products	2,767	1.8%

Source: 1997 CFS

Table 6.16 Rail freight flow with origin within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	27,101	53.4%
Base metal in primary or semifinished forms and in finished basic shapes	5,209	10.3%
Other prepared foodstuffs and fats and oils	3,523	6.9%
Cereal grains	2,661	5.2%
Pulp, newsprint, paper, and paperboard	1,602	3.2%
Plastics and rubber	1,419	2.8%
Milled grain products and preparations, and bakery products	1,291	2.5%
Coal	1,247	2.5%
Waste and scrap	1,227	2.4%
Animal feed and products of animal origin	1,017	2.0%

Source: 1997 CFS

Table 6.17 Rail freight flow with origin within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Cereal grains	16,299	24.3%
Other prepared foodstuffs and fats and oils	8,469	12.6%
Coal	7,829	11.7%
Metallic ores and concentrates	6,455	9.6%
Base metal in primary or semifinished forms and in finished basic shapes	5,512	8.2%
Motorized and other vehicles (including parts)	4,82	6.1%
Animal feed and products of animal origin	3,613	5.4%
Other agricultural products	3,557	5.3%
Milled grain products and preparations, and bakery products	2,863	4.3%
Waste and scrap	1,554	2.3%

Source: 1997 CFS

6.8 Intermodal (Rail and Truck)

This section discusses the usage trends for the shipments that use both truck and rail, which is generally referred to as intermodal shipments. Table 6.18 and Table 6.19 show the major origin-destination pairs with at least one end of the trip within the study area. The data are strikingly different from both rail-only and truck-only modes. The O-D wise concentration of freight movements is similar to that for trucks, but the Intermodal is used mostly for long-distance shipments, especially from/to California and Texas. Those two states account for approximately 50% of Intermodal tonnage originating in the Study Area. As such, there are hardly any shipments that stay within the study area. Also, most of the top origin-destination pairs are outbound, meaning they originate from the study area and go to the states outside the study area. In fact, the imbalance between outbound and inbound shipments is quite significant. A total of 6.3 million tons of intermodal shipments that are worth $21.5 billion originate within the study area. Meanwhile, the shipments that terminate in the study area amount to only 2.7 million tons in weight and $4.5 billion in values. This conflicts with the widely recognized trend that the intermodal shipments from the East and West coasts to the middle parts of the continent overwhelm the shipment in the other direction. The explanation can be found in the way the CFS records import shipment. The coverage of the import flow is one of the weaknesses of the CFS since the survey only targets the domestic shippers. The origins of the international shipments are recorded as "the point that they left the importer's domestic location for shipment to another location" (BTS 2004d). Thus, the CFS may record the state in which the importer is located rather than the point of entry. This apparent imbalance may be caused by the bias in the CFS data.

Table 6.18 Intermodal freight flow with origin or destination within the study area - top 15 origin-destination pairs by weight.

Origin	Destination	Weight (1000 tons)	% of Total
Illinois	California	762	9.1%
Ohio	California	611	7.3%
Michigan	California	372	4.4%
Michigan	Texas	216	2.6%
Kansas	Iowa	215	2.6%
Ohio	Texas	214	2.6%
Michigan	New Jersey	206	2.5%
California	Illinois	173	2.1%
Illinois	Tennessee	172	2.1%
Missouri	Indiana	166	2.0%
Illinois	New Jersey	155	1.9%
California	Michigan	154	1.8%
Indiana	California	153	1.8%
Illinois	Pennsylvania	151	1.8%
Minnesota	California	146	1.7%

Source: 1997 CFS

Table 6.19 Intermodal freight flow with origin or destination within the study area - Top 15 origin-destination pairs by value.

Origin	Destination	Value ($million)	% of Total
Illinois	California	2,319	9.4%
Michigan	California	1,633	6.6%
Ohio	California	1,609	6.5%
Michigan	Texas	1,588	6.4%
Michigan	New Jersey	912	3.7%
Kentucky	Michigan	858	3.5%
Michigan	Georgia	852	3.4%
Minnesota	Texas	796	3.2%
Michigan	Florida	776	3.1%
Minnesota	California	738	3.0%
Michigan	Washington	701	2.8%
Illinois	Virginia	618	2.5%
Ohio	Michigan	580	2.3%
Indiana	California	547	2.2%
Ohio	New Jersey	518	2.1%

Source: 1997 CFS

The breakdowns of the intermodal shipments that originate within the study area by weight, value, and ton-miles are shown in Table 6.20 through Table 6.22. The data indicate that the market niches for the Intermodal freight consist of high-value products such as automobile related products, other machines, processed food items, and chemicals. In particular, automobiles and related products account for 73% of value and 35% of tons of Intermodal shipments originating in the Study Area. Also, automobile related products and chemical products together account for well over half of total weight and ton-miles, and almost 80% of the total value of shipments.

Table 6.20 Intermodal freight flow with origin within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Motorized and other vehicles (including parts)	880	35.2%
Chemical products and preparations	552	22.1%
Other prepared foodstuffs and fats and oils	317	12.7%
Plastics and rubber	166	6.6%
Base metal in primary or semifinished forms and in finished basic shapes	129	5.2%
Milled grain products and preparations, and bakery products	128	5.1%
Machinery	89	3.6%
Articles of base metal	60	2.4%
Paper or paperboard articles	45	1.8%
Basic chemicals	43	1.7%

Source: 1997 CFS

Table 6.21 Intermodal freight flow with origin within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	7,529	72.9%
Chemical products and preparations	726	7.0%
Machinery	664	6.4%
Other prepared foodstuffs and fats and oils	317	3.1%
Plastics and rubber	237	2.3%
Base metal in primary or semifinished forms and in finished basic shapes	232	2.2%
Electronic and other electrical equipment and components and	196	1.9%
Milled grain products and preparations, and bakery products	157	1.5%
Paper or paperboard articles	90	0.9%
Articles of base metal	48	0.5%

Source: 1997 CFS

Table 6.22 Intermodal freight flow with origin within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (millions)	% of Total
Motorized and other vehicles (including parts)	1,327	29.3%
Chemical products and preparations	1,263	27.9%
Other prepared foodstuffs and fats and oils	739	16.3%
Plastics and rubber	376	8.3%
Milled grain products and preparations, and bakery products	188	4.2%
Basic chemicals	120	2.7%
Base metal in primary or semifinished forms and in finished basic shapes	80	1.8%
Paper or paperboard articles	77	1.7%
Machinery	69	1.5%
Nonmetallic mineral products	59	1.3%

Source: 1997 CFS

6.9 Air

A similar set of analyses is conducted for air freight. The CFS does not provide sufficient data for a complete analysis of the ton-miles of freight moved by air. Table 6.23 and Table 6.24 show the top fifteen origin-destination pairs by weight and value for air freight shipments that originate or terminate within the study area. While no origin-destination pair is dominant, California appears to be an important trade partner for air freight. It is somewhat surprising to find many pairs in the table with both origin and destination within the study area since air freight does not seem to offer competitive advantages over the trucks in shorter distance. Table 6.25 through Table 6.27 show the top five commodities transported by air in terms of the weight, value and ton-miles of shipments. Both tables show that 60 to 70 % of total shipment value can be attributed to precision machinery such as electronic equipments and instruments, suggesting a very narrow market niche for the air freight industry. The relative magnitude between the weight, shown in

Table 6.25, and value, shown in Table 6.26, underscores the extremely high value-to-weight ratio of the commodities transported by air freight. Modest amount of ton-miles, shown in Table 6.27, indicates that in spite of the very rapid growth during the last few years, air freight currently plays practically no role on relieving the congestion of other modes.

Table 6.23 Air freight flow with origin or destination within the study area - top 15 origin-destination pairs by weight.

Origin	Destination	Weight (1000 tons)	% of Total
Michigan	Michigan	31	6.3%
Ohio	Texas	25	5.0%
California	Illinois	19	3.8%
Minnesota	Illinois	16	3.2%
Illinois	California	15	3.0%
Michigan	Illinois	15	3.0%
Illinois	Illinois	14	2.8%
Wisconsin	Illinois	14	2.8%
California	Ohio	14	2.8%
Ohio	Illinois	13	2.6%
Michigan	Missouri	13	2.6%
New	Illinois	12	2.4%
California	Michigan	10	2.0%
Illinois	Florida	9	1.8%
Indiana	Illinois	9	1.8%

Source: 1997 CFS

Table 6.24 Air freight flow with origin or destination within the study area - top 15 origin-destination pairs by value.

Origin	Destination	Value ($million)	% of Total
California	Ohio	1,843	6.0%
California	Illinois	1,419	4.6%
Minnesota	Illinois	1,021	3.3%
Wisconsin	Illinois	886	2.9%
Ohio	Michigan	756	2.5%
Indiana	Illinois	716	2.3%
Texas	Illinois	714	2.3%
Illinois	California	633	2.1%
Kansas	Illinois	623	2.0%
Texas	Minnesota	592	1.9%
Michigan	Illinois	527	1.7%
Illinois	Florida	505	1.6%
Minnesota	California	478	1.6%
Texas	Michigan	463	1.5%
California	Minnesota	432	1.4%

Source: 1997 CFS

Table 6.25 Air freight flow with origin within the study area - Top 5 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Electronic and other electrical equipment and components and office equipment	23	35.4%
Motorized and other vehicles (including parts)	23	35.4%
Machinery	7	10.8%
Miscellaneous manufactured products	4	6.2%
Precision instruments and apparatus	4	6.2%

Table 6.26 Air freight flow with origin within the study area - Top 5 commodities by value.

Commodity	Value (in $million)	% of Total
Electronic and other electrical equipment and components and office equipment	2,996	42.7%
Precision instruments and apparatus	1,669	23.8%
Machinery	1,184	16.9%
Motorized and other vehicles (including parts)	411	5.9%
Printed products	33	0.5%

Source: 1997 CFS

Table 6.27 Air freight flow with origin within the study area - Top 5 commodities by ton-mile.

Commodity	Ton-mile (millions)	% of Total
Electronic and other electrical equipment and components and office equipment	37	45.1%
Motorized and other vehicles (including parts)	24	29.3%
Machinery	6	7.3%
Miscellaneous manufactured products	5	6.1%
Plastics and rubber	5	6.1%

Source: 1997 CFS

6.10 Waterway

The Great Lakes and the inland waterway system provide an extensive network for the movement of freight by water. Like some of the other modes analyzed previously, water freight serves relatively narrow market niches. The niches are defined by both the geographical areas as well as commodity types. In general, low value freight that is time sensitive moves by this mode. The movement is predominately north-to-south taking advantage of the Mississippi River system. Compared with other modes the volume and value of the freight using this mode is low.

Table 6.28 and Table 6.29 show top fifteen origin-destination pairs for the shipments that originate or terminate within the study area by weight and value, respectively. Freight movement from Illinois to Louisiana account for a large share of all movements in terms of both tonnage and value. The combined tonnage of the shipments within the study area (Great Lakes traffic), at nearly 30% of total, is also significant. The value of shipments, however, is completely dominated by the shipments destined for Louisiana, accounting for almost 75% of the total. The data presented in Table 6.30 through Table 6.32 show that cereal grains account for a major part of waterway freight movements in terms of weight, value, and also ton-miles. Products moved tend to be relatively low value bulky products.

Table 6.28 Waterway freight flows with origin or destination within the study area - Top 15 origin-destination pairs by weight.

Origin	Destination	Weight (1000 tons)	% of Total
Illinois	Louisiana	32,904	30.5%
Michigan	Michigan	12,129	11.3%
Minnesota	Louisiana	8,538	7.9%
Iowa	Louisiana	6,021	5.6%
Michigan	Ohio	4,933	4.6%
Illinois	Illinois	4,321	4.0%
Michigan	Indiana	4,271	4.0%
Ohio	Ohio	4,127	3.8%
Michigan	Wisconsin	3,832	3.6%
Louisiana	Illinois	3,222	3.0%
West Virginia	Ohio	2,675	2.5%
Kentucky	Ohio	2,518	2.3%
Indiana	Louisiana	2,176	2.0%
Pennsylvania	Ohio	2,128	2.0%
Ohio	Louisiana	2,032	1.9%

Source: 1997 CFS

Table 6.29 Waterway freight flow with origin or destination within the study area - Top 15 origin-destination pairs by value.

Origin	Destination	Value (in $million)	% of Total
Illinois	Louisiana	4,856	51.9%
Minnesota	Louisiana	1,174	12.5%
Iowa	Louisiana	961	10.3%
Illinois	Illinois	508	5.4%
Ohio	Louisiana	466	5.0%
Louisiana	Illinois	280	3.0%
Louisiana	Ohio	240	2.6%
Michigan	Michigan	175	1.9%
Louisiana	Indiana	135	1.4%
Wisconsin	Wisconsin	112	1.2%
Missouri	Illinois	92	1.0%
Kentucky	Ohio	84	0.9%
Michigan	Ohio	65	0.7%
West	Ohio	61	0.7%
Pennsylvania	Ohio	53	0.6%

Source: 1997 CFS

Table 6.30 Waterway freight flows with origin within the study area - Top 5 commodities by weight

Commodity	Weight (1000 tons)	% of Total
Cereal grains	33,427	45.1%
Gravel and crushed stone	19,947	26.9%
Other agricultural products	11,315	15.3%
Coal	2,475	3.3%
Animal feed and products of animal origin	2,101	2.8%

Source: 1997 CFS

Table 6.31 Waterway freight flow with origin within the study area - Top 5 commodities by value

Commodity	Value (in $million)	% of Total
Cereal grains	3,497	48.8%
Other agricultural products	2,723	38.0%
Animal feed and products of animal origin	430	6.0%
Other prepared foodstuffs and fats and oils	296	4.1%
Nonmetallic mineral products	97	1.4%

Source: 1997 CFS

Table 6.32 Waterway freight flow with origin within the study area - Top 5 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Cereal grains	41,061	63.3%
Other agricultural products	13,042	20.1%
Gravel and crushed stone	6,246	9.6%
Animal feed and products of animal origin	2,265	3.5%
Other prepared foodstuffs and fats and oils	868	1.3%

Source: 1997 CFS

6.11 Analysis of Canada - US Freight Flow

In this section, the flow of freight between the province of Ontario, Canada, and the US subdivided into the states in the study area and the rest of the U.S. is discussed. The data are derived from the 1999 Ontario Commercial Vehicle Survey (CVS) provided by the Ontario Ministry of Transportation and also the 1999 Transborder Surface Freight Data published by the Bureau of Transportation Statistics. The US-Canadian exchange rate as of September 1, 1999 is used to calculate the value of freight.

Each day, a total of 78,000 tons of freight worth $222 million is imported from and 71,000 tons worth $273 million is exported to Ontario. In contrast, the flow of freight between Manitoba, which shares the border with Minnesota, and US is less than 3,000 tons per day. Therefore, the analyses in this section focus mostly on the trade traffic between Ontario and the study area states. In some instances, the analysis area is expanded to cover Canada.

Figure 6.12 and Figure6.13 depict the relative weight and value of commodities that are imported from and exported to Ontario, respectively. The figures show that Michigan is by far the most significant trade partner with Ontario. In fact, in terms of tonnage, Michigan accounts for approximately 40% of imports and 27% of exports between Ontario and the US. In terms of truck trips, approximately 8,000 trucks travel from Ontario to US each day. Of those, 46% are destined to Michigan. For the approximately 7,500 trucks that travel to Ontario form US each day, 41% originate in Michigan.

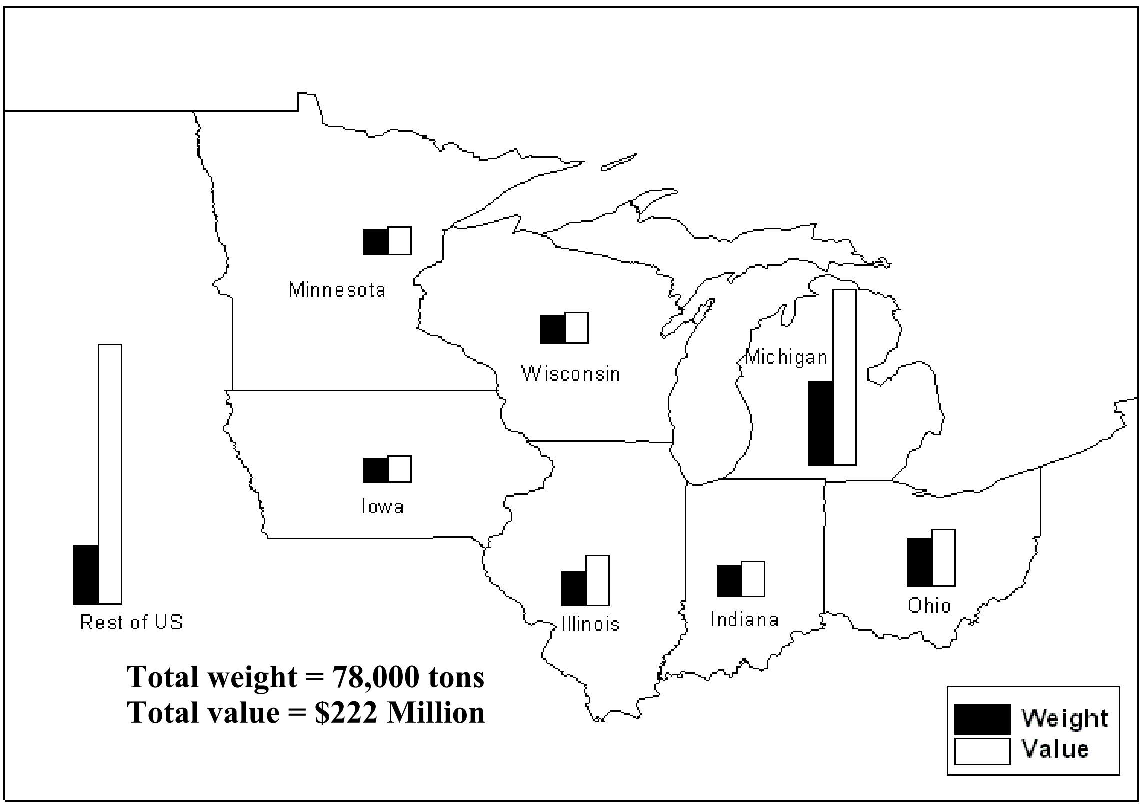


Figure 6.12   Daily weight and value of imports from Ontario to US

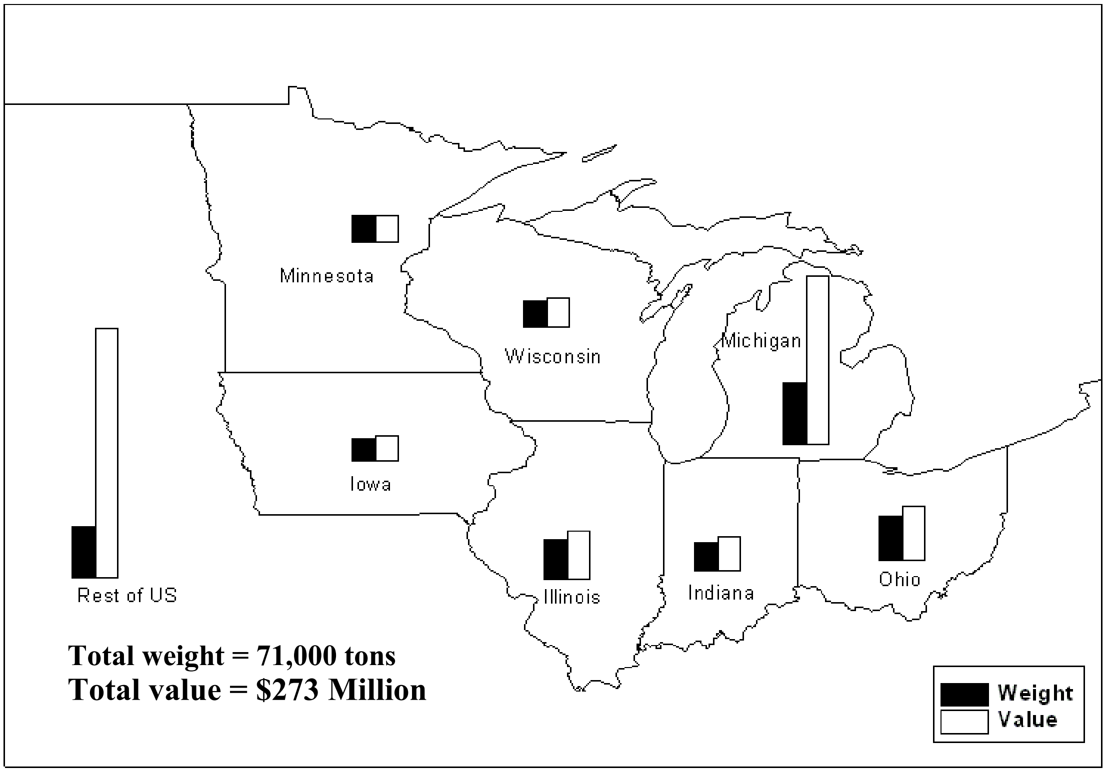


Figure6.13 Daily weight and value of exports from US to Ontario

Table **6.33** shows the type of commodities transported between the study area and Ontario. For both import and export, the most important commodities are transportation equipment, including automobiles, wood and wood products as well as metal and metal products. It should be noted that the movement of empty containers and empty trips account for as much as the trade of major commodity groups such as food and manufactured products.

Table 6.33 Breakdown of daily freight flow between the study area and Ontario by commodity

Commodity	Import		Export	
	Tons	Value (in $1000)	Tons	Value (in $1000)
Agricultural Products	2,479	5,467	2,565	1,672
Food	2,172	2,124	2,679	3,094
Minerals & Products	2,177	1,325	3,343	2,187
Petroleum & Products	866	386	694	428
Chemicals & Products	4,146	17,131	3,899	9,329
Wood & Products	5,924	6,426	11,405	13,907
Metals & Products	10,662	11,593	6,938	9,942

Machinery & Electrical	3,009	16,721	3,880	15,938
Manufactured Products	2,098	9,284	1,845	9,019
Transportation	11,538	30,160	11,856	49,919
Waste & Scrap	2,484	776	2,387	909
Shipping Containers Returning Empty	1,640	0	2,778	0

Source: Ontario CVS Data

Using the Ontario CVS data, select link analyses were performed for the locations shown in Figure 6.14. Table 6.34 shows the volumes of daily cross-border truck trips that are regional (i.e. originate or terminate within the study area) and pass through the region (i.e. originate or terminate outside the study area). The volumes reflect only the truck trips that originate or terminate in Canada. Except for the location D, I-94 near Michigan/Indiana border, the truck volumes attributed to the cross-border trips are modest considering that all the locations carry between 6,000 and as much as 15,000 daily truck trips. At location D, the cross-border trips account for approximately 35% of the total daily truck volume. The split between the regional and through trips varies by location, but in general, the share of the through trips increases as one moves away from the point of border crossing.

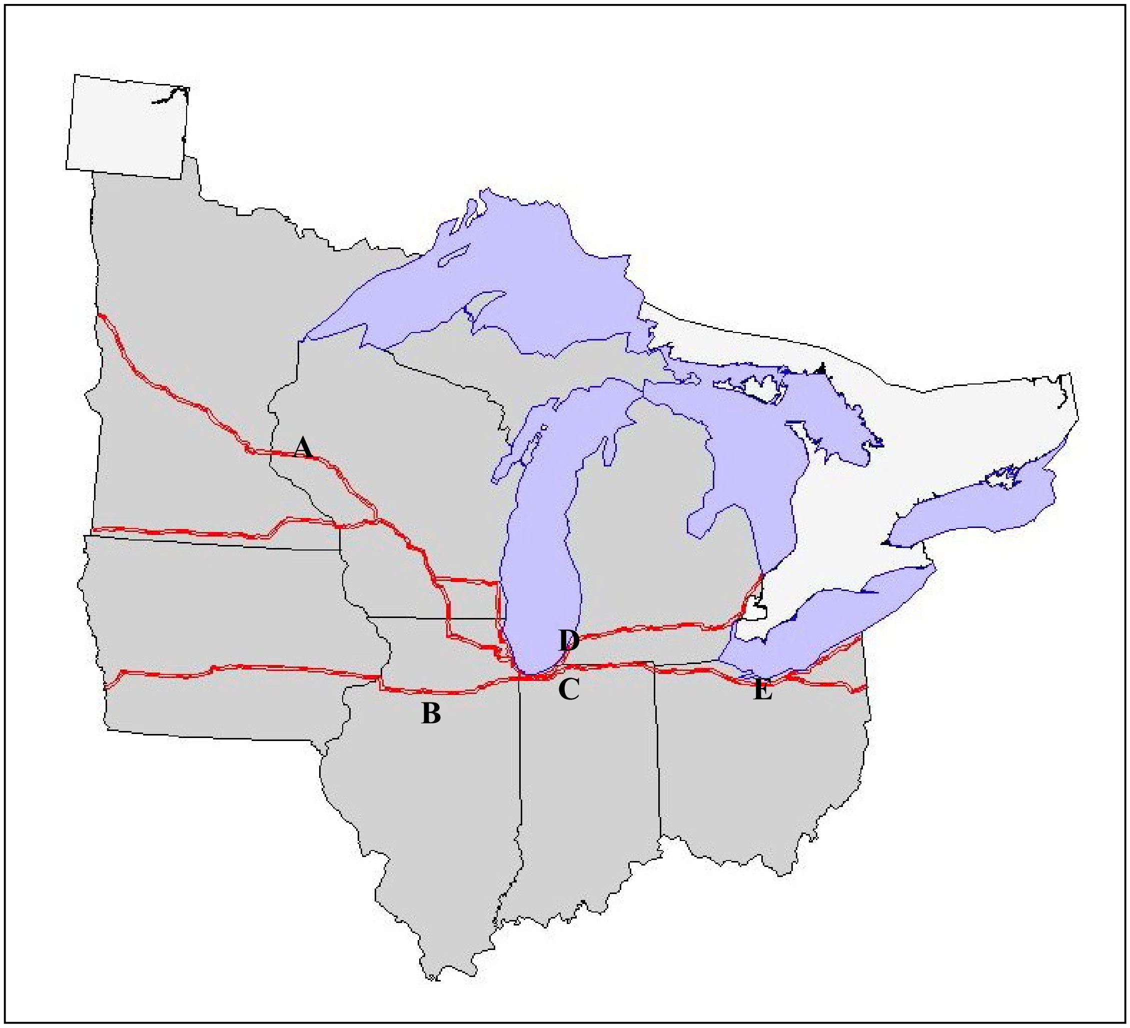


Figure 6.14 Analysis locations for cross-border truck traffic

Table 6.34 Breakdown of cross-border truck trips by movement types

Analysis location	Description	Daily trips	
		Regional	Through
A	I-94 at WI/MN Border	223	166
B	I-80 between I-39 and Geneseo, IL	255	578
C	I-80/90 West of South Bend, IN	34	85
D	I-94 at South of Benton Harbor, MI	1,994	1,240
E	I-80/90 Near Norwalk, OH	346	193

6.12 Macro-level Assessment of Long Range Forecasts of Freight Activity

In the late 1990's, various freight studies, most notably the Freight Analysis Framework, generated long-term projections of freight activities over the next two to three decades. The figures reported were alarmingly large, over 70% for the truck VMT and even greater for some of the indicators. However, since then the US economy and freight activity in general have experienced a brief period of downturn in 2001 and 2002, which may impact the long-term growth. Thus, an analysis was conducted to re-evaluate the long-term projections and prognosis for the freight transportation in the nation and also for the Upper Midwest region. The meta analysis relied on existing economic and freight activity data from various sources.

The analysis began with a comparison of various measures of freight activity against economic indicators. The objective was to identify economic indicators that are also reliable indicators of freight activities. If such indicators can be successfully identified, they can be used as a base to crosscheck long-term freight projections from various sources. Chart 6.5 shows the relationship between various indicators of freight activity and economic activity. While more detailed analysis must be conducted to determine the statistical validity, the following relationships between economic and freight activity indicators can be observed:

- Diesel fuel consumption and Truck VMT,
- GDP and Intercity truck ton-mile,
- Total employment and Class I railroad ton-miles, and
- Total employment and total domestic freight ton-mile.

By comparing the projections for the economic indicators listed above to the expected freight activity growth, realistic boundaries for the latter over the next 10 to 15 years can be estimated.

Table 6.35 shows the projections for some of the economic indicators. The total employment, which is closely associated with the total and also rail ton-miles, is projected to grow only about 20 % between 2000 and 2020 for the entire nation and only 19% for the Great Lakes Regional Economic Area (REA). The diesel fuel consumed by the transportation sector, which tracks well with the truck VMT is expected to increase by 51%, 37%, and 48% for the nation, for the East North Central region (Ohio, Michigan, Indiana, Illinois, and Wisconsin), and for the West North Central region (Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas), respectively.

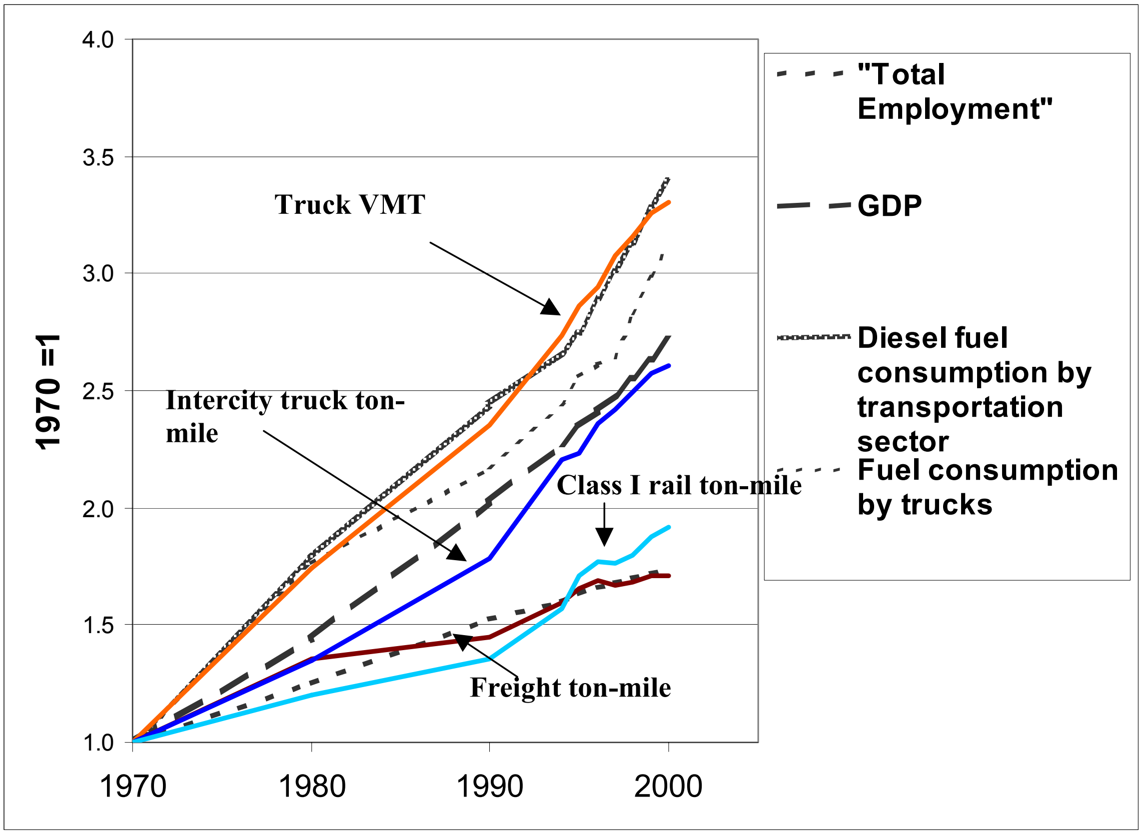


Chart 6.5 US freight activity and indicators (1970-2000).

Sources: Energy Information Administration 2003, FHWA

Table 6.35 Growth projections for economic indicators

Source and Data	Growth projections (2000 - 2020)
Woods & Poole Total employment[a]	1.23
Woods & Poole Total employment - Great Lakes REA[a]	1.19
Woods & Poole GDP[a]	1.78
EIA Diesel fuel consumption by transportation sector[b]	1.51
EIA Diesel fuel consumption by transportation sector - (IL, IN, MI, OH, WI only)[b]	1.37
EIA Diesel fuel consumption by transportation sector - (MN, IA, MO, ND, SD, NE, KS only)[b]	1.48

a - Woods & Poole Economics 2003 *b - Energy Information Administration 2003*

Table 6.36 shows the projected growth in various freight indicators. The economic projections in Table 6.35 suggest a moderate rate of growth when compared with the figures in Table 6.36. Chart 6.6 compares the projected changes in economic indictors and freight activities for the Upper Midwest Region. The growth in the economic indicators is considerably lower than the VMT increase forecasted by the FAF. It should be noted that all the projections in Table 6.36, including the ones produced by the Energy Information Administration (EIA), a branch of the Department of Energy (DOE), are based on the economic forecasts developed by the WEFA, a consulting company. While the projections published by FAF and AASHTO were made in the late 1990's, the projections with moderate growth figures, Woods & Poole and also EIA, were developed more recently, after the economic downturn during 2001 and 2002. In fact, for the time period between 2004 and 2020, the projected growth rates for truck VMT by FAF and EIA are very similar. Thus, the difference in the growth rate is almost entirely caused by the economic downturn during 2001 and 2002.

In light of the findings discussed above, it is reasonable to state that the growth in freight activity over the next 15 to 20 years is likely to be less than the figures suggested by the studies conducted in the late 90's when the economic growth was very robust. Recent projections suggest that the total freight activity in the U.S. is likely to grow by 40 to 55 % between 2000 and 2020. The truck VMT growth for the Upper Midwest Region is likely to be slightly lower than those figures. It should be stressed, however, that freight activity is closely tied to the economic growth, and consequently, any unforeseen events that may impact the US economy positively or negatively would also bring about unexpected swings in the freight indicators.

Table 6.36 Comparison of Growth Projections.

Indicators	Source and Data	Growth projections (2000 - 2020)
Truck VMT	EIA truck VMT[a]	1.55
	FAF total truck VMT[d]	1.73
	FAF study area truck VMT[d]	1.70
Truck ton	AASHTO truck tons[c]	1.62
	FAF truck tons[b]	1.59
Truck ton-mile	AASHTO truck ton-miles[c]	1.58
Rail ton	AASHTO rail tons[c]	1.44
	FAF rail tons[b]	1.39
Rail ton-mile	AASHTO rail ton-miles[c]	1.47
	EIA rail ton-miles[a]	1.31
Air ton	AASHTO air tons[c]	2.81
	FAF air tons[b]	2.43
Air ton-mile	EIA air ton-mile[a]	2.15
	AASHTO air ton-miles[c]	2.82
Water ton	AASHTO water tons[c]	1.39
	FAF water tons[b]	1.30
Water ton-mile	EIA water ton-miles[a]	1.19
	AASHTO water ton-miles[c]	1.14
Total ton	AASHTO total tons[c]	1.57
	FAF total domestic tons[b]	1.54
Total ton-mile	AASHTO total ton-miles[c]	1.50
Regional ton	AASHTO central region tons (OH, IN, IL, MI, WI, MN, IA, MO, ND, SD, NE, KS)[c]	1.63

a - Energy Information Administration 2003

b – FHWA 2002c

c – AASHTO 2003, Freight Rail Bottom Line Report

d - Derived from GeoFreight data set

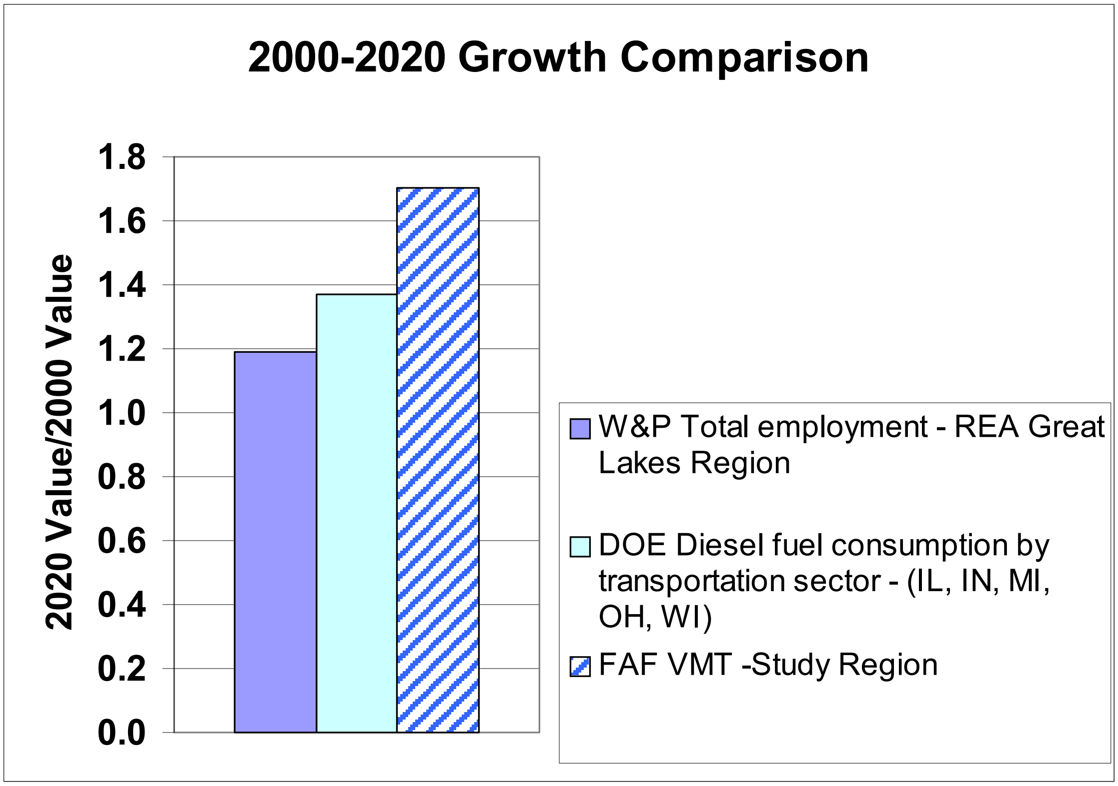


Chart 6.6 Projected growth for the Upper Midwest Region (2000 - 2020).

Sources: Wood and Poole, 2003, EIA, 2003, FHWA 2002d

6.13 Summary of Key Usage Characteristics

In this section, some of the key findings from the analysis of the usage data are summarized.

- The Upper Midwest Region plays a very important role in the nation's freight transportation, accounting for roughly one-third of the total freight activities that occur in the U.S. For some modes, such as Intermodal, the share is considerably higher.

- In terms of tonnage, the freight activity in the seven states included in the study region (IA, IL, IN, MI, MN, OH, WI) is dominated by the intrastate truck shipments. However, low-value shipments such as gravel and non-metallic minerals account for about 30% of all the intrastate truck freight movements. Since the trip lengths for those commodities tend to be very short, the analyses of other indicators of freight activity such as value of shipments and ton-miles reveal that other types of freight movements such as medium distance trucking (i.e. inter-state movements within the study area), long-distance trucking (external or through movements), rail, and water play a critical role in the efficacy of region's freight system and economy.

- The analysis of the truck shipments with either origin or destination in the study area reveals that although gravel and crushed stone accounted for over 23%, of truck freight movements in terms of weight, its economic significance is negligible (0.3% of total value). Meanwhile, finished goods and machines account for a significant percentage, approximately 25%, of the total value of the shipments moved by the trucks. For the I-80/90/94 corridor, intrastate shipments typically account for less than 20% of the total truck tonnage transported on any given link. The remainder is attributed to the intra-regional (going from one state to another within the region), external (going from one state within the region to outside the region) and through (going from outside the region to outside the region) shipments. These figures underscore the importance of the regional approach for dealing with freight traffic.

- For rail freight, five out of the ten largest traffic generating regions in the nation are either within or in the close proximity of the study area, underscoring the importance of the study corridor for the movement of freight by rail. By weight, the Chicago region ranks third and first as origin and destination of the rail shipments, respectively. In terms of weight, bulk commodities account for most of the rail shipments. Roughly 70% of the rail shipments that originate or terminate in the study area is either coal, metallic ores, or cereal grains. Rail freight is important for the region's automobile-related industries since over 20% of the total ton-miles of transporting motorized equipment and parts is by rail or truck-rail combination.

- Intermodal (i.e. truck and rail combination) is used mostly for long-distance shipments of high-value commodities. As such, there is hardly any Intermodal shipment that stays within the study area. Although, the CFS data indicate that a high percentage of the shipments are outbound, meaning they originate from the study area and go to the states outside the study area, it may be caused by the bias in the data. California is by far the most important destination for the Intermodal shipments originating from the study area.

- The Great Lakes and the inland waterway system provide an extensive network for the movement of freight by water. In general, low value freight that is time sensitive moves by this mode. The movement is predominately north-to-south taking advantage of the Mississippi River system, but the traffic within the Great Lakes system is significant in terms of the tonnage of freight transported. Freight movement from Illinois to Louisiana account for almost a third of all movements in terms of tonnage and over 50% by value.

- The types of commodities and also origin-destination pairs served by the air transportation are similar to the Intermodal. California appears to be an important trade partner for air freight. Approximately 60 to 70 % of the total value of all the shipments can be attributed to precision machinery such as electronic equipments and instruments, suggesting a narrow market niche for the air freight industry.

- In general, all freight modes cater to fairly specific market niches that are defined by the origin-destination pairs and commodities. For example, a considerable portion of the freight moved by water transportation involves low-value bulk goods such as coal and grain between the Upper Midwest Region and Louisiana ports. Intermodal competes against truck and air for certain high-value commodities such as automobile parts, electronics and other machinery. California is a major origin and destination location for those modes. Consequently, the flow of freight is driven largely by a limited number of origin-destination and commodity combinations. Chart 6.7 and Chart 6.8 show the shares of top fifteen origin-destinations pairs and top five commodities within the total freight activities for each mode, respectively. Chart 6.7 indicates that typically about one-third of the freight flow can be attributed to the top 15 origin-destination pairs. Since a large share of the freight transported by the trucks can be attributed to short trips carrying sand and gravel, the figure for the tons is much higher than that for value or ton-miles. Chart 6.8 shows that truck is by far the most versatile in terms of the types of commodities transported. All other modes are narrowly focused on only a several commodities that typically account for over 80% of total freight transported.

- Most of this analysis used data from secondary sources with the original data often being based on samples or models. Given the complexity of the system, the number of modes and routes available for moving freight and the huge volume and value of freight moved in and through the Upper Midwest Corridor, the key findings presented here attempt to recognize the inherent limitations of the data and analysis.

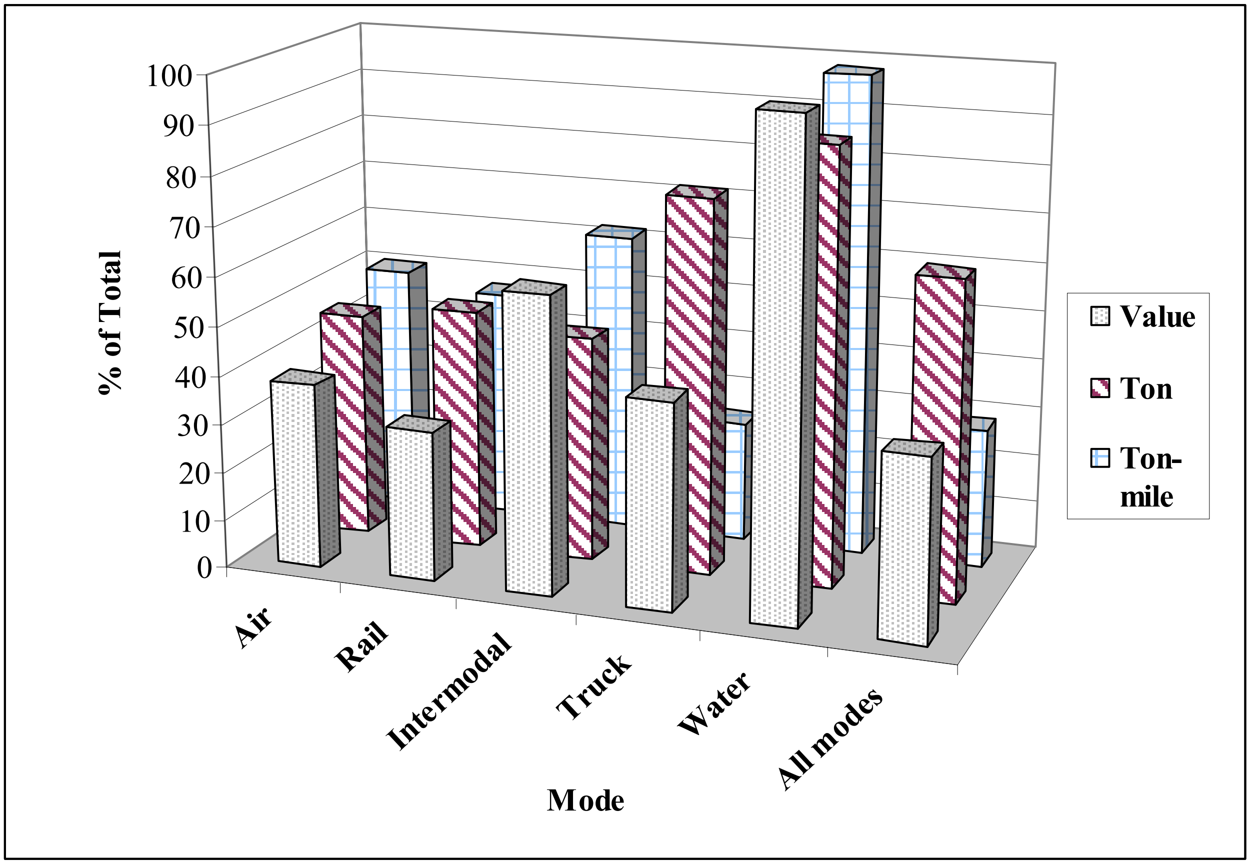


Chart 6.7 Share of Top 15 Origin-Destination Pairs - Freight with Origin or Destination in the Study Area.

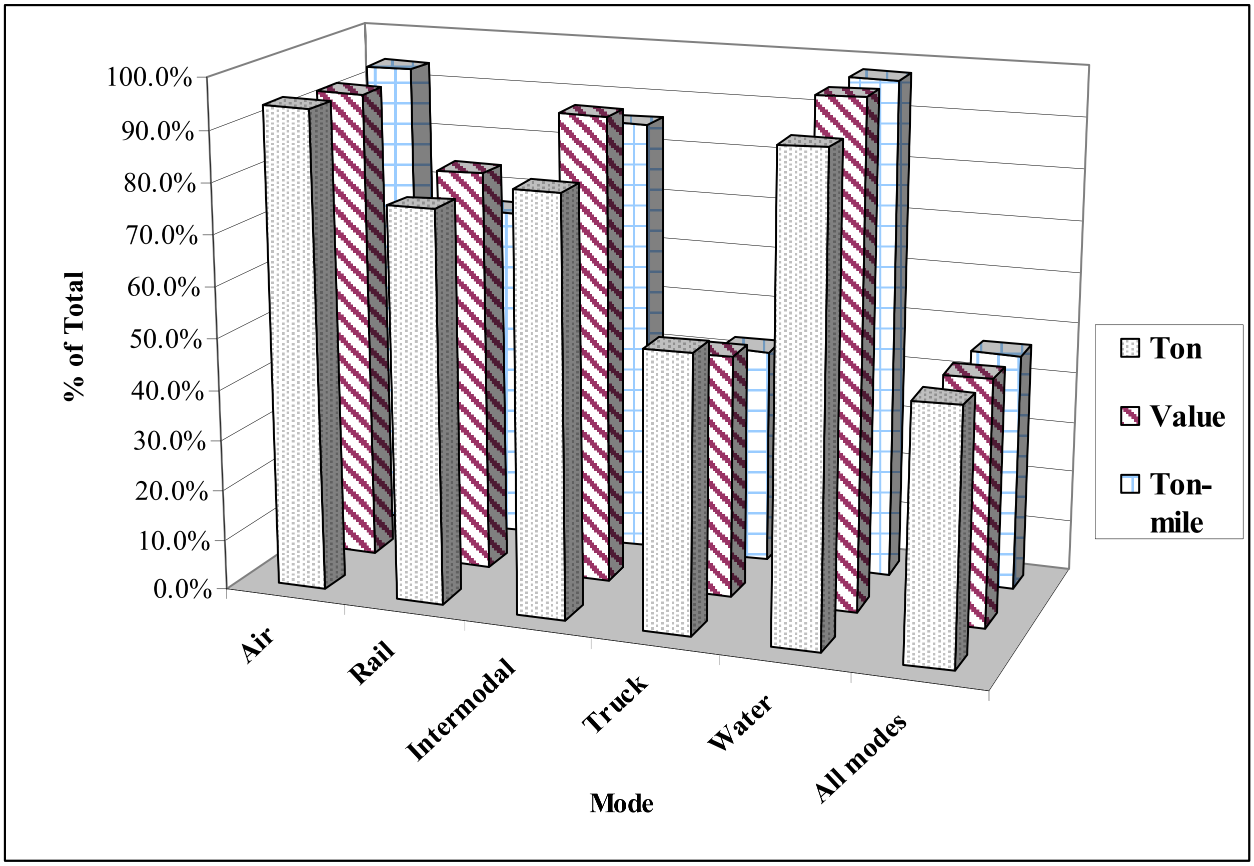


Chart 6.8 Share of Top 5 Commodities - Freight with Origin in the Study Area.

6.14 Opportunities

While the long-term growth projection mentioned previously is lower than the estimates that were made in the late 1990's, it will still impose a severe strain on the region's transportation network. While detailed network-level analyses must be conducted to determine the actual impacts on the study corridor, it is unlikely that the highway expansion alone can provide sufficient capacity to meet the future demand. Even the Intermodal, which is frequently mentioned as the possible alternative to trucking, is unlikely to be the comprehensive solution as illustrated by the following simple scenario analysis. According to the 1997 CFS, the most recent official data available for Intermodal activities, Intermodal accounted for 0.5% of tons, 2.1% of ton-miles, and 1.1% of value of the total freight movement in the US. Assuming Intermodal grew at the annual rate of 7% between 1997 and 2002, and continue to grow at the same rate thereafter until 2020, and total freight will grow at only 2% a year, Intermodal will account for merely

1.6% of tons, 5.8% of ton-miles, and 3% of value of the total freight in the US in 2020. However, these are national figures, and as discussed in the following section, alternative modes, including Intermodal, can play s significant role in some cases.

6.14.1 Exploring the Potential for Mode Shift

Although each mode analyzed in this study generally caters to specific market niches (i.e. a combination of commodity transported and origin-destination), there may be opportunities to shift a part of existing freight from one mode to another to achieve a balanced capacity utilization throughout the study corridor. In this section, an example of the planning approach that can be employed to identify the market segments that show a potential for modal shift is discussed.

The most critical factor that can be used to assess the feasibility of mode shift is the value-to-weight ratios. Table 6.37 shows the average value per ton of shipments transported by various modes for both the nation as a whole and for the shipments that originate or terminate in the study area. The data show that for some cases, the gap between two modes is so large that any notion of a substitution between them seems implausible. However, it should be mentioned that the figures presented in Table 6.37 are averages, and thus do not preclude substantial mode shifts within a market niche that may have real system-wide impacts. For example, approximately ten percent of the total shipment tonnage that is transported from the study area to California is by Intermodal. This is equivalent to three to four percent of the truck shipments that are transported on some sections of I-80 in Iowa.

It is known that due to the economics involved in the movement of freight, in general, the value-to-weight ratios are positively correlated with the shipping distance (BTS 2004e). For example, the average shipment distances of high value commodities such as textiles, leather, and related products and also electronic and office equipment exceed 600 miles, while sand and gravel are shipped about 60 miles on average. Thus, within the trucking industry, there are market segments that directly compete against Intermodal or even air. These are the types of market segments that present a potential for modal shift. On the other hand, there are segments, such as sand and gravel, which can only be served by trucking, and thus is not likely to be affected by minor changes in the relative cost and reliability among the modes.

Table 6.37 Comparison of value per ton across modes.

Mode of transportation	Average value per Ton (in $)**		
	Nation		Study area*
	2002	1997	1997
Truck	793	647	760
Rail	166	206	258
Water	131	135	87
Air (includes truck and air)	70,468	51,176	61,974
Parcel, U.S.P.S. or courier	38,715	36,129	30,639
Intermodal (truck and rail)	1,627	1,951	2,957
Truck and water	616	272	N/A
Rail and water	32	21	20

** Shipments that originate or terminate within the study area*
*** Values are not adjusted for price changes*
Source: 1997 CFS, 2002 CFS

The modes that share somewhat similar value-to-weight ratios are: truck and Intermodal, rail and water, rail and truck, and truck and truck and water. Thus, the mode shift opportunities between these mode combinations need to be assessed for each market segment, defined by both origin-destination and commodity type.

Figure 6.15 shows an example of such analysis. The three-dimensional chart is used to visualize each market defined by the origin-destination and the commodity. In the example, the market with Illinois and California as the origin and the destination, respectively, and the SCTG group 7 (food, fats, and oils) as the commodity, is highlighted. The 1997 Commodity Flow Survey (CFS) estimated a total of 1,142 million tons per year of shipments for this market. The mode shares for the market are computed from the CFS. The pie chart shows that this market is served by three modes, with the majority of the market is contested by truck and rail and Intermodal play a relatively minor role. By conducting similar analyses for all the markets and comparing the mode share trend with the characteristics of commodities such as value-to-weight ratio, time sensitivity, and temperature control requirement, as well as the characteristics of the origin and destination parings such as the distance and presence of ports, the factors that determine the mode usage can be identified. Those factors can be used to identify the markets with a potential for major mode shift. Also, some markets may be identified as having a potential but none of the alternative modes can compete against the "incumbent" mode due to a shortcoming that may be remedied by public sector interventions. Knowing the potential markets will enable the public and private sectors to undertake focused efforts to address existing deficiencies that may be preventing shippers from using alternative modes.

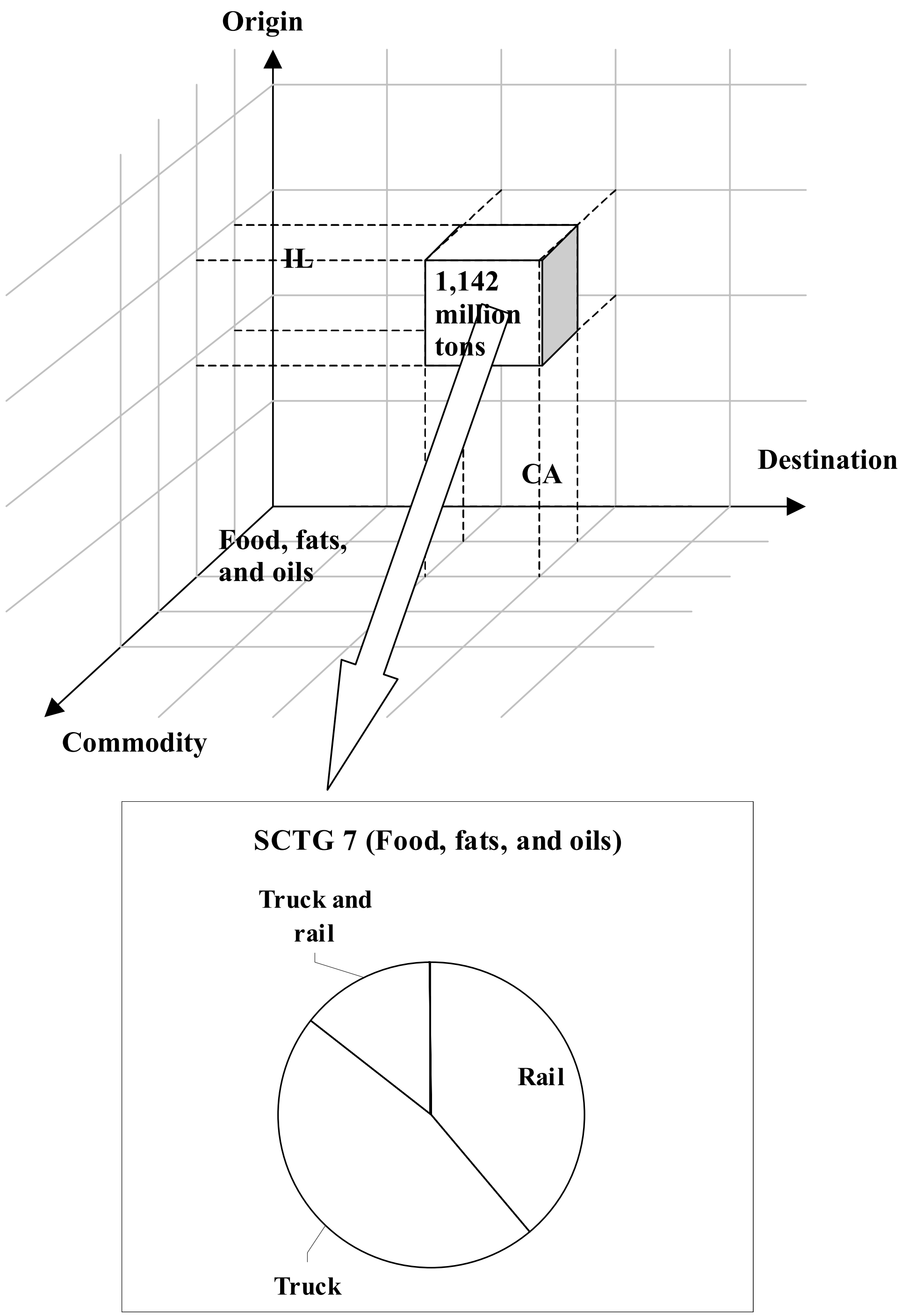


Figure 6.15 An Example of Exploring Mode Shift Opportunities - SCTG 7 (food, fats, and oils) Shipments Originating in Illinois and Terminating in California.

Data source: 1997 CFS

6.14.2 Regional Approach

As shown in Figure 6.16, the most important trade partners of the states within the study area are other states in the study area. The select link analyses of the I-80/I-90/I-94 corridor, discussed in the Subsection 6.6.2 also reveals that at various locations along the corridor expressways, the majority of the truck traffic is regional in nature. Thus, the most efficient planning framework for addressing the freight capacity problems within each of the study are state would be to address the flow of freight from the regional perspective rather than individual state's.

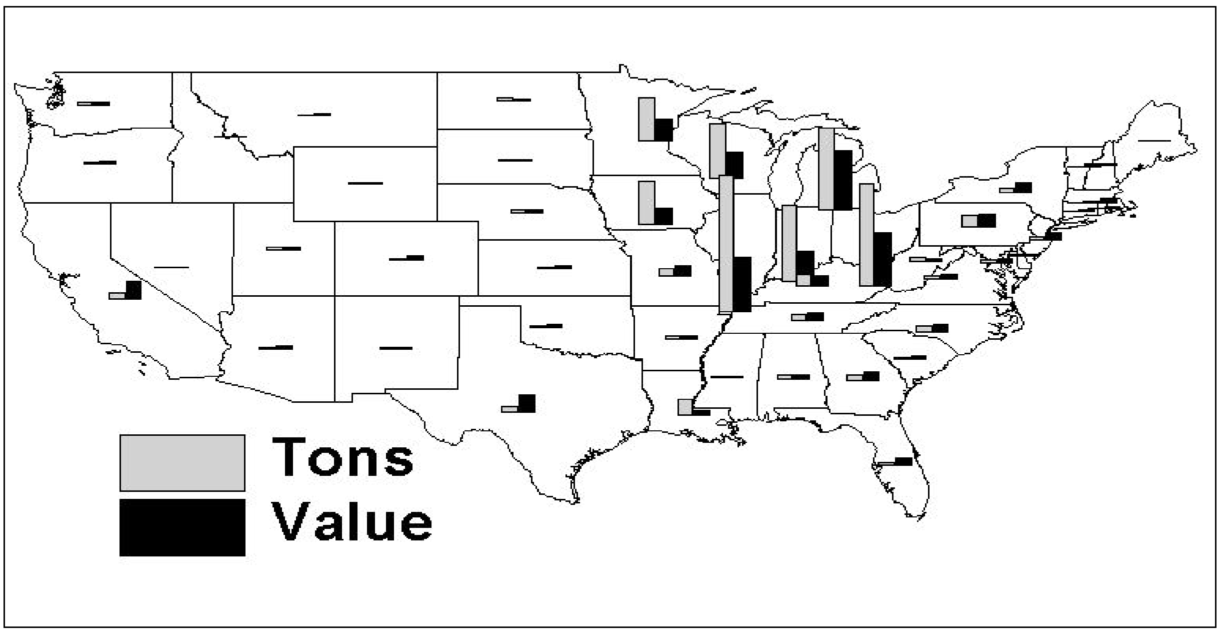


Figure 6.16 Total Freight Flow by Destination - Shipments with Origin within the Study Area

Source: 1997 CFS

7 CAPACITY

7.1 Highways

Under the standard base condition as defined in the Highway Capacity Manual, roadway and traffic conditions impact capacity and performance of each type of highway. (HCM 2000) By assuming highways and roadways have ideal roadway conditions then traffic parameters such as directional distributions, peak hour factor and percentage of heavy vehicles will impact service flows at the desire level of service. Generally it is expected that highways should operate at a level of service C or better to have reasonably free flow operating condition.

Design of highway facilities to meet the demand is based on several factors. Critical factors are the operational capacity and level of service. Generally, highways are designed at LOS 'C' or better so that they can meet the future travel demand. It is hypothesized that if highways are operating at LOS 'D' and 'E' may become potential bottlenecks in near future. Based on these criteria, theoretical analysis is performed by considering AADT and percentage of heavy vehicles. Other attributes such as terrain condition, shoulder width, lane width, directional split and 30th highest hour factor (K-factor) are also considered. The analysis provided the effect of increasing percentage of heavy vehicles on service flow and level of service. The results are compared with the highway capacity manual to generalize the effect of percentage of heavy vehicles on LOS.

By considering ideal physical and some of the traffic attributes, Table 7.1 is developed to show threshold values for AADT and percentage of heavy vehicles for four lane, six lane and multilane highways to operate at a LOS 'C'. All parallel and intersecting highways that have higher AADT and heavy vehicles percentage values as compared to the values listed in Table 7.1 are selected for the capacity analysis. For two lane highways AADT of 10,000 and 10 percent of heavy vehicles is considered as a threshold value.

Table 7.1 Criteria for Selection of Freight Routes.

Highway type	Four lanes	Six lanes	Speed considered
Freeway	50,000 and 40%	80,000 and 25%	65
Multilane	30,000 and 10%	40,000 and 20%	60

Source: Highway Capacity Manual 2000.

7.1.1 Data Collection and Processing

BTS maintains data for transportation networks for the entire United States. The data includes shapefiles of the highway network, the rail network, ports, airports and intermodal connectors. The shapefiles provided by BTS contain cartographic data that helps in developing maps for the study area. The BTS data has been used to identify important highways, whereas data from National Highway Planning Network (NHPN) is used to identify the last mile connectors for the intermodal terminals. The NHPN does not contain capacity attributes that could be used in capacity analysis, thus each DOT in the study region were contacted for the capacity related data. The data was made available by each state to the research team.

The most difficult tasks the research team faced is to convert all the data in a particular format so that it could be a part of input file to capacity program. For a regional study of this stature, it is desirable that all states jointly develop a common platform for reporting data so that it is readily usable in the capacity program and other analysis. A listing of the data source for the capacity analysis is in Appendix A, Table 1. Some of the problems encountered in data incompatibility are listed below.

- MSEXCEL file format has a limitation of holding data (68,000 columns and 264 rows). If a data file is larger than it can hold, then erroneous results occur.
- Data conversion from MSEXCEL to MSACCESS file requires redefining fields and creating new field for compatibility to shapefiles.
- Maximum number of characters is “segseqse” field are 4 and “stateroute” field are 4, requiring creation of a unique ID to join two fields.
- Maps are available in PDF format with very little traffic data in electronic format. It needs extra effort to manually enter the data on to the NHPN shapefile.
- Sometimes traffic data is available in database without a common identifier to the database to shapefiles.
- In few cases, the physical terrain attributes are missing.
- Highway performance monitoring system (HPMS) data is most complete but in few instances percentage of trucks are erroneous.

7.1.2 Capacity and Level of Service

Level of service is defined in Highway Capacity Manual 2000 through the concept of operating condition of highway during peak hour. Each level of service represents a range of operating conditions and users perceptions of those conditions. Level of service A indicates comfort level of the passenger very high and F indicates difficult driving conditions. In general, level of service A, B and C are considered good operating conditions. Level of service D, E and F are considered potential bottlenecks that impede the traffic flow.

HCM-2000 suggests the methodology for estimation of the level of service for freeways, multi- lane highways and two lane highways. This methodology is used for the capacity analysis. As discussed earlier, most of the physical and some of the traffic parameters except AADT and percentage of trucks were assumed ideal and default values are used in performing capacity calculations. Appendix A, Table A2 shows the default values for various parameters of physical and traffic conditions for urban and rural highways. The default values are only used in case of actual data is not available. By assuming the default values remain constant, estimation of LOS is performed for different AADT. The level of service changes with AADT. The values in Table 7.2 are compared with the traffic volume data obtained from BTS/HPMS and the state DOTs to ascertain the operating condition of highways in terms of level of service.

Table 7.2   Level of Service by AADT for Various Urban and Rural Highways.

	Level of service			
Urban	**A/B**	**C**	**D**	**E/F**
4-lane freeway	0-38,000	54,000	71,000	>71,000
6-lane freeway	0-57,000	81,000	107,000	>107,000
8-lane freeway	0-76,000	109,000	143,000	>143,000
10-lane freeway	0-95,000	136,000	179,000	>179,000
12-lane freeway	0-113,000	163,000	214,000	>214,000
14-lane freeway	0-132,000	190,000	250,000	>250,000
Rural				
4-lane freeway	0-26,000	39,000	49,000	>49,000
6-lane freeway	0-39,000	58,500	74,000	>74,000

Source: Highway Capacity Manual 2000.

7.1.3 Capacity Analysis Program

The capacity of a highway facility is defined by HCM 2000 as the maximum hourly rate at which vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway. The maximum hourly rate occurs at a level of service E (that indicates a considerable slowdown of traffic). For smooth operational condition of facilities, it is generally accepted that a highway should be operating at a level of service C or better. For each level of service, there is a corresponding maximum hourly service flow rate that is expected to traverse a point or uniform segment of lane or roadway during a given period under prevailing roadway and traffic conditions. As the service flow rates are the maximums for each level of service, they effectively define the flow boundaries between levels of service.

Highway Capacity Software (HCS) incorporates the methodology suggested by HCM 2000. The HCS is developed to estimate highway capacity of uniform sections or segments. It requires manual input of data and the output is unique value of level of service. The limitation of the HCS is that it cannot read large data of various sections of highways from a database file. Also, the HCS does not provide the output that could be displayed as thematic maps. Because of these limitations the HCS is not applicable to the present study.

A capacity analysis program (CAP) using Visual Basic application, which works with Microsoft Excel, was developed using the methodology suggested by HCM 2000. The program works with the spatial databases. It takes the input directly from database files and performs capacity analysis and adds results of capacity estimation to the database files. From the database it is easy to display results of capacities of the entire network on thematic map. The output of the CAP is saved in database file to generate maps. ArcMap program by ESRI was used to generate thematic map depicting level of service. Appendix A, section A1 and Figure 1 contain more detailed information on the CAP and related methodologies.

7.1.4 Discussion of results

Figure 7.1 shows level of service for the highways analyzed in this study. Figure 7.1 shows most of the urban corridor highways have level of service F and have serious congestion problems. In the rural area highways are showing signs of congestion. It should be noted that the estimation of level of service shown in Figure 7.1, thematic map is by considering segments of highways of uniform conditions between interchanges. Interchanges configuration, directional traffic at interchanges, toll plazas, incident and weather condition will worsen the level of service and show congestion. A further detailed analysis is advisable to account for these variables.

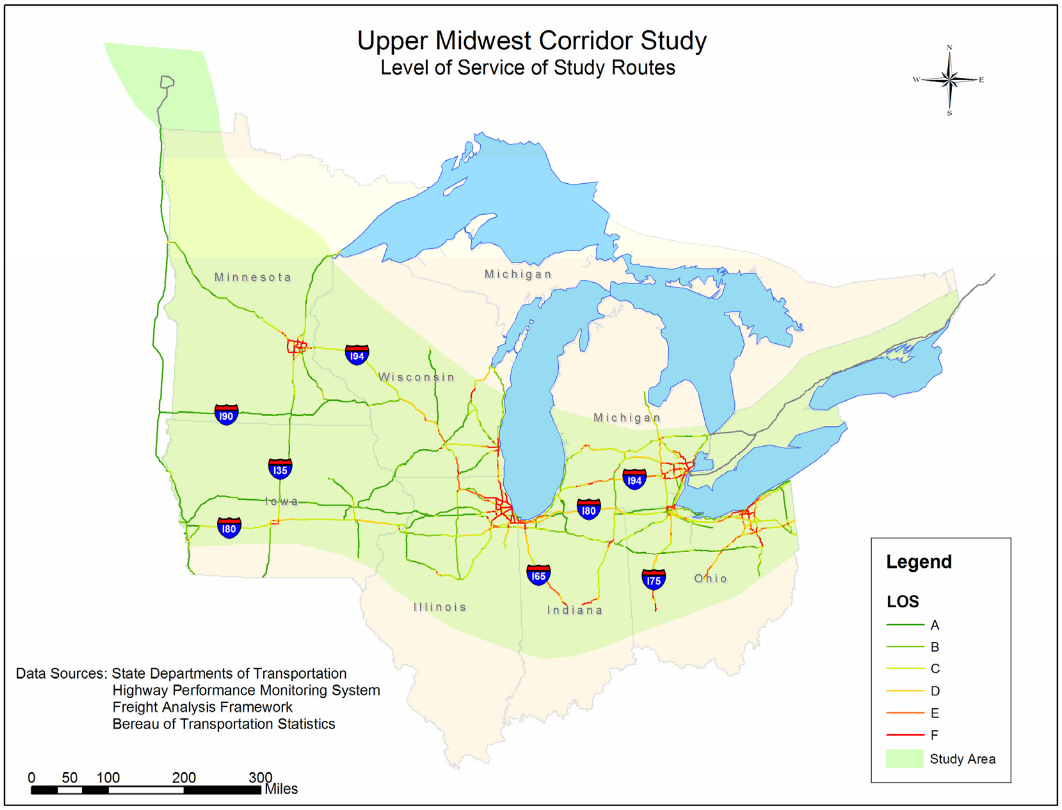


Figure 7.1 Highway Network Thematic Map showing Level of Service.

7.2 Railways

7.2.1 Selected Railroad Network

Railways play an important role in freight transportation. By land railways are cost effective as compared to other modes for transporting bulk and long distance commodities. The railroad network in this study's region consists of 58,426 track miles serving most of the intermodal terminals (where the goods are transferred form one mode to another) in the corridor. The Association of American Railroads (AAR) classified railroads in three categories on the basis of generation of revenues:

Class I railroads are the major freight railroads operating around 71 percent of the total track miles in the U.S. They generate more than 91 percent of total rail freight revenues. According to Federal Surface Transportation Board, class I railroads generates revenue of more than $256.4 million each year.

The Association of American Railroads categorized the railroads other than class I, into Regional and Local. **Class II** railroads are Regional with annual revenues between $20.5 million and $256.4 million. **Class III** is Local railroads with revenues less than $20.5 million.

The freight carried by the railroads is expressed in terms of density i.e. million gross ton mile/mile (MGTM/MI). The density of the line ranges from 0-7. Where 0 means it is an abandoned line and 7 means that the line can carry freight more than 100 million gross tons.

In the United States, railroads owners maintain their own railroads and charge user fees to others on the basis of MGTM. In the Upper Midwest, the following class I railroads are represented:

- Burlington Northern Santa Fe (BNSF)
- CSX Transportation (CSXT)
- Canadian Pacific Railway (CPRS)
- Canadian National Railway (CN)
- Norfolk and Southern Railroads (NS)
- Union Pacific Railroad (UP)

The class I railroads connect intermodal terminals and major cities in the study region. Forty two percent of the total track miles in the study region are classified as class I. Each link carries a maximum of 100 million gross tonnages of goods. Because of the bulk of freight carried by class I railroads, only class I railroads are initially considered as prime importance.

7.2.2 Railroad Capacity Parameters

An algorithm developed by PMM&Co (Peat et al. 1975) for FRA is used to estimate railroad capacity. The algorithm defines capacity as a function of parameters. Appendix A, section A.4 provides documentation of the rail line capacity algorithm. The main parameters affecting capacity are classified into three categories: Plant parameters, traffic parameters and operating parameters. Furthermore, plant parameters contain length, sidings and crossover spacing, traffic parameters contain speed limit and operating parameters contain attributes such as track outages, train stop time and maximum trip time. Using regression techniques, PMM&Co developed a set of equations for a 100-mile line to estimate the combined effect of the parameters on the railroad capacity. This model can be used for railroads up to four parallel side-by-side tracks.

7.2.3 Rail Segments for Capacity Analysis

Estimation of capacity of each link is tedious and time consuming. Therefore a method is developed to select a subset of the class I railroad segments for capacity analysis. The segment of class I railroad consists of:

- Railroad connecting two major cities.
- Railroad intersecting other class I railroad.
- Railroad connecting intermodal terminals.
- Railroad consists of similar operating conditions (Single track, Double track).

Figure 7.2 shows the selected railroad network for capacity analysis. A detailed procedure of selecting the class I railroad network based on segments is given in Appendix A, section A3.

7.2.4 Data Collection and Processing

The Bureau of Transportation statistics website contains traffic and link characteristics data. The link database provides two shape files, one is 1:100,000-scale network ("Rail100K") and the other is 1: 2,000,000 scale network ("Rail2m"). The FRA website contains crossing inventory database. This database corresponds to node data.

7.2.4.1 Railroad link by link Database

The "Rail100k" shape file has data by the railroad class, railroad owner and trackage rights of the links/lines. The "Rail 2m"shape file has the same data as "Rail100k" but it also includes the number of tracks, type of signal system operating on the link (i.e. absolute block system, centralized or manual traffic control system) and density on the links/lines.

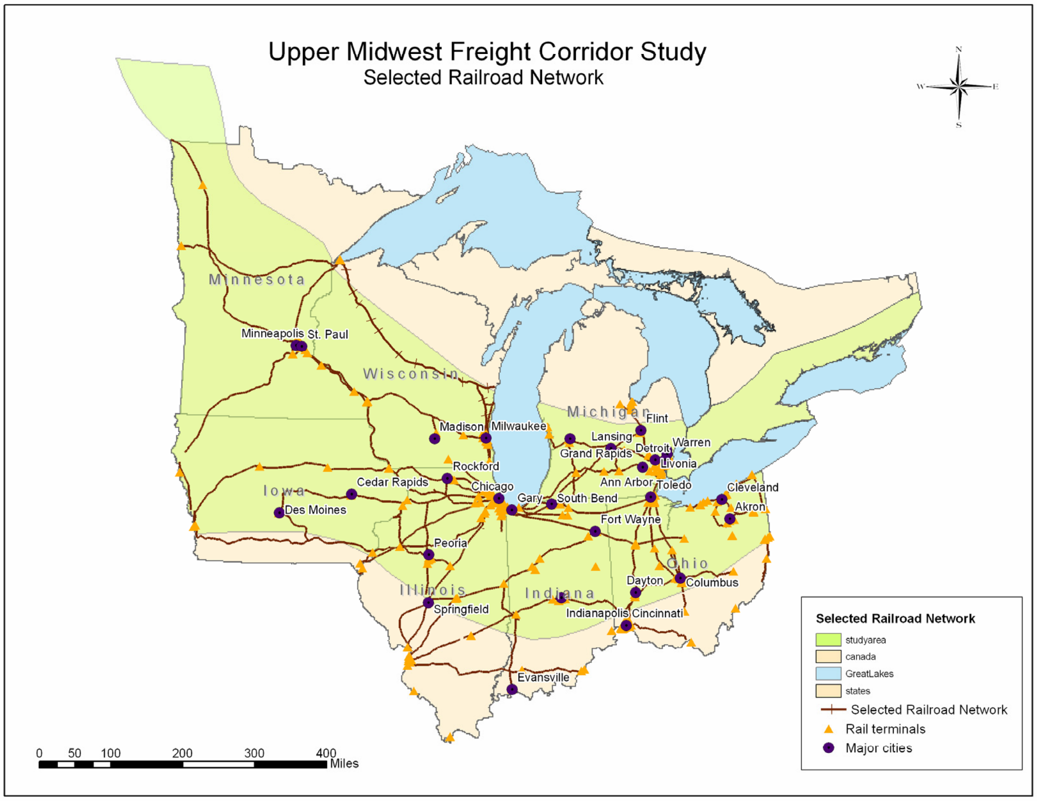


Figure 7.2 Selected Railroad Network that connects all Intermodal Terminals and Major Cities.
Source: 2003 Bureau of Transportation Statistics Rail (1:2,000,000) scale Network Data.

7.2.4.2 Railroad crossing node Data

The railroad crossing data obtained from the FRA website is in DBASE format. This database has data about sidings, passing, train speeds, signals, and number of tracks, highway signals, at grades, percent trucks and many more.

7.2.4.3 Assembling the Data for Railroad Capacity Calculations

For the railroad capacity estimations both the line and crossing databases are needed. As these two databases are obtained from two different sources there is no common identification number for easy merging. Thus using both link and node databases an "Integrated Class I Railroad Network" (scale 1:100,000) shape file, "rail100k dBase file", "rail2mdbasefile" and "crossing link dbase file" was developed. Appendix A, Figure 5 shows more information on integrating the databases from two sources and attributes in those databases.

7.2.5 Railroad Capacity Program

For estimation of railroad capacity, a computer program is written in Visual Basic language. This program uses the algorithm developed by PMM&Co for FRA as a commuter train dispatching simulation model. The program calculates the practical railroad capacity and estimate track utilization factor. The track utilization factor (TUF) is defined as the ratio of usage to practical capacity. The TUF is helpful in identifying the bottlenecks and areas with excess capacity.

Appendix A, Figure 4 provides the process of the algorithm and application of the program to obtain railroad capacity. The capacity is shown in terms of TUF using current number of trains per day. .

7.2.6 Display of Results

The railroad capacity program derives inputs from the integrated class I railroad network file and estimates capacities by segment. The output from the program is displayed in EXCEL format and then exported back in DBASE file to display thematic map using Arc Map/ Arc View. The program helps in identifying the segments of railroad network having limited (potential bottlenecks) or excess capacity using the track utilization factor (TUF). TUF < 0.5 provides an indication of the additional traffic volume (available capacity) that could be handled by the system while not exceeding the defined threshold. A TUF > 1.00 indicates the potential bottlenecks in the network.

Figure 7.3 shows the capacity of railroad network in the study region. Figure 7.3 shows the color-coded capacity in terms of TUF. The thematic map can be found on the upper Midwest freight corridor study website which is hosted by GISAG center of the University of Toledo. It is easy to use thematic map to obtain information for a particular segment of railroad network. By pointing and clicking the subject segment, one can obtain host of information regarding the segment. The information contains all parameter values and the segment TUF. The thematic map is color coded to reflect each level of TUF.

7.2.7 Discussion on Results

Figure 7.3 shows the thematic map and displays capacities in terms of TUF. It should be noted that the TUF shown in the thematic map are line capacities only. It shows that several segments of the railroad have TUF greater than 0.5, an indication of possible line congestion. Other parameters such as ratio of express train (fast train) to freight train (slow train), terminal and yard configurations, railroad crossings and signal blocking will have severe impact on railroad capacities. A further detailed analysis is advisable to account for these variables.

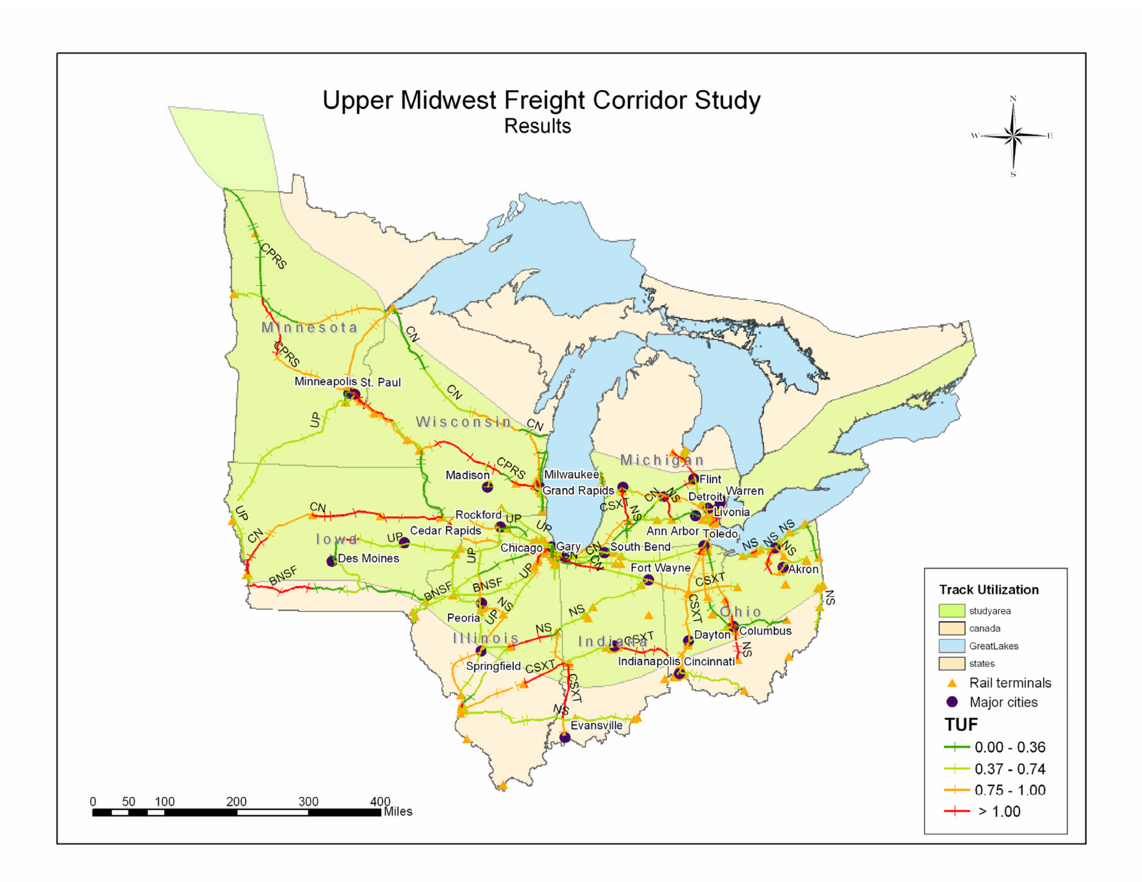


Figure 7.3   Track Utilization Factor of Selected Railroad Network.

Source: 2004 GISAG Base Map Network data.

7.3 Airport Terminals

7.3.1 Selection Criteria for Airports:

There are around 103 airports in the upper Midwest freight corridor study region. A large number of airports have no daily flight activity; therefore an elimination process was adopted for the selection of airports. The criterion used in the elimination process is as follows:

- Eliminate all airports having zero hourly arrivals and departures.

- Eliminate all airports that are not lying within 5mile distance from the intermodal facilities.
- Eliminate all airports with monthly freight volume less than 20 tons.

After the completion of elimination process nineteen airports remained for study. Table 7.3 shows the list of selected airport terminals showing the airport terminal name, airport location ID, state, and city. Table 7.4 shows the hourly arrivals, departures in terms of aircrafts/hour and monthly incoming, outgoing freight tons per month of the selected airports.

7.3.2 Capacity Parameters

The parameters affecting airport capacity are as follows:

- Configuration, number of runways, taxiways and aprons.
- Aircraft size, speed, ground maneuverability.
- Environmental conditions (i.e. Visibility, winds and weather).
- Runway surface conditions.
- Noise abatement requirements, operating strategy for runway and air traffic control rules and regulations.
- Aircraft parking position and gate.
- Passenger waiting area.
- Passenger security screening.
- Terminal circulation (stairs, corridors).
- Terminal curb.

Table 7.3 List of Selected Airports for the study.

S.N0	LOC_ID	STATE	CITY	AIRPORT NAME
1	CID	IA	Cedar Rapids	Eastern Iowa
2	DSM	IA	Des Moines	Des Moines Intl
3	MDW	IL	Chicago	Chicago Midway Intl
4	ORD	IL	Chicago	Chicago O'Hare Intl
5	MLI	IL	Moline	Quad City Intl
6	PIA	IL	Peoria	Greater Peoria Regional
7	RFD	IL	Rockford	Greater Rockford
8	FWA	IN	Fort Wayne	Fort Wayne International
9	IND	IN	Indianapolis	Indianapolis Intl
10	SBN	IN	South Bend	South Bend Regional
11	DTW	MI	Detroit	Detroit Metropolitan Wayne County
12	FNT	MI	Flint	Bishop International
13	GRR	MI	Grand Rapids	Gerald R. Ford International
14	AZO	MI	Kalamazoo	Kalamazoo/Battle Creek International
15	MSP	MN	Minneapolis	Minneapolis-St Paul Intl/World-Chamberlain
16	CLE	OH	Cleveland	Cleveland-Hopkins Intl
17	TOL	OH	Toledo	Toledo Express
18	ATW	WI	Appleton	Outagamie County Regional
19	MKE	WI	Milwaukee	General Mitchell International

Source: Bureau of Transportation Statistics Public use Airports Data.

Table 7.4 Hourly Arrivals and Departures and Freight Volumes of Selected Airports.

Airport LOC ID	Number of Hourly Departures	Number of Hourly Arrivals	Incoming freight (Tons/month)	Outgoing freight (Tons/month)
	4	3	1442	1486
DSM	5	5	4446	4188
MDW	24	24	1475	1360
ORD	96	94	79053	63159
MLI	2	2	77	57
PIA	2	2	2285	2652
RFD	1	1	7556	8358
FWA	4	3	6243	6734
IND	16	17	40028	42178
SBN	3	3	871	855
DTW	50	51	10240	8536
FNT	3	3	773	582
GRR	5	5	1619	1471
AZO	2	2	22	24
MSP	52	52	14016	14269
CLE	24	24	4106	4041
TOL	3	3	8036	8658
ATW	2	2	494	431
MKE	17	17	4436	4455

Source: Bureau of Transportation statistics, Air carrier statistics data.

7.3.3 Data availability

Most of the airport terminal data is available from Bureau of Transportation Statistics, and Air Carrier Statistics (Form 41 Traffic). Three different types of data files are available:

- T-100 segment database
- Public use runways
- Public use airports

The T-100 segment database combines domestic and international segment data by U.S. and foreign air carriers. It contains data on aircraft type, service class for passengers transported, freight and mail transported available capacity.

The Public Use Airport Runways database is a geographic dataset of runways in the United States and US territories containing information on the physical characteristics of the runways. This geospatial data is derived from the FAA's National Airspace System Resource Aeronautical Data Product (Effective 23 January 2003). This data provides users with information about the runway locations and attributes for national and regional analysis applications.

The Public-Use Airports database is a geographic point database of aircraft landing facilities in the United States and U.S. Territories. Attribute data is provided on the physical and operational characteristics of the landing facility, current usage including Enplanements and aircraft operations and congestion levels.

7.3.4 Airside and Landside Capacity

Airport capacity is complex in nature and is divided in two parts: airside and landside. Each part has several attributes that determine the capacity of that part of the airport. The overall capacity of the airport is then considered as the minimum capacity of the two parts. Federal Aviation Administration defined airside capacity as the maximum number of aircraft operations (arrivals, departures) that can take place in an hour. It mostly depends on runways. Runway capacity is divided in two parts: One is practical capacity corresponding to a tolerable level of average delay and the other ultimate capacity defined as the maximum number of aircraft that can be handled during a given period under conditions of continuous demand.

Landside capacity is the capability of the functional components to accommodate passengers, cargo, ground transport vehicles and aircraft. Service volume is the principal indicator of landside capacity, which is the number of passengers that can be accommodated by a functional component or group of components in a particular time period relative to a particular demand at a given service level. Generally the landside capacity is much less as compared to airside capacity. It involves numerous complex components and analysis. Due to limitation of time and resources landside capacity is not estimated. Only airside capacity in terms of ultimate capacity is expressed which does not take into account of weather condition, air traffic control system constraints and landside capacity constraints.

In this study two methodologies are used to calculate the ultimate capacity one is based on graph recommended by FAA (FAA 1976) and the other is based on mathematical formula recommended (Noritake and Kimura 1993) by International Association of Traffic and Safety Sciences (IATSS) Journal. Appendix A, section A.7 outlines the details of both the procedures. The methods suggested by the FAA and the IATSS are used to estimate airside capacity of the selected airports. Table 7.5 shows daily arrivals and departures, number of runways and the ultimate theoretical airside capacity of selected airports in the study region. As discussed earlier, the airside capacity is constrained by other parameters and the capacity shown is ultimate capacity only.

Table 7.5 Airside Capacities for Selected Airports.

LOCID	Daily Arrivals	Daily Departures	Number of Runways	Maximum Runway Capacity (graph)	Ultimate Runway Capacity (IATSS)	Total Operations	Unused Capacity (Graph)	Unused Capacity (IATSS)	Percent Unused Capacity (Graphical)
DSM	5	72	2	96	116	10	86	106	89.58
MDW	24	320	5	240	290	48	192	242	80
ORD	94	1223	7	336	406	190	146	216	43.45
IND	17	213	3	144	174	33	111	141	77.08
DTW	51	659	6	288	348	101	187	247	64.93
GRR	5	69	3	144	174	10	134	164	93.06
MSP	52	677	3	144	174	104	40	70	27.78
CLE	24	316	4	192	232	48	144	184	75
AZO	2	25	3	144	174	4	140	170	97.22
FNT	3	34	3	147	174	6	141	168	95.92
FWA	3	50	3	153	174	7	146	167	95.42
MKE	17	224	5	240	290	34	206	256	85.83
TOL	3	42	2	96	116	6	90	110	93.75
ATW	2	27	2	96	116	4	92	112	95.83
MLI	2	32	3	144	174	4	140	170	97.22
CID	3	46	2	96	116	7	89	109	92.71
RFD	1	14	2	96	116	2	94	114	97.92
PIA	2	28	2	96	116	4	92	112	95.83
SBN	3	43	3	144	174	6	138	168	95.83

Source: Bureau of Transportation statistics, Public use Runways, Air Carrier Statistics. Note: The Total operations, and capacity are all expressed in aircrafts per hour.

7.3.5 Results:

From the analysis the following points are observed:

Chicago's O'Hare International Airport (ORD) has maximum arrival and departures with ultimate capacity of 336 ~406 aircraft/hour. The maximum number of passenger flights (98 aircrafts /hour) are served by ORD –DTW corridor (Chicago and Detroit). Appendix A, Table 6 contains more information and data regarding airport capacity.

The thematic map showing the selected airports can be found on the website hosted by GISAG Center of the University of Toledo. The user can access the airport data by clicking and pointing on the particular airport of interest.

7.3.6 Discussion on Results

Table 7.5 shows the ultimate runway capacity of selected airports in the upper Midwest study region. It should be noted that the ultimate runway capacity is severely impacted by other factors such as weather condition, runway and taxiway configurations, and air traffic control system. By incorporating these parameters the practical capacity is generally between 30-40 percent of ultimate capacity. Landside capacity further constrains and creates bottleneck in the airport practical capacity. Thus, the airport capacity depends on airside and landside constraints. It is advisable to further study in detail the practical capacity of each airport.

7.4 Waterways

Great Lakes waterways and the Mississippi River system provide water borne transportation for the Upper Midwest region. Great Lakes serve the states of Wisconsin, Illinois, Indiana, Michigan and Ohio as freight routes. The Mississippi River system passes through the border of the Minnesota, Wisconsin, Illinois and Iowa. The Mississippi river system tributaries are Illinois River and Wisconsin River. These rivers pass through the Illinois and Wisconsin states respectively. The Ohio River falls outside of the corridor study area.

There are forty-two navigational locks in the Mississippi River system. Locks, due to their restricted sizes and difficulties in operation are the controlling factors for the total freight that can pass through the navigation system. Freight transportation is constrained by these locks.

7.4.1 Navigational Routes in the Study Region

Navigational routes are paths in lake or inland waterway system. Navigational routes are identified and maintained by US Army Corps of Engineers. The navigational data and statistics are maintained and updated by the Navigational Data Center (NDC). Figure 7.4 shows the Upper Midwest corridor inland waterway system with navigational routes and major ports.

7.4.2 Route Capacity and Constraints

The route capacity of the navigational waterways is regulated by the operation of locks or restricting widths and depths. Also, route capacity is governed by the delays at the locks, size and capacity of vessels and recreational vehicles percentage.

The Lock Performance Monitoring System (LPMS) provides monthly data for the commodities and vessels that are passing through the lock chambers. The data include tonnage, number of barges, total delay and average delay at the lock gates. However, the data are in one big database from which data has to be processed to get each year's tonnages.

The lock restrictions are the maximum dimensions that a passing vessel can have. Theoretical capacity of lock can be given by maximum capacity of the largest vessel that can pass through the lock cross-section multiplied by total number of passage that are allowed through in the period of concern. However this theoretical capacity can be often misleading. The lock operations consist of commercial lockage (freight), recreational lockage and other lockage such as public transportation. All the vessels that carry freight, people and recreational purpose share the lock system. It is difficult to identify the purpose and type of lockage performed. The sizes of vessels that carry freight and density of the freight vary, in which case it is very difficult to report the capacity of the lock by some quantity. Some of the ways in which the lock operating conditions can be reported are average delay at the locks and percentage of commercial versus recreational vessels.

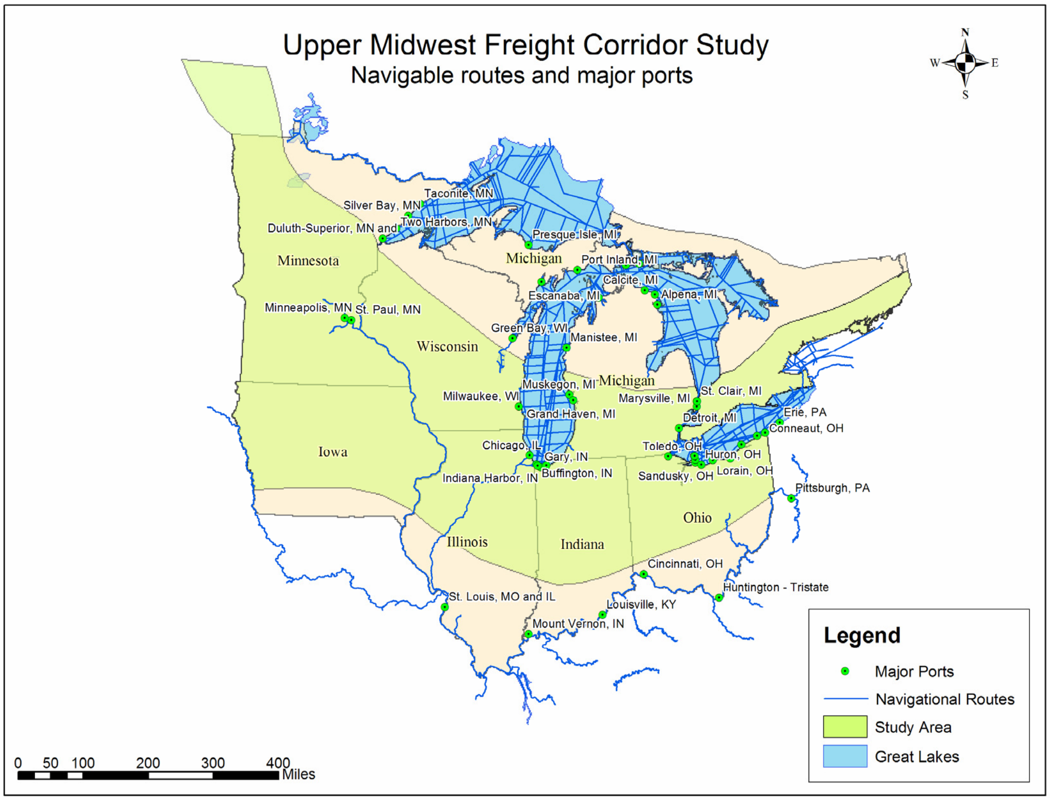


Figure 7.4 Navigational Waterways and Ports in the Upper Midwest.

Locks impede the freight flow for the following reasons:

- Due to the restricted size and depth available at the lock gates, the sizes of vessel are restricted to the size of lock gates.
- As recreational and commercial vessels share the locks, greater the percentage of recreational vehicles, lesser will be the freight capacity of the locks.
- Large barges are difficult to pass through the lock gate in single operation. Sometimes two operations are necessary in order to process the large barges or vessels.
- Delays at the lock gates often build up queues, which in turn affect the capacity.

Some of the ways in which the lock operating conditions can be reported are average delay at the locks and percentage of commercial versus recreational vessels. Figure 7.5 shows the positions of locks along the navigable waterways.

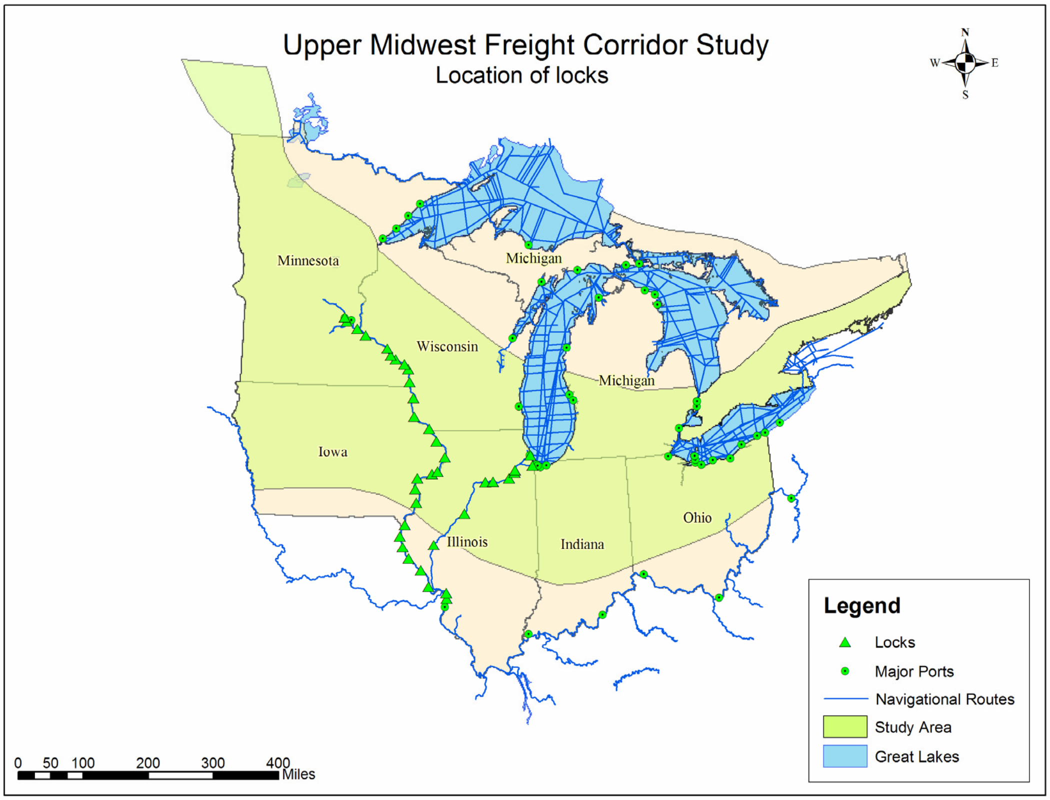


Figure 7.5 Positions of Locks along the Navigable Waterways.

Figure 7.6 shows the total tonnage of freight processed at the lock gates for the year 1999. These total tonnages are derived from addition of each month's tonnages at the lock chambers from the NDC waterway database. Generally, the data in the LPMS (Lock Performance Monitoring System) is updated every year, but the latest data available is for 1999. Figure 7.7 shows average delay at the lock gates. The link flow for waterway data is updated yearly and the latest data available is for 2002. Figure 7.8 shows the total tonnage that is shipped through the inland waterway system for the year 2002.

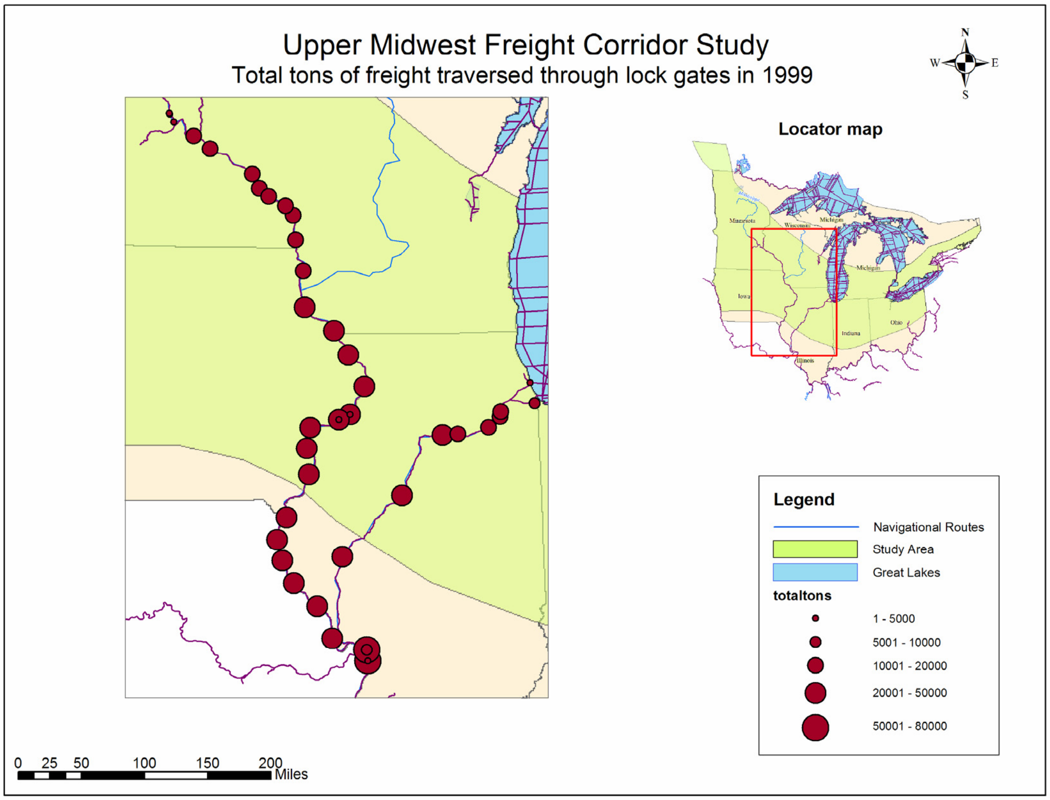


Figure 7.6 Total Tonnage Processed at the Lock Chambers for the Year 1999.

Source: Navigational Data Center, Corps of Engineers

7.4.3 Commodity Flow and Types of Barge

According to USACE (US Army Corps of Engineers) the major commodities that are shipped through inland waterways are petroleum, coal, machinery, finished products and agriculture. Some of the major commodities that are shipped through upper Midwest inland waterway system are coal, petroleum, chemical, crude and raw materials, manufactured goods, farm products and waste materials. Total commodities that are moved either upstream or downstream are given in Figure 7.8. Figure 7.8 shows total tons of freight that has been exported and imported at the major ports in corridor study region in the year 2002.

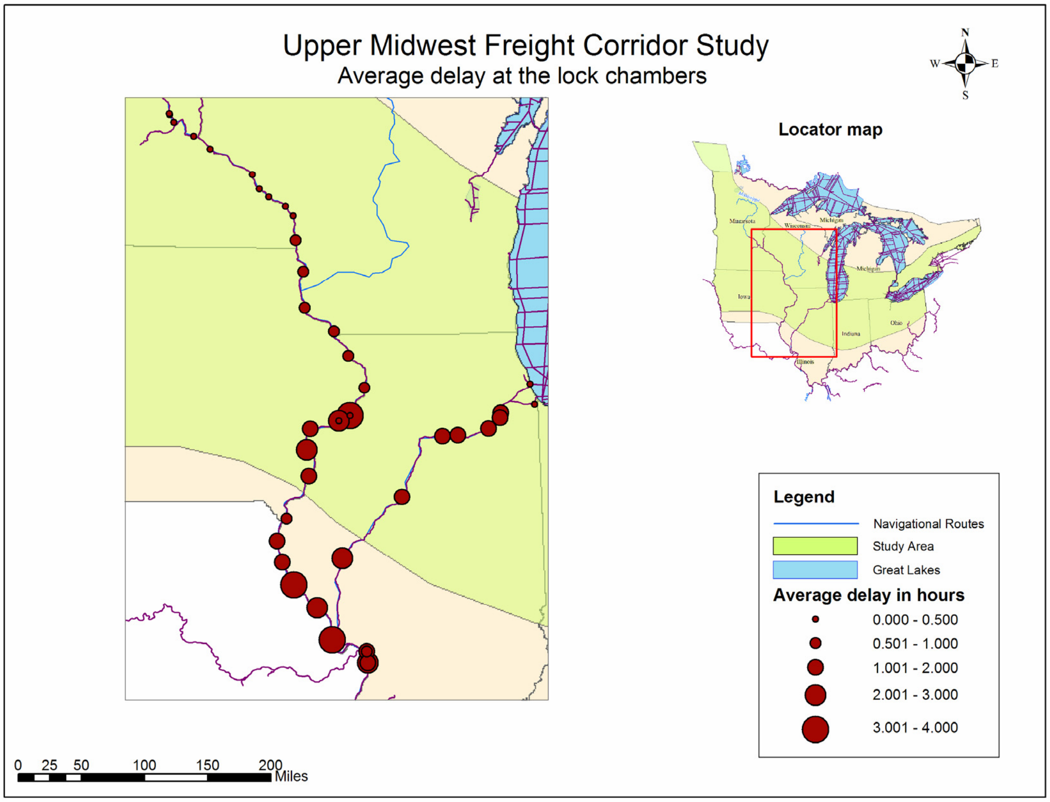


Figure 7.7 Average Delays at the Lock Chambers.

Source: Lock Performance Monitoring System

7.4.4 Methodology for Capacity at Lock Gates:

The theoretical capacity at the lock gates can be derived by a set of calculations as given in Appendix A, section A.8. The average processing time at each lock gate is available from lock performance monitoring system. Locks are subjected to a full 24-hour day operation, however the actual operation is considered as 20 hours per day. Number of tows that can be performed in 20 hours period is estimated by dividing 20 hours by average processing time. Number of tows that can be performed is 20/ average processing time. However some percentage of tows is delayed at the lock gates. Data is available on delayed time.

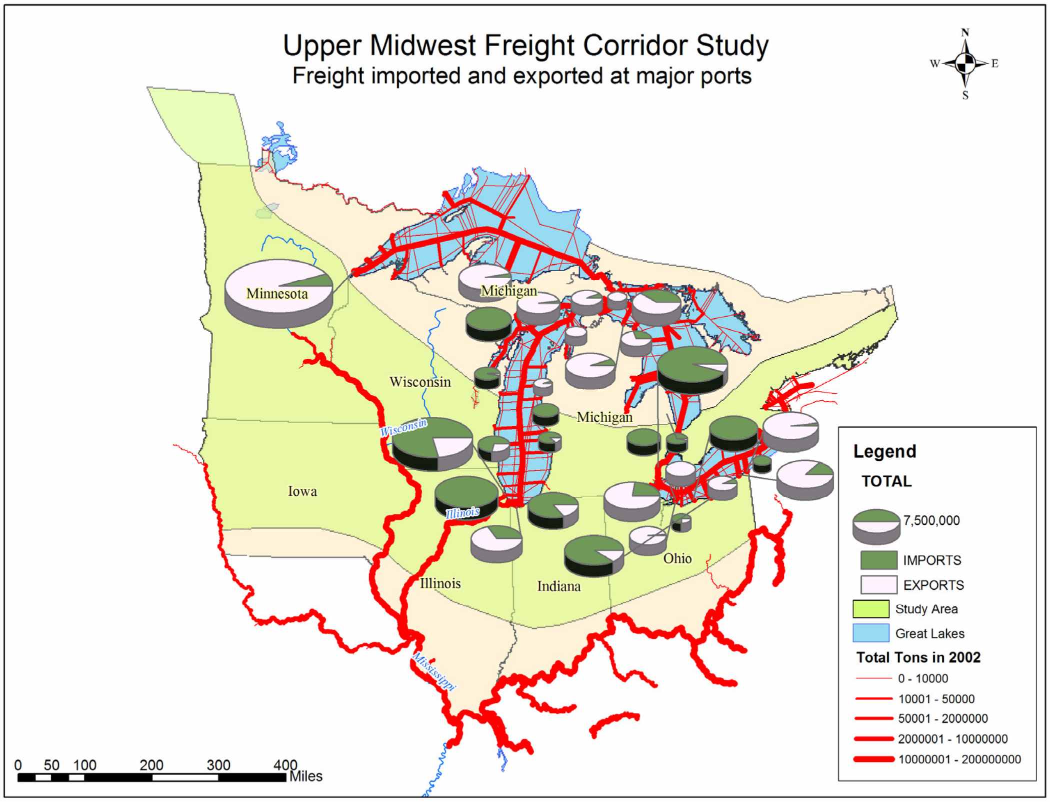


Figure 7.8 Freight movements in Imports and Exports at Major Ports.

Source: Lock Performance Monitoring System Results

7.4.5 Results

Additional data is shown in Appendix A, Table 10. This data from is used to estimate theoretical capacity, which again appended to the table as a field 'theoretical capacity' at each lock gate. Difference of theoretical capacity and the actual capacity will give the available unused capacity at the lock gate. Attributes and capacity information on each lock gate can be accessed through the data reporting website previously referenced.

7.4.6 Discussion on Results

The capacity of inland waterway system depends on the capacity of lock gates. The physical and operational characteristics of lock gates crate severe constraint in the inland navigational system. Figure 7.7 shows average delay at lock chambers for the Mississippi River navigational system. It shows that several locks in the system have excessive amount of delay thus making the practical capacity by 70 percent of theoretical capacity. Other factors such as barge size, lock operational characteristics and depth of navigational channel will further reduce the capacity to less than 50 percent. It is advised that a further detailed study of each lock and navigational channel should be conducted.

Due to limitation of time and resources, Great Lake waterways system is not studied in detailed. Figure 10 shows major import and export for the major ports. The data is obtained from the LPMS. The capacity of Great Lake waterways system depends on the port cargo handling characteristics, the depth and width of the navigational channel.

8 FUTURE EFFORTS

Freight transportation in the Upper Midwest states is critical to economic vitality of the region and the nation. The state DOTs and the university-based research team worked together to design a study that described four phases.

- Phase 1: Inventory/Data Collection – Assess freight flows, infrastructure, and administrative issues in the study area and discuss performance measures and synthesis of practices.
- Phase 2: Needs Analysis – Identify infrastructure and administrative needs.
- Phase 3: Action Plans – Develop and recommend action items to address needs.
- Phase 4: Implementation and Ongoing Efforts – Develop strategies for implementing these action plans and for continuing regional cooperation.

This report focuses on Phase 1. It provides documentation and analysis of the freight transportation system in the region and describes insights into the development of performance measures and the synthesis of practices. It is part of a continuing effort to establish a regional approach to improve freight transportation that is based on a multi-state, multi-jurisdictional partnership of public and private sector stakeholder interests. Goals for this phase of the study included:

- Compiling and synthesizing existing plans and efforts
- Creating a setting for coalition building through regular communication and data sharing
- Identifying and documenting the conditions and needs across all modes of freight transportation for the identified corridor
- Analyzing the non-physical capacity issues that may be an impediment to the efficient movement of freight in the region.

Phase 1 of the Upper Midwest Freight Corridor Study has six components: synthesis of practices, performance measures, administrative issues, usage, and capacity. The findings for these elements of the study are summarized in the Executive Summary and are not repeated here. An overview of the findings is also included in the Executive Summary.

This study was intended to be a first step in a comprehensive approach to understanding freight movements in the Upper Midwest states and the adjoining provinces of Canada. The region would benefit from the additional work described in Phases 2 through 4. At this point in time, the remaining work can be divided into four major components: 1) research and investigation; 2) data analysis and management;

3) process facilitation; and 4) organization and funding. While these lines are somewhat arbitrary, and topics do cross between the lines, the categorization is a useful way to discuss what might be done as next or future steps.

8.1 Research and Investigation

More information is needed on several topics. Much of this effort could be characterized as documenting best practices.

- Freight planning practice is still in its infancy. Few states or metropolitan planning agencies have done much in the field. Even fewer would argue that they have done it well. The region could benefit from an effort to evaluate the experiences of those past efforts across North America and around the world. The product of such an effort would be a model approach to freight planning. Such a model could be used by transportation planning agencies throughout the region. Such an approach, if it could be supported by all of those agencies, would go far toward improving communications and data compatibility across agency lines. It would allow plans to be compared across those lines, making borders more transparent. It should also improve the overall planning process.
- Freight public policy is also in its infancy. Legislative bodies in many states and provinces feel a need to address the "problem" of freight. The Congress clearly feels a similar need. But what policy options are really available? What might the consequence be of selecting one or more options? Which options might be most appropriate for specific public policy objectives? Many seem to have instincts about these policy options, but little real work has been done on issues like the appropriate role of the public sector in the various modes, where we have current policies that are the product of two hundred years of evolution and may not be appropriate to the 21st Century. Others talk of a defining a level "playing field" for all of the modes, but the meaning of that is not apparent. Still others advocate an effort to bring about some modal shift to optimize the entire transportation system, but the policies that might bring this about are not clear. All of these public policy issues, and others, could be studied with beneficial results for the region and the continent. A regional view would have to consider some of the unique geographic, political, and economic issues within the upper Midwest.
- Evaluation of the impacts of changing land use and business patterns. For example, the location of a major Intermodal facility will have an impact on the movement of freight across a large part

of the region. At present, such impacts are not reviewed from a regional perspective. Another example is the changing industrial base within the region. To a large extent, the nation's transportation system was designed for a very different set of industrial activities. What is the impact of changes that are happening now and of those changes that will likely happen in the future? These are only two examples. Many other possibilities exist. Reviewing some of these issues would allow agencies to plan in a much more pro-active manner.

- Build a regional coalition to cope with long-term increases in the demand for transportation. If nothing is done waits at waterway locks will grow longer, congestion at airports will increase substantially, and rail lines, which offer opportunities for intermodal links from truck to rail, will have more congestion at terminals and transfer points as well as at key main line routes. A regional mindset is imperative for any effort to address the freight-related problems along the I-80/90/94 corridor.
- Investigate ways to make intermodal transportation efficient and reliable enough to compete in the market for the medium and short shipments, which account for approximately 70% of the freight tonnage in the study area.

8.2 Data analysis and management

Good accessible data is key for good freight planning. The current study has made and good start in collecting, organizing and making available much data, but more could be done.

- Data sources to do meaningful freight planning are weak. Most of the data that is currently collected by transportation agencies deals with the movement of vehicles not of people or goods. Sound freight planning requires some knowledge of what is going where, why it is moving in the way that it is, the value of the product, and the tie of product movement to overall economic indicators. Even such basics as ton-miles of freight or the cost of moving a ton-mile of freight are not available. Research in this broad area could take two fundamental approaches. The first is simply trying to develop new data sources. Those sources would have to be largely in the private sector. They would have to be tailored to the needs of the region. They would have to be done in such a way as to demonstrate to potential data contributors that a benefit will be had in making needed data available. The second approach is in drawing relationships between existing data sources, primarily in the economic realm, and the data needs of freight planning. An obvious question that might be addressed in this manner is the relationship between freight volumes and the level of activity in specific business areas.

- Maintain a regional clearinghouse of collect freight information. The current study has amassed a huge amount of data. It is organized and available on a website. Some effort should be made to maintain and expand it so that the current investment is not lost. Similarly, the first ever catalog of information on freight studies in the region has been compiled and made available over the web. This, too, should be maintained and kept current.
- Use the database to simulate travel time on the highway and rail network. Detailed data pertaining to the interplay between travel time, traffic volume and capacity, and travel at specific times of day can be developed to simulate freight movements over the highway and rail networks. In this way, planners and users could estimate travel times.
- Add social and economic data to the database. This would allow the study team and others to examine the relationship between these data and freight movement.
- Some have suggested that more work be done to develop and apply a regional intermodal freight model, a model that would allow system level trade-offs and forecasts to be undertaken. This could be a very useful tool. It would require a significant investment of resources. If it was done correctly, it might reduce or eliminate the need for similar investments now being made in many states for purely state-level models.
- Performance measures could be a very powerful tool for the region. To be made useful, those measures need to be developed in a manner that will bring buy-in from all of the stakeholders; new data sources will have to be developed and refined; and the results of the measures will have to be reported on a regular basis.

8.3 Facilitation

According to most of the respondents to our surveys, the primary needs for improved freight planning are better communication and better understanding. Both of these and other aspects of the regional transportation effort would benefit from having some designated group to bring people together in a controlled, non-threatening environment to address common issues.

- Communication with the private sector at the regional level on an on-going basis would be very beneficial. A regional freight council might be considered. It would have to be staffed to ensure that the agendas are meaningful and that follow-up occurs.

- ITS applications, which will improve the management of the highway network, will be a key to improving the flow of freight. Yet no existing regional effort exists, or at least has been successful, in ensuring that the efforts of the states are technically compatible or functionally complementary. Facilitating a regional dialog on the problems to be addressed by these tools and the best solutions to these problems could be a major benefit.
- Regional communication among the public sector agencies has been a major benefit of the current study. The ability to come into contact with counterparts from other states and provinces has allowed a sharing of experiences and of direction that is invaluable. This should be continued.
- Influencing federal policy direction has been a major thrust of many other regional efforts. The Midwest could benefit from federal policy that reflects the unique crossroads aspects of the region. To be influential in this process, some regional collaboration and agreement will be needed.
- States and organizations in the region can share resources to improve efficiency. Agencies can jointly define problems, pool resources to solve them, and share the results of these efforts. The states achieve benefits by increasing efficiency through economies of scale. This could be applied to training, data collection, and working with the federal government in freight topics regionally instead of individually.
- To facilitate and coordinate transportation planning in the study area, it is essential that regional participants develop a set of measures to evaluate the efficiency, safety, and mobility of freight movements in the region. Measures are an important guide for determining practice and assessing performance. As noted in the data section, once these measures are determined, new data sources should be identified and data should be collected.

8.4 Organizational needs and funding

Clearly, this continued effort requires some organization and resources. The seven states and provinces should organize themselves into a regional coalition. This coalition would be governed by a board of directors made up of members from the agencies at an empowered, decision-making level. This implies linkages across the states and provinces at the level of the chief administrative officer so policy making could take place as well as at the operating level so that coordinated planning and the execution of those plans could take place. The board should be advised by a regional freight council, made up of private sector interests.

Effort to move the freight study forward should continue into the next phase. Decisions should be made about the staff to do this. Should it come from the university partners lead by the MRUTC, or should another source be found?

Funding would come from the state and provincial agencies. Depending upon the outcome of the federal reauthorization effort, the universities should be able to provide some matching dollars. This should be put into place to maintain the regional contacts and perspectives.

APPENDIX CONTENTS

APPENDIX A. ACRONYMS

AASHTO – American Association of State Highway and Transportation Officials

ADT – Average daily traffic

AADT – Average annual daily traffic

AAMVA- American Association of Motor Vehicle Administration

AAR – Association of American Railroads

ATIS — Advanced Trucker Information System

BEA – Bureau of Economic Analysis

BLS – Bureau of Labor Statistics

BNSF – Burlington Northern Santa Fe

BTS – Bureau of Transportation Statistics

CAP – Capacity Analysis Program

CDL – Commercial Drivers License

CDOT – Chicago Department of Transportation

CFS – Commodity Flow Survey

CN – Canadian National Railway

CNSC – Canadian National Safety Code

CPRS – Canadian Pacific Railway

CSXT – CSX Transportation

CTCO –Chicago Transportation Coordination Office

CTRE – Center for Transportation Research and Education

CVIEW- Commercial Vehicle Exchange Window

CVISN – Commercial Vehicle Information Systems and Networks

CVO – Commercial Vehicle Operations

CVS – Commercial Vehicle Survey

DOE – Department of Energy

DOT – Department of Transportation

DSL – Differential Speed Limit

DTW – Detroit Metro Airport

EA – Economic Area

EIA – Energy Information Administration

FAA – Federal Aviation Administration

FAF – Freight Analysis Framework

FEU – Forty-foot equivalent units

FFS – Free Flow Speed

FHWA – Federal Highway Administration

FMCSA- Federal Motor Carrier Safety Administration

FRA – Federal Railroad Administration

FTP – File Transfer Protocol

GAO – Government Accountability Office

GCM – Gary, Chicago, Milwaukee

GDP – Gross Domestic Product

GIS – Geographic Information System

GISAG – Center for Geographic Information Sciences and Applied Geographics

GVW- Gross Vehicle Weight

HAZMAT – Hazardous Materials

HERS – Highway Economic Requirements System

HCM – Highway Capacity Manual

HCS – Highway Capacity Software

HPMS – Highway Performance Monitoring Systems

HOS – Hours of Service

HVUT – Heavy Vehicle Use Tax

IBC – International Border Clearance Program

IFTA-International Fuel Tax Agreement

IMTC – International Mobility and Trade Corridor

IND – Indianapolis Airport

IRP- International Registration Plan

ISTEA-Intermodal Surface Transportation Efficiency Act

ITS – Intelligent Transportation Systems

GIS – Geographic information systems

GVW – Gross Vehicle Weight

LATTS - Latin American Trade & Transportation Study

LCV- Longer Combination Vehicles

LPMS – Lock Performance Monitoring System

LTL – Less Than Truckload

LTSS-Land Transportation Standards Subcommittee

MARAD – Maritime Administration, US Department of Transportation

MCMIS- Motor Carrier Management Information System

MGT – Million Gross Ton

MGTM-Million Gross Ton Mile

MPA- Metropolitan Planning Association

MPO – Metropolitan Planning Organization

MRUTC – Midwest Regional University Transportation Center

MSA – Metropolitan Statistical Areas

NAFTA- North American Free Trade Agreement

NASCO – North American Superior Corridor Coalition, Inc.

NAITC – North Americal International Trade Corridor

NCHRP –National Cooperative Highway Research Program

NDC – National Data Center (USACE)

NHPN – National Highway Planning Network

NN- National Network

NORPASS – North American Electronic Screening System

NS – Norfolk and Southern Railroad

ORD – Chicago O'Hare International Airport

ORNL – Oak Ridge National Laboratory

PIERS - Port Import Export Reporting Service

REA – Regional Economic Area

RSPA – Research and Special Programs Administration

SAFER- Safety and Fitness Electronic Records System

SCTG – Standard Classification of Transportation Goods

SSRS-Single Rate Registration System

STAA – Surface Transportation Assistance Act

STB – Surface Transportation Board

STCC – Standard Transportation Commodity Code

TEA 21-Transportation Equity Act for the 21st Century

TEU – Twenty-foot Equivalent Units

TIFIA – Transportation Finance and Innovation Act

TL – Truckload

TRB – Transportation Research Board

UIC – University of Illinois at Chicago

UP – Union Pacific

USACE – US Army Corps of Engineers

WIM- Weigh-In-Motion

WCOG – Whatcom Council of governments

APPENDIX B. STUDY PARTICIPANTS

B.1 Structure of Organization

The study's direction was ultimately decided by the steering committee, which had representatives from the states and provinces in the study's region. Each state participating in the pooled fund had an official vote on decisions regarding the study, via their department of transportation representative.

The research team was made up of faculty, research staff, and students from three universities across the region. Their backgrounds included engineering, geography, planning, public policy, and business. The team communicated via frequent emails, bi-weekly conference calls, and several meetings.

The advisory committee was made up of other stakeholders in the freight transportation system of the region. Their role was to assist the steering committee and research team with various matters in the study. For example, a representative from a motor carrier reviewed a survey being sent out to regional trucking firms before it was sent out. They also assisted in outreach efforts for the study, using their networks of contacts to publicize the efforts of the study.

The research team would like to thank this entire group for their time and effort that they gave towards this study. This is a dedicated group of individuals who are working to improve the flow of freight in the Upper Midwest region.

B.2 Steering Committee (as of 10/19/04)

Name	Title	Organization
	State DOTs (voting rights)	
Sandra Beaupre'	Director of Planning	Wisconsin Department of Transportation
William Gardner	Director-Frieght Planning & Development	Minnesota Department of Transportation
Larry Goode	Division Chief, Multimodal Transportation	Indiana Department of Transportation
Craig O'Riley	Transportation Planner	Iowa Department of Transportation
Suzann Rhodes	Administrator	Ohio Department of Transportation
Keith Sherman	Section Chief, Planning and Systems	Illinois Department of Transportation
	Federal Highway Administration Divisional Offices	
John Cater	Planning and Development Manager	Federal Highway Administration-Iowa Division
David Franklin	Community Planner	Federal Highway Administration-Indiana Division
Stephanie Hickman	Community Planner	Federal Highway Administration-Wisconsin Division
Dean Mentjes	Mobility Engineer	Federal Highway Administration-Illinois Division
Susan Moe	Minnesota Division	Federal Highway Administration
Kate Quinn	Indiana Division	Federal Highway Administration
Stew Sonnenberg	Urban Planning Engineer	Federal Highway Administration-Ohio Division
Steven Call	*Planning and Urban Mobility Engineer*	*Federal Highway Administration*
	Other	
Rob Tardif	Senior Planner	Ontario Ministry of Transportation
Amar Chadha	Director, Transportation Systems Planning & Development	Manitoba Ministry of Transportation
Robert Gale	Freight Planning Manager	Minnesota Department of Transportation
Al Stanek	Intercity Planning Chief	Wisconsin DOT
Ethan Johnson	Program/Planning Analyst	Wisconsin DOT
Tom Beck	Rail Planner	Indiana Department of Transportation
Steve Smith	Transportation Planning Section	Indiana Department of Transportation
Ron Thomas	Special Projects Director	Indiana Department of Transportation

Italics indicates past member that is currently not active.

B.3 Research Team (as of 10/19/04)

Name	Title	Organization
Teresa Adams	Professor, Civil and Environmental Engineering	University of Wisconsin-Madison
Travis Gordon	Research Specialist	Midwest Regional University Transportation Center
Jiwan Gupta	Professor, Civil Engineering	The University of Toledo
Kazuya Kawamura	Assistant Professor, Urban Planning and Policy Program	University of Illinois - Chicago
Peter Lindquist	Chair, Department of Geography	The University of Toledo
Sue McNeil	Director and Professor, Urban Transportation Center	University of Illinois - Chicago
Mark Vonderembse	Interim Director, Intermodal Transportation Institute	The University of Toledo
Ernie Wittwer	Director	Midwest Regional University Transportation Center

B.4 Advisory Committee (as 10/19/04)

Name	Title	Organization
Joe Alonzo	Transportation Planner	Chicago Department of Transportation
Art Arnold	President	Ohio Railroad Association
Jim Barton		Metropolitan Council
Doris Bautch	Director	U.S. Maritime Administration-Great Lakes Region
Bruce Betts	V.P., Business Development	Ozinga Transportation
Alex Bourgeau	Transportation Coordinator	Southeast Michigan Council of Governments
Tamiko Burnell	Transportation Planning Engineer	Federal Highway Administration-Michigan Division
Dave Casanova	Manager, Line Haul	Roadway Express
David Chandler	Senior Business Analyst	Center for Neighborhood Technology
Gloria Combe	Director-U.S. Government Affairs	CN Rail
Bob Cook	Executive Director	Transportation Development Association of Wisconsin
Bruce Dahnke	President	SkyTech Transportation
Kenneth Dallmeyer	Director of Transportation Planning	Northwestern Indiana Regional Planning Commission
W. Randy Daniels	DOT Coordinator	Marathon Ashland Petroleum, LCC
Rose Ann DeLeon	Director of Strategic Development	Cleveland-Cuyahoga County Port Authority
Matt Dietrich	Assistant Director	Ohio Rail Development Commission
Bill Drusch	President	Twin Cities & Western Railroad
John Duncan Varda	Counsel	DeWitt Ross & Stevens s.c.
Ronald J. Dvorak	Logistics Manager	Missota Paper Co. LLC
David R. Dysard	Vice President of Transportation	Toledo Metropolitan Area Council of Governments
Ronald Eckner	Director of Transportation Planning	Northeast Ohio Areawide Coordinating Agency
Gary Failor	President	Cleveland-Cuyahoga County Port Authority
Kerry Ferrier	Traffic Engineer	Ohio Turnpike Commission
Steve Fisk	Senior Manager Business Development	Canadian Pacific Railway
David Forkenbrock	Director & Professor	University of Iowa
John Fuller	Director & Professor	University of Iowa
Tim Gahagan	Planner	Toledo Metropolitan Area Council of Governments
Adam Garms	*Transportation Planner*	*Des Moines Area MPO*
John Gentle	Global Leader Carrier Relations	Owens Corning
Robert Greenlese	Director, Surface Transportation & Logistics	Toledo-Lucas County Port Authority
Jack Hall	Senior Transportation Planner	Northeast Ohio Areawide Coordinating Agency

Tom Harper	Director of Terminal Operations	USF Holland
James Hartung	President	Toledo-Lucas County Port Authority
Robert Hoffman	Director of Business Development	World Business Chicago
Tom Howells	President	Wisconsin Motor Carriers Association
J. Lee Hutchins, Jr.	Principal	ETP Limited
John Kerr	Economic Development Specialist	Detroit/Wayne County Port Authority
Steve Laffey	Policy Analyst	Illinois Commerce Commission
Ken Lucht	Community Development Manager	Wisconsin & Southern Railroad Co.
Mary Beth McAdams	Transit Manager	Michiana Area Council of Governments
Dennis H. Miller	Executive Vice President	Iowa Interstate Railroad, Ltd.
Milt Morris		SC Johnson
Dan Murray	Director of Research	American Transportation Research Institute
Roger Nordtvedt	Milk Assembly Manager	Land O' Lakes, Inc. dba NFPT
Paul Nowicki	Assistant V.P. Government Affairs	Burlington Northern Santa Fe
Libby Ogard		Prime Focus
Francis Owens		Iowa Corn Growers Association
Carmine Palombo	Transportation Director	Southeast Michigan Council of Governments
Patrick Pittenger	Senior Planner	Southeastern Wisconsin Regional Planning Commission
Barry Prentice	Director	Transport Institute at the University of Manitoba
Gerald Rawling	Director of Operations Analysis	Chicago Area Transportation Study
Craig Rockey	VP - Policy & Economics	Association of American Railroads
Ann Schell	Assistant Director	East Central Wisconsin RPC
Sandra Seanor	*Executive Director*	*Michiana Area Council of Governments*
Tony Shallow	Senior Economist	Transport Canada-Ontario Region
Scott Sigman	Senior Director, Intermodal	Ports of Indiana
Kevin Soucie	Consultant (representing CN)	Soucie & Associates
Richard Stewart	Director, Transportation & Logistics Research Center	University of Wisconsin-Superior
Ronald Sucik	Manager, Market Development	TTX
Stuart Theis	Consultant	Cleveland-Cuyahoga County Port Authority
Brian Tremblay	Senior Buyer-Procurement Transportation	Kraft Foods Inc.
Forrest Van Schwartz	Managing Director--Commissioner	Global Trans Consultancy--WI River Rail Transit Comm
Erika Witzke	Intermodal Programs Engineer	Mid-Ohio Regional Planning Commission
Larry Woolum	Director of Regulatory Affairs	Ohio Trucking Association
Sweson Yang	Chief Transportation Planner	Indianapolis Metro Planning Organization
Ken Yunker	Deputy Director	Southeastern Wisconsin Regional Planning Commission

Italics indicates past member that is currently not active.

APPENDIX C. METHODOLOGY FOR DEFINING CORRIDOR

C.1 Background

The objective of this memorandum is to document the process and criteria used to select highway links to be included in the link-by-link analysis of demand and capacity. The team, including the authors of this memorandum and graduate research assistants met on the University of Toledo campus on 2/27/04 for a one-day working session. The end product, a map of the highway network to be studied, is shown on the attached map (Figure 9).

C.2 Process and Guidelines

Departments of Transportation and Metropolitan Planning Organizations were requested to identify important freight routes in their jurisdictions early in the study (in addition to the main corridor highways of I-80/90/94). The responses from DOTs and MPOs are listed in Table 6.

Table 6 Important Parallel and Connecting Highways in the Study Region.

State	Parallel routes	Intersecting routes and connectors
Ohio	I-76, I-70, US 20, S.R. 2, US 30, US 24	I-75, I-71, I-77, US 23, S.R. 8
Michigan	S.R. 14	I-75, US 23, US 127, I-69
Indiana	I-70, US 30	I-65, I-69, US 31
Illinois	US 20, I-72, I-74, I-88, I-70	I-39, I-57, I-55, I-290, I-355
Wisconsin	ST 29	US 41, US 45, I-43, I-39, I-894, USH 53, IH 26, I 894, STH 294, IH 794
Iowa	SR 14	I-35, I-69, US 23, US 127
Minnesota	US 10	I-35, I-29

Each route included in the highway network map prepared by the University of Wisconsin team (Figure 10) was reviewed by the team. The inclusion/exclusion of each route was determined by a consensus of the team.

In most cases, several guidelines were used in conjunction to reach the decision. Following are the descriptions of the guidelines used:

- Direct connection to Intermodal terminals. Routes that have a direct connection to a major Intermodal terminal were selected except when such route was far from meeting the traffic volume criteria discussed below.
- ADT, Truck ADT, and truck percentage of ADT. These three variables were used jointly to determine whether the route is considered to be a regionally significant freight route, and also whether the route is likely to be experiencing congestion from truck traffic. The 50 percentile of the truck volumes for all the links (i.e. national network) included in the Freight Analysis Framework's 1998 truck ADT data is 1890 trucks per day. This figure was used to judge the significance of a route as a truck route (Figure 11). Also, based on the impact of truck traffic on the level of service, the threshold values of truck percentages were calculated for various level of ADT and lane configurations.
- Potential to serve as the alternative route to I-80/90/94. There were several sub-criteria for determining whether a route has the potential to serve as the alternative route to I-80/90/94. First, the route must be able to accommodate freight flow at the regional scale. This requires the route to show continuity through the significant portion of the study area. Exception was made for the urban routes such as beltways and bypasses that can provide local but considerable congestion relief in the urban areas. Second, the route must cater to the same demand as the I-80/90/94 corridor does. When necessary, the select link analysis function of the GeoFreight software was used to analyze the origins/destinations of the freight transported on the route in question. If the origins/destinations did not approximately match those identified for the I-80/90/94 corridor, the route was not selected since it is unlikely that the route can serve as the alternative route. I-70 corridor was excluded from the network based on the finding that most of the shipments on the route come from or go to the southwestern part of the U.S. while the I-80/90/94 corridor serves the northwestern part.
- Connectivity. In some cases, routes that served as the critical connector to other major freight corridors, such as I-70 and I-74, were included in the study network even if they did not meet other criteria.
- Proximity to manufacturing activities measures in terms of value added. From an economic development standpoint, it is clear that those highways in close proximity to manufacturing will experience major truck traffic pressure. This trend is clearly indicated in the map in Figure 12 that shows a significant spatial correlation between value added by manufacturing (by county) and average daily truck traffic on the network. Those routes aligned within significant manufacturing regions and those that connect manufacturing regions to markets or product

destinations are the ones with higher truck traffic volumes and should be given higher priority in this study. This accompanying map thus highlights many of the selected routes

It should be noted that these guidelines were applied with enough flexibility to allow for the unique circumstances that may exist in each sub-area within the study area. In most cases, not meeting one of the guideline did not determine the fate of a route. Rather, the routes that were excluded usually suffered from a combination of several shortcomings.

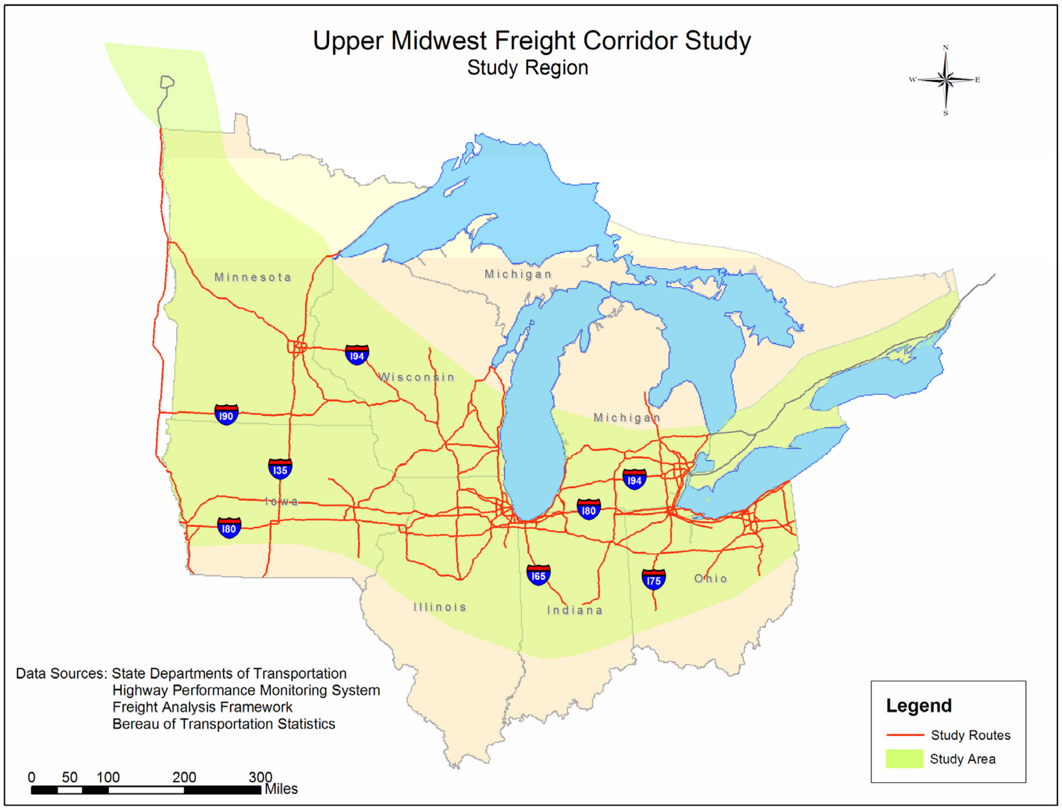


Figure 9 Recommended Highway Network Selection.

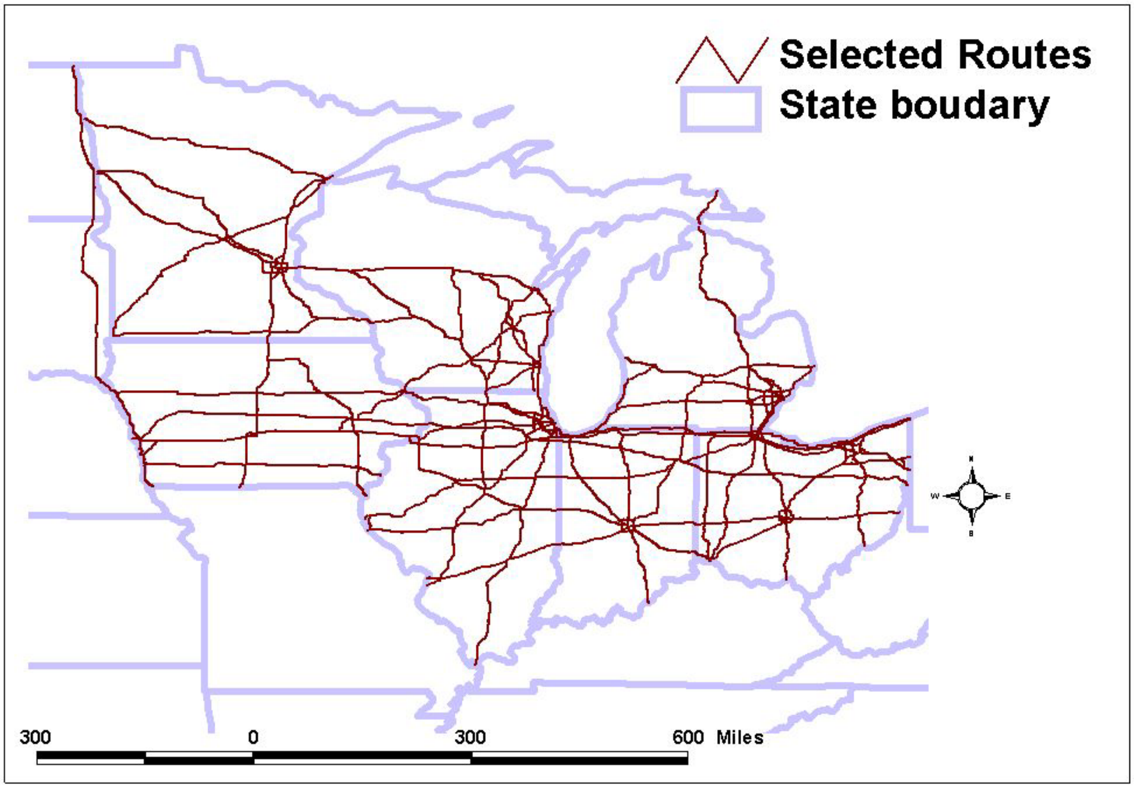


Figure 10 Draft Highway Network Selection.

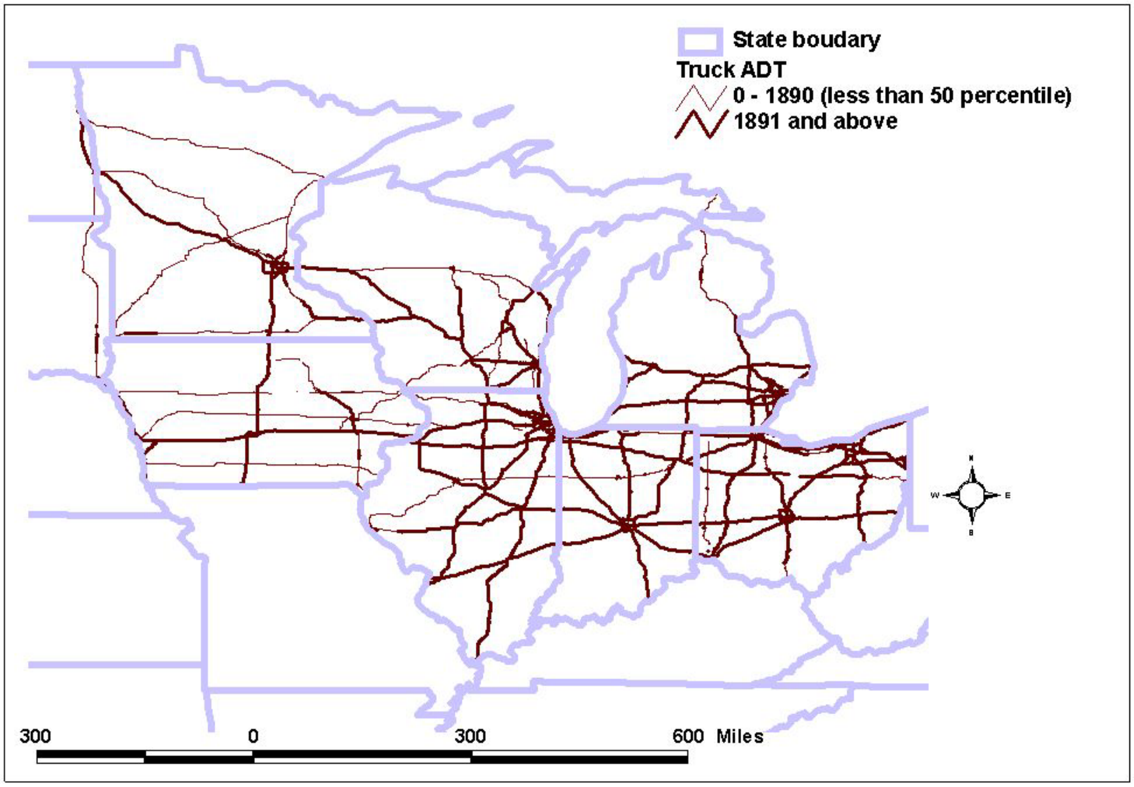


Figure 11 1998 Truck ADT.

Source: FAF

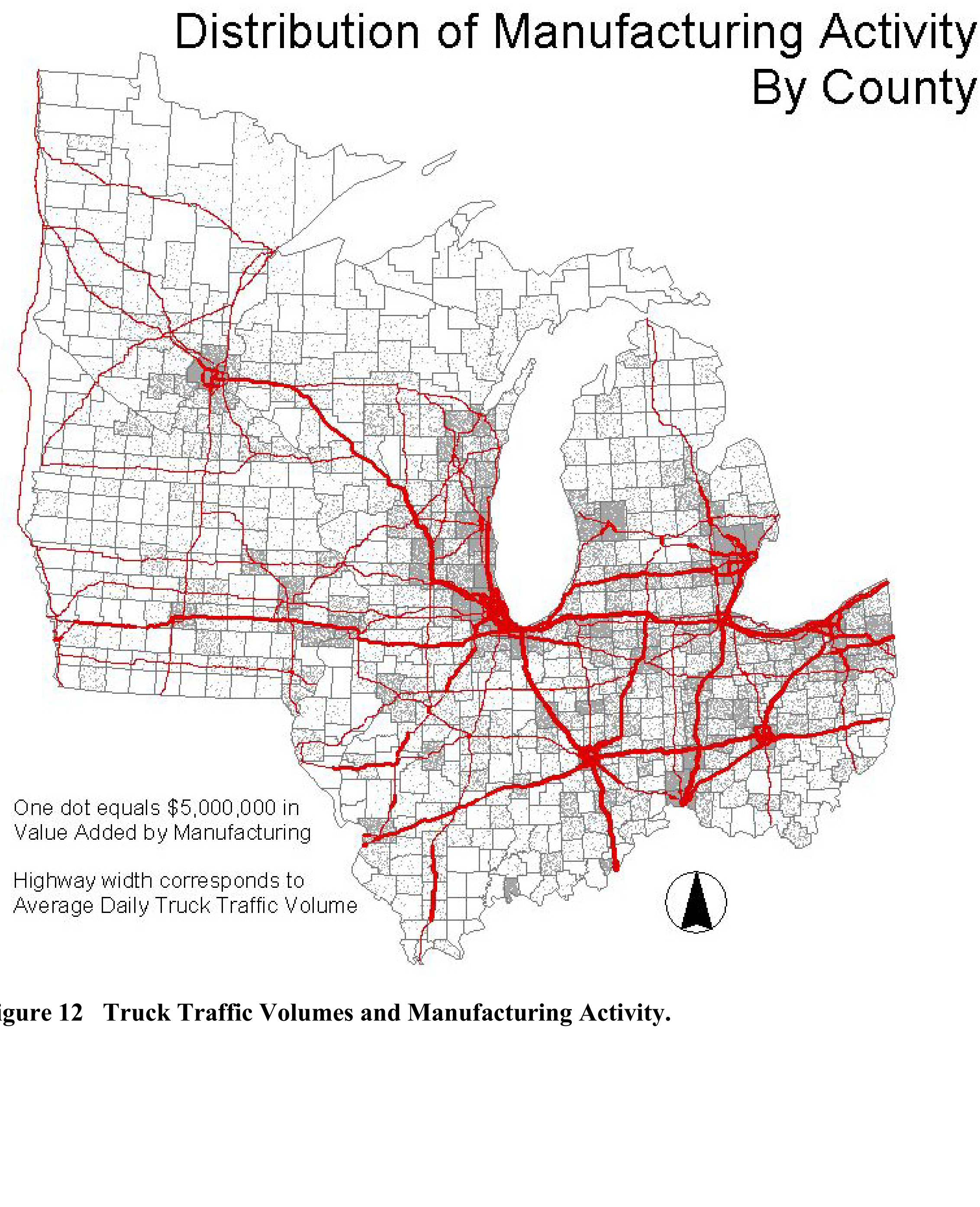


Figure 12 Truck Traffic Volumes and Manufacturing Activity.

APPENDIX D. DATA STRUCTURES

This appendix documents the formation of a regional database consisting of all of the elements comprising the freight transportation system within the study region. It was recognized early in the study that such a database structured within a internet-based distributed GIS delivery system could serve not only as a mechanism for reporting on the condition of the regional freight infrastructure, but it could provide a central focus for the continued study of freight movements within the region.

The database documented in this report was assembled from a wide range of sources that include highways rail lines and waterways, airports, ports and intermodal terminals. Additional data dealing with usage, capacity and administrative policies have been tied to these components of the network. The network also contains existing data sets from BTS, FHWA, FRA and state DOT databases as a means to provide as detailed a description of the network as possible. In addition, the regional database contains detailed regional economic data that includes employment figures, number and locations of establishments, and the types of commodities produced within each portion of the region.

It should be emphasized here that this database was designed with the objective of providing a wide range of data for the region that heretofore has not been assembled in one location. As a result, the database serves as much a resource for the community of transportation professionals and economic development authorities as it is for the research team; it is an important tool in drawing the essential link between economic activity and the capacity of the freight infrastructure to support the movement of goods in the region.

D.1 Data Organization

The database is structured into a continuous, seamless coverage of the regional transportation system rather than a patchwork of individual states' and provinces' transportation maps. This approach was intentionally adopted to underscore the importance of the study's regional perspective and to enable stakeholders and public officials to gain a wider view of freight movements beyond their local regions, states, or provinces. The database and data delivery system were also designed to bring together transportation professionals from a wide range of organizations such as State / Provincial DOTs, MPOs, economic development organizations, private sector participants and research organizations.

Considerable effort has been devoted by the research team with respect to the assembly, organization, management, and reporting of freight flows, capacities and regulatory policies within the corridor region. In addition, a significant volume of data pertaining to employment, establishments and commodities produced within the region has been added to relate freight flows with economic activity. Population and housing characteristics within the region and the nation as a whole are also included in the database to provide a means to relate freight movements to regional and national markets.

Much of this effort has been devoted to assembling geospatial data from diverse sources that included both private sector data sets as well as those from federal sources (*e.g*., BTS, FHWA, Corps of Engineers, *etc*.), state transportation departments and Metropolitan planning organizations. As might be expected, few datasets were compatible with others and few, if any data reporting standards were evident in working with these data. As a result, the research team spent many hours inspecting, converting, reconciling, and ultimately integrating different elements of the transportation infrastructure into a single comprehensive database that formed the basis for the findings reported in this document. However, once the data were reconciled, they were made available in a spatially-referenced data reporting site on the internet that is maintained at the Toledo Site.

The contents and structure of the geospatial database assembled for the seven-state and two-province corridor region will be documented on the basis of the following:

- The assembly of the data in a centralized data repository;
- The design of the structure and organization of the data;
- Documentation and archiving efforts for the database; and
- The development of an internet-based data reporting site for freight movements.

Given the inherent spatial nature of the transportation infrastructure, the organization of the data in this study is assembled within a geographic information system. Much of the data reported by agencies at all levels of government is either encoded in a GIS format, or can be made compatible with existing GIS data. The challenge to the research team was therefore to organize the data in such a way that all elements of the database are spatially compatible with respect to data structure format, geo-referencing, scale, segmentation, and compatibility with widely-used GIS software. The following discussion in this appendix and the next describes the contents of this GIS database with respect to structure, contents, documentation, availability and reporting venues, and in the techniques used to assemble the data and reconcile diverse components into a comprehensive, seamless, continuous map of the freight infrastructure found in the corridor region.

D.1.1 Schematic Diagram of the database

The diagram below in Figure 13 shows the structure of the database stored at the Toledo site. Each of the boxes in the diagram is displayed on a web page and contains links to documentation pages as well as to the data stored in the project FTP site. Users may navigate through the data storage directories and also through the documentation page by clicking on the text of the boxes in the diagram.

All of the data referenced in the dark boxes correspond to the spatially referenced data used to represent the objects in the database ranging from highways to railroads, airports, ports and intermodal facilities. The light-shaded boxes represent attributes linked to the objects in the GIS that describe the various measured properties and characteristics of each object in the database (*e.g.*, highway attributes would include such features as number of lanes, speed limits, capacities, level of service, flows, *etc*.). It should be noted that the attributes assigned to highways and railroads are obtained from more than one source, which presented significant challenges to the research team in assigning specific attributes to their proper location in the network.

All of the data stored in the clear boxes deal with data that are not spatially referenced but deal with documentation of various components of the network and of freight movements in the network. The clear boxes contain additional data documents furnished by MPOs and DOTs as separate documents. Each box in the diagram represents a particular set of data. From each box users can access both the documentation describing the contents of each data set as well as the data themselves. All of the data stored at the FTP Site are READ ONLY and users in the research team are instructed to transfer these data to their local site to modify the data or make additions to the data. When users are finished, the data are returned to a location in the data repository known as the “Drop Box” (seen at the top of the diagram) and inform other members of the research team regarding any changes made to the data.

As mentioned above, each component of the database reported in the boxes found in Figure 13 is linked to a data documentation page that describes the contents of that particular data set. This collection of ***Metadata*** will be available to users of the data reporting site as well as the members of the research team. An example of a data documentation link is presented in Figure 14 which corresponds to the ***Highway Capacity Attribute Table*** associated with the ***NHPN Segmented Highway Network*** GIS database.

D.1.2 Overview of the Structure of the Database

As mentioned above, the database consists of both geospatial and aspatial data. The aspatial data residing in the database, such as that associated with the Commodity Flow Survey are stored separately and can be retrieved by research team members from the secured ftp site.

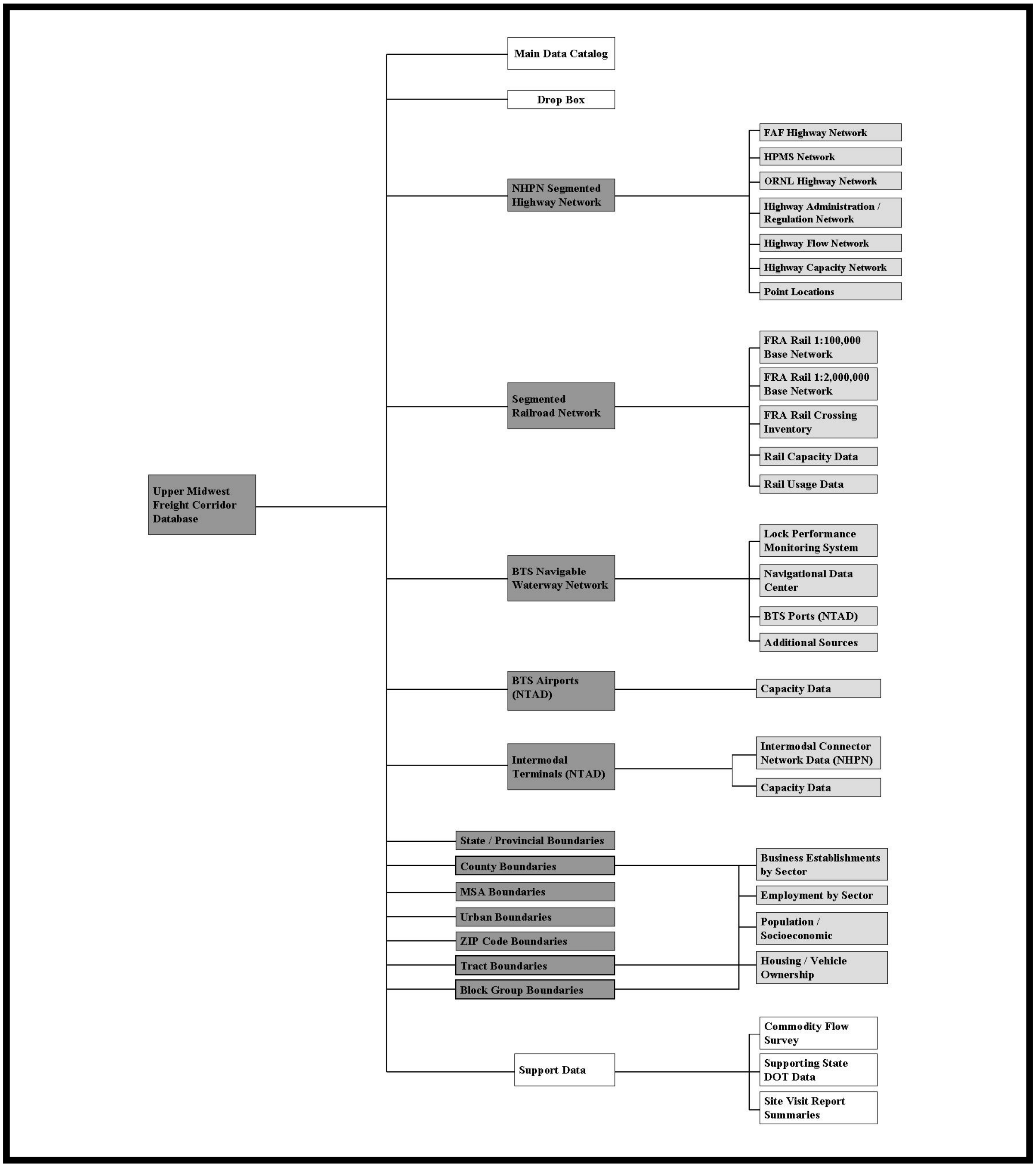
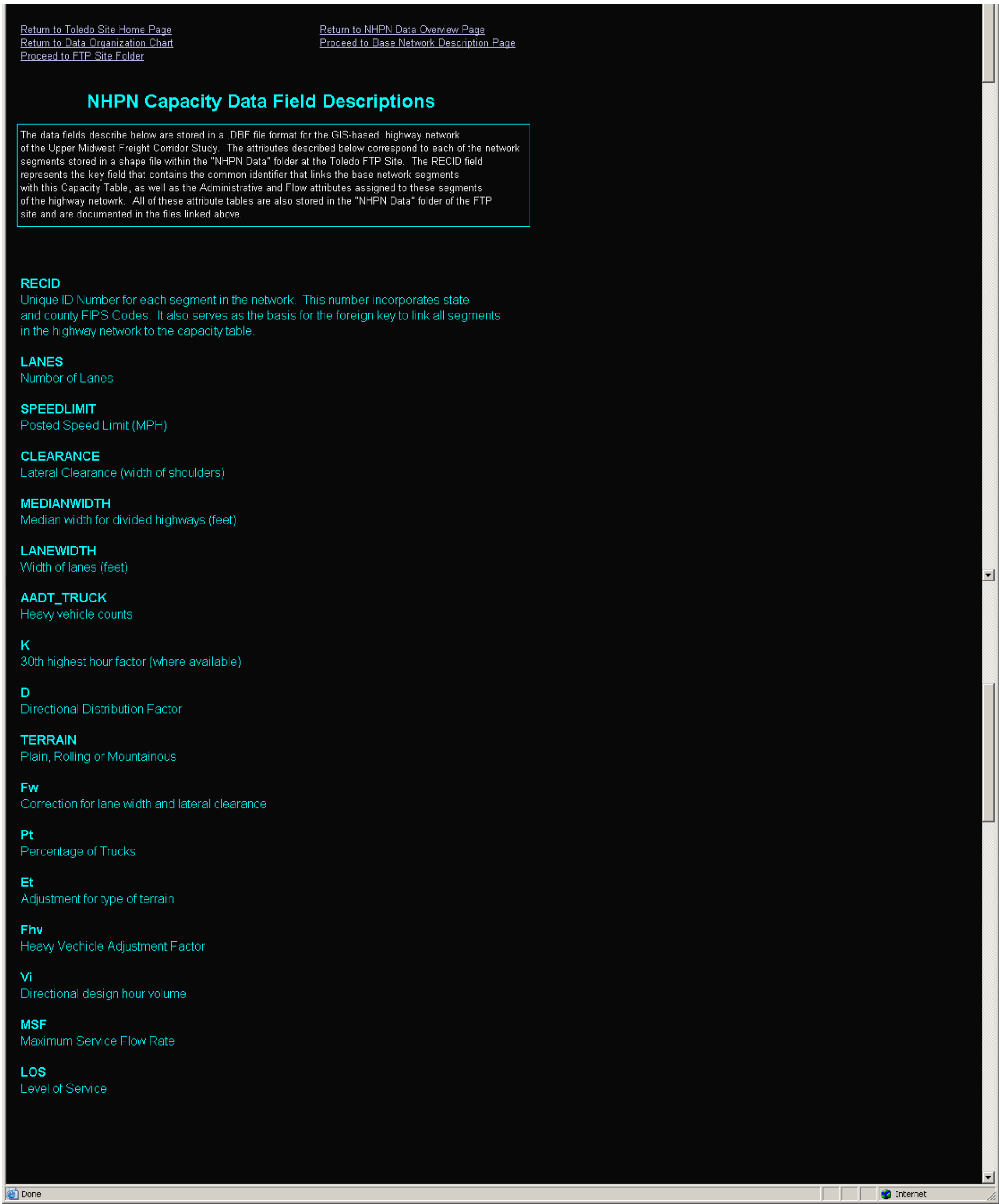


Figure 13 Components of the Upper Midwest Freight Corridor Regional Database.



Return to Toledo Site Home Page
Return to Data Organization Chart
Proceed to FTP Site Folder

Return to NHPN Data Overview Page
Proceed to Base Network Description Page

NHPN Capacity Data Field Descriptions

The data fields describe below are stored in a .DBF file format for the GIS-based highway network of the Upper Midwest Freight Corridor Study. The attributes described below correspond to each of the network segments stored in a shape file within the "NHPN Data" folder at the Toledo FTP Site. The RECID field represents the key field that contains the common identifier that links the base network segments with this Capacity Table, as well as the Administrative and Flow attributes assigned to these segments of the highway netowrk. All of these attribute tables are also stored in the "NHPN Data" folder of the FTP site and are documented in the files linked above.

RECID
Unique ID Number for each segment in the network. This number incorporates state and county FIPS Codes. It also serves as the basis for the foreign key to link all segments in the highway network to the capacity table.

LANES
Number of Lanes

SPEEDLIMIT
Posted Speed Limit (MPH)

CLEARANCE
Lateral Clearance (width of shoulders)

MEDIANWIDTH
Median width for divided highways (feet)

LANEWIDTH
Width of lanes (feet)

AADT_TRUCK
Heavy vehicle counts

K
30th highest hour factor (where available)

D
Directional Distribution Factor

TERRAIN
Plain, Rolling or Mountainous

Fw
Correction for lane width and lateral clearance

Pt
Percentage of Trucks

Et
Adjustment for type of terrain

Fhv
Heavy Vechicle Adjustment Factor

Vi
Directional design hour volume

MSF
Maximum Service Flow Rate

LOS
Level of Service

Done
Internet

Figure 14 Example of data documentation for Capacity Highway Database.

Given the strong network orientation of the database, the geospatial (GIS) data are arranged and stored in a vector data structure and using the ESRI *Shape File* format, which minimally consists of the shape file referencing object locations (*.shp) (dark boxes in Figure 13), an index file that coordinates the objects and their locations (*.shx), and attribute file that describes measured characteristics of each object stored in the database (*.dbf) (light shaded boxes in Figure 13). Each object in the shape file references not only the coordinates describing the location and alignment of point, line or areal-based objects, but also includes a primary identifier attribute that links each object to its corresponding attribute in the database. These data were then transferred into a relational database management system on the project data reporting site.

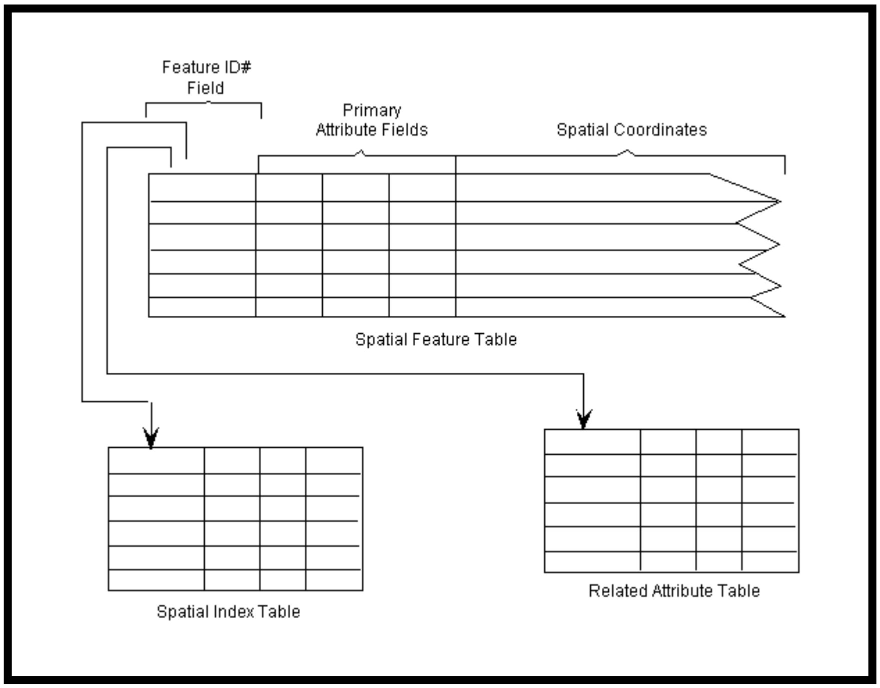


Figure 15 The data structure adopted for the data repository.

Source: ESRI.

The major advantages of this system include high performance with large databases and robust data administration tools for data manipulation and analysis. They also provided better opportunities to integrate spatial data with other information that organizations may store in a relational database, creating a "data-warehouse". These provide a more open architecture for managing GIS data and allow access with multiple client software for data query suitable for client/server architecture.

This system permits each object, whether it is a highway link, an airport, or a county boundary to be directly linked to one or more attribute tables in the database that store its measured properties. This approach was incorporated in the data collection stage and permitted the efficient storage of each element in the transportation infrastructure. It also facilitated the efficient exchange of data through the secure FTP site among the members of the research team.

The data stored in the database consists of point-based objects, linear objects and areal objects. The main point-based objects in the database include ports, airports and intermodal terminals, as well as other point-based features such as locks, railroad crossings, highway weigh stations and toll plazas. Linear features include primarily highway links and railroads. Areal data are also included in the database in the form of state and county boundaries, metropolitan regions and cities, and other data collection and storage units such as ZIP code areas, census tracts and block groups.

The relational database system containing the spatial data repository was originally developed by implementing ***ArcSDE*** (Spatial Database Engine) over ***MS SQL*** (Microsoft SQL server 2000) within a ***Microsoft WINDOWS 2000*** Operating System environment. ***ArcSDE*** is a tool that allows for the storage and management of spatial data in this selected relational database management system (RDBMS) and provides a gateway between the GIS and the RDBMS to share and manage spatial data in a series of interconnected tables. The original design was to link ***ArcSDE*** with ESRI's ***Arc Internet Map Server*** (***ArcIMS***) with the spatial data being managed within the RDBMS. However, this plan was replaced with a more direct approach that involved the development of a specialized ***ArcView*** desktop GIS intallation to run within a ***Citrix Metaframe*** system. Such a system takes advantage of this widely-used desktop GIS system and reduces the maintenance and development efforts associated with that of the ***ArcSDE*** / ***ArcIMS*** system. Thus users can view the entire freight network within the corridor among different scales, and can generate maps carry out queries, and perform basic GIS analyses. In time, other specialized applications will be developed on the site to users over the internet.

D.1.3 The Data Repository

The next critical issue in the development of a regional database deals with the formation of a system to store, manage, archive, update and deliver the data collected during this first phase of the project. As would be expected, acquisition and integration of these data into a seamless, comprehensive and cohesive database formed the single largest task in the development of the project's data delivery system. The next challenge involved the development of a facility for storage and retrieval of the data within a centralized repository. All of the data collected, organized and analyzed by the research team in this study are currently stored in a centralized repository maintained on a server at the Toledo site. The members of the research team have secured FTP access to this repository as a means to facilitate exchange among the three sites. In addition, complete documentation of the data is posted on a web site for easy access to research team members as well as stakeholders and decision makers in the region. In addition, the data repository for the Upper Midwest Freight Corridor Study was designed with the objective of efficient retrieval and delivery to the region's policymakers, stakeholders and decision makers from an internet-based GIS facility located at the Toledo site.

A brief description of the contents of this database is provided below. More detailed descriptions of the data and full metadata documentation are provided on the project web maintained at the Toledo site. The contents described are subdivided into point-based, linear and areal features.

D.1.4 Point Data Layers

Weigh stations: Weigh stations data have been plotted using available resources from the internet. The weigh station data may not be accurate and may not be legal data. It is approximate data file created with information from some private websites.

Locks: Lock chambers data is maintained by lock performance monitoring system. Lock data consists of lock chamber dimensions, delays at the lock chambers and total barges, tons of freight processed through the lock chambers.

Intermodal terminals: Intermodal terminals data is a point data layer which has location data of the terminal, major commodity of transfer, primary modes of transfer, directionality of intermodal transfer (e.g., rail to road).

Airports: Four Point data files are available from the repository:

- Public use airports.
- Public use runways.
- T-100 segment database.
- Geofreight Airports

The Public Use Airports database is a geographic point database of aircraft landing facilities in the United States and U.S. Territories. Attribute data is provided on the physical and operational characteristics of the landing facility. The data provides the information about the Location ID, State, Airport name, Facility Use i.e. used for Public or Private, Facility Owner and Total domestic enplanements, *etc*. The data is available for the year 2001, from BTS.

The Public Use Airport Runways database is a geographic point dataset of runways in the United States and US territories containing information on the physical characteristics of the runways. These data provides users with information about the runway location ID, runway length, and runway width, *etc*. The database is obtained from the BTS.

The T-100 segment database combines domestic and international segment (a pair of points served or scheduled to be served by at least one flight at any given time) data by U.S. and foreign air carriers. It contains data on aircraft type, service class for passengers transported, freight and mail transported, available capacity. The database is obtained from Bureau of Transportation Statistics, Air Carrier Statistics (Form 41 Traffic), 2003.

The Geofreight airports data adapted from BTS for U.S. Has data about capacity benchmarks (the number of flights an airport can handle per hour). Capacity benchmark ranges are given for both optimum and reduced conditions. Optimum conditions are simply good weather. Reduced conditions include poor visibility, unfavorable winds, or heavy precipitation. Capacity benchmark improvements include new runways (if built) and new technology.

Ports: Ports data contains latitude, longitude, docking facilities, intermodal connections, nearest highways, operator name, and address. Ports data has been gathered from two sources. While BTS data contains more geographic data NDC data has commodity flow. NDC data has major commodity shipped at the port and also for major ports total tons of freight has been given. The freight is classified as imports, exports, international, domestic and total in tons at the particular port.

Railroad Crossing Inventory Database: Federal Railroad Administration (FRA) provides a state crossing (at Highway-Railway crossing) inventory database for whole U.S. This Point database contains Crossing IDs, Speeds, total trains, Main track (single, double), other track (sidings, yards, passings), railroad owner, state and Signals *etc*. Most of the data is useful for railroad capacity estimations.

D.1.5 Linear (Network) Data Layers

National Highway Planning Network: National Highway Planning Network comprises geographic data of highways in the U.S. This network data is distributed through BTS as the National Transportation Atlas Database (NTAD). NHPN data are used for the base network and for the identification of important highways. The NHPN data are suitable for corridor studies because it is uniform through out the corridor. However the NHPN data does not have the necessary attributes for the capacity analysis.

Some of the attributes which are necessary for capacity analysis include number of lanes, annual average daily traffic (AADT), percentage of heavy vehicles, lane width, shoulder width, directional factor and peak hour factor. State departments of transportations maintain inventory of physical characteristics of highways and also traffic counts, which will be updated every year to reflect the latest information. State DOTs and MPOs were requested for latest traffic counts and inventory data in geographic file format.

Some states responded with the exact form of data, while others responded with either hard copy data or reports available in their websites. All these individual data files are again used to create a uniform layer for the entire corridor study area.

Intermodal Connectors: Intermodal connectors are mostly local roads, which have lower design standards than the main highways, which connect intermodal transfer facilities with national highway system. The intermodal connectors are integrated in the NHPN, however queries should be performed to get connectors data. Connectors database consist of attributes which have information about the terminal to which it is connecting and total length of the connector.

Freight Analysis Framework: The FAF estimates commodity flows and related freight transportation activity among states, sub-state regions, and major international gateways. The FAF also forecasts changes in those flows and activity based on shifts in economic conditions, availability of transportation facilities, and other factors.

Highway Performance Monitoring System: The HPMS is a national level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the nation's highways. The HPMS data are used extensively in the analysis of highway system condition, performance, and investment needs. HPMS data contains most of the capacity data, however the data is collected only on sample sections. Also heavy vehicle (truck) counts are not accurate. The main advantage with using HPMS is its availability for all the highways in the corridor area. Wherever data are not available, HPMS can be a good alternative for the capacity analysis.

Waterway network: The waterway network is a shapefile that contains navigable waterways in the great lakes region. Navigable waterways are the routes in great lakes through which navigation is possible. United States Army Corps of Engineers (USACE) control, maintain the navigable waterways. USACE publishes data on navigable waterways. Inland waterways data is derived from two different data files, rivers and navigable waterways. Data from navigation data center also contains total freight moved up and down the navigable inland waterways. The freight is classified by STCC code or commodity name.

Oak Ridge National laboratory network: The Oak Ridge National Highway Network (NHN) is a database of major highways in the United States. It is designed primarily to address vehicle routing and scheduling problems, but naturally may be used in other studies that require an analytic or geographically-based national highway network. The NHN includes both attribute and locational data about roadways acquired from a wide variety of sources. It has been enhanced at Oak Ridge National Laboratory by adding additional roads and attribute detail and adjusting topology to produce a true analytic network. Sign route, Access control, Number of lanes are some of the useful attributes available in this data.

Railroad Network Data Layers: The railroad network adopted in the study consists of three components:

- FRA Rail (1:100,000) scale Network.
- FRA Rail (1:2,000,000) scale Network.
- Integrated / Segmented Class I Railroad Network (1: 100,000) scale Network.

The FRA Rail Network is a comprehensive database of the nation's railway system at the 1:100,000 scale. The Rail100k shape file has data by the railroad class, railroad owner and track age rights of the links/lines.

The second FRA Rail Network is a comprehensive data set of the nation's railway system at the 1:2,000,000 scale. Rail (1:2,000,000 scale) network has the same data as Rail100k but it also includes the number of tracks, type of signal system operating on the link (i.e. absolute block system, centralized or manual traffic control system) and density on the links/lines. This data is useful railroad capacity estimations.

The Integrated / Segmented Class I railroad Network (1:100,000 scale) is Class I segmented network developed by the research team and used as final network for railroad capacity estimations. This database integrates the three different Rail network (scale 1:2,000,000), Crossings Inventory data and Rail network (scale 1:100,000) to Class I segmented (1:100,000 scale) network.

The Integrated Class I Railroad Network contains all the data needed for railroad capacity estimation. Some of the important data variables in this database are number of signals, speed, railroad owner, and signal system, number of tracks, sidings and density of the links. The data variables obtained after capacity estimation are Siding spacing, average block length, Maximum trip time, Average delay, Capacity (Number of trains per day), Track utilization factor.

The Rail (1:100,000 scale), Rail (1:2,000,000 scale) network databases were obtained from Bureau of Transportation Statistics, 2002.

D.1.6 Area Data Layers

The Area data layers used in the study were compiled to serve not only as a spatial context for the transportation network in all maps produced in this report and in the data reporting site, but also were an important source of data relating to transportation flows, origins, and destinations. Significant volumes of data pertaining to economic activity both inside and outside the corridor were assembled and are available on the data reporting site. Additional population, housing, demographic and socioeconomic data were also compiled and are available on the ***Midwest FreightView*** data reporting site.

All areal data are exactly registered to the transportation network and users are able to relate a wide range of variables in map form on the ***Midwest FreightView*** data reporting site (*e.g.*, relating patterns of such variables as regional population and motor vehicle ownership to peak traffic volumes and truck traffic volumes on urban interstate highways). The data described below are organized by areal units.

Major Water Bodies: Major water bodies, notably the Great Lakes, are available as a means f provide a spatial and regional context to data displays in map form and to show waterway movements.

States: Detailed state boundaries are available as a means to provide a spatial and regional context to data displays in map form.

Counties: Detailed county boundaries are available as a means to provide a spatial and regional context to data displays in map form, but additional attribute data area are also available with respect to economic activity and to population and socioeconomic characteristics of regions. Detailed documentation of these variables is available on the project web-based documentation page.

City and Metropolitan Area Boundaries: Detailed urban boundaries are available as a means to provide a spatial and regional context to data displays in map form.

Census Tracts: Detailed tract boundaries are available to provide detailed attribute data with respect to economic activity and to population and socioeconomic characteristics of regions. Detailed documentation of these variables is available on the project web-based documentation page.

Census Block Groups: Detailed block group boundaries are available to provide highly detailed attribute data with respect to economic activity and to population and socioeconomic characteristics of regions. Detailed documentation of these variables is available on the project web-based documentation page.

Economic Data: Economic data pertaining to establishment locations, employment, commodities produced according to land use type and SIC Code are provided on the County, Census Tract and Block Group Level. Data are organized within the corridor and nationally. Data Sources include ***ESRI Business Map*** (***Dun and Bradstreet data***), ***Demographics Plus Business Counts*** and ***ESRI Business Analyst*** database. These data are linked directly to the boundary files within the data repository.

Documentation is provided on the data repository web page. Agriculture production data are also available from the National Agricultural Statistics Service (USDA) for counties within the region.

Population / Housing / Socioeconomic Data: These data are provided within both the corridor database and a national database available on the ***Midwest FreightView*** data reporting site. The data furnished in this portion of the database are linked to counties and census tracts only, and include data pertaining to population, income, housing characteristics, vehicle ownership, employment and other related variables that are useful in delineating markets.

D.1.7 Data Sources

Major sources for the data are listed on the data documentation web page at the Toledo site. Given the diverse sources and the temporal nature of the data, it is anticipated that the composition of the database will continue to be somewhat fluid over time and that the most effective means of documentation will be on the data repository web page at the Toledo site (www.midwestfreight.utoledo.edu).

D.2 The Data Reporting Site: *Midwest FreightView*

The final issue in the development of the regional freight database deals with the internet-based data delivery system. This system, entitled ***Midwest FreightView***, enables users from different organizations to access the database through a specialized ***Citrix Metaframe*** server located at the Toledo site. Users are given set of permissions to use the site and gain initial access using a standard web browser with no additional software requirements needed. Users operate the delivery system entirely on the Toledo server and screen images, not data, are transferred to users. Thus all data are stored and maintained at the Toledo site in order to maintain data quality and security.

The data within ***Midwest FreightView*** are maintained in ESRI shape files that conform to a single georeferencing system:

- Projection: Lambert Equal Area Azimuthal
- Datum: NAD 83
- Central Meridian: -89.00
- Reference Latitude: 43.00
- Distance Units: Feet

The main backbone of the system is based on a modified ***ArcView*** application that has been transformed to permit data viewing only; no data transformations or reorganization will be permitted except for members of the research team. A full range of mapping and query functions are available on the site and users can download map compositions to their local printers after viewing the data.

The user interface for this data reporting system was designed to be as logical and intuitive as possible. A number of automated scaling and display options were built into the system so that users can concentrate on the selection of desired features and variables and not on learning how to display them. Two viewing scales were developed: one that contains detailed data within the corridor states and provinces and one that contains a national map along with the Canadian portions of the corridor. The wider viewing scale on the national level was included within the system to place the corridor region within a national context and to provide additional flexibility in showing trade linkages beyond the corridor.

At present, ***Midwest FreightView*** is primarily a data viewer that contains basic thematic mapping functions to enable users to graphically link different components the transportation network together and to map them in relation to regional populations and patterns of economic activity. Users are also provided with a full range of query and selection options to display only desired portions of the transportation network or to examine relationships between different variables within a desired portion of the network or within a specific location.

D.2.1 Interface Development and Data retrieval on WWW

Information on the Web is virtually platform independent, unrivalled in its capacity to reach many users at minimal costs and easy to update frequently. It allows for a dynamic and interactive dissemination of Geospatial data. Thus this approach was adopted for the development of the ***Midwest FreightView*** data delivery system.

D.2.2 System Architecture

The final data delivery system was developed around a ***Citrix Metaframe*** installation hosting a specialized installation of ***ArcView*** Desktop GIS software to act as an online data server with distributed GIS capabilities and adopting the three tier client/server computing architecture (see Figure 16). The client viewer was developed as a light client so that remote users with modest computer system resources can still take full advantage of the system.

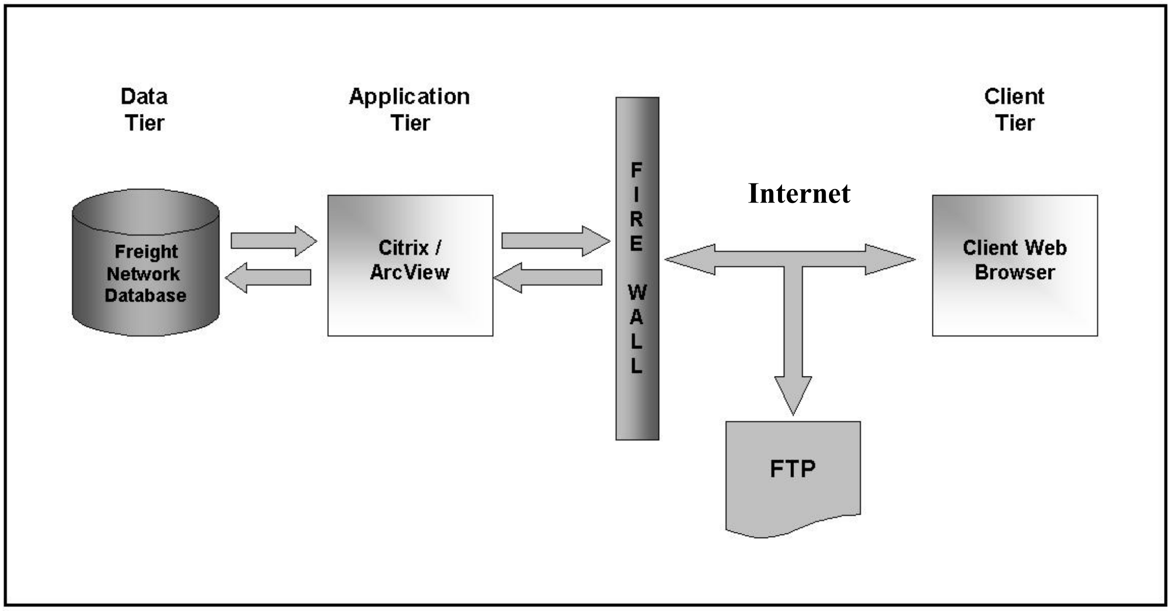


Figure 16 System Architecture for the Data Reporting Site.

Interface development consists of a specialized ***ArcView*** installation containing a simplified user interface and Avenue scripting to retrieve and display data from the repository. Most of the commands within the system are generalized and intuitive to enable users to quickly retrieve the desired data. Variables listed in the database are described in "plain English" to the greatest extent possible to reduce confusion and to preclude constant accessing of data documentation pages and help menus. The modified ***ArcView*** user interface maintains many of its' basic display functions and querying tools. Additional display and identification tools are also retained. Users still have access to selection and measurement functions and can still examine spatial relationships between network flows, capacities, bottlenecks, and points of production and consumption in the region.

Technical System Specifications for the data delivery system are described as follows. The repository is installed on a ***Dell PowerEdge 2650*** Server with a ***Dual Xeon*** 2.4 GHz processor and 4GB of RAM. The server resides in the Geographic Information Science and Applied Geographics (GISAG) Center at The University of Toledo. A ***Citrix Presentation Server Standard Edition*** permitting 20 simultaneous users is installed on the server. The ***Citrix*** server hosts the ***ArcView*** installation; remote users can access the ***Citrix*** server through the Toledo Site web page (www.midwestfreight.utoledo.edu). Users are provided with the necessary permissions to access ***Midwest FreightView***, but may not retrieve any data or make modifications to the database. All functions are performed on the ***Citrix*** server; only screen images are transferred to remote clients. The contents of the GIS database and the capabilities of the site to date are summarized in Figure 17.

D.2.3 Sample "Walk Through" of *Midwest FreightView*

A brief illustration of the capabilities of ***Midwest FreightView*** is presented here. Figure 18 shows the user interface displaying the basic corridor-level map. Users simply access one of the pull-down menus to retrieve the desired data layer. In this case, the region's highway network is selected. Users have a variety of display options within ***ArcView***. Moving to Figure 19, a second data layer corresponding to manufacturing on the census tract level is selected. These data are overlayed onto the highway network in the form of a dot distribution map showing the locations of manufacturing establishments within the region. Finally, truck traffic volumes (average annual daily truck traffic) are displayed on the links to compare the distribution of truck traffic to manufacturing activity in the region. This simple overlay can then be exported to a map composition template in ***Midwest FreightView*** for insertion of other features such as titles, legends, scales and a north arrow. Users may then choose to export the map to a graphics file or send the map image to their local desktop printer from the Toledo Site server.

Geodatabase:

- Highways
- Airports
- Railroads
- Ports (Great lakes, inland waterways)
- Intermodal connectors and facilities
- Waterway Networks (including locks)
- Geographic Regions: States/Provinces, counties, tracts, block groups

Salient Features:

- User friendly interface
- Large viewer area
- Pop-up tools
- Scale dependent layer visibility
- Secure data viewing

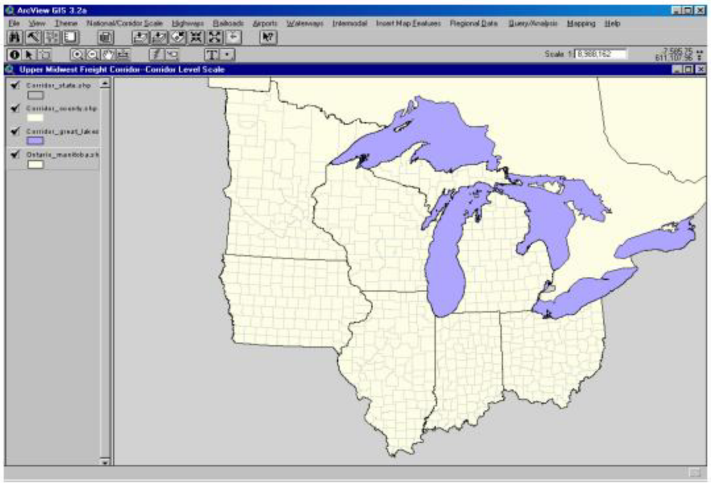
System capabilities:

- Display highway and rail alignments, airport, port and intermodal transfer locations
- Display capacities within the system
- Display flows within the system
- display administrative regulations within the system
- identify bottlenecks; points of congestion
- enable remote users to query the geodatabase and relative flows, and capacity and regulations on the World Wide Web (WWW)
- Enable remote users to produce maps, graphs and data tables

Toolbox:

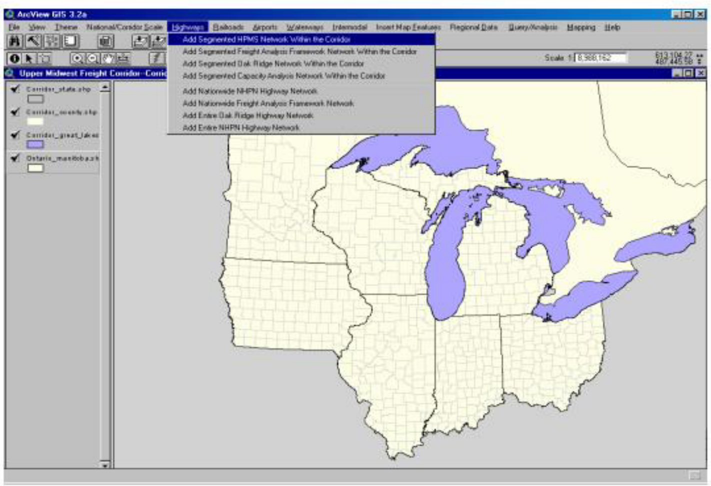
- Feature identification tools
- GIS layer manipulation tools (including map overlay)
- Database query facility using SQL querying and spatial querying techniques used in ***ArcView***
- Measuring tools
- Map production and customizing tools
- Map layout creating for printing purposes

Figure 17 System Capabilties and Database Contents of *Midwest FreightView*



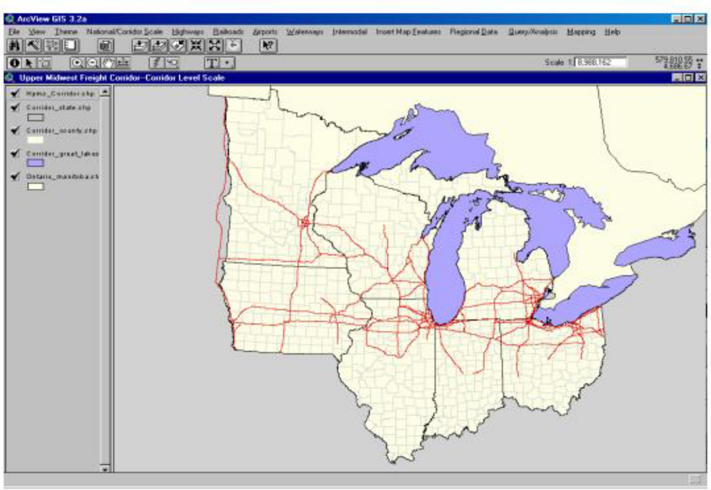
User Interface:

Corridor View



User Interface:

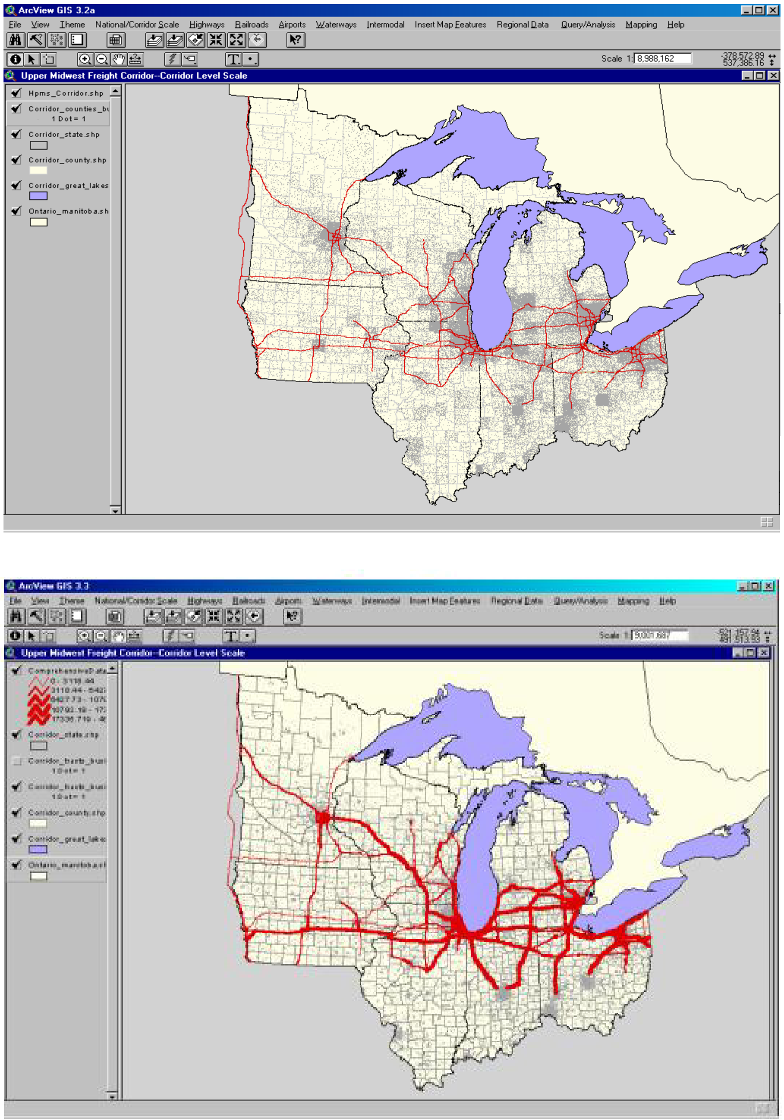
Pull-Down Menu



User Interface:

Corridor Highway Map

Figure 18 Basic Thematic Mapping Capabilities in the *Midwest FreightView* User Interface.



Thematic Mapping: Manufacturing and Average Daily Truck Traffic Volume

Figure 19 Manufacturing and Average Annual Daily Truck Traffic in *Midwest FreightView*.

The next illustration of ***Midwest FreightView's*** capabilities deal with query functions. Users can access the ***ArcView*** attribute query function from the *Query/Analysis* pull down menu as seen in Figure 20. In this example, all links in the corridor highway network designated as LOS E or F in the capacity analysis and containing the top twenty five percent of average daily truck volumes are selected using ***ArcView***'s SQL menu. These links are highlighted in yellow on the map display as potential bottleneck links.

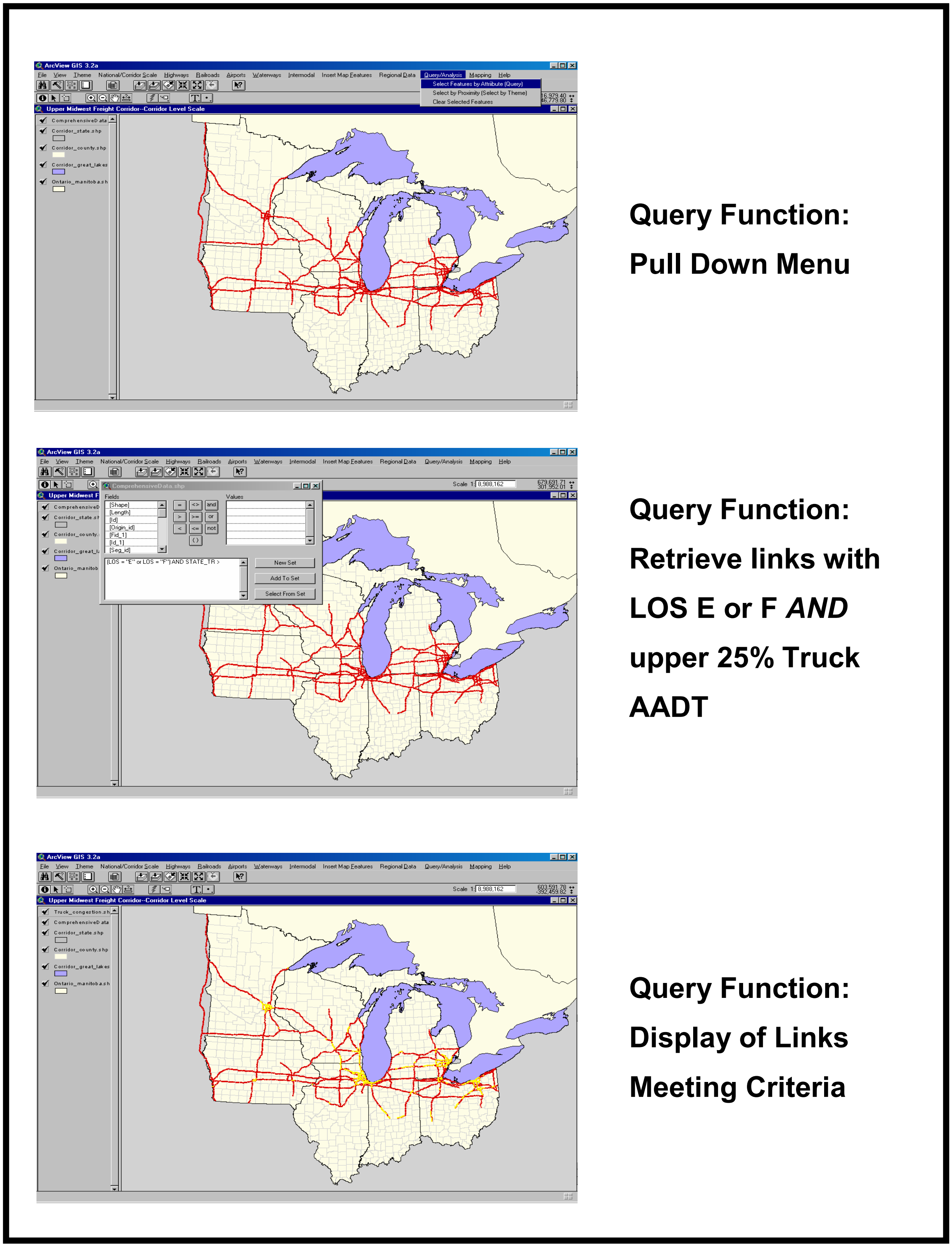


Figure 20 Attribute Query Functions in *Midwest FreightView*.

In addition to attribute query functions, the ***ArcView***–based interface also enables users to select features on the basis of spatial relationships. These spatial query, or *select by proximity* functions enable users to use location and proximity as criteria to retrieve sets of features that can be displayed or saved as a separate data set in the same way as the attribute query functions. This additional feature in ***Midwest FreightView*** takes advantage of the spatial relationships built into the regional database and provides greater flexibility for users to retrieve information out of the site. The spatial query functions within ***Midwest FreightView*** are summarized as follows:

- Select features that share the same space as a selected areal feature (*e.g*., select all highways within a selected county). Options within this selection technique include:
    - Objects that "Are Completely Within" a selected geographic area or set of areas (***ArcView*** Menu Command)
    - Objects that "Have their Center in" a selected geographic area or set of areas (***ArcView*** Menu Command)
    - Objects that "Intersect" an area or set of areas (***ArcView*** Menu Command)
- Select features within a specified distance to a selected object (*e.g*., all highways within 10 miles of a selected airport)
- Select larger features that contain a set of selected features either partially or entirely (*e.g*., all ZIP Code areas that contain a set of selected intermodal terminals)
- Select non-areal features that touch or intersect non-areal features (*e.g*., select all highway links that connect to a selected link or set of links)

In addition to the spatial query functions listed above, the system enables users to combine spatial and attribute query functions for more refined selection of objects (*e.g.*, select all highway links within a selected airport or set of airports whose AADT lies above the 50th percentile for all highways in the region).

D.3 Extending Midwest FreightView

At present, ***Midwest FreightView*** is primarily an internet-based data delivery system developed to report the findings of this study. However, plans are currently underway to expand this system into a more comprehensive transportation asset management and Spatial Decision Support System (SDSS) for the Upper Midwest that consists of advanced decision making modules and tools to assist transportation planners, shippers, carriers, public officials, policymakers and Homeland Security officials in making informed decisions. A wider variety of query functions and analysis tools will be added to accommodate a wider range of users that extends between casual browsers and "basic mappers" to more experienced systems analysts and GIS database users.

Given the establishment of this comprehensive data repository and an efficient data delivery system, greater attention can now be devoted to the development of a freight-based Spatial Decision Support System (SDSS). The system could be designed to perform "What If?" scenario modeling to evaluate management alternatives or alternative infrastructural improvements and also to formulate tactical plans subject to unplanned events (e.g., accidents, bridge closings) and to evaluate their effects on congestion patterns. The system can be further expanded to include additional analysis capabilities to simulate freight movements, evaluate alternative planning and policy scenarios.

One anticipated extension proposed for the ***Midwest FreightView*** is travel simulation on the highway network. Detailed data pertaining to the interplay between travel time, traffic volume and capacity, and travel at specific times of day can be developed to simulate truck movements over the highway network. Thus users could estimate travel times between stops on a proposed truck trip. Users interested in industrial location and economic development could also estimate the portion of the U.S. market that can be reached from a selected point of production as seen in Figure 21.

This illustration begins with the national view within the Midwest FreightView. The National Highway Planning Network within the data viewer is displayed in Figure 21. Truck travel times were roughly estimated in this highway layer based on assumed truck travel speeds as follows:

10. Rural Interstates (60 MPH)
11. Urban Interstates and Expressways (45 MPH)
12. Rural Two-Lane Routes (50 MPH)
13. Urban Arterials (30 MPH)
14. Other Urban Links (20 MPH)

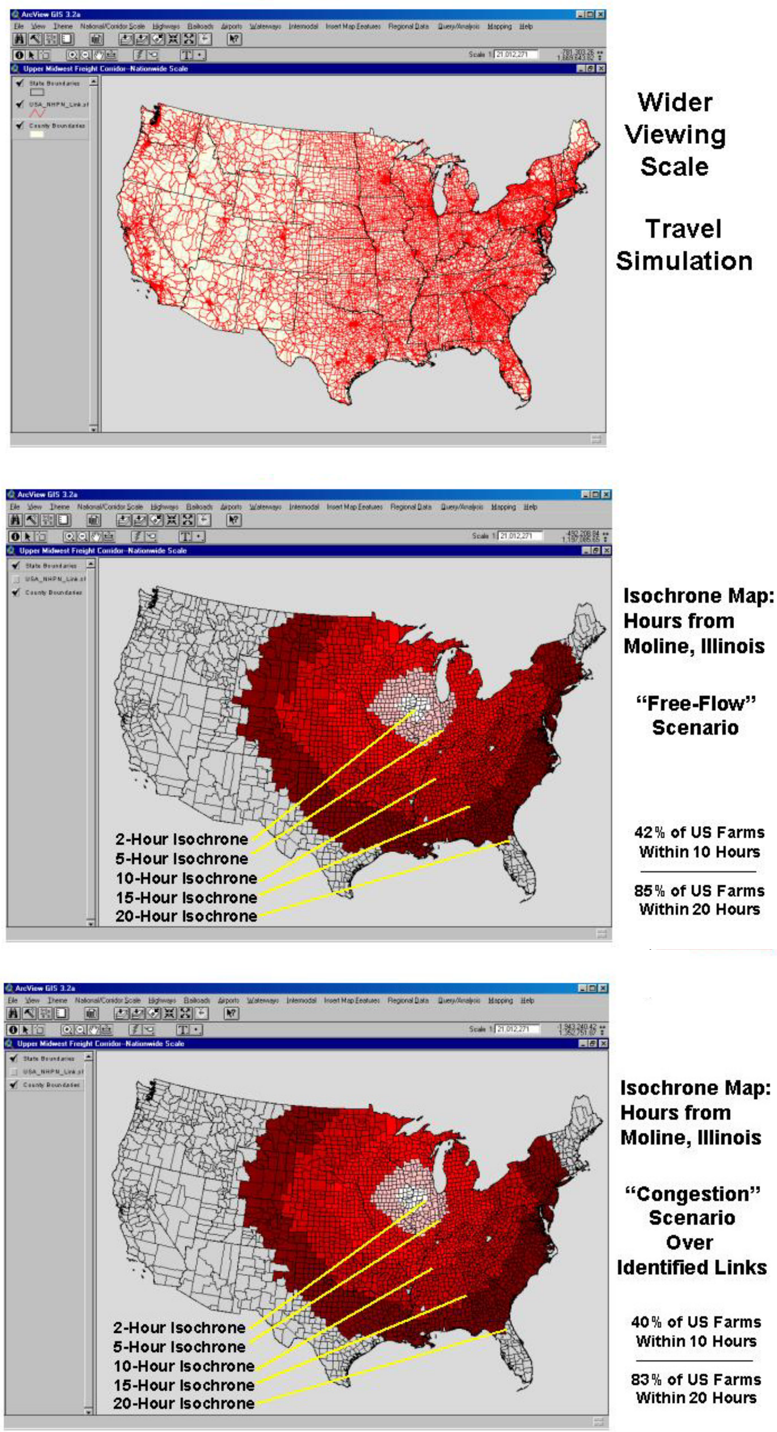


Figure 21 Example of Derivation of Isochrone maps showing travel times from Moline, Illinois to the national market under "Free Flow" and "Congestion" scenarios.

Initial "free flow" travel times were then derived by combining link lengths (miles) with these assumed speeds for all of the links in the national network. Using Moline, Illinois as a sample point, travel times from Moline to the rest of the lower 48 states of the U.S. were computed using a minimum path algorithm. Path skims were then assigned to the centroid of each U.S. county in total hours of drive time.

The query functions in ***Midwest FreightView*** were then used to assign counties in into classes according to drive time from Moline. These classes are mapped out in the middle "isochrone" map of Figure 21. In addition, a second query was performed on the counties to identify the total number of farms within a 10-hour drive and a 20-hour drive on the network to estimate the portion of the national market accessible to farm implement manufacturers in Moline. These figures are posted on the map.

In a second analysis, the congested links selected in the query operation illustrated in Figure 20 were overlayed on the NHPN network. A "congestion" attribute was then transferred to those NHPN links. These links were then assigned a travel time penalty by reducing the travel speed to 1/3 of the original estimated speed and then recomputing travel times over those links. Again, travel times from Moline to the rest of the lower 48 states of the U.S. were computed using a minimum path algorithm on this modified network. The new path skims were then assigned as a separate attribute to the centroid of each U.S. County in total hours of drive time. The results are posted on the lower map in Figure 21.

It should be noted here that this second "congestion" scenario computed here used links only within the study's corridor; no link modifications were made on the network outside of the corridor. Thus this example shows the effects of congested links within the study region on accessibility to national markets—two percent of the national market was lost due to the simulated congestion effects within the corridor.

This example is intended to illustrate only one application of ***Midwest FreightView.*** Travel times were crude estimates only. Travel times in these areas can, however be obtained and can be inputted into the network in the next phase of this study. In addition, dwell times at toll plazas or weigh stations were not accounted for. Using actual travel times and dwell times, these estimates can be refined to account for time of day, season, weather and other factors.

It must be emphasized at the time of the preparation of this report that ***Midwest FreightView*** is in the beginning stages of development; the fundamental framework for these efforts has been assembled and additional work is envisioned to provide a useful tool for freight professionals in the region and that the research team views this system as a long-term resource proposed for the region. Some of the major opportunities envisioned for users in the region include not only a managed regional freight infrastructure inventory system, but also a means to link economic development to freight capacity. The system also provides an excellent opportunity to serve as the framework for further work in modeling, simulation and forecasting of freight flows based on goods produced and demanded within the region. In addition, ***Midwest FreightView*** may also serve as means to monitor reliability of the system through assembling and reporting performance measures on different components of the regional freight infrastructure. In time, the system may even be able to provide near real-time data through linkages to ITS and other informatics technologies including weather conditions.

Before these innovations can be implemented however, a number of challenges must be addressed and overcome to assure efficient, timely and accurate information exchange within the region. The first of these issues deals with regional interest, dialog, and participation among the players within the region. Without regional cooperation, it will be difficult to develop data reporting standards and process requests for data from the different states, provinces and MPO regions. Another key issue deals with gaining access to technologically-assisted and/or automated data acquisition and management systems and the processing of these data to be included in the reporting site. It is recognized that an effective long-term reporting system must use reliable and timely data if users are to find any utility in it. Finally, such a system as the ***Midwest FreightView*** will require sufficient funding to continuously acquire, manage and deliver the data necessary to support the efficient transfer of commodities through the region.

APPENDIX E. DATA RECONCILIATION

E.1 Incompatibilities in Georeferencing among Diverse Data Sources

As mentioned in the previous appendix, considerable effort has been devoted to assembling geospatial data from diverse sources that included both private sector data sets as well as those from federal sources (*e.g.*, BTS, FHWA, Corps of Engineers, *etc*.), state transportation departments and MPOs. Given the lack of standardization in the reporting of transportation related data among these organizations and agencies, it was anticipated that few datasets were compatible with others. As a result, the research team spent many hours inspecting, converting, reconciling, and ultimately integrating different elements of the transportation infrastructure into a single comprehensive database that formed the basis for the findings reported in this document.

E.2 Geometrically Reconciling Network Data from Diverse Sources

As mentioned above, the data assembled in this study were obtained from diverse sources, all with different georeferencing systems (e.g., projections, coordinate systems, ellipsoid, datum, etc.). For example, ORNL data arrived in geodetic coordinates (Latitude/Longitude format), while the Geofreight data arrived in an orthographic projection on a sphere. Some data arrived registered in feet, some in meters, and some in geodetic coordinates. As a result, one of the first challenges for the research team was to reproject all of the data onto a standardized georeferencing system for the corridor:

- Projection: Lambert Equal Area Azimuthal
- Ellipsoid: WGS 84
- Horizontal Datum: NAD 83
- Central Meridian: -89.00
- Reference Latitude: 43.00
- Distance Units: Feet

These reprojection efforts however, do not guarantee that all of the data would be exactly registered onto one another. While this approach provides reasonable alignments within regional error tolerances for point data, a number of additional problems arise with network-based data or geographical boundaries; the alignment of one network or boundary segment from one source would not lay exactly over the alignment on the others (even with the same georeferencing scheme), resulting in a braided appearance between segments from different data sources that were actually developed to represent the same boundary, road or railroad alignment on the ground! This problem is illustrated in Figure 22 that shows two overlayed networks that are supposed to represent the same network but were derived from different sources and developed by different organizations.

In other cases, network segments representing the same features are not subdivided in exactly the same way among all of the measured attributes that they contain. For example, pavement types on highways may not be aligned exactly with speed limits and weight restrictions. Hence it is very difficult to combine these different attributes or make meaningful comparisons between them over the same section of highway.

E.2.1 Dynamic Segmentation Problems

Data in the form of network attributes are often not assigned to the same sections of the network; for example, pavement types may be subdivided into one set of links or portions while speed limits and weight restrictions are subdivided into another set. This presents significant challenges in displaying each combination of characteristics within all portions of the network as they may not line up exactly in the same locations. In addition, a second network representing the same section of highway that may contain other attributes that also cannot be directly aligned into the same segments or sections of the network. As a result, pavement types, speed limits, and weight restrictions from one network will not align directly with flows or capacity characteristics on a second network along the exact same links or sections. The solution to this is to subdivide all of the networks into a "least common denominator" set of segments where all possible combinations of characteristics associated with all segments are accounted for in a linear referencing system. This problem is illustrated in Figure 22 where Network A illustrates the variations in speed limits among three sections of a hypothetical highway network. Network B illustrates two pavement types. Neither network overlays with the other to form neatly-partitioned networks without substantial re-dividing of the network into a set of links representing all possible combinations of speed limits and pavement types.

A related problem deals with the fact that some point-based data that directly affect the linear network such as railroad crossings, toll plazas or weigh stations cannot be directly reported and incorporated into the network. In many cases, it is useful to identify portions of highway networks that contain these point-based features and assign them as network attributes.

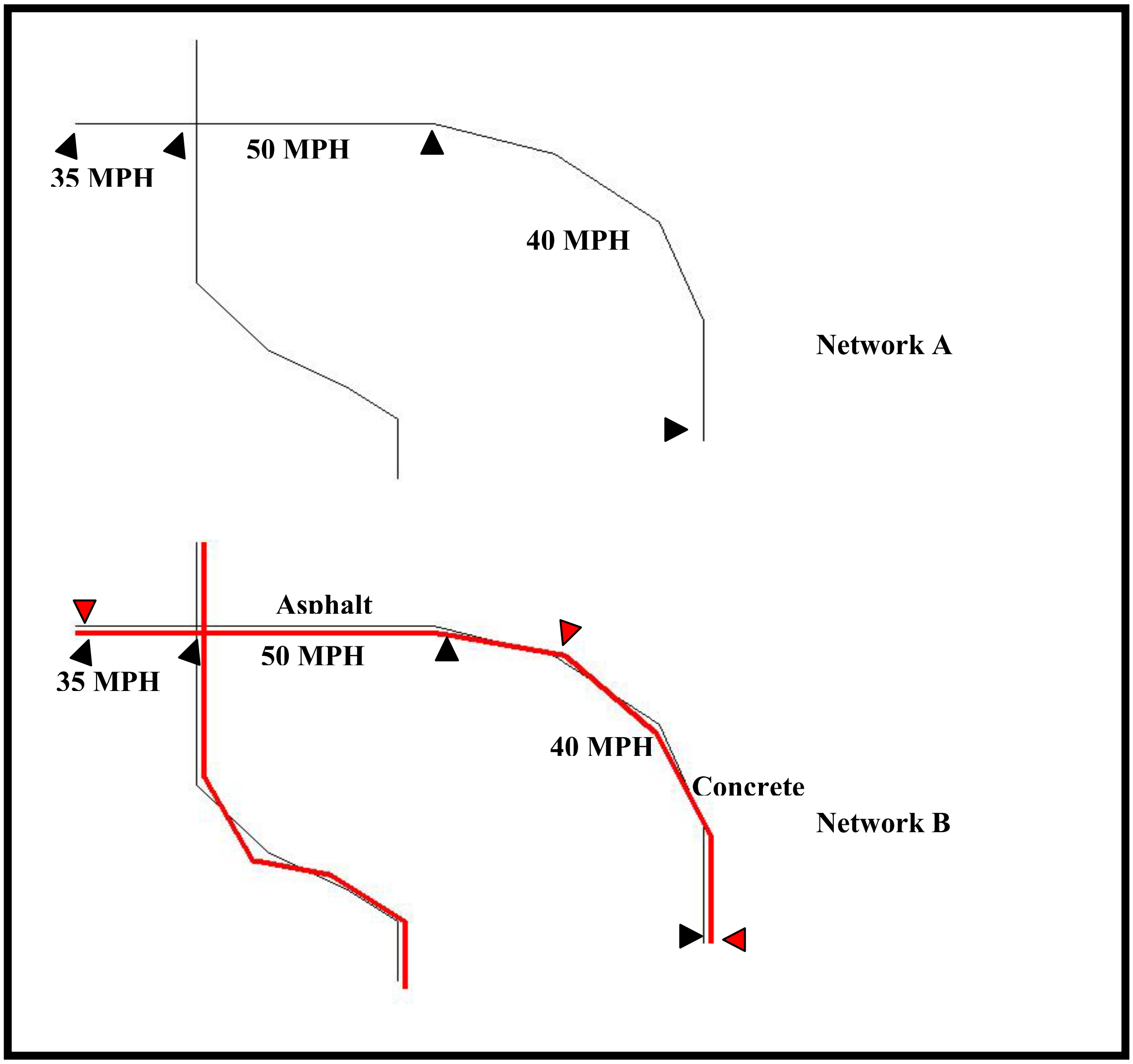


Figure 22 Alignment incompatibility between two networks representing the same features on the ground based on Dynamic Segmentation Problems (incompatible alignment among features delineated by triangular markers) and Conflation Problems (uneven, braided alignment among network segments representing the same portion of the roadway)

E.2.2 Conflation Problems:

Many GIS data networks derived from different organizations that were developed to represent the same features on the ground will not geometrically align themselves exactly over one another when overlayed—even when they are stored with the same georeferencing system. Encoding errors in the data yield conditions where overlayed networks display a twisted, braided effect as also seen in Figure 22. In addition, it is very difficult to transfer attributes from one network developed by one organization to another when the alignments of their features do not match geometrically. The ideal condition for overlaying network segments is for one segment to "snap" onto the other to enable a direct transfer of data.

Both of these problems of dynamic segmentation and conflation arose in the compilation of both the highway and railroad networks. However, the research team was able to overcome these geometric obstacles as detailed in the next section. This solution involved the selection of a single network to serve as a "base network", upon which the attributes of other networks as well as point coverages could be transferred to. For highways, the base network was taken from the 1:100,000 National Highway Planning Network (NHPN); for railroads, the 1:100,000 FRA railroad network was used.

E.2.3 Solution: Combining Points, Networks and Areas into a Comprehensive Network

The solution to this problem was to use the selected segments in the 1:100,000 National Highway Planning Network (NHPN) and in the 1:100,000 FRA railroad network subdivide them into ½-mile long segments using a segmentation algorithm. Each ½-mile segment was then assigned a midpoint using the same key identifier as its corresponding segment as illustrated in Figure 23 using the simplified network. This approach is analogous to converting an areal Vector GIS image into a raster image and transferring the attributes into the grid derived from this conversion. In the present case, each linear feature is simply subdivided into uniform components that permit the transfer of network attributes from adjacent network representations.

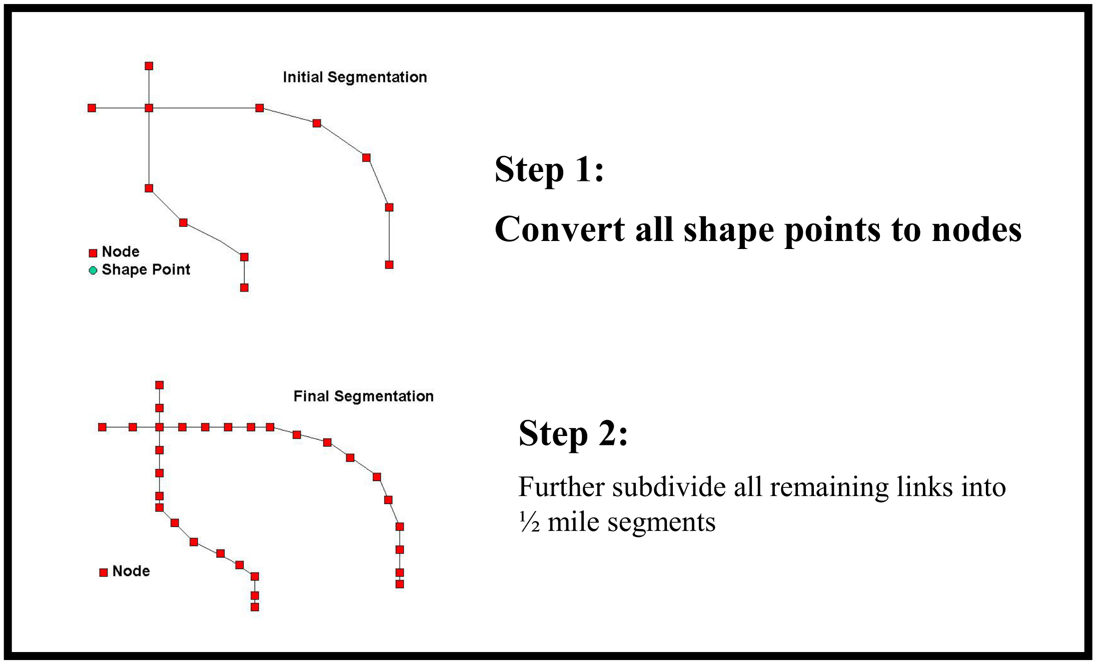


Figure 23 Segmentation procedure to produce minute ½-mile segments.

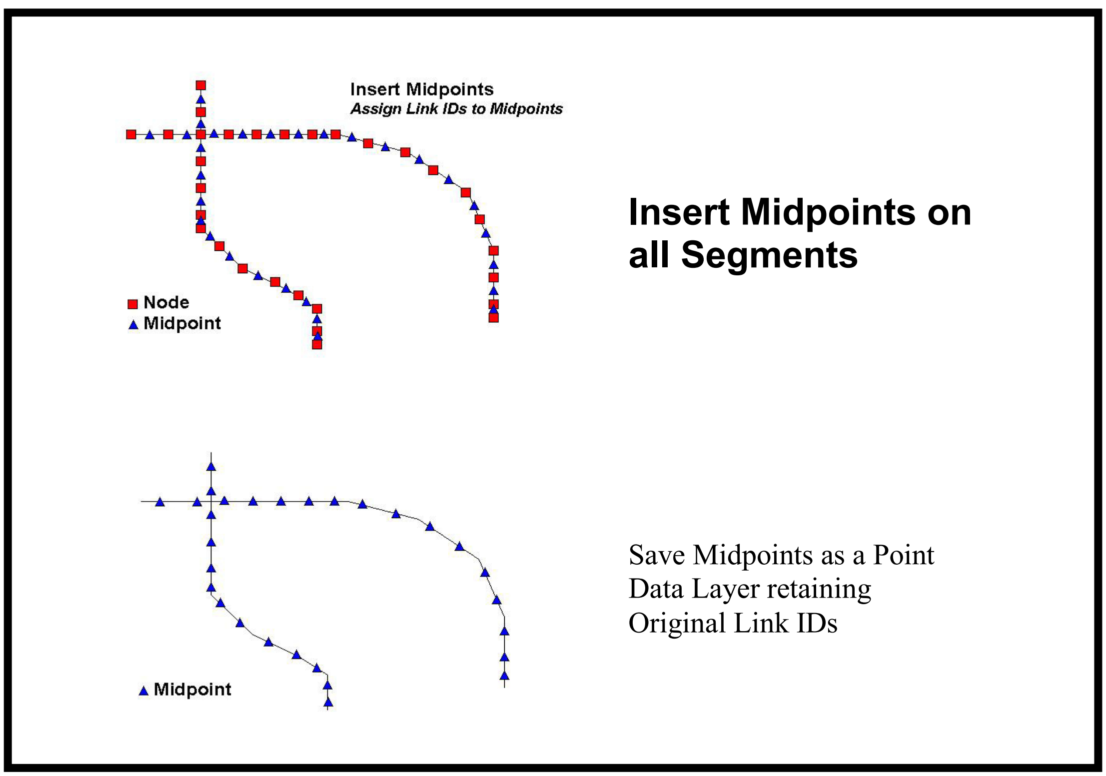


Figure 24 Derivation of the Midpoint Data Layer.

Each of these new minute segments is assigned its own unique identification number and also retains the identification number of the original link that it was derived from. As a result, the minute link can be reassembled into a larger link segment later. In one additional step, a single point is computed in the middle of each ½ mile segment as seen in Figure 24. Each midpoint is assigned the same unique minute link Identification number that it was derived from. These points are then used in the final step of transferring data between networks.

E.2.4 Data Merging Algorithms Used in Merging the Data

The points generated in the previous step are then applied in simple spatial overlay methods where a second network can be placed over the points and point-based searches are used to identify the closest network segment to the point, as seen in Figure 25.

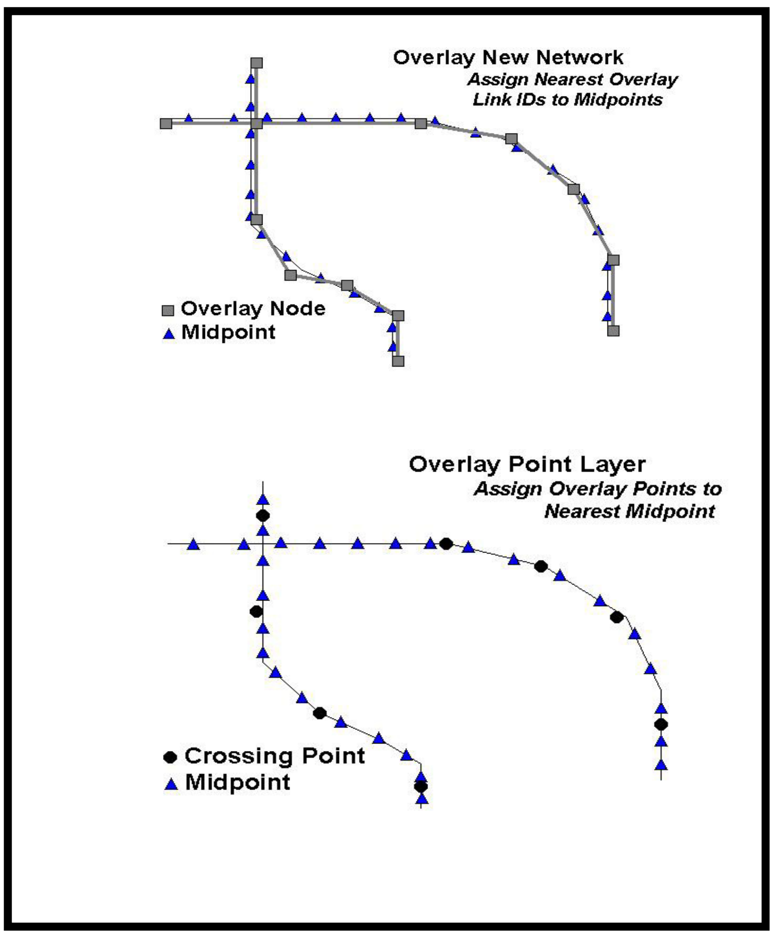


Figure 25   Final Step: Assigning midpoints to nearest network segment or point.

The unique minute link identification number assigned to each midpoint in the previous step is then appended to each record in the overlayed network attribute table. These tables are then used in relational joins with the segmented base network attribute table (corresponding to the aforementioned NHPN and FRA 1:100,000 base networks) via this identification key. This approach also works with assigning discrete point data such as railroad crossings, weigh stations and toll plazas to individual ½ mile segments as seen in the lower diagram in Figure 25. These data can then assigned as network attributes that can be incorporated in capacity computations and travel time estimates for travel simulation routines and system performance measures.

This technique yields a network representation system in which the highly segmented networks serve as the base geometric network for railroads and highways and are linked directly to all of the attributes from other networks whose attributes are needed for this study. Upon completion of this transfer, the segmented network can be consolidated by "zipping up" all adjacent ½-mile segments that share *all* of the same attributes when linked to a specific network attribute table. In addition, the attributes associated with diverse network sources can be stored separately and do not have to be appended to the base network unless the user chooses to do so.

This automated process precludes the tedious manual transfer of network attributes from a wide array of sources ranging from individual state DOTs, MPOs, BTS sources, HPMS, FAF and other network sources containing data desired for incorporation into the comprehensive ***Midwest FreightView*** database. These data are thus projected onto individual base networks as attribute files; the need to maintain and conflate each source network is not necessary. The main disadvantage of this system is the storage of data into a highly segmented network. However, computing speeds at the Toledo Site are sufficient to minimize any inconvenience associated with waiting for map images to appear on the data viewer.

APPENDIX F. MPO INTERVIEWS

F.1 Introduction

During the development of the proposal for the Upper Midwest States Freight Study, the study team realized the importance of working with the Metropolitan Planning Organizations (MPO) and invited them to participate as part of the Advisory Committee. In the design of the study, the MPOs were expected to provide direction for study efforts, data and information about freight flows and capacities with in their regions, and important feedback as the study team attempted to reconcile the national flows with the flows within the MPOs. It was also clear that many (and probably most) of the critical problems for freight movement in the region occurred within the jurisdiction of the MPOs. So, it was only reasonable to ask them about bottlenecks and flow constrictions within their areas of responsibility.

F.2 List of MPOs

The following MPOs were contacted for site visits or in depth phone interviews. Moving from east to west across the region, these include:

- Eastgate Regional Council of Governments, (Youngstown, Ohio; www.eastgatecog.org)
- Akron Metropolitan Area Transportation Study, (Akron, Ohio; www.ci.akron.oh.us/AMATS/
- Northeast Ohio Areawide Coordinating Agency, (Cleveland, Ohio; www.noaca.org)
- Toledo Metropolitan Area Council of Governments, (Toledo, Ohio; www.tmacog.org)
- Southeast Michigan Council of Governments, (Detroit, Michigan; www.semcog.org)
- Northeastern Indiana Regional Coordinating Council, (Fort Wayne, Indiana)
- Northwestern Indiana Regional Planning Commission, (Portage, Indiana; www.nirpc.org)
- Chicago Area Transportation Study, (Chicago, Illinois; www.catsmpo.com)
- Northeastern Illinois Planning Commission, (Chicago, Illinois; www.nipc.cog.il.us)
- Bi-State Regional Commission (Rock Island, Illinois, Quad Cities; www.bistateonline.org/index_ie.shtml)
- Rockford Areas Transportation Study (Rockford, Illinois)
- Southeast Wisconsin Regional Planning Commission, (Milwaukee, Wisconsin; www.sewrpc.org)
- Metropolitan Council, (Minneapolis and St. Paul, Minnesota; www.metrocouncil.org)
- Des Moines Area Metropolitan Planning Organization, (Des Moines, Iowa; www.dmampo.org)

F.3 Summary of MPOs Reports

The MPOs offered a different yet important perspective for the Upper Midwest States Freight Study.

F.3.1 The MPO Perspective

The MPO's are the foundation of the transportation planning system in the U.S. They have detailed information about the movement of people and freight in their area, and they are aware of the bottlenecks and constriction points that exist in their regions. They work closely with their state Departments of Transportation to monitor, planning, and improve transportation. They have been very willing to work with us and they have been very helpful in providing information, both flow and capacity data. These organizations act as anchors that help us to determine if our approach and the results of our efforts are accurate.

F.3.2 List of Bottlenecks Identified by MPOs

As the study progressed, two bottlenecks seemed to stand above the rest. Continuing and substantial delays at border crossings between Canada and the U.S., especially between Windsor, Ontario and Detroit, Michigan, present a major bottleneck to trade. The convergence of major rail lines and highways in Chicago present a continuing set of problems for the efficient movement of freight. In addition to these, the MPOs have identified the following constraints within their regions.

F.3.2.1 Identified Bottlenecks – Eastgate Council of Governments, Youngstown, Ohio:

- I-80 through Youngstown is heavily utilized with particular emphasis on the segment between I-76 and St. Rt. 46, which is currently two lanes in each direction, with plans to expand it to three lanes. They anticipate that this will be carried out.
- Intersection with I-80, I-680 and St. Rt. 11 is problematic as well.
- I-80 and I-76 interchange also slows traffic.

F.3.2.2 Identified Bottlenecks – Akron Metropolitan Area Transportation Study, Akron, Ohio:

- Improvements in the SR 8 interchange with I-80
- CSX has a single track from Clinton to Barberton, which may have to be expanded
- Norfolk Southern may need a third track on the main line that passes through the region

F.3.2.3 Identify Bottlenecks – Northeast Ohio Areawide Coordinating Agency, Cleveland, Ohio:

- SR-2 and SR-640; lane drop eastbound
- I-480 at Warrensville Center Road: lane drop eastbound
- I-77 at I-490; lane drops northbound and southbound
- I-90 at US-20 (Euclid Avenue); lane drops eastbound and west bound
- I-77 at I-480; lane drops northbound and southbound

- I-271 at I-480N; lane drops northbound and southbound
- I-480 at I-71/SR-237; lane drops eastbound and westbound
- SR-2 at I-90 in Euclid; land drops eastbound and westbound
- I-480 at I-77; lane drops eastbound and westbound
- I-77 at Pleasant Valley Road; land drop southbound
- I-71 at IR-480; land drops northbound and southbound
- I-90 (The Innerbelt Curve) at SR-2; land drop westbound
- SR-2 (Memorial Shoreway) between Lakeside Avenue and East 9th Street; lane drops eastbound and westbound
- SR-2 at I-90 (The Innerbelt Curve); lane drops eastbound and west bound
- I-271 at I-90; lane drops northbound and southbound
- I-90 at SR-252 (Columbia Road); lane drop westbound
- I-271 at US-322 (Mayfield Road); land drops northbound and southbound
- I-71 at I-90/I490; land drop northbound
- I-90 at I-71/I490; lane drops eastbound and westbound

F.3.2.4 Identified Bottlenecks – Toledo Metropolitan Council of Governments, Toledo, Ohio:

- Vickers at-grade rail crossing between CSX and Norfolk Southern.
- CSX single track headed south to Cincinnati should be expanded to double track.
- Norfolk Southern double track headed to Chicago should be expanded to a triple track. Currently, passenger rail service between Toledo and Chicago shares these tracks. Future plans should accommodate high-speed passenger rail in an alternate corridor from Toledo to Chicago.
- I-280 interchange with I-80/90, which is scheduled for improvement in 2004
- Reynolds Road interchange with I-80/90, which is currently heavily used and the lack of an interchange between I-475 and I-80/90. A Dussel interchange upgrade with I-475 is scheduled for construction in 2006.
- I-75 and I-475 interchange at mile marker 205 is heavily congested. This project is currently in design.
- I-75 as it moves through north Toledo is congested and dangerous. This project is being reviewed for consideration.
- I-75 south of I-80/90 (mile marker 182 and south to Dayton) should be expanded from two to three lanes.
- I-475 is currently overloaded and should be expanded from two to three lanes

F.3.2.5 Identified Bottlenecks – Bi-State Regional Commission, Quad Cities:

- Intermodal section of Long Range Plan indicates river crossing capacity creates major bottlenecks in metro area.
- Smaller occurrences impact rail and automotive travel, especially along riverfront
- Old Davenport barge terminal conflicts with freight access

F.3.2.6 Identified bottlenecks – Rockford Areas Transportation Study, Rockford, Illinois:

- I-39/I-90 interchange
- Toll plazas, SR 251 – design deficiencies are major problem
- Problems with local routes include 90 degree turns on 251, below standard intersection capacities, and sub-standard lane widths
- Not enough volume on any of the rail lines to create capacity problems
- Airport access roads substandard, no interchange access to Rockford Airport, however airport is only at 50% of capacity

F.4 Reports Generated from MPO Visits

Following are a set of reports generated for each visit to the major MPOs along the study route.

F.4.1 Eastgate Council of Governments (www.eastgatecog.org)

The Eastgate Regional Council of Governments is responsible for a variety of federal, state, and local planning and project implementation programs for. As the Metropolitan Planning Organization and Areawide Water Quality Management Agency for Mahoning and Trumbull Counties, and the designated Economic Development District, Eastgate continues to maintain required certifications and planning documents to qualify the region for federal and state funding. Eastgate is committed to promoting cooperative regional efforts in the planning, programming, and implementation of public sector activities. Eastgate serves as a forum to discuss common problems, formulate policies, and affect rational plans for the benefit of the region.

F.4.1.1 Traffic Count Data on Study Routes and Major Connectors

Data taken from I-76/80 Corridor Study done by URS, 564 White Pond Drive, Akron, Ohio 44320-1100, (330) 836-9111. Average daily traffic counts on I-80:

- From Pennsylvania Border to SR-62 and SR-7 interchange – 28,500 ADT in 2001 and 38,400 ADT in 2025.
- From SR-62 and SR-7 interchange to SR-193 interchange 35,950 ADT in 2001 and 50,980 ADT in 2025
- From SR-193 interchange to SR-11 (North) interchange 38,390 ADT in 2001 and 57,140 ADT in 2025
- From SR-11 (North) interchange to SR-422 interchange 59,810 ADT in 2001 and 60-790 ADT in 2025
- From SR-422 interchange to Salt Springs Rd. interchange 60,110 ADT in 2001 and 68,690 ADT in 2025
- From Salt Springs Rd. interchange to I-680 and SR-11 (South) interchange 49,840 ADT in 2001 and 62,470 in 2025
- From I-680 and SR-11 (South) interchange to SR-46 interchange 61,790 ADT in 2001 and 78,300 in 2025
- From SR-46 interchange to I-76 interchange 51,030 ADT in 2001 and 70,010 in 2025. Programmed reconstruction, widen to three lanes

F.4.1.2 Average Daily Traffic Counts on Main Connectors

- SR-11 (South) 43,200 ADT in 2001 and 39,230 ADT in 2025
- I-680 36,170ADT in 2001 and 34,800 ADT in 2025

F.4.1.3 Additional information is available on the web site. Following are some of those reports.

- 2003 Annual Report: Eastgate Regional Council of Governments annual report for 2003
- 2030 Long Range Transportation Plan
- Transit Development Program
- Transportation Improvement Program

F.4.2 Akron Metropolitan Area Transportation Study (www.ci.akron.oh.us/AMATS/)

The Metropolitan Transportation Policy Committee of the Akron Metropolitan Area Transportation Study (AMATS) is the Metropolitan Planning Organization (MPO) for Summit and Portage counties and Chippewa Township in Wayne County. In addition, AMATS is designated as the organization certified by the Ohio Environmental Protection Agency (OEPA) to coordinate the development of the transportation plan elements for the Implementation Plan required CAAA for Summit and Portage counties.

F.4.2.1 Traffic Count Data on Study Routes and Major Connectors

- Average daily traffic counts on I-80 in the Akron area as well as major connectors are given in table at the end of this report. Most of I-80 through the region has three lanes in each direction so capacity is sufficient for demand. The only section that is currently two lanes (SR 8 to I-480) will be expanded to three lanes in each direction in the next two years.
- SR 8 is a significant truck route that should be added to the study.
- I-76 through Akron carries substantial traffic and may require upgrade and improvements.
- I-77 also carries substantial traffic Please expand on these problems including flows and an assessment of capacity.
- Interchanges between I-76 and I-77 are potential bottlenecks.

F.4.2.2 Important Intemodal Terminals

There is no significant water port in the MPO. The regional airport has had significant passenger growth, but there is limited freight activity.

F.4.2.3 Bottlenecks

- Improvements in the SR 8 interchange with I-80
- CSX has a single track from Clinton to Barberton, which may have to be expanded
- Norfolk Southern may need a third track on the main line that passes through the region

Additional information, including AMATS transportation plan for 2025 is available on its web site.

Table 7 Ohio Turnpike Traffic Volume For Year Ending 2003.

Class	Weight Classification (Pounds)	Gate 161-173 Sum Co line to I-77	Gate 173-180 I-77 to SR 8	Gate 180-187 SR 8 to I-480	Gate 187-193 I-480 to SR 44	Gate 193-209 SR 44 to Por Co line
1	< or = 7,000	28,814	28,057	21,651	27,539	26,079
2	7,001 - 16,000	1,249	1,119	1,018	1,185	1,145
3	16,001 - 23,000	357	340	315	413	404
4	23,001 - 33,000	1,017	991	910	1,265	1,254
5	33,001 - 42,000	966	908	838	1,035	1,028
6	42,001 - 53,000	1,253	1,194	1,154	1,343	1,341
7	53,001 - 65,000	1,318	1,277	1,239	1,396	1,395
8	65,001 - 78,000	2,150	2,050	2,004	2,221	2,223
9	78,001 - 90,000	190	160	154	163	155
10	90,001 - 115,000	94	64	64	60	60
11	115,001 - 127,400	16	13	13	12	12
	AADT	37,424	36,174	29,360	36,632	35,097

Table 8 IR 80 Connectors in Summit and Portage Counties.

Connector	P&A	B&C	Total ADT	ODOT Count No.
IR 77 N. of IR 80	41680	4280	45960	28577
IR 77 S. of IR 80	39990	4630	44620	28477
SR 21 N. of IR 80	15450	1160	16610	20077
SR 21 S. of IR 80	17440	1540	18980	65977
SR 8 N. of IR 80	33020	4030	37050	15077
SR 8 S. of IR 80	46420	4660	51080	14977
IR 480 N. of IR 80	36380	4940	41320	16767
SR 14 S. of IR 80	31430	3910	35340	1267
SR 44 N. of IR 80	6900	530	7430	19867
SR 44 S. of IR 80	6570	800	7370	26067

Note: All counts were done in 2001

F.4.3 Northeast Ohio Areawide Coordinating Agency (NOACA) www.noaca.org

The Northeast Ohio Areawide Coordinating Agency is the Metropolitan Planning Organization for Cuyahoga, Geauga, Lake, Lorain and Medina Counties in Ohio. NOACA is responsible for regional planning efforts including Long Range Transportation Plan, the Transportation Improvement Program (TIP), the region's water quality plan and an Overall Work Program (OWP) which carries out national planning guidance, air quality conformity, watershed planning, and special studies. NOACA suggests that we consider adding SR 18 from Medina to Norwalk. It is a route that is commonly used to bypass the turnpike. Trucks on I-76 and I-80 continue on I-76 through Akron. They pick up SR-18, which they take until they reach Norwalk where they move over to US-20. NOACA also suggested including SR-422 from I-271 to I-80.

F.4.3.1 Traffic Count Data on Study Routes and Major Connectors

Freeway Travel Time Study (June, 2000) provides travel speeds and delays for the major interstates (I-480, I-90, SR-176, and I-271). There is analysis for AM peak, PM peak, and OFF peak comparisons across I-480 and I-90. The web site www.noaca.org has many useful reports. Some are listed here.

- Federal Aid for Transportation: How it Works in the NOACA Region (464.2 KB - February 2003)
- Improvement Study of S.R. 306 at U.S. 422 (12 MB - June 2003)
- FY 2003 NOACA Legislative Monitoring and Advocacy-Related Activities Summary Report (1.9 MB - June 2003)
- 2001 Motor Vehicle Accident Report(4,636 KB-May 2003)
- FY 2003 Project Planning Reviews Summary (4.41MB -June 2003)
- FY 2003 Public Outreach Meeting Summary (4,086 KB -June 2003)
- SFY 2003 Service Request Report (430 KB - June 2003)
- FY 2003 Specialized Transportation Program Summary Reports Vehicle Application Process (3.0 MB - June 2003)
- 2003 State of the Region Report (64.7 MB-June 2003)
- NOACA 2002 Transit Network Guide (2.48 MB - June 2003)
- SFY 2003 Transportation Enhancement Process Report (1.14 MB -June 2003)
- *NOACA Transportation Links to Communities Program*:
  - Improvement of Traffic Ingress to the Gilmour Academy (1.09 MB - June 2003)
  - Traffic Calming for Two Neighborhoods in Beachwood (2.92 MB - June 2003)

- Traffic Signal Improvement Study for the Richmond Road and Shaker Boulevard Intersection (2.54 MB - August 2002)

- Congestion Management System Manual of Practice (1,174 KB-October 2002)
- Framework for Action 2025 Update(2,998 KB-June 2002)
- Freeway Travel Speed and Delay Study (10,109KB-December 2002)
- 2000 Motor Vehicle Accident Report (3,145 KB-June 2002)
- Regional Indicators Report (519 KB-June 2002)
- Summary of NOACA Region's Five-County Zoning Data Analysis (1,756 KB-September 2002)
- Transit Network Guide (731 KB-July 2002)
- State of the Region Report-2002 (1,355 KB-June 2002)
- State of the Region Report-2001 (1,211 KB-June 2001)
- Framework for Action 2025-Tier 1 Project List (26 KB-February 2001)

F.4.3.2 Rail Data Trains per Day

From east to west the following rail lines are important through the Cleveland area.

- CSX line from Buffalo through Cleveland (passing through Berea) heading southwest to Indianapolis, Indiana, which has about 80 trains per day
- Norfolk Southern's (NS) line from Buffalo through Cleveland has several connection points: NS Chicago (W.Shore), which passes through residential areas has been limited to 14 trains per day; NS Chicago (Elyria), which passes through Berea has about 100 trains per day; NS Pittsburg, which has more than 30 trains per day

F.4.3.3 Important Intermodal Terminals

- Cleveland Hopkins Airport – Potential for development (within a mile of the airport are major interstates (I-480 and I-71 which provide easy access to I-77, I-80, and I-90) and mainline tracks for Norfolk Southern and CSX. Currently, there are no meaningful connections among the airport, the rail lines, and the highways.
- Port of Cleveland is the largest water port in the region. There are, however, more than 30 intermodal facilities along the Cuyahoga River.
- Norfolk Southern – Maple Heights rail to truck (approximately 300 trucks per day)
- CSX – Collinwood rail to truck (approximately 400-500 trucks per day)

F.4.3.4 Bottlenecks

There is a detailed study of Freeway System Bottlenecks (1996) that is summarized here.

- SR-2 and SR-640; lane drop eastbound
- I-480 at Warrensville Center Road: lane drop eastbound
- I-77 at I-490; lane drops northbound and southbound
- I-90 at US-20 (Euclid Avenue); lane drops eastbound and west bound
- I-77 at I-480; lane drops northbound and southbound
- I-271 at I-480N; lane drops northbound and southbound
- I-480 at I-71/SR-237; lane drops eastbound and westbound
- SR-2 at I-90 in Euclid; land drops eastbound and westbound
- I-480 at I-77; lane drops eastbound and westbound
- I-77 at Pleasant Valley Road; land drop southbound
- I-71 at IR-480; land drops northbound and southbound
- I-90 (The Innerbelt Curve) at SR-2; land drop westbound
- SR-2 (Memorial Shoreway) between Lakeside Avenue and East 9th Street; lane drops eastbound and westbound
- SR-2 at I-90 (The Innerbelt Curve); lane drops eastbound and west bound
- I-271 at I-90; lane drops northbound and southbound
- I-90 at SR-252 (Columbia Road); lane drop westbound
- I-271 at US-322 (Mayfield Road); land drops northbound and southbound
- I-71 at I-90/I490; land drop northbound
- I-90 at I-71/I490; lane drops eastbound and westbound

F.4.3.5 Other Transportation Issues

- Aggregates and other bulk commodities moving into the Port of Cleveland and the possibility of using Whiskey Island at the mouth of the Cuyahoga River as a consolidation and transshipment point
- Berea is a substantial rail concern. Norfolk Southern's mainline and CSX's mainline intersect at this point. Currently, there are plans to address this constriction point, which process about 180 trains per day.

F.4.3.6 Economic Development Plans

NOACA participated in a detailed study of Northeast Ohio Logistics Analysis (February 1999). This was part of the Northeast Ohio Trade & Economic Consortium (NEOTEC). The study done by Wilber Smith Associates, Rebbie Associates, and Moffat & Nichol describes logistic trends and strategies; air cargo, rail, trucking, port and waterway systems and services; regional commodity flows, commodity forecasts and international trade, and competing communities. It also outlined an action plan.

F.4.4 Toledo Metropolitan Area Council of Governments (Contact David Dysard 419-241-9155; www.tmacog.org)

TMACOG is the MPO for the City of Toledo, Lucas, Wood, and Ottawa County, as well as adjacent townships in Monroe County in Michigan. Its goals are to improve quality of life in the Region by promoting a positive identity for the Region, enhancing awareness of the Region's assets and opportunities, being an impartial broker of Regional disputes and challenges, providing stakeholders a voice in Regional decision-making, and supporting opportunities for Regional stakeholder networking.

F.4.4.1 Traffic Count Data on Study Routes and Major Connectors

Average Daily Traffic Counts I-80/90

- Westbound: Before I-280 interchange – 20,200; Between I-280 and I-75 interchanges – 15,750; Between I-75 and Reynolds Road Interchanges – 14,500; Between Reynolds Road and Toledo Express Airport Interchanges 11,300; After Toledo Express Airport Interchanges – 11,150.
- Eastbound: Before Toledo Express Airport Interchanges – 11,300; Between Toledo Express Airport and Reynolds Road Interchanges 11,400; Between Reynolds Road and I-75 Interchanges – 14,900; Between I-75 and I-280 Interchanges – 15,350; After I-280 interchange 20,400.

Average Daily Traffic Counts on Main Connectors

- I-280: Headed North away from I-80/90 –13,500; Headed South towards I-80-90 – 13,050.
- I-75: about 30,000 both North and South
- I-475 does not intersect with I-80/90 but flows at that point are about 34,500

Capacity Problems at Interchanges with I-80/90

- I-280 is the busiest truck interchange on the Ohio Turnpike. Many westbound cars and trucks on I-80/90 exit at I-280 and head North to catch I-75 in North Toledo and move on to Detroit and beyond. In some cases they are making the trip around Lake Erie to Windsor, Ontario. Many cars and trucks headed south on I-280 enter I-80/90 and take it east to Cleveland and beyond. This explains the large difference in average daily traffic counts on I-80/90 that occurs east and west of the I-280 interchange. The interchange is scheduled for a major upgrade in the Summer of 2004.
- I-75 has about half of the daily demand as I-280. The I-75 interchange was constructed in the past decade and is not a constriction point. It is interesting to note that prior to this addition, there was no interchange between I-80/90 and I-75, two of the busiest highways in the U.S. The closest interchange was seven miles away using surface streets.
- The Reynolds Road interchange has demand levels that are close to those at the I-280 interchange so there is congestion. This interchange must meet the needs of traffic on I-475 because there is

no interchange between I-475 and I-80/90 and there is not likely to be one in the future. The flow on I-475 as it crossest I-80/90 is about 34,500 vehicles per day. Vehicles attempting to shift between I-475 and I-80/90 must travel over congested surface streets with traffic control signals that create additional delays. There are two factors working against building a new interchange. The area around the intersection of I-475 and I-80/90 is well developed, and the current interchange has a major UPS sorting facility with direct access from the facility to the turnpike, so UPS can send and receive triple trailers. To offer some relief, there is a plan to update the I-475 interchange at Dussel Road, which is about 1.5 miles west of the Reynolds Road interchange with I-80/90.

- The Toledo Express Airport interchange was built in the last five years and is dramatically under utilized.

F.4.4.2 Other

- Details of the flows at the intersections are available on the flow map.
- Counts by time of day are not available
- Speed data: Posted maximums
- Travel time on I-80/90 from I-280 interchange on the east to the Airport interchange on the west is about 25 to 30 minutes in either direction to cover about 30 miles.
- Reliabilities of these times are very good. Construction, traffic accidents, and weather can increase these times. Traffic accidents are relatively infrequent.

F.4.4.3 Rail Data Trains per Day

- Norfolk Southern (east-west mainline Cleveland - Chicago) 75-80 trains per day
- CSX (north-south mainline Detroit – Columbus) 25 trains per day
- CSX (north-south mainline Detroit – Cincinnati) 25 trains per day

F.4.4.4 Capacity and Flow (Intermodal) from

- Airport to Truck: The only major freight airport in the Region is Toledo Express Airport, which is about 20 miles south west of downtown Toledo. It is interesting to note that the airport is owned by the City of Toledo but is operated by the Toledo-Lucas County Port Authority. The Airport facilities are underutilized, the surrounding traffic network is not congested, and there is substantial room for expansion. BAX global has a major airfreight hub. It sends out about 40 trailers per day, which access St. Rt. 2, St. Rt. 20A, or I-80/90. Flows on St. Rt. 2 are reasonably high, 17,000 average daily traffic volumes that includes both directions. Flows on I-80/90 at that point are about 11,000 in each direction. From the I-80/90, there is easy access to I-75.

- Water Port to Truck and to Rail: The Port of Toledo is located in North East Toledo where the Maumee River empties into Lake Erie. The seaport ships general cargo, coal, and ore on the great lakes and across the oceans. General cargo is often transported by truck. Coal comes in by train and leaves by ship (about 4.5 million tons per year) and ore comes in by ship and leaves by train. The port has modern unloading and loading equipment for rail operations. It has very large capacity cranes for unloading general cargo.
- Truck traffic that enters and leaves the Port of Toledo must do so by surface streets until they reach I-280 about 2.5 miles. The volume of truck traffic is small and the street network in not heavily utilized in that area.
- Train traffic that enters and leaves the Port of Toledo is primarily on CSX. The most significant problem may be a rail-to-rail at-grade crossing between Norfolk Southern and CSX (Vickers) that delays CSX traffic.
- Rail to Truck: The primary rail to truck link takes place at Airline Yard in Toledo. Currently, this intermodal link is substantially underutilized. Originally, this facility was created to carry intermodal freight from Toledo to the east coast. When Con-Rail was absorbed by Norfolk Southern and CSX, the links at the end of the mainline were divided between these rail companies and the intermodal traffic on this line has been reduced.

F.4.4.5 Important Intemodal Terminals

- Toledo Express Airport is directly across SR-2 from an entrance to I-80. At this point, the mainline for Norfolk Southern is parallel to I-80. This has the potential to create an important intermodal connection point.
- The Port of Toledo has important links with both truck and rail for shipment of bulk commodities and general freight.
- In addition to the Airport, Seaport, and Airline Yard, there are major intermodal facilities that transfer grain from truck to ship. These facilities, which are south of the major assets in the Port of Toledo, are in close proximity of I-75, which give highway access north and south as well as access to I-80/90.

F.4.4.6 Bottlenecks

- Vickers at-grade rail crossing between CSX and Norfolk Southern.
- CSX single track headed south to Cincinnati should be expanded to double track.

- Norfolk Southern double track headed to Chicago should be expanded to a triple track. Currently, passenger rail service between Toledo and Chicago shares these tracks. Future plans should accommodate high-speed passenger rail in an alternate corridor from Toledo to Chicago.
- I-280 interchange with I-80/90, which is scheduled for improvement in 2004
- Reynolds Road interchange with I-80/90, which is currently heavily used and the lack of an interchange between I-475 and I-80/90. Dussel interchange upgrade with I-475 is scheduled for construction in 2006.
- I-75 and I-475 interchange at mile marker 205 is heavily congested. This project is currently in design.
- I-75 as it moves through north Toledo is congested and dangerous. This project is being reviewed for consideration.
- I-75 south of I-80/90 (mile marker 182 and south to Dayton) should be expanded from two to three lanes.
- I-475 is currently overloaded and should be expanded from two to three lanes

F.4.4.7 Economic Development Plans

These are generally not available at the MPO, but may be able to be gathered from other agencies in the Toledo area. We may want to see what we can get from federal sources.

F.4.5 Southeast Michigan Council of Government

Southeast Michigan Council of Government (SEMCOG www.semcog.org/) is the regional transportation planning agency for an area that includes Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne counties. SEMCOG supports local government planning in the areas of transportation, environment, community and economic development, and education. SEMCOG's mission is solving regional problems — improving the efficiency and effectiveness of the region's local governments as well as the quality of life in Southeast Michigan. SEMCOG has substantial information available on its web site. In addition to being available from SEMCOG, much of this data is on file with the Upper Midwest Freight Study Project Team.

Following is the web link for the border transportation partnership between Michigan and Ontario. http://www.partnershipborderstudy.com/main.htm

- External Commercial Vehicle Survey
- Internal Commercial Vehicle Survey
- National Roadside Survey (NRS) Canada
- Reebie Truck Data
- Transborder Surface Freight Data
- Border Crossing Traffic Volume
- Border-Crossing Travel Survey
- Southeast Michigan/Southwest Ontario BiNational Transportation Database

F.4.6 Northwestern Indiana Regional Planning Commission

- INDOT website has traffic counts for I-94. Toll Road Commission's Annual Report should provide information on truck usage.
- Heavy truck routes are on INDOT web site
- Add SR-49 on highway map
- Important connectors in the region include SR-12
- Important parallel routes US-20, US-6, and US-30
- Major rail lines: Norfolk Southern, CN, and CSX with significant terminal problems in Chicago. Examine Four City Rail Consortium Gary, Hammond, East Chicago, and Whiting. Contact: Justin Martin
- Major port in the area is Port of Indiana (Burns Harbor)
- Airport: Gary-Chicago International Airport could be expanded, but it is currently surrounded by rail lines and other industry
- Intermodal (BP-AMOCO): Tank Farm and Pipeline Terminal; Pipeline to truck

F.4.7 Bi-State Regional Commission (www.bistateonline.org)

The Bi-State Regional Commission is a local, voluntary organization of five counties and 44 municipalities in Western Illinois and Eastern Iowa. It serves as a forum for intergovernmental cooperation and delivery of regional programs and to assist member local governments in planning and project development.

F.4.7.1 Traffic Count Data on Study Routes and Major Connectors

24-hour average daily traffic – Bi-State used IL and IA DOT information and consolidated into one metro area map http://www.bistateonline.org/map_pub/map.shtml

F.4.7.2 Rail data for links and/or crossings

Rail data is derived from state information. Rail is included in the Long Range Transportation Plan and Community Economic Development Strategy (CEDS) both located online: http://wwww.bistateonline.org/ser/dat/ced.shtml, http://www.bistateonline.org/ser/tra/lon.shtml

Proposed plan to upgrade for passenger service and freight shared use, after completion of Chicago-St. Louis, Chicago-Milwaukee, Chicago-Quad cities and Omaha.

F.4.7.3 Intermodal Connections

Identify important intermodal terminals/any data regarding capacity and flow for intermodal facilities including:

- Proposed intermodal rail facility in the city of Silvis in the eastern part of the metro area.
- Environmental Impact Study has been conducted.
- Metropolitan Air Authority may have commercial and general air data
- Data for Davenport airport should be in Iowa's air plan. Check website.

F.4.7.4 Identify current system bottlenecks across all modes

- Intermodal section of Long Range Plan indicates river crossing capacity creates major bottlenecks in metro area.
- Smaller occurrences impact rail and automotive travel, especially along riverfront
- Old Davenport barge terminal conflicts with freight access

F.4.7.5 Long-term economic development and land use plans

Bi-State Commission received grant through DCEO and created a compiled (from various cities and counties) future land use map of the Quad Cities. Map is located at: http://www.bistateonline.org/html/ser/map/fut.shtml

Economic data (employment, output, etc., preferably by industry sectors) at county, state, or metropolitan area level for present and/or future/Economic development activities and identify partners in economic development:

- Refer to CEDS document at http://www.bistateonline.org/ser/dat/ced.shtml
- Under the Economic Development Administration, Bi-State updates the CEDS annually and re-evaluates economic strategies listed at the beginning of the document

Studies, plans, and reports that address current and future freight issues:

- See Long Range Plan and CEDS.
- A study was done in the late 1980s that looked at the feasibility of a publicly owned intermodal facility. The study determined that it would not be feasible due to the number of existing privately owned facilities in the region, primarily along the Mississippi River.

F.4.8 Rockford Area Transportation Study

Meeting began with an overview of the Upper Midwest Freight Corridor Project. RATS recommended that the study include I-39/U.S.20. A bypass through Rockford is utilized by many trucks to avoid the toll plaza. Illinois Tollway Authority may have accident data.

F.4.8.1 Traffic count data on study routes and major connectors with the study roads

- The IDOT website includes ADT data for years 1999 forward, click on "Identifier" to see the year figures are from
- New counts will be taken in the summer of 2004, no vehicle classifications
- RATS provided a hard copy map of 1999 ADTs. Should match IDOT website 1999 counts.
- 2002 Toll plaza counts (Beloit and Riverside toll plazas) maintained by Wilbur Smith should be available, including classifications
- RATS can provide the Rice study on I-90
- IDOT formula is used for traffic volume adjustment factors

F.4.8.2 Rail data for links and/or crossings

- RATS provided a consolidation study (on CD) that includes rough rail traffic numbers and rail line conditions (poor trackage, at-grade crossings, below standard clearances (23')) of main line (Canadian National). The line map on the CD is very accurate.
- There are 3 other railroads in Rockford that start and/or terminate in the city.
- Not enough traffic to invest in maintenance/upgrades

F.4.8.3 Identify important intermodal terminals

- Estimated truck volumes for intermodal terminals may be available
- Important terminals include Rochelle, Global I
- Intermodal data should be available for Rochelle and the Rockford Airport (RATS will provide Airport study)
- Rockford Airport is the 2nd largest UPS terminal in country
- FAA website has Region 5 cargo tonnage
- RATS can get capacity data from the Rockford Airport
- No water freight

F.4.8.4 Identify current system bottlenecks across all modes

- I-39/I-90 interchange

- Toll plazas, SR 251 – design deficiencies are major problem
- Problems with local routes include 90 degree turns on 251, below standard intersection capacities, and sub-standard lane widths
- Not enough volume on any of the rail lines to create capacity problems
- Airport access roads substandard, no interchange access to Rockford Airport, however airport is only at 50% of capacity

F.4.8.5 Long-term economic development and land use plans

Future construction includes proposed 4-laning of US 20 to Iowa (some Eng. I work in TIP)

F.4.8.6 Economic data

- Traffic demand model includes county level employment by sector
- Land use and employment forecast by sector (by SIC by TAZ). Kazuya says county-level is sufficient
- IDES (formerly DCCA) has employment projections on website (through 2008)
- Rockford has lost 12,000 manufacturing jobs in the past 5 years
- Dramatic changes in import/export flows from IL (2nd in country for loss of exports)
- IDOT – Randy Blankenhorn contact - Economic and transportation study by Michael Gallas & Assoc. RATS is hoping for a draft by March. Gallas spoke at the IL statewide planning conference (Dinner speaker 1st night)
- Bureau of Economic Analysis economic study

F.4.8.7 Economic development activities and identify partners in economic development

Marketing socio coalition

F.4.8.8 Studies, plans, and reports that address current and future freight issues

RATS will provide Airport study

F.4.8.9 Administrative issues

Wide variety in tax structure (state-by-state) on rolling stock, Rockford permit system has been centralized. UIC should contact RATS through Steve Ernst, steve.Ernst@ci.rockford.il.us, 815-967-6734

APPENDIX G. SURVEYS

G.1 Public sector survey respondents

Arkansas State Highway and Transportation Department
Association of Central Oklahoma Governments
Atlanta Regional Commission
Bi-State Regional Commission
Boston Metropolitan Planning Organization
Chittenden County Metropolitan Planning Organization
Colorado Department of Transportation
Connecticut Department of Transportation
Delaware Valley Regional Planning Commission
Des Moines Area MPO
Fargo-Moorhead Metropolitan Council of Governments
Florida Department of Transportation
Houston-Galveston Area Council
Indiana Department of Transportation
Indiana Toll Road Authority
Indianapolis Metro Planning Organization
Kentuckiana Regional Planning and Development Agency
Kentucky Department of Transportation
Knoxville Regional Transportation Planning Organization
Louisiana Department of Transportation and Development
Madison Area MPO
Maine Department of Transportation
Maricopa Association of Governments
Maryland Department of Transportation
Metropolitan Planning Council
Metropolitan Transportation Commission
Michigan Department of Transportation
Mid-America Regional Council
Mid-Ohio Regional Planning Commission
Mississippi Department of Transportation
Missouri Department of Transportation
Mountainland Association of Governments
Nebraska Department of Roads
New Hampshire Department of Transportation
New Jersey Department of Transportation
New York Metropolitan Transportation Council
New York State Department of Transportation
North Carolina Department of Transportation
North Dakota Department of Transportation
Northeastern Indiana Regional Coordinating Council
Northwestern Indiana Regional Planning Commission
Ohio Department of Transportation
Oklahoma Department of Transportation
Pennsylvania Department of Transportation
Puget Sound Regional Council
Rhode Island Statewide Planning Program
Richmond Regional Planning District Commission

South Dakota Department of Transportation
Southeast Michigan Council of Governments
State of Hawaii Department of Transportation
Texas Department of Transportation
Utah Department of Transportation
Vermont Agency of Transportation
West Virginia Department of Transportation
Wichita-Sedgwick County Metropolitan Area Planning Department
Wilmington Area Planning Council
Winston-Salem Department of Transportation
Wisconsin Department of Transportation
Wyoming Department of Transportation

G.2 Copy of public sector survey with aggregate responses

1) Which best describes your organization?

State DOT 29
Metropolitan planning organization 26
City planning organization 0
City DOT 1
Other (please describe:________________________________) 3

2) How do you determine if the facilities under your jurisdiction or for which you plan are operating well with regard to the movement of freight? (Circle all that apply)

Real time collection and reporting of traffic flow data 16
Periodic surveys of flow consistency or dependability 12
Periodic surveys of shippers or carriers 14
Periodic meetings with shippers and carriers 21
Not done 19

3) Which factor do you feel is the most critical in determining success in the movement of freight?

Travel time reliability 37
Safety 9
Speed 3
Cost 6
Other (please describe:________________________________) 8

4) Using your answer to question #3, what do you think would be the best measure of this factor? (Feel free to use measures beyond the scope of what your agency uses.) *SEE OPEN ANSWER RESPONSES AT END OF SURVEY*

5) Do you currently use a system of performance measurements relative to the operation of your facilities in the movement of freight?

Yes	7
No	52

6) If the answer to #5 is yes, what measures do you use? (Please append materials if you need more space.) *SEE OPEN ANSWER RESPONSES AT END OF SURVEY*

7) If the answer to #5 is yes, how did you develop the measures? (Circle all that apply)

In concert with the private sector interests	2
In concert with other public agencies	2
Through a public process	3
Based on available data sources	5
Internally in my agency	4

8) If the answer to #5 is yes, how are the measures reported? (Circle all that apply)

Internally to interest management and staff	4
Regularly to interested private sector organizations	0
Regularly to interested public agencies	3
Periodically to those who have expressed an interest	6
As needed	3

9) If the answer to #5 is yes, how often are measures reported?

In real time	1
Weekly	1
Monthly	2
Quarterly	2
Annually	4

10) If the answer to #5 is yes, how often are the measures revisited or updated?

Annually ··1
Every five years ··1
With our planning cycle (which is every ______ years) ·····················3
As needed ···2
Never been done ···0

11) If the answer to #5 is yes, what benefit have you found from having such measures?

Improved system performance ··2
Improved communications with decision makers·······························2
Improved communication with other organizations, public and private··········2
Improved understanding of the operations of our facilities ·················5
Little benefit ···0
Other (please describe:_______________________________)····················1

12) What advice would you give to an organization just embarking upon a system of performance measurement for freight? *SEE OPEN ANSWER RESPONSES AT END OF SURVEY*

13) Does your organization currently plan or have plans to coordinate with neighboring jurisdictions regarding: *ALSO SEE OPEN ANSWER RESPONSES AT END OF SURVEY*

Motor carrier enforcement of size/weight?
If Yes, please explain what data and with whom:··························21
Motor carrier enforcement of safety?
If Yes, please explain what data and with whom:··························21
Locating and operating scales and safety inspection points?
If Yes, please explain what data and with whom:··························17

14) Which best describes your agency's efforts in freight planning?

Freight is specifically addressed in the planning effort ···················24
Freight is a component of the multi-modal plan······························27
Freight is a part of individual modal plans ································4
Freight is considered only as a class of vehicle in highway plans ··········7
Freight is not addressed ···3

15) To the extent that freight is addressed in your planning process, which best describes the involvement of private sector interests in the plan?

Significant involvement throughout the planning process ………… 12
Involvement in reviewing products ………… 4
Some advisory involvement ………… 25
Little involvement ………… 17
No involvement ………… 3

16) To the extent that your organization has been involved in freight planning, which of the following best describes your approach?

Largely policy-based, trying to define the appropriate role for my organization in trying to address freight issues ··· 17
Somewhat policy-based, but including some effort to forecast demand, mode and corridor ··· 21
Equally policy and quantitative ··· 8
Somewhat quantitative, but including an element of policy analysis ··· 7
Largely quantitative ··· 5

17) Which best describes your agency's planning program for intermodal connectors? (Intermodal connectors are the roads and highways that connect rail terminals, airports, and ports to the main highway system.)

Intermodal connectors are an integral part of the planning program ··· 10
Intermodal connectors are a part of the planning program ··· 25
Intermodal connectors are a small part of the planning program ··· 17
No program in place ··· 8
Planning program not needed ··· 1

18) Has your organization been involved in interstate, or regional, efforts to study freight?

Yes ··· 44
No ··· 15

19) If the answer to #18 is yes, which regional effort? *SEE OPEN ANSWER RESPONSES AT END OF SURVEY*

20) If the answer to #18 is yes, what benefit has your organization received from the regional effort? (Circle all that apply)

Cooperative regional efforts in improving the infrastructure ··· 22
Better relationships with other agencies ··· 30
Better relationships with private sector interests ··· 17
Better understandings of freight issues ··· 32
Little real benefit ··· 0
Other (please describe:______________________________) ··· 3

21) If the answer to #18 is yes, what advice would you give to others who might be embarking on regional efforts? *SEE OPEN ANSWER RESPONSES AT END OF SURVEY*

22) What do you see as the greatest need in improving freight planning efforts?

Improved communication with the private sector	34
Better commodity flow data	25
Better understanding of mode choice	17
Better communication between public agencies	11
Better communication among the various modes	14
Other (please describe:______________________________)	5

23) What do you see as the greatest need to improve the actual movement of freight?

More physical capacity in highways, rails, harbors, or airports	19
Better management of the existing capacity	26
More real time communication of the conditions of the facilities	14
Better communication between the modes	7
More or better intermodal facilities	7
Other (please describe:______________________________)	7

G.2.1 Open answer responses

Question #4

Hours of vehicle delay/Vehicle miles traveled. Taking into account the average amount of traffic, the total amount of traffic, and the peak hour amount of traffic.
Percent of time that travel is completed with + or - a predetermined ideal time.
Consistency in travel and reduction in accident/fatals.
Travel time studies, ATM placement and real-time surveys
Shipper input on on-time delivery by mode.
Accident per VMT
The variation of expected arrival times. For rail: number of "at-grade crossings" closed on main-lines.
1. Cost: comparisons with other production centers. 2. Shipping delays/costs. 3. Safety records analysis. 4. Transit time comparisons with other production centers . . .
Safety: Reduce accident rates involving commercial vehicles. Reliability: Reduce time delays on overall/selected corridors.
$ per ton/mile
a. Predictability - shippers reports of on-time performance. B. Safety - accident rates.
Hours of minimum closure due to weather or other factors.
Travelers information and electronic toll collection.
Los / Traffic movement
Ability to contain congested periods to allow off-peak movement of goods/trucks
Limiting heavy trucks to roads that are best suited for their travel.
Not sure
Congested operating peak hour speed or average hour of delay.
Average travel time between locations
Origin to destination travel time variation by commodity type (includes switching or intermodal and other handling)

outliar's evaluated
average operating speed on highways
Parking ticket revenues (inverse thereof)
daily travel time by hour
A competitive measure that captures costs associated with travel time reliability, safety, speed, environmental impacts, public and private sector operations costs, etc.
vehicle hours of delay
Intervals of time e.g. 0-1 hour; 1-2 hours; 2-3 hours; etc: of delivery vs. promised/planned delivery.
Crash data from police reports or other incident
In the current "pull" economy (vs. a "push" economy), the most important measure would be to establish on-time reliability from a shippers perspective. This could be performed for each major mode of transportation.
perhaps a business survey of shippers
Reducing truck-auto accidents, reducing truck incidents that block traffic
We are still working on this, adding truck factors to our travel rate formula. We are looking at daily factors.
I feel a measure like "rail-use : capacity ratio" in tandem with "truck use : capactiy ratio". Also "freight revenue per ton mile" broken down by truck, rail, water, air, and aggregate.
Not sure what can measure this.
On GIS an overlay of congestion data (e.g. peak spreading, non-recurring incident) on a map of freight routes or O&D.
Travel time data
Higher level of competition between freight modes.
GPS or scan data on vehicles from point to point. Enact policy/law or advocate for expanded delivery hours.
Periodic meetings with shippers and carriers.
A. Truck survey for driver perception. B. Truck GPS tracking measurements. C. Incident management reports.
Accident statistics, safety of the trucks that are carrying the freight.
Measure time delays caused by congestion, incidents, and construction.
Volume/Service Ratio
For cost - cost/ton-mile. For speed - average speed. Don't have a good measure for reliability.
Meeting with shippers
Percentage of commercial truck VMT in urban areas that occurs under congested conditions.
There are several measures that could/should be used. Automative JiT=Time+Speed, Cost of delay at borders can be measured, Hazmat=Safety, Number of crashes, Heavy bul =Cost, Measure changes in freight rates/mile
Conversations with shippers/carriers, data collection
I'm not sure. I imagine the customers of freight carriers would be able to best measure this.
Estimated time versus actual time.
Travel time studies.
Avg. speed, responses via survey.
Measurement of travel time gained or lost due to congestion.

Question #6

We measure the revenue and traffic count derived from our toll collection system.
volumes, commodity flows
Level of Service (A, B, C, D, E, F)
Critical Rate for safety, Volume/Service for congestion
Total pounds of domestic cargo moved at BWI Airport. Annual tons of foreign cargo moved through Port of Baltimore. Tons of Maryland Port Administration Cargo. The MPA also uses ship customer satisfaction reports and also utilizes QCHAT-online form accessible to the steamship lines, stevedores, and terminal operators to assess 38 different quality factors for each ship.
Level of service for highways, Delay (crossing time) at border crossings, See long range plan for Michigan (enclosed)

Question #12

Make sure the objectives are the same for both the private sector and public agencies.
Talk with the freight industry people to determine what they feel are the most important performance measurements.
Hold for the present any new measurement investment. Use existing traffic data if possible. Wait for efficient and (relatively) inexpensive methods to be developed.
Currently taking steps to identify what PA needs for performance measurements for freight - nothing to suggest at this time.
a. Establish measure(s) that reflect the perspective of the users of the transportation facilities, rather than the perspective of the provider of the facilities/infrastructure (i.e., State DOT). B. Select appropriate measures that truly reflect "outcomes", not simply because data is convenient or readily accessible.
Educate yourself on the various modes of freigh transportation, and the issues those modes currently face . . .
Select a unit of measure that is readily obtainable to shippers/receivers.
Include shippers and their customers.
Focus on customer satisfaction and define good service.
Determine first what is important to measure (e.g. time, reliability) and how freight interacts with regular commute performance (is it necessary to separate the two?)
Develop a comprehensive data collection and analysis system on traffic flow, congestion - recurring and non-recurring, facility design, etc.
Stay with date that can be reliably obtained and understand how collected and collection idiosyncrasies.
Ask the freight companies to tell you what is important to them.
Build an inventory of all relevant issues before choosing or building a measurement index. Curb space management is critical in places like Boston and NYC, but don't jump out in traditional traffic-flow based analyses.
We are starting to develop
Think of ways that your agency can build trust with industry stakeholders before attempting to develop or use these performance measures. Engage industry in their development.
Select simple measures that can be updated in a straight forward manner
Be careful about the accuracy of data. I would encourage agencies to cross-check data sources.
We have found this to be a real tricky area for a variety of reasons. Intermodal facilities are so varied it makes it difficult to make comparisons (e.g. one facility may handle "tons" and another "TEUs"). Furthermore, facilities are often in competition with one another and it would imprudent to point out that inadequacies of one. Finally, as an MPO, our staffing and funding strengths more typically relate to things which take place outside the facility (i.e., on NHS connectors.)
Get reliable and consistent freight data for multiple years and modes first.
Gain the cooperation of freight operators, help them understand the benefit of their help.
We've developed a regional freight study . . . We utilized publicly available data such as the economic census and proprietary Reebie data . . . Additionally, the freight analysis framework recently released from FHWA office of Freight Management is very useful at deriving estimates of freight activity in relation to the rest of the nation or other regions therein . . .
(We have not yet gotten to the point in our freight planning process where I would feel comfortable giving such advice.)
Listen to the freight community about day-to-day variability.
We are looking at how to plan for freight.
1. Be realistic - start small. 2. Watch FHWA/NCHRP websites for helpful publications 3. Solicit PM's from other successful organizations.
Start at the local (MPO) level first to win confidence and trust. Treat long haul (50 miles or more) as part of statewide measurements. Organize a committee of stakeholders from various sectors of the freight industry to establish criteria for performance measures.
It would be inappropriate for us to offer advice since we have not worked towards establishing such a system ourselves since we function as landlords who provide the facilities. Such an inquiry should be forwarded to individual terminal facility operators.
Get with stakeholders - find out what they see as critical freight issues/measures
Get advise/input from the private sector regarding the issues, problems, and obstacles. Having their input helps you take a comprehensive look at the situation, so that decisions would not be made in a vacuum.

Start simple with measures that only require data that is easily collected. Everyone is under pressure to cut costs.
Be patient and flexible.
Keep the number and type of measurements to a level and form that is easily usable. Measures should be meaningful, manageable, measureable, and achievable and cover all facets of operations.
Measure what you can control.
To use the research and resources that already exist to help build your own system.
Form strong public-private partnership.
First develop them through a Statewide Planning process and tie them to investments for State TIPs.
Make sure measurement adds value to the purpose of the organization.

Question #13					
13a	**13a Comments**	**13b**	**13b Comments**	**13c**	**13c Comments**
Yes		Yes		Yes	
No		No		Yes	June 2003 started discussions with Maryland and W. VA on I-81 inspection points.
No		No		Yes	We have continuing discussions about possible collaboration on shared scales facilities
No		No	However, this is an area we are extremely interested in. Safety rarely has a "champion" at an MPO, and a freight advisory committee could fill this role.	No	
No		Yes	We are looking at accident data from our state DOT.	No	
Yes	CVISN - Commercial Vehicle Inspection System Network, PRISM - Performance Registration Information System Monitoring	Yes	CVISN, PRISM	Yes	CVISN, PRISM
Yes	Enforcement of oversize/overweight trucks is the responsibility of the Texas Department of Public Safety (TDPS).	Yes	Enforcement of motor carrier safety is the responsibility of TDPS.	Yes	TDPS coordinates the "locating and operating" of the permanent weight and safety inspection stations on the State Highway System, as well as conducting mobile weight and safety inspections of trucks. However, a few years ago, the Texas Legislature direct
Yes	Federal Highway Administration, US DOT, Annual size and weight certification, size/weight/content data with state DOT Motor Vehicle Safety Office and FMCSA	Yes	US DOT, Motor Carrier Safety Administration, Annual Commercial Safety Plan	Yes	Fixed scale sites and portable scale weigh sites.

Question #13					
13a	**13a Comments**	**13b**	**13b Comments**	**13c**	**13c Comments**
Yes	General coordination.	Yes		Yes	In New Brunswick perhaps on each side of the border
Yes	ITS and CVISN Okla. Tax Commission, Oklahoma Dept. of Public Safety (ODPS)	Yes	ITS-CVISN, ODPS	Yes	ODPS and Tax Commission, ITS - CVISN
Yes	Joint port with State of Montana	Yes	As above.	Yes	As above.
Yes	Just before the sugar beet harvest each fall, the shippers, carriers, local law enforcement, traffic engineers, etc. all get together to discuss issues, including weight restrictions, safety, law enforcement, etc.	Yes	see above	Yes	The Minnesota West Central Initiative completed a study in 2001 designed to better coordinate interstate weight restrictions, scale operation, and law enforcement. So far it remains unimplemented.
Yes	MN - inbound/outbound facility coordination, not fully implemented.	Yes	MN - regularly and routinely; IL with road officers (event specific); MI from time to time, based on need; Informally with Iowa in fall re: grain haulers.	Yes	Would like to try with IL - many variables due to toll system, esp with Kenosha facility being rebuilt, logistics complex at this point.
No	No direct. Not to my knowledge. We do have members on several national standing ASHTO, TRB and others on this subject.	No		No	
No	Not at this time.	Yes	Only as needed.	No	
Yes	Oversize/Overweight Permits Section coordinates with adjoining states concerning routing of OS/OW vehicles.	Yes	CVSA/FMCSA with member states	No	
Yes	Some local jurisdictions are experimenting with enforcement sharing.	Yes	Several motor carrier studies at selected locations are programmed for 2004-05.	No	An experimental weigh station study has been postponed pending funding.
Yes	State Police Motor Carriers Division	Yes	Inspections - State Police	Yes	Variety of scales conducted by State Police
Yes	States are required to report to FHWA all data related to size and weight enforcement. Missouri DOT have worked with other states on oversize/overweight dimension issues.	Yes	All state safety data is up loaded to national database. (Safety Net) (SAFER) Missouri Hwy Patrol coordinates with local agencies.	Yes	Missouri DOT builds and maintains weigh station (scales) and Missouri State Hwy Patrol is responsible for operating facilities.
Yes	There is a proposal to construct a truck weigh/inspection station on the I-81 corridor in cooperation with West Virginia. The project is in early construction stages with the FHWA and West Virginia. MDOT also	Yes	MDOT participates in the Commercial Vehicle Information System Network (CVISN). Access to national and state motor carrier	Yes	See 13a and b.

Question #13					
13a	**13a Comments**	**13b**	**13b Comments**	**13c**	**13c Comments**
	participates in a mulit state task force ins		databases is provided.		
Yes	This is an initiative that we have tried previously and remain committed to long term. We believe the CVISN program will enable the sharing of data needed to make this work.	Yes	State Police, Local PD that have signed our MOU.	No	We do mobile inspections and weighing. There is only one fixed safety inspection site in the state. Coordinating with other states would be almost impossible.
Yes	This is in the early stages along the Canamex Corridor; between Canada and Mexico via Utah . ..	No	(See above)	No	(See above)
Yes	We are beginning discussions through a regional freight conference scheduled for July 2003. MT, WY, MN, SD, IA, NE, Manitoba, and Saskatchewan	Yes	Same	No	
Yes	We are jointly operating weigh stations with the Mississippi Department of Transportation.	No		Yes	See 13a.
Yes	We coordinate with INDOT and Indiana Department of Revenue on permits.	Yes	With Indiana State Police motor carrier division.	Yes	Mobile scales with ISP.
No	We do not handle enforcement of size/weight.	No		No	
Yes	Within the state: State and local police, and federal agencies	Yes	Same as above.	No	
Yes	NJ State Police	Yes	NJ State Police	Yes	NJ Motor Vehicle Commission

Question #19

1999 Freight Movement Study for 3-county MPO area. North-South Transportation Initiative - SW Ohio I-75 Corridor.
A study of freight issues in the Chicago Metropolitan region
All Interstate 10 efforts, some are multi-regional and some are multi-state.
Atlanta Region Hourly Truck Study
Both the West Central Initiative mentioned earlier, and an effort from the Upper Great Plains Transportation Institute.
Consultant developed and MPO approved a Regional Intermodal Transportation Study
Eastern Border Transportation Coalition's "Truck Freight Crossing the Canada-US Border", NASTO Freight Service and Investment Study.
Eastern Colorado Mobility Study, Ports to Plans Feasibility Study, Ports to Plans Corridor Management Plan - Begin FY '04
FHWA - Truck Parking Areas
I-10 National Freight Study, Latin American Trade and Transportation Study
I-95 Corridor Coalition Mid-Atlantic Rail Operations Study, Central Jersey Transportation Forum, Wilmington-Harrisburg Freight Study, Port Authority of New York and New Jersey Port Inland Distribution Network Study, and Pennsylvania Agile Port
International study with Canada at Eastern border crossings.

Interstate Master Plans, Modal Freight Plans, Nation I-10 Plan, LATTS I & LATTS II, I-95 Corridor Plan
Involved in multi-state studies (such as LATTS), statewide freight components of the Long Range Plan, and regional freight studies for various areas in Arkansas.
Latin America Trade and Transportation Study
Latin American Trade and Transportation Study (LATTS), National I-10 Freight Corridor Study, I-10 San Antonio to New Orleans Early Deployment Study, Gulf Rivers Intermodal Partnership (now Heartland Intermodal Partnership)
Latin American Trade Transportation Study, IH 69 Corridor Study, IH 10 Corridor Study, Ports-to-Plains (Corridor) Study.
Latin American Transportation and Trade Study (LATTS)
Mid Atlantic Rail Operations Study: multi-state, multi-railroad effort to identify rail chokepoints and investigate possible funding scenarios; sponsored by the I-95 Coalition.
Mid-Atlantic Rail Operations Study, Northeastern Association of Transportation Officials (NASTO) Freight Study, AASHTO Rail Freight "Bottom Line" Report
Midwest Coalition
NASCO
New England Governors and Eastern Canadian Premiere's - Border Crossings and options to eliminate problems at the crossings.
Northeast - recent study by Cambridge Systematics
Northeastern Association of State Transportation Officials Freight Study
NTMTC(?) Regional Freight Plan Project
Our OKI MPO (Ohio Kentucky Indiana) studies freight in the Cincinnati Metro Area. Ohio has met with abutting states to discuss system connectivity issues and freight.
Participated in study of NAFTA trade impacts to I-35/I-29 corridor in 8 Midwest states.
State Interstate Highways Border Crossing Planning with adjoining states
State of Tennessee Rail Plan
State Universities are developing a freight forecasting model.
The Chittenden County Regional Freight Study - August 2001 http://www.ccmpo.org/activities/freight and the freight forum held in 2000.
The FAST Corridor, and the statewide Freight Mobility Strategies Investment Board, and WSDOT Office of Freight Strategies; and CASCADIA
The Northern Great Plains Initiative for Rural Development
This is also on-going, dealing with Union Pacific's railroad's monopoly along the "Central Corridor" from Denver to Northern California via Utah.
Transportation Trade and Economic Development: Maximizing Future Opportunities - Northern Great Plains, The Western Transportation Trade Network Study
Truck freight crossing the Canada/US border, Cost of delay at border crossings, Study new crossing at Detroit-Windsor, Transportation Efficiency Study-MDOT, Ontario Ministry of Transportation, Transport Canada
We lead the 2002 NASTO Freight Transportation Study. It looked at freight from Maryland to Newfoundland. Www.dot.state.ny.us/nasto/nastoreports.html
West Coast Corridor Conference, Bay Area Regional Goods Movement Study
Wilmington-Harrisburg Freight Study conducted by the Lancaster County (PA) Planning Commission
WTTN
Mid-Atlantic Rail Operations Study (MAROPS)

Question #21

Make sure the study provides for a means of implementing the needed improvements called for by the research.
It is worth the effort.
Be open minded and listen.
Wait to see if models developed are worth the cost and provide decision-making quality data.
Federal participation and internal department executive buy-in/support.

Try to get good data on freight movements.
Remember that moving freight is very different from moving people.
It takes time to "sell" this concept to many in state govt., but stay with it since such efforts are both valuable and often imperative. . .
Get involved at a regional/national/international level where freight movements are concerned.
Emphasize private sector involvement.
Just do it.
Offer cooperative suggestions - offer to help. Do NOT reject ideas.
Clearly define issues/problems, agree upon methodology to evaluate/address issues, seek active private sector participation.
Involve the public throughout the process.
Regional efforts are the best means of address freight needs since freight transportation are not captured to a single local jurisdiction.
It is important to build relationships with the private sector, but you can't just follow what the industry wants. There are times you'll disagree and times you need to push them in the right direction. They need to see the benefits to them.
freight movement has to be addressed at national, multi-state, regional, and local levels.
do it and it will help you understand how freight works
Spend some time planning who will lead or facilitate these relationships. Identify resources for someone to do this challenging work - if possible establish MOVs or MOAs to identify roles, responsibilities, and expectations before attempting any complicated inter-state planning work.
Reach out to key stakeholders.
Good interjurisdictional coordination is essential. A plan in which everyone gets something (i.e. everyone "wins") is much easier to implement than one in which there are clear "winners" and "losers".
A natural evolution and sophistication with respect to freight planning will necessarily take one outside traditional jurisdictional boundaries.
It is important to understand the regional context - otherwise you may be planning in a vacuum.
Private industries seem to be more interested in a regional effort. Freight needs to be addressed statewide or regionally since the majority of freight is being moved long distances.
Take the private sector problems with proposed solutions, listen and act on their feedback. Do it one problem at a time!
Find ways to engage and enroll interest of the private sector . . . This has been exceedingly difficult. . .
Seek co-sponsors for the effort.
Advisory committee of transportation users and providers of service.
Involve everyone, Form advisory groups, Regional coordination
Start with sensitivity to local truck issues such as operational and access issues. Establish a diverse committee of stakeholder both from the public and private sector to obtain input and transportation facility needs.
Critical to engage all stakeholders.
Regional efforts can be beneficial in understanding the impacts of freight movement.
Make sure you have clear goals and objectives. Review the goals and objectives at every meeting - it is very easy to get off track and lose focus. Don't get bogged down on details - regional planning efforts are more broad-based.
Relationships are everything.
Selling the idea of regional costs and benefits will be the biggest hurdle to overcome in implementing these projects. How do you see benefit to your state by contributing to the cost of a project in another state?
Focus efforts on an identified problem.
Industry data is difficult to assemble
Start the development of planning relationships with adjoining public sector organizations. Develop Metropolitan Planning Organization (MPO) freight planning capabilities.

G.3 Breakdown by industry of private sector survey respondents (both trucking version and "all other" version)

Type	Number of respondents
Railroad company	21
Trucking company	14
Maritime company	1
Logistics company	3
Industrial shipper	3
Retail shippers	2
Port authority	7
Agricultural/Food	1
Broker/Agent	1

G.4 Copy of private sector survey with responses (trucking version)

1) How would you describe your trucking operations? (Circle up to five.)

For-hire truckload carrier (TL)	5
For-hire less-than-truckload carrier (LTL)	4
Private carrier, not for-hire	4
Refrigerated, temperature sensitive service	2
Tank (liquid, bulk, chemical) carrier	0
Intermodal services, including drayage	3
Hazardous material or waste carrier	1
Warehousing services	1
Other	1

OTHER=HOUSEHOLD GOODS MOVING AND STORAGE

2) Please describe your company in terms of:

Number of truck tractor units:	1057
Number of straight trucks:	336
# of drivers (include both company and owner-operators):	966
Average annual trips per commercial vehicle:	443
The average driving distance per trip:	443
The average time taken per trip:	12.5
The average number of stops made per trip:	1.66

3) If your company does not carry hazardous materials or waste in any of the Midwestern states or provinces listed above, please go to question #6.

4) If you carry hazardous materials or waste, do any of these shipments cross state/province lines? (Circle all that apply.)

Yes, hazardous materials cross state/province lines.	3
Yes, hazardous waste crosses state/province lines.	0
No	1

5) If you carry hazardous materials or waste, please indicate the top three problematic regulations. (Please indicate 1, 2, 3, with 1 being the most problematic.)

Permitting and registration	5
Fees and fee scheduling	3
Transporter personnel licensing	2.6
Manifest requirements	2
Placarding and identification of materials	1.33
Other	X

6) At a recent workshop of freight transportation stakeholders, the following items were identified as being important in the movement of freight. Please rank them in terms of importance to your operations, with one as the most important and seven as the least.

Economic efficiency, the cost of transportation to the total economy.	5.3
Operational efficiency, the cost of specific trips or activities, including terminal operations or intermodal transfers.	4
Safety of employees, the safety record for employees and operations.	2.44
Security of shipments, the ability to move freight free from natural or human (terrorist or other) incidents.	4.44
Environmental impacts, the detrimental impacts of vehicle emissions, noise, etc.	5.44
Reliability, the ability to make or receive deliveries on a planned schedule consistently.	3.22
Operating margin/Return on investment.	3.11

7) What other issues would you add to those listed under #6 as being important to the success of the freight industry?

Question 7

DOT enforcement, particularily in Iowa, is to the point of costing companies margin, in time, and knit-picking offenses that ties the industry up.
Roadability issue now in Congress. Regulation or help dealing with railroads and steamship lines.
-carrier innovation, creativity -shipper collaboration
The proper maintance program "PM" very important to setup a good routine.
Clear, accurate communication regarding delay times

8) Does your company or organization use performance measures, or operational standards, to manage or evaluate your freight operations?

Yes··4
No (please go to #10)··································5

9) If the answer to #8 is yes, please list your top three measures utilized.

Question 9

Transit times; claim ratio; # of shipments moving damage free
Cost per standard case delivered; load factor both weight and cube; on time pick ups and deliveries; cost per pound
Daily revenue attainment; daily linehaul miles (loaded and empty); daily hours used in operations (manpower)
Safety; On-time deliveries; Profitability

10) If government agencies involved in freight transportation programs were to use one performance area to focus their activities, which would you suggest they use? (Circle one.)

Economic efficiency, the cost of transportation to the total economy. ···················3

Operational efficiency, the cost of specific trips or activities, including terminal operations or intermodal transfers. ···························1

Safety of employees, the safety record for employees and operations. ··················2

Security of shipments, the ability to move freight free from natural or human (terrorist or other) incidents.··························1

Environmental impacts, the detrimental impacts of vehicle emissions, noise, etc.··································0

Reliability, the ability to make or receive deliveries on a planned schedule consistently.·································0

Operating margin/Return on investment.···························1

Other 1
OTHER=ROADABILITY, RAILROADS, AND STEAMSHIP LINE EQUIPMENT

11) Since most of the information on the movement of freight resides with private companies, would you be willing to share your company's information if you thought it would improve the operations of governmental transportation programs? (Circle one.)

Yes. 1
Yes, but only selected items. 1
Yes, but only in a form that would not allow it to be
identified with my company. 2
Yes, but only selected items shared anonymously. 2
No. 3

12) Has your organization been an active participant in governmental freight planning efforts?

Yes (Please go to #14) 1
No 7

13) If the answer to #12 is no, why have you not participated? (Circle all that apply, go to #16.)

Not asked. 3
Too time-consuming. 2
No pay-off. 1
Not interested. 1
Other 1
OTHER=UNSURE

14) If the answer to #12 is yes, what is the most recent effort you or your organization participated in?

PRIVATE TRUCK COUNCIL; NFTA; FOOD SHIPPERS ASSOC.

15) If the answer to #12 is yes, what benefit has your organization received from this participation? (Circle all that apply.)

Better relationships with the public sector. 1
Better relationships with other private sector interests. 1
Better understandings of freight issues. 1

Little real benefit. 0
Other 0

16) What do you see as the greatest need in improving governmental freight planning efforts? (Circle one.)

Improved communication with the private sector. 2
Better commodity flow data. 0
Better understanding of freight industry. 3
Better communication between public agencies. 1
Better communication among the various freight modes. 2
Other 0

17) What would you recommend the focus of programs and efforts of government transportation agencies be in the area of freight? (Circle one.)

Managing highway systems 6
Improving intermodal connectors 0
Improving or providing intermodal facilities 1
Facilitating freight planning efforts 1
Improving inland waterways 0
Other 1

18) What form of government program would be most effective in improving the movement of freight? (Circle one.)

Direct provision of infrastructure 2
Legislative mandates 2
Tax incentives or disincentives 3
Facilitators of communication 1
Other 1

19) Please indicate the most problematic regulatory inconsistencies (not dealing with hazardous materials or hazardous waste) from state to state, state to province, or province to province. (Please indicate 1, 2, 3, etc with 1 being the most problematic.)

Truck length 2.375
Truck weight 2.25
Number of trailers 4.1
Insurance requirements 3
Driver/operator licensing 3.8

Other (please describe:________________________________)··························1

Other

Bridge laws-axle spacing
Hours of service change

20) Please tell us your experience at border crossings that are problematic due to regulatory inconsistencies.

Question 20

None for all except Canada, where they were non-applicable
Minn-Wisc: DOT way to strict Wisc-Ill: DOT way to strict Ill-In: Scales are rough In-Mich: Scales are rough In-Oh: Tolls expensive Oh-Mich: DOT excessive fines on trucks Mi-Ont: Boarder issues
None
n/a
None
None
Mn-Wis: Axle Spacing Mn-Iowa: None Mn-Man: n/a Wis-Mich: n/a Wis-Iowa: Axle spacing Wisc-Ill: Axle spacing Iowa-Ill: Axle spacing Ill-In: n/a In-Mich: n/a In-Oh: n/a Oh-Mich: n/a Mi-Ont: n/a Ont-Man: n/a

21) Please estimate your company's annual effort in time spent (person hours per vehicle) to complete the paperwork needed to comply with vehicle regulations.

0-100 hours/vehicle ··6
101-250··1
251-500··0
501-750··0
750+···1

22) If you could change one regulation of interstate transport of freight in this region, what would you change and why? (Please attach materials if it is more convenient for you.)

Question22

Get rid of logs it is a joke!
Non-issue
Increase length law because our products are very light weight-only 10-20000 pounds per load
Oversize permits-should be the same in all states
Consistant weight, size and axle spacing in all upper midwest states
Do away with the daily log book. Should be totally up to the owner operator/or business owner of the fleet. The driver knows when he's tired does not need a book to tell him when to sleep.

23) May we contact you again about the impacts of government regulations in freight transportation?

No 3
Yes 6

G.5 Copy of private sector survey with responses ("all other" version)

1) Which of the following best describes your organization? (Circle one.)

Railroad company 21
# of locomotives in operation:
Average annual trips per locomotive:
Trucking company 4
# of commercial vehicles in fleet:
Average annual trips per vehicle:
Maritime company 1
Total annual (2002) volume carried:
Logistics company 3
# of employees:
Industrial shipper 3
Total annual (2002) volume shipped:
Retail shippers 2
Total annual (2002) volume shipped:
Port authority 7
Annual tonnage (2002):
Other 2
Other: Agricultural/food; Broker/agent

2) Please indicate which of the following Midwestern states/provinces you operate in (have offices, terminals, or other facilities in), ship to or from, or travel through. (Check all that apply.)

3) Does your organization handle hazardous materials or waste in any of the states/provinces you marked? (Circle one.)

Hazardous materials. 16
Hazardous waste. 0
Both hazardous materials and hazardous waste. 2
No (Please go to question #6). 18

4) Do any of these hazardous materials or waste shipments cross state/province lines? (Circle all that apply.)

Yes, hazardous materials cross state/province lines. 16
Yes, hazardous waste crosses state/province lines. 2
No 2

5) If you carry hazardous materials or waste, please indicate the top three problematic regulations. (Please indicate 1, 2, 3, with 1 being the most problematic.)

Permitting and registration ....
Fees and fee scheduling ....
Transporter personnel licensing ....
Manifest requirements ....
Placarding and identification of materials ....
Other ....

6) At a recent workshop of freight transportation stakeholders, the following items were identified as being important in the movement of freight. Please rank them in terms of importance to your operations, with one as the most important and seven as the least.

Economic efficiency, the cost of transportation to the total economy. 3.66

Operational efficiency, the cost of specific trips or activities, including terminal operations or intermodal transfers. 3.83

Safety of employees, the safety record for employees and operations. 1.72

Security of shipments, the ability to move freight free from natural or human (terrorist or other) incidents. 5.11

Environmental impacts, the detrimental impacts of vehicle emissions, noise, etc. 6.03

Reliability, the ability to make or receive deliveries on a planned schedule consistently. 3.53

Operating margin/Return on investment. 3.94

7) What other issues would you add to those listed under #6 as being important to the success of the freight industry?

Question 7

Avoiding over-regulation
Increase of truck size and weight
Reliability and safety first, cost second
Connectivity of facilities and infrastructure.
Less urban traffic congestion
Lack of competent and reliable operators
Rail transit times; Class 1 service
Each mode should reflect its true cost in its pricing including the cost of right of way
Maintaining the inland waterway system in top repair and enhancing its efficiency

Fuel cost, rail, bridge upgrades to higher weight limits
Predictability
uniform length and weight laws across country
Less government intrusion on all levels
Infrastructure improving access and connectivity between modes

8) Does your company or organization use performance measures, or operational standards, to manage or evaluate your freight operations?

Yes...12
No (please go to #10)...24

9) If the answer to #8 is yes, please list your top three measures utilized.

Question 9

Do not wish to discuss in public
Cycle times
Safety; labor productivity; equipment productivity
Dwell time; Thru put; Cost per car
Cost and revenue per mile; Equipment utilization factors; Dock wait time/loading time
Interchange received to placed at customer; adherence to schedule; labor cost per car
On time performance; Competitive rates; Safety an overwhelming factor
Car days on line; fuel and labor cost per carload; profitability
Turn time (per cycle); fleet maintenance; base rates
Cost/hundred weight; Cost/mile; Utilization/power unit; accidents/mile
On time pick-up; on time delivery; damage; $
Labor productivity handling freight; volume in tons; revenue based on return on investment, before and after depreciation
Operating cost by department/KGTM; Net tons hauled/MH; Personal injury frequency ratio

10) If government agencies involved in freight transportation programs were to use one performance area to focus their activities, which would you suggest they use? (Circle one.)

Economic efficiency, the cost of transportation to the total economy. 11

Operational efficiency, the cost of specific trips or activities, including terminal operations or intermodal transfers. 6

Safety of employees, the safety record for employees and operations. 10

Security of shipments, the ability to move freight free from natural or human (terrorist or other) incidents. 3

Environmental impacts, the detrimental impacts of vehicle emissions, noise, etc. 0

Reliability, the ability to make or receive deliveries on a
planned schedule consistently. 8

Operating margin/Return on investment. 1

Other 1
Other: design of infrastructure revitalization programs

11) Since most of the information on the movement of freight resides with private companies, would you be willing to share your company's information if you thought it would improve the operations of governmental transportation programs? (Circle one.)

Yes. 7
Yes, but only selected items. 7
Yes, but only in a form that would not allow
it to be identified with my company. 11
Yes, but only selected items shared anonymously. 6
No. 5

12) Has your organization been an active participant in governmental freight planning efforts?

Yes (Please go to #14) 20
No 16

13) If the answer to #12 is no, why have you not participated? (Circle all that apply, go to #16.)

Not asked. 14
Too time-consuming. 3
No pay-off. 2
Not interested. 1
Other 1
Other: Don't trust the motives of governmental planners

14) If the answer to #12 is yes, what is the most recent effort you or your organization participated in?

Question 14

Superior Port Plan
MN Freight Advisory Council
Upper Midwest Freight Corridor Study; FHWA meeting in Detroit, MI
Upper Midwest Freight Corridor Study - 2000
Chicago CREATE Project

Delta Regional Authority Grant
We are active members of local MPO and serve on various transportation committees, including Freight Planning Committee
Center for Transportation Studies, U of MN; MNDot committees
Local, regional planning commissions
Done at corporate HQ in Panama City, FL
Answering INDOT and ORDC regarding assistance needs. Working with nine state regional consortium on high-speed rail planning
Advisory committee to department of transportation
Regional Planning Commission for Highway
Maritime Administration; Corps of Engineers; IL DOT
This study; MN Freight Advisory Committee; MN Governor's Task Force on Forestry; Forest Products Competetiveness
MN Freight Advisory Council
Transportation Corridor Planning Board
MPO meetings, interagency/bistate discussions
Ongoing modifications to the state rail revitalization program
WISDOT Translink 21; WI State Rail Plan

15) If the answer to #12 is yes, what benefit has your organization received from this participation? (Circle all that apply.)

Better relationships with the public sector. 11
Better relationships with other private sector interests. 7
Better understandings of freight issues. 13
Little real benefit. 0
Other 4

Other

Better interaction with federal government
Effectively communicate our needs to the public sector
Prep for combined Duluth-Superior Port Plan
Project in progress

16) What do you see as the greatest need in improving governmental freight planning efforts? (Circle one.)

Improved communication with the private sector. 8
Better commodity flow data. 1
Better understanding of freight industry. 16
Better communication between public agencies. 3
Better communication among the various freight modes. 4
Other 3

Other

I think maybe a little bit of all of the above
Keep out of the way of people who know what they are doing
no government

17) What would you recommend the focus of programs and efforts of government transportation agencies be in the area of freight? (Circle one.)

Managing highway systems····································3
Improving intermodal connectors····································3
Improving or providing intermodal facilities····································7
Facilitating freight planning efforts····································14
Improving inland waterways····································2
Other····································7

Other

Does not apply on our railroad
Figuring out a way to enhance rail traffic. The country is in the "I need it yesterday" mode
Improve shorline track conditions
Improving railroad infrastructure
Quit pumping 90% of funds into least efficient mode (trucks)
Railroad infrastructure
remove freeze on size and weight of trucks

18) What form of government program would be most effective in improving the movement of freight? (Circle one.)

Direct provision of infrastructure····································15
Legislative mandates····································3
Tax incentives or disincentives····································12
Facilitators of communication····································3
Other····································2

Other

More direct private industry oversight in freight planning and project prioritization
remove freeze on size and weight of trucks and give the states more control on that issue

19) Please describe the biggest regulatory barriers (not dealing with hazardous materials or hazardous waste) facing your company/organization in regards to freight transportation? (Please attach materials if it is more convenient for you.)

Question 19

Most regulation by the FRA involves safety. It is not a barrier.
DOT regulations
33CFR Part 105 Harbor maintenance tax
Security requirement mandates
Water - environmental issues; Trucks - congestion
Weight and size of loads
Small railroad company w/4 fte Making sure we are in compliance with all the FRA safety regulations that are the same for us as for Class 1's is very difficult. Have received 4 straight safety awards, so we value safety.
False publicity by the railroad and rail funded organizations, such as CRASH, against the trucking industry. Freeze on size and weight has a great impact on cost to the input and output of ag related products.

As a broker or third party, entry too easy as regard bonding, 10,000 too low, 100,000 sould be better qualify
Government should consider expanding highway system for more trucks and possibly carrier only roads.
Policy of government to favor highway mode almost exclusively in all areas (freight and passenger).
Being a public agency, we find funding of infrastructure to be the biggest challenge to our overall mission. There is never enough money to provide all of the necessary improvements to the system.
Our company is minimally affected
For the rail industry it would be the inability to serve customers, and the Class 1 railroad's "I could care less" attitude toward the shipping. We are losing market share in the short line industry because of our larger railroads.
The incredibly stupid regulations surrounding government financial assistance
The politics of the situation on the inland waterway system is the sing most important issue we face
Paper barriers with Class 1 railroads
Weights
Environmental regulatory restrictions; multiplicity of agencies with differing and overlapping rules
Weight restrictions; Hours of service
New HOS regulation will increase our costs; No consistent standards for lenghts and weights between neighboring states
FRA requirements
Too many governmental agencies--too much regulation, etc. On all levels of government too much paperwork, etc. One hand usually doesn't even know what the other is doing. Waste and abuse of the tax payer on all levels of government.
Cabetage; Harmonizing of regulations
Weight limits for highway GVWR; Speed limits
Environmental issues involving air pollution at bulk material handling facilities
Restrictive road weight and size regulations; Jones Act; US Cargo Preference Laws

20) If applicable, please estimate your company's annual effort in time spent (person hours per vehicle) to complete the paperwork needed to comply with vehicle regulations.

0-100 hours/vehicle ··24
101-250 ··1
251-500 ··1
501-750 ··0
750+ ··2

21) If you could change one regulation of interstate transport of freight in this region, what would you change and why? (Please attach materials if it is more convenient for you.)

Question 21

Work towards having regulations uniform among all states
Tailor safety regulations to fit small operations
Again, what is needed is carrier only highway system
Enforce truck weight laws and driver hours of service
Long Combination Vehicles (LCV) regulation. It is too restrictive and limits productivity.
How about if trucks pay the incremental cost of building highways to handle 80,000+lb trucks as opposed to 5,000lb or less passenger vehicles
Fully fund the inland waterway system to keep the nation's bulk commodities competetive in the world market. Lack of funding is a regulation.

Weight restrictions--Congestion is a major issue. Tractor/trailers using modern technology can handle vehicle weights much higher than allowed. In many cases a 50% increase load capacity is possible. Even at 33% that takes 1 truck of 3 off the road.
Consistent length and wieght standards between states. At present our next door states all have different length laws for straight trucks
Higher taxes on trucks to help with cost of massive damage they do to roads. Also farmers need to pay more. Vehicles don't even have to be registered and plated. No off-road fuel for farmers as they drive equipment on roads--usually overloaded!
Cabetage

22) Many studies have revealed that there is a relationship between various characteristics of a business establishment and the number of truck trips that depart or arrive at the establishment. From your perspective, which of the following characteristics do you think will be the most useful for making accurate estimates of the number of truck trips to/from your business? (Circle one.)

Number of trucks based at the business	5
Number of employees	0
Total acreage of the site	0
Total acreage of floor space	1
Number of drivers	2
Annual revenue	3
Other - please specify	12

Other

Annual revenue as an indicator of business level
annual revenue by type of business
Ease of access to and from highway systems
freight tonnage demand
number of annual railcar loads
number of tons or pounds shipped or received
Production and sales
Production capacity
Shipping volume
Tonnage moved
Tonnage throughput
tons handled

23) May we contact you again about the impacts of government regulations in freight transportation?

No	16
Yes	18

APPENDIX H. ADMINISTRATIVE ISSUES

H.1 Weigh Stations and Electronic Screening Facilities in the Upper Midwest Freight Corridor

Table 9 Location of Weigh Stations in Upper Midwest Freight Corridor.

Number	State	Route	Direction	Description
1	**WI**	**I94**	**WB**	**Menomonie, I94 MP 48.3**
2	**WI**	**I94**	**EB**	**Hudson, I94 MP 8**
3	**WI**	**I90**	**SB**	**Kegonsa, I90 MP 145.5**
4	**WI**	**U151**	**BD**	**Jamestown, US 11, 35 and 151**
5	**WI**	**I90**	**NB**	**Utica, I90 MP 147.8**
6	**WI**	**I94**	**NB**	**Kenosha, I94 MP 349.8**
7	**WI**	**I94**	**SB**	**Racine, I94 MP 327.3**
8	**WI**	**U41**	**NB**	**Wrightstown, Kaukauna, US41**
9	**WI**	**I43**	**SB**	**Newton, I43, MP 141**
10	**WI**	**I39**	**BD**	**Coloma, I39/US51**
11	**WI**	**I90**	**EB**	**West Salem, I90 MP 10.6**
12	**IL**	**U41**	**SB**	**Rosecrans, North of IL 173**
13	**IL**	**I80**	**BD**	**Moline, I80 MP 2**
14	**IL**	**I74**	**BD**	**Moline, I74, MP7, I74/I280**
15	**IL**	**I57**	**BD**	**Peotone, I57 MP 330**
16	**IL**	**I80**	**BD**	**Frankfort (south of Chicago, IL)**
17	**IL**	**I55**	**BD**	**Bolingbrook (southwest of Chicago, IL)**
18	**IL**	**U30**	**BD**	**Chicago Heights, East of Torrece Av.**
19	**IL**	**U30**	**BD**	**US 30, East of US51**
20	**IL**	**I74**	**BD**	**I74, MP 122**

21	**IA**	**I35**	**BD**	**I35 near MN/IA border**
22	**IA**	**I80**	**BD**	**Mount Vernon, I80 MP 44**
23	**IA**	**I80**	**BD**	**I80 MP 141**
24	**IA**	**I80**	**BD**	**De Soto, I80/I35**
25	**IA**	**I35**	**NB**	**Weldon, I35/S69**
26	**IA**	**I380**	**EB**	**Brandon, I380 MP 151**
27	**IA**	**I35**	**BD**	**Maxwell/Huxley, I35**
28	**IA**	**I80**	**WB**	**Elk Horn, I80 S59**
29	**IA**	**I29**	**BD**	**Missouri Valley/Wilson State Park, I29**
30	**IA**	**I29**	**SB**	**Sergeant Bluff, I29**
31	**IN**	**I65**	**BD**	**Lowell (south of Chicago, IL), I65**
32	**IN**	**I69**	**SB**	**Warren (south Fort Wayne, IN), I69 MP 80**
33	**IN**	**I94**	**BD**	**Chesterton (east of Chicago, IL, I94 MP 26**
34	**OH**	**I71**	**SB**	**Ashland (southwest of Akron, OH), I71 MP 190**
35	**OH**	**I75**	**SB**	**Hancock (north of Findlay, OH), I75 MP 162**
36	**OH**	**I75**	**NB**	**Wood (south of Toledo, OH), I75 MP 176**
37	**OH**	**I76**	**BD**	**Medina (west of Akron, OH), I75 MP 6**
38	**OH**	**I80**	**WB**	**Trumbull (north of Youngstown, OH), I80 MP 232**
39	**OH**	**I77**	**BD**	**Tuscarawas (south of Canton, OH), I77 MP 92**
40	**OH**	**I90**	**WB**	**Ashtabula (near OH/PA border), I90 MP 190**
41	**MI**	**I94**	**BD**	**I94 MP 4**
42	**MI**	**I94**	**BD**	**I94 MP 151**
43	**MI**	**I94**	**WB**	**I94 MP 246**
44	**MI**	**I75**	**BD**	**I75 MP 8**

45	MI	I75	BD	I75 MP 86
46	MN	I94	WB	I94 MP 257
47	MN	I94	EB	I94 MP 4
48	MN	I90	WB	I90 MP 256
49	MN	I90	EB	I90 MP 46
50	MN	I35	SB	I35 MP 128
51	MN	I35	NB	I35 MP 18
52	MN	I35	SB	I35 MP 236

Table 10 Location of Electronic Screening Facilities in the Upper Midwest Freight Corridor.

Number	State	Route	Direction	Description
1	**IL**	**I55**	**BD**	**Bolingbrook (southwest of Chicago, IL)**
2	**IL**	**I80**	**BD**	**Frankfort (south of Chicago, IL)**
3	**IL**	**I80**	**BD**	**Moline (southeast of Quad Cities)**
4	**IL**	**I74**	**BD**	**Moline (east of Quad Cities) I74/I280**
5	**IL**	**I57**	**BD**	**Peotone (south of Chicago, IL)**
6	**IA**	**I80**	**WB**	**Cedar County (Rochester) (west of Davenport, IA)**
7	**IA**	**I35**	**NB**	**Clark County (Osceola) (near IA/MO border)**
8	**IA**	**I80**	**EB**	**Dallas County (Van Meter) (west of Des Moines, IA)**
9	**IA**	**I80**	**WB**	**Mitchellville (east of Des Moines, IA)**
10	**IN**	**I94**	**BD**	**Chesterton (east of Chicago, IL)**
11	**IN**	**I65**	**SB**	**Lowell (south of Chicago, IL)**
12	**IN**	**I69**	**SB**	**Warren (south Fort Wayne, IN)**
13	**OH**	**I71**	**SB**	**Ashland (southwest of Akron, OH)**

14	**OH**	**I90**	**WB**	**Ashtabula (Conneaut) (near OH/PA border)**
15	**OH**	**I75**	**SB**	**Hancock (Findlay) (north of Findlay, OH)**
16	**OH**	**I76**	**BD**	**Medina (Wadsworth) (west of Akron, OH)**
17	**OH**	**I80**	**WB**	**Trumbull (Hubbard) (north of Youngstown, OH)**
18	**OH**	**I77**	**BD**	**Tuscarawas (Bolivar) (south of Canton, OH)**
19	**OH**	**I75**	**NB**	**Wood (Bowling Green) (south of Toledo, OH)**
20	**WI**	**I94**	**WB**	**Menomonie, I94 MP 48.3**
21	**WI**	**I94**	**EB**	**Hudson, I94 MP 8**
22	**IL**	**I74**	**BD**	**Carlock, I74, MP 122**

Source: Site Status 2004

H.2 Commodity Exemptions in the Upper Midwest Region

The states in the Upper Midwest region relax regulatory requirements for certain commodities. Table 11 lists commodity exemptions for each state in the. Details of the regulatory exemption along with a comparison with existing federal requirements are shown.

Information for Table 11 was obtained by searching each state's or province's government website. The table has only the most basic of information and does not include other detailed information associated with the commodity exemptions such as time of year, time of day, or other pertinent information regarding the applicability of the exemptions.

Table 11 Size and Weight Commodity Exemptions in the Upper Midwest Region

State/ Province	Commodity	Size/Weight Exemption	Federal Max Size/ Weight Allowed	Percent Increase
Illinois	**Hay, straw or other similar farm products**	**12 ft (144 in) width**	**102 in**	**41.2%**
	Poles, pipes, machinery, or other objects of a structural nature	**100 ft length**	**53 ft**	**88.7%**
Indiana	**Logs, wood chips, bark, sawdust, and bulk milk**	**88,000 lbs**	**80,000 lbs**	**10%**
Iowa	**Hay, straw, or stover**	**No width limit**	**102 in**	**N/A**
Michigan	**Concrete pipe, agricultural products, or unprocessed logs, pulpwood, or wood bolts**	**108 inches width**	**102 in**	**5.9%**
	Saw logs, pulpwood, and tree length poles	**75 ft length** **164,000 lbs weight**	**53 ft length** **150,000 lbs weight**	**Length - 41.5%** **Weight - 9.3%**
Minnesota	**Sugar beets, carrots, potatoes**	**88,000 lbs**	**80,000 lbs**	**10%**
Ohio	**Coal, farm commodities, and timber**	**86,000 lbs**	**80,000 lbs**	**7.5%**
	Wooden and metal poles, pipes	**No length limit**	**53 ft**	**N/A**
Wisconsin	**Tie logs, tie slabs, and veneer logs**	**9 ft (108 in) width (not on National Network)**	**102 in**	**5.9%**
	Hay in bales and Christmas trees	**12 ft (144 in) width**	**102 in**	**41.2%**
	Milk	**Weight: 1 axle - 21,000 lbs, 2 axles 8 or less ft apart - 37,000 lbs, 3 or more consecutive axles more than 9 ft apart, a weight of 2,000 lbs more than is shown in par. 348.15 (3) (c), but not to exceed 80,000 lbs**	**1 axle - 20,000 lbs** **2 axles - 34,000 lbs** **3 axles - See Figure 348.15 (3)**	**1 axle - 5%** **2 axles - 8.8%** **3 axles - variable**

			(c)	
	Unpeeled forest products cut crosswise, scrap metal	**Weight: one axle - 21,500 lbs, 2 axles 8 or less ft apart - 37,000 lbs, 3 or more consecutive axles more than 9 ft apart, a weight of 4,000 lbs more than is shown in par. 348.15 (3) (c), but not to exceed 80,000 lbs**	**1 axle - 20,000 lbs 2 axles - 34,000 lbs 3 axles - See Figure 348.15 (3) (c)**	**1 axle - 7.5% 2 axles - 8.8% 3 axles - variable**
Manitoba	**Loose hay, straw, or fodder**	**3.7 m (145.7 in) width**	**2.6 m (102 in)**	**42.8%**
Ontario	**Raw forest products**	**2.8 m length**	**2.6 m (102 in) len. 140,000 lbs weight**	**Length - 7.7%**
		154,000 lbs weight when roads are frozen		**Weight - 10%**
	Loose fodder	**No width limit**	**2.6 m (102 in)**	**N/A**

Sources:
Illinois Vehicle Code 625 ILCS 5, Chapter 15 http://www.legis.state.il.us/legislation/ilcs/ch625/ch625act5articles/ch625act5artstoc.htm
Indiana Code, Title 9 Motor Vehicles, Article 20 Size and Weight Regulation http://www.in.gov/legislative/ic/code/title9/ar20/
Iowa Code 2003 Chapter 321 http://www.legis.state.ia.us/cgi-bin/IACODE/Code2003.pl
Michigan Vehicle Code (Excerpt) Act 300 of 1949, Chapter 257 http://michiganlegislature.org/mileg.asp?page=getObject&objName=mcl-300-1949-VI-SIZE-WEIGHT-AND-LOAD&highlight=
Minnesota Statutes 2003 Chapter 169 http://www.revisor.leg.state.mn.us/stats/
Ohio Revised Code Title [55] Chapter 5577 http://onlinedocs.andersonpublishing.com/oh/lpExt.dll?f=templates&fn=titlepage.htm
Wisconsin Statutes, Chapter 348, Vehicles - Size, Weight and Load http://www.legis.state.wi.us/statutes/Stat0348.pdf
Manitoba Highway Traffic Act, Regulation 575/88, Registered December 19, 1988 http://web2.gov.mb.ca/laws/regs/pdf/h060-575.88.pdf
Ontario Highway Traffic Act R.S.O. 1990, CHAPTER H.8 http://192.75.156.68/DBLaws/Statutes/English/90h08_e.htm#P3344_414748

APPENDIX I. USAGE

I.1 Measures of Usage

Table 12 FHWA Vehicle Classifications.

Class	Description
1	Motorcycles (Optional)
2	Passenger Cars
3	Other Two Axle, 4 Tire Single Units
4	Buses
5	Two Axle, 6 Tire Single Units
6	Three Axle Single Units
7	Four or More Axle Single Units
8	Four or Less Axle Single Trailers
9	Five Axle Single Trailers
10	Six or More Axle Single Trailers
11	Five or Less Axle Multi-Trailers
12	Six Axle Multi-Trailers
13	Seven or More Axle Multi-Trailers

Table 13 The Standard Classification of Transported Goods (SCTG) Codes (2-digit).

SCTG Code	Commodity Description
0	All Commodities
1	Live Animals And Live Fish
2	Cereal Grains
3	Other Agricultural Products
4	Animal Feed And Products Of Animal Origin, N.E.C.
5	Meat, Fish, Seafood, And Their Preparations
6	Milled Grain Products And Preparations, And Bakery Products
7	Other Prepared Foodstuffs And Fats And Oils
8	Alcoholic Beverages
9	Tobacco Products
10	Monumental Or Building Stone
11	Natural Sands
12	Gravel And Crushed Stone
13	Nonmetallic Minerals N.E.C.
14	Metallic Ores And Concentrates
15	Coal
17	Gasoline And Aviation Turbine Fuel
18	Fuel Oils
19	Coal And Petroleum Products, N.E.C.
20	Basic Chemicals
21	Pharmaceutical Products
22	Fertilizers
23	Chemical Products And Preparations, N.E.C.
24	Plastics And Rubber
25	Logs And Other Wood In The Rough
26	Wood Products

27	Pulp, Newsprint, Paper, And Paperboard
28	Paper Or Paperboard Articles
29	Printed Products
30	Textiles, Leather, And Articles Of Textiles Or Leather
31	Nonmetallic Mineral Products
32	Base Metal In Primary Or Semifinished Forms And In Finished Basic Shapes
33	Articles Of Base Metal
34	Machinery
35	Electronic And Other Electrical Equipment And Components And Office Equipment
36	Motorized And Other Vehicles (Including Parts)
37	Transportation Equipment, N.E.C.
38	Precision Instruments And Apparatus
39	Furniture, Mattresses And Mattress Supports, Lamps, Lighting Fittings, And...
40	Miscellaneous Manufactured Products
41	Waste And Scrap
43	Mixed Freight

Table 14 Standard Transportation Commodity Code (STCC) (2-digit).

STCC Code	Commodity Description
1	Farm
8	Forest
9	Fish/Marine
10	Metallic Ores
11	Coal
13	Crude Petro/Natural Gas
14	Non-metalic Minerals
19	Ordnance/Accessories
20	Food/Kindred
21	Tobacco
22	Textile Mill
23	Apparel
24	Lumber/Wood
25	Furniture/Fixtures
26	Pulp/Paper/Allied
27	Printed Matter
28	Chemicals/Alllied
29	Petroleum/Coal
30	Rubber/Plastics
31	Leather
32	Clay/Concrete/Glass/Stone
33	Primary Metal
34	Fabricated Metal
35	Machinery Exc Electrical
36	Electrical Mach/Equip/Supp

37	Transportation Equipment
38	Instr/Optical/Watches/Clocks
39	Miscellaneous Manufacturing
40	Waste/Scrap Materials
41	Miscellaneous Shipping
42	Shipping Containers
43	Mail
44	Freight Forwarder
45	Shipper Association
46	Freight All Kind
47	Small Package
48	Hazardous Waste
49	Hazardous Materials
50	Secondary Moves
99	LTL-General Cargo

I.2 Cross Validation

When possible, the data from two different sources were cross-checked to assess the consistency and reliability. For example, Chart 9 compares the breakdown of shipment weights by commodity types for the domestic rail shipment from the 1998 Railroad Waybill Sample against the FAF's rail data for 1998. The comparison revealed that the two data sources are consistent with one another. However, another comparison, this time between FAF and CFS for the breakdown of tons of shipments by origin state across all modes, shown in Chart 10, revealed a high level of inconsistency. The chart shows that the FAF reports, for each state, greater tonnage than the CFS. The differences also vary by state. For example, CFS tonnage is 86% of FAF for Illinois while it is 57% for Wisconsin and 66% for Iowa. However, the inconsistency is not surprising since the FAF and CFS cover different populations. The most significant differences between the FAF and CFS are:

- FAF has a greater coverage of agricultural products. Since farms were not included in the CFS survey, only the secondary movements of agricultural goods are recorded. FAF used production data collected by the US Department of Agriculture to estimate the origin of the farm shipments. Then, the gravity model was used to estimate the distribution of the destinations.
- The treatment of international shipments is quite different between FAF and CFS. Since the only source of information for CFS is the survey response from the shippers, CFS is not able to capture the inbound shipments from abroad. As a result, CFS includes only exports. Meanwhile FAF used Transearch, Port Import Export Reporting Service (PIERS), Transborder Surface Freight Database, and Latin American Trade & Transportation Study (LATTS) to expand the coverage of international flow, including both imports and exports.
- FAF combined multiple data sources such as 1993 CFS[1], Transearch, Waybill sample to expand the coverage of the industries that are not covered by the CFS.
- FAF uses Standard Transportation Commodity Classification (STCC) to classify commodity groups shipped, while CFS uses Standard Classification of Transported Goods (STCG).

The exhibits in this report are mainly based on the 1997 CFS data rather than the FAF. This is because CFS data are somewhat more flexible for extracting necessary information. For example, the FAF does not make available the state-to-state flow in value[2] by commodity by mode while the CFS does.

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[1] According to the FAF documentation, "shorter haul truck volumes and patterns in the FAFD are chiefly a reflection of the CFS". (FHWA)

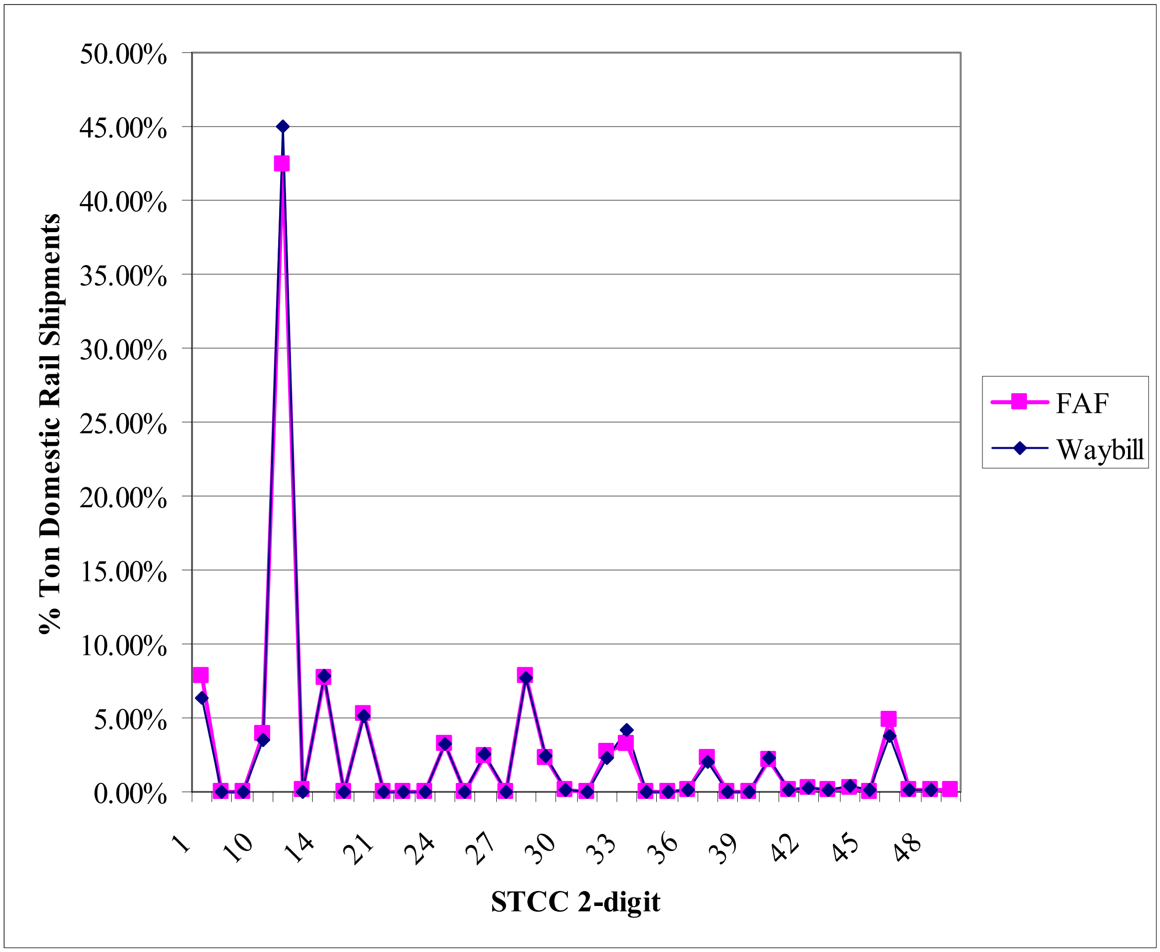

Chart 9 Comparison of FAF and Railroad Waybill data for 1998 - breakdown of commodity transported for all domestic rail shipments.

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[2] FAF only provides state-to-state flow by commodity by mode in weight

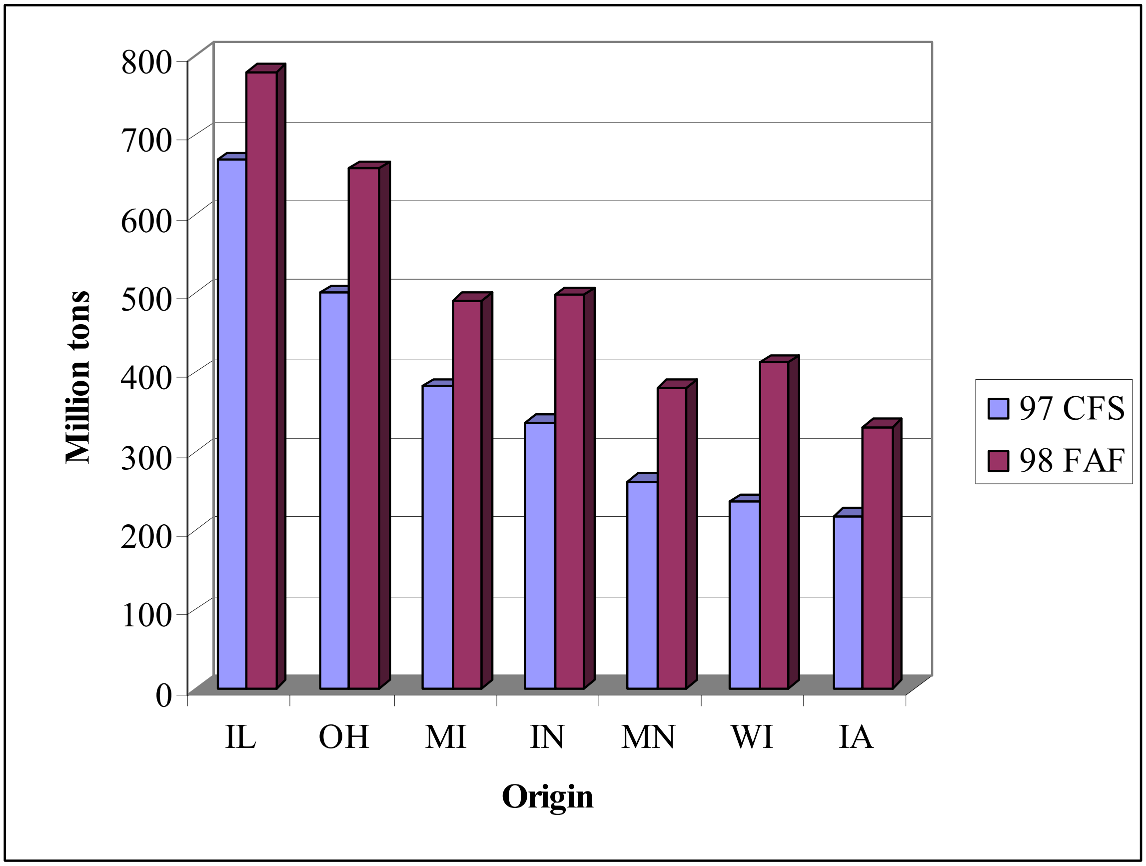

Chart 10 Comparison of 1998 FAF and 1997 CFS data - breakdown of origin states for all shipments originated or terminated in the study area.

I.3 Total Freight Activity and Modal Comparison

Table 15 Mode Shares of Major Freight Modes - US.

Mode	Ton	Value	Ton-mile
Truck	69.4%	71.7%	38.5%
Rail	14.0%	4.6%	38.4%
Truck-Rail	0.5%	1.1%	2.1%
Air	0.0%	3.3%	0.2%
Water	5.1%	1.1%	9.8%

Source: 1997 CFS

Table 16 Breakdown of Freight Shipments with Origin within the Study area.

Mode	Trip Type	TONS	VALUE	TON_MILE
Air	S-E	0.0%	0.7%	0.1%
Rail	S-E	4.4%	4.0%	22.1%
Truck	S-E	9.2%	30.3%	29.5%
Truck and rail	S-E	0.2%	1.4%	2.1%
Water	S-E	2.4%	0.5%	14.2%
Air	S-R	0.0%	0.4%	0.0%
Rail	S-R	2.4%	1.1%	3.9%
Truck	S-R	10.4%	21.9%	11.9%
Truck and rail	S-R	0.0%	0.0%	0.0%
Water	S-R	0.7%	0.0%	1.2%
Air	S-S	0.0%	0.1%	0.0%
Rail	S-S	5.1%	1.0%	2.2%
Truck	S-S	64.3%	38.4%	12.2%
Truck and rail	S-S	0.0%	0.0%	0.0%
Water	S-S	0.9%	0.1%	0.6%

Table 17 Total freight flow with origin or destination within the study area - Top 15 origin-destination pairs by weight.

Origin	Destination	Weight (1000 tons)	% of Total
Illinois	Illinois	459,751	15.0%
Ohio	Ohio	337,289	11.0%
Michigan	Michigan	278,128	9.1%
Indiana	Indiana	219,984	7.2%
Wisconsin	Wisconsin	173,904	5.7%
Minnesota	Minnesota	148,513	4.9%
Iowa	Iowa	145,820	4.8%
West Virginia	Ohio	37,651	1.2%
Illinois	Louisiana	35,184	1.2%
Illinois	Indiana	33,932	1.1%
Indiana	Illinois	29,575	1.0%
Michigan	Ohio	28,835	0.9%
Ohio	Michigan	21,089	0.7%
Ohio	Kentucky	20,881	0.7%
Pennsylvania	Ohio	20,576	0.7%

Source: 1997 CFS

Table 18 Total freight flow with origin or destination within the study area - Top 15 origin-destination pairs by value.

Origin	Destination	Value ($million)	% of Total
Michigan	Michigan	149,271	6.7%
Ohio	Ohio	142,519	6.4%
Illinois	Illinois	132,985	6.0%
Indiana	Indiana	62,978	2.8%
Wisconsin	Wisconsin	60,843	2.7%
Minnesota	Minnesota	59,392	2.7%
Iowa	Iowa	39,700	1.8%
Michigan	Ohio	33,840	1.5%
Ohio	Michigan	25,870	1.2%
Michigan	Indiana	20,052	0.9%
Illinois	Wisconsin	18,720	0.8%
Illinois	Indiana	18,525	0.8%
Indiana	Illinois	18,373	0.8%
Illinois	Ohio	17,907	0.8%
Michigan	Illinois	17,887	0.8%

Source: 1997 CFS

Table 19 Freight shipments that have at least one trip end in study area - breakdown by mode.

Mode	Ton (% of national)	Value (% of national)	Ton-mile (% of national)
All	3,057 Million (28.4%)	$ 2,227 Billion (32.7%)	913 Billion (38.4%)
Truck	2,114 Million (27.9%)	$ 1,608 Billion (33.0%)	350 Billion (36.4%)
Rail	432 Million (35.1%)	$ 111Billion (46.3%)	292 Billion (38.7%)
Truck & Rail	8.4 Million (41.3%)	$ 24.8 Billion (63.9%)	13.2 Billion (46.2%)
Air	0.5 Million (24.5%)	$ 30.7 Billion (24.6%)	0.6 Billion (21.8%)
Water	108 Million (25.8%)	$ 9.4 Billion (17.3%)	82 Billion (47.8%)

Table 20 Freight shipments with destination within the study area - breakdown by mode.

Mode	Ton (% of national)	Value (% of national)	Ton-mile (% of national)
All	2,604 Million (24.1%)	$1,547 Billion (22.7%)	541 Billion (22.7%)
Truck	1,900 Million (25.1%)	$1,181 Billion (24.2%)	213 Billion (22.1%)
Rail	330 Million (26.8%)	$55.6 Billion (23.1%)	190 Billion (25.2%)
Truck & Rail	2.7 Million (13.3%)	$4.5 Billion (11.6%)	3.4 Billion (11.9%)
Air	0.3 Million (14.8%)	$20.3 Billion (16.3%)	0.3 Billion (11.5%)
Water	51.5 Million (12.3%)	$1.9 Billion (1.8%)	16.2 Billion (9.4%)

Source: 1997 CFS

Table 21 Freight shipments with origin within study area - breakdown by mode.

Mode	Ton (% of national)	Value (% of national)	Ton-mile (% of national)
All	2,607 Million (24.2%)	$1,720 Billion (25.3%)	560 Billion (23.6%)
Truck	1,951 Million (25.8%)	$1,275 Billion (26.2%)	248 Billion (25.9%)
Rail	277 Million (22.5%)	$85 Billion (35.5%)	130 Billion (17.3%)
Truck & Rail	6.3 Million (31.1.0%)	$21.5 Billion (55.6%)	10 Billion (35.0%)
Air	0.3 Million (16.9%)	$17.1 Billion (13.7%)	0.3 Billion (13.0%)
Water	92.7 Million (22.2%)	$8.4 Billion (15.5%)	74.6 Billion (43.2%)

Source: 1997 CFS

Table 22 Freight shipments that have both origin and destination in study area - breakdown by mode.

Mode	Ton (% of national)	Value (% of national)	Ton-mile (% of national)
All	2,154 Million (20.0 %)	$1,040 Billion (15.3 %)	189 Billion (7.9 %)
Rail	174 Million (14.1%)	$29.7 Billion (12.3%)	28 Billion (3.7%)
Truck	1,737 Million (23.0%)	$ 848 Billion (17.4%)	112 Billion (11.6%)

Source: 1997 CFS

Table 23 Total freight flow with both origin and destination within the study area - 1997 (in 1000Tons).

	Destination							
Origin	**Illinois**	**Indiana**	**Iowa**	**Michigan**	**Minnesota**	**Ohio**	**Wisconsin**	**Total**
Illinois	459,751	33,932	8,778	11,340	4,843	11,363	10,836	**540,843**
Indiana	29,575	219,984	2,333	10,730	1,585	14,772	3,947	**282,926**
Iowa	15,187	1,400	145,820	1,800	6,614	1,999	3,742	**176,562**
Michigan	11,005	16,227	771	278,128	4,125	28,835	7,119	**346,210**
Minnesota	11,648	14,375	8,954	0	148,513	12,002	15,269	**210,761**
Ohio	8,441	15,254	1,124	21,089	0	337,289	2,925	**386,122**
Wisconsin	12,955	2,589	2,724	5,984	8,809	3,465	173,904	**210,430**
Total	**548,562**	**303,761**	**170,504**	**329,071**	**174,489**	**409,725**	**217,742**	**2,153,854**

Source: 1997 CFS

Table 24 Total freight flow with both origin and destination within the study area - 1997 (in $million).

	Destination							
Origin	**Illinois**	**Indiana**	**Iowa**	**Michigan**	**Minnesota**	**Ohio**	**Wisconsin**	**Total**
Illinois	132,985	18,373	6,875	17,887	7,526	15,030	13,374	**212,050**
Indiana	18,525	62,978	2,436	20,052	2,667	16,195	4,027	**126,880**
Iowa	10,402	2,464	39,700	3,206	3,985	3,073	3,448	**66,278**
Michigan	12,554	10,685	1,622	149,271	3,135	25,870	5,298	**208,435**
Minnesota	8,638	2,261	5,360	3,532	59,392	3,599	9,468	**92,250**
Ohio	17,907	16,861	3,701	33,840	3,608	142,519	5,428	**223,864**
Wisconsin	18,720	3,617	3,367	9,447	7,375	6,210	60,843	**109,579**
Total	**219,731**	**117,239**	**63,061**	**237,235**	**87,688**	**212,496**	**101,886**	**1,039,336**

Source: 1997 CFS

Table 25 Total freight flow with origin within the study area - Top 10 destinations outside the study area by weight.

Destination States	Weight (1000 tons)	% of Total
Louisiana	60,280	13.3%
Pennsylvania	41,508	9.2%
Kentucky	41,411	9.1%
Missouri	29,639	6.5%
Texas	25,440	5.6%
Tennessee	25,062	5.5%
California	21,437	4.7%
North Carolina	19,800	4.4%
Georgia	19,011	4.2%
New York	17,427	3.8%

Table 26 Total freight flow with origin within the study area - Top 10 destinations outside the study area by value.

Destination States	Value (in $million)	% of Total
Texas	68,904	10.1%
California	64,365	9.5%
Pennsylvania	49,496	7.3%
Missouri	41,186	6.1%
New York	39,532	5.8%
Kentucky	34,301	5.0%
Georgia	34,114	5.0%
Florida	31,344	4.6%
Tennessee	29,411	4.3%
New Jersey	26,325	3.9%

Table 27 Total freight flow with destination within the study area - Top 10 origins outside the study area by weight.

Origin States	Weight (1000 tons)	% of Total
Wyoming	81,192	18.0%
West Virginia	49,628	11.0%
Pennsylvania	35,504	7.9%
Kentucky	34,274	7.6%
Louisiana	27,639	6.1%
Montana	20,077	4.5%
Missouri	19,681	4.4%
North Dakota	18,414	4.1%
Texas	18,196	4.0%
New York	10,890	2.4%

Table 28 Total flow with destination within the study area - Top 10 origins outside the study area by value.

Origin States	Value (in $million)	% of Total
California	48,351	9.5%
Texas	45,220	8.9%
Pennsylvania	39,094	7.7%
New York	35,809	7.1%
Missouri	33,656	6.6%
New Jersey	33,066	6.5%
Kentucky	29,237	5.8%
North Carolina	21,853	4.3%
Georgia	19,140	3.8%
Tennessee	17,422	3.4%

Table 29 Total freight flow with destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	453,580	21.2%
Coal	268,362	12.5%
Gasoline and aviation turbine fuel	153,389	7.2%
Base metal in primary or semifinished forms and in finished basic shapes	145,370	6.8%
Nonmetallic mineral products	120,850	5.6%
Cereal grains	109,279	5.1%
Other prepared foodstuffs and fats and oils	88,654	4.1%
Fuel oils	72,863	3.4%
Coal and petroleum products	72,481	3.4%
Other agricultural products	53,259	2.5%

Table 30 Total freight flow with destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	183,834	13.6%
Electronic and other electrical equipment and components and office equipment	129,399	9.5%
Machinery	116,784	8.6%
Base metal in primary or semifinished forms and in finished shapes	99,101	7.3%
Miscellaneous manufactured products	79,658	5.9%
Other prepared foodstuffs and fats and oils	78,262	5.8%
Plastics and rubber	70,045	5.2%
Articles of base metal	54,893	4.0%
Printed products	42,961	3.2%
Textiles, leather, and articles of textiles or leather	40,218	3.0%

Table 31 Total freight flow with destination within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Coal	148,306	35.2%
Base metal in primary or semifinished forms and in finished basic shapes	26,980	6.4%
Gravel and crushed stone	24,188	5.7%
Metallic ores and concentrates	23,336	5.5%
Other prepared foodstuffs and fats and oils	20,270	4.8%
Wood products	15,301	3.6%
Basic chemicals	15,291	3.6%
Pulp, newsprint, paper, and paperboard	15,157	3.6%
Nonmetallic mineral products	12,403	2.9%
Plastics and rubber	12,386	2.9%

Source: 1997 CFS

Table 32 Total freight flow with both origin and destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	448,845	20.8%
Gasoline and aviation turbine fuel	152,363	7.1%
Base metal in primary or semifinished forms and in finished basic shapes	125,599	5.8%
Nonmetallic mineral products	109,785	5.1%
Coal	98,779	4.6%
Cereal grains	97,062	4.5%
Other prepared foodstuffs and fats and oils	77,334	3.6%
Fuel oils	71,952	3.3%
Coal and petroleum products	66,860	3.1%
Other agricultural products	50,700	2.4%

Source: 1997 CFS

Table 33 Total freight flow with both origin and destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	151,082	14.5%
Machinery	86,362	8.3%
Base metal in primary or semifinished forms and in finished basic shapes	77,564	7.5%
Electronic and other electrical equipment and components and office equipment	67,088	6.5%
Other prepared foodstuffs and fats and oils	62,896	6.1%
Miscellaneous manufactured products	48,652	4.7%
Plastics and rubber	43,086	4.1%
Articles of base metal	42,578	4.1%
Gasoline and aviation turbine fuel	39,471	3.8%
Printed products	31,742	3.1%

Source: 1997 CFS

Table 34 Total freight flow with origin within the study area and destination outside the study area- Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Cereal grains	49,381	16.1%
Base metal in primary or semifinished forms and in finished basic shapes	34,600	11.3%
Other prepared foodstuffs and fats and oils	32,549	10.6%
Other agricultural products	18,961	6.2%
Coal	18,647	6.1%
Motorized and other vehicles (including parts)	17,468	5.7%
Animal feed and products of animal origin	12,836	4.2%
Milled grain products and preparations, and bakery products	11,617	3.8%
Plastics and rubber	10,443	3.4%
Chemical products and preparations	9,853	3.2%

Table 35 Total freight flow with origin within the study area and destination outside the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	110,032	20.4%
Machinery	56,877	10.6%
Electronic and other electrical equipment and components and office equipment	56,771	10.5%
Miscellaneous manufactured products	42,011	7.8%
Base metal in primary or semifinished forms and in finished basic shapes	31,160	5.8%
Other prepared foodstuffs and fats and oils	30,799	5.7%
Plastics and rubber	30,234	5.6%
Articles of base metal	24,060	4.5%
Chemical products and preparations	20,314	3.8%
Printed products	16,559	3.1%

Table 36 Total freight flow with destination within the study area and origin outside the study area- Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Coal	169,583	48.6%
Base metal in primary or semifinished forms and in finished basic shapes	19,771	5.7%
Basic chemicals	14,214	4.1%
Pulp, newsprint, paper, and paperboard	13,098	3.8%
Cereal grains	12,217	3.5%
Wood products	11,485	3.3%
Other prepared foodstuffs and fats and oils	11,320	3.2%
Nonmetallic mineral products	11,065	3.2%
Plastics and rubber	10,939	3.1%
Nonmetallic minerals	7,911	2.3%

Table 37 Total freight flow with destination within the study area and origin outside the study area - Top 10 commodities by value.

Commodity	Value ($million)	% of Total
Electronic and other electrical equipment and components and office equipment	62,311	16.6%
Motorized and other vehicles (including parts)	32,752	8.7%
Miscellaneous manufactured products	31,006	8.3%
Machinery	30,422	8.1%
Plastics and rubber	26,959	7.2%
Textiles, leather, and articles of textiles or leather	26,003	6.9%
Base metal in primary or semifinished forms and in finished basic shapes	21,537	5.8%
Other prepared foodstuffs and fats and oils	15,366	4.1%
Articles of base metal	12,315	3.3%

Printed products	11,219	3.0%

I.4 Highway

Table 38 Truck freight flow with both origin and destination within the study area - 1997 (in 1000Tons).

	Destination							
Origin	**Illinois**	**Indiana**	**Iowa**	**Michigan**	**Minnesota**	**Ohio**	**Wisconsin**	**Total**
Illinois	379,354	17,586	7,760	7,333	3,884	5,843	9,357	**431,117**
Indiana	20,543	176,021	1,824	9,221	1,174	11,526	2,610	**222,919**
Iowa	7,632	1,205	139,062	1,242	4,970	1,263	3,290	**158,664**
Michigan	5,844	8,428	650	234,503	788	16,273	2,765	**269,251**
Minnesota	3,366	994	5,067	1,773	117,045	N/A	9,097	**137,342**
Ohio	6,643	13,433	962	17,015	N/A	284,135	2,347	**324,535**
Wisconsin	9,156	1,918	2,446	5,171	6,403	2,634	165,307	**193,035**
Total	**432,538**	**219,585**	**157,771**	**276,258**	**134,264**	**321,674**	**194,773**	**1,736,863**

Source: 1997 CFS

Table 39 Truck freight flow with both origin and destination within the study area - 1997 (in $million).

	Destination							
Origin	**Illinois**	**Indiana**	**Iowa**	**Michigan**	**Minnesota**	**Ohio**	**Wisconsin**	**Total**
Illinois	108,199	14,107	5,892	12,783	5,177	11,347	10,918	**168,423**
Indiana	14,713	49,115	2,045	18,353	2,012	14,033	3,286	**103,557**
Iowa	8,131	2,220	36,746	2,788	3,482	2,608	2,927	**58,902**
Michigan	9,239	8,310	979	129,165	1,833	19,241	4,035	**172,802**
Minnesota	4,966	1,312	3,810	2,376	46,911	2,141	7,045	**68,561**
Ohio	14,086	14,556	2,862	28,800	2,213	116,486	3,850	**182,853**
Wisconsin	15,065	2,947	3,008	7,954	5,867	5,099	53,635	**93,575**
Total	**174,399**	**92,567**	**55,342**	**202,219**	**67,495**	**170,955**	**85,696**	**848,673**

Source: 1997 CFS

Table 40 Truck freight flow with origin within the study area - Top 10 destinations outside the study area by weight.

Destination States	Weight (1000 tons)	% of Total
Kentucky	28,527	13.3%
Pennsylvania	25,905	12.1%
Missouri	20,168	9.4%
Texas	13,289	6.2%
New York	10,688	5.0%
California	10,404	4.9%
Tennessee	10,369	4.8%
Georgia	9,516	4.4%
Nebraska	7,333	3.4%
North Dakota	7,082	3.3%

Table 41 Truck freight flow with origin within the study area - Top 10 destinations outside the study area by value.

Destination States	Value (in $million)	% of Total
Texas	39,878	9.4%
Pennsylvania	36,677	8.6%
California	32,501	7.6%
Missouri	28,701	6.7%
Kentucky	26,710	6.3%
New York	25,199	5.9%
Georgia	22,467	5.3%
Tennessee	22,406	5.3%
Florida	16,942	4.0%
New Jersey	16,030	3.8%

Table 42   Truck freight flow with destination within the study area - Top 10 origins outside the study area by weight.

Origin States	Weight (1000 tons)	% of Total
Pennsylvania	19,097	11.7%
Kentucky	15,917	9.7%
Missouri	14,352	8.8%
New York	9,249	5.7%
Tennessee	8,408	5.1%
Nebraska	8,371	5.1%
North Carolina	7,213	4.4%
Texas	6,402	3.9%
Georgia	6,165	3.8%
North Dakota	5,883	3.6%

Table 43 Truck freight flow with destination within the study area - Top 10 origins outside the study area by value.

Origin States	Value (in $million)	% of Total
Pennsylvania	28,672	8.6%
New York	25,472	7.7%
California	23,982	7.2%
Kentucky	23,565	7.1%
Texas	22,948	6.9%
Missouri	21,120	6.4%
New Jersey	18,712	5.6%
North Carolina	18,281	5.5%
Tennessee	14,936	4.5%
Georgia	13,981	4.2%

Table 44 Truck freight flow with destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	405,174	26.7%
Base metal in primary or semifinished forms and in finished basic shapes	118,856	7.8%
Nonmetallic mineral products	112,860	7.4%
Gasoline and aviation turbine fuel	103,742	6.8%
Other prepared foodstuffs and fats and oils	80,455	5.3%
Cereal grains	76,662	5.0%
Coal and petroleum products	52,879	3.5%
Natural sands	46,232	3.0%
Other agricultural products	45,670	3.0%
Fuel oils	45,546	3.0%

Table 45 Truck freight flow with destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	135,712	13.4%
Machinery	94,497	9.3%
Base metal in primary or semifinished forms and in finished basic shapes	88,306	8.7%
Electronic and other electrical equipment and components and office equipment	74,803	7.4%
Other prepared foodstuffs and fats and oils	73,121	7.2%
Plastics and rubber	57,913	5.7%
Miscellaneous manufactured products	48,375	4.8%
Articles of base metal	43,804	4.3%
Chemical products and preparations	33,167	3.3%
Meat, fish, seafood, and their preparations	31,029	3.1%

Table 46 Truck freight flow with destination within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Base metal in primary or semifinished forms and in finished basic shapes	19,173	12.7%
Other prepared foodstuffs and fats and oils	14,383	9.5%
Gravel and crushed stone	12,776	8.5%
Nonmetallic mineral products	10,206	6.8%
Pulp, newsprint, paper, and paperboard	7,608	5.0%
Wood products	7,184	4.8%
Plastics and rubber	6,964	4.6%
Motorized and other vehicles (including parts)	6,304	4.2%
Chemical products and preparations	4,647	3.1%
Cereal grains	4,556	3.0%

Table 47 Truck freight flow with both origin and destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	402,235	23.2%
Nonmetallic mineral products	104,185	6.0%
Base metal in primary or semifinished forms and in finished basic shapes	103,944	6.0%
Gasoline and aviation turbine fuel	102,592	5.9%
Cereal grains	73,422	4.2%
Other prepared foodstuffs and fats and oils	71,977	4.1%
Coal and petroleum products	51,916	3.0%
Natural sands	46,171	2.7%
Fuel oils	44,561	2.6%
Other agricultural products	44,250	2.5%

Table 48 Truck freight flow with both origin and destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	110,142	13.0%
Machinery	71,447	8.4%
Base metal in primary or semifinished forms and in finished basic shapes	70,771	8.3%
Other prepared foodstuffs and fats and oils	59,860	7.1%
Electronic and other electrical equipment and components and office equipment	44,942	5.3%
Plastics and rubber	37,497	4.4%
Miscellaneous manufactured products	35,471	4.2%
Articles of base metal	34,934	4.1%
Chemical products and preparations	25,223	3.0%

Mixed freight	23,571	2.8%

Table 49 Truck freight flow with origin within the study area and destination outside the study area- Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Base metal in primary or semifinished forms and in finished basic shapes	23,657	17.0%
Other prepared foodstuffs and fats and oils	18,457	13.3%
Motorized and other vehicles (including parts)	8,619	6.2%
Nonmetallic mineral products	7,929	5.7%
Chemical products and preparations	7,673	5.5%
Plastics and rubber	7,450	5.4%
Articles of base metal	6,419	4.6%
Milled grain products and preparations, and bakery products	6,077	4.4%
Machinery	5,418	3.9%
Miscellaneous manufactured products	4,703	3.4%

Table 50 Truck freight flow with origin within the study area and destination outside the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	42,425	13.7%
Machinery	39,899	12.9%
Electronic and other electrical equipment and components and office equipment	27,510	8.9%
Base metal in primary or semifinished forms and in finished basic shapes	24,654	8.0%
Other prepared foodstuffs and fats and oils	24,049	7.8%
Plastics and rubber	23,324	7.5%
Miscellaneous manufactured products	22,600	7.3%
Chemical products and preparations	16,381	5.3%

Articles of base metal	15,998	5.2%
Meat, fish, seafood, and their preparations	11,102	3.6%

Table 51 Truck freight flow with destination within the study area and origin outside the study area- Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Base metal in primary or semifinished forms and in finished basic shapes	14,912	13.7%
Nonmetallic mineral products	8,675	8.0%
Other prepared foodstuffs and fats and oils	8,478	7.8%
Pulp, newsprint, paper, and paperboard	6,812	6.3%
Plastics and rubber	6,634	6.1%
Wood products	6,334	5.8%
Meat, fish, seafood, and their preparations	4,456	4.1%
Motorized and other vehicles (including parts)	4,351	4.0%
Articles of base metal	3,796	3.5%
Chemical products and preparations	3,546	3.3%

Table 52 Truck freight flow with destination within the study area and origin outside the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Electronic and other electrical equipment and components and office equipment	29,861	12.6%
Motorized and other vehicles (including parts)	25,570	10.8%
Machinery	23,050	9.7%
Plastics and rubber	20,416	8.6%
Base metal in primary or semifinished forms and in finished basic shapes	17,535	7.4%
Textiles, leather, and articles of textiles or leather	17,461	7.3%
Other prepared foodstuffs and fats and oils	13,261	5.6%

Miscellaneous manufactured products	12,904	5.4%
Meat, fish, seafood, and their preparations	9,102	3.8%
Articles of base metal	8,870	3.7%

I.5 Select Link Analysis

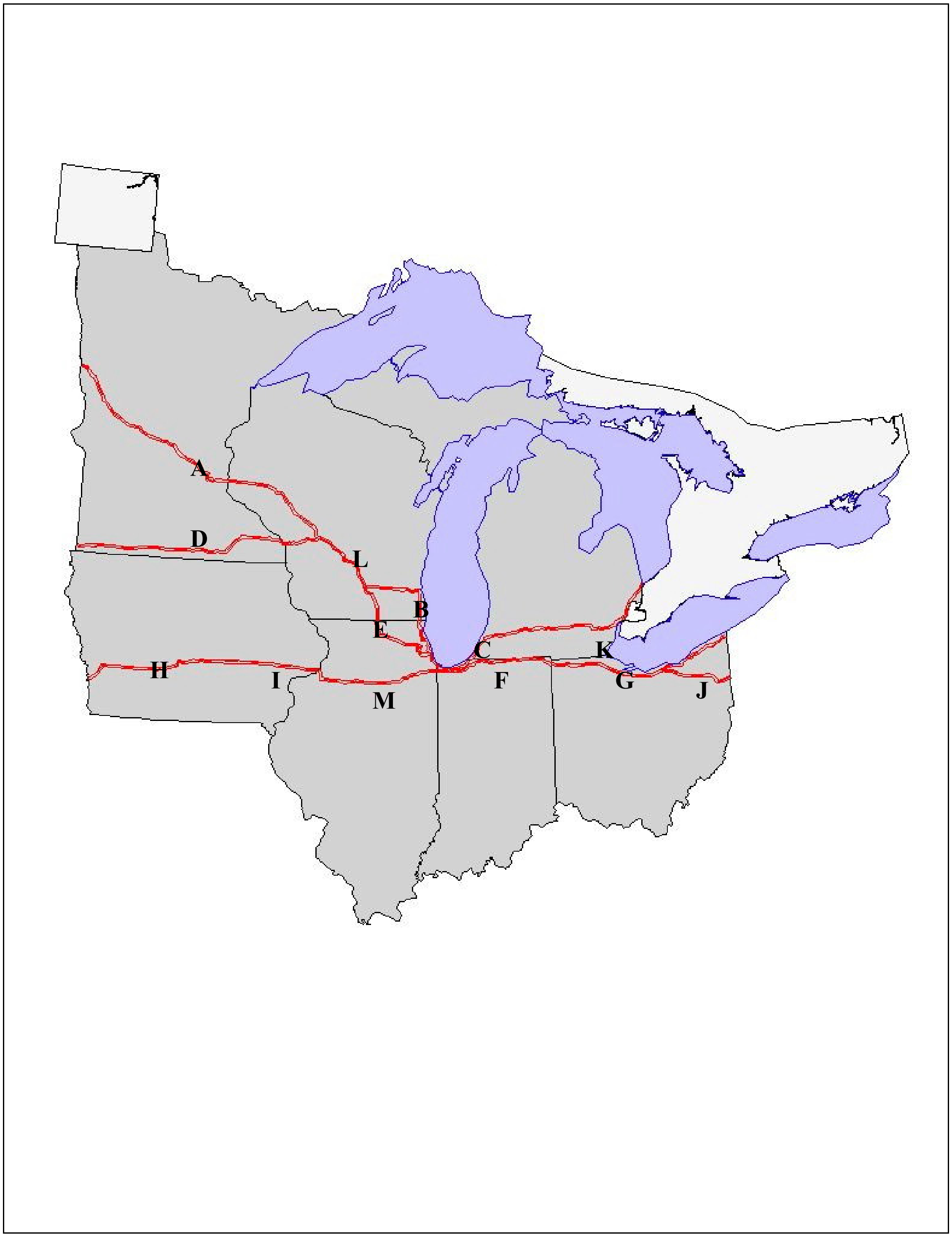

Figure 26 Locations of select link analysis

Table 53 Description of select link analysis locations.

Analysis location	Description	State
A	I-94 West of Minneapolis	MN
B	I-94 South of Milwaukee	WI
C	I-94 at South of Benton Harbor	MI
D	I-90 West of I-35 Interchange	MN
E	I-90 at South of Madison	WI
F	I-80/90 East of South Bend	IN
G	I-80/90 Near Norwalk	OH
H	I-80 West of Des Moines	IA
I	I-80 West of Davenport	IA
J	I-80 North of I-76 Interchange	OH
K	I-75 North of Toledo	MI
L	I-90/94 East of 90/94 Split	WI
M	I-80 East of I-39 Interchange	IL

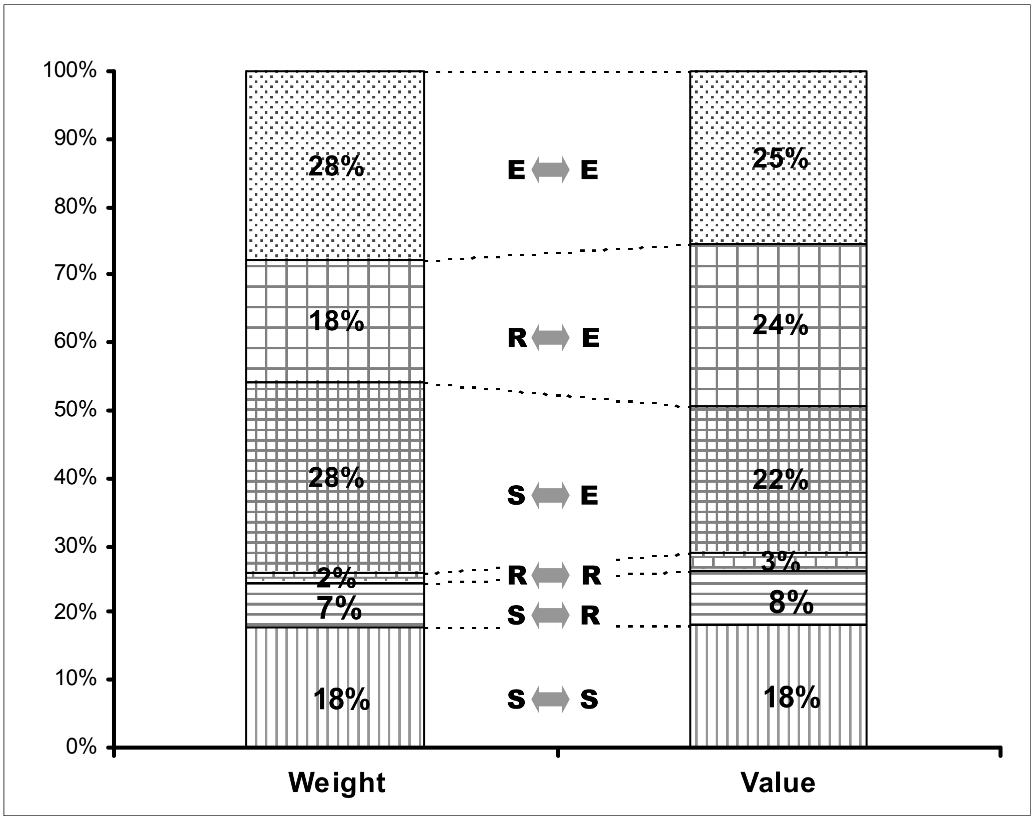

Chart 11 Breakdown of truck shipments by movement types: I-94 West of Minneapolis, MN (A).

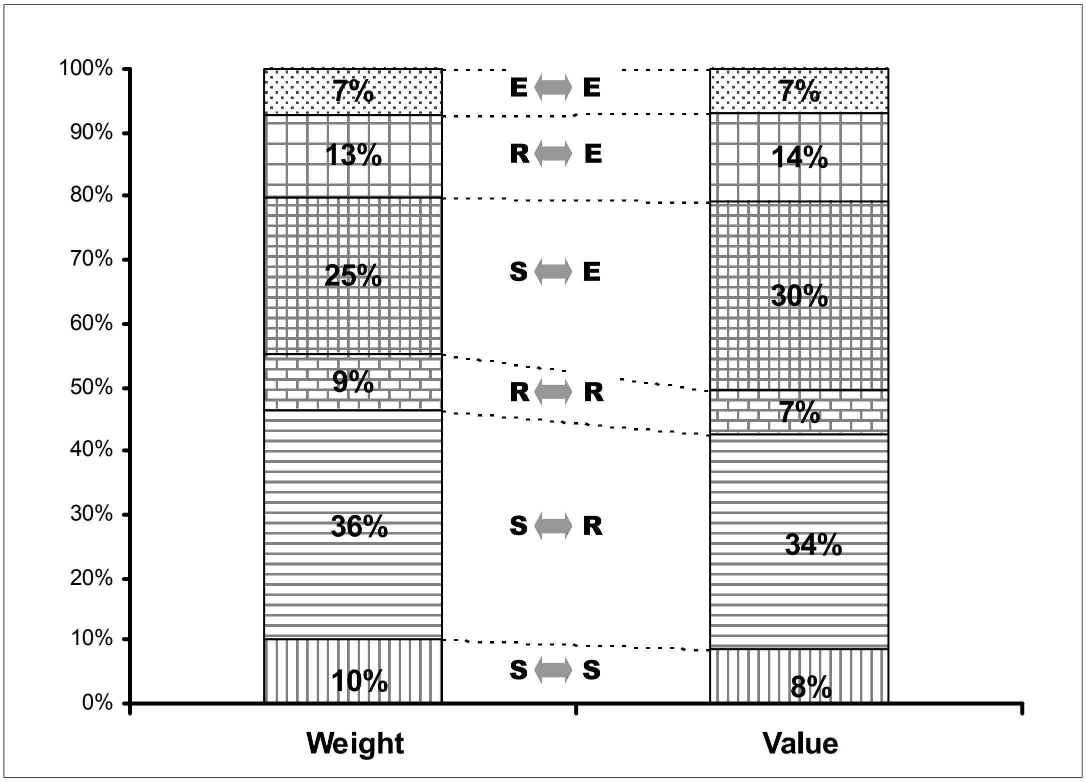

Chart 12 Breakdown of truck shipments by movement types: I-94 South of Milwaukee, WI (B).

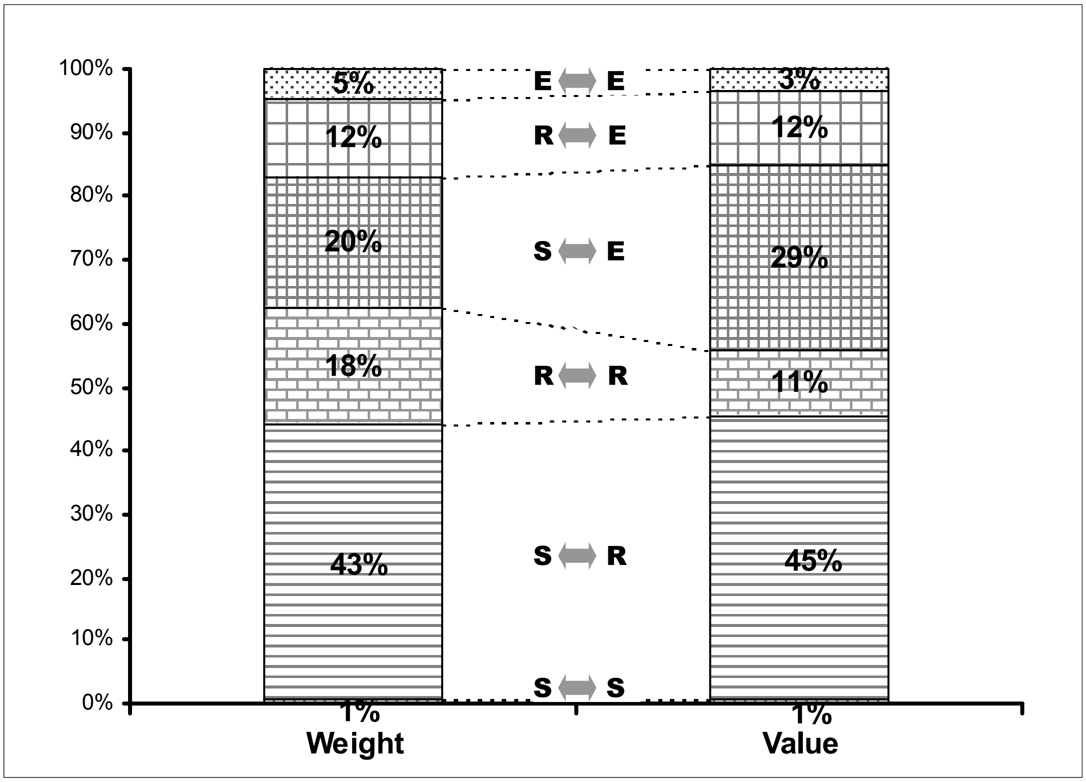

Chart 13 Breakdown of truck shipments by movement types: I-94 at South of Benton Harbor, MI (C).

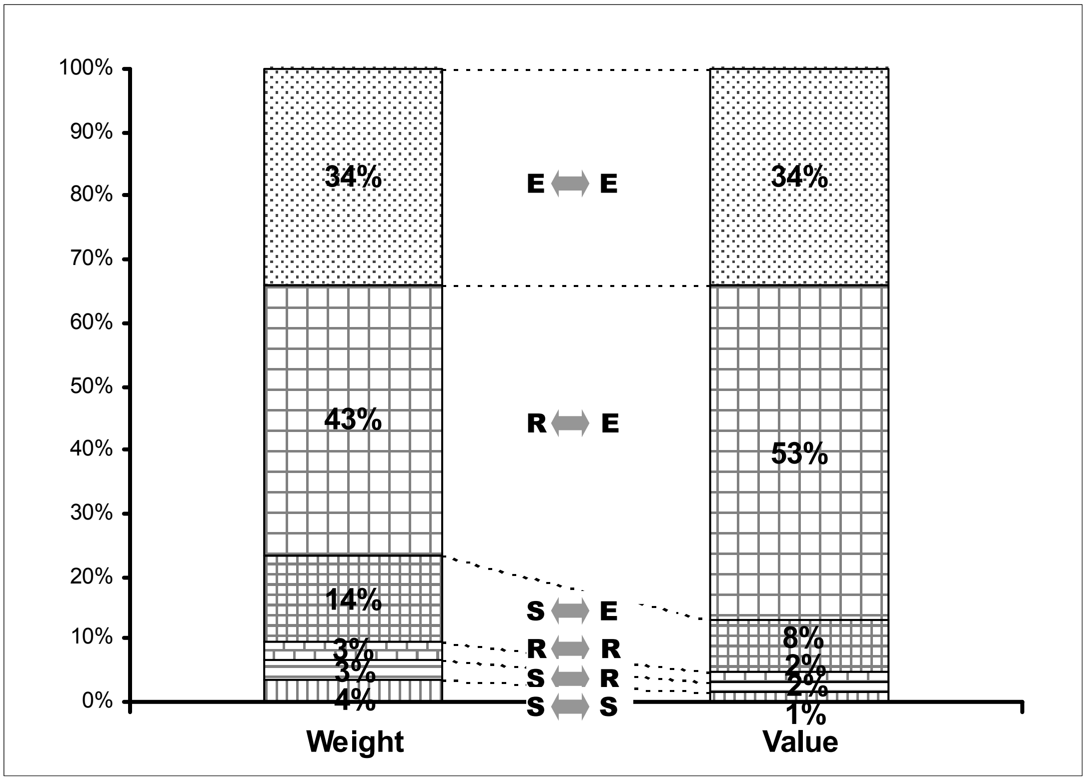

Chart 14 Breakdown of truck shipments by movement types: I-90 West of I-35 Interchange, MN (D).

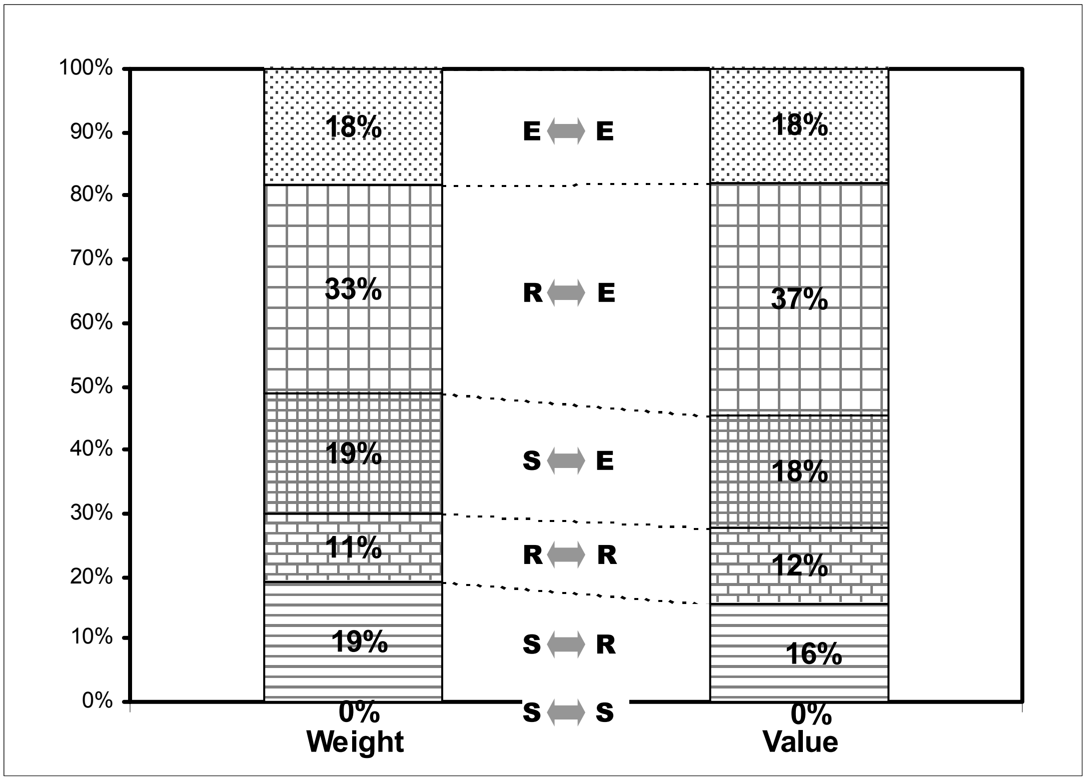

Chart 15 Breakdown of truck shipments by movement types: I-90 at South of Madison, WI (E).

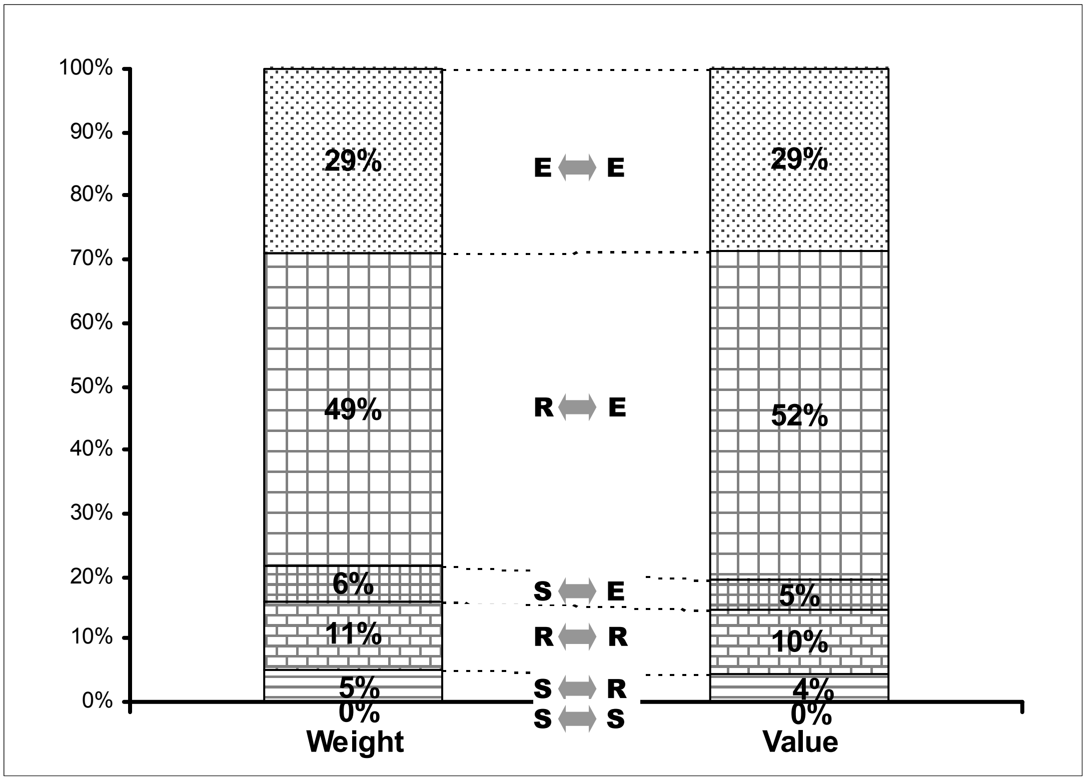

Chart 16 Breakdown of truck shipments by movement types: I-80/90 East of South Bend, IN (F).

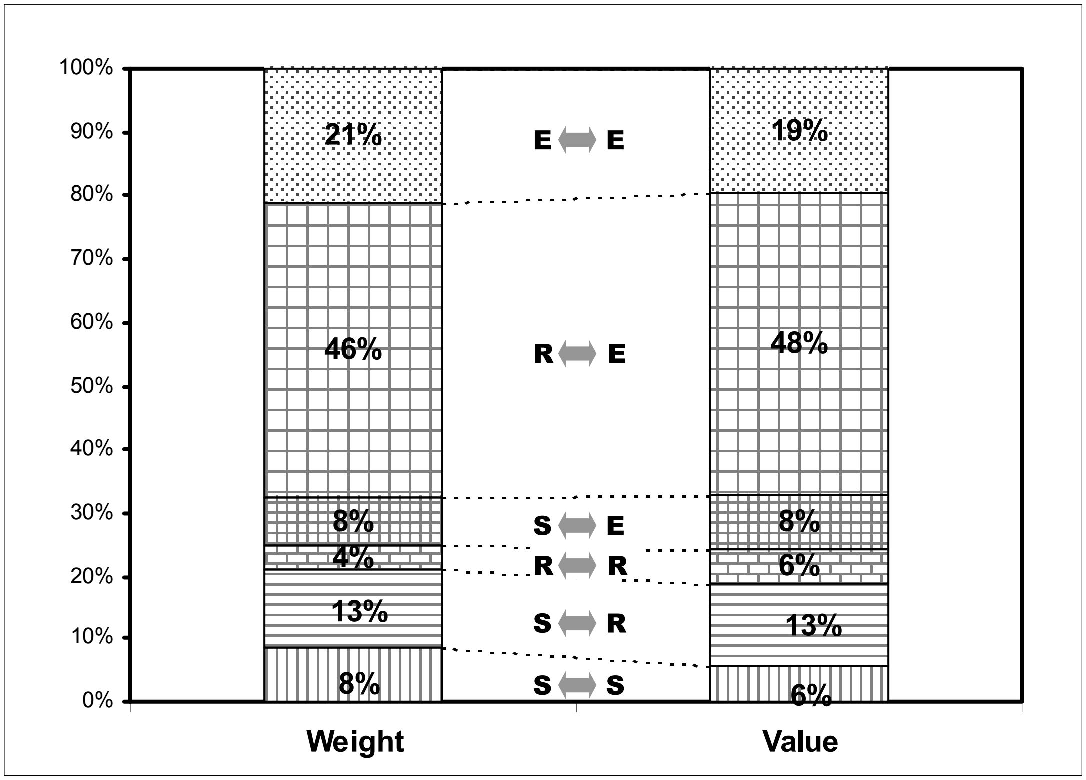

Chart 17 Breakdown of truck shipments by movement types: I-80/90 near Norwalk, OH (G)

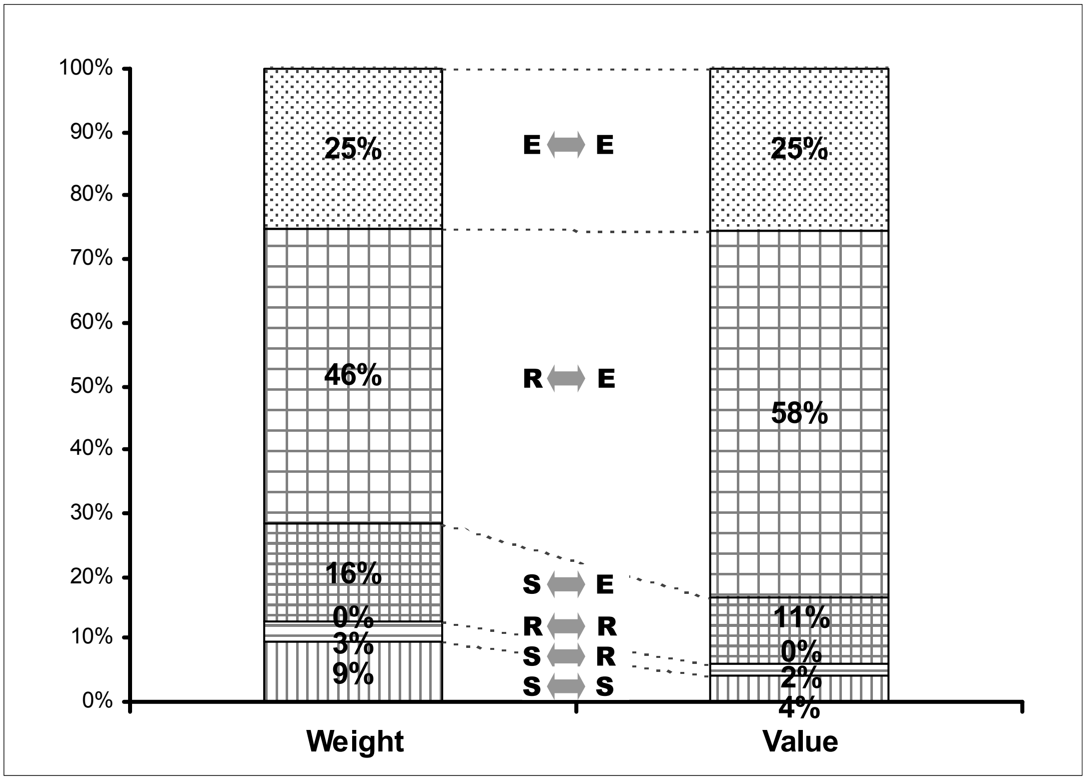

Chart 18 Breakdown of truck shipments by movement types: I-80 West of Des Moines, IA (H).

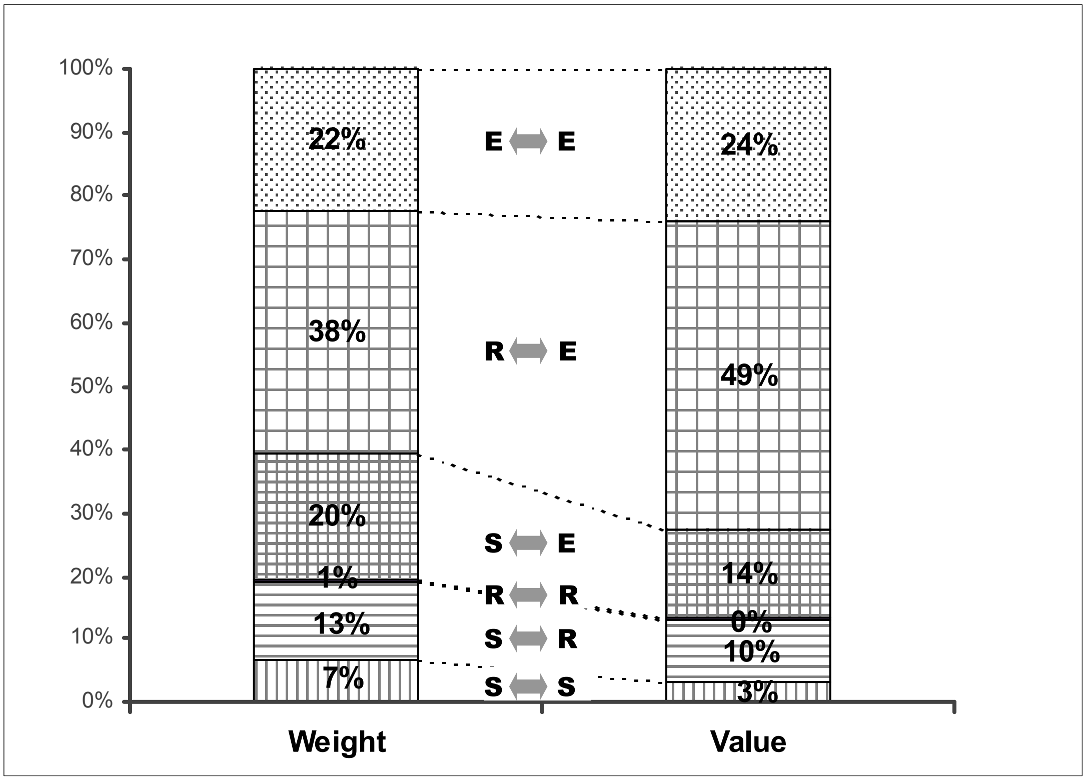

Chart 19 Breakdown of truck shipments by movement types: I-80 West of Davenport, IA (I).

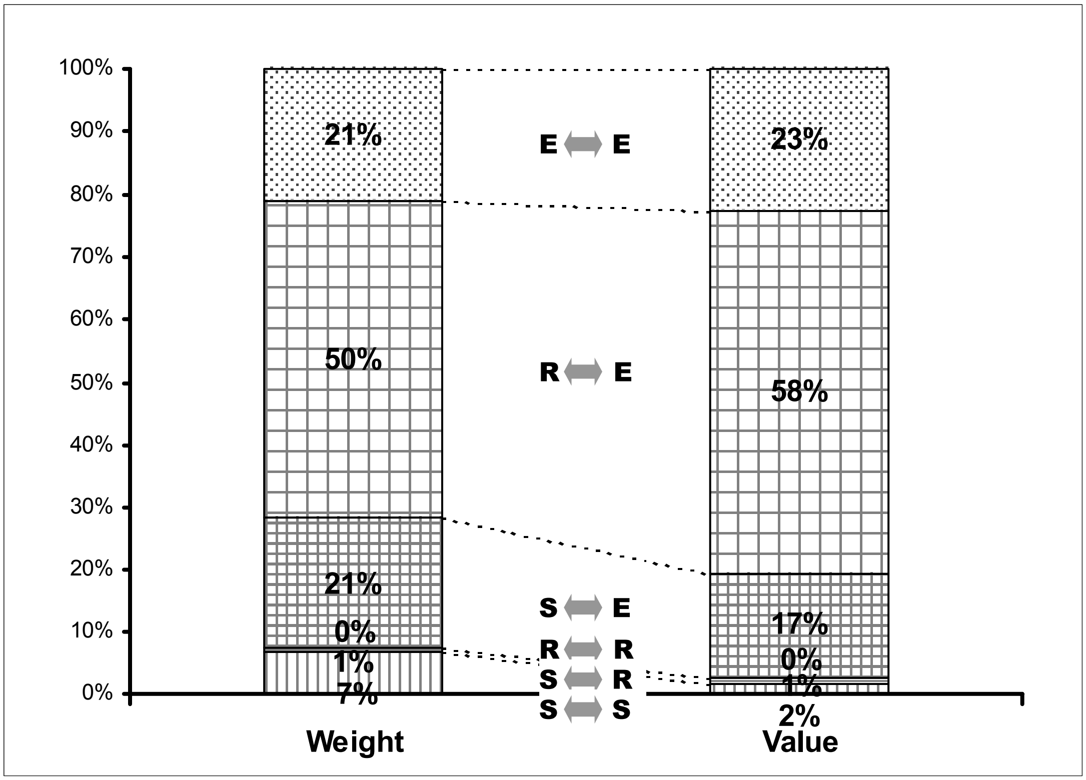

Chart 20 Breakdown of truck shipments by movement types: I-80 North of I-76 Interchange, OH (J).

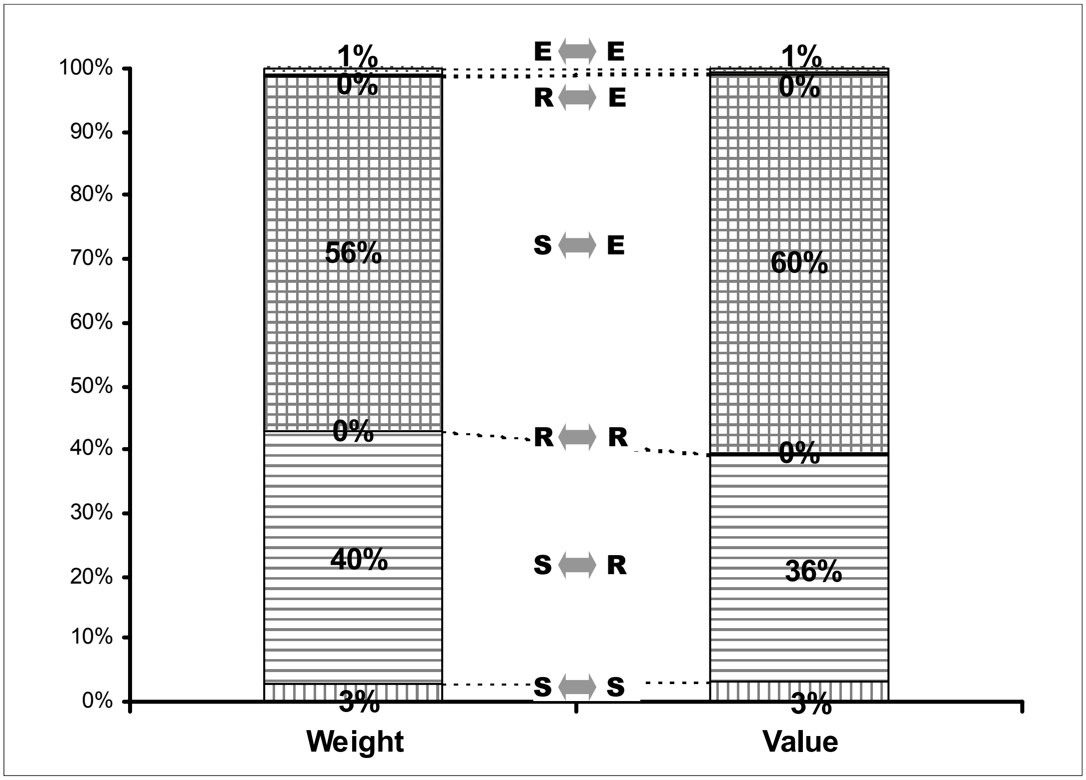

Chart 21   Breakdown of truck shipments by movement types: I-75 North of Toledo, OH (K).

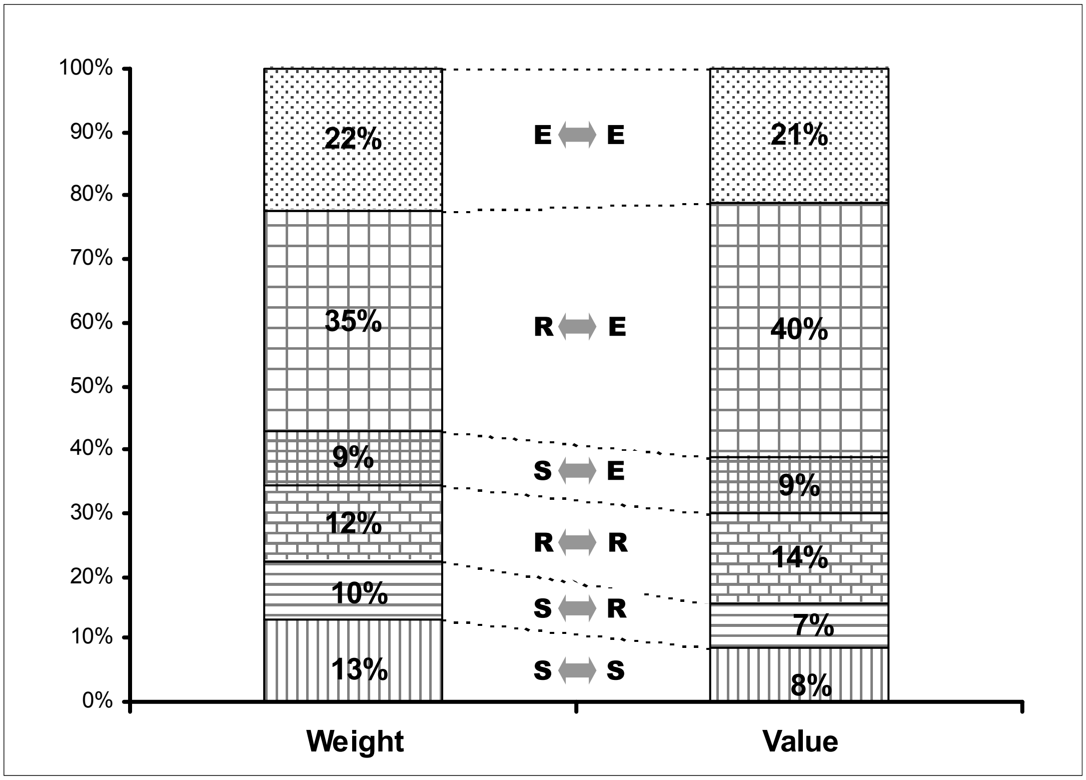

Chart 22 Breakdown of truck shipments by movement types: I-90/94 East of 90/94 Split, WI (L).

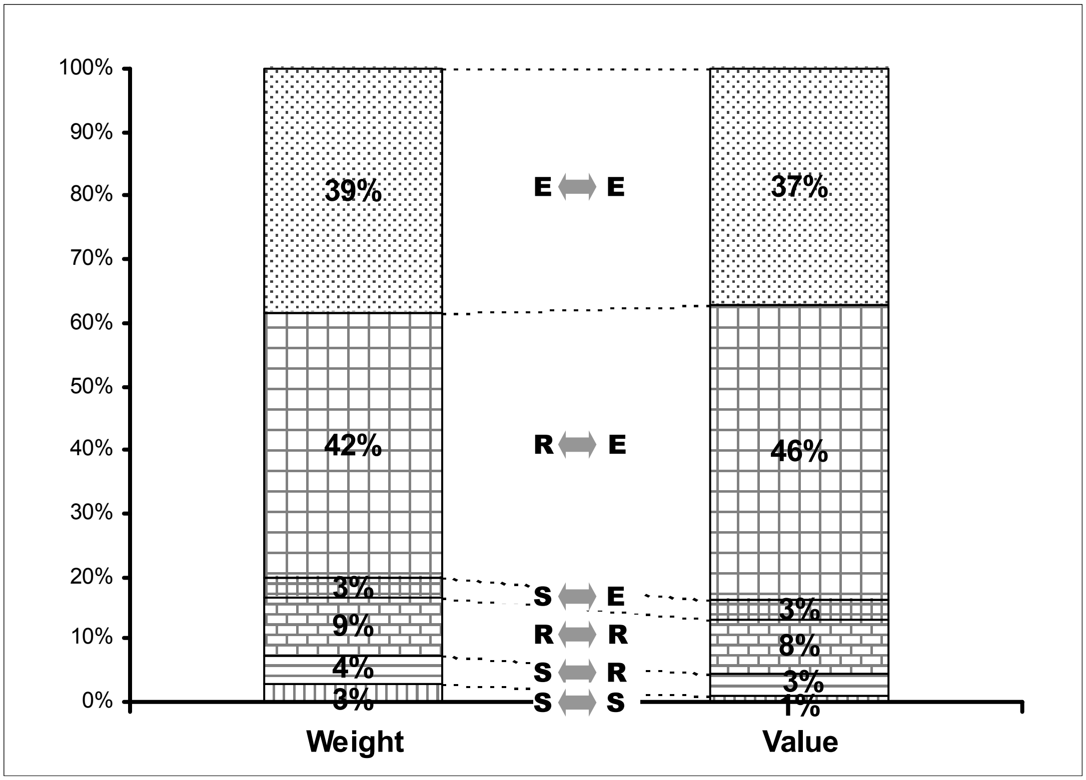

Chart 23 Breakdown of truck shipments by movement types: I-80 East of I-39 Interchange, IL (M).

I.6 Rail

Table 54 Rail freight flow with both origin and destination within the study area - 1997 (in 1000Tons).

	Destination							
Origin	**Illinois**	**Indiana**	**Iowa**	**Michigan**	**Minnesota**	**Ohio**	**Wisconsin**	**Total**
Illinois	31,818	7,292	946	0	808	1,392	685	**42,941**
Indiana	5,179	31,124	0	1,379	382	2,792	1,296	**42,152**
Iowa	7,416	183	5,682	540	1,405	713	354	**16,293**
Michigan	1,145	2,403	0	12,378	183	3,797	441	**20,347**
Minnesota	0	100	0	0	21,462	787	5,300	**27,649**
Ohio	1,338	926	0	0	91	10,544	438	**13,337**
Wisconsin	3,435	626	221	715	235	785	5,505	**11,522**
Total	**50,331**	**42,654**	**6,849**	**15,012**	**24,566**	**20,810**	**14,019**	**174,241**

Source: 1997 CFS

Table 55 Rail freight flow with both origin and destination within the study area - 1997 (in $million).

	Destination							
Origin	**Illinois**	**Indiana**	**Iowa**	**Michigan**	**Minnesota**	**Ohio**	**Wisconsin**	**Total**
Illinois	2,406	436	122	0	734	412	159	**4,269**
Indiana	805	2,607	24	536	177	722	332	**5,203**
Iowa	1,399	62	787	190	137	260	93	**2,928**
Michigan	1,290	1,255	0	3,652	683	0	457	**7,337**
Minnesota	721	43	0	0	1,528	76	533	**2,901**
Ohio	1,106	370	0	906	304	1,893	675	**5,254**
Wisconsin	413	165	32	229	52	176	714	**1,781**
Total	**8,140**	**4,938**	**965**	**5,513**	**3,615**	**3,539**	**2,963**	**29,673**

Source: 1997 CFS

Table 56 Rail freight flow with origin within the study area - Top 10 destinations outside the study area by weight.

Destination States	Weight (1000 tons)	% of Total
North Carolina	11,776	11.5%
Texas	8,883	8.7%
Georgia	8,330	8.1%
California	7,414	7.2%
Pennsylvania	6,918	6.7%
Washington	6,350	6.2%
Florida	5,565	5.4%
Missouri	5,390	5.3%
Kentucky	5,099	5.0%
Utah	4,416	4.3%

Table 57 Rail freight flow with origin within the study area - Top 10 destinations outside the study area by value.

Destination States	Value ($million)	% of Total
Texas	8,574	15.4%
California	7,814	14.0%
Missouri	4,687	8.4%
Georgia	4,408	7.9%
Florida	2,982	5.3%
New Jersey	2,912	5.2%
Pennsylvania	2,822	5.1%
North Carolina	2,554	4.6%
Washington	2,294	4.1%
Virginia	2,253	4.0%

Table 58 Rail freight flow with destination within the study area - Top 10 origins outside the study area by weight.

Origin States	Weight (1000 tons)	% of Total
Wyoming	66,293	42.6%
Montana	19,892	12.8%
Pennsylvania	10,489	6.7%
West Virginia	8,237	5.3%
Louisiana	6,442	4.1%
Texas	6,130	3.9%
Virginia	4,251	2.7%
Georgia	3,572	2.3%
Colorado	3,361	2.2%
Kentucky	3,312	2.1%

Table 59 Rail freight flow with destination within the study area - Top 10 origins outside the study area by value.

Origin States	Value (in $million)	% of Total
Texas	5,252	20.2%
Louisiana	4,385	16.9%
California	1,631	6.3%
Pennsylvania	1,195	4.6%
West Virginia	1,146	4.4%
Oregon	1,055	4.1%
Georgia	1,017	3.9%
Wyoming	878	3.4%
Washington	811	3.1%
Montana	780	3.0%

Table 60 Rail freight flow with origin within the study area - weight and value for selected commodities.

Commodity	Weight (1000 tons)	% of Total	Value ($ million)	% of Total
Coal	51,934	32.9%	1,247	2.5%
Cereal grains	25,042	15.9%	2,661	5.2%
Metallic ores and concentrates	21,096	13.4%	601	1.2%
Base metal in primary or semifinished forms and in finished basic shapes	12,395	7.9%	5,209	10.3%
Waste and scrap	10,524	6.7%	1,227	2.4%
Other prepared foodstuffs and fats and oils	8,763	5.6%	3,523	6.9%
Motorized and other vehicles (including parts)	4,985	3.2%	27,101	53.4%
Animal feed and products of animal origin	4,831	3.1%	1,017	2.0%

Source: 1997 CFS

Table 61 Rail freight flow with destination within the study area - weight and value for selected commodities.

Commodity	Weight (1000 tons)	% of Total	Value ($ million)	% of Total
Coal	149,926	63.2%	2,472	8.0%
Metallic ores and concentrates	18,132	7.6%	518	1.7%
Motorized and other vehicles (including parts)	1,593	0.7%	5,379	17.5%
Cereal grains	11,844	5.0%	1,479	4.8%
Waste and scrap	9,404	4.0%	1,142	3.7%
Base metal in primary or semifinished forms and in finished basic shapes	8,861	3.7%	3,967	12.9%
Basic chemicals	6,256	2.6%	3,700	12.0%
Pulp, newsprint, paper, and paperboard	5,689	2.4%	3,169	10.3%
Wood products	3,884	1.6%	1,641	5.3%
Plastics and rubber	3,600	1.5%	3,147	10.2%

Source: 1997 CFS

Table 62 Rail freight flow with destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Coal	149,926	63.2%
Metallic ores and concentrates	18,132	7.6%
Cereal grains	11,844	5.0%
Waste and scrap	9,404	4.0%
Base metal in primary or semifinished forms and in finished basic shapes	8,861	3.7%
Basic chemicals	6,256	2.6%
Pulp, newsprint, paper, and paperboard	5,689	2.4%
Wood products	3,884	1.6%
Nonmetallic minerals	3,650	1.5%
Plastics and rubber	3,600	1.5%

Table 63 Rail freight flow with destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	5,379	17.5%
Base metal in primary or semifinished forms and in finished basic shapes	3,967	12.9%
Basic chemicals	3,700	12.0%
Pulp, newsprint, paper, and paperboard	3,169	10.3%
Plastics and rubber	3,147	10.2%
Coal	2,472	8.0%
Wood products	1,641	5.3%
Other prepared foodstuffs and fats and oils	1,489	4.8%
Cereal grains	1,479	4.8%
Waste and scrap	1,142	3.7%

Table 64 Rail freight flow with destination within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Coal	107,630	72.2%
Wood products	6,145	4.1%
Basic chemicals	6,143	4.1%
Pulp, newsprint, paper, and paperboard	4,830	3.2%
Nonmetallic minerals	4,313	2.9%
Plastics and rubber	3,893	2.6%
Fertilizers	2,787	1.9%
Other prepared foodstuffs and fats and oils	2,547	1.7%
Cereal grains	2,510	1.7%
Base metal in primary or semifinished forms and in finished shapes	2,499	1.7%

Table 65 Rail freight flow with both origin and destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Coal	46,341	26.6%
Metallic ores and concentrates	18,088	10.4%
Cereal grains	11,844	6.8%
Waste and scrap	8,958	5.1%
Base metal in primary or semifinished forms and in finished basic shapes	7,357	4.2%
Other prepared foodstuffs and fats and oils	1,789	1.0%
Pulp, newsprint, paper, and paperboard	1,618	0.9%
Motorized and other vehicles (including parts)	1,503	0.9%
Milled grain products and preparations, and bakery products	1,462	0.8%

Gravel and crushed stone	1,338	0.8%

Table 66 Rail freight flow with both origin and destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	5,231	17.6%
Base metal in primary or semifinished forms and in finished basic shapes	2,654	8.9%
Cereal grains	1,479	5.0%
Pulp, newsprint, paper, and paperboard	1,246	4.2%
Coal	1,114	3.8%
Waste and scrap	1,096	3.7%
Other prepared foodstuffs and fats and oils	697	2.3%
Plastics and rubber	575	1.9%
Metallic ores and concentrates	515	1.7%
Milled grain products and preparations, and bakery products	342	1.2%

Table 67 Rail freight flow with origin within the study area and destination outside the study area- Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Cereal grains	13,198	25.5%
Other prepared foodstuffs and fats and oils	6,974	13.5%
Coal	5,593	10.8%
Base metal in primary or semifinished forms and in finished basic shapes	5,038	9.7%
Animal feed and products of animal origin	3,628	7.0%
Motorized and other vehicles (including parts)	3,482	6.7%
Metallic ores and concentrates	3,008	5.8%
Other agricultural products	2,371	4.6%
Milled grain products and preparations, and bakery products	2,211	4.3%
Waste and scrap	1,566	3.0%

Table 68 Rail freight flow with origin within the study area and destination outside the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	21,870	63.3%
Other prepared foodstuffs and fats and oils	2,826	8.2%
Base metal in primary or semifinished forms and in finished basic shapes	2,555	7.4%
Cereal grains	1,182	3.4%
Milled grain products and preparations, and bakery products	949	2.7%
Plastics and rubber	844	2.4%
Animal feed and products of animal origin	790	2.3%
Articles of base metal	569	1.6%
Other agricultural products	567	1.6%
Pulp, newsprint, paper, and paperboard	356	1.0%

Table 69 Rail freight flow with destination within the study area and origin outside the study area- Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Coal	103,585	78.8%
Basic chemicals	5,892	4.5%
Pulp, newsprint, paper, and paperboard	4,071	3.1%
Wood products	3,870	2.9%
Nonmetallic minerals	3,623	2.8%
Plastics and rubber	3,050	2.3%
Fertilizers	2,298	1.7%
Base metal in primary or semifinished forms and in finished basic shapes	1,504	1.1%
Other prepared foodstuffs and fats and oils	1,305	1.0%
Coal and petroleum products	1,112	0.8%

Table 70 Rail freight flow with destination within the study area and origin outside the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Basic chemicals	3,523	24.3%
Plastics and rubber	2,572	17.7%
Pulp, newsprint, paper, and paperboard	1,923	13.2%
Wood products	1,604	11.0%
Coal	1,358	9.4%
Base metal in primary or semifinished forms and in finished basic shapes	1,313	9.0%
Other prepared foodstuffs and fats and oils	792	5.5%
Fertilizers	399	2.7%
Coal and petroleum products	323	2.2%
Chemical products and preparations	203	1.4%

I.7 Intermodal

Table 71 Intermodal freight flow with origin within the study area - Top 10 destinations by weight.

Destination States	Weight (1000 tons)	% of Total
California	2,164	34.3%
Texas	566	9.0%
New Jersey	453	7.2%
Washington	450	7.1%
Michigan	324	5.1%
Florida	293	4.6%
Georgia	240	3.8%
Pennsylvania	234	3.7%
Tennessee	223	3.5%
Missouri	202	3.2%

Table 72 Intermodal freight flow with origin within the study area - Top 10 destinations area by value.

Destination States	Value (in $million)	% of Total
California	7,097	33.0%
Texas	2,905	13.5%
New Jersey	1,665	7.7%
Washington	1,485	6.9%
Georgia	1,349	6.3%
Florida	1,323	6.1%
Virginia	903	4.2%
Missouri	690	3.2%
Michigan	603	2.8%
Massachusetts	545	2.5%

Table 75 Intermodal freight flow with destination within the study area - Top 10 commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Nonmetallic minerals	215	26.5%
Other prepared foodstuffs and fats and oils	143	17.6%
Wood products	100	12.3%
Base metal in primary or semifinished forms and in finished basic shapes	85	10.5%
Plastics and rubber	61	7.5%
Motorized and other vehicles (including parts)	54	6.7%
Machinery	42	5.2%
Basic chemicals	36	4.4%
Articles of base metal	21	2.6%
Other agricultural products	19	2.3%

Table 76 Intermodal freight flow with destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Motorized and other vehicles (including parts)	1,114	50.4%
Machinery	419	18.9%
Other prepared foodstuffs and fats and oils	171	7.7%
Base metal in primary or semifinished forms and in finished basic shapes	115	5.2%
Wood products	95	4.3%
Plastics and rubber	77	3.5%
Miscellaneous manufactured products	68	3.1%
Basic chemicals	46	2.1%
Other agricultural products	46	2.1%

Pharmaceutical products	34	1.5%

Table 77 Intermodal freight flow with destination within the study area - Top 10 commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Other prepared foodstuffs and fats and oils	334	31.9%
Wood products	241	23.0%
Nonmetallic minerals	119	11.4%
Plastics and rubber	103	9.8%
Base metal in primary or semifinished forms and in finished shapes	91	8.7%
Other agricultural products	44	4.2%
Basic chemicals	34	3.2%
Miscellaneous manufactured products	23	2.2%
Motorized and other vehicles (including parts)	19	1.8%
Articles of base metal	13	1.2%

I.8 Air

Table 78 Air freight flow with origin within the study area - Top 10 destinations by weight.

Destination States	Weight (1000 tons)	% of Total
Illinois	83	24.3%
Michigan	47	13.7%
Texas	45	13.2%
California	32	9.4%
New York	22	6.4%
Missouri	15	4.4%
New Jersey	12	3.5%
Florida	11	3.2%
Indiana	9	2.6%
Ohio	9	2.6%

Table 79 Air freight flow with origin within the study area - Top 10 destinations by value.

Destination States	Value (in $million)	% of Total
Illinois	3,797	22.2%
California	2,087	12.2%
Michigan	1,546	9.0%
Texas	1,283	7.5%
New York	1,017	6.0%
Florida	942	5.5%
New Jersey	642	3.8%
Ohio	517	3.0%
Kentucky	494	2.9%
Pennsylvania	439	2.6%

Table 80 Air freight flow with destination within the study area - Top 10 origins by weight.

Origin States	Weight (1000 tons)	% of Total
California	55	17.80%
Michigan	46	14.89%
Illinois	30	9.71%
Ohio	24	7.77%
Minnesota	22	7.12%
New York	21	6.80%
Wisconsin	19	6.15%
Texas	13	4.21%
Indiana	12	3.88%
Missouri	11	3.56%

Table 81 Air freight flow with destination within the study area - Top 10 origins by value.

Origin States	Value (in $million)	% of Total
California	4,818	23.70%
Texas	2,087	10.27%
Minnesota	1,377	6.77%
Ohio	1,317	6.48%
Wisconsin	1,204	5.92%
Michigan	1,129	5.55%
Indiana	798	3.93%
Illinois	754	3.71%
Massachusetts	710	3.49%
New York	676	3.33%

Table 82 Air freight flow with destination within the study area - Top commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Electronic and other electrical equipment and components and office equipment	25	58.1%
Machinery	9	20.9%
Miscellaneous manufactured products	3	7.0%
Precision instruments and apparatus	3	7.0%
Motorized and other vehicles (including parts)	2	4.7%
Printed products	1	2.3%

Table 83 Air freight flow with destination within the study area - Top 10 commodities by value.

Commodity	Value (in $million)	% of Total
Electronic and other electrical equipment and components and office equipment	4,202	55.1%
Precision instruments and apparatus	1,454	19.1%
Machinery	972	12.8%
Motorized and other vehicles (including parts)	263	3.5%
Miscellaneous manufactured products	247	3.2%
Pharmaceutical products	198	2.6%
Textiles, leather, and articles of textiles or leather	132	1.7%
Transportation equipment	45	0.6%
Plastics and rubber	44	0.6%
Printed products	42	0.6%

Table 84 Air freight flow with destination within the study area - Top commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Electronic and other electrical equipment and components and office equipment	35	66.0%
Motorized and other vehicles (including parts)	6	11.3%
Miscellaneous manufactured products	4	7.5%
Machinery	3	5.7%
Textiles, leather, and articles of textiles or leather	3	5.7%
Precision instruments and apparatus	2	3.8%

I.9 Water

Table 85 Water freight flow with origin within the study area - Top 10 destinations by weight.

Destination States	Weight (1000 tons)	% of Total
Louisiana	51,671	55.7%
Michigan	12,129	13.1%
Ohio	9,060	9.8%
Illinois	6,285	6.8%
Wisconsin	4,392	4.7%
Indiana	4,271	4.6%
West Virginia	1,606	1.7%
Kentucky	1,507	1.6%
Pennsylvania	1,150	1.2%
Alabama	314	0.3%

Table 86 Water freight flow with origin within the study area - Top 10 destinations by value.

Destination States	Value (in $million)	% of Total
Louisiana	7,457	88.6%
Illinois	508	6.0%
Michigan	175	2.1%
Wisconsin	112	1.3%
Ohio	65	0.8%
Minnesota	45	0.5%
Kentucky	19	0.2%
Indiana	16	0.2%
West Virginia	12	0.1%
Texas	7	0.1%

Table 87 Water freight flow with destination within the study area - Top 10 origins by weight.

Origin States	Weight (1000 tons)	% of Total
Michigan	27,129	52.6%
Illinois	4,321	8.4%
Louisiana	4,201	8.2%
Ohio	4,127	8.0%
West Virginia	2,675	5.2%
Kentucky	2,518	4.9%
Pennsylvania	2,128	4.1%
Missouri	1,460	2.8%
Texas	1,438	2.8%
Wisconsin	871	1.7%

Table 88 Water freight flow with destination within the study area - Top origins by value.

Origin States	Value (in $million)	% of Total
Louisiana	655	35.1%
Illinois	508	27.2%
Michigan	256	13.7%
Wisconsin	157	8.4%
Missouri	92	4.9%
Kentucky	84	4.5%
West Virginia	61	3.3%
Pennsylvania	53	2.8%

Table 89 Water freight flow with destination within the study area - Top commodities by weight.

Commodity	Weight (1000 tons)	% of Total
Gravel and crushed stone	18,341	58.6%
Coal	6,289	20.1%
Nonmetallic minerals	3,302	10.6%
Nonmetallic mineral products	1,729	5.5%
Basic chemicals	759	2.4%
Cereal grains	521	1.7%
Other agricultural products	350	1.1%

Table 90 Water freight flow with destination within the study area - Top commodities by value.

Commodity	Value (in $million)	% of Total
Basic chemicals	493	50.9%
Coal	140	14.4%
Nonmetallic mineral products	97	10.0%
Other agricultural products	81	8.4%
Cereal grains	76	7.8%
Gravel and crushed stone	60	6.2%
Nonmetallic minerals	22	2.3%

Table 91 Water freight flow with destination within the study area - Top commodities by ton-mile.

Commodity	Ton-mile (million)	% of Total
Gravel and crushed stone	5,559	54.8%
Nonmetallic minerals	2,219	21.9%
Basic chemicals	1,151	11.3%
Nonmetallic mineral products	596	5.9%
Coal	539	5.3%
Other agricultural products	53	0.5%
Cereal grains	34	0.3%

I.10 Shares by Top 15 O_D Pairs and Top 10 Commodities

Table 92 Shares of Top 15 Origin-Destination Pairs - Freight with at Least One Trip End in the Study Area.

	Ton	Value	Ton-mile
Air	46.20%	37.80%	50.30%
Rail	49.40%	30.90%	47.20%
Intermodal	46.20%	60.80%	61.80%
Truck	76.60%	42.20%	24.80%
Water	88.90%	98.90%	98.20%
All modes	65.10%	36.80%	28.50%

Table 93 Shares of Top 5 Commodities - Freight with at Least One Trip End in the Study Area.

	Ton	Value	Ton-mile
Air	94.0%	92.8%	93.9%
Rail	76.8%	79.0%	66.4%
Intermodal	81.8%	91.7%	86.0%
Truck	54.1%	47.6%	42.7%
Water	93.4%	98.3%	97.8%
All modes	49.5%	48.1%	46.7%

APPENDIX J. CAPACITY

Table 94 shows the traffic and physical data sources by state. Some states provided data upon request while some states directed to web site for their data. Thus, ESRI shapefiles and PDF files of traffic data containing traffic counts were taken from their respective websites.

Table 94 Traffic and Physical Data Sources

State	Source/Format
Ohio	ESRI shapefile format
Michigan	Database format
Indiana	PDF format
Illinois	ESRI shapefile format
Wisconsin	ESRI shapefile format
Iowa	ESRI shapefile format
Minnesota	ESRI shapefile format

Wherever the actual data is not available some of the physical and traffic factors are assumed. These values are given in Table 95.

Table 95 Traffic and Physical Parameters Assumed

Physical and traffic parameters	Urban	Rural
Peak hour percent of AADT (k factor)	8	12
Directional distribution	60/40	55/45
Percent trucks	0.92	0.88
Lane width	12 feet	10 feet
Shoulder width	10 feet	10 feet
Terrain	Level	Level
Free flow speed	60 mph	70 mph

For the section of highways where actual data is not available, the default values from Table 95 are considered.

J.1 The capacity analysis program procedure

A capacity analysis program (CAP) using Visual Basic application, which works with Microsoft Excel, was developed. This program is flexible enough to perform capacity analysis with any data that has attributes needed for the capacity analysis. However this program needs certain modifications to assign the required field of attributes so that the program input field matches with data.

Data provided by states or BTS/NHPN is usually in ESRI shapefile format. The ESRI shapefile has a database file, which is connected with the link features. Database files have an extension ".dbf". These database files can be opened in Microsoft Excel, to view its contents. Usually for every database file, a metadata file (documentation of attribute fields and codes) is provided.

The database file is opened in Excel. The CAP is then linked to the database to perform capacity analysis. However before executing the program one must verify the number of rows and columns in the database and check for the respective column numbers for all the attributes necessary for capacity analysis. Once these checks are performed, the program can be executed.

Upon the execution of the program, the results of the capacity analysis are then added to the database. The following fields are added to the database.

Figure 27 shows the methodology of capacity analysis program

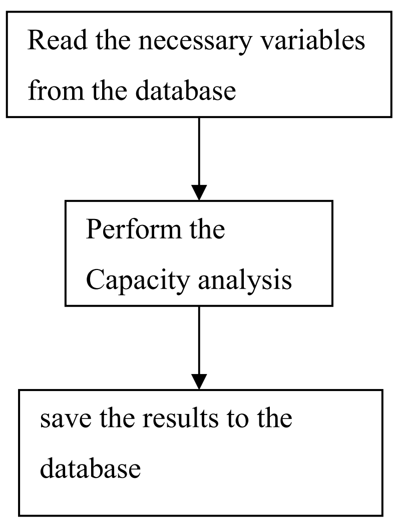

Figure 27 Methodology of Capacity Analysis Program

J.2 Results of capacity analysis

- FFS – Free flow speed

- Lane Width (Calculated from surface width/ Number of lanes)
- Lateral Clearance (Minimum of the shoulder widths)
- Fw- Correction for lane width and lateral clearance (from the lane width and lateral clearance, and from HCM 2000)
- Pt- Percentage of trucks
- Et- Truck factor for the terrain conditions (the terrain conditions are assumed as level terrain, Et=1.5)
- Fhv- Heavy vehicle adjustment factor (calculated from the Pt and Et)
- Vi- Directional design hour volume (AADT * K * D; K and D values are taken from K and D factors report from actual data where available)
- MSF- Maximum service flow rate
- LOS- Level of service (The LOS is taken from the HCM 2000, and all the values are programmed using speed and service flow rate.)

J.3 Procedure for selecting railroad network based on Segments

For the capacity analysis, class I railroad network is divided in segments such that the segments should have similar operating condition and must be fulfilling the need of freight movement in the region. The following are the criteria established for segments.

- Railroad connecting two major cities.
- Railroad intersecting other class I railroad.
- Railroad connecting the Intermodal terminals.
- Railroad consists of similar operating conditions (Single track, Double track).

Figure 28 shows the conceptual development of class I Railroad.

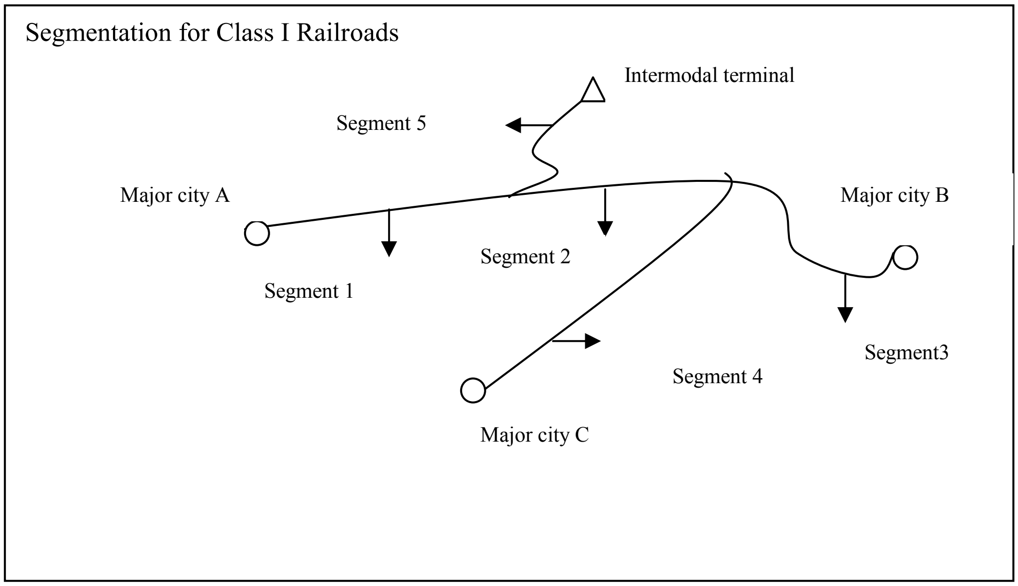

Figure 28 Conceptual Development of Class I Railroads.

Data obtained from Bureau of Transportation Statistics (BTS) in terms of the “Rail 2m.shp” file was used to divide the class I railroad network into segments. The “Rail 2m.shp”, file is used because it contains information regarding signaling and number of tracks. The railroad network generated using “Rail 2m .shp” and is divided based on railroad owners. It is further divided into segments based on the concept shown in Figure 28.

Once the segments are finalized then all segment links were given a unique ID called the “Seg_Id” (Segment Id). The “Seg_Id” contains the summation of all lengths of the links in the segment and has an attribute “Seg_length” which refers to length in miles. Another attribute “Seg_Descrp” refers to description of the segment. It provides state and terminal point ID, such as IA (1061), meaning major city by name or intersecting railroad by owner and link ID (i.e. BNSF (5697)). For the development of railroad network, all the major cities with population greater than 100,000 are considered.

By following the conceptual procedure, it may be possible that the segment so developed may have similar conditions (like track and signal system) and intersecting lines may be spaced too close i.e. at distance 3 to 5 miles. In such cases these railroads are neglected for duplicity.

Some of the class II (Regional Railroads) are also selected and added into the railroad network because they may sometimes be the connector to the Intermodal terminals and are owned by the main railroads (e.g. Canadian National, Norfolk southern) owners.

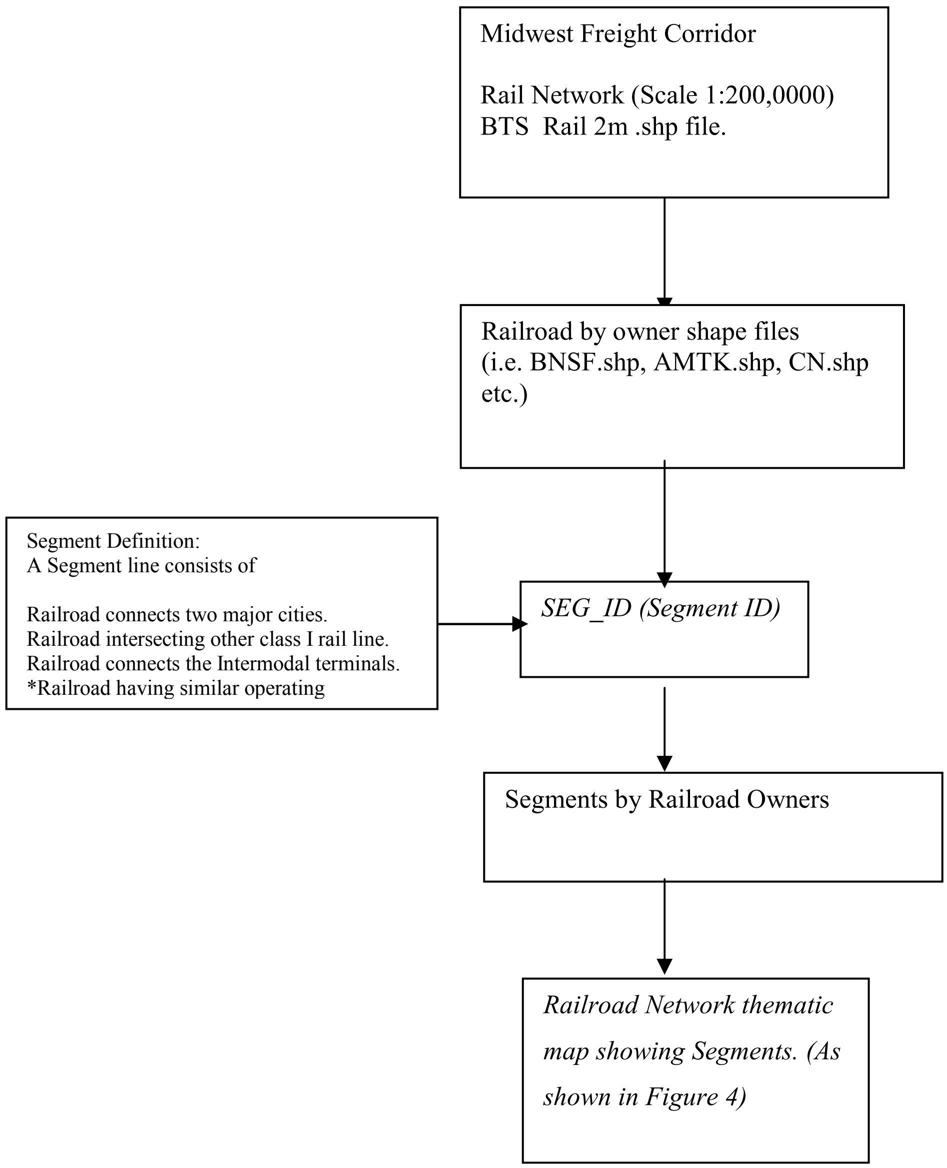

Figure 29 Flow Chart showing the Process of Segmentation.

J.4 Railroad Capacity Algorithm

PMM &Co (Peat et al. 1975) has developed an algorithm for the Federal Railroad Administration (FRA) as:

The Railroad Capacity is given by equation 1

$$C = Ac/K * (100/L). \qquad \text{----------- } 1$$

Where,

C = Capacity of the Railroad Trains per day.

Ac = Average delay per train at capacity (in hours).

K = Delay slope.

L = Length of line in Miles.

The Average delay per train depends on the number of tracks and operating characteristics.

Thus, For Single Track, it is given by equation 2:

$$Ac = [- b + \sqrt{b\text{^}2 - 4 * a * c}\,] / 2a \qquad \text{------------ } 2$$

Where,

a = 973.125* S/ L*L

b = (67.2765*P + 151.7085*D)/ L

c = 1.41432 –M*(150/L) +150/S +I

And for Double Track, it is given by equation 3:

$$Ac = 0.031274*L * \sqrt{1/S(M*150/L - 150/S - I - 1.84636} \qquad \text{------- } 3$$

Where,

M =Maximum allowable Total trip time.

S = Speed of the Slowest Class of through freight trains.

P = Dispatch peaking Factor

= (Trains per peak hour during peak/trains per peak during off peak) -1

D = Directionality factor.

= (Trains in Dominant direction / trains in opposite direction) –1

I = Amount of imposed delay on regular freight trains, including start and stop time.

Default values are assumed for the variables P, D, I in the model as:

P = 0

D = 0

I = 1.233

To estimate the effects on delay slopes with change in parameter values, a fractional approach was adopted. The delay slopes for modified (changed) cases were developed as fractions of the base case delay slope. It is given by equation 4 as:

$$F_{oi} = (K_i / K)^{-Pi} \qquad \text{------------} \quad 4$$

Where,

F_{oi} = Delay slope adjustment factor (obtained from simulations).

K_i = Delay slope for the change in parameter i.

K = Delay slope for the base case.

Pi = Percent change in parameter i.

$Pi = (Vi - Vo)/[0.5*(Vi+Vo)]$

Vo = Value of the Parameter in the base case.

Vi = Changed value of the parameter.

In multiple modification cases two components are multiplied, one is the slope increasing modifications and the other is the slope decreasing modifications.

An estimate of F_{om} from the individual component modifications is given by equation 5:

$$F_{om} = C_I * C_D^{-1} \qquad \text{----------} \quad 5$$

Where,

C_I = component of factors that increase the slope

C_D = component of factors that decrease the slope.

Therefore the multiple modification delay slope is given by equation 6.

$$K_i = K * C_I * C_D \qquad \text{----------} \quad 6$$

Figure 30 shows the flow diagram explaining the railroad capacity algorithm.

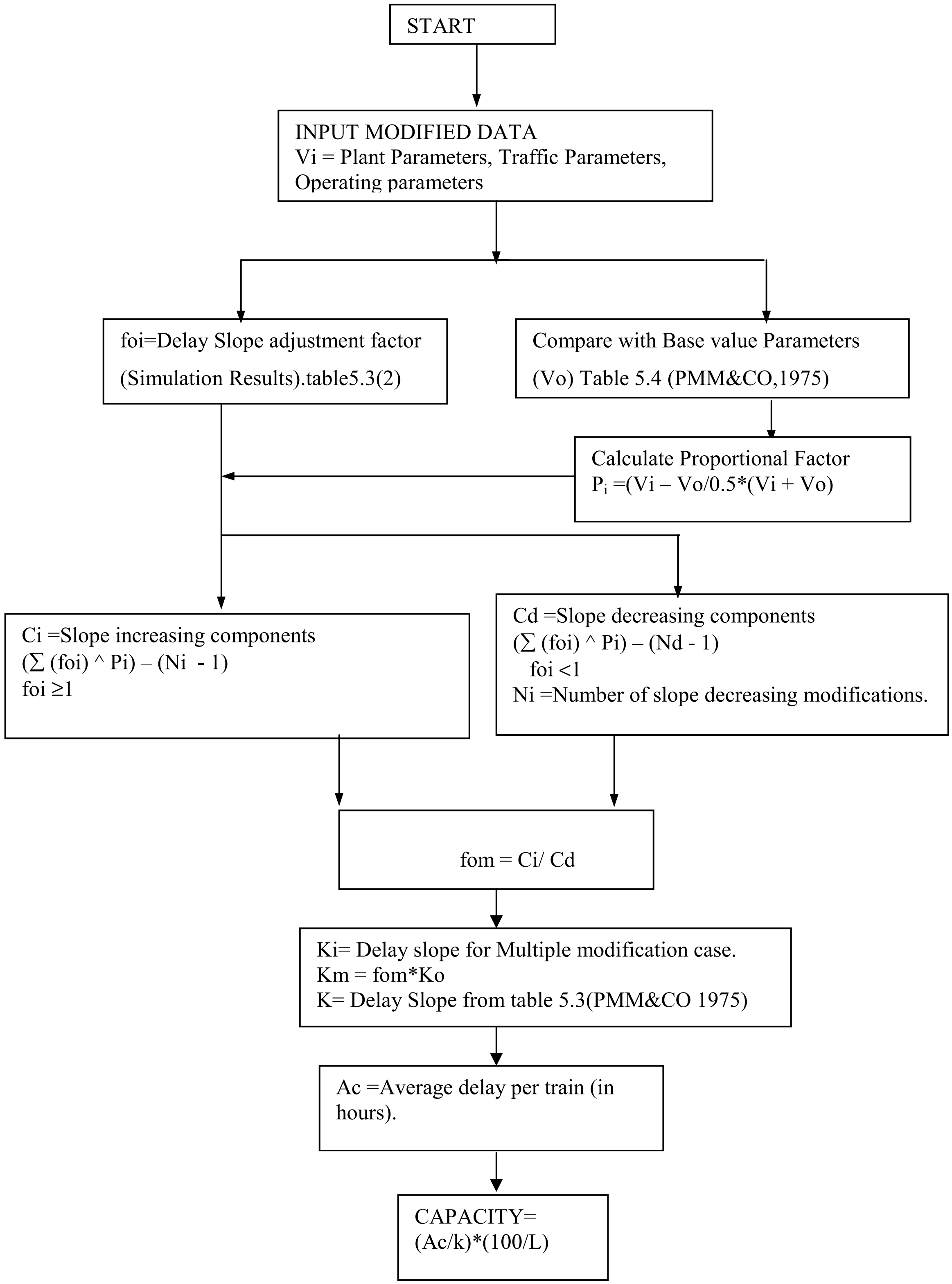
START
INPUT MODIFIED DATA
Vi = Plant Parameters, Traffic Parameters, Operating parameters
foi=Delay Slope adjustment factor
(Simulation Results).table5.3(2)
Compare with Base value Parameters
(Vo) Table 5.4 (PMM&CO,1975)
Calculate Proportional Factor
P_i =(Vi – Vo/0.5*(Vi + Vo)
Ci =Slope increasing components
(∑ (foi) ^ Pi) – (Ni - 1)
foi ≥1
Cd =Slope decreasing components
(∑ (foi) ^ Pi) – (Nd - 1)
foi <1
Ni =Number of slope decreasing modifications.
fom = Ci/ Cd
Ki= Delay slope for Multiple modification case.
Km = fom*Ko
K= Delay Slope from table 5.3(PMM&CO 1975)
Ac =Average delay per train (in hours).
CAPACITY=
(Ac/k)*(100/L)

Figure 30 Flow of Activities in Railroad Capacity Algorithm.

J.5 Data collection and Processing

Figure 31 shows the flow diagram for integrating databases from two sources for the Integrated Class I Railroad Network. Table 96 shows attributes in those databases for capacity analysis.

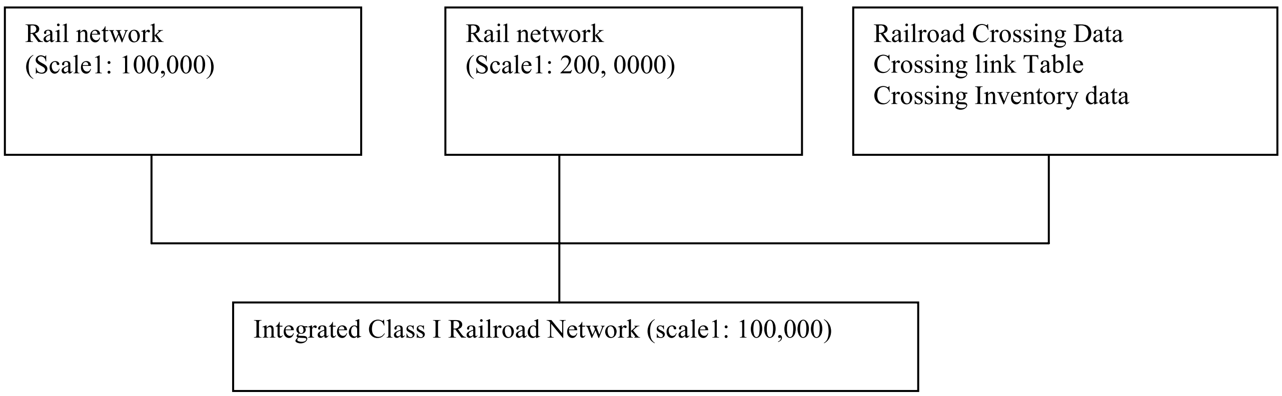

Figure 31 Databases for Developing Integrated Class I Railroad Network.

Table 96 Format and Attributes in BTS, FRA and Integrated Railroad Network Databases.

SOURCE	DATA FILE	FORMAT		ATTRIBUTES				
BTS	Rail2m	DBASE FILE	FRAID	RROWNER	TR	RRCLASS	DENSITY	MAIN_TRACK
BTS	Rail100K	DBASE FILE	FRAID	RROWNER	TR	RRCLASS	ABDYR	PASS
FRA	Crossing Link Table	DBASE FILE	FRAID	CROSSING ID1	CROSSING ID2	CROSSING ID3	CROSSING ID4	PASS
Output	Integrated Class I Railroad Network	SHAPE FILE	FRAID100 K	FRAID 2M				

Source: 2003 Bureau of Transportation statistics Rail data, FRA Crossing Inventory Data.

J.6 Process of linking the databases to Integrated Class I Railroad Network

First the “rail2m”and “rail100K” link databases are joined to the network with help of common identification numbers “FRAID100K”; “FRAID 2M”. Next, the crossing link table is joined with the crossing inventory database and linked back to the integrated network with help of “ID/FRAID”.

The database obtained after joining two databases has some repeated values like railroad owners, trackage rights, abandoned lines, railroad class etc. Duplicate and redundant fields were removed so that it is feasible to use.

The base railroad network has 33,271 links. It is difficult to apply the rail capacity model on this large database. Therefore for the capacity analysis the selected railroad network based on segments performed on “Rail2m” network is joined as “JOINed” to base railroad network database with the help of common identification number. A new database called rail segment network is extracted from the base network using the “DISSOLVE” tool. After calculations are performed rail segment network is linked back to the base network with the help of common identification number “SEG_ID”.

Table 97 shows some of the main variables useful for capacity calculations obtained from crossing inventory data. Figure 32 shows the flow diagram how the databases are arranged to obtain the final rail network that can be used directly for applying the railroad capacity model.

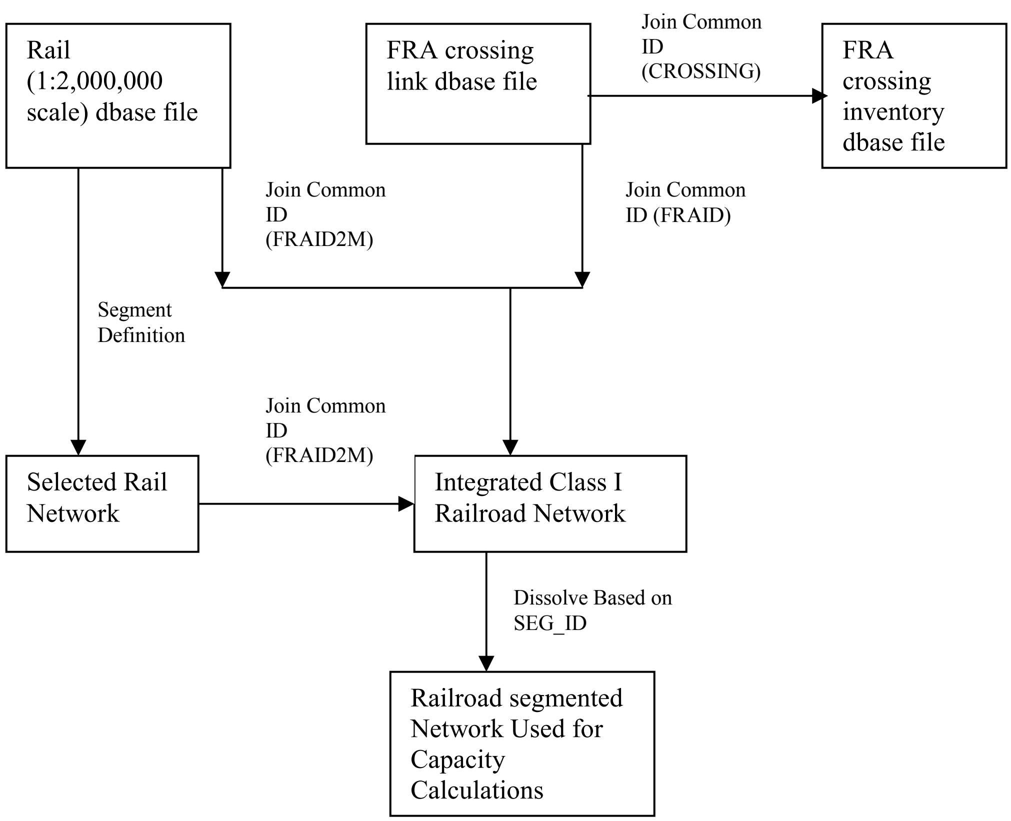

Figure 32 Flow of Activities to generate Final Database for Class I Railroad Network.

Table 97 Main Variables used for Capacity Estimations.

Variables	Description
Signals	The information about number of signals on the link is obtained from NOSIGN (indicates whether there is signal present or not), SIGNLEQP (Indicates whether signal is equipped to the track or not).
Sidings	The information of sidings is obtained from number of OTHTRTRKS. (Even check the description)
Speed	The information of speed is obtained from Maximum timetable speed, Maximum speed)
Train frequencies	The number of trains moving on link is obtained from TOTRNS (Total trains).

J.7 Runway Capacity Methodologies:

There are several techniques to calculate runway capacity. This report uses two methods to determine the runway capacity.

Method 1. The procedure followed is obtained from Department of Transportation, Federal Aviation Administration, and Systems Research and Development Services (FAA 1976). This is a graphical approach to determine runway capacity. The main parameters required are the aircraft mix, percent arrivals, percent touch and go and exit taxiways. The aircraft mix is expressed in terms of mix index. Table 98 shows the aircraft Classification given by Federal Aviation Administration.

Table 98 Aircraft Classification by Type.

Aircraft classification	Type of Aircraft
Class A	Small single engine aircraft weighing 12,500 lb or less.
Class B	Small twin-engine aircraft weighing 12,500 lb or less and Lear jets.
Class C	Large aircrafts weighing more than 12,500 lb up to 300,000 lb.
Class D	Heavy Aircraft weighing more than 300,000 lb.

Source: Aircraft Classification given by Federal Aviation Administration; Note: weights refer to maximum certificated takeoff weight.

For calculation purpose the parameters are given as:

Mix Index = Percent of Aircraft in Class C + 3* Percent of Aircraft in Class D.

- Percent arrivals = ((A+1/2(T+G)) /(A+D+(T+G)))*100
- Percent Touch and go = ((T+G)/(A+(T+G)))*100

Where,

A = Number of arrival operations in an hour.

D= Number of departure operations in an hour.

T+G = Number of touch and go operations in an hour.

The estimated parameters are used in the monographic stepwise process as:

Step 1. Determine the mix index, percent arrivals, percent touch and go and location of exit taxiways.

Step 2. From the graph (shown in Figure 33) match the percent arrivals and mix index and determine the hourly base capacity 'C'.

Step 3. Then multiply hourly base capacity with the touch and go factor and exit factor to obtain the ultimate single runway capacity.

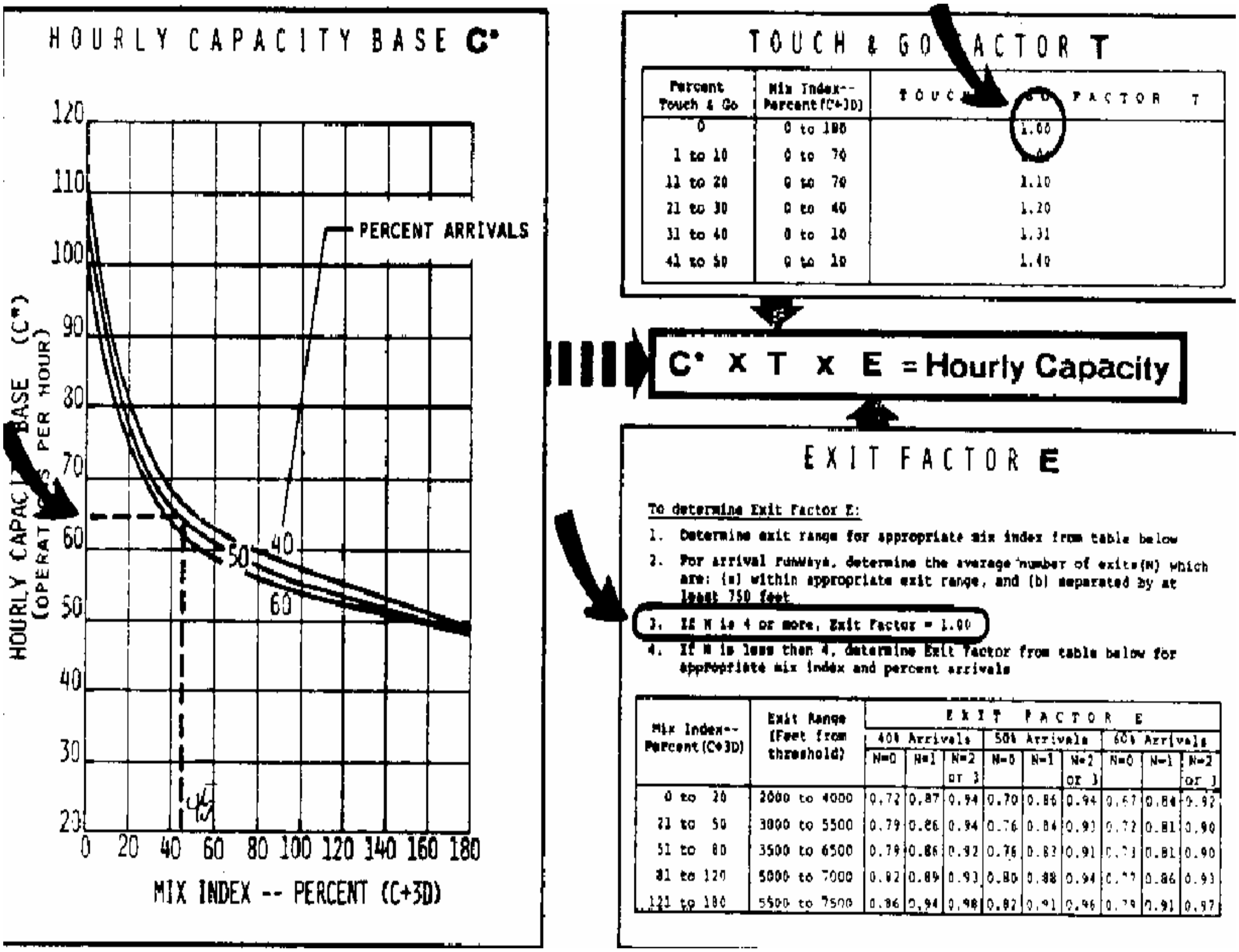

Figure 33 Graphical Runway Capacity.

Source: Federal Aviation Administration.

The following assumptions are made for the use of monographic method:

1. There are four exit taxiway locations, therefore Exit Factor = 1.00
2. There are zero percent touch and go flights, therefore touch go factor = 1.00

Method 2: Runway capacity estimations procedure is obtained from IATSS Research, Journal of International Association of Traffic and Safety Sciences. (Noritake and Kimura 1993)

The runway capacity is given by equation 7 as:

$$C= 7200/ (ta+td) \qquad \text{-----------} \quad 7$$

Where,

C = runway capacity in terms of number of aircrafts/hour.

t_a = runway occupancy time of arriving aircraft (65 seconds assumed).

t_d =runway occupancy time of departing aircraft (60 seconds assumed).

The IATSS suggests assuming 60 seconds for heavy aircraft and 50 seconds for other aircrafts.

By substituting values of t_a = 65 seconds and t_d = 60 seconds the ultimate runway capacity is approximately 58 aircrafts per hour.

To find the maximum number of passenger/ aircrafts served by each corridor find the ultimate capacity at each airport and multiply with the maximum person /freight occupancy per aircraft. This shows the number of passenger aircrafts per hour served by each corridor, the number of freight aircrafts per hour served by each corridor and the freight tonnage carried by each corridor.

Table 99 Number of Passenger Aircrafts per Hour.

O\D	DSM	MDW	ORD	IND	DTW	GRR	MSP	CLE	AZO	FNT	FWA	MKE	TOL	ATW	MLI	CID	RFD	PIA	SBN
DSM	0	9	19	0	5	0	13	0	0	0	0	8	0	0	0	7	1	4	0
MDW		0	0	22	68	9	14	19	0	33	4	17	16	0	25	12	1	0	24
ORD			0	17	**98**	28	20	22	51	0	17	27	8	22	32	28	0	23	24
IND				0	23	3	6	7	0	1	0	4	0	4	0	3	0	4	4
DTW					0	19	12	12	59	36	15	12	14	18	17	6	0	0	25
GRR						0	15	12	0	12	7	11	0	0	0	0	0	0	0
MSP							0	2	14	1	12	15	2	21	22	17	0	6	8
CLE								0	23	16	15	9	9	0	0	0	0	0	13
AZO									0	0	0	0	0	0	0	0	0	0	0
FNT										0	0	12	0	0	0	0	0	0	0
FWA											0	0	0	0	0	0	0	0	6
MKE												0	0	22	0	0	0	0	0
TOL													0	0	0	0	0	0	0
ATW														0	0	0	0	0	8
MLI															0	0	0	0	0
CID																0	0	0	0
RFD																	0	0	0
PIA																		0	0
SBN																			0

Source: Bureau of Transportation Statistics, Air carrier Statistics.

Table 100 Number of Freight Aircrafts per Hour.

O\D	DSM	MDW	ORD	IND	DTW	GRR	MSP	CLE	AZO	FNT	FWA	MKE	TOL	ATW	MLI	CID	RFD	PIA	SBN
DSM	0	1	2	0	0	0	1	0	0	0	0	1	0	0	0	1	8	1	0
MDW		0	0	3	0	0	0	0	0	3	0	0	3	0	1	1	0	0	2
ORD			0	4	0	3	0	1	0	0	7	1	2	2	1	4	0	8	2
IND				0	0	0	1	1	0	0	0	1	0	0	0	1	0	1	1
DTW					0	2	0	0	0	3	6	0	3	1	1	1	0	0	2
GRR						0	2	1	0	1	1	1	0	0	0	0	0	0	0
MSP							0	0	0	0	0	1	1	2	1	2	0	2	1
CLE								0	0	1	3	0	2	0	0	0	0	0	1
AZO									0	0	0	0	0	0	0	0	0	0	0
FNT										0	0	1	0	0	0	0	0	0	0
FWA											0	0	0	0	0	0	0	0	1
MKE												0	0	2	0	0	0	0	0
TOL													0	0	0	0	0	0	0
ATW														0	0	0	0	0	1
MLI															0	0	0	0	0
CID																0	0	0	0
RFD																	0	0	0
PIA																		0	0

Source: Bureau of Transportation statistics, Air carrier Statistics.

Table 101 Freight Volume (Tons/month).

O\D	DSM	MDW	ORD	IND	DTW	GRR	MSP	CLE	AZO	FNT	FWA	MKE	TOL	ATW	MLI	CID	RFD	PIA	SBN
DSM	0	0	5	0	0	0	9	0	0	0	0	0	0	0	0	244	283	93	0
MDW	5	0	0	48	126	1	16	50	0	0	0	0	0	0	3	0	61	0	0
ORD	18	0	0	**2441**	41	13	329	22	0	0	0	14	6	1	0	1	0	0	1
IND	16	46	2289	48	1279	311	1152	687	0	220	2	0	0	0	0	278	0	2148	34
DTW	0	70	11	733	0	1	167	15	3	1	318	51	0	0	0	0	324	0	0
GRR	0	0	11	313	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
MSP	4	0	596	1084	163	0	0	20	0	0	49	35	283	0	0	5	579	4	0
CLE	0	24	4	682	3	1	4	0	0	0	0	0	0	0	0	0	364	0	0
AZO	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FNT	0	0	0	0	1	0	0	0	0	0	193	1	0	0	0	0	0	0	0
FWA	0	0	0	0	351	0	65	0	0	0	18	0	0	0	0	0	16	0	469
MKE	2	0	18	0	4	4	246	4	0	2	0	0	0	56	0	0	0	18	0
TOL	0	0	0	0	0	0	339	0	0	0	0	0	0	0	0	0	505	0	0
ATW	0	0	0	283	0	0	0	0	0	0	0	28	0	0	0	0	0	0	68
MLI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CID	390	0	1	254	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
RFD	334	0	3	0	338	0	480	313	0	0	0	0	497	0	0	0	0	0	0

Source: Bureau of Transportation Statistics, Air carrier Statistics.

Table 102 Imports and Exports in tons at the Major Ports in Midwest Region

Port Name	Total	Domestic	Foreign	Imports	Exports
Huntington - Tristate	76669841	76669841	0	0	0
Duluth-Superior, MN and	39810866	26535026	13275840	746400	12529440
St. Louis, MO and IL	34432125	34432125	0	0	0
Chicago, IL	21975717	19352906	2622811	2055281	567530
Detroit, MI	16991159	12264488	4726671	4465273	261398
Cincinnati, OH	14098926	14098926	0	0	0
Indiana Harbor, IN	13579192	12836555	742637	742637	0
Cleveland, OH	11937815	9203587	2734228	2430028	304200
Two Harbors, MN	11874606	11874606	0	0	0
Shtabula, OH	10933552	5119678	5813874	797494	5016380
Toledo, OH	10534903	4531092	6003811	1377682	4626129
Conneaut, OH	10485286	3839842	6645444	179806	6465638
Presque Isle, MI	9474585	7633589	1840996	61880	1779116
Gary, IN	8907034	8517114	389920	128082	261838
Burns Waterway Harbor, I	8734585	6868802	1865783	1571657	294126
Calcite, MI	8317360	7266905	1050455	68558	981897
Stoneport, MI	8117640	7925853	191787	75880	115907
Lorain, OH	7864952	7564712	300240	300240	0
Escanaba, MI	6979732	6945860	33872	33872	0
Port Inland, MI	6260355	5154130	1106225	30882	1075343
St. Clair, MI	4818428	4818428	0	0	0
St. Paul, MN	4668033	4668033	0	0	0
Sandusky, OH	4649238	1473244	3175994	66466	3109528
Silver Bay, MN	4303847	4303847	0	0	0
Marine City, MI	3895797	3878025	17772	17772	0
Milwaukee, WI	3372651	1727803	1644848	1182124	462724
Port Dolomite, MI	3295076	2890731	404345	29005	375340
Alpena, MI	3268076	3121247	146829	42158	104671
Marblehead, OH	3035568	2660511	375057	0	375057
Mount Vernon, IN	3014017	3014017	0	0	0
Fairport Harbor, OH	2941603	2249354	692249	56974	635275
Muskegon, MI	2324433	1919315	405118	405118	0
Taconite, MN	2243162	2243162	0	0	0
Green Bay, WI	2241612	1743422	498190	480088	18102
Grand Haven, MI	1793510	1278638	514872	442282	72590
Minneapolis, MN	1535960	1535960	0	0	0
Charlevoix, MI	1532620	1428120	104500	0	104500
Marysville, MI	1503460	927499	575961	554302	21659
Huron, OH	1260207	1119318	140889	104887	36002
Manistee, MI	1226710	481195	745515	48657	696858
Drummond Island, MI	1197852	1183352	14500	0	14500
Buffington, IN	1143613	1143613	0	0	0
Kelleys Island, OH	1050295	1050295	0	0	0

Table 103 Physical and Operational Characteristics of Lock Gate

LOCK ID	Mnth	Length	Width	Depth	ADlDe	pvesdel	avgproc	totbrg	ttns	Twday	numbrgs	brgyr
3017938601	12	1200	110	9	1.58	60.64	0.67	76947	79857	9.70	145.5397	42497.6
3017938604	12	600	110	9	3.1	11.96	0.48	4091	3519	7.22	108.2333	31604.13
3020090601	12	1200	110	9	1.3	54.43	0.73	67425	69625	11.33	169.9607	49628.52
3020090604	12	600	110	9	2.6	12.13	0.41	8178	7957	8.09	121.4149	35453.16
3024140601	12	600	110	9	3.7	45.91	1.13	40262	39534	4.44	66.60838	19449.65
3027340601	12	600	110	9	2.81	50.3	1.21	40232	39296	5.29	79.42085	23190.89
3130120601	11	600	108	9	3.93	61.89	1.43	39027	38076	3.89	58.39164	17050.36
3132410001	12	600	108	9	2.04	52.88	1.19	38818	37864	6.66	99.94928	29185.19
3134310001	12	600	108	9	2.29	50.77	1.13	37482	36513	6.36	95.44548	27870.08
3136410001	12	1200	108	9	1.07	39.54	0.78	36585	35804	12.78	191.7529	55991.84
3141050601	10	600	108	9	2.35	47.51	1.23	36121	35706	6.19	92.8018	27098.13
3143710001	10	600	108	9	2.66	56.78	1.5	35014	34170	5.16	77.40919	22603.48
3145710001	10	600	108	9	2.29	45.8	1.16	34112	33140	6.43	96.40728	28150.93
3148210001	11	600	108	9	3.02	60.61	1.47	31578	30581	4.76	71.414	20852.89
3148210004	10	360	108	9	0.24	4.1	0.35	872	628	51.62	774.3179	226100.8
3149310601	11	600	108	9	4.05	50.38	1.2	33433	30839	4.13	61.90271	18075.59
3149310604	8	320	78	9	0	5.53	0.31	0	0	65.04	975.6098	284878
3152210001	10	600	108	9	1.65	27.12	1.01	24876	24806	9.43	141.4941	41316.26
3155610001	12	600	108	9	1.37	21.21	0.83	24389	24428	11.46	171.8497	50180.12
3158310001	12	600	108	9	1.2	21.45	0.83	22555	22496	12.23	183.4329	53562.41
3261510601	12	600	105	9	1.2	15.96	0.77	21966	22004	14.01	210.2063	61380.25
3264790601	12	600	105	9	1.06	17.67	0.79	18108	18820	14.40	215.9827	63066.94
3267920601	12	600	105	9	1.24	13.61	0.8	16724	16826	13.49	202.3016	59072.08
3270250601	12	600	105	9	0.99	15.08	0.68	16186	15855	16.26	243.9737	71240.33
3271430601	12	600	105	9	0.98	11.66	0.74	16173	15794	15.87	238.0116	69499.39
3272850601	12	600	105	9	0.75	9.87	0.56	12389	12761	20.93	313.9127	91662.5
3273810601	12	600	105	9	0.85	8.54	0.66	12370	12769	19.52	292.7263	85476.08
3275280601	12	600	105	9	0.92	8.35	0.61	12267	12339	19.20	288.0735	84117.45
3279690601	12	600	105	9	0.74	7.14	0.54	11452	11550	22.48	337.1304	98442.09
3281520601	12	500	110	9	0.86	7.56	0.58	11482	11541	19.78	296.6788	86630.21
3284060601	12	400	54	9	0.43	1.9	0.27	2292	2075	67.55	1013.222	295861
3285310101	12	400	54	9	0.29	4.98	0.27	2289	2068	66.99	1004.923	293437.6
3285378601	12	400	54	9	0.21	8.56	0.31	2285	2070	57.38	860.6934	251322.5
7708020601	12	600	108	9	4.13	43.35	1.2	32184	35600	4.45	66.74669	19490.03
7715770601	12	600	108	9	2.27	26.53	1.3	28078	31131	7.20	108.0704	31556.56
7723100601	12	600	108	9	2.41	31.01	1.27	19744	21382	6.81	102.1475	29827.06
7724460601	12	600	108	9	2.8	37.48	1.46	17729	19156	5.58	83.6544	24427.08
7727150601	12	600	108	9	1.85	33.34	1.17	17843	17746	8.14	122.1563	35669.64
7728600601	12	600	108	9	2.19	42.71	1.31	16702	16073	6.74	101.1041	29522.4
7729110601	12	600	108	9	2.43	42.67	1.39	16604	16040	6.23	93.4819	27296.72
7764300501	12	1000	108	9	0.28	5.06	0.42	8354	7373	42.09	631.3628	184357.9

Source: Navigational data center (US Army corps of Engineers)

Table 103 has the following table attributes; the description of each attribute is given below.

Lock – Unique identifier for each lock. If last digit is 4 in this code it is auxiliary lock.

Mnth = total months of operation

Length = length of lock gate in feet

Width = width of lock gate in feet

Depth = depth of lock gate in feet

ADlDe - Average Delay for Delayed Tows (hours) pvesdel - percentage of all vessels delayed

avgproc - average processing time

totbrg = Total barges that were processed at the lock gate

ttns = Total tons processed at the lock gate

Twday = Tows per day (estimated using theoretical model)

numbrgs = Number of barges per day (estimated using theoretical model)

Brgyr = Total barges estimated for one year (using theoretical model)

J.8 Estimation of Lock gate capacity

C = 20/((Pdt * (Avd+ Avp)) + (Ndt * Avp)) ------ 1

Where,

C = capacity of lock in terms of number of tows

Pdt = percent delayed tows

Avt = Average delay for the delayed tows

Ndt = percentage of non-delayed tows. ie., (1- Pdt)

Avp = Average processing time at the lock gates

The above equation provides number of tows per day through a certain lock in consideration. By obtaining data on number of barges per each tow it can be converted in number of barges. By using physical dimension of lock and principles of buoyancy factor it is theoretically possible to convert barges to tonnage of freight.