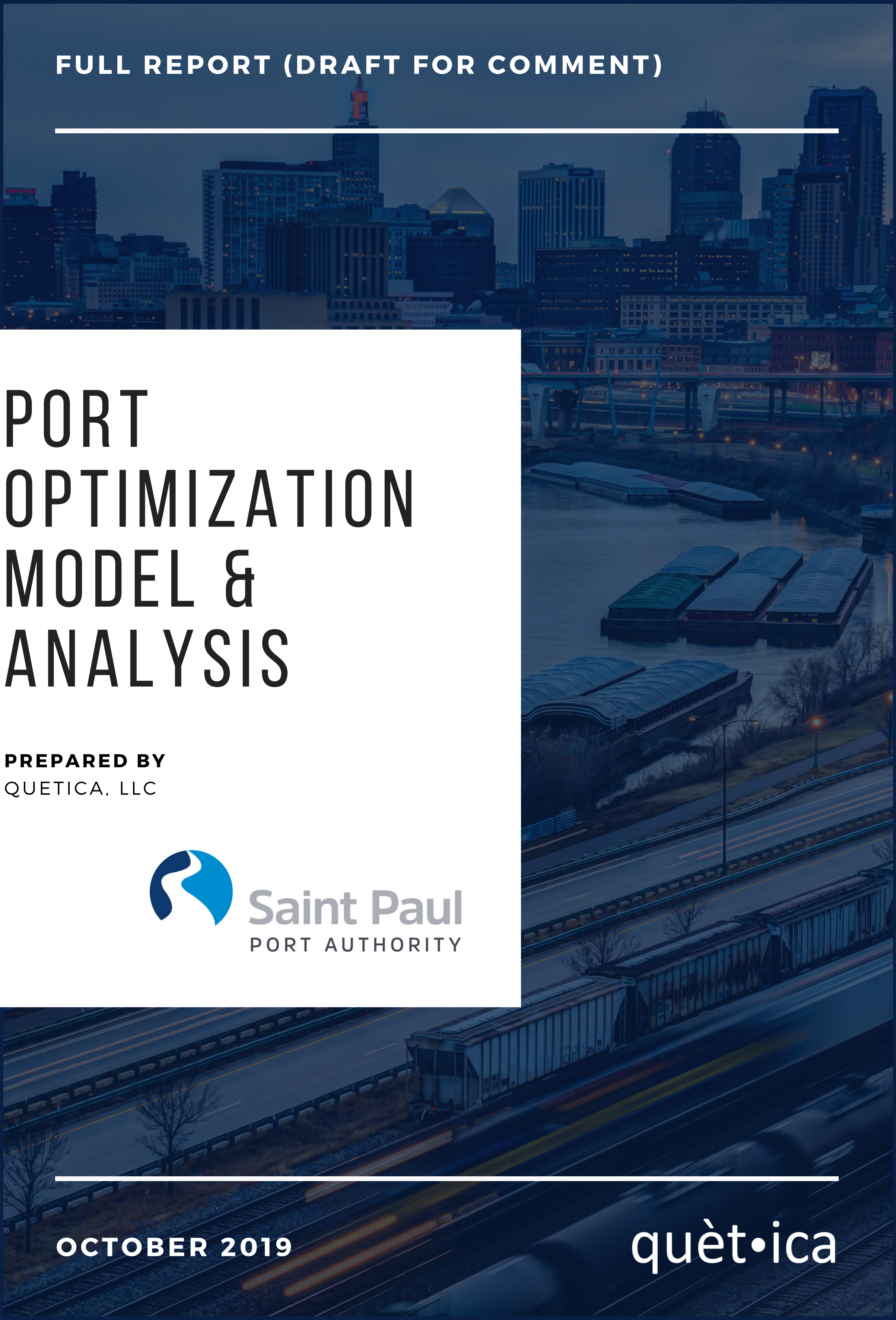
FULL REPORT (DRAFT FOR COMMENT)



PORT OPTIMIZATION MODEL & ANALYSIS

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PORT AUTHORITY

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Abstract

Leveraging private sector best practices in supply chain network design and optimization, the Saint Paul Port Authority (SPPA) undertook an initiative to develop a proprietary Port Optimization Model, in order to identify and analyze freight shipping efficiency opportunities and challenges in the Port's multimodal freight network. Linking Minnesota and Midwest producers to domestic and international markets, the Port of Saint Paul plays a critical role in the growth of the regional and local economy by facilitating the efficient movement of commodities by truck, rail and barge. Utilizing a quantitative, data-driven approach, the optimization analysis identified over $1 billion in annual potential savings to Minnesota businesses, across over 37 million tons of commodities, from freight shipping efficiency gains, transportation modal conversion opportunities and additional market potential.

The following document provides a summary of the findings from the study, including an overview of the Port of Saint Paul's multimodal supply chain network, current and forecasted demand for commodities flowing through the Port, as well as capacity and constraints in its supply chain. The analysis enables the Saint Paul Port Authority to identify the highest impact investments in its multimodal freight network, in order to take advantage of identified opportunities, increase freight mobility and significantly reduce costs for freight shippers in Minnesota and the Midwest by:

- Facilitating movement of additional commodities above and beyond what is flowing through the Port and other regional multimodal or intermodal facilities today, thus advancing economic growth;
- Reducing transportation costs, delays and constraints, while fulfilling supply chain needs throughout the region for additional low-cost, efficient and reliable methods for shipping freight; and
- Providing expanded multimodal, transload and intermodal services that offer competitive logistic solutions and an efficient, operational means of shipping the core commodities that businesses move into, out of, and through the region from both rural and urban communities.

The results of the study provide the Saint Paul Port Authority with the foundation to develop business case(s) and implementation strategies to address critical network constraints, as well as prioritize both public and private investments in the local and regional supply chain more effectively and efficiently.

The Saint Paul Port Authority is an economic development agency managing four multimodal freight terminals on the Mississippi River in Saint Paul, Minnesota. Inland, the organization is committed to commercial redevelopment projects that create quality job opportunities, expands the tax base, and advances sustainable design.

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Saint Paul PORT AUTHORITY

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1. Executive Summary

1.1 Project Overview

The **Port of Saint Paul plays a critical role in the regional and local economy by facilitating the efficient freight movements of commodities by truck, rail and barge**, linking Minnesota and other Midwest producers to domestic and international markets. Over 500 million tons of commodities flow to, from and within Minnesota each year by these transportation modes. Recognizing the **need to identify and prioritize the highest impact investments in its multimodal freight network** to support movement of these commodities and continued growth within the region, the Saint Paul Port Authority (SPPA) undertook an effort to identify and implement supply chain network planning and optimization strategies to:

- **Address transportation constraints** within the Port of Saint Paul;
- **Create competitive logistic solutions** for Minnesota businesses;
- **Improve operational efficiency** for regional shippers; and
- **Provide economic opportunities** for Port of Saint Paul tenants and their customers.

Leveraging private sector best practices in supply chain network design and optimization, the initiative included **development of a Port Optimization Model[1] to analyze opportunities and challenges** within the regional, national and global supply chain. The outputs of the model **identify over $1 billion in annual potential savings to Minnesota businesses**, across over 37 million tons of commodities, by leveraging more efficient modal options, transload and intermodal services (see Figure 1).

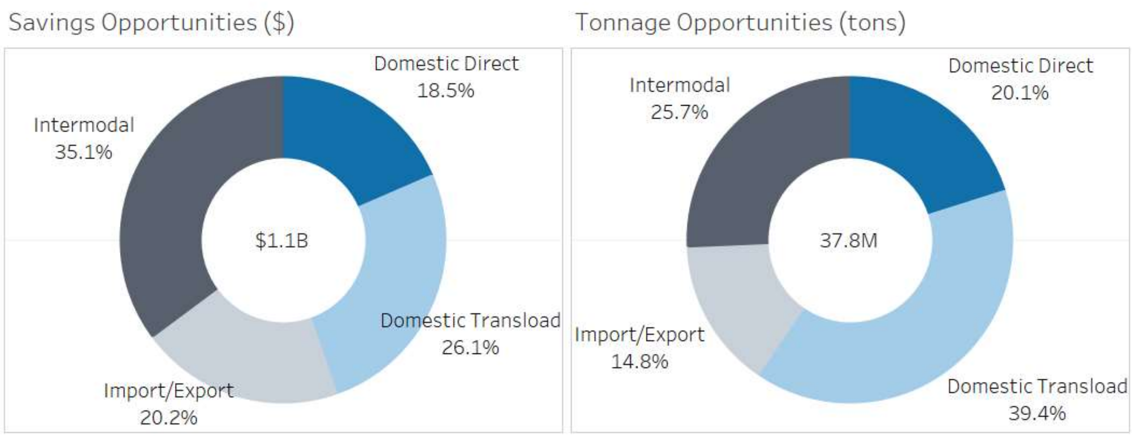

Figure 1 – Total Freight Optimization Market Opportunities for Port of Saint Paul Mississippi River Terminals

The analysis provides the foundation for SPPA to develop business case(s) and implementation strategies to address critical network constraints, as well as prioritize both public and private investments in the local and regional supply chain more effectively and efficiently.

SPPA owns and manages three Mississippi River freight terminals, providing barge, rail and truck transportation hub services in Saint Paul, Minnesota, at Southport Terminal, Red Rock Terminal and Barge Terminal 1.[2] A fourth terminal, Barge Terminal 2, houses the Harbor Operator providing services to

[1] Proprietary, demand-based model developed to identify and analyze freight shipping efficiency opportunities in Port of Saint Paul's multimodal freight network, leveraging private sector best practices in supply chain network design and optimization.
[2] Inland, SPPA is committed to commercial redevelopment projects that create quality job opportunities, expands the tax base, and advances sustainable design.

terminal users, including break-bulk, dry docking, barge maintenance and cleaning. Strategically located at the northernmost public harbor on the Upper Mississippi River System (UMRS), the Port of Saint Paul is a critical link in the Minnesota multimodal freight network and the national freight transportation network, including Marine Highway M-35 and its connection to international export markets via the U.S. Gulf Coast.

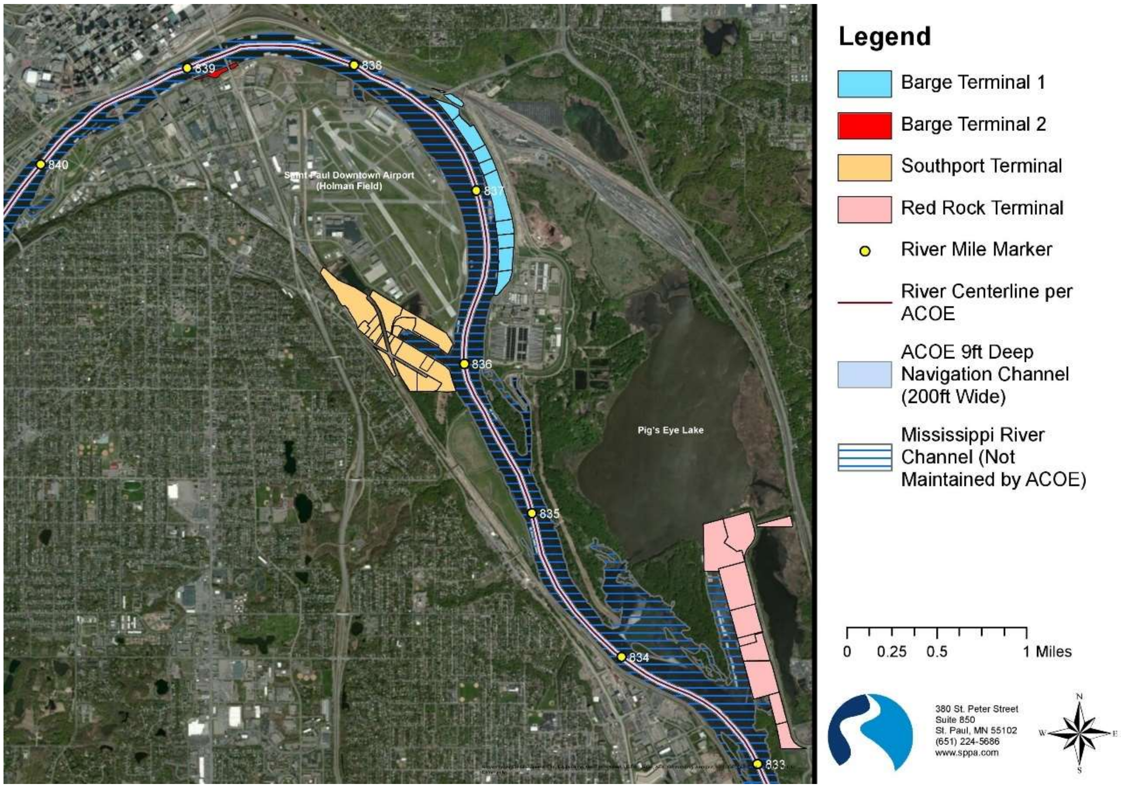

Figure 2 – Aerial View of Port of Saint Paul Multimodal Terminals and Mississippi River Navigation Channel

As a major multimodal transportation hub for regional Midwest businesses, these terminals handle 8 to 10 million tons of commodities each year on average and continue to grow.[3] The users of these multimodal terminals ship a mix of bulk products. Top outbound commodities include corn, soybeans, dried distillers' grain (DDGs), scrap metal and potash. Top inbound commodities include fertilizer, water treatment chemicals, steel, aggregates, cements and salt.

These commodities are loaded and unloaded to and from barge, rail and truck from over 30 businesses that operate within each terminal, as well as provide transportation services to a broad range of shippers within the region. **Linking Minnesota producers to domestic and international markets, the Saint Paul terminals play a vital role in the regional and local economy, facilitating the efficient movement of goods and services through the area.**

An optimized supply chain network can greatly improve a company's competitiveness and profitability. A supply chain consists of suppliers, plants, warehouses, and flows of products from origin to customers. **Up to 80 percent of the costs of a company's supply chain could be impacted by the location of the company's facilities and its access to the multimodal networks that determine the routing of product flows between these facilities.** Supply chain network design and optimization is the discipline employed to strategically determine the optimal location and size of facilities, and the flow through the network. It

[3] Volumes vary year-to-year. Statistic based on annual tonnage flowing into and out of SPPA terminals between 2016 to 2018.

helps companies deliver products to its customers at minimized costs, while improving service levels and operational agility.

Using a quantitative and data-driven approach to evaluate SPPA's multimodal freight network (including truck, rail, barge and connections to the ocean freight network), this demand-based methodology starts with current and forecasted demand for companies' products, both domestically and internationally. It then identifies cost, capacity and service level opportunities in the supply chain network of regional businesses. Constraints or bottlenecks in the network are analyzed and optimization strategies identified to address those constraints.

Proven in the private sector to optimize complex global supply chain networks for large corporations, this optimization approach is also a cutting-edge methodology used to optimize publicly-owned elements of freight transportation networks. An optimized, multimodal transportation network can greatly improve the competitiveness of businesses in the greater Minneapolis-St. Paul Metropolitan area and across Minnesota by providing an effective and efficient freight transportation infrastructure. **The business case and corresponding implementation strategies identified in the analysis allow SPPA to address critical network constraints, as well as prioritize investments more effectively and efficiently.**

The primary focus of the study is domestic, high-volume freight flows of commodities between the Twin Cities[4], 7-County Metropolitan area, in which the Saint Paul terminals reside and other origins and destinations across the United States (see Figure 3). In addition, domestic and import and export freight flows to/from other Minnesota counties are evaluated to identify incremental opportunities to utilize the Port of Saint Paul as a multimodal transportation hub to transload commodities between modes.

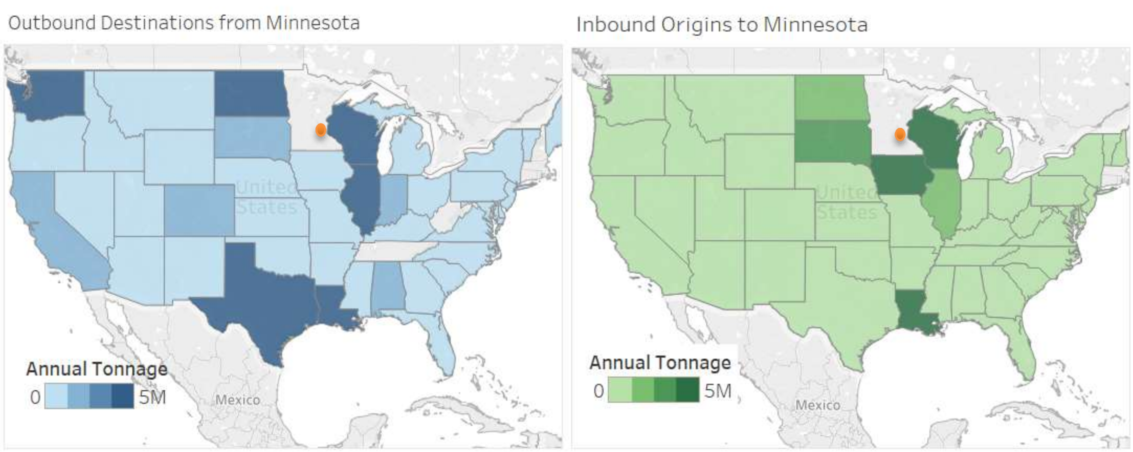

Figure 3 - Domestic Freight Flows to/from Minnesota Based on Annual Tonnage

Thirteen commodity categories were included in the freight flow analysis reflecting the core commodities that currently flow through the Port of Saint Paul via terminal users and its tenants (see Figure 4). These commodities are primarily bulk, low margin commodities that are highly-sensitive to the cost of transportation, where time delivery windows are not a key issue. The commodities within the scope of

[4] "Twin Cities" refers to the Greater Minneapolis-St. Paul Metropolitan area in Minnesota.

the study are all barge-capable,[5] although they may not currently be transported via barge to/from Saint Paul today.

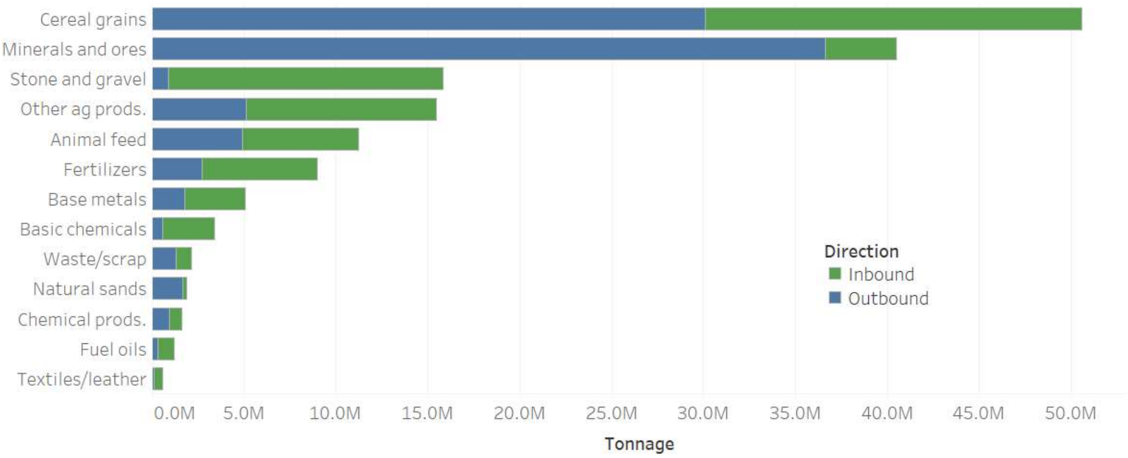

Figure 4 – Total Minnesota Freight Flows by Product for In-Scope Commodities (Annual Tonnage)

The optimization analysis examines existing freight shipments via truck, rail and barge. It assesses opportunities to increase freight efficiencies for Minnesota shippers by evaluating more cost-effective modes and/or routes between origins and destinations. Given the strategic location of the Saint Paul terminals on the Upper Mississippi River, analysis of barge opportunities focuses on long-distance shipments between Minnesota and other states with access to the Mississippi River navigation system and Gulf Coast via barge. Similarly, import/export analysis focuses on shipments outside of North America leveraging Gulf coast and other ocean ports to connect to international markets.[6]

Using a demand-based approach, the optimization analysis looks at the current (or baseline) demand for the in-scope commodities, where the products are moving to/from, as well as the most cost-effective means to get there. **The goal is to identify freight shipping efficiency gains, modal conversion opportunities and additional market potential**. The core scenarios include an analysis of:

- Opportunities for modal conversion between the Twin Cities and domestic origins/destinations to utilize more **cost-effective barge and rail modal options via a direct route**.
- Opportunities for modal conversion between Minnesota and domestic origins/destinations to more cost-effective barge and rail modal options **utilizing the Twin Cities as a transload hub**.
- Opportunities for modal conversion between Minnesota, U.S. ocean ports and international origins/destinations to leverage more cost-effective barge and rail modal options **utilizing the Twin Cities as a transload hub for import/export shipments.**

A fourth scenario looks at the potential to increase efficiencies with **greater intermodal utilization** within the region by converting existing long-haul truck shipments to/from the Twin Cities and surrounding area to intermodal.

1.2 Key Findings

Over 345 million tons of bulk commodities within the scope of the analysis, valued at $108 billion, flow to, from and within Minnesota annually via truck, rail and/or barge (see Figure 5). These in-scope

[5] "Barge-capable" commodities are identified as currently being transported via barge between domestic U.S. locations.

[6] Based on the project objectives, water shipments via the Great Lakes, as well as import/export shipments to Canada and Mexico are outside of the scope of the analysis.

commodities represent the types of bulk commodities that currently flow through the Port of Saint Paul today. Fifteen percent of these commodities flow to or from the Twin Cities metro area to domestic and international trading partners, representing 52 million tons of target commodities valued at over $32 billion.

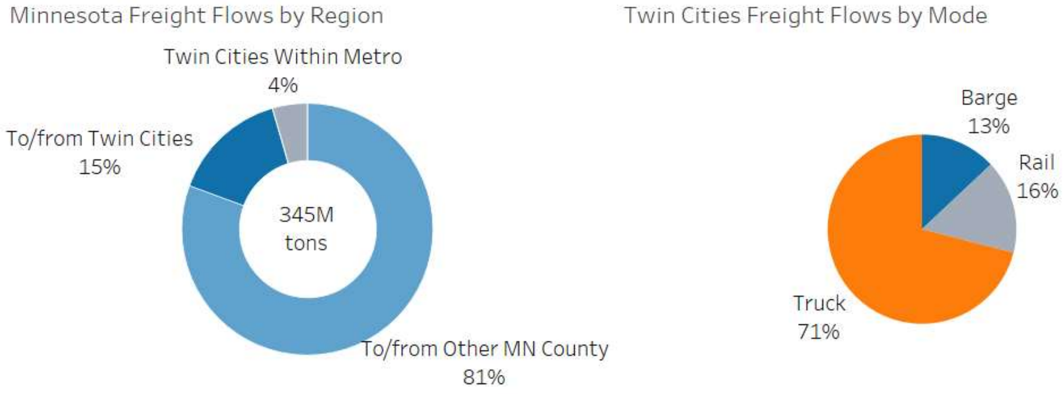

Figure 5 – Annual Freight Flows by Region and Mode for In-Scope Commodities

Another 15 million tons flow within the Twin Cities metro area. However, given the low likelihood of modal conversion over short distances, where the flexible, door-to-door nature of truck transportation is better suited, these local shipments are not a primary focus of the analysis.

Over 13 percent of Twin Cities combined outbound and inbound tonnage is transported via barge, with another 16 percent via rail, with the remaining 71 percent being shipped via truck.

Four percent of the in-scope commodity freight flows and 9 percent of all Minnesota shipments are to international markets. The analysis focuses on the top 3 import and top 3 export commodities to/from Minnesota within the 13-commodity study scope. These 6 commodities represent nearly 14 million tons of annual freight movements to international markets outside of North America, with transportation costs in excess of $2.3 billion. As a net producer, Minnesota exports are dominated by agricultural products and represent over 70 percent of the international shipments within the study scope. Top imports into Minnesota include fertilizers, minerals and ores, with textiles/leather a distant third.

Grain Loading onto Barge (Photo Credit: Dany Mages/Shutterstock.com)

Over 52.6 million tons of commodities that have the potential to be containerized are also shipped to/from Minnesota via truck with 50 percent of the volume to destinations around the U.S. over 500 miles from their origin. This long-haul truck volume represents potential to drive additional freight efficiencies with increased intermodal capacity or support services.

When making transportation modal decisions, organizations balance two key factors, cost and performance. An optimal network minimizes transportation costs, while delivering acceptable levels of performance, driven by speed, flexibility and reliability. As shippers strive to increase their competitiveness in the global marketplace, the most efficient choice may involve the utilization of multiple modes between origin and destination. For the bulk commodities within the study scope, where cost factors outweigh performance, opportunities exist to increase freight shipping efficiencies by increasing utilization of lower cost modal options, including barge, rail and intermodal rail.

In general, the business case for mode efficiency and conversion opportunities from truck to alternative modes increases with corresponding increases in the total shipment distance. However, costs and efficiencies depend on the specific lanes/routes, commodities and/or combinations of modes utilized.

The Port Optimization Model was utilized to identify the opportunities for freight shipping efficiencies in greater depth, based on these more complex factors. **Over 28 million tons and $700 million in potential shipping efficiencies for transportation of in-scope commodities for Minnesota shippers exist across these optimization scenarios. Eighty-seven percent or 24.6 million tons of the shipments deliver potential savings over $5.00 per ton, representing a greater likelihood for modal conversion.** An incremental 9.7 million tons in commodities represent $379.6 million in potential savings from increased intermodal rail utilization through the Twin Cities, with 85 percent (or 8.3 million tons) delivering savings of or greater $5 per ton. Table 1 summarizes the optimization opportunities.

Freight Optimization Scenarios	Total Market Opportunity	
	Tonnage	Savings ($)
(1) Twin Cities Domestic Optimization Opportunities via **Direct Route**	7.6M	$199.8M
(2) Minnesota **Domestic Transload** Optimization Opportunities via Twin Cities Hub	14.9M	$282.2M
(3) Minnesota **Import/Export Transload** Optimization Opportunities via Twin Cities Hub	5.6M	$218.6M
(4) Incremental Minnesota **Intermodal** Opportunities via Twin Cities Intermodal Hub	9.7M	$379.6M
Total Optimization Opportunities	37.8M	$1.1B

Table 1 - Total Market Opportunity by Optimization Scenario

For domestic, bulk shipments **to/from the Twin Cities**, the top opportunities exist for agricultural products, base metals, fertilizer, stone and gravel. Shipping costs reduce from $0.11-$0.14 to a range of $0.02- $0.06 per ton-mile (CPTM) with a shift from truck to rail or barge.

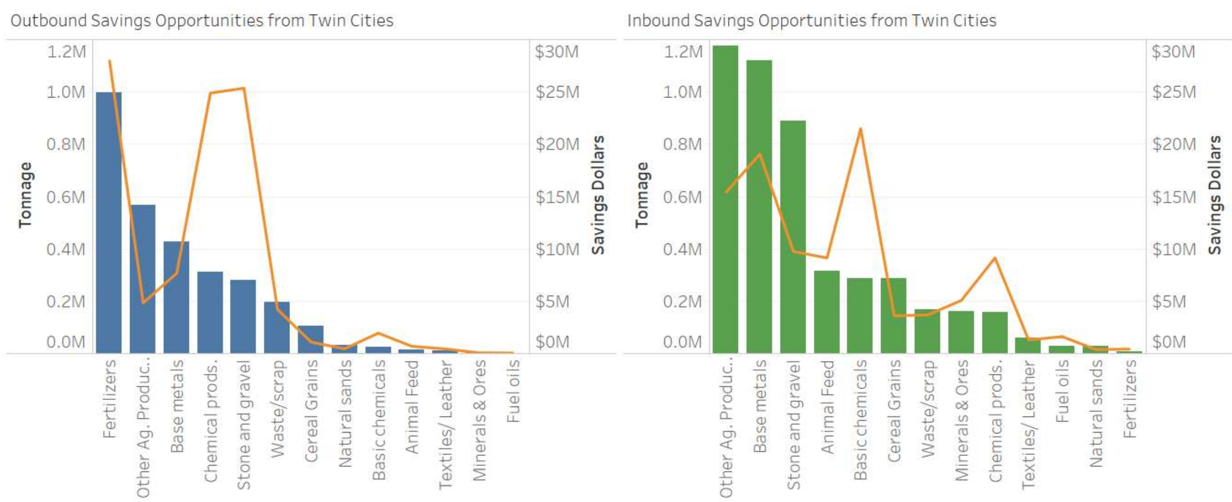

Figure 6 - Direct Optimization Opportunities by Commodity to/from Twin Cities

There is incremental potential for regional shippers in other parts of Minnesota to leverage barge or rail services via a multimodal hub in the Twin Cities by **transloading**. In these instances, the shippers in rural communities in outstate Minnesota may not have direct or cost-effective access to barge or rail locally.

The analysis identified a potential of 7.0 million outbound tons and 7.9 million inbound tons that have the potential to leverage more efficient barge or rail multimodal options via a multimodal hub. Top commodity opportunities by total tonnage include minerals and ore, agricultural products, base metals, animal feed and cereal grains. Shipping costs reduce from a baseline $0.10 to $0.17 per ton-mile to an optimized cost per ton-mile of $0.03 to $0.08. This scenario represents a potential of $282 million in annual savings.

The optimization analysis also identifies **over 3.4 million outbound tons and 2.2 million inbound tons with over $218 million in potential savings for international shipments leveraging a Twin Cities transload hub**. Cost per ton-mile decreases from $0.03 to $0.02 per ton-mile over the entire trip between Minnesota and the foreign origin/destination. However, with an average shipment distance over 7000 miles, the savings on a per ton basis averages over $50 per ton.

For long-haul shipments from Minnesota over 500 miles, **over 8.3 million tons have potential savings greater than $5 per ton using the Twin Cities as intermodal hub.**[7] **This volume represents a potential of 414,000 container shipments annually, with over $376 million in potential savings.** Top commodities for incremental intermodal opportunities include food and other agricultural products, non-metal mineral products and paper.

The ability to take advantage of these market opportunities depends on the capacity and constraints in the supply chain network. For businesses utilizing the Port of Saint Paul, the **capacity of the multimodal freight network and ability to meet service levels is impacted by constraints specific to the Port and its terminals, as well as constraints in the public transportation network that affect freight shippers across the region.**

Barge Capacity. The ability to access the U.S. Inland Waterway System for low-cost barge transport of bulk commodities is a strategic asset of the Port of Saint Paul and critical to the economic competitiveness of Minnesota producers in global markets. **From a transportation perspective, in addition to having the lowest cost on average, barge has the highest capacity, is the most fuel efficient and has the lowest environmental impact vs. truck and rail modal options.** With one tow of 15 barges having the freight capacity equivalent to 1050 long-haul trucks,[8] barge freight movements and infrastructure are essential to managing highway congestion, road maintenance and freight capacity, as well as supporting future freight growth across all modal options. However, barge transportation is inherently seasonal. Annual lock closures on the Upper Mississippi limit freight movements in winter months and can cause bottlenecks at the beginning of the river shipping season, with a backlog of barges entering the region in the spring. The commodities being shipped are also highly seasonal, resulting in demand peaks and variances in upbound and downbound river volumes.

Barge Fleeting Area on Mississippi River near Red Rock Terminal, Saint Paul, Minnesota (Photo Credit: SPPA)

[7] In the case of intermodal, scenarios are based on the intermodal rail hub being located in Ramsey County, MN within the Twin Cities Metropolitan area.
[8] Advantages of Inland Waterway Transport, U.S. Army Corps of Engineers, St. Paul District, August 2018

Aging lock and dam infrastructure along Marine Highway M-35 and beyond is a hard constraint. Standard tows of 15 barges must be broken up and reassembled, doubling the time required to pass through 600 ft single-chamber locks on the Upper Mississippi and limit barge capacity. With no redundancy, issues or outages (e.g. unscheduled lock outage, flooding) in the system can disrupt service and affect both upbound and downbound users.

Dredging is also needed to maintain river capacity, navigation and terminal access from shifting underwater sediment. Above Lock 2, currently 12 barges is the maximum tow into the Saint Paul area, where shifting sediment over time has narrowed a bend in the river, reducing the capacity and efficiencies versus river terminals to the south.

Capacity for barge movements within the Saint Paul terminals is based on a variety of factors, including dock wall length, depth, maintenance and utilization, fleeting space, land use, as well as equipment and worker availability to load and unload different types of commodities. SPPA and its tenants are required to perform ongoing maintenance on the existing dock walls to ensure a continuing state of good repair to support existing freight volumes, as well as potential growth.

Class I Rail Lines near Barge Terminal 1 in Saint Paul, MN (Photo Credit: SPPA)

Rail Capacity. Although barge service provides strategic advantages, rail capacity plays a critical role in the competitiveness of the Port of Saint Paul as a multimodal terminal. As the dominant mode for long-distance moves, rail provides a low-cost transportation option to non-barge capable origins and destinations, offsets the seasonality of barge transportation during the winter, and reduces truck volumes on local roads, highways and interstates.

Rail transportation is currently underutilized at the Saint Paul terminals versus other modes, with rail configuration presenting limitations. Spurs provide rail access to some tenant sites, but not to all sites that would like to leverage rail. In some instances, there are opportunities to extend current spurs or rehabilitate inactive spurs to allow for more efficient loading of rail cars and/or to facilitate more direct barge-to-rail and/or rail-to-barge transfers. There are no loop tracks and rail car storage space is limited.

The competitiveness of rail rates compared to other modes, as well as the available capacity on the regional and national rail network, varies over time. The limited ability to handle unit trains at Saint Paul river terminals reduces the competitiveness and efficiencies of rail.[9] When larger trains are handled within the terminals, the cars need to be broken down into smaller segments.

The cost of rail transportation on a per ton-mile basis also varies. Direct routes, where there is no switching between railroads, may be lower in cost than when 2 or more railroads are involved in providing service. Thus, routes where there is no direct service into the Saint Paul terminals could be less competitive. Rail shippers are also subject to the capacity of the individual railroads servicing their location, as well as regional rail bottlenecks.[10]

In addition, the configuration and location of at-grade rail crossings and spur lines at the terminals present additional safety and efficiency concerns from potential delays, accidents and restricted access to tenant sites in the event of an emergency.

There is also no current intermodal rail service at the Saint Paul terminals. Nationally, intermodal rail is very competitive for long-haul shipments over 750 miles, with a cost per ton-mile lower than truck, but higher than barge and rail carload shipments. Regional shippers can utilize two intermodal terminals within the Twin Cities to connect to the Pacific Northwest or Chicago. However, these sites are considered at capacity, limiting incremental intermodal utilization in the area. Also, lack of direct intermodal rail service from the Twin Cities to key intermodal terminals in the South and Southwest, like the Port of Los Angeles/Long Beach, reduces competitiveness. As a result, regional intermodal shippers often dray their shipments to Chicago area terminals as an alternative.

Truck Capacity and First-/Last-Mile Connections. Truck capacity is essential to all multimodal commodity movements into and out of the Saint Paul terminals. As a multimodal transportation hub, access to the Minnesota trunk highway system, regional freight network and national interstate system from the Saint Paul terminals via truck is crucial.

Truck capacity within the terminals is affected by the configuration and condition of roadways within individual tenant sites. Ongoing maintenance is required to address areas with deteriorating pavement and road debris to maintain current freight volumes and mitigate environmental impacts. The location, availability, age and condition of scales, conveyors, transload and other equipment also represent modal constraints.

The capacity, efficiency and proximity of the first/last-mile connections into the terminals affects the economic competitiveness and reliability of all terminal transportation and service options, as well as having safety, environmental and quality of life impacts on the local area. Constraints in these connections to each of the terminals from the national highway network include:

- Traffic congestion and backups
- Road/intersection configuration and traffic controls
- At grade rail crossings
- Number of terminal access points

> Rail costs are estimated to be 1.5 to 3.5 times lower when unit trains are utilized, with economies from shipping 80 to 100+ rail cars from a single origin to a single destination.

[9] An analysis of sample rail waybill data found costs for manifest shipments over 500 miles of 1-19 rail cars with a Minnesota origin were 1.5 times more expensive than shipments with 100-119 rail cars on a per ton-mile basis -- and 3.5 times more expensive for shipments to a Minnesota destination.

[10] The area to the east of Barge Terminal 1, Hoffman Junction, is considered a major regional rail bottleneck, where three Class 1 main lines and rail yards converge. (MnDOT, Minnesota State Rail Plan, 2015)

With strong economic growth and corresponding freight demand, shortages of qualified truck drivers, driver turnover and lack of adequate truck parking are also top issues influencing truck capacity both locally and nationally.[11]

Barge Terminal 1 in Saint Paul, Minnesota (Photo Credit: SPPA)

Other Constraints and Considerations. With a large portion of Minnesota products ultimately destined for export, ocean port capacity also has an impact on freight costs and performance for regional shippers. Without investments in capacity and infrastructure, congestion, delays and reliability become key concerns for shippers utilizing top bulk and container ports, as well as influence the competitiveness of different barge and rail routes to international destinations from Minnesota.

Inventory or storage capacity has a direct impact on transportation capacity at the river terminals across all modes. Transload capacity between truck, barge and rail is constrained by storage capacity during peak demand periods. In addition, available storage capacity has a strong influence on shipper economics and mitigates seasonality. Limited covered storage and lack of warehousing facilities within the terminals also limit the types of commodities stored and services provided.

Southport Terminal in Saint Paul, Minnesota (Photo Credit: SPPA)

Periodic flooding or drought can disrupt river shipping with fluctuating water levels, as well as tenant operations at the terminals.[12] Given the nature of river operations, flood management and any portions of property designated as flood plains affect operational requirements and risks at the port, as well as limit utilization of certain property areas.

Land use constraints also affect terminal capacity. There is a lack of open space for expansion within the terminals. All existing sites are leased to tenants on long-term leases. However, there are sites that are currently underutilized by existing tenants, which could be subleased and/or redeveloped. There are also tenant sites that could be better utilized by reconfiguring sites internally, as well as modernizing storage and other facilities to maximize throughput and capacity.

[11] American Transportation Research Institute, Critical Issues in the Trucking Industry, October 2018
[12] Statewide Port and Waterways Plan (MnDOT, 2014)

Located near environmentally-sensitive areas, the environmental impact of terminal operations, including air quality, water quality, management of hazardous materials, etc., are key considerations in any development or maintenance efforts within the terminals or on the river. In addition, any impact on neighboring communities and input from community groups needs to be considered. Opportunities to include ecosystem sustainability and rehabilitation projects, as well as integrate with river development projects for recreation and other uses, should be leveraged where synergies exist.

1.3 Recommendations

Through public-private partnerships, investments in infrastructure and other improvements to the supply chain network of the Port of Saint Paul are recommended to take advantage of these opportunities. The core objectives of the efforts are to increase freight mobility and significantly reduce costs for freight shippers in Minnesota and the Midwest by:

- Facilitating movement of additional commodities above and beyond what is flowing through the Port and other regional multimodal or intermodal facilities today, thus advancing economic growth;
- Reducing transportation costs, delays and constraints, while fulfilling supply chain needs throughout the region for additional low-cost, efficient and reliable methods for shipping freight; and
- Providing expanded multimodal, transload and intermodal services that offer competitive logistic solutions and an efficient, operational means of shipping the core commodities that businesses move into, out of, and through the region from both rural and urban communities.

The optimization opportunities and recommended actions focus on the more cost-effective use of barge and rail freight across all terminals in the Port of Saint Paul.

Terminal Access Improvements. Effective road access to/from the terminals with first-/last-mile connections into the national highway freight network are essential to maintaining existing barge and rail volumes through the multimodal terminals, as well as supporting additional growth. Reconfiguration of single point, access roads and/or intersections into the terminals, including at-grade rail crossings, is recommended to support targeted freight volumes, reduce delays and operational costs, while increasing safety in the terminal and surrounding area. In addition, access road rehabilitation and maintenance would mitigate the risk of restricted freight flows and reduced competitiveness of the terminals due to traffic delays, equipment and/or shipment damage, as well as reduce environmental concerns, such as fugitive dust. The efforts also present opportunities to incorporate and pilot innovative technologies pertaining to automated vehicles to increase transportation safety.

Traffic Congestion on Minnesota Trunk Highway 156 at Southport Terminal (Photo Credit: SPPA)

Barge Capacity Improvements. Dock walls are a critical component at any port and need to be structurally stable to provide safe access to port facilities. To maintain current barge volumes, as well as support projected growth, existing dock walls need to be rehabilitated. These efforts would sustain barge capacity by maintaining a state of good repair, but also accommodate increased transfers of bulk commodities and intermodal interchanges in the future. To keep up with increased demand, additional fleeting permits on the river and construction of more mooring cells should be explored to manage the increases in barge volume and reduce shipping delays.

Supporting the terminal level improvements, ongoing dredging and maintenance of the navigable channel on the Mississippi River, as well as the aging lock and dam infrastructure, is essential to support cost-effective barge transportation to/from Minnesota, as well as to retain the strong environmental and economic benefits of waterborne freight versus long-haul trucking. **With projected growth in Minnesota freight movements by 70.8 million tons annually (or the equivalent of 2.8 million annual truck trips),[13] investments in multimodal infrastructure, including river navigation, is vital to the regional and national economy.**

Enhanced Barge-To-Rail-To-Truck Transload Capabilities. The efficiency of transfers to/from barges impacts overall barge freight flow capacity. Opportunities exist at all terminals to invest in new and upgraded equipment (e.g. new overhead crane) for loading and unloading of barges to facilitate transfers to other modes, increase efficiency and capacity. At sites without direct barge-to-rail and/or rail-to-barge transload capabilities, transfers to rail are less efficient, requiring cumbersome storage and repositioning within the terminal. **The addition of direct barge-to-rail and barge-to-truck transload capabilities would greatly increase the capacity and ability to accommodate more cost-efficient barge and rail freight shipments regionally.**

Transload Expansion via Commodity Storage and Site Reconfiguration. Investments in commodity storage support an increase in multimodal transfers between barge, rail and truck. **With the seasonality of barge transportation and ongoing growth of commodity flows through the terminal, commodity storage is critical to building transload capacity.** Increases in storage capacity will help reduce transload constraints during peak periods for bulk commodities. It would also help resolve issues related to backlogs of barges after the river opens in the spring. Additional storage capacity will allow for an increase in new and existing commodity flows through the port.

Red Rock Terminal in Saint Paul, Minnesota (Photo Credit: SPPA)

Better Rail Access and Rail Spur Extensions. Upgrades and extensions of existing rail spurs across terminals will support increases in rail volumes by reaching new sites not currently accessed by rail, increasing capacity to handle more rail cars at existing spurs, as well as enable direct barge-to-rail transfers with closer alignment to dock walls. In addition, **access to new and existing storage facilities will further facilitate loading efficiencies and transfers.**

Unit Train Capacity and Expanded Multimodal Rail Yard. **Adding the ability to accommodate 100-car unit trains at the terminals is key to rail efficiency and cost competitiveness. It would address a high-value constraint within the Saint Paul Port terminals that becomes a bigger issue in the winter during the stoppage of barge movements.** Having the ability to continue a high-volume of commodity and freight movements throughout the winter via new or expanded rail yard(s) and/or a logistics park would have a significant economic impact on the Port of Saint Paul, its tenants, terminal users and the region as a whole.

[13] Based on FHWA Freight Analysis Framework (FAF 4.3) projected growth rates for Minnesota

New Intermodal Services and Capabilities. **Additions of new overhead crane(s), storage pads/facilities, rail spur and dock wall extensions can be utilized to facilitate increased intermodal services in the region.** The infrastructure can be used to offload empty rail cars from the lower Mississippi, as well as onload full containers. The improvements could also be used to load full containers-on-barge, supporting the growth in barge container movements, as well as containerization of agricultural products.

These improvements can provide tremendous economic and qualitative benefits across the Port of Saint Paul terminals, regional Minnesota businesses and surrounding communities, including:

- **Reducing shipping costs and increasing competitiveness** of Minnesota goods and services in global markets, while supporting the local economy.
- **Increasing freight efficiencies and resiliency** with increases in terminal and transload capacity, as well as intermodal services.
- **Reducing truck operating costs** and travel time benefits for businesses utilizing the terminals.
- **Improving access, reliability and safety** within terminals, as well reducing accidents and crash-related costs.
- **Reducing highway and regional road maintenance** costs and truck volumes on Minnesota roadways.
- **Reducing emissions** from increased utilization of more efficient modal choices and reduction in freight delays and idling traffic.
- **Reducing travel time delays** for passenger and freight users in the terminal area, surrounding neighborhood streets and highway connectors.
- **Maintaining navigable waterways** for barge freight, as well as recreational uses, while supporting wildlife habitat development and wetland rehabilitation.

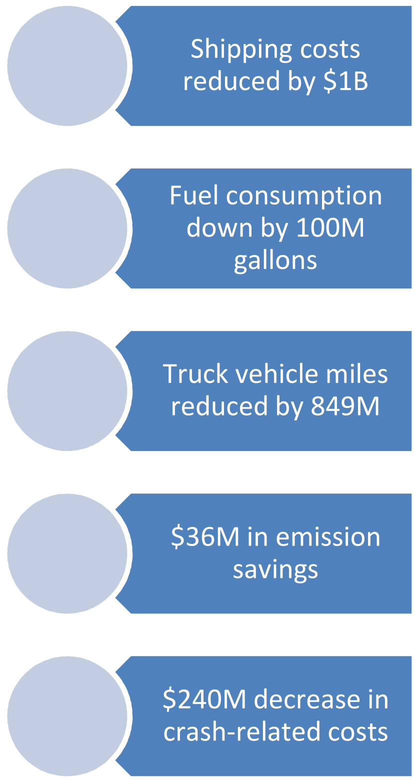

Figure 7 – Annual Savings Potential from Total Market Opportunity with Freight Optimization Strategies

Once implemented, the identified network enhancements will increase freight mobility regionally and significantly reduce costs for freight shippers in Minnesota and the Midwest, while achieving a significant reduction in traffic congestion and air pollution, potential traffic fatalities and serious injuries on the surface transportation system. The infrastructure being proposed will alleviate key bottlenecks in the regional freight supply chain along first-last mile connections and will ensure the good condition of infrastructure to support commerce and economic growth by supporting this inland river, multimodal port. The improvements will provide and improve connections to the Nation's transportation network and support the movement of freight and people.

2. Port of Saint Paul Multimodal Supply Chain Network

2.1 Supply Chain Overview

The Saint Paul Port Authority (SPPA) owns and manages three inland river freight terminals, providing barge, rail and truck transportation hub services in Saint Paul, Minnesota, along the Mississippi River at Barge Terminal 1, Red Rock Terminal and Southport Terminal (see Figure 8). Each of these multimodal terminals is a critical link in a much larger, highly complex, national freight transportation network. As a major multimodal transportation hub for regional Midwest businesses, these terminals handle 8 to 10 million tons of commodities each year on average and continue to grow.[14] A fourth terminal, Barge Terminal 2, houses the Harbor Operator that provides services to terminal users, including break-bulk, dry docking, barge maintenance and cleaning. The Saint Paul terminals play a major role linking Minnesota producers to domestic and international markets, while providing vital support to the regional and local economy.

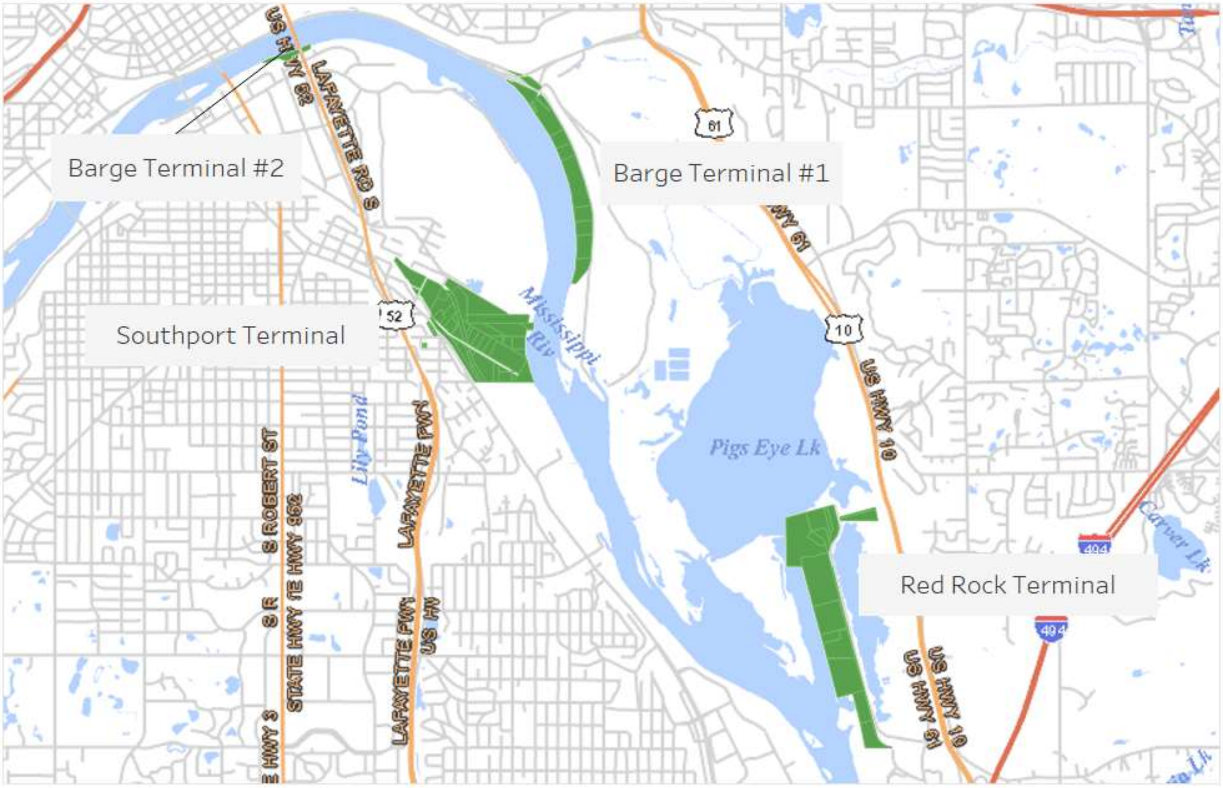

Figure 8 - Port of Saint Paul Multimodal River Terminals, Saint Paul, Minnesota

The users of these multimodal terminals ship a mix of bulk products. Top outbound commodities, shipped from Saint Paul to other states, Minnesota counties and international markets, include corn, soybeans, dried distillers' grain (DDGs), scrap metal and potash. Top inbound commodities into the Saint Paul harbor include fertilizer, water treatment chemicals, steel, aggregates, cements and salt. These commodities are loaded and unloaded to and from barge, rail and truck via over 30 businesses that

[14] Volumes vary year-to-year. Statistic based on annual tonnage flowing into and out of SPPA terminals between 2016 to 2018.

operate within each terminal, as well as provide transportation services to a broad range of non-tenant shippers within the region.

Minnesota's inland ports provide water-based connections to economic marketplaces for Minnesota agricultural products and other commodities throughout North America and around the world. Saint Paul Harbor is the largest port of three public river ports located on the Mississippi River in Minnesota (Red Wing and Winona are the other two). The Saint Paul harbor has 2.1 miles of dock wall or unloading area and 7.4 miles (38,985 linear feet) of fleeting.

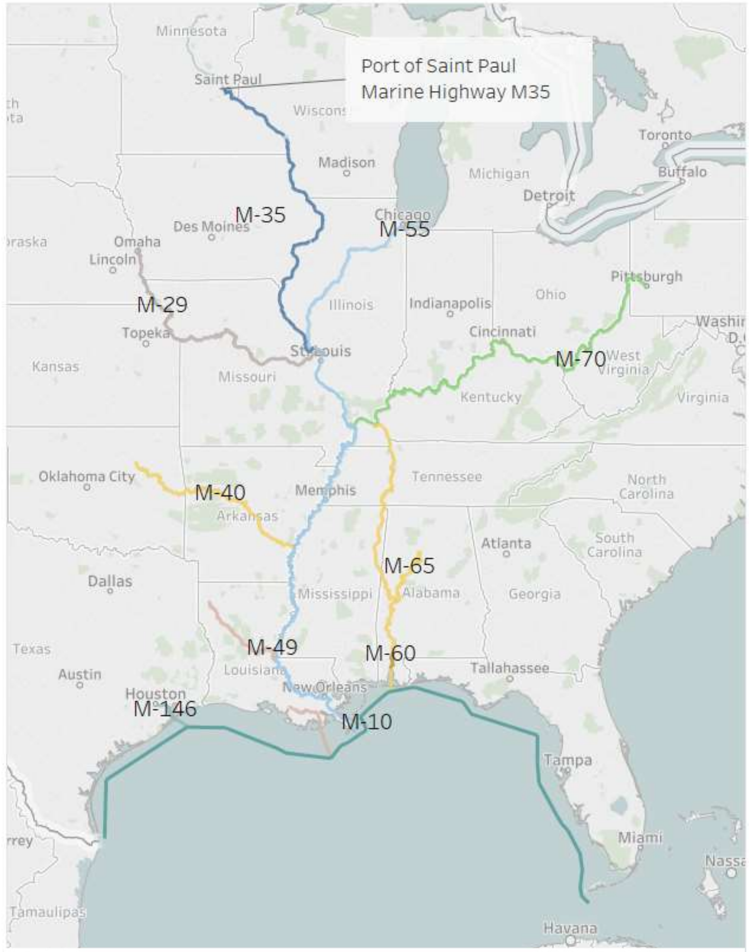

Figure 9 - U.S. Marine Highways Connected to Mississippi River Basin

The Saint Paul Harbor is strategically located at the northernmost navigable portion of the Mississippi River. It is a critical link in the Minnesota multimodal freight network and the national freight network, including Marine Highway M-35 and its connection to international export markets via the U.S. Gulf Coast (see Figure 9).

Barge represents the most efficient, surface freight transport option for bulk, long-haul shipments. Over 50 percent of Minnesota's agriculture exports are transported via the Mississippi River, with agriculture and related industries representing over 16 percent of Minnesota's gross domestic product.[15]

Maintained by the U.S. Army Corps of Engineers (USACE), the Mississippi River navigation channel is dredged to accommodate 9-foot deep barges, with connections via the lock and dam system from Minnesota to the Gulf coast, as well as other domestic markets along the commercial waterway.[16]

Each multimodal terminal is accessible via rail, served directly by Union Pacific (UP) or Canadian Pacific (CP) Class 1 railroads, linking the terminal users to destinations within the region, as well as key coastal gateways in the Gulf, Pacific and Atlantic coasts either directly or through connections with other Class 1 railroads. Shippers also have connectivity to regional railroads for shipments to/from outstate Minnesota locations.

The terminals are readily accessible to the national highway freight network and interstate system via state highway connectors.

[15] 2017 Gross Domestic Product by State, Bureau of Economic Analysis, October 2018
[16] Commercial Waterways, Minnesota Department of Transportation, October 2018l

2.2 Optimization Methodology

Recognizing the need to identify and prioritize the highest impact investments in the multimodal network of the Port of Saint Paul and its connections into the regional freight network to continue to support the needs of Minnesota shippers and businesses, SPPA developed a Port Optimization Model to analyze and identify opportunities in the Port's Multimodal Freight Network. Using a quantitative and data-driven approach to evaluate SPPA's multimodal freight network (including truck, rail, barge and connections to the ocean freight network), this demand-based approach starts with current and forecasted demand for companies' products (both domestically and internationally), and works its way back to identify cost, capacity and service level opportunities in the supply chain network of regional businesses.

Constraints or bottlenecks in the network and optimization strategies identified to address those constraints were analyzed using the network optimization model. Proven in the private sector to optimize complex global supply chain networks for large corporations, this optimization approach is also a cutting-edge method used to optimize publicly-owned elements of freight transportation networks. An optimized, multimodal transportation network can greatly improve the competitiveness of local businesses by providing an effective and efficient freight transportation infrastructure.

The Port Optimization Model is a living model that will be maintained and dynamically adjusted to reflect improvements and changes in the regional supply chain, which will continue to guide necessary improvements and solutions to address high-value opportunities and constraints. The business case and implementation strategy allow SPPA to address critical network constraints, as well as prioritize investments more effectively and efficiently. The results of the Port Optimization Model are used as the basis for benefit-cost analysis to drive the business case to support public and private investment.

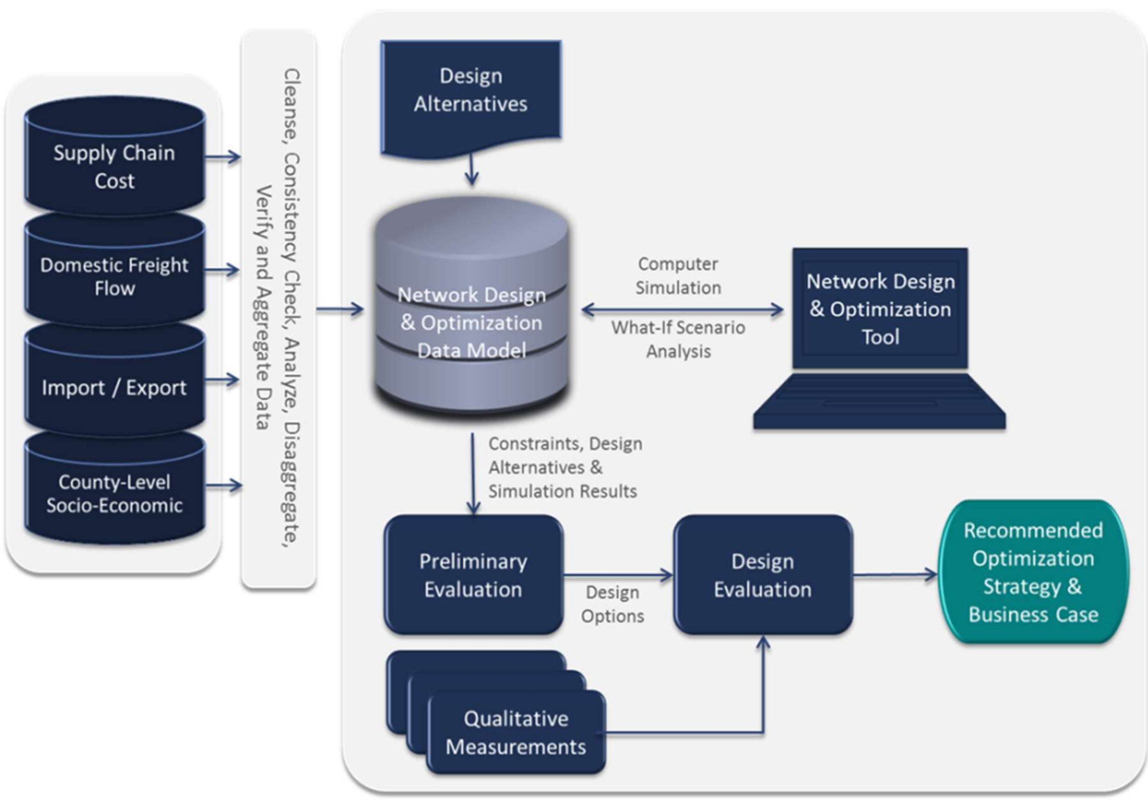

Figure 10 - Overview of Network Optimization Conceptual Architecture

Figure 10 illustrates the conceptual architecture of the Port Optimization Model. Using commodity flow and transportation network data, first a baseline model was developed to represent the current state of the regional, multimodal freight transportation network and the current demand on that network. The current state was calibrated using transportation cost benchmarks to quantify the total network cost, or the baseline performance. The baseline performance was analyzed in an optimization model to identify network constraints and design alternatives to address the constraints. The design alternatives were evaluated, including qualitative input from key stakeholders, and used to develop a baseline optimization model to reduce transportation costs using the existing transportation network. Next, additional optimization scenarios were performed to identify incremental freight network elements and opportunities to enhance the transportation network and reduce overall costs by addressing high value network constraints. As the final step, optimization strategies and the supporting business case were derived from the baseline and optimization scenarios to develop the final recommendations.

The underlying data includes detailed commodity, tonnage, distance and cost information across the primary origin/destination pairs identified in the analysis. The analysis identifies opportunities within the study scope area to deliver shipping cost savings to shippers by shifting commodity freight shipments from less efficient, long-haul truck lanes to more efficient modes, such as barge and/or rail.

The commodity flow information used within the model is derived from public and private sector data sources. It is a macro-level means of examining the demands upon various modal elements of a freight transportation network. Commodity flows can also provide insights about key trade and market relationships for a state or region. Commodity flows are the aggregation of individual shipment origin/destination (O/D) pairs. Since individual shipments for a state or region can number in the millions or billions on an annual basis, the commodity flow data is developed using sampling and modeling techniques.

The Port Optimization Model uses the Freight Analysis Framework (FAF) [17] commodity flow data set from the Federal Highway Administration (FHWA), as well as U.S. Census Bureau, Foreign Trade Division data for import/export shipments. The commodity flow data was enhanced with de-sensitized private sector shipment, regional business and supply chain benchmark data and disaggregated to the county level to analyze shipments. A proprietary economic model was utilized to forecast shipments for the analytical period. Figure 11 provides a high-level description of the data sources and integration process.

[17] U.S. Department of Transportation Bureau of Transportation Statistics, "The Freight Analysis Framework Version 4 (FAF4), Building the FAF4 Reginal Database: Data Sources and Estimation Methodologies", September 2016

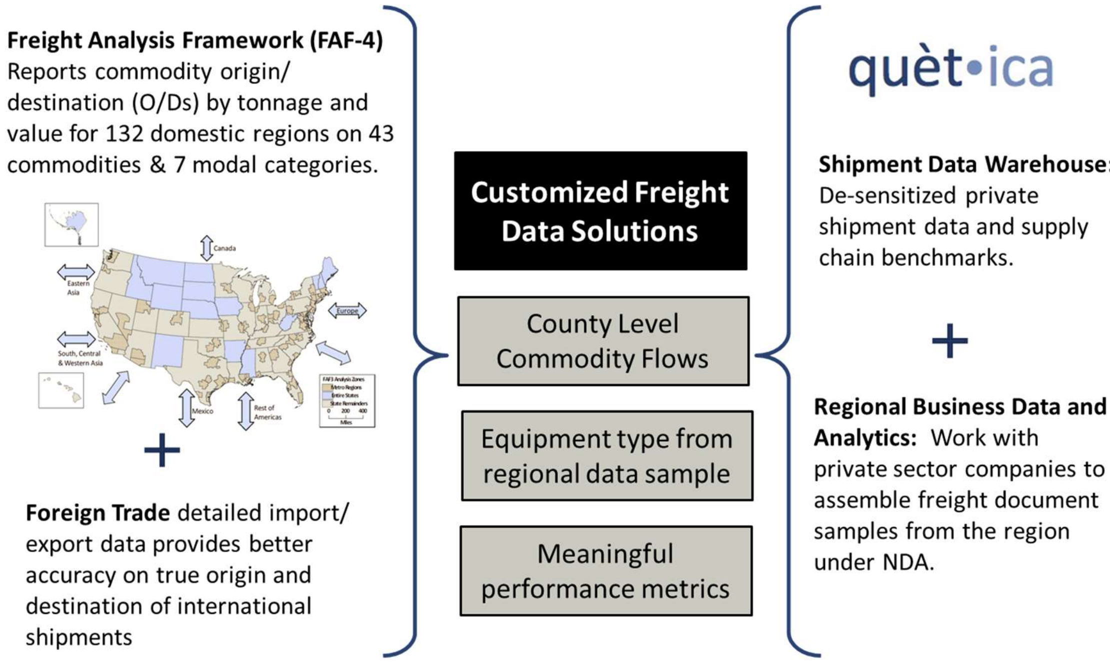

Figure 11 - Overview of Freight Flow Data Sources

2.3 Analysis Scope

From a Port Optimization Model (POM) scope perspective, the primary focus is on domestic freight flows of commodities to/from the Twin Cities, 7-County Metropolitan area, [18] in which the Saint Paul terminals reside (see Figure 12). Freight flows between the Twin Cities counties and other county level by origins and destinations across the United States were also analyzed as part of the study.

In addition, domestic and import/export freight flows to/from other Minnesota counties were evaluated to identify incremental opportunities to utilize the Port of St. Paul as a multimodal transportation hub to transload commodities between modes. Transloading involves transferring commodities from one mode to another without the use of a shipping container. Transloading can be an attractive option where shippers may not have direct access at production or warehousing facilities to some lower-cost, modal choices. Often organizations use transloading between multiple modes, trying to balance transportation cost and service level requirements, between origin and destination.

[18] "Twin Cities" refers to the Greater Minneapolis-St. Paul Metropolitan area in Minnesota defined by the 7 counties in Figure 12.

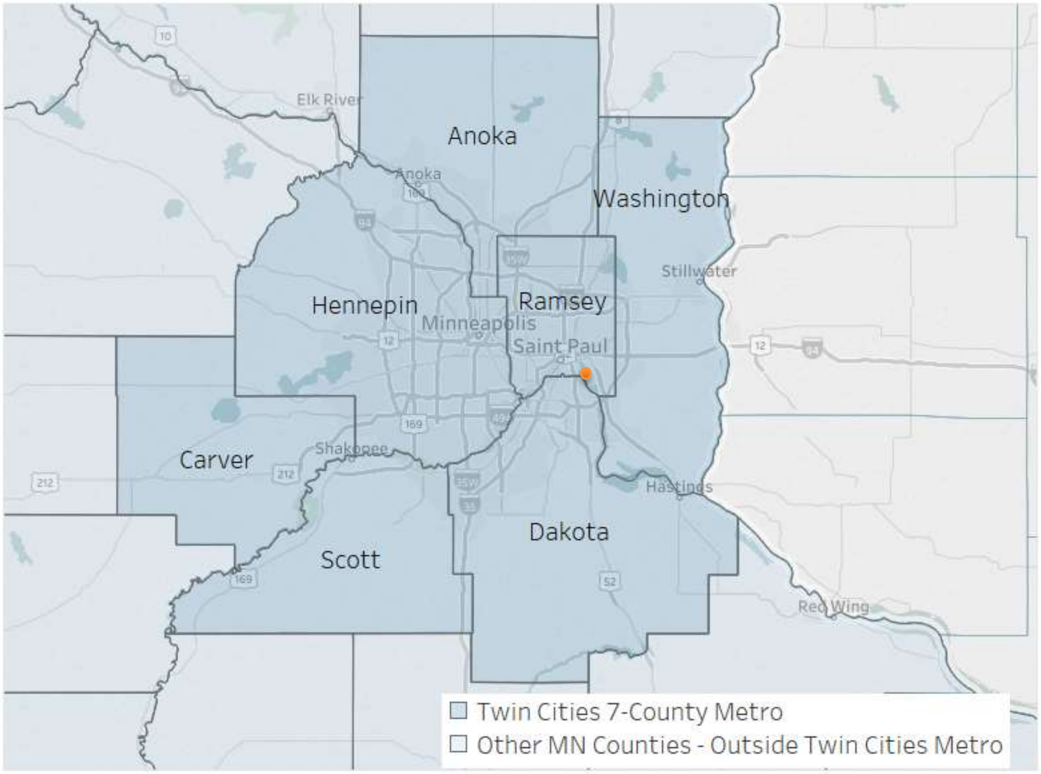

Figure 12 - Twin Cities 7-County Metro Area Geographic Scope

The thirteen commodity categories[19] included in the freight flow analysis reflect the core commodities that currently flow through the Port of Saint Paul via terminal users and its tenants (see Figure 13). These commodities are primarily bulk, low margin commodities that are highly-sensitive to the cost of transportation, but time sensitivity is low. The commodities within the study scope are all barge-capable,[20] although they may not currently be transported via barge to/from Saint Paul today.

[19] The commodities are summarized by 2-digit Standard Classification of Transported Goods (SCTG) to maintain the confidentiality of individual shippers.
[20] "Barge-capable" commodities are identified as currently being transported via barge between domestic U.S. locations.

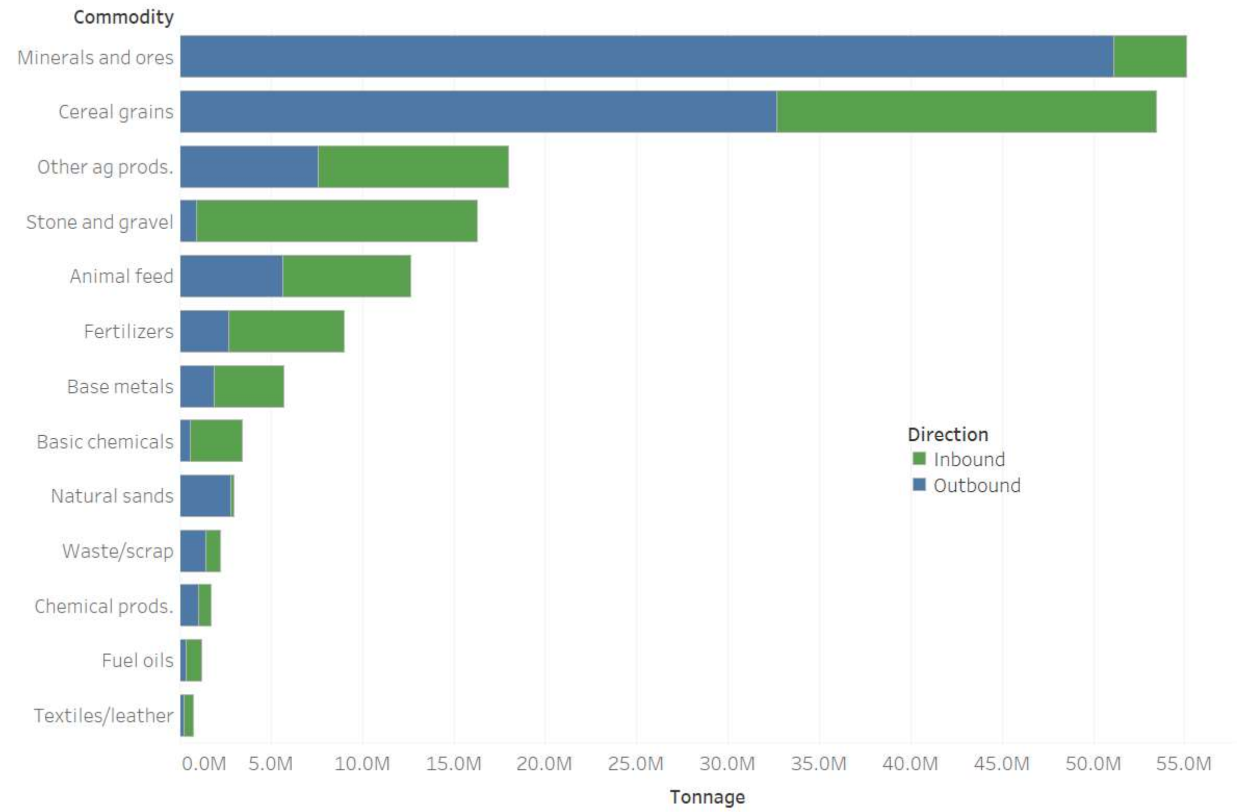

Figure 13 – Total Minnesota Freight Flows by Product for In-Scope Commodities (Annual Tonnage)

The optimization analysis examines existing freight shipments via truck, rail and barge, in order to assess opportunities to increase freight efficiencies for Minnesota shippers by evaluating more cost-effective modes and/or routes between origins and destinations. Shipments via other modes, like specialized package and air cargo shipments, are outside the scope of the analysis. These shipments have different service level requirements than bulk barge or rail shipments, due to product attributes such as a high cost to weight ratio, high inventory holding costs, perishability and time definite delivery window considerations. In addition, shipments that were identified as using multiple modes (e.g. truck and barge, truck and rail) were excluded from cost analysis, due to the difficulty in estimating baseline transportation costs with an unknown mix of modes and routes.

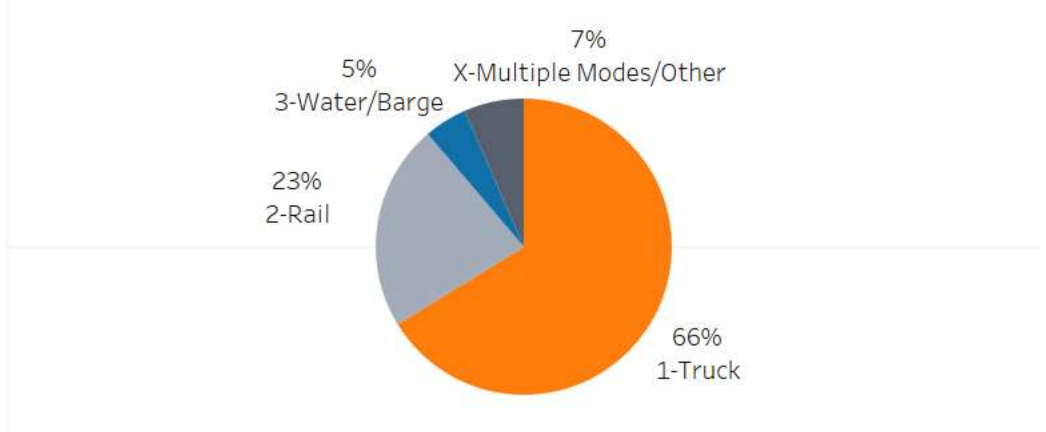

Figure 14 – Total Minnesota Freight Flows by Mode for In-Scope Commodities (Percent of Tonnage)

Trade lanes in the model were prioritized based on tonnage between county-to-county, origin/destination (O/D) pairs and include only those lanes with minimum annual shipment sizes of 1000 short tons for truck and 5000 short tons for rail or barge.[21] These thresholds are based on minimum volume assumptions to represent regular (roughly equivalent to at least one shipment per week) versus one-off shipment potential and make modal conversion a more viable consideration.

In addition, given the strategic location of the Saint Paul terminals as the northernmost port on the Mississippi River, analysis of barge opportunities focused on long-distance shipments between Minnesota and other states with access to the Mississippi River navigation system and Gulf Coast via barge (see Figure 15). Similarly, the import/export analysis focused on shipments outside of North America leveraging Gulf coast and other ocean ports to connect to international markets.[22]

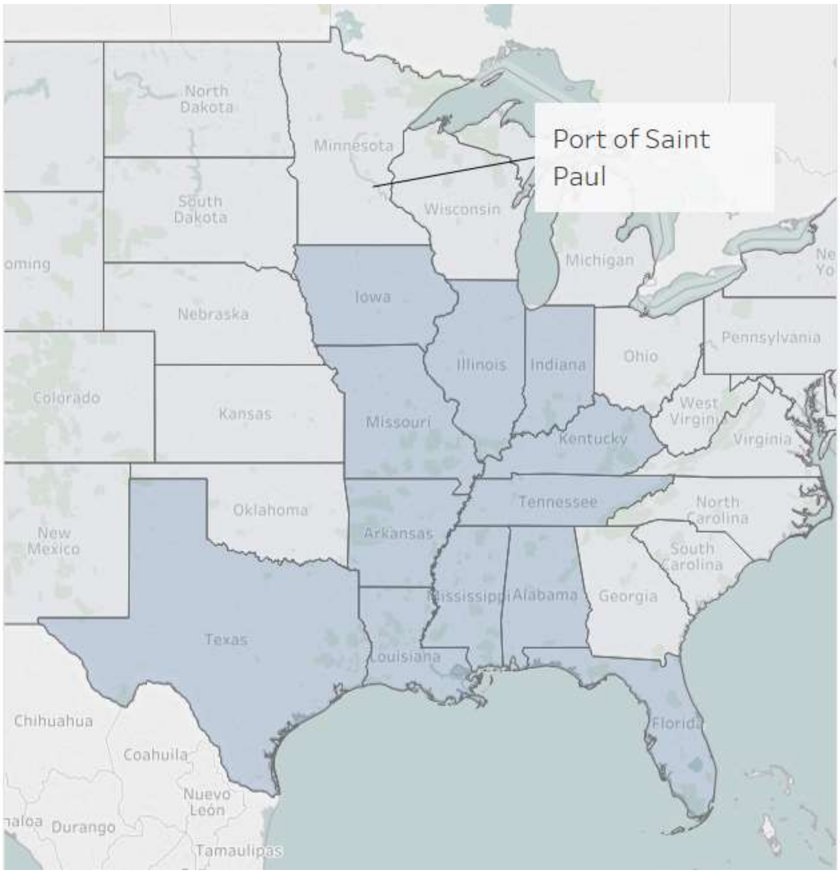

Figure 15 - Geographic Scope for Barge Opportunities Accessible via Mississippi River

These prioritized modes, commodities, origins and destinations represent the analysis scope addressed in subsequent sections of this report.

[21] All tonnage data within the model and this report are in U.S. short tons.

[22] Based on the project objectives, water shipments via the Great Lakes, as well as import/export shipments to Canada and Mexico are outside of the scope of the analysis.

3. Current Demand, Sourcing and Transportation Practices

Using a demand-based approach, the optimization analysis looks at the current (or baseline) demand for the target commodities, where the products are moving to/from, as well as the most cost-effective means to get there. The goal is to identify freight shipping efficiency gains, modal diversion opportunities and additional market potential. The core scenarios in the assessment (see Figure 16) include:

- Opportunities for modal conversion between the Twin Cities and domestic origins/destinations to utilize more cost-effective barge and rail modal options via a direct route.
- Opportunities for modal conversion between Minnesota and domestic origins/destinations to more cost-effective barge and rail modal options utilizing the Twin Cities as a transload hub.
- Opportunities for modal conversion between Minnesota, U.S. ocean ports and international origins/destinations to leverage more cost-effective barge and rail modal options utilizing the Twin Cities as a transload hub.

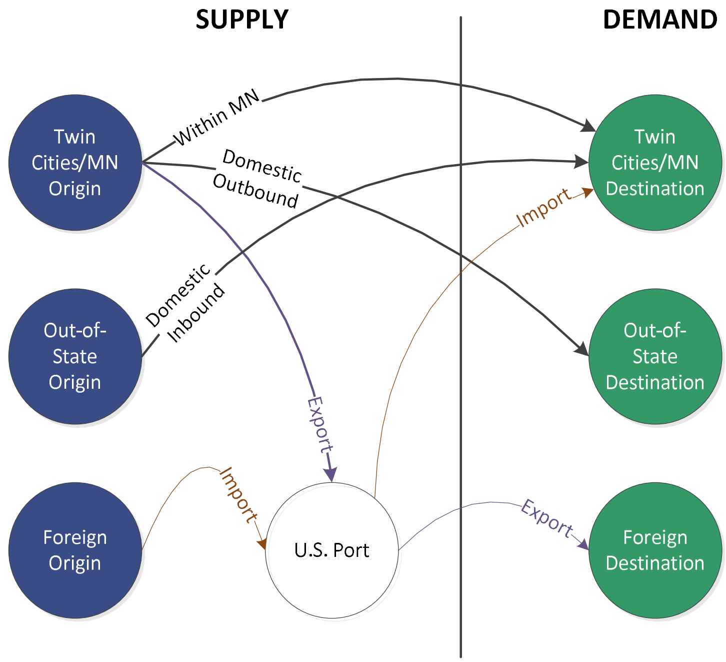

Figure 16 - Origin-Destination Scenario Analysis

A fourth scenario looks at the potential to increase efficiencies with greater intermodal utilization within the region by converting existing long-haul truck shipments to/from the Twin Cities and surrounding area to intermodal (containerized) rail transport.

Over 536 million tons of commodities, valued at over $396 billion, flow to, from and within Minnesota annually via truck, rail and/or barge. Sixty-four percent (64%) or 345 million tons, valued at $108 billion, represent the types of bulk commodities that currently pass through the Port of Saint Paul and are within the scope of the analysis. Fifteen percent (15%) of these commodities flow to or from the Twin Cities metro area to domestic and international trading partners, representing 52 million tons of target commodities valued at over $32 billion.

Another 15 million tons of commodity flows stay within the Twin Cities metro area. Due to the low likelihood of modal diversion over short distances, where the flexible, door-to-door nature of truck transportation is better suited, these local shipments are not a focus of the analysis.

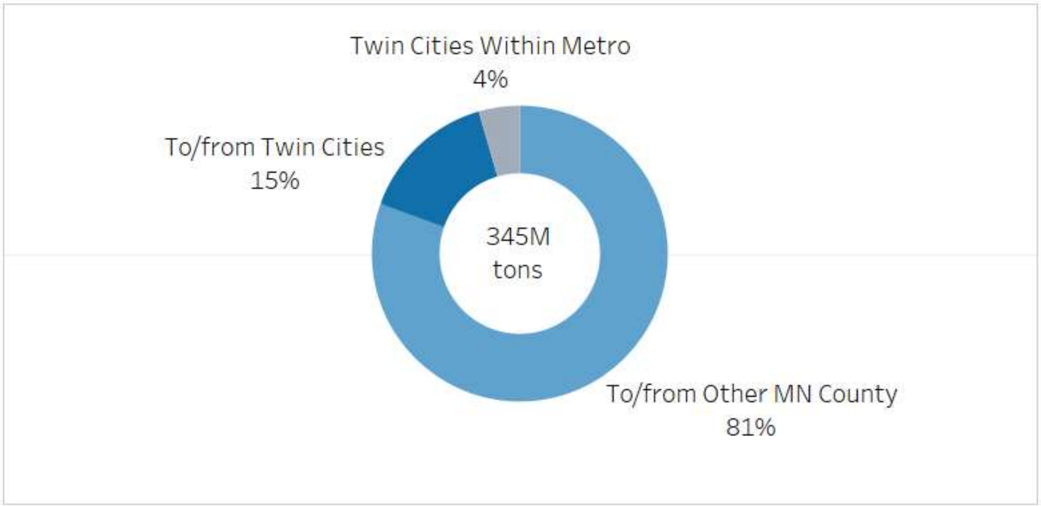

Figure 17 - Minnesota Freight Flows by Area for In-Scope Commodities (Percent of tonnage)

3.1 Domestic Market for In-Scope Commodities

The total volume of the in-scope commodities flowing inbound and outbound from the Twin Cities via truck, rail or barge is nearly 45 million tons (see Table 2 and Figure 17) with an associated transportation cost of over $1.4 billion annually. An additional 418 million tons of in-scope commodities flow from other Minnesota counties to domestic origin-destinations, with shipping costs over $10 billion annually.

Outbound Tonnage from Minnesota

Orig Region	Dest Region: 2 - Other MN	Dest Region: 3-Outside MN Domestic Coun..	Grand Total
1 - MN Twin Cities	13.2M	8.4M	21.6M
2 - Other MN	170.9M	44.0M	215.0M
Grand Total	184.1M	52.5M	236.6M

Inbound Tonnage to Minnesota

Dest Region	Orig Region: 2 - Other MN	Orig Region: 3 - Outside MN Domestic County	Grand Total
1 - MN Twin Cities	11.3M	12.0M	23.3M
2 - Other MN	170.9M	32.4M	203.3M
Grand Total	182.3M	44.4M	226.7M

Table 2 - Domestic Market for In-Scope Commodities (Annual Tonnage), Twin Cities and Outstate Minnesota Counties

The target commodities are moving between the Twin Cities and states across the U.S., with higher volumes in the Midwest and Gulf regions (see Figure 18).

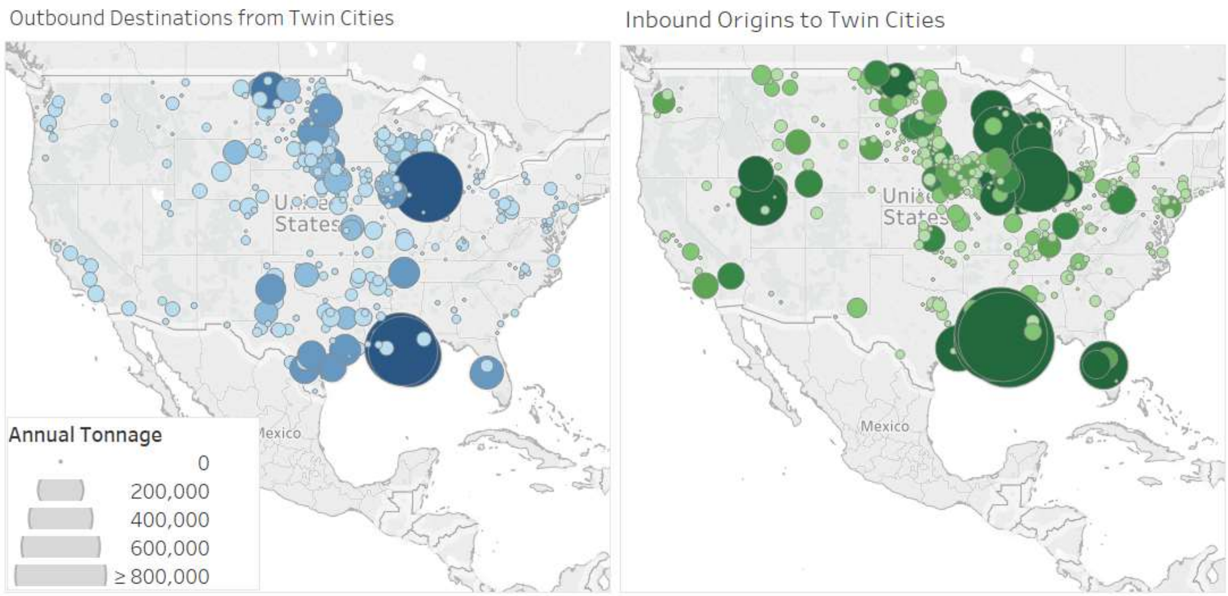

Figure 18 – Baseline Annual Freight Flows to/from Twin Cities to U.S. Counties Outside Minnesota (Annual Tonnage)

Table 3 displays the top origin/destination pairs between the Twin Cities and states for shipments in the targeted commodity groups. Outbound from the Twin Cities, over 2 million tons of Minnesota-produced agricultural products and other bulk commodities are moving to Louisiana via barge. Additionally, more than 3 million tons is flowing to destinations in Wisconsin, Texas, South Dakota and Illinois. These flows include fertilizers, natural sands, minerals and ores, as well as other agricultural commodities. From an inbound perspective, Louisiana is also the top domestic origin for commodities flowing into the Twin Cities, with nearly 3 million tons of fertilizer, minerals/ores and other commodities travelling via barge and leveraging the Twin Cities as an access point into the region. Other top origins are situated in neighboring Midwestern states, including Wisconsin, Iowa, North and South Dakota, bringing stone and gravel, cereal grains, animal feed and metals into the state (see Table 3). It should be noted that, although shipments between Minnesota and ocean ports like Louisiana are domestic freight shipments, many represent imports and exports shipped internationally at a different point in time (versus being produced or consumed in the ocean port state).

Outbound Tonnage by Top Destinations from Twin Cities

Dest State Name	1-Truck	2-Rail	3-Barge	Grand Total
Louisiana	0.15M	0.06M	2.03M	**2.24M**
Wisconsin	0.77M	0.28M		**1.05M**
Texas	0.03M	0.88M		**0.91M**
South Dakota	0.84M	0.04M		**0.89M**
Illinois	0.14M	0.56M		**0.70M**

Inbound Tonnage Top Origins to Twin Cities

Orig State Name	1-Truck	2-Rail	3-Barge	Grand Total
Louisiana	0.05M	0.04M	2.94M	**3.04M**
Wisconsin	1.77M	0.49M		**2.25M**
Iowa	0.55M	0.22M	0.39M	**1.16M**
North Dakota	0.03M	0.68M		**0.72M**
South Dakota	0.44M	0.08M		**0.51M**

Table 3 - Top Destinations and Origins by State for In-Scope Commodities to/from the Twin Cities

Figure 19 summarizes the mode share for inbound and outbound shipments in the targeted commodity groups. Over 13 percent of this combined outbound and inbound tonnage from the Twin Cities is transported via barge, with another 16 percent via rail (see Figure 19), with the remaining 70+ percent of the tonnage being shipped via truck.

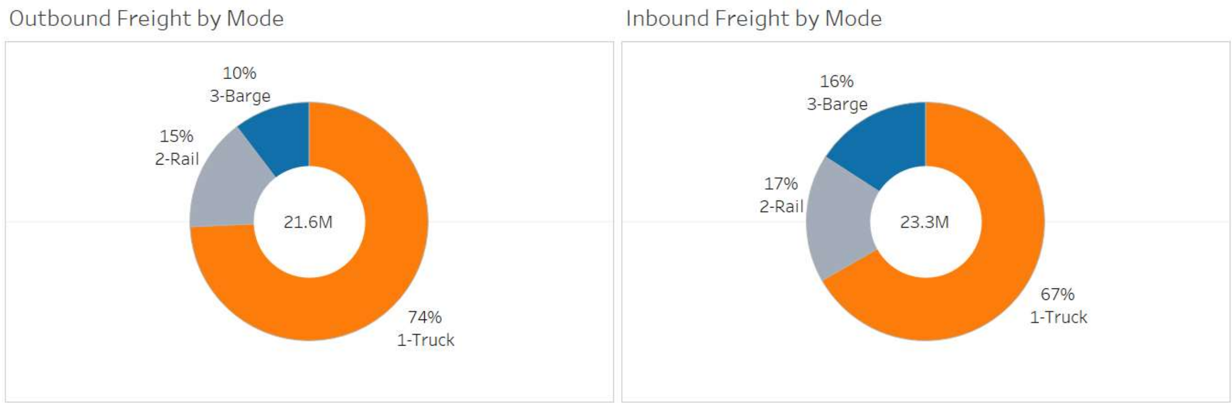

Figure 19 - Baseline Modal Mix between Twin Cities and Domestic Origins-Destinations

With average baseline costs per ton-mile for barge and rail between $0.02 to $0.06, there exists a potential opportunity to divert long-haul truck volume, with average costs of $0.14 to $0.23 per ton-mile, to more efficient modal options (see Table 4).

Base Mode 1	Inbound	Outbound	Grand Total
1-Truck	$0.14	$0.23	**$0.20**
2-Rail	$0.06	$0.05	**$0.05**
3-Barge	$0.02	$0.02	**$0.02**

Table 4 - Average Baseline Cost per Ton-Mile by Mode to/from the Twin Cities ($ per ton-mile)

Different equipment types are often used to safely transport different types of commodities from origin to destination, based on attributes inherent in the products. Figure 20 summarizes the equipment types employed to transport the target commodity groups. Eighty-five percent (85%) of the targeted commodities in the analysis are shipped using dry van equipment, 11 percent use tanker equipment designed for liquid commodities, and 4 percent use refrigerated, temperature-controlled transport, a.k.a. “reefer” (see Figure 20). Most barge shipments are dry, bulk shipments, with a small volume of liquid transport in specialized tanker barges.

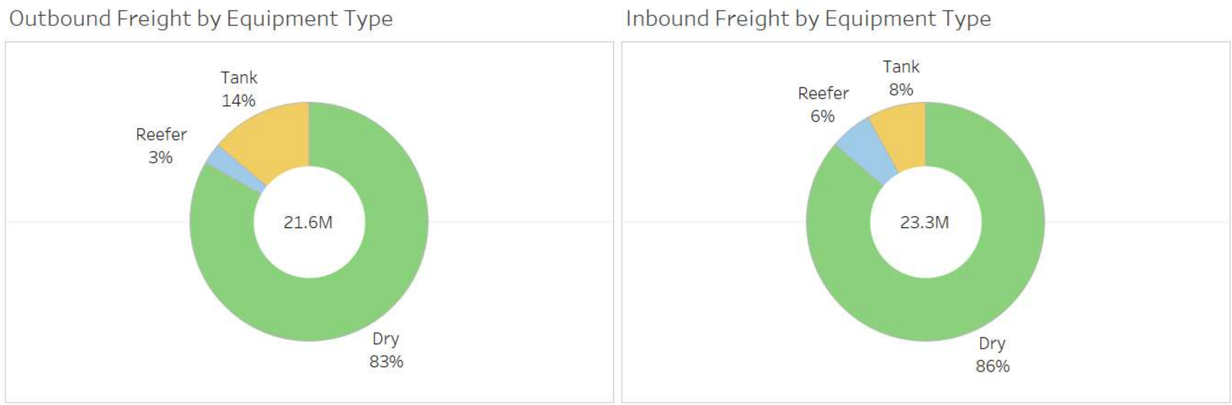

Figure 20 - Equipment Type Utilized between Twin Cities and Domestic Origins-Destinations

Table 5 shows the top origins and destinations for shipments to/from outstate Minnesota counties (i.e. counties beyond the seven-county Twin Cities metropolitan area), the modal mix and high-volume shipment lanes reflect a much higher utilization of rail with less access to river barge transportation. Outbound from Minnesota, agricultural products are moving to Washington state versus Louisiana, and minerals/ores, other bulk and agricultural commodities to Wisconsin, Texas, Illinois and North Dakota. Inbound to Minnesota, there is a high volume of agricultural commodities, as well as stone and gravel from Iowa, Wisconsin, South and North Dakota. Fertilizer and some minerals/ores are transported from Louisiana, with barge volume flowing through other ports and terminals in Southeastern Minnesota.

Outbound Tonnage by Top Destinations from Minnesota

Dest State Name	1-Truck	2-Rail	Grand Total
Wisconsin	1.08M	9.25M	**10.33M**
Washington		5.86M	**5.86M**
Texas	0.01M	5.72M	**5.73M**
Illinois	0.12M	5.35M	**5.47M**
North Dakota	2.89M	1.06M	**3.95M**

Inbound Tonnage Top Origins to Minnesota

Orig State Name	1-Truck	2-Rail	3-Barge	Grand Total
Iowa	16.87M	0.13M		**16.99M**
Wisconsin	7.30M	0.10M		**7.40M**
South Dakota	2.26M	0.50M		**2.76M**
North Dakota	0.41M	0.72M		**1.13M**
Louisiana	0.02M	0.06M	0.96M	**1.03M**

Table 5 - Top Destinations and Origins by State to/from Minnesota Counties Outside the Twin Cities Metro

The market for the bulk, in-scope commodities in Minnesota is growing expected to grow by 15 percent or 70.8 million tons annually, with a compound annual growth rate of 0.7 percent between 2018 and 2040.[23]

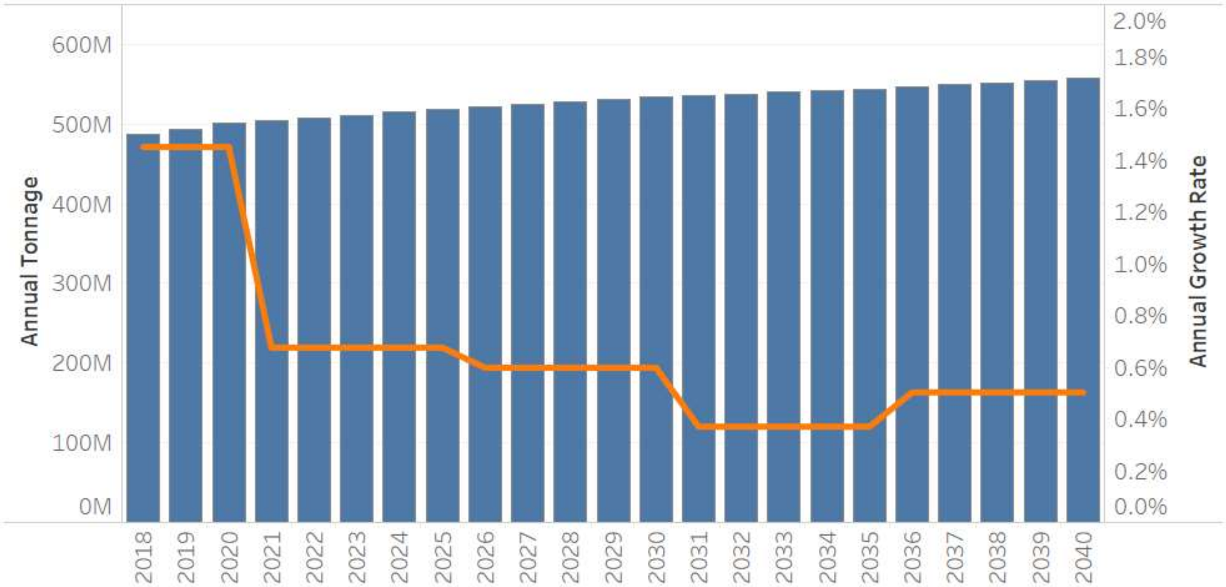

Figure 21 - Projected Minnesota Freight Flow Market Growth Rates (FAF) for In Scope Commodities

[23] Based on FHWA Freight Analysis Framework (FAF 4.3) projected growth rates for Minnesota

3.2 Import/Export Market for In-Scope Commodities

Four percent (4%) of the in-scope commodity flows and 9 percent of all Minnesota shipments are to/from international markets. The analysis focuses on the top 3 import and top 3 export commodities to/from Minnesota (see Figure 22) within the 13-commodity study scope. These 6 commodities represent nearly 14 million tons of annual freight movements to international markets outside of North America, with transportation costs in excess of $2.3 billion. As a net producer, Minnesota exports are dominated by agricultural products and represent over 70 percent of the international shipments within the study scope. Top imports into Minnesota include fertilizers, minerals and ores, with textiles/leather a distant third.

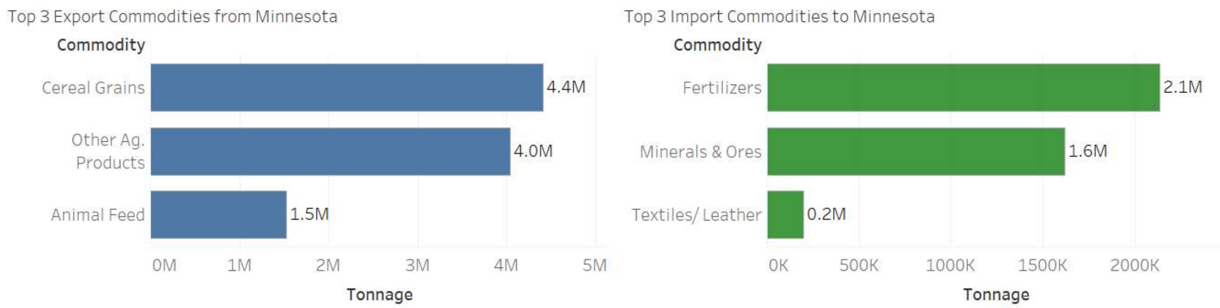

Figure 22 - Top Import and Export In-Scope Commodities to/from Minnesota (Annual Tonnage)

International shipments to/from Minnesota are predominately transloaded from domestic modes to ocean vessels at U.S. Gulf and West coast ocean ports (see Figure 23).

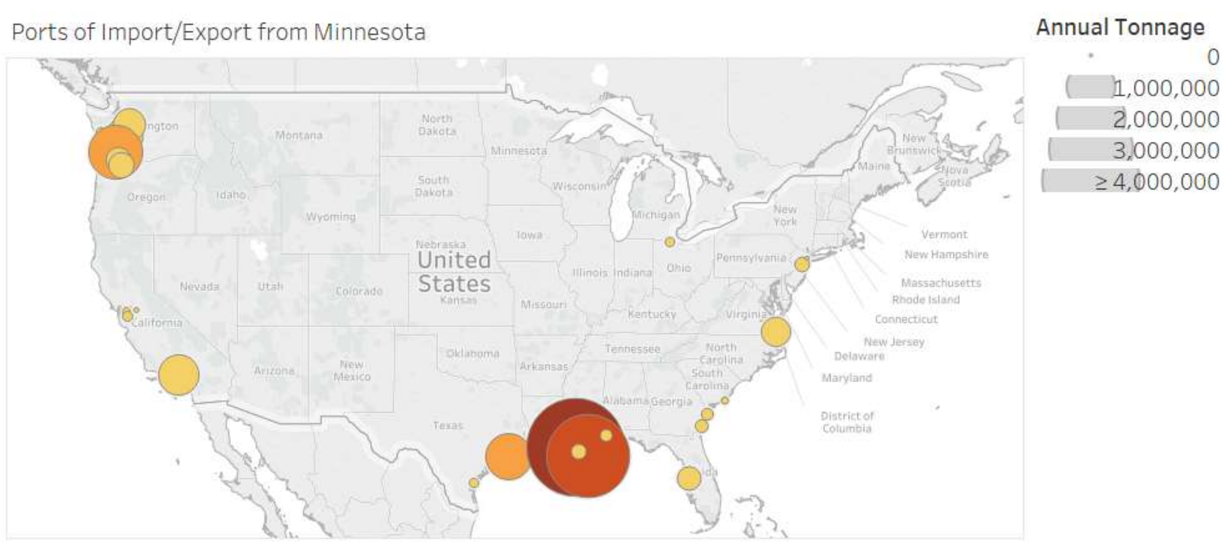

Figure 23 - U.S. Ports of Import/Export for Baseline Freight Flows to/from Minnesota (Annual Tonnage)

Over 8 million tons annually of both import and export commodities flow through ports near New Orleans, LA on their way to/from Minnesota, with 2.5 million flowing through ports near Vancouver, WA and Seattle/Tacoma. Another 2.3 million tons flow through ocean ports near Galveston, TX, Los Angeles/Long Beach, CA and Norfolk, VA on the East Coast (see Table 6).

Top U.S. Ports of Import/Export from Minnesota

Base Port State	Export	Import	Grand Total
Louisiana	5,621,405	2,639,634	**8,261,039**
Washington	2,414,171	103,488	**2,517,659**
Texas	302,641	870,226	**1,172,867**
California	694,409	66,389	**760,798**
Virginia	339,682	21,135	**360,817**

Top Export Destinations from Minnesota

Foreign Region	Export
China	3,227,784
Japan	1,557,323
Other South-Eastern Asia	749,669
Korea	691,045
Colombia	489,457

Top Import Origins to Minnesota

Foreign Region	Import
Other South America	1,475,891
Other Western Asia	1,447,411
China	378,673
Caribbean	323,222
Northern Africa	265,749

Table 6 - Top Import/Export Origins, Destinations and U.S. Ocean Ports for Minnesota In-Scope Commodities

The export products are primary destined for China, Japan, Korea and other Southeastern Asian countries, as well as Colombia and other South American markets. China is the largest consumer of animal feed and other agricultural products. Japan is the dominant consumer of cereal grains, followed by Korea. Fertilizer imports originate in Western Asia, China and the Caribbean, as well as South America and North Africa along with minerals and ores. China is the primary source for textiles and leather products inbound to Minnesota (see Figure 24).

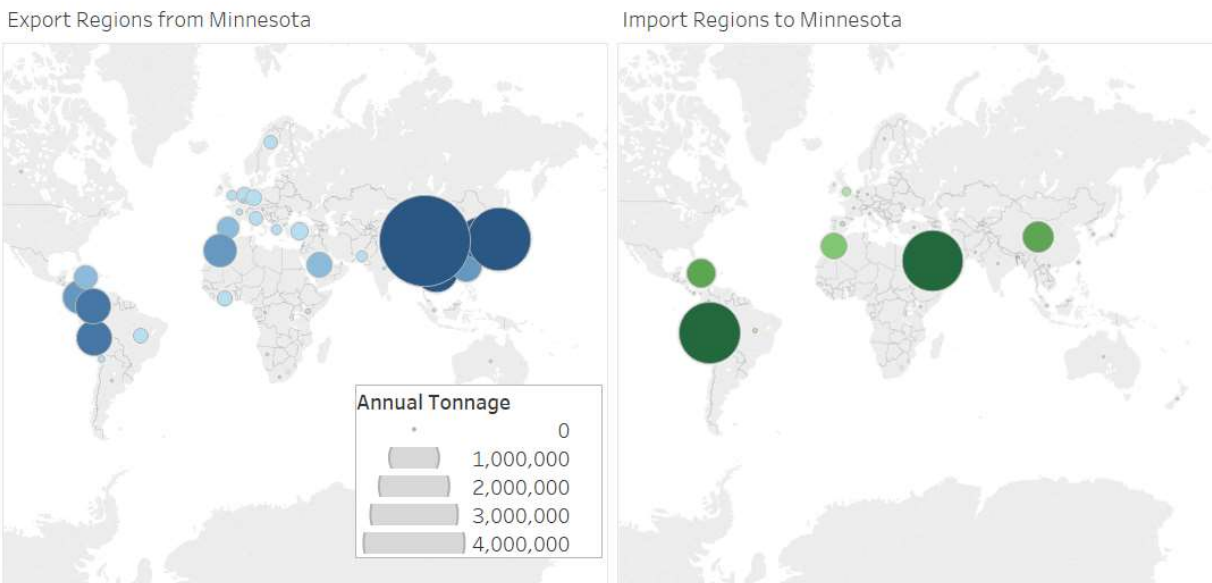

Figure 24 - Foreign Import/Export Origins and Destinations Regions for Baseline Freight Flows to/from Minnesota (tons)

For the domestic leg of the trip, the import/export commodities flow to/from Minnesota via truck, rail and barge. However, the modal mix is much different than domestic shipments with over 88 percent of these international shipments moving via barge and rail to minimize freight costs over these long-distance shipments. On average, international shipments show a cost per ton-mile of $0.02 to $0.03, including both the domestic and international legs, with shippers making route decisions based on the total combined costs across all modes.

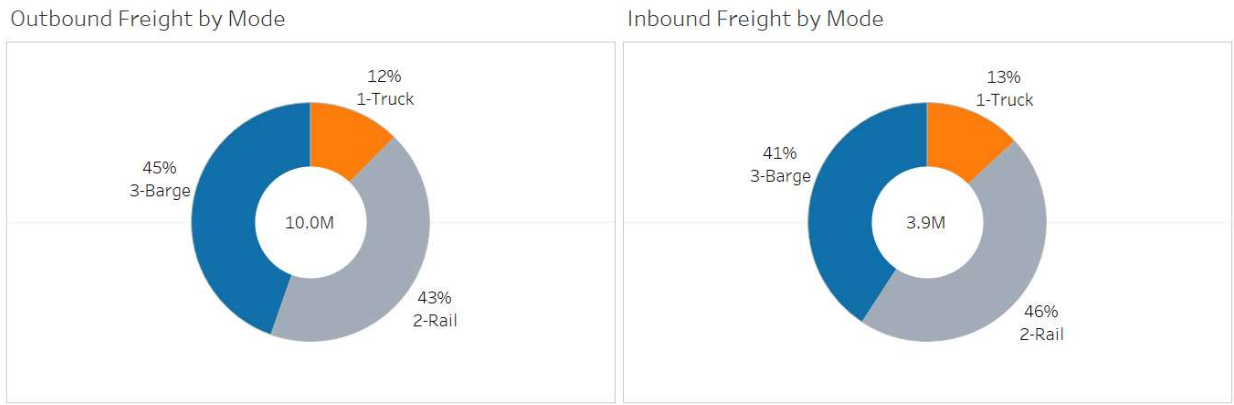

Figure 25 - Baseline Domestic Mode between Minnesota and U.S. Ports[24]

As shown in Figure 26, over 90 percent of ocean shipments for the commodities are bulk, with 10 percent or less being containerized at the ocean port.

Figure 26 - Container vs. Bulk Ocean Shipments for Top Minnesota Import/Export Commodities

3.3 Market for Containerized Commodities

Over 52.6 million tons of commodities that could be containerized are shipped to/from Minnesota via long-haul truck with 50 percent of the volume to destinations around the U.S. over 500 miles from their origin. This long-haul truck volume represents a potential opportunity for additional freight efficiencies with increased intermodal capacity or support services. These opportunities will be explored further in Section 5.

With intermodal rail, commodities are containerized at the origin and drayed to an intermodal ramp close to the source and shipped to an intermodal ramp close to the destination. BNSF Railway and Canadian Pacific (CP) have intermodal ramps in the Twin Cities. But, due to capacity limitations, many shippers choose to dray intermodal containers to Chicago.

Containerized commodities include manufactured or processed products, that can be transported in 53' domestic or 40' import/export containers.

[24] Domestic mode represents the transportation method for an import/export shipment within the continental U.S. before or after it is transloaded to ocean vessel for transport to/from an international origin or destination.

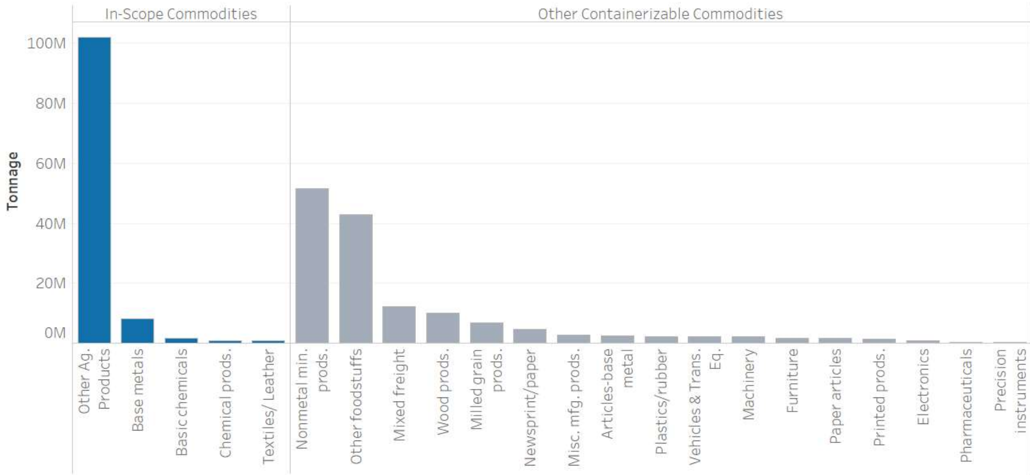

Figure 27 - Containerized Commodities Transported to/from Minnesota via Truck

In addition, the growth in the demand for Identity Preserved (IP) agricultural products in markets like Japan and China is increasing intermodal container use for agricultural commodities. Typically, IP commodities are loaded into an intermodal container at or near the farm and remains in the same container throughout the supply chain to its final destination.[25]

The market for the intermodal commodities in Minnesota is expected to grow by 36 percent or 76.9 million tons annually, at a compound annual growth rate of 1.5 percent between 2018 and 2040.[26]

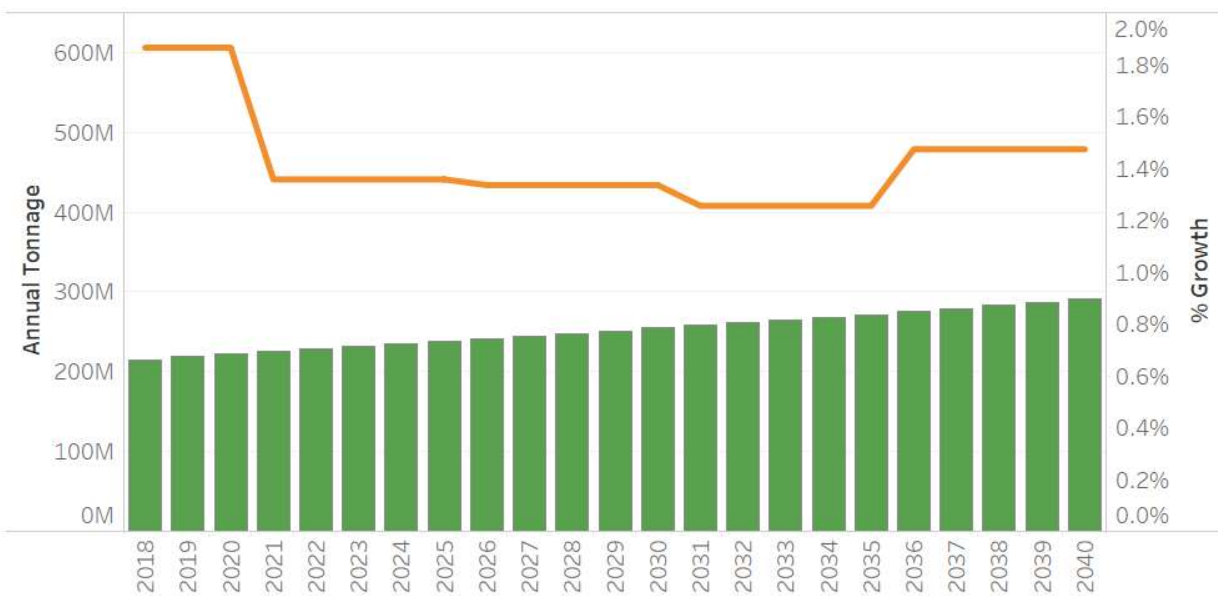

Figure 28 - Projected Minnesota Freight Flow Market Growth Rates (FAF)

[25] http://www.midwestshippers.com/identity-preservation

[26] Based on FHWA Freight Analysis Framework (FAF 4.3) projected growth rates for Minnesota

4. Capacity and Constraints in the Supply Chain

The ability to take advantage of these market opportunities identified through data analysis depends on existing capacity and the ability to address constraints in the supply chain network.

A business' supply chain consists of suppliers, plants, warehouses, and transportation modes used to move products from point of origin to the end customer. Up to 80 percent of the costs of a company's supply chain could be impacted by the location of the company's facilities and its access to the multimodal networks that carry product flows between these facilities.

A constraint is anything that prevents the system from achieving its performance goals.[27] By utilizing principles of supply chain network design and optimization, high-value constraints and inefficiencies in the Port's multimodal freight network can be identified and then addressed via strategic infrastructure investments.

For businesses utilizing the Port of Saint Paul, the capacity of the multimodal freight network and ability to meet service levels is impacted by constraints specific to the Port and its terminals, as well as constraints in the public transportation network that affect freight shippers across the region. These constraints are summarized in Figure 29.

Port/Terminal Constraints	Regional Constraints
• Barge Capacity and Seasonality	• Waterway capacity and seasonality
• Truck Capacity	• First-last mile links to terminals
• Rail Capacity	• Regional highway network
• Inventory Capacity	• Regional rail network
• Site Flow Constraints	• Regional intermodal capacity and container accessibility

Figure 29 - Port of Saint Paul Multimodal Supply Chain Constraints

4.1 Barge Capacity

The ability to access the U.S. Inland Waterway System for low-cost barge transport of bulk commodities is a strategic asset of the Port of Saint Paul and critical to the economic competitiveness of Minnesota producers in global markets. Thus, barge and waterway capacity considerations are essential to enabling continued growth of water-based freight movements to and from the region.

Barge transportation is inherently seasonal. Annual lock closures on the Upper Mississippi limit freight movements in winter months and allow for needed infrastructure maintenance.[28] The seasonality can also cause bottlenecks at the beginning of the river shipping season with a backlog of barges entering the region in the spring.

[27] Theory of Constraints (Goldratt, 1984)

[28] Locks north of Keokuk, IA typically close in November or December, for winter weather and maintenance, and reopen in March for river navigation.

The commodities being shipped are also highly seasonal, resulting in demand peaks and variances in upbound and downbound river volumes (see Figure 30). Products, like fertilizer, are in high demand during a concentrated, time-period in the spring and fall to support crop planting and development. Similarly, demand for cereal grains and other agricultural products is high in summer and in the fall after harvest. Other commodities exhibit seasonality, such as salt, used for winter road maintenance. This seasonality can also result in unused capacity with the need to move empty barges up river into Saint Paul to handle the demand for barge transportation to move Minnesota's production to external markets.[29] The demand fluctuations also impact transportation rates, with prices varying by season.

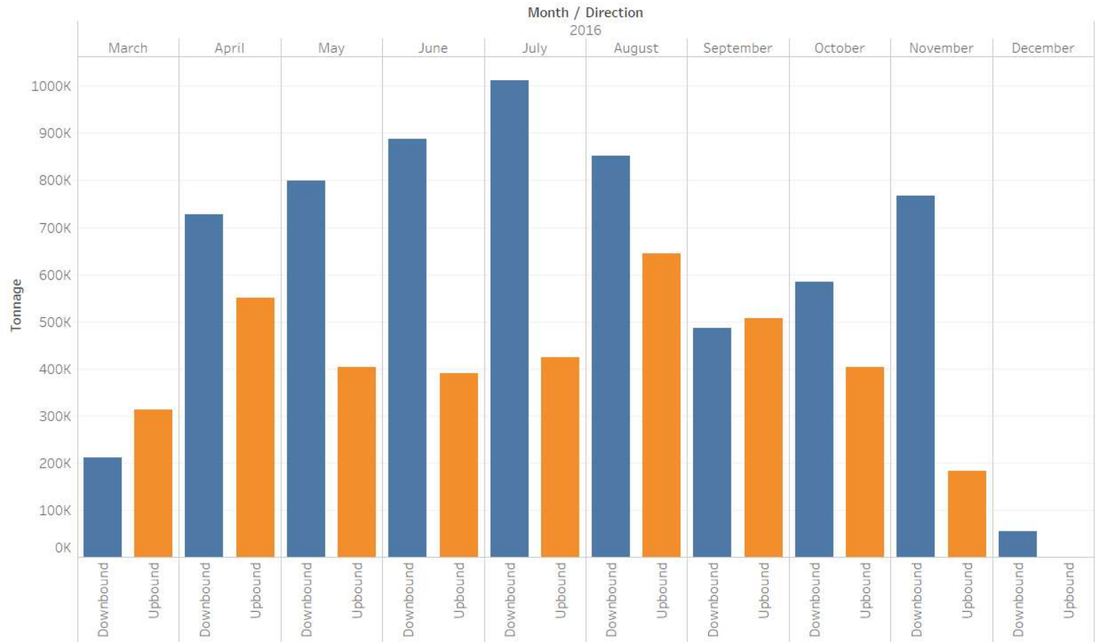

Figure 30 - Upbound and Downbound Tonnage Movements in 2016 through Lock & Dam 2 into Twin Cities, U.S Army Corp of Engineers

Along Marine Highway M-35 and beyond, barges must travel through a network of locks and dams. The size and capacity vary by lock. Older single-chamber locks on the Upper Mississippi (including those locks located in Minnesota) measure 110 feet wide by 600 feet long, while a few newer locks in Iowa and near St. Louis have chambers 110 feet by 1200 feet. With modern towboats being able to push 15+ barges, over 1200 feet in length, tows must be broken up to pass through the smaller chambers and reassembled, doubling the time required to pass through a lock and reducing overall capacity. In addition, with advancements in container-on-barge movements, the lock length will limit potential container shipments to specially-designed vessels under 600 feet.[30] With no redundancy, issues or outages (e.g. unscheduled lock outage, flooding) in the system can disrupt service and affect upbound and downbound users.

With the Mississippi River navigation system dates back to 1930. This aging infrastructure is a hard constraint, where ongoing funding and efforts to maintain the lock and dam system is essential to support ongoing use of this critical commercial navigation network. USACE estimates that the system of 37 lock and dam sites on the Upper Mississippi and Illinois rivers generates $3 billion of transportation

[29] Grain Transportation Report Datasets, U.S. Department of Agriculture, November 2018
[30] https://www.americanpatriotholdings.com/news/new-ga-of-the-772-ft-inland-container-vessel

cost savings to U.S. producers compared to its approximately $246 million operation and maintenance cost.[31] These maintenance efforts also have broader benefits to the surrounding communities with support for drinking water and power plant operators, industrial water users, and recreational boaters.[32] However, with project needs exceeding available funding, USACE is required to use a "fix-as-fail" strategy.[33] Emergency repairs and unscheduled delays (as long as days, weeks or months) can reduce freight efficiency, decrease reliability and increase transportation costs.

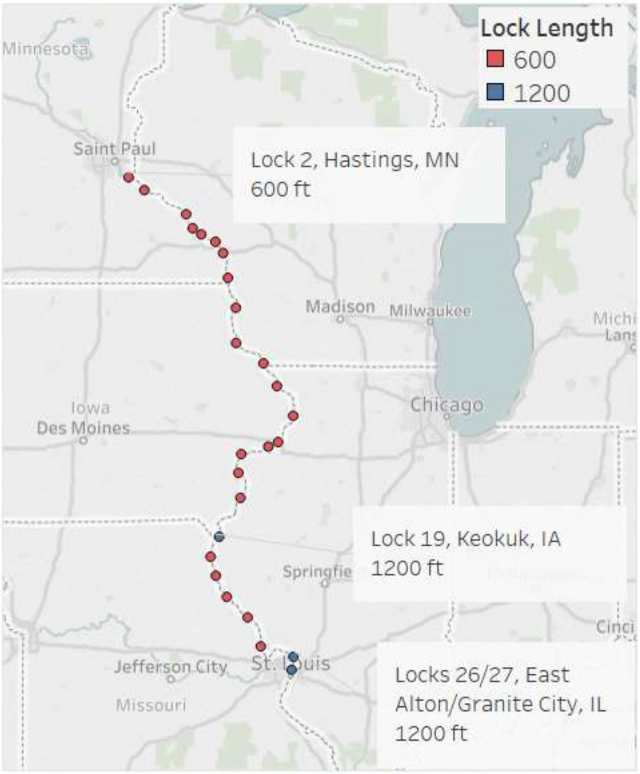

Figure 31 - Mississippi River Locks

In addition to maintaining the lock and dams, the USACE is responsible for maintaining a 9-foot deep navigation channel on the river, with the Port Authority managing dredging at the terminals. Dredging is needed to increase or maintain river capacity, navigation and terminal access from shifting underwater sediment.

Lock 2 (mile marker 815 near Hastings, MN) is the last lock travelling upbound on the Mississippi River before the Port of Saint Paul, as well as the northernmost lock open to barge navigation.[34] Above Lock 2, currently twelve barges is the maximum tow into the Saint Paul area, where shifting sediment over time has narrowed a bend in the river between miles 818 and 821, reducing the capacity and efficiencies versus river terminals to the south. Due to increased dredging demand and budget constraints, the channel has not been maintained to its authorized width. The construction of 2 proposed training wall structures to guide the flow of water could help restore the 15-barge, tow capacity to the Twin Cities.[35]

Capacity for barge movements within the Saint Paul terminals is based on a variety of factors, including dock wall length, depth, maintenance and utilization, as well as equipment availability to load and unload different types of commodities. The harbor infrastructure across the terminals includes over 8100 linear feet of dock wall, 22 permitted fleeting areas and 13 mooring cells. SPPA and its tenants are required to perform ongoing maintenance on the existing dock walls to ensure a continuing state of good repair to support existing freight volumes, as well as potential growth. Recent projects include dock wall rehabilitation at the Southport Terminal and infrastructure repairs at the Red Rock terminal. A heavy lift pad was also added at the Southport terminal in 2016 for shippers to transload oversized and overweight

[31] U.S. Army Corps of Engineers, Saint Paul District, 2017
[32] http://www.umrba.org/commercialnavigation.htm
[33] U.S. Army Corps of Engineers, Saint Paul District, 2017
[34] Upper St. Anthony Falls lock in Minneapolis, Minnesota was closed in 2015.
[35] Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2 Maintenance Project, Minnesota Department of Natural Resources, 2017

specialized cargo in a more efficient and cost-effective manner.[36] The heavy lift pad increased the maximum certified weight for loading/unloading in the terminals from 20 tons to 250 tons.

Currently, all riverfront sites at the SPPA terminals suitable for barge loading and unloading are utilized. However, the river is not actively used at all sites. Planning for any future tenant turnover should include the strategic reutilization of these properties adjacent to the river to facilitate additional barge transportation to/from the region.

Barge operators are responsible for long-distance moves of barges between ports. A harbor operator manages a fleet of towing vessels and is responsible for all barge movements between terminals within the Saint Paul Harbor and surrounding area for loading and unloading. The number of vessels and fleeting space has an impact on capacity and efficiency on these movements between sites. Additional fleeting space/permits at all Saint Paul terminals would build capacity to handle increases in volume. The location of empty barges, limited availability of hopper barges in the area, as well as towboat pilot availability, also impact capacity.[37]

At the tenant sites, the type and number of cranes and other equipment for commodity loading and unloading, as well as number of site workers and shift, have a direct impact on throughput. Staffing versus equipment can be adjusted for seasonal fluctuations in volume and/or to increase capacity, with the ability to add additional workers and/or shifts.

From a transportation perspective, in addition to having the lowest cost on average, barge has the highest capacity, is the most fuel efficient and has the lowest environmental impact vs. truck and rail modal options (see Table 7). A barge filled with grain has 16 times the capacity of a rail car and 70 times the capacity of a tractor trailer. A tow of 15 barges is roughly equivalent to two 108-car unit trains. A barge is also 1.4 times more fuel efficient than rail and 4.5 times more efficient than truck, resulting in a much lower carbon footprint.

Measure	Barge	Rail	Truck	Unit of Measure
Cargo Capacity (Grain)	1750	110	25	Tons
Equipment Requirements	1 Tow 15 Barges	6 Locomotives 216 Rail cars	1050 Large Semis /Tractor Trailers	Each
Equipment Length	0.25 miles	2.6 miles	13.9 miles	Miles
Fuel Efficiency	647 miles	477 miles	145 miles	Ton-miles travelled per gallon of fuel
Carbon Footprint (CO^2)	15.6	21.2	154.1	Metric tons of greenhouse gas per million ton-miles

Table 7 - Modal Comparison for Sample Grain Shipments[38]

The transit time for barge is typically the longest across modal options and thus better suited to bulk, long-distance shipments where time-sensitivity is not an issue. Also, since service can be disrupted for a

[36] The heavy lift pad can accommodate specialized cargoes, such as tanks, mills, transformers, mining equipment, military equipment, wind turbines, generator sets, concrete beams for buildings and bridges, precast concrete, aluminum and steel presses.
[37] The number of towboat pilots is declining with skilled resources moving to other high paying jobs.
[38] Advantages of Inland Waterway Transport, U.S. Army Corps of Engineers, St. Paul District, August 2018

variety of reasons (e.g. ice, flooding, drought, lock outage), barge is generally considered less reliable than truck and rail as a modal option.

4.2 Rail Capacity

Although barge service provides strategic advantages, rail capacity plays a critical role in the competitiveness of the Port of Saint Paul as a multimodal terminal. As the dominant mode for long-distance moves, rail provides a low-cost transportation option to non-barge capable origins and destinations, offsets the seasonality of barge transportation during the winter, and reduces truck volumes on local roads, highways and interstates. From a reliability, transit time and fuel efficiency perspective, rail typically is ranked between barge and truck.

Union Pacific (UP) and Canadian Pacific (CP) railroads provide direct service into the three multimodal terminals (see Figure 32) with access to key West Coast, Southwest and Gulf Coast destinations and ports in the U.S. and Canada. BNSF Railway's main line runs adjacent to Barge Terminal 1 and Red Rock. However, it has no direct line into the river terminals. BNSF and CP also have intermodal rail terminals in the metro area to the northeast of the Saint Paul terminals. However, lack of direct intermodal rail service from the Twin Cities to some key intermodal terminals in the South and Southwest, like the Port of Los Angeles/Long Beach, reduces competitiveness.

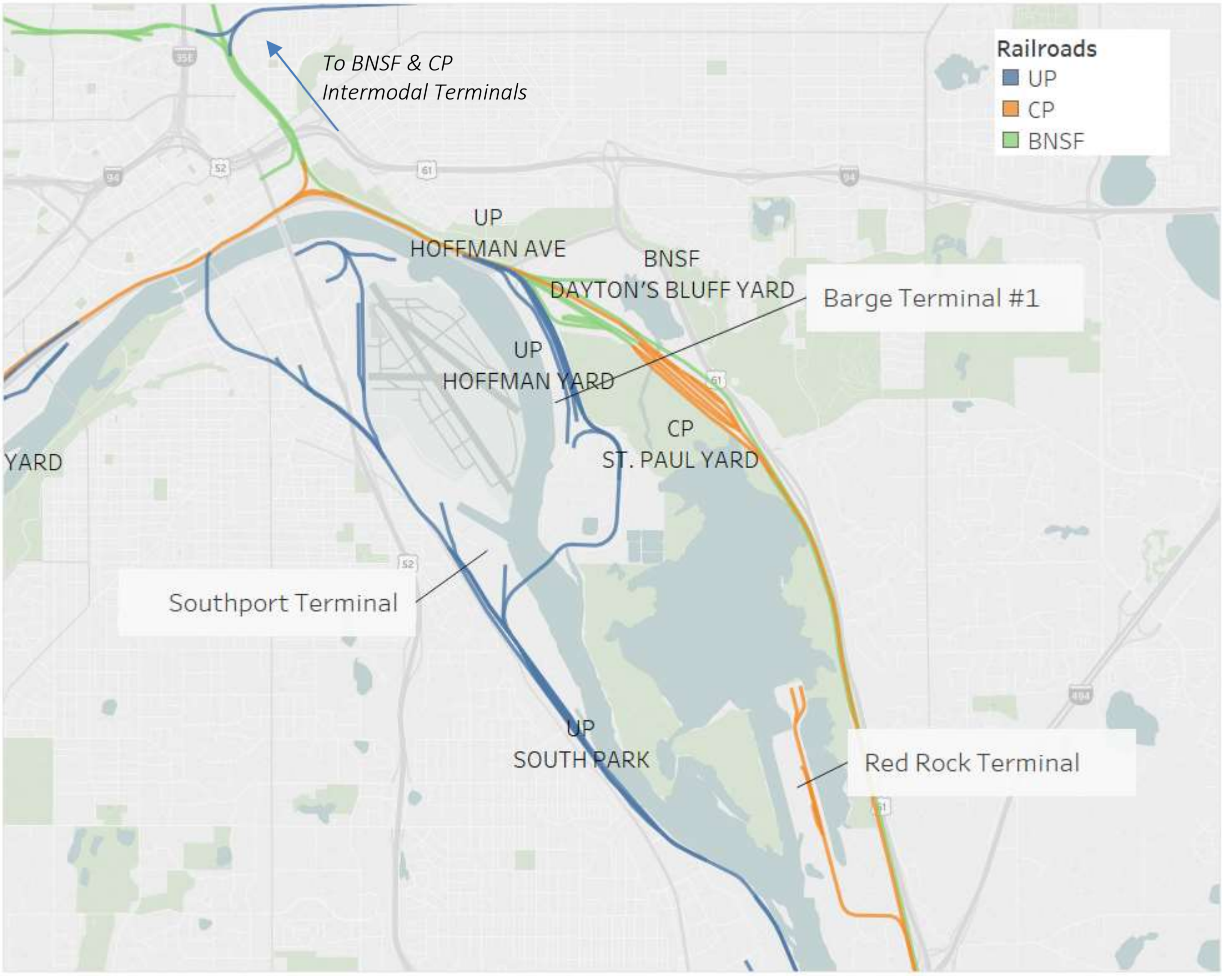

Figure 32 - Rail Service into Saint Paul Multimodal River Terminals

The three Class 1 railroads share trackage within the metro area, as well as connect to regional railroads like Twin Cities & Western Railroad (TCWR)[39] and Minnesota Prairie Line (MPLI)[40] that service Western Minnesota into South Dakota, Minnesota Commercial Railroad (MNNR) servicing within the Twin Cities Metro and Progressive Rail (PGR) with connections south of the Metro.

Figure 33 - Regional Railroad Connections to/from Twin Cities (Source: MnDOT)

The area to the east of Barge Terminal 1, Hoffman Junction, is considered a major regional rail bottleneck, where these Class 1 main lines and rail yards converge.[41] UP crosses the BNSF and CP mainlines in this area at an at grade crossing limiting capacity for all 3 railroads.

By connecting to other Class 1 (including CN to the east of the Twin Cities, and CSX and NS in Chicago) and regional railroads, metro shippers can connect via rail to locations across North America, including the East and Southeast destinations, as well as locations in Canada and Mexico (see Figure 34).

[39] TCWR receives and delivers rail traffic to the St. Paul Rail Yard for final furtherance to the Red Rock terminal by CP.
[40] MPLI is a subsidiary of TCWR. MPLI runs on track owned by Minnesota Valley Regional Railroad Authority (MVRRA).
[41] Minnesota State Rail Plan, Minnesota Department of Transportation, March 2015

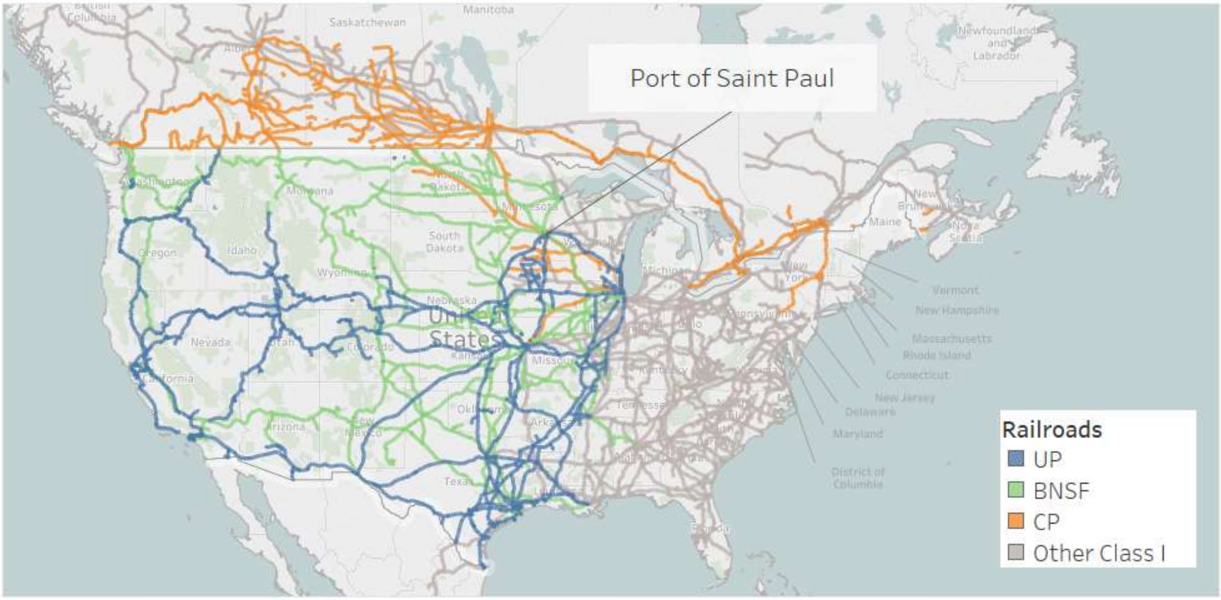

Figure 34 - Class 1 Railroad Connections from Twin Cities

The cost of rail transportation on a per ton-mile basis varies. Direct routes, where there is no switching between railroads, may be lower in cost than when 2 or more railroads are involved in providing service. Thus, routes where there is no direct service into the Saint Paul terminals could be less competitive. Rail shippers are also subject to the capacity of the individual railroads servicing their location.

The competitiveness of rail rates compared to other modes, as well as the available capacity on the regional and national rail network, varies over time. Demand for rail transportation and equipment was dominated by the oil industry for several years with the shale oil boom in North Dakota's Bakken region and other parts of the country.[42] Concurrent years of record agricultural harvests put further strain on limited rail resources. As petroleum markets decelerated in 2015, rail capacity began to free up and rail rates declined. However, with crude oil prices rebounding, the demand for crude-by-rail may increase, resulting in a corresponding increase in rail rates (see Figure 35).

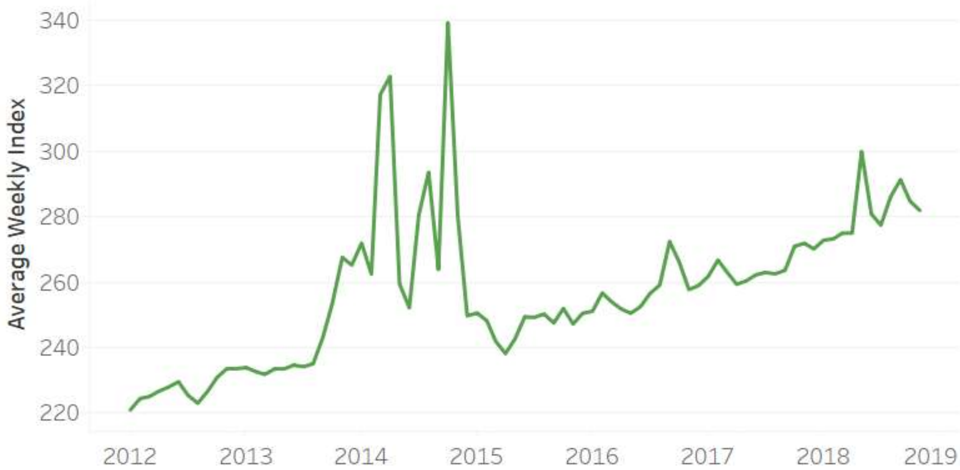

Figure 35 - USDA Grain Transportation Cost Weekly Index, Rail Unit Trains

[42] Minnesota State Rail Plan, Minnesota Department of Transportation, March 2015

Rail transportation is currently underutilized at the Saint Paul terminals versus other modes, with rail configuration presenting limitations. Spurs provide rail access to some tenant sites, but not to all sites that would like to leverage rail. In some instances, there are opportunities to extend current spurs or rehab inactive spurs to allow for more efficient loading of rail cars and/or to facilitate more direct barge-to-rail and/or rail-to-barge transfers. There are no loop tracks for unit trains and rail car storage space is limited.

Rail costs are lower when unit (vs. manifest) trains are utilized, with economies from shipping 80 to 100+ rail cars from a single origin to a single destination. An analysis of sample rail waybill data found costs for shipments over 500 miles of 1-19 rail cars with a Minnesota origin were 1.5 times more expensive than shipments with 100-119 rail cars on a per ton-mile basis.[43] The cost difference was 3.5 times more expensive in the sample data for shipments to a Minnesota destination. The limited ability to handle unit trains at Saint Paul river terminals reduces the competitiveness and efficiencies of rail. When larger trains are handled within the terminals, the cars need to be broken down into smaller segments.

At the Red Rock terminal, a spur line runs between the roadway and the tenant properties, causing potential safety issues if rail cars temporarily block road access to/from these sites. At the Southport terminal, there is an at-grade crossing of the UP main line (running into the Saint Paul Metro) across the single entrance roadway into the terminal. The crossing presents safety and efficiency concerns from potential accidents, delays and access to this industrial area for first responders in the event of an emergency.

There is no current intermodal rail service at the Saint Paul terminals. Nationally, intermodal rail is very competitive for long haul shipments over 750 miles, with a cost per ton-mile lower than truck, but higher than barge and rail carload shipments. But it generally is considered to have a shorter transit time and higher reliability than barge and rail carload. Regional shippers utilize the BNSF or CP intermodal terminals within the Twin Cities to connect to the Pacific Northwest or Chicago. However, these sites are considered at capacity, limiting incremental intermodal utilization in the area. There are also no direct intermodal connections from the Twin Cities terminals[44] or UP rail lines to key intermodal destinations in the South and Southwest, including California ports of L.A.-Long Beach which handle 54 percent of the container exports in the U.S.[45] Intermodal shippers often dray their shipments to Chicago area terminals as an alternative, due to terminal capacity constraints and where circuitous routes from the Twin Cities to key intermodal ramps reduces cost effectiveness. However, congestion in the Chicago area can increase transit time and decrease reliability. In addition, intermodal container availability locally can be an issue with the empty containers for export being concentrated in higher volume intermodal markets, like Chicago.[46]

4.3 Truck Capacity

Truck capacity is essential to all multimodal commodity movements into and out of the Saint Paul terminals. Truck has advantages for short distance and smaller shipments. Although more expensive than other modes for long-distance moves, it is considered faster, more flexible and reliable. From a resiliency perspective, there are typically more truck routing options available to avoid disruptions in the supply chain.

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[43] 2014 Confidential Rail Waybill Sample Data for Minnesota, Surface Transportation Board (STB)

[44] Intermodal ramps in the South and Southwest to/from the Twin Cities follow a circuitous vs direct route, decreasing the cost effectiveness of local intermodal service. (MnDOT, Minnesota State Rail Plan, 2015)

[45] Containerized Exports via the Inland Waterway System: An Opportunity for Agriculture?, Agribusiness Consulting, October 2018

[46] (MnDOT, 2015)

As a multimodal transportation hub, access to the Minnesota trunk highway system, regional freight network and National Highway System from the Saint Paul terminals via truck is crucial. Interstates I-94 and I-35 are accessible to the north and west of the terminals, and I-494 to the south. Terminals on the east side of the river connect via US 52 and Trunk Highway 156/Concord St, with terminals on the east side connecting via US 61/US 10 (see Figure 36).

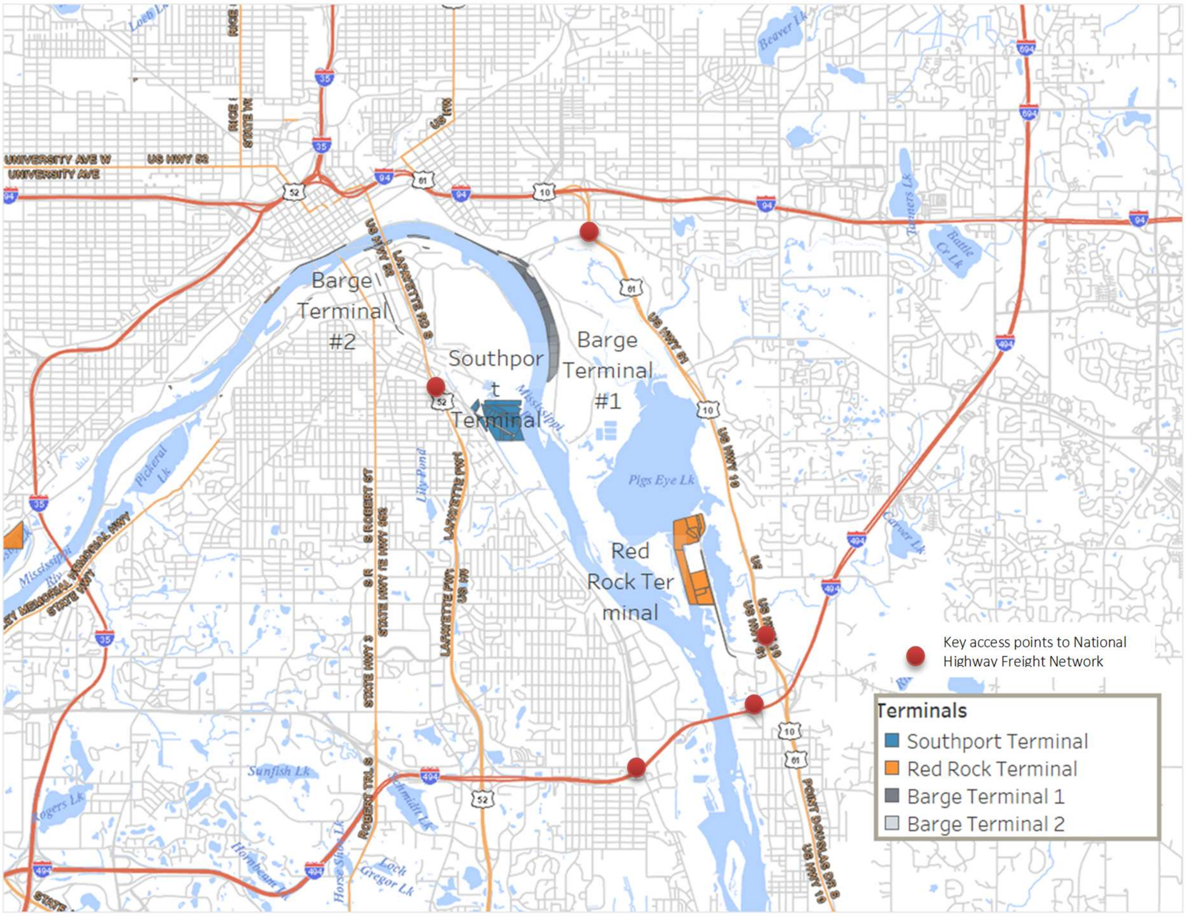

Figure 36 - Road Connections to National Freight Highway Network from Saint Paul River Terminals

Truck capacity within the terminals is also affected by the configuration and condition of roadways within individual tenant sites. The location, availability, age and condition of scales, conveyors, transload and other equipment also represent modal constraints.

With strong economic growth and corresponding freight demand, shortages of qualified truck drivers, driver turnover and lack of adequate truck parking are top issues influencing truck capacity both locally and nationally across the National Highway Freight Network.[47]

[47] American Transportation Research Institute, Critical Issues in the Trucking Industry, October 2018

4.4 First/Last-Mile Connections

The capacity, efficiency and proximity of the first/last-mile connections into the Saint Paul terminals affects the economic competitiveness and reliability of all terminal transportation and service options, as well as having safety, environmental and quality of life impacts on the local area. Constraints in these connections to each of the terminals from the national highway network include:

- Traffic congestion and backups
- Road/intersection configuration and traffic controls
- At grade rail crossings
- Number of terminal access points

The Metropolitan Council's Regional Truck Highway Corridor Study outlines the criticality of these first/last- mile connections into the Port and other freight facility destinations to the economic competitiveness of the Twin Cities.[48] Southport Terminal is accessible northbound or southbound from TH156/Concord St. via Barge Channel Road. Considered a Tier One truck corridor under the corridor study,[49] and ranked 17th as a top crash hotspot,[50] trucks back up on TH156. This traffic congestion is exacerbated by trains blocking Barge Channel Road at an at grade crossing of the UP main line. Delays can occur at the crossing based on the combined length and speed of trains, from train operations at the UP South St. Paul rail yard, as well as conflicts between barge traffic and the rail traffic on a bridge over the Mississippi River.[51] This congestion affects surrounding residential neighborhoods, industrial businesses in and around the terminal, as well as passenger and freight users of the roadway. The lack of an alternate exit from the terminal affects capacity, reliability and safety, as well as redundancy. The curve and width of the roadway at the at grade crossing also do not meet current design standards.

Similar constraints exist at the Red Rock Terminal with a single roadway into the main terminal and at grade crossing of single driveway access points into tenant sites.

At Barge Terminal 1, the current configuration of the Childs Road off ramp, the at grade rail crossings at Warner Road,[52] as well as the timing and configuration of the traffic signals connecting Warner Road to US 61/US 10, limit capacity and result in similar issues with backups, reduced freight efficiencies and potential safety concerns. With the closure of the Port of Minneapolis and the Upper St. Anthony Falls lock on the Mississippi River, redirected traffic has resulted in a significant increase in truck volumes moving aggregate and scrap metal to access the river at Barge Terminal 1, instead of in Minneapolis.[53]

Capacity at each of the terminals is affected by roadway conditions. Ongoing maintenance is required to address areas with deteriorating pavement and road debris to maintain current freight volumes and mitigate environmental impacts. In addition, upgrading pavement to 10-ton standards, where needed, is necessary to increase capacity and competitiveness to capture additional freight flows.

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[48] Metropolitan Council, Regional Truck Highway Corridor Study, May 2018
[49] Based on truck volume and proximity to freight facilities and terminals
[50] Based on maximum crash density by delay/hotspot
[51] Southport Industrial District Study, City of Saint Paul, October 2017
[52] Warner Road is known as Shepard Road east of US 52.
[53] Regional Truck Highway Corridor Study, Metropolitan Council, May 2018

4.5 Ocean Port Capacity

With a large portion of Minnesota's products ultimately destined for export, ocean port capacity also has an impact on freight costs and performance for regional shippers. It is a function of a variety of factors including:

- Channel depth, berth length, lift type and capacity for different types of ocean vessels
- Capacity of barge, truck and rail connections into the port facility
- Transload and equipment capacity
- Warehousing and container space
- Inbound/outbound scheduling of ocean vessels and other modes within terminal
- Weather and other external factors

Without investments in capacity and infrastructure, congestion, delays and reliability become key concerns for shippers utilizing top bulk and container ports. For example, at the Ports of Los Angeles/Long Beach, congestion and increased dwell time are ongoing issues that have been further exacerbated by other external factors, such as weather delays and labor disputes. Congestion concerns have also been noted by shippers moving commodities through Gulf Coast ports. With the high volume of barge shipments through Louisiana, it can be a choke point for shippers with maintenance of locks, shipping channels and other aging infrastructure being key variables affecting performance and reliability. In addition, severe weather events can have a major impact on any port, with Hurricane Harvey disrupting rail shipments through Texas, for example, in 2017. As shippers experience these issues, they seek alternatives ports and routes.

A recent infrastructure change affecting the utilization of different U.S. ocean ports is the Panama Canal lock expansion was completed in 2016. The expansion increased the maximum vessel size that can pass through the canal from a Panamax 5,000 TEU[54] cargo capacity standard to a New Panamax standard with 13,000 TEU cargo capacity. The Panamax expansion further increases the capacity and competitiveness of ocean shipments to Asian destinations via East and Gulf Coast ports, with many of these ports increasing channel depth and making other changes to accommodate additional volume post-expansion.

4.6 Other Constraints

Inventory or storage capacity has a direct impact on transportation capacity at the river terminals across all modes. Transload capacity between truck, barge and rail is constrained by storage capacity during peak demand periods (e.g. to handle volumes of seasonal commodities, like fertilizer, or to manage the spring backlog of barges after a winter river closure). Available storage capacity also has a strong influence on shipper economics and mitigates seasonality. For commodities like grain with low inventory costs, this flexibility is important to manage the timing of shipments to take advantage of higher commodity market prices and/or lower transportation costs. For example, with available storage capacity, shippers may wait until spring or early summer to ship commodities via barge versus ship in winter at higher rail rates. Limited covered storage and lack of warehousing facilities within the terminals limit the types of commodities stored and services provided.

Periodic flooding or drought can disrupt river shipping with fluctuating water levels,[55] as well as tenant operations at the terminals. Given the nature of river operations, flood management and any portions of property designated as flood plains affect operational requirements and risks at the port, as well as limit utilization of certain property areas. With ongoing changes in climate conditions, planning efforts should incorporate flood risk mitigation efforts. In the spring of 2019, historic flooding on the Upper Mississippi River disrupted barge freight shipments to/from the region for an extended period from March to June,

[54] TEU = Twenty-Foot Equivalent Unit representing typical size of import/export container (20 ft X 8 ft)
[55] (MnDOT, 2014)

having a negative economic impact on the agricultural sector in particular.[56] The inability to ship agricultural commodities from last fall's harvest down the Mississippi River to export markets in the spring put further strain on the agricultural supply chain, with lack of bulk storage capacity becoming a critical issue, and ripple effects to other sectors as typical barge shipments were diverted to rail and truck.

Land use constraints also affect terminal capacity. There is a lack of open space for expansion within the terminals. All existing sites are leased to tenants on long-term leases. However, there are sites that are currently underutilized by existing tenants, which could be subleased and/or redeveloped. There are also tenant sites that could be better utilized by internal site reconfiguration, modernizing storage and other facilities to maximize throughput and capacity.

Some sites could be redeveloped for alternative use upon tenant turnover that leverage key characteristics of the site, such as river and rail access for freight transportation. With limited industrial-zoned property in the City of Saint Paul and surrounding area and increased competition from alternative residential, commercial and recreational uses,[57] it is important to maximize the utilization of these industrial areas to provide business with access to competitive freight shipping options, while meeting the overall demand for industrial space. Both needs are key to local economic development goals, including job creation and job accessibility from neighborhoods and communities in Saint Paul.[58]

The Saint Paul terminals also include and/or are adjacent to wetlands and other environmentally-sensitive areas. This topography affects the placement of transportation and operational infrastructure. The environmental impact or risks of the tenant operations, including air quality, water quality, management of hazardous materials, etc., are key considerations in any development or maintenance efforts within the terminals or on the river.

In addition, any impact on neighboring communities and input from community groups needs to be considered from both a quality of life and economic development perspective. The effect of current and future operations on these neighborhoods, as well as communication and education of changes, risks and benefits, is essential to implementation activities. Air quality issues, such as fugitive dust from terminal operations, are key considerations, as well as traffic and safety impacts on the local community.[59] The balance between maintaining the working river and the environmental and recreation needs of the community are key goals in the City of Saint Paul Comprehensive Plan.[60]

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[56] https://www.mprnews.org/story/2019/05/18/flooding-disrupts-barge-traffic-on-mississippi-river
[57] (MnDOT, 2014)
[58] An Industrial Study for Saint Paul, ICIC, May 2012
[59] Southport Industrial District Study, City of Saint Paul, October 2017
[60] Great River Passage Master Plan, Addendum to City of Saint Paul Comprehensive Plan, April 2013

5. Optimizing the Regional Supply Chain

Leveraging the results of the Port Optimization Model, this section:

- Examines the potential freight efficiencies for regional Minnesota shippers with greater utilization of lower cost transportation options for the in-scope commodities;
- Outlines recommended implementation steps to facilitate these incremental freight movements via the multimodal hubs at the Port of Saint Paul; [61] and
- Provides an overview of the business case to support the infrastructure investments in the Port of Saint Paul's supply chain network to provide capacity and alleviate constraints to support the incremental freight movements.

5.1 Freight Shipping Efficiency Opportunities

When making transportation modal decisions, organizations balance two key factors, cost and performance. An optimal network minimizes transportation costs, while delivering acceptable levels of performance, driven by speed, flexibility and reliability. As shippers strive to increase their competitiveness in the global marketplace, the most efficient choice may involve the utilization of multiple modes between origin and destination.

Figure 37 illustrates the high-level relationship between performance attributes and cost attributes across modes. For the bulk commodities within the study scope, where cost factors outweigh performance, opportunities exist to increase freight shipping efficiencies by increasing utilization of lower cost modal options, including barge, rail and intermodal rail.

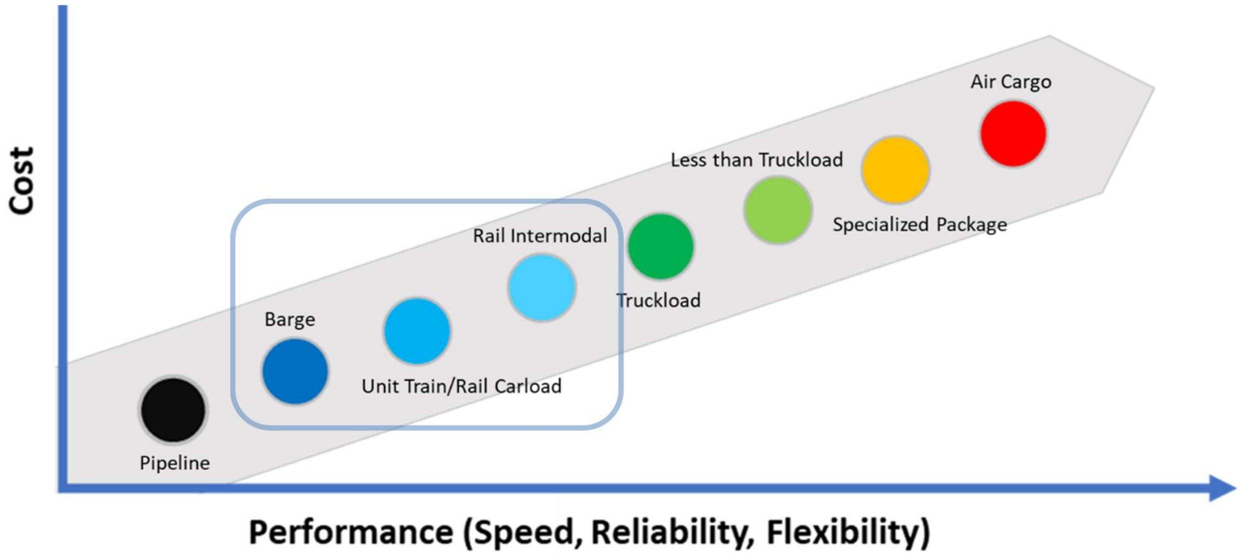

Figure 37 - Modal Service Attributes and Cost

In general, the business case for mode efficiency and conversion opportunities from truck to alternative modes increases with corresponding increases in the total shipment distance. However, costs and efficiencies depend on the specific lanes, commodities and/or combinations of modes utilized. Utilizing the Port Optimization Model, a series of scenarios were run and analyzed to identify the opportunities for

[61] Within this report, references to "incremental freight movements" represent opportunities to move additional tons of commodities beyond the current freight volumes that flow via a particular mode, route and/or facility today.

freight shipping efficiencies in greater depth, based on these more complex factors. The scenarios included:

- Domestic freight shipments direct to/from the Twin Cities
- Domestic freight shipments to/from Minnesota via the Twin Cities as a transload hub
- Import/export shipments to/from Minnesota via the Twin Cities as a transload hub
- Domestic intermodal shipments via the Twin Cities as an intermodal hub

Table 8 and the following section outline the more than 28 million tons and $700 million in potential shipping efficiencies for transportation of in-scope commodities for Minnesota shippers across these optimization scenarios. Eighty-seven percent (87%) or 24.6 million tons of the shipments deliver potential savings over $5.00 per ton, representing a greater likelihood for modal conversion.

	Total Market Opportunity		Target Opportunity > $5 Savings per Ton	
Freight Optimization Scenarios	Tonnage	Savings ($)	Tonnage	Savings ($)
Twin Cities Direct Domestic Optimization Opportunities	7.6M	$199.8M	7.3M	$198.4M
Minnesota Domestic Optimization Opportunities via Twin Cities Transload Hub	14.9M	$282.2M	12.1M	$276.4M
Minnesota Import/Export Optimization Opportunities via Twin Cities Transload Hub	5.6M	$218.6M	5.2M	$217.7M
Total In-Scope Commodity Optimization Opportunities	28.1M	$700.6M	24.6M	$692.6M
Incremental Minnesota Intermodal Opportunities via Twin Cities Intermodal Hub	9.7M	379.6M	8.3M	376.2M
Total Optimization Opportunities	37.8M	1,080.2M	32.9M	1,068.8M

Table 8 - Summary of Optimization Scenario Opportunities by Tonnage and Savings

An incremental 9.7 million tons in potential containerized commodities represent $379.6 million in possible savings from increased intermodal rail utilization through the Twin Cities, with 85 percent (or 8.3 million tons) delivering savings of at least $5 per ton.

The following subsections will detail the specific assumptions and opportunities with each of these scenarios.

5.1.1 Twin Cities Domestic Freight Flows

There are nearly 45 million tons of the in-scope commodities flowing to/from the Twin Cities across high volumes lanes between domestic origins and destinations with 70 percent moving via truck today. The optimization scenarios analyze the potential savings for Twin Cities shippers by moving these commodities via barge or rail from domestic origin to domestic destination (see Figure 38) by comparing the transportation costs by mode between the same locations.

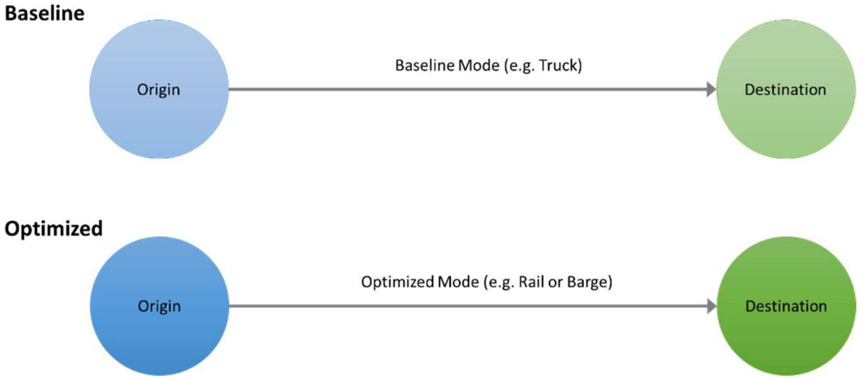

Figure 38 - Direct Domestic Freight Flow Optimization Scenario between Same Origin and Destination

Savings opportunities exist where the transportation cost for the baseline mode (e.g. truck) exceed the transportation cost for an alternative optimized mode (e.g. barge or rail).

i.e. where $\text{Cost}_{\text{baseline}} > \text{Cost}_{\text{optimized}}$

Table 9 outlines the tonnage and cost savings opportunity for Twin Cities' shippers by commodity identified by the Port Optimization Model. It identifies a potential of 3.0 million outbound tons and 4.7 million inbound tons (or 17 percent of total commodity flows to/from the Twin Cities) that have the potential to be converted from truck to more efficient barge or rail multimodal options, with a distance between origin and destination of 250 miles or greater.

Outbound Optimization Opportunities to Twin Cities

Base Mode	Optimized Mode	Tonnage	Total Savings	Total Distance
1-Truck	2-Rail	2.7M	$83.8M	589
	3-Barge	0.2M	$15.9M	973
Grand Total		3.0M	$99.7M	601

Inbound Optimization Opportunities to Twin Cities

Base Mode	Optimized Mode	Tonnage	Total Savings	Total Distance
1-Truck	2-Rail	4.2M	$88.1M	692
	3-Barge	0.5M	$12.0M	801
Grand Total		4.7M	$100.1M	698

Table 9 - Domestic Truck to Rail/Barge Optimization Opportunities by Tonnage to/from Twin Cities[62]

[62] All optimization results for the Twin Cities scenario is based on distances between Origin-Destination pairs greater than 250 miles.

The top opportunities exist for agricultural products, base metals, fertilizer, stone and gravel (see Figure 39).

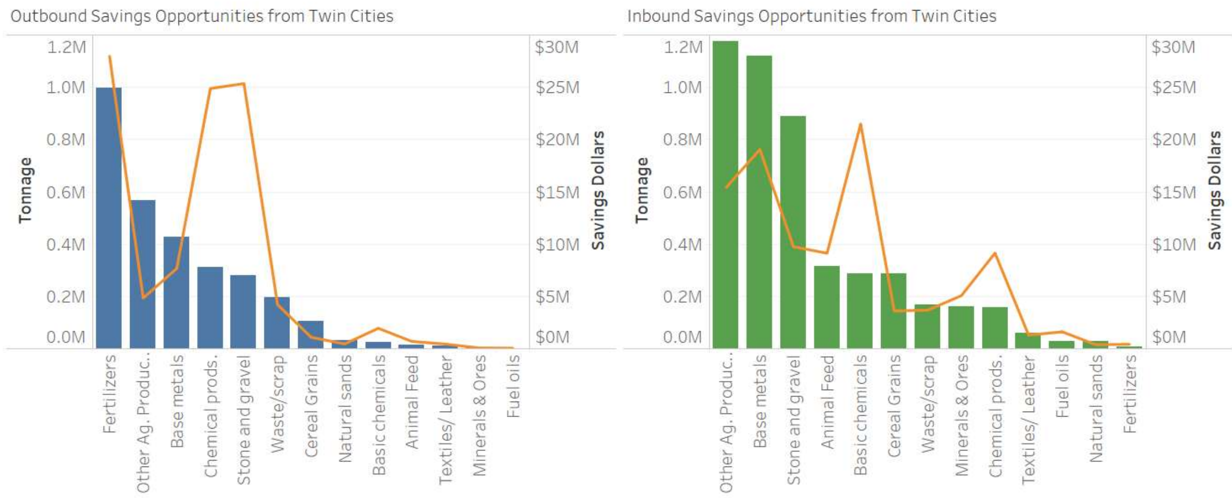

Figure 39 - Direct Optimization Opportunities by Commodity to/from Twin Cities[62]

Table 10 outlines the cost per ton-mile savings achievable by shifting specific lanes and commodities to more efficient barge and rail multimodal options. Shipping costs reduce from $0.11-$0.14 to a range of $0.02- $0.06 per ton-mile (CPTM) with a shift from truck to rail or barge. Focusing solely on domestic opportunities to and from the region, shifting from truck to barge/rail represents a potential of $199.8 million in savings.

Outbound Optimization Opportunities to Twin Cities

Base Mode	Optimized Mode	Base CPTM	Optimized CPTM	Savings per Ton
1-Truck	2-Rail	$0.14	$0.06	$37.49
	3-Barge	$0.11	$0.02	$38.63
Grand Total		**$0.14**	**$0.06**	**$37.52**

Inbound Optimization Opportunities to Twin Cities

Base Mode	Optimized Mode	Base CPTM	Optimized CPTM	Savings per Ton
1-Truck	2-Rail	$0.13	$0.06	$35.48
	3-Barge	$0.11	$0.02	$33.51
Grand Total		**$0.13**	**$0.06**	**$35.37**

Table 10 - Domestic Truck to Rail/Barge Optimization Opportunities by Cost per Ton-Mile to/from Twin Cities[62]

Geographically, the opportunities are concentrated in northwestern Minnesota and neighboring states followed by longer distance moves to Louisiana, Texas and Washington.

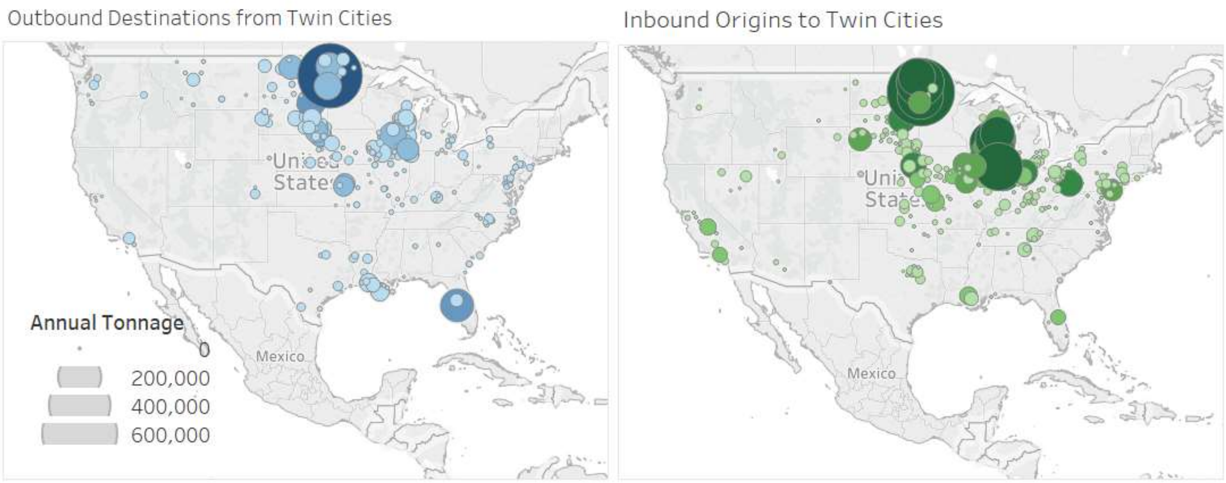

Figure 40 - Direct Optimization Opportunities by Origin/Destination to/from Twin Cities[62]

Top Outbound Opportunities by State from Twin Cities

Dest State	Tonnage	Total Savings	Avg. Base Distance	Base CPTM	Optimized CPTM	Savings per Ton
MN	706.5K	$7.1M	311	$0.12	$0.07	$12.29
WI	466.7K	$9.5M	305	$0.15	$0.07	$23.35
LA	150.6K	$15.5M	1,210	$0.16	$0.08	$74.68
TX	31.2K	$1.7M	1,188	$0.16	$0.11	$48.14
WA	16.1K	$1.7M	1,693	$0.14	$0.09	$88.27
Grand Total	1,371.2K	$35.5M	1,117	$0.15	$0.08	$61.70

Top Inbound Opportunities by State to Twin Cities

Orig State	Tonnage	Total Savings	Avg. Base Distance	Base CPTM	Optimized CPTM	Savings per Ton
MN	1,130.9K	$11.0M	313	$0.12	$0.08	$10.96
WI	1,089.0K	$12.9M	295	$0.13	$0.07	$15.02
IA	313.7K	$6.6M	319	$0.15	$0.06	$23.89
SD	282.9K	$4.8M	381	$0.14	$0.06	$27.24
LA	49.6K	$4.8M	1,189	$0.12	$0.05	$81.58
Grand Total	2,866.0K	$40.2M	350	$0.13	$0.07	$20.94

Table 11 -Top Direct Optimization Opportunities by State to/from Twin Cities[62]

Rail is more efficient when a unit train shipment can be leveraged and/or where a single railroad can carry the shipment from origin to destination. Additional scenarios were run to examine the price sensitivity between barge and rail. When rail prices decrease by 33 percent to reflect unit train efficiencies, there is a corresponding increase in savings by 38 percent or $76.5 million in the optimization scenario. Total tonnage remains at 7.7 million tons with an 8 percent increase in rail versus barge. However, with seasonal reductions in barge pricing, barge remains highly competitive against rail and retains the same optimal modal mix between rail and barge. As rail prices increase, rail opportunities decrease. With a 133 percent increase in rail pricing, there is a 73 percent increase in savings and a 77 percent decrease in rail tonnage. Barge opportunities remain relatively consistent, once river accessible freight market share is captured.

5.1.2 Minnesota Freight Flows via Twin Cities Transload Hub

There is incremental potential for regional shippers outside the Twin Cities to leverage barge or rail services via a multimodal hub in the Twin Cities by **transloading**. In these instances, shippers in outstate Minnesota may not have direct or cost-effective access to barge or rail locally. At a transload facility, commodities can be transferred from one mode to another between origin and destination. Transload facilities typically handle truck-to-rail, truck-to-barge and/or rail-to-barge operations.

There is an incremental 418 million tons of in-scope commodities flowing to/from Minnesota counties outside the Twin Cities across high-volume domestic lanes today. Optimization scenarios were developed to analyze the potential transportation cost savings by comparing the direct cost of transportation ($Cost_{baseline}$) via a single mode and comparing it to optimized cost via a hub utilizing multiple modes (see Figure 41):

i.e. where $Cost_{optimized}$

= The transportation cost from origin to a transload hub via 1st mode ($Cost_{mode1}$)

+ The transload cost to transfer from 1st to 2nd mode at the transload hub ($Cost_{transload}$)[63]

+ The transportation cost of 2nd mode from the transload hub to the destination ($Cost_{mode2}$)

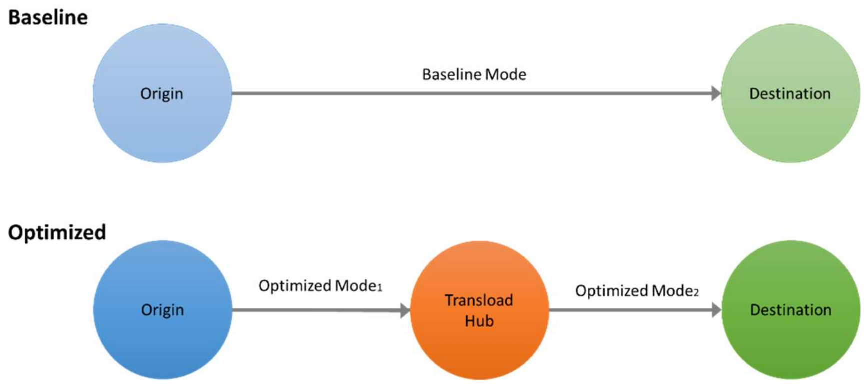

Figure 41 – Domestic Freight Flow Optimization Scenario via Transload Hub

Table 12 highlights the tonnage and cost savings opportunity for Minnesota shippers identified utilizing the Twin Cities as a transload hub for barge or rail. It identifies a potential of 7.0 million outbound tons and 7.9 million inbound tons that have the potential to leverage more efficient barge or rail multimodal options via a multimodal hub.

Transload - Outbound Domestic Destinations from MN

Mode 2	Tonnage	Total Savings	Avg. Total Distance	Distance to Hub
2-Rail	2.6M	$81.0M	653	87
3-Barge	4.4M	$57.8M	1,216	68
Grand Total	**7.0M**	**$138.8M**	**707**	**86**

Transload - Inbound Domestic Origins by Tonnage to MN

Mode 1	Tonnage	Total Savings	Avg. Total Distance	Distance from Hub
2-Rail	4.7M	$98.0M	760	113
3-Barge	3.3M	$45.3M	732	111
Grand Total	**7.9M**	**$143.3M**	**754**	**113**

Table 12 - Domestic Optimization Opportunities by Tonnage to/from Minnesota via Twin Cities Hub

63 An average cost of $8.00 per ton is used in the analysis for transload between truck, rail and/or barge.

Top transload opportunities by commodity tonnage include minerals and ore, agricultural products, base metals, animal feed and cereal grains (see Figure 42).

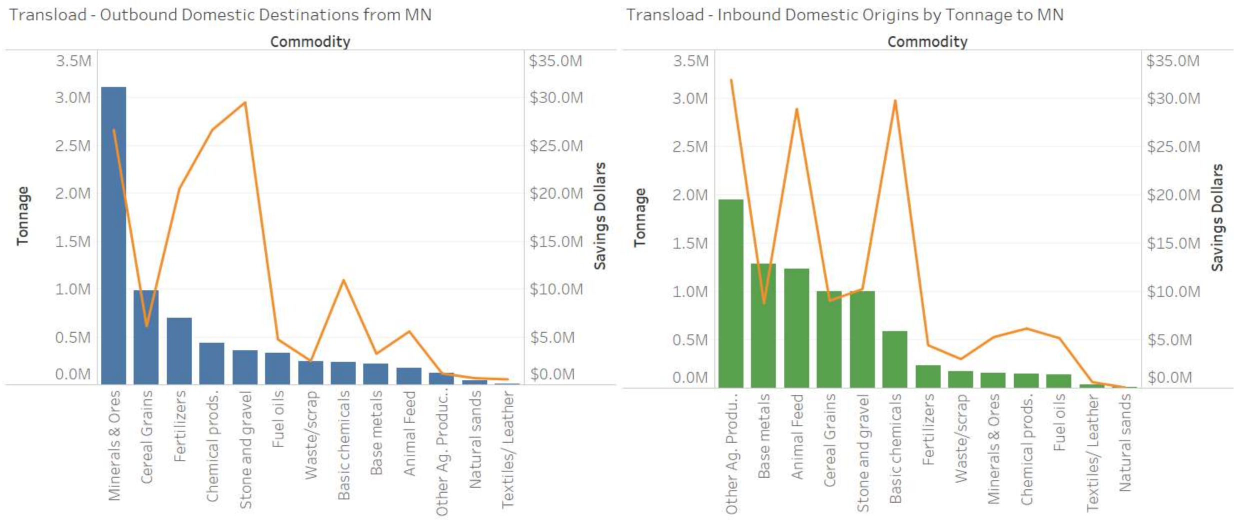

Figure 42 – Domestic Transload Optimization Opportunities by Commodity to/from Minnesota

Table 13 illustrates the cost per ton-mile savings achievable by shifting specific lanes and commodities to more efficient barge and rail multimodal options. Shipping costs reduce from a baseline $0.10 to $0.17 per ton-mile to an optimized cost per ton-mile of $0.03 to $0.08. This scenario represents a potential of $282 million in savings.

Transload - Outbound Domestic Destinations from MN

Mode 2	Base CPTM	Optimized CPTM	Savings per Ton
2-Rail	$0.17	$0.08	$32.52
3-Barge	$0.10	$0.03	$29.43
Grand Total	**$0.16**	**$0.07**	**$32.22**

Transload - Inbound Domestic Origins to MN

Mode 1	Base CPTM	Optimized CPTM	Savings per Ton
2-Rail	$0.16	$0.07	$30.41
3-Barge	$0.11	$0.04	$15.32
Grand Total	**$0.15**	**$0.07**	**$27.12**

Table 13 - Domestic Optimization Opportunities by Cost per Ton-Mile to/from Minnesota via Twin Cities Hub

Top origins and destinations include a variety of locations across neighboring states, including Iowa, Illinois and Wisconsin, with concentrated volumes in ocean port locations in Louisiana, Texas and Washington, as well as near St. Louis, as displayed in Figure 43 and quantified in Table 14.

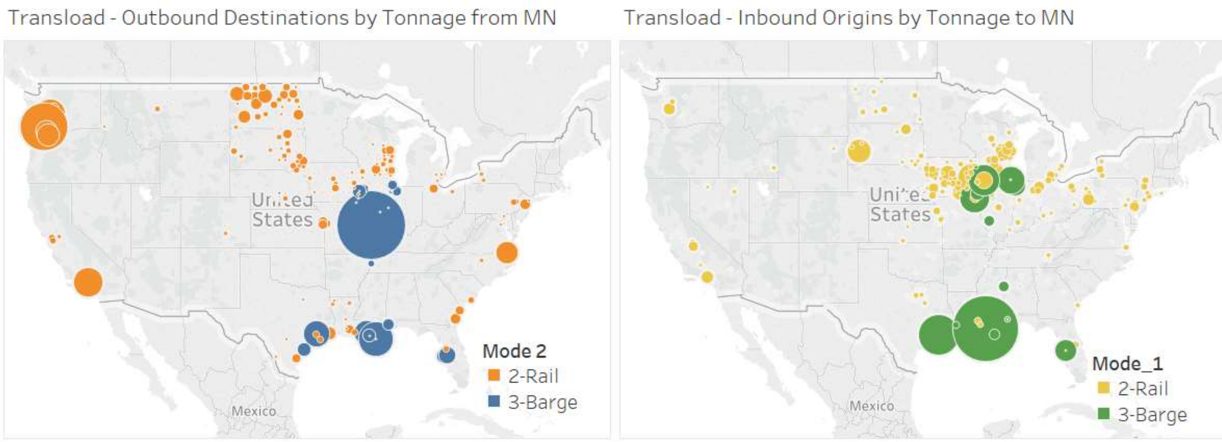

Figure 43 - Transload Optimization Opportunities by Origin/Destination to/from Minnesota

Transload - Outbound Domestic Destinations from MN

Dest St..	Tonnage	Total Savings	Avg. Distance
IL	3,305.1K	$28.2M	836
WI	342.8K	$10.5M	417
LA	295.0K	$16.4M	1,402
WA	3.6K	$0.5M	1,788
Grand Total	**3,946.6K**	**$55.6M**	**675**

Transload - Inbound Domestic Origins by Tonnage to MN

Orig St..	Tonnage	Total Savings	Avg. Distance
IA	3,801.5K	$48.66M	535
WI	740.5K	$12.52M	501
TX	179.7K	$6.44M	1,233
LA	109.1K	$6.24M	1,555
Grand Total	**4,830.7K**	**$73.85M**	**575**

Table 14 - Top Transload Optimization Opportunities by State to/from Minnesota

The opportunities to utilize the Twin Cities as a transload hub for barge and rail exists across Minnesota shipments. The distance travelled to/from the transload hub varies (see Table 12) with outbound shipments averaging 86 miles from a Twin Cities hub and 113 miles from the hub for inbound shipments. The range of distance from the hub is 7 to 505 miles with volumes concentrated closer to the hub. Although outside the scope of the analysis, it is expected that there are also incremental opportunities in neighboring states, such as Wisconsin, within a similar radius of the hub.

Incremental transload opportunities also exist between Minnesota and U.S. ocean ports by evaluating the domestic leg of import/export shipments.[64] Potential opportunities of 3.1 million tons exist for truck-to-rail or truck-to-barge conversion, as well as rail-to-barge (see Table 15) for top import/export commodities included in the study scope.[65]

[64] Analysis focuses on the domestic leg only of import/export shipments via truck, rail and/or barge. An import/export shipment is identified as a shipment with a foreign origin or destination.

[65] Section 5.1.3 identifies incremental opportunities for import/export considering both the domestic and international shipment legs. To avoid double counting of opportunities, the import/export domestic leg opportunities are not included in figures summarizing total optimization opportunities.

Transload - Outbound Import/Export Destinations from MN

Base Mode 1	Mode 2	Tonnage	Total Savings	Distance to Hub
1-Truck	2-Rail	0.7M	$86.3M	157
	3-Barge	0.5M	$67.1M	155
Grand Total		1.2M	$153.4M	156

Base Mode 1	Mode 2	Tonnage	Total Savings	Distance to Hub
2-Rail	3-Barge	0.8M	$57.4M	159

Transload - Inbound Import/Export Origins by Tonnage to MN

Base Mode 2	Mode 1	Tonnage	Total Savings	Distance from Hub
1-Truck	2-Rail	0.10M	$10.7M	166

Base Mode 2	Mode 1	Tonnage	Total Savings	Distance from Hub
2-Rail	3-Barge	1.02M	$137.9M	146

Table 15 - Optimization Opportunities by Tonnage for Domestic Leg of Minnesota Import/Export Shipments via Twin Cities Hub

The inbound opportunity highlights an opportunity to shift over 1.0 million tons from rail-to-barge from ports in Louisiana to Minnesota, with some smaller truck-to-rail conversion opportunities to Washington ports on the West Coast. On the inbound side, limited truck-to-rail conversion opportunities exist across key West and East Coast ports, with greater opportunities for barge in Louisiana, Alabama and Texas (see Table 16).

Transload - Outbound Import/Export Destinations from MN

Base Mode 1	Mode 2	Base Port State	
1-Truck	2-Rail	CA	0.10M
		GA	0.09M
		NJ	0.06M
		OH	0.04M
		OR	0.07M
		SC	0.02M
		VA	0.18M
		WA	0.17M
	3-Barge	AL	0.05M
		LA	0.43M
Grand Total			1.22M

Base Mode 1	Mode 2	Base Port State	
2-Rail	3-Barge	LA	0.63M
		TX	0.12M
Grand Total			0.75M

Transload - Inbound Import/Export Origins to MN

Base Mode 2	Mode 1	Base Port State	
1-Truck	2-Rail	WA	0.10M

Base Mode 2	Mode 1	Base Port State	
2-Rail	3-Barge	LA	1.02M

Table 16 - Optimization Opportunities by Port State for Domestic Leg of Minnesota Import/Export Shipments via Twin Cities Hub

5.1.3 Import/Export Freight Flows via Twin Cities Multimodal Hub and Ocean Ports

The prior section analyzed potential efficiencies for the domestic leg only of import/export freight flows between Minnesota and U.S. ocean ports. Incremental scenarios were run to identify additional opportunities by evaluating the entire trip between Minnesota and foreign origins/destinations. The analysis looks at both the domestic leg, as well as the international leg of the shipment between U.S. ocean ports and key foreign ocean ports. It also considers the use of alternative U.S. ocean ports, not just alternative modes between Minnesota and the ocean ports (see Figure 44).

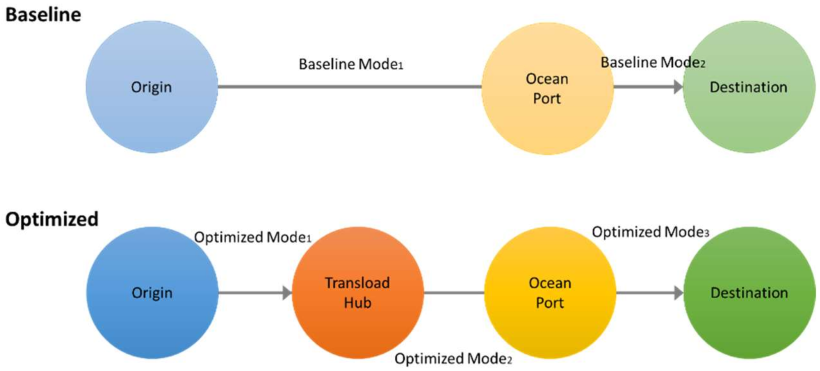

Figure 44 - Import/Export Freight Flow Optimization Scenario via Transload Hub and Domestic Ocean Port

The import/export optimization scenarios analyze the potential transportation cost savings by comparing the baseline cost of transportation via the existing route/ocean port ($Cost_{baseline}$) and comparing it to the optimized cost via an alternative route/ocean port, while utilizing the Twin Cities as a transload hub between domestic modes:

i.e. where $Cost_{optimized}$
= The transportation cost between domestic location and the transload hub ($Cost_{mode1}$)
+ The transload cost to transfer to/from barge or rail at the transload hub ($Cost_{transload}$)
+ The transportation cost between the transload hub and domestic ocean port ($Cost_{mode2}$)
+ The transportation cost between domestic ocean port and international port ($Cost_{ocean}$)[66]

This analysis identifies over 3.4 million outbound tons and 2.2 million inbound tons with over $218 million in potential savings for international shipments leveraging a Twin Cities transload hub (see Table 17).

Export Opportunities - Outbound Destinations from MN

Mode_2	Tonnage	Total Savings	Total Distance	Distance to Hub
2-Rail	2.9M	$104.8M	8,320	96
3-Barge	0.5M	$28.5M	4,332	94
Grand ..	3.4M	$133.3M	7,671	95

Import Opportunities - Inbound Destinations to MN

Mode_2	Tonnage	Total Savings	Total Distance	Distance from Hub
2-Rail	0.5M	$43.8M	7,801	88
3-Barge	1.7M	$41.6M	6,708	101
Grand ..	2.2M	$85.4M	7,305	94

Table 17 - Import/Export Optimization Opportunities by Tonnage to/from Minnesota via Twin Cities Hub

Cost per ton-mile decreases from $0.03 to $0.02 per ton-mile over the entire trip between Minnesota and the foreign origin/destination. However, with an average shipment distance over 7000 miles, the savings on a per ton basis averages over $50 per ton (see Table 18).

[66] Ocean transportation rates include cost to transfer commodities to/from a domestic mode to an ocean vessel.

Export Opportunities - Outbound Destinations from MN

Mode_2	Base CPTM	Optimized CPTM	Savings per Ton
2-Rail	$0.02	$0.02	$50.34
3-Barge	$0.04	$0.03	$47.83
Grand Total	**$0.03**	**$0.02**	**$49.93**

Import Opportunities - Inbound Destinations to MN

Mode_2	Base CPTM	Optimized CPTM	Savings per Ton
2-Rail	$0.03	$0.02	$68.45
3-Barge	$0.03	$0.02	$38.08
Grand Total	**$0.03**	**$0.02**	**$54.53**

Table 18 - Import/Export Optimization Opportunities by Cost per Ton-Mile to/from Minnesota via Twin Cities Hub

The potential savings are driven by more efficient modal utilization, as well as changes in route via alternative U.S. ocean ports. The top opportunities for import/export mode conversion are mapped in Figure 45.

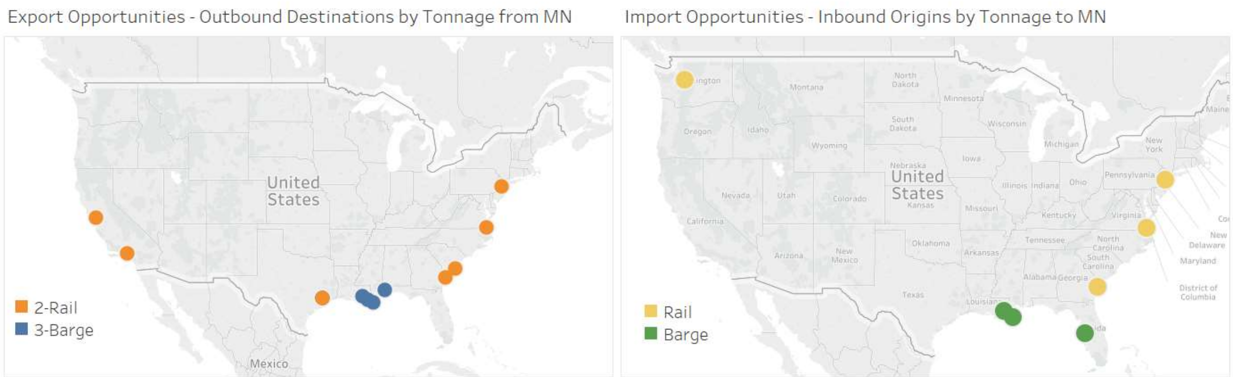

Figure 45 - Import/Export Optimization Opportunities by Origin/Destination to/from Minnesota

The analysis identifies optimization opportunities for barge via Louisiana to Central and South America, via Louisiana from Asia-Pacific, and via Florida from the Caribbean, as well as for rail routed through the Port of New York-New Jersey (NY-NJ) versus West and Gulf coast ports (see Table 19).

Export Opportunities - Outbound Destinations by Tonnage from MN

Opt. Port State	Opt. Mode	Export Countries	Base Port State	Base Mode	Tonnage	Total Savings
LA	3-Barge	Central & South A..	LA	1-Truck	0.1M	$7.8M
NJ	2-Rail	Asia-Pacific	CA	1-Truck	0.1M	$5.5M
			LA	1-Truck	0.1M	$10.5M
				2-Rail	0.3M	$5.7M
				3-Barge	0.1M	$1.0M
			VA	1-Truck	0.1M	$7.9M
			WA	1-Truck	0.2M	$18.0M
				2-Rail	1.4M	$23.5M
Grand Total					2.4M	$79.8M

Import Opportunities - Inbound Destinations to MN

Opt. Port State	Opt. Mode	Export Countries	Base Port State	Base Mode	Tonnage	Total Savings
LA	3-Barge	Asia-Pacific	LA	2-Rail	0.7M	$15.5M
			TX	1-Truck	0.2M	$5.1M
				2-Rail	0.4M	$11.9M
NJ	2-Rail	Asia-Pacific	CA	1-Truck	0.1M	$6.3M
			LA	2-Rail	0.1M	$11.6M
			TX	2-Rail	0.1M	$9.4M
			WA	1-Truck	0.1M	$6.1M
FL	3-Barge	Caribbean	FL	2-Rail	0.2M	$4.5M
Grand Total					1.8M	$70.5M

Table 19 - Top Import/Export Optimization Opportunities by State and Foreign Region

The choice of port, however, is highly sensitive to the relative cost of barge versus rail, the cost of rail between lanes, as well as the competitiveness of ocean rates from major U.S. ports to top foreign destinations. As rail and barge transportation rates change due to marketplace changes or seasonal fluctuations, the optimal route and/or mode combination may shift.

Additional rail price sensitivity analysis was performed to examine the competitiveness of transport costs on a per ton basis between East and West Coast rail services and Gulf Coast barge services in more detail. For example, the analysis compared the prices for outbound shipments from Minnesota for cereal grains to Japan via different modes and ocean ports. The baseline transportation costs using barge services through the Gulf Coast were competitive with routes using rail through ports in New York-New Jersey and California. As rail rates decreased, rail routes become more competitive in the Pacific Northwest, Georgia and Louisiana. As rail rates increased, barge routes were the more efficient choice.

It should be noted that the Port of NY-NJ is currently the third largest port based on total tonnage after the Ports of South Louisiana and Houston and the third busiest container seaport in the U.S. after the Ports of Los Angeles-Long Beach.[67] With deep water access for Panamex vessels, as well as recent investments to upgrade aging infrastructure,[68] NY-NJ cited a record year in 2018. The increase in competitiveness was reflected in lower transportation costs in the analysis and thus a greater share of potential optimization opportunities.

5.1.4 Intermodal Opportunities

Additional scenarios in the optimization analysis evaluated opportunities for greater utilization of intermodal rail via the Twin Cities. The focus was on converting long haul truck shipments from all Minnesota counties to intermodal rail at a Twin Cities hub. The analysis included both domestic (53' container) and import/export (40' container) intermodal markets.

The cost-benefit evaluation was conducted based on minimizing door-to-door costs. The analysis assumes that the closest intermodal ramps to the origin and destination are utilized to reduce truck drayage costs. For intermodal scenarios:

Intermodal door-to-door cost
= original dray cost + intermodal ramp-to-ramp cost + destination dray cost

Potential savings
= Intermodal door-to-door cost less the full truckload cost.

Typically, savings greater than $5.00 per ton are considered significant enough to justify switching from truck to intermodal rail. Of the target commodities that could move by intermodal container, 50 percent or 26.4 million tons are long-haul shipments moving over 500 miles. Of that volume, over 8.3 million tons had potential savings greater than $5 per ton using the Twin Cities as intermodal hub.[69] With an increase in local intermodal capacity, this scenario represents the following potential impacts for converting long haul truck shipments to intermodal rail:

- Potential incremental annual volume of 414,000 containers[70]
- Over $376 million in potential savings
- Increase in average annual savings of 27 to 31 percent

Top commodities for incremental intermodal opportunities include food and other agricultural products, non-metal mineral products and paper (see Figure 46). The top intermodal market opportunities are mapped in Figure 47.

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[67] Source: U.S. Department of Transportation, Bureau of Transportation Statistics
[68] http://www.panynj.gov/press-room/press-item.cfm?headLine_id=3066
[69] In the case of intermodal, scenarios are based on the intermodal rail hub being located in Ramsey County, MN within the Twin Cities Metropolitan area.
[70] Based on an average 20 tons of commodities transported per container

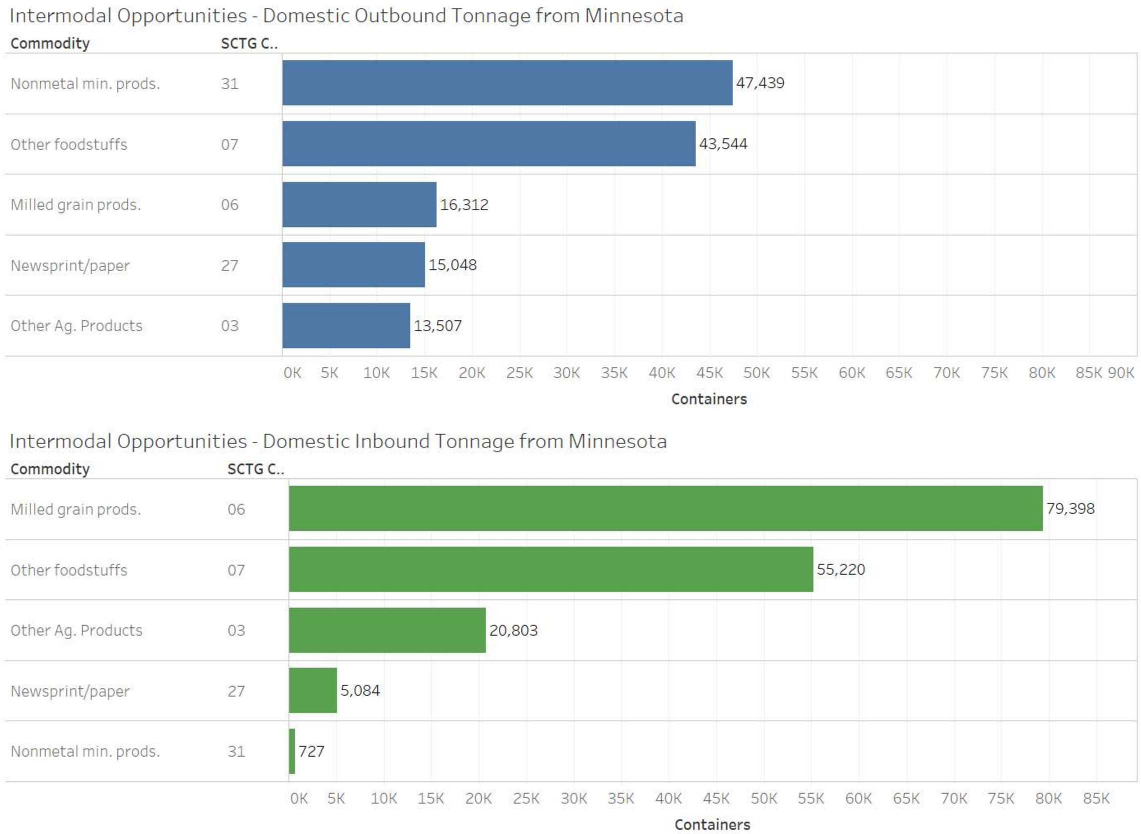

Figure 46 - Top Intermodal Opportunities by Commodity via Twin Cities Hub

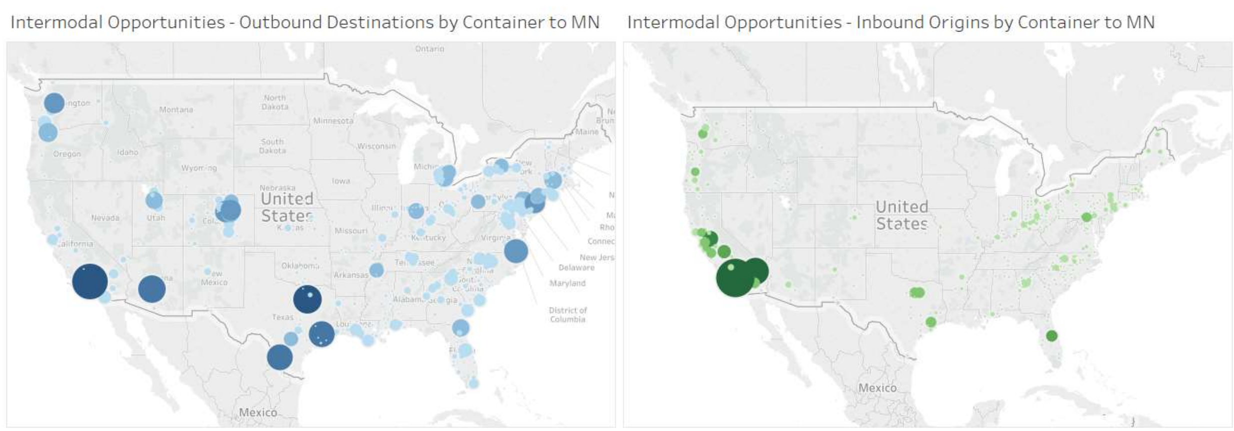

Figure 47 - Top Intermodal Opportunities by Container Volume via Twin Cities Intermodal Hub

Top incremental intermodal rail opportunities focus on westbound and southbound lanes outbound from Minnesota to ramps in Colorado, Texas and California, with demand for intermodal shipments from California dominating inbound demand. With Los Angeles-Long Beach positioned as the largest U.S. ocean port by volume, this route is critical to support inbound container volumes from Asia-Pacific and other markets.

Intermodal Opportunities - MN Outbound, Top Ramps over 7500 Containers

Dest State	Hub 2 Location	Containers	Savings $ Intermodal	Savings % Intermodal	Total Distance
Grand Total		74,614	$76.0M	36%	1,442
CO	Denver	21,939	$22.2M	37%	1,003
TX	Haslet	12,567	$8.1M	32%	1,101
	Houston	8,772	$6.4M	30%	1,313
CA	Los Angeles	16,141	$21.8M	40%	2,059
AZ	Phoenix	7,637	$11.5M	44%	1,932
NJ	Elizabeth	7,557	$6.1M	31%	1,292

Intermodal Opportunities - MN Inbound, Top Ramps over 7500 Containers

Orig State	Hub 1 Location	Containers	Savings $ Intermodal	Savings % Intermodal	Total Distance
Grand Total		127,190	$153.5M	34%	1,971
CA	Los Angeles	68,809	$93.2M	40%	2,056
	San Bernardino	17,266	$20.1M	37%	2,007
	Oakland	16,159	$19.4M	34%	2,150
	Stockton	8,888	$10.0M	33%	2,084
	Fresno	8,473	$9.7M	34%	2,183
TX	Haslet	7,595	$1.1M	11%	1,046

Table 20 - Top Intermodal Opportunities by Ramp via Twin Cities Intermodal Hub

Conversion of existing truck shipments to intermodal container will reduce shipper transportation costs and reduce truck congestion on Minnesota roads. In addition, increasing intermodal demand in the region may lead to greater intermodal competitiveness in the Twin Cities, which has higher intermodal costs than large markets like Chicago, and potentially higher investment in intermodal capacity.

Future opportunities should also be explored for container-on-barge (COB), focusing on containerized exports. There is the potential to move shipments north-south to the Gulf Coast via COB versus intermodal rail to West Coast gateways. COB commodity targets include lower value, less time-sensitive intermodal shipments due to the longer/more variable transit times to reach to the ocean port via barge. COB efforts are currently focused on grain exports and partially processed steel and metal products, semi manufactured industrial goods in other areas. It is ideal for identity-preserved grain industry (e.g. non-GMO) and specialty grains (e.g. soybean products to Asia).

5.2 Implementation Recommendations and Strategies

Through public-private partnerships, investments in infrastructure and other improvements to the supply chain network of the Port of Saint Paul are recommended to take advantage of these opportunities. The core objectives of the efforts are to increase freight mobility and significantly reduce costs for freight shippers in Minnesota and the Midwest by:

- Facilitating movement of additional commodities above and beyond what is flowing through the Port and other regional multimodal or intermodal facilities today, thus advancing economic growth;
- Reducing transportation costs, delays and constraints, while fulfilling supply chain needs throughout the region for additional low-cost, efficient and reliable methods for shipping freight; and
- Providing expanded multimodal and intermodal services, including bulk commodity, empty and full container-on-barge services that offer competitive logistic solutions and an efficient, operational means of shipping the core commodities that businesses move into, out of, and through the region from both rural and urban communities.

The optimization opportunities and recommended actions focus on the more cost-effective use of barge and rail freight across all terminals in the Port of Saint Paul. Current terminal-specific projects are highlighted in the next section. However, in most cases, similar improvement initiatives are applicable at each terminal and/or across multiple tenant sites. Projects will likely be phased and prioritized over multiple years based on need, funding, synergies and interdependencies with other private and public initiatives. Preliminary and ongoing work on prioritized projects should be conducted to advance project readiness, refine the business case and secure funding. Section 5.3 will address the business case for implementation in more detail.

5.2.1 Terminal Access Improvements

Effective road access to/from the terminals with first-/last-mile connections into the National Highway Freight Network (NHFN) is essential to maintaining existing barge and rail volumes through the multimodal terminals, as well as supporting additional growth.

New, Grade-Separated Access to Southport Terminal: A critical constraint of the Southport Terminal in the Port of Saint Paul is the existence of the at-grade, mainline rail crossing immediately adjacent to a single access point to the terminal from Concord Street/TH 156 to Barge Channel Road. Freight trains on this track often completely block access to the terminal causing serious safety issues and vehicular backups within the terminal. These blockages also cause a significant reduction in the volume of freight throughput within the terminal, accounting for delays in the movement of commodities, as well as causing traffic backups on Barge Channel Road and Concord Street/TH 156 that negatively impact adjacent neighborhoods.

To address this constraint, construction of a grade separation or bridge crossing over the existing rail mainline is recommended to reduce the shipping time for regional freight users, reduce the cost of freight transportation, and facilitate more intermodal and bulk commodity movements, allowing for safe, unrestricted and reliable access into the terminal. Built to a 10-ton standard, the grade separation includes a new access route to the north side of the Southport Terminal channel for tenants and users of the terminal, as well as road improvements along Barge Channel Road. The changes would accommodate the volume and type of targeted, multimodal freight movements (including heavy cargo), while directing freight traffic away from the surrounding communities and addressing air pollution concerns.

The project also complements planned improvements to Concord St/TH 156 by the City of South Saint Paul to increase safety for all transportation users of the road, while supporting access to businesses and economic development in the community.[71]

Traffic Congestion on TH156 at Entrance to Southport Terminal, Saint Paul, MN (Photo Credit: SPPA)

Access Road Rehabilitation and Maintenance at Red Rock Terminal and Barge Terminal 1: In order to accommodate current and future freight volumes, roadway improvements are needed at all terminals. Needed improvements include resurfacing Red Rock Road, as well as rehabilitating Childs Road at Barge Terminal 1. Lack of adequate maintenance can restrict freight flows and competitiveness of the terminals

[71] https://www.southstpaul.org/524/Concord-Street-Improvements

due to traffic delays, equipment and/or shipment damage, as well as reduce environmental concerns, such as fugitive dust.

Connectivity to Highway 61 from Barge Terminal 1: In addition, a preliminary assessment of the impact of potential changes to the highway access to/from Barge Terminal 1 should be conducted to reduce freight delays and inefficiencies, while mitigating safety concerns. The study area should include an evaluation of traffic counts and delays, road and intersection configurations, rail crossings and traffic signal configuration and timing. The tight turn radius of the Warner Road to Childs Road off ramp from US 61/ US 10, as well as convergence of the eastbound and westbound Warner Road traffic lanes at an at grade rail crossing connecting the terminal to a Class 1 main line, are difficult to navigate for trucks and result in backups for terminal users and tenants. Outbound traffic from the terminal is frequently delayed due to traffic signal timing at the intersection of Warner Road and US 61/ US 10. The potential for accidents from increased traffic volumes, as well as risks associated with blocking the single access route to/from the terminal, also present safety concerns. Based on this preliminary assessment, a more detailed design plan should be developed to prioritize investments that will meet cost-benefit criteria for implementation.

Designation as NHS Intermodal Connector: Obtaining designation for the Saint Paul terminals as National Highway System (NHS) Intermodal Connector(s) should also be explored. Intermodal Connectors provide access between major intermodal facilities and the National Highway System, roadways identified as important to the nation's economy, defense, and mobility.[72] Bulk commodity terminals (or clusters of terminals) that handle more than 500,000 tons per year by highway or 100 trucks per day in each direction on the principal connecting route may be eligible.[73] Status as an NHS Intermodal Connector could open up additional funding sources for infrastructure investments to support first-/last-mile connectivity into the national highway freight network. Local government funding for roads is often challenging for freight projects, where investment criteria favor residential and commuter corridor projects based on traffic volumes.

5.2.2 Barge Capacity, Transload and Storage Improvements

Barge-related improvements focus on maintaining and building capacity for waterborne transport both in the terminal and on the river. Maintaining the working river also delivers broader benefits to Saint Paul and the surrounding residential and industrial communities.

Dock Wall Extensions and Improvements: Dock walls serve as the bridges to the river shipping industry. They are a critical component at any port and need to be structurally stable to provide safe access to port facilities. Structural investigation of the Saint Paul Harbor terminals' dock wall has revealed that the current dock wall conditions are unstable and will require substantial repair and/or replacement within the next five years.

To maintain current barge volumes, as well as support projected growth, existing dock walls need to be repaired or reinforced to prevent them from collapsing. Over 50 percent (or 1000 linear feet) of the dock wall at the Southport Terminal was rehabilitated in 2018. Between 2009 and 2014, the dock wall was refaced at Barge Terminal 1. Without ongoing dock wall maintenance, barge capacity could decrease as conditions deteriorate.

In addition, efforts are underway to add new dock walls and/or increase the length of current dock walls used for transloading commodities to barge. At Barge Terminal 1, a loading cell is being rehabilitated to provide new river access at a site currently accessible by truck and rail today. At Southport Terminal, an

[72] https://www.fhwa.dot.gov/planning/national_highway_system/
[73] https://www.law.cornell.edu/cfr/text/23/appendix-D_to_subpart_A_of_part_470

additional 600 linear feet of dock wall is planned to be rehabilitated to accommodate increased intermodal interchanges and transfers of bulk commodities and/or containers in the future.

Fleeting Area, Port of Saint Paul, Minnesota (Photo Credit: SPPA)

Waterway Capacity: Ongoing dredging and maintenance of the navigable channel on the Mississippi River is essential to support cost-effective barge transportation to/from Minnesota, as well as to retain the strong environmental and economic benefits of waterborne freight versus long haul trucking. Construction of the proposed channel training structures by USACE in Lower Pool 2 at Boulanger Bend is essential to increase barge tow capacity. The work, which began in 2018 and is planned for completion in 2019, will "improve navigability and safety by helping to maintain the full congressionally-authorized channel width"[74] and is expected to return channel capacity above Lock 2 to the Twin Cities to 15 barges from the current restricted capacity of 12 barges. The effort will build capacity for growth in barge freight movements and reduce current backups during peak periods on the river. There are plans to use dredged material from Pool 2 to improve the ecosystem in Pigs Eye Lake by creating islands for fish and wildlife habitat[75]. With projected growth in Minnesota freight movements by 70.8 million tons annually (or the equivalent of 2.8 million annual truck trips),[76] investments in multimodal infrastructure, including river navigation, is vital to the regional and national economy. The U.S. Army Corps of Engineers estimates that its Civil Works projects generate about $16 in economic benefits for every $1 expended.[77]

To keep up with increased demand, additional fleeting permits on the river and construction of more mooring cells should be pursued to manage the increases in barge volume. Space limitations cause shipping delays and limit barge freight volumes.

Loading/Unloading Capacity: The efficiency of transfers to/from barges further impacts overall barge freight flow capacity. Opportunities existing at all terminals to invest in new and upgraded equipment for loading and unloading of barges to facilitate transfers to other modes. Upgrades are planned for Barge Terminal 1, as well as Southport, to increase transfer capacity and throughput. Construction of a new

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[74] https://www.dnr.state.mn.us/input/environmentalreview/boulanger-bend/index.html
[75] https://www.mvp.usace.army.mil/Home/Projects/Article/570917/continuing-authorities-program-beneficial-use-of-dredge-material-section-204-pi/
[76] Based on FHWA Freight Analysis Framework (FAF 4.3) projected growth rates for Minnesota
[77] https://www.lrb.usace.army.mil/Media/News-Stories/Article/1328990/determining-the-return-on-investment-of-civil-works-projects-a-look-behind-the/

overhead crane will increase efficiency and capacity by 3 times over current crane capacity for lifting freight off barges and transloading onto trucks, as well as adding direct rail-to-barge transfer capabilities.

At sites without direct barge-to-rail and/or rail-to-barge transload capabilities, transfers to rail are less efficient, requiring cumbersome storage and repositioning within the terminal. The addition of direct barge-to-rail and barge-to-truck transload capabilities will greatly increase the capacity and ability to accommodate more cost-efficient barge and rail freight shipments regionally.

Red Rock Terminal in Saint Paul, Minnesota (Photo Credit: SPPA)

Transload Expansion via Commodity Storage & Site Reconfiguration: Investments in commodity storage support an increase in multimodal transfers between barge, rail and truck. With the seasonality of barge transportation and ongoing growth of commodity flows through the terminal, commodity storage is critical to building transload capacity. Increases in storage capacity help reduce transload constraints during peak periods for bulk commodities. It also helps resolve issues related to backlogs of barges after the river opens in the spring. Additional storage capacity will allow for an increase in commodity flows through the port where current and known opportunities exist to increase tonnage and/or add new commodities. The addition of storage buildings allows transloading and storing of commodities from barge, truck and rail that require covered storage, fulfilling unserved needs within the Saint Paul terminals and surrounding area. Planned storage pads and/or structures at Barge Terminal 1, Red Rock and Southport Terminals, in combination with site reconfigurations supporting better material flows and transfers between barge, rail and truck should facilitate market growth. Other site improvements, such as stormwater management, are also planned.

5.2.3 Rail Capacity and Intermodal Services/Capabilities

The transload, storage and site flow improvements should increase rail capacity. However, additional changes are recommended to increase rail utilization and efficiency.

Better Rail Access and Rail Spur Extensions: Upgrades and extensions of existing rail spurs at Barge Terminal 1, Red Rock and Southport Terminals will support increases in rail volumes by providing rail access to new sites and increasing capacity to handle more rail cars at existing spurs. These upgrades will also enable direct barge-to-rail transfers with closer alignment to dock walls. Providing rail access to new and existing storage facilities will further facilitate loading efficiencies and transfers. Additional rail capacity supports increased utilization of rail as a low-cost transportation option to non-barge capable origins and destinations, offsets the seasonality of barge transportation during the winter, and reduces truck volumes on local roads, highways and interstates.

Multimodal Terminal in Saint Paul, Minnesota (Photo Credit: SPPA)

Unit Train Capacity and Expanded Multimodal Rail Yard: The ability to accommodate 100-car unit trains is key to rail efficiency and cost competitiveness. It is a high-value constraint within the Saint Paul Port terminals that becomes a bigger issue in the winter during commercial river closures. Having the ability to continue high-volume commodity movements throughout the winter via new or expanded rail yard(s) and/or a logistics park would have a huge economic impact for the Port of Saint Paul, its tenants, terminal users and the region as a whole.

Red Rock Terminal currently handles 1 to 2 unit trains per week. However, with the existing track configuration between the road and terminal sites, unit trains must be broken up causing frequent delays (upwards of 45 minutes) and frequently blocking road access to tenant sites[78]. A proposed reconfiguration of the tracks with a new rail spur on the north end of the terminal with direct access into the adjacent CP rail yard would overcome these inefficiencies and safety issues, while supporting additional unit train volumes to decrease rail transportation costs for regional shippers.

Adding the ability to handle unit trains is also recommended at Southport and Barge Terminal 1. Development of a long-range plan is essential to identify potential sites to expand rail service and rail yards in the terminals over time, accommodating longer trains and additional volumes while reducing costs. Unit train service would significantly reduce costs by 33 to 72 percent based on regional rail waybill data, increasing the competitiveness of Minnesota shippers in the global marketplace. Capacity for two unit trains with a terminal rail yard is recommended to support targeted growth.

New Intermodal Services/Capabilities: Section 4.2 also identified opportunities to add intermodal services. Planned additions of new overhead crane(s), storage pads/facilities, rail spur and dock wall

[78] https://www.sppa.com/safety-red-rock-terminal

extensions can be utilized to facilitate increased intermodal services in the region. The infrastructure can be used to offload empty rail cars from the lower Mississippi, as well as onload full containers.

Storage facilities and intermodal containers are both at critically low supply within the Port of Saint Paul and the region. Unused transportation capacity on deadhead barges heading northbound on the Mississippi River could be utilized to bring in empty containers into the Twin Cities from southern river ports with excess containers, to shift regional truck freight to more cost-effective, intermodal rail.

The improvements could also be used to load full containers-on-barge, supporting the growth in barge container movements, as well as containerization of agricultural products. COB would also require partnering with key destination ocean port and ocean carrier(s) aligned to the target commodities, barge operators and intermodal carriers, to coordinate operations and develop the opportunity within the Twin Cities market.

Efforts to add intermodal services should also consider establishing a Foreign Trade Zone (FTZ) at the Saint Paul terminal(s) to allow import/export commodities to pass through U.S. Customs in Minnesota vs. at the ocean port of export. Utilizing an FTZ close to the source or destination increases efficiencies, reduces costs and delays by allowing goods to flow from origin to destination in its international shipping container without intermediate customs inspections.

5.3 Business Case for Optimization

The improvements discussed in the previous section can provide tremendous economic and qualitative benefits across the Port of Saint Paul terminals, regional businesses and surrounding communities, including:

- Reduced Freight Transload Shipping Cost Benefits
- Reduced Freight Intermodal Shipping Cost Benefits
- Reduced Truck Operational Cost Benefits
- Reduced Highway Maintenance
- Reduced Emission Benefits
- Reduced Crash Cost and Accident Reduction Benefits
- Reduced Travel Time Benefits
- Increased Quality of Life Benefits

Once implemented, the identified network enhancements will increase freight mobility regionally and significantly reduce costs for freight shippers in Minnesota and the Midwest, while reducing traffic congestion and air pollution, as well as improving safety on the surface transportation system. The infrastructure being proposed will alleviate key bottlenecks in the regional freight network, especially on first-last mile connections and will ensure the good condition of infrastructure to support commerce and economic growth. The improvements will provide and improve connections to the Nation's transportation network and support the movement of freight and people. The benefits from improvement opportunities extend across multiple areas and are discussed in more detail in the following section.

5.3.1 Freight Mobility and Economic Competitiveness

The improvement opportunities facilitate maintaining and/or building capacity to support incremental barge, rail and intermodal movements above current freight volumes, while reducing transportation and operating costs. The benefits to Minnesota shippers include:

- Increased freight efficiencies, shipping cost reduction and resiliency with increase in terminal and transload capacity between truck, rail and/or barge, as well as with new intermodal services
- Reduced truck operating costs and travel time benefits for businesses utilizing the terminals

Section 5.1 outlines the total market opportunity from the optimization scenarios, representing over $1 billion in potential transportation costs savings from moving 37.8 million tons of freight more efficiently. This section looks further into the value derived from implementing the suggested improvements.

The likelihood of converting to more cost-effective mode(s) and/or routes increases where the savings to the shipper are greater than $5.00 per ton. Within the analysis, this "targeted opportunity" represents 87 percent of the tonnage or 32.9 million tons (see Table 21) and 99 percent of the dollar savings.

Annual Tonnage from Freight Shipping Efficiency Scenarios (Short Tons)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
In-Scope Bulk Commodity Optimization Opportunities	24.6M	1.2M	2.5M	3.7M
Intermodal Opportunities via Twin Cities Intermodal Hub	8.3M	0.4M	0.8M	1.2M
Total	32.9M	1.6M	3.3M	4.9M

Table 21 – Annual Tonnage Opportunities from Freight Shipping Efficiency Scenarios[79]

The business case for the suggested improvements looks at the benefits realized from capturing a portion of this target opportunity. The analysis looks at 3 different levels of penetration, including:

- Conservative case: 5% of target opportunity
- Base case: 10% of target opportunity
- Optimistic case: 15% of target opportunity

Based on this analysis, a base case penetration rate of 10 percent of the target opportunity identified in the optimization scenarios would result in $106.9 million in annual savings from reduced shipping costs (see Table 22).

Shipping Cost Reduction Benefits from Penetration of Target Opportunity ($)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
In-Scope Bulk Commodity Optimization Opportunities	$692.6M	$34.6M	$69.3M	$103.9M
Intermodal Opportunities via Twin Cities Intermodal Hub	$376.2M	$18.8M	$37.6M	$56.4M
Total	$1,068.8M	$53.4M	$106.9M	$160.3M

Table 22 – Annual Shipping Cost Reduction Benefits from Penetration of Target Optimization Opportunity[80]

Further efficiencies are gained by reducing operating costs for shippers. With the greater fuel efficiency of marine and rail transportation, there is an opportunity to reduce the gallons consumed in freight transportation by 100.1 million gallons across the target market opportunity (see Table 23).

[79] SPPA Port Optimization Model, 2018

[80] Freight shipping cost data and other transportation cost information is based on industry benchmark data and private commercial shipper data.

Reduction in Fuel Consumed from Penetration of Target Opportunity (Gallons)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
In-Scope Bulk Commodity Optimization Opportunities	48.4M	2.4M	4.8M	7.3M
Intermodal Opportunities via Twin Cities Intermodal Hub	51.8M	2.6M	5.2M	7.8M
Total	100.1M	5.0M	10.0M	15.0M

Table 23 – Annual Reduction in Total Gallons of Fuel Consumed with Optimization Scenarios[81]

Ten percent penetration equates to an annual savings of 10 million gallons of fuel. With average fuel costs in 2017 of $2.65 per gallon of diesel fuel,[82] the economic savings is $26.5 million annually.

Delays from blocking roads at or within the terminals, as well as congestion on surrounding roads and highways, also affect truck operating costs. Delays create service and reliability issues limiting the ability for facility operators to compete effectively with other modes and route options for these commodity movements. The American Transportation Research Institute (ATRI) estimates the average cost to operate a commercial truck is $66.65 per hour.[83] Eliminating the at-grade crossing and reconfiguring the entrance to the Southport Terminal is projected to reduce truck operating costs by $0.9 million per year.

Making investments in regional barge and rail facilities also increases the resiliency of regional supply chains, in the event of short-term and long-term network disruptions due to natural or man-made disasters.

5.3.2 State of Good Repair

The Minnesota Department of Transportation (MnDOT) Statewide Ports and Waterways Plan states: *"The future success of the ports and waterways system is contingent on having a solid and reliable infrastructure base- docks, slips, locks and dams, shipping channels, etc.- that can respond to changing market conditions."*[84] Maintenance of all freight infrastructure supporting all modes, including barge and rail freight, as well as truck access into the terminal for transload is essential. The key benefits relating to maintaining a state of good repair at the Port of Saint Paul include:

- Maintaining regional shipper savings from continued support for new and incremental barge and rail volumes
- Improving terminal access by upgrading roads and bridges into the terminal to support higher weight standards and volume increases
- Improving access, reliability and safety within the terminal through dock wall rehabilitation
- Maintaining navigable waterways for barge freight, as well as recreational uses
- Reducing highway and regional road maintenance costs

The movement of 5.9 million tons of in-scope commodities via barge and 7.2 million tons via rail flowing through the Twin Cities annually currently represent the avoidance of over 0.5 million trucks[85] on Twin Cities and regional roads.

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[81] Based on fuel efficiency comparisons by mode from *Advantages of Inland Waterway Transport*, U.S. Army Corps of Engineers, St. Paul District, August 2018
[82] Source: U.S. Energy Information Administration, www.eia.org
[83] Motor Carriers Average Marginal Costs per Hour in 2017, Source: ATRI Operating Costs of Trucking 2018
[84] Dated September 2014
[85] Based on average shipment size of 25 tons per truck

Maintenance and upgrades of these terminal and freight network assets (including Mississippi River dredging) are necessary to support the expansion of freight volumes via barge and rail beyond these current levels.

The target opportunity identified in the optimization scenarios to convert from long-haul truck freight to barge or rail is 25.2 million tons. Converting this volume could take another 1 million long-haul truck trips off Minnesota roads annually. A 10 percent penetration of the target opportunity would reduce truck volumes by 101,000 trucks annually (see Table 24).

Reduction in # of Trucks on MN Roads from Penetration of Target Opportunity (Trucks)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
In-Scope Bulk Commodity Optimization Opportunities	680K	34K	68K	102K
Intermodal Opportunities via Twin Cities Intermodal Hub	330K	17K	33K	50K
Total	1,010K	51K	101K	152K

Table 24 – Annual Reduction in Number of Trucks on Minnesota Highways and Roads with Optimization Scenarios[86]

Achieving the target opportunity of converting truck volume to barge, rail and intermodal would reduce truck vehicle miles travelled (VMT) by 848 million annually, thus reducing congestion on Minnesota highways and reducing road maintenance costs.[87] A 10 percent penetration of the target opportunity would reduce truck VMT by 84.9 million annually (see Table 25).

Reduction in Trucks VMT on MN Roads from Penetration of Target Opportunity (VMT)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
In-Scope Bulk Commodity Optimization Opportunities	405.4M	20.3M	40.5M	60.8M
Intermodal Opportunities via Twin Cities Intermodal Hub	443.2M	22.2M	44.3M	66.5M
Total	848.7M	42.4M	84.9M	127.3M

Table 25 – Annual Reduction in Truck VMT on Minnesota Highways and Roads with Optimization Scenarios[88]

5.3.3 Environmental Sustainability

Compared to truck, marine and rail transportation is more fuel efficient, and produces lower emissions. The environmental sustainability benefits enabled by the proposed port improvement projects are significant, by using more efficient methods of bulk commodity transportation including:

- Reduction in CO_2 emissions from increased utilization of barge and rail freight
- Reduction in CO_2 emissions from a reduction in freight delays (idling traffic)
- Reduction in surface water pollution through improved stormwater management facilities
- Support for wildlife habitat development and wetland rehabilitation

[86] Source: Texas A&M Transportation Institute, Center for Ports and Waterways. A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001-2014. January 2017.
[87] Truck VMT reduction is adjusted for the addition of truck/drayage trips in transload and intermodal optimization scenarios to travel to/from the hubs.
[88] http://www.dot.state.mn.us/roadway/data/data-products.html#VMT

Using ton-miles as a comparison metric, on average, barge transport produces just 10 percent of the greenhouse gas emissions of truck transport and rail produces 14 percent versus truck transport. Converting long-haul truck freight to barge and rail produces significant environmental benefits. A 10 percent penetration of the target opportunity identified in the optimization scenarios would result in $3.6 million in annual savings from emission reductions (see Table 26).

Savings from Penetration of Target Opportunity ($)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
Emission Reduction Benefits	$36.0M	$1.8M	$3.6M	$5.4M

Table 26 – Annual Emission Reduction Benefits from Penetration of Target Optimization Opportunity[89]

The suggested projects will lower emissions by reducing congestion, delays and idling traffic with terminal access improvements and from increased utilization of barge and rail freight. Each of the port infrastructure projects will promote a more environmentally sustainable transportation system, as well as follow the necessary regulatory and design processes to avoid impacts to important environmental resources.

The efforts can also leverage opportunities to address additional environmental goals, including incorporating state-of-the-art stormwater management systems to help protect critical water resources, rehabilitating neighboring wetlands, and reusing dredge materials to maintain wildlife habitats.

5.3.4 Safety

There are numerous safety benefits delivered by the proposed improvements including:

- Accident reduction from lower truck vehicle miles travelled (VMT)
- Reduction in downstream accidents resulting from traffic congestion
- Elimination or reduction of risk of at-grade railroad crossing accidents
- Elimination of potential delays for emergency response at rail crossings

Vehicular accidents will be reduced by conversion of volume from long-haul truck freight to barge or rail, as well as by reducing traffic congestion with terminal access improvements.

The potential crash savings impact of reducing truck VMT results is $24.0 million annually based achieving a 10 percent penetration of the target opportunity (see Table 27).

Savings from Penetration of Target Opportunity ($)	Total Target Opportunity	5% Penetration	10% Penetration	15% Penetration
Crash Reduction Benefits	$240.0M	$12.0M	$24.0M	$36.0M

Table 27 – Annual Crash Reduction Benefits from Truck VMT Reduction from Penetration of Target Optimization Opportunity[90] [91]

In addition, rail spur and roadway configuration changes that address trains blocking roads, as well as construction of a bridge for an above-grade rail crossing, will help further reduce or eliminate the potential for at-grade rail crossing accidents, as well as mitigate the risks of emergency response delays to these industrial areas.

[89] Based on estimated reduction in tons of PM2.5 and NOX per million ton-miles; See http://www.gao.gov/new.items/d11134.pdf

[90] Source: Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. DOT 2018

[91] Source: Minnesota Crash Mapping Analysis Tool, MnDOT 2018

For example, improvements to reconfigure access to Southport Terminal from TH156, including the grade separation over the Class I rail line, are estimated to produce $0.2 million in safety benefits annually. The estimate includes benefits from crash reduction by eliminating congestion and delays, as well as removal of the at-grade crossing.

The 2016 Minnesota Statewide Freight System and Rail Plan documents the safety concerns with at-grade crossings. The 2016 MnDOT Rail Grade Crossing Safety Project documented a risk-based methodology to assess and prioritize safety issues at rail crossings, looking beyond historical crash rates to the potential risk of future crashes or incidents. With a zero-fatality goal at rail crossings in Minnesota, attributes of the at-grade crossings at the terminals present risks that can be mitigated with the suggested improvements.

Similar benefits are expected at the other terminals. However, the potential benefits will vary depending on a variety of factors, including daily traffic counts, rail volumes and crash statistics.

5.3.5 Quality of Life

The suggested improvements also have a significant impact on the quality of life for both users of the terminals, as well as residents, businesses and communities in the surrounding neighborhoods including:

- Reduced travel times for passenger and freight users in terminal area, surrounding neighborhood streets and highway connectors
- Reduced noise from modal diversion from truck or rail to barge
- Increased property values from terminal improvements
- Direct access to good-paying jobs and public service centers

Passenger and commercial users of the terminal and first-/last-mile connector roads benefit from less time spent in traffic congestion. It is estimated that the cost of passenger traffic delays is $26.50 per hour for business travel and $14.20 for non-business travel.[92] The elimination of the at-grade crossing and reconfiguration of the access to the Southport terminal, for example, is expected to result in $2.4 million per year in travel time savings from a reduction in travel time delays in the terminal, connecting roads and highways.

At Southport terminal, surrounding neighborhoods can benefit from redirecting freight traffic away from residential roads with a new access point into the terminal. The components of the project will also address environmental impacts on neighborhoods and communities along the key transportation corridors, but also reduce noise impacts with modal shifts from truck or rail to barge.

Businesses may benefit from an increase in commercial property values with the implementation of the improvements and increased marketability of multimodal services through the terminal. Research shows industrial property values increase when adjacent to intermodal logistics centers.[93] The findings concluded that “the presence of an intermodal logistics center can result in higher property values for industrial properties on or near state highway routes,” with an increase equivalent to $0.25 per square foot. The improvements could not only increase property values within the terminals and adjacent properties but will likely have a positive impact on property values and economic development in the area and along associated transportation corridors.

The projects also further some of the Livability Principles developed by U.S. DOT in conjunction with the Department of Housing and Urban Development and the Environmental Protection Agency for multimodal transportation investments. The principles include promoting economic revitalization,

[92] Source: Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. DOT 2018

[93] The report, “Intermodal Logistics Centers and Their Impact on Transportation Corridor Industrial Property Value,” was completed by Urban Transportation Center (UTC) researchers at the University of Illinois at Chicago.

providing access to jobs, and achieving safer communities".[94] Aligned with these principles, the mission of SPPA is to build the job and tax base in Saint Paul, while creating sustainable development opportunities. The Saint Paul Harbor plays an important role in accomplishing this mission by providing businesses key transportation infrastructure to help keep them economically competitive. The improvements help increase access to good-paying jobs and service centers. A 2012 study of the industrial economy of Saint Paul notes "Existing industrial assets and a robust manufacturing legacy provide the opportunity to leverage industry into a sustainable vision that promotes growth in the city and region as a whole." The study emphasized the importance of industrial jobs to the neighborhoods and communities within the City of Saint Paul. When it comes to job creation, the focus is usually the number of jobs created. However, equally as important is the accessibility to those jobs, particularly for those workers without college educations. The study states, "In most sectors, increased wages correspond with higher barriers in terms of educational requirements; however, industrial jobs are actually more accessible than the average opportunity." In fact, the report shows, that Port Authority Business Centers provide even higher paying jobs than your average industrial job.

The projects also support and enhance existing communities in other ways. One-third of Saint Paul's land is tax exempt. These tax-exempt properties include schools, parks, public agencies, places of worship, and recreation centers. All of these tax-exempt properties are key amenities that serve as an asset to existing communities. Industrial land uses occupy another one-third of Saint Paul's land. In *An Industrial Strategy for Saint Paul*, the study demonstrates that industrial land uses generate more property taxes than the cost of city services they use. This analysis indicates that industry helps pay for many of these key community assets which supports and strengthens communities. Similarly, funding from barge freight and commercial uses of the river also provide funding and benefits for recreational use of the river, providing broader benefits to the community.

Towing Vessel on Mississippi River, Saint Paul, Minnesota (Photo Credit: Mark Johnson)

[94] https://www.fhwa.dot.gov/livability/

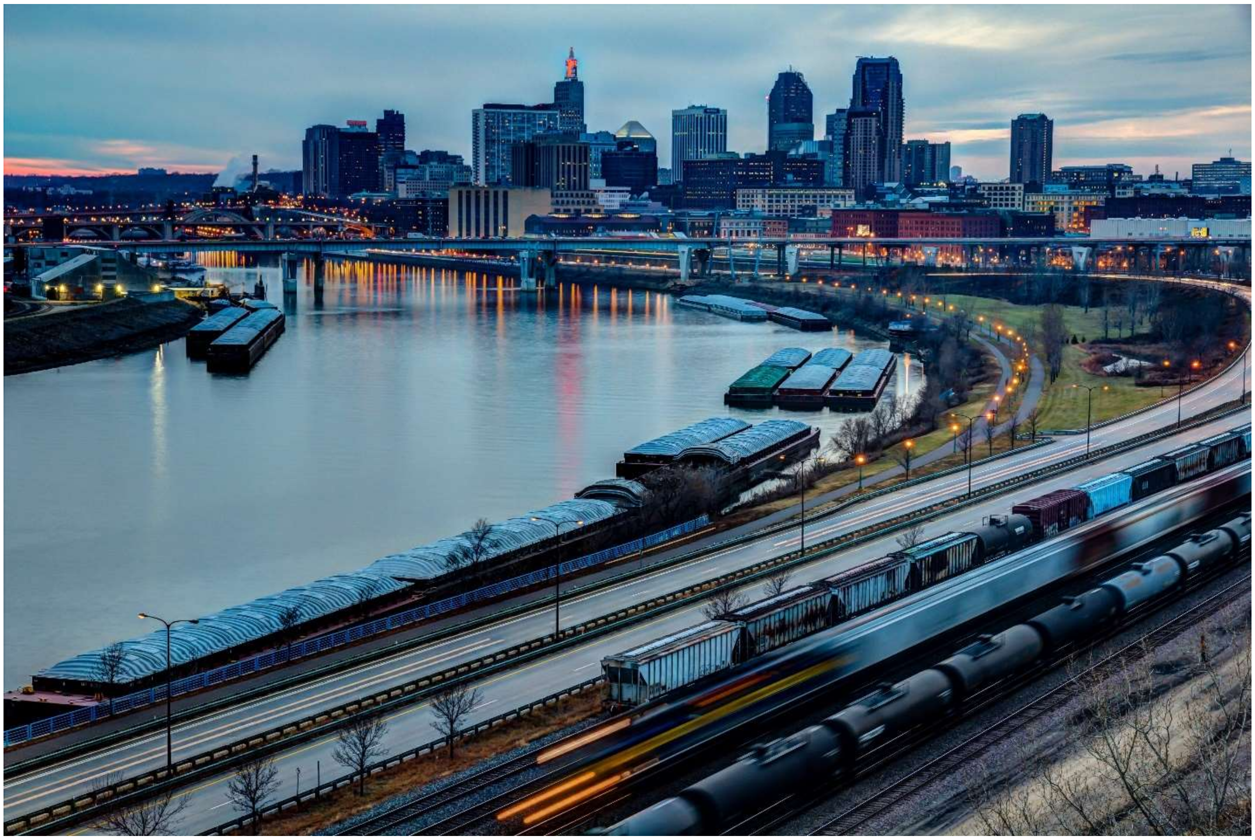
5.3.6 Summary of Benefits

Implementation of the proposed infrastructure investments at the Port of Saint Paul terminals will deliver significant benefits to local and regional businesses and surrounding communities. The following table summarizes key benefits and quantifies the annual value derived from the suggested improvements with 10 percent penetration of the target opportunity. Additional benefits also exist that can also be quantified at the project level for specific improvements.

Benefit Criteria	Quantified Value
Freight Mobility and Economic Competitiveness • Increased freight efficiencies, shipping cost reduction & resiliency with increase in terminal & transload capacity for truck-to-rail, truck-to-barge & rail-to-barge • Increased freight efficiencies & shipping cost reduction for regional businesses with new intermodal services & capabilities • Reduced truck operating costs & travel time benefits for businesses utilizing the terminals	Shipping cost savings of $106.9M annually Savings of 10.0M gallons of fuel annually Truck operating cost reductions of $0.9 annually[95]
State of Good Repair • Maintained trend in regional shipper savings from continued support for new & incremental barge & rail volumes • Improved terminal access by upgrading roads & bridges into the terminal to support higher weight standards & volume increases • Improved access, reliability & safety within the terminal through dock wall rehabilitation • Maintained navigable waterways for barge freight, as well as recreational uses • Reduced highway & regional road maintenance costs	Reduction in truck vehicle miles travelled of 84.9M annually
Environmental Sustainability • Reduced CO_2 emissions from increased utilization of barge & rail freight • Reduced CO_2 emissions from reduction in freight delays & idling traffic • Reduced surface water pollution through improved stormwater management facilities • Support for wildlife habitat development & wetland rehabilitation	Savings from emission reduction of $3.6M annually
Safety • Reduction in accidents resulting from a reduction in truck VMT • Reduction in downstream accidents resulting from traffic congestion • Elimination or reduction of risk of at-grade railroad crossing accidents • Elimination of potential emergency response delays with at-grade crossings	Savings from crash reduction of $24.0M annually
Quality of Life • Reduced travel time delays for passenger & freight users in terminal area, surrounding neighborhood streets & highway connectors • Reduced noise from modal diversion from truck or rail to barge • Increased commercial property values from terminal improvements • Direct access to good-paying jobs & public service centers	Savings from reduction in travel time delays of $2.4M annually[95]

[95] Dollar amount represents estimate specific to Southport terminal improvements. Additional benefits exist from similar improvements at other terminals.

Once implemented, the identified network enhancements will increase freight mobility regionally and significantly reduce costs for freight shippers in Minnesota and the Midwest, while achieving a significant reduction in traffic congestion and air pollution, potential traffic fatalities and serious injuries on the surface transportation system. The infrastructure being proposed will alleviate key bottlenecks in the regional freight supply chain along first-last mile connections and will ensure the good condition of infrastructure to support commerce and economic growth by supporting this inland river, multimodal port. The improvements will provide and improve connections to the Nation's transportation network and support the movement of freight and people.



View of Saint Paul Harbor on Mississippi River, Saint Paul, Minnesota (Photo Credit: SPPA)

6. Glossary

- Containerized Commodities – Commodities, often manufactured or processed products, that are capable of being transported in 53-foot domestic or 40-foot import/export, intermodal containers.
- Cost per Ton-Mile (CPTM) – Defined as total transportation cost divided by weight of shipment (in tons) and total distance from origin to destination; Measure used to compare costs between different modes and locations.
- Domestic Freight Shipments – Freight shipments between two domestic U.S. counties within the study scope; Domestic shipments may include the shipments to/from U.S. ocean ports, which are ultimately import or export at a different point in time.
- Import/Export Freight Shipments - Freight shipments between a domestic U.S. county and a foreign ocean port at an international origin or destination within the study scope; International shipments include multiple transportation modes, as well as both international and domestic shipment legs between the origin and destination.
- Incremental Shipments – Represent opportunities identified within the study optimization analysis to move additional or incremental tons of commodities, beyond the current freight volumes that flow via a particular mode, route and/or facility today.
- In-Scope Commodities - Thirteen bulk commodity categories included in the freight flow analysis within the study scope, reflecting the core commodities that currently flow through the Port of Saint Paul via terminal users and its tenants.
- Intermodal – Refers to freight shipments of commodities or goods via intermodal container across multiple transportation modes; Transfers between modes at intermodal terminals involve handling of the container vs. the freight within the container.
- International Freight Shipments – See *Import/Export Freight Shipments*.
- Multimodal - Refers to freight shipments of bulk commodities or goods across multiple transportation modes; Transfers between modes at multimodal terminals involve transloading and direct handling of bulk commodities between modes.
- Penetration Rate – Represents a portion of the *target opportunity* identified in the study optimization analysis assumed to be captured and/or flow through the Port of Saint Paul for the purpose of scenario and benefit-cost analysis.
- Saint Paul Port Authority (SPPA) – An economic development agency managing four multimodal freight terminals on the Mississippi River in Saint Paul, Minnesota. Inland, the organization is committed to commercial redevelopment projects that create quality job opportunities, expands the tax base, and advances sustainable design.
- Target Opportunity - Represents a subset of the *total market opportunity* in tons or dollars identified in the study optimization analysis, where potential transportation costs savings from switching from the current (or baseline) transportation mode(s) to alternative, optimized mode(s) are greater than $5 per ton – and have a greater likelihood of being converted from a baseline to an optimized mode.
- Total Market Opportunity – Represents the total opportunity in tons or dollars identified in the study optimization analysis, where potential transportation costs savings from switching from the current (or baseline) transportation mode(s) to alternative optimized modes exist; i.e. where potential savings from converting to the optimized mode(s) are greater than $0 per ton.
- Transloading - Involves transferring commodities from one transportation mode to another between the origin and destination of a shipment, where shippers may not have direct access at production or warehousing facilities to lower-cost, modal choices.
- Upper Mississippi River System (UMRS) – Nationally significant ecosystem and navigation system designated by Congress, consisting of the Upper Mississippi and Illinois Rivers and several important tributaries) (U.S. Geological Survey, 2019).

PORT OPTIMIZATION MODEL & ANALYSIS

Saint Paul
PORT AUTHORITY

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