FREIGHT TRAIN *to* COMMUNITY PROSPERITY

Metrics for the Integration of Community Economic Development and Efficient Freight Movement

CNT

Freight Train to Community Prosperity

Metrics for the Integration of Community Economic Development and Efficient Freight Movement

PREPARED BY THE CENTER FOR NEIGHBORHOOD TECHNOLOGY

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FORWARD

This document concludes a series of papers sponsored by the Ford Foundation on the subject of metrics for Cargo-Oriented Development (COD). This concise report is prepared for the benefit of corporate executives, public officials, and policy makers who want to quickly gain a familiarity with the core ideas of COD and the means of assessing it. The following links provide access to the interim COD reports, which paved the way for the development of the COD metrics. The accompanying technical report is forthcoming and will provide a more in-depth discussion of what COD entails and ways to measure its achievement.

- Cargo-Oriented Development: Concept and Opportunity (http://www.cnt.org/publications/cargo-oriented-development-concept-and-opportunity)
- Cargo-Oriented Development: Analysis and Implementation (http://www.cnt.org/publications/cargo-oriented-development-analysis-and-implementation)
- New Orleans-Baton Rouge: Capturing the Value of the Economic Boom and the Freight that Supports It (http://www.cnt.org/publications/new-orleans-baton-rouge-capturing-the-value-of-the-economic-boom-and-the-freight-that)
- America's Freight Future: Multiple Modes, Multiple Benefits, Multiple Opportunities (submitted directly to the Ford Foundation)

EXECUTIVE SUMMARY

Disconnected Investments

Over the last three years, private corporations have poured more than $25 billion per year into improving a freight transportation system that can anchor industrial redevelopment in most American metropolitan areas. At the same time, public agencies and not-for-profits are anxiously searching for private investments that can leverage the scarce resources available for redeveloping U.S. industries. Though they share the goal of industrial redevelopment, these parallel actors largely miss each other because they use different metrics to evaluate project feasibility and performance. Freight carriers, officials in departments of transportation, and their consultants are primarily concerned with measures of freight throughput, such as the volume, speed, and reliability of freight movements. Elected representatives, managers of economic development programs, and community leaders want to assess freight's impact on job creation, local economies, the environment, and the quality of life in surrounding neighborhoods.

Cargo-Oriented Development (COD) Metrics

Informed by years of direct experience in fostering sustainable development linked to freight transportation and studying comparable efforts around the nation and the world, CNT proposes that freight industry investments and public economic development initiatives can be usefully linked. The integrative concept in this synthesis is *cargo-oriented development (COD)* – a form of development that integrates freight system efficiency with the development of manufacturing and logistics businesses in ways that drive local economic growth, reduce poverty, improve the environment, and promote public safety. In this paper, CNT proposes metrics to assess the feasibility and performance of COD projects. Though these metrics are necessarily technical in detail, they are conceptually straightforward, involving criteria for evaluation in four categories (see table below).

The COD metrics are logically integrated and interdependent, so decisions meant to bolster ratings in one metric can, in many cases, have a ripple effect that boosts ratings in other metrics as well. This web of relationships becomes apparent when we consider the metric categories.

COD Metrics Overview

A. Local Economic Development	B. Freight System Efficiency	C. Environmental Impact
Industrial Location Efficiency	Truck and System Productivity	Air Quality
Access for Manufacturers	Travel Time and Reliability	Water Quality
Job Creation and Career Paths	Drayage and Terminal Operations	Noise Level
Worker Transportation Access	Right-Sized Shipping	Lighting
Public Costs and Revenues		Regional Land Use
	D. Safety (Affecting All Metrics)	

Facts and figures referenced in the executive summary are all footnoted in the body of the report.

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Local Economic Development

Industrial location efficiency is a set of characteristics that make an industrial district appropriate for COD. These characteristics include convenient access to multiple modes of freight transportation, clusters of existing manufacturing and logistics businesses, and a large local workforce that can reach the district by public transportation. Development in location-efficient settings can impact the retention and creation of jobs in manufacturing as well as logistics and distribution businesses. Additional impacts include: employment of workers from low-income urban communities who are able to reach the job sites; public infrastructure expenditures that are reduced when compact development allows truck trips to be shortened; and tax revenues that grow in mature industrial communities. These outcomes should be expected and measured when developing location-efficient sites.

Intermodal freight terminals are important anchors for COD. This relatively new mode of shipping, in which cargoes move in closed containers for some distance by truck and for the bulk of the trip by rail, is the fastest growing segment of freight transportation. Intermodal terminals, where containers are transferred from one mode to another, attract distribution and manufacturing businesses that reduce shipping costs by locating near these nodes of freight transportation. While many intermodal terminals are repurposed rail properties in location-efficient sites, terminals on new sites and their adjacent industrial parks are often built in greenfields, where developers can avoid the issues of brownfield remediation and complex land assembly.

These greenfield terminals are, in some respects, well suited to a one-way economy built for major retailers to distribute imported goods from a primary distribution center near the new terminal to smaller distribution centers within a 500-mile radius. But they are poorly positioned to provide many of the benefits of COD, including service to more centrally located manufacturers and potential exporters, jobs accessible to low-income community residents, the renewal of existing infrastructure, and public revenues for mature communities. In most U.S. metropolitan areas, public programs are in place to redevelop shovel-ready sites in older industrial districts, even on a large scale. When these public capacities are linked with private developers oriented to intermodal developments, new terminals can more readily be placed in mature communities, and industrial districts near existing terminals can be redeveloped to realize the full potential benefits of COD.

Image: Mi-Jack

Freight System Efficiency

Trucking is the predominant mode of freight transportation in America, handling 70% of freight movements by tonnage and value. Trucking maintains this leading position largely because roadways reach the doors of virtually every manufacturing plant and distribution center in the country. Trucking can move goods from point to point anywhere in the country in one trip, usually providing faster and more reliable on-time delivery than other modes. While trucking will always be an essential part of freight transport, moving freight by truck generates approximately seven times more shipping costs, fuel consumption, air pollution, and accidents than shipping by rail. Through the application of information systems to improve routing and load optimization, the trucking industry has improved productivity over the last decade, moving more goods with fewer truck miles. However, given the significant economic and environmental disadvantages of trucking compared to rail or water, American shippers must shift a significant share of freight to non-truck modes to stay competitive and sustainable.

Intermodal freight offers the best way of facilitating a substantial freight mode shift. Over the past 15 years, intermodal shipping has accelerated train running times and smoothed container transfer procedures so that its speed and reliability is comparable to trucking. Consequently, the intermodal industry has secured business from major shippers of time-sensitive cargoes, including United Parcel Service and Federal Express. During these 15 years, intermodal has tripled the ton-miles of freight it moves annually, but this growth has been from a small base, and intermodal has only grown from 2% to 6% of the ton-mile volume moved by truck alone. Intermodal shipping will need to reach a higher level of operational efficiency to achieve substantial mode shift.

The two principal constraints on intermodal growth are (a) drayage, the distance a truck must carry a container between a point of origin or destination and an intermodal terminal, and (b) the efficiency of intermodal terminal operations. COD may ease both of these constraints, and we have included metrics that measure its impacts on these two factors. Clearly, the compact industrial pattern of COD establishes shorter average drayage distances between intermodal terminals and their customers. Even if COD is only employed in the origin or destination city of an intermodal trip, the one city's compact development will reduce the total drayage costs. If both cities have customer bases in COD areas, the drayage costs for intermodal shipping between them may set records for economy and open new markets for intermodal.

COD can also ramp up the efficiency of operations. Intermodal shipping that serves the broader manufacturing base of COD may achieve improved balance, handling fewer empty containers and adding more high-value product loads to two-way traffic flows. Paradigm-changing technologies are now on the market that enable a terminal to handle a container fewer times during transfers, automate manual procedures, replace diesel with electric equipment, and use less than a third of the acreage required by the operating systems that are most prevalent today. All of these innovations involve both major gains in efficiency and major reductions in negative environmental impacts. Intermodal carriers in COD areas have strong market incentives and, in coordination with local governments, may have public sector incentives to adopt these new efficiencies in terminal operations.

A further opportunity to improve local economies through freight efficiencies is *right-sized shipping*, the coordination of shipping arrangements by multiple businesses to optimize efficiency in load size and consequently reduce shipping costs. This is especially significant for small manufacturers, which commonly face shipping costs two to three times higher than those of larger companies because they lack market power. In some cases, right-sized shipping arrangements involve establishing a user group to provide critical mass for an active rail siding or transload center. Users may also collectively reduce their costs for less-than-truck-load shipping or fill shipping containers to their weight and volume capacities. Increasingly, propositions for right-sized shipping are emerging from web-based information management tools that identify shipping opportunities and streamline routing, but applications of these tools are more likely to be practicable if the participating businesses are clustered near each other in COD districts.

Environmental Impacts

In many cases, the same actions that will generate positive ratings on COD metrics for economic development or freight system efficiency – such as redeveloping vacant industrial land, making work places accessible by public transit, reducing truck VMT, or adopting more efficient intermodal terminal technologies – will also positively impact the environment. For example, COD metrics for air quality estimate the presence of common pollutants – particulate matter (PM), nitrogen dioxide (NO_2), and carbon dioxide (CO_2) – by modeling data on truck VMT recorded or avoided. COD metrics use Leadership in Energy and Environmental Design (LEED) standards to measure negative impacts that are commonly experienced by neighbors of intermodal freight terminals, including potential stormwater runoff, noise, and light pollution. The extent to which favorable ratings by these metrics are attained will be determined largely by whether or not the terminal owner invests in efficient and environmentally beneficial technologies. COD metrics will also evaluate regional land use by measuring the extent to which industrial areas are intensively developed while farmland and open space are preserved. The outcome of these assessments will reflect the degree to which COD practices of location-efficient industrial development have been followed.

Image: Mi-Jack

Safety

Much like the consideration of environmental impacts, the COD metrics for safety use well-researched standards – adherence to the guidelines of federal agencies and comparison of local accident statistics to federal levels – to monitor safety in freight operations. Meeting these standards will depend largely on achieving economic development and improved freight efficiency by shifting freight movement from trucks to the statistically far less dangerous mode of rail. The final safety metric offered in this report is progress in fulfilling the federal mandate to install Positive Train Control (PTC) technology on all American rail lines. By making train derailments dramatically less likely, PTC provides the country's best practical defense against the possibility of a petroleum unit train derailing in a city and causing horrific damage. Simultaneously, PTC lays down a national smart grid of fiber optic cable along all rail lines, adding another potential benefit of COD.

Sample Application of COD Metrics

In addition to the series of research papers and case studies that CNT has developed for the Ford Foundation as part of this project, CNT has applied the COD metrics to compare development opportunities linked to freight transportation and major intermodal terminals in two metropolitan areas: Memphis, TN and Charlotte, NC. Our familiarity with the BNSF intermodal terminal in Memphis is based on a previous case study, and our information on the Norfolk Southern (NS) terminal in Charlotte is derived entirely from published information. Both of these regions are major centers of intermodal freight transportation, but the industrial geography of the two areas and the choices of technology under consideration in each terminal are quite different:

- **Memphis** has been a national manufacturing center for generations. It has a large traditional manufacturing district within its central city limits, which holds a third of the region's industrial jobs. However, it also contains thousands of acres of vacant, previously used land. In this district, BNSF has established a modern intermodal terminal by joining older rail properties. BNSF has equipped its terminal with technologies and operating systems that minimize emissions, noise, and space requirements and are well-suited to an urban location.
- **Charlotte** has a proud history dating back to the 18th century, but it is relatively young as a major city, having added most of its population during the last forty years. Geographically expansive, Charlotte contains extensive areas of previously undeveloped land within the boundaries of its central city. Charlotte's large industrial sector, which has grown up around an expressway belt system, is diffuse and has no effective center. Two years ago, NS opened a new intermodal terminal adjacent to the region's international airport and only seven miles from downtown Charlotte. While this terminal lies within Charlotte's city limits, it is built on previously undeveloped land, and thousands of acres of industrially zoned greenfields lie within five miles of the terminal. NS has equipped its terminal with an operating system that uses abundant available land to achieve efficiencies in processing time and is suited for an exurban environment.

In both of these cases, the major environmental benefits of moving more freight by intermodal would be experienced along the rail routes to trading partner cities. Within Memphis and Charlotte, truck drayage to and from the terminals would offset most of the local air quality benefits of intermodal shipping. Because Memphis' more compact industrial geography would give rise to shorter drayage trips and its terminal uses an operating system designed to generate less pollution, its local environmental benefit would be somewhat greater than Charlotte's.

In both regions, the major local benefit of COD would be stimulating economic development. By developing a third of the vacant, industrially zoned land within a five-mile radius of their respective terminals with manufacturing and logistics businesses, each region would create more than 10,000 jobs over a fifteen-year period and increase the assessed value of its industrial properties by more than $180 million in 2015 dollars. While the economic benefits of COD in these two regions would be similar, their development processes would differ. Memphis would restore previously used land to shovel-ready condition and attract investment to a mature industrial district. Charlotte would establish a new center for its industrial sector through the targeted development of greenfield land and transportation access to this center from its lower-income communities. In both regions, training workers for the skill certifications required for advanced manufacturing and logistics jobs would be a major initiative of the community college system.

Next Steps

Having developed the COD metrics presented in this paper, CNT plans to initiate a four-pronged strategy to refine the concept of COD and apply it as a national redevelopment strategy.

1 **Index:** CNT proposes to convene a group of experts in the fields encompassed by COD – community and industrial economic development, freight transportation, manufacturing, information management, and environmental science – to work with our organization to establish a weighted index that integrates all of the COD metrics. This index will facilitate the rapid yet holistic evaluation, comparison, and communication of COD opportunities.

2 **Research:** CNT will collaborate with other institutions to research issues that will clarify COD opportunities and constraints, such as service patterns in intermodal drayage, the types of businesses (especially manufacturers) for which COD locations will be most beneficial, the costs and benefits of emerging technologies for reducing the environmental footprint of freight transportation, and best practices for realizing COD in economically distressed communities.

3 **Industry Practice:** CNT seeks a dialog with freight industry managers and industrial developers about alternatives in terminal construction and linked industrial development that may better serve host communities, the environment, and industry interests through expansion of the intermodal freight market.

4 **Public Policy:** CNT will urge local and state governments to establish an open door for COD in their zoning and land use regulations and in their economic development plans and practice. Similarly, CNT seeks the adoption of federal policies and programs that encourage and reward local governments for pursuing COD, in keeping with the recommendations of the National Freight Advisory Committee.

5 **Design and Test One or More Models for Effective Data Sharing:** We recommend that a task force jointly funded by transportation departments and foundations design and test one or more models for effective data sharing. In a study on how public agencies measure the economic impacts of transportation investment done for the State Smart Transportation Initiative, funded by the Federal Highway Administration and the Rockefeller Foundation, we observed differences in how different parties define impact. State DOTs and transportation operators tended to describe their impacts in terms of the system being invested in and its users (e.g. system condition and performance, cost-effectiveness, and benefit-cost assessments), while local elected officials, community planners and stakeholders tended to describe these outcomes in terms of local economic development (such as affordability or value captured) and livability. Much of the data needed to conform these two essential views of "impact" will require effective knowledge sharing and data sharing.

THE PROMISE OF CARGO-ORIENTED DEVELOPMENT

Investments linked to freight transportation have become a driving force in the national economy. In each of the last three years, railroads and other freight carriers have invested more than $25 billion to improve America's freight transportation system.[1] These inputs are dwarfed by investments of logistics, distribution, and manufacturing companies that locate or expand plants to gain ready access to freight infrastructure.[2] The thousands of jobs that industrial companies create through these co-locations with freight transportation assets are not mere reorganizations of the labor pool, but rather new positions made possible by the structural competitive advantage of reduced transportation costs. Minimizing freight costs is also a factor in business retention, a compelling reason for manufacturing and distribution companies in mature industrial districts to retain locations near freight facilities, especially when these facilities are being modernized to provide greater efficiency.[3]

Increasingly, public policy makers have recognized that major freight system investments significantly impact large segments of the economy, the built environments of metropolitan areas, and the quality of the natural environment and community life. In the goals of the current federal transportation act, MAP-21, increased economic competitiveness, protection of the environment, and enhanced public safety are to be achieved through the further development of the national freight system. These recommendations are echoed by the Freight Advisory Committee, established according to MAP-21. As a step toward realizing such broad goals, the State Smart Transportation Initiative (SSTI) engaged the Center for Neighborhood Technology (CNT) to recommend criteria for evaluating economic impacts linked to freight transportation investments. A key finding of CNT's analysis is that stakeholders with different roles in freight system improvement and economic development consider different criteria for evaluating performance, as depicted in Figure 1. Freight carriers, officials in departments of transportation, and their consultants are primarily concerned with measures of freight throughput, such as the volume, speed, and reliability of freight movements. Elected representatives, managers of economic development programs, and community leaders want to assess impacts on job creation, local economies, the environment, and the quality of life in neighborhoods. The general public interest will be served to the extent that freight-linked development registers positive results by *all* these criteria.

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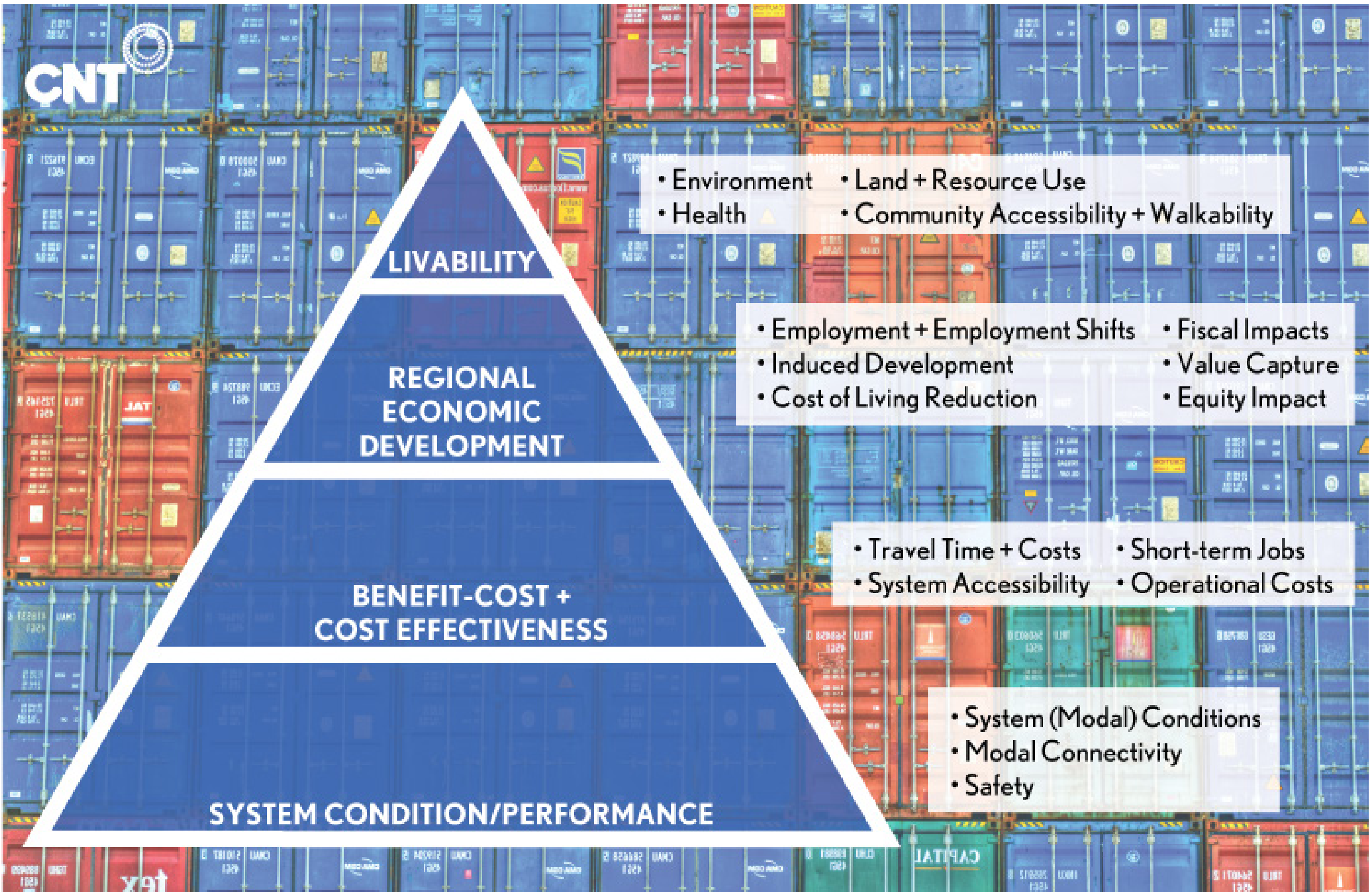
Cargo-oriented development (COD) is a form of development that integrates freight system efficiency with the development of manufacturing and logistics businesses in ways that drive local economic growth, reduce poverty, and improve the environment. In the implementation of COD:

- Freight facilities are located in industrial districts that include a mix of manufacturing and distribution businesses. This way, the freight system readily serves a two-way function, carrying finished goods and imports into COD sites and carrying out products from the nearby manufacturers for distribution domestically and abroad.
- Site predevelopment in existing industrial districts, supported by public policy and investment, places the costs of development at these locations on a level playing field with construction in greenfields.

FIGURE 1
Integrated Community and Freight System Planning
Source: CNT



- Public and private investments in infrastructure connecting freight terminals to rail and highway networks minimizes freight movement through non-industrial areas, ensures efficient freight movement through industrial districts, and enhances reliability.
- Workers can reach industrial districts by public transit, and publicly supported training programs qualify workers for jobs near their homes.
- Compact development patterns minimize the distances that freight must travel by truck, encouraging a market shift to more efficient modes. The close proximity of domestic manufacturers to freight nodes also helps balance product flows by facilitating high-value cargo movement in each direction.
- Private investments in state-of-the-art technologies and systems, incentivized by public sector programs, enable freight operations in CODs to proceed with maximum efficiency in space, time, and costs with minimum generation of air, water, noise, or light pollution.
- The improved efficiency of freight movement enhances public safety by reducing the public's exposure to freight vehicles.

While many freight facilities and linked industrial developments incorporate some COD characteristics, few capture all or even most of them. Today, COD is a feasible form of development where public-private collaboration exists, but it is not yet an industry standard.

COD METRICS

The Center for Neighborhood Technology (CNT) has proposed metrics for assessing the economic development, system efficiency, environmental and public safety impact of COD.

COD Metrics Overview		
A. Local Economic Development	**B. Freight System Efficiency**	**C. Environmental Impact**
Industrial Location Efficiency	Truck and System Productivity	Air Quality
Access for Manufacturers	Travel Time and Reliability	Water Quality
Job Creation and Career Paths	Drayage and Terminal Operations	Noise Level
Worker Transportation Access	Right-Sized Shipping	Lighting
Public Costs and Revenues		Regional Land Use
D. Safety (Affecting All Metrics)		

In each of the following sections of this paper, a concise statement of the metrics in categories A, B, C, and D is followed by a brief discussion of the reasons for selecting these metrics and factors to consider in their application. Appendix A is a chart outlining each COD metric with a statement of the metric, principal benefits to be measured by its application, benchmarks for its use, and references to its consideration in professional literature.

Taken together, the COD metrics are more than a checklist of discrete tests. They are logically integrated and interdependent, so that decisions leading to a favorable rating by one metric will have similarly positive impacts on other metrics. The potential for these types of relationships are clarified in the following discussions of each group of COD metrics.

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A. Local Economic Development

Statement of Metrics

1. Industrial Location Efficiency

a) ***Access to multiple modes of freight transportation:*** Minutes it takes a truck to drive between industrial plants and freight facilities

b) ***Load consolidation and clustering opportunities:*** Number of manufacturing, distribution, and logistics firms and jobs along a shared rail spur or within a 30-minute truck drive

c) ***Available industrial district land:*** Contiguous acres of vacant or severely under-utilized land zoned and previously used for industrial purposes

d) ***Convenient access for a large local workforce:*** Number of area residents who can reach the site within 30 minutes via public transit or active transportation

e) ***Safe and convenient truck access:*** Truck routes that connect expressway exits, freight facilities, and industrial plants; are free of infrastructure impediments; and pass entirely through industrial districts

f) ***Location-efficient development:*** Number of acres of location-efficient sites returned to productive use

2. Job Creation and Career Development

a) ***Good job creation and retention:*** Number of jobs created or saved that pay above the regional median wage for the educational level the job requires

b) ***Career development:*** Number of workers in training for manufacturing/logistics skill certifications

3. Worker Transportation Access

a) ***Worker transportation access:*** Number and percentage of workers in a COD district who commute without driving alone

4. Public Cost Savings and Revenue Growth

a) ***Infrastructure cost savings:*** Road construction and maintenance dollar savings correlated to reductions in truck vehicle miles traveled

b) ***Tax base growth:*** Increase in assessed property values, purchases subject to sales tax, and corporate and employee income subject to tax, all resulting either directly or indirectly from COD

Discussion

Many opportunities for COD, especially as a form of local economic development, lie in a national trend toward the greater use of intermodal freight transportation. In land shipments by intermodal freight, cargo containers are carried most of the way by rail, with truck drayage for the first and last legs of the trip. Over the last fifteen years, the volume of intermodal freight has doubled,[4] and America's Class I railroads have built out their network of intermodal yards to include approximately 187 terminals serving 64 of the country's largest metropolitan areas.[5] Because rail portions of intermodal shipments are approximately seven times more fuel efficient than truck transport, intermodal transport substantially reduces shipper costs and air pollution compared to moving freight entirely by truck.[6] Thus, intermodal terminals have become powerful magnets for attracting and retaining logistics and manufacturing businesses. In 17 cases from across the country summarized from the literature in Appendix B, new intermodal terminals have anchored hundreds to thousands of jobs , depending on the scale of freight movement through the terminal and the degree of local public sector involvement in related business development. In Chicago, research found that preserving intermodal terminals in the city was also essential for the retention of thousands of industrial jobs.[7]

If intermodal terminals and the businesses they attract were consistently sited to optimize economic and environmental benefits, they would have the features of COD termed *industrial location efficiency*. Besides convenient access to multiple modes of freight transportation, location-efficient sites are close to existing centers of manufacturing and distribution and connected by public transportation to a large and skilled workforce. Such sites are usually found in the industrially zoned districts of central cities or first-tier suburbs. At these locations, terminals anchor business retention as well as job creation. They are positioned to handle containers of locally produced goods consolidated

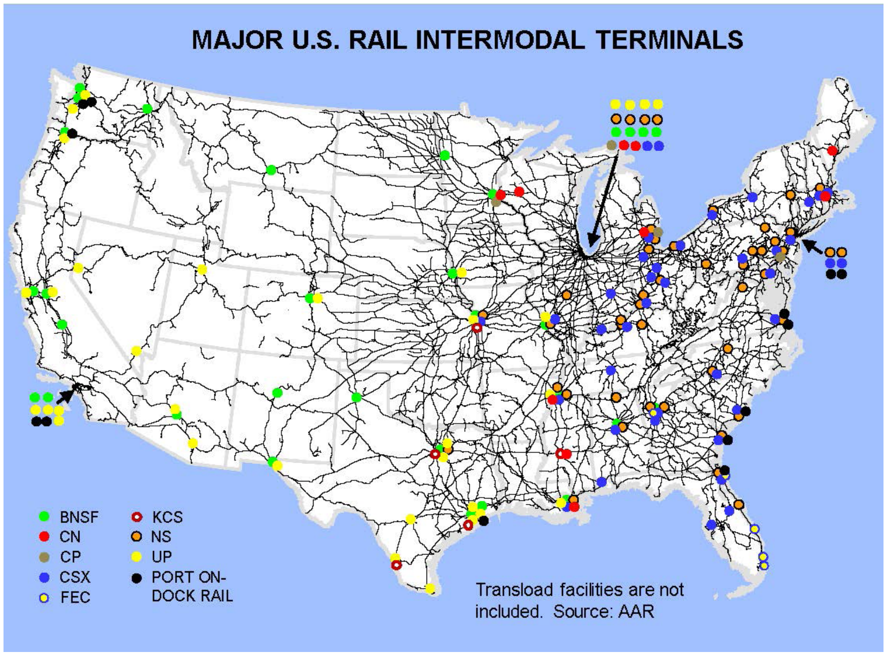


FIGURE 2
Major U.S. Rail Intermodal Terminals
Source: American Association of Railroads

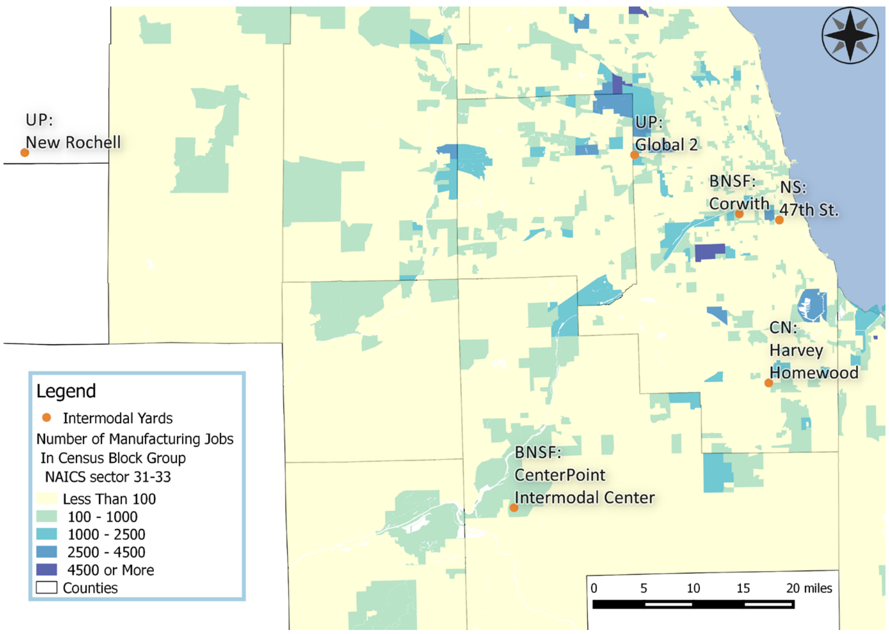


FIGURE 3
Location of Selected Intermodal Terminals and Manufacturing Job Centers in Metropolitan Chicago
Source: CNT Analysis of Longitudinal Employer-Household Dynamics (LEHD) Data 2013

Name	Mean Distance to Manufacturing Jobs
UP - Global 2	19.41158557
BNSF - Corwith	21.94395637
NS - 47th St.	23.92049384
CN - Harvey/Homewood	31.40638945
BNSF - CenterPoint Intermodal Center	42.6437734
UP - New Rochell	64.92027132

for shipment to domestic or foreign destinations and to stage containers of imports to distribution centers. Intermodal terminals in urban districts are commonly built on legacy rail properties, providing optimal use of these fixed investments. Proximity and public transit access give local residents opportunities to gain employment, provided that the area's workforce development organization is offering training and "stackable" credentials for logistics and manufacturing positions that meet employer needs.[8]

The benefits of location efficiency are numerous. Compact development patterns minimize truck mileage, which can drive down shipper costs, public costs for road maintenance,[9] and regional air pollution.[10] Through public incentives and careful planning, negative environmental impacts in neighborhoods near intermodal terminals can be substantially mitigated by currently available technologies and operating systems.[11] Wealth generated by new and expanded businesses and newly employed workers can circulate in established communities and reduce public welfare costs while building public revenue bases.

However, new intermodal terminals and adjacent industrial parks are frequently built in exurban greenfields, removed from existing centers of manufacturing and population. While these exurban locations serve inter-regional shipping patterns that efficiently distribute finished (often imported) goods across North America, they erode a number of the potential benefits of COD. Exurban terminals add truck miles to intra-regional distribution, especially to trips that serve manufacturers of high-value exports, which remain concentrated in the industrial districts of cities and inner-ring suburbs of most U.S. metropolitan areas. For example, in the regions of Chicago, Memphis, and Columbus, OH, terminals in exurban locations are twice as far from the majority of manufacturing jobs as terminals in the central

Average Distance from Intermodal Freight Terminals to Manufacturing Jobs in Several Metropolitan Areas

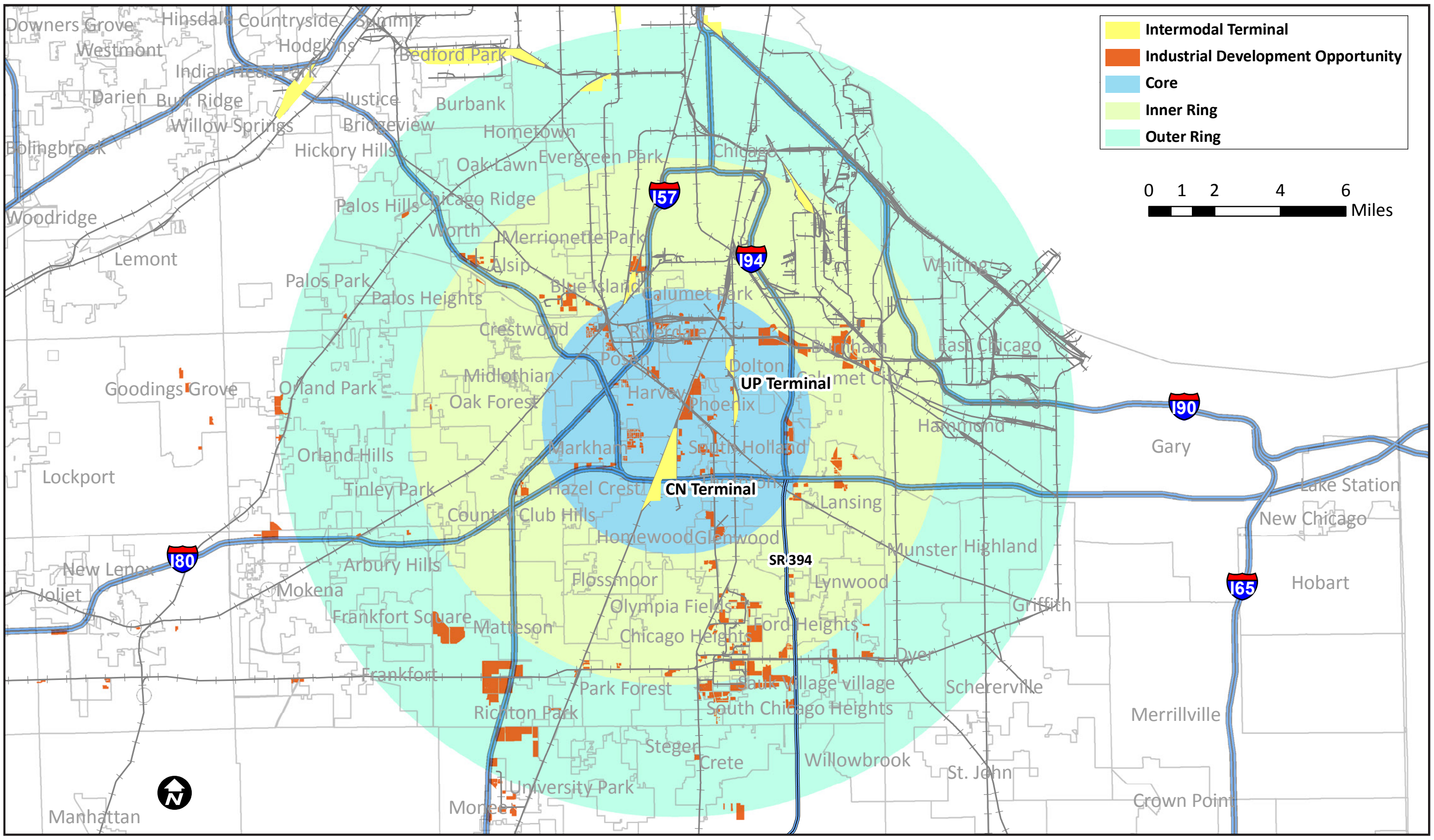
Terminal Name	Region	Distance (miles)
UP - Global 2	Chicago	19.41
BNSF - Corwith	Chicago	21.94
NS - 47th St.	Chicago	23.92
CN - Harvey/Homewood	Chicago	31.41
BNSF - CenterPoint Intermodal Center	Chicago	42.64
UP - New Rochelle	Chicago	64.92
CSX - Buckeye Yard	Columbus	17.72
NS - Rickenbacker	Columbus	22.46
CSX - Marysville	Columbus	35.00
BNSF - Memphis	Memphis	11.37
CN - Memphhis	Memphis	13.93
CSX - Memphis	Memphis	14.13
NS - Rossville	Memphis	21.44
UP - Marion	Memphis	23.96

"Distance" refers to the distance from the intermodal terminal to the geographic center of manufacturing employment in that metropolitan statistical area.

city or first-tier suburbs.[12] Exurban terminals and linked industrial parks also require long commutes by car for most workers, which pose serious obstacles to employment for aspiring workers from lower-income communities in inner cities or first-ring suburbs.

Developers and railroads commonly assume that they must choose exurban locations in order to assemble the land required for new intermodal facilities and co-located businesses, and in the absence of effective public sector support, these assumptions are often correct. However, in well-planned COD projects, public initiatives can assemble large blocks of previously used industrial land, clean up brownfields, and upgrade connecting infrastructure to deliver sites to the market on terms that are competitive with greenfields. This work of predevelopment to prepare sites for private investment is complex, requiring the capacity to integrate several sources of public funds, remediate environmental contamination, and understand the business requirements of industrial development. However, in the large majority of U.S. metropolitan areas, not-for-profit economic development corporations – formed through the cooperative efforts of local governments and civic leadership – perform the type of project-by-project land assembly, brownfield cleanup, and clearance work that is required to create shovel-ready sites in older industrial districts. A COD strategy allows public interest organizations to focus their efforts on properties that have inherent market value because of their freight transportation assets.

Through such actions, local governments and not-for-profit organizations can make it possible to develop new or modernized intermodal facilities with co-located industrial plants in the industrial districts of central cities or inner-ring suburbs. Similar public actions can also facilitate the concentration of industrial users along rail lines that provide rail car load service to manufacturers and distributors. In areas with industrial density, the public sector can also facilitate the development of consolidation centers or transload facilities, which can reduce the shipping costs of small manufacturers.



43 Chicago-area towns, coordinated by the South Suburban Mayors and Managers Association and working closely with CNT, have made the restoration of their industrial districts through COD a cornerstone of their redevelopment strategy. In the implementation of their strategic plan, the ***Green TIME Zone*** *("TIME" is an abbreviation of Transit, Intermodal, Manufacturing, Environment), the participating towns rely on COD as a major job creation strategy and work to revitalize their traditional downtowns through transit-oriented development (TOD). In the ongoing implementation of their plan, Chicago's southern suburbs have already created an online* ***GIS atlas*** *of their redevelopment areas, established a land bank, assessed or remediated over 600 acres of brownfields, built a pipeline of over 20 COD sites in various stages of predevelopment, attracted over $70 million in public and private investments in their projects, facilitated the creation or retention of more than 500 jobs, and founded an industrial worker training program that has placed more than 150 local residents in good manufacturing or logistics jobs.*

Sterling Lumber is a manufacturer of specialized wood products that ships primarily by rail and is growing its intermodal shipments. Sterling recently built an expanded plant on a remediated brownfield served by a rail spur and a CN intermodal terminal less than a mile away, in the mature industrial suburbs of Phoenix and Harvey, IL. Sterling is adding employees and working with the not-for-profit organization OAI, Inc. to hire and train local residents.

B. Freight System Efficiency

Statement of Metrics	
1.	**Truck and Freight System Productivity**
a)	***Reductions in truck vehicle miles traveled (VMT)*** relative to freight tonnage and value, achieved through a combination of trucking efficiency, mode shift, and compact industrial development
2.	**Travel Time and Reliability**
a)	***Travel time:*** Average time to complete freight deliveries on a given route
b)	***Reliability:*** Percentage of freight shipments delivered on time
3.	**Efficiencies in Intermodal Drayage and Terminal Operations**
a)	***Drayage:*** Average truck VMT in trips to and from an intermodal terminal
b)	***Fuel use:*** Average fuel consumed per container moved through an intermodal terminal
c)	***Terminal size:*** Terminal footage required per container moved through an intermodal terminal
4.	**Right Sized Shipping**
a)	Dollar savings in shipping costs through the coordination of shipping arrangements by multiple businesses to optimize efficiency in load size

Discussion

Truck and Freight System Productivity

Trucking has been, and continues to be, the principal mode of freight transportation in America. In 2007 and again in 2013, approximately 70% of freight in the U.S. (by tonnage and by value) was moved by truck.[13] Trucking maintains this predominant position in large part because road coverage is virtually ubiquitous; waterways and railroads do not reach the doorways of most manufacturing plants and distribution centers, but truck routes do. Because of its exhaustive reach, trucking can move goods from point to point anywhere in the country in one trip. Truck-only trips do not require cargo transfers or multiple carriers, so trucking is usually faster and provides more reliable on-time delivery than water or rail modes.

Yet, on a per ton-mile basis, moving freight by truck generates approximately seven times more fuel consumption and other shipping costs than transport by rail. Consequently, rail is far more competive with trucking on longer trips and carries roughly the same volume of freight per ton-mile as trucking.[14] If freight movement in America is to become more economical, as well as safer and more environmentally benign, three interrelated transformations must take place:

- Trucking must become more productive and energy efficient, moving more cargo with less VMT and reducing its fuel consumption per ton-mile.
- A significant percentage of total freight tonnage must be shifted from trucking to less expensive, less polluting, and safer modes.
- To facilitate trucking efficiency and mode shift, average truck trips need to become shorter, as a result of land use and industrial development patterns becoming more compact.

Data indicate that some of these changes are occurring, but the pace of change needs to be radically accelerated.

Average Percentage of Year-to-Year Change in Key Economic Indicators					
	Heavy Truck VMT	VMT for All Vehicles	Gross Domestic Product (GDP)	Manufacturing Output Value	Transportation + Logistics Value
Average Y-to-Y % Change, 2003 to 2013*	-0.59%	0.41%	1.74%	2.83%	4.33%
Average Y-to-Y % Change, 2008 to 2013	-1.58%	-0.23%	0.80%	1.41%	2.58%

**Year 2007 removed from average due to FHWA's change in the classification of heavy duty vehicles*

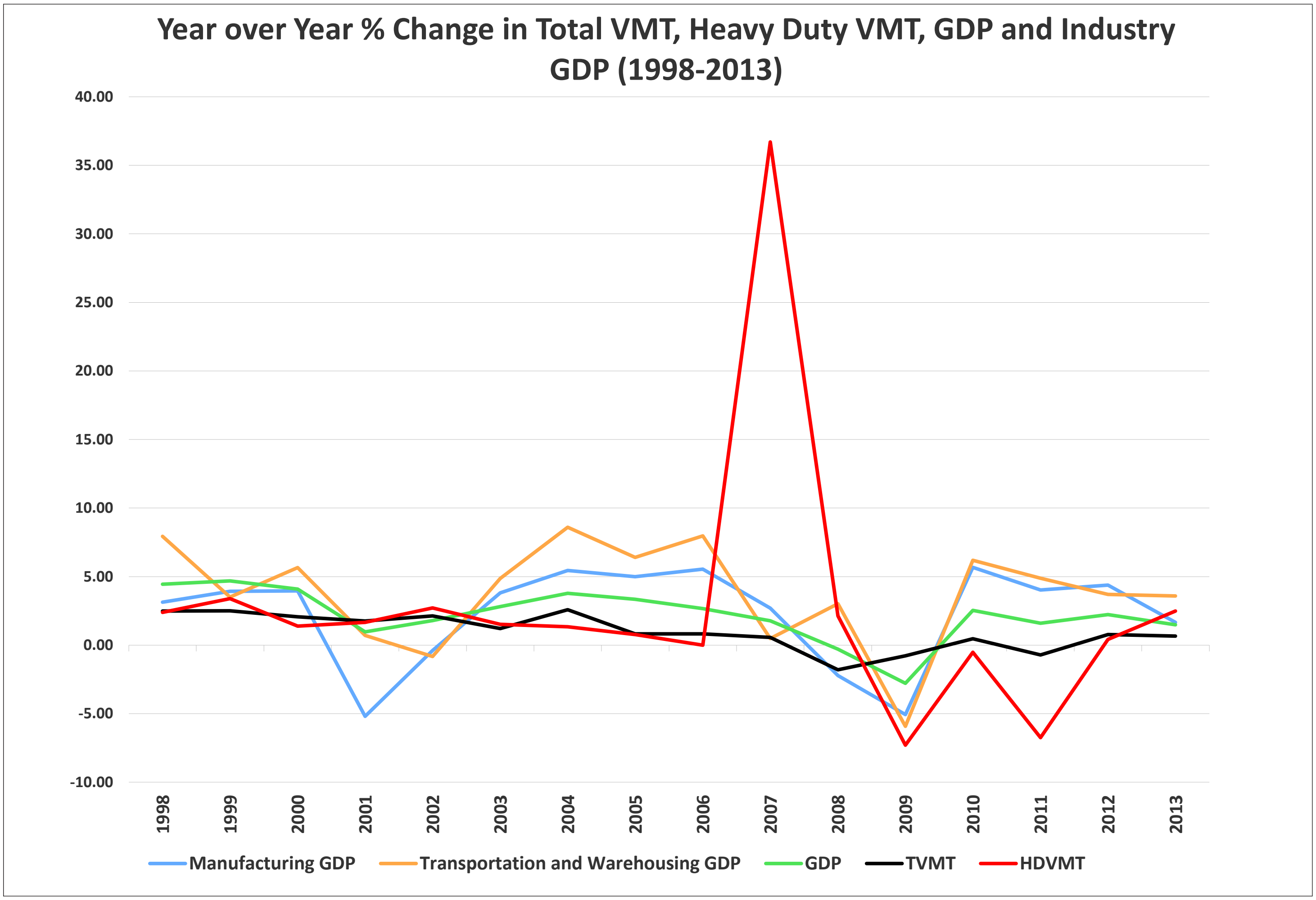
Source: U.S. Department of Commerce, Bureau of Economic Analysis and U.S. Department of Transportation, Federal Highway Administration[17]

Interpreting historical data on truck VMT is problematic because in 2007, the Federal Highway Administration (FHWA) substantially changed the vehicle categorization it uses to track VMT. FHWA expanded the definition of "Heavy Duty Vehicles," which includes large trucks used for shipping. Despite the problem of data consistency and some year-to-year volatility, long-term trends in truck VMT are clear. During the early 1990s, year-over-year truck mileage grew by several percentage points each year, as it had in past decades, but in the early 2000s the rate of growth in truck VMT gradually declined and became negligible. Between 2008 and 2011, change in year-over-year truck VMT turned sharply negative.[15] This pattern follows the same direction as VMT for all vehicles in the U.S., which declined as the population has aged, become more urbanized, and in some segments, made cultural choices to curtail driving.[16] However, the fall in the growth rate of truck VMT has been deeper.

The long-term decline in the growth rate of truck VMT contrasts with the relatively steady year-over-year growth of U.S. gross domestic product (GDP), the value of manufacturing production, and the value of logistics services – all economic indicators that have been more closely correlated with truck VMT in the past and continue to depend on reliable truck service. As noted above, the decline in truck VMT has not changed trucking's percentage of all U.S. freight movements by tonnage or value—it still hovers around 70%. The necessary conclusion from these data trends is that the U.S. trucking industry is doing more with less VMT. This is not surprising in light of the influx of information technology products and services that have poured into the support market for the logistics industry during the last decade.[18] These software programs, web-based data services, and third party logistics (3PL) companies all share the objectives of reducing empty truck miles, optimizing truck routes, and filling truck loads to capacity. Clearly, they are having some effect.

Despite the downward trend between 2008 and 2011, truck VMT did rise between 2011 and 2013. Although federal truck VMT data is not available on a month-to-month basis, monthly trucking tonnage data is reported, and truck tonnage has grown in monthly year-over-year comparisons (i.e., August 2015 was higher than August 2014, etc.) for the past 30 months as the economic recovery has continued.[20] When the FHWA releases more recent VMT data in 2016, it is likely that it will reveal a continued increase in truck VMT. This recent rise indicates that while productivity measures within the trucking industry have been helpful in reducing VMT, they are not enough to drive a sustained truck VMT

FIGURE 4
Year Over Year Percent Change in Total VMT, Heavy Duty VMT, GDP and Industry GDP (1998-2013)
Source: U.S. Department of Commerce, Bureau of Economic Analysis and U.S. Department of Transportation, Federal Highway Administration[19]



reduction when the economy grows.

The trucking industry is proposing more radical innovations in technology and has permitted practices to move more freight with fewer drivers. These include double chassis combination trucks, higher load weight limits, and "platooning" through which multiple linked trucks would be controlled by a single driver or be completely automated. The impacts of such innovations on fuel efficiency, highway infrastructure, and safety are unclear, as are the prospects of lawmakers allowing these innovations on public roadways.

Travel Time, Reliability, and the Growth of Intermodal Shipping

Intermodal shipping offers the nation's most promising option for moving substantial amounts of freight more safely, cheaply, and sustainably. This hybrid mode combines the economy of rail for the longest part of each shipment with the door-to-door reach of trucking in the first and last legs. However, to be competitive, intermodal carriers must move trains and transfer cargo containers with enough speed and efficiency to compete with all-truck travel times and reliability. In the early 1990s, leading industry analysts posited that such standards could not be reached. They predicted that intermodal's role would be limited to total shipments greater than 800 or 1,000 miles, long enough for economies in the rail portion of the trip to compensate for relatively slow rail speeds and the costs and delays of container transfers.[21] However, through massive railroad

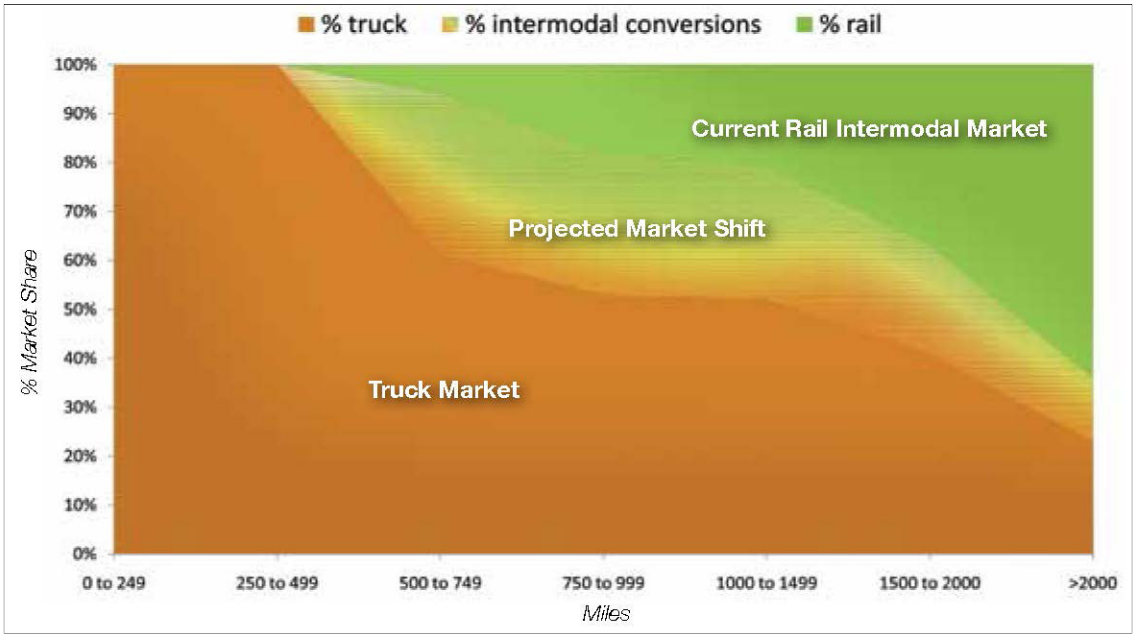


FIGURE 5
Truck and Intermodal Rail Market Share
Source: National Rail Plan: Moving Forward. Federal Railroad Administration, September 2000

investments in corridors and terminals,[22] coupled with the trucking industry's integration of its operations with intermodal rail,[23] the expectations of twenty years ago have been exceeded.

By 2014, the records of the Surface Transportation Board showed that Class I railroads were running intermodal trains at speeds approximately one third faster than their general train movements.[24] Analysts commonly agreed that more than 95% of intermodal shipments were meeting delivery times[25] and that intermodal was able to compete with trucking for shipments within 400 to 600 miles.[26] During the last two years, intermodal freight operations have suffered, along with the overall reliability of the railroads, as the industry has absorbed a massive increase of oil movement. However, the established capacity of the intermodal network has continued to grow even during this stressful period, providing the basis for an incremental shift of freight from all-truck to intermodal transport.[27]

With intermodal's gains in speed and reliability, leading providers of time-sensitive delivery services, including United Parcel Service (UPS) and Federal Express, have become major customers.[28] Between 1993 and 2013, the volume of intermodal shipping doubled.[29] The success that intermodal shipping has achieved and the need for its acceleration are indicated by the following chart, which shows data summarized from several tables of the Oak Ridge Laboratory's current T*ransportation Energy Data Book*.[30]

As the table on the next page indicates, the trend in shipping by rail alone is virtually flat; a substantial shift from truck to rail appears most likely to come through intermodal. The pace of intermodal growth far outstrips truck or rail, though this growth arises from a relatively small base. Intermodal expansion must accelerate to achieve a shift of significant scale in the overall volume of U.S. freight movement.

Goods Shipped in the US by Selected Modes, 1997 -2014			
	1997	2012	Average Annual Change
Value of Goods Shipped (2012 dollars, billions)			
Truck	$7,126	$10,132	2.4%
Rail	$457	$473	0.2%
Intermodal, Truck-Rail	$108	$225	5.0%
Tons of Freight Shipped (millions of tons)			
Truck	7700.7	8060.2	0.3%
Rail	1549.8	1628.5	0.3%
Intermodal, Truck-Rail	54.2	213.8	9.6%
Ton-Miles (billions)			
Truck	1032.5	1247.7	1.3%
Rail	1022.5	1211.5	1.1%
Intermodal, Truck-Rail	55.6	169.5	7.7%
Average Miles Per Shipment			
Truck	144	227	3.1%
Rail	769	805	0.3%
Intermodal, Truck-Rail	1347	998	-2.0%

Source: Transportation Energy Data Book, Edition 34, Tables: 5.14, 5.15, 5.16, 5.17

Efficiencies in Intermodal Drayage and Terminal Operations

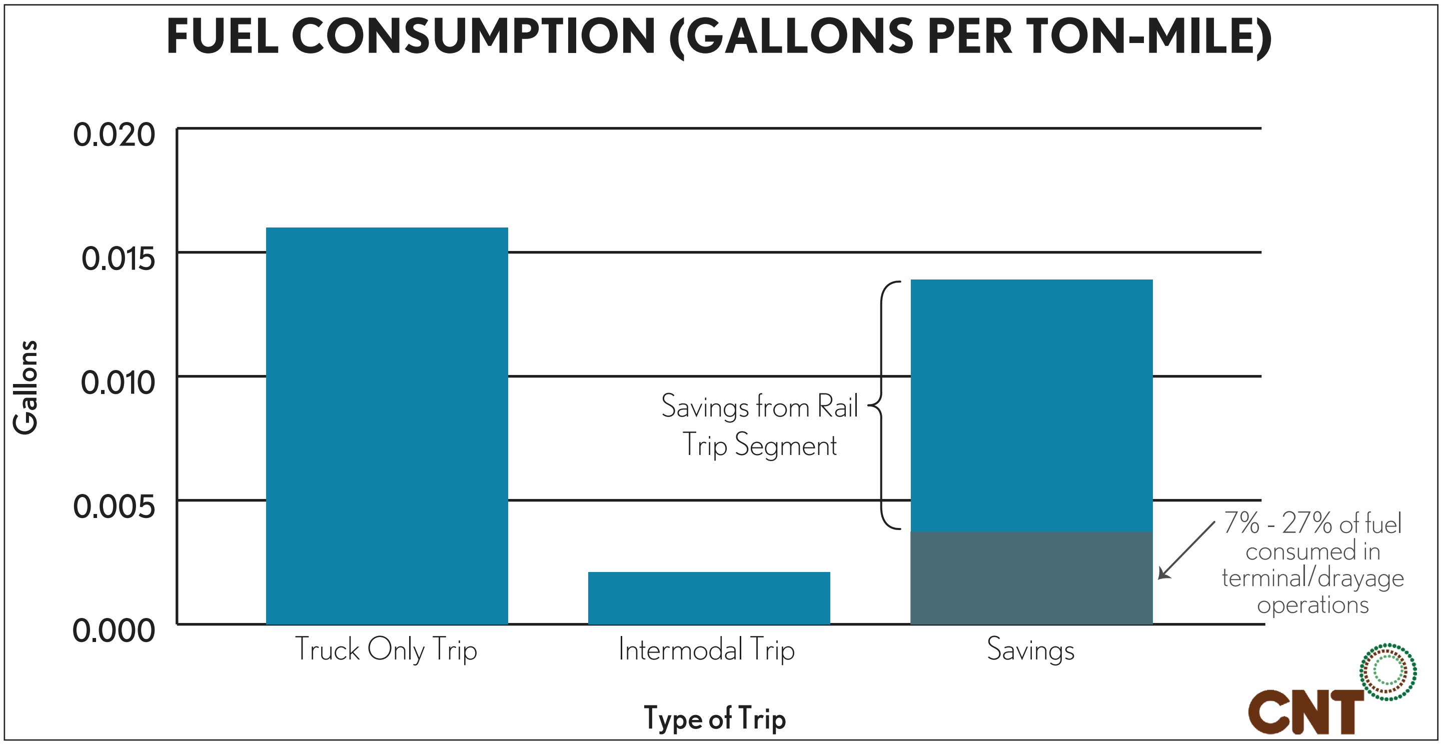
To consider how intermodal freight might reach a new level of growth, it is necessary to measure the two major constraints on its expansion:

- The length of truck drays to and from intermodal terminals
- The efficiency of intermodal terminal operations

A recent study for the U.S. Department of Transportation found that drayage and terminal operations may consume 7% to 27% of the savings intermodal generates through the rail leg of the trip (when compared to trucking).[31] This finding is consistent with the rule of thumb, commonly used by freight professionals in intermodal planning, that to be profitable an intermodal shipment must (a) limit drayage to less than 15% of total trip mileage and (b) limit drayage plus terminal costs to less than 25% of total shipment costs. Intermodal freight's competitiveness – and market share – depends on short drayage and the efficiency of terminal operations. By reducing the key constraints of drayage and terminal operating costs, COD builds the market for intermodal freight, including manufacturing, which can add to balanced, two-way intermodal cargo flows.

Short drayage may be achieved through development in the compact, location-efficient patterns of COD discussed in the section on Local Economic Development (starting on page 4 of this report). With support from the public and not-for-profit sectors, such locations may provide convenient access to clusters of existing industrial customers, including manufacturers, and to shovel-ready sites for new, large businesses within five miles of intermodal terminals. Service between location-efficient industrial districts near the origin and destination terminals of intermodal trips could be feasible at distances as short as 200 miles, opening a vast new market to intermodal shipping. To the extent that the customer base of these districts includes manufacturers, the service would also carry high-value cargoes in both directions, helping to achieve the balance sought in intermodal shipping.

FIGURE 6
Fuel Consumption
(Gallons per Ton-mile)
Source: U.S.D.O.T. National Transportation Statistics, ICF International



The development of intermodal terminals and co-located industrial districts in the compact patterns of COD will also encourage investment in state-of-the-art truck, rail, and intermodal terminal technologies that increase efficiency while minimizing fuel consumption and pollution. For example, urban terminals will be motivated to use automated gate technologies, now widely deployed in the industry, to prevent truck queueing on access roads.[32] To minimize associated pollution, they will encourage or require the use of the most efficient locomotive and truck engines and idling emissions controls.[33] Optimally, they will follow the example of the ports of Los Angles, Long Beach, and Houston and work with local governments to establish programs that incentivize and require clean truck technologies in the vehicles that serve them.[34]

In an urban environment with limited available land, intermodal terminals will be especially motivated to optimize the speed and efficiency with which they process containers by minimizing the number of times the containers must be handled by cranes and moved within the terminal. To do this, they may employ double cycling of container lifts with fully electric overhead cranes, much like CSX's northwest Ohio terminal.[35] They may also optimize land use by opting for a "grounded" or "stacked" system of storing containers vertically, as in BNSF's Memphis terminal, rather than the currently more common "wheeled" system of mounting each container on a chassis to be moved between storage and loading areas within the terminal. In a logical extension of a stacked operation, terminals may adopt a technology like the Automated Transfer Management System (ATMS) now offered by the Mi-Jack Corporation. ATMS hydraulic work stations (now employed in a number of terminals as individual units) hold several containers in a rack structure. The ATMS work station receives or provides a container to be loaded by a crane. At ground level, it can also decouple and remove a container from a chassis or load a container onto a chassis without the use of a crane. Mi-Jack

FIGURE 7
Double Cycle Operation: Illustration of Mi-Jack Automated Transfer Management System (ATMS) Technology
Source: Mi-Jack

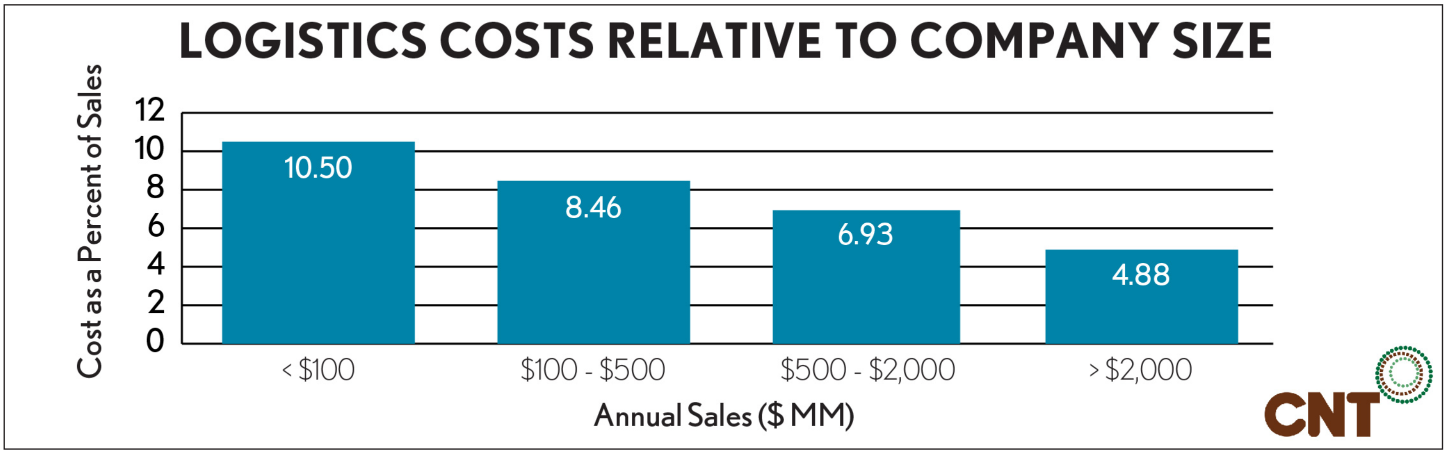
proposes using walls of ATMS units along rail tracks, from which the containers on intermodal trains may be loaded or unloaded by overhead cranes, while trucks are loaded and unloaded without crane movements.[36] The combination of these technologies can reduce the fuel consumption generated by the operations of an intermodal terminal by more than two thirds. It can also reduce the ground area requirements of an intermodal terminal by more than two thirds, greatly easing the placement of such facilities in urban industrial districts.[37] Investments that reduce fuel consumption and pollution in intermodal terminals should be, and have been, incentivized by local governments seeking to stimulate economic development while reducing negative environmental impacts.[38]

Right-Size Shipping

Industrial businesses, particularly smaller manufacturers, may contribute to reductions in truck VMT and their freight transportation costs through *right-size shipping*: the coordination of shipping arrangements by multiple businesses – either through cooperative efforts or the services of a third party -- to optimize efficiency in load size and, consequently, reduce shipping costs. Location within a COD increases potential opportunities for right-size shipping, as does the use of emerging information technologies. A range of models for right-size shipping exist:

- **Rail-served industrial districts:** Within COD districts, some manufacturers may be able to follow a traditional path to reduced freight costs through carload service to plants clustered along active rail lines. For example, the industrial development and freight transportation firm Omnitrax builds rail-served industrial parks, buying or constructing a short-line rail connection to a Class I railroad and developing the park with a sufficient density of manufacturers to make both the industrial park and the rail operation viable.[39]
- **Transload Centers:** Districts densely settled with manufacturers will be well positioned to support transload services, which break down rail carload shipments carrying cargo for a number of customers, making the economies of rail transportation available to companies that are not necessarily located on an active rail spur. For example, the City of Davenport, Iowa, used a grant from the federal Economic Development Administration to build a multi-purpose rail transload center as a key amenity of an industrial park.[40]
- **Load Consolidation:** In their outbound shipments, smaller manufacturers frequently rely on "less-than-

FIGURE 8
Logistics Costs Relative to Company Size
Source: Adapted from Establish Davis Logistics, Report to the Council of Supply Chain Management Professionals (CSCMP) re the Council's annual report "State of Logistics 2013"



truck-load (LTL)" services that consolidate shipments from a number of users into full truck loads, commonly with full containers. LTL shipment is three to four times more expensive than full truck or container load rates, posing a substantial impediment to the growth of smaller manufacturers.[41] Prospects to lower LTL rates lie in the extreme competitiveness of this industry. Major multi-modal freight carriers, including FedEx and UPS, compete in this market along with national trucking companies and third party logistics (3PL) firms. LTL carriers operate freight consolidation centers to which their customers' cargoes are drayed and organized into full truck loads. Smaller LTL competitors mine information and identify concentrations in the industry and geographic clusterings of potential customers to find market opportunities. For example, the 3PL firm Kane is Able worked with Sun-Maid Raisins and other California food producers to establish direct purchasing agreements with major retailers that could be met with load consolidation arrangements for the producers' shipments.

- **Load Balancing:** Creativity in load consolidation is not limited to reducing the high costs of LTL shipping. In an example now widely reported in professional literature, Dial Tile, a manufacturer of floor tiles in Mexico, was concerned that its heavy products reached maximum weight limits for containers and box cars while leaving substantial volume empty in the shipping cubes. Over several years, Dial Tile worked with 3PLs and freight carriers to establish load sharing partnerships with three other manufacturers to carry its products with lighter manufactured goods in configurations that optimized the volume and weight capacities of trucks, intermodal containers, and box cars moving across North America.[42]

While opportunities to reduce the delivered costs of manufactured products through right-size shipping will be attractive to firms of any size, they are particularly important to smaller manufacturers that commonly pay twice the shipping costs of the largest producers because they lack market power.[43] Smaller manufacturers are especially likely to be located in the central industrial districts of urban areas, where they can reuse older industrial buildings and benefit from clustering arrangements with nearby customers and suppliers. Smaller manufacturers of all types—from business incubator graduates to suppliers to exporters—are particularly important to local economies and the nation because can they grow into key suppliers to larger companies, innovators of new ideas, and sources of new exports. Fostering right-size shipping for smaller manufacturers is critical for building COD strategies that maximize economic development through compact industrial development and better connections with the freight transportation system.

C. Environmental Impacts

Statement of Metrics	
1.	**Air Quality**
a)	***Pollution levels:*** Presence in the air of three common pollutants: particulate matter (PM), nitrogen dioxide (NO_2), and carbon dioxide (CO_2), measured using estimates modeled from data on truck VMT and fuel use
2.	**Freight facility and infrastructure design to achieve Leadership in Energy and Environmental Design (LEED) standards for industrial properties, including:**
a)	***Water Quality:*** On-site absorption of stormwater
b)	***Noise Level:*** Measured at intermodal terminal boundaries, not to exceed 55 dBA
c)	***Lighting:*** Measured at intermodal terminal boundaries, not to exceed .20 footcandles
3.	**Regional Land Use**
a)	***Land use:*** Percentage of acres in productive use in industrially zoned districts
b)	***Jobs:*** Number of jobs per acre in industrially zoned districts
c)	***Open space preservation:*** Percentage of regional acres in parks or protected open land

Discussion

Trucking Efficiencies and Environmental Impacts

Reductions in truck mileage, including drayage, along with the application of the most efficient freight technologies will reduce diesel fuel consumption and, consequently, multiple forms of air pollution in ways that have been extensively studied. Air pollution reductions may thus be reliably modeled from known fuel use. Some forms of water and soil pollution caused by the settling of airborne pollutants may also be minimized and modeled as a function of fuel use.

A number of considerations make reduction in truck VMT as essential for environmental reasons as it is for the economic development and system efficiency dimensions of COD. First, as a consequence of trucking's relatively low fuel efficiency, moving a ton-mile of freight by truck rather than rail multiplies emissions of greenhouse gases and other air pollutants.

At the present time, reducing the amount of freight moved by truck appears to be the most effective way to reduce truck-generated air pollution because the basic technology and operating format of trucking has only made incremental,

Air Pollutants Per Million Ton-Miles of Freight Movement

	Truck	Rail
Tons of CO_2 equivalents per million ton-miles	229.8	28.96
Tons of nitrogen dioxide (NO_2) equivalents per million ton-miles	3.0193	0.6747
Tons of particulate matter per million ton-miles	0.1191	0.0179

Source: U.S. Government Accountability Office, A Comparison, of the Costs of Road, Rail, and Waterways Freight Shipments that Are Not Passed on to Consumers, *January 2011, http://www.gao.gov/new.items/d11134.pdf*

Fuel Consumption and Freight Ton-Miles Moved by Truck and Rail, 1980 -2011				
Year	Truck		Rail	
	Diesel Fuel Consumed (thousands of barrels per day)*	Ton-Miles of Freight (millions)**	Diesel Fuel Consumed (thousands of barrels per day)*	Ton-Miles of Freight (millions)**
1980	1,302	1,266,631	262	932,000
1990	1,597	1,707,373	216	1,064,408
2000	2,298	2,326,524	256	1,546,319
2011	2,766	2,643,567	253	1,725,634

** Transportation Energy Data Book, Edition 34, Table 1.14*

*** Bureau of Transportation Statistics, National Transportation Statistics, Table 1-50, Ton-Miles of Freight*

at best, progress in achieving fuel efficiency per unit of freight moved. This fact is illustrated by the following summary of fuel consumed and ton-miles moved by truck and rail over the past three decades.

During these thirty years, as the ton-miles shipped by truck approximately doubled, the amount of diesel fuel to move this freight increased in direct proportion. In contrast, ton-miles by rail also nearly doubled during the same period; however, through a combination of improvements in technology, infrastructure, and operating practices, the rail industry absorbed this volume increase with no increase in fuel consumption.[44]

For the two basic classes of heavy trucks recognized by the FHWA, median fuel efficiency has not improved in recent decades. In 2013, "Single Unit Trucks" showed a median efficiency of 7.3 miles per gallon (mpg), while median "Combination Trucks" recorded 5.8 mpg.[45]

Trucking's record of emitting greenhouse gases and criteria pollutants (the six pollutants regulated by the Clean Air Act) are also a cause of concern. Between 1990 and 2013, carbon dioxide emissions from heavy truks rose at an average annual rate of 2.4%, faster than the increase in truck VMT and at a higher rate than emissions from any other transportation source.[46] The contributions of transportation activities to the generation of criteria pollutants was sharply curtailed with changes in the formulae of standard gasolines. However, diesel fuels generally did undergo these improvements, and as primary users of diesel fuel, heavy trucks have increased their percentage contributions to the levels of these pollutants in the air.[47]

Public action to stimulate improvement in the fuel efficiency of trucks and further improvement in rail energy efficiency per ton-mile is underway. A 2007 ruling of the U.S. Supreme Court empowered the EPA to regulate the emissions of greenhouse gases.[48] This authorization, along with the power to regulate pollutants under the Clean Air Act, has led to the promulgation of federal standards that new transportation vehicles are required to meet in the reduction of greenhouse gases and criteria air pollutants.[49] (Following the 2007 precedent, a controversial June 2014 Suprene Court decision has affirmed the EPA's authority to regulate a range of stationary sources of greenhouse gases and airborne pollutants, though not without cautionary chiding from the Court's more conversative members.)[50]

In 2009, the EPA issued fuel efficiency standards that trucks

Heavy Trucks Using Diesel Fuel as a Factor in the Presence of Criteria Pollutants

(millions of short tons)		
Pollutant	**1970**	**2011**
Carbon Monoxide		
Total Generated by Transportation	174.6	36.3
Heavy Diesel Vehicles	0.49	0.77
Percent Diesel	0.3%	4.2%
Nitrogen Oxides		
Total Generated by Transportation	15.27	7.16
Heavy Diesel Vehicles	1.76	2.56
Percent Diesel	14.5%	45.8%
Volatile Organic Compounds		
Total Generated by Transportation (millions)	18.53	4.01
Heavy Diesel Vehicles (thousands)	460	213
Percent Diesel	2.7%	9.7%
Particulate Matter (PM-10)		
Total Generated by Transportation (millions)	0.64	0.49
Heavy Diesel Vehicles (thousands)	113	168
Percent Diesel	23.5%	45.3%

Source: Transportation Energy Handbook, Tables 12.2 to 12.11

manufactured between 2014 and 2018 were required to meet, and in 2015 the Truck and Engine Manufacturers Association has reported that these requirements have been satisfied. Under further regulations proposed by the EPA, which are now under review, the average fuel efficiency of a truck built after 2021 will be approximately 24% higher than that of trucks built to satisfy the 2018 standards.[51] While these improvements in new trucks will be significant in light of the huge volume of truck movements, they will take years to work through the aging U.S. truck fleet. As of 2013, approximately 38% of the heavy-duty trucks in U.S. industry were more than 10 years old, and the median age at which a truck is scrapped in 28 years.[52] When the currently proposed EPA standards are eventually realized in the U.S. truck fleet, the percentage improvements they entail will be small compared to the differences of several hundred percent in the relative efficiencies of shipments by rail or intermodal.

Trucks that utilize fundamentally new technologies – including compressed natural gas, electric power, and hydrogen – are being manufactured on a very limited basis. The *Transportation Energy Databook* reports that 91.5% of the energy currently supplied to the transportation sector is from petroleum. Of the remaining 8.5% of the transportation sector's energy, 85.7% is supplied by ethanol. The remaining amount is divided among all other energy sources.[53] While the *Databook* reviews passenger vehicles that use alternative fuels, it does not comment on the vanishingly small percentage of the transportation sector that consists of alternative-energy trucks. Given the early stage of alternative truck development, organizations that are among the most progressive advocates of clean air and alternative energy, including the National Resources Defense Foundation and the American Lung Association. limited their input on the EPA's current truck regulations to support of the agency's proposals rather than championing a still burgeoning technology. For the foreseeable future, if the U.S. economy linked to freight transportation is to become more sustainable, it will do so primarily through a shift to more energy-efficient modes and development policies.

Environmental Concerns Linked to Freight Facilities

Additional negative environmental impacts that commonly result from freight movement and industrial activity include stormwater inundation, noise, and light pollution. When state-of-the-art technologies and industrial designs that improve the efficiencies of freight operations, as discussed in Section II.B., are applied to the mitigation of these problems and the impacts are measured by COD metrics, the results can be transformative:

- Truck routes to major freight facilities, such as intermodal terminals, pass entirely through industrial areas.
- Trucks are admitted to terminals in seconds via automated gate systems that read digital codes, eliminating truck queues.
- Trucks and locomotives using intermodal facilities meet current USEPA standards for new engines and technologies that minimize emissions during idling.
- Within terminals, trucks discharge and receive containers from automated stations without the use of cranes. A wall of these stations holds the containers in a rack structure several containers high for loading onto or off of intermodal trains. Multiple movements of containers within the terminal are eliminated, so the required land footprint is 60% to 80% smaller than conventional terminals today.
- Containers are lifted between the rack structure and trains by overhead, fully electric cranes, which consume no fuel onsite and operate with virtually no noise.
- Terminal lighting is directional, illuminating work areas with negligible spillage to surrounding properties.
- Terminal grounds are designed to hold rainwater in place.
- Terminal buildings and grounds conform, in their overall design, to Leadership in Energy and Environmental Design (LEED) standards.

Terminals built and operating in these ways are cleaner, greener, quieter, and smaller than today's standard intermodal terminal. Although such terminals seem like a distant dream, all of these elements can be found in intermodal facilities throughout the U.S.

Building or remodeling intermodal freight facilities to function in these ways and to help nearby industrial businesses thrive will also have transformative long-term effects on American metropolitan areas. These decisions will build compact urban environments in which businesses have the advantages of clustering, workers have access to jobs through public transportation, and mobile sources of air pollution are minimized, while farmland and open space are preserved.

During the 1990s, analysts believed the intermodal market would be limited to trips of 800 miles or more. By 2012 intermodal was competing for trips as short as 400 miles in some regions.

Image: Mi-Jack

D. Safety

Statement of Metrics
1. **Trucking adherence to the guidelines** of the Federal Motor Carrier Safety Administration's Safety Measurement System
2. **Railroad adherence** to the guidance of the Federal Railroad Administration's Risk Reduction Program
3. **Local safety records** to compare the number of local injuries and fatalities caused by freight accidents to national averages per billion tons of freight moved by rail and truck
4. **Implementation of Positive Train Control,** measured by the percentage of train track miles in a region in which this federally mandated technology has been installed

Discussion

As COD reduces truck mileage, creates jobs near worker communities, and scales back pollution, it will simultaneously reduce the risk of accidents and threats to public health. A project's success in meeting these objectives will be monitored by metrics that call for compliance with two extensively studied federal guidelines: the Federal Motor Carrier Safety Administration's Safety Measurement System and the Federal Railroad Administration's Risk Reduction Program. Additionally, local and project records of injuries and accidents will be compared with national averages for such incidents, relative to volumes of freight moved by rail and truck.

The final COD metric is progress in fulfilling the federal mandate to install Positive Train Control (PTC) technology on all American rail lines. By making train derailments dramatically less likely, PTC provides the country's best practical defense against the possibility of a petroleum unit train derailing in a city and causing horrific damage. Simultaneously, PTC lays down a national smart grid of fiber optic cable along all rail lines, adding another dimension to the potential benefits of COD.

APPLYING COD METRICS

Regions and Terminals

In order to demonstrate an application of these COD metrics, CNT examined intermodal operations, and the corresponding economic and environmental considerations, in the metropolitan areas of Memphis, TN and Charlotte, NC. In both regions, CNT has identified strengths and challenges that each would face in following development patterns that would rank highly on the COD metrics. We focused particularly on the Burlington Northern Santa Fe (BNSF) terminal in Memphis and the Norfolk Southern (NS) terminal in Charlotte. CNT's knowledge of the BNSF terminal is based on an earlier case study that included a site visit and interviews with managers; our information on the NS terminal in Charlotte is taken only from public presentations and published reports. Both regions have expanding economies in which freight transportation is both an important industry in its own right and an essential support service for larger distribution and manufacturing industries. Despite their economic strength, both regions have high percentages of households in poverty, which are concentrated in the center of their core cities. Both the BNSF and NS terminals have opened within the last five years. Each terminal now processes more than 200,000 freight containers annually and was designed with the expectation of processing more than 600,000 per year.

Terminal Locations

The BNSF Memphis terminal is located within the city's traditional industrial district, near the nation's busiest freight airport. The area within a five-mile radius of the terminal contains over 2,500 acres of previously used vacant industrial land and hundreds of vacant industrial buildings, but it nonetheless houses 33% of all the industrial jobs and 18 of the 25 largest logistics or manufacturing companies in the Memphis Metropolitan Statistical Area (MSA). The 185-acre BNSF terminal was formed by merging several older railroad properties. Charlotte's rapidly expanding industrial sector is geographically diffuse and has no single center. In 2013, NS opened its present terminal adjacent to the region's airport, in keeping with long-term city and regional plans. The present NS terminal consists of 170 acres with options to acquire and expand onto adjacent land. While this terminal lies within the city limits of Charlotte, the surrounding area contains thousands of acres of industrially zoned greenfields. With further planning, the airport and NS terminal have the potential to become the industrial center that Charlotte currently lacks.

Terminal Operations

The NS Charlotte terminal uses a *wheeled operating system* in which containers are shifted between train loading areas and parking lots within the terminal by hostler trucks. The BNSF Memphis facility, on the othe hand, employs a *grounded system* in which containers are stacked within a crane's reach of train loading areas. The wheeled system is highly time and cost efficient, but its in-terminal container movements require higher fuel costs and a larger footprint than a grounded system that uses the most energy-efficient technology. NS has secured options to expand onto adjacent land as the Charlotte terminal increases its containervolume. This terminal's wheeled system is best suited for a location where real estate is inexpensive. The BNSF Memphis terminal demonstrates a different type of efficiency. Its grounded system minimizes in-terminal container movements and uses fully electric, rail-mounted cranes that consume no fuel on the terminal site and are virtually noiseless. The BNSF terminal design also directs lighting downward to cover the working area without shining on neighboring properties. BNSF plans to eventually have this terminal to process 600,000 containers per year without major adjustments and expects it to eventually accommodate 1 million containers annually within its current footprint. It is a system well suited for an urban environment.

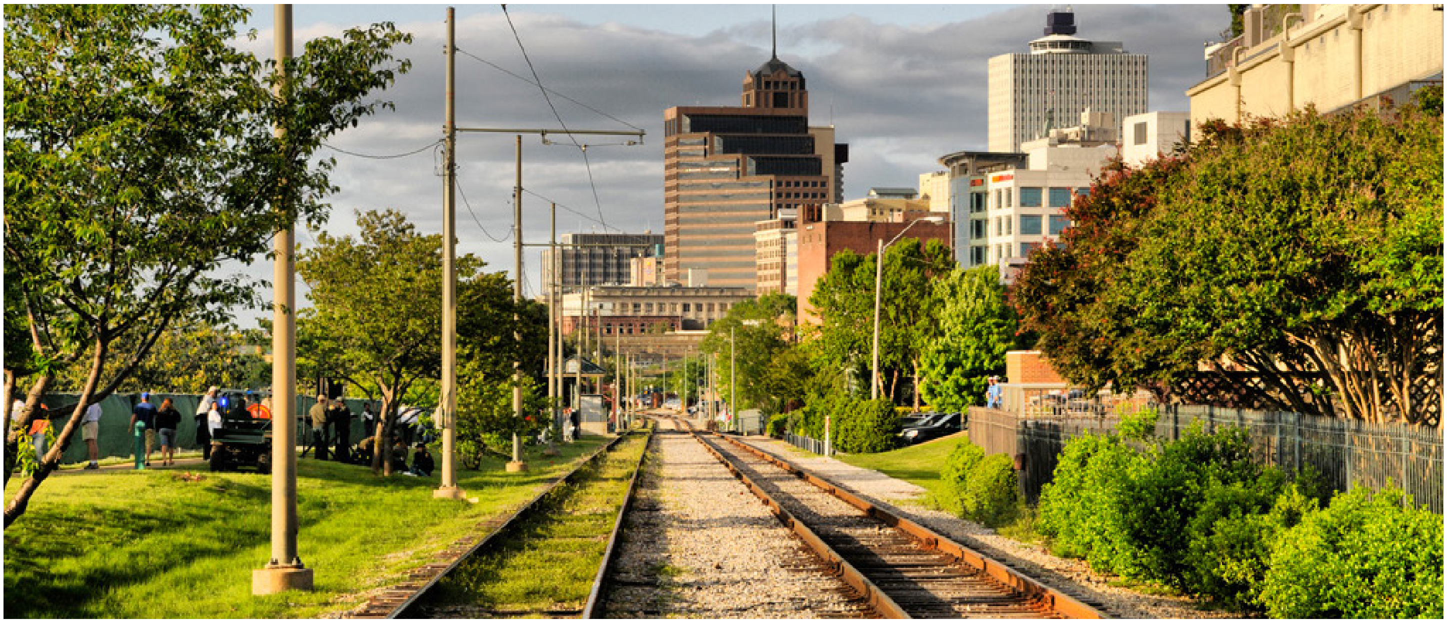


Photo: Isaac Singleton Photography/Creative Commons

Local (Intra-Regional) Economic Benefits

For Memphis and Charlotte, intermodal freight's biggest benefits lie in local economic development – the opportunity to carry out COD on a scale comparable to developments linked to similarly sized terminals in other U.S. regions. In each city, capitalizing on this opportunity over 15 years will mean developing approximately a third of the vacant acres in industrially zoned districts within a five-mile radius of the terminals, which can create over 10,000 jobs in manufacturing and logistics businesses and increasing the assessed value of the industrial properties by more than $180 million. These direct economic impacts will trigger a series of indirect and induced benefits, including an expanded market for local goods and services and enhanced clustering opportunities for industrial businesses.

National (Inter-Regional) Benefits

By applying data from the U.S. Commodity Flow Survey to the COD metrics, CNT estimated the results of moving the number of containers processed through the BNSF Memphis and NS Charlotte terminals by intermodal rather than truck-only shipments. These estimates were made for the approximate current volume of the terminals,and for a time when each terminal reaches the anticipated volume of 600,000 containers per year. In both cities at current container volumes, intermodal shipping would save over 12 million gallons of fuel, $105 million in shipping costs, and $11 million in public road maintenance costs over a year's time. Thousands of tons of air pollution would not be emitted, and more than 50 injuries and at least one fatality would likely be avoided. When volumes reach 600,000 containers per year in each terminal, these benefits will increase by 200% to 300% in 2015 dollars. These benefits will be realized largely over the long distances between principal trading partner cities linked to Memphis and/or Charlotte, so they will accrue to the nation as a whole rather than be confined to any particular region.

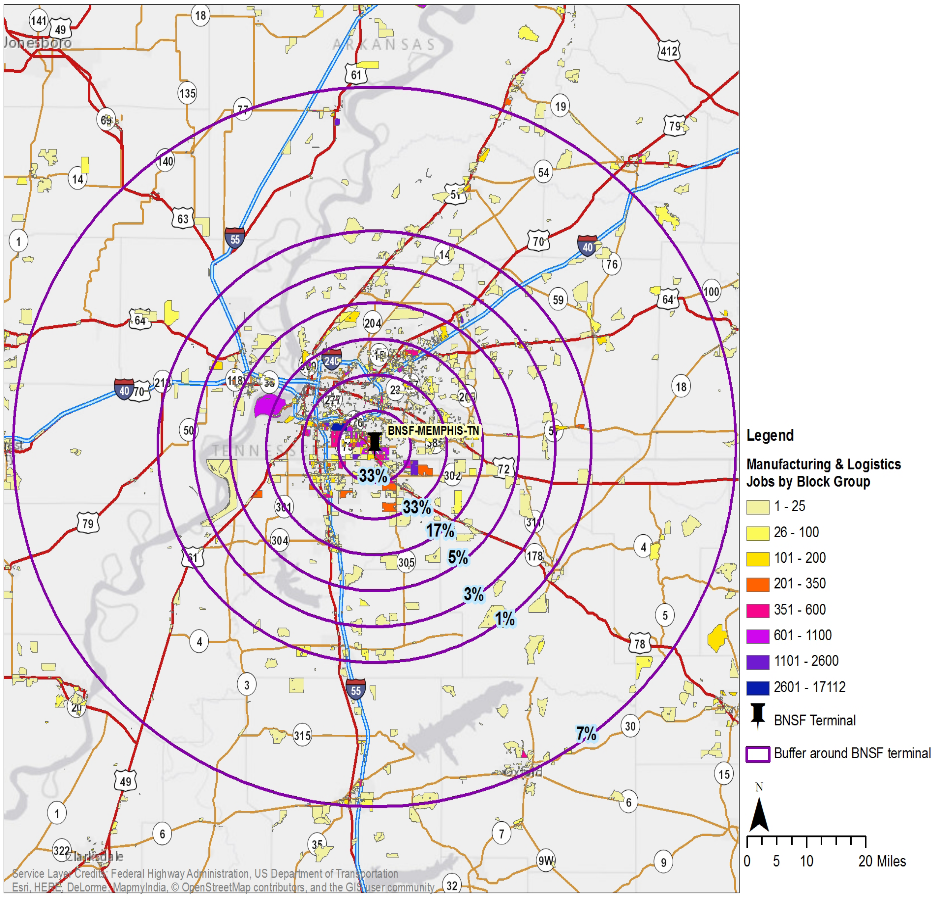


FIGURE 9
Manufacturing and Logistics Jobs within 50 Miles of Memphis BNSF Terminal Area
Source: Longitudinal Employer-Household Dynamics (LEHD)

Local (Intra-regional) Environmental Benefits

CNT also estimated environmental benefits from intermodal freight movements and COD within the MSAs of Memphis and Charlotte for 2015 and projected out to a year when full terminal capacity is reached. In these estimates, intra-regional benefits linked to reduced truck VMT and fuel consumption are a small fraction of the benefits estimated on a national scale. This is because local benefits are limited to the short distances within the MSA for which rail replaces truck movements, while fuel consumed by drayage and terminal operations reduces net local benefits. In Memphis, the estimated local benefits based on fuel savings are 30% to 100% higher than in Charlotte, primarily because the distribution of industrial business is currently more compact, making the average local dray shorter. Memphis' fuel savings are also driven by its grounded intermodal terminal, whichuses electrically powered cranes that are likely to consume less fuel per container moved.

Public Sector and Civic Institutions' Role in Facilitating COD

The tasks of the government-led public-private partnerships needed to seize these opportunities will differ in each region. The Memphis development team will need to systematically assess options for reusing specific sites, triaging existing buildings, assembling land now held in fragmented ownership, remediating brownfields, and improving the appearance of the district to make it ready for private investment. The primary task in Charlotte's COD will be bringing adequate infrastructure to land that has not been used intensively in the past but is now strategically positioned for industrial development. In both regions, critical tasks will include:

- Fully implementing the logistics and manufacturing workforce development programs now getting underway
- Establishing robust transit connections between neighborhoods with high unemployment and COD job centers, coordinated with employers through Transportation Management Associations (TMA)

NEXT STEPS

Immediate COD Index Proposal

In CNT's opinion, the present set of COD metrics, taken together, covers the major issues that should be considered in planning or evaluating any major economic development project or initiative linked to freight transportation. However, the metrics currently lack integration into an index that can assign point scores to each metric to provide a quantified, overall assessment of a plan or project. Such an index would add value in several ways. It would condense extensive analysis into a succinct statement of a project's planned or actual realization of COD. It would provide a means of comparing COD projects, and it could be used as a diagnostic tool to pinpoint the criteria by which a project excelled or needed correction in meeting its COD goals.

If America had years to wait, a COD index could emerge from long-term research and project experience. However, the issues addressed by COD are of such scale and urgency that CNT proposes to establish an initial COD index within nine months by gathering expert opinion on the refinement and relative importance of the metrics. The implementation of this immediate project includes the following major steps:

1. Secure participation from a panel of 10 to 14 experts whose collective knowledge encompasses:
   a. Urban industrial area redevelopment from public agency and private investor perspectives
   b. Freight railroad, trucking, intermodal terminal, and third party logistics firm operations
   c. Freight shipping from a manufacturing perspective
   d. Sustainable freight systems and related information management technologies
   e. State or national experience in managing departments of economic development, environmental protection, and freight development, and in the formation of public policy governing these departments
2. Distribute this current study and other selected materials to the panel. Then gather and document their initial reactions to this information in advance of a general meeting.
3. Convene the panel for a two-day workshop with the explicit purpose of establishing a weighted index of the COD metrics.
4. Synthesize the outcomes of the workshop into the integrated index of COD metrics.

Research

While the COD metrics index will provide a starting point for initiating projects, the refinement of COD principles and the identification of best practices for achieving COD in public policy and market practice will open a field of research into the interface of economic development, freight transportation efficiency, and environmental sustainability. Issues in this field that require further research include:

1. Service patterns in intermodal drayage
2. The types of businesses (especially manufacturers) for which COD locations will be most beneficial
3. The costs and benefits of emerging technologies for reducing the environmental footprint of freight transportation
4. Best practices for realizing COD in economically distressed communities

These issues can be addressed most efficiently by an analysis of COD opportunities in the tier of cities with the largest apparent potential for this type of development, leading to a program to implement COD with systematic analysis of the results.

Industry Practice

CNT seeks a dialog with railroads, trucking firms, and industrial developers about alternatives in terminal and industrial park development that may better serve host communities, the environment, and developers' interests in expanding the intermodal freight market, introducing balance in the two-way flow of intermodal cargos, and creating productive collaboration with public officials and local communities.

Public Policy

In light of the potential benefits of COD, CNT urges local and state governments to establish an open door for this form of development in their zoning and land use regulations and in their economic development plans and practice. Similarly, CNT seeks the adoption of federal policies and programs that encourage and reward local governments for pursuing COD. As Congress continues to debate a federal transportation bill, CNT continues to advocate for incorporation of the recommendations of the National Freight Advisory Committee, which would establish a firm basis for COD in federal policy. CNT also encourages the federal government to initiate further interdepartmental cooperation for programs that would grant priority consideration for proposals that incorporate the principles of COD, support research and incentives for the rapid adoption of energy-efficient and space-efficient freight technologies, and collaborate in a demonstration program for the redevelopment of older industrial communities through the application of COD strategies.

Design and Test One or More Models for Effective Data Sharing

We recommend that a task force jointly funded by transportation departments and foundations design and test one or more models for effective data sharing. In a study on how public agencies measure the economic impacts of transportation investment done for the State Smart Transportation Initiative, funded by the Federal Highway Administration and the Rockefeller Foundation, we observed differences in how different parties define impact. State DOTs and transportation operators tended to describe their impacts in terms of the system being invested in and its users (e.g. system condition and performance, cost-effectiveness, and benefit-cost assessments), while local elected officials, community planners and stakeholders tended to describe these outcomes in terms of local economic development (such as affordability or value captured) and livability. Much of the data needed to conform these two essential views of "impact" will require effective knowledge sharing and data sharing.

As good as the federal freight data system is, there are many gaps in the coverage. MAP-21 required USDOT to experiment with non-traditional and private data sources to fill in those gaps. As of a public report[54] in November 2014, products like the forthcoming manual on producing freight performance measures will not be available until sometime in 2016, and the responsible offices had just starting acquiring private data two years after the requirement passed. Prior reports produced in 2011 for the National Cooperative Freight Research Program noted the continued focus on network integrity, congestion, and travel times, but added this relevant observation:

"Even less understood by the public sector are impediments and delays caused by inefficient linkages between the modes. These inefficient handoffs between port and rail shipments, between trucks and trains at intermodal yards, or between ships and railroads at ports are not regulated, measured, or quantified by the public sector. As result, the magnitude of the inefficiencies at the linkages between modes is only partially and anecdotally understood."

America's freight networks produce data in real-time, and effectively sharing it would improve the quality and functionality of freight planning. As the development of near-port and inland port terminals and associated industrial activity requires private sector cooperation and growth, a system that responsibly merges public and private data to support decisions about particular freight system elements (including geo-spatial knowledge) would advance the state of planning at all levels. NCHRP also noted:

"Virginia DOT reported that the effort of creating a dashboard of performance measures was made simpler by having a data warehouse. In the development of performance measures, the agency combined different kinds of data to produce a single measure. The data warehouse provided that one stop for the different data used to automate the generation of the performance measures. Where data do not exist, the business requirements are formalized for data needed before any changes are made to existing systems or before new systems are developed."

Much as new kinds of public-private data warehouses have advanced the state of climate protection planning (for example, merging private utility data with public transportation data), putting the effort into creating such public-private initiatives for freight activity would be well worth it.

On October 15, 2015, USDOT Secretary Anthony Foxx released the draft National Freight Strategic Plan for comment.[55] Recommendation B.4, "Ensure availability of better data and freight transportation models" on pages 112 and 113, would be enhanced by recommending a specific mechanism for a public-private data warehouse.

There are precedents for the federal use of private data, ranging from the climate protection activities of the National Climate Assessment Program to a variety of risk-reduction initiatives underway (such as the USDOE-led Quadrennial Energy Assessment), and more recently the cooperative development of the Location Affordability Index by the Center for Neighborhood Technology for HUD and USDOT. NCFRP Report 9, Guidance for a Freight System Data Architecture, lays the groundwork for such an initiative. The Census and Bureau of Labor Statistics offer an interesting model for dealing with confidentiality issues that was developed for their joint Local Employment and Housing Dynamics (often referred to as On the Map) program.

Photo: Thomas Hawk/Creative Commons

APPENDIX A: SUMMARY OF COD METRICS

A. Local Economic Development

	Specific Metric	Further Description and Benchmarks	Freight System Benefits	Public Benefits	References to Relevant Studies and Comparable Metrics
1.	**Industrial Location Efficiency**				
a)	***Access to Multiple Modes of Freight Transportaton***	Minutes required to drive a truck between industrial plants and freight facilities	Reduced first/last mile shipping costs	Reduced air pollution, traffic congestion and public infrastructure costs	*"SteSteele, Christopher W. Freight Facility Location Selection: A Guide for Public Officials. Vol. 13. Transportation Research Board, 2011. http://www.trb.org/Main/Blurbs/166143.aspx CS NS 47th St Study / CS NS 47th St Study"*
b)	***Load Consolidation and Clustering Opportunities***	Number of manufacturing, distribution, and logistics firms and jobs along a shared rail spur or within a 30-minute truck drive	Opportunities for load sharing or distribution\ consolidation services	Improved environment for business attraction\ retention & job creation	*The Freight-Manufacturing Nexus: Metropolitan Chicago's Built-in Advantage, August 2013. http://www.cmap.illinois.gov/documents/10180/27283/Freight-Manufacturing-Nexus-8-6-13-1.pdf/16f3459b-05af-4eac-af71-f9a8f18f7bc2*
c)	***Available Industrial District Land***	Industrially zoned and previously used acreage that is vacant or severely under-utilized	Reduced first/last mile shipping costs; increased reliability for on-time delivery; increased opportunity to serve manufacturers	Compact land use patterns that raise value of industrial properties, preserve open space, and reduce air pollution in the region	*Site Selection Index from Center for Neighborhood Technology COD Optimizer™ used to assess site-specific data. Previous studies include: Cargo-Oriented Development (COD) Analysis and Implementation, September 2013. http://www.cnt.org/media/COD-AnalysisAndImplementation.pdf.; Center for Neighborhood Technology. West Cook County COD+TOD Report, October 2012. http://www.cnt.org/media/CNT_WestCookCountyCODTOD.pdf*
d)	***Convenient Access for a Large Local Workforce***	Number of area residents who can reach the site within 30 minutes via public transit or active transportation	Larger potential labor force; improved employee retention	Improved access to logistics/ industrial jobs, especially for workers with lower financial resources; reduced worker transport costs	*Defined by CNT's Transit Access Shed Index: Population of the area that can be reached from the business location via public transit within 60 minutes. See: H+T® Affordability Index Methodology. http://htaindex.org/*
e)	***Safe and Convenient Truck Access***	Truck routes that connect expressway exits, freight facilities, and industrial plants; are free of infrastructure impediments; and pass entirely through industrial districts.	Enhanced community goodwill and reduced liability\ Efficiency in freight routing and improved utilization of assets	"Avoided exposure of sensitive populations to air pollution and risks to public safety; Reduced traffic congestion and air pollution"	*National Center for Healthy Housing. Baltimore-Washington Rail Intermodal Facility Health Impact Assessment, September 2013. http://nchh.org//Portals/0/Contents/Baltimore-Washington-Intermodal-Facility-HIA_Final-Report.pdf.;National Gateway. http://www.nationalgateway.org/news-resources/faq ; Federal Highway Administration. National Bridge Inventory. Provides GIS data on location and maximum vertical clearance needed on all bridges in the U.S. http://www.fhwa.dot.gov/bridge/nbi.cfm*
f)	***Acres of Location Efficient Industrial Land Redeveloped***	Demonstrated capacity to resolve the challenges of redevelopment – including land assemby, brownfields remediation, building rehabilitation or clearance through public-private coordination	Realization of Industrial Location Efficiency Benefits; All of 1.a. – 1.e. benefits	Realization of Industrial Location Efficiency Benefits; All of 1.a. – 1.e. benefits	*New Jersey Institute of Techology,"Brownfield Economic Redevelopment: Preparing Modern Intermodal Freight Infrastructure to Support Economic Revelopment" http://transportation.njit.edu/nctip/final_report/BrownfieldsReport.pdf ; Chicago's South Suburbs: Smart Growth in Older Communities http://www.transportchicago.org/uploads/5/7/2/0/5720074/chandler-mckinley_final.pdf*

A. Local Economic Development *(continued)*

	Specific Metric	Further Description and Benchmarks	Freight System Benefits	Public Benefits	References to Relevant Studies and Comparable Metrics
2. Job Creation and Career Development					
a)	***Good Job Creation & Retention***	Jobs with salares above regional median wage for the educational level required	High productivity through retention of a skilled workforce	Increased employment, household income, and market strength; reduction of poverty	*Current Average Salaries: Bureau of Labor Statistics. Occupational Employment Statistics, 2014. http://www.bls.gov/oes/ ; Current Employment Conditions: US Census. Longitudinal Employer-Household Dynamics, 2014. http://lehd.ces.census.gov/; Estimated Impact: Regional Economic Models, Inc. http://www.remi.com/ ; Employment Opportunities: O*Net. http://www.onetonline.org/*
b)	***Career Development***	Number of workers in training for manufacturing/ logistics skill certifications	Capacity to meet future labor needs	Sustained skilled job growth	*Institute for Supply Management. http://www.ism.ws/;Statements of corporate training programs, technical/community colleges, and certifying professional associations re capacity of training programs, e.g., training for Certified Product Technician (CPT) and Certified Logistics Technician (CLT) through the Manufacturing Skills Council, Commercial Driver's License (CD) www.msscusa.org*
3. Worker Transportation Access Achieved					
	Worker Transportation Access Achieved	Percentage of workers in a COD district who commute without driving alone	Larger labor force; Improved employee retention	Reduced household travel expense; Reduced traffic congestion, road maintenance costs, and air pollution	*American Community Survey: Means of transportation to work by block group. http://www.census.gov/programs-surveys/acs/*
4. Public Cost Savings and Revenue Growth					
a)	***Infratructure Cost Savings***	Road construction and maintenance dollar savings correlated to reductions in truck VMT	Reduced public infrastructure costs assigned to other projects, possibly public-private partnerships	Increased resources for public services and other investments	*United States Government Accountability Office. A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers, January 2011. http://www.gao.gov/new.items/d11134.pdf. Table 6, page 44.*
b)	***Tax Base Growth***	Increase in assessed property values, purchases subject to sales tax, and corporate and employee income subject to tax	Improved long-term operating conditions and costs and established position to negotiate public-private partnerships	Increased revenue to meet community obligations; Lower tax rates to attract\ retain businesses and residents	*Delaware Valley Regional Planning Commission. The Crescent Corridor Improving Lives and Livelihoods, 2009. http://www.dvrpc.org/freight/pdf/2009-10-CrescentCorridor-Smith.pdf: Cambridge Systematics. Public Benefits of Increased Intermodal Activity at the Norfolk Southern 47th Street Intermodal Facility in Chicago. Norfolk Southern.; Regional Economic Models, Inc. http://www.remi.com/*

B. Freight System Efficiency

	Specific Metric	Further Description and Benchmarks	Freight System Benefits	Public Benefits	References to Relevant Studies and Comparable Metrics
1.	**Truck & Freight System Productivity**				
a)	***Reduction in Truck VMT Relative to Freight Tonnage & Value***	Change in light of relative efficiencies: Truck: 0.0160 Gallons of Fuel per Ton-Mile,14.24 Cents per Ton-Mile; Rail: 0.0021 Gallons of Fuel per Ton-Mile, 2.35 Cents per Ton-Mile	Reduced shipping costs	Reduced traffic congestion, infrastructure costs, and air pollution; Improved climate for business attraction, retention and job creation	*US Department of Transportation. National Transportation Statistics, 2011: Table 4-5 Fuel Consumption by Mode of Transportation in Physical Unit.;http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_05.html; United States Government Accountability Office. A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers, GAO Report (GAO-11-134, Jan 26, 2011).http://www.gao.gov/new.items/d11134.pdf*
2.	**Travel Time & Reliability**				
a)	***Travel Tme***	Average time to complete deliveries on a given route	Optimal utilization of assets, return on investment	Positive conditions to attract & retain investment, job creation & retention; area competitiveness	*Rail\Truck firm schedules, e.g.:BNSF. Intermodal Schedules, 2014. http://www.bnsf.com/customers/prices-and-tools/intermodal-schedules/; Surface Transportation Board: Rail Service Perfomance Data Reporting – Weekly Service Update; http://www.stb.dot.gov/railserviceissues.nsf?OpenDatabase&Start=1&Count=300&ExpandView*
b)	***Reliability***	Percentage of shipments delivered on time. 95%+ industry standard	Capacity to support just-in-time manufacturing & distribution	Positive conditions to attract & retain investment, job creation & retention; area competitiveness	*Anthony Hatch, "Ten Years After, The Second Intermodal Revolution" https://www.intermodal.org/information/research/assets/tenyrsafter.pdf; Surface Transportation Board: Rail Service Perfomance Data Reporting – Weekly Service Update; http://www.stb.dot.gov/railserviceissues.nsf?OpenDatabase&Start=1&Count=300&ExpandView*
3.	**Efficiencies in Intermodal Drayage & Terminal Operations**				
a)	***Drayage***	Average truck VMT in trips to and from an intermodal terminal	Reduced first\last mile travel costs; increased market for intermodal	Compact industrial development: investment & job creation\retention within established communities	*ICF International, commissioned by the Federal Railroad Administration. "Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors," November 2009, Exhibit 4-14, p. 75. Accessed October 9, 2015. https://www.fra.dot.gov/eLib/details/L04317*
b)	***Terminal Operations***				
	(1) Energy Efficiency	Average fuel consumed per container moved through an intermodal terminal	Reduced costs of intermodal shipping	Enhanced asset for business attraction\ retention; minimal negative environmental impact	*Goodchild, Anne, J. McCall, John Zumerchik, and Jack Lanigan. "Reducing Train Turn Times with Double Cycling in New Terminal Designs." Transportation Research Record: Journal of the Transportation Research Board 2238 (December 1, 2011): 8–14*
	(2) Space Efficinency	Terminal footage required per container moved through an intermodal terminal	Wide range of potential terminal locations, including urban sites	Compact industrial development: investment & job creation\ retention within established communities	*Zumerchik, John, Jack Lanigan Sr., and Jean-Paul Rodrigue. "Incorporating Energy-Based Metrics in the Analysis of Intermodal Transport Systems in North America." Journal of the Transportation Research Forum 50, no. 3 (2011): 97*

B. Freight System Efficiency *(continued)*

	Specific Metric	Further Description and Benchmarks	Freight System Benefits	Public Benefits	References to Relevant Studies and Comparable Metrics
4.	Right Sized Shipping				
a)	***Savings in shipping costs***	Achieved through cooperation among shippers to optimize effiiciency in load size	Reduced costs for smaller shippers, including manufacturers	Supportive conditions for a broad range of businesses	*"Sun-Maid Uses Consolidation to Drive a 62% Reduction in Outbound Freight Costs." Kane Is Able, Inc. Accessed October 9, 2015, http://www.kaneisable.com/sun-maid-case-study-reduce-outbound-freight-costs; Harrington, Lisa H. "U.S.–Mexico Trade: Two-Way Traffic." Inbound Logistics, January 2013. Accessed on October 9, 2015. http://www.inboundlogistics.com/cms/article/us-mexico-trade-two-way-traffic/*

C. Environmental Impacts

	Specific Metric	Further Description and Benchmarks	Freight System Benefits	Public Benefits	References to Relevant Studies and Comparable Metrics
1. Air Quality					
a)	***Levels of key greenhouse gases and criteria pollutants***	Carbon Dioxide, Carbon Monoxide, Nitrogen Oxide, Particulate Matter	Healthy working environment, community good will, capacity to operate in an urban environment	Public health protection; Attractive community environment; Combat climate change	*Transportation Energy Data Book, Oak Ridge Laboratory, Chapters 11 -12*
2. LEED Standards in Freight Facility Design					
a)	***Water Quality***	On-site absorption of storm water	Attractive working environment, community goodwill, capacity to operate in an urban environment	Attractive community environment, quality of life	*U.S. Green Building Council. LEED® Green Building Rating SystemTM For Core and Shell Development Version 2.0, July 2006. http://www.usgbc.org/Docs/Archive/General/Docs1728.pdf. http://nssustainability.com/2014_sustainability_report/NS_CR14_Full_Report.pdf.*
b)	***Noise Level***	Not to exceed 55 dBA	Per 2.a.	Per 2.a.	*Federal Transit Administration. Transit Noise and Vibration Impact Assessment, May 2006. http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf*
c)	***Lighting***	Not to exceed 20 footcandles	Per 2.a.	Per 2.a.	*National Center for Freight & Infrastructure Research & Education. Getting the Goods without the Bads: Freight Transportation Demand Management Strategies to Reduce Urban Impact,2013 - Table 6*
3. Regional Land Use					
a)	***Intensive Use of Industrial Location Efficient Land***	(1) Percentage of acres in productive use (2) Number of jobs per acre	Reduced first\last mile costs, increased clustering and right size shipping opportunities	Compact industrial development: investment & job creation\ retention within established communities	*Mack, James. Brownfield Success Stories Case Histories and Lessoned Learned. New Jersey Institute of Technology. http://www.njit.edu/tab/downloads/removing-barriers/Brownfield_Success_Stories.pdf.*
a)	***Preservation of Open Space***	Percentage of regional acres in parks or protected open land	Community good will	Enhanced quality of life	*National Recreation and Park Association, National Parkland Standards http://pgccreative.temp-website.com/land_standards*

D. Safety

	Specific Metric	Further Description and Benchmarks	Freight System Benefits	Public Benefits	References to Relevant Studies and Comparable Metrics
1.	**Adherence to Federal Safety Guidelines**				
a)	***Adherence to Trucking Safety Guidelines***	"Safety Measurement System" of the Federal Motor Carrier Safety Association	Worker safety, insurance cost management, corporate citizenship	Enhanced public safety, quality of life	*"Safety Measurement System" of the Federal Motor Carrier Safety Associationhttps://csa.fmcsa.dot.gov/about/basics.aspx*
b)	***Adherence to Railroad Safety Guidelines***	"Risk Reduction Program" of the Federal Railroad Administration	Per 1.a.	Per 1.a.	*"Risk Reduction Program" of the Federal Railroad Administration https://www.fra.dot.gov/Page/P0049*
2.	**Local Safety Record Analysis**				
a)	***Local Safety Records***	Comparison of local freight linked accidents, injuries, fatalities against federal statistics	Per 1.a.	Per 1.a.	*United States Government Accountability Office. A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers, January 2011. http://www.gao.gov/new.items/d11134.pdf. Table 8, page 49.; National Center for Freight & Infrastructure Research & Education. Getting the Goods without the Bads: Freight Transportation Demand Management Strategies to Reduce Urban Impact,2013 – Table 5http://www.ssti.us/wp/wp-content/uploads/2013/10/Final-FreightReport.pdf*
3.	**Implimentation of "Positive Train Control"**				
a)	***Implimentation of "Positive Train Control (PTS)"***	Percentage of railroad track in the region in which PTS has been installed	Critical Precaution against accidents, particularly derailment\ New infrastructure of fiber optic cable	Critical Precaution against accidents, particularly derailment\ New infrastructure of fiber optic cable	*"Positive Train Control Information Summary", Federal Railroad Administration.,https://www.fra.dot.gov/Page/P0152*

APPENDIX B: EXAMPLES OF INTERMODAL TERMINAL AND LINKED INDUSTRIAL DEVELOPMENT PROJECTS

#	Project & Status	Railroads	Public\Private Partners	Freight Volume (Containers 000s)	Job Creation (In terminal, industrial park & region)	Public Benefits
1	*Virginia Inland Port (Front Royal, VA): Opened 1989. Studied 2009*	NS	Port of Virginia	34 (2008)	17 terminal, 8,000 park (achieved)	*5.4 M VMT reductions; 3,100 Tons of CO2 avoided annually, valued at $105,000*
2	*Rickenbacker Intermodal Terminal (Columbus, OH): Opened 2012. Key component Heartland Corridor*	NS	Columbus Airport Authority, Duke Realty, City of Columbus	150 (2012), capacity 500,000	150 terminal, 20,000 park & region (projected)	*Heartland Corridor. Per annum after 10 years, 49 M VMT, $660M shipper costs, $2 M road maintenance, $2.45 M in accident costs avoided*
3	*Northwest Ohio Terminal (NW terminus of National Gateway Corridor): Opened 2011*	CSX	NW Terminal largely CSX. Gateway Corridor 6 states and DC	2,000 capacity	300 terminal (achieved)	*Gateway Corridor over 30 years: 50,000 jobs created, and 14 B truck VMT, 20 M tone CO2, $3.5 B shipper costs avoided.*
4	*Charlotte Intermodal (NC): Opened Dec 2013 (1 of 4 terminals on Crescent Corridor opened within the last 18 months)*	NS	City of Charlotte	200	157 terminal, 5,000 park, 70,000 region (projected)	*Crescent Corridor. Per annum by 2030, eliminated or avoided: 1.3 M truck trips, $575 M traffic congestion costs, 169 M gallons of fuel, 1.9 M tons CO2.*
5	*Alliance Global Logistics Hub (Forth Worth, TX): In operation since 1989*	BNSF, UP	Hillwood Development, City of Ft. Worth	600 (2011). Capacity 2,000	28,000 park, 63,000 region (achieved)	*Generated more than $43 billion in economic impact, job anchor - created 35,000 jobs and developed communities surrounding it. Designation as Foreign Trade Zone has kept companies from off-shoring jobs.*
6	*Santa Teresa Intermodal Terminal (Las Cruses, NM Area): Construction completed 2014*	UP	Verde Realty, State of New Mexico,	250 capacity	600 terminal (projected)	*Projected overall economic impact of $500 million for New Mexico. Planned road infrastructure improvements will streamline and speed up freight border traffic. Expected to jump-start development in the region.*
7	*Logistics Park Chicago (Elwood, IL Chicago region): Opened 2004*	*BNSF*	CenterPoint Properties, Will County, State of IL	800 (2010), capacity 1,000	8,000 park (60% achieved)	*Redevelopment of a brownfield site to create jobs and alleviate freight congestion to access a strong local market.*
8	*Global IV, Joliet, IL Intermodal Terminal (Chicago region): Opened 2011*	*UP*	CenterPoint Properties, Will County, State of IL	500 (2012), Capacity 1,200	1,300 terminal, 7,500 park & region (projected)	*Anchor job center, up gradation of surrounding roadways to direct intermodal traffic. Uses green technologies such as solar panels, use of wind generated electric power and electric cranes.*
9	*47th Street Intermodal Terminal (Chicago): Terminal expansion to be completed in 2015*	*NS*	CREATE Partnership	480 (2011), capacity 800	300 terminal (projected)	*By 2022 per annum: 176 M less truck VMT resulting in shipper, congestion, fuel, emissions, and accident costs avoided totaling $118 M nationally, $15 M in Chicago*
10	*Gateway Terminal (Memphis, TN): Property leased 2013, expansion of terminal built 2005*	*CN*	Exeter Property Development	150 (2013) 300 capacity	120 terminal, 5,000 park (projected)	*Operated jointly by CN & CSX, the revised operation can handle 35 or more freight trains per day.*

#	Project & Status	Railroads	Public\Private Partners	Freight Volume (Containers 000s)	Job Creation (In terminal, industrial park & region)	Public Benefits
11	*Memphis Intermodal Terminal (Lamar Avenue): Redeveloped 2009*	*BNSF*		275 (2013), capacity 1,000	100 terminal (achieved)	*State of the art technology minimizes negative environmental impacts, anchors job center with >10,000 workers in depressed city neighborhood*
12	*Rossville Intermodal Terminal (Memphis area): Opened 2012*	*NS*	William Adair , CBRE, DeSoto County, MS	106 (2013), capacity 327,000	43 terminal, 6,200 park & region (projected)	*One of 4 terminals in the Crescent Corridor opened within the last 18 months*
13	*Central Florida Intermodal Logistics Center (State Road 60 in Winter Haven, Florida)*	*CSX*	Evansville Western Railway, CSX Intermodal Terminals Inc	300	1,300 terminal, 7,500 park & region (projected)	*Anchor job center, up gradation of surrounding roadways to direct intermodal traffic. Uses green technologies such as solar panels, use of wind generated electric power and electric cranes.*
14	*Garrows Bend Intermodal Container Facility (end of 2015)*	*BNSF, CN, CSX, Kansas City Southern, Norfolk Southern*	Alabama State Port Authority, R.T. Milord, USDOT TIGER Grant	800 (full build-out)	351 direct jobs, 392 induced/indirect jobs	*20 acres of intermodal rail yard with two support tracks and one run-around track linked to five Class I railroads through a rail bridge. The terminal received a $12 million TIGER Grant in 2013.*
15	*Florida East Coast Railways Intermodal Container Transfer Facility*	*CSX, NS*	Broward County, State of Florida, FEC	450	11,687 direct jobs, 210,000 jobs impacted in state	*"FEC said the new facility will allow the company to build 9,000-foot unit trains within the facility without blocking any city streets, and will allow cargo to move through Port Everglades to Atlanta and Charlotte, North Carolina, in two days. Nashville and Memphis, Tennessee, can be reached in three days."*
16	*Pittsburgh Intermodal Rail terminal (early 2017)*	*CSX*	McKees Rocks and Stowe Township, Allegheny County, Pennsylvania Transportation Assistance Program Grant	50	40 terminal, 40 drayage jobs,100 indirect jobs in the region, 9,000 (statewide)	*Utilizing CSX'S National Gateway project funding to create a highly efficient and environmentally friendly double-stack cleared rail corridor. Funding includes a $35 million Pennsylvania Transportation Assistance Program Grant.*
17	*Buckeye, Columbus, Ohio,*	*CSX*		360	5,907 jobs within 3 miles	*New crane technology enables efficient lifts within a smaller footprint (36 acres). The electric cranes produce zero emissions and generate minimal noise – they generate electricity that is returned to the grid.*

Examples 1, 2, 5, and 7: Christopher Steele, CWS Consulting Group, et al, NCFRP 13, "Freight Facility Location Selection: A Guide for Public Officials, Background Research Material", 2011, supplemented with information from concerned railroad and project websites;

Examples 2, 3: Mark Szakonyi, "CSX, NS Take Differing Intermodal Strategies to Next Phase", Journal of Commerce, January 24, 2014 , supplemented with information from concerned railroad and project websites;

Examples 2, 4, 6, 12: Chad Miller, Martin Lipinski, et al, "Job Creation Factors for Inland and Near Dock Intermodal Facilities", research performed for the Mississippi Department of Transportation, http://www.memphis.edu/ifti/pdfs/research_job_creation_factors.pdf; supplemented with information from concerned railroad and project websites;

Example 8: Union Pacific web site for Global IV http://www.uprr.com/customers/intermodal/intmap/global4.shtml

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Examples 10, 11, and 12: Conversations with Dan E. Pallme and Martin Lapinski of the Intermodal Freight Transportation Institute of the University of Memphis, along with site visits to the these 3 terminals, by David Chandler for the Center for Neighborhood Technology, supplemented by information from the concerned railroad websites

Example 13: CSX Website "State-of-the-Art Terminal Begins Operations in Winter Haven", http://www.csx.com/index.cfm/media/press-releases/state-of-the-art-terminal-begins-operations-in-winter-haven/

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- The weighted average distance was then calculated for each intermodal terminal, using the number of manufacturing workers in the block groups as the weight.

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