ITS MARAD Truck Staging Study

Final Report

www.its.dot.gov/index.htm

Final Report – May 2, 2019

U.S. Department of Transportation

Produced by Battelle and Gannett Fleming
U.S. Department of Transportation
Federal Highway Administration
Maritime Administration
Office of the Assistant Secretary for Research and Technology

Notice

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
ITS MARAD Truck Staging Study Final Report	May 2, 2019
	6. Performing Organization Code 100102939
7. Author(s)	**8. Performing Organization Report No.** 100102939-05a
9. Performing Organization Name and Address Gannett Fleming, Inc. PO Box 67100 Harrisburg, PA 17106-7100 Battelle 505 King Avenue Columbus, OH 43201-2696	**10. Work Unit No. (TRAIS)**
	11. Contract or Grant No. DTFH6116D00049 – 0006
12. Sponsoring Agency Name and Address Federal Highway Administration 1200 New Jersey Avenue SE Washington, DC 20590	**13. Type of Report and Period Covered** Final project report, September 2017 to May 2019
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Intelligent Transportation Systems (ITS) Joint Program Office (JPO), the Maritime Administration (MARAD), and other administrations within the United States Department of Transportation are seeking ways to improve the efficiency of drayage trucking at ports. The needs of ports were assessed through in-person interviews with port and terminal operators, authorities, and drayage trucking firms. An online questionnaire supplemented the stakeholder information. Potential solutions range from off-site staging areas, to virtual gates, all the way to automated trucks and innovative vehicles on limited routes. Four alternative approaches were selected for detailed benefit-cost analysis. These approaches were analyzed for implementation at five different types of ports, each representing a combination of land cost, cargo volume, and other factors. Through continued involvement of stakeholders, pilot programs can lead to demonstrating and implementing the solutions.

17. Keywords	18. Distribution Statement
	Distribution unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	156	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Table of Contents

List of Tables

List of Figures

Executive Summary

The Maritime Administration (MARAD), Intelligent Transportation Systems Joint Program Office (ITS JPO), the Federal Highway Administration (FHWA), and the Federal Motor Carrier Safety Administration (FMCSA) have collaborated to address maritime port challenges by evaluating the impacts of Intelligent Transportation Systems (ITS), including automation and increased connectivity. This effort furthers the two key ITS Program priorities of the *ITS Strategic Plan 2015-2019*: realizing connected vehicle implementation and advancing automation.

The ITS MARAD Truck Staging Study is intended to establish the foundation for the long-term development and demonstration of port truck staging concepts. The program will improve the safety, access, reliability and readiness of port facilities through advanced technologies and techniques to increase the reliability and efficiencies of truck movements. The economic and other benefits associated with these improvements cannot be overstated. The overarching research objectives are "to determine the state of the practice regarding truck staging, including access, queuing, and parking, at maritime ports and to identify port operators' and trucking industry needs; and to perform an economic feasibility study of automated truck queuing as a technology solution."

The study includes two economic feasibility analyses. The first is a high-level evaluation of the economic feasibility for the future deployment of port staging technologies at port facilities, including technologies and partnerships between port authorities and commercial freight companies and operators. The second economic feasibility analysis addresses increased productivity through automated port queuing. It includes the technology concept of an automated slow-speed, in-queue truck application that meets the standards of Level 4 as defined in SAE J3016.[1] In this configuration, the driving system can fully operate a truck in queue and ***within*** a port terminal while the operator would exit the cab and assume an hours-of-service (HOS) status of "On Duty, Not Driving." When the truck is loaded or unloaded, the driver would be notified, re-enter the vehicle, change his or her operating status to "On Duty, Driving," and leave the port.

A screening process was used to identify prospective solutions to address truck congestion and queuing issues at port terminals. The four screened solutions that were then subject to more detailed feasibility analyses included the following:

- Off-site parking and staging
- Off-site parking and staging combined with a "virtual gate" where some terminal transaction processes can be done

[1] https://www.sae.org/standards/content/j3016_201806/

- Automated truck (Level 4) in queue
- Automated truck (Level 4) in queue plus off-site load staging

These four solutions were tested under five representative port operations:

1. A hypothetical "generic port" scenario that coincides with the analytical approach presented in a prior 2017 MARAD analysis of port technologies.
2. A port in a major urban area serving primarily a local market (e.g., New York/New Jersey)
3. A port in a major urban area with a local ***and*** hinterland market (e.g., Los Angeles/Long Beach)
4. A port in a minor urban area with a predominantly hinterland market (e.g., Savannah)
5. An inland port (e.g., Columbus)

A summary of the Benefit/Cost Analyses for the four screened solutions is presented in Table 1 below.

Table 1. Summary of Relative Benefit/Cost Ratios

	SCENARIOS				
SOLUTIONS	Generic Port	Major Urban to Local Market	Major Urban to Mixed Market	Minor Urban to Hinterland	Inland Port
Off-Site Staging/Parking	**Moderate**	**Low**	**Low**	**Moderate**	**Moderate**
Staging/Parking + Virtual Gate	**High**	**High**	**High**	**Very High**	**High**
Automated Truck in Queue	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Automated Truck + Off-Site Staging	**Very High**	**High**	**High**	**High**	**Very High**

A number of general themes emerged in the research, outreach and analytical process including the following:

- High land costs in major urban areas play a major role in determining the economic feasibility of off-site parking and staging areas.
- Off-site parking and staging areas are more feasible if some terminal gate functions can be accomplished while trucks are staged at the off-site locations.
- The ability of automated truck technology to perform with the precision and efficiency in a port environment (that has been built into these analyses) is essential to the economic feasibility of the technology.

- The technologies studied are generally scalable to ports of different sizes, but in practice it is not likely that they would be implemented at small ports that handle low cargo volumes. There are economies of scale in the implementation of technologies such as automated trucks and advanced terminal gate systems that make them impractical in low-volume applications.
- A multi-terminal environment where trucks may be dropping cargo at one terminal and picking up cargo at another is an obstacle to optimization in the marine cargo handling process.
- The combination of lower land acquisition costs and a single-terminal operation would make a major port in a smaller urban area an ideal testing ground for some of the practices and technologies analyzed in this report.
- The technologies and infrastructure improvements documented in this study are likely to change over time in ways that alter the findings of these analyses. Land acquisition and construction costs are almost certain to escalate, while technology will typically grow less expensive as it matures and is implemented on broader scales.
- The complexity of the marine cargo handling process in general, and the drayage trucking process in particular, is a critical factor in addressing terminal congestion reduction solutions. The industries currently at the forefront of developing, testing, and implementing automated vehicle technology have been slow to make their way into the port trucking realm. The less complex operation of over-the-road trucks makes them better suited for many of the automated processes that would be necessary for a drayage truck to operate in a marine terminal environment.

The study conclusions, outlined in Chapter 9, include recommendations for four next steps that would provide a systematic framework for moving forward to implement technology-based solutions to address port terminal congestion and queuing:

- Stakeholder Outreach
- Pilot Project Development
- Industry and Public Agency Collaboration
- Ongoing Review of Other Automated Truck Applications

Chapter 1. Introduction

Background

The Maritime Administration (MARAD), Intelligent Transportation Systems Joint Program Office (ITS JPO), the Federal Highway Administration (FHWA), and the Federal Motor Carrier Safety Administration (FMCSA) have collaborated to address maritime port challenges by evaluating the impacts of Intelligent Transportation Systems (ITS), including automation and increased connectivity. This effort furthers the two key ITS Program priorities outlined in the *ITS Strategic Plan 2015-2019*: realizing connected vehicle implementation and advancing automation.

The ITS MARAD Truck Staging Study is intended to establish the foundation for the long-term development and demonstration of port truck staging concepts. The program will improve the safety, access, reliability and readiness of port facilities through advanced technologies and techniques to increase the reliability and efficiencies of truck movements. The overarching research objectives are "to determine the state of the practice regarding truck staging, including access, queuing, and parking, at maritime ports and to identify port operators' and trucking industry needs; and to perform an economic feasibility study of automated truck queuing as a technology solution."

This study incorporates two economic feasibility analyses for Task 4 of this project. The first analysis is a high-level evaluation of the economic feasibility for the future deployment of port staging technologies at port facilities, including technologies and partnerships between port authorities and commercial freight companies and operators. The second economic feasibility analysis addresses increased productivity through automated port queuing. It includes the technology concept of an automated slow-speed, in-queue truck application that meets the standards of Level 4 as defined in SAE J3016.[2] In this configuration, the driving system can fully operate a truck in queue and within a port terminal while the operator would exit the cab and assume an hours-of-service (HOS) status of "On Duty, Not Driving." When the truck is loaded or unloaded, the driver would be notified, re-enter the vehicle, change his or her operating status to "On Duty, Driving," and leave the port.

Approach

This study was conducted using a multi-step approach built on background document research, industry outreach, and an analytic process for operational and economic feasibility. The background research included a state of practice research scan, as documented in Chapter 3 of this report. The port industry stakeholder outreach was comprised primarily of stakeholder interviews at select U.S. ports (Chapter 5), supplemented by an online questionnaire distributed to coastal and river ports throughout the country (Chapter 6). A long list of potential solutions to address port terminal congestion was screened to a select

[2] SAE International, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles," J3016_201806. (June 15, 2018)

set of solutions for detailed analyses (Chapter 7). Barriers to implementation are discussed in Chapter 8, and recommendations for next steps are outlined in Chapter 9.

Trends

U.S. port cargo volumes have been increasing steadily while the overall number of commercial truck drivers continues to fall short of the growing demand. Increasing truck freight volumes, Federal Hours of Service requirements, increased congestion on roadways, and an aging driver pool each contributes to the increased demand for new drivers. A 2017 report by the American Trucking Associations (ATA) indicated an industry-wide shortage of approximately 50,000 drivers by the end of the year, a figure that could grow to almost 175,000 by the mid-2020s.[3] While the ATA study does not break these numbers down by trucking industry subsector (long-haul, short-haul, drayage, etc.), recent reports indicate that a growing shortage of drayage truck drivers is being seen in some ports and intermodal hubs. In response to this driver shortfall, automated truck staging and driverless trucks are gaining increased interest from port operators, shippers and public-sector agencies.

Freight transportation has experienced dramatic changes in the national and global landscape in recent decades, much of it occurring outside of the public eye. Population growth and shifts, changes in consumer behavior, economic dynamism globally, and technology advances have driven dramatic changes in freight transportation. The increasing complexity of global logistics and the supply chain process has made port operations a critical link for raw materials and finished goods to the benefit of the U.S. economy.

Trucking Industry Segmentation

Truck industry segmentation is an important context for understanding the staging, access, queuing and parking needs for drivers, and the types of facilities available and their function.

Staging vs. Parking

Truck staging areas are locations designed and designated for trucks waiting for pick-up and/or deliveries. They are short term formal and informal parking locations that are used by each driver for an average of an hour or less. They are located in close proximity to or ideally within truck-oriented establishments such as ports, warehouses, and large retail areas. Truck parking facilities are generally designed and designated for long haul drivers to rest in order to meet the FMCSA hours of service regulations. These areas are generally located along interstates or other major highways. Public rest areas are typically owned and operated by state departments of transportation or toll authorities, the majority of which are accessed directly from the highway within the right of way. Private truck stops are generally located near highway interchanges and tend to provide many more spaces than public rest areas for trucks.[4] The drayage trucking industry often uses facilities for both staging and parking activity – staging while waiting

[3] Truck Driver Shortage Analysis 2017, American Trucking Associations (published October 2017)

[4] North Jersey Transportation Planning Authority (NJTPA), North Jersey Truck Rest Stop Study

for port terminal gates or customer warehouse locations to open. Depending on the time of day, use of rest areas for staging may limit availability of this parking to meet FMCSA hours of service requirements.

Short-Haul vs. Long-Haul Trucking

Although there is no strict definition of short- or long-haul trucking, short-haul drivers generally operate within a 150-mile radius, while long-haul drivers usually have a driving radius of 250 or more miles. Each trucking industry segment has its own staging and parking needs. Trucks that require space for staging generally operate within the 'last mile' of a trip (e.g., near port facilities, warehousing districts) to meet pick-up and delivery windows. Short and long-haul trips made by trucks each have staging requirements, but long-haul trucks require additional alternatives for extended parking along the highway system. Short-haul trucks generally make several trips to and from a facility originating and ending at the same facility within a day.

Drayage Trucking

The term "drayage trucking" refers to the segment of the trucking industry that transports freight from another mode of transportation to a customer (or vice versa). In marine cargo transportation, drayage trucks transport cargo through port terminal gates to or from the marine terminal. Drayage trucks can operate over short-haul or long-haul distances described above, but they are usually distinguished from traditional short-haul and long-haul trucking because of unique operating aspects of intermodal freight transportation.

Warehouse vs. Port Access

The needs of the trucking industry for traditional deliveries related to warehousing and the needs of port drayage trucking are crucial factors in truck staging and parking demand and location. Warehouses are located in proximity to the consumer markets that they serve. These facilities receive trucks throughout the day based on time windows designated to drivers and tend to have staging and parking needs spread out over the course of a full day. Peak parking and staging activity usually occurs in the hours before a warehouse opens in the morning. Port facility operations are dictated by shipping schedules at marine ports and require many carefully scheduled drivers to be ready for the removal, loading, and staging of cargo.

Regulatory Oversight

The FHWA supports state, metropolitan, and local governments in the design, construction, and maintenance of the nation's highway system, including public truck parking facilities. The Fixing America's Surface Transportation (FAST) Act is the most recent transportation multi-year policy authorization, and truck parking activities are authorized as eligible activities for various funding programs. Additionally, the previous Federal transportation funding legislation The Moving Ahead for Progress in the 21st Century Act (MAP-21) required a survey of state capability to provide truck parking, an assessment of truck volumes in each state and the development of a system of metrics to evaluate parking (Jason's Law).

FHWA formed the National Coalition on Truck Parking in August 2015 with the goal of enhancing public, private, and shared planning and investments to respond to truck parking needs. With an interest in

continuing the dialogue on national truck parking needs, the coalition of stakeholder organizations was convened and conducted four regional truck parking meetings aimed at identifying truck parking solutions around the nation.[5]

MARAD is the United States Department of Transportation's (USDOT's) maritime agency and is charged with promoting the development and maintenance of a strong merchant marine for national defense and the development of foreign and domestic commerce. MARAD oversees the promotion and development of ports and transportation facilities along the coasts, inland waterways, and Great Lakes. MARAD supports ports in their efforts to plan, finance, and implement projects that improve port capacity and efficiency, and efficient truck parking and staging projects (especially as it pertains to their use of ITS solutions). MARAD is actively working on freight solutions and advancing the benefits of ITS.

The FMCSA, whose mission includes preventing commercial motor vehicle-related fatalities and injuries, identifies truck parking as a tool to promote safety. Among other truck parking projects, the FMCSA has published a SmartPark Technology Demonstration Project report, examining the feasibility of matching parking demand to supply using real-time truck parking information.[6]

Port Trucking Overview

Port access is critical for the economic well-being of the country. Freight transportation has experienced dramatic changes in the national and global landscape in recent decades, much of it occurring behind the scenes and outside of the public eye. Population growth and shifts, changes in consumer behavior, economic dynamism globally, and technology advances have driven dramatic changes in freight transportation. The increasing complexity of the global logistics and supply chain process has made port operations a critical linkage for raw materials and finished goods to the benefit of the US economy.

U.S. port cargo volumes have been increasing steadily while the overall number of commercial truck drivers continues to fall short of the growing demand. Increasing truck freight volumes, increased congestion on roadways, and an aging driver pool each contributes to the increased demand for new drivers. There are regions in the Southeastern U.S. where drayage hauls tend to be longer than in most ports and where drayage drivers are more likely to require minimum ten-hour rest periods under FMCSA hours of service rules because they do not return to a home terminal at the end of every work shift. In response to this driver shortfall, automated truck staging and driverless trucks are gaining increased interest from port operators, shippers and public-sector agencies.

Densely populated areas like many port regions that accommodate large volumes of truck traffic on the highway system have common characteristics that diminish truck parking and staging capacity. Some of these factors include congested roads, heavy parking activity at public rest areas and privately-owned truck stops, increased use of the highway system among various users (automobiles, buses and trucks), and an overlap of different types of trucking activity including long-haul and short-haul trucking, drayage to and from terminals, and local distribution and delivery. This complex pattern of roadway usage is

[5] FHWA, https://ops.fhwa.dot.gov/publications/fhwahop17026/fhwahop17026.pdf

[6] FMCSA, https://www.fmcsa.dot.gov/safety/research-and-analysis/smartpark-real-time-parking-availability-6-month-field-operational-test

accompanied by land use costs and urban development constraints that make it increasingly difficult to expand existing truck parking facilities or build new ones.

Queuing at marine terminals has been a recurring problem for many of the nation's ports, and this problem has worsened as the world of ocean cargo transport has changed dramatically in recent years. Vessel sizes have grown, and ports have been making major investments to expand berth space, widen and deepen harbor channels, and address vertical clearance constraints along channels that access these ports. In many ports, constraints on inland connections have become increasingly gridlocked as these larger vessels and expanded marine infrastructure result in heavier "surges" of cargo at the marine terminals. The resulting landside congestion, lengthy queues, and accompanying air quality impacts add substantial financial and environmental costs for shippers/receivers and communities surrounding these ports.

In addition to these broad factors and trends, the efficiency of operations at a typical marine port is affected by the complexity of the import and export processes and the array of different stakeholders in the port commerce environment. These include the following:

- Ocean carriers
- Port authorities
- Marine terminal operators
- Intermodal trucking firms and port drayage truck drivers[7]
- Railroads
- Chassis pool operators
- Shippers/receivers and third-party logistics firms
- Chassis and container equipment leasing companies
- U.S. Customs and Border Protection
- State and local government agencies and Metropolitan Planning Organizations (MPOs)

A port operation involves cargo movements between three general areas of activity and responsibility: (1) inside-the-gate operations, (2) a transitional movement between the marine terminal and the external road network, and (3) the external activity where a cargo is delivered to a receiver.[8] The relationships between these cargo-handling stakeholders in terms of their function in the supply chain for import/export cargo movement are shown below in Table 2.

[7] The drayage trucking industry includes different players who operate through their own contractual relationships. An intermodal/drayage trucking firm typically conducts business transactions with customers and terminals and provides scheduling and dispatching service for drivers, while executing the drayage trucking service with a combination of company trucks and owner-operators who work under contract with the firm.

[8] For the purpose of simplicity, general descriptive information about port operations is described in this report in the context of an import move. A corresponding reverse process takes place for export moves.

Table 2. Port Stakeholders and Areas of Operation/Responsibility

Inside the Gate	Transition (Inside-Outside)	Outside the Gate
• Ocean carriers • Marine terminal operators • Trucking firms/operators • Railroads • Chassis pool operators • U.S. Customs & Border Protection	• Trucking firms/operators • Railroads • Chassis pool operators	• Trucking firms/operators • Railroads • Chassis pool operators • Shippers/receivers • State and City DOTs • Metropolitan Planning Organizations

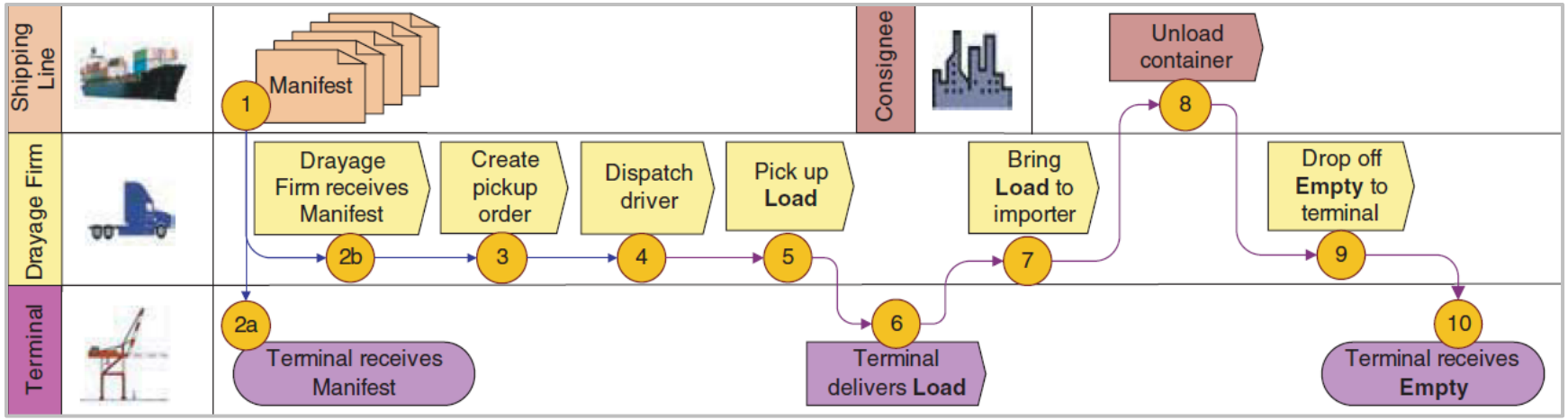
Drayage trucks, their equipment (i.e., container chassis) and railroads are involved in a particularly complex part of the supply chain because they operate in all three steps in this transport process. The transition from the marine terminal and the external road network involves not only a physical movement of cargo, but a transfer of the legal responsibility for the cargo from one party to another.

Public agencies have conducted several studies and research efforts in recent years to document the complexity of this landside supply chain and identify potential infrastructure investments and operational improvements to reduce inefficiencies in the process specifically as it relates to this transition between the "inside-the-gate" operation at a marine terminal and the external drayage truck movement to the receiver. These previous studies are documented in the *State of Practice Research Scan Report* (3/28/2018) that was completed for this project.

One particularly relevant study was the *Truck Drayage Productivity Guide* completed through the National Cooperative Freight Research Program (NCFRP) and documented in NCFRP Report #11, which contains a wealth of information about the drayage process and the interaction of the port industries described above. The import and export container handling processes are shown schematically in Figures 1 and 2 on the following pages.

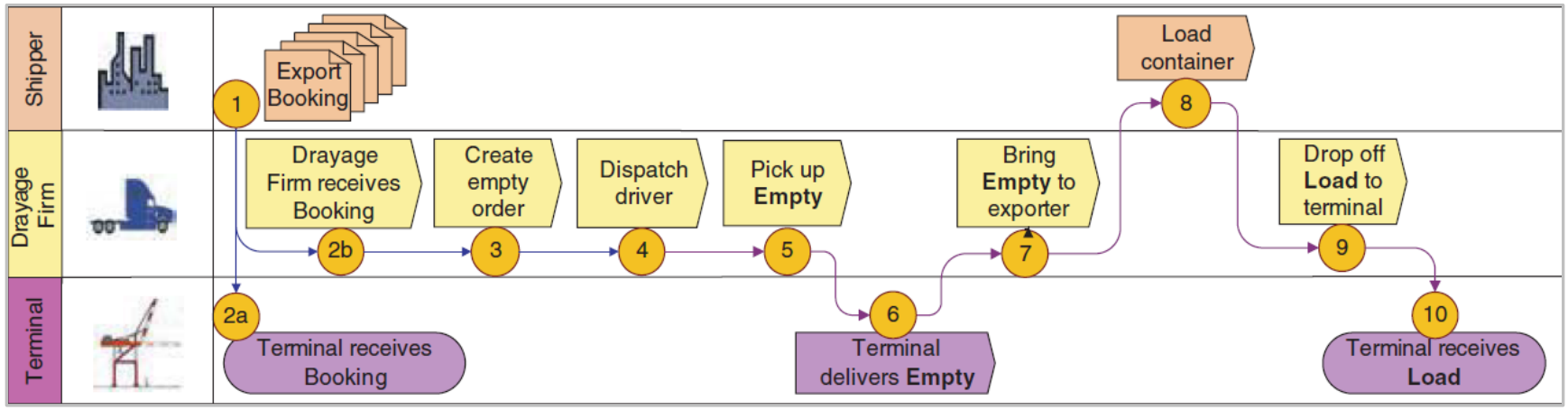
NCFRP Report #11 provides a detailed examination of the cargo handling process at the terminal gate. The complexity of this process, which all takes place within Steps 5 and 6 as described in Figure 1, is clear in Figures 3 through 5 on the following pages. The process illustrated in these figures is for a drayage pick-up of an imported cargo only. A two-way trip involving a drop-off and a pick-up on the same trip involves a separate set of steps to be completed before the truck can be loaded with a container.

The numerous steps in the cargo handling process outlined in these figures have major implications for any proposed operational improvements at a port terminal. These will be discussed in detail in Chapter 6.



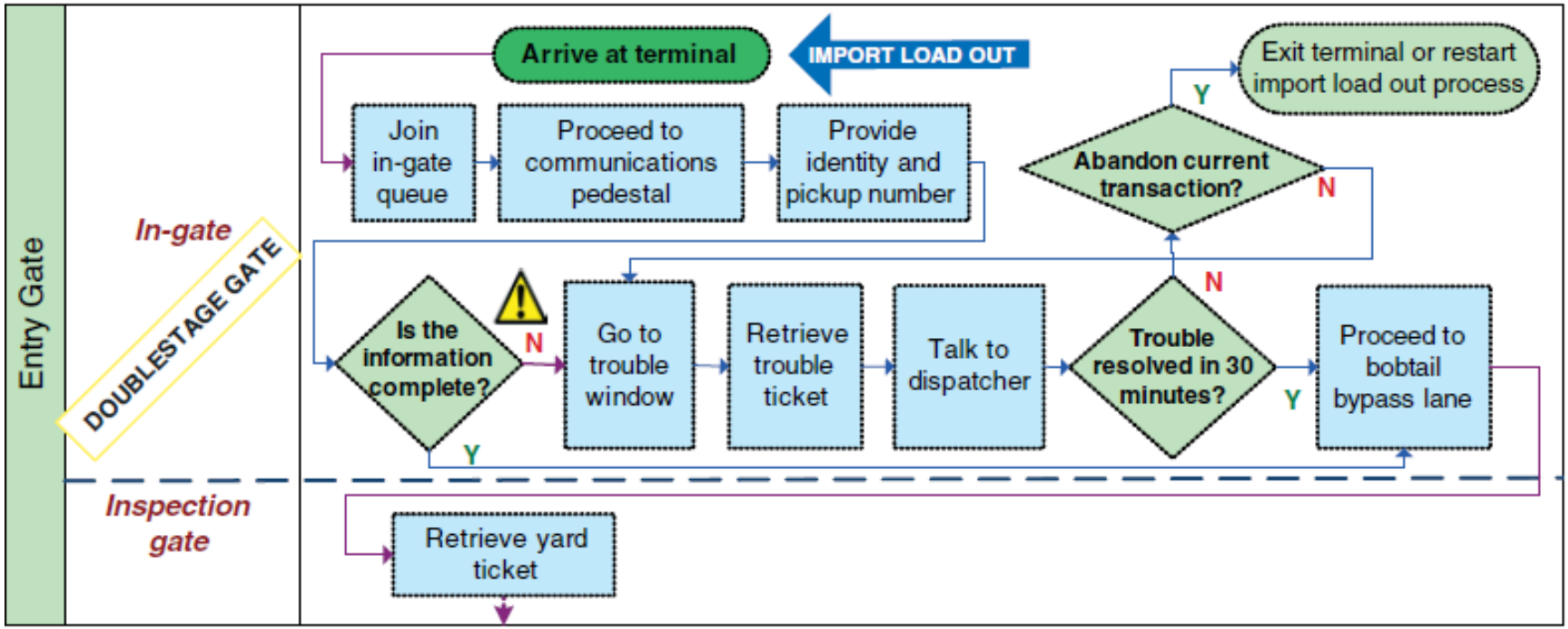
Source: Truck Drayage Productivity Guide, Figure 2-3 (NCFRP)

Figure 1. Import Drayage Process Map



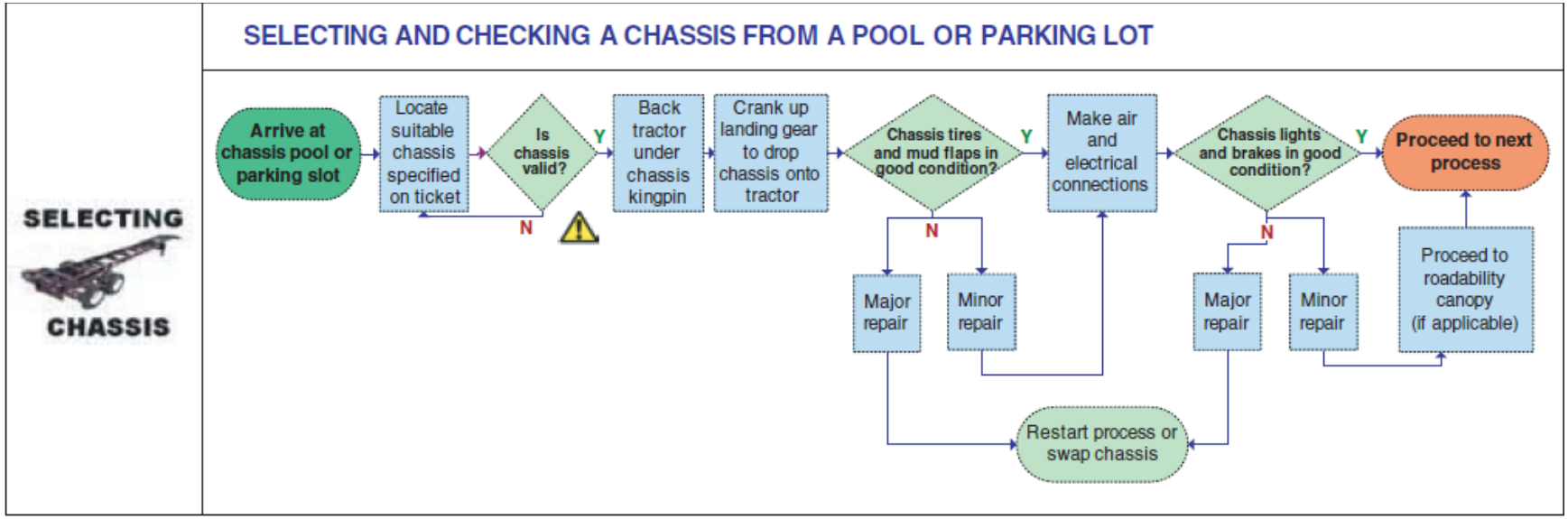
Source: Truck Drayage Productivity Guide, Figure 2-4 (NCFRP)

Figure 2. Export Drayage Process Map



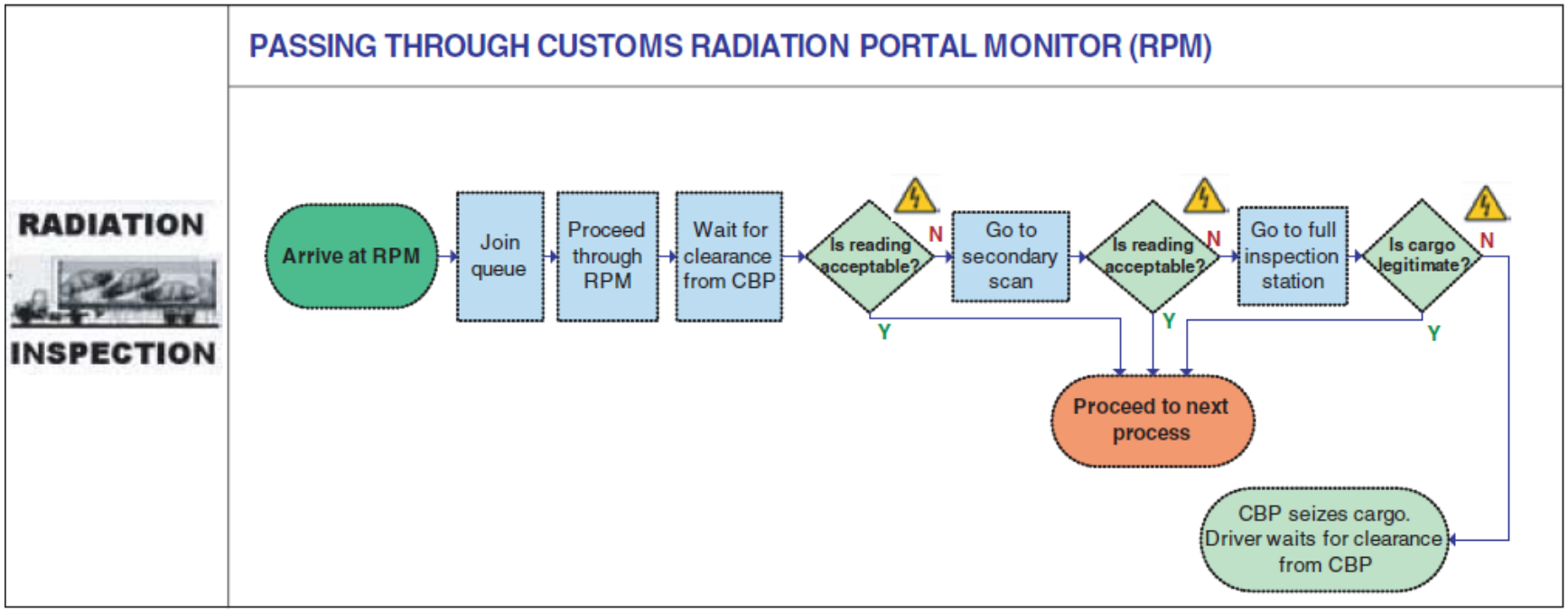
Source: Truck Drayage Productivity Guide, Figure 2-6 (NCFRP)

Figure 3. Two-Stage In-Gate Subprocess



Source: Truck Drayage Productivity Guide, Figure 2-7 (NCFRP)

Figure 4. Chassis Subprocess



Source: Truck Drayage Productivity Guide, Figure 2-9 (NCFRP)

Figure 5. Radiation Portal Monitoring Subprocess

Chapter 2. Port Needs and Issues

Port Access Road Congestion and Terminal Gate Queues

Congestion-related delays on port access roads and at marine terminal gates is one of the major causes of lost productivity for drayage truck drivers. Causes of this congestion range from insufficient roadway capacity to operational issues at port terminals (e.g., insufficient terminal staffing, cargo surges) to sporadic disruptions such as weather events and port labor strikes. To deal with the uncertainty associated with these delays the drayage trucking industry has adopted new practices at many ports. During peak days of operation after a major vessel unloading at a port terminal it is not uncommon for drayage trucks to arrive in the pre-dawn hours to stand in line before the terminal gates open. This rush to avoid delays exacerbates these delays by creating a queue that can take several hours for the terminal gates to process.

This interaction between terminal gate staff and drayage trucks is one of the most unpredictable elements of a marine terminal operation, and consequently one of the most difficult to address. Interviews with various port stakeholders indicated that marine terminal operators generally have a high degree of confidence in managing their internal operations efficiently. Some described the terminal operation as a "conveyor belt" model where the main challenge is ensuring that each step in the cargo handling procedure is processing cargo at the same rate. When larger ships began to call at these ports, the terminal operators extended berths and added cranes. This step was matched by adding equipment to handle cargo within the terminals. Gates were expanded, and technology was implemented so the gate operations could match the processing rate of the dock cranes and the internal cargo handling equipment.

Drayage trucks, however, operate independently of the marine terminal operators. This means that even a terminal operator with a highly efficient operation inside the gate cannot ensure that truck arrivals at the gates are timed in a way that matches the "conveyor belt" process of the terminal. This disconnect between the terminal operator and the drayage trucker has historically been the primary obstacle to efficient drayage and terminal gate operations. Several technologies have been implemented in the port industry to address these inefficiencies in recent years. ITS technology solutions were studied in an internal state of the practice review in Phase 1 of the ITS JPO / MARAD program. Many of the solutions identified in that study are aimed at bridging the "barrier" between port terminals and the drayage trucking industry through improved transparency and visibility of cargo data. Some of these that relate to truck queuing and staging issues will be discussed in Chapter 6 of this report.

Drayage Truck Delays Within Terminals

The drayage subprocesses illustrated in Figures 3 through 5 reflect a complex process that is prone to a high degree of uncertainty in terms of turn times, driver productivity, and scheduling of deliveries later in the supply chain (e.g., when a container is delivered to a receiver). The aforementioned NCFRP report on drayage productivity lists a number of causes of drayage delays within marine terminals. Most of these do

not directly relate to the objective of this current study, but they are listed here to illustrate the complexity of the problem in the context of some of the solutions that will be discussed in Chapter 6. Common causes of delays within marine terminals include:[9]

- Drivers and tractors getting out of order in lines waiting to receive containers in the stacks
- Lift equipment malfunctions
- Errors in communication between the gantry crane operator and driver
- Drivers pulling the wrong container in wheeled terminals[10]
- Lift equipment transferring the wrong container in stacked terminals
- High wind conditions that can slow or interfere with lift equipment operations
- Retrieving containers that require excessive re-handling due to their position in a stack
- Shift changes for terminal staff
- General congestion with too many trucks in the terminal
- Lane blockages from trucks queuing behind a specific crane
- Computer system breakdowns
- Poor chassis condition, maintenance and repair of chassis

Impact of FMCSA Hours of Service Rules on Drayage Operations

Commercial motor carriers are governed by an extensive set of regulations adopted by the Federal Motor Carrier Safety Administration (FMCSA). These regulations cover a wide range of passenger and freight transportation operations, and are aimed at reducing crashes, injuries and fatalities involving large commercial vehicles.[11] The FMCSA regulations regarding hours of service (HOS) for commercial drivers are most relevant to this study. In summary, the pertinent HOS regulations for truck operators are as follows:[12]

- Drivers may be on duty for a maximum of 14 consecutive hours after a minimum off-duty period of 10 consecutive hours.
- The driver may not drive after the end of this 14-hour on-duty period without first taking 10 consecutive hours off duty.
- A driver may drive a total of 11 hours during the 14-hour on-duty period.

[9] National Cooperative Freight Research Program, *Truck Drayage Productivity Guide* (NCFRP Report #11), p.71

[10] Container terminals and/or different areas within terminals generally function as “wheeled” operations, where containers are parked on chassis, and “stacked” operations, where containers are stacked separate from chassis.

[11] FMCSA Mission Statement, https://www.fmcsa.dot.gov/mission (retrieved 11/6/2018)

[12] FMCSA regulations documented in Electronic Code of Federal Regulations (e-CFR): Title 49 (Transportation), Volume 5, Chapter III, Part 395. Maximum driving time rules are contained in §395.3.

- A driver cannot drive for more than 8 hours without taking a rest break of at least 30 minutes. This regulation is waived for drivers who qualify as "short-haul" drivers under the FMCSA rules.[13]

One of the most important performance metrics for a marine terminal is the terminal turn time, which is the duration that a drayage truck spends inside the terminal from the time it enters the gate to the time it exits through the gate. Terminal turn time can range from 10-15 minutes up to multiple hours, depending on the complexity of the operation, the number of transactions a drayage driver conducts within a gate (i.e., a driver arriving with no load and picking up a container is a "one-way" move, while a driver arriving with one container and leaving with another is a "two-way" move), and the incidence of in-terminal delays as described in the previous section of this chapter. In the port stakeholder interview process conducted in Task 3, terminal operators reported average turn times of 25 to 35 minutes for one-way moves and 50 to 70 minutes for two-way moves (at some of the select ports where the interviews were conducted). These interviews also indicated that these figures have generally improved in recent years as terminals and other port industry partners have implemented some of the technology improvements identified in MARAD's internal 2017 review.

While the terminal turn time is used to measure performance in marine terminal operations, the more important metric for the drayage trucking industry is the overall turn time for a driver making a delivery. The terminal turn time is only one element of this broader measure. The overall turn time includes the entire duration of time for a driver to start his or her trip to a terminal, wait in queue at the terminal gate, conduct the transaction(s) within the terminal, and deliver the cargo to the customer. This metric varies widely because it is influenced by multiple factors that are not all predictable, including: (1) delays within the terminal, (2) travel distance and roadway congestion between the port and the shipper/receiver, and (3) loading/unloading time at the customer's location. Turn times can also be driven by the operating practices of drayage trucking firms that may use short-distance shuttle operations to intermediate staging yards to address inefficiencies in the direct drayage process.

This overall turn time is directly impacted by FMCSA HOS rules, and these rules drive the business practices of drayage trucking firms. The wide range of turn times even for drayage drivers serving a single port terminal illustrates the high degree of inefficiency that is built into the drayage trucking process. A driver that can complete an overall turn in five hours for a typical drayage haul, for example, can complete two turns within an 11-hour driving day but cannot complete a third. Eliminating 30 minutes of time wasted in queue on each trip would reduce this 5-hour turn time to 4.5 hours, which is still not enough to enable the driver to get a third turn during the day. But eliminating 30 minutes of wasted time for a driver with an average turn time of six hours does facilitate a second turn during the 11-hour driving day (two 5.5-hour turns), a third turn for a driver who currently has a four-hour average turn time (three 3.5-hour turns), etc.[14] There is a substantial amount of "slack" in the drayage industry due to this mismatch between HOS rules and turn times for drayage truck drivers, and well-managed trucking firms work hard to fine-tune their operations to get their driver schedules as closely aligned with these HOS rules as possible.

[13] In general, a driver who operates within a radius of 100 air miles of a work location, returns to that work location, and is released from work within 12 hours, is considered a "short-haul" driver.

[14] For illustrative purposes, the role of "half-turns" in the drayage industry has been ignored here. However, it is not unusual for drayage trucking firms to make second or third pickups at a marine terminal in a day even if it is not possible for the last load of the day to be delivered to the customer within the 11-hour driving window. These loads are removed from the terminals at the end of one day and then delivered to the customer the following morning.

In general, the impacts of terminal delays that increase turn times are most keenly felt for drayage truckers who serve customers located short to intermediate distances (up to about 100 miles). For longer drayage hauls, delays at port terminals may impact driver schedules and operating efficiency for the trucking firm, but do not impact a driver's ability to make even a second turn in the course of a single day. At the Port of Savannah, for example, the most common destination for imported cargo was identified as the Atlanta metro area. This trip is nearly a four-hour drive time even under ideal travel conditions, so a driver hauling a load between these points could not make a second trip under any circumstances.

Terminal congestion time and other related delays impact the trucking industry the same way the industry is impacted by detention time at shippers/receivers. The industry generally allots a maximum of two hours for a truck to be unloaded at a customer's location if the driver waits for the loading process to be completed. A 2014 FMCSA study indicated that drivers typically experience detention time beyond the two-hour standard on about 1 in 10 hauls, and the average excess detention time is 1.4 hours.[15] This is completely unproductive time for a driver, as it generates no additional revenue but reduces the available on-duty time within the 14-hour on-duty window described previously. The drayage trucking industry can reduce detention time for high-volume customers by using a preferred "drop and hook" or "drop and pick" operation. In this scenario, a driver will drop off one container at a customer's location and then immediately take an empty one back to the port; the customer then unloads the delivered container without any impact on the driver's schedule. This operation is typically not an option for truckers serving low-volume customers that do not constantly cycle loaded and empty containers at the same location.

Empty and Bobtail Trips

Drayage trucks typically engage in four types of transactions during the course of doing business at a marine terminal. These correspond to the types of equipment and loaded or unloaded status of a shipping container. The four types of transactions are:

- Tractor hauling a loaded container
- Tractor hauling an empty container
- Tractor pulling a chassis with no container
- Tractor with no trailer (known as a "bobtail" configuration in the trucking industry)

In terms of importance to the business operation of a drayage trucking firm, the turn times described in the previous section are second only to the maximization of revenue moves for a driver or company. Striving for efficiency means minimizing moves in the third and fourth categories above, as these are non-revenue moves for the drayage trucker. The movement of chassis with no container was uncommon outside the terminal gates when chassis were owned by ocean carriers and stored in marine terminals. Over time, the ownership of these chassis has slowly migrated to third-party chassis pools as the ocean carriers have begun to shed these operations. Chassis are not a core function for vessel operators, and today most ports have near-terminal chassis pools that are an integral part of the port operation. Drayage truckers have long dealt with the challenge of ensuring any chassis they use from a third-party provider is roadworthy, as the chassis equipment becomes the driver's responsibility as soon as it leaves the chassis yard or marine terminal. One change that has occurred over time in the drayage industry is that more and more of these chassis are now owned by trucking firms and even by customers. The chassis ownership

[15] *Driver Detention Time in Commercial Motor Vehicle Operations*, FMCSA (December 2014)

arrangement has major implications for automated truck operations and will be discussed in more detail later in this report. This is but one example of the multiple organizations involved in moving goods in and out of ports, adding to the complexity of the problem-solving process.

Figure 6, which is from the NFCRP Report #11, shows the array of combinations for inbound and outbound truck trips with the four different transaction types listed above. The shaded cells correspond to the typical transactions at a marine terminal; the unshaded cells are for inbound/outbound combinations that rarely occur. Each of the four transaction types is processed differently at a terminal; this has major implications for potential operational improvements related to queuing and staging that will be examined in Chapter 6 of this report.

Transaction Types		Entry			
		Bobtail	Bare Chassis	Empty on Chassis	Load on Chassis
Exit	Bobtail	Bobtail in Bobtail Out	Chassis in Bobtail Out	Empty in Bobtail Out	Export in Bobtail Out
	Bare Chassis	Bobtail in Chassis Out	Chassis in Chassis Out	Empty in Chassis Out	Export in Chassis Out
	Empty on Chassis	Bobtail in Empty Out	Chassis in Empty Out	Empty in Empty Out	Export in Empty Out
	Load on Chassis	Bobtail in Import Out	Chassis in Import Out	Empty in Import Out	Export in Import Out

Source: Truck Drayage Productivity Guide, Table 2-1 (NCFRP)

Figure 6. Exit/Entry Transaction Types. Shaded cells are more common at marine terminals.

Idle Containers

The divergent ownership interests in the various pieces of equipment used in the container shipping business adds a degree of complexity not found in other areas of the trucking industry. A drayage truck hauling a loaded container from a marine terminal to a customer will often be responsible for transportation equipment owned by three different entities: the container (owned by the ocean carrier), the chassis (usually owned by the ocean carrier or a third-party chassis pool operator) and the truck tractor itself (owned by the trucking firm). One of the complexities of this process is that the owners of this varied equipment and the entities responsible for them at different points in the delivery process have potentially conflicting business interests that impact other players in the process.

Shipping containers, for example, are generally given a specified number of days of “free time” in a marine terminal, after which the container is subject to a daily demurrage charge that must be paid by the customer. “Free time” is usually 4-5 business days, but ocean carriers have been reducing this figure over time as a means of enhancing revenue. Once a container leaves the terminal gate, it is subject to a per diem charge (usually with another allotment of “free time”) that is intended to incentivize the customer to unload the container as quickly as possible. Ocean carriers typically have a standard per diem charge, but sometimes this is negotiated separately between the cargo owner (customer) and the ocean carrier. These variations in per diem charges can present operational challenges for drayage trucking firms.

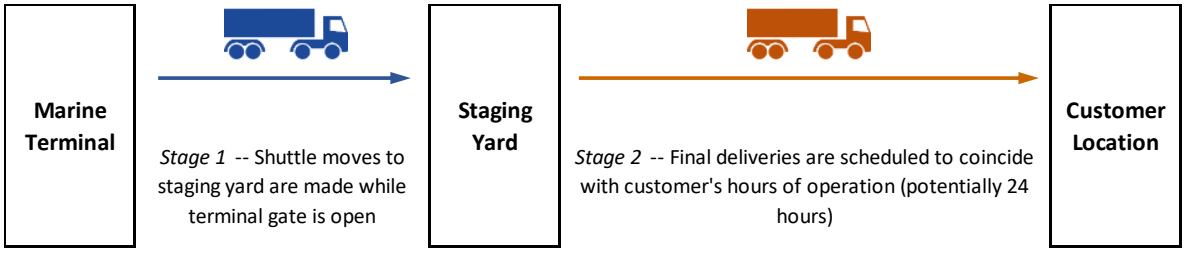
A major shipper such as Walmart, for example, may negotiate a 15-day “free time” period with its ocean carriers while other shippers only enjoy two free days before the container begins accruing per diem charges. The extended free time has implications for the owner of the chassis. If the chassis is part of a third-party chassis pool, it is subject to per diem charges even if the container is not. And if the chassis is owned by the drayage trucking company, then the drayage firm will lose the use of its chassis for an extended period of time, often without any additional compensation from the customer. These complexities in the relationship between the drayage trucking firm, the customer, the ocean carrier, and the chassis pool operator drive many of the operational decisions for the trucking firm.

Shuttle Movements

One of the inherent constraints for the drayage trucking industry is the common mismatch between the hours of operation at a marine terminal and the hours of operation at the shipper/receiver where a load originates or is being delivered. This operational challenge is exacerbated when the customer is located some distance away from the marine terminal and the travel time must be considered in the scheduling of the load delivery. For example, if a marine terminal is open from 7:00 AM to 7:00 PM and the customer has the same operating hours but is located three hours away, then a drayage truck operator making a delivery to this customer must complete a pick-up and leave the terminal by 4:00 PM to reach the destination by the customer’s closing time.

Some drayage trucking firms that do a substantial volume of business with large customers will mitigate the inefficiencies of this situation by doing hauls in a two-stage process with separate dedicated teams of drivers as illustrated in Figure 7. One team of drivers will operate between the port and a nearby staging area that may be the drayage firm’s home terminal or a gated lot owned or leased by the firm near the port. The cargo is stored temporarily in this lot on the chassis. This operation is done while the terminal gates are open. The second team of drivers operates between the staging yard and the customers, hauling the combined container/chassis for the second stage of the trip and returning with empty containers if needed.

In some cases, this operation is carried out even if both the marine terminal and the customer are open 24 hours. This is common for export containers (empty or loaded) that must be delivered from the customer to the terminal within a defined window of time several days in advance of the ocean carrier’s vessel arrival. Drayage firms will use this process to place the containers as close to the port as possible to minimize the risk of missing the required window of time to meet the vessel.



Source: MARAD, 2019

Figure 7. Two-Step Shuttle/Staging Operation

Chapter 3. State of Practice Research Scan

Introduction

The research scan completed as part of Task 2 of this project provided truck staging findings and perspectives from previous research in an organized summary. The Task 2 objective was to conduct a review of current research to document port truck staging trends and innovations being adopted and those that have promise (potential) for future adoption. The reports reviewed are listed in Appendix A. It is important to emphasize that this report is a summary of the documents reviewed. Recent and more in-depth information on truck staging innovations and technology continues to be produced and will be documented in future tasks. The documents summarized through this report were published up to 2015.

Reports were reviewed for eight relevant topic areas as shown in Table 3 and listed below.

- Advanced Truck Technology
- Economic Issues
- Environmental Issues
- Freight System Preservation
- General Truck Mobility
- Port Access
- Truck Parking and Staging Issues
- Truck Safety Improvements

This section describes the overarching themes and findings of the documents reviewed. The focus on overarching themes and findings provides useful context for the balance of the study.

Table 3. Reports Reviewed and Relevant Topic Areas

Report Title	Advanced Truck Technology	Economic Issues	Environmental Issues	Freight System Preservation	General Truck Mobility	Port Access	Truck Parking and staging	Truck Safety Improvements
2015 AASHTO Transportation Bottom Line Report		◉		◉				
A Guidebook for Engaging the Private Sector in Freight Transportation Planning				◉				◉
An Interim Guidebook on the Congestion Management Process in Metropolitan Transportation Planning		◉	◉		◉			
Baltimore Truck Parking Partnership Study			◉		◉		◉	◉
Driver Detention Times in Commercial Motor Vehicle Operations		◉	◉	◉	◉			◉
Evaluating Alternatives for Landside Transport of Ocean Containers					◉		◉	
Global Intermodal Freight: State of Readiness for the 21st Century (Report of a Conference)		◉	◉	◉	◉	◉		◉
Jason's Law Truck Parking Survey Results and Comparative Analysis	◉						◉	◉
Mitigating Freight Impacts on Nearby Communities		◉	◉					◉
NCFRP 01: Public and Private Sector Interdependence in Freight Transportation Markets	◉	◉	◉					
NCFRP 02: Institutional Arrangements for Freight Transportation Systems				◉	◉			◉
NCFRP 05: North American Marine Highways		◉		◉		◉		
NCFRP 06: Impacts of Public Policy on the Freight Transportation System	◉		◉		◉		◉	◉
NCFRP 07: Identifying and Using Low-Cost and Quickly		◉	◉		◉		◉	◉

Report Title	Advanced Truck Technology	Economic Issues	Environmental Issues	Freight System Preservation	General Truck Mobility	Port Access	Truck Parking and staging	Truck Safety Improvements
Implementable Ways to Address Freight-System Mobility Constraints								
NCFRP 10: Performance Measures for Freight Transportation	◉	◉	◉	◉	◉	◉		◉
NCFRP 11: Truck Drayage Productivity Guide	◉					◉	◉	◉
NCFRP 12: Framework and Tools for Estimating Benefits of Specific Freight Network Investments		◉		◉	◉			◉
NCFRP 13: Freight Facility Location Selection: A Guide for Public Officials		◉	◉					
NCFRP 16: Preserving and Protecting Freight Infrastructure and Routes		◉		◉	◉			◉
NCFRP 18: Synthesis of International Freight Scans		◉				◉		
NCFRP 20: Guidebook for Assessing Evolving International Container Chassis Supply Models				◉	◉	◉	◉	
NCFRP 33: Improving Freight System Performance in Metropolitan Areas: A Planning Guide	◉	◉	◉	◉	◉		◉	◉
NCFRP 40: Improving Export Freight Logistics		◉			◉		◉	
NCHRP 03-94: Transportation Systems Operations and Management Guide				◉				
NCHRP 08-36: Best Practices in Statewide Freight Planning		◉	◉	◉	◉			◉
NCHRP 20-80: Long Range Strategic Issues Facing the Transportation Industry: Final Research Plan Framework (Task 2)		◉	◉					
NCHRP Synthesis 320: Integrating Freight Facilities and Operations with Community Goals		◉	◉		◉		◉	◉

Report Title	Advanced Truck Technology	Economic Issues	Environmental Issues	Freight System Preservation	General Truck Mobility	Port Access	Truck Parking and staging	Truck Safety Improvements
North Jersey Truck Rest Stop Study Refinement and Action Plan		◉	◉	◉	◉	◉	◉	◉
North Jersey Truck Rest Stop Study: An Assessment of Potential Locations for Truck Rest Areas in Northern New Jersey and the Port District		◉	◉	◉	◉	◉	◉	◉
SHRP 2 Report S2-C01-RR-1: Framework for Collaborative Decision Making on Additions to Highway Capacity				◉	◉			◉
SHRP 2 Report S2-C15-RW-2: Integrating Freight Considerations into the Highway Capacity Planning Process: Practitioner's Guide				◉	◉			◉
Truck Parking in Pennsylvania		◉	◉	◉			◉	◉
USDOT's Intelligent Transportation Systems (ITS) ITS Strategic Plan 2015-2019	◉	◉	◉	◉	◉		◉	◉

Advanced Truck Technologies

Advanced truck technologies come in many forms. They range from cargo tracking to automated vehicle operation. Most technologies are aimed at improving the efficiency and/or safety of the freight system either from a private or public perspective.

Data

Sophisticated technology has allowed global supply chains to be tracked, linked, and managed more effectively, thus reducing cost and improving the efficiency of the system.[16] The implementation of dynamic routing to optimize fleet management has also helped in recent years to benefit logistics providers and their customers.[17] For the private sector, these technology implementation decisions are often made by freight carriers or shippers. Government regulation or funding sometimes influences these decisions.

[16] NCFRP 01: Public and Private Sector Interdependence in Freight Transportation Markets

[17] NCFRP 33: Improving Freight System Performance in Metropolitan Areas: A Planning Guide

Public sector innovations such as real-time traffic data collection through the National Performance Management Research Data Set (NPMRDS), Prepass and toll transponders, and Weigh in Motion (WIM) data provide information on truck bottlenecks and freight performance. This information has been used by state DOTs to assist in tracking freight performance and prioritizing investments in transportation infrastructure improvements. Information technology is transforming freight and passenger transportation and represents one of the most strategic trends to leverage for problem solving—particularly as it relates to solutions that span/connect the wide range of port stakeholders.

Truck Automation

Automated trucks are an integral element of advanced truck technologies. Due to the rapid recent developments in automated vehicle (AV) technologies and issues with private/ proprietary information, this research scan did not yield much information from the publications listed in Appendix A. However, there has been some ongoing research that helped to guide further information gathering about AV technology in subsequent study tasks. These will be discussed in more detail in subsequent report chapters.

The six levels of vehicle automation as defined by the SAE International and adopted by the USDOT are:

- Level 0 – No Automation
- Level 1 – Driver Assistance
- Level 2 – Partial Automation
- Level 3 – Conditional Automation
- Level 4 – High Automation
- Level 5 – Full Automation

Automated guided vehicles (AGV) are those that are computer-controlled and perform a set of defined tasks by following specific instructions with minimal or no human intervention. Level 4 automated vehicles can operate without any intervention from a human within a specified domain, such as at low speeds within a defined roadway system in a port. Conceivably, a driver could leave a Level 4 automated truck at the entrance to a port, go off duty while the truck makes its way through the port, and then return to the truck when it is ready to leave the port to enter the highway network.

The FHWA and FMCSA has been conducting research on truck platooning, which involves connected vehicle technology that enables vehicles to continuously communicate and coordinate travel with other trucks to follow each other closely.[18]

Marine Terminal Gate Queuing

As advance decisions are made at operations centers about the order in which trucks enter the port and where they should park while waiting to pick up a load, this information needs to be conveyed to individual drivers. Changeable message signs, in-cab messaging (which may be existing telematics products or Vehicle-to-Infrastructure (V2I) signals sent through dedicated short-range communications

[18] FHWA: https://www.fhwa.dot.gov/research/truck_platooning/

(DSRC), and smart phone messages are possible approaches. Each of the approaches has unique advantages and disadvantages. Many large fleets already use in-cab messaging to dispatch their trucks, but more than one system is in use and small fleets and individual owner-operators that tend to be heavily represented in the drayage trucking industry may not be equipped with these technologies. V2I offers advantages of standardization, but this technology is not yet widespread.[19]

Economic Issues

In addition to truck staging and parking benefitting the port, they benefit the movement of goods throughout the surrounding region. Expanding truck parking facilities and improving operations at existing facilities will support freight movement at a wide range of industrial sites, including port and intermodal terminals and shippers/receivers. Public sector organizations often use cost models to provide information about how well each infrastructure investment, such as improvements to port truck staging, provides an economic benefit for the proposed investment. The duration of time required to recover the initial investment and the rate of return is compared against other operational investments and ongoing maintenance costs that may be considered to prioritize such investments.[20]

All of this is to say that transportation agencies are giving unprecedented attention to asset management (with systems and plans) and thereby strengthening a culture of investment economics in public infrastructure. Clearly, ports are a key element of our nation's economic activity. As such, public and private investments in port infrastructure must be viewed in the context of providing long-term economic dividends.

The economic impacts of port and other transportation infrastructure improvements include those associated with initial construction and direct economic activity as well as the secondary and tertiary impacts such as:

- Business Output – The increase in total sales by industries.
- Employment – The generation of direct, indirect and induced employment related to construction and operation.
- Value Added – The difference between the total output and the cost of intermediate goods for the industry or establishment.
- Labor Income – Labor income, comprised of wages, benefits and proprietor income, resulting from direct, indirect and induced jobs related to the facility.
- Tax Revenue.

Environmental Issues

Ports tend to be in heavily populated areas. There are environmental impacts associated with vehicular traffic from a port and the surrounding metropolitan area. Efforts to protect the environment, such as

[19] NCFRP 11: Truck Drayage Productivity Guide

[20] NCFRP 13: Freight Facility Location Selection: A Guide for Public Officials

regulations, mitigation programs, fees, and taxes, often affect freight transportation planning efforts and decision-making. The National Environmental Policy Act (NEPA) and other federal and state laws have significantly affected decisions about the operation and expansion of the freight transportation system.[21] New intermodal facilities can provide tangible environmental benefits through technological improvements that reduce truck idling and reduce emissions.[22]

The Environmental Protection Agency's (EPAs) SmartWay Program offers freight carriers technical and financial information on a range of truck and engine technologies and practices designed to conserve fuel and reduce emissions.[23] The EPA has also developed a tool called DrayFLEET® to model the effects of port activities on the environment. The model analyzes drayage in terms of vehicle miles traveled (VMT), emissions cost, and throughput. It accounts for the effects of engine technology including diesel particulate filters and idling controls. DrayFLEET® allows port managers to predict the environmental effects of terminal operations, cargo volume, and new initiatives such as neutral chassis pools and automated gates. Such information provides an opportunity for ports to be increasingly green as they strive to be efficiently lean as well.

Freight System Preservation

The preservation of the freight system is addressed in most of the literature reviewed, primarily in terms of funding needs and requirements. The research emphasizes that funding is critical for the preservation of the existing system which is a priority for the USDOT, states and localities. Preservation has also been a funding priority in MAP-21 and the FAST-federal funding legislation.[24] Preservation is a vital component of achieving and sustaining a desired state of good repair of highway facilities. This makes the maintenance of federally funded transportation infrastructure (which includes many port access roadways) a priority.

Beyond the roadway system covered by this federal legislation, many other port roadways are maintained by port authorities or local public agencies. State DOTs and Metropolitan Planning Organizations are addressing freight today to a much greater degree than in the past. This is particularly promising and encouraging from the perspective of freight needs being considered in transportation plans and transportation improvement programs.

General Truck Mobility

As discussed previously, trucking activity on the nation's roadway system has accelerated in recent years as supply chain management practices have been refined to reduce inventory and transportation costs. To address congestion, public sector transportation agencies have initiated efforts to reduce truck bottlenecks by reducing truck VMT, encouraging off-hour deliveries, and improving roadway geometry. In addition, these agencies have researched potential solutions to improve freight mobility through measures such as increases in truck size and weight, implementation of truck-only lanes, and

[21] NCFRP 01: Public and Private Sector Interdependence in Freight Transportation Markets

[22] NCFRP 13: Freight Facility Location Selection: A Guide for Public Officials

[23] NCFRP 11: Truck Drayage Productivity Guide

[24] FHWA Memo: Guidance on Highway Preservation and Maintenance, February 25, 2016.

modifications in local and regional truck routes. Operational inefficiencies are generally categorized as speed-based and process-based delays in truck movements.

A classification of the travel speed-based and process-based delay for trucks[25] is shown in Table 4 and Table 5.

Table 4. Classification of Travel Speed-Based Delay Truck Bottleneck

Cause of Travel Speed Bottleneck	Bottleneck Type
Truck bottlenecks caused by too much traffic volume	• Peak-period traffic • Roadway geometrics (lane drop) • Steep grades, terrain • Special event traffic • Seasonal traffic volumes • Surges of truck traffic from unloading of large container ships
Truck bottlenecks caused by temporary loss of operational capacity	• Work zones • Weather • Poor signal timing • Traffic incidents • Processing delays (toll booths, weight enforcement stations, terminal gates, international border crossings)
Truck-only bottlenecks (delays) caused by roadway limitations due to vehicle characteristics	• Roadway geometrics • Steep grades • Tight curves • Narrow lanes
Rerouting	• Low bridge heights • Truck weight restrictions • Hazardous materials restrictions

[25] NCHRP 08-98: Guide for Identifying, Classifying, Evaluating, and Mitigating Truck Freight Bottlenecks

Table 5. Classification of Process-Based Delay Truck Bottlenecks

Impact of Process-Based Bottleneck	Bottleneck Type
Rerouting	• Low bridge heights • Truck weight restrictions • Hazardous materials restrictions
Making additional trips	• Spring thaw load restrictions when no alternate routes • Truck size (length) restrictions
Truck bans or restrictions	• Time-of-day restrictions • Truck pick-ups and deliveries in off-hours
Delays in searching or waiting for loading zones or parking	• Inefficient truck movements due to "last-mile" facilities (e.g., parking facilities, loading zones, terminal gates) with insufficient capacity or poor operations

Port Access

Every marine container terminal uses a terminal operating system (TOS) to help manage and track the flow of containers through its gates, yard, and berths. In the past, many terminals relied on their own in-house software and tools for these operations. In today's fast-changing environment with rapid technological advances and constant practice changes, terminals are finding it more cost effective, convenient, and reliable to outsource this service. In addition to providing the core functionalities for terminal operations, the TOS is often linked to other systems such as billing, gate automation technology, and Web-based applications where customers can track their containers, make payments, or make an appointment for a pickup or delivery.[26]

A growing number of drayage firms use global positioning systems (GPS) or automatic vehicle locators (AVL) to track and dispatch their vehicles. GPS/AVL records are sometimes required as a reporting requirement for trucks that participate in air quality grant programs. In other cases, GPS or radio-frequency identification (RFID) are used to ensure that drayage trucks do not enter city streets or other corridors that cannot accommodate commercial loads. AVL systems are also used for theft recovery, and some insurers give discounts to drayage firms that use such systems. "Fleet telematics" systems take the concept further by permitting two-way data exchange between the vehicle and the home terminal.[27]

Container terminal operating systems collect information on gate activity. The gate data are entered by the clerks who check inbound and outbound trucks, or through automated systems such as swipe cards or optical character recognition (OCR) camera systems. When a drayage driver pulls a container from the terminal interchange, documents are completed to transfer legal custody of the container and chassis (and the contents, if loaded). Movement of loaded containers, empty containers, and bare chassis to and from the marine terminals tends to be well documented, but some reconciliation between interchange documentation and gate records may be required.[28]

[26] NCFRP 11: Truck Drayage Productivity Guide

[27] NCFRP 11: Truck Drayage Productivity Guide

[28] NCFRP 11: Truck Drayage Productivity Guide

Although technology has helped improve port access and efficiency of operations for drayage trucks, physical constraints may still exist. If roads are designed with insufficient turning radii, for example, some oversized trucks may be unable to use these routes or access facilities along these roads. Many port operators and transportation agencies have made it a priority to relieve these impediments.

Truck Parking and Staging

Densely populated areas like many port regions that accommodate large volumes of truck traffic on the highway system, have several inherent characteristics that diminish truck parking and staging capacity. These include congested roads, heavy parking activity at public rest areas and privately-owned truck stops, heavy use of the highway system among various users (automobiles, buses and trucks), and a variety of trucking activity, including long-haul and short-haul trucking, drayage to and from terminals, and local distribution and delivery. This complex and demanding pattern of roadway usage occurs against the backdrop of significant resource constraints that make it difficult to expand existing facilities or build new ones.[29] As an important aside, it is very important to keep the matter of local land use planning and control (e.g., zoning) in view and recognize municipal government as a stakeholder in addressing this issue.

To cope with these constraints, the industry is becoming increasingly adept at using technology and developing applications for truckers to identify the availability of parking spaces and even to make reservations at some facilities.[30] Fortunately, at a time when capacity expansion is fiscally constrained to such a great degree, technology advances have the potential to address some of the capacity challenge through improved operating efficiency and throughput.

There has been little or no research to measure the effectiveness of these technologies. There have been a number of studies conducted on real-time parking data collection using equipment such as digital video cameras, in-pavement detectors, or a combination of technologies to measure truck parking activity on an ongoing basis. This non-intrusive data collection is usually intended to provide real-time parking information for truck drivers in regions where parking capacity is often constrained, but the technology allows for archiving massive quantities of data and measuring parking by time of day, by season, and by any other relevant temporal distribution.[31] The FMCSA is currently developing a plan for accelerating deployment of SmartPark systems by assessing market forces, attitudes, technology, and other opportunities and barriers and promoting deployment of ITS technology to direct truck drivers to suitable parking. The American Transportation Research Institute (ATRI) has been compiling and analyzing truck parking location and duration data for its internal research efforts on behalf of its member companies.

In addition to truck staging and queuing issues, the positioning, condition and availability of chassis and containers is equally important in an efficient port operation. Many truckers believe that chassis waiting in terminal staging areas or at off-site depots should already be inspected and roadworthy. Instead, intermodal equipment providers are depending on driver discretion to discern whether a chassis is usable. Many carriers are contracting with chassis leasing companies to secure their own equipment

[29] NJTPA, North Jersey Truck Rest Stop Study

[30] FHWA, Jason's Law Truck Parking Study

[31] FHWA, Jason's Law Truck Parking Study

instead of relying on port chassis pools. Others are buying their own chassis and augmenting capacity when necessary by negotiating with smaller equipment pools.[32]

Container availability is dynamic and varies widely by region. There is generally a surplus of available containers near coastal seaports, while many hinterland regions face a deficit of this equipment. This has both a geographic and seasonal aspects due to the fluctuations in import cargo volumes and exports from domestic shippers. Larger metropolitan areas tend to be heavy import regions with fewer export industries, while key agricultural and manufacturing industries with heavy export cargo volumes are often located in the interior of the United States. While these equipment imbalances can be addressed through an ongoing repositioning of empty shipping containers, neither the container owners nor exporters have taken on that role to meet these industry demands. Because of the importance of containers to the agricultural economy, the U.S. Department of Agriculture (USDA) has developed the Ocean Shipping Container Availability Report (OSCAR) to monitor empty container availability. The weekly report shows the availability of ocean containers at 18 intermodal locations for westbound trade lanes.[33]

Truck Safety Improvements

Safety is a primary study consideration. Truck parking in inappropriate locations such as highway shoulders and interchange ramps is an inherent safety risk to motorists.

Public sector protection of worker and traveler safety extends from construction and operation of transportation infrastructure to the regulation of the manufacture and sale of equipment used for freight transportation. There are financial and operational consequences of government safety regulations. Regulations can also affect the structure of the freight transportation system by influencing the relative cost of operations between modes of transportation.[34]

Larger trucking companies are purchasing tractors with more sophisticated safety features. In addition to forward collision alerts, automated braking, lane keeping assist, stability control systems, and other active collision avoidance and mitigation systems are becoming commonplace. The industry emphasizes that these features significantly reduce the frequency and severity of crashes involving trucks.

Technology-Based Assessment of Future State of Port Truck Parking and Staging

Of the research reviewed, there was little information about technology and the future of port truck parking and staging. Most of the information gleaned from the research is focused on non-technological aspects of truck staging and parking. However, there are some indications as to what the future may hold. More information about future developments in port truck parking and staging was obtained during the stakeholder outreach process documented in subsequent chapters of this report.

[32] NCFRP 40: Improving Freight Export Logistics

[33] NCFRP 40: Improving Export Freight Logistics

[34] NCFRP 01: Public and Private Sector Interdependence in Freight Transportation Markets

ITS Applications

Intelligent Transportation Systems (ITS) have become progressively operational over the past several decades. ITS applications for truck parking and staging have been discussed briefly earlier and include items such as:

- Vehicle and cargo tracking
- Weigh in Motion technology
- Parking availability and reservation systems
- Smart Roadside Initiative

A recent FHWA/MARAD analysis includes a port technology scan, gap analysis and four business cases that can be used to provide guidance to port authorities, terminal operators, MPOs, and related stakeholders on how to best leverage FAST ACT grant programs for ITS solutions to port industry challenges. The study identifies 20 ITS technology solutions currently in place at ports, and include:

- Dedicated Short-Range Communication (DSRC)
- 3G/4G
- Wi-Fi
- Variable Message Signs (VMS)
- Highway Advisory Radio (HAR)
- Mobile Applications
- Radio Frequency Identification (RFID)
- Global Positioning System (GPS)
- Bluetooth
- Closed-Circuit TV (CCTV)
- Appointment System
- Bypass/Gate Automation/Pre-Clearance
- Weigh-in-Motion (WIM)
- Optical Character Recognition (OCR)
- License Plate Readers (LPR)
- Real-time Truck Parking and Staging
- Advanced Transportation Management Systems (ATMS)
- Queue Time Detection
- Terminal Operating System (TOS)
- Port Community System (PCS)

The technologies selected for additional analysis as part of this study include:

Port Community System (PCS): A neutral and open electronic platform providing secure electronic information exchange among all ports and logistics sector partners. It enables electronic information exchange with logistics partners via multiple methods.

Queue Detection (QD) Systems: These are designed to measure truck queue lengths and wait times at port terminal gates, and monitor turn times to allow a more even distribution of truck gate access, limiting wait times and improving efficiency of terminal operations. These systems are comprised of sensors positioned at key points approaching the terminal gates that detect when the queue exceeds a certain length or video cameras that provide a real-time view of queuing activity.

Truck Appointment System (TAS): This system is usually implemented through an online portal which enable logistics companies to book a gate appointment time at port terminals, with dedicated lanes to provide expedited entry for those truck drivers with appointments. A TAS can help ease congestion and pollution at marine terminals, reduce travel delays, improve supply chain reliability, and manage inflow and outflow of trucks at different terminals.

Advanced Transportation Management Information and Security System (ATMIS) / Freight Advanced Traveler Information Systems (FRATIS): ATMIS can improve port productivity by allowing terminal operators to monitor queues and local traffic, while informing truck drivers of necessary routing changes to reduce problems such as heavy congestion or to avoid accident areas. FRATIS can improve port and logistics companies' productivity by increasing the efficiency of truck utilization and scheduling.

Automated Trucking

Automated trucks at port facilities dispatched and coordinated from a centralized location facilitate the movement of drayage cargo. In the more distant future, an automated truck could approach the port gates at which point the operation could be assumed automatically by the central terminal for pick up or drop of its load and then released.

Per the ITS JPO,[35] automated vehicles offer several potential benefits to surface transportation system, including:

- Reducing the number of crashes caused by drivers or other conditions (e.g., weather and roadway conditions)
- Reducing aggressive driving
- Reducing travel time and improving travel time reliability
- Expanding the reach of transportation modes to disabled and older users, as well as providing "first mile, last mile" connectivity service for all users
- Increasing the efficiency and effectiveness of existing transportation systems.

The prospects for and the role of automated trucks are key research questions for this project and the subject of analysis in subsequent chapters of this report.

[35] ITS JPO, 2015-2019 ITS Strategic Plan

Chapter 4. Port Industry Stakeholder Interviews

Interview Process

The objective of the port industry stakeholder interviews was to build upon the literature research to investigate the needs of port facilities to develop and expand their parking and staging practices such as access, queueing and parking. This task involved a series of in-person and telephone interviews with port industry stakeholders to gain a further understanding of the gaps in knowledge related to port truck parking and staging. This effort also provided a first-hand look at the port operations and issues facing the port and drivers in terms of truck staging and parking. The USDOT identified the mix of ports where interviews would be conducted. A select group of ports was selected for these interviews to ensure wide geographic coverage across the U.S. and to incorporate a range of different markets and regions, with a primary focus on higher volume ports which inherently experience more truck congestion. The ports selected included the following:

- East Coast: Port of New York & New Jersey (in-person)
- East Coast: Savannah, Georgia (telephone)
- Gulf Coast: Houston, Texas (in-person)
- West Coast: Seattle/Tacoma Alliance (telephone)
- West Coast: Port of Los Angeles and Port of Long Beach (in-person)
- Inland Port: Columbus, Ohio (telephone)

The interview process for each location included initial outreach (where applicable) to the appropriate port authority to identify broad issues related to truck staging, parking, and terminal gate efficiency. This initial interview was also used to identify additional port industry stakeholders in each port region for subsequent interviews. The Ports of New York and New Jersey, Houston, Los Angeles, and Long Beach were selected for in-person interviews, while the remaining three (Port of Savannah, Seattle/Tacoma Alliance and Columbus) were conducted through phone interviews.[36]

A formal interview approach document and list of interview questions were developed and submitted as earlier deliverables for Task 3. A general list of issues discussed in the interviews included the following:

- Descriptive information about the port and region
- Strengths and weaknesses of the port as it relates to the particular industry or individual
- Current operational constraints, particularly as it relates to truck access, queuing, staging, parking and terminal congestion
- Coping strategies employed by terminal operators, carriers and shippers to address constraints
- Weaknesses and challenges across multiple industries (customers, partners, freight carriers, service providers, government agencies, etc.) that affect staging and queueing issues
- Ongoing initiatives to improve efficiency in staging, parking and terminal gate operations
- Potential strategies for implementation
- Potential for implementing technological solutions, with a focus on automated vehicle technology (either inside or outside the terminal gate)
- Decision factors used to evaluate the feasibility of improvements
- Institutional impediments to implementing improvements
- Improvements tested or implemented in the past but discontinued or eliminated from consideration
- A high-level “wish list” of ideas for each port to enhance efficiency of the port under ideal conditions

Additional input was obtained from PSA Singapore, the operating entity for the Port of Singapore. The PSA is pursuing a number of different initiatives for automation at its port terminals, and agreed to share some insights that could provide guidance for research and testing efforts in the U.S.

A recap of the interview results for each of the port regions is contained in the following sections of this chapter. A summary of general themes and highlights of the interviews is presented in the final section.

[36] A set of interviews was conducted at each of the three “in-person” ports, followed by additional telephone interviews with individuals who were not available during the period when the consultant team was traveling to that city.

Port of New York & New Jersey

The Port of New York and New Jersey (PONYNJ)[37] is the largest port on the East Coast and is ranked #3 in the U.S. after Los Angeles and Long Beach for container volume. The port handled 6.7M TEUs[38] in 2017, up 7.3 percent over 2016. Information provided by the Port Authority of New York & New Jersey (PANYNJ)[39] indicates that they are projecting 200 to 300 percent growth by 2046. There is a heavy trade imbalance here, with many containers being shipped out empty due to the huge import volumes and minimal exports. The port activity is heavily focused on the local market; it is estimated that 85 percent of the cargo shipped to this port stays within 250 miles.

The PONYNJ is centered in the largest consumer market in North America, with 127 million people living within a 36-hour drive of the main port complex. It is a major multipurpose port, with busy terminals handling bulk, breakbulk and autos. The port also sees substantial cruise ship activity. There are six container terminals in the port: five of them are west of the Hudson River, while one (Red Hook) is in Brooklyn, New York. The Port Newark/Elizabeth complex is the core area of the port, with three of the five west-of-Hudson container terminals located there.

The port has a 50-foot channel depth, and the terminals in Newark Bay and along the Arthur Kill have a 215-foot air draft since the Bayonne Bridge clearance project was recently completed.

Key Interview Feedback

Highway congestion is a big issue in the New York City (NYC) region in general, particularly on the New York side of the river. This affects landside truck operations at the terminals, but also constrains access to cargo destinations across the region. Trucks mix with general vehicular traffic on most major roads. Congestion is generally a problem on local streets in the port areas, but significant progress has been made in the last decade.

The land-to-water interface is especially critical at a busy port in a dense urban environment like the NYC region. Population density in the region also drives up real estate costs, which impacts decisions on the marine cargo operations side. Environmental justice issues are prominent at port facilities located near residential areas. A general constraint in the NYC area is that they are “shoehorning terminals into 1960s-era footprints.” In addition, a port with multiple terminals like the PONYNJ must deal with the added complexity of “disconnected” two-way moves, with a drayage truck dropping a container off at one terminal and then picking another container up at a different terminal. This system works most effectively when all the terminals have similar load management systems and operating arrangements. It is difficult,

[37] The Port of New York and New Jersey (PONYNJ) is the port district of the New York City metropolitan area. This term describes the port district in general and its various elements such as channels, berths, terminals and landside transportation infrastructure.

[38] A TEU (twenty-foot equivalent unit) is an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals. It is based on the volume of a 20-foot-long (6.1 m) intermodal container, a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains and trucks.

[39] The Port Authority of New York and New Jersey (PANYNJ) is the public operating authority for the PONYNJ port district.

for example, for a drayage trucker to meet an appointment at the “pickup” terminal if there are unforeseen delays at the “drop-off” terminal on this type of two-way trip.

The Council on Port Performance was established in the PONYNJ to address region-wide issues that affect the entire port’s competitive position. One of the early action items was the development of a single port portal system for all five west-of-Hudson container terminals. Another near-term priority was to conduct a detailed analysis of supply chain impacts of terminal and customer hours of operations. Chassis yards have been moved from the terminals to off-site locations, so terminals now have more room for their own operations.

A landlord port like the PANYNJ that must manage a complex system was seen by some as an impediment here. The PANYNJ regulations related to chassis pools are not ideal, according to terminal operators. “Corralling five different terminals is hard.”

On-dock rail was seen as an asset in general, but there may be some terminals where the loss of terminal space to an on-dock rail facility may reduce throughput for that terminal. One suggestion was to consolidate and share rail terminals the way ExpressRail operates at Port Elizabeth, with one rail terminal accessible by multiple marine terminals. It was believed that this is the most efficient on-dock rail facility because it straddles the Maher and APM terminals and is accessible to both.

Terminal gates are only open about ten hours per day Monday through Friday. This is driven mainly by customer operations at cargo destinations. Municipal ordinances limiting activity at industrial sites in urban areas also play a role. The New York-New Jersey market is dominated by small shippers; 68 percent of imports are delivered to customers who receive fewer than 500 containers per year. This comprises 87,600 shippers. The remaining 32 percent of imports are delivered to only 300 very large customers. Small customers are less flexible when it comes to hours of operation. Terminal operators are seeing extended dwell times for containers inside the gate in recent months.

Global and Maher Terminals are two of the prominent marine terminal operators in the port district. Global’s expanded terminal is heavily automated and operates on an appointment system for the busiest hours from 6:00 AM to 10:00 AM. The expanded area of Global Terminal in Bayonne is a state-of-the-art facility. The appointment system is part of an internal system that is used to manage operations inside the terminal, with stacking done for the following morning based on appointed arrivals. Global looks to manage a transaction instead of managing traffic at the gate. Their approach is: “Don’t manage queues; eliminate them.”

The PANYNJ and many of its stakeholders see expanded hours and appointment systems as their best tools to deal with port terminal congestion, along with barge operations and expanded rail volume for certain trade corridors. In addition to Global, two more terminals are expected to be using appointment systems by the end of 2018. The Port Authority is ultimately looking to implement a uniform appointment system across all container terminals. The PANYNJ has established a collective goal of 45-minute turnaround time for single loads and 60 minutes for double moves. A single-day average for Global Terminal on the day of the interview for this effort was 26.9 minutes for single moves and 53.4 minutes for double moves.

Observations at the port terminals and the surrounding region yielded some important relevant information for this study: (1) There are no pre-dawn queues at Global Terminal in Bayonne; (2) there are extensive queues at the terminals in the Port Newark/Elizabeth complex; and (3) counts taken at public

rest areas and private truck stops in the vicinity of the Port Newark/Elizabeth complex and along some of its main access highways indicate that 5 to 8 percent of the trucks parked in these facilities between 3:00 AM and 5:00 AM are drayage trucks handling marine containers.

Staging areas were not viewed favorably among most stakeholders for two major reasons: (1) the cost of real estate makes other options more attractive, and (2) so much of the cargo is local anyway, so direct deliveries are seen as more efficient. Some terminals use off-site areas for staging empty containers, though. Maher terminal has a 60-acre empty depot that complements its 460-acre main terminal.

The PANYNJ and terminal operators also did not view automated trucks in a port environment favorably; safety is a concern, and there was a consensus that humans can operate trucks in this environment more efficiently. Terminal operators see their labor agreements as the biggest institutional hurdle to automated vehicles. The Port Authority is, however, open to some automated processes for high-volume moves over short distances. They identified a possible automated guided vehicle (AGV) concept between rail and marine terminals in close proximity, with specialized vehicles towing small “trains” of 10-12 containers along a route with an embedded guidance system in the pavement.

One terminal operator saw a short-haul staging move as less attractive than an intermediate-haul “sprint train” to a rail hub like Bethlehem, Pennsylvania (about 75 miles away). There was a general sense that conducting some terminal functions such as customs clearance at off-site yards instead of at the marine terminals would be helpful. The ultimate scenario for the PONYNJ would likely be a 24-hour, seven-day operation. Until then, “better use of usable hours” is the preferred strategy.

A “gray chassis pool” was viewed as a potential huge improvement in efficiency here, but there are several institutional hurdles that would have to be addressed before it could be implemented. Under current rules, vessel operators can require a drayage trucker to either use a specific chassis to transport a container or will not reimburse the cost of the chassis to a trucker who uses another chassis. A “gray pool” concept allows any trucker picking up a load from any vessel operator at any terminal to use a chassis provided by a third-party chassis pool operator. Similarly, a “gray container pool” was mentioned by one stakeholder as one of the single greatest improvements that can be made in the industry overall. Containers are currently owned by individual vessel operators and must be returned to the same vessel operator after it is unloaded at a shipper/receiver. This process results in a large number of empty containers returning to their originating terminals even if other shippers need an empty container for an export move. A “gray pool” for containers would allow shippers using one vessel operator to load a container owned by another vessel operator if it was more convenient to pick up an empty container from a nearby location instead of having an empty container drayed all the way from the port.

Terminals have invested heavily in technology over the years, including new gate technology, optical character recognition (OCR) technology, better cameras, better software, global position systems (GPS) to locate containers, and computers in straddle carriers. One terminal operator described an optimal operation as a “conveyor belt,” with berthing activity synchronized with the number of cranes synchronized with the straddle carrier operations synchronized with the gates. The vessel activity and customer operations (and their related trucking activity) are not in the terminal’s control, so most inefficiencies are seen in these areas. Berthing capacity is generally not an issue in this port; it is the terminal gate operations that are the weak link in the “conveyor belt” model.

Options for Queuing, Staging and Technology Improvements

Options for public staging areas appeared to be limited here, due to the cost of real estate in the immediate vicinity of the core terminal areas and the higher value of this real estate for other port-related uses. In addition, there are multiple terminals at the PONYNJ in four different areas around the region (Port Newark/Elizabeth, Bayonne, Staten Island and Brooklyn). This arrangement makes it more difficult to establish a single staging area that functions as an extended operation of the marine terminal (i.e., a separate staging area would be needed for each terminal).

The Port Authority and its terminal operators are already in the process of implementing several changes to address queuing and delays at the terminals. Early indications are that the appointment system model coupled with the automated internal operations at Global Terminal are very successful at eliminating queues and addressing truck delays at that particular terminal.

Two areas of potential interest are:

- The AGV or similar short-distance shuttle operation between a marine terminal and an on-dock or near-dock rail terminal is of interest to the PANYNJ. This would function as an “inside-the-gate” operation and may provide some options for consolidating rail terminals if it can be implemented in the Port Newark/Elizabeth complex. The PANYNJ envisions a vehicle-to-infrastructure interface for the one application it is considering, but there are automated vehicle options for this.
- The NYC region may be ideally suited for an intermediate-haul “sprint train” or similar automated vehicle concept to shuttle containers not to a staging area, but to an off-site terminal located at an existing rail hub or major industrial/distribution complex. A rail shuttle to Bethlehem, Pennsylvania, was mentioned as an interesting option by one terminal operator, but an automated vehicle concept might be feasible over this route or along a route to an industrial hub 20-30 miles away such as Raritan Center or the Cranbury area at Interchange 8A of the New Jersey Turnpike.

Port of Savannah

The Port of Savannah was ranked #4 among U.S. ports by the American Association of Port Authorities (AAPA) in 2017 (4 million TEUs), and self-described as the fastest-growing port in the U.S. There are two terminals (Garden City and Ocean); the container terminal is at Garden City. The Garden City terminal has 9,700 feet of contiguous berth space and is the largest single container terminal in the U.S. at 1,200 acres. It has 22 Post-Panamax cranes and 4 Super Post-Panamax cranes, and can handle 14,000-TEU ships. The container terminal handles 12,000 truck transactions on a typical day. The completion of the Jimmy DeLoach Connector will extend a divided road all the way to the port gates from I-95; this road has helped reduce travel times along this route.

Georgia Ports (GP) estimated that the terminal is currently operating at about 50 percent of its full build-out capacity. The Savannah Harbor Expansion Project is underway; when complete, the port will have a channel depth of 47 feet at low tide. Both CSX and Norfolk Southern (NS) have on-dock rail access. There are three million square feet of warehouse space within 30 miles of the port.

Key Interview Feedback

Savannah has a number of favorable characteristics for a major North American port. The port has minimal congestion on the landside transportation network. The area surrounding Savannah is not as heavily populated as many other U.S. port cities. The port has good rail and highway access, with two Class I railroads on terminal, and I-95 and I-16 close by.

Savannah can get two-way truck moves done in less than an hour, averaging about 55 minutes as of the time this interview was conducted.

Two major weaknesses here include long dwell times for loaded containers (average 5-6 days) and chassis pool shortages due to out-of-service problems. An average tide swing of 7-8 feet presents challenges in scheduling port calls for largest vessels. In recent years, the combination of "surge discharge" from post-Panamax ships and the scheduling challenges while abiding by the hours-of-service rules for drivers has resulted in a major drayage trucking capacity crunch. The last turn of the day can be particularly challenging.

Queuing on inbound moves does not occur regularly, but lines can build up around 10:00 AM and in the early afternoon. Queuing on outbound moves can be a problem. The terminal is set up so the queue snakes around rather than working in a straight line, due to space constraints. This causes confusion and jockeying for position at the exit gates, especially when only 4 or 5 of the 12 truck lanes are open. Last-minute jockeying at the gates causes lots of collisions there. Trucking industry representatives think a linear queue would work much better here.

GP is looking at off-terminal staging options to reduce dwell times inside the terminal. Their focus is to get containers out of the terminal as quickly as possible after they are off-loaded from ships. A staging area is seen as a means of alleviating in-terminal congestion during these surges.

Major investments for operational improvements are not a priority for GP because additional capacity is available by expanding hours. The terminal is only open 12 hours per day during the week and has a shorter eight-hour day on Saturday. They believe they can expand gate hours to 24/7 if needed.

There is an on-dock rail terminal expansion ongoing that will allow for up to 1M lifts per year. Approximately 18 percent of the containers moved through Savannah are handled by rail, and Georgia Ports is projecting this to rise to 25 percent or more in the future. Atlanta is currently the largest market for Savannah (about 50 percent of the cargo). Memphis is a major target for growth. Memphis, Chicago, St. Louis, Kansas City, Columbus, and Dallas are some of the markets that can be served by Savannah with intermodal rail service.

GP is looking to reduce truck-miles traveled within the terminal. Strategies for this include consolidating reefer operations on the site, providing external information to direct trucks to the appropriate gate before they get there, and potentially eliminating personal vehicles from the terminal for safety and operating efficiency reasons; may introduce terminal bus system for employees.

In addition to the general trucking industry capacity crunch, drayage capacity is affected by the length of drayage hauls at Savannah. There is not a lot of warehouse space in the local area, so Savannah has longer drayage hauls than most ports. Savannah is the one port included in this interview process where

abiding by the FMCSA hours of service rules can have a major impact on trucking operations due to the length of the drayage hauls.

The trucking industry reported that Savannah has a well-balanced import/export mix. The industry indicated a preference for 24-hour operations here but recognized that the biggest challenge is coordinating terminal hours with shipper hours. This lack of coordination is exacerbated by the longer drayage hauls here than at most ports. The industry has seen more peaks and valleys in activity since the widening of the Panama Canal. There is a "mad dash to get the containers returned" in advance of vessel departures. One port stakeholder in Savannah pointed out that "massive boats create a lot of slack in the supply chain."

Trucking firms serving Savannah have worked hard to refine their operating models to reflect the local conditions. Most of the larger trucking firms use staging areas in various forms at Savannah. One trucking operation schedules drivers to work 10-12 hour shifts and does a lot of "slip-seating" moves.[40] Most loads are delivered 200-300 miles in one direction (Atlanta is about 250 miles away, for example), with drivers changing in the middle of the trip so they can maximize their hours of service. Another firm operates a 30-acre facility in Savannah (about 6-7 miles away from the port) that can hold 500 containers on wheels. This facility is used to deal partly with off-hour moves when the terminal is closed, but it is mainly to position export containers that must be delivered within a narrow (9-11 days) window before a vessel departure. Without this delivery window requirement, this yard could be about one-third its current size. Another firm uses a drop yard 115 miles from Savannah for Atlanta loads. This yard is used mainly for situations where there are delays at the port; it makes it easier to run loads a shorter distance rather than all the way from Atlanta, getting more turns under hours of service rules in the process.

Another well-managed trucking firm functions as a "mini-inland port" themselves. They hold loads at their facility four hours from Savannah and provide warehousing there for their customers. They make bi-directional moves with two dedicated driver crews and fleets: one fleet goes east to Savannah and back, one fleet goes west to the customer and back. Drivers leave their home terminal between 2:00 and 3:00 AM to make a trip to Savannah, and they return to the home terminal by early afternoon.

The trucking companies interviewed for Savannah try to target "drop and hook" customers to minimize turn times; this type of operation involves a 30-minute delivery time to drop a loaded container at a customer and leave it there to be unloaded, compared to having the driver spend two or more hours waiting with the container at the customer's location while it is being unloaded. Night runs to Atlanta are preferred due to heavy congestion in that metro area.

One of the complaints from the trucking industry was that free time and per-diem charges have not changed even though there are bigger surges in cargo deliveries since the Panama Canal widening was completed in 2016. They reported that marine carrier charges are rising all the time. The issue of marine carrier relationships is complicated by beneficial cargo owner (BCO) contracts; some containers can sit in the port for up to 21 days under these contracts for preferred customers.

[40] "Slip-seating" is a relay-type delivery operation where a single truck is used to transport a load from origin to destination with multiple drivers along the route. In this case, the driver who hauls the load from the port terminal drives the truck to the company's truck yard several hours away. This first driver exits the vehicle at the yard, and a second driver then takes it to the ultimate destination.

In general, the drayage trucking industry operates at the mercy of the marine carriers. Bigger vessels force drayage trucks to "run stupid" (i.e., moving bobtails or empty chassis) more often.

The cargo surges, long drayage trips, and complex marine carrier rules make it very difficult for the trucking industry to balance inbound and outbound moves. Ideally, the industry would love to have more customers open 24 hours.

The trucking industry representatives who participated in these interviews were very amenable to implementing technology. Generally, the technology focus is on safety first: forward-facing technology for braking, lane guidance, etc. Some of these firms have been using ELDs for a decade or more, and they use it for dispatching, constant reporting of drop-offs and pick-ups, and with their transportation management systems for communications.

One major limitation to the acceptance of automated truck technology was the perception that it is not ready for implementation yet, especially in the intermodal world. One company had some conversations with Peloton Technology to do a pilot for platooning,[41] but believed this is only feasible for over-the-road trucking. Intermodal trucking has several challenges that make it far from an ideal application for automated truck technology, such as the lack of standardized chassis equipment.

The logistics of chassis operations are challenging. Balancing “port chassis” vs. “company chassis” is important for some of these trucking firms. Drayage firms do not want to leave their own chassis under a container at a loading dock for days. Some drayage trucking outfits have been operating with a mix of port chassis and their own chassis for years, and they are now seeing more shippers/receivers buying their own chassis fleets to cope with a chronic chassis shortage here.

Options for Queuing, Staging and Technology Improvements

An “intermediate yard” concept might work well in Savannah due to the length of drayage hauls. The primary need here is not staging trucks to cope with terminal gate congestion, but moving the land-to-water interface some distance inland to alleviate pressure on the terminal itself and allow the drayage trucking industry to pick up and drop off loads even when the terminal gates are closed. This operation would be used to stage loads, not stage trucks – and would presumably be a wheeled operation to eliminate the need to add any container lifts to the delivery process.

Georgia Ports may be able to secure a parcel of land between the port and the interstate (about five miles down the road) to facilitate an operation like this. This off-site yard could possibly be operated with automated trucks during overnight hours, though technology hurdles and labor agreements would have to be addressed. There is a simple, direct route to the potential off-site staging yard.

Savannah has one key characteristic that makes this type of off-site operation ideal: since it is a single contiguous “common user” terminal, the off-site staging yard could effectively function as an “inside the gate” operation where the container is still under the responsibility of the terminal operator while it is in the intermediate yard. The complexity of chassis operations would have to be addressed in this scenario, due

[41] Truck platooning is the linking of two or more trucks in a convoy, using connectivity technology and automated driving support systems. It is intended to improve fuel efficiency, reduce emissions, and improve safety through automatic and coordinated braking among the multiple trucks in a platoon.

to the variety of chassis providers operating in the industry (third party pool, company fleets, shipper/receiver fleets).

Another challenge in implementing this type of off-site load staging operation for Savannah is that many of the larger trucking firms have already developed their business practices around their own off-site staging yards. A "common user" off-site staging area would effectively consolidate many of these facilities into one, and these trucking firms would have to see a value to embracing an operation that may eliminate competitive advantages they have under their current operations.

Port of Houston

The Port of Houston is the largest port on the Gulf Coast and is ranked #2 in the U.S. in terms of tonnage and #1 for foreign tonnage. The Port comprises a 25-mile complex of almost 200 private and public terminals. Annual port calls are made by 8,200 vessels and 215,000 barges, with nearly 250 million tons of cargo moving through the greater Port of Houston.

Eight public terminals are owned, operated, managed or leased by the Port of Houston Authority (POHA), including the two container terminals: Barbours Cut and Bayport. These terminals handled about 2.3 million TEUs in 2017, roughly evenly split between the two. Barbours Cut is to the north and has on-dock rail access; Bayport is to the south and does not. This is mainly a local port, with only 30 percent of the container cargo moving to/from destinations or origins outside the region. Asian cargo has grown from 0 to 30 percent of the container cargo here over the last ten years; the Panama Canal expansion and Los Angeles/Long Beach strikes have driven this, according to the POHA.

The Houston-Galveston Area Council was undertaking a Ports Area Mobility Study while this USDOT study was ongoing.

Key Interview Feedback

Highway congestion was identified as a major issue in Houston. The port's location inside the metro area makes access a challenge, particularly for upriver terminals inside the city limits. Trucks mix with general vehicular traffic on most major roads, so general congestion impacts port traffic even outside the immediate area of the port terminals. State Highway 146 (SH 146) is the major north-south route down to the two container terminals; the Texas Department of Transportation (TxDOT) has completed a number of improvements along this corridor in recent years.

Waterway congestion is a bigger problem here than most outsiders might realize, with some conflicts between container ships at mouth of the Channel and bulk ships further upstream. Channel deepening and widening is a major upcoming effort here. Some port stakeholders indicate that the Port of Houston is very well managed for safety but not for operations.

Truck queuing at port terminals is a problem that is getting attention by multiple players. First-mile/last-mile travel for trucks is a general problem in the Houston area, since these trips are often made on county or municipal roads.

TxDOT is heavily focused on ITS applications to relay congestion information, and for vehicle and train detection at highway-railroad grade crossings where truck delays are problematic (Beaumont, for example). Idling and congestion on port access roads are key concerns of TxDOT in general.

Repositioning of empty containers in the area is inefficient; this seems to be a problem at almost every port included in this interview process.

The gate operation system at the container terminals seems to be working well, with an average processing time of 25-30 minutes estimated by the POHA. POHA believes the port will slowly be moving to 24-hour operations over time. Container terminals are now open until 11:00 PM to handle plastics/polyethylene demand; this activity has been slow to materialize due to delays in new facility construction in the industry around Houston, but it is expected to pick up this year. There were no complaints from POHA about truck parking and staging needs, though queues were observed at both container terminals during visit.

The POHA is looking at the Texas A&M Transportation Institute (TTI) freight shuttle concept[42] as an alternative to extending the rail line at Barbours Cut down to Bayport, a distance of 7.2 miles. Containers off-loaded in Bayport and moving to rail destinations would be shuttled north to Barbours Cut and processed at the rail intermodal terminal there. Conceptually, this could also be extended northward to the industrial/warehouse area north of the Ship Channel; the project would be costly but would probably be less expensive than replacing/expanding the existing SH 146 bridge. The POHA's general strategic approach is: "Build assets ahead of the demand." Freight shuttle is an innovative concept that would work well in high-volume corridors between high-density origins and destinations. A fixed-guideway concept in a highway right-of-way would alleviate congestion with minimal right-of-way acquisition costs. It addresses the key limitation of automated trucks by getting the vehicle out of a congested traffic stream.

The POHA has a keen interest in on-dock rail service to Dallas. There is currently one train per week operating now, and they are looking to schedule a second train soon. At 4-5 trains per week, POHA believes the eight-hour train move can compete with a four-hour truck move in this corridor for cost.

Impediments to port-related upgrades in Houston include funding constraints tied to the structure of government in the region. Many roads are under county and municipal jurisdiction, and TxDOT cannot build projects off their network.

The current port leadership is described as extremely proactive and trucker-friendly. Improving information-sharing between vessel operators and terminal operators might be a good opportunity for improving efficiency. The Port Bureau thinks a parallel to the "captain of the port" on the highway side might help a lot, as the lack of central authority landside is an issue.

Truck industry focus is on limiting waste; eliminate waiting for bad paperwork at port terminals. The POHA and select trucking firms conducted a trial of automatic in-gating: unmanned gate with pre-clearance, and

[42] https://tti.tamu.edu/freight-shuttle/

TWIC[43] verification by camera. “Transparency using technology is key,” according to one trucking firm. Minimizing the frequency of trouble tickets is critical to a smooth operation: “Don’t send a truck until the box is cleared.” One company that participated in this trial reported 20-25 minute processing times now, compared to 45-90 minutes under the “old” system.

Trucking firms that are comfortable with technology integrate port technology into their operating systems. Electronic data interchange (EDI), which involves the direct transfer of data from one computer system to another, is used extensively by some. One company created an “EDI light” package for customers that do not currently use it. The trucking industry believes their best improvements in efficiency can be gotten through shortening transaction times and shortening the “information cycle.”

Shippers must be part of the solution to maximize the efficiency of the entire process. Many of them do not understand the role they play in the trucking capacity crunch! “The whole supply chain must tighten up,” according to one trucking industry representative.

Truckers are generally not keen on the prospect of using an appointment system, mainly due to uncertainty about what happens if they miss an appointment for reasons outside their control. Staging areas would likely be critical if this is implemented in Houston.

Moving operations nearby but outside the “TWIC area” seems to be getting some attention among some shippers. A “staging warehouse” 8-10 miles from the port was implemented by one major shipper in Freeport to handle export moves.

Bulk terminals are a big issue for congestion, since these terminals are less automated than container operations and often have a heavy seasonal variation. Grain shipments are a unique challenge in Houston. Lansing Grain has constructed an off-site staging area to accommodate truck queues. Cargill is open 24 hours/day during harvest seasons (e.g. wheat in February-April, sorghum in July-September). Cargill has no staging area but has worked with the municipality to widen one of the approach roads to the facility. Trucks park along the streets leading to the terminal for staging.

Options for Queuing, Staging and Technology Improvements

Houston faces similar limitations on public staging areas as the ones discussed previously for the Port of NY/NJ. Houston is a port that primarily serves a local market, so the added cost and lost time of a staging move limits the appeal of this type of operation here. In addition, there are lower-cost options to reduce terminal queuing and congestion available, including extended gate hours and an appointment system.

Houston does have some features that make a short-haul drayage operation potentially feasible, and has demonstrated an interest in certain applications already. The TTI freight shuttle goes beyond a traditional automated vehicle, and may be an option for movements between the POHA container terminals and other areas of concentrated industrial activity. In addition to the warehousing and distribution district north

[43] The Transportation Worker Identification Credential (TWIC) is a security initiative managed by the U.S. Department of Homeland Security and the U.S. Coast Guard. All personnel accessing secure areas at marine ports are required to have this credential, and the TWIC verification is a critical element in a marine terminal gate transaction process.

of the Ship Channel, other destinations for short-haul drayage could include rail intermodal terminals elsewhere in the Houston region.

For any automated truck or freight shuttle operation, Houston has a similar advantage as Savannah in that the POHA serves as the terminal operator for both marine container terminals. This would eliminate the complexity of an operation with a multi-terminal arrangement such as the ones in New York/New Jersey and Los Angeles/Long Beach.

Ports of Los Angeles & Long Beach

The two ports comprising the San Pedro Basin port complex are one of the busiest freight hubs in North America. The Port of Los Angeles (POLA) ranks #1 in North America in container cargo volume, followed by the Port of Long Beach (POLB) at #2. The two ports handled nearly than 17 million TEUs (loaded and empty) in 2017. Container volumes are projected to exceed 40 million TEUs by 2040. These ports handle about 40 percent of the nation's import traffic and 25 percent of the nation's export traffic.

These ports are supported by over half a billion square feet in warehousing space and serviced by 1,000 drayage trucking companies. In 2013, California's freight-dependent industries accounted for more than $700 billion in revenue and supported more than five million jobs.

The Port of Los Angeles facilities are spread over 4,300 acres of land, while the Port of Long Beach encompasses 3,200 acres. The port complex has twelve container terminals, all of which are privately operated. The complex also has an automobile terminal, dry and liquid bulk terminals, breakbulk terminals, passenger cruise terminals, and recreational marinas.

Rail transportation is a major component of the port operations at Los Angeles/Long Beach. All but one terminal has on-dock rail, with rail services provided by a local Class III railroad that uses the Alameda Corridor to connect to either the Burlington Northern Santa Fe (BNSF) or Union Pacific (UP). Approximately 25% of container movements use on-dock rail. Both ports are investing in additional on-dock rail capacity with a goal to increase on-dock container traffic substantially in the future. Approximately 7% of container movements in the complex are made to the Intermodal Container Transfer Facility (ICTF), a near-dock rail facility located within six miles and operated by UP. The Southern California International Gateway (SCIG), to be operated by BNSF, is a proposed second near-dock rail facility that is being held up by legal challenges.

Both BNSF and UP have intermodal terminals approximately twenty miles from the ports. About 11 percent of container movements are drayed between the ports and these off-dock terminals. Approximately 60 percent of container drayage moves from the ports are to destinations within approximately 20 miles, including trips to distribution facilities, transload facilities, and rail intermodal terminals.

The West Coast Marine Terminal Operator Agreement (WCMTOA), incorporating the twelve container terminals in the Ports of Los Angeles and Long Beach, is a discussion agreement filed with the Federal Maritime Commission (FMC) in 2004. The WCMTOA is the vehicle for adopting and enforcing port-wide policies to improve efficiency and reduce environmental impacts of port operations, including the PierPass® program to address issues such as congestion, security and air quality that affect multiple terminals in the two ports. The PierPass program provides for the opening of night operations at the

terminals, paid for a by a fee assessed on gate moves during the day time. Using a congestion pricing model, PierPass charges a Traffic Mitigation Fee (TMF) on weekday daytime cargo moves to incentivize cargo owners to use off-peak shifts at night and on Saturdays.

Key Interview Feedback

The Los Angeles ports are the most complex operations of any that were included in this interview process. This complexity is driven by the number of port terminals, the interaction between marine and landside transportation modes, and the sizeable transload share of the container market.

All but three of the container terminals are currently using appointments, but there is no consistency among them in how their systems operate. Service during the night shifts is reportedly not as good as during the day; turn times are higher, and there is a smaller management presence on site.

WCMTOA has developed proposed revisions to the PierPass program aimed at addressing some of the issues that have become problematic due to the success of the original PierPass program. Delays and queues occur around the transition from “pay” time to “free” time at many terminals. The WCMTOA plans to reduce the current fee but to apply it to all loaded transactions, and to have the arrival distribution of trucks controlled solely by an appointment system.

Truckers surveyed for the PierPass alternatives study expressed desire for a “single portal”, with a single appointment system covering all terminals. Some port stakeholders interviewed in this effort expressed concern about how the appointment systems would work in the new PierPass program. The primary concern involves unforeseen schedule changes, traffic congestion, the ability to reschedule appointments, and the possibility of incurring demurrage charges if an appointment cannot be scheduled in time.

The appointment system has been an improvement over the “random arrival model,” but queuing at the gates is still a problem. Of particular note is that drayage truckers need to plan at least a 25-minute buffer for an appointment. Also, the appointments generally include a 60- to 90-minute window for truck entry around the actual appointment time. Drivers that arrive and join the gate queue prior to that window create congestion at the terminal gates and delay other drivers. Terminals are now more consistently turning away those drivers, but even the process of turning them around creates congestion.

WCMTOA, the Harbor Trucking Association (HTA), and the Pacific Merchant Shipping Association (PMSA) all support the concept of a “cell phone lot,” which is the local term they use for a truck staging area. The main objective for them is to provide a place for early-arriving trucks to wait for their appointment window to open. Currently, there is no parking provided; truckers park along the roads in the port area or get on line and “park” in line.

Ports have not been willing to provide the real estate for such a facility. One port representative indicated in the interview that the queues are a problem of the truckers’ own making. That is, they choose to arrive and line up on port streets. “The queue is not the problem, it is the arrival pattern.” There is also a concern with a staging facility being used as a parking/rest area for truckers who are not waiting for their appointment window.

Abiding by the hours of service rules can make scheduling a particularly challenging issue. Even the short drays typical of this area are affected, because the rules can effectively restrict the number of loads a trucker can haul in a day.

The drayage trucking industry expressed some ideas for an ideal truck staging area in the Los Angeles area, with features such as fuel/energy (including diesel, electric charging capability, electricity for reefer units, etc.), bathrooms, chassis servicing, and food. The facility would be operated by a third-party operator through a lease arrangement with the appropriate port authority. One of the weaknesses of this model would be that it would only be viable if the port authority would be willing to accept a lower lease rate for the property than it could get for other port-related uses.

There are reportedly at least three existing container staging sites operating in the area. Shippers Transport operates one in collaboration with SSA Terminals. The use of container staging has made SSA the most efficient terminal in terms of cost per lift and lifts per acre per year. Until now, the company's value proposition has been to take advantage of the off-peak period to pick up imports and take them to its yard in Carson. This yard essentially functions as an off-site terminal.

The Harbor Performance Enhancement Project (HPEC) is a $100 million on-site container staging facility proposed for an unused 80-acre site at the Port of Los Angeles. Local trucking entrepreneur David Rosenthal has reportedly arranged hedge fund financing for the project, and environmental reviews are underway. There is reportedly some doubt about the viability of the project, related to the fact that any cargo handling on port property must be done by International Longshore and Warehouse Union (ILWU) labor. Projected to handle 3,500 truckloads per day, HPEC reportedly plans to use solar power and low or zero emission trucks to shuttle the containers from the terminals to the staging area.

The ILWU was identified as a major impediment to enhancing terminal productivity. Required breaks, scheduling limitations and resistance to automation were listed among the productivity drags with ILWU labor.

The Port of Los Angeles implemented the GE Port Optimizer / GE Information Portal software on a pilot basis at one terminal in 2017. The software takes streams of data from different sources and harmonizes them so they can all work on one platform. Each company's competitive, proprietary data is secured from view of other users of the software. The Port of Long Beach will begin its own pilot implementation at three terminals this year. The POLB application will include MatchBack systems for dual transactions and advanced/predictive analytics addressing truck congestion using GeoStamp's IOT platform. The platform increases the visibility of cargo on the vessel, from two days to two weeks.

A fully functional GE portal could provide: vessel tracking, vessel operating status (e.g. discharge activity), container tracking, container allocation (i.e. matching motor carriers with which containers), empty container management, terminal operational status (e.g., dwell time, container availability), and chassis readiness by size at each terminal.

The Ports and the container terminal operators view the increased use of "peel-off" piles as one of the means to increase terminal productivity. A "peel-off" pile is a stack of containers that are bound for the same beneficial cargo operator (BCO) or group of cooperating BCOs. Any drayage truck operator with a contract with that BCO can take any container in the pile. This allows for improved efficiency by adding flexibility to drayage truck operations and reducing container unstacking and repositioning movements for gantry cranes in the terminal. A 2015 study by the HTA indicated that the average drayage truck turn in Los Angeles took 89 minutes, which included 70 minutes inside the terminal and only 19 minutes outside the gate.

Options for Queuing, Staging and Technology Improvements

The complexity of the operations at the Ports of Los Angeles and Long Beach presents a challenge for implementing many of the potential solutions to address terminal congestion, queuing and staging. In particular, the combination of two port authorities and a dozen container terminals presents a challenge for any solution that involves the interaction of a terminal operator with an off-site staging area.

On a positive note, the volume of cargo and existing transportation constraints in the Los Angeles region make some of the proposed solutions more feasible through existing arrangements such as the WCMTOA. Technology such as the GE Port Optimizer and Information Portal is already being adopted to address these challenges, and can play an integral role in testing solutions such as off-site staging areas and autonomous trucks operating in queues at marine terminals and/or shuttling cargo to off-site terminals. The “peel-off” process used by WCMTOA could be implemented in conjunction with an off-site staging location. Since this strategy would involve a cooperative arrangement among drayage truckers and (potentially) between BCOs, it could be an ideal process for testing and introducing some form of automation.

The substantial drayage activity to rail yards outside the immediate vicinity of the port complex presents an opportunity to test an autonomous truck concept or other non-traditional shuttle similar to the inter-terminal operation under consideration at the Port of Houston.

Ports of Seattle & Tacoma

The Northwest Seaport Alliance (NWSA) is an operating partnership of the Port of Seattle and the Port of Tacoma. The NWSA ranked #5 among ports in North America for container volumes, handling nearly 3.7 million TEUs. The Puget Sound ports are well positioned for Asia trade because of their closer proximity to major Asian trading partners than the California ports to the south. Seattle-Tacoma is also a major trade gateway for Alaska, with 80 percent of Alaska’s trade with the Lower 48 states handled in these ports. If measured as a separate trading partner, Alaska would rank #4 for the NWSA ports behind China, Japan and South Korea.

Between the two ports the NWSA hosts twelve container terminals, with additional terminals for autos, bulk and breakbulk cargoes. Top imports include industrial machinery and computers, electrical machinery and electronics, and motor vehicles and vehicle parts. Top exports from the NWSA ports include grain, food products, and industrial machinery and computers.

Key Interview Feedback

The Port of Seattle has limited options for expansion due to the surrounding urban development. Tacoma has more options for expansion but has faced a long-term operational challenge because it was originally configured to mainly accommodate a maritime-rail interface, with trucks being a secondary consideration. Truck queuing on local streets is commonplace at terminals. Truck parking and staging at highway interchanges is a major problem. The Port of Tacoma is working closely with terminal operators to develop a near-site staging facility for trucks. Keeping trucks off local streets is a major priority here.

The region’s clean trucks program has placed a heavy burden on a trucking industry already stretched to the limit by the driver shortage and maintaining efficient drayage truck schedules while following the hours

of service rules. Another issue is the difficulty in finding truck storage locations around the urban area; most drayage truckers live within 20 miles of the port area but cannot take their trucks home with them.

Seattle has three main terminals: T18, T30, and T25. The primary cause of terminal congestion and queues at these facilities is the simultaneous arrivals of multiple large cargo ships. Vessel scheduling deviations are seen as a problem here; almost every port stakeholder interviewed at Seattle/Tacoma mentioned late vessel arrivals as a major issue that impacts the efficiency of their business operations.

The Husky/ITS Container Terminal is rolling out an appointment system soon. They see the ability to control truck arrival times as critical to any effort to address queues and terminal congestion. Managing truck volumes in coordination with gate operations is their preferred approach to managing congestion. Truck queues build in the morning on a regular basis, and a truck arriving at 6:00 AM can count on a wait time of at least one hour before getting to the gate. Reducing trouble tickets at the gate by improving cargo visibility and moving some parts of the gate transaction away from the terminal area were identified as two potential strategies to alleviate queues.

The NWSA is spearheading an effort to increase the use of mobile phone applications to improve information exchange and coordination between terminals and the trucking industry. Some terminal operators and transload companies are looking for ways to more accurately measure turn times and congestion. The geo-fencing approach used in Los Angeles is something they are striving for in Seattle-Tacoma.

There is a long-term need for a greater consistency of information flow across the system. Fortunately, the various stakeholders are starting to communicate better. Communication across all port stakeholders/users/operators is key to improved operations and is an essential starting point for technology implementation. Comments about the need for greater cargo visibility seem to be more frequent here than any other port involved in these interviews. There is a high level of preference for technology investments in cargo visibility than in any other part of the supply chain.

Shippers in the region see improving throughput as the top priority for the Ports of Seattle/Tacoma. There is a heightened focus on unloading containers at warehouses quickly and returning empties to the port as soon as possible. Shippers seem more receptive to the idea of off-site staging than terminal operators do; shippers are focused on terminal gate inefficiencies and truck queue times, while terminal operators seem to understand that off-site staging cannot be accommodated with their current gate configurations. The “peel-off” process described previously for Los Angeles and Long Beach is starting to get some traction in Seattle-Tacoma. The disconnect between port hours of operation and customer hours of operation is a major issue here.

Several port stakeholders identify the competitive position of this port against other U.S. ports as a major concern. Changing ocean carrier alliances make it more difficult to make long-term plans about port terminal operations. The combinations of carriers using one vessel seem to be changing frequently.

Seattle DOT identified extended roadway outages at railroad crossings as a major issue. They also identified creative truck parking arrangements under highway overpasses and in wide sections of rights-of-way as a short-term coping measure to address staging needs. There is a discussion within the city to look at temporary parking permits for the trucking industry that would be managed similar to the overweight permit system they currently use.

Non-traditional cargoes such as raw logs, lumber and paper have unique handling needs and queuing issues here and at other ports across Puget Sound on the Olympia Peninsula.

Options for Queuing, Staging and Technology Improvements

One of the major challenges in the NWSA ports is the large number of container terminals relative to the cargo volume. NWSA has the same number of container terminals as the two ports in the Los Angeles region combined, but only handles about 40 percent of the Los Angeles/Long Beach volume. The disaggregation of port terminals makes it difficult to test and implement any queuing, staging or autonomous truck solutions across the entire port. In addition, it is apparent that technology implementation for other port functions such as cargo visibility and container handling at the NWSA ports lags behind larger ports such as Los Angeles/Long Beach, New York/New Jersey, and Savannah.

With all this in mind, it appears that Seattle-Tacoma has less potential for implementing and testing staging or autonomous vehicle applications than other major ports. Seattle in particular is a very challenging environment for port operations; it has the same urban constraints as other major ports in urban areas but does not handle the same volume as most of them. In this sense, it is comparable to Houston, but without the efficiency of a single terminal operator for its container operations. Even low-technology solutions like an off-site staging area would be challenging to implement here – at least in Seattle.

Despite these limitations, the NWSA ports may offer an opportunity for testing solutions for queuing and off-site staging. This would require a limited application involving one or two port terminals in close proximity to each other, working collaboratively with a public agency (state or municipal DOT) that can serve as a mechanism for securing and developing off-site facilities for truck or load staging.

Columbus (Ohio) Inland Port

The Columbus, Ohio region has developed into a major inland port over the years due to its location and accessibility via multiple freight transportation modes. Centrally located in the Midwest, Columbus is a one-day truck drive from 45 percent of the U.S. population, 33 percent of the Canadian population, and 46 percent of the U.S. manufacturing capacity. The 25-county area surrounding Columbus comprises Foreign Trade Zone #138 – ranked #8 among 195 FTZs nationally. The region has 75 million square feet of distribution space within a few miles of the Rickenbacker Terminal and Logistics Park located just outside the city limits.

The Columbus area is served by both eastern U.S. Class I railroads (CSX and Norfolk Southern), and its rail yards accommodate a mix of domestic and marine intermodal traffic. Rail connections are available to major East and West Coast ports. CSX Columbus Intermodal Terminal handles 180,000 annual lifts, with capacity for 350,000 lifts. It is a hybrid facility with both grounded and wheeled operations. The Norfolk Southern (NS) Rickenbacker Terminal handles 260,000 annual container lifts, with room to expand; high-speed, high-capacity, state-of-the-art facility. This is a non-grounded container-on-chassis facility with automated dispatch. The average truck dwell time is less than 20 minutes.

NS is particularly well positioned in the Columbus market since the completion of the Heartland Corridor initiative in 2010. This project was aimed at improving NS connections to Chicago and Columbus from Norfolk, Virginia by raising vertical clearances to permit the operation of double-stack intermodal trains.

Columbus – and the Rickenbacker facility in particular – has tremendous potential for growth. Strong growth is projected for both air and marine cargo. It is seen as a perfect location relative to Norfolk for marine cargo, and great airside facilities for air cargo. This is a relatively uncongested region that serves as a multimodal gateway into/out of the eastern U.S. The speed of logistics process in this region is good; it is less expensive to operate here than most other places. Distribution centers are getting built as quickly as possible, with 10 million square feet of new space just in the last few years alone.

The Mid-Ohio Regional Planning Commission (MORPC) is undertaking a Rickenbacker Area Study that goes beyond transportation and incorporates energy, economic development, workforce development and land use.

Key Interview Feedback

The Ohio Department of Transportation (ODOT) and NS partnered on a USDOT Transportation Investment Generating Economic Recovery (TIGER) grant project five years ago to address highway-railroad grade crossing issues in the area of the Rickenbacker Intermodal Facility. The roadway was elevated over the railroad to provide a connection between US-23 and Rickenbacker. These improvements, in conjunction with the Heartland Corridor initiative, eliminated a bottleneck at Rickenbacker but exacerbated congestion problems on the rest of the network because it enabled NS to run longer double-stack intermodal trains to Rickenbacker. The volume of cargo moving through Rickenbacker has grown considerably since these improvements were completed, resulting in higher truck volumes on the surrounding roadway network. First-mile/last-mile truck moves are a challenge throughout the region.

Truck volumes on the Outerbelt (I-270) are also a challenge. Alum Creek Drive is the only connection between I-270 and the Rickenbacker Global Logistics Park. This interchange on I-270 has been upgraded, and ODOT has a focused interest in technology applications along this corridor (smart signals and truck platooning are options). Infrastructure for Rebuilding America (INFRA) grant money has been sought for some of these projects.

South of I-270, US-23 is a north-south route west of Rickenbacker. This roadway has intersection congestion problems. Limited east-west connections to Rickenbacker area place burden on turning moves. A new east-west road may be the ultimate solution here. Jurisdictional issues are a challenge for the Columbus region in general, with different roadway jurisdictions in freight-intensive areas of the region. Getting everyone on the same page and sharing funding for projects is not easy.

In 2016, Columbus was the winner of the USDOT's "Smart City Challenge." The Smart Columbus initiative includes several freight-oriented initiatives related to truck operations. On arterials with heavy truck traffic, vehicle detection at signalized intersections will provide extended green times for trucks to traverse an intersection during a signal phase cycle. All public roads in Ohio are now open to autonomous vehicle testing.

The Smart Columbus initiative includes fiber connecting Marysville to Columbus to Rickenbacker. Smart signal technology is also being implemented in Marysville. There is a Rickenbacker-Honda partnership in place for the Marysville plant, and NS and Honda are looking to improve efficiency for moves between these locations. Honda is mainly a marine cargo customer, but Rickenbacker handles some auto parts out of Europe to the Columbus area by air.

Ohio has a keen interest in Hyperloop technology. This technology involves the transportation of a pod through a sealed tube with minimal air resistance or friction, enabling the efficient movement of passengers and cargo at high speeds. ODOT sees a "technology revolution" underway in transportation, and believes Hyperloop will be implemented for freight before it is used for passenger travel.

Truck parking is one of the biggest issues ODOT is dealing with; this is a global issue associated with long-haul trucking, not specific to drayage at the intermodal hubs. The Ohio Trucking Association is an active, engaged industry group in Ohio but does not have a drayage-focused committee or subgroup.

The CSX Intermodal Yard is located on the west side of the city. Congestion has not been identified as a major problem there, though it does occasionally become a problem when surges of activity occur. No appointment system is used at this facility. The company has a robust online portal for shippers, with e-mail notifications to customers when intermodal trains arrive. The biggest problem for the CSX operation in Columbus is the third-party chassis pools at off-site locations. Chassis shortages are sometimes a problem on weekends; the railroad operates seven days a week, while chassis pool yards are only open five days.

One of the major impediments to efficient intermodal transportation is the unpredictable nature and frequency of situations where a container is delayed at a terminal for reasons outside the control of the terminal operator or carrier. These situations, which are referred to as "trouble tickets" in the industry, typically occur when a damaged container is reported, there is a paperwork problem, or U.S. Customs has selected a particular container for inspection. In general, CSX indicated that trouble tickets occur far less frequently at inland port locations since boxes have already cleared customs at a port of entry. The major reasons for trouble tickets at CSX are hazmat loads, damage to containers, and load shifts.

Options for Queuing, Staging and Technology Improvements

The nature of operations at an inland port like Columbus makes it difficult to separate marine traffic from domestic intermodal activity. Container volumes even at a major hub like Rickenbacker Terminal are measured in hundreds of thousands of lifts per year, compared to major marine ports where they are measured in the millions of annual TEUs. Congestion problems in these inland ports tend to be a function of background traffic across a larger region, with minimal terminal congestion that is often overshadowed by general freight activity on the regional highways and local access roads to the terminals.

Columbus does present a great opportunity for testing advanced vehicle technologies through their Smart Columbus initiatives. Part of the road network in the vicinity of Rickenbacker Terminal is already being upgraded to incorporate smart signals, signal prioritization, and potential truck platooning. Columbus could be an ideal location for testing truck platooning technology through the ITS Joint Program Office.

Port of Singapore

The Port of Singapore is one of the busiest in the world, handing nearly 31 million TEUs in 2016. Singapore is also the world's busiest transshipment port, serving as a key Asian hub for cargoes that include containers and liquid and dry bulk commodities. Singapore is involved in an ongoing initiative called the Tuas Megaport, which is being developed in stages with a goal of being one of the premier state-of-the-art automated port facilities in the world. Representatives of PSA Singapore provided

valuable insights on their various automation projects that are being tested and implemented as part of the long-term Tuas program.

Singapore's current truck automation initiatives are comprised of two main elements: (A) a truck platooning pilot test for transporting cargo between two terminals located approximately 10 kilometers (6.2 miles) apart, and (B) a longer-term automatic guided vehicle (AGV) concept with "Level 4+" automation. PSA sees AGV as the ultimate technology for truck movement at the port. The automation initiative at the port is driven by a desire to reduce PSA's heavy dependency on low-skilled foreign labor and replace many of the port job functions with high-skilled workers. As part of an early test project, PSA has deployed several automated cranes and a fleet of 30 AGVs for an inside-the-gate operation between berths at the Pasir Panjang Terminal.

Information from PSA Singapore that offers guidance for this research effort includes the following:

- One critical consideration for PSA's implementation of automated truck technology is that any technology must be fully operational in a mixed-fleet environment (i.e., automated trucks operating alongside manned vehicles).
- Along these lines, all the technology they test and introduce must have the flexibility to be introduced in stages in limited areas and/or with limited functional capability at first.
- In the short to intermediate term, the cost savings in the use of AGVs is anticipated to be tied entirely to reduced labor requirements, not enhanced productivity with AGVs processing cargo more quickly. This may change in the future as larger fleets of automated vehicles are introduced.
- Developing algorithms to prioritize AGV movements at conflict points is essential to a safe and efficient operation,
- PSA's strong collaborative relationship with business partners and labor unions is critical to successful implementation of technology. Their port worker's union sees automation as a means to "upscale" workers and expand their skills for long-term employment. Labor force reductions will be accomplished through natural attrition rather than layoffs.
- The truck platooning concept currently in testing and development will involve a dedicated fleet of vehicles with one driver leading platoons of three trucks. The effectiveness of this technology is limited under the current gate configuration at PSAs terminals, as these platooned vehicles must be processed through the same gates as regular drayage trucks. The installation of a separate "flow-through" gate system would help improve the efficiency of this operation.
- PSA uses light detection and ranging (LIDAR) technology for platooned vehicle operations. The biggest challenge they've faced with this technology involves difficulty in image processing under conditions with sun glare and heavy rain.
- The length of a truck platoon is a major physical constraint, particularly in an urban setting such as Singapore. In addition, the LIDAR technology presents some difficulties for maintaining consistent horizontal vehicle tracking along curved roadways.
- Due to the physical and operational constraints described above, PSA sees AGV technology as a more feasible development than truck platoons in the long term.

Highlights and General Themes

The port industry stakeholder interview effort of the ITS MARAD Truck Staging Study provided valuable insight into the critical issues facing maritime ports in the U.S. This interview process reinforced and supplemented the research and document review described in Chapter 3 with additional detail about operations at specific maritime ports.

The wide coverage of port interviews, both in terms of geography and range of stakeholders, pointed to a number of common themes. Each is listed below and briefly summarized and will inform the economic analyses and recommendations in later chapters of this report. This “roll-up” of themes should also prove useful for decision makers and others involved in establishing an action agenda and future research based on this study. (Note: These themes are not presented in any particular order of priority.)

The information presented in the numbered paragraphs below reflects the input received from port stakeholders through the interview process. It does not reflect the opinions of USDOT or its affiliates and is not intended to represent any formal conclusions or findings in this study.

1. **The complexity of a port operation with multiple players affects the viability of solutions.** The wide range of participants and stakeholders involved in maritime port operations exacerbates the challenge of moving cargo efficiently. A single container movement from a cargo ship to a shipper/receiver involves a shipping line and vessel operator, a terminal operator, a chassis pool operator (usually), a drayage trucking firm, and the shipper/receiver. The movement of cargo from a marine terminal to the road network outside the gate involves not just a physical process, but a transition across jurisdictional and institutional boundaries that will impact the feasibility of many technology applications. Many of the inefficiencies in the supply chain for this cargo movement are the result of a lack of coordination among the various players as well as conflicting financial interests in some of their primary functions. Many of those interviewed see progress and see promise in solutions aided by technology that establishes virtual integration as other industries have accomplished. The complexity of these multiple players cannot be viewed as an inflexible limitation on efficiency; it must be viewed as a barrier that is surmountable.
2. **Land use limitations are a constraint, especially for ports in large metropolitan areas.** For many ports, growth in port traffic has had impacts on surrounding areas. Additional land for port expansion is limited, and is expensive to obtain. Industrial land uses compete for port-related uses in most areas. In larger cities such as New York, Los Angeles, Seattle and Houston, some port facilities are situated adjacent to urban residential and commercial properties. Some port-related uses such as staging and queuing areas are land-intensive but are not considered critical to the core functions of a port by many terminal operators and port authorities. The relationship and interaction between surface transportation modes and land use are a growing area of attention for departments of transportation (DOTs), cities, counties, communities and metropolitan planning organizations (MPOs). This area of growing expertise and experience should be extended by these multimodal organizations to maritime ports.
3. **The use of automated vehicles at marine ports is likely to be limited to specific applications.** Automated and connected vehicles are receiving considerable attention from state and local transportation agencies, vehicle manufacturers and others. Many port stakeholders see these technological advances differently – at least for now. Certain aspects of port operations make it difficult to implement technologies in port trucking that are designed for over-the-road

trucking applications. The involvement of terminal operators, drayage trucking firms, chassis pool operators, and the U.S. Department of Homeland Security in port operations makes this process somewhat more complex than a typical truck delivery. Automated vehicle technologies are more feasible in a wholly contained operation within a terminal area; the interaction between internal operations at a terminal and outside-the-gate operations on public roads is particularly challenging. In addition, the wide array of players involved in a port operation make it difficult for any one player to justify the substantial investment in new technology that may benefit others along the supply chain. For the most part, port users would give greater priority to leveraging information technology for a more integrated sharing of information at every stage of the shipping process. Automated and connected vehicle applications outside the terminal gate are likely to be most feasible in locations where there is a heavy concentration of port traffic to specific nearby destinations such as rail terminals and warehouse districts. Long term this may have the greatest potential where dedicated rights of way can be targeted for moving freight using some form of automated conveyance.

4. **Port markets and metro areas are critical considerations.** The interviews underscored that ports are very much a part of the local community and the global community, and serve different markets that may be unique to a local region. Seattle-Tacoma, for example, receives ships from Asia and Canada and yet also functions daily as part of a local intermodal transportation system with all the challenges ranging from local congestion to traffic signals to parking. Savannah is a very busy port but has a unique operating environment because it is not surrounded by a major metro area; drayage trips from this port tend to be longer than elsewhere, and the trucking industry has already adopted business practices aimed at coping with the delays and lost time at port terminals. Many of these business practices such as near-port staging yards may not be feasible in a dense metropolitan area where land costs are high.
5. **Single-terminal ports and multiple-terminal ports can function very differently.** A port like Savannah with a single container terminal, or one like Houston where the port authority operates both container terminals, offers some opportunities for testing solutions for staging and queuing that are more difficult to implement in a multiple-terminal environment. The single-operator arrangement eliminates one of the institutional obstacles and competitive constraints that have been identified previously in Item #1.
6. **Targeted capacity improvements have been effective and hold great promise.** Ports have been strategic in making investments to improve efficiency and capacity. Investments in expanded gates and new gate technology, remote-controlled and automated cranes, optical character recognition (OCR) software, radio-frequency identification (RFID), and remote image inspections have had a positive impact on improving the functionality of port terminals. These have helped port terminals expand their cargo throughput within existing footprints but are not a panacea in the face of growing volumes, traffic congestion, and driver shortages.
7. **Cargo visibility is critical to efficient operations.** Many of the improvements mentioned in Item #6 rely on cargo data transparency throughout the supply chain. Some of those interviewed – particularly shippers and carriers – see a need for better data and cargo visibility through geo-fencing to better define the problem and support the measurement of useful performance characteristics for problem solving and analysis. Shippers and receivers, for example, are several steps removed from the vessel operations link in the supply chain, and therefore face challenges in coordinating their internal operations with the delivery schedules of their freight when vessel arrivals are delayed.

8. **Institutional collaborations to date have been successful.** A common theme heard from port authorities, terminal operators, drayage trucking firms is that these various port stakeholders are working more closely together in individual port regions at a high level. The establishment of partnership and collaboration can portend even greater opportunities going forward. Organizations like the Northwest Seaport Alliance are widely hailed for convening the various port stakeholders to address issues and opportunities. Organizations like the Alliance also carry out a critical advocacy and education role that is vital for the mode of transportation often not seen by many. This is an important foundation to build on, especially in relation to a more integrated approach to information technology. Port stakeholders are increasingly collaborating in an advocacy role as they see themselves as competitors with other ports.
9. **Under the right conditions, queues can be addressed through low-cost operational solutions.** Many of the stakeholders interviewed in this process identified efficient gate management, drayage truck appointments, and extended hours as low-cost solutions to port terminal congestion problems. The interviews strongly demonstrate that gate queue problems are not solvable by a single silver bullet, but by a toolbox of solutions to stretch capacity and improve turns. The improved cargo visibility described in Item #7 and the high-level institutional collaboration described in Item #8 can facilitate the operational coordination between port terminals, drayage trucking, and shippers/receivers that is critical to making these low-cost solutions work.
10. **Minimizing container lifts is critical to any strategy for addressing queuing and staging needs at port terminals.** One of the recurring themes heard at many of these ports is that inefficiencies in moving stacked containers around a facility have a ripple effect that impacts other players in the supply chain. In general, a staging operation where containers are moved to an off-site location and left on a chassis is likely to be far more efficient than one where containers are stacked a second time (after they have already been stacked at the marine terminal) before being transported to their ultimate destinations.
11. **Some public agencies are looking at the creative use of public rights of way for truck parking.** A number of public agencies have been looking for opportunities to expand truck parking capacity at rest areas and service plazas to address the growing truck parking activity on the nation's highway system. Parking associated with staging at port terminals is a unique element of this parking demand that could potentially be addressed outside traditional parking facilities for long-haul trucks. DOTs develop truck parking to assist drivers in meeting rest requirements and address safety concerns with driver fatigue; using these spaces for staging may limit parking availability for its intended safety use. Parking spaces in public rights of way can be of great importance to operators and the performance of the ports. This has been one approach to dealing with seasonal surges in queuing at grain terminals in the Port of Houston. Surrounding jurisdictions are sometimes challenged with reuse/development of blighted brownfields and other properties. This appears to be an area of promise by establishing a partnership or strategic alliance between maritime ports and their neighboring communities to target port uses where it is feasible and compatible.
12. **Advanced information technology (IT) in the transaction process can yield big dividends in efficiency improvements.** The importance of IT is a recurring theme as noted in the other items in this section. "Cargo visibility" was a prominent item of discussion, and this extends to other aspects of the cargo handling process – including chassis and containers. While the technology platforms exist to improve the efficiency of transactions such as gate security clearances, there are still a range of issues including truck operator readiness, understanding, knowledge, etc. High

tech must be addressed with high touch as so many other sectors and industries have discovered. Technology deployments must be systematic in ensuring greater alignment with user needs and capabilities. This area of challenge may be ripe for involvement of the human resources industry, training experts, and researchers.

13. **Labor agreements are a major consideration in any operational changes in a port environment.** This theme was heard in discussions at nearly every port in this interview process. The barrier between "inside the terminal" and "outside the gate" is not just a physical one. There are major institutional issues like labor agreements that drive many of the operating practices in a marine terminal, and these agreements will also be critical for any changes in these operations. PSA Singapore has an ambitious program for testing and implementing technology at the port, and the Singapore Port Workers Union (SPWU) has been a strategic partner in this effort.
14. **There is a growing importance of the DOT and MPO as partners and stakeholders.** State and large municipal DOTs are paying more attention to freight transportation issues and technology than ever before. Strategies to address queuing and staging outside a terminal gate will often require the involvement of one or more public agencies in addition to the port authority. The heightened awareness of freight issues can bode well for maritime ports, but these public agencies will need to be at the table consistently to ensure that their critical role is integral to transportation planning, project development and system operations. ITS architectures, for example, provide a good starting point for port operators and stakeholders to help the DOTs understand how to best apply these frameworks for improved port operations.
15. **Trucker sophistication will drive industry acceptance of many solutions.** The trucking industry is an integral part of our nation's freight transportation system. It is being strained by congestion, operates in a complex regulatory environment, and is often forced to cope with operating constraints that are outside its control. The improving economy will further exacerbate the chronic driver shortage the industry is facing. This is a difficult environment. One needed paradigm shift is to bring trucking firms and their drivers directly into the problem-solving process. For example, information technology deployments in other industries are vigorous in involving the users in design and testing. Trucker acceptance of technology can increase through greater involvement.

Chapter 5. Port Questionnaire

Questionnaire Process

The objective of the port questionnaire was to complement the port stakeholder interviews described in the previous chapter. This was done to investigate the needs of a broader range of port facilities for developing and expanding their parking and staging practices such as access, queueing and parking. This task involved an online questionnaire that was distributed to a set of port stakeholders with a series of general questions about queuing and terminal congestion challenges they are facing, strategies they have implemented to address these issues, and other options they are considering.

The USDOT team developed a questionnaire approach document and list of questions. Questions included the following:

- Identifying information for the questionnaire respondent
- Descriptive information about the port, region and industry
- What truck queuing, parking, and staging problems are you experiencing?
- What actions to improve truck queuing, parking and staging have you taken or are you taking that have worked?
- Conversely, what actions have not worked?
- What other actions or approaches might you consider implementing for improved truck queuing, parking, and staging?
- Has your organization conducted any research or investigation of autonomous trucks or other advanced technologies to help address these challenges? If so, what have you found?
- Do you have any other insights on this issue that could be applicable to this national research effort?

The questionnaire was developed as an online survey. A link to the survey was distributed to nearly 200 port authority representatives listed in MARAD's database of American Association of Port Authority (AAPA) representatives. Approximately 25 of the contact e-mail addresses were either no longer valid or had e-mail notifications set up to notify senders that the recipient would be absent for an extended period of time. A second attempt to reach alternative contacts was made for these, and a third set of outreach e-mail was distributed about 3 to 4 weeks after the questionnaire was posted online. In total, approximately 190 successful contacts were made in this e-mail distribution process. In several cases the respondent contacted the consultant team directly; based on the extensive response or unique issues presented.

The ports where the detailed interviews described in the previous chapter were conducted were not included in the e-mail distribution list for these questionnaires.

A total of 25 questionnaires were completed, with respondents ranging from major ports such as Virginia and Miami to small river ports along the Mississippi River. A summary of the questionnaire results and key

themes is contained in this chapter of the report. A copy of the online questionnaire is attached as Appendix B. The highlighted presented below are a summary of the questionnaire outreach process for the ITS MARAD Truck Staging Study. The information presented in the numbered paragraphs below reflects the input received from port stakeholders via the questionnaires. It does not reflect the opinions of USDOT or its affiliates and is not intended to represent any formal conclusions or findings in this study.

Highlights and General Themes

The port industry stakeholder interviews provided valuable insight into the critical issues facing maritime ports in the U.S. This questionnaire process reinforced and supplemented the document review process described in Chapter 3 and the stakeholder interviews described in Chapter 4 with additional information about issues at specific maritime ports.

Responses to the online questionnaire were provided by the following ports:

- Florence Lauderdale Port Authority
- Port of Beaumont Navigation District of Jefferson County
- PortMiami
- Massport
- Albany Port District Commission
- South Carolina Ports Authority
- Panama City Port Authority
- Port of Grays Harbor
- Port of Corpus Christi Authority
- Maryland Port Administration
- Virginia Port Authority
- America's Central Port (St. Louis)
- Port of Everett
- Hancock County Port and Harbor Commission
- PhilaPort - The Port of Philadelphia
- City of Seward
- Alabama State Port Authority
- Port of Indiana
- Port of Cleveland
- Mississippi State Port Authority
- Port of San Diego
- Alaska Railroad Corporation

- Port of Alaska (formerly the Port of Anchorage)
- Paducah-McCracken County Riverport Port Authority
- Little Rock Port Authority

The questionnaire responses identified a number of common themes and interesting, relevant observations. These themes and observations of note are listed below, and will inform the economic analyses and recommendations in later chapters of this report.

1. Nearly 65 percent of the respondents indicated that they experience some sort of difficulties with truck parking, queuing or staging, or were preparing to deal with anticipated difficulties related to terminal expansion projects. The most common problem identified was truck queuing outside terminal gates, particularly related to surge activity with vessel operations at a marine terminal.
2. One respondent indicated that truck queues are a symptom of a problem that is not best addressed through the development of staging and queuing areas on valuable port property. Improved cargo visibility and coordination of activity between various players in the supply chain would be much more effective at dealing with the problem.
3. Truck appointment systems have been implemented even at some smaller ports around the country.
4. The Virginia Port Authority (VPA) provided a detailed response to the questionnaire, with a degree of detail that is comparable to the Task 3 interview process. The three major terminals that were the focus of their response are facing congestion and queuing challenges similar to what was identified in the interviews at other major maritime ports around the U.S. One interesting item they provided was that safety issues with heavy truck activity inside a terminal gate will occasionally result in deliberate reductions in inbound gate operations to limit the number of trucks in the terminal.
5. The VPA is currently investing more than $700 million in capacity improvements at its terminals to meet a projected strong growth in cargo volumes in the next few years. The VPA was cited by several East Coast port interviewees in Task 3 of this project as a model for some of these improvements. The VPA is very aggressive about implementing strategies to maximize the throughput of their terminals. Gate hours have been gradually extended in recent years. A truck reservation system is included in its near-term upgrades, and adequate truck queuing space was identified as one of the major design considerations for its upgraded terminals. One of the challenges they are facing has been mentioned in a number of interviews: a disconnect between their gate hours and the operating hours of shippers/receivers where loads are originating or being delivered.
6. The Port of Miami has a unique challenge associated with cruise ship activity. As a major cruise ship port, the facility is served by up to 200 trucks daily, delivering provisions for cruise ships. The combination of truck activity at the cargo terminals and cruise ship terminal frequently causes congestion in and around the port.
7. The Port of Miami was recently awarded a $7M INFRA grant from USDOT to expand and modernize their gate system and install state-of-the-art technology at the terminal gates. Their goal is to reduce truck turn times by 50 percent from their current level (excess of two hours). They are also looking at a potential inland staging yard at the Miami warehouse district to alleviate terminal gate congestion.

8. The Port of Boston reported no issues with queuing at its terminal gates. They had faced a queuing problem in the past and were dealing with trucks staging on local streets. To address this issue, they developed a parking and staging area just outside the terminal gate with parking capacity for 80 trucks, and have not had a problem since then.
9. The Port of Beaumont (Texas) identified railroad grade crossings as a major bottleneck for port truck traffic. This reinforces the information provided by the Texas Department of Transportation during the Task 3 interviews. Beaumont already uses an appointment system that has been effective in managing queues and congestion. They are looking at an off-site staging yard as a short-term measure to alleviate the situation with road closures at railroad crossings.
10. Very few respondents indicated an interest in autonomous truck technology at this time. The Albany Port District Commission completed an internal review of potential autonomous truck applications but determined that the volume of cargo handled at this port would not justify the cost of implementation.
11. The South Carolina Ports Authority identified Automatic Gate System (AGS) and optical character recognition (OCR) as their most recent technological advances. This has helped reduce on-terminal staging and queuing. Their next priority is to address capacity constraints and safety issues on the public roads leading to the port.
12. The Panama City Port Authority (PCPA) does not have a major queuing or congestion issue, but even the minor one they're facing has adverse impacts on the local roadway network because of the limited queuing space at the terminal. The PCPA was the one respondent to identify that operating within the hours of service rules as a contributing factor, and suggested a near-port truck parking area as a measure to alleviate this problem with drivers who arrive at the port near the end of their service hours. They are also considering an appointment system to reduce delays related to congestion.
13. The Port of Corpus Christi is facing a queuing issue associated with deliveries to its grain terminals. They had dealt with this issue in the past by having trucks queue on a lightly-used road near the port and use a simple CB radio dispatch arrangement, but with ongoing port development this option no longer exists. They are looking at an off-site staging area to accommodate their peak seasonal demand. The Port also sees coordination between the trucking industry and port tenants as a key to successfully reducing congestion and queues.
14. The Port of Baltimore identified peak off-loading of multiple vessels as a major contributor to its truck congestion and queuing problem. Their average two-way turn time of 60 minutes increases to 90 minutes when multiple vessels are berthed. The Port has completed a number of improvements in recent years to deal with strong growth in cargo volumes, including gate expansion and technology implementation. An upgrade of their terminal operating system (TOS) is a short-term priority. They identified their current labor agreement as an impediment to some of the technology improvements they are considering.[44]
15. The Port of Philadelphia is facing problems with trucks queuing on local streets around the port. The urban density and industrial development in the surrounding area makes this a difficult issue to address. They are looking at two options for alleviating this problem: (1) closing some streets in the area during daytime hours to non-port traffic and establishing a designated "port access road"

[44] This reflects one of the themes that came up in some of the port stakeholder interviews in Task 3.

on the city's street network, and (2) developing a near-site staging area for trucks. Option (2) may be more feasible but they have had a difficult time finding a nearby parcel of land suitable for a staging operation.

16. The Port of Cleveland instituted a truck appointment system several years ago but recently terminated it because they found that trucks frequently missed appointments due to circumstances out of their control. The Port is looking to develop an off-site staging area instead, but is facing similar challenges as Philadelphia in finding a suitable parcel of land for the operation.
17. The Paducah-McCracken County Riverport Port Authority is aggressively pursuing terminal improvements to meet projected growth of cargo volumes. Some of these measures seem to be uncommon at a river port. They are incorporating truck queuing areas and an off-site staging yard in their terminal expansion plan.

One of the interesting recurring themes in these questionnaire responses was that port authorities have a good understanding of how the complex nature of freight transportation results in inefficiencies even at a very local scale. Nearly all of the respondents have embraced various technology applications and low-tech solutions to address these operational challenges, even at locations where the cargo volumes and economies of scale make short-term implementation of more costly solutions infeasible. Off-site staging locations are already in use or under development at many of these ports, and even some smaller ports are using appointment systems to manage gate congestion. Larger ports are using radio frequency identification (RFID) technology inside the gate, and in many cases have already implemented AGS technologies.

Another interesting observation of these responses was that many small ports, including river ports in the interior of the U.S., pay close attention to developments at the major maritime ports such as Los Angeles, Long Beach, and Norfolk to identify potential operational improvements that might be scaled down and applicable to a smaller port. Albany, Cleveland, Gulfport, Little Rock, Paducah-McCracken County and San Diego are examples of some smaller ports that identified an interest in researching technology applications – even unspecified ones – to address port congestion and other operational challenges.

The responses to the questionnaire are important elements of the stakeholder outreach process for the ITS MARAD Truck Staging Study. The applicability of these responses to the economic analyses and recommendations of this study generally falls into two areas:

1. For the larger ports, the information reinforces and supplements the interview results documented in Chapter 4.
2. For smaller ports, the responses provide a valuable point of comparison to identify the appropriate scales for some of the proposed measures to address truck parking, queuing and staging needs at maritime terminals.

Chapter 6. Potential Solutions

Categories of Potential Solutions

By way of review, the detailed outreach effort included a comprehensive set of interviews of industry and public sector stakeholders at a set of six select ports (Task 3) and a broader online survey conducted at various ports around the U.S. (Task 6). This outreach, coupled with the state of practice research scan conducted in Task 2, provided a set of potential solutions to address port terminal congestion and queuing issues. These solutions will be described and subjected to a preliminary screening in Chapter 6 of this report. A set of potential measures warranting a more detailed operational and economic feasibility assessment will be examined in Chapter 7.

The proposed solutions that have been subject to prior and ongoing studies in the port industry can be organized into four general categories. A single solution can provide benefits in one or more categories but has typically been proposed to primarily address problems in one category in particular. The four categories of potential solutions are:

- General measures to expand port capacity or manage demand
- Measures aimed at staging inbound (into the terminal) trucks and managing queues outside the terminal gate
- Measures aimed at addressing inside-the-gate queuing and congestion for outbound (out of the terminal) truck moves
- Measures aimed at automating the transportation process outside the terminal gate by moving cargo from the terminal to an external staging yard through automated vehicles, which may be trucks or may be innovated vehicles other than trucks (e.g., monorail or linear-induction technology)

The last category involves a highly (or even fully) automated drayage process, while the first three can include traditional “low-tech” measures as well as some degree of automation.

Feasibility Assessment and Economic Analysis Parameters

The assessment process for this study is a two-part economic feasibility analysis. The first is an operational and economic feasibility analysis of port staging technologies and practices at marine terminals, while the second is a similar evaluation of automated truck technologies and associated staging options at marine terminals. These analyses are driven by the prior research conducted in this study, along with the internal study on port technologies completed by MARAD in 2017.

Based on the description of marine terminal operations and drayage trucking operations in Chapters 1 and 2, it is evident that for any proposed solution to be workable it must be implemented with a high degree of cooperation and partnerships between public sector agencies and various private stakeholders

involved in the marine cargo transportation process. The operational feasibility of the proposed solutions was based on several key parameters, including:

- Limits of the proposed technology
- Technology implementation status (proven, new, or future technology)
- Practicality of implementation, in terms of complexity of implementation and benefits to users
- Potential future scalability
- General cost of implementation

Potential Solutions for Efficiency Improvements and Preliminary Screening

The potential solutions for screening and further analysis were organized into two groups. Group A includes port staging technologies and practices at marine terminals that generally fall under the first three bullets in the four categories on page 67. Group B includes automated truck technologies and associated staging options at marine terminals and falls under the last category in the list.

It is critical for any improvements identified here to function in a manner that is fully compatible with the terminal operating system (TOS) for the port and/or its associated terminals. The development of the TOS as a third-party operational tool has helped the industry make great strides in efficiency by consolidating various port functions such as cargo/container tracking, gate automation, interfacing between customers and terminals, billing, and appointments. Advances in cargo visibility have been the focus of much investment in technology in recent years.

Another important consideration is that any improvements must account for the contractual relationships between the various port stakeholders involved in the process of handling and transporting marine cargo. Containerized cargo operations are governed by contracts between ocean carriers, railroads, drayage trucking firms and equipment leasing companies. The Uniform Intermodal Interchange & Facilities Access Agreement (UIIA) is a standard contract that establishes the rules for interchanging equipment between the various players in the cargo handling process.[45] This document (see current version in Appendix C) covers all of the critical aspects of equipment handling by multiple carriers in the transportation process, including equipment handling procedures, provisions for interchanging equipment between parties, terminal access, liability limitations, and insurance requirements. These contracts will have major implications for any solutions proposed for further testing and implementation that involve changes in these inter-party relationships.

Group A: Port Staging Technologies and Practices at Marine Terminals

This group of potential solutions includes operating practices and technologies that have been implemented at some major ports or terminals within these ports. Some of these solutions have been

[45] Uniform Intermodal Exchange & Facilities Access Agreement (UIIA), Intermodal Association of North America (current version of this standard contract is effective 10/1/2018)

implemented successfully and are under further refinement to link them to broader efficiency improvement measures documented in MARAD's internal 2017 technology review.

Expanded gate hours have long been viewed by port authorities and transportation planners as an ideal measure to expand terminal capacity without major capital investments. The rationale for this approach is simple: there are 168 hours in a seven-day week, and most U.S. port terminals are open for only a fraction of that time. A terminal such as Bayport Terminal at the Port of Houston, for example, that is open from 7:00 AM to 7:00 PM on weekdays will typically have an 11-hour inbound gate operating window.[46] Even if this terminal is open for a short 4- to 5-hour day on Saturdays, it is still only open for about 35% of the available hours during a full seven-day week. There are a number of operational and financial challenges that must be addressed before a terminal can open for a full 24 hours, including overtime labor costs and a lack of synchronization between terminal operating hours and shipping/receiving hours for the customers who use the port. This measure requires a high degree of coordination between marine terminals, drayage trucking firms, and shippers/receivers. Financial incentivization for off-hour utilization of the terminals was critical for the success of this measure in the Ports of Los Angeles and Long Beach.

> *Screening Recommendation:* No further analysis. Expanded gate hours are not directly related to this research effort and are being implemented independently of this technology research. However, this should be recognized as a low-cost measure that may limit the appeal of other capital-intensive solutions for port stakeholders.

A **truck appointment system (TAS)** can be used by a marine terminal to limit gate queues by allocating gate entries on a reservation-only basis. This measure is similar to the way long lines disappeared from ticket windows at sports and entertainment venues with the advent of telephone and online ticket sales. The general strategy has been described by one port terminal operator as: "Don't manage the queue; eliminate it." As with the expanded gate hours, this solution requires extensive collaboration among various port stakeholders. One of the major challenges for implementation is that drayage trucks have no control over traffic conditions that may affect their ability to meet an appointment. This is exacerbated in ports with multiple terminals where a drayage carrier may be dropping a container off at one terminal and then picking one up at a second terminal. The driver may miss the appointment at the second terminal if delays are experienced at the first terminal. As implemented today, these appointment systems typically require a drayage truck to arrive at the terminal within a specific block of time that ranges from one hour at Global Container Terminal in Bayonne (with a 30-minute "grace period" at either end) to two hours in Vancouver to four hours in Los Angeles/Long Beach. Trucking industry acceptance, the establishment of efficient appointment windows that are effective in managing truck arrivals, and uniform TAS requirements for a port and/or its individual terminals is critical for successful implementation of a TAS.

> *Screening Recommendation:* No further analysis. An assessment of TAS technology was done as part of MARAD's internal technology review in 2017. An appointment system on its own is not directly related to this research effort but can be a valuable feature of an off-site parking and staging operation.

An **off-site parking and staging area** in close proximity to a port terminal is a low-tech solution that can alleviate inbound terminal queues by moving them off-site to a nearby lot. Variations of this solution have been adopted at a number of ports around the U.S., and some large drayage trucking firms operate

[46] Marine container terminals typically close their inbound gates one hour before the official closing time of the terminal, to ensure loads are processed within the terminal during the posted hours of operation.

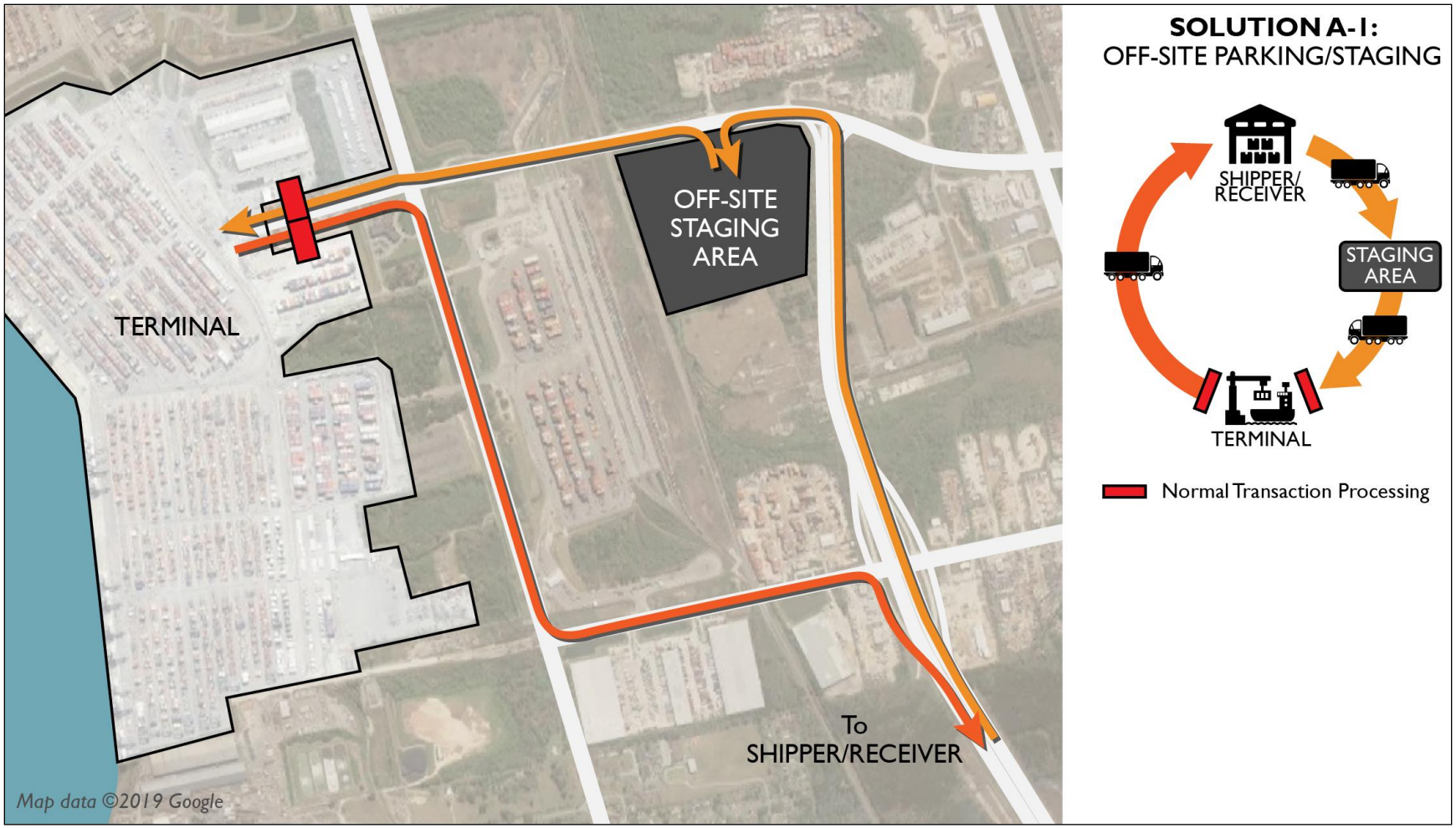
staging lots at their own facilities. This measure is relatively easy to implement and requires minimal coordination among port stakeholders once the facility is constructed and adequately marked with trailblazing signs for drayage truckers who may not be familiar with the area. An added benefit of such a parking area is that for many ports it can effectively complement parallel efforts by the FHWA and its industry partners to address the chronic truck parking shortage on much of the National Highway System. The stakeholder interviews in this effort suggest that an off-site parking and staging area may be most suitable for port terminals handling bulk cargo with heavy seasonal peaking characteristics where the parking area simply alleviates the impact of an occasional surge of activity that overwhelms the normal terminal operation. This solution is identified as Solution A-1 in the remainder of this report and illustrated in Figure 8.

Screening Recommendation: Advance for further analysis.

The combination of an **off-site parking and staging area** and a **TAS** addresses one of the primary weaknesses of a standalone off-site parking and staging area. A parking and staging area without any other technological or operational features is essentially a relocation of an on-street queue from a terminal gate to a nearby location. A TAS, combined with the ongoing advances in information technology and cargo visibility documented in the 2017 MARAD port technology review, can turn a simple parking and staging area into a powerful terminal management tool. Rather than serve to simply relocate a terminal gate queue, the parking and staging area becomes a nearby gathering place where drayage truckers who already have an appointment can park near a terminal (or group of terminals) for short periods of time that roughly coincide with the one- to four-hour appointment windows. The function of this facility would be similar to a “cell phone lot” used at some airports to provide short-term parking for motorists arriving to pick up passengers on arriving flights.

While this solution offers promising benefits for the drayage trucking industry and for marine cargo supply chains in general as a result of the enhanced productivity and increased port terminal throughput that are realized through the implementation of a TAS, a detailed analysis of this solution would be redundant with the 2017 study and potentially misleading results when coupled with an off-site parking and staging area. The 2017 study indicated that TAS technologies are being advanced independently of any added considerations of an off-site parking and staging area and adding the substantial land acquisition and construction costs of the parking and staging area to this ITS solution may appear to diminish the value of the TAS technologies in a benefit-cost calculation.

Screening Recommendation: No further analysis. The costs and benefits of this solution are likely to be comparable to the off-site parking and staging area with a virtual gate, as documented below.



Source: MARAD, 2019

Figure 8. Off-Site Parking and Staging Area (Solution A-1)

An **off-site parking and staging area with a "virtual gate"** offers an opportunity for added operational efficiency and a possible further alleviation of terminal congestion. A modern entry gate at a container terminal is usually designed as a two-stage process. The first stage includes a validation of the transaction, verification of the identity of the driver and the trucking firm, and confirmation that the load is ready to be delivered or picked up. Most of this transaction is conducted electronically. The second step is the actual entry into the terminal, where the equipment is inspected and the driver receives instructions on where to pick up or drop off a container within the terminal. This two-step process allows credentialing or other paperwork problems to be identified before the truck arrives at the main terminal gate. A "virtual gate" at an off-site parking and staging area may offer an opportunity for this first step of the process to be completed before the truck arrives in the immediate vicinity of the terminal. There are obviously logistical and legal issues that would have to be addressed to ensure that the transaction is conducted seamlessly, and all security protocols and contractual requirements are met. This measure may be most effective at a multi-terminal port where it may be possible for the terminal operators to enjoy some economies of scale in the first-stage transaction process by consolidating the operations at a single location that serves multiple terminals. This solution is identified as Solution A-2 in the remainder of this report and illustrated in Figure 9.

Screening Recommendation: Advance for further analysis.

A number of port industry stakeholders identified a **"gray box" (or "neutral") container system** as one of the most effective measures for improving port efficiency. Shipping containers are owned by the ocean carriers under current port operations, and a shipper contracting with an ocean carrier to transport a containerized load must use a container owned by that carrier. This rigid requirement in an age of increasing flexibility and delivery efficiency needs for shippers often results in inefficient moves by drayage carriers. Suppose a drayage trucking firm is dropping off a loaded container from Ocean Carrier A at a warehouse for Customer X located 25 miles away and is tasked with returning an empty container from that same customer to the same ocean carrier at the port. Customer Y is located next door to Customer X and needs an empty container for an export shipment. If Customer Y is using the same Ocean Carrier A to carry the export cargo, then the drayage trucker can simply move the empty container from Customer X to Customer Y before delivering it back to the port after it is loaded by Customer Y. However, if Customer Y is using Ocean Carrier B to carry the export cargo, then the drayage trucker must first bring the empty "A" container from Customer X back to the port, pick up an empty "B" container from Ocean Carrier B (which may even operate out of a different terminal), and return that empty container to Customer Y. In a "gray box" system, the containers would be owned by third parties (similar to the chassis pool operators described previously) and could be freely interchanged between different ocean carriers and their respective customers. The shipping industry has done a number of studies on this subject over the years. A 2017 report on the subject indicated that ocean carriers spend $20 billion every year moving empty containers back to exporting countries, and some experts see this neutral container concept as a way to reduce the costs associated with moving the empties.[47] This practice would have similar benefit of reducing empty landside container movements as well.

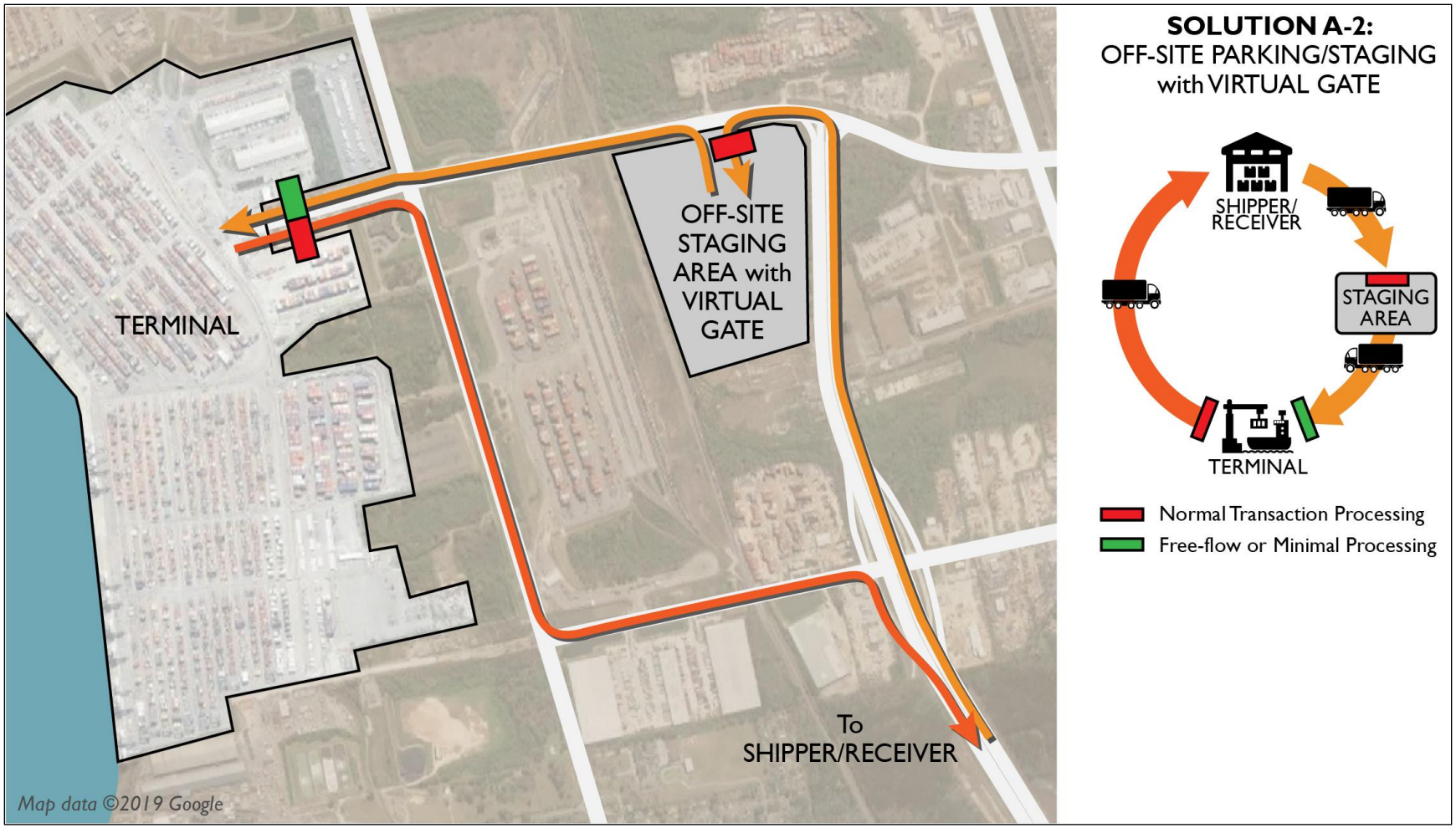
Screening Recommendation: No further analysis. This is beyond the scope of this study and will likely be implemented (or not) without any consideration of the staging and queuing issues identified here.

[47] *Forward With Toll*, "Neutral Containers – A Grey Area for Containers?", 4/20/2017, https://www.fwd.news/neutral-containers-grey-area-carriers/ (retrieved 11/9/2018)

The proposed alternative container system described above is similar to the ongoing changes that have been seen in the port industry with **modified chassis pool operations** over time. Third party container pools have replaced the ocean carrier-owned pools at many U.S. ports, and chassis owned by drayage trucking firms are becoming more common as well. This solution for improving port efficiency does not directly relate to this study but does have important implications for some of the automated truck concepts that will be discussed later.

> *Screening Recommendation:* No further analysis. This is beyond the scope of this study but is an important consideration for the automated truck operations included in the next section of this report.

The port stakeholder outreach process for this project provided valuable insight on industry receptivity to a number of **other technology applications** to address staging and queuing inefficiencies at port terminals. Most of these were listed among the ITS solutions documented in MARAD's internal 2017 port technology study. No further analyses of these solutions will be done in this study, but those that are integral to the implementation of any solutions examined here will be highlighted in later sections of this report.



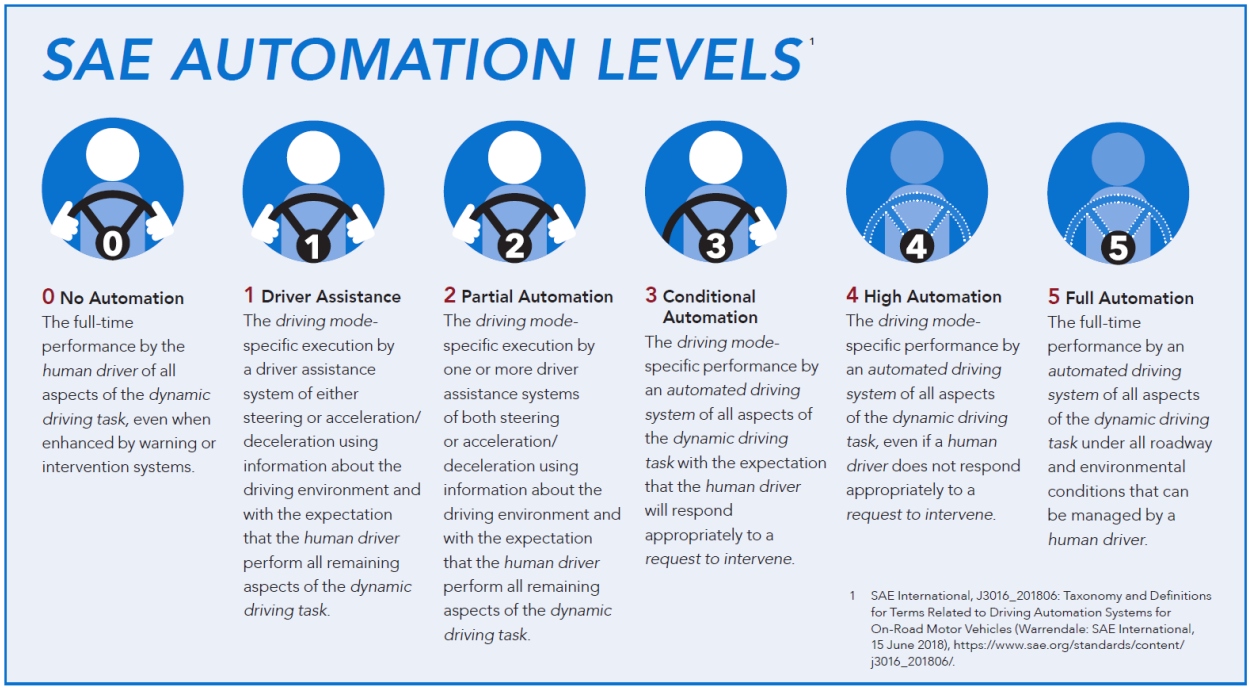
Source: MARAD, 2019

Figure 9. Off-Site Parking and Staging Area with Virtual Gate (Solution A-2)

Group B: Automated Truck Technologies

One of the key outcomes of this study was an assessment of automated trucks in a port environment to potentially improve the efficiency of the queuing process and improve productivity for drayage truck drivers. The improved productivity would be gained by drivers who can exit the cab of the truck and assume an "On-Duty, Not Driving" status under the Level 4 automation as defined in SAE J3016.[48]

To recap the information presented in the *State of Practice Research Scan Report* completed in Task 2 of this project, Figure 10 shows the six levels of vehicle automation as defined by SAE and adopted by the U.S. Department of Transportation. As described in the Task 2 report, a Level 4 automated vehicle would typically require a driver to monitor the vehicle under normal operations on a public roadway and take control of it if necessary. But when operating at low speeds in a controlled environment such as a port terminal, it is conceivable that the driver could exit the vehicle while the drayage truck makes its way through the port, and then return to the truck when it is ready to leave the port to enter the public road network and complete the drayage delivery trip.



Source: National Highway Traffic Safety Administration (NHTSA)

Figure 10. SAE Taxonomy of Automation Levels

The vehicle and process described above is an **automated Level 4 truck in queue**. This solution offers an intriguing opportunity for advancing automated truck research and development in a controlled environment but presents a number of operational and jurisdictional challenges for implementation. The automated cargo handling process is technologically feasible, as evidenced by the various stages

[48] The driver can also assume an "Off Duty" status, but from a productivity standpoint under current FMCSA HOS rules there is no distinction between "Off Duty" and "On-Duty, Not Driving" unless the driver remains off duty for ten consecutive hours.

of implementation for automated guided vehicles (AGVs) in major ports such as Yangshan (China), Singapore, and Rotterdam. In the context of this USDOT study, an important distinction of these technologies is that they involve inside-the-gate operations in a controlled environment. The introduction of Level 4 automation into the drayage trucking process has a multitude of challenges. These include the following:

(a) The drayage trucking process is inherently inefficient for reasons that are outside the industry's control. As an intermediary between a shipper/receiver and the ocean carrier contracted to move its cargo, the drayage trucker is often forced to cope with conflicting schedules, priorities, and operating environments. Automating a single process within a larger supply chain with several other inefficient steps may not be the most effective approach to streamlining the process. The level of precision required to automate this one process may make the automation of the drayage truck the equivalent of using a stopwatch calibrated to the nearest thousandth of a second to measure time in a subprocess when the overall process is measured in hours.

(b) The complexity of the port terminal process – particularly as it relates to drayage trucking activity – presents a daunting challenge for automation. The steps illustrated in Figures 3 through 5 must be completed at some point in the terminal process for a drayage truck even if one major element of the pick-up or drop-off process is automated. In addition, an automated inside-the-gate operation will have to account for the eight combinations of the entry-exit transactions described in Figure 6.

(c) The standard contracts used to govern the drayage process will likely require some revisions to account for a new operation where the relationship between a terminal operator and a drayage trucking firm changes. The UIIA described earlier in this chapter would be an important consideration in an automated truck operation. Importantly, there are a number of potential legal considerations and insurance issues that must be addressed when a driver leaves an automated truck that is then operating within a terminal environment without any driver control or supervision. For example, cargo handling agreements typically include specific provisions that outline the responsibility of the drayage trucking firm for the cargo while the cargo is being carried by the truck. The elimination of the driver from a step in this handling process removes an individual who might be in a position to identify a cargo loading or handling problem immediately. The marine terminal operator may be required to take on more reporting obligations and liability for the truck and load during the period when there is no driver operating the truck within the terminal.

(d) Another example of contractual arrangements that may require some scrutiny is the detailed description of responsibilities in these contracts for an extensive range of elements of container and chassis equipment such as container doors, latches, tires, brakes, mud flaps, and electrical wiring. These contracts typically require some form of visual or audible inspection of these various elements by the drayage truck operator before departing from the terminal. The inspection process would have to be scrutinized closely to determine if it can be done without direct human involvement, or could be done at a point in the process where the human driver is prepared to return to the vehicle to leave the terminal. This will have important implications for both the cargo handling process and the outbound terminal gate layout.

(e) Automated drayage trucks as a stand-alone solution may have limited impacts on overall port efficiency. The ambitious program for automation and truck platooning underway at the Port of Singapore is predicated on labor savings from reduced manpower requirements with automated and platooned vehicles, not an operation that is faster or more precise than one controlled by

humans. Increasing the overall throughput of a port facility may require the automation of multiple steps in the cargo handling process. The Qingdao New Qianwan Container Terminal (QQCTN) in China, which laid claim to implementing the first fully automated terminal in Asia, reported a 30% improvement in efficiency through the implementation of automated cranes and automated guided vehicles (AGVs) that operate within the terminal area.[49]

(f) The current FMCSA hours of service rules may limit the productivity improvements that an automated truck in queue can offer to the drayage industry. The primary characteristic of a Level 4 automated truck in this environment is that it enables the driver to exit the vehicle while the terminal gate transaction and the loading/unloading process is completed inside the gate while the truck is in driverless mode. Current FMCSA rules allow drivers to operate a truck for 11 hours within a 14-hour "On Duty" window that must be followed by a minimum 10-hour rest period. The gate transaction and loading/unloading process for a drayage truck may range from 20 minutes to several hours, depending on complications in the paperwork and marine terminal processes. This means the productivity improvement will be a function of allowing the driver to recapture some of the 11-hour driving time within that 14-hour "On Duty" window. While this could certainly improve productivity by enabling a driver to complete more turns in a day, there will be almost no benefit at all in the vast majority of cases where the primary constraint on the number of turns is not the FMCSA HOS rules, but the operating hours of the port terminals or shippers/receivers. In the Houston case, for example, a driver whose 11 driving hours can be extended to 12, 13 or 14 hours in an "On Duty" window will not see any improvement in productivity if the terminal gates are only open for 11 hours of the day. At best, a Level 4 automated operation may enable a driver to complete one extra "half-turn" at the end of the day when the driver's last load has been moved out of the terminal and the customer is an hour or two away.

(g) This disconnect between terminal hours of operation and the FMCSA HOS rules also shows one of the underlying weaknesses in a drayage truck automation strategy. In order for such a solution to work most effectively, it will also be necessary to make other changes in terminal operations (extended gate hours, for example) that will usually have an independent value of their own – and may even eliminate the queuing problem at terminal gates entirely.

(h) Drayage trucking is a highly fragmented industry. A typical port is served by a multitude of drayage trucking firms conducting business with a combination of employee drivers in company vehicles and owner-operators working as contractors. Automating vehicles in this environment will likely be even more challenging than the "clean trucks" standards adopted over the years by some major ports. Those regulations involved modifications to powertrains and trucks but involved no other changes to vehicle operations and contract terms within the transportation industry.

(i) The drayage business is highly competitive and operates with low profit margins, so capital investments in new automated equipment will have major cost implications for the industry.

(j) The ownership/management model of the container chassis in the drayage process will likely have to change. Automation of truck operations will require chassis to be seamlessly compatible with automated tractors for functions involving container loading/unloading, braking, and following distance. Automated trucks will likely require dedicated fleets of chassis owned by drayage trucking firms, not third-party chassis pool operators.

[49] *Port Technology*, "Asia Enters Fully Automated Terminal Era", 5/15/2017, https://www.porttechnology.org/news/asia_enters_fully_automated_terminal_era (retrieved 1/18/2019)

(k) Larger trucking firms interviewed for this study indicated that they see automation and platooning for over-the-road trucking as more promising technology applications in the near future. They cited many of the complexities described here to reinforce this view.

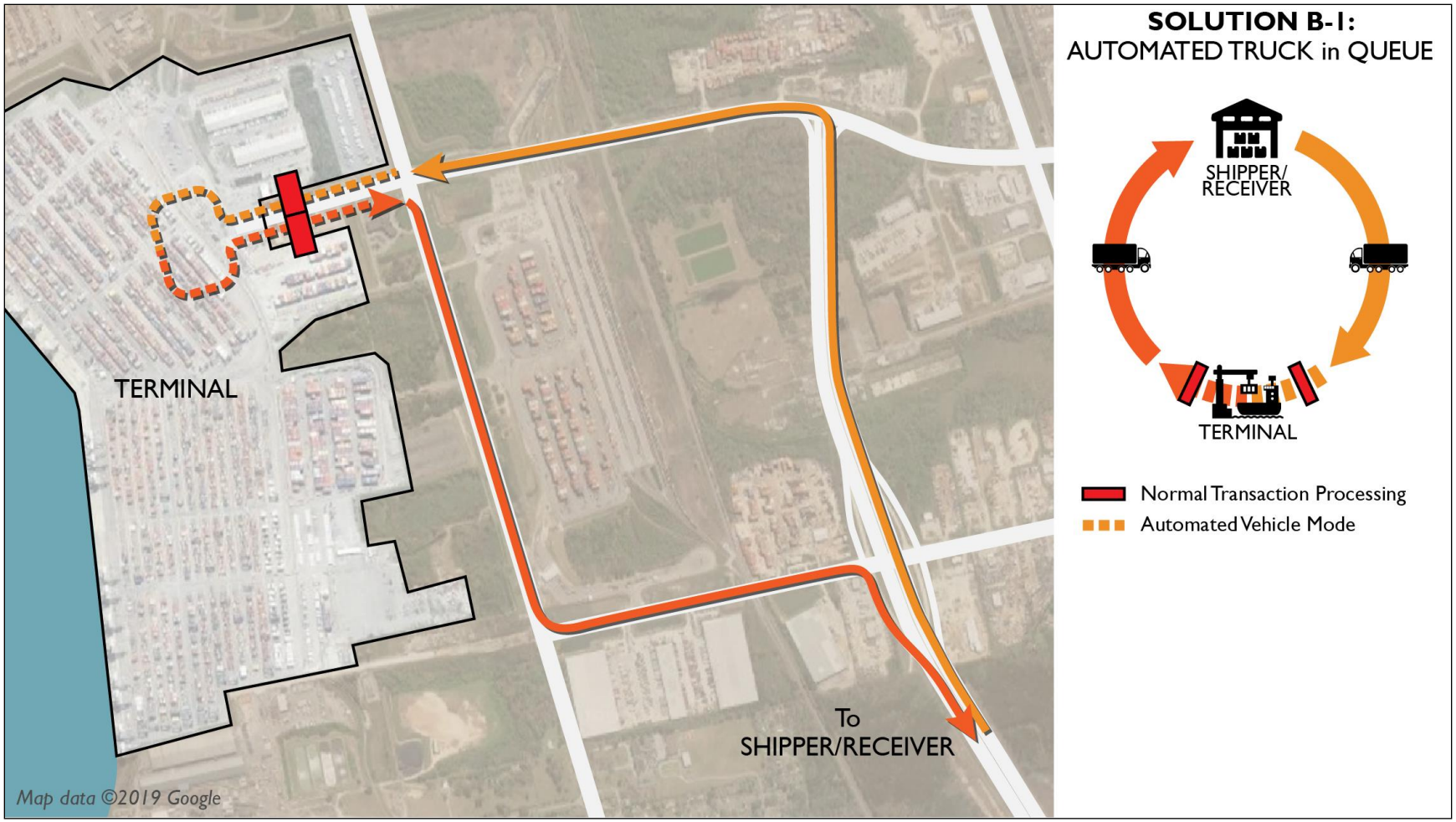
Despite these challenges, there are prospects for the research and testing of automated Level 4 trucks in queue. The on-board truck technology will be no different than what is already under development by truck manufacturers, and the benefits could be tangible even if they are difficult to quantify. Additionally, an operation in a controlled environment inside a terminal gate will not have the safety concerns associated with automated vehicles operating in mixed traffic on a public roadway system. This solution is identified as Solution B-1 in the remainder of this report and illustrated in Figure 11.

Screening Recommendation: Advance for further analysis.

A potential enhancement of the automated Level 4 truck in queue described above is a modification of the terminal gate operation process that combines the **automated Level 4 truck in queue** with an **off-site staging area**. Many of the challenges described for the automated truck in queue are a function of the limits on productivity improvements that can be realized when even a highly automated transaction process still requires an interchange of cargo between the terminal and the drayage trucking firm at the terminal gate. This limitation could be partially overcome if the transaction takes place away from the terminal gate and involves a staging step that enables drayage trucks to pick up and drop off cargo away from the port terminal. Such an operation would be similar to the off-site parking and staging area with a "virtual gate" described in Group A, but with the staging-to-terminal movement (and vice versa) done with an automated Level 4 truck that is different than the one hauling the load to or from the terminal. This operation would be a load staging area, not a truck staging area.[50]

When a drayage firm makes an appointment to pick up a load at the port terminal through the TAS previously, an order would be sent to the terminal operator to transport the load from the container stacks in the port to an off-site yard where it would wait for the drayage truck to come and retrieve it. The movement between the terminal and the staging area would be a shuttle operation conducted by the terminal operator, not the drayage truck. The truck would arrive in a bobtail configuration because the container will be loaded on a chassis in the staging yard. The staging yard would be a "wheeled" container facility, not a "stacked" facility. This will enable the staging activity to be done without any additional container lifts that would reduce the efficiency of the process. The entire gate transaction between the terminal and the drayage trucking firm would take place at the off-site staging yard, not at the marine terminal gate. Since the automated leg of the operation is conducted by the terminal operator instead of the drayage trucking firm, some of the legal and contractual issues identified for the automated truck in queue described in the prior solution may not apply.

[50] The Harbor Performance Enhancement Center (HPEC) that has been proposed at the Port of Los Angeles is one potential application of this "load staging" concept.



Source: MARAD, 2019

Figure 11. Automated Truck in Queue (Solution B-1)

In this solution, the automated leg of the haul effectively operates as an advanced variation of Stage 1 in the two-stage drayage haul illustrated in Figure 7. Whereas that figure illustrates a business practice carried out by trucking firms using their own facilities, this solution would involve a common cargo staging area open to all drayage firms conducting business at a port or terminal. This solution is identified as Solution B-2 in the remainder of this report and illustrated in Figure 12.

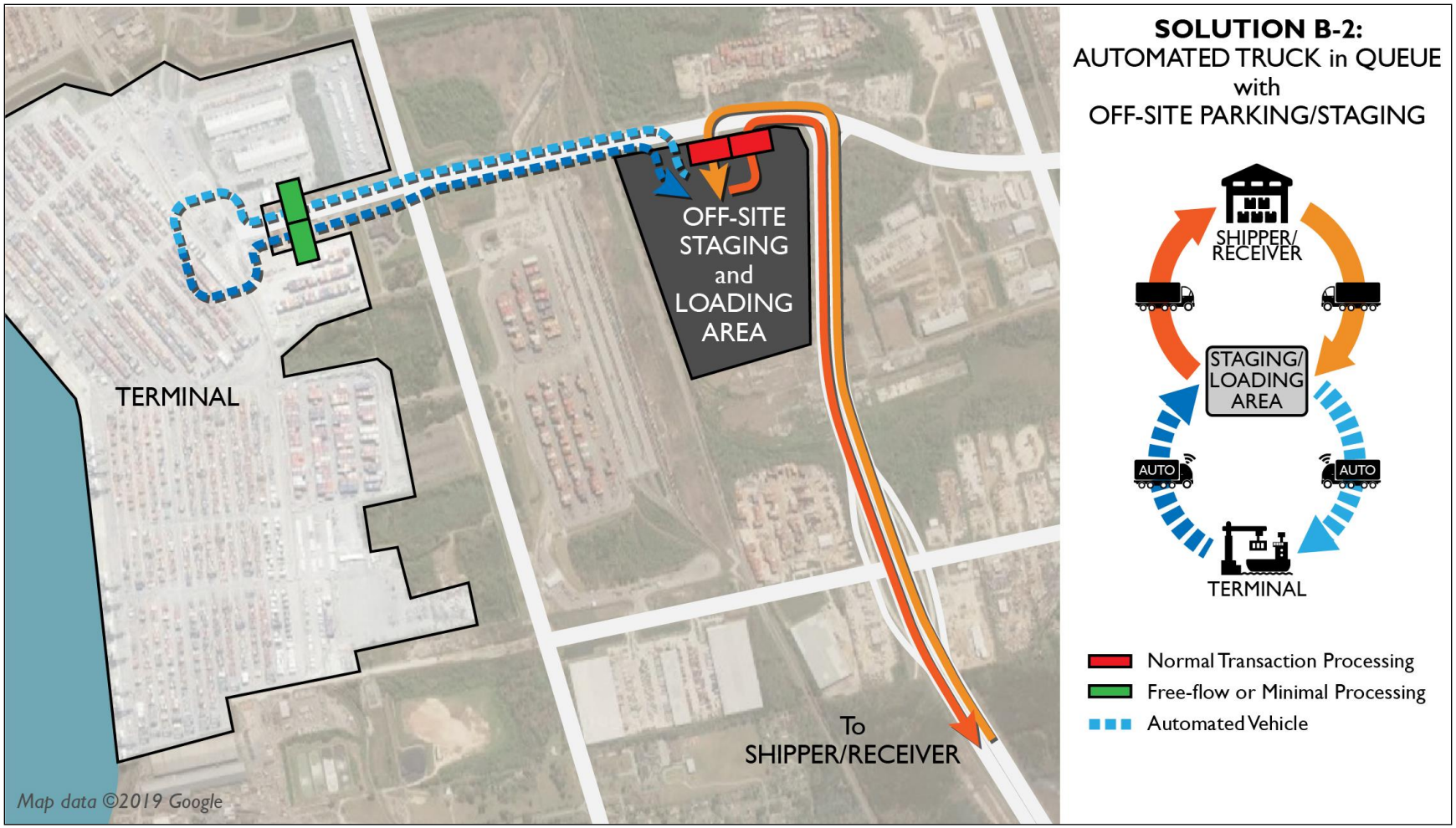
Screening Recommendation: Advance for further analysis.

The automated truck shuttle described above would be suited for an operation between a marine terminal and a nearby off-site staging area. This concept can be further developed to provide more robust shuttle services over longer distances between a port and a major inland freight hub. Beyond a certain distance, a fixed-guideway system would likely become a more efficient alternative than a truck shuttle for large volumes of freight. This **alternative transport mode to and from off-site staging** could be as simple as a "sprint train" operating as an intermodal rail shuttle to an inland port 25-50 miles away, or a more advanced technology such as the Freight Shuttle prototype that has been developed by the Texas A&M Transportation Institute (TTI).[51] The Freight Shuttle uses linear-induction propulsion to operate in an elevated configuration in a highway right-of-way to alleviate congestion with minimal right-of-way acquisition costs. It addresses the key limitation of automated trucks by getting the vehicle out of a congested traffic stream. These alternative transport modes to off-site staging areas are beyond the scope of this study but represent an additional option for addressing terminal delays and queues.

Screening Recommendation: No further analysis.

The economic analyses of those solutions screened for further examination is contained in Chapter 7 of this study. A generic economic analysis will be done for each of the four solutions from Groups A and B proposed for further assessment, along with a sensitivity analysis using four common "prototypes" of port environments. A table documenting the solutions examined in Chapter 6 and the scenarios for the economic analysis is included in Appendix D of this report.

[51] https://tti.tamu.edu/freight-shuttle/ (retrieved 11/28/2018)



Source: MARAD, 2019

Figure 12. Automated Truck in Queue with Off-Site Parking and Staging (Solution B-2)

Chapter 7. Feasibility Analysis of Screened Solutions

Operational Feasibility

Four of the potential solutions documented in Chapter 6 were selected for further analysis. The operational feasibility of each solution has been addressed in the descriptions provided in the previous chapter. Each potential solution is operationally feasible, with some possible practical limitations of the standalone automated Level 4 truck in queue (Solution B-1). For the economic feasibility analysis, the four solutions advanced to this step of the screening process are as follows:

- Solution A-1: Off-site staging area
- Solution A-2: Off-site staging area with a "virtual gate"
- Solution B-1: Automated Level 4 truck in queue
- Solution B-2: Automated Level 4 truck in queue with off-site staging area

Economic Feasibility: Introduction

The economic analyses include monetized benefits and costs as measured through a benefits-cost analysis, along with additional benefits that are not measured but identified qualitatively. To the extent possible, the approach in this study mirrors the methodology outlined in MARAD's internal 2017 port technology assessment.

Each of the four of the potential solutions was analyzed in five port configurations or "scenarios." The economic analysis includes one base scenario with a generic port with terminals and then four additional scenarios corresponding to representative ports in actual port environments. The five cases are:

- A generic or baseline port scenario with parameters similar to the scenario presented in the 2017 analysis. Variables, unit measurements, model assumptions and calculated values for this port are listed in Table 6.
- A port in a major urban area serving primarily a local market (e.g., New York/New Jersey)
- A port in a major urban area with a local and hinterland market (e.g., Los Angeles, Seattle)
- A port in a minor urban area with a predominantly hinterland market (e.g., Savannah)
- An inland port (e.g., Columbus)

Table 6. Economic Analysis Parameters for a Generic Port

Measurement	Unit	Value	Source
Container Lifts	lifts/year	365,000	Model assumption
Annualization Factor	days/year	250	
Daily Container Lifts	lifts/day	1,460	Calculated
Lifts per Truck Move	lifts/truck	1.7	Model assumption
Daily Truck Moves	trucks/day	859	Calculated
Port Hours of Operation	hours/day	11	Model assumption
Hourly Truck Moves	trucks/hour	78.1	Calculated
Truck Fleet Size	trucks	292	Model assumption[52]
Average Wait Time	hours/truck	0.3	Model assumption
Average Loading Time	hours/truck	0.6	
Average Haul Length	miles	30	
Average Travel Speed	mph	25.0	
Total In-Terminal Turn Time	hours/truck	0.9	Calculated
Average Trucks Processing	trucks	23.4	Calculated (78.1 x 0.3)
Average Arrival Window	hours	3	Model assumption
Maximum Parking Demand	trucks	47	Calculated [23.4 x (3-1)]
Land Area for Truck Parking	acres/space	0.1	Model assumption[53]
Land Cost	$/acre	$250,000	CBRE[54]
Truck Parking Capital Cost	$/space	$10,000	Model assumption
Truck Parking Maintenance Cost	$/space/year	$400	4% of capital cost
Amortization (Land/Improvements)	years	25	Model assumption
Amortization (Equipment)	years	5	
Discount Rate	Annual %	3%-7%	
Truck Driver Value of Time	$/hour	$28.60	USDOT[55]
Gallons per Fuel Used, Idling	gallons/hour	0.64	U.S. Dept. of Energy[56]

[52] Ratio of 1 truck serving a port for every 1,250 annual lifts assumed, based on estimate calculated using PANYNJ data for 2017. This ratio is scaled accordingly for the four analysis scenarios.

[53] Based on average 10 spaces per acre from prior truck parking studies. Average area includes parking spaces, drive aisles, access roads and landscaping.

[54] "Pay Dirt: Industrial Land Prices Rise Sharply (U.S. MarketFlash)," CBRE (12/20/2017). Average national price for "Urban Infill Last-Mile Sites" used here, with these specific metro-area rates for the four scenarios: Major Urban/Local $1.75M (NY/NJ), Major Urban/Hinterland $980,000 (Los Angeles), Minor Urban/Hinterland $195,000 (Houston), and Inland Port $105,000 (Kansas City).

[55] *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, USDOT (June 2018)

[56] Argonne National Laboratory and Clean Cities (U.S. Department of Energy), "Idling Reduction Savings Calculator"

Measurement	Unit	Value	Source
Fuel Price, Net of Taxes	$/gallon	$2.11	U.S. Dept. of Energy[57]
Automated Truck Cost	$/truck	$35,000	Model assumption[58]
Automated Truck Maintenance Cost	$/truck/year	$1,750	5% of capital cost
Truck Emissions Base	model year	2010 (100%)	Model assumption
Idling Emissions: HC	tons/1000 hr.	0.000507	SmartWay DrayFLEET® model, U.S. Environmental Protection Agency
Idling Emissions: NO_x	tons/1000 hr.	0.006239	
Idling Emissions: CO_2	tons/1000 hr.	1.085775	
Idling Emissions: PM2.5	tons/1000 hr.	0.000209	
Social Cost: HC	$/1000 hr.	$0.97	Calculated based on SmartWay DrayFLEET® model, with per-ton social cost 2010 base values inflated to 2017
Social Cost: NO_x	$/1000 hr.	$46.84	
Social Cost: CO_2	$/1000 hr.	$26.77	
Social Cost: PM2.5	$/1000 hr.	$71.93	
Total Unit Social Cost (Emissions)	$/1000 hr.	$146.51	Calculated
Annual Hours Waiting + Loading	hours	193,275	Calculated
Annual Fuel Use	gallons/yr.	123,696	Calculated
Annual Fuel Cost	$/year	$260,999	Calculated
Drayage Truck-Miles Traveled	TMT/yr.	6.443 million	Calculated
Drayage Truck-Hours Traveled	THT/yr.	257,720 hours	Calculated
Total Truck-Hours Traveled	TH/yr.	450,995 hours	Calculated
Total Driver Labor Cost	$/year	$12,898,457	Calculated
Total Social Cost (Emissions)	$/year	$28,316	Calculated
Total Annual Cost	**$/year**	**$13,187,772**	**Calculated (Fuel + Labor + Social)**

The economic analyses detailed below are based on parameters documented in the USDOT's 2018 *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*. The parameters and variables listed in the table above are adjusted for each solution, and then further adjusted for each scenario within each solution. The general approach is as follows:

Step 1: Compute benefits and costs for the proposed solution applied under the operating conditions of the Generic Port, using the baseline information in Table 6.

Step 2A: Adjust the operating conditions of the Generic Port to reflect a baseline scenario for a Major Urban/Local port, with 10 million annual container lifts and the associated level of truck activity with the

[57] U.S. Energy Information Administration, *Annual Energy Outlook 2018*

[58] Healy, James; "Sciences Academy Panel Sees Self-Driving Trucks on Road in Five Years," *Trucks.com* (January 10, 2017). Assumes retrofit of existing trucks. $35,000 cost based on range of estimates presented in report, weighted toward higher cost of short-term implementation.

remaining Generic Port operating parameters in place. Compute annual operating and monetized environmental costs associated with this baseline scenario for a Major Urban/Local port.

Step 2B: Adjust the operating conditions for the baseline scenario for a Major Urban/Local port to incorporate infrastructure improvements and estimated operational improvements with the solution in place. Compute annual operating costs, monetized environmental costs, and annualized capital costs. Compute Benefit Cost Ratio for this scenario compared to the baseline scenario for Step 2A.

Step 3A: Adjust the operating conditions of the Generic Port to reflect a baseline scenario for a Major Urban/Hinterland port, with 15 million annual container lifts and the associated level of truck activity with the remaining Generic Port operating parameters in place. Compute annual operating and monetized environmental costs associated with this baseline scenario for a Major Urban/Hinterland port.

Step 3B: Adjust the operating conditions for the baseline scenario for a Major Urban/Hinterland port to incorporate infrastructure improvements and estimated operational improvements with the solution in place. Compute annual operating costs, monetized environmental costs, and annualized capital costs. Compute Benefit Cost Ratio for this scenario compared to the baseline scenario for Step 3A.

Step 4: Complete Steps 3A and 3B for a Minor Urban/Hinterland port with 7 million annual container lifts and the associated level of truck activity.

Step 5: Complete Steps 3A and 3B for an Inland Port with 200,000 annual container lifts.

Steps 1 through 5 were conducted for Solutions A-1, A-2, B-1 and B-2. The results of these analyses are detailed in the sections below. A detailed description of Solution A-1 is laid out in the following section. The results of the analyses for all of the solutions and all scenarios within these solutions are summarized in Tables 7 through 10.

Economic Feasibility: Overview

The quantitative analysis and results are presented in Tables 7 through 10. The following sections describe the steps in the analysis, with further comments on qualitative benefits. The quantitative benefits in the tables include financial and environmental benefits.

Solution A-1, an off-site parking and staging area with no further treatment, was not found to be cost beneficial in the urban ports. The solution was beneficial in the other ports only at the lower discount rate, and only barely beneficial.

Solution A-2, off-site parking and staging area with a virtual gate, had benefit-cost ratios well above unity.

Solution B-1, automated level 4 trucks in queue, had benefit-cost ratios between 1.0 and 2.0.

Solution B-2, automated level 4 trucks in queue with off-site staging, was more beneficial than automation without off-site staging, with the larger benefits in scenarios having lower land costs.

Solution A-1: Off-Site Parking and Staging Area

The quantitative benefits are summarized in Table 7. Assumptions and adjustments for the five scenarios are described in the paragraphs and bullets below. The sole quantitative benefit could be an estimated 5% reduction in wait time for an average drayage truck using the staging area. This would mainly be a function of a slight improvement in truck management by the drayage trucking industry and would include financial and environmental benefits.

Table 7. Solution A-1: Off-Site Parking and Staging Area

MEASUREMENT	UNIT	SCENARIOS				
		Generic	Major Urban (Local)	Major Urban (Hinterland)	Minor Urban (Hinterland)	Inland Port
Container Lifts	lifts/year	365,000	10M	15M	7M	200,000
Off-Site Parking	spaces	45	1,283	1,925	898	26
Off-Site Yard Size	acres	4.5	128.3	192.5	89.8	2.6
Unit Land Cost	$/acre	250k	1.75M	985k	195k	105k
Total Land Cost	$	1.125M	224.5M	189.6M	17.5M	273k
Construction Cost	$	450k	12.8M	19.3M	9.0M	260k
Annualized Capital Cost (at 7% discount)	$/yr.	117.4k	16.8M	14.9M	2.0M	41.4k
Annualized Capital Cost (at 3% discount)	$/yr.	59.6k	7.5M	6.8M	1.0M	23.1k
Annual Maintenance Cost	$/yr.	18.0k	513k	770k	359k	10.4k
Total Annual Costs (7%)	$/yr.	135.4k	17.3M	15.7M	2.4M	51.8k
Total Annual Costs (3%)	$/yr.	77.6k	8.0M	7.6M	1.4M	33.5k
Benefits	$/year	96.9k	2.7M	4.0M	1.9M	53.1k
Benefit-Cost Ratio (at 7% discount)	**--**	**0.72**	**0.15**	**0.25**	**0.79**	**1.03**
Benefit-Cost Ratio (at 3% discount)	**--**	**1.25**	**0.33**	**0.53**	**1.33**	**1.59**

The Baseline Generic Port scenario documented above was adjusted to reflect the conditions of **Solution A-1** implemented at the **Generic Port**. Key information for Solution A-1 includes the following:

- The general characteristics of this scenario match the information contained in Table 6.
- The solution includes the construction of a 45-space queuing/staging area to meet the calculated parking need for a three-hour arrival window for drayage trucks in the Baseline scenario. This facility

would cover 4.5 acres and would have a land acquisition cost of $1,125,000 and a construction cost of $450,000.

- Based on an amortization of 25 years the land would have a residual value of $207,280 at a discount rate of 7% and $537,306 at a discount rate of 3%.[59]
- The annualized capital cost would be $117,365 at a discount rate of 7% and $59,593 at a discount rate of 3%.
- Annualized costs for Solution A-1 at the Generic Port would be $135,365 at a discount rate of 7% and $77,593 at a discount rate of 3%.
- The annual benefit for Solution A-1 at the Generic Port would be $96,948, including truck labor cost savings and reduced fuel and emissions costs from reduced idling time.

The Benefit-Cost Ratio for this improvement would be **0.72** at a discount rate of 7% and **1.25** at a discount rate of 3%. Qualitative benefits include **congestion reduction** in the immediate vicinity of the port terminal, **potential safety and community benefits** from removing trucks from local streets in neighboring communities, and some **additional parking capacity for long-haul truckers** in nearby truck stops and highway rest areas.[60] There will also be minor **productivity improvements** for drayage truck drivers, with the 5% reduction in waiting time resulting in slightly reduced turn times.

The benefits of this solution primarily accrue to the drayage trucking industry, with secondary benefits to the long-haul trucking industry and the local communities surrounding the port. The cost of this type of solution would typically be incurred by a port authority or public agency that has the authority to acquire property through eminent domain if necessary. The location of the off-site parking and staging area will need to consider the compatibility with surrounding land uses, the suitability/capacity of the roadway to the port for heavy truck movements, and the site's access to the greater regional transportation network.

A second scenario was analyzed for **Solution A-1** implemented at a **Major Urban Port/Local Market**. Key information for Solution A-1 in this scenario includes the following:

- The general characteristics of this scenario are based on a major port with 10 million lifts per year aggregated across all terminals.
- Based on the parameters laid out in Table 6, this level of port activity would generate a parking and staging need for 1,283 trucks across all terminal facilities. This would require an aggregate of 128.3 acres in one or more parking areas.
- Land acquisition costs for this scenario are $1.75 million per acre, with a total land acquisition cost of $224.525 million. The construction cost would be $12.83 million.

[59] These figures correspond to a no-depreciation scenario where the land retains 100% of its nominal value ($1,175,000) through the 25-year amortization period and there is no appreciation of value in the land. The $216,493 and $561,187 represent the present worth of the land at a discount rate of 7% and 3%, respectively.

[60] Data collected at highway rest areas along the major interstate highways in the vicinity of the port terminals in northern New Jersey during the course of this study indicate that 3% to 5% of the trucks parked in those facilities during weekday predawn hours are hauling marine containers or empty container chassis. These trucks would ideally use an off-site parking/staging area near the port instead of a highway rest area for staging.

- Based on an amortization of 25 years the land and capital improvements would have a residual value of $41.368 million at a discount rate of 7% and $107.234 million at a discount rate of 3%.
- The annualized capital cost is $16,817,699 at a discount rate of 7% and $7,472,550 at a discount rate of 3%.
- Annualized (capital and maintenance) costs for a Major Urban/Local Port with Solution A-1 in place are $17,330,899 at a discount rate of 7% and $7,985,750 at a discount rate of 3%.
- The 5% reduction in wait time for an average drayage truck using the staging area described for Solution A-1 at the Generic Port would remain unchanged. This translates to an annual benefit of $2,655,561, including financial and environmental benefits.

The Benefit-Cost Ratio for this improvement would be **0.15** at a discount rate of 7% and **0.33** at a discount rate of 3%. The substantial cost of constructing and maintaining an off-site staging area in this scenario exceeds the minor benefit by a wide margin. Qualitative benefits are the same as those described previously for Solution A-1 implemented at a Generic Port, as are the allocation of costs and benefits among the port industry stakeholders.

A third scenario was analyzed for **Solution A-1** implemented at a **Major Urban Port/Hinterland Market**. Key information for Solution A-1 in this scenario includes the following:

- The general characteristics of this scenario are based on a major port with 15 million lifts per year aggregated across all terminals.
- Based on the parameters laid out in Table 6, this level of port activity would generate a parking and staging need for 1,925 trucks across all terminal facilities. This would require an aggregate of 192.5 acres in one or more parking areas.
- Land acquisition costs for this scenario are $985,000 per acre, with a total land acquisition cost of $189.613 million. The construction cost would be $19.25 million.
- Based on an amortization of 25 years the land would have a residual value of $34.936 million at a discount rate of 7% and $90.56 million at a discount rate of 3%.
- The annualized capital cost is $14.925 million at a discount rate of 7% and $6.794 million at a discount rate of 3%.
- Annualized (capital and maintenance) costs for a Major Urban/Hinterland Port with Solution A-1 in place are $15.695 million at a discount rate of 7% and $7.564 million at a discount rate of 3%.
- The 5% reduction in wait time for an average drayage truck using the staging area described for Solution A-1 at the Generic Port would remain unchanged. This translates to an annual benefit of $3.983 million, including financial and environmental benefits.

The Benefit-Cost Ratio for this improvement would be **0.25** at a discount rate of 7% and **0.53** at a discount rate of 3%. As with the previous scenario for Solution A-1, the substantial cost of constructing and maintaining an off-site staging area in this scenario exceeds the minor benefit by a wide margin. Qualitative benefits are the same as those described previously for Solution A-1, as are the allocation of costs and benefits among the port industry stakeholders.

A fourth scenario was analyzed for **Solution A-1** implemented at a **Minor Urban Port/Hinterland Market**. Key information for Solution A-1 in this scenario includes the following:

- The general characteristics of this scenario are based on a major port in a small urban area with 7 million lifts per year aggregated across all terminals.
- Based on the parameters laid out in Table 6, this level of port activity would generate a parking and staging need for 898 trucks across all terminal facilities. This would require an aggregate of 89.8 acres in one or more parking areas.
- Land acquisition costs for this scenario are $195,000 per acre, with a total land acquisition cost of $17.511 million. The construction cost would be $8.98 million.
- Based on an amortization of 25 years the land and capital improvements would have a residual value of $3.226 million at a discount rate of 7% and $8.363 million at a discount rate of 3%.
- The annualized capital cost is $1.996 million at a discount rate of 7% and $1.041 million at a discount rate of 3%.
- Annualized (capital and maintenance) costs for a Minor Urban/Hinterland Port with Solution A-1 in place are $2.356 million at a discount rate of 7% and $1.400 million at a discount rate of 3%.
- The 5% reduction in wait time for an average drayage truck using the staging area described for Solution A-1 at the Generic Port would remain unchanged. This translates to an annual benefit of $1.859 million, including financial and environmental benefits.

The Benefit-Cost Ratio for this improvement would be **0.79** at a discount rate of 7% and **1.33** at a discount rate of 3%. As with the previous scenario for Solution A-1, the cost of constructing and maintaining an off-site staging area in this scenario exceeds the minor benefit at a discount rate of 7% and is lower than the benefit at a discount rate of 3%. Qualitative benefits are the same as those described previously for Solution A-1, as are the allocation of costs and benefits among the port industry stakeholders.

The fifth and last scenario was analyzed for **Solution A-1** implemented at an **Inland Port**. Relevant information for Solution A-1 in this scenario includes the following:

- The general characteristics of this scenario are based on an inland port with 200,000 lifts per year.
- Based on the parameters laid out in Table 6, this level of port activity would generate a parking and staging need for 26 trucks, with 2.6 acres in a single parking area.
- Land acquisition costs for this scenario are $105,000 per acre, with a total land acquisition cost of $273,000. The construction cost would be $260,000.
- Based on an amortization of 25 years the land and capital improvements would have a residual value of $50,300 at a discount rate of 7% and $130,386 at a discount rate of 3%.
- The annualized capital cost is $41,421 at a discount rate of 7% and $23,121 at a discount rate of 3%.
- Annualized (capital and maintenance) costs for an Inland Port with Solution A-1 in place are $51,821 at a discount rate of 7% and $33,521 at a discount rate of 3%.

- The 5% reduction in wait time for an average drayage truck using the staging area described for Solution A-1 at the Generic Port would remain unchanged. This translates to an annual benefit of $53,157, including financial and environmental benefits.

The Benefit-Cost Ratio for this improvement would be **1.03** at a discount rate of 7% and **1.59** at a discount rate of 3%. Qualitative benefits are the same as those described previously for Solution A-1. The allocation of costs and benefits among the industry stakeholders would be similar, with the exception that the cost of acquiring land and constructing the facility would typically be borne by an economic development authority and/or the railroad(s) serving the inland port terminal.

The Benefit-Cost Ratio calculations documented in this section indicate that a standalone off-site parking and staging area at a small to mid-sized port is likely to have minimal economic benefits compared to the cost of constructing and operating the facility. This type of improvement may also provide qualitative benefits such as some congestion mitigation, community benefits associated with the removal of trucks from local streets, and additional parking capacity for long-haul trucks at nearby truck stops and highway rest areas. At major ports, especially in urban areas where land costs are very high, the cost of acquiring land far outweighs the economic benefits of these facilities.

Solution A-2: Off-Site Parking and Staging Area with a Virtual Gate

The general characteristics of this scenario match the information contained in Table 6. One key exception is the reduced demand for staging capacity due to reductions in waiting and loading time. The solution includes the construction of a queuing/staging area to meet the calculated parking need for a three-hour arrival window for drayage trucks in each scenario, along with the IT hardware and infrastructure for a “virtual gate” at the external staging area.

The quantitative benefits are summarized in

Table 8. These results are based on an estimated 30 percent reduction in wait time and 15 percent reduction in loading time. Qualitative benefits include **congestion reduction** in the immediate vicinity of the port terminal, **potential safety and community benefits** from removing trucks from local streets in neighboring communities, and some **additional parking capacity for long-haul truckers** in nearby truck stops and highway rest areas. There will also be some **productivity improvements** for drayage truck drivers, with the reductions in waiting and loading times resulting in a 20 percent improvement in turn times within the port.

Table 8. Solution A-2: Off-Site Parking and Staging Area with a Virtual Gate

MEASUREMENT	UNIT	SCENARIOS				
		Generic	Major Urban (Local)	Major Urban (Hinterland)	Minor Urban (Hinterland)	Inland Port
Container Lifts	lifts/year	365,000	10M	15M	7M	200,000
Off-Site Parking	spaces	33	898	1,348	629	18
Off-Site Yard Size	acres	3.3	89.8	134.8	62.9	1.8
Automated Gates	number	1	9	13	6	1
Unit Land Cost	$/acre	250k	1.75M	985k	195k	105k
Total Land Cost	$	825k	157.2M	132.8M	12.3M	189k
Construction Cost	$	330k	9.0M	13.5M	6.3M	180k
New Gate Cost	$	250k	2.2M	3.2M	1.5M	250k
Annualized Capital Cost (at 7% discount)	$/yr.	147.0k	12.3M	11.2M	1.8M	89.6k
Annualized Capital Cost (at 3% discount)	$/yr.	98.3k	5.7M	5.5M	1.1M	70.6k
Annual Maintenance Cost (for the infrastructure)	$/yr.	13.2k	359.2k	539.2k	251.6k	7.2k
Annual Maintenance Cost (for the gate)	$/yr.	37.5k	337.5k	487.5k	225.0k	37.5k
Total Annual Costs (7%)	$/yr.	197.7k	13.0M	12.3M	2.2M	134.3k
Total Annual Costs (3%)	$/yr.	149.0k	6.4M	6.5M	1.5M	115.3k
Benefits	$/year	1.16M	31.9M	47.8M	22.3M	637.9k
Benefit-Cost Ratio (at 7% discount)	**--**	**5.88**	**2.45**	**3.90**	**9.96**	**4.75**
Benefit-Cost Ratio at (at 3% discount)	**--**	**7.81**	**4.97**	**7.36**	**14.55**	**5.53**

The benefits of this solution primarily accrue to the drayage trucking industry, with secondary benefits to the long-haul trucking industry and the local communities surrounding the port. The cost of the parking facility would typically be incurred by a port authority or public agency that has the authority to acquire property through eminent domain if necessary. The capital and operating costs of maintaining the gate system at the off-site lot would be borne by the terminal operator(s) using the facility. As with Solution A-1, the location of the off-site parking and staging area will need to consider the compatibility with surrounding land uses, the suitability/capacity of the roadway to the port for heavy truck movements, and the site's access to the greater regional transportation network.

Solution B-1: Automated Level 4 Truck in Queue

The general characteristics of this scenario match the information contained in Table 2. The primary feature of this solution is the instrumentation of a full fleet of trucks serving each prototype port to enable them to operate in a Level 4 automated mode while waiting in a terminal queue on both the inbound and outbound trips at the terminal. The base cost of instrumentation per truck is $35,000, with an annual maintenance cost of $1,750 (5% of the capital cost).

The quantitative benefits for this solution are summarized in Table 9. These are based on a 40 percent reduction in wait time and a 40 percent reduction in loading time. Qualitative benefits could include **congestion reduction** in the immediate vicinity of the port terminal, **improved productivity** for drivers who can secure an additional turn at the end of a day due to the elimination of a period of "On-Duty, Driving" status for each turn at the port terminal, **safety improvements** in the port environment if the trucks operate more safely in automated mode than with human drivers. and a **general improvement of supply chain efficiency**.

Table 9. Solution B-1: Automated Level 4 Trucks in Queue[61]

MEASUREMENT	UNIT	SCENARIOS				
		Generic	Major Urban (Local)	Major Urban (Hinterland)	Minor Urban (Hinterland)	Inland Port
Container Lifts	lifts/year	365,000	10M	15M	7M	200,000
Number of trucks	--	292	8,000	12,000	5,600	160
Total truck capital cost	$	10.2M	280M	420M	196M	5.6M
Annual capital cost (7%)	$/yr.	2.5M	68.3M	102.4M	47.8M	1.4M
Annual capital cost (3%)	$/yr.	2.2M	61.1M	91.7M	42.8M	1.2M
Annual maintenance cost	$	511k	14.0M	21.0M	9.8M	280k
Total Annual Costs (7%)	$/yr.	3.0M	82.3M	123.4M	57.6M	1.6M
Total Annual Costs (3%)	$/yr.	2.7M	75.1M	112.7M	52.6M	1.5M
Benefits	$/year	3.6M	97.4M	146.1M	68.2M	1.9M
Benefit-Cost Ratio (at 7% discount)	**--**	**1.18**	**1.18**	**1.18**	**1.18**	**1.18**
Benefit-Cost Ratio at (at 3% discount)	**--**	**1.30**	**1.30**	**1.30**	**1.30**	**1.30**

[61] The benefit-cost ratios are identical for all five scenarios in Solution B-1 because there are no land acquisition costs associated with this solution. Variations in land costs are the primary distinguishing characteristic among the various geographic areas used to establish the scenarios in this study. All of the capital and operating cost parameters used for Solution B-1 are based entirely on truck fleet sizes that are computed based on a fixed ratio of trucks to the number of container lifts for each scenario.

The benefits of this solution primarily accrue to the drayage trucking industry and its customers, with secondary benefits to the marine terminal operator if terminal throughput is enhanced. The capital and operating costs of the automated truck technology would be incurred by the drayage trucking industry.

Solution B-2: Automated Level 4 Truck in Queue with Off-Site Staging

A more ambitious and complex application of automated trucks in a port environment involves an automated truck operating with a port terminal similar to Solution B-1, but also draying containers to an off-site staging yard a short distance away where they can be picked up by the drayage trucking firms that ultimately deliver them to the shippers/receivers. This solution takes advantage of some key benefits of other solutions examined in this study, including the "virtual gate" incorporated in Solution A-2 and the efficiency enhancements provided by Solution B-1. The automated drayage operation effectively functions as Stage 1 of the two-step drayage process shown in Figure 7, with the marine terminal operator retaining control of the cargo during the automated drayage process between the main terminal and the off-site yard. The drayage trucking firm would not take control of the cargo until after it was picked up and removed from the staging yard.

The primary feature of this solution is the instrumentation of a select group of trucks serving the hypothetical port to enable them to operate in a Level 4 automated mode while transporting containers to an off-site yard where they will be staged for delivery to the customers. The off-site staging yard would function as a wheeled operation, with containers stored on chassis and moved out of the staging area in this configuration by the drayage trucking firms. The automated truck movements between the port terminal and the off-site staging area would operate 24 hours a day, even if the normal hours of operation of the port are much shorter. This would enable the automated trucking operation to complement any other automated functions inside the marine terminal that can be conducted during off-hours. For the purpose of this analysis it is assumed that the off-site staging yard will be located three miles away from the port terminal.

The benefits of the operation will include: (1) the average haul length for the drayage truckers will be reduced by three miles from 30 to 27, while the average speed will increase to 35 miles per hour due to the reduced queue time and no need to operate inside the port terminal; and (2) the transaction time for a drayage truck move at the off-site yard will be reduced to a total of 10 minutes.[62] The quantitative results are summarized in Table 10. It should be noted that the Benefit-Cost Ratios for this solution are very high for the following reasons:

1. Unlike Solutions A-1, A-2 and B-1, Solution B-2 was analyzed for a 24-hour operation that would function for an average of 350 days per year. This increases the throughput of the ports under the scenarios included in this analysis relative to each infrastructure and equipment element. For example, a fleet of automated trucks that operates 24 hours per day in Solution B-2 will handle 2.18 times more loads over the course of a year than a fleet of trucks (automated or conventional) operating only 11 hours per day under the other scenarios.

[62] The total transaction time for a drayage truck for this solution is substantially reduced because the off-site yard is a "wheeled" operation and the container is already on the chassis when the drayage truck arrives at the off-site yard.

2. The analysis assumes that the automated truck operation and the drayage truck transactions at the off-site terminal gate are a highly coordinated, efficient operation where containers are moved from the pier area to the off-site yard shortly before a drayage truck is scheduled to arrive to pick it up (and vice versa). This minimizes the footprint of the off-site load staging yard. Without such a refined operation in place, the off-site staging areas used for the various scenarios would have to be substantially larger and the capital costs of these operations correspondingly higher.
3. The coordination described in Item #2 between the port terminal and the drayage trucking industry that would be necessary to manage this highly efficient operation would require a substantial investment by the port terminal in other technology. In particular, a port community system (PCS) documented in the internal MARAD technology review completed in 2017 would ideally be used to share information and coordinate activity between logistics partners in the supply chain (vessel operator, port terminal, drayage trucking firm, etc.). The cost of a PCS and associated technology is not included in this analysis, as it is assumed that Solution B-2 would only be implemented at a port that already had these technologies in place.

Table 10. Solution B-2: Automated Level 4 Trucks in Queue with Off-Site Staging

MEASUREMENT	UNIT	SCENARIOS				
		Generic	Major Urban (Local)	Major Urban (Hinterland)	Minor Urban (Hinterland)	Inland Port
Container Lifts	lifts/year	365,000	10M	15M	7M	200,000
Instrumented Trucks	--	26	700	1,050	490	14
Off-Site Yard Size	acres	2.6	70	105	49	1.4
Automated Gates	number	2	58	88	41	1
Unit Land Cost	$/acre	$250k	$1.75M	$985k	$195k	$105k
Total Land Cost	$	$650k	$122.5M	$103.4M	$9.6M	$147k
Construction Cost	$	$260k	$7M	$10.5M	$4.9M	$140k
Truck Equip. Cost	$	$910k	$24.5M	$36.8M	$17.2M	$490k
New Gate Cost	$	$500k	$14.5M	$22M	$10.2M	$250k
Total Annual Costs (7%)	$/yr.	$552k	$24.6M	$29.7M	$10.5M	$273k
Total Annual Costs (3%)	$/yr.	$491k	$19.6M	$24.9M	$9.4M	$246k
Benefits	$/year	$7.4M	$130M	$194.9M	$91.0M	$2.6M
Benefit-Cost Ratio (at 7% discount)	**--**	**13.33[63]**	**5.35**	**6.57**	**8.65**	**9.53**
Benefit-Cost Ratio at (at 3% discount)	**--**	**15.01**	**6.62**	**7.82**	**9.67**	**10.58**

[63] Benefit-Cost Ratios for the Generic scenario is inordinately high due to the comparison to the Baseline Generic scenario with the original parameters and no improvements that result in enhanced efficiency or productivity.

Another potential benefit may be that the off-site staging yard would be a heavily secured area but may be established in a way that eliminates the need for the external drayage trucker to have a Transportation Worker Identification Credential (TWIC) for access. This could have positive cost implications for the drayage process and may also allow for a more efficient transfer of marine cargo from "inside the gate" to the external road network.

The costs of implementation would be borne almost entirely by a marine terminal operator, since this is entirely an inside-the-gate operation. While the port terminal may enjoy benefits such as increased throughput and enhanced terminal productivity, the primary beneficiaries are the drayage trucking firms that save a substantial amount of time in the transaction processes and their customers who benefit from lower transportation costs.

Summary

The economic analyses completed for this study provide valuable insight into the potential for further development of port technologies aimed at mitigating the impacts of trucks queued at port terminals. Most of the solutions examined here indicated a positive Benefit-Cost Ratio using the broad model assumptions documented here. A more detailed analysis based on a more accurate set of vehicle operating characteristics and port/vehicle performance metrics would be needed to confirm the validity of many of these model assumptions. Notable observations from these analyses are as follows:

- High land costs in major urban areas play a major role in determining the economic feasibility of off-site parking and staging areas.
- The ability of automated truck technology to perform with the precision and efficiency in a port environment that has been built into these analyses is essential to the economic feasibility of the technology. This is one of the ongoing challenges with the testing and deployment of automated vehicles in general.
- The technologies studied here are generally scalable to ports of different sizes, but in practice it is not likely that they would be implemented at small ports that handle low cargo volumes. There are economies of scale in the implementation of technologies such as automated trucks and advanced terminal gate systems that make them impractical in low-volume applications. Even a solution as simple as a staging area requires some minimum critical mass of trucks in queue before the process of acquiring property and improving the lot is worthwhile.
- One of the limitations of this analysis is that it is built on generic conditions at hypothetical ports without regard to the complexities of specific ports in the U.S. In particular, a multi-terminal environment where trucks may be dropping cargo at one terminal and picking up cargo at another is a major obstacle to optimization in the marine cargo handling process.
- The combination of lower land acquisition costs and a single-terminal operation would make a major port in a smaller urban area an ideal testing ground for some of the practices and technologies analyzed in this report. Savannah, for example, was the model for the Minor Urban (Hinterland) scenario in these analyses. This city is much smaller than most major U.S. ports, but the scale of its operation and the volume of cargo it handles are comparable in scale to other ports in large urban centers like New York and Los Angeles.

- The technologies and infrastructure improvements documented here are likely to change over time in ways that alter the findings of these analyses. Land acquisition and construction costs are almost certain to escalate, while technology will typically grow less expensive as it matures and is implemented on broader scales.
- The complexity of the marine cargo handling process in general, and the drayage trucking process in particular, is an important aspect of marine cargo handling. The industries currently at the forefront of developing, testing, and implementing automated vehicle technology have been slow to make their way into the port trucking realm, and for good reason. The less complex operation of over-the-road trucks makes them better suited for many of the automated processes that would be necessary for a drayage truck to operate in a marine terminal environment.
- Accurately measuring the benefits of potential technology solutions to address queuing challenges at port terminal gates is challenging, due to the cumulative benefits of "layered solutions" that may diminish the benefits of any one technology. The port community system (PCS) described in the 2017 internal MARAD technology assessment, for example, would almost be a necessity for the implementation of Solution B-2. For some ports, the implementation of a PCS without an automated truck component may provide substantial improvements in operating efficiency that could effectively make an automated truck operation a redundant improvement.

Chapter 8. Barriers to Implementing Solutions and Options for Overcoming Them

This research effort in truck queuing and staging practices and potential technology applications provides valuable insight into the complexity of the port environment and the challenges of implementing solutions to address terminal congestion and other issues that adversely impact the efficiency of the nation's supply chain. Some of the challenges in advancing and implementing solutions in this landscape are daunting. As with automated vehicles in general, the cost of implementation and the limits of technology can be some of the easier hurdles to overcome. Several major challenges for implementing solutions and potential measures to address these challenges are discussed in the sections below.

Marine Terminal Supply Chain Complexity

This has been identified as perhaps the single biggest obstacle for improving port efficiency throughout the stakeholder outreach process for this research effort. The Task 3 interview summary report outlines the industry feedback from various stakeholders.[64] The multitude of players in the cargo handling process and the often-conflicting goals of these players forces inefficiencies into the system that cannot be readily addressed by any one stakeholder group. Marine cargo transportation seems to be several generations behind other logistics processes that have matured over time and undergone extensive consolidation in search of efficiencies. It might be worth a separate research effort to envision a hypothetical scenario where a single business entity took it upon itself to broaden its business practices to take on functions across the entire supply chain. Reducing the number of players in the process would reduce the complexity of the cargo handling operation and eliminate many business transactions entirely. The responsibility for a loaded container, for example, would not have to transition between a terminal operator and a drayage trucking firm if the same company ran both operations. How much more efficiently would the process work if, for example, Amazon operated marine terminals and a drayage trucking fleet, or Walmart owned an ocean carrier subsidiary?

This is not a barrier that can be overcome through a proactive approach in government and academia. The current players in this space would have to be challenged to make ambitious changes in their business models to remove much of the "slack" from this supply chain. There is currently little incentive for any one player in the process to improve the overall efficiency of the process independently of the other players. A combination of external financial incentives in the form of federal matching funds for individual improvement projects and regulations that address inefficiencies with broad impacts across the supply chain and in affected communities (environmental impacts, for example) may be an ideal way to address these barriers to implementation in an inherently complex process.

[64] *ITS MARAD Truck Staging Study: Interview Results Report*, Chapter 9

In the meantime, it is essential for government and industry to cultivate and maintain a robust stakeholder outreach process to ensure that changes in one supply chain partner that have ripple effects across the entire supply chain are identified early and understood as clearly as possible by all affected parties.

This outreach process is already a fact of life in the marine cargo world and its government partners. However, it is worth exploring a separate (but integrated) outreach effort that is aimed at advancing technology development in port environments. This may take the form of a high-level task force comprised of government officials, transportation industry representatives, and major shippers/receivers.

Legal and Organizational Hurdles

One example of successful collaboration across industries has been cited in this report. The Uniform Intermodal Exchange & Facilities Access Agreement (UIIA) described earlier in this report was created out of necessity to overcome a costly and highly inefficient system of contractual relationships between ocean carriers, marine terminal operators, equipment providers, drayage trucking firms, railroads, and insurance companies. One of the recurring themes that has come up in the various tasks in this study is the major barrier to efficiency that exists at the marine terminal gate. This gate is not just a physical barrier but an institutional and jurisdictional one as well and will play a major role in any technology development that bridges the barrier between terminal operations and drayage trucking.

There are several key issues related to inter-industry relationships that must be considered in implementing automated truck technologies, including the following:

- The role of the container chassis in the marine cargo handling process, and the complications it brings to the interaction between the terminal operator and the drayage trucking firm, have been discussed previously in this report in Chapters 1 and 2. The chassis has all the operating functions of a trailer in a tractor-trailer combination vehicle, including braking capability, tail lights, and other safety features. An automated tractor will have to be inter-operable with all chassis equipment it uses and encounters while operating in automated mode. Chassis fleets would have to be functional with automated tractors and have a high degree of uniformity in terms of electronics (wiring, LED lighting) and braking systems.
- Related to the previous point, an automated truck operation in a port environment will have to accommodate the chassis retrieval and drop-off process and all of the contractual requirements this involves between the terminal operator, the drayage trucker, and the chassis provider. A “bobtail” truck configuration commonly found at marine terminal gates, with many trucks either arriving without a chassis and departing with one or arriving with a chassis and leaving it at the terminal. As shown in the table in Figure 6, these “bobtail” configurations represent seven of the sixteen combinations of pick-up/drop-off moves, and four of the eight most common combinations.
- Labor agreements between marine terminal operators and longshoremen’s’ unions have been cited by several port stakeholders as an important issue that would likely have to be addressed in some automated truck operations described in this report. This was mentioned as one of the issues to be addressed for the development of the Harbor Performance Enhancement Center (HPEC) proposed at the Port of Los Angeles that is referenced in Chapter 4 of this report. These labor agreements dictate terms that apply to operations within marine terminals, and under the movement of containers to nearby staging areas may require the use of union labor at the off-site staging area. One major East Coast port that completed the Task 6 questionnaire indicated that new technology implementation

efforts had been temporarily suspended while labor negotiations were ongoing, since the labor agreement in question had such important implications for the technologies under consideration. These issues are most relevant to Solutions A-2 and B-2 in this report, since these solutions involve transactions and cargo handling operations outside a typical marine terminal gate and may therefore be governed by labor agreements.

- One of the keys to the success of the Singapore initiative is that the longshoremen's labor union in Singapore is one of the major partners in the effort. Labor agreements have been identified as one of the primary hurdles to technology implementation in the port industry by multiple stakeholders at every step in this study. Technology is disruptive by its nature, and even a cautious implementation of technology is likely to have adverse impacts on the lives of many people who work in the various industries involved in marine trade. These labor agreements are contractual matters between private business and labor interests, so the opportunity for external involvement is limited. To the extent possible, labor union representatives should be seen as an important stakeholder in any initiatives involving the testing and implementation of technology solutions in the marine cargo environment.

Despite these challenges, automated truck technology applications in a marine terminal environment have a distinct advantage over automated trucks on public roads. The confined nature of a marine terminal outside a public road system effectively minimizes (or eliminates) legal, safety and regulatory barriers that are major factors in technology implementation in mixed vehicular traffic on public roads. Technology development in drayage trucking may be accelerated if technology providers and developers in the automated truck realm actively engage the Intermodal Association of North America (IANA) in the testing and implementation process for new technology implementation.

Divergence of Costs and Benefits

One of the consequences of the challenges described above related to supply chain complexity and legal/jurisdictional barriers is that freight transportation – particularly for marine cargo – is fraught with situations where costs and benefits are misallocated among the industry players. Drayage trucking is a perfect case in point, where the truck driver who is subject to congestion, delays and a highly unpredictable work environment often bears the burden of conditions established by other industries in the supply chain (ocean carriers, terminal operators, shippers/receivers, etc.). Marine terminal operators conduct business in a highly competitive environment, and yet they are often the ones who make the largest investments in infrastructure and equipment to promote efficiency improvements that have benefits along the entire supply chain.

The parking and queuing issues studied in this project are very similar to the issues faced by long-haul truckers who serve as an intermediary between shippers and receivers and conduct their business on a public roadway system whose conditions are completely out of their control. The business and consumers who buy the products and raw materials transported on our nation's highway system and through our ports are ultimately the drivers of this process, and one of the keys to the successful implementation of any technology-based initiative is to ensure that the costs and benefits are allocated as fairly as possible among all of the public and private stakeholders involved in the transportation process.

Pilot Projects

Perhaps the easiest approach for advancing technology development to address truck queuing and congestion issues at port terminals would be for the Maritime Administration or any of its partner agencies to sponsor one or more pilot projects aimed at testing and implementing a specific technology. This is the approach that has been taken at the Port of Singapore to advance their AGV, truck platoon and other technology developments. Importantly, the Singapore model is being advanced as part of a broader initiative to consolidate multiple port terminals into a state-of-the art 21st Century port. Research, development and implementation of ITS solutions is one of the objectives under Strategic Goal #5 (Maritime Innovation) in MARAD's current strategic plan.[65] This will be discussed further in Chapter 9.

[65] *Maritime Administration Strategic Plan: Navigating the Future (2017-2021)*

Chapter 9. Recommendations for Next Steps

The study's operational feasibility assessment and economic analyses conducted reflect a high-level overview of potential solutions to address port terminal congestion and queuing issues around the United States. The study results detailed in Chapter 7 apply to representative types of ports in various markets and metropolitan areas. The study serves as a foundation for additional steps to further refine these results and move forward with testing and potential implementation of one or more of the solutions described herein. Combinations of solutions, or variations of the solutions documented here, may also be feasible for implementation at particular ports. To that end, the following recommendations are outlined below, listed generally in the order of effectiveness and value. The four recommendations provide a systematic or holistic framework for moving forward.

1. Stakeholder Outreach through the Intermodal Association of North America (IANA)

The Intermodal Association of North America (IANA) is a major industry group representing various industries involved in intermodal freight transportation. The organization's wide-ranging membership includes port authorities, railroads, marine (ocean and river) carriers, intermodal facility operators, trucking firms, equipment manufacturers and leasing firms, and third-party logistics firms. IANA also maintains relationships with non-voting members such as shippers/receivers, academic institutions, and public sector agencies.

The complexity of the marine cargo supply chain has been described at length in this report and has been identified as one of the major issues that must be addressed when implementing many of the solutions examined. The Uniform Intermodal Exchange & Facilities Access Agreement (UIIA) described previously and contained in Appendix C has been established under the oversight of the IANA, and the organization has engaged in ongoing revisions to the agreement over time. As such, it is perhaps the ideal stakeholder organization to serve in an advisory and review capacity for any technology improvements that involve cargo transfers at marine terminals.

2. Pilot Project Development

Pilot projects were identified in the previous chapter as a potential approach for advancing technology development to address truck queuing and congestion issues at port terminals. This approach would have the added advantage of helping to more fully document barriers to implementation and identify measures to overcome these barriers.

Ideally, a set of pilot projects would be conducted at select U.S. ports of various sizes, in different geographic areas, and serving different types of markets for marine cargo. Based on the scenarios

described in Chapter 7 and the level of interest expressed by various port stakeholders in the interview and questionnaire outreach tasks, these ports could include the following:

- A major coastal port in a large urban area
- A major coastal port in a small city
- A secondary coastal port – perhaps with a focus on specialized cargoes (liquid bulk, grain, etc.)
- A river port in the interior of the U.S.
- An inland port region that handles a substantial volume of marine cargo

The purpose of a pilot study would be to identify and test one or more truck technology applications in a specific port, with a particular focus on measuring costs and benefits to a greater level of detail than documented in this study. The interoperability of these truck technologies with various other technology applications already in use at U.S. ports (e.g., PCS, TAS, RFID) would be a major area of interest as well. These pilot projects could be conducted in conjunction with the IANA outreach recommended above; this would provide the various industry groups in the marine cargo supply chain with the opportunity to identify additional operational, contractual, or legal hurdles to implementation early in the process, and help develop a roadmap for addressing those hurdles within a limited context instead of grappling with potentially contentious issues on a large scale.

Of the solutions examined in this study, the one that may be most conducive to a pilot test is Solution B-2 (Automated Level 4 Truck in Queue with Off-Site Staging). This type of operation can be implemented within a port terminal area, either outside a public road system or on public roads under limited conditions (e.g., during overnight hours when the roads are closed to other vehicular traffic). This solution has an added advantage in that it only requires a limited number of instrumented vehicles operating along a fixed route. A pilot test for Solution B-1, in comparison, would require a fleet of instrumented vehicles that would either operate in mixed traffic with other drayage trucks, or would operate through dedicated gates at a marine terminal that are designed to accommodate only the automated trucks. A port that has a port community system (PCS) in place or is in the process of implementing such a system would be an ideal testing ground for Solution B-2.

3. Industry and Public Agency Collaboration

Effective collaboration among stakeholders and across sectors represents a fundamental success factor for the future. This point was emphasized by some of the stakeholders who, through the challenge of addressing the issue of technology implementation at ports, see how essential institutional synergy is among other factors, but potentially overlooked or underemphasized. As a starting point, the following are three foundation building recommendations. (In addition to those listed, broad based port partnerships such as The Northwest Seaport Alliance (NWSA) offer powerful models of collaboration that deserve attention going forward.)

Systematic Raising of Awareness

Because the port industry involves a myriad of stakeholders, raising awareness of terminal queuing and congestion issues in more systematic ways represents a low-cost, high-impact short term strategy. As technologies continue to emerge, the various stakeholders need to be at the same table to discuss their

broader impacts and implications. This includes port owners and operators, State DOTs, and MPOs. Because a principal role of the MPO is to serve as a focus point of collective regional interests, this represents an area of important leadership for our regional planners. Fortunately, in the decades since the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), more MPOs have freight task forces or committees, freight plans, or both. Their focus on truck parking, staging, and queuing and aligned technology advances is now particularly opportune.

Leveraging Grant Programs

The programs of the USDOT are often the springboard for process and program innovation and breakthroughs. It is recommended that steps be taken to ensure and enable prospective applicants to more effectively compete for USDOT grant opportunities (e.g., INFRA, BUILD, and ATCMTD). Grant programs often take several years to design and implement in terms of objectives, criteria, rules, etc. Given the economic importance of truck parking, staging and queuing and the likely opportunity for greater leveraging of technology, it is recommended that the program managers and administrators, with input from non-federal and industry stakeholders, together consider how to continually align the programs to this need/opportunity and technology dynamics.

Technology Tracking and Transfer

Coordinated efforts should be made to continue to survey the global landscape of technology implementation, as discussed in the previous “Ongoing Review of Other Automated Truck Applications” item in this section. Monitoring and tracking technology trends in the context of collaborative approaches will prove to be particularly valuable. Organizations too often work in siloes to their own detriment. Over the next 5-10 years in particular it will be important if not essential for public and private sector port stakeholders to collaborate around technology and its application and adaptation. As the technology skills of DOTs and MPOs have expanded, port operators, shippers and carriers should consider how the public sector programs and capacities might best align with their own.

4. Ongoing Review of Other Automated Truck Applications

Automated truck technology is a rapidly-changing field, and ongoing developments in other industries may have implications for further USDOT research and testing for implementation in a port environment. Over-the-road trucking is a key focus for technology developers in this area, and it is anticipated that the automated truck technology described in this study will generally be developed and refined independently of drayage truck operational needs.[66] In addition, there are other public and private sector interests in the supply chain outside of marine cargo that are addressing technology development and staging practices of their own. Border crossings, for example, are a subject of ongoing study by the Federal Highway Administration and U.S. Customs and Border Protection. The queuing and congestion issues in that environment are similar to the issues faced by marine terminals, and the solutions developed for one may be suitable for implementation at another.

[66] As indicated earlier in this report, the role of a container chassis is unique to intermodal trucking and would have to be addressed for any automated truck technology to be applied to a port/marine terminal operation.

Appendix A. Reports Reviewed

2015 AASHTO Transportation Bottom Line Report, Executive Version. American Association of State and Transportation Officials. 2015

A Guidebook for Engaging the Private Sector in Freight Transportation Planning, Federal Highway Administration, 2010

Barbaresso J., Gustave Cordahi, Dominie Garcia, Christopher Hill, Alex Jendzejec, Karissa Wright, *USDOT's Intelligent Transportation Systems (ITS) ITS Strategic Plan 2015-2019*, USDOT 2014

Best Practices in Statewide Freight Planning, American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Planning, 2003

Dunn, Naomi J., Hickman, Jeffrey S., Soccolich, Susan, and Hanowski, Richard J., Driver Detention Times in Commercial Motor Vehicle Operations, FMCSA, 2014

Evaluating Alternatives for Landside Transport of Ocean Containers. Transportation Research Board, 2015.

Flanigan, Erin and Mark Howard, *An Interim Guidebook on the Congestion Management Process in Metropolitan Transportation Planning*, Federal Highway Administration, 2008

Global Intermodal Freight: State of Readiness for the 21st Century (Report of a Conference), Transportation Research Board, 2000.

Holguin-Veras, Jose, et al. *NCFRP 33: Improving Freight System Performance in Metropolitan Areas: A Planning Guide.* Transportation Research Board, 2015.

Jason's Law Truck Parking Survey Results and Comparative Analysis, Federal Highway Administration Office of Management and Operations, 2015.

Kruse, C. James, and Nathan Mark Hutson. *NCFRP 05: North American Marine Highways*. Transportation Research Board, 2010.

Mitigating Freight Impacts on Nearby Communities, Caltrans Division of Research, Innovation and System Information, June 2015

NCFRP 11: Truck Drayage Productivity Guide. Transportation Research Board, 2011.

NCFRP 18: Synthesis of International Freight Scans, Transportation Research Board, 2009.

NCFRP 40: Improving Export Freight Logistics, Transportation Research Board, 2015.

NCFRP 01: Public and Private Sector Interdependence in Freight Transportation Markets. Transportation Research Board, 2009.

NCFRP 02: Institutional Arrangements for Freight Transportation Systems. Transportation Research Board, 2009.

NCFRP 06: Impacts of Public Policy on the Freight Transportation System. Transportation Research Board, 2011.

NCFRP 10: Performance Measures for Freight Transportation. Transportation Research Board, 2011.

NCFRP 12: Framework and Tools for Estimating Benefits of Specific Freight Network Investments. Transportation Research Board, 2011.

NCFRP 16: Preserving and Protecting Freight Infrastructure and Routes. Transportation Research Board, 2012.

NCFRP 20: Guidebook for Assessing Evolving International Container Chassis Supply Models. Transportation Research Board, 2012.

NCHRP 03-94: Development of an AASHTO Guide for Systems Operations and Management. Transportation Research Board, 2013.

NCHRP 20-80: Long Range Strategic Issues Facing the Transportation Industry: Final Research Plan Framework (Task 2), National Cooperative Highway Research Program, Transportation Research Board, 2008.

North Jersey Truck Rest Stop Study Refinement and Action Plan, North Jersey Transportation Planning Authority, 2009

North Jersey Truck Rest Stop Study: An Assessment of Potential Locations for Truck Rest Areas in Northern New Jersey and the Port District, North Jersey Transportation Planning Authority, 2008

Short, J, Todd Trego, Dan Murray, Joan Yim Timothy Neuman, Gordon Proctor, Robert Gallamore, Shobna Varma, *NCFRP-07: Identifying and Using Low-Cost and Quickly Implementable Ways to Address Freight-System Mobility Constraints. TRB, 2010.*

SHRP 2 Report S2-C01-RR-1: Framework for Collaborative Decision Making on Additions to Highway Capacity. Transportation Research Board, 2014.

SHRP 2 Report S2-C15-RW-2: Integrating Freight Considerations into the Highway Capacity Planning Process: Practitioner's Guide. Transportation Research Board, 2014.

SHRP2 C15: Integrating Freight Considerations into the Highway Capacity Planning Process: Practitioner's Guide, Second Strategic Highway Research Program, 2014.

Steele, CW, and Daniel Hodge et. al. *NCFRP 13: Freight Facility Location Selection: A Guide for Public Officials.* Transportation Research Board, 2011.

Strauss-Wieder, Anne. *NCHRP Synthesis 320: Integrating Freight Facilities and Operations with Community Goals.* Transportation Research Board, 2003.

Truck Parking in Pennsylvania, Pennsylvania State Transportation Advisory Committee, 2007

Truck Parking Partnership Study, Baltimore Metropolitan Council, 2006

Appendix B. Online Questionnaire

Port Industry Survey for the U.S. DOT ITS Joint Program Office and Maritime Administration

Truck Staging at U.S. Ports

This port industry survey is for terminal operators, port authorities, and trucking organizations serving ports in the United States.

The 6-question survey asks you to share your perspective on current practices related to truck parking and staging practices and knowledge of future initiatives for the same. The result will be used to develop a research plan and portfolio of ITS projects that will improve the performance of maritime ports and terminals.

The survey is being conducted under a cooperative research program of the U.S. Department of Transportation's Intelligent Transportation Systems Joint Program Office and the Maritime Administration. Tom Phelan of Gannett Fleming, Inc., a consultant to the USDOT, is the survey administrator. If you have questions about the survey, please contact Tom Phelan at 908-358-6767, or by email at tphelan@gfnet.com. If you have questions about the cooperative research program, please contact Travis Black, StrongPorts Team Lead, Office of Ports & Waterways at 202-366-9087, or by email at travis.black@dot.gov.

Your response will be kept confidential. We require that you include your organization's name and a contact person so that we can evaluate the total response response by industry and region and clarify responses, if needed.

You are encouraged to share the survey link with your employees, contractors, public agencies, and other businesses involved in freight transportation at U.S. ports.

The survey will close on June 30, 2018. Thank you for your prompt participation.

Instruction: Please answer each of the six questions below. Include as much detail as you deem necessary.

1. What truck queuing, parking, and staging problems are you experiencing?

2. What actions to improve truck queuing, parking and staging have you taken or are you taking that have worked? Briefly list and note the basis of success or effectiveness. *Examples include GPS or RFID technology, terminal gate appointment systems, queue time detection, off-site truck staging, or other strategies used to deal with terminal queuing and congestion.*

3. Conversely, what actions have not worked? Briefly indicate why.

4. What other actions or approaches might you consider implementing for improved truck queuing, parking, and staging?

5. Has your organization conducted any research or investigation of autonomous trucks or other advanced technologies to help address these challenges? If so, what have you found?

6. Do you have any other insights on this issue that could be applicable to this national research effort?

* 7. Your Organization

* 8. Port or region

* 9. Name of survey respondent or contact

* 10. Phone number

Appendix C. Uniform Intermodal Interchange and Facilities Access Agreement (UIIA)

Click here to print the UIIA Agreement

Developed By:
The Intermodal Interchange Executive Committee

Effective: October 1, 2018

UNIFORM INTERMODAL INTERCHANGE AND FACILITIES ACCESS AGREEMENT (U I I A)

Administered By:

The Intermodal Association of North America
11785 Beltsville Drive, Suite 1100
Calverton, Maryland 20705-4049
Phone: Toll-Free (877)438-UIIA (438-8442) or (301)474-8700
Fax:(301)982-3414 or (301)982-5478 Website: www.uiia.org

Table of Contents

Table of Contents (continued)

FORM 2

UNIFORM INTERMODAL INTERCHANGE
AND
FACILITIES ACCESS AGREEMENT

(A Program of the Intermodal Association of North America)

Participating Party Agreement

The Party named below agrees that by executing the Uniform Intermodal Interchange and Facilities Access Agreement (UIIA) it will be bound by the provisions of the UIIA, and subsequent amendments and/or revisions of that Agreement, and any addendum thereto, that does not conflict with the terms of this Agreement, which govern the interchange and use of Equipment in intermodal interchange service. The Provider named below agrees that in its interchange activities with Motor Carrier participants who are signatories to the Agreement, this Agreement will be the only Agreement it will use, unless superseded in whole by a separate bilateral written equipment interchange agreement.

This Agreement shall be effective unless cancelled in writing, by mutual consent of the Parties, or by any Party upon thirty (30) days prior Notice to the other Party. A copy of the required written Notice must be provided to the President of IANA at the time it is issued. **[Revised 08/01/14]**

COMPANY NAME:_____

AUTHORIZED BY: (Print or Type)_____

SIGNATURE:_____ **TITLE:**_____

BUSINESS ADDRESS:_____
(Mailing Address) No. Street City

_____
State/Province Zip/Postal Code Phone No. Fax E-Mail

Indicate Nature of Business: _____Motor Carrier _____Provider

If Motor Carrier, please check all that apply to your business operations: ☐ Smartway Carrier

☐ For Hire ☐ Private ☐ Interstate ☐ Intrastate ☐ Commercial Zone/Terminal Area Operator

Standard Carrier Alpha Code (SCAC):_____

MC Number: _____ **DOT Number:** _____

Tax Identification No. or Canadian Business Number: _____

The provisions of this agreement shall become effective on the date accepted by the Association of the above named carrier and published in the list of subscribers or supplements thereto.

Acceptance Date:_____ By: _____
Assistant Vice President
Intermodal Information Services

Due to GDPR, if you are an EU resident, please check below:

[ ] I have read and accepted the IANA Privacy Policy: http://intermodal.org/privacy-policy
[ ] I have read and provide consent to the use of my personal data: http://intermodal.org/forms/eu-gdpr

Back to Top

FORM 2

UNIFORM INTERMODAL INTERCHANGE
AND
FACILITIES ACCESS AGREEMENT

(A Program of the Intermodal Association of North America)

Participating Party Agreement

The Party named below agrees that by executing the Uniform Intermodal Interchange and Facilities Access Agreement (UIIA) it will be bound by the provisions of the UIIA, and subsequent amendments and/or revisions of that Agreement, and any addendum thereto, that does not conflict with the terms of this Agreement, which govern the interchange and use of Equipment in intermodal interchange service. The Provider named below agrees that in its interchange activities with Motor Carrier participants who are signatories to the Agreement, this Agreement will be the only Agreement it will use, unless superseded in whole by a separate bilateral written equipment interchange agreement.

This Agreement shall be effective unless cancelled in writing, by mutual consent of the Parties, or by any Party upon thirty (30) days prior Notice to the other Party. A copy of the required Notice must be provided to the President of IANA at the time it is issued. **[Revised 08/01/14]**

COMPANY NAME:_____

AUTHORIZED BY: (Print or Type)_____

SIGNATURE:_____ **TITLE:**_____

BUSINESS ADDRESS:_____
(Mailing Address) No. Street City

_____
State/Province Zip/Postal Code Phone No. Fax E-Mail

Indicate Nature of Business: _____Motor Carrier _____Provider

If Motor Carrier, please check all that apply to your business operations: ☐ Smartway Carrier

☐ For Hire ☐ Private ☐ Interstate ☐ Intrastate ☐ Commercial Zone/Terminal Area Operator

Standard Carrier Alpha Code (SCAC):_____

MC Number: _____ **DOT Number:** _____

Tax Identification Number or Canadian Business Number: _____

The provisions of this agreement shall become effective on the date accepted by the Association of the above named carrier and published in the list of subscribers or supplements thereto.

Acceptance Date: _____

By: Debbie Tasko
Assistant Vice President
Intermodal Information Services

Back to Top

UNIFORM INTERMODAL INTERCHANGE AND FACILITIES ACCESS AGREEMENT

A. Purpose

The Parties to this Agreement hereby acknowledge their respective responsibilities in one Party's access to the Premises of the other for the purpose of interchanging intermodal transportation Equipment and further establish the terms and conditions under which such intermodal Equipment will be used.

B. Definitions of Terms

1. Actual Cash Value: Replacement cost less depreciation as referred to on Equipment Owners' or Providers' Books.
2. Addendum/Addenda: Providers' schedule of economic and commercial terms not appropriate for inclusion in the uniform Agreement and other terms and conditions of Equipment use. **[Revised 04/11/07]**
3. Agreement: This Agreement or amendments thereto and Addendum/Addenda.
4. Chassis: A steel frame equipped with wheels, landing gear, and kingpin assembly with locking devices for securing and transporting a container as a wheeled vehicle. **[Revised 06/08/15]**
5. Chassis Use/Rental Charge: Daily charge to be paid for use of chassis, as agreed to by the Parties. **[Revised 01/17/12]**
6. Container: An intermodal cargo carrying device capable of road transport when mounted on a chassis or other suitable device. **[Revised 11/18/09]**
7. Container Use Charge: Daily charge to be paid for use of Containers, as agreed to by the Parties. **[Revised 06/10/12]**
8. Contamination: Damage resulting from release of a hazardous material or other substance in Equipment which prevents subsequent use of the Equipment without removal of the material or substance. **[Revised 10/22/04]**
9. Damage: Any condition that prevents the intended use of the Equipment including those conditions described in Exhibit C; and Exhibit B that are not a result of normal Wear & Tear. **[Revised 02/10/14]**
10. Defect: Any condition (including dents, scrapes, cuts or missing items) that may, or may not, require the repair, replacement or renewal of items, but does not prevent the intended use of the Equipment. **[Revised 09/01/09]**
11. Destroyed: Where the reasonable and customary cost to repair Equipment exceeds its Actual Cash Value or depreciated replacement value. **[Revised 07/25/07]**
12. Equipment: Equipment commonly used in the road transport of intermodal freight including, trailers, chassis, containers and associated devices, but excluding tractors. **[Revised 11/18/09]**
13. Equipment Owner: The holder of actual or beneficial title to the Equipment, regardless of the form of the title. **[Revised 04/11/07]**
14. Equipment Interchange Receipt (EIR): A document confirming the interchange of Equipment between Parties to this Agreement, or their agents. The physical condition of the Equipment may be described by either Party within the EIR or via **R**ecorded **I**mages taken at the time of Interchange. **[Revised 04/11/07]**

Back to Top

15. Facility Operator: Party whose Premises are accessed for the purpose of effecting an interchange between signatories to this Agreement. **[Revised 02/24/06]**

16. Indemnitees: Provider, Equipment Owner and/or Facility Operator, as their interest may appear.

17. Interchange: The transfer of physical possession of Equipment under the Agreement.

18. Interchange Period: The period, commencing upon Interchange to Motor Carrier and concluding upon Interchange to Provider or another Motor Carrier that is authorized for Interchange by that Provider. **[Revised 06/13/16]**

19. Motor Carrier: The Party being granted access to the Provider's facilities and/or having physical possession of the Equipment for the purpose of road transport or its designated agent or contractor.

20. Notice: A communication between Parties of this Agreement required by the terms of the Agreement.

21. Parties: The Provider, Motor Carrier and/or Facility Operator who are signatories to this Agreement. **[Revised 02/24/06]**

22. Per Diem: Charge to be paid when intermodal Equipment is not returned by the end of the allowable free time to its origin or to another location, as specified by the Provider, or at the discretion of Provider, is Interchanged to another Motor Carrier. A charge meeting the foregoing description constitutes Per Diem under this Agreement whether or not it is referred to as Per Diem, a detention charge, or otherwise. **[Revised 08/01/18]**

23. Premises: The property operated by Provider or Facility Operator for the purpose of Interchange. **[Revised 09/01/09]**

24. Provider: The Party or Parties authorizing delivery and/or receipt of physical possession of Equipment with a Motor Carrier. The Provider of the Chassis and Container may not necessarily be the same Party. **[Revised 06/08/15]**

25. Recorded Image: A date and time stamped electronic image, which depicts the physical condition of the Equipment. **[Revised 04/11/07]**

26. Storage/Ocean Demurrage: Charge to be paid when intermodal Equipment is stored on property**. [Revised 07/25/07]**

27. Wear and Tear: A loss or condition resulting from reasonable and normally anticipated use of Equipment that includes deterioration. Deterioration is defined as a loss or condition resulting from the passage of time, exposure to elements and the repetitive normal and customary use of Equipment. **[Revised 11/18/09].**

C. Premises Access

1. Provider and/or Facility Operator grants to Motor Carrier the right to enter upon its terminal facility for the sole purpose of completing an Interchange of Equipment.

2. Nothing in this Agreement shall preclude Provider or Facility Operator from refusing access to a Motor Carrier for good cause shown. Provider or Facility Operator shall exercise this right in good faith, providing to Motor Carrier a written statement of the reason for its action by registered mail, e-mail or confirmed facsimile no less than three (3) business days prior to the suspension. **[Revised 11/08/10]**

Back to Top

D. Equipment Interchange

1. Notification of Equipment Availability

   a. If Provider and/or Facility Operator undertakes to notify Motor Carrier of Equipment availability, it represents that the Equipment will be available for Interchange when the Motor Carrier arrives. **[Revised 09/01/09]**

   b. Where it is notified, as provided herein, Motor Carrier must Interchange Equipment promptly upon notification. Motor Carrier will be responsible to Provider for the charges, as may be described in Provider's Addendum hereto, in the event Motor Carrier fails to remove Equipment during the free time provided in the Addendum.

2. Equipment Interchange Receipts

   a. At the time of Interchange, the Parties or their agents shall execute an Equipment Interchange Receipt and/or exchange an electronic receipt equivalent, which shall describe the Equipment and any Damage observable thereon at the time of Interchange, reasonable Wear and Tear excepted. The physical condition of the Equipment may be described by either Party within the EIR or via Recorded Images taken at the time of Interchange. **[Revised 05/12/10]**

   b. Use of electronic EIRs requires that the Provider or the Facility Operator provide an electronic system whereby the Motor Carrier may describe electronically, the condition of the Equipment at the time of Interchange, without substantially burdening the Motor Carrier's use of electronic EIRs at the same Premises, and that this information be incorporated as part of the electronic EIR. **[Revised 09/16/17]**

   c. Each Party shall be entitled to receive a copy and/or an electronic receipt equivalent of the Equipment Interchange Receipt as described in D.2.a above without charge. **[Revised 11/12/12]**

   d. If Recorded Images are taken at the time of Interchange, Damage will not be reported on ingate or outgate EIR. The words "Damage is captured on Recorded Images" will be printed on the Equipment Interchange Receipt. All such Recorded Images will be made available for each Party for a period of 1 year from Interchange without charge. **[Revised 11/12/12]**

3. Equipment Condition

   a. Warranty: **WHILE PARTIES MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE FITNESS OF THE EQUIPMENT, THEY RECOGNIZE AND AFFIRM THEIR RESPONSIBILITIES UNDER THE FEDERAL MOTOR CARRIER SAFETY REGULATIONS ("FMCSRs") AND AGREE THAT THEY SHALL NOT INTERCHANGE EQUIPMENT UNLESS THEY HAVE COMPLIED WITH THE FMCSRs. [Revised 10/01/18)**

   b. Motor Carriers will conduct a pre-trip inspection prior to departing with interchanged Equipment that will include those items set forth in Exhibit A to this Agreement. **[Item Re-numbered 10/01/18]**

   c. Equipment controlled by Provider shall have a valid FMCSA inspection sticker. Provider will reinspect and recertify the Equipment, at Motor Carrier's request, if the existing inspection will expire during the Addendum free time period of the Motor

Back to Top

Carrier's use. This provision is only applicable to the Provider of the Chassis. **[Revised 06/08/15]**

d. Motor Carrier will reinspect and recertify the Equipment if the existing inspection will expire prior to the Motor Carrier's return of the Equipment to the Provider. This provision is only applicable to the Provider of the Chassis. **[Revised 06/08/15]**

e. Motor Carrier will Interchange the Equipment to the Provider or another Motor Carrier that is authorized for Interchange by that Provider, in the same condition, reasonable Wear and Tear excepted. **[06/13/16]**

1) The responsibility for the repair and/or replacement of Equipment items during the Interchange Period are listed in Exhibits B and C of this Agreement. **[Revised 07/25/07]**

2) Motor Carrier and Provider will not issue an invoice for repair items equal to or less than $50 per unit per Interchange Period. Provider may, in its Addendum, adopt a different threshold amount as long as that amount is greater than $50 and applies to both Motor Carrier and Provider**. [Revised 07/25/07]**

E. Equipment Use

1. Equipment Return

a. Absent a separate bilateral equipment interchange agreement in written or electronic form between the Parties, the Motor Carrier shall use the Equipment for only the purposes for which it was interchanged, not authorize use by others, and promptly return the Equipment after its interchange purpose is complete. An Addendum to this Agreement does not constitute a separate bilateral equipment interchange agreement. **[Revised 02/08/16]**

b. Motor Carrier shall return the Equipment to the physical location at which the Equipment was received unless the Provider directs the Equipment to be returned to a satellite location**(**s**):** 1) as governed by a written bilateral equipment interchange agreement between the Parties or 2) as specified in a notification from the Provider to Motor Carrier via internet posting or e-mail to return the Equipment to a Provider-designated satellite location, listed in IANA's Equipment Return Location Directory (ERLD). Satellite location(s) are facilities which are within the same local commercial territory and support operations of the Provider for the location from which the Equipment was originally received. Whenever a return location is changed, Provider must notify the Motor Carrier by e-mail by 16:00 p.m. local time the business day prior to the change becoming effective. Motor Carrier must furnish the Provider with e-mail addresses to be used for Motor Carrier notification when return locations are changed. **[Revised 02/08/16]**

c. Provider may add or delete satellite locations to its listing by giving fourteen (14) days written notice to IANA. **[Added 02/08/16]**

d. Should the notification required under subsection 1.b. above not be made one (1) business day prior to the effective date of the change, and the late notification delayed the Interchange of Equipment, then the Motor Carrier would be entitled to one (1) additional business day to return the Equipment. **[Added 02/08/16]**

e. Nothing in Section E. shall be interpreted to preclude Motor Carrier from receiving compensation when Provider directs Equipment to be returned to a satellite

location. Compensation for services rendered in these circumstances is outside the scope of this Agreement. **[Added 02/08/16]**

2. Lost, Stolen, or Destroyed Equipment

   a. In the event the Equipment is lost, stolen from, or Destroyed by Motor Carrier, the method of settlement shall be the Actual Cash Value or the depreciated replacement value, as agreed between the Parties. **[Revised 09/01/09]**

   b. In the event Motor Carrier is compelled to compensate Provider for loss or damage to Equipment due to the acts of third parties, Provider will assign to Motor Carrier its rights against such third party upon receiving payment in full from Motor Carrier.

   c. When Equipment is lost, stolen or Destroyed, the Motor Carrier and Provider will follow the notification and invoicing processes as set forth in the Provider's Addendum. If the Provider's Addendum does not contain notification and/or invoicing processes for lost, stolen, or Destroyed Equipment, the following will apply:

      Motor Carrier shall promptly notify Provider when Equipment is lost, stolen, or Destroyed. Provider shall within thirty (30) days after receipt of such notification, secure and furnish to the Motor Carrier a written statement of the depreciated replacement value or Actual Cash Value of the Equipment, as agreed between the Parties [or as set forth in Provider's Addendum]. Motor Carrier shall pay Provider the amount specified in the written statement within (30) days of the date of such written statement. **[Revised 09/01/09]**

   d. Provider will notify Motor Carrier within 18 months from the date of Interchange if Equipment is declared lost, stolen or Destroyed. If Provider does not so notify Motor Carrier, the right to recover any associated charges or Actual Cash Value will be lost. **[Revised 09/01/09]**

3. Damage to Equipment

   a. Motor Carrier shall pay to Provider the reasonable and customary costs to repair Damages done to Equipment during Motor Carrier's possession. **[Revised 09/01/09]**

      1) A Provider will determine the Motor Carrier that it will invoice for Damage to Equipment that occurred during the Interchange Period. **[Revised 01/01/18]**

      2) To be valid, invoices must detail the repairs done; include a copy of the actual repair bill upon which the invoice is based and include the factual documentation supporting the Provider's determination that the Motor Carrier is responsible. In instances where a copy of the actual repair bill is not available to Provider, documentation containing the repair vendor's name, repair date, location and a control number that ties the documentation to the invoice provided to the Motor Carrier is acceptable, in lieu of the actual repair bill. In the case of **a** gate transaction **using Recorded Images** such documentation must include images depicting the condition of the Equipment at the time of that Interchange. **[Revised 10/01/18]**

   b. Where the reasonable and customary cost to repair exceeds the casualty loss value as determined in Section E.2.a hereof, the Motor Carrier shall be obligated only for the lesser sum.

Back to Top

c. Parties shall invoice repair costs no later than the following timeframes: If Parties are not invoiced within the established timeframes, the right of the Invoicing Party to recover such charges will be lost: **[Revised 01/26/15]**

1) Standard Gate System (manned) or Interchange between Motor Carriers: Invoices for repair of Damages must be issued no later than 165 calendar days from the date of Interchange at the time the Damage was documented. **[Revised 06/13/16]**

2) **Gate transactions using Recorded Images**: Invoices for repair of Damages must be issued no later than 120 calendar days from the date of Interchange at the time the Damage was documented. **[Revised: 10/01/18]**

1) Invoices for repairs made during the Interchange Period must be issued no later than 90 calendar days from the date of the repair. Provider may, in its Addendum, adopt a shorter billing timeframe, which is no less than 45 days, and applies to both the Motor Carrier and Provider. **[Revised 01/26/15]**

2) The above timeframes shall not apply with respect to any Equipment that has been placed on hold at the request of any of the Parties because the Equipment was involved in an incident that could give rise to a claim or litigation. The applicable timeframe shall begin to run from the date on which all Parties agree to release the Equipment for repair.

In the event that the circumstances referred to in this situation arise and a hold is placed by Provider, upon receiving notice of the damage, the Provider will give notice to the interchanging Motor Carrier that such damages have occurred and that a hold has been placed on the repair. Failure to give such notice within 45 days of the Equipment being placed on hold will void the right of the Provider to invoice for such repairs. **[Revised 08/26/13]**

4. Tires

a. Repair of Damage to tires during Motor Carrier's possession is the sole responsibility of Motor Carrier**,** based on prevailing reasonable and customary repair costs and equipment use. **[Revised 09/01/09]**

b. Repair of tires unrelated to Damage occurring during Motor Carrier's possession is the sole responsibility of the Provider**,** based on prevailing reasonable and customary repair costs and equipment use. **[Revised 09/01/09]**

c. Photographic evidence shall be used for tire repair responsibility assignment. Photos of the tire will be produced by the road service provider based upon the stipulated criteria set forth in the Supplement to Exhibit C, Tire Marking and Photo Requirements of the UIIA. **[Added 08/01/18]**

d. A Provider cannot require the Motor Carrier to return the physical carcass of a tire. **[Added 08/01/18]**

5. Disposal of Dunnage

a. Motor Carrier shall return Equipment with all dunnage, bracing, contaminants and debris removed and the floor swept. This provision is only applicable to the Provider of the Container. **[Revised 06/08/15]**

6. Free Days**,** Per Diem, Container Use, Chassis Use/Rental and/or Storage/Ocean Demurrage Charges

    a. Interchange of Equipment is on a compensation basis. Provider may permit some period of uncompensated use and thereafter impose Per Diem, Container Use, Chassis Use/Rental and/or Storage/Ocean Demurrage charges, as set forth in its Addendum. **[Revised 01/17/12]**

    b. Motor Carrier shall be responsible for Per Diem, Container Use, Chassis Use/Rental and/or Storage/Ocean Demurrage charges set forth in the Addenda. **[Revised 01/17/12]**

    c. Provider shall invoice Motor Carrier for Per Diem, Container Use, Chassis Use/Rental and/or Storage/Ocean Demurrage charges within sixty (60) days from the date on which Equipment was returned to Provider by Motor Carrier. If Motor Carrier is not invoiced within the established timeframe, the right of the Provider to recover such charges will be lost. **[Revised 01/17/12]**

    Should Provider invoice the incorrect party, Provider may invoice the interchanging Motor Carrier within thirty (30) days from the date the incorrect party disputes the charges with Provider or within the original sixty (60) day deadline, whichever is later. The preceding sentence only applies as long as the Provider issues such invoice to the interchanging Motor Carrier within ninety (90) days from the date on which Equipment was returned. **[Added 01/01/17]**

    d. Notwithstanding anything to the contrary in this Agreement, when a Motor Carrier disputes a Per Diem invoice on the basis that the amount due is different than the amount that would otherwise be due under a separate third party agreement, the Motor Carrier must provide documentation supporting this claim, and the Provider shall not suspend the Motor Carrier's interchange privileges until the discrepancy has been resolved by the Provider. **[Added 03/1/18]**

    e. Provider shall provide the Motor Carrier documentation as is reasonably necessary to support its invoice.

    f. Motor Carrier shall respond in writing to Provider's invoices within thirty (30) days, documenting with appropriate evidence its disagreement with any of Provider's invoices it believes to be incorrect.

    g. Motor Carrier will participate in good faith in Provider's established method of dispute resolution, as set forth in its Addendum.

F. Liability, Indemnity and Insurance

    1. Fines, citations: Motor Carrier shall pay all fines arising out of its acts or omissions in the operation of Equipment during the Interchange Period.

        a. Motor Carrier will provide a corrected copy of Equipment-related citations to Provider upon completion of Interchange.

    2. Independent contractor status: No Party or its agents is the employee or agent of any other Party.

    3. If the Equipment is interchanged by Motor Carrier or is otherwise authorized by Motor Carrier to be in the possession of other parties, the Motor Carrier shall be responsible for the performance of all terms of this Agreement in the same manner as if the Equipment

Back to Top

were in the possession of the Motor Carrier, unless the written **or electronic** consent of Provider has been obtained. **[Revised 06/13/16]**

4. Indemnity:

   a. Subject to the exceptions set forth in Subsection (b) below, Motor Carrier agrees to defend, hold harmless and fully indemnify the Indemnitees (without regard to whether the Indemnitees' liability is vicarious, implied in law, or as a result of the fault or negligence of the Indemnitees), against any and all claims, suits, loss, damage or liability, for bodily injury, death and/or property damage **(other than cargo loss, damage, or delay unrelated to a commercial motor vehicle accident involving the Motor Carrier or theft of the cargo during the Interchange Period),** including reasonable attorney fees and costs incurred in the defense against a claim or suit, or incurred because of the wrongful failure to defend against a claim or suit, or in enforcing subsection F.4 (collectively, the "Damages"), caused by or resulting from the Motor Carrier's: use or maintenance of the Equipment during an Interchange Period; and/or presence on the Facility Operator's premises. **[Revised 10/01/18]**

   b. Exceptions: The foregoing indemnity provision shall not apply to the extent Damages: (i) occur during the presence of the Motor Carrier on the Facility Operator's premises and are caused by or result from the negligent or intentional acts or omissions of the Indemnitees, their agents, employees, vendors or third party invitees (excluding Indemnitor); or (ii) are caused by or result from defects to the Equipment with respect to items other than those set forth in Exhibit A, unless such defects were caused by or resulted from the negligent or intentional acts or omissions of the Motor Carrier, its agents, employees, vendors, or subcontractors during the Interchange Period. **[Revised 1/17/05]**

5. Notice of Filed Claims:

   a. Motor Carrier shall promptly notify Provider, Equipment Owner and/or Facility Operator of any claim arising against Motor Carrier under Section F.4, and shall also advise Provider, Equipment Owner and/or Facility Operator at that time of the legal defense undertaken regarding that claim. Failure of the Motor Carrier to timely provide such legal defense, and the undertaking of that legal defense by Provider, Equipment Owner and/or Facility Operator to protect such Party's respective interests, shall result in the Motor Carrier's bearing such reasonable attorney fees and costs incurred by the Provider, Equipment Owner and/or Facility Operator in providing such legal defense.

   b. Provider, Equipment Owner and/or Facility Operator shall promptly notify Motor Carrier of any claim arising under Section F.4. which Provider, Equipment Owner and/or Facility Operator receives. Provider, Equipment Owner and/or Facility Operator shall not undertake any legal defense of or incur any legal expenses **(including, but not limited to, accident investigation and reconstruction costs)** pertaining to the claim submitted to the Motor Carrier, unless Motor Carrier fails to timely do so as provided in Section 5.a. **[Revised: 10/01/18]**

6. Insurance: To the extent permitted by law, Motor Carrier shall provide the following insurance coverages in fulfillment of its legal liability and obligations contained in this Agreement:

   a. A commercial automobile insurance policy with a combined single limit of $1,000,000 or greater, insuring all Equipment involved in Interchange including vehicles of its agents or contractors; said insurance policy shall be primary to any and all other applicable insurance and shall name the Provider as additional insured. The extent of

Providers' additional insured status is limited to the provisions of Section F.4 hereof. **[Revised 09/01/09]**

b. A commercial general liability policy with a combined single limit of $1,000,000 per occurrence or greater, of which no portion can be self-insured. **[Revised 04/11/07]**

c. Motor Carrier shall have in effect, and attached to its commercial automobile liability policy, a Truckers Uniform Intermodal Interchange Endorsement (UIIE-1), which includes the coverages specified in Section F.4. Motor Carrier shall use endorsement form UIIE-1 (or other corresponding forms which do not differ from UIIE-1) in the most current form available to the insurance carrier. Evidence of the endorsement of the policy and the coverage required by this provision shall be provided to IANA by the insurance company.

d. IANA shall receive a minimum of thirty (30) days advance Notice of cancellation of any insurance coverage set forth in Section F.6. of the Agreement in addition to any insurance coverage required in the Provider's Addendum, unless such cancellation is due to non-payment of premium in which case a minimum of ten (10) days advance Notice of cancellation is required. **[Revised 01/17/12]**

7. The Provider agrees that it will obtain all information concerning Motor Carrier Certificates of Insurance from the Intermodal Association of North America, and that additional evidence of insurance will not be requested from Motor Carrier Participants.

G. General Terms

1. Entire Agreement: This Agreement, including its Addendum, but only to extent that its terms do not conflict with this Agreement, contain the entire Agreement between the Parties hereto. This Agreement supersedes all prior agreements and understandings, oral or written, if any, between the Parties except as contained herein. No modification or amendment of any of the terms, conditions or provisions herein may be made otherwise than by written Agreement signed by the Parties.

   This Agreement shall apply unless it is superseded in whole by a separate bilateral written equipment interchange agreement. **[Revised 08/01/14]**

2. Headings: The headings contained in this Agreement are for reference purposes only and shall not affect in any way the meaning or interpretation of this Agreement.

3. Waiver: The terms or conditions of this Agreement may be waived at any time by the Party entitled to the benefit thereof, but no such waiver shall be effective unless the same is in writing and no such waiver shall affect or impair the right of the waiving Party to require observance, performance or satisfaction either of that term or condition as it applies on a subsequent occasion or of any other term or condition hereof. The waiver by any Party of a breach of any provision of this Agreement shall not operate or be construed as a waiver of any subsequent breach of the same or any other provision of this Agreement by either Party.

4. Material Breach: If it is determined that, at the time of Interchange, the Motor Carrier was not insured in accordance with Section F.6. of this Agreement, the Motor Carrier shall have been in material breach of this Agreement and the Agreement shall, subject to the survivability provisions hereof, terminate immediately pursuant to Section G.16.

   With the exception of Section G.4., no breach of this Agreement, either by an individual Motor Carrier or by an individual Provider/Facility Operator, shall affect the rights and obligations of that Motor Carrier or Provider/Facility Operator with all other Parties hereto.

5. Assignment: No Party shall assign this Agreement or any part hereof without the written consent of the other Parties provided that no such consent shall be required in the event of Provider's assignment to a successor-in-interest as a result of a merger or sale of substantially all of Provider's assets.

   Except as otherwise provided herein, this Agreement shall be binding upon and inure to the benefit of the Parties hereto and their respective successors and permitted assign.

6. No Third Party Beneficiaries: Except as expressly provided herein, nothing in this Agreement shall entitle any person other than the Parties or their respective successors and mutually accepted assigns to any claim, cause of action, remedy or right of any kind. **[Revised 04/11/07]**

7. Governing Law: The laws of the state of Maryland, the location at the principal place of business of the Intermodal Association of North America shall govern the validity, construction, enforcement and interpretation of this Agreement without regard to conflicts of law principles.

8. Venue: Any action which may be brought to enforce or interpret this Agreement shall be brought in a trial court of competent jurisdiction as follows:

   a. As to questions of interpretation or enforcement of the Agreement, at the location of the principal place of business of the Intermodal Association of North America;
   b. As to questions of indemnification under the Agreement at the situs of the transaction giving rise to the requested indemnification;
   c. As to monetary obligations between the Parties by reason of Equipment usage charges at the situs of the transaction giving rise to the requested damages;
   d. As to monetary damages between the Parties arising out of physical damage to or loss of Equipment, at the situs at which the Equipment was last interchanged prior to such loss or damage.

9. Severability: If any one or more of the provisions contained in this Agreement shall for any reason be held to be invalid, illegal or unenforceable in any respect, such invalidity, illegality or enforceability shall not change or invalidate any other provisions hereof.

10. Survival: Cancellation of this Agreement notwithstanding, Motor Carrier shall remain obligated to return Equipment provided hereunder and otherwise perform its obligations outstanding at the time of cancellation.

11. Compliance with the Law: The Parties shall obey all applicable federal, state and local laws, rules and regulations including those pertaining to the transportation of hazardous material. **[Revised 08/26/13]**

12. Force Majeure: In the event the Motor Carrier is unable to Interchange Equipment to Provider within the free time as specified in Provider's Addendum, or Provider's applicable Tariff, as a result of Acts of God, war, insurrections, strikes, fire, flood or any like causes beyond the Motor Carrier's control, the Motor Carrier shall be exempted from the Per Diem charges to the extent of, and for the duration of, the condition that prevented the redelivery of the Equipment. **[Revised 09/13/04]**

13. Attorney's Fees: Should any action be brought by either Party to enforce or for the breach of any other terms, covenants or conditions of this Agreement, either Party shall be entitled, if it shall prevail, to recover reasonable attorneys' fees together with the cost of the suit therein incurred.

14. Notices:

    a. The Provider agrees to provide ten (10) days written Notice to the Motor Carrier of any changes to the terms or conditions of its Agreement Addendum. The effective date of any change shall be no less than thirty (30) days from the date of notification to Motor Carrier. **[Revised 06/02/05]**

    b. Notices required under this Agreement from Motor Carrier to Provider, or from Provider to Motor Carrier, shall be in writing and sent via e-mail, by confirmed facsimile or by first class mail, postage paid, and properly addressed to IANA. Alternatively, such written Notice can be personally served, sent by registered or certified mail, postage prepaid, or by a national overnight courier or delivery service, properly addressed to the individual shown in the UIIA subscriber record. Either Party, at any time, may change its address by written Notice to IANA via e-mail, fax or mail. The earlier of (1) the date of receipt or (2) three days after the date such written Notice is given in accordance with this Paragraph shall constitute the initial date of Notice in computing the elapsed time as specified in any Notice requirement in this Agreement. **[Revised 05/12/10]**

    c. In the event it becomes necessary for the Provider to suspend a Motor Carrier's interchange privileges for non-payment of outstanding invoices, Provider shall notify Motor Carrier, via confirmed facsimile, e-mail or letter, no less than 3 business days prior to suspension, that unless the outstanding issue is resolved, suspension of interchange privileges may occur. The final notification shall include contact information necessary for the Motor Carrier to resolve the outstanding issue. **[Revised 04/26/05]**

15. Multiple Counterparts: The Agreement may be executed in a number of identical counterparts, each of which for all purposes is to be deemed an original, and all of which constitute, collectively, one Agreement; but in making proof of this Agreement, it shall not be necessary to produce or account for more than one such counterpart.

16. Term: This Agreement shall be effective for a period of one year from its execution and shall continue in effect thereafter for consecutive one year terms unless cancelled in writing, by consent of the Parties, or by any Party upon thirty (30) days prior Notice to the other Party or to the President of IANA.

    A Party whose participation in the Agreement has been cancelled for nonpayment of the IANA Administrative Service Fee may not assert any rights under this Agreement for any Interchange undertaken during the period of the cancellation.

    The absence of insurance as required in Section F.6. hereof shall effect immediate cancellation of the Motor Carrier's rights under this Agreement until such time said requirements are again satisfied.

    Notwithstanding any other provisions of this Agreement, the obligations and rights of the Parties under Section F.1, 4, 5, and 6 shall survive any cancellation of this Agreement.

H. Default Dispute Resolution and Binding Arbitration Processes

1. In absence of a dispute resolution process contained in the Provider's Addendum that establishes timeframes for signatories to the Agreement to dispute invoices and respond to the dispute with respect to Per Diem, maintenance and repair or Equipment use/rental charges, the following default dispute resolution process will apply: **[Revised 05/01/17]**

Invoiced Party shall advise Invoicing Party in writing of any disputed items on invoices within 30 days of the receipt of such invoice(s), documenting with appropriate evidence, its disagreement with any of Invoicing Party's bills it believes to be incorrect. Invoicing Party will respond in writing to such disputed items within 30 days of receipt of Invoiced Party's notice with its decision to accept or deny the Invoice Party's dispute. The Invoiced Party will have 15 days from the date of the Invoicing Party's response to either pay the claim(s) or seek arbitration. Such disputes do not constitute valid grounds for withholding or delaying payments of undisputed charges as required by the Terms of this Agreement. **[Revised 06/13/16]**

2. Should no resolution be reached between the Parties for charges disputed within the applicable dispute resolution process, then the Parties will have the ability to submit the disputed charges for binding arbitration in accordance with Exhibit D of the Agreement. The arbitration panel will determine the Party responsible for payment based on the terms and conditions of the Agreement and the Provider's Addendum along with the supporting documentation presented by the involved Parties.

   If a Provider's Addendum contains a dispute resolution process that does not include an arbitration provision, then the terms under Exhibit D to the UIIA will apply. **[Revised 04/14/11]**

3. Should Invoiced Party fail to dispute an invoice relating to Per Diem**,** maintenance and repair or Equipment use/rental charges within 30 days after receipt of the invoice, the Invoiced Party will lose any further right to dispute the invoice under the Invoicing Party's initial dispute process, or in absence of a dispute resolution process in the Provider's Addendum, the default dispute resolution process in Section H.1. Further, the Invoiced Party, upon failing to dispute the invoice or seek arbitration within the prescribed timeframe, immediately will be responsible for payment thereof to the Invoicing Party and will lose its right to pursue binding arbitration under Exhibit D of the Agreement or assert any other defense against the invoice. **[Revised 05/01/17]**

4. Should the Invoicing Party fail to respond to the Invoiced Party's dispute of an invoice relating to Per Diem**,** maintenance and repair or Equipment use/rental charges within the established timeframes in the Provider's Addendum, or in absence of a dispute resolution process in the Provider's Addendum, the default dispute resolution process in Section H.1., the Invoicing Party will lose its right to collect such charges and its ability to pursue binding arbitration under Exhibit D of the Agreement. **[Revised 05/01/17]**

5. If any dispute between Invoiced Party and Invoicing Party has not been submitted to binding arbitration as described in this section, and in the event that charges have been verified by Invoicing Party and are again rejected and disputed by Invoiced Party for whatever reasons, Invoicing Party and Invoiced Party reserve their rights and remedies under the law regarding the payment of such charges. Further, the Parties may pursue any rights and remedies they may have under the law to enforce an award of the arbitrators made under this Agreement and Exhibit D, or under the terms of the Provider's Addendum. **[Revised 04/14/11]**

I. Execution Clause

This Agreement shall be binding upon all Parties, and of full force and effect, at the time of its signing by a duly authorized official of a Party and its acceptance by IANA. An authorized official's signing constitutes the executing Party's representation that the executor possesses such authorization.

J. Agreement Effective Date **(added 01/17/12)**

A Party's signature on the Preamble or Participating Party signature page to the UIIA binds that Party to the terms and conditions of the Agreement and all Providers' Addenda, and any subsequent amendments and/or revisions to the Agreement and any Providers' Addenda. The effective date of participation in the Agreement, including any Providers' Addenda, is the date of execution by the Party entered on the Preamble or Participating Party Agreement signature page and is contingent upon acceptance of this document by IANA.

This Agreement and all Providers' Addenda shall be effective unless cancelled in writing, by mutual consent of the Parties, or by any Party upon thirty (30) days prior Notice to the other Party. A copy of the required written Notice must be provided to the President of IANA at the time it is issued.

Back to Top

Appendix I

ADMINISTRATIVE PROCEDURES

I. Administration and Implementation

A. The Intermodal Interchange Executive Committee (hereinafter called the "Committee"), a Standing Committee of the Intermodal Association of North America, is responsible for the administration and interpretation of the Agreement, and for the processing of changes and/or modifications to the Agreement. **[Revised 04/06/05]**

B. All proceedings of the IIEC are considered privileged and confidential. This would include but not be limited to: All documents and correspondence, written or electronic, relating to the administration of the Uniform Intermodal Interchange and Facilities Access Agreement (UIIA) and specific discussions of the Committee in the course of administering the UIIA. **[Revised 08/26/13]**

C. The Chairperson of the Committee shall be the President of the Intermodal Association of North America, who shall serve without voting privilege. The President is responsible for the Administration and Management of IANA and the Agreement, as provided in IANA's bylaws.

1. IANA's sole responsibility is to accurately report any information, as provided, that is required for participation in this Agreement. **[Revised 04/20/09]**

D. The Committee shall consist of a minimum of two representatives from each mode representing Motor, Ocean and Rail Carriers participating in the Agreement, with an equal representation of each mode. **In addition, one representative and two alternates from Equipment Leasing Companies participating in the Agreement will also serve on the Committee.** Each alternate shall participate in Committee meetings and serve as a voting member in the absence of a principal representative. In such absence, the modal voting members shall select the alternate who will act as the voting representative. Representatives and alternates must be from companies that are current signatories to the Agreement. Attendance at meetings is limited to voting members and alternates. If Committee members wish to have an industry representative invited to attend a meeting in an advisory capacity, the majority of the Committee must approve of this invitation prior to it being delivered. **[Revised 10/01/18]**

E. To conduct business under the IANA Agreement, a quorum shall consist of the Chairperson and at least two Committee representatives **each** from **the Motor, Ocean and Rail modes and one Committee representative from the Equipment Leasing Company Providers. [Revised 10/01/18]**.

F. Items to be included on the Agenda for any regularly scheduled meeting of the Committee must be provided, in writing, to the Chairperson, at least forty-five (45) days in advance of the meeting date. Agenda items received less than 45 days prior to a regularly scheduled Committee meeting, will be placed on the Agenda under Other Business, and will be discussed, time permitting. **[Revised 04/06/05]**

G. The duties of the Chairperson, shall consist of the following:

1. The Chairperson shall be responsible for the day-to-day management of the Interchange program, including marketing and promoting the Agreement among the various segments of the industry; retaining the originals of the signed Uniform Intermodal Interchange and Facilities Access Agreements or amendments thereof; and exchanging information with Committee members concerning new signatories.

2. The Chairperson shall maintain a current list of the Parties to the Agreement and shall periodically identify newly terminated participants.

3. The Chairperson shall disseminate pertinent information on participating Motor Carriers to Providers in a method mutually agreed to by Providers and the IANA. Entry by new participants to the Agreement shall become effective on the date the Agreement is accepted by the Chairperson as being in compliance.

4. Committee members will be provided with the meeting Agenda and appropriate backup materials, at least thirty (30) days in advance of any regularly scheduled meeting. **[Revised 04/06/05]**

H. In the absence of a definitive process within these Administrative Procedures, all meetings shall be conducted in accordance with Roberts Rules of Order. **[Revised 04/06/05]**

II. Review Procedures for New or Revised Providers Addenda

A. The appropriate modal Committee members will review the Addenda for new Providers and revisions to Addenda for existing Providers. These Committee members will determine whether the Addenda language is consistent with the existing provisions of the Agreement. Economic terms and those commercial terms that are not appropriate for consideration within the UIIA which are included in the Addenda are not reviewed. **[Revised 04/11/07]**

B. A new or existing Provider shall submit Addendum language to the Chairperson of the Committee a minimum of ninety (90) days prior to the effective date of the Addendum. Within ten (10) working days after receipt of new or revised Addendum language, the Chairperson shall forward, through facsimile transmission or mail, and/or by e-mail, a copy of the proposed Addendum language and an evaluation by IANA staff of the conformance of such language with the Agreement to Committee members representing the affected mode(s). Economic or commercial terms will be deleted from the Addendum before forwarding to the Committee members. **[Revised 04/06/05]**

C. Modal Committee members shall review the Addendum language and submit any comments, in writing, to the Chairperson of the Committee within fifteen (15) working days of their confirmation of receiving the new Addendum language, and **[Revised 04/06/05]**

1. In the absence of the submission of any adverse comments from the modal Committee members conducting the review, the new or revised Addendum will become effective on the proposed effective date. **[Revised 11/01/06]**

2. If any modal Committee member questions Addendum language as being in conflict with the Agreement, a conference call shall be held between the Committee members conducting the review, the Provider submitting the Addendum language in question, and a designated IANA staff member. The purpose of the call will be to discuss the specific provisions in question and shall be held within fifteen (15) working days after the timeframe for Committee review has expired. **[Revised 11/01/06]**

a) If a majority of the modal Committee members participating in the meeting or conference call determine that the Addendum language conflicts with the Agreement, the Provider will be requested to modify or delete the specified Addendum language. If such revisions responsive to the Committee's determination are made the Addendum will become effective on the proposed

Back to Top

effective date. In the event the Provider refuses to modify the Addendum language, participation in the Agreement will be declined. Regarding modifications to existing Addendum language, Provider will be requested to modify or delete the involved Addendum language and will be provided a ten (10) day comment period to respond to the Committee's determination. Refusal by a Provider to adopt the language modifications will result in the termination of participation in the Agreement.

If a "simple" majority of the modal Committee members participating in the meeting or conference call do not agree on acceptance or denial of the addendum language, the Addendum language in question, will be denied. **[Revised 04/06/05]**

b) If a majority of the Committee members participating in the meeting or conference call do not agree that the Addendum language conflicts with the Agreement, the Addendum will become effective on the proposed date.

3. Once Addendum language is approved by the modal Committee members, with the exception of the discovery of a material mistake regarding the consistency of an Addendum provision with the UIIA, no additional requests from Committee members for modifications to the approved language in the Addendum will be entertained for a period of six months from the effective date of the Addendum. **[Revised 04/11/07]**

III. Requests for Interpretation of Agreement Provisions

A. Requests for interpretations of the Agreement shall be handled initially by informal ruling of the Chairperson in consultation with Committee members representing the industry segments involved. IANA's General Counsel will serve as legal advisor for such consultations. Such interpretations shall be limited to applicability or consistency with existing provisions in the Agreement and/or Provider's Addenda. **[Revised 04/20/09]**

The Party seeking an interpretation shall submit its request in writing to the Chairperson of the Committee, who within seven (7) working days of receipt, shall send a copy to any other party involved in [the particular instance prompting] or known to support the request. Such party shall submit to the Chairperson within seven (7) working days a statement of its position on the matter. The Chairperson shall disseminate both the original request for interpretation and any statements provided by other parties to Committee members representing the involved industry Parties within five (5) working days of receipt. The modal Committee members shall provide the Chairperson with their comments regarding the request for interpretation within ten (10) working days from receipt of information provided by Chairperson. **[Revised 04/06/05]**

B. The Chairperson shall promptly advise the Party(ies) by facsimile or mail, of the modal Committee members' action on the requested interpretation within five (5) working days. Should the interpretation rendered by the modal Committee members following consideration and determination not be agreed with by the Party(ies) participating in the requested changes or modification, or commenting on the proposed language, such Party(ies), upon a demonstration of new information or previous information not considered or other provisions in the Agreement supporting the proposed language or changes, may request an interpretation by the full Committee. The Committee shall within fifteen (15) working days of request either (1) confirm the determination of the Chairperson and the modal representatives who made the initial interpretation, (2) render a revised interpretation, or (3) decline further comment because good cause has not been shown for reconsidering the initial interpretation. **[Revised 04/06/05]**

C. In cases of interpretations which affect Parties other than those involved in a particular request, or whose outcome involves a substantive change in the terms of the Agreement, the Chairperson shall prepare and serve Notice thereof on all Parties via first class U.S. mail.

IV. Requests for Modifications to the Agreement.

A. The full Committee shall be responsible for considering requests for changes to the Agreement. Such requests shall be submitted in writing to the Chairperson and may be filed by any Party that is a participant in the Agreement. The Chairperson shall transmit the request to the full Committee for consideration at its next scheduled meeting. **[Revised 04/11/07]**

B. The Committee shall consider requests for modification at the next scheduled meeting of the Committee at which a quorum is present and promptly advise petitioner of its decision and reason(s) for that action. A proposed change to the Agreement will require a three-fourths (3/4's) majority vote of those Committee members in attendance at which a quorum is present. **[Revised 05/12/10]**

V. Notice of Proposed Modifications to the Agreement and Comment Process

A. If the Committee votes to propose modifications to the Agreement, the Chairperson shall provide Notice in writing and by posting on IANA website within ten (10) working days of the Committee vote, of the proposed language and effective date of the modifications to all Participants in the Agreement. UIIA Participants shall have thirty (30) days from the date of this notification to provide comments on the proposed change. Comments must be submitted in writing to the Chairperson, who shall transmit the comments to the full Committee for consideration within ten (10) working days after the close of the thirty (30) day comment period. The Committee shall consider comments, if received, and vote to approve the proposed modification(s) within fifteen (15) working days from receipt of comments provided by Chairperson. If a proposed change to the Agreement is not approved by a three-fourths (3/4's) majority vote of those Committee members in attendance at which a quorum is present, the proposed modification will fail. **[Revised 05/12/10]**

Notice of the Committee's final decision will be provided to all Parties within five (5) working days from the close of the period to receive comments from the Committee and the proposed effective date of any changes shall not be less than fifteen (15) days from this date of notification. **[Revised 04/06/05]**

B. Staff will review existing Addenda for consistency with the approved modification(s). If changes are required, the Parties must do so within 30 days of this notice of that requirement, and submit the revised Addenda to IANA. **[Revised 05/12/10]**

VI. Prerequisites for Participation

A. Parties seeking to participate in this Agreement must first provide to IANA, its officially-registered Standard Carrier Alpha Code (SCAC) as issued by the National Motor Freight Traffic Association, the cost of which shall be borne by the prospective Agreement participant. Failure of the participant to maintain its officially-registered SCAC shall constitute grounds for immediate cancellation of its participation in the Agreement and related Addendum/Addenda.

B. Parties to this Agreement shall maintain facsimile and electronic communications capabilities on a 24 hour per day, 7 days per week, basis. Failure to provide such communication capabilities can result in the cancellation of this Agreement and related Addendum/Addenda. **[Revised 04/11/07]**

Back to Top

C. Upon demand, Motor Carrier shall furnish to the Intermodal Association of North America (IANA), the insurance policies required under this Agreement and/or any participating Equipment Provider's Addendum. Failure of the Motor Carrier to furnish said policy(ies) on demand shall constitute a breach of this Agreement, and shall be cause for immediate cancellation of the Motor Carrier's Agreement.

D. Companies "Doing Business As" another entity will be listed in the UIIA database and in other appropriate documents, by the company name as placarded and/or stenciled on the interchange Equipment. Certificates of insurance must clearly identify said company as having all insurance coverages as required under the Agreement and/or any participating Providers' Addenda. **[Revised 09/01/09]**

E. Motor Carriers must maintain a US DOT Number and, if applicable, an active Motor Carrier operating authority number (MC Number). **[05/12/10]**

VII. Party's Right to Terminate Participation

A. Any party desiring to terminate participation in this Agreement, as subsequently revised or supplemented, shall so notify the Chairperson, in writing, by Certified mail, prior to the effective date of the modification. The absence of such notification will constitute acknowledgement of the Party's intent to continue to participate in the revised or supplemented Agreement.

VIII. Compliance with the Agreement **[Revised 03/01/18]**

A. Parties to this Agreement agree to be bound by the provisions of the UIIA, including its Exhibits, and subsequent amendments and/or revisions of that Agreement, and any addendum thereto, that does not conflict with the terms of this Agreement.

B. Parties to this Agreement are bound to comply with binding arbitration case decisions rendered under the terms of Exhibit D of the UIIA. A Party's non-compliance with an arbitration decision is a violation of this Agreement.

C. Violations to this Agreement, upon verification by IANA, will be reported to the Party committing the violation, in writing via registered overnight mail and to the e-mail address of record for that Party, by the Chairman of the IIEC, with a request to correct the action(s) that are not in compliance. The Party in violation will be given ten (10) business days from the date of IANA's notice to refute or correct the action.

D. Parties that violate the provisions of this Agreement may face cancellation of their participation in the UIIA. In these instances, the determination to cancel participation in the UIIA will be decided by a three-fourths majority vote of the Committee. Should cancellation occur, notice will be provided to the Party, via registered overnight mail and to the e-mail address of record for that Party, within three (3) business days of the Committee's decision on this matter. Cancelled parties will be reinstated by a simple majority vote of the Committee upon determination that the violation which gave rise to the cancellation has been cured.

E. Violations related to commercial issues contained within a Provider's Addendum will be handled directly between the Parties in accordance with the terms of the Agreement and the Provider's Addendum.

Agreement Last Revised: October 1, 2018

EXHIBITS TO THE

UNIFORM INTERMODAL

INTERCHANGE AND FACILITIES

ACCESS AGREEMENT

(UIIA)

Back to Top

Exhibit A to UIIA
Motor Carrier Pre-Trip Inspection
As referenced in Sections D.3.**b.** and F.4.b.
(Added to UIIA 1/17/08 / Revised 10/01/18)

The following list sets forth those items, which the Motor Carrier has responsibility for visually or audibly checking prior to use of the Equipment:

1. Chassis Twist Locks and Safety Latches – (Check that twist locks and safety latches are engaged and properly secured.)

2. Slider Pins – (Check that slider pins are engaged for all sliding chassis.)

3. Bolsters (Check that bolsters are not bent and the container can be secured properly.)

4. Landing Legs (Check that Landing legs are in 90 degree position and they move up and down properly.)

5. Sand Shoes (Check that sand shoes or dolly wheels are attached to landing legs and secure.)

6. Crank Handles (Check that handle is attached, secure and operable to move landing legs up and down.)

7. Mud Flaps – (Check that mud flaps are whole and properly secured.)

8. Tires (Check that the following conditions are **not** present.)

   a. Tire is flat, underinflated or has noticeable (e.g., can be heard or felt) leak.
   b. Any tire with excessive wear (2/32nds or less thread depth), visually observable bump, or knot apparently related to tread or sidewall separation.
   c. Tire is mounted or inflated so that it comes in contact with any part of the vehicle. (This includes any tire contacting its mate in a dual set.)
   d. Seventy-five percent or more of the tread width is loose or missing in excess of 12 inches (30cm) in circumference.

9. Rims (Check that rims are not cracked and/or bent.)

10. Rear Underride Guard ("ICC Bumper") (Check that Guard is in place and not bent under the frame.)

11. Electrical Wiring/Lights – (Check that lights are in working order.)

12. Reflectors/Conspicuity Treatments (Check for reflector lenses and presence of conspicuity tape or bar on the 3 visual sides of the chassis.)

13. Brake Lines, Including Air Hoses and Glad Hands – (Check for audible air leaks and proper pressurization only.)

14. Current License Plate (Check to see that it is affixed to equipment.)

15. Proper Display of Hazardous Cargo Placards, In Accordance with Shipping Papers

16. Display of Current Non-expired Federal Placards or Stickers (Check to see that it is affixed to equipment.)

The **above Motor Carrier Pre-Trip Inspection** does not include **the responsibility to identify** latent defects unless caused by or resulting from the negligent or intentional acts or omissions of the Motor Carrier, its agents, employees, vendors or subcontractors during the Interchange Period. **[Revised 10/01/18]**

Back to Top

Exhibit B to UIIA
Provider Responsibility
(added to UIIA on 07/25/07, Last Revised 10/01/18)

Axles
Batteries**, broken**
Battery box covers
Brake adjustments on trailers or chassis (1)
Brake and brake component repairs (2)
Container **or Closed Trailer,** roof bows
Container or Trailer, caulking/sealing of **existing** patches **& seams**
Container or Trailer, interior lining **and interior posts**
Container securement device handles
Conspicuity treatment
Dolly axle**, wheels and sand shoes**
Dolly crank **handle, replacement**
Door locking bar handles **and tie-backs**
Electrical connector socket**, cleaning, adjustment and replacement**
Fasteners, component, bolts, rivets, welds
Floor or decking **(3)**
Gladhands**, replacement or repair**
Hub assembly due to insufficient lubrication
Inspections, **FMCSA and BIT**
Landing gear, **interior components and** operating cross shaft
Lift pads
Lights
Manifest box
Markings**, initial and number**
Mud flaps **and** brackets
Refrigeration**/Heating** unit repairs **including cabinet doors**
Registration papers**, application**
Roll-up doors
Safety latches
Side doors
Sign boards
Sliding Tandem removable locking bars
Tank container components
Tires **and T**ubes**, renewals, repairs or replacement**
Trailer/Chassis locking assemblies
Trailer crossmembers**, Damage** (4)
Vehicle license plates**, application**

(1) Not equipped with automatic slack adjusters
(2) Except servicing due to accumulation of ice and snow
(3) Damage caused during cargo loading/unloading operations excluded from Motor Carrier responsibility.
(4) **Damage to the first three crossmembers l**ocated behind the grid section of trailers not originally equipped with grid extension plate.

A repair made to any item listed in Exhibit B **is the responsibility of the Provider unless the repair made is** a result of damage **that occurred during the Interchange Period**.

Back to Top

Exhibit C to UIIA
(Added to UIIA on 07/25/07, Last Revised 10/01/18)

Tires

Tire **sidewall,** shoulder and/or tread cut/punctured**/damaged exposing belt material**

Slid Flat Damage to tire and/or tube - removal of tread or rubber to 2/32 inches of remaining tread depth or less in the affected area (flat spot) while the remaining unaffected tread depth is more than 4/32 inches.

Run Flat **D**amage to tire and/or tube

Missing Tire, tube or rim

Removable Items
Missing chains, binders and cables
Missing tarpaulins and securements
Missing tarpaulins bows
Missing rear header bar
Missing bulkhead

Cut or Torn (through the thickness of metal)
Metal door, gate, sheet, post, crossmember, brace or support
DOT Under Ride Guard

Bent (where proper operation or function of unit is impaired)
Metal door, gate, sheet, post, crossmember, brace or support
DOT Under Ride Guard

Missing Items
DOT Under Ride Guard
Door or Gate
Removable side or section
Refrigeration unit parts

Interior
Interior not free of dunnage, bracing and/or debris
Contamination

Other - Correction of temporary repairs

Citations - Citations **associated with the use of Equipment** may be rebilled from the **Provider** to the **Motor Carrier**

The foregoing list does not include Defects as defined in Section B, Definitions of Terms.

Back to Top

Supplement to Exhibit C of the UIIA

Tire Marking and Photo Requirements/Criteria
(Added 08/01/18)

Photo requirements for each tire repair/replacement

- Tires must be marked with chalk in the sidewall and not within the tread material. Stickers are not acceptable.
- Photos taken at no less than 1MP resolution supporting the damage/defect.
- A wide angle view of the tire including the below marking requirements to be physically marked on the damaged tire:
    - Chassis: alpha prefix and numbers
    - Container: alpha prefix and numbers
    - Date of repair
    - Cause of Failure or Why Made Code
    - Wheel position
- Tread Depth measurements for slick tread (09) and slid flat (34)
- A secondary photo from a close-up view of the damage/defect portion of the tire at a 45-degree viewing angle.
- A third photo of the Manufacturer's DOT ID # and the latest Re-capper DOT ID # (chalked over) is required.
- Photos of blister (11) and channel crack or weather check (17) should be taken while tire is mounted and inflated on the equipment.
- Photos of run flat (13) should be taken after tire is dismounted from the rim and additional photos taken of the inner liner.

The above criteria is based on the road service provider performing the tire marking and photo requirements.

EXHIBIT D TO THE UIIA
BINDING ARBITRATION PROCESS GUIDELINES
(Added to UIIA on 8/1/08)
(Last Revised 09/16/17)

1. This process is applicable for disputed transactions relating to Per Diem, maintenance and repair or Equipment use/rental charges between Providers and Users (Motor Carriers) of Equipment who are signatories to the Uniform Intermodal Interchange and Facilities Access Agreement (UIIA). **[Revised 05/01/17]**

2. Disputes handled under the arbitration process will be mandatory and binding upon the Parties. The arbitration process will be administered exclusively by IANA. **[Revised 04/14/11]**

3. A two-member arbitration panel will be appointed by IANA to handle disputed invoices submitted for arbitration. The panel will consist of one IIEC member from each mode involved in the dispute. In the event that the arbitrators from the involved modes cannot agree on a resolution of this dispute, a decision will be rendered by a majority of a senior panel consisting of the longest tenured IIEC member or alternate from each mode, as determined by the Chairperson. **[Revised 09/16/17]**

4. Members of the arbitration panels will serve on a voluntary basis without compensation, and for a period of one year. To qualify as an arbitrator the individual must have five years' operating experience involving such matters as gate interchanges, the yard procedures associated with vessels and trains, loading and unloading operations, the operations of marine and rail container yards, the receiving and delivery of containers, and/or with road equipment.

5. Disputes must be submitted to IANA in writing and in accordance with Section H.1. and must be accompanied by a filing fee made payable to IANA to cover the costs of the administration of the arbitration process. **[Revised 04/14/11]**

6. Disputes must be confined to charges arising from Per Diem, maintenance and repair or Equipment use/rental charges. There will be no limitation on the financial amount in controversy. The number of disputed invoices that may be consolidated under a single arbitration claim is limited to five (5) provided that they involve the same or related charges or unlimited if they involve identical facts and argument based on UIIA language. **[Revised 05/01/17]**

7. The arbitration process will be initiated by the Invoiced Party or the Invoicing Party (Moving Party) by the filing of: a Notice of Intent to Seek Arbitration and information and arguments supporting the dispute including evidence that the applicable dispute resolution process had been followed, as set forth under Section H.1. Such Notice and required information may be submitted to IANA by e-mail, facsimile, or overnight mail. Failure of the Moving Party to submit the required documentation as outlined above will result in the claim(s) being rejected. **[Revised 08/26/13]**

8. IANA will review the Notice of Intent to Seek Arbitration and the required information and arguments. If IANA determines that the submitted claim (s) has already been addressed and resolved in a prior arbitration case, the claim (s) will be dismissed and the precedent in the former proceeding will be sent to the Moving and Responding Parties. The decision from the former proceeding will apply to the current claim(s).

   The Moving and/or Responding Parties will then have 10 days to provide additional information on why either the precedent does not apply to its claim or why the precedent is in conflict with the language of the Agreement, upon which IANA will commence the arbitration process. **[Revised 08/26/13]**

9. The arbitration process will be commenced by IANA's transmittal of the Notice of Intent to Seek Arbitration and the required information and arguments to the appropriate individual in the Invoicing Party or Invoiced Party (Responding Party) organization designated to receive such Notice and information. The Responding Party will have 15 calendar days from the date of transmittal of the arbitration documents from IANA to respond. Upon receipt of the Responding

Exhibit D of the UIIA (continued)

Party's documents, the complete record will be transmitted by IANA to the arbitrators. Failure of the Responding Party to respond to the claim (s) within this timeframe will result in the arbitration panel rendering its decision based solely on the supporting documentation submitted by the Moving Party, along with the terms and conditions of the UIIA and/or the Providers' Addenda. **[Revised 08/26/13]**

10. The arbitration panel will have 45 days from the date the information and arguments submitted by the Parties are sent by IANA to render a written decision indicating the basis for its conclusions. Its findings will address the validity of the claims and the Party responsible for payment or satisfaction thereof. The determinations are to be based solely on the rules in the UIIA and the rules and charges in the Provider's Addendum.

11. If during an arbitration panel's deliberations it appears that further clarification or explanation is needed from a Party or the Parties, a conference call may be conducted with both Parties in the arbitration process participating in the call.

12. The decision of the arbitration panel will be transmitted to IANA which will, in turn, forward the decision to the Parties by e-mail, facsimile, or overnight mail. The decision of the arbitration panel is final and no appeal is permitted.

13. If any part of an invoice submitted for arbitration is not disputed that part must be timely paid and cannot be withheld during the arbitration process. In response to the arbitration panel's decision, order of reimbursement, payment or cancellation of the invoice must occur within 15 days from the date of receipt of the arbitrators' decision. **[Revised 05/12/10]**

14. The cost of the filing fee is assessed against the Party against whom the arbitrators' decision is rendered. Should the filing fee have been paid by the prevailing party, it is entitled to reimbursement by the losing party.

15. Once the arbitration process has been initiated, no suspension, cancellation, termination or any type of interruption of the Motor Carrier's interchange privileges for the disputed claims may occur. The Provider and Motor Carrier, nevertheless, retain all their rights and remedies for the enforcement of the binding arbitration decision. **[Revised 04/14/11]**

16. Initiation of the arbitration process by a Motor Carrier does not preclude a Provider from suspending, cancelling, or terminating the interchange privileges of this Motor Carrier for reasons not related to the subject of the disputed claim and that are governed by the provisions of the UIIA and/or the Provider's Addendum. **[Revised 09/01/09]**

17. Invoices submitted for arbitration must arise on or after the announced effective date of the implementation of the program, which is August 1, 2008. **[Revised 04/14/11]**

18. Except for the decision by the arbitration panel, all documents, including e-mails, and oral and written communications generated under the Binding Arbitration Process and/or submitted by the Invoicing Party and Invoiced Party are confidential, and will not be released by IANA to any other person without the express written consent of all Parties to the arbitration. **[Revised 04/14/11]**

Back to Top

UIIA ADDENDUM TEMPLATE

Listed below is the universe of economic issues that the Intermodal Interchange Executive Committee has approved for inclusion in each participating Provider's Addendum to the Uniform Intermodal Interchange and Facilities Access Agreement (UIIA).

Providers who subscribe to this Agreement will utilize this template in creating their individual Addenda. They are not required, nor are they expected, to utilize every component listed below in creating their proprietary Addendum. For example, certain of the Addendum template provisions are more germane to rail-truck Interchange than water carrier-truck Interchange, and vice-versa.

The Parties may not use this Addendum to obviate or undermine the intent of the Agreement. For example, the Agreement contemplates certain reimbursements for the cost of repairs. The Parties may agree to limit the potential cost of those repairs, but such limitations may not be so restrictive that they would virtually eliminate responsibility for reimbursement.

It will be impermissible for Provider Agreement subscribers unilaterally to add other provisions to their individual Addendum to this Agreement. Requests for addition(s) to the universe of economic issues that can be utilized in an Addendum to this Agreement shall be submitted to the Intermodal Interchange Executive Committee for consideration as set forth in Part II, Implementation, Review, Interpretation and Modification Procedures.

I. **Notification and Free Time**
A. Free Time Commences
B. Amount of Free Time
   1. Load/Empty
   2. Load/Load
   3. Empty/Load
C. Weekends – interruption of expiry of free time
D. Holidays – interruption of expiry of free time
E. Unroadworthy Equipment – suspension of expiry of free time
F. Interchange to Inland Carrier – equivalent of termination

II. **Origin Storage**
   A. Free Time Commences
   B. Amount of Free Time
   C. Charges Per 24-hour Period
   D. Chassis Use/Rental Charges

III. **Destination Storage**
   A. Free Time Commences
   B. Amount of Free Time
   C. Charges Per 24-hour Period
   D. Chassis Use/Rental Charges

IV. **Per Diem**
   A. Type of Equipment
      1. Free Time Allowance
      2. Per Diem
      a) Day 1 – _____
      b) Day_____– _____
      c) Day_____– _____

V. **Method of Invoice Dispute Resolution**

VI. **Other Charges**
   A. Empty to Empty
   B. Crossover
   C. Failure to File Crossover Interchange
   D. Hazardous/Municipal Waste
   E. OTHER

VII. **Damages to Equipment**
   A. Method of Determining Cost
   B. Other

VIII. **Repairs to Equipment**
   A. Tires
   B. Other

IX. **Lost, Stolen or Destroyed Equipment**
   A. Suspension of Per Diem
   B. Disposition of Destroyed Equipment

X. **Insurance**
   A. Amounts of Additional Required Coverage by Class
   B. Limitations on Rating Level of Insurer
   C. Self-Insurance and Minimum Permissible Deductibles

Appendix D. Summary of Potential Solutions

POTENTIAL SOLUTIONS	WORK PLAN REFERENCE	APPLICATION		SCENARIOS			
				Major City - Local	Major City - Hinterland	Minor City - Hinterland	Inland Port
		Inbound	*Outbound*	*(NY/NJ)*	*(LA/LB)*	*(Savannah)*	*(Columbus)*
expanded gate hours	A	●	●	*	*	*	*
appointment system		●	N/A	*	*	*	*
off-site parking and staging		●	N/A	✓	✓	✓	✓
appointment system + off-site parking/staging		●	●	*	*	*	*
off-site parking and staging with a “virtual gate”		●	●	✓	✓	✓	✓
“gray box” container system		N/A	N/A	*	*	*	*
modified chassis pool operations		N/A	N/A	*	*	*	*
other technology applications		N/A	N/A	*	*	*	*
automated truck (Level 4) in queue	B	●	●	✓	✓	✓	✓
automated truck (Level 4) in queue + off-site staging		●	●	✓	✓	✓	✓
alternative transport mode to/from off-site staging		●	●	*	*	*	*

A – Corresponds to evaluation of port staging technologies and practices at marine terminals

B – Corresponds to evaluation of automated truck technologies and associated staging options at marine terminals

✓… Indicates improvements analyzed in Chapter 4

* … Indicates improvements covered previously in other research efforts and incorporated here qualitatively

Summary of Benefit-Cost Analysis

SOLUTIONS	SCENARIOS: Generic Port	Major Urban to Local Market	Major Urban to Mixed Market	Minor Urban to Hinterland	Inland Port
Off-Site Staging/Parking	Moderate	Low	Low	Moderate	Moderate
Staging/Parking + Virtual Gate	High	High	High	Very High	High
Automated Truck in Queue	Moderate	Moderate	Moderate	Moderate	Moderate
Automated Truck + Off-Site Staging	Very High	High	High	High	Very High

Based on analysis of solutions and scenarios using a 3% annual discount rate.

Low = Benefit-Cost (B-C) Ratio below 1.0

Moderate = B-C Ratio between 1.0 and 2.0

High = B-C Ratio between 2.0 and 10

Very High = B-C Ratio above 10.0

U.S. Department of Transportation
ITS Joint Program Office – HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487

www.its.dot.gov

U.S. Department of Transportation