Delaware First/Final Mile Freight Network Development

Working Paper 1:
Initial Identification of First/Final Mile Freight Network

Prepared for:

WILMAPCO and DelDOT

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Delaware First/Final Mile Freight Network Development

The objective of this network development effort is to create a greater understanding of Delaware's first/final mile connections that link businesses to state and national highway networks. A second objective is identifying freight transportation needs and issues on these connections so that DelDOT, WILMAPCO, and other planning stakeholders can address these issues in the future.

Ultimately, the project will help Delaware's transportation stakeholders make effective improvements and maintain first/final mile connections while balancing the needs of other transportation users.

Working Paper

This Working Paper is the first in a series of two that together inform the Study. This Working Paper provides results of an initial literature review and an exercise to identify of first/final mile freight connections in Delaware.

Acknowledgements

The CPCS Team acknowledges and is thankful for the input of those consulted in the development of this Working Paper, as well as the guidance and input of representatives from WILMAPCO, DelDOT and their study partners.

Opinions

Unless otherwise indicated, the opinions herein are those of the authors and do not necessarily reflect the views of WILMAPCO or DelDOT.

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Acronyms / Abbreviations

AADTT	Average Annual Daily Truck Traffic
CBECS	Commercial Buildings Energy Consumption Survey
CRFC	Critical Rural Freight Corridor
CRFF	Multimodal Critical Rural Freight Facilities
DC	Distribution Center
DelDOT	Delaware Department of Transportation
DOT	Department of Transportation
DVRPC	Delaware Valley Regional Planning Commission
EIA	Energy Information Administration
FHWA	Federal Highway Administration
MPO	Metropolitan Planning Organization
NCFRP	National Cooperative Freight Research Program
NHFN	National Highway Freight Network
NMFN	National Multimodal Freight Network
TAZ	Traffic Analysis Zone
WILMAPCO	Wilmington Area Planning Council

1 Introduction

1.1 What are First/Final Mile Connections?

In the context of freight, **first and final mile connections are roadways that link truck trip origins or destinations with mainline routes of travel such as interstates or major regional highways**. In the broadest sense, almost *all* roads serve in a first/final mile role, as even minor roads in residential or rural areas accommodate the movement of mail, packages, and garbage trucks. However, first/final mile connections more commonly refer to the roadways that link individual freight handling facilities such as manufacturing facilities, retail centers, distribution centers, warehouses, ports, intermodal terminals, and farms with major travel corridors such as limited-access highways. For example, trucks shipping goods from a factory may have to drive on first-mile surface streets to reach a highway, and food delivery trucks may have to find a last-mile surface route from highways to local restaurants, through an artery. It is important to note that, despite their name, first/final mile connections may extend for multiple miles between freight facilities and mainline highways, especially in rural areas.

First/final mile connections are important elements of Delaware's freight network because they provide businesses with access to major highways, ports, airports, and intermodal terminals.

First/final mile connections are typically functionally-classified as collector or local routes and may have a relatively high truck trip share of the vehicle traffic. For instance, an example of a critical first/final-mile connection in Delaware is State Route 9 (Terminal Avenue), which links the Port of Wilmington with I-95 through I-295 and I-495. More than 3,700 vehicles use this route daily, about 20 percent of which are trucks.[1] Figure 1 illustrates this connection.

Figure 1: First/Final Mile Connection at Port of Wilmington

Source: Google Earth. 2020.

However, not all first/final mile connections have high volumes of traffic and are not exclusive to industrialized areas. In some areas, first/final mile connections may serve retail hubs or a limited number of industrial businesses, carry a limited number of trucks, and pass through residential areas. While these routes may have lower traffic volumes, they support multiple types of users and land uses, and as a result, freight problems on these routes may be more visible and relevant to the general

[1] DelDOT Open Data Tool, Delaware Traffic Counts, 2019 and Delmarva Freight Plan, 2015.

public. Figure 2 provides an example of a lower-volume last-mile connection on Old Coochs Bridge Road in Newark.

Figure 2: First/Final Mile Connection in Residential Area, Newark

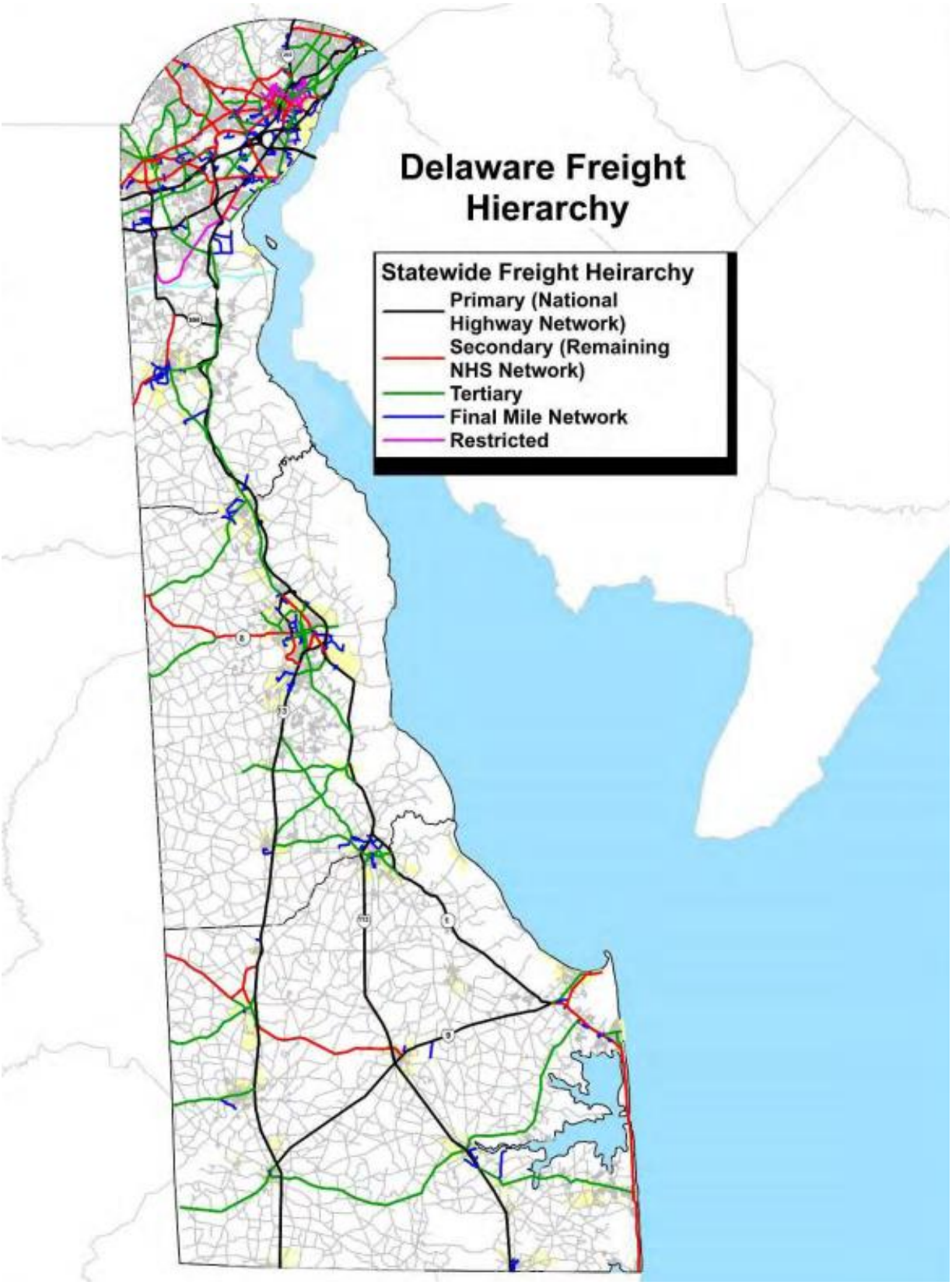
Source: Freight Planning in the WILMAPCO Region, Presented to DVRPC, October 2017.

1.2 Project Objective

Efficient and safe freight transportation such as trucking, railroad operations, and shipping is a key driver of the continued viability and success of many of Delaware's businesses and is crucial to meeting the demands of Delaware's consumers. The Delaware Department of Transportation (DelDOT) and its local planning partners such as the Wilmington Area Planning Council (WILMAPCO), Dover/Kent County Metropolitan Planning Organization (MPO), and Salisbury-Wicomico MPO have sought to preserve and improve freight mobility through prior freight planning work such as the State Freight Plan.

One element of this planning work includes understanding the location and performance of first/final mile freight connections. DelDOT and Delaware MPOs including WILMAPCO recognize the importance of first/final mile connections for freight movement and previously developed the Delaware Freight Hierarchy to catalog some of these routes. The Hierarchy is an inventory of important freight-carrying roads throughout the state, including some first/final mile connections. This inventory builds upon the National Highway Freight Network (NHFN), the National Multimodal Freight Network (NMFN), and the Multimodal Critical Rural Freight Facilities (CRFF) information to identify additional secondary routes that are critical to the state's freight operations. The Delaware Freight Hierarchy map is presented in Figure 3.

Figure 3: Previously-Identified Delaware Freight Hierarchy



Source: 2017 Delaware Statewide Freight Plan.

This previous network development included assessment, rating, and prioritization of roadway segments based on factors such as truck volumes and pavement conditions. However, the Hierarchy's identification and evaluation of first/final mile connections was limited in scope, and these agencies have sought to create a more-comprehensive inventory of first/final mile facilities and connections, as well as the needs and issues associated with these connections.

With this previous work in mind, the first objective of this first/final mile network development project is to create a greater understanding of the specific first/final mile connections that link freight-dependent businesses to state and national highway networks. In turn, knowledge of these locations and routes will support a second objective of improving the understanding of the needs of freight users, potential deficiencies in first/final mile connections, and potential conflicts between trucks and other transportation users.

Ultimately, this project will help Delaware's transportation stakeholders effectively maintain and improve first/final mile freight transportation connections while balancing the needs of other transportation users including passenger traffic, bicyclists, and pedestrians.

1.3 Project Structure

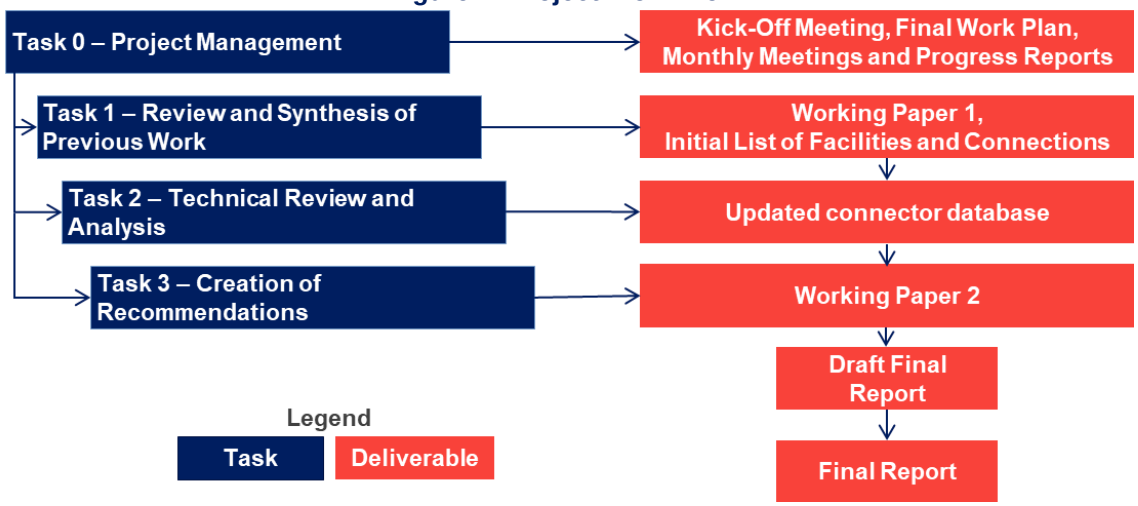
Key Questions

To achieve the project objective, CPCS is working with WILMAPCO, DelDOT, and other planning stakeholders to address several "key questions." We have framed this series of questions to respond to all items in the Scope of Work and to be addressed in the Working Papers and other Deliverables. These key questions are:

- How should a first/final mile facility or connection be defined?
- What and where are Delaware's first/final mile facilities and connections?
- How do Delaware's first/final mile connections perform?
- How should Delaware improve and maintain its first/final mile connections?

In line with the Key Questions, the following figure presents an overview of tasks for developing the Delaware First/Final Mile Network.

Figure 4: Project Work Flow



Source: CPCS

1.4 Overview of this Working Paper

Purpose

The purpose of this Working Paper is to build an initial understanding of the location of first/final mile connections in Delaware as well as the first/final mile needs and issues that have been previously documented. This Working Paper also profiles trends driving changes in the location or character of first/final mile freight traffic, and incorporates a literature review's findings on other states' and regions' first/final mile identification and evaluation methodologies that are relevant to Delaware.

WILMAPCO's first/final mile network development web page is a key complement to this Working Paper, as it provides an interactive map of initially-identified first/final mile connections, and allows users to comment on areas where connections are not currently identified, and comment on the performance, condition, and safety of connections. Further information will be posted at http://www.wilmapco.org/finalmile/.

Methodology

This Working Paper was prepared using a literature review of prior first/final mile identification and evaluation projects across the United States, as well as data from DelDOT, WILMAPCO, and other local partners. This data included:

- Delaware Freight Hierarchy shapefiles
- Zoning or land use shapefiles, to aid in the identification of areas generating freight traffic.
- ReferenceUSA information on the location of freight-related businesses
- Traffic Analysis Zones (TAZs) provide estimates of truck trip generation based on economic activity in each zone.
- Satellite and Street-Level imagery from Google Maps and Bing.

Further information on how this data was incorporated into specific steps of the analysis is available in **Chapter 3: First/Final Mile Network Identification.**

Limitations

Some of the findings in this report are based on the analysis of third-party data. While CPCS makes efforts to validate data, CPCS cannot warrant the accuracy of third-party data.

2 First/Final Mile Needs and Issues

First/final mile connections are roadways that link truck trip origins or destinations with mainline routes of travel such as interstates or major regional highways. While the critical role of these connections in freight supply chains is undeniable, there can be many challenges to making them operationally-efficient due to issues such as congestion, limited accessibility for trucks, and land-use incompatibilities.

Common problems on first/final mile connections include narrow lanes, narrow or no shoulders, tight turns, and conflicts with adjacent neighborhoods including excessive noise and exposure to diesel emissions. Broader trends such as the continued development of new residential neighborhoods adjacent to freight facilities, and the development of new distribution centers could contribute to continued first/final mile problems in the future.

2.1 Common First/Final Mile Problems

Identifying and addressing problems on first/final mile connections is important because barriers to safe and efficient freight movements can have substantial impacts on the viability of the businesses that depend on these connections, as well as the health and wellbeing of communities surrounding these connections. For example, in the context of e-commerce,

> **First and final-mile shipments are estimated to account for about 28 percent of total freight delivery prices, primarily due to inefficient connections to hubs or pickup and delivery points.[2]**

Given the potential negative impact of first/final mile problems on competitiveness as well as health and well-being, one of the major goals of this current first/final network development project will be to improve DelDOT, WILMAPCO, and other agencies' understandings of specific first/final mile problems like these in their own communities.

As part of this project, CPCS conducted a literature review of prior first/final mile identification and performance evaluation efforts. A list of the literature sources reviewed for this work is provided in **Appendix A,** and the information presented here is the product of a synthesis of findings from all of these sources. Many of the previous sources discussed problems with first/final mile connections in some form, but one of the key items reviewed was the Federal Highway Administration's (FHWA) 2017 *Freight Intermodal Connectors Study*. The study investigated a variety of connector-related trends, needs, and issues, including an assessment of connectors' performance.

The intermodal connectors studied were designated by FHWA in consultation with state DOTs and MPOs. While not all first/final mile routes in Delaware are intermodal connectors, the FHWA's study is useful because it captures common first/final mile issues from across the United States, and provides

[2] Best Practices for Optimizing Last Mile Delivery, Descartes Knowledge Center, 2020.

both context and framework for discussing problems in Delaware, as well as potential tools for solving or reducing first/final mile problems.

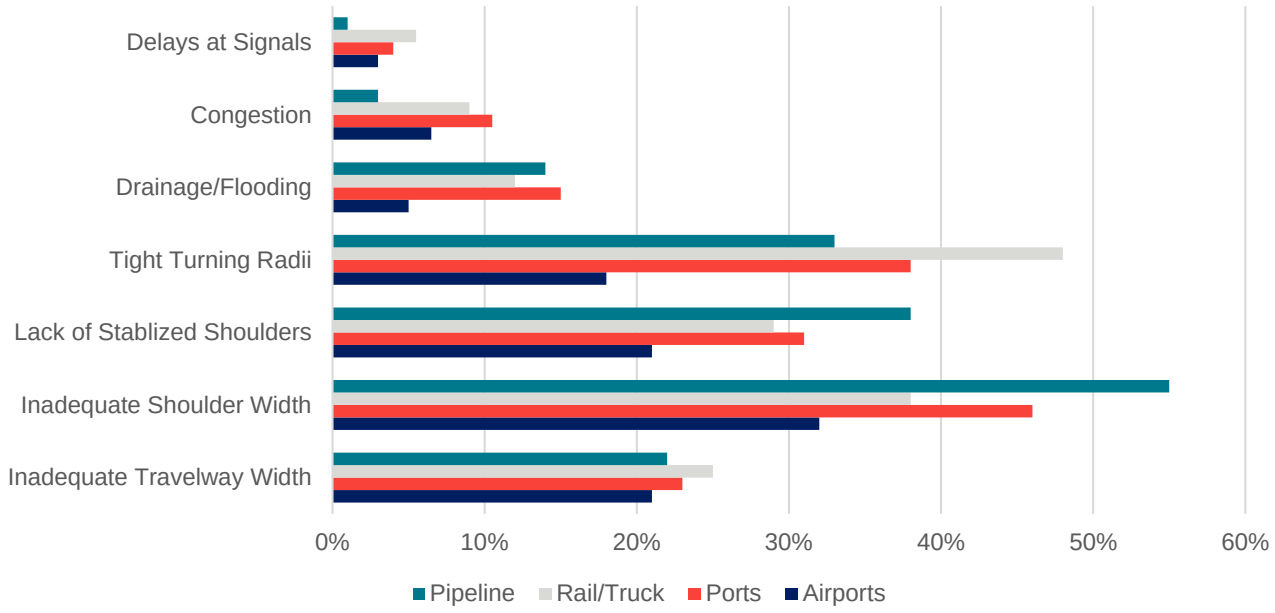
Common problems are grouped into four categories below. In practice, many problems will span multiple categories. For example, tight turns are a mobility problem as they impede the efficient movement of trucks, but they can also create safety risks for other roadway users, including bicyclists and pedestrians.

- **Mobility** problems refer to barriers to efficient or "smooth" freight movement, including traffic congestion, impediments to direct routing (such as low-clearance bridges forcing trucks to take longer, circuitous routes), tight turns, narrow lanes or shoulders, or passing lanes.
- **Safety** problems refer to design characteristics or user behavior that increase the likelihood or severity of accidents, including poor sightlines at intersections, drivers speeding, or co-location of truck routes and bicycle lanes.
- **Condition** problems relate to the poor condition of pavement or bridges on freight routes, or accelerated deterioration of infrastructure as a result of frequent heavy truck traffic.
- **Land Use** problems relate to conflicts that arise as a result of freight routes passing through residential, commercial, or environmentally-sensitive areas. Most commonly, land-use conflicts relate to freight routes passing through residential areas, potentially exposing residents to undesirable noise, vibration, and air emissions.

Mobility Problems

Freight mobility is the ability to move efficiently through the transportation network. Mobility problems can be broken down into two general categories: geometric constraints, and congestion. Geometric constraints are physical characteristics that make the passage of trucks challenging or impossible, and Figure 5 lists the most common geometric constraints identified as part of the FHWA *Freight Intermodal Connectors Study*, which evaluated 616 intermodal connectors across the United States.

Figure 5: Geometric, Physical, and Operational Deficiencies by Terminal Type



Source: *Freight Intermodal Connectors Study*. Federal Highway Administration. 2017.

Concerns with shoulder width and stability, as well as tight turns stand out as a common problem across multiple types of intermodal connectors, and similar first/final mile assessment work in other states and regions has also identified these topics as key mobility concerns on first/final mile connections. It is important to note that these types of problems are not exclusive to urban areas, as shoulder width and stability is a noted problem on rural roads in many portions of the United States. These types of problems also impact roadway condition and safety as well. For example, trucks making tight turns can damage utility poles, signs, gutters, and curbs, and can pose a risk to "clipping" other vehicles. Or, in rural areas, a lack of stabilized or wide shoulders removes truckers' "room for error" in accommodating other roadway users, especially on narrow roads. Figure 6 summarizes the common mobility problems identified in the literature review, and their importance or consequences.

A consequence of many mobility problems is slower travel speed, or longer travel routing to avoid barriers. Slower travel and longer routings reduce the effective "speed" of freight movement, which means that smaller volumes of freight can be moved in any given amount of time. In turn, these lower capacities often translate into higher freight costs for shippers.

Mobility problems impact the efficient movement of freight, increasing travel times, decreasing freight throughput. Ultimately, these efficiency impacts can increase shipping costs.

Figure 6: Common First/Final Mile Mobility Problems and Their Impacts

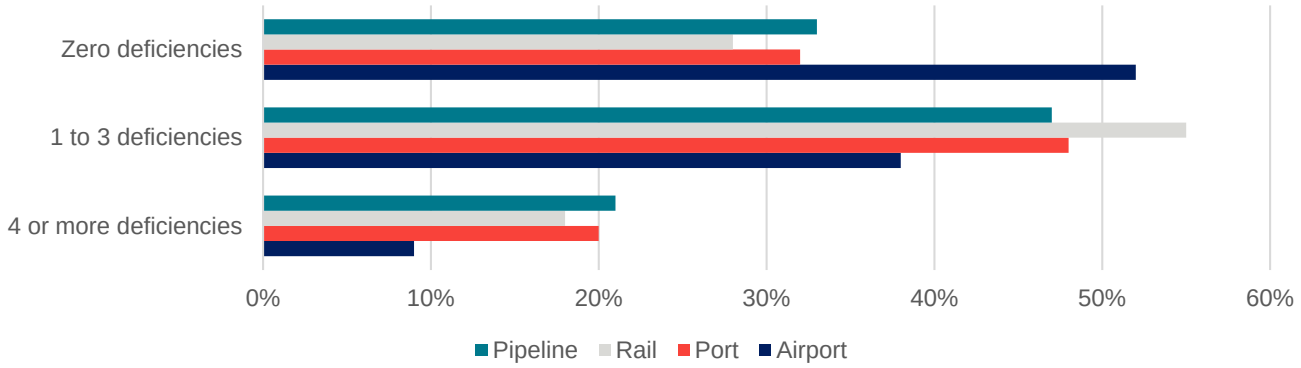
Mobility Problem	Impacts
 Congestion on first/final mile route	Congestion increases travel time, results in increased shipping costs.
 Congestion at a junction with major highway	Congestion increases travel time, results in increased shipping costs. Slow-moving trucks may further exacerbate congestion at traffic lights, or cause slowdowns/backups on highway ramps.
 Tight turns	Need for careful maneuvers reduces travel speed, may damage infrastructure, or increase the likelihood of accidents.
 Narrow lanes or shoulders	Need for careful maneuvers reduces travel speed, which may increase the likelihood of accidents.
 Soft shoulders	Need for careful maneuvers reduces travel speed, incursion on a soft shoulder may increase the likelihood of accidents.
 Low-clearance bridges	Circuitous routing to avoid barrier results in increased travel time, shipping costs.

Mobility Problem	Impacts
 Railroad crossing delays	Delays result in increased travel time, shipping costs.

Image source: FHWA Manual on Uniform Traffic Control Devices

Often, mobility problems do not "stand alone" – the presence of one problem on a first/final mile route means that other mobility, condition, or safety problems are likely to be present, and the FHWA's intermodal connector study illustrates this case. Figure 7 shows the relative number of deficiencies observed on different types of connectors, and almost half of the 616 terminals examined had at least 2 deficiencies.

Figure 7: Share of Intermodal Connectors with Multiple Deficiencies



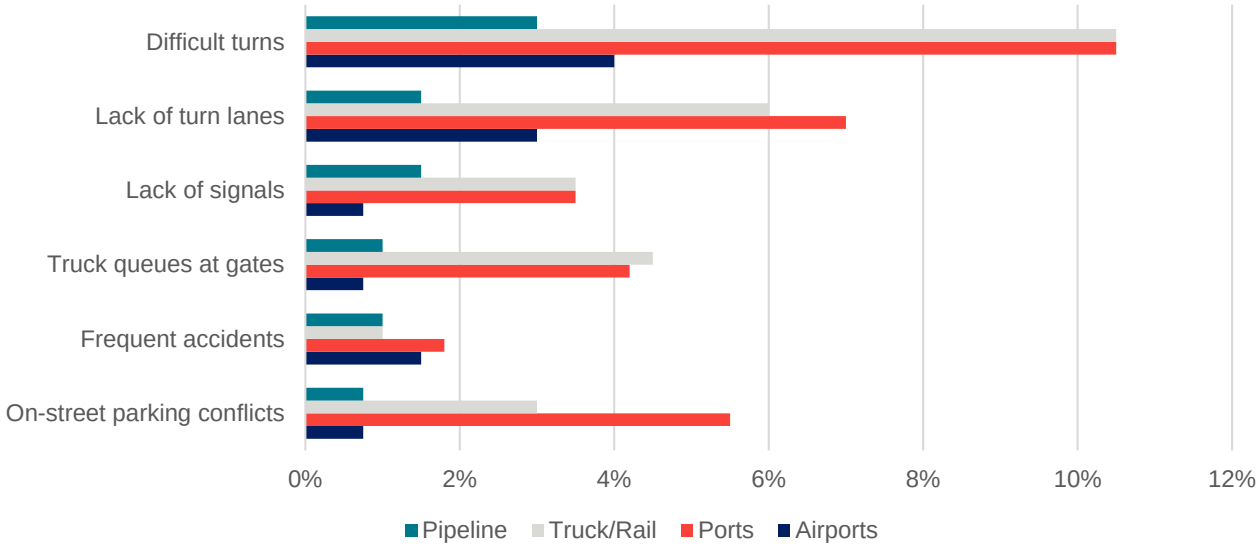
Source: *Freight Intermodal Connectors Study*. Federal Highway Administration. 2017.

Safety Problems

As noted above, the ultimate impacts of mobility problems go beyond simple impacts on shipping efficiency, but can also impact shipping costs as well as highway safety. In addition to safety concerns that arise from mobility problems, there are stand-alone safety issues documented in prior first/final mile literature. Understanding these safety issues is particularly important because these issues are often more-visible or more-relevant to the general public, and can have significant impacts on the health and safety of other road users.

As before, FHWA's intermodal connectors study provides a good snapshot of common first/final mile safety issues that are also documented in many of the other prior first/final mile studies reviewed. Based on FHWA's work, the safety problems observed here are less-common than the mobility problems above.

Figure 8: Safety Problems Observed on Intermodal Connectors



Source: *Freight Intermodal Connectors Study*. Federal Highway Administration. 2017.

While the frequency of safety concerns is lower relative to mobility concerns, a common thread between safety and mobility problems is a focus on problems at intersections, particularly on turning movements. In both urban and rural areas, concerns around intersections often relate to the relatively slow turning movements and slow acceleration and deceleration of trucks relative to overall traffic speed. This speed differential can make accidents more likely, particularly at locations where trucks must join fast-moving mainline highways that lack signalized controls, or where trucks block traffic while waiting to make left turns. Additional commonly-noted first/final mile safety concerns and their impacts are listed in Figure 9 below.

Figure 9: Common First/Final Mile Safety Problems and Their Impacts

Safety Problem	Impacts
 Tight turns	Potential for collision with oncoming traffic in the opposite lane, the potential for "clipping" nearby vehicles, pedestrians, bicyclists.
 Lack of turn lanes or signals	Limited time to accelerate or decelerate or blockage of lanes during turns increases the likelihood of accidents.
 Conflicts with on-street parking	Narrow lanes or poorly-parked vehicles increase the likelihood of collision with parked vehicles, other road users.
 Overlap with pedestrian and bicycle facilities	Lower-visibility of bicyclists and pedestrians and limited – visibility from trucks increases the risk of accidents.

Safety Problem	Impacts
 Grade crossing safety	Lack of crossing protection (active signals) or short sightlines increases the risk of train-truck collisions.

Image source: FHWA Manual on Uniform Traffic Control Devices

The problems listed above may manifest themselves in the form of crash occurrences on first/final mile routes, but prior crash occurrences should not be the only measure of safety on first/final mile connections, as crash databases do not track "near misses". While such events will not show up in databases, they can have a strong impact on the public's perception of freight and general road safety.

Condition Problems

Like safety problems, condition problems are less-frequently mentioned in much of the national work on first/final-mile connections, relative to mobility problems. However, first/final condition is a worthwhile characteristic to explore because condition deficiencies (such as rough pavement or potholes) can damage freight, and increase vehicle maintenance costs. For example, prior research indicates that the *additional* cost of operating a truck on pavement rated as "poor" condition could range from $0.04 to $0.23 per mile.[3]

Poor-condition pavements and bridges can be impediments to efficient truck movement, and impose additional costs on shipping through increased degradation of vehicles, and potential damage of freight.

Another condition-related concern is the operation of trucks on under-engineered first/final mile connections, which can result in premature degradation of pavements and bridges, and create a need for more frequent maintenance. This concern was observed throughout the literature in both rural and urban areas. In urban areas, much of this concern about damage was focused on facilities generating large volumes of truck traffic each day, such as ports, rail intermodal terminals, and distribution centers. Similarly, in the case of rural areas, new industrial developments that generate large volumes of truck traffic such as large consolidated grain elevators, fracking wells, quarries, and landfills were identified as generators of truck volumes that could rapidly degrade inadequately-prepared local roads.

Land Use Conflicts

Freight and land use conflicts often arise as a result of freight routes passing through residential, commercial, or environmentally-sensitive areas. Additionally, the overlap between first/final mile routes and other land uses can create or exacerbate many of the mobility and safety problems noted above. Freight and land use conflicts occur most frequently in and around developed areas. For example, conflicts can be found in long-standing neighborhoods surrounding urban industrial facilities, ports, or intermodal terminals where trucks may pass through residential neighborhoods to reach major highways. However, new conflicts are also emerging on the fringe of urban areas, as new residential development encroaches on formerly-isolated industrial parcels, or as new warehousing or distribution center development on the urban fringe generates large influxes of new truck traffic on local roads.

[3] Freight Intermodal Connectors Study. Federal Highway Administration. 2017.

In both areas, the types of problems associated with freight and land-use conflict are similar and primarily relate to the negative externalities generated by truck operations. Figure 10 lists the common freight and land use conflicts identified in the literature reviewed for this project. Not all of these problems will be present for each first/final mile connection, as some problems depend on the type of freight carried, the time of day of freight operations, and the design of the first/final mile connection itself.

Figure 10: Common Freight and Land Use Conflicts

Problem Type	Description
 Air and Water Pollution	Air emissions from vehicle operations on first/final-mile routes negatively impact the health and well-being of adjacent residents. Additionally, spills of hazardous materials carried on first/final mile routes may pose a risk to water sources.
 Light Pollution	For freight facilities operating 24 hour hours a day, the lighting used at freight facilities, and trucks' headlights may negatively impact residents' quality of life at night.
 Noise Pollution	High noise volumes from frequent truck operations may be disruptive to residents and businesses adjacent to first/final mile routes, and negatively impact health or quality of life.
 Vibration	Vibration generated by frequent truck operations may be disruptive to residents and businesses adjacent to first/final mile routes, and negatively impact the quality of life.
 Safety Problems	Safety risks listed in Figure 10 in such as conflicts with parked cars and the risk of collision with pedestrians and bicyclists can negatively impact residents' safety and quality of life.
 Congestion	Slow-moving truck traffic (sometimes due to problems listed in Figure 5) can reduce overall traffic speed and create localized congestion on first/final mile routes.

Source: adapted from NCFRP Report 16: Protecting and Preserving Freight Infrastructure and Routes National Academy of Sciences. 2012.

Unlike the safety, mobility, and condition problems noted above, many freight and land use problems are less likely to directly impact the cost of shipping. However, these problems can have major impacts on residents' safety and quality of life, and thus their perception of freight operations in their communities. Additionally, given their undesirable nature and potential negative effect on land values, the impacts of freight and land use conflicts may be disproportionately focused on low-income communities, including communities of color. Therefore, understanding the location and characteristics of these conflicts in Delaware is a key element of this current first/final network development project.

Institutional Problems

In addition to the specific types of problems noted above, there are generalized problems that are not exclusive to first/final mile connections but can explain why some first/final mile problems arise and persist. Many of these problems relate to governmental fragmentation with planning, ownership, and

maintenance of infrastructure distributed across state, county, and local agencies. Some examples include:

- Land use and transportation planning responsibilities are entrusted to different agencies with different knowledge and priorities, resulting in the potential for new freight and land use conflicts in the future.
- First/final mile routes may be owned by multiple government agencies, making it difficult to coordinate improvements.

Problems such as these suggest that greater coordination between different agencies, as well as private businesses and community organizations may be necessary to understand and ameliorate first/final-mile problems. These institutional problems and potential solutions will be explored in greater depth in later Working Papers and the Final Report.

2.2 Delaware-Specific First/Final Mile Problems

According to Delaware-specific planning and research materials such as the Delmarva Freight Plan (2015) and Delaware State Freight Plan (2017), there are multiple areas of concern related to first/final mile connections in Delaware. Figure 11 summarizes these issues, with additional information provided below.

Figure 11: Noted First/Final Mile Problems in Delaware

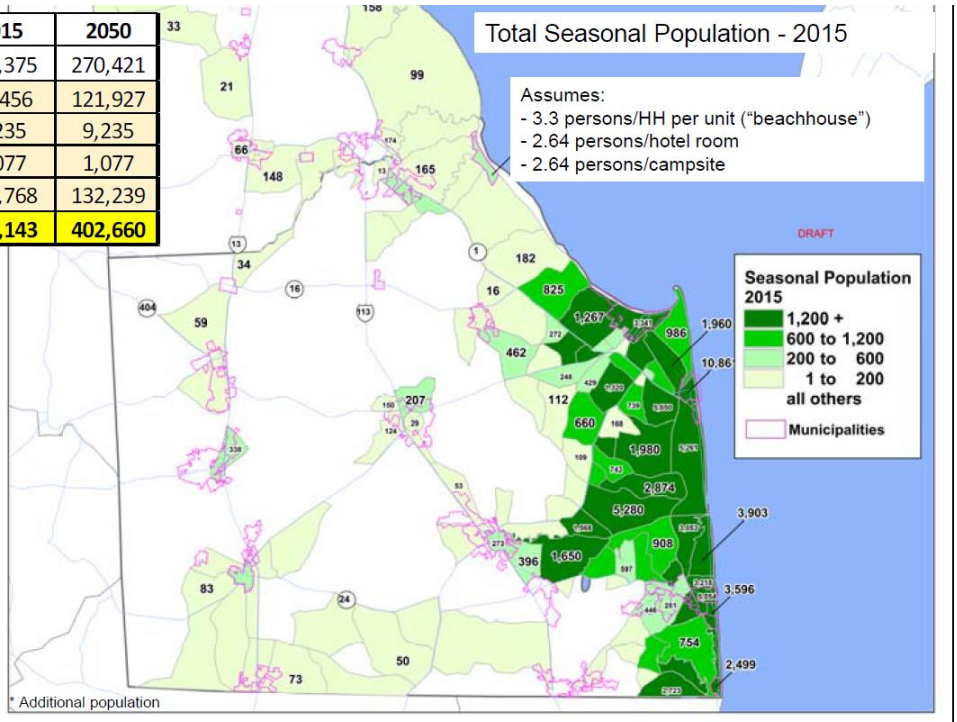
Problem Type		Description
	Seasonal Tourist Traffic Congestion	Seasonal summer tourist traffic, and truck traffic serving tourist areas can create congestion.
	Agricultural Traffic on Rural Roads	Slow-moving agricultural traffic on rural roads, and increased agricultural traffic during harvest times can create localized congestion.
	Flooding and Sea Level Rise	Some low-lying roads may be affected or occasionally blocked by coastal flooding, with an increasing likelihood of flooding in the future.
	Institutional Coordination	First/final-mile routes may be owned, managed, and maintained by multiple government agencies, such as cities, counties, or the state. Communicating about the importance of first/final mile routes and coordinating improvements is complicated by the presence of multiple agencies.

Tourism and Seasonal Traffic Congestion

Tourism is a key industry for Delaware and brings over nine million visitors to the state each year.[4] Beaches and coastal communities are some of Delaware's biggest tourist attractions, particularly during the summer months. For example, the population of Sussex County is estimated to increase by over 100,000 people each summer, and Figure 12 illustrates how this estimated seasonal population is concentrated in tourist areas along the coast.

Figure 12: Estimated Seasonal Population Increase, Sussex County.

Sussex	Population	2015	2050
	Annual from DPC	215,375	270,421
Seasonal	Vacants (@80%)	96,456	121,927
	Hotels (@80%)	9,235	9,235
	Campsites (@80%)	1,077	1,077
	Total Seasonal	106,768	132,239
Total	**Seasonal + Annual**	**322,143**	**402,660**



Source: WILMAPCO. 2018.

This large influx of tourism during summer months generates passenger traffic, as well as additional truck traffic supporting service industry establishments in tourist centers. For example, in the prior Delmarva Freight Plan (2015), DelDOT estimated that traffic can more than double on some major routes during the tourist season. Continuing all-season community growth in Sussex and Dover Counties is likely to further exacerbate this congestion issue in the future.

In Delaware, noted bottlenecks for tourist and truck traffic include routes that serve coastal communities, including DE-1, DE 404, US-113, and US-9. These routes can experience congestion in cities removed from the coast as well, such as Dover, Milford, and Millsboro. Information on specific first/final mile connection congestion associated with tourist traffic is unavailable, but congestion on these mainline routes is likely impacting freight connectivity and mobility. Additionally, the Delaware

[4] Delaware Tourism Office. 2020. Report: Delaware tourism sets new records.

Freight Hierarchy already identifies the roads serving cores of tourist areas such as Rehoboth, Lewes, and Bethany as primary, secondary, and tertiary freight routes.

Agricultural Shipments in Rural Areas

Agriculture is a major freight-reliant industry for much of the Delmarva peninsula and is made possible by a wide network of rural first- and final-mile connections. Previous transportation plans such as the Delmarva Freight Plan and Delaware State Freight Plan identified multiple rural road needs and issues that are relevant to this project, including:

- Poor pavement and bridge conditions in rural areas,
- High truck volumes on rural routes, which can create congestion or deteriorate under-engineered pavements,
- Seasonal congestion created by large volumes of freight moving at harvest time, and;
- General traffic, especially seasonal tourist traffic impeding the efficient movement of time-sensitive or perishable cargo, such as live poultry.

In addition to the work above, the Delmarva Freight Plan has identified several rural routes from a mix of minor arterials, collector roads, and local roads that would not qualify for critical freight corridor designation but carry high truck volumes, primarily serving the region's agriculture, poultry, and food products industries. These routes include:

- MD 291 and DE 6 (from US 301 toward Clayton and Smyrna)
- MD 300 and DE 300 (from US 301 toward Smyrna)
- MD 302 and DE 8/11/44 (from US 301 toward Smyrna/Dover)
- MD 304/311 and DE 10 (from US 301 toward Dover)
- MD 317 and DE 14 (from MD 404 toward Harrington)
- DE 36 (from DE 404 toward Greenwood)
- DE 26 (from DE 30 toward Dagsboro)

The draft first/final mile freight network identified in the following chapter incorporated previously-identified rural connections like these, as well as new rural connections identified through a review of freight-related business locations. These draft connections will be further refined in later stages of the project.

Flooding and Sea Level Rise

Continued sea level rise associated with climate change is a major threat to low-lying elements of Delaware's road network, and significant weather and tidal events also can flood elements of the road network.[5] While work has been done to identify roadways subject to flooding, or at risk of future flooding, prior projects did not identify specific freight roadways impacted by this problem. As part of this project, identified first/final mile connections will be screened against sea level rise estimate data provided by WILMAPCO, DelDOT, and other agencies to determine which connections are at risk for current or future flooding.

[5] Strategic Implementation Plan for Climate Change, Sustainability & Resilience for Transportation. Delaware DOT. 2017.

Institutional Coordination

Both the Delmarva and Delaware state freight plans stress the importance of state-level leadership or support for balancing economic growth and development opportunities with critical freight infrastructure and freight-oriented land use preservation. Since Delaware is a Home Rule state, land use decisions are made at the county and municipal level. This has created challenges for DelDOT and MPOs, including WILMAPCO, to preserve freight land use and ensure compatibility in specific areas.

Other First/Final Mile Topics

In addition to the topics above, some other emerging first/final mile issues relevant to Delaware and mentioned in prior Delaware-specific projects include:

- Projected land use conflicts between urban residential areas and business/industry hubs.
- Impacts of potential future expansion or development projects at the Port of Wilmington on truck volumes.
- Continued traffic volume growth. According to WILMAPCO's 2018 Inter-Regional Report, without investments in highway infrastructure by 2045, the region's congestion will significantly impede freight flows on most highways and especially along the I-95 corridor with a projected 20,700 daily truck volume.

2.3 Trends Impacting First/Final Mile Routes

The location and problems of first/final-mile routes continue to evolve as market and social forces shape economic development. Understanding the trends impacting first/final mile routes provides context for connection improvement strategies discussed in later Working Papers.

National Trends

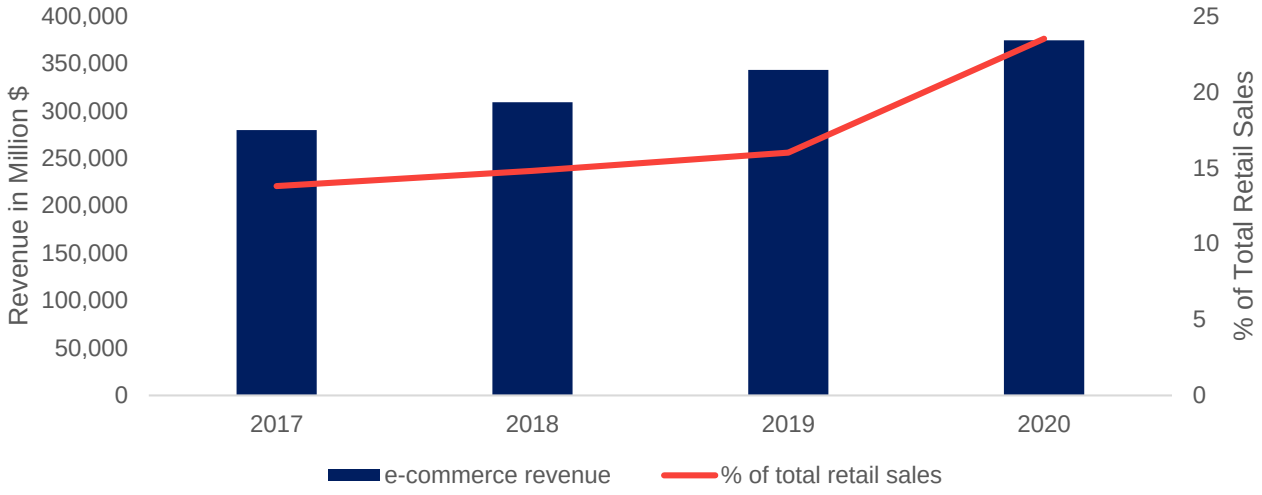
1. Development of warehousing/distribution centers:

Warehouses and distribution centers (DCs) are primarily served by trucks. Recent growth in e-commerce across the US and the globe has revolutionized the warehousing and distribution industry, pushing for innovative solutions to increase/diversify the inventories, reduce shipping times, and improve service reliability. The resulting growth in new warehouses and DCs generates additional truck traffic on first/final mile connections, which can negatively affect the condition and performance of these corridors.

Growing truck traffic volumes on first/final mile connections between limited-access highways and warehouses or DCs is an emerging issue for transportation agencies across the country, due in part to e-commerce's explosive growth and increasing demand for shorter delivery times.

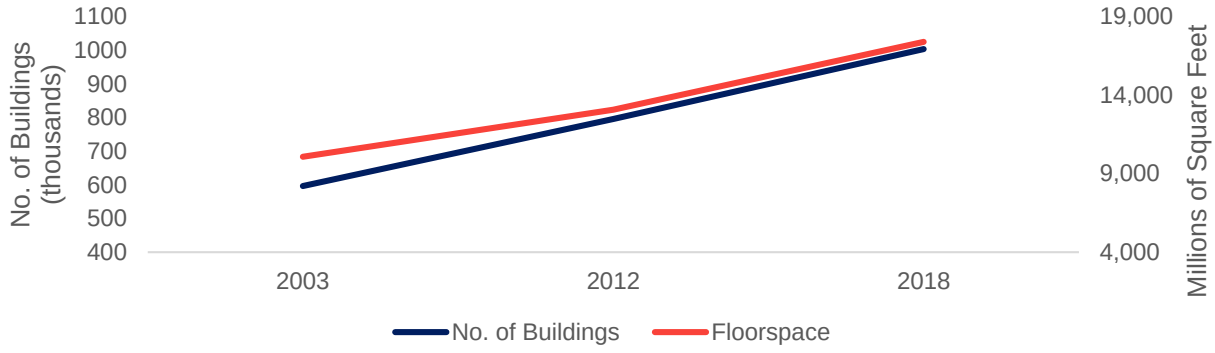
Figure 13 and Figure 14 illustrate the scale of this growth in the past years, with a significant jump in e-commerce activity during the 2020 COVID pandemic. In addition to the truck traffic generated by new warehouses and DCs, existing facilities are generating additional truck traffic as retailers and carriers alter their operations to support shorter shipping times. For example, warehouses and DCs are increasingly receiving more frequent less-than-truckload shipments rather than larger, less frequent truckload shipments.

Figure 13: Retail E-Commerce Sales in the US



Source: Census Bureau, Quarterly Retail E-Commerce Sales, 2020.

Figure 14: Warehouse and Storage Facility Total Floorspace in the US



Source: EIA CBECS Survey Data.

The impacts of increased truck traffic associated with warehouses and DCs fall into two broad categories that relate to freight:

1. **Facility access problems** include poorly-designed or placed entrances and exits to warehouses and DCs, geometric road design without considering trucks' operational factors, incompatible corridor use (i.e., bike routes next to truck lanes), and a truck parking shortage.
2. **Corridor management problems** include traffic signal operational challenges and the impact of slow-moving trucks on roadway performance, especially at peak traffic times.

Both facility access and corridor management problems can create or exacerbate congestion, resulting in lost productivity, increased air pollution, and decreased quality of life.

New and emerging advancements in technology and data sources can improve this situation by providing enhanced truck observability at a local level. For instance, the low cost of GPS tracking units, cellular internet service, and ready-made analytical software has made it easy and cost-effective for private trucking companies to track and analyze their vehicles' and drivers' performance in real-time. Also, emerging technologies in the public sector help improve the visibility of truck movements; e.g., traffic cameras equipped with analytical software can automatically classify and count vehicles, providing real-time traffic information.

Final 50-Feet Access

The continued rise of e-commerce and delivery services has created new freight transportation pressures at an extremely local level. While first/final mile connections facilitate freight movements between mainline transportation corridors and local facilities, the concept of final 50-feet access focuses on trucking activities at or near the points of pick-up or delivery, especially in urban areas. The final 50-feet of a trip begins when the truck stops, and the driver must carry goods the remainder of the distance, often greater than a strict 50 feet.

The high volume of package movements associated with e-commerce, combined with the need to supply restaurants and retail establishments means that in urban areas, final 50-feet access problems contribute to and are affected by geometric road design, traffic control management, and traffic congestion. An example of these problems is trucks parking illegally or double-parking while unloading in dense urban areas.

Source: NCFRP 49, National Academies of Sciences, 2019.

2. Residential growth encroaching on freight areas:

In the US, urban encroachment often occurs due to the demand for housing in low-density residential zones beyond a compact urban area. The continuing growth of residential areas not only threatens the industrial and agricultural land uses and natural habitats but can create and exacerbate traffic congestion on connecting corridors between metropolitan areas.

Within the urban areas, redevelopment of former freight-generating sites to residential and commercial land uses can push freight development to rural areas increasing the truck miles traveled in first/final mile delivery trips, which in turn will increase air quality, congestion, safety, and infrastructure maintenance issues.

Among the tools that public agencies at the state, regional, and local levels can use to encourage freight land use preservation are the use of financial incentive programs. For instance, many states offer property tax relief for certain freight-generating properties. Also, at the Federal level, tax credits (ranging from 10 to 20 percent) are granted to projects that rehabilitate existing or historic industrial buildings.[6] Such tools will be explored in greater depth in later Working Papers.

Natural real estate market forces can also respond to the urban encroachment issue by escalating the costs of extending roads, utilities, public transportation, and other services to lower-density residential areas. However, land use and zoning plans often are developed at the county-level with little or no

[6] FHWA Freight and Land Use Handbook, 2006.

coordination among agencies. An ongoing pattern among the local agencies across the US is offering tax-based incentives to developers to see growth at any cost. This issue has constrained the effects of market forces on industrial land use preservation.

3. Growing awareness of disparate impacts on frontline communities:

Although first/final mile freight connections facilitate economic activities with benefits that expand across a wide geographic area, their negative social impacts mostly affect frontline communities, or the communities adjacent to freight-related activity. On the flip side of the freight-generating land use preservation efforts are the community concerns regarding high truck traffic volumes near residential neighborhoods. Concerns regarding freight community impacts fall into the following categories:

- **Safety problems** are generally related to the incompatibility of the truck maneuvers with that of other road users, including cyclists and pedestrians. Due to their disproportionate size and weight compared to passenger vehicles, truck crashes often lead to serious injuries and damages.

- **Diesel emission problems** are primarily associated with localized air pollution and noise emission impacts of trucking activities. Residential proximity to routes with high truck traffic volumes has been associated with adverse physical health effects, including asthma, lung cancer, cardiovascular diseases, and adverse birth outcomes.[7] Research has also shown that in addition to the physical and mental effects, the levels of truck traffic noise and vibration are positively correlated with property value depreciation in communities near routes with high truck traffic volumes.[8]

Over the last decade, the rise of e-commerce has resulted in changes in the size and spatial distribution of new warehouses and DCs. Nationwide trends show a growth in the number of smaller warehouses and DCs located closer to densely populated urban areas to enable faster and more frequent deliveries. Even if freight volumes were projected to be constant (which they are not as freight demand, especially for e-commerce, is generally increasing), a higher number of smaller facilities would generate more freight traffic. Newer and cleaner truck engine technologies can mitigate some of the air quality and emission impacts of first/final mile deliveries. However, increased truck traffic will still negatively impact congestion, safety, and curbside accessibility.

Due to these problems, public agencies are increasingly seeking policy and strategy solutions to balance the economic development concerns with community needs. Coordinated freight and land use planning, improving road safety design, innovative traffic management practices, and private sector and community outreach are among the solutions sought by public agencies across the US.

Delaware-Specific Trends

A key trend relevant to Delaware has been the continued development of new residential properties, which can put pressure on formerly-isolated industrial areas. Figure 15 and Figure 16 show the trends in residential and non-residential development applications and building permits in Delaware between 2008 and 2018. Residential data is presented in number of units, while the non-residential data which

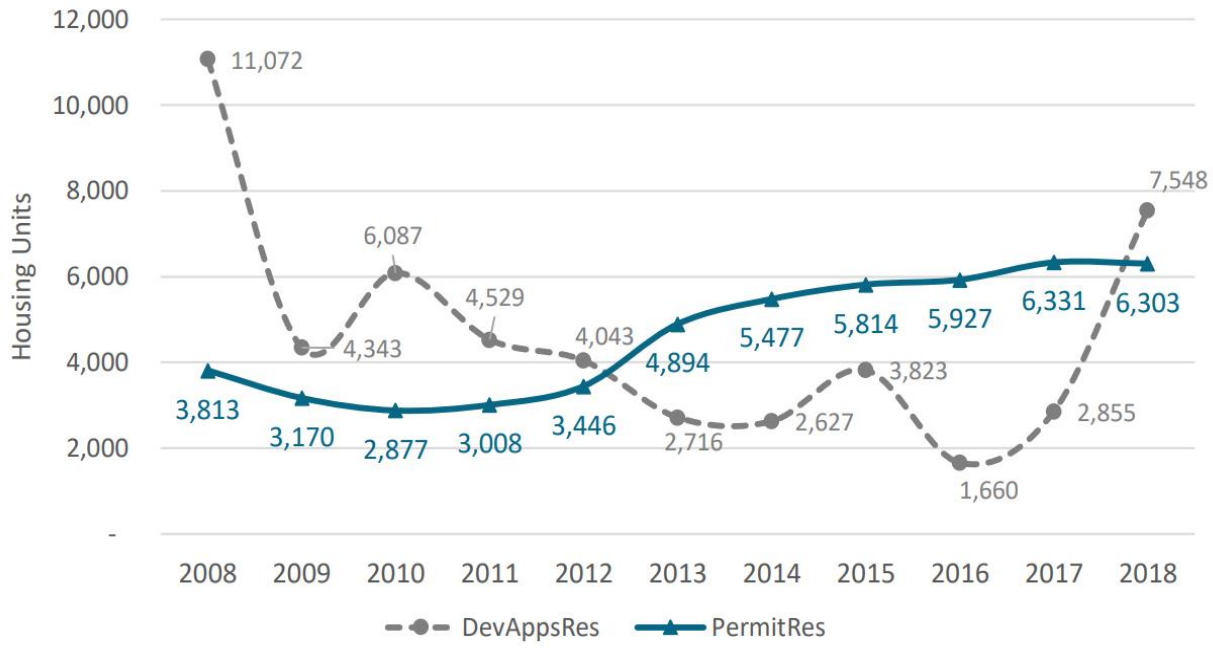
7 Adar and Kaufman, Cardiovascular disease and air pollutants: evaluating and improving epidemiological data implicating traffic exposure, 2007.
8 Li and Saphores, Assessing Impacts of Freeway Truck Traffic on Residential Property Values, TRB, 2012.

includes commercial, office, industrial, and institutional uses are presented in square feet of development.

The graphs, developed by the Cabinet Committee on State Planning show that over the past five years, residential applications and permitting activity statewide has remained higher compared to non-residential development. Between 2013 and 2018, more than 21,200 residential units were approved for development in Delaware, the majority of which (46 percent) were in Sussex County. During the same period, non-residential development applications and permits have been focused in New Castle County.

The locations of new development applications and permits have in general been in alignment with the State's land-use development and growth strategies with the exception of Sussex County, where about 30 percent of the residential growth and 14 percent of the non-residential growth has not been guided by the State strategies.[9]

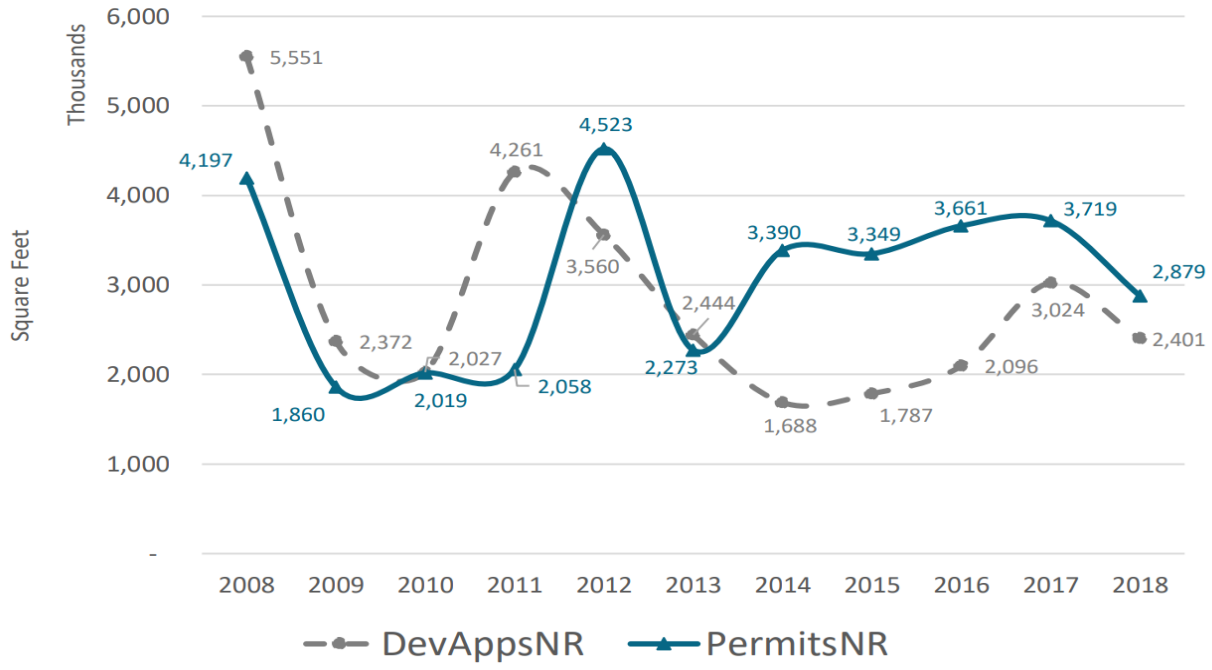
Figure 15: Number of Residential Units in Development/Permitting - 2008–2018



Source: Cabinet Committee on State Planning, Delaware State Planning Report, 2019.

[9] Cabinet Committee on State Planning, Delaware State Planning Report, 2019.

Figure 16: Non-Residential Square Footage in Development/Permitting - 2008–2018



Source: Cabinet Committee on State Planning, Delaware State Planning Report, 2019.

2.4 Conclusion

First/final mile connections are critical elements of the freight network, and problems on these connections have significant impacts on the efficiency and safety of freight transportation, as well as the safety and quality of life of residents adjacent to these routes. Additional problems are likely to arise in the future as industrial and residential development continues, and planning responsibilities remain divided among different levels of government.

A key element of this first/final-mile network development project is identifying potential solutions for first/final mile problems. Therefore, beginning in January 2021, CPCS will be soliciting feedback from Delaware's stakeholders on the location of first/final mile connections, and the problems present on these connections. This feedback will be a critical input for further work on this project.

3 Identification of the First/Final-Mile Freight Network

A key step in this network development project is the initial identification of first/final mile corridors in Delaware. This initial identification is meant to provide a network that Delaware freight stakeholders can react to, providing additions, and identifying specific problems on identified connections. This chapter provides an overview of prior problem identification efforts that are relevant to Delaware, and the methodology used to complete the initial identification of first/final-mile routes.

3.1 Prior Identification Methodologies

In addition to a review of previously-documented first/final mile problems, this project's literature review sought to collect information on the methods and data used to identify and evaluate first/final-mile routes in other regions. In general, many of the reviewed studies evaluated performance on pre-identified corridors, such as designated routes to and from major intermodal facilities. Relatively few studies sought to identify new connectors, and those that did were either focused on smaller areas (such as metropolitan areas), or extensively leveraged input from local planning and business stakeholders to "crowd-source" an understanding of first/final-mile connection locations. This chapter provides information on the relevant findings from the literature review, the initial first/final mile route identification process, and the results of that identification work.

Various criteria, methodologies, and prioritization approaches can be used in first/final-mile connection analysis. A review of the relevant national, state, and regional studies shows that functional classification, Annual Average Daily Truck Traffic (AADTT), connectivity to primary routes such as interstate and US highway systems, land use development/preservation strategies, and access to truck trip generators (such as ports, airports, rail terminals, industrial manufacturing land uses, storage and distribution facilities, and strategic defense infrastructure) are key criteria categories in first/final mile connection analysis. Figure 17 summarizes the criteria used in prior studies to identify and prioritize first/final mile connections. This figure illustrates how AADTT, freight volumes, and road functional classifications have been frequently used in the past and could be some of the key elements used to score or prioritize Delaware's first/final mile connections later on in this network development process.

In multimodal connection analysis studies, the Average Annual Daily Truck Traffic (AADTT) criterion is often replaced by corridor-level freight volumes. Also, the truck percentage of the total traffic volume is sometimes used in conjunction with AADTT to consider the wear and tear impacts of truck trips, even on rural routes with lower traffic volumes. The frequency of truck parking citations and truck crashes are also factors that impact a route's congestion and affect first/final mile deliveries. As discussed earlier, these factors generally occur in the context of freight and land use compatibility assessments.

Figure 17: Criteria Used to Identify and Prioritize First/Final Mile Connections

Study/Report Name	Year	Region	First/Final Mile Connection Identification/Prioritization Criteria											
			No. of Lanes	AADTT	Truck Percentage of Traffic Volume	Annual Freight Volumes	Land-use Strategies	Access to Key Truck Trip Generators/ Defense Facilities	Road Functional Classification	Network Connectivity	Infrastructure Condition	Density of Warehouses and DCs	Alternative Cross-State Route	Truck Parking Citations / Truck Collisions
Delaware State Freight Plan Addendum	2017	DE		✓	✓		✓	✓	✓		✓			
Delmarva Freight Plan	2018	DE						✓	✓					
WILMAPCO Interregional Report	2018	DE		✓					✓					
NCFRP 16: Preserving and Protecting Freight Infrastructure and Routes	2012	USA		✓			✓	✓				✓		
NCFRP 25: Freight Trip Generation and Land Use	2012	USA		✓	✓		✓							
FHWA Freight Intermodal Connectors Study	2017	USA	✓	✓				✓	✓	✓				
Defining the Washington State Truck Intermodal Network	2011	WA				✓		✓						
Washington State Freight and Goods Transportation System Update	2019	WA		✓		✓	✓	✓	✓				✓	
Washington State Freight System Plan	2017	WA				✓		✓					✓	
Atlanta Regional Freight Mobility Plan Update	2016	GA						✓				✓		
Regional Truck Highway Corridor Study	2017	MN				✓			✓	✓				
Analysis of Freight Transport Strategies & Methodologies	2017	FL		✓	✓			✓		✓				
Los Angeles County Strategic Goods Movement Arterial Plan	2015	CA	✓	✓		✓	✓		✓	✓			✓	✓
Last-Mile Freight Delivery Study	2020	CA		✓			✓	✓	✓			✓		✓

Source: CPCS review of listed documents/reports.

Additionally, the first/final mile identification/prioritization criteria included in the Delaware State Freight Plan are listed in Figure 17, and below.[10]

1. Proximity to priority land uses identified in the 2015 State Freight Plan;
2. Proximity to high truck trip generation areas;
3. Route segments with high truck AADTT and truck share of all vehicle traffic;
4. Route pavement condition.

The high truck trip generation areas were identified using Traffic Analysis Zone (TAZ) employment by industry. The AADTT and truck percentage data are extracted from DelDOT's Peninsula Travel Demand Model and used to create a hybrid criterion that captures truck activity impacts on both urban and rural routes. Other information considered for first/final mile identification/prioritization includes functional classification, bridge condition, and funding availability. Previously-identified routes from the State Freight Plan are included in later analysis in this chapter.

3.2 Initial Route Identification Approach

Based on the findings of the literature review, available data, and project goals and timelines, a "hybrid" qualitative-quantitative identification approach was developed for Delaware, with an initial identification exercise driven partially by data and partially by ground-truthing potential connections using a manual review of Google Maps and Google StreetView. The purpose of this work was to produce a "first draft" network that could be used to support stakeholder outreach and collection of further information on the system.

The key sources of data used in the initial identification process were:

- Delaware Road Network shapefiles
- Delaware Freight Hierarchy shapefiles
- Zoning and land use shapefiles from each of Delaware's three counties
- ReferenceUSA records of business locations
- Google Maps satellite imagery
- Google StreetView street-level imagery
- ESRI Network Analyst road network files

Step 1: Freight Activity Identification

To start, areas of likely freight activity were identified using business establishment data from ReferenceUSA, along with zoning information for each county. ReferenceUSA data was chosen as it was used during the previous development of the Delaware State Freight Plan and provides information across Delaware and a wide range of industries. Figure 18 lists the criteria used to identify freight-generating business establishments in Delaware, and the number of businesses initially identified in each industrial group. Zoning information was also included to help illuminate areas of freight activity that could potentially be "missed" in the ReferenceUSA data.

[10] 2017 Delaware Statewide Freight Plan Addendum.

Figure 18: Reference USA Criteria for Freight-Reliant Businesses

Employment at Site	Primary Industry Classification (Based on NAICS codes)	Number of Sites
20+	11 - Agriculture, Forestry, Fishing, and Hunting	10
	21 - Mining, Quarrying, and Oil and Gas Extraction	2
	22 – Utilities	37
	23 – Construction	226
	31, 32, 33 – Manufacturing	195
	42 – Wholesale Trade	140
	48 – Transportation and Warehousing	72
100+	44, 45 Retail Trade	112
	Total	794

A higher threshold of employment was used for retail establishments, as including retail establishments with lower employment would significantly increase the number of establishments that would have to be screened and reviewed, without providing as much insight into the location of major freight traffic generators. Tourist service establishments such as hotels and restaurants are not included because including them would significantly further increase the burden of the review process and because major tourist service clusters in towns such as Rehoboth, Lewes, and Bethany were already identified as primary, secondary, or tertiary routes in the Delaware Freight Hierarchy.

Another noteworthy item is the relatively small number of agricultural and resource extraction sites that were identified. This lack of establishments is likely due to the criteria that each site must have 20 or more employees. Since lowering the threshold of required employees would make a ReferenceUSA query return many more establishments (significantly increasing the effort needed for review tasks), the ReferenceUSA data was supplemented with zoning data for parcels identified as “industrial,” so as to include more potentially-freight generating areas in the review.

Step 2: Filtering Establishments with Prior Freight Connections

Since DelDOT, WILMAPCO, and other stakeholders had already invested in identifying many elements of Delaware’s freight network (the Delaware Freight Hierarchy), this information was leveraged to aid in simplifying the review. Parcels and establishments within parcels adjacent to Delaware Freight Hierarchy road segments were removed from further evaluation, as those locations already have immediate access to the freight network, or already had their first/final mile connections identified.

The prior Delaware Freight Hierarchy developed during the creation of the State Freight Plan proved to have excellent coverage: over half of the identified ReferenceUSA points were adjacent to roads already included in the Hierarchy.

Step 3: Review of Remaining Points, Manual Identification of Connections

Google Earth and StreetView were used to screen the remaining sites, and include sites not identified in the ReferenceUSA, such as some landfills and quarries. Based on this manual review process, 23 additional business establishments were included for this route analysis.

For most of the remaining ReferenceUSA points, manually identifying first/final-mile connections was straightforward, as there were limited (one or two) roads connecting to these facilities, or they were very close (but not adjacent) to the existing designated freight hierarchy routes. For these facilities,

first/final mile road segments were flagged and added to a new spatial shapefile containing manually-identified routes. About 50 first/final mile routes were identified using this process.

Step 4: Automated Route Identification with ESRI Network Analyst

After manual route identification was complete, 37 freight facilities remained without designated first/final mile connections. In many cases, these were freight facilities located in rural areas, and nearly equidistant between major freight hierarchy routes, with no immediately-apparent preferred routings to major highways. ESRI Network Analyst's route solving tools and roadway network dataset was used to calculate routes from each of these facilities to seven exit/entry points around the border of Delaware. This approach focusing on borders was chosen because ESRI's network analyst tool requires the input of discrete origin and destination points to solve routes, and the prior 2015 Delmarva freight plan noted that 36% of Delmarva peninsula freight movements were inbound or outbound from the region, while only 8% were "internal" movements starting and ending in the region. Therefore, it was assumed that using border points as "anchors" for route solving analysis would capture the most likely first/final mile truck routes for these 37 facilities. These seven exit/entry points were based on the points at which primary and secondary freight hierarchy roads touched the border of Delaware.

The results of route identification from Steps 1 through 4 are shown in Figure 19. Connections that were previously-identified in the Freight Hierarchy work are shown in red, connections that are manually-identified are shown in orange, connections that were identified or mentioned in the Delaware State Freight Plan are shown in green, and routes identified by ESRI network analysis are shown in blue.

Step 5: Incorporation of Stakeholder Feedback

The first/final-mile connections shown in Figure 19 will be uploaded to the project website's interactive map at https://wikimapping.com/Delaware-Final-Mile.html where Delaware's stakeholders can identify additional routes, as well as first/final mile problems they are familiar with. This feedback will be used to further expand and refine the comprehensive dataset of first/final mile connections, as well as noted problems with these connections.

Step 6: Incorporation of INRIX GPS Data

During or after the inclusion of stakeholder feedback, CPCS will use INRIX data to identify any remaining road segments with recorded truck traffic. This dataset is a record of truck GPS "pings" in Delaware, and these GPS records can be used to identify other roads that are supporting the movement of truck traffic, but which were not identified in any of the prior steps of the analysis. An initial identification process will be conducted using INRIX's GPS waypoints, with the addition of GPS-identified truck trip origins and destinations if needed.

3.3 Data Sources for Performance Evaluation

Once the analysis steps listed above are complete, road segments will be screened for potential problems using a variety of performance evaluation tools. Data collection for this task is ongoing. Figure 20 lists the common data sources used to evaluate the performance of first/final-mile routes from prior studies and the types of data that CPCS is seeking to leverage for this project. As part of ongoing stakeholder engagement, CPCS will be seeking input from the Focus Group and the Steering Committee on other datasets of interest for screening first/final mile connections for problems/

Figure 19: Delaware First/Final-Mile Freight Connections

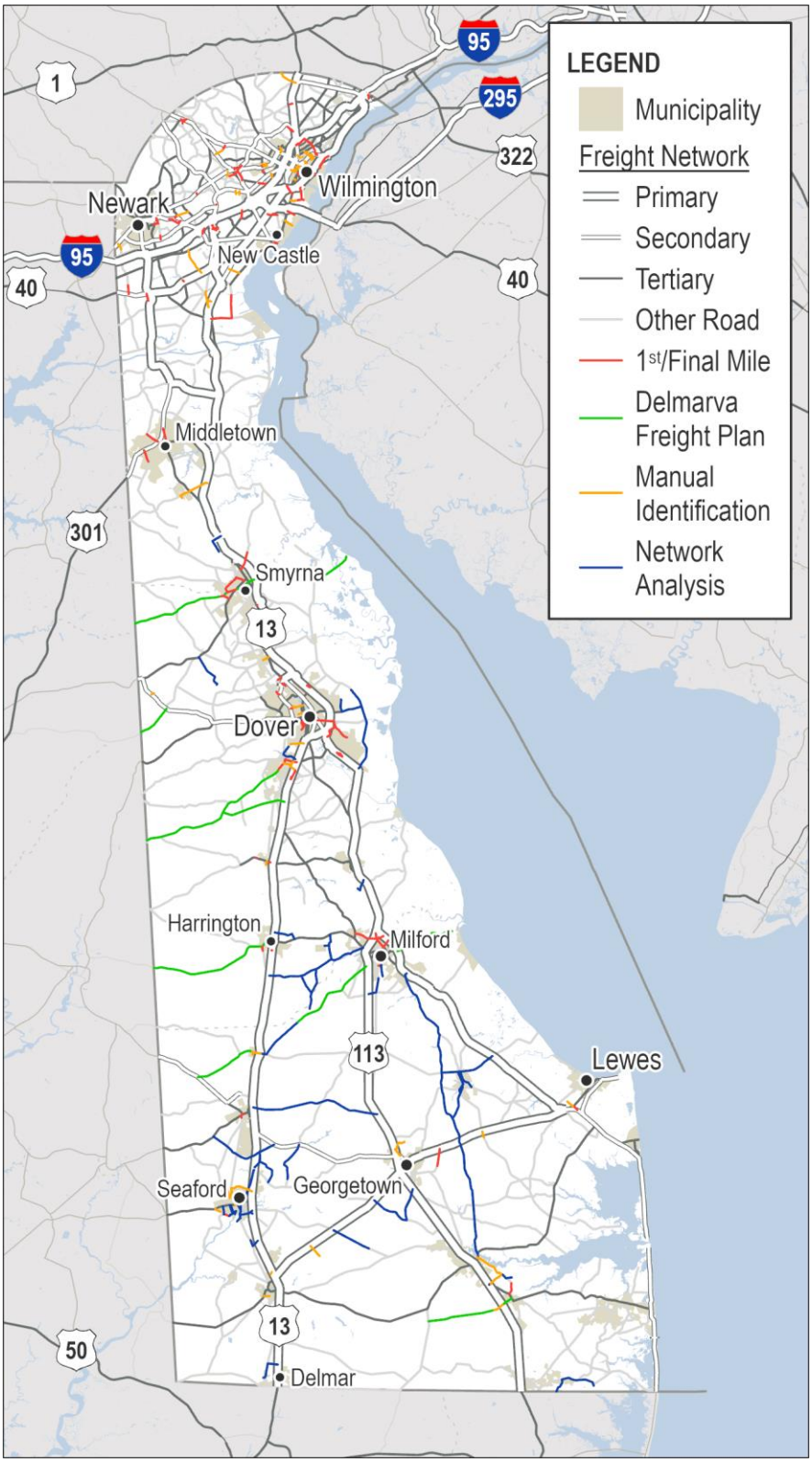


Figure 20: Data to Assess Performance and Conflicts on First/Final Mile Corridors

Category	Information	Potential Source
Highway Infrastructure Characteristics	Pavement Condition	DelDOT, FHWA
	Functional classification	
	Travelway Width	
	Number of Lanes	
	Bike Routes	
	Sidewalks	
	Shoulder Width	
	Intersection Design	
	Drainage or Flooding Prevention Systems	
	Sight Distances	
	Bridge Clearances	
	Warning Devices	
	Segment Length	
	Speed Limits	
Social Characteristics/ Impacts	Population density	Census Bureau, US EPA, State of Delaware Mobile Source Emissions Inventory, Cabinet Committee on State Planning Land Use Database, Delaware State Police Accident Reports
	Employment by Industry	
	Rural/Urban Designation	
	Land Use Strategies	
	Emission Impacts (Pollution, Noise)	
	Truck-involved crash history	
Rail Infrastructure	Road-Rail Crossing Characteristics (Alignment, Warning Devices, Number of Trains, Crossing Ownership, Accidents)	Federal Railroad Administration Crossing Inventory and Safety Information Database
	Blocked Crossing	
Other Information	Truck Volumes	DelDOT, FHWA, Freight Analysis Framework, Census Bureau County Business Patterns
	Truck Parking Shortage	
	Infrastructure Maintenance Costs	
	Truck Operating Costs	
	Congestion Cost	
	Supply Chain Characteristics	
	Programmed Freight Projects	

Source: CPCS review of relevant documents/reports.

4 Conclusion and Next Steps

This Working Paper provides an initial understanding of first/final mile needs and issues that may be relevant to Delaware, as well as identification of draft first/final mile connections that can be used to support further outreach with stakeholders.

The next phase of this work will include the collection of stakeholder feedback on the initially-identified first/final connections and their needs and issues. This will be accomplished through an online mapping tool, as well as a Focus Group meeting. Once feedback is collected, further work will be done to screen identified routes against INRIX GPS “ping” data and produce the most comprehensive list of first/final mile connections possible. Further work in spring will focus on evaluating the performance of these connections, which in turn will support the creation of strategies and recommendations to address Delaware’s first/final mile needs and issues.

Appendix A

List of Documentation Reviewed:

Agency or Author	Study	Year
Atlanta Regional Commission	Freight Mobility Plan Update	2016
Australasian Transport Research Forum	Regional First and Last Mile Pilot Project	2016
Chicago Metropolitan Planning Agency	Freight Committee Archive	2017 - 2019
Community Planning Association of Southwest Idaho	COMPASS Freight Study	2017
Delaware DOT	Delmarva Freight Plan	2015
Delaware Valley Regional Planning Commission	National Highway System Connectors Freight Facilities	2007
Federal Highway Administration	Freight and Land Use Handbook	2012
Federal Highway Administration	Freight and Land Use Travel Demand Evaluation	2018
Federal Highway Administration	Freight Intermodal Connectors Study	2017
Florida DOT	Analysis of Freight Transport Strategies and Methodologies	2017
Florida DOT	District 7, Tampa Bay Strategic Freight Plan	2018
Florida DOT	Freight and Land Use Planning Trends	2019
Khalid Aljohani and Russell Thompson	An Examination of Last Mile Delivery Practices of Freight Carriers Servicing Business Receivers in Inner-City Areas	2020
Los Angeles Metro	Development of a Countywide Strategic Truck Arterial Network (CSTAN) for Los Angeles County	2015
Los Angeles Metro	Goods Movement Strategic Plan	2020
Minneapolis-St. Paul Metropolitan Council	Regional Truck Highway Corridor Study	2017
National Academies of Sciences	NCFRP Report 16: Preserving and Protecting Freight Infrastructure and Routes	2012
National Academies of Sciences	NCFRP Report 19: Freight Trip Generation and Land Use	2012
National Academies of Sciences	NCFRP Report 49: Understanding and Using New Data Sources to Address Urban and Metropolitan Freight Challenges	2018
National Academies of Sciences	Vehicle Emissions Evaluation on Intersections along 'First-last mile' Freight Intermodal Connectors	2019
Oregon DOT	Oregon Freight Intermodal Connector System Study	2017
Southern California Association Of Governments	Last Mile Freight Delivery Study	2020
Washington Department of Transportation	Freight and Goods Transportation System (FGTS) Update	2019
Washington Department of Transportation	Mapping State Freight Corridors Based on Freight-Intensive Land Use	2015
Washington Department of Transportation	Washington State Freight Plan	2017

Will County Center for Economic Development	Community Friendly Freight Mobility Plans	2017
Wilmington Area Planning Council	Inter-Regional Report	2008, 2018