Delaware First/Final Mile Freight Network Development

Final Report

Prepared for:

DelDOT and Delaware's Metropolitan Planning Organizations

Prepared by:

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Delaware First/Final Mile Freight Network Development

This network development effort created a greater understanding of Delaware's first/final mile connections, the roads that link businesses to state and national highway networks. A second objective was identifying freight transportation needs and issues on these connections so that DelDOT, Delaware's Metropolitan Planning Organizations (MPOs), and other planning stakeholders can address these issues in the future.

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

Acknowledgements

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Opinions

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

Contact

Questions and comments on this Working Paper can be directed to:

Eric Oberhart
Project Manager
T: 815-345-1022
E: eoberhart@cpcstrans.com

Executive Summary

What are First/Final Mile Connections?

First and final mile connections are roadways that link truck-generating facilities to 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.

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.

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. This connection is shown at left below. 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 public. The image at right below provides an example of a lower-volume last-mile connection on Old Coochs Bridge Road in Newark.

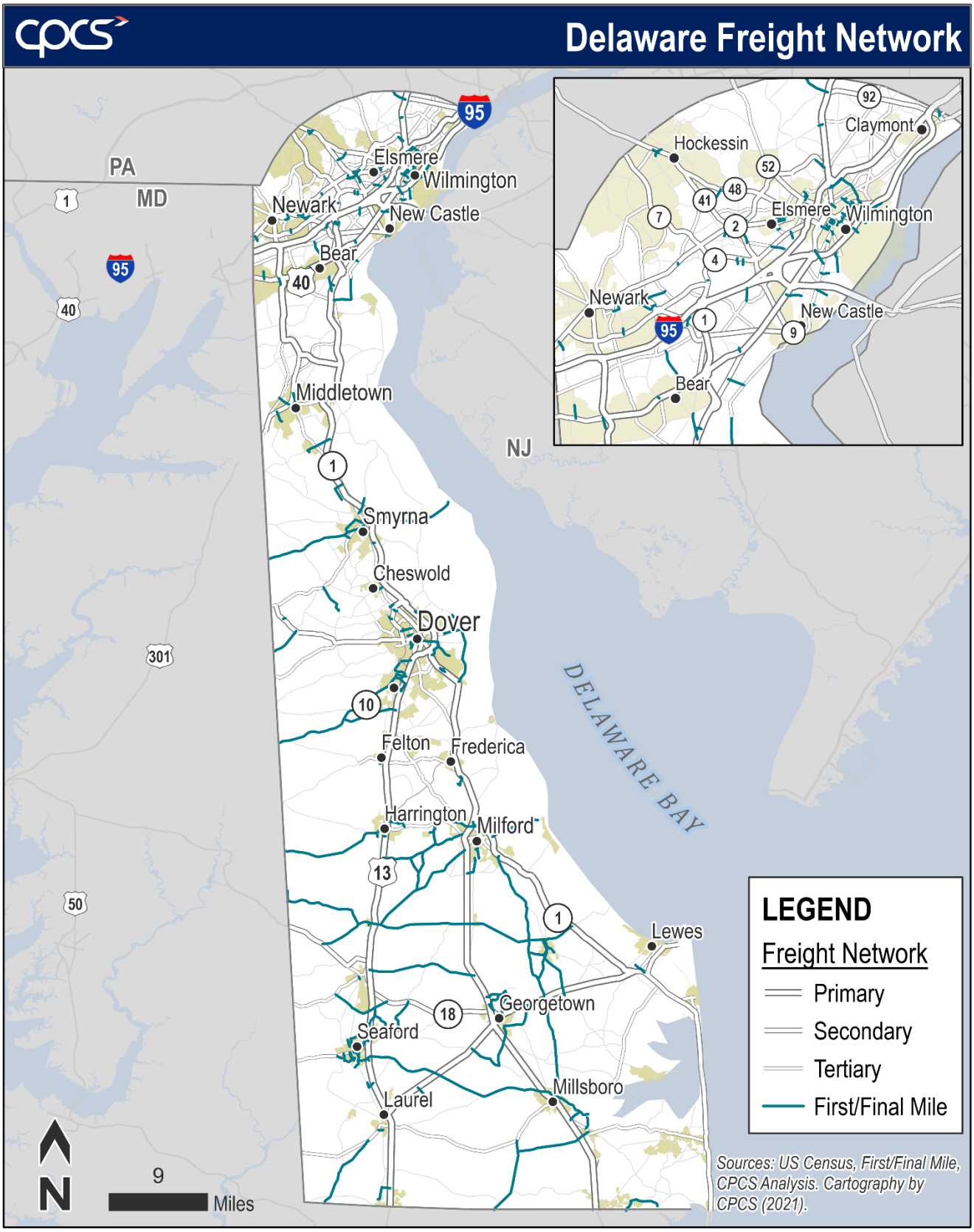
Figure ES-1: First-Final Mile Connection Examples

Source: Google Maps, 2020. *Freight Planning in the WILMAPCO Region*, Presented to DVRPC, October 2017.

Delaware's First/Final Mile Network

The Wilmington Area Planning Council (WILMAPCO) and DelDOT previously identified some of Delaware's first/final mile network during the creation of the state freight plan. This project supplemented the initial network, and identified additional first/final mile routes using a variety of data sources, including the location of freight-related businesses, truck GPS tracking records, and stakeholder feedback collected through an online mapping tool. The project team, led by WILMAPCO and DelDOT and supported by consulting team, identified and screened the first-last mile segments to produce this report between July 2021 and August 2022. Figure ES-2 shows this first/final mile network as well as previously identified inter-regional freight networks.

Figure ES-2: Delaware's First/Final Mile Freight Network



First-final mile freight routes are present in many of Delaware's communities and are not limited to select areas.

Delaware's First/Final Mile Needs and Issues

Once the first/final mile network was identified, the project team screened for potential needs and issues using 26 different data attributes, including data on road characteristics, congestion, land use, and environmental assets. In addition to this data screening, the project team collected stakeholder feedback on specific needs and issues via an interactive online map, which received 127 comments from public agency, industry, and general public stakeholders. Needs and issues are broken down into five major categories.

Institutional problems include difficulty coordinating freight investments across multiple levels of government, communicating the importance of freight transportation to local partners, and data availability issues. Notable institutional issues 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 or fund needed improvements.
- Data related to understanding first/final mile needs and issues may be fragmented across multiple agencies, making the future identification of needs and issues more difficult.

Land Use problems relate to conflicts that arise from the location 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. Notable land use-related first/final mile issues in Delaware include:

- Continued residential and industrial development in rural and exurban areas is a driver of some current and future freight and land use conflict.
- Concentration of existing first/final mile connections and their associated negative impacts in lower-income and minority areas.
- A significant number of first/final mile connections are located close to natural resources such as waterbodies, wetlands, and natural areas.

Mobility problems refer to congestion, as well as barriers to efficient or "smooth" freight movement, such as impediments to direct routing (for example, low-clearance bridges forcing trucks to take longer, circuitous routes), tight turns, narrow lanes, shoulders, or passing lanes. Two significant sources of mobility problems in Delaware are:

- Tourism-oriented areas generate seasonal traffic surges and conflicts.
- Agricultural and rural production activities generate heavy truck traffic.

Safety problems refer to design characteristics or user behavior that increase the likelihood or severity of accidents, including poor sightlines at intersections, driver speeding, or co-location of truck routes and bicycle lanes. Many of Delaware's safety concerns relate to the co-location of truck routes alongside bicycle and pedestrian facilities.

Condition problems relate to the poor condition of pavement or bridges on freight routes, or accelerated deterioration of infrastructure because of frequent and heavy truck traffic. Delaware has very limited first/final mile condition problems, and the few problems identified were related to very specific industrial facilities.

Recommendations

DelDOT and its MPO partners have four types of tools to improve the first/final mile freight system:

- **Policies** that govern data collection, maintenance, development, or operation of first/final mile routes.
- **Partnerships** with state and local stakeholders to better understand or communicate about first/final mile needs and issues, or implement efforts to address needs and issues.
- **Projects**, including infrastructure maintenance, improvement, or expansion.
- **Programs** designed to support investment in projects.

Each of these four "P's" has a different role in addressing first/final mile network issues. Projects may appear to be the most important category because they produce real-world results. However, identifying and addressing needs and issues through project work would be impossible without partnerships to gather feedback, policies to guide partnership and investment, and programs to secure or allocate funding. Figure ES-3 provides a summary of the tools Delaware can use to address its first/final mile needs and issues, and the types of problems that each tool can solve.

Figure ES-3: Improvements or Solutions for Delaware's First/Final Mile Needs and Issues

Improvement or Solution	Institutional	Land Use	Mobility	Safety	Condition
Policies					
Make first/final mile network knowledge readily available to partners	✓				
Incorporate first/final mile checks into project or plan screening tools	✓	✓	✓	✓	✓
Implement freight data changelogs and succession standards	✓				
Designation of truck routes and restrictions		✓	✓	✓	✓

Improvement or Solution	Institutional	Land Use	Mobility	Safety	Condition
Partnerships					
Educate local planning stakeholders about freight operations		✓	✓	✓	
Support truck safety education and outreach for the general public			✓	✓	
Continue public outreach and inclusion for freight projects		✓			
Projects					
Build truck-specific intersection improvements			✓	✓	
Adjust signal timings and detection for truck operations			✓	✓	
Ensure adequate lane and shoulder widths on roads			✓	✓	
Programs					
Leverage federal funding programs for freight improvements			✓	✓	✓
Explore state-level funding programs for first/final mile improvements			✓	✓	✓

A common thread for many recommendations is collaboration. Collaboration with other agencies and stakeholders is a key tool for addressing existing first/final mile problems or preventing new ones from emerging. Therefore, DelDOT and its MPO partners must ensure that their planning, operations, and development partners across the state have easy access to relevant information from this project. In particular, ensuring local planning stakeholders have an understanding of their communities' freight routes and the impacts of freight-related development will help to reduce potential freight-related land use conflicts in the future.

In addition to these specific recommendations, DelDOT, Delaware MPOs, and their planning partners should consider using a strategic lens such as the PMA (Protect – Manage – Accommodate) framework to contextualize and prioritize which freight conflicts they wish to address.

Figure ES-4: PMA Framework

	Protect freight industries from unreasonable conflicts.	**Manage** conflicts in tactical and targeted ways	**Accommodate** freight needs to prevent major issues
Emphasis	Freight needs come first	Balancing freight and other transportation users	Freight is subordinate to other transportation users
Context	Areas where freight industries are dominant. Freight facilities of high importance.	Areas where freight and non-freight activities are both significant land uses.	Areas where non-freight businesses and/or residential communities are dominant.

	Protect freight industries from unreasonable conflicts.	**Manage** conflicts in tactical and targeted ways	**Accommodate** freight needs to prevent major issues
Examples	• Freight clusters • Ports, airports, intermodal terminals	• Mixed-use areas • Freight clusters transitioning to mixed use	• Central business districts or small-town downtowns. • "Stranded" freight facilities (legacy facilities enveloped by communities)

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Acronyms / Abbreviations

DelDOT	Delaware Department of Transportation
DMTA	Delaware Motor Transport Association
DVRPC	Delaware Valley Regional Planning Commission
FHWA	Federal Highway Administration
GARVEE	Grant Anticipation Revenue Vehicle
GPS	Global Positioning System
INFRA	Infrastructure for Rebuilding America
IPA	University of Delaware Institute for Public Administration
MPO	Metropolitan Planning Organization
NHPP	National Highway Performance Program
NHS	National Highway System
PMA	Protect, Manage, Accommodate
PRNS	Projects of National and Regional Significance
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
STP	Surface Transportation Program
TIFIA	Transportation Infrastructure Finance and Innovation Act
TIGER	Transportation Investment Generating Economic Recovery
TIIF	Transportation Infrastructure Investment Fund
USDOT	United States Department of Transportation
WILMAPCO	Wilmington Area Planning Council

1 First/Final Mile Freight Network

First/final mile connections are roadways that link truck trip origins or destinations to mainline routes of travel such as interstates or major regional highways. While the critical role of these connections in supply chains is undeniable, there can be many challenges to making them operate efficiently or safely due to issues such as congestion, limited accessibility for trucks, and conflicts with other land uses such as residential neighborhoods.

Delaware's first/final mile freight network is made up of 346 miles of road across the state and was identified using data such as business establishment information, land use data, truck GPS data, and qualitative feedback provided by stakeholders and the general public.

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 to 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 delivery 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. 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.

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

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 public. Figure 2 provides an example of a lower-volume last-mile connection with multiple adjacent land uses 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 History and 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.

During the development of the State Freight Plan, DelDOT and WILMAPCO created the Delaware Freight Hierarchy network. The Freight Hierarchy identifies and classifies major freight routes (primary, secondary, tertiary), and contains some identified first/final mile connections. However, the Freight Hierarchy's inventory of first/final mile connections was not complete and did not include the entire state.

This project built upon the Delaware Freight Hierarchy to fully identify first/final mile connections in Delaware, evaluate potential transportation needs and issues on these routes, and provide Delaware's planning stakeholders with guidance on how first/final mile needs can be addressed in the future. Ultimately, this project helps 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 Delaware's First/Final Mile Network

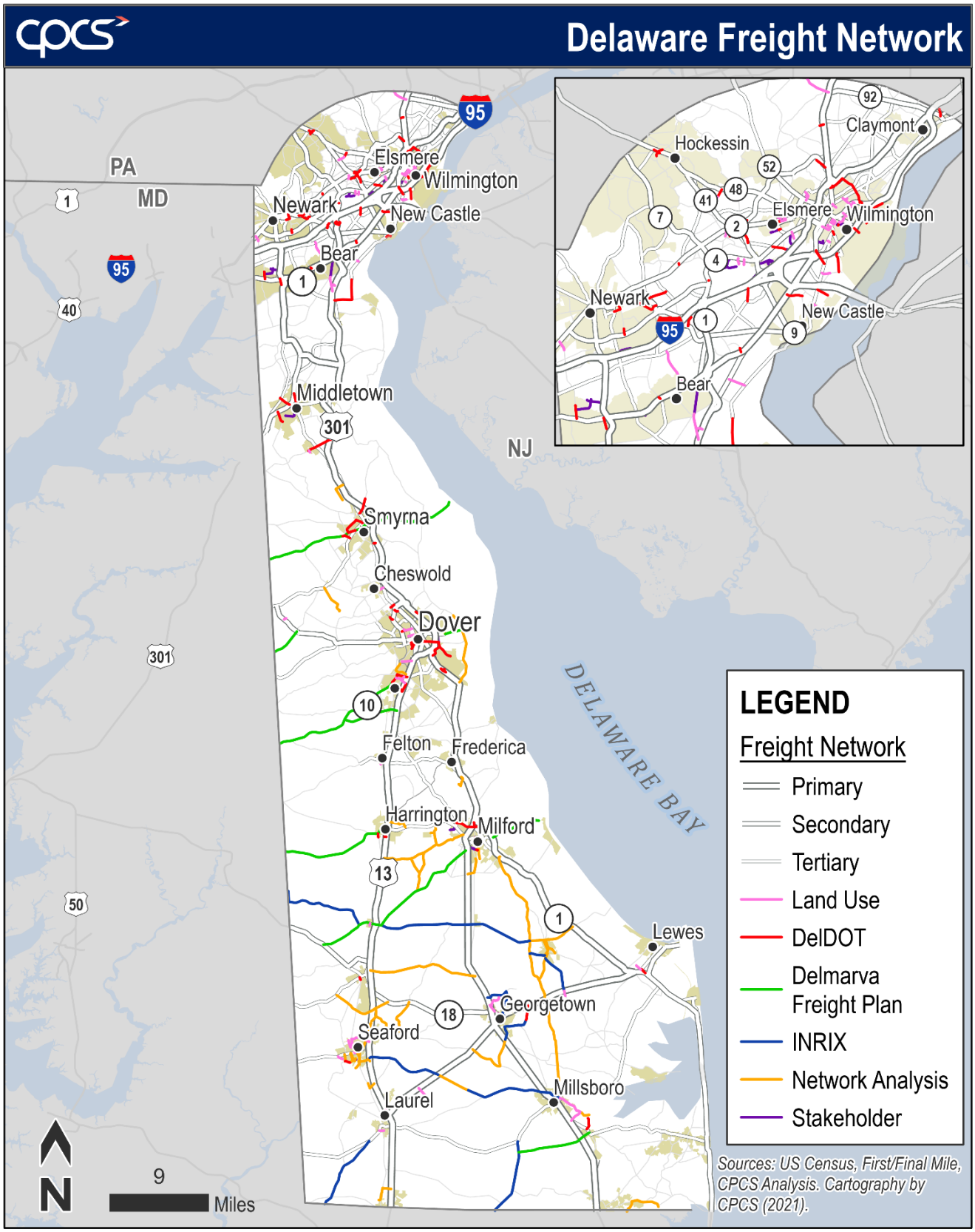
Starting with the network identified in the Delaware Freight Hierarchy, this project used a variety of quantitative and qualitative data sources to identify first/final mile connections in all areas in the state. Initially, a draft network was identified based on analysis conducted using business establishment data from Reference USA, land use and zoning data from the state, Google Earth satellite images, and GPS tracking data from trucks. This data-identified network was supplemented and revised with qualitative information gathered from Delaware's planning stakeholders, industry stakeholders, and the general public via an interactive online interactive map application. Technical details on the quantitative analysis process are available in Appendix A, and a summary of qualitative stakeholder feedback is available in Appendix B.

Figure 3 shows Delaware's identified first/final mile network as well as primary, secondary, and tertiary freight routes. First/final mile road segments are color-coded to reflect the type of data or analysis that identified them:

- **Land Use** shows connections identified using business establishment and land use data.
- **DelDOT** shows first/final mile connections previously identified by DelDOT and WILMAPCO.
- **Stakeholder** lists connections that were identified by stakeholders in the Wikimapping system.
- **Delmarva Freight Plan** connections were identified as key rural routes for agriculture in the Delmarva Freight Plan but were not identified as primary, secondary, or tertiary freight routes.
- **INRIX** reflects connections where INRIX truck GPS data identified truck traffic moving on roads that were not previously classified as freight routes.
- **Network Analysis** connections were identified by ESRI's truck routing algorithms and provide connections to business establishments that did not have a clear route to the primary or secondary freight system identified during the "CPCS" analysis.

The network analysis conducted using this information identified about 346 miles of first/final mile freight connections throughout Delaware.

Figure 3: Delaware's First/Final Mile Freight Network



2 First/Final Mile Needs and Issues

Once the first/final mile network was designated, transportation needs and issues on first/final mile freight connections were identified through additional quantitative analysis as well as solicitation of stakeholder comments.

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 Introduction

During and after stakeholder feedback collection, CPCS worked with DelDOT and its local partners to collect data for the performance screening. Data were assembled from a variety of sources and mapped onto the identified first/final mile network. Examples of transportation issues that were screened for include:

- Location of residential property adjacent to first/final mile routes
- The presence of bike lanes and crosswalks on first/final mile routes
- Truck-involved crash locations on first/final mile routes
- Width of traffic lanes and shoulders on first/final mile routes
- First/final mile route proximity to waterways, wetlands, and natural protected areas

Needs and issues are grouped into five broad categories of first/final mile problems present in Delaware or the United States. Each section of this chapter is centered on one of these five categories:

Institutional problems, which include difficulty coordinating freight investments across multiple levels of government, communicating the importance of freight transportation to local partners, and data availability issues.

Land Use problems, which relate to conflicts that arise because 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, which 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, shoulders, or passing lanes.

Safety problems, which refer to design characteristics or user behavior that increase the likelihood or severity of accidents, including poor sightlines at intersections, driver speeding, or co-location of truck routes and bicycle lanes.

Condition problems, which relate to the poor condition of pavement or bridges on freight routes, or accelerated deterioration of infrastructure because of frequent and heavy truck traffic.

2.2 Institutional Needs and Issues

Institutional needs and issues in Delaware that affect first/final mile truck movements include difficulty coordinating planning and investment between public stakeholders, limited funding to support first/final mile investments, and limitations associated with freight-related data.

Freight conflicts can be caused or exacerbated by institutional issues within the public sector. Three major institutional needs and issues were identified as part of this project.

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. A notable institutional challenge in Delaware is the fragmentation of land use and transportation planning across multiple levels of government. Both the Delmarva freight plan and Delaware state freight plan 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. However, since Delaware is a Home Rule state, land use decisions are made at the county and municipal levels. This has created challenges for DelDOT and MPOs to preserve freight land use and ensure compatibility in specific areas.

First/final mile routes may be owned by multiple government agencies, making it difficult to coordinate or fund needed improvements. In particular, *Innovation in Motion*, the Delaware Long Range Transportation Plan, notes that Delaware is experiencing downward pressure on its transportation revenue sources and that additional revenue may be needed in the future to keep up with current infrastructure standards, build resilience for climate change, and buffer against potential federal shortfalls in highway funding. Challenges such as these could make funding first/final mile improvements more difficult in the future, particularly for any connections that are not owned or maintained by DelDOT.

Data related to understanding first/final mile needs and issues may be fragmented across multiple agencies, making the identification of needs and issues more difficult. The data-driven analysis conducted during the development of the project illuminated some data deficiencies that, if addressed, could improve future evaluations of first/final mile needs and issues or general analysis of transportation performance in Delaware. Several datasets could not be obtained because the individual believed to be responsible for that dataset was unreachable or unresponsive to queries. Often, staff turnover and personnel changes cause data assets to be lost for a variety of reasons. Even when the data is not lost, specific individuals carry hard-won institutional knowledge about how the data was generated, how it has evolved, and relative advantages and disadvantages.

2.3 Land Use Conflicts

Freight and land use conflicts can have a significant impact on residents' health, safety, and general well-being, as well as negative impacts on the natural environment. Additionally, freight and land use conflicts often indicate the presence of other truck mobility and safety problems.

In Delaware, a significant freight and land use concern is the expansion of residential areas into formerly-undeveloped areas, and the subsequent creation of new freight and land use conflicts in suburban or exurban areas. Other potential conflicts include seasonal traffic congestion created by agricultural and tourist-related activities, some segments' proximity to natural areas, and a relatively higher concentration of first/final mile segments in areas with poor or minority populations.

Freight and land use conflicts often arise when freight routes pass through residential, commercial, or environmentally sensitive areas. Additionally, the overlap between first/final mile routes and potentially conflicting land uses can create or exacerbate many of the mobility and safety problems noted in the following sections. Freight and land use conflicts occur most frequently in and around developed areas. For example, conflicts can occur in long-standing neighborhoods surrounding urban industrial facilities, ports, or intermodal terminals where trucks may pass through residential neighborhoods to reach major highways. Figure 4 provides a visual example of one potential conflict, with a freight facility located adjacent to a school.

Figure 4: Freight Facility Next to a School in Selbyville

Source: Google Maps Street View. 2020.

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 generates large influxes of new truck traffic on local roads.

Freight and land use conflicts contribute to a negative public perception of freight, and may impact residents' health, safety, and quality of life.

Unlike the safety, mobility, and condition problems documented in the following sections, 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, health, 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 and minority communities. The major freight and land use conflicts identified as part of this project include:

Continued residential and industrial development in rural and exurban areas is a driver of future freight and land use conflict. Most of Delaware's first/final mile connection mileage is located in rural areas or areas that are sparsely populated relative to the state as a whole. However, freight still has impacts on residents, and 70% of the first/final mile connection mileage is within 50 feet of residential dwellings.

Existing impacts or conflicts are expected to be compounded by ongoing growth, as Delaware's population grew by 10% between 2010 and 2020, and is expected to keep growing.[2] Specifically, 23% of Delaware's first/final mile connections are in areas that the Delaware Office of Planning and State Coordination has identified as developing or likely to develop, and an additional 30% are in areas considered "mature" urban areas.

Figure 5: First/Final Mileage by Development Zone

107.5 miles	**42.1** miles	**39.4** miles	**156.8** miles
Level 1 Mature areas with infrastructure and services. Ex: Dover, Wilmington, Seaford	**Level 2** Urbanizing areas near Level 1, with newer or planned infrastructure.	**Level 3** Less established, but has development pressures. Long-range growth areas	**Level 4** Rural areas, including agricultural and natural resource areas

Source: CPCS analysis of Delaware Office of Planning and State Coordination data. 2021.

Concentration of existing first/final mile connections in lower-income and minority areas. First/final mile segments were screened against the US Environmental Protection Agency's environmental justice indices. 52% of Delaware's first/final route mileage is in Census blocks where there is a greater share of low income and minority population than for the Delaware state population as a whole, and 23% of first/final mile route mileage is in Census block areas with environmental justice indices of 70 or higher (indicating high concentrations of low income or minority individuals relative to the state average). This information suggests Delaware's first/final mile connections are concentrated slightly more heavily in communities that are relatively poorer or have higher shares of minority populations.

Potential environmental conflicts. As part of work to provide Planning and Environmental Linkages information, first/final mile connections were screened for potential impacts on environmentally sensitive areas. Notable findings from this screening are listed in Figure 6 with further detail in Appendix C.

[2] US Census Bureau.

Figure 6: Summary of Environmental Impact Screening

158	56 miles	89 miles	23 miles	4.8 miles
River or stream crossings	Within 500 feet of natural protected areas	Within 500 feet of wetlands	Within wellhead protection areas	Inundated under 1' of Sea Level Rise

Source: CPCS analysis. 2021.

2.4 Mobility Needs and Issues

First/final mile freight mobility problems include congestion, as well as geometric constraints on truck movement such as low bridges, tight streets, and tight turns. In both cases, mobility problems reduce the efficiency of freight transportation, and can contribute to increased first/final mile shipping costs. In Delaware, many mobility concerns relate to traffic congestion during tourist season and agricultural harvest times.

Freight mobility is the ability to move efficiently through the transportation network, and mobility problems often relate to traffic congestion or geometric constraints on truck movement such as tight turns or low clearance bridges. An example of geometric constraints noted by a stakeholder in Delaware is shown in Figure 7.

Figure 7: Tight Turns for Trucks at Main St. and State St. in Millsboro

Source: Google Street View. 2020.

A consequence of many mobility problems is slower travel speed, or longer travel routing to avoid barriers. Slower travel and longer routings can reduce the effective "speed" of freight movement, which can ultimately translate into higher freight shipping costs.

Prior national research by the Federal Highway Administration found that mobility problems do not "stand alone" – the presence of one problem on a first/final mile route often means that other mobility,

condition, or safety problems are likely to be present. Therefore, the mobility needs and issues presented here should also be considered as context for the following safety and condition discussions. For much of Delaware, there are two general mobility needs and issues that are primarily related to traffic congestion and competing land uses:

Tourism-oriented areas generate seasonal traffic surges and conflicts. Tourism is a key industry for Delaware and brings over nine million visitors to the state each year. 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.[3]

This large influx of tourism during the 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.

Agricultural and rural production activities as generators of heavy truck traffic. 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, and this project identified 193 miles of first/final mile connections in areas that were not designated as urban, including 71 miles of state highway that the Delmarva Freight Plan identified as important rural routes not listed in the Delaware Freight Hierarchy. Specific challenges related to agricultural activity and rural traffic include:

- 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 these mobility concerns, prior plans note that high truck volumes on rural routes create condition problems, as heavily-loaded trucks can deteriorate under-engineered pavements and bridges, particularly on local road networks.

Beyond these two general mobility concerns, the data analysis for this project found relatively few statewide needs and issues. The only state-wide mobility concern was narrow shoulders, as nearly 9% of the identified first/final mile route mileage has between 0 and 1 feet of shoulder space. This relatively small shoulder space may make it more difficult for trucks to turn and provides less "room for error." Figure 8 provides an example of the mobility and safety challenges created by a lack of shoulders, where wide trucks may occupy portions of oncoming lanes to avoid soft or narrow shoulders. By comparison, other mobility problems such as narrow lanes, railroad crossings, and bridge clearances were either (1) not relevant, or (2) only relevant to very small portions of the network.

[3] WILMAPCO. 2018.

Figure 8: Narrow Shoulders and Lane Encroachment in Delmar

Source: CPCS.

2.5 Safety Needs and Issues

Compared to land use and mobility issues, Delaware's first/final mile safety problems were less-frequently mentioned in both the literature and stakeholder feedback. Generally, safety problems are focused on specific portions of the road network with a high crash rate, or where residents perceive that safety problems exist. Many of these truck-related safety problems can be addressed through infrastructure changes and investments, such as improved intersections or widened lanes.

In addition to the safety concerns that arise from the mobility problems listed above, there were stand-alone safety issues documented in prior first/final mile literature, such as concerns about a lack of turning lanes or traffic signals, conflicts with parked cars, pedestrians, or bicyclists, and railroad grade crossing safety. Understanding these safety issues is important because these types of issues are often more visible or more relevant to the general public, and can have significant impacts on the health and safety of other transportation users.

Between 2014 and 2019, 1,122 crashes were observed on Delaware's first/final mile network, about ten percent of all truck-related crashes in the state. The majority of these first/final mile crashes (75%) were property damage only. However, injury and fatality crashes make up a greater share of first/final mile network crashes, compared to Delaware as a whole, and this comparison illustrates why safety is an important topic for first/final mile networks.

Figure 9: Truck Crashes on First/Final Mile Network and All Delaware Roads

	First/Final Mile Network		All of Delaware	
	Count	Percent	Count	Percent
Property Damage	846	75%	8,899	81%
Injury	266	24%	1,995	18%
Fatality	10	1%	71	1%
Total	1,122	100%	10,965	100%

Source: CPCS analysis of WILMAPCO and DelDOT data. 2021.

In addition to crash histories and clusters, this project screened for a variety of other potential safety risk factors, particularly conflicts with other users. Figure 10 highlights the noteworthy potential risk

factors identified in the data analysis. Figure 11 illustrates a location some stakeholders identified as a potential site for safety risk. Wrangle Hill Road (SR 72) is an example of a corridor that is important as a freight access corridor to newly developed distribution centers, but also as a transportation corridor for nearby neighborhoods and schools (including an elementary school located along a 1-mile stretch from a new distribution center to the highway). The corridor has narrow bicycle lanes and no sidewalks, and a commenter has noted that the road does not feel safe for pedestrians or cyclists given the increasing truck volumes.

Figure 10: Noteworthy Safety Risk Factors for Delaware's First/Final Mile Routes

814	52.7	215
Pedestrian crosswalks	Miles of first/final mile network with sidewalks	Miles of first/final mile routes with bike designations

Source: CPCS analysis of WILMAPCO and DelDOT data. 2021.

Figure 11: Co-location of Bike Lanes and First/Final Mile Truck Traffic on Wrangle Hill Road

Source: Google Street View. 2020.

2.6 Condition Needs and Issues

Condition concerns were the least-frequently mentioned first/final mile problems not only in Delaware, but also in much of the national literature review conducted for this project. Many condition needs and issues do not require additional attention, as they can be addressed within existing pavement replacement programs operated by DelDOT and its local partners.

Condition, like safety, is generally less frequently mentioned in national literature on first/final mile needs and issues. In Delaware, condition was not mentioned often in prior discussions of first/final mile issues and was primarily discussed regarding poor pavement and bridge condition of rural areas, and the general need for maintenance on first/final mile connections. This was validated through this project's outreach, as condition needs and issues were the least frequently-mentioned type of first/final mile problem in the online map outreach's comments. The two condition-related items identified in the project were select specific areas with poor drainage and flooding problems, and localized complaints about debris tracked by trucks leaving quarry facilities.

3 First/Final Mile Freight Solutions

Collaboration is a key tool for addressing existing first/final mile problems or preventing new ones from emerging. Therefore, DelDOT and its MPO partners must ensure that their planning, operations, and development partners across the state have access to relevant information from this project. In particular, ensuring local planning stakeholders have an understanding of their communities' freight routes and the impacts of freight-related development will help to reduce potential freight-related land use conflicts in the future.

3.1 Introduction

DelDOT, MPOs, and their partners have four types of tools to improve the first/final mile freight system:

- **Policies** that govern data collection, maintenance, development, or operation of first/final mile routes.
- **Partnerships** with state and local stakeholders to better understand or communicate about first/final mile needs and issues, or implement efforts to address needs and issues.
- **Projects** including infrastructure maintenance, improvement, or expansion.
- **Programs** designed to support investment in projects.

Each of these four "P's" has a different role in addressing first/final mile network issues. Projects may appear to be the most important category because they produce real-world results. However, identifying and addressing needs and issues through project work would be impossible without partnerships to gather feedback, policies to guide partnership and investment, and programs to secure or allocate funding.

This chapter provides a toolkit of first/final mile-related improvements that DelDOT, Delaware MPOs, and their planning partners can employ to address the state's first/final mile freight needs and issues. Improvements are organized around these "P" categories, and information for each of the categories comes from this project's analysis of data, stakeholder feedback, and findings and recommendations from prior first/final mile projects across the United States.

Like first/final mile problems, many first/final mile improvements are relevant to multiple types of transportation performance such as mobility, safety, and condition.

As noted in Chapter 2, the world of first/final mile freight transportation needs and issues can be difficult to categorize, as many problems are relevant to multiple topics such as mobility and safety. Furthermore, many needs and issues do not stand alone, and the presence of one problem is often indicative of other problems. A similar situation exists for improvements or solutions, as many of the tools described here are relevant to multiple types of problems. Figure 12 provides a list of these improvements and solutions, organized by the "4 P's" and marked to correspond to the types of first/final mile problems that they can help address. It is also important to note that many solutions apply to a wide range of freight-related issues, not just first/final mile problems.

Figure 12: First/Final Mile Recommendations, Solutions, and Corresponding Problem Types

Improvement or Solution	Institutional	Land Use	Mobility	Safety	Condition
Policies					
Make first/final mile network knowledge readily available to partners	✓				
Incorporate first/final mile checks into project or plan screening tools	✓	✓	✓	✓	✓
Implement freight data changelogs and succession standards	✓				
Designation of truck routes and restrictions		✓	✓	✓	✓
Partnerships					
Educating local planning stakeholders about freight operations		✓	✓	✓	
Support truck safety education and outreach for the general public			✓	✓	
Continue public outreach and inclusion for freight projects		✓			
Projects					
Build truck-specific intersection improvements			✓	✓	
Adjust signal timings and detection for truck operations			✓	✓	
Ensure adequate lane and shoulder widths on roads			✓	✓	
Programs					
Leverage federal funding programs for freight improvements			✓	✓	✓
Explore state-level funding programs for first/final mile improvements			✓	✓	✓

Source: CPCS

3.2 Strategic Context for First/Final Mile Problems and Solutions

The root of many first/final mile conflicts can be traced back to the specific locations and operations of facilities that generate or attract truck traffic. Understanding the logic of these facilities' placement provides context for how and why freight problems arise and persist. In turn, this context provides a few "lenses" through which some of the freight conflicts and the solutions described below can be applied.

3.2.1 Freight Facility Site Selection

Freight facilities such as modal transfer facilities (e.g. ports, intermodal terminals), distribution and centers and warehouses, and freight-reliant industries (e.g. manufacturing facilities and plants) have

particular needs when it comes to site selection. The most significant considerations for these types of facility location decisions tend to be factors such as access to key markets, proximity to the transportation network, availability of labor/workforce, and total cost environment (to include factors like taxes, utilities, etc.).

In practical terms, this often means the ideal modern sites are located in an exurban environment (i.e. on the urban periphery). Such locations achieve proximity to the local workforce and development environment (e.g. utilities, road infrastructure), while also satisfying a desire for low-cost land that is not as highly sought-after by other competing land uses. Specifically, ideal freight facility development sites are often located close to interstate highways or other major highway corridors, in areas with other industrial or non-residential land uses, thereby providing maximal flexibility and minimal impedance concerning factors such as noise, odor, light, traffic, and hours of operation.

3.2.2 Common Causes of Freight Conflicts

Although freight industries typically seek out locations associated with minimal conflict, such conflicts can nevertheless emerge over time due to a variety of factors that often relate to land use choices:

- **Growth and urban encroachment**: Many types of freight facilities are relatively immobile, requiring significant investments in fixed capital. Once these investments are made, it can be difficult and expensive for these facilities to relocate, even as population growth and suburban expansion impede on traditional freight lands. Over time, some former freight lands may be redeveloped for the new highest and best land use, while others may remain fixed in place. In addition, freight areas may be surrounded by residential developments.

- **Uncoordinated land use planning**: Another source of conflict is uncoordinated land use planning. Where regulations and official plans do not prescribe allowable uses or anticipate freight-related transportation impacts, freight facilities and non-freight land uses may be developed near one another, leading to potential conflicts.

- **Competition for land**: In growing metropolitan areas where greenfield land is at a premium (whether due to planning restrictions or market forces), freight and non-freight developers may compete for the same parcels of land. This may also put place similar pressures on brownfield developments. As an example, an e-commerce fulfillment center may need to be located close enough to the urban core to enable rapid express deliveries, and thereby may compete for the same land as a commercial plaza or housing development.

3.2.3 Strategic Lens on Freight Conflicts

Policymakers and agencies must carefully balance a range of competing interests when conflicts emerge and make decisions in the best interest of all of their constituents. In such a context, absolutes are rarely helpful or productive.

On the one hand, freight facilities may not be able to operate on a competitive commercial basis if heavy restrictions or impedances are imposed to assuage non-freight interests. Over time, such facilities may relocate or invest out-of-state or in other jurisdictions, potentially removing a source of employment and tax revenues (not to mention spin-off economic activity.

On the other hand, a community's full economic potential and maximum quality of life may not be achieved if freight impacts such as noise, traffic, emissions, and safety go unaddressed.

A strategic lens, such as the PMA (Protect – Manage – Accommodate) framework shown below can help agencies contextualize and prioritize which freight conflicts they wish to address.

Figure 13: Strategic Lens for Contextualizing Freight Conflicts

	Protect	Manage	Accommodate
Definition	**Protect** freight industries from unreasonable conflicts	**Manage** conflicts in tactical and targeted ways	**Accommodate** freight needs to prevent major issues
Context	Areas where freight industries are dominant. Freight facilities of high importance.	Areas where freight and non-freight activities are both significant land uses.	Areas where non-freight businesses and/or residential communities are dominant.
Examples	• Freight clusters • Ports, airports, intermodal terminals	• Mixed-use areas • Freight clusters transitioning to mixed use	• Central business districts or small-town downtowns. • "Stranded" freight facilities (legacy facilities enveloped by communities)

A framework like this does not need to be rigidly interpreted, but it can provide a strategy to help think about emerging freight needs and issues systematically:

- **Protect:** Where possible, it is desirable to separate major freight activities and important facilities to protect them from potential sources of conflict. The focus is thus on accommodating non-freight needs where reasonable, while prioritizing support for the competitiveness and productivity of the area's commercial and industrial base. This can require considerable advance planning to prevent non-industrial activities' encroachment into industrial areas.
- **Manage:** When protecting freight industries and subordinating other uses is not achievable or desirable, managing conflicts is the next best option. A balanced approach reflects the reality that freight industries may impose negative externalities on communities (such as traffic and noise), but these industries may also constitute significant businesses employing many of the people in those same communities. If done well, conflicts can be managed by finding tactical, targeted, and creative solutions rather than merely striving for compromise between competing stakeholders.
- **Accommodate:** In situations where non-freight interests are dominant, it is important to not forget about freight operations altogether. The beneficiaries of efficient freight movement are not only transportation companies and large shippers, but also freight receivers such as homes, businesses, and restaurants. These receivers rely on trucks for deliveries of everyday goods. Therefore, ensuring the safety and mobility of all road users, including local trucks, is to everyone's benefit, even in situations where freight mobility is not a prime policy objective.

Strategic frameworks such as the PMA above can be applied to a wide range of transportation and land use challenges, and the PMA framework is used here to help DelDOT and their partners understand which first/final mile solutions or improvements may be relevant for specific parts of Delaware.

3.3 Policies

Policies govern how Delaware's transportation stakeholders will develop, operate, and maintain the state's transportation system. This project generated a substantial amount of new information on Delaware's first/final mile needs and issues, and many of the policy recommendations provided here

relate to how DelDOT, MPOs, and other partners can use this new information to improve land use planning and transportation investment decision making in the future.

DelDOT, MPOs, and other planning organizations should seek to weave this new-found first/final mile network information into existing planning processes and outreach to partners.

3.3.1 Make First/Final Mile Knowledge Readily Available

As noted below, the information created by this project is useful for a wide range of stakeholders including transportation agencies, economic development agencies, university staff, environmental agencies, and local town governments. Since the information is widely applicable for an audience that may not have the skills or resources to utilize applications like ArcGIS, or the familiarity with freight to derive actionable information from the data, DelDOT and the MPOs should consider ways that they can push relevant first/final mile information to partners on an "as needed" basis. One potential approach to pushing information could be through a project or plan screening process noted below. Another may be making reference information available for partners in a "beginner-friendly" format, such as an interactive Google Maps page where users can easily query attributes of specific road segments, or as QGIS-accessible shapefiles.

3.3.2 Incorporate First/Final Mile Knowledge Into Transportation Project and Land Use Development Screening Tools

Now that there is a large reference list of first/final mile needs and issues at hand, Delaware's transportation and land use planners should seek to ensure this list is reviewed whenever new project planning begins, so that planning staff are aware of any potential freight needs or problems that may need to be protected, managed, or accommodated during a project's development. In the future, the database or reference list of freight problems could be expanded to include primary, secondary, and tertiary freight connections as well, giving DelDOT additional freight reference resources to incorporate into specific project plans. Incorporating freight considerations into the planning process early on will potentially help Delaware fix freight mobility, safety, and condition problems faster and more cost-effectively than identifying and developing freight-specific stand-alone projects.

To make compliance easy, first/final mile-related screening processes should very simple. For example, on statewide project screening forms, a checkbox could be added to indicate whether a project or development touches a first/final mile freight route. A simple screening check like this will prompt planning and development staff to check the first/final mile database, and in doing so they also can review the database for specific freight needs and issues relevant to the project.

This approach can also help DelDOT and the MPOs push freight-relevant information to local planning partners, as needs and issues can be summarized, contextualized, and then provided to partners who may not have a similar degree of familiarity with freight operations.

3.3.3 Designate a Primary "Owner" to Update the Data

DelDOT and its partners should seek to continue updating the first/final mile dataset in the future. In particular, simply adding or removing first/final mile connections as the transportation system and land uses changes will be important to keep this dataset relevant. To ensure that data is consistently updated and maintained uniformly, DelDOT or an MPO partner such as WILMAPCO should identify a staff member who will be responsible for updating the data in the future. This "owner" would also be responsible for soliciting updates or comments from Delaware's transportation community on an annual or biennial basis. Such updates could be solicited through an online comment form or email blast, or also incorporated as points of discussion for planning-related meetings such as MPO Technical Advisory Committee meetings.

3.3.4 Improve Stewardship of Freight-Related Data

The data-driven analysis conducted during the development of this Working Paper illuminated some data deficiencies that, if addressed, could improve future evaluations of first/final mile needs and issues, or general analysis of transportation performance in Delaware.

Data Stewardship Succession Planning

Several datasets could not be obtained because the individual believed to be responsible for that dataset was unreachable or unresponsive to queries. Often, staff turnover and personnel changes cause data assets to be lost for a variety of reasons. Even when the data is not lost, specific individuals carry hard-won institutional knowledge about how the data was generated, how it has evolved, and relative advantages and disadvantages. In turn, new staff may need training to update, distribute, and utilize existing datasets appropriately.

Capturing this knowledge and effectively imparting it to successive individuals improves an organization's ability to continue to generate value from its data assets. One of the simplest ways to roll forward accumulated knowledge is with a changelog: a listing that describes any modifications made to a dataset, and the dates on when they occurred. Inaugurating a changelog for important data assets requires little up-front investment but can pay off significantly down the road.

Longer-term investments in data stewardship succession planning may include developing onboarding modules to train new staff on specific datasets that are integral to their role. It may also include assigning ownership of each data asset to at least one individual and allocating time for that individual to maintain the dataset as part of their core job duties. The overall health and status of an organization's data assets may be assessed annually or periodically through organization-wide reviews or audits.

Adopting Data and Documentation Standards

On several occasions during this project, a lack of data documentation made data interpretation challenging. There are two primary types of dataset documentation:

- **Metadata –** Strictly speaking, metadata is information about the dataset as a whole, such as author, publication date, or licensing information. The term "metadata" is also used more colloquially to refer to any contextual information or background that explains some aspect of a dataset.
- **Data Dictionary –** Data dictionaries explain the *individual attributes* of the observations in a dataset. They may list the allowed values for each attribute and provide a plain text description of those values if their meaning is not obvious.

Starting a data dictionary for important data assets is the easiest way to get started with data documentation. Adhering to existing standards, such as those created by the Federal Geographic Data Committee, can ensure an organization's data is easy to share and build upon. Over time, some organizations choose to invest in advanced data governance by implementing cross-department frameworks for making decisions about data and data management, like the State of Minnesota's Geospatial Advisory Council.

3.3.5 Designation of Truck Routes or Restrictions

A strategic truck route network fits into the *manage* element of the PMA framework: it seeks to decrease negative community impacts by funneling trucks to specific routes that are best capable of handling them. Such a network can be voluntary or suggestive, whereby an agency publishes a network of recommended routes (thereby relying on the mutual interest on the behalf of truck drivers in choosing safer and more appropriate access roads); or regulatory/enforced, whereby an agency will

specifically define which roads trucks may use. In either case, first and final mile connectors are a critical component of any strategic truck network. Establishing or formalizing truck routes may also be a "quick win" option for some communities, especially if minor investments in new or improved signage can improve truck wayfinding. The figure below illustrates differences in route and restriction signage in Seaford.

Figure 14: Truck Restriction (Left) and Route (Right) Signage in Seaford

Source: CPCS

A drawback of stronger versions of this approach may be that funneling trucks onto a single route may not always be desirable. For example, in cases where there is no single road that is clearly most appropriate as a connector, such an approach may simply concentrate the freight impacts onto one corridor, rather than spreading them out. Additionally, it is important to consider redundancy and resiliency so that trucks have multiple options in the event of planned and unplanned road closures.

In comparison to truck routes, truck restrictions work by prohibiting or restricting truck activity in certain locations, at certain times, or for certain types of vehicles. A wide variety of restrictions may be used depending on the jurisdiction. The key types of restrictions are shown below.

Figure 15: Types of Truck Restrictions

Type	Details
Route restrictions	Consider implementing truck prohibited road segments where truck activity occurs adjacent to sensitive land uses (e.g. schools, parks) and where an alternate route is available.
Time of day restrictions	Consider targeted time-of-day restrictions such as at nighttime near hospitals or seniors' residences, or during school hours beside schools.
Size and weight regulation	Consider prohibiting large trucks from routes where roadway geometrics are not supportive, and where an alternate more appropriate route is available. Restrictions could be based on vehicle dimensions, number of axles/tires, or vehicle weight/capacity.

Type	Details
Hazmat restrictions	Consider restrictions on where/when trucks carrying hazardous materials can operate.
Emissions controls	Consider idling regulations and engine compliance rules.
Commercial vehicle parking and loading zones	Consider designated loading zones and times for curbside loading and unloading; or restrictions to low emissions/zero-emissions vehicles in sensitive locations.

3.4 Partnerships

To fully identify, address, or prevent first/final mile needs and issues, DelDOT and Delaware's MPOs will need to collaborate with other partners throughout Delaware. Some specific partnership recommendations have been identified based on feedback from this project's Focus Group members who included DelDOT, MPO representatives.

3.4.1 Educating Local Planning Stakeholders about Freight Operations

A key challenge for Delaware's first/final mile network is the continued growth of suburban and exurban areas. Residential development in these areas can create conflicts with formerly isolated freight facilities, and new freight developments can generate large influxes of truck traffic. Development in many of these areas is guided by local municipal and county councils or commissions who may have limited transportation planning experience or knowledge of freight transportation needs. Ensuring that these local planning stakeholders have basic information on their communities' freight connections as well as the specific needs or characteristics of truck operations will help them create local land use and transportation plans that can avoid or mitigate first/final mile conflicts.

A key partner in this work will also be the University of Delaware's Institute for Public Administration (IPA), which provides planning and development programming support for local and state governments in Delaware. Therefore, DelDOT should ensure that IPA staff have access to the first/final mile dataset, so that IPA staff can be aware of first/final mile needs and issues and bring them to the attention of their local planning partners. In addition to access to the first/final mile data, it will also be beneficial to provide local partners with high-level information on the types of first/final impacts created by new freight-related development. This information will help individual communities appropriately plan for these freight impacts if they seek to attract industrial development such as warehouses and distribution centers. An example handout for impacts of freight-related development is provided in Appendix D.

3.4.2 Support Truck Safety Outreach to the General Public

This recommendation corresponds to the PMA lens of *protecting* freight transportation. Feedback from the project Focus Group and work in other states have indicated that members of the public may not understand the operational characteristics and blind spots of trucks, and this lack of awareness of trucks' limitations can contribute to safety risks. To reduce potential safety concerns on first/final mile routes and at specific locations like roundabouts, DelDOT and Delaware's MPOs should consider a partnership with the Delaware Motor Transport Association (DMTA) to improve public awareness of truck operations. One example of this type of work is DMTA's ongoing outreach at Delaware high schools, which is intended to help new drivers understand the blind spots of trucks.

3.4.3 Continued Public Engagement and Environmental Justice Inclusion in Freight-Related Work

As demonstrated by the environmental justice index screening done for this project, Delaware's first/final mile network connections are more commonly found in areas of low-income and minority populations. Because of this characteristic, first/final mile freight transportation's negative impacts may fall unevenly on these portions of the population, and these impacts are relevant for discussions of environmental justice. Environmental justice, as it relates to freight, is the fair treatment and meaningful involvement of all people in the development, implementation, and enforcement of environmental laws, regulations, and policies directed towards the movement of goods. Therefore, an important step in moving towards environmental justice is the inclusion of all populations in the planning process, especially those that are typically underrepresented. In many situations, inviting community members to meetings outside of their neighborhoods will not be sufficient. Improved engagement with local communities can often be achieved by going to locations that local populations frequent such as grocery stores, community centers, or churches.

By including local community members in the planning process, the solutions to many environmental issues can more easily be identified. As an example, an industrial area located near a low-income neighborhood would have projects identified and prioritized that mitigate the impacts of first/final mile truck trips to match the needs of that community.

3.5 Projects

Many freight-related improvements can be included in existing projects instead of being scoped as entirely new projects. This section discusses a few common examples of "quick win" design treatments that DelDOT and MPOs may wish to explore and incorporate into their ongoing planning and maintenance work.

Figure 16 displays some common types of truck-related design issues. The following boxes provide an overview of some key design guidelines and tips that account for the unique needs of trucks. It is important to note that design solutions rarely only benefit or impact trucks, given that most roadways are inherently shared multimodal corridors. The optimal design solutions in a freight cluster may not be the same as the best solutions in an urban center or small town. A balanced and context-specific perspective is therefore important for improving safety and mobility for road users. Oftentimes, modest, practical and low-cost solutions can go a long way.

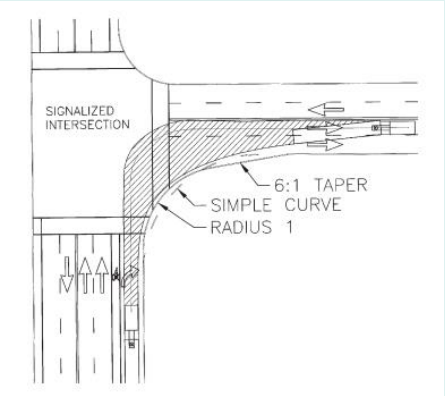
Figure 16: Common Types of Truck-Related Issues Addressed by Projects

Type of Issue	Description
Turning movements	Trucks require a larger turning path and may exhibit "offtracking," i.e. encroachment on the curb line or another lane.
Truck length	Turn lanes should be long enough to take into account truck queuing (a standard semi-truck may be around 72 feet in length, compared to 15-20 feet for a passenger vehicle).
Truck height	Trucks may not have vertical clearance under certain underpasses (e.g. older bridges)
Acceleration and deceleration	Trucks take longer to accelerate and decelerate, which can create challenges especially in heavy traffic conditions or complex multimodal environments.

Type of Issue	Description
Truck rollover	The higher center of gravity of trucks may pose a rollover risk, though this is more acute in higher speed environments such as highway off-ramps.
Deliveries and parking	Locations where deliveries must be made do not always have sufficient or suitable spaces for trucks to stop and unload.
Interaction with other modes	Potential conflicts can emerge between trucks and other road users (e.g. pedestrians, cyclists) due to the size of trucks, reduced sightlines, sudden and unexpected movements by other road users, complex intersections, etc.

Turn Radius at Intersections

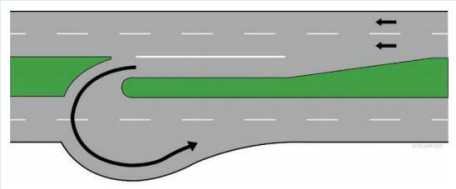
- Designing for the "swept path width" reduces encroachment except in the case of oversize trucks
- Wide turning radius reduces encroachment, but the benefits for trucks may be outweighed by other considerations, depending on the location
- Different tapering designs (see image) can balance turning mobility and crosswalk length
- At tight intersections, solutions may include removing parking spaces that interfere with truck turning, and moving back the STOP bar location to provide for enhanced maneuverability in the intersection. Recessed stop bars can also provide additional pedestrian and bicycle safety.



Tapered Curb/Corner
Source: City of Portland, 2008

Other Turning Considerations

- Turning lanes (especially left turn) have significant benefits for traffic flow and safety where there are large truck turning volumes. Higher-width (e.g. 12-foot) lanes are preferable for high volume locations.
- Where space allows, offset left-turn lanes are safer as auto drivers' view of oncoming traffic may be highly obstructed by trucks in the opposing left-turn lane.
- Double left turn lanes can improve capacity, though need to be designed to avoid conflicts where two trucks are turning adjacent to one another. Trucks usually prefer to use the right-most lane in such circumstances for greater turning radius.
- Designs that rely on U-turns to facilitate turning are generally undesirable for truck mobility. A loon (see image) is a design feature that provides more space for U-turns, in locations known to be used by trucks.
- In roundabouts, designing traversable truck aprons or mountable center islands provides added turning mobility (see image)
- The traveled right-of-way (lanes or shoulders) may need to be widened on horizontal curves to reduce offtracking and improve safety. This issue may arise in particular on curving high-speed rural roads where two trucks may not have space to safely pass each other traveling in opposite directions.



A loon at a median U-turn.
Source: NCHRP Report 943, 2020

Truck using a traversable apron at a roundabout.
Source: NCHRP Report 672, 2010

Signalization

- Truck signal priority is a signal modification that extends the green signal using detection sensors. It can improve safety and mobility, especially at uphill or downhill approaches where truck acceleration or deceleration are especially challenged.
- Other enhancements include extending the green time for left turn signals, or extending yellow or all-red signals at downhill approaches, for locations known to have high truck volumes
- Advance warning signs (see image) help drivers prepare to brake and can be especially beneficial on high-speed downhill approaches.

Advance red light warning sign on a poor-visibility downhill approach.
Source: Google Street View, image capture Aug 2017, © 2021 Google

Other Design Guidance

- Paved shoulders of 10+ feet are desirable on truck routes in rural areas, to provide space for truck breakdown or law enforcement needs.
- Vertical clearance of 16 feet is desirable on truck routes.
- It may be desirable to avoid locating bicycle facilities along truck routes (if avoidable), otherwise a buffer of at least 1.5 to 2 feet is advisable between travel lanes and bike lanes. Other options are off-road paths, wider curb lanes, or wider shoulders to accommodate bicycles.

Source: NCHRP Report 943

Buffered bike lane.
Source: Google Street View, image capture Feb 2021, © 2021 Google

Planning references for DelDOT and WILMAPCO

- NCHRP Research Report 943, "Design and Access Management Guidelines for Truck Routes: Planning and Design Guide," 2020.
- AASHTO, "A Policy on Geometric Design of Highways and Streets, 7th Edition," 2018.
- NACTO, "Optimizing Large Vehicles for Urban Environments," 2018.
- City of Portland Office of Transportation, "Designing for Truck Movements and Other Large Vehicles in Portland," 2008.
- NCHRP Report 505, "Review of Truck Characteristics as Factors in Roadway Design," 2003.

3.6 Programs

In the context of this project, programs refer to the broader funding efforts intended to allocate resources for improvements. Within this context, it is important to note the significant challenge of budget limitations. *Innovation in Motion*, the Delaware Long Range Transportation Plan, notes that Delaware is experiencing downward pressure on its transportation revenue sources and that additional revenue may be needed in the future to keep up with current infrastructure standards, build resilience for climate change, and buffer against potential federal shortfalls in highway funding. Challenges such as these could make funding first/final mile improvements more difficult in the future, particularly for any connections that are not owned or maintained by DelDOT.

3.6.1 Leveraging Federal Freight Funding

The Federal Highway Administration (FHWA) administers multiple programs that may be relevant to funding first/final mile improvements in Delaware. Specifically, the Federal funding programs available for federal highways, freight intermodal connectors, and some types of first/final mile connections include:

- **National Highway Performance Program (NHPP) –** Provides support for the condition, performance, and construction of the National Highway System (NHS).

- **Surface Transportation Program (STP) –** Provides flexible funding that may be used to preserve and improve the conditions and performance on any Federal-aid highway, including freight projects.
- **Highway Safety Improvement Program –** Achieve a significant reduction in traffic fatalities and serious injuries on public roads, including non-state-owned public roads and roads on Tribal lands.
- **Congestion Mitigation and Air Quality Improvement Program –** Funding source to reduce congestion and improve air quality. Available to State and local governments for transportation projects in nonattainment and maintenance areas.
- **Projects of National and Regional Significance (PNRS): Section 1120 –** Program that provides grants to States to improve the safe, secure, and efficient movement of people and goods through the U.S. to improve the national economy.

There also are several Federal financing tools that can be applied to freight connections. These tools include:

- **Transportation Infrastructure Finance and Innovation Act (TIFIA) –** Provides Federal credit assistance to eligible surface transportation projects, including highway, transit, intercity passenger rail, some types of freight rail, and intermodal freight transfer facilities. The program leverages substantial private co-investment by providing projects with supplemental or subordinate debt.
- **Rebuilding American Infrastructure with Sustainability and Equity (RAISE) –** Discretionary grant program that is the successor to the Better Utilizing Investments to Leverage Development (BUILD) and Transportation Investment Generating Economic Recovery (TIGER) programs. USDOT intends to award $1 billion in discretionary grants in the fiscal year 2021 for multimodal transportation projects that meet criteria, including safety, environmental sustainability, quality of life, economic competitiveness, state of good repair, innovation, and partnership. The department also intends to prioritize projects that demonstrate improvements to racial equity, reduce climate change and create good-paying jobs. An equal amount of funding is intended for urban and rural areas. This program allows regional and local governments to compete directly for funding.
- **Infrastructure for Rebuilding America (INFRA) –** Discretionary grant program to fund transportation projects of national and regional significance. The USDOT reserves 10% of available funds for small projects (grants of at least $5 million, compared to large project grants of at least $25 million). Additionally, at least 25% of funding must be used for rural projects. USDOT is particularly interested in shovel-ready projects, produce good-paying jobs, improve safety, and use transformative technology. For the first time in 2021, USDOT is interested in projects that address climate change and environmental justice.
- **Grant Anticipation Revenue Vehicles (GARVEE) –** Financing instrument that allows States to issue debt backed by future Federal-aid highway revenues. Eligibility for freight projects is constrained by the underlying Federal-aid programs that will be used for debt service.

3.6.2 State-Level Approaches to Funding First/Final Mile Investments

In addition to different federal freight funding programs, Delaware could develop new funding programs or leverage existing ones to improve first/final mile connections. Delaware already has one such program – the Transportation Infrastructure Investment Fund (TIIF), which was created in 2019. This fund focuses on transportation investments that support new economic development, including projects that construct, maintain, or enhance road infrastructure. However, many states have programs tailored to addressing freight needs for existing users, or varied programs to support economic development.

Some other states have also taken the initiative to develop their own funding programs that either support freight transportation explicitly or as part of broader transportation improvement efforts. Many of these programs are closely tied to economic development initiatives. Some examples include:

- Pennsylvania's **Multimodal Transportation Fund**, which is available for port, rail, and freight improvements (as well as broader economic and safety improvements).
- Minnesota's **Transportation Economic Development** program, which provides funding awards to state highway projects that provide measurable economic benefits, including retention of existing businesses. This program also awards competitive points to projects that address previously identified mobility, safety, and condition concerns for truck movement, including high-crash areas, areas with frequent flooding, and geometric barriers to trucks.
- Wisconsin's **Transportation Economic Assistance** program, which provides matching state grants to government partners for projects that either attract new employers or support retention of existing business and industry. $3.4 million is available each year. Wisconsin also operates a **state infrastructure bank** program that is used to fund access improvements for vehicle traffic near commercial or industrial sites, as well as road modifications to accommodate truck movements.

Appendix A Network 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
- INRIX truck GPS tracking data

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 17 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.

Figure 17: 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 were 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.

Step 5: Incorporation of Stakeholder Feedback

The draft list of first/final-mile connections was uploaded to the project website's interactive map where Delaware's stakeholders identified additional routes, as well as first/final mile problems they are familiar with. This feedback was 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 the inclusion of stakeholder feedback, INRIX data was used 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. INRIX GPS waypoints were mapped to the Delaware road network, and roads with documented truck traffic and no prior freight hierarchy designation were added to the first/final mile network inventory.

Appendix B Stakeholder Feedback Results

Different Wikimapping (interactive webmap) links were sent to two broad groups of stakeholders: (1) public agencies and industry stakeholders, and (2) the general public. This divided response format was used since responses can be seen and commented on by other users with the link, and the project team wanted to ensure that private industry stakeholders would be willing to share their needs, issues, and concerns. Note that some Wikimapping comments mentioned multiple issues, and thus the number of mentions, corrections, and additions exceeds the number of comments received.

Figure 18: Wikimapping Application Feedback Summary

	Stakeholder Group	
	Industry and Public Agency	General Public
Unique Commenters	7	14
Comments Received	67	60
Substance of Comments		
Network Corrections or Additions	42	7
Land Use Mentions	20	13
Mobility Mentions	2	31
Safety Mentions	3	11
Condition Mentions	1	1

Government and industry stakeholders primarily provided corrections and additions to the first/final mile network, as well as general comments about land use conflicts. By comparison, public stakeholders primarily identified mobility and safety concerns.

While both Wikimapping surveys received a similar number of comments, there was a significant difference in the type of comments received. Public agencies and industry stakeholders provided more additions and corrections to the first/final mile network, as well as comments about land use conflicts. By comparison, the public provided more feedback on mobility and safety concerns. This difference can be explained by work focuses and perspectives: public agency staff, particularly planners, will have insight into broad land use problems or transportation network issues within their areas of practice, while residents know very specific needs and issues that personally affect them. Insight from specific comments is included in the following chapters of this Working Paper.

Appendix C Performance Evaluation Results

This appendix provides an overview of the attributes and data sources used to evaluate the performance of identified first/final mile connections. It also summarizes major findings from the analysis of this data.

Land Use Needs and Issues

Figure 19: Land Use Attributes and Data Sources

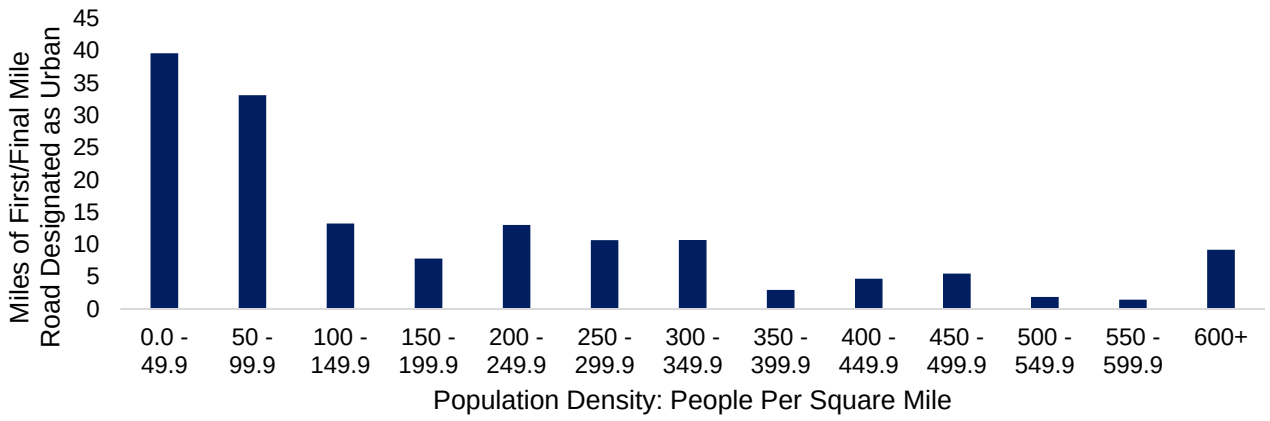
Attribute	Data Source
Urban Region Designation	WILMAPCO - Unpublished
Population Per Square Mile	US Census Bureau American Community Survey
Land Use Types	Delaware 2017 Land Use Land Cover
Planning Investment Level	Office of State Planning Coordination
Environmental Justice Index	US Environmental Protection Agency
River Crossings	US Census Bureau Aerial and Linear Hydrography
Wetland Location	WILMAPCO - Unpublished
Natural Protected Area Location	WILMAPCO - Unpublished
Wellhead Protection Area Location	WILMAPCO - Unpublished
Sea Level Rise	WILMAPCO - Unpublished

Urban Areas and Population Density:

About 44% or 154 miles, of the identified first/final mile connection mileage is located within areas designated as urban. The size of this share is heavily influenced by the long-distance rural first/final mile connections identified in Kent and Sussex Counties within the Delmarva Freight Plan.

Even in areas designated as “urban,” it appears that most of Delaware’s first/final mile connections lie within relatively sparsely-populated areas. For example, 136 miles, or 88%, of “urban” connections are located in areas with a population density less than Delaware’s statewide density of 460.8 people per square mile. Only 2.8 miles of connections had a population density higher than that of New Castle County.

Figure 20: Population Density of Delaware’s Urban First/Final Mile Connections



Source: CPCS analysis of US Census Bureau American Community Survey Data

This data suggests that Delaware's current first/final mile connections are most heavily concentrated in lower-population and rural areas. Urban first/final mile connections' mileage skew towards low-population areas is likely due to several factors:

- Many existing urban freight routes are already classified as secondary or tertiary freight routes and therefore are excluded from this first/final mile analysis.
- Freight routes in urbanized areas are concentrated in industrial areas, where the localized population is lower.

Delaware's urban first/final mile road connections appear to be concentrated in areas with relatively low population density.

This finding aligns with the needs and issues documented in Working Paper 1 – particularly the multiple concerns about the impact of continued suburban development on formerly-rural freight routes, or the new development of warehouses and distribution centers in exurban areas. This concern was also echoed by comments within the Wikimapping application, where both public commenters and agency and industry users noted some areas of ongoing development for potential future conflict.

Land Uses:

The 2017 Delaware Land Use Land Cover dataset provides information about the general types of land use in Delaware. This information was used to help illuminate potential types of conflicts across the state.

Figure 21: First/Final Mile Connection Mileage with Potential Land Use Conflicts Within 50 Feet

Single Family Dwellings	Multi-Family Dwellings	Commercial	Mixed Urban or Built-Up Land
241.7 miles 69%	**10.7 miles** 3%	**98.7 miles** 28%	**76.9 miles** 22%

Source: CPCS analysis of WILMAPCO data

As before, there is a relatively high share of connection milage with some adjacency to residential properties, but there is relatively little mileage adjacent to potentially denser development like multi-family dwellings. This further supports the idea that many of Delaware's first/final mile and land use conflicts are likely to be found in areas of new development, in suburbs or the urban fringe.

Development Levels:

The Delaware Office of State Planning Coordination (OSPC) has created strategies for policies and spending. Specifically, strategies created in 2020 identify goals and policies for land use and infrastructure investment. As part of this strategy development work, OPSC has identified four "investment levels" to depict growth strategies for varying areas of the state. Levels 1, 2, and 3 are defined as "urban" or "urbanizing growth", while Level 4 is considered more rural. Additionally, some areas are marked as "out of play" for private development, and a small amount of first/final mile mileage falls into this category.

Figure 22: Mileage of First/Final Mile Segments by OPSC Development Level

Level 1	Level 2	Level 3	Level 4
Mature areas with infrastructure and services. Ex: Dover, Wilmington, and Seaford.	Urbanizing Areas near Level 1, with newer or planned infrastructure.	Less-established but experiencing development pressures. Long-range growth areas.	Rural areas, including agricultural and natural resource areas.
107.5 Miles 30%	**42.1 Miles** 12%	**39.4 Miles** 11%	**156.8 Miles** 45%

Source: CPCS analysis of Delaware OPSC data

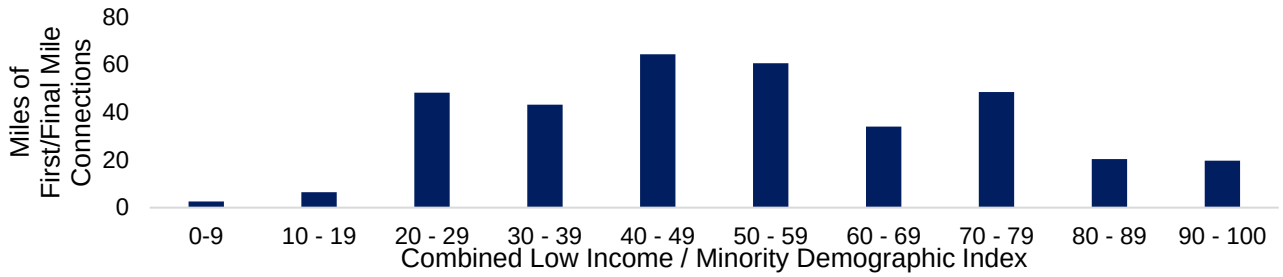
23% of Delaware's First/Final Mile connections are in urbanizing or developing areas.

Environmental Justice

As noted in Working Paper 1, there are multiple potential negative impacts of freight transportation and industrial activity, such as air emissions, noise, light pollution, and vibration. These negative impacts, their corresponding impact on land value, and other longstanding factors like institutional racism mean that low-income communities and communities of color have often been disproportionately affected by the negative impacts of industrial activity and corresponding freight transportation. Therefore, future efforts to improve first/final mile connections must consider historic and potential future impacts on frontline communities.

The US Environmental Protection Agency's (EPA) environmental justice screening data was used to understand potential impacts on low-income communities of color and highlight potential areas that would require additional environmental review or community engagement. Specifically, this project uses the EPA's environmental justice demographic index, which is based on the average of two demographic factors in each Census block group: percentage of the population that is low income, and percentage of the population that is classified as a minority group. This index reflects Delaware's overall demographic makeup, with an index value of 50 representing an income and minority population make-up similar to the state as a whole, values less than 50 reflecting higher income or less minority population share, and values greater than 50 reflecting lower income and higher minority population share. Delaware's first/final mile connections are more concentrated in areas with lower income and greater minority shares of the population. Among first/final mile connections, 52% of the mileage was in Census blocks with indices of 50 or higher, and 80 miles of connections are in Census block areas with indices of 70 or higher.

Figure 23: Environmental Justice Demographic Index



Source: CPCS analysis of US Environmental Protection Agency data

Delaware's first/final mile connections are concentrated slightly more heavily in communities that are relatively poorer or have higher shares of minority populations.

Intersections and Proximity to Other Environmental Features:

In addition to the land use screenings above, CPCS conducted a review to identify potential environmental land use conflicts. This screening supports the project's PEL objective, as it helps WILMAPCO and DelDOT understand which first/final mile connections are likely to require further environmental review as part of further planning or project development. Of note, there are 158 river or stream crossings documented for the first/final network, and 23 miles of first/final mile network lie within wellhead protection areas.

Figure 24: Mileage of First/Final Mile Connections within Given Distances to Environmental Areas

Distance from Road:	50 Feet	100 Feet	500 Feet
Natural Protected Areas	28.1	35.6	56.5
Wetlands	21.3	27.9	89.3

Source: CPCS analysis of WILMAPCO data

Sea Level Rise:

While sea level rise is a significant concern for Delaware, it is of limited relevance to the first/final mile network developed in this project, as less than 1 percent of the identified network mileage was likely to be inundated with up to 3' of sea level rise. These at-risk connections were primarily concentrated in coastal New Castle County, and these issues were also documented in feedback from the Wikimapping application.

Figure 25: Mileage of First/Final Mile Connections Affected by Projected Sea Level Rise

1' Rise	2' Rise	3' Rise
4.8 miles 0.01%	9.6 miles 0.02%	12.0 miles 0.03%

Source: CPCS analysis of WILMAPCO data

Relatively small portions of Delaware's first/final-mile network are at risk of temporary or permanent closure due to near-term sea level rise.

Mobility Needs and Issues

Figure 26: Mobility Attributes and Data Sources

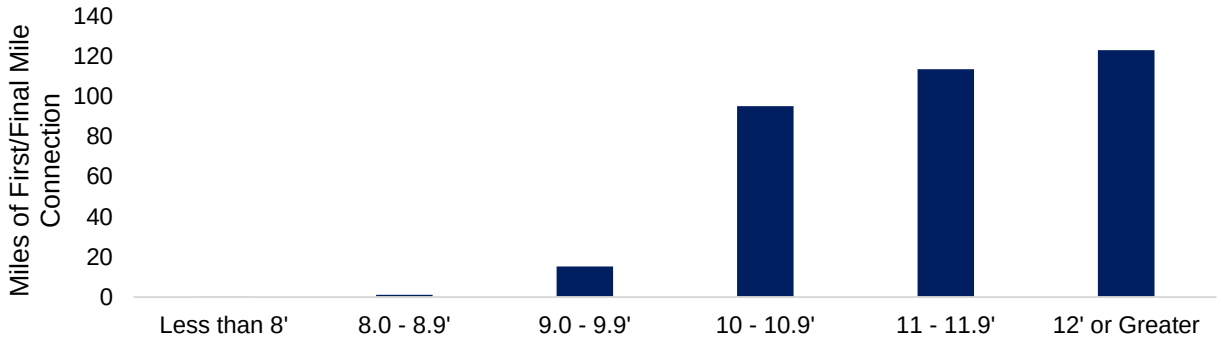
Attribute	Data Source
Shoulder Width	Delaware DOT Road Inventory
Number of Lanes	Delaware DOT Road Inventory
Road Width	Delaware DOT Road Inventory
Speed Limit	Delaware DOT Road Inventory
Average Truck Speed	WILMAPCO Congestion Management Data
Travel Time Index	WILMAPCO Congestion Management Data
Grade Crossing Train Frequency	Federal Railroad Administration
Grade Crossing Maximum Blockage Time	Federal Railroad Administration
Roundabout	Delaware DOT Roundabout Inventory

Attribute	Data Source
Bridge Vertical Clearance Over Road	WILMAPCO - Unpublished
Bridge Weight Restriction	WILMAPCO - Unpublished

Roadway Widths

The standard semi-trailer dry van is roughly 8.5' wide, and narrow streets present a potential mobility barrier for trucks. Recommended lane widths for road design usually vary between 10 and 12 feet, depending on the road's location, speed, and intended use.[4] Based on this guidance, it appears that the majority of Delaware's first/final mile connections do not have mobility impediments associated with narrow lanes. Figure 27 illustrates how 95% of Delaware's first/final mile connections have lane widths of greater than 10 feet. Narrower lane widths are primarily concentrated in developed urban areas.

Figure 27: Delaware's First/Final Mile Lane Width



Source: CPCS analysis of Delaware Road Inventory data

In addition to lane width, shoulder width is an important mobility and safety consideration, as shoulders give truckers "room for error" in maneuvering their vehicles and accommodating other road users. Stakeholders noted issues with road and shoulder widths on both urban and rural roads. Specific concerns included narrow or tight ramps on limited-access highways, tight corners that cannot accommodate passing trucks, and stretches of road without adequate shoulders. This feedback has been assigned to specific road segments in the network dataset. Nearly 9% of Delaware's first/final mile connections have between 0 and 1 feet of shoulder width, while 70% of the first/final mile network has shoulders of 4' or greater.

[4] *AASHTO Green Book.*

Figure 28: Shoulder Widths of Delaware's First/Final Mile Connections

Left Shoulder Width (Feet)	Right Shoulder Width (Feet)										
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10
0-1	8.9%	0.1%	0.4%	0.3%	0.2%	0.4%	0.7%	0.1%	0.4%	0.7%	0.5%
1-2	0.1%	0.3%	0.8%	0.4%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%
2-3	0.3%	0.0%	4.2%	0.3%	0.4%	0.0%	0.1%	0.3%	0.1%	0.3%	0.2%
3-4	0.2%	0.0%	0.2%	2.6%	0.3%	0.1%	0.1%	0.2%	0.7%	0.1%	0.3%
4-5	0.2%	0.0%	0.2%	0.0%	10.4%	0.9%	0.3%	0.2%	0.1%	0.3%	0.1%
5-6	0.2%	0.0%	0.0%	0.3%	0.9%	5.6%	0.2%	0.2%	0.1%	0.2%	0.2%
6-7	0.1%	0.0%	0.1%	0.2%	0.1%	0.9%	2.9%	1.6%	0.2%	0.1%	0.2%
7-8	0.6%	0.0%	0.2%	0.1%	0.1%	0.1%	0.7%	3.5%	5.7%	1.1%	0.2%
8-9	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.9%	8.2%	5.2%	0.3%
9-10	0.2%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	1.8%	11.1%	0.8%
>10	0.7%	0.0%	0.3%	0.1%	0.1%	0.3%	0.2%	0.2%	0.3%	1.4%	1.6%

Source: CPCS analysis of Delaware Road Inventory data

Bridge Clearances and Weight Limits

Low clearance bridges can be particularly problematic barriers to efficient truck movement, as they can serve as bottlenecks and require trucks to take substantial detours to avoid them. 16 bridges cross over the identified first/final mile network, and a small number of bridges are too low to safely accommodate standard-sized box dry van truck trailers.

Figure 29: Count of Low-Clearance Bridges on Delaware's First/Final Mile Network

Under 13'6"	Under 14'6"
Maximum Truck Height without Oversize Permit in Delaware	FHWA Recommended Bridge Clearance Over Road
3 bridges	7 bridges

Source: CPCS analysis of WILMAPCO data

These low-clearance bridges are all associated with major rail corridors in New Castle County and are located on Old Ogletown Road in Newark, a service road for Stanton Christiana Road, and James Street in Newport. However, all three of these low-clearance bridges have major freight corridors nearby, so they do not create much of a true bottleneck for truck movement.

In addition to these height limitations, bridge weight restrictions can also affect truck routes and mobility. The identified first/final mile road network crosses over 135 bridges, and only three rural bridges on the network have posted weight limits.

First/final mile bridge height and weight restrictions do not create substantial barriers for freight mobility in Delaware.

Other Mobility Considerations

The data analysis also examined other potential influences on mobility, including travel time index, travel time reliability, grade crossings, and train frequency. These factors were only relevant to very small portions of the network (<5% of mileage), and based on analysis and a lack of stakeholder comments, do not appear to be relevant mobility issues for the currently-identified first/final mile network.

Based on the initial analysis conducted and stakeholder comments, mobility concerns are generally limited for Delaware's first/final mile network and are focused on geometric mobility issues related to shoulders.

Safety Needs and Issues

Figure 30: Safety Attributes and Data Sources

Attribute	Data Source
Truck-Involved Crashes and Crash Severity	WILMAPCO - Unpublished
Intersection Safety Ratings	WILMAPCO - Unpublished
Bike Route Information	Delaware Bike Council
Sidewalk Locations	DelDOT Unmotorized Inventory
Crosswalk Locations	DelDOT Unmotorized Inventory

First/Final Mile Truck-Related Crashes

Between 2014 and 2019, 1,122 crashes were observed on Delaware's first/final mile network. The majority of these crashes (75%) were property damage only.

Figure 31: Count of First/Final Mile Road Crashes by Severity

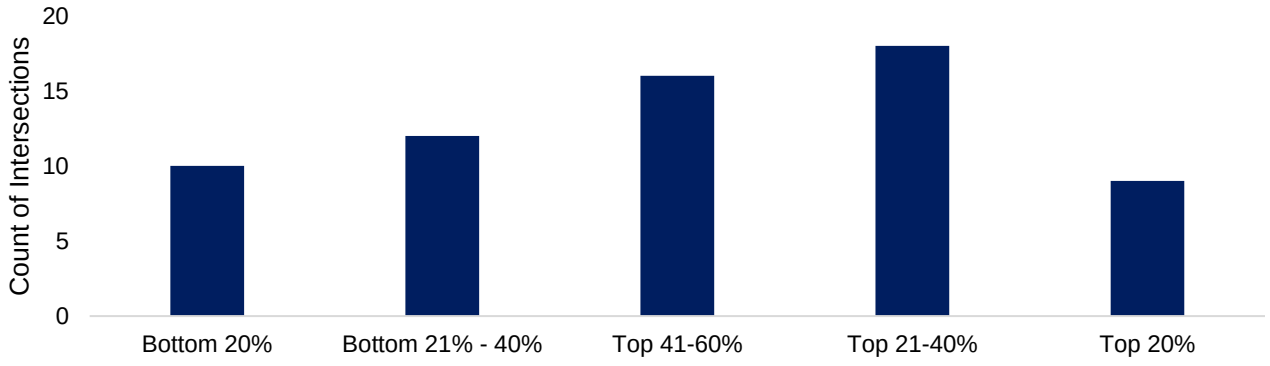
Property Damage Only	Injury	Fatality
846 **75%**	**266** **24%**	**10** **1%**

Source: CPCS analysis of WILMAPCO data

Intersection Risk Scores

Delaware has conducted a risk assessment for intersections based on a ten-year average of vehicle crashes and other risk factors. 65 first/final mile intersections were represented in this dataset, which is broken into quintiles based on crash frequency. Figure 32 illustrates the distribution of risk ratings for the 65 first/final mile intersections that had been assessed.

Figure 32: First/Final Mile Intersections' Risk Rating



Source: CPCS analysis of WILMAPCO data

Crosswalks and Sidewalks

Prior first/final mile research, such as the FHWA's Intermodal Connector Study, noted that the presence of crosswalks and sidewalks can be risk factors for first/final mile safety, as wide-turning trucks can occupy large portions of intersections or could be at risk of "hopping' the curb on narrow urban streets. Additionally, some of the general public feedback noted concerns about pedestrian safety in neighborhoods that surrounded freight routes, particularly in some communities in New Castle County. Based on the review of data listed in Figure 32 there were 814 pedestrian crosswalks on Delaware's first/final mile network, and sidewalks parallel at least one side of 57.2 miles of this network.

Bicycle Facilities

Based on data from the DelDOT Delaware Bike Council, 215 miles of first/final mile connections (about 62% of the state total) have some form of designed bicycling facilities, and there are 228 intersections between the first/final mile network and other transportation assets with some form of bike infrastructure or designation.

Condition Needs and Issues

Figure 33: Condition Attributes and Data Sources

Attribute	Data Source
Pavement Condition Rating	DelDOT Planning Section Road Inventory
Bridge Condition Rating	FHWA National Bridge Inventory

Pavement condition rating information is available for about 302 miles of the first/final mile network, with rating 1 being the worst, and rating 5 being the best. Based on this assessment, 75% of Delaware's first/final mile connections are rated "3" or higher, suggesting that poor condition is not a significant concern for the system overall.

Bridge condition ratings are available for 48 bridges on the first/final mile network, and Figure 34 lists the count of each bridge by condition rating.

Figure 34: Condition of Bridge's on Delaware's First/Final Mile Network

Poor	Fair	Good
2	27	19

Appendix D Planning Partner Outreach Materials