FDOT

Freight Mobility and Trade Plan

Technical Memorandum 5

Needs, Issues and Scenario Planning

April 2020

CONTENTS

FIGURES

TABLES

Introduction

This technical memorandum identifies freight mobility and trade specific needs and issues that need to be addressed as the state works towards achieving the FMTP objectives. Each need and issue was identified through a review of current conditions, industry trends, stakeholder input and past studies. The respective needs and issues in this memorandum are organized by mode, including multimodal considerations. Table 1 provides a list of the issues and needs which might impact the state's ability to meet FMTP objectives. This memorandum also explores potential future scenarios, and concludes with a comprehensive SWOT analysis – which will be used to inform this project's recommendations and implementation effort.

Table 1 | Freight Needs and Issues

	Needs and Issues	
Highway	• Congestion/Bottlenecks • State of Good Repair • Truck parking • Domestic Freight Imbalance	• Driver Shortage • Insurance Costs • Highway Technology
Freight Rail	• Precision Scheduled Railroading (PSR) • Rail Bottlenecks/On-Dock Rail • Positive Train Control	• Supply Chain Visibility • Road Grade Crossings
Maritime	• Access Channel Draft • Inland Distribution • Marine Terminal Technology	• Emissions • Resiliency • International Market Share & Port Investment
Aviation	• Land Use Conflicts • Effect of Highway Congestion • Aviation Manufacturing	
Space	• International Competition • Public-Private Partnerships	
Pipeline	• Capacity	
Multimodal	• Freight Optimization • Cargo Theft • Environmental Stewardship & Community Concerns • Trade Barriers (and Agreements)	• Land Use • Community/Collaboration/ Partnerships • Funding

Needs and Issues

Highway

According to the Florida Chamber of Commerce, "By 2030, there will be approximately four to five million new Florida drivers commuting on (Florida's) roads. Along with the (more than) 112 million visitors that come to the state each year, it is estimated that there will be more than 150 million daily vehicle miles added to Florida roads."[1]

According to the American Society of Civil Engineers, "Since 1984, the number of highway system miles has increased by 25%, while the daily vehicle miles traveled increased by 84%."

- *Source: 2016 Report Card for Florida's Infrastructure," American Society of Civil Engineers.*

Moreover, according to the American Transportation Research Institute, traffic congestion costs the U.S. trucking industry more than $75 billion.

- *Source: "Breaking: Florida's Economy Hits New $1 Trillion GDP Milestone," Florida Chamber of Commerce, July 13,*

These new drivers impact Florida's freight system in two ways:

1. More residents mean more freight demand; and
2. Increased passenger and truck travel can create increased congestion and reliability issues – particularly in urban areas.

Congestion/Bottlenecks

Stakeholders statewide stated that congestion is their number one issue. The Florida Chamber of Commerce identified congestion as the primary hindrance delaying overall economic activity but more specifically, the logistics industry. In 2016, the freight industry's share of the total cost of congestion in Florida was more than $5.6 billion.[2] With combined passenger and truck growth (trucks currently account for 70 percent of Florida's freight movement), congestion will continue to increase without significant action.

However, there are several contributing factors that add to the complexity of solving the congestion issue. First, e-commerce has shifted distribution patterns linking distribution centers to brick-and-mortar establishments to neighborhood homes. While the long-term effect of this

[1] Source: Florida Chamber of Commerce, https://www.flchamber.com/advocacy/issues/transportation-investments/.

[2] Source: "On MCSAW, TDA, and TSM&O Synergy: Intelligent Connected Freight Mobility" By Paul Clark, Statewide Scale Operations Manager, FDOT; Ed Hutchinson, Transportation Data and Analytics Office Manager, FDOT; Pradeep Rao, HNTB Corporation. It appeared in July-August 2019 edition of the TSM&O Disseminator

shift is unknown, most experts expect the freight industry to continue moving from large trucks to smaller delivery vehicles – while safer for pedestrians, this increases overall VMT.[3]

Another significant factor is the state's lack of petroleum pipelines. With the population growth and the resulting demand for energy, more energy means more trucks and therefore more VMT.

There are a growing number of vehicles on the road – a mix of freight traffic and passenger traffic (residential and visitor) - leading to unpredictability in travel times and more crashes. Highway reliability, specifically dependability and consistency, is a major concern for shippers. Stakeholders identified that the conversation around congestion does not always have to be about freight movement – investments in public transit would help get predominately single occupancy cars off the road and could free highway capacity for other users, including freight.

State of Good Repair

Florida's state roads, U.S. and Interstate Highways are in a state of good repair. For example, there are 140 bridges in Florida that are rated as "Poor" in the National Bridge Inventory (only 13 are on FDOT routes).[4] Similarly, only 9 percent of all roads in Florida are considered below "ride quality."[5] As truck traffic continues to increase, care should be taken to retain Florida's quality road network including through continued leveraging of federal funds for emergency repairs, given the cost to develop new interstate in urban and/or rural areas.[6]

Truck Parking

While FDOT's new Truck Parking Availability System (TPAS) has helped align truck parking demand with available supply, truck parking remains a challenge. Stakeholders identified the most significant needs near Jacksonville, Miami and along the I-4 corridor. FDOT found that overall truck parking facility demand is near 85 percent for truck stops and 50 percent at rest areas statewide. However, during peak periods, truck parking demand can exceed 150 percent in some areas.[7] When there is limited parking available, drivers often park in unauthorized areas including the right-of-way on access and egress ramps. In recent years, a reduction in allowable driving time and not being able to take rest breaks from driving without forfeiting total work

[3] Fulfillment and consolidation centers are commonly located closer to target markets and associated with more truck trips to directly serve urban populations. DCs serve a state or region and serve business locations.

[4] Source: National Bridge Inventory Data. Available at http://bridgereports.com/.

[5] "Transportation Asset Management Plan," Florida Department of Transportation, June 28, 2019.

[6] Source: "U.S. Department of Transportation Announces $871.2 Million in Emergency Relief for Road and Bridge Repairs," Federal Highway Administration, September 10, 2019. Florida Federal Lands received $4.9 million.

[7] Source: "Statewide Truck GPS Data Analysis – Parking Supply and Utilization," Florida Department of Transportation, April 15, 2019.

time arising from Federal HOS regulations and the ELD mandate has manifested into a challenging situation for commercial drivers in seeking out truck parking availability.

Domestic Freight Imbalance

There is a domestic trade imbalance between Florida and the rest of the United States. Stakeholders identified that this was likely the result of a consumption based economy and a population growth rate of more than 1 percent annually over the past eight years. This creates an environment where 30 to 50 percent of truck backhauls out of Florida are empty increasing unproductive truck VMT.

Driver Shortage

Florida is feeling the effects of a commercial driver shortage in the trucking industry. The American Trucking Association reports the industry is short 60,000 drivers nationally. The shortage is most notable in the long-haul truckload segment of the market, where drivers are unable to return home every night and are sometimes on the road for weeks at a time. Truck drivers are not the only workers in shortage; diesel mechanics are in short supply as well.

However, stakeholders identified a potential role for technology to help solve this issue. Technology could reduce the amount of miles being driven by trucks, and help attract young talent to the industry. This type of shift coupled with driving automation/truck platooning could lead to a more appealing job for the next generation of truck drivers, who may avoid dealing with the challenges of the job including the long time away from home, lack of truck parking, congestion, and hours of service regulations.

Insurance Costs

Another issue affecting the trucking industry in Florida is the increase in insurance costs. The trucking industry faces issues when it comes to litigation due to crashes which result in damages, injuries, time-lost, and other associated factors. Vehicles equipped with expensive technology, declining insurer competition, and "nuclear verdicts," (repeated stakeholder term) are contributing to the issue. The latter, resulting from a Florida tort law allows juries to award damages if a trucker is 1 percent negligent, whereas in states like Georgia, juries demand that litigants prove a trucker is 50 percent negligent.[8]

Highway and Vehicle Technology

Advanced vehicle technologies will have profound impacts on the freight industry and Florida roadways. Some of these technologies are already embedded in commercial vehicles offered by Original Equipment Manufacturers (OEMs) while some technologies are aftermarket options and other technologies are brought onboard on a daily basis (navigation via smartphone app).

[8] https://www.bizjournals.com/jacksonville/news/feature/statewide-transportation/2019/03/florida-tort-law-makes-it-tough-for-truckers.html

Emerging technologies supplement and/or serve as a catalyst for improved operations on top of advanced vehicle technologies. Although it is important for the Florida Department of Transportation (FDOT) to be aware of all emerging technologies that operate on its facilities, this section is strategically focused on the technologies that could impact FDOT's business practices, mission, and vision of moving freight on highways. More specifically, it will focus only on those technologies that may potentially pose issues for which FDOT, or other state agencies, may be able to take action.

At a high level, technologies that could impact freight movement on highways include the following:

- Advanced Driver Assistance Systems (ADAS), which include low levels of automated vehicle features
- Highly Automated Trucks (HATs), which include higher levels of automation;
- Connected Vehicles (CAVs)
- Driver-Assistive Truck Platooning (DATP)
- Alternative Fuels (AFs)
- Blockchain
- Last-mile package delivery vehicles and devices
- Electronic Logging Devices (ELDs)

These eight technology categories will be discussed further in the following sub-sections.

Advanced Driver Assistance Systems (ADAS)

Advanced Driver Assistance Systems (ADAS) are considered low-levels of automation (Automation Level: 0-2), as defined by the Society of Automotive Engineers. These are generally safety or convenience-oriented vehicle features, such as adaptive cruise control, blind spot monitoring, forward collision warning, lane departure warning, active lane centering, and automatic emergency braking. These features, some of which are becoming standard equipment, can be found on modern long-haul trucks.

ADAS is included in the FMTP because commercial vehicles equipped with ADAS, as well as Highly Automated Trucks (HATs), rely heavily on accurate roadway characteristics, for which FDOT has direct responsibility for maintaining (on state-owned roadways).

The underlying technologies for ADAS features rely on cameras, radars, drive-by-wire, central processing units, and/or LiDAR. These are essentially the 'eyes, ears and brain' of advanced vehicle technologies and are, collectively, referred to as "machine-vision." It is imperative for the safe operation of these advanced vehicle technologies to accurately perceive (i.e., object

detection and recognition) roadway characteristics (lane markings, lane width, signage, edge of pavement, traffic signals, etc.) and other transportation roadway users (vehicles, pedestrians, etc.). There are instances, usually associated with low contrast between pavement markings, which can result in poor 'readability' of the infrastructure on behalf of these systems. Updated Connected/Automated Vehicle (CAV)-ready infrastructure design standards and maintenance cycles can have a direct influence on the safe operation and reliability of these advanced vehicle technologies.

FMO, through the FMTP, recommends to other FDOT offices that CAV-ready infrastructure design standards should be developed for commercial vehicles, in addition to passenger vehicles. Another recommendation could be to partner with Florida Highway Patrol, Florida Department of Safety and Motor Vehicles, and federal agencies to promote the adoption and safe use of ADAS by commercial vehicle operators.

Highly Automated Trucks (HATs)

Highly Automated Trucks (HATs) rely on more robust sensor suites, have more sophisticated algorithms and superior computing power over ADAS technology. HATs are not yet ready for commercial production, as successfully executing decisions and tactical maneuvers for edge case[9] situations are extremely difficult to master. As such, some HAT developers have developed operational models that rely on tele-operations (i.e., remote control) of the vehicle when not on limited-access facilities. When on arterials and other lower functionally classified roadways, an operator controls the HAT using cellular connectivity, on-board cameras, HD maps and telematics data.

Fully autonomous vehicles can legally operate on Florida roadways without the operator being physically present in the vehicle (i.e., being operated remotely).[10] Potential issues for HATs operating on the roadway are difficult to predict. Some potential benefits include exemption from driver HOS restrictions, demand reduction of truck parking, and improved safety.

Connected Vehicles (CAVs)

Connected Vehicles (CAVs) can provide drivers with enhanced situational awareness by-way-of Traveler Information Messages (TIMs) and Basic Safety Messages (BSMs) and can deliver safety-critical data for ADAS/HATs to use as input to execute decisions and make tactical maneuvers. HATs may likely differ very little in operational and logistical behavior (compared to traditionally driven trucks) as standalone vehicles on Florida highways without CAV technology. However, with CAV technology, they may be able to travel in much closer proximity (reduced distance

[9] 'Edge case', in the AV developer community, refers to those situations that are extremely rare and/or difficult to program (software code) for how a machine should handle the situation.
[10] The Florida Legislature unanimously passed a bill legalizing the use of self-driving cars statewide on May 1, 2019.

between vehicles), whether or not they form an official platoon (which will be addressed in the next section). This Vehicle-to-Vehicle (V2V) communications concept does not require Infrastructure-to-Vehicle (I2V) communications, hence no assistance is needed from Road Side Units (RSUs) to be deployed along FDOT ROW. Although, this is generally considered an improvement in capacity of freight movement, it could create issues for law enforcement such as Florida's 'following too closely' law for tractor-trailer combination vehicles.

CAV RSUs could be deployed in strategic locations to deliver BSMs such as 'low bridge clearance ahead,' 'curve speed warning' or in known bottleneck areas (i.e., dense interchanges in urbanized areas) a 'queue warning' message once other traffic monitoring systems detect congestion. Although these could significantly improve safety (when RSUs are operational), FDOT will need to ensure 24/7/365 functionality to be recognized as reliable sources of information. FMO may want to consider coordinating with the Transportation Systems Management and Operations (TSM&O) office to identify which CAV applications, and where, CAV can best improve freight operations.

Driver-Assistive Truck Platooning

Driver-Assistive Truck Platooning (DATP) is a combination of ADAS features and CAV connectivity between two to four trucks. Most system development in the United States has involved two trucks, with potential for more in the future, but not likely to exceed four trucks due to concerns over 'road trains' and issues with other vehicles needing to merge into through lanes. For this reason, it is recommended that policy and regulation limit DATP operation to two trucks, at least in the near-term.

DATP is considered a low-level automation feature, as it requires the lead truck driver to remain fully engaged with the task of driving, as well as keeping in mind the additional vehicle in the follow position (i.e., when overtaking slower vehicles). The driver of the follow truck, typically only relinquishes control of longitudinal maneuvers (i.e., braking and acceleration) while still maintaining control of the lateral maneuvers (i.e., steering). He/she must still be able to resume braking and/or acceleration at any given time, and remain fully engaged in all other driving tasks at all times. However, subsequent systems could allow the driver to cede control of lateral maneuvers in the near or mid-term. In the mid/long-term, the following truck driver may be able to relinquish total control of the truck and occupy the sleeper berth, thereby potentially complying with HOS regulations while the vehicle is in motion. Again, while this can generally be seen as an improvement in freight operations, there may be issues that could arise.

One of the issues already identified by FDOT for DATP operations involves bridge sufficiency ratings for platooning trucks. Bridge engineers were concerned that axle spacing, and their respective per-axle loads, of two trucks (with 5+ axles each) had not been taken into account when bridge design standards were developed. An initial concern was the spacing of the two

trucks, which was presumed to be 30 feet apart (last axle of the lead truck to the first axle of the follow truck), may be too close to comply with FHWA Bridge Formula load ratings. Based on an assumed weight of 80,000 pounds for each truck, six bridges in Florida were found to be 'insufficient' to handle these loading dynamics. For trucks with an assumed weight of 88,000 pounds, 22 bridges were found to be 'insufficient' to handle these loading dynamics. However, after coordination with DATP developers, it was found that the optimal spacing between two trucks is 65 feet, which largely quelled bridge engineers concerns. The limiting factor for the minimum truck following distance is related to a lack of airflow for the following trucks' cooling system leading to overheating of the engine. However, it may be prudent to develop policy or regulations indicating where and/or when platooning operations must temporarily disengage. This could be executed by either an electronic file of geo-fenced areas or by CAV RSUs, and may not need to be limited to bridges of concern.

Alternative Fuels

Alternative fuels (AFs) for commercial vehicles will likely outpace market adoption compared to AFs for personal vehicles. The return on investment and narrow profit margins will drive this trend. Alternative fuels include electricity, Compressed Natural Gas (CNG), biodiesel, ethanol, propane and hydrogen.[11] To date, biodiesel and CNG are the most widely adopted AFs, as it is relatively easy to convert a traditional diesel engine to operate on these fuels. While there are many positive outcomes associated with AFs, such as reduced emissions, reduced operating and maintenance costs, and improved hauling performance, there are a few issues for public agencies to consider as well.

Infrastructure for charging or refueling stations will largely remain a private industry issue. However, co-locating AF stations, specifically for electric vehicles (EVs), at public parking facilities (i.e., rest areas) may increase the utilization of these existing assets and infrastructure for both passenger and commercial vehicle operations. The primary issue with co-location stems from federal limitations related to commercial operations of retail and other revenue generating activities at rest areas. Electrification of commercial vehicles is rapidly approaching, as developers are announcing plans for commercial availability and fleet operators are showing interest and demand for electric trucks. Additionally, rest area electrification (using on-board power infrastructure) for truck parking spaces could also be offered as an incentive for drivers to better utilize these locations.[12] This can allow sleeper berth trucks to power down diesel engines while retaining power for electrical equipment. This not only reduces emissions, but also addresses community concerns and ordinances that prohibit overnight idling. The primary issue

[11] USDOT – Fuels and Vehicle Technology, https://www.transportation.gov/sustainability/climate/fuels-and-vehicle-technology

[12] California Air Resources Board – Idle Reduction Technologies for Sleeper Berth Trucks - https://ww3.arb.ca.gov/msprog/cabcomfort/cabcomfort.htm

with electrification of rest area truck parking spaces is the same as for co-locating EV charging stations at rest areas. Providing these services is best contracted out to third party vendors, which is not explicitly allowed under current federal regulations (MAP-21, section 1531).

Another eminent issue stemming from AFs involves a reduction in funding for Florida's State Transport Trust Fund (STTF) resulting from declining revenue generation from fuel use and sales taxes. For more information on the transportation tax structure in Florida, please refer to the footnote below.[13] As AFs improve fuel efficiency and dependence on petroleum-based fuels, the existing tax structure will not adequately sustain the STTF. Continuation of funding the STTF is commensurate with transportation roadway users contributing their fair share for the use of public assets (roadways). Potential solutions to this issue include; 1) annual registration fees for AF vehicles, 2) tax structure for AFs, similar to existing (petroleum-based) fuel taxes, or 3) mileage-based user fees. However, the last option has proven difficult for a majority of the public to accept in places where pilot projects are on-going.[14]

Blockchain

Publicly available data sources for transportation planning analyses are limited in scope, especially for freight planning purposes. For example, FHWA's Freight Analysis Framework (FAF) does not allow for commodity flow analyses at the corridor-level. More disaggregated data is needed to identify what commodities are moving, where and when, on certain routes. This level of insight can be used to better allocate funding investments and policy decisions. In turn, these decisions can support existing critical industries and attract more freight volume to Florida ports for value-added and manufacturing processes to then export to markets outside of Florida. This could also reduce truck empty back haul and make Florida a more attractive market for securing a load upon leaving Florida.

One way to achieve this level of insight is through the extraction of pertinent data from Bill of Lading documentation. However, the issue is that this data can be very difficult for state DOTs to obtain in a usable format. Proprietary and Personally-Identifiable Information (PII) is not necessary for these analyses, in fact, state DOTs are not interested in those data attributes. The useful data is limited to location of port of entry, date, time, commodity, weight, and value as well as freight origin and destination.

Blockchain is an emerging technology that provides a platform for transactional data to be used by all actors within a supply-chain. It is being developed as a secure, seamless and transparent way to exchange everything from Bill of Lading documentation, to contracts and proof of

[13] FDOT – Florida's Transportation Tax Sources (2017) - https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/comptroller/pdf/gao/revmanagement/tax-primer.pdf?sfvrsn=f1eadaf7_0

[14] Oregon's OReGO program - http://www.myorego.org/

insurance, and certificates of origin.[15] The healthcare and financial industries have spearheaded the development and application of Blockchain technology. The transportation (freight, logistics and supply-chain) industry has already begun to adopt Blockchain technology.[16] There are multiple levels of actors (or access privileges) within a Blockchain, for which a state DOT may be able to be granted read-only with limited access for data extraction. Specific information such as account numbers, PII, etc. can be redacted from public viewing so as to maintain confidentiality but also provide enhanced transparency for all actors involved.

Last-Mile Package Delivery Devices

Florida Statute (316.2071) explicitly allows for the operation of Personal Delivery Devices (PDDs) (i.e. Delivery Robots) on sidewalks along Florida roads. Autonomous Ground Vehicles (AGVs) are designed to operate in dense urban areas to deliver retail goods, parcels and food within a short distance of their operating base. As one-hour, or less, guaranteed deliveries continue to grow in popularity, this is one solution the e-commerce industry may turn to.

One potential issue for FDOT to consider includes establishing provisions to ensure that AGVs do not negatively impact capacity and/or safety for the travelling public on state-owned roadways. From quickly traversing a designated crosswalk to ensuring they stay on the sidewalk (i.e., not inadvertently entering the roadway), adequate paint or other roadway design feature(s) may be necessary for the safe and effective operation of these new transportation technologies. Additionally, FDOT could effectively prohibit PDDs from entering traffic lanes by providing an electronic geo-fenced dataset for which PDD developers must incorporate into their Operational Design Domain (ODD). Lastly, curb management strategies may need to be explored with municipalities to ensure safe operation leading up to their final point of delivery (doorsteps).

Electronic Logging Devices

Electronic Logging Devices (ELDs) were first mentioned as part of MAP-21, and officially went into effect as required equipment in December of 2017. The requirement provides transparency between driver, fleet operator and law enforcement, and reduces paperwork while drivers are on the clock. However, they also pose hours of service (HOS) complications for drivers by removing the ability to round their time by a quarter hour. This was a key strategy employed by drivers to maintain HOS compliance while spending the final 15 to 30 minutes of a trip finding safe and authorized parking. Another issue ELDs pose arises when documentation must be provided to law enforcement as there are compatibility incongruences with other parties such as weigh stations and law enforcements. There are many manufacturers of ELDs and equipment deployed by state agencies may not be compatible with the newest product offerings. For this reason

[15] www.Export.gov - https://2016.export.gov/logistics/eg_main_018121.asp
[16] IBM – Blockchain for Supply Chain - https://www.ibm.com/blockchain/industries/supply-chain

interoperability standards need to be adopted more quickly to allow law enforcement to review electronic documentation in a more efficient manner.

Freight Rail

Florida's freight rail system is comprised of more than 15 railroads that traverse over 2,800 miles of track. Based on stakeholder input, the greater needs/issues for Florida's freight rail system are precision railroading, on-dock rail, intermodal transport, technology/infrastructure, highway/rail grade crossing separations, and on-dock rail improvements.

Precision Scheduled Railroading (PSR)

Since the last FMTP was completed, the Class I railroads have largely adopted a new operations model – Precision Scheduled Railroading (PSR). Under this new model, maintaining an on-schedule service is the main operational focus. PSR railroads operate like an airline. If a passenger is late for a flight, they miss the flight and must be re-booked. In the railroads case, if a shipper is late for their delivery window, the train will pass them by.

Generally speaking, velocity (train speed) and volume (train length) are still important, but the PSR model focuses on moving rail cars. The PSR concept manifests into better utilization of rail cars and for customers, more liable, consistent, and reliable service. While this creates efficiencies and improved revenue for the railroads, it requires shippers to have little margin of error in their supply chain and/or to maintain buffer inventory to hedge against a missed shipment.

Rail Bottlenecks and On-Dock Rail

The previous FMTP identified on-dock rail needs and increasing rail access to ports as major potential rail bottlenecks. To address those concerns, PortMiami completed development of on-dock rail in the South Florida Container Terminal, and JAXPORT completed a new Intermodal Container Transfer Facility at Dames Point.[17] JAXPORT also has on-dock rail service at the Blount Island Marine Terminal.

In 2016, Port Tampa Bay announced it is partnering with a local developer through a public-private partnership to finalize the financing of an on-dock cold storage facility. Moreover, the Port of Pensacola updated its on-dock rail service served by three different rail providers in 2016.[18] As freight volumes increase at Florida's ports, on-dock rail capacity should continue to be monitored and improved.

[17] The 2013 FMTP cited that Governor Scott committed millions toward new Intermodal Container Transfer Facilities (ICTFs) at JAXPORT and Port Everglades to restore or provide new on-dock rail service to terminals and facilitate the direct transfer of containers between ships and trains.
[18] Railroads include CSX Transportation, BNSF Railway, and Rail America.

Further, the 2019 Florida Rail System Plan identified two major rail bottlenecks that need to be addressed:

- **Missing Double Track Section at the Miami River**: The double tracking project that was completed in 2007 left one section of South Florida Rail Corridor (SFRC) single track in the vicinity of the Miami River. This project will fill in the gap, adding capacity and addressing an operational bottleneck for Tri-Rail, Amtrak and CSX freight operations. It will also improve access to the Miami Intermodal Center (MIC).
- **CSX – FEC Rail Connection at Pompano Beach**: A third east-west connection between the Florida East Coast Railway (FEC) and SFRC will be at Pompano Beach. This will provide for freight rail connection to/from Port Everglades.

Positive Train Control

Perhaps the most visible technological issue impacting Florida's railroads is the shift towards Positive Train Control (PTC). PTC is an automated system that brings a train to a controlled stop, if its operator exceeds operating conditions (i.e. excess speed, missed signals, etc.). Federal law required PTC to be installed on, "Class I railroad main lines (i.e., lines with over 5 million gross tons annually) over which any Poisonous- or Toxic-by-Inhalation (PIH/TIH) hazardous materials are transported; and, on any railroad's main lines over which regularly scheduled passenger intercity or commuter operations are conducted."[19]

While initially required by 2018, the widespread adoption of PTC has been hindered by PTC supplier issues and funding challenges. In Florida, CSX and Norfolk Southern have implemented PTC along 94 percent and 74 percent of its track, respectively.[20] Furthermore, the FRA has issued a time extension to complete PTC implementation on the Central Florida Rail Corridor (owned by FDOT).

Supply Chain Visibility

Stakeholders mentioned that a major impediment to shifting their shipments to rail was their inability to track shipments once loaded onto a train. This issue will become increasingly important as consumers' rapid fulfillment expectations grow and challenges with trucking such as increased congestion, driver shortage and increased operational costs potentially drive more freight volume to rail.

[19] https://www.fra.dot.gov/Page/P0358

[20] "PTC Implementation Status by Railroad: Q4 Oct 1. – Dec 31, 2018," Federal Railroad Administration. Available at www.fra.dot.gov/app/ptc/. Also, PTC implementation in Florida for CSX and Norfolk Southern is not available.

Railroad Grade Crossings

Florida has over 3,700 highway/railroad at-grade crossings. From a freight perspective, grade crossings create a delay and safety issue – especially in areas with freight intensive industries. *NCHRP Report 755: Comprehensive Costs of Highway-Rail At-Grade Crossing Crashes* calculated that the cost (delay, risk, etc.) associated with railroad crossings (individually) can reach $40-100 million. While there have been significant improvements to crossings in South Florida, sustained investments will be required to reduce delays and improve safety and quality of life for Florida's residents.

Due to the relatively high number of crossings in Florida, the state receives the fourth largest USDOT Railway-Highway Crossings Program allocation annually. Nationally, Florida has the sixth most train/vehicle collisions and the greatest share of related fatalities (13 percent). Given that half of all collisions occur when arms are down and active (lights flashing), Florida (and the railroads) should explore increased use of quadrant gates and roadway channelization near crossings.[21]

Maritime

Florida's 15 seaports serve as a global gateway for the Southeastern U.S. Additionally, JAXPORT serves as a point of embarkation for the U.S. military. Because of industry and global market trends, there is an increasing need to address port access channel depths, inland distribution capacity and modal choice, technology, emissions, and international market share.

Port Access Channel Depth

Over the past decade, ports along the East Coast have focused on preparing for the completion of the Panama Canal and accommodating larger "Post-Panamax" ships. These larger ships can have a depth (draft) of 55 feet versus what was previously considered a "Panamax" ship with a draft of about 40 feet. While JAXPORT, PortMiami and Port Tampa will have 47, 43, and 50-foot controlling access depth, respectively, the success of Florida's seaports is a much larger story.

Like the air cargo industry, Florida's ports serve as the nation's gateway to the Americas. While ports serving this market do not typically require 50-foot channels, Florida still has maritime needs. These include greater depth at the Port of Pensacola to compete with the Port of Mobile, the development of inland intermodal facilities in Western Florida to capture market share from Georgia, and technology such as truck reservation systems integrated with mapping technology ("assistive intelligence") to help provide the ports the ability to move goods quicker and easier (and therefore at less cost) to inland markets and destinations.

[21] Source: Operation Lifesaver, Inc.

Inland Distribution

The majority of Florida's ports are located in urban areas. As such, truck trips generated at/near the port are impacted by and create increasing levels of congestion. To help alleviate these issues, stakeholders have identified the need for increased inland distribution options – including the development of an inland port. This inland port would allow containers to be shuttled between the ports and an area of the state with less highway congestion and lower land/operating costs.

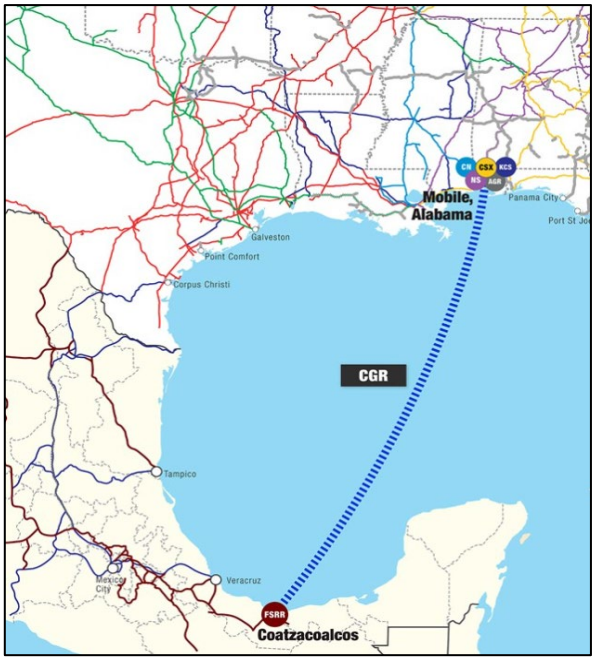

Figure 1 | MX-U.S. Railbarge Service

On a larger scale, Florida has the potential to help support over-the-water container moves between Coatzacoalcos, Mexico and a proposed freight logistics zone near the Port of Pensacola. This improved facility could generate increased over-the-water moves that are currently destined for Mobile, Alabama.[22] See Figure 1.

Marine Terminal Technology

As marine terminal volumes increase, technological improvements can help mitigate the impact of the resultant truck surge and congestion outside marine terminals. For example, the Ports of Los Angeles/Long Beach (PierPass) and New York/New Jersey have employed truck reservation systems. These systems have allowed port authorities to mitigate surge and spread out truck arrivals over a given period of time. More recently, PortMiami has employed the use of PierPass to help organize truck traffic through their gate(s). JAXPORT's Talleyrand Terminal has a similar project in the pipeline. Inside the fence, technology can help Florida's ports move cargo more efficiently, including container staging and continued investment in terminal operating systems (port automation).

Emissions

Marine vessel emissions have fallen as a result of several domestic and international regulations (North American Emission Control Area and the International Maritime Organization (IMO 2020)) enforcing limitations on sulfur content in ship's fuel. Furthermore, eleven major banks will include emissions in their consideration to issue ship-building loans.

[22] The service is operated by SeacoHoldings, Inc. and Genessee & Wyoming, Inc. Also, see FS 311.03 for "Designation of state freight logistics zones."

In addition, marine terminals are switching from diesel to electric gantry cranes and Liquefied Natural Gas (LNG) while changing terminal equipment to alternative fuels such as Compressed Natural Gas (CNG).[23] These and other efforts including recent development of the first natural gas pushboat highlight the focus within the marine industry to reduce emissions.[24]

Resiliency

According to the National Oceanic and Atmospheric Administration (NOAA), the average global sea level has increased 2.6 inches between 1993 and 2014. While, this growth is around one-eighth inch annually, NOAA identifies a more telling figure - nuisance flooding is estimated to be from 300 percent to 900 percent more frequent within U.S. coastal communities than it was just 50 years ago.[25] It should be noted this issue affects all freight modes, as many roadways, rail lines and runways are located near coast lines and at sea level.

Any increase in sea levels impacts infrastructure – whether it is nuisance flooding or increased vulnerability to storm surge. All modes are impacted by sea-rise, but ports (because of their vicinity to the sea) are particularly at risk. Additionally, there is a need to address utility infrastructure that supports facilities moving cargo. Examples include protecting crane power transfer and rail switching stations; raising emergency generators, fuel tanks, and air conditioning; and ensuring grade separated roadways accessing marine terminals have adequate flood control equipment.

International Market Share and Port Investment

Border congestion at the Ports-of-Entries between the United States and Mexico are a multinational trade issue. Trucks often sit at the border in a five-mile queue for over 10 hours. While, a more viable solution could be Florida – located only 13 hours (by sea) from Mexico. The Journal of Commerce estimated that transit from Latin America via PortMiami to Atlanta can save up to two days and $2,500 compared to an all-truck route.[26] Cargo volume for two Port of

[23] Source: "H-Energy to Develop LNG Terminal at India's Kakinada Port," World Maritime News, September 9, 2019. This implies the possibility of an LNG terminal at JAXPORT, given the facility there fueling Crowley Ships that operate along the East Coast and for its Caribbean service.
[24] Source: "Robert Allan Ltd. And MTU team up to develop first natural gas fueled shallow draft pushboat," gCaptain, August 20, 2019.
[25] Source: "Is sea level rising?" National Oceanic and Atmospheric Administration, Accessed September 6, 2019. Available at https://oceanservice.noaa.gov/facts/sealevel.html.
[26] "US East Coast reaps gains from rise in Mexico ro-ro," Journal of Commerce, August 12, 2019. Available at https://www.joc.com/maritime-news/short-sea-shipping/us-east-coast-reaps-gains-rise-mexican-ro-ro_20190812.html.

Tampa routes to Mexico that initially started in 2016 increased dramatically – 232 percent in 2017 and another 90 percent in 2018.[27]

In addition, freight rail is being affected by slow interchanges along the rail crossings between Texas and Mexico. The results has been self-imposed embargoes of grain products (used for Florida poultry production), by Union Pacific Railroad (UPRR) and Burlington Northern-Santa Fe (BNSF). This is the result of slow interchanges with Mexico rail carriers including Kansas City Southern de Mexico (KCSM) and Ferromex (FXE).[28]

Aviation

Florida has 20 commercial service airports that enplanes and deplanes approximately 10 percent of U.S. air cargo. Miami International Airport accounts for over 80 percent of Florida's air cargo volume and serves as the nation's global air gateway to the Americas. Florida has four large hub airports (Orlando, Tampa, Miami and Ft. Lauderdale) – the most of any state. Primary issues include land use, freight access (ground/truck access), the international market, and the aviation manufacturing industry.

Land Use Conflicts

While most large airports were originally developed away from residential land uses, residential developments have encroached on airports and nearby supporting land uses, affecting noise requirements for flight paths and the future location of new commercial/industrial land uses. To create long-term economic development, air cargo reliant industries should be given precedent when allocating land uses near major airports.

Effect of Highway Congestion

By their nature, air cargo shipments are very time-sensitive. Congestion on key highway routes that access airports and nearby freight centers are counter to the long-term growth of this freight sector in Florida. While large investments are made or planned for large airports like Miami, smaller airports like Lakeland Airport are also seeing significant air cargo growth.

Spaceports

The 2011 conclusion of National Aeronautic Space Administration 's (NASA) Space Shuttle program led to 10,000 Floridian job losses. While that is a significant figure, the Space Coast Economic Development Commission believes more than 8,700 new jobs have been created by

[27] Source: "US importers from Mexico ramp up ocean routing to avoid land border," Journal of Commerce, August 17, 2018. Available at https://www.joc.com/port-news/us-ports/us-importers-mexico-ramp-ocean-routing-avoid-land-border_20180817.html.
[28] "Grain Transportation Report," U.S. Department of Agriculture, May 7, 2019. Available at https://www.ams.usda.gov/sites/default/files/media/GTR10112018.pdf.

50 new space-related projects since 2011. For Florida, its ideal location and industry employment highlights the importance of continued investment in its space industry.

International Competition

While the U.S. (and Florida in particular) have been leaders in the space industry, competition is increasing globally, with over 40 known space launch sites around the world.[29] However, Florida offers an ideal location, industry support, and state and federal financial mechanisms in a competitive (free market) environment. New companies including Firefly, Blue Origin and SpaceX have located in-state to develop space-related vehicles and infrastructure, creating jobs and therefore public dollars for reinvestment. However, these efforts are often not visible to the general public. Therefore the public is generally less aware of state and regional efforts in support of the industry, and the state must be vigilant in remaining competitive in this industry.

Public-Private Partnerships

NASA leverages public-private partnerships (P3s) to share risk due to the nature of the space industry. While Florida's space industry success is already rooted in partnership – there is a potential opportunity to leverage FDOT's success in undertaking P3 projects. This input has the potential to benefit economic development statewide and even beyond state lines. Guidance provided by the state could be incorporated into the Florida Spaceport Improvement Program Project Handbook and the Cape Canaveral Development Manual – providing guidance and information to the private sector.

Pipelines

Interstate pipelines are governed by the federal government. In Florida, intrastate pipelines are governed by the Florida Public Service Commission. While FDOT has no formal role in pipeline governance, pipelines do and could play a greater role in the movement of Florida's liquid and natural gas.

Florida imports up to 40 percent of its energy for the residential, commercial/industrial and transportation markets. While Florida residents use less than one percent of petroleum products for heating, 90 percent is used by the transportation sector. Despite Florida's 1,400 oil wells and supply of U.S. crude oil reserves, the state imports fuel oil by water from refineries in the Caribbean and the Gulf Coast of the United States.[30]

[29] In contrast to other modes, the spaceport industry is uniquely international.

[30] There are currently more than 1,400 permitted wells in Florida; and Congress constitutionally banned offshore drilling within 12 nautical miles of the shoreline until 2022.

There is a petroleum pipeline from Bainbridge, Georgia and two in-state respectively from Port Tampa to Orlando and Port Everglades to Miami.[31] In addition, existing natural gas pipelines include "Gulfstream" across the Gulf of Mexico from Mississippi and Alabama; "Florida Gas" from Texas through Louisiana, Mississippi and Alabama; and the Sabal line from Alabama to Florida via Georgia. A portion of this natural gas goes to Jax LNG and Eagle LNG which supply marine vessels at JAXPORT by barge and truck.

In 2017, almost three million gallons entered Florida via short sea service from the Gulf Coast while 538 gallons were imported (mostly by water) and then moved domestically again by water (63 percent), truck (35 percent), and rail (two percent). In addition, 16.6 million tons of fuel oil was moved from other states to Florida by truck.[32] Assuming an average capacity of 20 tons (carried per truck), 828,000 trucks were attributable to fuel oil on Florida's roadway network. If pipeline capacity was improved or expanded (beyond current projects and development plans), the state could see improvements in roadway development and maintenance costs, less reliance on ports given sea level rise, and greater resilience for energy demand, given projected population growth in 2045.

Multimodal

While there are clearly distinct, individual modal needs and issues, there are also issues that cut across modes.

Freight Optimization

The largest firms in the freight industry (Wal-Mart, Amazon, UPS, FedEx, etc.) have access to the most advanced freight technology. They use data analytics to process their cargo in real-time and are able to employ advanced sensors/bar codes/RFIDs to track packages. They also have access to software which optimizes routes for their truckers.

Smaller owner-operator trucking companies often do not have the same resources that enhance efficiency. FMTP stakeholders argue that publicly providing optimization software and data across the trucking industry would provide a better return on investment than direct capacity improvements that improve efficiency for only a short time.

[31] Source: "Today in Energy," U.S. Energy Information Administration. Available at https://www.eia.gov/todayinenergy/detail.php?id=15651.
[32] Source: Freight Analysis Framework

Cargo Theft

In 2017, Florida was the fourth highest state regarding cargo theft and had the highest share of food and drink theft – 29 percent.[33] Given the economic cost to deter cargo theft, FDOT would benefit from being a member of the Florida Commercial Vehicle and Cargo Theft Task Force.

Environmental Stewardship and Community Concerns

While, Florida meets the 2015 EPA 8-Hour Ozone Nonattainment standards, it is still important to limit the impact of point source emissions along freight corridors. Balancing resident's livability and freight mobility is important, given the continued growth of the State's population.

Trade Barriers (and Agreements)

Trade barriers are an historical issue to global trade and have impacted the movement of cargo, since global sea-going trade began. Today, the growing shift from global (offshoring) manufacturing to regional (re-shoring) has changed trade and corresponding job growth, which could bring more freight to Florida because of its proximity to Mexico, the Caribbean, and Latin America. However, if trade barriers expand to Latin America, facilities like JAXPORT could see an 18 percent drop in imported/exported vehicle throughput.[34]

Land Use

Freight Forum participants identified a need for the freight planning conversation to be extended to the land use planning community. In each forum, stakeholders identified how local land use decisions impacted the transportation network. While FDOT has no statutory authority over land use, stakeholders felt FDOT could help facilitate the larger discussion.

Communication/Collaboration/Partnerships

Getting the right people to the table is difficult, especially across the public/private sector divide. One inhibitor is planning timelines. Private industry plans for the more immediate future, while the public sector tends to plan with much longer horizons. There is a perception that the freight industry should not be bothered because they are dealing with their own issues, when the reality is that these issues are all interwoven.

Funding

Funding is needed across the board. The Districts need more money for local project matches and the ability to more wisely spend the currently existing money. There tends to be a lack of prioritization for freight policy – with both projects and funding. There should be a more robust

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[33] Source: "2018 Miami-Dade County Freight Plan Update," Miami-Dade Transportation Planning Organization, June 2018. Available at http://www.miamidadetpo.org/library/studies/freight-plan-update-2018-06.pdf.

[34] Source: "In search of the promised land," Automotive Logistics, July 8, 2019. Available at https://www.automotivelogistics.media/home/in-search-of-the-promised-land/38642.article.

FDOT SIS Quick Fix program, and public service announcements to highlight improvements and where the money is being invested.

Scenario Planning

As the future becomes increasingly uncertain, traditional planning methods – which use past data trends to predict the future – become less useful. Scenario planning provides an alternative process, which instead focuses on preparing for hypothetical but plausible future scenarios.

Scenario planning uses qualitative and quantitative analyses to explore what plausible freight-related futures could mean for Florida. More importantly, the process identifies specific steps the state could undertake to capitalize on opportunities and mitigate future challenges.

According to the FHWA, "scenario planning helps transportation agencies work with stakeholders and the public to establish a vision and implement a strategic plan for success in uncertain times. Well-crafted scenarios inspire critical thinking about issues and events that could significantly affect a region's economy, environment, and quality of life. In addition to using modeled forecasts based on historical trends or formulas, scenarios typically use words, pictures, and numbers to describe complex data analyses in the form of holistic, plausible illustrations of future conditions. Scenario planning typically includes both qualitative and quantitative analyses to illustrate the tradeoffs between different futures and their relative impacts on different community goals."[35] See Figure 2.

[35] Source: "Supporting Performance-Based Planning and Programming through Scenario Planning," U.S. Department of Transportation, Federal Highway Administration, June 2016.

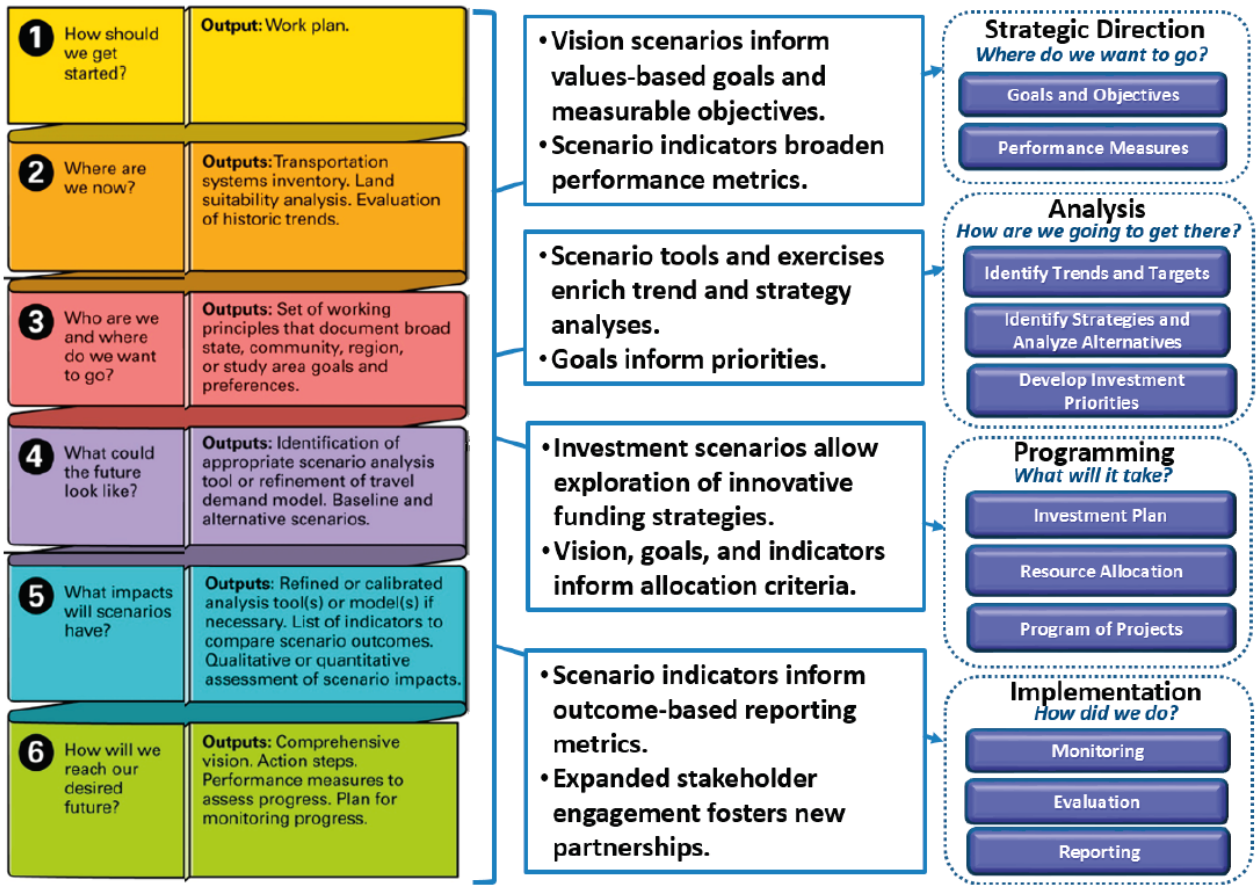

Figure 2 | Application of Scenario Planning to Performance-Based Planning and Programming (FHWA, 2016)

For the 2019 FMTP, the following three scenarios address (1) Resiliency, (2) Technology, and (3) Enhanced Economic Growth. These three scenario topics were selected due to their cross-cutting nature. The FTP identifies that resilience, technology, and the economy are topics that impact each of their goals. These three topics were discussed and agreed upon as cross-cutting with all stakeholders.

The purpose of this section is to consider plausible freight conditions for the future year of 2045. The current state of technological advancements, susceptibility to natural disasters, and relatively stronger economic growth will be accounted for, and assumptions will be made for the context of following discussions. Further (and as applicable) the scenarios will be introduced, defined, and quantified using previous Strategic Intermodal System (SIS) network modelling efforts. Finally, these scenarios will be used to identify recommendations for FMO to consider for policy and programming decisions to proactively achieve specific positive outcomes and limit potentially negative situations.

Scenario 1: Infrastructure and Supply-Chain Resiliency through Climate Change

Introduction

The scenario addresses the multimodal nature of goods movement across the supply-chain and considers the four phases of emergency management (EM); 1) mitigation, measures to prevent and/or minimize future events, 2) preparedness, plans or preparations to handle an impending emergency, 3) response, action taken during an emergency, and 4) recovery, actions taken after an emergency. This scenario will focus on maintaining efficient and effective supply-chain operations year-round with an emphasis on creating resilient infrastructure - consistent with FDOT's primary mission to provide safe, efficient transportation facilities through physical assets, operational strategies and financial investments.

This scenario defines plausible environmental conditions for the year 2045 and provides a discussion on implications for infrastructure that can sustain the movement of freight in, out, and within Florida, based on the state being more susceptible to storm-related events given climate change. Further, recommendations are offered to ensure Florida remains a freight hub regardless of climate and natural disaster challenges for the year 2045. However, the first phase (mitigation) will be the focus for defining the scenario and subsequent recommendations.

Scenario Defined

By 2045, average temperatures in Florida have increased by 4 degrees Fahrenheit while sea levels have risen by nearly 12 inches along most of Florida's coastline.[36] Some coastal communities and downtown Jacksonville, Miami and Tampa have had to reinforce and expand seawalls and bulkheads to reduce Sea Level Rise (SLR) impacts to freight movement and daily life. Due to atmospheric warming, rising surface sea temperatures have resulted in greater frequency and strength of hurricanes and associated storm surges. Flooded roadways due to SLR and hurricanes have deteriorated roadway base layers and pavement on many state roads immediately adjacent to the coast and in some cases inland. These impacts have resulted in significant FDOT investments in pervious pavement, ultra-high strength concrete, roadway elevation projects, bio swales, pumping/lift stations and other washout prevention strategies. Additionally, due to higher water tables near coastal communities, septic tanks have become a top environmental concern (including for algae blooms) and potable water wells have become useless due to saltwater intrusion. For communities that cannot afford desalination plants, pipelines have been built for the transmission of potable water.

Total annual precipitation has decreased, primarily in south and central Florida, which has led to an increase in the frequency and duration of drought conditions. Inland, the water table of the Floridian aquifer has shrunk due to reduced rainfall and increased depletion caused by residents,

[36] NOAA National Center for Environmental Information: State Climate Summaries - Florida

visitors, and commercial activities. Water supply for commercial agriculture and wildfire management have also become top priorities for the Florida Department of Agriculture and Consumer Services. To make matters worse, extreme rainfall events (>4 inches/event) have increased, resulting in more severe flooding and stormwater runoff. These climatic events perpetuate negative impacts from SLR on transportation facilities, especially for infrastructure that must support the weight associated with the movement of freight.

The amalgamation of these climatic realities pose serious challenges for uninterrupted freight movement, especially near coastal urban cores and seaports. Significant resources have been allocated to "push-button (on-call) contracts" to rapidly deploy supplies to storm-affected areas, in addition to regulation waivers regarding HOS, vehicle weight and other factors for emergency management operations. Other operational strategies include readying on-call truck drivers and pre-positioning of commercial vehicles, police escorts, coordination with ports and other bulk storage facilities, and subsidies for retail fuel stations to position temporary back-up generators for post-storm operations. Waiving truck weight restrictions in the days leading up to and immediately following a major storm has proven effective for re-positioning idle inventory to protect it from storm impacts. Additionally, diversifying the modal split for high-demand post-storm commodities from warehouse to rail, as part of emergency preparedness strategies, has proven effective as an alternative temporary storage location that can quickly mobilize these goods when highway operations are limited due to storm surge and debris removal efforts.

Regular, daily freight operations rely more heavily on parallel corridors and freight bypass routes, which has increased the SIS network and expanded the National Highway Freight Network within Florida. Once considered a viable option for only high-value commodities, aviation for freight movement is now common for mid-value commodity movement within and out of Florida. Perishable goods are also more commonly seen on rail as a result of refrigerated containers and the use of photovoltaic cells to fuel the refrigeration units.

It is industry knowledge that natural disasters cause numerous shock and stress factors for logistics providers and freight carriers throughout the supply-chain and across all modes. Prior planning (i.e., emergency preparedness) to import necessary supplies such as fuel, potable water, and food need to be coordinated so they are in strategic locations for rapid delivery post-storm. This requires ample, and appropriate, storage facilities, available truck drivers, and provisions for maintenance of traffic and pre-determined alternative routes to prioritize the movement of these goods to the areas of impact. In order for these operational strategies to be implemented, hardened infrastructure (i.e., emergency mitigation) has been built and/or deployed in order to meet the demands of these system shocks and stresses.

A prime example is the supply-chain resiliency of fuel (petroleum products) used for transportation and back-up generators (i.e., emergency recovery). Prior to a storm, fuel retailers

benefit from having push-button contracts with fuel wholesalers to ensure their supply can keep pace with demand. Also, any fuel retailer within five miles of an evacuation route is equipped with the necessary wiring and transformer capabilities to handle adequate power from back-up generators to keep all fueling stations operational. This does not mean that permanent back-up generators are necessarily installed on-site, but rather that they could be hauled to fuel retailers ahead of a storm as a storm preparation activity. In order to keep up with retailer demand, adequate reserves are imported at the beginning of each hurricane season to appropriate bulk-storage facilities and rack-terminals. Additionally, a denser network of smaller rack-terminals have been developed to more quickly satisfy regional and/or local (in dense urban areas) fuel demand needs.

As a result of the increased adoption of electric passenger and commercial vehicles, roadside photovoltaic cells and inductive charging loops embedded in the roadway have been deployed to ensure vehicles stay charged during emergency evacuations. During evacuations, this is a free service for all highway users but during normal operations they serve as a new source of revenue generation for the state and is offered as an optional service.

Quantified Implications for Freight Infrastructure Resiliency in 2045

According to FDOT's Resiliency Primer, state and local agencies can no longer rely on static historical records to help determine future conditions. Extreme weather events are becoming stronger and more frequent. Significant resources must be allocated to address historic levels of flooding and storm surge impacts. While the private industry and public agencies are attempting to address resiliency through studies, legislation, regulations, programs and executive orders, there is still inherent risk in planning for the unknown.

The FDOT 2018 Risk Assessment on SIS Facilities study "was intended to analyze the Strategic Intermodal System (SIS) highway network to identify critical infrastructure, network risks and vulnerabilities due to impacts of flooding and lay the groundwork for pre-disaster mitigation planning as it relates to all SIS facilities, including retrofitting, adapting or diversifying infrastructure to promote resilience; pre-disaster emergency response planning, and emergency response operations immediately following a flood-event; and longer-term restoration of affected infrastructure."[37] The following figures (Figures 3 – 5) and tables (Tables 2 – 4) from the Resiliency Primer illustrate the conditions depicted in this scenario.

[37] FDOT – Risk Assessment on SIS Facilities (2018)
http://www.floridatransportationplan.com/pdf/FDOT-SIS_ResiliencePhaseI-TechMemo_wApp_8-22-18.pdf

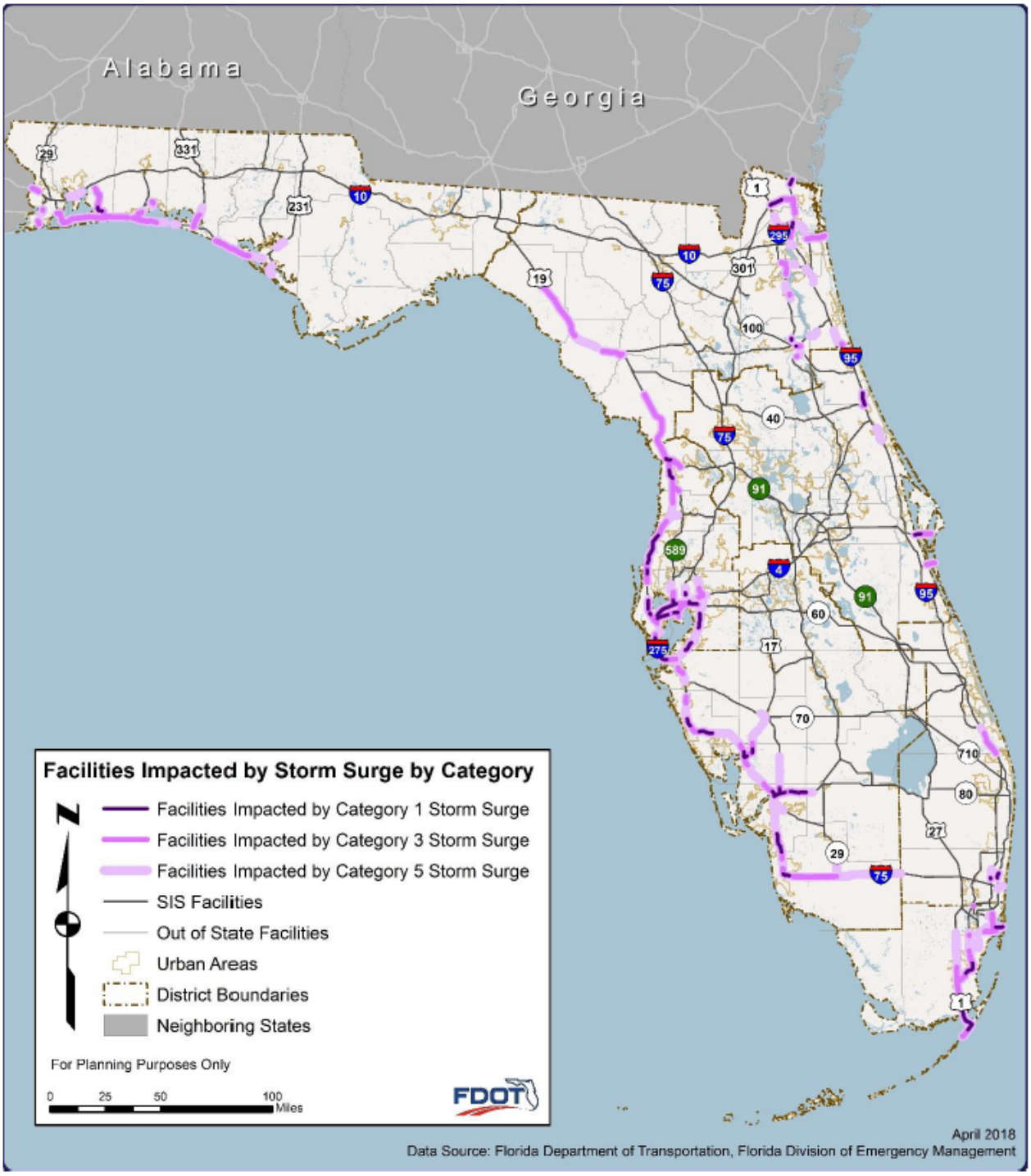

Figure 3 | SIS Facilities Impacted by Storm Surge

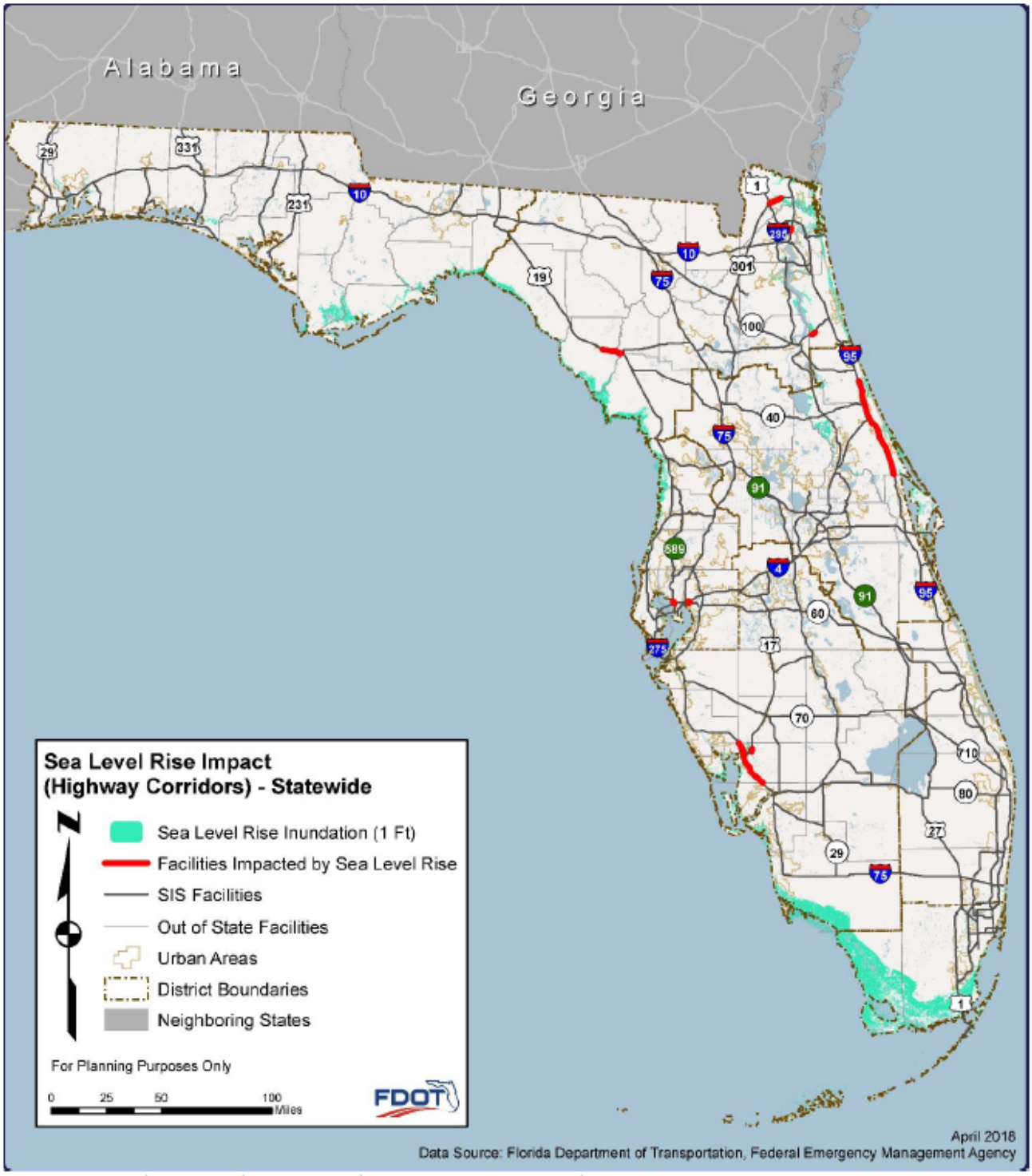

Figure 4 | SIS Facilities Impacted by 1 foot SLR

Table 2 | SIS Facilities Impacted by 1 foot SLR (FDOT SIS 2018)

Name	County	From	To	Centerline	DVMT*
SR 207	St. Johns	Main St	SR 206	1.87	35,041
SR A1A/SR 200	Nassau	Alligator Creek	Griffin Rd	5.59	48,068
I-95/SR 9	Duval	Tallulah Ave.	Zoo Parkway	1.37	147,698
I-95/SR 9	Volusia	Brevard/ Volusia County Line	Old Dixie Highway	13.94	926,852
I-95/SR 9	Volusia	Granada Blvd.	US 1	1.71	86,135
I-95/SR 9	Volusia	N of Canal St.	Taylor Rd.	1.92	77,949
I-75/SR 93	Charlotte	Duncan Rd.	S. of Harborview Rd.	0.76	49,490
US-17/SR 35	Charlotte	Washington Loop Rd.	Washington Loop Rd.	0.51	5,457
I-75/SR 93	Charlotte	Charlotte/Lee County Line	Charlotte/Desoto County Line	6.70	435,630
US 19/SR 55/ SE US-19	Dixie	300th St.	Dixie/Gilchrist County Line	2.92	35,043
I-4/SR 400/SR 618/ Connector	Hillsborough	E. of 39th St.	11th Ave.	1.38	19,085
SR 60	Hillsborough	W. John F. Kennedy Blvd.	S. of SR 60/ Courtney Campbell Causeway	0.52	73,170

*Daily Vehicle-Miles Travelled

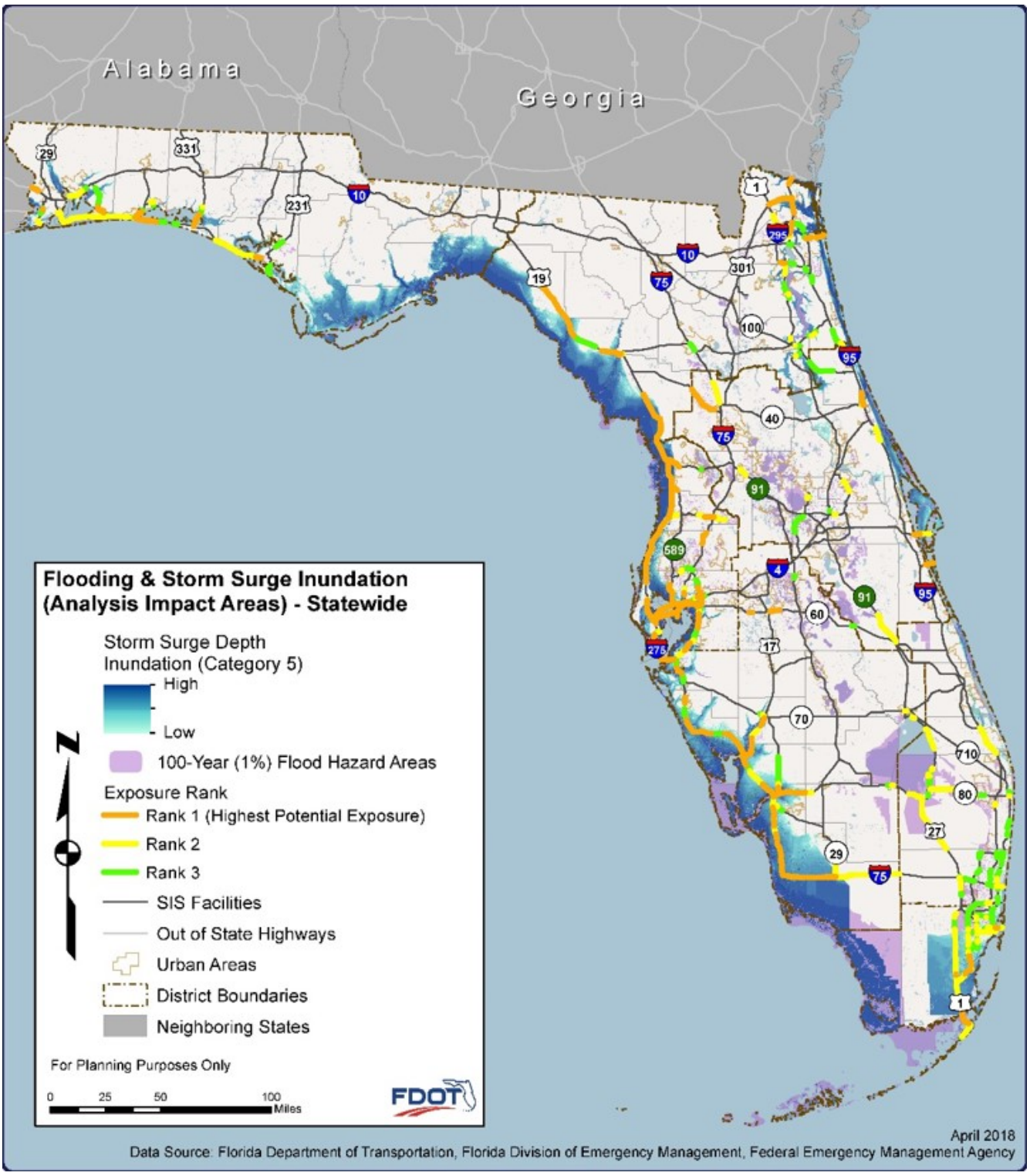

Figure 5 | Flooding & Storm Surge Inundation (FDOT SIS 2018)

Table 3 | SIS Highway Corridors Impacted by Rank (FDOT SIS, 2018)

Rank	Centerline	DVMT	Centerline (%)	DVMT (%)
Rank 1	513	23,924,222	10.8%	11.1%
Rank 2	461	18,663,512	9.7%	8.7%
Rank 3	283	18,973,279	5.9%	8.8%

Table 4 | SIS Bridges Impacted by Rank (FDOT SIS 2018)

Rank	Centerline	DVMT	Centerline (%)	DVMT (%)
Rank 1	64	3,126,645	38.7%	42.4%
Rank 2	11	465,060	6.4%	6.3%
Rank 3	12	613,675	7.3%	8.3%

Significant funding has been provided to remediate damage sustained by the SIS network as a result of hurricanes and other natural disasters. Despite FEMA's assessment that every dollar spent on hurricane surge protection saves $7, the impacts of climate change will result in additional unknown costs. In addition, since 1989, FEMA has spent more than $1.23 billion on pre-storm event costs of which more than $8.73 million was obligated for roads including culvert repair or replacement.[38]

Economic Case Study: Hillsborough County MPO Vulnerability Assessment and Adaptation Pilot Project

On the Gulf-shore of Florida, critical transportation assets are particularly vulnerable to impacts from sea level rise and storm surge. Several critical roadway and railway links in the SIS network would be under water during a Category 3 storm surge with 2040 projected sea level rise. The Hillsborough County Metropolitan Planning Organization conducted a climate change vulnerability assessment in partnership with the FHWA to identify cost-effective strategies to mitigate and manage risks of coastal and inland inundation for incorporation into their general transportation decision-making processes in addition to informing the county's 2040 Long Range Transportation Plan and its Post-Disaster Redevelopment Plan. The project examined several critical infrastructure assets in the region and evaluated the mobility and economic impacts of scenarios that would involve closing these facilities.

[38] Source: "Natural Hazard Mitigation Saves," Federal Emergency Management Agency, January 2018. Available at https://www.fema.gov/media-library-data/1528727738945-e9805d8703ed4a1b02c5e2861b7ac65a/MitigationSaves_FEMA_180611_508.pdf.

One of the links evaluated in this project included a key evacuation route from adjacent Pinellas County to access the Gandy Bridge. Currently, a Category 1 (weakest storm in the five-level scale) storm surge would block this link for approximately 1 week while a Category 3 storm surge would require closure for approximately four weeks. The assessment returned a recommendation to spend approximately $1.9 M on various adaptation strategies to allow the facility to continue operations compared to the $3 M cost of facility replacement.[39]

FMTP Recommendations on Planning for Resilient Infrastructure

Resiliency planning for Florida's critical infrastructure and services is a responsibility shared across many different state, regional, and local agencies, in collaboration with FDOT and a variety of other state and federal agencies. A share of this responsibility falls to FDOT and is addressed through a variety of policy and planning mechanisms. The FMTP is one of those mechanisms, specialized and optimized for freight, and is a component of a larger universe of FDOT initiatives. The challenge for the FMTP is to define a resiliency planning strategy that is specifically oriented and focused to benefit freight movement and advance the goals of the FMTP, consistent with this larger planning and policy universe.

FMTP Recommendation Area #1: Pre-Planning for Resilient Infrastructure

1.1. Capacity, Choice and Connectivity. Prioritize policies and investments that ensure the long-term availability of freight handling capacity for Florida's freight shippers, receivers and communities. Promote the choice of multiple freight transportation modes for freight shippers, receivers, and communities, and in cases where service by multiple modes cannot be provided, promote the availability of multiple routes and corridors for the mode that is available. Prioritize policies and investments that promote and enhance the interconnectivity and interoperability of different freight transportation modes, maximizing the chances that transportation services and complex supply chains can be maintained under conditions of stress.

1.2. Critical Freight Network (CFN) Identification. Work with partners at the national, state, regional, and local levels to identify a limited core network of the most critical freight transportation infrastructure and facilities for "hardening" – e.g., construction to highly resilient standards or retrofitting/improvement to such standards. This could be the SIS, or a subset of the SIS, or some blend of SIS and non-SIS facilities (including different modes), and should achieve the intent of Recommendation 1.1. The CFN should represent the "minimum operating network" to keep Florida well-served during periods of potentially sustained disruption.

[39] Hillsborough County MPO, (2014). Vulnerability Assessment and Adaptation Pilot Project. http://www.planhillsborough.org/wp-content/uploads/2013/10/NoAppendix_Hillsborough-MPO_FHWA-Pilot-Final-Report.pdf

1.3. CFN Design Standards. Work with modal system and intermodal facility partners from the public and private sectors to prepare specific definitions of 'highly resilient standards' to implement Recommendation 1.2.

1.4. Reduce Future Risk. Encourage investments in freight network or facility improvements in known low-risk areas, when the larger context allows it, except where consistent with Recommendations 1.1 and 1.2 and the CFN Design Standards of Recommendation 1.3.

1.5. Focus Federal Freight Funding on Resiliency Enhancements. Coordinate and focus the use of FAST Act freight funds on projects that achieve Recommendations 1.1 through 1.4. Where the state has multiple opportunities to sponsor or support discretionary grant applications for freight projects, support and sponsor projects that are consistent with recommendations 1.1 through 1.4 as a first priority.

1.6. Facilitate Multi-Level Program Coordination. Work to establish the achievement of Recommendations 1.1 through 1.5 as priority factors in the preparation of state, regional, and local government investment work programs, plan preparation, project studies, funding applications, supporting the consistent application of resiliency efforts across all layers of government in a collaborative and mutually beneficial way.

FMTP Recommendation Area #2: Pre-Planning for Critical Supply Chain Continuity during Disruptions

2.1. Critical Supply Chain (CSC) Identification. Define critical supply chains that must be maintained during and immediately after periods of disruption, prior to full restoration of services. These supply chains include, but are not necessarily limited to, the movement of: fire and life safety protective equipment; food and potable water; fuel and power generating equipment; shelter and building materials; medical, sanitation and comfort necessities; telecommunications and electrical system repair/restoration equipment; personal/property security equipment; and equipment and supplies necessary for immediate clean-up (sandbags, pumps, etc.).

2.2. Marshaling, Prepositioning and Move Planning. Identify locations throughout the state, and possibly other states, to marshal and/or pre-position the full range of CSC commodities and equipment. Identify primary and secondary routes and modes between these CSC hubs and areas within Florida where the CSN commodities and equipment could potentially be needed. Identify 'contingency' routes or modes to be used in cases where the primary and secondary options are unavailable. Contingency services could include temporary water operations (via tug/barge or feeder vessel), airlift services where possible, etc. Plan for the procurement of transport equipment to provide such services when needed from federal, state, regional, and private sector partners. Secure the commitment of private transportation service providers where necessary to operate the identified services and supporting facilities and networks.

Recommendation Area #3: Pre-Planning for Rapid Service Restoration after Disruptions

3.1. Restoration of Services. Effectively implementing Recommendations 2.1 and 2.2 to accommodate Critical Supply Chain movements will provide impacted regions with immediate resources for emergency operations and construction. Depending on conditions, CSC movements may need to be maintained for weeks via the emergency/alternative routes and modes, although in the best case scenarios, normal routes and modes will become operable for freight movement within days. Construction materials, equipment, and labor necessary to effect rapid repairs to normal routes and modes should be identified, designated for use in areas potentially impacted by disruptions, and – in the case of foreseeable disruptions – made ready for pre-positioning in advance of anticipated events.

3.2. Budgeting and Programming. To the extent that effective preparation to implement Recommendation 3.1 may require the acquisition of additional equipment, materials, and labor capabilities, FDOT should identify the budget impacts and work with policy makers to meet potential shortfalls.

Table 5 | Summary of Freight Resiliency Strategies and Adaptations -

Strategy	Pre or Post	Strategy Type	Examples	Stakeholders*
Vulnerability Assessments	Pre	Planning/ Policy	Conducting quantitative analysis of potential impacts of climate changes and other challenges during asset management process.	Local/ State/ Federal
Mitigation measures used in concert with adaptation to reduce climate risks	Pre	Planning Policy	Coordinating land use and transportation infrastructure; supporting innovative technologies; promoting less carbon-intensive freight modes	Local/State
Harden core protected network of critical links and nodes against disaster and flood risk	Pre	Physical Infrastructure	Flood catchment vaults; raise road/rail profile; salt-resistant drainage pumps; levees; raise causeways and stabilize buffer slopes; water plazas and vegetated flood catchment basins; redesign bridge elevations above highest storm surge forecasts; install seawalls; armor erosion-prone slopes; marsh restoration; wave attenuation devices (WADs); enhance roadway base	Local/ State / Federal
Incorporate climate-related risks into the location of future transportation projects	Pre	Planning/ Policy and Physical Infrastructure	Establishing redundancy in transport networks; avoid construction and development of roads and rails in areas vulnerable to floods and storm surges	Local/ State

Strategy	Pre or Post	Strategy Type	Examples	Stakeholders*
Leverage logistics knowledge of transportation companies	Pre	Planning/ Policy	Establish public-private cooperative agreements to engage major freight carriers to plan disaster mitigation, adaptation, and response strategies	State
Evaluate damages caused and costs for repair and compare to other alternatives	Post	Planning/ Policy	Conduct a benefits-costs assessment of repairing or retreating from the infrastructure	Local/ State/ Federal
Develop post-disaster eval. framework for infrastructure performance during & after event	Post	Planning/ Policy	Require measurement and evaluation process of infrastructure performance in disaster recovery and incorporate that into planning and development of repairs or expansion of new facilities	Local/ State/ Federal
Coordinate with utility providers for adaptation of infrastructure put into place functions during preparation and recovery efforts	Both	Planning/ Policy and Physical Infrastructure	Pipeline and other power transmission infrastructure is important to continued operations of intermodal hubs, bascule bridges, and adaptation infrastructure like pumps installed to improve roadway/railway drainage	Local
Plan and implement multi-modal contingency plans for freight transport of emergency materials after disaster events	Post	Planning/ Policy	Using barges to transport emergency materials to areas inaccessible by other modes due to flooding or inundation events	State/ Federal

** Local stakeholders including municipal and county government agencies. State stakeholders include FDOT and FDEM. Finally, Federal stakeholders include FHWA, FRA/PHMSA (e.g., transport of emergency materials) and FEMA.*

Scenario 2: Technology Facilitates Higher-Frequency Freight Movements

Introduction

The Internet of Things (IoT) and mobile connectivity will enable purchases and transactions, travel decisions, and work/life balances to be conducted more quickly, and more frequently, than at any point in history. These decisions will enable how individuals interact with society at a micro-temporal scale.

App-based services such as retail purchasing platforms (Amazon), (potentially automated) Transportation Network Companies (TNCs) (i.e. UBER and LYFT), universal mobile fare payment options, on-demand pickup and delivery services, and urbanization will contribute to how/when/why/ where these transactions occur. By 2045, the digital infrastructure and societal behavior will have profound impacts for the freight industry across all modes. To gain insight into a plausible future which accounts for these technological possibilities, the following planning scenario is presented to spur discussion and identify freight planning needs.

Scenario Defined

By 2045, this planning scenario assumes near ubiquity of the aforementioned app-based services. This scenario will focus on the behind the scenes production that enables real-time and dynamic purchasing options and the freight factors that will become significantly more frequent.

Guarantees of one-hour delivery windows require exhaustive amounts of prior planning, research, infrastructure investment, and logistics, all of which is based on business models that are reliant upon highly time-sensitive freight operations. Fulfillment Centers (FCs) are located closer to the consumers within a market area and are specialized by commodity type, rather than retailer (as was the practice in 2019). Locally focused FCs have resulted in more urban warehousing and value-added packaging facilities to satisfy on-demand consumers with a 95 percent delivery reliability.

Following the supply chain, these regional DCs, value-added packaging facilities, urban warehouses, and FCs will be more numerous in every major urbanized area within Florida, while each facility is smaller and more automated than they were in 2019.

On-Demand Pickup and Delivery Services (ODPDS) are the preferred transactional option which has reduced the amount of traditional retail locations, and increased prevalence of FCs. These are the locations where the ODPDS providers assemble individual orders to be delivered to end consumers. The remaining retail locations have converted vast amounts of parking spaces into curb-side management and operations for commuters who choose to pick up orders on their way home from work.

Just-in-Time inventory management and 3D printing capabilities have enabled micro-local production facilities, which results in the transportation of more raw commodities over the road and through ports. This results in a shift within the freight transportation industry to use larger, heavier long-haul trucks to transfer goods from regional DCs to local FCs. Cargo containers have also increased freight movement via maritime and rail modes, allowing heavy trucks to focus on the middle-mile and drayage operations within the supply chain.

Many of these last-mile delivery services rely on Highly Automated Trucks (HATs) which operate nearly non-stop. Tractor-trailer combinations are limited to limited-access facilities, divided highways and connectors leading to DCs and industrial land uses. The frequency of freight deliveries, public acceptance of rideshare platforms, and vehicle platooning technologies has enabled widespread acceptance of truck-only lanes and/or dedicated facilities.

Environmental challenges, diminishing availability of fossil fuels and societal preference has resulted in mass adoption of electric vehicles. Increases in battery performance, including range and recharge times, lower maintenance costs, density of charging stations, and on-demand torque has led the trucking industry to move away from diesel engines. The annual operational cost savings per EV truck over a traditional diesel truck provided a smooth transition from fuel (petroleum) sales tax to the state adoption of an EV recharge sales tax (per kWh). This transition has also significantly reduced community concern about overnight truck idling at truck stops and rest areas. Due to the prevalence of EVs (cars and trucks), nearly every freight facility and truck parking location has installed photovoltaic cells to supply energy for EV charging stations.

New industries have emerged to support these business models. High-tech companies have shifted away from Silicon Valley and global companies operate more on a regional level, allowing for services to be highly adaptable to various societal preferences, trends and demands. Companies that utilize HATs have transportation management and operations centers to monitor their vehicles and remotely operate (via telematics) them under certain conditions. Repair and maintenance technicians require advanced education and training to keep the sensors and computers in good repair. Advanced technology suppliers of all industries, such as sensor manufacturers, require more highly trained staff to keep pace with industry development which also boosts academic institutions. Blockchain, artificial intelligence, and machine learning have become commonplace within freight and logistics operation centers that require computer and data science professionals, which was only being developed in 2020.

By 2045, Florida's High-Tech Corridor has become a global attraction for innovative research and development while south Florida is established as the nucleus for implementing innovative work/life balance. Freight professionals in the public sector that took heed of these potential changes identified in 2020 were able to adapt and not only reduce governmental lag, but help

set the tone, to keep pace with the private sector for how freight moves in, out and through Florida.

Quantified Implications for Transportation System (SIS) Capacity and Safety in 2045

The following capacity, mobility and safety analyses were conducted for the SIS-led project. The SIS analyses for projected capacity and safety implications were for SIS facilities, statewide, and looked as far as the year 2060. In Figures 6, 7, 8, and 9, the Red vertical line highlights the year 2045, for which this scenario planning is focused. These analyses are not specific to freight-only vehicles, but the underlying assumptions account for a shift of heavy vehicle versus passenger vehicle VMT, e-commerce, and other freight factors. These analyses were also the first look into realistic, plausible expectations of CAV-related impacts on capacity and safety for the State of Florida's highest priority system – The SIS.

The capacity analysis indicates that substantial improvements, given the existing SIS network, can be expected as CAVs enter, and saturate, the U.S. vehicle fleet. These improvements may likely be realized first, and most drastically, within Florida on SIS facilities given the geometric, operational, and geographic attributes of these facilities. The mobility analysis provides insight into alternative capacity impacts that further supports previous scenario planning alternatives, but includes quantification of impacts as evidenced by national CAV research, new technological trends, and observed transportation data on SIS facilities. As the following graphs (Figures 6 – 9) indicate, there will likely be a slight degradation of mobility in the 10-15 year planning horizon, but as CAV adoption increases beyond the 50 percent market threshold (between the years of 2035-2045), positive benefits start to accrue that yields additional capacity as a result of the technologies.

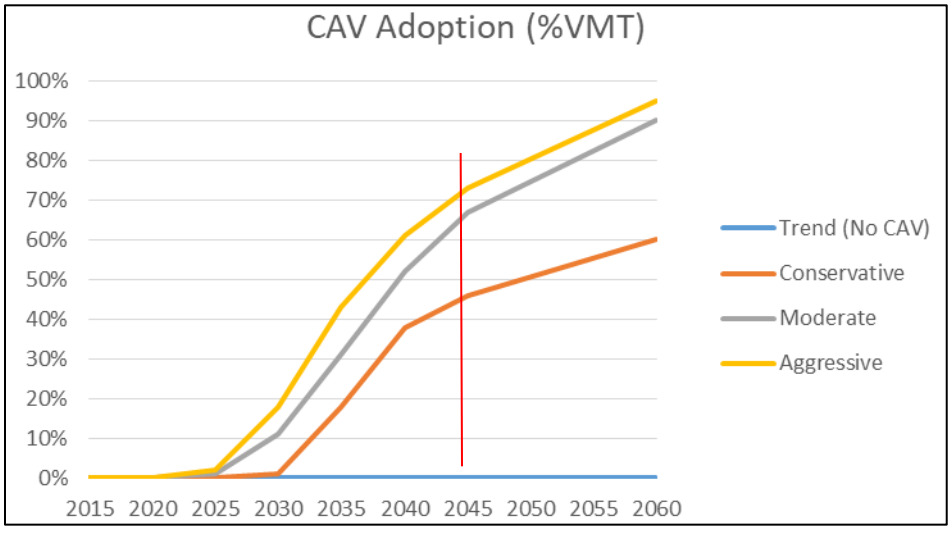

Figure 6 | National CAV Adoption as Percent of Vehicle Miles Traveled (VMT)

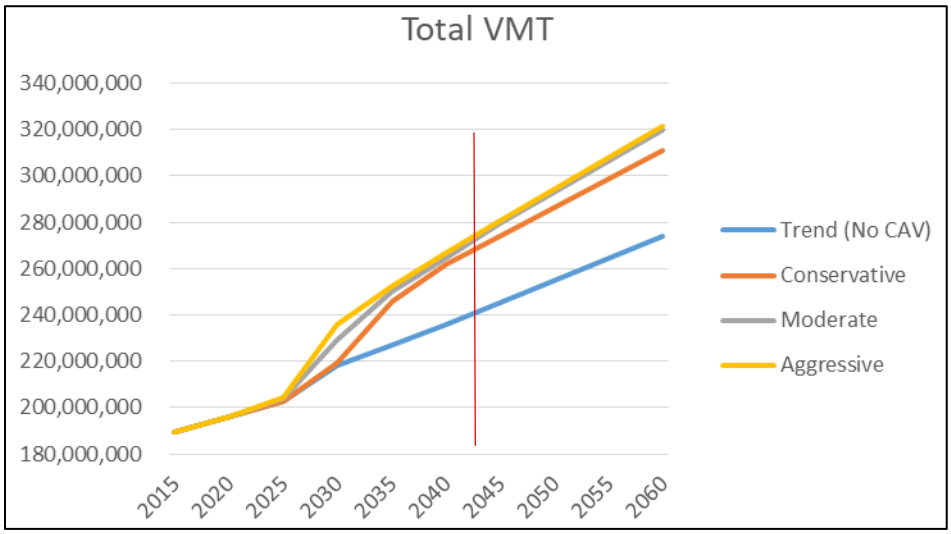

Figure 7 | SIS System-wide Total Vehicle Miles Traveled Projected

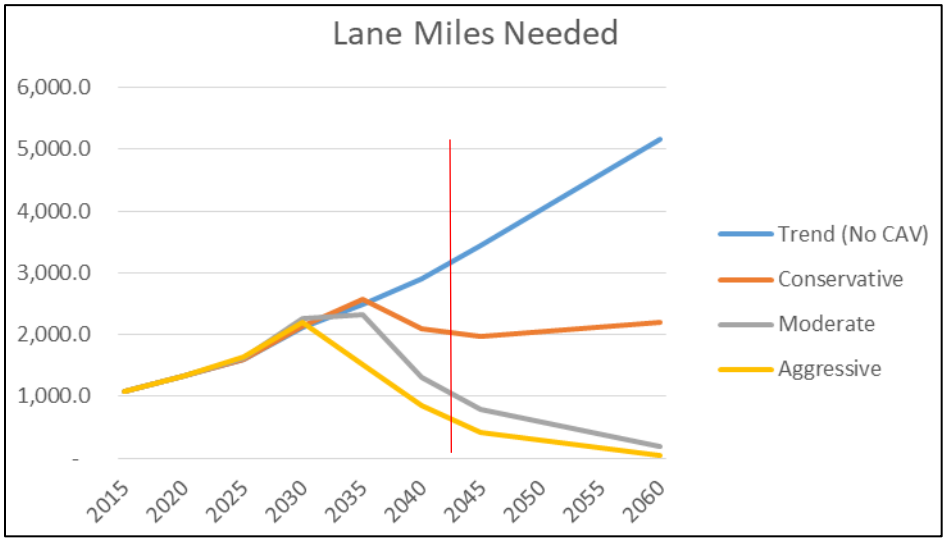

Figure 8 | SIS System-wide Lane Miles Needed

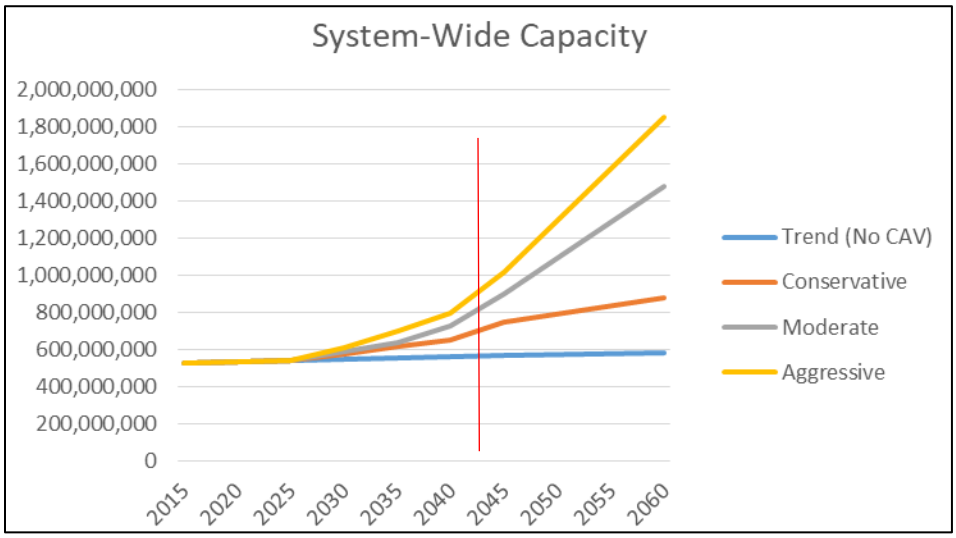

Figure 9 | SIS System-Wide Capacity Projections

If moderate adoption of CAVs is realized, it is expected that system-wide capacity will significantly increase due to improved efficiencies and reduced crashes as a result of advanced vehicle technologies operating on SIS facilities. A significant reduction in crashes will increase traffic throughput since non-recurring congestion associated with crashes will be reduced, effectively increasing capacity. In such a scenario, traditional capacity added to the system by way of additional lane miles may be not necessary and such investments may not be the best use of public resources. Rather, improving roadway characteristics and deploying smart infrastructure will enhance advanced vehicle technology effectiveness, thereby resulting in additional capacity gains.

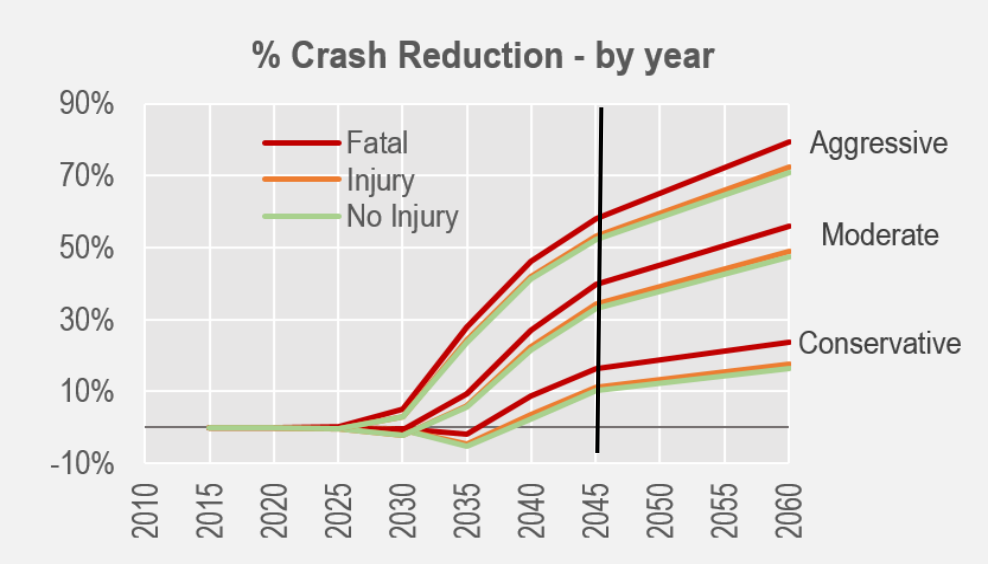

Figure 10 | SIS System-wide Crash Reductions by Year with CAV Factors Incorporated

As depicted in Figure 10, the safety analysis indicates that, with conservative adoption of CAVs, the annual reduction in fatal crashes is approximately 15 percent by 2045. Forty percent of all fatal crashes annually could be prevented by 2045 with a moderate adoption rate of CAVs. Finally, approximately 60 percent of all annual fatal crashes could be prevented by 2045 assuming an aggressive, yet plausible, adoption rate of CAVs. The assumptions and parameters for safety and CAV are defined in Figure 11.

Basic Safety Trend Assumptions (User may modify)

	Conservative	Moderate	Aggressive
Ultimate reduction factor for crash RATE expected with CAVs (vs. FL benchmark) [100% = no change]	50%	35%	20%
How far toward the ultimate rate CAVs will be by 2060 ("nearl y ultimate" rate)	99%	99%	99%
Initial reduction factor (or increase if >100%) in crash rate when CAVs first introduced (vs. benchmark)	120%	100%	80%
Trillions of miles CAVs will need to travel in the US before the "nearly ultimate" crash rate is reached	10.0	10.0	10.0
Likelihood that CAV fleet already deployed in a given future year willbe able to adopt/evolve to that year's model CAVs' ("state of the art") safety characteristics	5%	20%	50%

How much each crash type will increase/ decrease in response to CAVs, compared to the average

K - Fatalities	70%
A - Incapacating Injuries	80%
B - Noncapacating Injuries	90%
C - Possible Injury	100%
O - No Injury	100%

Figure 11 | Basic Safety Trend Assumptions/ Parameters

FDOT identified several transportation impacts and action items to help prepare Florida for a future that resembles this scenario (Table 6).

Table 6 | Technology Scenario Action Items

Transportation Impacts	Potential Action Items/Needs
Dedicated lanes/ facilities for trucks	Signage Striping (for CAVs) Policy
More frequent last-mile delivery vehicles	Enhanced curb-side management strategies
Highly Automated Vehicles create the need for CAV-Ready infrastructure	Pavement markings, signage, traffic signal contrast, etc. for effective machine-vision recognition of roadways in all conditions C-V2X RSUs and adequate signal controllers, and supporting backhaul communications (fiber optic cabling, wireless radios, etc.) to enable the exchange of safety critical Basic Safety Messages (BSMs) for Infrastructure-to-Vehicle (I2V) applications More frequent inventory of roadway characteristics for asset monitoring and maintenance HD mapping to support Highly Automated Vehicles and locational reference markers (to supplement GPS accuracy)
Highly Automated Vehicles wide-spread use results in reduced demand for truck parking locations, as automated trucks do not meet FMCSA HOS requirements	Do not overbuild truck parking spaces. Re-purposing stranded assets in the future should be a consideration in the planning process.
More, smaller production facilities located closer to urbanized areas	Increase in SIS Highway Connectors May need to consider lower functionally classified roadways for SIS eligibility
Urban warehouses to support on-demand delivery services	Curbside management strategies
Drone delivery	Service providers may opt to implement use of drones in lieu of paying roadway user fees

Scenario 3: Export Growth and Productivity-Enhanced Economy

Introduction

This scenario focuses on economic resiliency by enhancing productivity-oriented strategies for the State of Florida. The scenario defines how Florida could position itself to be a major pass-through and value-added logistics hub for the year 2045.

Scenario Defined

This scenario discusses the nature of Florida's economic drivers, and how further diversification of its freight portfolio can enhance economic resiliency over the long term. Florida is primarily a consumer state, given the imbalance of goods entering the state versus the volume leaving. Truck empty back haul is identified as a major issue facing the freight industry within the state. In addition to traditional means of improving productivity and, therefore, growing the economy – the attraction of value-added and mid-level manufacturing facilities could increase exports (and imports) to establish Florida as a pass-through hub across multiple supply chains. Another primary mission of FDOT is to enhance economic prosperity, which can be achieved by reducing bottlenecks and challenges in the freight industry.

Background

To envision the improved alternative scenario, it is instructive to briefly review some of the historical experience and forecasted future baseline trends in Florida's economic indicators. (See Table 7 for summary growth rates.)

Table 7 | Summary Economic Growth Rates (Florida)

	1990-2018 Annual Growth Rate	2019-2045 Annual Growth Rate Forecast
Gross State Product	3%[1]	2.1%[1] to 2.6%[1]
Employment	2.1%[1]	1.1%[1] to 1.5%[1]
Visitors (Tourism)	4.1%[1]	3.4%[1]
Population	1.8%[1]	1%[1]

While the Sunshine State has historically enjoyed relatively strong growth and achieved high levels across different socioeconomic metrics,[40] these key indicators show that in the future, while still projected to grow through 2045, Florida's maturing economy is expected to do so at a decelerated pace. This slower growth, combined with other factors, will have impacts on freight movement in Florida, and presents an opportunity for investments in the state to steer its future onto a desirable prosperity path.

[40] For instance, Florida's GSP is currently fourth largest among the American States, and 17th in the World when compared to national economies, according to the U.S. BEA, and Florida Chamber of Commerce.

Components - Potential Investments for More Robust Economic Growth

Freight movement is correlated with economic growth, which is driven by increased productivity (Rodrigue & Notteboom, 2019). In turn, productivity is determined by the labor force - fundamentally determined by human capital, physical capital, technological progress, and entrepreneurship (Mankiw, Romer, & Weil, 1992; and McConnell, Brue, & Flynn, 2018). Changes in productivity largely dictate what businesses can afford to compensate their workers, which impacts consumer expenditures and influences living standards. Ultimately this will affect freight movement and business revenues and profits (Van Ark & McGuckin, 1999). By influencing the factors behind productivity, and labor force growth will determine future performance of the Florida economy and its related freight needs.

Human Capital/Employed Labor Force

Employed labor force is a function of persons employed, which in turn depends on population size. [41] Florida's future population is expected to grow, but at a slower pace. To keep the state's population growing may entail various strategies, such as providing access to quality healthcare and educational facilities, as well as clean environment, and public safety and security, complemented by varied employment opportunities, and creative out-of-state marketing to potential target audiences. This all translates to a "healthier economy."

Technology

Technological progress is where Florida can shine. This will, however, entail consistent investments in innovation technologies and related Research and Development (R&D). Such R&D could pertain to citrus fruit-related disease eradication, healthcare (particularly related to the elderly, given the aging demographics in the state), higher education, robotics, 3D printing, ACES (Autonomous, Connected, Electric, and Shared) vehicle technologies, supply chain logistics for brick-and-mortar and e-commerce, and tourism. Strong technological progress and education are closely intertwined as highly educated labor force makes development and implementation of innovation into productive uses and growth inducement possible (McConnell, Brue, & Flynn, 2018).

Physical Capital

Increased stock of physical capital[42] will need to be in place to support and accommodate higher economic growth and freight movement. This would include advanced transportation networks/hubs across all the modes, including Space Travel cluster around Cape Canaveral, with well-integrated multimodal/intermodal connections within the state and from/to origins and

[41] Labor force includes persons 16 years of age or older that are employed or are unemployed and seeking work (McConnell, Brue, & Flynn, 2018).

[42] Physical capital refers to machinery, equipment, and other capital means including infrastructure used in producing goods and services (McConnell, Brue, & Flynn, 2018).

destinations out-of-state. Other infrastructure, such as water resources, telecommunications, and energy will also need to be developed and functioning at a higher level of technology and accessibility to business and consumers. Such advanced infrastructure systems will be agile and resilient to a wider spectrum of shocks, making the cost of doing business and living more affordable, increasing attractiveness of Florida for economic activity.

Value Added Manufacturing

By focusing investments in this area – with the target on applying this capacity on goods destined for export - the State has an opportunity to increase overall exports globally and to other states.

Institutional/Entrepreneurial Arrangements

Various growth-supportive institutional arrangements will be in place to bolster entrepreneurial spirits and overall dynamism of the Florida economy. These will include:

1. *Fortified property rights* to build trust and encourage ownership and maintenance of private property and the related returns on investment;
2. Greater *free trade* stimulating efficient specialization and dissemination of new ideas inducing innovation leading to faster growth;
3. *Strengthened patent and copy rights processes* to encourage inventors and entrepreneurs to create and sell their innovative ideas from Florida;
4. *Expanded efficient financial sector* supporting flows of savings into productive investments through various markets including bonds, equities, venture capital, real estate, other innovative capital funding and financing; as well as
5. *Improved business climate i*ncluding streamlined regulations, tax structures, growth-targeted government expenditures within the balanced budget constraint, and various productive public-private partnerships to stimulate investments and incremental growth (Florida Chamber of Commerce, 2017; Florida Chamber Foundation, 2017; McConnell, Brue, & Flynn, 2018).

Recommendations

Based on the conditions outlined in this economic scenario, it is recommended for the state to support investments in:

1. *Human Capital* includes education at all levels from K through graduate school. Retraining the labor force is necessary for the advanced production processes of the 21st century and globalizing the knowledge economy. State agencies could also make concerted efforts to attract the best and the brightest talent from out of state to settle in Florida and productively apply their skillsets to contribute to the state's economic

performance. Such efforts would entail investments and maintenance of the various natural resource/amenities that have made Florida a very attractive place to visit and reside in decades past.

2. *Physical Capital* in the form of expanded and enhanced infrastructure. Firstly, transportation networks and hubs need to be modernized to accommodate the expected future freight (and passenger) movements. This will encompass the different modal facilities serving all kinds of movements from interstate and international cargo movements to the last mile and parking. Incorporating ACES technologies, where Florida is already among the national leaders, should be an important part of this larger investment to modernize freight movements in Florida. Additionally, support for investments in other infrastructure such as advanced telecommunications, water infrastructure, and strong and sustainable energy supplies will be needed.
3. *Innovative technologies* through fostering research and development, particularly as it pertains to the industry clusters of opportunity (Florida Chamber Foundation, 2017), including: Aerospace and Aviation, Life Sciences, and Tourism where Florida has been in the leadership position, and can further boost its advantages to spill into the larger freight and overall future economic activity.
4. *Institutional arrangements* to promote dynamic, competitive forces to elevate economic growth. This should include minimizing red tape while maximizing property rights, as well as copyright and patents protection. Additionally, casting export tentacles wider through increased trading relationships domestically as well as internationally, particularly in Florida's natural sphere of trade in Latin America, and the Caribbean, including eventual liberalization of Cuba, would be beneficial to bolstering freight, innovation, and larger economic activity expansion.
5. *Advanced Manufacturing and Export Development*. By leveraging and capitalizing on Florida's strengths as an advanced manufacturing center and global gateway, the state can not only create jobs that add value to exported goods, but increase Florida's share of U.S. exportation overall.

Support in the form of partnerships and various incentives in all these growth-contributing factors is likely to yield positive return on investment in both the freight sector and overall economy of Florida.

While the focus of this scenario is on the improved economic performance in the long-term, there will inevitably be business cycle-related fluctuations (recessions, slowdowns, and recoveries) and other challenges that residents and commercial entities in Florida will encounter. Also, some of the developments, such as more open trade may prove to be controversial as adjustments and reallocations take place; however, globalization/open trade has been a very

powerful source that has improved economies and people's lives. Further, globalization can lead to larger productivity gains and choice improvements with overall benefits outweighing the costs (Gerber, 2011). Freight and trade are tightly interwoven, and enhanced partnerships with Florida's existing and potential domestic and foreign trade partners will have overall positive spillovers onto freight movement and economic growth. It should also be acknowledged here that while the various Florida agencies and decision makers will have critical roles in shaping the enhanced productivity scenario and its impacts on freight, a number of drivers, such as federal fiscal and monetary policies, as well as various geopolitical events will remain largely outside of Florida's sphere of control.

Nevertheless, the state decision makers can chart an elevated growth trajectory, combined with a well-functioning freight system, for sustainably enhanced prosperity of Floridians for generations to come.

SWOT Analysis

A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was conducted based on the comprehensive reviewed outlined in Technical Memos 2, 3, 4 and 5. This SWOT analysis started with the 2019 objectives outlined in Technical Memo 1 (reiterated in Table 8) and helped determine the FMTP recommendations outlined above.

Table 8 | 2019 FMTP Objectives

Issue	Objectives
Safety and Security	• Leverage multisource data and technology to improve freight system safety and security.
Agile, Resilient, Quality	• Create a more resilient multimodal freight system. • Ensure the Florida freight system is in a State of Good Repair.
Efficient & Reliable Mobility	• Drive innovation to reduce congestion, bottlenecks and improve travel time reliability.
Transportation Choices	• Remove institutional, policy and funding bottlenecks to improve operational efficiencies and reduce costs in supply chains • Improve last mile connectivity for all freight modes.
Economic Competitiveness	• Continue to forge partnerships between the public and private sectors to improve trade and logistics. • Capitalize on emerging freight trends to promote economic development.
Quality Places	• Increase freight-related regional and local transportation planning and land use coordination.
Environment & Conserve Energy	• Promote and support the shift to alternatively fueled freight vehicles.

The team reviewed the systems and assets Florida has to offer and subsequent performance and conditions, respectively outlined in Technical Memos 2 and 3. The team then examined freight transportation industry trends and issues/needs Florida experiences, respectively outlined in Technical Memos 4 and 5.

The team subsequently conducted a comprehensive qualitative analysis of current strengths and weaknesses based on state and federal transportation policy/funding priorities and general goods movement/transportation challenges; e.g., economic development, funding, technology, environment/sustainability, population/quality of life, and the state's current state of transportation infrastructure. The team also considered external opportunities and threats based on current issues throughout the United States and specific to Florida (e.g., sea level rise and truck parking).

A comprehensive list of issues by type (e.g., economic development) was developed and collaboratively vetted, given the foci of comprehensively considering issues including "Resilience" as a strength and "Climate Change" as a threat. The alternative, complimentary issue was to avoid duplicating issues between internal strengths and weaknesses such as "Freight Priority/Funding Focus" and a lack of transportation funding when infrastructure investment is typically considered a critical issue. The result of this analysis and the vetting process is outlined in Table 9.[43]

[43] The 2019 FMTP and resulting SWOT analysis support the FDOT mission to ensure the mobility of people and goods, enhanced economic prosperity, and preserve the quality of environment and communities.

Table 9 | Florida Freight SWOT Analysis

Strengths	Weaknesses
1. Strategic Intermodal System (SIS) 2. Freight leadership and foresight 3. Multimodality and connectivity 4. Resiliency 5. Proximity to Latin America 6. Industry diversity 7. Legacy of Public-Private Partnership 8. Culture of technological innovation 9. Freight Priority/Funding Focus 10. Environmental Stewardship	1. Truck Parking 2. Growing, Aging Population 3. Domestic Freight Imbalance 4. Roadway Congestion
Opportunities	**Threats**
1. Advanced Manufacturing 2. Automated Vehicle (AV) Technology 3. Alternative Fuels 4. Advanced ITS 5. Airport/Seaport Expansion 6. Trade Growth	1. Climate Change 2. Trade Barriers 3. Driver Shortage

Strengths

These ten strengths can support Florida's freight system. They also highlight the state's ability to be a leader in maintaining, modernizing, and expanding Florida's freight system to support industries, economic development, and quality of life needs. See Table 9 below for a description of each strength.

Table 9 | Florida Freight Strengths

Strength	Description
Strategic Intermodal System (SIS)	Florida is the only state to have legislatively designated a "Strategic Intermodal System," supporting critical facilities on the multimodal system. The SIS includes highways, railroads and terminals, airports, seaports, and Florida's spaceport.
State leadership and foresight	The state has a proactive approach on goods movement issues that involve all modes - seaports, highway, freight rail, aviation and spaceports. Efforts include developing funding programs, applying for federal funding to address challenges such as truck parking, and focusing on natural gas to supply energy.

Strength	Description
Multimodality & Connectivity	Florida serves as an air cargo and maritime global gateway to the Americas. The State is a multimodal leader, based on having 15 ports that serve different markets throughout the world and commodity/cargo types. It also has three internal primary north-south highway corridors including I-95, I-75 and the Florida Turnpike that help comprise 122,000 miles of roadway. Further, it has 15 freight rail providers using 3,000 miles of track.
Resiliency	The State has been focused on improving the reliability, recoverability and durability of transportation infrastructure due to its experience with 48 storm events since 1980. Most recently, the development of the 2018 "Transportation Resilience Primer" highlights the state's focus on resiliency.
Geographic proximity to Latin America	The State's location and expansive coastline provide it an inherent strength to leverage seaport market share and expeditiously handle goods entering the Southeast United States. It also offers good highway and freight rail access to the Midwest consistent with current efforts to provide deeper draft access to Miami and JAXPORT.
Industry diversity	The State economy relies on six primary industries to support jobs and goods movement to serve its population growth. These include tourism, agriculture, international trade, aerospace and aviation, life sciences (e.g., pharmaceuticals and R&D), and financial services.
Public-Private Partnerships	Florida has been a national leader in the development of P3 transportation projects. This includes I-4 Ultimate, the PortMiami Tunnel, and multiple projects along or in the I-95 Corridor.
Culture of technological innovation	FDOT has implemented transportation technology to increase capacity, throughput, and safety; e.g., the state's Truck Parking Availability System.
Freight Priority/ Funding Focus	In 2003, the state developed the Strategic Intermodal System, a high priority network of transportation facilities supporting the state economy. The state also funds freight infrastructure development through eight other programs including the Strategic Port Investment Initiative, Intermodal Development Programs, Economic Development Funding, Intermodal Logistics Center Infrastructure Support, Transportation Regional Incentive, P3, State Infrastructure Bank, and Economic Development Transportation Fund Programs.

Strength	Description
Environmental Stewardship	In 2017, Florida Power & Light closed its last coal-fired plant to provide energy to residential, commercial and industrial (transportation-sector) customers. It has subsequently replaced coal with natural gas moved by pipeline. Further, the state has ensured that mangroves and manatees are protected, including in the middle of a large economic generator (Port Everglades). Moreover, FDOT has prioritized the development of express lanes to help reduce congestion and vehicle emissions. Finally, it has worked with Florida Highway Safety and Motor Vehicles (FLHSMV) to issue HOV decals and allow Inherently Low Emission Vehicles (ILEV) and Hybrid vehicles certified by the U.S. Environmental Protection Agency drive in HOV lanes at any time regardless of their occupancy.

Weaknesses

There are four weaknesses affecting Florida's freight system. Table 10 shows the weaknesses and respective descriptions.

Table 10 | Florida Freight Weaknesses

Weakness	Description
Truck parking	While the State has been instituting the real-time Truck Parking Availability System, demand exceeds available parking along I-4 and along I-95.
Shrinking workforce capacity	Florida's median age has steadily increased from 40.7 to 42.9 years old since 2010.[44] This is based on a net in-migration (growing population) of permanent residents to the state as well as a national trend in which older adults are projected to outnumber children (aging population) by 2035.[45] This trend could translate to future workforce availability challenges.
Domestic freight imbalance	Based on the increasing State population, inbound goods movement outweighed outbound goods movement in 2015 by more than 75,000 tons.[46] According to the Weigh-In-Motion (WIM) data, more than half of trucks entering Florida in 2015, 2016, and 2017 were full while only 38 percent leaving the state were fully laden.
Roadway Congestion	Roadway congestion has a significant impact on cargo movement. For example, trucks in Miami experienced 11,000 hours of wasted time in traffic resulting in $593 million in lost productivity and wasted fuel, and 21.9 million gallons of excess fuel due to congestion.

[44] Source: U.S. Census Bureau. Available at https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk#.
[45] Source: "Stats for Stories: National Senior Citizens Day: August 21, 2019." Newsroom, U.S. Census Bureau. Available at https://www.census.gov/newsroom/stories/2019/senior-citizens.html.
[46] Source: "Freight Analysis Framework," Federal Highway Administration, August 13, 2019.

Opportunities

There are five opportunities that Florida can further leverage to foster job growth and support its economy. Table 11 shows the opportunities and respective descriptions with the suggested timing to advance initiatives.

Table 7 | Florida Freight Opportunities

Opportunity	Description
Advanced Manufacturing	Florida's 19,000 manufacturers employ more than 330,000 employees. Almost 70 percent of manufacturing employees hold an Associate's degree or higher.[47]
Develop new sustainable energy sources	The state has actively supported alternatively fueled vehicles – including liquefied natural gas, solar energy and electric vehicles.
AV Technology	Connected and automated vehicles have the potential to reduce crashes, emissions and alleviate the truck driver shortage.
Advanced ITS	ITS solutions have the potential to increase operational capacity and safety of the transportation network.
Airport/Seaport Expansion	Florida's position as a gateway to the Americas can be expanded with further development of seaport and air cargo related airport expansion.

[47] Source: "Manufacturing," Enterprise Florida. Available at https://www.enterpriseflorida.com/wp-content/uploads/brief-manufacturing-florida.pdf.

Threats

There are three threats facing Florida that it should address. Table 12 shows the threats and respective descriptions with strategies for consideration to minimize impacts.

Table 82 | Florida Freight Threats

Threat	Description
Climate Change	Florida has experienced severe weather events at a more frequent rate. Furthermore, these storm events have been consistently more severe than in the past. This has required periodic delays to goods movement based on the occurrence of natural hazard events with greater effects in Florida. Rising sea levels threaten seaports and other infrastructure including rail lines and roadway networks.
Trade Barriers	Trade barriers are a significant threat to Florida economy. Florida is the 17th largest economy in the world,[48] and 232,300 Floridian jobs relied on exports in 2016.[49] No matter the current status of trade agreements, Florida can mitigate this long-term threat by diversifying their trading partners.
Workforce shortage	Florida's logistics industry is facing a workforce shortfall. Most visibly, the trucking industry is experiencing a shortfall of available, qualified drivers and mechanics. Florida is reliant on the trucking industry for many critical goods (e.g., fuel, food, etc.), so a driver and mechanic shortage can impact the availability and cost of many inputs and finished goods.

[48] Florida Chamber of Commerce, 2017.

[49] Source: "Jobs Supported by State Exports, 2016," International Trade Administration, Office of Trade and Economic Analysis - Industry and Analysis, December 2017. Available at https://www.trade.gov/mas/ian/build/groups/public/@tg_ian/documents/webcontent/tg_ian_005558.pdf.

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