Managed Lanes
GUIDEBOOK

2023

FLORIDA DEPARTMENT OF TRANSPORTATION
SYSTEMS IMPLEMENTATION OFFICE

Table of Contents

Figures

Tables

1 INTRODUCTION

1.1 Preface

In support of the Florida Department of Transportation's (FDOT's or Department's) mission of providing a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities, it is the policy of the Department to employ managed lanes.

The Department will strategically implement and operate managed lanes that are designed to maximize the movement of people and goods by utilizing any combination of vehicle eligibility, transit, access control, tolling, and other applicable techniques. Managed lanes will be considered as an alternative to increase capacity on corridors to address existing and future congestion, but shall not be implemented on existing general use lanes (GUL) for limited access facilities.

The Department will prioritize this approach to deploy a safe, community centric, resilient, equitable, and accessible transportation system.

1.2 Purpose

The purpose of the ***FDOT Managed Lanes Guidebook*** (Guidebook) is to provide guidance for implementation of the Department's *Managed Lanes Policy, Topic No. 000-525-045*. This Guidebook is intended to be used during the development, implementation, and operations of managed lanes on the following facilities:

- Interstate System,
- Florida's Turnpike Enterprise (FTE) System,
- Non-interstate limited access facilities, and
- The State Highway System (SHS)

This Guidebook is designed to work in conjunction with other FDOT manuals, procedures, handbooks, guidebooks, and design criteria used in the development, implementation, and operation of FDOT projects.

1.3 Scope

This Guidebook is intended for use by Department staff and practitioners who conduct work on behalf of the Department. It includes information and guidance on project identification and development, operational strategies, facility types, screening of managed lanes, tolling, express lanes software, design considerations, operations and maintenance (O&M), mobility performance reporting, and funding and financing.

Managed lanes are an innovative solution to congestion management. They are usually newly constructed travel lanes with access limited to specific vehicle classes by a toll or vehicle volume. Managed lanes are highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing traffic conditions. The following types of managed lanes facility types are discussed in this Guidebook:

- **Express Lanes** – Express lanes are optional travel lanes, located on an interstate, that customers can choose to use when they want a more predictable travel time. Customers in the express lanes pay a dynamically priced toll that increases as traffic begins to build in the express lanes and decreases as traffic reduces. Express lanes are designed with a limited number of entrance and exit points to serve longer, more regional trips.

- **Long-Distance Trip Lanes (Thru Lanes)** – Thru lanes are additional travel lanes that help provide congestion relief in high traffic areas. These lanes offer customers making longer, more regional trips, the ability to bypass the local traffic entering and exiting the road. The Department currently implements thru lanes on key locations on the Turnpike System. Customers traveling in the Turnpike's thru lanes pay the same toll as customers traveling in the general lanes.
- **Truck-Only Lanes** – Truck-only lanes are a managed lanes facility type that separates heavy vehicles from mixed-flow traffic along a highway mainline and allows for the exclusive use of trucks.
- **Managed Transit Lanes** – According to **National Cooperative Highway Research Program (NCHRP) Research Report 835**, bus-only lanes, transitways, and busways are managed lanes dedicated primarily for buses. The goal of bus-only lanes is to make public transportation a more desirable option by reducing trip times and improving travel time reliability.
- **Part-Time Shoulder Use (PTSU)** – PTSU is the temporary use of the left or right shoulders of an existing roadway for travel, typically during the peak periods when capacity is needed most. **All requests to implement PTSU are determined on a case-by-case basis and must be approved by the Chief Engineer**.
- **Connected and Automated Vehicle (CAV)-Only Lanes** – CAV-only lanes use a vehicle eligibility strategy by providing one or more separate lanes exclusively for CAVs.
- **Reversible Lanes** – Dedicated freeway lanes that serve directional peak period demands.
- **Carpool 3+ Lanes** – Lanes reserved or dedicated for passenger vehicles carrying a minimum of three people in the vehicle.

2 PROJECT IDENTIFICATION AND DEVELOPMENT

2.1 Project Identification

Project identification for managed lanes, as part of new capacity on the SHS, initially includes a high-level consideration of various planning, traffic operations, geometric, and other factors that are specific to each corridor. The screening of managed lanes strategies starts in the planning phase of the project development process and is primarily based on the future anticipated traffic demand, both cars and heavy vehicles, along the corridor. Traffic, along with the other considerations, helps identify whether a particular managed lanes strategy should be further evaluated during the Project Development and Environment (PD&E) phase of the process. The initial planning and programming of improvement projects is performed by the Districts and should be in coordination with local and regional planning documents. Some of the basic considerations for managed lanes project identification are summarized in ***Figure 2-1*** below.

Managed Lanes Guidebook

CONSIDERATIONS

Key Considerations

The more considerations that can be answered "Yes", the more favorable the project is to managed lanes.

If these considerations cannot be met, some mitigation may be implemented before developing the project as managed lanes. Any particular "No" answer does not mean a managed lanes project is not warranted.

Planning

- YES / NO — Do managed lanes alternatives meet the purpose and need for the project?
- YES / NO — Do the managed lane alternatives ensure the corridor meets the Design Year level of service (LOS) target?
- YES / NO — Is this the final widening?
- YES / NO — Is there potential to connect the project to the existing managed lanes system?
- YES / NO — Does the project have logical termini that support major origin-destination movements?
- YES / NO — Does the project serve areas with high Values of Time? (ie. above the regional average, such as airports)

Operations/ Geometric

Can the ingress/ egress locations geometrically fit and operate?

- NO → *Potential Mitigation Efforts*
  - Revise ingress/ egress locations
  - Consider design exception
- YES ↓

- YES / NO — Do the managed lanes alternatives have the ability to bypass congested segments?
- YES / NO — Do the managed lanes alternatives have the ability to provide operations that satisfy the purpose and need of the project?
- YES / NO — Do the managed lanes alternatives termini maintain operations in the general use lanes?
- YES / NO — Can the ingress/egress points be located so as to limit creating merging/diverging conflicts with the general uselanes traffic?
- YES / NO — Is there potential to provide direct access ramps to/from major connecting corridors?
- YES / NO — Can the project be designed to provide easy access/egress for emergency vehicles?
- YES / NO — Is there adequate right of way available to accommodate the number of managed lanes needed?

Multimodal Components

Are there existing Express Bus services within the corridor?

- YES → Can the managed lanes project provide travel time savings to Express Bus services? YES / NO
- NO → Would the managed lanes project support the establishment of Express Bus service? YES (→ Can the managed lanes project provide travel time savings to Express Bus services?) / NO

Are there existing intermodal passenger hubs or multimodal facilites (i.e. trails, streetcars, commuter rail, etc.) within the Corridor?

- YES → Can the project connect directly to intermodal passenger hubs and multimodal facilities Facilities? YES / NO
- NO → Would the project support the establishment of intermodal passenger hubs and multimodal facilities? YES (→ Can the project connect directly to intermodal passenger hubs and multimodal facilities Facilities?) / NO

Other

- YES / NO — Are there other considerations that would make managed lanes more or less favorable? Keep additional information in the project file to be provided as needed.
- YES / NO — Do the managed lanes alternatives connections support the FDOT Florida Transportation Plan goal of transportation choices that improve equity and accessibility?
- YES / NO — Are express lanes being considered? (If yes, the managed lane cannot be operated as a non-tolled lane per Section 338.151, F.S.)
- YES / NO — Can the project help to advance the region's transportation goals?
- YES / NO — Are managed lanes included in local and regional planning documents?

Figure 2-1 Project Identification Considerations

The project identification process is closely coordinated with the ***Strategic Intermodal System* (*SIS) Plan***. The ***SIS Plan*** includes a funded, cost-feasible component, known as the SIS Funding Strategy, as well as an unfunded, long-term needs component. Coordination with the SIS planning process ensures statewide consistency and facilitates prioritization of project funding needs.

If managed lanes are identified, it is important to coordinate during the Planning and PD&E phases, or as early as practical, regarding the managed lanes strategy proposed for the corridor. The preferred approach for most strategies is to provide a minimum of two managed lanes in each direction. This allows the recommended managed lanes strategy to operate safely while achieving the desired mobility goals. Evaluation of tolling is recommended if no additional capacity projects are anticipated for the corridor after the current project but may also be considered for any managed lanes project. The number of GUL shall remain the same as under the No-Build scenario if express lanes tolling is the recommended strategy.

2.2 Project Coordination

2.2.1 Managed Lanes Planning Team

The Managed Lanes Planning Team coordinates agencywide to facilitate statewide consistency for managed lanes project development. This team consists of representatives from Central Office Planning Team's Systems Implementation Office (SIO), the Traffic Engineering and Operations Office (TEO), and FTE.

2.2.2 Central Office

Managed lanes projects are also coordinated with other subject matter experts (SMEs) from Central Office including Project Finance (PF) within the Financial Management Office, TEO, Maintenance, Design, Modal Development, and Planning. The Managed Lanes Planning Team will coordinate with these offices and SMEs, as well as with the General Counsel's Office as needed. Communication with the Chief Engineer will also be coordinated through the Managed Lanes Planning Team.

2.2.3 District

The District is responsible for identifying a multidisciplinary core team that will be involved throughout project development, including representatives from Planning, PD&E, Design, Construction, Operations, Maintenance, and Public Involvement.

The District is responsible for leading all feasibility assessments for a proposed project. Refer to **Chapter 3** for other considerations. Design elements that must be considered during the Planning phase include:

Network Connections – Network connections provided by direct access to other facilities of regional significance expand the potential number of facility users by providing continuous trips to major roadways and facilities like park-and-ride lots and transit facilities.

Separation Type – The separation type influences the operation and constructability of a managed lanes project. The appropriate separation type must consider access type, construction cost, right of way (ROW) needs, O&M costs, safety and operational characteristics, enforcement needs, and Traffic Incident Management (TIM). **(See Section 3.2.1)**

Access Points – Determine the appropriate amount, distance between, and location of access points to the managed lanes. The District responsibilities include considering the end users when defining segments of the managed lanes and understanding the market share that will be captured based on the access provided. **(See Section 3.2.2)**

Tolling Locations (if applicable) – Managed lanes access points are the preferred location of tolling and data gantries. The location and length of individual segments of the managed lanes will also be considered when determining additional tolling locations. The District responsibilities include considering the trips that are being provided based on segmentation and how the tolling configuration layout must be provided to capture all trips and major network connections. **(See Section 6.3)**

The District Transportation Systems Management and Operations (TSM&O) Office will provide support during the Design phase with direct input on design features including, but not limited to, intelligent transportation systems (ITS), signage, ingress and egress, incident management staging, and other operational features specific to the project. Additionally, the District TSM&O Office will support the updates and development of Systems Engineering documentation. **(See Chapter 8)**

During the Construction phase of a managed lanes project, the District TSM&O Office will utilize their resources as needed to serve as a liaison between the contractor responsible for system implementation and the design team. The District TSM&O Office will work with the construction engineering inspection (CEI) team to support construction by reviewing shop drawing submittals and responding to comments.

The District TSM&O Office is responsible for integrating all new ITS field devices into SunGuide®, as well as configuring the express lanes facility in the Statewide Express Lanes Software (SELS).

The District will coordinate, as required, with FTE as it relates to the construction, testing, and acceptance of the tolling devices, toll building, and toll gantry. The District will coordinate with FTE on the preferred location of tolling and data gantries (access points are a factor that determine where gantries are placed). The District will also coordinate with FTE to facilitate end-to-end testing for each tolling corridor.

Operational strategies that impact the managed lanes will also be the responsibility of the District TSM&O Office to plan and manage. These include TIM services, management, and coordination of Road Rangers, and facilitating Florida Highway Patrol (FHP) hire back contracts (if warranted). Other operational strategies include management of ramp metering and arterial operations when applicable.

2.2.4 Florida's Turnpike Enterprise

If the proposed managed lanes include tolling, coordination with FTE is required. Coordination should be initiated during Planning, PD&E, or as early as practical during project development, but no later than the start of toll plan development. For more information on coordination with FTE for tolling projects**. (See Chapter 6)**

2.3 Project Planning

The project planning process for managed lanes includes preparation of a corridor phasing plan, a detailed access plan, and traffic forecasting and analysis.

2.3.1 Corridor Phasing Plan

A corridor phasing plan identifies the ultimate corridor configuration as well as the individual projects that can be constructed and operated on an interim basis until the ultimate corridor is fully operational. Corridor phasing plans identify the project sections, the order in which these will open to traffic, and the phasing of the managed lanes components within each section. The traffic analysis and the access plan, as well as other factors, help facilitate development of the corridor phasing plan. Phasing of the project may result in refinements to the project limits originally identified in the Work Program or early planning efforts, such as a Master Plan.

Each phase of the project should be designed in consideration of the ultimate corridor configuration in order to minimize rework and utilize as much of the interim infrastructure as possible. Access points, sign structures, and toll/data gantries (if applicable) are placed in their ultimate locations, when feasible. Each phase of the corridor phasing plan is documented in a managed lanes diagram, as detailed in Section 2.3.2.1.

2.3.2 Access Plan

An access plan is a key input to traffic analysis as it helps to identify eligible trips. Development of an access plan begins during Planning and PD&E and is finalized when the project moves forward in Design.

Locating access points should be based off an origin-destination (O-D) study and include input from various technical disciplines, including Planning, PD&E, Design, and Operations. It is also important to communicate potential access point locations with the public during a project's public involvement and outreach efforts. The access plan development is coordinated with the Managed Lanes Planning Team.

A key objective of an access plan is to minimize weaving and provide a safe condition for users entering and exiting the system. The access plan should also reflect the unique operating characteristics of the corridor and be used to achieve project-specific goals, such as facilitating longer-distance trips or promoting carpooling and transit usage. The access plan includes the number of managed lanes, location of access points, access types, and separation type. The final access plan should be consistent with the final traffic analysis and reflect the final corridor phasing plan.

When developing an access plan for managed lanes, it is important to consider the number of interchanges along the managed lanes corridor, as well as the length of the corridor segments and the percentage of trips estimated to be eligible to use the managed lanes. Eligible trips are defined as trips that have the ability to enter and exit the managed lanes based on their O-D.

2.3.2.1 Managed Lanes Diagram

A managed lanes diagram shows the number of lanes, access points, destination signs, first available interchange exit and entrance, separation type, and Work Program financial project identification (FPID) project limits. Each interim phase should be independent and fully operational after construction is complete. Testing of each toll segment (if applicable) should occur within the associated FPID limits. An example of a managed lanes diagram is shown in ***Figure***

2-2. (Please note that the example shown in the figure has more elements listed in the legend than may be used.) The managed lanes diagram is a tool used to capture the overall concept in a stick-figure format. For illustrative purposes, the diagram shown includes an example of an express lanes facility. Development of a managed lanes diagram should begin in the Planning and PD&E phases of the project and in coordination with the respective District TSM&O office and FTE. The diagram should be updated throughout project development to reflect the latest configuration.

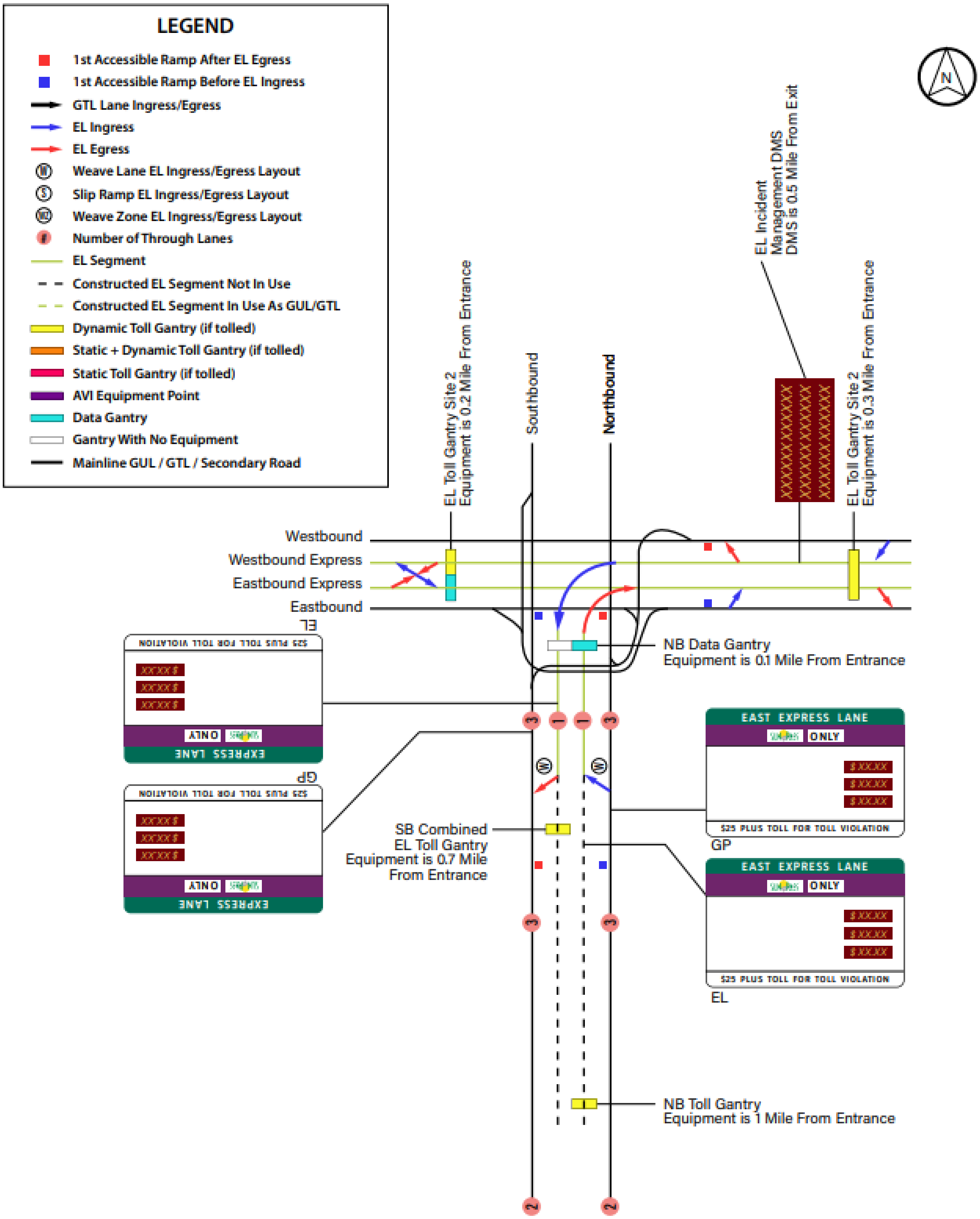


Figure 2-2 Managed Lanes Diagram Example

2.3.3 Traffic Forecasting and Analysis for Managed Lanes

A project traffic forecast and analysis is used in the development of managed lanes projects to ensure that the project will operate acceptably without adverse impacts to the adjacent GUL or existing interchanges. The demand to use managed lanes is affected by many factors, including roadway network and traveler characteristics. Traffic analysis includes collection of O-D data and a traffic safety and operational analysis.

The traffic analysis can be documented in a Master Plan Planning Study, a Project Traffic Analysis Report (PTAR), and/or an Interchange Access Request (IAR) during the Planning or PD&E phase. Refer to the FDOT Project Traffic Forecasting Handbook, FDOT Traffic Analysis Handbook, FDOT Interchange Access Request User's Guide, FDOT PD&E Manual Part 2 Chapter 2, Highway Capacity Manual (HCM), and Highway Safety Manual (HSM) for additional requirements.

2.3.4 Interchange Access Request

The implementation of managed lanes projects may result in changes or modifications to existing interchanges. Some examples include direct connections with adjacent facilities and the addition of complex weaves zones. Refer to the FDOT Interchange Access Request User's Guide for more information on the requirements, including the coordination activities with the District Interchange Review Coordinator (DIRC).

2.4 Project Development and Environment

The managed lanes alternative(s) developed and evaluated as part of the PD&E phase should utilize the latest version of *FDOT's PD&E Manual, Topic 650-000-001* for guidance related to preliminary engineering, alternatives analysis, engineering considerations, and other PD&E requirements. Any project that includes managed lanes will require coordination with the District TSM&O Office during the PD&E phase. This includes the development of a Concept of Operations (ConOps) and system requirements as described in *Florida's Statewide Systems Engineering Management Plan (SEMP)*. This may also include coordination with adjacent Districts for multi-jurisdictional projects.

2.4.1 Concept of Operations

In accordance with FDOT Systems Engineering and Intelligent Transportations Systems Architecture, Procedure 750-040-003c, ITS projects are required to conform to the applicable Regional Intelligent Transportation System Architecture (RITSA) and to develop a ConOps. The ConOps is the document in which the project stakeholders detail their shared understanding of the whole system to be developed and how it will be operated and maintained. It is a user-oriented document that describes a system's operational characteristics from the end user's viewpoint and is needed for all managed lanes facility types. A ConOps document is a system-level detail of the portion of the Operational Concept (OpsCon) in the RITSA.

A ConOps is developed as part of the larger system engineering process that describes the managed lanes system, including operational scenarios, incident management, and maintenance. This planning-level document is based on the *SEMP*. The ConOps defines system elements and capabilities, user needs, geographical and physical extent, and stakeholder roles and responsibilities. Stakeholders can include operators, emergency responders, law enforcement, maintenance providers, local governments, transit agencies, customers, and others.

The managed lanes system is defined by two levels of ConOps: regional and project specific. A regional concept of transportation operations (RCTO) may be developed to establish a high-level managed lanes network and identify stakeholders' roles and responsibilities. As specific projects within a corridor are identified, project ConOps are developed during the PD&E phase. The District develops the ConOps in coordination with the District and Central Office Traffic Operations. When a project is implemented in phases, or a series of closely related projects are in development along a corridor, the project ConOps is developed to address the project being implemented and the implementation of the larger system of projects. Major elements for each level of ConOps are summarized in ***Figure 2-3***.

REGIONAL CONOPS (RCTO)

- High-Level Network Map
- Stakeholder Roles and Responsibilities
- Coordination
- Planning and Policy Framework
- Operations Objectives and Strategies
- Project Delivery Approach
- Relationships and Procedures
- Design of Physical Improvements
- Resource Needs
- Project Phasing
- Risk Analysis

PROJECT CONOPS

- Project Goals and Objectives
- Refinement of Elements in Regional ConOps
- Managed Lanes Implementation Plan and Project Phasing
- Operational Scenarios
- Toll Project Responsibility Matrix (if applicable)
- Stakeholder Needs
- Roles and Responsibilities
- System Concept
- User Requirements
- Managed Lanes Diagram
- Telecommunications Concept
- ITS Concept
- Risk Analysis

Figure 2-3 Major Elements of a ConOps

The regional and project operations influence many aspects of managed lanes design. Any change to the managed lanes or GUL, including access, toll gantry locations, or signing, can impact the operations of the project and those of an adjacent project or the overall corridor. Therefore, all changes to these elements are reviewed against ConOps documents as necessary. Changes identified early in the project development process have fewer cost, scope, and schedule impacts than changes made later in the process.

2.4.2 Project Concept of Operations

The project ConOps is typically developed during the PD&E phase and considers the concept of operations for the PD&E project limits in the context of the larger network. The purpose of a project ConOps is to document user needs and operational scenarios which can be used to ensure that operational needs are considered in the design and phasing of a project. For example, some corridors will open to traffic under interim conditions until all projects along the entire length of the corridor are completed. In other cases, a corridor will not open until all managed lanes projects within that corridor are ready to be open to traffic. Therefore, it is important that the managed lanes diagram for the corridor ConOps is developed for interim and ultimate configurations and aligns with the corridor phasing plan. The project ConOps is updated throughout the project lifecycle as the system and operational roles and procedures are refined.

3 MANAGED LANES OPERATIONAL STRATEGIES

Managed lanes are implemented to provide congestion relief. Because every corridor or system is different with its own unique operating characteristics, managed lanes should be operated in a manner individually designed to maximize throughput on the specific system.

The three primary operational components used for developing managed lanes are vehicle eligibility, separation and access control, and tolling. Managed lanes facility types are determined on a project-by-project basis and can be implemented using any combination of these operational strategies to best meet the needs of a system.

3.1 Vehicle Eligibility

Vehicle eligibility refers to management based on the user group or vehicle type permitted in managed lanes. Vehicle eligibility controls what types of user groups or vehicles may be either allowed or restricted to increase overall throughput and achieve other transportation management goals established for the corridor.

An example of a user group eligibility restriction on managed lanes is vehicle occupancy. Minimum occupancy rates per vehicle can be required for use of the lanes. Managed lanes can also improve operations by separating vehicle types; vehicles may be allowed or not allowed to use the lanes based on vehicle classification—such as trucks, public transit vehicles, emergency response vehicles, motorcycles, and CAVs. Examples from existing facilities in operation that separate vehicle types include requiring vehicles to have transponders, allowing public transit vehicles, and restricting multi-axle vehicles.

In addition to continuous application, vehicle eligibility may also be applied seasonally or during specified times of day.

3.2 Managed Lanes Separation and Access Control

Separation and access control work together to create separate lanes on a corridor that serve more regional, long-distance trips. This is achieved through the type of separation, as well as the number and spacing of ingress and egress points along a corridor.

3.2.1 Managed Lanes Separation

Managed lanes are separated from the GUL. Determination of the appropriate separation type is typically made during the PD&E phase by the District and coordinated with the Managed Lanes Planning Team.

3.2.1.1 Separation Types

The following types of separation may be used on the Department's managed lanes projects:

A. Grade Separation
   An elevated or depressed section of roadway, completely distinct from the adjacent corridor.
B. Barrier Separation
   Continuous concrete walls with access gates provided periodically for emergency management.
C. Wide Buffer Separation
   An area of grass or pavement between the managed lanes and the GUL. Wide buffers may include roadside safety elements such as guardrails, cables, and/or tubular markers.
D. Buffer Separation with Tubular Markers

Pavement markings used in combination with a series of high-performance tubular pylons called tubular markers.

E. **Buffer Separation with Pavement Marking**
Use of double skip or solid striping. See Continuous Access in **Section 3.2.2.1**. **The use of pavement markings with no tubular markers to separate managed lanes may be considered but requires additional coordination and approval by the State Traffic Operations Engineer. This type of separation is not compatible with managed lanes with a tolling component.**

3.2.1.2 Factors for Determining Separation Type

Design of separation types is included in FDM 211. The use of tubular markers must conform to the guidelines published in *FDOT Standard Specification 704*.

The separation type is a critical design decision that influences the operation and constructability of a managed lanes project. Access type, construction cost, ROW needs, O&M costs, safety and operational characteristics, enforcement needs, and TIM must be considered in determining the appropriate separation type.

Additional considerations should include maintaining corridor consistency and flexibility to accommodate future corridor growth and multimodal envelopes. Considerations of the different separation types are provided in ***Table 3-1***, below.

Table 3-1 Considerations of Separation Types

TYPE OF SEPARATION	CONSIDERATIONS
GRADE SEPARATION	– Additional ROW requirements – Increased response time due to limited access – Limited area for staging during recovery operations – Improved safety and operations by eliminating weaving conflicts – Eliminates access violations
BARRIER SEPARATION	– Additional ROW requirements – Increased response time due to limited access – Limited area for staging during recovery operations – Improved safety and operations by eliminating weaving conflicts – Eliminates access violations
WIDE BUFFER SEPARATION	– Possible access violations and wrong-way driving maneuvers – Additional ROW requirements – Improved access – Additional staging area for emergency responders – Improved safety and operations by reducing weaving conflicts
BUFFER SEPARATION WITH TUBULAR MARKERS	– Possible access violations – Reduced construction costs and ROW needs – Potential for additional costs for maintenance and enforcement – Limited area for staging during recovery operations – Potential friction between high-speed managed lanes and low-speed GUL – Improved access

TYPE OF SEPARATION	CONSIDERATIONS
BUFFER SEPARATION WITH PAVEMENT MARKING	– Possible access violations – Potential friction between high-speed managed lanes and low-speed GUL – Potential for additional enforcement costs – Reduced construction costs and ROW needs

3.2.2 Managed Lanes Access Control

Access control improves safety and manages congestion by providing ingress to or egress from the managed lanes at designated access points along the corridor. Access points are located at the start, end, and intermediate points along the managed lanes corridor. Access point locations are determined based on the purpose of the project, O-D patterns, Park & Ride lots, and existing interchanges and roadway infrastructure. Access points are initially determined during the Planning and PD&E phases and optimized during the Design phase.

3.2.2.1 Access Types

The types of access on managed lanes projects include the following:

A. **Slip Ramps**
   A dedicated lane that accommodates movement either into or out of the managed lanes.
B. **Direct Connect Ramps**
   A dedicated ramp used for high volume system-to-system connections, park-and-ride lots, and other major roadways.
C. **Weave Lanes**
   A dedicated lane that allows movements both into and out of the managed lanes.
D. **Weave Zones**
   A break in the managed lanes separation that allows for movements both into and out of the managed lanes. No additional pavement is provided.
E. **Continuous Access**
   Designed and operated much like GUL. Vehicles can enter and exit at any point. The use of continuous access may be considered but must be coordinated with the Managed Lanes Planning Team and approved by the State Traffic Operations Engineer. This type of access is not compatible with managed lanes with a tolling component.

3.2.2.2 Factors for Determining Access Types

The advantages and disadvantages of each access type must be evaluated on a project-by-project basis and may also be evaluated for consistency among projects within a corridor. Selection of access types should be done in conjunction with the determination of separation type, as detailed in **Section 3.2.1**. Access points are designed in accordance with the criteria established in the FDM 211 and considerations in the FDOT Traffic Analysis Handbook.

Construction cost, ROW needs, separation type, O&M costs, safety and operational characteristics, enforcement needs, and TIM must be considered in determining the appropriate access type.

Considerations for determining the access type are provided in ***Table 3-2***, below.

Table 3-2 Considerations for Determining Access Types

TYPE OF ACCESS	CONSIDERATIONS
SLIP RAMPS	– Additional pavement width required – Commonly used with barrier separation but can also be used with other separation types – Reduces the potential for unstable flow created by the speed differential between the managed lanes and the GUL. In some cases, a slip egress may lead to failure within the managed lanes if the GUL system fails at the egress point. – Requires the longest distance for both ingress and egress to be achieved since the slip ramps need to be spaced out
WEAVE LANES	– Allows the weaving and speed changes required for merging between the GUL and the managed lanes to occur in a separate lane – Consideration for transit operations when designing the required weave
WEAVE ZONES	– Does not require extra roadway width – Consideration for transit operations when designing the required length of weave – Not recommended for barrier-separated facilities due to safety and operational issues
DIRECT CONNECT RAMPS	– Eliminates weaving to and from GUL and ramps – Requires sufficient demand for the ramp – High construction costs
CONTINUOUS ACCESS	– Low construction costs – May require increased enforcement – Prohibited for express lanes – Increased eligibility and more spread-out weaving movements

3.2.2.3 Factors for Determining Access Locations

Factors that should be considered when choosing the most appropriate access locations and access types include, but are not limited to, the following:

A. **Project Traffic Demand**
Project traffic is used to determine how many lanes are needed in each direction. Project traffic forecasting methods are detailed in the FDOT Project Traffic Forecasting Handbook.

B. **O-D Patterns**
O-D data analysis defines study area travel patterns for existing and design horizon years. O-D data can be collected and analyzed at the Planning or PD&E phase of a managed lanes project. Preliminary access points are proposed after O-D data analysis at locations with high-frequency O-D pairs.

C. **Geometric Characteristics of the Corridor**
For managed lanes, important geometric characteristics for locating access points are corridor length and spacing of interchanges. Access points should encourage long-distance trips, bypassing two or more interchanges within each segment.

D. **Operational Characteristics of the Corridor**
Traffic analysis identifies any potential operational or safety issues related to access locations. A tiered traffic analysis for access locations is recommended with preliminary analysis during Planning and PD&E phases and a detailed analysis during the Design phase. Consider interim and ultimate configurations during operational

traffic analysis. Refer to the FDOT Traffic Analysis Handbook and FDOT Interchange Access Request User's Guide for guidance on operational analysis of access locations and weave segments.

E. Early Design Considerations
Locating access points requires an early review of possible design and ROW constraints. Maintain a minimum weave length of at least 1,000 feet per lane change for vehicles entering or exiting the corridor to or from the managed lanes, as specified in the FDM 211. Access points are located to avoid congestion points and high-incident locations and minimize queues at managed lanes termination points and ingress and egress points. Proposed access locations are evaluated using established design criteria as detailed in the FDM 211.

F. ITS Signing
The signing sequence for managed lanes may extend several miles in advance of access points. Access points are located with adequate space for interim and ultimate signing requirements. For information regarding express lanes sign types and access signing sequences, refer to **Section 8.2** and Chapter 2, Signs, Section 2.42 Guidelines for Express Lanes Signing, Traffic Engineering Manual.

G. Transit Service and Park-and-Ride Lot Locations
Transit services in managed lanes increase capacity and person throughput and help reduce overall corridor congestion. Consider locating park-and-ride lots in alignment with the corridor's major origins and destinations to encourage use of transit services. Direct connects should also be considered to park-and-ride lots, particularly if the arterial corridor is congested. A transit ridership forecast helps ensure adequate demand for transit services. For express bus service planning guidelines, see the FDOT Express Bus / Express Lanes Systems Planning Guidelines.

H. Impacts to the Environment
The potential environmental impacts of managed lanes projects, including the location of access points, are evaluated through the PD&E process. For more information, refer to the PD&E Manual, Topic No. 650-000-001.

I. Construction Cost
Construction cost varies depending on the type of access and lane separation technique provided. While cost is a consideration in the process of locating ingress and egress points, traffic volume and safety should be considered before cost when selecting the appropriate access type.

J. Tolling Infrastructure (If Applicable)
For express lanes, toll gantries are located within one mile of the ingress point to minimize travel time from the Toll Amount Sign (TAS) to the toll gantry. Identifying tolling infrastructure, including locations, is coordinated with FTE through development of a Toll Siting Technical Memorandum (TSTM). Additional information on tolling for express lanes is included in **Chapter 6**.

It is important to communicate potential access point locations to the public during a project's public involvement and outreach efforts. During the Planning phase, managed lanes strategies are identified based primarily on the future traffic demand along the corridor. Data such as speed, volume, and O-D are collected. An initial managed lanes diagram including initial location of access points, number of managed lanes, and type of separation is prepared. A high-level screening of the managed lanes strategies is performed using a planning tool such as Highway Capacity Software (**HCS**).

During the PD&E and Design phases of the project, the design concept is developed including elements such as ROW, signing, and tolling, if applicable. A project ConOps is also prepared. Internal stakeholder meetings are held throughout the process to obtain agreement on the concept and the general locations of the access points. Following this, the project moves to the Public Alternatives Meeting.

A detailed analysis is performed next using microsimulation to finalize the managed lanes concept and access point locations. An internal stakeholder meeting is held to discuss the final managed lanes concept and the access locations. If revisions are suggested, then the concept is reanalyzed. Upon agreement by the stakeholders, the project proceeds to public hearing/meeting.

With all these considerations, a methodology for determining access points is outlined in ***Appendix C***. This flowchart shows the project phases and the major tasks to be completed within each phase. A simplified version is shown below in ***Figure 3-1***.

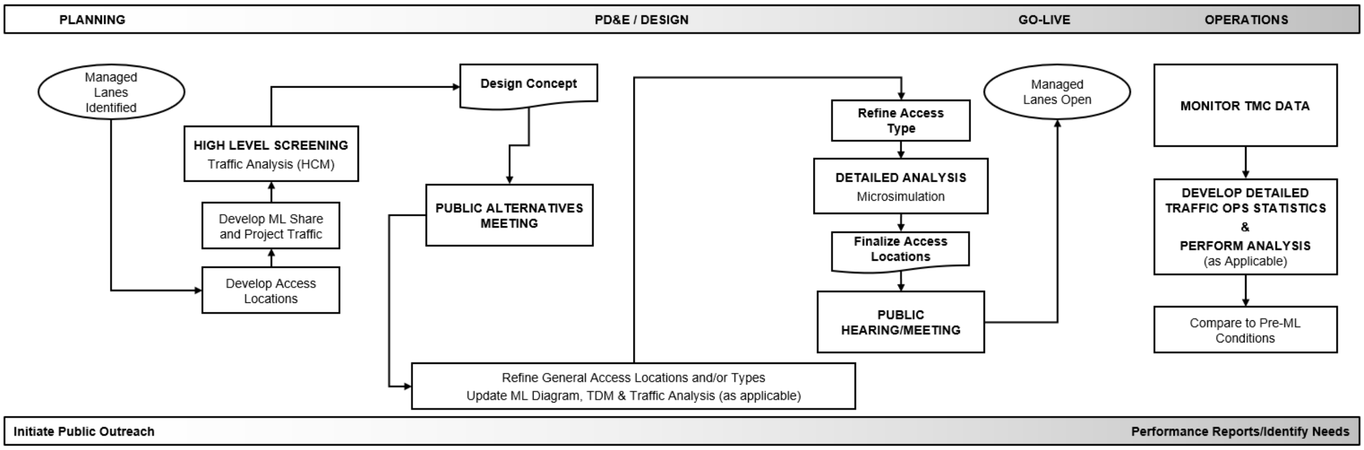


Figure 3-1 Access Point Location Flowchart (Simplified)

3.2.2.4 Considerations for Direct Connect Evaluation

Providing a direct connection between managed lanes and the GUL or managed lanes of another system requires an evaluation of traffic in the corridor to determine whether there is sufficient demand for the ramp. The following are considered when evaluating the feasibility of direct connect ramps:

A. **Assessment of Directional Design Hour Volume**
If the directional design hour volume (DDHV) on direct connect ramps exceeds 400 vehicles per hour (vph) for a single lane, then a ramp is feasible according to the ***High-Occupancy Vehicle Facilities: A Planning, Design, and Operations Manual (1990)***. DDHVs greater than 1,700 vph warrant dual lane ramps.

B. **Determination of Benefits**
The determination of the incremental benefits of a proposed direct connect ramp is assessed through a comparison with a slip ramp connection. Once demand projections are determined for each scenario, an operational analysis is performed in accordance with the FDOT Traffic Analysis Handbook. The demonstrated tangible benefits to the operation of the system are assessed through reduced weaving volumes and improved speeds.

C. **Consideration of Cost**
The total additional costs attributed to the implementation of the managed lanes to managed lanes ramps are compared to the potential incremental benefits.

3.3 Managed Lanes Tolling

Managed lanes that use pricing, or tolling, as a way to manage congestion to provide a more predictable travel time are called express lanes. For limited access non-Turnpike facilities, tolling can be used to promote free-flow travel, which is the Department's primary performance measure for express lanes. Per 14-100.003 FAC, free flow for express lanes means conditions under which travel is unimpeded and motor vehicles can safely operate at speeds of at least 45 miles per hour (mph) in the express lanes.

3.3.1 Tolling Strategies

A corridor's tolling strategy may evolve over time to address the changing needs of the system. See **Chapter 7** for more information on SELS and Toll Setting Parameters.

Dynamically priced express lanes are tolled based on the traffic demand in the express lanes, with a goal of maintaining safe operating speeds of at least 45 mph. The minimum toll amount is $0.50 per express lanes toll segment, as stated in 14-100.003, FAC. If the average travel speed in express lanes falls below 40 mph (average travel speed is calculated from the customer's entry point to the customer's exit point), the minimum toll amount is charged, as stated in Section 338.166 (5), F.S.

Different types of tolling strategies used for Florida's managed lanes include:

A. Static Tolling
Fixed toll amounts that are predetermined and applied during all hours of the day.

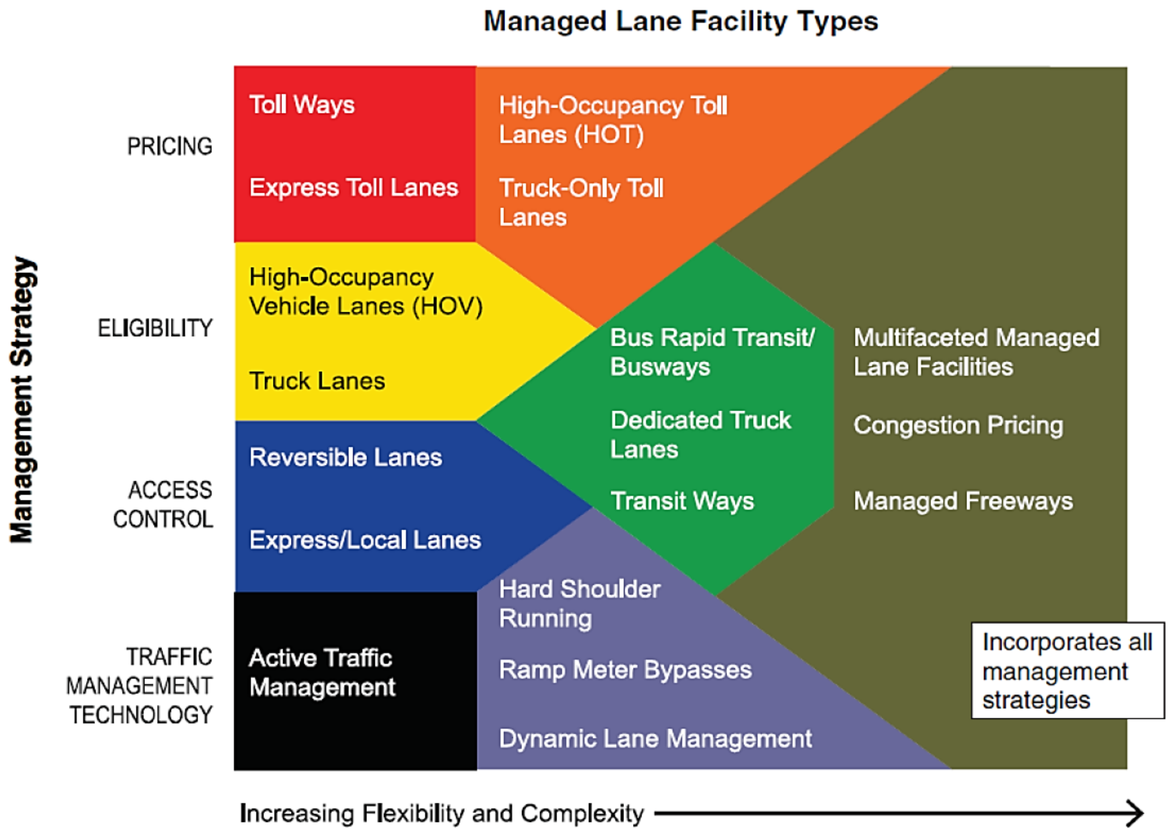
B. Time of Day (TOD) Tolling
Fixed or varying toll amounts that are adjusted according to a predetermined established schedule.

C. Dynamic Tolling
Varying toll amounts that are adjusted based on real-time monitoring of traffic conditions in the express lanes.

D. Combination Tolling
Utilization of different tolling strategies throughout the day, such as TOD tolling during non-peak periods and dynamic tolling during peak periods.

4 MANAGED LANES FACILITY TYPES

The purpose of managed lanes is to provide a proactive alternative to improve or maintain operations along a facility. *Figure 4-1*, is an example of how different operational strategies can be combined to create managed lanes facilities.



Source: NCHRP Research Report 835: Guidelines for Implementing Managed Lanes

Figure 4-1 Managed Lanes Facility Types and Strategies

Managed lanes can implement one or more of the above strategies, depending on limitations and complexity. The following sections describe the managed lanes facility types typically considered in Florida.

4.1 Express Lanes

Express lanes are a type of managed lanes where congestion is managed with vehicle eligibility, separation and access control, and tolling. Express lanes are implemented on non-Turnpike facilities to address existing and future congestion, enhance transit services, accommodate future regional growth and development, and improve system connectivity between key limited access facilities. Express lanes are separated from GUL and provide optional travel lanes for two-axle vehicles (such as passenger cars) equipped with a transponder. In addition to vehicle eligibility, express lanes also use access control and tolling. Access is controlled using limited entrance and exit points that usually serve longer, regional trips. Tolling refers to static, TOD, or dynamic tolls during times with high demand such as peak travel periods. The two examples of express lanes shown below in *Figure 4-2* are of I-95 Express Lanes in Miami-Dade and Broward Counties, which use a 2–4-foot buffer and tubular markers for lane separation.

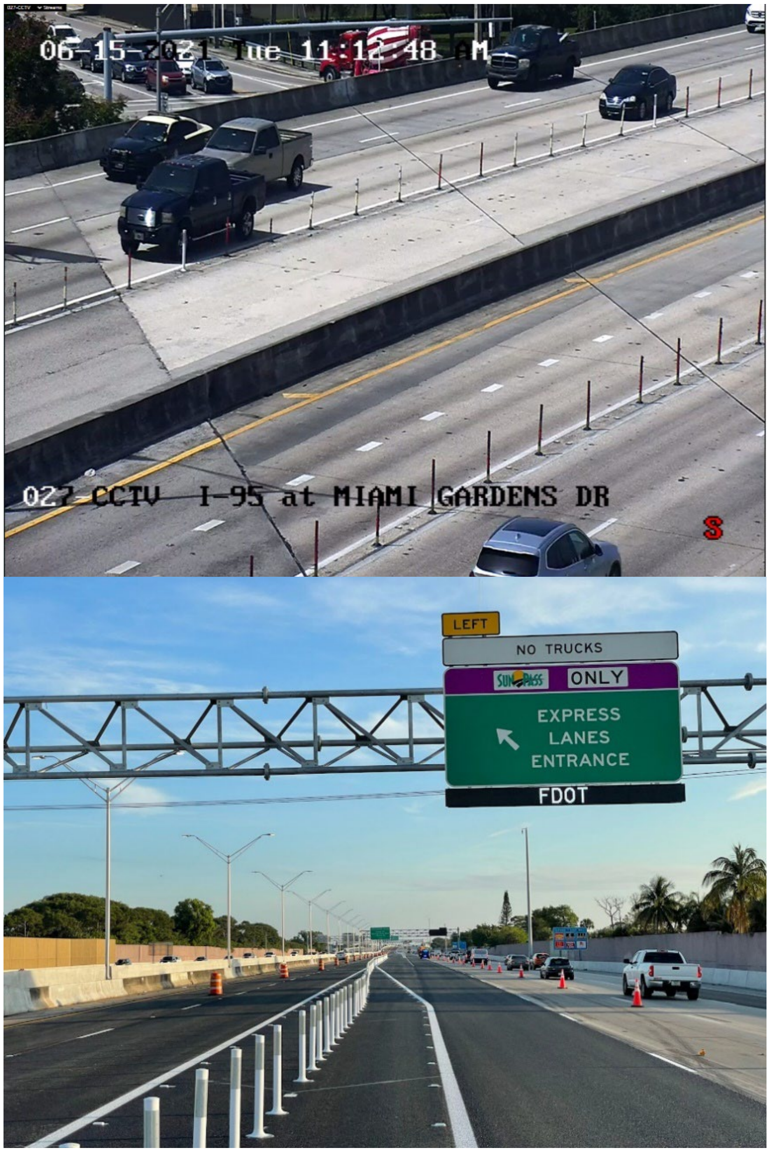


Figure 4-2 Express Lanes Examples

4.1.1 Additional Considerations for Express Lanes

The additional considerations for express lanes are based on project experience and lessons learned from project development, implementation, maintenance, and operations. Additional considerations specific to other types of managed lanes will be developed in future iterations of this Guidebook based on the state of the practice.

4.1.2 Express Lanes Demand

In addition to the factors for managed lanes, the demand to use express lanes is also affected by socioeconomic data, value of travel time savings (VTTS), and value of reliability. These factors help to determine the existing and future demand for express lanes. Refer to Chapter 8 of the FDOT Project Traffic Forecasting Handbook for details on project traffic forecasting for express lanes.

4.1.3 Vehicle Eligibility

According to 14-100.003, FAC, only two-axle vehicles, buses, and motorcycles equipped with a properly mounted SunPass® (or other interoperable transponder) are eligible to travel in express lanes. In Florida, vehicles with three or more axles and passenger cars pulling trailers or boats are not permitted in express lanes.

4.1.4 Tolling Exemptions

Properly registered public transit buses, school buses, over-the-road buses, and vanpools are exempt from paying the express lanes toll based on 14-100.006, FAC. According to Section 338.155, F.S., other exemptions are allowed for law enforcement and emergency vehicles on official business.

4.2 Long-Distance Trip Lanes (Thru Lanes)

Long-distance trip lanes, or thru lanes, are additional travel lanes located on a tolled or non-tolled facility that help provide congestion relief in high traffic areas. Thru lanes use vehicle eligibility and separation and access control as operational strategies to manage congestion. Unlike express lanes, thru lanes do not use tolling as an operational strategy. While thru lanes are mainly used as a managed lanes strategy on Turnpike facilities, they may be considered on non-tolled facilities.

Thru lanes are separated from GUL with limited entrance and exit points that serve long-distance trips by isolating traffic that does not need to access a certain area within the corridor. This reduces the conflicts that occur due to weaving in an area with many interchanges and high congestion. This management strategy allows vehicles traveling long distances to safely maintain higher speeds by being separated using physical barriers, such as buffer separation with tubular markers, or pavement markings, as shown in *Figure 4-3.*

The major benefit of a thru lane is that it allows commuters to bypass the heavy ramp merge/diverge congestion at interchange locations.

Figure 4-3 Thru Lanes Examples: Veterans Expressway and Beachline West

4.3 Truck-Only Lanes

Truck-only lanes are a managed lanes facility type that separates heavy vehicles from mixed-flow traffic along a highway mainline and allows for the exclusive use of trucks. Implementation of truck-only lanes on a highway facility creates a dual facility with physically separated inner and outer roadways. This facility type is used to improve movement of commercial goods and services and enhance safety for roadway users. Truck-only lanes reduce potential conflicts between trucks and passenger vehicles to provide operational and safety benefits. For example, truck-only lanes allow trucks to travel at proper spacing without fear of passenger cars cutting between them. According to the NCHRP Research Report 649, truck-only lanes reduce collisions by 15% and reduce fatal crashes by 44%.

Trucks are defined as vehicles having three or more axles. Truck-only lanes are also referred to as truck-preferred lanes, commercial vehicle lanes, or truck-only facilities. Truck bypass facilities, exclusive truck roadways (truckways), and climbing lanes are not considered truck-only lanes. An example of a truck-only lane is shown in *Figure 4-4*.

Figure 4-4 Truck-Only Lane Example (I-5)

4.3.1 Benefits

Truck-only lanes offer various safety, mobility, economic development, and environmental benefits. These benefits are applicable to users of both truck-only lanes and GUL:

- **Safety** – Separation of trucks enhances safety by reducing risk exposure to car/truck conflicts, which results in fewer and less severe crashes.
- **Mobility** – Separation of trucks from mixed traffic allows all vehicles to travel at their designated speeds, which results in reduced delays and improved operational efficiency.
- **Economic Development** – Truck-only lanes enhance productivity of a region by improving efficiency of freight movement and access to distribution centers.
- **Environment** – Reduced congestion and improved travel speeds result in reduced air pollution from emissions of stalled or slowed vehicles.

Projects that would consider truck-only lanes as an alternative should include freight-specific performance metrics that can be used to measure these benefits and compare truck-only lanes with other capacity and operational alternatives.

4.3.2 Special Considerations

Planning and development of potential truck-only lanes should include the following considerations in addition to measures and benefits discussed in **Chapter 5** of this Guidebook.

- **Geographic Context** – Knowledge of regional freight issues is critical to determining whether implementation of truck-only lanes would address local or regional freight needs. Establishment of logical termini for truck-only lane alternatives should consider break points in truck volumes and independent utility of the project. The geographic limits of evaluation of candidate locations for truck-only alternatives depend on whether the truck demand is related to a single corridor or a regional network. If a regional network is desired, the evaluation of truck-only lane alternatives should cover a broader geographic area in order to provide the greatest opportunity to enhance regional freight mobility.
- **Policy Considerations** – Type of eligible vehicles and whether the facility will be tolled need to be considered in the planning and project development process.
- **Technology Considerations** – Truck-only lanes provide opportunities for technology deployment, including CAVs, in controlled settings.
- **Location and Design** – Truck-only lanes may be designed in various physical configurations depending on ROW, environmental, and other physical constraints. In general, truck-only lanes may be placed in the median of existing roadways, in the outer sides of the existing roadway lanes, or vertically separated from existing roadways. Interchange configurations are considered during concept development and preliminary design to address issues related to queueing, weaving, merge/diverge, and other types of limited geometry such as short radius loops. Planning and design of truck-only lanes should include provisions to remove stalled trucks, access to truck parking, and handling of incidents involving hazardous materials. Generally, two lanes in each direction for heavy vehicles is preferred. When one truck-only lane is proposed in each direction, provisions for staging areas and opening of barrier walls to divert trucks back into GUL in case of emergency are necessary. Additionally, consideration may be given to roadway grade and adding passing lanes in areas where some trucks may be expected to operate at lower than the maximum speed limit due to their weight.
- **O&M** – Truck-only lanes experience a higher degree of pavement degradation, and the extra O&M cost should be taken into consideration when evaluating managed lanes alternatives. At the same time, removing trucks from the GUL will increase pavement life.
- **Environmental Impacts** – Aside from the reduction of fuel consumption and air pollution discussed Section 4.3.1, it is important to consider potential environmental issues that may be created by implementation of truck-only lanes. These issues may include increased noise pollution and potential impact to natural and cultural environments.
- **Stakeholder Engagement** – Gaining early stakeholder support is one of the important success factors of truck-only lanes. Freight stakeholder outreach, including the trucking industry, is critical for understanding stakeholder needs and garnering support for the project. Public acceptance of these facilities is another important consideration in the planning and project development process.

4.4 Managed Transit Lanes

Transit is an increasingly important mode of transportation in Florida, and, to encourage the growth of transit use, it must be effective, efficient, and readily accessible. One strategy for improving transit is implementing managed transit lanes (MTL). MTL, or bus-only lanes, are traffic lanes on a surface street reserved for the exclusive use of public transportation vehicles, providing enhancements to transit systems and traffic operations for the benefit of all users. MTL can accommodate public transportation on limited access freeways and arterial roadways, although the operation and design differ between the two facility types. In addition, MTL restrictions for both limited access freeways and arterial streets can vary in date and location based on need, particularly with congestion levels.

4.4.1 Managed Transit Lanes on Limited Access Roads

On limited access freeways, MTL can be designed as either separated transit-only facilities or by permitting buses in high-occupancy vehicle (HOV) lanes. According to the Federal Highway Administration (FHWA), local agencies must establish procedures to determine the application and enforcement for transit vehicles to use HOV lanes, such as clear identification of transit vehicles and allowing for single occupancy use when the driver is the sole occupant. For further guidance on MTL on freeways, see the FDOT ***Methodology for Locating Express Lanes Access Points***.

4.4.2 Managed Transit Lanes on Arterial Roadways

The nationwide expansion of Bus Rapid Transit (BRT) systems has increased the popularity and interest in MTL. However, these systems also require capital and operational improvements in dedicated lanes and other transit infrastructure. Therefore, allocating roadway capacity for transit travel is not always feasible, which has resulted in some cities and transit agencies adapting managed lane features to mixed traffic conditions. In Florida, FDOT has defined three types of MTL:

Mixed Traffic Transit Lanes	Transit operates without a dedicated lane but with operational strategies to improve service. These strategies include transit signal priority, prepaid fares, level boarding platforms, and station design enhancements. An example is shown in ***Figure 4-5.***
Special Use Transit Lanes	Transit operates in a dedicated lane with other special uses. Examples include business access and transit (BAT) lanes, right-turning vehicles, and TOD parking. An example is shown in ***Figure 4-6.***
Dedicated Transit Lanes	A dedicated transit lane is separated from regular vehicle traffic by signage, paint, or a physical barrier or tubular markers. It prohibits non-transit vehicle use at all times with limited access points. An example is shown in ***Figure 4-7.***

Figure 4-5 Mixed Traffic Transit Lanes (The Jacksonville Transportation Authority's First Coast Flyer Operating in Mixed Traffic, Jacksonville, FL) Source: JTA

Figure 4-6 Special Use Transit Lanes (PSTA SunRunner rendering shows the BAT lanes that allow turning traffic to utilize the MTL, Pinellas County, FL) Source: PSTA

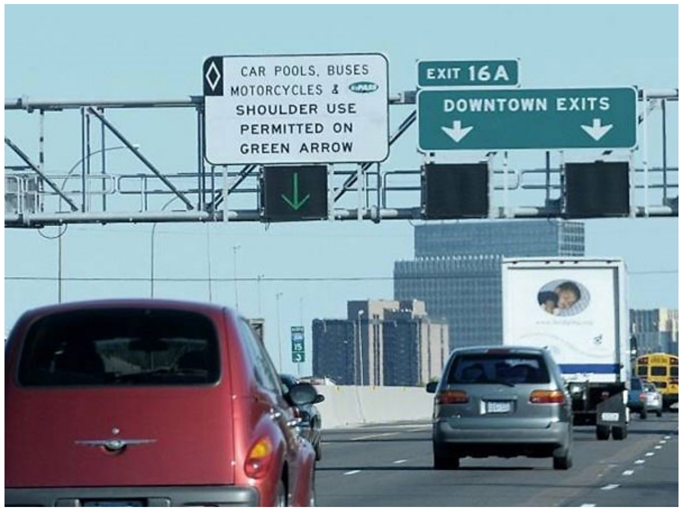
Figure 4-7 Dedicated Transit Lanes (The Lynx Lymmo in Downtown Orlando runs on dedicated lanes, Orlando, FL) Source: Global BRTdata

4.5 Part-Time Shoulder Use

PTSU is the temporary use of the left or right shoulders of an existing roadway for travel, typically during the peak periods when capacity is needed most. PTSU, also known as temporary shoulder use or hard shoulder running, is typically implemented on freeways and can be either static or dynamic. PTSU has been used for buses and general traffic and can be used for predetermined hours of operation or dynamically based on live traffic conditions. The use of PTSU for buses is discussed further in **Section 4.6**. A PTSU lane example is shown in *Figure 4-8*.

This managed lanes facility type addresses congestion and reliability issues during peak periods, while preserving the shoulder for its traditional safety and incident management function during the remainder of the day. This facility type relieves congestion and improves safety because reduced congestion tends to reduce crashes. PTSU can also be activated when an incident along the roadway occurs.

The shoulder must have adequate width, vertical and horizontal clearances, and pavement structure to carry the necessary additional vehicle loading to be utilized for this facility type. If PTSU is considered on a corridor with existing or proposed toll facilities, additional consideration should be given to providing safe access for toll equipment maintenance. Additionally, intermittent pull-offs should be considered to provide emergency access for disabled vehicles. All requests to implement PTSU are determined on a case-by-case basis and must be approved by the Chief Engineer.



Source: Use of Freeway Shoulders for Travel – Guide for Planning, Evaluating, and Designing PTSU as a Traffic Management Strategy, FHWA-HOP-15-23

Figure 4-8 PTSUP Example

4.5.1 Transit PTSU

In a Transit PTSU facility type, the shoulder is used under the same conditions outlined in Section 4.5 but restricted to buses. Its use can be in certain locations when speed in the GUL falls below a threshold set by the TEO or based on time of day. Buses traveling on the shoulder in this facility type are prohibited from exceeding the speed of the adjacent traffic by more than 15 mph as per the FHWA guidance. This is to reduce the risk of incidents due to the speed differential between the two lanes.

4.6 Connected and Automated Vehicle-Only Lanes

CAV-only lanes use a vehicle eligibility strategy by providing one or more separate lanes exclusively for CAVs. Connected vehicles use vehicle-to-vehicle, vehicle-to-infrastructure, and vehicle-to-everything communications to exchange information between vehicles, drivers, roadside infrastructure, bicyclists, and pedestrians. The Society of Automotive Engineers defines six levels of automation. Levels 0 and 1 vehicles have no, or very little, automation. Levels 2 and 3 automated vehicles are equipped with advanced sensors and computing abilities to assist the human driver in driving tasks. Levels 4 and 5 automated vehicles complete the driving tasks with little or no human intervention, respectively. CAVs allow for vehicles to travel more closely together than vehicles in a typical GUL. Factors that influence CAV-only lanes include:

- CAV market penetration
- Roadway geometry, including ingress/egress, number of lanes, etc.
- Enforcement
- Toll collection
- Hours of operation
- CAV technology

Managed lanes may be leveraged for CAVs because the infrastructure is already present. The Michigan Department of Transportation is exploring this with its CAV Corridor Concept. In Florida, for road segments with two managed lanes, one lane could be repurposed for CAV while the other could be used as an express lane (only for non-Turnpike facilities).

Furthermore, managed lanes could be used to demonstrate a connected vehicle tolling application or a map-based tolling application that could be universally adopted by the automobile original equipment manufacturers (OEMs) and toll authorities.

Currently, CAV market penetration is low. As the vehicle fleet turns over, OEMs are manufacturing new vehicles with technology that will be able to communicate with roadside infrastructure, smartphones, and other devices. FDOT is creating a vehicle-to-everything data exchange platform to support FDOT's future CAV project corridors. The system includes taking CAV data to make real-time and predictive decisions and assist stakeholders in the auto industry, research, traffic engineering, and other areas. This system will provide safety and mobility data to all road users, thus increasing the productivity in transportation operations. This data could be useful for developing tolling applications and future managed lanes.

4.6.1 Market Penetration

NCHRP Research Report 891 (Dedicated Lanes for Priority or Exclusive Use by Connected and Automated Vehicles) found that at lower CAV market penetration, CAVs sharing lanes with HOVs would prevent oversaturation of the GUL. When there is 10% market penetration, shared managed lane should be considered, and at higher CAV market penetration, CAV-only lanes should be considered. Refer to **Chapter 5** for additional discussion on screening criteria for CAV-only lanes.

4.7 Reversible Lanes

Reversible lanes may be used as dedicated freeway lanes that serve directional peak period demands. These lanes are physically separated from GUL and typically operated on a set schedule to provide consistency to the traveling public. If tolling is used, the lanes are considered reversible express lanes.

Reversible lanes are most appropriate on freeways that experience large directional traffic imbalances or are forecasted to do so. These facilities are usually one to three lanes operating in one direction. The direction of traffic can then be changed based on the peak direction of traffic. These lanes typically require barrier channelization, gating, or flyover structures to prevent wrong-way movements. The lanes can be located between opposing directions, elevated or in the outer roadway, depending on the ROW available. This is a less costly alternative to adding GUL capacity for the peak direction of traffic. Reversible lanes require a significant amount of time to safely reverse their direction. Therefore, it is recommended that reversible lanes be implemented on roadways where the traffic shifts are predictable and recurring in the direction of peak demands for the entire peak period. In Florida, the Lee Roy Selmon Expressway in Tampa and the I-595 expressway in Davie utilize reversible lanes. ***Figure 4-9*** shows the reversible lanes for the I-595 expressway.

Figure 4-9 Reversible Lane Example

4.8 Carpool 3+ Lanes

Carpool 3+ lanes are lanes reserved or dedicated for passenger vehicles carrying a minimum of three people in the vehicle. The passenger vehicles traveling in the carpool lanes can include motorcycles, registered carpools, registered vanpools, and buses. Where permitted, passenger cars with a single occupant can travel in the lane by paying a toll. The goal of carpool 3+ lanes is maximizing person throughput. Carpool lanes may be continuously accessible from the GUL, or access can be limited to specific access points.

5 SCREENING OF MANAGED LANES

Managed lanes may be implemented to accomplish various goals for the project corridor. Mobility goals, focused on demand and accessibility, aim to improve the overall mobility of the facility or system. Safety goals aim to reduce crashes by mitigating congestion, limiting lane changes, and minimizing vehicle conflicts. Community goals aim to incorporate local interests into the development of the managed lanes corridor. The following list provides examples of possible goals and objectives for managed lanes:

- Provide a transportation system that can handle current and future demand
- Provide travel choice options
- Increase mobility and accessibility by offering travel options
- Provide additional facility capacity
- Optimize existing managed lanes capacity
- Provide congestion relief
- Modify travel demand
- Enhance alternative modes
- Improve accessibility
- Improve the safety of corridor travel
- Minimize environmental impacts
- Preserve neighborhoods
- Maintain land use patterns
- Improve transit service and operation
- Improve freight travel time reliability
- Improve system resiliency

Screening criteria help identify which types of managed lanes will accomplish the project goals. These criteria were developed through a review of NCHRP Research Reports 649 and 835, the HCM 6th Edition, and FHWA publications. Detailed screening criteria for the managed lanes facility types are discussed in the following sections, and general screening criteria are listed below.

- Physical constraints
- Truck characteristics
- O-D patterns
- Land use
- Funding

5.1 Express Lanes

Express lanes may be a viable solution on non-Turnpike facilities when additional widening of the corridor is no longer possible due to ROW or other constraints. Connectivity with the regional managed lanes and tolling network is also a strong consideration for the use of express lanes. An understanding of traffic patterns along the corridor and major O-D movements is critical to determining the feasibility of express lanes and other types of managed lanes. Refer to the Project Identification Considerations Chart in *Figure 2-1*.

5.2 Long-Distance Trip Lanes (Thru Lanes)

Similar to express lanes, thru lanes may be considered as a solution when a GUL widening is not a viable option. Unlike express lanes, thru lanes are considered when tolling is not used as operational strategy. The **Project Identification Considerations Chart** in *Figure 2-1* can be used to determine the viability of thru lanes.

Key screening criteria to be considered for a successful thru lane project include:

Screening Thresholds
▪ Provide at least two thru lanes in each direction, if geometry and ROW allows ▪ Project segments bypass at least two interchanges ▪ Logical termini supports major O-D movements ▪ Physical geometry allows for thru lanes to properly terminate into free-flow conditions ▪ Thru lane design hour volume (DHV) ≥ 50% of thru lane capacity

The capacity of a thru lane is the same as a managed lane based on the separation type in accordance with the HCM 7th Edition, Exhibit 12-11. For example, the capacity of two buffer separated managed lanes at 70 mph is 1,800 pc/hour/lane. Per the criteria above, the thru lane volume should be at least 50% of the capacity or equivalent 900 pc/hour/lane.

5.3 Truck-Only Lanes

Truck-only lanes are a potential solution when traffic volumes are high and include a significant percentage of heavy vehicles. Truck-only lanes should be considered as a potential alternative for evaluation when at least three of the following criteria are met:

Screening Thresholds
▪ Annual average daily traffic (AADT) greater than 100,000 (this can be existing year or design year AADT) ▪ Truck AADT greater than 25% of the total AADT ▪ Truck AADT greater than 15,000 ▪ Combination truck planning time index greater than 1.2

The Truck-Only Lanes Screening Tool was developed by FDOT's Freight and Rail Office to identify candidate corridors using standard transportation planning criteria quickly and systematically. The tool is hosted on an ArcGIS web app platform, and as a primary feature, the ArcGIS web app displays all the standard transportation planning criteria associated with identifying candidate truck-only lanes in Florida. These criteria are overlaid with the FDOT Linear Referencing System (LRS) and uploaded to ArcGIS Online as feature services. Additionally, reference layers, seaports, generalized future land use, and average VHU/MI are also included in the web app. The web app allows viewers to visualize potential truck-only lanes in addition to all the input criteria and other reference layers.

Output of the tool is the potential truck-only lanes feature service or layer which allows users to visualize and inspect roadway segments in Florida that meet three or more of the truck-only lanes criteria.

A combination Truck Planning Time Index (PTI) is defined as the ratio of the 95th percentile peak period or peak hour travel time to the free-flow travel time. This measure represents the additional time that a shipper should budget to ensure on-time arrival 95% of the time. The reporting period is the peak period (4:00 p.m. to 6:00 p.m.) for the urbanized areas of the seven largest metro areas and the peak hour in other urbanized areas and elsewhere.

$$PTI = \frac{Travel\ Time_{95th\ percentile}}{Travel\ Time_{free-flow}}$$

Data Source: FDOT Traffic Characteristic Inventory and HERE Technologies-Travel Time Data
Data Coverage: National Highway System (NHS) and other major roadways

Additionally, understanding of truck travel patterns (O-D) is a prerequisite for feasibility determination of truck-only lanes. Proximity to major freight generators can also be an important factor for consideration.

5.4 Managed Transit Lanes

Implementing an MTL is an involved process and will be customized for each facility based on needs, goals, and objectives. The guidance provided below reflects research from around the country and FDOT performance criteria and is a framework reference for considering an MTL by type.

Managed Transit Lane Type	Buses per Hour[1]	Number of Routes Served	Mobility Objectives Priority (i.e., Fare Collection)
Mixed Traffic	0–4	1–2	Low
Special Use Lane	5–10	2–4	Medium
Dedicated Lane	10+	4+	High

[1]Ridership information is also a consideration.

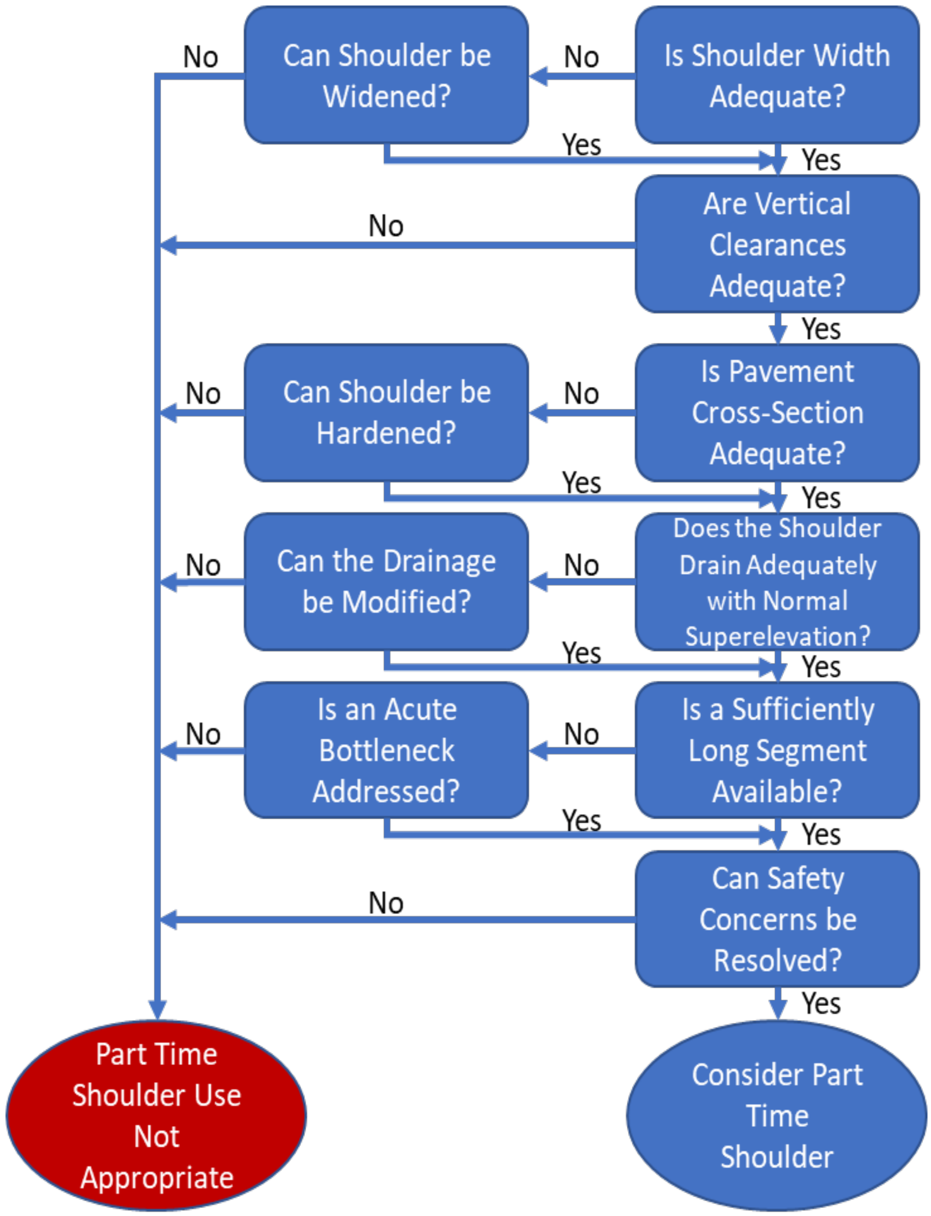
5.5 Part-Time Shoulder Use

All requests to implement PTSU will be determined on a case-by-case basis and must be approved by the Chief Engineer. PTSU should meet the initial screening criteria listed in the screening chart below in *Figure 5-1* to be considered as a viable managed lanes facility type. If the corridor currently serves a transit route, then adequate coordination should occur between the Central Office Public Transit Office and TEO, the District Transit Office, and the local transit agency prior to using the shoulder.

Other considerations during the planning and design process as identified in FHWA's "Use of Freeway Shoulders for Travel — Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy" include:

- Planning, screening, decision-making, and preliminary engineering
- Mobility analysis
- Safety analysis

- Environmental analysis
- Cost-benefit analysis
- Geometric, off/on-ramp design consideration
- Implementation including legal, exceptions, Manual on Uniform Traffic Control Devices (MUTCD), engagement, and public involvement
- Day-to-day operations on maintenance, incident management, and law enforcement



Source: FHWA Use of Freeway Shoulders for Travel – Guide for Planning, Evaluating, and Designing PTSU as a Traffic Management Strategy

Figure 5-1 PTSU Screening Chart

5.6 Connected and Autonomous Vehicle-Only Lanes

CAV-only lanes are a new managed lanes facility type nationally. At this time, there are no set screening criteria. The guidelines will be reevaluated at each guidebook update as this technology matures. Research conducted and documented in the NCHRP Research Report 891 (Dedicated Lanes for Priority or Exclusive Use by Connected and Automated Vehicles) may be utilized during the planning phases. Research conducted and documented in the **NCHRP Research Report 891** concluded if CAV-only lanes were implemented, the following would be advisable.

- If CAV market penetration is approximately 10%, then CAV-only lanes can be utilized but must allow HOV to share the lane.
- If CAV market penetration is approximately 25–45%, then CAV-only lanes can be dedicated only for CAVs.
- If CAV market penetration is greater than 45%, dedicated CAV-only lanes may be provided.

5.7 Reversible Lanes

Reversible lanes are considered viable if the following screening thresholds are met.

Screening Thresholds
▪ Ratio of peak direction to reverse direction flow exceeds 2:1
▪ Reversible lanes DHV ≥ 50% of reversible lanes capacity

A critical threshold that must be met is that the peak direction volume is twice the off-peak direction volume. For example, if the peak direction volume is 1,800 pc/hour/lane, the off-peak direction must have a volume of 900 pc/hour/lane or less. Another threshold that must be met is that the DHV of a reversible lane should be at least 50% of the capacity of the reversible lanes. At 70 mph, this capacity value would be 2,400 pc/hour/lane based on HCM 6th Edition. As per the criteria listed above, the reversible lanes volume should be at least 50% of the capacity or equivalent to 1,200 pc/hour/lane. In addition to these screening thresholds being met, the reversible lanes should preferably bypass significant merge/diverge congestion and multiple interchanges and provide access to/from freeway-to-freeway interchanges.

5.8 Carpool 3+ Lanes

For carpool 3+ lanes to be viable, the peak-hour DDHV must be greater than 1,000 pc/hour/lane in the design year.

Screening Thresholds
▪ In the design year: – Carpool 3+ lanes DDHV > 1,000 pc/h/ln

6 TOLLING OF MANAGED LANES

This chapter identifies guidelines and requirements related to the various aspects of using pricing for managed lanes. When implementing tolling on managed lanes, coordination with FTE is facilitated by the Managed Lanes Planning Team.

6.1 Toll Project Responsibility Matrix

A Toll Project Responsibility Matrix is required for all toll projects and identifies responsibilities between FTE and the Districts. This includes roadway and tolling infrastructure, design, operations, maintenance, ownership, and any financial obligations. The Toll Project Responsibility Matrix is included on FDOT's Tolls Design webpage.

6.2 Toll Collection System

FTE is responsible for collection of tolls for the Department. The toll collection system includes the Turnpike Toll System Back Office (Back Office) and the roadside toll equipment.

The Back Office includes the transaction host (Host) and the Centralized Customer Service System (CCSS). The Host serves as the clearinghouse between the toll gantries on the express lanes and the CCSS, where customer accounts are maintained. The CCSS is responsible for processing toll transactions and toll violations as well as managing accounts.

The Turnpike toll collection system interfaces with the District's Transportation Management Center (TMC) to support express lanes operations and share toll amount data. The District uses the toll amounts to operate the express lanes, and the Turnpike needs the toll amounts to process all toll transactions. The communications and interactions between the systems are defined by interface control documents (ICD), which are maintained by the FTE. The two key interfaces are explained below and shown in ***Figure 6-1***.

A. Toll Amount Interface
   This interface is used by FTE to receive the final toll amount information from the TMC.

B. Customer Service Interface
   This interface allows FTE Customer Service Representatives at the CCSS to look at information that was posted on the Toll Amount Dynamic Message Sign (TADMS) when customers have questions regarding transactions.

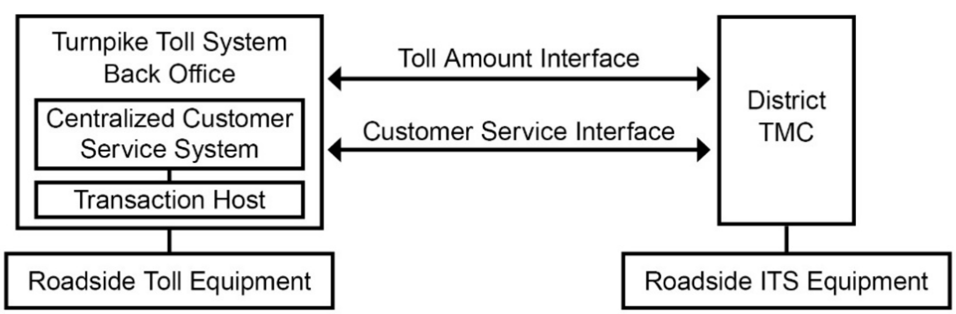


Figure 6-1 Typical Toll System Interfaces

6.3 Toll Segment Development and Access Considerations

Tolls in the express lanes are charged on a per segment basis. Tolling locations are dependent on the ingress and egress points, making them a key input into the access plan. Development of toll segments is coordinated with the access plan development covered in Section 2.3.2*.*

The toll segment definitions contained in this Guidebook are intended for use in corridor planning and development of express lanes. Definitions used by the SELS to operate express lanes facilities may vary from the toll segment definitions included below. The toll plan should be developed in close coordination with FTE and Central Office. Toll plans may vary to better meet the needs of the corridor and the region.

6.3.1 Basic Toll Segment

Generally, each express lanes toll segment is at least one mile long and has only one gantry that charges a toll. The basic express lanes toll segment begins with an ingress and ends with an egress, as shown in ***Figure 6-2*** below.

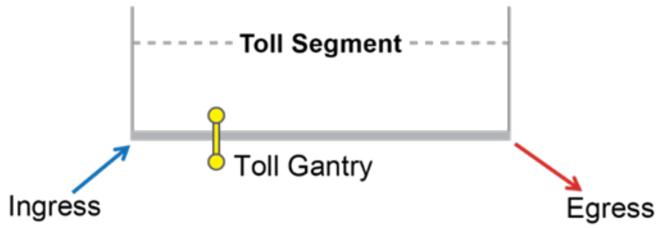


Figure 6-2 Basic Toll Segment

6.3.2 Alternative Toll Segment Configurations

For successive egresses, a toll gantry is placed before each egress, creating additional express lanes toll segments as shown in ***Figure 6-3.***

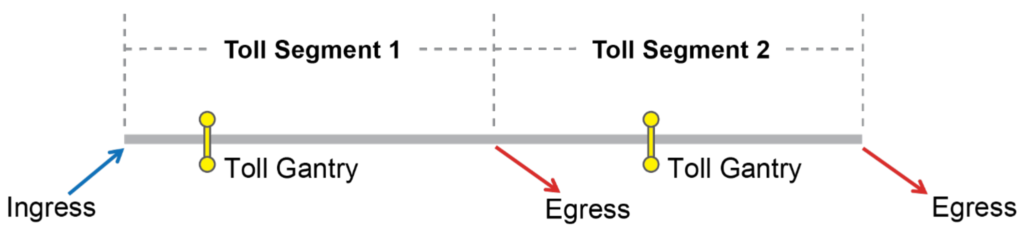


Figure 6-3 Toll Segment with Successive Egresses

For successive ingresses, the express lanes toll segment is from the first of the successive ingresses to the first egress. In this case, a data gantry is required between successive ingresses. A data gantry does not charge a toll. It collects the information needed to accurately identify the customer's entry into the express lanes. A toll gantry is placed before the egress, as shown in ***Figure 6-4.***

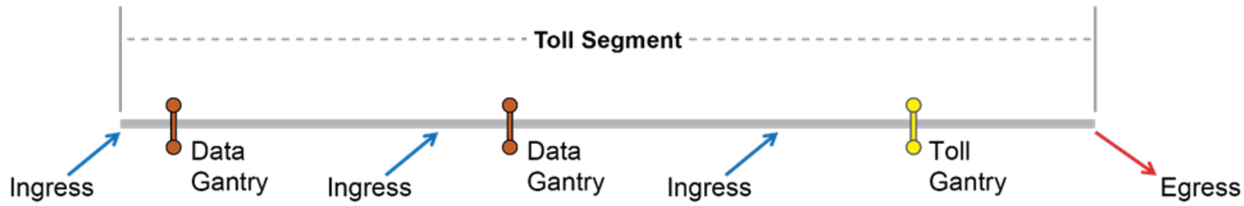


Figure 6-4 Toll Segment with Successive Ingresses

When an additional lane is added to a single express lane via an intermediate ingress, a toll gantry is placed both before and after the intermediate ingress, creating two express lanes toll segments as shown in ***Figure 6-5***. This allows for more effective congestion management of the express lanes.

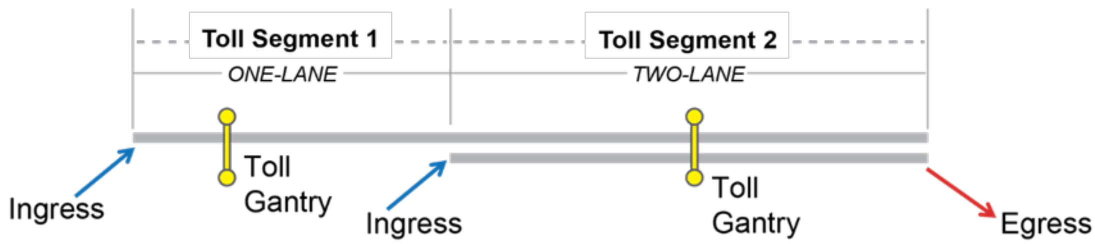


Figure 6-5 Toll Segment for Transitions from One to Two Express Lanes

6.4 Traffic and Revenue Studies

A Traffic and Revenue (T&R) study evaluates the projected traffic demand on a toll project and estimates a multi-year, gross toll revenue forecast. Each year, the FTE coordinates directly with PF to determine which FDOT-owned toll facilities require a T&R study. If PF determines that a toll facility requires a T&R study in a given year, the FTE will contract with third-party consultants to complete the T&R study. If PF determines that a toll facility does not require a T&R study, PF will complete an in-house update of projected toll revenue forecasts based on historical traffic and toll revenue trends.

Each FDOT District is responsible for paying for their facility's T&R study if tolls have not commenced for the relevant facility. After a facility's toll commencement, toll funds can be used to pay for T&R forecast updates, if available. Otherwise, the District will continue to pay for the forecast using District-allocated funds. Since the Districts lead the planning, design, and maintenance of FDOT-owned toll facilities, they must coordinate with PF and FTE once PF and FTE have determined that a T&R study is required.

T&R study guidelines are as follows:

- Sketch-level T&R study should be conducted during the planning stage of a facility and no later than five years prior to the toll facility achieving toll commencement.
- Planning-level T&R study should be conducted no later than two years prior to the facility achieving toll commencement.
- Generally, a forecast update should be conducted in the fiscal year when tolling commences and every fiscal year after tolls have commenced. Once tolls have stabilized, forecasts may be reduced from annually. Every year, PF and FTE will determine whether a toll facility requires a forecast update, which will capture considerations such as the amount of toll revenues collected in prior years.

6.5 Public Outreach

FTE has resources and materials available to support SunPass® outreach for tolling projects. The District develops outreach materials for the project in coordination with Central Office. These materials should be shared with FTE for consistency of messaging between the District and the Customer Service Representatives at the SunPass® call center.

6.6 Design

FTE Tolls Design is responsible for reviewing each toll facility design for compliance with the General Tolling Requirements (GTR) criteria when managed lanes include a tolling component. FTE Design also provides a limited review of the signing associated with toll facilities. A Toll Sighting Technical Memorandum (TSTM) is required for all express lanes projects. The TSTM documents the evaluation of a project's toll site infrastructure in relation to GTR criteria. The development of the TSTM begins during PD&E and is typically completed during Design. For design-build projects, the TSTM is developed as part of the design-build Request for Proposal (RFP). The TSTM Template is available on the FTE's website, and the criteria is included in GTR.

6.6.1 Toll System Maintenance

FTE and the Districts share the responsibility of maintaining the express lanes tolling system and infrastructure. In general, FTE is responsible for maintaining the physical toll equipment building and the tolling system. The District maintains the supporting infrastructure and funds the maintenance of the tolling system. Specific project responsibilities are defined in the Toll Project Responsibility Matrix. When a project spans multiple Districts, it is recommended that a Memorandum of Understanding (MOU) be in place to define responsibilities, in addition to the Toll Project Responsibility Matrix. Refer to **Section 9.5** for more information.

7 STATEWIDE EXPRESS LANES SOFTWARE

All express lanes in Florida use the SELS to assign toll amounts. SELS uses traffic conditions in the express lanes to determine toll amounts that facilitate free-flow operating conditions, as defined in [14-100.003 FAC](). SELS can be used under static, TOD, or dynamic tolling conditions. Many express lanes open under static tolling conditions before transitioning to another type of tolling.

SELS is currently implemented as a module within the FDOT Operations Task Manager (OTM) software system. OTM is a suite of software modules designed to assist and enhance daily TMC operations. It interacts with external systems including SunGuide®, the FTE Back Office, as well as local email, file, and database systems. SELS is currently being updated as a stand-alone software outside of OTM.

7.1 SELS Change Management Team

The SELS Change Management Team (CMT) is a cross-functional body established to manage changes to the software. The SELS CMT is led by the State TSM&O Software Engineer and is responsible for the oversight and direction of the SELS change management process, which guides how the software is updated. The SELS CMT consists of members from each FDOT District with an express lanes project, Central Office, and FTE. SELS CMT operating procedures are outlined in the ***SELS CMT Plan***.

7.2 Functions of Statewide Express Lanes Software

SELS uses traffic data received from roadside traffic detectors to perform the following:

- Calculate express lanes toll amount
- Perform toll setting for each express lane segment
- Post toll amount on TADMS and lane status on Lane Status Dynamic Message Sign (LSDMS) through the Department's SunGuide® software
- Verify and document that the toll amount and lane status messages are accurate and being displayed properly
- Associate SunGuide® events with tolling conditions
- Maintain toll amount records
- Communicate toll amounts to the FTE Back Office
- Provide interfaces with SunGuide® to receive data from real-time monitoring devices
- Analyze historical traffic patterns
- Generate reports

7.3 Establishing Toll Setting Parameters

7.3.1 Static Pricing

In some cases, a static toll amount, which does not change based on traffic conditions or TOD, may be the desired tolling approach for a segment or corridor. This is known as static pricing.

7.3.2 Time of Day Pricing

TOD pricing implements a toll amount that varies based on the TOD and day of the week, according to a predetermined schedule established in a TOD Table.

A TOD Table automates the changing of the toll amounts based on a schedule determined by the District which specifies the toll amount in effect based on the TOD and type of day (weekday, weekend, or holiday/special event).

7.3.3 Dynamic Pricing

Dynamic pricing uses varying toll amounts adjusted based on real-time monitoring of traffic conditions in the express lanes.

If utilizing dynamic pricing, there are three configurable tables used by SELS to determine the toll amount in different situations: (1) Level of Service (LOS) Table, (2) Delta-Density Table, and (3) TOD Table. These tables contain the toll setting parameters described below.

(1) LOS Table
This table contains the traffic density (TD) values and the corresponding variable toll ranges associated with each LOS value, A through F. Changes in toll amounts correspond to changes in the roadway's LOS. A statewide default LOS table is available for use as a starting point in establishing the toll setting parameters.

(2) Delta-Density Table
This table contains toll increments (either an increase or a decrease) used to calculate the toll for a specific time interval based on a change in traffic density. The table makes incremental changes to the toll amount by comparing the current TD to the density in the previous interval. It then matches that delta in density to the appropriate toll amount.

(3) TOD Table
Like TOD pricing, dynamic pricing can also use a TOD table. However, in this mode the TOD table is only used on a temporary basis. Specifically, when there is no data available from detectors for the software to calculate the toll. When utilizing dynamic pricing and that scenario occurs, the system will implement rates from a TOD table. As soon as detector operation has been restored, SELS automatically reverts to pricing dynamically. Refer to the FDOT Traffic Analysis Handbook for information on default LOS and Delta Tables.

7.3.4 Establishing and Amending Toll Setting Parameters

The District Traffic Operations Engineer (DTOE) is responsible for developing the initial tolling approach, including the type of tolling, toll amount, and LOS or TOD tables (if applicable) in accordance with the process outlined below. Once a tolling approach is approved, changes must be coordinated with the state TEO. This includes changes to the type of tolling, toll amount, LOS tables, and/or TOD tables.

A. DTOE, Turnpike DTOE, and Director of Traffic Engineering and Operations
The DTOE prepares a Draft Toll Setting Parameters Memorandum to initiate a request for establishing or changing toll setting parameters. The memorandum is circulated to the Turnpike DTOE and the Director of the TEO for review. They are responsible for circulating the memorandum for other input at the Turnpike and

Central Office, respectively. If the Turnpike DTOE and the Director of TEO concur with the memorandum, it is submitted for recommendation by the District Secretary.

B. **District Secretary**

Once the District Secretary approves, the memorandum is submitted to the Executive Director of the Turnpike for review and approval.

C. **Executive Director of the Turnpike**

Once the Executive Director of the Turnpike approves, the memorandum is submitted to the Chief Engineer for review and approval.

D. **Chief Engineer**

Once the Chief Engineer approves, the memorandum is submitted to the Secretary for approval.

E. **Secretary**

The Secretary provides the approval signature on the memorandum prior to implementation.

If concurrence is not reached at any step in the process outlined above, the District, the FTE, and Central Office work together to address any concerns and revise the memorandum. The revised memorandum will then begin the process again. Please see **Appendix E** for an example of a Toll Setting Parameter Memorandum Template.

8 DESIGN CONSIDERATIONS

Consistency in the design of managed lanes is essential to project success from safety, operational, and customer perspectives. The design of managed lanes facilities needs to provide operable managed lanes segments under both interim and ultimate conditions. During conceptual and final design, consider proposed connections to adjacent managed lanes, GUL, and any infrastructure needs for subsequent implementation phases of the managed lanes (e.g., signing, ITS infrastructure, and toll sites). Specific design criteria, standardized construction plans and specifications, and other guidance can be found in the following documents:

- FDOT Design Manual (FDM)
- FDOT Standard Plans for Road and Bridge Construction
- FDOT Standard Specifications for Road and Bridge Construction
- FDOT Traffic Engineering Manual (TEM)
- General Tolling Requirements (GTR) (if applicable)
- Manual on Uniform Traffic Control Devices (MUTCD)

Managed lanes projects are subject to additional design considerations as described in **Chapter 3**.

8.1 Tubular Markers

When tubular markers are selected as the separation type, they must conform to the guidelines published in ***FDOT Standard Specifications 704.*** At specific locations where stopping sight distance criteria cannot be met with markers that are 36 inches in height, the height of the marker above the pavement surface should be 24 inches. A Modified Special Provision to Specification 704 must be processed for the 24-inch height tubular markers.

8.2 Signing, Pavement Markings, and Intelligent Transportation Systems

Managed lanes are subject to additional requirements for signing, pavement marking, and ITS design. Within the ***MUTCD***, express lanes are referred to as priced managed lanes, and sign guidelines are categorized under ***Chapter 2G – Preferential and Managed Lane Signs***. The Department's express lanes signs are detailed in TEM 2.42. Pavement marking guidelines are included in TEM 4.5 and FDM 230 and are categorized under ***Chapter** 3D **– Markings for Preferential Lanes*** of the ***MUTCD***. ITS requirements are detailed in FDM 233.

8.3 Direct Connections Between Managed Lanes Facilities

For managed-lanes-to-managed-lanes project connections, additional signing may be needed to inform the driver of a closed connection between systems. There are several options to communicate the managed lanes status to drivers. Any available three-line Dynamic Message Sign (DMS) may be used to inform the driver of a closed system on connections between systems. An LSDMS may also be used to alert drivers of the lane status. If needed, a single-line DMS may be added below the managed lanes exit sign panel.

These strategies may be combined as needed to meet the needs of the system. Each connection will be handled on a project-by-project basis, requiring coordination between Design and TEO at both the District and the FTE. The final decision is made by the DTOE and coordinated with the TEO and the Managed Lanes Planning Team.

9 OPERATIONS AND MAINTENANCE

O&M needs for managed lanes impact key project development decisions from planning through implementation of the project. Each District is responsible for planning and programming all O&M project costs.

9.1 Operations

Coordination between Design and TEO ensures that the preferred geometric design concept supports incident management and enforcement operations. These operations are examined on a project-specific basis to identify and incorporate required design elements. Incident management plans are also critical design inputs for the managed lanes project. Design elements such as roadside toll equipment (if applicable), emergency turnaround areas, access to the managed lanes, and emergency refuge areas (ERAs) may be necessary to support the operational needs of a managed lanes project.

ERAs that include staging and incident investigation areas may help improve safety and reduce impacts to operations on constrained facilities. See FDM 211 for ERA criteria.

Project-specific characteristics can result in operational differences that need to be considered early in the Planning phase of the project development process. These characteristics include ingress and egress design and location, separation type between the managed lanes and the GUL, reversibility of the managed lanes segment, and the use of other TSM&O strategies along the corridor.

9.2 Project Concept of Operations and System Validation

The project ITS architecture and the project ConOps, as required by FDOT Systems Engineering and Intelligent Transportations Systems Architecture Procedure (750-040-003c) and detailed in **Chapter 2**, are used for further development of additional operational documents such as incident management plans, standard operating guidelines and procedures, and interagency communication guidelines.

When construction is complete and the managed lanes system is in operation, a system validation is performed using the criteria and high-level requirements outlined in the project ConOps. The system validation answers the following question: Was the right system built to accomplish the user needs expressed in the ConOps?

9.3 Transportation Management Centers and Standard Operating Guidelines

9.3.1 Transportation Management Centers

The TMC disseminates traffic information to the traveling public. It houses operators and coordinates closely with other operations and dispatch partners such as FHP, local law enforcement, and fire and rescue personnel.

Additional TMC resources may be needed for operation of some managed lanes projects. If needed, a plan is developed for adding personnel (e.g., operators) and infrastructure (e.g., building, equipment, and workstations) in the early stages of project development—prior to opening of the managed lanes system. This plan is developed as early as possible to allow enough time for the training of TMC operators and implementation of any infrastructure modifications. The District TMC staff is responsible for the following:

- Monitoring the traffic and roadway using cameras and vehicle detectors
- Performing incident management including incident response coordination
- Dispatching Road Rangers to clear incidents, remove debris, and assist stranded motorists
- Monitoring vehicle detection devices and other ITS equipment in order to identify any equipment failures
- Conducting freeway traffic management, ramp signal operations, and arterial operations coordination
- Monitoring the health of the ITS device and communication systems
- Reporting damage to the facility and tolling system, if applicable

9.3.2 Standard Operating Guidelines

Regional TMC Standard Operating Guidelines (SOG) are published by the Central Office TEO to help facilitate the proper operation of Florida's roadway transportation system by providing general guidance to TMC administrative and management personnel. Standard Operating Procedures (SOP) are developed by the local TMCs and define specific operational procedures that will be followed at each TMC.

9.4 Traffic Incident Management for Managed Lanes

During incidents and crashes, the managed lanes will operate per incident management procedures established in the Regional TMC SOGs. The managed lanes project ConOps, as defined in Chapter 2, provides project-level details on the roles and responsibilities.

TIM SOPs for emergency response and incident management clearance are influenced by separation type and shoulder width. For barrier-separated facilities, gates are provided at intermittent locations for access to the managed lanes. For facilities that are buffer separated with tubular markers, incident management personnel access the managed lanes by temporarily removing or driving over the tubular markers. Incident management personnel may use the paved shoulder as a pull-off area. In addition, incident staging areas and Emergency Stopping Sites (ESS) aid in faster incident response and clearance.

Gates, Road Rangers, Asset Maintenance Contractors, and Law Enforcement Officers may be used to enforce hard closures at managed lanes access points. TIM SOPs should be coordinated with incident management and law enforcement stakeholders. *Figure 9-1* illustrates operations of a managed lanes lane closure.

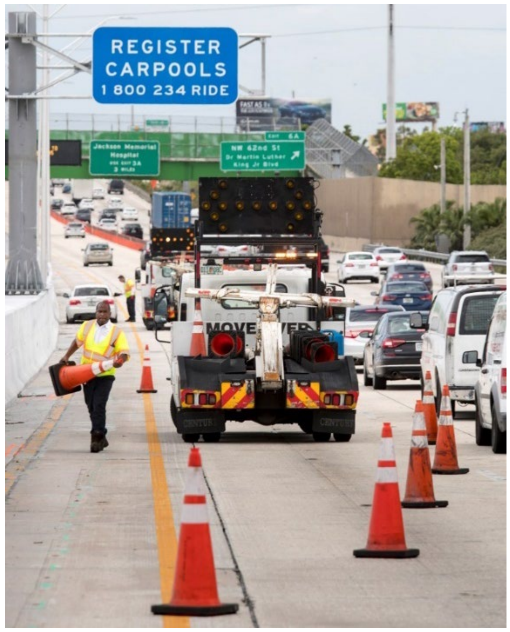


Figure 9-1 FDOT Road Rangers Responding to a Managed Lanes Incident

9.4.1 Incident Staging Areas

Incident staging areas are strategic locations along the corridor dedicated to TIM equipment and personnel. By proactively staging equipment in these areas, incident responders can have fast and safe access to the managed lanes when incidents occur. TIM equipment dedicated to these areas may include tow trucks and incident response vehicles (IRV). Incident staging areas aid in quick event clearance and opening of the managed lanes corridor by expediting deployment of TIM personnel and resources.

Locations for potential incident staging area locations should consider the following.

- Proximity to frequent crash areas along the corridor and nearby construction
- Easy access to the managed lanes such as interchange on-ramps and turnaround locations
- Existing paved areas that at minimum can accommodate a tow truck and IRV
- Safety and protection such as lighting and a guardrail or adequate clear zone for responders
- Property owner agreements
- Access to restroom facilities if available

Development and identification of staging areas should be performed and included in the project's Concept of Operations. Coordination with the District's TMC representatives and Florida Highway Patrol (FHP) is important for understanding where the staging areas are most needed. Incident staging areas can be created from a variety of existing opportunities with easy managed lanes access such as an existing gore area with proper pavement and drainage, underpass areas and ramps, park and ride lots, and multimodal facilities. Design considerations of incident staging areas should include adequate room for the vehicles needing to be staged there, signage and pavement markings delineating the area for staging, proper drainage, lighting, and protection for responders. Additional ITS devices may be needed to monitor staging and closure areas, so ITS design should also be considered. ***Figure 2-2*** shows an incident staging area in FDOT District 6.

Figure 9-2 Staging Area at Golden Glades Multimodal Facility in FDOT District 6

Incident staging areas are typically staffed Monday through Friday during the AM and PM peak periods. They may also be staffed during peak holiday travel times. Depending on the identified need, vehicles may be staged during weekends and hours outside of the peak periods.

Incident staging areas can also serve as an ESS for use by FHP and other responders to work events once they have been removed from travel lanes or shoulder of the managed lanes.

9.4.2 Emergency Stopping Site

An ESS is the emergency pull-off bay located on the mainline shoulders or at the interchanges utilizing easily accessible dead spaces. These sites can be used as crash investigation sites, moving abandoned vehicle from travel lanes, vehicle transfers, staging areas for tow trucks, law enforcement, or other incident management or enforcement related activities. The goal of implementing ESS is to improve driver and incident responder safety and reduce secondary crashes and incident clearance time from the travel lanes. The Incident Commander (IC) on scene should have the final choice on which relocation site is used.

The use of ESS is prioritized on freeways and expressways in urban settings with medium to high AADT or with recurring congestion segments. ESS in urban areas should be one to two miles apart, alternating along the inside and outside shoulders. Guidance for ESS use in other context classifications can be referred to in NCHRP 835 Guidelines for Implementing Managed Lanes.

Previous deployments in Florida include five (5) emergency stopping sites on I-95 Expressway along the inside shoulders in FDOT District 6 and on the I-75 off ramp in FDOT District 1. ***Figure 9-3*** shows a typical ESS concept.

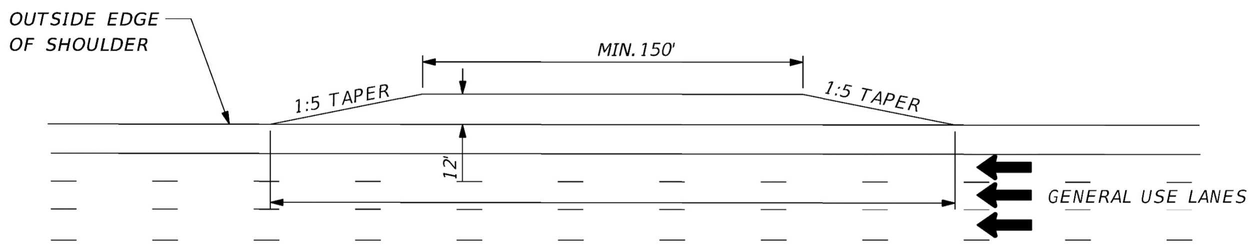


Figure 9-3 FDOT ESS Concept

The location and size of the ESS is dependent on several factors.

- Availability of space and width of the right of way
- Roadway geometry constraints including vertical and horizontal curves, bridges, and interchanges
- Recurring traffic congestion locations limiting the effective use of sites

Detailed ESS design guidelines have been developed by the FDOT Traffic Engineering and Operations Office, and design considerations are also published in NCHRP 835 Guidelines for implementing Managed Lanes. These guides provide the standard signing, sight distance, ingress and egress tapers, striping, and other geometric concepts. The ESS design should include clear delineation, advance driver notification at ½ mile and 1 mile in advance and provide driver notification of limitations of use. Sites currently in use by FDOT consist of 13-foot shoulders, measuring between 1,200 and 1,900 feet in length.

9.4.3 ESS Use for Incident Staging Areas

ESS can be used as an incident staging area to reduce incident response times and clearance durations. A pilot project in District 6 resulted in reduced arrival times during the weekday PM peak period by 19 to 24 percent for lane blocking events and 23 to 70 percent for disabled vehicle events. However, additional factors such as available staging space and responders' safety should be considered when deciding to utilize an ESS for a staging area.

The space available at the ESS for staging areas is restricted by the ESS's primary purpose of enforcement activities and temporary stopping site for disabled vehicles. This limits the number and types of resources that can be staged at the ESS. An example staging layout is illustrated in *Figure 9-4*.

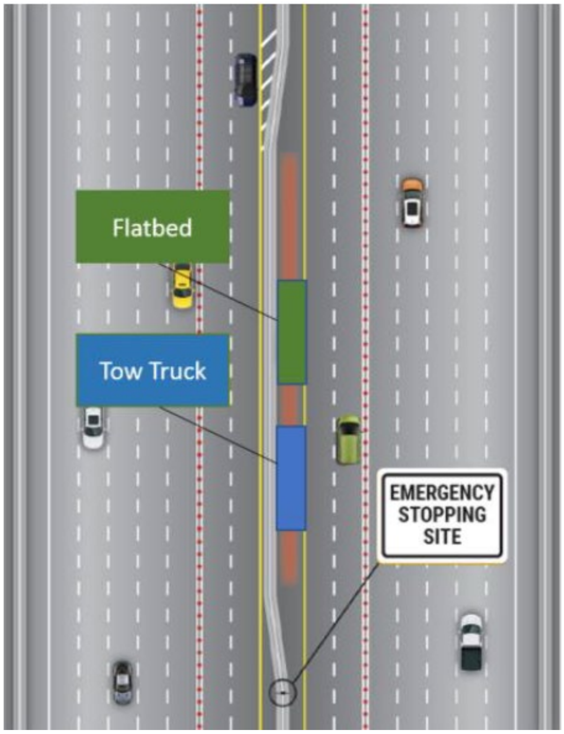


Figure 9-4 Road Rangers Staging Layout at ESS

In addition to size limitations when deciding what resources can be staged at an ESS, the types and duration length of the event should be considered. Flatbed trucks have been found to be the most effective vehicle staged along 95 Express in Miami-Dade County, since disabled vehicles count for more than half of the non-scheduled lane blockage events. Additionally, the blockage duration of disabled vehicles is three times longer than all other non-scheduled lane blockage events.

The safety of the incident responders staged at an ESS must also be accounted for. By staging adjacent to the travel lanes, there is potential for the staged vehicles to be involved in a rear end or sideswipe incident. The use of ESS as staging areas should therefore be restricted to the peak periods when the responders are most needed and managed lanes speeds are lower due to congestion.

9.5 Maintenance

Managed lanes maintenance is performed for the ITS equipment and the portion of the roadway that is operating as managed lanes. Such roadway features include assets such as drainage, guardrails, crash cushion, pavement marking, rigid or flexible pavement, signs, tubular markers, and concrete barriers; inspections are also included. Every effort should be made to coordinate scheduled maintenance activities and repairs and minimize managed lanes closures. The following sections cover maintenance requirements for all managed lanes. For additional maintenance requirements for express lanes, see Chapter 6. When a project spans multiple Districts, it is recommended that an MOU be in place to define responsibilities.

9.5.1 Types of Maintenance

In general, there are two types of maintenance activities on managed lanes:

Routine Maintenance – Consists of routine, scheduled ITS equipment and roadway maintenance with the intent of preventing or minimizing a future equipment failure and preserving, repairing, or replacing roadway features.

Responsive Maintenance – Occurs in response to equipment failure or an incident. This type of maintenance cannot be scheduled in advance and typically must be attended to quickly to address the failure and return the system to full functionality.

9.5.2 Intelligent Transportation Systems

ITS maintenance is important for managed lanes operations because any interruption of ITS services can result in operational failures. Maintenance work on managed lanes ITS equipment is done in accordance with the maintaining District's TMC SOPs, as well as with the manufacturer's recommendations and industry best practices.

9.5.3 Routine ITS Maintenance

Routine maintenance reduces equipment failures and extends the life of the ITS system. It includes daily, weekly, monthly, or semi-annual inspections of the systems, and detailed procedures for field checks of all the ITS components. Maintenance intervals may need to be adjusted based on location, equipment type, and the criticality of the device to managed lanes operations.

For each managed lanes system, the following preventive ITS maintenance is conducted, at a minimum:

A. **Dynamic Message Signs**
Maintenance of displays, battery backup, AC power, trimming of any trees obstructing views, and checking of all connections.

B. **Cameras**
Lens and dome cleaning, pan/tilt/zoom (PTZ) assembly maintenance, communications checks, power checks, clearance of any trees obstructing views, and camera alignment corrections for maximum visibility. Districts may consider enhanced maintenance tasks for dedicated verification cameras.

C. **Vehicle Detectors**
Calibration, communications checks, and power checks.

D. **Communications Equipment**
Checking and repair of the fiber communications system between TMCs, and from the TMC to the field.

E. **Transportation Management Center Equipment**
Maintenance of all equipment within the TMC, including the video wall, backup power, and other ancillary hardware. Districts are also responsible for the recurring system costs and general building maintenance.

F. **Software and Hardware**
Updates and patches to the SunGuide® software, SELS if applicable, maintenance of the hardware for database and system management, and hardware additions for any new or expanded software patches or capabilities.

G. **Access Gates**
Power system, communication system, access control unit, and mechanical system maintenance.

H. **ITS Cabinets**
Power system, backup power system, communication system, equipment and air conditioning unit maintenance, cabinet security checks, and vandalism protection or abatement.

I. **Power Subsystem and Generator Backup**
Maintenance of oil, gas filters, regular run cycles, automatic transfer switch (ATS) testing, supervisory control and data acquisition (SCADA) alarm validation, and disconnect switch, fuses, etc.

9.5.4 Responsive ITS Maintenance

Responsive maintenance is necessary when problems arise with any portion of the ITS system. A problem can be anything from a failed component that needs repair to a portion of software that needs reconfiguring. The priority of the maintenance response is dependent on the severity of the component failure.

Typical causes of component malfunctions requiring immediate attention include lack of communication, vehicle crashes, theft, vandalism, and weather damage. Priority should be given to addressing these critical failures through expedited response.

Non-critical failures include problems that do not immediately affect the demand management of the managed lanes. Each District evaluates existing protocols for responding to critical and non-critical failures and adjusts them, as necessary, for different types of managed lanes ITS infrastructure.

9.5.5 Roadway Maintenance

Roadway features (drainage, guardrails, crash cushion, pavement marking, rigid or flexible pavement, signs, tubular markers, concrete barriers, etc.) that are part of managed lanes are maintained as part of, and in the same manner as, a limited access system. In order to minimize downtime of the managed lanes system, it is a best practice to schedule non-critical ITS maintenance tasks concurrently with roadway maintenance tasks, if possible.

9.5.6 Tubular Markers Maintenance

When a managed lanes system utilizes a buffer with tubular markers as the chosen separation type, the tubular markers must comply with *FDOT Standard Specifications 704* and *991* for tubular markers.

Special consideration is given for the maintenance of tubular markers. If a performance-based asset maintenance contract is being used to maintain the roadway portion, then it is recommended that specific performance criteria for tubular markers and other unique managed lanes roadway features be used and for language to be included as part of the scope of services for the particular contract. Maintenance of tubular markers should at a minimum comply with the Maintenance Rating Program Handbook for Object Markers and Delineators.

10 MOBILITY PERFORMANCE REPORTING

Performance monitoring for the Department's managed lanes is achieved through a combination of before and after studies, structured reporting, and Quality Assurance (QA) and Quality Control (QC). This allows projects to be evaluated against the original goals to determine if operational changes are needed to meet project objectives.

Performance reporting can be used to evaluate and track mobility and safety characteristics of managed lanes, as well as any specific project innovations. Performance reports are prepared by each District in coordination with the Managed Lanes Planning Team, TEO, and PF. Reports should be customized to meet the needs of each individual facility. Reports may be posted on the facility's website or shared with project stakeholders. The reporting plan for each system can be updated as the system's reporting needs change.

11 FUNDING AND PROJECT FINANCE FOR NON-TURNPIKE, DEPARTMENT-OWNED TOLL FACILITIES AND MANAGED LANES

This chapter identifies the roles and responsibilities of the Districts and PF in the development of managed lanes projects, including financial impacts and cost breakout for projects. It also establishes policies for the use of express lanes revenue in support of regional networks. This chapter applies to non-Turnpike, Department-owned facilities.

11.1 Project Finance within the Financial Management Office

PF provides strategic and innovative financing solutions, analysis, and reporting. PF ensures the advancement of transportation projects and accountability and consistency with the Department's policies and procedures.

PF must be contacted with any questions related to finance processes required for a toll facility, including, but not limited to, the following: managed lanes finance plans to include both the capital and on-going operating and maintenance costs; funds specific to managed lanes and programming of those funds; the Florida Department of Transportation Financing Corporation (TFC); loans from the State Transportation Trust Fund (STTF); repayment of debt; major project financial plans required by FHWA; Public-Private Partnerships (P3); and State Infrastructure Bank (SIB) loans.

PF is involved in the early stages of project planning for all managed lanes projects, in part, to assist in determining the best financing approach for project delivery, but also, just as importantly, for the planning of ongoing O&M costs and the funds to pay for those project costs. All discussions regarding project revenue distribution on a network are also coordinated through PF.

11.2 Flow of Funds

Unless otherwise specified in a legally binding contract to which the Department is a party (e.g., a toll facility's bond indenture), the Department applies toll revenues against a toll facility's costs in the following order:

- O&M
- debt service payments (if applicable)
- renewal and replacement costs (e.g., ITS replacement, resurfacing, etc.)

Section 338.166, F. S., dictates how the flow of funds is implemented once a facility's debt has matured. Under this statute, the Department is permitted to continue collecting tolls on a facility after retiring any project debt (as applicable). Toll revenues are first used to pay O&M and subsequently renewal and replacement costs. Any remaining toll revenue (excess revenue) is used by the Department for the construction, maintenance, or improvement of any road on the SHS within the county or counties in which the revenues were collected, or to support express bus service on the facility where the toll revenues were collected.

Generally, the Department will not require repayment of a project's original capital costs (i.e., construction) that are funded with SIS funds unless otherwise required by law or bond documents. Exceptions will be determined on a case-by-case basis.

Figure 11-1 illustrates the flow of funds for a generic toll facility.

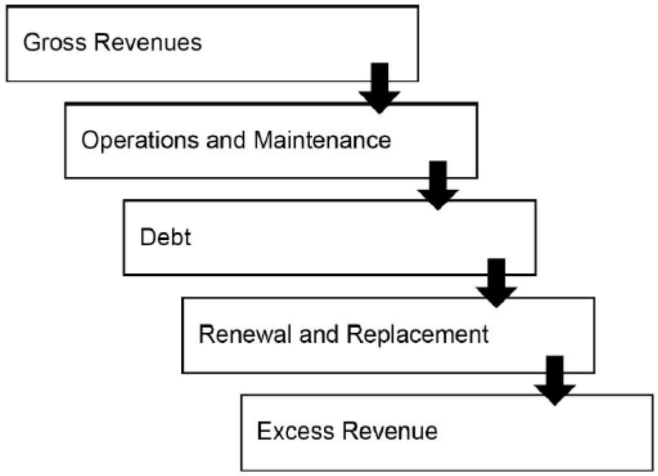


Figure 11-1 Flow of Funds

Tolls collected on the FTE System are required to be used on the FTE System as defined by Section 338.22, F. S. (also known as *Florida Turnpike Enterprise Law*).

11.3 Constructing New Facilities When Debt Is Issued

When constructing new facilities, the Department may enter into service contracts with the FDOT Financing Corporation, or other debt instruments, in connection with approved projects. Debt repayments will be funded with available toll revenue or other District or statewide funds if toll revenues are not sufficient to cover the debt service. Coordination with PF is required to ensure appropriate funding of debt service in the Work Program.

11.4 Managed Lanes Traffic and Revenue Studies

In conjunction with the Districts, PF develops toll facility finance plans pertaining to all sources and uses of revenues for the facility. A sketch-level T&R study should be conducted during the planning stage of a facility and no later than five years prior to the toll facility achieving toll commencement. This timeframe generally coincides with the initial finance plan development at the time of construction programming. A Planning-level T&R study should be conducted no later than two years prior to the facility achieving toll commencement. Generally, a forecast update should be conducted in the fiscal year when tolling commences and every fiscal year after tolls have commenced. Once tolls have stabilized, forecasts may be reduced from annually. Every year, PF and FTE will determine whether a toll facility requires a forecast update, which will capture considerations such as the amount of toll revenues collected in prior years. All T&R studies are paid for by the Districts or facility, with oversight of the study provided by FTE.

Targets and Production Accomplishment Report (PAR) Program Targets are program dollar-level requirements, by District and program area, that establish specific programming objectives to be attained in developing the Tentative and Adopted Five-Year Work Program. Targets are derived from the objectives developed pursuant to Section 334.046, F.S., through needs assessments and related statutory criteria, and are implemented using individual allocations, or by requiring mandatory use of specific levels of other allocations. Program targets are published in Schedule B of the Work Program Instructions. Schedule B is a schedule that shows the allocation of program targets by District and fiscal year.

A PAR and Target are established for express lane facilities to ensure that the cost of the express lane portion of any project is covered first with toll revenues, if available. Toll PAR allocations are established by PF for each toll facility based upon the most recent T&R Study. To the extent that toll revenues are insufficient to cover express lane costs, districts must apply other funding sources (District or statewide funds) to meet the needs of the facility.

For more information on the use and programming of toll revenues, please see the Work Program Instructions, Chapter 41: Florida Turnpike Enterprise, Other Toll Facilities, and Managed Lanes. Fund allocations and program targets are also published in Schedule A and Schedule B of the Work Program Instructions.

11.5 Operations and Maintenance of Express Lanes

All operating costs for the express lanes are accounted for by prorating the number of express lanes to the overall number of lanes on the corridor. For maintenance cost estimates, an average per lane mile cost is used based on the average urban lane cost for maintenance provided by the State Maintenance Engineer.

FTE estimates annual operating costs each year, but the District produces a budget for each toll facility. To the extent that toll revenues are available, operating costs are programmed using the TOXX Work Program fund code, and maintenance costs are programmed using the TMXX Work Program fund code. To the extent that toll revenues are available, Planning, PD&E, Construction (periodic maintenance, renewal and replacement, and capital improvement), CEI, and all in-house phases are programmed using the DSBX Work Program fund code. If toll revenues are insufficient to cover all TOXX, TMXX, and DSBX costs, Districts must apply other funding sources (District or statewide funds) to meet the needs of the facility. The availability of toll revenue is determined by the toll facility's PAR balance. PF and District Work Program offices can assist with ensuring Toll PARs are balanced to available revenue.

The Districts are expected to program to the targets and allocations published by the Finance, Program and Resource Allocation (FPRA) group. If there is not enough target to cover the District need for all facilities (general use, toll facilities and managed lanes), the District should contact the responsible office (Traffic Operations or Maintenance) to raise their needs in preparation for the Program Planning Workshops held each spring. These workshops are the primary opportunity for Districts to discuss funding needs.

11.6 Periodic Maintenance

Periodic maintenance consists of periodic repair, rehabilitation, and capital improvements such as resurfacing and ITS replacement, which uses DSBX funds. To the extent that toll revenue is available on the toll facility's PAR, Districts may program periodic maintenance using the appropriate DSBX fund. If toll revenues are insufficient to cover periodic maintenance DSBX costs, Districts must apply other funding sources (District or statewide funds) to meet the needs of the facility.

Please refer to Chapter 41: Florida Turnpike Enterprise, Other Toll Facilities, and Managed Lanes in the Work Program Instructions for complete programming guidelines for managed lanes operated as toll facilities.

11.7 Finance Plan (Sources and Uses)

A finance plan, also known as the sources and uses forecast, is a net financial impact of a toll facility and its programming impact to the STTF. The sources and uses forecast is used to determine whether a facility has excess revenue that may be used in accordance with Section 338.166, F. S. Additionally, it shows how much of the facility is funded with toll revenue and how much is funded with other District or statewide funds. The sources and uses forecast includes the revenue forecast, toll operating costs, District operating costs, maintenance costs, repayment of debt, current projects programmed in the Five-Year Work Program, and future periodic maintenance forecasts (beyond the Five-Year Work Program). It is the responsibility of the Districts to ensure all projected operating, maintenance, and Renewal and Replacement (R&R) costs are programmed in the Five-Year Work Program for their existing facilities, as well as facilities to be constructed and/or planned to open during the Five-Year Work Program. Once debt, if any, has been fully repaid, and all future express lanes network needs are met, remaining revenue is used in accordance with Section 338.166, F.S., with approval from the Assistant Secretary of Finance and Administration.

The sources and uses forecast is updated after each snapshot. Updates to the revenue forecasts are developed by FTE in coordination with the District that is the project owner and PF. Operations, maintenance, and periodic maintenance programming updates are made in accordance with the Tentative and Adopted Work Program development cycle, and it is the responsibility of the District to work with PF on programming matters for toll funds (i.e., TO, TM, DSB).

11.8 FDOT Toll Facility/Managed Lanes Toll Programming Guidance

Please refer to Chapter 41: Florida Turnpike Enterprise, Other Toll Facilities, and Managed Lanes in the Work Program Instructions for complete programming guidelines for managed lanes operated as toll facilities.

11.8.1 Excess Toll Revenues

Excess toll revenues are defined as the toll revenues after funds have been set aside and programmed to cover anticipated facility O&M costs, R&R costs, and if applicable, fund deposits, annual debt service, escrow deposits (accumulation of cash to cover planned deposits), and availability payments.

As evidenced in the toll facility PAR, if excess revenues are anticipated for a toll facility/managed lanes, and a District would like to program toll funds based on those excess revenue estimates to support off-facility costs, the following conditions will have to be met:

- The toll facility/managed lanes must have been operational for a minimum of three years.
- The cumulative debt due to STTF must be paid down to $0.
- The toll facility/managed lanes must have two consecutive years of excess revenues following debt being paid down to $0.
- The request for additional programming must be submitted to PF and approved by the Assistant Secretary of Finance and Administration.

If a steady yearly stream of excess toll revenues is projected, a commitment of toll funds for off-facility use for future years may be permitted. However, Department staff are not to assume excess toll funds exist—it is important to consult with PF to determine the amount of excess toll revenues that are projected and in which years excess toll revenues exist. PAR balances alone do not determine excess revenue. Facility sources and uses, in conjunction with revenue and expense statements must be reviewed by PF to determine if excess revenue exist and are available for use.

If excess revenue does not exist for toll facilities/managed lanes, additional toll funds may not be programmed beyond what are already programmed. These facilities must utilize District funds to accommodate additional programming needs. If District funds are unavailable, Districts should inform their respective leadership team (District Secretary) to commence executive-level discussions about alternate sources of funds that may be available (e.g., SIS funds).

11.9 Major Projects Financial Plan

Toll facility projects that are over $500 million in total project costs and have federal funds programmed on them (past, present, or future) are considered Major Projects by FHWA. Major projects are required to have an approved

- Project Management Plan (PMP),
- Cost and Schedule Risk Assessment (CSRA), and
- Initial Financial Plan (IFP) and annual updates.

The scope of the major project includes all work under the National Environmental Policy Act (NEPA) limits (i.e., all costs, all phases). For Design-Bid-Build projects, all major project documents (PMP, CSRA, and IFP) must be approved by FHWA in order to receive federal authorization to advertise. For P3 and Design-Build projects, conditional federal authorization may be given by FHWA prior to award, but all major project documents (PMP, CSRA, and IFP) must be approved by FHWA by notice to proceed to begin construction.

Please contact PF for guidance.

11.10 U.S.C. Section 129 Requirements

Annual Certification. For Department-owned, federally supported facilities that are tolled, the Department is required to comply with ***U.S.C. Title 23, Section 129*** *-Toll roads, bridges, tunnels, and ferries subsections (A) and (B)*, which requires an annual certification that

- toll revenues have been properly expended, and
- facilities have been properly operated and maintained.

PF coordinates the annual certification for Section 129(3)(A) and (B).

Tolling Agreements and MOUs. FDOT and FHWA will execute an MOU for each new toll facility authorization; however, previous toll agreements that were executed between FDOT and FHWA remain active and may be amended as required. Contact PF for guidance and the most recent MOU template. PF will coordinate the execution of MOUs for new facilities approximately two months before the facility opens to tolling.

Equal Access for Buses. Section 129(9)(A) requires that Over the Road Buses (OTRBs) have equal access to federal-aid toll facilities as Public Transportation Vehicles (PTVs). PF is responsible for compliance reporting. PF should be notified immediately if any rates, terms, or conditions for PTVs differ from the rates, terms, or conditions applicable to OTRBs.

APPENDICES

A. Acronyms

ACRONYM	TERM
AADT	Annual Average Daily Traffic
ADA	American Disabilities Act
ATS	Automatic Transfer Switch
CAV	Connected and Automated Vehicle
CCSS	Centralized Customer Service System
CEI	Construction Engineering Inspection
CEQ	Council on Environmental Quality
CMT	Change Management Team
ConOps	Concept of Operations
CSRA	Cost and Schedule Risk Assessment
DDHV	Directional Design Hour Volume
DHV	Design Hour Volume
DMS	Dynamic Message Sign
DTOE	District Traffic Operations Engineer
ERA	Emergency Refuge Area
ESS	Emergency Stopping Sites
FAC	Florida Administrative Code
FDM	FDOT Design Manual
FDOT	Florida Department of Transportation
FHP	Florida Highway Patrol
FHWA	Federal Highway Administration
FPID	Financial Project Identification
FS	Florida Statutes
FTE	Florida's Turnpike Enterprise
GTR	General Tolling Requirements
GUL	General Use Lane
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HSM	Highway Safety Manual
IAR	Interchange Access Request
IARUG	Interchange Access Request User's Guide
IC	Incident Commander
IFP	Initial Financial Plan
IRV	Incident Response Vehicle
ITS	Intelligent Transportation Systems
LOS	Level of Service
LSDMS	Lane Status Dynamic Message Sign
MOU	Memorandum of Understanding
MPH	Miles per Hour
MPO	Metropolitan Planning Organization
MTL	Managed Transit Lane
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
O-D	Origin-Destination
O&M	Operations and Maintenance
OTM	Operations Task Manager
P3	Public-Private Partnership
PD&E	Project Development and Environment
PF	Project Finance within the Financial Management Office
PMP	Project Management Plan
PTAR	Project Traffic Analysis Report
PTSU	Part-Time Shoulder Use
PTZ	Pan/Tilt/Zoom
QA	Quality Assurance
QC	Quality Control
R&R	Renewal and Replacement
RCTO	Regional Concept of Transportation Operations
RFP	Request for Proposal
RITSA	Regional Intelligent Transportation System Architecture
ROW	Right of Way
SCADA	Supervisory Control and Data Acquisition
SELS	Statewide Express Lanes Software
SEMP	Systems Engineering Management Plan
SHS	State Highway System
SIB	State Infrastructure Bank

ACRONYM	TERM
SIO	FDOT Systems Implementation Office
SIS	Strategic Intermodal System
SMEs	Subject Matter Experts
SO&E	Safety, Operational, and Engineering
SOG	Standard Operating Guidelines
SOP	Standard Operating Procedures
STTF	State Transportation Trust Fund
T&R	Traffic and Revenue
TADMS	Toll Amount Dynamic Message Sign
TAS	Toll Amount Sign
TD	Traffic Density
TEM	Traffic Engineering Manual
TEO	FDOT Traffic Engineering and Operations Office
TFC	Florida Department of Transportation Financing Corporation
TIM	Traffic Incident Management
TMC	Transportation Management Center
TOD	Time of Day
TSM&O	Transportation Systems Management and Operations
TSTM	Toll Siting Technical Memorandum
U.S.C.	United States Code
VPH	Vehicles per Hour
VTTS	Value of Travel Time Savings

B. Definitions

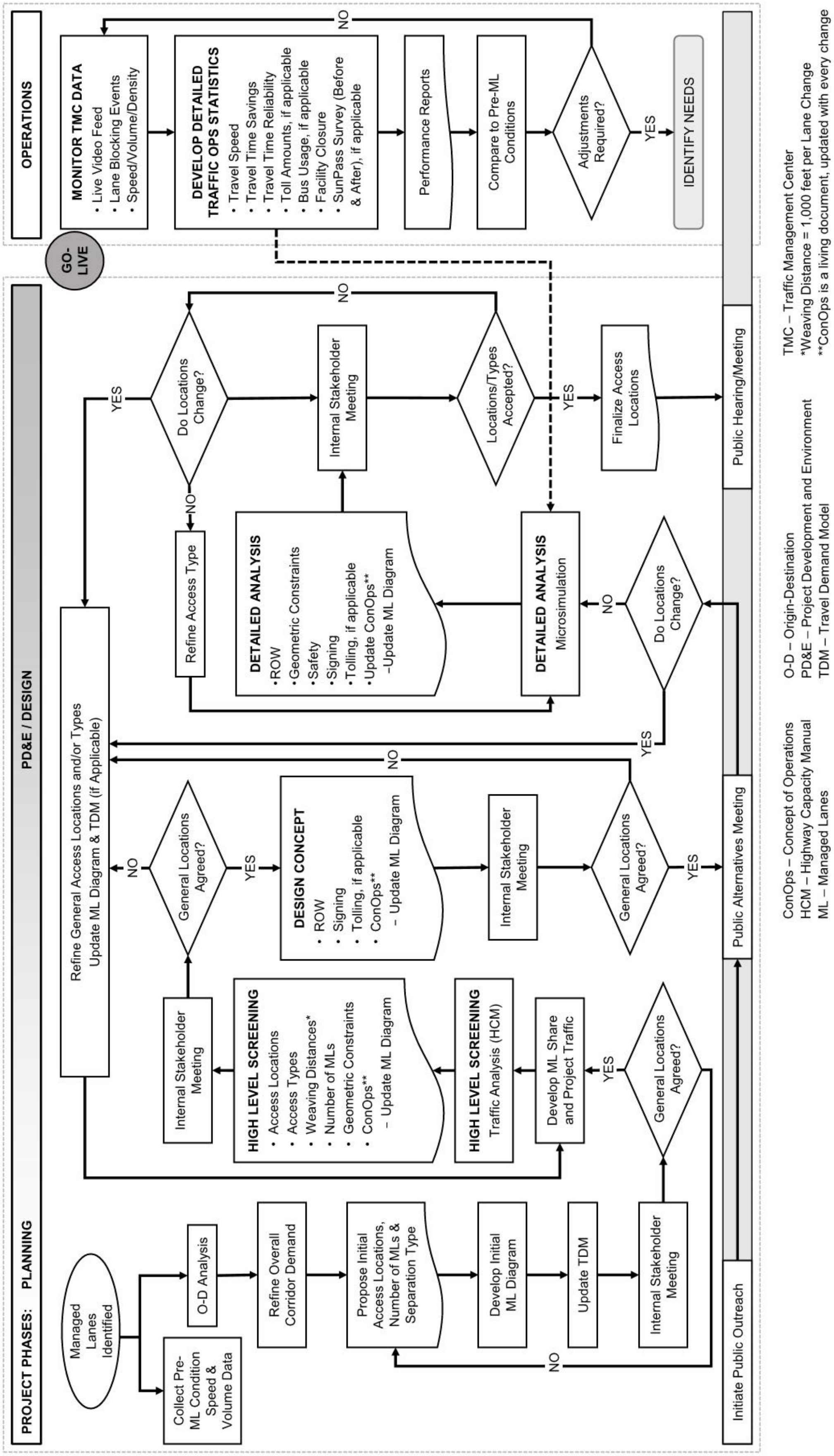
TERM	DEFINITION
Annual Average Daily Traffic (AADT)	A measurement of the number of vehicles that use a highway over a period of a year divided by 365 to obtain the average for a 24-hour period.
Average Daily Traffic (ADT)	The number of vehicles that traverse a segment of roadway over a 24-hour period.
Barrier Separation	Continuous concrete barrier that is used to separate the managed lanes from the general use or thru lanes.
Bus-Only Lane	A managed lanes facility dedicated primarily for buses and often active only on certain days and times in severely congested urban areas with the goal of reducing trip times and improving travel time reliability. Typically designed to use the fastest route between the major origin and destination points utilizing existing managed lanes to meet that goal.
Carpool 3+ Lanes	Lanes reserved or dedicated for passenger vehicles carrying a minimum of three people in the vehicle.
Data Gantry	A toll gantry that only collects information needed to accurately identify the customer's entry into the express lane. The toll site infrastructure for a data gantry and a toll gantry are identical.
Design Hour Volume (DHV)	The traffic volume expected to use a highway segment during the design hour of the design year.
Directional Design Hour Volume (DDHV)	The traffic volume expected to use a highway segment during the design hour of the design year in the peak direction.
Dynamic Message Sign (DMS)	A large electronic sign over or near roadways used to display real-time traffic information to travelers.
Dynamic Pricing	A toll amount that is adjusted based on traffic conditions in the express lanes.
Dynamic Tolling	Varying toll amounts adjusted based on real-time monitoring of traffic conditions in the express lanes.
Eligible Trips	Trips that have the ability to enter and exit the express lanes based on their origin and destination.

TERM	DEFINITION
Exemption	Immunity from the requirements to which others must abide. For express lanes, exemptions are defined in *Sections 14-100.004(4) and 14- 100.006(3), Florida Administrative Code,* which identify vehicles that are not required to pay tolls.
Express Bus Service	A service in the managed lanes with the goal of making public transportation a more desirable option by reducing trip times and improving travel time reliability. Often used to carry a significant number of passengers between major origination and destination points.
Express Lanes	Optional travel lanes, located on an interstate or toll road, that customers can choose to use when they want a more predictable travel time. Customers in the express lanes pay a dynamically priced toll that increases as traffic begins to build in the express lanes and decreases as traffic reduces. Express lanes are designed with a limited number of entrance and exit points to serve longer, more regional trips.
General Tolling Requirements (GTR)	Source of toll infrastructure criteria/requirements for all project delivery methods including Conventional Projects (Design-Bid-Build) and Non-Conventional Projects (Design-Build, Design-Build Finance, and Public-Private-Partnership).
General Use Lanes (GUL)	Non-tolled travel lanes adjacent to managed lanes.
High Occupancy Vehicle (HOV)	A vehicle carrying two or more passengers.
Highway Capacity Manual (HCM)	A publication of the Transportation Research Board of the National Academies of Science that provides concepts, guidelines, and computational procedures to determine the capacity and quality of service for various highway facilities.
Highway Capacity Software (HCS)	Software that implements most of the HCM methodologies.
Highway Safety Manual (HSM)	TThe premier guidance document for incorporating quantitative safety analysis in the highway transportation project planning and development processes.
Intelligent Transportation Systems (ITS)	Electronics, photonics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system (from Section 501 of Title 23, United States Code, as amended).
Lane Status Dynamic Message Sign (LSDMS)	Notifies users if the express lanes facility is open or closed and provides other relevant warnings prior to entering the express lanes.

TERM	DEFINITION
Level of Service (LOS)	A quantitative stratification of the quality of traffic service into six letter grade levels, with "A" describing the highest quality and "F" describing the lowest quality.
Long-Distance Trip Lanes (Thru Lanes)	Additional travel lanes that help provide congestion relief in high traffic areas. These lanes offer customers making longer, more regional trips, the ability to bypass the local traffic entering and exiting the road.
Managed Lanes	Highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing traffic conditions.
Managed Lanes Diagram	A diagram that illustrates the number of managed lanes, GULs, ingress and egress points, FPID project limits, toll sites, and conceptual signing for the corridor. Managed lanes diagrams should include all interim and ultimate phases to ensure traffic and tolling operations can be maintained.
Managed Lanes Toll Segment	The distance between an ingress (entry) to the managed lanes and the next point of egress (exit).
Manual of Uniform Traffic Control Devices (MUTCD)	Contains the national standards governing all traffic control devices. All public agencies and owners of private roads open to public travel across the nation rely on the MUTCD to bring uniformity to the roadway. The MUTCD plays a critical role in improving safety and mobility of all road users.
Part-Time Shoulder Use (PTSU)	The use of the left or right shoulders of an existing roadway for travel during certain hours of the day, typically during the peak periods when capacity is needed most.
Responsibility Matrix	A table that identifies the roles and responsibilities for many elements of the express lanes facility, from planning through operations and maintenance.
Static Tolling	Fixed toll amounts that are predetermined and applied during all hours of the day.
SunGuide®	Florida's statewide advanced traffic management systems (ATMS) software that monitors traffic, manages incidents, disseminates traveler information, exchanges critical information among agencies, and collects and reports data regarding the operation of Florida's transportation system.
SunPass®	FDOT's prepaid toll program.
Systems Engineering Management Plan (SEMP)	A plan used by the Project Manager or ITS Engineer to manage a project with systems engineering principles and methods. For more information, refer to *Florida's Statewide Systems Engineering Management Plan, March 2005*.

TERM	DEFINITION
Time of Day (TOD) Pricing	A method of establishing an automated toll amount schedule from historical data that specifies the toll in effect for each fifteen-minute interval for each type of day.
Toll Amount	The charge for using the express lanes. The toll amount can be a minimum charge or higher, as determined by the dynamic pricing software, per Florida Administrative Code and Florida Statutes.
Toll Amount Sign (TAS)	Displays the toll amount that will be charged to the customer for traveling to one or more destinations in the express lanes.
Toll Gantry	Truss structure supporting the toll equipment over the roadway.
Truck-Only Lanes	A lane management strategy that separates heavy vehicles from mixed-flow traffic along a highway mainline and allows for the exclusive use of trucks.
Tubular Markers	A series of tubular pylons or delineators that separate the managed lanes from the general use or thru lanes.
Value of Travel Time Savings (VTTS)	Perceived value of travel time saved from traveling a tolled facility instead of taking an alternate, non-tolled route for the same trip. The amount that a traveler would be willing to pay in order to save time and have a more reliable travel time.
Vehicle Eligibility	Management based on user group or vehicle type permitted in managed lanes. Controls what types of user groups or vehicles may be either allowed or restricted to increase overall throughput and achieve other transportation management goals established for the corridor.
Violation	When a driver uses the express lanes without traveling in an eligible vehicle or without having a properly mounted, activated SunPass® or other interoperable transponder.
Violator	A registered owner of a vehicle operated in an express lane without being an authorized user.

C. Access Point Location Flowchart



Working Technical Memorandum

METHODOLOGY FOR LOCATING EXPRESS LANES INGRESS/EGRESS POINTS

1.1 GENERAL

Locating express lanes ingress/egress points is a key part of the express lanes project development process. It is an interactive and iterative process that involves various technical disciplines throughout the entire project lifecycle, including Planning, Project Development and Environment (PD&E), Design, Signing, Tolling, Operations, and Public Outreach. Preliminary ingress/egress locations are proposed during Planning and PD&E and are refined as a project moves forward in Design. If proposed ingress/egress locations cannot be accommodated at any future phase of the project due to constraints, ingress/egress points are adjusted and re-evaluated.

This ***Working Technical Memorandum*** includes the overall methodology, depicted in a flowchart, a table showing participants at each project phase, and considerations for locating express lanes ingress/egress points.

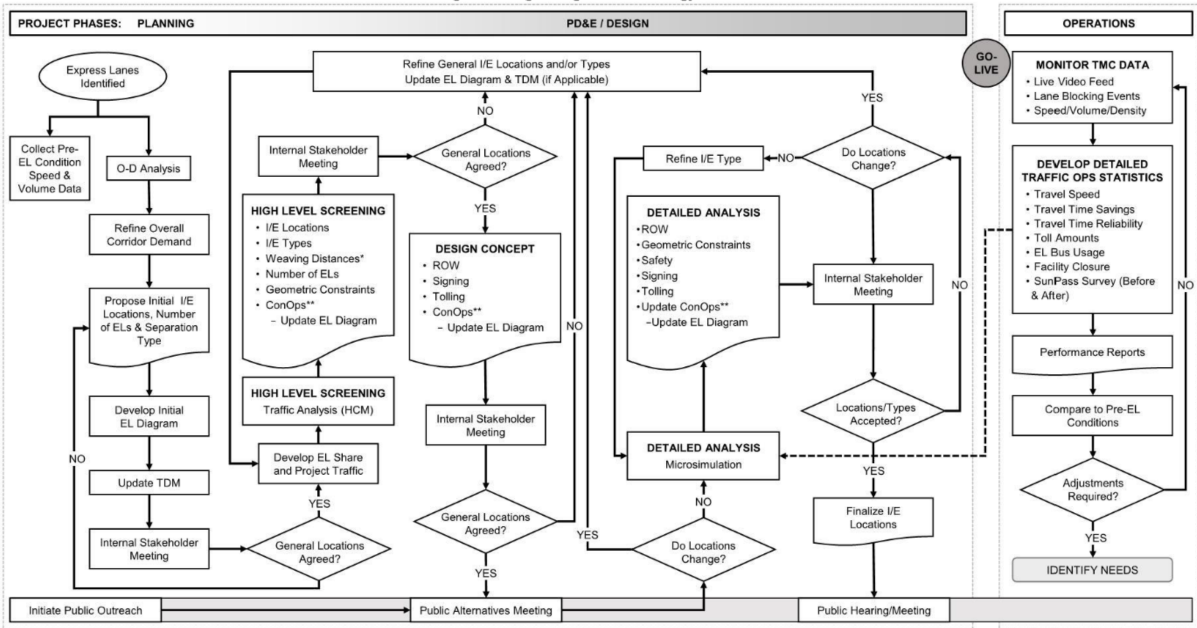
There are three (3) types of access points between general use or general toll lanes, and express lanes, including: point of ingress, intermediate point of ingress or egress, and termination of express lanes. For more information, refer to the ***Florida Department of Transportation (FDOT) Express Lanes Manual (FELM) 2.6.3.1***.

Types of express lanes access include slip ramps, weave lanes, weave zones, and direct connect ramps. Express lanes separation types include buffer separation with express lane markers, wide buffer separation, barrier separation, and grade separation. For information on express lanes access types and separation types, refer to ***FELM 4.3 and 4.6***.

1.2 INGRESS/EGRESS METHODOLOGY FLOWCHART

The ingress/egress methodology flowchart is shown in ***Figure 1-1***. This flowchart shows the project phases and major tasks to be completed within each phase

Figure 1-1: Ingress/Egress Methodology Flowchart



ConOps – Concept of Operations
EL – Express Lanes
ELToD – Express Lanes Time of Day

HCM – Highway Capacity Manual
I/E – Ingress/Egress
O-D – Origin-Destination

PD&E – Project Development and Environment
PIO – Public Information Office
TDM – Travel Demand Model

TMC – Traffic Management Center
*Weaving Distance = 1,000 feet per Lane Change
**ConOps is a living document, updated with every change

1.2.1 Overview of Methodology Flowchart

The ingress/egress methodology begins in the Planning phase, when express lanes are determined to be a feasible capacity improvement option for the facility. At the initiation of the Planning phase, origin-destination (O-D) data should be collected for the express lanes project. It is also important to collect pre-express lanes condition speed and volume data. This data collection can occur concurrently, but must occur before construction to accurately represent “before” conditions. In the Planning phase, as part of the Concept of Operations (ConOps), an initial express lanes diagram is developed using the access locations identified per the O-D analysis and corridor demand. The express lanes diagram begins as a simple stick diagram and is an important communication tool throughout the project lifecycle. It is used at internal stakeholder meetings, held at milestone points throughout the project to gain consensus on the proposed project from all disciplines of the project team. Potential key stakeholders include representatives from all the technical areas involved throughout the express lanes project lifecycle, including: Planning, PD&E, Design, Right of Way (ROW), Signing, Tolling, and Operations. Stakeholder meetings help ensure that appropriate considerations have been accounted for, in an effort to minimize re-evaluation or re-location of ingress/egress points. For more detail on express lanes diagram, refer to ***FELM 2.6.2***.

As the project moves into PD&E, project traffic and express lanes share are developed using the Express Lanes Time of Day (ELToD) model or other travel demand model (TDM) tools. High-level traffic analysis, based on the Highway Capacity Manual (HCM) analytical tools is used to screen multiple ingress/egress points and evaluate operational performance as access points are refined from preliminary to more specific locations. During Design, additional and more detailed traffic analysis is performed to demonstrate safety and operational acceptability of ingress/egress points. As the methodology flowchart details, if ingress/egress points are not agreed upon by stakeholders at any phase of the project, they must be adjusted and re-evaluated.

Many express lanes projects are being implemented as phased segments of a larger corridor project or as part of a regional network. Within interim project limits, each step of the methodology should be checked and to the greatest extent possible, access points should be located in the ultimate condition to avoid adjusting interim ingress/egress points when the project moves to the ultimate phase, and to avoid ending interim express lanes in a pre-existing traffic bottleneck or creating new traffic bottleneck. Refer to ***FELM 2.8*** for more information on interim versus ultimate project phasing.

Once a facility “goes-live” and is open to traffic, it remains important to collect detailed traffic operational data and develop performance reports periodically based on facility needs. The data can also be used to calibrate and validate a microsimulation model for detailed traffic analysis. After a facility is open, ingress/egress points can be re-evaluated and adjusted if needs are identified.

Public outreach, including three major public meetings and various communication with the public, is a continuous and consistent process that initiates at the beginning of an express lanes project and continues throughout the life of the project.

1.2.2 Interchange Access Request for Ingress/Egress Points

The need for an Interchange Access Request (IAR) is dependent on the type of access proposed for the express lanes project, and the decision of whether to prepare an IAR for an express lanes project needs to be made collaboratively between the District Interchange Review Coordinator (DIRC), State Interchange Review Coordinator (SIRC), and FHWA. The use of slip ramps, weave lanes, and weave zones does not require the preparation and approval of an IAR. The use of direct connect ramps, however, requires an IAR to be prepared and approved, following the process outlined in ***FDOT's Interchange Access Request Users Guide (IARUG).*** When an IAR is required, the IAR process should be coordinated with the express lanes project traffic development, so that projected traffic is consistent and duplicative work is avoided.

1.2.3 Change of Project Assumption(s)

Locating ingress/egress points is an iterative process and feedback is obtained throughout the project lifecycle. If project assumptions change and ingress/egress locations are no longer valid, location of ingress/egress points are re-evaluated and adjusted accordingly. Key stakeholders from various disciplines should be involved throughout project development. If major project assumptions change, these stakeholders should be consulted to review and update the ingress/egress points as needed.

1.3 PARTICIPANTS BY PROJECT DEVELOPMENT PHASE

In addition to the flowchart, Participants from each technical discipline and their roles for each step of the express lanes ingress /egress methodology are listed in ***Table 1-1***. While leading and supporting roles are identified, it is important for the entire project team to be involved throughout the project lifecycle. To reinforce this participation, internal stakeholder meetings are identified in the methodology flowchart to be held at project milestones. This will promote consensus from all disciplines of the project team before moving forward on the location of express lanes ingress/egress points.

District technical disciplines are the lead and responsible for District facilities, and Florida's Turnpike Enterprise (Turnpike) technical disciplines are the lead and responsible for Turnpike facilities. Turnpike is always available to assist on District and Turnpike facilities.

Table 1-1: Ingress/Egress Methodology Participants

Project Phase	Technical Disciplines Involved		Tasks
	Leading Role	Supporting Role	
Planning	Planning (Project Traffic Forecasting)	Planning (Traffic Analysis), PD&E and Operations	• Analyze O-D data • Refine overall corridor demand • Update Travel Demand Model • Collect pre-express lanes condition speed and volume data
	Planning (Traffic Analysis)	Planning (Project Traffic Forecasting) and PD&E	• Refer to initial ConOps • Propose initial ingress/egress locations, number of express lanes and express lanes separation types • Develop initial express lanes diagram
	Planning and PD&E	Design, Signing, Tolling, Operations and other relevant project stakeholders	• Conduct first Internal stakeholder meeting as a milestone meeting to gain consensus from internal stakeholders
	Public Outreach and PD&E	Planning	• Initiate public involvement process
PD&E / Design	Planning (Project Traffic Forecasting /Traffic Analysis) and PD&E	Design, ROW, Signing, Tolling and Operations	• Develop express lanes share and project traffic • Use HCM-based tools to screen ingress/egress alternatives • Update ConOps and express lanes diagram after screening
	Planning and PD&E	Design, ROW, Signing, Tolling, Operations and other relevant project stakeholders	• Conduct second Internal stakeholder meeting as a milestone meeting to gain consensus from internal stakeholders
	Public Outreach and PD&E	Planning	• Continue public involvement, conduct Public Alternative Meeting
	Planning (Traffic Analysis)	PD&E	• Detailed analysis using Microsimulation-based tools to identify operational issues
	Design, ROW, Signing, Tolling, and Operations	PD&E	• Detailed analysis for ROW, geometric constraints, safety, signing, and tolling • Update ConOps and express lanes diagram after screening
	Design, ROW, Signing, Tolling, and Operations	Planning, PD&E and other relevant project stakeholders	• Conduct third Internal stakeholder meeting as a milestone meeting to gain consensus from internal stakeholders
	PD&E and Design	Public Outreach, Planning, Design, ROW, Signing, Tolling and Operations	• Conduct Public Hearing/Meeting
Operations	Operations	Planning	• Operate facility • Monitor TMC Data • Provide detailed traffic operations statistics • If needed, collect operational data to calibrate microsimulation model • Prepare performance reports • Compare to pre-express lanes data collected prior to construction
	Operations	Planning, PD&E, Design, ROW, Signing, Tolling and other relevant project stakeholders	• Identify needs for ingress/egress points reevaluation and/or adjustments

1.4 CONSIDERATIONS FOR LOCATING EXPRESS LANES INGRESS/EGRESS POINTS

Throughout the express lanes project development process, several considerations are used to locate ingress/egress points and identify access type. These considerations include the following:

(1) Corridor Origin-Destination (O-D) Patterns;
(2) Project Traffic and Operational Characteristics of the Corridor;
(3) Design Criteria and Availability of Right of Way (ROW);
(4) Tolling Infrastructure Considerations;
(5) Signing Considerations;
(6) Public Outreach;
(7) Express Bus Services and Park-and-Ride Facilities in the Corridor;
(8) Impacts to the Environment; and
(9) Cost

1.5 CORRIDOR O-D PATTERNS

O-D data analysis defines study area travel patterns. It is a requirement for all express lanes projects, as detailed in ***FELM 2.6.1*** O-D data is collected and analyzed at the Planning stage of an express lanes project. Analysis provides existing and design horizon year traffic patterns for the express lanes corridor. Preliminary ingress/egress locations are proposed after O-D analysis is conducted and are further refined by various technical disciplines as the project progresses.

1.5.1 Approaches to Acquire O-D Data

O-D data is acquired from an existing dataset or via field data collection. Existing data sources include U.S. Census Bureau Longitudinal Employer-Household Dynamics (LEHD) data and proprietary travel pattern data, such as Big Data. Field data collection involves conducting an O-D survey to collect corridor interchange-to-interchange movements, existing traffic counts and travel speeds. Approaches to obtain O-D data include the following:

(1) Bluetooth Detectors,
(2) License Plate Identification,
(3) SunPass Tag Data, or
(4) SunPass Toll Tag Readers.
(5) Big Data – Location Based Services

O-D data collection technique and the associated methods are detailed in ***Table 1-2***, below.

Table 1-2: Approaches to Acquire O-D Data

Collection Technique	Method	Time and Cost	Sample Rates	Limitations
Bluetooth Detectors	Capture unique signals from in-vehicle mobile devices	Time and cost efficient	Low sample rates	Low sample rates
License Plate Identification	Detectors to identify vehicle license plates	Higher cost compared to Bluetooth and time consuming	High sample rates	Camera resolution
SunPass Tag Data	Track tolling point transactions	Time and cost efficient	High sample rates	Only applies to toll facilities in operation and only collects data for vehicles paying a toll
SunPass Toll Tag Readers	Similar to Bluetooth detectors, capture SunPass tag data	Higher cost compared to Bluetooth	Sample rates depend on SunPass tag penetration rate in the region and the number of readers available	Only collects data from vehicles equipped with SunPass transponders
Big Data – Location Based Services	Collect locational data from smartphone and mobile devices	Time and cost efficient	High sample rates	Geographical sampling bias

The quality and cost of O-D data is affected by data availability and/or the data collection technique used. An appropriate approach is selected based on project scope and budget.

1.5.2 Steps to Analyze O-D data

When identifying potential ingress/egress locations, consideration is given to both existing year and design horizon year O-D patterns. O-D data can only be collected for the existing year. Collected O-D data, traffic counts, and travel speed data, is used as an input to calibrate a TDM, which provides O-D patterns for both the existing and design horizon year.

There are three (3) steps to analyze O-D data:

(1) Process and expand the O-D data to match the daily and peak period traffic counts.

(2) Review capacity improvements, new facilities, or existing facilities that may have an impact on the demand for the express lanes facility and include in the TDM study area for the design horizon year.

(3) With inputs from step (1) and (2), use the TDM to develop O-D patterns for design horizon year.

After O-D analysis, preliminary ingress/egress points are proposed at preliminary general locations based on high frequency O-D pairs, high volume interchanges, and long-distance eligible trips. Eligible trips are defined in ***FELM 2.6.3.3,*** as trips that have the ability to enter and exit the express lanes based on their origin and destination. It is recommended that estimated eligible trips be greater than forty percent (40%) of total corridor trips for each segment.

1.6 PROJECT TRAFFIC AND OPERATIONAL CHARACTERISTICS OF THE CORRIDOR

Project traffic is developed during the Planning and PD&E phases. The express lanes project traffic includes both the corridor demand, and the split between the general use or general toll lanes and express lanes traffic. Unlike revenue traffic, project traffic is used to determine the number of express lanes needed in each direction. It is recommended that at least two (2) express lanes per direction are implemented, where feasible.

The traffic analysis uses the express lanes project traffic results to provide operational characteristics of the project corridor and identify any potential operational and safety issues related to ingress/egress locations.

During the traffic analysis, multiple ingress/egress points are evaluated, and the points are refined from preliminary to more specific locations. The refined access locations are used to perform additional and more detailed traffic analysis for demonstration of safety and operational acceptability during Design.

1.6.1 Project Traffic Development

There are three (3) approaches to forecast project traffic for express lanes:

(1) *Manual Estimation*
This method uses a manual estimation of the express lanes volume by applying a fixed percentage of the express lanes share of traffic to future year peak hour O-D volumes. Express lanes shares can be derived from observed data on operating express lanes facilities or other factors, including configuration of roadway network, travel demand, and traveler's value of travel time savings.

(2) *Travel Demand Model*

(a) Regional Travel Demand Model with Dynamic Toll Function or Willingness to Pay (WTP) Curve
TDMs can have embedded highway assignment scripting that can estimate express lanes traffic. TDMs with dynamic toll functions or WTP curves can be used to develop express lanes project traffic.

(b) Express Lanes Time of Day (ELToD) Model
ELToD is a traffic assignment tool used in conjunction with a regional travel demand model to split traffic between express lanes and general use or general toll lanes. ELToD is the Florida Department of Transportation's (Department's) preferred tool for forecasting traffic demand and developing

express lanes project traffic. When used to develop project traffic forecasts, appropriate inputs are required to ensure that the forecasts reflect the highest level of traffic that can be accommodated by the facility. For more information refer to ***FELM 3.6.3***.

(3) *Microsimulation Model with Toll Choice Model*
A microsimulation model with a dynamic traffic assignment module and toll choice model can be used to develop project traffic. However, the default toll choice model needs to be modified by the actual model developer to be consistent with the ELToD toll choice model.

Among the three methods, TDMs are the most widely used and recommended tool. Manual estimation is only used for preliminary estimation of project traffic, if the project team has good knowledge of local O-D patterns. Project traffic developed from manual estimation can only serve as a reference and should not be used as the basis for locating ingress/egress points. A microsimulation model can be used on projects where geometrical configuration may have significant impact on project traffic.

1.6.2 Tiered Traffic Analysis

After project traffic is developed, traffic analysis is performed to evaluate the operational performance of ingress/egress locations, mainlines, and ramp junctions. There are two (2) types of traffic analysis tools used:

(1) Deterministic: HCM and HCM-based tools
(2) Stochastic: Microsimulation-based tools

HCM-based tools take less time and cost less compared to microsimulation-based tools but provide less detail and have limitations when analyzing oversaturated conditions and time-varying demand. For more information refer to ***FDOT Traffic Analysis Handbook Chapter 6 and Highway Capacity Manual Volumes 2 and 3***. It is recommended HCM-based tools be used in the Planning phase for high-level screening of ingress/egress locations and microsimulation-based tools be used for detailed operational analysis of preferred ingress/egress locations.

1.7 DESIGN CRITERIA AND AVAILABILITY OF RIGHT OF WAY

Design criteria, spacing and geometry of existing interchanges, length of express lanes segment(s), separation type, geometric characteristics of the corridor, operational characteristics of the corridor, and availability of ROW are considered when choosing the most appropriate access locations and types.

Proposed ingress/egress locations are evaluated using established design criteria detailed in the ***FDOT Design Manual (FDM) 211***.

1.7.1 Selection of Express Lanes Access and Lane Separation

Selection of express lanes ingress/egress access type is driven by the express lanes separation technique, traffic volume, safety, operational characteristics, available ROW, construction cost, and the interchange being served. A range of access types from the general use or general toll lanes to the express lanes are provided; direct connects provide the highest level of separation, followed by slip ramps, weave lanes, and weave zones. As the level of separation increases, the access type can serve higher traffic volumes and provide increased safety; however, with increased level of separation there are potential increased ROW, environmental impacts, and construction costs.

1.7.2 Design Considerations for Locating Ingress/Egress Points

There are five (5) key design considerations in locating ingress/egress points:

(1) *Maintain minimum length of weave*
The length of weave refers to the minimum distance needed per lane change required to move to/from an express lanes ingress/egress to/from an existing interchange ramp. A minimum of one-thousand (1,000) feet per lane change (as specified in ***FDM 211.14.1***) is needed for ingress and egress locations to/from the surrounding roadway network. However, consideration should also be given to traffic volume and lane separation technique. Minimum length of weave is analyzed using microsimulation. With inputs of traffic volume and lane separation technique, microsimulation demonstrates if the operation of express lanes and general use or general toll lanes are acceptable based on the minimum length of weave. If microsimulation shows the deterioration of operations, length of weave must be increased. A sensitivity analysis can be performed to determine the optimal length of weave. If deterioration of operations persists, access points need to be re-evaluated.

(2) *Recommended segment lengths*
Recommended segment lengths vary based on the number of express lanes in each direction, which is determined by project traffic. It is recommended that a segment should at least:
(a) Serve three (3) to seven (7) miles for express lanes corridors with one (1) express lane in each direction
(b) Serve four (4) to ten (10) miles for corridors with two (2) express lanes in each direction; and
(c) Bypass at least two (2) interchanges.

(3) *Avoid congestion points*
Express lanes weaving maneuvers increase friction in the general use or general toll lanes, which can lead to operational issues. If ingress/egress points are proposed at an existing congested interchange experiencing issues with operational performance, express lanes access cannot be provided until interchange issues are addressed. In general, ingress/egress points must bypass congestion areas before they can open for weaving movements.

(4) *Avoid high-incident locations*
A safety analysis, as detailed in ***FELM 2.6.5***, is performed to examine the effects of express lanes on the performance of the facility. Express lanes access weaving movements should avoid areas with a high crash frequency.

(5) *Avoid queue backup at express lanes termination points*
Express lanes serve highly congested areas and are typically implemented in phases, so it is common for the location of interim termination points to be in a pre-existing traffic bottleneck. Merging express lanes traffic should not deteriorate traffic in adjacent general use or general toll lanes. There are several options for terminating express lanes, including merging express lanes back into general use lanes, terminating an express lane at a major traffic attraction, or continuing an express lane as a general use lane, before merging with general use lanes. Traffic flow in the area should be analyzed to determine the recommended merge treatment at express lanes termination.

1.7.3 Design Considerations for Emergency Access

Emergency access is vital to express lanes operations. Emergency access is designed to give first responders access to incidents within the express lanes without the limitation of express lanes ingress/egress points. Emergency access design is dependent on the express lanes separation type utilized. Generally, buffer separation allows more flexibility for first responders access. Barrier separated express lanes require special considerations to accommodate emergency access.

1.7.4 Design Considerations for System-to-System Direct Connections

As the number of express lanes in operation and under construction increases, express lanes are transitioning from independent corridors to regional networks. Therefore, system-to-system direct connect ramps between express lanes are considered and implemented to serve regional needs. There are four (4) types of system-to-system direct connections:

(1) *Express Lanes-to-Arterial (EL-to-Arterial)*
EL-to-Arterial direct connect ramps provide access between express lanes and local arterials.

(2) *Express Lanes-to-Express Bus Park-and-Ride (EL-to-Express Bus PnR)*
EL-to-Express Bus PnR lot direct connect ramps provide access between express lanes and Express Bus Park-and-Ride Lots.

(3) *Express Lanes-to-General Use Lanes or General Toll Lanes(EL-to-GUL/GTL)*
EL-to-GUL/GTL direct connect ramps provide direct access between express lanes and adjacent facility general use or general toll lanes.

(4) *Express Lanes-to-Express Lanes (EL-to-EL)*
EL-to-EL direct connect ramps provide access between express lanes facilities using dedicated ramps. Directly connecting two (2) or more express lanes facilities requires unique considerations when locating ingress/egress points. More considerations for EL-to-EL direct connects are detailed in ***FELM 2.7***. When two (2) different express lanes facilities are directly connected, efficient and timely coordination between the two (2) facilities is required.

System-to-system direct connections are special cases that are more complex than the typical process for locating ingress/egress points. With direct connections, it is even more important to involve all disciplines early in the process, including local government partners, when applicable. Additional guidance will be developed as more experiences are gathered.

1.8 SIGNING CONSIDERATIONS

An express lanes diagram, paired with a conceptual master signing plan, ensures express lanes signage is clear, consistent, and appropriately located. Conceptual signing plans developed by the Districts during the Design phase must be reviewed by Turnpike. The Districts and Turnpike work collaboratively to confirm ingress/egress points and signage are properly located. During the PD&E and Design phases, if identified ingress/egress points cannot accommodate required signage, feedback must be provided to the project team and technical disciplines including Planning, Tolling, Design, ROW, and Operations to possibly revise the ingress/egress point.

For information regarding express lanes sign types and ingress/egress signing sequences, refer to ***Chapter 2, Signs, Section 2.42 Guidelines for Express Lanes Signing, Traffic Engineering Manual (TEM) 2018***.

There are three (3) key signing considerations in locating ingress/egress points:

(1) *Ingress/egress points are adequately spaced*
If ingress/egress points are spaced too closely, it can be difficult to adhere to required signing sequence.

(2) *Ingress/egress points are located with consideration of future signing needs*
It is preferred that current project signing support the regional express lanes network plan and accommodate planned future projects.

(3) *Signing and toll collection system are evaluated simultaneously*
Signing and tolling work collectively on express lanes projects and should be evaluated simultaneously.

1.9 TOLLING CONSIDERATIONS

Tolling refers to the overall operations of the toll collection system, which includes Turnpike Toll System Back Office and roadside toll equipment. For more information on the toll collection system, refer to ***FELM 5.2***.

A toll gantry must be placed near an express lanes ingress point. The roadside toll equipment site must be considered early in the Design Phase for site requirements during the process of locating ingress/egress points. In areas of limited right-of-way or sensitive environmental resources it is recommended that toll equipment sites be evaluated in the PD&E Phase.

There are two (2) key tolling considerations in locating ingress/egress points:

(1) *Locate the toll gantry as close as possible to the ingress point*
If traffic flow is not interrupted, toll gantries should be located within one (1) mile downstream from the last express lane entrance sign, with lane status, at the ingress. This minimizes travel time from the Toll Amount Sign (TAS) to the toll site, so that toll amounts more accurately reflect travel conditions.

(2) *Develop toll plans symmetrically by direction*
A balanced toll plan, with the same number of ingress/egress points in each direction, is preferred.

1.10 PUBLIC OUTREACH

It is important to obtain public support regarding the locations of proposed ingress/egress points. Public outreach introduces express lanes access and usage. It is a continuous and consistent process initiated at the beginning of an express lanes project and continues throughout the project lifecycle. For more information refer to ***FELM Chapter 8.***

1.10.1 Communication with Stakeholders and the Public

It is important to communicate to stakeholders and the public how ingress/egress locations are determined. There are many types of public meetings that may be held during project development to facilitate communication with the public. Ingress/egress locations should be presented to the public during the following three meetings: kick-off meeting, public alternatives meeting, and public hearing. Informal meetings and small groups or committee meetings may be convened to discuss specific ingress/egress locations. For more information about these meetings refer to ***PD&E Manual Part 1 Chapter 11, Topic No. 650-000-001.***

1.10.2 Addressing Comments

The District Public Information Officer (PIO) is the express lanes project representative for all technical disciplines. The PIO presents the express lanes ingress/egress point selection, focusing on how communities benefit, even without direct access to the express lanes. Also, as express lanes are typically implemented in phases, it is important to address interim access points along with future express lanes segments during public outreach. Public input regarding locations and types of access points should be considered and appropriately documented.

Below are potential messages to address questions and complaints from the public regarding access:

(1) Access points were selected based on traffic patterns (O-D data) and interchange spacing to achieve optimal traffic benefits.

(2) Express lanes benefit every user of a roadway. Express lanes provide an alternative to congested general use or general toll lanes. As more vehicles utilize

express lanes, there is less traffic in general use or general toll lanes, which improves travel times for all users of the facility.

(3) Express lanes are not the best option for every trip. Express lanes cover longer distances with limited access; therefore, access may not be provided for short distance trips.

Even after an express lanes system is open to traffic, public outreach continues. Continuous public input allows the Department to better understand the user's experience. This input provides valuable information for making decisions to revise or relocate access points based on operational and safety needs.

1.11 EXPRESS BUS SERVICES AND PARK-AND-RIDE FACILITIES IN THE CORRIDOR

Express bus services in express lanes increases person throughput and helps provide more reliable travel times in express lanes. Reasonably located park-and-ride lots are important to encourage passenger use of express bus service. Lots should be located in alignment with the corridor's major origins and destinations. An express bus ridership forecast helps ensure adequate demand for the express bus services. The forecast is usually based on service area population and employment, park-and-ride lots, express bus stations, frequency of express bus services, and other relevant factors. For more guidance on the planning and design of express bus services, refer to ***FDOT Bus/Express Lane System Planning Guidelines***. If express bus services and/or Park-and-Ride facilities already exist in a corridor, it is important to consider locating ingress/egress points to serve these facilities in an effort to enhance multimodal connectivity. EL-to-Express Bus PnR lot or bus terminal direct connect ramps should be considered if possible.

1.11 IMPACTS TO THE ENVIRONMENT

Potential impacts of express lanes access should be identified early in the project development process. Location of ingress and egress points should be evaluated with respect to potential benefits and impacts to social, natural, cultural and physical environments to satisfy PD&E requirements, including the National Environmental Policy Act (NEPA). Refer to the ***PD&E Manual, Topic No. 650-000-001*** for more detail***.***

1.12 COST

Cost including Construction cost and Operation and Maintenance (O&M) cost varies depending on the type of access and lane separation technique provided. While cost is an important consideration in the process of locating ingress and egress points, previously discussed considerations should be considered before cost when selecting the appropriate access type.

D. Transit Managed Lanes

Bus on shoulder

- D6-Julia Tuttle/I-195 http://www.fdotmiamidade.com/design-projects/beaches/sr-112i-195julia-tuttle-cswy-from-e-of-sr-5biscayne-blvd-to-sr-907alton-rd.html
- D7 – I-275/Pinellas https://www.fdottampabay.com/project/466/443684-1-52-01
- MDX – outside shoulder

Business Access Transit (BAT) lanes

- Jacksonville/JTA – Blanding Blvd
- Pinellas/PSTA – Central Ave BRT https://stpeterising.com/home/2020/7/8/psta-reveals-name-for-st-petes-bus-rapid-transit-project

Bus only

- Jacksonville/JTA - Bay, Jefferson and Broad streets and Kings Avenue
- Orlando/Lynx – Downtown Orlando - https://www.golynx.com/plan-trip/riding-lynx/lymmo/
- Miami/Miami Dade Transit – South Dade Busway https://www.miamidade.gov/transportation-publicworks/routes_detail.asp?route=38

In planning

- International Drive Transit Lanes http://ocfl.net/TrafficTransportation/TransportationProjects/InternationalDriveTransitLanes.aspx
- SMART Plan - http://www.miamidade.gov/citt/smart-plan.asp

E. Examples of Dynamic and Time of Day Toll Setting Parameters Memorandums

FDOT

Florida Department of Transportation

RON DESANTIS
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

KEVIN J. THIBAULT, P.E.
SECRETARY

MEMORANDUM

DATE: Month Day, 20XX

TO: FTE Traffic Operations Engineer
Director of Traffic Engineering and Operations Office

FROM: District X Traffic Operations Engineer

COPIES: District X Secretary

SUBJECT: Express Lanes Project Draft Toll Setting Parameters Template

Suggested Contents

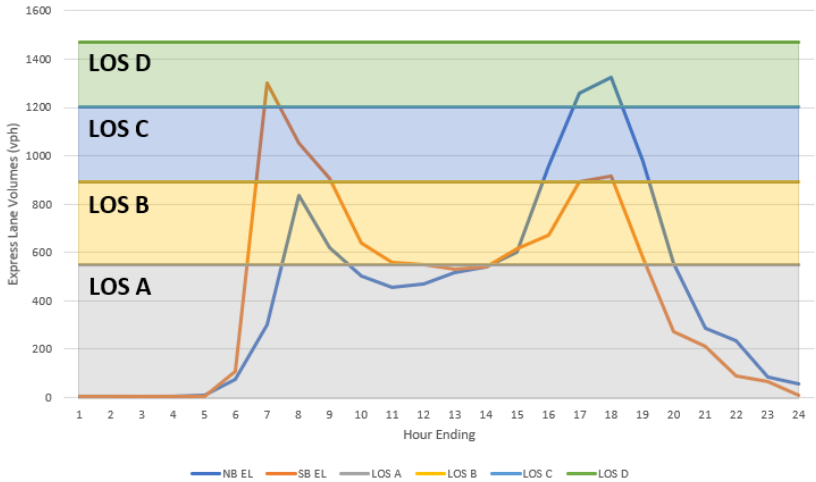
- Project Background
- Tolling Approach
- Basis for Recommendation
- Plan for Project Opening

Example Table 1: Initial LOS Table for Express Lanes Project A

Level of Service	Traffic Density		Dynamic Toll Rate	
	Minimum	Maximum	Minimum	Maximum
A	0	11	$0.50	$0.50
B	12	18	$0.50	$0.50
C	19	26	$0.50	$0.75
D	27	35	$0.75	$2.00
E	36	45	$2.00	$3.00
F	46	50	$3.00	$3.00

Example Figure 1 shows the projected LOS by hour.

www.fdot.gov



Example Figure 1: LOS Table with Projected Hourly Volumes

It is recommended to begin Express Lanes Project A with the initial LOS table (Table 1).

Recommendation:

District Secretary
District X Secretary
Florida Department of Transportation

Enterprise Director & CEO
Enterprise Director & Chief Executive Officer,
Florida Department of Transportation

Chief Engineer
Chief Engineer,
Florida Department of Transportation

Approval:

Department Secretary
Secretary,
Florida Department of Transportation

F. Authority and References

Authority

Sections 20.23(3)(a) and 334.048(3), Florida Statutes (F.S.).

References

Florida Statutes and Florida Administrative Code

- 316.0741 (4)(5)(6), F.S. – *High-occupancy-vehicle lanes (HOV)* – This statute describes the type of vehicles to be driven in an HOV and the decal and registration certificate process that needs to be followed by the Department.
- 335.02(3), F.S. – *Authority to designate transportation facilities and rights-of-way and establish lanes; procedure for redesignation and relocation; application of local regulations* — Section (3) of this statute establishes the process the Department needs to follow when determining the number of lanes for any regional corridor or section of highway on the SHS.
- 338.22, F.S. – *Florida Turnpike Enterprise Law* — Sections 338.22-338.241 may be cited as the "Florida Turnpike Enterprise Law."
- 338.151, F.S. – *Authority of the department to establish tolls on the SHS* – This statute describes when the Department may establish tolls on new facilities on the SHS. In addition, an exception for HOV, express lanes, turnpike systems, and others authorized by law is described when the Department may not establish tolls on limited access facilities.
- 338.155, F.S. – *Payment of toll facilities required: exemptions* – This statute provides a list of the exemptions when a person may use a toll facility without payment of tolls.
- 338.166, F.S. – *High-occupancy toll lanes or express lanes* – This statute allows the Department to issue bonds on high-occupancy toll lanes or express lanes owned by the Department.
- 338.221, F.S. – *Definitions* – This statute defines the terms as used in Chapter 338 from Statute 338.22 to 338.241.
- 14-100.003, Florida Administrative Code (FAC) – *Express Lane Tolling* – The purpose of this rule is to establish criteria for express lanes tolling by FDOT. This rule describes toll criteria for variable tolling, authorized users, and display of toll criteria.
- 14-100.004, FAC – *95 Express Lane Tolling* – The provisions of this section apply to only express lanes on I-95 in Miami-Dade, Broward, and Palm Beach Counties.
- 14-100.005, FAC – *Video Billing* – This rule establishes the process of video billing on the FTE System, other Department-owned toll facilities, and on toll facilities owned by a public or private entity for which the Department collects tolls pursuant to an agreement between the Department and the private or public entity authorized by Section 338.161(5), F.S.
- 14-100.006, FAC – *Department Express Lane Toll Registration Exemption* – This rule establishes the criteria for toll exemptions on express lanes owned by FDOT, excluding the FTE System.

United States Code

- **U.S.C. Title 23, Section 129:** *Toll Roads, Bridges, Tunnels, and Ferries* – Provides limitations on the use of toll revenues generated from FDOT-owned facilities that were funded (in whole or in part) by FHWA or any other federal entity.
- **U.S.C. Title 23, Section 146:** *Carpool and Vanpool Projects* – In order to conserve fuel, decrease traffic congestion during rush hours, improve air quality, and enhance the use of existing highways and parking facilities, the Secretary may approve federal financial assistance from funds apportioned under section 104(b)(2) of this title, projects designed to encourage the use of carpools and vanpools. Such a project may include, but is not limited to, such measures as providing carpooling opportunities to the elderly and handicapped, systems for locating potential riders and informing them of convenient carpool opportunities, acquiring vehicles appropriate for carpool use, designating existing highway lanes as preferential carpool highway lanes, providing related traffic control devices, and designating existing facilities for use as preferential parking for carpools.
- **U.S.C. Title 23, Section 166:** *HOV Facilities* – A public authority that has jurisdiction over the operation of an HOV facility shall establish the occupancy requirements of vehicles operating on the facility.
- **U.S.C. Title 23, Section 167***: National Freight Program* – It is policy to improve the condition and performance of the National Highway Freight Network to ensure that the network provides the foundation for the United States to compete in the global economy and achieve the goals described below:
    1. to invest in infrastructure improvements and to implement operational improvements on the highways of the United States.
    2. to improve the safety, security, efficiency, and resiliency of freight transportation in rural and urban areas.
    3. to improve the state of good repair of the National Highway Freight Network.
    4. to use innovation and advanced technology to improve the safety, efficiency, and reliability of the National Highway Freight Network.
    5. to improve the efficiency and productivity of the National Highway Freight Network.
    6. to improve the flexibility of states to support multi-state corridor planning and the creation of multi-state organizations to increase the ability of states to address highway freight connectivity.
    7. to reduce the environmental impacts of freight movement on the National Highway Freight Network.

FDOT Policy and Procedures

- Topic 000-525-045: *Managed Lanes Policy* – This procedure provides guidance for employing managed lanes on appropriate facilities that experience significant congestion in existing or projected future conditions.
- Topic 525-030-120: *Project Traffic Forecasting* – This procedure provides instructions for using design traffic criteria to forecast corridor traffic and project traffic. The selection of the most appropriate analysis method(s) must be coordinated with FDOT before conducting the study. District planning offices will be responsible for carrying out the traffic forecasting process.
- Topic 525-030-160: *New or Modified Interchanges* — This procedure sets forth the state and federal requirements and processes to be used for determination of Safety, Operational, and Engineering (SO&E) acceptability associated with adding or modifying interchange access to limited access facilities on Florida's SHS. Full compliance with the requirements and processes in this procedure is required for any Interchange Access Request (IAR).

- Topic 525-030-260: *Strategic Intermodal System Highway Component Standards and Criteria* — This procedure addresses the responsibilities of the various offices within FDOT to develop and implement the Strategic Intermodal System (SIS). It also defines the requirements for coordination with the local government and Metropolitan Planning Organization (MPO) transportation planning process. Such coordination is needed to ensure IARs are consistent with the SIS Master Plan and Action Plan for the affected facilities.
- Topic 650-000-001: *Project Development and Environment (PD&E) Manual* — This manual describes in detail the process by which transportation projects are developed by the Department to fully meet the requirements of the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ), and other related federal and state laws, rules, and regulations. The manual aids project analysts and project managers in understanding all aspects of the project development process and its requirements, such as engineering and environmental analyses, public involvement, and documentation.
- Topic 625-000-002: *FDOT Design Manual (FDM)* – This manual sets geometric and other design criteria, as well as procedures, for FDOT projects. The information in the FDM applies to the preparation of contract plans for roadways and structures.
- Topic 750-000-005: *Traffic Engineering Manual (TEM)* – This manual provides traffic engineering standards and guidelines to be used on the SHS by the Department's District Traffic Operations Offices.
- Topic 750-040-003c: *FDOT Systems Engineering and Intelligent Transportations Systems Architecture Procedure* – This procedure concerns all entities associated with federally funded intelligent transportation systems (ITS) projects including local agencies, MPOs, and all applicable units of FDOT. This procedure contains information related to the methodology and maintenance of ITS architecture and the roles of agencies in ensuring this procedure is applied.

G. Resources

Managed Lanes Projects Database
https://managedlanes.wordpress.com/2021/01/05/projects-database/

Managed Lanes Chapter for the Freeway Management and Operations Handbook; Office of Operations, FHWA
https://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/revision/jan2011/mgdlaneschp8/sec8.htm

Congestion Pricing: A Primer; Publications, FHWA
https://ops.fhwa.dot.gov/publications/congestionpricing/sec2.htm

Toll Facilities in the United States; Office of Highway Policy Information, FHWA
https://www.fhwa.dot.gov/policyinformation/tollpage/2015/history.cfm

Guidance General Tolling Programs; MAP-21, FHWA
https://www.fhwa.dot.gov/map21/guidance/guidetoll.cfm

Traffic Engineering and Operations Office, Managed Lanes
https://www.fdot.gov/traffic/its/managedlanes.shtm

FDOT Project Traffic Forecasting Handbook
https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/2019-project-traffic-forecasting-handbook.pdf?sfvrsn=e105e71d_2

FDOT Traffic Analysis Handbook
https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/planning/systems/systems-management/document-repository/traffic-analysis/traffic-analysis-handbook_05-2021.pdf?sfvrsn=cecdd23b_2

FDOT Interchange Access Request User's Guide
https://www.fdot.gov/planning/systems/documents/sm/default.shtm

FDOT Project Development and Environment (PD&E) Manual
https://www.fdot.gov/environment/pubs/pdeman/pdeman-current

FDOT Design Manual
https://www.fdot.gov/roadway/fdm

FDOT Traffic Engineering Manual
https://www.fdot.gov/traffic/trafficservices/studies/tem/tem.shtm

FDOT Standard Specifications
https://www.fdot.gov/programmanagement/specs.shtm

Florida's Statewide Systems Engineering Management Plan
https://www.fdot.gov/traffic/ITS/Projects-Deploy/SEMP.shtm

General Tolling Requirements
General Tolling Requirements – Florida's Turnpike (floridasturnpike.com)

Manual on Uniform Traffic Control Devices (MUTCD), FHWA
https://mutcd.fhwa.dot.gov/index.htm

Federal Transit Administration Bus Lanes Research
https://www.transit.dot.gov/research-innovation/bus-lanes

23 USC 166: HOV facilities
https://uscode.house.gov

NCHRP Research Report 835. National Academies of Sciences, Engineering, and Medicine 2016. *Guidelines for Implementing Managed Lanes*. Washington, DC: The National Academies Press. https://doi.org/10.17226/23660.

NCHRP Research Report 891: National Academies of Sciences, Engineering, and Medicine 2018. *Dedicating Lanes for Priority or Exclusive Use by Connected and Automated Vehicles*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25366.

NCHRP Report 649. National Academies of Sciences, Engineering, and Medicine 2010. *Separation of Vehicles CMV-Only Lanes*. Washington, DC: The National Academies Press. https://doi.org/10.17226/14389.

HCM 6th Edition Transportation Research Board. 2016. *Highway Capacity Manual 6th Edition: A Guide for Multimodal Mobility Analysis*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24798.

Fuhs, C.A. *High-Occupancy Vehicle Facilities: A Planning, Design, and Operations Manual*. Parsons Brinckerhoff, Inc., December 1990. https://trid.trb.org/view/369933.