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# 2024 TRANSPORTATION SYMPOSIUM

## Smart Work Zone Design



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# Objectives

- What is a Smart Work Zone (SWZ)?
- What Are Benefits of SWZ?
- FDOT SWZ Strategies
- SWZ Design Resources
- Use of Resources for Selecting and Designing SWZ Strategies

# What Makes SWZ Smart?

SWZ have the following general characteristics:

-  • **Real-time:** The system obtains and analyzes traffic flow data in real-time, providing frequently updated information to motorists.
-  • **Portable:** The system is portable, allowing its installation at different locations (with configuration modifications, as necessary).
-  • **Automated:** The system operates in an automated manner with minimal human supervision.
-  • **Reliable:** The system provides accurate and reliable information, keeping in mind the serious consequences of misinforming motorists in work zone situations.

# SWZ Strategies

SWZs use combinations of technologies to create strategies in response to work zone traffic impact scenarios. FDOT SWZ strategies covered in the SWZ Guidebook and Developmental Design Concept (DDC) include:

- Work Zone Data Exchange (WZDx)
- Dynamic End of Queue/Slow Speed Warning (DQW)
- Dynamic Lane Merge (DLM)
- Dynamic Speed Harmonization (DSH)

# Benefits of SWZ

Benefits	WZDx	DQW	DLM	DSH
Reduce WZ crashes (sideswipe)			✓	
Reduce WZ crashes (rear-end)		✓	✓	✓
Reduce WZ speed variation, stop and go traffic		✓	✓	✓
Improve WZ vehicle throughput		✓	✓	✓
Reduce WZ congestion		✓	✓	✓
Improve WZ traveler information	✓	✓	✓	✓

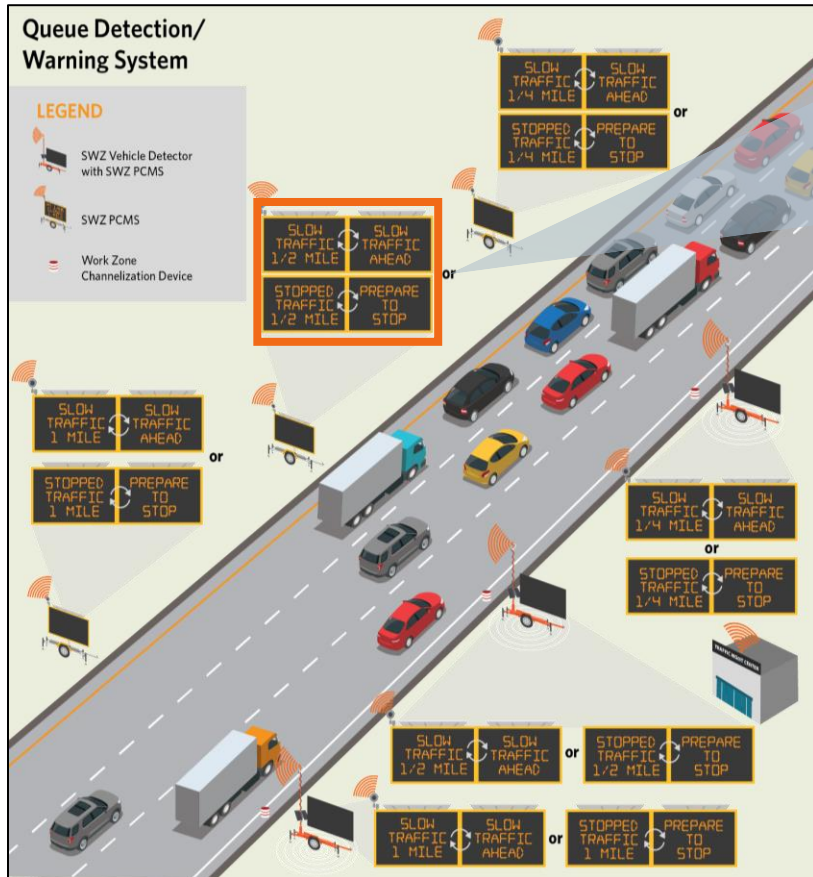
# Work Zone Data Exchange (WZDx)

- **Program Sponsor:** Federal Highway Administration (FHWA)
- **Goal:** Safe work zone navigation for vehicles equipped with automated driving systems (ADS)
- **Work Zone Data:** Near real-time work zone data for third party use
- **Recommended:** Use for projects impacting traffic or when workers are adjacent to open traffic lanes
- **Long Term:** Eventually use WZDx on all projects that potentially impact traffic





# Dynamic Queue Detection / Slow Speed Warning (DQW)

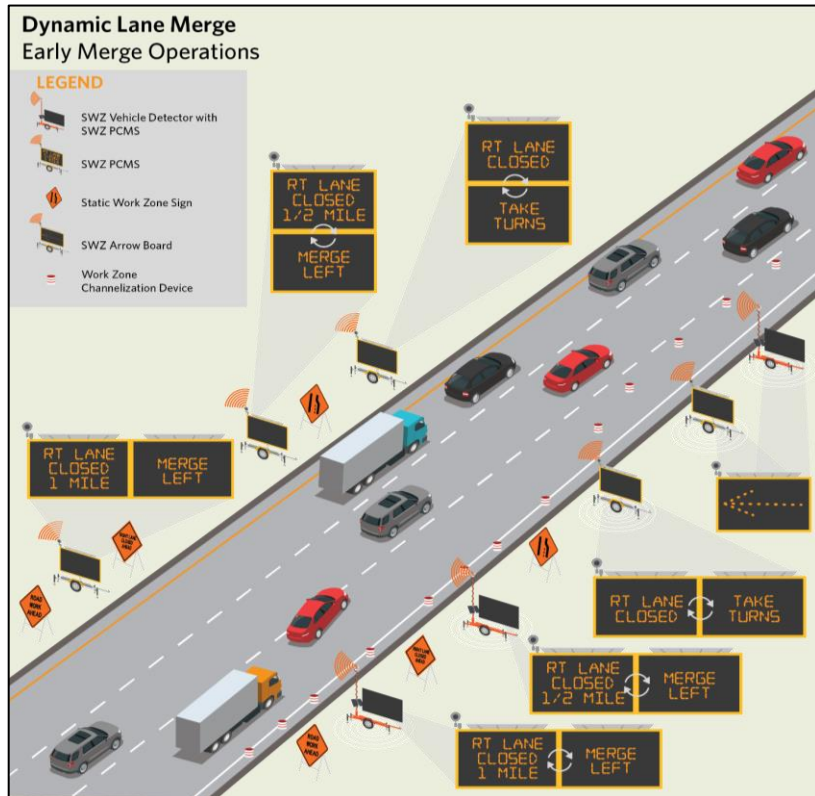


- **Goals**
  - Fewer work zone crashes
  - Increased throughput
- **SWZ Vehicle Detectors**
  - Traffic speeds
  - Traffic volumes



- **SWZ Central Processor**
  - Locate slower traffic
  - Locate stopped traffic
  - Locate end of queue
  - Selects messages from pre-approved library
  - Posts messages to PCMS
- **Portable Changeable Message Signs (PCMS)**

# Dynamic Lane Merge (DLM)



- **DLM Scenarios**

- **Early Merge:** move traffic ( $\leq 1,500$  vehicles/lane/hour) to open lanes as early as possible
- **Late Merge / Zipper Merge:** keep traffic ( $> 1,500$  vehicles/lane/hour) in all lanes until the lane closure

- **Goals**

- Increase safety (hard braking, road rage)
- Reduce queue length
- Increase throughput

- **SWZ Detectors**

- Speed and volume approaching merge and through the work area

- **SWZ Central Processor**

- Determine applicability of **early merge** or **late merge** based on pre-determined algorithms
- Select PCMS messages from pre-approved library
- Post messages to PCMS

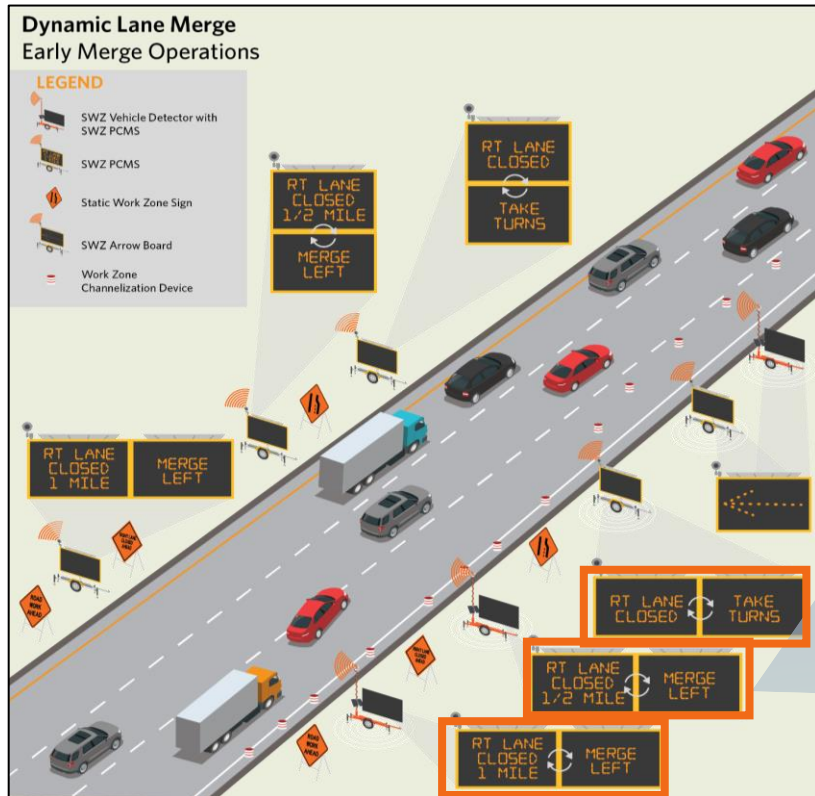
- **SWZ PCMS**

- Post early merge or late merge messages from Central Processor



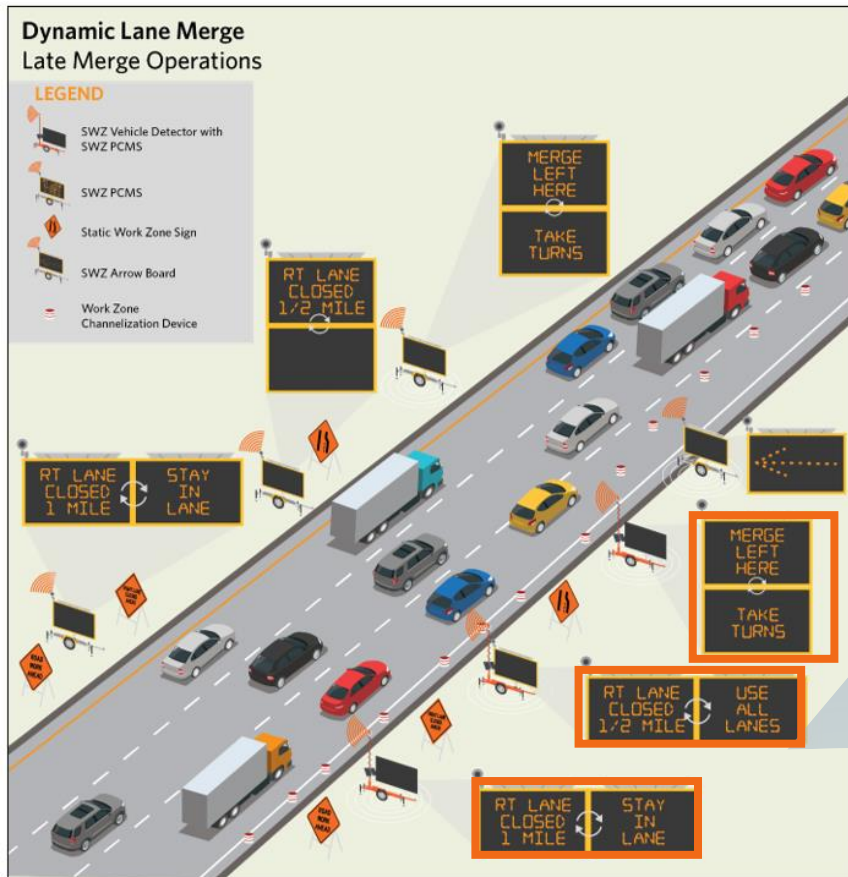
# Dynamic Lane Merge (DLM)

## PCMS for DLM Early Merge Scenario

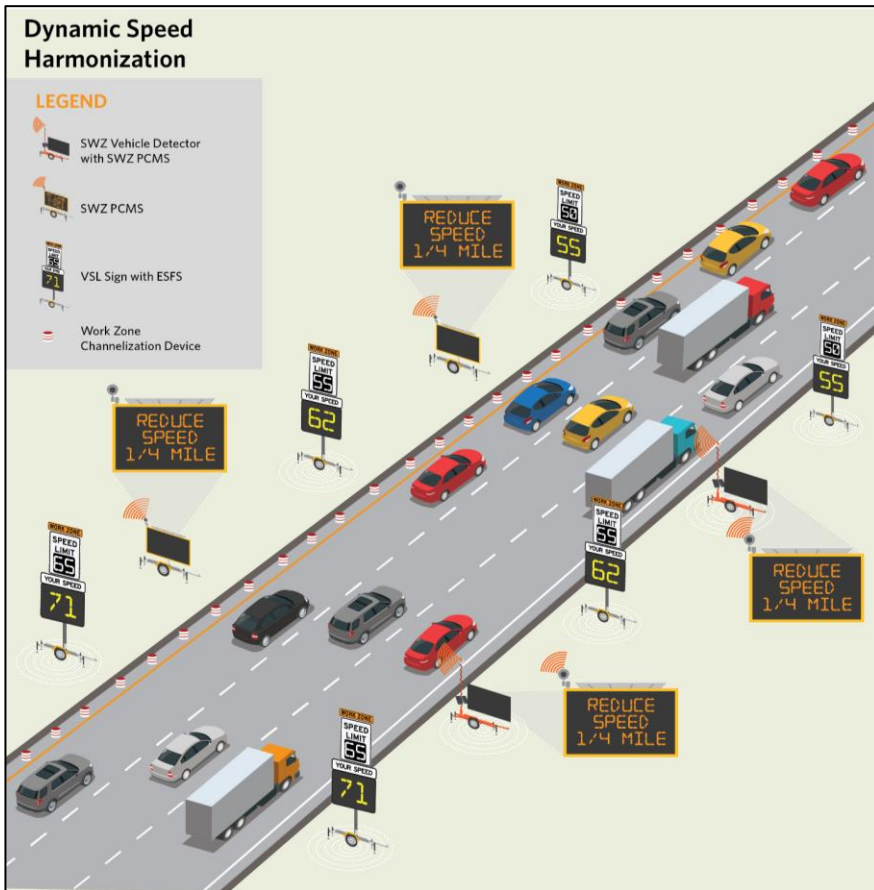


# Dynamic Lane Merge (DLM)

## PCMS for DLM Late Merge Scenario



# Dynamic Speed Harmonization (DSH)



- **Goals**
  - Uniform speeds approaching and the through work zones
- **SWZ Vehicle Detectors**
  - Vehicle speeds approaching and through work area
- **SWZ Central Processor**
  - Locates slow traffic speed areas
  - Determines speed limits for traffic approaching slowed speed areas and posts speeds to SWZ VSL signs
  - Determines PCMS messages from pre-approved library and posts messages to SWZ PCMS
- **SWZ PCMS**
  - Reduced speed ahead messages
- **SWZ Variable Speed Limit (VSL) Signs with Electronic Speed Feedback Signs (ESFS)**
  - VSL: Current speed limit based on downstream traffic
  - ESFS: Displays speed of traffic passing the sign



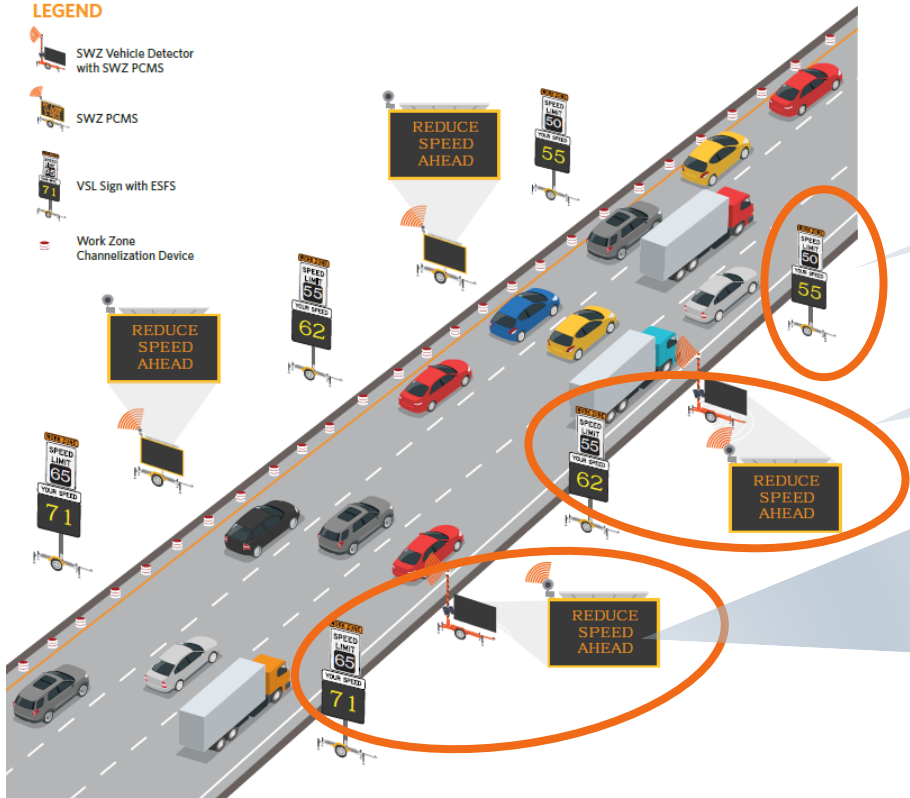
# Dynamic Speed Harmonization (DSH)

## SWZ PCMS and VSL with ESFS for DSH

### Dynamic Speed Harmonization

#### LEGEND

- SWZ Vehicle Detector with SWZ PCMS
- SWZ PCMS
- VSL Sign with ESFS
- Work Zone Channelization Device



REDUCE SPEED AHEAD



REDUCE SPEED AHEAD



# **Goal is to Mainstream Smart Work Zones**

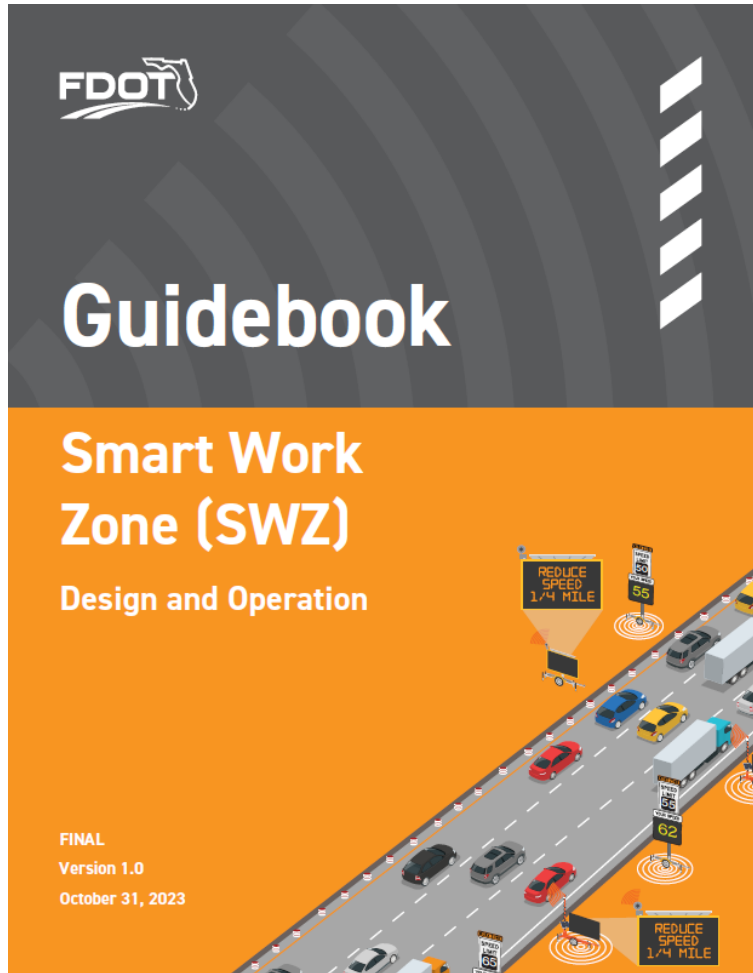
- **Mainstream SWZ into projects based on objective criteria**
- **Promote statewide driver expectations and recognition**

# Resources to Support Design & Construction

- Smart Work Zone Design and Operations Guidebook
- Developmental Standard Plans for 102-600 series
- Developmental Design Criteria (DDC) for FDOT Design Manual (FDM) Section 240 Transportation Management Plan
- Developmental Specs (DevSpecs) for:
  - Section 102 Maintenance of Traffic
  - Section 990 Temporary Traffic Control Device Materials



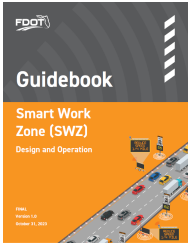
# SWZ Design and Operations Guidebook



## Chapters:

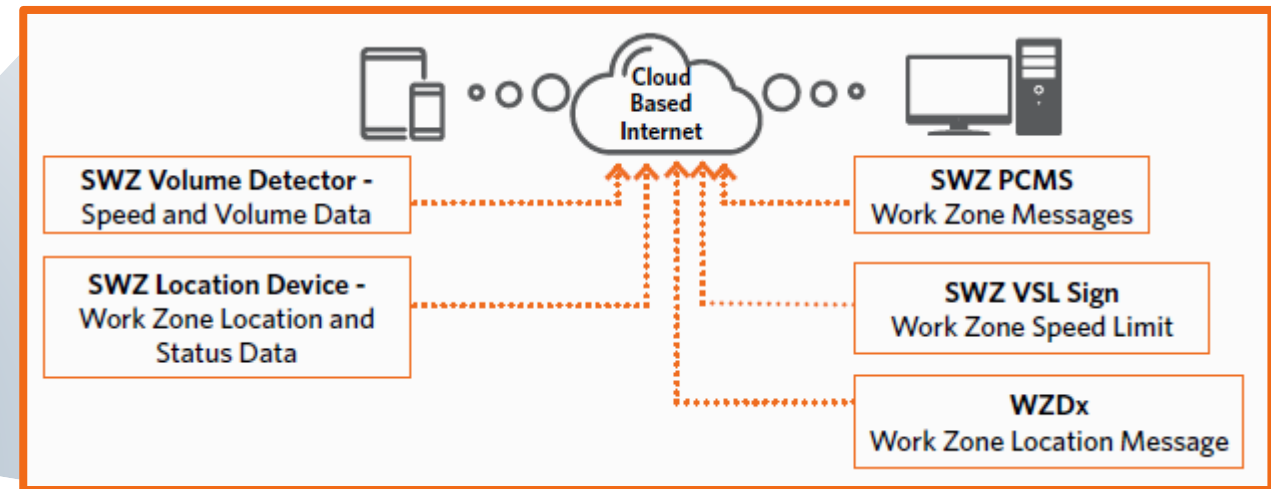
1. Introduction
2. Programming and Scoping
3. Identification and Selection of SWZ Strategies
4. SWZ Systems Engineering Analysis
5. SWZ Public Information Plan

# Guidebook Chapter 1 - Introduction



## Chapter 1 Contents:

- Purpose of the SWZ Guidebook
- Characteristics of SWZ
- SWZ Technologies
- SWZ Strategies and Systems
- SWZ Operations

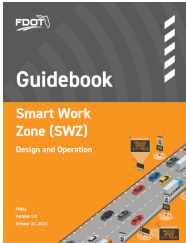


SWZ Central (Cloud-based) Processor

# Guidebook Chapter 2 - Programming and Scoping

## Chapter 2 Contents:

- Assess Projects for SWZ Priority
- Include SWZ in the Design Scope of Services



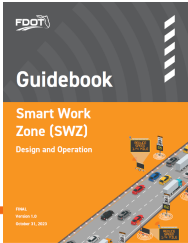
# Guidebook Chapter 3 - SWZ Strategies

## Chapter 3 Contents

- Work Zone Data Exchange
- Dynamic Lane Merge
- Dynamic Speed Harmonization
- Dynamic End of Queue/Slow Speed Warning

## Strategy Descriptions Include:

- Use Cases
- Concept of Operations
- Technologies
- ITS Architectures
- Conceptual Layouts



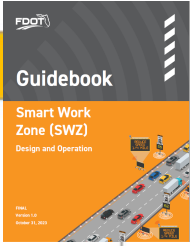
# Guidebook Ch 4 - SWZ Systems Engineering Analysis

## Chapter 4 Content

- SWZ Active Management and Operations Plan
- SWZ Communication and CAV Plan
- SWZ Training

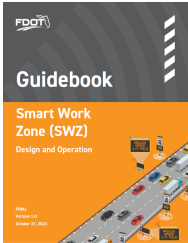


SWZ Stakeholders	Training Objectives
Designers, TTCP Developers	<ul style="list-style-type: none"> <li>• Selection of SWZ strategies</li> <li>• SWZ Developmental Specifications</li> <li>• SWZ DDC</li> <li>• SWZ Developmental Standard Plan</li> <li>• Incorporation of SWZ into TTCP</li> <li>• SWZ Management and Operations Plan development</li> <li>• Systems engineering for SWZ</li> <li>• Requirements development for design/build projects</li> </ul>
State and local traffic law enforcement officers	<ul style="list-style-type: none"> <li>• Enforcement expectations, practices</li> <li>• Speed harmonization concept, current speed limits</li> </ul>
Contractor traffic management superintendent and personnel	<ul style="list-style-type: none"> <li>• Installation, setup, and configuration expectations</li> <li>• Installation verification testing</li> <li>• Installation monitoring and oversight</li> <li>• Installation maintenance</li> </ul>
Construction Engineers and Inspectors	<ul style="list-style-type: none"> <li>• Installation inspection</li> <li>• Installation verification testing oversight</li> <li>• Installation monitoring and oversight</li> </ul>
RTMC Managers and Operators	<ul style="list-style-type: none"> <li>• Monitoring SWZ with permanent ITS and temporary ITS equipment and communication</li> <li>• Monitoring SWZ through Internet portals</li> <li>• Managing DSH applications, setting speed limits</li> </ul>



# Guidebook Chapter 5 - SWZ Public Information Plan

## Chapter 5 Content



When using SWZ strategies and technologies in the TTCP, the Public Information Plan (PIP) described in **FDM 240.4** should **address SWZ elements included in the project**. The PIP should **communicate to the traveling public the intent, features, and duration of smart work zone strategies planned for the project**. The PIP should take into consideration needs relative to multiple trip types such as daily commuters and tourists.



# Developmental Design Criteria - Section 240 Transportation Management Plan

## DDC Content Includes:

- Sec 240.2.1.2 – Work Zone Speed
- Table 240.3 Transportation Operations Plans – adds SWZ strategies to Table 240.3.1
- Sec 240.4 – addresses SWZ in Public Information Plans
- Sec 240.6 – SWZ Strategies and Technologies
  - 240.6.1 SWZ Strategies and Technologies
  - 240.6.2 Smart Work Zone Criteria

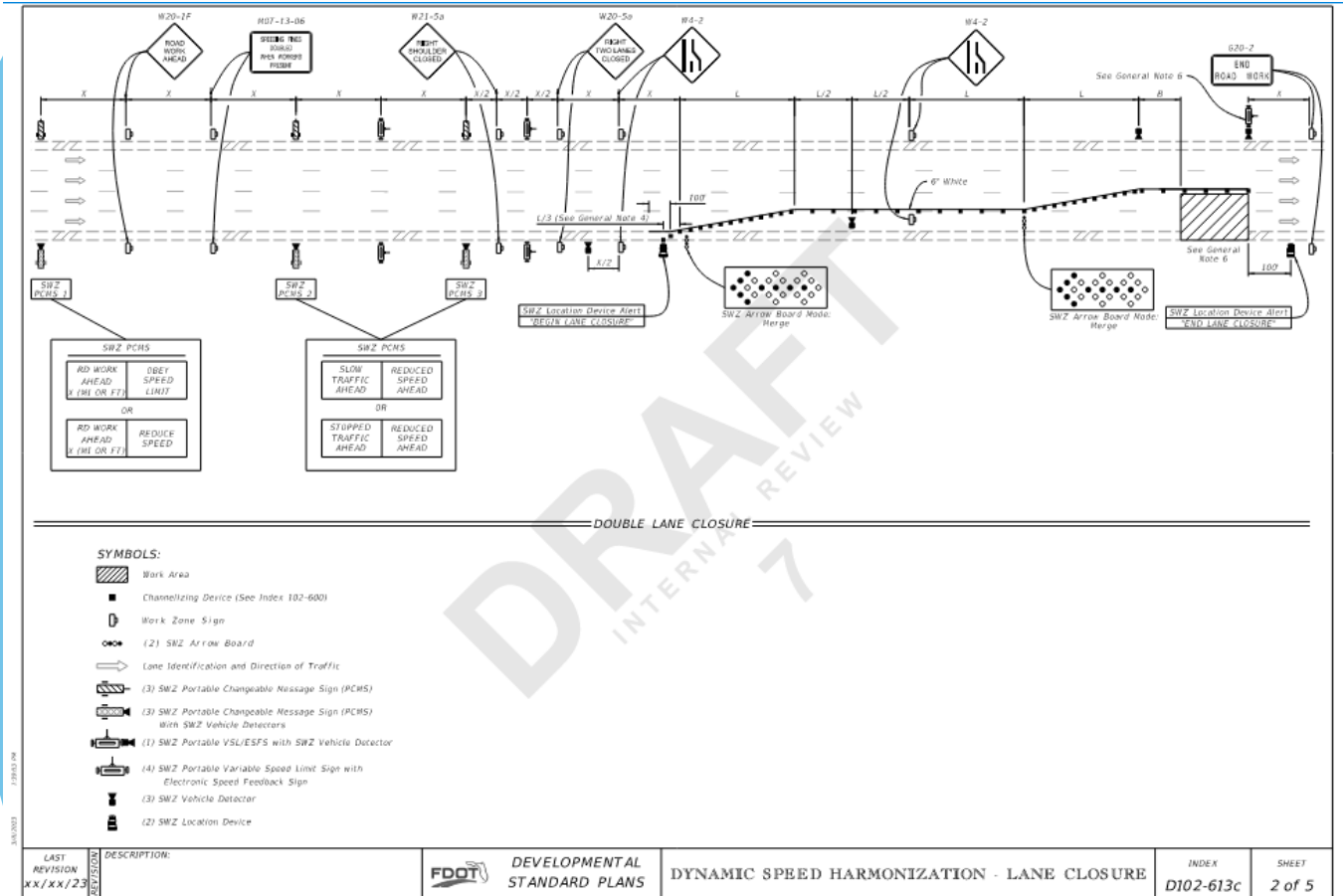
Table 240.3.1 Transportation Operations Strategies

Category			
Demand Management	Corridor/Network Management	Work Zone Traffic Management	Safety Management and Enforcement
Transit services improvements	Signal timing/ coordination improvements	Speed limits reduction or variable speed limits, <b>Speed harmonization</b>	ITS for traffic monitoring and Management
Transit incentives	Temp. traffic signals	Temp. traffic signal	Transportation Management Center (TMC)
Shuttle services	Intersection improvements	Temp. barrier	Aerial surveillance
Ridesharing/ carpooling incentives	Bus turnouts	Crash Cushions	Milepost markers
Park-and-Ride promotion	Turn restrictions	Automated flagger assistance devices (AFAD)	Service patrol
HOV lanes	Truck restrictions	On-site safety training	Local detour routes
Variable work hours	Dynamic lane close system	TMP inspection team meetings	Contract support for incident management
Telecommuting	Ramp closures	<b>Dynamic lane merge</b>	Incident/emergency response plan
	Railroad crossing controls	<b>Dynamic queue detection and warning</b>	Law enforcement

# Developmental Standard Plans Index 102-600 Series

## Developmental Indexes

- D102-608 Two-Lane, Two-Way Diversion Connection
- **D102-613 Multi-Lane Roadway, Lane Closures**
- D102-620 Multi-Lane Roadway, Temporary Diversion
- ***These Indexes cover DQW, DSH, and DLM SWZ strategies***



# Developmental Specifications - Dev 102 & 990

## Developmental Specs (DevSpecs)

- **Dev102SWZ:** Maintenance of Traffic – Smart Work Zone (SWZ) Management

- **Dev990SWZ:** Temporary Traffic

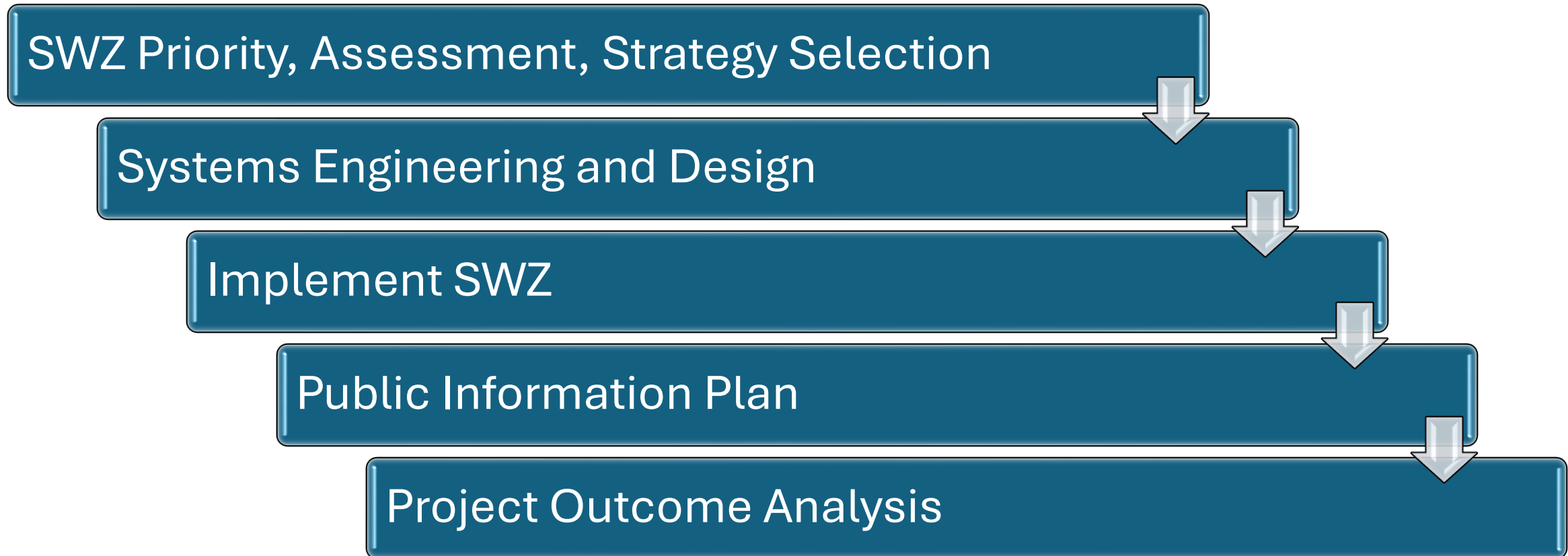
Control Device Materials – Smart Work Zone (SWZ) Management System

• **990-3 Portable Devices (Arrow Boards, SWZ Arrow Boards, Changeable Message Signs, SWZ Changeable Message Signs, Regulatory Signs, Radar Speed Display Units and Truck Mounted Changeable Message Signs, Automated Flagger Assistance Devices SWZ Variable Speed Limit (VSL) Signs, SWZ VSL with an Electronic Speed Feedback Sign (ESFS), SWZ Vehicle Detectors, SWZ Cameras).**

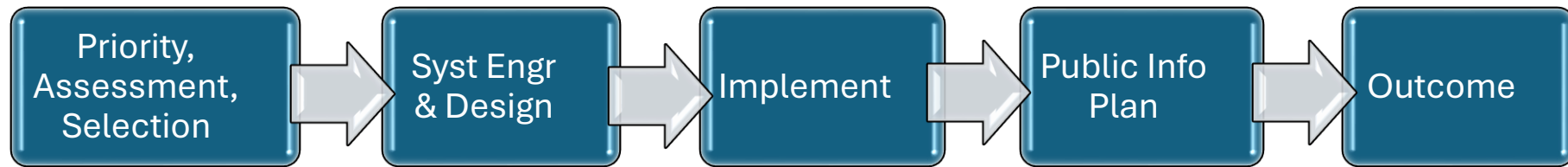
- **990-3.1 General:** With the exception of the SWZ Camera and SWZ Vehicle Detector, all portable devices shall meet the physical display and operational requirements of the Manual on Uniform Traffic Control Devices (MUTCD). With the exception of SWZ devices, all portable devices shall be listed on the Department's Approved Product List (APL). Except for SWZ location devices, all SWZ devices are mounted on trailers. Manufacturers seeking evaluation of their product must submit the following:

# SWZ Strategy Selection, Design, and Implementation Process

# Steps of Process



# Steps of Process





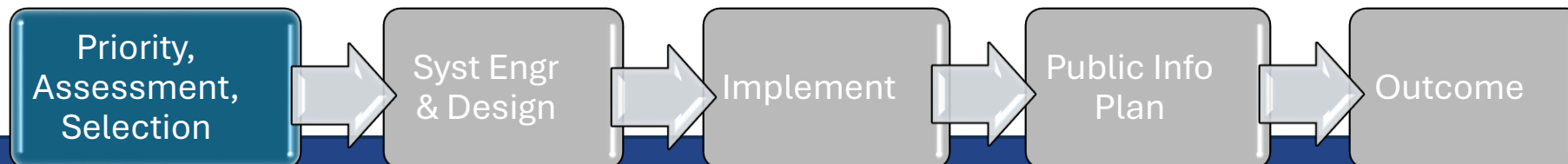
# Step One - A : Determine Priority

## Primary Prioritization Factors

- Highway Functional Classification
- Existing posted speed
- Existing Level of Service or anticipated work zone traffic congestion
- Work zone traffic impacts (Lane closures, diversions, lane shifts)
- Construction duration

## Additional Considerations

- Truck volume
- Speed compliance history
- Crash history
- Frequent changes in traffic conditions
- Sight distance, lateral offset, clear zone, or other geometric restrictions
- Emergencies, special event, or traffic incident management need



# Step One - A : Determine Priority

## FDM DDC 6.2 SWZ CRITERIA - MANDATORY SWZ USE

- Route Characteristics → Limited access or high-speed route with Level of Service E/F (Existing or anticipated during construction)
- Traffic Impact Duration → 5 days or longer
- Construction Duration → 6 months or greater with anticipated queuing or travel time delays
- All Projects with Traffic Impacts → WZDx SWZ Location Devices



# Step One - B : Assess Candidate Strategies

## DLM USE CASES

- Predicable traffic speed and volume changes
- Speed differentials between lanes

## DSH USE CASES

- Speed variation through work zone
- High speeds approaching work zone
- Workers exposed to traffic

## DQW USE CASE

- Slow or stopped traffic in work zone due to work activities or a traffic incident causing variable length queues

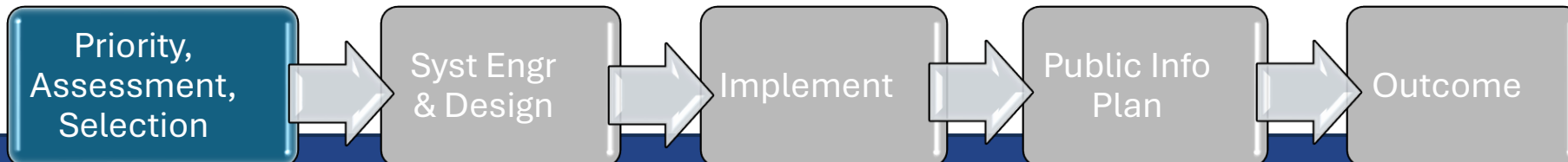
## Tools from SWZ Guidebook

- 3.2.1 DLM Use Cases
- 3.3.1 DSH Use Case
- 3.4.1 DQW Use Case



# Step One - C : Select Strategy or Strategies

- Minimum: WZDx
- Other SWZ Strategy or Strategies Inputs
  - Collaboration: Design, Traffic Operations, Construction
  - Construction staging and phases
  - Lane closures (long and short-term)
  - Geometric restrictions (curves, sight distance, shoulders, lane width, etc.)
- Resources:
  - SWZ Guidebook, Chapter 3 Identification and Selection of SWZ Strategies
  - FHWA [Work Zone Intelligent Transportation Systems Implementation Guide](#), Jan 2014



# Step Two – A : Systems Engineering for SWZ

Include SWZ Systems Engineering in Design  
Scope of Services

Identify SWZ Stakeholder, Roles, and  
Responsibilities

Assess SWZ Risk and Complexity: Do  
Developmental Standard Plans Apply?

Develop Concept of Operations  
Develop Operational Plan

Develop Agreements between Stakeholder, if  
Needed

## TOOLS:

- **Guidebook Chapter 3**  
Identification and Selection of  
SWZ Strategies
- **Guidebook Chapter 4: SWZ**  
Systems Engineering Analysis
- **FDOT Procedure 750-040-002**  
Systems Engineering and  
Intelligent Transportation  
Systems (ITS) Architecture  
Procedure
- **FDM Sec. 240.3** Transportation  
Operations Plan

Priority,  
Assessment,  
Selection

Syst Engr  
& Design

Implement

Public Info  
Plan

Outcome

# Step Two - B : SWZ Plans, Specs, & Estimates

Include SWZ Design in the Design Scope of Services

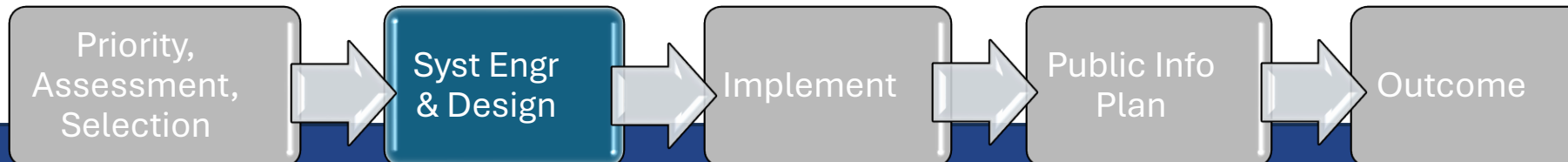
Develop SWZ plans from Developmental Standard Plans for each phase construction phase requiring lane closures (daily or long term)

Adjust device layouts based on actual roadway conditions. Extend devices upstream beyond backups

For Design/Build: Include SWZ in Scope of Services. Reference applicable developmental standards and specifications

## TOOLS:

- **SWZ Guidebook**
  - Chapter 3 Identification and Selection of SWZ Strategies
- **Dev Standard Plans:**
  - D102-608 Two-Lane, Two-Way Diversion Connection
  - D102-613 Multi-Lane Roadway, Lane Closures
  - D102-620 Multi-Lane Roadway, Temporary Diversion



# Step Two - C : SWZ Plans, Specs, & Estimates

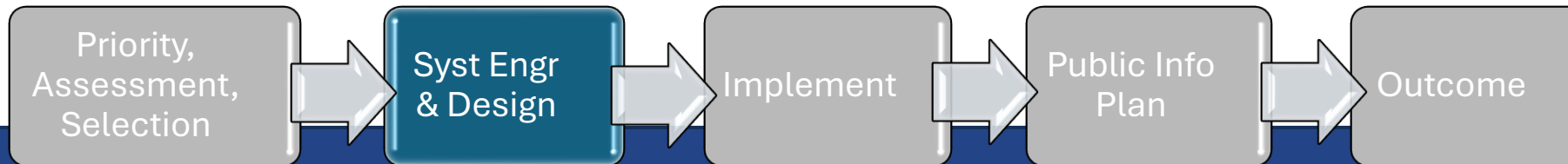
Include SWZ Design in the Design Scope of Services

Develop specifications  
*Package*

Develop engineering estimates

## FDOT Resources for Development of TSP and MSP:

- ✓ [FDOT Specifications Handbook](#)
- ✓ [FDOT Specifications Guidance](#)
- ✓ FDOT Procedure 630-010-001 “Specification Development”
- ✓ Developmental Specifications
  - Dev102SWZ Maintenance of Traffic – Smart Work Zone (SWZ) Management System
  - Dev990SWZ Temporary Traffic Control Device Materials – Smart Work Zone (SWZ) Management System





# Step Three - Implement SWZ

Install devices per Dev Std Plans and Temporary Transportation Control Plans

Integrate SWZ Devices with SWZ Cloud Processor. Verify SWZ is functioning

Train personnel on SWZ Cloud Processor, Responsibilities for Operations and Maintenance

Activate, use, and monitor SWZ strategy per Operations Plan

## TOOLS:

- **SWZ Guidebook**
- **Chapter 3** Identification and Selection of SWZ Strategies
- **Guidebook Chapter 4:**
  - SWZ Systems Engineering Analysis
  - Concept of Operations
  - Management and Operations Plan
- **TTCP**
- **Specifications**
  - **MSP, TSP**
  - **DevSpecs Dev102SWZ, Dev990SWZ**



# Step Four - SWZ Public Information Plan

Develop Public Information Plan (PIP),  
prior to activating the SWZ strategy

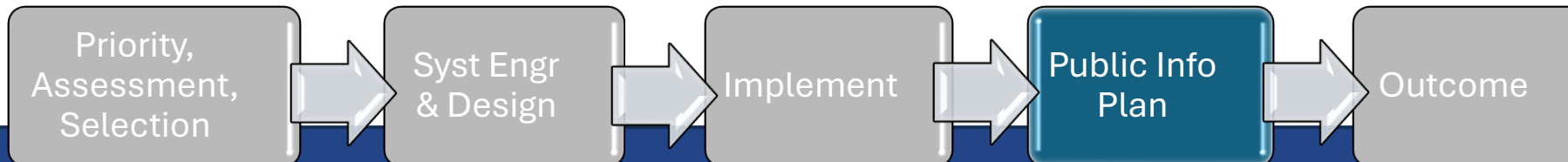
Activate the PIP public  
information elements

Monitor and Assess public  
feedback on the SWZ

Consider modifications to SWZ  
depending on public comments

## TOOLS:

- **DDC Section 240.4** Public Information Plan
- **Guidebook Chapter 5:** Public Information Plan



# Step Five - SWZ After Analysis

## Assessments

- Did the SWZ system work as intended?
- How well did the SWZ strategy worked relative to the goals?

## Data Sources

- SWZ Central Processor data
- FDOT traffic, speed, and/or crash data

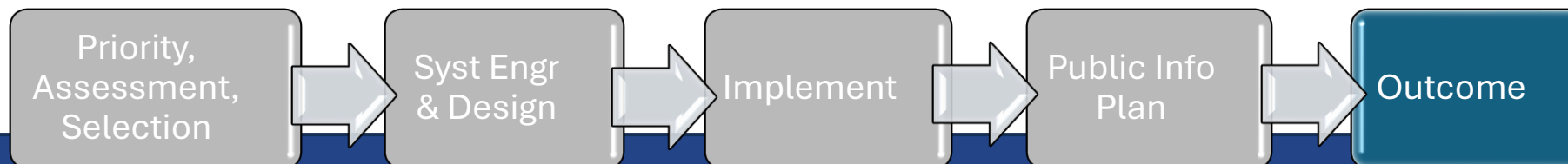
## Possible Assessment Milestones

- Monthly
- At end of SWZ construction Phase
- At end of the project
- At the end of each construction phase using SWZ

Develop feedback for updates to DDC, Dev Std. Plans, DevSpecs, and Guidebook

## TOOLS:

- Data collected by SWZ Central Processor
- Field observations
- Evaluation plan (if developed as a part of the ConOps)



# What We Covered

- Basics of SWZ
- SWZ Benefits
- Four SWZ Strategies
- SWZ Mainstreaming and Design Resources
- Use of Resources for Selecting, Designing, and Implementing SWZ Strategies

# Contact Us



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# Thank you!

## WORK ZONE SAFETY It's Everyone's Job

### TIPS FOR ROAD USERS

- **WATCH**  
for vehicles entering and leaving the roadway.
- **BE AWARE**  
of workers while driving through an active work zone.
- **SLOW DOWN,**  
follow posted speed limit.
- **SAVE LIVES,**  
avoid distractions and always drive sober.







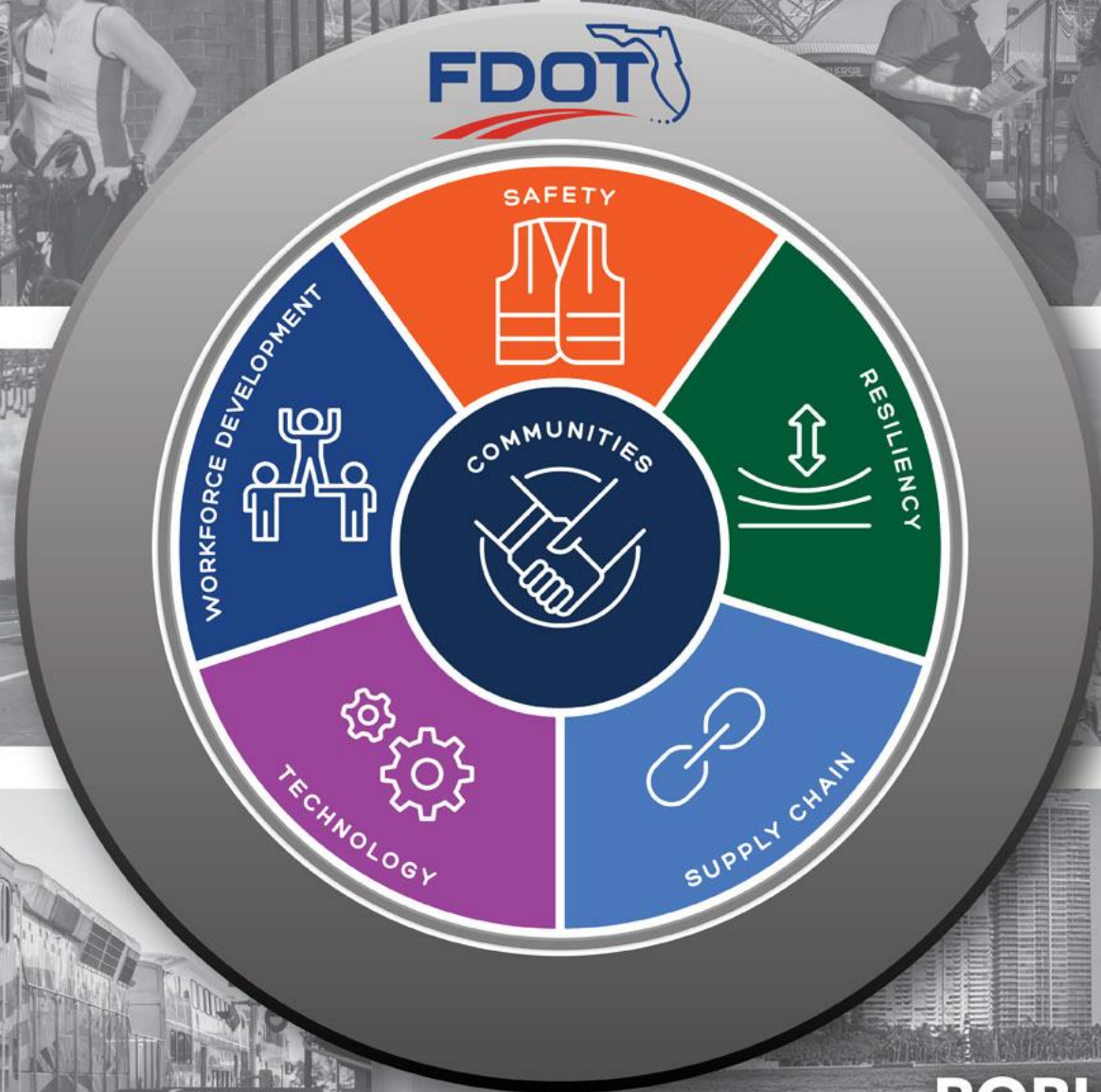
**SAFETY**



**COMMUNITIES**



**WORKFORCE DEVELOPMENT**



**RESILIENCY**



**TECHNOLOGY**



**ROBUST SUPPLY CHAIN**