Systems Implementation Office

# Statewide Access Management

WEBINAR SERIES

# Webinar Staff

Gina Bonyani

John Freeman

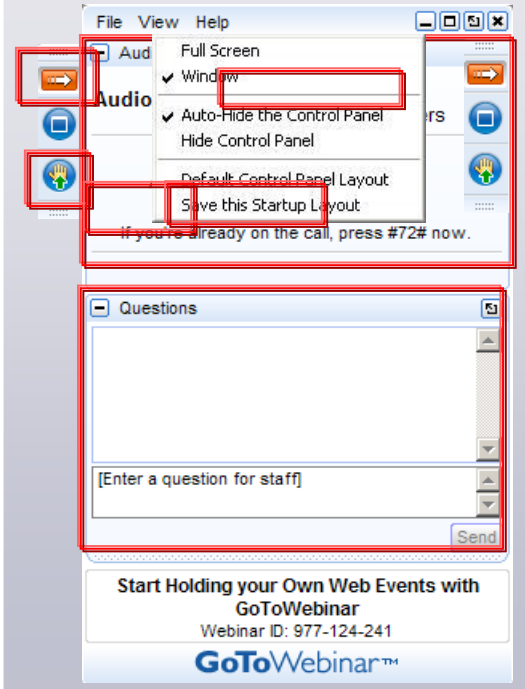
Jenna Bowman

Karla Matos

# Agenda

- How to Participate
- Credits and Webinar Material
- Intersection Control Evaluation (ICE)
- Questions
- Contact Info

# How to Participate Today




- Open and close your Panel
- View, Select, and Test your audio
- Submit text questions
- Raise your hand
- Q&A addressed throughout the webinar

# Learning Curve

FDOT's Systems Implementation Office is utilizing the **Learning Curve** system for participant communications and management of the Statewide Access Management Quarterly Webinar.

# Credits Information

- Credits will be distributed four to **five** business days after the webinar, through Learning Curve.
  - PDH's Credits, AICP Credits Information, and Course Certificates
- Your participation will be recorded by GoToWebinar.
  - You will need to attend to the **entire webinar** with the ***unique link*** provided by GoToWebinar.

GoToWebinar LearningCurve

FDOT

# Webinar Material

- Webinar materials will be sent via the **Learning Curve System.**
- Recorded webinars and presentation material will be posted on the Systems Implementation Office website:
  - Training & Webinars
    - Access Management

# Statewide Access Management

WEBINAR SERIES

**The FDOT Access Management Webinar Series 2019-2020 have been scheduled for the following dates:**

Tue, Aug, 27, 2019 | 2:00PM - 3:30PM EDT
Tue, Nov 12, 2019 | 2:00PM - 3:30PM EST
Tue, Feb 11, 2020 | 2:00PM - 3:30PM EST
**Tue, May 12, 2020 | 2:00PM - 3:30PM EDT**

# Statewide Access Management

WEBINAR

## Today's Webinar

### Intersection Control Evaluation (ICE)-Overview

Tuesday, May 12, 2020

2:00PM – 3:30 PM, EDT

Credits: 1.5

Speaker:

John "Jack" Freeman Jr., P.E. PTOE, RSP1

*Kittelson and Associates, Inc., Senior Principal*

**What organization do you represent?**

- FDOT
- Local Government
- Private Firm
- Other

**How familiar are you with ICE?**

- Very Familiar
- Somewhat Familiar
- Not Familiar

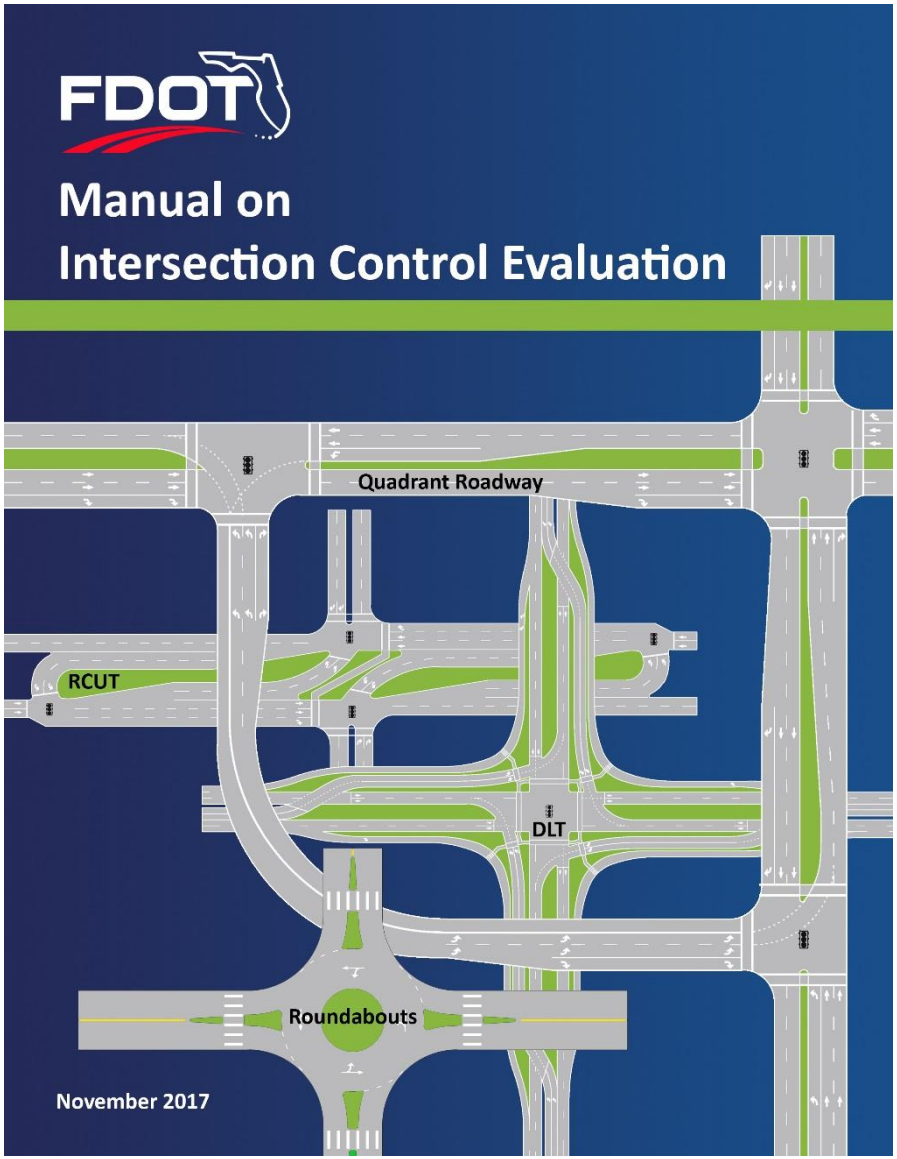
# INTERSECTION CONTROL EVALUATION

## Overview Presentation

FDOT

# ICE OVERVIEW AGENDA

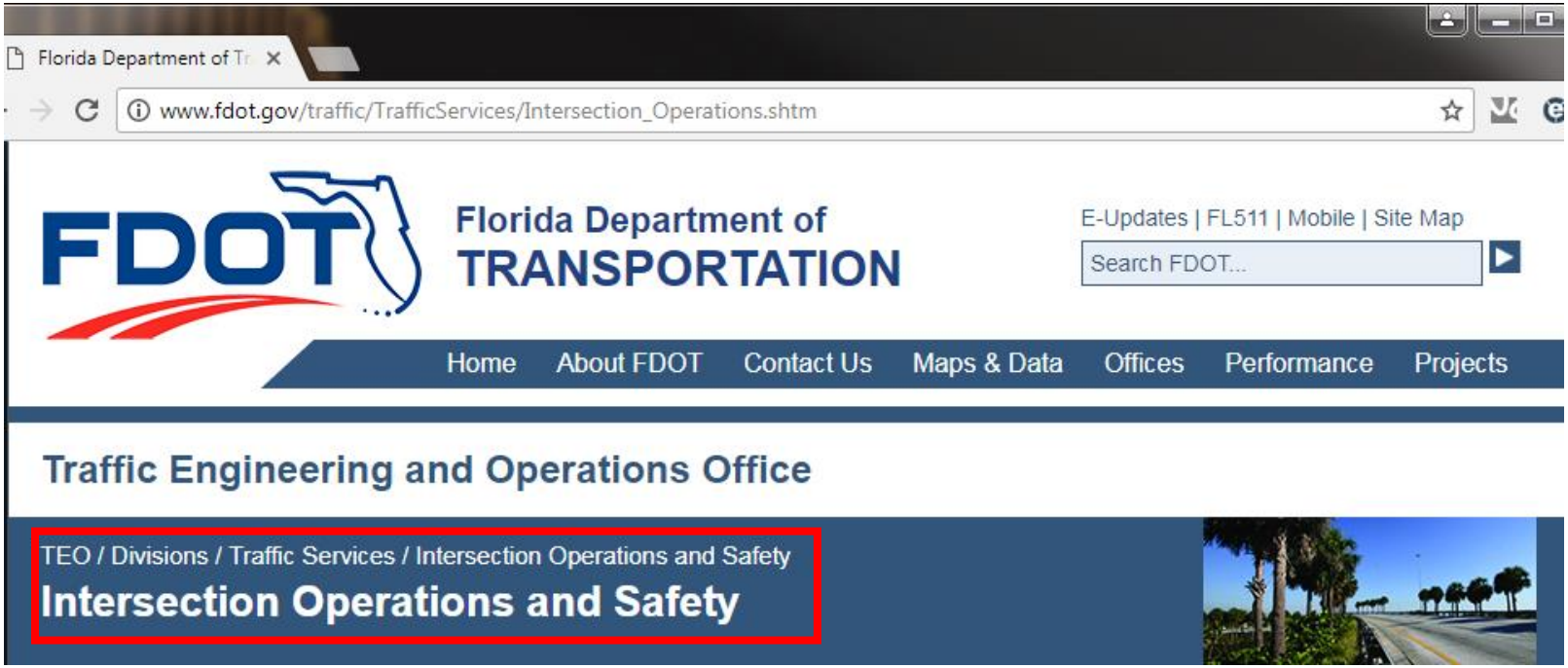
- Why ICE?
- When ICE is Required?
- Applicability and Process
- Tools and Resources
- Forms



# ICE PURPOSE

- Consistently consider multiple context-sensitive control strategies when planning a new or modified intersection through…
  - Informed decision-making considering
    - purpose and need, context classification, safe travel facilities for all road users, with the overall best value
  - Select a context-sensitive control strategy considering
    - the goals and needs of the community and all road users
  - Measure the control strategy's value using
    - performance-based criteria
- Promotes thoughtful consideration of alternative intersection types through quantitative analysis

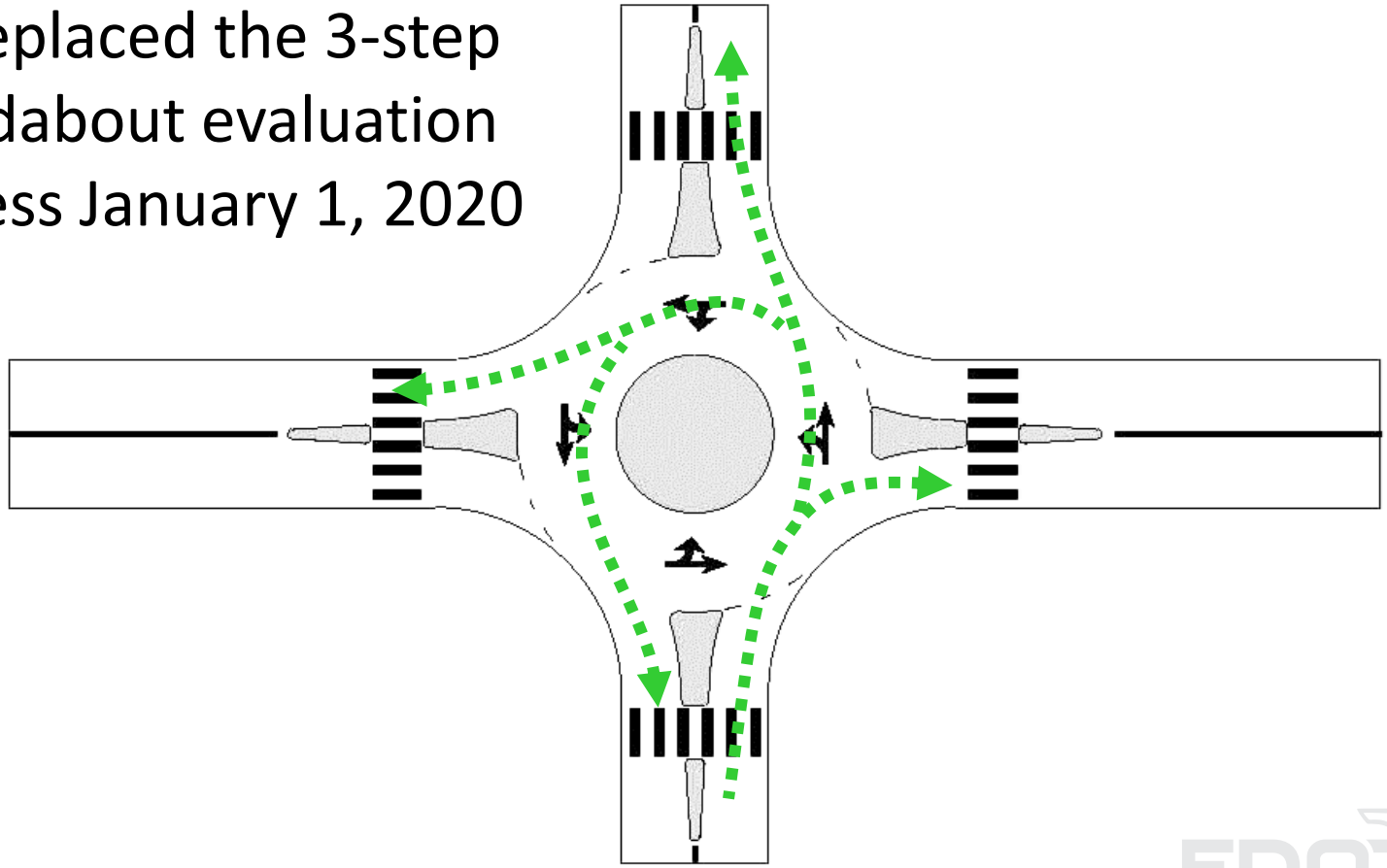
# AVAILABLE RESOURCES




http://www.fdot.gov/traffic/TrafficServices/Intersection_Operations.shtm

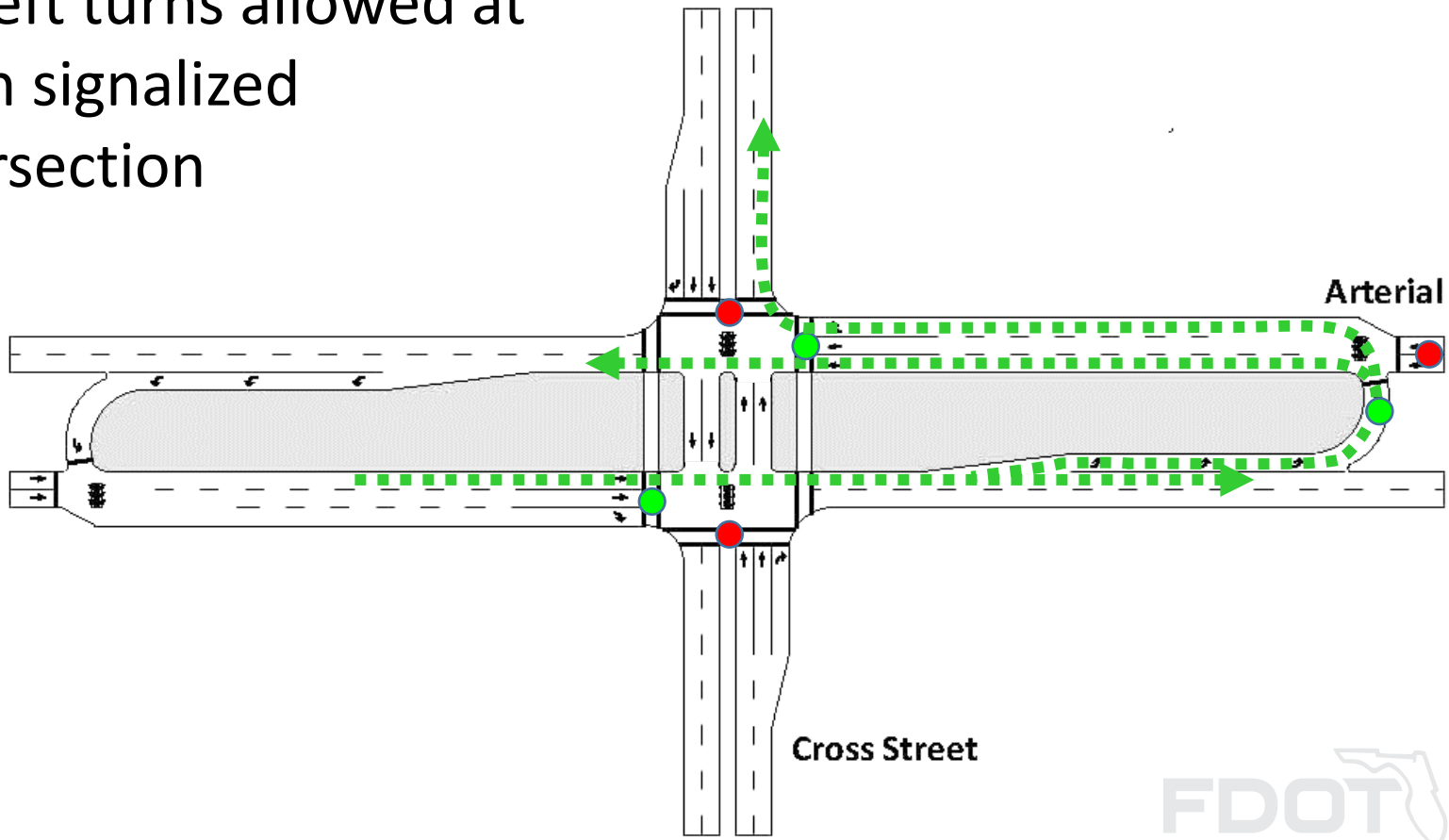
## Roundabout

ICE replaced the 3-step roundabout evaluation process January 1, 2020



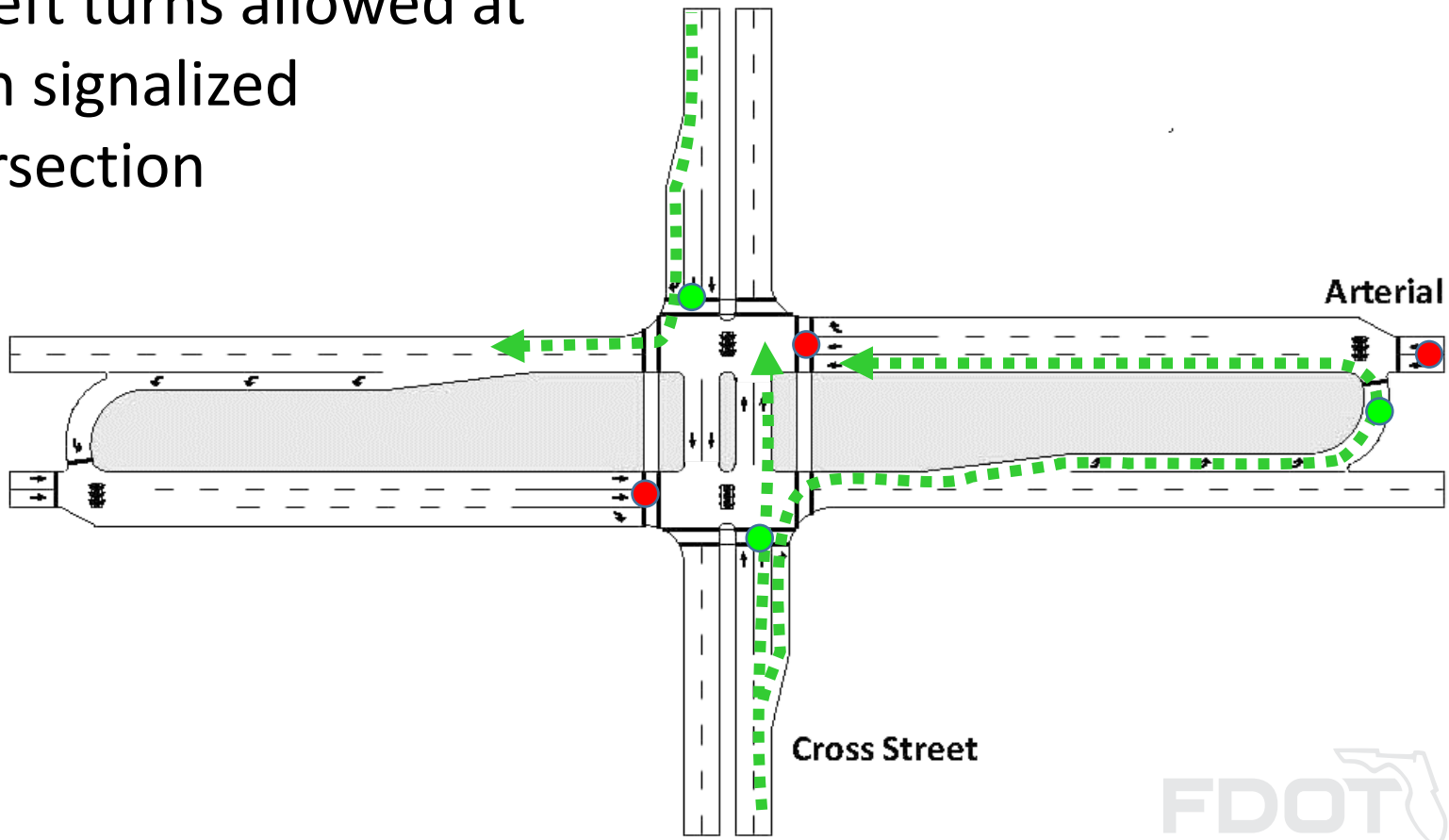
## Median U-Turn (MUT)

No left turns allowed at main signalized intersection



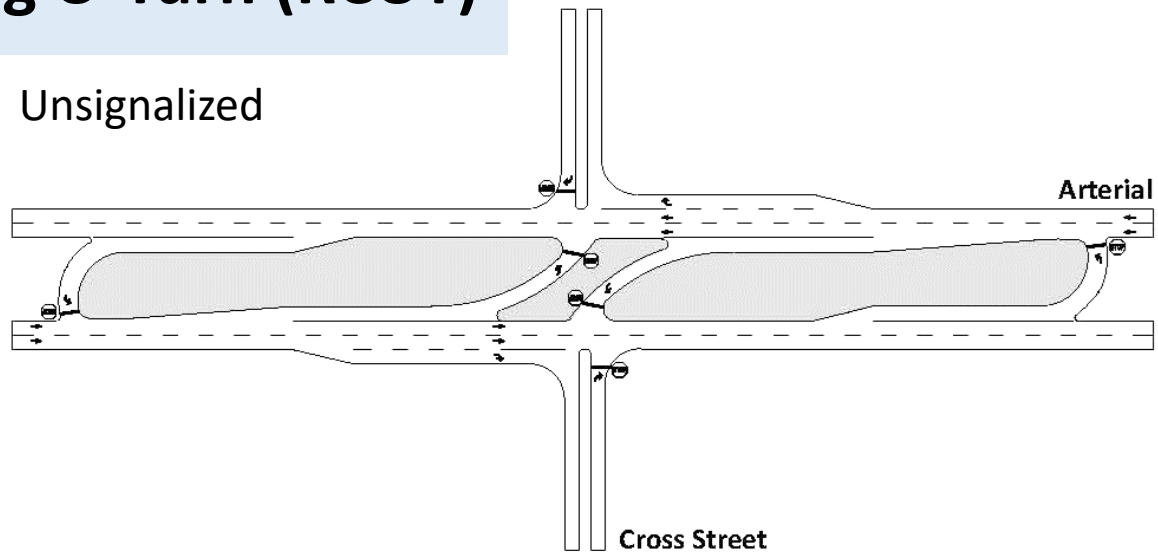
## Median U-Turn (MUT)

No left turns allowed at main signalized intersection

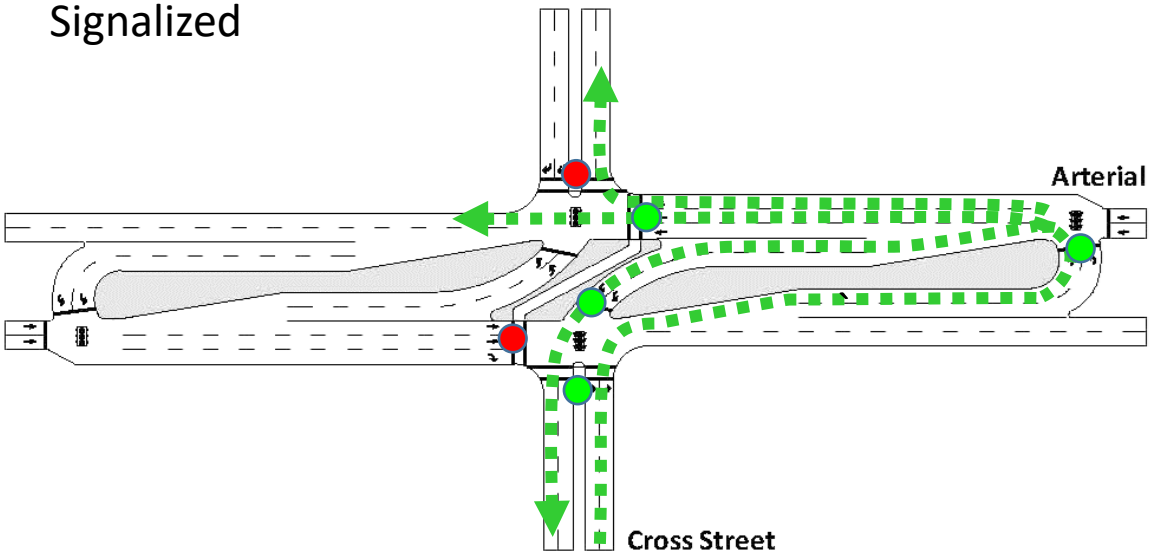


# Restricted Crossing U-Turn (RCUT)

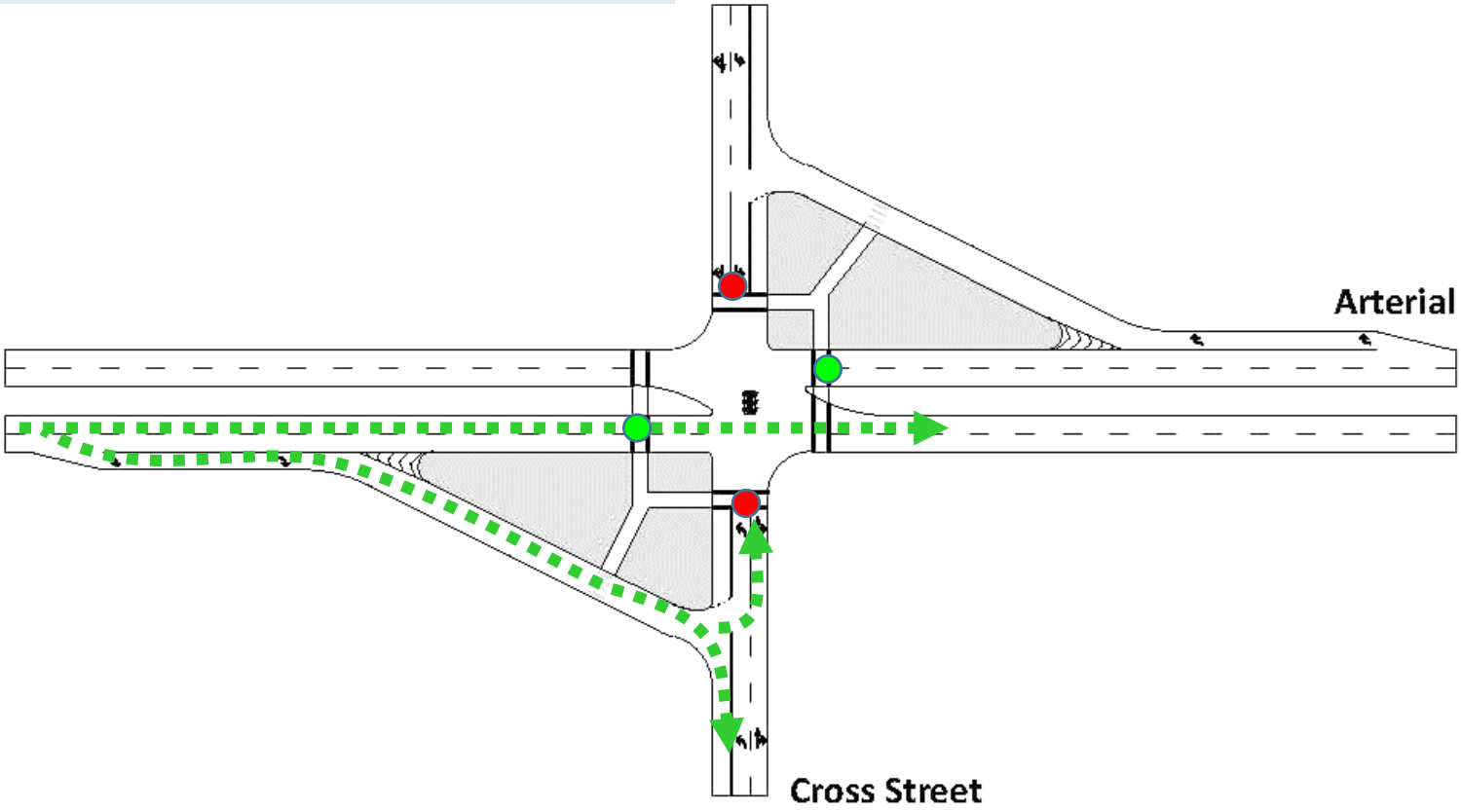
Unsignalized




Signalized

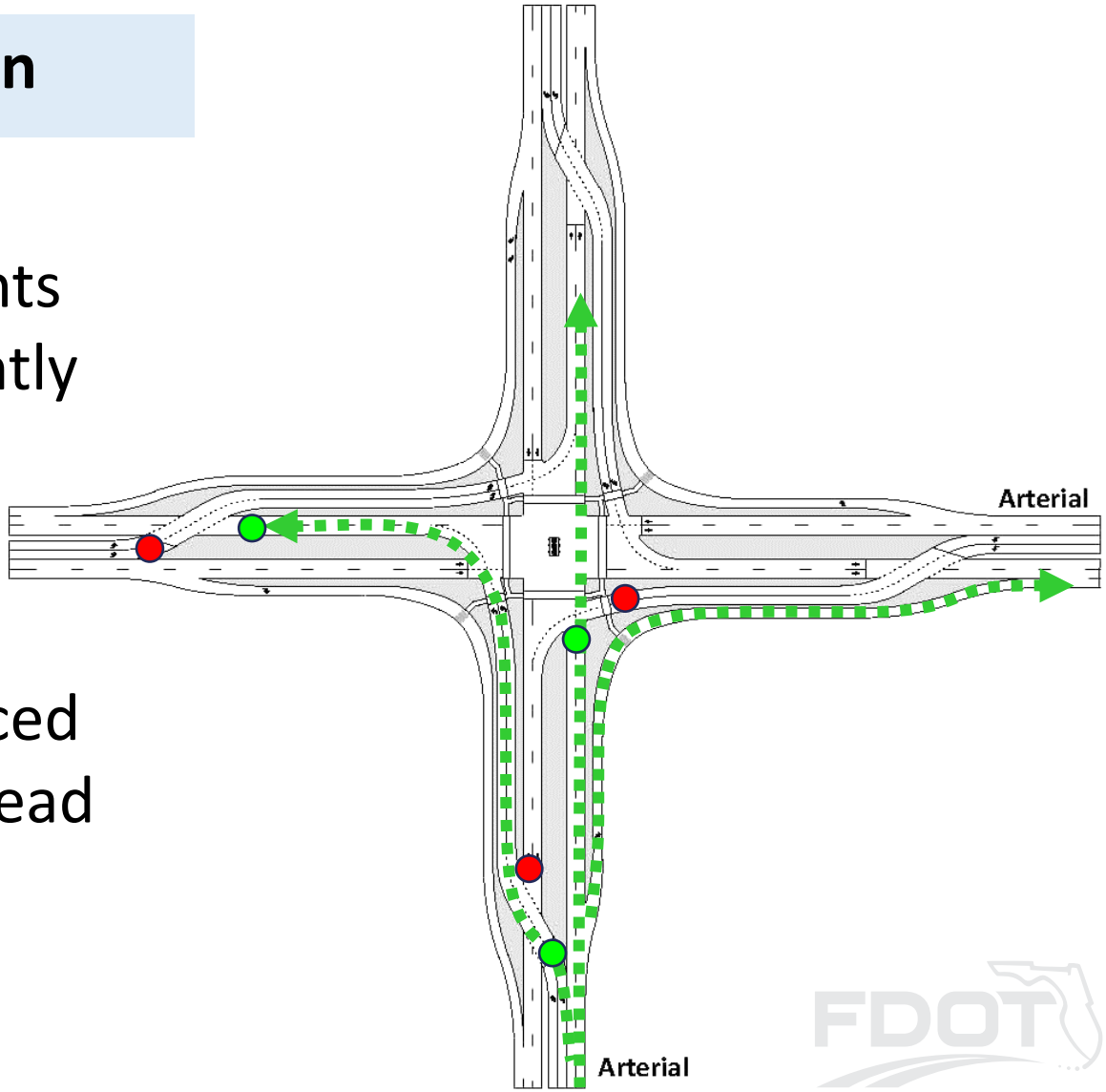


## Jughandle

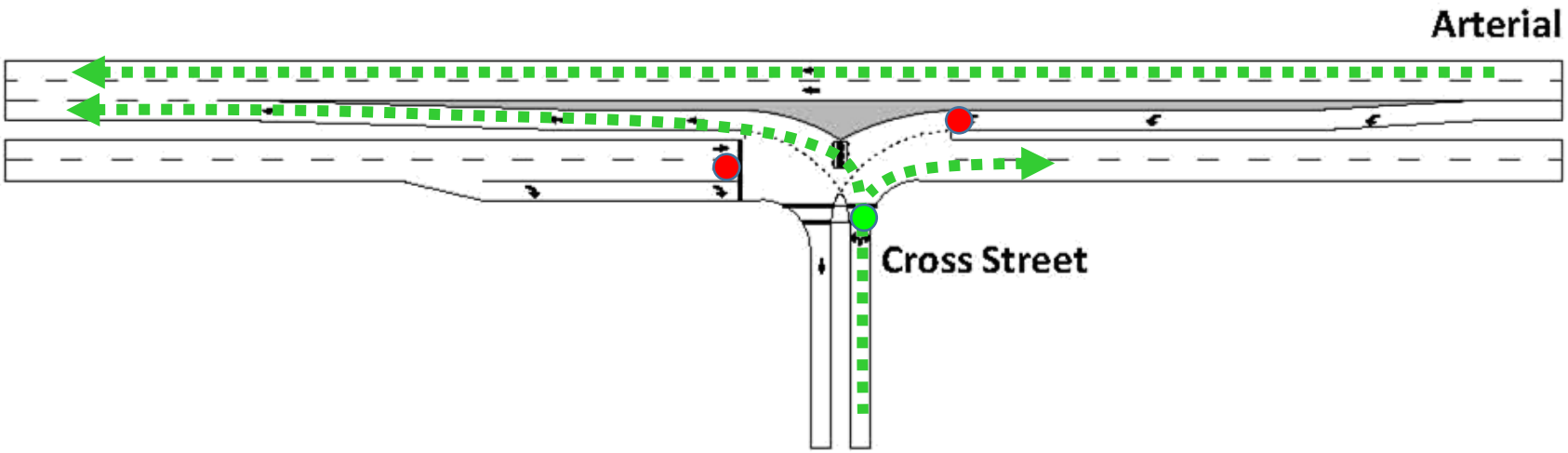


- **Displaced Left Turn**

- Left turns and through movements operate concurrently
- Also called continuous flow intersection
- Could have displaced lefts on 2 legs instead of all 4

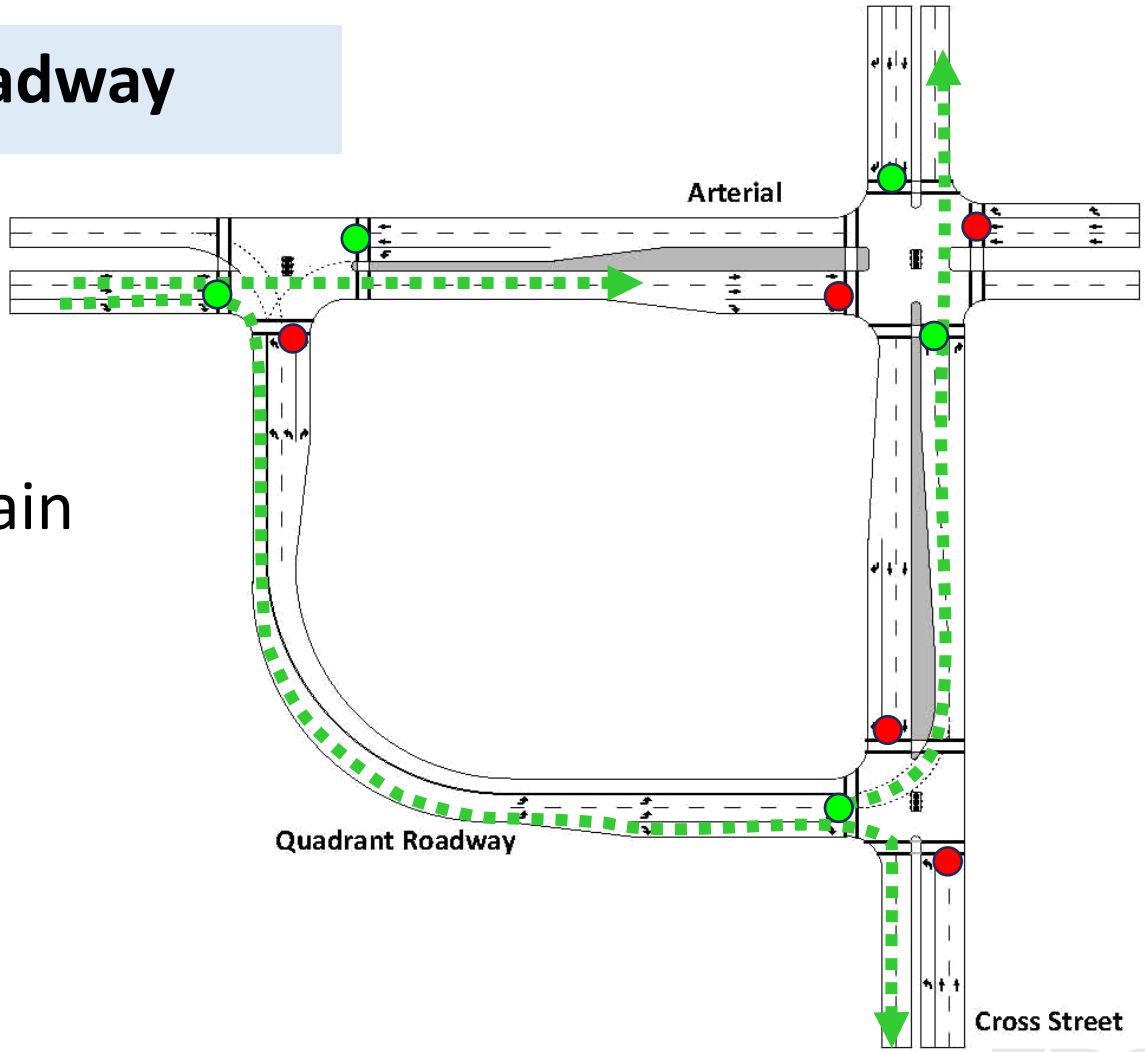


## Continuous Green T



## Quadrant Roadway

No left turns allowed at main signalized intersection



# STAGES OF ICE

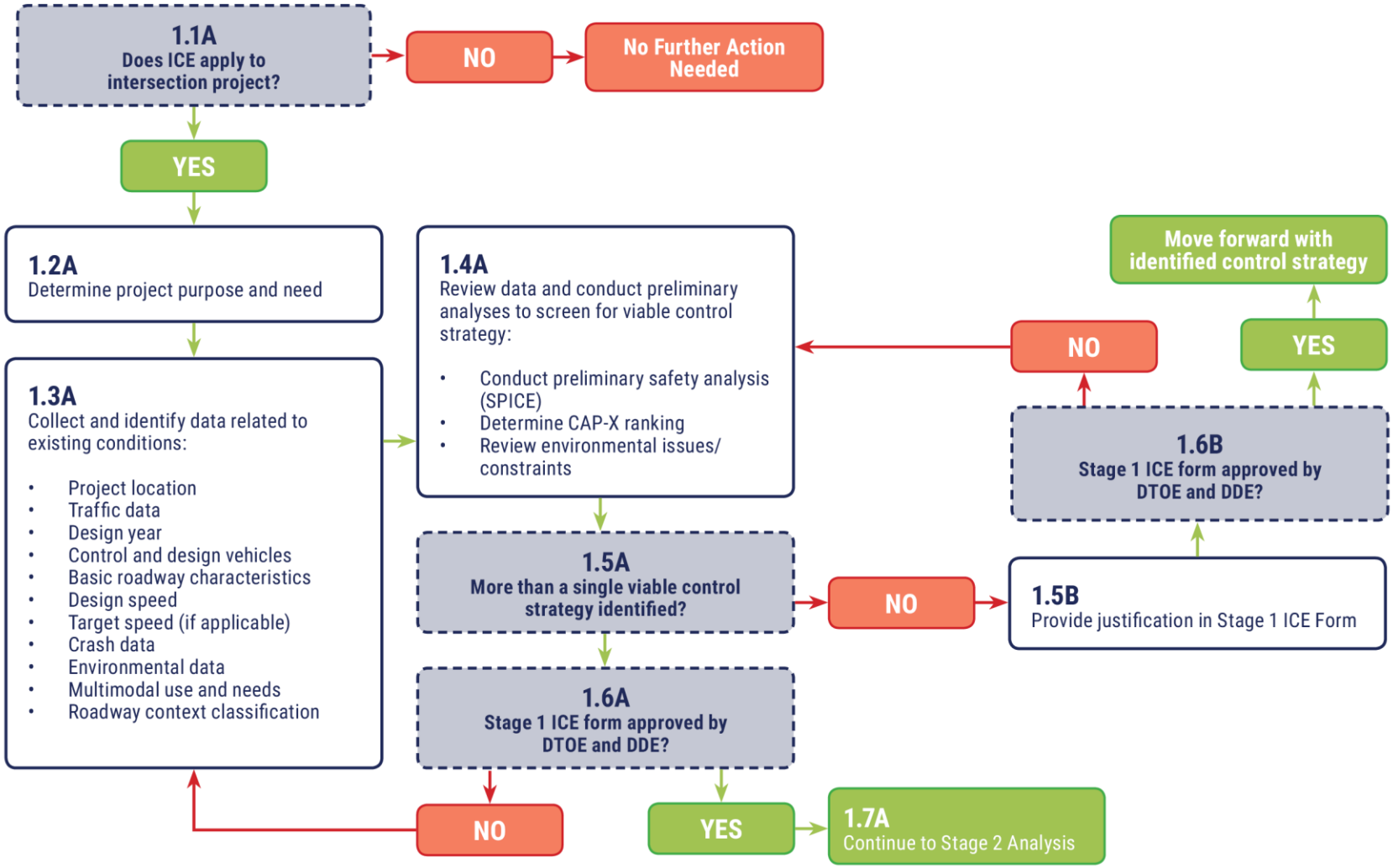
| Stage 1 | Stage 2 | Stage 3 |
|---|---|---|
| Screening | Preliminary Control Strategy Assessment | Detailed Control Strategy Assessment |

| ICE Procedure and Tools | | |
|---|---|---|
| Stage 1 | CAP-X | |
| Stage 2 | SPICE; Analysis Guidance; Default SYNCHRO; FDOT ICE Tool | |
| Stage 3 | No specific tools. Reuse Stage 2 tools or address qualitative issues. | |



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 1; Page 7

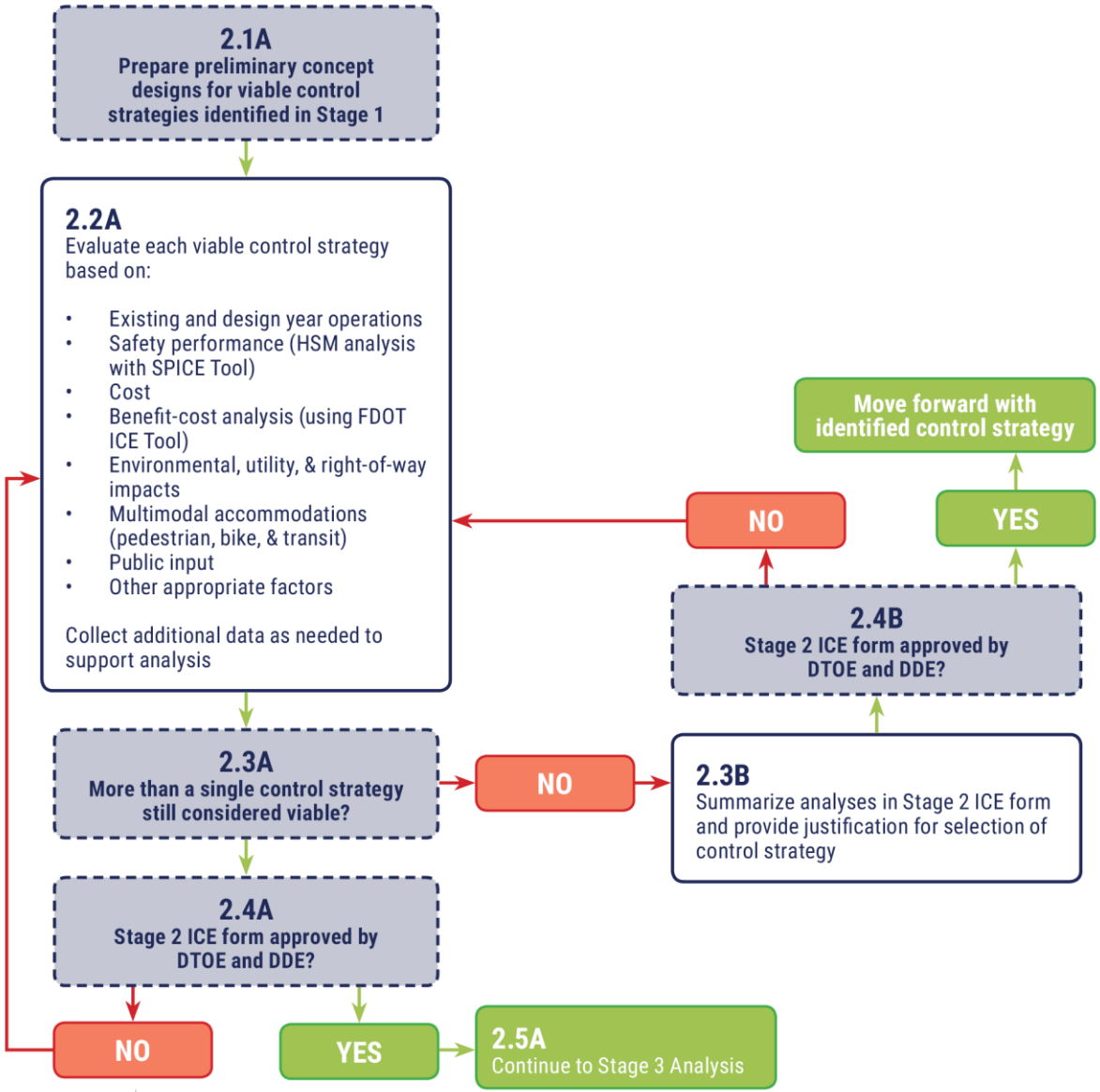
# ICE STAGE 1 PROCESS






Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 2; Page 10

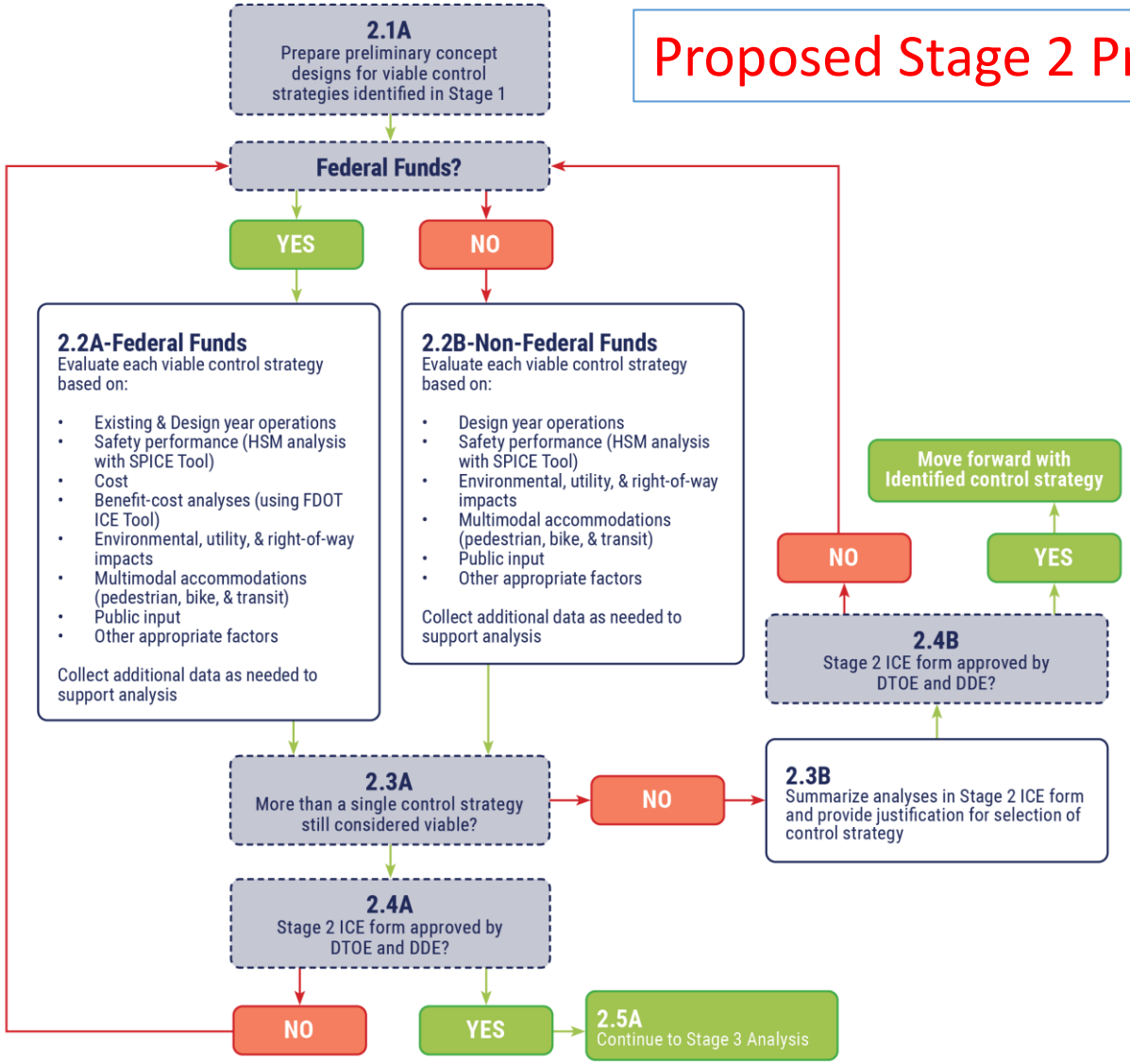
# ICE STAGE 2 PROCESS



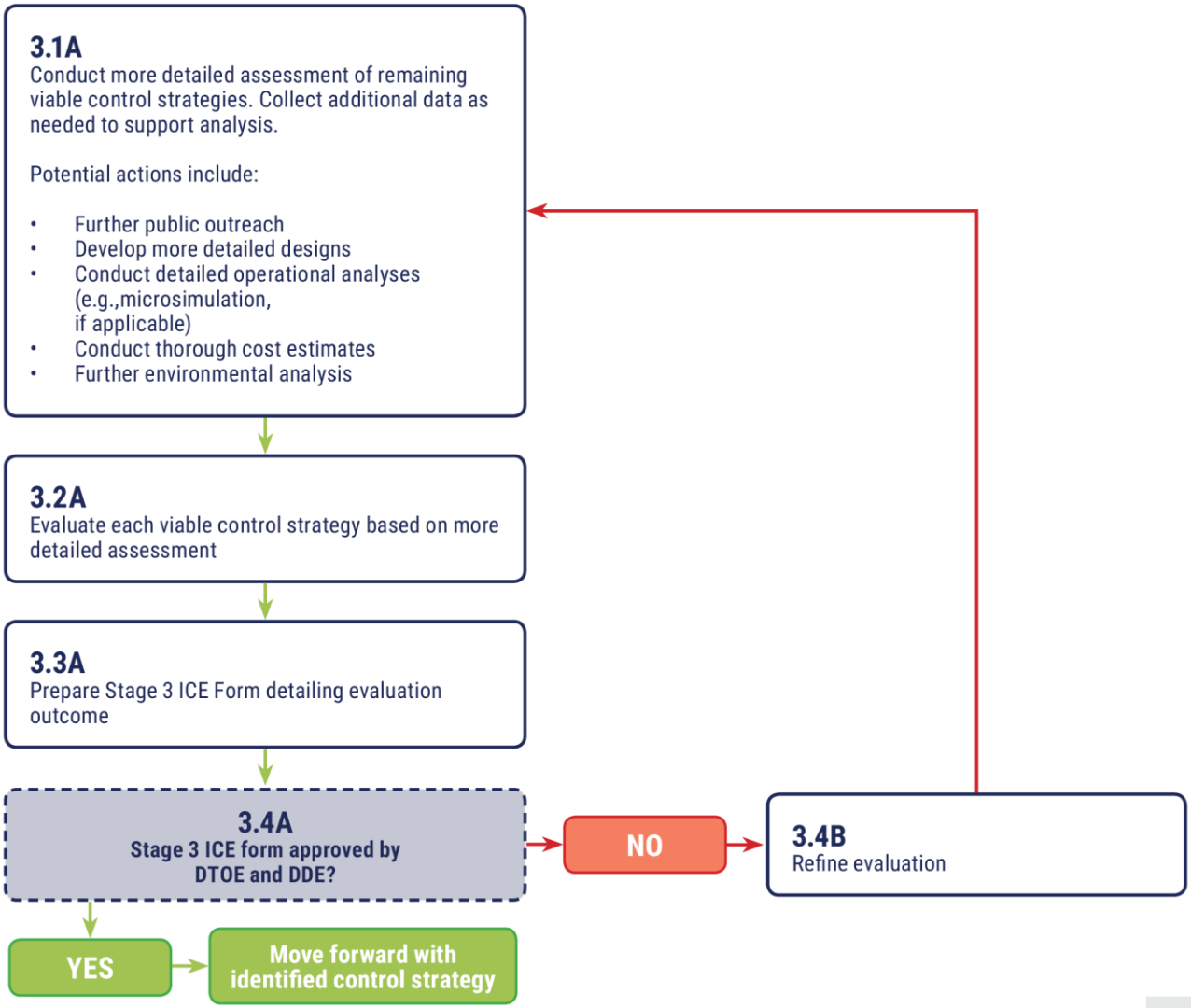



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

# Proposed Stage 2 Process



# ICE STAGE 3 PROCESS






Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 4. Page 18

# WHO COMPLETES THE FORM?

**FDOT PROJECTS**

- FDOT staff
- Consultants

**Driveway / Connection Permits on State Highways**

- Applicant

# GUIDANCE FOR ICE EVALUATION – APPENDIX B

- Appendix B provides information details to be provided in ICE Forms
- Forms have to be approved by District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE)
- One form available for each Stage
  - Excel Spreadsheet Format
    - Yellow cells provide a dropdown menu
    - Gray cells require manual input regarding project specific information
    - Auto-populates project information and control strategies to Stage 2 and Stage 3

**Florida Department of Transportation**

Intersection Control Evaluation Form 750-010-003

**Intersection Control Evaluation (ICE) Form**

**Stage 1: Screening**

To fulfill the requirements of Stage 1 (Screening) of FDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms can be submitted to the District Traffic Operations Engineer (DTOE) and District Design Engineer (DDE) for the project's approval.

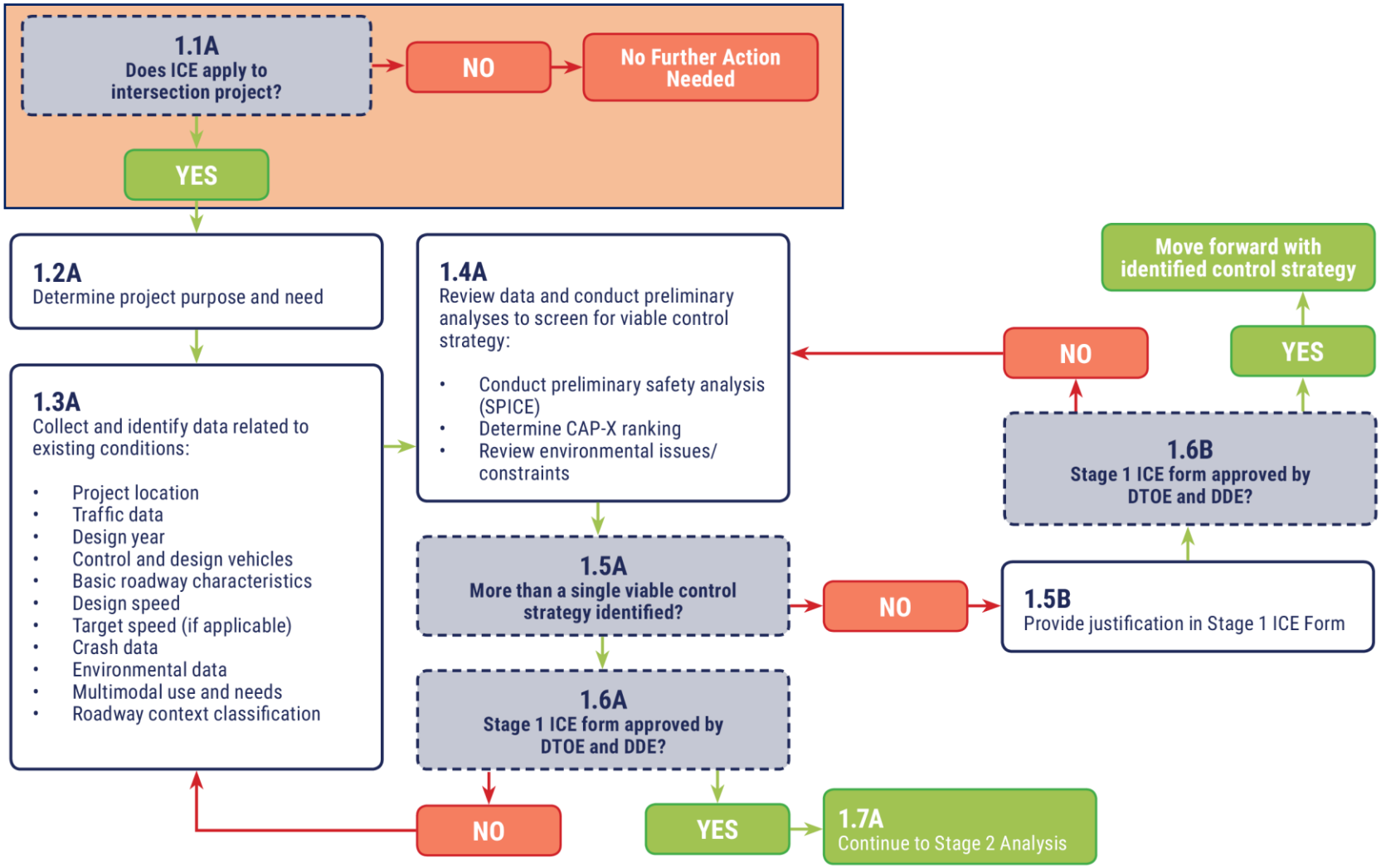
| | | | | | |
|---|---|---|---|---|---|
| Project Name | | FDOT Project # | | Date | |
| Submitted By | | Agency/Company | | Email | |
| FDOT Context Classification | | FDOT District | | County | |

# FDOT ICE IMPLEMENTATION PLAN

- 2018: Training and Acclimation
  - Implementation Focus: District Training
    - Two intersections per district
- 2019: Districts Identify & Conduct ICE Analysis for Additional Locations
  - Implementation Focus: Refine ICE Process
    - Evaluate minimum of three projects in these offices/focus areas
      - PD&E
      - Traffic Operations
      - Access Management/Permitting
  - Conduct second round ICE Training
- 2020: Full ICE Procedure Implementation by Districts
  - Implementation Focus: Mainstream ICE Process
    - ICE Manual Procedures fully effective January 1, 2020
    - Quality Assistance Reviews (QAR) starting in Year 4

# STAGE 1

# ICE STAGE 1 PROCESS






Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 2; Page 10

# ICE is REQUIRED when

- New signalization is proposed
- Major reconstruction of existing signalized intersection is proposed
  - Adding exclusive left turns, adding intersection legs
- Conversion of a directional or bi-directional median opening to a full median opening is proposed
- Driveway/Connection permit applications for Category E, F, G
- District Design Engineer (DDE) and District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Section 2.3; Page 5

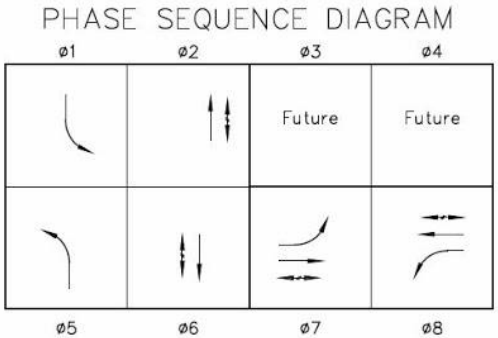
## 14-96.003 General Provisions

(3)~~(4)~~ Traffic Control Features and Devices in the State Right of Way. Traffic control features and devices in the right of way~~, such as traffic signals, channelizing islands, medians, median openings, and turn lanes~~ are operational and safety characteristics of the State Highway System and are not means of access. The Department may install, remove, or modify any present or future traffic control feature or device in the right of way to promote traffic safety in the right of way or promote efficient traffic operations on the highway. A connection permit is only issued for connections and not for any present or future traffic control features or devices at or near the permitted connections. The permit may describe these features and/or devices, but such description does not create any type of interest in such features. Applicants requesting or requiring the addition, removal, or modification of a traffic signal for Category E, F, and G connections, must submit an Intersection Control Evaluation Form, Form 750-010-30, effective 1/19, incorporated herien at . All traffic control features and devices requested by an Applicant, if approved, will require a construction agreement between the Department and the Permittee.

- ICE is Required for
  - Addition, removal, or modification of traffic signal
  - Category E, F, and G connections

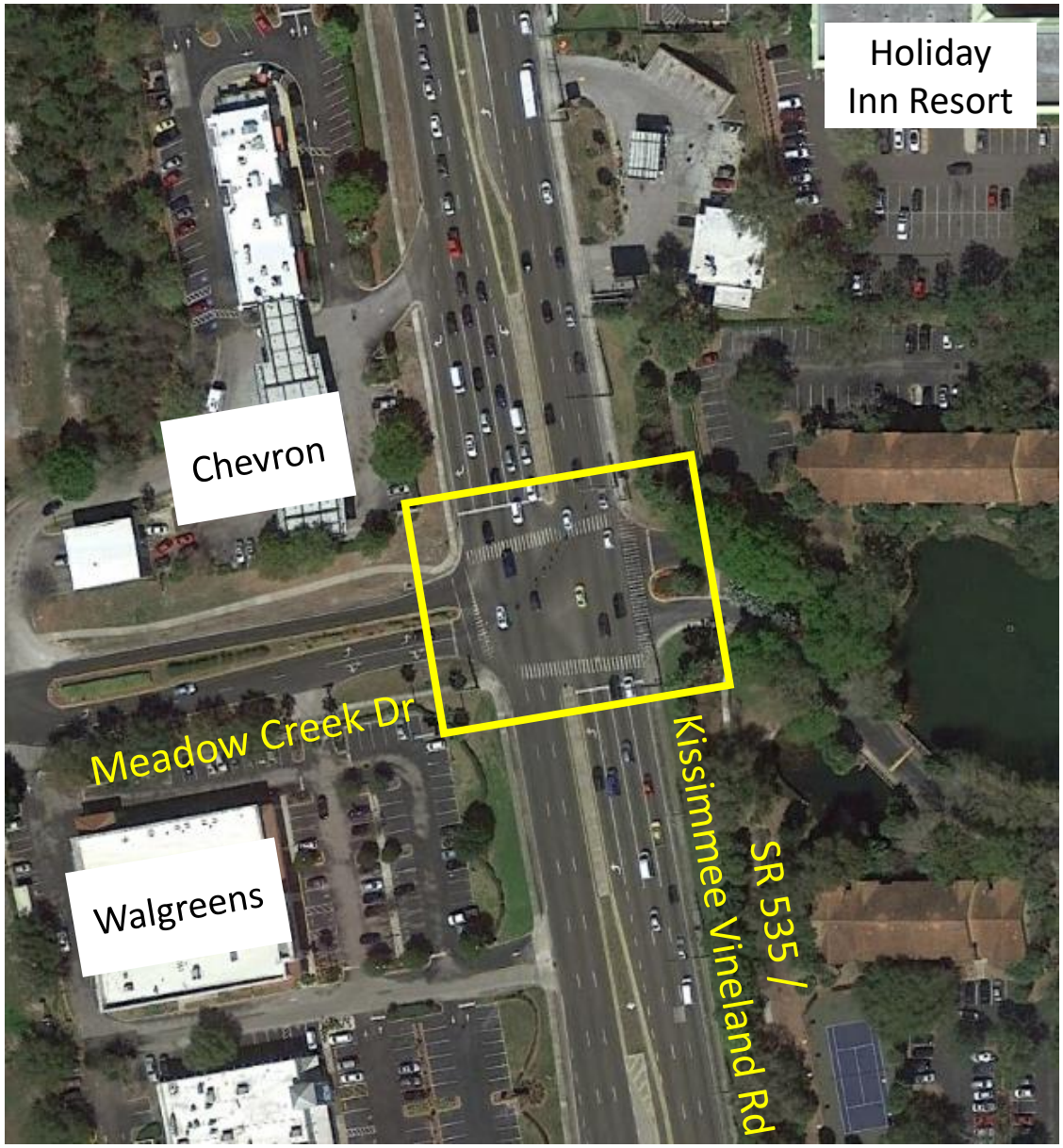
# ICE NOT REQUIRED

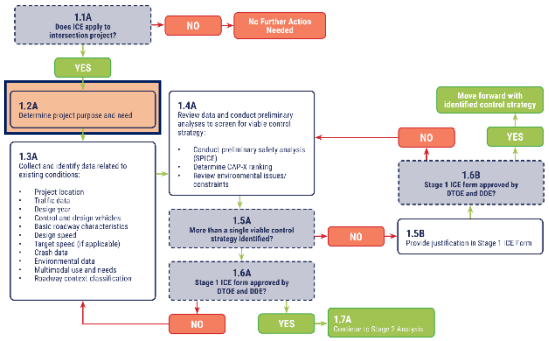
- Work does not include substantive proposed changes to intersection
  - Mill and resurface pavement; changing full median opening to directional median opening
- Minor intersection operational improvements
  - Adding right turn lane or signal phasing changes or equipment upgrades
- Encouraged for local roadways, not required
- Recommended for ramp terminal intersections (stop control, signalized, or yield), not required



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Section 2.3; Page 5

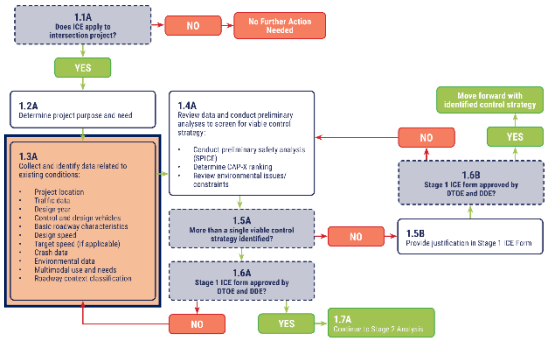
# 1.2 A – PROJECT PURPOSE AND NEED




- Increasing throughput capacity along SR 535
- Pedestrian crossing safety
  - 1 marked pedestrian crossing for over a mile south of the I-4 interchange
  - Look for signalized crossing opportunities

# 1.3 A – DATA COLLECTION FOR EXISTING CONDITIONS




- Roadway Context Class
- Intersection Configuration
- Analysis Years
  - 2015 – Existing
  - 2020 – Opening
  - 2040 – Design
- Existing TMC
  - 2015 AM/PM
- Posted speeds
- AADTs
  - 2020 – Opening
  - 2040 – Design
- Truck Percentages
- Design Vehicle

# Project Information

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Name | SR 535 at Meadow Creek Drive | | FDOT Project # | | | Date | 03/29/18 |
| Submitted By | KAI | Agency/Company | FDOT Central Office | | Email | | |
| FDOT Context Classification | C3C - Suburban Commercial | | FDOT District | District 5 | County | Orange | |
| Project Locality (*City/Town/Village*) | Unincorporated Orange County | | Project Type | Multimodal Improvement | | | |
| Project Purpose (*What is the catalyst for this project and why is it being undertaken?*) | Study location currently a signalized intersection. The area is expected to experience an increase in throughput capacity along SR 535. Pedestrian crossing safety is one of the driving components to find alternative intersections as there is only 1 marked crossing for over a mile south of the I-4 interchange. The evaluation and implementation of alternative intersections at this location can help provide more signalized crossing opportunities | | | | | | |
| Project Setting Description (*Describe the area surrounding the intersection*) | SR 535 is classified as an urban minor arterial, 6-lane facility. The immediate land uses surrounding the intersection comprise mostly commercial use. | | | | | | |
| Multimodal Context (*Describe the pedestrian, bicycle, and transit activity in the area and the potential for activity based on surrounding land uses and development patterns*) | 5' sidewalks are provided on all four legs of the intersection and high emphasis crosswalks are provided an all intersection legs at Meadow Creek Dr. No bicycle lanes are provided, there are 2' curb and gutter on the inner and outside shoulders of SR 535. | | | | | | |

**ICE Forms For Reporting, Not Analysis**

# Basic Intersection Information

| Major Street Information | | | | | | | |
|---|---|---|---|---|---|---|---|
| Route #: | 535 | Route Name(s) | Kissimmee Vineland Road | | | Milepost | 1.903 |
| Existing Control Type | Signal | | Existing AADT | 49,700 | | Design Year AADT | 70,000 |
| Design Vehicle | Interstate Semitrailer (WB-62) | | Control Vehicle | Interstate Semitrailer (WB-62) | | | |
| Primary Functional Classification | Urban Minor Arterial | | | | | Design Speed (mph) | 45 |
| Secondary Functional Classification (if app.) | | | | | | Target Speed (mph) [if app.] | |

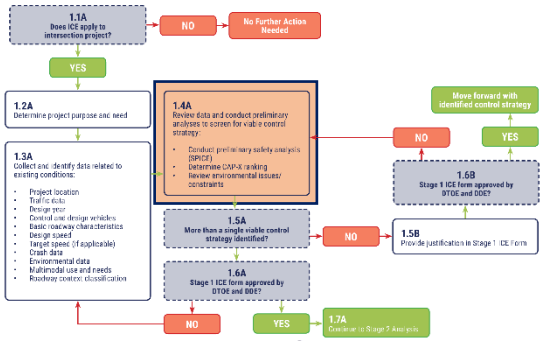
| Approach #1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Direction | Northbound | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
| Sidewalks along | Neither side of the approach | Left-Turn | 1 | | | | |
| Crosswalk on Approach? | Yes | Left-Through | | Weekday AM Peak | | Weekday PM Peak | |
| On-Street Bike Facilities? | No | Through | 2 | Left | 41 | Left | 67 |
| Multi-Use Path? | No | Left-Through-Right | | Through | 1,710 | Through | 1,487 |
| Scheduled Bus Service? | No | Through-Right | 1 | Right | 6 | Right | 17 |
| Bus Stop on Approach? | No | Right-Turn | | Daily Truck % | | 2.5% | |

| Approach #2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Direction | Southbound | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
| Sidewalks along: | Neither side of the approach | Left-Turn | 1 | | | | |
| Crosswalk on Approach? | Yes | Left-Through | | Weekday AM Peak | | Weekday PM Peak | |
| On-Street Bike Facilities? | No | Through | 3 | Left | 39 | Left | 101 |
| Multi-Use Path? | No | Left-Through-Right | | Through | 1,118 | Through | 1,647 |
| Scheduled Bus Service? | No | Through-Right | | Right | 63 | Right | 154 |
| Bus Stop on Approach? | No | Right-Turn | 1 | Daily Truck % | | 3.5% | |

# 1.5 B – FDOT ICE FORMS – STAGE 1

| Control Strategy Evaluation | | | | | | |
|---|---|---|---|---|---|---|
| Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts. | | | | | | |
| Control Strategy | CAP-X Outputs | | | SPICE Ranking | Strategy to Be Advanced? | Justification |
| | V/C Ratio | | Multimodal Score | | | |
| | | | | | | |
| Two-Way Stop-Controlled | | | | | | |
| All-Way Stop-Controlled | | | | | | |
| Signalized Control | | | | | | |
| Roundabout | | | | | | |
| Median U-Turn | | | | | | |
| RCUT (Signalized) | | | | | | |
| RCUT (Unsignalized) | | | | | | |
| Jughandle | | | | | | |
| Displaced Left Turn | | | | | | |
| Continuous Green Tee | | | | | | |
| Quadrant Roadway | | | | | | |

# 1.4 A – CONDUCT CAP-X




## ICE Procedure and Tools

| | |
|---|---|
| Stage 1 | CAP-X |
| | SPICE |
| Stage 2 | Analysis Guidance; Default SYNCHRO; FDOT ICE Tool |
| Stage 3 | No specific tools. Reuse Stage 2 tools or address qualitative issues. |

TOOLS

# CAP-X

# 1.4 A – VISION AND NEED FOR THE CAP-X TOOL

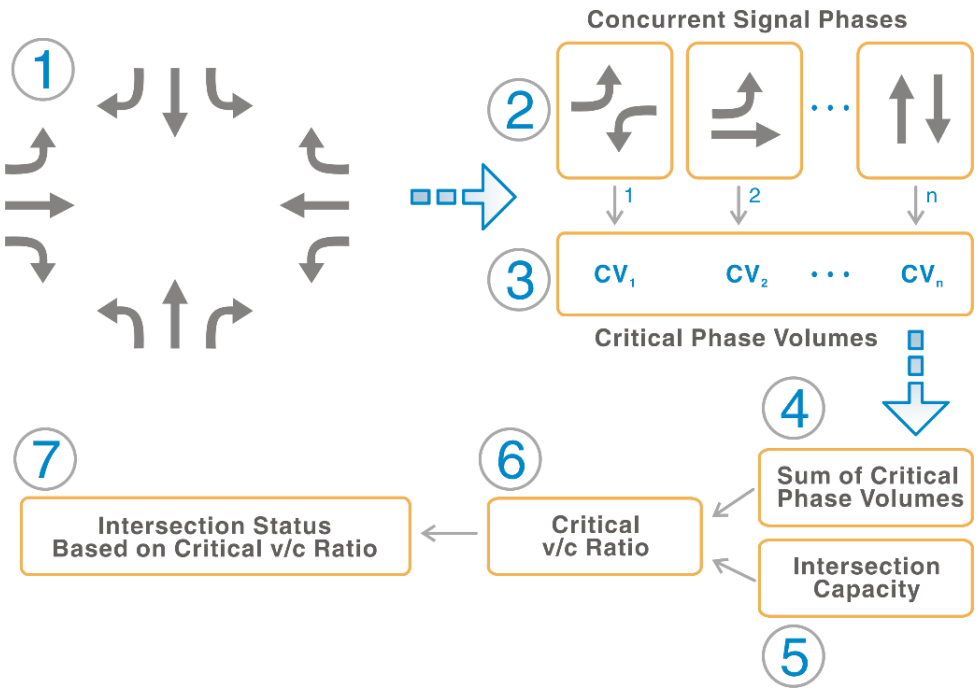
- Capacity Analysis for Planning of Junctions (CAP-X)
- FHWA tool for planning-level capacity assessment
- Stage 1 tool for Intersection Control Evaluation
- Initial operational screening of intersection control alternatives
  - Can be used during project's scoping stage
- Simple tool for efficient comparisons
  - User-friendly
  - Only requires readily available inputs
- FDOT updates
  - Incorporation of multimodal considerations
  - Improved input sheets and output comparisons
  - Updated inputs to reflect FDOT default values
  - HCM 6th Edition roundabout capacity analysis
  - Added stop-controlled intersections
  - Additional intersection alternatives

# 1.4 A – CAP-X TOOL OVERVIEW

- Conducts critical movement analysis (CMA) to gauge the potential performance of intersection and interchange types
- CMA identifies the critical movements at an intersection and estimates whether the intersection is operating below, near, at, or over capacity;
- Includes vast majority of intersections and interchange types

- At-Grade Intersections
  - All Way Stop Control
  - Two Way Stop Control
  - Traffic Signal
  - Continuous Green-T
  - Quadrant Roadway
  - Displaced Left Turn
  - Median U-Turn
  - Restricted Crossing U-Turn
- Roundabouts
  - 50 and 75 ICD Mini-roundabouts
  - 1-Lane Roundabouts
  - 2-Lane Roundabouts
  - Hybrid 1x2 lane configurations
- Grade-Separated Interchanges
  - Traditional Diamond
  - Partial Cloverleaf
  - Displaced Left Turn
  - Diverging Diamond Interchange
  - Single Point Diamond

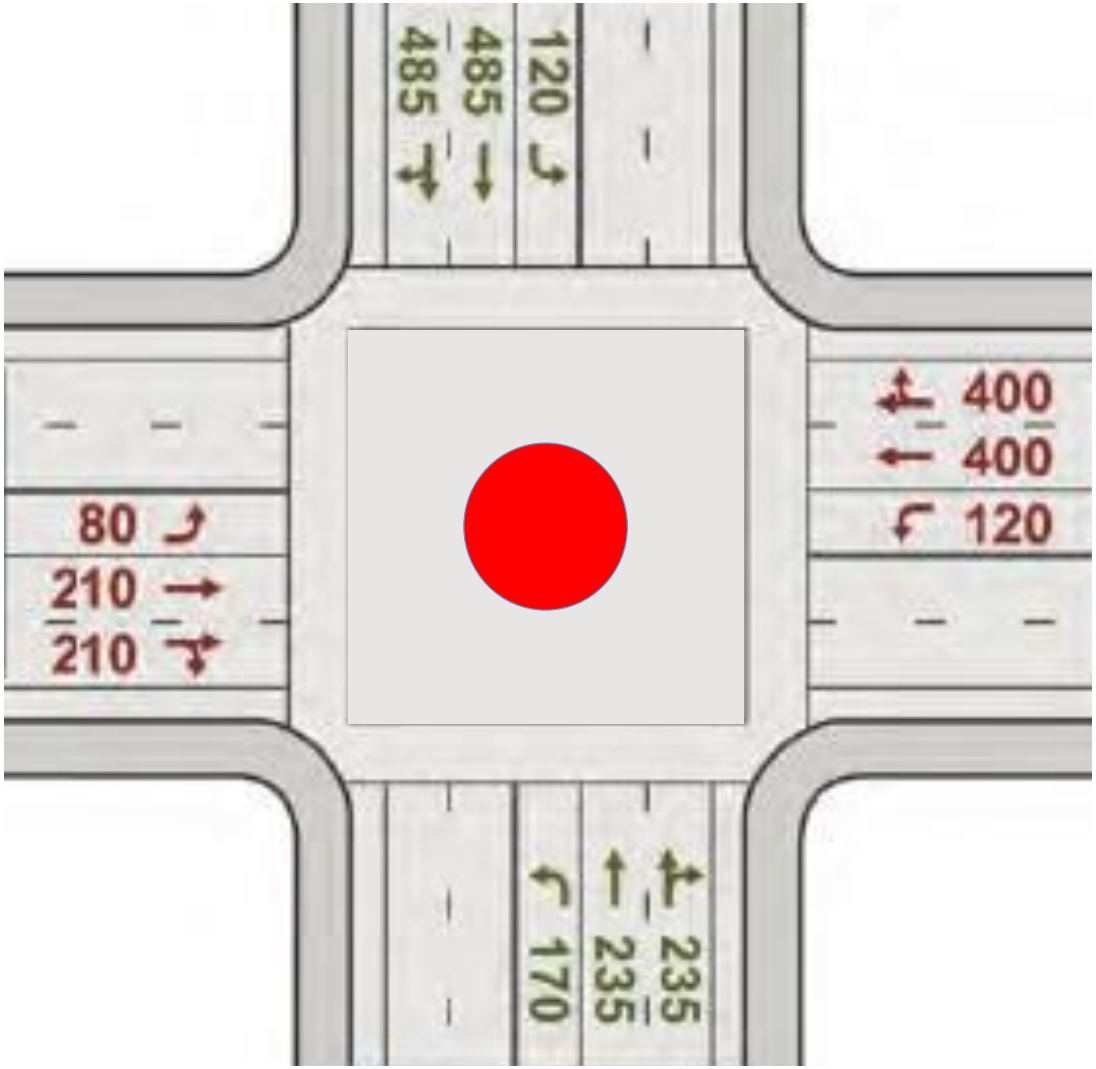
Included in the 1985 HCM and NCHRP Report 812: Signal Timing Manual, 1st Edition




*Source: Traffic Signal Timing Manual – 1st Edition*

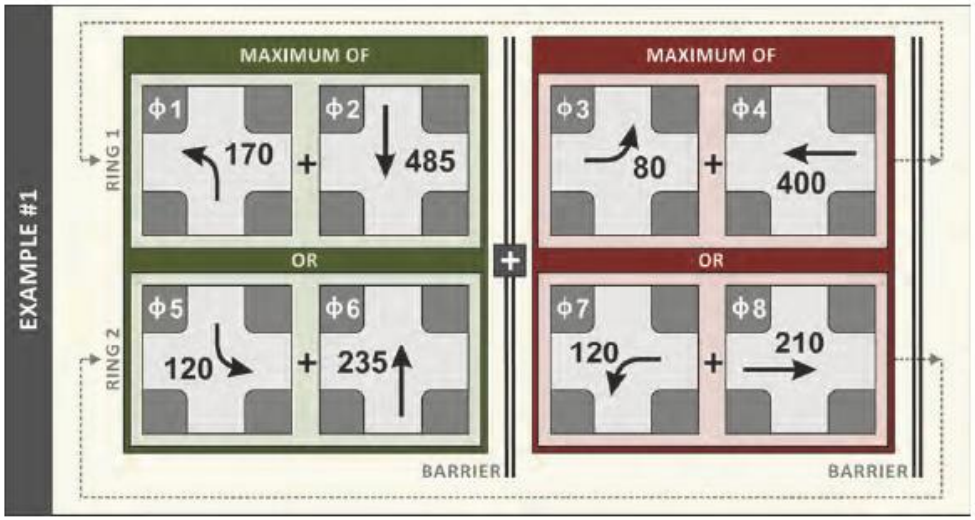
1) Identify movements served, # lanes and volumes per lane
2) Arrange in desired sequence of phases
3) Determine critical volume per lane to be accommodated
4) Sum the critical volumes
5) Determine maximum critical volume for intersection – CAP-X
6) Determine volume to capacity ratio

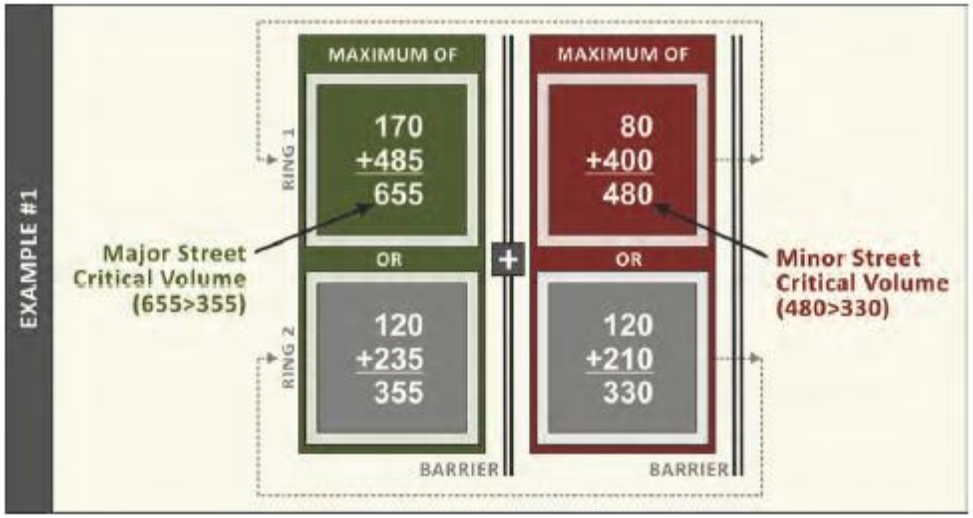
# CMA EXAMPLE: IS THIS INTERSECTION OVER CAPACITY?

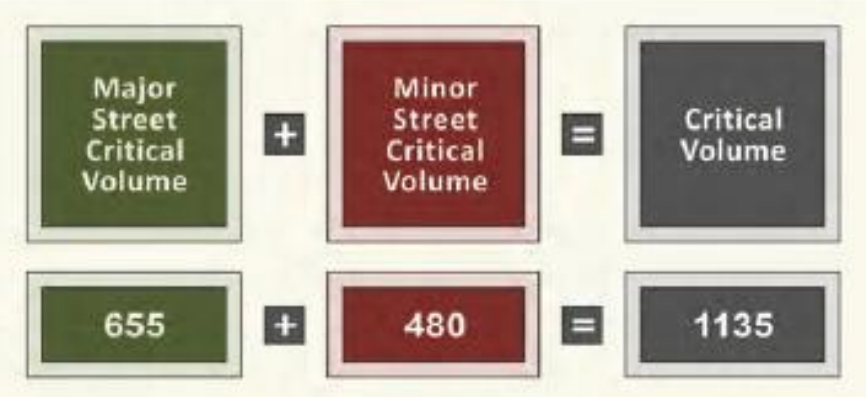



What is the sum of critical movements at this point?

# CMA EXAMPLE: WHAT IS THE V/C RATIO?

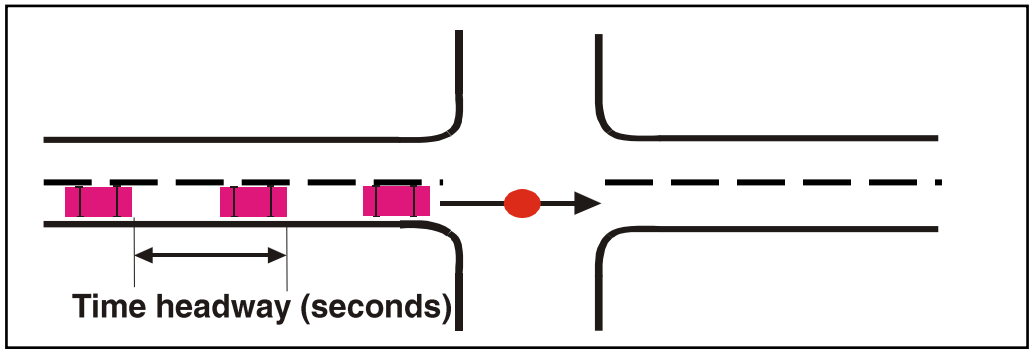



$$\frac{v}{c} = \frac{1135}{1700} = 0.67$$

# WHAT IS THE CAPACITY OF A POINT?




Capacity of Intersection is essentially saturation flow rate minus sum of lost times.

$$c = s * \frac{g}{C}$$

4 critical phases/cycle

$$c = 1{,}950 * \frac{(120sec - 4 * 4sec)}{120sec} = 1{,}690$$

2 critical phases/cycle

$$c = 1{,}950 * \frac{(120sec - 2 * 4sec)}{120sec} = 1{,}820$$

*Assumptions:*

- *s = Base Sat Flow = 1,950 pc/h/ln*
- *C = 120-second cycle length*
- *g = green time per phase*
- *4 seconds lost time/phase*

**Cap-X Default Values**

| | | | |
|---|---|---|---|
| Critical Lane Volume Threshold | 2-phase signal | **Suggested = 1800** | **1800** |
| | 3-phase signal | **Suggested = 1750** | **1750** |
| | 4-phase signal | **Suggested = 1700** | **1700** |

# 1.4 A – CAP-X INPUTS

| Traffic Volume Demand | | | | | | |
|---|---|---|---|---|---|---|
| | Volume (Veh/hr) | | | | Percent (%) | |
| | U-Turn | Left | Thru | Right | Heavy Vehicles | Volume Growth |
| Eastbound | 0 | 113 | 2 | 43 | 14.00% | 0.00% |
| Westbound | 0 | 21 | 2 | 58 | 0.00% | 0.00% |
| Southbound | 0 | 39 | 1118 | 63 | 5.00% | 0.00% |
| Northbound | 0 | 41 | 1710 | 6 | 3.00% | 0.00% |
| Adjustment Factor | 0.80 | 0.95 | | 0.85 | | |
| Suggested | **0.80** | **0.95** | | **0.85** | | |
| Truck to PCE Factor | | | | **Suggested = 2.00** | 2.00 | |
| FDOT Context Zone | | **C3C-Suburban Commercial** | | | | |
| Critical Lane Volume Threshold | 2-phase signal | | | **Suggested = 1800** | **1800** | |
| | 3-phase signal | | | **Suggested = 1750** | **1750** | |
| | 4-phase signal | | | **Suggested = 1700** | **1700** | |

| Equivalent Passenger Car Volume | | | | |
|---|---|---|---|---|
| | Volume (Veh/hr) | | | |
| | U-Turn | Left | Thru | Right |
| Eastbound | 0 | 113 | 2 | 43 |
| Westbound | 0 | 21 | 2 | 58 |
| Southbound | 0 | 41 | 1174 | 66 |
| Northbound | 0 | 42 | 1761 | 6 |

- Movement Volumes
- Multimodal level of activity (FDOT addition)
- Additional planning-level values
- Individual analysis spreadsheets required for each study period (AM, Midday, PM Peak)

## Step 2A: Base Conditions Analysis

| | |
|---|---|
| Project Name: | *SR 535 at MeadowCreek Drive ICE Training* |
| Project Number: | *XXXXX.XX* |
| Location: | *Orlando, FL* |
| Date: | 2016 AM |
| Major Street Direction | North-South |

| Existing Intersection Configuration | *Traffic Signal* |
|---|---|

**Number of Lanes for Existing Configuration**
(Can be edited in "3- Alt Num Lanes Input" as needed)

| TYPE OF INTERSECTION | Sheet | Northbound | | | | Southbound | | | | Eastbound | | | | Westbound | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| *Traffic Signal* | FULL | | 1 | 3 | 0 | | 1 | 3 | 1 | | 1 | 1 | 0 | | 0 | 1 | 0 |

**Results for Existing Configuration**

| TYPE OF INTERSECTION | Sheet | Zone 1 (North) | | Zone 2 (South) | | Zone 3 (East) | | Zone 4 (West) | | Zone 5 (Center) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLV | V/C | CLV | V/C | CLV | V/C | CLV | V/C | CLV | V/C | | |
| *Traffic Signal* | FULL | -- | -- | -- | -- | -- | -- | -- | -- | 834 | *0.55* | -- | -- |

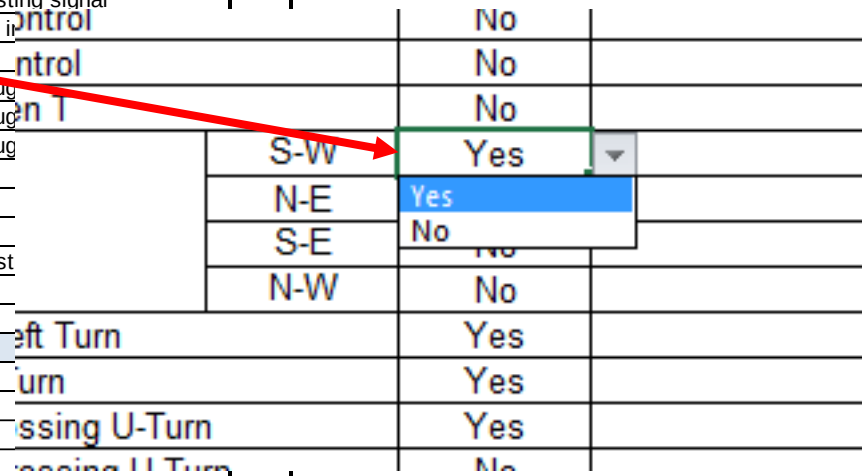
**Existing Configuration Results**

| Overall v/c Ratio | 0.55 | Pedestrian Accommodation | Fair | Bicycle Accommodation | Fair | Transit Accommodation | Good |
|---|---|---|---|---|---|---|---|

# 1.4 A – CAP-X INPUTS

**Step 2B: Alternative Selection**

| Rankings Inclusion | | Yes/No | Comment |
|---|---|---|---|
| At-Grade Non-Roundabout Intersections? | | Yes | |
| Traffic Signal | | Yes | |
| Two-Way Stop Control | | No | Existing signal |
| All-Way Stop Control | | No | Existing signal |
| Continuous Green T | | No | 4 leg i |
| Quadrant Roadway | S-W | Yes | |
| | N-E | No | Would go throug |
| | S-E | No | Would go throug |
| | N-W | No | Would go throug |
| Partial Displaced Left Turn | | Yes | |
| Displaced Left Turn | | Yes | |
| Signalized Restricted Crossing U-Turn | | Yes | |
| Unsignalized Restricted Crossing U-Turn | | No | Exist |
| Median U-Turn | | Yes | |
| Partial Median U-Turn | | Yes | |
| Roundabouts? | | No | |
| 50 ICD Miniroundabout | | | |
| 75 ICD Miniroundaobut | | | |
| 1x1 | | | |
| 1x2 | | | |
| 2x1 | | | |
| 2x2 | | | |
| Grade Separated Interchanges? | | No | |
| Diamond | | | |
| Partial Cloverleaf A | | | |
| Partial Cloverleaf B | | | |
| Displaced Left Turn Interchange | | | |
| Diverging Diamond Interchange | | | |
| Single Point | | | |




**Continue to Step 3**

Step 3

Introduction | Abbreviations & Assumptions | 1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report

# 1.4 A – CAP-X INPUTS

0 40 200
Feet

# 1.4 A – CAP-X INPUTS

- New and revised input sheets to facilitate more efficient analysis
- Number of lanes inputs consolidated to a single worksheet
- Quadrant use respective intersection tabs.
- R-CUT and DLT, MUT (Full and Partial) require input for major street direction alternative

**Number of Lanes for Non-roundabout Intersections**

| TYPE OF INTERSECTION | Sheet | Northbound | | | | Southbound | | | | Eastbound | | | | Westbound | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | U | L | T | R | U | L | T | R | U | L | T | R | U | L | T | R |
| Traffic Signal | FULL | | 1 | 3 | 0 | | 1 | 3 | 1 | | 1 | 1 | 0 | | 0 | 1 | 0 |
| Quadrant Roadway | S-W | Use the respective intersection tab(s) to specify the # of lanes inputs. | | | | | | | | | | | | | | | |
| Partial Displaced Left Turn | N-S | | 1 | 3 | 0 | | 1 | 3 | 1 | | 1 | 1 | 0 | | 0 | 1 | 0 |
| Displaced Left Turn | FULL | | 1 | 3 | 0 | | 1 | 3 | 1 | | 1 | 1 | 0 | | 1 | 1 | 0 |
| Signalized Restricted Crossing U-Turn | N-S | 1 | 1 | 3 | 0 | 1 | 1 | 3 | 1 | | | | 1 | | | | 1 |
| Median U-Turn | N-S | 1 | | 3 | 0 | 1 | | 3 | 1 | | | 1 | 0 | | | 1 | 0 |
| Partial Median U-Turn | N-S | 1 | | 3 | 0 | 1 | | 3 | 1 | | 1 | 1 | 0 | | 0 | 1 | 0 |

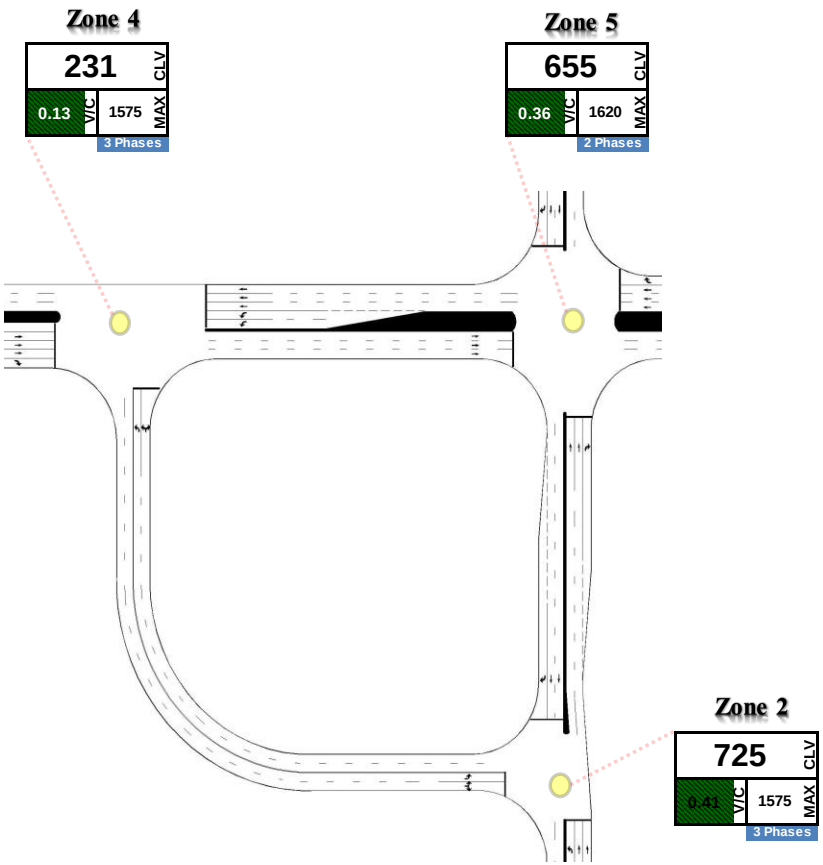
# 1.4 A – CAP-X INPUTS: QUADRANT ROADWAY INTERSECTION

## Quadrant Roadway Intersection (S-W)

**Design and Results**

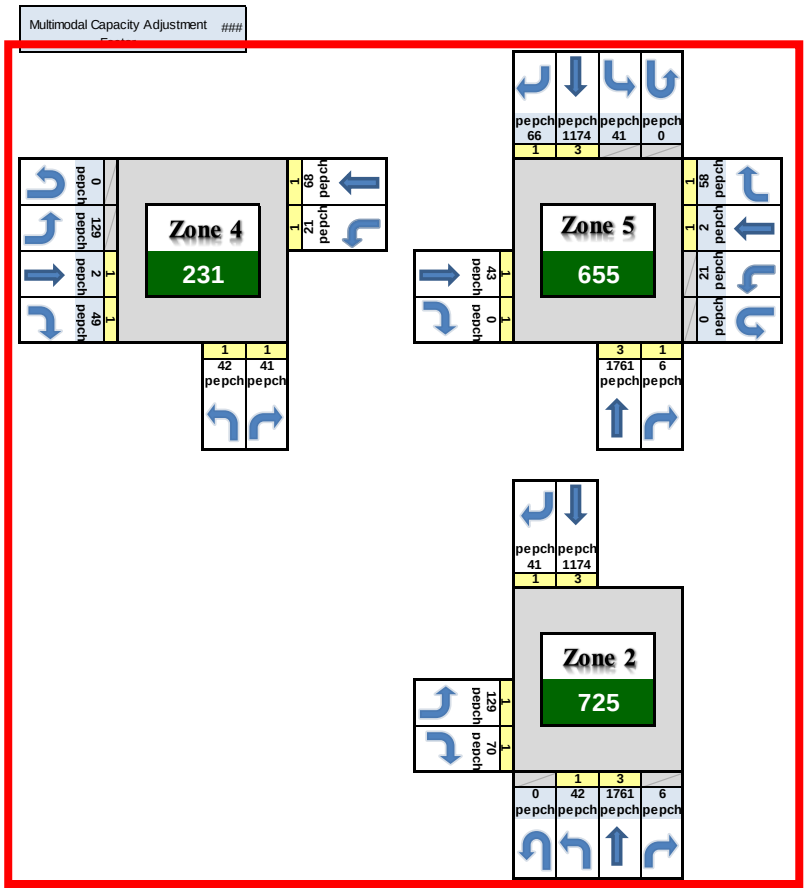
| | |
|---|---|
| Project Name: | SR 535 at MeadowCreek Drive ICE Training |
| Project Number: | XXXXX.XX |
| Location | Orlando, FL |
| Date | 2016 AM |

| Volume-to-Capacity Ratio | | | |
|---|---|---|---|
| < 0.750 | 0.750 - 0.875 | 0.875 - 1.00 | ≥ 1.00 |
| VOLUME / CAPACITY RATIO: | | | 0.41 |




## Quadrant Roadway Intersection (S-W)

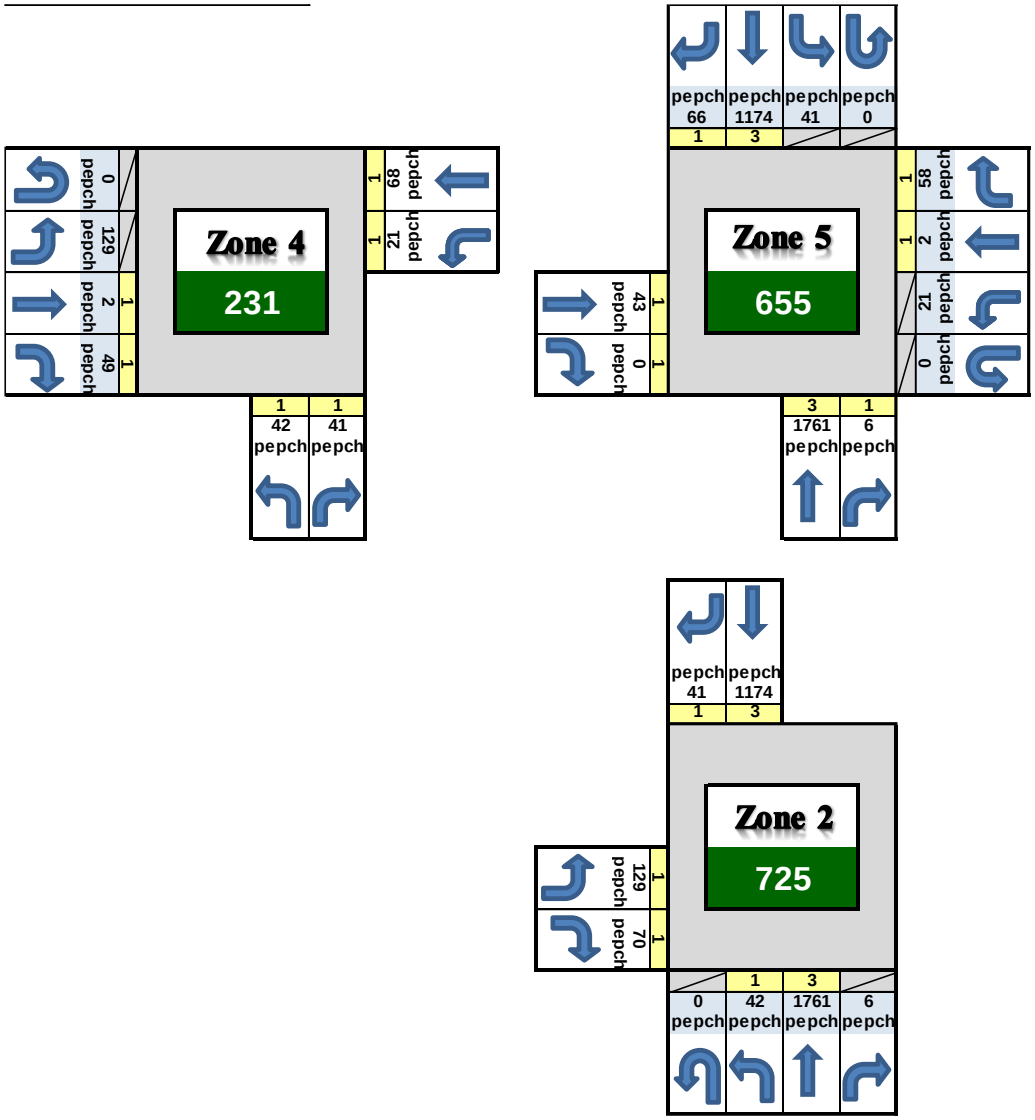
**Data Input and Configuration**




Back to Results

1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report | Traffic Signal | QR S-W

# 1.4 A – CAP-X INPUTS: QUADRANT ROADWAY




1 - Volume Input | 2 - Base and Alt Sel | 3 - Alt Num Lanes Input | 4a - Detailed Results | 4b - Summary Results | 5a - Summary Report | 5b - Detailed Report | Traffic Signal | QR S-W

# 1.4 A – CAP-X MULTIMODAL ACCOMMODATIONS CONSIDERATIONS

- Multi-Modal Accommodation Framework custom-developed for FDOT
- Not true safety prediction, but more qualitative assessment
- Framework considers range of factors:
  - crossing control (signal vs. uncontrolled)
  - crossing width (short vs. long)
  - vehicle speed (slow vs. fast)
  - volume (high vs. low)
  - out-of-direction travel
- Factors evaluated for each crossing at each of the intersections
- Score aggregated across modes for entire intersection
- Weighting Factors: Pedestrians (x3), Bicycles (x2), Transit (x1)

# 1.4 A – CAP-X FULL OUTPUT

- Full results provided for each zone of each alternative
- Includes multimodal details based on specified level of activity

| | | Estimated Volume-to-Capacity Ratio | | | |
|---|---|---|---|---|---|
| Project Name: | SR 535 at Meadow Creek Drive ICE Training | Number of Configurations | | | |
| Project Number: | XXXXX.XX | < 0.750 | 0.750 - 0.875 | 0.875 - 1.00 | ≥ 1.00 |
| Location | Orlando, FL | 7 | 0 | 0 | 0 |
| Date | 2016 AM | | | | |

**Results for Non-roundabout Intersections**

| TYPE OF INTERSECTION | Sheet | Zone 1 (North) | | Zone 2 (South) | | Zone 3 (East) | | Zone 4 (West) | | Zone 5 (Center) | | Overall v/c Ratio | Pedestrian Accommodations | Bicycle Accommodations | Transit Accommodations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLV | V/C | CLV | V/C | CLV | V/C | CLV | V/C | CLV | V/C | | | | |
| Traffic Signal | FULL | | | | | | | | | 851 | 0.56 | 0.56 | Fair | Fair | Good |
| Quadrant Roadway | S-W | | | 725 | 0.41 | | | 231 | 0.13 | 655 | 0.36 | 0.41 | Fair | Fair | Fair |
| Partial Displaced Left Turn | N-S | 692 | 0.38 | 459 | 0.25 | | | | | 806 | 0.46 | 0.46 | Fair | Fair | Good |
| Displaced Left Turn | FULL | 692 | 0.38 | 459 | 0.25 | 71 | 0.04 | 180 | 0.10 | 725 | 0.40 | 0.40 | Fair | Fair | Good |
| Signalized Restricted Crossing U-Turn | N-S | 456 | 0.25 | 767 | 0.43 | 725 | 0.40 | 610 | 0.34 | | | 0.43 | Good | Good | Fair |
| Median U-Turn | N-S | 506 | 0.28 | 816 | 0.45 | | | | | 755 | 0.42 | 0.45 | Good | Good | Fair |
| Partial Median U-Turn | N-S | 480 | 0.27 | 654 | 0.36 | | | | | 820 | 0.47 | 0.47 | Good | Good | Fair |

# 1.4 A – CAP-X SUMMARY OUTPUTS

- Summary with dynamic rankings based on V/C
- Includes multimodal details based on level of activity (based purely on intersection control)

| TYPE OF INTERSECTION | Overall V/C Ratio | V/C Ranking | Multimodal Score | Pedestrian Accommodations | Bicycle Accommodations | Transit Accommodations |
|---|---|---|---|---|---|---|
| Displaced Left Turn | 0.40 | 1 | 4.8 | Fair | Fair | Good |
| Quadrant Roadway S-W | 0.41 | 2 | 4.4 | Fair | Fair | Fair |
| Signalized Restricted Crossing U-Turn N-S | 0.43 | 3 | 6.3 | Good | Good | Fair |
| Median U-Turn N-S | 0.45 | 4 | 6.3 | Good | Good | Fair |
| Partial Displaced Left Turn N-S | 0.46 | 5 | 4.8 | Fair | Fair | Good |
| Partial Median U-Turn N-S | 0.47 | 6 | 6.3 | Good | Good | Fair |
| Traffic Signal | 0.56 | 7 | 4.8 | Fair | Fair | Good |

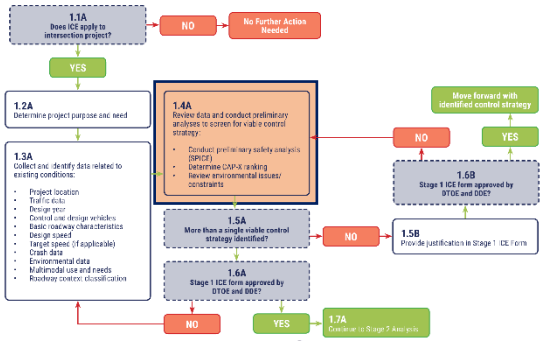
# 1.4 A – CAP-X IN FDOT ICE FORMS – STAGE 1

Control Strategy Evaluation

Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts.

| Control Strategy | CAP-X Outputs | | | SPICE Ranking | Strategy to Be Advanced? | Justification |
|---|---|---|---|---|---|---|
| | V/C Ratio | | | | | |
| | Weekday AM Peak | Weekday PM Peak | Multimodal Score | | | |
| Two-Way Stop-Controlled | - | - | - | | | |
| All-Way Stop-Controlled | - | - | - | | | |
| Signalized Control | 0.56 | 0.68 | 4.8 | | | |
| Roundabout | - | - | - | | | |
| Median U-Turn | 0.45 (Full)<br>0.47 (Partial) | 0.53 (Full)<br>0.57 (Partial) | 6.3 (Both) | | | |
| RCUT (Signalized) | 0.43 | 0.57 | 6.3 | | | |
| RCUT (Unsignalized) | - | - | - | | | |
| Jughandle | | | | | | |
| Displaced Left-Turn | 0.40 (Full)<br>0.46 (Partial) | 0.50 (Full)<br>0.55 (Partial) | 4.8 (Both) | | | |
| Continuous Green Tee | - | - | - | | | |
| Quadrant Roadway | 0.41 | 0.55 | 4.4 | | | |

# 1.4 A – CONDUCT SPICE




| ICE Procedure and Tools | | | | |
|---|---|---|---|---|
| Stage 1 | CAP-X | SPICE | | |
| Stage 2 | Analysis Guidance | Default SYNCHRO | FDOT ICE Tool | |
| Stage 3 | No specific tools. Reuse Stage 2 tools or address qualitative issues. | | | |

**SPICE is used in both: Stage 1 and Stage 2 analyses**

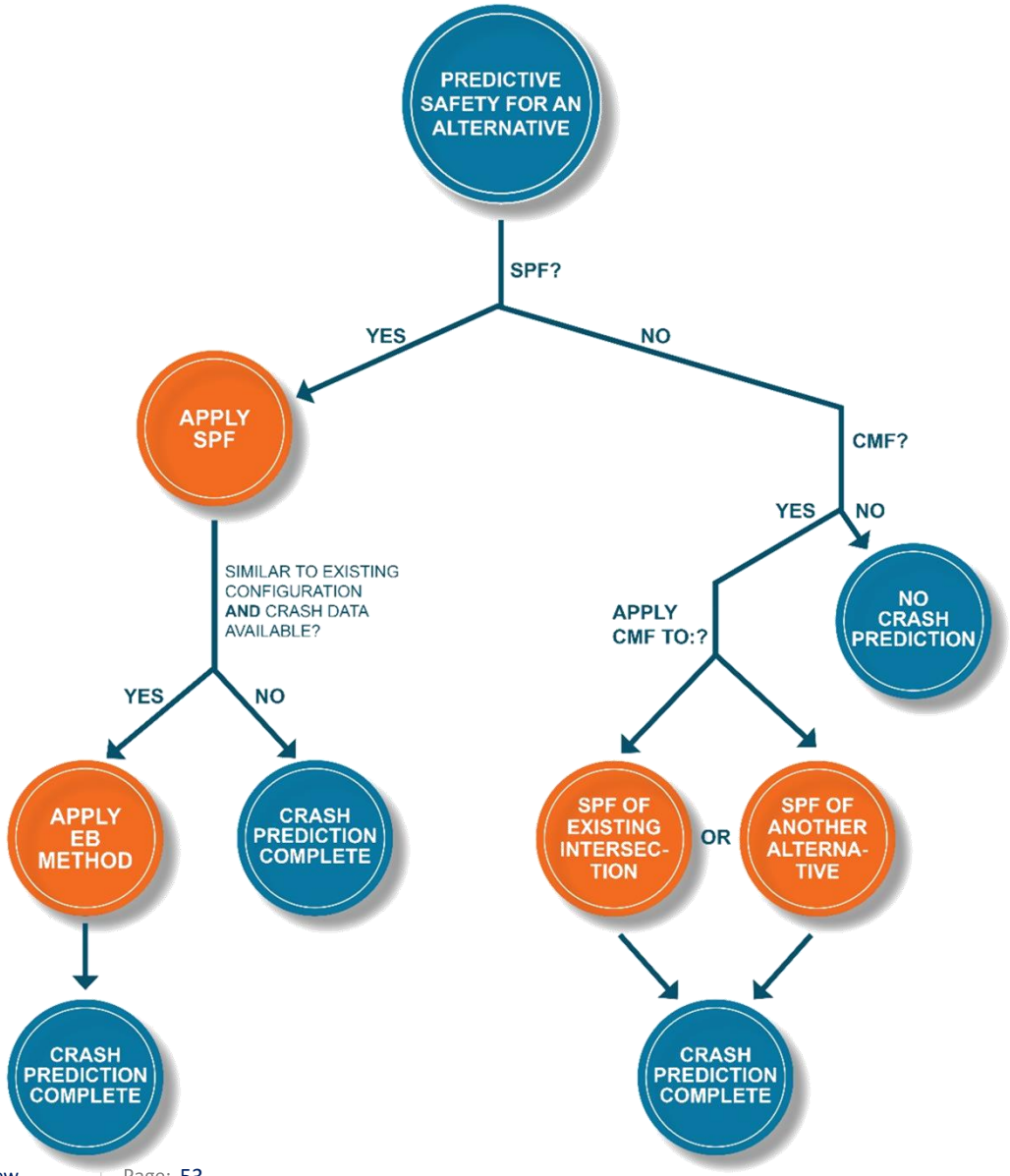
TOOLS

# SPICE – STAGE 1

# 1.4 A – VISION AND NEED FOR THE SPICE TOOL

- Safety Performance Intersection Control Evaluations (SPICE)
- Safety comparisons of intersections becoming more common – ICE, increased use of HSM in general, etc.
- FHWA recognizes everyone is struggling with them
  - Which Crash Modification Factor (CMF) is *right*?
  - What should the CMF be applied to (existing, another alt, etc.)?
  - New Safety Performance Functions (SPFs) being produced through NCHRP (such as 6 and 8 lane arterials/roundabouts) and FDOT research for RCUTs.
- Simple tool needed for safety comparisons only
  - Same level of effort as CAP-X

# 1.4 A – SPICE TOOL OVERVIEW



# 1.4 A – SPICE: INPUTS AND CONTROL STRATEGY SELECTION

## Control Strategy Selection and Inputs

*Specify the Facility Level Inputs and the Control Strategies to be included in the SPICE Analysis.*

| | | |
|---|---|---|
| **Intersection Type** | At-Grade Intersections | |
| **Analysis Year** | Opening and Design Year | |
| **Opening Year** | 2020 | |
| **Design Year** | 2040 | |
| **Facility Type** | On Urban and Suburban Arterial | For more information on how to determine these values, see the "Definitions" worksheet |
| **Number of Legs** | 4-leg | |
| **1-Way/2-Way** | 2-way Intersecting 2-way | |
| **# of Major Street Lanes (both directions)** | 6 or more | |
| **Major Street Approach Speed** | Less than 55 mph | |
| **Opening Year - Major Road AADT** | 50,000 | |
| **Opening Year - Minor Road AADT** | 3,500 | |
| **Design Year - Major Road AADT** | 70,000 | |
| **Design Year - Minor Road AADT** | 5,000 | |

| Control Strategy | Include | Base Intersection | | |
|---|---|---|---|---|
| Traffic Signal | Yes | -- | | |
| Traffic Signal (Alternative Configuration) | No | -- | | |
| Minor Road Stop | No | -- | | Design Year AADT Outside of SPF Development Range |
| All Way Stop | No | -- | | |
| 1-Lane Roundabout | No | -- | Opening Year AADT Outside of SPF Development Range | Design Year AADT Outside of SPF Development Range |
| 2-Lane Roundabout | No | -- | Opening Year AADT Outside of SPF Development Range | Design Year AADT Outside of SPF Development Range |
| Displaced Left Turn (DLT) | Yes | Traffic Signal | | |
| Median U-Turn (MUT) | Yes | Traffic Signal | | |
| Signalized Restricted Crossing U-Turn (RCUT) | Yes | -- | | Design Year AADT Outside of SPF Development Range |
| Unsignalized Restricted Crossing U-Turn (RCUT) | No | -- | Opening Year AADT Outside of SPF Development Range | Design Year AADT Outside of SPF Development Range |
| Continuous Green-T Intersection | No | Traffic Signal | | |
| Jughandle | Yes | Traffic Signal | | |
| Other 1 | No | Traffic Signal | *Please Select | |
| Other 2 | No | Minor Road Stop | *Please Select | |

# 1.4 A – SPICE: AT-GRADE INTERSECTION INPUTS

Required

| Input | | Control Strategy: Traffic Signal | Displaced Left Turn (DLT) | Median U-Turn (MUT) |
|---|---|---|---|---|
| Opening Year Major Road AADT | Optional AADT Overrides | 50000 | 50000 | 50000 |
| Opening Year Minor Road AADT | | 3500 | 3500 | 3500 |
| Design Year Major Road AADT | | 70000 | 70000 | 70000 |
| Design Year Minor Road AADT | | 5000 | 5000 | 5000 |
| Number of Approaches with Left-Turn Lanes | Additional Required Control Strategy Inputs | 3 | | |
| Number of Approaches with Right-Turn Lanes | | 1 | | |
| Number of Uncontrolled Approaches with Left-Turn Lanes | | | | |
| Number of Uncontrolled Approaches with Right-Turn Lanes | | | | |

Optional for Stage 1, Required for Stage 2

Keep default values below here for planning-level analysis, override with actual values for full HSM Analysis

| Reset Planning Inputs to Defaults | Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE | | | |
|---|---|---|---|---|
| Skew Angle | A yellow cell indicates the value may be used in the SPF computation | N/A | CMF - No Inputs Required | CMF - No Inputs Required |
| Lighting Present | | Yes | | |
| # of Approaches Permissive LT Signal Phasing | | 0 | | |
| # of Approaches Perm/Prot LT Signal Phasing | | 0 | | |
| # of Approaches Protected LT Signal Phasing | | 0 | | |
| Number of Approaches with Right-Turn-on-Red Prohibited | | 0 | | |
| Red Light Cameras Present | | No | | |
| Number of Major Street Through Lanes | | 0 | | |
| Number of Minor Street Lanes | | 0 | | |
| # of Major St Approaches w/ Right-Turn Channelization | | 0 | | |
| Number of Approaches with U-Turn Prohibited | | 0 | | |
| Pedestrian Volume by Activity Level | | Low (50) | | |
| User Specified Sum of all daily pedestrian crossing volumes | | 50 | | |
| Max # of Lanes Crossed by Pedestrians | | 5 | | |
| Number of Bus Stops within 1000' of Intersection | | 0 | | |
| Schools within 1000' of intersection | | No | | |
| Number of Alcohol Sales Establishments within 1000' of Intersection | | 0 | | |

- AADT Volumes for major/minor roads for the opening and design years
- Number of major approaches with left-turn or right-turn lanes
- Stage 1 - Pre-filled planning-level defaults
  - Can be overridden by analyst
- Stage 2 - Detailed information for CMF Analysis

## At-Grade Intersection to include in SPICE Tool

| | | | | | | |
|---|---|---|---|---|---|---|
| Traffic Signal | On Rural Two Lane Highway | 3 leg | - | - | 1 | SPF under development in 17-68 |
| | On Rural Multilane Highway | 3 leg | - | - | 3 | SPF under development in 17-68 |
| | | 3 leg | 2x2 | 6 or more | 7 | SPF from 17-58 |
| | | 4 leg | 2x2 | 6 or more | 8 | SPF from 17-58 |
| | | 3 leg | 1x2 | - | 9 | SPF from 17-58 |
| | | 4 leg | 1x2 | - | 10 | SPF from 17-58 |
| | | 3 leg | 1x1 | - | 11 | SPF from 17-58 |
| | | 4 leg | 1x1 | - | 12 | SPF from 17-58 |
| | | 5 leg | - | | 13 | SPF under development in 17-68 |
| | On High Speed (50+ MPH) Urban and Suburban Arterial | 3 leg | - | - | 14 | SPF under development in 17-68 |
| | | 4 leg | - | - | 15 | SPF under development in 17-68 |
| | | 5 leg | - | - | 18 | SPF under development in 17-68 |
| | | 3 leg | 2x2 | 6 or more | 23 | SPF from 17-58 |
| | | 4 leg | 2x2 | 6 or more | 24 | SPF from 17-58 |
| | | 3 leg | 1x2 | - | 25 | SPF from 17-58 |
| | | 4 leg | 1x2 | - | 26 | SPF from 17-58 |
| | | 3 leg | 1x1 | - | 27 | SPF from 17-58 |
| | | 4 leg | 1x1 | - | 28 | SPF from 17-58 |
| | On High Speed (50+ MPH) Urban and Suburban Arterial | 3 leg | - | - | 29 | SPF under development in 17-68 |
| | | 4 leg | - | - | 30 | SPF under development in 17-68 |
| All-Way Stop | On Rural Two Lane Highway | 4 leg | - | - | 31 | SPF under development in 17-68 |
| | On Urban and Suburban Arterial | 3 leg | - | - | 32 | SPF under development in 17-68 |
| | On Urban and Suburban Arterial | 4 leg | - | - | 33 | SPF under development in 17-68 |

## Legend

| |
|---|
| Completed SPF - include in SPICE Tool |
| SPF Under Development - Include in SPICE Tool |
| Exclude from SPICE Tool |

# RCUT SPFs

- HSM does not have SPFs for RCUTs, none planned for HSM 2
- FDOT developed their own
  - Data from 14 states, but not FL (no RCUTs)
  - Majority of US RCUTs

FLORIDA A&M UNIVERISTY-
FLORIDA STATE UNIVERSITY

**Development of Safety Performance Functions for Restricted Crossing U-Turn (RCUT) Intersections**

Sponsor Award No.: BDV30 977-19

A Report Submitted to Florida Department of Transportation, Traffic Engineering and Operations Office

***Task 5a: Draft Final Report***

Start Date: 02/07/2017; End Date: 02/28/2019

*FDOT Project Manager*: **Alan El-Urfali**,
State Traffic Services Program Manager, Traffic Engineering and Operations Office

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February 2019

# RCUT SPFs Limitations

- Major road AADTs above 65K will experience higher crashes
- When minor road AADTs are higher than 17,500 higher crashes can be expected
- Minor road AADT's threshold decreases with major volumes > 55K AADT

| Major Road AADT | Ratio Factor | Minor Road AADT Limit |
|---|---|---|
| 5,000 | 1.059 | 5,300 |
| 15,000 | 0.825 | 12,370 |
| 25,000 | 0.642 | 16,050 |
| 35,000 | 0.500 | 17,500 |
| 45,000 | 0.390 | 17,530 |
| 55,000 | 0.303 | 16,690 |
| 65,000 | 0.236 | 15,360 |

# 1.4 A – SPICE: CRASH PREDICTION OUTPUTS

- Computes predicted crashes for all selected control strategy types
- Predicted crashes are broken into “Total” and “Fatal & Injury” groups
- Ranking is based on “Fatal & Injury” crashes.

| Crash Prediction Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| Control Strategy | Crash Type | Opening Year | Design Year | Total Project Life Cycle | Rank | AADT Within Prediction Range? | Source of Prediction |
| Traffic Signal | Total | 7.65 | 9.37 | 179.06 | 5 | Yes | Uncalibrated SPF |
| | Fatal & Injury | 4.12 | 5.11 | 97.12 | | | |
| Displaced Left Turn (DLT) | Total | 6.73 | 8.24 | 157.58 | 3 | N/A | CMF |
| | Fatal & Injury | 3.62 | 4.50 | 85.47 | | | |
| Median U-Turn (MUT) | Total | 6.50 | 7.96 | 152.20 | 1 | N/A | CMF |
| | Fatal & Injury | 2.88 | 3.58 | 67.99 | | | |
| Signalized RCUT | Total | 13.07 | 22.12 | 366.83 | 4 | No | Uncalibrated SPF |
| | Fatal & Injury | 3.30 | 5.83 | 94.91 | | | |
| Jughandle | Total | 5.66 | 6.93 | 132.51 | 2 | N/A | CMF |
| | Fatal & Injury | 3.05 | 3.78 | 71.87 | | | |

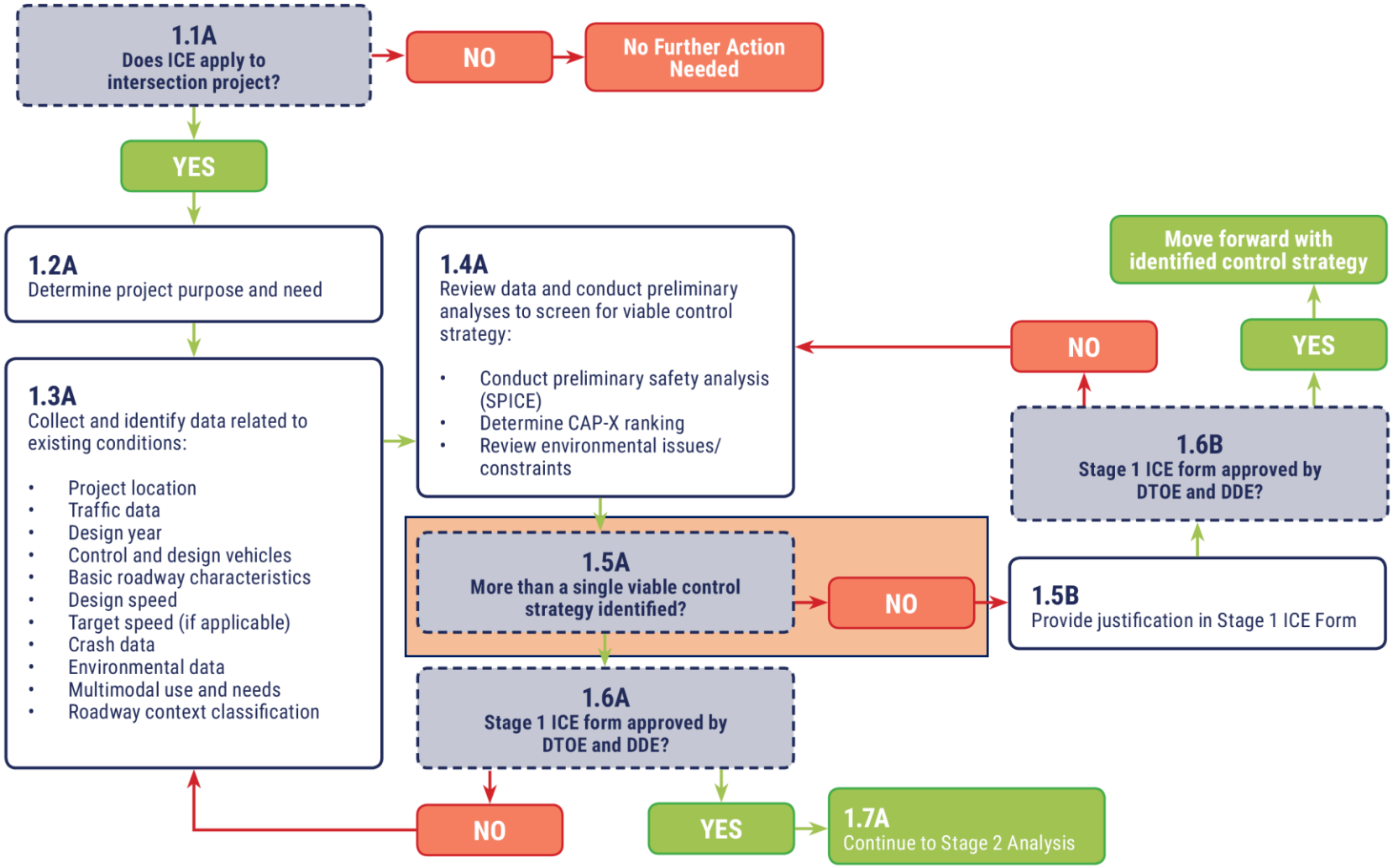
# 1.4 A – SPICE IN FDOT ICE FORMS – STAGE 1

Control Strategy Evaluation

Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts.

| Control Strategy | CAP-X Outputs | | | SPICE Ranking | Strategy to Be Advanced? | Justification |
|---|---|---|---|---|---|---|
| | V/C Ratio | | Multimodal Score | | | |
| | Weekday AM Peak | Weekday PM Peak | | | | |
| Two-Way Stop-Controlled | - | - | - | - | No | Currently a signalized intersection. |
| All-Way Stop-Controlled | - | - | - | - | No | Currently a signalized intersection. |
| Signalized Control | 0.56 | 0.68 | 4.8 | 5 | Yes | The existing condition will move forward in the analysis as the future no-build condition. |
| Roundabout | - | - | - | - | No | |
| Median U-Turn | 0.45 (Full)<br>0.47 (Partial) | 0.53 (Full)<br>0.57 (Partial) | 6.3 (Both) | 1 | Yes | The full MUT would force EB/WB left turns to drive straight through the intersection with limited U-turn locations available on the minor street legs. The |
| RCUT (Signalized) | 0.43 | 0.57 | 6.3 | 4 | Yes | |
| RCUT (Unsignalized) | - | - | - | - | No | |
| Jughandle | | | | 2 | No | ROW impacts would outweigh the benefit. |
| Displaced Left-Turn | 0.40 (Full)<br>0.46 (Partial) | 0.50 (Full)<br>0.55 (Partial) | 4.8 (Both) | 3 | Yes | Low left turning volume from the minor road to justify the associated costs with a full DLT. The study intersection has heavier left turning volumes |
| Continuous Green Tee | - | - | - | - | No | The study intersection is a 4-leg intersection and a Green T is not feasible. |
| Quadrant Roadway | 0.41 | 0.55 | 4.4 | | No | The re-routing of the left turns at the study intersection would not represent a significant operational improvement. The roadway network |

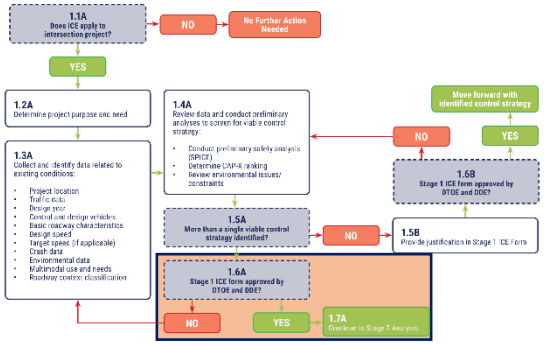
# ICE STAGE 1 PROCESS






Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 2; Page 10

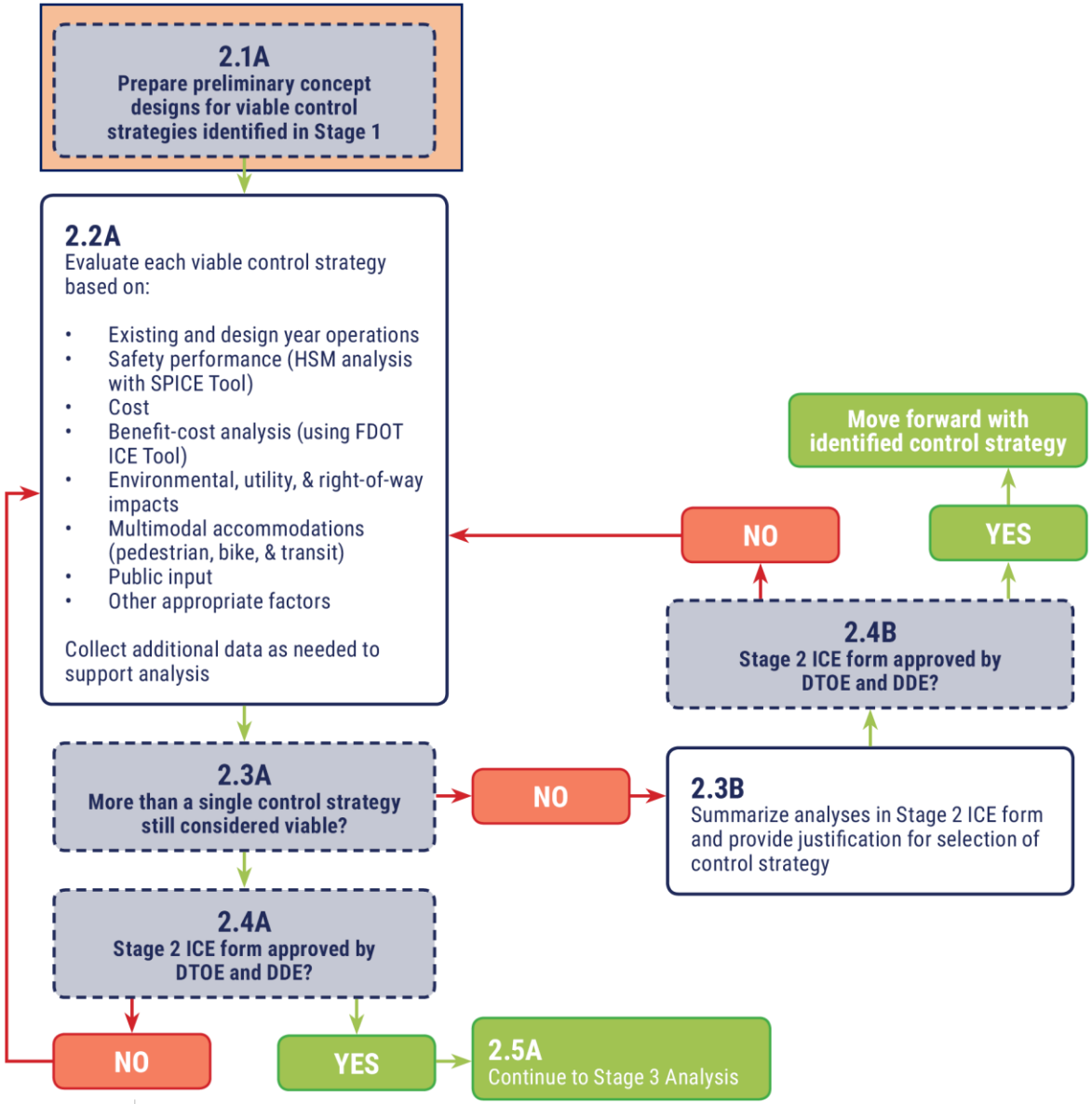
# 1.6 A – ICE FORM APPROVAL




| Resolution | | | | | |
|---|---|---|---|---|---|
| *To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer* | | | | | |
| Project Determination | Multiple Viable Alternatives Identified: Continue to Stage 2 | | | | |
| Comments | | | | | |
| DTOE Name | | Signature | | Date | |
| DDE Name | | Signature | | Date | |

# STAGE 2

# ICE STAGE 2 PROCESS






Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

TOOLS

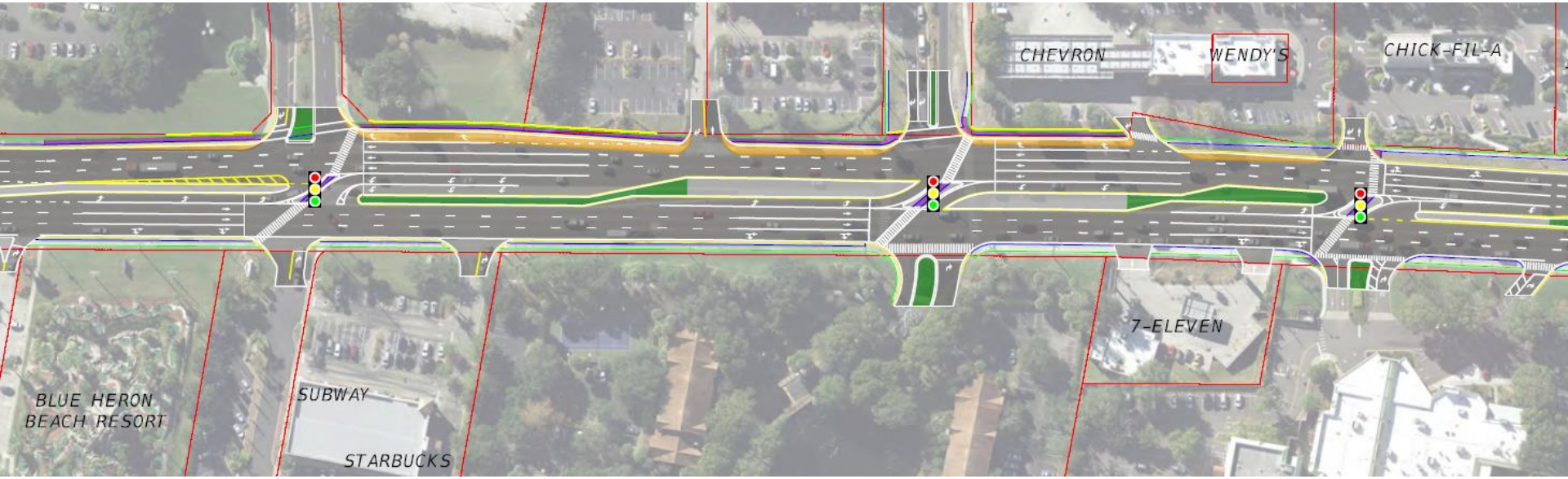
# CONCEPT DEVELOPMENT

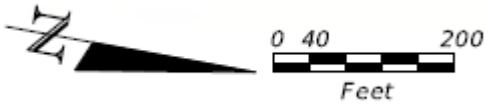
# Signalized Restricted Crossing U-Turn N-S

Construction - $1,300,000

Design Cost - $430,000

ROW Cost - $500,000



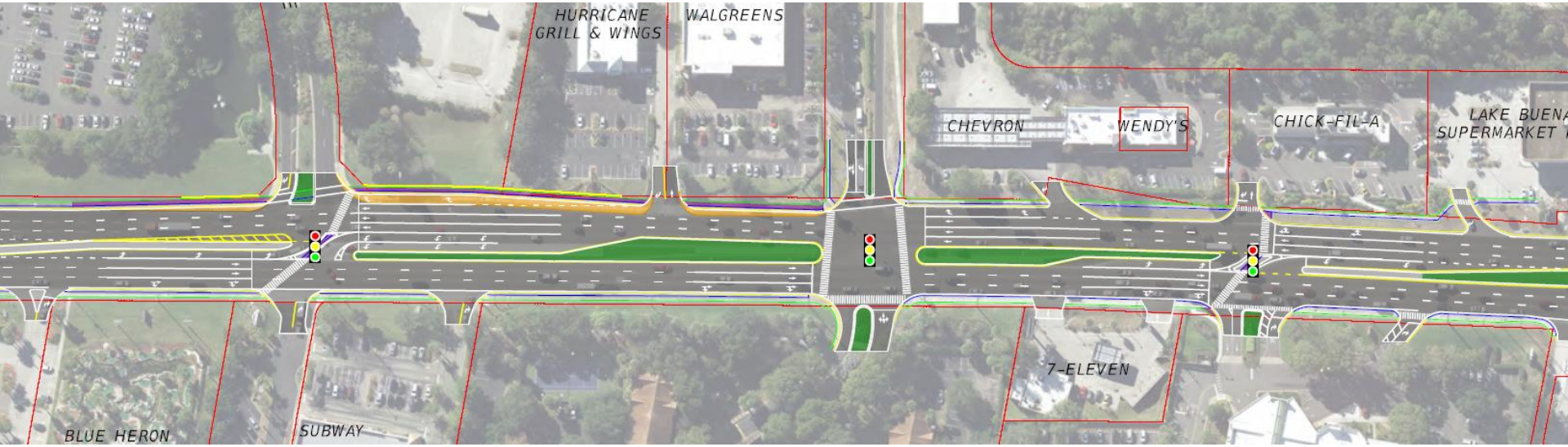



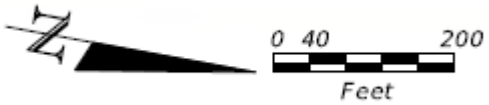
# Median U-Turn N-S

Construction - $1,220,000

Design Cost - $320,000

ROW Cost - $510,000



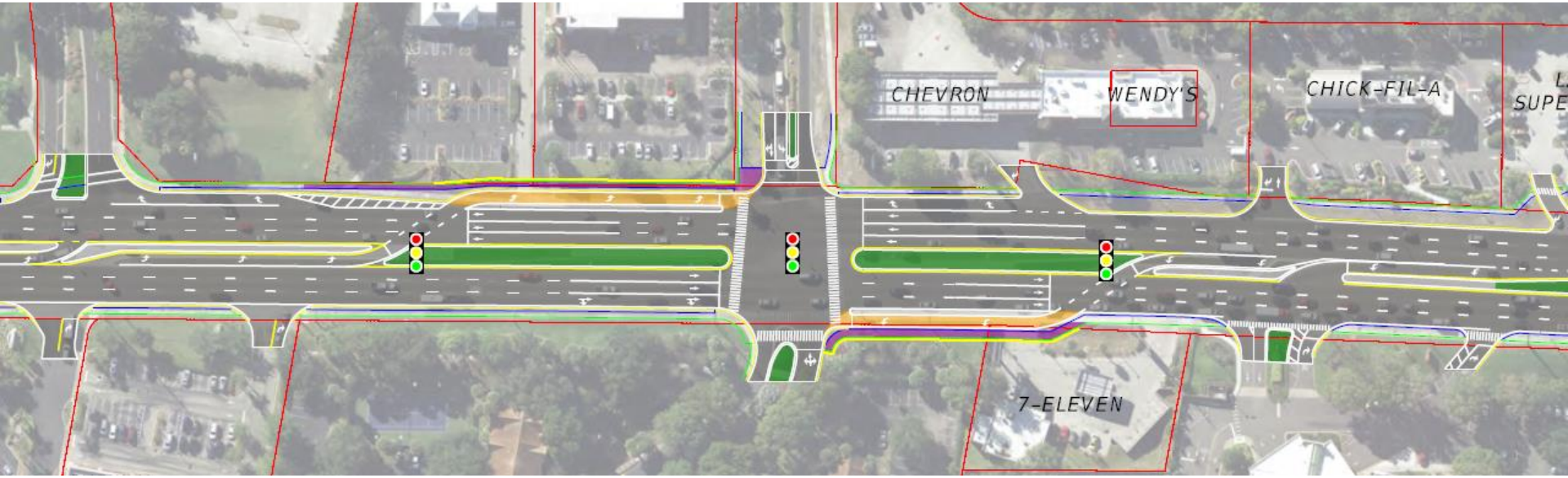



# Partial DLT N-S

Construction - $1,170,000

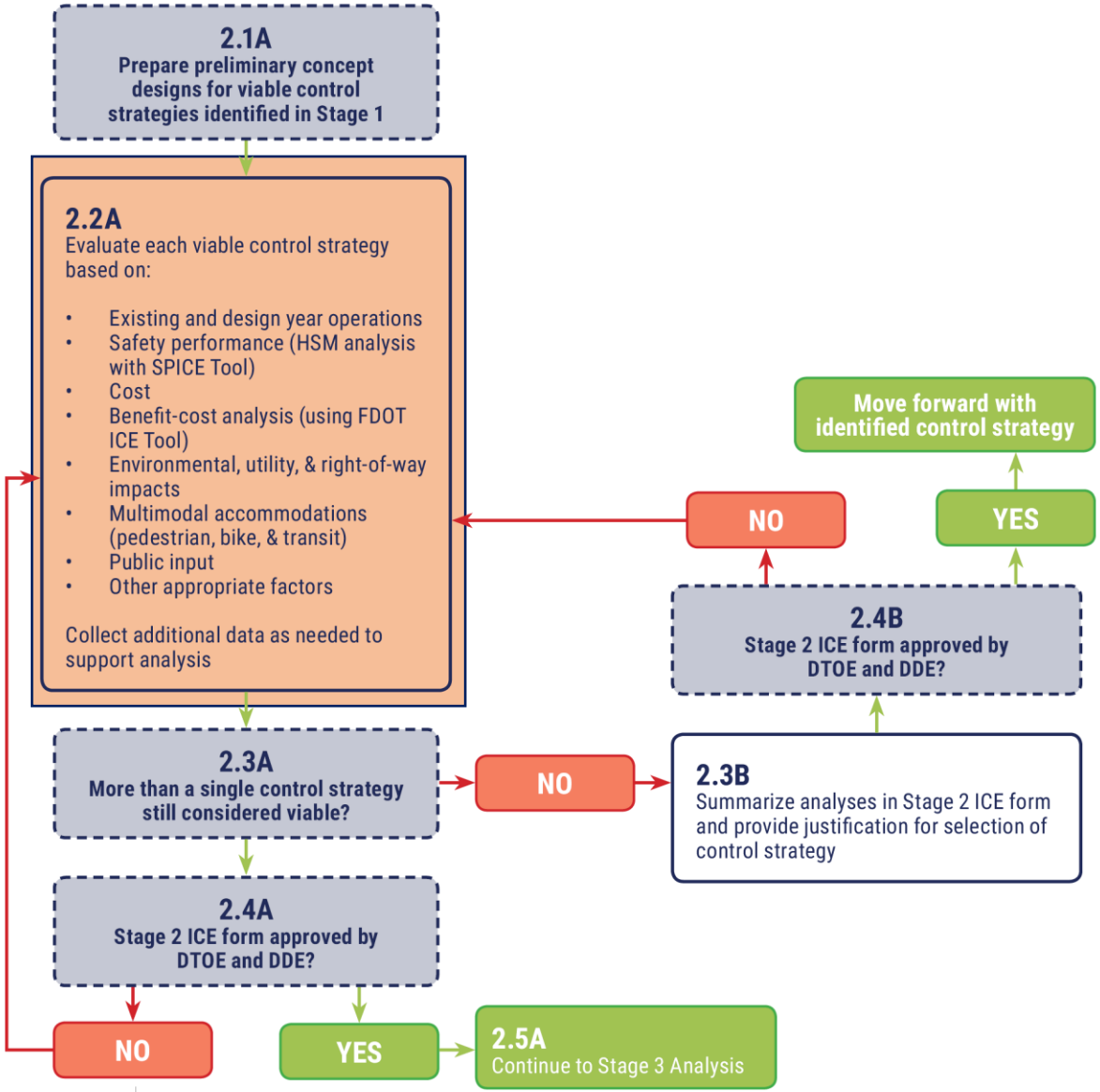
Design Cost - $320,000

ROW Cost - $4,500,000




0 40 200
Feet

# ICE STAGE 2 PROCESS



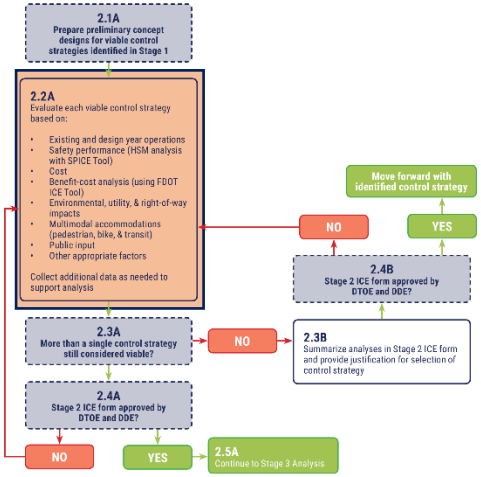



Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

# ICE PROCEDURE

## ICE Procedure and Tools

| | | | |
|---|---|---|---|
| **Stage 1** | CAP-X | SPICE | |
| **Stage 2** | Analysis Guidance | Default SYNCHRO | FDOT ICE Tool |
| **Stage 3** | No specific tools. Reuse Stage 2 tools or address qualitative issues. | | |

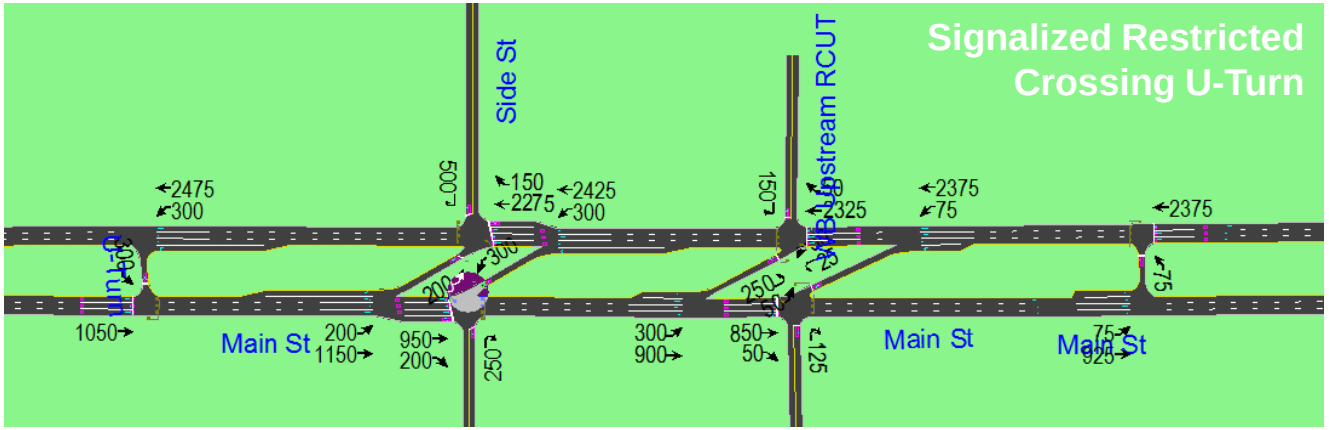


TOOLS

# SYNCHRO

# 2.2 A – SYNCHRO DEFAULT VALUES

- Library of SYNCHRO default files
  - Include proper default signal phasing and saturation flow
- Review of documents for Florida SYNCHRO practice:
  - FDOT Traffic Analysis Handbook (March 2014)
  - FDOT 2013 Quality/Level of Service Handbook



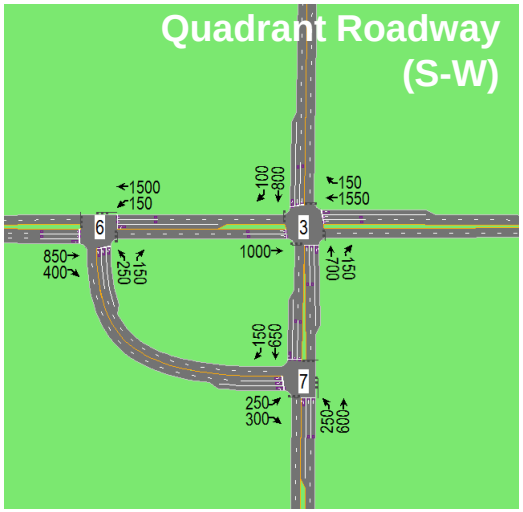

| LANE SETTINGS | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBR | NBR2 | SWL2 | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lanes and Sharing (#RL) | | | | | | | | | | | | |
| Traffic Volume (vph) | 0 | 950 | 200 | 0 | 0 | 0 | 0 | 0 | 250 | 0 | 300 | 0 |
| Future Volume (vph) | 0 | 950 | 200 | 0 | 0 | 0 | 0 | 0 | 250 | 0 | 300 | 0 |
| Street Name | | | | | | | Side St | | | | | |
| Link Distance (ft) | — | 150 | — | — | 426 | — | 671 | — | — | — | 167 | — |
| Link Speed (mph) | — | 30 | — | — | 30 | — | 30 | — | — | — | 30 | — |
| Set Arterial Name and Speed | — | EB | — | — | WB | — | NB | — | — | — | SW | — |
| Travel Time (s) | — | 3.4 | — | — | 9.7 | — | 15.3 | — | — | — | 3.8 | — |
| Ideal Satd. Flow (vphpl) | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 | 1950 |

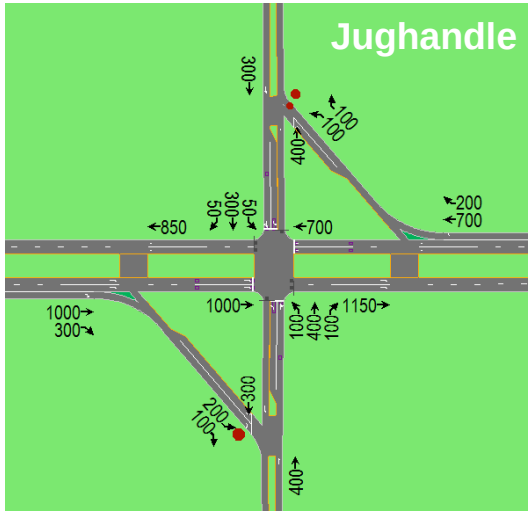
# SYNCHRO INNOVATIVE INTERSECTION TEMPLATES: VISION AND NEED

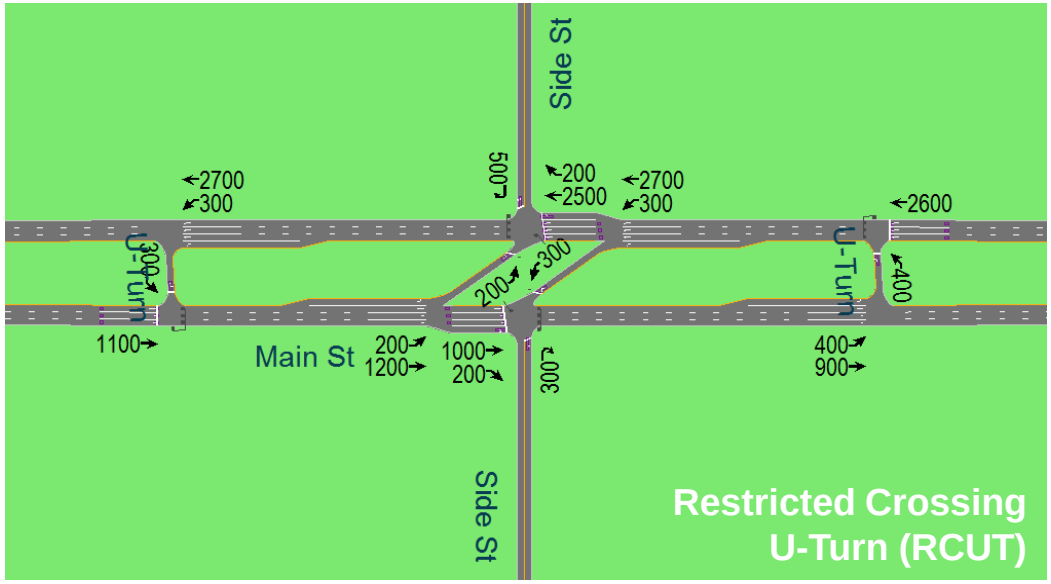
- Stage 2 tool for more detailed operational analysis of alternative intersections
- Need for SYNCHRO templates
  - Modeling alternative intersections in SYNCHRO can be challenging
  - Developing SYNCHRO files on a case-by-case basis is time consuming and prone to error
  - Need for a consistent modeling approach for fair comparisons
- Designed to be quick and easy to use tool
  - Default SYNCHRO files requiring limited data inputs
  - Parameters consistent with HCM 6th Edition and FDOT recommendations
- Flexible enough to accommodate all intersection alternatives and various geometries

# 2.2 A – SYNCHRO TEMPLATES OVERVIEW

- Median U-Turn (MUT)
- Restricted Crossing U-Turn (RCUT)
  - Unsignalized
  - Signalized
  - Expanded to corridors
- Jug-handle
- Displaced Left Turn (DLT)
  - Full
  - Partial
- Continuous Green T
- Quadrant Roadway
- Diverging Diamond Interchange (DDI)

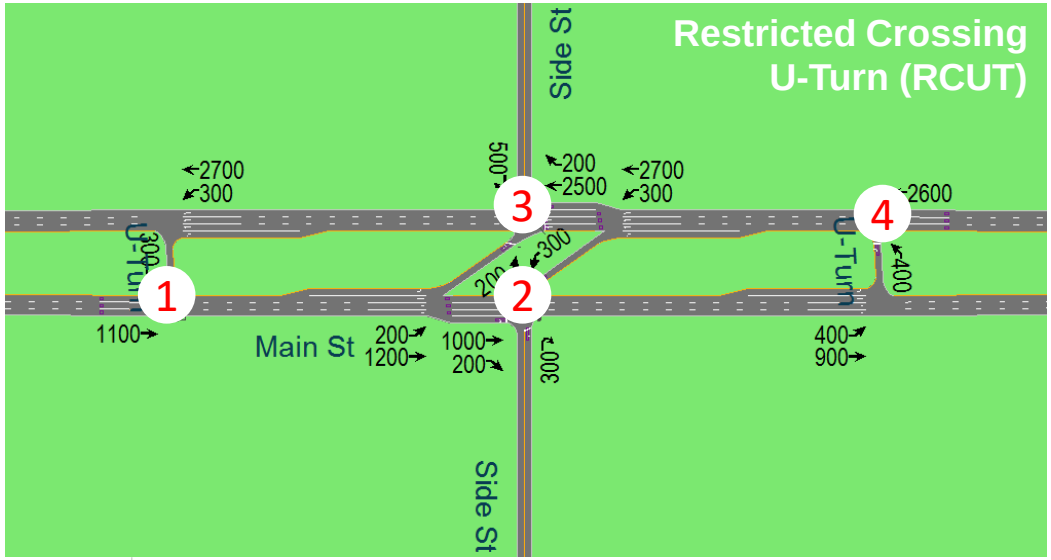


# 2.2 A – RCUT, MUT and DLT DELAY OVERVIEW

- Signalized Restricted Crossing U-Turns (RCUTs) can be analyzed in SYNCHRO
  - Limitations: SYNCHRO doesn't know you're modeling an RCUT
  - Assumes it is a network of 4 separate signals
- FDOT ICE tool provides a worksheet to overcome this limitation
  - User enters lane group delay outputs from each intersection's SYNCHRO report
  - User enters travel speed and distance to crossovers to account for out of direction travel
  - FDOT ICE tool computes single delay value for signalized RCUT consistent with HCM 6th Edition (with assumed coordination of signals)
  - FDOT ICE tool also has MUT, DLT and TWSC worksheets



# 2.2 A – ICE FORM STAGE 2

Operational Analyses

Summarize the results of the peak hour analysis performed for each control strategy. Select analysis year based on guidance in the ICE procedures document. Refer to Exhibit 19-8 of the *Highway Capacity Manual, 6th Edition* (HCM6) to determine the appropriate LOS based on intersection delay (*hover over this cell for Exhibit 19-8*).

| Design Vehicle | Interstate Semitrailer (WB-62) | Control Vehicle | Interstate Semitrailer (WB-62) |
|---|---|---|---|

| Opening Year | 2020 | | | | | | |
|---|---|---|---|---|---|---|---|
| Control Strategy | Peak Hour | | Weekday AM Peak | Peak Hour | | Weekday PM Peak | |
| | LOS | Delay (sec.) | All Queues Accommodated? | LOS | Delay (sec.) | All Queues Accommodated? | |
| Signalized Control | C | 20.1 | Yes | C | 28.9 | Yes | |
| Median U-Turn | B | 12.1 | Yes | B | 14.6 | Yes | |
| RCUT (Signalized) | B | 14.0 | Yes | C | 20.5 | Yes | |
| Displaced Left-Turn | B | 12.6 | Yes | B | 19.7 | Yes | |
| | | | | | | | |
| | | | | | | | |

| DesignYear | 2040 | | | | | | |
|---|---|---|---|---|---|---|---|
| Control Strategy | Peak Hour | | Weekday AM Peak | Peak Hour | | Weekday PM Peak | |
| | LOS | Delay (sec.) | All Queues Accommodated? | LOS | Delay (sec.) | All Queues Accommodated? | |
| Signalized Control | C | 22.2 | Yes | D | 35.4 | Yes | |
| Median U-Turn | B | 12.2 | Yes | C | 23.0 | Yes | |
| RCUT (Signalized) | C | 21.8 | Yes | D | 49.4 | No | |
| Displaced Left-Turn | B | 15.7 | Yes | C | 25.6 | Yes | |

| |
|---|
| ICE based on |
| |
| |
| PM Peak |
| Queues modated? |
| Yes |
| Yes |
| Yes |

**Exhibit 19-8**
LOS Criteria: Motorized Vehicle Mode

Exhibit 19-8 lists the LOS thresholds established for the motorized vehicle mode at a signalized intersection.

| Control Delay (s/veh) | LOS by Volume-to-Capacity Ratio[a] ≤1.0 | >1.0 |
|---|---|---|
| ≤10 | A | F |
| >10–20 | B | F |
| >20–35 | C | F |
| >35–55 | D | F |
| >55–80 | E | F |
| >80 | F | F |

Note: [a] For approach-based and intersectionwide assessments, LOS is defined solely by control delay.

Source: Exhibit 19-8 of the Highway Capacity Manual, 6th Edition (HCM6)

# 2.2 A – CONDUCT SPICE ANALYSIS

**SPICE is used in both: Stage 1 and Stage 2 analyses**

TOOLS

# SPICE – STAGE 2

# 2.2A – SPICE: BASIC INPUTS AND CONTROL STRATEGY SELECTION

## Control Strategy Selection and Inputs

*Specify the Facility Level Inputs and the Control Strategies to be included in the SPICE Analysis.*

| | | |
|---|---|---|
| **Intersection Type** | At-Grade Intersections | |
| **Analysis Year** | Opening and Design Year | |
| **Opening Year** | 2020 | |
| **Design Year** | 2040 | |
| **Facility Type** | On Urban and Suburban Arterial | For more information on how to determine these values, see the "Definitions" worksheet |
| **Number of Legs** | 4-leg | |
| **1-Way/2-Way** | 2-way Intersecting 2-way | |
| **# of Major Street Lanes (both directions)** | 6 or more | |
| **Major Street Approach Speed** | Less than 55 mph | |
| **Opening Year - Major Road AADT** | 50,000 | |
| **Opening Year - Minor Road AADT** | 3,500 | |
| **Design Year - Major Road AADT** | 70,000 | |
| **Design Year - Minor Road AADT** | 5,000 | |

| Control Strategy | Include | Base Intersection | | |
|---|---|---|---|---|
| Traffic Signal | Yes | -- | | |
| Traffic Signal (Alternative Configuration) | No | -- | | |
| Minor Road Stop | No | -- | | Design Year AADT Outside of SPF Development Range |
| All Way Stop | No | -- | | |
| 1-Lane Roundabout | No | -- | Opening Year AADT Outside of SPF Development Range | Design Year AADT Outside of SPF Development Range |
| 2-Lane Roundabout | No | -- | Opening Year AADT Outside of SPF Development Range | Design Year AADT Outside of SPF Development Range |
| Displaced Left Turn (DLT) | Yes | Traffic Signal | | |
| Median U-Turn (MUT) | Yes | Traffic Signal | | |
| Signalized Restricted Crossing U-Turn (RCUT) | Yes | -- | | Design Year AADT Outside of SPF Development Range |
| Unsignalized Restricted Crossing U-Turn (RCUT) | No | -- | Opening Year AADT Outside of SPF Development Range | Design Year AADT Outside of SPF Development Range |
| Continuous Green-T Intersection | No | Traffic Signal | | |
| Jughandle | No | Traffic Signal | | |
| Other 1 | No | Traffic Signal | *Please Select | |
| Other 2 | No | Minor Road Stop | *Please Select | |

# 2.2A – SPICE STAGE 2: AT-GRADE INTERSECTION INPUTS

Required

| Input | | Control Strategy: Traffic Signal | Displaced Left Turn (DLT) | Median U-Turn (MUT) | Signalized RCUT |
|---|---|---|---|---|---|
| Opening Year Major Road AADT | Optional AADT Overrides | 50000 | 50000 | 50000 | 50000 |
| Opening Year Minor Road AADT | | 3500 | 3500 | 3500 | 3500 |
| Design Year Major Road AADT | | 70000 | 70000 | 70000 | 70000 |
| Design Year Minor Road AADT | | 5000 | 5000 | 5000 | 5000 |
| Number of Approaches with Left-Turn Lanes | Additional Required Control Strategy Inputs | | | | |
| Number of Approaches with Right-Turn Lanes | | | | | |
| Number of Uncontrolled Approaches with Left-Turn Lanes | | | | | |
| Number of Uncontrolled Approaches with Right-Turn Lanes | | | | | |

Keep default values below here for planning-level analysis, override with actual values for full HSM Analy

Optional for Stage 1, Required for Stage 2

| Reset Planning Inputs to Defaults | Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE | | | | |
|---|---|---|---|---|---|
| Skew Angle | A yellow cell indicates the value may be used in the SPF computation | N/A | CMF - No Inputs Required | CMF - No Inputs Required | Scroll Down for Signalized RCUT SPF Inputs |
| Lighting Present | | No | | | |
| # of Approaches Permissive LT Signal Phasing | | 2 | | | |
| # of Approaches Perm/Prot LT Signal Phasing | | 0 | | | |
| # of Approaches Protected LT Signal Phasing | | 2 | | | |
| Number of Approaches with Right-Turn-on-Red Prohibited | | 0 | | | |
| Red Light Cameras Present | | No | | | |
| Number of Major Street Through Lanes | | 6 | | | |
| Number of Minor Street Lanes | | 2 | | | |
| # of Major St Approaches w/ Right-Turn Channelization | | 0 | | | |
| Number of Approaches with U-Turn Prohibited | | 0 | | | |
| Pedestrian Volume by Activity Level | | Low (50) | | | |
| User Specified Sum of all daily pedestrian crossing volumes | | 50 | | | |
| Max # of Lanes Crossed by Pedestrians | | 8 | | | |
| Number of Bus Stops within 1000' of Intersection | | 0 | | | |
| Schools within 1000' of intersection | | No | | | |
| Number of Alcohol Sales Establishments within 1000' of Intersection | | 7 | | | |

- AADT Volumes for major/minor roads for the opening and design years
- Number of major approaches with left-turn or right-turn lanes
- Pre-filled planning-level defaults
  - Can be overridden by analyst

# 2.2A – SPICE STAGE 2: AT-GRADE INTERSECTION INPUTS

Required

| Input | | Control Strategy: Traffic Signal | Displaced Left Turn (DLT) | Median U-Turn (MUT) | Signalized RCUT |
|---|---|---|---|---|---|
| Opening Year Major Road AADT | Optional AADT Overrides | 50000 | 50000 | 50000 | 50000 |
| Opening Year Minor Road AADT | | 3500 | 3500 | 3500 | 3500 |
| Design Year Major Road AADT | | 70000 | 70000 | 70000 | 70000 |
| Design Year Minor Road AADT | | 5000 | 5000 | 5000 | 5000 |
| Number of Approaches with Left-Turn Lanes | Additional Required Control Strategy Inputs | | | | |
| Number of Approaches with Right-Turn Lanes | | | | | |
| Number of Uncontrolled Approaches with Left-Turn Lanes | | | | | |
| Number of Uncontrolled Approaches with Right-Turn Lanes | | | | | |

Keep default values below here for planning-level analysis, override with actual values for full HSM Analy

Reset Planning Inputs to Defaults

Optional for Stage 1, Required for Stage 2

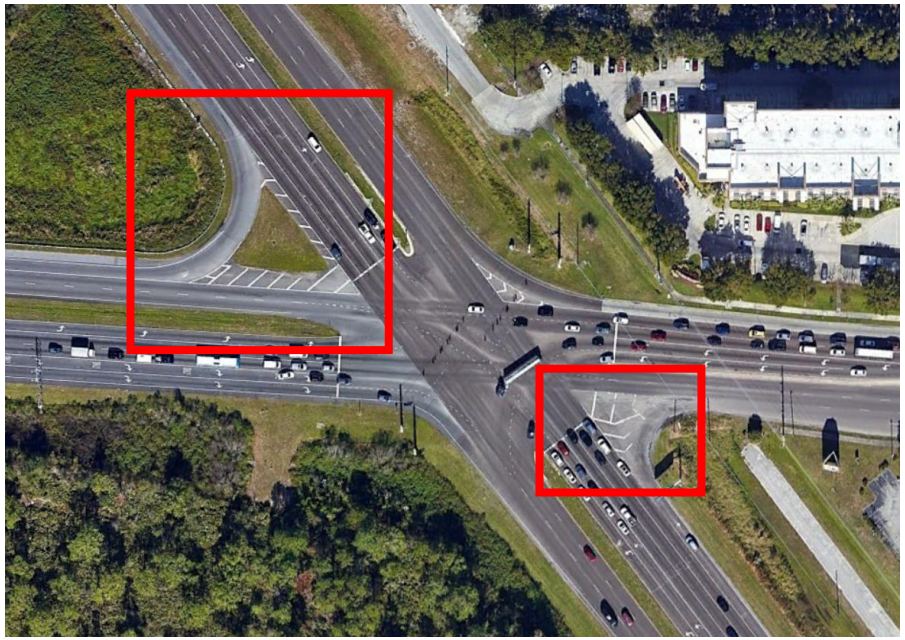
| | Part C CMFS Optional For Stage 1 ICE, Required for Stage 2 ICE | | | | |
|---|---|---|---|---|---|
| Skew Angle | A yellow cell indicates the value may be used in the SPF computation | N/A | CMF - No Inputs Required | CMF - No Inputs Required | Scroll Down for Signalized RCUT SPF Inputs |
| Lighting Present | | No | | | |
| # of Approaches Permissive LT Signal Phasing | | 2 | | | |
| # of Approaches Perm/Prot LT Signal Phasing | | 0 | | | |
| # of Approaches Protected LT Signal Phasing | | 2 | | | |
| Number of Approaches with Right-Turn-on-Red Prohibited | | 0 | | | |
| Red Light Cameras Present | | No | | | |
| Number of Major Street Through Lanes | | 6 | | | |
| Number of Minor Street Lanes | | 2 | | | |
| # of Major St Approaches w/ Right-Turn Channelization | | 0 | | | |
| Number of Approaches with U-Turn Prohibited | | 0 | | | |
| Pedestrian Volume by Activity Level | | Low (50) | | | |
| User Specified Sum of all daily pedestrian crossing volumes | | 50 | | | |
| Max # of Lanes Crossed by Pedestrians | | 8 | | | |
| Number of Bus Stops within 1000' of Intersection | | 0 | | | |
| Schools within 1000' of intersection | | No | | | |
| Number of Alcohol Sales Establishments within 1000' of Intersection | | 7 | | | |

- 6-lane inputs only
  - # Major Street Through Lanes
  - # Minor Street Lanes
  - # Major Approaches w/RT Channelization
  - # Approaches w/U-turn Prohibited

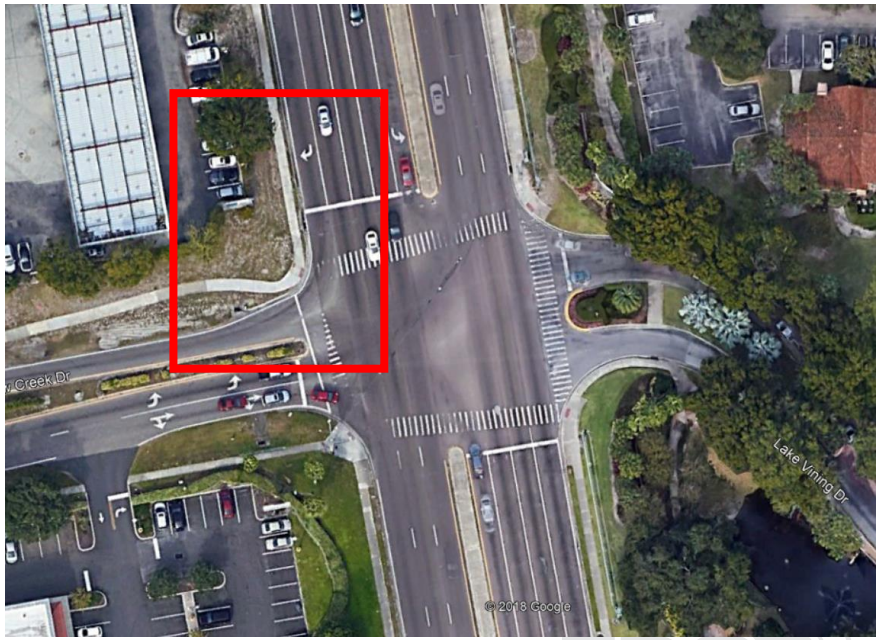
# 2.2A – SPICE STAGE 2: AT-GRADE INTERSECTION INPUTS

Right Turn Channelization - When a marked or raised-curb island is present, or when the right turner can make a free or yield-controlled turning movement. Applies to major road only.

Major road right turn channelization



No major road right turn channelization

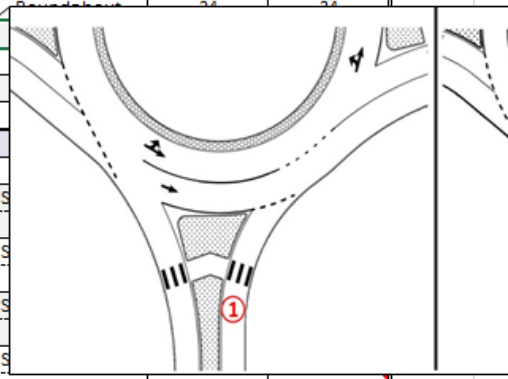


# 2.2A – SPICE: ROUNDABOUT CMF INPUTS

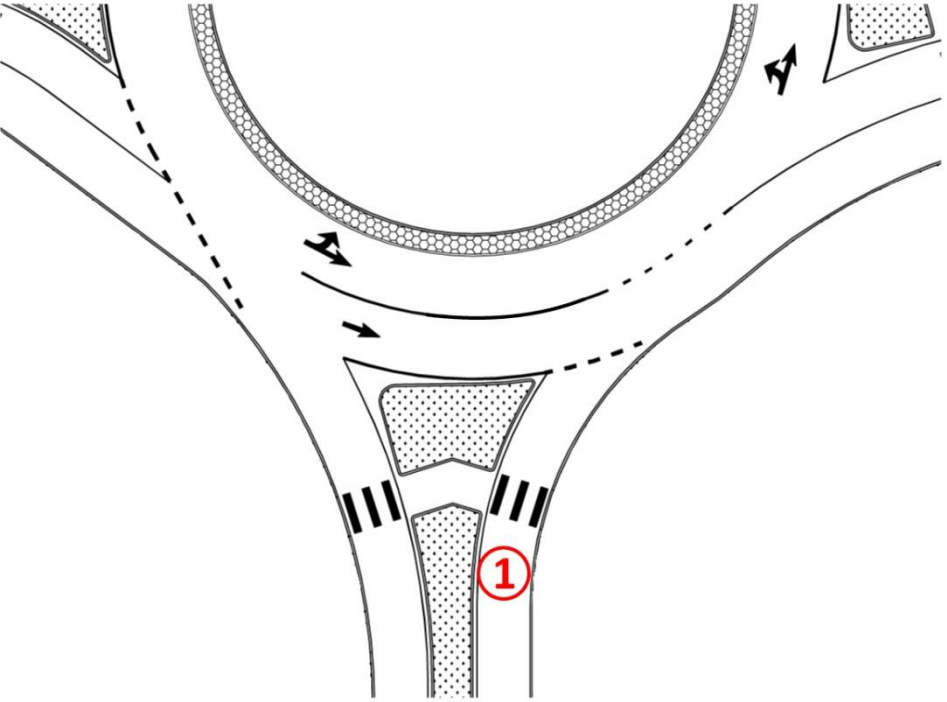
| | | Control Strategy | |
|---|---|---|---|
| Input | | Traffic Signal | 2-lane Roundabout |
| | Roundabout CMF Inputs | | |
| Inscribed Circle Diameter (ft) | | | |
| Leg 1 (Major Leg #1) | Leg 1 (Major Leg #1) | | |
| Opening Year Entering AADT | | | 25,000 |
| Leg has Right-Turn Bypass | | | No |
| # of Access Points within 250' of Yield Line | | | |
| Entering Width (ft) | | | 34 |
| # of Entering Lanes | | | 2 |
| # of Circulating Lanes | | | 2 |
| Leg 2 (Major Leg #2) | Leg 2 (Major Leg #2) | | |
| Opening Year Entering AADT | | | 25,000 |
| Leg has Right-Turn Bypass | | | No |
| # of Access Points within 250' of Yield Line | | | |
| Entering Width (ft) | | | 34 |
| # of Entering Lanes | | | 2 |
| # of Circulating Lanes | | | 2 |
| Leg 3 (Minor Leg #1) | Leg 3 (Minor Leg #1) | | |
| Opening Year Entering AADT | | | 1750 |
| Leg has Right-Turn Bypass | | | No |
| # of Access Points within 250' of Yield Line | | | |
| Entering Width (ft) | | | 24 |
| # of Entering Lanes | | | 2 |
| # of Circulating Lanes | | | 2 |
| Leg 4 (Minor Leg #2) | Leg 4 (Minor Leg #2) | | |
| Opening Year Entering AADT | | | 1,750 |
| Leg has Right-Turn Bypass | | | No |
| # of Access Points within 250' of Yield Line | | | |
| Entering Width (ft) | | | 24 |
| # of Entering Lanes | | | 2 |
| # of Circulating Lanes | | | 2 |

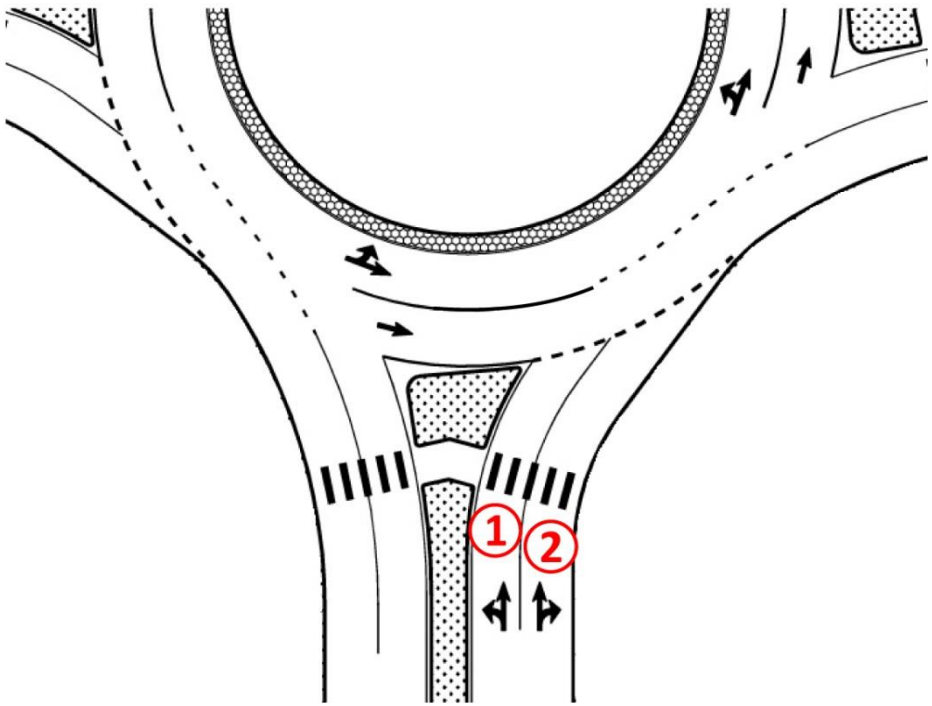
# 2.2A – SPICE STAGE 2: ROUNDABOUT CMF INPUTS

| User Input Variable | Units | Definition | Applicable Ranges | | |
|---|---|---|---|---|---|
| | | | Range for: | Lower Limit | Upper Limit |
| **Control Strategy Selection** | | | | | |
| Number of Major Street Lanes | lanes | Number of lanes on the major street (both directions - does not include turn lanes) | - | - | - |
| **At-Grade Intersection Inputs** | | | | | |
| Major/Minor Road AADT | veh/day | Average annual daily traffic (AADT) volume for the major and minor street approaches (see table for ranges). | See table starting in column I (to the right). | | |
| Skew Angle | degrees | Intersecting angle between major street and minor street approaches *(hover cursor for graphical representation)* | - | - | - |
| Number of Major Street Through Lanes | lanes | Number of through lanes on the major street (both directions - includes shared through lanes) | - | - | - |
| Number of Minor Street Lanes | lanes | Number of lanes on the minor street (both directions - does not include turn lanes) | - | - | - |
| Inscribed Circle Diameter | feet | | Roundabout | 90 | 160 |
| Opening Year Entering AADT | veh/day | | Roundabout | See Table in Column O | |
| Leg has Right-Turn Bypass | yes/no | | Roundabout | - | - |
| Access Point within 250' of Yield Line | - | | Roundabout | 0 | 8 |
| Entering Width | feet | | | | |
| Number of Entering Lanes | lanes | Number of lanes entering a leg of the roundabout *(hover cursor for graphical representation).* | | | |
| Number of Circulating Lanes | lanes | Number of lanes circulating a leg of the roundabout *(hover cursor for graphical representation)* . | | | |
| **Ramp Terminal Intersection Inputs** | | | | | |
| Crossroad | - | References the major street of the ramp terminal intersection (i.e., the non-ramp terminal legs) | | | |
| Crossroad AADT - Inside Leg | veh/day | AADT volume of the crossroad leg located between the two ramp terminals of the interchange | | | |
| Crossroad AADT - Outside Leg | veh/day | AADT volume of the crossroad leg located outside of the interchange | | | |
| Ramp AADT - Exit | veh/day | AADT volume of the exit ramp | | | |
| Ramp AADT - Entrance | veh/day | AADT volume of the entrance ramp | Signalized | 0 | 31,000 |
| Exit Ramp Skew Angle | degrees | Skew angle equals 90 minus the intersection angle (in degrees) *(hover cursor for graphical representation* ). | Stop-Controlled | 0 | 70 |
| Presence of Non-Ramp Public Street Leg | yes/no | Any ramp that has a fourth leg that: (1) is a public street serving two-way traffic and (2) intersects with the crossroad at the terminal. At most ramp terminals, the public street leg will be on the opposite side of the crossroad from the exit ramp. | - | - | - |
| | | | Stop-Controlled | 1 | 2 |

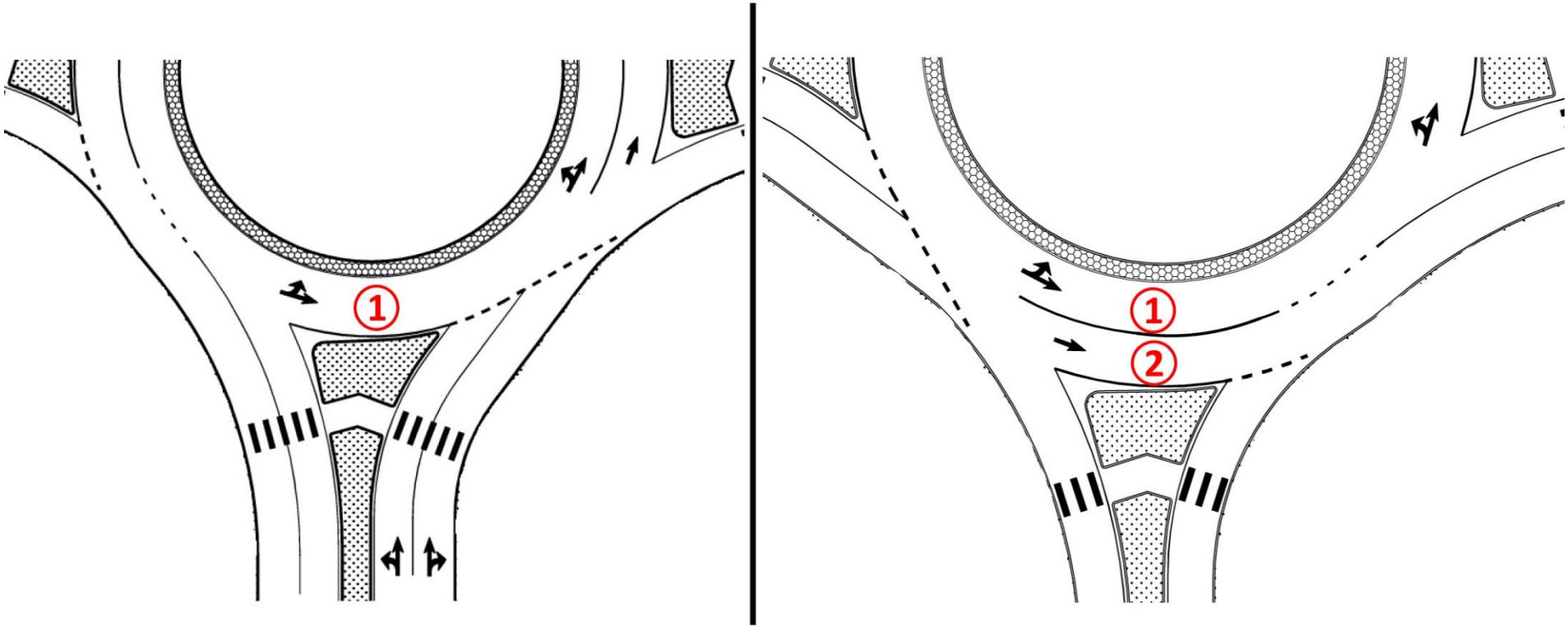


# 2.2A – SPICE STAGE 2: ROUNDABOUT ENTRY LANES



# 2.2A – SPICE STAGE 2: ROUNDABOUT CIRCULATING LANES



- RCUT SPFs have new variables and new input area in SPICE for CMFs

| | | Control Strategy | | | |
|---|---|---|---|---|---|
| Input | | Traffic Signal | Traffic Signal (Alt) | Signalized RCUT | Unsignalized RCUT |
| Number of Bus Stops within 1000' of Intersection | A yellow cell indicates the value may be used in the SPF computation | | | Scroll Down for Signalized RCUT SPF Inputs | Scroll Down for Unsignalized RCUT SPF Inputs |
| Schools within 1000' of intersection | | | | | |
| Number of Alcohol Sales Establishments within 1000' of Intersection | | | | | |
| | | | | Restricted Crossing U-Turn (RCUT) CMF Inputs | |
| # U-Turns | | | | 1 | 1 |
| # of Major Roadway Lanes | | | | 2 | |
| # of Minor Roadway Lanes | | | | 2 | |
| Total Offset Distance (ft) | | | | 1250 | 1250 |
| Number of Driveways | | | | 4 | 4 |
| Total Deceleration Lane Length (ft) | | | | 750 | 750 |
| Total Acceleration Lane Length (ft) | | | | | 750 |
| Number of Left-Turn Lanes From Major Road | | | | 1 | |
| Major Road Speed Limit (mph) | | | | <=50 | |
| Total Median Width (ft) | | | | 65 | |
| Maximum Median Width (ft) | | | | | 40 |

- Total Offset Distance CMF – crashes increase with increased offset distance
- Median width CMF – crashes reduce with greater median width

| | Restricted Crossing U- |
|---|---|
| | 2 |
| | 3+ |
| | 1 |
| | 1200 |
| | 3 |
| | 34 |
| | |
| | 2 |
| | <= |
| | 6 |
| | |

**Total Offset Distance (TOD)**
The total distance between the center of intersection and U-turn locations (e.g. if one approach has 800 ft of offset and the other one has 600 ft of offset, then total offset is 1400 ft)

| | |
|---|---|
| | 2+ |
| | <=50 |
| | 64 |
| | |

**Total Median Width**
The total median width of the major approaches (e.g. if one approach has a 40 ft median and the other one has a 25 ft median, then the total median width is 65 ft).

# 2.2A – SPICE: HISTORICAL CRASH DATA

- Empirical Bayes (EB) Analysis – recommend to use min. of 5 years crash data
- Existing intersection must be signalized or minor road stop
- Only applies EB to intersections with CMFs – DLT & MUT not Roundabout & RCUT

**Historical Crash Data Input**

*Note: In order to use Empirical Bayes (EB), the historical intersection type must be a traffic signal or a minor road stop. Additionally, this alternative must be selected to be included in the analysis, and the historical intersection specified below. Up to 10 years of historical data can be used to perform the EB adjustment.*

| | | | |
|---|---|---|---|
| Is historical crash data available? | Yes | | |
| Number of years available: | 5 | (Up to 10) | First Year Data is available: 2013 |
| Historical Intx Type: | 4SG | | |

| Historical Crash Counts | | Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 | 2017 | -- | -- | -- | -- | -- | Total |
| Combined | Total | 44 | 30 | 60 | 64 | 42 | -- | -- | -- | -- | -- | 240 |
| | Fatal/Injury | 9 | 8 | 17 | 16 | 10 | | | | | | 60 |
| | PDO | 35 | 22 | 43 | 48 | 32 | | | | | | 180 |
| Single-Vehicle | Total | | | | | | | | | | | |
| | Fatal/Injury | | | | | | | | | | | |
| | PDO | | | | | | | | | | | |
| Multiple-Vehicle | Total | | | | | | | | | | | |
| | Fatal/Injury | | | | | | | | | | | |
| | PDO | | | | | | | | | | | |
| Veh-Ped | Fatal/Injury | 0 | 1 | 0 | 1 | 0 | | | | | | 2 |
| Veh-Bike | Fatal/Injury | 0 | 0 | 0 | 0 | 0 | | | | | | 0 |
| Total | All | 44 | 31 | 60 | 65 | 42 | -- | -- | -- | -- | -- | 242 |

# 2.2A – SPICE: CRASH PREDICTION OUTPUTS

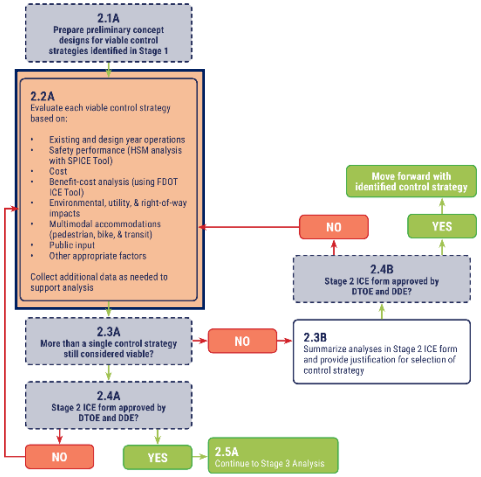
- Computes predicted crashes for all selected control strategy types
- Predicted crashes are broken into “Total” and “Fatal & Injury” groups
- Ranking is based on “Fatal & Injury” crashes.

| Crash Prediction Summary | | | | | | | |
|---|---|---|---|---|---|---|---|
| Control Strategy | Crash Type | Opening Year | Design Year | Total Project Life Cycle | Rank | AADT Within Prediction Range? | Source of Prediction |
| Traffic Signal | Total | 36.39 | 44.21 | 848.19 | 4 | Yes | Uncalibrated SPF w/ EB |
| | Fatal & Injury | 9.02 | 11.21 | 212.86 | | | |
| Displaced Left Turn (DLT) | Total | 32.02 | 38.90 | 746.41 | 2 | N/A | CMF |
| | Fatal & Injury | 7.94 | 9.86 | 187.31 | | | |
| Median U-Turn (MUT) | Total | 30.93 | 37.58 | 720.96 | 1 | N/A | CMF |
| | Fatal & Injury | 6.31 | 7.84 | 149.00 | | | |
| Signalized RCUT | Total | 31.42 | 53.16 | 881.50 | 3 | No | Uncalibrated SPF |
| | Fatal & Injury | 6.86 | 12.11 | 197.31 | | | |

# ICE PROCEDURE

## ICE Procedure and Tools

| | | | | |
|---|---|---|---|---|
| **Stage 1** | CAP-X | | | |
| | | SPICE | | |
| **Stage 2** | Analysis Guidance | Default SYNCHRO | FDOT ICE Tool | |
| **Stage 3** | No specific tools. Reuse Stage 2 tools or address qualitative issues. | | | |



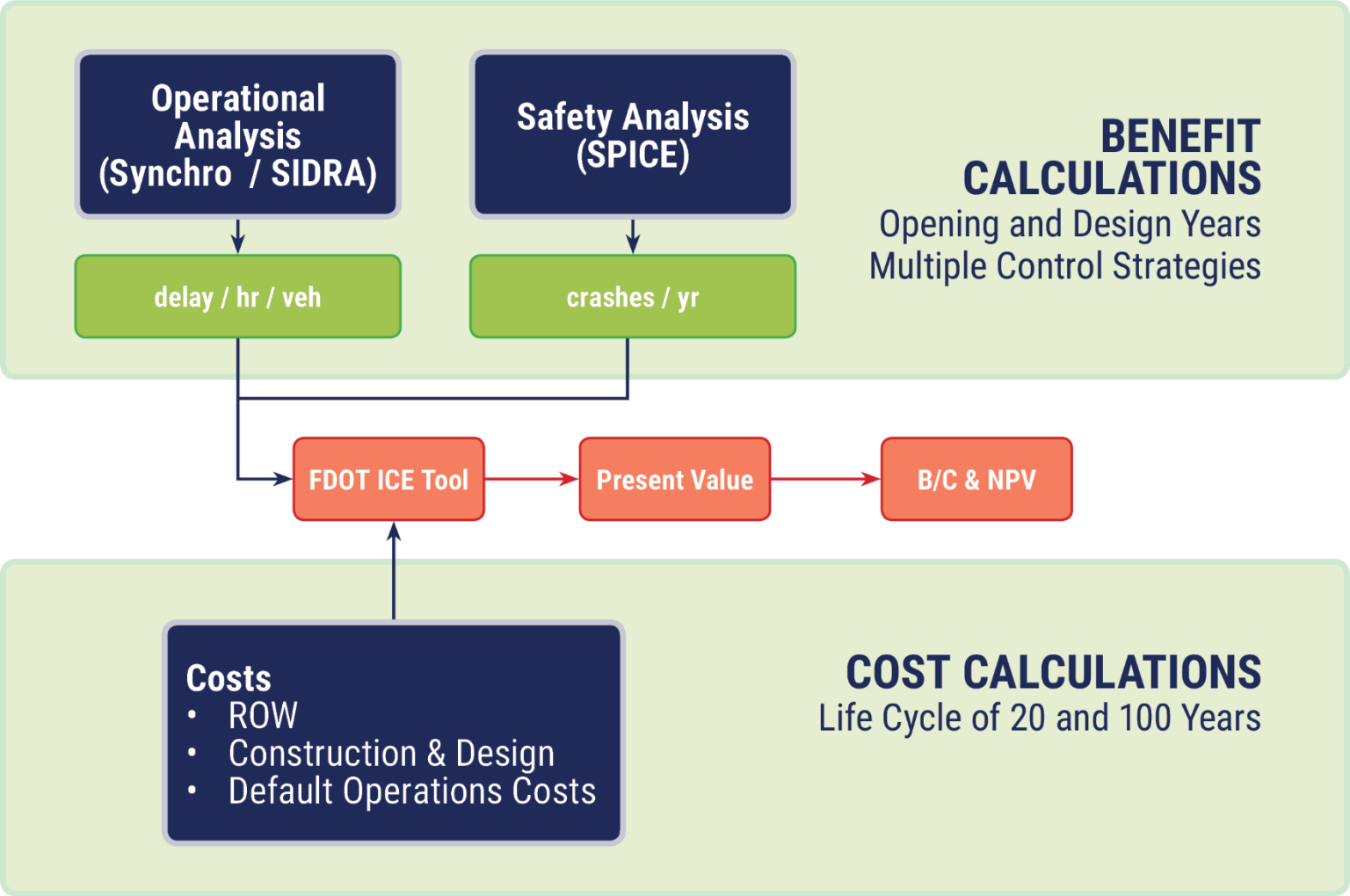
TOOLS

# FDOT ICE TOOL

# VISION AND NEED FOR THE FDOT ICE TOOL

- Stage 2 tool for financial analysis of intersection alternatives
- Needed inputs for life-cycle cost analysis
  - Safety - SPICE
  - Vehicular delay – SYNCHRO, VISSIM, HCS, SIDRA, etc.
  - Design, construction, right-of-way, and operating costs
- Conducts benefit-cost / net present value analysis
- Designed to be quick and easy to use – hour(s) not day(s)
  - Limit data inputs to readily available or computable values
  - Utilize information of previous stages of ICE analysis (e.g., SPICE tool)
- Flexible enough to accommodate all intersection alternatives

# 2.2 A – FDOT ICE TOOL OVERVIEW



# 2.2 A – FDOT ICE TOOL: STRATEGIES SELECTION

| | Open Year | Design Year |
|---|---|---|
| Operating Cycle | 2020 | 2040 |
| **Peak Hour Start** | **From** | **To** |
| AM peak | 7:00 AM | 8:00 AM |
| PM peak | 4:00 PM | 5:00 PM |
| Weekend peak | 10:00 AM | 11:00 AM |

Enter peak period begin and end times:

Select Analysis Basis: Specific Day/Month

Select facility type: 16 - Urban Minor Arterial

Weekday Count: Tuesday, April 12, 2016 Enter dates as "mm/dd/yyyy"

Weekend Count: Enter dates as "mm/dd/yyyy"

**Show/Hide Detailed Demand Profiles**

Specify total volumes or turning counts?

| Turning Counts | (Select from drop-down menu) |
|---|---|

Enter the turning movement counts in the DemandCounts worksheet for the peak hours. If data is not available for the weekend peak hour please leave blank.

| Units | Year | |
|---|---|---|
| | Opening | Design |
| | 2020 | 2040 |
| | Intersection 1 | |
| AM peak hour volume | veh/hr | 3,465 | 4,713 |
| PM peak hour volume | veh/hr | 4,449 | 6,014 |
| Weekend peak hour volume: | veh/hr | | |
| Average annual auto occupancy | Passengers per vehicle | 1.0 | 1.0 |
| Average annual % trucks | Average % | 3.1% | 3.1% |

**At-Grade Control Strategies**

| Control # | Include | Short Name | Description |
|---|---|---|---|
| 1 | No | TWSC | Two-Way Stop Control |
| 2 | No | AllStop | All Way Stop |
| 3 | Yes | TrafficSignal | Traffic Signal |
| 4 | No | TrafficSignalAlt | Traffic Signal (Alt.) |
| 5 | No | Roundabout | Roundabout |
| 6 | Yes | DLT | Displaced Left Turn (DLT) |
| 7 | Yes | MUT | Median U-Turn (MUT) |
| 8 | Yes | SignalRCUT | Signalized Restricted Crossing U-Turn (RCUT) |
| 9 | No | UnsignalRCUT | Unsignalized Restricted Crossing U-Turn (RCUT) |
| 10 | No | GreenT | Continuous Green-T Intersection |
| 11 | No | Jughandle | Jughandle |
| 12 | No | Quadrant Itx | Quadrant Roadway Intersection |
| 13 | No | Other1 | Other 1 |
| 14 | No | Other2 | Other 2 |

Setup Worksheets

Press the "Setup Worksheets" button to create hidden worksheets that compute performance measures for each selected control strategy.

- Demand Profiles – Florida Daily & Monthly values by functional classification

**Passenger Vehicle Demand Profile Parameters**

Note: All charts illustrating volume profiles are shown to right of Column "R"

Review Daily Profile or Override Values:

*Chart shown at right*

| Day of Week | 04 - Rural Principal Arterial -- Other | 06 - Rural Minor Arterial | 07 - Rural Major Collector | 08 - Rural Minor Collector | 14 - Urban Principal Arterial -- Other | 16 - Urban Minor Arterial | 17 - Urban Major Collector |
|---|---|---|---|---|---|---|---|
| Monday | 88.2% | 80.6% | 90.2% | 79.9% | 75.6% | 75.1% | 74.7% |
| Tuesday | 97.9% | 98.3% | 96.3% | 97.8% | 101.3% | 101.1% | 101.7% |
| Wednesday | 97.6% | 102.2% | 98.7% | 106.1% | 105.5% | 106.8% | 107.2% |
| Thursday | 99.1% | 103.2% | 99.5% | 103.8% | 106.7% | 107.3% | 108.3% |
| Friday | 102.6% | 105.7% | 102.4% | 105.9% | 107.3% | 107.8% | 108.0% |
| Saturday | 114.3% | 113.4% | 112.6% | 110.8% | 111.2% | 111.8% | 109.9% |
| Sunday | 100.1% | 96.6% | 100.2% | 95.7% | 92.4% | 90.2% | 90.1% |

Review Monthly Profile or Override Values:

*Chart shown at right*

| Month | Functional Class | | | | | | |
|---|---|---|---|---|---|---|---|
| | 04 - Rural Principal Arterial -- | 06 - Rural Minor Arterial | 07 - Rural Major Collector | 08 - Rural Minor Collector | 14 - Urban Principal Arterial -- Other | 16 - Urban Minor Arterial | 17 - Urban Major Collector |
| January | 92.5% | 93.2% | 95.7% | 92.7% | 98.3% | 94.0% | 101.7% |
| February | 101.0% | 102.6% | 105.7% | 102.3% | 104.8% | 103.1% | 113.0% |
| March | 107.1% | 105.9% | 110.6% | 109.9% | 107.1% | 107.6% | 113.5% |
| April | 103.6% | 103.8% | 106.7% | 105.2% | 103.9% | 100.6% | 110.5% |
| May | 103.2% | 103.6% | 103.1% | 101.8% | 98.0% | 98.7% | 102.7% |
| June | 102.5% | 101.0% | 100.5% | 95.4% | 97.6% | 95.0% | 90.7% |
| July | 100.2% | 101.0% | 97.7% | 92.3% | 96.2% | 96.1% | 89.5% |
| August | 94.7% | 98.3% | 91.0% | 94.6% | 96.6% | 96.9% | 93.9% |
| September | 94.5% | 98.6% | 89.2% | 94.3% | 96.1% | 97.0% | 94.7% |
| October | 100.5% | 100.6% | 102.7% | 100.6% | 99.6% | 102.5% | 95.2% |
| November | 101.5% | 94.7% | 98.9% | 104.6% | 101.2% | 104.8% | 96.9% |
| December | 98.7% | 96.9% | 98.3% | 106.4% | 100.3% | 103.5% | 97.8% |

# 2.2 A – FDOT ICE TOOL: FLORIDA DEMAND PROFILES

- Demand Profiles – Florida Weekday hourly values by functional classification
- Weekend values also available

Review Weekday Hourly Demand Profile or Override Values:
*Chart shown at right*

| Category | Hour Starting | Functional Class | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 04 - Rural Principal Arterial -- | 06 - Rural Minor Arterial | 07 - Rural Major Collector | 08 - Rural Minor Collector | 14 - Urban Principal Arterial -- | 16 - Urban Minor Arterial | 17 - Urban Major Collector |
| Weekday | 12:00 AM | 0.7% | 0.5% | 0.5% | 0.4% | 0.8% | 0.6% | 0.5% |
| | 1:00 AM | 0.5% | 0.3% | 0.3% | 0.2% | 0.5% | 0.4% | 0.3% |
| | 2:00 AM | 0.4% | 0.3% | 0.3% | 0.2% | 0.4% | 0.3% | 0.2% |
| | 3:00 AM | 0.6% | 0.4% | 0.3% | 0.2% | 0.4% | 0.3% | 0.2% |
| | 4:00 AM | 1.1% | 0.9% | 0.8% | 0.6% | 0.7% | 0.5% | 0.4% |
| | 5:00 AM | 2.5% | 2.3% | 2.0% | 1.8% | 1.7% | 1.5% | 1.1% |
| | 6:00 AM | 4.8% | 4.9% | 4.3% | 5.9% | 4.2% | 3.8% | 3.6% |
| | 7:00 AM | 6.2% | 6.9% | 6.2% | 8.6% | 6.4% | 6.2% | 6.8% |
| | 8:00 AM | 5.7% | 5.8% | 5.7% | 7.0% | 6.3% | 6.2% | 6.7% |
| | 9:00 AM | 5.5% | 5.6% | 5.8% | 5.0% | 5.6% | 5.6% | 5.7% |
| | 10:00 AM | 5.8% | 5.8% | 6.2% | 4.7% | 5.6% | 5.7% | 5.6% |
| | 11:00 AM | 6.1% | 6.2% | 6.5% | 4.7% | 5.9% | 6.1% | 6.0% |
| | 12:00 PM | 6.2% | 6.4% | 6.7% | 4.8% | 6.3% | 6.5% | 6.4% |
| | 1:00 PM | 6.3% | 6.4% | 6.7% | 5.3% | 6.3% | 6.5% | 6.4% |
| | 2:00 PM | 6.6% | 6.9% | 7.0% | 5.8% | 6.6% | 6.8% | 6.8% |
| | 3:00 PM | 7.2% | 7.7% | 7.5% | 7.0% | 7.1% | 7.4% | 7.4% |
| | 4:00 PM | 7.8% | 8.0% | 7.8% | 8.9% | 7.5% | 7.8% | 8.0% |
| | 5:00 PM | 7.8% | 8.0% | 7.9% | 10.2% | 7.6% | 7.9% | 8.4% |
| | 6:00 PM | 5.8% | 5.6% | 5.8% | 7.3% | 6.0% | 6.1% | 6.3% |
| | 7:00 PM | 4.1% | 3.9% | 4.1% | 4.2% | 4.4% | 4.5% | 4.4% |
| | 8:00 PM | 3.1% | 2.9% | 3.0% | 3.0% | 3.5% | 3.5% | 3.4% |
| | 9:00 PM | 2.4% | 2.1% | 2.1% | 2.0% | 2.8% | 2.8% | 2.6% |
| | 10:00 PM | 1.7% | 1.4% | 1.5% | 1.3% | 2.1% | 1.9% | 1.7% |
| | 11:00 PM | 1.1% | 0.9% | 1.0% | 0.8% | 1.4% | 1.2% | 1.1% |

- AM and PM peak delay inputs
  - Required for opening and design years
  - Optional specification of weekend peak
  - Optional worksheets for aggregating a single delay value for MUTs, RCUTs, TWSC from multiple intersection SYNCHRO output sheets

| | | | | Opening Year | | Design Year | |
|---|---|---|---|---|---|---|---|
| **At-Grade Intersections** | | | | Average vehicle delay | | Average vehicle delay | |
| **Control Strategy** | | Delay Type | Units | AM peak | PM peak | AM peak | PM peak |
| Traffic Signal | Single Input | Single Input | sec/veh | 20.1 | 28.9 | 22.2 | 35.4 |
| | | | | | | | |
| Displaced Left Turn (DLT) | Single Input | Worksheet (Partial N-S) | sec/veh | 12.6 | 19.7 | 15.7 | 25.6 |
| | | | | | | | |
| Median U-Turn (MUT) | Select Input Type | Worksheet (N-S) | sec/veh | 12.1 | 14.6 | 12.2 | 23.3 |
| | | | | | | | |
| Signalized Restricted Crossing U-Turn (RCUT) | Select Input Type | Worksheet (N-S) | sec/veh | 14.0 | 20.5 | 21.8 | 49.4 |
| | | | | | | | |

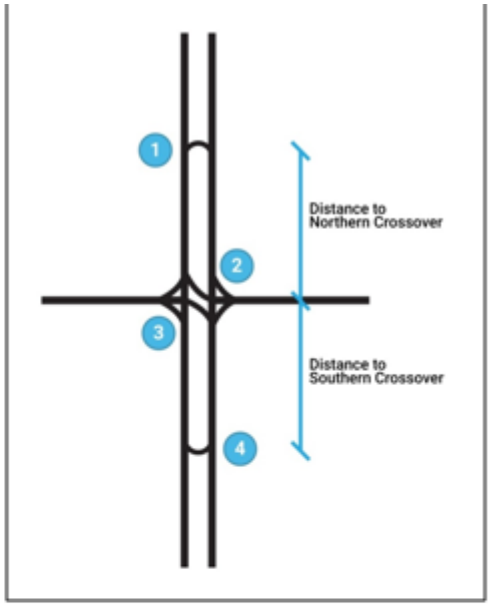
# 2.2 A – FDOT ICE TOOL: DELAY WORKSHEET

**RCUT N-S**

Use this sheet to enter the delay information for a Signalized RCUT with the major street running North-South. (Requires turning movement count demand inputs)

User must enter value on this sheet

| | Southern Crossover | Northern Crossover |
|---|---|---|
| Distance from main intersection to: | 700 | 900 |
| Free-flow speed on major street: | 45 | |




*Volumes are computed based on values entered in DemandCounts and Exhibit 6-2 of FHWA RCUT Guide

**Opening Year AM Peak**

| Intersection* | SB Thru | NB U-Turn | | |
|---|---|---|---|---|
| Volume | 1316 | 23 | | |
| Delay | 2.4 | 16.7 | | |
| Intersection* | NB Left | NB Thru | NB Right | WB Right |
| Volume | 41 | 1976 | 8 | 81 |
| Delay | 35.1 | 6.1 | 2.7 | 25 |
| Intersection* | SB Left | SB Thru | SB Right | EB Right |
| Volume | 39 | 1235 | 65 | 158 |
| Delay | 23.7 | 4.7 | 2.5 | 24.2 |
| Intersection* | NB Thru | SB U-Turn | | |
| Volume | 1910 | 115 | | |
| Delay | 6.8 | 24.2 | | |

**Opening Year PM Peak**

| Intersection* | SB Thru | NB U-Turn | | |
|---|---|---|---|---|
| Volume | 2379 | 25 | | |
| Delay | 5.3 | 34.2 | | |
| Intersection* | NB Left | NB Thru | NB Right | WB Right |
| Volume | 68 | 1834 | 30 | 64 |
| Delay | 22.4 | 2.4 | 0.1 | 37.7 |
| Intersection* | SB Left | SB Thru | SB Right | EB Right |
| Volume | 101 | 2146 | 157 | 299 |
| Delay | 53.2 | 9.7 | 3.8 | 47.9 |
| Intersection* | NB Thru | SB U-Turn | | |
| Volume | 1707 | 225 | | |
| Delay | 9.2 | 32.6 | | |

**Opening Year Weekend Peak**

| Intersection* | SB Thru | NB U-Turn | | |
|---|---|---|---|---|
| Volume | 0 | 0 | | |
| Delay | | | | |
| Intersection* | NB Left | NB Thru | NB Right | WB Right |
| Volume | 0 | 0 | 0 | 0 |
| Delay | | | | |
| Intersection* | SB Left | SB Thru | SB Right | EB Right |
| Volume | 0 | 0 | 0 | 0 |
| Delay | | | | |
| Intersection* | NB Thru | SB U-Turn | | |
| Volume | 0 | 0 | | |
| Delay | | | | |

- Requires Total and Fatal & Injury crashes for each intersection
- Input SPICE Tool outputs

| At-Grade Intersection | Crash Type | Opening Year | Design Year |
|---|---|---|---|
| Traffic Signal | Total | 36.39 | 44.21 |
| | Fatal & Injury | 9.02 | 11.21 |
| Displaced Left Turn (DLT) | Total | 32.02 | 38.90 |
| | Fatal & Injury | 7.94 | 9.86 |
| Median U-Turn (MUT) | Total | 30.93 | 37.58 |
| | Fatal & Injury | 6.31 | 7.85 |
| Signalized Restricted Crossing U-Turn (RCUT) | Total | 31.42 | 53.16 |
| | Fatal & Injury | 6.86 | 12.11 |

| CMFs | | | |
|---|---|---|---|
| | Displaced Left Turn (DLT) | Total | 0.88 |
| | | Fatal & Injury | 0.88 |
| | Median U-Turn (MUT) | Total | 0.85 |
| | | Fatal & Injury | 0.70 |
| | Signalized Restricted | Total | |
| | | Fatal & Injury | |

This table contains the same CMFs as the FDOT SPICE tool. The CMFs are automatically applied to the user inputs for Traffic Signal or Minor Road Stop, an can be overridden at the user's discretion.

## Analysis Summary

| Cost Categories | Net Present Value of Costs | | | |
|---|---|---|---|---|
| | Traffic Signal | Displaced Left Turn (DLT) | Median U-Turn (MUT) | Signalized Restricted Crossing U-Turn (RCUT) |
| Planning, Construction & Right of Way Costs | $ - | $ 2,390,000 | $ 1,642,000 | $ 1,830,000 |
| Post-Opening Costs | $ 98,229 | $ 238,276 | $ 238,276 | $ 238,276 |
| Auto Passenger Delay | $ 35,897,182 | $ 24,009,965 | $ 20,363,630 | $ 30,687,128 |
| Truck Delay | $ 6,142,739 | $ 4,107,923 | $ 3,484,252 | $ 5,246,883 |
| Safety | $ 44,155,139 | $ 38,856,522 | $ 31,567,706 | $ 40,016,414 |
| **Total cost** | **$86,293,288** | **$69,602,686** | **$57,295,864** | **$78,018,702** |

→ Net present value of Costs

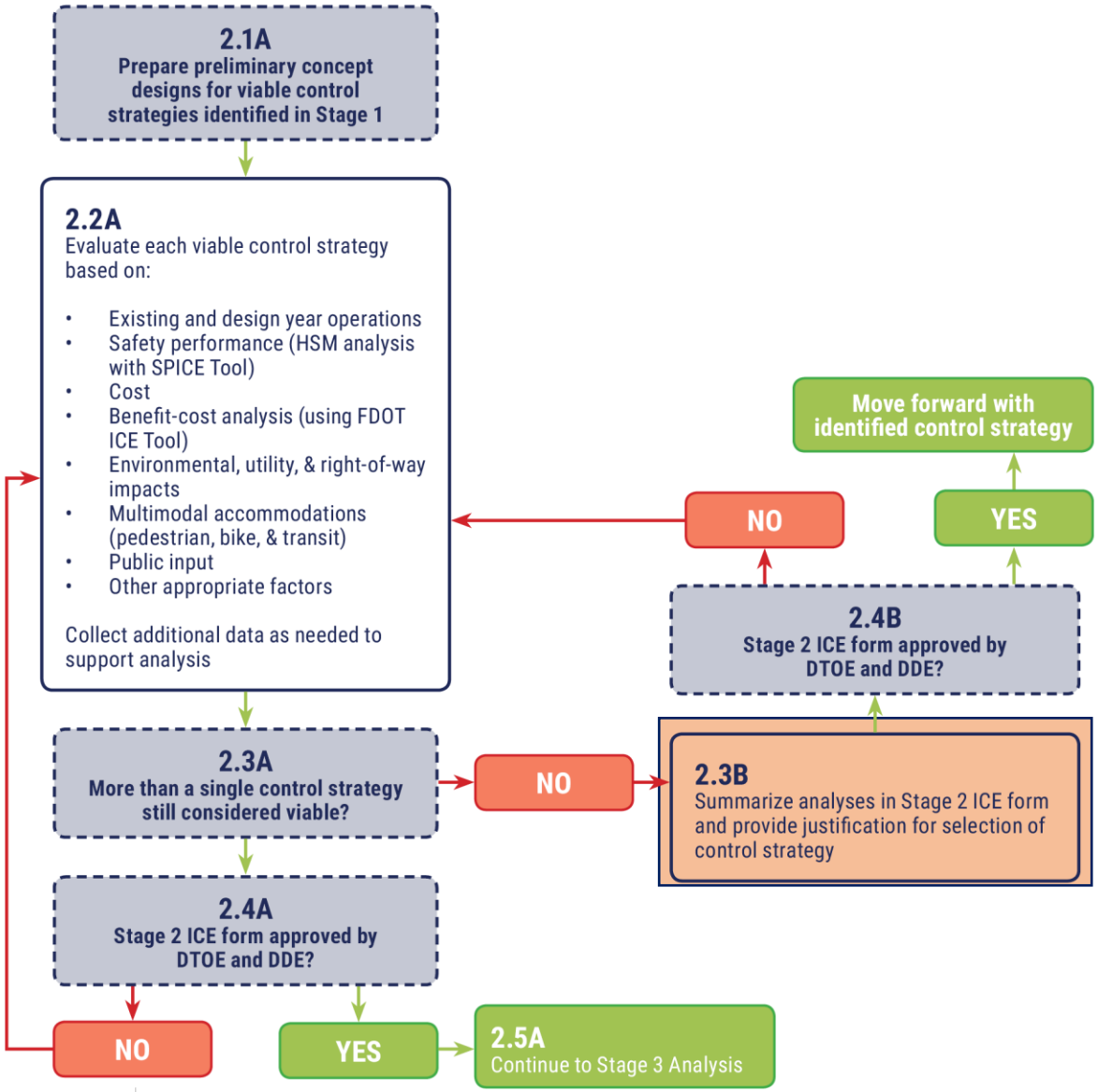
| Select Base Case for Benefit-Cost Comparison: (Choose from list) | Traffic Signal |
|---|---|

| Benefit Categories | Net Present Value of Benefits Relative to Base Case | | | |
|---|---|---|---|---|
| | Traffic Signal | Displaced Left Turn (DLT) | Median U-Turn (MUT) | Signalized Restricted Crossing U-Turn (RCUT) |
| Auto Passenger Delay | | $ 11,887,217 | $ 15,533,552 | $ 5,210,053 |
| Truck Delay | | $ 2,034,816 | $ 2,658,487 | $ 895,856 |
| Safety | | $ 5,298,617 | $ 12,587,433 | $ 4,138,724 |
| **Net Present Value of Benefits** | | **$ 19,220,650** | **$ 30,779,472** | **$ 10,244,634** |
| **Net Present Value of Costs** | | **$ 2,530,048** | **$ 1,782,048** | **$ 1,970,048** |
| **Net Present Value of Improvement** | | **$ 16,690,602** | **$ 28,997,424** | **$ 8,274,586** |
| **Benefit-Cost (B/C) Ratio** | | **7.60** | **17.27** | **5.20** |
| **Delay B/C** | | **5.50** | **10.21** | **3.10** |
| **Safety B/C** | | **2.09** | **7.06** | **2.10** |

→ Net present value of Benefits

→ Benefit-Cost Ratio (if Base Case exists)

# ICE STAGE 2 PROCESS






Reference: FDOT Manual of Intersection Control Evaluation; Nov. 1, 2017; Figure 3; Page 14

# 2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

| Multimodal Accomodations | | | | | | |
|---|---|---|---|---|---|---|
| Note the existing/anticipated level of pedestrian/bicyclist activity at the study intersection during the peak hours of the typical day. See ICE procedures document for activity level thresholds: | | | | | | |
| | Weekday AM Peak | | Weekday PM Peak | | Acitivity Level | |
| | Major Street | Minor Street | Major Street | Minor Street | Ped. | Bicycles |
| # of ped. crossings (both approaches, if app.): | 17 | 20 | 67 | 14 | Medium | Low |
| # of cyclists (both approaches, if app.): | 0 | 0 | 0 | 0 | | |

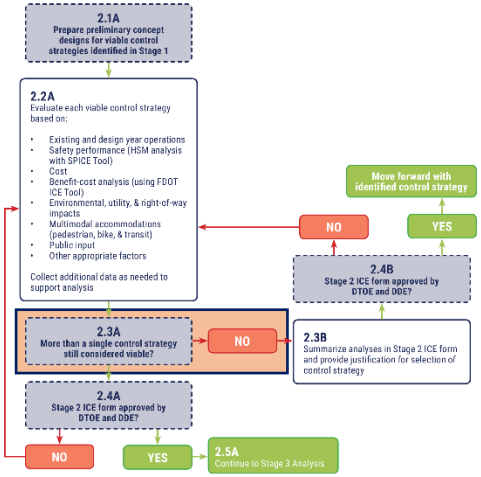
| Summarize the ability of each viable control strategy to accommodate the exisitng/anticipated level of: | | | |
|---|---|---|---|
| Control Strategy | Pedestrians and Bicyclists | Transit Services | Freight Needs |
| Signalized Control | The signalized control allows for ped crossing on all intersection legs. Bicycle facilities should still be | No change from existing. | No change from existing. |
| Median U-Turn | PARTIAL - The MUT would allow ped crossings upstream and downstream U-turn locations. | No change from existing. | No change from existing. |
| RCUT (Signalized) | The RCUT can provide ped x-walks on all intersection legs. Provides opportunities for ped | No change from existing. | No change from existing. |
| Displaced Left-Turn | PARTIAL - The DTL would still allow ped crossings on all intersection legs, crossing distance | No change from existing. | No change from existing. |

# 2.2 A – ICE FORM STAGE 2: DOCUMENTATION OF EVALUATION

| Environmental, Utility, and Right-of-Way Impacts | |
|---|---|
| Summarize any issues related to environmental, utility, or right-of-way (including relocation) impacts specific to each control strategy. Be sure to consider the NEPA requirements for each control type. | |
| Signalized Control | No impacts anticipated. |
| Median U-Turn | ROW acquisition needed on the SW corner of the intersection. |
| RCUT (Signalized) | ROW acquisition needed on the SW corner of the intersection. |
| Displaced Left-Turn | ROW acquisition needed on the NE and SW corners of the intersection. Two driveway will be closed due to intersection reconfiguration, one on each corner. |
| | |
| | |

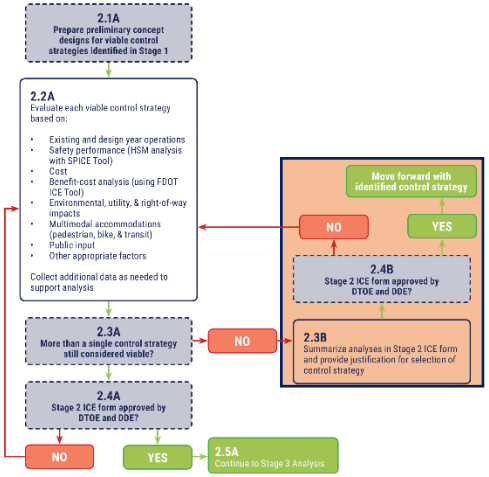
| Public Input/Feedback (if appropriate) |
|---|
| Summarize any agency or public input regarding the control strategies: |
| None performed to date. |

# 2.3 A – ICE FORM STAGE 2: VIABLE CONTROL STRATEGIES SELECTION




| Control Strategy Evaluation | | |
|---|---|---|
| Provide a brief justification as to why each of the following is either viable or not viable. If a single contro the only strategy to be advanced. | | |
| Control Strategy | Strategy to be Advanced? | Justification |
| Signalized Control | No | The Signalized Control performs operationally slightly better than the RCUT for the 2040 PM but worse than the Partial MUT. From a safety perspective, the traffic signal performs worse than the Partial MUT, Signalized RCUT and Partial DLT. |
| Median U-Turn | Yes | PARTIAL - The MUT performs better than the Signalized Control, RCUT and Partial DLT control alternatives in terms of operations and safety (overall crashes and fatal/injury). |
| RCUT (Signalized) | No | The RCUT presents the worst performance when compared to the Signalized Control, PMUT and PDLT alternatives. In terms of safety benefit, the RCUT presents similar safety performance to the DLT with a slight increase in the predicted fatal/injury crashes. |
| Displaced Left-Turn | No | PARTIAL - The DLT performs better operationally than the signalized RCUT control alternative and the third overall safety performance when compared to the rest of the alternatives. |

# 2.4 B – FDOT ICE FORM APPROVAL – STAGE 2




| Resolution | | | | | |
|---|---|---|---|---|---|
| *To be filled out by FDOT District Traffic Operations Engineer and District Design Engineer* | | | | | |
| Project Determination | Identified Control Strategy Approved | | | | |
| Comments | | | | | |
| DTOE Name | | Signature | | Date | |
| DDE Name | | Signature | | Date | |

# QUESTIONS?

# Contact Info

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