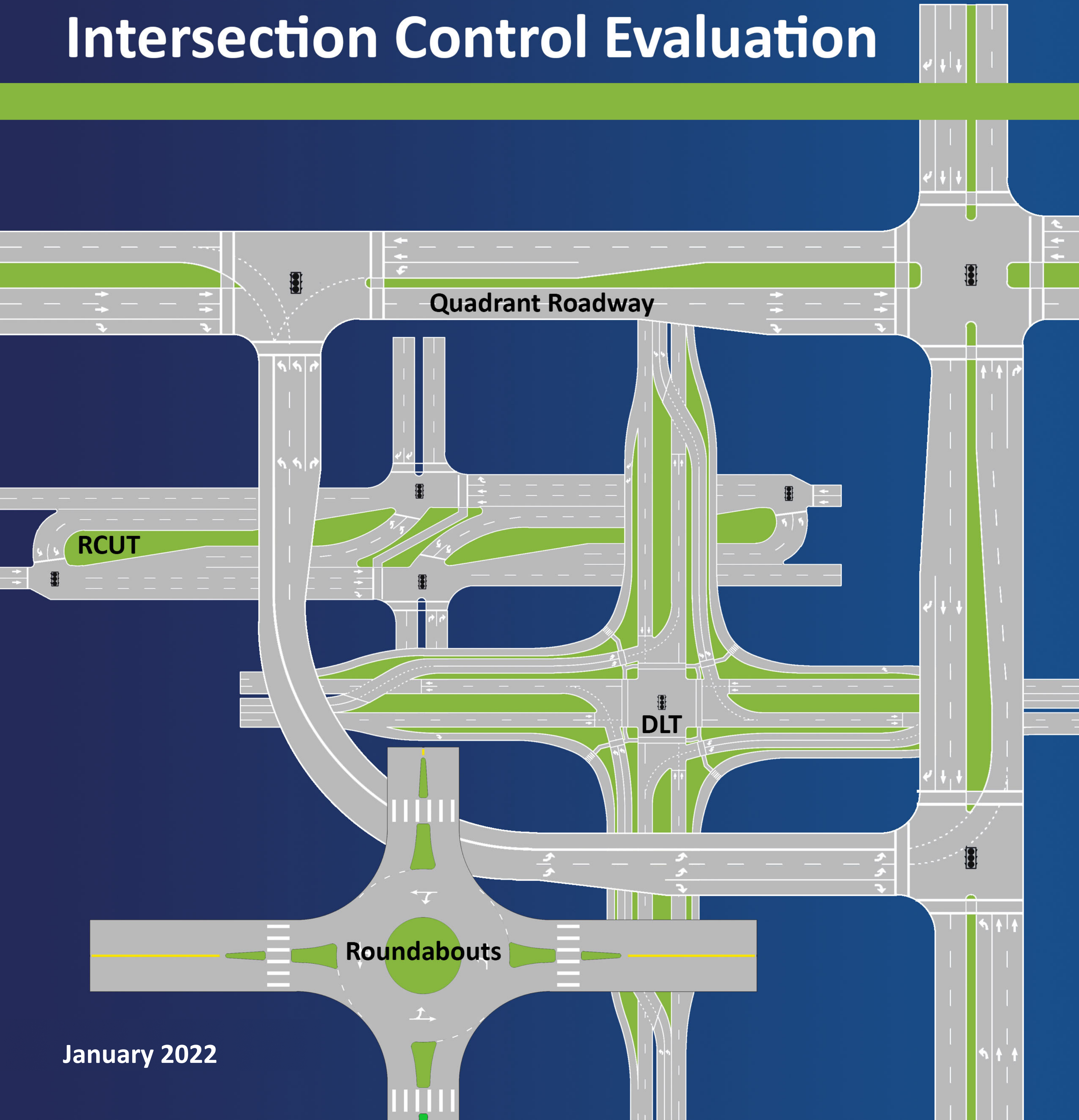
# Manual on Intersection Control Evaluation




January 2022

# MANUAL ON
# INTERSECTION CONTROL EVALUATION

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# CHAPTER 1
# ADOPTION PROCEDURE

## PURPOSE:

To implement the Intersection Control Evaluation (ICE) procedure, standards, and guidelines used on the State Highway System.

## AUTHORITY:

Sections 20.23(3)(a), 334.048(3), Florida Statutes

## REFERENCES:

Chapter 316, F.S. Rule 14-15.010, Florida Administrative Code (FAC), Manual on Uniform Traffic Control Devices Standard Operating System, Topic No. 025-020-002

## SCOPE:

The ICE Manual affects the following Florida Department of Transportation Offices and consultants at the state and district level: Traffic Engineering and Operations, Safety, Roadway Design, Environmental Management, Access Management, and Permitting.

## 1.1 Distribution

This document is available electronically on the ICE Manual website:

***www.fdot.gov/traffic/TrafficServices/intersection-operations.shtm***

ICE Manual users can register to receive notifications of updates and Traffic Engineering and Operations Bulletins online through the Department's Contact Management Database at:

***https://fdotewp1.dot.state.fl.us/ContactManagement***

## 1.2 Registration

Users of the ICE Manual interested in receiving automatic notifications of revisions to the manual by e-mail may subscribe from the Department's website.

## 1.3 Revisions and Additions

**(1)** The District Traffic Operations Engineers (DTOE), the State Traffic Operations Engineer (STOE) and the State Roadway Design Engineer constitute the Manual Review Committee.

**(2)** Items warranting immediate change can be made with the approval of the STOE (after a majority vote of the Manual Review Committee and consultation with any other affected parties). Statewide meetings of DTOEs are held every six months, and a major agenda item will be any additions or changes either necessary or recommended to the ICE.

**(3)** All revisions are to be coordinated through the Forms and Procedures Office prior to implementation.

**(4)** Substantive revisions or policy-related issues, as determined by the Manual Review Committee, are approved by the Secretary following the process established in the Standard Operating System, Topic No. 025-020-002.

**(5)** Once revisions and/or additions have been approved by the Secretary they are posted on the State Traffic Engineering and Operations Office website.

**(6)** All registered holders of the ICE Manual are to receive e-mail notification that the revisions have been posted on the website.

## 1.4 Training

Training has been provided by the State Traffic Engineering and Operations Office.

## 1.5 Forms

The following form is available from the Department’s Forms Library:

750-010-003, Intersection Control Evaluation Form including tabs for Stage 1, Stage 2, and Stage 3

# CHAPTER 2
# INTERSECTION CONTROL EVALUATION

## 2.1 Purpose

**(1)** The purpose of ICE is to consistently consider multiple context-sensitive control strategies when planning a new or modified intersection.

**(2)** The goal of ICE is to better inform the FDOT's decision-making to identify and select a control strategy meeting the project's purpose and need, fitting the intersection location's context classification, providing safe travel facilities for all road users, and reflecting the overall best value. A context-sensitive control strategy is a flexible approach to identifying a control type meeting the goals and needs of the community and all road users. The control strategy's value is measured in terms of performance-based criteria within available resources.

**(3)** The ICE procedure is the same for new intersections or modifications to existing intersections.

**(4)** The FDOT ICE procedure promotes thoughtful consideration of alternative intersection types. The procedure also outlines methods of quantitative analysis to select intersection control types. FDOT created this procedure for a range of activities to support objective evaluations of intersection control strategies. The procedure guides users through steps to conduct an intersection control evaluation. Completion of forms is required to document project decisions. ICE is intended to be flexible and adaptable. ICE activities could potentially be streamlined on some projects while other projects may require more extensive analyses. This could result in early, sketch-level evaluations to support quick planning-level decisions or detailed and robust evaluations to address complex projects. The users should use their judgment to apply the ICE procedure in the way that meets project needs, the ICE procedure goals, and follows the process described in this manual.

**(5)** The ICE process replaces the FDOT roundabout evaluation process.

## 2.2 Background

**(1)** The primary intent of any transportation project should be to promote a sustainable transportation system safeguarding the mobility and safety of all users. Perhaps the greatest opportunity for realizing this goal lies at at-grade intersections, where crossing traffic patterns potentially place users of various modes in conflict with each other creating delay. Therefore, transportation practitioners should work to deploy the most prudent intersection control type at each intersection on Florida's public roadways. An informed decision-making process evaluates many quantifiable factors, though engineering judgement is often required in selecting the most 'appropriate' intersection design.

**(2)** The Florida Department of Transportation (FDOT) prepared a 2021 update to the Strategic Highway Safety Plan (SHSP). Intersection safety is one of 12 emphasis areas shown in the SHSP. Nationally, Florida ranks as the #1 state in the country with the most intersection and intersection-related traffic fatalities. The SHSP shows in 2019, almost 28% of all Florida traffic fatalities occurred from intersection-related crashes. The SHSP intersection emphasis area acknowledges the safety benefit of roundabouts and has a control strategy saying:

*Roundabouts can reduce fatalities by 90 percent and improve overall traffic flow at intersections.*

**(3)** In September 2014, the FDOT adopted the *Statewide Complete Streets Policy **(Topic No. 000-625-017).*** The FDOT Complete Streets policy builds on flexibility and innovation to ensure that all state roadway projects are developed based on their context classifications. In 2018, FDOT published the FDOT Design Manual (FDM) incorporating context classification and context-based design criteria. Intersections play an essential role in the roadway network and offer connections to different routes and facilities while providing necessary access to adjacent residential, commercial, and industrial developments. As a result, FDOT's ICE procedure is a key component of the Department's Complete Streets implementation.

**(4)** Intersections comprise a small portion of total road system mileage, but they account for a high percentage of all crashes, especially severe crashes producing injuries and fatalities. Safety of all road users must be considered during intersection design. The quantitative methods outlined in this ICE procedure include safety evaluations, in addition to auto-focused performance metrics.

**(5)** Traditionally, the most common solutions to intersection challenges involved stop-controlled, conventional signalization scenarios, or interchanges. Many of the performance metrics used to select between these common solutions focused on the movement of vehicles through the intersection. In recent years, a number of new or innovative intersection designs have been introduced across the United States. These "alternative" intersection control types are enhancing safety and improving operations, along with varying degrees of other benefits. This re-imagining of geometric design and traffic control has improved the movement of people and vehicles across and through intersections. Alternative intersections (including roundabouts, cross-over-based designs, and U-turn-based designs) often consider community needs, transportation needs, and control strategies to achieve multiple objectives. This is consistent with the FDOT Complete Streets policy. Objective intersection control evaluations use performance-based criteria to determine the most viable control type for a project. ***Appendix A*** includes a description of at-grade intersection and ramp terminal intersection design concepts applied throughout the United States.

## 2.3 Applicability

**(1)** An ICE is required when:

**(a)** New intersection signalization is proposed except for signalization at a midblock crosswalk;

**(b)** Major reconstruction of an existing signalized intersection is proposed (e.g., adding a left-turn lane for any approach; adding an intersection leg);

**(c)** Changing a directional or bi-directional median opening to a full median opening;

**(d)** Driveway Connection permit applications for Category E, F, and G standard connection categories (defined by average daily trips thresholds in Rule 14-96.004, F.A.C.) add, remove, or modify a traffic signal; or

**(e)** District Design Engineer (DDE) and District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project.

**(2)** An ICE is not required for intersection projects if any of the following apply:

**(a)** Work involved does not include any substantive proposed changes to an intersection (e.g., a project limited to only “mill and resurface” pavement with no change to intersection geometry or control; converting a 2-way stop intersection to a 4-way stop intersection; changing a full median opening to a directional median opening).

**(b)** Minor intersection operational improvements (such as adding right-turn lanes or changing signal phasing) or signal replacement projects where the primary purpose is to upgrade deficient equipment and installations.

**(3)** FDOT encourages local agencies and counties to perform an ICE for projects they lead on locally maintained roadways, but ultimately it is the choice of the local jurisdiction.

**(4)** For service interchanges, an ICE is recommended for ramp terminal intersections. For example, if a diamond form is selected, an ICE may be used to consider and recommend a control strategy at the ramp terminal intersections, with options including stop control, signalized, or yield (roundabouts).

## 2.4 Conducting an ICE

**(1)** ICE activities are the same for any intersection project regardless of the sponsor or project need. An ICE must be prepared under the supervision of a licensed Professional Engineer in the State of Florida. Supporting documentation for Stages 1, 2, and 3 submittals shall be signed and sealed by said Professional Engineer. It is recommended the signed and sealed supporting documentation be submitted with each stage of ICE approval. FDOT retains final approval authority for the ICE, except for local-agency-led projects on locally maintained roadways not using FDOT funds.

### 2.4.1 Project Purpose and Need

**(1)** Projects may be initiated for a variety of reasons – traffic operations, safety, multimodal access, land access, and place-making are examples of potential project needs. The project's purpose and need and the project location's context classification guide the selection of a control strategy.

### 2.4.2 Design Year

**(1)** ICE analysis is to be completed for the existing year (year of data collection) and the design year. The design year is 10 years for operation improvement projects such as signalization; resurfacing, restoration, and rehabilitation (RRR) projects; and safety or operational improvements. The design year is 20 years for projects that add capacity with new construction or reconstruction. If the level of service is failing in the design year, the failure year should be noted on the ICE Form. For interchange access requests, additional analysis years may be requested. The DTOE or DDE may require the analysis of an additional design year further into the future. The development of design year traffic volumes should follow the FDOT Project Traffic Forecasting Handbook and the guidance given in Paragraph 2.7 – Project Traffic Demand Forecasting of the FDOT Traffic Analysis Handbook dated May 2021.

### 2.4.3 Study Area

ICE is focused on the isolated intersection or intersections under consideration; however, evaluations may need to expand beyond the study intersections if:

**(a)** Queue spillback is anticipated to impact the operations of adjacent intersections;

**(b)** Modifications are being made to an intersection within a coordinated signal system;

**(c)** Queue spillback onto the mainline of a freeway is likely (for ramp terminal intersections);

**(d)** A corridor study is being conducted involving multiple intersections; or

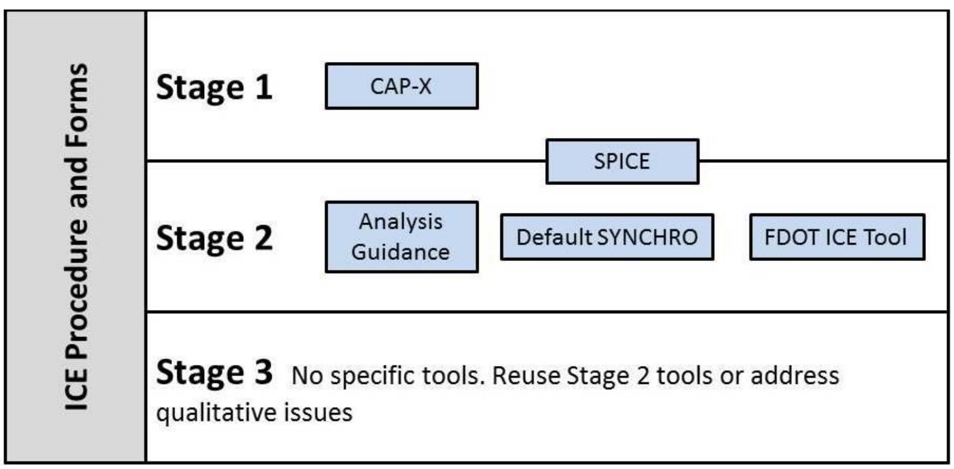
**(e)** Modifications to multiple intersections require an ICE to be completed for each intersection or as a grouping of intersections if the intersections do not operate independently of each other, such as a median U-turn intersection.

The ICE tools do not have the ability to analyze a group of intersections that operate independently of or in coordination with each other.

## 2.5 ICE Procedure

**(1)** The ICE activities consist of three stages; however, determining the selected intersection control strategy may not require all three stages. ***Figure 1*** illustrates the three stages of the ICE procedure and forms.

**FIGURE 1. STAGES OF ICE PROCEDURE AND TOOLS**




**(2)** As previously documented, the scope of an ICE is scalable commensurate to the analysis required to select a viable control strategy for the intersection. Some projects may require only one or two stages. Each stage requires more detailed analysis until a single intersection control strategy is identified.

**(a)** Stage 1: Screening – completed during a project's initial stage. FHWA's Capacity Analysis for Planning of Junctions (CAP-X) is an operational analysis tool to evaluate selected types of innovative intersection designs. FDOT has expanded this tool for use in Florida. FHWA's Safety Performance of Intersection Control Evaluations (SPICE) is a separate tool used for safety analysis. FDOT's version of SPICE includes two complimentary approaches to safety analysis: 1) crash prediction based on safety performance functions (SPFs) and crash modification factors (CMFs) and 2) a Safe System-based analysis using FHWA's Safe System for Intersections (SSI) method. Details of the SSI method can be found in ***Appendix C***. Due to a lack of field installations, SPFs and CMFs are not available for the signalized and unsignalized thru-cut intersections and the safety analysis is to be done using the SSI method.

**(b)** Stage 2: Preliminary Control Strategy Assessment – completed following a project's initial stage when more detailed information is available. SPICE is used for a more detailed safety analysis than in Stage 1. FDOT has developed default Synchro templates for operations analysis of certain types of alternative intersections. The FDOT ICE Tool is a separate tool for benefit-cost analysis. If the project does not have federal funds, benefit-cost analysis may not be required in Stage 2.

**(c)** Stage 3: Detailed Control Strategy Assessment – completed prior to Preliminary Design/Phase I plans. Stage 3 analysis is not required for Project Development and Environment (PD&E) studies as this analysis type is a normal part of PD&E.

**(3)** At the completion of each stage, the appropriate FDOT ICE form with supporting documentation is completed and submitted to the DTOE and DDE for signature before advancing to the next stage. ***Table 1*** illustrates the party typically responsible for completing and submitting the ICE forms and supporting analysis for common project types. *To fully set-up the ICE forms, the user must go to the Stage 1 form and use the pull-down menus to populate the "Intersection Type" and the "Project Funding Source".*

**TABLE 1. AGENCY OR PARTY TYPICALLY RESPONSIBLE FOR COMPLETING ICE FORMS BASED ON PROJECT TYPE**

| Project Type | Typical Agency or Party to Complete ICE Forms |
|---|---|
| FDOT projects | FDOT staff or their consultants |
| Driveway Connection Permits on state highways | Applicant |

**(4)** Completing the Stage 1 ICE form is required for all projects outlined in the "applicability" section of this document. Stage 2 and Stage 3 ICE forms are required if prior stages did not identify a single viable control strategy. The breadth of supporting documentation appended to the form should be proportionate to the level of analysis required to identify the selected control strategy. ***Appendix B*** contains the FDOT ICE forms.

### 2.5.1 Stage 1: Screening

**(1)** The purpose of Stage 1: Screening is to establish a list of viable traffic control strategies for the intersection.

**(a)** For Driveway connection permit applications, the applicant's engineers and FDOT staff should determine at the pre-application meeting or at a district's access management review committee meeting which viable control strategies the applicant should assess. The completed Stage 1 ICE Form is provided at the pre-application meeting to facilitate this discussion.

**(b)** For PD&E studies, the Stage 1 ICE can serve as the initial screening of potential alternative intersection strategies as part of PD&E's Alternatives Analysis process and should be completed with the Project Traffic Analysis Report (PTAR).

**(2)** ***Figure 2*** illustrates the Stage 1 activities, while ***Table 2*** provides a discussion of each step.

The Stage 1 Screening considers many potential intersection control strategies and evaluates them using information shown in 1.3A and 1.4A of ***Figure 2*** and the CAP-X and SPICE tools. The Stage 1 data collection requirements are provided in ***Appendix B***. Ultimately, the analysis in Stage 1 may result in two possible outcomes (identified by the green boxes in ***Figure 2***):

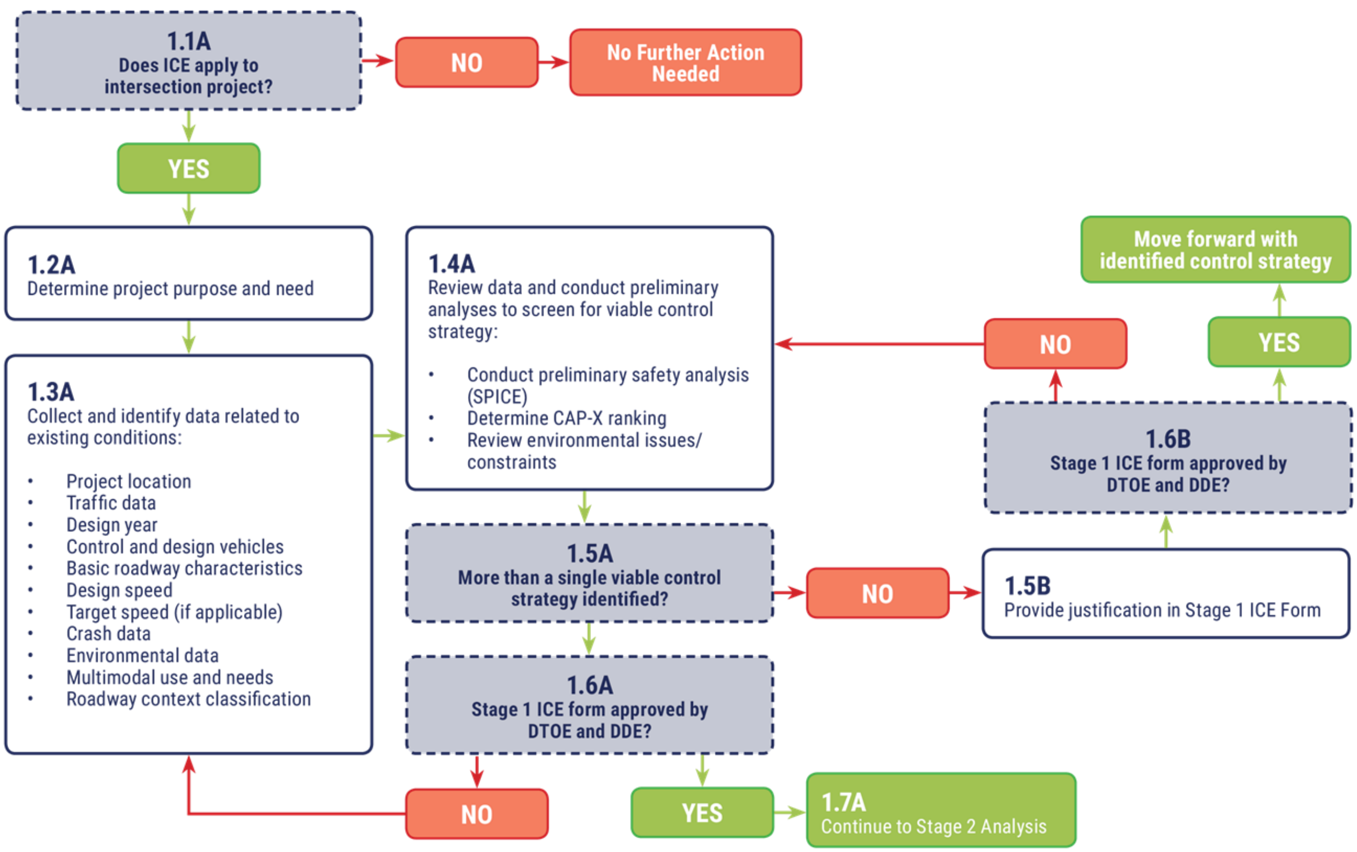
**(a)** A Stage 1 analysis leads to a single viable control strategy meeting the project's purpose and need and is applicable to the corridor's context classification. The party identified in ***Table 1*** completes a Stage 1 ICE form, receives DDE and DTOE approval and no further stages of ICE are required. It is expected that minor projects may be able to identify a single viable control strategy in Stage 1.

**(b)** A Stage 1 analysis indicates multiple control strategies as viable and meeting the project's purpose and need and the corridor's context classification. The party identified in ***Table 1*** completes a Stage 1 ICE form. The analysis results are shared with the DTOE, the DDE, and the project team to determine next steps and scope as the analysis transitions into Stage 2.

For the two possible outcomes listed above, the completed Stage 1 ICE form is submitted to the DTOE and DDE for approval. Stage 1 is completed as part of the project's initial study process. The project's funding source should be identified on the Stage 1 ICE form. For non-federally funded projects or those not requiring a benefit-cost analysis, a reduced Stage 2 analysis may be an option.

The ICE analysis required in a PD&E study will vary based on the level of engineering analysis needed for the PD&E phase and early coordination with the District DTOE and DOE. At a minimum, the Stage 1 ICE analysis will be performed during PD&E and alternatives will be developed and documented based on the Stage 1 ICE results.

**FIGURE 2. INTERSECTION CONTROL EVALUATION – STAGE 1: SCREENING**



## TABLE 2. STAGE 1 PROCEDURAL STEPS

| Step | | Description |
|---|---|---|
| 1.1A | Does intersection require an ICE? | Determine if the study intersection requires an Intersection Control Evaluation based on the criteria established in the *Applicability* section of this document. |
| 1.2A | Determine project purpose and need | Determine the purpose and need for the project. |
| 1.3A | Collect data on existing conditions | If ICE is applicable, collect certain minimum information about the existing conditions. This includes the project location, traffic data (including peak hour data), basic roadway characteristics, control and design vehicles, design and target speeds, crash data, environmental data, multimodal use(s), and roadway context classifications. Refer to the FDOT ICE Procedure spreadsheet, FDOT *Project Traffic Forecasting Handbook*, and FDOT *Traffic Analysis Handbook* for specific data requirements. Make a preliminary determination whether there are any environmental or right-of-way factors which may preclude a control strategy from selection. Identify whether the project is federally or non-federally funded. |
| 1.4A | Review data and conduct preliminary analyses to screen for viable control strategies | Input data into the FDOT ICE spreadsheet tool to aid in identifying various traffic control strategies. Input CAP-X rankings obtained from the CAP-X analysis spreadsheet. Conduct preliminary safety analysis of viable alternatives using crash prediction with SPICE Tool and input crash prediction-based rankings into Stage 1 ICE form. Conduct SSI analysis of viable alternatives with SPICE tool and input SSI-based rankings into Stage 1 ICE form. Review environmental issues or constraints. Reference **Appendix A** to determine the viability of a control type. Apply engineering judgement in evaluating these aspects. Forecasted volumes should be prepared in accordance with the FDOT *Project Traffic Forecasting Handbook* and with Paragraph 2.7 – Project Traffic Demand Forecasting of the FDOT *Traffic Analysis Handbook.* |
| 1.5A | More than a single viable control strategy identified? | The Professional Engineer (PE) overseeing the evaluation has discretion to determine whether control strategies are still viable based on the evaluation of the conceptual designs. Coordinate efforts and results with FDOT throughout the evaluation to ensure acceptance of the results and conclusions. |
| 1.5B | Provide justification in Stage 1 ICE form | If a preferred intersection control strategy is identified through preliminary analyses, include the justification in the completed Stage 1 ICE form. Submit the Stage 1 ICE form to the DTOE and DDE for concurrence and approval. Attach supporting documentation, including CAP-X and SPICE analysis spreadsheet output sheets and supporting data. Factors used for justification include the following:<br>• Existing safety and congestion issues<br>• Plans for the roadway based on an adopted corridor or PD&E study<br>• The spacing of nearby intersections or driveways and how they conform to adopted access management guidelines<br>• The adjacent environment and land uses (existing and proposed)<br>• Area type (urban, suburban, or rural)<br>• Community goals and objectives<br>• Future anticipated traffic volumes<br>• Pedestrian and bicycle usage and needs<br>• The breakdown and percentage of types of vehicles<br>• Design vehicle accommodation<br>• Sight distance<br>• Available right of way<br>• Environmental constraints<br>• Support of the local users, local agencies, and local government |
| 1.6A | Stage 1 ICE form approved by DTOE and DDE? | If the Stage 1 ICE form is approved, prepare the proposed control strategies for Stage 2: Control Strategy Assessment.<br>If the Stage 1 ICE form is not approved, the DTOE or DDE may require additional data collection to help identify viable control strategies (return to Step 1.3A). |
| 1.6B | Stage 1 ICE form approved by DTOE and DDE? | If the Stage 1 ICE form is approved, proceed to preliminary design for the recommended control strategy.<br>If the Stage 1 ICE form is not approved, the DTOE or DDE may require additional analysis to determine appropriate viable control strategies (return to Step 1.4A). Submit a second Stage 1 form to the DTOE and DDE when Stage 1 is repeated. |
| 1.7A | Continue to Stage 2 Analysis | As a preferred control strategy was not identified in Stage 1, conduct a more detailed analysis of the remaining control strategies in Stage 2: Control Strategy Assessment. |

## 2.5.2 Stage 2: Preliminary Control Strategy Assessment

**(1)** If Stage 1 identified a single selected control strategy, Stage 2 is not necessary. If Stage 1 helped narrow down a list of potential intersection control strategies but did not select a single one, Stage 2 is intended to help differentiate any remaining control strategies with a more detailed vetting. Prior to conducting additional analyses, develop a conceptual design for each viable control strategy. These conceptual designs are essential for communicating control strategy concepts to the public and evaluating factors (such as cost, right-of-way impacts, and environmental impact on a site-specific basis). Evaluation of other factors (such as design users, community preferences, consistency with future land use, the roadway's context classification, transportation plans for the surrounding area) is captured with outreach to local agencies and the general public. Strategies to better incorporate pedestrian and bicycle facilities into RCUT, MUT and DLT designs are available thru FDOT produced videos which can be viewed at FDOT's Traffic Engineering and Operations Office, Intersection Operations and Safety website.

**(2)** If a PD&E study's level of detail includes a final design component, the Stage 2 evaluation will be incorporated into the PD&E's alternative evaluation process. The alternative intersection's traffic operations analysis should be based upon the project's design year traffic volumes and incorporated into the PD&E's Project Traffic Analysis Report (PTAR) and summarized in the Preliminary Engineering Report (PER). The life cycle safety analysis from SPICE, to include both the crash prediction and the SSI metrics, should also be summarized in the PER. If the PD&E project is a combined PD&E and Design project or programmed for Design Build, then full Stage 2 ICE procedures will need to be followed including DDE and DTOE approval of the Stage 2 ICE Form.

When an approved PD&E study proceeds to design then full Stage 2 ICE procedures will need to be followed including DDE and DTOE approval of the Stage 2 ICE Form for any impacted intersection meeting the ICE applicability guidance (Section 2.3).

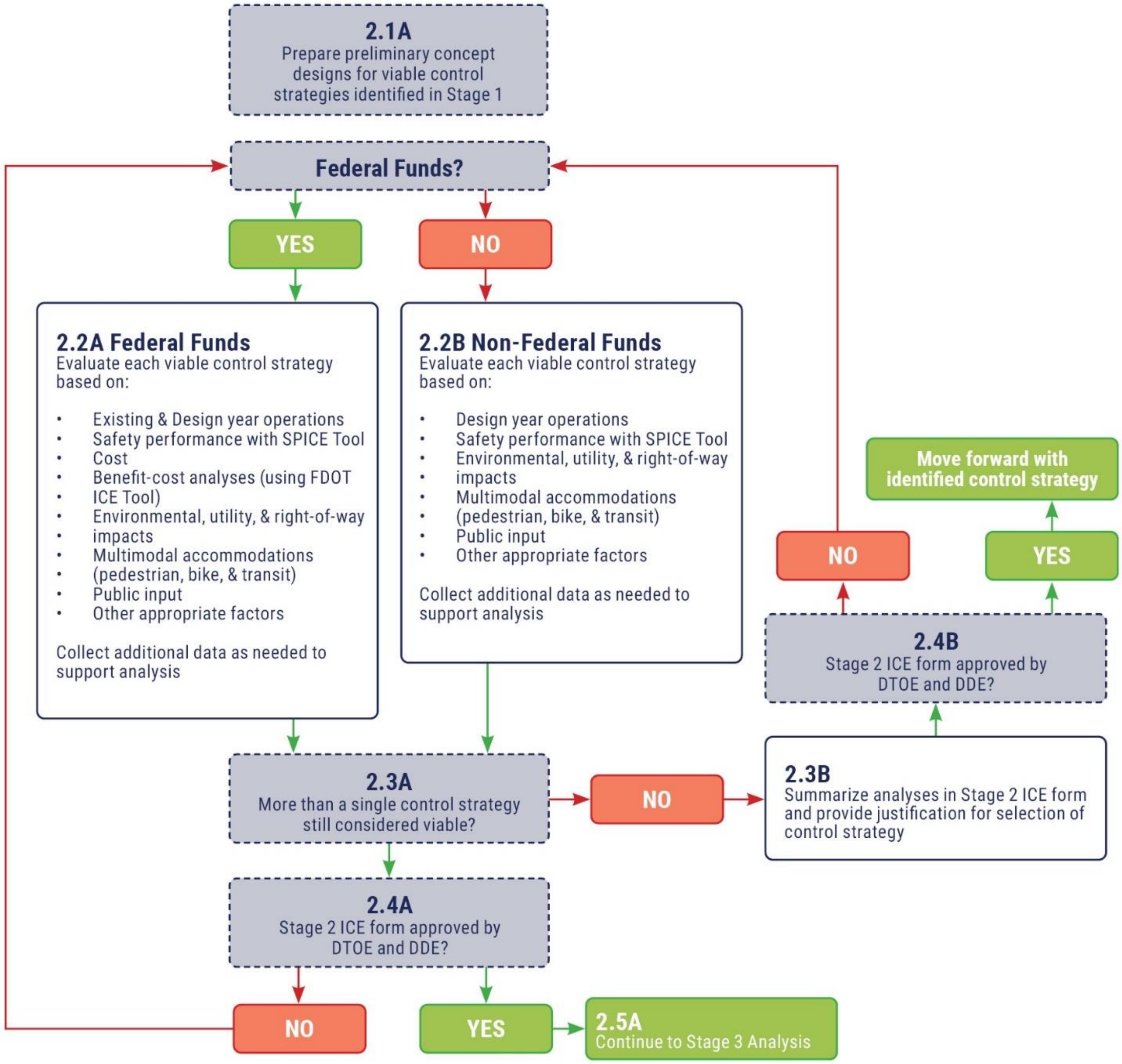
**(3)** ***Figure 3*** illustrates the Stage 2 activities, while ***Table 3*** discuss the potential steps followed within Stage 2. The outcomes of Stage 2 are as follows (identified by the green boxes in ***Figure 3***):

**(a)** Through more detailed analysis, a single control strategy is identified as preferred. A Stage 2 ICE form is completed, and the supporting analyses (e.g., Synchro operational analysis, crash prediction with SPICE Tool, SSI analysis with SPICE tool) are conducted. Analysis results may be appended to the form or documented in a memorandum. Please note, while the Stage 2 crash predictions in SPICE will change from Stage 1 due to the use of historic crash data (EB method) and population of the Crash Modification Factors (CMFs), the Stage 1 SSI results will not change.

**(b)** For non-federally funded projects, the operational analysis is modified to only be the design year's critical peak hour to support the concept development. The Stage 2 SPICE safety analyses are not changed. Construction and right of way cost estimates are not required unless needed for other reasons. The Stage 2 ICE Tool and associated benefit-cost analysis is not required unless the LOS worksheets are needed for comparative operations analysis.

If the analysis of the conceptual designs failed to clearly distinguish a single control strategy above the others. Results of the analysis are shared with the DTOE, DDE, and applicable staff to determine next steps and scope as the analysis transitions into Stage 3.

## FIGURE 3. INTERSECTION CONTROL EVALUATION – STAGE 2: PRELIMINARY CONTROL STRATEGY ASSESSMENT



## TABLE 3. STAGE 2 PROCEDURAL STEPS – FEDERALLY FUNDED PROJECT

| Step | | Description |
|---|---|---|
| 2.1A | Prepare preliminary conceptual designs | Prepare a layout or conceptual plan showing the proposed geometrics for each intersection control strategy. Document changes from the existing conditions in the plan. This conceptual design lays the foundation for much of the evaluation in Step 2.2A. |
| 2.2A | Evaluate each control strategy | Conduct a more detailed analysis of each control strategy is based on the conceptual designs. Areas of analysis include:<br>• Operations (Apply *Highway Capacity Manual*, Synchro, or other applicable methodologies). Refer to the FDOT *Traffic Analysis Handbook* for guidance. Suggested software is shown in **Appendix A**. Requires opening and design year AM and PM peak hour analysis.<br>• Safety Performance (Evaluate control strategies based on anticipated safety performance and SSI metrics using the *SPICE Tool)*<br>• Construction, right-of-way and design costs<br>• Benefit-Cost Analysis (evaluate using the operations and safety performance above using FDOT ICE Tool)<br>• Environmental impacts<br>• Utility impacts<br>• Right-of-way impacts<br>• Multimodal accommodations (including pedestrians, bikes, and transit)<br>• Agency coordination and public input (if appropriate)<br>Use the FDOT ICE Tool to identify “viable” traffic control strategies for the intersection. **Appendix C** provides a more detailed discussion on each of these analysis areas. Collect additional data if needed to conduct Stage 2 analysis. Refer to the FDOT *Traffic Analysis Handbook* for guidance on data collection and operations analysis tools. |
| 2.3A | More than a single control strategy still considered viable? | The Professional Engineer (PE) overseeing the ICE evaluation uses discretion to determine whether control strategies are still viable based on the evaluation of the conceptual designs. Coordinate efforts and results with DTOE and DDE staff throughout the evaluation to facilitate acceptance of the results and conclusions. |
| 2.3B | Summarize analyses in Stage 2 ICE form and provide justification for selection of control strategy | If a preferred traffic control strategy is identified through the analysis of the conceptual designs, submit a completed Stage 2 ICE form to the DTOE and DDE. Attach the proper justification to the Stage 2 ICE form. |
| 2.4A | Stage 2 ICE form approved by DTOE and DDE? | If the Stage 2 ICE form is approved, prepare the proposed control strategies for Stage 3: Detailed Control Strategy Assessment.<br>If the Stage 2 ICE form is not approved, the DTOE or DDE may require additional analysis and evaluation to help identify viable control strategies (return to Step 2.2A). |
| 2.4B | Stage 2 ICE form approved by DTOE and DDE? | If the Stage 2 ICE form is approved, proceed to the preliminary design phase for recommended control strategy.<br>If the Stage 2 ICE form is not approved, the DTOE or DDE may require additional justification or further vetting of potential control strategies (return to Step 2.2A). |
| 2.5A | Continue to Stage 3 Analysis | Conduct a more detailed analysis of the remaining control strategies in Stage 3: Detailed Control Strategy Assessment. |

### TABLE 4. STAGE 2 PROCEDURAL STEPS – NON-FEDERALLY FUNDED PROJECT

| Step | | Description |
|---|---|---|
| 2.1A | Prepare preliminary conceptual designs | Prepare a layout or conceptual plan showing the proposed geometrics for each intersection control strategy. Document changes from the existing conditions in the plan. This conceptual design lays the foundation for much of the evaluation in Step 2.2A. |
| 2.2A | Evaluate each control strategy | Conduct a more detailed analysis of each control strategy is based on the conceptual designs. Areas of analysis include:<br>• Operations (Same as federally funded project except only done for design year critical peak hour)<br>• Safety Performance (Evaluate control strategies based on anticipated safety performance and SSI metrics using the *SPICE Tool)*<br>• Environmental impacts<br>• Utility impacts<br>• Right-of-way impacts<br>• Multimodal accommodations (including pedestrians, bikes, and transit)<br>• Agency coordination and public input (if appropriate)<br>Use comparison of operations and safety analyses to identify "viable" traffic control strategies for the intersection. **Appendix C** provides a more detailed discussion on each of these analysis areas. Collect additional data if needed to conduct Stage 2 analysis. Refer to the FDOT *Traffic Analysis Handbook* for guidance on data collection and operations analysis tools. |
| 2.3A | More than a single control strategy still considered viable? | The Professional Engineer (PE) overseeing the ICE evaluation uses discretion to determine whether control strategies are still viable based on the evaluation of the conceptual designs. Coordinate efforts and results with DTOE and DDE staff throughout the evaluation to facilitate acceptance of the results and conclusions. |
| 2.3B | Summarize analyses in Stage 2 ICE form and provide justification for selection of control strategy | If a preferred traffic control strategy is identified through the analysis of the conceptual designs, submit a completed Stage 2 ICE form to the DTOE and DDE. Attach the proper justification to the Stage 2 ICE form. |
| 2.4A | Stage 2 ICE form approved by DTOE and DDE? | If the Stage 2 ICE form is approved, prepare the proposed control strategies for Stage 3: Detailed Control Strategy Assessment.<br>If the Stage 2 ICE form is not approved, the DTOE or DDE may require additional analysis and evaluation to help identify viable control strategies (return to Step 2.2A). |
| 2.4B | Stage 2 ICE form approved by DTOE and DDE? | If the Stage 2 ICE form is approved, proceed to the preliminary design phase for recommended control strategy.<br>If the Stage 2 ICE form is not approved, the DTOE or DDE may require additional justification or further vetting of potential control strategies (return to Step 2.2A). |
| 2.5A | Continue to Stage 3 Analysis | Conduct a more detailed analysis of the remaining control strategies in Stage 3: Detailed Control Strategy Assessment. |

**(4)** For each possible outcome listed above, the completed Stage 2 ICE form is submitted to the DTOE and DDE for approval. Stage 2 is typically completed immediately following the project's initial study portion or as part of the project's alternatives and comparative evaluation. The DTOE and DDE approval of a single control strategy in Stage 2 ICE (or any ICE stage) means a preferred control strategy has been selected to be advanced to final design. During final design when more detailed information is available, the preferred alternative may no longer be the best improvement option for many reasons. Some examples are a contamination site has been discovered on a parcel needed for right-of-way acquisition and it is decided to not acquire the parcel. Another example is local government approved a new nearby development impacting the intersection's traffic volumes and the preferred control strategy's operations and safety. In cases such as these, the DTOE and DDE may direct ICE analysis to be re-evaluated.

### 2.5.3 Stage 3: Detailed Control Strategy Assessment

**(1)** While Stage 2 included the development and analysis of conceptual designs, Stage 3 requires a more in-depth analysis and/or public vetting of control strategy options. This may involve:

- advancement of design plans,
- more detailed traffic analysis,
- more detailed cost estimating and right-of-way need determination,
- additional assessment of environmental impacts,
- additional engagement with the public or local officials,
- additional engagement with road users (e.g., freight industry, school bus operators, adjacent property owners), or
- any other activities necessary to identify the preferred control strategy.

**(2)** Detailed design plans are necessary only if they assist in the outstanding issues evaluation. For example, community engagement or multimodal needs may determine the preferred control strategy, instead of further technical analysis. When Stage 1 or Stage 2 does not identify a selected control strategy, users may customize Stage 3 activities to address the outstanding issues. For a PD&E project, the Stage 3 screening is not required as the steps taken above are a normal part of the PD&E process and are documented in the Preliminary Engineering Report, Project Traffic Analysis Report and the environmental documentation.

**(3)** For projects outside the PD&E process, ***Figure 4*** illustrates the Stage 3 evaluation, while ***Table 5*** discusses the potential steps encountered within Stage 3. Stage 3 results in one outcome: a selected control strategy.

## FIGURE 4. INTERSECTION CONTROL EVALUATION – STAGE 3: DETAILED CONTROL STRATEGY ASSESSMENT

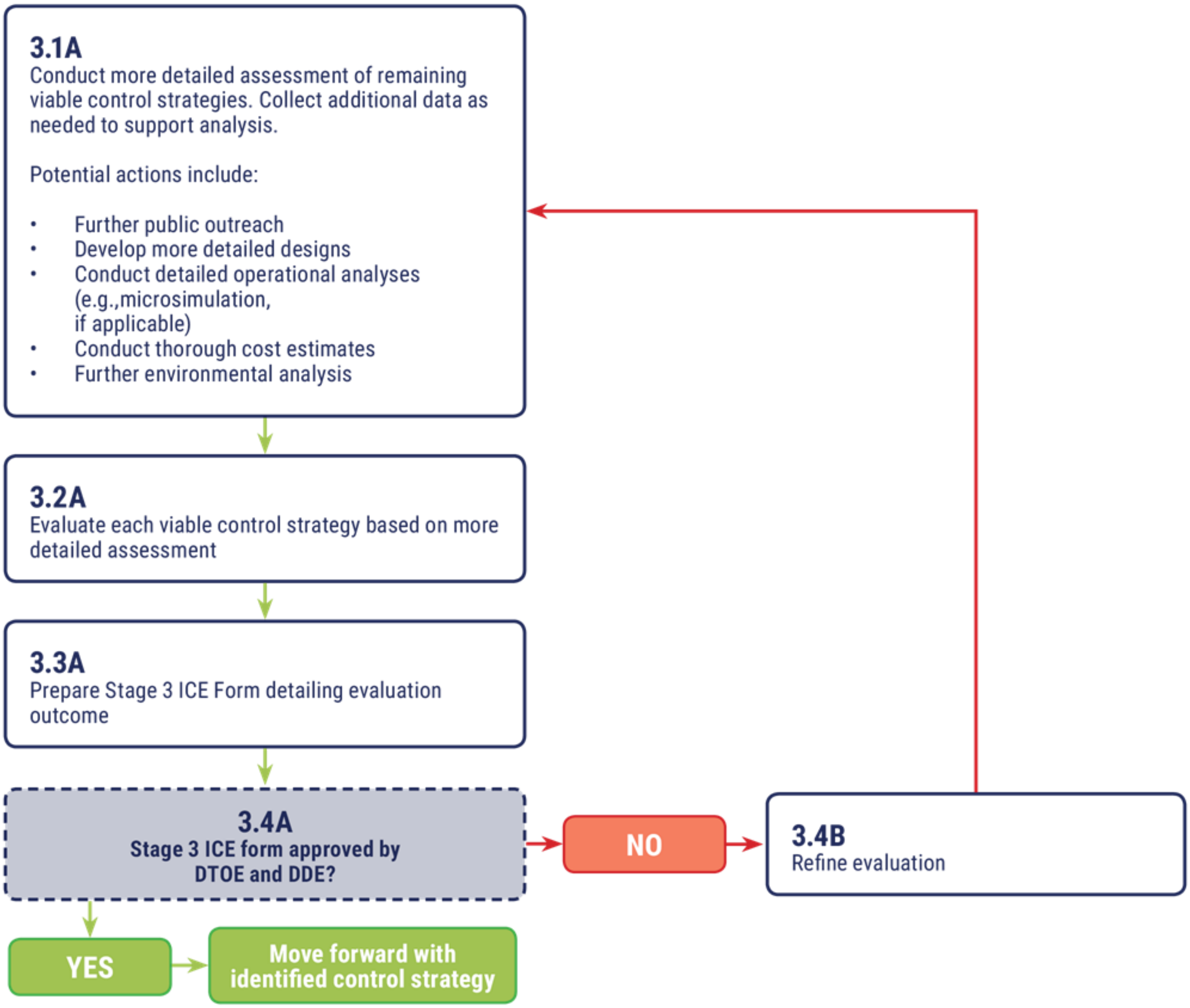


**TABLE 5. STAGE 3 PROCEDURAL STEPS**

| Step | | Description |
|---|---|---|
| 3.1A | Conduct more detailed assessment of remaining control strategies | Revisit the control strategies that remain after the Stage 2 analysis. Conduct detailed analyses regarding issues and/or findings that have led a control strategy to **not** to be selected in Stage 2 (i.e., areas warranting further investigation). |
| 3.2A | Evaluate each viable control strategy based on more detailed assessment | Coordinate efforts and results with FDOT throughout the evaluation to facilitate acceptance of the results and conclusions. However, discretion lies with the Professional Engineer (PE) overseeing the evaluation to determine whether control strategies are still viable based on the evaluation of the conceptual designs. |
| 3.3A | Prepare Stage 3 ICE form detailing evaluation outcome | Prepare a Stage 3 ICE form detailing or justifying the selected control strategy. Attach supporting documentation to the form. |
| 3.4A | Stage 3 ICE form approved by DTOE and DDE? | If the Stage 3 ICE form obtains approval from the DTOE and DDE, proceed to preliminary design for the recommended control strategy.<br><br>If the Stage 3 ICE form is not approved, incorporate the comments from the DTOE or DDE into the analysis and justification form. This may include modifications to control strategy designs, operational analyses, or additional evaluations. The party responsible for submitting the ICE is required to re-submit the Stage 3 ICE form after accounting for comments from the DTOE and/or DDE. Coordinate efforts and results with FDOT throughout the evaluation to avoid unnecessary iterations. |
| 3.4B | Refine design | If the submission of the Stage 3 ICE form is not approved, the party responsible for submitting the ICE form must revise their analysis or modify their evaluation based on the comments received from the DTOE and/or DDE (i.e., repeat Step 3.1A with revisions). |

## 2.6 Tools and Resources

**(1)** ***Table 6*** provides links to potentially useful tools and resources when conducting an ICE.

**TABLE 6. USEFUL TOOLS AND RESOURCES FOR ICE**

| Category | Title | Description | Web Link |
|---|---|---|---|
| **Operational and Safety Performance Evaluation Tools** | Safety Performance for Intersection Control Evaluation (SPICE) Tool | Excel spreadsheet-based safety performance screening tool for conventional and alternative intersection types | https://www.fdot.gov/traffic/trafficservices/intersection-operations.shtm |
| | Capacity Analysis for Planning of Junctions (CAP-X) Tool | Excel spreadsheet-based critical lane method operational analysis tool | https://www.fdot.gov/traffic/trafficservices/intersection-operations.shtm |
| | Highway Capacity Manual | Definitive reference for traffic analysis of intersections and underlying basis of many intersection operation software packages | http://www.trb.org/main/blurbs/175169.aspx |
| | FDOT NCHRP 17-38 Spreadsheet | FDOT Present Worth Analysis - FDOT Procedural Forms 750-020-21(A-C) | https://www.fdot.gov/traffic/trafficservices/studies/muts/muts.shtm |
| | A Safe System-Based Framework and Analytical Methodology for Assessing Intersections | Quantitative framework for assessing the extent to which intersection alternatives in a given context align with Safe System principles | https://safety.fhwa.dot.gov/intersection/ssi/fhwasa21008.pdf |
| **Life-Cycle Cost Analysis Tools** | NCHRP Intersection Lifecycle Cost Analysis (LCCA) Tool | Excel spreadsheet-based economic evaluation tool | http://www.trb.org/Main/Blurbs/173928.aspx |
| **Intersection Pedestrian and Bicycle Facility Videos** | ICE Example Videos | Videos showing operations for various pedestrian and bicycle facility designs at MUTs, RCUTs, and DLTs | https://www.fdot.gov/traffic/trafficservices/intersection-control-example-videos |
| **Intersection Control Type Reference Guides** | Unsignalized Intersections Improvement Guide (UIIG) | PDF report documenting safety, mobility, and accessibility improvements to unsignalized intersections | http://www.ite.org/uiig/ |

| | | | |
|---|---|---|---|
| | FHWA-SA-13-027: Signalized Intersections Informational Guide, 2nd Edition | PDF report providing guidance on enhancing the safety of signalized intersections | http://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/fhwasa13027.pdf |
| | FHWA-SA-14-069: Median U-Turn Intersection Informational Guide | PDF report providing guidance on median U-turn (MUT) intersections | http://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14069_mut_infoguide.pdf |
| | FHWA-HRT-09-055: Displaced Left-Turn Intersection | PDF report providing guidance on displaced left-turn intersections | http://www.fhwa.dot.gov/publications/research/safety/09055/09055.pdf |
| | FHWA-SA-14-070: Restricted Crossing U-Turn Intersection Informational Guide | PDF report providing guidance on restricted crossing U-turn (RCUT) intersections | http://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14070_rcut_infoguide.pdf |
| | FHWA-HRT-07-032: Traffic Performance of Three Typical Designs of New Jersey Jughandle Intersections | PDF report providing guidance on New Jersey Jughandle intersections | http://www.fhwa.dot.gov/publications/research/safety/07032/07032.pdf |
| | FHWA-SA-14-068: Displaced Left-Turn Intersection Informational Guide | PDF report providing guidance on displaced left-turn (DLT) intersections | http://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14068_dlt_infoguide.pdf |
| | FHWA-SA-09-016: Continuous Green T-Intersections | PDF report providing guidance on continuous green T-intersections | http://safety.fhwa.dot.gov/intersection/innovative/others/casestudies/fhwasa09016/fhwasa09016.pdf |
| | FHWA-HRT-09-058: Quadrant Roadway Intersection | PDF report providing guidance on quadrant roadway intersections | http://www.fhwa.dot.gov/publications/research/safety/09058/09058.pdf |
| | FHWA-HRT-09-060: Alternative Intersections/Interchanges: Informational Report (AIIR) | PDF report providing guidance on various alternative intersection control types. Information on MUT, RCUT, and DLT intersections superseded by the individual guidebooks above. | http://www.fhwa.dot.gov/publications/research/safety/09060/09060.pdf |

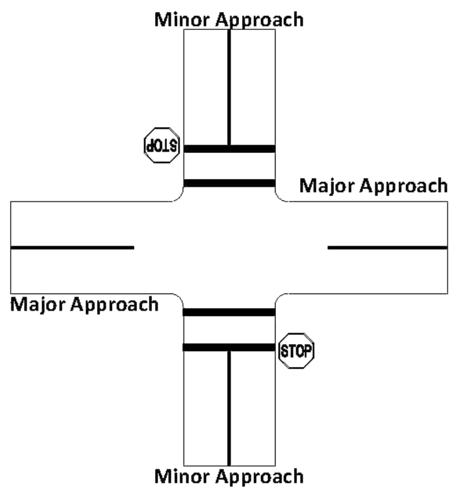
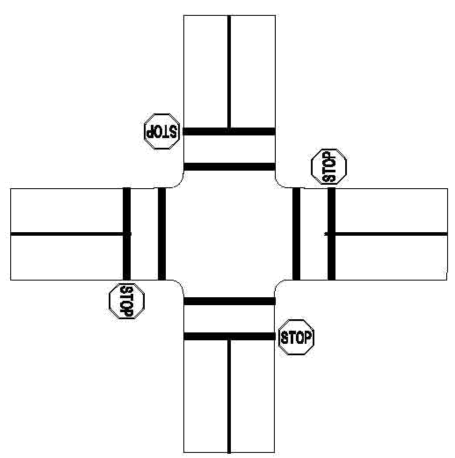
| | | | |
|---|---|---|---|
| | NCHRP 345 – Single Point Urban Interchange Design and Operations Analysis | PDF report providing guidance on design and operation of single point interchanges. | http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_345.pdf |
| | NCHRP 672 - Roundabouts: An Informational Guide, 2nd Edition | PDF report discussing roundabout design and evaluation | http://www.trb.org/Publications/Blurbs/164470.aspx |
| | NCHRP Report 888 – Development of Roundabout Crash Prediction Models and Methods | Provides SPF's and CMF's used to estimate severity and number of crashes at roundabouts. | http://www.trb.org/Publications/Blurbs/178663.aspx |
| | NCHRP 948 – Guide for Pedestrian and Bicyclist Safety at Alterative and Other Intersections and Interchanges | PDF report providing guidance for comparative qualitative evaluation of pedestrian and bicyclist safety at any intersection or interchange type. Information on MUT, RCUT, DLT, and DDI recommend pedestrian and bicyclist facility designs also provided. | http://www.trb.org/Main/Blurbs/181781.aspx |
| | NCHRP 959 – Diverging Diamond Interchange Informational Guide, Second Edition | PDF report providing guidance on safety, operations, design, and multimodal considerations of DDIs | http://www.trb.org/Publications/Blurbs/181562.aspx |

# Appendices

# Appendix A
# Intersection Type References

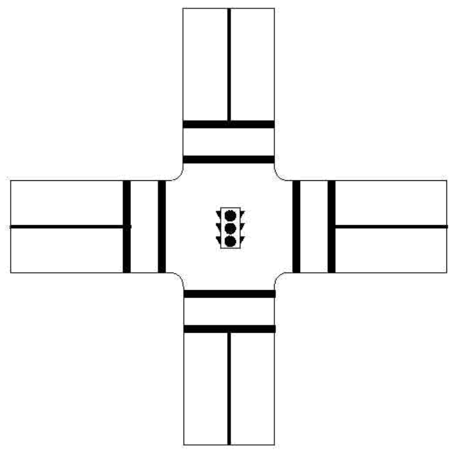
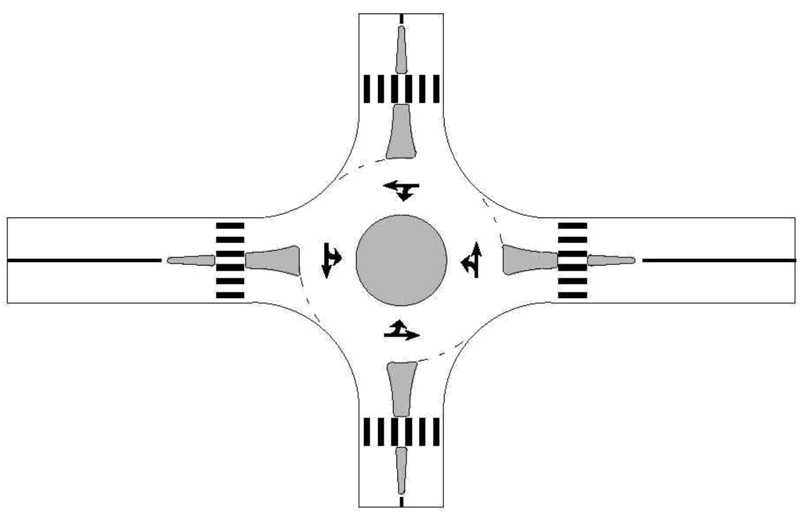
The information in ***Table A1*** and **Table *A2*** provide basic information on at-grade and ramp terminal intersections, respectively, for ICE practitioners who may not be familiar with them.

### TABLE A1. CONSIDERATIONS FOR AT-GRADE INTERSECTION DESIGN AND OPERATIONS

| Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Volume Thresholds | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|---|
| **Intersection Name** | **Illustration** | **Description** | **Vehicles** | **Pedestrians** | **Bicycles** | | | |
| Two-way stop-control |   | Conventional intersection control type in which the minor street approaches are stop-controlled and major street movements do not encounter any traffic control devices.<br><br>Advantages: Simple and low-cost<br><br>Disadvantages: Cannot effectively serve higher volumes of traffic | Through- and right-turn movements on the major street approaches are free-flow movements, while left-turn movements are permissive. All minor street approaches are stop-controlled. | Pedestrians crossing the minor street approaches have right-of-way and are crossing at a stop-controlled location; however, the lack of signalization does not provide any protected pedestrian movement across the major street. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | UIIG | See **Figure A1** for intersection control types and corresponding peak-hour volume thresholds | HCS, SYNCHRO |
| All-way stop-control |   | Conventional intersection control type in which every approach is stop-controlled.<br><br>Advantages: Simple, low-cost, and safe<br><br>Disadvantages: Lowest capacity of any intersection type | All vehicles are required to stop before proceeding through the intersection. | All pedestrian crossings are located at the same place as stop signs | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | UIIG | See **Figure A1** for intersection control types and corresponding peak-hour volume thresholds | HCS, SYNCHRO |

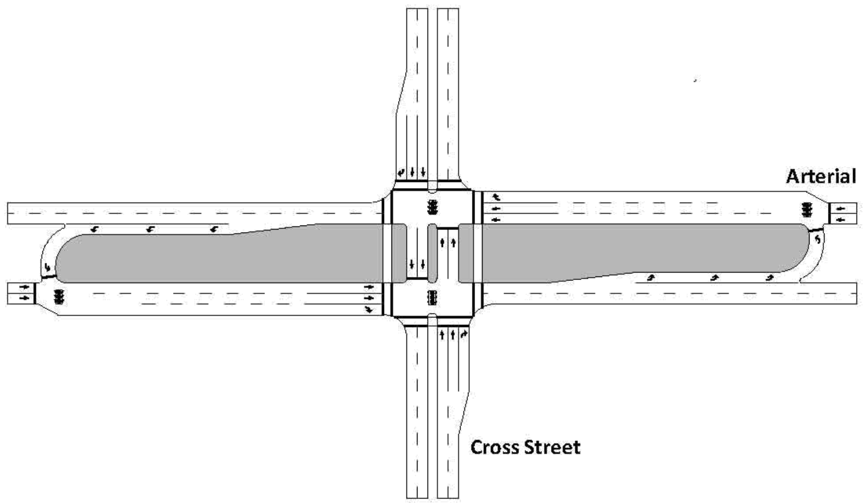
[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microsimulation software for oversaturated conditions

| Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Volume Thresholds | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|---|
| **Intersection Name** | **Illustration** | **Description** | **Vehicles** | **Pedestrians** | **Bicycles** | | | |
| Signalized Control |  | Conventional intersection control type in which each approach is controlled by a traffic signal.<br><br>Advantages: Most common form of control for higher volume intersections, fully and established and understood by all users<br><br>Disadvantages: Increased delay at high volumes compared to alternative intersections | Vehicular movements on each approach are controlled through protected, permissive, or prohibited lights on the traffic signal. | Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | Signalized Intersection Guide, 2nd Edition | See **Figure A1** for intersection control types and corresponding peak-hour volume thresholds | HCS, SYNCHRO |
| Roundabout |  | A subset of traffic circles that feature yield control of all entering vehicles, channelized approaches, and horizontal curvature and roadway elements to induce desirable vehicle speeds.<br><br>Advantages: Usually reduced crashes and delay compared to signalized control<br><br>Disadvantages: Usually higher cost and require more right-of-way than signalized control | Vehicles approaching the intersection must yield to vehicles circulating within the circulatory roadway. | Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length. | Bicyclists may ride in the roadway with vehicles or transition to multi-use paths via bicycle ramps (if present). Bike lanes should not be used at roundabouts | FDM 212.3 & NCHRP 672 | See **Figure A1** and **Table A3** for volume thresholds for roundabouts | SIDRA with US HCM Model |

[1] Refer to **Table 6** for a hyperlink to each reference document.

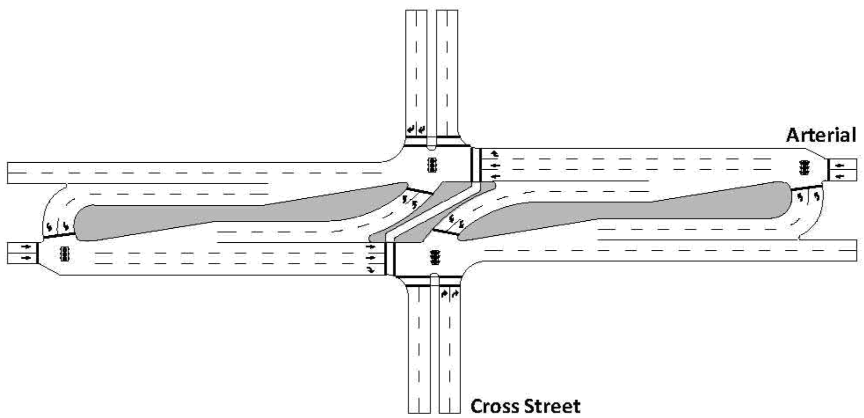
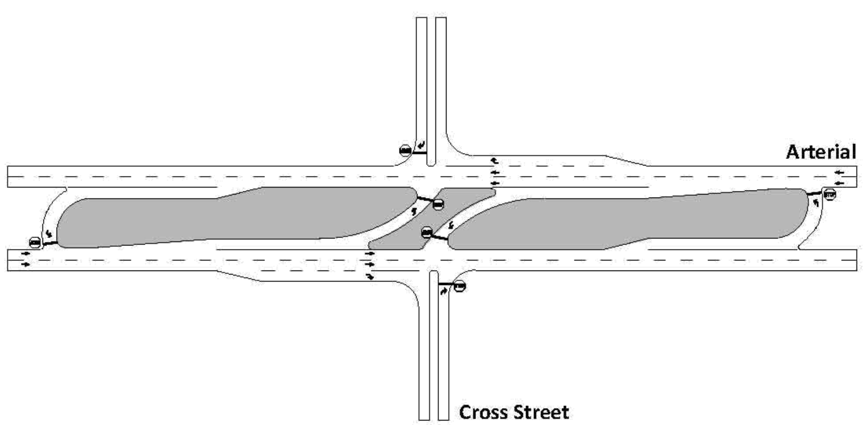
[2] Use VISSIM or similar microsimulation software for oversaturated conditions

| Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Volume Thresholds | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|---|
| Intersection Name | Illustration | Description | Vehicles | Pedestrians | Bicycles | | | |
| Median U-Turn (MUT) |  | An intersection treatment that eliminates direct left-turns at signalized intersections from major and minor approaches an replaces them with U-turns on the major street<br><br>Advantages: Fewer signal phases and conflict points than a conventional signal, better suited for high through volume cross streets than an RCUT<br><br>Disadvantages: Out-of-direction travel for left turn movements, requires wide median or outside right-of-way at U-turn crossover | Drivers desiring to turn left from the major road onto an intersecting cross street must first travel through the at-grade, signal-controlled intersection and then execute a U-turn at the median opening downstream of the intersection. These drivers then can turn right at the cross street.<br><br>For drivers on the side street desiring to turn left onto the major road, they must first turn right at the signal-controlled intersection and then execute a U-turn at the downstream median opening and proceed back through the signalized intersection. | Larger clearance intervals are required for the side street signal phase, and wider medians are often used to accommodate U-turns. When wide medians are used, pedestrian crossings are often two-stage; however, this tends to increase pedestrian delay. Single stage crossings are desirable. Medians can be reduced by using bulb-outs at the U-turn location, reducing major street lane widths, or reducing the number of major street lanes. Increased right turn volume may lead to more vehicle-pedestrian conflicts and can be mitigated through leading pedestrian intervals.<br><br>Midblock crossings may be provided at the U-turn location with minimal delay to outbound traffic. Additional guidance is available in NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 6. FDOT has published three videos showing different pedestrian treatments at MUTs. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Design techniques for direct left turns are available such as a two-stage bicycle turn box. Increased right turn volume may lead to more vehicle-bicycle conflicts and can be mitigated through leading bicycle intervals. Additional guidance is available in NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 6. FDOT has published three videos showing different bicycle treatments at MUTs. | FHWA-SA-14-069<br><br>NCHRP Report 948<br><br>Pedestrian and bicycle facility operations videos FDOT Traffic Engineering and Operations Office, Intersection Operations and Safety website | 300 veh < Major Street Volume < 1,900 veh; 100 veh < Minor Street Volume < 500 veh<br><br>**Figure A2** provides an example on determination of optimal unconventional intersections based on approach volumes. Please see the reference provided for **Figure A2** for further details. | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microsimulation software for oversaturated conditions

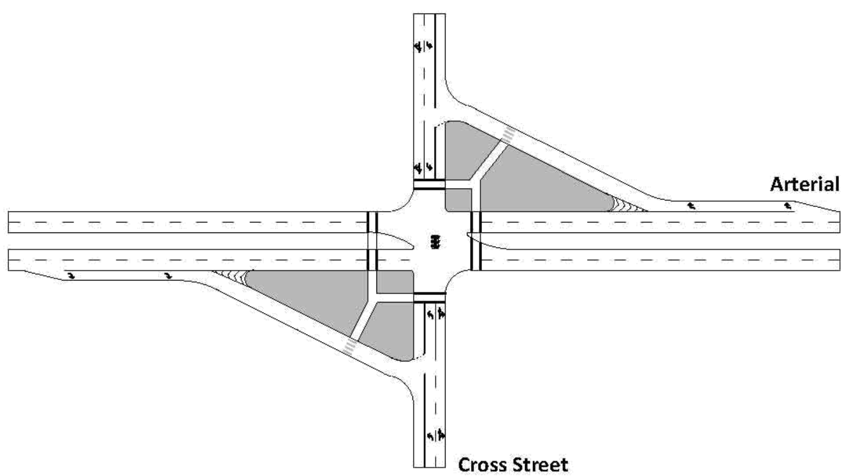
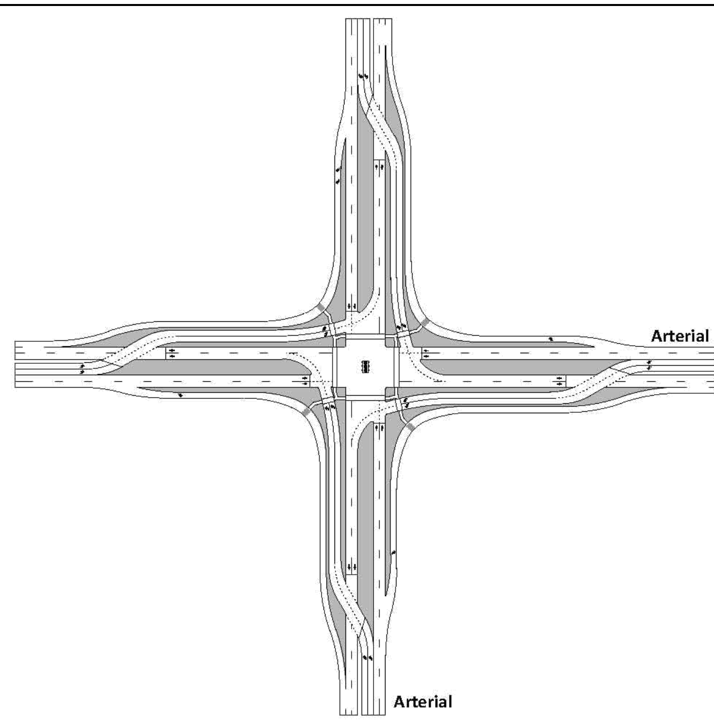
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

<table>
<tr><th colspan="3">Intersection Control Type</th><th colspan="3">Mode Accommodations</th><th rowspan="2">Reference Material[1]</th><th rowspan="2">Volume Thresholds</th><th rowspan="2">Recommended Stage 1 and 2 Analysis Tool(s)[2]</th></tr>
<tr><th>Intersection Name</th><th>Illustration</th><th>Description</th><th>Vehicles</th><th>Pedestrians</th><th>Bicycles</th></tr>
<tr><td>Signalized Restricted Crossing U-Turn (RCUT), or Superstreet</td><td></td><td rowspan="2">An intersection design that restricts left-turn and through movements from side street approaches as permitted in conventional designs.<br><br>Advantages: Fewer signal phases and conflict points (if signalized) than a conventional intersection, enables major street to operate as one-way couplet if signalized<br><br>Disadvantages: Out-of-direction travel for side street left and through movements, requires wide median or outside right-of-way at U-turn crossover</td><td>Left-turns and through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way, signalized median opening desirably 400 to 800 feet after the intersection. The major street effectively operates as a pair of one-way streets because no movement ever crosses both directions of the major street at once.</td><td>Pedestrian crossings of the major road at the RCUT intersection are usually accommodated on one diagonal “Z” path from one corner to the opposite corner, and each crossing is signalized. Direct paths across all four legs are also possible. Increased right turn volumes from the minor street may result in more vehicle-pedestrian conflicts and can be mitigated through prohibiting right turn on red.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 7 for additional guidance on pedestrian treatments. FDOT has published three videos showing different pedestrian treatments at signalized RCUTs</td><td>Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Side street through and left turn movements can use pedestrian crossings to avoid use of U-turn movements Increased right turn volumes from the minor street may result in more vehicle-bicycle conflicts and can be mitigated through prohibiting right turn on red.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 7. for additional guidance on bicycle treatments. FDOT has published three videos showing different bicycle treatments at signalized RCUTs</td><td rowspan="2">FHWA-SA-14-070<br><br>NCHRP Report 948<br><br>Pedestrian and bicycle facility operations videos FDOT Traffic Engineering and Operations Office, Intersection Operations and Safety website</td><td>Not suitable for an intersection of two arterials<br><br>Minor street demand threshold of 25,000 vpd (or 2,250 vph)<br><br>See Figure A3 for further details.</td><td rowspan="2">CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3]</td></tr>
<tr><td>Unsignalized Restricted Crossing U-Turn (RCUT), or J-Turn</td><td></td><td>Left-turns and through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way, stop-controlled median opening desirably 600 to 1,000 feet after the intersection.</td><td>Unsignalized RCUTs are usually located in rural areas and do not typically have pedestrian facilities. If there is pedestrian demand, accommodations should be provided.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 7 for additional guidance on pedestrian treatments.</td><td>Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Direct crossings from minor street to minor street can be facilitated with a cut-through in the median island.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 7 for additional guidance on bicycle treatments.<br>.</td><td>Minor street demand threshold of 5,000 vpd (or 450 vph)<br><br>See Figure A3 for further details.</td></tr>
</table>

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microsimulation software for oversaturated conditions

[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

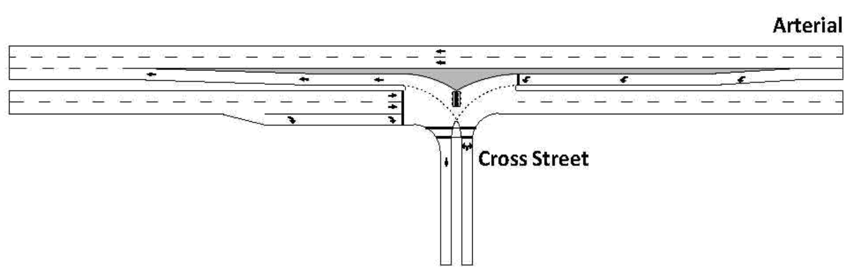
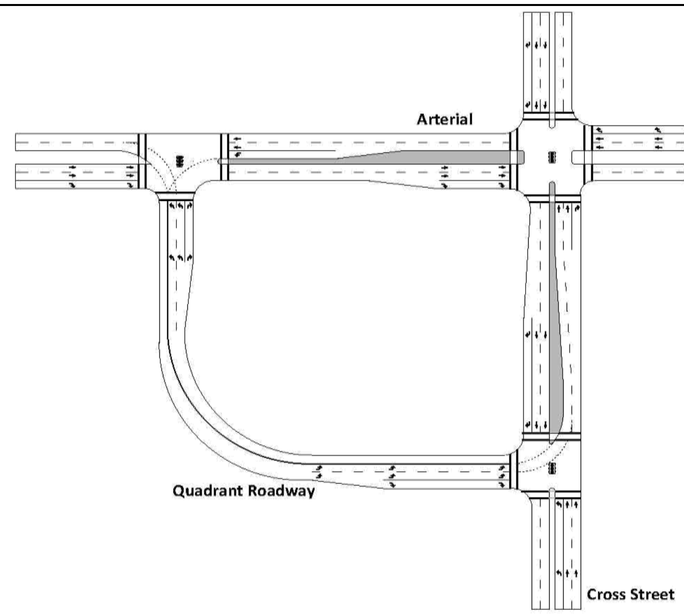
| Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Volume Thresholds | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|---|
| **Intersection Name** | **Illustration** | **Description** | **Vehicles** | **Pedestrians** | **Bicycles** | | | |
| Jughandle |  | A signalized intersection that uses at-grade ramp connectors between intersecting roadways to facilitate indirect left-turns or U-turns. The image shown has diagonal connectors upstream of the cross street, but loop connectors may also be placed downstream of the cross street.<br><br>Advantages: Fewer signal phases and conflict points than a conventional signal<br><br>Disadvantages: Out-of-direction travel for left turn movements and additional right-of-way requirements | Major street vehicles attempting to make a left-turn or U-turn utilize a connector ramp either upstream (short diamond-style ramp) or downstream (loop-style ramp) that connects to the minor street approach upstream of the signal. | Depending on the desired inbound and outbound sidewalks, some pedestrians may be required to cross one additional street compared to a conventional signalized intersection.<br><br>If pedestrians do not interact with the quadrant where a jughandle is located, there is no notable difference compared to a conventional signalized intersection. | Same as conventional intersection. Additional crossing infrastructure is provided at the ramp connector. | FHWA-HRT-07-032 | 1,900 veh < Major Street Volume < 2,300 veh; Minor Street Volume < 350 veh | CAP-X (planning level)<br><br>SYNCHRO, SimTraffic[3] |
| Displaced Left-Turn |  | A signalized intersection where one or more left-turn movements are relocated to the other side of the opposing traffic flow. These movements proceed through the intersection simultaneously with the through movements, which eliminates the left-turn phase on the approach. The image shown here has displaced lefts on both streets, but often they are displaced on only one street.<br><br>Advantages: Fewer signal phases and conflict points than a conventional signal, well-suited for high left-turn volumes<br><br>Disadvantages: Footprint of intersection is large and right-of-way and access management needs are great. | Left-turn movements at the intersection are relocated to the other side of the opposing roadway, eliminating the left-turn phase for the approach at the main intersection. Left-turns are brought across the opposing travel lanes via a signalized intersection several hundred feet upstream of the main intersection. Left-turn vehicles then travel on a new roadway parallel to the opposing lanes and execute the left-turn maneuver simultaneously with the through traffic at the main intersection. | Pedestrians may be required to cross more travel lanes than at a conventional intersection, and direction of traffic in those lanes may be counterintuitive to pedestrians. Many DLT intersections are set up for pedestrians to cross in multiple stages with median refuge islands. Aligning crosswalks to land between outbound travel lanes and inbound left turn lanes (as show in image) allows for concurrent movement of pedestrians and left turning vehicles. Aligning crosswalks outside of the inbound left turn lanes may require use of protected left turns to avoid vehicle-pedestrian conflicts.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 8 for additional guidance on pedestrian treatments at DLTs. FDOT has published three videos showing pedestrian treatments at DLTs. | Bicyclists can be provided on the road using marked bicycle lanes and design techniques for direct left turns are available although this would likely be used only by the most confident bicyclists. Design techniques for direct left turns are available, such as a two-stage bicycle turn box. Shared-use paths and protected bicycle lanes are also options.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 8 for additional guidance on bicycle treatments at DLTs. FDOT has published three videos showing different bicycle treatments at DLTs. | FHWA-SA-14-068<br><br>NCHRP Report 948<br><br>Pedestrian and bicycle facility operations videos FDOT Traffic Engineering and Operations Office, Intersection Operations and Safety website | Major Street Volume > 2,000 veh; Minor Street Volume > 300 veh.<br><br>A full 4-approach DLT with 2-3 lanes per approach can handle about 12,000[4]<br><br>A DLT with 2-approach can accommodate up to 10,000 vph[4] | CAP-X (Planning Level)<br><br>HCS, SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microscopic software for oversaturated conditions.

[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

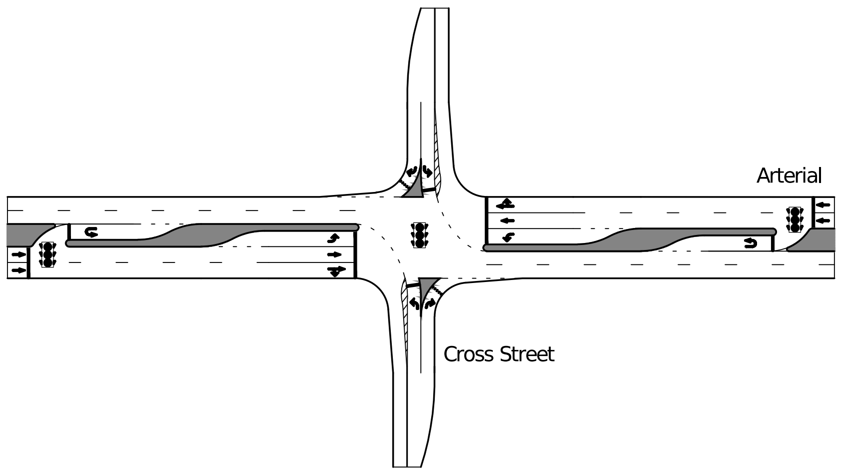
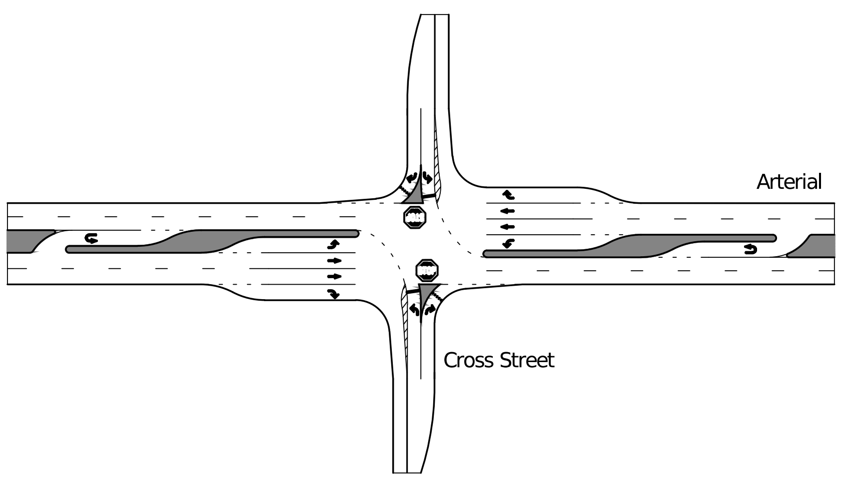
[4] Innovative Intersections: Overview and Implementation Guidelines. Community Planning Association of Southwest Idaho.

| Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Volume Thresholds | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|---|
| Intersection Name | Illustration | Description | Vehicles | Pedestrians | Bicycles | | | |
| Continuous Green Tee |  | A continuous green tee intersection is a signalized 3-leg intersection that features raised channelization that separates the "top" through movement from the other movements of the intersection, enabling the top through movement to operate unsignalized with no conflicting movement.<br><br>Advantages: One direction of arterial never has to stop<br><br>Disadvantages: No pedestrian crossing of arterial unless full signal is provided | Minor street left-turns are channelized, allowing a continuous green signal to be displayed to the "top" mainline through movement. | Permissive pedestrian crossings are provided across the minor street at the signal. Due to the continuous flowing nature of through movements on one of the major approaches, pedestrian movements across the mainline should be accommodated at an adjacent intersection or via a mid-block crossing, as appropriate. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | FHWA-SA-09-016 | N/A | CAP-X (planning level)<br><br>SYNCHRO, SimTraffic[3] |
| Quadrant Roadway |  | A quadrant roadway intersection is intended to eliminate all direct left-turn movements from the main intersection by re-routing them to turns to and from a connector roadway located in one quadrant.<br><br>Advantages: Reduced signal phases at main intersection<br><br>Disadvantages: Out of direction travel for some movements, Footprint of intersection is large and right-of-way and access management needs are great. | Left-turn movements are rerouted to use a connector roadway (i.e., the quadrant). All left-turns at the main intersection are prohibited, allowing for two-phase signal operation at the main intersection. | Depending on the desired inbound and outbound sidewalks, some pedestrians are required to cross an extra street to make their desired movement compared to a conventional signalized intersection. The two-phase signal operation reduces the delay incurred by pedestrians at each crossing of the main intersection. | Similar to conventional intersection. Design techniques for direct left turns are available. | FHWA-HRT-09-058<br><br>AIIR | N/A | CAP-X (planning level)<br><br>SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microscopic software for oversaturated conditions.

[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

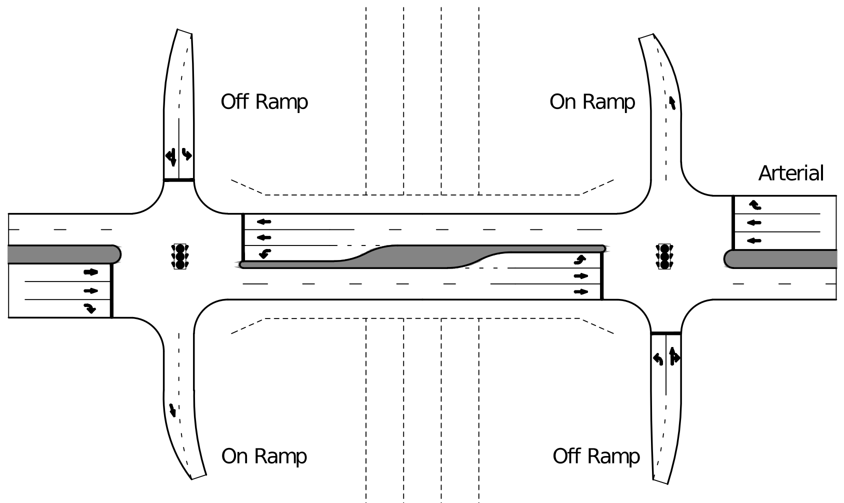
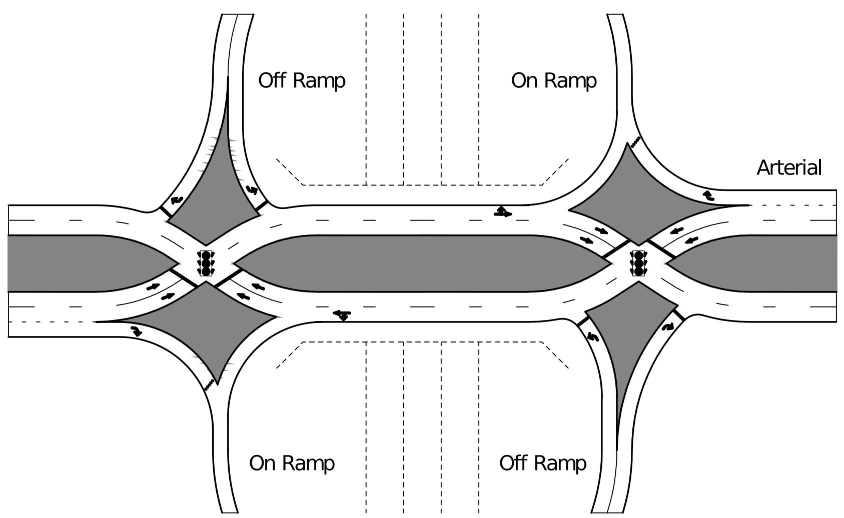
| Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Volume Thresholds | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|---|
| Intersection Name | Illustration | Description | Vehicles | Pedestrians | Bicycles | | | |
| Signalized Thru-Cut |  | An intersection design that restricts through movements from the minor streets as permitted in conventional intersections.<br><br>Advantages: Protected left turns from the side street (if signalized) without a four critical phase signal.<br><br>Disadvantages: Out-of-direction travel for minor street through movements, requires wide median or outside right-of-way at U-turn crossover | Through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way median opening 400 to 800 feet downstream of the intersection. | Pedestrian crossings of the major road at the Thru-Cut intersection are usually accommodated by direct paths across all four legs. Increased right turn volumes from the minor street may result in more vehicle-pedestrian conflicts and can be mitigated through prohibiting right turn on red. Consideration should be given to the signal timing configuration to mitigate conflicts between pedestrians and left turning vehicles. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Side street through and left turn movements can use pedestrian crossings to avoid use of U-turn movements Increased right turn volumes from the minor street may result in more vehicle-bicycle conflicts and can be mitigated through prohibiting right turn on red. | | | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |
| Unsignalized Thru-Cut |  | | Through movements from the minor street are required to turn right onto the main road and then make a U-turn maneuver at a one-way median opening 600 to 1,000 feet downstream of the intersection. | Unsignalized Thru-Cuts are usually located in rural areas and do not typically have pedestrian facilities. If there is pedestrian demand, accommodations should be provided. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Medians wide enough for bicycle storage boxes allow side street through and left turn movements to cross in two stages. | | | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microscopic software for oversaturated conditions.

[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

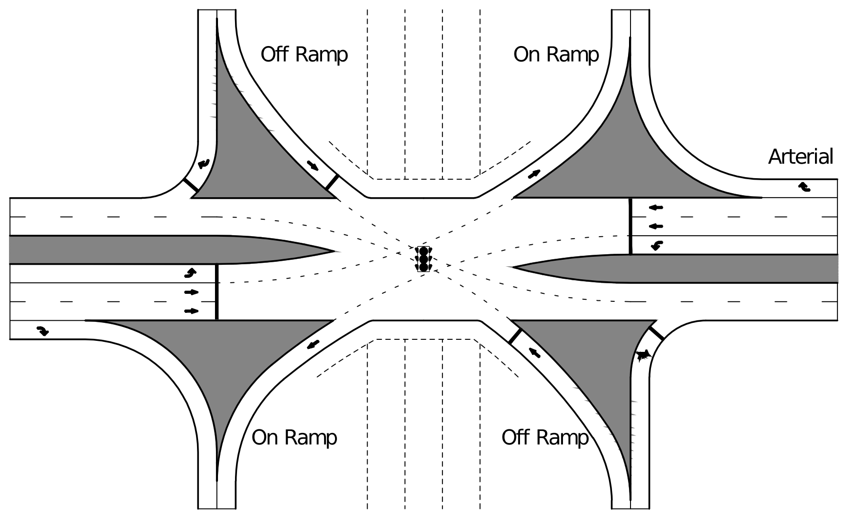
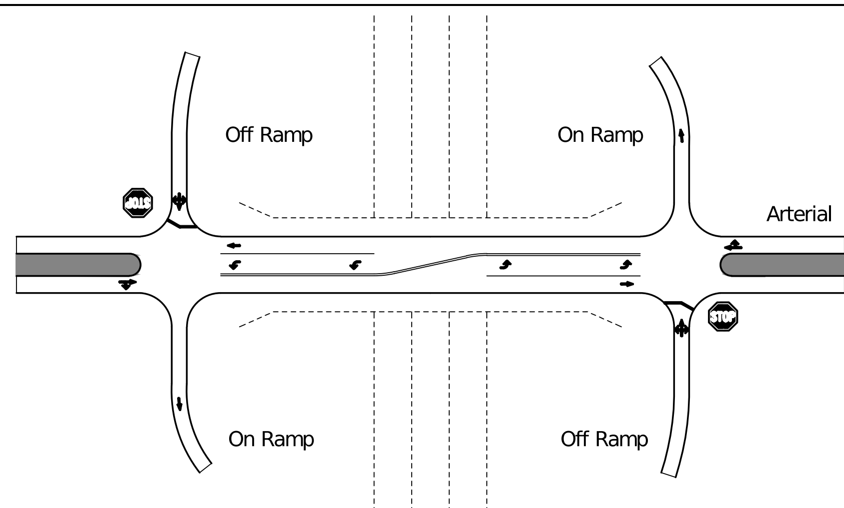
## TABLE A2. CONSIDERATIONS FOR RAMP TERMINAL INTERSECTIONS DESIGN AND OPERATIONS

| Ramp Terminal Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|
| **Ramp Terminal Intersection Name** | **Illustration** | **Description** | **Vehicles** | **Pedestrians** | **Bicycles** | | |
| Signalized Diamond |  | Conventional control type in which each approach is controlled by a traffic signal.<br><br>Advantages: Most common form of control for higher volume intersections, fully and established and understood by all users<br><br>Disadvantages: Increased delay at high volumes compared to alternative ramp terminal control | Vehicular movements on each approach are controlled through protected, permissive, or prohibited lights on the traffic signal. | Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized. Pedestrian crossings across the cross-street are typically provided on the outside of the ramp terminals. Crossings on the inside of ramp terminals will need additional signal consideration. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | Signalized Intersection Guide, $2^{nd}$ Edition | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |
| Diverging (or Double Crossover) Diamond |  | A diamond design in which cross-street through and left turning vehicles are routed onto the left side of the cross-street at the upstream signalized crossover.<br><br>Advantages: Left turns onto and off of the limited access road turn without crossing through vehicles on the cross-street. Can increase throughput without increasing bridge width.<br><br>Disadvantages: Redirection onto the left side of the roadway defies driver expectation. Additional right of way may be needed immediately upstream of crossover to allow for proper alignment through crossover. | Cross-street through vehicles and left turns from the limited access road return to the right side of the cross-street at the downstream signalized crossover. Right turning vehicles can be either free-flowing or signalized. | Pedestrian phases can be built into the signal timing to allow for protected pedestrian crossings into the median pedestrian walk and/or across the on- and off-ramps, depending on the location of the pedestrian facilities. Accessible pedestrian signals and pushbuttons can be utilized.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 9 for additional guidance on pedestrian treatments at DDIs. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Right side barriers provided for median pedestrian path may provide discomfort for bicyclists on roadway.<br><br>See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 9 for additional guidance on bicycle treatments at DDIs. | NCHRP Report 959<br><br>NCHRP Report 948 | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microscopic software for oversaturated conditions.

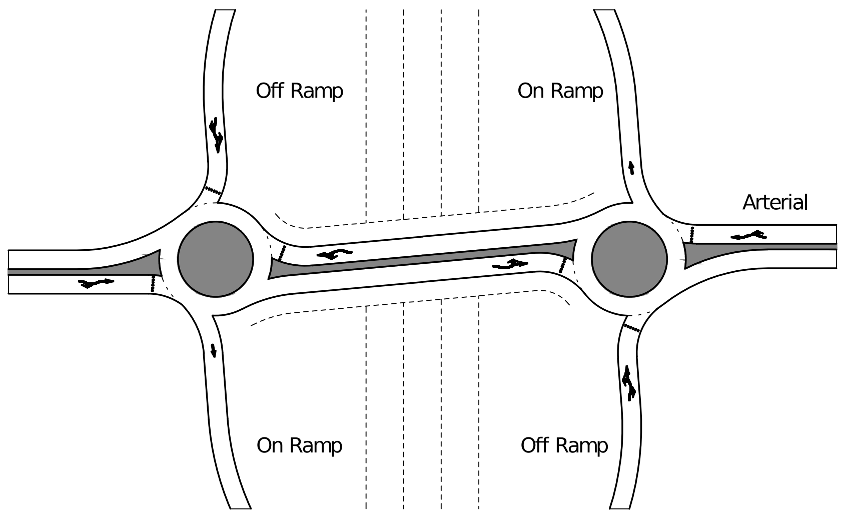
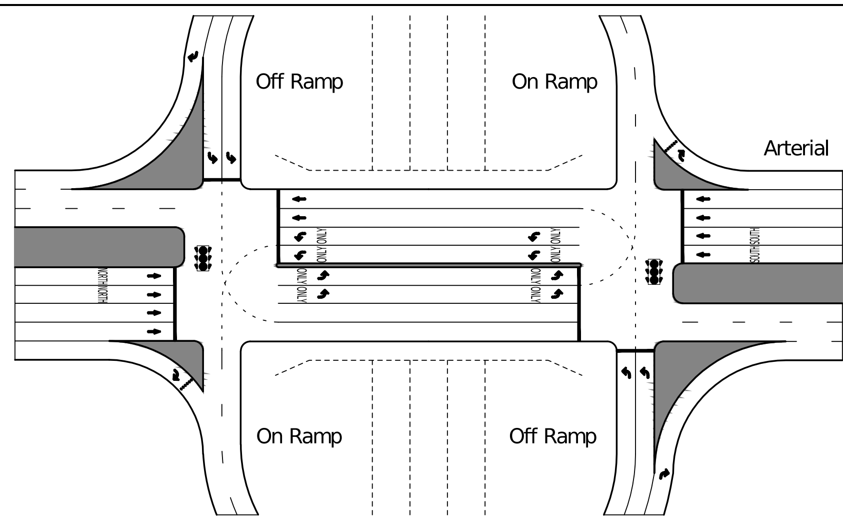
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

| Ramp Terminal Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|
| **Ramp Terminal Intersection Name** | **Illustration** | **Description** | **Vehicles** | **Pedestrians** | **Bicycles** | | |
| Single-Point Diamond |  | Advantages: All movements can be served using a single controller<br><br>Disadvantages: Require a wider bridge structure | Left- and through-movements on each approach are controlled through protected signal indications. Right- turn movements on the arterial approaches are free flow movements while movements from the limited access roadway are yield-controlled or served through permissive signal indications. | Pedestrians cross the ramp terminals with non-conflicting phases. Exclusive pedestrian phases are necessary if pedestrian crossings across the arterial are provided at the intersection. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | NCHRP Report 345 | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |
| Unsignalized Diamond |  | Conventional control type in which the minor street approaches are stop-controlled and major street movements do not encounter any traffic control devices.<br><br>Advantages: Simple and low-cost<br><br>Disadvantages: Cannot effectively serve higher volumes of traffic | Through- and right-turn movements on the arterial approaches are free-flow movements, while left-turn movements are yield-controlled. All minor street approaches are stop-controlled. | Pedestrians crossing the minor street approaches have right-of-way and are crossing at a stop-controlled location; however, the lack of signalization does not provide any protected pedestrian movement across the cross-street. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microscopic software for oversaturated conditions.

[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

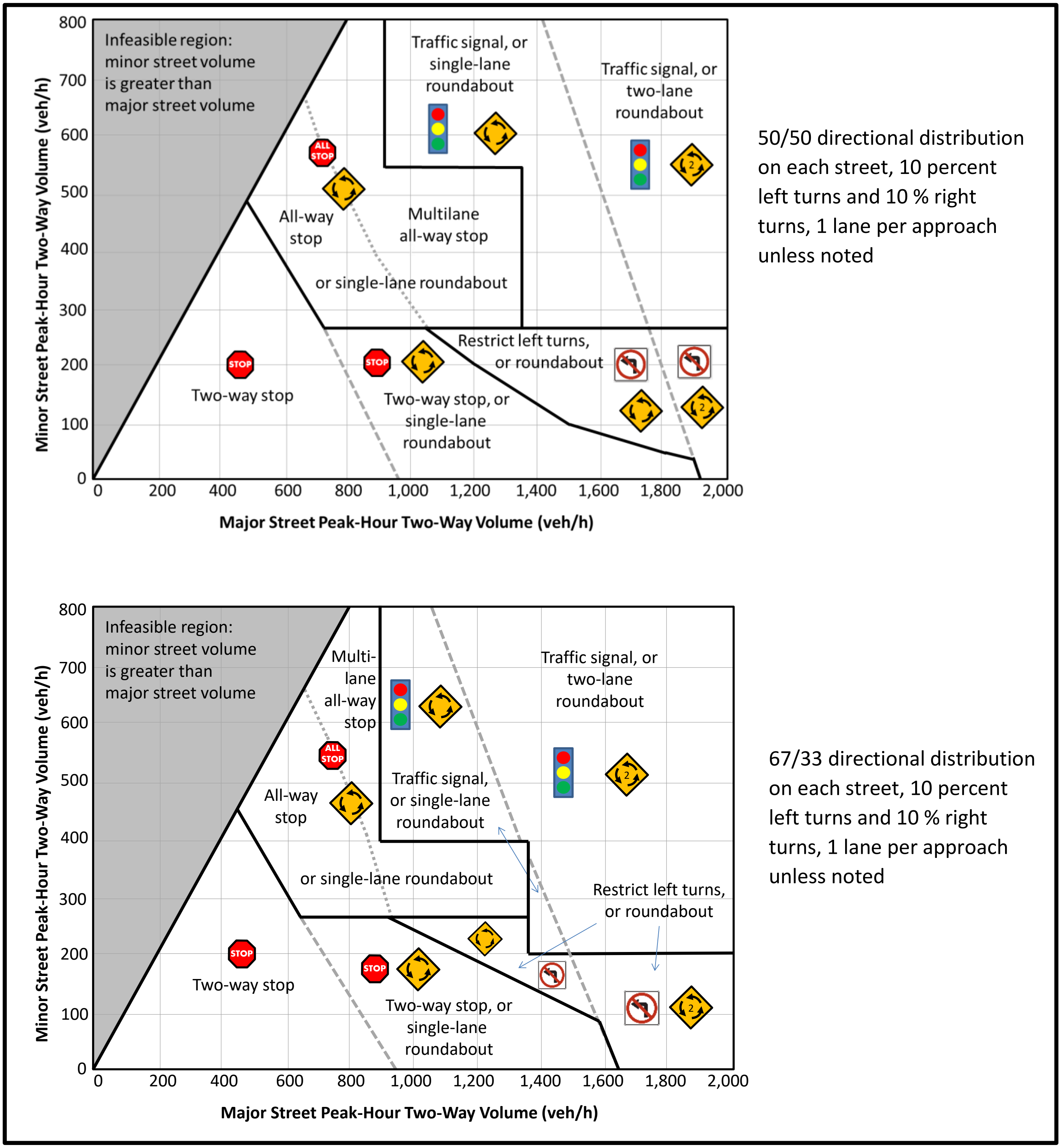
| Ramp Terminal Intersection Control Type | | | Mode Accommodations | | | Reference Material[1] | Recommended Stage 1 and 2 Analysis Tool(s)[2] |
|---|---|---|---|---|---|---|---|
| **Ramp Terminal Intersection Name** | **Illustration** | **Description** | **Vehicles** | **Pedestrians** | **Bicycles** | | |
| Roundabout |  | A subset of traffic circles that feature yield control of all entering vehicles, channelized approaches, and horizontal curvature and roadway elements to induce desirable vehicle speeds.<br><br>Advantages: Usually reduced crashes and delay compared to signalized control<br><br>Disadvantages: Usually higher cost and require more right-of-way than signalized control | Vehicles approaching the intersection must yield to vehicles circulating within the circulatory roadway. | Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length. | Bicyclists may ride in the roadway with vehicles or transition to multi-use paths via bicycle ramps (if present). Bike lanes should not be used at roundabouts | FDM 212.3 & NCHRP 672 | SIDRA with US HCM Model |
| Signalized Tight Diamond |  | A compressed diamond design featuring two closely spaced intersections, approximately 200-400 feet apart. Left turn lanes are developed in advance of the upstream intersection.<br><br>Advantages: Ability to manage long left turn queues onto the limited access roadway<br><br>Disadvantages: Require a wider bridge structure | Vehicular movements on each approach are controlled through protected, permissive, or prohibited lights on the traffic signal. Left turn storage for turns onto the limited-access road are developed in advance of the upstream intersection. | Pedestrian phases can be built into the signal timing to allow for permissive pedestrian crossings at the designated crosswalks. Accessible pedestrian signals and pushbuttons can be utilized. Pedestrian crossings across the cross-street are typically provided on the outside of the ramp terminals. Crossings on the inside of ramp terminals will need additional signal consideration. | Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. | Signalized Intersection Guide, 2nd Edition | CAP-X (planning level)<br><br>HCS, SYNCHRO, SimTraffic[3] |

[1] Refer to **Table 6** for a hyperlink to each reference document.

[2] Use VISSIM or similar microscopic software for oversaturated conditions.

[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis

## Figure A1: Intersection Control Type by Peak Hour Volume Thresholds[5]



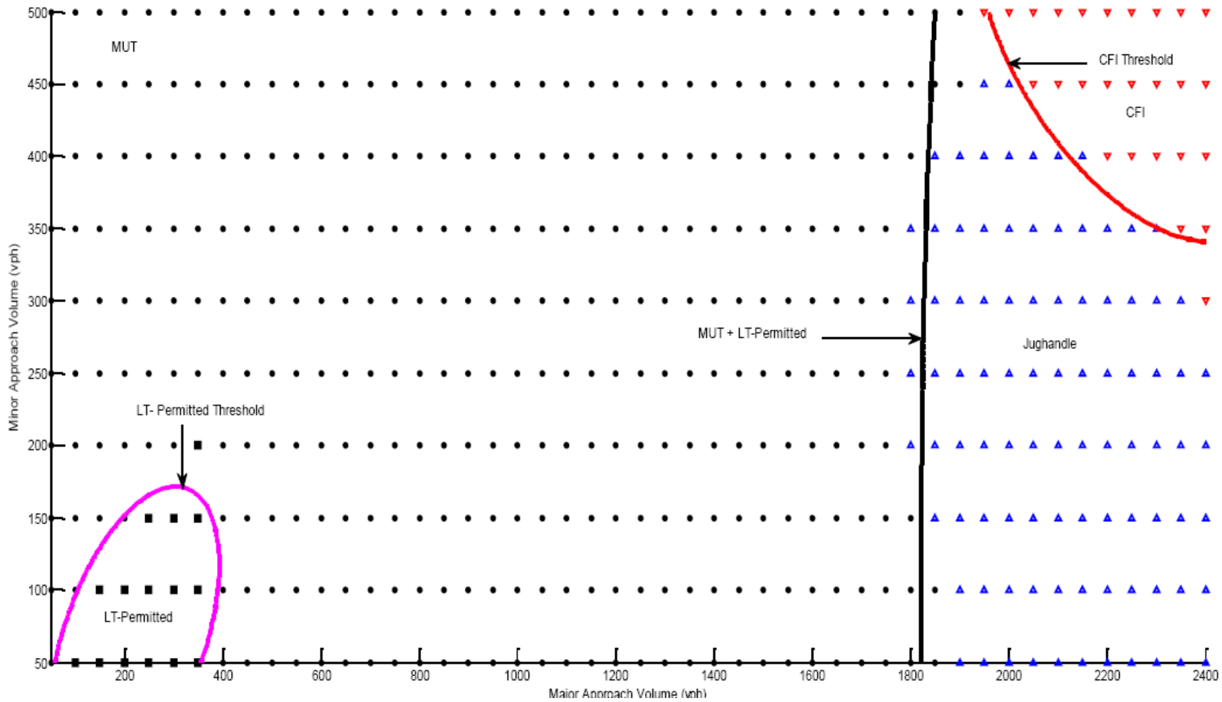

[5] NCHRP Report 825: Planning and Preliminary Engineering Applications Guide to Highway Capacity Manual. In Florida, roundabouts are discouraged if the major road volume exceeds 90% of the total entering volume per FDOT 2015 Intersection Design Guide.

## Table A3: Sum of Entering and Conflicting Volume Thresholds for Roundabouts[6]

| Volume Range (sum of entering and conflicting volumes) | Number of Lanes Required |
|---|---|
| 0 to 1,000 veh/h | ▪ Single-lane entry likely to be sufficient |
| 1,000 to 1,300 veh/h | ▪ Two-lane entry may be needed<br>▪ Single-lane may be sufficient based upon more detailed analysis. |
| 1,300 to 1,800 veh/h | ▪ Two-lane entry likely to be sufficient |
| Above 1,800 veh/h | ▪ More than two entering lanes may be required<br>▪ A more detailed capacity evaluation should be conducted to verify lane numbers and arrangements. |

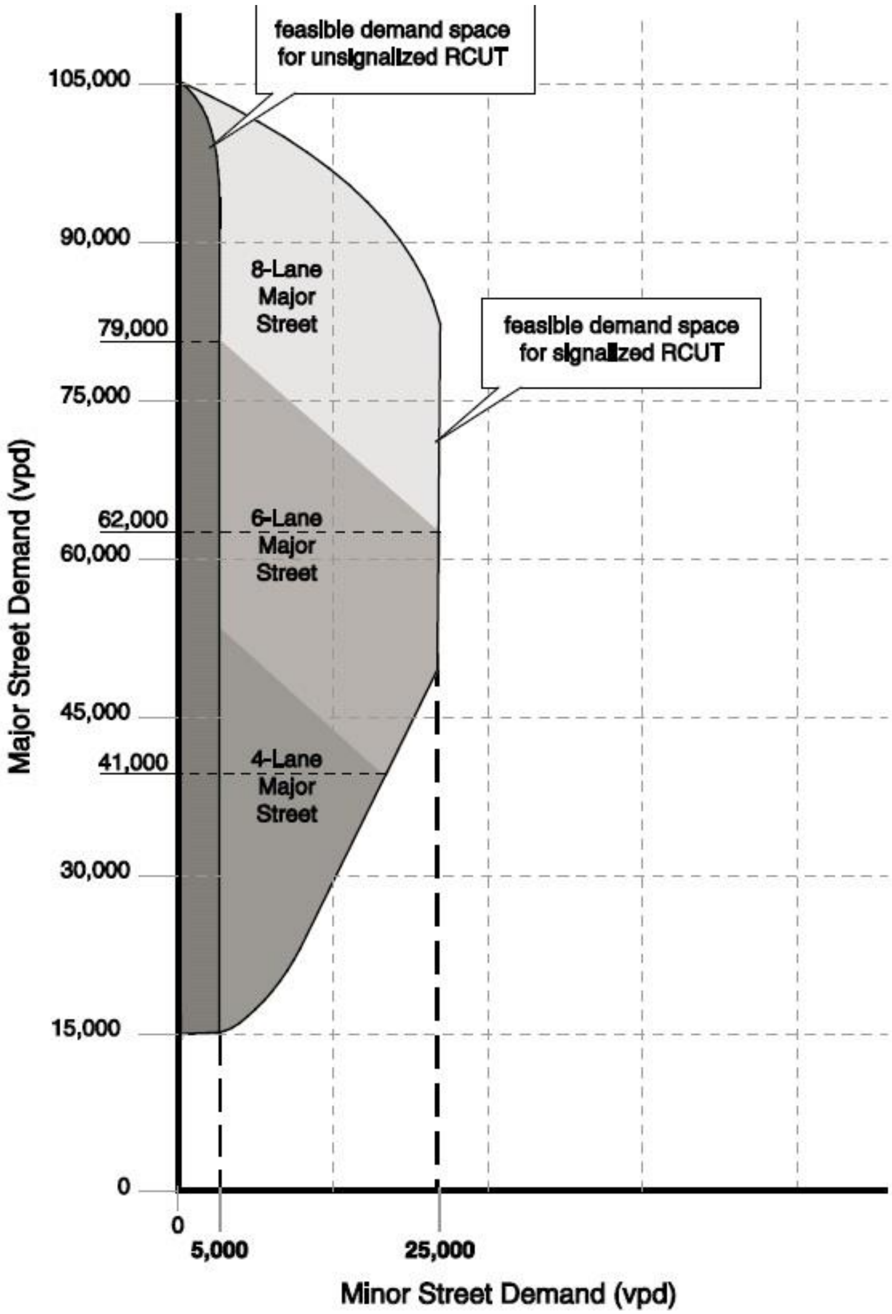
[6] NCHRP Report 672 Exhibit 3-14

## Figure A2: Decision Assistance Curves for Optimal Performance of Unconventional Intersections[7]




[7] Gyawali, Sunil, "A New Decision Making Approach for Indirect Left Turn Treatments by Utilizing Decision Assistance Curves" (2014). *Civil Engineering Theses, Dissertations, and Student Research*. Paper 73.

## Figure A3: Feasible Demand Space for Signalized RCUT[8]




[8] Restricted Crossing U-Turn Intersection Informational Guide, August 2014, FHWA.

# Appendix B
# FDOT ICE Forms

## Stage 1 ICE Form (At-Grade Intersection) – Page 1

**Florida Department of Transportation**
**Intersection Control Evaluation (ICE) Form**
**Stage 1: Screening**

Intersection Control Evaluation Form 750-010-003

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. Selections must be made in the "Intersection Type" and "Project Funding Source" cells below for the appropriate Stage 1 and Stage 2 forms to fully populate.

| | | | |
|---|---|---|---|
| Project Name | | FDOT Project # | |
| Submitted By | | Agency/Company | |
| Date | | | |
| Email | | FDOT District | |
| County | | | |
| Project Locality (*City/Town/Village*) | | | |
| Intersection Type | At-Grade Intersection | FDOT Context Classification | |
| Project Funding Source | Federal | Project Type | |
| Project Purpose (*What is the catalyst for this project and why is it being undertaken?*) | | | |
| Project Setting Description (*Describe the area surrounding the intersection*) | | | |
| 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*) | | | |

**Major Street Information**

| | | | | | |
|---|---|---|---|---|---|
| Route #: | | Route Name(s) | | Milepost | |
| Existing Control Type | | Existing AADT | | Design Year AADT | |
| Design Vehicle | | Control Vehicle | | | |
| Primary Functional Classification | | Design Speed (mph) | | | |
| Secondary Functional Classification (if app.) | | Target Speed (mph) [if app.] | | | |

| Approach | | | | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
|---|---|---|---|---|---|---|---|---|
| Approach #1 | Direction | | Number of Lanes | | | | | |
| | Sidewalks along | | Left-Turn | | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left | |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through | |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right | |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | | |
| Approach #2 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
| | Sidewalks along: | | Left-Turn | | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left | |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through | |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right | |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | | |

Page 1 of 4

## Stage 1 ICE Form (At-Grade Intersection) – Page 2

FDOT ICE: Stage 1

| Minor Street Information | | | | | | |
|---|---|---|---|---|---|---|
| Route #: | | Route Name(s) | | | Milepost (if app.) | |
| Existing Control Type | | | Existing AADT | | Design Year AADT | |
| Design Vehicle | | | Control Vehicle | | | |
| Primary Functional Classification | | | | | Design Speed (mph) | |
| Secondary Functional Classification (if app.) | | | | | Target Speed (mph) [if app.] | |

| Approach | Field | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
|---|---|---|---|---|---|---|---|---|
| Approach #1 | Direction | | | | | | | |
| | Sidewalks along: | | Left-Turn | | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left | |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through | |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right | |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | | |
| Approach #2 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
| | Sidewalks along: | | Left-Turn | | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left | |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through | |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right | |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | | |
| Approach #3 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes | |
| | Sidewalks along: | | Left-Turn | | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left | |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through | |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right | |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | | |

| Crash History (Existing Intersections Only) |
|---|
| Append the most recent five-years of crash data for the intersection from the CAR System. If the crash data evidences any issues relating to safety performance, discuss briefly here: |
| |

Page 2 of 4

## Stage 1 ICE Form (At-Grade Intersection) – Page 3

FDOT ICE: 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. | | | | | | | |
| | CAP-X Outputs | | | SPICE Outputs | | | Justification |
| | V/C Ratio | | | Crash | | | |
| Control Strategy | | | Multimodal Score | Prediction Rank | SSI Rank | Strategy to Be Advanced? | |
| 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 | | | | | | | |
| Thru-Cut | | | | | | | |
| Other 1 (Type) | | | | | | | |
| Other 2 (Type) | | | | | | | |

Page 3 of 4

# Stage 1 ICE Form (Ramp Terminal Intersection) – Page 1

## Florida Department of Transportation
## Intersection Control Evaluation (ICE) Form
## Stage 1: Screening

Intersection Control Evaluation Form 750-010-003

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. Selections must be made in the "Intersection Type" and "Project Funding Source" cells below for the appropriate Stage 1 and Stage 2 forms to fully populate.

| | | | | | |
|---|---|---|---|---|---|
| Project Name | | FDOT Project # | | | |
| Submitted By | | Agency/Company | | Date | |
| Email | | FDOT District | | County | |
| Project Locality (*City/Town/Village*) | | | | | |
| Intersection Type | Ramp Terminal Intersection | FDOT Context Classification | | | |
| Project Funding Source | Federal | Project Type | | | |
| Project Purpose (*What is the catalyst for this project and why is it being undertaken?*) | | | | | |
| Project Setting Description (*Describe the area surrounding the intersection*) | | | | | |
| 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*) | | | | | |

## Stage 1 ICE Form (Ramp Terminal Intersection) – Page 2

FDOT ICE: Stage 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Cross-Street Information** | | | | | | | |
| Route #: | | Route Name(s) | | | | Milepost | |
| Existing Ramp Control Type | | | Existing AADT | | | Design Year AADT | |
| Design Vehicle | | | Control Vehicle | | | | |
| Primary Functional Classification | | | | | | Design Speed (mph) | |
| Secondary Functional Classification (if app.) | | | | | | Target Speed (mph) [if app.] | |
| Approach #1 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes |
| | Sidewalks along | | Left-Turn | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | |
| Approach #2 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes |
| | Sidewalks along: | | Left-Turn | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | |
| Approach #3 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes |
| | Sidewalks along: | | Left-Turn | | | | |
| | Crosswalk on Approach? | | Left-Through | | | | |
| | On-Street Bike Facilities? | | Through | | Left | | Left |
| | Multi-Use Path? | | Left-Through-Right | | Through | | Through |
| | Scheduled Bus Service? | | Through-Right | | Right | | Right |
| | Bus Stop on Approach? | | Right-Turn | | Daily Truck % | | |
| **Exit Ramp Information** | | | | | | | |
| Route #: | | Route Name(s) | | | | Milepost (if app.) | |
| Existing Ramp Control Type | | | Existing AADT | | | Design Year AADT | |
| Design Vehicle | | | Control Vehicle | | | | |
| Primary Functional Classification | | | | | | Design Speed (mph) | |
| Secondary Functional Classification (if app.) | | | | | | Target Speed (mph) [if app.] | |
| Approach #1 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes |
| | Crosswalk on Approach? | | Left-Turn | | | | |
| | | | Left-Through | | | | |
| | | | Through | | Left | | Left |
| | | | Left-Through-Right | | Through | | Through |
| | | | Through-Right | | Right | | Right |
| | | | Right-Turn | | Daily Truck % | | |
| Approach #2 | Direction | | Number of Lanes | | Study Period #1 Traffic Volumes | | Study Period #2 Traffic Volumes |
| | Crosswalk on Approach? | | Left-Turn | | | | |
| | | | Left-Through | | | | |
| | | | Through | | Left | | Left |
| | | | Left-Through-Right | | Through | | Through |
| | | | Through-Right | | Right | | Right |
| | | | Right-Turn | | Daily Truck % | | |

Page 2 of 4

## Stage 1 ICE Form (Ramp Terminal Intersection) – Page 3

FDOT ICE: Stage 1

| Crash History (Existing Intersections Only) |
|---|
| Append the most recent five-years of crash data for the intersection from the CAR System. If the crash data evidences any issues relating to safety performance, discuss briefly here: |
| |

Ramp Terminal 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.

| Ramp Terminal Control Strategy | CAP-X Outputs | | | SPICE Outputs | | Strategy to Be Advanced? | Justification |
|---|---|---|---|---|---|---|---|
| | V/C Ratio | | Multimodal Score | Crash Prediction Rank | SSI Rank | | |
| Conventional Traffic Signal | | | | | | | |
| Conventional Traffic Signal (Alt) | | | | | | | |
| Crossover Traffic Signal (of DDI) | | | | | | | |
| Single-Point Diamond Traffic Signal | | | | | | | |
| Minor Road (Ramp) Stop | | | | | | | |
| 1-Lane Roundabout | | | | | | | |
| 2-Lane Roundabout | | | | | | | |
| Tight Diamond Interchange | | | | | | | |
| Other 1 (Type) | | | | | | | |
| Other 2 (Type) | | | | | | | |

# Stage 1 Form

## General information

The Stages 1, 2 and 3 forms are set up in Excel format to record project and analysis information for submittal. The yellow shaded cells contain pull down menus to aid the user. In some cases, information will auto populate from one stage to another. *In the Stage 1 Form the user needs to complete two cells to properly set up the form.* The first is "Intersection Type" which has two selections being "At-Grade Intersection" or "Ramp Terminal Intersection". This will set up the Stage 1 Form for the proper analysis condition. The other cell to set up the Stage 2 Form is the "Project Funding Source" which has two selections "Federal" and "Non-Federal". This sets up the Stage 2 Form for when B/C analysis is or is not conducted.

## Required Tools

Analysis tools required to complete this form include:

- FDOT-expanded version of FHWA's Capacity Analysis for Planning of Junctions (CAP-X) tool
- FDOT-expanded version of FHWA's Safety Performance of Intersection Control Evaluations (SPICE) tool.

## Project Information

- **Project Name:** Enter the project name associated with the project.
- **FDOT Context Classification:** Select the appropriate FDOT Context Classification that best describes the surrounding project area. A description of each Context Classification can be found in Table 200.4.1 of the 2018 FDOT Design Manual. A graphical representation of each can be found here: http://www.flcompletestreets.com/files/FDOT-context-classification.pdf.
- **FDOT Project #:** Enter the FDOT project number assigned to the project. For a project conducting ICE as part of a driveway connection permit, enter "N/A".
- **FDOT District:** Select the appropriate FDOT District in which the project takes place.
- **County:** Select the appropriate county in which the project takes place.
- **Project Locality (City/Town/Village):** Enter the specific city, town, or village in which the project takes place.
- **Intersection Type:** Select the appropriate intersection type from the two choices being "At-Grade Intersection" or "Ramp Terminal Intersection". This should match

the selection made on the SPICE spreadsheet Control Strategy tab. *This selection is important to set up the remainder of the Stage 1 Form.*

- **Project Funding Source:** Select whether this improvement is to be federally funded or non-federally funded. *This is important to set up the appropriate Stage 2 Form.*
- **Project Type:** Select the project type best describing the proposed project. If the project does not fit any of the project types listed, select "Other (Please type)" and type a more applicable description.
- **Project Purpose:** Describe the catalyst for the project and why it is being undertaken. (e.g., a private developer seeking a new access point for their proposed development)
- **Project Setting Description:** Describe the area surrounding the intersection. Be sure to include information pertaining to adjacent land uses, presence of potential constraints (e.g., environmental and right-of-way constraints), and any other pertinent information regarding the study area that may affect the application of some control strategies.
- **Multimodal Context:** Describe pedestrian, bicycle, and transit activity in the area and the potential for activity based on surrounding land uses and development pattern.

## Basic Intersection Information – At-Grade Intersection

- **Major Street:** Defined as the street normally carrying the higher volume of vehicular traffic.
    - **Major Street Route Number(s):** Enter the designated route number(s) for the major street. For streets with dual or overlapping route numbers, be sure to list both (e.g., "US 1/SR 708").
    - **Major Street Route Name:** Enter the common name of the major street (e.g., "Main Street").
    - **Milepost:** Enter the milepost of the intersection on the major street (e.g., 35.2). This information can be found in the appropriate FDOT Straight Line Diagram (SLD).
    - **AADT:** Enter the Annual Average Daily Traffic (AADT) volume carried on the major street. The latest AADT values can be found on FDOT's Florida Traffic Online viewer: http://flto.dot.state.fl.us/website/FloridaTrafficOnline/viewer.html
    - **Existing Control Type:** Select the existing control strategy employed at the intersection. If no intersection currently exists (i.e., the project is proposing a new intersection), select "None/New Intersection".

- **Design Vehicle:** Select the most appropriate design vehicle for the major street. The design vehicle is defined as the largest vehicle that is accommodated without encroachment on to curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.5 of the 2018 Florida Design Manual.
- **Control Vehicle:** Select the most appropriate control vehicle for the major street. The control vehicle is defined as an infrequent vehicle that is accommodated by encroachment into opposing lanes if no median is present and minor encroachment onto curbs and areas within the curb return (if no critical infrastructure present). For more information on control vehicles, see Section 201.5.1 of the 2018 Florida Design Manual.
- **Primary Functional Classification:** Select the functional classification of the major street approach legs. If the classification of the major street changes at the intersection, select the higher order functional classification. Space for secondary classifications is provided in the adjacent cell.
- **Secondary Functional Classification:** If the functional classification of the major street changes at the intersection, select the lower-order functional classification in this cell.
- **Design Speed:** Enter the design speed for the major street. The design speed is defined as the principal design control that regulates the selection of many project standards and design criteria. For more information on design speed, see Section 201.4 of the 2018 Florida Design Manual.
- **Target Speed:** Enter the target speed for the major street. The target speed is defined as the speed at which vehicles should operate in a specific land use context and consistent with the multimodal activity generated by adjacent land uses. For more information on target speed, see Section 9.4 of FDOT's Speed Zoning for Highways, Roads, and Streets in Florida (Topic No. 750-010-002).
- **Major Street Ownership:** Enter the appropriate agency or governing body who is responsible for the major street (e.g., FDOT).
- **Sidewalks are present along:** Select whether sidewalks are present along either or both sides of the major street.
- **Crosswalks:** Check this box if one or more crosswalks are present for pedestrians to cross the major street.
- **On-Street Bike Facilities?**: Check this box if on-street bike facilities (e.g., protected bike lanes) are present along the major street.

- **<u>Multi-Use Path?</u>**: Check this box if a multi-use path is present along one or more sides of the major street.
- **<u>Scheduled Bus Service?</u>**: Check this box if scheduled bus services operate along the major street and through the intersection. A bus stop does not need to be located at the intersection to check this box. Presence of a bus stop can be indicated in the adjacent cell.
- **<u>Bus Stop at Intersection?</u>**: Check this box if a bus stop serving a scheduled bus line is located within 1,000 feet of the center of the intersection.
- **<u>AM Peak Period</u>**: Defined at the hour with the highest volumes during the weekday a.m. peak period. A consistent a.m. peak hour should be used for both the major street and minor street.
  - **<u>Number of Lanes (Count Shared Lanes as Through)</u>**: Enter the number of left-turn, through, and right-turn lanes in the adjacent cells. If a shared lane is present (e.g., count the shared lane as a through lane. For example, if the approach includes a left-turn lane and a shared through-right lane, a '1' would be entered into the "left-turn" and "through" cells.
  - **<u>Peak Hour Traffic Volumes</u>**: Enter the turning movement volumes during the identified a.m. peak hour. Regardless of lane configuration, the number of vehicles making left-turns, through-movements, and right-turns should be separated into their respective cells (e.g., a shared through-right lane carrying 150 through movements and 50 right-turn movements during the a.m. peak hour would be entered as "150" in the "through" cell and "50" in the "right-turn" cell.)
- **<u>PM Peak Period</u>**: Defined at the hour with the highest volumes during the weekday p.m. peak period. A consistent p.m. peak hour should be used for both the major street and minor street.
  - **<u>Number of Lanes (Count Shared Lanes as Through)</u>**: Enter the number of left-turn, through, and right-turn lanes in the adjacent cells. If a shared lane is present (e.g., count the shared lane as a through lane. For example, if the approach includes a left-turn lane and a shared through-right lane, a '1' would be entered into the "left-turn" and "through" cells.
  - **<u>Peak Hour Traffic Volumes</u>**: Enter the turning movement volumes during the identified p.m. peak hour. Regardless of lane configuration, the number of vehicles making left-turns, through-movements, and right-turns should be separated into their respective cells (e.g., a shared through-right lane carrying 150 through movements and 50

right-turn movements during the p.m. peak hour would be entered as "150" in the "through" cell and "50" in the "right-turn" cell.)

- **Minor Street**: Defined as the street carrying the lower volume of vehicular traffic. If two minor streets are present (e.g., a five-leg intersection), the information for all minor street legs should be input under this same section.
  - **Minor Street Route Number(s):** Enter the designated route number(s) for the minor street. For streets with dual or overlapping route numbers, be sure to list both (e.g., "SR 200/SR 500").
  - **Minor Street Route Name:** Enter the common name of the minor street (e.g., "Main Street").
  - **Milepost (if applicable):** Enter the milepost of the intersection on the minor street (e.g., 35.2). If the minor street is a local road, a milepost will not be applicable.
  - **AADT:** Enter the Annual Average Daily Traffic (AADT) volume carried on the minor street. The latest AADT values can be found on FDOT's Florida Traffic Online viewer: http://flto.dot.state.fl.us/website/FloridaTrafficOnline/viewer.html
  - **Existing Control Type:** Select the existing control strategy employed at the intersection. If no intersection currently exists (i.e., the project is proposing a new intersection), select "None/New Intersection".
  - **Design Vehicle:** Select the most appropriate design vehicle for the minor street. The design vehicle is defined as the largest vehicle that is accommodated without encroachment on to curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.5 of the 2018 Florida Design Manual.
  - **Control Vehicle:** Select the most appropriate control vehicle for the minor street. The control vehicle is defined as an infrequent vehicle that is accommodated by encroachment into opposing lanes if no median is present and minor encroachment onto curbs and areas within the curb return (if no critical infrastructure present). For more information on control vehicles, see section 201.5.1 of the 2018 Florida Design Manual.
  - **Primary Functional Classification:** Select the functional classification of the minor street approach legs. If the classification of the minor street changes at the intersection, select the higher order functional classification. Space for secondary classifications is provided in the adjacent cell.

- **Secondary Functional Classification:** If the functional classification of the minor street changes at the intersection, select the lower-order functional classification in this cell.
- **Design Speed:** Enter the design speed for the minor street. The design speed is defined as the principal design control that regulates the selection of many project standards and design criteria. For more information on design speed, see Section 201.4 of the 2018 Florida Design Manual.
- **Target Speed:** Enter the target speed for the minor street. The target speed is defined as the speed at which vehicles should operate in a specific land use context and consistent with the multimodal activity generated by adjacent land uses. For more information on target speed, see Section 9.4 of FDOT's Speed Zoning for Highways, Roads, and Streets in Florida (Topic No. 750-010-002).
- **Minor Street Ownership:** Enter the appropriate agency or governing body who is responsible for the minor street (e.g., FDOT).
- **Sidewalks are present along:** Select whether sidewalks are present along either or both sides of the minor street.
- **Crosswalks:** Check this box if one or more crosswalks are present for pedestrians to cross the minor street.
- **On-Street Bike Facilities?**: Check this box if on-street bike facilities (e.g., protected bike lanes) are present along the minor street.
- **Multi-Use Path?**: Check this box if a multi-use path is present along one or more sides of the minor street.
- **Scheduled Bus Service?**: Check this box if scheduled bus services operate along the minor street and through the intersection. A bus stop does not need to be located at the intersection to check this box. Presence of a bus stop can be indicated in the adjacent cell.
- **Bus Stop at Intersection?**: Check this box if a bus stop serving a scheduled bus line is located within 1,000 feet of the center of the intersection.
- **AM Peak Period**: Defined at the hour with the highest volumes during the weekday a.m. peak period. A consistent a.m. peak hour should be used for both the major street and minor street.
  - **Number of Lanes (Count Shared Lanes as Through)**: Enter the number of left-turn, through, and right-turn lanes in the adjacent cells. If a shared lane is present (e.g., count the shared lane as a through lane. For example, if the approach includes a left-turn lane and a

shared through-right lane, a ‘1’ would be entered into the “left-turn” and “through” cells.

- **Peak Hour Traffic Volumes**: Enter the turning movement volumes during the identified a.m. peak hour. Regardless of lane configuration, the number of vehicles making left-turns, through-movements, and right-turns should be separated into their respective cells (e.g., a shared through-right lane carrying 150 through movements and 50 right-turn movements during the a.m. peak hour would be entered as “150” in the “through” cell and “50” in the “right-turn” cell.)

- **PM Peak Period**: Defined at the hour with the highest volumes during the weekday p.m. peak period. A consistent p.m. peak hour should be used for both the major street and minor street.
  - **Number of Lanes (Count Shared Lanes as Through)**: Enter the number of left-turn, through, and right-turn lanes in the adjacent cells. If a shared lane is present (e.g., count the shared lane as a through lane. For example, if the approach includes a left-turn lane and a shared through-right lane, a ‘1’ would be entered into the “left-turn” and “through” cells.
  - **Peak Hour Traffic Volumes**: Enter the turning movement volumes during the identified p.m. peak hour. Regardless of lane configuration, the number of vehicles making left-turns, through-movements, and right-turns should be separated into their respective cells (e.g., a shared through-right lane carrying 150 through movements and 50 right-turn movements during the p.m. peak hour would be entered as “150” in the “through” cell and “50” in the “right-turn” cell.)

## Basic Intersection Information – Ramp Terminal Intersection

This is very similar to the entry information for the At-Grade Intersection. This section will only discuss the differences.

- **Cross Street:** Defined as the street crossing through the interchange area and interchange with the limited access facility. The entries are the same as previously described in Major Street.
- **Ramp Information:** Defined as the exit ramps from the limited access facility to the cross street.
  - **Route Number(s):** Enter the designated route number(s) for the limited access roadway where the exit ramps originated. For roadways with dual or overlapping route numbers, be sure to list both (e.g., “SR 200/SR 500”).

- **Minor Street Route Name:** Enter the common name of the limited access roadway (e.g., "I-95").
- **Milepost:** Enter the milepost of the intersection on the limited access roadway (e.g., 35.2).
- **AADT:** Enter the Annual Average Daily Traffic (AADT) volume carried on the limited access roadway.
- **Primary Functional Classification:** Select the functional classification of the limited access roadway. If the classification of the limited access roadway changes at the interchange, select the higher order functional classification. Space for secondary classifications is provided in the adjacent cell.
- **Secondary Functional Classification:** If the functional classification of the limited access roadway changes at the interchange, select the lower-order functional classification in this cell.
- **Direction:** Select the direction of vehicular travel along the exit ramp.

## Crash History

*This section of the form is for existing intersections only.*

After reviewing the five most-recent years of crash data from the CARS System, summarize any trends or patterns in the crash history at the intersection. It is especially important to note the numbers of angle and left turn crashes at the existing intersection.

## Screening Evaluation

Apply the FDOT-expanded versions of the CAP-X and SPICE tools to determine the ranking of each control strategy based on its ability to provide adequate capacity and its anticipated safety performance, respectively. Based on these rankings and the qualitative factors analyzed in Stage 1, a determination should be made for each control strategy on whether or not it is to be advanced. Justification should be provided for each control strategy as to why it was advanced or not.

- **CAP-X Ranking:** Enter the V/C Ratio and Multimodal Score from the CAP-X analysis. The lower V/C Ratios indicate better vehicular operations. The higher Multimodal Scores indicate better multimodal conditions.
- **SPICE Outputs:** SPICE does safety analysis using two different methods. The first is the crash prediction method using HSM predictive methods. The second is the Safe System for Intersections (SSI) method providing a score for each control strategy. The Stage 1 Form shows the comparative ranking of each control strategy with a ranking of "1" considered best.

- **Crash Prediction Rank:** Enter the relative ranking of each control strategy based on the SPICE's crash prediction analysis. A ranking of "1" is considered to be the safest alternative.
- **SSI Rank:** Enter the relative ranking of each control strategy based on the SPICE's SSI analysis. A ranking of "1" is considered the safest alternative with respect to the SSI analysis.

- **Strategy to be Advanced?:** Select whether the control strategy is to be advanced to for further evaluation based on the analyses conducted in Stage 1. If only a single control strategy is proposed to be advanced (i.e., Stage 1 analysis illustrates a single, preferred control strategy) only a single "Yes" should be entered on the form.
- **Justification:** Provide brief justification as to why a control strategy was selected to be advanced or not. It is possible for a control strategy to have a high Crash Prediction Ranking and a low SSI Ranking. Please consult ***Appendix C*** for further information regarding the analysis differences. The project's purpose and need should be considered in determining if a control strategy should advance. For example, if the project type and project purpose are multimodal based, then SSI's nonmotorized score from SPICE's SSI Results tab should be considered in making this determination.

## Resolution

This section is to be filled out by the FDOT District Traffic Operations Engineer and FDOT District Design Engineer only.

## Stage 2 – ICE Form with Federal Funds

### Florida Department of Transportation
### Intersection Control Evaluation (ICE) Form
### Stage 2: Initial Control Strategy Assessment

Intersection Control Evaluation Form 750-010-003

To fulfill the requirements of Stage 2 (Intersection Control Strategy) 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 | |
| List all viable intersection control strategies identified in Stage 1 (Screening): | | | | | |
| | | | | | |
| | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | Control Vehicle | | | | | |
| Opening Year | | | | | | | | | |
| Control Strategy | Peak Hour | | | Peak Hour | | | Peak Hour | | |
| | LOS | Delay (sec.) | All Queues Accommodated? | LOS | Delay (sec.) | All Queues Accommodated? | LOS | Delay (sec.) | All Queues Accommodated? |
| | | | | | | | | | |
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| Design Year | | | | | | | | | |
| Control Strategy | Peak Hour | | | Peak Hour | | | Peak Hour | | |
| | LOS | Delay (sec.) | All Queues Accommodated? | LOS | Delay (sec.) | All Queues Accommodated? | LOS | Delay (sec.) | All Queues Accommodated? |
| | | | | | | | | | |
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| Provide any additional discussion necessary regarding the results of the operational analysis: | | | | | | | | | |

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## Stage 2 – ICE Form without Federal Funds

### Florida Department of Transportation
### Intersection Control Evaluation (ICE) Form
### Stage 2: Initial Control Strategy Assessment

Intersection Control Evaluation Form 750-010-003

To fulfill the requirements of Stage 2 (Intersection Control Strategy) 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 | |
| List all viable intersection control strategies identified in Stage 1 (Screening): | | | | | |
| | | | | | |
| | | | | | |

| | | | | |
|---|---|---|---|---|
| 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 | | Control Vehicle | | |
| Design Year | | | | |
| Control Strategy | Critical Peak Hour | | | |
| | LOS | Delay (sec.) | All Queues Accommodated? | |
| | | | | |
| | | | | |
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| | | | | |
| | | | | |
| Provide any additional discussion necessary regarding the results of the operational analysis: | | | | |

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## Stage 2 – ICE Form with or without Federal Funds (Page 2)

FDOT ICE: Stage 2

| Safety Performance | | | | | | | |
|---|---|---|---|---|---|---|---|
| Enter the most recent five (5) years of crash data from the CAR System. | | | | Most recent year of crash data available | | | |
| Crash Type | | | | | | | Total |
| Combined | Total | | | | | | |
| | Fatal/Injury | | | | | | |
| | PDO | | | | | | |
| Single-Vehicle | Total | | | | | | |
| | Fatal/Injury | | | | | | |
| | PDO | | | | | | |
| Multi-Vehicle | Total | | | | | | |
| | Fatal/Injury | | | | | | |
| | PDO | | | | | | |
| Vehicle-Pedestrian | Fatal/Injury | | | | | | |
| Vehicle-Bicycle | Fatal/Injury | | | | | | |
| Total | All | | | | | | |

Apply the FDOT SPICE Tool to model anticipated safety performance of each control strategy. For intersection types not accommodated in the tool, manually apply crash modification factors detailed in the ICE procedures document or qualitatively describe anticipated safety impacts.

| Control Strategy | Anticipated Impact on Safety Performance | Opening Year | | | Design Year | | |
|---|---|---|---|---|---|---|---|
| | | Predicted Total Crashes | Predicted Fatal+Injury Crashes | SSI Score | Predicted Total Crashes | Predicted Fatal+Injury Crashes | SSI Score |
| | | | | | | | |
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# Stage 2 Form

## Required Tools

Analysis tools required to complete this form include:

- FDOT-expanded version of FHWA's Safety Performance of Intersection Control Evaluations (SPICE) tool.
- FDOT's Intersection Control Evaluation (ICE) Tool

## Project Information

All fields in the "Project Information" section of the form will be auto-populated from information input to the Stage 1 form. No changes to this information are necessary, unless person responsible for submitting the form has changed between stages.

## Operational Analyses

- **Design Vehicle:** Select the most appropriate design vehicle for the major street. The design vehicle is defined as the largest vehicle that is accommodated without encroachment on to curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.5 of the 2018 Florida Design Manual.
- **Control Vehicle:** Select the most appropriate control vehicle for the major street. The control vehicle is defined as an infrequent vehicle that is accommodated by encroachment into opposing lanes if no median is present and minor encroachment onto curbs and areas within the curb return (if no critical infrastructure present). For more information on control vehicles, see Section 201.5.1 of the 2018 Florida Design Manual.
- **Existing Year:** Space is provided to enter the analysis results of two peak hours under existing conditions.
  - **Analysis Year:** Enter the current year for which the analysis is being conducted.
  - **Peak Hour Analyzed:** Enter the appropriate peak hour being analyzed (e.g., weekday a.m. peak hour, weekday p.m. peak hour). For a non-federally funded project, the existing year, peak hour analysis is not required.
  - **LOS:** Enter the overall intersection level-of-service or level-of-service for the critical approach (if overall intersection LOS not applicable) for each control strategy.

- **V/C:** Enter the overall intersection volume-to-capacity ratio or volume-to-capacity ratio for the critical approach (if overall intersection V/C not applicable) for each control strategy.
- **Delay:** Enter the overall intersection delay or delay for the critical approach (if overall intersection delay not applicable) for each control strategy.
- **All queues accommodated?:** Select "yes" or "no" to reflect whether the forecast 95$^{th}$ percentile queues for all approaches are accommodated by the storage provided by each control strategy. Be sure to account for queue spillback to adjacent intersections. If queues are not accommodated, it may be worthwhile to discuss queuing in the space provided at the end of the "Operational Analysis" section of the form.

- **Design Year:** Space is provided to enter the analysis results of two peak hours under design year conditions. For the appropriate design year, please refer to the FDOT ICE Manual Section 2.4.
  - **Analysis Year:** Enter the design year for which the analysis is being conducted.
  - **Peak Hour Analyzed:** Enter the appropriate peak hour being analyzed (e.g., weekday a.m. peak hour, weekday p.m. peak hour). For a non-federally funded project, only the design year, critical peak hour analysis is required.
  - **LOS:** Enter the overall intersection level-of-service or level-of-service for the critical approach (if overall intersection LOS not applicable) for each control strategy.
  - **V/C:** Enter the overall intersection volume-to-capacity ratio or volume-to-capacity ratio for the critical approach (if overall intersection V/C not applicable) for each control strategy.
  - **Delay:** Enter the overall intersection delay or delay for the critical approach (if overall intersection delay not applicable) for each control strategy.
  - **All queues accommodated?:** Select "yes" or "no" to reflect whether the forecast 95$^{th}$ percentile queues for all approaches are accommodated by the storage provided by each control strategy. Be sure to account for queue spillback to adjacent intersections. If queues are not accommodated, it may be worthwhile to discuss queuing in the space provided at the end of the "Operational Analysis" section of the form.
- **Provide any additional discussion necessary regarding the results of the operational analysis**: If any additional clarification is required regarding the existing and design year operations analyses, describe here. In particular, note if

additional operational metrics were evaluated that may help justify/refute the validity of a particular control strategy.

## Costs

- **ROW Cost ($):** Enter the estimated right-of-way costs required to implement each control strategy. This value is not required for a non-federally funded project.
- **Design & Construction Costs ($):** Enter the estimated design and construction costs required to implement each control strategy. This value is not required for a non-federally funded project.

## Safety Performance

- **Anticipated Impact on Safety Performance:** After applying the FDOT SPICE tool, describe the anticipated impact of each control strategy on crash frequency.
- **Predicted Total Crashes:** Enter the predicted number of total crashes (opening & design year) from the FDOT SPICE tool for each control strategy.
- **Predicted Fatal & Injury Crashes:** Enter the predicted number of fatal and injury crashes (opening & design year) from the FDOT SPICE tool for each control strategy.
- **Safe System for Intersection (SSI) Score:** Enter the overall intersection SSI score (opening & design year) from the FDOT SPICE tool for each control strategy.

## Benefit-Cost Ratios

- **Delay B/C:** After applying FDOT's ICE Tool, enter the delay B/C estimated for each control strategy. B/C analysis is not required for a non-federally funded project.
- **Safety B/C:** After applying FDOT's ICE Tool, enter the safety B/C estimated for each control strategy. B/C analysis is not required for a non-federally funded project.
- **Overall B/C:** After applying FDOT's ICE Tool, enter the overall B/C estimated for each control strategy. B/C analysis is not required for a non-federally funded project.

## Multimodal Accommodations

- **# of pedestrian crossings (both approaches, if app):** Enter the number of pedestrian crossings during the typical a.m. and p.m. peak hours for the intersection. If crosswalks/crossings are present on both approaches of the major or minor streets, combine the number of crossings from both approaches into a single number of crossings per street.
- **# of bicycle crossings (both approaches, if app):** Enter the number of bicycle crossings during the typical peak hour for the intersection. If crosswalks/crossings

are present on both approaches of the major or minor streets, combine the number of crossings from both approaches into a single number of crossings per street.

- **Level of pedestrian activity:** Select the appropriate level of pedestrian activity identified in the FDOT CAP-X Tool:

| Level of Pedestrian Activity | Threshold (pedestrians/day) | Associated Context Classification Zones |
|---|---|---|
| Low | < 240 | Natural, Rural |
| Medium | 240 ≤ x < 3,200 | Rural Town, Suburban, Residential/Commercial |
| High | ≥ 3,200 | Urban Center, Urban Core |

- **Level of bicycle activity:** Select the appropriate level of bicycle activity identified in the FDOT CAP-X Tool:

| Level of Bicycle Activity | Threshold (bicycles/day) | Associated Context Classification Zones |
|---|---|---|
| Low | < 240 | Natural, Rural |
| Medium | 240 ≤ x < 3,200 | Rural Town, Suburban, Residential/Commercial |
| High | ≥ 3,200 | Urban Center, Urban Core |

## Environmental, Utility, and Right-of-Way Impacts

Summarize any impacts of the proposed control strategy to the surrounding environment or adjacent properties. These need to focus on social, natural, or physical environment impacts which may preclude the advancement of a particular alternative control strategy. It should also contain considerations for acquiring right-of-way due to costs or environmental impacts. This is also the location to document impacts to major utilities which may be impacted by implementing a control strategy.

## Public Input/Feedback

Summarize the feedback received from relevant agencies and the public during outreach efforts, even if that feedback does not present a preferred alternative.

## Control Strategy Evaluation

- **Strategy to be Advanced?:** Select whether the control strategy is to be advanced to for further evaluation based on the analyses conducted in Stage 1 and Stage 2. If only a single control strategy is proposed to be advanced (i.e., Stage 2 analysis illustrates a single, preferred control strategy) only a single “Yes” should be entered on the form.
- **Justification:** Provide brief justification as to why a control strategy was selected to be advanced or not.

## Resolution

This section is to be filled out by the FDOT District Traffic Operations Engineer and FDOT District Design Engineer only.

**Stage 3 ICE Form – Page 1**

## Florida Department of Transportation
## Intersection Control Evaluation (ICE) Form
## Stage 3: Detailed Control Strategy Assessment

Intersection Control Evaluation Form 750-010-003

To fulfill the requirements of Stage 3 (Detailed Control Strategy Assessment) of FDOT's ICE procedures, complete the following form and append all supporting documentation, which may include detailed design plans of each control strategy analyzed. 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 | |

List all viable intersection control strategies identified in Stage 2 (Initial Control Strategy Assessment):

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| Additional Analysis | |
|---|---|
| What issues and/or findings to date have led to a control strategy NOT being selected in Stage 2? | |
| Category | Description of Issues/Findings |
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| Describe specific evaluation activities undertaken in Stage 3 analysis to identify a preferred control strategy and discuss the findings: | |
| Category | Description of Issues/Findings |
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# Stage 3 Form

## Required Tools

No specific tools are required to complete this analysis.

## Project Information

All fields in the "Project Information" section of the form will be auto-populated from information input to the Stage 1 and Stage 2 forms. No changes to this information are necessary, unless person responsible for submitting the form has changed between stages.

## Additional Analysis

- **Category:** Select the analysis area where additional analysis was conducted. This should be an analysis area needing further investigation to help differentiate the remaining control strategies.
- **Description of Issues/Findings:** Describe the issues/previous findings from Stage 1 and Stage 2 related to the analysis category. Be sure to discuss why this category is being investigated further (e.g., preliminary operational analyses did not identify a preferred control strategy, so more rigorous evaluation methodologies are being employed).
- **Description of Additional (Stage 3) Analysis:** Describe the additional analyses undertaken in Stage 3 for each of the categories. Be sure to describe assumptions, methodologies and software used, results of the analyses, and any other pertinent information.

## Public Input/Feedback

If public input/feedback was not discussed under "Additional Analysis" section, describe the additional outreach efforts made during Stage 3 analysis.

## Control Strategy Evaluation

- **Strategy to be Advanced?:** Select whether the control strategy is to be advanced to for further evaluation based on the analyses conducted in Stages 1, 2, and 3. Only a single control strategy should be advanced.
- **Justification:** Provide brief justification as to why a control strategy was selected or not.

# Appendix C
# Analysis Considerations

# Safe System Performance and SSI Analysis

The SSI method provides a technical basis by which intersection planners and designers can apply Safe System-based principles, such as kinetic energy management and simplified decision-making for different road users, to common intersection projects. The method incorporates concepts of conflict point identification and classification, exposure, kinetic energy transfer, conflict point severity, and intersection movement complexity. Application of the SSI method results in multiple measures of effectiveness (MOEs) and a set of SSI scores that characterize the extent to which an intersection alternative in a given context aligns with the principles a Safe System-based approach.

FDOT has expanded the FDOT version of SPICE to include FHWA's SSI method as a complement to the crash prediction methods based on SPFs and CMFs that were already in FDOT's SPICE tool. According to the FHWA report that documents the SSI method, *A Safe System-Based Framework and Analytical Methodology for Assessing Intersections*, the SSI MOEs and SSI scores can complement crash-based metrics that come from predictive approaches like those in the *Highway Safety Manual* (HSM) by:

- Being sensitive to speed and cross section characteristics. Current intersection crash predictive methods are generally insensitive to intersection characteristics that are key to Safe System principles and will influence SSI results, such as the number of lanes carrying conflicting traffic, turning volumes, nonmotorized user volumes, and speeds.
- Focusing on fatalities and serious injuries defined on the maximum abbreviated injury scale (MAIS) and the key contributors that lead to these injuries (e.g., speeds, collision angles). Crash-based predictive methods are based on data from crash reports. Relationships between injuries reported as suspected serious injuries (A) on crash reports and serious injuries as defined by medical professionals on the MAIS scale may vary from location to location depending on crash reporting practices. Crash costs in the USDOT's Benefit-Cost Analysis Guidance for Discretionary Grant Programs suggest that, on average, only a percentage of reported crashes coded as suspected serious injuries (A) on crash reports are serious injuries as defined by medical professionals on the MAIS scale.
- Providing a metric for the safety of nonmotorized users while robust crash-based metrics are still in development. The SSI metrics for nonmotorized conflict points are sensitive to several intersection characteristics, including the number of lanes crossed by nonmotorized users making different movements, presence of refuge areas (e.g., medians, refuge islands) the speed of conflicting traffic, type of traffic control, indirect nonmotorized paths through an intersection, and the presence of nonintuitive vehicle movements. Crash-based predictive methods for crashes involving nonmotorized users are still limited in their capabilities and generally insensitive to these types of intersection characteristics.

- Communicating tradeoffs between vehicle-vehicle conflict point SSI metrics and scores and vehicle-nonmotorized conflict point SSI metrics and scores across different intersection alternatives. The SSI method communicates these tradeoffs by reporting SSI metrics and an SSI score for each conflict point type (i.e., crossing, merging, diverging, nonmotorized), in addition to an SSI score for the intersection as a whole.

The SSI MOEs and SSI scores can also provide metrics that consider safety in the absence of an HSM analysis. This may be valuable in cases where it is not possible to conduct crash prediction-based analyses on one or more alternatives, such as for atypical or emerging intersection concepts that are not-addressed by crash prediction-based methods.

The Safe System concepts of kinetic energy transfer and management are grounded in science and represent a mechanistic approach to predicting crash injury outcomes. In order to explore the relationship of this SSI method to crash-based studies and models, developers of the SSI method qualitatively compared the results of the SSI analysis to results of crash-based predictive methods, particularly crash-based results applicable to fatal and injury (i.e., F&I or KABC) crashes. Given the current focus of the SSI method on a Stage 1 ICE application, the qualitative “litmus-test” comparisons highlighted general similarities and differences in the relative positions of intersection alternatives compared to an existing or future no-build condition. Differences are most likely due to the sensitivities to intersection characteristics that are present in the SSI method that are currently not captured by predictive methods (e.g., speeds, the number of lanes carrying conflicting traffic, turning volumes). Chapter 4 of the FHWA report that documents the SSI method includes such comparisons for three example project scenarios. Of particular note is the impact of the exclusive pedestrian phase for the signalized thru-cut. When pedestrian volumes are exceedingly high, the thru-cut may show a better score than the RCUT, despite the increased crossing conflicts present in the thru-cut.

***Table C1*** and ***Table C2*** present the assumptions in the SSI method calculations for each at-grade and ramp terminal intersection type. These are the default assumptions made in the FDOT SPICE tool for each intersection alternative. There are several overarching assumptions that apply across multiple alternatives:

- The calculations assume that intersection approaches have medians, channelizing islands, and/or nonmotorized refuge points only when those features are inherent to the design of the intersection alternative.
- The calculations do not consider U-turn movements unless they are an inherent part of the intersection design (such as in an RCUT or MUT intersection).
- The calculations do not consider exit ramp-to-entrance ramp through movements at ramp terminal intersections.

## TABLE C1. ASSUMPTIONS FOR SSI CALCULATIONS BY INTERSECTION TYPE

| At-Grade Intersection Name | SSI Considerations |
|---|---|
| Two-way stop-control | • No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands. |
| All-way stop-control | • No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands. |
| Signalized Control | • No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands. |
| Roundabout | • Three roundabout entry geometries considered: 1x1 Roundabout (1 lane in each direction on all approaches), 2x1 Roundabout (2 lanes in each direction on major road, which yield to one circulating lane; 1 lane in each direction on minor road, which yield to two circulating lanes), and 2x2 Roundabout (2 lanes in each direction on all approaches, yielding to two circulating lanes).<br>• All approaches have splitter islands/pedestrian refuge islands.<br>• All approaches operate under yield control.<br>• Indirect Paths adjustment applied to all nonmotorized movements due to footprint and placement of crosswalks. |
| Median U-Turn (MUT) | • All approaches have medians/pedestrian refuge islands.<br>• All direct left turns are removed from intersection.<br>• U-turn movements operate under traffic signal control. |
| Signalized Restricted Crossing U-Turn (RCUT), or Superstreet | • All approaches have medians/pedestrian refuge islands.<br>• Z-type pedestrian crossing pattern is utilized, Indirect Paths adjustment applied to nonmotorized road users crossing major road.<br>• U-turn movements operate under traffic signal control. |
| Unsignalized Restricted Crossing U-Turn (RCUT), or J-Turn | • All approaches have medians/pedestrian refuge islands.<br>• Z-type pedestrian crossing pattern is utilized, Indirect Paths adjustment applied to nonmotorized road users crossing major road.<br>• U-turn movements operate under stop control. |
| Jughandle | • Though other configurations are possible, the most common type, the forward jughandle, is assumed.<br>• No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands. |
| Displaced Left-Turn | • Two DLT alternatives considered: partial DLT (displaced left turns on major street approaches only) and full DLT (displaced left turns on all four approaches).<br>• All approaches have medians/pedestrian refuge islands and right turns are all channelized.<br>• Indirect Paths adjustment applied to all nonmotorized conflict points (due to channelized right turns); Non-Intuitive Motor Vehicle Movements adjustment applied to nonmotorized conflict points along nonmotorized movements that cross approaches with displaced left turns (i.e., all nonmotorized conflict points for full DLT. |
| Continuous Green Tee | • Nonmotorized movements crossing the continuous through movement on the major road are protected through user actuated signal control.<br>• Major road approach without continuous movement has median that provides nonmotorized user refuge. |
| Quadrant Roadway | • Though it is possible for other configurations, such as having quadrant roadways in two quadrants or having roundabouts serve as the secondary intersections, a single quadrant roadway with signalized T-intersections is assumed.<br>• No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands. |
| Signalized Thru-Cut | • All approaches have medians/pedestrian refuge islands.<br>• All pedestrian movements operate simultaneously during an exclusive pedestrian phase.<br>• Left turns from the minor road operate under permitted phasing. |

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| | • U-turn movements operate under traffic signal control. |
| Unsignalized Thru-Cut | • All approaches have medians/pedestrian refuge islands.<br>• Stop control on minor road approaches.<br>• U-turn movements operate under stop control. |

## TABLE C2. ASSUMPTIONS FOR SSI CALCULATIONS BY RAMP TERMINAL INTERSECTION TYPE

| Ramp Terminal Intersection Name | SSI Considerations |
|---|---|
| Signalized Diamond | • No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands.<br>• Nonmotorized user paths across the cross-street are located outside the ramp legs. |
| Diverging (or Double Crossover) Diamond | • Nonmotorized users travel using the centerline median island.<br>• Indirect Paths adjustment applied to all nonmotorized conflict points; Non-Intuitive Motor Vehicle Movements adjustment applied to all nonmotorized conflict points.<br>• All signal-controlled movements are protected. |
| Single Point Diamond | • Nonmotorized user paths across the cross-street are located just outside the single point intersection.<br>• The on- and off-ramp pedestrian crossings feature refuge islands.<br>• Indirect Paths adjustment applied to nonmotorized movements crossing the cross-street. |
| Unsignalized Diamond | • No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands.<br>• Nonmotorized user paths across the cross-street are located outside the ramp legs. |
| Roundabout | • Three roundabout entry geometries considered: 1x1 Roundabout (1 lane in each direction on all approaches), 2x1 Roundabout (2 lanes in each direction on major road, which yield to one circulating lane; 1 lane in each direction on minor road, which yield to two circulating lanes), and 2x2 Roundabout (2 lanes in each direction on all approaches, yielding to two circulating lanes).<br>• Cross-street approaches have splitter islands/pedestrian refuge islands.<br>• All approaches operate under yield control.<br>• Indirect Paths adjustment applied to all nonmotorized movements due to footprint and placement of crosswalks. |
| Signalized Tight Diamond | • No median, or median, if present, is inadequate to store vehicle for two-stage crossing.<br>• No approaches have pedestrian refuge islands.<br>• Left turns onto ramps operate under protected signal phasing. |

# Control Strategy Evaluation Consideration

The following sections highlight areas of consideration when evaluating control strategies:

## Context Classification

ICE evaluations consider the FDOT context classification of the project intersection. The Context Classification of the roadway is determined by FDOT. The selected control type should serve the transportation needs of all of the transportation system users of all ages and abilities, including pedestrians, bicyclists, transit riders, motorists, and freight handlers. Refer to the FDOT's *Florida Design Manual (FDM)* for more information on context classifications.

## Design User

Design users are those anticipated users of a roadway (including drivers, pedestrians, bicyclists, transit, and freight handlers) forming the basis of each roadway's design. Roadway users' varying skills and characteristics introduce a variety of human factors that can influence users' driving, walking, and bicycling capabilities. Design users and the design vehicle should be taken into consideration when determining design details such as sidewalk widths, type of bicycle facility, design speed, signal timing and spacing, location of pedestrian crossings, location of transit stops, number of vehicular travel lanes, intersection width, required turning radii based on design vehicle, and lighting. Refer to FDOT's FDM for more information on design users.

## Target Speed

FDM Section 202.2.1 – Target Speed says target speed is the highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multi-modal activity generated by adjacent land uses, to provide mobility and safety for all users. It is the speed at which vehicles should operate. Target speed is influenced by elements of roadway design that are governed by design speed, as well as the form and function of the adjacent uses beyond the right of way. The concept of target speed utilizes design strategies and elements to reinforce operating speeds consistent with the posted or proposed speed limit.

For lower-speed roadways, those with design speed 45 mph or less, it is desirable for the posted speed, the operating speed, and the design speed to be identical.

Refer to the FDOT *Speed Zoning Manual*, FDM, and the upcoming revisions to the FDOT *Traffic Engineering Manual* for more information on target speed, design speed, and other design controls based on context classification.

## Crash Prediction and Evaluation

Safety for all modes is a top priority for FDOT. Stage 1 contains a qualitative assessment for pedestrians, bicyclist, and transit in the CAP-X tool. Stage 2 evaluations include Highway Safety Manual (HSM) analysis. The HSM provides crash prediction for conventional signalized and stop-controlled intersections using safety performance functions (SPFs). Evaluations for alternative intersections which do not have SPFs should use the Crash Modification Factors (CMFs) listed in ***Table C3***. These CMFs are included in FDOT’s Safety Performance for Intersection Control Evaluation (SPICE) tool. The FDOT SPICE Tool is a modified version of the FHWA version.

The FDOT SPICE Tool contains the following

- NCHRP Project 17-70 has developed SPFs for roundabouts which have been incorporated into the FDOT ICE analysis.
- FDOT has developed SPFs for signalized and unsignalized RCUTs and these are included in SPICE.
- NCHRP 17-58 SPFs for intersections on 6 and 8 lane roadways and one-way streets.
- NCHRP 17-68 SPFs for conditions not in the original HSM such as 55+ mph major street approach speeds for urban and suburban arterials, 3 leg signalized intersections and some ramp terminal intersections.

The SPICE Tool also contains crash prediction capability for some ramp terminal intersections. These include diamond (signalized and unsignalized), tight diamond, crossover or displaced diamond (DDI), single-point diamond and roundabout ramp terminal intersections. This SPICE analysis is only for the actual ramp terminal intersection and does not contain any crash prediction for the freeway mainline or ramps. This analysis needs to be done separately following HSM Chapters 18 and 19 or using the ISATe spreadsheet.

**TABLE C3. ALTERNATIVE INTERSECTION CRASH MODIFICATION FACTORS**

| Intersection Type | CMF for Total Crashes | CMF for Fatal-Injury Crashes | Apply CMF to: | Data Source |
|---|---|---|---|---|
| Displaced Left Turn | 0.88 | - | Crash Prediction for a Conventional Signalized Intersection | Development of Performance Matrices for Innovative Intersections and Interchanges (UDOT) |
| Median U-Turn | 0.85 | 0.70 | Crash Prediction for a Conventional Signalized Intersection | NCHRP Report 420 |
| Continuous Green T | 0.96 | 0.85 | Crash Prediction for a Conventional Signalized Intersection | FHWA Safety Evaluation of Continuous Intersections (2016) |
| Jughandle | - | 0.74 | Crash Prediction for a Conventional Signalized Intersection | FHWA Traffic Performance of Three Typical Designs of New Jersey Jughandle Intersections |
| Diverging Diamond Interchange Ramp Terminal Intersection | 0.67 | 0.59 | Crash Prediction for a Signalized Ramp Terminal Intersection | FHWA Field Evaluation of Diverging Diamond Interchanges (2015) |

## Agency Coordination and Public Input

Evaluations should assess driver expectations, agency coordination, and public input for each viable control strategy. When determining the acceptability of a control strategy, evaluators should typically consult the local jurisdictions, other important stakeholders, and potentially the general public. The evaluation should eliminate control strategies from further consideration if a result is negative, especially if cost participation is required. The project manager in consultation with local stakeholders and FDOT functional units should determine the degree of public involvement in the control strategies' discussion. The evaluators should make stakeholders aware of the technical merits and potential issues of each control strategy.

## Unconventional Intersection Geometry Evaluation

Conventional forms of traffic control are often less efficient at intersections with a difficult skew angle, significant offset, odd number of approaches, or close spacing to other intersections. Roundabouts may better suit such intersections because they do not require complicated signing or signal phasing. Roundabouts' ability to accommodate high turning volumes makes them especially effective at "Y" or "T" junctions. The use of roundabouts may also eliminate a pair of closely spaced intersections by combining them to form a multi-legged roundabout. Intersection sight distance for roundabouts is significantly less demanding than for other conventional intersection treatments.

## Adjacent Intersections and Coordinated Signal Systems

The spacing of intersections along a highway corridor should be consistent with the spacing of primary full-movement intersections as shown in the FDOT Access Management Policy (Rule 14-97). District Traffic Operations Engineer may allow intersection spacing exceptions for roundabouts based on justifiable merits on a case-by-case basis. Positioning a roundabout within a coordinated signal system or very near to an adjacent signal is not preferred, however, under some circumstances it may be an acceptable option. A comprehensive traffic analysis is needed to determine if it is appropriate to locate a roundabout within a coordinated signal network.

## System Consistency

On Strategic Intermodal System (SIS) facilities or other highways where a corridor study was previously prepared, any ICE should address the impact on the SIS performance or compare control strategies to those recommended in the corridor study.

## Pedestrian and/or Bicycle Issues

Accommodating non-motorized users is a priority. Depending on the volume of users and the sensitivity of the location, one control strategy may be preferred to another entirely for pedestrian and bicycle reasons.