Manual on Intersection Control Evaluation

January 2023

MANUAL ON
INTERSECTION CONTROL EVALUATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
ADOPTION PROCEDURE

1.1 PURPOSE

The Manual on Intersection Control Evaluation sets forth procedures, standards, and guidelines for evaluating intersection control strategies used on the State Highway System (SHS).

1.2 AUTHORITY

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

1.3 REFERENCES

Chapter 316, F.S., Rule 14-15.010, Florida Administrative Code (F.A.C.), Manual on Uniform Traffic Control Devices

1.4 SCOPE

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

1.5 DISTRIBUTION

This document is available electronically on the FDOT Traffic Operations and Safety website:***www.fdot.gov/traffic/TrafficServices/intersection-operations.shtm***

1.6 REGISTRATION

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***

1.7 REVISIONS AND ADDITIONS

(1) The District Traffic Operations Engineers (DTOEs), the Director of Traffic Engineering and Operations, and the Director of Roadway Design constitute the Manual Review Committee.

(2) Items warranting immediate change can be made with the approval of the Director, Traffic Engineering and Operations after a majority vote of the Manual Review Committee and consultation with any other affected parties. In all other cases, any additions or changes either necessary or recommended need to be discussed in statewide meetings of DTOEs held every six months.

(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 users of the ICE Manual are to receive e-mail notification that the revisions have been posted on the website.

1.8 TRAINING

Training has been previously provided by the FDOT Traffic Engineering and Operations – Central Office. New Computer-Based Training (CBT) is being developed and will be available in 2023.

1.9 FORMS ACCESS

The Intersection Control Evaluation Form (Form 750-010-30) including tabs for Stage 1, Stage 2, and Stage 3 is available in the Department's Procedural Document Library and the FDOT Traffic Engineering and Operations Office website shown below.
www.fdot.gov/traffic/trafficservices/intersection-operations.shtm

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 intersection or modifications to an existing intersection. 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.

(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. 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 to the conventional signalized intersection. The procedure also outlines methods of quantitative analysis to select an appropriate intersection control type. FDOT created this procedure for a range of activities to support objective evaluations of intersection control types or strategies. The procedure guides users through steps to conduct an intersection control evaluation. Following the ICE procedure, completion of ICE Form (Form 750-010-30) 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 is 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, increasing the likelihood of crashes. Therefore, transportation practitioners should work to deploy the most prudent 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) Intersection safety is one of 12 emphasis areas identified in the FDOT's 2021 Strategic Highway Safety Plan (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.

(3) In September 2014, 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 for the first time. 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 multi-modal safety evaluations, in addition to vehicular capacity performance metrics.

(5) Traditionally, the most common solutions to intersection challenges involved stop-control, conventional signal control, or diamond 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, also referred to as "alternative" intersection control types, 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 and transportation needs 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 alternative design concepts included in the ICE procedure.

2.3 APPLICABILITY

(1) An ICE is required when any of the following applies:

(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.) to add, remove, or modify a traffic signal.

(e) District Design Engineer (DDE) and/or 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 applies:

(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-controlled intersection to a 4-way stop-controlled intersection; changing a full median opening to a directional median opening).

(b) Minor intersection operational improvements (e.g., adding right-turn lanes or changing signal phasing/timing) 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 configuration 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). ICE can also be used to comparatively evaluate the ramp terminal intersection of different diamond interchange types such as signalized standard diamond, diverging diamond, and single point diamond.

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), the opening year, 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. Further information is provided in Section 201.3 of the 2022 FDM. If the level of service (LOS) 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 the DDE may require the analysis to be done for an additional design year further into the future. The development of design year traffic volumes should follow the 2019 FDOT Project Traffic Forecasting Handbook and the guidance given in Paragraph 2.7 – Project Traffic Demand Forecasting of the 2021 FDOT Traffic Analysis Handbook.

2.4.3 Study Area

(1) ICE is focused on the isolated intersection or intersections under consideration; however, evaluations may need to expand beyond the study intersections using some other tools 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

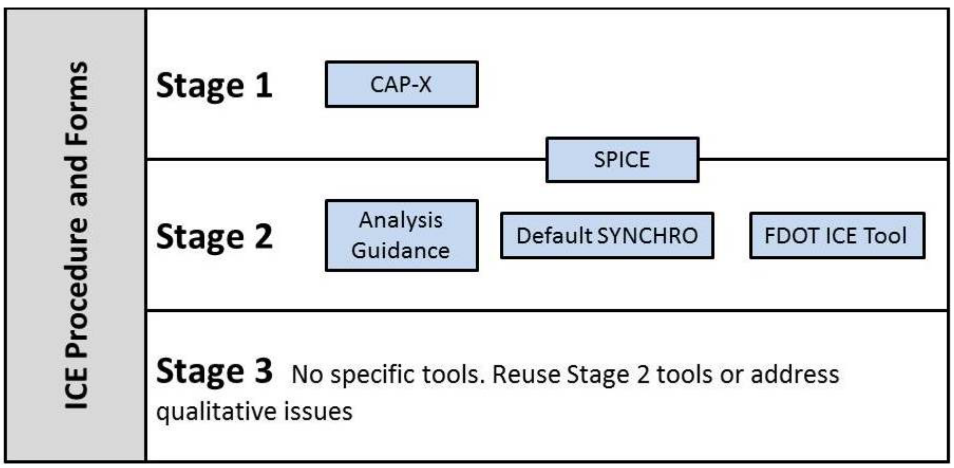
(e) Modifications to multiple intersections require an ICE to be completed for each intersection or a group of intersections if the intersections do not operate independently of each other, such as a median U-turn intersection.

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. The analysis in Stage 1 requires using two tools:

(i) *Capacity Analysis for Planning of Junctions (CAP-X)*. CAP-X, originally developed by Federal Highway Administration (FHWA), is an operational analysis tool to evaluate selected types of innovative intersection designs. FDOT has expanded this tool for use in Florida to include an enhanced pedestrian and bicycle operational analysis.

(ii) *Safety Performance of Intersection Control Evaluations (SPICE)*. SPICE, originally developed by FHWA, 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*** and FHWA Report *A Safe System-Based Framework and Analytical Methodology for Assessing Intersections*. Due to a lack of field installations, SPFs and CMFs are not available for neither signalized and unsignalized thru-cut intersections nor bowtie intersections, and the safety analysis is to be done using the SSI method.

Stage 1 SPICE analysis allows the user to select multiple control strategies and compare their safety performances where the primary variables are annual average daily traffic (AADT), rural or urban facility type, posted speed, and the number of lanes. In Stage 1, the user may use preselected standard values for the CMFs since concepts have not been prepared.

(b) Stage 2: Preliminary Control Strategy Assessment – completed following a project's initial stage when more detailed information is available and contains both safety and operational analyses. SPICE is used for a more detailed safety analysis than in Stage 1 where the user enters variables for the CMFs corresponding to intersection geometry features based on developed concepts and crash data to conduct an Empirical Bayes (EB) analysis. FDOT has developed default Synchro templates for the operational analysis of certain types of alternative intersections. The operational analysis is done for the AM and PM peak hours of the opening and design years. In addition, the FDOT ICE Tool can be used for benefit-cost analysis in Stage 2, depending on the project funding source. 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 – Stage 3 involves a more detailed evaluation of multiple control strategies selected in Stage 2 before the final selection of a preferred control strategy. 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 the DDE for approval 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 or Engineer appointed/selected by the 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 the immediate prior stages do 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 appointed/selected 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 by the applicant’s engineers 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.

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 as below (identified by Box 1.5A in ***Figure 2***):

(a) A Stage 1 analysis leads to a single viable control strategy meeting the project’s purpose and need. The party identified in ***Table 1*** completes a Stage 1 ICE Form, receives approval from the DTOE and the DDE, 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. If the ICE preparer needs to conduct a benefit-cost analysis, conducting the Stage 2 analysis maybe an option.

(b) A Stage 1 analysis indicates multiple control strategies as viable, meeting the project's purpose and need. 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 the DDE for their 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 as discussed in Section 2.5.2(3)(b) may be an option. ***Figure 3*** boxes 2.2A and 2.2B provides guidance regarding the analysis differences between federally and non-federally funded projects.

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 DTOE and the DDE. At a minimum, the Stage 1 ICE analysis shall be performed during a PD&E study; and based on the Stage 1 ICE results, alternatives will be developed, and analysis results will be documented.

Figure 2. Intersection Control Evaluation – Stage 1: Screening

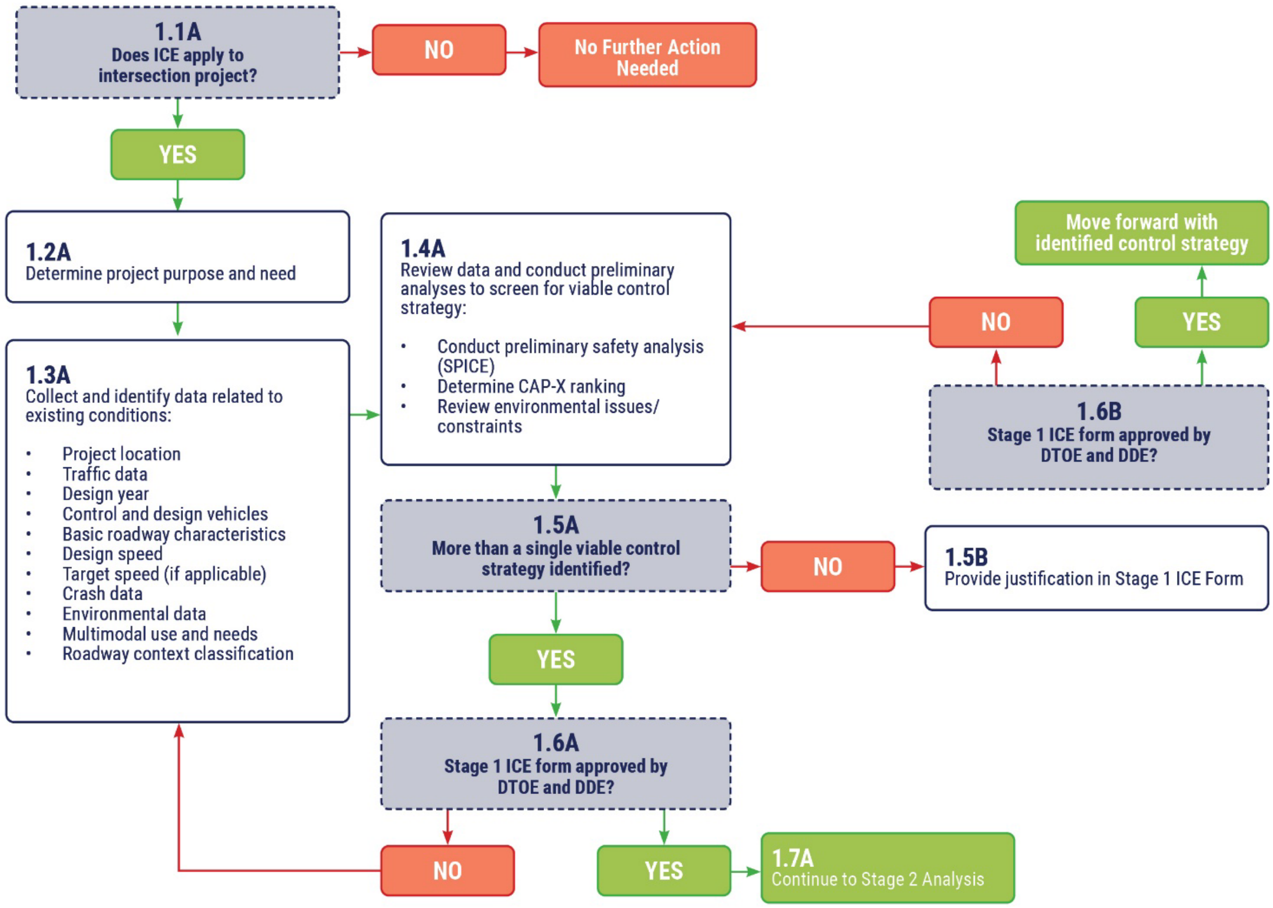


Table 2. Stage 1 Procedural Steps

Step		Description
1.1A	Does the intersection require an ICE?	Determine if the study intersection requires an Intersection Control Evaluation based on the criteria established in the *Applicability* section (Section 2.3) 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 that 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 alternatives for crash prediction using the SPICE Tool and input crash prediction-based rankings into the Stage 1 ICE Form. Also, conduct SSI analysis of alternatives using the SPICE Tool and input SSI-based rankings into the Stage 1 ICE Form. Review environmental issues or constraints. Refer to ***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 multiple control strategies are still viable based on the evaluation of the conceptual designs. Coordinate efforts and results with District's Traffic Operations Office and Design Office staff 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 the DDE for concurrence and approval. Attach supporting documentation, including CAP-X and SPICE analysis spreadsheet output sheets and analysis data. Factors used for justification include the following: • Existing safety and congestion issues • Plans for the roadway based on an adopted corridor or PD&E study • The spacing of nearby intersections or driveways and how they conform to adopted access management guidelines • The adjacent environment and land uses (existing and proposed) • Area type (urban, suburban, or rural) • Community goals and objectives • Future anticipated traffic volumes • Pedestrian and bicycle usage and needs • The breakdown and percentage of types of vehicles • Design vehicle accommodation • Sight distance • Available right of way • Environmental constraints • Support of the local users, local agencies, and local government
1.6A	Stage 1 ICE Form approved by the DTOE and the DDE?	If the Stage 1 ICE Form is approved, prepare the proposed control strategies for Stage 2: Control Strategy Assessment. If the Stage 1 ICE Form is not approved, the DTOE or the DDE may require additional data collection to help identify viable control strategies (return to Step 1.3A).

Step		Description
1.6B	Stage 1 ICE Form approved by the DTOE and the DDE?	If the Stage 1 ICE Form is approved, proceed to preliminary design for the recommended control strategy. If the Stage 1 ICE Form is not approved, the DTOE or the 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 the DDE when Stage 1 is repeated.
1.7A	Continue to Stage 2 Analysis	If a preferred control strategy is 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 analysis is completed with the selection of a single control strategy for the intersection, Stage 2 analysis is not necessary. When Stage 1 analysis narrows down a list of potential intersection control strategies without identifying a preferred control strategy, Stage 2 is intended to help differentiate the remaining potential 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, roadway's context classification, and 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. Traffic operational analysis of the alternative control strategies should be based upon the project's design year traffic volumes and incorporated into the PD&E's PTAR and summarized in the Preliminary Engineering Report (PER). The life cycle safety analysis results from SPICE, including both the crash predictions and the SSI metrics, should also be summarized in the PER. If the project is a combined PD&E and Design project or programmed as a Design-Build project, then full Stage 2 ICE procedures will need to be followed including the DTOE and the DDE 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 the DTOE and the DDE 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 discusses 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 a preferred control strategy. A Stage 2 ICE Form is completed, and the supporting analyses (e.g., Synchro operational analysis, SPICE safety analyses including crash predictions and SSI analysis) are conducted. Analysis results may be appended to the ICE Form or documented in a memorandum. Note that while the Stage 2 crash predictions in the SPICE Tool may change from Stage 1 crash predictions due to the use of historic crash data for the EB method and population of the CMFs corresponding to detail intersection geometry features, the Stage 2 SSI results will not change from Stage 1 SSI results.

(b) For non-federally funded projects, the operational analysis is modified to include only the design year's critical peak hour to support the concept development. The Stage 2 SPICE safety analyses will remain the same as that for a federally funded project. Construction and right of way cost estimates are not required unless needed for other reasons. Use of the Stage 2 ICE Tool is not required for benefit-cost analysis unless the LOS worksheets are needed for comparative operational analysis.

If the analysis of the conceptual designs fails to clearly distinguish a single control strategy above the others, it is suggested to share the results of the analysis with the DTOE, the DDE, and applicable staff to determine next steps and scope as the analysis transitions into Stage 3.

(4) For each possible outcome listed above, the completed Stage 2 ICE Form is submitted to the DTOE and the DDE for their 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's and the DDE's approval of a single control strategy in Stage 2 ICE (or any ICE stage) Form indicates that 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. One such example is the discovery of a contamination site on a parcel needed for right-of-way acquisition, leading to a decision to not acquire the parcel. Another example is a new nearby development approved by local government may impact the intersection's traffic volumes and the preferred control strategy's operations and safety. In cases such as these, the DTOE and/or the DDE may direct ICE analysis to be re-evaluated.

Figure 3. Intersection Control Evaluation – Stage 2: Preliminary Control Strategy Assessment

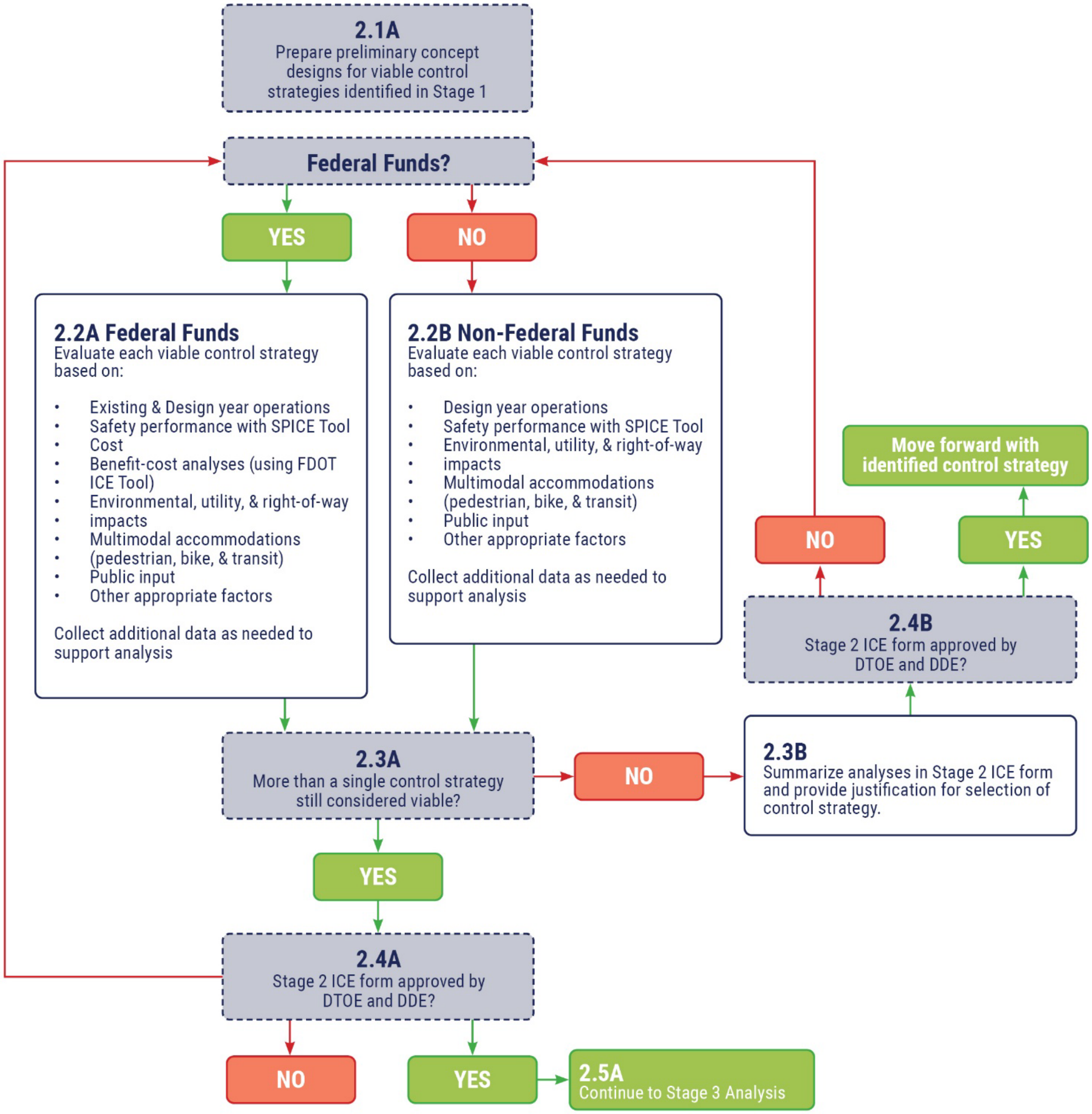


Table 3. Stage 2 Procedural Steps – Federally Funded Project

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. It is suggested that the operational analysis be conducted concurrently with the concept development. 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 based on the conceptual designs. Areas of analysis include: • 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. • Safety Performance (evaluate control strategies based on anticipated safety performance and SSI metrics using the SPICE Tool) • Construction, right-of-way, and design costs • Benefit-Cost Analysis (evaluate using FDOT ICE Tool) • Environmental impacts • Utility impacts • Right-of-way impacts • Multimodal accommodations (including pedestrian, bike, and transit) • Agency coordination and public input (if appropriate) 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 operational analysis tools.
2.3A	More than a single control strategy still considered viable?	The Professional Engineer (PE) overseeing the ICE analysis uses discretion to determine whether more than one control strategies are still viable based on evaluation of the conceptual designs. Coordinate efforts and results with District's Traffic Operations Office and Design Office staff throughout the evaluation to facilitate acceptance of the results and conclusions. If a preferred control strategy is not selected in the Stage 2 analysis; note the reasons why the selection cannot be made for them to be studied in Stage 3.
2.3B	Summarize analyses in Stage 2 ICE Form and provide control strategy selection justification	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 the DDE. Include the proper justification for the selection or non-selection of each potential control strategy considered in Stage 2 to the Stage 2 ICE Form.
2.4A	Stage 2 ICE Form approved by the DTOE and the DDE?	If the Stage 2 ICE Form is approved, proceed to the preliminary design phase for the recommended control strategy. If the Stage 2 ICE Form is not approved, the DTOE or the DDE may require additional analysis and evaluation to identify viable control strategies (return to Step 2.2A).
2.4B	Stage 2 ICE Form approved by the DTOE and the DDE?	If the Stage 2 ICE Form is approved, proceed to the preliminary design phase for the recommended control strategy. If the Stage 2 ICE Form is not approved, the DTOE or the 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. It is suggested, the operational analysis be conducted concurrently with the concept development. This conceptual design lays the foundation for much of the evaluation in Step 2.2A.
2.2B	Evaluate each control strategy	Conduct a more detailed analysis of each control strategy based on the conceptual designs. Areas of analysis include: • Operations (same as federally funded project except only done for design year critical peak hour) • Safety Performance (evaluate control strategies based on anticipated safety performance and SSI metrics using the FDOT SPICE Tool) • Environmental impacts • Utility impacts • Right-of-way impacts • Multimodal accommodations (including pedestrian, bike, and transit) • Agency coordination and public input (if appropriate) Use comparison of operational 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 operational analysis tools.
2.3A	More than a single control strategy still considered viable?	The Professional Engineer (PE) overseeing the ICE analysis uses discretion to determine whether more than one control strategies are still viable based on the evaluation of the conceptual designs. Coordinate efforts and results with District’s Traffic Operations Office and Design Office 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 the DDE. Include the proper justification for the selection or non-selection of each potential control strategy considered in Stage 2 to the Stage 2 ICE Form.
2.4A	Stage 2 ICE Form approved by the DTOE and the DDE?	If the Stage 2 ICE Form is approved, proceed to the preliminary design phase for the recommended control strategy. If the Stage 2 ICE Form is not approved, the DTOE or the 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 the DTOE and the DDE?	If the Stage 2 ICE Form is approved, proceed to the preliminary design phase for the recommended control strategy. If the Stage 2 ICE Form is not approved, the DTOE or the 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.

2.5.3 Stage 3: Detailed Control Strategy Assessment

(1) While Stage 2 includes 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 estimation 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 evaluating the outstanding issues. For example, community engagement or multimodal needs may determine the preferred control strategy, instead of further technical analysis. When Stage 1 or Stage 2 evaluation does not identify a selected control strategy, users may customize Stage 3 activities to address the outstanding issues. For a PD&E project, Stage 3 analysis is not required as the steps taken above are a normal part of the PD&E process and are documented in the PER, PTAR, 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

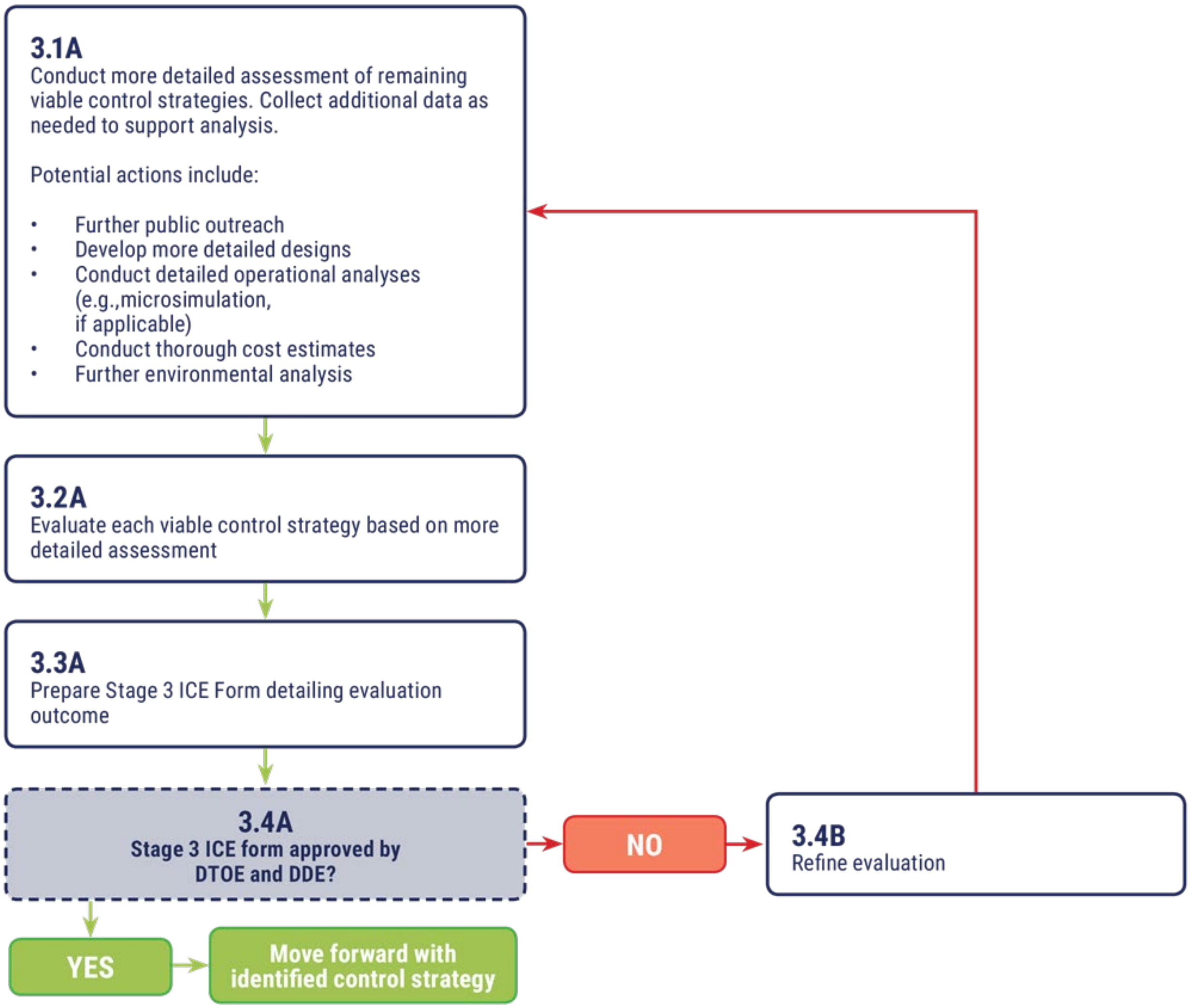


Table 5. Stage 3 Procedural Steps

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 which control strategy is the most viable alternative for the intersection.
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 the DTOE and the DDE?	If the Stage 3 ICE Form obtains approval from the DTOE and the DDE, proceed to preliminary design for the recommended control strategy. If the Stage 3 ICE Form is not approved, incorporate the comments from the DTOE or the 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 Form is required to re-submit the Stage 3 ICE Form after accounting for comments from the DTOE and/or the 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 the 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	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
	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
	Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis	Definitive reference for traffic analysis of intersections and underlying basis of many intersection operations software packages	http://www.trb.org/main/blurbs/175169.aspx
	FDOT-extended NCHRP 17-38 and 17-58 Spreadsheets	FDOT Present Worth Analysis - FDOT Procedural Forms 750-020-21(A-D)	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 MUT, RCUT, and DLT intersections	https://www.fdot.gov/traffic/trafficservices/intersection-control-example-videos
Intersection Control Type Reference Guides	Unsignalized Intersections Improvement Guide (UIIG)	A web-based guide documenting safety, mobility, and accessibility improvements to unsignalized intersections	https://toolkits.ite.org/uiig/default.aspx
	FHWA-SA-13-027 – Signalized Intersections Informational Guide, Second 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	https://rosap.ntl.bts.gov/view/dot/29476

Category	Title	Description	Web Link
	FHWA-HRT-09-055 – Displaced Left-Turn Intersection	Technical brief about displaced left-turn (DLT) 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	https://rosap.ntl.bts.gov/view/dot/29477
	FHWA-HRT-07-032 – Traffic Performance of Three Typical Designs of New Jersey Jughandle Intersections	Technical brief about performance of 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-19-032 – Safety Evaluation of Continuous Green T Intersections	Technical brief about safety impacts of continuous green T (CGT) intersections	http://safety.fhwa.dot.gov/intersection/innovative/others/casestudies/fhwasa09016/fhwasa09016.pdf
	FHWA-HRT-09-058: Quadrant Roadway Intersection	Technical brief about quadrant roadway (QR)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 DLT, MUT, QR, and RCUT 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	Research report providing guidance on design and operations of single point urban interchanges	http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_345.pdf
	NCHRP 672 - Roundabouts: An Informational Guide, Second Edition	Research 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	Research report providing SPFs and CMFs to estimate number and severity 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	Research report providing guidance for comparative qualitative evaluation of pedestrian and bicyclist safety at any intersection or interchange type. Information on MUT, RCUT, DLT, and	http://www.trb.org/Main/Blurbs/181781.aspx

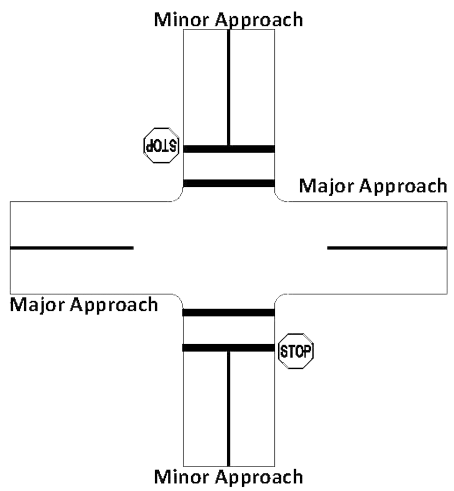
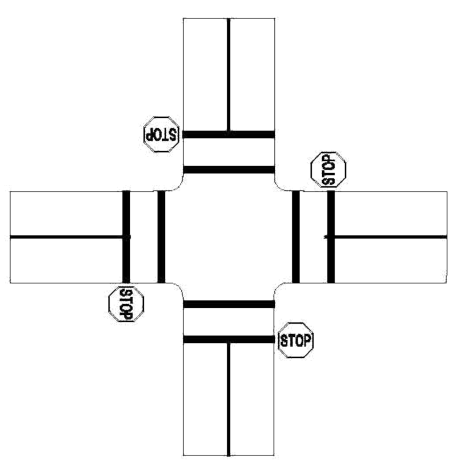
Category	Title	Description	Web Link
		Diverging Diamond Interchange (DDI) pedestrian and bicyclist facility designs are also provided.	
	NCHRP 959 – Diverging Diamond Interchange Informational Guide, Second Edition	Research report providing guidance on safety, operations, design, and multimodal considerations of DDIs	http://www.trb.org/Publications/Blurbs/181562.aspx

APPENDICES

APPENDIX A
INTERSECTION TYPE REFERENCES

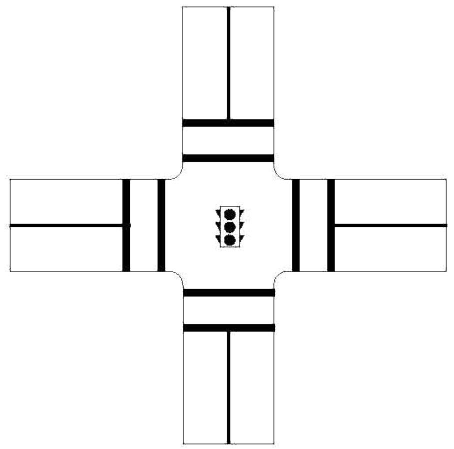
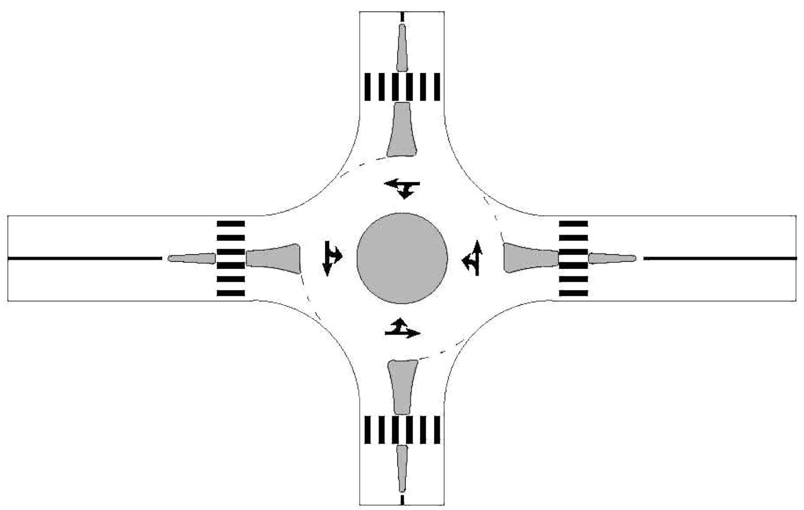
Table A1 and **Table *A2*** provide basic information on at-grade and ramp terminal intersections, respectively, for ICE practitioners who may not be familiar with them.

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 Operational Analysis Tool(s)[2]
Intersection Name	Illustration	Description	Vehicles	Pedestrians	Bicycles			
Two-way stop-control		Conventional intersection control type in which minor street approaches are stop-controlled and major street movements do not encounter any traffic control devices. Advantages: Simple and low-cost Disadvantages: Not effective in serving 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 movements must stop before proceeding through the intersection.	Pedestrians crossing the minor street approaches have the 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.	Unsignalized Intersection Informational Guide (UIIG)	See ***Figure A1*** for peak-hour volume thresholds correspondin g to two-way stop control	CAP-X (planning level), HCS, SYNCHRO
All-way stop-control		Conventional intersection control type in which every approach is stop-controlled. Advantages: Simple, low-cost, and safe 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 peak-hour volume thresholds correspondin g to all-way stop control	CAP-X (planning level), HCS, SYNCHRO

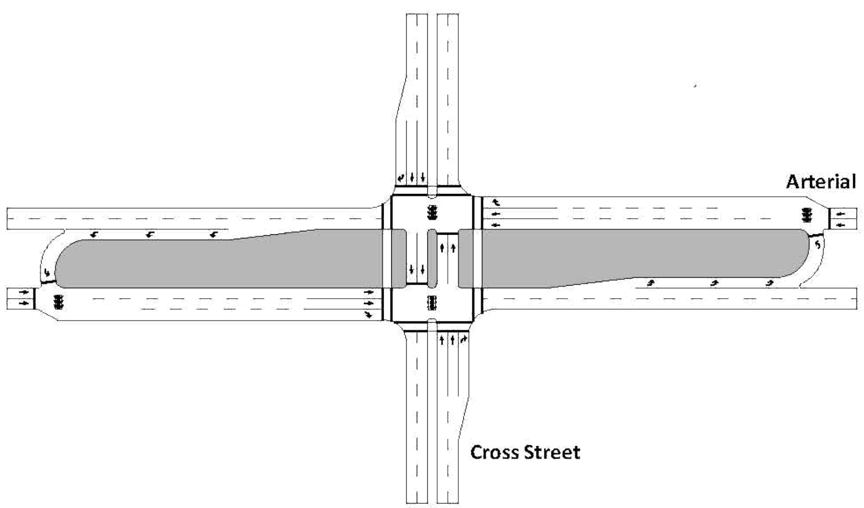
[1] Refer to ***Table 6*** for a hyperlink to each reference document.

[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 Operational 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. Advantages: Most common form of control for higher volume intersections, fully established and understood by all users 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	CAP-X (planning level), 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. Advantages: Usually reduced fatal and injury crashes and delay compared to signalized control 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	CAP-X (planning level), SIDRA with US HCM Model

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

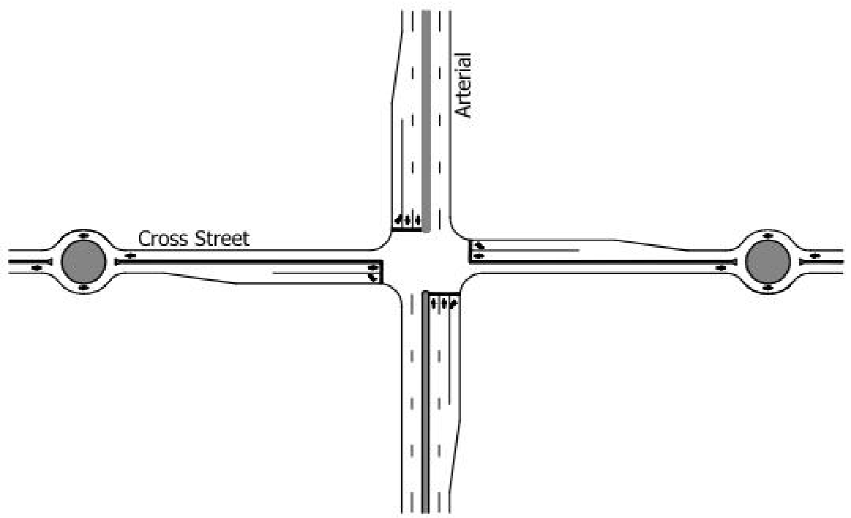
[2] Use VISSIM or similar microsimulation software for oversaturated conditions.

Intersection Control Type			Mode Accommodations			Reference Material[1]	Volume Thresholds	Recommended Stage 1 and 2 Operational 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 and replaces them with U-turns on the major street Advantages: Fewer signal phases and conflict points than a conventional signal, better suited for high through volume cross streets than an RCUT 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 downstream median opening. These drivers then can turn right at the cross street. For drivers on the cross 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 cross 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. 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 the 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 NCHRP Report 948 Pedestrian and bicycle facility operations videos in FDOT Traffic Engineering and Operations Office website	Major Street Volume: 300 - 1,900 veh/hr/ln; Minor Street Volume: 100 - 500 veh/hr/ln. ***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), 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

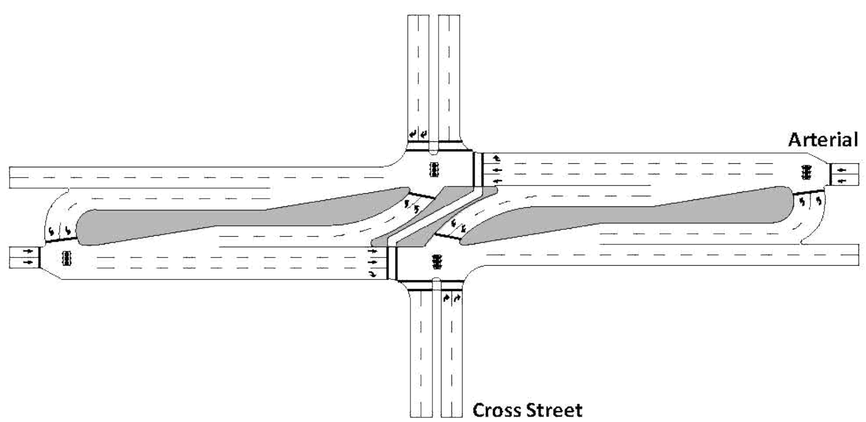
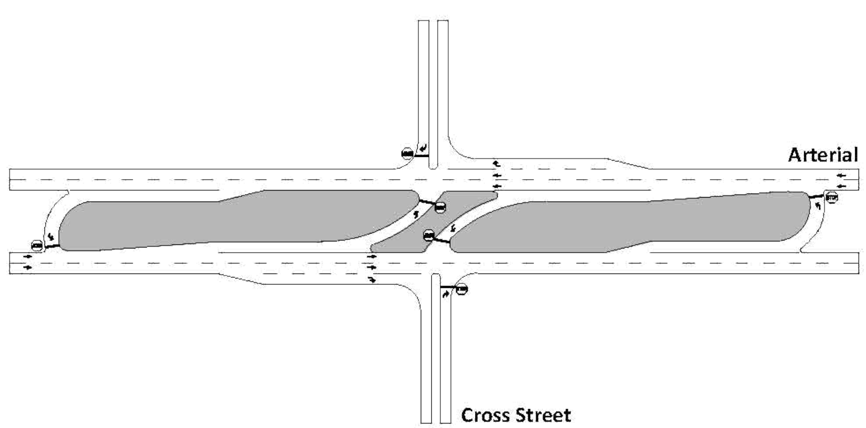
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis.

Intersection Control Type			Mode Accommodations			Reference Material[1]	Volume Thresholds	Recommended Stage 1 and 2 Operational Analysis Tool(s)[2]
Intersection Name	Illustration	Description	Vehicles	Pedestrians	Bicycles			
Bowtie		An intersection treatment that eliminates direct left-turns from major and minor approaches and replaces them with U-turns executed via roundabouts on the minor street. The roundabouts can have two or more legs. Advantages: Fewer signal phases and conflict points than a conventional signal, viable for intersections where major street median is not available for U-turns Disadvantages: Out-of-direction travel for left turn movements, requires additional right-of-way on minor street	Drivers desiring to turn left from the major road onto an intersecting cross street must first turn right at the signal-controlled intersection and then execute a U-turn at the downstream roundabout and proceed back through the signalized intersection. For drivers on the cross street desiring to turn left onto the major road, they must first travel through the signal-controlled intersection and then execute a U-turn at the downstream roundabout. These drivers then can turn right onto the major road.	Increased right turn volume may lead to more vehicle-pedestrian conflicts and can be mitigated through leading pedestrian intervals. Midblock crossings may be provided at the roundabout. Pedestrian crossings are located only across the legs of the roundabout, typically separated from the circulatory roadway by at least one vehicle length.	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. Bike lanes should not be used at roundabouts			CAP-X (planning level), HCS, SYNCHRO, SimTraffic[3], SIDRA with US HCM Model if roundabout have more than two legs

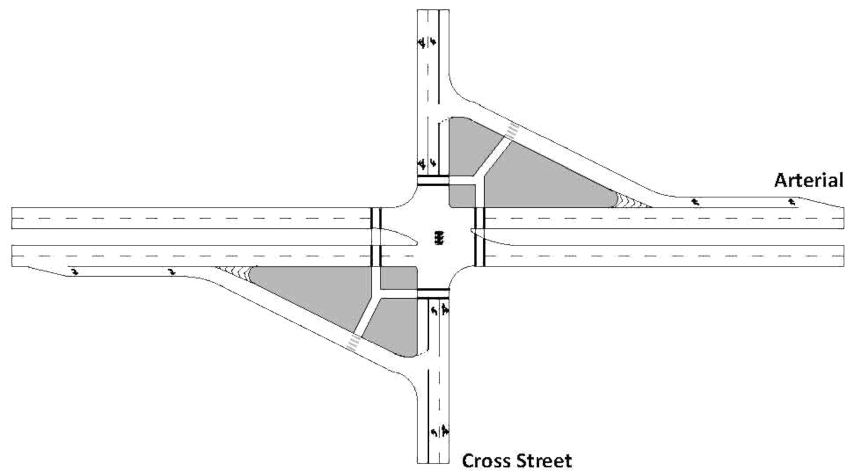
[1] Refer to ***Table 6*** for a hyperlink to each reference document.

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

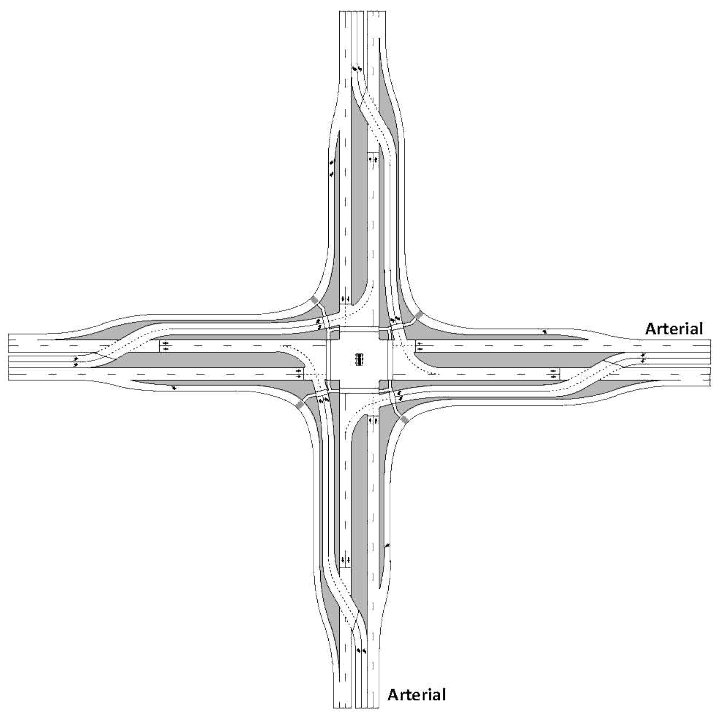
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis..

Intersection Control Type			Mode Accommodations			Reference Material[1]	Volume Thresholds	Recommended Stage 1 and 2 Operational Analysis Tool(s)[2]
Intersection Name	**Illustration**	**Description**	**Vehicles**	**Pedestrians**	**Bicycles**			
Signalized Restricted Crossing U-Turn (RCUT), or Superstreet		An intersection design that restricts left-turn and through movements from cross street approaches as permitted in conventional designs. Advantages: Fewer signal phases and conflict points (if signalized) than a conventional intersection, enables major street to operate as one-way couplet if signalized Disadvantages: Out-of-direction travel for cross street left and through movements, requires wide median or outside right-of-way at U-turn crossover	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.	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. 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.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Cross 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. 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.	FHWA-SA-14-070 NCHRP Report 948 Pedestrian and bicycle facility operations videos FDOT Traffic Engineering and Operations Office, Intersection Operations and Safety website	Not suitable for an intersection of two arterials Minor street demand threshold of 25,000 vpd (or 2,250 vph) See ***Figure A3*** for further details.	CAP-X (planning level), HCS, SYNCHRO, SimTraffic[3]
Unsignalized Restricted Crossing U-Turn (RCUT), or J-Turn			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.	Unsignalized RCUTs are usually located in rural areas and do not typically have pedestrian facilities. If there is pedestrian demand, accommodations should be provided. See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 7 for additional guidance on pedestrian treatments.	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. See NCHRP Report 948: Guide for Pedestrian and Bicycle Safety at Alternative Intersections and Interchanges; Chapter 7 for additional guidance on bicycle treatments.		Minor street demand threshold of 5,000 vpd (or 450 vph) See ***Figure A3*** for further details.	

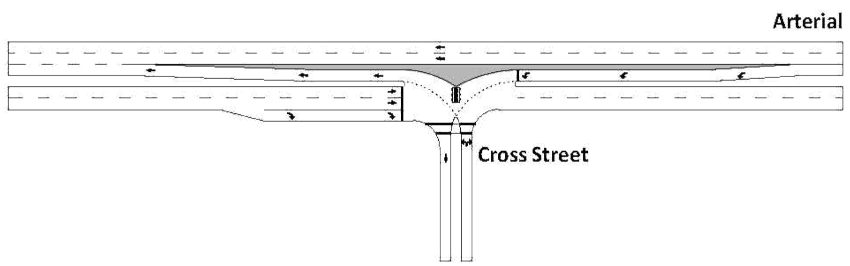
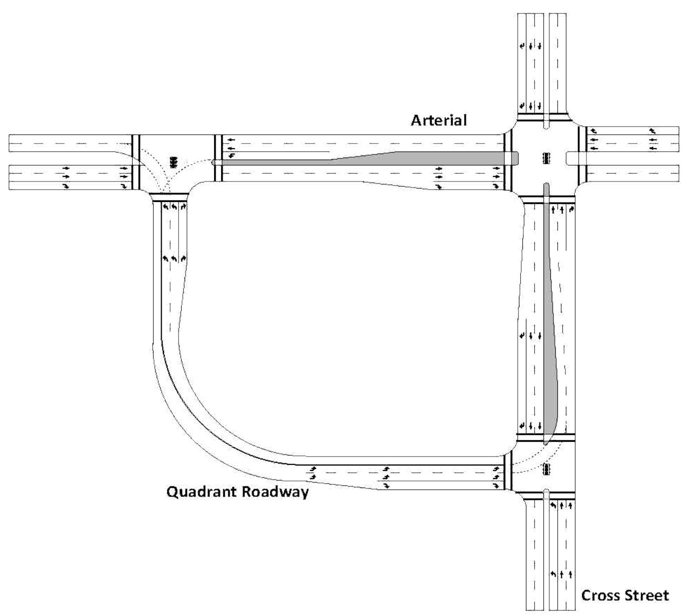
[1] Refer to ***Table 6*** for a hyperlink to each reference document.
[2] Use VISSIM or similar microsimulation software for oversaturated conditions
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis.

Intersection Control Type			Mode Accommodations			Reference Material[1]	Volume Thresholds	Recommended Stage 1 and 2 Operational 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. Advantages: Fewer signal phases and conflict points than a conventional signal 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. 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/hr/ln < Major Street Volume < 2,300 veh/hr/ln; Minor Street Volume < 350 veh/hr/ln	CAP-X (planning level), SYNCHRO, SimTraffic[3]

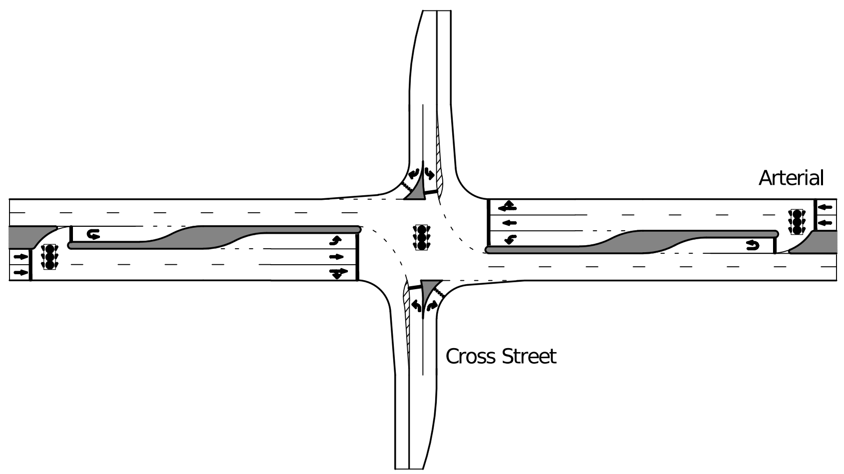
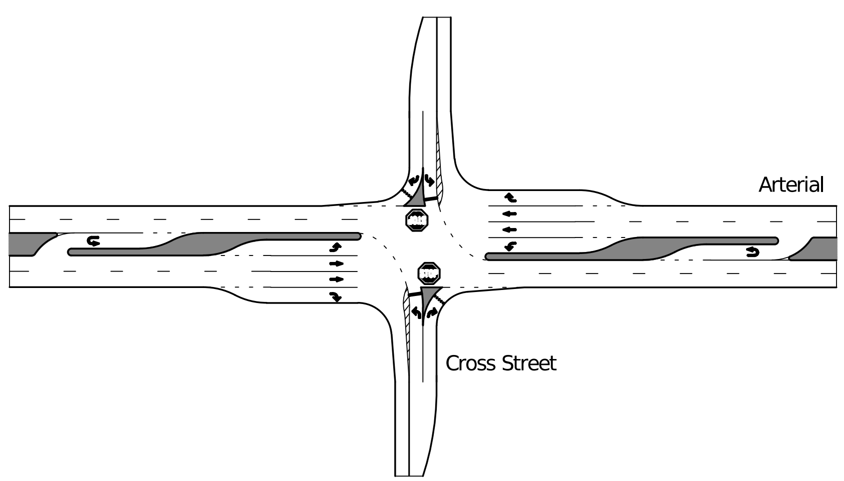
[1] Refer to ***Table 6*** for a hyperlink to each reference document.
[2] Use VISSIM or similar microsimulation software for oversaturated conditions
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis.

Intersection Control Type			Mode Accommodations			Reference Material[1]	Volume Thresholds	Recommended Stage 1 and 2 Operational Analysis Tool(s)[2]
Intersection Name	Illustration	Description	Vehicles	Pedestrians	Bicycles			
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. Advantages: Fewer signal phases and conflict points than a conventional signal, well-suited for high left-turn volumes 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. 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. 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 NCHRP Report 948 Pedestrian and bicycle facility operations videos FDOT Traffic Engineering and Operations Office, Intersection Operations and Safety website	Major Street Volume > 2,000 veh/hr/ln; Minor Street Volume > 300 veh/hr/ln. A full 4-approach DLT with 2-3 lanes per approach can handle about 12,000 vph[4] A partial DLT with 2-3-lanes per approach can accommodate up to 10,000 vph[4]	CAP-X (planning level), 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 Operational 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. Advantages: One direction of arterial never has to stop 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), 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. Advantages: Reduced signal phases at main intersection 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. Pedestrian conflicts exist with vehicles making left turns from the stems of the T at the auxiliary intersections. This can be mitigated through exclusive pedestrian phasing.	Similar to conventional intersection. Design techniques for direct left turns are available.	FHWA-HRT-09-058 Alternative Intersections/ Interchanges: Informational Report (AIIR)	N/A	CAP-X (planning level), 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.

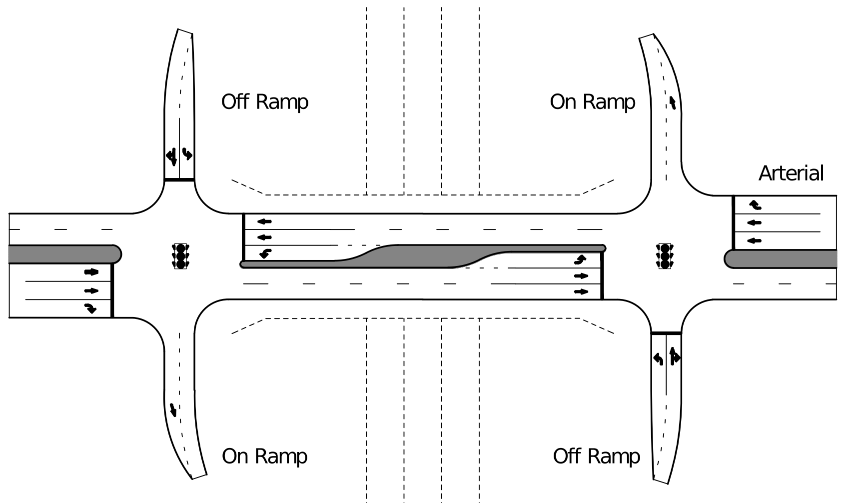
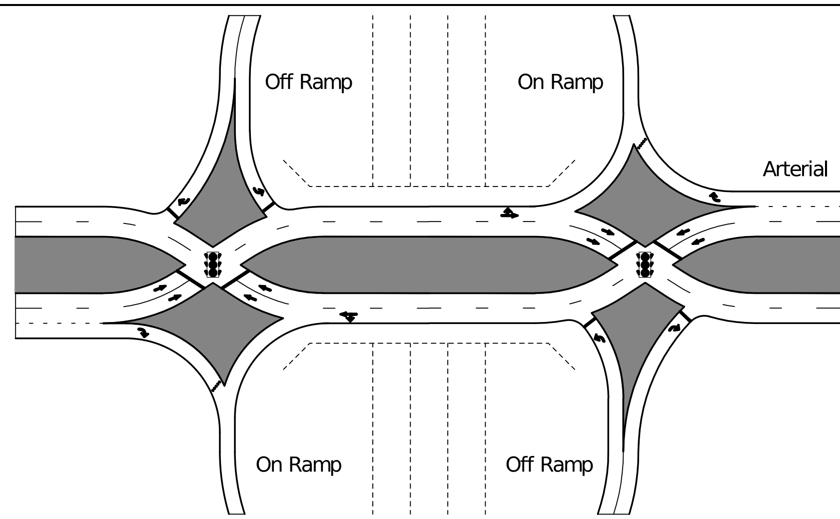
Intersection Control Type			Mode Accommodations			Reference Material[1]	Volume Thresholds	Recommended Stage 1 and 2 Operational Analysis Tool(s)[2]
Intersection Name	Illustration	Description	Vehicles	Pedestrians	Bicycles			
Signalized Thru-Cut		An intersection design that restricts through movements from the minor streets as permitted in conventional intersections. Advantages: Protected left turns from the cross street (if signalized) without a four critical phase signal. 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. Exclusive pedestrian phasing may be appropriate.	Ride on street in travel lane or bicycle lane (if available) unless multi-use path is present. Cross 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), 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 cross street through and left turn movements to cross in two stages.			CAP-X (planning level), 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.

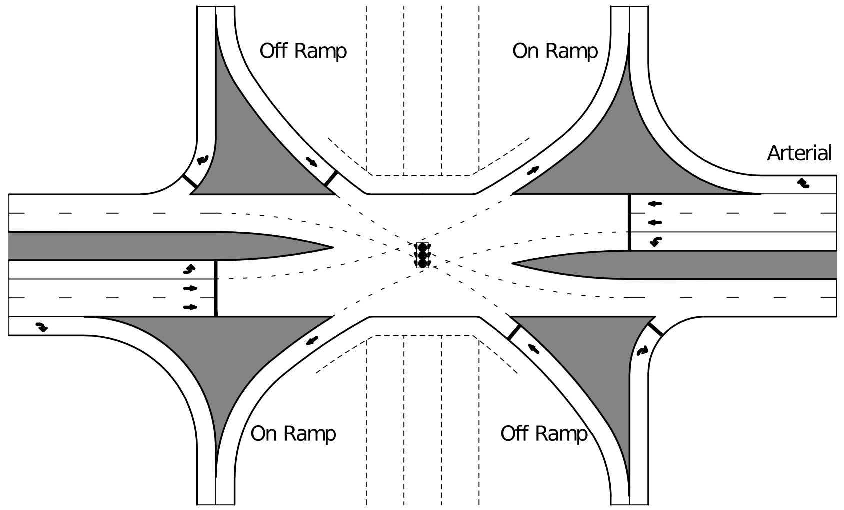
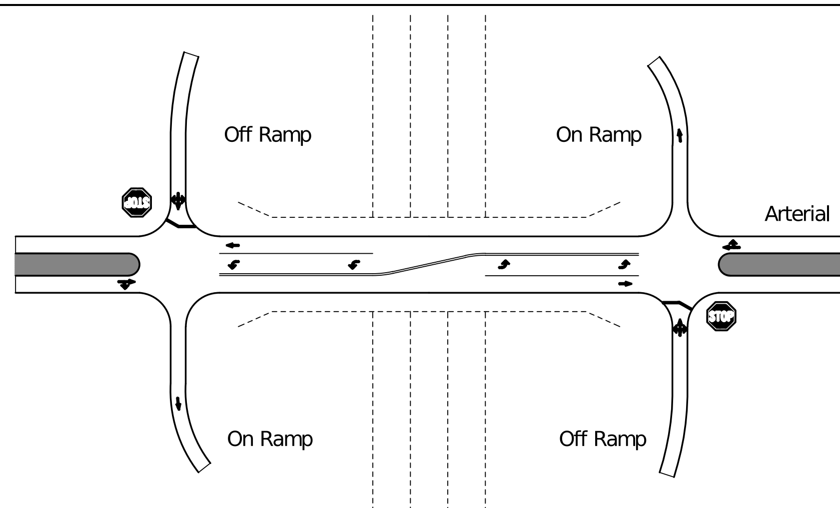
Table A2. Considerations for Ramp Terminal Intersections Design and Operations

Ramp Terminal Intersection Control Type			Mode Accommodations			Reference Material[1]	Recommended Stage 1 and 2 Operational 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. Advantages: Most common form of control for higher volume intersections, fully and established and understood by all users 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, 2nd Edition	CAP-X (planning level), HCS, SYNCHRO, SimTraffic[3]
Diverging Diamond (or Double Crossover)		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. 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. 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. 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. 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 NCHRP Report 948	CAP-X (planning level), 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.

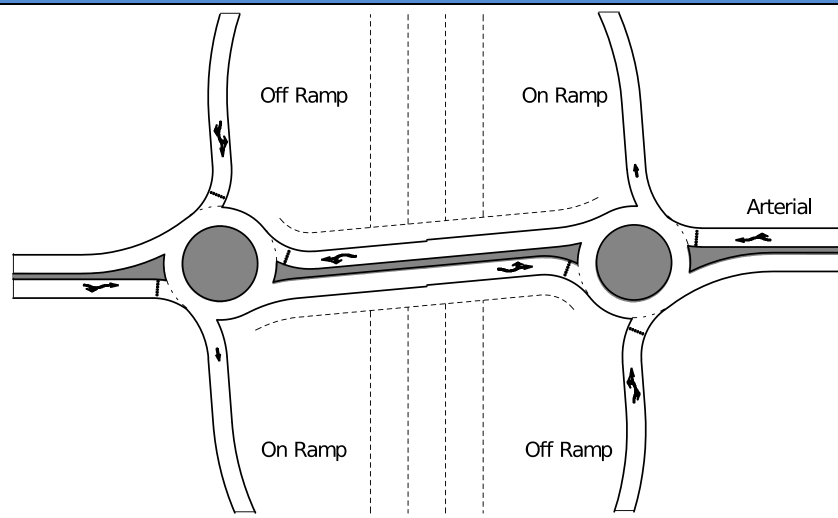
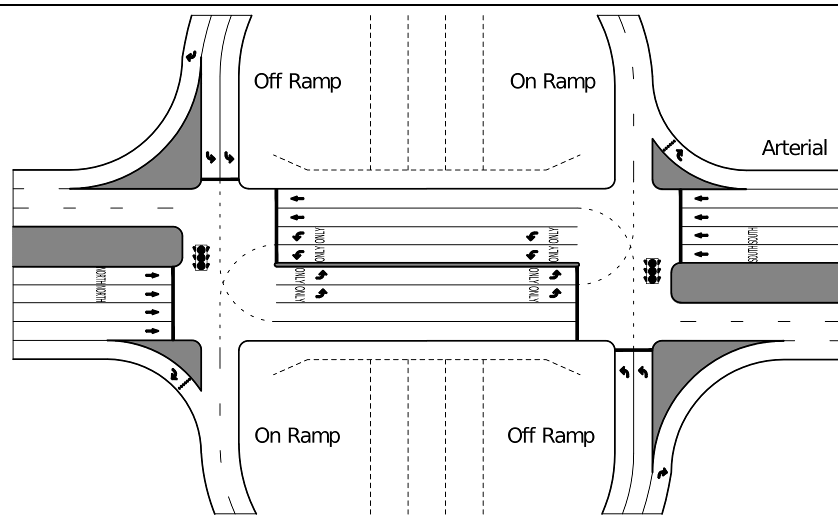
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis.

Ramp Terminal Intersection Control Type			Mode Accommodations			Reference Material[1]	Recommended Stage 1 and 2 Operational 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 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), 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. Advantages: Simple and low-cost 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), 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.

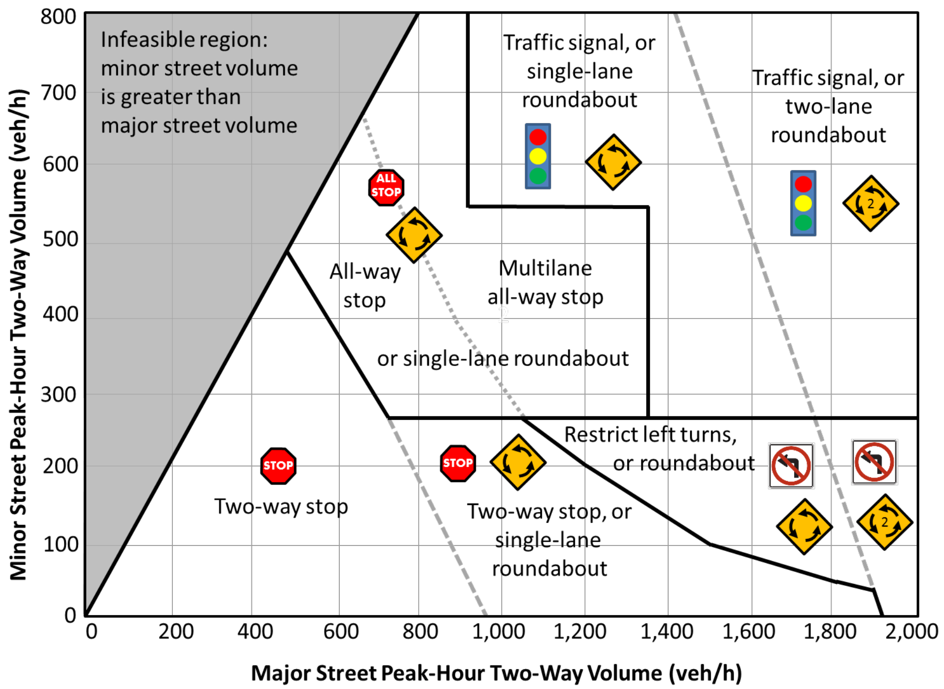
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis.

Ramp Terminal Intersection Control Type			Mode Accommodations			Reference Material[1]	Recommended Stage 1 and 2 Operational 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. Advantages: Usually reduced crashes and delay compared to signalized control 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	CAP-X (planning level), 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. Advantages: Ability to manage long left turn queues onto the limited access roadway 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 roadway 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, 2^{nd} Edition	CAP-X (planning level), HCS, SYNCHRO, SimTraffic[3]

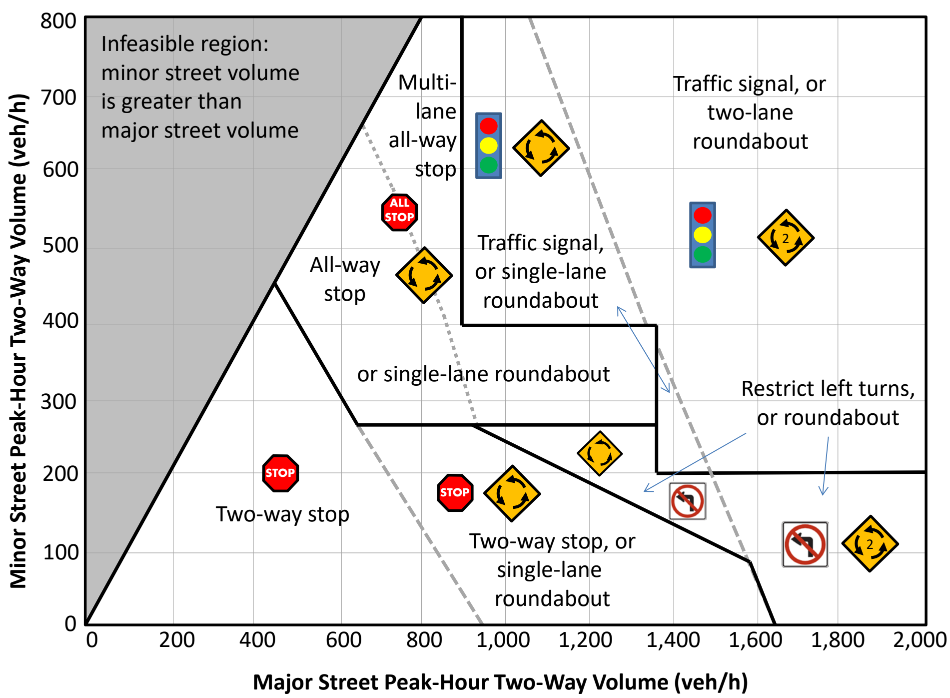
[1] Refer to ***Table 6*** for a hyperlink to each reference document.
[2] Use VISSIM or similar microscopic software for oversaturated conditions.
[3] Use VISSIM or similar microsimulation software in complicated scenarios where adjacent intersections crossings need to be considered in the operational analysis.

Figure A1: Intersection Control Type by Peak Hour Volume Thresholds[6]

Use intersecting peak hour volumes to determine potential intersection control.



50/50 directional distribution on each street, 10 percent left turns and 10 % right turns, 1 lane per approach unless noted



67/33 directional distribution on each street, 10 percent left turns and 10 % right turns, 1 lane per approach unless noted

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[5] NCHRP Report 825: Planning and Preliminary Engineering Applications Guide to Highway Capacity Manual.

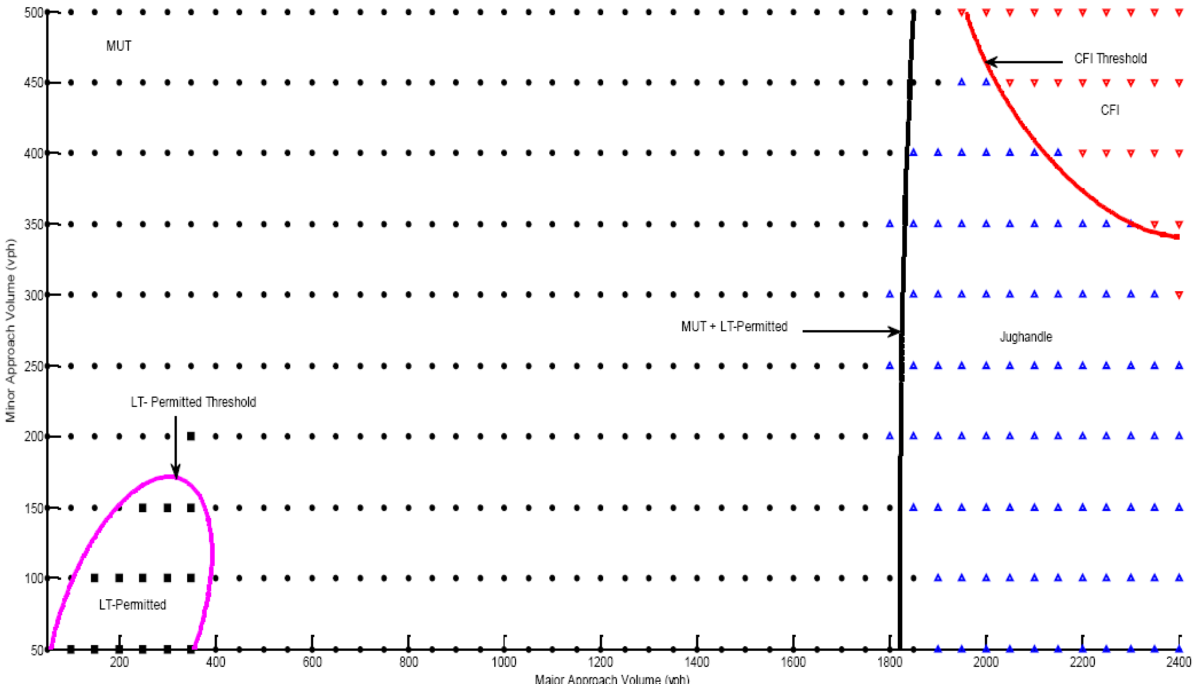
Table A3: Sum of Entering and Conflicting Volume Thresholds for Roundabouts[7]

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. ▪ 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. ▪ A more detailed capacity evaluation should be conducted to verify lane numbers and arrangements.

[6] NCHRP Research Report 962: Proposed Modification to AASHTO Cross-Frame Analysis and Design (Exhibit 3-14)

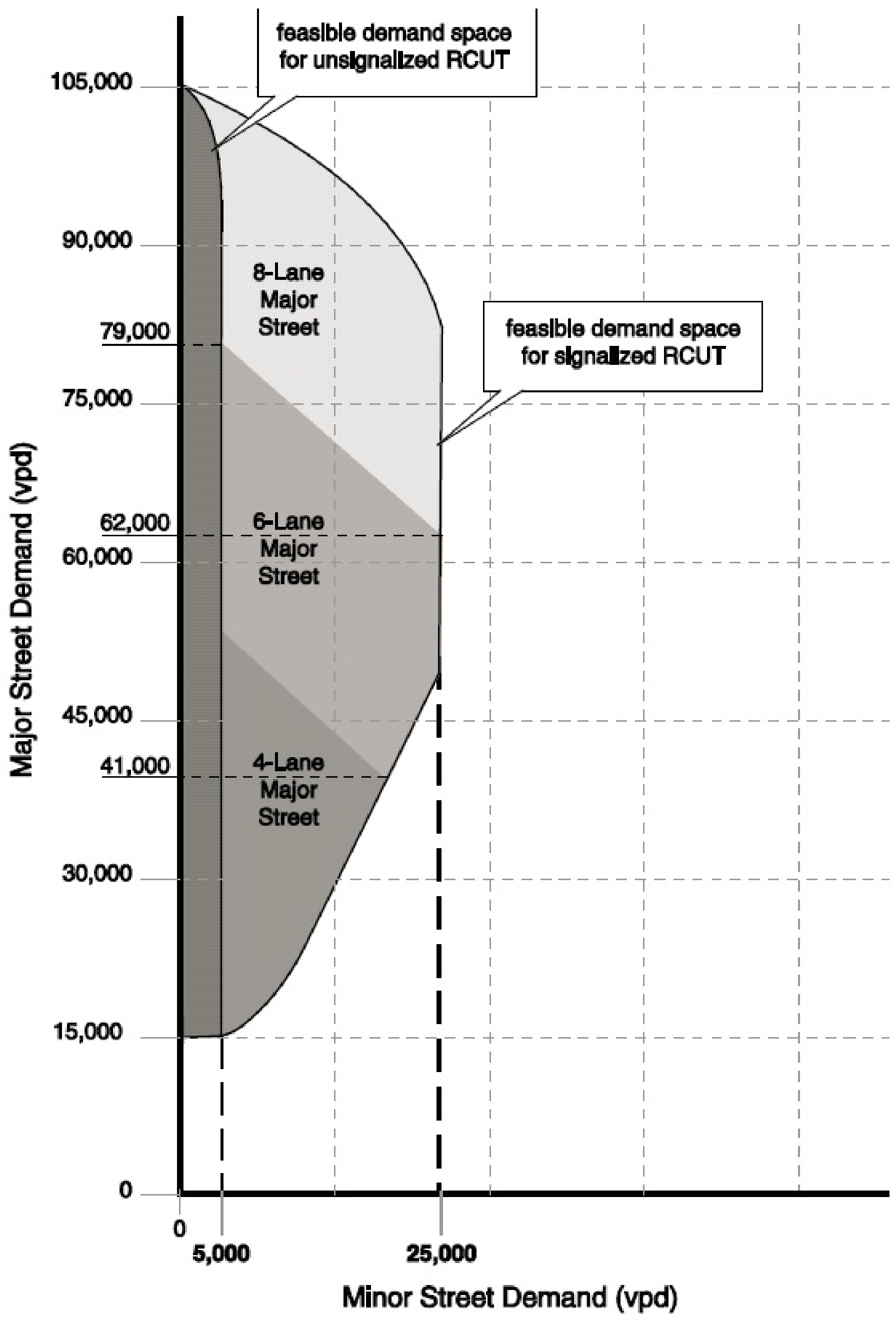
Figure A2: Decision Assistance Curves for Optimal Performance of Unconventional Intersections[7]

Thresholds for MUT, Jughandle, and DLT (CFI) Intersections with the following assumptions:
Ratio of approach traffic volume to total approach traffic volume = 0.60,
Left Turn Percentage = 15%, and Truck Percentage = 10%



[7] Gyawali, S., "A New Decision Making Approach for Indirect Left Turn Treatments by Utilizing Decision Assistance Curves", Ph.D. Dissertation, The University of Nebraska-Lincoln, 2014. http://digitalcommons.unl.edu/civilengdiss/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 750-010-30

To fulfill the requirements of Stage 1 (Screening) of FDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms are to 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.]	

			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							
	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 %			

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

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 #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 %				

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:

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

Control Strategy Evaluation								
Provide a brief justification as to why each of the following control strategies should be advanced or not. Justification should consider potential environmental impacts.								
Control Strategy	CAP-X Outputs: V/C Ratio		Ped Accom.	Bike Accom.	SPICE Outputs: Crash Prediction Rank	SSI Rank	Strategy to be Advanced?	Justification
Two-Way Stop-Controlled								
All-Way Stop-Controlled								
Signalized Control								
Roundabout (1-lane)								
Roundabout (2-lane)								
Median U-Turn								
RCUT (Signalized)								
RCUT (Unsignalized)								
Jughandle								
Displaced Left-Turn								
Continuous Green Tee								
Quadrant Roadway								
Thru-Cut (Signalized)								
Thru-Cut (Unsignalized)								
Bowtie								
Other (Type)								

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 750-010-30

To fulfill the requirements of Stage 1 (Screening) of FDOT's ICE procedures, complete the following form and append all supporting documentation. Completed forms are to 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

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 %			

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

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		Ped Accom.	Bike Accom.	Crash Prediction Rank	SSI Rank		
Signalized Diamond								
Signalized Diamond (Alt)								
Diverging Diamond								
Single-Point Diamond								
Unsignalized Diamond								
Signalized Tight Diamond								
Roundabout (1-lane)								
Roundabout (2-lane)								
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 to the FDOT District Traffic Operations Engineer (DTOE) and the District Design Engineer (DDE) for their approval and/or comments. 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 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.***
- **FDOT Context Classification:** Select the appropriate FDOT Context Classification for the project area from the Preliminary Context Classification TDA GIS layer in the FDOT Open Data Hub. If the information is not available, select

the most appropriate FDOT Context Classification that best describes the surrounding project area using the information presented in Table 200.4.1 of the 2022 FDOT Design Manual. A graphical representation of each can be found here: http://www.flcompletestreets.com/files/FDOT-context-classification.pdf.

- **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 Information:** Defined as the street normally carrying the higher volume of vehicular traffic.
  - **Route #:** 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").
  - **Route Name(s):** 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).
  - **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".

- **Existing 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: *https://tdaappsprod.dot.state.fl.us/fto/*.
- **Design Year AADT:** Enter volume based on guidance of Section 2.4.2 of this manual.
- **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 201.6 of the 2022 FDM.
- **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 201.6.1 of the 2022 FDM.
- **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.
- **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 201.5. of the 2022 FDM.
- **Secondary Functional Classification:** If the functional classification of the major street changes at the intersection, select the lower-order functional classification in this cell.
- **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 202.2.1 of the 2022 FDM.
- **Direction:** Select direction of travel for vehicle approach.
- **Sidewalks along:** Select whether sidewalks are present along one side or both sides of the corresponding major street approach.
- **Crosswalks on Approach:** Select "Yes" if a crosswalk is present for pedestrians to cross this approach.

- **On-Street Bike Facilities?**: Check this box if on-street bike facilities (e.g., protected bike lanes) are present along the major street.
- **Multi-Use Path?**: Check this box if a multi-use path is present along one or more sides of the major street.
- **Scheduled Bus Service?**: 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.
- **Bus Stop on Approach?**: Check this box if a bus stop serving a scheduled bus line is located along major street within 1,000 feet of the center of the intersection.
- **Number of Lanes:** Enter the number of lanes for the movements described in the form.
- **Study Period Traffic Volumes**: Use the pull-down menu to describe time period for traffic volumes provided in cells below. Enter hourly volumes for each movement in appropriate cells. Also, enter daily truck % for major street.

- **Minor Street Information**: Defined as the street carrying the lower volume of vehicular traffic. If a third approach is present (e.g., a five-leg intersection), the information for all minor street legs should be input under this same section.
  - **Route #:** 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”).
  - **Route Name(s):** 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.
  - **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
  - **Existing 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*:* *https://tdaappsprod.dot.state.fl.us/fto/*
  - **Design Year AADT:** Enter volume based on guidance of Section 2.4.2 of this manual.

- **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 201.6 of the 2022 FDM.
- **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 201.6.1 of the 2022 FDM.
- **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.
- **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 201.5 of the 2022 FDM.
- **Secondary Functional Classification:** If the functional classification of the minor street changes at the intersection, select the lower-order functional classification in this cell.
- **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 202.2.1 of the 2022 FDM
- **Direction:** Select direction of travel for vehicle approach.
- **Sidewalks along:** Select whether sidewalks are present along one side or both sides of the corresponding minor street approach.
- **Crosswalks:** Select “Yes” if a crosswalk is present for pedestrians to cross this approach.
- **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 on Approach?**: Check this box if a bus stop serving a scheduled bus line is located along minor street within 1,000 feet of the center of the intersection.
- **Number of Lanes:** Enter the number of lanes for the movements described in the form.
- **Study Period Traffic Volumes**: Use the pull-down menu to describe time period for traffic volumes provided in cells below. Enter hourly volumes for each movement in appropriate cells. Also, enter daily truck % for minor street.

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 Information:** Cross street is defined as the surface street crossing through the interchange area. The Ramp Terminal Intersection is formed by the intersection of the limited access facility ramps and the cross street. The entries are the same as previously described in Major Street.
- **Exit Ramp Information:** Defined as the exit ramps from the limited access facility to the cross street.
    - **Route #:** 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., “I-4/SR 400”).
    - **Route Name:** Enter the common name of the limited access roadway (e.g., “I-95”).
    - **Milepost:** Enter the milepost of the ramp terminal intersection based on the mainline of the limited access roadway (e.g., 35.2).
    - **AADT:** Enter the Annual Average Daily Traffic (AADT) volume carried on the limited access roadway’s exit ramp.
    - **Primary Functional Classification:** Select the functional classification of the limited access roadway from the pull-down menu. The classifications are urban or rural interstate or freeway/expressway facilities. If the classification of the limited access roadway changes at the interchange, select the higher order functional classification.
    - **Secondary Functional Classification:** Select the secondary functional classification of the limited access roadway from the pull-down menu. If

the functional classification of the 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, Ped Accommodation Score, and Bike Accommodation Score from the CAP-X analysis. The lower V/C Ratios indicate better vehicular operations. The higher Ped and Bike Accommodation Scores indicate better multimodal conditions.
- **SPICE Outputs:** SPICE does safety analysis using two different methods. The first is the crash prediction method using the HSM predictive methods. The second is the Safe System for Intersections (SSI) method providing a score for each control strategy based on traffic volume, operating speed, and the number of conflicts. The Stage 1 Form shows the comparative ranking of each control strategy with a ranking of “1” considered the best.
    - **Crash Prediction Rank:** Enter the relative ranking of each control strategy based on the SPICE’s crash prediction analysis. The control strategy having a ranking of “1” is considered to be the safest alternative with respect to crash predictions.
    - **SSI Rank:** Enter the relative ranking of each control strategy based on the SPICE’s SSI analysis. The control strategy having 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 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 to determine 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 DTOE and DDE 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 750-010-30

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 are to 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?
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?

Provide any additional discussion necessary regarding the results of the operational analysis:	

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 750-010-30

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 are to 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?	
Provide any additional discussion necessary regarding the results of the operational analysis:				

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

Stage 2 Form

Required Tools

Analysis tools required to complete this Form include:

- Synchro 10 (or newer version) with FDOT developed templates,
- SIDRA for roundabouts,
- FDOT-expanded version of FHWA's Safety Performance of Intersection Control Evaluation (SPICE) tool, and
- FDOT's Intersection Control Evaluation (FDOT 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 the 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 onto curbs (when present) or into adjacent travel lanes. For more information on design vehicles, see Section 201.6 of the 2022 FDM.
- **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 201.6.1 of the 20122 FDM.
- **Opening Year:** Enter the anticipated opening year for the improvement. Space is provided to enter the analysis results of two peak hours for the opening year..
  - **Peak Hour:** 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 opening year peak hour analysis is not required.
  - **LOS:** Enter the overall intersection level-of-service (LOS) or LOS for the critical approach (if overall intersection LOS not applicable) for each control strategy. This is a Synchro and Sidra output value.
  - **Delay:** Enter the overall intersection delay or delay for the critical approach (if overall intersection delay not applicable) for each control strategy. This is a Synchro and Sidra value. To obtain the overall intersection delay for the Two-way Stop Control, DLT, MUT, RCUT, Thru-Cut, and Bowtie

intersections, the delay tab of the FDOT ICE Tool provides a worksheet to do this calculation.

- **All Queues Accommodated?:** Select "Yes" or "No" to reflect whether the forecasted 95th 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 Section 201.3 of the 2022 FDM.
  - **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. This is a Synchro and Sidra output value.
  - **Delay:** Enter the overall intersection delay or delay for the critical approach (if overall intersection delay not applicable) for each control strategy. To obtain the overall intersection delay for the Two-way Stop Control, DLT, MUT, RCUT, Thru-Cut, and Bowtie intersections, the delay tab of the FDOT ICE Tool provides a worksheet to do this calculation.
  - **All Queues Accommodated?:** Select "Yes" or "No" to reflect whether the forecasted 95th 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 opening and design year operational analyses, describe here. In particular, note if additional operational metrics were evaluated that may help justify/refute the validity of a particular control strategy.

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 and 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 and design year) from the FDOT SPICE tool for each control strategy.
- **Safe System for Intersection (SSI) Score:** Enter the overall intersection SSI score (opening and design year) from the FDOT SPICE tool for each control strategy.

Benefit-Cost Ratios

- **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.
- **Delay B/C:** After applying the FDOT 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 the FDOT 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 the FDOT 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 applicable):** Enter the number of pedestrian crossings 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 applicable):** 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 SPICE Tool.:
- **Level of bicycle activity:** Select the appropriate level of bicycle activity identified in the FDOT SPICE Tool:

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 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 DTOE and DDE 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 750-010-30

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 are to 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):					

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
Describe specific evaluation activities undertaken in Stage 3 analysis to identify a preferred control strategy and discuss the findings:	
Category	Description of Issues/Findings

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 Form. 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 is 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 of the Safe System-based approach.

FDOT has expanded the 2022 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 vehicle operating speeds of various movements.
- 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 points and vehicle-nonmotorized conflict points across different intersection alternatives. The SSI method communicates these tradeoffs by reporting SSI MOEs 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 safety metrics for intersection forms where SPFs or CMFs are not available. The SSI method may also 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 at the signalized thru-cut intersection. When pedestrian volumes are exceedingly high, the thru-cut intersection may show a better SSI score than the RCUT intersection, despite the increased crossing conflicts present at the thru-cut intersection.

Table C1 and ***Table C2*** present the assumptions made 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.
- Where left turn or exclusive pedestrian phasing is modifiable, as noted in ***Table C1*** and

- ***Table C2***, the default assumption is protected left turn phasing without exclusive pedestrian phasing.

Table C1. Assumptions for SSI Calculations by Intersection Type

At-Grade Intersection Name	SSI Considerations
Two-way stop-control	• Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
All-way stop-control	• Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
Signalized Control	• Presence of street median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Left turn phasing operation is modifiable on SSI Input sheet.
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). • All approaches have splitter islands/pedestrian refuge islands. • All approaches operate under yield control. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized movements due to footprint and placement of crosswalks.
Median U-Turn (MUT)	• All approaches have medians/pedestrian refuge islands. • All direct left turns are removed from intersection. • U-turn movements operate under traffic signal control.
Bowtie	• Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
Signalized Restricted Crossing U-Turn (RCUT) or Superstreet	• All approaches have medians/pedestrian refuge islands. • Z-type pedestrian crossing pattern is utilized. • Indirect Paths (out of direction travel) adjustment is applied to nonmotorized road users crossing major street. • U-turn movements operate under traffic signal control.
Unsignalized RCUT or J-Turn	• All approaches have medians/pedestrian refuge islands. • Z-type pedestrian crossing pattern is utilized. • Indirect Paths (out of direction travel) adjustment applied to nonmotorized road users crossing major street. • U-turn movements operate under stop control.
Jughandle	• Though other configurations are possible, the most common type–the forward jughandle–is assumed. • For left turns at the main intersection which are not redirected, phasing operation is modifiable on SSI input sheet. • Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.

At-Grade Intersection Name	SSI Considerations
Displaced Left-Turn	• Two DLT alternatives considered: partial DLT (PDLT), displaced left turns on major street approaches only) and full DLT (displaced left turns on all four approaches). • All approaches have medians/pedestrian refuge islands and right turns are all channelized. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized conflict points (due to channelized right turns); Non-Intuitive Motor Vehicle Movements adjustment is applied to nonmotorized conflict points along nonmotorized movements that cross approaches with displaced left turns (i.e., all nonmotorized conflict points for full DLT). • For PDLT, minor street left turn phasing operation is modifiable on SSI input sheet.
Continuous Green T	• Nonmotorized movements crossing the continuous through movement on the major road are protected through user actuated signal control. • Major road approach without continuous movement has median that provides refuge to nonmotorized users. • Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet. • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet.
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. • Presence of median opening adequate to store vehicle for two-stage crossing is modifiable on SSI Input sheet • Presence of major or minor street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Phasing operation for left turns onto auxiliary road is modifiable on SSI input sheet. • Analysis for exclusive pedestrian phasing at auxiliary intersections is available on SSI input page in SPICE and QR tab in CAP-X.
Signalized Thru-Cut	• All approaches have medians/pedestrian refuge islands. • U-turn movements operate under traffic signal control. • Left turns from the major road operate under protected phasing. • Analysis for exclusive pedestrian phasing is available on SSI input page in SPICE and QR tab in CAP-X.
Unsignalized Thru-Cut	• All approaches have medians/pedestrian refuge islands. • Stop control is present on minor road approaches. • 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	• Presence of cross street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Nonmotorized user paths across the cross-street are located outside the ramp legs. • Left turn phasing operation from the arterial is modifiable on SSI input sheet.
Diverging Diamond	• Nonmotorized users travel using the centerline median island. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized conflict points; Non-Intuitive Motor Vehicle Movements adjustment is applied to all nonmotorized conflict points. • All signal-controlled movements are protected.
Single Point Diamond	• Nonmotorized user paths across the cross-street are located just outside the single point intersection. • Analysis for exclusive pedestrian phasing is available on SSI input page in SPICE and Single Point tab in CAP-X. • The on- and off-ramp pedestrian crossings feature refuge islands. • Presence of cross street median serving as pedestrian refuge island is modifiable on SSI Input sheet. • Indirect Paths (out of direction travel) adjustment is applied to nonmotorized movements crossing the cross-street.
Unsignalized Diamond	• No median present, or if present, the median is inadequate to store vehicle for two-stage crossing. • No approaches have pedestrian refuge islands. • 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). • Cross-street approaches have splitter islands/pedestrian refuge islands. • All approaches operate under yield control. • Indirect Paths (out of direction travel) adjustment is applied to all nonmotorized movements due to footprint and placement of crosswalks.
Signalized Tight Diamond	• Presence of cross street median and channelized turning islands serving as pedestrian refuge island is modifiable on SSI Input sheet. • 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 Section 200.4 in the 2022 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 2022 FDM for more information on design users.

Target Speed

The 2022 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 of 45 mph or less, it is desirable for the posted speed limit, the operating speed, and the design speed to be identical.

Refer to the FDOT *Speed Zoning Manual*, 2022 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, bicyclists, and transit users 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 original FHWA version.

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, 2015)
Median U-Turn	0.85	0.70	Crash prediction for a conventional signalized intersection	NCHRP Report 420: Impacts of Access Management Techniques (TRB, 1999)
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 (2016)
Diverging Diamond Interchange Ramp Terminal	0.67	0.59	Crash prediction for a signalized ramp terminal intersection	FHWA Field Evaluation of Diverging Diamond Interchanges (2015)

The FDOT SPICE Tool contains the following

- NCHRP 17-70 SPFs for roundabouts,
- SPFs for signalized and unsignalized RCUTs developed by FDOT[15],
- NCHRP 17-58 SPFs for intersections on six- and eight-lane roadways and one-way streets.

[15] Ozguven, E. E. et al., *"Development of Safety Performance Functions for Restricted Crossing U-Turn (RCUT) Intersections"*, FAMU/FSU Department of Civil and Environmental Engineering, 2019.

- NCHRP 17-68 SPFs for conditions not in the original HSM such as 55+ mph major street approach speeds for urban and suburban arterials and 3-leg rural two-lane and rural multilane signalized intersections.

The SPICE Tool also contains crash prediction capability for some ramp terminal intersections. These include diamond (signalized and unsignalized), tight diamond, diverging diamond, 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. Analysis for freeways and ramps needs to be done separately following HSM Supplement 2014 Chapters 18 and 19 or using the Enhanced Interchange Safety Analysis Tool (ISATe) spreadsheet.

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 stakeholder engagement is negative, especially if their cost participation is required. The project manager in consultation with local stakeholders and FDOT functional units should determine the degree of public involvement required/necessary 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 traffic control strategies 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). The DTOE 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 non-motorized users and the context of the location, one control strategy may be preferred to another entirely for pedestrian and bicycle reasons.

Pedestrian and Bicycle Evaluation Consideration

With the November 2022 FDOT ICE Manual update, the multimodal scoring capability of CAP-X has been changed. The new CAP-X version has a Multimodal Ped tab and a Multimodal Bike tab to calculate separate scores for each mode. This section explains the data requirements for these assessments.

Multimodal Ped Tab

The *Multimodal Ped* worksheet contains previously provided user inputs and default values for conducting the assessment of pedestrian accommodation. Default values are prepopulated for most inputs in the tab with the exception of roadway speeds. The pedestrian analysis will not provide results until the roadway operating speeds are entered. For each row, the analyst can use drop-down menus or direct inputs to override default values.

Previously provided user inputs in the CAP-X workflow, which are auto-populated in the *Multimodal Ped* worksheet, include:

- Number of lanes (per crossing)
- Vehicle volume (per crossing)

Default input values include for the following items:

- Out of direction travel (per intersection)
- Multistage crossing (per intersection)
- Conflicting vehicle type (per crossing)
- Marking type (per crossing)

New user inputs require for the following item:

- Roadway speeds (per crossing)

Default Crossing Locations and Markings

Each intersection has a default number of crossings, where a crossing is the path between any two curbs either at the edge of the roadway or along a median. This can be overridden as discussed in the **Customizing Crossings** section. The location of each default crossing can be seen in the image which appears when hovering over the cells of the “Sheet” column accompanying the “Type of Intersection” column. This image also provides the default conflicting vehicle type (coded by color) and the marking type (coded by crosswalk shading style). Note the images are static and will not update with a change to inputs such as lane numbers. These images are also available at the end of this Appendix. A legend is provided at the top of the *Multimodal Ped* worksheet and in ***Figure C1***.

Figure C1. Crosswalk Marking Legend

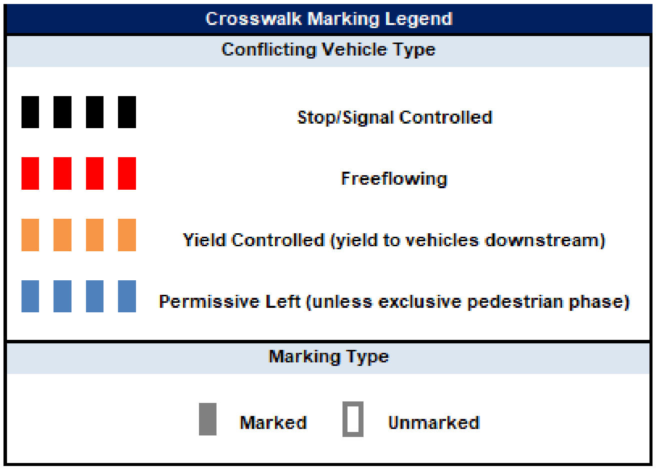


Figure C2 depicts the default crossing assignments, conflicting vehicle types, and marking types for the east-west Two-Way Stop Control design. Note that directionality is important due to the importation of volumes that were entered earlier in the CAP-X workflow. This intersection design is assumed to have four crosswalks. The major street crosswalks, crossings 1 and 3, are assumed to conflict with free flowing traffic (red) and are unmarked (hollow shading). The minor street crosswalks, crossings 2 and 4, are assumed to conflict with permissive left turns from the major street (blue) and are marked (solid shading). Further explanation of the selection of default crossing types is provided in the Inputs section below.

Figure C2. Assumed Crossing Assignments, Conflicting Vehicle Types, and Marking Types

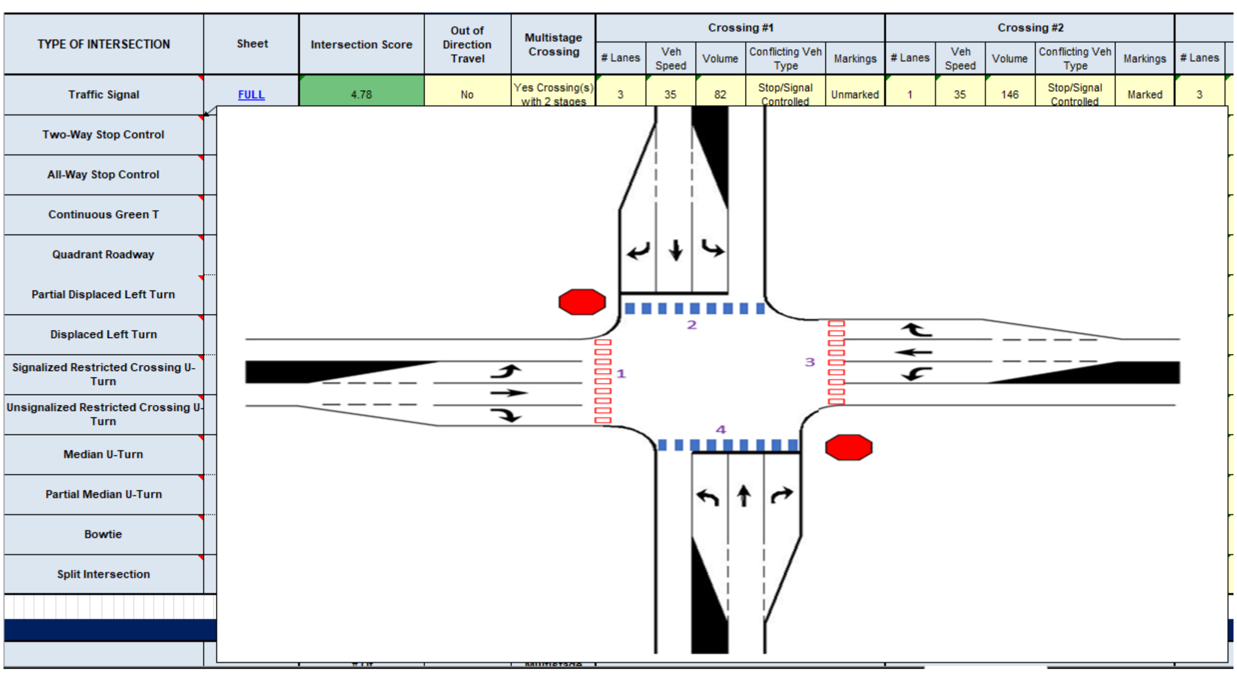


Figure C3 shows the default values for crossings 1 and 2 entered into the *Multimodal Ped* worksheet.

Figure C3. Multimodal ped worksheet inputs (partial)

TYPE OF INTERSECTION	Sheet	Intersection Score	Out of Direction Travel	Multistage Crossing	Crossing #1					Crossing #2				
					# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings	# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings
Traffic Signal	FULL	4.78	No	Yes Crossing(s) with 2 stages	3	35	82	Stop/Signal Controlled	Unmarked	1	35	146	Stop/Signal Controlled	Marked
Two-Way Stop Control	E-W	2.40	No	No	4	45	1324	Free Flowing	Unmarked	4	35	228	Permissive Left	Marked

Default values can always be reset using the "Reset Default Values" button located at the top of the worksheet (***Figure C4***).

Figure C4. Reset default values button.

Inputs

Roadway Operating Speeds & Vehicle Speeds

Default roundabout speeds are prepopulated, but input by the user is required for the major and minor street speed limits. Edits are made by direct input. Input overrides must be positive integers and divisible by 5. Once provided in the *Roadway Speeds* input table (***Figure C5***), the *Vehicle Speed* cell for each crossing in each row will auto-populate. *Vehicle Speeds* can be overwritten at the cell level as necessary.

Figure C5. Roadway Speeds Inputs

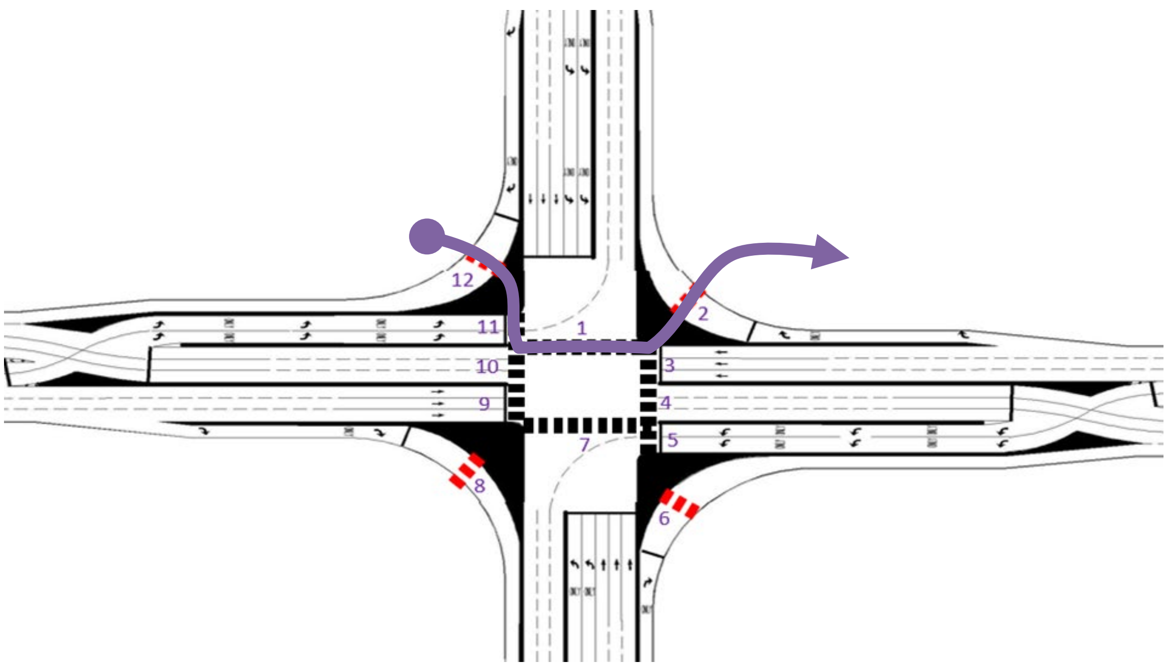
Roadway Operating Speeds (MPH)	
Major Street Speed Limit	45
Minor Street Speed Limit	35
Mini Roundabout Entry & Exit Speed	20
1-Lane Roundabout Entry & Exit Speed	25
2-Lane Roundabout Entry & Exit Speed	30

Out of Direction Travel

Out of direction travel is gathered at the intersection level and prepopulated by default for all intersections. Edits are made using the drop-down menu. Input overrides must be a categorical value of either “yes” or “no”.

This factor considers the desire of pedestrians to cross an intersection in the most direct path possible. It should be flagged as yes if one or more pedestrian paths between adjacent quadrants deviates significantly from a straight line. For example, for the east-west Partial Displaced Left Turn intersection *Out of Direction Travel* is assumed to be “yes” because a pedestrian crossing from the northwest quadrant to the northeast quadrant must first travel south, then east, then back north to complete the crossing (***Figure C6***).

Figure C6. Example of Pedestrians’ Out of Direction Crossing Direction using Marked Crosswalks

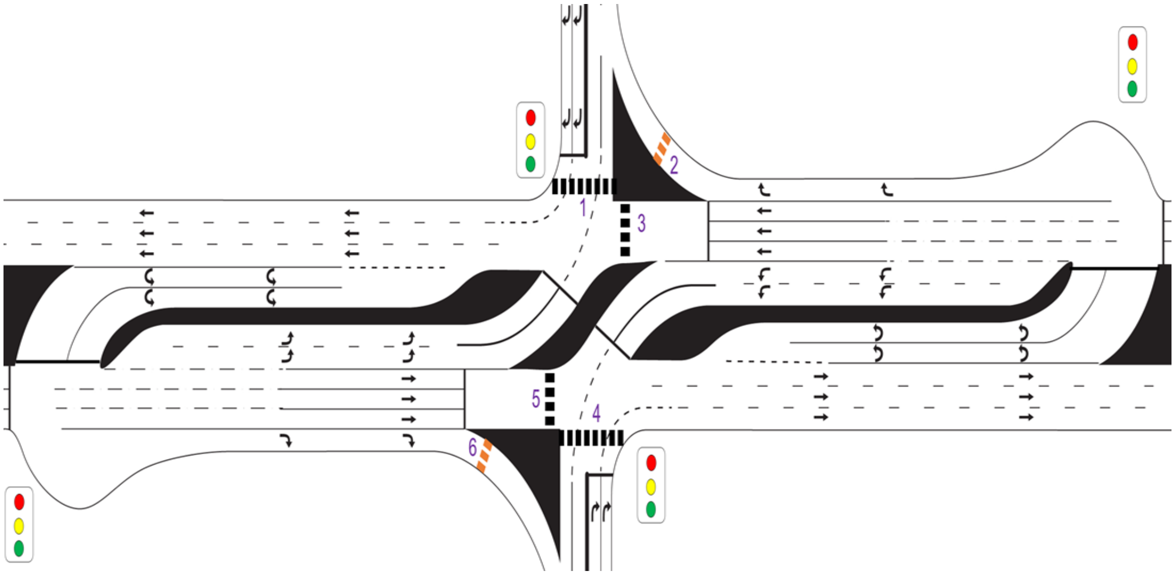


Multistage Crossing

Multistage crossing is gathered at the intersection level and prepopulated for all intersections. Edits are made using the drop-down menu.

The consideration of multistage crossings is by movement between adjacent quadrants, even if the design does not feature a direct path between two quadrants. For example, the RCUT design shown in ***Figure C7*** does not have a direct path provided between the southeast and northeast quadrant, but the analyst should still consider how a pedestrian desiring to go from the southeast to the northeast quadrants would travel. In this example, it would require four stages (using crosswalks 4, 5, 3, and 2).

Figure C7. Crosswalk Assignments for RCUT



Input overrides must be one of the following categorical values:

- **Yes, crossing(s) with 3+ stages** – select if at least one movement between adjacent quadrants are completed in three or more stages.
- **Yes, crossing(s) with 2 stages** – select if at least one movement between adjacent quadrants are completed in two stages, but no movement is completed in three stages. A movement that features a median refuge but for which the signal timing allows the movement to be completed in one stage should be considered as two-stage crossing.
- **No** – select if all movements between adjacent quadrants are completed in one stage.

Number of Lanes

Number of lanes is gathered at the crossing level and is directly collected from prior user inputs on the *Alt Num Lanes Input* worksheet. Any override input must be a positive integer. This factor totals the number of approach and departure lanes intersecting the associated crossing.

Vehicle Volume

Vehicle volume is gathered at the crossing level and is directly collected from prior user inputs on the *Volume Input* worksheet. Any override input must be a positive integer. This factor totals the number of vehicles intersecting the crossing either as they approach or depart the intersection.

Conflicting Vehicle Type

Conflicting vehicle type is gathered at the crossing level and is prepopulated by default based on typical control at each intersection form. Edits are made using the drop-down menu. This factor considers the most severe vehicle movement to intersect the crossing. The categorical conflicting vehicle types from least to most severe are:

- **Stop/signal controlled** - select when all vehicle movements intersecting the crossing are either stop controlled or have protected signal control. This could also be selected if a yield controlled movement, such as a channelized right turn, features a design element (e.g., a raised crosswalk) that reduces vehicle speeds to near 0 mph.
- **Permissive left** – select when the most severe vehicle movement intersecting the crossing is a permissive left. If no pedestrians conflict with the permissive left because the pedestrians are moving under an exclusive pedestrian phase, stop/signal controlled can be selected.
- **Yield controlled** – select when the most severe vehicle movement intersecting the crossing yields to oncoming traffic immediately after the pedestrian crossing, such as at a channelized turn lane. These vehicles are likely decelerating unlike free flowing vehicles. “Yield controlled” should not be used for crossings where an otherwise free flowing vehicle must yield to a pedestrian in a crossing.
- **Free flowing** – select when the most severe vehicle movement intersecting the crossing is free flowing, such as the uninterrupted leg of a two way stop controlled intersection.

Markings

Marking type is gathered at the crossing level and is prepopulated by default, per the drawings at the end of this chapter. Edits are made using the drop-down menu. Input overrides must be the categorical values of either “marked” or “unmarked”.

This factor considers whether the crossing is marked or unmarked. Note that while the legend and assumed crossing assignment diagrams feature zebra style crosswalk markings, the presence of any style marking qualifies as “marked”. Regardless of marking presence, each intersection is assumed to have crossings on the major and minor streets for intersections or the crossroad and ramps for interchanges. At intersection control strategies where a crossing is not typically provided, the tool still assumes it is present and unmarked. This results in a decreased pedestrian score due to the lack of formal crossing availability.

Customizing Crossings

The default crosswalk locations and markings are intended to align with typical concept-level layouts of the intersection designs. However, it is possible that local design guidelines, prior project decisions, or emerging concepts for newer intersection designs result in different crossing quantities or locations. This is most likely to occur due to

- Presence or absence of channelized turn lanes,
- Presence or absence of a median, and
- Local practices regarding pedestrian facility designs for specific intersection types

When eliminating or adding a crossing, the pedestrian volumes and the number of lanes in the remaining crossings are usually impacted, and so, the user will need to manually input (or manually rewrite cell formulas for) the values for the impacted crossings.

To reset the spreadsheet to the default values, click the “Reset Default Values” button at the top of the tab. This ensures the spreadsheet has the default number of crossings for each intersection type and the cells reflect the correct default values or formulas.

Example: Eliminating a Crossing

Following is an example of modifying the traffic signal evaluation to eliminate the median refuge island on the northern approach. ***Figure C8*** shows the default crossing locations of which there are eight. This layout assumes a median refuge island exists at each approach. (Note: because the images in the *Multimodal Ped* worksheet are static, median refuge islands are not shown but implied due to the presence of two crossing assignments). The modified locations are shown in ***Figure C9***. Note that crossing 2 has been removed.

Figure C8. Default Crossing Locations and Markings for Traffic Signal

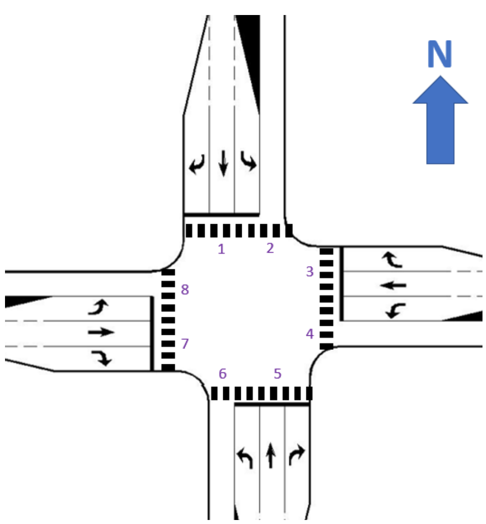


Figure C9. Modified Crossing Locations and Markings for Traffic Signal

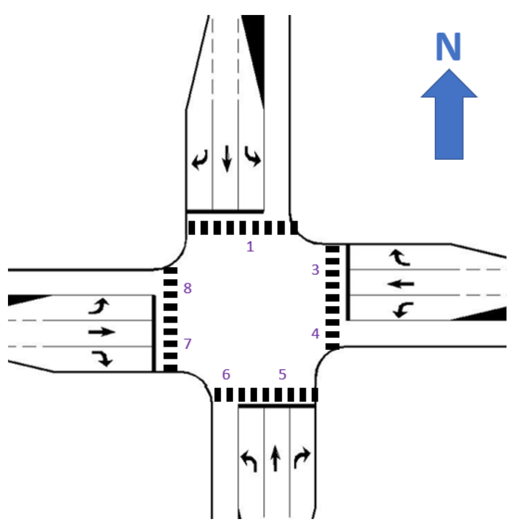


Figure C10 and ***Figure C11*** show the default and modified inputs corresponding to default and modified crossing locations, respectively. Note that the number of lanes and volume from the default Crossings 1 and 2 were combined for the modified Crossing 1. When calculating the overall intersection score, the tool will ignore Crossing 2 because the cells are empty.

Figure C10. Default Inputs for Traffic Signal

TYPE OF INTERSECTION	Sheet	Intersection Score	Out of Direction Travel	Multistage Crossing	Crossing #1					Crossing #2				
					# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings	# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings
Traffic Signal	FULL	4.78	No	Yes Crossing(s) with 2 stages	3	35	82	Stop/Signal Controlled	Unmarked	1	35	146	Stop/Signal Controlled	Marked

Figure C11. Modified Inputs for Traffic Signal

TYPE OF INTERSECTION	Sheet	Intersection Score	Out of Direction Travel	Multistage Crossing	Crossing #1					Crossing #2				
					# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings	# Lanes	Veh Speed	Volume	Conflicting Veh Type	Markings
Traffic Signal	FULL	4.65	No	Yes Crossing(s) with 2 stages	4	35	228	Stop/Signal Controlled	Unmarked					

Scores

Each crossing receives a crossing score. The intersection score is a combination of each crossing score as well as scores for the intersection-based inputs of out of direction travel and multistage crossing. A higher score indicates a safer design with the highest possible score being 6 and the lowest possible score being 0.9.

Crossing Score

The score for crossing *i* (C_i) is a combination of the factor scores for number of lanes (F_L), vehicle speed (F_S), vehicle volume and conflicting vehicle type (F_{VC}), and presence of markings (F_M). These scores are shown in the following pages.

$$C_i = \frac{F_L + F_S + F_{VC} + F_M}{4}$$

Intersection Score

The intersection score is a combination of all *n* crossing scores (C_i) and the factor scores for out of direction travel (F_T) and the multistage crossing (F_C). These scores are shown in the following pages. The out of direction travel and multistage crossing factors are inputs to the intersection score rather than crossing score because one out of direction travel or multistage crossing experience occurs over multiple crossings. Averaging the square root of the crossing scores incentivizes improving poor performing crossings over making high performing crossings marginally better.

$$Intersection\ Ped\ Score = \left[\frac{\sum_{i=1}^{n} \sqrt{C_i}}{n}\right]^2 F_T F_C$$

Factor Scores

Number of Lanes (F_L)

The score for the number of lanes ranges from 5 (best) to 1 (worst) and is shown in ***Table C4***. It is based on the commonly accepted belief that the more lanes a pedestrian must cross, the more likely the pedestrian is to experience a crash due to increased workload. This is confirmed by focus group data that pedestrians prefer crossing fewer lanes.[16]

Table C4. Number of Lanes Score

Number of Lanes	Score
1	5
2	4
3	3
4	2
5+	1

Vehicle Speed (F_S)

The score for the vehicle speed ranges from 5 (best) to 1 (worst) and is shown in ***Table C5***. It is based on the findings in the AAA study, *Impact Speed and Pedestrian's Risk of Severe Injury or Death.*[17]

Table C5. Vehicle Speed Score

Speed (mph)	Score
$\le$ 25	5
26-34	4
35-40	3
41-50	2
51+	1

[16] Schroeder, B. J., et al. "Guide for pedestrian and bicyclist safety at alternative and other intersections and interchanges." *Transportation Research Board Annual Meeting,* Washington, DC, 2021.

[17] Tefft, B. C., "Impact speed and a pedestrian's risk of severe injury or death." *Accident Analysis & Prevention,* 50: 871-878, 2013. https://www.sciencedirect.com/science/article/pii/S000145751200276X

Figure C12. Risk of severe injury by impact speed (Tefft, 2011).

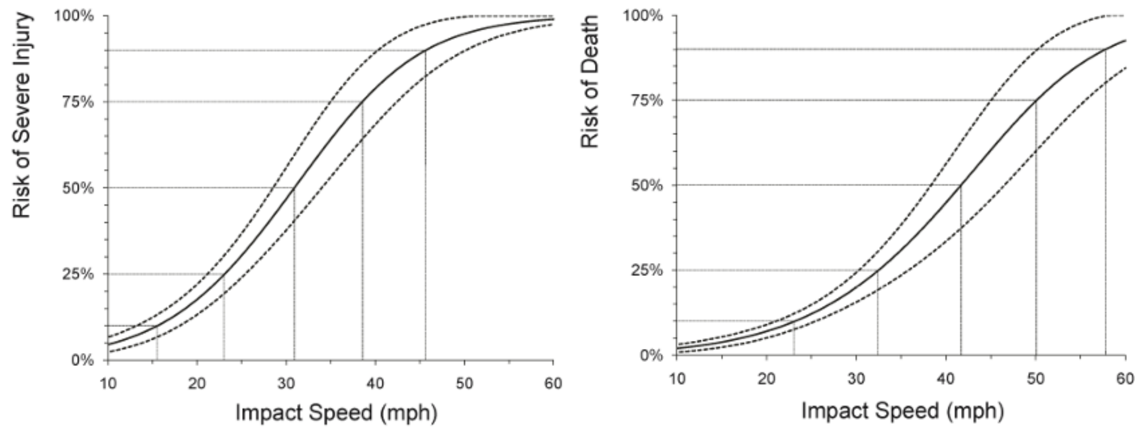


Figure 1. Risk of severe injury (left) and death (right) in relation to impact speed in a sample of 422 pedestrians aged 15+ years struck by a single forward-moving car or light truck model year 1989–1999, United States, 1994–1998. Risks are adjusted for pedestrian age, height, weight, body mass index, and type of striking vehicle, and standardized to the distribution of pedestrian age and type of striking vehicle for pedestrians struck in the United States in years 2007–2009. Dotted lines represent point-wise 95% confidence intervals. Serious injury is defined as AIS score of 4 or greater and includes death irrespective of AIS score.

Vehicle Volume and Conflicting Vehicle Type (F_{VC})

The score for the vehicle volume and conflicting vehicle type ranges from 5 (best) to 1 (worst) and is shown in ***Table C6***. The volume thresholds are based on the relationship between AADT and pedestrian crashes as reported in the *Temporal Analysis of Predictors of Pedestrian Crashes*[18] study, which shows on average across all time periods, pedestrian-vehicle crashes tend to increase as AADT increases until 100,000 vehicles and then level off. To generate hourly volumes, it was assumed that the typical hour K value was 9% and the volumes were identical across all four approaches. This yielded an hourly volume of 1,500 vehicles, which was set as the threshold for a rating between 1 and 2.

In assigning scores for the various conflicting vehicle types, the separation of movements by time under protected stop/signal control results in the driver having fewer traffic streams to focus on and increasing the likelihood of identifying a pedestrian. So, all volumes for stop/signal controlled will receive a score of 5. Permissive and yield controlled movements are similar in driver behavior such that the driver is looking for a gap in oncoming vehicles, and therefore, the scores are the same for those two conflicting vehicle types. Finally, free flowing vehicles received the lowest scores because drivers typically are not anticipating yielding to other users, whether vehicle or pedestrian. At higher volumes, the gaps available to pedestrians are smaller in size; therefore, all volumes will receive a score of 1 when the free-flowing volume is above 450 veh/hr.

[18] Guerra, E., et al. "Temporal Analysis of Predictors of Pedestrian Crashes." *Transportation Research Record* 2674(8): 252–263, 2020. https://doi.org/10.1177/0361198120920633.

Table C6. Vehicle Volume and Conflicting Vehicle Control Type Score

Volume (vph)	Conflicting Vehicle Control Type			
	Stop/Signal	Permissive Left	Yield	Free Flowing
< 225	5	5	5	3
226-450	5	4	4	2
451-1,350	5	3	3	1
1,351-2,250	5	2	2	1
>2,250	5	1	1	1

Presence of Markings (F_M)

The score for the presence of crosswalk markings is a binary of 5 (best) and 1 (worst) and is shown in ***Table C7***. Crosswalk markings at the intersection reduce the likelihood of right turning vehicles encroaching on the crossing. This also creates an additional disincentive for designs that fail to provide full access to pedestrians across major and minor streets (intersections) or ramps and crossroads (major intersections). Failure to mark a crosswalk does not result in a lack of pedestrian attempts to cross.

Table C7. Presence of Markings Score

Marking	Score
Present	5
Absent	1

Out of Direction Travel (F_T)

The score for out of direction travel is a binary of 1 (best) and 0.9 (worst) and is shown in ***Table C8***. It is based on the finding that pedestrians experiencing delay are more likely to exhibit risky behavior.[19]

Table C8. Out of Direction Travel Score

Out of Direction Travel	Score
No	1.0
Yes	0.9

Multistage Crossing (F_C)

The score for the multistage crossing ranges from 1.2 (best) to 0.8 (worst) and is shown in ***Table C9***. It is based on the FHWA report, *Safety Effects of Marked vs*

[19] TRB. *Highway Capacity Manual, Sixth Edition*. Transportation Research Board of the National Academies, Washington, DC, 2016.

Unmarked Crosswalks at Uncontrolled Locations, which found the presence of raised medians reduced pedestrian crashes by 46%.[20] This suggests a two-stage crossing improves pedestrian safety. However, surveys and focus groups of pedestrians found three or more stages to be confusing.[21]

Table C9. Multistage Crossing Score

Number of Stages	Score
1	1.0
2	1.2
3+	0.8

Multimodal Bike Tab

The *Multimodal Bike* worksheet contains previously provided user inputs, new user inputs, and default values for conducting the assessment of bicycle facilities. Two new user inputs must be added for valid bicycle scores. The analyst can use drop-down menus or direct inputs to override default values.

Previously provided user inputs in the CAP-X workflow, which are auto-populated in the *Multimodal Bike* worksheet, include:

- Number of adjacent thru lanes (per leg)
- Leg AADT (calculated from previous volume entry)
- Roadway speeds (entered by user on the *Multimodal Ped* worksheet)

Default values include for the following items:

- Conflicting control type (per leg)
- Out of direction travel (per leg)
- Riding between travel lanes (per leg)
- Riding across free flow ramp (per leg)

New user inputs require for the following item:

- Major and minor street bicycle facility type

[20] Zegeer, Charles V., et al. *Safety Effects of Marked vs Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines*. No. FHWA-RD-01-075. FHWA, Washington, DC, 2002.
[21] Schroeder, B. J., et al. "Guide for pedestrian and bicyclist safety at alternative and other intersections and interchanges." *Transportation Research Board Annual Meeting,* Washington, DC, 2021.

Leg Assignment

The *Multimodal Bike worksheet* considers approach legs of an intersection. For most intersections, there are four or fewer (e.g. continuous green T) legs. However, some intersections have more than four legs due to the presence of auxiliary intersections. A description of the assignment of any additional leg, noted in the spreadsheet as "[Direction] 2" can be found by hovering over that intersection's "Type of Intersection" cell.

Inputs

Facility Types

The Facility type for both the major and minor roadways is a required input to the bicycle methodology. It is found at the top of the worksheet and serves as an input to all intersection types. Edits are made using the drop-down menu. Categorical inputs include:

- **Shared with vehicles** – select if bicycles and vehicles will use the same space on the roadway, such as a motor vehicle travel lane with no other bicycle facility provided.
- **On-street lane** – select if a dedicated bicycle space is provided adjacent to the motor vehicle travel lane. This includes parking separated or bollard separated bicycle lanes. This facility type can still be selected if vehicle and bicycle paths cross at points near the intersection (e.g., for the opening of an exclusive right turn lane).
- **Shared use path** – select if an off-street facility is provided for bicycles. This includes facilities which are at the same elevation of the motor vehicle facilities but physically and continuously separated (e.g., by a continuous median or curb).

The *Facility Type* input table in CAP-X (***Figure C13***) is found at the top of the worksheet and serves as an input to all intersection types.

Figure C13. Facility Type Inputs

Facility Type	
Major Street Facility Type	Shared with Vehicles
Minor Street Facility Type	On-Street Lane

Leg AADT

AADT is gathered at the leg level and is directly collected from prior user inputs on the *Volume Input* tab. Any override input must be a positive integer. This factor considers the vehicular AADT adjacent to the bicyclist.

Weekday K factors were calculated for each hour of the day by averaging the K factor for 7 different roadway classifications found in the FDOT ICE Tool. The highest hourly K factor was then used to convert hourly volumes provided on the *Volume Input* worksheet into AADTs.

Roadway Operating Speeds

Default roadway operating speeds are prepopulated from the *Multimodal Ped* tab. Edits should be made on the Multimodal Ped worksheet so that pedestrian and bicycle analysis is conducted with the same roadway operating speeds. The *Roadway Speeds* input table in CAP-X (***Figure C14***) is found at the top of the worksheet and serves as an input to all intersection types.

Figure C14. Roadway Speeds Inputs

Roadway Operating Speeds (MPH)	
Major Street Speed Limit	45
Minor Street Speed Limit	35
Mini Roundabout Entry & Exit Speed	20
1-Lane Roundabout Entry & Exit Speed	25
2-Lane Roundabout Entry & Exit Speed	30

Number of Adjacent Thru Lanes

Number of lanes is gathered at the leg level and is directly collected from prior user inputs on the *Alt Num Lanes Input* tab. Any override input must be a positive integer. This factor considers the number of thru lanes a bicyclist would need to cross to move into the left turn lane. It totals the number of thru lanes traveling in the same direction as the bicyclist on the same approach leg. If two stage left turn boxes or some other method of turning left will be provided, the input should be set to 1.

For the minor legs of the signalized and unsignalized restricted crossing U-turn intersections, this factor considers the number of adjacent thru lanes on the major leg after the bicyclist has made the right turn from the minor leg.

Conflicting Control Type

Conflicting vehicle type is gathered at the leg level and is prepopulated by default. Edits are made using the drop-down menu. This factor considers the dominant control type for vehicular traffic moving perpendicular to the direction of the bicyclist. The categorical conflicting control types are:

- **Stop/signal controlled** - select when the conflicting vehicles operate under stop or signal control. This can still be selected if a right turning movement operates under yield control.
- **Yield controlled** – select when the conflicting vehicles operate under yield control, such as at roundabouts.
- **Free Flowing** – select when the conflicting vehicles are free flowing, such as the uninterrupted leg of a two way stop controlled intersection.

Out of Direction Travel

Out of direction travel is gathered at the leg level and prepopulated by default for all intersections. Edits are made using the drop-down menu. Input overrides must be a categorical value of either “yes” or “no”.

This factor considers the desire of bicyclists to travel in the most direct path possible. It should be flagged as yes if any movement by a bicyclist on that leg results in vertical or horizontal out of direction travel. For example, the minor legs of the Restricted Crossing U-Turn intersection *Out of Direction Travel* is assumed to be “yes” because a bicyclist desiring to go straight or turn left must turn right and travel to the downstream U-turn.

It is assumed at Median U-Turns that bicyclists will perform a two-stage left turn even if no pavement marking for such is provided.

Riding Between Opposing Travel Directions

Riding between travel lanes moving in two opposite directions is gathered at the leg level and prepopulated for all intersections. Edits are made using the drop-down menu. Input overrides must be a categorical value of either “yes” or “no”.

This factor considers instances where a bicyclist is traveling between opposing directions of motor vehicle traffic, such as at the displaced left turn.

Riding Across Free Flow Ramp or Channelized Turn Lane

Riding across free flow ramp is gathered at the leg level and is prepopulated by default. Edits are made using the drop-down menu. Input overrides must be the categorical values of either “yes” or “no”.

This factor considers whether a bicyclist traveling along the leg must cross a free flowing vehicle movement. This most often occurs when a bicyclist crosses the downstream end of a channelize turn lane or the up- or downstream end of a loop ramp.

Scores

Each crossing receives a leg score which is then combined with all other leg scores at the intersection. The intersection score is a combination of each leg score. A higher score indicates a safer design with the highest possible score being 5 and the lowest possible score being 1score

Leg Score

The score for Leg *i* (L_i) is a combination of the factor scores of facility type, leg AADT, and speed (F_{FAS}), number of adjacent thru lanes (F_A), conflicting control type (F_C), out of direction travel (F_T), riding between travel lanes (F_B), and riding across free flow ramps (F_R). The scores for these values are shown later in this document.

$$L_i = \frac{F_{FAS} + F_A + F_C + F_T + F_B + F_R}{6}$$

Intersection Score

The intersection score is a combination of all *n* leg scores (L_i). Averaging the square root of the leg score incentivizes improving poor performing legs over making high performing legs marginally better.

$$Intersection\ Score = \left[\frac{\sum_{i=1}^{n} \sqrt{L_i}}{n}\right]^2$$

Factor Scores

Facility Type, Leg AADT, and Roadway Speeds (F_{FAS})

The score for the facility type, leg AADT, and roadway speeds ranges from 5 (best) to 1 (worst) and is shown in ***Table C10***, ***Table C11***, and ***Table C12***. Grouping of facility type and vehicle speeds, as well as AADT thresholds of 3,000 and 7,000 veh/day were selected based on the FHWA Bikeway Selection Guide[22] preferred bikeway types shown in ***Figure C15***. Assigned scores for shared use paths were set to 5 due to the bicycle-vehicle interaction being limited to designated crossings.

Table C10. Leg AADT and Roadway Operating Speed Score for Shared Use Path Facility

Volume (vpd)	Operating Speed
	All
≤ 3,000	5
3,001 - 7,000	5
>7,000	5

[22] Schultheiss, Bill, et al. *Bikeway Selection Guide*. No. FHWA-SA-18-077. FHWA Office of Safety, 2019.

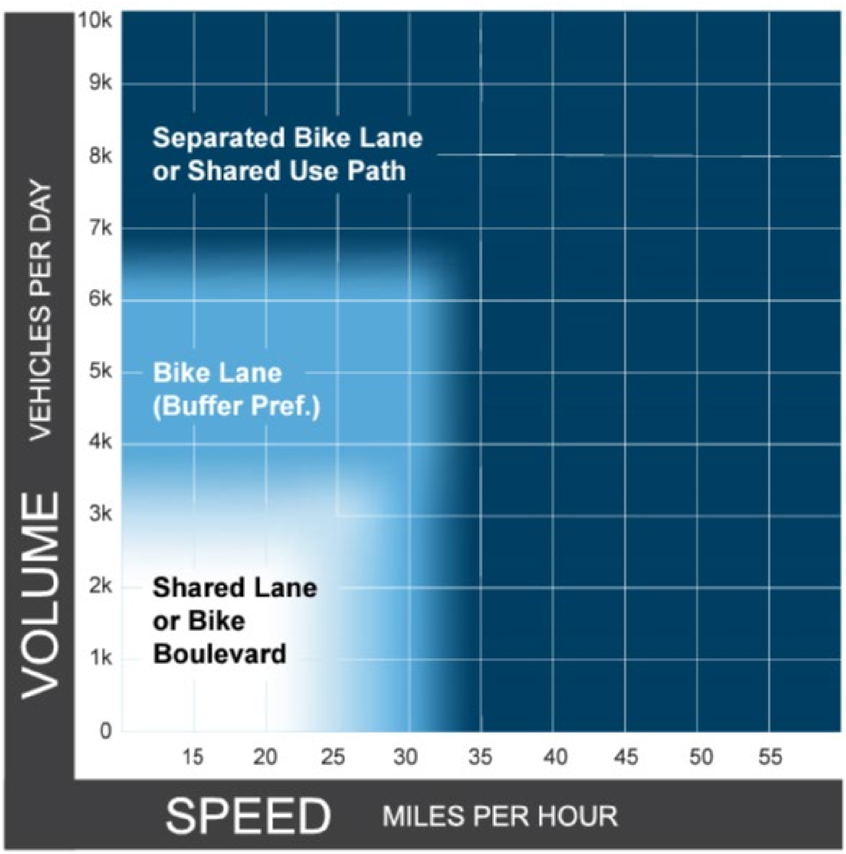
Table C11. Leg AADT and Roadway Operating Speed Score for On-Street Lane Facility

Volume (vpd)	Operating Speed (mph)			
	≤ 25	26-30	31-39	≥ 40
≤ 3,000	5	4	4	2
3,001 - 7,000	4	4	4	2
>7,000	3	2	2	1

Table C12. Leg AADT and Roadway Operating Speed Score for Shared with Vehicle Facility

Volume (vpd)	Operating Speed (mph)			
	≤ 25	26-30	31-39	≥ 40
≤ 3,000	5	4	3	2
3,001 - 7,000	3	3	2	1
>7,000	2	1	1	1

Figure C15. Preferred Bikeway Type for Urban, Urban Core, Suburban, and Rural Town Contexts (Source: FHWA Bikeway Selection Guide, 2019)[22]



Assigned scores for on-street lanes and shared lanes are guided by level of traffic stress (LTS) scoring tables[23] shown in ***Figure C16***.

For on-street lane facilities, the mixed traffic criteria table is used (***Figure C16a***). Where the LTS tables provided more granular scoring (e.g., sub-classification of AADTs), average values across all LTS are used. For example, in considering the score for on-street lanes with operating speeds between 26 and 30 mph and AADT less than or equal to 3,000 veh/day, all LTS scores which meet those criteria (highlighted in red) are averaged.

For bike lane facilities, the "bike lanes and shoulders not adjacent to a parking lane" table is used (***Figure C16b***). LTS for "1 thru lane per direction, or unlaned" is used to determine scores for AADTs less than or equal to 3,000 veh/day. LTS for "2 thru lanes per direction" is used to determine scores for AADTs between 3,000 and 7,000 veh/day. In both instances, LTS values are averaged across speed and bike lane width as necessary. LTS values for "3+ lanes per direction" is used to determine scores for AADTs greater than 7,000 veh/day.

Figure C16. Level of Traffic Stress Criteria for Road Segments, Version 2.0: (a) Mixed Traffic Criteria and (b) Bike Lanes and Shoulders not Adjacent to a Parking Lane (Source: Peter Furth, 2017)

__Mixed traffic criteria__

Number of lanes	Effective ADT*	Prevailing Speed						
		≤ 20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50+mph
Unlaned 2-way street (no centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 1	LTS 1	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4
	1501-3000	LTS 2	LTS 2	LTS 2	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
1 thru lane per direction (1-way, 1-lane street or 2-way street with centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4
	1501-3000	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
2 thru lanes per direction	0-8000	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	8001+	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4
3+ thru lanes per direction	any ADT	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4

* Effective ADT = ADT for two-way roads; Effective ADT = 1.5*ADT for one-way roads

(a)

__Bike lanes and shoulders not adjacent to a parking lane__

Number of lanes	Bike lane width	Prevailing Speed					
		≤ 25 mph	30 mph	35 mph	40 mph	45 mph	50+ mph
1 thru lane per direction, or unlaned	6+ ft	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
2 thru lanes per direction	6+ ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	4 or 5 ft	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 4
3+ lanes per direction	any width	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4

Notes 1. If bike lane / shoulder is frequently blocked, use mixed traffic criteria.
2. Qualifying bike lane / shoulder should extend at least 4 ft from a curb and at least 3.5 ft from a pavement edge or discontinuous gutter pan seam
3.Bike lane width includes any marked buffer next to the bike lane.

(b)

[23] Furth, P. "Level of Traffic Stress Criteria for Road Segments V.2." Level of Traffic Stress, https://peterfurth.sites.northeastern.edu/2014/05/21/criteria-for-level-of-traffic-stress/

Number of Adjacent Thru Lanes (F_A)

The score for the number of adjacent thru lanes ranges from 5 (best) to 1 (worst) and is shown in ***Table C13***. It considers the number of lanes a bicyclist must cross to move from the right side of the road when making a left turn. Each movement across a lane is a potential interaction with at least one motor vehicle driver. Additional lanes result in increased interactions and therefore receive lower scores.

Table C13. Number of Adjacent Thru Lanes Score

Number of Lanes	Score
1	5
2	4
3	2
4+	1

Conflicting Control Type (F_C)

The score for the vehicle volume and conflicting vehicle type ranges from 5 (best) to 1 (worst) and is shown in ***Table C14***. In assigning scores for the various conflicting vehicle types, the separation of movements by time under protected stop/signal control results in additional protection for the bicyclist and therefore is given a score of 5. Yield controlled movements, found at roundabouts, receives a score of 4 because drivers have a slightly higher workload but are still actively looking for roadway users. Finally, free flowing vehicles received the lowest score 1 because drivers are not anticipating the need to yield and bicyclists must look for and accept a gap in traffic.

Table C14. Conflicting Control Type Score. a)

Conflicting Control Type	Score
Stop/Signal	5
Yield	4
Free Flowing	1

Out of Direction Travel (F_T)

The score for out of direction travel is a binary of 5 (best) and 1 (worst) and is shown in ***Table C15***. It is based on the commonly accepted belief that bicyclists experiencing additional delay for out of direction travel are more likely to exhibit risky behavior.

Table C15. Out of Direction Travel Score

Out of Direction Travel	Score
No	5
Yes	1

Riding Between Opposing Travel Directions (F_B)

The score for riding between travel lanes is a binary of 5 (best) and 1 (worst) and is shown in ***Table C16***. Bicyclists in focus groups confirmed riding between travel lanes increases discomfort due to being unable to maneuver away from an errant motor vehicle.[24] Additionally, riding between travel lanes almost always results in bicycle and motor vehicle paths crossing at least once.

Table C16. Riding Between Travel Lanes Score

Riding Between Travel Lanes	Score
No	5
Yes	1

Riding Across Free Flow Ramp or Channelized Lane (F_R)

The score for riding across free flow ramps is a binary of 5 (best) and 1 (worst) and is shown in ***Table C17***. Vehicles making a free flow movement are typically not expecting to yield to another user, so bicyclists crossing such a movement are at increased risk as compared to a bicyclist continuing to move parallel to motor vehicles.

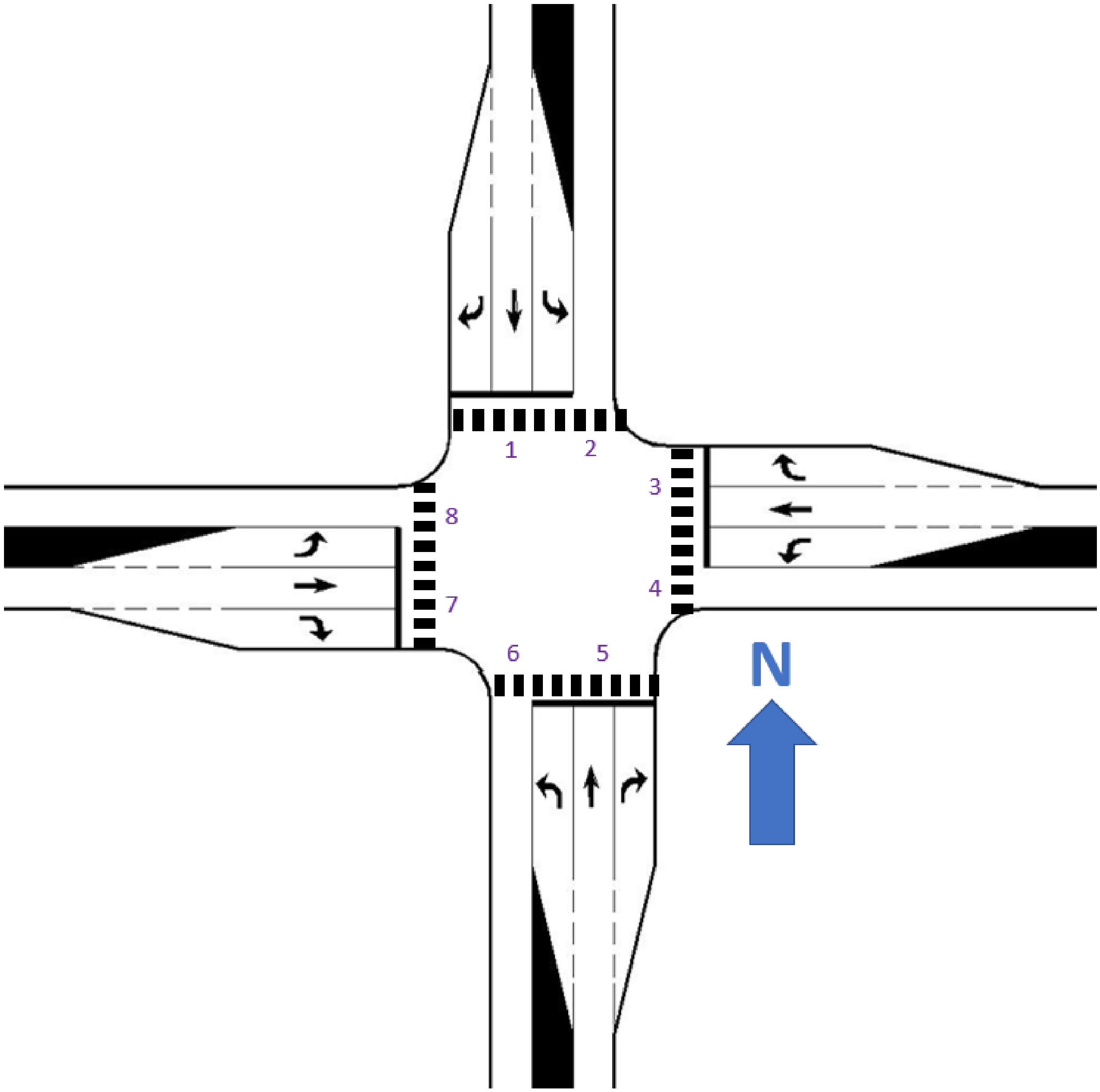
Table C17. Riding Across Free Flow Ramp Score

Riding Across Free Flow Ramp	Score
No	5
Yes	1

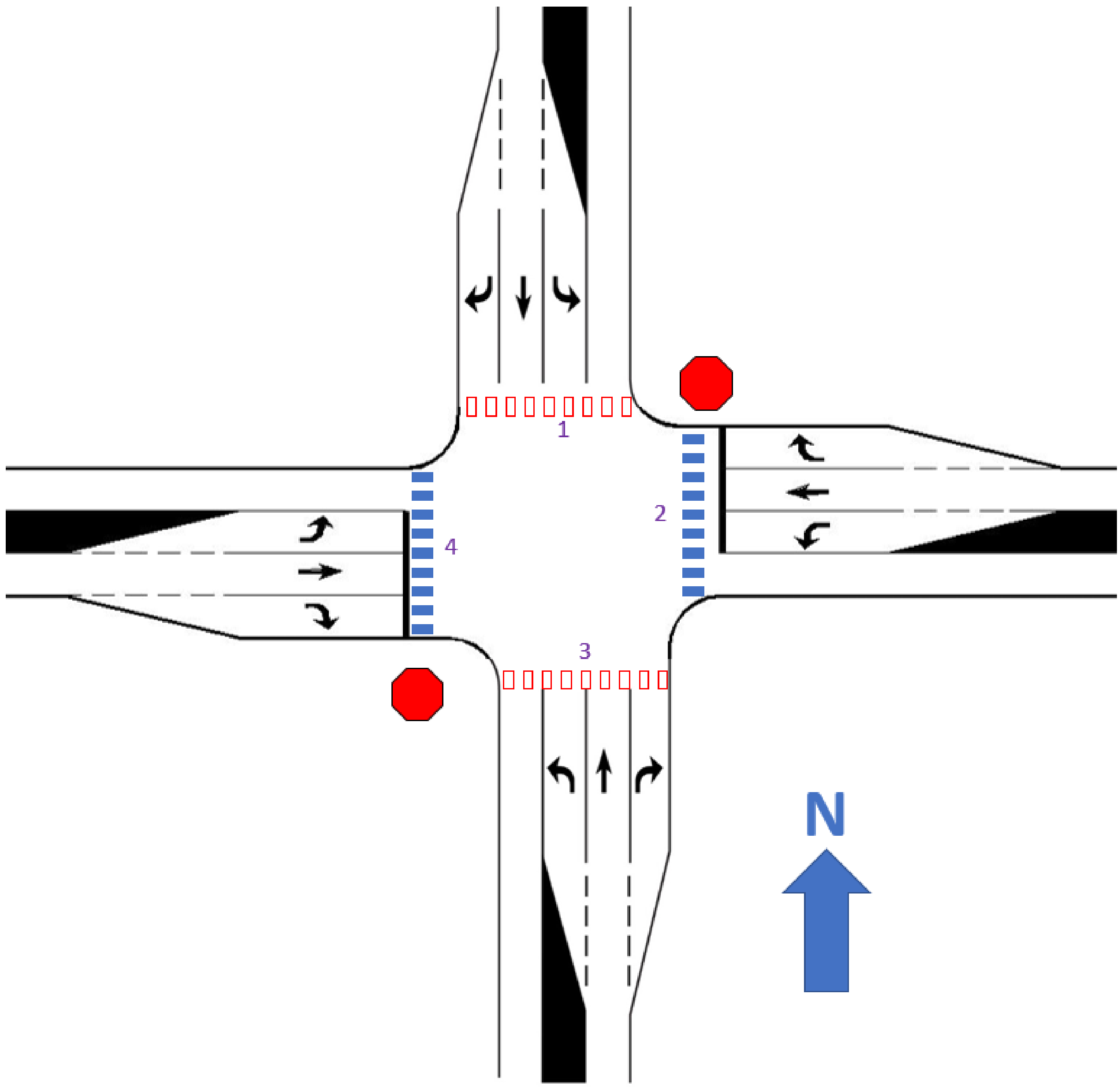
[24] Schroeder, B. J., et al. "Guide for pedestrian and bicyclist safety at alternative and other intersections and interchanges." *Transportation Research Board Annual Meeting,* Washington, DC, 2021.

Pedestrian Default Crossing Locations and Marking Images

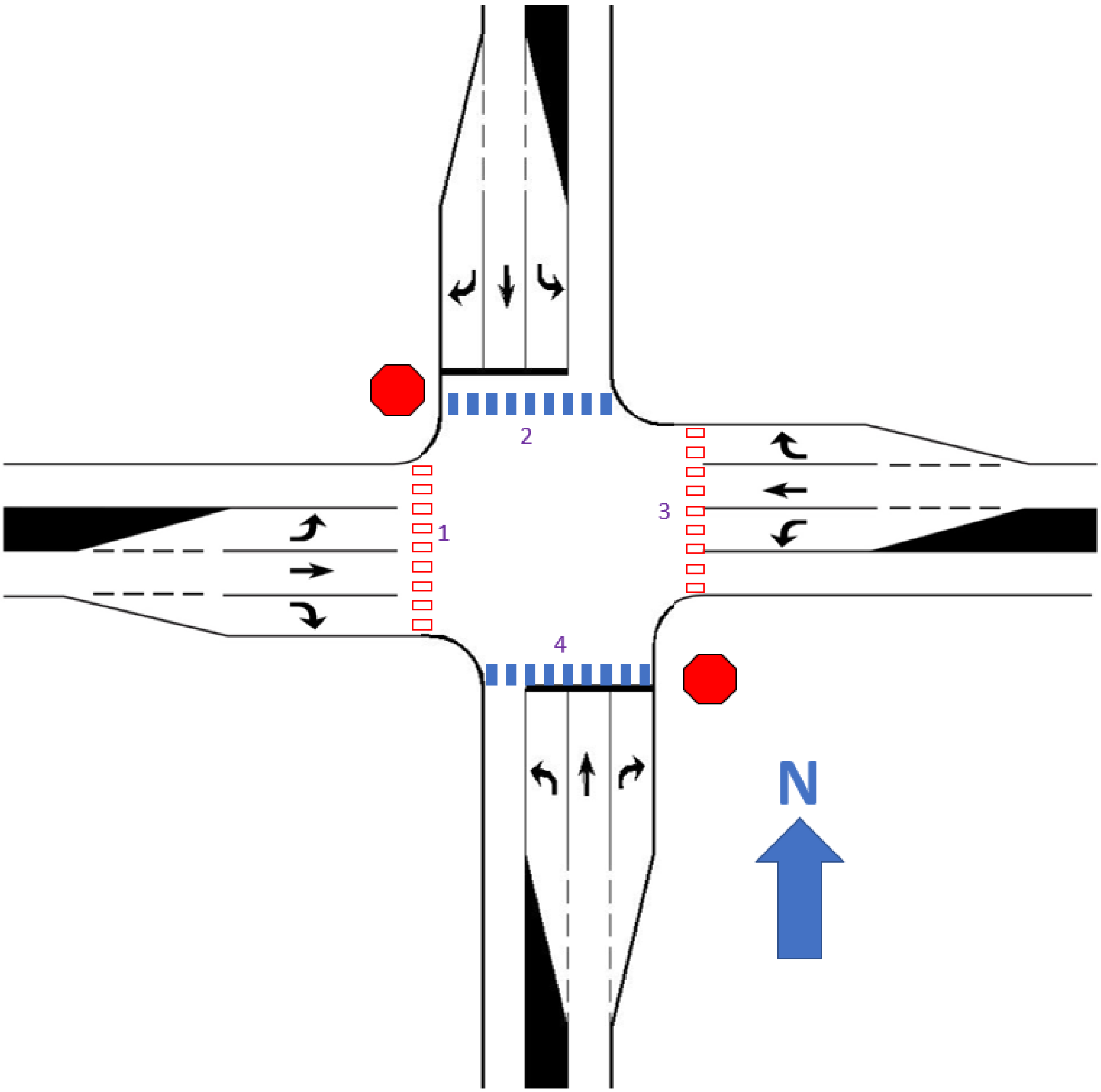
Traffic Signal



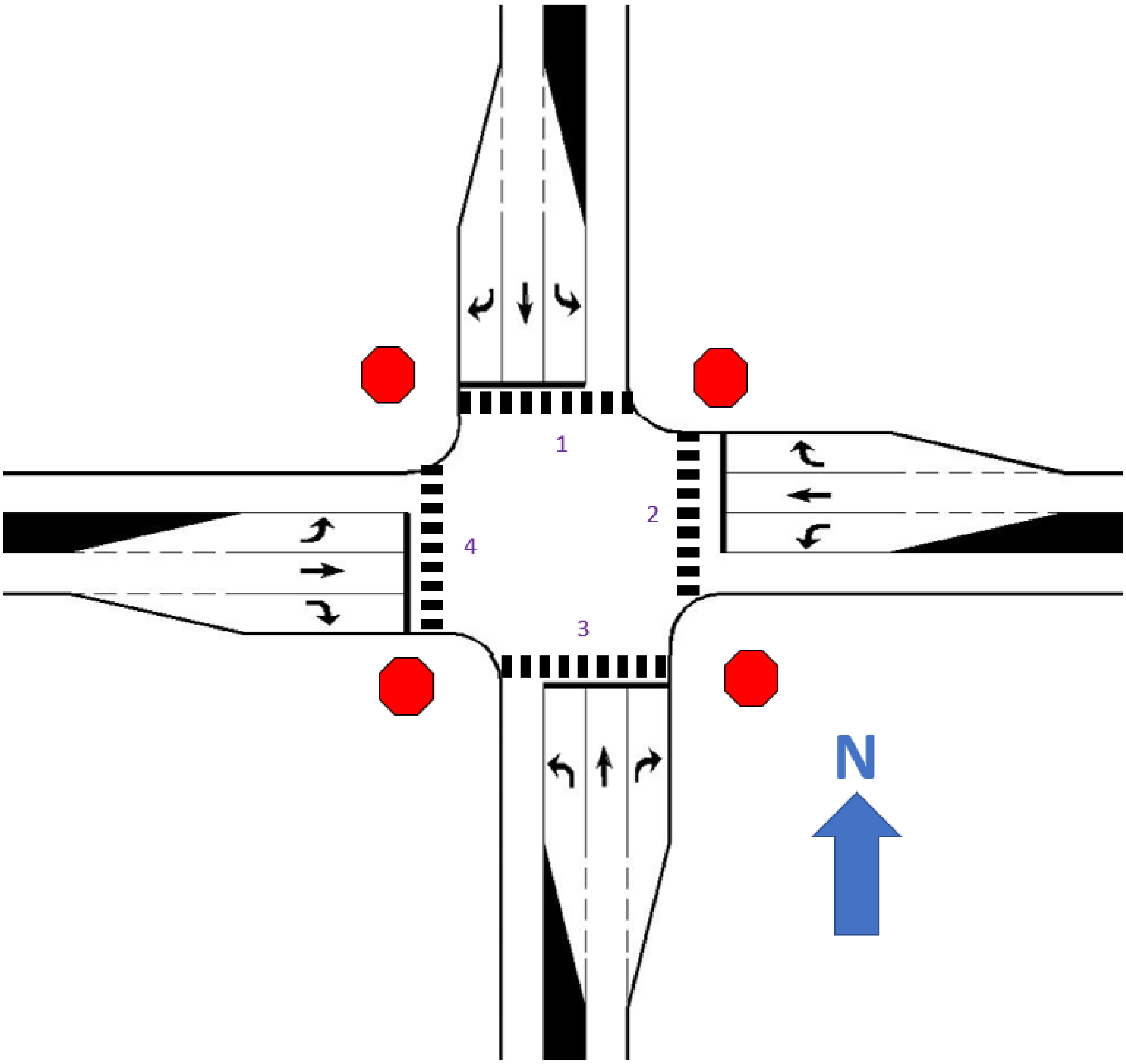
Two-Way Stop Control (N-S)



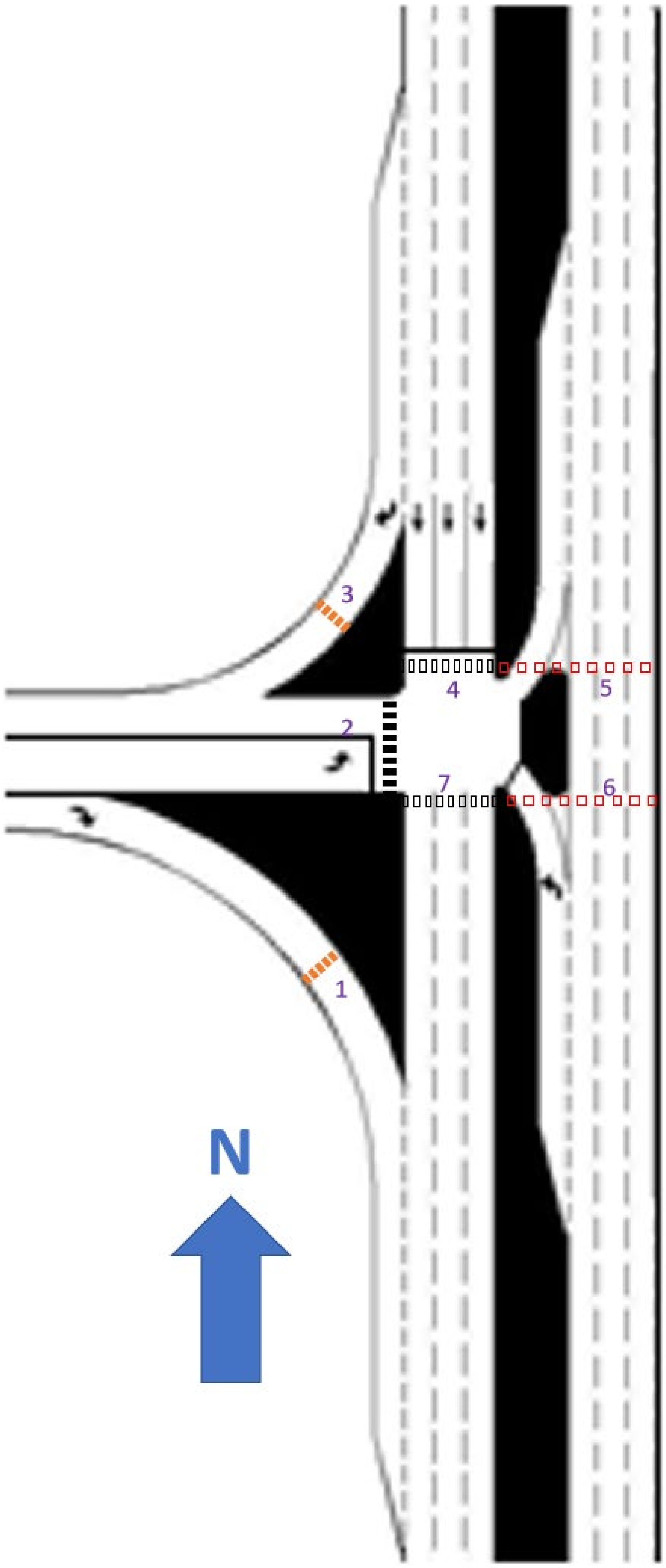
Two-Way Stop Control (E-W)



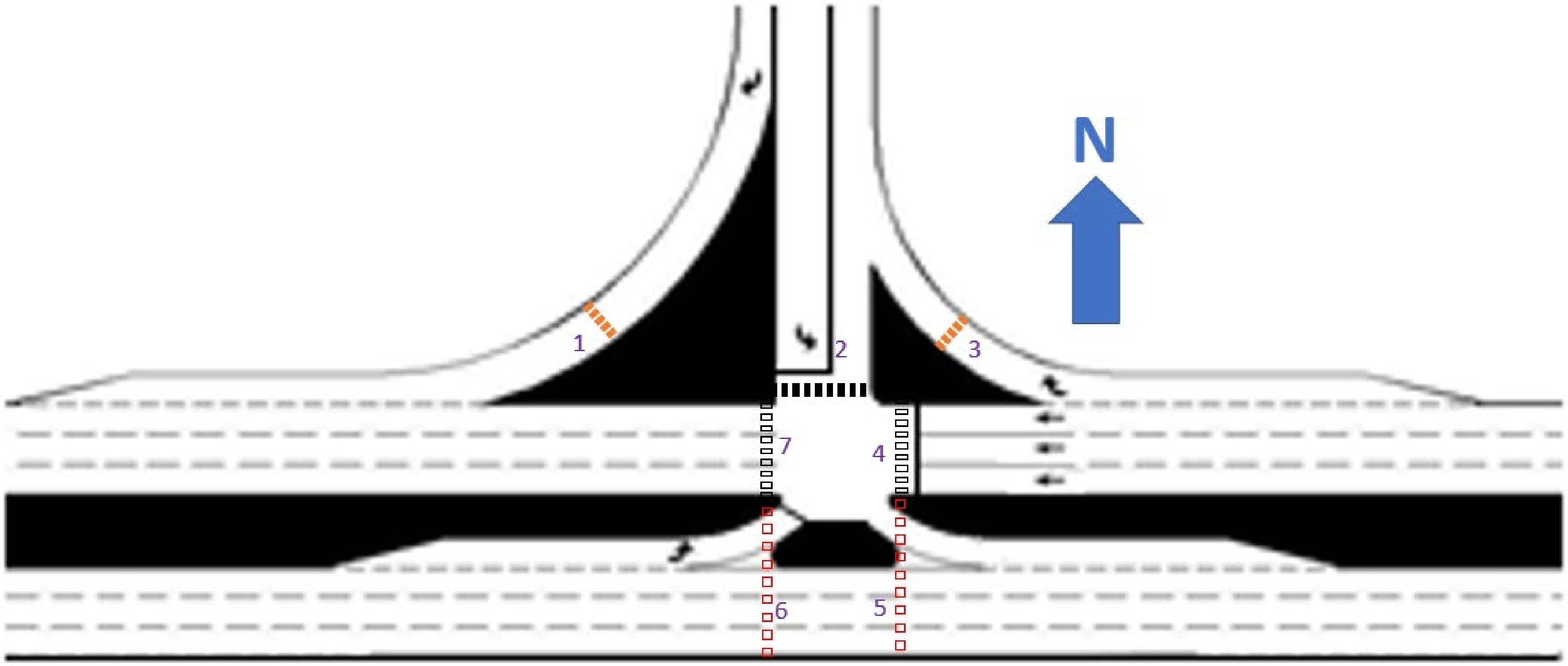
All-Way Stop Control



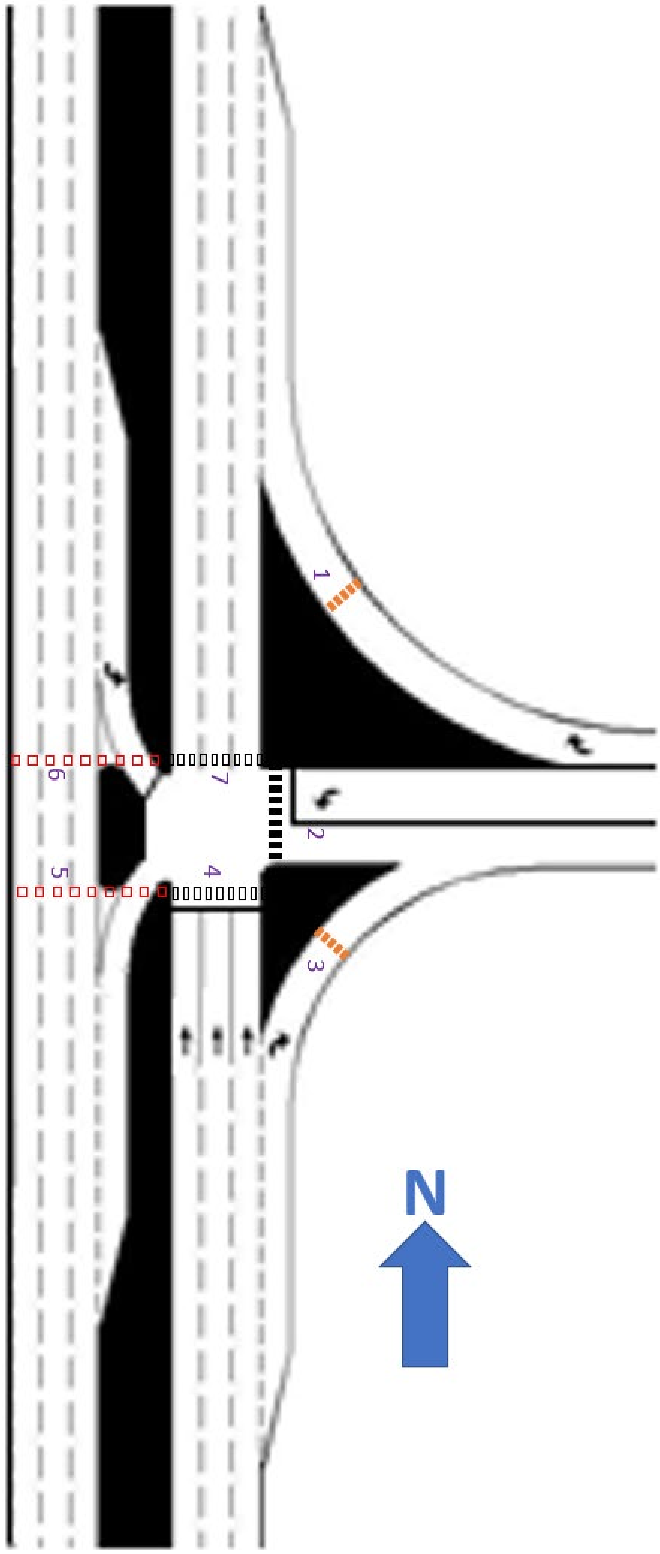
Continuous Green T (W)



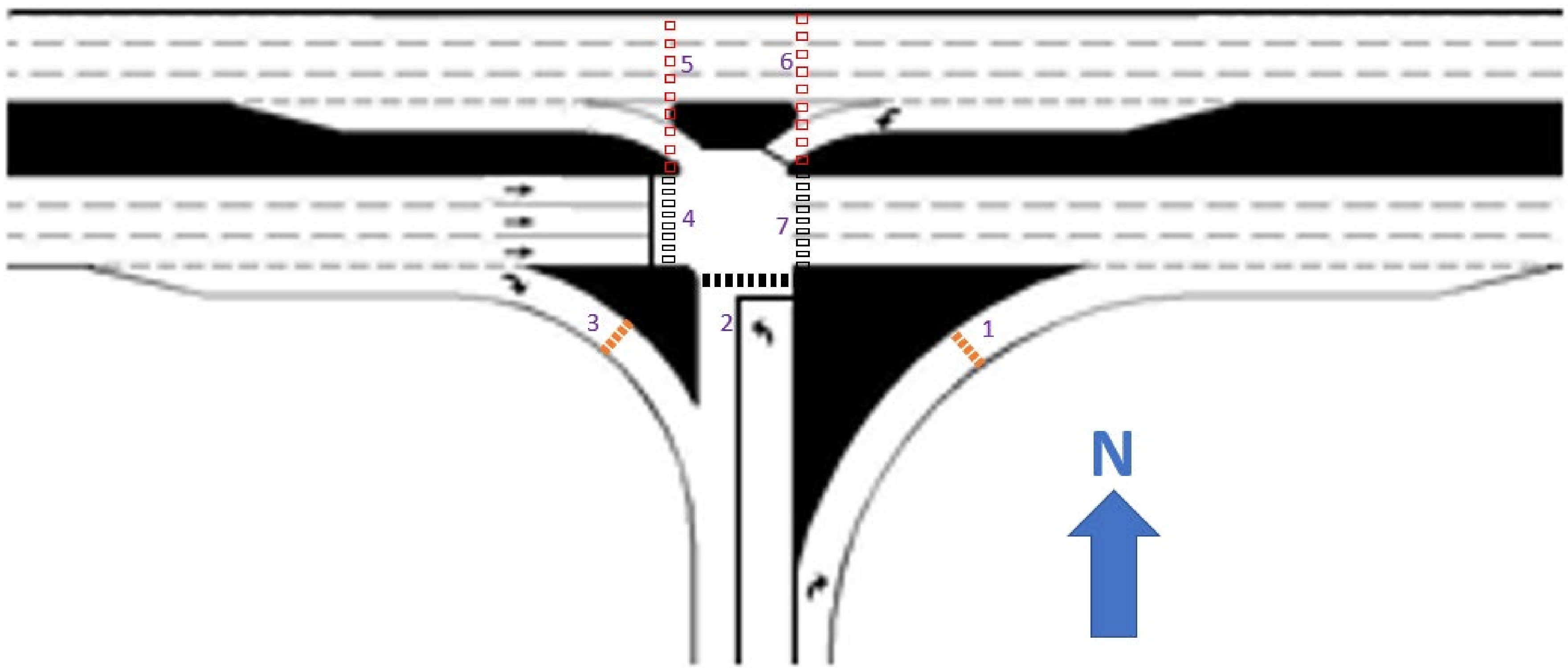
Continuous Green T (N)



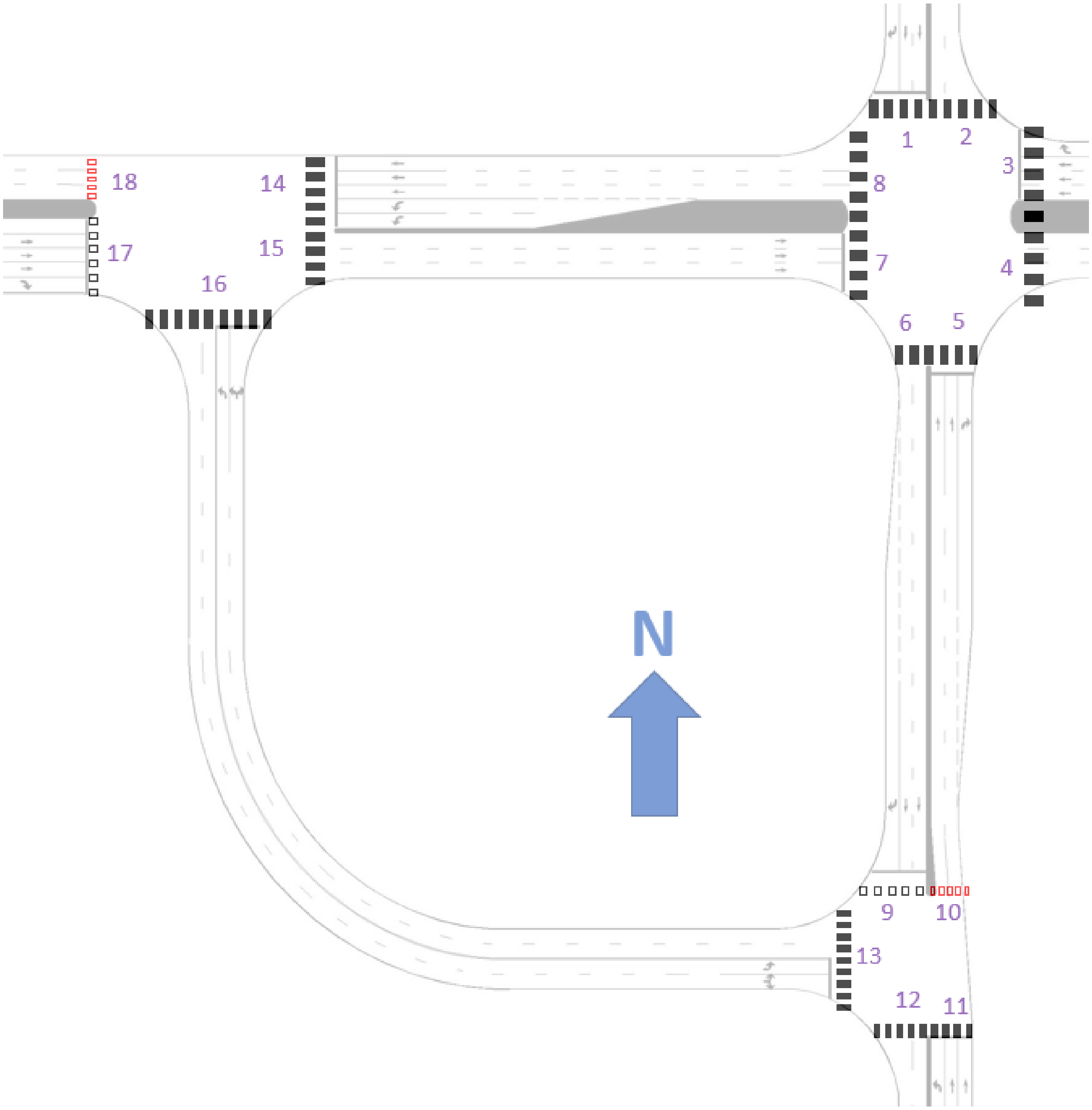
Continuous Green T (E)



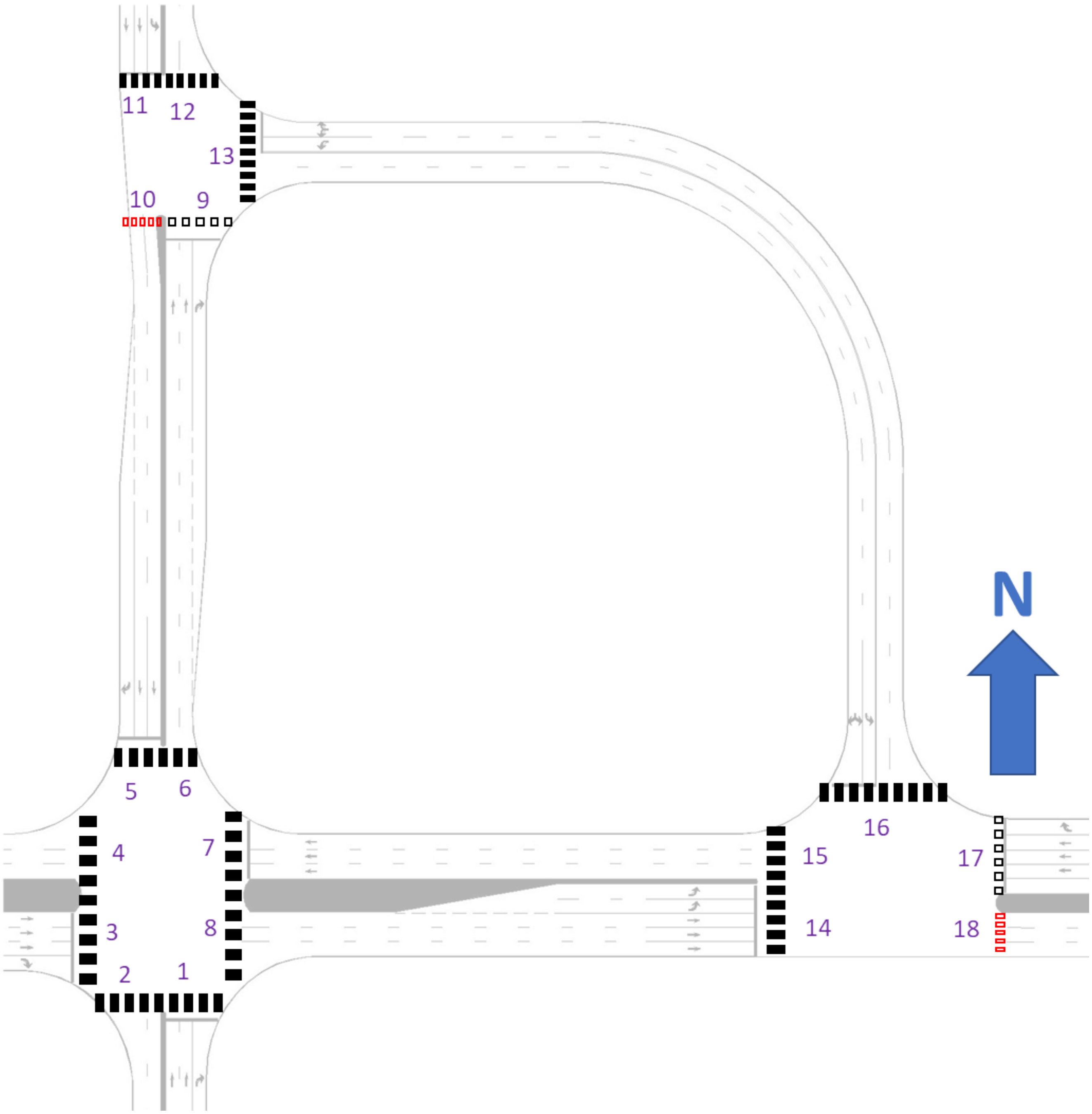
Continuous Green T (S)



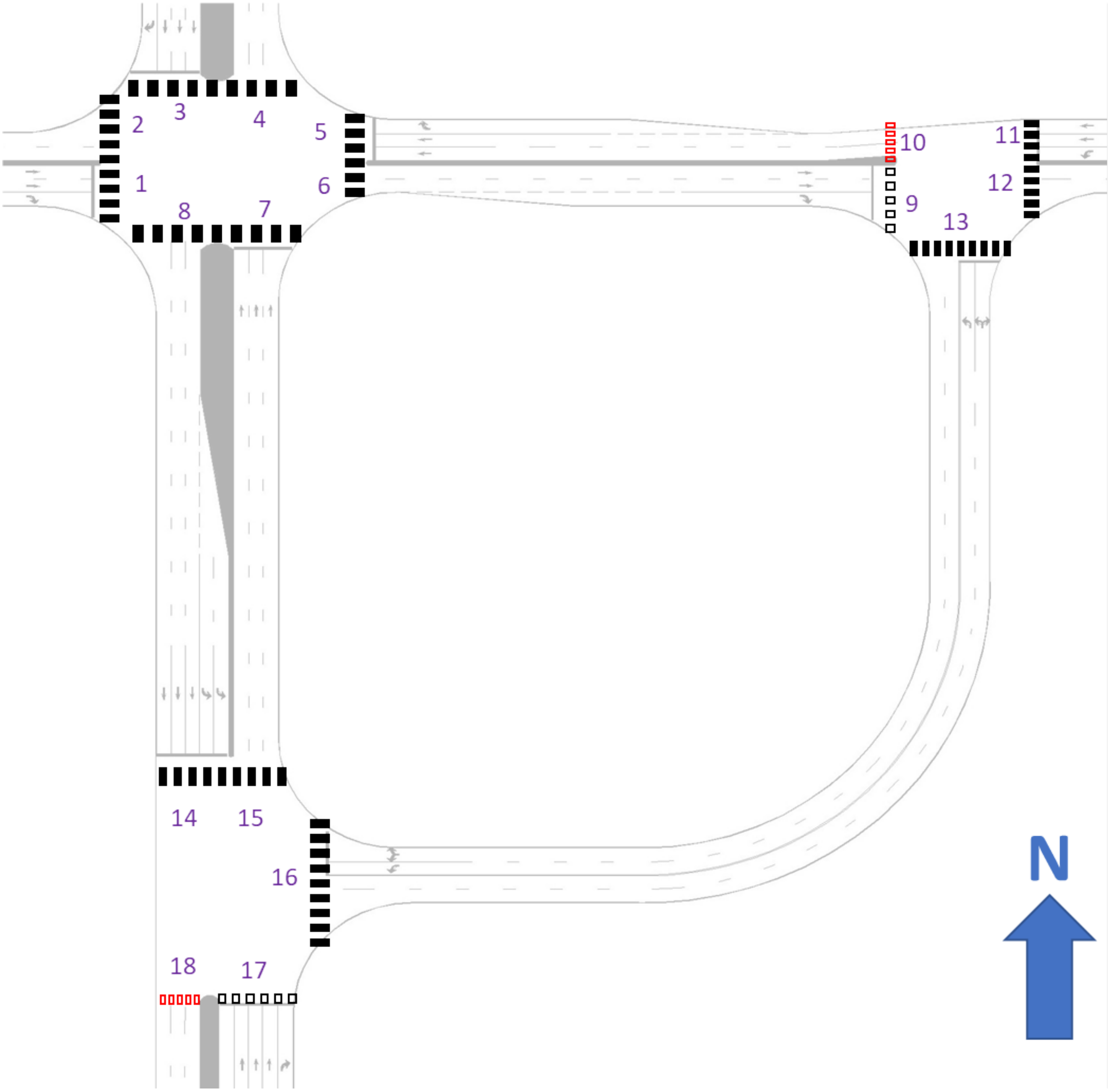
Quadrant Roadway (S-W)



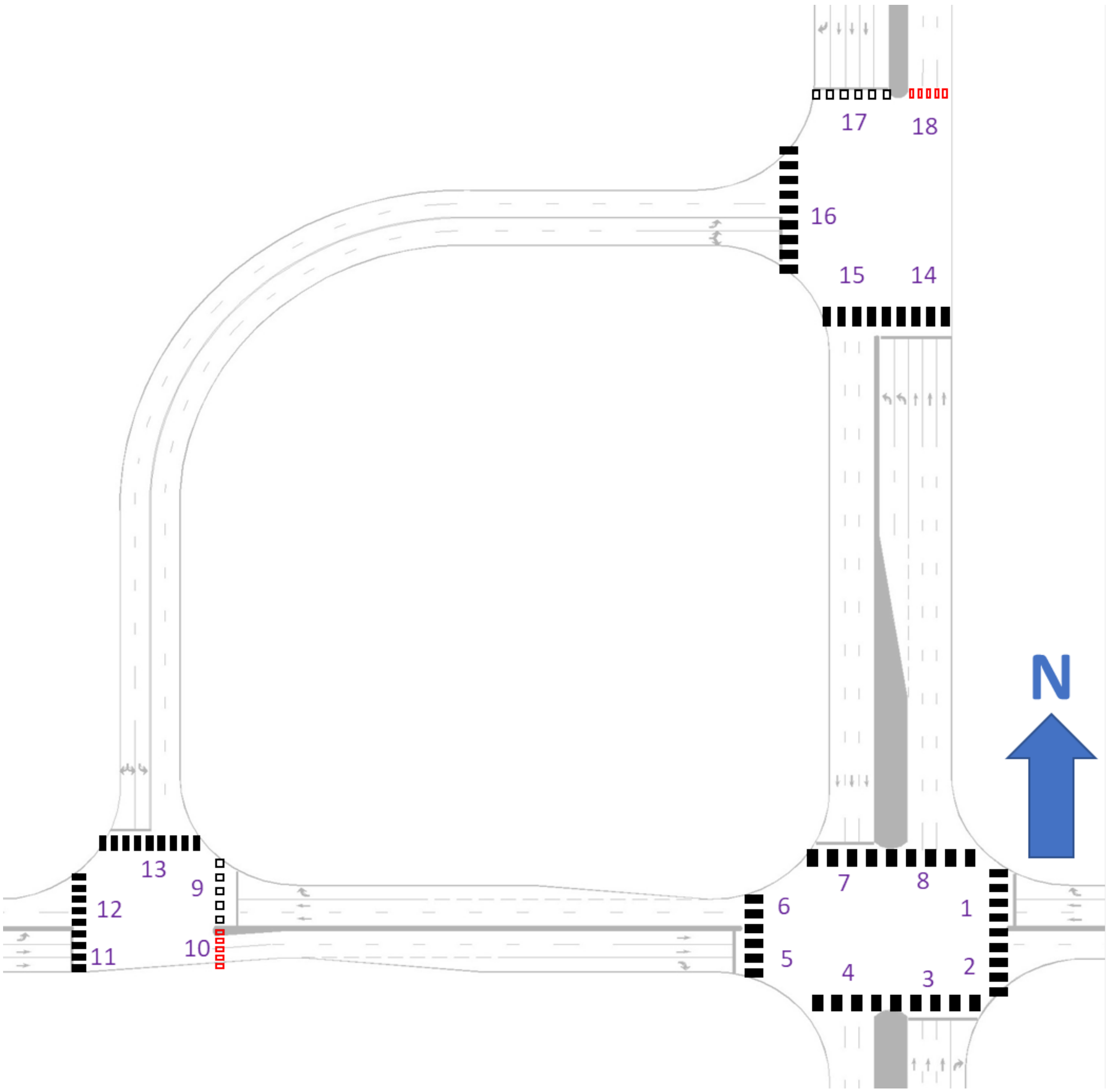
Quadrant Roadway (N-E)



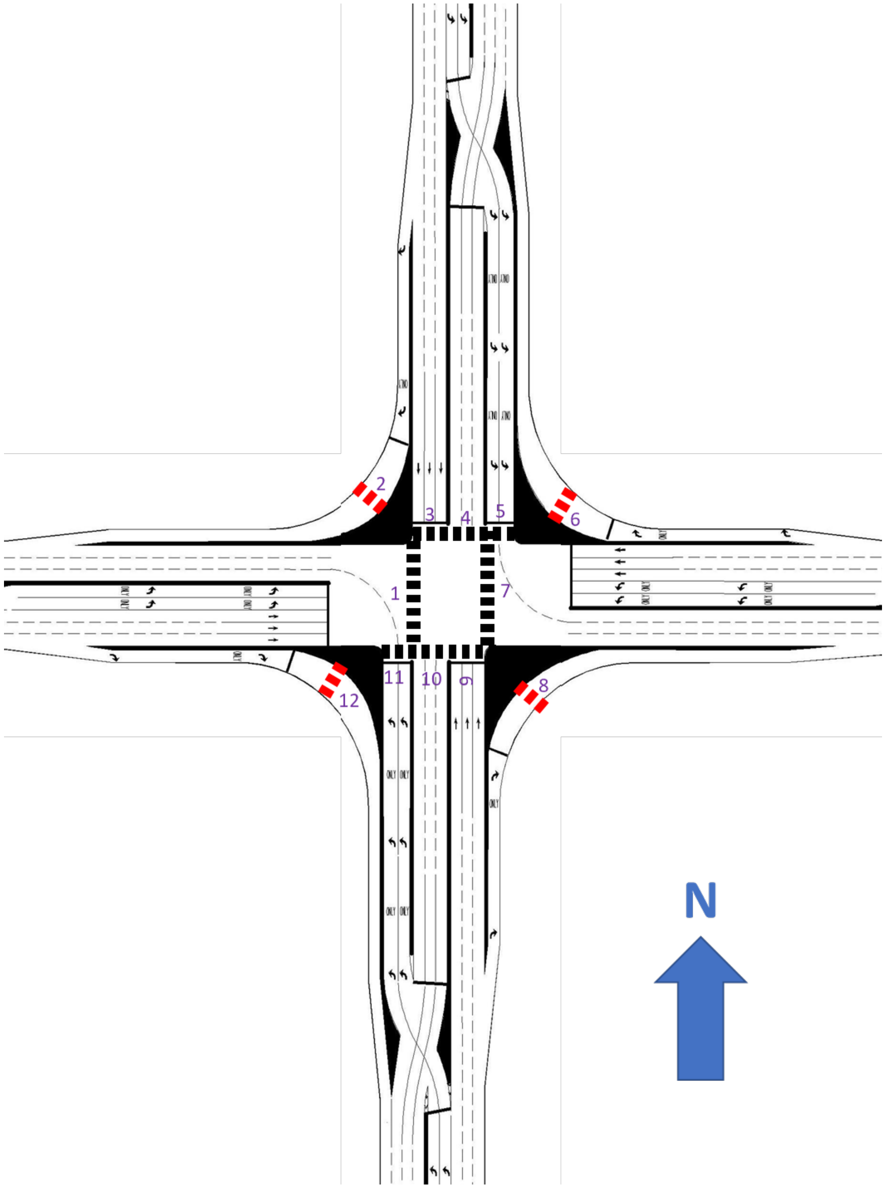
Quadrant Roadway (S-E)



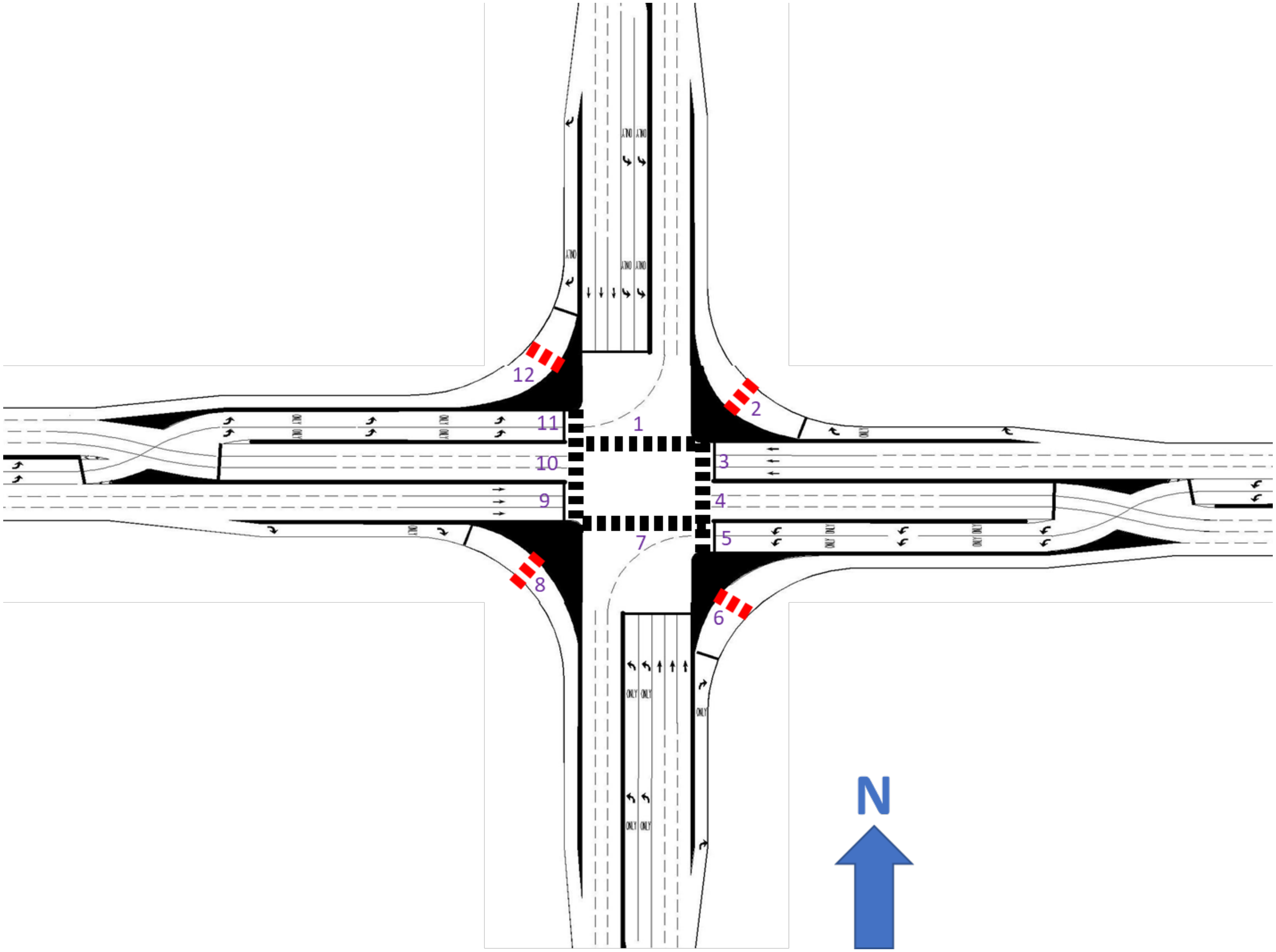
Quadrant Roadway (N-W)



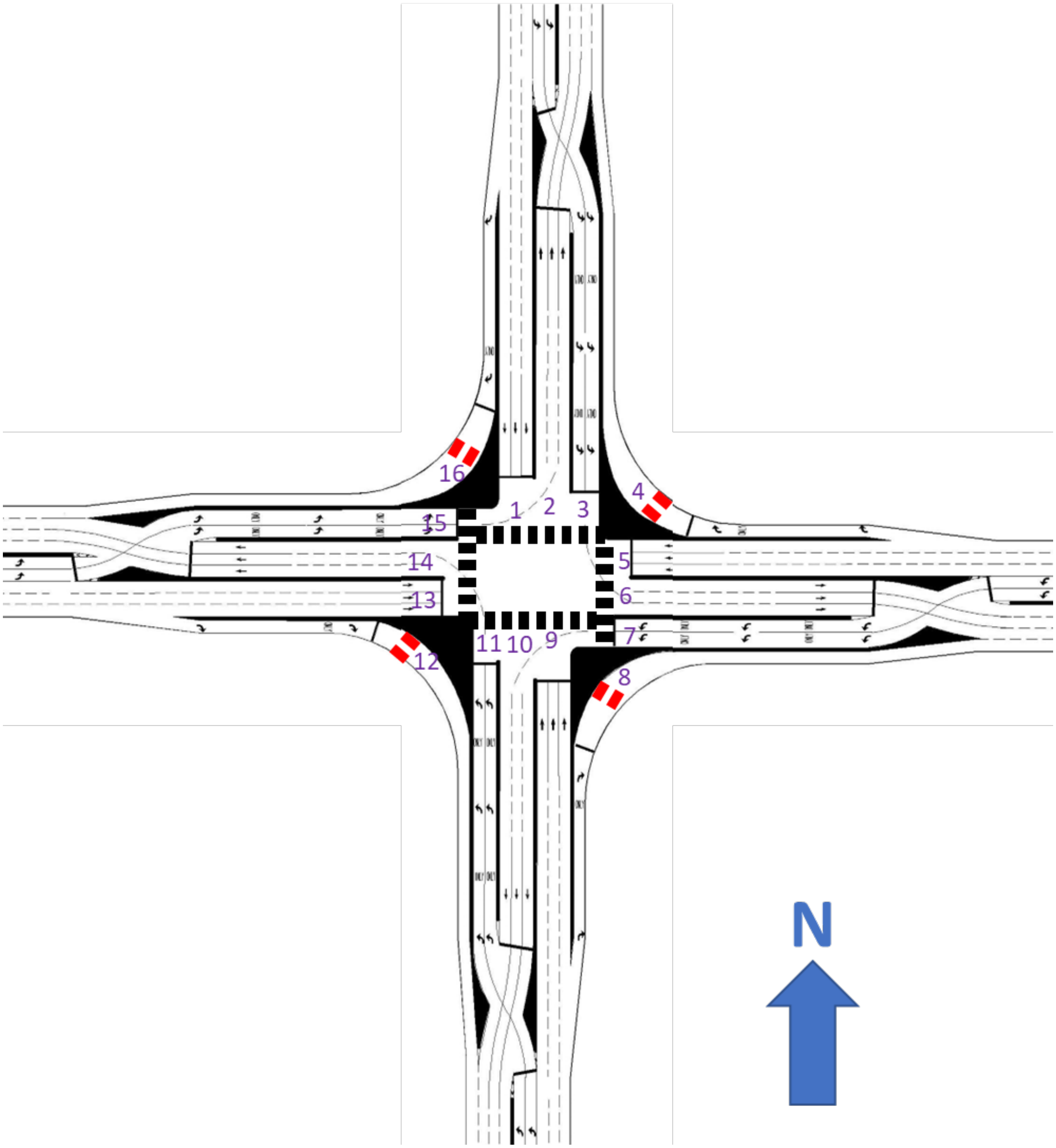
Partial Disaplced Left Turn (N-S)



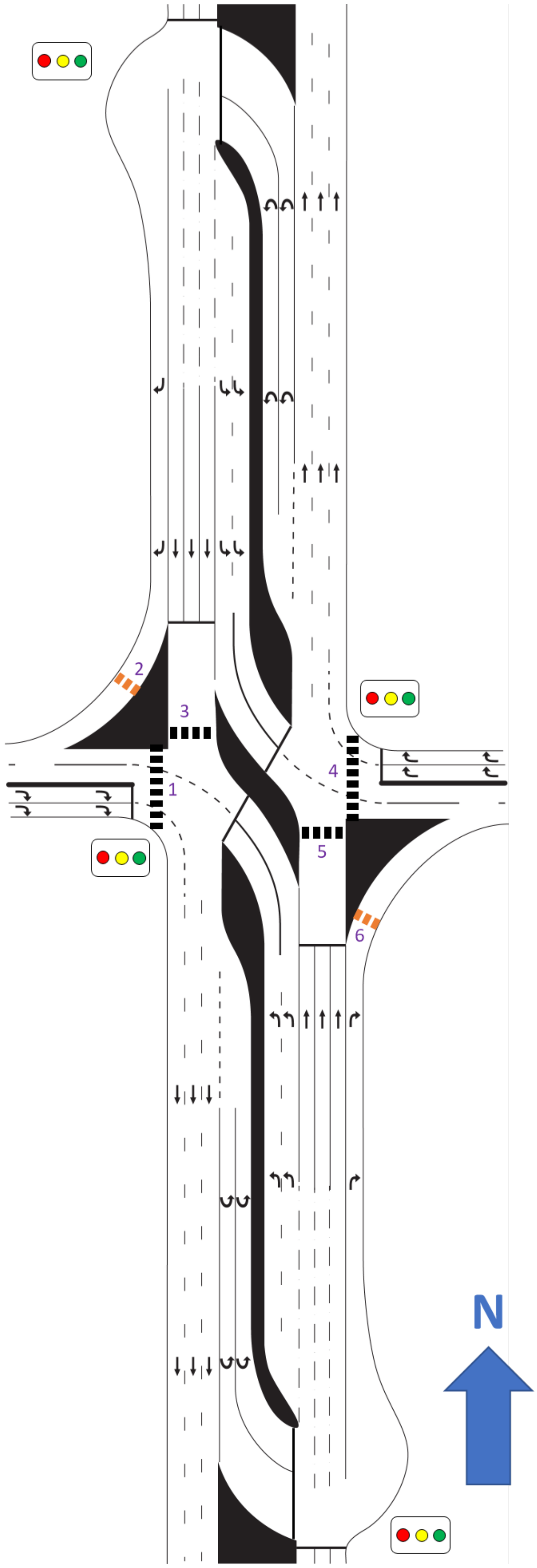
Partial Disaplced Left Turn (E-W)



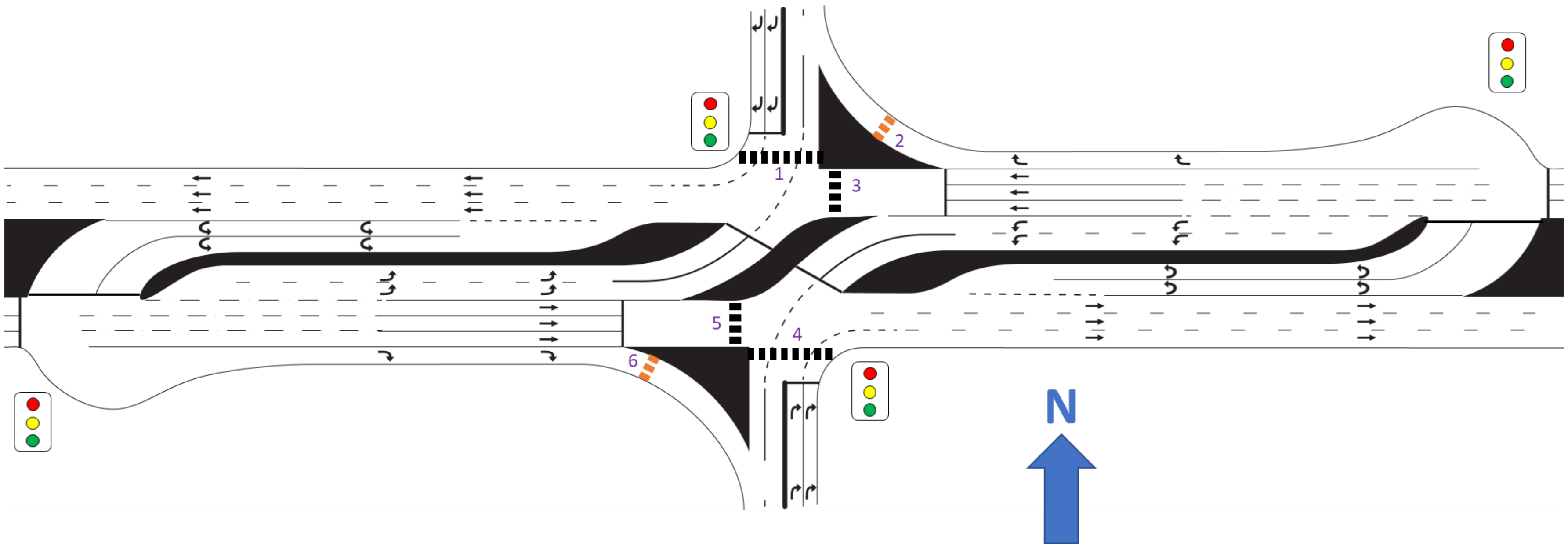
Displaced Left Turn



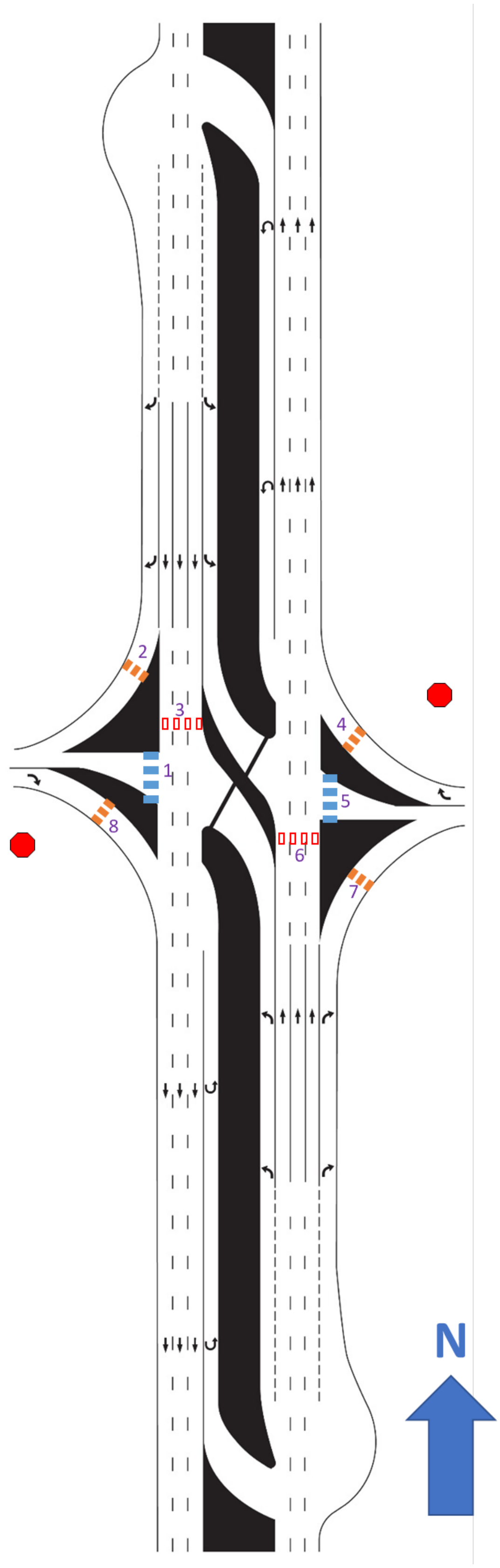
Signalized Restricted Crossing U-Turn (N-S)



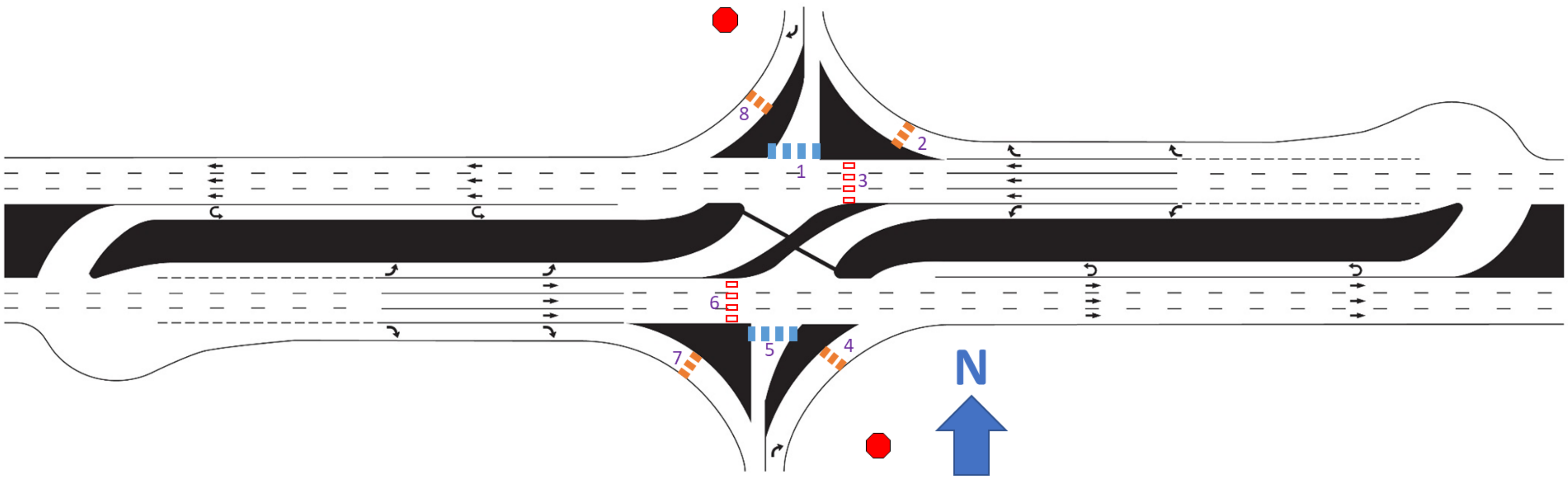
Signalized Restricted Crossing U-Turn (E-W)



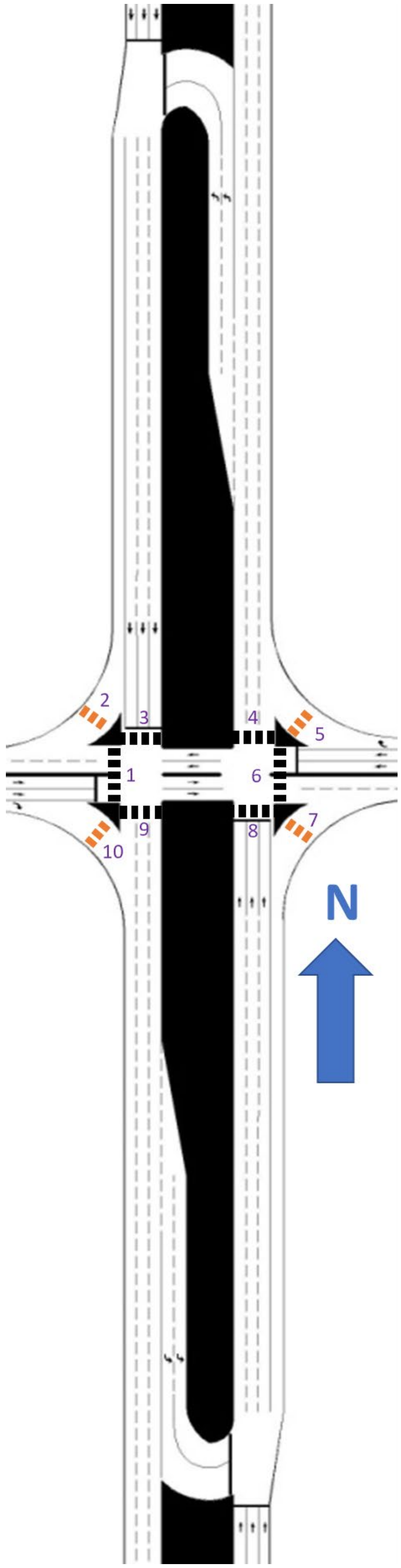
Unsignalized Restricted Crossing U-Turn (N-S)



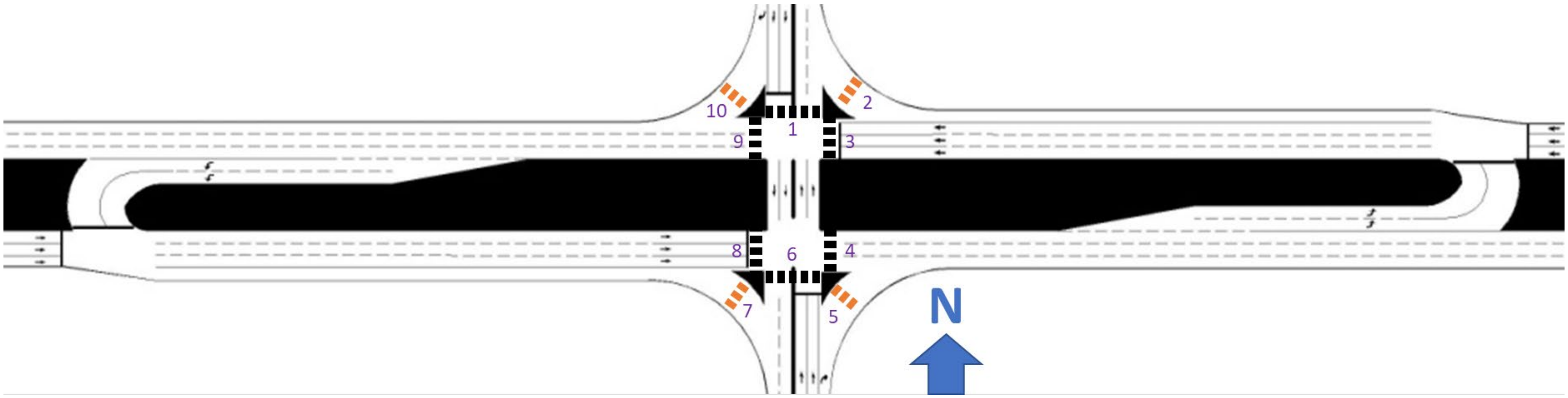
Unsignalized Restricted Crossing U-Turn (E-W)



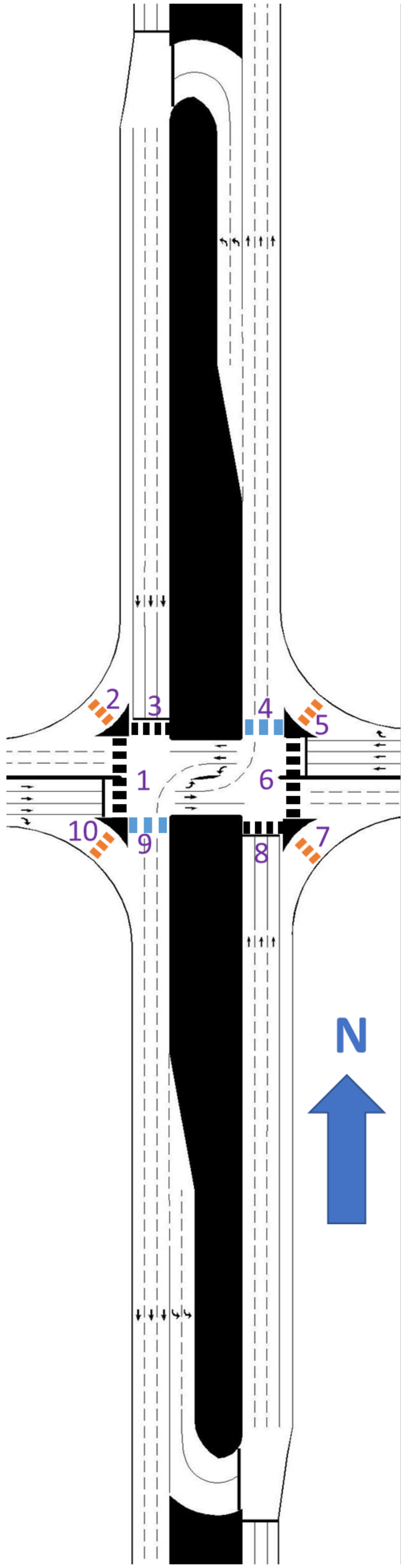
Median U-Turn (N-S)



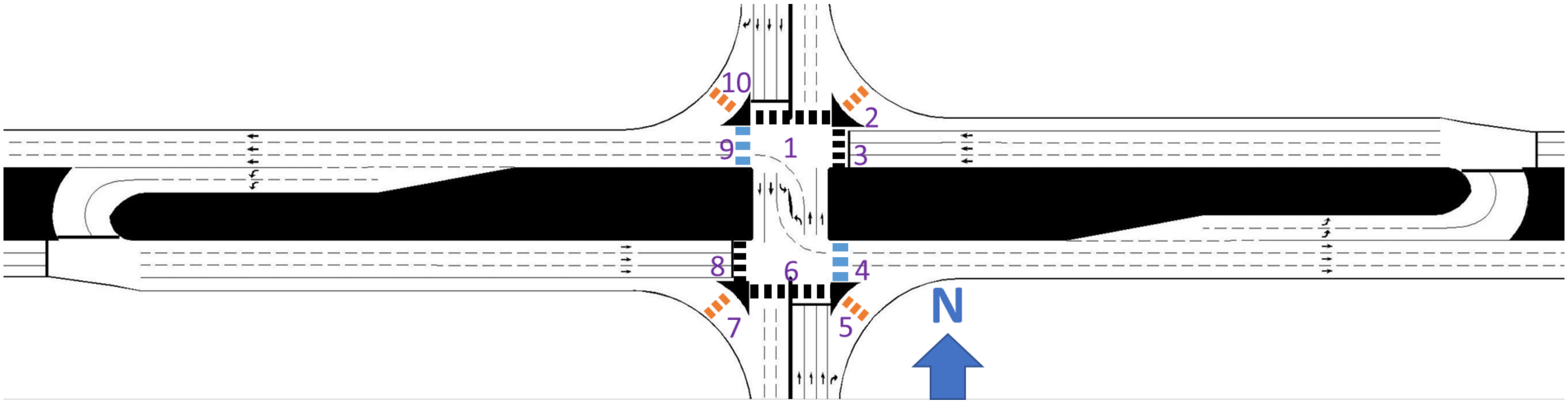
Median U-Turn (E-W)



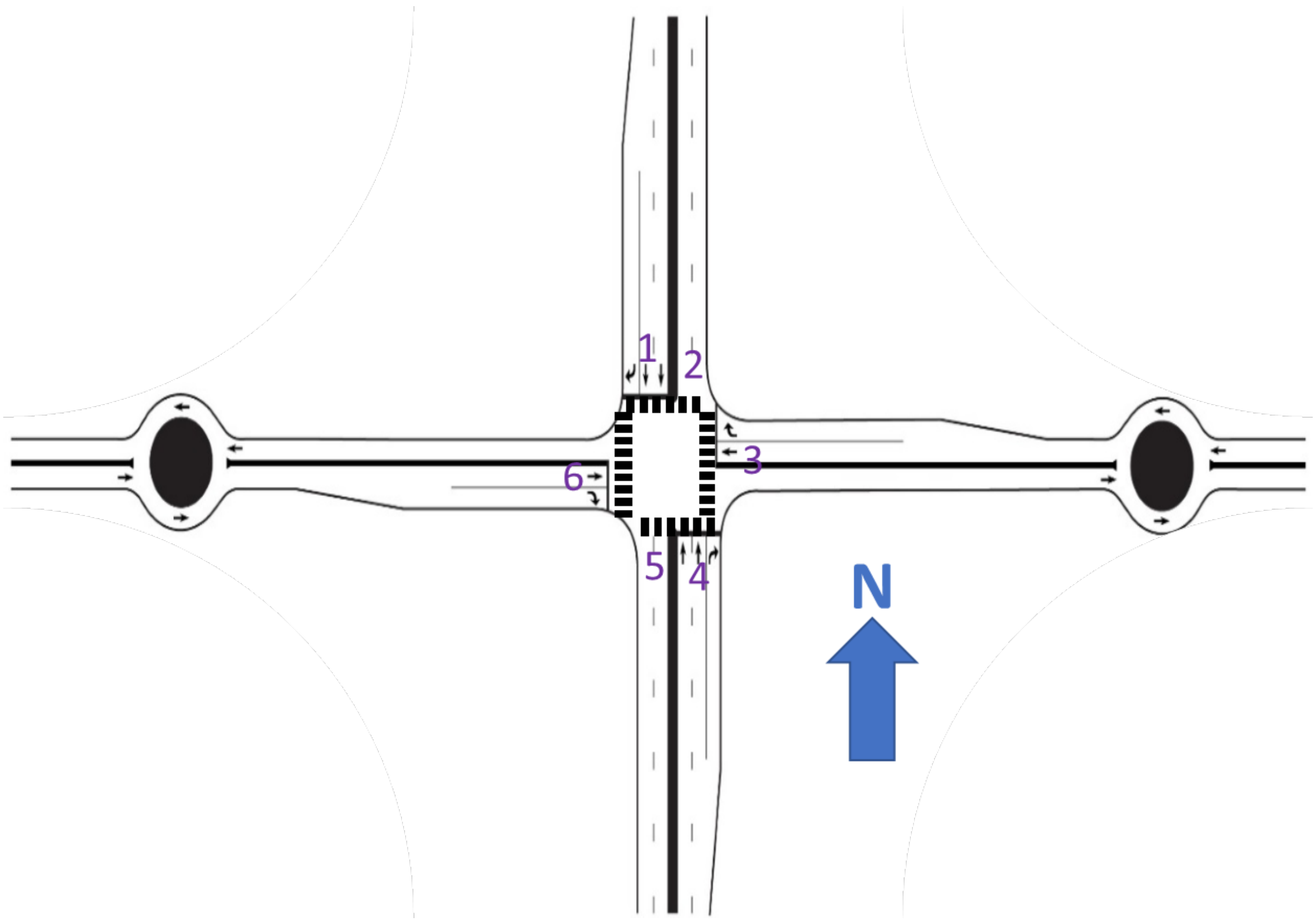
Partial Median U-Turn (N-S)



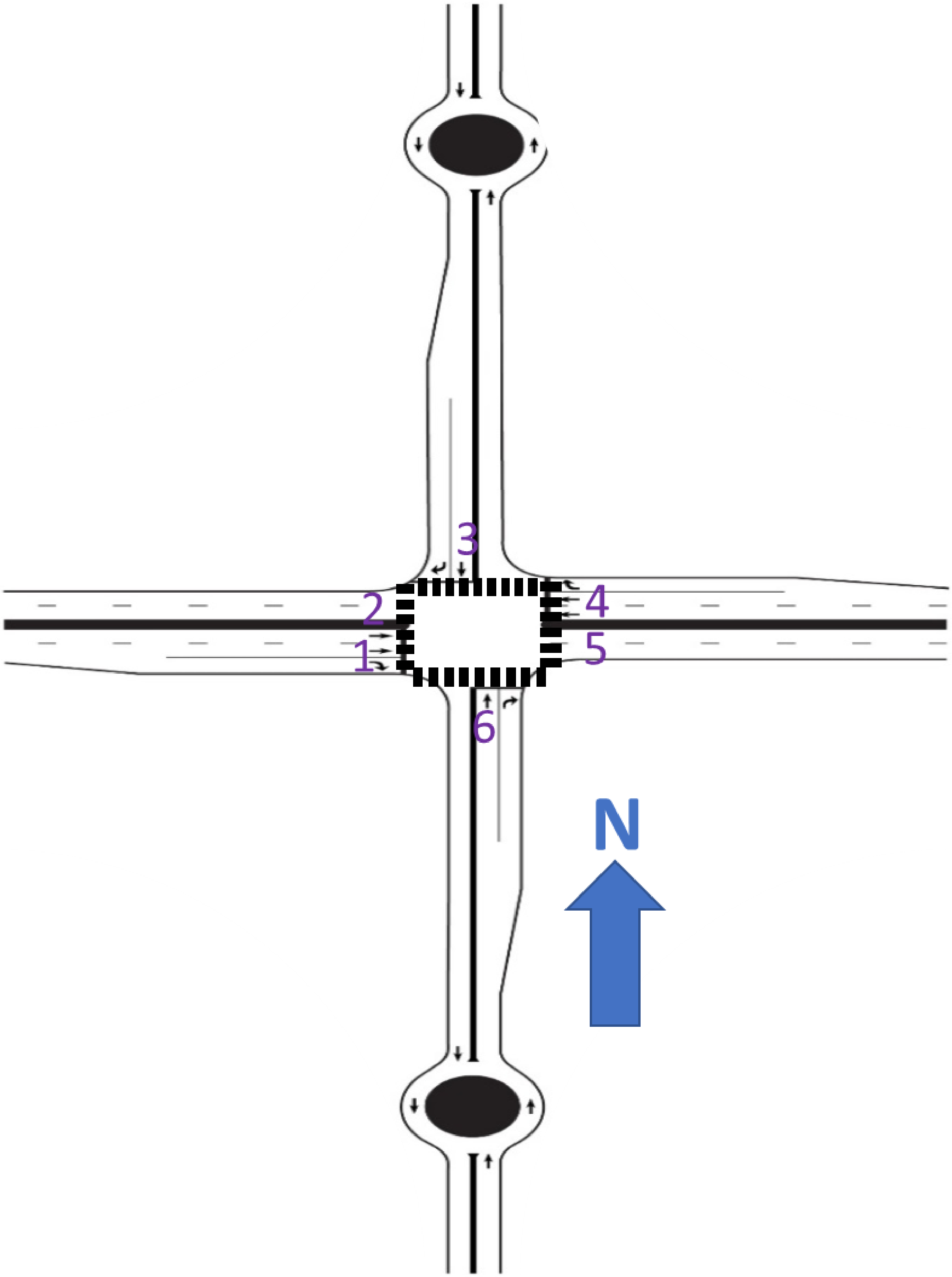
Partial Median U-Turn (E-W)



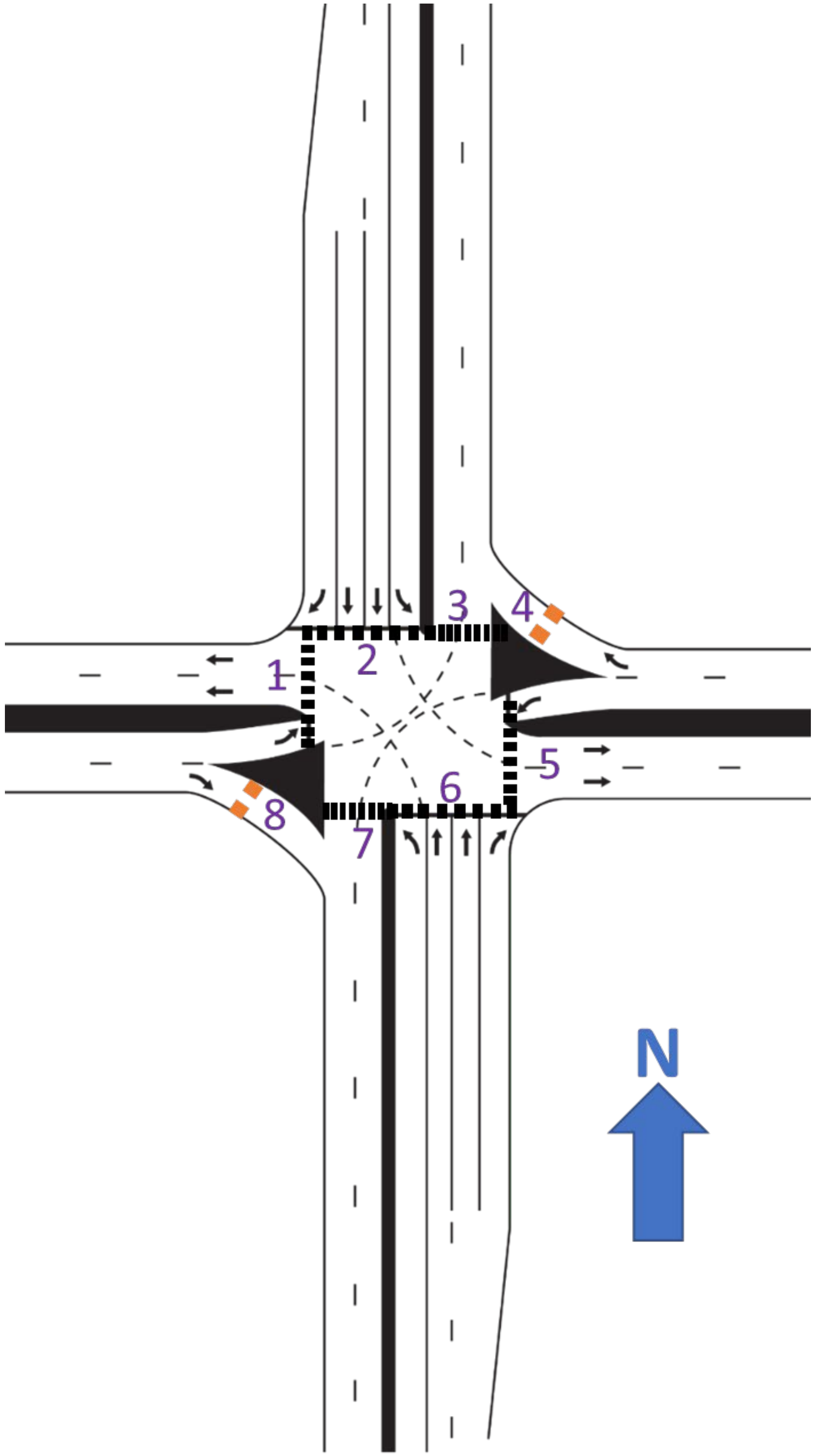
Bowtie (N-S)



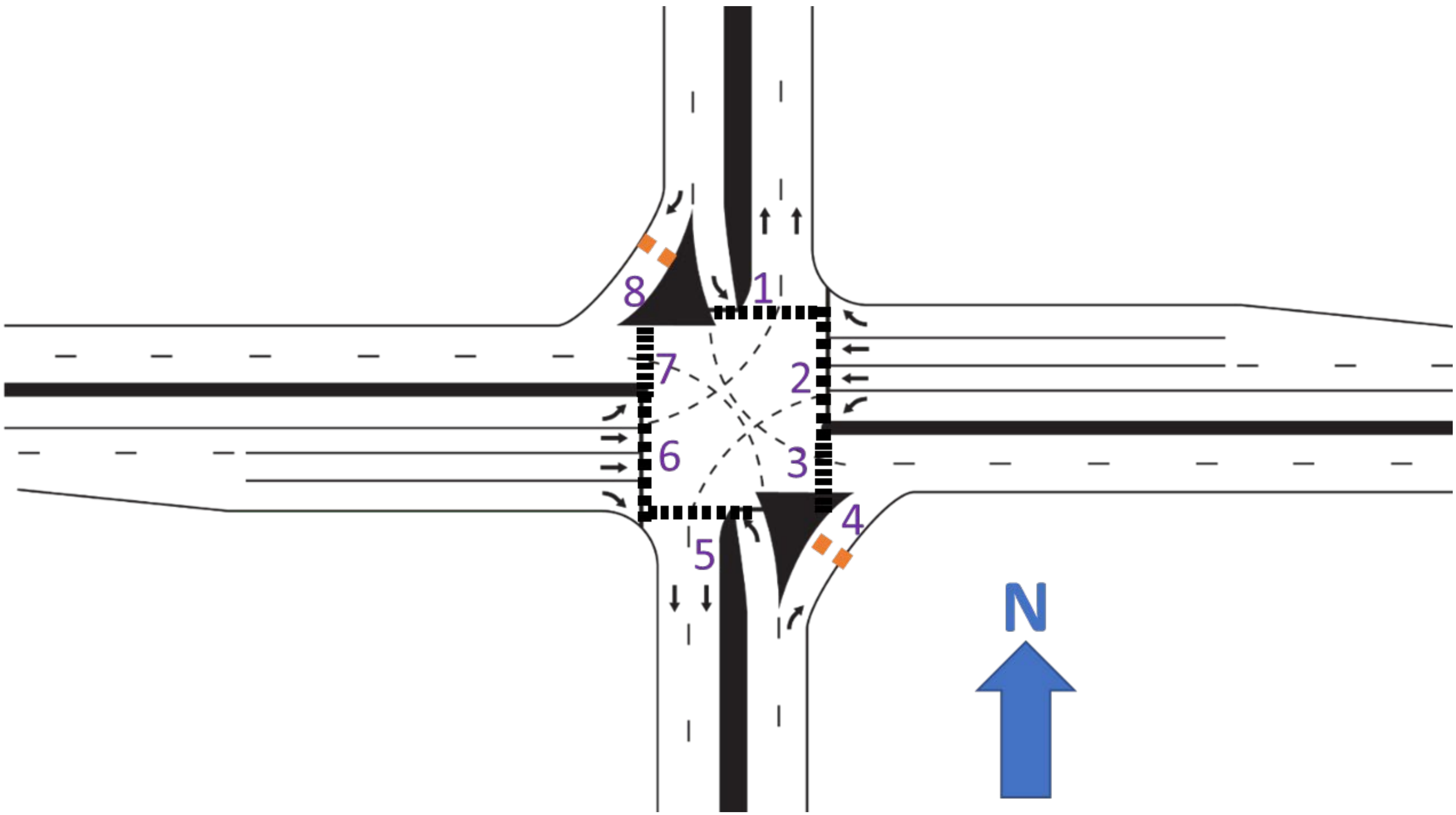
Bowtie (E-W)



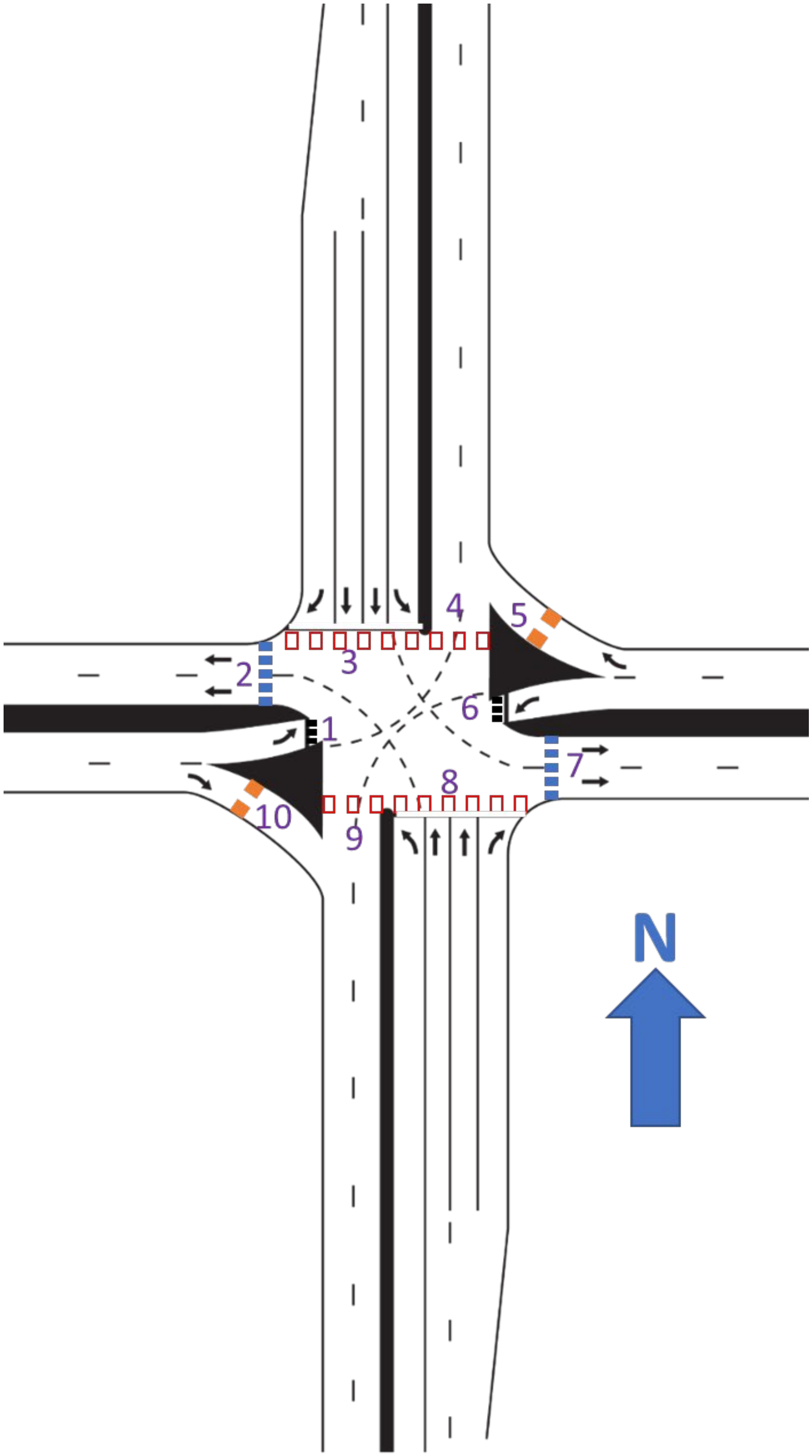
Signalized Thru-Cut (N-S)



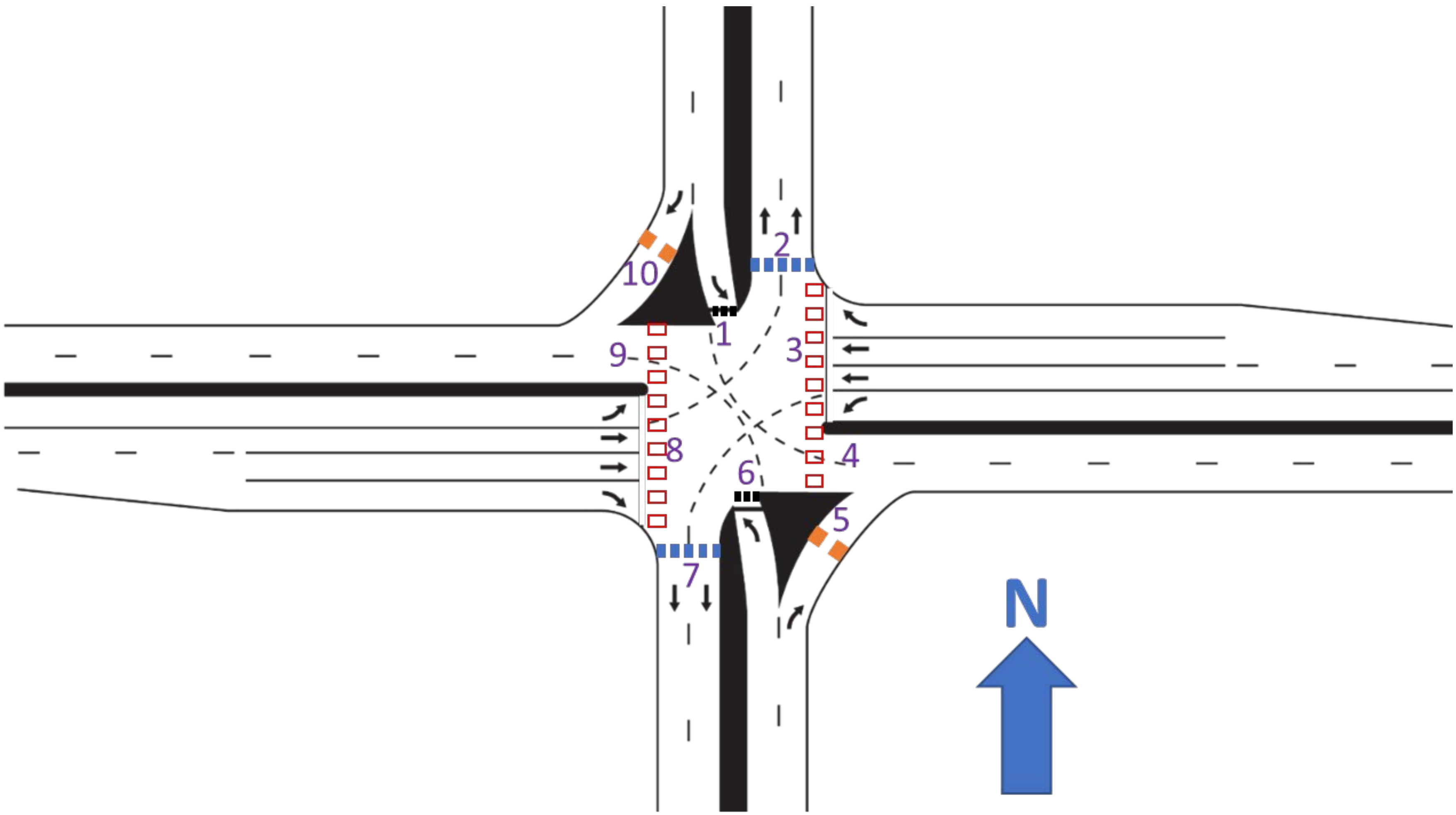
Signalized Thru-Cut (E-W)



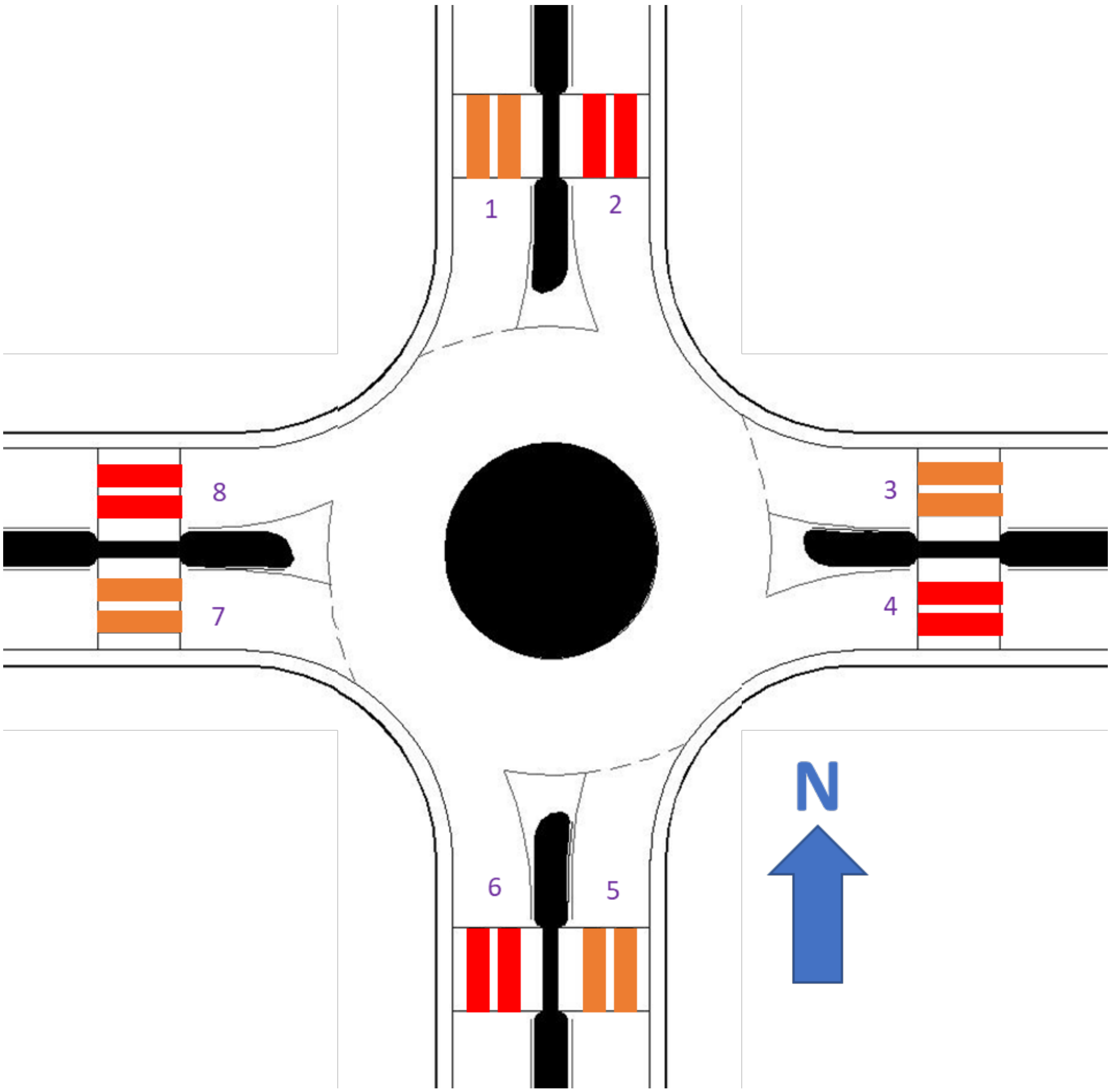
Unsignalized Thru-Cut (N-S)



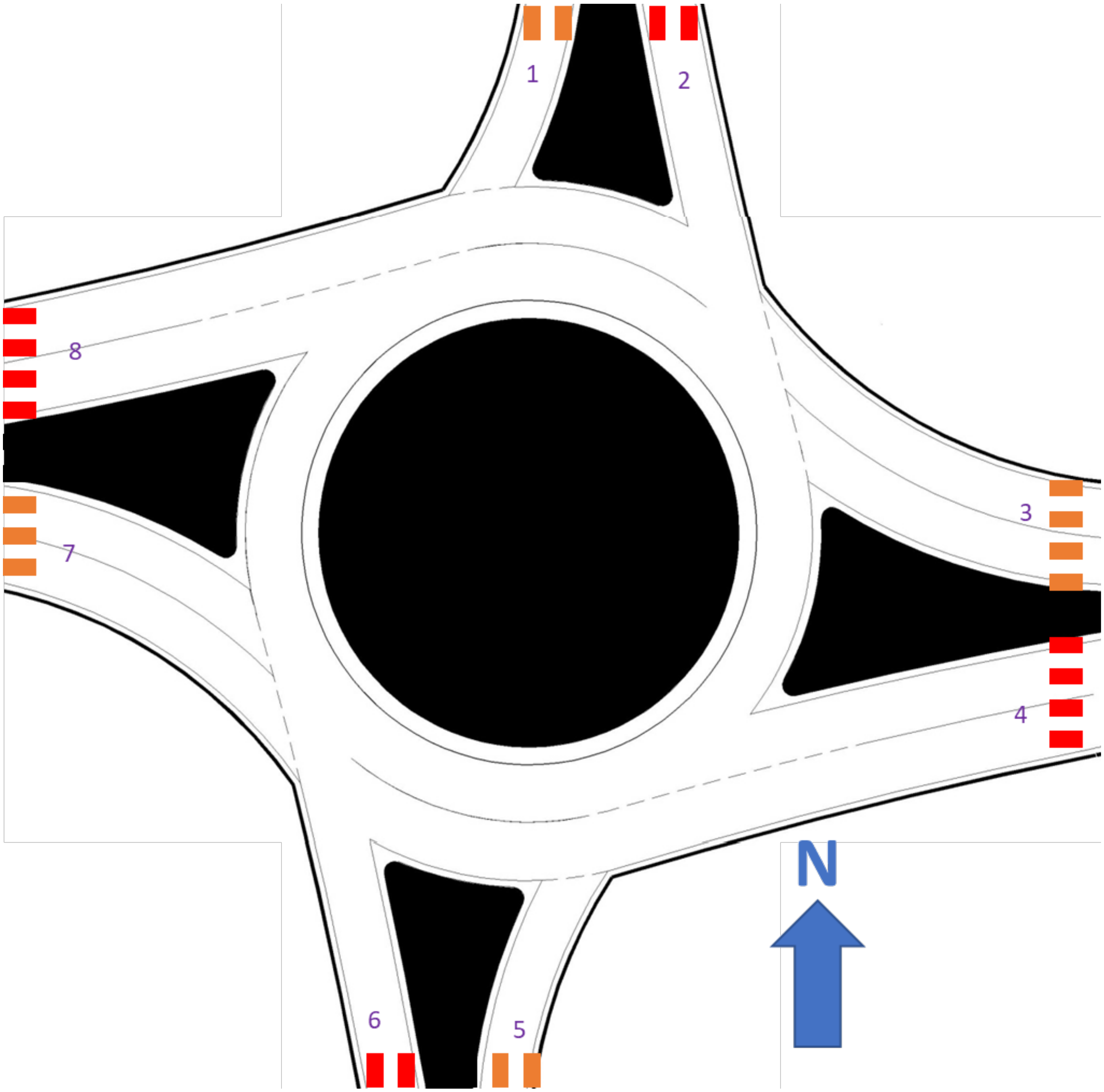
Unsignalized Thru-Cut (E-W)



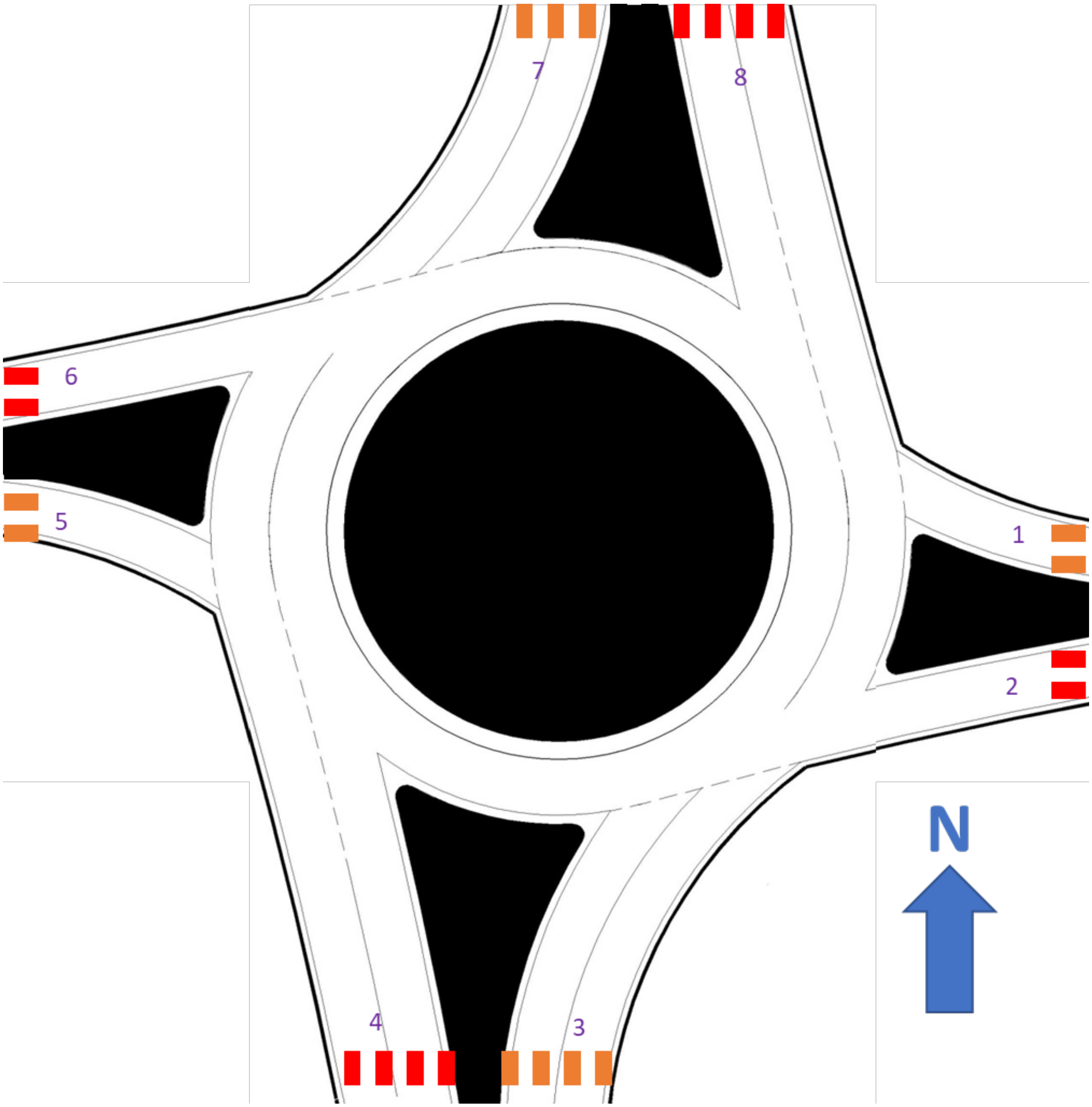
Mini and Single Lane Roundabout



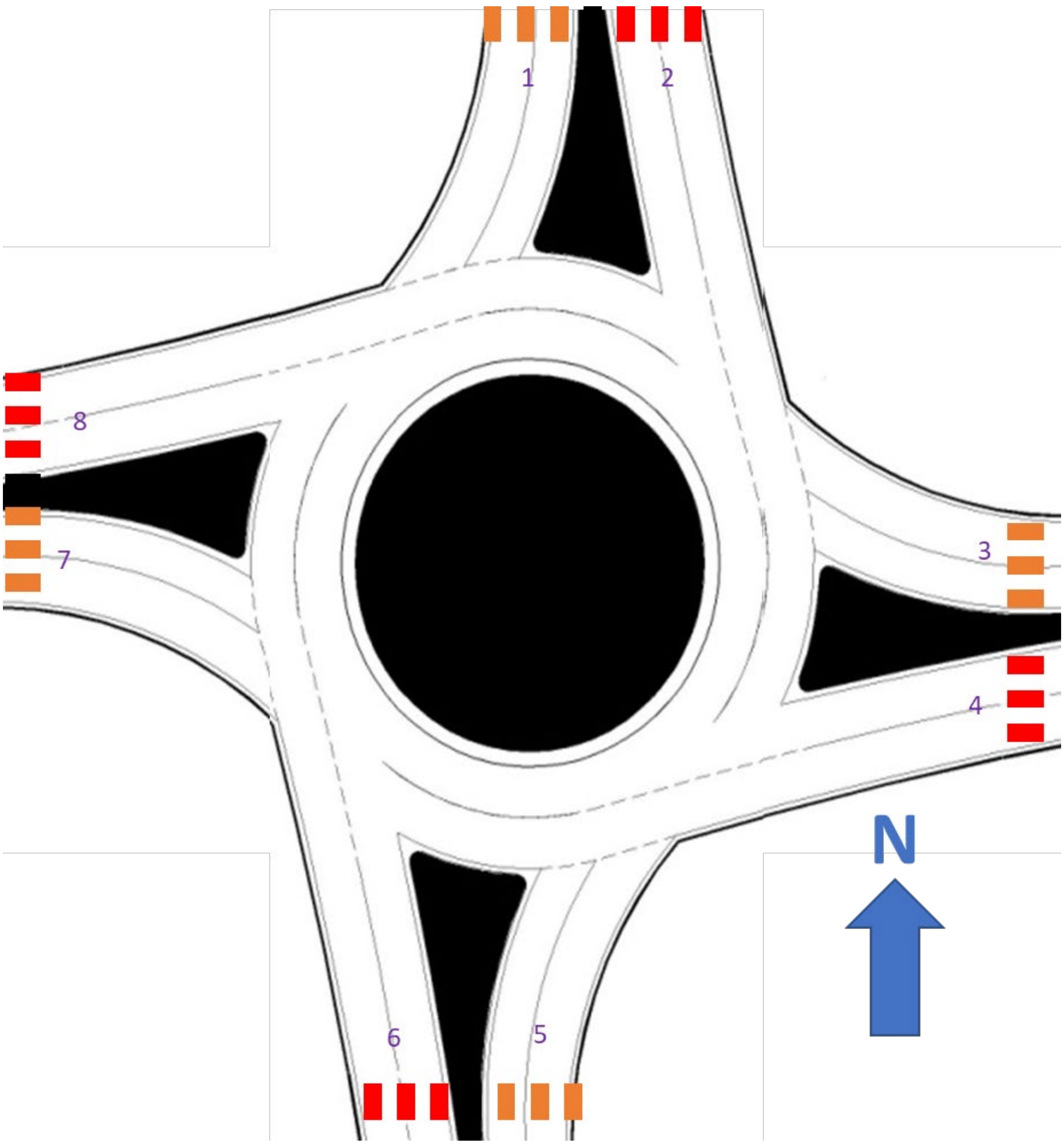
1NS X 2 EW Roundabout



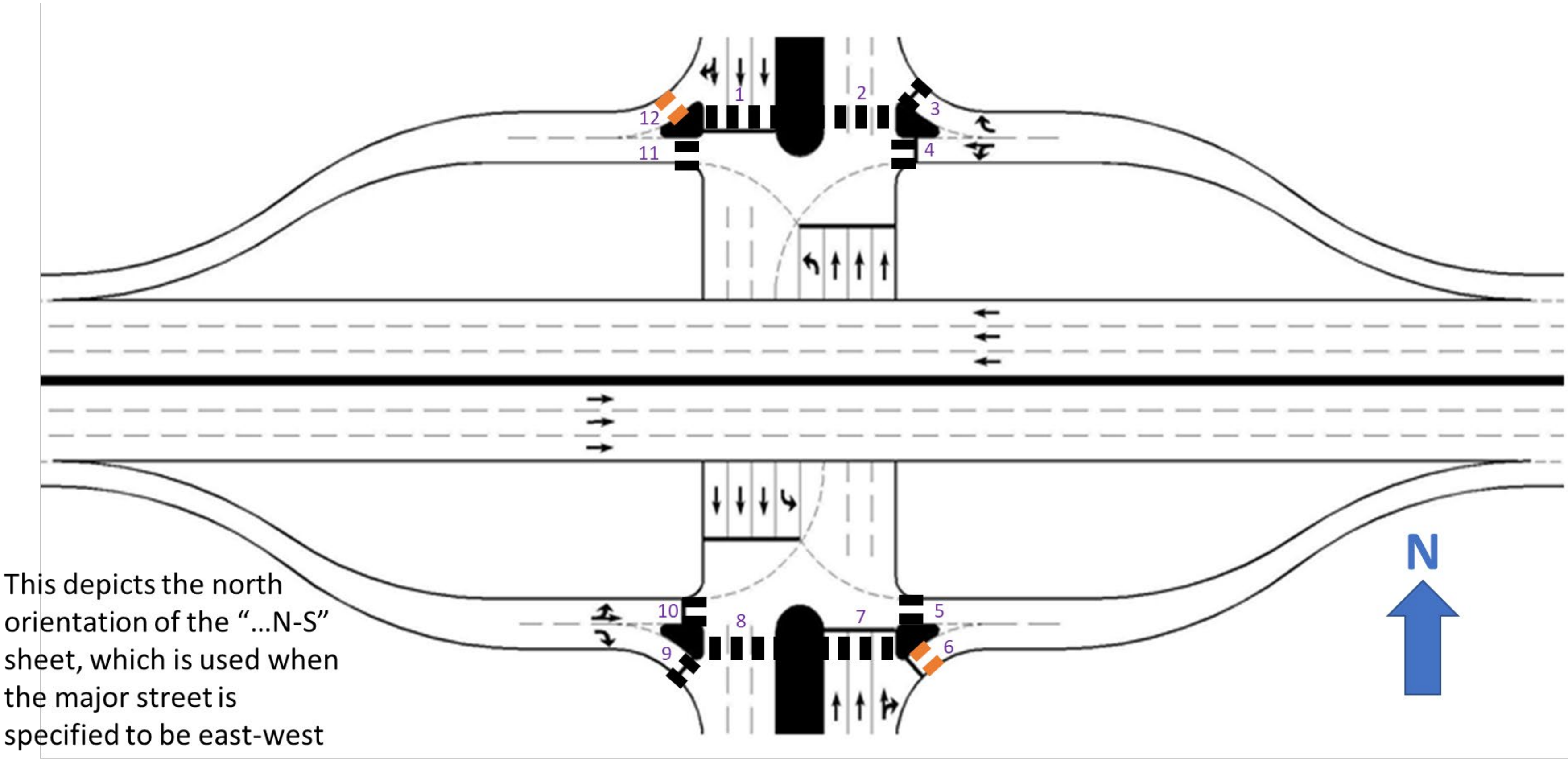
2NS X 1EW Roundabout



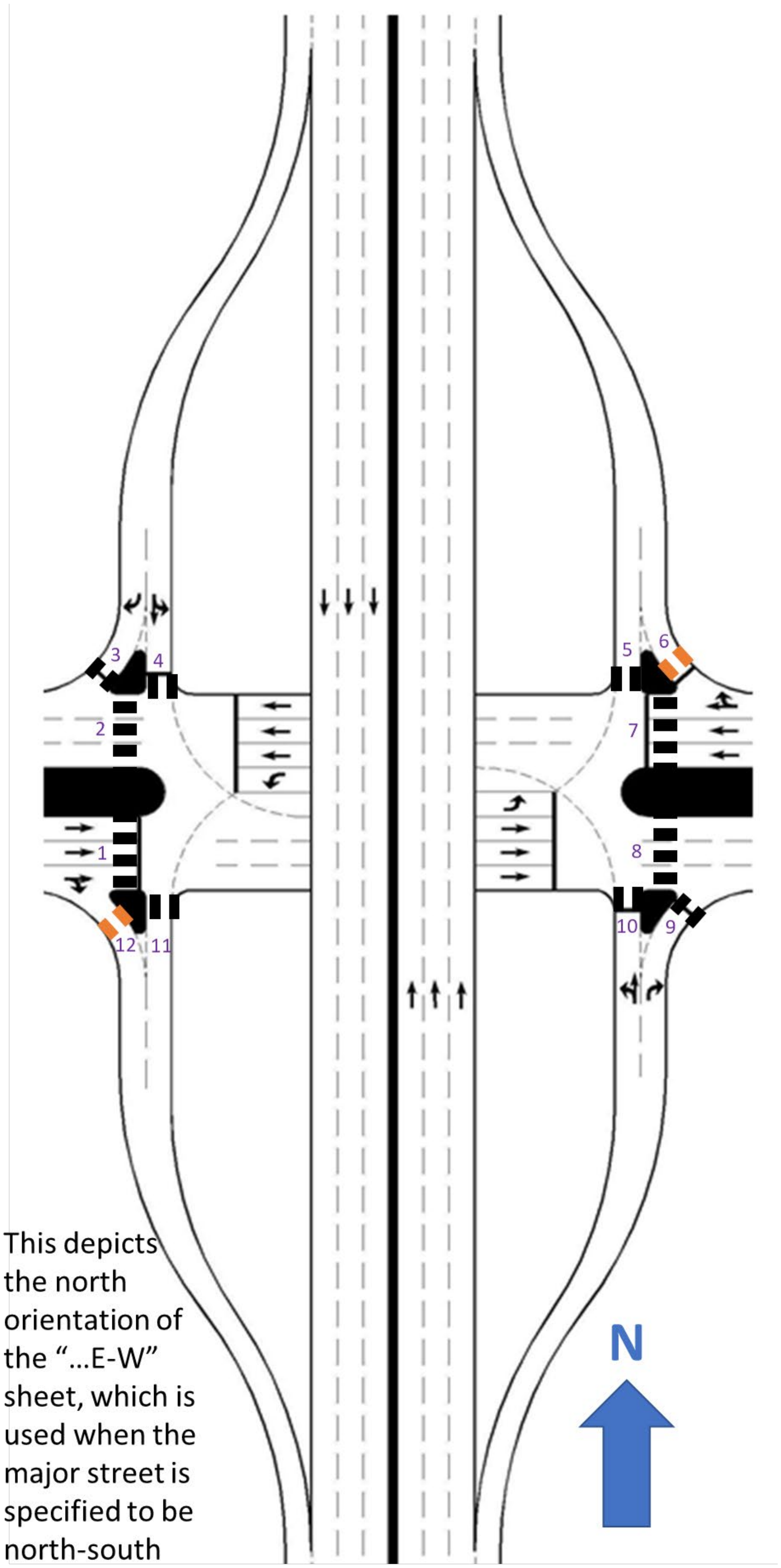
2X2 Roundabout



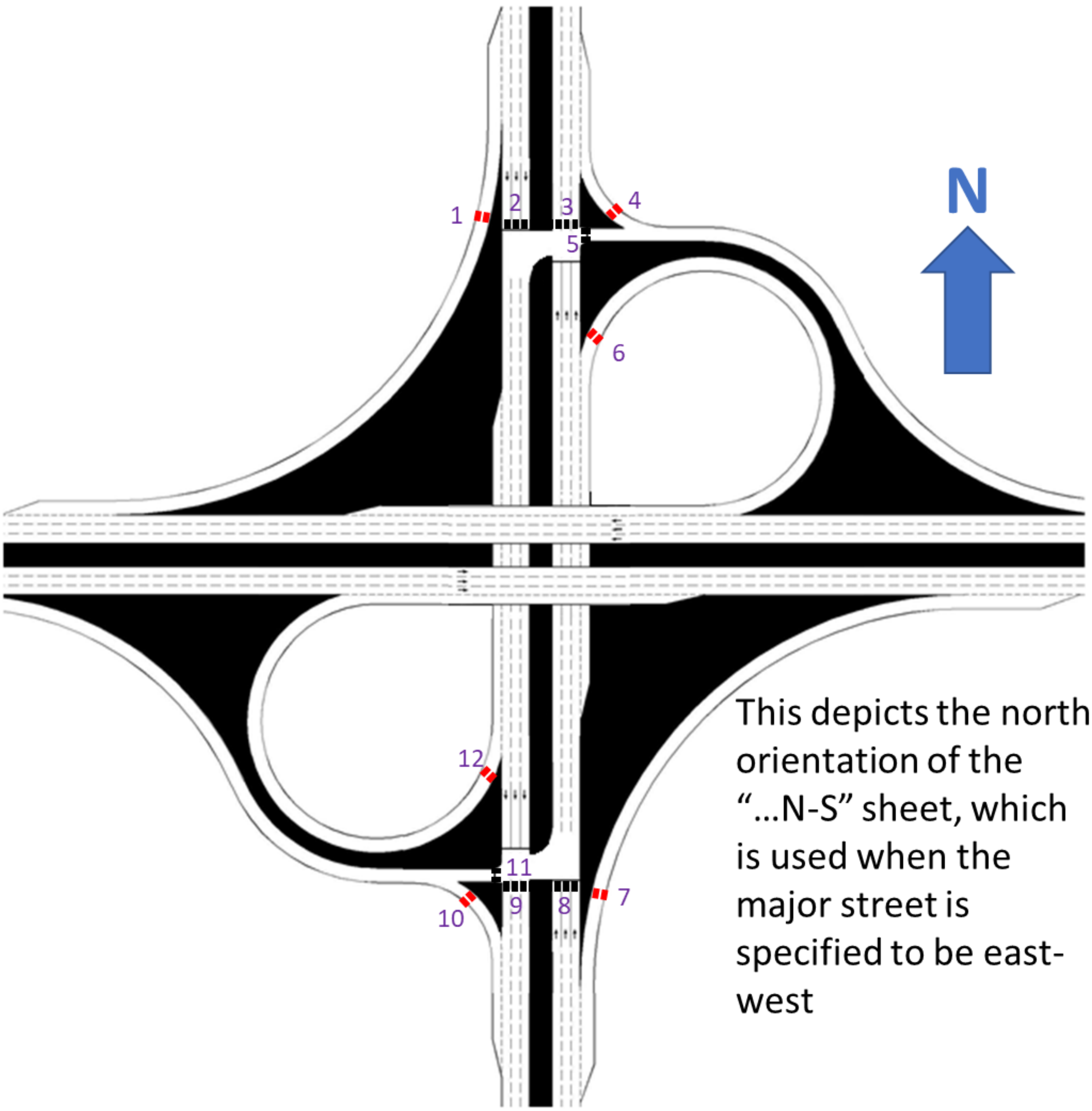
Diamond (N-S)


1
2
3
4
5
6
7
8
9
10
11
12
N
This depicts the north orientation of the "...N-S" sheet, which is used when the major street is specified to be east-west

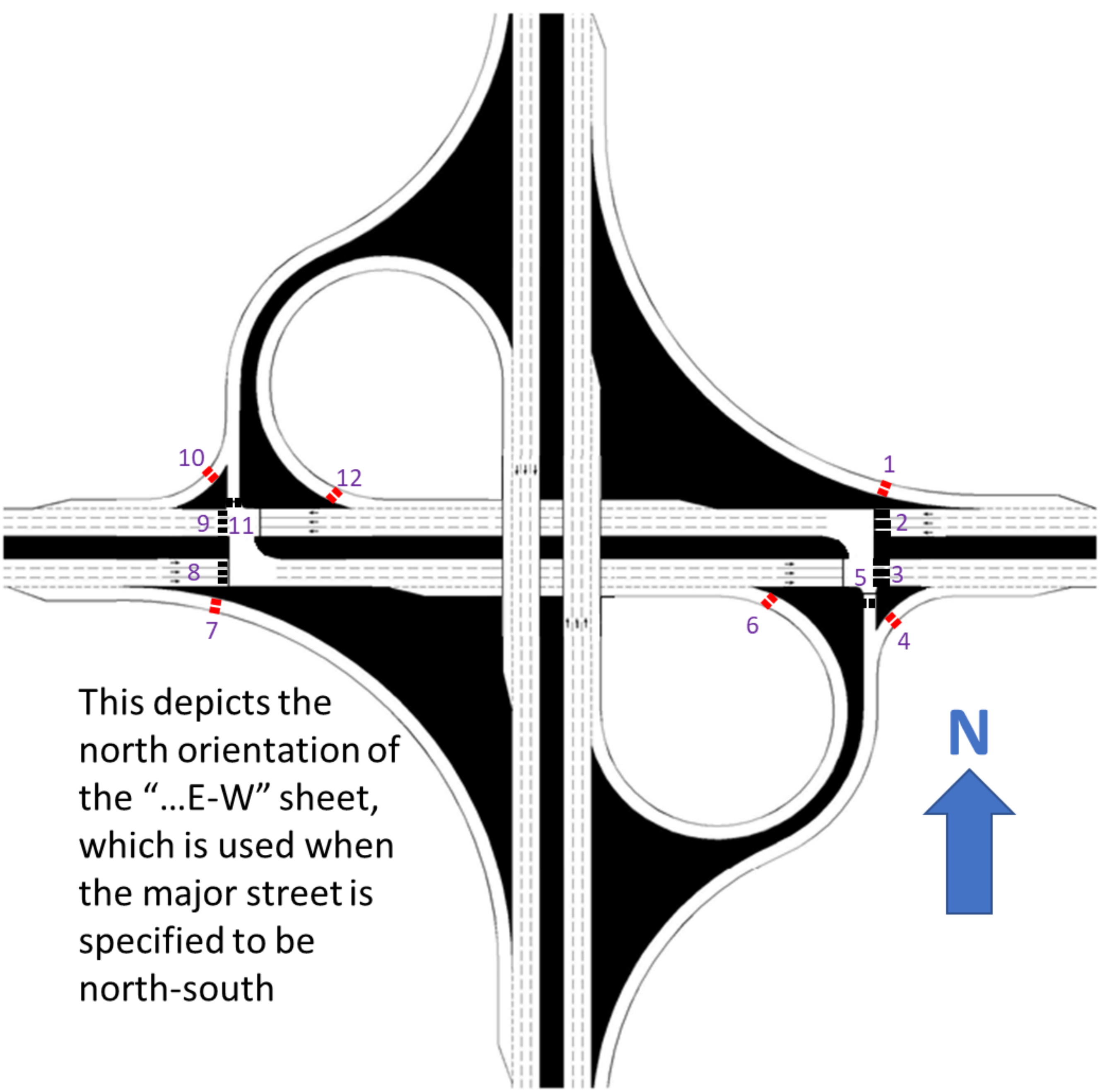
Diamond (E-W)


1
2
3
4
5
6
7
8
9
10
11
12
N
This depicts the north orientation of the "…E-W" sheet, which is used when the major street is specified to be north-south

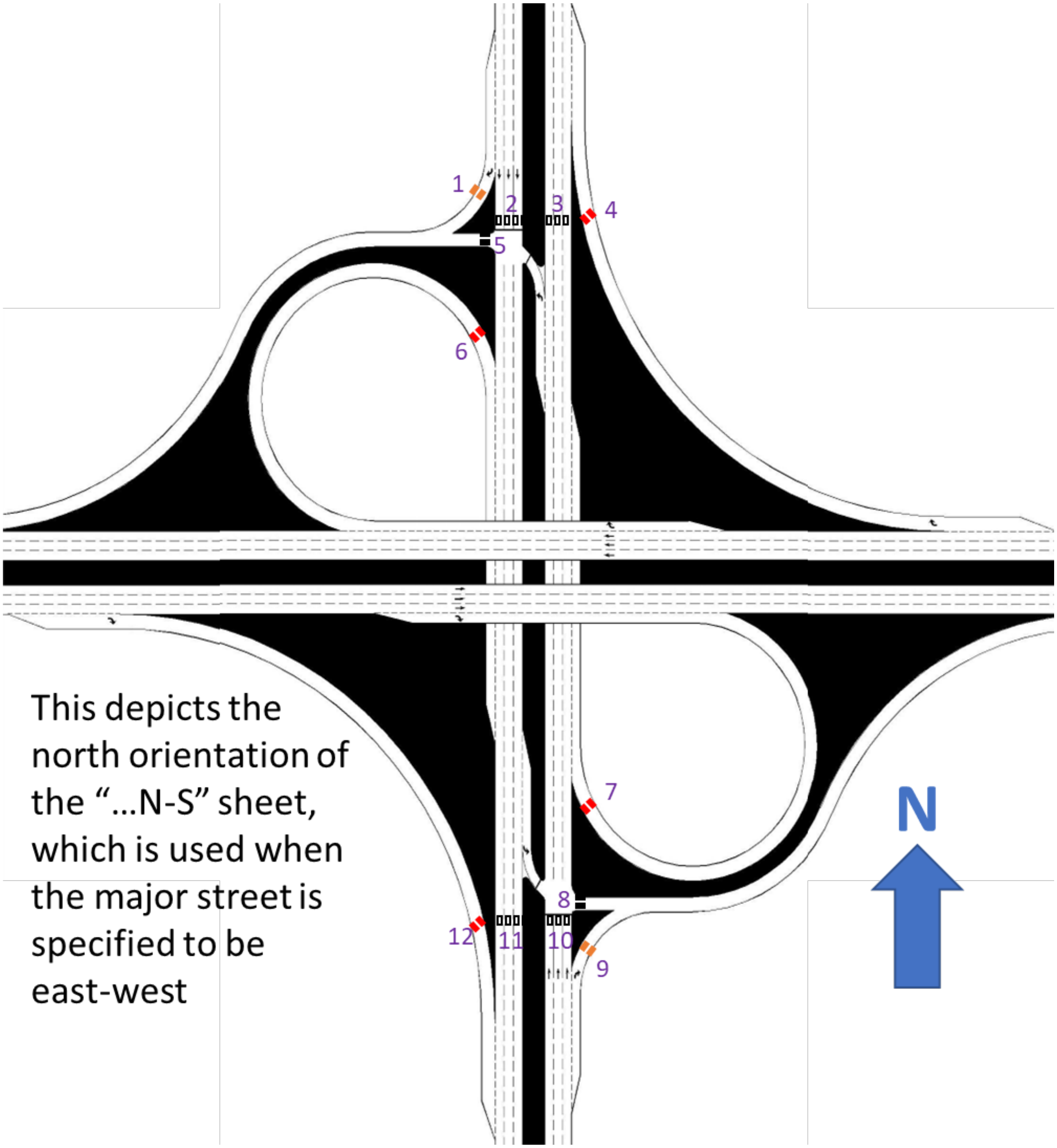
Partial Cloverleaf A (N-S)



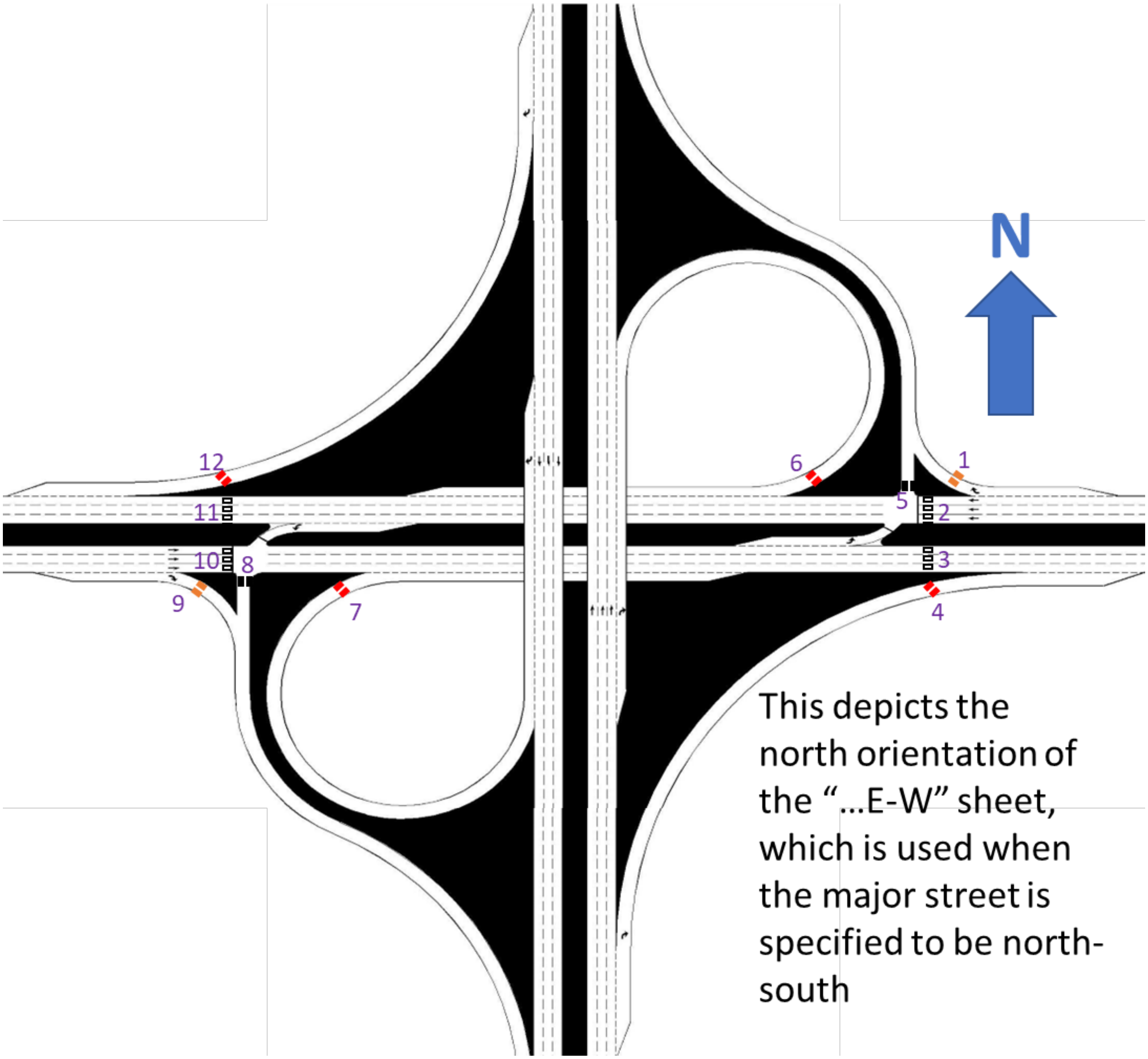
Partial Cloverleaf A (E-W)



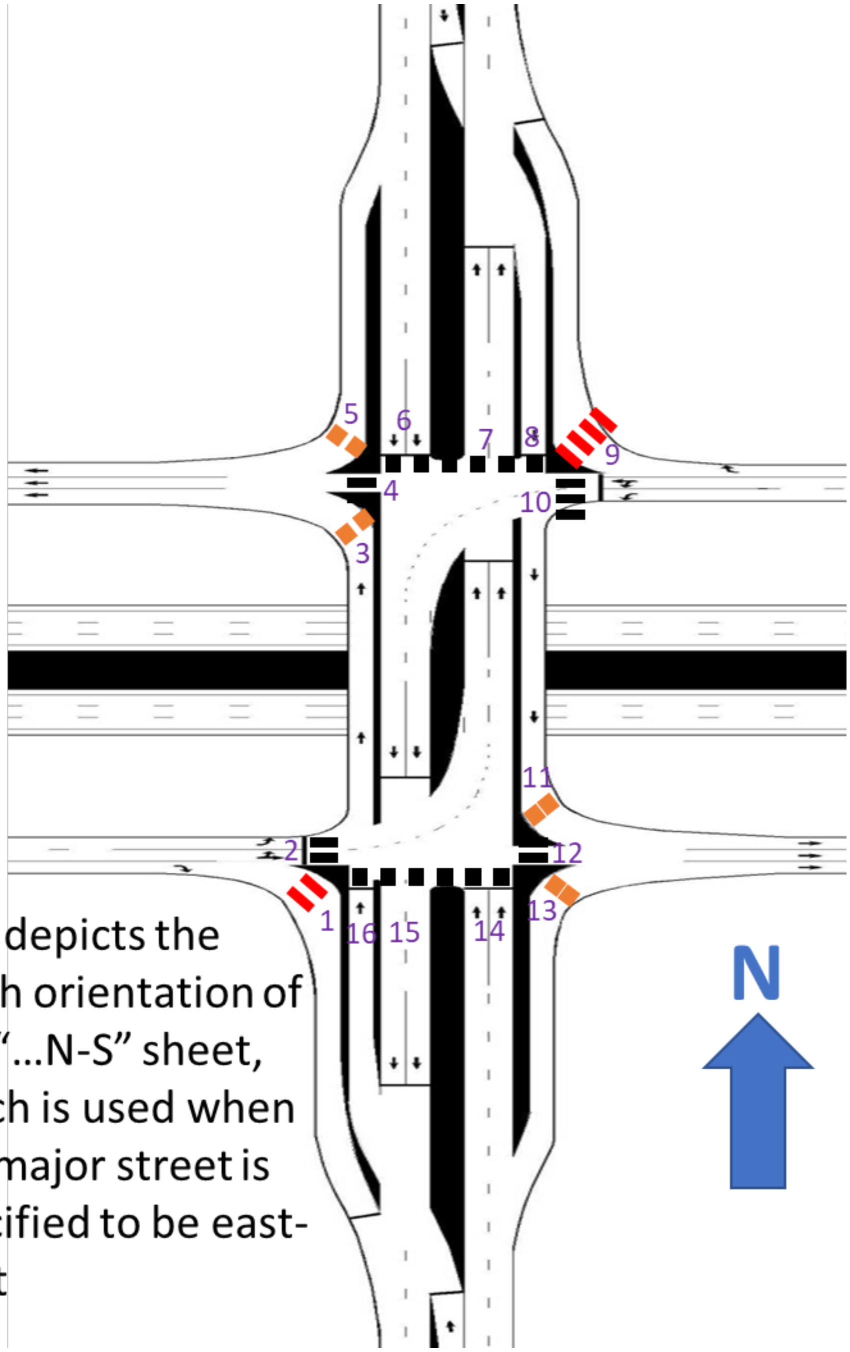
Partial Cloverleaf B (N-S)



Partial Cloverleaf B (E-W)

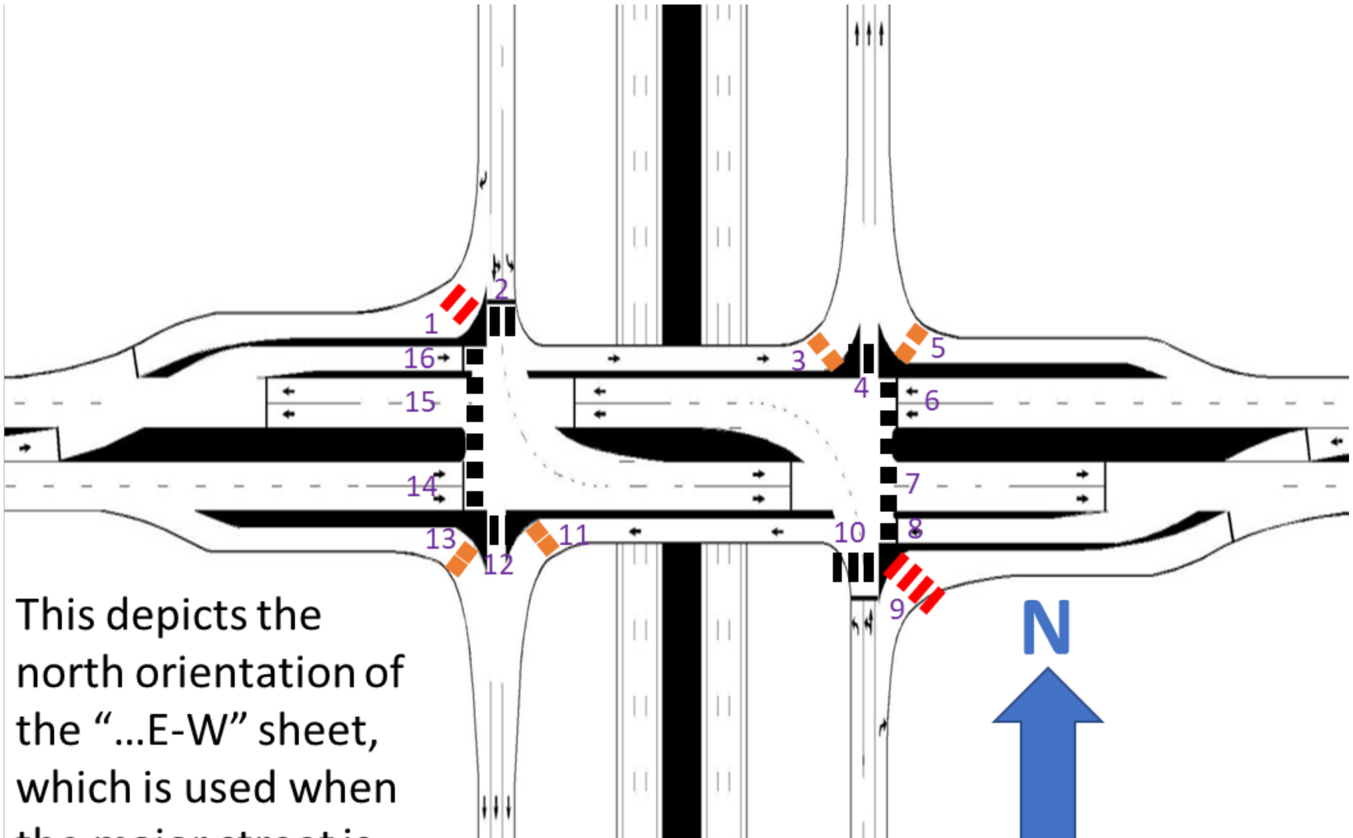


Displaced Left Turn Interchange (N-S)



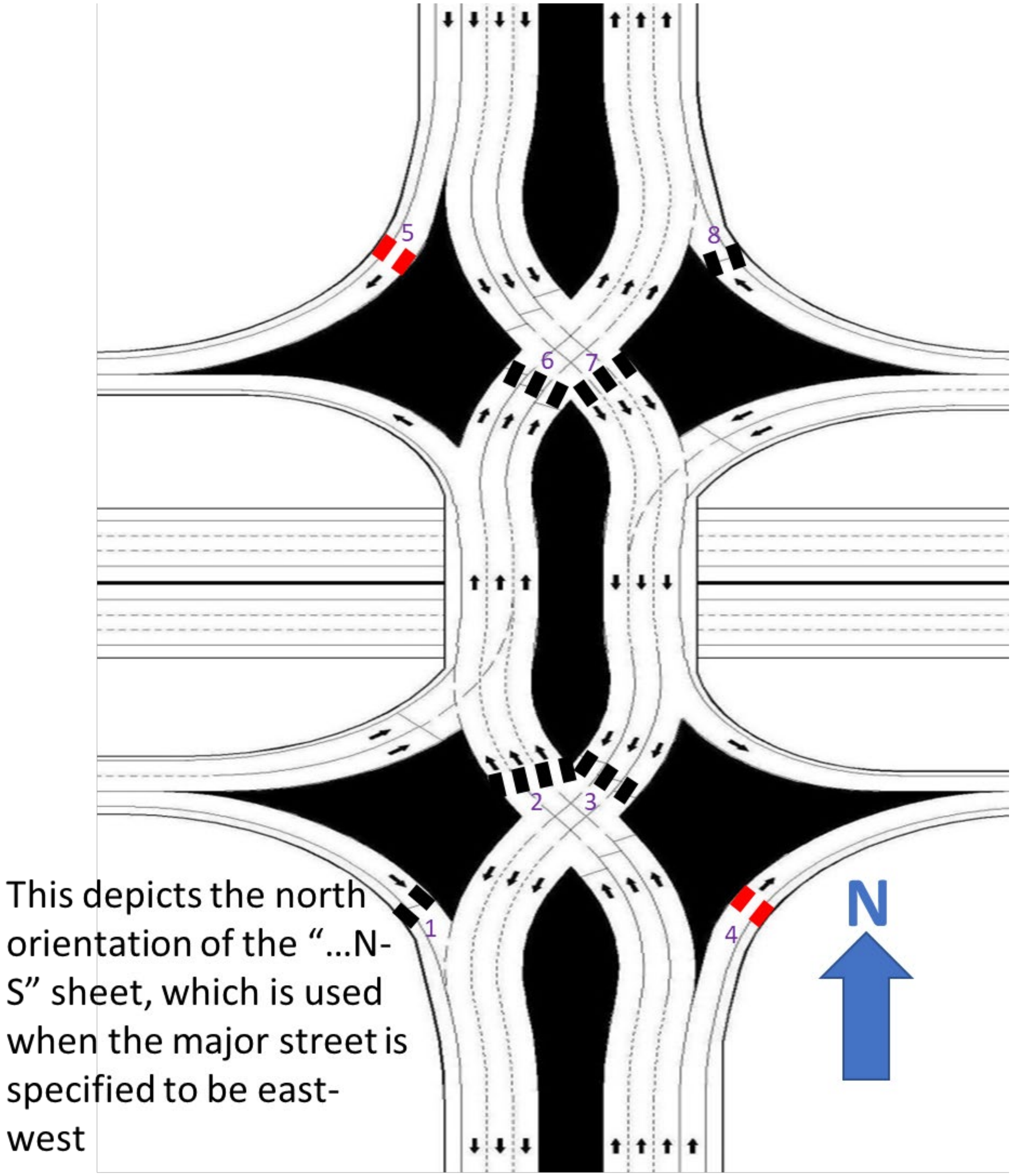
This depicts the north orientation of the "…N-S" sheet, which is used when the major street is specified to be east-west

Displaced Left Turn Interchange (E-W)

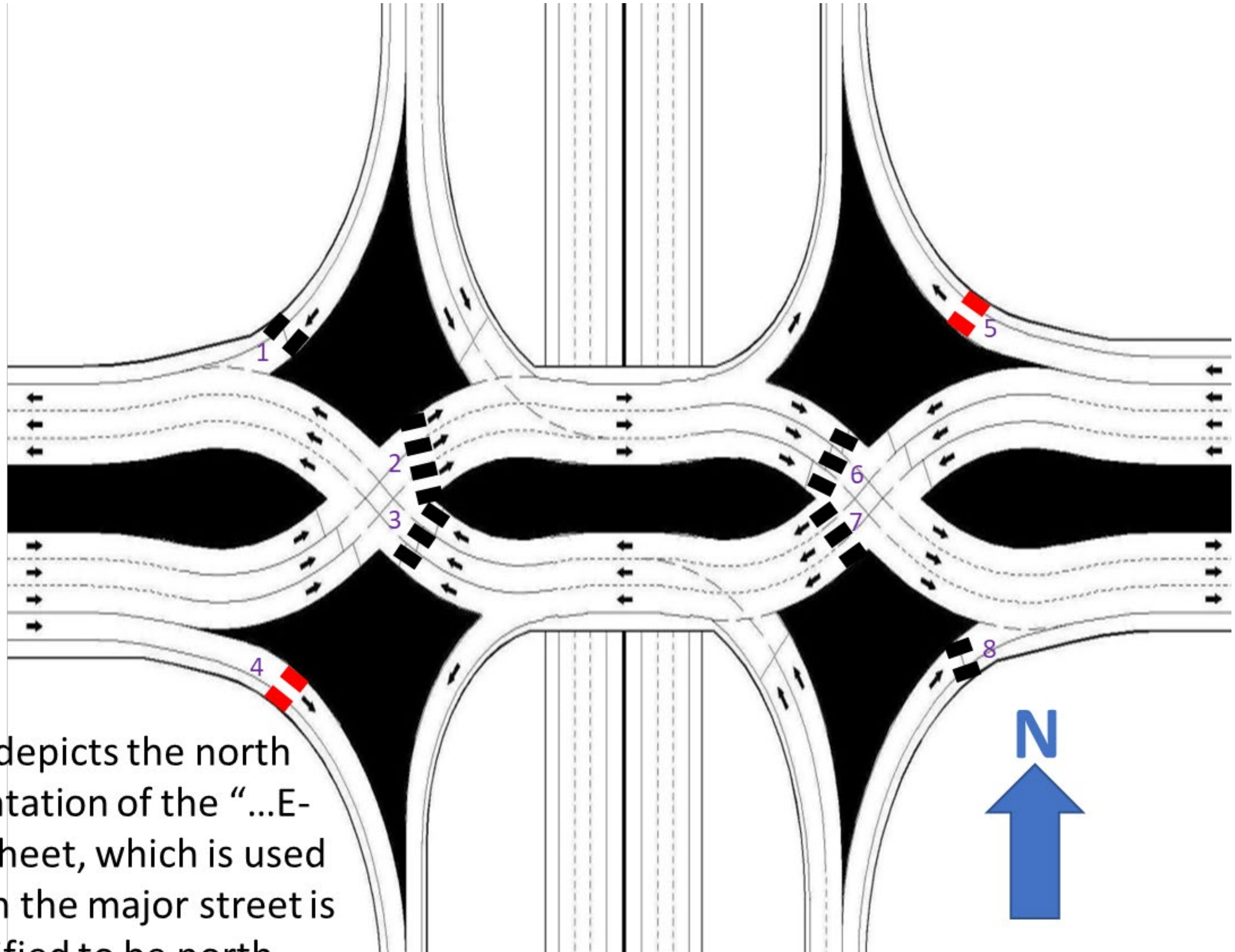


This depicts the north orientation of the "…E-W" sheet, which is used when the major street is specified to be north-south

Diverging Diamond Interchange (N-S)

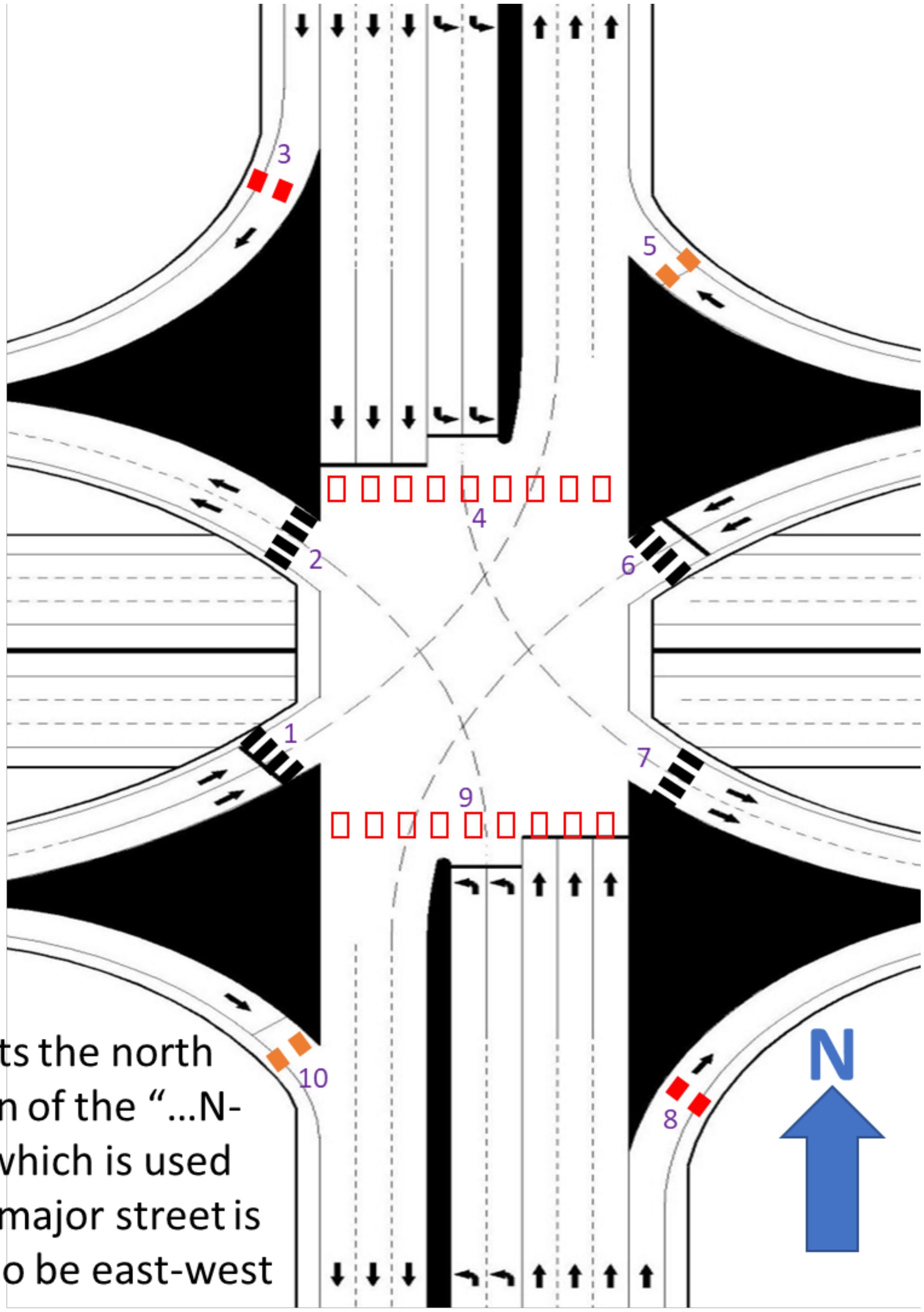


Diverging Diamond Interchange (E-W)



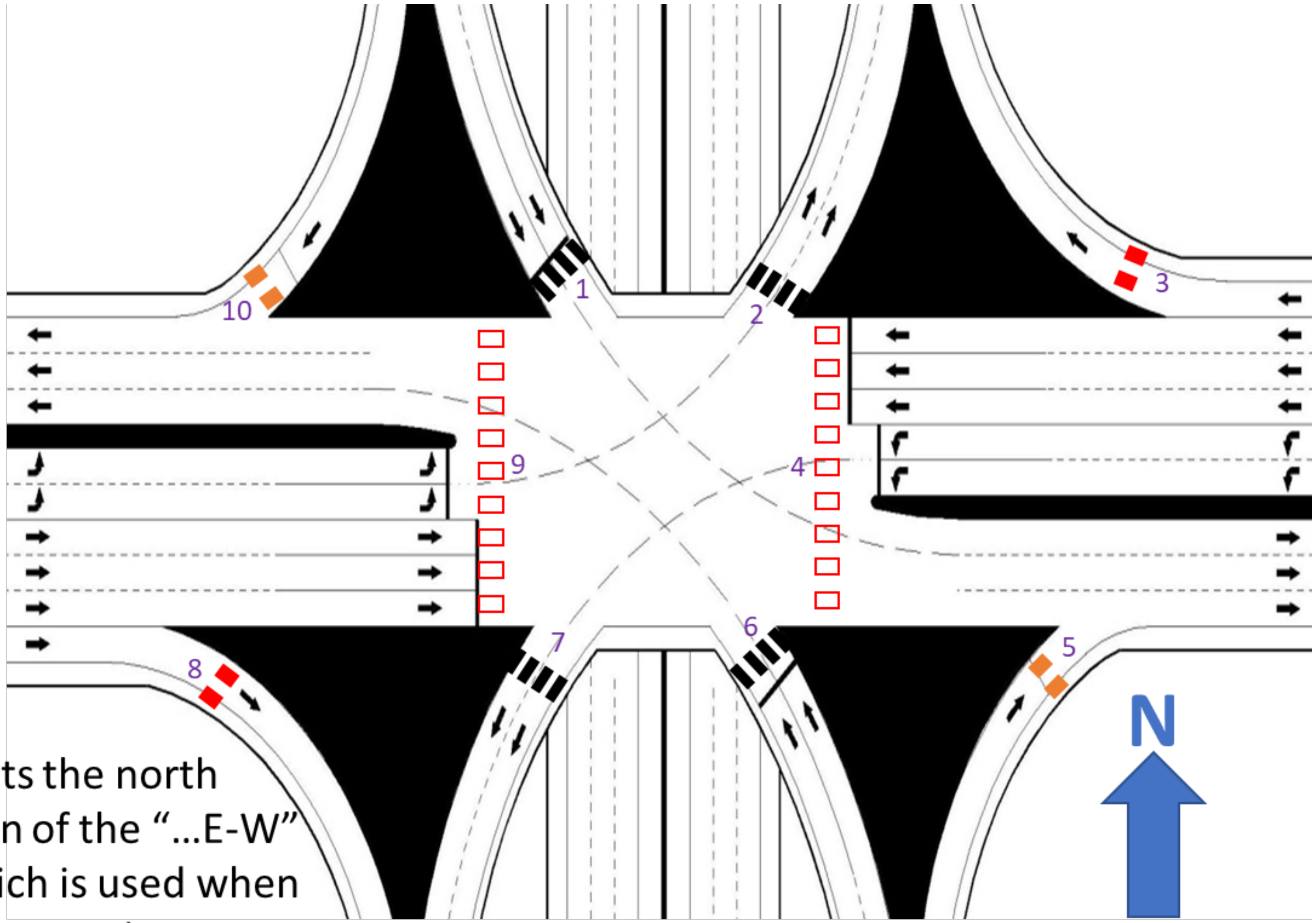
This depicts the north orientation of the "...E-W" sheet, which is used when the major street is specified to be north-south

Single Point Interchange (N-S)



This depicts the north orientation of the "...N-S" sheet, which is used when the major street is specified to be east-west

Single Point Interchange (E-W)



This depicts the north orientation of the "...E-W" sheet, which is used when the major street is specified to be north-south