



Iowa DOT Intersection Control Evaluation (ICE) Manual

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1 Introduction

Intersection Control Evaluation (ICE) is a data-driven, performance-based framework and approach used to objectively screen alternatives and identify an optimal geometric and control solution for an intersection. This Manual sets forth the need and process for completing ICE on projects in Iowa. Supplemental tools and resources are referenced throughout the Manual and provided on the [Iowa DOT ICE webpage](#).

1.1 Purpose of ICE

The purpose of ICE is to analyze multiple alternatives and identify a recommended alternative for an intersection. The ICE process incorporates a greater awareness of innovative intersection designs that have shown improved safety and operational benefits compared to more traditional intersection alternatives. The ICE process provides transparency, consistency, flexibility and adaptability when identifying feasible

alternatives and selecting a recommended alternative to improve an intersection. ICE is also scalable to meet project objectives and make decisions with an appropriate level of analysis.

ICE increases awareness of innovative solutions, provides consistency for evaluating and selecting recommended solutions, and is scalable.

1.2 Benefits of ICE

There are several benefits of using ICE:

- Implementation of safer, more balanced and more cost-effective solutions
- Increased awareness of innovative intersection solutions
- Consistent procedures to develop and evaluate intersection alternatives, including an emphasis on objective performance metrics
- Consistent documentation that improves the transparency of transportation decisions
- Opportunity to consolidate and streamline intersection policies and procedures (access/encroachment approvals, new signal requests, traffic impact studies, etc.)

2 Supporting Initiatives

Iowa DOT has developed several statewide initiatives that focus on improving the safety and mobility of transportation facilities for all users. These initiatives support the goal of ICE and can be incorporated into the ICE process.

2.1 Complete Streets Policy

Complete Streets are streets designed and operated to enable safe use and support mobility for all users. Motor vehicle, public transportation, bicycle, and pedestrian modes are each integral to the transportation system, and all transportation improvements are an opportunity to improve safety, access, and mobility for all transportation users. Following a recommendation from Iowa DOT's Bicycle and Pedestrian Long-Range Plan, Iowa DOT developed a [Complete Streets Policy](#) to emphasize improvements related to non-motorized transportation. The intent of Iowa DOT's Complete Streets Policy is to improve conditions for bicycling and walking.

The Complete Streets Policy applies to all Iowa DOT projects, including new construction, reconstruction, and 3R projects (resurfacing, restoration, or rehabilitation). Exceptions to the provision of bicycle and pedestrian accommodations may be made in certain circumstances, as outlined in the Complete Streets Policy.

Design guidance supporting the Complete Streets Policy are found in the [Iowa DOT Design Manual](#), Chapter 12 – Sidewalks and Bicycle Facilities. The latest Iowa DOT Complete Streets Policy should be reviewed and incorporated, as appropriate, into an ICE analysis.

2.2 Strategic Highway Safety Plan (SHSP)

A Strategic Highway Safety Plan (SHSP) is a statewide coordinated safety plan that provides a comprehensive framework for reducing fatalities and serious injuries on all public roads. Iowa DOT and partnering agencies and organizations developed [Iowa's SHSP](#) to meet the significant challenge of reducing fatal and serious injury crashes. The purpose of the SHSP is to identify effective safety strategies to address areas of greatest need to make roadways safer.

Iowa DOT has identified eight priority safety emphasis areas following crash data analysis and extensive statewide input from Iowa's traffic safety stakeholders. **Relevant to the ICE process, one of the priority safety emphasis areas is "Intersections", with the following strategies:**

- Develop educational resources informing the public of alternative intersection types, traffic signals, and laws.
- Conduct enforcement campaigns related to bicycle and pedestrian awareness at targeted intersections.
- Use systemic approaches to improve visibility and awareness of intersections.
- Implement alternative intersection designs that reduce conflict points and enhance safety and mobility.



- Develop an intersection configuration/evaluation tool to aid planners and designers in selecting appropriate intersection types.
- Approach intersections with caution and get familiar with new designs in your community.

The development of this ICE Manual is supported by the SHSP “Intersections” priority safety emphasis area strategies. The goal of applying the SHSP to improve intersection safety is to match the solution to the problem. When the solution includes changing the geometry or design, the ICE process should be considered.

2.3 Transportation Systems Management and Operations (TSMO)

Transportation Systems Management and Operations (TSMO) optimizes the performance of existing infrastructure through the implementation of multimodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve the security, safety, and reliability of the transportation system. [Iowa's TSMO Program](#) provides strategic direction, program development, and specific steps for systems management and operations in Iowa.

TSMO strategies are used to proactively manage the transportation system by addressing recurring and non-recurring congestion in real time and improving safety. TSMO strategies focus on operational improvements that can maintain and restore the performance of the existing transportation system before capacity improvements are needed.

TSMO strategies are often reviewed and considered before determining the need for ICE, though ICE may be completed as part of incorporating TSMO strategies such as “Integrated Corridor Management”, “Access Management”, or “Improved Bicycle and Pedestrian Crossings”. Additionally, TSMO strategies that do not incorporate ICE may be used as an interim step to address operational and safety performance before additional improvements are determined through ICE. For example, a TSMO solution that Iowa DOT has implemented at intersections to improve safety without geometric improvements is the intersection conflict warning system (ICWS). ICWS warns both the driver on the highway and those approaching on the minor roadway stop-controlled approach. ICWS deployment in Iowa has an associated Crash Reduction Factor (CRF) of 25% for all crashes at rural minor road stop-controlled intersections.

3 Applicability

ICE is applicable for any project on the State highway system that would result in creation of a new intersection or a fundamental change to an existing intersection. A fundamental change involves a planned change to the intersection's configuration, type of traffic control, or number of through or left-turn lanes. Intersections on [Iowa DOT's Potential for Crash Reduction \(PCR\) website](#) rated "Medium PCR" or "High PCR" are applicable

intersections to apply ICE when considering improvements at those locations. ICE is not applicable for projects to 3R projects unless intersection improvements are combined with the 3R project that would result in a new intersection or fundamental change to an existing intersection. ICE may also not be applicable for Super-2 Highway projects, where an additional through lane would be constructed; however, completing ICE at select intersections along the project may be beneficial and should be considered with the project.

Project representatives communicate with the appropriate Iowa DOT District Engineer (or ICE representative designated by the District) before, or during, project scoping to determine the need for ICE on the project. The determination of a fundamental change needing ICE is made by the appropriate Iowa DOT

District Engineer or designated District ICE representative. For projects where ICE may not be necessary, an ICE Exemption Form (provided in the [Iowa DOT ICE Forms Spreadsheet Tool](#)) should be completed and submitted to the appropriate District Engineer or District ICE representative.

ICE is intended to occur as part of an established project development process and to run concurrently with existing project development activities. It is important that the ICE process occurs as early in the project development as practical to limit impacts to project scope, schedule and budget.

ICE is applicable for any project on the State highway system that results in creation of a new intersection or a fundamental change to an existing intersection.

Iowa DOT District makes determination on need for ICE on a project.

4 ICE Procedures

ICE is conducted in one or two stages:

- Stage 1 – Alternatives Screening
- Stage 2 – Recommended Alternative Selection

If the Stage 1 alternatives screening only identifies a single viable alternative, alternative selection and documentation are based on the Stage 1 evaluations, and Stage 2 is not completed.

Evaluations completed for ICE are documented in the [Iowa DOT ICE Forms Spreadsheet Tool](#), which contains forms that are the primary deliverable for ICE.

A general overview of ICE Stages 1 and 2 and the steps required to complete each stage are provided in the following sections. The [Iowa DOT ICE Forms Spreadsheet Tool](#) follows the steps outlined in the following sections to streamline completion of ICE. It is important to note that ICE is generally expected to conclude at the end of Stage 1 with a single viable alternative. For select locations where a single viable alternative cannot be determined in Stage 1, the ICE will advance to Stage 2 for more detailed assessment.

4.1 Stage 1 – Alternatives Screening

The purpose of Stage 1 is to screen intersection alternatives to identify which one is recommended or which ones merit further consideration. Alternatives are screened through a combination of qualitative and quantitative evaluations in Stage 1. Selection of a recommended alternative or those for further consideration is determined by an alternative's ability to meet the project objectives and whether it is practical to pursue. The practicality to pursue an alternative is largely based on the likely impacts or costs of the alternative within the general expectation for the project.

A base range of intersection alternatives, provided on the [Iowa DOT ICE webpage](#), are screened in Stage 1. The base range of intersection alternatives includes traditional intersection geometry/control strategies, such as two-way stop-controlled and signalized intersections, and alternative intersections common in other State ICE procedures, such as a reduced conflict intersection (RCI) and median U-turn intersection (MUT). Additional alternatives beyond those in the base range can also be developed and screened in Stage 1.

At the end of Stage 1 either a single alternative is determined viable and recommended or multiple alternatives that merit further consideration are carried forward into Stage 2. If only one alternative is determined to be viable in Stage 1, ICE is concluded with Iowa DOT approval following Stage 1.

Stage 1 alternatives meriting further consideration are carried into Stage 2 unless only one viable alternative is recommended at the conclusion of Stage 1.

The steps of ICE Stage 1 procedures are outlined in [Figure 4-1](#).

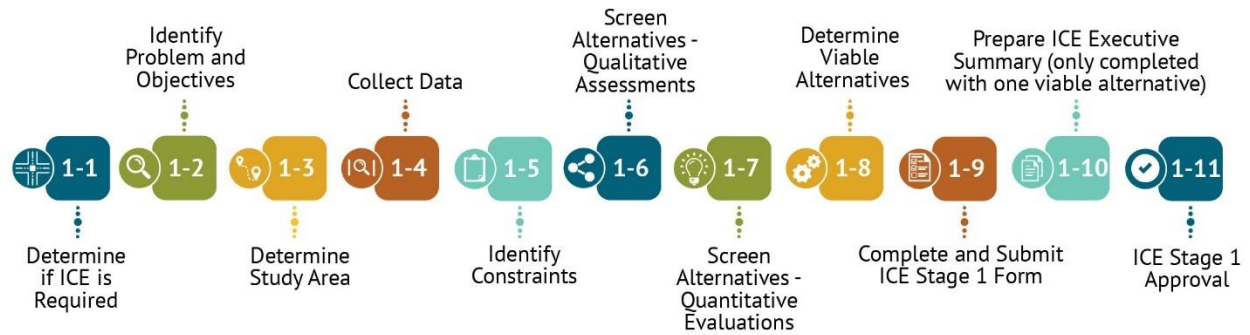


Figure 4-1. ICE Stage 1 Steps



Step 1-1 – Determine if ICE is Required

Determine if the project intersection requires ICE based on applicability and coordination with the Iowa DOT District Engineer or designated District ICE representative. For projects requiring ICE, follow the steps for Stages 1 and 2, as needed, and complete the appropriate ICE forms in the [Iowa DOT ICE Forms Spreadsheet Tool](#).

For projects where it is expected that ICE is not needed, an ICE Exemption Form should be completed and submitted to the appropriate District Engineer or District ICE representative for review and final determination. The ICE Exemption Form is included in the [Iowa DOT ICE Forms Spreadsheet Tool](#). If ICE exemption is granted, the ICE process ends and the District Engineer files the Exemption Form with project files; otherwise, the ICE process continues with the remainder of Stage 1.



Step 1-2 – Identify Problem and Objectives

Identify deficiencies of the project intersection and key issues to be addressed by the project. Identify objectives for the project solution (e.g., reduce crash frequency and/or severity, improve operations, new intersection, improvements needed for development growth).



Step 1-3 – Determine Study Area

Determine the study area for the ICE based on identified deficiencies of the project intersection. The study area for ICE is typically focused on an isolated project intersection; however, evaluations may need to expand beyond the project intersection for the following conditions:

- Queue spillback is anticipated to impact the operations of adjacent intersections
- Modifications are being made to an intersection within a coordinated signal system
- A corridor study is being conducted involving multiple intersections
- Modifications are being made to multiple intersections that do not operate independently, such as closely spaced signals

For projects where multiple intersections are included in the ICE, ICE Forms should be completed for each project intersection that is a new intersection or would have a fundamental change. Coordinate with the District Engineer or District ICE representative to determine project intersections to apply the ICE process versus those adjacent intersections that are part of evaluations but not proposed for improvement.



Step 1-4 – Collect Data

Collect data and information for the study area, including but not limited to:

- Project location
- Area setting (e.g., urban, suburban, rural town, rural)
 - For additional context, it may be beneficial to gather additional information on existing and future land uses. Coordinate with the local Metropolitan Planning Organization (MPO), Regional Public Agency (RPA) and other agencies to obtain recent long-range plans, comprehensive plans, land use plans and other completed studies that document existing and planned land use or development.
- Multimodal activity through and adjacent to the project location
- Existing basic roadway characteristics (e.g., intersection configuration, traffic control, functional classification, number of lanes, route number, milepost, posted/design speed, right-of-way (ROW) width, design vehicle)
- Existing traffic counts (Annual Average Daily Traffic volumes (AADTs) and AM/PM peak hour turning movement counts, including heavy vehicles, pedestrians, bicycles and transit vehicles, if applicable)
 - For new intersections, use other study sources such as a Traffic Impact Study or Travel Demand Model to estimate existing or opening year volumes.
 - Gather latest counts from [Iowa DOT's Traffic Count Data Portal](#).
 - Collect new counts as needed, and coordinate with Iowa DOT Systems Planning Bureau to determine data collection preferences and how to share collected data back to DOT for the DOT's record.
- Travel speeds
 - Posted speed is appropriate for use in evaluating traffic conditions at many locations. For locations where speed is a key problem to be addressed or free-flow speed is desired, posted speed plus some nominal speed (e.g., 5 mph) or detailed speed data may be more appropriate for use. For detailed speed data, coordinate with Iowa DOT Systems Planning Bureau on availability of speed data from Automated Traffic Recorders or Iowa DOT Traffic Operations Bureau on access to INRIX data.
- Crash history
 - For new intersections, this can be skipped.

- Use the [Iowa DOT's Potential for Crash Reduction \(PCR\) website](#) to record the following:
 - Severe (fatal/injury) PCR and All PCR values of the intersection.
 - Severe (fatal/injury) PCR and All PCR levels (High, Medium, Negligible).
 - The safety performance function (SPF)/PCR category for the intersection.
- If PCR values are unavailable, request PCR calculation support either through the "Contact Us" tab near the top of the webpage or by sending an email to DOT-SafetyAnalysis@iowadot.us.
- For locations with a PCR level of "Medium" or "High", obtain crash data from [Iowa DOT Iowa Crash Analysis Tool \(ICAT\)](#) for the most recent five full calendar years with complete data.
 - Refer to the Iowa DOT Safety Analysis Guide (SAG) on the [Iowa DOT About Traffic & Safety webpage](#) for methodology to determine intersection-related crashes.
 - Create collision diagram from ICAT.
 - Create Quick Report from ICAT.
- Highlight any safety performance issues from the crash data (trends in type, cause or severity).
- Future year traffic volume forecasts
 - It is preferred to use future year volumes when performing an ICE to evaluate an intersection configuration's ability to adequately serve future traffic volumes. If existing volumes seem appropriate for evaluating ICE in Stage 1, coordinate with the Iowa DOT District Engineer or District ICE representative to determine if existing volumes can be used to screen alternatives in Stage 1.
 - Forecast scenarios may include:
 - Project design year conditions (typically a minimum of 20 years beyond the opening year of Build improvements)
 - Opening year conditions
 - Other interim or horizon years determined to be needed for evaluation
 - An interim year scenario may be needed when project improvements are to be staged. Interim evaluations can be used to determine the timing of improvements beyond those needed for the opening year Build condition.
 - A horizon year scenario may be needed when a design year is not very far into the future (e.g., less than 20 years out). This may be because of additional planned improvements in the area to occur after the design year. A horizon year beyond the design year can be used to identify the ability of alternatives to serve traffic needs further into the future (20 years or more into the future).

- Coordinate with Iowa DOT Systems Planning Bureau and local MPO/RPA to gather travel forecasts or assumed growth rate, and forecasting procedures to be applied on the project.
- Environmental data
 - Use online and/or field review to identify potential environmental constraints in the study area. Coordinate with Iowa DOT Location and Environment Bureau on availability of environmental data, if needed.
- ROW information and adjacent land uses
 - Use online and/or field review to identify available ROW and land use information adjacent to the study area. Coordinate with Iowa DOT District for additional ROW resources, if needed.
- Previously completed studies
- Previously provided stakeholder/public input



Step 1-5 – Identify Constraints

Identify physical constraints and local expectations/requirements of the solution, including but not limited to:

- Known environmental, historic property, railroad and utility constraints to avoid
- ROW availability, expectation for purchase and property unavailable/unlikely for purchase
- Bridge impacts to avoid or bridges to consider for replacement as part of the project
- Scale of roadway realignment allowed
- Multimodal accommodations that are a priority
- Expectations for solution cost
- Solutions that stakeholders or the public have expressed support for or opposition to



Step 1-6 – Screen Alternatives – Qualitative Assessments

Qualitatively screen alternatives based on ability to meet the project objectives and are practical to pursue. Steps for qualitative screening of alternatives are outlined below and in the ICE Stage 1 Form.

1. Screen the base range of alternatives (provided on the [Iowa DOT ICE webpage](#)) to determine which alternatives merit further consideration based on basic roadway/intersection context (which alternatives make sense for roadway type, size and location) and AADTs. For example, a displaced left-turn intersection configuration likely does not make sense for a rural intersection. Screening inclusion criteria are included in the [Iowa DOT ICE Forms Spreadsheet Tool](#) to screen the base range of alternatives based on basic roadway/intersection context.

2. Perform qualitative evaluations to screen out alternatives that do not meet project objectives or key considerations by answering the following:
 - Does the alternative meet the objectives of the project?
 - Does the alternative satisfy multimodal needs?
 - Does the alternative fit the context of the surrounding transportation network?
 - Does the range of expected cost for the alternative meet local and Iowa DOT expectations for intersection improvements?
 - Supplemental information on range of intersection cost is provided on the [Iowa DOT ICE webpage](#).
 - Does the alternative have any environmental impacts?
 - Does the alternative have any ROW impacts?
3. Perform warrant analyses (all-way stop, signal) for alternatives, as appropriate. Use future year volumes unless previously determined to complete Stage 1 evaluation with existing traffic volumes. For locations with existing all-way stop or signal control, it may not be necessary to evaluate these for warrants.
4. Identify alternatives that are not feasible based on qualitative evaluations.
5. It may be beneficial or necessary to develop and evaluate supplemental alternatives (in addition to those in the base range of alternatives). This may be for instances where few base alternatives meet most qualitative screening criteria.
 - Consider alternatives that are hybrids of the base alternatives, incorporating only part of one base alternative or combining features from multiple base alternatives, such as:
 - A displaced left turn on only one approach
 - A loop in one quadrant of an intersection to serve left turns and a median U-turn on one leg to serve opposing left turns
 - Supplemental alternatives may also include variations of base alternatives with combinations of left- and right-turn lanes, offset turn lanes or bypass lanes.
 - Develop hand sketches of possible geometry that fit within project constraints to include with the ICE form.
 - Answer qualitative evaluation questions to determine if the supplemental alternatives meet project objectives or key considerations.



Step 1-7 – Screen Alternatives – Quantitative Evaluations

Perform quantitative screening of remaining alternatives through operational and safety performance evaluation. As noted previously, it is preferred to use future year volumes when performing an ICE to evaluate an intersection configuration's ability to adequately serve future traffic volumes. If existing volumes seem appropriate for evaluating ICE in Stage 1, coordinate with the Iowa DOT District Engineer or District ICE representative to determine if

existing volumes can be used to screen alternatives in Stage 1. It is also preferred to evaluate two peak hours (e.g., AM Peak Hour, PM Peak Hour) to capture directional peaking that may occur.

Determine volume-to-capacity ratio (V/C) for alternatives during each study period using a consistent analysis tool. Tools such as FHWA Capacity Analysis for Planning of Junctions (CAP-X), Highway Capacity Software (HCS), Synchro and SIDRA are appropriate. These tools should be used to estimate number of lanes and traffic control at the intersection to meet operational requirements.

- It is suggested to use CAP-X for quick reporting of V/C to screen alternatives, particularly when more than a few alternatives remain after the qualitative evaluations. CAP-X provides multiple variations for many intersection types (e.g., median U-turn intersections (MUTs) are evaluated in CAP-X with U-turns on the major road or on the minor road). The reported V/C for a given alternative should be based on the most likely variation for the study intersection and report the worst-case intersection V/C if multiple intersections are part of an alternative (e.g., RCI or quadrant roadway). If using CAP-X and an alternative is not included in CAP-X, the critical lane volume should be calculated and divided by the same capacity threshold used in CAP-X (e.g., 1,600 passenger cars per lane per hour) for reported V/C.
- If only a few alternatives are remaining for the quantitative evaluation, it may be desirable to conduct a more detailed analysis with a tool like HCS, Synchro or SIDRA. This may lead to more accurate V/C due to added alternative information and easier determination of a single viable alternative in Stage 1.

Evaluate safety performance with the FHWA Safe Systems for Intersections (SSI) spreadsheet tool (originally developed through the National Cooperative Research Program (NCHRP) Project 17-98). The SSI tool reports SSI Scores to evaluate safety performance. The SSI tool requires limited basic information (number of through lanes, AADTs and posted speed). SSI uses optional information for directional split of traffic volumes, AM and PM peak hour volumes and left-turn signal phasing to refine calculation of SSI Scores. For alternatives not included in the SSI tool, it is advised to use the SSI Score from an available alternative as a surrogate and modify SSI inputs as needed. Below are some examples for reporting SSI Scores of intersection alternatives not included in the SSI tool:

- Right-In/Right-Out intersection alternative: Report the SSI Score for Traditional Minor Road Stop. Modify SSI inputs for geometry and volumes to remove movements that would not exist for this alternative.
- Right-In/Right-Out/Left-In intersection alternative: Report the SSI Score for Traditional Minor Road Stop. Modify SSI inputs for geometry and volumes to remove movements that would not exist for this alternative.
- Offset-T intersection alternative: Report the SSI Score for Traditional Minor Road Stop or Traditional Signal depending on traffic control of the Offset-T intersections. Modify SSI inputs for geometry and volumes to remove movements that would not exist for this alternative. Evaluate each of the offset-T intersections and report the lower of the two intersection SSI Scores.

- Continuous Greet-T intersection alternative: Report the SSI Score for Traditional Signal. Modify SSI inputs for geometry and volumes to remove movements that would not exist for this alternative.



Step 1-8 – Determine Viable Alternatives

Determine which alternatives are viable based on the completed evaluations in Steps 1-6 and 1-7. As noted previously, ICE is generally expected to conclude at the end of Stage 1 with a single viable alternative. For select locations where a single viable alternative cannot be determined in Stage 1, narrow the range of viable alternatives to no more than five to be advanced to Stage 2.



Step 1-9 – Complete and Submit ICE Stage 1 Form

Complete the Stage 1 Form in the [Iowa DOT ICE Forms Spreadsheet Tool](#) and submit it to the appropriate District Engineer or designated District ICE representative for review and approval. Attach traffic counts, future volume sets, any evaluations completed outside of the Stage 1 Form (ICAT Quick Report, warrants, CAP-X, HCS, Synchro, SPICE, etc.) and any other supporting materials (e.g., supplemental alternative sketches or environmental or ROW reviews) to the Stage 1 Form submittal.

A meeting with Iowa DOT may be required to review the completed evaluations and determination of viable alternatives, and to discuss whether additional reviews or evaluations are needed in Stage 1. If updates to the Stage 1 evaluations and Stage 1 Form are required, the form must be resubmitted.



Step 1-10 – Prepare ICE Executive Summary (only completed with one viable alternative)

If only one viable alternative is determined in Stage 1, prepare and submit an executive summary memorandum that describes the project and ICE outcome. If more than one viable alternative is determined at the end of Stage 1, Stage 2 is required. The executive summary memorandum is intended to be relatively brief, on the order of 2-3 pages, and include the following sections:

- Introduction
- Constraints
- Data Sources and Volume Development
- Analysis Tools and Methods
- ICE Result



Step 1-11 – ICE Stage 1 Approval

If only one viable alternative is determined and recommended in Stage 1, the ICE process for the project intersection is concluded with the approval of the ICE Stage 1 Form by the appropriate Iowa DOT District Engineer or designated District ICE representative.

4.2 Stage 2 – Recommended Alternative Selection

Stage 2 does not need to be completed if only one viable alternative was identified in Stage 1. The purpose of Stage 2 is to complete detailed evaluations of the alternatives identified for further consideration in Stage 1 to identify a recommended alternative. The Stage 2 evaluations objectively compare the viable alternatives to each other. Stage 2 of ICE should result in the identification of one recommended alternative to carry forward.

In Stage 2, detailed evaluations are completed to identify a recommended alternative among those carried forward from Stage 1.

The steps of Stage 2 of the ICE procedure are outlined in [Figure 4-2](#).

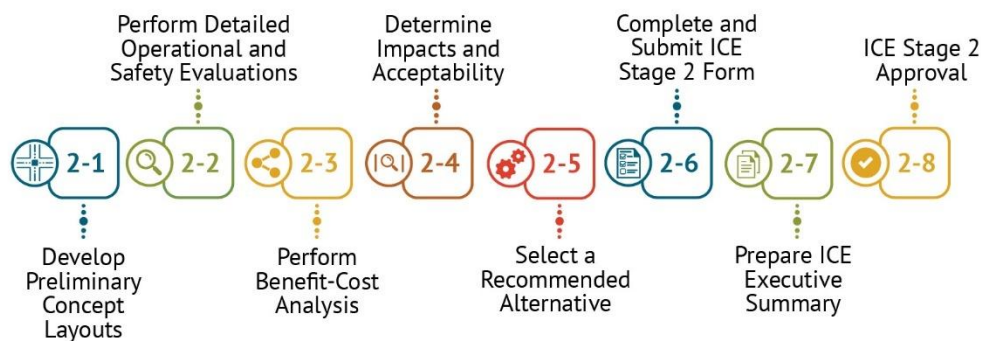


Figure 4-2. ICE Stage 2 Steps



Step 2-1 – Develop Preliminary Concept Layouts

Develop a conceptual layout showing the proposed geometrics and traffic control for each viable alternative identified in Stage 1. Note that each viable alternative identified in Stage 1 may be used to create multiple alternatives in Stage 2. For example, a quadrant roadway intersection may have the quadrant roadway in the northeast quadrant in one alternative and in the southwest quadrant in another alternative. Also, a median U-turn intersection may have the median U-turns on the major road in one alternative and on the minor road in another alternative. The layouts will be used to complete operational and safety evaluations in Step 2-2, calculate construction costs in Step 2-3 and help determine the ROW impacts and environmental impacts in Step 2-4. Conceptual layouts will also help communicate intersection alternatives to stakeholders and the public.

Note that Steps 2-1 and 2-2 can be somewhat iterative, as it may be beneficial to perform detailed operational or safety evaluations (Step 2-2) before spending much time to develop conceptual layouts. While conceptual layouts inform the location for movements and constraints, evaluations will shed light on geometric needs to meet operational and safety objectives that inform the conceptual layouts. The geometric needs identified through operational or safety evaluations may result in an alternative not being viable, eliminating the need to develop a conceptual layout for that alternative.



Step 2-2 – Perform Detailed Operational and Safety Evaluations

Perform detailed operational and safety evaluations of the viable alternatives identified in Stage 1. Two analysis years are required for the operational and safety evaluations, with a third year as optional. For the analysis years, it is suggested to use opening year and design year as the two required years. Two peak hours are required for the operational analysis, with a third peak hour as optional. Note that a third analysis year and third analysis hour may be beneficial to assess changes to operational and safety performance over the life of the project. Using a third analysis year and third analysis hour will also create a more refined regression curve for calculating benefits in Step 2-3.

- Traffic Forecasts
 - Develop any future year forecasts not developed in Stage 1 to fulfil the multiyear requirements in Stage 2.
- Operational Analysis
 - Use deterministic or microsimulation modeling tools (HCS, Synchro, SIDRA, Vissim, TransModeler, etc.) as appropriate to evaluate alternative operations for each analysis year and peak hour.
 - Deterministic tools (e.g., HCS, Synchro, SIDRA) are likely appropriate for most intersection types. More advanced microsimulation analysis should be considered for intersections with closely spaced or complex movements (e.g., displaced left-turn intersections, jughandle intersections or multilane roundabouts) or in locations where adjacent intersections or driveways may impact operations at the study intersection, or vice versa. Operations analysis tool selection should be discussed with the Iowa DOT District Engineer or designated District ICE representative.
 - For intersection types with out-of-distance travel, use HCM procedures for calculating Experienced Travel Time and determining LOS.
 - Based on the operational analysis, identify any alternatives that may no longer be viable and eliminate them from further evaluations.
- Safety Performance
 - Use predictive safety resources and modeling tools (e.g., SPICE, Highway Safety Manual (HSM), Highway Safety Software (HSS), Interactive Highway Safety Design Model (IHSDM)) to evaluate alternative safety performance for each analysis year.
 - Predictive safety spreadsheet tools, such as SPICE or those developed from the HSM, are likely appropriate for most ICE projects. For complex intersection alternatives, including hybrid alternatives, those with complex movements and those not incorporated into spreadsheet tools, more advanced safety performance modeling with a tool like IHSDM should be considered.

- Based on the safety performance, identify any alternatives that may no longer be viable and eliminate them from further evaluations.



Step 2-3 – Perform Benefit-Cost Analysis

Perform a benefit-cost analysis of remaining alternatives.

- Develop planning and construction cost estimates for each alternative, including costs for planning and design, ROW, construction, environmental mitigation, contingency, etc. Effort to develop cost estimates should be limited to concept-level; design is not expected to develop cost estimates. Pavement area from a conceptual layout may be suitable for calculating some concept-level cost estimates. Cost estimates should be estimated in year of expenditure dollars.
- Develop operating and maintenance costs for each alternative in current year dollars. Identify the duration of operating and maintenance costs. It is suggested to use opening year as the begin year and design year as the end year for operating and maintenance costs.
- Calculate value of benefit-cost for each alternative using cost estimates and results from operational and safety evaluations. It is recommended to use the opening year as the first year for the economic analysis. The design year is suggested for the last year of the economic analysis but may be appropriate to use a different future horizon year. Note that values of benefits are not calculated for new intersections since there is not a no-build condition for comparison.



Step 2-4 – Determine Impacts and Acceptability

Determine impacts and acceptability of remaining alternatives through review of environmental, ROW and utility impacts, multimodal accommodations, constructability and stakeholder/public input.

- Environmental, ROW, and Utility Impacts
 - Summarize issues related to environmental, ROW, or utilities for each alternative, noting issues that may likely preclude an alternative.
- Multimodal Accommodations
 - Summarize the need for multimodal accommodations and the ability of each alternative to accommodate these modes.
- Miscellaneous Factors
 - Summarize other factors for each alternative that differentiate them to support the selection of a recommended alternative.
 - Constructability
 - Stakeholder and public input

- The local jurisdictions, other important stakeholders, and the general public should be consulted to determine the acceptability of the alternative intersections. The degree of public involvement should be determined by the project manager in consultation with stakeholders and Iowa DOT.



Step 2-5 – Select a Recommended Alternative

Determine a recommended alternative based on the completed evaluations in Step 2-2 through Step 2-4. In the Stage 2 Form, note the recommended alternative and provide brief justifications for the selection of the recommended alternative and why other alternatives were not selected.



Step 2-6 – Complete and Submit ICE Stage 2 Form

Complete the Stage 2 Form in the [Iowa DOT ICE Forms Spreadsheet Tool](#) and submit it to the appropriate District Engineer or designated District ICE representative for review and approval. Attach alternative conceptual designs, any evaluations completed outside of the Stage 2 Form (HCS, Synchro, Vissim, IHSDM, etc.) and any other supporting materials to the Stage 2 Form submittal.

A meeting with Iowa DOT may be required to review the completed evaluations and determination of the recommended alternative, and to discuss whether additional reviews or evaluations are needed in Stage 2. If updates to the Stage 2 evaluations and Stage 2 Form are required, the form must be resubmitted.



Step 2-7 – Prepare ICE Executive Summary

Prepare and submit an executive summary memorandum that describes the project and ICE outcome. The executive summary memorandum is intended to be relatively brief, on the order of 2-3 pages, and should include the following sections:

- Introduction
- Constraints
- Data Sources and Volume Development
- Analysis Tools and Methods
- ICE Result



Step 2-8 – ICE Stage 2 Approval

The appropriate Iowa DOT District Engineer or designated District ICE representative approves the ICE Stage 2 Form to complete the ICE process.