ICE Procedure Overview

Intersection Control Evaluation Procedure

What is ICE

- ICE is an acronym for Intersection Control Evaluation
- ICE is a **three-stage** approach to develop traffic control alternatives for intersections. **ICE considers potential safety impacts, operational impacts, and multimodal factors for each alternative.**
  - **Stage 1: Screening**
  - **Stage 2: Initial Assessment**
  - **Stage 3: Detailed Assessment**
- The control strategies that can be analyzed include a traffic signal; minor road stop; 1 and 2 lane roundabout; displaced left turn; median u-turn; signalized and unsignalized restricted crossing u-turn; continuous green-t; and a jughandle.
- The result of the ICE procedure is a lifecycle cost for each feasible intersection control strategy. The lifecycle cost factors in the construction and maintenance costs, vehicle delay, and safety.

Why ICE

From the concept-stage, designers will consider alternative intersection designs (also called control strategies)

Through the ICE procedure, designers objectively evaluate and compare different intersection designs

In this procedure, the decision for a specific control strategy is documented

The ICE procedure is a "rapid" comparative analysis for all control strategies (the whole procedure should take about 8 hours)

When is ICE Required

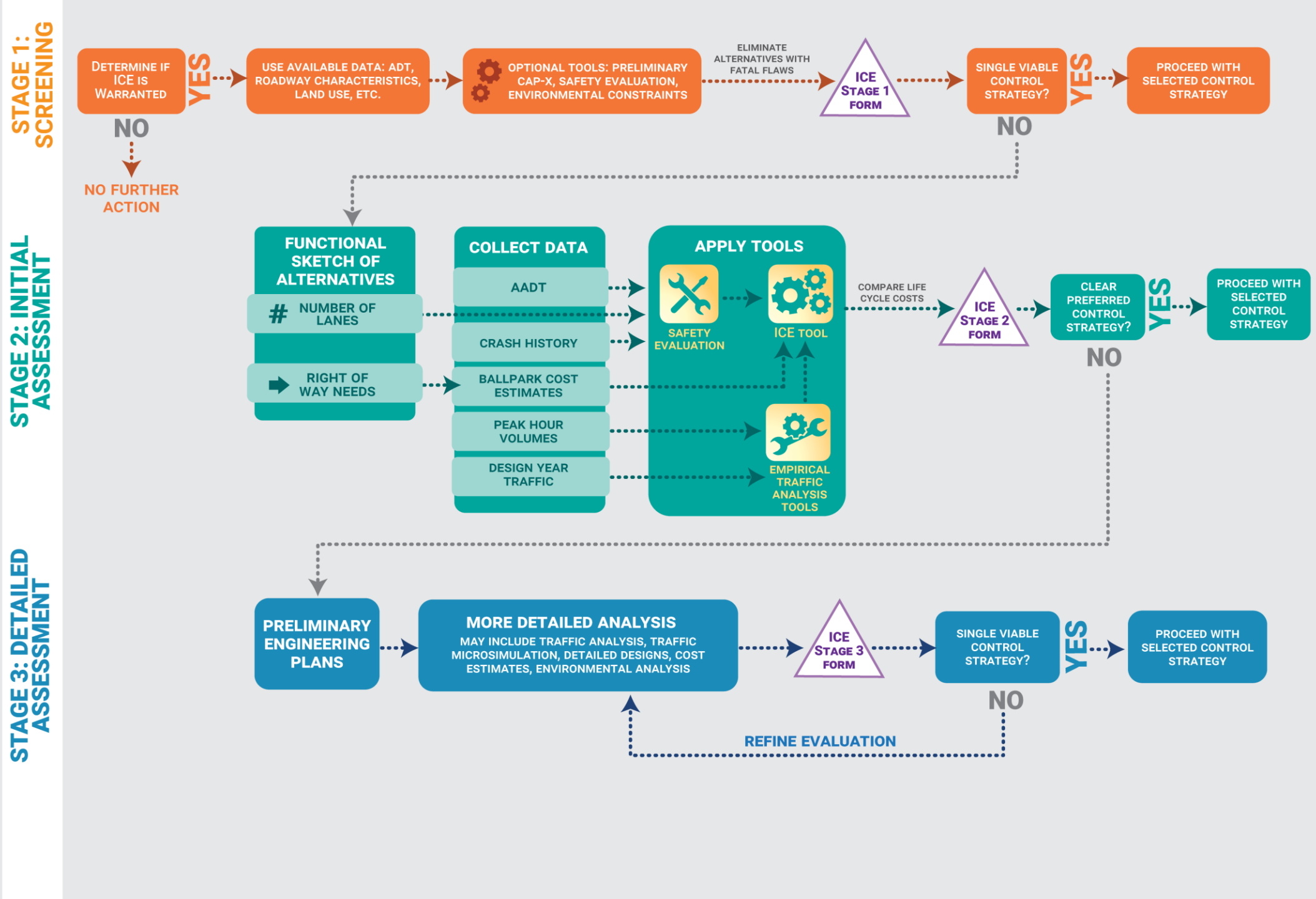
- When a project is on a State Highway or receiving MassDOT or Federal Highway Administration funds and meets any of the following criteria:
  - Creation of a new intersection on State Highway
  - Adding a leg to an existing intersection
  - Adding a through lane or left turning lane at an existing intersection
  - Changing the traffic control at an existing intersection; this includes:
    - Adding, removing, or major modifications to a traffic signal
    - Adding or removing a Stop or Yield sign to control an intersection leg
  - Full-depth pavement reconstruction of an existing intersection on any NHS roadway
  - If the project area includes a high crash location **(except when the scope of work is limited to maintenance or resurfacing only)**

When is ICE NOT Required

- A project is municipal-led on locally maintained roadways, and no federal funds are used for design or construction
- Work involved does not change the number of vehicular lanes at the intersection
- Work involved is limited to maintenance or pavement resurfacing
- The minor street is a low volume roadway with an AADT less than 1,000 vehicles per day
- Traffic signal retiming or equipment upgrades
- Adding only right turn lanes on one or more approaches
- Any various locations contract
- Footprint bridge projects

Note: MassDOT encourages municipalities to perform an ICE for projects they lead on locally maintained roadways, but ultimately it is the choice of the municipality

ICE Procedure



ICE Timeline

STAGE 1:

IS PREPARED BY THE PROJECT PROPONENT

Shall be completed and submitted with the Step 1 Project Initiation Form (PIF) to the MassDOT District via MaPIT.

STAGE 2:

IS PREPARED BY THE PROJECT DESIGNER

Should be completed as part of and submitted with the pre-25% design package if a single alternative does not emerge out of Stage 1.

STAGE 3:

IS PREPARED BY THE PROJECT DESIGNER

Should be developed and documented prior to the 25% submission package if one preferred control strategy does not emerge out of Stage 2.

ICE Documentation and Support Tools

MassDOT ICE Forms
- Used in all 3 Stages for documentation

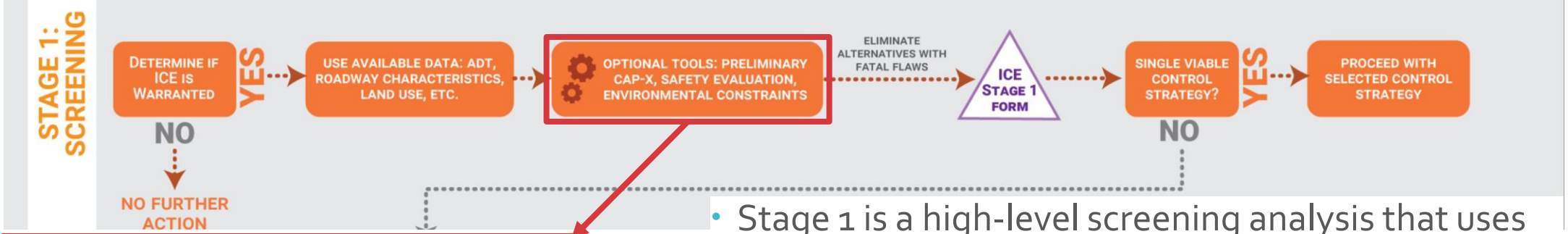
MassDOT ICE (lifecycle) Tool
- 1 spreadsheet for all control strategies
  - Only used in **Stage 2**

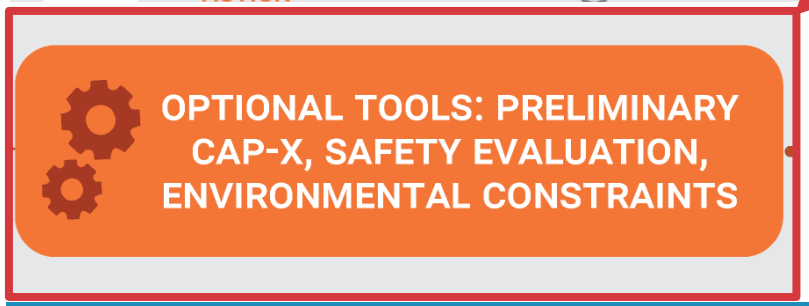
MassDOT Safety Alternatives Analysis Guide
- 1 spreadsheet for all control strategies
  - Optional in **Stage 1**
  - Required in **Stage 2**

FHWA Cap-X (Optional)
- Best used in **Stage 1**

Most information can be transferred automatically between spreadsheets tools

Stage 1 Overview





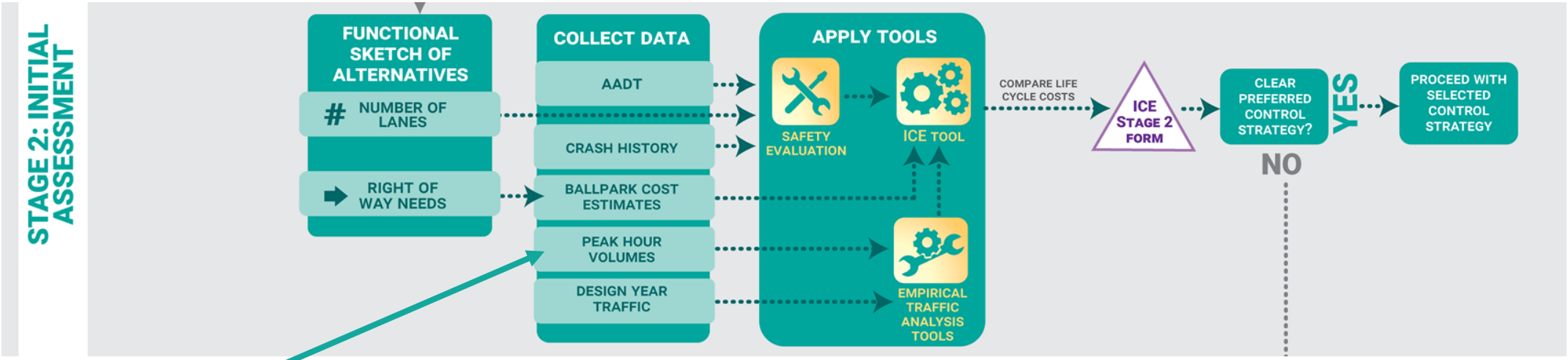
- Stage 1 is a high-level screening analysis that uses the **ICE Form** to document the viability of 12 control strategies (pictured below).
- If a safety analysis is performed in Stage 1, the **MassDOT Safety Alternatives Analysis Guide** should be followed.
- If there are multiple viable control strategies at the end of Stage 1, they are further analyzed in Stage 2. If only 1 control strategy is viable, then the ICE procedure is complete.

Notes: Optional analyses (like a capacity analysis using FHWA's CAP-X tool) are recommended in Stage 1 to help evaluate the feasibility of each control strategy.

Control Strategy									Decision Ju
Two-Way Stop-Controlled									
All-Way Stop-Controlled									
Signalized Control									
Roundabout									
Median U-Turn									
Restricted Crossing U-Turn (RCUT) Signalized									
Restricted Crossing U-Turn (RCUT) Unignalized									
Jughandle									
Displaced Left-Turn									
Continuous Green Tee									
Quadrant Roadway									
Other									

Note: It's expected that only a few control strategies will move into Stage 2 based on the project site context.

Stage 2 Overview



Stage 2 Data Needs Include:

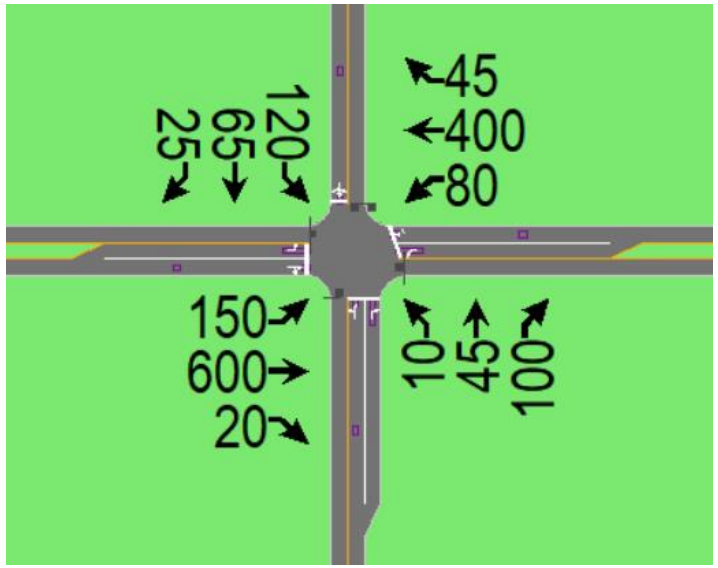
- Proposed lane configurations for each control strategy
- Major and minor road AADT
- Traffic counts for an opening and design year
- Crash history
- Cost estimate

Note: It's expected that the ICE Procedure will be complete for most projects after Stage 2.

- Stage 2 includes basic analyses of each viable control strategies from Stage 1.
- In Stage 2, the **ICE Tool** is used to **determine the lifecycle cost and a benefit-cost ratio** for each control strategy. The ICE tool requires three inputs (described in more detail on following slides)
  - Empirical traffic analysis
  - Safety analysis (**MassDOT Safety Alternatives Analysis Guide**)
  - Design and construction cost estimates
- Stage 2 also documents the multi-modal accommodations, the right-of-way, utility, and environmental impacts, and any public feedback of each control strategy.
- The results from the Stage 2 analyses are documented in the **ICE Form**. If there are multiple viable control strategies at the end of Stage 2, they are further analyzed in Stage 3. If only 1 control strategy is viable, then the ICE procedure is complete.

Stage 2
Empirical Analysis

- An empirical analysis evaluates the vehicle delay for each control strategy. To perform the empirical analysis:
  - Project data like expected turning movement counts and lane configurations need to be collected.
  - The project data is then plugged into standard traffic analysis tools like Synchro, Sidra, and HCS to determine the intersection delay.
- The intersection delay for the AM and PM peak hours for the opening and design year from the empirical analysis are plugged into the ICE Tool.



Note: The empirical analysis tool used for each project will vary based on the project purpose and needs. This analysis is intended to be relatively quick so microsimulation tools should not be used in this stage.

Stage 2
Safety Analysis

- The safety analysis evaluates the predicted total and fatal and injury (F&I) crashes for each control strategy. The **MassDOT Safety Alternatives Analysis Guide** should be used for all safety analyses.
- Inputs needed for the **MassDOT Safety Alternatives Analysis Guide** analysis include basic project data like the major and minor road AADT, facility type, and the number of intersection legs.
- The Total and Fatal and Injury (F&I) crashes from the safety analysis for the opening and/ or design year are plugged into the **MassDOT ICE Tool**.

Step 1.1E - Calculate Expected Number of Crashes in the Design Year

Crash Type, Severity	Predicted Crashes during the Study Period ($N_{pr,study}$)	Predicted Crashes during the Design Year ($N_{pr,design}$)	Growth Ratio ($N_{pr,design}/N_{pr,study}$)	Expected Crashes during the Study Period ($N_{exp,study}$)	Estimated Crashes during the Design Year ($N_{estimated,design,nobuild}$)
MV, FI	1.281	0.256	0.20	0.82	0.16
MV, PDO	5.284	1.057	0.20	2.18	0.44
SV, FI	0.136	0.027	0.20	0.12	0.02
SV, PDO	0.421	0.084	0.20	0.39	0.08
Ped, FI	0.107	0.021	0.20	0.11	0.02
Ped, PDO					
Bike, FI	0.036	0.007	0.20	0.04	0.01
Bike, PDO					
Total (FI)	**1.56**	**0.31**	-	-	**0.22**
Total (PDO)	**5.70**	**1.14**	-	-	**0.51**
Total	**7.26**	**1.453**	-	-	**0.73**

Stage 2
Cost Analysis

- The cost parameters include design, construction, right-of-way, and maintenance costs for each control strategy.
- The design and construction costs need to be estimated for each control strategy. These estimates are plugged into the **ICE Tool**. Planning level maintenance costs come pre-programed into the **ICE Tool** but can be updated if a more-accurate cost is known.

Note: The costs for each control strategy are intended to be ball-park estimates based on the available project information. A more detailed estimate can be incorporated into the ICE Procedure in Stage 3, if needed.

Cost Parameters

This sheet defines the basic cost parameters used in the benefit-cost analysis. You may either use the default values or override the defaults with your own values. **Note that all costs must be in the same year dollars, preferably in base year dollars.** Consult the Bureau of Labor Statistics web site for latest information on the consumer price index to adjust values to current year: http://www.bls.gov/cpi/

Type	Category	Unit valuation	Default value	Override value	Use value	Override date	Notes/References
Existing (Base) year for discounting	N/A	N/A	N/A	2021	2021		All costs will be discounted to the Base Year for Discounting. *Enter the year in the "Override Value" column.*
Opening Year	N/A	N/A	N/A	2021	2021		
Design Year	N/A	N/A	N/A	2041	2041		
Discount rate	N/A	Percent	0.04		0.04		OMB Circular A-4 recommends using both 3% and 7% real rates.
Value of time	Person (weekday)	$ per person hou	$ 17.67		$ 17.67		2015 TTI Urban Mobility Report
	Person (weekend)	$ per person hou	$ 17.67		$ 17.67		
	Trucks	$ per truck hour	$ 94.04		$ 94.04		
Crashes	Fatal & Injury Crashes	$ per crash	$ 327,600		$ 327,600		MassDOT 2016 Top Crash Locations Report (December 2018) https://www.mass.gov/files/documents/2019/03/01/dot-2016TopCrashLocationsRpt.pdf
	Property damage only crashes	$ per crash	$ 15,600		$ 15,600		*Fatal & Injury (KABC) Crashes are give a weight of 21 times that of property damage only (O) crashes.

These following values define the planning & construction and the operating & maintenance costs of the control strategy alternatives. A single total cost is required for planning and construction. Default values are provided for all operating & maintenance cost, but can be overridden by the user.

At-Grade Intersections	Total Design	Total Construction	Operating & Maintenance	Signal Retiming	Power	Lighting	Signal Maintenance	Roundabout Landscaping	Other	Other 2	Other 3	Other 4	Other 5
Two-Way Stop Control	$ 50,000	$ 100,000	Cost	$ -	$ -	$ 1,262	$ -	$ -	$ -	$ -	$ -	$ -	$ -
			Period	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)
Traffic Signal	$ 50,000	$ 500,000	Cost	$ 5,000	$ 4,500	$ 1,262	$ 3,750	$ -	$ -	$ -	$ -	$ -	$ -
			Period	Every 3 years	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)
Roundabout	$ 100,000	$ 1,500,000	Cost	$ -	$ -	$ 3,155	$ -	$ 2,000	$ -	$ -	$ -	$ -	$ -
			Period	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)	1 (yearly)

Intersection, the area type, and the number of lanes (see below).

Use this button to import Safety Data from SPIC

Introduction | OrganizationInformation | Alternatives_MasterList | DemandCounts | CostParameters | Delay | Outputs | TWSC_Delay | NameDefinitionsForMacros | NumericValues ...

Stage 2
ICE Tool Output

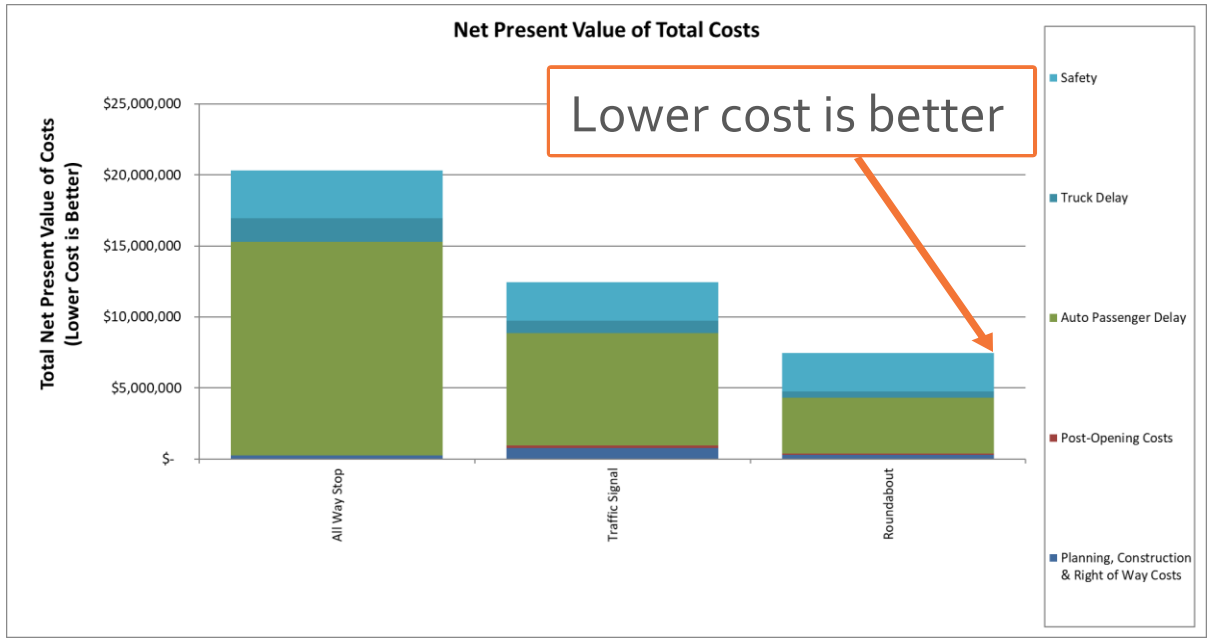
Higher B/C ratio is better

Analysis Summary

Cost Categories	Net Present Value of Costs		
	Two-Way Stop Control	Traffic Signal	Roundabout
Planning, Construction & Right of Way Costs	$ 150,000	$ 550,000	$ 1,600,000
Post-Opening Costs	$ 18,413	$ 164,060	$ 75,213
Auto Passenger Delay	$ 3,630,816	$ 5,093,322	$ 3,588,271
Truck Delay	$ 394,352	$ 553,199	$ 389,731
Safety	$ 17,676,312	$ 8,967,658	$ 7,064,035
Total cost	**$21,869,894**	**$15,328,239**	**$12,717,250**

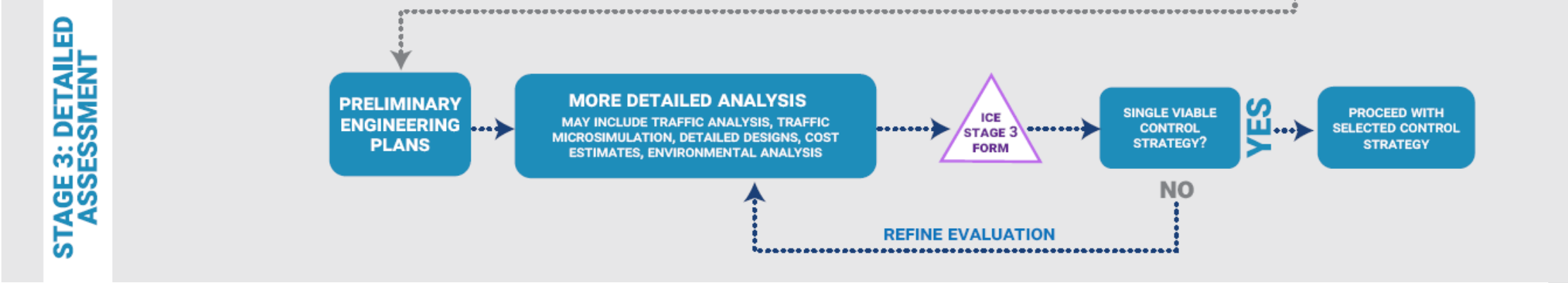
Select Base Case for Benefit-Cost Comparison:	Traffic Signal		
	Net Present Value of Benefits Relative t		
Benefit Categories	**Two-Way Stop Control**	**Traffic Signal**	**Roundabout**
Auto Passenger Delay	$ 1,462,506		$ 1,505,051
Truck Delay	$ 158,846		$ 163,467
Safety	$ (8,708,654)		$ 1,903,623
Net Present Value of Benefits	**$ (7,087,302)**		**$ 3,572,142**
Net Present Value of Costs	**$ (545,647)**		**$ 961,153**
Net Present Value of Improvement	**$ (6,541,655)**		**$ 2,610,989**
Benefit-Cost (B/C) Ratio	Benefits are less than base case and cost is less than base case.		**3.72**
Delay B/C	preferred. Benefits are greater than base case and cost is less than		**1.74**
Safety B/C	Benefits are less than base case and cost is less than base case.		**1.98**

- After the Empirical Traffic Analysis, Safety Analysis, and Cost Analysis are completed, the ICE Tool calculates the life cycle for each control strategy. Based on the lifecycle cost, most projects should be able to select 1 preferred control strategy.
- The ICE Tool can also calculate the relative benefit-cost (B/C) ratio between the different proposed control strategies. **Selecting the No-build option as the base of comparison is not recommended as it does not require any capital costs improvements.**
- If there is more than 1 preferred control strategy, each strategy is further evaluated in Stage 3.
- Data for the Empirical Analysis, Safety Analysis, and Cost Analysis, and the preferred alternative is documented in the **ICE Form**.



Note: A lower lifecycle cost is preferred. However, it is understood, and can be documented, that a control strategy with a higher cost can be selected as the preferred control strategy.

Stage 3 Overview



Note: It's expected that the ICE Procedure will be complete for most projects after Stage 2. If the ICE Procedure is finished in Stage 2, then Stage 3 is not required.

- Stage 3 performs a deeper analysis of each control strategy that emerges from Stage 2.
- In Stage 3, the traffic operations; project costs; safety; multi-modal accommodations; the right-of-way, utility, and environmental impacts; and public input are further refined compared to Stage 2. The tools used in this stage are not defined and will depend on the project needs and requirements.
- At the end of Stage 3, one control strategy is selected as the preferred alternative. All findings in Stage 3 are documented in the **ICE Form**.

Questions?

TrafficSafetyAnalysis@dot.state.ma.us