COLORADO
Department of Transportation
Division of Maintenance & Operations

Intersection Control Assessment Tool (ICAT)

VERSION 1.0 – SEPTEMBER 24, 2021

Agenda

- Description of ICAT and why it was developed by CDOT
- The goals and benefits of ICAT
- Walk-through guide of each worksheet
  - Introduction Data
  - Stage 1 Shortlist
  - Stage 2 Assessment
- Use of an example case study to illustrate tool functionality

What is ICAT?

- CDOT's Intersection Control Assessment Tool (ICAT)
  - Data-driven, performance-based approach
  - Objectively screen multiple alternatives
  - Identify optimal intersection control
- Support Colorado's safety policies and procedures
  - Traceability, transparency, consistency, and accountability when selecting an intersection type
  - Shift away from wider/larger intersections & signalization
  - Mainstream proven innovative and underutilized strategies
  - Emphasize context sensitivity, cost-effectiveness and sustainability

Why ICAT?

- Highway Safety Improvement Program: Focus on areas with greatest potential to improve safety, including:
  - Intersection safety
  - Quantitative analysis to select intersection control
  - Consider context-sensitive control strategies
  - Consider project life cycle costs (not just capital costs)
  - Safe facilities for all users with overall best value
  - Evaluation of multiple alternatives using quantitative analysis
  - Documentation to support control decision

Why ICAT?

- Ensure intersection investments across the state are prioritized
- Defensible benefits for safety and operations
- Provide simplified and consistent use of data to assess and quantify intersection control improvement benefits

Benefits of ICAT

Simplified, consistent way to use data to quantify & evaluate intersection control

Reduces time to analyze & compare multiple alternatives

Provide traceability, transparency, consistency and accountability when evaluating and selecting control types

Serves as agreed upon decision document in the planning process

Getting Started

- ICAT is open-source Excel workbook that includes 7 worksheets:
  - **Introductions and Intersections:** Purpose and goals, tool processes and responsibilities descriptions and graphics of intersection types and publication links
  - **Intersection Data:** Roadway, intersection, control, safety and traffic data entry
  - **Stage I:** Screening to eliminate alternatives and advance shortlist
  - **Costs and Stage II:** Generate cost estimates, assess shortlisted alternatives and select preferred alternative
  - **Environmental Impacts:** Document environmental mitigation needed
- Computations rely on input from multiple worksheets - no results should be considered final until all worksheets are fully complete

Getting Started

- Several tools provided to assist tool data entry:
  - ICAT Users Guide – provides step by step process for entering data
  - Data Entry Checklist – provides checklist for all data needed and entered in ICAT

CDOT INTERSECTION CONTROL ASSESSMENT TOOL (ICAT)

Version 1.0 Users Guide

The CDOT Intersection Control Assessment Tool (ICAT) is an open-source Excel workbook that includes seven (7) worksheets, each containing information and data inputs to complete an intersection control assessment. Note, computations may rely on input from multiple worksheets, and the analysis results are continually updated as the worksheets are completed. Therefore, no results should be considered final until all worksheets are fully complete.

INTRODUCTION WORKSHEET

The *Introduction* worksheet provides information on the purpose and goals of the intersection control assessment, a description of the tool processes and responsibilities, answers to frequently asked questions, and documentation of ICAT version updates.

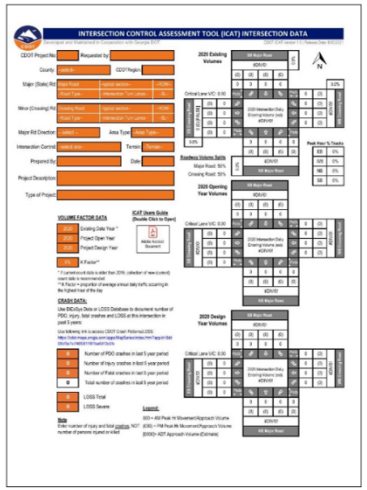
INTERSECTIONS WORKSHEET

The *Intersections* worksheet provides descriptions and graphics of each intersection type included for evaluation and links to national publications that describe each intersection type in greater detail.

INTERSECTION DATA WORKSHEET

The *IntersectionData* worksheet begins the ICAT data entry process. **Figure 1** illustrates a blank worksheet and requested inputs for project, traffic, and safety data. Here and throughout the tool, orange text or boxes indicate required data inputs, and blue text or text boxes indicate

Figure 1: Blank *IntersectionData* Worksheet



CDOT ICAT: User Testing Guidelines and Checklist

Developed and Maintained in Cooperation with Georgia DOT

CDOT ICAT Version 1.0 | Release Date: 3/30/2021

Instructions:

1. Using own Test Case example and data, input information into the ICAT and check appropriate check-boxes in the input checklist below when complete.
2. Take screen shots at the incremental steps listed below to ensure complete data entry and to assist with troubleshooting.
3. If an issue is identified, include a screen shot and supporting details in the additional tabs provided. Duplicate the tabs if multiple issues are identified.
4. Once the checklist and ICAT are completed, upload to your Region folder in the Google Drive link provided.

Note: The ICAT must be opened in Excel, not Google Sheets

Input Checklist:

"IntersectionData" Tab:

- ☐ County
- ☐ CDOT Region
- ☐ Major Street: Name, Typical Section, ROW, Roadway Classification, Turn Lanes at Intersection, and Speed
  - **Note that without inputting Intersection Turn Lanes, user may get error message in future tabs*
- ☐ Minor Street: Name, Typical Section, ROW, Roadway Classification, Turn Lanes at Intersection, and Speed
  - **Note that without inputting Intersection Turn Lanes, user may get error message in future tabs*
- ☐ Major Road Direction, Area Type, Existing Intersection Control, and Terrain
- ☐ Update Existing, Opening, and Design Project Traffic Year; If future volumes are unknown, include Annual Growth Rate and K Factor
- ☐ Input existing traffic volumes, truck percentages, and pedestrians; if known, input future traffic information

Introduction

- Summarizes tool goal and requirements
- Introduces two-phase process and roles and responsibilities
- Link to ICAT Users Guide
- Track future versions and program updates

COLORADO INTERSECTION CONTROL ASSESSMENT TOOL (ICAT)

Developed and Maintained in Cooperation with Georgia DOT

CDOT ICAT Version 1.0 | Release Date: 8/30/2021

About the Colorado ICAT:

Introduction: The Intersection Control Assessment Tool (ICAT) uses a data-driven, performance-based approach to objectively screen alternatives and identify an optimal geometric and control solution for an intersection. In 2015, Colorado Governor Hickenlooper announced Colorado's safety initiative to reduce transportation related deaths: Moving Colorado Towards Zero Deaths. Zero deaths and serious injuries is a core value of the state's Strategic Transportation Safety Plan, which provides innovative and data-driven approaches to improving highway safety. Colorado's ICAT was developed to ensure intersection investments across the state are prioritized and implemented with defensible benefits for safety and operations.

Tool Goal: The goal of ICAT is to provide a simplified and consistent way of importing traffic, safety, cost, environmental impact and stakeholder data to assess and quantify intersection control improvement benefits. The tool supports Colorado's stated policies and procedures to provide traceability, transparency, consistency and accountability when identifying and selecting an intersection control solution that both meets project purpose and reflects overall best value in terms of specific performance-based criteria. Note that a PDF of the ICAT users guide is available on both this tab (right) and the IntersectionData tab.

Requirements: Use of ICAT shall be required for any intersection or ramp termini improvement (new intersection, intersection modification, widening/reconstruction corridor project, or work requiring an access permit that affects an intersection) when: **1)** The intersection includes at least one roadway designated as a State Highway or part of the NHS, **2)** The intersection will be designed or constructed using State or Federal funding, **3)** The intersection is included in Access Control Plans (ACP), Planning and Environmental Linkages (PEL), Corridor Planning Studies, or Traffic Impact Studies (TIS), or **4)** Requested by the Regional Traffic Representative's (RTR). Use of ICAT shall NOT be required when the proposed work does not include any geometric or capacity changes to the intersection design such as (but not limited to): resurfacing pavement projects, striping projects, routine maintenance projects, traffic signal retiming projects (that do not include adding a phase), a proposed RIRO intersection that meets the Colorado State Highway Access Code, or signal maintenance projects (to upgrade deficient equipment). A waiver eligibility form must be completed by the Project Manager and submitted to the RTR, and if approved, the project shall be exempt from ICAT requirements.

Two-Stage Process: The assessment process consists of two stages: Stage 1, a Screening Analysis and Stage 2, Alternative Selection. The intent of Stage 1 is to eliminate any infeasible intersection types through a series of screening questions. The purpose of Stage 2 is to perform a detailed analysis to determine a preferred alternative selection. The ICAT forms are designed to minimize required data inputs using drop-down menu choices and limiting text entry. All fields shaded in orange require either data entry or drop-down menu choices, and data fields in all worksheets must be filled before any reliable results can be obtained. All non data-entry cells in worksheets are locked, and all worksheets are password protected.

Stage 1: Screening Decision Record Stage 1 is intended to screen many different intersection types and select between 2 and 5 alternatives for detailed analysis in Stage 2. The purpose of Stage 1 is not to compare intersection alternatives against each other but to assess the different intersection types individually to determine if and to what extent they potentially meet the project purpose and need, strategic program goals and project context by answering a number of questions regarding intersection right-of-way, safety, context, operations and costs. After the Stage 1 analysis is complete, the ICAT Champion will review and verify the results prior to the user moving onto the Stage 2 alternative selection.

Stage 2: Alternative Decision Record Stage 2 further analyzes intersection types selected from the Stage 1 screening and determines the best possible intersection type for the project needs. The Stage 2 analysis includes additional safety and operational analysis, environmental, utility, and right-of-way impacts, cost comparisons, and other factors specific to the context. Once all data is entered, each alternative is scored and ranked, and results provided inform on the best intersection control(s). Once determined, the user will collaborate with the ICAT Champion to recommend the final solution. The ICAT Champion will review and verify the analysis results and the RTR

Intersections

- Provides information on all intersection types in tool
- Educational links – click on image to access published guides or research on each intersection

INTERSECTION CONTROL DESCRIPTIONS

Click on intersection images for additional resource publications

Signalized At-Grade Intersections

Signalized Intersection: The most common type of signalized intersection with high driver familiarity. Signal could be simple two-phase or more complex 8-phase to serve vehicular demand. Left turns can be permitted or protected (or combination of both). At a conventional 4-leg intersection there are 32 baseline conflict points.

Jughandle: Much like an at-grade diamond interchange, ramps on the major street diverge from the right side in advance of a cross street intersection, removing the left turn movement from directly at the cross-street intersection. Major street left turns are made at minor, stop-controlled intersections on the cross-street. Left turns from the cross-street remain as direct movements at the main intersection.

Median U-Turn: Left turn movements otherwise occurring at the main intersection are made via U-turns in the median, preceding or following right turns. U-turns may be only on major roadway or on both major and minor roadways. A conventional MUT has 16 baseline conflict points and has shown significant operational and safety benefits. Also known as: Indirect Left, Michigan Left, MUT

Continuous Green-T: Three-leg intersection that features raised channelization to allow the "top" through movement to operate under continual green. The opposite direction intersects with the major and minor street lefts at a signalized intersection (minor left turns merge with the continual through movement downstream). A Continuous Green-T has 9 baseline conflict points, the same as a conventional 3-leg.

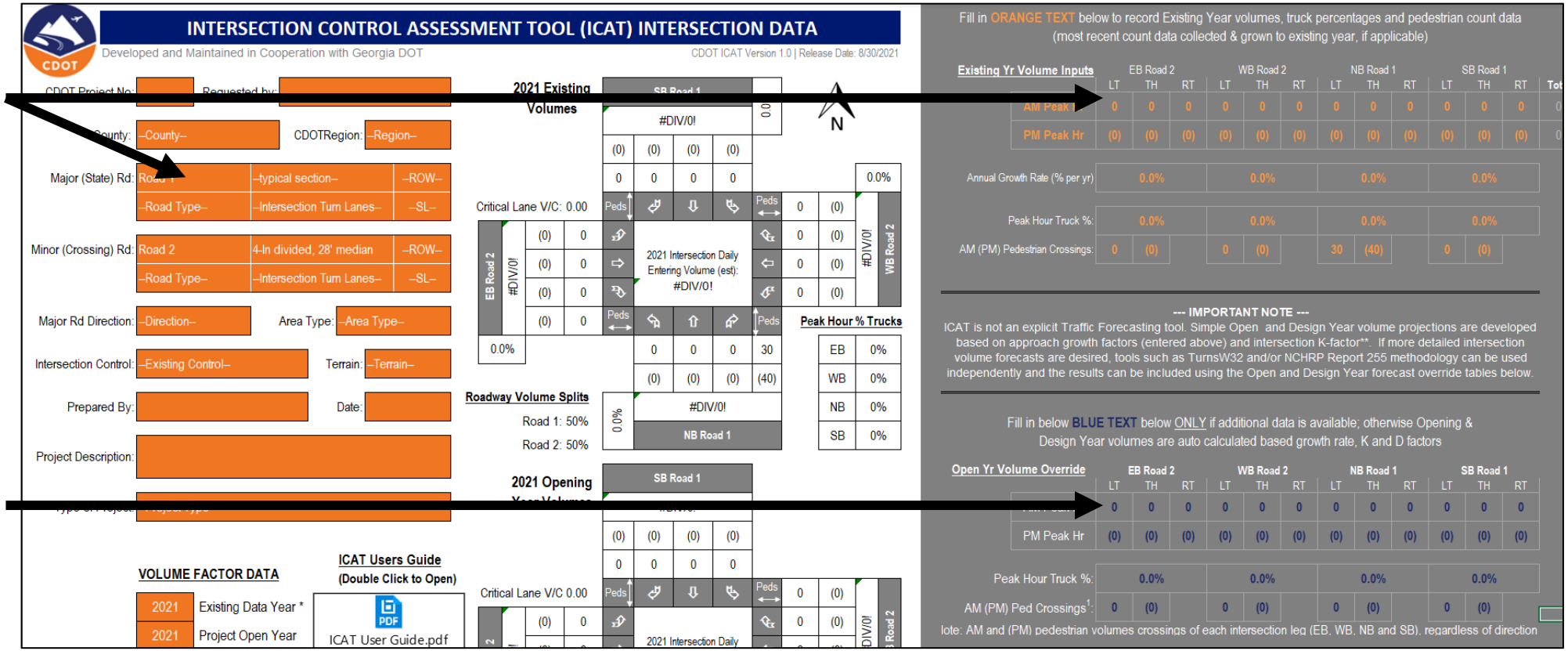
Superstreet / Reduced Conflict Intersection: Similar to the Median U-turn but features break in cross-street traffic that allows signals on opposite directions to operate independently. Left turns can make direct turns onto the minor road but minor road thru and left turn movements are made using the directional U-turn crossovers. A Superstreet / RCI has 14 baseline conflict points (over 3 intersections).

Offset-T Intersection: The minor street is bifurcated at the major roadway at two T-intersections, whereas through movements on the minor roadway use a portion of the major street between intersections. The minor street can be either offset right (as pictured above) or offset left, and the intersections can be unsignalized or signalized. If signalized, proper signal coordination is essential for efficient

Intersection Data

Orange text or boxes (drop-down selections) are REQUIRED

Blue text or boxes (drop-down selections) are OPTIONAL



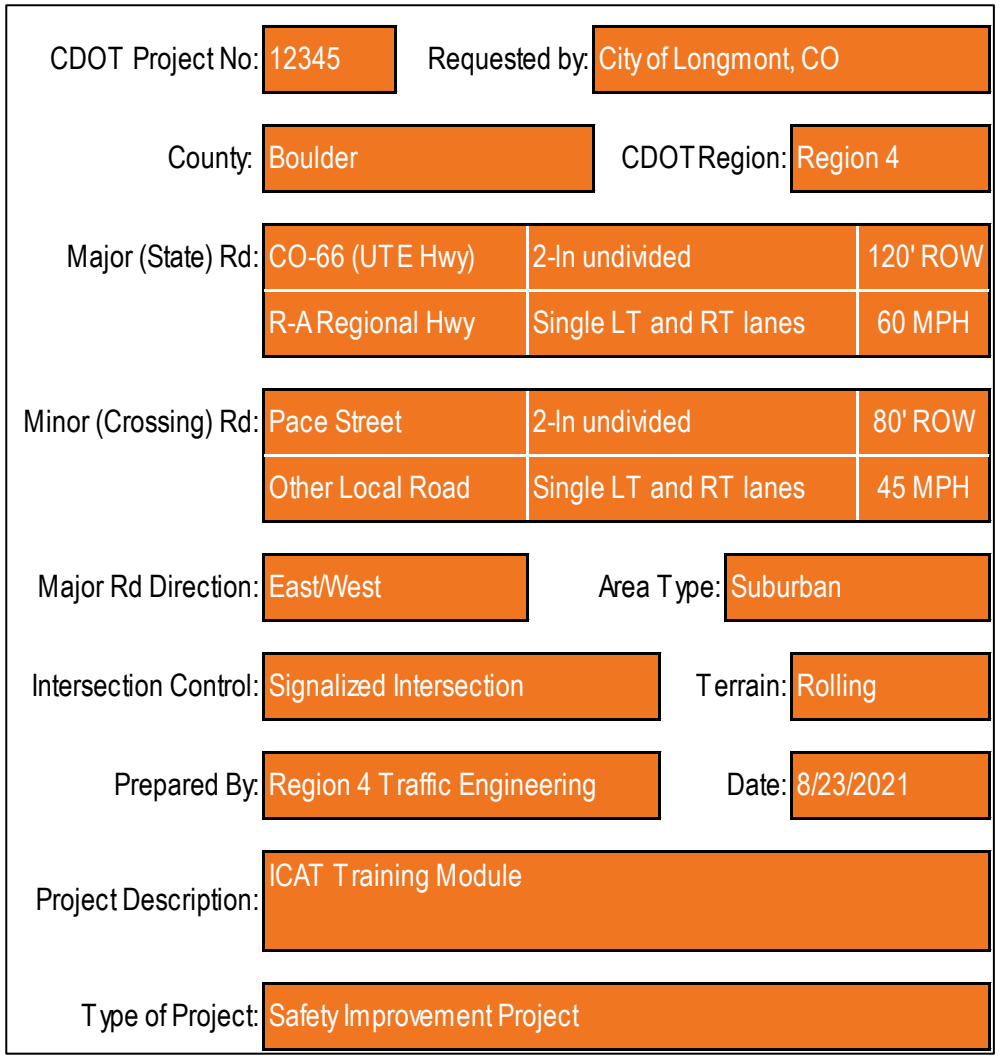
Inputs in grey-shaded area are outside print border

Case Study Example

- Not actual case study
  - Exercise meant to show functionality of tool
- Hwy 66 at Pace Street, City of Longmont CO
  - Signalized T-intersection
  - High-speed rural highway intersecting local collector

Intersection Data

- Input intersection, volume, crash data
- Project number and requested by
- County selection drop box and CDOT region
- Major and Minor Road data
  - Name (limit to 15 characters)
  - Typical section (most conservative) and ROW
  - Turn lanes (most conservative if different)
  - Speed limit
- Area type, current control, general terrain
- Preparer (agency/firm), date, project description
- Type of project (important to evaluation factors)



Intersection Data

- Volume factor data
  - Existing, Opening and Design Year
  - Intersection K-factor
  - Used to generate volume forecasts
- Crash data
  - CDOT LOSS Total and Severity Score
  - PDO, injury & fatal crashes over 5 years

VOLUME FACTOR DATA

ICAT Users Guide
(Double Click to Open)

ICAT User Guide.pdf

2021	Existing Data Year *
2023	Project Open Year
2043	Project Design Year
10%	K Factor**

* If current count data is older than 2016, collection of new (current) count data is recommended

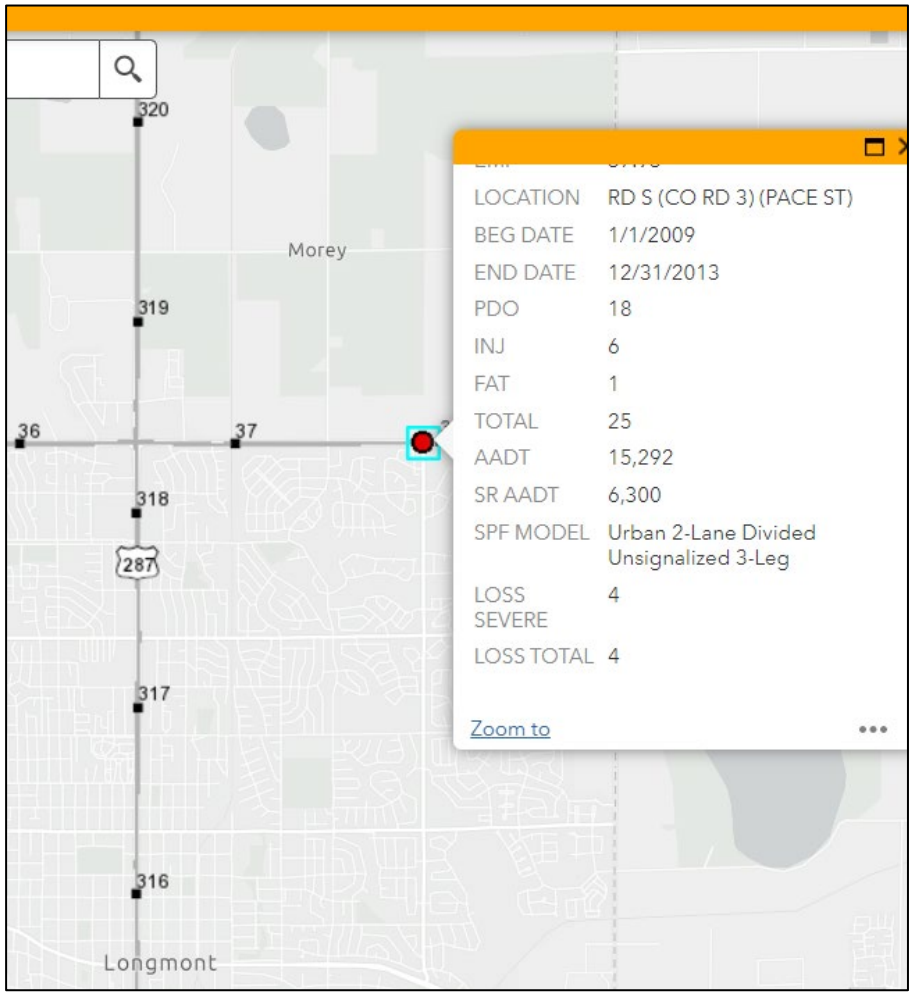
** K Factor = proportion of average annual daily traffic occurring in the highest hour of the day

CRASH DATA:

Use DiExSys Data or LOSS Database to document number of PDO, injury, fatal crashes and LOSS at this intersection in past 5 years:

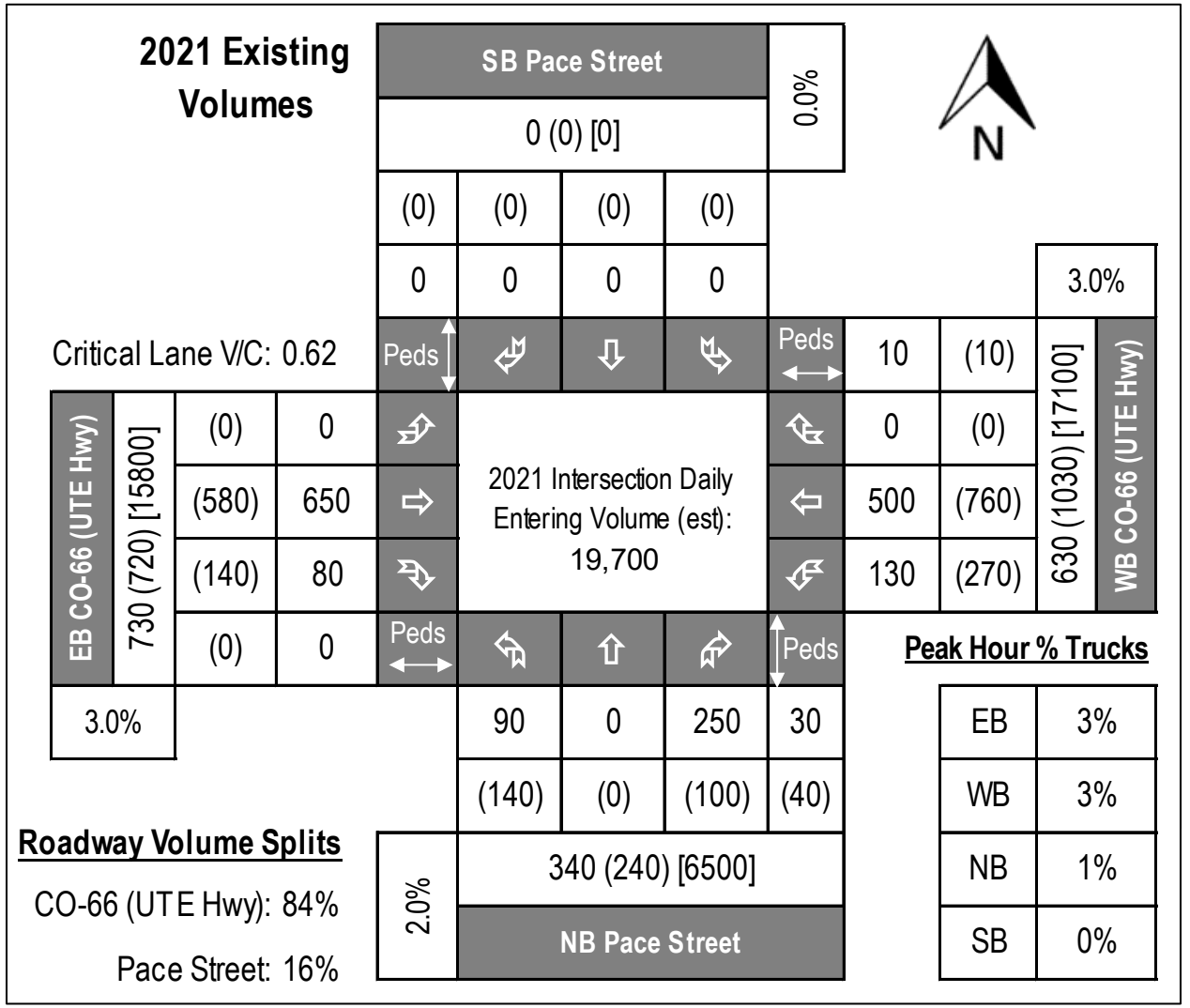
Use following link to access CDOT Crash Patterns/LOSS:
https://cdot.maps.arcgis.com/apps/MapSeries/index.html?appid=3dd05bf3e7e746f5811f81ba6d13c5fe

18	Number of PDO crashes in last 5 year period
6	Number of Injury crashes in last 5 year period
1	Number of Fatal crashes in last 5 year period
25	Total number of crashes in last 5 year period
4	LOSS Total
4	LOSS Severe



Intersection Data

- Existing AM (PM) volume data
- Annual growth rate on each approach
- Truck percentage on each approach
- Existing pedestrian crossing data (if available)
- Approach volumes, ADT's and future volume estimates appear in graphic
- ICAT not a traffic forecasting tool
  - Can import outside traffic forecast data
  - Will override calculated data



ICAT Stage I

Stage I – 15 Context Questions

- 15 questions related to ROW constraints, safety, road context, operations and maintenance and costs to understand intersection needs and context

ICAT STAGE 1: ALTERNATIVE SHORT-LIST DECISION RECORD

Developed and Maintained in Cooperation with

Project Number:	0012345
Project Location:	CO-66 (UTE Hwy) @ Pace Street
Existing Control:	Signalized Intersection
Prepared by:	Region 4 Traffic Engineering
Date:	8/23/2021

1 Answer questions 1-16 with rating of 0, 1 or 2.

2 Deselect or select any alternative by placing an X or Y (respectively) in column to right of score; Enter change justification in rightmost column

	Right of Way			*Safety*				*Roadway Context*				*Operations/Maintenance*			*Costs*	
Intersection Alternatives: (see Intersections tab for detailed description of intersection/interchange type)	Q1: Is ROW on major road constrained? (0=no, 1=somewhat, 2=highly)	Q2: Is ROW on minor road constrained? (0=no, 1=somewhat, 2=highly)	Q3: Intersection quadrants constrained? (0=no, 1=somewhat, 2=highly)	Q4: Are there intersection safety issues? (0=low, 1=moderate, 2=crash hot spot)	Q5: Are there significant pedestrian crossings? (0=none/low, 1=moderate, 2=high)	Q6: Is there significant bicycle activity? (0=none/low, 1=moderate, 2=high)	Q7: Are one or more approach speeds high? (0=no, 1=moderate, 2=high)	Q8:Do roadway contexts, characteristics transition at intersection? (0=no, 1yes)	Q9: Are there numerous driveways near intersection? (0=no, 1=few, 2=many)	Q10: What is adjacent intersection spacing? (0=isolated, 1=network, 2= dense network)	Q11: Is this a T-intersection? Or can minor ST thru or left turns be eliminated? (0=No, 2=Yes)	Q12: Are design yr no-build volumes high? No-Build 2043 V/C=1.16; (0=low, 2=mod, 4=high)	Q13: Are exist LT volumes high? (Max 2021 LT =270 vph) ; (0=no, 1=somewhat, 2=yes)	Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)	Q15: Are costs a primary decision factor? (0=no, 1=somewhat, 2=yes)	**Total Stage 1 Screening Evaluation Score**
	1	0	0	2	1	1	2	0	0	1	2	2	1	0	1	

0
1
2

Q1: Is ROW on major road constrained? (0=no, 1=somewhat, 2=highly)

Q2: Is ROW on minor road constrained? (0=no, 1=somewhat, 2=highly)

Q3: Intersection quadrants constrained? (0=no, 1=somewhat, 2=highly)

Q4: Are there intersection safety issues? (0=low, 1=moderate, 2=crash hot spot)

Q5: Are there significant pedestrian crossings? (0=none/low, 1=moderate, 2=high)

Q6: Is there significant bicycle activity? (0=none/low, 1=moderate, 2=high)

Q7: Are one or more approach speeds high? (0=no, 1=moderate, 2=high)

Q8:Do roadway contexts, characteristics transition at intersection? (0=no, 1yes)

Q9: Are there numerous driveways near intersection? (0=no, 1=few, 2=many)

Q10: What is adjacent intersection spacing? (0=isolated, 1=network, 2= dense network)

Q11: Is this a T-intersection? Or can minor ST thru or left turns be eliminated? (0=No, 1=Yes)

Q12: Are design yr no-build volumes high? No-Build 2043 V/C=1.65; (0=low, 2=mod, 4=high)

Q13: Are exist LT volumes high? (Max 2021 LT =400 vph) ; (0=no, 1=somewhat, 2=yes)

Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)

Q15: Are costs a primary decision factor? (0=no, 1=somewhat, 2=yes)

Stage I – 15 Context Questions

- 15 questions related to ROW constraints, safety, road context, operations and maintenance and costs to understand intersection needs and context

ICAT STAGE 1: ALTERNATIVE SHORT-LIST DECISION RECORD

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2 Deselect or select any alternative by placing an X or Y (respectively) in column to right of score; Enter change justification in rightmost column

	Right of Way			*Safety*				*Roadway Context*				*Operations/Maintenance*			*Costs*	
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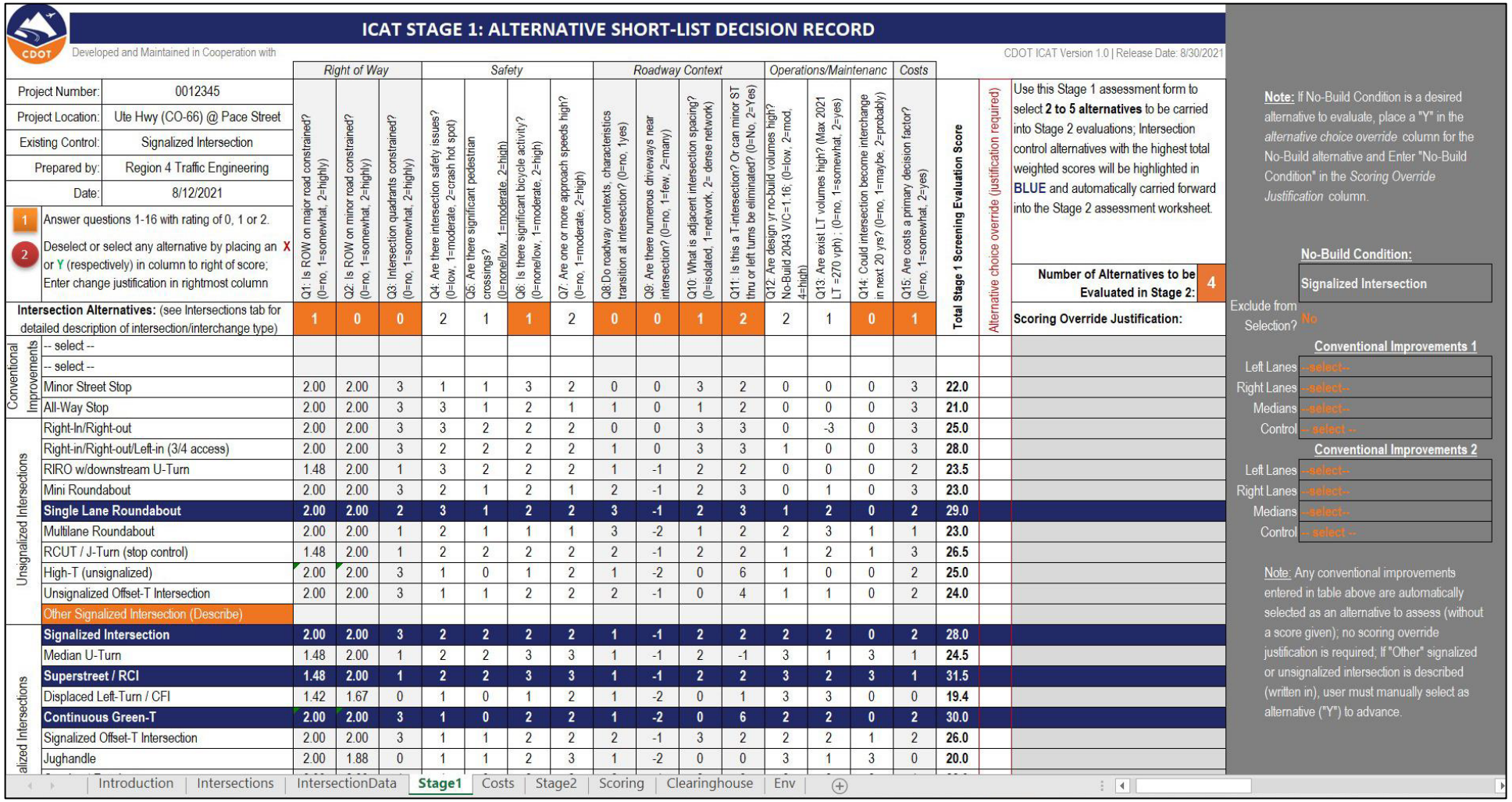
	1	0	0	2	1	1	2	0	0	1	2	2	1	0	1	

0
1
2

Stage I – Shortlist Selection

- Overall intersection score determined
- Users can create conventional alternatives
- Select/deselect alternatives (with justification) in order to shortlist alternatives



ICAT STAGE 1: ALTERNATIVE SHORT-LIST DECISION RECORD

Developed and Maintained in Cooperation with

CDOT ICAT Version 1.0 | Release Date: 8/30/2021

Project Number:	0012345
Project Location:	Ute Hwy (CO-66) @ Pace Street
Existing Control:	Signalized Intersection
Prepared by:	Region 4 Traffic Engineering
Date:	8/12/2021

1 Answer questions 1-16 with rating of 0, 1 or 2.

2 Deselect or select any alternative by placing an X or Y (respectively) in column to right of score; Enter change justification in rightmost column

Use this Stage 1 assessment form to select **2 to 5 alternatives** to be carried into Stage 2 evaluations; Intersection control alternatives with the highest total weighted scores will be highlighted in BLUE and automatically carried forward into the Stage 2 assessment worksheet.

Number of Alternatives to be Evaluated in Stage 2: 4

Scoring Override Justification:

	Intersection Alternatives: (see Intersections tab for detailed description of intersection/interchange type)	Q1: Is ROW on major road constrained? (0=no, 1=somewhat, 2=highly)	Q2: Is ROW on minor road constrained? (0=no, 1=somewhat, 2=highly)	Q3: Intersection quadrants constrained? (0=no, 1=somewhat, 2=highly)	Q4: Are there intersection safety issues? (0=low, 1=moderate, 2=crash hot spot)	Q5: Are there significant pedestrian crossings? (0=none/low, 1=moderate, 2=high)	Q6: Is there significant bicycle activity? (0=none/low, 1=moderate, 2=high)	Q7: Are one or more approach speeds high? (0=no, 1=moderate, 2=high)	Q8:Do roadway contexts, characteristics transition at intersection? (0=no, 1yes)	Q9: Are there numerous driveways near intersection? (0=no, 1=few, 2=many)	Q10: What is adjacent intersection spacing? (0=isolated, 1=network, 2= dense network)	Q11: Is this a T-intersection? Or can minor ST thru or left turns be eliminated? (0=No, 2=Yes)	Q12: Are design yr no-build volumes high? No-Build 2043 V/C=1.16; (0=low, 2=mod, 4=high)	Q13: Are exist LT volumes high? (Max 2021 LT =270 vph) ; (0=no, 1=somewhat, 2=yes)	Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)	Q15: Are costs a primary decision factor? (0=no, 1=somewhat, 2=yes)	Total Stage 1 Screening Evaluation Score	Alternative choice override (justification required)
		Right of Way			Safety				Roadway Context				Operations/Maintenanc			Costs		
		1	0	0	2	1	1	2	0	0	1	2	2	1	0	1		
Conventional Improvements	-- select --																	
	-- select --																	
	Minor Street Stop	2.00	2.00	3	1	1	3	2	0	0	3	2	0	0	0	3	22.0	
	All-Way Stop	2.00	2.00	3	3	1	2	1	1	0	1	2	0	0	0	3	21.0	
Unsignalized Intersections	Right-In/Right-out	2.00	2.00	3	3	2	2	2	0	0	3	3	0	-3	0	3	25.0	
	Right-in/Right-out/Left-in (3/4 access)	2.00	2.00	3	2	2	2	2	1	0	3	3	1	0	0	3	28.0	
	RIRO w/downstream U-Turn	1.48	2.00	1	3	2	2	2	1	-1	2	2	0	0	0	2	23.5	
	Mini Roundabout	2.00	2.00	3	2	1	2	1	2	-1	2	3	0	1	0	3	23.0	
	Single Lane Roundabout	**2.00**	**2.00**	**2**	**3**	**1**	**2**	**2**	**3**	**-1**	**2**	**3**	**1**	**2**	**0**	**2**	**29.0**	
	Multilane Roundabout	2.00	2.00	1	2	1	1	1	3	-2	1	2	2	3	1	1	23.0	
	RCUT / J-Turn (stop control)	1.48	2.00	1	2	2	2	2	2	-1	2	2	1	2	1	3	26.5	
	High-T (unsignalized)	2.00	2.00	3	1	0	1	2	1	-2	0	6	1	0	0	2	25.0	
	Unsignalized Offset-T Intersection	2.00	2.00	3	1	1	2	2	2	-1	0	4	1	1	0	2	24.0	
	Other Signalized Intersection (Describe)																	
alized Intersections	**Signalized Intersection**	**2.00**	**2.00**	**3**	**2**	**2**	**2**	**2**	**1**	**-1**	**2**	**2**	**2**	**2**	**0**	**2**	**28.0**	
	Median U-Turn	1.48	2.00	1	2	2	3	3	1	-1	2	-1	3	1	3	1	24.5	
	Superstreet / RCI	**1.48**	**2.00**	**1**	**2**	**2**	**3**	**3**	**1**	**-1**	**2**	**2**	**3**	**2**	**3**	**1**	**31.5**	
	Displaced Left-Turn / CFI	1.42	1.67	0	1	0	1	2	1	-2	0	1	3	3	0	0	19.4	
	Continuous Green-T	**2.00**	**2.00**	**3**	**1**	**0**	**2**	**2**	**1**	**-2**	**0**	**6**	**2**	**2**	**0**	**2**	**30.0**	
	Signalized Offset-T Intersection	2.00	2.00	3	1	1	2	2	2	-1	3	2	2	2	1	2	26.0	
	Jughandle	2.00	1.88	0	1	1	2	3	1	-2	0	0	3	1	3	0	20.0	

Introduction | Intersections | IntersectionData | Stage1 | Costs | Stage2 | Scoring | Clearinghouse | Env

Note: If No-Build Condition is a desired alternative to evaluate, place a "Y" in the *alternative choice override* column for the No-Build alternative and Enter "No-Build Condition" in the *Scoring Override Justification* column.

No-Build Condition:

Signalized Intersection

Exclude from Selection? No

Conventional Improvements 1

Left Lanes --select--
Right Lanes --select--
Medians --select--
Control -- select --

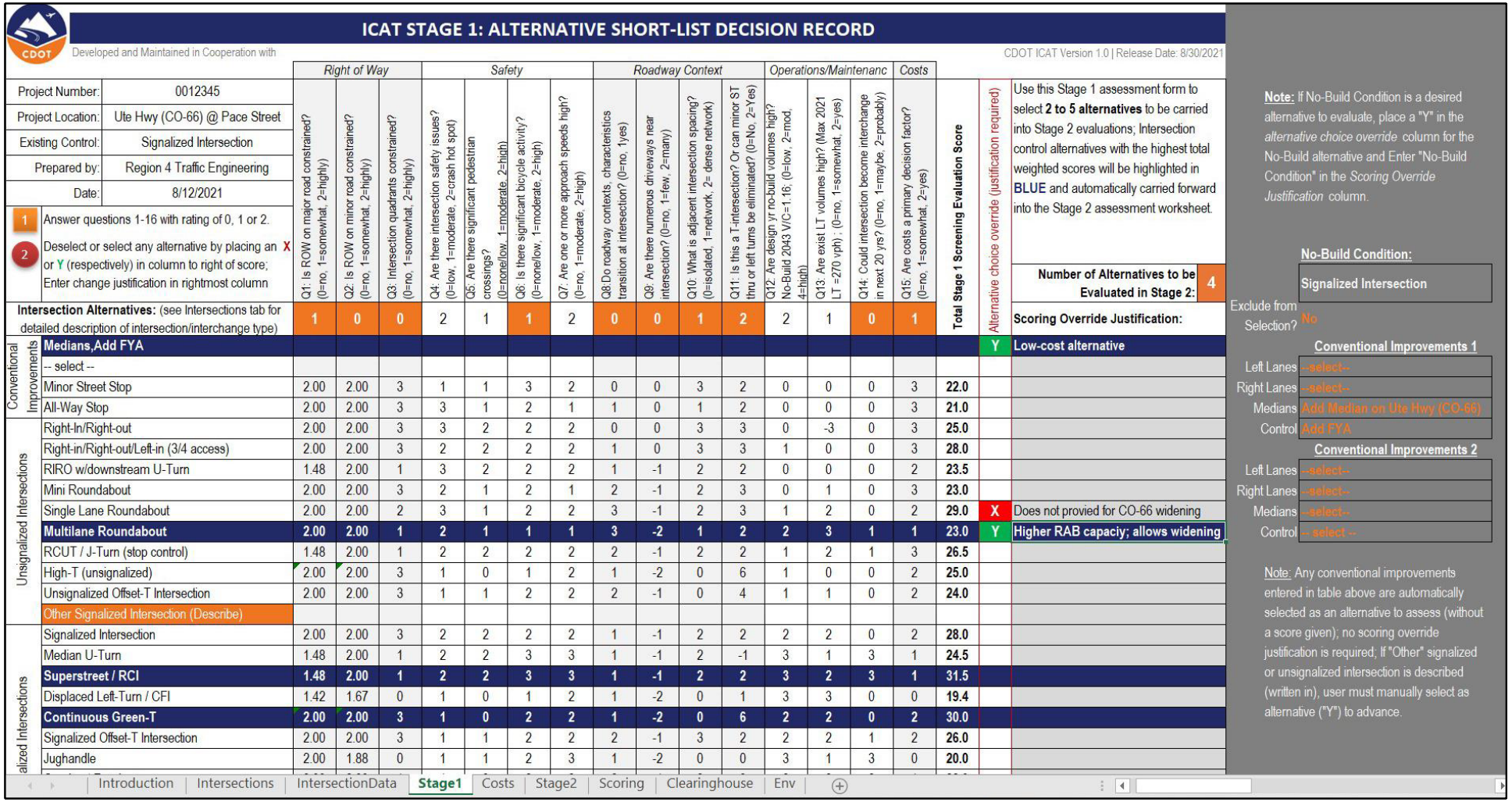
Conventional Improvements 2

Left Lanes --select--
Right Lanes --select--
Medians --select--
Control -- select --

Note: Any conventional improvements entered in table above are automatically selected as an alternative to assess (without a score given); no scoring override justification is required; If "Other" signalized or unsignalized intersection is described (written in), user must manually select as alternative ("Y") to advance.

Stage I – Shortlist Selection

- Overall intersection score determined
- Users can create conventional alternatives
- Select/deselect alternatives (with justification) in order to shortlist alternatives



ICAT STAGE 1: ALTERNATIVE SHORT-LIST DECISION RECORD

Developed and Maintained in Cooperation with

CDOT ICAT Version 1.0 | Release Date: 8/30/2021

Project Number:	0012345
Project Location:	Ute Hwy (CO-66) @ Pace Street
Existing Control:	Signalized Intersection
Prepared by:	Region 4 Traffic Engineering
Date:	8/12/2021

1 Answer questions 1-16 with rating of 0, 1 or 2.

2 Deselect or select any alternative by placing an X or Y (respectively) in column to right of score; Enter change justification in rightmost column

Use this Stage 1 assessment form to select **2 to 5 alternatives** to be carried into Stage 2 evaluations; Intersection control alternatives with the highest total weighted scores will be highlighted in **BLUE** and automatically carried forward into the Stage 2 assessment worksheet.

Number of Alternatives to be Evaluated in Stage 2: 4

	Intersection Alternatives: (see Intersections tab for detailed description of intersection/interchange type)	Right of Way Q1: Is ROW on major road constrained? (0=no, 1=somewhat, 2=highly)	Right of Way Q2: Is ROW on minor road constrained? (0=no, 1=somewhat, 2=highly)	Right of Way Q3: Intersection quadrants constrained? (0=no, 1=somewhat, 2=highly)	Safety Q4: Are there intersection safety issues? (0=low, 1=moderate, 2=crash hot spot)	Safety Q5: Are there significant pedestrian crossings? (0=none/low, 1=moderate, 2=high)	Safety Q6: Is there significant bicycle activity? (0=none/low, 1=moderate, 2=high)	Safety Q7: Are one or more approach speeds high? (0=no, 1=moderate, 2=high)	Roadway Context Q8: Do roadway contexts, characteristics transition at intersection? (0=no, 1yes)	Roadway Context Q9: Are there numerous driveways near intersection? (0=no, 1=few, 2=many)	Roadway Context Q10: What is adjacent intersection spacing? (0=isolated, 1=network, 2= dense network)	Roadway Context Q11: Is this a T-intersection? Or can minor ST thru or left turns be eliminated? (0=No, 2=Yes)	Operations/Maintenanc Q12: Are design yr no-build volumes high? No-Build 2043 V/C=1.16; (0=low, 2=mod, 4=high)	Operations/Maintenanc Q13: Are exist LT volumes high? (Max 2021 LT =270 vph) ; (0=no, 1=somewhat, 2=yes)	Operations/Maintenanc Q14: Could intersection become interchange in next 20 yrs? (0=no, 1=maybe, 2=probably)	Costs Q15: Are costs a primary decision factor? (0=no, 1=somewhat, 2=yes)	Total Stage 1 Screening Evaluation Score	Alternative choice override (justification required)	Scoring Override Justification:
		1	0	0	2	1	1	2	0	0	1	2	2	1	0	1			
Conventional Improvements	**Medians,Add FYA**																	Y	**Low-cost alternative**
	-- select --																		
	Minor Street Stop	2.00	2.00	3	1	1	3	2	0	0	3	2	0	0	0	3	22.0		
	All-Way Stop	2.00	2.00	3	3	1	2	1	1	0	1	2	0	0	0	3	21.0		
Unsignalized Intersections	Right-In/Right-out	2.00	2.00	3	3	2	2	2	0	0	3	3	0	-3	0	3	25.0		
	Right-in/Right-out/Left-in (3/4 access)	2.00	2.00	3	2	2	2	2	1	0	3	3	1	0	0	3	28.0		
	RIRO w/downstream U-Turn	1.48	2.00	1	3	2	2	2	1	-1	2	2	0	0	0	2	23.5		
	Mini Roundabout	2.00	2.00	3	2	1	2	1	2	-1	2	3	0	1	0	3	23.0		
	Single Lane Roundabout	2.00	2.00	2	3	1	2	2	3	-1	2	3	1	2	0	2	29.0	X	Does not provied for CO-66 widening
	Multilane Roundabout	**2.00**	**2.00**	**1**	**2**	**1**	**1**	**1**	**3**	**-2**	**1**	**2**	**2**	**3**	**1**	**1**	**23.0**	Y	**Higher RAB capaciy; allows widening**
	RCUT / J-Turn (stop control)	1.48	2.00	1	2	2	2	2	2	-1	2	2	1	2	1	3	26.5		
	High-T (unsignalized)	2.00	2.00	3	1	0	1	2	1	-2	0	6	1	0	0	2	25.0		
	Unsignalized Offset-T Intersection	2.00	2.00	3	1	1	2	2	2	-1	0	4	1	1	0	2	24.0		
	Other Signalized Intersection (Describe)																		
alized Intersections	Signalized Intersection	2.00	2.00	3	2	2	2	2	1	-1	2	2	2	2	0	2	28.0		
	Median U-Turn	1.48	2.00	1	2	2	3	3	1	-1	2	-1	3	1	3	1	24.5		
	Superstreet / RCI	**1.48**	**2.00**	**1**	**2**	**2**	**3**	**3**	**1**	**-1**	**2**	**2**	**3**	**2**	**3**	**1**	**31.5**		
	Displaced Left-Turn / CFI	1.42	1.67	0	1	0	1	2	1	-2	0	1	3	3	0	0	19.4		
	Continuous Green-T	**2.00**	**2.00**	**3**	**1**	**0**	**2**	**2**	**1**	**-2**	**0**	**6**	**2**	**2**	**0**	**2**	**30.0**		
	Signalized Offset-T Intersection	2.00	2.00	3	1	1	2	2	2	-1	3	2	2	2	1	2	26.0		
	Jughandle	2.00	1.88	0	1	1	2	3	1	-2	0	0	3	1	3	0	20.0		

Introduction | Intersections | IntersectionData | Stage1 | Costs | Stage2 | Scoring | Clearinghouse | Env

Note: If No-Build Condition is a desired alternative to evaluate, place a "Y" in the *alternative choice override* column for the No-Build alternative and Enter "No-Build Condition" in the *Scoring Override Justification* column.

No-Build Condition:

Signalized Intersection

Exclude from Selection? No

Conventional Improvements 1

Left Lanes --select--
Right Lanes --select--
Medians Add Median on Ute Hwy (CO-66)
Control Add FYA

Conventional Improvements 2

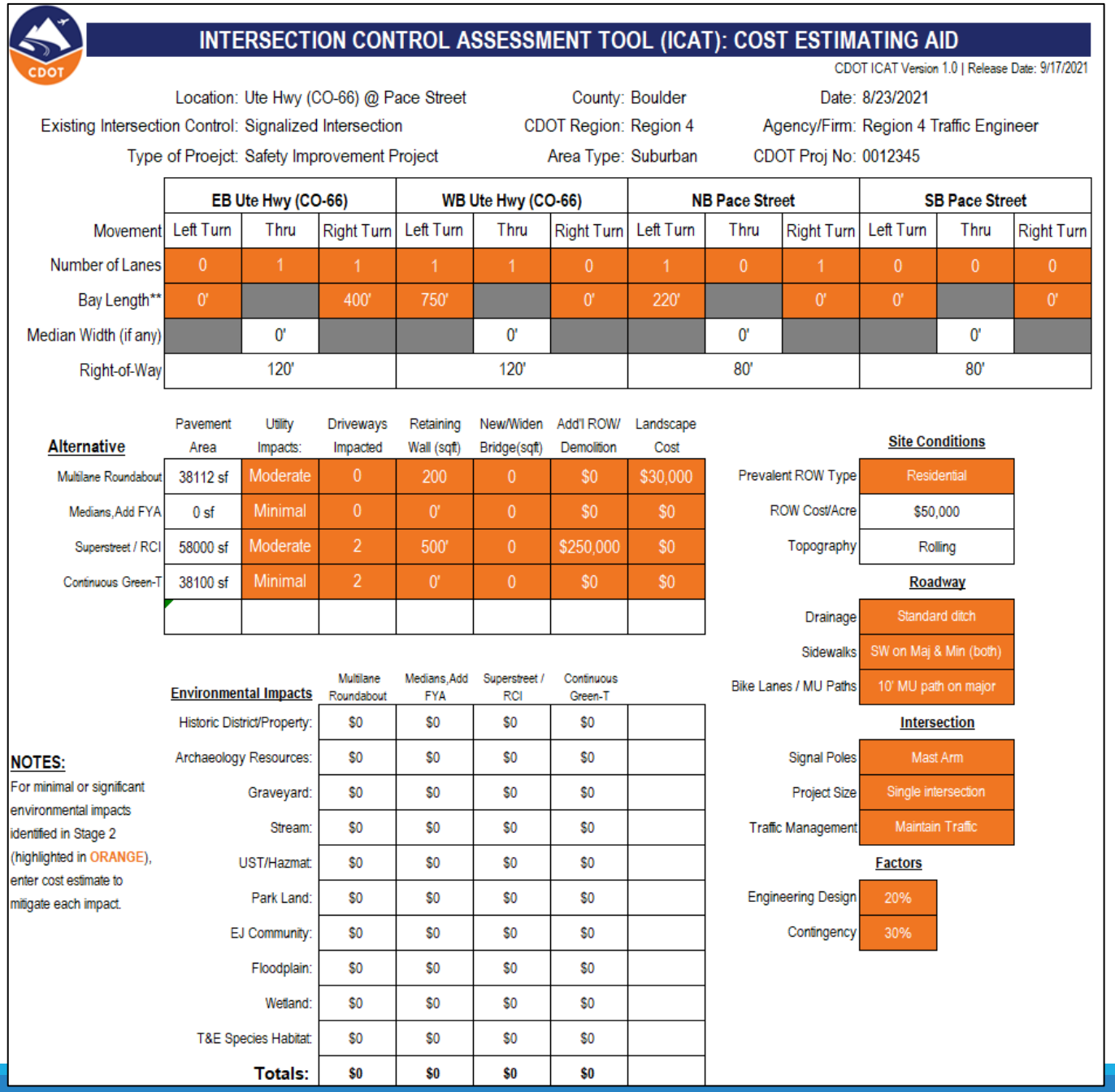
Left Lanes --select--
Right Lanes --select--
Medians --select--
Control -- select --

Note: Any conventional improvements entered in table above are automatically selected as an alternative to assess (without a score given); no scoring override justification is required; If "Other" signalized or unsignalized intersection is described (written in), user must manually select as alternative ("Y") to advance.

ICAT Cost Worksheets (Optional)

Costs Worksheet

- Optional to aid cost development
- Existing conditions data
- Alternative Specific Data
  - Utility, driveway impacts
  - Wall, bridge area
  - Additional ROW & landscape costs
- Site Conditions
  - ROW, drainage type
  - Sidewalk/bike/MUP facilities
  - Project size / traffic management
  - Design/contingency factors



INTERSECTION CONTROL ASSESSMENT TOOL (ICAT): COST ESTIMATING AID

CDOT ICAT Version 1.0 | Release Date: 9/17/2021

Location: Ute Hwy (CO-66) @ Pace Street | County: Boulder | Date: 8/23/2021
Existing Intersection Control: Signalized Intersection | CDOT Region: Region 4 | Agency/Firm: Region 4 Traffic Engineer
Type of Proejct: Safety Improvement Project | Area Type: Suburban | CDOT Proj No: 0012345

	EB Ute Hwy (CO-66)			WB Ute Hwy (CO-66)			NB Pace Street			SB Pace Street		
Movement	Left Turn	Thru	Right Turn	Left Turn	Thru	Right Turn	Left Turn	Thru	Right Turn	Left Turn	Thru	Right Turn
Number of Lanes	0	1	1	1	1	0	1	0	1	0	0	0
Bay Length**	0'		400'	750'		0'	220'		0'	0'		0'
Median Width (if any)		0'			0'			0'			0'	
Right-of-Way		120'			120'			80'			80'	

Alternative	Pavement Area	Utility Impacts:	Driveways Impacted	Retaining Wall (sqft)	New/Widen Bridge(sqft)	Add'l ROW/ Demolition	Landscape Cost
Multilane Roundabout	38112 sf	Moderate	0	200	0	$0	$30,000
Medians,Add FYA	0 sf	Minimal	0	0'	0	$0	$0
Superstreet / RCI	58000 sf	Moderate	2	500'	0	$250,000	$0
Continuous Green-T	38100 sf	Minimal	2	0'	0	$0	$0

Environmental Impacts	Multilane Roundabout	Medians,Add FYA	Superstreet / RCI	Continuous Green-T	
Historic District/Property:	$0	$0	$0	$0	
Archaeology Resources:	$0	$0	$0	$0	
Graveyard:	$0	$0	$0	$0	
Stream:	$0	$0	$0	$0	
UST/Hazmat:	$0	$0	$0	$0	
Park Land:	$0	$0	$0	$0	
EJ Community:	$0	$0	$0	$0	
Floodplain:	$0	$0	$0	$0	
Wetland:	$0	$0	$0	$0	
T&E Species Habitat:	$0	$0	$0	$0	
Totals:	**$0**	**$0**	**$0**	**$0**	

NOTES:
For minimal or significant environmental impacts identified in Stage 2 (highlighted in ORANGE), enter cost estimate to mitigate each impact.

Site Conditions

Prevalent ROW Type	Residential
ROW Cost/Acre	$50,000
Topography	Rolling

Roadway

Drainage	Standard ditch
Sidewalks	SW on Maj & Min (both)
Bike Lanes / MU Paths	10' MU path on major

Intersection

Signal Poles	Mast Arm
Project Size	Single intersection
Traffic Management	Maintain Traffic

Factors

Engineering Design	20%
Contingency	30%

Costs Worksheet

- Alternative specific factors chosen to better define costs
- Examples include:
  - Pavement improvement type
  - Roundabout diameter
  - U-turn crossover distances
  - Adding turn lanes
  - Intersection spacing
  - Median openings
  - Median treatments
  - Lane channelization
  - Special signing and marking

Control Alternative	Baseline Alternative Description	Criteral 1	Criteria 2	Criteria 3
Mini Roundabout	New mini RND w/splitter islands, paved (traversable) center island	70' Inscribed Dia (default mini)	1 RT by-pass lane	
Single Lane Roundabout	New single lane RND w/splitter islands, truck apron and landscaped median	130' Inscribed Dia (default single)	No RT by-pass lanes	
Multilane Roundabout	New multi-lane RND w/splitter islands, truck apron and landscaped median	180' Inscribed Dia (default multi)	No RT by-pass lanes	2x1 Multilane RND
RCUT / J-Turn (stop control)	Add directional U-turns, left turn channelization; restrict turns from minor Street		Avg 600' U-turn spacing (Default)	2 new directional openings
High-T (unsignalized)	Separate through lane from left turn traffic w/downstream merge condition		4' raised median separator	Convert existing LT lane
Unsignalized Offset-T Intersection	Separate intersection legs into two T-intersections		Offset left / right intersection	500' intersection spacing (Default)
Other Signalized Intersection (Describe)	Cost estimate not available			
Signalized Intersection	Signalize existing intersection	Resurface intersection	Add left lanes on Both	No new right turn lanes
Median U-Turn	Add directional U-turns on Main Road; signalize crossovers	New full depth pavement	Avg 600' U-turn spacing (Default)	2 new directional openings
Superstreet / RCI	Add directional U-turns on Main Road; signalize main intersection and crossovers; RT only from Minor Road	Resurface intersection	Avg 800' U-turn spacing	2 new directional openings
Displaced Left-Turn / CFI	Right turn bypass lanes; signalized main and crossover intersections	Resurface intersection	Avg 600' crossover spacing (Default)	Two-leg CFI (crossovers on Main)
Continuous Green-T	Single through lane on high side	Resurface intersection	4' raised median separator	Convert existing LT lane
Signalized Offset-T	Separate intersection legs into two T-intersections	New full depth	Offset left / right	500' intersection spacing

50' Inscribed Diameter
70' Inscribed Dia (default m
90' Inscribed Diameter
110' Inscribed Diameter
130' Inscribed Dia (default s
150' Inscribed Diameter
180' Inscribed Dia (default
200' Inscribed Diameter

ICAT Stage II

Stage II

COLORADO
Department of Transportation
Division of Maintenance & Operations

- Evaluation of 5 Factors:
  - Costs
  - Traffic Operations
  - Safety
  - Environmental Impacts
  - Stakeholder Input
- Cost data from Cost worksheet
  - Generates costs for each alternative
  - Can adjust cost specifics
- Traffic analysis measures
  - No-build design year operations
  - Delay, V/C for each alternative

ICAT STAGE 2: ALTERNATIVE SELECTION DECISION RECORD

Developed and Maintained in Cooperation with Georgia DOT — CDOT ICAT Version 1.0 | Release D

CDOT Project Number: 0012345
Project Location: CO-66 (UTE Hwy) @ Pace Street
Existing Intersection Control: Signalized Intersection
County/Region: Boulder / CDOT Region 4
Area Type: Suburban
Prepared by: Region 4 Traffic Engineering
Date: 8/23/2021
Type of Project: Safety Improvement Project

Existing / Design Year No-Build Traffic Operations

Traffic Analysis Measure of Effectiveness	Intersection Delay	
Traffic Analysis Software Used	Synchro 10	
Analysis Time Period	AM Peak Hr	PM Peak Hr
2021 Existing No-Build Peak Hr Intersection Delay	40.0 sec	52.0 sec
2021 Existing No-Build Peak Hr Intersection V/C ratio	0.80	0.90
2043 Design Yr No-Build Peak Hr Intersection Delay	64.0 sec	82.0 sec
2043 Design Yr No-Build Peak Hr Intersection V/C ratio	1.10	1.25

Alternatives Analysis	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Proposed Control Type Improvement:	Multilane Roundabout		Medians,Add FYA		Superstreet / RCI		Continuous Green-T	
Project Cost *(From Cost Worksheet)*	*Add addt'l description here*		*Add addt'l description here*		*Add addt'l description here*		*Add addt'l description here*	
Construction Cost	$1,439,400		$450,000		$1,403,215		$673,383	
ROW Cost	$0		$0		$283,058		$0	
Environmental Cost	$0		$0		$0		$0	
Reimbursable Utility Cost	$51,321		$40,000		$70,161		$20,202	
Design & Contingency Cost	$513,215		$240,000		$701,608		$336,692	
Cost Adjustment (justification req'd)	0%		0%		0%		0%	
Total Cost	$2,003,936		$730,000		$2,458,042		$1,030,277	
Traffic Operations								
Traffic Analysis Software Used	SIDRA 7		Synchro 10		Synchro 10		Synchro 10	
Analysis Period	AM Peak Hr	PM Peak Hr	AM Peak Hr	PM Peak Hr	AM Peak Hr	PM Peak Hr	AM Peak Hr	PM Peak Hr
2043 Design Yr Build Intersection Delay	30.0 sec	35.0 sec	55.0 sec	66.0 sec	40.0 sec	48.0 sec	24.0 sec	53.0 sec
2043 Design Yr Build Intersection V/C	0.65	0.70	0.95	1.10	0.70	0.90	0.55	0.98

Stage II: Safety

- Safety benefit by change of intersection control determined using FHWAs CMF Clearinghouse (www.cmfclearinghouse.org)
  - CMFs (Crash Modification Factor) used to compute the expected number of crashes after implementing a given improvement
  - CRFs (Crash Reduction Factors) estimates % reduction in crashes
- Many CMFs predefined based on existing/ proposed control; for some, users may have to find or develop and document

Stage II

- Safety data from CMF Clearinghouse or added from other data sources
- Identify any potential environmental impacts for each alternative
- *Environmental Impacts* worksheet used to identify mitigation efforts; add mitigation costs to *Cost* worksheet

Safety Analysis				
Predefined CRF: PDO	26%	0%	15%	4%
Predefined CRF: Fatal/Inj	71%	0%	15%	4%
Predefined CRF Source:	FHWA Clearinghouse IDs: 4196 / 4195	-	FHWA Clearinghouse ID:9984	CDOT Study ID:8655
User Defined CRF: PDO		8%		
User Defined CRF: Fatal/Inj		8%		
User Defined CRF Source (write in if applicable):		CDOT CMF Factor		
Environmental Impacts				
Historic District/Property:	None	None	None	None
Archaeology Resources:	None	None	None	None
Graveyard:	None	None	None	None
Stream:	Minimal	None	None	None
UST/Hazmat:	None	None	None	None
Park Land:	None	None	None	None
EJ Community:	None	None	None	None
Floodplain:	None	None	None	None
Wetland:	None	None	**Significant**	Minimal
T&E Species Habitat:	None	None	None	None

Stage II

- Stakeholder Inputs (if known)
  - Negative, neutral or supportive
  - Local Community Support
  - CDOT Region Support
- Final score and ranking and input of any comments

Proposed Control Type Improvement:	Multilane Roundabout	Medians,Add FYA	Superstreet / RCI	Continuous Green-T
Stakeholder Support:				
Local Community Support	Strong	Negative	Negative	Neutral
CDOT Region Support	Supportive	Negative	Supportive	Neutral
Final ICAT Stage 2 Score:	**6.3**	**3.8**	**3.1**	**4.3**
Rank of Control Type Alternatives:	**1**	**3**	**4**	**2**
Provide additional comments and/or explain any unique analysis inputs, or results (as necessary):	Multilane RAB is final selected alternative Design to provide for future fourth intersection leg			

Conclusions

- ICAT process is intended to:
  - Provide the optimal intersection solution
  - Document the data and approach used to select control choice
- Tool should NOT replace good engineering judgement
  - Use best judgment entering data
  - Lower scoring alternative can be selected (with justification) if scores are close
- CDOT will soon be issuing guidance on how and when to use ICAT
- Suggestions for improvements to the tool are welcome, and updates to ICAT are expected in future version releases
- Thank you and please visit the Learning Lane to view additional training videos, the ICAT worksheet and Users Guide