1 - Intersection Control Evaluation

It is important to evaluate an intersection to determine the appropriate intersection control. Typical intersection analysis will include criteria such as crash data, crash diagrams, user delay or level of service for all current and design year traffic movements, appropriate design vehicle (WB-65[1] on the STH system), right-of-way impacts and other safety improvements for pedestrians and bicyclists.

All roadways that intersect with a State Trunk Highway shall have some type of control. There are 3 types of intersection control to consider for at grade intersections. The 3 types are:

1. Stop Control - The intersection may have two-way stop control, or four-way stop control. The two-way stop control is most common and requires traffic to stop at the minor road connection to a major highway. The four-way stop is used when warrants or safety concerns are identified and believed to improve the safety of the intersection.
2. Signal Control - This is an intersection control alternative to consider when certain traffic warrants are met (MUTCD, Section 4C).
3. Roundabout Control - This requires a yield condition at entry and is warranted by vehicular volumes that meet the four-way stop or traffic signal warrants. There may be situations where it is appropriate to evaluate a roundabout where an intersection may have unique safety or geometry concerns or may be stop controlled. For example an interchange ramp terminal or other intersection within the 20 year design life of the project traffic volumes increase to the point where traffic signals are anticipated within 10 years from date of construction (see Table 3, Anticipated Traffic Signal). It may be desirable to construct the roundabout with the initial project or to preserve right-of-way for the roundabout in the future. Another situation is where a current two-way stop controlled intersection has safety concerns a roundabout may be appropriate.

There is guidance on how many crashes may be reduced by implementing certain improvements. For information on Crash Reduction Factors refer to the "Desktop Reference For Crash Reduction Factors", September 2007, Publication Number FHWA-SA-07-015.

http://www.transportation.org/sites/scohts/docs/Crash Reduction Factors Desktop Reference 12-19-07.pdf

If an intersection warrants a signal or a four-way stop within the design life of the proposed project, the modern roundabout shall be evaluated as an equal alternative. Where there is an existing four-way stop or signal and there are operational problems with the current control, then the roundabout shall be considered as a viable alternative. As stated above the roundabout may be a viable alternative for a two-way stop control in certain circumstances. In either case, roundabouts are a potential intersection control strategy until such time that the evaluation indicates that the roundabout alternative is not appropriate.

2 - Early Evaluation Process

This section describes a process to evaluate intersections to help determine the appropriate intersection control. The evaluation process begins in the Region SPO-Planning unit and is referred to as Program Level Scoping phase. At this phase an intersection is evaluated by reviewing the nine factors described in Table 1.

Review Figure 1 to become familiar with the WisDOT Life Cycle process. Figure 1 provides an overview of the terminology that is used to describe a project from initiation through Life Cycle 40. The Life Cycle numbers are milestones. The time between the Life Cycle numbers are the phases of the process. This figure also identifies who at WisDOT is in responsible charge of the process.

[1] A WB-65 uses a 43 ft distance between the centerline of the king pin to the centerline of the rear duals. This is the maximum allowed by state statute.

Life Cycle	LC 00 Unprogrammed	LC 10 Authorized	LC 11 Program Level Scoping	LC 12 PMP Approved		LC 15 DSR	LC 20 PS&E	LC 40 Award
Project Initiation Process	Needs Identification	CDR	Program Level Scoping	PMP Approval	---	---	---	---
PMP Development Phase	---	---	Program Level Scoping	PMP Approval	Preliminary Plan Review	DSR	PS&E	Design Project Closeout
Project Review Meeting								
Time Required	---	3-6 months *	3-12 months	3-18 months	3-12 months	5-18 months	7-30 months	3-6 months
Responsible Section	Programming	Programming	Programming	PDS	PDS	PDS	PDS	PDS

Figure 1. Life Cycle Project Overview

Project evaluations are conducted internally by the WisDOT Region Project Initiation Process (PIP link) Scoping Team. PIP teams will typically consist of the following members: PDS Representative*, Pavement Engineer*, Traffic / Safety Engineer*, Roadway Maintenance Engineer*, Bridge Maintenance Engineer*, Planning Engineer* and other functional areas as needed (* indicates required team members).The SPO-Planning level effort is typically less rigorous, less data driven, and less accurate than the higher level of effort completed by the Project Development Section (post-life cycle 11).

The objective of Program Level Scoping is the completion of the project scoping and feasibility well enough to identify deficiencies, potential environmental and right-of-way impacts, safety concerns, structure needs, lighting and landscaping needs, major bid item cost estimate, summary schedule, begin State-municipal agreements, order mapping if needed and prepare a preliminary budget anticipated to be within 80% of the final budget. The PIP team, working together in a collaborative effort shall decide the viable intersection control alternatives that are taken to the post-Life cycle 11 project team. If a cost estimate for one intersection control alternative is considerably higher than the other, then the higher cost alternative is used to determine the project budget. Both alternatives are taken forward to the post-Life cycle 11 project team. Typically, the PIP team will identify viable alternatives but usually will not have conducted an in-depth evaluation of the 9 factors. The factors are explained in Table 1 and Table 2, to help determine the selected alternative.

A WisDOT Region may decide during the Program Level Scoping phase to submit a portion of a project to a consulting firm for the preliminary evaluation. This may include at-grade intersections, preliminary environmental impacts, structures, or other deficiencies identified by the PIP team. But this does not change the overall process to determine deficiencies, impacts, viable alternatives, or preliminary costs.

The Project Management Plan (PMP) approval phase is when SPO-Planning and Project Development agree to the final project scope. Once the Program Level Scoping work, cost estimate, etc. is complete, the PDS Unit becomes the lead, this is known as the post-Life cycle 11 phase. This is also when the Project Management Plan (PMP link) is developed and maintained by the PDS Unit. The project development section will determine whether an improvement project will be completed in-house (by WisDOT employees) or made available to a consulting firm.

The following projects that are designed and constructed with federal or state funding must comply with the Intersection Control Evaluation process.

1. Improvement Projects (3R, 4R) – the scoping and feasibility evaluation occurs at the Program Level Scoping phase (SPO-Planning leads the process, Pre-Life Cycle 11). A more detailed evaluation occurs during the post-Life Cycle 11 phase (PDS leads the process) as addressed in FDM 11-26-5.

2. Majors - the evaluation would take place in time to incorporate the findings into the environmental document.

3. Highway Safety Improvement Program (HSIP) - the evaluation is in the agreement with WisDOT per the Division of Transportation Investment Management's Program Management Manual, Section 04-01-10, that signal and roundabout alternatives will be evaluated as equals. HSIP funds are made available as a result of an identified safety problem/concern, therefore the preferred intersection control alternative is a roundabout, unless it can be demonstrated that another intersection control will function more safely and efficiently.

4. Traffic Impact Analysis (TIA) - the evaluation is part of the documentation prepared for the project alternatives.

5. Safe Routes To School (SRTS) - the analysis is part of an intersection alternative evaluation.
6. Congestion Mitigation and Air Quality (CMAQ) – Contact, John Duffe by email at john.duffe@dot.state.wi.us or by phone at (608) 264-8723
7. Local projects - the analysis is part of an intersection alternative evaluation.

The intersection control evaluation process is the same for projects identified by WisDOT, counties, municipalities, or local units of government that are interested in receiving federal or state funds on any of the projects identified above.

There are three conditions that should be identified early during the Program Level Scoping. The impact of any of these conditions may be so great that with proper justification may allow the scoping team to dismiss the roundabout as a viable intersection control alternative. The 3 conditions are:

1. The intersection in question is part of a larger coordinated signal system (more than two) that is interconnected to form a progressive signal system.
2. The right-of-way impact of the properly sized and located roundabout has far greater adverse real estate impacts than the other intersection control alternatives. This requires an evaluation of each intersection control alternative.
3. The proposed improvement to the intersection is rather minor and requires no right-of way to complete. An example of this situation may be extending a left turn bay, or adding a left turn bay where a median already exists, or upgrading (not adding) signal heads and/or controller box to improve operational efficiency.

The intersection must have stopping sight distance for any type of intersection control. However, this is typically achievable through intersection geometric improvements.

An Intersection Control Evaluation shall be completed during Program Level Scoping by the PIP team and during Project Development by the PDS team. See the following definitions.

1. Intersection Control Evaluation, Program Level Scoping. This phase is a planning level of effort that may not have detailed project information and is intended to include enough information to determine what types of intersection control are viable alternatives. See Table 1 for a listing of issues that need to be addressed at the Program Level Scoping (pre-Life Cycle 11) in a spreadsheet of 9 factors.
2. Intersection Control Evaluation, Project Development. This phase (see Table 2)is quantitative and involves a greater level of effort to document the strength and weakness of each intersection alternative. The list of 9 factors is the same for the Program Level Scoping (pre-Life cycle 11) as for the more rigorous project development phase conducted during (post-Life cycle 11). Table 3 has a worksheet of factors called the Intersection Control Evaluation. Since there are 2 levels of evaluation effort each spreadsheet needs to identify the level of effort that is provided in the spreadsheet, thus select the option for your spreadsheet. Select the alternative control that is addressed in that column. This document will become part of the project file.

For those outside of the WisDOT system that are planning to request federal or state funding the evaluation process is the same. In other words the local governmental agency shall first look at the intersection to determine the extent of the problem. Use the Intersection Control Evaluation, Program Level Scoping, 9 factors, to determine if one of the 3 conditions above exist that may drop one alternative from further consideration.

After the Program Level Scoping is completed and it's discovered that more that than one alternative is viable then all the alternatives are taken to the Project Development phase. At the Project Development phase a more rigorous evaluation is required. See Table 2 to complete a more rigorous evaluation of the intersection.

The following steps describe the process used to complete an Intersection Control Evaluation. The intent of the Program Level Scoping evaluation is to compare alternatives and document the recommendation.

Step 1

Identify the intersection location.

Step 2

Check the box for each intersection. Select "Anticipating traffic signal" when it appears that traffic signal warrants will be met within 10 years from the construction year. Rather than installing the infrastructure needed for a future traffic signal (i.e. pull boxes and conduit), the Project Team should also consider a modern roundabout. It may be desirable to install the roundabout with the initial construction.

Step 3

Complete the nine factors for each alternative. Table 1 describes the Program Level Scoping evaluation. Table 2 describes the Project Development evaluation. Complete Table 3 for both the Program Level Scoping evaluation and the Project Development evaluation. Continue to update Table 3 as more information becomes available.

Step 4

Generally, take the roundabout alternative beyond Scoping and Feasibility (Life Cycle 11) for further evaluation.

Table 1. Intersection Control Evaluation – Program Level Scoping (Pre-Life Cycle 11)

Factor	Description	Responsibility
Safety	Review crash diagrams, crash type and other relevant crash data to assess existing conditions. Explain what percent of crashes and the type of crashes that each alternative would eliminate. Provide an overview of access concerns near the intersection and the side road traffic impacts.	Traffic Safety Engineer
Operational Analysis	Provide a traffic distribution overview. Identify intersections that require a higher level of control such as signal, four way stop, or roundabout. Explain if an existing signalized intersection needs minor geometric improvements. For roundabout analysis and to estimate circle size use the Traffic Flow Worksheet, FDM 11-26-20, Figure 5 and the Typical Geometric Parameters in Table 4. If the scoping team (PIP) is unfamiliar with roundabout sizing use the following general guidance; for <20,000 vehicles entering the intersection use single lane, 130-ft ICD; for 20,000 to 45,000 use double lane, 160-ft ICD; for 45,000 to 65,000 use triple lane, 220-ft ICD. Sketch circle placement in most desirable intersection location to cause the least impacts. Use caution with results based only on vehicles entering the intersection thresholds. More experienced Program Level Scoping teams may analyze the roundabout and estimate circle size by using the Traffic Flow Worksheet, FDM 11-26-20, Figure 5. Prepare conceptual sketches of alternatives for the signal and the roundabout alternative when appropriate.	Traffic & Operations
Construction Cost	Prepare cost estimate based on past typical project costs for each alternative, Identify the cost of high-cost utility impacts. Assume the highest cost alternative and carry to Post-Life Cycle 11. Indicate the anticipated construction year.	SPO – Planning and PIP Team
Right-of-way	Prepare a best estimate based on rough anticipated R/W acreage needs and real estate cost for each alternative.	SPO – Planning, PIP Team, and Real Estate
Practical Feasibility	Consider the 3 conditions identified previously that may eliminate a roundabout from further consideration, if so desired. For HSIP projects involving intersections with history of safety problems, roundabouts should receive primary consideration. Use FDM 11-26-15, Table 1 for values associated with the cost of a crash, by type. Over the design life of a project the socio-economic benefit as a result of reducing injury type crashes could have a large monetary benefit to society. It may be justifiable to select a higher cost intersection control alternative when the number of reduced crashes are taken into consideration. If the intersection is on an alternate route consider the capacity and safety implications. State concerns about major adverse impacts on businesses, parking availability; real estate, environment, utilities, for each alternative.	PIP Team
Operation and Maintenance Costs	Prepare a preliminary project agreement to address funding. Also prepare a maintenance agreement to address the responsibility for traffic control devices, lighting & landscaping.	SPO – Planning, Maintenance, and Traffic & Operations
Environmental	Identify significant environmental impacts for each alternative.	PIP Team, and Env. Coordinator
Pedestrian and Bicycles	Identify nearby pedestrian generators, bike routes, and ADA impacts.	SPO - Planning, Bicycle & Pedestrian Coordinator, and Traffic & Operations
Recommendation	Each viable alternative is carried forward to Post Life Cycle 11. Discuss the recommended alternative when applicable.	PIP Team

Table 2. Intersection Control Evaluation – Project Development (Post-Life Cycle 11)

Factor	**Description**	**Responsibility**
Safety	Review crash diagrams, crash type and other relevant crash data to assess existing conditions. Explain what percent of crashes, and type of crashes, that will be reduced by this alternative and the affects on the most common type of crash. State the anticipated crash severity reduction. Provide an overview of access near the intersection and side road traffic impacts. Describe any unique feature or issue that may make one type of intersection control less safe than the alternative traffic control.	Traffic Safety Engineer, PDS has a role with access impacts
Operational Analysis	List any traffic warrants for a signal or 4-way stop that will be met within 10 years of the initial construction (anticipating signal warrant)? State what traffic control warrant(s) have been met to justify a signal or 4-way stop. Quantify the LOS with a letter for each movement, leg and intersection average, for whatever the analysis software provides. Show delay in seconds, queue length in number of vehicles or feet whatever the software provides. Describe how the queue length may impact adjacent driveways and other access points. Describe the distribution of traffic by approach and movement. State the fluctuation of traffic by time of day or by time of year. Document if a railroad crossing is within 500 feet of the intersection and state if any mitigation measures or devices have been considered when a railroad is near by. Is this intersection within a well-coordinated progressive signalized system? Estimate intersection size and prepare a drawing of the intersection alternatives.	PDS in collaboration with the Traffic & Operations
Construction Cost	State the estimated hard dollar construction cost for each alternative. Include all appropriate utilities cost associated with each alternative. Indicate the anticipated construction year.	PDS
Right-of-way	List type of land use and amount of R/W acreage impacted (i.e. # of relocations, access restrictions, type of land use). State the anticipated R/W and real estate cost associated with the intersection improvement.	PDS and Real Estate
Practical Feasibility	List concerns that this alternative may present. List signal system consideration. Consider history of safety problems. What are the operational consequences if this intersection is within a major alternate route? Identify major impacts on businesses, parking availability, real estate, environmental and utilities. Use FDM 11-26-15, Table 1 for values associated with the cost of a crash, by type. Over the design life of a project the socio-economic benefit as a result of reducing injury type crashes could have a large monetary benefit to society. It may be justifiable to select a higher cost intersection control alternative when the number of reduced crashes are taken into consideration. For HSIP projects involving intersections with history of safety problems, roundabouts should receive primary consideration. Frequency of use as an alternate route, and effect on each alternative. Identify major impacts on businesses, parking availability, real estate, environment, utilities, etc.	PDS with input from other sections
Operation and Maintenance Costs	Discuss cost implications and maintenance commitment of signal lighting, overhead street lighting, landscaping maintenance at the intersection for each alternative. Are there any additional signing and marking considerations? A paved central island is not an option.	PDS with input from the Traffic & Operations and Maintenance
Environment	Describe the type (historical, archeological, wetlands, or hazardous material) and amount of environmental acreage affected by each alternative. List the advantages / disadvantages for each traffic control alternative.	PDS and the Env. Coordinator
Pedestrian and Bicycles	Describe the need for accommodating facilities for pedestrians & bicyclists. State whether schools or bike routes are nearby. State whether sidewalks are proposed, within, or near the project area. List the advantages / disadvantages for each traffic control alternative.	PDS, Bicycle & Pedestrian Coordinator with input from Traffic & Operations
Recommendation	Discuss each alternative and make PDS recommendation before the environmental documentation completion.	PDS and Team

Table 3. Intersection Control Evaluation Worksheet

Project ID ___________________ Intersection Location				
Factor	**ALTERNATIVE CONTROL** ☐ TRAFFIC SIGNAL, ☐ ANTICIPATING TRAFFIC SIGNAL ☐ ROUNDABOUT ☐ 4-WAY STOP ☐ 2-WAY STOP ☐ EXISTING CONTROL		**ALTERNATIVE CONTROL** ☐ TRAFFIC SIGNAL, ☐ ANTICIPATING TRAFFIC SIGNAL ☐ ROUNDABOUT ☐ 4-WAY STOP ☐ 2-WAY STOP ☐ EXISTING CONTROL	
Safety				
Operational Analysis				
Construction Cost				
Right-of-Way				
Practical Feasibility				
Operation & Maintenance Cost				
Environmental				
Pedestrian and Bicycles				
Recommendation				
Responsibility	PIP Team	PDS Team	PIP Team	PDS Team

The intent of Table 3 is to show the input from the PIP team adjacent to the input from the PDS team. Over time the PDS team will update or add information to the table. See FDM 11-25-3, doc1 for a 11" x 17" spreadsheet.

The Project Development phase has three stages where the various levels of project progress are identified. Stages 1, 2 and 3 are described in FDM 11-26-5. These stages require participation from a qualified designer.

3 - Roundabout as viable alternative

When the Intersection Control Evaluation determines that a roundabout is a viable alternative the general and initial guidance provided in Table 4 will help to begin the roundabout design. See FDM 11-26-30 for the 10 steps in developing a roundabout design. Determining the size and space requirements of a roundabout is an iterative process. However, it is appropriate to begin with certain typical initial values for the six geometric parameters provided in Table 4. Note that the typical initial values for circulating roadway and exit radius are for general information and are not required in the RODEL analysis. The typical initial values are just the first step in the roundabout development process. These typical initial values are most likely not the final values used in the project.

Table 4. Typical Initial Geometric Parameters [A] for Both Urban & Rural Roundabouts [C]

Geometric Parameter	Single-Lane Entry	Dual-Lane Entry	Triple-Lane Entry
Half width (V)[B]	Travel lane width approaching the roundabout prior to any flared section, typically 12 feet per lane. Do not include bike lanes.		
Entry width (E)[B]	18-22 ft (5.5-6.7 m)	24-28 ft (7.3-8.5 m)	34-40 ft (10.4-12.2 m)
Effective Flare Length (L')[B]	15-330 ft **(5-100 m)**		
Inscribed diameter (DIA)	130 ft **(40 m)**	160 ft **(50 m)**	220 ft **(67 m)**
Entry Radius (RAD)	65 ft **(20 m)**	65 ft **(20 m)**	65 ft **(20 m)**
Entry angle (phi)	30 Degrees		
Circulating roadway width	Typically 1.0 to 1.2 times the width of the widest entry into the roundabout.		
Exit radius	Typical range is 200-1000 feet. Exit curves should be larger than entry curves and typically have R3 speeds higher than the R2 speed.		

[A] At this time RODEL works only with metric values.

[B] High influence on capacity.

[C] The values provided in this table are for general design guidance and are not intended to be strict standards that ensure good design.