

BISMARCK-MANDAN INTERSECTION ANALYSIS STUDY

Traffic Control Fact Sheets



Bismarck-Mandan
METROPOLITAN PLANNING ORGANIZATION



ENGINEERING, REIMAGINED

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PROTECTED/ PERMITTED LEFT TURN PHASING



Bismarck, North Dakota

Protected/permitted left turn phasing is a traffic signal operation in which both permissive (green ball or flashing yellow arrow) and protected (green arrow) modes can occur during the same cycle. Using a solid green arrow signal, the protected mode allows left turns to be made at the intersection either before or after through traffic has a green light. During this phase, movements are given the right of way and do not conflict with any other traffic or pedestrian movements. The permissive mode of the traffic signal operation uses a flashing yellow arrow signal to indicate that left turns are permitted after yielding to conflicting pedestrians and opposing traffic, if any. In alignment with federal rules, North Dakota Department of Transportation (NDDOT) uses a steady green arrow to indicate a permissive phase when there is a dedicated left turn lane (MUTCD 4D.18.02). Flashing yellow turn arrows should be installed with new traffic signal and traffic signal upgrade projects.

SAFETY BENEFITS

33% Reduction in all crash types.



Proven Safety Measure

ESTIMATED COST



\$4,000-\$50,000
per intersection

Source: NDDOT Historical Bid Price

MODAL IMPACT



MOTORIST

- » Easy to understand and encourages uniform motorist behavior.
- » May decrease delay for left turning vehicles, but increase delay for other movements.



BICYCLIST

- » Allows protected left turn phase to clear left turning motorists from intersection before or after through bicycle movements.



PEDESTRIAN

- » Allows protected left turn phase to clear left turning motorists from intersection before or after pedestrian crossing.



LARGE TRUCKS

- » May reduce delay due to the need for large gaps to make left run movements under permissive only phasing.

➔ CONSIDERATIONS

- » Ensure adequate sight distance is available to left turning motorists.
- » NDDOT has explicit criteria for the installation of flashing yellow arrows, including prohibiting their use with negative offset turn lanes.
- » Green left turn arrows can be used either before (leading) or after (lagging) through traffic has a green light.
- » Flashing yellow arrows installed with Protected/Permitted Left Turn phases are effective at reducing yellow trap events. Yellow traps occurs when a motorist pulls into an intersection during a protected or permissive phase. The trap occurs when the green arrow/ball turns yellow in one direction but remains green for the other direction (split phasing). The left turning motorist assumes the other direction also received yellow indications and proceeds with their turn to avoid getting “trapped” in the intersection by future cross traffic. However, since the opposing direction has green indications they are likely to collide with the left turning motorist. Flashing yellows mitigate this dilemma because they are timed concurrently with the opposing through movement instead of the permissive phase of the adjacent through movement.
- » The permitted phase (green arrow) can be omitted, and replaced with a flashing yellow arrow, when a pedestrian call is made.

➔ MITIGATED CRASH TYPES



Rear End



Left Turn

➔ APPLICABLE CONTEXT

Protected/permitted left turn phasing is applicable at signalized intersections with dedicated left turn lanes. This countermeasure can be applied to both new construction and existing signals with modifications. The NDDOT Traffic Operations Manual describes the process for determining the appropriate signal and phasing.

What drivers should know



STOP. Left-turning drivers must stop and wait.



WARNING / CAUTION. The left turn signal is changing to red.



CAUTION. You may cautiously turn left **after** yielding to oncoming traffic and to pedestrians (similar to a green ball). Oncoming traffic will typically have a green light.



GO. Left-turning drivers have the right of way.

Source: NDDOT

➔ COMPLEMENTARY COUNTERMEASURES

Required

- » Traffic Signal
- » Turn Lanes

Optional

- » Signal Timing and Coordination
- » Pedestrian Countdown Signals
- » High-Visibility Crosswalk

Additional Information & Resources

- » North Dakota Department of Transportation (NDDOT): <https://www.dot.nd.gov/divisions/programming/flashing-yellow-arrow.htm>
- » NCHRP 25905: [Decision-Making Guide for Traffic Signal Phasing \(2020\)](#)
- » FHWA: <https://www.fhwa.dot.gov/publications/research/safety/09035/index.cfm>
- » Crash Modification Factor: <http://www.cmfclearinghouse.org/detail.cfm?facid=4143>
- » NDDOT Traffic Operations Manual: <https://www.dot.nd.gov/divisions/programming/docs/trafficops.pdf>

TURN LANES



Bismarck, North Dakota

www.pedbikeimages.org / Michael Frederick

Left and right turn lanes provide physical separation between turning traffic that is slowing or stopped and adjacent through traffic at approaches to intersections. Turn lanes can be designed to encourage deceleration prior to a turn, and can act as storage of vehicles that are stopped and waiting for the opportunity to complete a turn. The North Dakota Department of Transportation (NDDOT) has guidelines in the NDDOT Traffic Operations Manual for when the installation of right and left turn lanes are recommended. The decision is typically based on traffic volume, heavy vehicle traffic, the speed limit, and the slope of terrain. Exceptions can be made if professional judgment determines a turn lane would improve operations, particularly if turning related crashes are common. Similarly, right turn lanes can be dangerous in the presence of heavy pedestrian and bicycle traffic, even if they are warranted by motorized traffic.

➔ SAFETY BENEFITS

28% / 14% Reduction in all crash types at signalized intersections (left turn lanes / right turn lanes).

27% / 14% Reduction in all crash types at unsignalized intersections (left turn lanes / right turn lanes).



Proven Safety Measure

➔ ESTIMATED COST



Varies

Minimal costs if only restriping is necessary. Higher costs if additional pavement is needed.

➔ MODAL IMPACT



MOTORIST » Provides separation between slowing traffic and through traffic.



BICYCLIST » Increases crossing exposure, potentially reducing safety.
» May provide opportunity for other crossing countermeasures to be installed.



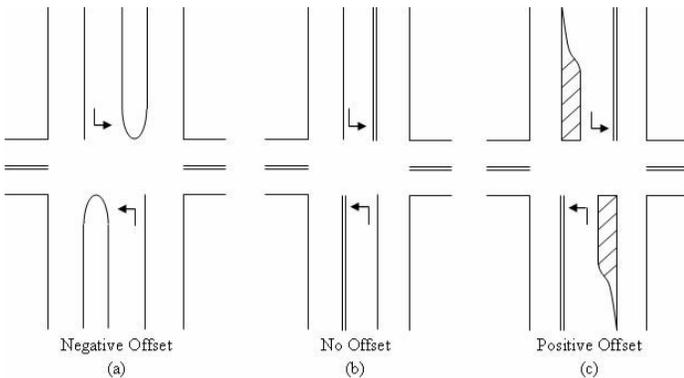
PEDESTRIAN » Increases crossing exposure, potentially reducing safety.
» May provide opportunity for other crossing countermeasures to be installed



LARGE TRUCKS » Provides separation between slowing traffic and through traffic.

➔ APPLICABLE CONTEXT

Turn lanes are appropriate anywhere there are a high number of turning vehicles. The NDDOT Traffic Operations Manual has guidelines for when the installation of right and left turn lanes are recommended.



Source: FHWA Safety Evaluation of Offset Improvements for Left-Turn Lanes

➔ CONSIDERATIONS

- » Use turning volumes and traffic operations analysis to determine appropriate storage length.
- » There may be roadway width or right of way constraints.
- » Left turn lanes are sometimes installed with a negative offset, especially at divided highway intersections. If feasible, positive offset or zero offset left turn lanes should be installed.
- » Positive offset left turn lanes improve the visibility of oncoming through traffic, allowing left turning motorists to use the available gaps more effectively, and decrease the possible conflict between opposing left turning motorists.
- » Turn lanes, including the taper area, should be kept clear of any additional points of access.

➔ MITIGATED CRASH TYPES



Rear End



Angle



Left Turn



Right Turn

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- » Signal Timing and Coordination
- » Protected/Permitted Left Turn
- » Raised Median/Crossing Island
- » Traffic Signal
- » All Way Stop Control
- » Two Way Stop Control
- » Protected/Permitted Left Turn

Additional Information & Resources

- » North Dakota Department of Transportation (NDDOT): <https://www.dot.nd.gov/divisions/programming/docs/trafficops.pdf>
- » FHWA: https://safety.fhwa.dot.gov/provencountermeasures/left_right_turn_lanes/
- » FHWA: https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/ub1_leftturnlanes.pdf
- » FHWA: https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/ub6_right_turn_lanes.pdf
- » Crash Modification Factor: http://www.cmfclearinghouse.org/study_detail.cfm?stid=24

SIGNAL TIMING AND COORDINATION



Bismarck, North Dakota

Signal timing refers to the duration of time assigned to each phase at an intersection. This time must include the green, yellow, and red indication for each movement. Signal timing treatments may also include but are not limited to altering cycle length, pedestrian crossing time, vehicle detection priority and extensions, phase order, leading or lagging left turn phases, time of day plans, and dedicated bicycle or pedestrian phases. Coordination is the relationship between traffic signals along a corridor. Coordination aids in the progression of vehicles moving through a corridor by reducing unnecessary stops and delays. Signal timing should be re-evaluated periodically and when major changes in traffic patterns or volumes occur.

SAFETY BENEFITS

Varies

Crash reduction depends on the specific signal timing implemented. A study conducted in Phoenix, Arizona found that crashes decreased by about seven percent along a corridor once the traffic signals were coordinated. A separate study in Phoenix found that crashes at coordinated intersections decreased by 3 to 18 percent.

ESTIMATED COST



Minimal costs to re-time or incorporate coordination if appropriate infrastructure is in place.

MODAL IMPACT



MOTORIST

- » Allows continuous movement along a coordinated route if road capacity is sufficient.
- » May decrease delay.



BICYCLIST

- » May incorporate elements that protect bicyclist movements.
- » May reduce risky or impatient interactions between motorists and bicyclists.



PEDESTRIAN

- » May incorporate elements that protect pedestrian crossings.
- » May reduce risky or impatient interactions between motorists and pedestrians.



LARGE TRUCKS

- » Allows continuous movement along a coordinated route if road capacity is sufficient.
- » May decrease delay.

➔ CONSIDERATIONS

- » Poor signal timing can increase delay and fuel consumption.
- » Coordination loses its effectiveness across longer distances. Coordinated signals should be less than 0.5 miles apart.
- » Infrastructure can have significant costs and must be reliable to ensure signal cycles and offsets remain synchronized along the corridor.
- » Signals should generally be retimed every 5 years to maintain effectiveness. This time frame can be longer in areas with minimal change and shorter in areas of notable change.

➔ MITIGATED CRASH TYPES



Rear End



Left Turn



Right Turn



Angle



Bicyclist ride through/out signalized intersection



Motorist left turn into pedestrian parallel path



Motorist right turn into pedestrian parallel path



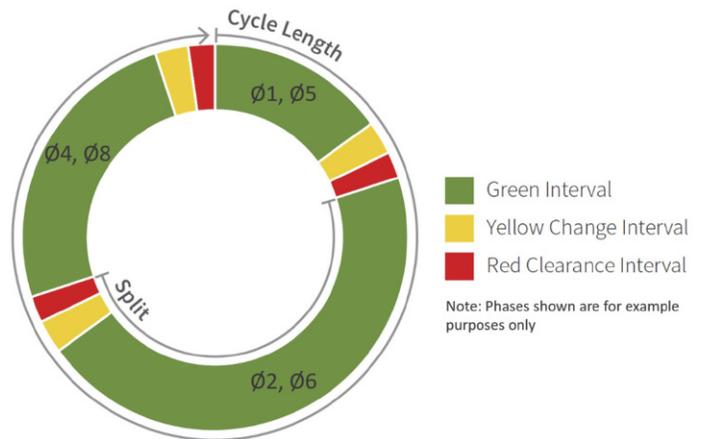
Motorist right turn into bicyclist opposite direction



Motorist right turn into bicyclist same direction

➔ APPLICABLE CONTEXT

This countermeasure should be considered at locations with a high frequency of relevant crash types (see mitigated crash types). Signal timing and coordination will have a high benefit to cost ratio at intersections where infrastructure is already in place. In addition to safety concerns, this countermeasure is applicable where delay and poor traffic operations exist.



Source: NCHRP 25905

➔ COMPLEMENTARY COUNTERMEASURES

Required

- » Traffic Signal

Optional

- » Turn Lanes
- » Pedestrian Countdown Signals
- » Bike Signals
- » High Visibility Crosswalk Marking
- » Crossing Islands
- » No Turn on Red Signs
- » Leading Pedestrian/Bicycle Interval
- » All-Walk Phase

Additional Information & Resources

- » Minnesota Department of Transportation (MnDOT): http://www.dot.state.mn.us/trafficeng/publ/signaloperations/2013_Signal_Opt_and_Timing_Manual.pdf
- » FHWA: <https://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/ch8.cfm#s833>
- » NCHRP 25905 <https://www.nap.edu/catalog/25905/decision-making-guide-for-traffic-signal-phasing>

TRAFFIC SIGNAL



Bismarck, North Dakota

A traffic signal is a device used to control the flow of traffic at intersections, where traffic is alternately directed to stop and permitted to proceed. Traffic includes pedestrians, bicyclists, and vehicles. A traffic signal can be considered if an intersection meets one of eight warrants described in the Manual of Uniform Traffic Control Devices (MUTCD). The warranting factors include high vehicle volumes, high pedestrian volumes, frequent crossings by school children, a need for coordination with nearby intersections, high crash rates, and several other special scenarios. Generally it is best if an intersection meets multiple warrants before a traffic signal is installed. Further, the installation of a traffic signal is not required when warrants are met.

➔ SAFETY BENEFITS

44% Reduction in all crash types where warranted.

 Proven Safety Measure

➔ ESTIMATED COST

\$\$\$

\$250,000-\$300,000
per intersection

Source: NDDOT Historical Bid Price

➔ MODAL IMPACT



MOTORIST

- » May increase delay for mainline traffic and decrease delay for sidestreet traffic when compared to two way stop control.
- » May decrease overall delay and increase travel time reliability when compared to all way stop control.



BICYCLIST

- » Provides opportunity for protected crossing.



PEDESTRIAN

- » Provides opportunity for protected crossing.



LARGE TRUCKS

- » Delay effect will be similar to motorists. The delay increase may be more significant for large trucks due to increased start and stop time.

➔ CONSIDERATIONS

- » Traffic signals may increase rear end crashes.
- » A traffic signal should not be installed if it will seriously disrupt progressive traffic flow.
- » Traffic signals may be pretimed or actuated. A traffic study should be completed to determine the best configuration.
- » In addition to upfront costs, traffic signals require constant electrical power, will have equipment maintenance, and should be retimed every 3 to 5 years.
- » Review traffic signal removal countermeasure.

➔ MITIGATED CRASH TYPES



Angle



Left Turn



Right Turn



Motorist failed to yield to pedestrian



Pedestrian failed to yield



Pedestrian dash



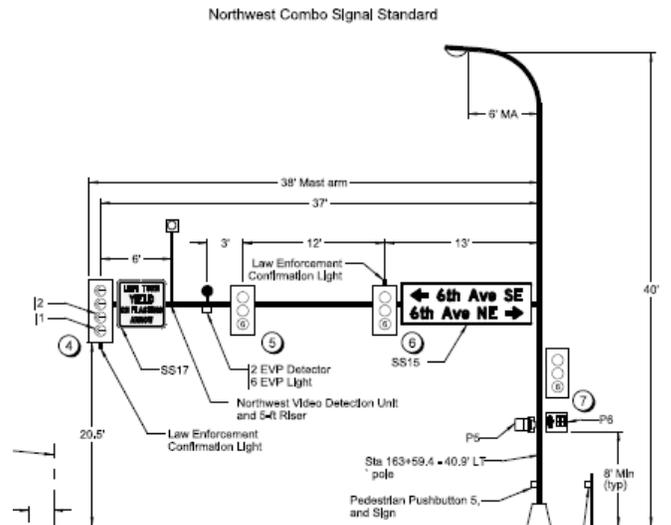
Bicyclist crossing path with uncontrolled motorist



Bicyclist ride through/out stop sign

➔ APPLICABLE CONTEXT

Traffic signals should be installed only when warranted based on requirements within the MUTCD if no other alternatives are deemed appropriate.



Source: Main Street Mandan Project

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- » Signal Timing and Coordination
- » Protected/Permitted Left turn phasing
- » Turn Lanes
- » Pedestrian Countdown Signals
- » Bike Signals
- » High Visibility Crosswalk Marking
- » Crossing Islands
- » No Turn on Red Signs
- » Leading Pedestrian/Bicycle Interval
- » All-Walk Phase
- » Curb Ramps

Additional Information & Resources

- » NDDOT Spec & Code 772-9811
- » Crash Modification Factor: <http://www.cmfclearinghouse.org/detail.cfm?facid=325>
- » MUTCD Chapter 4

LAW ENFORCEMENT CONFIRMATION LIGHT



Bismarck, North Dakota

Law enforcement confirmation lights are mounted on signal heads, mast arms, or poles that are directly connected to a red light indication of a traffic signal. The light activates at the onset of the red phase and allows an enforcement officer to observe red light running downstream of the intersection. This strategy is intended to reduce the frequency of crashes resulting from drivers disobeying traffic signals by providing a safer and more efficient means for police to enforce the red.

SAFETY BENEFITS

15% Reduction in all crash types.



Proven Safety Measure

ESTIMATED COST



\$500
per light

Source: NDDOT Historical Bid Price

MODAL IMPACT



MOTORIST » Improved traffic signal compliance.
» May reduce right angle crashes but increase rear end crash types.



BICYCLIST » Improved vehicle compliance at intersections may improve bicyclist safety.



PEDESTRIAN » Improved vehicle compliance at intersections may improve pedestrian safety.



LARGE TRUCKS » Improved traffic signal compliance.
» May reduce right angle crashes but increase rear end crash types.

➔ CONSIDERATIONS

- » There should be discussion with local law enforcement to develop best policy for implementation.
- » Law enforcement confirmation lights are most effective when combined with public education and additional enforcement.
- » If confirmation lights are deployed on multiple traffic signals along a corridor it can provide enforcement agencies with the ability to change the time and location of enforcement for a broader safety effect on the traveling public.

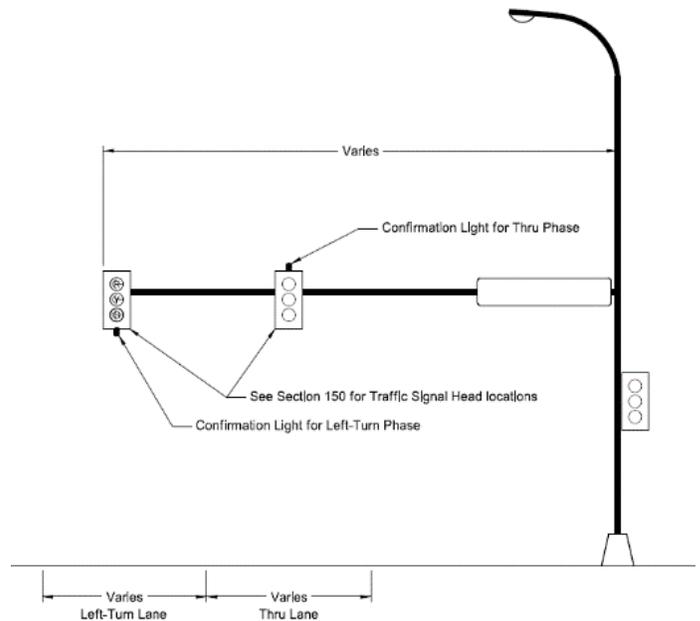


Source: City of Bismarck

➔ APPLICABLE CONTEXT

This countermeasure is applicable at signalized intersections where there are a high number of red light runners, and where police will prioritize enforcement.

DETAIL 4
Protected Only Left-Turn Standard Detail



Source: City of Bismarck

➔ MITIGATED CRASH TYPES



Angle



Left Turn



Motorist failed to yield to pedestrian

➔ COMPLEMENTARY COUNTERMEASURES

Required

- » Traffic Signal

Optional

- » Education
- » Leading Pedestrian Interval
- » All Walk Phase

Additional Information & Resources

- » FHWA: <https://www.fhwa.dot.gov/publications/research/safety/17077/17077.pdf>
- » City of Bismarck: <https://www.bismarcknd.gov/1800/Red-Light-Confirmation-Lights>
- » Minnesota Department of Transportation (MnDOT): <https://www.dot.state.mn.us/stateaid/trafficsafety/safety/traffic-signal-confirmation-lights.pdf>

ALL WAY STOP CONTROL



Bismarck, North Dakota

All way stop control requires all approaching motorists at an intersection to stop prior to crossing the intersection, and proceed through once it is safe to do so. All way stop control must be warranted based on the Manual of Uniform Traffic Control Devices (MUTCD) requirements. The warranting factors include a high crash rate that could be reduced by the installation of an all way stop control, vehicle volumes averaging at least 300 vehicles per hour during an 8 hour period on an average day, or combined traffic volume from all modes averaging at least 200 vehicles per hour during the same 8 hour period. If no single criterion is satisfied, an all way stop control can still be warranted if all criteria are met at 80 percent of the minimum values.

➔ SAFETY BENEFITS

53% Reduction in all crash types where warranted.
(conversion from two way stop control)



Proven Safety Measure

➔ ESTIMATED COST



\$800
per intersection

Source: NDDOT Historical Bid Price

➔ MODAL IMPACT



MOTORIST » Increase delay for mainline traffic.
» Reduced delay for cross street traffic.



BICYCLIST » Allows for controlled crossing.



PEDESTRIAN » Stop signs allow right of way to alternate between pedestrians and vehicles.



LARGE TRUCKS » Increase delay for mainline traffic.
» Reduced delay for cross street traffic.

➔ CONSIDERATIONS

- » All way stop control should not be used as a traffic calming measure. Research has found that, overwhelmingly, multi-way stop signs do not control speed except under very limited conditions.
- » If drivers encounter substantial delays, they may become impatient and act dangerously, which can lead to increased crashes.
- » Drivers may disregard unexpected stop signs. There are many options to enhance stop sign visibility which may include larger stop sign size, advance “Stop Ahead” warning signs, gated stop signs (signs on both the left and right side of the approach), and LED flashers embedded within the sign.

➔ APPLICABLE CONTEXT

All way stop control is applicable at uncontrolled intersections, two way stop controlled intersections, or unwarranted traffic signals. This countermeasure is highly relevant at locations with a history of angle crashes and turning crashes. Generally, All way stop control works best where volumes are moderate and relatively balanced on all approaches.



Source: RoadTrafficSigns.com

➔ MITIGATED CRASH TYPES



Angle



Left Turn



Right Turn



Motorist failed to yield to pedestrian



Pedestrian Failed to Yield



Bicyclist crossing uncontrolled motorist

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- » Turn Lanes
- » Narrow Lanes

Additional Information & Resources

- » FHWA https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/uf2_allway_stop_control.pdf
https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa10005/brief_4.cfm
- » Rapid City: <http://archive.rcgov.org/pw20120214/PW021412-16.pdf>
- » MUTCD Chapter 2

TWO WAY STOP CONTROL



Bismarck, North Dakota

Two way stop controlled intersections require traffic on two opposite approaches to come to a full stop before turning or crossing the intersection, while traffic on the other approaches may proceed through the intersection without stopping. A typical application of this control type is the intersection of a major and minor road, where traffic is heavily concentrated on the major approaches. A stop sign on one or more approaches must be warranted based on the Manual of Uniform Traffic Control Devices (MUTCD) requirements. The warranting factors for a stop sign on minor approaches of an intersection include vehicle traffic volumes in excess of 6,000 vehicles per day on the major road, a high crash rate that could be reduced with the installation of a stop sign, or a restricted view that prevents drivers from seeing conflicting traffic.

➔ SAFETY BENEFITS

51% Reduction in all crash types where warranted.
(conversion from uncontrolled intersection)



Proven Safety Measure

➔ ESTIMATED COST



\$400

per intersection

Source: NDDOT Historical Bid Price

➔ MODAL IMPACT



MOTORIST » Increased awareness of traffic on major approach.



BICYCLIST » Uncontrolled motorists on the major road may pose a threat to crossing bicyclists.



PEDESTRIAN » Uncontrolled motorists on the major road may pose a threat to crossing pedestrians.



LARGE TRUCKS » Increased awareness of traffic on major approach.

➔ CONSIDERATIONS

- » Side street traffic may have difficulties crossing the major road compared to an all way stop controlled or signalized intersection. If delay is significant for side street traffic, it may cause unsafe gap decisions and lead to more crashes. Access management may be an acceptable alternative countermeasure for certain locations.
- » Bicycles and pedestrians may find it extremely difficult to cross the uncontrolled major roadway.
- » Installing left turn lanes and/or right turn lanes should be considered for the major road approaches to improve safety where significant turning volumes exist or where there is a history of turn related or rear end crashes. Left and right turn lanes on the major approach can reduce crashes by up to 48% and 26% respectively at two way stop controlled intersections.

➔ APPLICABLE CONTEXT

Two way stop control is appropriate at intersections of a major and minor road. Intersections that have sight line issues are also candidates for this countermeasure.



Source: RoadTrafficSigns.com

➔ MITIGATED CRASH TYPES



Angle

➔ COMPLEMENTARY COUNTERMEASURES

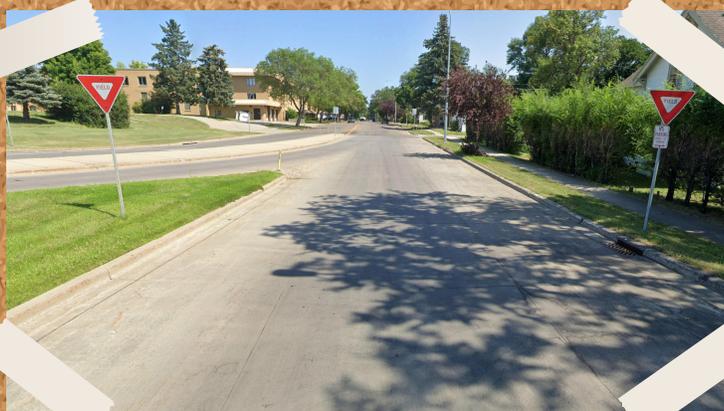
Optional

- » Turn Lanes
- » Narrow Lanes
- » Raised Median/Crossing Island

Additional Information & Resources

- » FHWA: https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa10005/brief_4.cfm
https://safety.fhwa.dot.gov/provencountermeasures/left_right_turn_lanes/
- » MUTCD Chapter 2

YIELD CONTROL



Bismarck, North Dakota

Yield control requires that drivers slow down and prepare to stop when approaching an intersection. Unlike stop control, merging drivers are not required to stop if there is no conflicting traffic. Yield control can be placed on the minor approaches of an intersection similar to two way stop control. Where stop signs are not warranted yield control may be appropriate. Yield control is also commonly used for channelized right turns, midblock pedestrian crossings, and roundabouts.

SAFETY BENEFITS

Undefined

Studies quantifying the benefits of yield control are not available. Yield control signs placed at uncontrolled intersections can clarify right of way, address sight distance issues, improve awareness of opposing traffic, and reduce turning speeds. Motorist compliance may improve when implemented in place of unwarranted stop control. Studies have shown that unwarranted stop control may exhibit a noncompliance rate up to 30%. Although undefined, it is expected that appropriate yield signs can have a big impact on a wide variety of safety concerns.

ESTIMATED COST



\$200
per sign

Source: NDDOT Historical Bid Price

MODAL IMPACT



MOTORIST

- » Designates right of way and reduces potential conflicts at uncontrolled locations.
- » Increases compliance at unwarranted stop sign removal locations.



BICYCLIST

- » Designates right of way and improves safety with reduced turning speeds.
- » Increases safety with better motorist compliance at unwarranted stop sign removal locations.



PEDESTRIAN

- » Designates right of way and improves safety with reduced turning speeds.
- » Increases safety with better motorist compliance at unwarranted stop sign removal locations.



LARGE TRUCKS

- » Designates right of way and reduces potential conflicts at uncontrolled locations.
- » Increases compliance at unwarranted stop sign removal locations.

➔ APPLICABLE CONTEXT

Applicable locations for yield control include uncontrolled intersections (minor road approach), channelized turn lanes, roundabouts, and any other condition where a full stop is not required. Yield control may be a good option where unwarranted stop signs exist. They create a less restrictive right of way designation while providing more structure than a completely uncontrolled intersection.

➔ CONSIDERATIONS

- » Yield control for minor vehicle approaches may not clearly convey pedestrian right of way. Supplementary signs or countermeasures may be appropriate.
- » Since yield control allows drivers to bypass stopping when appropriate, clear sight lines must be maintained to allow drivers enough time to make a smart stopping decision.
- » Converting from stop signs to yield signs has been shown to increase crashes, with the exception of low compliance rate stop sign locations.
- » Locations with restricted sight lines are not good candidates for this countermeasure.



Source: MUTCD



Source: MUTCD

➔ MITIGATED CRASH TYPES



Angle

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- » Turn Lanes
- » Roundabout
- » High Visibility Crosswalk

Additional Information & Resources

- » Iowa State University Institute For Transportation: https://intrans.iastate.edu/app/uploads/2018/03/sign_effectiveness_guide_w_cvr.pdf
- » MUTCD Chapter 2

TRAFFIC SIGNAL REMOVAL



Herkimer, New York

Source: Donna Thompson/Times Telegram

Traffic signals can be harmful to both traffic operations and safety when implemented at intersections with low traffic volumes. By creating unnecessary delays at the intersection, motorists may drive more aggressively and be particularly prone to rear end and angle crashes. Unwarranted traffic signals may also cause motorists to reroute and avoid the intersection all together, creating challenges at other locations. For pedestrians and cyclists, removal of an unwarranted traffic signal has the potential to reduce the threat of aggressive driving behavior, but may require additional crossing amenities to improve crossing safety. Common replacement intersection controls are roundabouts and all way stop control.

SAFETY BENEFITS

24% Reduction in all crash types.



Proven Safety Measure

ESTIMATED COST



\$7,500
per intersection

Source: NDDOT Historical Bid Price

MODAL IMPACT



MOTORIST » Shorter delay for mainline traffic if signal was unwarranted.



BICYCLIST » Reduction of motorist movement control increases conflicts.
» Could delay the flow of turning or crossing bicyclists through the intersection.
» Could reduce start up time and improve through movement travel time.



PEDESTRIAN » Reduction of motorist movement control increases conflicts.
» Could delay the flow of pedestrians through the intersection.



LARGE TRUCKS » Shorter delay at intersection if signal was unwarranted.

➔ CONSIDERATIONS

- » Traffic signals are typically removed when a study of traffic patterns shows significant change over time.
- » Sight distance should be considered when determining the replacement intersection control.
- » A single traffic light can cost \$8,000 per year to maintain.



Mandan, North Dakota

➔ APPLICABLE CONTEXT

Signal Removal is applicable when the signal is no longer warranted, as described in the Manual of Uniform Traffic Control Devices (MUTCD). An intersection may no longer warrant a signal if traffic volumes have decreased since the initial installation. Alternatively, even if a traffic signal is warranted, there may be cause to remove it if crash patterns indicate that the signal has created new traffic safety issues.

If an engineering study concludes that a traffic signal is no longer justified, the following steps should be taken:

- » Determine the appropriate traffic control to replace the signal
- » Remove any sight distance restrictions
- » Inform the public of the removal study
- » Flash or cover (see image) the signal heads for a minimum of 90 days, and install the replacement signal control
- » Remove the signal if the data collected during the study period confirms that the signal is no longer needed.

➔ APPLICABLE CRASH TYPES



Rear End



Angle



Other
reduction in
crash severity

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- » Roundabout
- » All Way Stop Control
- » Two Way Stop Control
- » Yield Control
- » Raised Median/Crossing Island
- » Pedestrian Crossing Amenities
- » Education

Additional Information & Resources

- » FHWA: https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/sa7_remove_unwarranted_signal.pdf
- » Washington State Department of Transportation: <https://wsdot.wa.gov/Operations/Traffic/signals.htm>

ALL WAY STOP CONTROL REMOVAL



Laredo, Texas

Source: Danny Zaragoza/Laredo Morning Times

All way stop controlled intersections may no longer meet the demands of an intersection that has experienced an increase in traffic volumes over time. Conversely, all way stop control may cause compliance issues if traffic volumes are too low. Removing all way stop control and replacing it with appropriate traffic control (two way stop control, roundabout, or traffic signal) to address the observed issues can improve the intersection for all modes.

➔ SAFETY BENEFITS

Undefined

Studies quantifying the benefits of removing an unwarranted stop sign are not available. However, studies have shown that an unwarranted stop may exhibit a noncompliance rate up to 30 percent. Local studies have found that stop sign compliance is positively correlated with the conflicting traffic volume that opposes the stop sign. Further, traffic volumes are a greater determinant of driver compliance than the classification of the road.

➔ ESTIMATED COST

\$

\$500

per intersection

Source: NDDOT Historical Bid Price

➔ MODAL IMPACT



MOTORIST » Eliminate unnecessary delays and safety issues that were related to noncompliance.



BICYCLIST » Safety could improve with the sign removal. If a stop sign is perceived as unnecessary, motorists are likely to either run the stop sign or fail to stop before the corner.



PEDESTRIAN » Safety could improve with the sign removal. If a stop sign is perceived as unnecessary, motorists are likely to either run the stop sign or fail to stop before the corner.



LARGE TRUCKS » Eliminate unnecessary delays and safety issues that were related to noncompliance.



Source: Redbubble images

➔ APPLICABLE CONTEXT

Stop sign removal is applicable where traffic volumes do not warrant stop control, or crash patterns could be mitigated with a less restrictive intersection control. Additionally, stop control may no longer be able to handle the volume or directionality of traffic. In these cases a roundabout or warranted traffic signal may be appropriate.

➔ MITIGATED CRASH TYPES



Rear End



Angle



Other
reduction in
crash severity

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- » Roundabout
- » Two Way Stop Control
- » Yield Control
- » Education

➔ CONSIDERATIONS

- » Removing unwarranted stop signs has an overall user economic benefit. Studies have found that installing unwarranted stop signs increases operating costs for the traveling public. The operating costs involve vehicle operating costs, costs for increased delay and travel time, cost to enforce signs, costs for fines, and increases in insurance premiums.
- » Unwarranted stop signs may still be effective in reducing crashes where sight lines are an issue.
- » Removal of stop signs will decrease noise in the vicinity of the intersection. The noise is created by the engine exhaust, brake, tire and aerodynamic noises when the vehicle decelerates and accelerates.
- » Many times stop signs are installed without a warrant study or some documentation which can create liability concerns for noncompliance with the MUTCD.

Additional Information & Resources

- » FHWA: https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa09027/resources/lowa%20Traffic%20and%20Safety%20FIS-%20Unsignalized%20Intersections.pdf
- » City of Fargo: https://download.fargond.gov/0/stop_sign_fact_sheet.pdf
- » W. Martin Bretherton Jr., P.E.(M): <http://archive.rcgov.org/ca20140902/PW081214-09/RESEARCH%20ON%20EFFECTIVENESS%20OF%20ALL-WAY%20STOPS.pdf>
- » <http://www.spackconsulting.com/findings-preview-stop-sign-compliance-research/>

ROUNDBABOUTS/ MINI ROUND- ABOUTS



Woodbury, Minnesota

Source: Washington County

Roundabouts and mini roundabouts most often take the place of a stop-controlled or signalized intersection. On low traffic residential streets, mini-roundabouts can be installed within the existing intersection, requiring motorists to slow down without coming to a complete stop. Roundabouts are effective at reducing vehicle speeds, eliminating angle and high speed collisions, allowing traffic to flow efficiently, and reducing operation costs compared to signalized intersection.

➔ SAFETY BENEFITS

84% Reduction in Fatal and Serious Crashes



Proven Safety Measure

➔ ESTIMATED COST



\$5,000- \$2,000,000

➔ MODAL IMPACT



MOTORIST » Greatly reduces the chance of crashes resulting in injury.



BICYCLIST » The safety impacts of roundabouts on bicyclists is unclear. Lower vehicle speeds often improve safety for bicyclists.



PEDESTRIAN » May increase safety if the roundabout is replacing an uncontrolled intersection. Lower vehicle speeds often improve safety for pedestrians.



LARGE TRUCKS » Greatly reduces the chance of crashes resulting in injury.

➔ CONSIDERATIONS

- » When determining if a roundabout is feasible for a given intersection, the available right-of-way may place constraints on the number of travel lanes and additional pedestrian and bicycle facilities.
- » In general, entry speeds on each leg of the intersection should be designed for speeds between 15 and 18 mph.
- » Multi-lane roundabouts should employ additional pedestrian and bicycle safety measures to counteract multiple threat crashes.
- » Given that the safety impacts of roundabouts on bicyclists is unclear, special attention should be given to bicycle treatments around the perimeter of the roundabout.

➔ APPLICABLE CONTEXT

- » In general, any intersection that meets the criteria for traffic control beyond stop control qualifies for evaluation as a roundabout.
- » Roundabouts may be particularly effective at intersections where many vehicles make left-turning movements.
- » Intersections where traffic signals are not warranted but traffic flow and/or safety issues exist.



St. Paul, Minnesota

➔ MITIGATED CRASH TYPES



Motorist failed to yield to pedestrian



Angle

➔ COMPLEMENTARY COUNTERMEASURES

Optional

- Yield Sign
- Crosswalks
- Pedestrian refuge island
- Pedestrian activated signals
- Advance stop/yield lines (multi-lane roundabouts)

Additional Information & Resources

- » FHWA: https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/sa7_remove_unwarranted_signal.pdf
- » <http://archive.rcgov.org/pw20120214/PW021412-16.pdf>
- » MnDOT: <https://www.dot.state.mn.us/trafficeng/safety/docs/roundaboutstudy.pdf>
- » NCHRP: <http://www.trb.org/Main/Blurbs/180624.aspx>

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