

BISMARCK-MANDAN INTERSECTION ANALYSIS STUDY

Traffic Calming Fact Sheets



Bismarck-Mandan
METROPOLITAN PLANNING ORGANIZATION

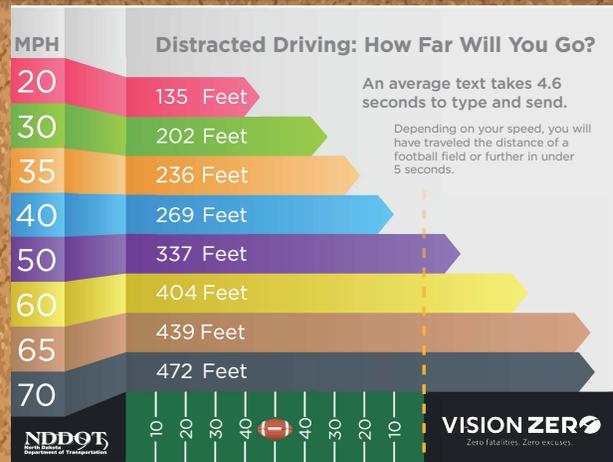


ENGINEERING, REIMAGINED

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EDUCATION



North Dakota Department of Transportation

Education is outreach for the general public which is a tool used to improve driver behavior. Education can take many forms, including neighborhood meetings, traffic safety newsletter, neighborhood pledges, or media campaigns. Educational efforts typically are an ongoing effort, as improvements in behavior are typically only seen in the short term. Education can be especially effective when informing the public of a newly implemented countermeasure and how to properly navigate and use the new countermeasure.

→ APPLICABLE CONTEXT

Education is applicable in neighborhoods or areas with a high percentage of local drivers that will be using the new countermeasure on a regular basis.

→ ESTIMATED COST



\$5,000-\$15,000

Highly cost effective, but cost is dependent on level of effort

→ CONSIDERATIONS

Determining the correct type of education and amount can rely on many factors. Some important questions to answer before using this countermeasure may include

- » Is this a brand new countermeasure or is it used elsewhere in the community?
- » Is continuous education needed, or on a scheduled reoccurring basis?
- » What are the budgetary constraints?

Examples of education initiatives includes the following:

- » Neighborhood meetings with the affected neighborhood can help discuss the specific traffic issues and ways for residents to personally reduce speeds and increase safety in their neighborhood.
- » A traffic safety newsletter may be designed for a specific neighborhood describing the traffic concerns and recommendations. The newsletter may provide information on volumes and speeds in the area, as well as reminders of traffic laws and traffic safety tips.
- » Neighborhood pledge or “pace” cars are a pledge form that may be distributed through the neighborhood to encourage neighbors to commit to driving the speed limit. The City may also provide a bumper sticker or decal for residents who will lead by example through their neighborhood and others.
- » Media stories or social media blasts with information on the new countermeasure such as benefits and how to use correctly.

Additional Information & Resources

- » City of Moorhead Traffic Calming Manual: <http://www.cityofmoorhead.com/departments/engineering/forms-resources/traffic-calming-policy>

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RAISED MEDIAN ISLANDS



Fargo, North Dakota

Image Source: Google Earth

A raised median island located along the street centerline of a roadway and narrows the travel lanes at that location. A median island serves a different purpose than a standard continuous median because the narrowed lanes encourage motorists to slow. In addition to slowing traffic, raised median islands provide opportunities to provide landscaping, or installation of gateway signs.

SAFETY BENEFITS

8 mph Reduction in speed.

ESTIMATED COST

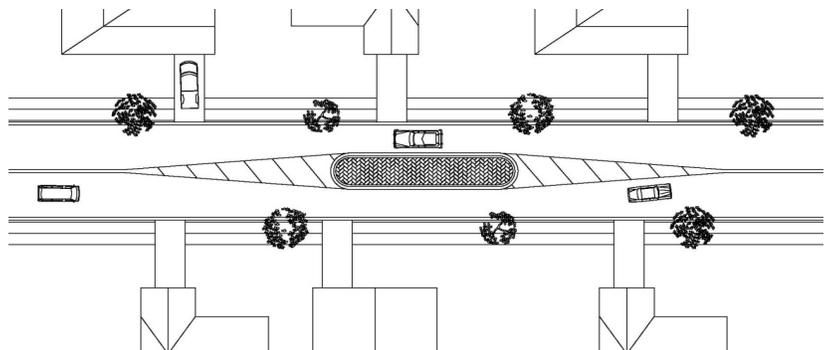
\$ \$1,500-\$10,000
Source: ITE Traffic Calming Fact Sheets

APPLICABLE CONTEXT

This countermeasure is highly applicable to many locations in urban and suburban settings. It is appropriate for arterial, collector, and local roadways of all sizes and traffic volumes. Some jurisdictions set an upper speed limit guidance for this countermeasure ranging between 30 and 45 miles per hour.

CONSIDERATIONS

- » A median island can often double as a pedestrian refuge island. Where a crosswalk already exists, it is desirable to locate the median island at the crosswalk. A median island should be at least 6 feet wide to accommodate pedestrian refuge.
- » There may be street parking and drainage impacts.
- » Raised median islands can make snow removal operations more difficult.



Source: Delaware Department of Transportation

Additional Information & Resources

- » ITE Traffic Calming Fact Sheets: <https://www.ite.org/pub/?id=2c1ffc15%2D9945%2D08b7%2D78d9%2D5e1cb0ac12b6>
- » FHWA: https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3pt3.cfm#mod318
- » NACTO: <https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/median-refuge-island/>

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STATIONARY RADAR SIGNS/ SPEED DISPLAY BOARD



Fargo, North Dakota

Image Source: Google Earth

A stationary radar sign collects the speed of passing vehicles and displays the speed on a dynamic board. This speed reduction technique captures motorists' attention by flashing the vehicles' speed or a "Slow Down" message (red or amber displayed speed) when a driver exceeds the posted speed limit by a programmable threshold.

SAFETY BENEFITS

10mph

Reduction in speed.



Proven Safety Measure

ESTIMATED COST



\$10,000-\$20,000

Source: Moorhead Traffic Calming Manual

CONSIDERATIONS

- » In some cases, failure of motorists to obey the posted speed limit stems from inappropriate site conditions. An engineering study should be completed to determine if there are systematic issues.
- » This countermeasure is dependent on motorist compliance. Excessive signage could lead to non-compliance.
- » Most effective at reducing excessive speeds (vehicles traveling greater than 10 mph over the speed limit).

APPLICABLE CONTEXT

There are many applicable contexts, such as: locations where the speed limit decreases greatly, curve approaches, transitions zones between rural and urban settings, school and park zones, and residential areas.

Additional Information & Resources

- » FHWA: https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa1304/resources2/36%20-%20Guidance%20for%20Radar%20Speed%20Sign%20Deployments.pdf
- » FHWA Report No. FHWA-HRT-14-020. McLean, Virginia. (January 2015). <https://www.fhwa.dot.gov/publications/research/safety/14020/14020.pdf>
- » City of Moorhead Traffic Calming Manual: <http://www.cityofmoorhead.com/departments/engineering/forms-resources/traffic-calming-policy>

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CURB RADIUS REDUCTION



New York City, New York

Image Source: NACTO

The radius of a street corner impacts motorist turning speeds and pedestrian crossing distance. A large curb radius typically results in high-speed turning movements putting pedestrians at a higher risk of being struck by fast right turning vehicles. Reducing the corner radius can improve pedestrian safety by requiring motorists to reduce speeds, and shortening pedestrian crossing distances which thereby improves signal timing. Additionally, a smaller radius provides a larger pedestrian waiting areas at corners, improves sight distance, and allows for greater flexibility of curb ramp placement. Curb radius reduction is similar to the bulb-outs countermeasure.

ESTIMATED COST



\$15,000-\$40,000

per intersection

Source: FHWA Pedsafe

SAFETY BENEFITS

40% Reduction in right turn speeds.

APPLICABLE CONTEXT

This countermeasure is applicable in urban areas with low heavy vehicle volumes. Intersections that have a skew are candidate locations, especially corners with larger turning angles.

CONSIDERATIONS

- » A truck apron can be used to provide a curb radius reduction targeted to slow smaller vehicles while accommodating the needs of larger vehicles like school buses and emergency response vehicles.
- » All curb radius geometries should be designed to prevent turning vehicles from tracking over the curb which could injure people waiting on the corner.
- » Bulb-outs are similar in function but more commonly used by states and local jurisdictions than curb radius reductions because they do not impact vehicular movements as significantly.
- » Designers often determine corner radii based on the curb geometry only and overlook the effective radius. Effective radius takes into account elements like additional through lanes, bike lanes, and parking. As a result, drivers may still turn as wide as possible to maintain travel speeds if there is physical space available.
- » There may be parking and drainage impacts.
- » This countermeasure can make snow removal operations more difficult.

Additional Information & Resources

- » Alta Planning: https://altago.com/wp-content/uploads/Corner-Design-for-All-Users_Alta_Sept-2020.pdf
- » For additional resources consult this countermeasure in the bicycle and pedestrian section

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SPEED HUMPS, TABLES AND KIDNEYS



Grand Forks, North Dakota

Image Source: Google Earth

Speed humps, tables, and kidneys are vertical traffic calming measures that are implemented to reduce speeds and/or traffic volumes. Both speed humps and tables span across the whole roadway width, sometimes leaving a path for bicyclists. Speed tables provide a 10 to 14 foot flat section in the middle compared to a speed hump that contains a quick parabolic rise of two to three inches. A speed kidney is a curved speed hump that does not occupy the entire street cross-section. The design allows motorist to follow the curvature at a lower speed to avoid the vertical discomfort. Multiple options exist for temporary applications to test effectiveness prior to permanent installation.

→ SAFETY BENEFITS

25% Reduction in speed.



Proven Safety Measure

→ ESTIMATED COST



\$2,000-\$4,000

Source: ITE Traffic Calming Fact Sheets

→ CONSIDERATIONS

- » Speed Humps are effective and self enforcing when placed in a series 300 to 500 feet apart.
- » Where a speed table coincides with a crossing or crosswalk, it should be designed as a raised crosswalk.
- » Speed Kidneys may be more appropriate in areas with a high number of emergency vehicles as they allow for smoother vehicle access.
- » All designs should consider snow removal operations and drainage.
- » All of these countermeasures can increase in road noise.

→ APPLICABLE CONTEXT

These countermeasures are applicable on corridors with poor speed limit compliance. Residential or local streets, and streets with speed limit below 35 miles per hour are appropriate for the installation of this traffic calming tool.

Additional Information & Resources

- » ITE Journal 82, December 2012: <https://www.ite.org/pub/?id=E258A49F-2354-D714-5118-60240310359E>
- » ITE Traffic Calming Fact Sheets: <https://www.ite.org/pub/?id=2c815e39%2Dbb70%2D72a3%2D4e31%2D0356ae6af6b0>
- » NACTO: <https://nacto.org/publication/urban-street-design-guide/street-design-elements/vertical-speed-control-elements/speed-table/>

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RAISED INTERSECTIONS



Portland, Oregon

Image Source: NACTO

A raised intersection is a flat area that covers an entire intersection near sidewalk grade with ramps on all roadway approaches. They are intended to slow all vehicular movements through the intersection.

SAFETY BENEFITS

10% Reduction in speed.

ESTIMATED COST



\$15,000-\$60,000

Source: ITE Traffic Calming Fact Sheets

CONSIDERATIONS

- » Raised intersections may be less effective in reducing speeds than speed humps or speed tables.
- » Snow removal operations should be considered in the design.
- » Can have major drainage and utility impacts.
- » Emergency vehicle response times may be impacted.
- » Traffic noise may increase from braking and acceleration of vehicles.
- » Bollards along corners may keep motorists from crossing into the pedestrian space without a curb line.



Source: NACTO

APPLICABLE CONTEXT

Raised intersections are applicable for intersections with substantial pedestrian activity, such as neighborhood shopping areas and college campuses. The countermeasure is most common in dense urban settings. It is best suited for locations with low speed limits (35 miles per hour or less).

Additional Information & Resources

- » ITE Traffic Calming Fact Sheet “Raised Intersection”: <https://www.ite.org/pub/?id=2c3e7d2b%2D0d3a%2D93b9%2Daf9d%2D99dce352e79d>
- » NACTO: https://nacto.org/wp-content/uploads/2015/04/DE-Traffic-Calming-Manual_2012.pdf
- » FHWA: https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module3pt2.cfm

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RAISED CROSSWALK



Bismarck, North Dakota

Image Source: Google Earth

Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at mid block crossing locations. They act as speed tables with crosswalk markings, signage or textured pavement. By raising the level of the crossing to be flush with the height of the sidewalk, pedestrians will appear more visible to approaching vehicles and be able to cross at grade with the sidewalk.

SAFETY BENEFITS

11mph Reduction in speed.



Proven Safety Measure
(pedestrian crashes)

APPLICABLE CONTEXT

Best suited for high pedestrian activity areas with poor compliance of speed limits. Raised crosswalks are typically installed on 2-lane or 3-lane roads with speed limits of 30 mph or less and annual average daily traffic below about 9,000.

ESTIMATED COST

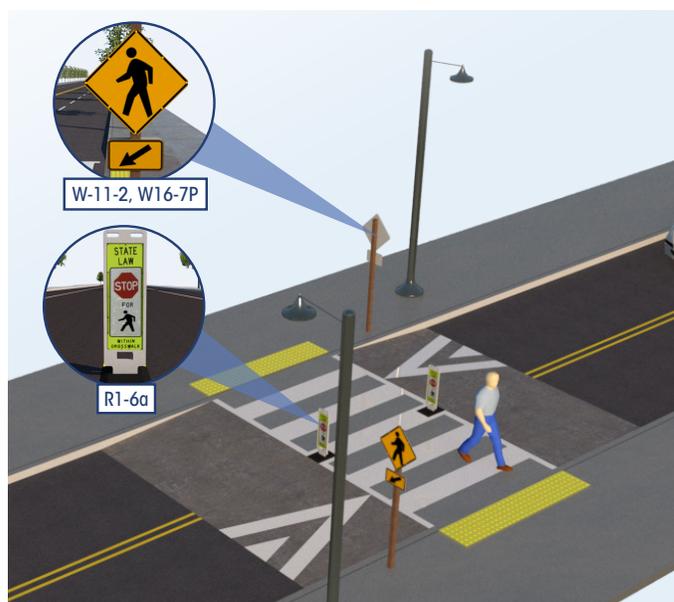


\$7,000-\$20,000

Source: FHWA

CONSIDERATIONS

- » The crosswalk table is typically at least 10 feet wide and designed to allow the front and rear wheels of a passenger vehicle to be on top of the table at the same time.
- » Drainage and snow removal can be issues.
- » Raised crosswalks may not be appropriate for bus transit routes or primary emergency vehicle routes.



Source: FHWA

Additional Information & Resources

- » FHWA: https://safety.fhwa.dot.gov/ped_bike/step/docs/TechSheet_RaisedCW_508compliant.pdf
- » FHWA: https://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/2014/reducing_speed.cfm

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CHICANES



Unknown Location

Image Source: FHWA Scott Wainwright

A chicane is a horizontal diversion type of traffic calming tool that takes a naturally straight mid-block section and creates an S-shaped curving street segment. Chicanes use lane narrowing, curb extensions or on-street parking that alternate from one side of the street to another that require additional maneuvering for motorists, discouraging high speeds and cut-through traffic.

SAFETY BENEFITS

25% Reduction in traffic volumes.

9 mph Reduction in speed.

APPLICABLE CONTEXT

Chicanes are best suited for low volume and low speed roadways.

ESTIMATED COST



\$8,000-\$25,000

Source: ITE Traffic Calming Fact Sheets



Source NACTO

CONSIDERATIONS

- » Design may make maintenance, such as snow removal, or drainage more difficult.
- » Should be designed so that drivers can not cut straight through, when crossing centerline.
- » May reduce the amount of on street parking.
- » Emergency vehicle response times could be impacted.

Additional Information & Resources

- » ITE Traffic Calming Fact Sheet “Chicane”: <https://www.ite.org/pub/?id=29df6928%2D0059%2D96b7%2Dcfb7%2Dc79b3585a17d>
- » FHWA: https://safety.fhwa.dot.gov/speedmgmt/ref_mats/eng_count/2014/eng_ctm_spd_14.pdf

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ROAD DIET



Bismarck, North Dakota

A road diet is a width reduction of the motorist portion of a roadway cross section. This is commonly achieved by removing a through lane or narrowing vehicle lanes to create space for pedestrian and bicyclist safety treatments and/or parking. In addition to safety treatments like raised medians and bike lanes, road diets typically serve as a traffic calming measure to reduce motorist travel speed. The most common road diet configuration involves converting a four-lane road into three lanes, with one travel lane in each direction and a center left turn lane, often supplemented with painted or raised center islands.

SAFETY BENEFITS

5 mph

Reduction in speeds.
(4 to 3 lane conversion)



Proven Safety Measure

ESTIMATED COST



\$1,500-\$40,000 *per mile*

Costs can vary greatly depending on the desired cross section elements. Re-striping can be very low cost while raised medians and separated bike lanes can increase costs drastically.

APPLICABLE CONTEXT

Road Diets are applicable on both urban and rural roads that prioritize bicycle and pedestrian travel. A good candidate location will have extra capacity and predictable traffic growth. A traffic engineering analysis or assessment should be completed to ensure that removal of lanes does not create congestion on the roadway.

CONSIDERATIONS

- » Many different roadway configurations are considered road diets. There are many site specific factors that play a role in determining the most effective cross section reduction. Traffic mix, left turn volumes, access density, existing roadway width and drainage, roadway alignment and sight distances, crash history, and land use are some examples of factors to be considered.
- » Signal modifications may be needed at certain locations which can increase the cost of this countermeasure significantly, like realigning signal heads, which may require new mast arms, or new signal heads for new turn lane configuration.

Additional Information & Resources

- » Federal Highway Administration (FHWA): https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/rdig.pdf
- » For additional resources consult this countermeasure in the bicycle and pedestrian section.

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BULB-OUTS/ CHOKERS



Devils Lake, North Dakota

Bulb-outs (also known as neckdowns and curb extensions) are an extension of the sidewalk into the driving lane. This results in shorter crossing distances for pedestrians and improving visibility for oncoming vehicles. A choker is the narrowing of a roadway through the use of bulb-outs. It can be created by a pair of bulb-outs at a mid block location that narrows the street. Bulb-outs can create space for accommodating curb ramps, landscaping, and street furniture. They also create space for additional countermeasures to be placed appropriately, such as active bicycle detection, beacons, and other signs.

➔ SAFETY BENEFITS

4 mph

Reduction in Speed.



Proven Safety Measure
(pedestrian crashes)

➔ ESTIMATED COST



\$10,000 *per bulb-out*

Source: ITE Traffic Calming Fact Sheets

➔ APPLICABLE CONTEXT

Bulb-outs are well suited for downtown areas where space is limited to provide curb ramps and areas with on street parkings since bulb-outs create protected parking bays. Chokers are appropriate in urban or suburban settings on low volume low speed roadways.

➔ CONSIDERATIONS

- » If funding for curb work is not available several lower cost alternatives include bollards, temporary curbs, planters or striping are available. The ND Moves Demonstration in project in Mandan, North Dakota used some of these options for effectiveness testing.
- » The turning needs of larger vehicles that routinely use the intersection, such as school buses, should be taken into account when designing.
- » Changes or relocation of drainage structures may be required to maintain water flow to the existing drainage system.
- » Could impact snow removal operations.
- » Could impact on street parking and driveway access.
- » The length of a choker island should be at least 20 feet, the length of a single car.
- » Chokers are most easily installed on a closed-section roadway that has curb and gutter.
- » Emergency vehicle response times could be impacted.

Additional Information & Resources

- » ITE Traffic Calming Fact Sheets

<https://www.ite.org/pub/?id=2a288a67%2D0a3d%2D00d2%2D9e87%2Dc82b9ebd6171>

<https://www.ite.org/pub/?id=2a11c074%2Dde6e%2Dd5d1%2D1d7a%2Db2c383f66596>

- » MnDOT: https://www.dot.state.mn.us/state_aid/traffic_safety/reference/ped-bike-handbook-09.18.2013-v1.pdf

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REALIGNED INTERSECTIONS



New Castle, Delaware

Image Source: Delaware DOT

Intended for T intersections within residential areas, a realigned intersection modifies the through movement by changing the alignment into a curving segment. Treatment includes gradual curb extension or a bulb at the top of the “T” that creates a slight horizontal deflection as vehicles pass through and may discourage traffic from continuing through a neighborhood by restricting certain traffic movements. A realigned intersection can provide landscape opportunities.

SAFETY BENEFITS

13 mph Reduction in speeds.

ESTIMATED COST



\$15,000-\$60,000

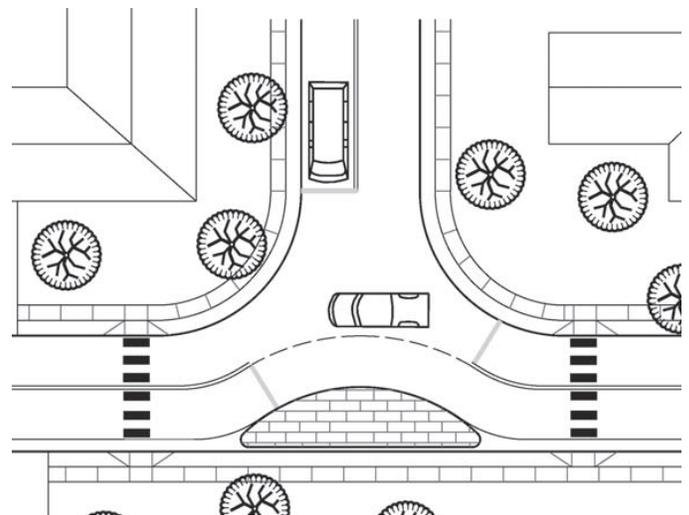
Source: ITE Traffic Calming Fact Sheets

CONSIDERATIONS

- » There could be a confusion over priority movements which may lead to more conflicts.
- » A typical realigned intersection design needs to consider snow removal, drainage and bicycle access.
- » Emergency vehicle response times could be impacted.

APPLICABLE CONTEXT

Realigned intersections are appropriate in urban or suburban settings at T intersections with low volume and speed. This countermeasure is most common near residential land uses.



Source: Delaware Department of Transportation

Additional Information & Resources

- » ITE Traffic Calming Fact Sheet “Realigned Intersect”: <https://www.ite.org/pub/?id=2c484b0b%2De14e%2Dcb0e%2D05d9%2D717bc1ae514a>
- » Delaware Department of Transportation Traffic Calming Manual (2012): https://nacto.org/wp-content/uploads/2015/04/DE-Traffic-Calming-Manual_2012.pdf

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FULL CLOSURES



Saint Paul, Minnesota

Image Source: Google Earth

A full street closure redirects traffic to other routes and should only be considered when other calming measures have failed. A full closure is created with the use of bollards or landscaping that creates a dead end or cul-de-sac style road. Pedestrian and bicycle access can be maintained through the closure.

SAFETY BENEFITS

44% Reduction in cut-through diverted traffic.



Proven Safety Measure

APPLICABLE CONTEXT

Full closures are costly and dramatic treatments that should be implemented at locations only after other traffic calming measures have failed.

ESTIMATED COST

\$\$\$

\$10,000-\$100,000

Source: ITE Traffic Calming Fact Sheets.

Complex closures with drainage modifications may exceed \$100,000

CONSIDERATIONS

- » Effective at reducing cut through traffic.
- » Potential increase in trip length by creating circuitous routes for local residents.
- » Limits access for emergency vehicles.
- » A full closure design needs to consider snow removal, drainage, and pedestrian and bicycle access.
- » Increase volumes on parallel/adjacent streets.
- » Clear signing and delineation needs to be implemented with this countermeasure.
- » There are many devices that may be used to achieve a full closure such as flexible delineators, bollards, curbs/medians, landscaping etc. Traffic volume, compliance, posted speed limit, pedestrian and bicycle access, and maintenance are factors that should be considered when selecting a closure device.
- » Conflict points with motor vehicles are reduced from 32 to 9 by closing one leg of a traditional four legged intersection (see below).

Additional Information & Resources

- » ITE Traffic Calming Fact Sheet "Closure": <https://www.ite.org/pub/?id=2a1fe02b%2Dccde%2Db0d3%2D10b6%2D5d9812f37163>
- » Texas Transportation Institute Texas A&M University System: <https://static.tti.tamu.edu/swutc.tamu.edu/publications/technicalreports/167707-1.pdf>

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HALF CLOSURES



Unknown Location

Image Source: FHWA James R. Barrera

A half closure physically closes or blocks one direction on a street, preventing vehicles from entering but allowing vehicles to exit. Half closures are typically implemented by extending the curb or placing a barrier at the entry. This measure allows for restricted access without creating one-way streets. Variations of half closures include median barriers and forced turn islands that focus on prohibiting left turn lanes to and from a side-street. A median barrier is typically located along the centerline of a major street and will prohibit unsafe left turns to a side street. A forced turn island is located on the side street and restricts through or left-turn movements from the side street.

SAFETY BENEFITS

42% Reduction in cut-through diverted traffic. (half closure)

APPLICABLE CONTEXT

Similar to full closures, half closures are costly and dramatic treatments that should be implemented at locations only after other traffic calming measures have failed.

ESTIMATED COST



\$3,000-\$40,000

Source: ITE Traffic Calming Fact Sheets.

Complex closures with drainage modifications may exceed \$40,000

CONSIDERATIONS

- » Potential increase in trip length by creating circuitous routes for local residents.
- » Limits access for emergency vehicles.
- » A half closure design needs to consider snow removal, drainage, and pedestrian and bicycle access.
- » Increase volumes on parallel/adjacent streets.
- » Clear signing and delineation needs to be implemented with this countermeasure.
- » There are many devices that may be used to achieve a half closure such as flexible delineators, bollards, curbs/medians, landscaping etc.
- » Half closures are even less common than full closures. They may be unexpected or confusing resulting in driver errors and creating more conflicts.

Additional Information & Resources

- » ITE Traffic Calming Fact Sheet "Closure": <https://www.ite.org/pub/?id=2a1fe02b%2Dccde%2Db0d3%2D10b6%2D5d9812f37163>
- » Delaware Department of Transportation Traffic Calming Manual (2012): https://nacto.org/wp-content/uploads/2015/04/DE-Traffic-Calming-Manual_2012.pdf
- » Texas Transportation Institute Texas A&M University System: <https://static.tti.tamu.edu/swutc.tamu.edu/publications/technicalreports/167707-1.pdf>

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DIAGONAL DIVERTERS



Minneapolis, Minnesota

Image Source: Google Earth

Diagonal diverters are a volume reducing measure that interrupts the traffic flow through a neighborhood intersection. They consist of diagonally placed barriers across an intersection which blocks through and/or turning movements. They can provide landscaping opportunities and are capable of maintaining full pedestrian and bicycle access.

SAFETY BENEFITS

35% Reduction in cut-through diverted traffic.

ESTIMATED COST



\$6,000

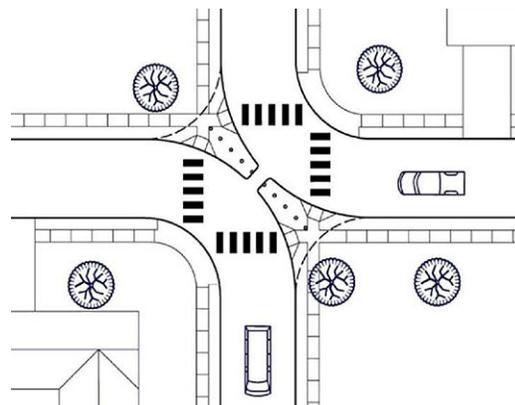
Source: ITE Traffic Calming Fact Sheets

CONSIDERATIONS

- » Potential increase in trip length by creating circuitous routes for local residents.
- » Limits access for emergency vehicles.
- » Increase volumes on parallel/adjacent streets.
- » Clear signing and delineation needs to be implemented with this countermeasure.
- » There are many devices that may be used to achieve a diagonal diversion such as flexible delineators, bollards, curbs/medians, landscaping etc. Traffic volume, expected compliance, posted speed limit, pedestrian and bicycle access, and maintenance are factors that should be considered when selecting a device.

APPLICABLE CONTEXT

Diagonal diverters are appropriate in urban or suburban settings on low volume, low speed roadways.



Source: Delaware Department of Transportation

Additional Information & Resources

- » ITE Traffic Calming Fact Sheet “Diagonal Diverters”: <https://www.ite.org/pub/?id=2a33066a%2Dc570%2D9a6a%2D64b7%2D8856c5906c10>
- » Delaware Department of Transportation Traffic Calming Manual (2012): https://nacto.org/wp-content/uploads/2015/04/DE-Traffic-Calming-Manual_2012.pdf
- » Texas Transportation Institute Texas A&M University System: <https://static.tti.tamu.edu/swutc.tamu.edu/publications/technicalreports/167707-1.pdf>

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