A Guide to Urban Work Zone Temporary Traffic Control

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16 Abstract

This guide describes the characteristics that are specific to urban work zones and provides possible mitigation strategies to address site-specific safety issues. Urban work zones present unique challenges that are not addressed specifically in great detail in the Manual on Uniform Traffic Control Devices. The urban roadway environment encompasses many distinctive characteristics which need to be taken into consideration. A few characteristics to be noted are high traffic demand and low travel speeds, frequent intersections and driveway accesses, right of way and space limitations, on street parking and roadside access, roadway geometry, traffic control issues, non-motorized transportation facilities, bus stops and transit access. In addition, special events and compliance with the requirements of "Significant Projects" which require attention must be considered. This document includes example plans and a table that highlights the important issues regarding urban work zones and feasible mitigation strategies.

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1.0 A GUIDE TO URBAN WORK ZONE TEMPORARY TRAFFIC CONTROL

The design and implementation of temporary traffic control (TTC) for work zones requires a careful balance between safety, mobility, and constructability. The *Manual on Uniform Traffic Control Devices (MUTCD)* presents a concise summary of minimum standards for work zone TTC. This includes guidance that creates uniformity and consistency, thereby ensuring that work zones are easily recognizable and well understood by the traveling public. The *MUTCD* Part VI includes a series of Typical Applications (TAs) which illustrate appropriate temporary traffic control plans (TTCPs) for a variety of work zone scenarios.

Given the wide range of site-specific factors that may be encountered, the *MUTCD* recommends the use of engineering judgment to adjust each TA as appropriate for actual field conditions. As each work site presents unique conditions, it is imperative that TTCPs should be developed that account for the potential impacts of these conditions on safety and mobility. This task can be particularly challenging in urban environments, which present a number of considerations that are not addressed in great detail in the *MUTCD*. Some of the distinguishing characteristics of urban roadway environments include:

- High traffic demand and low travel speeds
- Frequent intersections and driveway accesses
- Right-of-way (ROW) and space limitations
- On-street parking and roadside access
- Roadway geometry
- Traffic control issues
- Non-motorized transportation facilities
- Bus stops and transit access
- Special events
- Significant projects

This document describes characteristics that are unique to urban work zones and provides possible mitigation strategies to address site-specific safety issues. It also includes example plans and a list that highlights important issues regarding urban work zones to be considered in conjunction with the mitigation strategies.

2.0 URBAN WORK ZONE CHARACTERISTICS

Urban work zones present unique challenges that need to be considered in planning and design of a work zone TTC, and may require special attention by field crews. Specifics of such urban work zone characteristics are detailed in this section. Emphasis is placed on those aspects of urban roadways that warrant additional consideration beyond the fundamental aspects as outlined in the *MUTCD*.

2.1 High Traffic Demand and Low Travel Speeds

Urban environments are often comprised of a dense street network, which require appropriately designed signal timing plans that allow for progression, and minimize control delay. Disruption of normal flow patterns can often require revised timing plans to mitigate potential congestion issues related to TTC. Significant levels of congestion and queuing may occur, even under normal operations. These effects are intensified when TTC requires a lane closure or other modifications to typical road operations that result in reductions in travel speed. Increased congestion can also lead to other issues, such as extensive queuing especially for turning movements. This is of particular concern where auxiliary turn lanes are provided and queue spillback may result in upstream traffic conflicts. Work zone planners and field personnel must be cognizant of how TTC design may create such mobility issues.

2.2 Frequent Intersections and Driveway Access

One of the principal concerns in urban work zones is how to accommodate access points, such as cross streets (i.e., intersections), driveways, and storefronts. The introduction of TTC in these instances may lead to potential sight distance issues or restrict the ability of drivers to execute turning movements, particularly left-turn maneuvers, which require greater driver focus. Public agencies performing construction work on streets with significant adjacent development have a responsibility to maintain access to these developments, or to provide alternate accommodations where direct access cannot be provided. The layout of TTC devices and any associated site-specific issues should be addressed at the planning stage to minimize the need for on-site modifications.

2.3 Right-of-Way and Space Limitations

Urban environments frequently lack available ROW to affect temporary changes to traffic patterns by utilizing wide lanes or shoulders. Additionally, urban roadsides can provide limited space for traffic control devices, construction vehicles, and on-site material storage. These limitations influence the design of urban work zones in terms of providing adequate lateral and longitudinal buffers and placement of traffic control devices.

2.4 On-Street Parking and Roadside Access

Maintaining access to parking is a primary concern in urban environments where the availability of parking is directly related to maintaining normal business operations. Many urban roadways include on-street parking, for which coordination with the municipal parking authority must occur before any changes to signed or metered parking is considered as part of a TTCP. Where changes are made, additional work items such as bagging meters, covering regulatory parking signs, provisions for alternate parking, and supplementary pedestrian wayfinding may be required to facilitate the temporary removal of parking spaces. These work items should be addressed both in the planning stages and be documented in the TTC plans and specifications.

2.5 Roadway Geometry

There is a variety of geometric issues that must also be considered in developing TTCPs in urban areas. Most urban roadways use a "closed section" roadway, incorporating curb and gutter for roadside drainage in lieu of a rural "open section" roadway that provides a smooth transition from travel lanes, to shoulder, to graded roadside. Bike lanes must be treated in the same manner as vehicular travel lanes, and signed appropriately where temporary changes are required. These features may require modification of the TAs provided in the *MUTCD*.

2.6 Traffic Control Issues

Designing TTC strategies require the consideration of existing (e.g., permanent) traffic control devices, such as signage and traffic signals. In urban areas, signs tend to be more frequent and more closely spaced. Introducing additional signs increase visual clutter and affect the clarity of existing signs. An important early step in TTC design is to document and inventory the existing signs. In subsequent design steps, existing signs are marked as "to be covered", "to be removed" or "to be relocated", with consideration for how these signs fit in with the temporary traffic patterns in place during construction. Existing signs that still serve a regulatory, warning, or directional guidance function cannot be obscured or removed simply for the convenience of the TTC designer – visibility of these signs is as much the responsibility of the designer as the TTC. Traffic signals may also require temporary modification, which could include covering (e.g., deactivating) the signals on a temporary basis, such as, temporary elimination of left-turn movement and

phases, or shifting the signal head to reflect lane shifts during the construction work activity. Work zones at urban signalized intersections may also require phasing and timing changes due to:

- Closing of turn lane(s)
- Using shared through and turn lanes
- Temporary relocation of lanes

Changing the phasing design (i.e., use of a split phase) and adjusting green times for various phases can improve traffic operations and safety during the construction phase.

2.7 Non-Motorized Transportation Facilities

The presence of houses, businesses, and transit facilities along urban roadways increase the level of pedestrian and bicycle traffic. Bike lanes, crosswalks, and sidewalks are often impacted by TTC and it is critical that such facilities are considered in the development of a TTCP.

Maintaining pedestrian access is an essential part of urban work zone traffic control, including:

- Providing continuity of pedestrian access where necessary (e.g., sidewalks).
- Ensuring that pedestrian traffic detours are well signed and consider natural pedestrian travel routes.
- Separating pedestrian and vehicular traffic as necessary (i.e., using portable barriers), particularly at locations with higher traffic volumes or speed limits.
- Maintaining Americans with Disabilities Act (ADA) compliant access during the construction period.

These issues and other site-specific concerns must be addressed during the TTCP development process.

2.8 Bus Stop and Transit Access

Another urban work zone concern related to non-motorized users is the need to provide access to bus stops and transit stations. TTCPs may require the identification of appropriate alternate routes if the work zone inhibits pedestrian or bicyclist access. The closure of sidewalks or nearby crosswalks may limit the ability of transit users to reach bus stops or transit stations. The impact of significant bus volumes in the traffic stream should be considered as work zone-related lane closures that reduce work zone capacity. Alternate bus routes or stops may become necessary in some instances and require coordination with the transit providers.

2.9 Special Events

Special events such as stadium events, theater events, or street festivals are a common occurrence in urban areas, and create unique traffic operation related scenarios. These situations require specific traffic control, even under normal operations, and may significantly complicate the implementation of TTC. Work should be planned to avoid schedule overlap with special events if possible.

3.0 TRAFFIC CONTROL STRATEGIES FOR URBAN WORK ZONES

The special characteristics of urban work zones identified in the previous section require the development of TTCPs to address them. TTCPs for urban work zones must provide: (a) access for road users; (b) access to adjacent properties; and (c) clear, consistent traffic control that accommodates such access in a manner that is both safe and efficient. The following list indicates a number of strategies that can be considered in regards to access.

- **Adjacent Houses and Businesses** – TTCPs should be developed in regards to the impact of work activities on adjacent access that should be maintained to the greatest extent practical, with consideration given to the potential for traffic conflicts related to access restrictions. Driveway closures may be acceptable for facilities that have multiple access points, and adequate information is provided to drivers. Appropriate construction staging is essential to avoid long disruption of facilities. Ultimately, TTCPs should ensure that the work activities allow adequate access to adjacent houses and businesses. Projects with potential for significant impacts may consider hosting public meetings to identify issues and mitigate concerns in advance of construction.

- **Parking Facilities** – Urban roadway environments often involve on-street parking facilities that may be impacted by TTC or work activity. Efforts should be made to maintain normal operations of these facilities when possible, since their disruption may adversely impact surrounding houses and businesses. However, these areas may also provide key space for TTC or storage of work vehicles and equipment, and may also be involved directly in the work to be completed. If parking spaces must be closed, channelizing devices, signing, and other TTC devices should be utilized to prevent vehicles from using these facilities.

- **Intersections and Driveways** – Urban work zones may also impact access to intersections and/or driveways potentially resulting in higher traffic conflicts or queues. TTCPs should avoid the closure of lanes that restrict turning movements. For example, a left lane with high turning volumes would present concerns and a possible solution to restrict left turns during the construction period, an option. The impact on sight distance should be considered when closing lanes.

- **Pedestrians and Other Non-Motorized Users** – Given the typically increased presence of pedestrians, bicyclists, and other non-motorized traffic in urban areas, providing safe access through the work zone is required. Due to the limited space available, pedestrian and bicycle facilities are often located close to vehicular traffic and/or the work space. When developing a TTCP, existing levels of accessibility for pedestrians with disabilities should be maintained and include ADA-compliant sidewalks and crosswalks, as well as the consideration of visual or auditory impairments. This may include the use of audio devices that describe an alternative route message. Channelizing devices with continuous detectable edges are required to delineate the traveled way. Pedestrians should be encouraged to cross at intersections and marked crosswalks. Work vehicles and equipment should be positioned so that they do not interfere with sidewalks. Work zones must maintain suitable access for non-motorized traffic and all TTC treatments must be ADA compliant and provide the same level of accessibility as the existing facilities, per the *MUTCD*.

- **Public Transit** – Public transit facilities such as bus stops are a common feature of the urban environment. Maintaining access to these facilities is a necessary consideration. As part of standard practice, transit authorities should be notified of any proposed work expected to impact transit stops for longer than a very brief period. During planning activities, it is important to consider whether bus access may be affected by TTC or work activity in order to avoid potential queuing issues and blocked access. Care should also be taken to ensure that sidewalks and access points to bus stops are available to pedestrians, including those with disabilities. In instances where bus or rider access cannot be safely established, the stops may be relocated to an area outside of the work zone or the route can be temporarily modified to avoid specific stops. This requires close coordination with transit authorities as necessary.

- **Special Events** – Special events or other unique circumstances might occur during a long-term work zone that may require modification of the TTC in the field. No uniform set of guidelines can address these sorts of unique situations. Special events generally require a higher level planning in order to assess the broad impacts of TTC. Typically work should be scheduled to avoid these planned events when possible. Work crews should be aware of, and be prepared to alter TTC for any unplanned events as they arise. Often, temporary suspension of work and restoring the roadway to as near as normal operation as possible, may be the only effective solution.

- **Significant Projects** – The preceding bullets highlighted several unique issues of concern for TTC in urban settings. It should be noted that due to the ***Rule on Work Zone Safety and Mobility*** (23 CFR 630 Subpart J) published in 2004, operations which are deemed as a **"significant project"** will require additional documentation.

Significant Projects include: ***Section 630.1010 of the Rule defines a significant project as one that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts that are greater than what is considered tolerable based on State policy and/or engineering judgement. All Interstate system projects within the boundaries of a designated Transportation Management Area (TMA) that occupy a location for more than three days with either intermittent or continuous lane closures shall be considered as significant projects.***

For significant projects, a transportation management plan (TMP) is required which includes the following components:

- TTCP
- Public Information Strategies
  - Related to improving public awareness of the project
  - To inform motorists of the project
- Transportation Operations Strategies
  - To address the management of traffic demand in the work zone
  - To address corridor or network level operations
  - Specific to work zone safety management
  - Related to incident management and enforcement

For further information on TMPs and the Work Zone Safety and Mobility Rule (http://www.ops.fhwa.dot.gov/wz/resources/final_rule.htm), please refer to: "Developing and Implementing TMPs for Work Zones, Federal Highway Administration, 2005" (http://www.ops.fhwa.dot.gov/wz/resources/publications/trans_mgmt_plans/trans_mgmt_plans.pdf).

4.0 TEMPORARY TRAFFIC CONTROL PLAN DEVELOPMENT

Development of an efficient and effective TTC plan for urban work zones should follow a logical process, such as the one shown in Figure 1. The process begins with gathering site and work characteristics that are relevant to the development of work zone traffic control. Using this information, an appropriate TA that closely represents the work zone under consideration can be selected using the TTCP Software. Urban work zone TTCP development includes identification of the unique characteristics and traffic control strategies outlined previously. Modifying the appropriate TA to address the unique characteristics of urban work zone environments will aid in the development of an effective TTCP. The complete process of developing a TTCP is described in detail in the following steps.

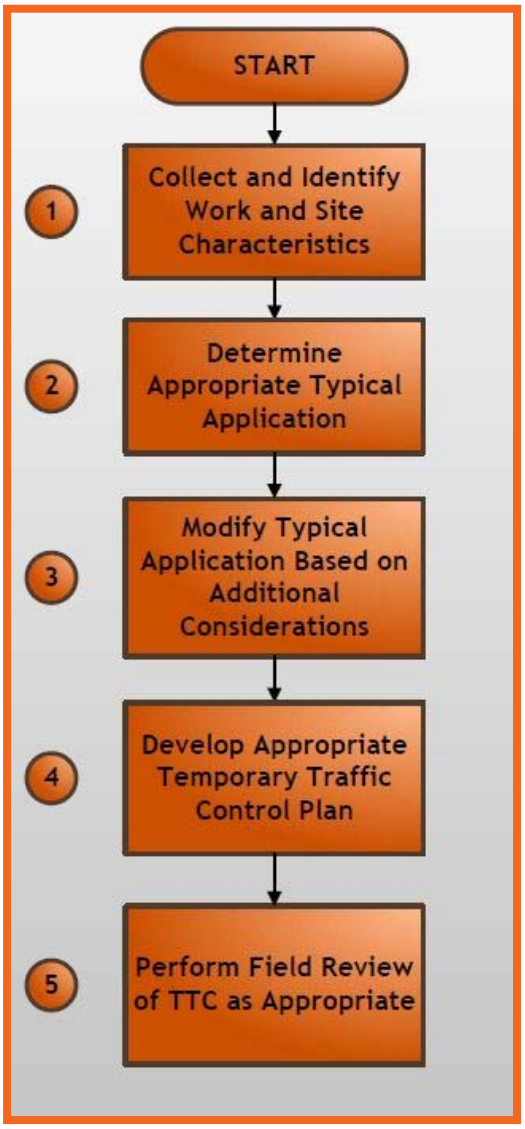


Figure 1 – Temporary Traffic Control Plan Development

STEP 1: Collect and Identify Work and Site Characteristics

In order to assist in the identification of geometric, traffic control, traffic and environmental characteristics of a typical work site, a check list is provided in Appendix I. The same check list can be accessed on-line at http://workzone.eng.wayne.edu/Software/CheckList/CheckList.html.

Among the pertinent data to collect include the following:

- Geometric characteristics (e.g., lane width, number of lanes, presence of shoulders, locations of intersections/driveways)
- Existing traffic control characteristics (e.g., signs, signals, etc.)
- Traffic characteristics (e.g., motor vehicle, pedestrian, and bicycle demand)
- Environmental and other surrounding characteristics (e.g., land use, sight distance, etc.)

- Proposed work activity
- Proposed work duration (lower and upper bounds)
- Necessary workers, vehicles and other equipment

STEP 2: Determine Appropriate Typical Application

Given these basic characteristics, a TA can be selected from the TTCP Selection Software (http://workzone.eng.wayne.edu/Software/FlowChart/MainModule.html) developed by the Wayne State University – Transportation Research Group. The TTCP Selection Software is a decision-support tool which includes 102 example plans, in addition to the 46 *MUTCD* TAs, to assist in developing a TTCP for a wide range of highway work zones. The software can also provide access to an additional 2,500 TTCPs from various state department of transportation (DOT) standards. The user should select the TTCP that satisfies the needs of the site and characteristics that most resembles the work activity.

STEP 3: Modify Typical Application Based on Additional Considerations

Once an appropriate TA has been selected, it must be modified to suit the actual field conditions for the proposed work activity. The supplementary notes provided for the TA within the *MUTCD* should be reviewed.

STEP 4: Develop Appropriate Temporary Traffic Control Plan

An effective TTCP can be developed by selecting an appropriate TA and modifying it, as necessary, to the site specific factors as needed. TTCPs should include:

- A schematic of TTCP and necessary devices
- Special instructions for field personnel
- Project coordination strategies

STEP 5: Perform Field Review of Temporary Traffic Control as Appropriate

Regardless of the level of detail of initial planning efforts, actual field conditions may vary significantly from initial expectations and should be reviewed.

Table 1 describes some common work site characteristics that often create challenges that may require field adjustment. Based on the work site characteristics, possible mitigation strategies are suggested. These strategies can be utilized to improve selected TTCPs.

Table 1 – Urban Work Zone Challenges and Mitigation Strategies

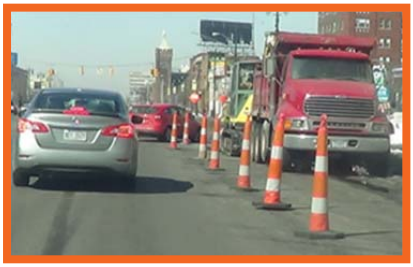
WORK SITE CHARACTERISTICS	CHALLENGES THAT REQUIRE FIELD ADJUSTMENT	POSSIBLE MITIGATION STRATEGIES
Work on traveled way	• Driveway access • Turning movement at intersection • Lane closure interfere with land access	• Use flagger when facilitating alternate traffic or roadside accesses are closed for short period • Turning movement prohibition • Use of alternate access where feasible • Use of self-regulating traffic control devices for low volume roads • Advance warning for lane closure, turn prohibition
Work in crosswalk or on sidewalk	• Pedestrian facility continuity	• Sidewalk detour • ADA compliant • Portable barrier
	• Pedestrian crossing interruption	• Pedestrian detour signs • ADA compliant
Work on traveled way requiring lane closure	• Traffic congestion and unacceptable level of service (LOS)	• Consider advance warning signs regarding expected congestion • Peak hour reopening to traffic • Plan for off-peak work • Consider staged operation • Night work
Presence of grade/ horizontal curve	• Sight distance problem due to grade	• Move lane closure taper to top of vertical curve • Use arrow board for visibility from longer distance • Extend physical limits of work zone to ensure adequate sight distance to warning signs, flaggers, or other TTC devices
	• Sight distance problem at horizontal curve	• Provide lane closure taper and arrow board at the tangent section
Lane closure	• Sight distance problem due to roadside fixed objects	• Increase taper length • Increase longitudinal buffer
	• Driver distractions due to existing signs and billboards	• Use dominant traffic control devices • Traffic control devices (signs) with orange flags (*MUTCD* 6F.62) • Modify longitudinal buffer to avoid conflicts
Work space adjacent to sidewalk	• Separating pedestrian traffic from work space	• Pedestrian detour • Portable barriers • Pedestrian route wayfinding signs

The possible mitigation strategies included in Table 1 when appropriately used can assist road users to navigate through urban work zones safely and efficiently. They include common countermeasures that are either required or are considered best practices under appropriate circumstances. The following list provides further explanation on when common mitigation strategies can be used.

- **Left-turn prohibition** can be considered when a work zone interferes with a driveway or a cross street. For example, if there is only one lane open for travel, restricting motorists from making a left turn onto a cross street or into a driveway would reduce queue buildup upstream and maintain the level of service for through traffic. Another example would be to restrict vehicles from making a left turn out of a driveway to avoid any sight distance issues the driver may have or disrupting the flow of traffic. Restricting movements to and from a driveway will require coordination with the business owner, especially if alternate access is not available.

- **Portable barriers** may be used when a work zone causes a sidewalk closure. For example, if a sidewalk needs to be closed for an extended amount of time, portable barriers can be used to direct pedestrians temporarily into the roadway, while keeping them separated from motor vehicles. Standard signs should supplement portable barriers.

- **Increasing longitudinal buffer** can be a strategy when the taper is in conflict with a field condition. For example, if the taper interferes with a driveway, alley, or a minor street, increasing the longitudinal buffer space can push the taper upstream to avoid the interference and also provide additional protection to the workers and space for work vehicles.



- **Off-peak or nighttime work** can be a method used on a busy roadway during the peak hour. For example, if the work zone is located in a high impact urban area, work can be paused during the peak hour and steel plates can be used to cover construction related pavement cutouts and temporarily reopen the roadway to help maintain the level of service during peak periods.

- **Flaggers or self-regulating traffic control devices** may be used for a lane closure on a low volume, two-lane road. For example, if a work zone causes one lane of a two-lane roadway to be closed, a flagger or self-regulating traffic control device can allow for two-way traffic to share the same travel way. Other examples where a flagger or self-regulating traffic control device may be used at is a haul road crossing, one-way bridge operation, or sight distance restriction. However, they are not typically used in high traffic volume areas or near intersections or driveways.

4.1 Use of Specific Temporary Traffic Control Devices

TTCPs should consider differences and utilize devices that provide the most effective positive guidance. Some possible devices are detailed below:

- ***Channelizing Devices*** - Type 3 Barricades (*MUTCD* 6F.68) are more effective than smaller channelizing devices in restricting vehicles and pedestrians from entering the work space. Where space is limited, vertical panels (*MUTCD* 6F.66) provide effective channelization and present a larger and more visible target, especially at night.
- ***Portable Changeable Message Signs*** (*MUTCD* 6F.60) are useful in urban work zones to convey unique or special messages not easily communicated by static TTC signs, such as closures to cross streets, information on active work times, or other atypical scenarios.
- ***Arrow Boards*** (*MUTCD* 6F.61) effectively provide warning and directional information to road users concerning lane closures.
- ***Temporary Traffic Signals*** (*MUTCD* 6F.84) may be very effective in certain urban situations including areas of increased traffic volumes through unsignalized intersections caused by diverted traffic.

4.2 Layout of Temporary Traffic Control Devices

The TAs from the *MUTCD* may include traffic control device layouts that are impractical to implement due to specific site conditions. This could be due to the presence of other traffic control devices (e.g., signs), proximity to intersections or driveways, or sight distance obstructions due to fixed objects (e.g., trees, business signs, etc.). TTC devices should be located, as necessary, to make them visible and conspicuous to drivers.

4.3 Ensure Guide Signs Are Conspicuous and Well-Marked

Urban highway environments often involve complex navigational tasks, which may be further complicated by the implementation of TTC. The visibility of existing street signs with block numbering should be maintained where they exist, or temporary signs added where none exist. Advance signage should be provided to notify road users of any alterations to existing traffic patterns or to closures and detours.

4.4 Modification of Existing Signal System

Traffic operations may be significantly impacted by TTC, especially in urban areas where the following aspects of the existing signal system should be considered, in consultation with a qualified professional:

- Existing signal timing plans, including phasing, should be analyzed and altered if traffic operations are likely to be significantly impacted.
- Alternative phasing or cycle lengths, which may reduce the potential for queues to develop within the work zone, should be considered.
- Traffic operations should be monitored in the field once TTC is in place.
- All signal heads and other traffic control devices should be clearly visible.
- Pedestrian walk times are an important consideration and should also be adjusted as needed.
- Work vehicles, equipment, and TTC should be located where they do not obscure existing signal heads.
- Signal heads not in use as a part of the TTC should be covered, including pedestrian signals.

4.5 Geometric Considerations

Urban highway environments often involve roadway geometry that is restrictive to traffic movements due to tight constraints on ROW. When developing a TTCP for an urban work zone, the following should be considered:

- Maximize turning radii of affected intersections or driveways. This will help to improve maneuverability through the area, but care should be taken to ensure this does not encourage higher speeds.
- Minimize the space needed for the placement of work vehicles and equipment, allowing for maximum utilization of the available space for road users.
- Maximize optional buffer spaces where practical to protect highway workers.

4.6 Impact of Working Near an Intersection

Highway work activities in urban areas often take place within or in close proximity to intersections, which may significantly complicate TTC and require special considerations.

For work occurring ***BEFORE*** an intersection:

- Consider a closure (or an increase in the optional longitudinal buffer space included on many TAs) in advance of an intersection to channelize the traffic stream. This may help to reduce traffic conflicts, as well as the potential for errant vehicles to enter the work space.
- Consider separating the traffic stream (through movements and turning movements) in advance of the work space, which may reduce traffic conflicts and mitigate queues due to restricted turning movements.

For work occurring ***WITHIN*** an intersection:

- Use of dominant (such as arrow boards and/or vehicle mounted flashers) warning devices is critical to provide clear warning to motorists in all directions. "Road Work Ahead" signs may be used in advance of all intersection approaches.
- Use of flaggers should be considered for urban work zone scenarios that require alteration from normal operations, as static TTC devices may be insufficient. For example, Note 2 from TA-27 from the *MUTCD* indicates, "Depending on road user conditions, flagger(s) or uniformed law enforcement officer(s) should be used to direct road users within the intersection."
- Develop closures as far in advance of the work space as reasonable in order to ensure proper channelization. Carefully consider traffic demand, especially turning movements, as this may make closing lanes further upstream from the intersection impractical.
- In cases where developing closures sufficiently upstream of the work zone are impractical, ensure that work areas are well defined and protected by a traffic barrier or a shadow vehicle with a truck mounted attenuator (TMA) in order to reduce the risk of errant vehicles intruding in the work space.

For work occurring ***BEYOND*** an intersection:

- Consider closing affected lanes upstream of the intersection to channelize the traffic stream in advance of the intersection. Consider traffic demand (especially turning movements) as this may make advance lane closures impractical. For example, significant turn volumes may be addressed by allowing turning vehicles to continue to use a lane that must be closed to through traffic beyond the intersection.

5.0 EXAMPLE PLANS

In order to supplement the TAs in the *MUTCD*, several example plans are provided which address work zone scenarios in urban environments.

Note: Lane tapers (L) and sign spacing (A, B, and C) are determined based on the posted work zone speed limit as calculated in Tables 6H-3 and 6H-4 of *MUTCD*.

Lane Shift on Roads with Parking Lane (Figure 2)

- Parking lanes should be closed utilizing a taper length of 1/3L (as calculated in Table 6H-4 of the *MUTCD*).
- Provide Type 3 barricades and other channelizing devices to divert traffic to and from parking lanes.
- Regulatory signs showing the prohibition and availability of parking should be visible both at the beginning and end of the work zone.
- Lane shift provides an optimal solution from a mobility standpoint if 10 feet of traveled way can be maintained in each direction because it allows both travel lanes to remain open.
- If space is limited, the end taper can be omitted in order to increase the number of available parking spaces.

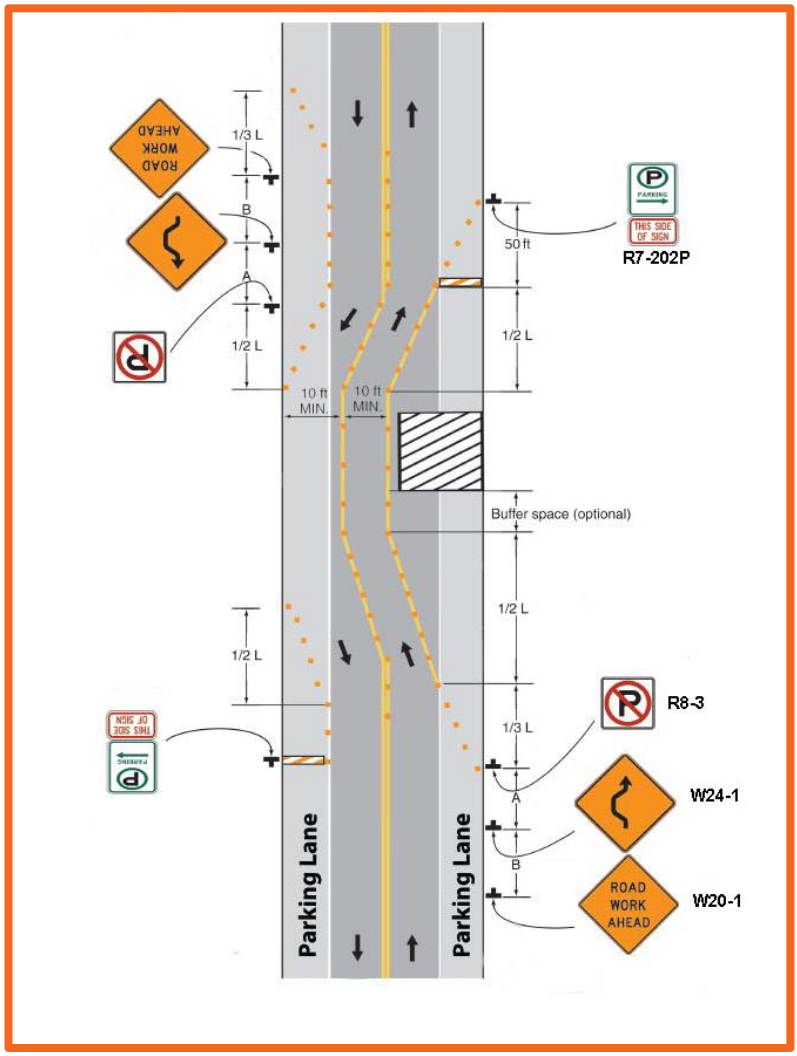


Figure 2 – Lane Shift on Roads with Parking Lane

- If sidewalks are adjacent to the work activity, ensure that they are shielded utilizing Type 3 Barricades and other channelizing devices which meet the *MUTCD* accessibility requirements.

Closure of Right Lane on Roads with Multiple Low Volume Driveways (Figure 3)

- Moving the lane closure further upstream helps to channelize and stabilize traffic flow prior to the work space.
- High right turning movements into and out of driveways may limit the practicality of moving the lane closure upstream.
- Use Type 3 barricades as shown to keep road users from entering the closed lane. However, if these large devices interfere with sight distance at driveways, smaller devices such as vertical panels or Type I barricades may need to be substituted.
- The optional arrow board shown on this plan may improve positive guidance to road users.

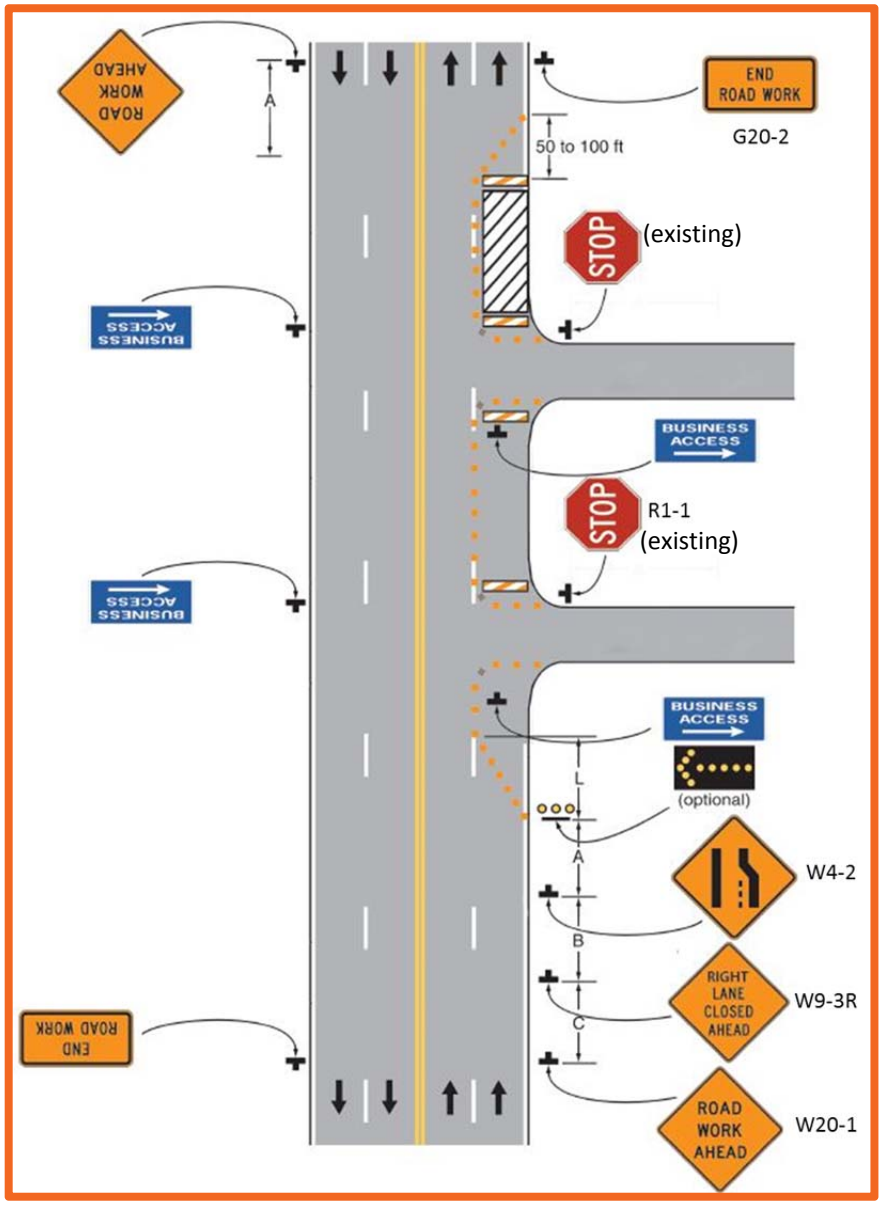


Figure 3 – Closure of Right Lane on Roads with Multiple Low Volume Driveways

Closure of Two inside Lanes near an Intersection (Figure 4)

- Closure of lanes on the far side of the intersection complicates driveway access. Providing alternate routes to driveways should be considered if driveway volumes are high, especially if alternate approaches are not readily available.
    - Provide Type 3 barricades around the work space to reduce risk of vehicle intrusion.
- Provide arrow boards at the start of lane closures, especially if traffic volumes are high.
- Prohibit left turns out of driveways throughout the closed lane and work space.
    - Where space permits, full lane closure should extend a length of 2L before it is reopened as a left turn lane.
- Consider left turn queue build-up in selecting lane closure points and length of lane closures to allow adequate storage for left turning vehicles.

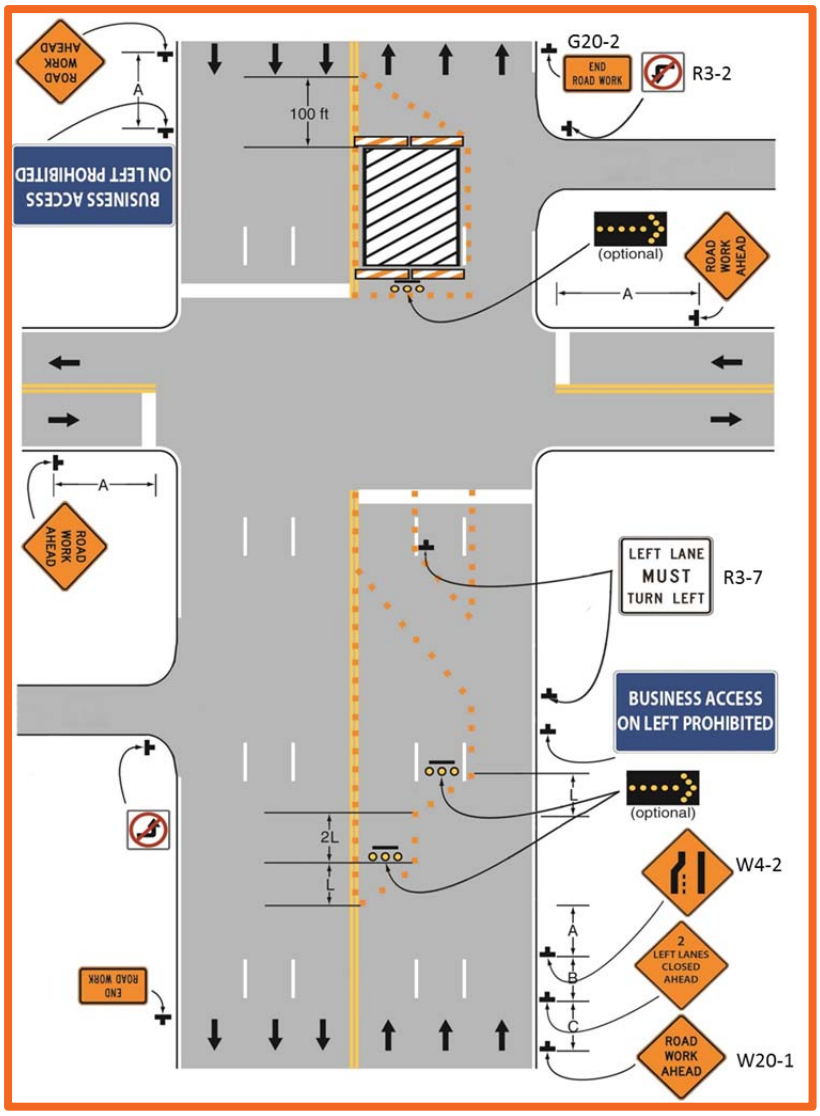


Figure 4 – Closure of Two Inside Lanes Near an Intersection

Work on Far Right Lane near Signalized Intersection (Figure 5)

- Closure of the right lane a considerable distance upstream of the intersection will be helpful in stabilizing traffic flow and allowing reopening the closed lane as a right turn only lane.
- Provide "Road Work Ahead" signage on all four approaches.
- A "No Turn on Red" sign may be added on the right side approach to reduce the risk of right turning vehicles intruding into the work space, especially if traffic volumes are high.
- Prohibiting left turns at the downstream driveway will help to reduce traffic conflicts due to vehicles exiting the facility and turning left, considering the potentially reduced sight distance due to the work activity.

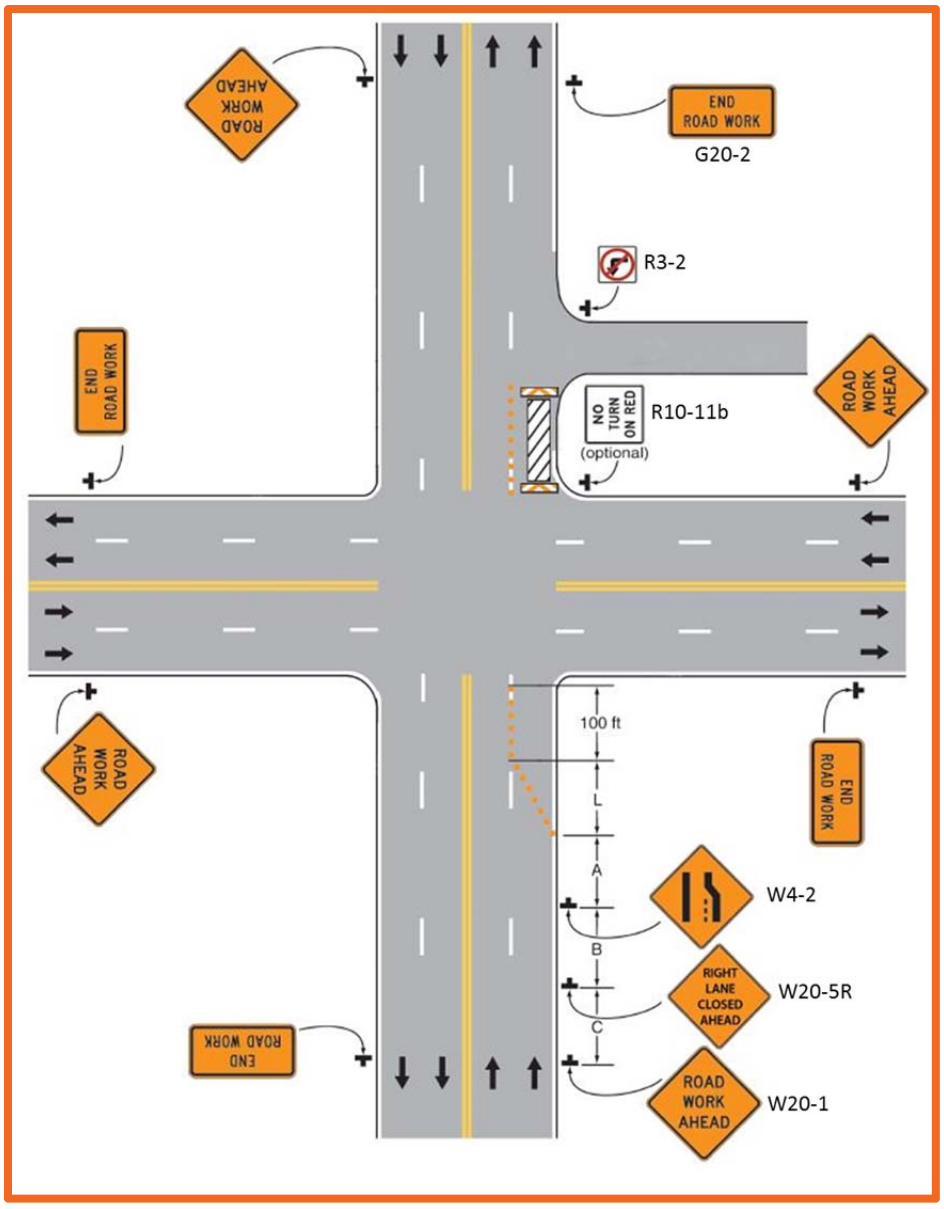


Figure 5 – Work on Far Right Lane Near Signalized Intersection

Sidewalk Closure Involving Minor Street in Urban Area (Figure 6)

- Certain construction or repair activities may require closing or relocating pedestrian facilities in urban areas.
- Accessibility features existing prior to the work activity must be maintained.
- Use portable plastic barriers or other suitable devices such as a portable concrete barrier to shield pedestrians from adjacent active traffic streams.
- TTC for pedestrians are shown in this example, but additional devices will be required for the vehicular traffic.

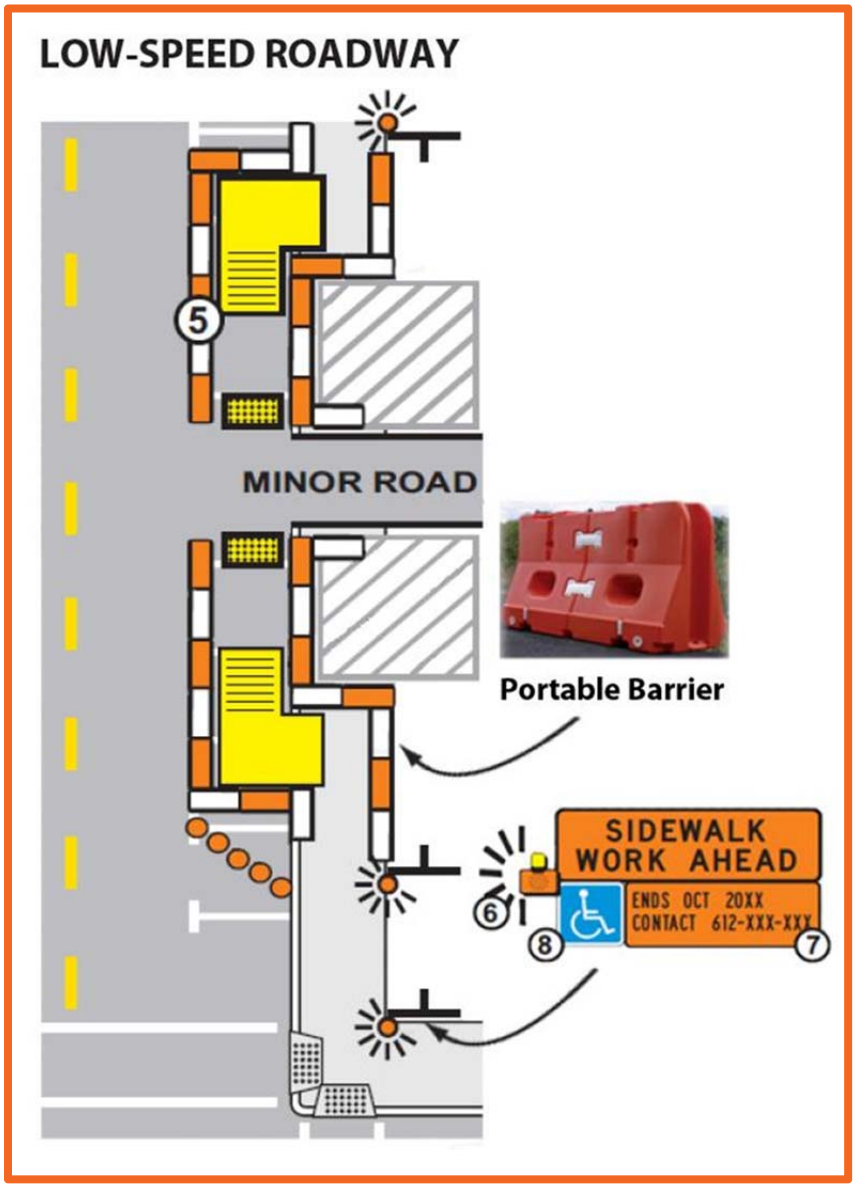


Figure 6 – Sidewalk Closure Involving Minor Street in Urban Area (85a – Minnesota MUTCD)

Pedestrian Facility Rerouted into Traveled Lanes (Figure 7)

- Construction or repair activities may require rerouting of pedestrian facilities.
- One option is to reroute these facilities into the traveled way. However, the mobility impact on the existing traffic system must be considered and alternative solutions, such as a pedestrian detour may be an option. The *MUTCD* provides a discussion of the pros and cons of pedestrian detours.
- Shielding the pedestrian facility from the traffic stream is a key consideration in this application. Where traffic speeds and or volumes are high, a temporary traffic barrier is desirable to prevent vehicle intrusion into the relocated sidewalk.

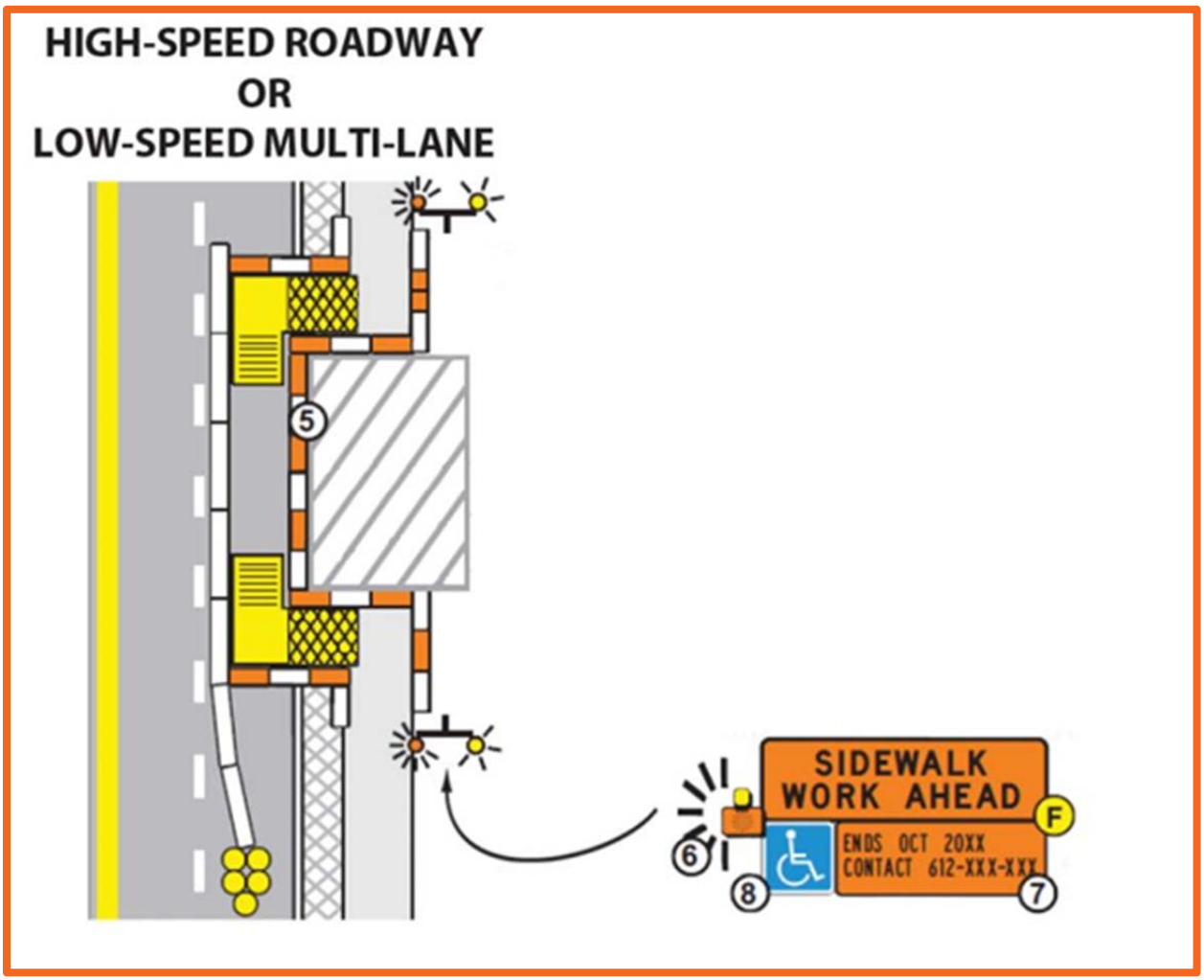


Figure 7 – Pedestrian Facility Rerouted Into Traveled Lanes
(85b – Minnesota MUTCD)

Work on Far Side Right Lane Including Bicycle Lane (Figure 8)

- Bicycle traffic, a common characteristic of many urban roadways, must be considered when developing a TTCP.
- In this case, the right-most lane is utilized as an exclusive right turn lane with the lane closure implemented on the far side of the intersection.
- Additional "Share the Road" bicycle signage should be located upstream of the lane closure.

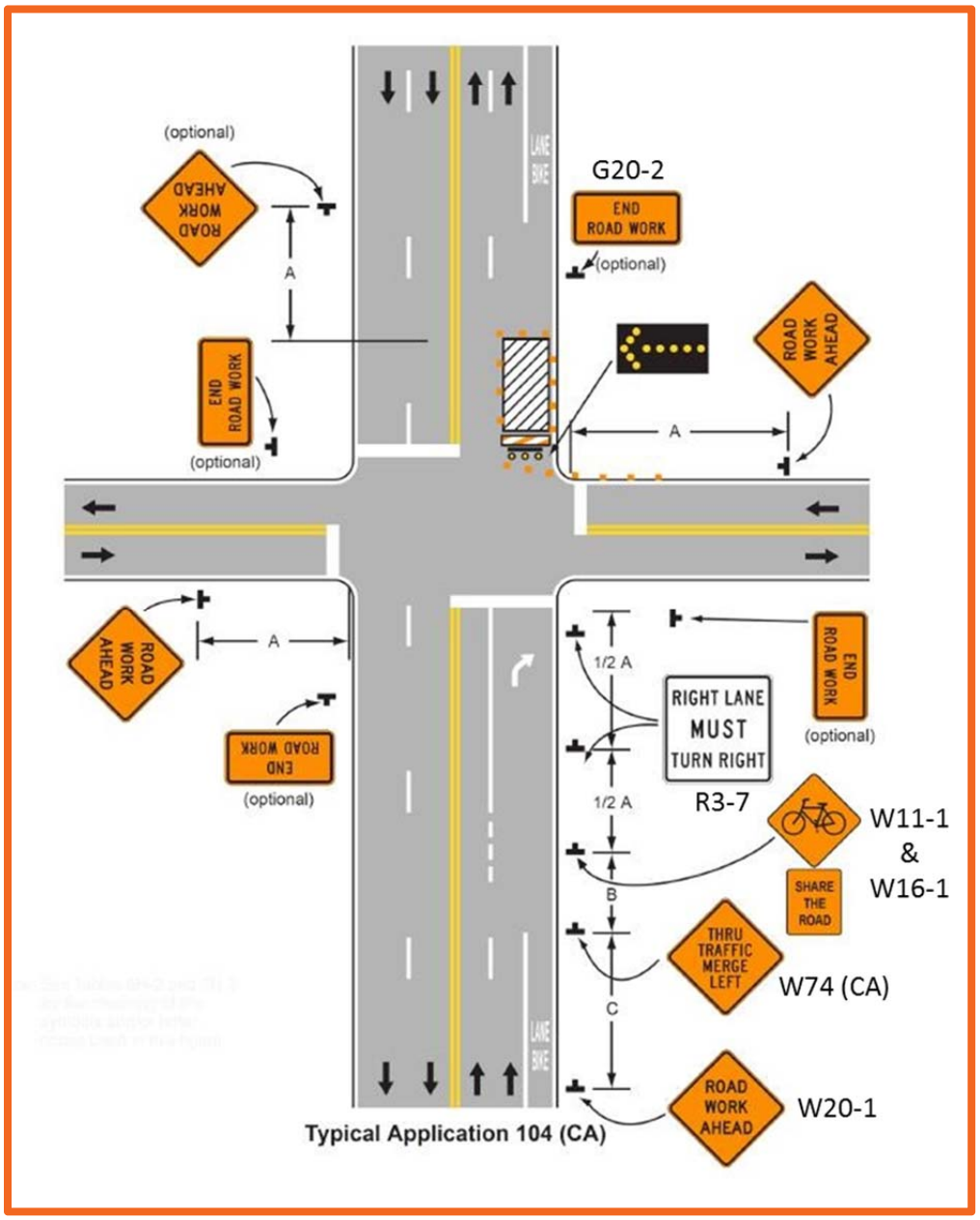


Figure 8 – Work on Far Side Right Lane Including Bicycle Lane [California MUTCD Figure 6H-104 (CA)]

Shoulder Closure on Urban Location with Bicycle Traffic (Figure 9)

- Work in urban areas may interrupt exclusive bike lanes or bicycle traffic.
- Where possible, adequate lane width should be provided for bicyclists and motorists to drive side by side, otherwise **"Bicyclists May Use Full Lane"** sign is recommended.
- The temporary traffic barrier and lights are shown as optional and may be appropriate for long-term work zone scenarios.
- All temporary signs should be placed such that the path of travel for bicyclists is not blocked, while maintaining good visibility for drivers.

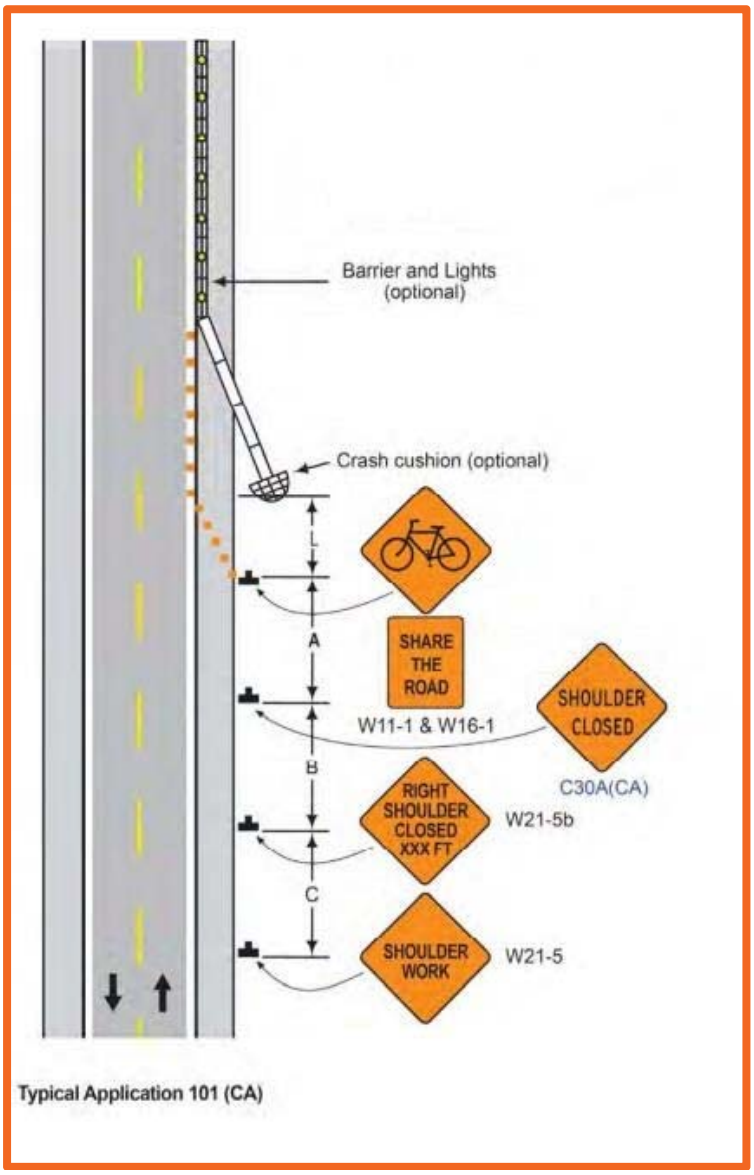


Figure 9 – Shoulder Closure on Urban Location with Bicycle Traffic [California MUTCD Figure 6H-101 (CA)]

6.0 ADDITIONAL RESOURCES

Refer to Wayne State University - Transportation Research Group Work Zone Safety Website (workzone.eng.wayne.edu) for copies of this document, other products developed under FHWA Work Zone Safety Grant, as well as the *Temporary Traffic Control Plan Selection Software* and *Work Zone Safety Compendium of Documents*.

Further information on highway work zone safety can be found in the following resources:

- Federal Highway Administration: http://www.ops.fhwa.dot.gov/wz/index.asp
- National Work Zone Safety Information Clearinghouse: http://www.workzonesafety.org/
- Manual on Uniform Traffic Control Devices: http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf
- 23 Code of Federal Regulations, Part 630, Subpart J: http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=23:1.0.1.7.21#sp23.1.630.j and Subpart K: http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=23:1.0.1.7.21#sp23.1.630.k
- Traffic Control and Work Zone Safety for High Volume Roads, Final Report: http://www.nj.gov/transportation/refdata/research/reports/FHWA-NJ-2013-002.pdf
- Developing and Implementing Transportation Management Plans for Work Zones, Federal Highway Administration, 2005: http://ops.fhwa.dot.gov/wz/resources/publications/trans_mgmt_plans/trans_mgmt_plans.pdf
- American Road and Transportation Builders Association: http://www.artba.org/
- American Traffic Safety Services Association: http://www.atssa.com/
- Institute of Transportation Engineers: http://www.ite.org/
- National Highway Institute: http://www.nhi.fhwa.dot.gov/home.aspx
- Occupational Safety and Health Administration: http://www.osha.gov/
- Texas Transportation Institute: http://tti.tamu.edu
- Transportation Research Board: http://www.trb.org/

APPENDIX I – TEMPORARY TRAFFIC CONTROL PLAN CHECKLIST OF WORK ZONE CHARACTERISTICS

Work Characteristics

Duration	Check
< 1 hr.	
> 1 hr. and < 1 day	
Moving	
> 1 day and < 3 days	
Night work > 1 hr.	
> 3 days	

Type of Work	Check
Road Maintenance	
Utility (including water & sewer)	
TCD maintenance/installation	
Road work mobile	

Work Space Located In:	Check
Urban	
Rural	
Midblock	
Intersection	

Area Land Use:	Check
Commercial	
Residential	
Industrial/Office	
Agricultural	

Traffic Characteristics

Traffic Volume:	Check
High	
Moderate	
Low	

Speed Limit:	Note
Posted Speed Limit	

Geometric Characteristics and Work Location

Work Location:	Check
Beyond shoulder	
On shoulder	
On roadway	

Roadway Characteristics	Note
Number of lanes (total):	
Approximate lane width:	

Closure:	Check
Closure width	
Length of closure	

Presence of:	
Curb	
Shoulder	

Determine Typical Application

Roadway Type:	Check
Freeway	_____
Intersection	_____
Two-lane	_____
Multi-lane	_____

Launch TTCP Software

http://workzone.eng.wayne.edu/ttcp.html

State-Specific Standard Plans

In the TTCP software, is an appropriate work zone traffic control plan available in the standard plans of your state? Yes _____ No _____

If Yes, use State's standard plan.
If No, continue.

Can selected TA be applied at the work site as shown? Yes ____ No ____

If No, why not?

No room for required taper	_____	**Sight distance problem**	_____
Presence of driveway/cross street	_____	Presence of tree	_____
Work zone warning sign location over-crowded with other permanent signs	_____		

Perform field modification of TTCP as needed.