Work Zone Safety

Guidelines for Construction, Maintenance, and Utility Operations

HIGH POINT

NORTH CAROLINA'S INTERNATIONAL CITY™

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Introduction

The purpose of this handbook is to present guidelines for work zone traffic control. This training covers the basic requirements of Part 6 of the Manual on Uniform Traffic Control Devices (MUTCD) with particular emphasis on short-term work sites on roads and streets in rural and small urban areas. These requirements apply to construction, maintenance, and utility work zones.

This handbook presents information and gives examples of typical traffic control applications for two-lane and multi-lane work zones. This information is intended to illustrate the principles of proper work zone traffic control, but is not a standard. Part 6 of the MUTCD contains the standards for work zone traffic control. .

Traffic Control Devices

The following are four types of traffic control devices used in work zone traffic control:

- Signs
- Channelizing Devices
- Lighting Devices
- Pavement Markings

Signs

Signs used in work zone traffic control are classified as regulatory, guide, or warning. Regulatory signs impose legal restrictions and may not be used unless authorized by the public agency having jurisdiction. Guide signs commonly show destinations, directions, and distances. Warning signs give notice of conditions that are potentially hazardous to traffic.

Bicycles & Pedestrians

Most of the applications in the guide are for work zones with cars and trucks only. In locations with pedestrians and bicyclist, special care should be taken. See the MUTCD for more information. Any requirements of the Americans with Disability Act (ADA) shall be followed for any work zone.

Spacing of Advance Warning Signs

Road Type	Distance Between Signs
Urban, 35 mph or less	100 feet
Urban, 45-50 mph	350 feet
Rural, 55 mph	500 feet
Expressway/Freeway	1,000 feet, 1,500 feet, 2,650 feet

Distances shown are approximate. Sign spacing should be adjusted for curves, hills, intersections, driveways, etc., to improve sign visibility.

Warning Signs – Construction and maintenance warning signs are used extensively in street and highway work zones. These signs are normally diamond shaped, having a black symbol or message on an orange background. As a general rule these signs are located on the right-hand side of the street or highway.

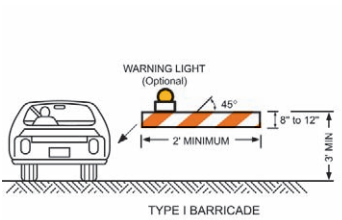
Size – The standard size for advance warning signs in work zones is generally 48 inches by 48 inches. Larger or smaller signs should be used as conditions warrant. See Part 6 of the MUTCD for specific sign sizes.

Mounting – Standards for height and lateral clearance of roadside signs are included in Part 6 of the MUTCD. Post-mounted signs installed in rural areas shall be mounted at a height of at least 5 feet above the traveled way (measured from the bottom of the sign), and 7 feet in urban areas. Signs mounted on barricades or other portable supports may be at lower heights, but the bottom of the sign shall be no less than one foot above the traveled way. Sign supports shall be crashworthy.

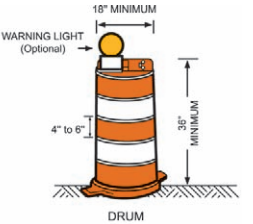
Illumination and Retroreflectorization – All signs used during the hours of darkness shall be made of retroreflective material or illuminated. (Street or highway lighting is not regarded as meeting the requirements for sign illumination.)

Removal – When work is suspended for short periods, all signs that are no longer appropriate shall be removed, covered, or turned so they are not visible to drivers.

Channelizing Devices

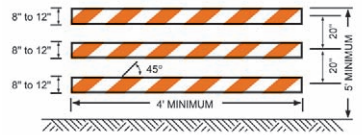


TYPE I BARRICADE

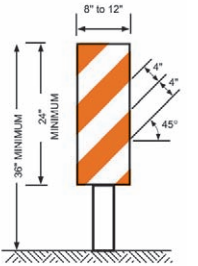


DRUM

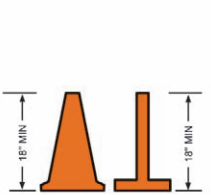
TYPE II BARRICADE



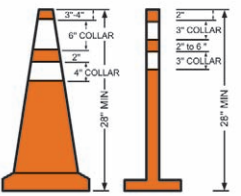
TYPE III BARRICADE



VERTICAL PANEL

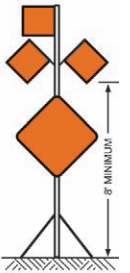


Daytime-Only, Low-Speed Roadways
(≤ 40 mph)



Higher-Speed Roadways (≥45 mph)
and all facilities at night

CONES AND TUBULAR MARKERS



HIGH-LEVEL
WARNING DEVICE
(FLAG TREE)

Notes:

1. Stripes on barricade rails slope downward at an angle of 45 degrees in the direction traffic is to pass.
2. Barricade rail stripe widths shall be 6 inches, except that 4-inch wide stripes may be used if rail lengths are less than 36 inches.
3. The sides of barricades facing traffic shall have retroreflective rail faces.

Channelizing Devices

Channelizing devices are used to warn and alert drivers of hazards in work zones, protect workers, and guide and direct drivers and pedestrians past the hazards. Channelizing devices include cones, tubular markers, vertical panels, drums and barricades. The most common channelizing device used in temporary work zones is the traffic cone.

Traffic Cones – Traffic cones must be orange in color and a minimum of 18 inches in height. Traffic cones used on freeways and other higher-speed roadways (≥45mph) and on all facilities during hours of darkness shall be a minimum of 28 inches in height. Cones used at night shall be retroreflectorized as shown on the previous page.

Spacing – Channelizing devices should be spaced so that it is apparent that the roadway or work area is closed to traffic. There are several rules of thumb that can be used to guide you in the proper spacing of channelizing devices.

1. The maximum spacing between devices in a taper should not exceed a distance, in feet, equal to the speed limit in MPH. For example if the taper is on a street with a 35 MPH speed limit, the devices may be spaced up to 35 feet apart.
2. All tapers should be made up of at least 6 channelizing devices.
3. The spacing between devices in a buffer or work area should not exceed a distance, in feet, of 2 times the speed limit in MPH. For example, if the street has a speed limit of 35 MPH, the devices in the buffer and work area may be spaced up to 70 feet apart.
4. In urban areas shorter spacing between devices in the buffer and work areas may be more appropriate. For example, the spacing used in tapers could also be used in buffers and work areas.

Number of Channelizing Devices Needed

Length (ft)	35 MPH		45 MPH		55 MPH	
	Taper	Buffer/ Work	Taper	Buffer/ Work	Taper	Buffer/ Work
100	6	2 - 3	6	2 - 3	6	2 - 3
150	6	3 - 5	6	2 - 4	6	2 - 3
200	7	3 - 6	6	3 - 5	6	2 - 4
250	9	4 - 8	7	3 - 6	6	3 - 5
300	10	5 - 9	8	4 - 7	7	3 - 6
350	11	5 - 10	9	4 - 8	8	4 - 7
400	13	6 - 12	10	5 - 9	9	4 - 8
450	14	7 - 13	11	5 - 10	10	5 - 9
500	16	8 - 15	13	6 - 12	11	5 - 10
550	17	8 - 16	14	7 - 13	11	5 - 10
600	19	9 - 18	15	7 - 14	12	6 - 11
650	20	10 - 19	16	8 - 15	13	6 - 12

Lighting Devices

Lighting devices for short-term work zones are designed to supplement the signs and channelizing devices used in these zones. Typical lighting devices include warning lights, vehicle rotating or strobe lights, and arrow panels.

Warning Lights – the principal types and use of warning lights are:

1. **Low-Intensity Flashing Lights (Type A) –** used at night to warn of an isolated hazard.
2. **High-Intensity Flashing Lights (Type B) –** used both day and night to warn of an isolated hazard or draw attention to advance warning signs.
3. **Low-Intensity Steady-Burn Lights (Type C) –** used at night in a series to delineate the edge of the travel-way and channel traffic.

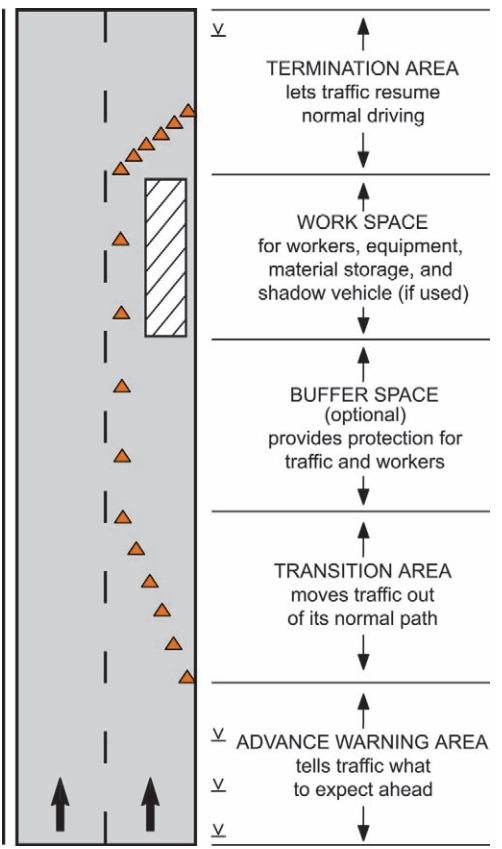
Arrow Panels

Panel Type	Roadway Speed	Min. Size	Min. # Lamps	Min. Legibility Distance
A	≤ 35 mph	48″ x 24″	12	1/2 mile
B	40 - 50 mph	60″ x 30″	13	3/4 mile
C	≥ 55 mph	96″ x 48″	15	1 mile

For mobile operations on high-speed roadways Type B (60" x 30") Arrow Panels may be used.

Five Parts of a Traffic Control Zone

The traffic control zone is the area between the first advance warning sign and the point beyond the work space where traffic is no longer affected. Below is a diagram showing the five parts of a traffic control zone.



Taper Length Criteria for Work Zones

There are five types of tapers used in work zone traffic control. The following are their lengths.

Type of Taper	Taper Length
Merging Taper	L Minimum
Shifting Taper	1/2 L Minimum
Shoulder Taper	1/3 L Minimum
One-Lane, Two-Way Traffic Taper	50 feet Minimum to 100 feet Maximum
Downstream Taper *(use is optional)*	100 feet per lane Minimum

Formulas for L

Speed Limit	Formula
40 MPH or Less	$L = \frac{WS^2}{60}$
45 MPH or Greater	$L = WS$

L = Taper length in feet

W = Width of offset in feet

S = Posted speed limit, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph

Buffer Lengths

The buffer area is an optional part of the work zone. It serves to separate traffic flow from the work area or a potentially hazardous area and might provide recovery space for an errant vehicle. Neither work activity nor storage of equipment, vehicles or materials should occur in this area.

Guidelines for Buffer Lengths

speed (mph)	length (ft)	speed (mph)	length (ft)
20	115	45	360
25	155	50	425
30	200	55	495
35	250	60	570
40	305	65	645

A lateral buffer space may also be used to separate passing traffic from the work area. Its use and width is based on conditions at the work site.

Duration of Work

Work duration is a major factor in determining the number and types of devices used in temporary traffic control zones. As a general rule, the longer the operation will last, more traffic control devices will be needed.

Long-Term Stationary – Work that occupies a location more than 3 days.

Intermediate-Term Stationary – Work that occupies a location from overnight to 3 days or nighttime work lasting more than 1 hour.

Short-Term Stationary – Daytime work that occupies a location for more than 1 hour within a single daylight period.

Short Duration – Work that occupies a location up to 1 hour.

Mobile – Work that moves intermittently or continuously.

Location of Work

The choice of traffic control needed for a temporary traffic control zone depends upon where the work is located. As a general rule, the closer the work is to traffic, more traffic control devices will be needed.

Definitions

The following are several important definitions for terms used in these guidelines. These definitions were developed to aid the supervisor at the job site in determining the appropriate traffic control for the existing street or highway conditions. If the traffic conditions change during the course of the work, then the traffic control may need to change also.

Low Speed – As a general rule, a low-speed road can be considered one on which the posted speed limit is 35 miles per hour (MPH) or less.

Intermediate Speed – For these guidelines, roads with posted speed limits of 40 to 50 MPH can be considered intermediate-speed roads.

High Speed – For these guidelines, roads with posted speed limits of 55 MPH or greater can be considered high-speed roads.

Low Volume – As a general rule, a low-volume road can be considered one on which the average daily traffic volume (ADT) does not exceed 400 vehicles per day. If the traffic volumes are not known, the following rule of thumb can be used.

Rule of Thumb – Count the number of vehicles that pass a single reference point over a five (5) minute period. If no more than 3 vehicles pass the reference point in that period, then the road can be considered low volume.

Special attention should be given to local, nearby facilities, such as schools, manufacturing plants, etc., that cause special traffic generation. Consideration should also be given as to whether the work zone location is subject to peak-hour traffic increases. Peak hours are usually 7-9 a.m. and 4-6 p.m., but will vary in different areas.

Urban Street Conditions – These streets are characterized by relatively low speeds, pedestrian activity, intersections, and frequent driveways for businesses and houses. While urban work zones will usually be on a city or village street, a work area does not have to be within a municipality's corporate limits in order to be considered an urban condition.

Minor Urban Street – A low-volume, low-speed, two-lane urban street.

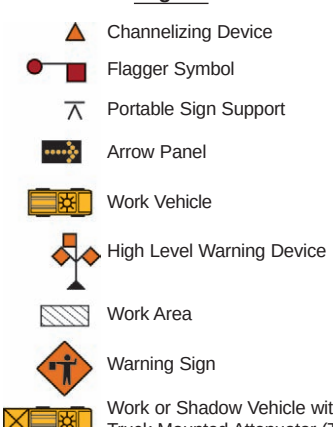
Typical Application Diagrams

The diagrams on the following pages represent examples of the application of principles and procedures for safe and efficient traffic control in work zones but are not intended to be standards. Part 6 of the MUTCD is the standard for work zone traffic control. It is not possible to include illustrations to cover every situation which will require work area protection. These typical layouts are not intended as a substitute for engineering judgment and should be altered to fit the conditions of a particular site.

In addition to the typical diagrams, notes and tables are presented which provide important information for the user. **Read all notes before using these diagrams.** The information presented in these diagrams and tables are generally minimums for standard street and highway conditions. Also, it is the condition of the area that should be considered during application of these typicals. The work zone set up should be based upon anticipated vehicle speeds and rural versus urban conditions instead of posted speed limits or a municipality's corporate limits.

Expressway and freeway conditions will require longer distances and more conspicuous devices. For further information, refer to Part 6 of the MUTCD.

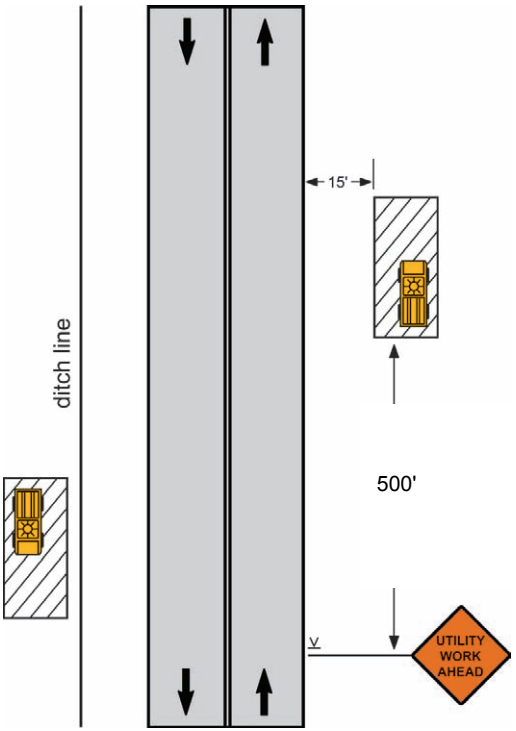
Legend



Note: Taper lengths in these guidelines are based upon 12-foot lanes and 10-foot shoulders.

Work Beyond the Shoulder

(15′ or More From the Edge of Pavement)

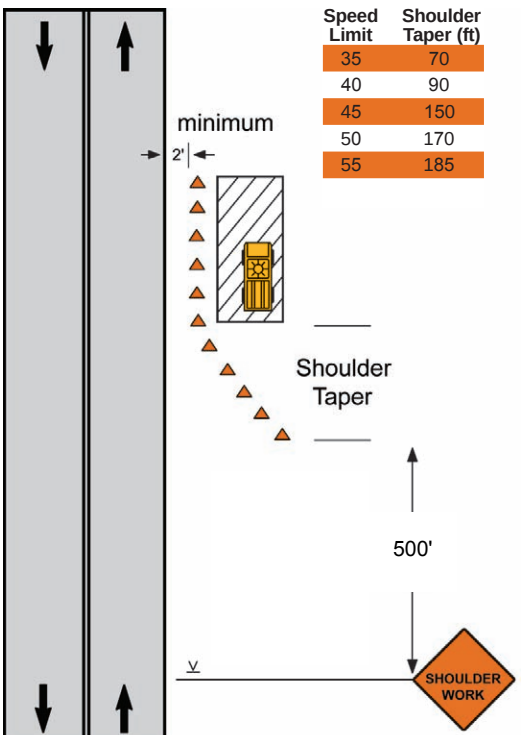


Notes:

1. If vehicle and work activity are both behind a ditchline, behind guard rail, more than 2′ behind curb, or 15′ or more from the edge of any traveled way, then only an activated rotating or strobe light is needed.
2. An advance warning sign should be used if the work will be performed immediately adjacent to the shoulder, if vehicles will access the work space from the roadway, if equipment will travel on or cross the highway, or if the activity may distract motorists.
3. Other acceptable advance warning signs are those indicating “Shoulder Work” or “Road Work Ahead”.

Shoulder Work

(2'-15' From the Edge of Pavement)



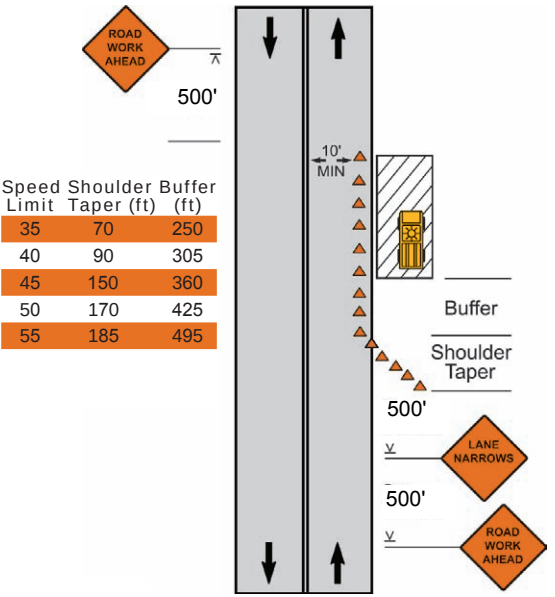
Speed Limit	Shoulder Taper (ft)
35	70
40	90
45	150
50	170
55	185

Notes:

1. For operations of 60 minutes or less, all signs and channelizing devices may be eliminated if a vehicle with an activated rotating or strobe light is used.
2. For low-speed conditions, a 200-foot sign spacing may be used. For speed of 40 to 50 MPH, a 350-foot sign spacing may be used.
2. "Utility Work Ahead", "Road Work Ahead", or Worker symbol signs may be used instead of the "Shoulder Work" sign.
3. For work performed on a paved shoulder at least 8 feet wide, an additional general warning sign (e.g. "Road Work Ahead") should be used in advance of the "Shoulder Work" sign.

Shoulder Work With Minor Encroachment

(Within 2' of the Edge of Pavement)



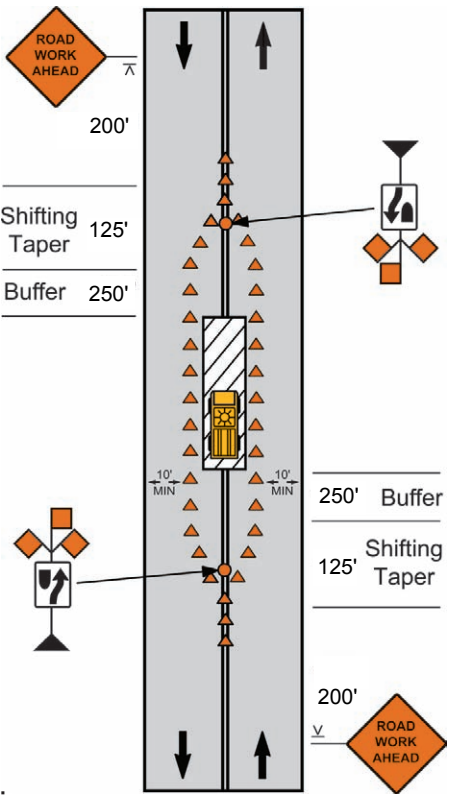
Speed Limit	Shoulder Taper (ft)	Buffer (ft)
35	70	250
40	90	305
45	150	360
50	170	425
55	185	495

Notes:

1. For traffic conditions with speeds greater than 35 MPH, a lane closure should be considered. For traffic conditions with a speed of 55 MPH and/or significant truck traffic, a lane closure should be used. (see pages 19 and 20).
2. The lane encroachment should either permit a remaining lane width of 10′, or the lane should be closed. However, a 9-foot width is acceptable for use on low-volume, low-speed roadways, provided the traffic does not include long and/or wide heavy commercial vehicles.
3. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.
4. The “Lane Narrows” sign may be deleted on low-volume, low-speed roadways.
5. For short-duration work (60 minutes or less), the taper and channelizing devices are optional if a protection vehicle with an activated strobe light is used in advance of the work area.

Work in Center of a Minor Urban Street

(Maintaining Two-Way Traffic)

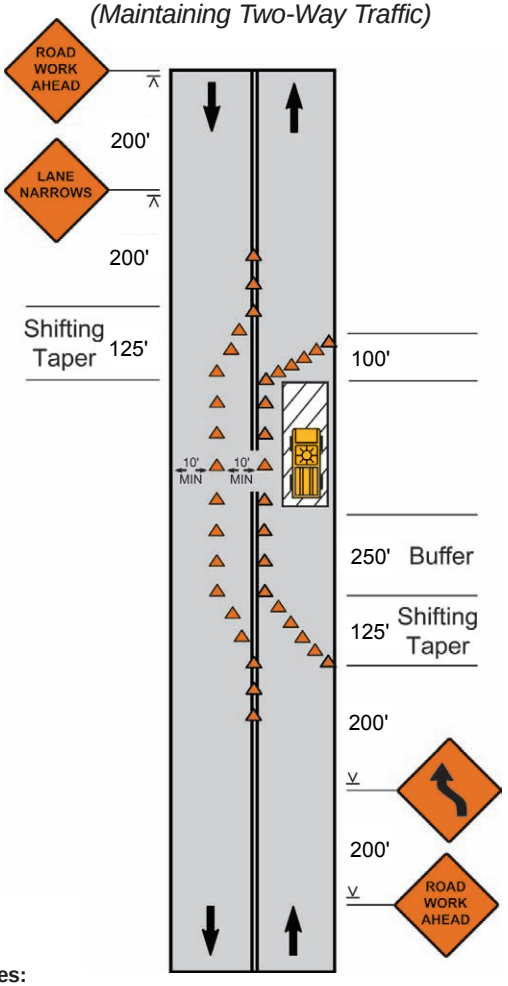


Notes:

1. This layout is only appropriate for low-volume, low-speed (35 MPH or less) urban streets.
2. A minimum lane width of 10′ should be provided in both directions as measured from the channelizing devices to the edge of pavement.
3. The “Keep Right” symbol signs may be replaced with “Lane Narrows” signs placed 200 feet from the beginning of the taper.
4. The tapers or the high-level warning devices may be eliminated if the work vehicle displays a rotating or strobe light.

Work in Travel Lane on a Minor Urban Street

(Maintaining Two-Way Traffic)

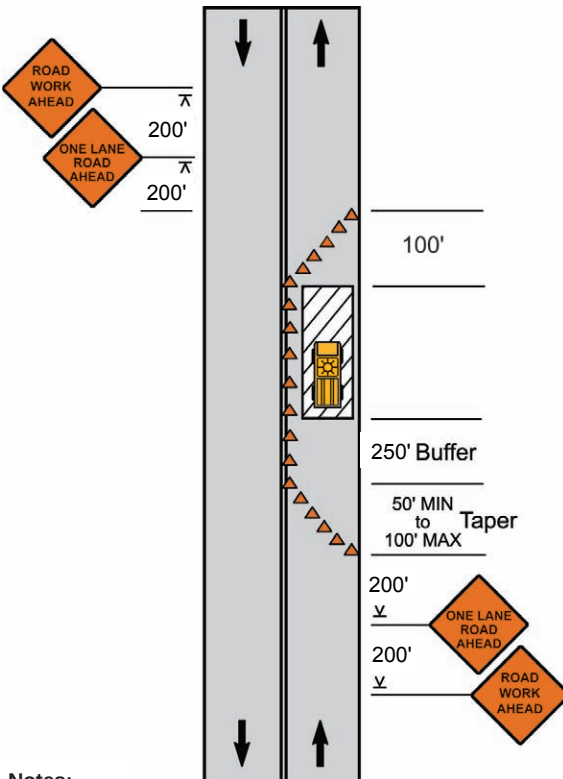


Notes:

1. This layout is only appropriate for low-volume, low-speed (35 MPH or less) urban streets.
2. A minimum lane width of 10′ should be provided in both directions, measured between the channelizing devices and from the channelizing devices to the edge of pavement.
3. Additional advance warning may be appropriate, such as “Lane Shifts” and “Lane Narrows” signs.

Lane Closure on a Minor Urban Street

(No Flagger, Traffic Self-Regulating)

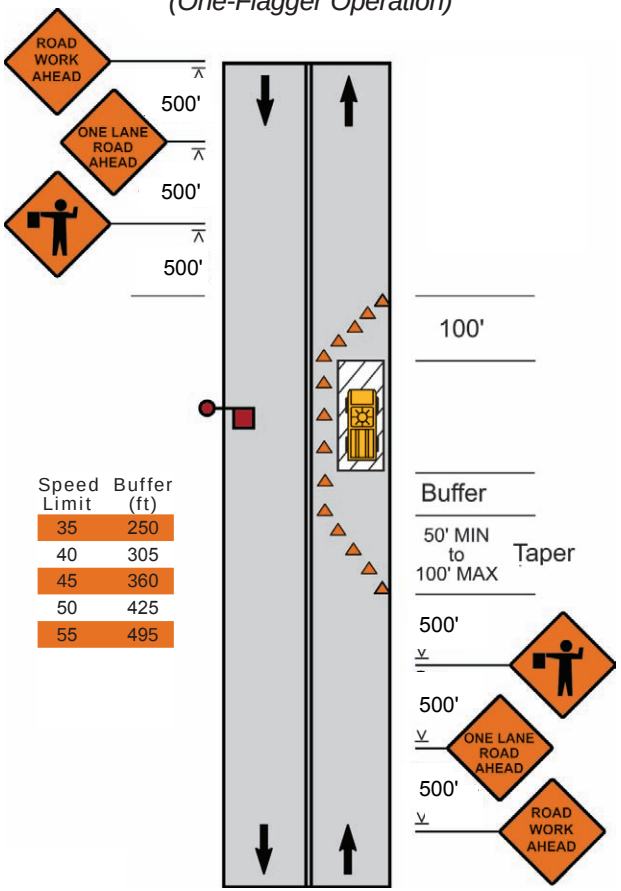


Notes:

1. This layout is only appropriate for low-volume, low-speed (35 MPH or less) streets, such as local residential streets, where work areas are short and sight distance is good. This procedure is not to be used in rural areas.
2. Traffic must be able to regulate itself. The volumes must be low and the length of the work space short, thus allowing traffic to readily see the roadway beyond.
3. Where traffic does not self-regulate effectively, use one or two flaggers (see pages 19 and 20).
4. A “Utility Work Ahead” sign may be used in place of the “Road Work Ahead” sign.

Lane Closure on a Two-Lane, Low-Volume Road

(One-Flagger Operation)



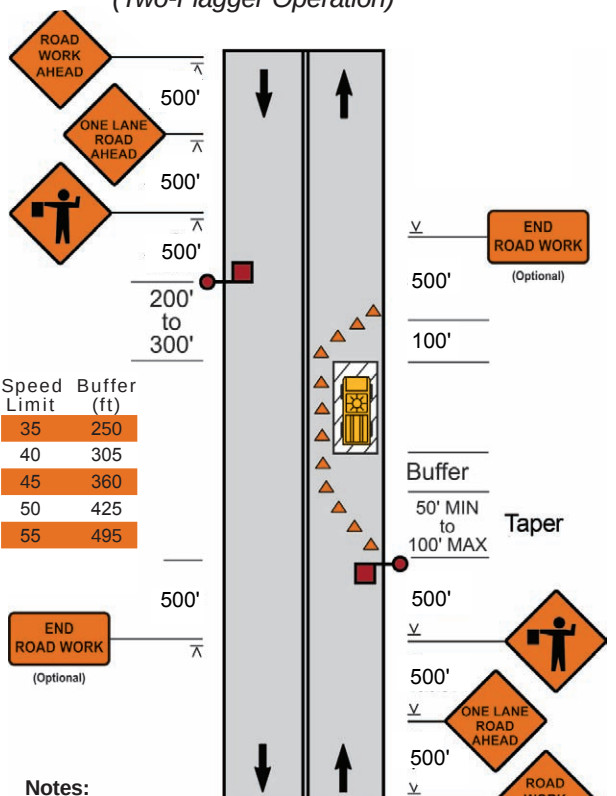
Speed Limit	Buffer (ft)
35	250
40	305
45	360
50	425
55	495

Notes:

1. A single flagger may be adequate for low-volume situations with short work zones on straight roadways. Where one flagger is used, the flagger must be positioned to be visible to approaching traffic from both directions.
2. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.
3. For operations of 60 minutes or less, the "Road Work Ahead" sign may be ommitted.

Lane Closure on a Two-Lane Road

(Two-Flagger Operation)



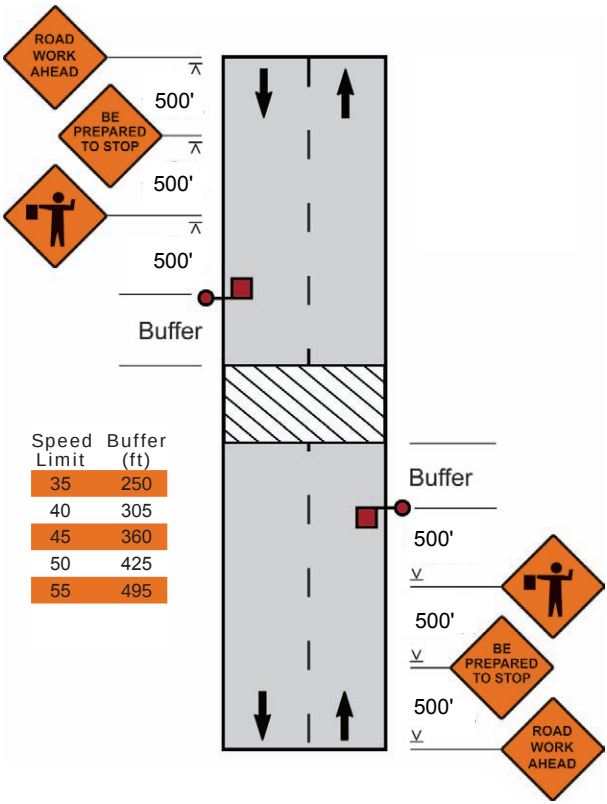
Speed Limit	Buffer (ft)
35	250
40	305
45	360
50	425
55	495

Notes:

1. A "Be Prepared To Stop" sign may be added to the sign series, located between the Flagger symbol and the "One Lane Road Ahead" signs. If used, then the spacing of all four signs in the series will be 500 feet.
2. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.
3. For operations of 60 minutes or less, the "Road Work Ahead" sign may be omitted.
4. Generally, the use of "End Road Work" signs is optional for short duration work sites. However, if the work site itself is long, or the beginning and end of the work site are not visible to a driver passing through it, then "End Road Work" signs should be used.

Temporary Road Closure

(Not to exceed 20 Minutes)

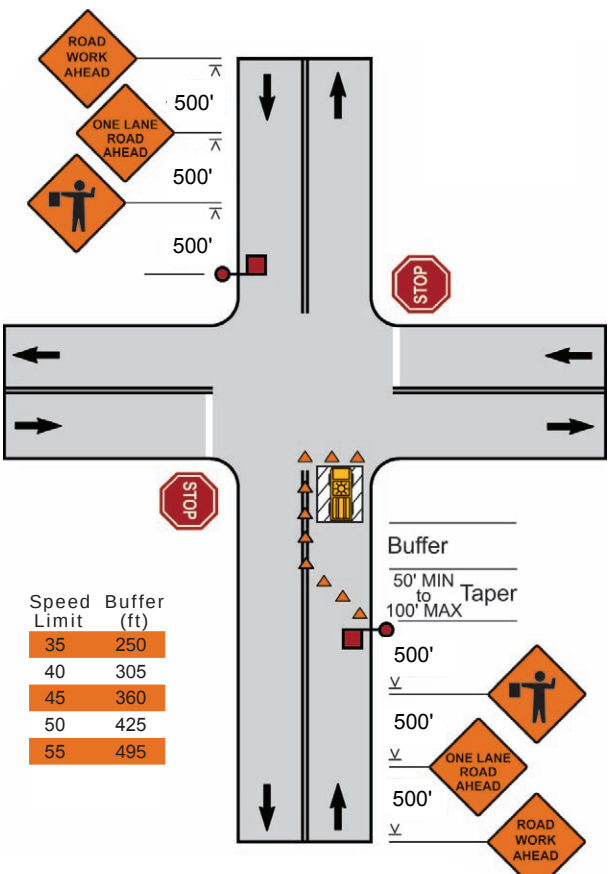


Speed Limit	Buffer (ft)
35	250
40	305
45	360
50	425
55	495

Notes:

1. Conditions represented are for work which requires closings during daytime hours only.
2. This application is intended for a planned temporary closing not to exceed 20 minutes.
3. For high-volume roads, a police patrol car and/or a changeable message sign may be added.
4. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.

Lane Closure in Advance of an Intersection
(Work Area on the Through Road)



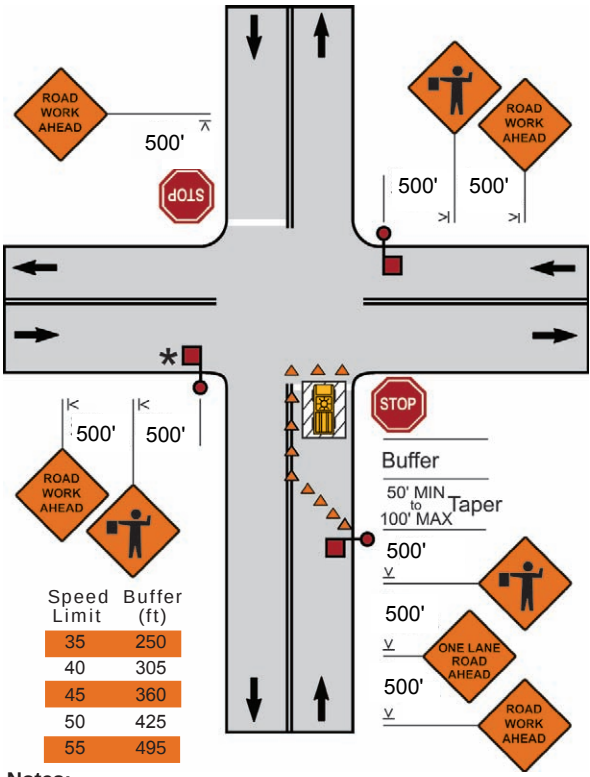
Speed Limit	Buffer (ft)
35	250
40	305
45	360
50	425
55	495

Note:

1. Depending on traffic conditions, additional traffic control, such as flaggers and appropriate signing, may be needed on the side road approaches.
2. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.

Lane Closure in Advance of an Intersection

(Work Area on the Side Road)



Speed Limit	Buffer (ft)
35	250
40	305
45	360
50	425
55	495

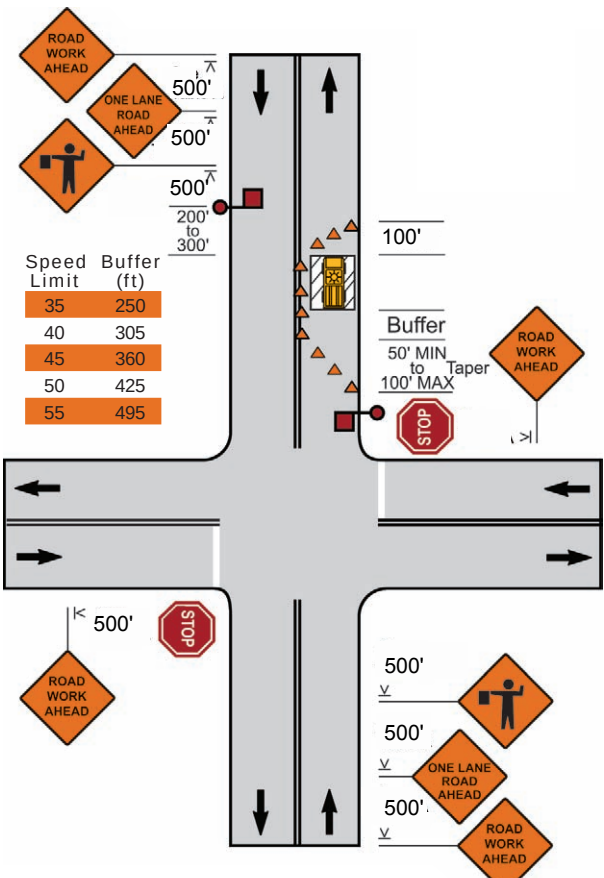
Notes:

1. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.
2. Depending on traffic conditions, additional traffic control, such as flaggers and appropriate signing, may be needed.

*3. The middle flagger has the best view of traffic from all directions. This flagger should be designated lead flagger and should coordinate the actions of the other flaggers.

Lane Closure Beyond an Intersection

(Work Area on the Through Road)

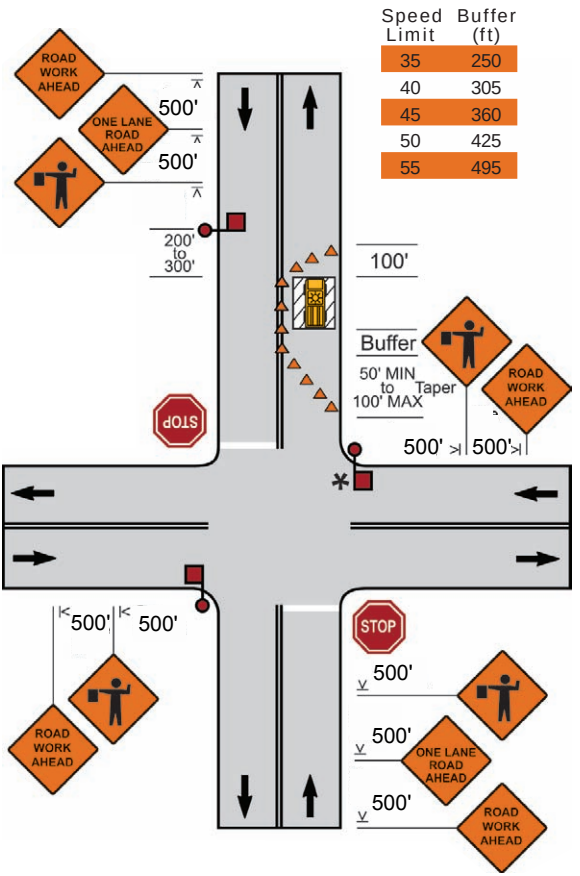


Note:

1. Depending on traffic conditions, additional traffic control, such as flaggers and appropriate signing, may be needed.
2. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.

Lane Closure Beyond an Intersection

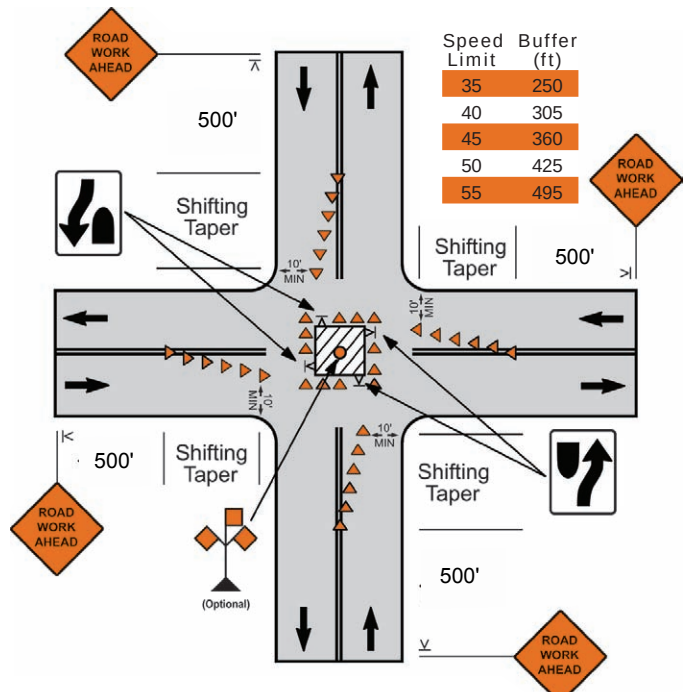
(Work Area on the Side Road)



Notes:

1. Depending on traffic conditions, additional traffic control, such as flaggers and appropriate signing, may be needed.
2. ✱ The middle flagger has the best view of traffic from all directions. This flagger should be designated lead flagger and should coordinate the actions of the other flaggers.
3. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.

Closure in the Center of an Intersection



Notes:

1. Prohibit left turns as required by traffic conditions. Unless the streets are wide, it may be physically impossible to turn left, especially for large vehicles.
2. A minimum of six channelizing devices shall be used for each taper.
3. For operations of 60 minutes or less, the channelizing devices may be eliminated if a vehicle with an activated rotating or strobe light is used in the work space.
4. The “Keep Right” symbol signs may be replaced with “Lane Narrows” signs placed between the “Road Work Ahead” signs and the beginning of the tapers. Standard sign spacing should be used.
5. A high-level warning device (flag tree) may be used for added visibility.
6. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.

Mobile Operations

Mobile operations are work activities that move along the road either intermittently or continuously. Safety for mobile operations should not be compromised by using fewer devices simply because the operation will frequently change its location.

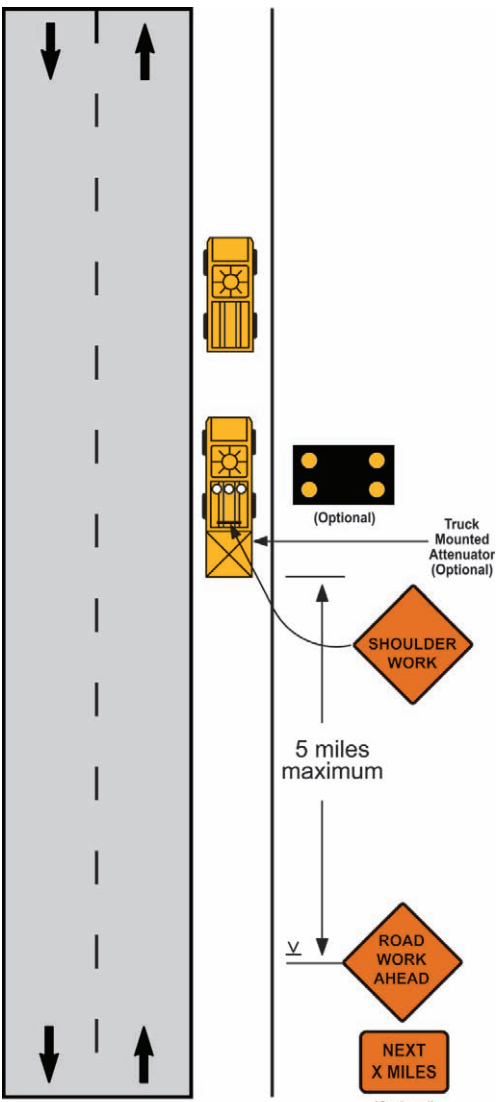
For mobile operations to be successful, the advance warning area for these operations must move with the work area or be repositioned periodically to provide warning for the motorist.

Portable devices should be used. Appropriately colored and marked vehicles with rotating or strobe lights, perhaps augmented with signs, arrow panels, or changeable message signs, may be used in place of signs and channelizing devices. Shadow vehicles with truck-mounted attenuators (TMA's) should also be considered.

Intermittent Mobile Operations – These mobile operations (such as litter cleanup, pothole patching, or utility operations) often involve frequent short stops, and are similar to stationary operations. With operations that move slowly (less than 3 MPH), it may be feasible to use stationary signing that is periodically retrieved and repositioned in the advance warning area. Flaggers may be used, but caution must be exercised so they are not exposed to unnecessary hazards.

Continuously Moving Mobile Operations – These mobile operations include work activities in which workers and equipment move along the road without stopping (mowing, pavement striping, street sweeping, or herbicide spraying), usually at slow speeds. Where volumes are light and visibility is good, a well-marked and well-signed vehicle may suffice. If volumes and/or speeds are higher, a shadow vehicle should be used so that the advance warning area moves with the work area.

Mobile Operation on the Shoulder

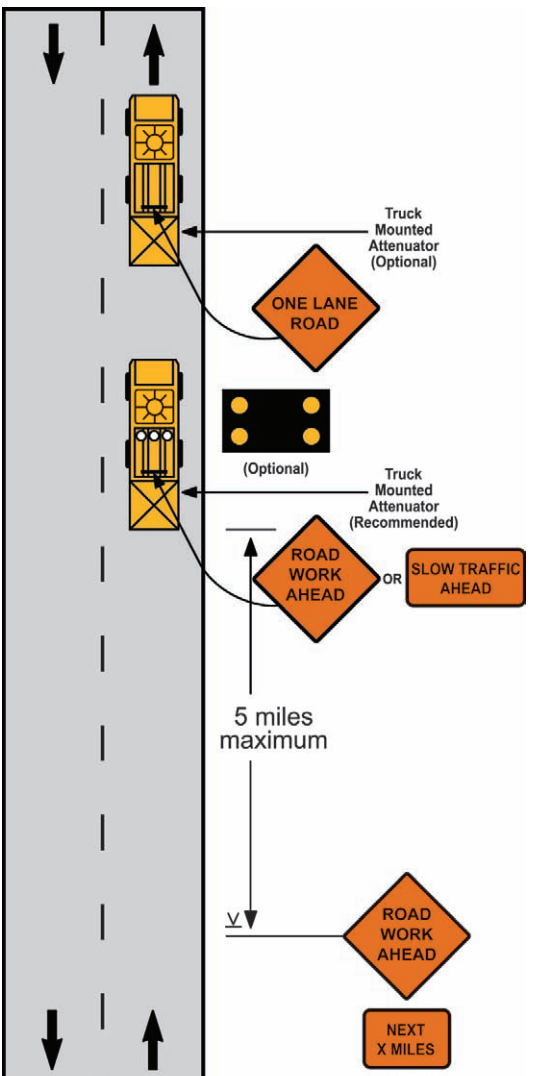


Mobile Operation on the Shoulder

Notes:

1. If the operation requires encroachment on the travelway, a mobile or stationary lane closure should be used.
2. For operations that move slowly (less than 3 MPH) and in situations where multiple work locations in a limited distance make it practical to place stationary signs, the distance between the advance warning sign and the work should not exceed 5 miles.
3. For work zones of more than 2 miles in length, a supplemental distance plaque ("Next X Miles") should be used with the "Road Work Ahead" sign, or a length of work sign ("Road Work Next X Miles") may be used.
4. A shadow vehicle equipped with a "Shoulder Work" sign and optional truck-mounted attenuator (TMA) and/or arrow panel may be used, depending on availability and type of operation. If used, it is located behind the work vehicle to provide advance warning of the operation. If the shadow vehicle with sign is used, the ground mounted sign may be eliminated.
5. If the shadow vehicle is equipped with an arrow panel, it shall ONLY be used in the CAUTION mode.
6. Warning signs may be omitted if the work vehicle displays a rotating or strobe light, if the distance between work locations is one mile or more, and if the work vehicle travels at traffic speeds between locations.
7. Other acceptable advance warning signs include "Utility Work Ahead", "Mowing", Worker symbol signs, or "Road Machinery Ahead".

Mobile Operation on a Two-Lane Road



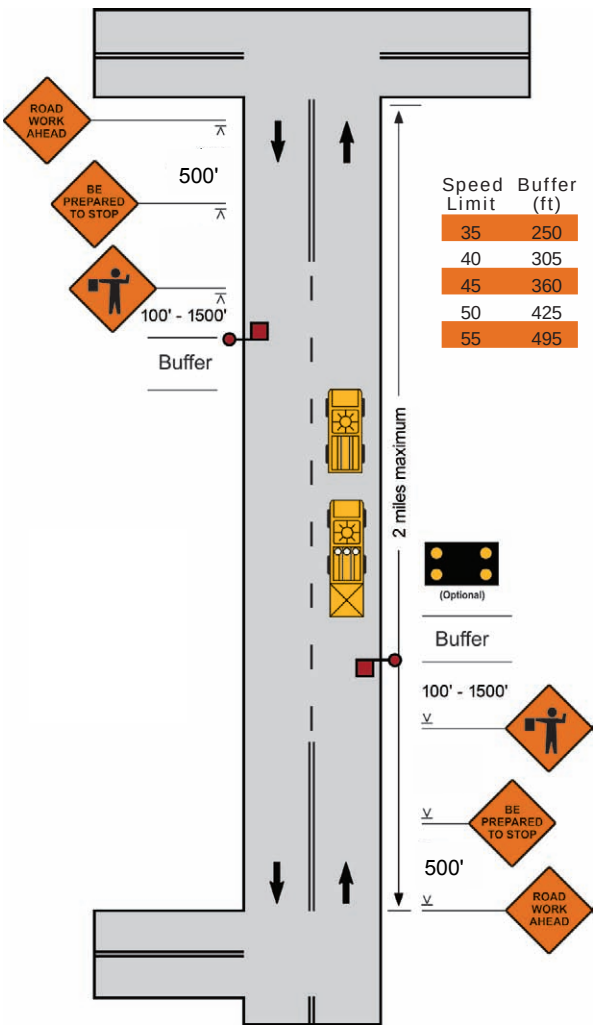
Mobile Operation on a Two-Lane Road

Notes:

1. Where practical and when needed, the work and shadow vehicles should pull over periodically to allow traffic to pass. If this can not be done frequently, a “Do Not Pass” sign may be placed on the rear of the vehicle blocking the lane.
2. Shadow vehicles are used to warn traffic of the operation ahead. The distance between the work and shadow vehicles may vary according to terrain, paint drying time, and other factors. Whenever adequate stopping sight distance exists to the rear, the shadow vehicle should maintain the minimum distance and proceed at the same speed as the work vehicle. However, the shadow vehicle should slow down in advance of vertical or horizontal curves that restrict sight distance.
3. Additional shadow vehicles to warn and reduce the speed of oncoming or opposing traffic may be used. Police patrol cars may also be used for this purpose.
4. A truck-mounted attenuator (TMA) should be used on the shadow vehicle and may be used on the work vehicle. If the shadow vehicle is equipped with an arrow panel, it shall ONLY be used in the CAUTION mode on two-lane operations.
5. Work and shadow vehicles shall display rotating or strobe lights, both forward and to the rear. The shadow vehicle should also be equipped with two high-intensity flashing lights mounted on the rear adjacent to the sign.
6. Vehicle-mounted signs shall be mounted with the bottom of the sign at a minimum height of 4 feet above the pavement. Sign legends shall be covered or turned from view when work is not in progress.
7. Ground-mounted advance warning signs similar to that on the shadow vehicle may be used to provide additional advance warning for the operation. These signs might include “Slow Moving Traffic”, “Road Work Ahead”, “Paint Crew Ahead”, etc. Where speed and/or volumes are high, these signs should be considered.
8. If ground-mounted signs are used and the activity is spread out over a distance of more than 2 miles, a supplemental distance plaque (“Next X Miles”) should be used with the “Road Work Ahead” sign, or a length of work sign (“Road Work Next X Miles”) may be used.
9. For low-volume, low-speed urban conditions, the shadow vehicle may not be practical. For high-volume and/orhigh-speed conditions, the shadow vehicle should be used.
10. If a shadow vehicle is not used then ground-mounted signs should be used to provide advance warning for the mobile operation.

Mobile Operation on a Two-Lane Road Using Flaggers

(15 minutes or less per work area and traveling at less than 3 mph)



Mobile Operation on a Two-Lane Road Using Flaggers

(15 minutes or less per work area and traveling at less than 3 mph)

Notes:

1. The distance between “Road Work Ahead” signs should not exceed approximately 2 miles.
2. Where feasible, well defined end points (intersections, major driveways, city limits, etc.) should be used to establish the limits of the work zone.
3. The Flagger symbol warning signs are repositioned periodically as the operation moves. These signs should be kept within 500′ to 1500′ of the flaggers.
4. The Flagger symbol warning signs should be positioned so that the flaggers are able to see the back of the warning signs. This will assure flagger visibility of traffic and driver’s visibility of them.
5. Work and shadow vehicles shall display rotating or strobe lights, both forward and to the rear.
6. Suggested shadow vehicle configuration includes an arrow panel and a truck-mounted attenuator (TMA).
7. If the shadow vehicle is equipped with an arrow panel, it shall ONLY be used in the CAUTION mode on two-lane operations.
8. A "Be Prepared To Stop" sign may be added to the sign series, located 500 feet after the "One Lane Road Ahead" sign.
9. For low-speed (35 MPH or less) conditions, a 200-foot sign spacing may be used. For speeds of 40 to 50 MPH a 350-foot sign spacing may be used.

Pedestrian and Worker Safety

Pedestrian Safety

When pedestrian travel paths (sidewalks or footpaths) are closed or disrupted by a construction, maintenance, or utility operation, then pedestrian traffic control is needed. This includes the use of signs, channelizing devices, flags, suitable fencing, etc. to direct pedestrian movement through or around the work zone.

There are three major considerations in planning for pedestrian safety in work zones on streets and highways:

- Pedestrians should not be led into direct conflicts with work site vehicles, equipment, or operations.
- Pedestrians should not be led into direct conflicts with mainline traffic moving through or around the work zone.
- Pedestrians should be provided with a safe, convenient travel path that replicates as nearly as possible the most desirable characteristics of sidewalks or footpaths.

All pedestrians, including young, older and disabled, need protection from potential injury and a smooth, clearly defined travel path without abrupt changes in grade or terrain.

Worker Safety

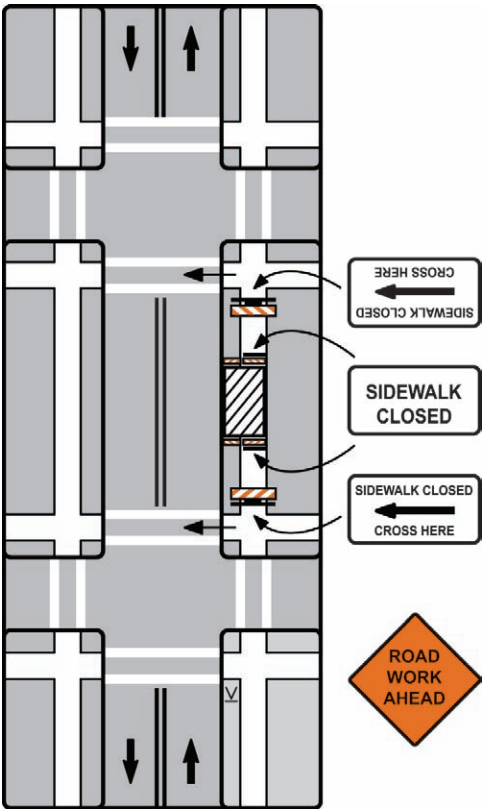
The safety of workers in a work site is just as important as the safety of the public traveling through the work zone. The best protection for both is good work zone traffic control.

All workers should be trained in how to work next to traffic in a way that minimizes their vulnerability. In addition, workers with specific traffic control responsibilities should be trained in traffic control techniques, device usage, and placement.

Workers shall wear approved safety apparel. Approved colors are fluorescent orange-red or florescent yellow/ green.

To further improves worker safety, consider the use of shadow vehicles, temporary traffic barriers, police, and road closure.

Sidewalk Closure
(Pedestrian Detour)

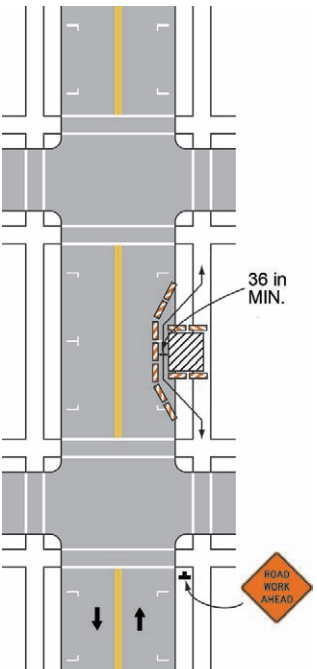


Notes:

1. Where sidewalks exist, provisions shall be made for disabled persons (requirement of ADA).
2. Only the traffic control devices controlling pedestrian flows are shown. Other devices may be needed to control traffic on the streets. Use lane closure signing, “Road Narrows”, or “Lane Narrows” signs as needed.
3. For nighttime closures, Type A flashing warning lights may be used on barricades that support signs and close walkways. Temporary street lighting may also be considered.

Sidewalk Diversion

(Pedestrian Bypass Provided)



Notes:

1. Where sidewalks exist, provisions shall be made for disabled persons (requirement of ADA).
2. Only the traffic control devices controlling pedestrian flows are shown. Other devices may be needed to control traffic on the streets. Use lane closure signing, “Road Narrows”, or “Lane Narrows” signs as needed.
3. For nighttime closures, Type A flashing warning lights may be used on barricades that support signs and close walkways. Type C steady-burn lights may be used on channelizing devices separating the temporary walkway from vehicular traffic. Temporary street lighting may also be considered.
4. Where high speeds are anticipated, a temporary traffic barrier should be used to separate pedestrians from vehicular traffic. Refer to Part 6 of the MUTCD for information on barriers.
5. Signs may be placed along a temporary walkway to guide or direct pedestrians. Examples include “Keep Right” and “Keep Left” signs.

Flagging Procedures

Properly Trained Flaggers

- provide clear messages to drivers as shown
- allow distance for drivers to react
- coordinate with other flaggers

Properly Equipped Flaggers

- approved sign paddles
- approved safety vest and hat
- retroreflective equipment

Proper Flagging Stations

- good approach sight distance
- highly visible to traffic
- never stand in a moving traffic lane
- illuminated at night

Proper Advance Warning Signs

- always use warning signs
- allow reaction distance from signs
- remove signs when not flagging

Flags should only be used in emergency situations. Flags used for signaling shall be a minimum of 24" x 24", red in color, and mounted on a staff about 3' long.

Liability

Steps to Minimize Liability:

- have a current traffic control plan
- follow the MUTCD (Manual on Uniform Traffic Control Devices)
- minimize traffic disruptions
- promptly remove devices
- train all personnel
- inspect work zone sites regularly for conformance

Elements of a Good Inspection Program:

- routine schedule
- report form
- hazard identification
- adequate personnel and equipment inventory
- repair verification
- formal documentation

Minimum Documentation

- date with starting and ending time of work
- location of work
- type, condition, and position of traffic control devices
- names of personnel
- type of equipment used
- any change in temporary or permanent regulatory devices
- additional information should be gathered in the event of an accident

Supervisor's Checklist

1. Follow Part 6 of the MUTCD. It is the national standard for work zone traffic control.
2. State and local manuals that supplement the MUTCD may need to be used.
3. Have a plan before going to the work site.
4. Ask yourself, "What is the driver's view?"
5. Remove the devices in a timely manner.

Acknowledgements

These guidelines were developed by the Institute for Transportation Research and Education (ITRE) at North Carolina State University through a project sponsored by the North Carolina League of Municipalities and the North Carolina Governor's Highway Safety Program. The project was directed by a steering committee comprised of 26 members representing Communities and organizations across North Carolina.

- Bell South
- Carolinas AGC
- City of Charlotte
- City of Conover
- City of Durham
- City of Gastonia
- City of Greensboro
- City of Winston-Salem
- Duke Power Company
- Electricities of North Carolina
- Federal Highways Administration
- North Carolina Association of Electric Cooperatives
- North Carolina Department of Transportation
- North Carolina Governor's Highway Safety Program
- North Carolina League of Municipalities
- Public Service Company of North Carolina
- Sprint
- Town of Holly Springs
- Town of Tarboro
- Town of Wake Forest

This guide is intended for quick reference. It should not substitute for full information from the MUTCD. Users of the guide should be sure to review the MUTCD and current standards for any changes since this guide was prepared.

Information and Training

Contact ITRE for information on these guidelines or training, or your Local Technical Assisstance Program (LTAP) center.

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