

Oregon Temporary Traffic
Control Handbook
FOR OPERATIONS OF
THREE DAYS OR LESS

DRAFT

*Prepared by the Oregon Department of
Transportation*

These standards were adopted by the Oregon Transportation Commission on May 24, 2006 as the standard for all temporary traffic control in place for three days or less on Oregon public roads per ORS 810.200.

The development of this handbook has been a cooperative effort of the Oregon Department of Transportation, the Oregon Traffic Control Devices Committee and its subcommittee including representatives from the following agencies and businesses:

Oregon Department of Transportation Office of Employee Safety
Oregon Department of Transportation Maintenance Districts
Oregon Occupational Safety and Health (OR-OSHA)
Oregon Department of Transportation Rail Division
Marion County Public Works
Deschutes County Public Works
City of Salem Public Works
City of Portland Public Works
City of Eugene Public Works
Central Coast Public Utility District
Springfield Utility Board
Evergreen Public Utility District
Portland General Electric
Northwest Natural Gas
Pacific Power
National Electrical Contractors Association (NECA)
Comcast Communications Corp.
Electrical Construction Company (ECC)
Wildish Construction
Morse Bros. Inc.
North Santiam Paving
K & D Traffic Safety Services
D & H Flagging Inc.
Northwest Traffic Control Inc.
Northwest Traffic Contractors
Mama Jo's Traffic Control Services
D & D Safety Consultants
Oregon Department of Transportation Traffic Engineering and Operations

DATE: June 1, 2006

TO: Handbook Users

We are pleased to bring you this revision to the Temporary Traffic Control Handbook. The many changes and added information have been thoughtfully reviewed by representatives of those who work on and along Oregon roads and highways. We gratefully acknowledge their time, expertise and energy in bringing this handbook revision together.

Within these pages, you can find the guidance to apply the 2003 Manual on Uniform Traffic Control Devices to your work needs. This handbook and related information can be accessed via the internet in the Publications listing on the Traffic Engineering and Operations web site under the Highway Division of the Oregon Department of Transportation.

By cooperative agreement with ODOT, the Training & Economic Development Center of Chemeketa Community College in Salem provides handbooks, training classes and Flagger certification cards through the ODOT Work Zone Traffic Control and Flagging Program. They also can supply additional handbook copies. Their phone number is (503) 399-5181.

Ed Fischer
State Traffic Engineer

Table of Contents

<u>Chapter No.</u>	<u>Page</u>
1. GENERAL STANDARDS AND PRINCIPLES	8
1.0 Scope	8
1.1 Worker Safety Apparel	9
1.2 Surveying and Other Short Duration Work	10
1.3 Bicycle and Pedestrian Considerations	10
1.4 Night Operations	11
1.5 FLAGGING & PORTABLE SIGNALS	12
1.6 Roundabouts	20
1.7 Pavement Markings	20
1.8 Unattended Work Sites	21
1.9 Temporary Traffic Control Zone Components	21
2. SETTING UP THE WORK ZONE	24
2.0 Tapers	24
2.1 Device & Taper Spacing	26
2.2 Device Placement	26
2.3 Signs	28
3. EQUIPMENT SPECIFICATIONS	31
3.0 Signs	31
3.1 Barricades, Cones, Tubular Markers & Drums	32
3.2 Shadow and Protection Vehicles	33
3.3 Truck-mounted Attenuators (TMAs)	34
3.4 Lights and Lighted Signs	34
4. TYPICAL APPLICATIONS	38
Traffic Control for Mobile Operations	38
Traffic Control for Stationary Work	38
TYPICAL APPLICATION DIAGRAMS	40
Section 000 – Detail Drawings	41
Section 100 – Mobile Operations	47
Section 200 – Shoulder Work	63
Section 300 – Work on 2-Lane, 2-Way Roads	67
Section 400 – Work on 3-Lane, 2-Way Roads	83
Section 500 – Work on Multi-Lane Roads	91
Section 600 – Intersection Operations	95
Section 700 – Work on Freeways	107

Table of Contents (continued)

5. INCIDENT TRAFFIC CONTROL	125
5.0 Incident Traffic Control.....	125
5.1 Incident Response Needs.....	126
5.2 Detours.....	127
5.3 Safety Apparel	127
5.4 Emergency Response Example.....	128
APPENDIX A: GLOSSARY OF TERMS.....	130
APPENDIX B: ODOT SHORT TERM TRAFFIC CONTROL PLAN	134
APPENDIX C: CHECKLIST FOR SORK ZONE LAYOUT & OPERATION	135
INDEX	138

LIST OF FIGURES & TABLES

The following list of Figures & Tables in this handbook is included for a quick reference:

		<i>Page</i>
Figure 1-1	General Details of a Temporary Traffic Control Zone	22
Figure 2-2	Cone Spacing Detail	27
Figure 5-1	Emergency Response Example	126
		<i>Page</i>
Table 2-1	Taper Length and Channelizing Device Chart	25
Table 2-2	Sign & Buffer Spacing	30
Table 3-1	Minimum Arrow Panel Sign Sizes	35
Table 4-1	Shadow Vehicle Use and Number on Multi-Lane Roads	53
Table 4-2	Device and Sign Guidance for Shoulder Work	65

LIST OF DIAGRAMS

The following list of diagrams is organized by the area affected.

Work area on the shoulder

Diagram:

002: Pedestrian Layout Details	43
100: Mobile Operations on the Shoulder	47
200: Shoulder Occupation with Brief Road Work	63
210: Work on Shoulder	65
300: Minor Road Encroachment	67
710: Freeway Shoulder Work	110

Work area with lane closure(s), non-intersection:

Diagram:

001: Detail Sheet (Extended Traffic Queues/PCMS/Bicycles)	41
003: Rail Grade Crossing Detail	45
110: Mobile Operation on a 2-Lane, 2-Way Road	50
120: Mobile Operation on a Multi-Lane Road	53
125: Rolling Slowdown.....	56
130: Line Marking on 2-Lane, 2-Way Road	59
135: Line Marking on Multi-Lane Road.....	61
310: 2-Lane Traffic Diversion Using Shoulder	69
320: Lane Closure with Flagging on 2-Lane, 2-Way Road.....	71
330: Lane Closure with Traffic Control Signals.....	75
340: Lane Closure with Pilot Car on 2-Lane, 2-Way Road.....	77
350: Self-Regulating Lane Closure on 2-Lane, 2-Way Road	79
360: Work in Center of Low-Speed Road	81
400: 2+1 Travel Lanes - Work in Single Lane Direction	83
410: 2+1 Travel Lanes - Work in Two-lane Direction	85
420: Work in a Continuous Left Turn Lane	87
430: Diversion into a Continuous Left Turn Lane Section	89
500: Right Lane Closure on a Multi-Lane Road, Non-freeway	91
510: Interior Lane Closure on a Multi-Lane Road, Non-freeway	93
700: Freeway Mobile Operations	108
720: Freeway Lane Closures	112

Work area near Intersections

Diagram:

600: Lane Closure – Near Side of Intersection.....	95
605: Left Turn Refuge Closure.....	97
610: Lane Closure – Far Side of Intersection	99
620: Lane Closure at Intersection with Flagging.....	101
630: Work in Center of an Intersection	103
640: Work in a Roundabout	105

Work area near Freeway Ramps

Diagram:

730: Work Near an Exit Ramp	115
740: Work On an Exit Ramp	117
750: Exit Ramp Closure	119
760: Work Near an Entrance Ramp – Right Side of Entry	121
770: Work Near an Entrance Ramp – Left Side of Entry	123

Oregon Temporary Traffic Control Handbook

For Operations of Three Days or Less

Chapter 1. GENERAL STANDARDS AND PRINCIPLES

1.0 Scope

This handbook provides a reference for the temporary traffic control principles and standards for temporary traffic control zones in place for three days or less on public roads in Oregon. It is based on the principles set forth in Part 6 of the Manual on Uniform Traffic Control Devices [MUTCD] and is an Oregon Supplement to the 2003 MUTCD. For work requiring devices in place longer than three days, a site specific traffic control plan based on the principles in Part 6 of the MUTCD is required. In addition, OR-OSHA has the authority to set and enforce worker safety standards depending on your work activity.

This handbook is applicable to all public roads in Oregon. Each road jurisdiction (City, County, or State) may have additional or more restrictive requirements, and will generally require permits to work in their public right-of-way. The appropriate road jurisdiction should be contacted prior to planning or beginning any work within their jurisdiction.

The primary function of temporary traffic control is to provide safe and efficient movement of road users through or around work zones while protecting workers and emergency response personnel. There are safety concerns for workers while setting up and taking down traffic control zones. As a result, this document is based on the premise that simplified traffic control procedures are warranted for shorter term activities.

1.01 Planned, Emergency and Special Event Traffic Control

Planned Traffic Control includes traffic control for routine maintenance, repair or new installation of road or roadside hardware, whether road-related or not. The traffic impacts from planned work can be anticipated and the proper equipment that complies with the MUTCD and this handbook may be stocked and available as the crew heads out to work. This is true even if the work function is to survey and perform general clean-up and repairs as needed along a stretch of road.

Emergency Traffic Control is used during unanticipated events that require an immediate response to control traffic for responder and/or road user safety. Emergency activities road take precedence over planned activities.

All traffic control devices or equipment used for temporary traffic control shall be in compliance with the MUTCD. However, in emergency situations, the responder may use any available devices or equipment, whether they are in compliance or not, to control and guide traffic through the incident response area. As soon as practical, devices and equipment that comply with the MUTCD and this handbook should be placed to control traffic.

Special Event Traffic Control is designed for planned events that impact the flow of traffic by drawing or releasing large volumes of traffic suddenly into the road system. The traffic operations of the special event should be thoroughly studied and analyzed for expected traffic volumes, entry and exit locations, and available alternate routes.

Check with local jurisdictions and road authorities for information, special requirements, and needs for the special event.

1.1 Worker Safety Apparel

All workers exposed to the risks of moving traffic or construction equipment should wear high-visibility safety apparel meeting the requirements of the ANSI/ISEA High Visibility Safety Apparel guidelines, or equivalent revisions, and labeled as ANSI 107-1999 or later for standard performance for class one, two or three risk exposure.

Small personal steady burn light devices can be attached to the worker's clothing to enhance the visibility of the worker.

A competent person designated by the employer to be responsible for the worker safety plan within the activity area of the job site should make the selection of the appropriate class of garment.

1.2 Surveying and Other Short Duration Work

Surveying work, utility location, manhole inspection and activities similar in nature, are worthy of special attention. This type of work involves multiple, short-duration activities using lightweight, portable equipment and often a single support vehicle. Therefore, quick deployment and portability are important in minimizing worker exposure and risk of injury.

Several techniques can be employed to adequately protect workers involved with this type of work that may appear to deviate from typical applications.

- Lighted message boards, additional lighting and other more dominant devices such as high-intensity rotating, flashing, oscillating or strobe lights on work vehicles may replace more typical advance warning sign sequences
- Advance warning signs should always be used to indicate the presence of workers in the road, as appropriate
- Work vehicles can be placed as a shadow vehicle to provide additional protection to the workers
- Use of a spotter is recommended for work within the road where the worker is unable to monitor or respond to traffic themselves

1.3 Bicycle and Pedestrian Considerations

Accommodate all road users (motorists, bicyclists, and pedestrians - including those with disabilities or visual impairments) at all times within a temporary traffic control work zone. Accommodations for persons with disabilities and visual impairments shall be in accordance with the Americans with Disabilities Act (ADA) of 1990, Title II, Paragraph 35.130 and its revisions, and Part VI of the 2003 MUTCD.

The placement of additional temporary signing and TCD for the control of non-motorized vehicles and pedestrians should be considered where a reasonable volume of users are expected and where work is expected to last longer than one hour.

Basic Principles

Make every practical effort to satisfy the following.

- Match the level of accommodation to the existing facilities available prior to the work.
- Use sufficient TCDs to keep bicycles and pedestrians outside active work areas and away from work equipment.

- Avoid placing bicycles and pedestrians in conflict with live traffic, work site vehicles, materials or operations.
- If using an alternate route, provide sufficient and appropriate advance warning and detour signing for bicycles and pedestrians.
- Work equipment or traffic control device(s) should not protrude into pedestrian or bicycle paths below adult eye level.

Accommodation

- Unless an alternate route is provided, maintain a 4-foot minimum width for bicycles.
- If a significant volume of bicycles can be expected and work requires bicycles to use the travel lanes, install a "BICYCLES ON ROADWAY" sign in advance of the work area. These signs are to remain in place until completion of the shoulder or bikeway surface. See Diagram No. 001 for placement of the sign.

Pedestrian Accommodation

- If work is expected to last longer than a single shift, provide an adequate surface for pedestrians or suitable alternate route.
- Provide a path for pedestrians when work impacts an existing sidewalk unless an alternate route is designated.
- If work closes a sidewalk or sidewalk ramp, close sidewalks at a point where there is an alternate way to proceed or provide an alternate route for pedestrians.

1.4 Night Operations

Working at night when there is less traffic on the road can be the only practical way to accomplish some work tasks. Any time drivers must use their headlights for visibility should be considered the same as night conditions. Use the following basic principles for adjusting your traffic control for night conditions:

- Use enough lighting to provide a safe work environment without creating glare in the path of road users.
- All devices, including flagger STOP/SLOW paddles, shall be retroreflective.
- Signs, cones and worker safety attire used at night should be kept in like new condition.

- If pedestrian facilities are present, check that the path provided for them is lit well enough for people to see any obstructions or surface hazards in their way.
- Traffic control devices marking a boundary for pedestrians, should be clearly visible.
- In residential areas, try to avoid floodlights or glare aimed into homes or yards.

For information on night flagging, see the Night Flagging Section below.

1.5 FLAGGING & PORTABLE SIGNALS

When one direction of the road is closed and road users must alternately share the remaining open portion for both travel directions, flagging, pilot car operation or portable signals shall be used for the safety of workers and road users, including cyclists and pedestrians. Flaggers may be used for traffic control past a closed area. Pilot cars are used to guide traffic around and past long work areas. A pilot car operation uses flaggers at each end of the one lane, two-way section. Portable signals may be used when a regulated two-way traffic movement is needed for the work.

1.51 Flaggers & Flagging

1.510 Flagger Qualifications:

1. Flaggers shall be trained as outlined i below under Flagger Training Requirements and shall be able to show proof of such training
2. Any person from another state with verification of flagger training equivalent to the training required in this manual shall be deemed to have met the flagger training requirement.
3. Flaggers should be able to satisfactorily demonstrate the following abilities outlined in the MUTCD, Section 6E.01:
 - a. Ability to receive and communicate specific instructions clearly, firmly, and courteously;
 - b. Ability to move and maneuver quickly in order to avoid danger from errant vehicles;
 - c. Ability to control signaling devices (such as paddles and flags) in order to provide a clear and positive guidance to drivers approaching a temporary traffic control zone in frequently changing situations;
 - d. Ability to understand and apply safe traffic control practices,

- sometimes in stressful or emergency situations; and
 - e. Ability to recognize dangerous traffic situations and warn workers in sufficient time to avoid injury.
4. Flaggers shall be 18 years of age or older.

1.511 Flagger Training Requirements

Flagger training requires a course of instruction in the following topics. Re-training shall be completed every three years.

Basic Flagger Course Outline:

- a. Fundamental Principles from Part VI of the MUTCD
- b. The Four Parts of Temporary Traffic Control Zones.
- c. Main Traffic Control Devices
 - 1. Signs
 - 2. Cones
 - 3. Barricades
 - 4. Arrow Panels
 - 5. Portable Changeable Message Signs (PCMS)
- d. Location/Spacing of Devices
- e. Flagging Principles
 - 1. Qualifications
 - 2. Clothing
 - 3. Tools
 - 4. Positions
 - 5. Use of Hand-Signaling Devices
 - 6. Pilot Car Operations

1.512 Flagging Principles:

- 1. Flaggers shall be used only when other traffic control methods are inadequate to safely guide traffic through a work area or assure the safety of workers.
- 2. **IT IS ILLEGAL TO CONTROL TRAFFIC BY FLAGGING IN CONFLICT WITH NORMAL INTERSECTION TRAFFIC CONTROL.**
ONLY UNIFORMED POLICE OFFICERS MAY CONTROL TRAFFIC BY FLAGGING IN

CONFLICT WITH NORMAL INTERSECTION TRAFFIC OPERATION UNDER OREGON LAW. See ORS 811.265 This means that traffic can not be flagged to proceed through when facing a red traffic signal light or stop sign, nor flagged to stop when the traffic signal is green.

3. Flagger stations:
 - a. Shall be located such that approaching road users will have sufficient sight distance to be able to stop at an intended stopping point.
 - b. Should be kept clear of all equipment and vehicles, leaving the flagger an open escape route from approaching vehicles when necessary.
 - c. Placing one to three cones on the shoulder at an angle in front of the flagger station will help to draw attention to the flagger.
 - d. Should be within closed lanes or on the shoulder or behind curb. If necessary, move to the center of the approach lanes when traffic is stopped to be visible to incoming traffic.
 - e. Flaggers should stand alone, never permitting a group of workers to congregate around the flagger station.
4. Vehicles should not be delayed longer than 20 minutes under normal conditions, including travel time past the work area. In emergency situations or for clearing the road in operations such as blasting, longer delays may be allowed with advance signing. Every effort should be made through media communications to alert the public of long delays.
5. Conflicting existing regulatory signs, such as STOP, YIELD or RIGHT TURN ONLY, shall be covered.

1.513 Flagging Signs & Equipment:

1. FLAGGER AHEAD signs shall precede flaggers at all times.
2. BE PREPARED TO STOP signs shall be used before the FLAGGER AHEAD sign when the posted speed is 45 MPH or above. The BE PREPARED TO STOP sign is optional for roads with a speed of 40 mph or below. The designated (posted) speed is the speed set by the road jurisdiction or the statutory speed set in Oregon Revised Statutes.
3. FLAGGER AHEAD and BE PREPARED TO STOP signs shall be removed, covered or turned away from traffic when there is no flagging going on.
4. Flaggers shall use a minimum 18" x 18" octagon-shaped retroreflective STOP/SLOW paddle. The paddle shall be made of light, semi-rigid material and the full face of the STOP and the SLOW sides shall be visible and legible at all times when the paddle is in use. A 24" x 24"

octagonal paddle is recommended at high speeds or in other situations where more visibility is needed,

5. Flaggers shall use only those hand signals approved in the Manual on Uniform Traffic Control Devices ANSI D6.1e89 as shown in Figure 6E-1 on page 6E-3 of the 2003 MUTCD.
6. Advance flaggers:
 - a. May use a 24" x 24" red flag on a three foot staff or an 18" x 18" minimum octagon paddle with SLOW facing traffic.
 - b. Advance flaggers shall be preceded by an additional set of appropriate signs.
7. If a staff or extended handle is used, the bottom of the paddle shall be a minimum of five feet above the pavement or just above the flagger's eye level, whichever is higher. Any equipment, clothing or other objects attached to the staff shall be well secured and not allowed to hang freely or loosely.

1.514 Flagger Attire

1. While on duty, flaggers shall be fully clothed. No abbreviated clothing such as swimsuits, shorts, tank tops or halter tops shall be worn.
2. Flaggers shall wear safety apparel meeting ANSI Class two risk exposure standard for high-visibility vest, shirt or jacket.

1.515 Flagging through intersections

Flagging through intersections is especially hazardous, both for road users and workers. Other alternatives should be considered to accommodate the work without affecting normal intersection traffic control, including closing the intersection and diverting traffic.

Concepts applicable to all Intersections:

1. Contact the road jurisdiction traffic office ahead of time for help in determining what closures or detours can be set up to minimize traffic movement through the intersection. All closures shall be approved by the road jurisdiction.
2. Avoid flagging if possible during peak traffic times, especially on major commuter routes.
3. There should be one flagger for each approach (See Diagram 620).
4. With multiple flaggers, designate one as a control flagger. Effective means of communication such as radio devices should be used unless

ambient noise levels allow voice communication at all times.

5. Approach lanes should be reduced to a single through lane. Consider closing lanes that are not a major movement, such as right turn lanes with only occasional use. Consider prohibiting left turns if there is work or obstruction within the intersection.
6. Dedicated lanes may be provided for those major turning movements with appropriate signing such as RIGHT TURN ONLY. Non-conflicting turning movements may be allowed concurrently with other movements.
7. Conflicting regulatory signs, such as STOP, YIELD or RIGHT TURN ONLY, shall be covered.

1.516 Flagging at Signalized Intersections:

1. IT IS ILLEGAL TO CONTROL TRAFFIC BY FLAGGING IN CONFLICT WITH NORMAL INTERSECTION TRAFFIC CONTROL.

ONLY UNIFORMED POLICE OFFICERS MAY CONTROL TRAFFIC BY FLAGGING IN CONFLICT WITH NORMAL INTERSECTION TRAFFIC SIGNAL OPERATION UNDER OREGON LAW. See ORS 811.265. This means that traffic can not be flagged to proceed when facing a red traffic signal light or stop sign, nor flagged to stop when the traffic signal is green.

2. Conflicting displays or signs shall be turned off or covered.
3. Contact the road jurisdiction for permission to turn off the signal. This may mean coordinating with city/county or region electrical crew personnel or the local police. For work under ODOT permit, this should be included in the permit.
4. Flagging shall continue until the signal is back in operation.

1.517 Night Flagging:

When flaggers and/or pilot cars are necessary during night operations, flagger stations shall be illuminated, and shall be illuminated separately from the work area. Consider using ANSI class three high visibility safety attire during night operations.

The following Night Time Flagger Illumination strategies should be followed:

1. The light equipment should:
 - a. be located on the same side of the highway as the flagger,
 - b. be located on the road shoulder approximately 5-10' from the edge of the traveled way,

- c. illuminate the flagger from above at a height of approximately 15-25'.
2. Light output should be at least 250 watts and not exceed 2,000 watts.
3. Spot lights should not be used.

Consider using the following to increase visibility during night flagging:

1. Additional lights on the STOP/SLOW paddle as allowed by the MUTCD.
2. Flashing warning lights on the advance warning signs, especially the Flagger Ahead sign.
3. A 24" x 24" STOP/SLOW paddle, as it is much more visible than the smaller signs.
4. The staff or extended handle of the STOP/SLOW paddle may have 2" reflective bands of white or alternating red and white diagonal stripes.

1.518 Flagging on Bridges and Viaducts:

Avoid setting up flagger stations on a bridge, viaduct or other road section where there is no feasible escape route. On very long bridges with high traffic volumes where flagging can not be moved to the ends, leave a full length buffer space free of equipment and vehicles. (See Table 2-2)

1.52 Pilot Car Operation

A pilot car may be used to guide traffic through a long section of one lane, two-way road past the road sections closed for work activity. A pilot car should be considered if a driver can not see from one end of the job to the other after entering the one lane section and there is opportunity to move into the closed lane. Alternately, the closed lane may be emphasized with cones or other channelizing devices and occasional transverse barricade or cone taper inside the closed lane.

1. Operation of the pilot vehicle shall be coordinated with flagging operations at each end of the one lane section.
2. The PILOT CAR FOLLOW ME sign shall be mounted in a conspicuous location on the rear of the vehicle. A PCMS may be used for the pilot vehicle sign.
3. The pilot vehicle guides traffic through the work zone by driving in front of the traffic queue, maintaining a safe speed.
4. Radio or other communications should be available between the pilot

vehicle driver, the flaggers and the work superintendent or designated worker at all times.

5. No vehicles should be allowed to pass the pilot vehicle
6. The last vehicle following a pilot car in a queue may be identified by handing off a flag between driver and flaggers. Alternately, the last vehicle can be identified by communications between flaggers.
7. The pilot vehicle should have the name of the road jurisdiction or the contractor prominently displayed on the vehicle.
8. Side accesses should be controlled with flaggers. If entering traffic is rare and the access can be monitored, FOLLOW PILOT CAR signs may be used instead of flaggers.

1.53 Portable Traffic Control Signals

This section covers the use of portable traffic control signals to control traffic through a one lane, two-way work zone. The use of portable signals is discouraged for work lasting three days or less.

1. Portable traffic control signals shall be set up for line of sight from one end of the one-lane section to the other and always requires hard wire interconnect.
2. Any intersecting roads or driveways between the portable traffic signals shall be closed..
3. An all-red interval is required that is long enough for road users to clear the one lane section.
4. The portable signal control equipment shall have safeguards that eliminate the possibility of conflicting signal indications at each end of the traffic control zone.
5. Portable traffic signals shall have vertically arranged 12 inch diameter signal lenses.
6. Each portable traffic control signal unit shall have at least one signal head mounted on a pole with the bottom of the signal head at least eight feet above the sidewalk or, if there is no sidewalk, above the centerline of the road. At least one vehicle signal head shall be located over the travel lane(s) with a minimum vertical clearance of 17 feet to 19 feet.
7. On state highways, use of portable traffic control signals shall be by permit, and approval from the State Traffic Engineer is required before a permit is issued. Equipment shall be listed on the ODOT Qualified Products List (QPL). On local roads, check with local jurisdictions for signal approval.

8. The timing parameters are supplied by the agency Traffic Engineer to the user in order to properly time the signal and shall not be changed without prior approval.
9. Portable signals are for stationary work only.

1.54 Spotter Guidelines:

A spotter's sole duty is to provide immediate warning of approaching vehicles, equipment, or other hazards. A spotter is typically used for brief roadwork (See Section 200). The use of a spotter may enhance the safety and efficiency of both road users and workers. Typical work requiring a spotter includes debris removal, tagging of survey markers, or marking utility lines.

A spotter does not control traffic.

Determining the need for a Spotter: Consider using a spotter when:

- the work activity is short, i.e. 15 minutes or less,
- workers must have their backs to traffic or other hazards.
- traffic does not need to be controlled for safe access to the work area so that work in the road may coincide with gaps in the traffic,
- there is at least ten feet of clearance between the work vehicle and the centerline (See Diagram 200),
- sight distances are limited by vegetation or other conditions
- traffic speeds are not high.

Using Warning Devices: If a spotter is not within visual and/or verbal contact of employee an air-horn, two-way radio, or other warning device shall be used.

Alerting Call or Device: The 'Alert Call' shall be agreed upon by all affected parties prior to use of a spotter and shall be clearly heard above all surrounding noise levels.

Escape Route: A predetermined escape route for each spotter and the protected employee(s) will be established prior to beginning work.

Commencement of work: The spotter shall be in place and be prepared to issue alerts before the work operation begins.

1.6 Roundabouts

Roundabouts pose unique challenges when work or incident management must be done in the vicinity. It is recommended that work take place during the hours of low traffic volumes

A roundabout is not designed to hold stopped or waiting traffic. Detour signing or flagging may be required when the work blocks traffic from using the circular road.

1.7 Pavement Markings

Where visible permanent markings are inconsistent with the intended travel paths, use highly visible temporary devices such as signs and cones or tubular markers to clearly show the appropriate path. All pavement marking / delineation shall match the existing markings at both ends of the work zone.

The intended vehicle path should be defined in day, night, and twilight periods, and under both wet and dry pavement conditions. All devices and markings that must be visible at night shall be retroreflective. Removable nonreflective preformed tape may be used where markings need to be covered temporarily. If raised pavement markers are used to substitute for pavement markings in work zones, their application shall meet the requirements of the MUTCD for the line type they are replacing.

Pavement markings shall be replaced before the road is re-opened to traffic:

- if work covers or removes the pavement markings for a distance longer than two skip markings or 80 feet measured along the centerline or
- if they are covered or removed for any distance in critical areas such as problem horizontal curves, vertical curves, or weaving areas.

Temporary pavement markings may be used until the earliest date it is practical and possible to install permanent pavement markings. They should not be allowed to remain in place for more than two weeks unless justified by an engineering study. **“No Passing Zones”** for a two or three-lane road, may be identified by using DO NOT PASS and PASS WITH CARE signs rather than pavement markings when in place for three days or less. These signs may also be used instead of pavement markings on low volume (average daily traffic [ADT] less than 400) roads for longer periods in accordance with the road jurisdiction's policy.

If two-way traffic will be allowed without a marked centerline, use DO NOT PASS and PASS WITH CARE signs at the start and end of no-pass zones.

For use on state highways, see the ODOT Construction Specifications Temporary Traffic Control Sections 220 and 225; otherwise follow the road jurisdiction's policy for layout of temporary pavement markings.

1.8 Unattended Work Sites

If a work site must be left unattended before the work is completed, all warning signs and channelization devices shall be in place before opening the road to traffic. Turn, cover or remove all inappropriate signs and traffic control devices. Equipment left at the work site should be off the shoulder if possible. If equipment must be left on the shoulder less than 15 feet from the edge of travel way or in a closed lane, the equipment shall be delineated the same as a PCMS.

Changes in road surface such as rough pavement, excavations or raised plates in the road shall have the appropriate advance warning signs in place. Advance warning signs also shall be in place for such obstructions and the obstruction shall be delineated and protected by cones, drums or barricades.

All unattended work sites with traffic control left in place should be routinely inspected by a knowledgeable person for adequate compliance, visibility and condition of the traffic control devices. Immediately replace all damaged or missing TCD. Devices left in place must be appropriate for all expected or anticipated conditions such as daylight, darkness and twilight, and wet or dry conditions.

1.9 Temporary Traffic Control Zone Components

The temporary traffic control zone as shown in Figure 1-1 has four parts and extends from the initial advance warning signs through the last temporary traffic control device.

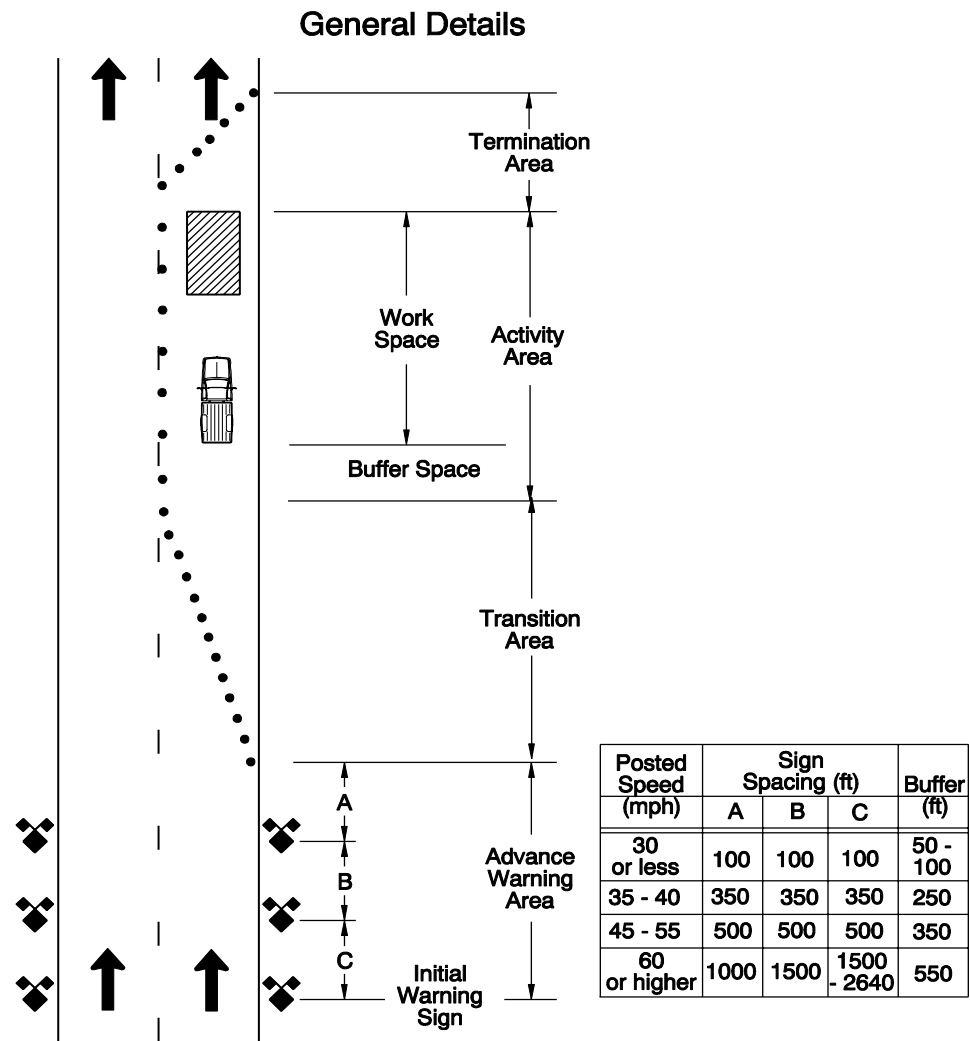


Figure 1

- A. **Advance Warning Area:** An advance warning area is necessary for all traffic control zones, and may vary from a series of signs starting a mile or more in advance of the work area to a single sign or flashing lights on a vehicle.
1. **The advance warning** area should give road users enough time to respond to any changes in the transition area. The length of the advance warning area will vary based on road type, posted speeds, etc. Refer to diagrams for specific advanced warning area lengths.
 2. **Extended traffic queues (those which** extend beyond sight distance of the BE PREPARED TO STOP SIGN), require additional signing. If queue lengths frequently and significantly change consideration should be given to use of a PCMS up to ½ mile in advance of the work zone signing, especially on high speed roads (See Diagram No. 001).
 3. If **Pedestrian or Bicycle** traffic can be expected, traffic control set up shall adequately provide for their safe use. C. Allowances for pedestrians with disabilities appropriate to the level of normal pedestrian facilities shall be provided. Blocking of bicycle and pedestrian traffic is discouraged.
- B. **Transition Area:** In a transition area, traffic is channelized from normal public road lanes to the path required to move traffic around the work area. The transition area contains the tapers which are used to close the lane(s).
- C. **Activity Area:**
1. **A Buffer Space** is a short section of clear road between the cone taper and the work area which can provide an extra margin of safety for both traffic and workers. The buffer space should be kept clear of vehicles, equipment, materials and personnel to provide a clear recovery area. The buffer space is optional but should be provided when space is available.
 2. **Work Space or "Work Area"** is that portion of the road which contains the work activity and that is set aside exclusively for workers and equipment. It should be sufficiently delineated and protected.
- D. **Termination Area:** The termination area provides a short distance for traffic to clear the work area and return to normal operation. Like the buffer space, the downstream cone taper is optional. An END CONSTRUCTION or END ROAD WORK sign is optional.

Chapter 2. SETTING UP THE WORK ZONE

This section provides guidelines and procedures for setting up work zone, special event or incidence response. .

2.0 Tapers

Taper lengths shown in the table or calculated are minimum taper lengths. Longer tapers may be necessary for drivability, for instance around curves or on a steep. To determine if a taper length is adequate, watch traffic maneuver through the work zone.

There are five types of tapers:

Merging Taper: merges two traffic lanes in the same direction into one lane

Shifting Taper: moves traffic from one path to another with the same number of lanes

Shoulder Taper: used when shoulder is closed to traffic **One-Lane, Two-way Taper:** closes lanes leaving only one lane open to handle two alternating directions of traffic.

Downstream Taper: or termination taper, guides the motorist back into their normal travel path.

See **TABLE 2-1** – Taper Length values were calculated using the formulas below with posted speed and widths of closed lane.

For taper lengths not shown in Table 2-1, calculate the lengths using the Formulas below.

Work Zone Taper Length

Merging taper - minimum	=	L
Shifting taper - minimum	=	$\frac{1}{2}$ L
Shoulder taper - minimum	=	$\frac{1}{3}$ L
One-Lane, Two-way Traffic taper	=	50 feet min. - 100 feet max.
Downstream taper	=	100 feet

Work Zone Taper Length Formulas

Table 2-1 shows formula results for posted speed.

Posted or statutory speed = 40 MPH or less: $L = WS^2 / 60$

Posted or statutory speed = 45 MPH or more: $L = W \times S$

L = Taper length in feet

W = Width of offset in feet

S = Posted speed

TABLE 2-1: Taper Lengths

Taper Length and Channelizing Device Chart

Lane Width	10 Feet				11 Feet				12 Feet				Shoulder Tapers	
	"L"		"1/2 L"		"L"		"1/2 L"		"L"		"1/2 L"		"1/3 L"	
MPH	Merge	Cone	Shift	Cone	Merge	Cone	Shift	Cone	Merge	Cone	Shift	Cone	10 Ft. Shldr	Cone
20	70	5	35	3	75	5	40	3	80	5	40	3	25	3
25	105	7	55	4	115	7	60	4	125	8	65	5	35	3
30	150	9	75	5	165	10	85	6	180	10	90	6	50	4
35	205	12	105	7	225	13	115	7	245	14	125	8	70	5
40	270	15	135	8	295	16	150	9	320	17	160	9	90	6
45	450	13	225	7	495	14	250	8	540	15	270	8	150	5
50	500	14	250	8	550	15	275	8	600	16	300	9	170	6
55	550	15	275	8	605	17	305	9	660	18	330	10	185	6
60	600	16	300	9	660	18	330	10	720	19	360	10	200	6
65	650	18	325	10	715	19	370	11	780	21	390	11	220	7
70	700	19	350	10	770	21	385	11	840	22	420	12	235	7

All taper lengths are rounded up to the nearest 5 feet.
Shoulder taper is figured on a ten (10) foot shoulder width.

Cone spacing is 20 feet for speeds of 40 and below
Cone spacing is 40 feet for speeds of 45 and above

2.1 Device & Taper Spacing

- **Taper Spacing:** The longitudinal distance between cones in the taper should equal 20 feet for posted speeds of 40 MPH or less and 40 feet for posted speeds of 45 MPH or more. Optionally, the taper cone spacing may be equal to the posted speed in feet.
- **Offset:** The offset will vary with the lane width and length of the taper. The required number of cones to make the taper length should be evenly offset over the lane width. Table 2-1 includes the number of cones for each taper.
- **One-Lane/Two-way & Downstream:** Cones in one-lane/two-way and downstream tapers should be spaced at 20 foot intervals. A one-lane/two-way taper is a minimum of 50 feet and a maximum of 100 feet. A downstream taper is 100 feet per closed lane. If applied, a minimum of six cones shall be used for a downstream taper.
- **Buffer & Work Area (Tangent) Cones:** Cone spacing alongside the buffer and work area (tangent) in feet equals twice the taper spacing. Spacing is 80 feet for 45 MPH and above; 40 feet for 40 MPH and below. Optionally, the buffer and work area (tangent) cone spacing may be equal to the twice the posted speed in feet.

2.2 Device Placement

- 1) **Determine the taper length and cone spacing** using the Taper Length Table and cone spacing guidelines.
- 2) **Place the first cone** starting at the activity area, pace off the taper length along the road edge or edge of travel way. Place the first cone at the outside lane or edge of travel way for merging and shifting tapers, at the road edge for shoulder work.
- 3) **Place the second cone in the taper** by starting back towards the work area, walking along the road edge or edge of travel way a distance equal to the selected cone spacing. Then move over the required offset and place the second cone (See Figure 2-1).
- 4) **Place the third cone** by moving towards the work area a distance equal to the selected cone spacing, move over twice the required offset and place the third cone.
- 5) **Place the remaining cones in the taper** by continuing to move back towards the work area a distance equal to the selected cone spacing, and over into the lane until reaching the distance equaling the required offset past the last cone.

Cone Spacing
12 FOOT LANE WIDTH
POSTED SPEED 35 MPH

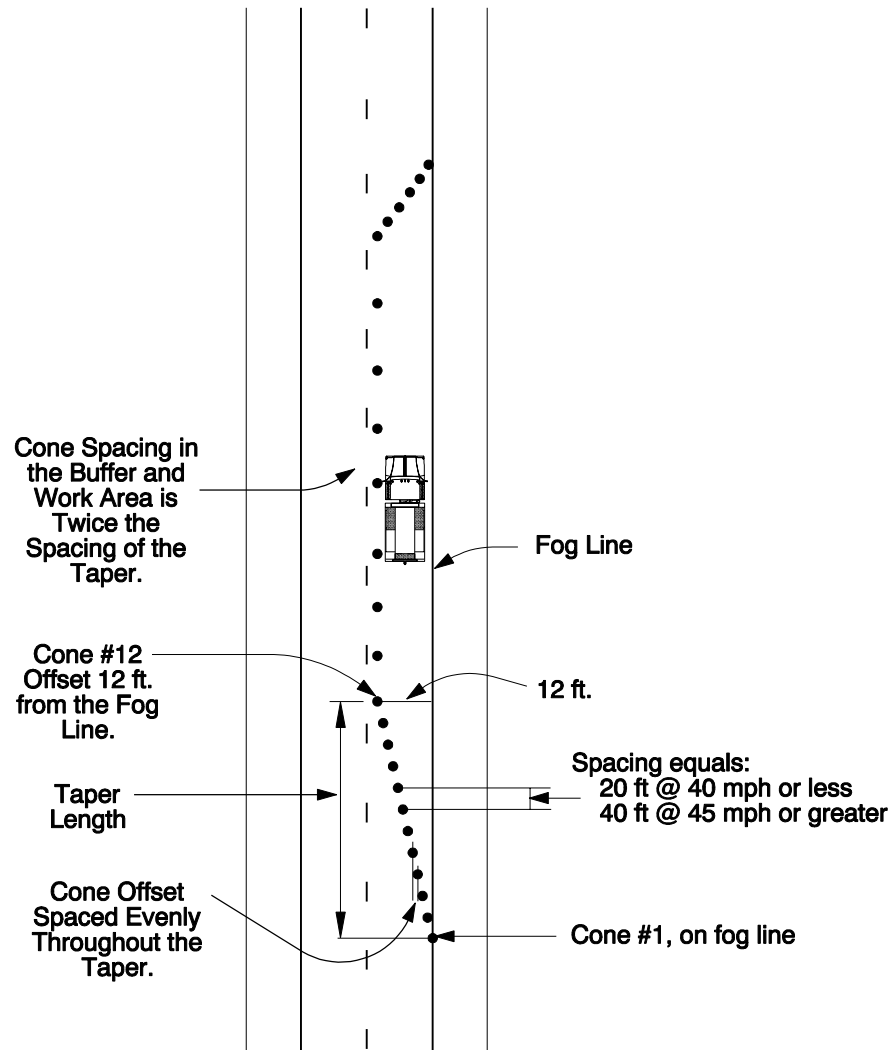


Figure 2

2.3 Signs

Choosing Signs: Effective work zone signing tells the road user what action or direction to take. Avoid general warning signs without any specific action or condition. For instance, follow a SHOULDER WORK AHEAD by SHOULDER CLOSED sign rather than by a CAUTION sign.

The initial warning signs should indicate the type of work the driver can expect. Typical signs include, but are not limited to:

ROAD WORK AHEAD
SHOULDER WORK
BRIDGE WORK AHEAD
LITTER CREW
UTILITY WORK
INCIDENT AHEAD
WORKERS ON ROADWAY
SURVEY CREW
WRECK AHEAD

A distance may be substituted for AHEAD on any warning sign, or may be added as a rider.

Additional advance or interim signing may be necessary, in some cases, in order to extend advance signing. Signs should be appropriate to what the motorist might encounter. Typical signs include but are not limited to:

WORKERS
BICYCLES ON ROADWAY
Bicycle Symbol Sign
Pedestrian Symbol Sign
SLOW (Used only to complement other warning signs)

Work zone signs shall:

- be clean, fully legible and in good condition.
- be mounted so that the bottom of the sign is not less than one foot above the road.
- allow pedestrians and/or cyclists an unobstructed travel path.

When signs are used on the shadow and work vehicle, they shall be facing the rear so that the entire sign face is visible at all times.

The following signing enhancements may be used:

- Signs that are larger than the minimum standard may be used any time. Larger signs can be more effective when the visual landscape is crowded or traffic volumes are high.
- Brighter sheeting.

- Add a flashing warning light to advance signing, if the sign/light/support combination has passed crash testing.

To keep the road users' respect and maintain credibility, cover, turn or remove all signs when the work zone is not active or flagger is not present. IF "FLAGGER" SIGNS ARE IN PLACE, A FLAGGER MUST BE ACTIVE, even if just to warn drivers of approaching work zone activity.

Sign Placement: Sign spacing and placement in this handbook are for open, unobstructed road conditions. Placement should adequately control traffic and protect the work area. The layout may be modified as necessary to provide visibility, allow safe passage of pedestrians and cyclists and avoid interference with physical features such as curves, hills, intersections, driveways or other traffic control devices. Consider the following when determining sign layout:

- Place the initial work advance signs such as ROAD WORK AHEAD before entering a horizontal curve or before the crest of a hill if needed to provide adequate sight distance. Space the remaining signs leading up to the work area close enough together to maintain road user awareness and still maintain the minimum sign spacing for the posted speed. Sign spacing shall not exceed twice (2X) the minimum sign spacing.
- If sign spacing needs to be adjusted, keep all the sign spacing distances similar to maintain driver expectancy.
- If a driveway comes in between the last work zone sign and the work, but the work zone is not apparent from the driveway approach, use a sign or cones at the driveway to alert users.
- Alter the sign spacing distances slightly when necessary to provide a level area for sign placement. If no level placement is available, make sure the sign is stable and the message is fully visible to approaching drivers.

Standard Sign Spacing: See the table below for standard sign spacing.

Distance A: is the distance from the last warning sign to the taper or work area if there is no taper. If only one sign is used, the placement will be based on distance A

Distance B: is the distance between signs in the middle of a sign sequence.

Distance C: is the distance from the initial warning sign to the next sign in the sequence.

Sign spacing and placement set forth in this handbook is a guide intended for open and unobstructed road conditions. Suggested sign spacing should be adjusted if necessary to;

- control traffic,
- allow safe passage of pedestrians and cyclists,
- protect the work area,
- provide good visibility of the sign and
- avoid interference with physical features such as intersections, driveways or other traffic control devices.

Placement may be modified based on good judgment and traffic patterns. If one sign spacing in a sequence needs to be lengthened, all the sign spacing distances should be proportionately changed.

Table 2-2: Sign and Buffer Spacing

Posted Speed*	A	B	C	Suggested Buffer
30 MPH or less	100	100	100	50 - 100
35 MPH - 40 MPH	350	350	350	250
45 MPH - 55 MPH	500	500	500	350
60 MPH and higher ^	1000	1500	1500 - 2640	550

All distances in feet

* Posted speed or statutory speed if not posted

^ Includes all freeways and expressways, regardless of posted speed

Chapter 3. EQUIPMENT SPECIFICATIONS

All traffic control devices used on state highways shall be listed on the ODOT Qualified Products List.

3.0 Signs

Unless otherwise noted, all warning signs used for temporary traffic control shall have standard black legends and borders on an orange, fluorescent red-orange or fluorescent yellow-orange background except that signs for emergency response may be black legends and borders on fluorescent pink. A fluorescent yellow border may be added to the truck-mounted signs to enhance their visibility.

Temporary regulatory and guide signs have the same shapes and colors as the permanent signs.

All warning and regulatory signs used for temporary traffic control shall be retroreflective. Non-retroreflective signs in good or better condition may be used during daylight hours until July 2008 to allow for replacement based on useful life.

Only flexible signs may be used on portable sign supports. Rigid signs may be used on barricades when appropriately crash tested or when mounted on a vehicle. Existing rigid signs, used only in unexpected emergency situations, may be used through their life cycle. When these signs are replaced, the replacement signs shall meet the current standard. The exception does not apply to signs used for regularly occurring flooding, slides, or similar situations that can be expected in a particular location.

Standard size of the diamond-shape advance warning signs is 36" x 36" except on freeways.

Standard size of the diamond-shape advance warning signs on freeways is 48" X 48".

Except on state highways, 30" x 30" warning signs may be used on low volume roads or less with the permission of the road jurisdiction.

Signs on portable supports shall have two fluorescent orange or orange-red flags at least 16 inches square mounted at the top of the sign. Flags shall be mounted so that the entire sign legend is visible.

All signs shall have been crash tested as a combination with the sign support and/or any warning light attached and met the federal crash worthiness requirements. This can be researched on the Federal Highways Administration web site, or through the ODOT Qualified Products List.

Sign Supports: Sign supports shall be crashworthy. Signs may be mounted on portable sign supports or barricades. For frequently moving work, signs may be placed on a vehicle. Place ballast on portable sign supports or barricades only on the bottom feet or frame. Sign supports or barricades shall not be ballasted by non-deformable objects such as rocks or concrete blocks.

3.1 Barricades, Cones, Tubular Markers & Drums

BARRICADES: Barricades are classed as Type I, Type II, or Type III. They have from one to three rails with alternating orange and white strips sloping downward at an angle of 45 degrees in the direction road users are to pass. The minimum length for Type I and Type II barricades shall be 24 inches and the minimum length for Type III barricades shall be 48 inches. The sides of barricades facing traffic shall have retroreflective rail faces.

Barricades should be crashworthy per NCHRP 350 requirements. Ballast may be placed on the lower parts of the frame or stays. Do not place ballast on top of any striped rail. Do not use non-deformable objects such as rocks or chunks of concrete as ballast.

Signs and flashers may be installed on barricades. The combination of sign and/or flasher and barricade should have been tested and meet NCHRP 350 requirements.

CONES: Standard cone height is 28 inches. Cones used only during daylight and on low speed roads may have a minimum height of 18 inches. Cones shorter than 28 inches may not be used on roads with speeds of 45 MPH or greater or at night. All cones shall have a weighted base and be capable of remaining upright and in place during normal traffic flow and wind conditions common to the area.

Cones used at night shall be retroreflectorized. Twenty-eight (28) inch cones shall have a minimum 6-inch wide retroreflectorized band three to 4-inches below the top and a 4-inch wide band a minimum of two inches below the 6-inch band. Cones may be equipped with lighting devices for maximum visibility. The combination of cone and light should meet NCHRP 350 requirements.

DRUMS (BARRELS): Drums used for traffic control shall be constructed of lightweight, flexible, and deformable materials; be a minimum of 36 inches in height; and have at least an 18-inch minimum width, regardless of orientation. The markings on drums shall be horizontal, full circumference, alternating orange and white retroreflective stripes four to six inches wide. Each drum shall have a minimum of two orange and two white stripes. Any non-retroreflective spaces between horizontal orange and white stripes shall not exceed two inches wide. Drums shall have closed tops that will not allow collection of roadwork or other debris.

Drums should not be used to mark pedestrian paths unless they are continuous between individual devices and detectable to users of long canes. Metal drums shall not be used.

TUBULAR MARKERS: Tubular markers are cylindrical in shape with a weighted base. The tube shall be a minimum of two inches wide facing traffic. Standard tubular marker height is 28 inches. Tubular markers used only during daylight and on low speed roads may have a minimum height of 18 inches. Tubular markers shorter than 28 inches may not be used on roads with speeds of 45 MPH or greater or at night.

Tubular markers used at night shall be retroreflectorized. Twenty-eight (28) inch tubular markers shall have two 3-inch wide bands no more than two inches below the top with no more than six inches between bands

Non-cylindrical tubular markers may be used only if they will be secured in a way which ensures that the width facing traffic meets the minimum requirements.

3.2 Shadow and Protection Vehicles

Shadow and Protection Vehicles are strategically placed to protect the workers and work activity and may be used to warn traffic of the operation ahead. A Truck-Mounted Attenuator (TMA) may be used on a shadow vehicle or protection vehicle (see Truck-Mounted Attenuators).

If using shadow or protection vehicles, use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all vehicles. Arrow Panels, when not displaying directional mode arrows or chevrons, may be operating in a non-directional mode (caution mode) in lieu of warning lights (see section on Arrow Panels for when to use directional or non-directional modes). Vehicle hazard signal lights may be used only as a supplement the warning lights but shall not be used as a replacement for warning lights.

Signs should be mounted in a manner such that they are not obscured by equipment or supplies. Signs should be covered or turned and warning lights turned off when traveling to and from the work area and work is not in progress.

A SHADOW VEHICLE is used as a warning and traffic control vehicle in a **mobile** work zone (See Diagram No. 120). Shadow vehicles provide both the advance warning area and lane or shoulder closures for a mobile work zone. When adequate sight distance exists to the rear, a shadow vehicle should maintain a space between the other vehicles that is minimized to deter road users from driving in between.

Additional shadow vehicles may be used to warn oncoming or opposing traffic.

A PROTECTION VEHICLE is used as a stationary vehicle placed to protect the workers and work activity (See Diagram No. 310). The protection vehicle is placed after the buffer space and sufficiently in advance of the work area protected to allow for run-out if hit but not so far that road users can drive between it and the work area.

3.3 Truck-mounted Attenuators (TMAs)

Truck-mounted attenuators (TMAs) are crash cushion systems that lower the severity of a rear-end hit by an oncoming vehicle. They are located to protect the work vehicle(s) and workers ahead of the vehicle with the TMA.

TMAs are designed for use on different classes of vehicles and for specific travel speed ranges. The manufacturer's rating shall be considered in choosing equipment for any particular job site. TMAs used on freeways should be rated for high speeds. Use of a TMA/vehicle combination rated for less than the posted speed where you will be working should only be considered when more appropriate equipment is not available.

When traveling to or from the work site, the TMA shall be in an upright position. When used, the attenuator should be in the full down and locked position.

For stationary operations, the TMA-equipped vehicle's parking brake should be set, and when possible, the front wheels turned to direct the vehicle away from the work site if hit and into a safe area. Placement of the rollout distance of the TMA should be based on manufacturer's recommendations.

For moving operations, the shadow vehicle with a TMA shall be positioned far enough in advance of the workers or work equipment being protected so that there will be sufficient distance for run-out from impact but not so far that errant vehicles can travel around the protecting vehicle, re-enter the work vehicle array and strike the protected workers or equipment. If only one TMA is used in a mobile work train, the shadow vehicle with the TMA should be the first vehicle exposed to traffic in the travel lane. In this case, a hazard assessment conducted by the supervisor will determine which vehicle should be equipped with the TMA.

3.4 Lights and Lighted Signs

3.40 ARROW PANELS: Sign panels conforming to the requirements of the MUTCD with a matrix of lights capable of either flashing or sequential display of directional mode arrows or chevrons or non-directional (caution) mode. Caution mode consists of a four-corner display or mid-position full

horizontal bar, and can be steady or flashing on and off. When sign is flashing in caution mode, it shall not show any sequential movement.

- Arrow panels in the directional mode are required for use on freeway lane closures, and are suggested for use on multi-lane roads to help warn of lane closures requiring merging of travel lanes.
- For shoulder closure, arrow panels are only used in the caution mode. The use of arrow panels in caution mode is recommended for shoulder closure on freeways.
- On two-way, two-lane roads, arrow panels shall be used in the caution mode only except for centerline operations.

For lane closures, the arrow panel should be located on the shoulder at the beginning of the cone taper. Where the shoulder is too narrow, they may be placed in the lane being closed. For closure of more than one lane, an arrow panel should be used per each additional closed lane.

Table 3-1: Minimum Arrow Panel Sign Sizes

Panel Type	Minimum Size (Inches)	Minimum Legible Distance	Min. # Elements
A Urban	48 x 24	½ mile	12
B Standard	60 x 30	¾ mile	13
C Freeway	96 x 48	1 mile	15

Type B arrow panels are appropriate for intermediate speed facilities and for maintenance or mobile operations on high speed roads or freeways.

Arrow panels used for night operations shall be capable of 50% dimming from their full rated lamp voltage.

3.41 FLOODLIGHTS: Floodlights should be used to illuminate the work area, flagger stations, equipment crossings and other areas such as nearby intersections during nighttime operations. Flagger stations shall be illuminated separately from the work area. You shall ensure that each setup does not aim excessive light into the eyes of oncoming drivers or produce excessive glare making it difficult to see beyond the main illuminated area. The best way to determine if floodlighting is well placed is to drive through the set up after dark from each approach direction.

Research indicates that 50 lux (five foot candles) is a desirable nighttime illumination level where workers are active. If everything in the light appears in full color, the lighting level is satisfactory. Sidewalks or pedestrian detours should be included in the lighted perimeter.

3.42 PORTABLE CHANGEABLE MESSAGE SIGNS (PCMS): Also described as portable variable message signs. PCMS include a message sign panel, control system, power source and mounting and transporting equipment. They shall conform to all requirements in the MUTCD and shall be listed on the Qualified Products List for use on state highways. PCMS are used mainly as a supplement to and not as a substitute for conventional signs, pavement markings and lighting. Standard messages and abbreviations should be used whenever possible. See the ODOT [Guidelines for Operation of Variable Message Signs on State Highways](#) for information on standard messages.

Per MUTCD 2A.07, variable message signs may be used in lieu of required warning signs for frequently changing situations (see Section 100 Mobile operations for typical applications). PCMS may not be used for STOP or YIELD signs. For moving work zones, a series of truck-mounted PCMS displaying the advance warning messages and moving with the work is recommended for all roads and required on freeways.

The display of a PCMS should be visible from ½ mile away under both day and night conditions. Choose a location such that the entire message can be read at least twice by approaching drivers.

A message may contain up to three lines per panel, although less is best. Display may be one or two panels when posted speeds are 55 MPH and above. The display rate shall be set so that the entire message can be read at least twice when approached at the posted speed. It is appropriate to consider the operating speed if it is much higher than the posted speed when setting the display rate.

If three panels are required for the entire message, a second PCMS unit should be set up at the appropriate sign spacing so that drivers have the opportunity to see the entire message twice.

PCMS shall be mounted a minimum of seven feet above the road when in operating mode. PCMS should be placed on the shoulder of the road or, if practical, further from the travel lane. The installation should not block pedestrian facilities. The face of the sign should be located and angled to be legible to approaching traffic for the needed distance.

For greater visibility, trailer-mounted PCMS shall be delineated by a shoulder taper of six cones or drums. If space allows, drums should be used for greater visibility. Maximum spacing is 20 foot. For work lasting more than eight hours, one or more Type III barricade(s) should be placed facing traffic, in front of the equipment and behind the cones or drums, and 40 feet in front of the sign (See Diagram No. 001). The total length of the barricades should be adequate to fully cover the width of the trailer.

3.43 WARNING LIGHTS (FLASHERS & STEADY-BURN)

Warning lights may be added to temporary signs or barricades as a means to increase device visibility in poorly lit areas, during inclement weather or at night.

When warning lights are used, they can be mounted on temporary signs or barricades in a manner that, if hit by an errant vehicle, they will not separate from the device. The combination of sign and light or barricade and light must have been crash-tested and be approved as a crashworthy device under NCHRP 350 guidelines. Obtain proof of crashworthiness from vendors and/or manufacturers of the devices being used.

Flashing warning lights shall not be used for delineation. Maximum spacing for warning lights should match TCD spacing requirements. All lights shall be mounted a minimum of 30 inches from the ground to the bottom of the lens.

Type A, B, C and D, 360-degree warning lights shall be portable, enclosed, self-powered, lens-directed, amber-colored lights. All types shall be in accordance with the current ITE "Purchase Specification for Flashing and Steady-Burn Warning Lights". All lights shall be visible on a clear night from 3000 feet.

Type A:

Low-intensity flashing warning light used during night hours.

Type B:

High-intensity flashing warning light. shall be visible on a sunny day from 1000 feet. Used during day and night hours. For 24-hour use.

Type C:

Flat lens, steady-burn warning light. Used at night to delineate edge of traveled way. If used in curved section, place only on outside of curve.

Type D:

Steady-burn, 360-degree warning light. Used at night to delineate edge of traveled way. If used in curved section, place only on outside of curve.

Chapter 4. TYPICAL APPLICATIONS

Traffic Control for Mobile Operations

Mobile operations include work activities such as sweeping and line marking where workers and equipment move continuously along the road at speeds of greater than 3 MPH. The advance warning area moves with the work area. Mobile work does not include stopping in the travel lane to perform the work.

Mobile operations will usually provide for safe traffic control by signs on the work vehicles. This requires at least one shadow vehicle except on some lower speed roads (see applicable notes on diagrams). On freeways, at least two shadow vehicles are required.

The work zone can be bordered by advance signing to alert road users to the presence of the slow moving work train ahead, covering a distance that includes the location of the work area for a significant period of time. Care shall be taken that the road user is still alert to the hazard by the time they reach the active work area. This can be achieved with a NEXT X MILES rider on the advance warning sign and occasional cones along the shoulder of the road with interim signing.

Traffic Control for Stationary Work

Stationary work includes work that will be in place for up to three days, including short duration work that will be in one place for an hour or less.

Stationary work can take just a few minutes in one place while changing signal lenses or filling a pot hole, or can be for a paving operation taking an entire day. The activity can be off the traveled portion of the road or occupy one or more travel lanes and directions. Work may proceed without any disruption of normal traffic flow, or may require traffic to stop and alternate direction of flow through the work area. Accordingly, the Typical Application diagrams for all stationary operations are arranged by the location of the work on the road, the extent of traffic control needed and the time required by the work activity or emergency response.

Typical Application diagrams do not cover every possible situation. Please refer to the principles described in this handbook as well as the Manual on Uniform Traffic Control Devices when applying the diagrams to your situation.

Lane Closures, Diversions and Detours: Lane use changes should be well marked and the alternate path made clear to the traveling public.

Extended traffic queues may result from the loss of road capacity, increasing the chance of collisions. Know the likely traffic volumes and conditions as well as you can and be prepared to install additional signing when needed.

Onsite conditions may vary requiring modification to the minimum distances shown in the Typical Applications and Standards if the work is on a curving or hilly section of road. Look for a balance between giving warning in time, keeping the work signs free from other roadside clutter and having too much distance between the advance warning and the work so that road users are otherwise distracted or have forgotten the warning.

Chapter 4. TYPICAL APPLICATION DIAGRAMS

The diagrams are organized into sections by the type of road and area of work. The first page in each section is tabbed.

SECTION 000: Detail Drawings. This section contains detail drawings which can apply in any situation. The details shown are added to the traffic control setup shown in the typical application for the work. These include bicycle signing, extended traffic queues, PCMS setup, pedestrian signing and work near rail grade crossings.

SECTION 100: Mobile Operations. This section applies to continuously moving operations not on freeways.

SECTION 200: Shoulder Operations. This section contains the typical applications for work or equipment on the shoulder, not on freeways

SECTION 300: Work on 2-Lane, 2-Way Roads. This section applies to 2-lane, 2-way roads with or without a closed median, and in any area.

SECTION 400: Work on 3-Lane, 2-Way Roads. This section applies to any section with a continuous two-way left turn lane, or with an added passing lane. The minimum number of lanes would be three.

SECTION 500: Work on Multi-Lane Non-Freeway Roads. This section applies to road sections with two or more lanes in each direction, with or without a closed median, and in any area.

SECTION 600: Intersection Operations. This section applies to work in or near any intersection in any area.

SECTION 700: Work on Freeways. This section applies to work on controlled access roads including the entrance and exit ramps.

Chapter 4, Section 000 Detail Drawings

4.000 Detail Drawings

Diagram 001

Diagram No. 001 shows the details for the typical setup of traffic control for extended traffic queues, bicycle traffic and the standard setup for a PCMS.

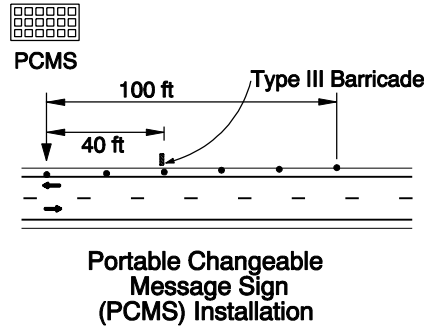
Extended Traffic Queues: Note that the ROAD WORK AHEAD (or equivalent) sign is moved when setting the additional extended queue signs. This sign is always the first sign the road user sees and is seen only once per approach to the work zone.

PCMS Installation: The trailer-mounted PCMS requires a shoulder taper with six cones or drums, with a barricade placed as shown 40 feet in front of the trailer.

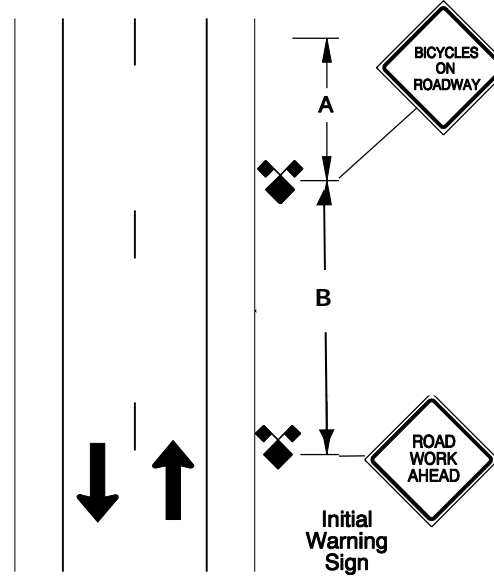
Bicycle Signing: Add a "BICYCLES ON ROADWAY" sign to the advance warning sign sequence in any work zone where a significant volume of bicycles can be expected and the work requires bicycles to use the travel lanes. "BICYCLES ON ROADWAY" signs are required if the work closes a marked bicycle facility and should be considered in areas where bikes may be encountered.

Place the "BICYCLES ON ROADWAY" sign as the second sign after the initial ROAD WORK AHEAD sign. See Diagram 001 for an example.

Detail Sheet



Posted Speed (mph)	Sign Spacing (ft)			Buffer (ft)
	A	B	C	
30 or less	100	100	100	50 - 100
35 - 40	350	350	350	250
45 - 55	500	500	500	350
60 or higher	1000	1500	1500 - 2640	550



Bicycle Signing Example

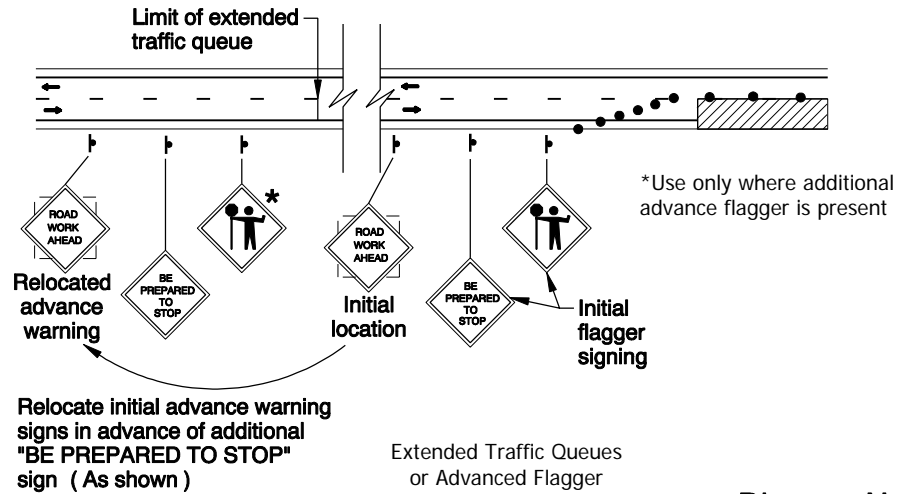


Diagram No. 001

4.002 Pedestrian Layout Details

Diagram 002

This diagram covers closures or diversions of sidewalks on urban streets. This diagram may be used in combination with any other diagram when pedestrian traffic is diverted from their normal path.

1. Stay alert for pedestrians and bicycle traffic and accommodate safe passage for them as needed.
2. If the work will impact the sidewalk or pedestrian path the pedestrian should be provided a safe and accessible path that as replicates, as nearly practical, the characteristics existing facilities.
3. Traffic control devices, work vehicles and parked vehicles should not intrude onto usable sidewalk width.
4. Unless a reasonably safe route can be provided through the work area, pedestrians should be appropriately directed with advance signing to cross the road. Do not divert pedestrians into the travel lanes.
5. The sidewalk should be closed at the nearest intersection on each side of the work area when a safe path around the work area of the width of the sidewalk or 4 feet, whichever is less, is not available.
6. Where there are business destinations between the nearest crosswalk and the work area, close the sidewalk at the nearest business access if possible.
7. The work area should be protected from pedestrian intrusion by barricades or channelizing devices.
8. For work near an intersection, close crosswalks and/or sidewalks as necessary when safe passage cannot be maintained.
9. Maintain access to a transit stop or clearly close the transit stop with barricades or channelizing devices.

Pedestrian Layout Details

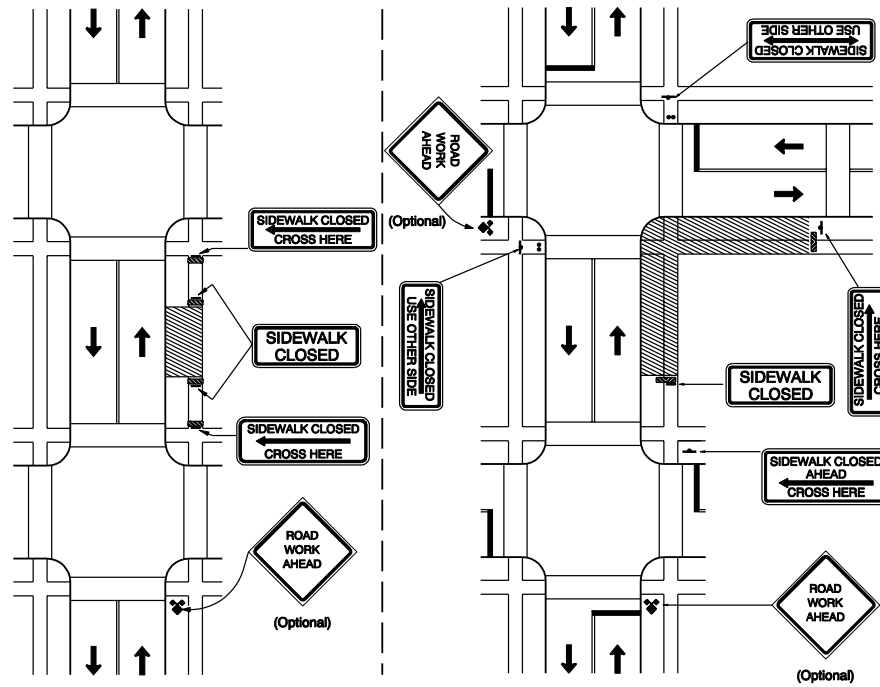


Diagram No. 002

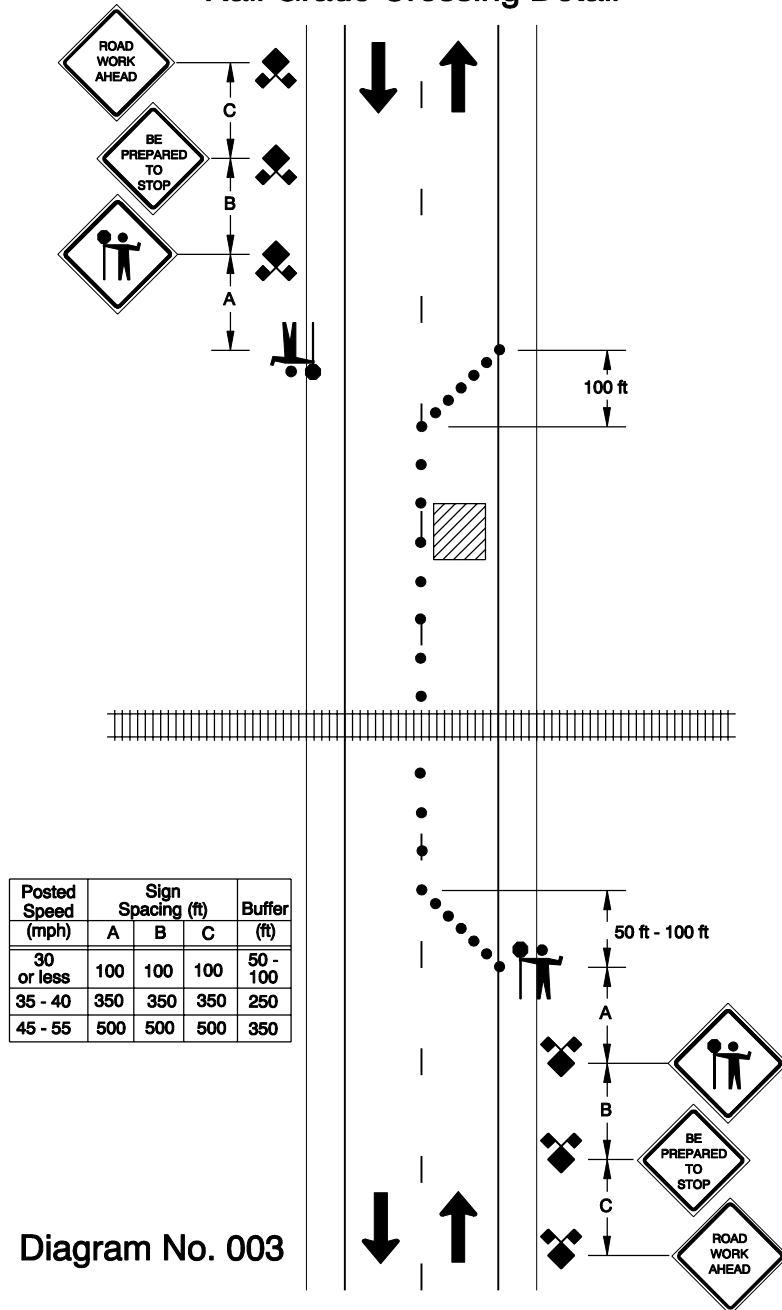
4.003 Rail Grade Crossing Detail

Diagram 003

This diagram covers work in the travel lanes near an at-grade public road-rail crossing. This drawing should be consulted whenever work traffic control may cause traffic queues to form up to and/or across the rails.

1. Minimize the possibility that vehicles may be stopped within the rail crossing, defined as being 15 feet either side of the closest and farthest rail. Position the work or shadow vehicle to keep traffic from stopping near the rails if work will be in place for just a few minutes.
2. If any permanent DO NOT STOP ON TRACKS sign is obscured or if none are posted, a regulatory DO NOT STOP ON TRACKS sign shall be placed on the approach to the tracks. Place the sign on the right and near the stop bar if there is one, or at least eight feet from the tracks if there is no stop bar. On multi-lane roads, a left side sign may be needed especially if there are three or more lanes in a direction.
3. If the queuing of vehicles across rail tracks can not be avoided, a law enforcement officer or flagger shall be provided at the crossing to prevent vehicles from stopping within the rail crossing, even if automatic warning devices are in place.
4. Maintain pedestrian access across the tracks or close the pathway. Use cones or Type II barricade and a SIDEWALK CLOSED sign if your work needs to impact the pedestrian crossing. Place the closure where pedestrians are directed to an alternate safe passage.
5. When work will be done within the railroad right-of-way, the railroad should be notified. The ODOT Rail Divisions Railroad Contact list can be found at <http://www.oregon.gov/ODOT/RAIL/docs/freightr.pdf> to locate the contact information for the railroad.

Rail Grade Crossing Detail



Chapter 4, Section 100 – Mobile Operations

4.100 Mobile Operation on Shoulder

Diagram 100

Diagram No. 100 covers a typical continuous moving operation on the shoulder not on a freeway (see Section 700 for work on freeways). A continuous moving operation moves along the road at an average speed of 3 MPH or more.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work and shadow vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. A shadow vehicle should be used when:
 - a. Sight distance is periodically less than 750 feet, or
 - b. Dust created by the operation, fog or other low visibility conditions reduces sight distance to less than 500 feet, or
 - c. The posted speed is 45 MPH or higher.If the above conditions are not met, the shadow vehicle is optional.
3. The shadow vehicle is also optional when the traffic volume is below 400 ADT.
4. When a shadow vehicle is used:
 - a. signs on work vehicle are optional, and
 - b. the shadow vehicle may replace the advance warning signs.
5. The shadow vehicle should:
 - a. Adjust the space between the work vehicle and between each additional shadow vehicle to deter road users from driving in between.
 - b. Slow down in advance of vertical or horizontal curves that restrict sight distance.
6. If a shadow is not used:
 - a. advance warning signs or PCMS may be used, and
 - b. the signs may cover up to five miles and should include the distance on the sign.
7. When the work vehicle is traveling alone, a TMA should be considered. The initial vehicle, either work or shadow vehicle, which will be exposed to traffic in the travel lane may be equipped with a TMA.

8. Use SHOULDER WORK (AHEAD), SHOULDER CLOSED (AHEAD) or other work-appropriate sign on the initial vehicle. Minimum sign size is 36 inches. A PCMS may be used in place of signs.
9. If the work equipment has to be partially in the travel lane, maintain a lane width of ten feet or occupy the adjacent travel lane and use the appropriate mobile lane closure diagram. On low volume roads, a minimum lane width of 9 feet may be allowed.
10. Where practical and when needed, the work and shadow vehicles should pull over periodically to allow motor vehicle traffic to pass.

Mobile Operation on Shoulder

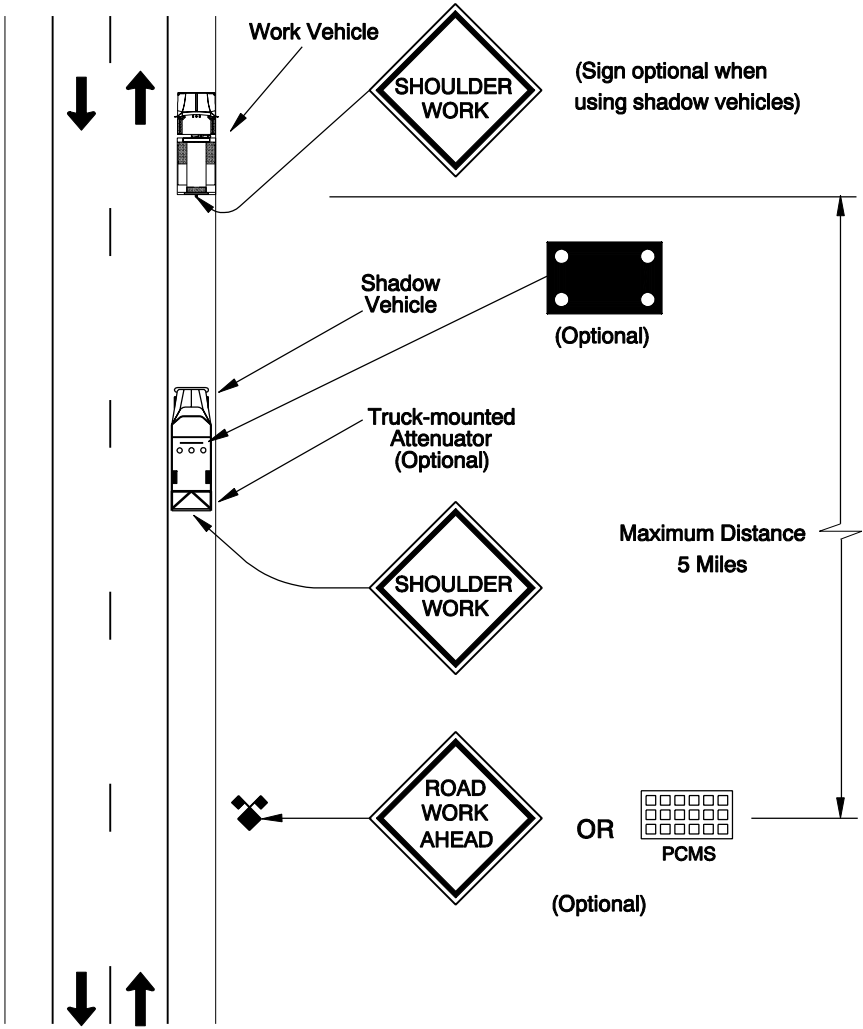


Diagram No. 100

4.110 Mobile Operation on 2-Lane, 2-Way Road

Diagram 110

Diagram No. 110 covers a typical continuous slow-moving operation in the travel lane of a two-lane, two-way road. It does not include a layout for every possible work situation, but shows the minimum requirements for this type of operation.

1. Use truck-mounted high-intensity rotating, flashing, oscillating or strobe warning lights with 360° visibility on all work and shadow vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. A shadow vehicle is optional, but should be used when:
 - a. Sight distance is less than 750 feet, or
 - b. Dust created by the operation, fog or other low visibility conditions reduces the sight distance to less than 500 feet.
 - c. The speed is 45 MPH or higher.If the above conditions are not met, the shadow vehicle is optional.
3. The shadow vehicle is also optional when the traffic volume is below 400 ADT.
4. When a shadow vehicle is used:
 - a. signs on work vehicle are optional, and
 - b. the shadow vehicle may replace the advance warning signs.
5. The shadow vehicle should:
 - a. Adjust the space between the work vehicle and between each additional shadow vehicle to deter road users from driving in between.
 - b. Slow down in advance of vertical or horizontal curves that restrict sight distance.
 - c. Maintain a position on the right side of the highway as much as possible.
6. If a shadow vehicle is not used,
 - a. Advance warning signs or PCMS may be used.
 - b. The signs may cover up to five miles with the distance shown on the sign.
7. When the work vehicle is traveling alone, a TMA should be considered. The initial vehicle, either work or shadow vehicle, which will be exposed to traffic in the travel lane may be equipped with an attenuator.
8. Where practical and when needed, the work and shadow vehicles should pull over periodically to allow motor vehicle traffic to pass.

9. Use ROAD WORK, SWEEPER or other work-appropriate rear mounted signs with a minimum size of 36". When there will be limited opportunity for passing, the sign may be substituted with a black-on-white, rectangular YIELD TO ONCOMING TRAFFIC or DO NOT PASS sign.
10. A trailer or truck-mounted PCMS may be placed at the beginning of the section of road to warn traffic of the work ahead. If left in place at the beginning of the work section, the sign should state the type of work on panel one and NEXT X MILES on panel two. The distance should be limited to five miles or less. The sign should be moved during the day to stay within the stated distance of the work.

Mobile Operation on 2-Lane, 2-Way Road

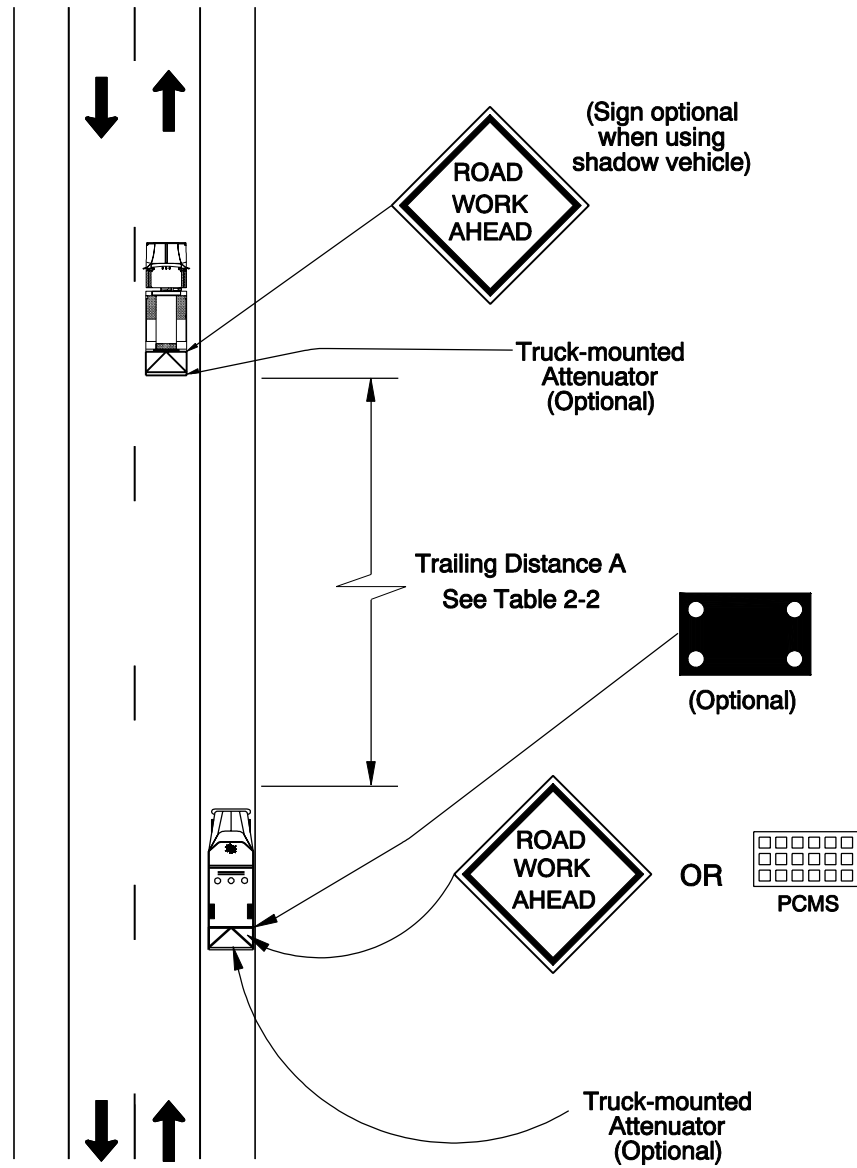


Diagram No. 110

4.120 Mobile Operation on Multi-Lane Road **Diagram 120**

Diagram No. 120 covers mobile operations occupying one lane of a multi-lane road not a freeway (see section 700 for work on a freeway). Work should normally be done in off-peak hours on high speed or high volume roads.

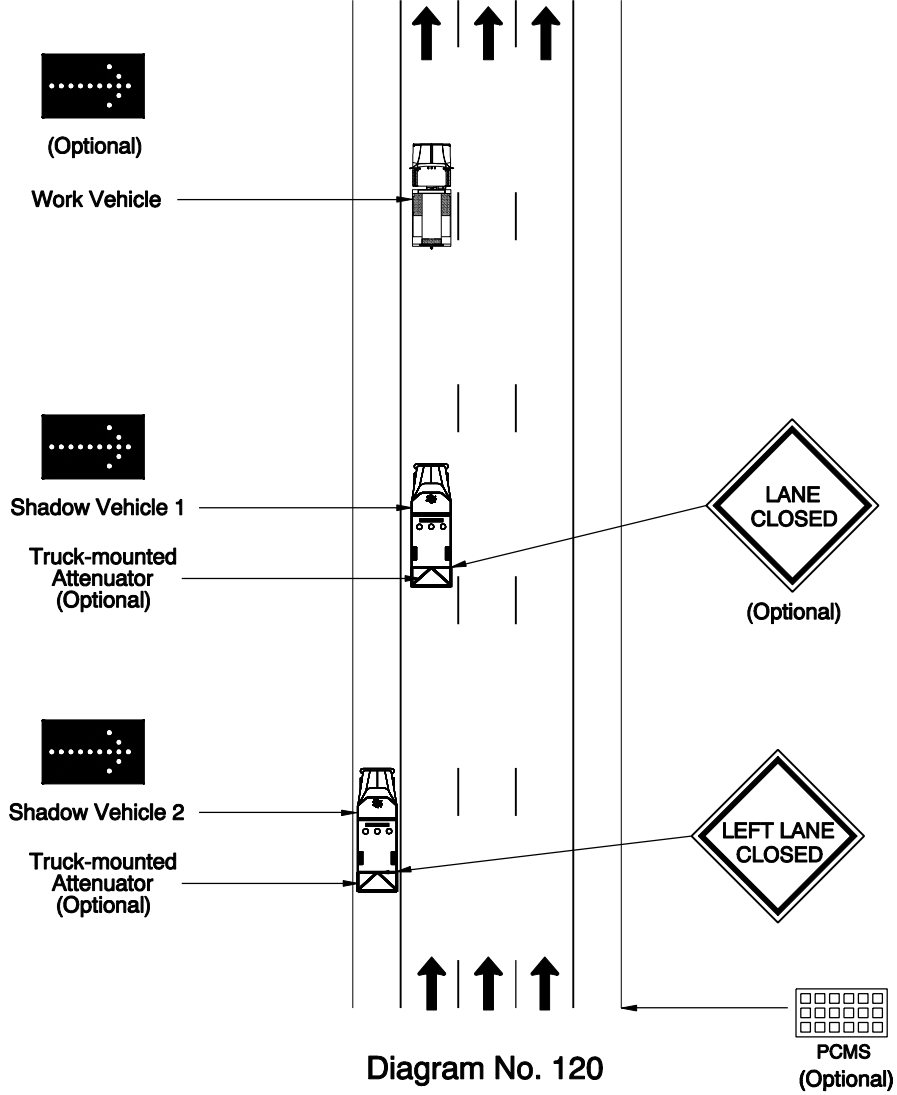
1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work and shadow vehicles. Arrow panels or PCMS are desirable..
2. Table 4-1, Shadow vehicles on Multi-Lane Roads:

Speed	Shadow Vehicles
0-25 MPH	Optional
30-40 MPH	One required
45 MPH and above	Two required

3. Shadow vehicle one, if used:
 - a. Should be equipped with an arrow display or PCMS.
 - b. Should be equipped with an appropriate lane closure sign placed on the vehicle so as not to obscure the arrow display.
 - c. Adjust the space between the work vehicle and between each additional shadow vehicle to deter road users from driving in between.
 - d. Vehicle that is minimized to deter road users from driving in between.
 - e. Should vary distance from the work operation so as to provide adequate sight distance for traffic approaching from the rear.
 - f. Should not protrude into traffic any further than the vehicle being protected.
 - g. A truck-mounted attenuator (TMA) is optional.

4. Shadow vehicle #2, if used,
 - a. Should be equipped with an arrow display.
 - b. An appropriate lane closure sign should be placed on vehicle two so it does not obscure the arrow display.
 - c. A truck-mounted attenuator (TMA) is optional. On high speed or high volume roads, consider adding a TMA.
5. Additional shadow vehicles may be used.
6. The trailing vehicle should be on the shoulder so there is one shadow vehicle on the shoulder, one straddling the edge line and the other vehicles in the closed lane. Where adequate shoulder is not available, the trailing vehicle may drive partially in the lane.
7. When the work vehicle occupies an interior lane (not the far right or far left) of a with a shoulder width of ten feet or more, shadow vehicle two should drive the right shoulder with a sign indicating that work is taking place in the interior lane.
8. A PCMS may be placed at the beginning of the section of road to be worked to warn traffic of the obstruction ahead. If left in place at the beginning of the work section, the sign should state the type of work on panel one and NEXT X MILES on panel 2. The distance should be limited to five miles or less. The sign should be moved during the day to stay within the stated distance of the work.

Mobile Operation on Multi-Lane Road



4.125 Rolling Slowdown

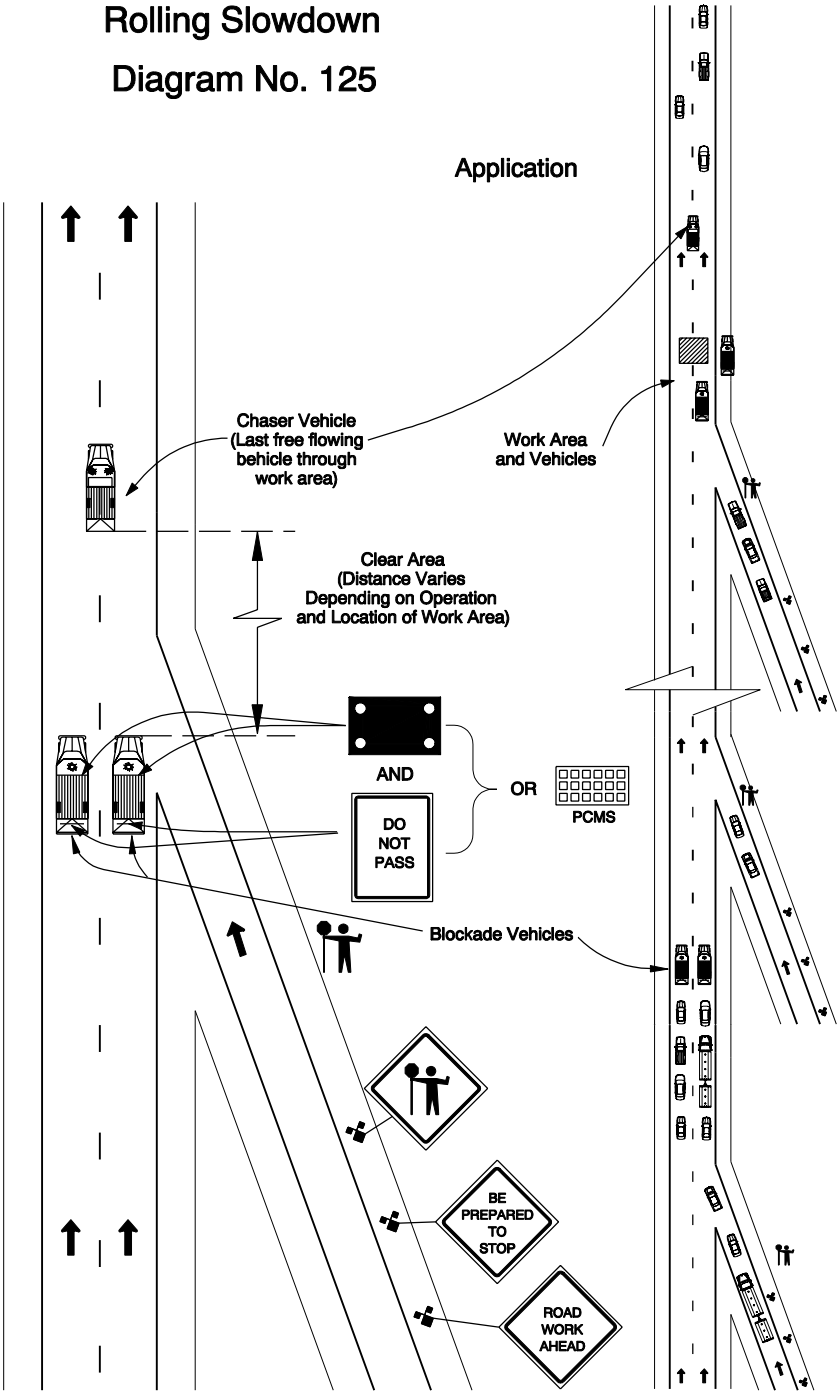
Diagram 125

A rolling slowdown provides short road closures for such activities as cleaning debris from the road, pushing disabled vehicles to the shoulder or pulling power lines across the road. Although rolling slowdowns are typically done on freeways, they may be used on other limited access roads as well. The diagram shows the standard configuration for performing a rolling slowdown.

1. The slowdown should be scheduled during off-peak traffic periods except in emergencies.
2. Inform all local enforcement offices of the slowdown.
3. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work and shadow vehicles.
4. The slowdown should be planned to maintain at least 15 MPH. If the work is progressing more slowly than planned, the traffic speeds can be reduced as needed. The queue should not stop completely at any time.
5. Advance warning is required at least ½ mile before the start of the slowdown. Changeable message signs, either portable or permanent, are required at least as the initial sign.
 - a. A typical message sequence would be SLOW TRAFFIC AHEAD / ALL LANES.
 - b. The slowdown may be announced in advance on changeable message signs. Consider public service announcements when there is primarily local traffic.
 - c. Start the sign displays as soon as the traffic control vehicles are ready to enter the road and continue until the traffic speeds are close to normal travel speeds.
6. Advance signing shall be placed at the approach to each entry ramp except when not practical for emergency operations.
7. All ramps and entrances to the road between the moving blockade and the work area shall be temporarily closed using traffic control equipment and flagger.
8. Enough blockade control vehicles to block all traffic lanes are required.
 - a. One blockade control vehicle per lane should be used.
 - b. Each vehicle shall have an arrow panel in caution mode and DO NOT PASS black-on-white regulatory sign.

- c. A truck-mounted PCMS (DO NOT PASS / ROLLING SLOWDOWN) may take the place of the arrow panel and sign.
- 9. A chaser vehicle follows the last free-moving vehicle through the work area to give the signal it is safe to begin work.
- 10. The slowdown proceeds as follows:
 - a. The chaser vehicle notifies flaggers when to stop traffic.
 - b. Traffic is held at every entrance until the rolling slowdown passes.
 - c. The blocking traffic control vehicles notify flaggers when to release traffic.
- 11. Good communication is essential among all traffic control vehicles, flaggers, chaser vehicle and the job site. Assign a competent person at the job site to keep in contact with the slowdown vehicles. This person makes sure the road is open and clear before the slowdown arrives at the work site and advises of speed adjustments needed to allow the work to be completed and keep traffic moving.

Rolling Slowdown Diagram No. 125

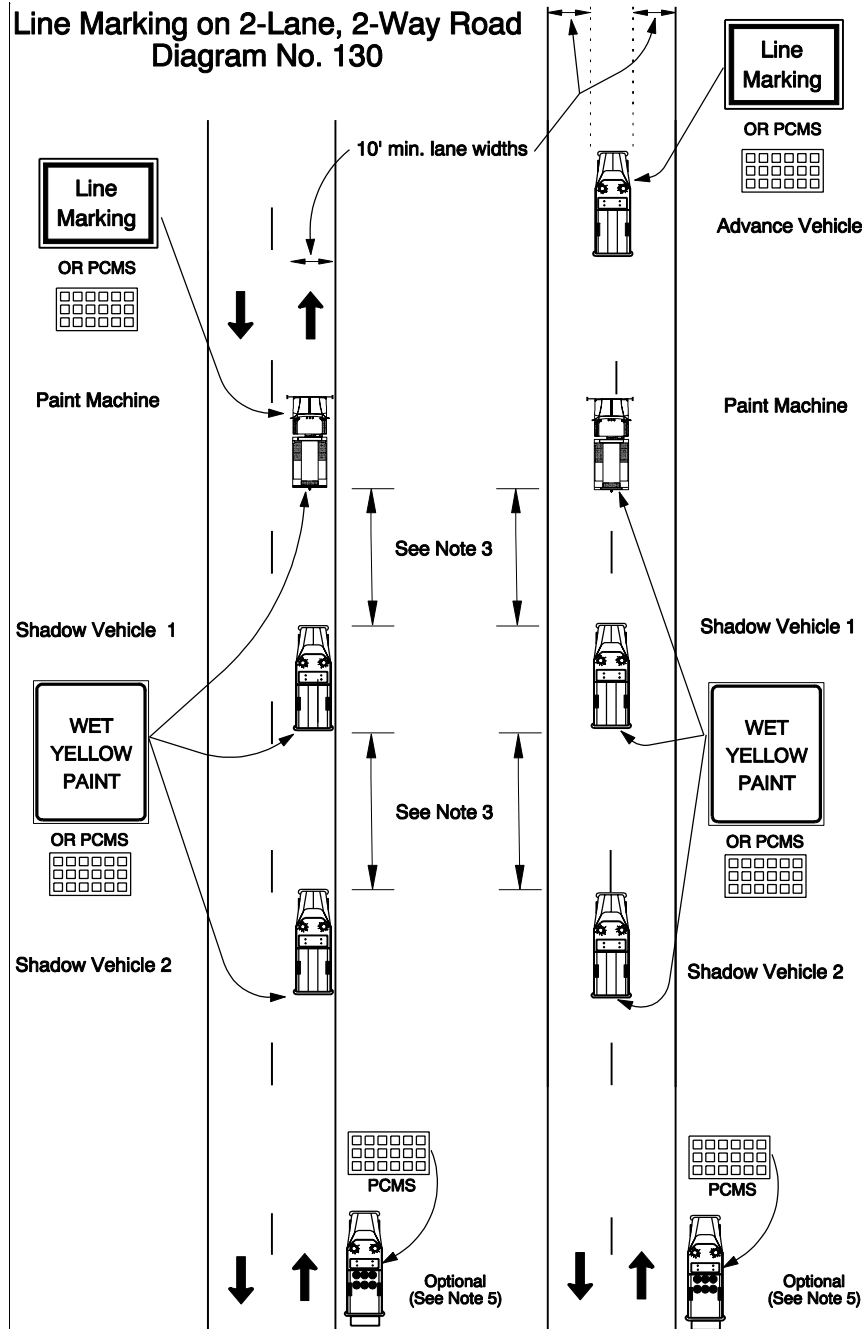


4.130 Line Marking on 2-Lane, 2-Way Road Diagram 130

Diagram No. 130 covers striping operations on a 2-way, 2-lane road. The left-hand drawing illustrates a typical layout when using paint equipment, which marks up to two lines from the side of the equipment. Consider using an advanced vehicle if striping the center line. The right-hand drawing illustrates a typical layout when the paint equipment straddles and marks a single line at a time. These drawings cover any equipment configuration which accomplishes the applicable marking operation.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility and appropriate signs on all work and shadow vehicles.
2. Arrow panel displays should be in caution mode. A truck-mounted PCMS may be used. Arrow mode displays should not be used unless you are directing traffic out of their travel lane. On a PCMS, the message WET PAINT/KEEP RIGHT (LEFT) or WET PAINT/PASS TO RIGHT (LEFT) is appropriate.
3. The number of vehicles and vehicle spacing are important factors in establishing a clean marking. Maintain spacing between vehicles to allow enough time for the marking material to set up adequately to take traffic without smearing. However, the spacing should not encourage traffic to travel in the space between work vehicles. This may be the deciding factor in how many vehicles to use.
4. A vehicle with truck-mounted PCMS may shadow the work array on the right shoulder as advance warning. This vehicle may be the service truck for the paint machine.
5. A truck or trailer-mounted PCMS may be placed at the beginning of the section of road to warn traffic of the work ahead. The sign should state the type of work on panel one and NEXT X MILES on panel 2. The distance should be limited to five miles or less. The sign should be moved during the day to stay within the stated distance of the work.
6. For night work, work lights should be provided on the striper as required to illuminate the work area, and may be provided on other vehicles as needed.

**Line Marking on 2-Lane, 2-Way Road
Diagram No. 130**



4.135 Line Marking, Multi-Lane Road, Non-Freeway

Diagram 135

Diagram No. 135 covers line marking operations on a one-direction, multi-lane road not a freeway.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility and appropriate signs on all work and shadow vehicles.
2. Maintain at least a ten foot lane in the adjacent travel lanes.
3. When striping the center lane of a three lane or more highways, advance warning must be placed on the right shoulder.
4. A trailing vehicle may shadow the work array on the right shoulder at a distance of up to ½ mile as advance warning. This vehicle may be the service truck for the paint machine. A vehicle with a truck-mounted PCMS is preferable for warning traffic in this situation. If a PCMS is not available, a ROAD WORK sign should be used. Do not use an arrow display in this situation.
5. The vehicle array and spacing are important factors in establishing a clean marking. Maintain spacing between vehicles to allow enough time for the marking material to set up adequately without smearing. However, the spacing should not encourage traffic to travel in the space between work vehicles. This may be the deciding factor in how many vehicles to use.
6. Use of TMAs is optional. On roads with a posted speed of 45 MPH or more, use of at least one TMA is recommended. If used, the TMA should be the first vehicle exposed to traffic in the travel lane. In this case, a hazard assessment conducted by the supervisor will determine which vehicle should be equipped with the TMA.
7. A PCMS may be placed at the beginning of the section of road to be worked on to warn traffic of the obstruction ahead. If left in place at the beginning of the work section, the sign should state the type of work on panel one and NEXT X MILES on panel 2. The distance should be limited to five miles or less. The sign should be moved during the day to stay within the stated distance of the work.

Line Marking on Multi-Lane Road

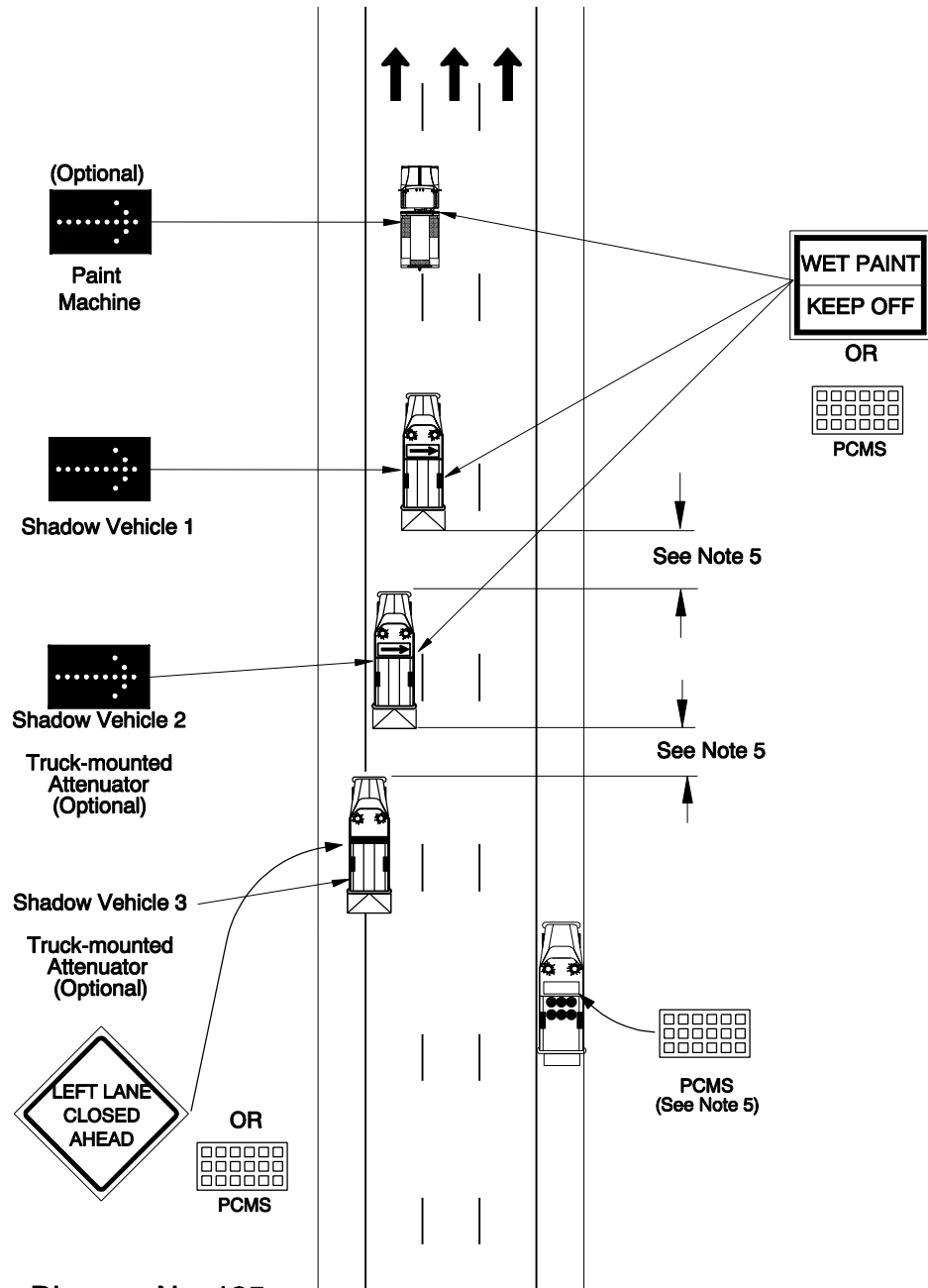


Diagram No. 135

Chapter 4, Section 200 – Shoulder Work

4.200 Brief Road Work

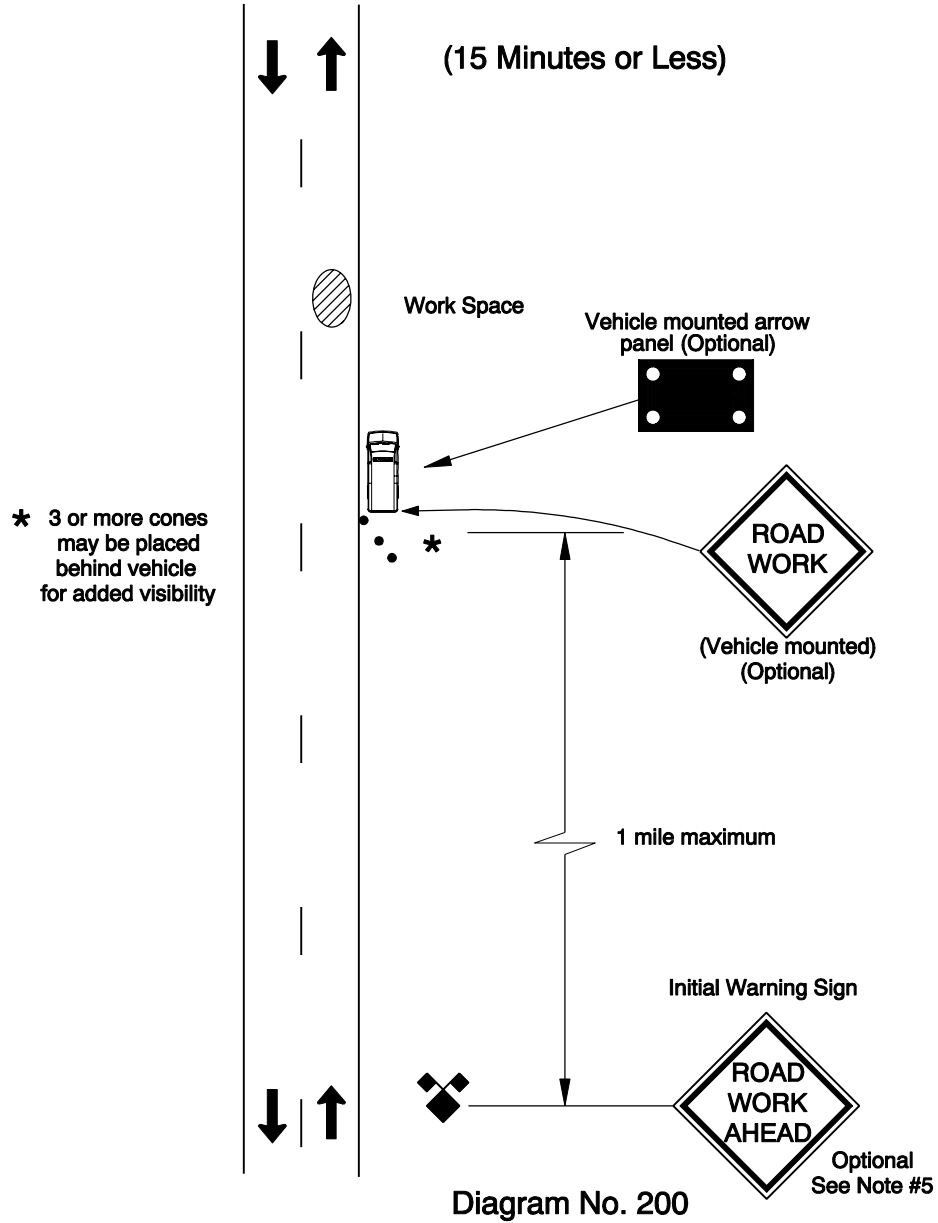
Diagram 200

This diagram covers activity in the roadway of 15 minutes or less. Typical work includes debris removal, tagging of survey markers, or marking utility lines. Work in the roadway coincides with gaps in the traffic so flow is not impeded.

1. Do not use this diagram if traffic must be controlled to gain safe access to the work area due to conditions such as high travel speeds or traffic volumes. Use the appropriate lane closure or mobile work zone layout.
2. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility and appropriate signs on all work vehicles.
3. The work vehicles should be parked as far off the travel lanes as practical.
4. If a ten-foot minimum travel lane can not be maintained or when opposing direction of traffic can not safely pass, use the appropriate lane closure diagrams such as Diagram No. 310 through Diagram No. 350.
5. The initial warning sign should be used if the sight distance is less than 750 feet and traffic volumes are over 400 ADT.
6. A spotter may be used to warn workers of approaching traffic. This is especially appropriate when sight distances are limited or speeds are high. See spotter guidelines section for additional information.

Brief Road Work

(15 Minutes or Less)



4.210 Work on Shoulder**Diagram 210**

Diagram No. 210 covers stationary work with work or parked equipment on the shoulder. This diagram does not cover work on a freeway shoulder. See Diagram 710 for Freeway Shoulder work.

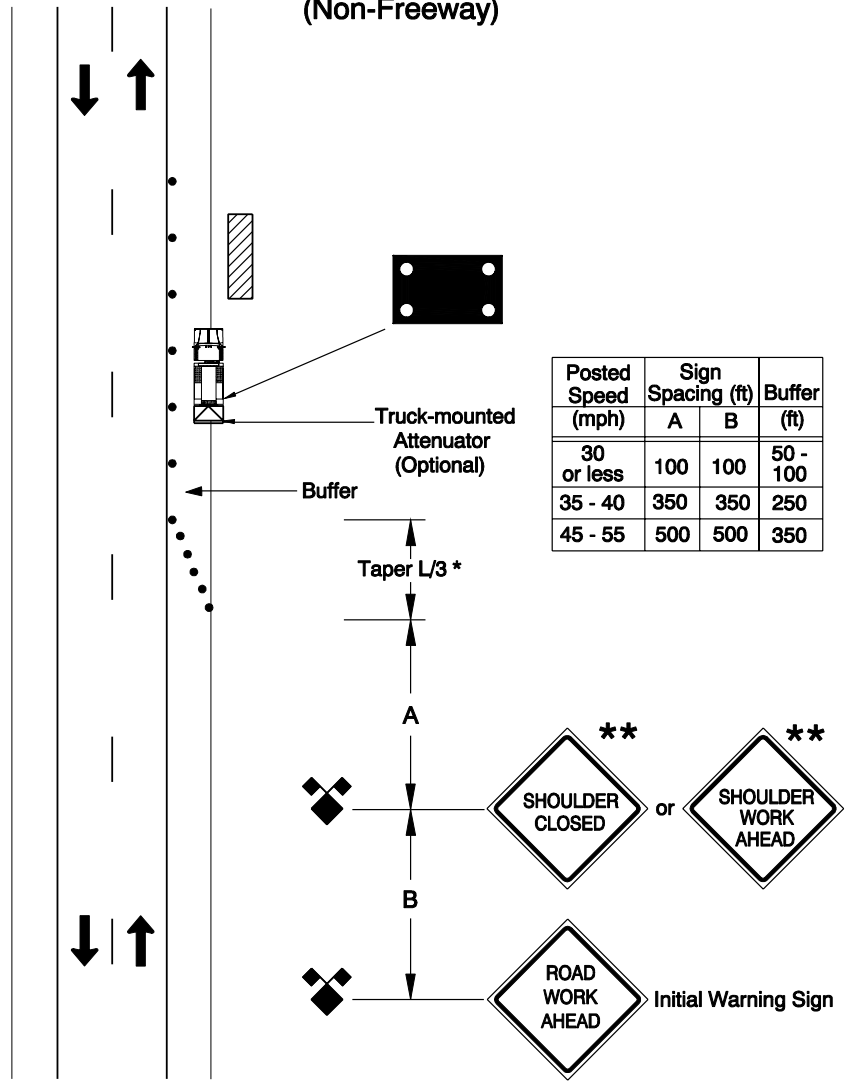
1. Vehicles should be parked as far off the roadway as practical.
2. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility and appropriate signs on all work and shadow vehicles.
3. Requirements for Signs and Devices based on Proximity to Edge of Travel Way and Duration of Activity are shown in Table 4-2.

Table 4-2 Device and Sign Guidelines for Shoulder Work.

	Proximity to the Edge of Travel Way	
	More than 15 Feet or Behind barrier/guardrail	Less Than 15 Feet
Work in Place More Than One Hour	Signs and cones are optional	One advance warning sign is required and two signs are recommended Cone taper is required.
Work in Place Less Than One Hour	Signs and cones are optional.	Signs and cones are optional.

4. Arrow panels in caution mode are recommended for work on roads with posted speeds of 45 MPH or greater and high traffic volumes, greater than 2000 average daily traffic (ADT).

Work on Shoulder (Non-Freeway)



* Use as appropriate - see text
 ** Recommended when work is in place longer than 1 hour

Diagram No. 210

Chapter 4, Section 300 Work on 2-Lane, 2-Way Roads

4.300 Shoulder Work with Minor Road Encroachment

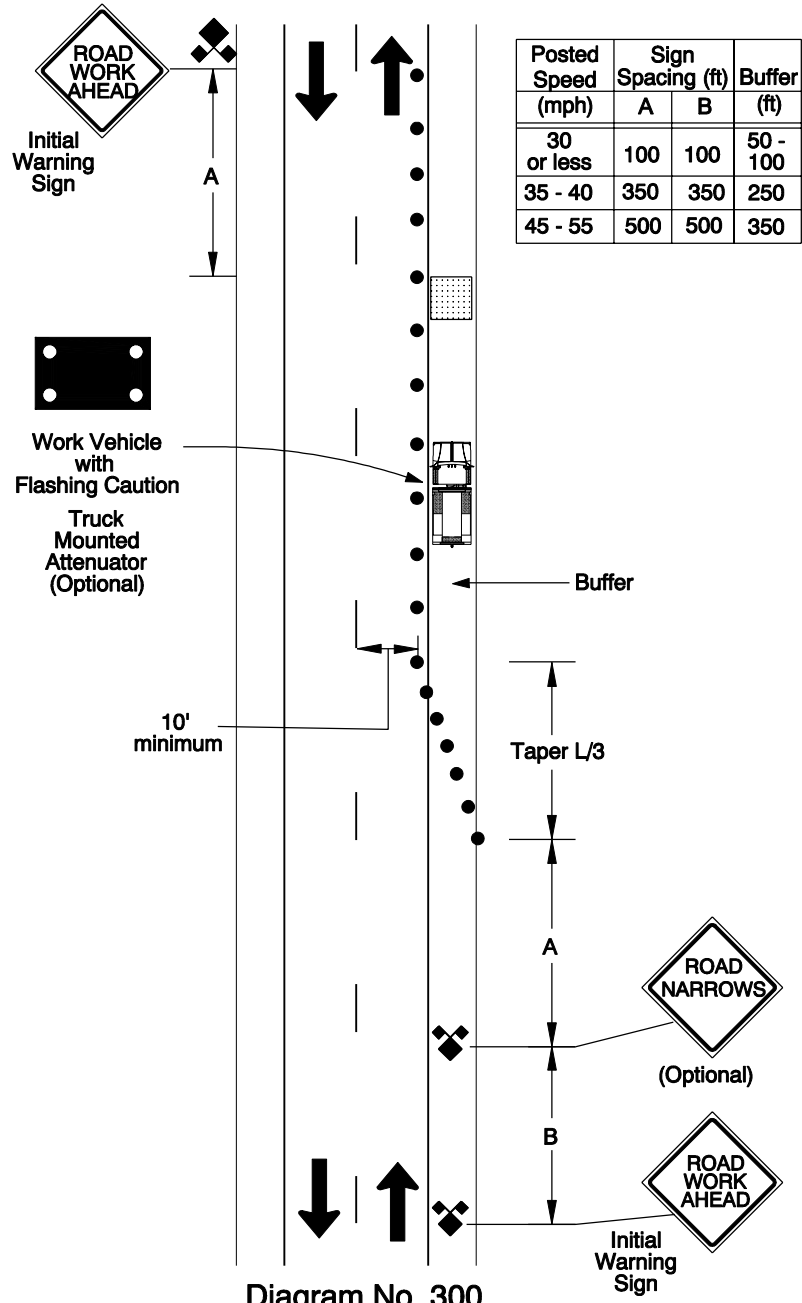
Diagram 300

This diagram covers work which will extend into a travel lane not on a freeway when the work area will leave at least a ten foot lane. If a ten-foot minimum travel lane can't be maintained or when traffic can't safely pass by in both lanes simultaneously, use the appropriate lane closure diagrams such as Diagram No. 310 through Diagram No. 350.

A lane closure may be appropriate for conditions such as high traffic volumes, high speeds, and inadequate approach sight distance to the work area, or heavy equipment adjacent to the travel lane.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work and shadow vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. If the speed is 45 MPH or higher, opposing traffic lanes should be separated by a line of cones or tubular markers. Consider channelization for opposing traffic whenever traffic volumes are high or the travel path is curved.
3. Cones shall be placed the entire length of the work area.
4. If a protection vehicle is used and work is in place one hour or less, the taper and tangent devices may be omitted.
5. An arrow panel in caution mode or truck-mounted PCMS with SHOULDER WORK or other appropriate message may be used for higher visibility.

Shoulder Work with Minor Road Encroachment



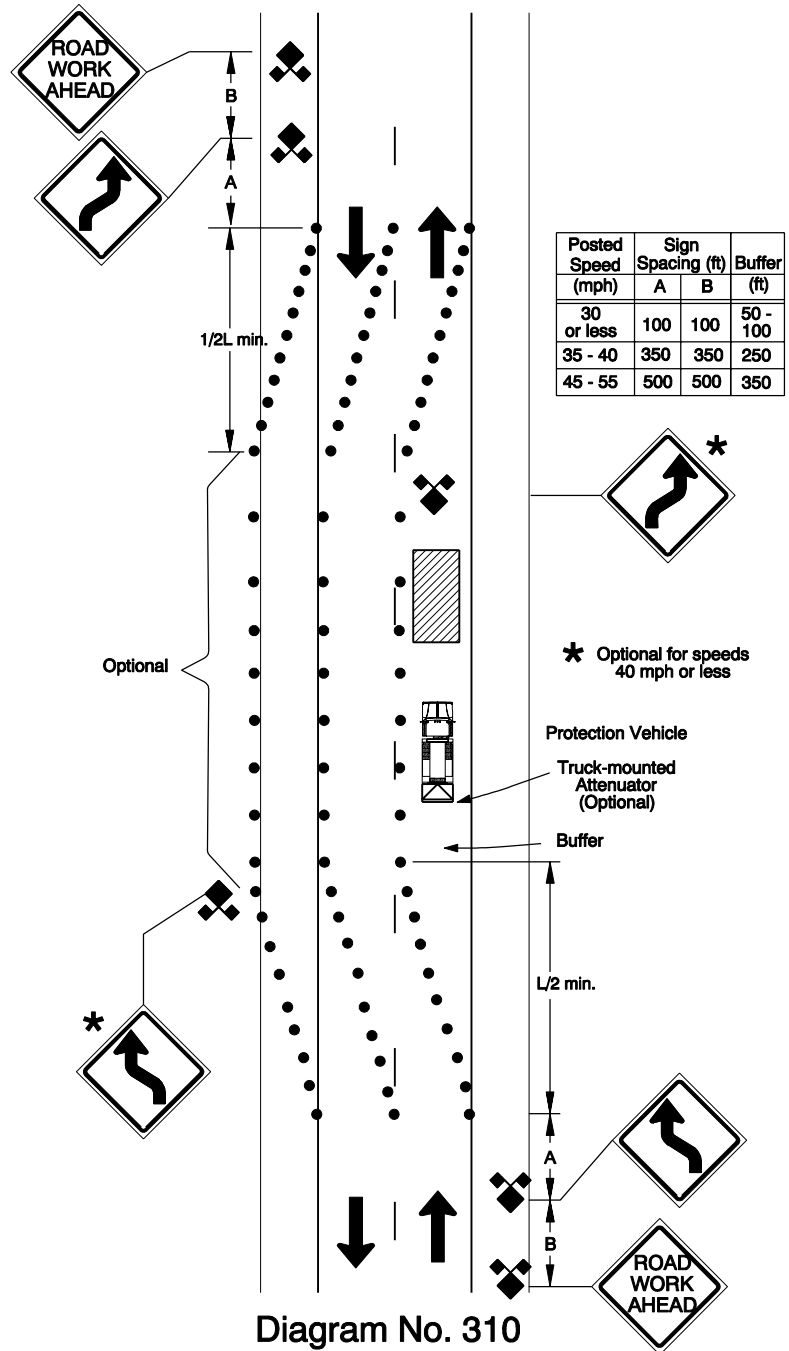
4.310 2-Lane Traffic Diversion Using Shoulder

Diagram 310

Diagram No. 310 covers shifting traffic lanes on a two-lane, two-way roadway around the work site with one lane partially or fully on the shoulder.

1. All travel lanes should have a minimum ten feet lane width.
2. Shoulder shall be adequate in width and surfacing to carry the traffic.
3. Two advance warning signs are required.
4. Place cones as shown. Cones along the far edge of travel lane, farthest from the work area, are optional and may be added to clearly mark the travel path.
5. A protection vehicle may be placed inside the closed area. When used, the protection vehicle should be positioned so there is an adequate run out distance between the vehicle and the work area.

2-Lane Traffic Diversion Using Shoulder



4.320 Lane Closure with Flagging

Diagram 320

Diagram No. 320 covers total closure of one lane of a 2-lane, 2-way roadway and road closure for 20 minutes or less using flaggers. The right-hand drawing illustrates the use of two flaggers, one for each approach. The left-hand drawing illustrates the use of a single flagger to control both lanes of traffic on low volume (less than 400 average daily traffic [ADT]) roads with good sight distances as discussed below.

1. The ONE LANE ROAD AHEAD sign is optional.
2. Flaggers at each approach are required if any of the following conditions exist:
 - a. Night Operations or,
 - b. Work area is over 200 feet in length or,
 - c. Sight distance is less than 750 feet from each approach through the lane closure or,
 - d. Traffic volumes are greater than 400 ADT.
3. The length between the flagger signs shall not exceed one mile.
4. Cones should be used to outline the work area when curves or other roadway alignments prevent clear direction for the motorists to pass the work zone safely. Cones along side the work area are recommended when posted speeds are 45 or greater, when working under heavy traffic or when travel lanes are narrower than 11 feet.
5. Extended queue signing (as shown on Diagram No. 001) should be used when traffic queues extend beyond the initial advance warning sign.
6. When flagging near an intersection, the FLAGGER AHEAD sign should be visible to traffic entering from any side road. Additional advance warning and flagger ahead signs may be placed on the side road(s).
7. Sign set-up and flagger placement shown in Drawing No. 320 may be used for intermittent full road closures of 20 minutes or less.

Lane Closure with Flagging

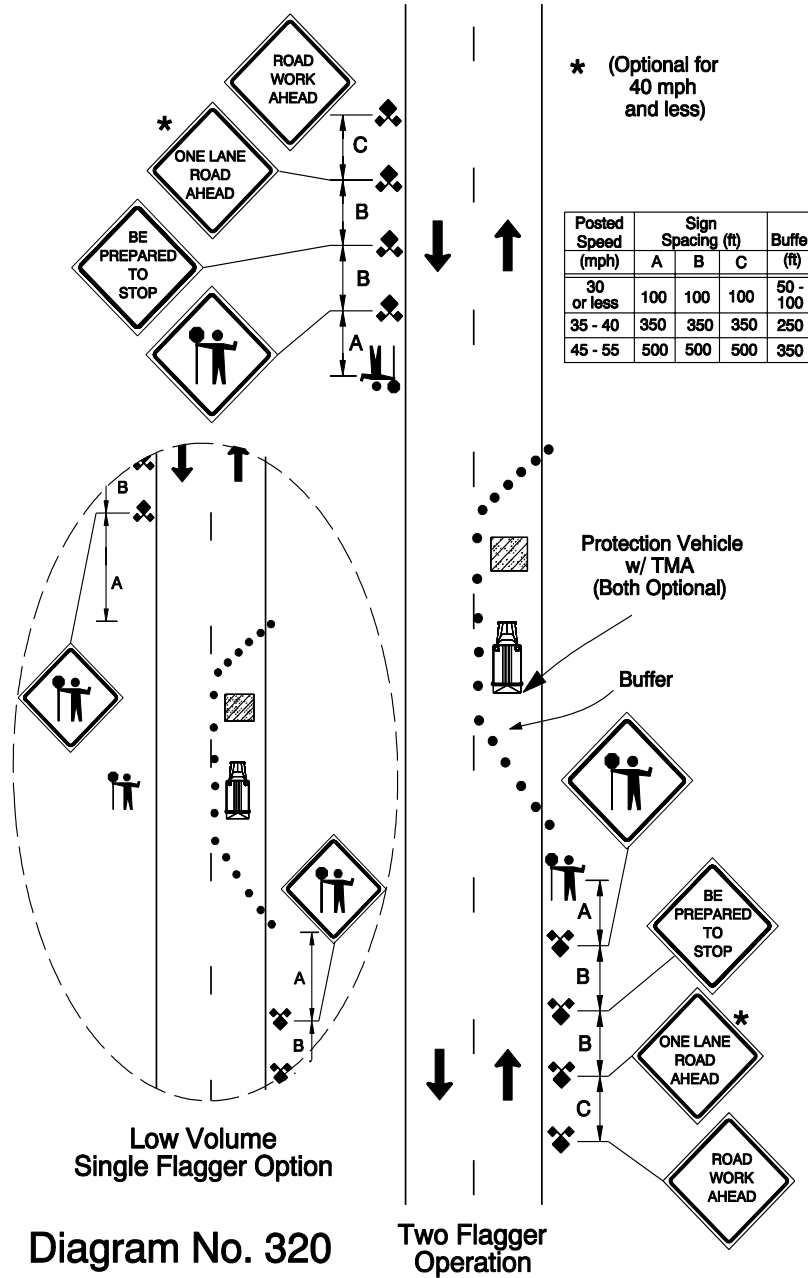


Diagram No. 320

4.325 Short Duration Operation Using Flaggers

Diagram 325

Diagram No. 325 covers work activities that move along the road intermittently and involves frequent short stops. Only use this diagram when the work can move through the one mile in three hours or less.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. Flaggers shall be stationed for the best visibility for the situation and within sight distance of the active work area except at curves or crests on the road. Flaggers may not be more than 3500 feet from the FLAGGER NEXT MILE sign.
3. When the Flagger is more than 1000 feet from the FLAGGER NEXT MILE sign, cones shall be placed on the shoulder at 500 foot intervals.
4. Flaggers are required at each end of the work area if any of the following conditions exist:
 - a. night operations
 - b. sight distance is less than 750 feet from each approach through the lane closure
 - c. Average Daily Traffic is greater than 400.
5. The length of the work zone between flagger signs shall not exceed one mile in length.
6. Extended queue signing (as shown on Diagram No. 001) should be used when traffic queues extend beyond the initial advance warning sign.
7. When flagging near an intersection, the FLAGGER AHEAD sign should be visible to traffic entering from any side road. Additional advance warning and flagger ahead signs may be placed on the side road(s).

Short Duration Operation Using Flaggers

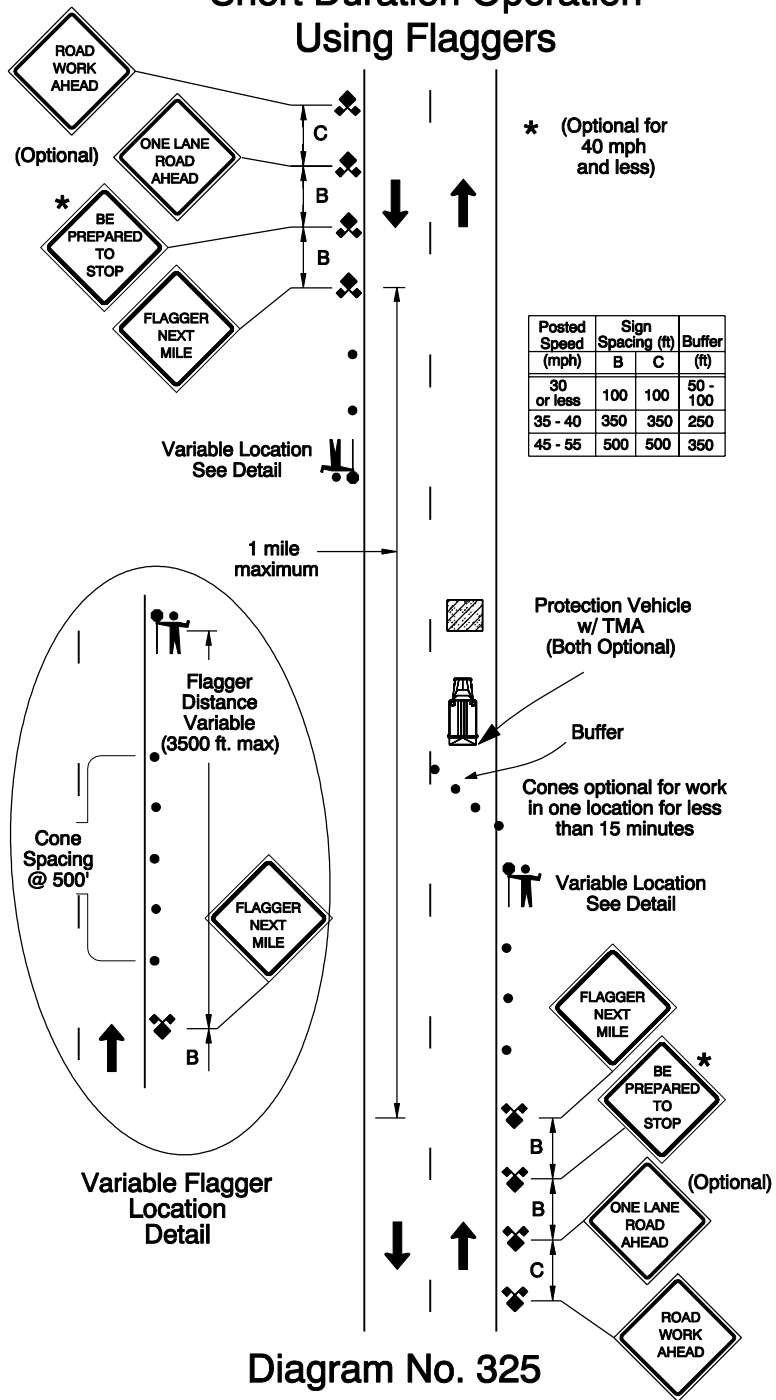


Diagram No. 325

4.330 Lane Closure with Traffic Control Signals

Diagram 330

The use of portable signals is discouraged for work lasting three days or less. This diagram covers a lane closure on a two-lane, two-way road using portable traffic control signals. The length of the closed lane should be less than 1,000 feet. Traffic volumes should be less than 3500 ADT.

Place one dual-head unit each direction with the overhead signal head between the center of the approach lane and centerline, and the pole mounted signal head on the shoulder.

1. Maintain line of sight at all times between stop bars.
2. The signal timing parameters on which the signal timing will be based shall be provided by the traffic engineering staff of the road jurisdiction and the parameters shall not be changed without approval. The red light time shall allow sufficient time for all vehicles to clear the work area completely before opposing traffic is released. Consider cyclist or pedestrian traffic when relevant.
3. Place enough sets of warning signs to provide adequate warning for traffic approaching the end of the traffic queue. It may be necessary to use a second set of signs or adjust the placement during the day. There shall be a Signal Ahead warning sign at distance A from the stop bar.
4. A temporary stop bar is required for work that will be in place for more than one hour.
5. The closest edge of the signal head on the pole shall be at least two feet back from the edge of travel lane.
6. The bottom of the signal head on the pole should be 12 feet with a minimum of eight feet of clearance from the sidewalk or road surface if there is no sidewalk. Adjust the bottom of the overhead signal head to 17 feet to 19 feet from the road surface.
7. Direct each head for maximum visibility of the lens to vehicles approaching at 550 feet in rural areas to a minimum of 200 feet on low speed urban streets
8. Portable signals are for stationary work only.
9. On state highways, approval from the State Traffic Engineer is required before the required permit is issued for portable traffic control signals. Also for state highways, equipment shall be listed on the ODOT Qualified Products List (QPL). On local roads, check with local jurisdictions for signal approval and approved equipment lists.

Lane Closure with Traffic Control Signals

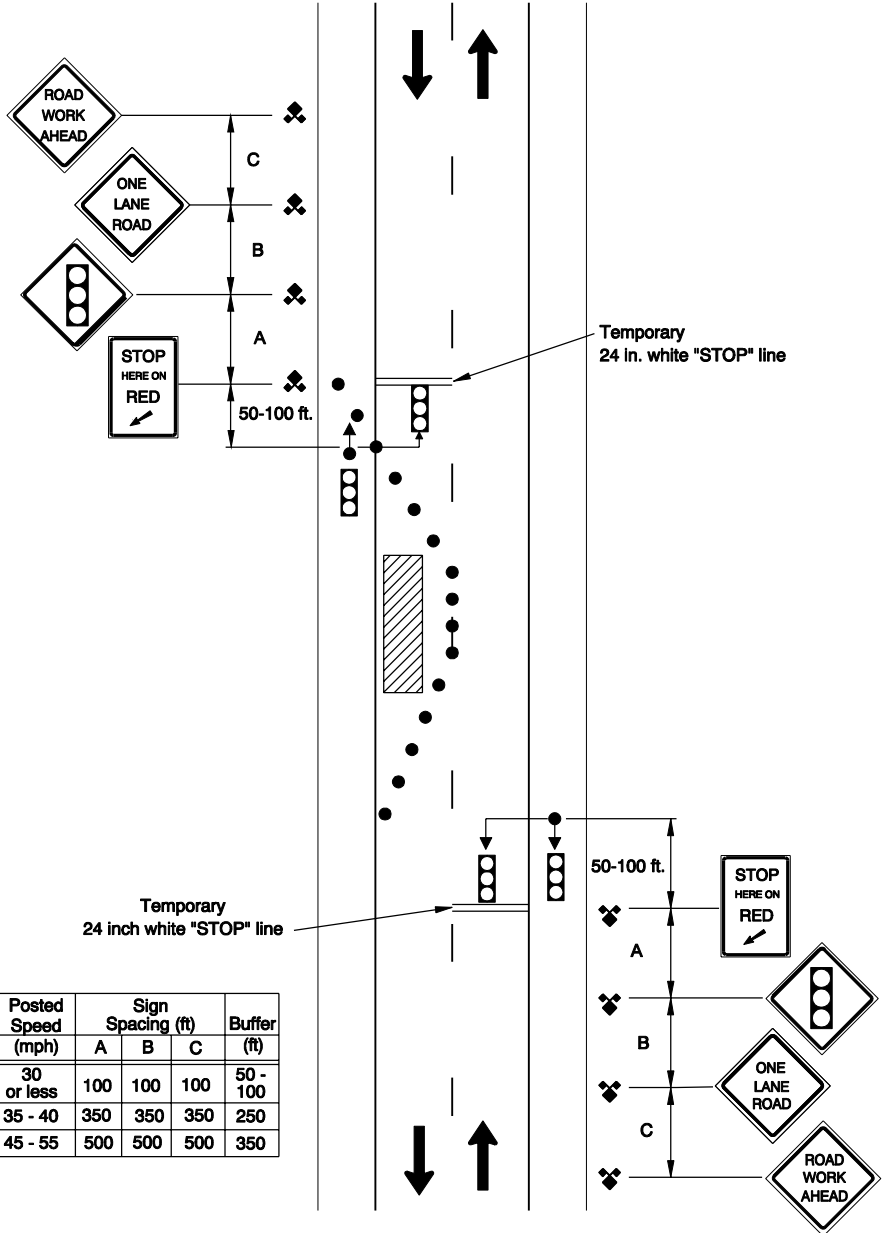


Diagram No. 330

4.340 Lane Closure with Pilot Car

Diagram 340

Diagram No. 340 covers closure of one lane of a 2-lane, 2-way road when a pilot car is used. A pilot car is used to guide traffic through a long section of one lane, two-way road past the work zone.

1. A pilot car should be considered when a driver entering the one lane section cannot see from one end of the work zone to the other.
2. A pilot car should be considered for night operations. See also section on Night Flagging.
3. Operation of the pilot vehicle shall be coordinated with flagging operations at each end of the one lane section.
4. Radio, cell phone or other reliable communications shall be maintained among flaggers, the pilot car and the work superintendent or designated worker at all times.
5. Side accesses should be controlled by flaggers. If entering traffic is low volume, FOLLOW PILOT CAR signs may be posted instead of flaggers. For residential driveways, residents can be contacted and arrangements made so that flaggers are not needed.
6. The PILOT CAR FOLLOW ME sign shall be mounted in a conspicuous location on the rear of the pilot vehicle. A PCMS may be substituted for the PILOT CAR FOLLOW ME sign.
7. The last vehicle following a pilot car in a queue may be identified by handing off a flag between driver and flaggers. Alternately, the last vehicle can be identified by communications between flaggers.
8. No vehicles should be allowed to pass the pilot vehicle.
9. Cones along side of the work area are optional.
10. The pilot vehicle should have the name of the road jurisdiction or the contractor prominently displayed on the vehicle.
11. Oiling and chip sealing operations:
 - a. When traffic is allowed on loose gravel, the following black-on-orange, diamond-shape signs or their equivalent should be used:
CONSTRUCTION SPEED 35 (use appropriate speed for conditions)
LOOSE GRAVEL
 - b. Signs should remain in place until the majority of the loose rock is removed.
 - c. The sign sequence should be repeated every ½ to 1 mile throughout for both directions of traffic.

Lane Closure with Pilot Car Option

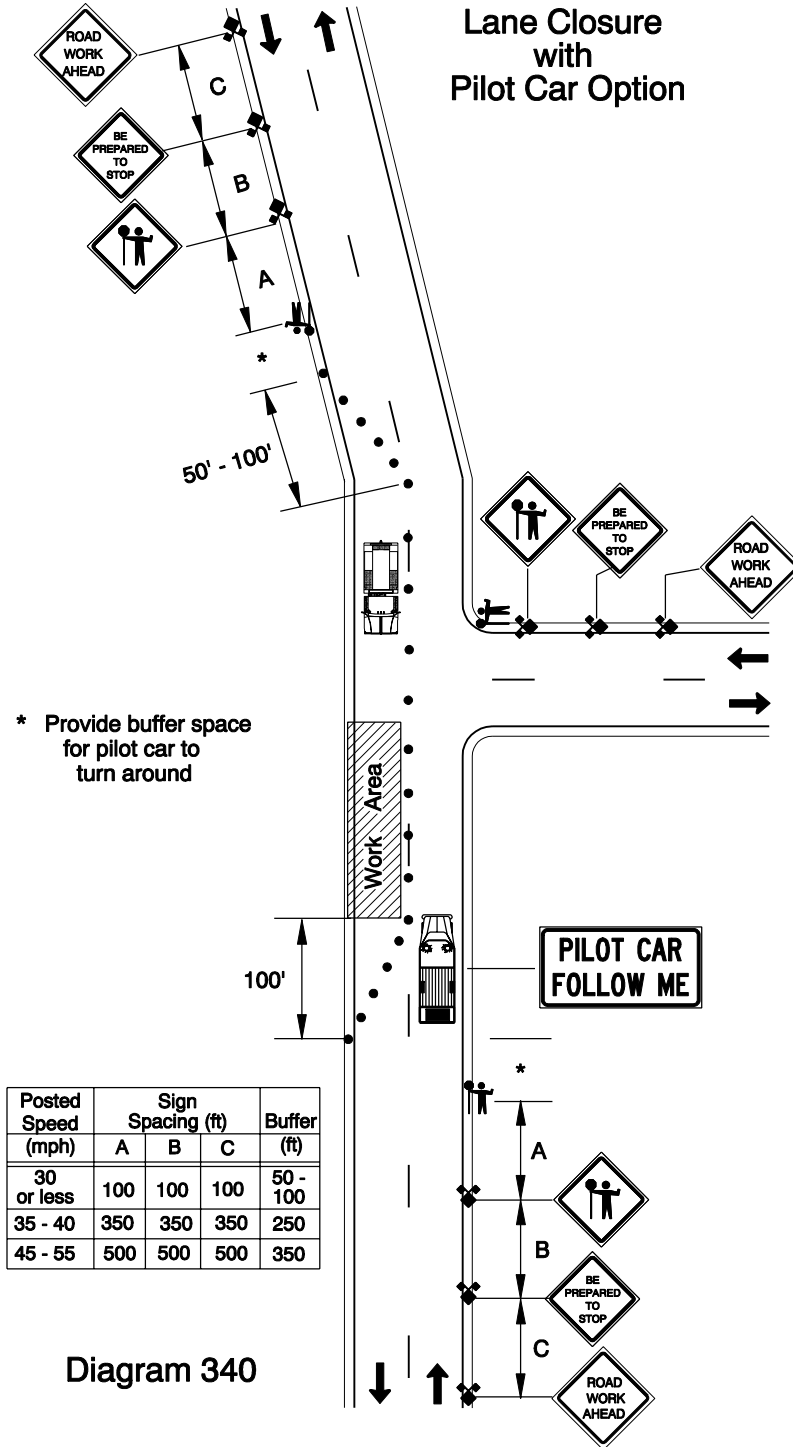


Diagram 340

4.350 Self-Regulating Lane Closure

Diagram 350

Diagram No. 350 covers closure of one lane of a low speed two-lane, two-way road.

1. Use this diagram only if all of the following are true:
 - a. Work area is less than 200 feet.
 - b. The posted speed is 40 MPH or less.
 - c. Average Daily Traffic (ADT) is less than 400.
 - d. Sight distance (in feet) is more than 750 at each end.
2. Use truck-mounted high-intensity, rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles.
3. A RIGHT LANE CLOSED sign may be placed inside the cone taper for more emphasis.
4. For work in place less than one hour, a truck-mounted or single portable PASS WITH CARE sign may be used in lieu of other advanced warning signs.

Self-Regulating Lane Closure

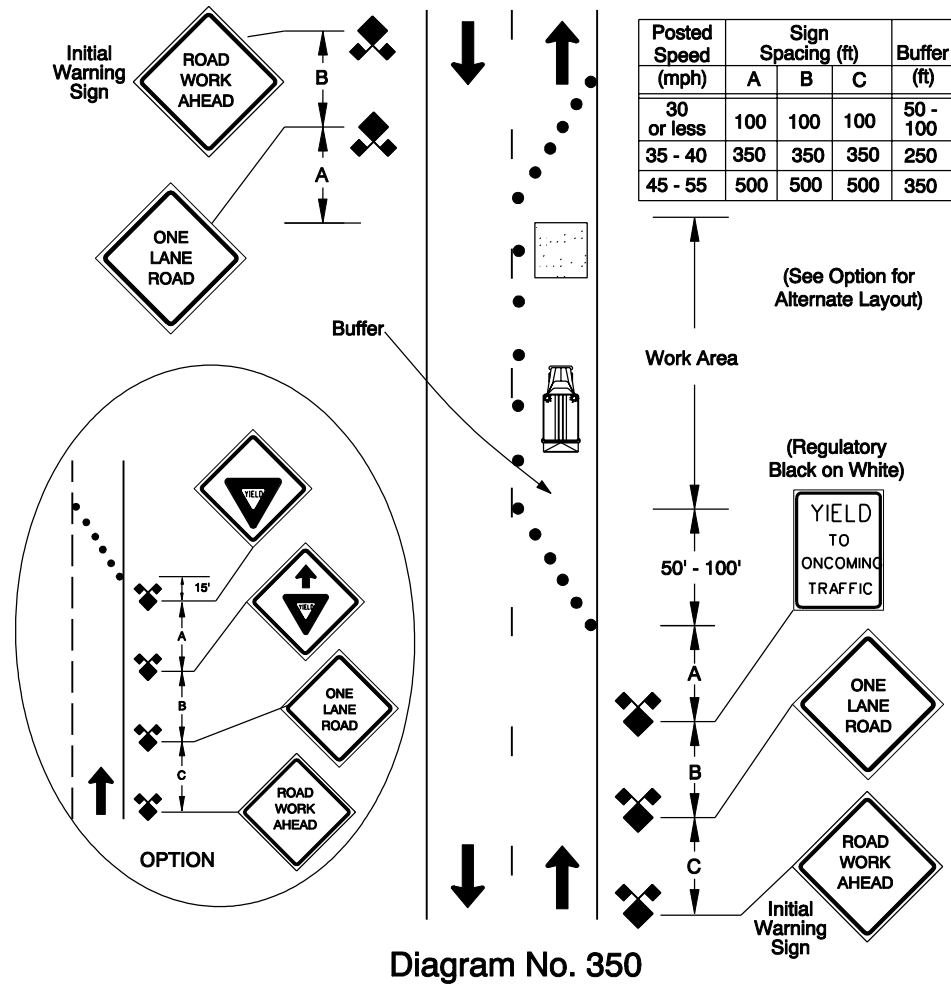


Diagram No. 350

4.360 Work in Center of Low-Speed Road Diagram 360

Use this diagram only on two-lane two-way streets with a posted speed of 40 MPH or less and when there is sufficient lane and shoulder width to allow a ten foot travel lane on each side of the work area.

1. When work vehicle(s) are in the work area, use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all vehicles. Allow a sufficient distance between the vehicle and work activity for safe run out if the vehicle is struck.
2. Cones are required.
3. A strobe or flashing warning light mounted on Type II barricade may be used just inside the end of the closed section. The Pass to Right sign may be mounted on the barricade if the total combination has passed NCHRP 350 crash testing.

Work in Center of Low-Speed Road

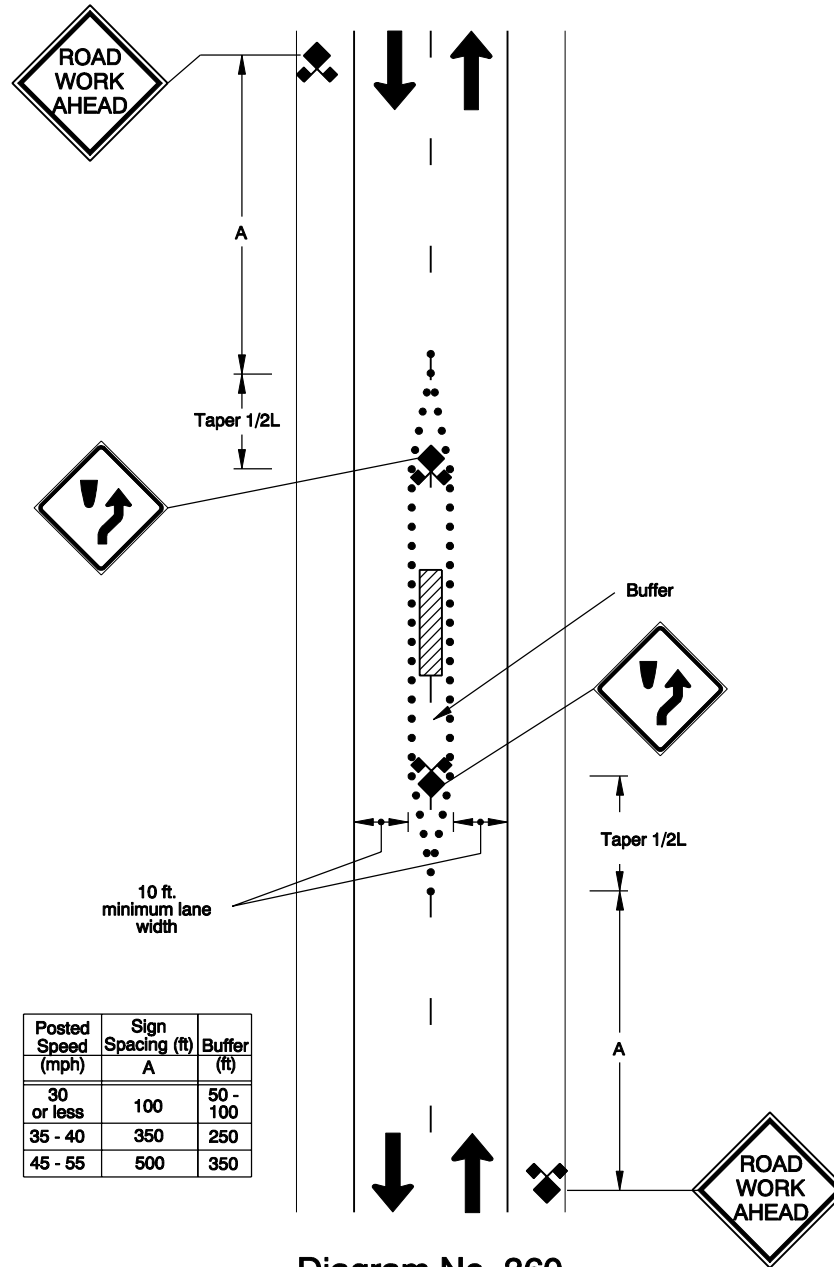


Diagram No. 360

Section 400 – Work on 3-Lane, 2-Way Roads

4.400 2 + 1 Travel Lanes – Work in Single Lane Direction Diagram 400

Diagram 400 shows work in the single lane direction of a 3-lane, 2-way road with two travel lanes in one direction and a single travel lane in the opposing direction.

Use the diagram to close the single travel lane and maintain a travel lane for each direction.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe lights on work vehicles that need to be at the work area.
2. On the single lane approach, cover any passing lane signs such as YIELD CENTER LANE TO UPHILL TRAFFIC.
3. On the single lane approach, extending the cones across the shoulder in a shoulder taper (L/3) is recommended.
4. On the single lane approach, extend the cones on the center skip strip as shown when the speeds are 45 mph or greater.
5. On the two lane approach, the use of 3 to 6 cones on centerline in advance of the taper is recommended.
6. An advance PCMS may be used, and should be considered when closing a passing lane.
7. If this is an added passing lane section (3-lane section on an otherwise 2-lane road):
 - a. The passing lane should be closed from the beginning (see exception below), keeping traffic in one lane each direction until past the work area.
 - b. Replace the Left Lane Ends symbol sign shown on the diagram with a black-on-white DO NOT PASS or KEEP RIGHT (+ arrow) sign.
 - c. Cover or place a CLOSED rider across the face of the permanent advance passing lane signs. These can include PASSING LANE 1 MILE, a Lane Transition sign and KEEP RIGHT EXCEPT TO PASS.
 - d. The passing lane should be closed to the end if there will be less than 1000 feet of passing lane remaining beyond the lane closure.
 - e. The passing lane should be closed from the beginning if there will be less than ½ mile of passing lane prior to the lane closure.

2+1 Travel Lanes - Work in Single Lane Direction

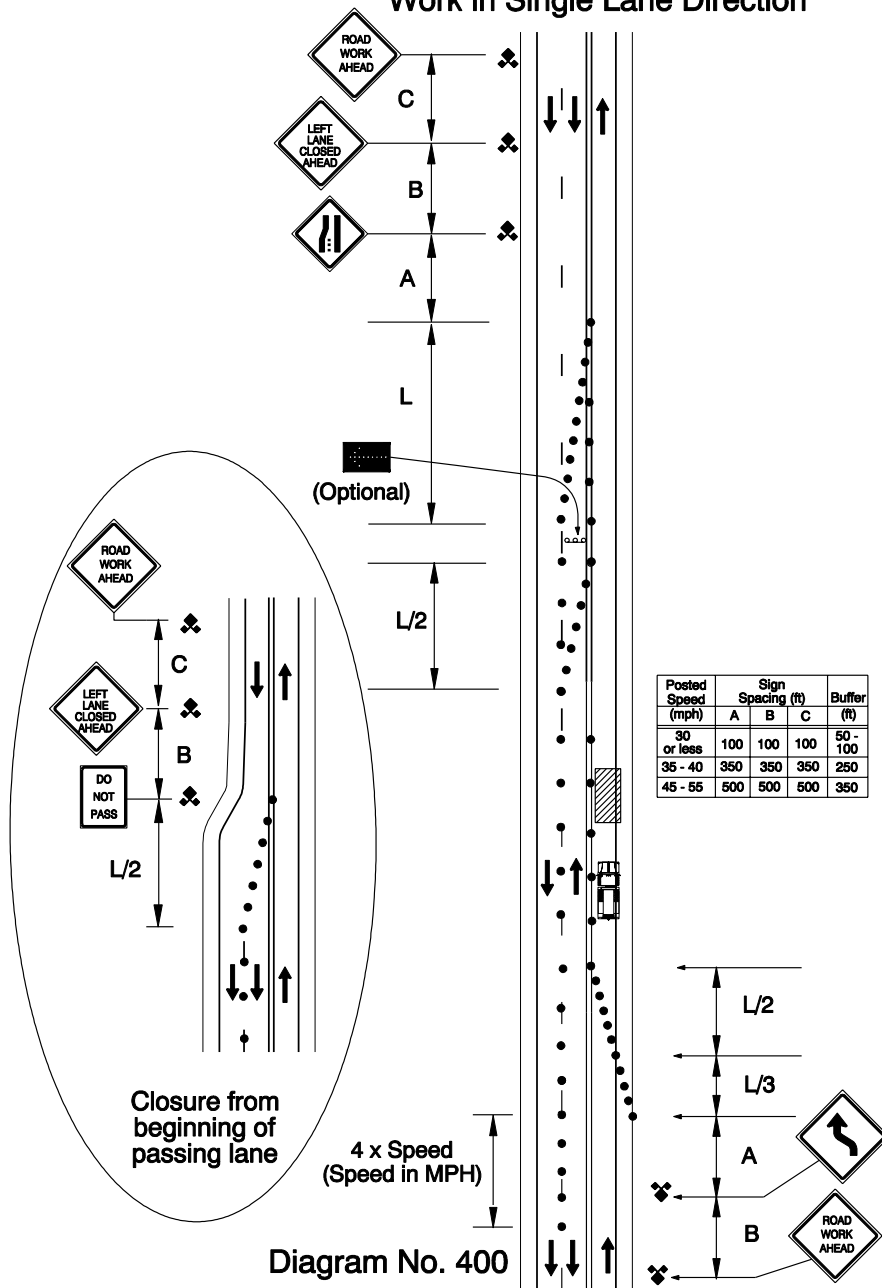


Diagram No. 400

4.410 2 + 1 Travel Lanes – Work in the Two-lane Direction Diagram 410

Diagram 410 shows work in the dual lane direction of a 3-lane, 2-way road with two travel lanes in one direction and a single travel lane in the opposing direction. Use the diagram to close one lane of the dual lane direction and maintain a travel lane for each direction.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe lights on work vehicles that need to be at the work area.
2. For a middle lane closure, 3 to 6 cones on centerline in advance of the closed area in the single lane direction may be used especially at speeds of 45 MPH or greater.
3. For a right lane closure (not shown), centerline cones through the work area may be used if lanes are narrow, sight distances are limited or the extra separation is needed for other conditions.
4. On the single lane approach, cover any passing lane signs such as YIELD CENTER LANE TO UPHILL TRAFFIC.
5. An advance PCMS is recommended, and should be considered when closing a passing lane.
6. If this is a passing lane section:
 - a. The passing lane should be closed from the beginning, keeping traffic in one lane each direction until past the work area.
 - b. Replace the Right/Left Lane Ends symbol sign as shown on the diagram with a black-on-white DO NOT PASS or KEEP RIGHT (+ arrow) sign.
 - c. Cover or place a CLOSED rider across the face of the permanent advance passing lane signs. These can include PASSING LANE 1 MILE, a Lane Transition sign and KEEP RIGHT EXCEPT TO PASS.
 - d. The passing lane should be closed to the end if there will be less than 1000 feet of passing lane remaining beyond the lane closure.
 - e. The passing lane should be closed from the beginning if there will be less than ½ mile of passing lane prior to the lane closure.

2+1 Travel Lanes - Work in the 2-Lane Direction

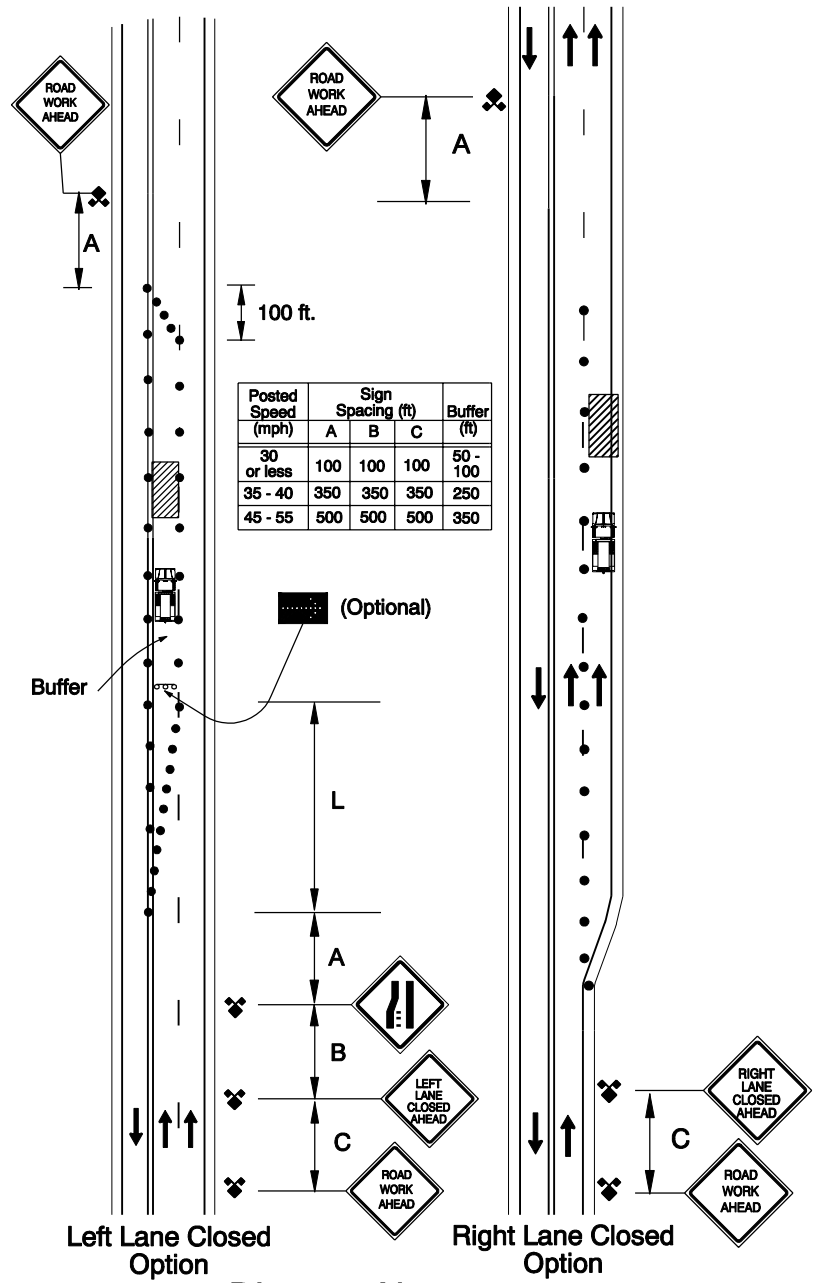


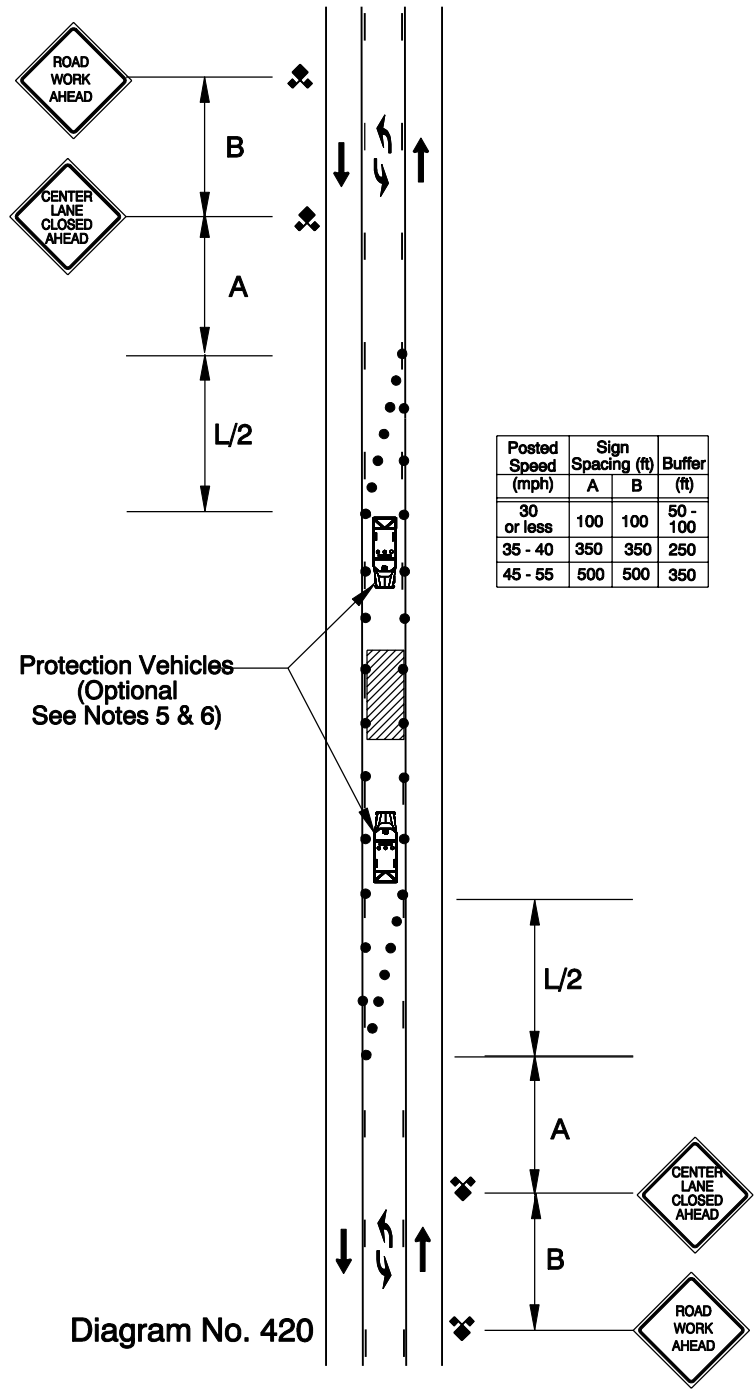
Diagram No. 410

4.420 Work in a Continuous Left Turn Lane Diagram 420

Diagram 420 shows work in the continuous two-way left turn lane of a 2-way road with 3 or more lanes.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe lights on work and traffic control vehicles.
2. For operations of more than one hour, cones and signs are required as shown, protection vehicles are optional.
3. For operations between 15 minutes and one hour, including work that will relocate intermittently, cones are required and signs may be replaced by protection vehicles with activated high-intensity rotating, flashing, oscillating, or strobe lights.
4. For operations of 15 minutes or less, signs and cones may be replaced by one or more protection vehicles with activated high-intensity rotating, flashing, oscillating, or strobe lights.
5. When only one protection vehicles is used, the use of a spotter(s) is recommended to warn workers of approaching traffic.
6. When protection vehicles are used and the speed is 45 MPH or greater, use of a TMA on the protection vehicle should be considered.

Work Area in a Continuous Left Turn Lane



4.430 Diversion into a Continuous Left Turn Lane

Diagram 430

Diagram 430 shows work in the travel lane(s) next to a continuous two-way left turn lane with one direction of traffic diverted into the continuous two-way left turn lane.

1. When two or more travel lanes are reduced to a single lane before the diversion, each lane shall be closed separately. A longitudinal distance equal to $2L$ is required between each lane closure.
2. A shifting taper ($L/2$) may be added in the diverted traffic direction across the continuous 2-way left turn lane (as shown). This option is recommended when the speed is 45 MPH or greater.
3. When protection vehicles are used and the speed is 45 MPH or greater, use of a TMA on the protection vehicle is recommended.

Diversion into a Continuous 2-Way Left Turn Lane

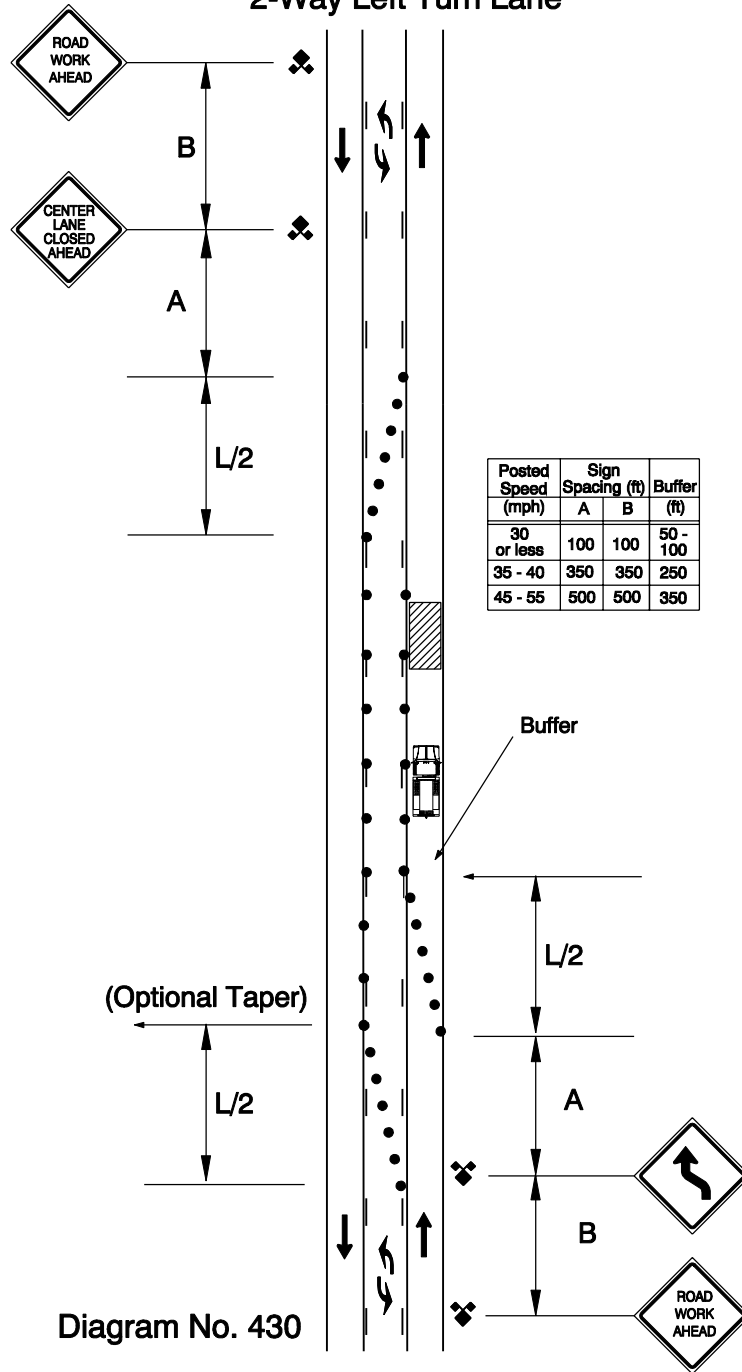


Diagram No. 430

Chapter 4, Section 500 – Work on Multi-Lane Roads

4.500 Right Lane Closure, Multi-Lane Non-Freeway Road Diagram 500

This diagram covers work which will block the right lane(s) of a multi-lane non-freeway road.

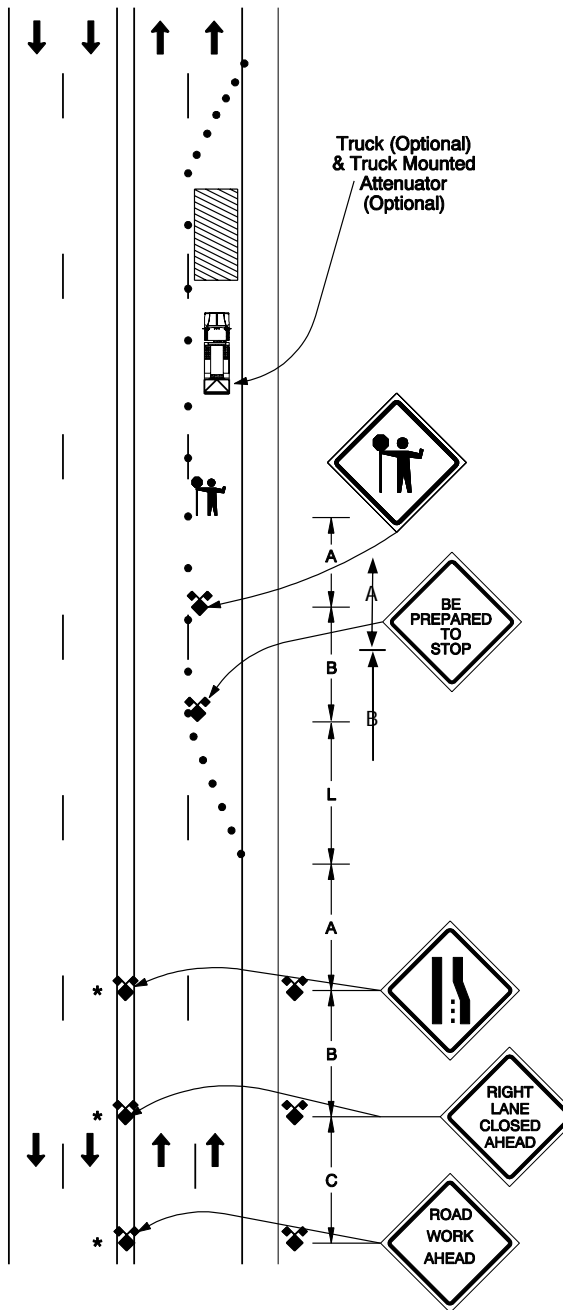
1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, truck mounted arrow panels in the caution mode or PCMS may be used to supplement visibility.
2. When the posted speed is 40 MPH or less, the RIGHT LANE CLOSED AHEAD signs may be omitted.
3. Placement of signs in a non traversable median or other median that is not a two-way left turn lane is required for lane closures any time when there is room for a truck to be standing on the left out of the travel lane. For lane closures when there is no room for a truck to be parked on the left, placement of signs in the median is optional for work that is less than four hours in duration.

Right Lane Closure on a Multi-Lane Road

Posted Speed (mph)	Sign Spacing (ft)			Buffer (ft)
	A	B	C	
30 or less	100	100	100	50 - 100
35 - 40	350	350	350	250
45 - 55	500	500	500	350

* See Note 4

Diagram No. 500

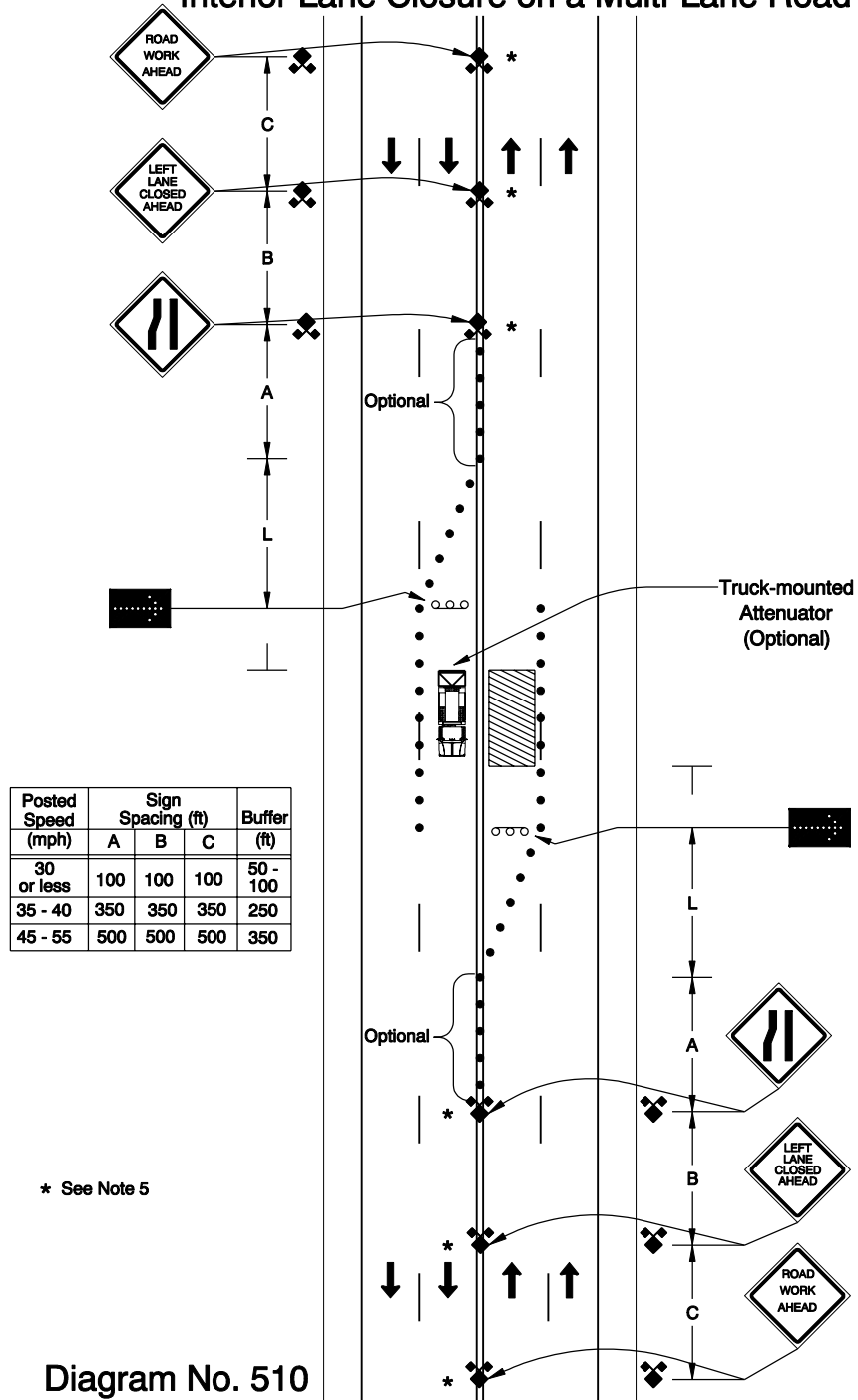


4.510 Interior Lane Closure, Multi-Lane Non-Freeway Road Diagram 510

This diagram covers work which will block the left lane(s) of a multi-lane non-freeway road.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights on all vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. If the adjacent lane in the opposing direction is not closed, cone off the work space placing the cones in the median or along the centerline if there is one.
3. When the posted speed is 40 MPH or less, the LEFT LANE CLOSED AHEAD signs may be omitted.
4. Placement of signs in a non-traversable median or other median that is not a two-way left turn lane is required for lane closures any time when there is room for a truck to be standing on the left out of the travel lane. When there is no room for a truck to be parked on the left an additional LEFT LANE CLOSED AHEAD sign should be placed on the right side and placement of signs in the median is optional for work that is less than four hours in duration.
5. Cones may be placed as shown on centerline in advance of the work to better gain the attention of motorists.
6. Work vehicle(s) with or without a TMA may be used to protect the workers and work space. If used, the vehicles should be parked far enough from the work space to come to a stop, if hit, before intruding into the work activity or travel lanes.

Interior Lane Closure on a Multi-Lane Road



* See Note 5

Diagram No. 510

Chapter 4, Section 600 – Intersection Operations

4.600 Lane Closure – Near Side of Intersection

Diagram 600

This diagram covers closure of an intersection approach lane. Work vehicles may or may not be in the work area. Prohibiting left turns will require additional advance warning signs. Check with the road jurisdiction before placing “No Left Turn” regulatory symbol signs. Movement of traffic through the intersection is regulated by existing traffic control only.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. When the posted speed is 40 mph or less and work in place for less than 15 minutes, a truck mounted arrow panel or PCMS may be used in place of required signs and cones shown on the drawing.
3. A minimum 36” LANE CLOSED sign is required at the closed lane. The sign may be truck-mounted, and may be a PCMS.
4. Where space allows, install advance warning signs in the median on multi-lane roads, especially for left lane closures.
5. An “Arrow” symbol sign may be installed on a Type II barricade inside the closure taper.
6. When closing an interior lane of a three or more-lane facility, the closure taper shall direct traffic into only one of the adjacent lanes, but not both.

Lane Closure - Near Side of Intersection

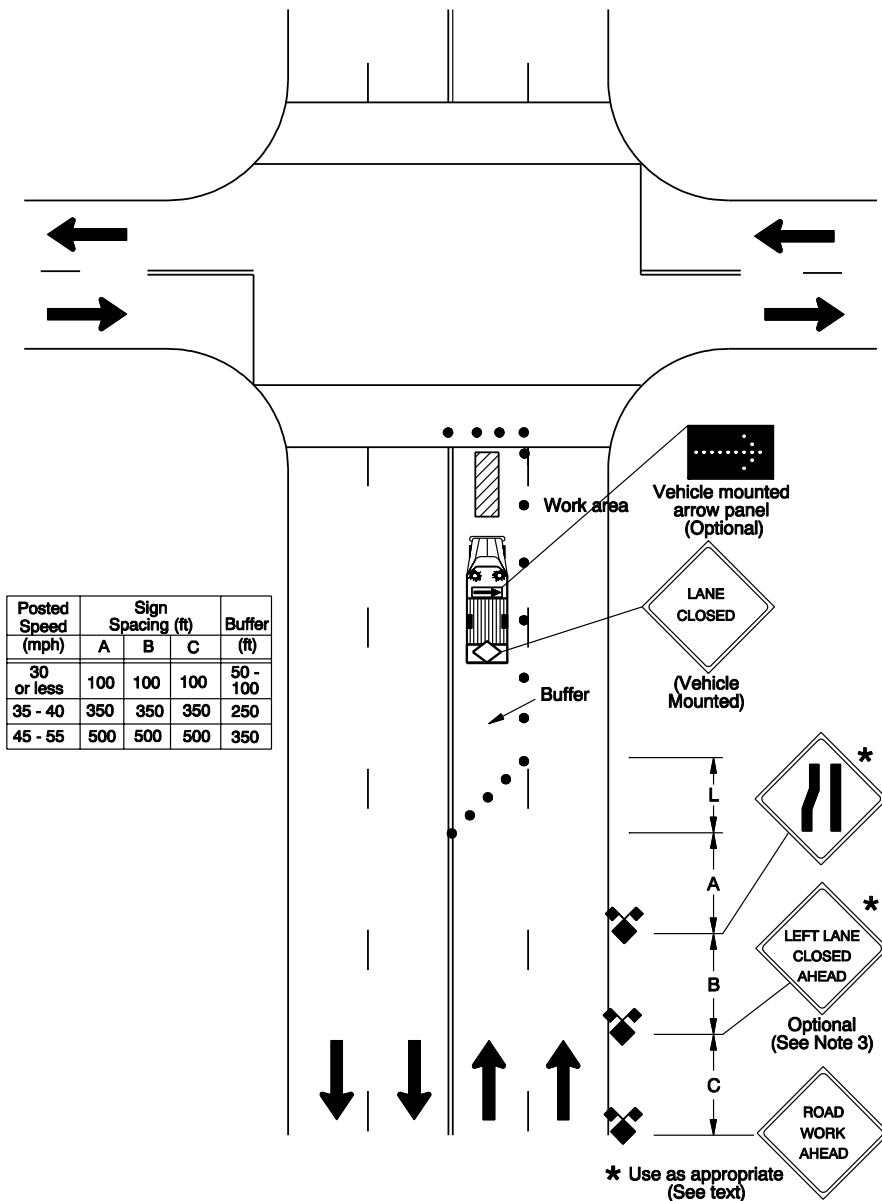


Diagram No. 600

4.605 Left Turn Refuge Closure

Diagram 605

This diagram covers work which closes an exclusive left turn refuge. When working in a left turn refuge, close the entire refuge. Left turns movements can be made from the left-most through-lane unless regulatory signs prohibit turns from that lane. Prohibiting left turns will require additional advance warning signs. Check with the road jurisdiction before placing "No Left Turn" regulatory symbol signs.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. A minimum 36" LANE CLOSED sign inside the cone taper or mounted on the work vehicle is required. The sign may be a truck mounted PCMS.
3. When the posted speed is 40 mph or less and work in place for less than 15 minutes, an arrow panel in caution mode or PCMS with the LEFT (or RIGHT) LANE CLOSED message may be used in place of the required signs and cones shown on the drawing.
4. A minimum of two advance warning signs on the right are required, as shown.

Left Turn Refuge Closure

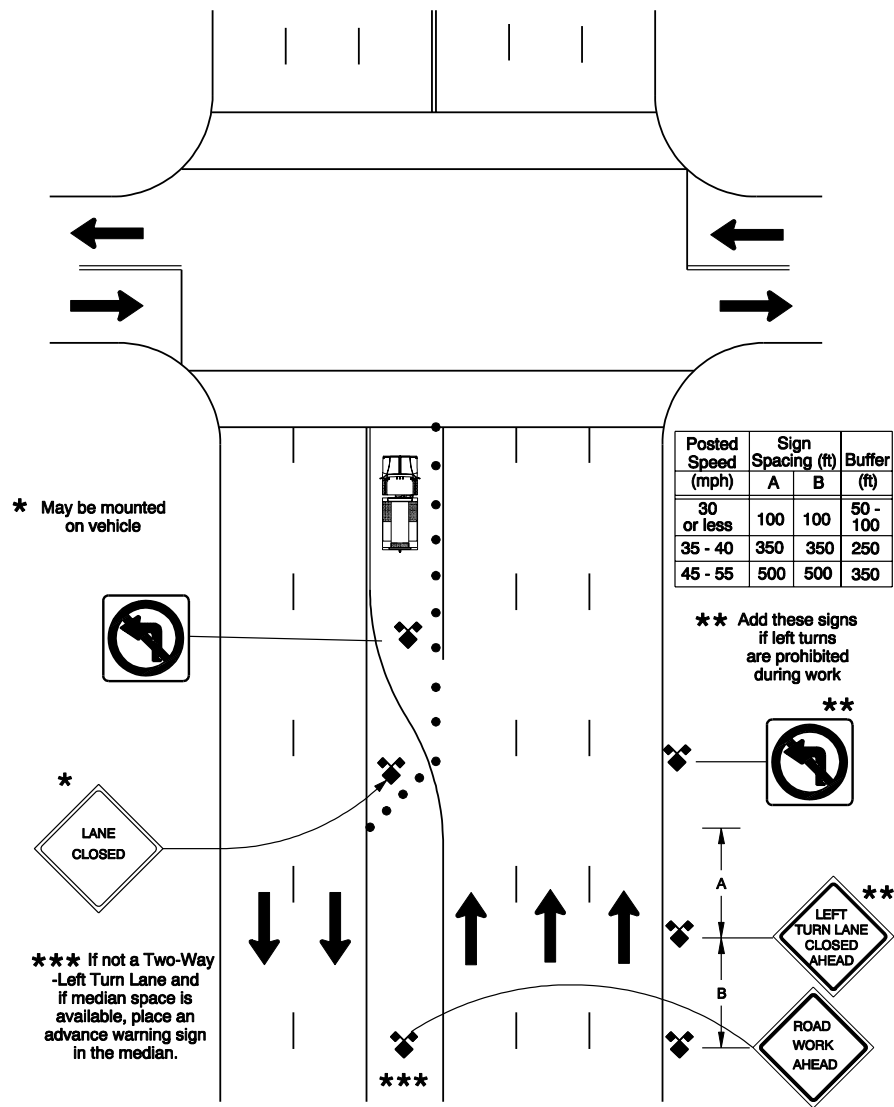


Diagram No. 605

4.610 Lane Closure – Far Side of Intersection Diagram 610

This diagram covers work within an area immediately downstream of an intersection. Work vehicles may or may not be in the work area. Movement of traffic through the intersection is regulated by existing traffic control only.

1. If left turns can not be prohibited, a left turn lane may be set up after the lane closure by leaving an opening long enough for vehicles to enter. There should be a minimum of 75 feet of storage beyond the opening in the left turn lane. Adjust the length of the lane closure to accommodate the left turn lane.
2. If providing a left-turn lane, place black-on-white, rectangular “LEFT LANE MUST TURN LEFT” signs on the right shoulder and inside the closed lane in advance of the left turn opening and in lieu of the NO LEFT TURN sign(s).
3. When closing an interior lane of a three or more-lane facility, the closure taper shall direct traffic into only one of the adjacent lanes, but not both.

4.620 Lane Closure at Intersection with Flagging

Diagram 620

This diagram covers work within an intersection when normal traffic control must be interrupted. Work vehicles may or may not be in the work area.

1. During flagging, traffic signals shall be turned off. Contact the road jurisdiction for approval and assistance see (section 1.516).
2. For multi-lane facilities, traffic approaching the intersection shall be reduced to a single lane on each approach and approach. See Chapter 1.515 and 1.516 for information on flagging through intersections.
3. There should be one flagger for each approach. One flagger may control two adjacent approaches if sight distance, low volumes on side roads and flagger position allows for safe operation and clear direction to motorists. For low traffic volume intersections (fewer than 400 entering vehicles per day), one flagger may be used.
4. When the posted speed is 40 mph or lower, only the ROAD WORK AHEAD and Flagger Symbol advance warning signs are required, the BE PREPARED TO STOP sign is optional.

Lane Closure at Intersection with Flagging

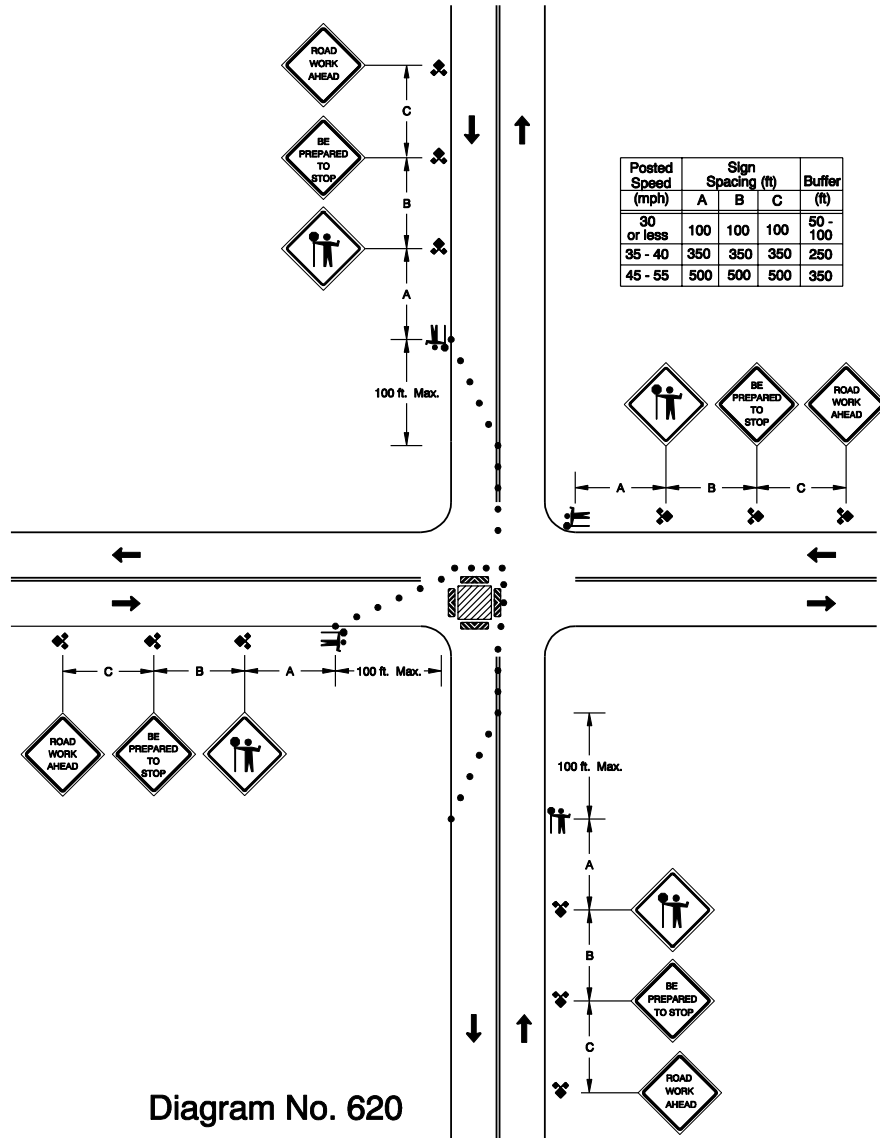


Diagram No. 620

4.630 Work in the Center of an Intersection Diagram 630

This diagram covers work within an intersection of two-way streets. Movement of traffic through the intersection is regulated by existing traffic control only.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. For multi-lane approaches, merge traffic into one lane in advance of the intersection.
3. For high speed or high traffic volume operations, consider using flaggers to control traffic.
4. When the operation will take less than one hour:
 - a. If traffic must move out of a travel lane, cones are required.
 - b. For multi-lane approaches, additional cones may be required to guide traffic around the work area.
 - c. Advance warning signs are required for all approaches unless the work will be in place for 15 minutes or less.
5. When the posted speed is 40 mph or less and work in place for less than 15 minutes,
 - a. An arrow panel in caution mode or PCMS with the LEFT (or RIGHT) LANE CLOSED message may be used in place of the required signs and cones as shown on the drawing and discussed below.
 - b. The channelizing devices may be eliminated if high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility are on work vehicles.

Work in the Center of an Intersection

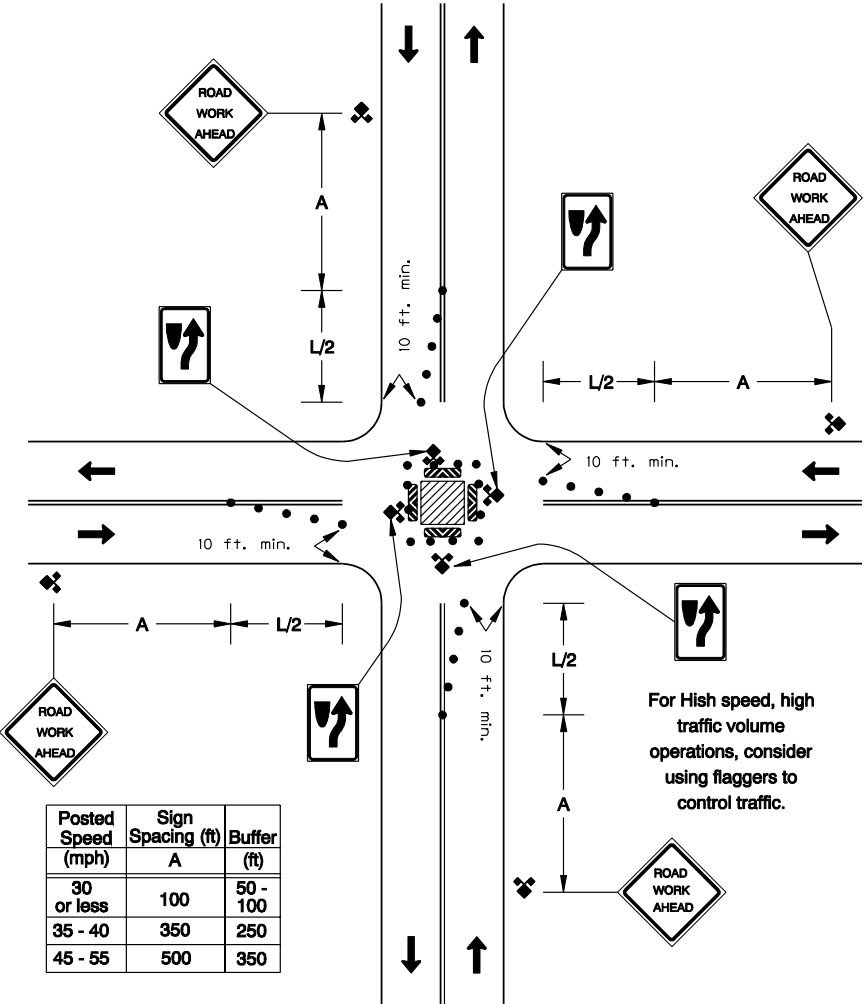


Diagram No. 630

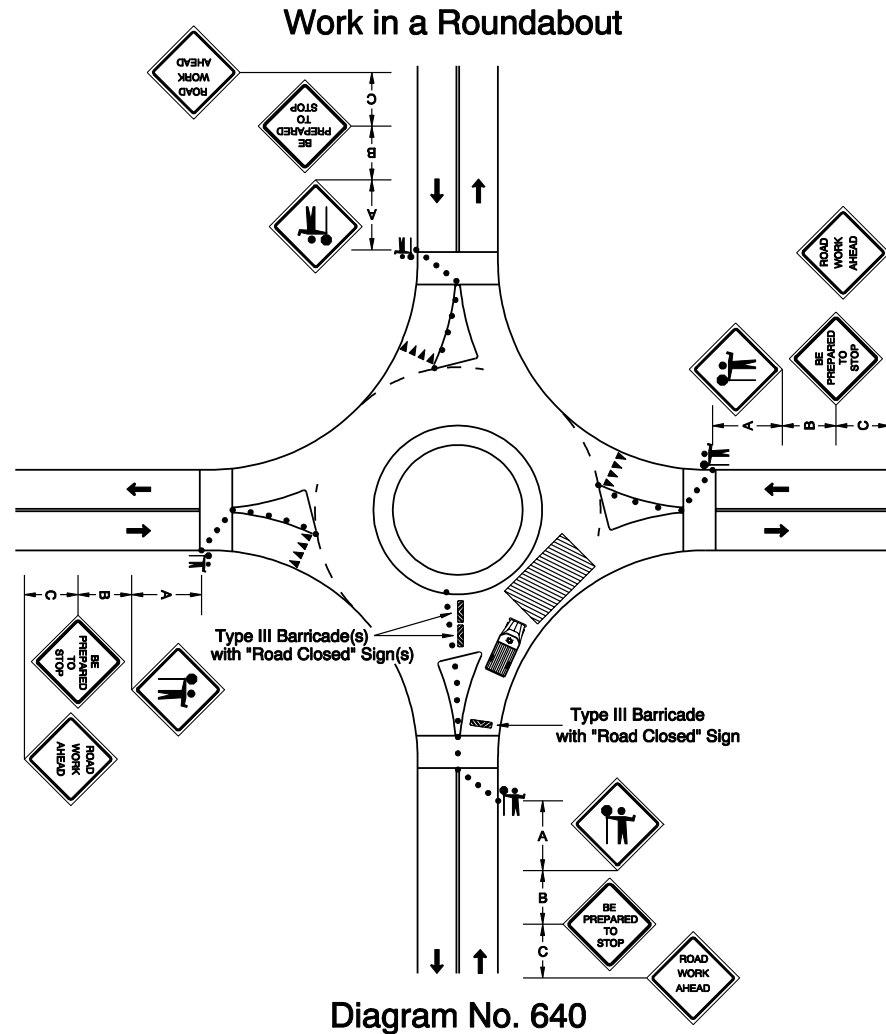
4.640 Work in a Roundabout

Diagram 640

This diagram covers work near and within a roundabout. The diagram shows closure of a portion of the roundabout with flagging control of alternating one-way traffic.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. If any of the road approaches can not access the intersection due to the work area, a detour may be required. Road closure approval and the detour route should be provided by the road jurisdiction. For short closures of 20 minutes or less, traffic may be held in place.
3. For work within the roundabout island, initial advance warning signs are required on each approach leg. If the work and all work vehicles are off of the travel lanes and island apron, a single sign per approach is all that is required.
4. If the center island apron will be impacted by the work or equipment, treat it as a shoulder closure for the length of work. But consider diverting truck traffic due to large vehicle off-tracking.
5. For multi-lane roundabouts, if work can be done without closing both travel lanes, flaggers may not be needed. Appropriate signs for the lane closure at each entry are required.
6. Cones may not be needed along the splitter islands on the approaches if these are raised islands. In such cases, the flagger may have to move far enough ahead on the approach of the splitter island so that traffic can maneuver into the roundabout.
7. If the lane closure with flagging is on an approach leg, flaggers may not be needed on the other entering legs. However, the ROAD WORK AHEAD and BE PREPARED TO STOP signs would still be required at each entry, with a Flagger symbol sign placed before the exit into the lane closure. In a small roundabout, the signing shown may still be needed.
8. If a travel lane width of at least ten feet can be maintained for shoulder work on an approach lane, the lane can remain open to traffic. Close the work area with a shoulder taper and longitudinal cones. An initial advance sign and a SHOULDER (SIDEWALK) CLOSED sign are required unless the work will take less than 15 minutes.

NOTE: The barricades as shown on the drawing are not required traffic control. The use of barricades or other protective devices should be appropriate for the work as determined by the competent person at the work site.



Chapter 4, Section 700 – Work on Freeways

4.7 Freeways

Freeways are defined by separation of traffic directions, high speed road design and controlled accesses. Freeways have only separated grade interchanges with exit and entrance ramps which are considered part of the freeway.

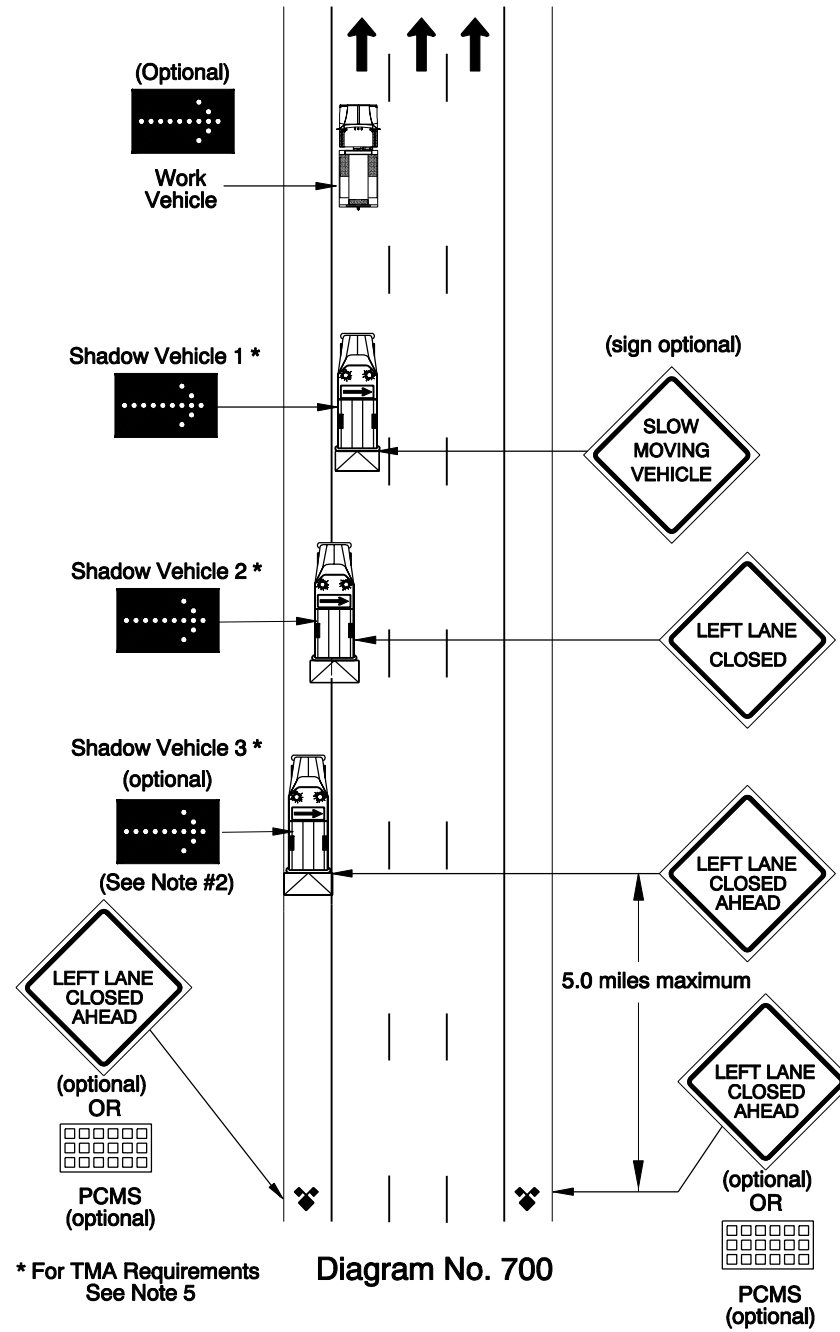
The high speeds and normally uninterrupted flow on freeways increases the risks for workers and road users. More visibility, better protection and earlier advance warning are needed for freeway work areas than on other roads.

Interstate highways are defined as freeways but other highways may have sections of road that effectively look like freeways, with grade separated road, access control, and/or separation of traffic directions. See section on multi-lane roads for non-freeway roads, but depending on the type of work and the discretion of a responsible person, the freeway section concepts may be applied.

This diagram covers mobile operations occupying one lane of a freeway.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work and shadow vehicles. In addition, arrow panels in caution mode or PCMS may be used.
2. Moving operations that take place on the shoulder i.e. brooming and spraying, where there is no encroachment and the operation does not stop, one shadow vehicle with advance warning sign is required. An additional sign or PCMS are recommended if sight distance of 1000' is not maintained.
3. Two shadow vehicles are required and three are recommended. All shadow vehicles will be equipped with an arrow display or PCMS. Any signs placed on the vehicle shall not obscure the arrow display or PCMS.
4. Each shadow vehicle should vary the trailing distance from the next shadow or work vehicle to provide adequate sight distance for traffic approaching from the rear.
5. The spacing between work vehicles and shadow vehicles should be minimized to deter road users from driving in between.
6. A truck-mounted attenuator (TMA) is required on the first vehicle exposed to approaching traffic in the travel lane.
7. Shadow vehicle one is in the closed lane covering the working equipment. Shadow vehicle one displays a truck-mounted SLOW MOVING VEHICLE or other appropriate sign so the full message can be read by approaching traffic.
8. Shadow vehicle two displays a truck-mounted appropriate LANE CLOSED AHEAD or other appropriate sign so the full message can be read by approaching traffic.
9. Shadow vehicle three, when used, displays a truck-mounted appropriate LANE CLOSED AHEAD or other appropriate sign so the full message can be read by oncoming traffic. When adequate shoulder width is not available, shadow vehicle three should stay as far onto the shoulder as possible and not protrude into traffic any further than necessary.
10. A truck or trailer mounted PCMS or advanced warning sign, placed at the beginning of the work section, is optional. Panel one should give warning of the type of work with NEXT X MILES on panel two. The signs should be moved during the day to stay within five miles of the work.

Freeway Mobile Operations



* For TMA Requirements See Note 5

Diagram No. 700

4.710 Freeway Shoulder Work

Diagram 710

This diagram covers stationary work with work operations and/or parked equipment on the shoulder and not encroaching on the travel lanes, lasting one hour or more.

1. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility on all work vehicles. In addition, arrow panels in the caution mode or PCMS may be used.
2. Shoulder work i.e. litter bag pick-up and site post repair where there is no encroachment and the operation moves continuously with frequent stops, in place less than 15 minutes, no advance warning signs or cones are required if 1000' of site distance is maintained. The advanced warning sign may be ground-mount RWA or PCMS.
3. The shoulder should be closed as shown if the sight distance is reduced to less than 750 feet or if 15 feet of clearance between the work vehicle and the edge of travel way can't be maintained. However, if the shoulder is wide, paved and typically used as an auxiliary travel lane, use the shoulder as an auxiliary travel lane, available to traffic.
4. For work lasting longer than 15 minutes, a minimum of two signs should be used.
5. If equipment operation and activities are more than 15 feet from the edge of travel way signs and cones are not required.
6. The advance work sign or a truck-mounted work sign shall be maintained within 1500 feet of the work.
7. If work is in the median, there shall be left side signing or if space not available on left, at least two sets of advance signs on the right shoulder. One advance sign in such cases should be a PCMS.
8. For work that moves frequently and is in one place less than one hour, signs and cones can be omitted and advance warning signing may be placed to cover a distance that includes all work locations for a maximum 5 miles. Initial advance warning signs may be either stationary or truck mounted.

Freeway Shoulder Work

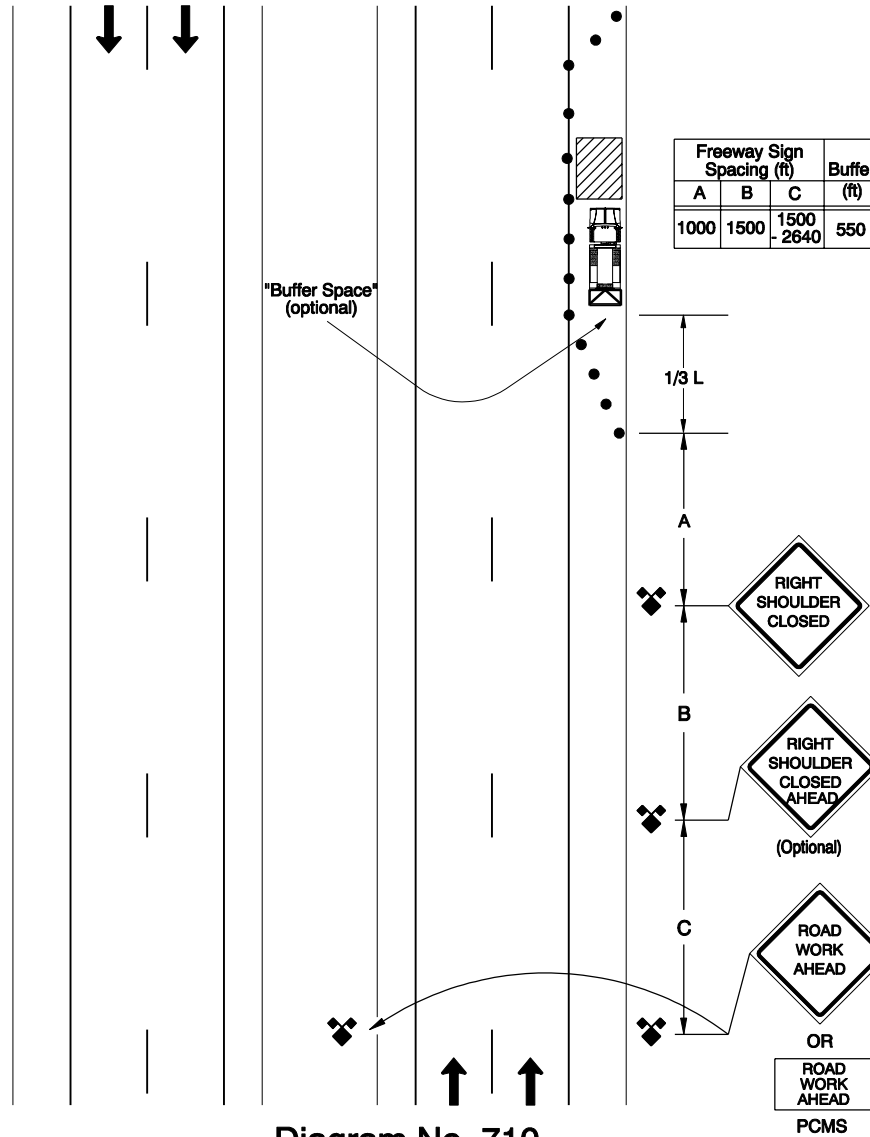


Diagram No. 710

4.720 Freeway Lane Closures

Diagram 720

The diagram covers lane closures on a freeway. It is recommended that lane closures only be in place during off peak hours. The traffic control should be placed during the lowest traffic volume period available.

1. A minimum of three advance warning signs is required.
2. Use truck-mounted high-intensity rotating, flashing, oscillating, or strobe warning lights with 360° visibility, arrow boards in caution mode, or PCMS on any vehicles less than 15 feet off the edge of travel way.
3. Placement of signs in the median are required for left lane closures and any time when there is room for a truck to be parked on the left out of the travel lane to place the signs. For right lane closures when there is no room for a truck to be parked on the left, placement of signs in the median is optional for work that is less than four hours in duration. Smaller 36 inch signs may be used where there is not sufficient room for a 48 inch sign with a one to two foot shy distance to the edge of travel way.
4. If signs are not used in the median, additional advanced warning devices shall be used such as PCMS or ground mounted signs on the right shoulder to provide additional warning to the motorists. There should be at least 1500 feet between each advance sign sequence. This option should not be used for work in place longer than one work shift or for sections with four or more lanes.
5. When an interior lane must be closed, close the adjacent lanes from the shoulder toward the work area. Start from the closest shoulder to minimize the number of closed lanes. When closing lanes from the median side extra attention should be given to advance warning and good sight exposure for the transition areas.
6. An arrow panel or PCMS is required in arrow mode for each lane closure. Only one arrow panel per lane closure is allowed. If an arrow panel is placed near the work activity in the closed lane, it shall be set in caution mode.
7. Closure distances or sign spacing may be lengthened as needed to provide for safe transition movements in unusual situations such as crest or horizontal curves.
8. A downstream taper may be used at the end of the lane closure(s) to transition traffic back to normal lane use.

9. A PCMS located at least 1/2 mile before the initial advance warning sign is recommended. The distance should be determined by a competent person on site based on field conditions. The PCMS should give the closed lane information (RIGHT, LEFT, LANE or 2 LANES) and the distance ahead of the closure.
10. Use extended queue signing if traffic backs up beyond the initial advance warning signs (see Diagram No. 001)

Freeway Lane Closures

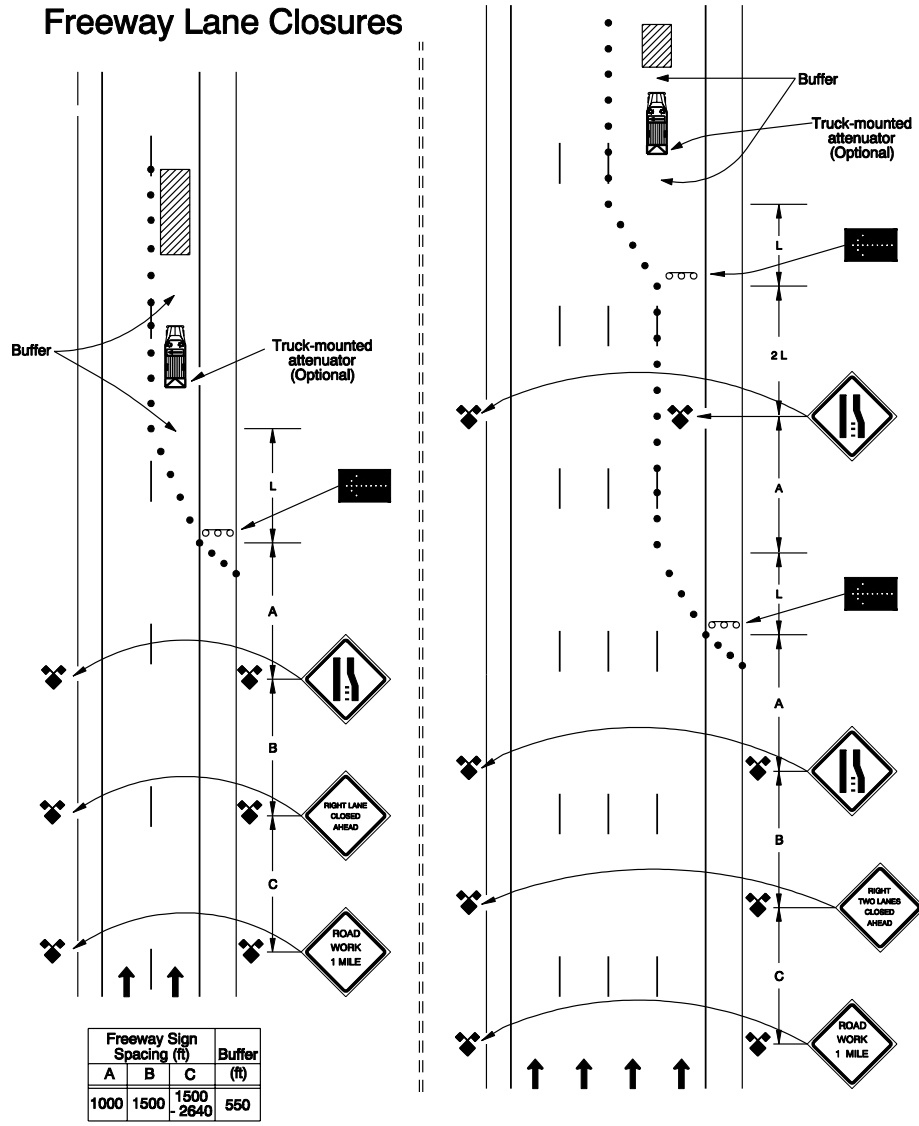


Diagram No. 720

4.730 Work Near an Exit Ramp

Diagram 730

Diagram No. 730 covers work that affects the approach to an exit ramp. The drawing shows work in the gore area. Similar traffic control would be placed for work near the entry area and shoulder. Traffic control should make the exit path clear to approaching motorists.

1. Use enough cones, barricades or tubular markers to provide a clear, smooth exit for motorists.
2. A white-on-green EXIT/arrow sign is required if the exit point is moved or re-shaped. Cover or remove inappropriate permanent EXIT/arrow signs.
3. A black-on-orange EXIT OPEN sign with an arrow or a PCMS, trailer or truck-mounted, may be used to indicate the point of exit in advance.
4. For multi-lane exits, keep exiting vehicles to one lane until past the work area.
5. Park equipment and vehicles inside the coned off area.

Work Near an Exit

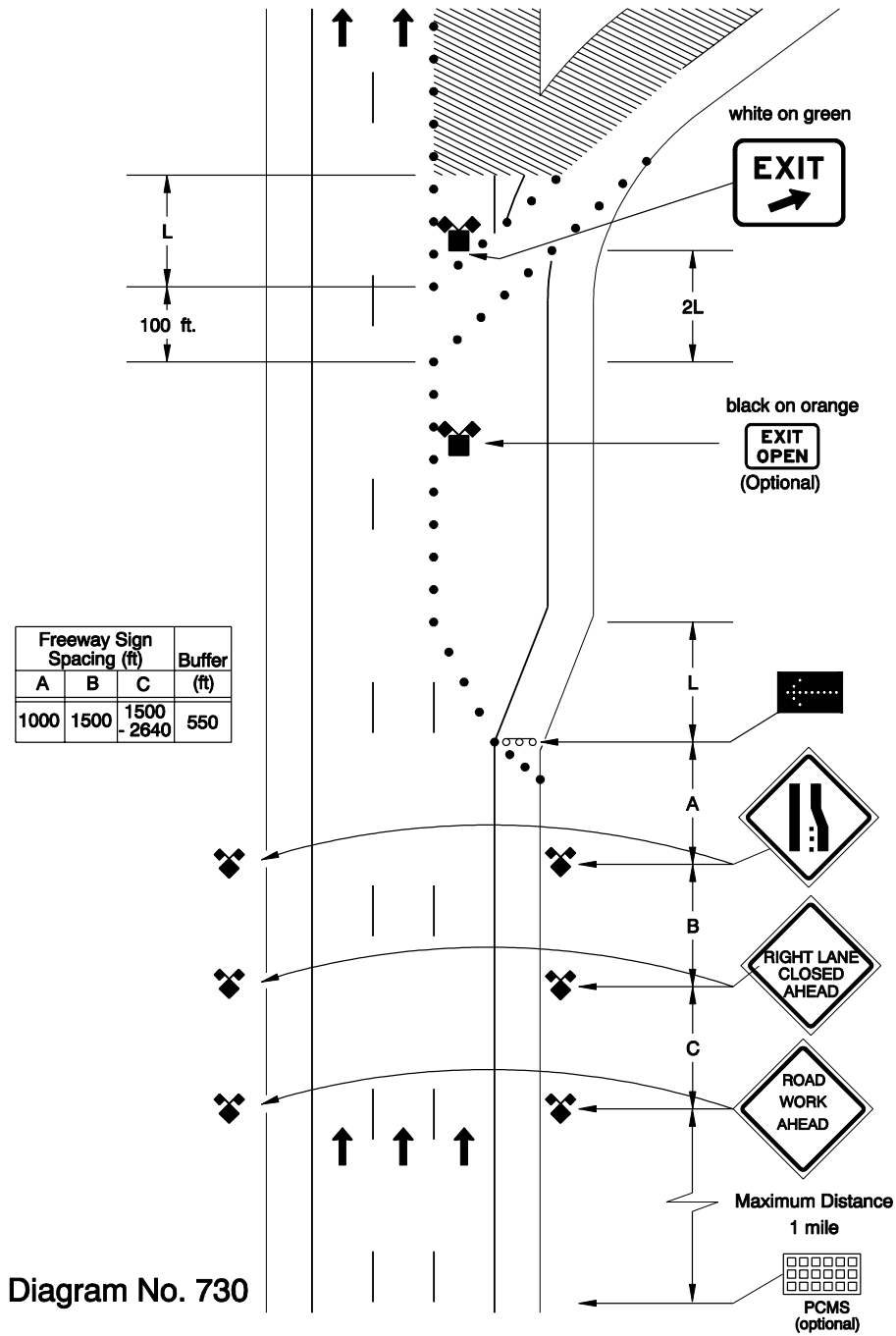


Diagram No. 730

4.740 Work On an Exit Ramp

Diagram 740

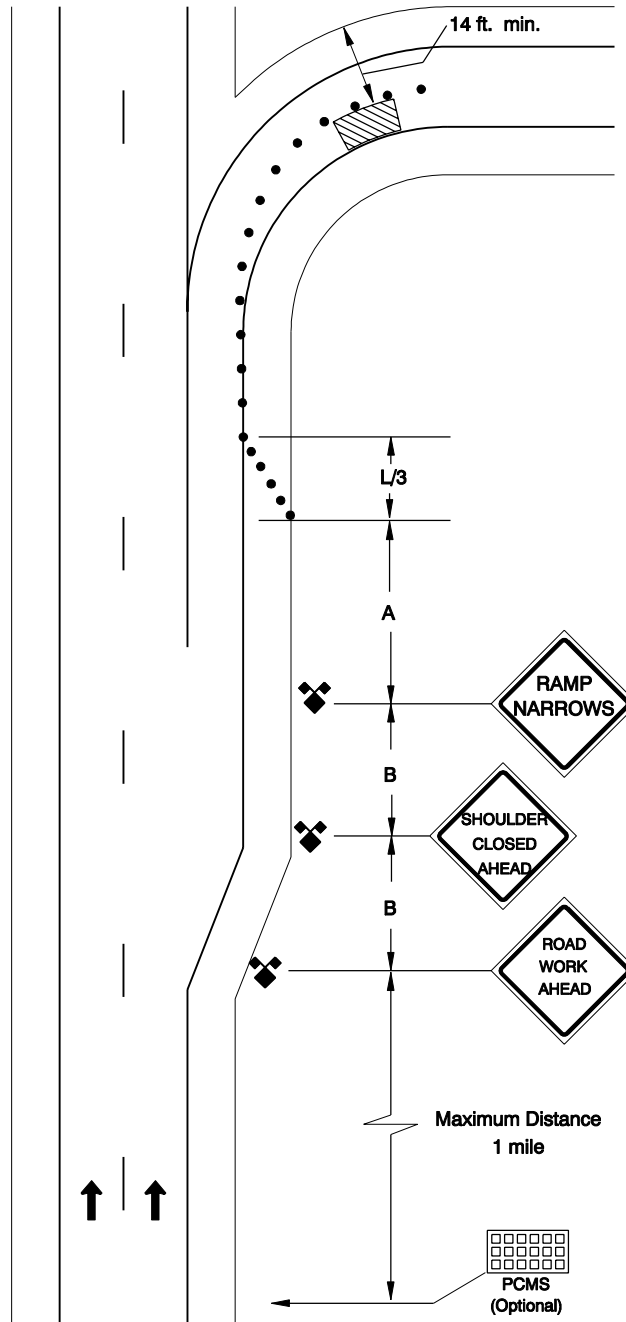
Diagram No. 740 covers work that encroaches on the travel lane of an exit ramp.

1. Maintain a minimum 14 foot width for traffic.
2. Use enough cones, barricades or tubular markers to provide a clear, smooth exit for motorists.
3. Place SHOULDER CLOSED signs, as needed.
4. Park equipment and vehicles inside the coned off area.
5. For multi-lane exits, keep exiting vehicles to one lane until past the work area.

Work On the Exit Ramp

Freeway Sign Spacing (ft)		Buffer (ft)
A	B	(ft)
1000	1500	550

Diagram No. 740



4.750 Exit Ramp Closure

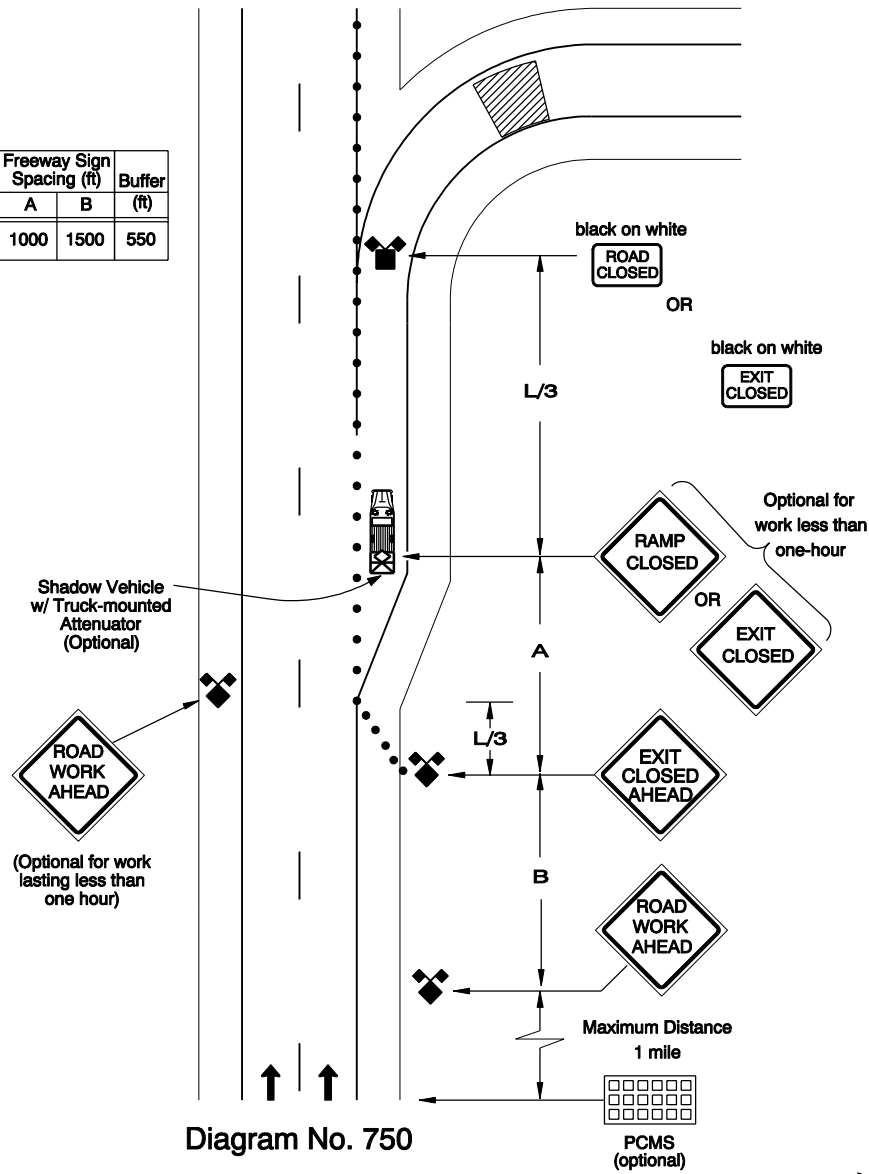
Diagram 750

Diagram No. 750 covers full closure of an exit ramp.

1. Place cones across the exit. Black-on-white EXIT CLOSED or ROAD CLOSED roll-up signs shall be placed in the closed travel lane on the ramp.
2. Placement of signs in the median are required for lane closures and any time when there is room for a truck to be parked on the left out of the travel lane to place the signs. When there is no room for a truck to be parked on the left, placement of signs or PCMS in the right is optional for work lasting than one hour.

Exit Ramp Closure

Freeway Sign Spacing (ft)		Buffer
A	B	(ft)
1000	1500	550



4.760 Work Near an Entrance Ramp, Right Side

Diagram 760

Diagram No. 760 covers work on or near the right-hand side of a freeway entrance ramp. Traffic on the freeway is moved out of the right lane to create an adequate merge area (refer to Diagram 720, Freeway Lane Closures). Ramp traffic is carried onto the freeway in the closed lane to merge with freeway traffic beyond the work area.

1. If the freeway merge area can not be established by merging the freeway through lanes, consider closing the ramp. Advance signing of the closure will be needed on the cross road in all approach directions.
2. If an exit ramp is in close proximity (1 mile or less downstream from work zone) so that any traffic in the left lane desiring to exit has insufficient opportunity to weave with traffic in the right lane, consider closing the ramp. Weaving is affected by length and volumes and may require a special analysis to determine if the weaving can be accommodated safely.
3. The ramp should be restricted to one lane. Flagging may be considered when work will sometimes use the entire width of the ramp. If flagging will impact traffic beyond the ramp, work and flagger advance signs shall be placed on the appropriate approaches.
4. The mainline merging taper with the arrow panel at its starting point should be located sufficiently in advance so that the arrow panel is not confusing to drivers to the drivers on the entrance ramp, and so that the mainline traffic merging from the lane closure has the opportunity to stabilize before encountering the merging ramp traffic.

NOTE: Many freeway interchanges have restricted merge designs. Engineered traffic control plans should be prepared for routine work at freeway entrances, especially when merge distances are short or there are restricted sight distances. The traffic control plans should be updated if the interchange is reconstructed or the freeway is changed.

Work Near an Entrance Ramp - Right Side

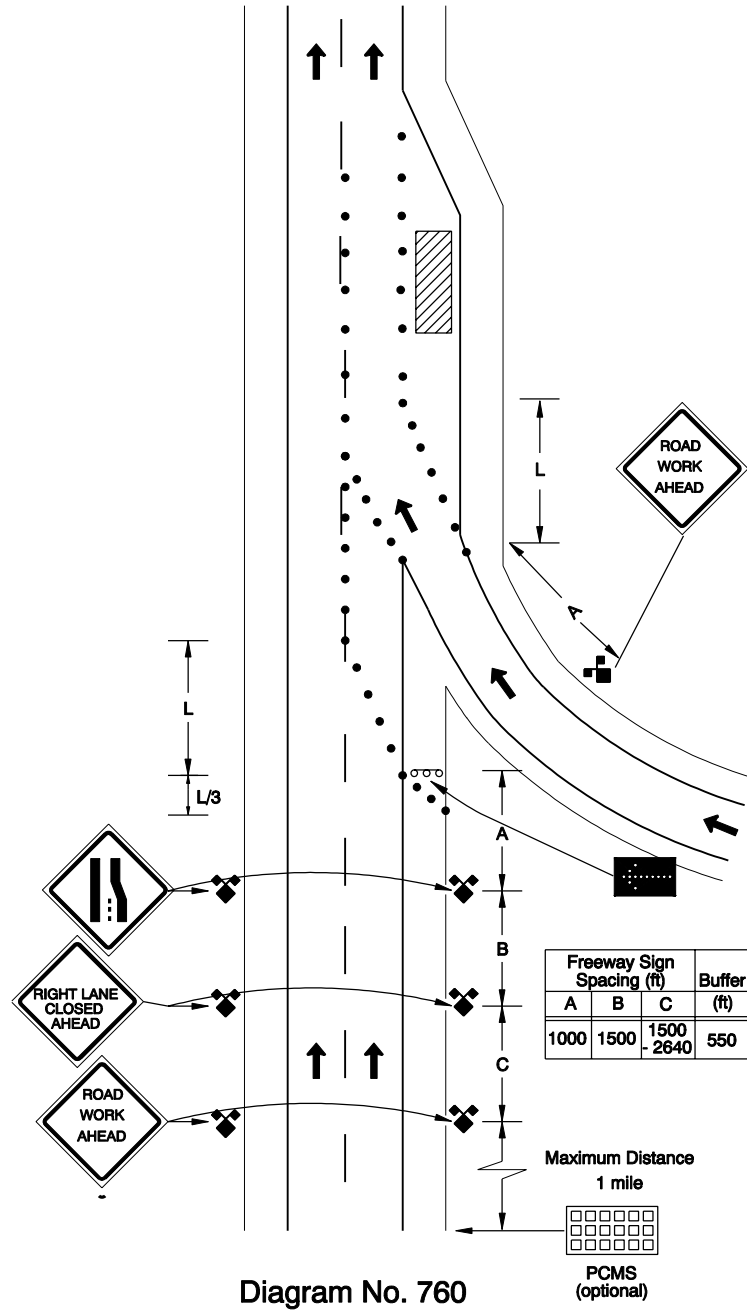


Diagram No. 760

4.770 Work Near an Entrance Ramp – Left Side

Diagram 770

Diagram No. 770 covers work on or near the gore area of a freeway entrance ramp. Traffic on the freeway is moved out of the right lane to clear the work area. The right lane remains closed until past the entry merge area (refer to Diagram 720, Freeway Lane Closures).

1. If the freeway merge area can not be established by merging the freeway through lanes, consider closing the ramp. Advance signing of the closure will be needed on the cross road in all approach directions.
2. If an exit ramp is closer than one mile downstream from this location, traffic analysis of the weave section should be performed to determine if the distance from the end of the cones to the next exit is adequate to safely accommodate the weave of the exiting traffic that was diverted to the left lane. If the weave distance is not sufficient the ramp should be closed
3. The ramp should be restricted to one lane. Flagging may be considered when work will sometimes use the entire width of the ramp. If flagging on the ramp will impact traffic above the ramp, work and flagger advance signs shall be placed on the appropriate approaches.
4. The mainline merging taper with the arrow panel at its starting point should be located sufficiently in advance so that the arrow panel is not confusing to drivers to the drivers on the entrance ramp, and so that the mainline traffic merging from the lane closure has the opportunity to stabilize before encountering the merging ramp traffic.

NOTE: Many freeway interchanges have restricted merge designs. Engineered traffic control plans should be prepared for routine work at freeway entrances, especially when merge distances are short or there are restricted sight distances. The traffic control plans should be updated if the interchange is reconstructed or the freeway is changed.

Work Near an Entrance Ramp - Left Side

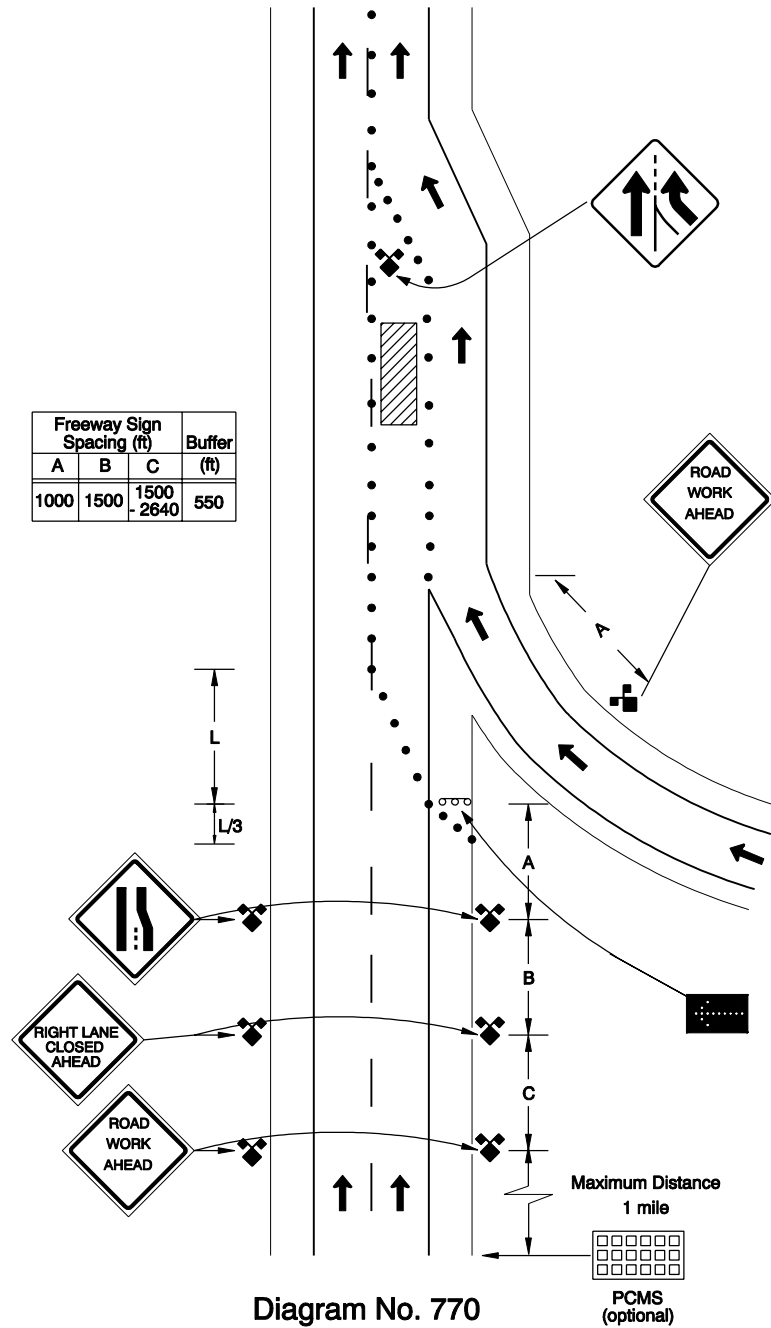


Diagram No. 770

Chapter 5. INCIDENT TRAFFIC CONTROL

A traffic incident can be any emergency, natural disaster, or other unplanned event that affects or impedes the normal flow of traffic. Incident Traffic Control takes priority over planned activities.

5.0 Incident Traffic Control

Traffic incidents can be emergencies that are road-related, such as a traffic crash or fuel spill, or non-road-related, such as a wildfire or flood.

Responders may use any available devices or equipment to guide traffic through the incident area until proper equipment is available, as long as the devices themselves do not create additional hazards. As soon as practical, MUTCD-compliant devices and equipment should be used.

The **goal of Incident Traffic Control** is the safe and effective control of traffic through the incident management area.

The **objectives** of the incident traffic control plan are to:

- Protect responders, victims and other personnel at the site,
- Provide reasonably safe traffic flow,
- Prevent secondary traffic crashes, and
- Manage the impact to the surrounding local road system.

A traffic **incident management area** is the section of highway where temporary traffic control devices are placed to delineate the incident area and keep traffic away from workers and equipment. The management area extends from the initial warning device (i.e. a sign or cone), to the last temporary traffic control device or to where vehicles return to their normal travel path beyond the incident.

A **staging area** for arrival and placement of emergency response vehicles may be included in the incident management area. It may be inside, in advance of, or beyond the activity area. It may also include space for emergency vehicles, incident command, and/or an enforcement vehicle (See Figure 5-1).

The **incident traffic control plan** should use the diagrams in Chapter 4 that are appropriate for the incident.

5.1 Incident Response Needs

The incident **traffic control needs** are classified into three categories based on their duration. The duration includes clean-up and any road or utility repairs that may continue the impact to traffic. The assessment of the incident duration should be made as soon as possible.

The duration categories should be used as a guideline for setting up traffic control for an incident. Other factors such as traffic volumes, speeds, road geometry or complexity of the response activities can also affect the traffic control needed.

The incident response duration categories are:

Major Incident –more than two hours

Intermediate Incident – 30 minutes to two hours

Minor Incident – under 30 minutes

If the incident is anticipated to last more than 24 hours, a site specific traffic control layout plan should be implemented by the road jurisdiction.

Major Incidents involve closing all or part of a road facility for **more than two hours**.

Contact road jurisdictions whose systems are affected by the incident or may carry diverted traffic.

Temporary traffic control measures for Major Incidents typically include:

- Advance warning signs
- Additional advance warning signs for extended traffic queues
- Signed detour route(s)
- Shoulder and/or lane closure devices and signing
- Channelization devices for the incident area
- Media contacts and frequent bulletins
- Certified Flaggers and/or Uniformed Police officers, as needed

Intermediate Incidents affect travel lane operation from **30 minutes to two hours**. Full road closures may be needed for short periods during clearance or clean-up operations.

Temporary traffic control measures for Intermediate Incidents typically include:

- Advance warning signs

- Additional advance warning signs for extended traffic queues
- Shoulder and/or lane closure devices and signing
- Channelization devices for the incident area
- Certified Flaggers and/or Uniformed Police officers, as needed

Minor Incidents – Disruptions to traffic operations typically last for **less than 30** minutes. On-scene responders typically include law enforcement, highway agency vehicles and towing companies. Diversion of traffic into other lanes and lane closures are often not needed or are needed only briefly. Traffic control is usually conducted by on-scene responders.

5.2 Detours

Before establishing any detour, contact all appropriate road jurisdictions whose systems are affected by the incident or that may carry diverted traffic. Some degree of traffic engineering and enforcement is needed for an effective detour.

The local road jurisdiction and enforcement jurisdiction will:

- Determine the most appropriate detour route(s),
- Install detour route signing,
- Maintain the detour route, and
- Remove all devices and signing when the detour is no longer needed.

Consideration for large trucks shall be made if they are being routed onto a local highway or street network. Large trucks may need to follow a separate detour route.

Local road authorities should work together to choose the best detour route and determine if it can support the additional traffic, including large trucks, while the detour is in effect.

5.3 Safety Apparel

It is important that all personnel exposed to traffic be highly visible and easily recognizable as a person. See Sections 1.100, 1.400, 1.514 and 1.517 of this handbook for safety apparel recommendations.

5.4 Emergency Response Example

Figure 5-1 shows a modified version of 2003 MUTCD, Typical Application 31 (Figure 6H-32) for Half Road Closure on Multi-lane, High-Speed Highway for the temporary traffic control for an emergency response activity. The incident command determines the layout and placement of all resources.

Elements of the Incident area may include a(n):

- incident command post,
- staging area,
- heavy engine protection vehicle, and
- Police presence.

Additional elements that may be needed include:

- An incident command post set up outside the incident work area.
- Having more than one staging area so incoming service vehicles are positioned for easy and safe access.
- Additional PCMS may be placed in advance of the incident area in the opposite travel lanes.
- A sequential arrow panel may be placed inside the lane shift taper between the first and second cones to help guide traffic.

Emergency Response Example

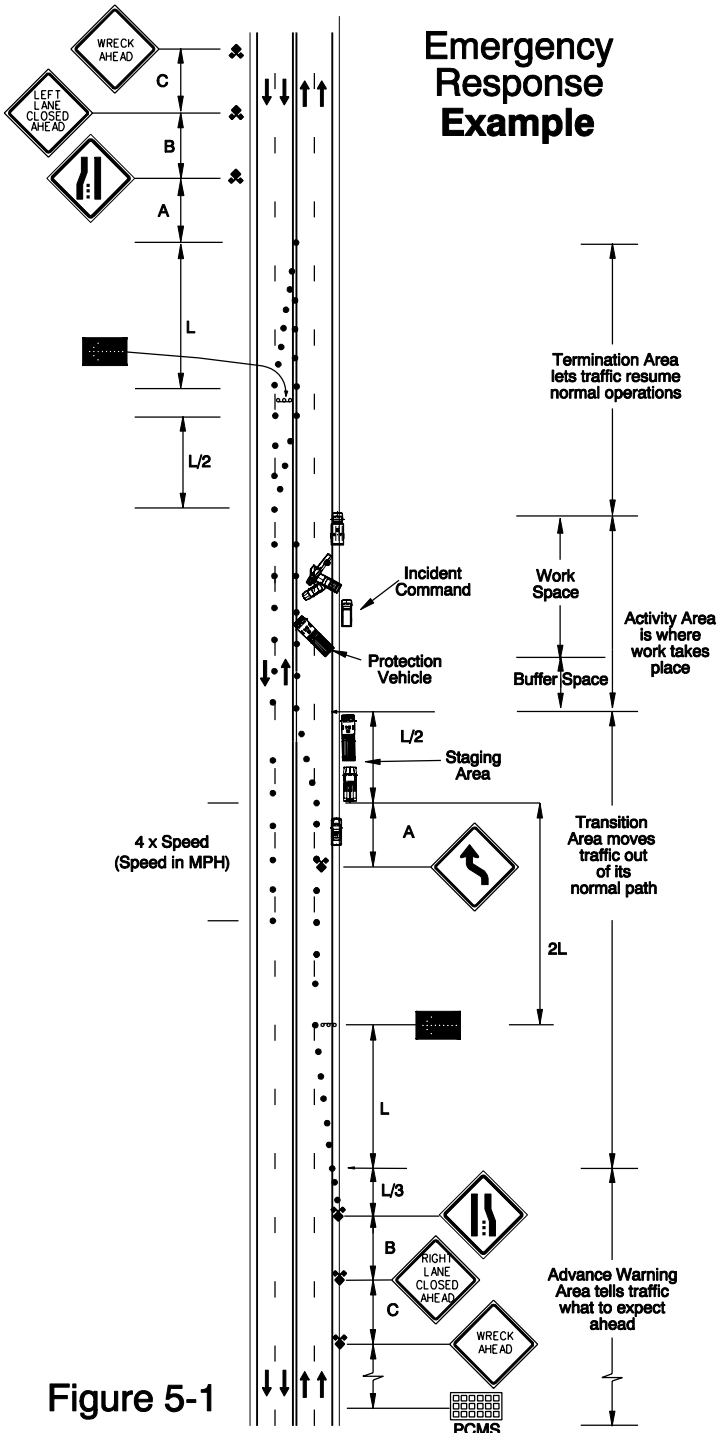


Figure 5-1

Appendix A

Glossary of Terms

ADT: Average Daily Traffic volume - average number of vehicles per day (number shown typically represents both directions of travel combined).

(SEQUENTIAL) ARROW PANELS: Lighted sign panels conforming to the requirements of the MUTCD with a matrix of lights capable of either flashing or sequential display of directional mode arrows or chevrons or non-directional (caution) mode. [also called arrow boards.]

BEACON (TRUCK-MOUNTED): A yellow rotating flashing light or strobe light mounted on a vehicle.

BARRICADES: A portable device having from one to three rails with appropriate markings, used to control traffic by closing, restricting, delineating or channelizing all or a portion of the highway.

BLOCKADE VEHICLE: A traffic control vehicle used to control the speed of following traffic in a rolling slowdown. A blockade vehicle is made highly visible with high-intensity rotating, flashing, oscillating, or strobe lights, an arrow panel and sign or PCMS.

BUFFER SPACE: An open space between the end of the transition area or traffic separation channelization and the work space. The buffer space does not include any equipment, stored materials, work activity or service vehicles.

CHASE VEHICLE: The vehicle that enters the road first in a rolling slowdown. The chase vehicle moves forward with traffic in front of the rolling blockade, positioning itself behind the last through vehicle before entering the work area. Seeing the chase vehicle go by, workers can move into the open travel lanes and begin working.

CLEAR ZONE: The unobstructed area provided beyond the edge of the travel lane(s) for the recovery of errant vehicles, including any shoulders or auxiliary lanes. The clear zone ends where obstructed by guardrail, curb, steep side slope, fence, trees, non-stabilized ground or other non-traversable features. The clear zone does not extend beyond the road right-of-way.

CONE SPACING: The longitudinal distances between channelization devices in a taper or the tangent sections along work areas and buffer spaces.

TAPER: A series of channelization devices (i.e. cones, tubular markers, drums) placed at an angle to the highway to guide traffic out of its normal path. Commonly used to close a highway shoulder or travel lane.

CONES: A conical-shaped channelization device with a weighted base. Cones are used to temporarily redirect traffic traveling through a work zone or incident response area. Cones can be used in tapers and along tangent areas to separate traffic from a work area and guide traffic along a desired path.

DRUMS (BARRELS): Drums are lightweight, flexible, and deformable barrel-shaped channelization devices used to temporarily redirect traffic traveling through a work zone or incident response area. Drums can be used in tapers and along tangent areas to separate traffic from a work area and guide traffic along a desired path.

EDGE OF TRAVEL WAY: The travel way is the portion of the highway for the movement of vehicles not including shoulders. The edge of travel way is often delineated by the “fog line” or edge of pavement markings.

EXTENDED TRAFFIC QUEUE: When the line of vehicles (queue) stopped at the beginning of a work zone extend beyond the initial advance warning signs. To prevent rear-end collisions at the end of the queue, additional advance warning signs are installed further in advance of the work zone. Advance Flaggers are sometimes used in addition to the additional signing. See **Advance Flagger**, below.

FLAGGER: A qualified and certified person responsible for controlling the flow of traffic through a work zone. A flagger must complete an approved flagger training course every three years, as outlined in this manual. A flagger is required to wear reflective clothing and uses a reflective STOP/SLOW sign paddle to control traffic.

ADVANCE FLAGGER: An additional flagger(s), stationed in advance of the primary flagger, responsible for warning approaching traffic that traffic is slowed or stopped ahead and that they need to slow down themselves. The advance flagger is preceded by additional flagger signing – see **Extended Traffic Queue**. The advance flagger does not stop traffic, and uses the SLOW sign paddle or a 24” x 24” red flag three only to get the approaching drivers’ attention.

HIGH SPEED: A designated (posted) speed of 45 MPH or above.

LOW SPEED: A designated (posted) speed of 40 MPH or below.

LOW VOLUME: An average daily traffic volume (ADT) of 400 vehicles per day or less.

MAY: Indicates an allowed alternative to a mandatory condition or action.

MOBILE OPERATION: Work activities where workers and equipment are moving along the road at a speed of 3 mph or more.

MULTI-LANE ROAD: A road with at least two lanes in one or both directions.

MUTCD: The national Manual on Uniform Traffic Control Devices published by the Federal Highway Administration and adopted as the statewide standard for traffic control devices by OAR 734-20-001 under the authority of ORS 810.200.

PILOT CAR: A four-wheeled vehicle no smaller than a compact pickup, identified by a 36" by 18" PILOT CAR FOLLOW ME sign mounted on the rear and equipped with a beacon and two-way radios or other communication devices. The communication devices shall have a range suitable for the length and terrain of the project.

PORTABLE CHANGEABLE MESSAGE SIGN (PCMS): PCMS include a message sign panel, control system, power source and mounting and transporting equipment. They shall conform to all requirements in the MUTCD and shall be listed on the Qualified Products List for use of state highways.

PORTABLE TEMPORARY SIGNAL: A portable temporary signal is a self-contained, self-powered green-yellow-red traffic signal used for controlling traffic through a short term traffic control section. Portable signals used on state highways shall be on the Qualified Products List or Conditional Use List for use in short term work zones and have State Traffic Engineer approval.

PROTECTION VEHICLE: A vehicle strategically placed to protect the workers and work activity. The protection vehicle may be in a stationary work zone or be the vehicle immediately behind the work vehicle(s) in an array of mobile work vehicles. The protection vehicle is placed after the buffer space and sufficiently in advance of the work area protected to allow for run-out if hit but not so far in advance that traffic can enter the space before the work area.

ROAD Every public way, state highway, county road, or city street.

RUN-OUT: The distance in front of a protection vehicle equal to the distance the vehicle is likely to move if hit. The length of the buffer space between a protection vehicle and the work activity should be at least equal to the run-out.

SHADOW VEHICLE: A trailing vehicle used as a warning and traffic control vehicle in a mobile work zone. Shadow vehicles provide both the advance warning area and any lane or shoulder closures for a mobile work zone. A shadow vehicle may also be a protection vehicle depending on the number of vehicles used in a mobile work zone.

SHALL: Indicates a mandatory condition or action.

SHORT DURATION WORK: Work activities that move along the road intermittently. Short duration work involves frequent short stops of up to one hour such as litter cleanup or pothole patching.

SHORT TERM WORK ZONE: A work area set up for one 8-hour shift or less in daylight conditions or one hour or less in dark conditions.

SHOULD: A should condition is the recommended option or action and is the standard treatment under normal conditions.

SHOULDER: That portion of a road adjoining but outside of the normal travel lanes.

SIGHT DISTANCE: The unobstructed distance of highway ahead visible to the driver. There are several types of sight distance, however. The most prevalent is Stopping Sight Distance (SSD) – the minimum distance required for a vehicle traveling at a particular speed to come to a complete stop after an obstacle on the road becomes visible. SSD is measured from the driver's eye (3.5' above the road) to an object 6" above the pavement surface. Safe SSD is the combination of two measurements – SSD and the distance the vehicle takes to actually stop. See the SSD Table in **Section 2.3 – Sign Placement** for an example.

SPEED: The designated (posted) speed set by the road jurisdiction or the statutory speed set in Oregon Revised Statutes.

SPOTTER: A worker who takes a position near the work with a clear view of the work area and the road whose primary duty is to warn the other worker(s) of approaching traffic. A spotter does not control traffic.

TRAFFIC CONTROL WORK ZONE: A section of road that begins with the initial advance warning of the work activity, includes all work activity and signing, and ends where traffic may resume normal operations.

TRAFFIC VOLUME PARAMETERS:

- High Traffic Volumes are average daily traffic (ADT) volumes more than 2000.
- Low Traffic Volumes are ADTs less than 400.

TRUCK-MOUNTED ATTENUATORS (TMA): Truck-mounted attenuators (TMAs) are energy absorbing devices attached to the rear of a heavy vehicle. They are used on equipment located in advance of workers or work equipment to reduce the severity of rear-end crashes from errant vehicles. A TMA may be used on a work vehicle, protection vehicle or shadow vehicle.

TUBULAR MARKERS: Tubular markers are channelization devices that are cylindrical in shape with a weighted base.

WORK AREA: That portion of the work zone which contains the work activity and equipment.

WORK COMMENCEMENT: The start of work activity in or along the road.

APPENDIX B

These pages can be copied and enlarged as needed. An enlargement of 150% will fit a sheet of standard letter size paper. These plan sheets along with blank diagrams are also available on the internet on ODOT Traffic Section's web site under Publications/Work Zone Related.

Freeway/Multi-Lane, Road Diagram – Pg. # from Temporary Traffic Control Handbook (_____)

Type of Signs Required	No.	Type of Signs Required	No.	Other Traffic Control	No.
Flagger Ahead		Transition		Cones	
Be Prepared to Stop		Road Narrows		Signs	
Road Work Ahead		Right Lane Ends		Shadow Vehicles	
End Road Work		Left Lane Ends		Flaggers	
Shoulder Work		Pilot Car Follow Me		Arrow Boards	
Survey Crew Ahead		One Lane Ahead		Variable Message Signs	
Road Closed		Road Machinery Ahead		Barricades	
Right Lane Closed		Other:		Portable Lighting	
Left Lane Closed		Other:		Other:	

Comments or revisions:

Intersection Road Diagram – Page # from Temporary Traffic Control Handbook (_____)

Type of Signs Required	No.	Type of Signs Required	No.	Other Traffic Control	No.
Flagger Ahead		Transition		Cones	
Be Prepared to Stop		Road Narrows		Signs	
Road Work Ahead		Right Lane Ends		Shadow Vehicles	
End Road Work		Left Lane Ends		Flaggers	
Shoulder Work		Pilot Car Follow Me		Arrow Boards	
Survey Crew Ahead		One Lane Ahead		Variable Message Signs	
Road Closed		Road Machinery Ahead		Barricades	
Right Lane Closed		Other:		Portable Lighting	
Left Lane Closed		Other:		Other:	

Comments or revisions:

APPENDIX C

Check List for Work Zone Layout & Operation

Use the following check list for good practices in work zone layout and operations:

- **Each operation requires a work zone traffic control plan.**
 - Determine and note the relevant diagram(s) in the handbook.
 - Note any special or unique traffic control needs and revisions to a diagram to accommodate the work and site conditions.
 - Consult with a qualified person in your agency and/or the permitting agency for any changes not discussed in this handbook.
 - All changes shall meet the standards and guidelines of this handbook and the MUTCD.
- **Stay out of the travel lanes as much as possible.**
 - Maintain normal travel paths as much as possible while allowing for work area safety.
 - The traffic control should be designed to move traffic past the area smoothly.
- **Do not tell drivers to break the law.**
 - This means being aware of regulatory signs, pavement markings and traffic signals that will conflict with your traffic control.
 - Be sure you have road jurisdiction permission to override and cover any regulatory traffic movement signs and signals.
 - For work in place less than an hour, emphasize your work activity by using a combination of highly visible signs, flashing/rotating beacons or light bar, arrow panel or truck-mounted PCMS.
- **Do not let traffic stop on or across the tracks or between the crossing markings and the tracks at a railroad crossing.**
 - Extend the work area if it's close to the tracks to include the railroad crossing inside your traffic control zone.
 - If the work site is away from the crossing but traffic queues may reach across the tracks, provide flaggers at the railroad crossing to prevent vehicles from stopping on or too near the tracks.
- **Always give advance warning.**
 - Use advance warning shown in this handbook for the type of work.

- Be sure that approaching drivers can see the work area in plenty of time to be able to pass by safely. Adjust the spacing of signs and tapers as necessary.
- Maintain a consistent distance between warning signs. If one distance needs to be adjusted, adjust all the distances similarly.
- **Delineate the work area and travel paths clearly with cones, tubes, drums or barricades. Driver confusion = crashes.**
 - Chevrons, arrows, or flashers on cones may be added if needed.
 - Too many devices can make curved section travel path hard.
 - Drive through the traffic control zone and then adjust if necessary.
- **Place signs where they will do their job properly.**
 - Keep at least the minimum spacing between signs from the sign spacing table.
 - Keep sign spacing consistent for each approach to the work site.
 - Maintain good sight distances:
 - for each sign,
 - for lane shifts and changes, and
 - for equipment and workers in the road or on the immediate shoulder. Use at least three cones placed near the work if the work is not visible from the nearest advance warning sign.
 - Make sure the signs are placed in the driver's line of sight and within the headlight beams if headlights are needed.
 - Make sure signs are not blocked by parked vehicles, trees, utility poles or other roadside features. Adjust the sign spacing if necessary.
- **Remove signs, cones and drums as soon as they are no longer appropriate.**
 - Keep in place only what is needed.
 - Inappropriate signs and devices can confuse drivers or lead them into your work area.
- **Ensure that all workers are wearing high visibility clothing appropriate for the work.**
 - Safety attire shall be clean and in good condition.
 - Safety attire shall be worn and function properly so that the reflective area has 360° visibility.

- The type of clothing shall meet the minimum requirements for the work as determined by the employer and/or permit or contract.
- **Leave a safety clearance area or buffer.**
 - Maintain the buffer area clear of work vehicles, equipment, materials and activity.
 - Leave as close to 5 feet or more as practical of clearance between your work area and the line of cones used to mark the edge of the travel lane.
 - Allow for a leading buffer on the near traffic approach to the work area if possible. Consider closing off parking spaces if there is on-street parking.
- **For worker protection, you may position a work vehicle in an area closed to traffic and in front of the work.**
 - Leave enough buffer space to the work activity to allow for run-out if the vehicle is hit.
 - Turn the vehicle wheels so that if it's hit, the vehicle will move away from both traffic and the work activity.
- **Accommodate safe and convenient access for pedestrians and cyclists including pedestrians with disabilities.** Consider any pedestrian and cyclist needs including accessibility when setting up the traffic control for a work area.

INDEX

2

2-Lane, 2-Way Roads, 4, 40, 67

3

3-Lane, 2-Way Roads, 4, 40, 83

A

Activity, 23, 65
Activity Area, 23
ADA, 10
ADT, 20, 47, 50, 63, 65, 71, 75,
79, 130, 131, 133
Advance Warning, 23
Alert Call, 19
Approach, 16
Arrow Panel, 4, 5, 13, 33, 35
Arrow Panels, 4, 13, 33
Average Daily Traffic, 73, 79, 130

B

Ballast, 32
Barricades, 4, 13, 32
Bicycle, 4, 10, 11, 23, 28, 41
Buffer, 23, 26

C

Caution, 34
Channelization, 126, 127
City, 2, 8
Closure, 6, 7, 97, 112, 119, 128
Components, 4, 21
Cones, 4, 13, 26, 32, 67, 69, 71,
77, 81, 93, 105, 131
Construction, 2, 21
Continuous Left Turn Lane, 6, 87,
89
County, 2, 8
Crossing, 6, 45

D

Detail, 4, 5, 6, 40, 41, 45
Detour, 20
Device, 5, 19, 26, 65
Diagram, 6, 7, 11, 15, 19, 23, 33,
34, 36, 41, 43, 45, 47, 50, 53,
56, 59, 61, 63, 65, 67, 69, 71,
73, 75, 77, 79, 81, 83, 85, 87,
89, 91, 93, 95, 97, 99, 101,
103, 105, 108, 110, 112, 113,
115, 117, 119, 121, 123
Distance, 29, 35, 133
Diversion, 6, 89, 127
Downstream, 24, 26
Drawing, 71

E

Emergency, 5, 9, 128
Emergency Response, 5, 128
Emergency Traffic Control, 5, 9
Entrance Ramp, 7, 121, 123
Equipment, 14, 18, 21
Escape Route, 19
Event Traffic Control, 5, 9
Exit Ramp, 7, 115, 117, 119
Extended Traffic Queue, 6, 41,
131

F

Far Side, 6, 99
Flagger Training, 12, 13
Flagging, 2, 3, 4, 6, 12, 13, 14,
15, 16, 17, 71, 101, 121, 123
Flashers, 4
Freeway, 6, 35, 65, 108, 110,
112, 121, 123

H

High Visibility, 9

I

Incident, 125, 126, 128
 Intermediate, 126
 Intersection, 4, 6, 40, 95, 99, 101, 103
 ISEA, 9

L

Lane Closure, 6, 38, 71, 75, 77, 79, 91, 93, 95, 99, 101, 112, 121, 123
 Layout, 6, 43, 135
 Left Side, 7, 123
 Lighted Sign, 4, 34
 Lights, 4, 34
 Line Marking, 6, 59, 61

M

Major Incident, 126
 Merging, 24
 Message, 4, 13, 36
 Message Sign, 4, 13, 36
 Minor Incident, 126, 127
 Minor Road, 6, 67
 Mobile Operation, 4, 6, 38, 40, 47, 50, 53, 108
 Multi-Lane, 4, 5, 6, 40, 53, 61, 91, 93
 MUTCD, 8, 9, 10, 12, 13, 15, 17, 20, 34, 36, 125, 128, 130, 132, 135

N

Near Side, 6, 95
 Night Flagging, 12, 16, 77
 Night Operation, 4, 11, 71
 Non-Freeway, 40, 61, 91, 93

O

Offset, 26
 Oiling, 77
 Operation, 14, 17, 36, 73, 77, 135
 OR-OSHA, 2, 8

P

Park, 115, 117
 Pass, 81
 Pavement Markings, 4, 20
 PCMS, 4, 6, 13, 17, 21, 23, 36, 40, 41, 47, 48, 50, 51, 53, 54, 56, 59, 61, 67, 73, 77, 83, 85, 91, 93, 95, 97, 103, 105, 108, 110, 112, 115, 119, 128, 130, 132, 135
 Pedestrian, 4, 6, 10, 11, 23, 28, 43
 Pilot Car, 4, 6, 13, 17, 77
 Placement, 4, 26, 29, 30, 34, 91, 93, 112, 119, 133
 Police, 126, 127, 128
 Portable Changeable, 4, 13
 Portable Signal, 4
 Posted, 25
 Protection Vehicle, 33

Q

QPL, 18, 75

R

Rail, 2, 6, 45
 Refuge, 6, 97
 Response, 126
 Right Side, 7, 121
 Road Work, 6, 63
 Rolling Slowdown, 6, 56
 Roundabout, 6, 105

S

Safety, 2, 4, 9, 127, 136
 Safety Apparel, 4, 9, 127
 Self-Regulating, 6, 79
 Shadow Vehicle, 5, 53
 Shifting, 24
 Short Duration, 10, 73
 Short Term, 5
 Shoulder, 4, 5, 6, 24, 40, 47, 63, 65, 67, 69, 110, 126, 127

Shoulder Work, 4, 5, 6, 63, 65,
67, 110
Signal, 75
Signs, 4, 11, 13, 14, 28, 31, 32,
33, 65, 77
Slow, 47, 50
Spacing, 4, 5, 13, 26, 29
Speed, 6, 53, 81, 128
Spotter, 19
State, 3, 8, 18, 36, 75, 132
Stationary, 38
Steady-burn, 4, 37
Surveying, 4, 10

T

Taper, 5, 24, 25, 26
Taper Length, 5, 24, 25, 26
TCDs, 10
Termination Area, 23
TMA, 33, 34, 47, 50, 53, 54, 61,
87, 89, 93, 108, 133

Traffic Control, 1, 2, 3, 4, 5, 6, 8,
9, 13, 15, 18, 21, 38, 75, 125,
132
Traffic Diversion, 6, 69
Traffic Volumes, 133
Transition Area, 23
Truck-Mounted Attenuator, 33
Tubular Marker, 4, 32
Type, 32, 35, 36, 37, 45, 81, 95
Typical Application, 38, 39, 128

U

Unattended Work Site, 4, 21
Urban, 35

W

Warning Light, 4, 37
Work Area, 23, 26
Work Zone, 3, 24, 25, 134, 135