

# **HIGHWAY DESIGN MANUAL**

## **Chapter 16 Maintenance and Protection Of Traffic In Highway Work Zones**

**Revision 48**

**January 20, 2006**

**This page is intentionally left blank.**

**CHAPTER 16  
MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Table of Contents**

<u>Contents</u>	<u>Page</u>
<b>16.1 INTRODUCTION</b>	
16.1.1 Organization of the Chapter .....	16-1
16.1.2 Purpose .....	16-2
16.1.3 State and Federal Policies .....	16-3
16.1.4 National Highway Institute Training Courses .....	16-5
<b>16.2 TRAFFIC CONTROL DEVICES</b>	
16.2.1 Standards .....	16-6
16.2.2 Revisions and Interpretations .....	16-7
16.2.3 Requirements .....	16-8
16.2.4 Construction Signs .....	16-9
16.2.5 Portable, Variable-Message Signs .....	16-14
16.2.6 Arrow Panels .....	16-17
16.2.7 Channelizing Devices .....	16-20
16.2.8 Pavement Markings .....	16-26
16.2.9 Hand Signaling Devices and Warning Flags .....	16-36
16.2.10 Temporary Traffic Signals .....	16-39
16.2.11 Portable Traffic Signals .....	16-41
16.2.12 Barrier Warning Lights .....	16-41
<b>16.3 SAFETY DEVICES AND BARRIERS</b>	
16.3.1 Temporary Traffic Barriers .....	16-42
16.3.2 Vehicle-Arresting Barrier (Net Type) .....	16-48
16.3.3 Shadow Vehicles and Barrier Vehicles .....	16-51
16.3.4 Temporary Impact Attenuators .....	16-54
16.3.5 Temporary Sand Barrel Arrays .....	16-55
16.3.6 Temporary Rumble Strips .....	16-56
<b>16.4 MAINTENANCE AND PROTECTION OF TRAFFIC (MPT) PLANS</b>	
16.4.1 General .....	16-60
16.4.2 Fundamental Principles .....	16-64
16.4.3 Elements of Highway Work Zones .....	16-66
16.4.4 Safety Considerations .....	16-72
16.4.5 Sequence of Construction .....	16-86
16.4.6 Work Zone Speed Limits .....	16-89
16.4.7 Work Zone Traffic Control Layouts .....	16-104

**CHAPTER 16  
MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Table of Contents**

<b><u>Contents</u></b>	<b><u>Page</u></b>
<b>16.5</b> <i>SELECTING A TRAFFIC MANAGEMENT STRATEGY</i>	
<b>16.6</b> <i>TIME-RELATED CONTRACT PROVISIONS</i>	
<b>16.7</b> <i>DEDICATED POLICE TRAFFIC SERVICES</i>	
<b>16.8</b> <b>REFERENCES</b>	
<b>APPENDICES</b>	
Appendix 16A Local Road Detour Information Form .....	16A-1

*NOTE: Material in italics is in development and will be issued at a later date.*

**CHAPTER 16  
MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**List of Exhibits**

<b><u>Number</u></b>	<b><u>Title</u></b>	<b><u>Page</u></b>
16-1	Sample Special Note: Requirements for Portable, Variable-Message Signs . .	16-16
16-2	Advantages and Disadvantages of Channelizing Devices . . . . .	16-20
16-3	Spacing of Channilizing Devices for Work Zones on One-Way Roadways . . .	16-22
16-4	Permitted Uses of Pavement Marking Materials for Temporary Pavement Markings . . . . .	16-27
16-5	One-Lane, Two-Way Traffic Control Flagger Station Enhancement With Flag Tree and Cones . . . . .	16-37
16-6	Recommended Minimum Flare Rates for Temporary Concrete Barrier . . . . .	16-42
16-7	Guidelines for Ranking the Assignment of Shadow Vehicles and Barrier Vehicles . . . . .	16-52
16-8	Temporary Rumble Strips (Suggested Layouts) . . . . .	16-58
16-9	Component Parts of a Highway Work Zone . . . . .	16-68
16-10	Taper Length Criteria . . . . .	16-69
16-11	Maximum Speed Reductions . . . . .	16-94
16-12	Signing Requirements for Reducing 65 mph Speed Limits in Work Zones . . .	16-98
16-13	Advantages and Disadvantages of Speed Control Methods . . . . .	16-100
16-14	Suggested Steps for Selecting Traffic Control Strategy . . . . .	16-105
16-15	Example of Crossover Entrance in Two-Lane, Two-Way Operation . . . . .	16-117
16-16	Example of Two-Lane, Two-Way Operation . . . . .	16-118
16-17	Example of Exit in Two-Lane, Two-Way Operation . . . . .	16-119
16-18	Advantages and Disadvantages of Road Closures and Detours . . . . .	16-129

**CHAPTER 16  
MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**This page is intentionally left blank.**

## **16.1 INTRODUCTION**

### **16.1.1 Organization of the Chapter**

Section 16.1 Introduction describes the purpose of the chapter, states the general policy and objectives for maintenance and protection of traffic in construction work zones, and provides information on work zone traffic control training conducted by the NHI for Department Designers.

Section 16.2 Traffic Control Devices provides an overview of traffic control devices and includes guidance on their use for both daytime and nighttime operations.

Section 16.3 Safety Devices and Barriers discusses supplementary devices including temporary traffic barriers, vehicle arresting barriers, shadow vehicles, barrier vehicles, crash cushions and attenuating systems, sand barrel arrays, and temporary rumble strips.

Section 16.4 Maintenance and Protection of Traffic (MPT) Plans deals with the general requirements for traffic control plans, presents the fundamental principles of traffic control, describes the elements of work zones, discusses the considerations for work zone safety, details the requirements for work zone speed limits, and describes various work zone layouts for maintaining traffic through or around construction work zones. The section also describes the methods and strategies that may be used to aid workers, vehicle drivers, and pedestrians to navigate highway construction work zones.

Section 16.5 Selecting a Traffic Management Strategy is presented within the framework of the project development process and outlines a process for evaluating traditional maintenance and protection of traffic schemes to determine if they will be satisfactory for managing traffic during construction. There is a discussion of nighttime construction factors that should be considered when investigating work zone alternatives. This section also discusses transportation management plans and what they involve.

Section 16.6 Time-Related Contract Provisions presents guidance and procedures for the use of time-related contract provisions, such as incentive/disincentive clauses, A+B bidding, and lane rental.

Section 16.7 Dedicated Police Traffic Services presents guidelines and procedures for including dedicated police traffic services in a project.

Section 16.8 References is the list of all the references used to develop the chapter.

Titles of publications are shown in italics. The publications used in the preparation of this chapter are listed in Section 16.8.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.1.2 Purpose

A temporary highway work zone or traffic control zone is an area of a highway where road user conditions are changed by the use of temporary traffic control devices, flaggers, police, or other authorized personnel, because of a work zone or incident. Standards and guidelines for the maintenance and protection of traffic in highway work zones have been developed by the Department over the years. They are found in Chapter V of Title 17 of the *Official Compilation of Codes, Rules, and Regulations of the State of New York* (a.k.a. the *New York State Manual of Uniform Traffic Control Devices* (NYSMUTCD)), the *Standard Specifications* Section 619, Standard Sheets, Engineering Instructions (EIs), and various other Department publications, which serve, for the most part, as the basis for this chapter. The designer should be familiar with these other references.

Chapter 16 is an instructional aid and reference guide. It brings together existing policies, procedures, and design guidance and expands on this material, where necessary, to provide comprehensive coverage of the subject.

This chapter provides guidance to those who are responsible for determining how to deal with traffic on construction/reconstruction and maintenance projects and those who are responsible for developing MPT plans. Primarily, they include design, traffic, and maintenance engineers, although planners, project developers, and project managers may find information pertinent to their roles in project development. Engineers-in-Charge may also find this chapter useful during project construction if it becomes necessary to modify MPT plans due to changing field conditions or project schedules.

The requirements and guidelines provided in this chapter apply to construction and maintenance work zones and work performed under highway work permits.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-3

### 16.1.3 State and Federal Policies

#### 16.1.3.1 NYSDOT Policy

It is the policy of the New York State Department of Transportation that Department projects shall include provisions, and plans when necessary, for the maintenance and protection of traffic, workers, motorists, pedestrians, bicyclists, and persons with disabilities, in highway work zones. Such provisions and plans should strive to achieve an appropriate balance of the following objectives:

1. Provide a high level of safety for workers and the public.
2. Minimize congestion and community impacts by maintaining acceptable levels of service as close as possible to preconstruction levels.
3. Provide a feasible design of highway traffic control during highway and bridge operations.
4. Provide the contractor with access to the roadway that is adequate to complete the work efficiently while meeting the quality requirements of the contract.
5. Keep the cost as low as possible, consistent with safety and an appropriate degree of convenience for the public.

This policy shall apply whenever work is performed within the highway boundaries for a period of time longer than can be handled under the protection of manual flagging. This policy applies to all types of bridge and highway construction, reconstruction, and maintenance projects on the State Highway System, projects on local systems that are administered by NYSDOT, and urban as well as rural facilities.

In applying this policy, all feasible alternatives for maintaining traffic should be examined and, where possible, the most cost-effective alternative, consistent with safety standards, should be selected.

Projects should also have environmental and community concerns incorporated into the project development process in accordance with Department policy and guidance given in EI 01-020 Context Sensitive Solutions (CSS). CSS maintains safety and mobility as priorities, yet recognizes that these are achieved in varying degrees with alternative solutions. The decision as to how best to balance competing values remains the responsibility of the designer.

When it is not possible to achieve substantial balance among the objectives listed above through maintenance and protection of traffic schemes for daytime construction, the feasibility of nighttime construction shall be evaluated along with other traffic systems management strategies. In addition, for Regions 10 and 11, the feasibility of nighttime construction must be evaluated for "every major limited access highway, expressway, and parkway capital construction project ..... with a cost of more than two million dollars in region ten, and with a cost of more than five million dollars in region eleven ....." Refer to Sections 16.2 and 16.4 for further guidance on nighttime construction.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

The development of a strategy to maintain and protect traffic should be an integral part of the project development process from initial planning and project scoping through preliminary and final design. This will ensure that the project's cost, schedule, scope, and quality goals adequately reflect the needs of the management plan or control plan. The cost to protect and maintain traffic and mitigate the impacts of highway work zones should be considered an integral part of the project development and design process.

Maintaining traffic is an essential project cost, yet it is not intended to provide a lasting benefit after the project is completed. Accordingly, improvements needed to maintain traffic should not ordinarily be designed to provide long-term benefits after construction is completed, although sometimes this may be the result. If significant road or bridge work and expense is necessary to maintain traffic, consideration should be given to retaining the work as a permanent improvement, if it would be useful to do so, rather than discarding the investment.

The Department has a goal to increase mobility whenever possible and the techniques of Transportation Systems Management (TSM) should be used when it is appropriate. Consideration should be given to incorporating cost-effective TSM measures, e.g., intelligent transportation system (ITS) elements, as part of the plans for maintenance and protection of traffic. In addition, allowing temporary improvements to remain in place should be considered if they provide long-term mobility improvement.

M.A.P. Procedure 7.12-14, titled Quality Assurance of Work Zone Maintenance and Protection of Traffic. It describes the roles and responsibilities of the involved Main Office groups and responsibilities to be assigned to various Regional groups. It is based on the premise that the quality assurance (QA) oversight work will be delegated to the Regional Traffic Group; however, it does not preclude the Regional Director from assigning the oversight responsibility for the QA effort elsewhere.

The QA procedure helps optimize the quality of maintenance and protection of traffic in highway work zones by delegating overall Department responsibility and authority for QA of maintenance and protection of traffic to the Traffic Engineering & Highway Safety Division, and, in most Regions, the Regional Traffic Engineering & Safety Group.

The QA procedures should assign quality assurance/quality control (QA/QC) responsibilities for design and implementation of maintenance and protection of traffic to the appropriate Regional group, and should detail areas of coordination between Regional groups. QA/QC procedures should be developed for operational needs, such as lane closures or restrictions, establishing work-area speed limits, obtaining police enforcement, use of variable message signs, media coordination, and consideration of corridor-wide or system-wide impacts of concurrent projects.

### 16.1.3.2 FHWA Policy

“Each State shall implement a policy for the systematic consideration and management of work zone impacts on all Federal-aid highway projects. This policy shall address work zone impacts

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-5

throughout the various stages of the project development and implementation process. This policy may take the form of processes, procedures, and/or guidance, and may vary, based on the characteristics and expected work zone impacts of individual projects or classes of projects. The States should institute this policy using a multidisciplinary team and in partnership with the FHWA. The States are encouraged to implement this policy for non-Federal-aid projects as well.”

**16.1.4 National Highway Institute Training Courses**

Each year, the Department offers training courses on work zone traffic control put on by the National Highway Institute (NHI). The courses are available to Designers statewide and provide the latest guidance in work zone strategy planning, design, and operation.

All designers responsible for or involved in some way in work zone traffic control design are urged to attend these training courses. Contact the Regional Training Coordinator for information on when the courses will be offered.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.2 TRAFFIC CONTROL DEVICES

#### 16.2.1 Standards

The 17 NYCRR Chapter V (a.k.a. the NYSMUTCD) sets forth the basic principles governing the design, use, installation, and operation of traffic control devices in NYS. These principles are reflected throughout the NYSMUTCD in discussions of devices, and should be followed in the selection and application of each device.

The NYSMUTCD is approved by the Federal Highway Administration (FHWA) as the standard for all highways in New York State open to public travel, regardless of type or the governmental agency having jurisdiction.

There are many information sources on traffic control theory and practice, traffic control device design, hardware, installation practices, etc., listed in the NYSMUTCD which may be used to augment standards and specifications. However, these documents may illustrate devices and control techniques not included in, nor consistent with, the NYSMUTCD. Only those consistent with the NYSMUTCD may be used. The National MUTCD is an excellent source. It is available on the internet at <http://mutcd.fhwa.dot.gov/>.

Any traffic control device authorized in the NYSMUTCD may be used, where applicable and permitted by the *Standard Specifications*, for highway work zone traffic control. Devices to be used only in work zones are found in Parts 218, 238, 254, and Subchapter G of the NYSMUTCD. General guidance as well as device application and example illustrations of traffic control at work areas are found in Subchapter H of the NYSMUTCD.

The guidelines and standards included in this section are provided to assist designers in the consistent use of traffic control devices on Department construction contracts and maintenance operations.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-7

**16.2.2 Revisions and Interpretations**

Improvements in devices, technology, and techniques are continually being developed, requiring frequent revisions of the provisions in the NYSMUTCD. In addition, unique situations occasionally arise that require special devices or unusual applications. General revisions are made to the NYSMUTCD periodically to reflect operational needs or changes in State law and keep State traffic control device standards in harmony with Federal standards.

The devices in the NYSMUTCD will adequately serve the vast majority of situations encountered. Devices not in the NYSMUTCD but included in the National MUTCD may be used. However, situations will arise where a singular device or an unusual application of a device is necessary. The Department may consider using such devices or applications, and where a legitimate need is demonstrated, be authorized to use them. The Traffic Engineering and Highway Safety Division, through the Regional Traffic Engineer, should be consulted for review and approval of such authorizations.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.2.3 Requirements

Traffic control devices include signs, signals, pavement markings, delineation devices, channelizing devices, hand-held signaling devices, warning flags, and lighting devices, which regulate, warn, and guide traffic. All traffic control devices must meet the following basic requirements to be effective:

- Fulfill a need.
- Command attention.
- Convey a clear, simple meaning.
- Command respect of road users.
- Give adequate time for proper response.

Under normal circumstances, other than on highway or bridge projects, actions required by regulatory devices must be specified by state statute, or by local ordinance or resolution. On the other hand, on highway or bridge projects with restricted highway designations, the Engineer-in-Charge has the legal authority to use regulatory devices without such requirements. For more information on the restricted highway designation, refer to §16.4.1 of this chapter and §104-05 of the *Standard Specifications*.

Five factors that should be considered in the application of each device to ensure that it is effective include:

- Design.
- Placement.
- Operation.
- Maintenance.
- Uniformity.

Refer to the NYSMUTCD §200 for discussion of these factors.

Two of the most basic principles of traffic engineering are that a traffic control device should (1) be used only when it meets a specific need, and (2) always be used in a consistent manner. Unnecessary and nonstandard applications are undesirable because they tend to reduce motorists' respect for the device and can cause confusion. Nonstandard applications require a considered response, rather than an automatic response and, over time, they will detract from the overall effectiveness of traffic control devices.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-9

### 16.2.4 Construction Signs

Construction signs are a separate pay item in the *Standard Specifications*.

#### 16.2.4.1 General

When choosing signs for work zones, the following should be considered:

- Choose signs that are appropriate and that accurately describe the roadway conditions. Avoid messages having only local meaning since it may not be clear to strangers.
- Choose the message on signs according to what action the driver needs to take.
- Use larger signs when greater visibility is desired, as with high speed or volume or on multilane roadways.
- Consider using smaller signs in narrow medians if larger signs will overhang the adjacent travel lane.
- Start with a general warning sign about the existence of work activity (e.g., ROAD WORK) in advance of the work area. Then use a signs to warn of the specific condition ahead (e.g., LEFT LANE CLOSED). The last sign should warn of the next geometric or traffic control features to be encountered in the work zone, such as a flagger or a traffic signal, and should be closest to the work area.
- Advance warning signs should not give general, repetitious warnings, e.g., ROAD WORK 1500 FT, ROAD WORK 1000 FT, ROAD WORK 500 FT. Repetition of general signs is a waste of money and causes drivers to pay less attention to them. The signs should describe the specific actions required by drivers.
- The message AHEAD, or an appropriate distance, is used on most warning signs. Generally, AHEAD is used on roadways that have an operating speed less than 45 mph, and on side-street approaches to work zones. Advance posting of signs with an AHEAD distance is generally 60 m. Numeric distances are used on all other roadways. The magnitude of the numeric distances (1500 FT, 1 MILE, etc.) is based on the operating speed, roadway type, and other prevailing conditions (geometry, type of work zone, etc.). Numeric distances and AHEAD should never be intermixed.
- The reference point for advance warning distance should be selected from the following:
  - The beginning of the transition area for a lane closure or lane shift or shoulder closure.
  - The work area for work beyond the shoulder.
  - The shadow vehicle location for short-duration or moving operations on the shoulder or in the lane where channelizing devices are not used.
  - The upstream end of the buffer space for temporary road closures.
  - The beginning of the realignment of the roadway for an on-site diversion.
- The overall effect of the signs should be to make drivers aware of what they are approaching, what action may be required, and the distance to where it is located.

The NYSMUTCD describes several design qualities of fixed-message traffic signs that should be considered in the layout of a maintenance and protection of traffic (MPT) plan. Refer to Part 201 in the NYSMUTCD.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

Signs used to alert drivers to daytime or nighttime operations and provide information on road and ramp closures, must be designed to ensure legibility. Messages must be simple and concise so drivers can read them at prevailing operating speeds. Long or involved messages cannot be read and may distract drivers from other tasks. If it is necessary to provide messages more than a few words in length, they must be split between two or more signs placed at least 100 m, preferably 150 m apart. To ensure that drivers comprehend the total message, no intervening signs should be placed between the two, and the distance between the signs should not be extended such that the connection between the two is lost. Unneeded or inapplicable signs are distracting or misleading and must be completely covered or removed.

Signs should be positioned according to the following guidance:

- Locate signs where they are easily seen.
- Place signs so drivers have time to respond.
- As a general rule, place signs on the right-hand side of the roadway.

Occasionally, it may be necessary to locate special first-warning signs farther upstream from the work zone than normal if hazardous conditions such as steep grades make the information useful or necessary at a particular location so a driver can take appropriate action. The presence of warning signs at the top of a mountain would warn truck drivers that they may encounter traffic congestion, and perhaps be required to stop at or before they reach the bottom. Such traffic control could include a truck turnaround or a mandatory stop to check brakes, if space is available.

Guidance for the location and minimum spacing of signs is given in the NYSMUTCD Subchapter H Part 301. Signs should not be mounted on barricades.

Regulatory signs with black legends on white background are used in work zones to inform highway users of applicable traffic laws and regulations. The restrictions they impose must be legally established so they can be properly enforced. Refer to §16.4.6 of this chapter regarding work zone speed limit signing. State and local police should be consulted as a courtesy during the development of MPT plans to address enforcement needs. When regulatory changes are made, the responsible law enforcement agency should be notified. Refer to the NYSMUTCD Part 218 for guidance in the use, location, and spacing of work zone regulatory signs.

Work zone warning signs (black legend on orange background) identify or emphasize particular conditions on or adjacent to the roadway. The number of different warning messages needed for a work area is dependent upon the nature of the highway, the speed and volume of traffic, and the type and complexity of the control measures through the work area. Warning signs installed specifically for highway work zones should have black legend on an orange background, except the W5-14 railroad advance warning sign, which shall have black legend on a yellow background. Refer to the NYSMUTCD Part 238 for guidance in the use, location, and spacing of work zone warning signs.

Large information signs (black legend on orange background) can be used to list work locations and dates, and to suggest alternate routes. To be legible at operating speeds, the messages on these

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-11

signs should be restricted to no more than three lines of text, with no more than a few words per line.

Work zone guide signs (black legend on orange background) are used to provide drivers with information that will guide them through a work zone, or bypass it altogether by detour, in a simple, direct manner. Road users should be informed of their future course before entering the work zone. Guide signs in work zones should include, when necessary:

- Standard route markings where temporary route changes occur.
- Directional signs and street name signs.
- Special guide signs relating to the condition of work being done.

The colors of these signs must conform to those specified in the MUTCD. If additional temporary guide signs are used in work zones, they shall have a black legend and border on orange background.

Refer to the NYSMUTCD Parts 254, 255, and 302 for guidance in the use, location, and spacing of work zone guide signs.

Signing sequences for closely spaced highway work zones must not overlap or confuse drivers with conflicting messages. Traffic controls for these situations should be coordinated to present a logical sequence of messages to drivers as they pass from one zone to another. Where it is necessary to have work zones that are closely spaced, it may be advantageous to combine the separate work zones into a single work zone, which may then be shortened as the work is completed.

### 16.2.4.2 Warning Signs for Nighttime Construction and Daytime Operations that Remain in Place Overnight

Extra care is needed to ensure that warning signs are located properly and provide adequate visibility and legibility at night. Designers should apply the following guidance.

#### Location

- Drivers are not accustomed to encountering construction activities at night, so adequate advance warning distances should be provided. A minimum of a 1.6 km advance warning distance is to be provided on roadways with operating speeds of 50 mph or higher. These distances may be shortened to 450 m on roadways with speeds of 40 mph or less.
- Location of advance warning signs should consider exiting and entering traffic. It is generally not desirable to start a warning sign series upstream from a major exit or intersection, except when it is desirable to divert traffic off the route at that point.
- Advance warning signs should be double-posted (posted on both sides of the roadway) for short-duration or long-duration, stationary operations involving one or more lane closures or lane shifts, left or right lanes, on freeways or expressways. Multilane, high-speed highways with narrow medians need not be double-posted.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

- In general, the first sign encountered by motorists in a warning series is the ROAD WORK XX FT (W8-1). General warning signs such as ROAD WORK XX FT (W8-1) should be limited to the first sign in a countdown series. After the first sign, more specific signs (e.g., LANE CLOSED, LANE SHIFT, ONE LANE ROAD) should be used, if appropriate.
- Standard distances to be used on countdown warning signs employed in long-duration work zones on high-speed roadways, include 1 MILE, ½ MILE, 1500 FT, 1000 FT, and 500 FT. Generally, three signs are adequate for a countdown series with the specific distances selected to fit site conditions.
- Where single advance warning signs are provided on ramps or minor intersecting roads, the AHEAD wording rather than a specific distance is preferred because it is easier to adapt to site conditions and reduces sign inventory needs for the contractor.
- ROAD WORK AHEAD may be used separately or as the first sign in a warning sign series on minor side roads where distance information is not necessary.
- Advance warning signs must be adequately spaced to provide recognition and legibility. On roadways with high speeds and volumes, signs must be spaced at least 150 m apart. This applies equally to construction signs and permanent signs.
- Actual distance from a warning sign to the condition should be close to the stated distance on the sign and in accordance with §300 of the NYSMUTCD. However, positioning of the sign to enhance visibility and avoid conflicts with other traffic control devices and roadway features is more important than precise agreement with the stated distance.
- BUMP (W8-1) signs shall be used to provide advance warning of isolated bumps in the pavement 25 mm or more in height. An object marker or a drum with flashing lights should be placed at the bump. Advance warning distances are given in the NYSMUTCD Table 230-2.

### Placement

- Warning signs must be located to provide adequate visibility distance to drivers. They must not be blocked by foliage, roadway features, or other signs and traffic control devices, nor interfere with other signs.
- Warning signs should not be located where glare from light sources behind the sign may reduce visibility.
- Low-beam headlight patterns must be considered in sign placements to ensure that the signs will be visible at night. Refer to the appropriate Standard Sheets in the M645 series.

### Visibility

- In situations where signs cannot be located to be visible under headlight illumination, artificial illumination should be used to enhance visibility and legibility, or the sign must be moved.
- Larger sign sizes enhance sign legibility, especially at night.
- Messages on warning signs should identify specific conditions to the greatest extent possible. Appropriate messages include lane and shoulder closure, alignment and intersection signs, flagger and worker symbol signs, road or bridge closed, detour, and other appropriate texts as described in the NYSMUTCD.
- Type B flashing, high-intensity warning lights should be considered to emphasize the presence and enhance the visibility of isolated warning signs where high-speed, free-

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-13

- flowing traffic raises concerns that drivers will fail to notice the advance warning signs.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.2.5 Portable, Variable-Message Signs

Portable, variable-message signs are a separate, special specification pay item.

This guidance is for contractor-owned, contractor-provided, portable, variable-message signs (PVMSs).

Portable, variable message signs are to be used as supplemental, temporary work zone warning devices and for lane and roadway closures. They have the flexibility to display messages which apply to the particular locations at which they are placed. PVMSs are especially useful for providing information regarding highway work zones. The NYSMUTCD allows the use of PVMSs in highway work zones to supplement, but not replace regulatory or warning signs. They may also be used in lieu of or to supplement guide signs. A PVMS should only be used where it will be more effective than standard signs used alone.

VMSs are highly visible aids to traffic maintenance and can be very effective when used appropriately. However, the effectiveness of these signs can be diminished if they are used too frequently or inappropriately.

The following guidelines are provided to help the designer determine whether or not to select VMSs for use in work areas on daytime construction projects.

The following items should be determined when considering specifying PVMSs in a contract:

1. Variability. Would the various messages relayed by this sign make it cost-effective and/or improve safety more than an equivalent number of fixed-message, standard construction signs? Is "real time" information necessary? How often would the message be expected to change?
2. Conspicuity. Can sufficient conspicuity be achieved using standard construction signs? What are the consequences of not noticing the sign? Would a standard construction sign be obscured at the needed location due to numerous other construction signs, poor geometrics, etc.?
3. Cost-effective. If several standard construction signs are viable alternatives to a single PVMS unit, what is the cost difference?
4. Overriding Considerations. Are there any overriding considerations to warrant a PVMS unit, even if other warrants are not met? Such considerations could include, but are not limited to, a need for improved conspicuity or emphasis, presence of workers in the roadway without barrier protection, speed-limit reductions, a new traffic pattern, warning of police enforcement, and other motorist awareness messages.

For assistance with PVMS use within Regions, designers should consult with the Regional Transportation Services Group, Regional ITS Coordinator, and/or Regional Transportation Management Center. A representative from the Transportation Management Center and/or the Regional ITS Coordinator should be invited to the scoping and preconstruction meetings to provide input on PVMS use on the contract. All work on a contract must occur within the contract limits,

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

16-15

though limits need not be contiguous nor continuous. For distant locations, small areas approximating the PVMS location should be bounded by contract limits.

PVMSs may be specified using pay units of each or week. The designer must include a Special Note titled "Requirements for Portable, Variable-Message Signs (PVMSs)" to give the contractor information needed to bid the PVMSs, taking into consideration if they can use the PVMS in multiple locations and how many PVMSs they will have in operation during various stages of construction. A sample special note is illustrated in Exhibit 16-1. The following information should be included in the Special Note:

- The approximate locations of PVMSs.
- The required sight distance along the approaches.
- An estimate of the approximate dates and lengths of time the PVMS unit will be in use at each location, in weeks (only when specifying by the week).

**Sign Selection.** The PVMS specification requires the designer to choose between light-emitting-diode (LED) types and hybrid-flip-disk types. Each of these types has advantages and disadvantages. Hybrid units were previously favored due to the combination of the benefits of both types of displays, but recent improvements in LED technology and lower operating costs have led to increasing use of LED units.

**LED (Light-Emitting Diode).** Advantages are its low maintenance, long life due to no moving parts, and lower cost. Disadvantages are if LED modules are not properly repaired and replaced, displays can become dim. LED units can be difficult to see in direct sunlight and at wider approach angles. LED units will probably result in lower costs and can provide adequate visibility where the angle of the sun and the highway alignment are favorable.

**Hybrid (Flip-Disk and LED).** Advantages are high visibility in direct sunlight and at wider approach angles and they operate if the light source fails. Disadvantages are that hybrids are more expensive than LED and have higher maintenance requirements. Hybrid units should be considered where the sun angle and highway alignment may significantly reduce the effectiveness of LED units.

**Cellular Communications Option.** Cellular-equipped units can be operated via cellular phone by authorized personnel and should be specified unless the PVMS unit would not need to be remotely controlled through the entire contract or if there is no cellular reception in the area.

**Radar Option:** Radar-equipped units with speed display provide the ability to determine the speed of an approaching vehicle and interrupt the programmed sequence with a special default message displaying the vehicle's speed. They are required in all "major active work zones."

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Exhibit 16-1 Sample Special Note: Requirements for Portable, Variable-Message Signs**

PHASE I

PVMS 1

LOCATION: EASTBOUND ROUTE 123, ONE-HALF MILE WEST OF THE START OF THE LEFT LANE CLOSURE.

DURATION: THIS LOCATION SHOULD BE OCCUPIED FOR THE FIRST XX WEEKS OF PHASE I.

PVMS 2

LOCATION: WESTBOUND ROUTE 123, ONE-HALF MILE EAST OF THE START OF THE LEFT LANE CLOSURE.

DURATION: THIS LOCATION SHOULD BE OCCUPIED FOR THE FIRST XX WEEKS OF PHASE I.

---

PHASE II

PVMS 1

LOCATION: EASTBOUND ROUTE 123, ONE-HALF MILE WEST OF THE START OF THE ROUTE 89 RAMP.

DURATION: THIS LOCATION SHOULD BE OCCUPIED FOR THE FIRST XX WEEKS OF PHASE II.

PVMS 2

LOCATION: NORTHBOUND ROUTE 89, ONE-HALF MILE EAST OF THE ROUTE 123 RAMP.

DURATION: THIS LOCATION SHOULD BE OCCUPIED FOR THE FIRST XX WEEKS OF PHASE II.

PVMS 3

LOCATION: WESTBOUND ROUTE 123, ONE-HALF MILE EAST OF THE START OF THE ROUTE 89 RAMP.

DURATION: THIS LOCATION SHOULD BE OCCUPIED FOR THE FIRST XX WEEKS OF PHASE II.

PVMS 4

LOCATION: SOUTHBOUND ROUTE 123, ONE-HALF MILE EAST OF THE START OF THE ROUTE 123 RAMP.

DURATION: THIS LOCATION SHOULD BE OCCUPIED FOR THE FIRST XX WEEKS OF PHASE II.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-17

### 16.2.6 Arrow Panels

Arrow panels (flashing arrow boards) are a separate pay item in the *Standard Specifications*.

#### 16.2.6.1 General

Arrow panels are trailer-mounted (or truck-mounted when shadow vehicles are used), diesel-powered or solar-charged, self-contained units which are very effective in making drivers aware of lane closures and the resultant need to change lanes.

An arrow panel consists of yellow lamps arranged in a pattern on the face of a nonreflective, rectangular black panel. The lamps are positioned to form displays for Left Arrow, Right Arrow, Left and Right Arrow, and Caution. Guidelines for the application, design, operation, and location of arrow panels is found in §294.5 in the NYSMUTCD. Additional information may be found in the *Standard Specifications* §619.

#### A. Allowable and Prohibited Uses

- Arrow panels shall be used for lane closures on all multilane highways where the preconstruction posted speed limit is 45 mph or higher.
- Arrow panels shall be used for lane closures on high-speed and/or high-volume arterials in the same manner as for freeway lane closures.
- Arrow panels should be used for lane closures on other multilane highways if the project designer or the Engineer-In-Charge (EIC) determines that high traffic volumes or other considerations would warrant their use.
- Only one arrow panel is to be used for each lane closure, placed as close to the start of the lane closure taper as possible. Use of multiple arrow panels to emphasize a single stationary lane closure is prohibited.
- Arrow panels may be used for shoulder closures and lane shifts only when operating in the caution mode with corners flashing; no flashing bar is permitted.
- Arrow panels shall be used for lane splits on multilane highways where the preconstruction posted speed limit or the operating speed is 45 mph or higher. For the purpose of this guidance, a lane split is defined as a splitting of travel lanes around a work area without a reduction in the number of available traffic lanes.
- To accomplish a center lane closure, the left or right lane should be closed first, using either a right arrow or a left arrow in the flashing mode, and the remaining lanes may then be split around the work area using a flashing, double-headed arrow.
- Arrow panels should always be used in combination with the appropriate signs, barricades, or other traffic control devices.
- Arrow panels shall not be used for lane shifts. Other devices are readily available for this purpose (e.g., warning signs, chevrons, flags, warning lights). For the purpose of this guidance, a lane shift is defined as a lateral shift in travel path without a reduction in the number of available traffic lanes.
- Arrow panels in the flashing arrow mode are not to be used as a warning device for

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

- shoulder work or for roadside work near the shoulder. Vehicle warning lights, signs, and channelizing devices are more effective for these situations and are the preferred treatment. An arrow panel in the nondirectional caution mode is permitted as an option.
- Arrow panels in the flashing arrow mode shall not be used on two-lane, two-way roadways, either in a driving lane or on the shoulder under any circumstances. Such use may result in a head-on collision. An arrow panel in the nondirectional caution mode, shown in the NYSMUTCD Figure 302-19, is permitted as an option.

### B. Allowable and Prohibited Operations

- An arrow panel shall display a flashing arrow for lane closures.
- It is essential that the motorist's view of arrow panels not be obstructed by signs or other equipment of roadside features. Arrow panels should not obstruct the motorist's view of other signs.
- Arrow panels must be dimmed at night to avoid glare that may blind drivers.
- Solar-powered arrow panels are recommended for night operations, where necessary, and within the speed limitations stated above, to eliminate the noise of diesel-powered units.
- Arrow panels used for a traffic split shall display only a flashing, double-headed arrow.
- If used as a general warning device on a shoulder or elsewhere, the arrow panel shall display the nondirectional caution mode described in the NYSMUTCD. Display of a flashing bar is explicitly prohibited, and shall not be used on Department projects.

### C. Location

- Arrow panels should be positioned as close as practicable to the beginning of the lane closure taper (on the shoulder, if space permits), taking into consideration sight distance restrictions, shoulder widths, and other factors. A lane closure taper should not begin just before or just past the crest of a vertical curve or partially into or just beyond a horizontal curve. It is important that the driver be able to see the entire taper as he/she approaches. Warning signs should be located so as to avoid obscuring the arrow panel.
- For moving operations, an arrow panel should be mounted on the first upstream vehicle fully occupying a shoulder or travel lane to be encountered by traffic from the rear. Refer to the NYSDOT *Work Zone Traffic Control Manual*. If more than one travel lane is taken, an arrow panel should also be mounted on the first upstream vehicle fully occupying each additional travel lane that is closed. Additional arrow panels can be mounted on intermediate vehicles located between two travel lanes that are closed, or on vehicles further upstream which are located either partially or fully on the shoulder adjacent to a travel lane that is closed.
- For moving operations, an advance warning vehicle equipped with appropriate static signs, warning lights, and other devices may be positioned fully on the shoulder upstream of the arrow panel, if traffic and roadway conditions so indicate.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-19

- For operations located where the shoulder is too narrow for the advance warning vehicle, the appropriate static advance warning signs shall be placed upstream of the arrow panel and the advance warning vehicle will be positioned in the lane in which the work area is located. Refer to the NYSDOT *Work Zone Traffic Control Manual* Typical TAM-E5 and TAM-E7.

### D. Power Source

- Arrow panels used on roadways where the preconstruction posted speed is 45 mph (70 km/h) or greater, shall be powered by self-contained, engine-driven generator systems.
- Arrow panels shall be capable of being powered by utility company service.
- Solar-charged arrow panels may be used experimentally (up to 4 per Region) on high-speed roadways.
- Solar-charged arrow panels may be used on multilane highways with lane closures where the preconstruction posted speed limit at a closure and for at least 2 km upstream is below 45 mph (70 km/h).

### E. Other Requirements

- Except as noted above, all other provisions of the NYSMUTCD relating to arrow panels - size, type, style, location, and all other requirements - shall be adhered to at all times. See the NYSMUTCD §294.5 for details.
- The requirements of the *Standard Specifications* relating to arrow panels shall be adhered to at all times.

#### 16.2.6.2 Arrow Panels for Nighttime Construction

Arrow panels used at night shall be properly dimmed as described in the NYSMUTCD and the *Standard Specifications* to avoid glare for approaching motorists.

- Arrow panels are required for all nighttime lane closures on multilane highways, regardless of the traffic speed.
- Solar-charged arrow panels are recommended where the preconstruction posted speed is less than 45 mph (70 km/h) to eliminate the noise of diesel-powered units.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.2.7 Channelizing Devices

Channelizing devices are included in the Basic Maintenance and Protection of Traffic item in the *Standard Specifications*.

All channelizing devices except Type III construction barricades are included in the *Standard Specifications* Basic Maintenance and Protection of Traffic. Type III construction barricades are a separate item. Guide rails, curbs, and barriers are highway design features and are not considered to be traffic control channelizing devices (see §16.3 of this chapter).

#### 16.2.7.1 General

The function of channelizing devices is to alert road users to conditions created by work activities in or near the roadway, to guide them through the work zone, and to help protect workers in highway work zones. Channelizing devices are used to provide a physical separation between the travel space and the work and buffer spaces, pedestrians, opposing traffic, and pavement drop-offs.

Channelizing devices are also used to provide for safe, smooth, and gradual lane merges, lane shifts, bypasses and detours, and narrowing of lanes. Channelizing devices include cones (standard - 700 mm; tall - 900 mm; extra-tall - 1050 mm), tubular markers (temporary; interim), vertical panels (standard - 600 mm min.; oversize - 900 mm min.), drums, and barricades. Refer to Part 292 of the NYSMUTCD.

Perhaps the most important consideration in selecting and placing channelizing devices and delineation treatments is that they should contribute to the total system of traffic control devices at the restricted work zone and should not be considered in isolation. The designer should be knowledgeable of the site to prevent the channelizing devices from conflicting with other traffic control devices. The advantages and disadvantages of each type of channelizing device are presented in National Highway Institute's *Design and Operation of Work Zone Traffic Control* and included in Exhibit 16-2.

While channelizing devices cannot physically prevent intrusions, longitudinally placed devices are highly effective in providing positive guidance and in discouraging intrusions. Transverse devices provide redundant warning to drivers of an area closed to traffic. The appropriate travel path for vehicles, pedestrians, and bicycles through the work zone should be clearly defined using channelizing devices and delineation treatments that are effective under varying light and weather conditions.

The most critical portion of the work zone in terms of the need for positive guidance is the transition area. Special attention should be given to the placement of devices in this part of the work zone. The use of channelizing devices in the transition area and through the work area should be consistent with the NYSMUTCD. For long-duration projects (see the *NYS Work Zone Traffic Control Manual*), interim pavement markings of solid white and yellow edge lines should be placed along the edges of tapers and parallel to the channelizing devices and/or barriers in tangent sections to further enhance path delineation.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-21

**Exhibit 16-2 Advantages and Disadvantages of Channelizing Devices**

<b>Channelizing Device</b>	<b>Advantages</b>	<b>Disadvantages</b>
Cones	<ul style="list-style-type: none"> <li>• Are minor impedances to traffic flow.</li> <li>• Do not interfere with traffic flow.</li> <li>• Will not damage a vehicle when hit.</li> <li>• Are well recognized and understood.</li> <li>• Are easy to set up, take down, store, and transport.</li> </ul>	<ul style="list-style-type: none"> <li>• Are not formidable.</li> <li>• Command minimal respect from drivers.</li> <li>• Are easily penetrated.</li> <li>• Are easily displaced and knocked over.</li> <li>• Are not self-restoring.</li> <li>• Require special treatment for nighttime application.</li> <li>• Provide little separation of traffic flow from adjacent areas being used for other purposes.</li> <li>• Cannot be attached to the pavement.</li> <li>• Have minimal target-value reflective sheeting.</li> </ul>
Tubular Markers	<ul style="list-style-type: none"> <li>• Are minor impedances to traffic flow.</li> <li>• Do not interfere with traffic flow.</li> <li>• Will not damage a vehicle when hit.</li> <li>• Are well recognized and understood.</li> <li>• Are easy to set up, take down, store, and transport.</li> <li>• Can be fastened to the pavement.</li> <li>• Can be made to be self-restoring when hit.</li> </ul>	<ul style="list-style-type: none"> <li>• Are not formidable.</li> <li>• Command minimal respect from drivers.</li> <li>• Are easily penetrated.</li> <li>• Are easily displaced and knocked over.</li> <li>• Require special treatment for nighttime application.</li> <li>• Provide little separation of traffic flow from adjacent areas being used for other purposes.</li> <li>• Are not stackable.</li> <li>• Have minimal target-value reflective sheeting.</li> </ul>
Vertical Panels	<ul style="list-style-type: none"> <li>• Are very effective where available lateral spacing is limited.</li> <li>• Can be mounted on posts driven into embankment or within roadway edge excavations to delineate drop-offs, downed guide rail, etc.</li> <li>• Provide good target value.</li> <li>• Provide good portability.</li> <li>• The air-spill barricade vertical panel is self-restoring.</li> </ul>	<ul style="list-style-type: none"> <li>• Are easily penetrated.</li> <li>• Are easily displaced and knocked over.</li> <li>• Not visible from all approach angles.</li> </ul>
Drums	<ul style="list-style-type: none"> <li>• Are highly visible.</li> <li>• Give the appearance of being formidable objects.</li> <li>• Command the respect of drivers.</li> <li>• Have target value from all viewing angles.</li> </ul>	<ul style="list-style-type: none"> <li>• May reduce roadway capacity if placed near traffic lane.</li> <li>• Prone to improper lighting attachment.</li> <li>• May cause poor sight distance at intersections, driveways, etc.</li> </ul>
Barricades	<ul style="list-style-type: none"> <li>• Appear as obstacles and create driver respect.</li> <li>• Provide good visibility with a large retroreflective area.</li> <li>• Are useful for pedestrian control.</li> <li>• Provide good supports for barricade lights.</li> </ul>	<ul style="list-style-type: none"> <li>• Are prone to overturn in high winds or when placed near high-speed traffic.</li> <li>• May cause damage to an impacting vehicle.</li> <li>• Prone to improper lighting attachment.</li> <li>• May cause poor sight distance at intersections, driveways, etc.</li> </ul>

Adapted from: *Design & Operation of Work Zone Traffic Control*

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

The type of channelizing devices used should be consistent throughout the work zone. Different devices should not be alternated or mixed, e.g., alternating drums and cones. This may cause confusion to drivers. Exceptions to this are locations at gores, ramps, and intersections as described in §16.2.7.2 of this chapter. At locations where lane or shoulder closures are protected by temporary concrete barrier, a taper of channelizing devices is placed upstream of the end of the barrier where the closure begins (see the National MUTCD, Figure 6H-5). The benefits of the taper are that it:

- Provides better delineation of the barrier end than treatments placed directly on the barrier itself.
- Moves traffic out of the closed lane upstream of the barrier end.
- Serves as a forgiving first alert to a driver deviating from the intended path.
- Creates a buffer space between the taper and the barrier end.
- Reduces the probability of vehicles striking the barrier end.

The NYSMUTCD Part 292 contains detailed guidance in the application, design, location, and spacing of channelizing devices, but little specific information is available on the effects of device size and spacing. Based on favorable experience at nighttime construction zones, and on urban projects in several Regions, and more recently with the implementation of work zone intrusions countermeasures, it appears that the use of close device spacing, combined with the use of larger devices, reduces intrusions.

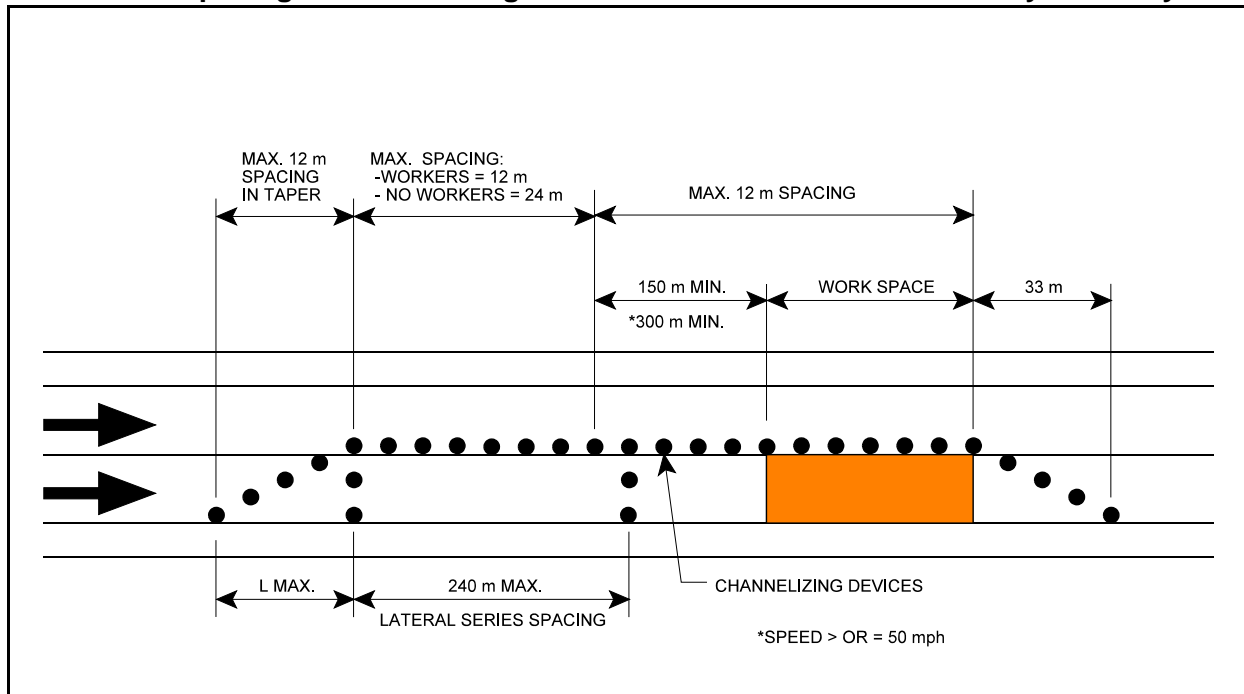
Close spacing of channelizing devices applies to all stationary work zones (day or night) where workers are exposed to traffic and the use of channelizing devices is appropriate, as described below.

- When used to close travel lanes at work sites where workers are exposed to traffic, the spacing of channelizing devices in tangent sections and tapers shall not exceed 12 m. (Note: 12 m is the standard broken lane-line spacing. See Exhibit 16-3.)
- The 12-m maximum spacing should be maintained in tangent sections for a reasonable distance (minimum 150 m for speeds <80 km/h, 300 m for speeds ≥80 km/h) upstream of the work area. The 12-m maximum spacing may be used throughout the work zone (see Exhibit 16-3).
- Where engineering judgment indicates a special need for closer device spacing, such as to reduce speeds or provide positive guidance to motorists in curved sections of the roadway, channelizing devices should be spaced 6 m apart.
- When used to close travel lanes at work sites where no workers are present, the spacing of channelizing devices in tangent sections may be increased, not to exceed 24 m.
- Drums or vertical panels are to be used for long-duration, daytime or nighttime lane-closure tapers, and at locations where the risk of intrusion is high.
- Vertical panels should be used only in locations where the panel faces will be clearly visible to all approaching traffic.
- Tall cones are allowed only in longitudinal-run sections, and where there are width restrictions which prevent the use of drums. Tall cones are not allowed in merges, tapers, or shifts.
- Cones and tubular markers without reflectorized tape shall not be used for nighttime

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-23

**Exhibit 16-3 Spacing of Channelizing Devices for Work Zones on One-Way Roadways**



- closures.
- In long lane or shoulder closures, at least two channelizing devices should be placed transversely, at maximum 240-m intervals, measured from the downstream end of the taper, to discourage traffic from driving through the closed lane (see Exhibit 16-3).
- For paving operations on 2-lane, 2-way roadways, longer device spacings may be used where a pilot vehicle is used, or where setting and retrieving the additional devices does not provide any significant safety improvement, such as on roadways with low vehicle volumes, where the work area limits are visible to motorists, etc.
- Where driveways or intersecting streets or crossovers are located within the work zone, channelizing devices should be placed to adequately define their turning radii. A 2-m spacing between channelizing devices should be adequate for most circumstances.
- Type III construction barricades shall be used at all locations where a highway, bridge, ramp, or other segment of the roadway is closed to traffic.
- Type III barricades may interfere with sight distance at ramps and intersections and roadway entrances because of their 1.5-m height. Care must be taken to ensure that these devices are not placed where they will interfere with sight distance.
- Drums should be provided to designate a change in grade such as a pavement rebate.

### 16.2.7.2 Channelizing and Guiding Devices for Nighttime Construction

Because of reduced visibility and the potential for the increased presence of impaired drivers, work zone intrusions are a higher risk at night. In addition to the guidance provided in §16.2.7.1,

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

enhanced channelization and driver guidance is required to protect workers and the public from the severe consequences of vehicle intrusions into nighttime work areas. The following requirements are to be met for channelizing and guiding devices used for nighttime closures:

- Each series of channelizing devices shall begin with one drum equipped with a Type A, low-intensity flashing light. If the distance from the end of one series to the beginning of the next series exceeds 1 km, the succeeding series must start with a drum and a flashing light.
- Tall cones may be used on nighttime closures, only when marked with reflectorized tape in accordance with the NYSMUTCD, except in tapers.
- At gores, ramps, and intersections where reduced spacing is used, channelizing devices are to be either drums or vertical panels.
- Type III construction barricades shall be used to form road closures on mainlines and ramps. They may be supplemented by drums, vertical panels, or tall cones to form tapers and otherwise direct traffic past closures.
- Type III barricades used to form roadway or ramp closures are to be equipped with flashing warning lights (either Type A or Type B). One light is to be provided on each barricade.
- Because they are more difficult to set up and remove and are a separate pay item, Type III barricades are not recommended as the primary channelizing devices in tapers or tangent sections of lane closures that are set up and removed nightly. They may be used at periodic intervals, with or without single-arrow signs, to reinforce lane closures and to add emphasis at critical points.
- Type A, flashing, low-intensity warning lights are excellent devices for directing driver attention to roadway hazards during the hours of darkness. They should not be used in a longitudinal series except as the first unit at the start of the lane-closure taper, shoulder closure, rebate, pavement drop-off, and other locations defining roadway hazards. Type B, flashing, high-intensity warning lights may be substituted where the device is left in place during daytime, and where additional emphasis is desirable.
- Each Type III construction barricade used to form a closure on a highway, bridge, ramp, sidewalk, or other segment of roadway shall be equipped with one Type A, flashing, low-intensity or one Type B, flashing, high-intensity warning light.
- Type III construction barricades used to form a taper shall not be lighted.
- Flashing warning lights are not to be used on channelizing devices or traffic barrier in a longitudinal series along the path of traffic.
- Type C, steady-burning, low-intensity warning lights do not significantly enhance the visibility of reflectorized channelizing devices such as drums, 300 mm x 600 mm vertical panels, or Type III barricades and should not be used.
- Type C, steady-burning, low-intensity warning lights provide useful delineation on nonreflectorized safety devices such as temporary concrete barrier, and they may be used as needed to delineate temporary concrete barrier or similar objects that are located close to travel lanes.
- Other guiding devices such as raised pavement markers or post-mounted delineators should be considered to mark travel paths and temporary concrete barriers when site conditions are not amenable to the use of channelizing devices or warning lights.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-25

### 16.2.7.3 Delineators

Delineators may be used, as provided in Part 291 of the NYSMUTCD, to guide traffic through a work zone by indicating the horizontal alignment of the proper travel path. Elongated (75 mm x 150 mm) delineators shall be used on freeways and interstate highways. They may be used on other highways as allowed by Part 291. They should be spaced sufficiently close to clearly indicate the proper vehicle path during darkness. They are not a substitute for reflectorization of channelizing devices or warning lights.

Temporary concrete barrier must be delineated to make it visible to traffic. Methods available for this are warning lights and delineators in accordance with the requirements of the *Standard Specifications*.

### 16.2.7.4 Pavement Edge Drop-off Protection

The pavement edge drop-off protection requirements found in the *Standard Specifications* §619 are appropriate for the majority of Department construction projects. However, extremely high traffic volumes or extremely poor geometrics and/or sight distance may, in the judgement of the designer, require more protection than prescribed in the *Standard Specifications*. The designer is reminded to include appropriate details, pay items, and notes when modifying the prescribed drop-off protection treatment. Documentation for modifying the prescribed pavement edge drop-off protection treatment should be included when preparing the M&PT plans for approval.

Contract document for projects that require guide rail replacement, resetting, or new installations should provide the contractor with the allowable guide rail installation time allowances. The designer should refer to Chapter 10, §10.5.7.4 of this manual for the recommended durations for allowable out-of-service time durations.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.2.8 Pavement Markings

The Department's policy for highway work zone pavement markings presents a procedure for applying pavement markings on highway construction and maintenance projects. The provisions set forth in the policy and guidelines and must be implemented on all contracts.

The policy established short-term markings, final pavement markings, and construction zone pavement markings. They are renamed herein to correlate them to the terminology used in the National MUTCD.

- Temporary Pavement Markings (formerly Short-Term Pavement Markings)
- Interim Pavement Markings (formerly Construction Zone Pavement Markings)
- Final Pavement Markings

Temporary pavement markings (TPMs) are used when it is necessary to open any State highway that is under construction, (1) to traffic or (2) by the end of the work shift (day or night) on resurfacing or milling projects, and the contractor is unable to install final pavement markings or interim pavement markings before opening the roadway.

Interim pavement markings are used to delineate detours, diversions, and other temporary traffic patterns including pavement realignments, median crossovers, lane shifts, and lane closures.

Final pavement markings are the last pavement markings placed on a project, in accordance with the project's final pavement marking pattern.

Pavement markings used in work zones must be the same color and style and convey the same message as final markings, except that broken lines may be shortened to 1.2 m long.

Coding for work zone pavement markings should follow these guidelines:

- In general, on all highways under construction with opposing traffic, the pavement markings separating opposing traffic should be yellow, full-barrier markings indicating a no-passing zone.
- In general, on all highways under construction with two or more lanes of traffic in the same direction of travel, white lane lines should be used between adjacent lanes of same-direction travel.
- For one-lane, two-way, alternating flow operations, solid white edge lines shall be used as channelizing lines on both sides of the lane to direct traffic in either direction around the work area in accordance with the NYSMUTCD §260.6.

#### 16.2.8.1 Temporary Pavement Markings

Temporary (formerly short-term) pavement markings are a separate pay item in the *Standard Specifications*.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-27

### A. Policy Statement

This policy does not change any of the provisions set forth in the Department's *Pavement Marking Maintenance Policy*, Code 7.9-9, concerning the requirements for year-round pavement markings. It is Department policy that before any interim or final course of pavement on any State highway under construction is opened to traffic, or by the end of the work shift on resurfacing or milling projects, temporary pavement markings complying with the requirements of this policy and the NYSMUTCD must be in place.

### B. Policy Summation

The procedure and guidelines herein for applying pavement markings on new, reconstructed, resurfaced, or milled pavements is in full compliance with Federal guidelines. In consideration of continuity and liability, the procedures and guidelines shall apply to all Department work completed under contract regardless of funding source. While this policy is primarily worded for projects constructed by contract, its provisions should be applied to maintenance work with few, if any, modifications.

With the great diversity of projects that are affected, the highway work zone pavement marking policy allows for the application of various scenarios, depending on whether the final contract markings will be traffic paint or durable material, and whether the final pavement marking pattern can be determined prior to placement of the final course of pavement. See §16.2.8.2.

For projects where the reconstruction may affect passing sight distance, thereby changing the location of passing zones, the policy provides for the application of temporary pavement markings before nightfall or the end of the work day, followed by the placement of the final markings after the Department codes the final marking pattern.

### C. Guidelines

Temporary pavement markings are pavement markings that are placed for short periods not to exceed 14 days. They must be in place prior to opening new or reconstructed pavements or milled surfaces to traffic, or before nightfall on resurfacing projects or before morning or opening to traffic in the case of nighttime paving.

Temporary pavement markings should comply with the standards and guidelines in the National MUTCD §6F.66 and with the specific provisions described in this section. Temporary pavement markings shall be either Temporary Pavement Markings (Top Course) or Temporary Pavement Markings (Underlying Course), as designated by the designer. Edge lines, stop lines, cross walks, letters, symbols, and other transverse or special-purpose markings are not required temporary pavement markings, except when: (1) in the designer's judgment they are necessary, based on functional classification, urban or rural conditions, highway geometry, highway alignment (vertical and horizontal), traffic speeds and volumes, traffic signal locations, roadside hazards, construction phasing, drop-off protection, etc., or (2) the conditions described in §16.4.4.2.B.8 Pavement Markings, are encountered. When selected markings are required,

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

those markings (or appropriate channelizing devices (drums, cones, etc.)) and appropriate signing shall be shown on the contract plans and included in the contract documents.

For information on the use of temporary pavement markings to help avoid motor vehicle encroachment into shoulders used by pedestrians and/or into bicyclist's paths of travel, refer to sections 16.4.4.2.A.5 and 16.4.4.2.B.8.

The following summary provides guidance in the use of temporary pavement markings .

C.1 Permitted Materials. Materials permitted to be used for temporary pavement markings include traffic paint, nonremovable tape, removable tape, and removable raised pavement markers, as specified in the *Standard Specifications*, except as described below. Exhibit 16-4 shows the conditions for which the use of each marking material is permitted.

**Exhibit 16-4 Permitted Uses of Pavement Marking Materials for Temporary Pavement Markings**

<p align="center"><u>KEY</u></p> <p>P = Traffic Paint R = Removable Tape or Removable Markers NT = Nonremovable Tape</p> <p align="center"><u>NOTES</u></p> <p>1. Must install in final location. 2. Install directly over P. 3. Must offset from final location.</p>		Durable Final Pavement Markings In Contract			
		Epoxy <sup>2</sup> or Polyester <sup>2</sup>		Thermoplastic or Preformed	
		Final Marking Pattern Known	Final Marking Pattern Unknown	Final Marking Pattern Known	Final Marking Pattern Unknown
Top (Final) Course	Solid Line	P <sup>1</sup> , R <sup>3</sup>	R <sup>3</sup>	R <sup>3</sup>	R <sup>3</sup>
	Broken Line	P <sup>1</sup> , R <sup>3</sup>	R <sup>3</sup>	R <sup>3</sup>	R <sup>3</sup>
Underlying Courses	Solid Line	P, R	P, R	P, R	P, R
	Broken Line	P, R, NT	P, R, NT	P, R, NT	P, R, NT

C.1.a Temporary Pavement Markings (Underlying Course). Temporary pavement markings (underlying course) shall be installed using traffic paint, nonremovable tape, removable tape, or raised removable pavement markers.

C.1.a(1) Traffic Paint. Traffic paint may be used for solid and broken lines on any underlying pavement course and need not be removed before placing a subsequent course.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-29

C.1.a(2) Removable Tape, Raised Removable Markers. Removable tape and raised removable pavement markers may be used on any underlying pavement course. These materials must be removed before placing a subsequent course.

C.1.a(3) Nonremovable Tape. Nonremovable tape may be used only for 1200 mm or shorter broken-line segments, in accordance with the appropriate specification and only on an underlying pavement course. The broken-line segments need not be removed before placing a subsequent course. Nonremovable tape is not allowed to be used to mark solid lines on any underlying pavement course.

C.1.b Temporary Pavement Markings (Top Course). Temporary pavement markings (top course) shall be installed using traffic paint or removable tape or raised removable markers.

C.1.b(1) Traffic Paint. Traffic paint may be used for solid and broken lines on the top or final pavement course only when the final pavement marking pattern is known, only when the temporary pavement markings are placed in the exact location of the final pavement markings, and only when the final pavement markings will be paint, epoxy, or polyester markings.

C.1.b(2) Removable Tape, Raised Removable Markers. Removable tape and raised removable markers may be used for solid or broken lines on any top or final pavement course. Removable pavement markings material shall be selected for use and applied in accordance with the appropriate specification. These markings must be removed before placing the final pavement markings.

C.1.b(3) Nonremovable Pavement Markings. Nonremovable pavement markings are not allowed to be used as temporary pavement markings on any top or final pavement course.

C.1.b(4) Location of Temporary Pavement Markings. Temporary pavement markings shall be offset from the location of the final pavement markings when the final pavement markings will be thermoplastic or preformed because the residue remaining on the pavement after their removal will interfere with the adhesion of the final pavement markings. Temporary pavement markings shall be installed on the exact location as the final pavement markings when the final pavement markings will be paint, epoxy, or polyester.

C.2 Removal of Temporary Pavement Markings. If it is known at the time of installation that temporary pavement markings will have to be removed for any reason, and/or to prevent the damage and scarring imposed on final pavement courses when attempting to remove fresh paint or nonremovable tape, only removable tape or raised removable pavement markers will

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

be allowed for temporary pavement markings on final courses.

C.3 Temporary Pavement Markings, Patterns, and Colors. Temporary pavement markings, patterns, and colors shall be in accordance with Parts 260 through 263 in the NYSMUTCD as determined by the designer. The following pavement marking patterns shall be installed as temporary pavement markings:

- Yellow broken lines, partial barrier lines, and full-barrier lines as required by the NYSMUTCD, used to separate opposing traffic flows on two-way roadways.
- White solid or broken lines to define lanes for traffic moving in the same direction on multilane highways.
- Other markings as determined by the designer and specified in the contract documents.

When deemed necessary, specify edge lines, gore channelizing markings, or certain transverse or special-purpose markings as temporary pavement markings. This may occur for instance, when paving a multilane, urban/suburban arterial in a major commercial area with double left-turn lanes, traffic signals, turn lanes that are slotted away from through lanes, etc. This can be especially important if motorists need to be in a particular position to actuate traffic detectors. The designer should consult with the Regional Traffic Engineer when conditions require special pavement markings.

All broken-line temporary pavement markings for top and underlying pavement courses shall be a minimum of 1200 mm long in 12.2-m cycle lengths. Under special conditions, such as roadways with severe curvature, 600-mm long temporary markings in 6.1-m cycle lengths may be used. For broken lines on underlying pavement courses, reflectorized pavement marking paints, nonremovable tape, or removable tape may be used.

Temporary pavement markings should be 100-mm wide minimum. Raised removable markers 100 mm wide may be used to supplement or simulate 100-mm wide, temporary pavement markings.

C.4 Removable Raised Pavement Markers. Removable raised pavement markers may be used as supplements to or substitutes for longitudinal temporary pavement markings. They are not suitable for use as supplements to or substitutes for transverse markings. Removable raised pavement markers should not be used during winter months.

All removable raised pavement markers, when used as a substitute for pavement markings in work zones, shall be retroreflective, shall be the same color as, and placed in the same location as the pavement markings for which they are substituted, except offset from final pavement marking locations on top (final) pavement courses, and shall be visible during the daytime.

Individual raised pavement markers spaced every 1500 mm may be used as a substitute for solid markings. As a substitute for yellow, full-barrier markings, pairs of removable raised markers shall be placed side-by-side at the same 1500-mm spacing to simulate a double line.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-31

Removable raised pavement markers must be removed prior to the placement of the subsequent course of pavement.

C.5 Temporary Pavement Markings Restrictions Temporary pavement markings are not for use in marking detours or temporary traffic patterns.

C.6 Temporary Pavement Markings Quantity Estimate. The designer is alerted to the fact that the quantity estimated for temporary pavement markings cannot necessarily be derived from the quantity for the final pavement markings since passing may be prohibited during the construction phase where passing may be permitted afterwards. The estimate must include the quantities for each pavement course for the various stages or phases of construction.

### 16.2.8.2 Interim Pavement Markings

Interim (formerly construction zone) pavement markings are a separate pay item in the *Standard Specifications*.

Interim pavement markings apply only to markings for temporary traffic patterns associated with construction activities for detours, temporary pavement realignments, median crossovers, lane shifts, and lane closures. It is recommended that interim pavement markings be removable pavement marking tape, and/or removable raised pavement markers. Traffic paint is allowed, but its use is discouraged due to its lower visibility, especially at night, and the need for reapplications. The recommendations below are provided to assist in the selection of the appropriate type of marking to fit various project situations and traffic needs.

Interim pavement markings are those that are in place for more than 14 days. Their widths should be either 100 mm or 150 mm to conform to the widths of the existing markings which they replace. Raised removable markers 100 mm wide may be used to supplement or simulate 100-mm wide, interim pavement markings and supplement 150-mm wide, interim pavement markings.

#### A. Preformed Removable Pavement Marking Tape

Preformed, removable pavement marking tape is intended for use on pavement that is to remain in place without being overlaid after the temporary traffic pattern is removed, where scarring of the pavement surface would be objectionable, and where good visibility, both daytime and nighttime, is desired. A typical example of its use is for temporary traffic patterns at an angle to the permanent pattern where pavement marking removal scars crossing permanent lanes at an angle would create an unacceptable appearance on the finished pavement and confusion for traffic. These materials are relatively expensive, and may not adhere well to existing pavement if applied to dirty or dusty surfaces. They should be specified primarily in situations where easy removal with minimal scarring is essential. This material provides excellent durability, excellent daytime visibility, and good night visibility under dry

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

conditions, but may be susceptible to snow plow damage.

### B. Raised Removable Pavement Markers

Raised pavement markers are appropriate for use where extremely effective nighttime delineation (especially under rainy conditions) is important. Appropriate situations include lane closure and lane-shift tapers, median crossovers, and narrow roadways.

Interim pavement marking paint stripes, supplemented with raised markers, is an appropriate choice where excellent daytime visibility, as well as wet-night visibility is important. To enhance wet-night delineation on temporary traffic patterns striped with an optional pavement marking item, removable marking tape, or existing markings, supplemental raised pavement markers may be added. This is an especially good choice on curved or narrow alignments with lower design speeds than the adjoining highway sections.

If supplemental delineation is required during the winter, use of raised pavement markers is discouraged because they will be easily removed by snow plows. Alternative supplemental delineation, i.e., post-mounted delineators or other devices should be considered.

A decision of whether to replace raised markers in the spring should be based on the work zone requirements at that time, including duration of work remaining, traffic patterns, other markings and delineation devices present, etc.

Raised removable pavement markers shall not be used to simulate marking letters or symbols or transverse markings such as hatch lines, stop lines, or crosswalks.

### 16.2.8.3 Final Pavement Markings

Final pavement markings are a separate pay item in the *Standard Specifications*.

Final pavement markings will be the last pavement markings placed on a project in accordance with the project's final pavement marking pattern. They are intended to endure until the project receives either durable markings under the Regional durable marking contract, or subsequent restriping under the Region's annual maintenance marking program. "Durable markings" refers to longitudinal epoxy, polyester, preformed, and thermoplastic pavement markings as described in the Department's *Pavement Marking Materials Guidelines* available from the Materials Bureau. "Durable transverse markings" and "durable special-purpose markings" refer to stop lines, letters, symbols, and other transverse or special purpose durable markings. These markings are typically placed using preformed tape, although other durable types may be used and included in contracts as needed, regardless of the type of longitudinal markings in the contract.

If any pavement course on a highway or a portion of a highway under construction, any surfaced detour, or any roadway is designed to carry traffic for more than 14 days (i.e., interim courses or detours upon which traffic is to be maintained for long periods, such as over a winter season),

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-33

interim pavement markings (see §16.2.8.2) should be provided for and in place prior to opening to traffic.

When traffic paint is used for temporary pavement markings on the top of final pavement course, it shall be installed in the exact location of the project's final pavement markings. When the project's final pavement markings are specified to be epoxy or polyester, these materials shall be applied directly over the temporary painted markings, provided they consist of only a single layer of paint. If the temporary pavement markings are more than a single layer of paint, the pavement surface must be cleaned and prepared according to the requirements of §635 of the *Standard Specifications*. Interim pavement markings may also be used on detours to provide permanent markings that will remain in place after the route is no longer used as a detour.

On all permanent pavement surfaces or final pavement courses, the final and complete pavement markings should be installed as soon as practicable. However, since the coding of the final pavement markings may not be known or established until after placement of the final pavement course, and because a limited number of projects receive durable pavement markings as a contract item, it may not be possible or necessary to install the final pavement markings prior to opening to traffic. In these situations, temporary pavement markings must be installed on final pavement courses.

Depending on the situation and contract provisions, one of the following cases and subsequent procedures should be followed.

### A. Case 1 - Projects With Durable Longitudinal Markings

This procedure is for construction projects which include durable longitudinal markings as a contract requirement.

Before nightfall or the end of the work shift, temporary pavement markings which meet the requirements previously cited must be installed. Only removable tape or removable pavement markers are allowed as temporary pavement markings on the top course when thermoplastic or preformed durable final pavement markings are specified. The temporary pavement markings used in such cases must be offset from the final position of the durable markings because when removed, they leave a residue which may interfere with the bond of the durable markings.

The use of pavement marking paint (maximum of one layer applied directly to the pavement) is permitted for temporary pavement markings only when epoxy or polyester durable final pavement markings are specified. The paint markings must be placed on the exact location as the final markings.

The use of pavement marking paint and nonremovable tape is prohibited when thermoplastic or preformed tape is used for temporary pavement markings because paint interferes with the bond and would have to be removed by grinding or sand-blasting the final pavement surface prior to placement of durable markings resulting in damage to the pavement.

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

Durable longitudinal markings must be installed within 14 days.

### **B. Case 2 - Projects With Painted Final Pavement Markings and Pattern is Known**

This procedure is for construction projects which include painted final pavement markings as a contract requirement, where the final permanent marking pattern (i.e., passing zones vs. no-passing zones) is indicated on the plans, or can be designated by the EIC prior to placement of the final course of pavement

Final pavement markings, excluding edge lines, must be installed by nightfall using traffic paint as indicated or designated for the center lines and lane lines. Only removable tape or raised removable pavement markers will be allowed as temporary pavement markings, either of which must be offset from the position of the final painted pavement markings to be subsequently placed.

The final pavement markings including edge lines and all other specified markings must be installed within 14 days.

### **C. Case 3 - Projects With Painted Final Pavement Markings and Pattern is Unknown**

This procedure is for construction projects which include painted final pavement markings as a contract requirement, where the final pavement marking pattern is not indicated on the contract plans or cannot be designated by the EIC prior to placement of the final course of pavement.

Temporary pavement markings meeting the requirements previously cited, must be installed before nightfall or the end of the work day, except that only removable tape or removable raised pavement markers will be allowed as substitutes for final pavement markings, including edge lines, either of which must be offset from the final position of the durable markings to be subsequently placed.

It is the EIC's responsibility to designate the final marking pattern within 7 days. Prior to the 14-day limit, the contractor must install the final pavement markings using traffic paints.

### **D. Case 4 - Region-Wide Durable Marking Contract With Removal of Existing Markings**

This procedure is for Region-wide durable marking contracts, which may require the removal of existing markings prior to application of the durable marking material.

The highway will be considered to be under construction, and the provisions for highway work zone pavement markings will apply. Since the provisions for temporary pavement markings allow a highway to be without edge lines for up to 14 days, any or all edge lines may be removed, with the provision that the new durable edge line markings will be in place within 14

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-35

days at any location where such lines were removed.

Any or all center lines and lane lines may be removed, with the provision that the new durable center line and lane line markings will be in place before nightfall or the end of the work day of the day of removal, at any location where such lines were removed. Should the new durable center line and lane line markings not be installed before nightfall or the end of the work day, temporary pavement markings meeting the requirements previously cited must be installed at no cost to the State, except that only removable tape or removable raised pavement markers will be allowed as substitutes for pavement markings, either of which must be offset from the final position of the durable markings.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.2.9 Hand Signaling Devices and Warning Flags

Hand-signaling devices and warning flags are included in the Basic Maintenance and Protection of Traffic item in the *Standard Specifications*. Refer to the NYSMUTCD §301.9 for guidance on the proper application and location of flaggers and flagger stations.

Flaggers are used to stop traffic intermittently at work sites and to assign right of way, or to slow traffic as it passes the activity area to help protect the work crew. A flagger sign (W8-22) should be used to warn drivers that they are approaching a flagger station. While flagging is an acceptable method of traffic control, it should be used only when other methods of traffic control are not suitable or practical for the situation.

A flagger location that will provide as much advance sight distance as can reasonably be obtained should be selected. Increasing the distance between the flagger and the transition area optimizes the visibility of the flagger to approaching traffic. This is especially critical at crest vertical curves and horizontal curves where the flagger may have to be moved upstream to assure adequate sight distance for approaching traffic.

Since all traffic in the lane in which the work area is located will be slowed considerably or stopped before entering the transition area, a 30-m (15-m minimum) entry taper in a one-lane, two-way, flagger-controlled operation is acceptable, regardless of lane width. Longer tapers up to 75 m maximum, may be used if specific site conditions such as low volumes or high-speed trucks or night construction suggest that vehicles may encounter the taper at high speeds.

The spacing of the channelizing devices should be 6 m or less. The distance from the downstream end of the lane taper to the work space is the longitudinal buffer space (refer to Exhibit 16-5 in this chapter and the NYSMUTCD §301.13, Table 301-2). It is acceptable to increase the buffer distance for downgrades in accordance with the criteria established for AASHTO stopping distances for various approach speeds.

Enhancement of flagger stations with supplemental traffic control devices (flag trees, cones, etc.) upstream of flagger locations has the potential to increase conspicuity and alert drivers that they are approaching a work site. These additional devices are very low in cost, and are easily deployed. Exhibit 16-5 shows a typical layout for a flagger station with cones and a flag tree for enhancements. The actual distance to these enhancements will vary to meet approach speeds and roadway conditions, and minor adjustments should be made as necessary to achieve the best results.

Flag trees (F5-1) shall be used for all stationary work zones that include flaggers. Flag trees shall be located a distance of one-half the advance posting distance for Category 1 signs, but no less than 75 m and no more than 200 m in advance of the flagger location. This is particularly important in situations where the work zone setups are on roadways with significant horizontal and/or vertical curves. When the W8-22 flagger symbol sign is used, additional cones and flag trees are also recommended.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-37

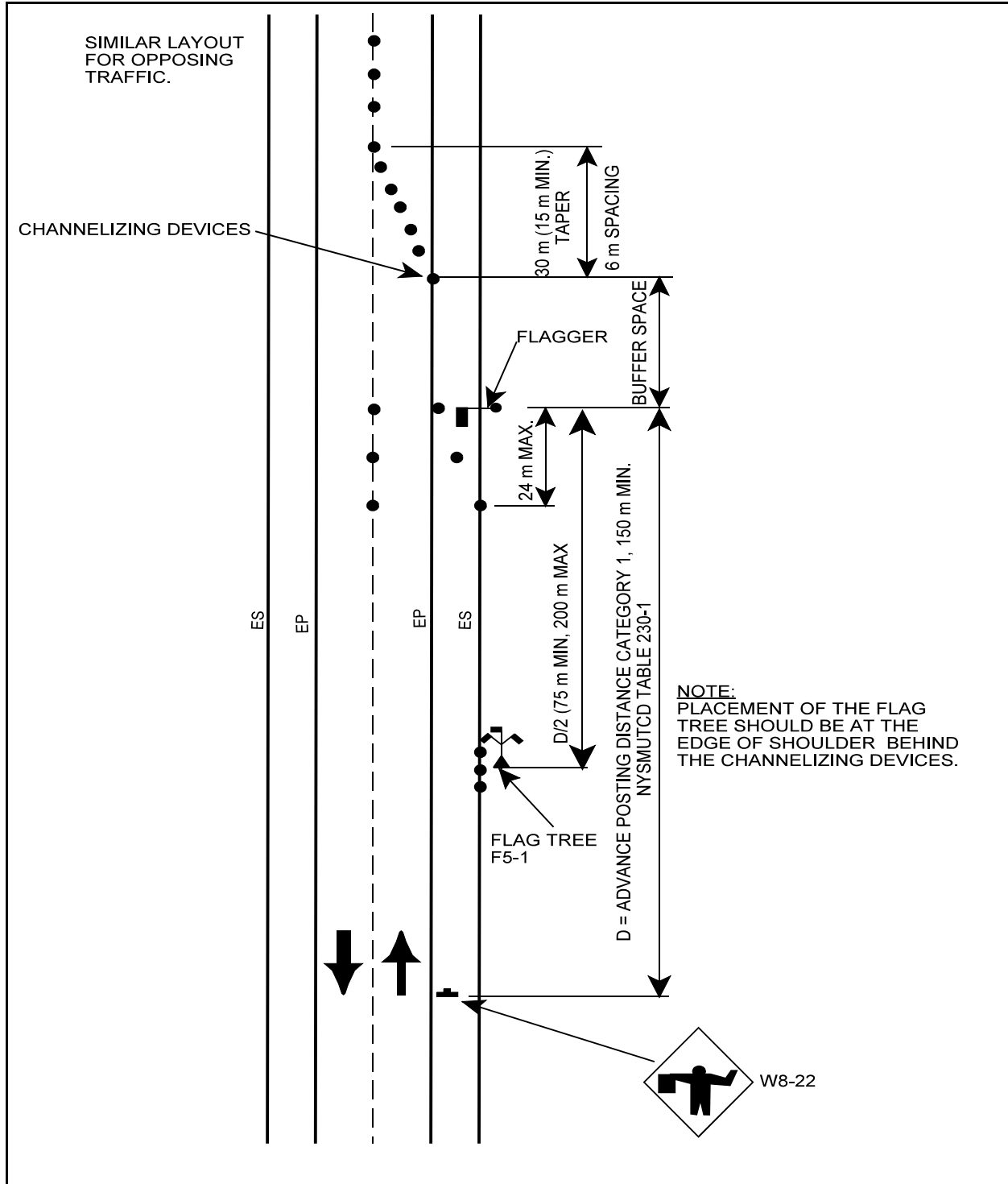
Regional experience using flagger station enhancements indicates that flag trees may be less effective in urban or congested areas than in rural or open areas due to background clutter caused by signs, buildings, traffic, etc. It may also be difficult to use flag trees for moving and short-duration operations. In those situations where, in the designer's judgement, flag trees will not be effective in conveying adequate warning to drivers, or where they would cause or result in conflicts with existing or work zone signing or roadside features, or where the operations are constantly moving or are at one location for no more than a few minutes, the use of flag trees is optional.

The use of centerline cones immediately upstream of the flagger station is also an enhancement which should be considered on a project-by-project basis and selected for use based on good engineering judgement. Centerline cones may be omitted from roadways with narrow cross sections or in situations where drivers may be confused by the cones, causing them to move to their left into the opposing lane.

When flagger station enhancements are selected for construction, maintenance, or utilities operations, notes should be included on the contract documents.

### MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

**Exhibit 16-5 One-Lane, Two-Way Traffic Control Flagger Station Enhancement With Flag Tree and Cones**



## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-39

### 16.2.10 Temporary Traffic Signals

Temporary traffic signals are a separate pay item in the *Standard Specifications*.

Temporary traffic control signals are installed for a limited period of time to control road user movements through temporary traffic control zones. Typical work zone situations for which temporary traffic signals are used include temporary haul road crossings, temporary one-way operations along a two-lane, two-way highway, temporary one-way operations on bridges, reversible lanes, and intersections. Temporary signals are custom designed and are more able to accommodate project-specific needs such as driveways and pedestrians. Temporary signals can involve considerable design complexity and effort to address traffic needs. Designers should seek the advice of the Regional Traffic Engineer. Refer to Chapter 11 of this manual for guidance in traffic signal design.

The location of temporary traffic signals should be announced by advance warning signs. Temporary traffic signals must be located so motorists have sufficient time to see the signal and react safely. The design elements that should be considered for temporary traffic signal installations include number, size, mounting alternatives, physical arrangement, placement of the individual signal heads, signal timing, detection, and the accommodation of intersections and driveways.

Advance warning signs in accordance with §275.2(f) of the NYSMUTCD are required to ensure that the motorist is alerted to the presence of a work zone and traffic signal. Other traffic control devices, including regulatory, warning, and guide signs, pavement markings, and channelizing devices should be used to supplement temporary traffic control signals.

Temporary traffic control signals should be used only in situations where they are preferable over other means of traffic control, such as using flaggers to control one-way or crossing movements, using STOP (R1-1) or YIELD (R1-2) signs, or using warning devices alone. Flaggers would be required 24 hours per day. Signs may not be adequate for safe control of traffic.

Before using temporary traffic signals, the existing roadway and traffic conditions should be assessed. A survey should be made at the time of day when the work will be done. The following is a list of the minimum information that should be gathered:

- Identify locations for temporary traffic signals. Determine the distance between the proposed signal locations (area between the stop lines). The practical maximum length of activity area for one-way traffic signal control should not exceed 800 m. Shorter lengths are desirable, especially if the activity area is on a roadway with limited sight distance and/or higher volumes would encourage red-light violations. Signal timing may also limit the length of the work zone.
- Check the locations for adequate visibility of the signals as motorists approach them. The signal locations will have to be adjusted if minimum sight distance guidelines are not met.
- Note the presence of intersecting streets and driveways. If the work zone limits include high-volume driveways and intersections with major routes, it may be necessary to include temporary traffic signals within the activity area to control the intersecting traffic, and

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

- interconnect them with existing traffic signals that may be located within or adjacent to the activity area.
- Record traffic conditions. Count the number of vehicles passing a stationary point during 4-minute intervals, the maximum reasonable wait time. This will be an indicator of how many vehicles would be expected to queue at the signal. Document if the flow is evenly split between the two lanes, or if it is uneven, favoring one direction over the other. Check these conditions at different times throughout the day.
- Document the speed at which motorists are approaching the proposed work zone. The speed on approach is an important factor in determining sight distance requirements.

The physical details that affect the driver's ability to see and respond to the signal display are the minimum visibility requirements, number and location of signal faces, size and arrangement of signal indications, and illumination. Traffic signals should be visible to traffic approaching the signals at the decision sight distances given in the AASHTO 2004 "green book" Exhibit 3-3. This requirement is particularly important where temporary traffic signals are used and motorists are not expecting the need to stop or slow down, for instance, due to a queue of several vehicles stopped at the signal. If the proper decision sight distance is not available, a W2-17 signal ahead sign shall be installed at the proper distance given in the Advance Posting Distances for Signs in Posting Category I, Table 230-1 in the NYSMUTCD.

Methods that may be used to economically mount signal indications at restricted work zones are span-wire-mounted and post-mounted signals. There are several characteristics and advantages and disadvantages of each type of signal mounting that should be considered during the design and installation of temporary traffic signals. One advantage of the span-wire mounted signals is that the overall conspicuity is greatly improved because the faces are directly in line with the motorist's approach to the work zone.

Span-wire-mounted signals are more commonly used at restricted work zones, but post-mounted signals are also used. A potential problem associated with post-mounted signals located beside the roadway is that the visibility of the signal may be blocked by large trucks. The presence of signals on both sides of the roadway will ensure that approaching drivers see the red indication and do not attempt to pass. Furthermore, post-mounted signals located beyond vertical curves may not be high enough to be seen over the crest of a hill. In this case, special consideration must be given to the visibility of the signal. Stability is also a concern. Temporary traffic control signals mounted on fixed supports have better resistance to displacement or damage by severe weather, vehicle impact, and vandalism.

Figure 302-8 B in the NYSMUTCD illustrates an example of a work zone layout using a temporary traffic signal. Refer also to the National MUTCD Figure 6H-12.

Motorists approaching a work zone must have adequate time to see and respond to work zone traffic control devices. The NYSMUTCD §272.11(b) requires that all traffic signals have at least two signal heads per approach. If any signal heads are located above a travel lane, the bottom of such a signal head must be at least 4.6 m in height, but no greater than 5.8 m above the road surface.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-41

### 16.2.11 Portable Traffic Signals

Portable traffic signals may be proposed for use by the contractor, for which they must conform to the *Standard Specifications*. The Department maintains an approved list of portable traffic signals.

### 16.2.12 Barrier Warning Lights

It may be necessary or desirable to supplement signs, barriers, and channelizing devices with lighting devices mounted on them, especially at night. This may be accomplished by using flashing warning lights, and/or steady-burning electric lights. The different types of lights and the guidance for their application, design, and location is provided in the NYSMUTCD Part 294. Refer to §16.2.4.2, §16.2.7.1, and §16.2.7.2 in this chapter for discussions of Types A, B, and C warning lights.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES****16.3 SAFETY DEVICES AND BARRIERS****16.3.1 Temporary Traffic Barriers**

Temporary concrete barrier is a separate pay item in the *Standard Specifications*.

**16.3.1.1 Temporary Concrete Barrier**

Temporary concrete barrier (TCB) is similar in shape to the Jersey-shape permanent concrete median barrier. The main difference relates to the need to make the installation temporary. To accomplish this, the temporary units are cast with a flared base and holes for embedded anchorage. The ends of each unit include vertical steel tubes with a continuous vertical slot to accommodate a small built-up I-section that may be dropped into facing slots as a connection key. Units are cast with openings through the base to serve as drainage pockets. To limit deflections on impact, grout may be placed between the base portions of successive units as shown on the Standard Sheets for 619 series items. To permit further reduction in the deflection, the units are provided with holes through the shoulders (outside portion of the base) so that units can be anchored in place by steel anchor rods on alternate sides of the units. Table 10-3 in Chapter 10 of this manual shows the standard deflection for each case. The designer should show the areas where these deflection-limiting measures are desired on the plans. Details of the units, connection keys, and anchoring details are shown on the Standard Sheets for 619 series items. Also shown on the Standard Sheets are details of the tapered end sections. Delineation is required.

The recommended flare rates will differ depending on whether TCB is being placed (1) to merge traffic, (2) to divert traffic at signal-controlled, one-lane reversible operations, or (3) adjacent to the traveled way. The recommended minimum flare rates are shown in Exhibit 16-6. In some situations, the proximity of driveways or other features may make the use of more abrupt flares necessary.

Approach ends of TCBs should be flared away from the road at the rates given in the Exhibit 16-5. Barrier flares shall be preceded by a taper of channelizing devices for a distance "L" from the start of the taper, using the taper rate given in the NYSMUTCD Table 262-2. Where possible, the channelizing device taper should be followed by a tangent section of channelizing devices for a minimum distance equal to the longitudinal buffer distance in the NYSMUTCD Table 301-2.

Where practical, the approach ends should be embedded into a back slope or started behind an existing barrier and beyond its deflection distance. (Consideration may be given to temporarily reducing the deflection of the existing rail system by the placement of additional back-up posts up to the spacing limits shown in Table 10-3 in Chapter 10 of this manual.) If approach ends cannot practically be embedded, shielded by sand barrel arrays, or carried beyond the clear zone, the ends must be suitably treated. Impact attenuators should be provided if (1) the anticipated operating speeds are 70 km/h or greater, (2) the ends cannot be conveniently embedded or shielded, and (3) the ends are closer than 3.6 m to approaching traffic lanes. Where sand barrel arrays are used

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Exhibit 16-6 Recommended Minimum Flare Rates for Temporary Concrete Barrier**

Barrier Location	Anticipated Operating Speed (km/h)	Recommended Minimum Approach Flare Rate
In travel lane or within 0.6 m of existing delineated edge of travel lane.	110	20:1
	100	18:1
	90	16:1
	80	14:1
	70	12:1
	60	10:1
	50	8:1
More than 0.6 m beyond existing delineated edge of traveled way.	110	14:1
	100	13:1
	90	12:1
	80	11:1
	70	10:1
	60	9:1
	50	8:1
In travel lane at signal-controlled, one-lane, reversible operations	50 (May assume due to signalization. If higher speeds are expected, use flare rates for the above speeds.)	8:1

Note: Barrier flares shall be preceded by a taper of channelizing devices.

Source: *Roadside Design Guide*

for shielding and traffic will only be on one side of the array, the barrels on the traffic side of the array should be in a straight line to minimize the potential for errant vehicle to crash directly into one of the heavily loaded barrels in the back of the array without first impacting the lighter barrels in front.

If the first full-height section of TCB will be 3.6 m or more removed from approaching traffic lanes or if the anticipated operations speeds will be less than 70 km/h, a tapered end section may be used where embedment or shielding is not practical. Impact attenuators may be warranted for ends over 3.6 m from traffic in areas where sharp curves, short sight distances, high-volume weaves, merges, or other traffic conflict situations increase the possibility of vehicles leaving the traveled way.

Rapid changes in horizontal or vertical alignment cannot be accommodated by TCB connections. In most locations, there is a significant drop beyond the shoulder, making it necessary to place fill, which could be a significant amount, to run TCB outside the clear zone. The only practical option is to protect or shield the ends of the TCB. At locations where the likelihood of collisions is low or where a vehicle has adequate opportunity to slow significantly before reaching the tapered end

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

section, engineering judgement should be used to determine what level of protection is necessary and how best to provide that protection.

In certain circumstances, such as rural bridge redecking jobs where traffic is maintained parallel to the direction of travel, and driveways or intersections are immediately upstream from the bridge, it may not be possible to use the desired flare rates for the TCB, or even to adequately bury or extend the lead end of the TCB. If it is judged that TCB is needed to protect the workers, then the TCB on the tapered approach should be placed on as much of a skew as possible to minimize the severity of impact for errant vehicles.

Other alternatives available for consideration include attenuators or sand barrel arrays, movable concrete barrier since it can be flared on a shorter radius than TCB, TCB with a flared approach, an attenuator with a proprietary movable barrier gate to protect the opening, or vehicle-arresting barriers. TCB alignments at or near-right-angle alignments to the roadway should not be used unless none of the aforementioned alternatives are appropriate.

On projects where it is necessary to close a bridge to complete the work, worker protection should be provided, even though the approach highway is closed to through traffic. Under the best circumstances where adequate space is available, the approach to the bridge should be closed with Type III barricades and the proper advance warning and regulatory signs, in accordance with the MUTCD. In situations where the available space is not suitable, a vehicle-arresting barrier should be installed. (Refer to 16.3.2.) TCB placed across the approach highway at or near 90 degrees to the road alignment should not be used unless protection is necessary and there is no other alternative method.

When flaring TCB on approaches, the barrier may come close to an existing run of guide rail. This is very typical on bridge projects, especially in urban areas. The requirements to get the end of the barrier 3.6 m removed from traffic may put the tapered-down end section in a location where an errant vehicle that hits the existing guide rail upstream could be led along the rail and right into the end of the TCB. In those cases, the guide rail should be fastened to the face of the TCB as a first preference. If that is not possible, temporary impact attenuators should be specified.

### 16.3.1.2 Moveable Concrete Barrier

Moveable concrete barrier is a PIN-approved item. The designer must obtain approval from the Design Quality Assurance Bureau to use it on a project. Barrier and the custom-designed vehicle to move it are typically rented from the vendor.

Moveable concrete barrier (MCB) is used on construction projects in congested areas to provide additional traffic lanes to accommodate both AM and PM peak-hour traffic. It is also used to provide a safe means of expanding the contractor's work area and the opportunity to stage projects in a more effective manner.

Advantages of using MCB on congested construction projects include the following:

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-45

- Construction workers in temporary lane closures are protected behind positive physical barriers.
- Errant vehicles are better prevented from intruding into work zones.
- Routine and repetitive lane closures can be accomplished quicker than by using typical channelizing devices or barrier and without exposing workers to traffic.
- Congestion and air quality impacts can be reduced during construction by opening travel lanes during peak traffic times.
- The Contractor's lane rental costs and/or construction schedule duration may be significantly reduced, in which case, the cost savings should be factored into lane rental charges.

Refer to Chapter 10, §10.2.4.9 of this manual for further information on and additional advantages and disadvantages of MCB.

Generally, during preliminary design, TCPs have not been progressed to the extent that an adequate assessment of the appropriateness of MCB can be made. Nevertheless, enough data should be available at this point to allow for a screening to be done to make an initial determination as to the use of MCB. The answers to the following questions will help the designer determine if the use of MCB should be considered during detail design.

### Preliminary Design Phases I-IV

Need 1: Is there a need during the peak hour(s) to restore to use a lane or shoulder that is closed?

Need 2: Is there a need to alter the lane configuration to improve directional traffic flow in the peak direction?

If the answer to both questions is no, then MCB is not needed. This should be documented in the design approval document (DAD). If the answer to either (or both) question(s) is yes, the next question is:

Need 3: Is positive protection of the work zone warranted?

If the answer is no, then MCB is not needed. If the answer is yes, the designer should document in the DAD that further analysis to determine the appropriateness of MCB will be done during detail design. MCB is a high-cost item that requires special design considerations and should be used only when necessary. If the needs screening indicates it is needed, an analysis should be done as early in the project design as possible to validate its use. Documentation of the need for that analysis in the DAD is considered appropriate.

During Detail Design Phases V and VI, as traffic control concepts are further progressed on projects where the DAD indicates that MCB should be considered, additional analysis should be conducted to determine whether MCB should be utilized on the project and the answers to the three questions should be confirmed. Factors to be considered when performing this analysis should

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

include, but are not necessarily limited to the following:

- Safety and Traffic Operations
  - Can traffic operations be improved, in terms of safety, with the use of MCB compared to other barrier types?
  - Is positive protection of the work zone warranted? (This may be critical for projects which include nighttime construction.)
  - Can traffic flow be improved without adversely impacting construction scheduling or quality?
- Will there will be frequent, short-duration lane closures where MCB will provide the optimal protection to traffic and workers without permanently closing the lane?
- How many lanes is it permissible to close? (Roadways where only single-lane closures are permitted would likely require positive barrier separation for safety reasons.)
- Is the nature of the work conducive to using MCB?
- Is daily contraflow or reversible operation proposed?
- Is there a need to restore closed lane(s) or shoulder to traffic during peak traffic periods?
- Can construction be expedited or quality improved or productivity increased while maintaining a minimum level of acceptable traffic performance?
- Are the benefits in terms of reduced delay worth the extra cost, and can the project budget absorb the increase in cost that may result from the use of MCB? (If MCB is determined to be appropriate for safety reasons, the project budget should be adjusted to accommodate it.)
- How will delivery and storage of materials and equipment be facilitated?
- Can additional activity area be gained during off-peak hours and substantially reduce construction time?
- Can restaging of work be kept to a minimum?

When developing the MPT plan, the use of MCB should be limited to projects where a greater benefit can be attained than if standard methods and equipment were used. Listed below are types of projects for which MCB may be a viable option.

- Widening or reconstruction projects on arterials or expressways with high peak-hour traffic volumes, e.g., peak directional traffic operating at or near capacity (level of service E or F) during peak periods and/or is expected to exhibit unacceptable (as determined by the Region) levels of congestion during construction.
- Projects where a reversible traffic lane would be beneficial during peak traffic periods and which would allow for better staging. This has been effective in median reconstruction and has also been used successfully on the reconstruction of parallel structures by increasing the capacity of one structure while closing down the other.
- Projects where the size of the construction work zone is very restricted. Significant construction quality, efficiency, and time savings may be obtained by widening the work area during off-peak periods. MCB may help a contractor reduce lane rental costs.
- Projects on which traffic must be managed on site due to insufficient excess capacity or other operational deficiencies on alternate routes.
- Nighttime construction projects.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-47

- Projects where site constraints preclude temporary or permanent widening.
- Projects where traffic flow is highly directional and conducive to the use of a reversible lane.
- Significant construction quality, efficiency, or schedule benefits can be obtained by widening the work area during off-peak periods.

The cost-effectiveness of MCB as a traffic management tool should be evaluated by comparing the expected benefits to the cost of obtaining and operating the MCB system. The economic benefit of reduced delay and enhanced construction efficiency (reduced costs) need to be estimated. The QuickZone computer program is an analytical tool to help with this analysis. It was developed by FHWA to evaluate work zone capacity and delay cost.

Safety benefits, construction quality benefits, and public relations benefits are more intangible but should be considered. Assess the potential for severe traffic accidents in lane closures without concrete barrier, which could be prevented or reduced in severity by a barrier, by considering the proximity of traffic to workers and equipment, presence of edge drop-offs, and experience with similar construction projects.

For Consultant-designed projects, the preparation of the technical assessment should be made part of the consultant scope of work for appropriate projects.

If MCB is selected for use on any project operation, the MPT plans should detail where and when it is to be used and the appropriate pay items should be included in the contract documents.

### 16.3.1.3 Temporary Box Beam Barrier

Temporary box beam barrier is a separate pay item in the *Standard Specifications*. It must conform to the requirements for box beam median barrier, except that it need not be new. Refer to Chapter 10 of this manual for design guidance.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.3.2 Vehicle-Arresting Barrier (Net-Type)

Vehicle-arresting barrier is a PIN-approved item. The designer must obtain approval from the Design Quality Assurance Bureau to use it on a project.

Vehicle-arresting barriers (VAB) (net-type) are used at highway construction work zones to prevent errant vehicles from entering work areas and causing injury and damage. They have proven effective in restraining vehicles ranging from motorcycles to 18 000 kg trucks. Once a vehicle is caught in the net, it is safely brought from highway speed to a full stop by the release, at a predetermined resistance, of restraining cables on the net. The deceleration rate and final distance traveled before coming to a full stop can be determined from the design formulas below and should be shown on the plans. Vehicles can be stopped with a relatively low "G" force.

These devices protect against vehicles breaching road or ramp closures. Consideration should be given to including VAB in the MPT plans (or by order-on-contract when work is initiated after the letting) at any locations where there is a concern that drivers will enter the closed roadway. A VAB is detailed on Standard Sheets M619-6 and M619-7 Vehicle-Arresting Barrier (Net-Type) Details. The following points are to be addressed if VABs are used.

- VAB locations are to be shown in the MPT plans.
- Type III barricades, with flashing warning lights, and appropriate ROAD/RAMP CLOSED (R8-1) signs, must be provided in front of the VAB.
- Where the net is located some distance beyond the closure, a secondary set of Type III barricades should be placed immediately in front of the net to alert construction traffic and any drivers who circumvent the primary closure.
- Adequate stopping distance free of all objects and vehicles must be provided beyond the VAB. See below for information on computing the required stopping distance.
- Consideration should be given to providing access for construction vehicles and other official traffic to enter the closed roadway.
- When there is a concern that drivers will deliberately try to enter the closed roadway by driving around the net, stationing a watchman or police officer in a vehicle at the entry point should be considered. The vehicle should be equipped with appropriate warning lights and positioned where it is visible to approaching traffic, but in a location where it is not at risk of being struck. The watchman should be equipped with a radio to alert the work area of any vehicle intrusions.

The vehicle-arresting barrier (VAB) is approved by the FHWA for use on federal-aid projects.

#### 16.3.2.1 Guidelines for the Use of Vehicle-Arresting Barriers (Net-Type)

A VAB (net-type) may be considered for use at locations where one or more of the following situations exist:

- Vehicle encroachment into the work area would result in a probable injury to either workers

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-49

or vehicle occupants or both. A good example is a bridge removal and replacement project at the bottom of a long downgrade where motorists are more likely to lose control of their vehicles.

- Vehicle encroachment into the work area would be at high speed, usually not requiring any turning movements to enter the work area. A good example is a full closure of a high volume expressway, where contractor operations extend over a long period of time, but the roadway must be reopened daily to traffic.
- Past accident and operational history indicates that conventional equipment, such as Type III Barricades, temporary concrete barrier, and safety fences, are unable to prevent errant vehicles from entering the work area, or are otherwise unsuitable for a particular site.
- For off-peak or night work where the roadway is closed intermittently over a period of days or weeks. A VAB (net-type) can be assembled or disassembled in just 15 minutes once the concrete anchors are installed.
- Errant vehicles must be brought to a full stop so as not to enter the work area.

A VAB (net-type) should not be used for the following situations.

- Where the stopping distance beyond the VAB is inadequate.
- For single lane closures of multilane roadways.
- Where workers will not be available to periodically check the condition of the various components unless specified in the contract documents.
- Where less costly and less maintenance-intensive conventional equipment could effectively be utilized without sacrificing the safety of the workers or vehicle occupants.

VABs should be used in conjunction with Type III barricades, plastic drums, adequate signing, etc., to alert motorists of a roadway closure. In addition, the anchor posts should be shielded from impact, by ramping soil up to the top of the post, as shown on the Standard Sheets, and provisions should be made for performing repairs as quickly as possible.

Disadvantages of a VAB (net type) are:

- The units are subject to vandalism or theft.
- After each impact, maintenance is required which consists of:
  - Minor impact - replace the tape assembly.
  - Severe impact - replace most components.
- The contractor must be notified quickly to provide maintenance after each impact since the system has no second-hit capability. A battery-powered electronic device to notify the contractor in the event of an impact or vandalism is available from the supplier at extra cost.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.3.2.2 Design Computations for Vehicle-Arresting Barrier

L = length of net (metal bender to metal bender), m.

X = travel distance of vehicle after engaging net, m.

W = weight of vehicle, kg (assume 820 kg and 2050 kg).

V = initial velocity of vehicle, m/sec. (assume 27 m/sec.).

T = metal bender (energy absorber) taped tension force, kg (see available energy absorbers below).

g = acceleration due to gravity, 9.81 m/sec<sup>2</sup>.

F = maximum vehicle stopping force, kg.

G<sub>max</sub> = maximum G force on vehicle, kg.

G<sub>avg</sub> = average G force on vehicle, kg.

R = runout of metal bender (energy absorber) tape, m.

The following manufacturer's design formulas should be computed in the order shown to obtain the travel distance (X) after engaging the net, and the deceleration rate (G<sub>avg</sub>) for the system chosen.

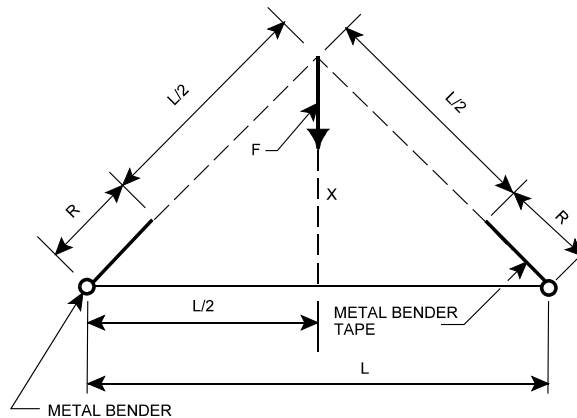
$$1. R = \frac{WV^2}{4Tg}$$

$$2. X = (R^2 + RL)^{\frac{1}{2}}$$

$$3. F = \frac{2TX}{R+(L/2)}$$

$$4. G_{\max} = \frac{F}{W}$$

$$5. G_{\text{avg}} = \frac{V^2}{2gx}$$



AVAILABLE ENERGY ABSORBERS		
Tension (T)	Runout Tape (R)	Usual Guide
2050 kg	23 m	Usual Case, Average Vehicle Mix
2050 kg	61 m	High Percentage of Heavy Trucks

Deceleration rates (G<sub>avg</sub>) should be limited to 3 to 6 Gs, when feasible, but in no case should the deceleration rate exceed 10 Gs.

Refer to the Standard Sheets for details of VAB (net-type).

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-51

### 16.3.3 Shadow Vehicles and Barrier Vehicles

#### 16.3.3.1 General

Shadow/barrier vehicles are included in the Basic Maintenance and Protection of Traffic item.

A shadow vehicle is an occupied vehicle equipped with a truck-mounted impact attenuator located a short distance upstream from a slowly moving lane or shoulder closure area (refer to the *NYSDOT Work Zone Traffic Control Manual*). Shadow vehicles are used in moving and mobile work areas that occur on or adjacent to the highway and where workers are not protected by traffic barriers, barricades, channelizing devices, or flag persons. Moving and mobile work zones typically do not have barrier or channelizing devices.

For maintenance-type, mobile, or slow-moving operations, an advance warning vehicle may be used as the first vehicle on the shoulder when it is impractical to install ground-mounted signing. A pickup truck with an arrow panel or sign is often used, however, it may not be used in a travel lane as a shadow vehicle.

A barrier vehicle is an unoccupied vehicle equipped with a truck-mounted impact attenuator and parked a short distance upstream from a stationary lane or shoulder work area (refer to the *NYSDOT Work Zone Traffic Control Manual*). Barrier vehicles are used to protect motorists and workers in stationary work areas that occur on or adjacent to the highway, except when they are protected by temporary concrete barriers or vehicle arresting barriers.

Barrier vehicles may also be used to protect motorists from work area hazards when there are no workers to be exposed to moving traffic adjacent to the work area. If there would be less damage or serious injury resulting from an errant vehicle impact with the barrier vehicle than with a work area hazard, a barrier vehicle may be considered. If, however, it can be shown that the presence of a barrier vehicle would produce greater damage or injury, then it should not be specified.

A shadow/barrier vehicle should be located in each of the lane(s) and/or shoulder in which the work area is located. This information should be shown on the plans.

Shadow or barrier vehicles should be positioned a sufficient distance upstream of the workers and/or equipment being protected to allow for the distance they will roll ahead upon impact, but not so far that an errant vehicle can travel around the shadow or barrier vehicle and strike the workers/equipment. They should be at the downstream end of any buffer space (refer to the NYSMUTCD §301.13 and the *NYSDOT Work Zone Traffic Control Manual*).

Shadow or barrier vehicles located (moving or parked) in a travel lane or shoulder upstream of the work area shall be equipped with arrow panels, rotating beacons, and truck-mounted impact attenuators. Variable message signs may also be used where specially worded guidance to the motorist is needed.

Shadow vehicles used in moving operations not protected by channelizing devices must be

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

equipped with operational arrow panels in the appropriate flashing arrow mode (see the NYSDOT *Work Zone Traffic Control Manual*). The arrow panel on the first shadow vehicle should be operated in the flashing arrow mode if it is located at the beginning of the lane closure.

The arrow panels on barrier vehicles used in closed lanes defined by channelizing devices downstream of the taper must not be operated in the flashing arrow mode but may be operated in the flashing corner caution mode, or be turned off.

Where the posted speed limit is 55 mph or less, barrier vehicles shall be equipped with NCHRP Test Level-2, truck-mounted impact attenuators. Where the posted speed limit is greater than 55 mph, barrier vehicles shall be equipped with Test Level-3, truck-mounted impact attenuators.

In assessing the need for a shadow or barrier vehicle, the following items should be considered:

- Type of facility.
- Type of work operation.
- Location of the work area (travel lane, shoulder, roadside, etc.).
- Special hazards.
- Traffic speed and volumes.
- Traffic patterns (turns, merges/diverges, weaves, etc.).
- Roadway geometry including approach sight distance.
- Type of separation device between traffic and the work area.
- Lateral separation between traffic and the work area.

When determined by the designer to be necessary for the project, shadow and barrier vehicles should be shown or called for in the contract documents.

Refer to Exhibit 16-7 for guidelines to rank the assignments for shadow and barrier vehicles.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-53

**Exhibit 16-7 Guidelines for Ranking the Assignment of Shadow Vehicles and Barrier Vehicles**

Element Closure/Worker Exposure Condition	Ranking <sup>1,2</sup> for All Highway Types
Lane closed, without ground-mounted signs and channelizing devices for work zone	
Involving exposed personnel <sup>3</sup>	A
Not involving exposed personnel	C
Shoulder closed, without ground-mounted signs and channelizing devices for work zone	
Involving exposed personnel <sup>3</sup>	B
Not involving exposed personnel	C
<p>1. The ranking letter indicates the priority assigned to the use of a shadow vehicle. A shadow vehicle:</p> <ul style="list-style-type: none"> <li>A Is to be used.</li> <li>B Should be used if use is practical for the subject operation.</li> <li>C May be used, based on special conditions encountered on an individual project, when an evaluation of the circumstances indicates that an impact with a shadow vehicle is likely to result in less serious damage and/or injury than would impact with a working vehicle or the hazard.</li> </ul> <p>2. For all speeds <math>\geq</math> 50 km/h.</p> <p>3. Exposed personnel may be on foot or in work vehicles.</p>	

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES****16.3.4 Temporary Impact Attenuators**

Temporary (construction) impact attenuators have been developed specifically to shield TCB end sections and other rigid objects in construction zones. The attenuators currently approved for general use include:

- QuadGuard-Construction Zone.
- Construction Zone REACT 350.
- Trinity Attenuating Crash Cushion (TRACC).
- ADIEM II is Special Specification.

These systems are all compliant with NCHRP 350 TL3. Refer to Chapter 10 of this manual and EI 98-039, EI 04-004, and portions of EI 01-003 for selection guidance.

The designer should note that these systems are proprietary, and a justification for their use must be submitted with the PS&E package.

**16.3.5 Temporary Sand Barrel Arrays**

Sand barrels are arranged in arrays designed to gradually transfer the momentum on an impacting vehicle to the sand. Lighter barrels are placed near the front of the arrays to gradually slow small vehicles, which are usually considered to be in the 800 kg category. Heavier barrels are placed farther back in the array to slow the larger passenger vehicles, which are in the 2000 kg category.

Refer to Chapter 10 of this manual for additional guidance on sand barrel arrays.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.3.6 Temporary Rumble Strips

Temporary rumble strips are included in the *Standard Specifications* as a separate pay item. The specification allows the use of raised asphalt strips, recessed saw-cut or milled-in strips, and strips formed from layers of pavement marking masking tape.

Temporary rumble strips are placed transversely across a travel lane to alert motorists to the presence of workers. Because they are intended as a temporary measure, rumble strips should only be used on pavement that will subsequently be overlaid, removed, or replaced, or can be otherwise restored to an acceptable condition.

Rumble strips formed from pavement-marking tape provide optimal performance when multiple layers of tape, preferably four, are placed directly on top of one another. These strips create the right level of noise and can be felt inside a vehicle without causing a jarring effect. By providing audible and tactile warnings, rumble strips can be effective in drawing a driver's attention to traffic control devices or potential hazards that unfamiliar drivers may not see. This effect is especially helpful in situations where drivers have been mesmerized by traveling long distances on an unrestricted roadway, and then suddenly encounter a construction work zone with roadway width and alignment restrictions, and potential conflicts with slowing traffic and construction activities. Even if the rumble strips do not achieve a speed reduction, alerting drivers to the change in roadway character should reduce accident potential.

#### 16.3.6.1 Criteria for Use

Warning signs are provided to inform drivers when they are approaching disruptions to the normal travel pattern. Rumble strips are supplementary devices which should be placed upstream from the first advance warning sign in the series on long-duration projects, such that drivers are alerted in time to see and read the signs.

Rumble strips should not normally be used in conjunction with short-duration ( $\leq 1$  week) or portable warning signs where the work zone is set up and removed daily (or nightly), or the location of the situation is subject to frequent changes.

Alternative and supplemental means for alerting inattentive drivers should be considered, including the use of oversize signs or variable-message display units, the use of warning lights and/or flags to draw attention to warning signs, and the posting of signs on both sides of the roadway.

Potential locations for temporary rumble strips should be evaluated on a project-by-project basis. Generally, rumble strips are not effective in urban settings and are not appropriate for residential or commercial settings because of the noise. Rumble strips should be considered on high-speed facilities with uninterrupted flow where motorists are less likely to see and react to work zone traffic control.

Rumble strips should be installed at long-term sites such as paving, bridge repairs, and other sites where temporary traffic controls are in place for more than one week. Rumble strips should not be

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-57

placed on curves with a radius less than 440 m to ensure that they do not adversely affect vehicle traction around the curve. Rumble strips should not be used during winter months when they may be damaged by snow plows or interfere with snow removal.

On designated bicycle routes or other routes with routine bicycle traffic, where there is no usable shoulder or the shoulder is less than 0.9 m wide, rumble strips should be ended 0.9 m short of the edge of usable pavement.

Rumble strips are not to be used where they will create operational problems, or where they will provide no additional value, including the following:

- In close proximity to residences where noise may be objectionable.
- On milled surfaces or very rough pavement.
- Interrupted flow conditions or low speeds.

The Regional Traffic Engineer should be consulted for a recommendation as to the desirability of using rumble strips at a particular work zone. This recommendation should consider the integration of rumble strips into the overall MPT plan, as well as the spacing and locations of the individual strips.

### 16.3.6.2 Patterns and Location

As a guide, a rumble strip pattern consisting of six separate strips placed on 3-m centers and traversing the full width of each travel lane is generally acceptable for use on high-speed, multilane roadways. On curbed roadways, rumble strips should end a minimum of 0.9 m from the curb in order not to interfere with drainage.

Unless site conditions warrant otherwise, a standard rumble strip installation consisting of a 6-strip pattern shall be placed in advance of each of the last three advance warning signs for the condition to which drivers are being alerted. On expressways and similar roadways with typically long sign spacings, rumble strip patterns placed 150 m to 300 m upstream from each sign (with the higher values used for larger signs that can be read at a greater distance) should provide adequate driver response time. On highways where warning signs are spaced at 150 m apart, each of the last two patterns should be placed approximately 15 m downstream of the preceding sign in the series.

Suggested layout details are shown in Exhibit 16-8. Other patterns and locations may also be appropriate, but should be used only with the approval of the Regional Traffic Engineer.

For long projects such as highway reconstruction or 3R, where there are multiple work zones, sets of rumble strips may be installed at specific work sites, if appropriate. Intermediate rumble strips should be located in advance of warning signs such as ROAD WORK 1 MILE (W8-1), TWO-WAY TRAFFIC (W3-3), or NO SHOULDER (W4-13).

Project plans or drawings by EICs should show the actual spacing and locations of rumble strips at each installation.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

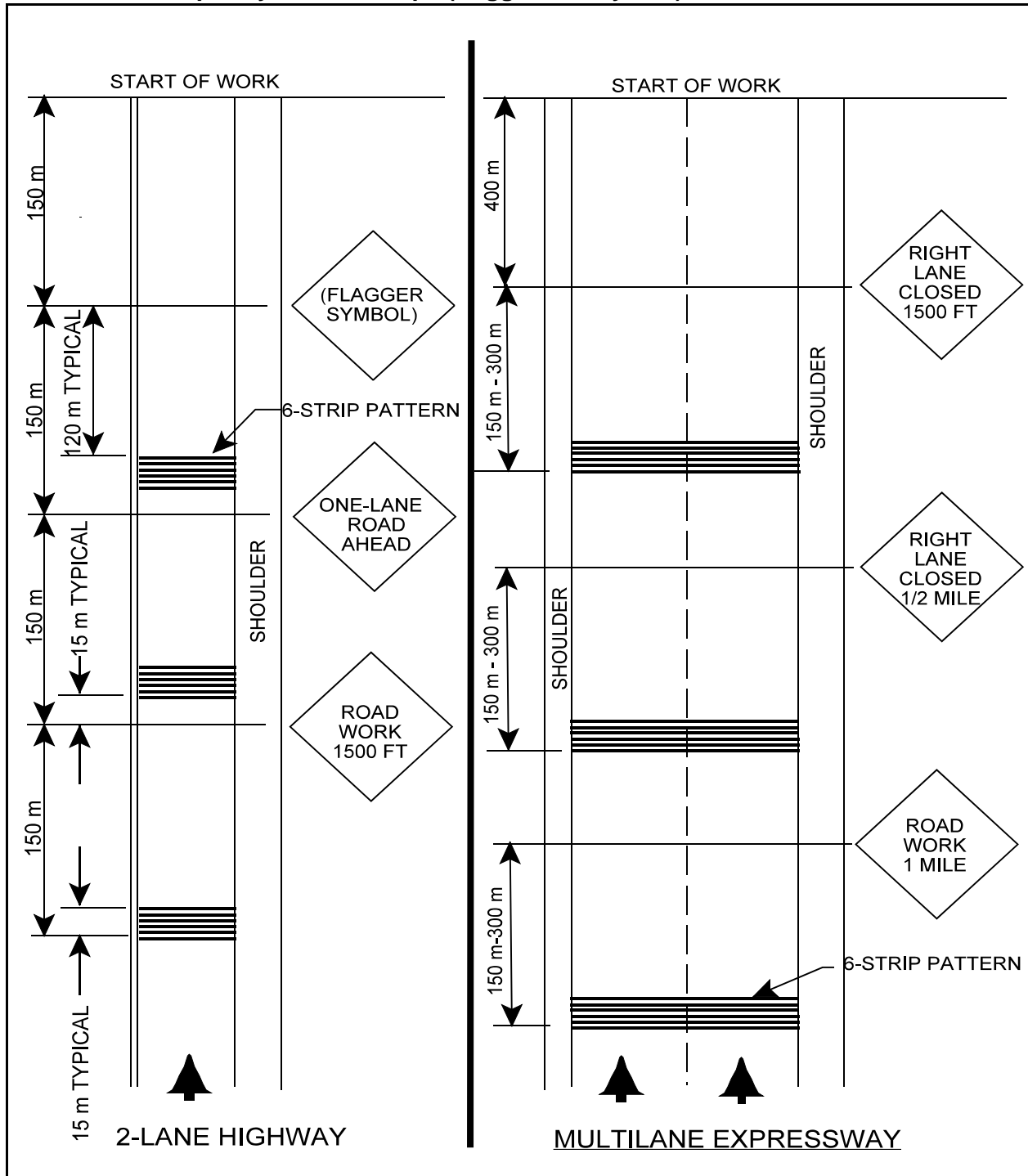
## 16.3.6.3 Removal

Rumble strips must be filled in or removed before the start of the winter plowing season and before the placement of an overlay. On multiyear projects where it is desired to have rumble strips in place for more than one construction season, the rumble strips must be installed, removed, and paid for separately each year they are used.

MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES

16-59

Exhibit 16-8 Temporary Rumble Strips (Suggested Layouts)



## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.4 MAINTENANCE AND PROTECTION OF TRAFFIC (MPT) PLANS

#### 16.4.1 General

Whether driving, walking, or bicycling, safely negotiating a temporary highway work zone or traffic control zone can be a disturbing and difficult experience. It is an environment that may present obstructions to and diversions from the normal driving environment to which they are accustomed. Highway work zones often change as the work progresses, further disrupting the travelers' expectations. Therefore, to fulfill the objectives stated in §16.1, as well as both State and Federal policies, it is necessary to prepare some form, whether basic or complex, of maintenance and protection of traffic (MPT) plans.

The pay item for Basic Maintenance and Protection of Traffic in the *Standard Specifications* is used when it is necessary to maintain traffic 24 hours per day (not removed and restored each day) on new construction and reconstruction projects through work zones which may be more restrictive than the conditions were prior to or will be after completion of the work.

There are, however, a number of projects, such as sign refurbishing, guide rail replacements, signing contracts, lighting contracts, and signal replacement contracts where the roadway and shoulders can be cleared of work zone traffic control equipment and devices each night. On these projects, less elaborate and presumably more economical traffic controls are generally appropriate. For such projects, regardless of whether or not the highway is designated as restricted, the designer should specify the special specification for the Maintenance and Protection of Traffic pay item, when all the following conditions apply:

- All the traffic lanes and highway shoulders can be restored to normal use at the end of each work day.
- It would not be reasonable to require pavement repairs because the work is outside the pavement and shoulders and of a nature not likely to affect either, other than temporary occupation by construction equipment.
- No separate detours are needed.

MPT plans describe the methods, strategies, and sequence of construction to be used to facilitate the safe movement of motorists, bicyclists, pedestrians, and workers through and/or around highway or street work zones. They generally contain specific information about placement, type, and maintenance of traffic control devices, methods and devices for delineation and channelization, construction scheduling, application and removal of pavement markings, roadway lighting requirements, traffic regulations, and surveillance and inspection procedures for each stage or phase of work. The complexity of the work and the extent to which it will impact traffic determines the level of detail necessary in the MPT plans.

A workable plan should be developed at the earliest possible stage of design and if major impacts are expected, they should be discussed in the Design Report/Environmental Document. Refer to the Project Development Manual for guidance as to the information to be included in the Design Report/Environmental Document. The MPT plan should be prepared by persons trained and

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-61

knowledgeable in the fundamental principles of temporary traffic control and the work activity to be performed.

The complexity and duration of the work, and the type of traffic and portion of the highway affected by the work, are all considerations in selecting the most appropriate method of highway work zone traffic control. Large, complex projects located in congested urban areas may require a broad analysis of the corridor, and development of a transportation management plan. For smaller, less complex projects, especially those located in rural areas, it may be appropriate to develop special notes and include Regional "typicals." References should not be made to examples given in the NYSMUTCD, as they, "in themselves, do not establish standards, and do not necessarily illustrate the only appropriate treatment for a given situation." They do not have the appropriate level of detail for contract purposes.

The MPT plan should clearly indicate all required phasing, method of traffic control, and any time or construction limitations that will be placed on the contractor. Attention should be given to developing strategies that will limit impact to the traveling public. As much as possible, the designer should attempt to maintain the existing number of lanes and avoid speed reductions throughout a construction project, particularly on interstates and other major routes. Where it is determined that lane restrictions are necessary, work should be restricted during peak periods of traffic flow on the route and nighttime construction should be considered. The MPT plan should also take into account other adjacent roadway sections that may be under construction and avoid conflict between competing phases of adjacent projects or work on routes chosen for detours. The needs of oversize vehicles and those with special dimensions should be considered, especially if the project affects a route specifically designated for them.

The Department has the regulatory authority to put in place the necessary highway work zone and traffic control devices as authorized by §104-a of the Highway Law and §1625 of the Vehicle and Traffic Law. When a contract is awarded, the section of highway under contract is designated as a "restricted highway," unless otherwise specified. The decision whether to designate a restricted highway is a project-specific decision and must be made for each project during the design process. An Official Order is required and must be prepared by the designer and cleared with all affected Regional units and submitted to the Regional Director for concurrence. It is then sent to the Office of Operations for approval and filing with the Secretary of State. The project proposal is normally marked with the words "Restricted Highway" when this decision is made before letting. A designer who bases an MPT plan on the assumption that the highway will be restricted should ensure that the Order is prepared and filed. Only nonrestricted highways will be identified, when applicable, by the designer by special note in the contract proposal. Refer to §16.4.7.2 for more information.

The Department normally allows contractors to develop and use alternate MPT plans or make value-engineering changes, but only if they are approved by the Department. This provides the flexibility of permitting modifications to the MPT plan due either to changed conditions, or to the development of better and safer methods of handling traffic.

The information developed for the MPT plan should, when appropriate, include, but not necessarily be limited to:

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

- Plan view showing overall project including signing of the roads and streets to be used for alternate routes during construction.
- Official detour map showing on-site diversions, off-site detours, construction phasing, and traffic patterns through the work zone.
- Notes describing the phasing or staging. Complex projects may require multiple layout maps for clarity.
- Scaled drawings of the highway work zone.
- Scaled drawings of construction stages (daytime or nighttime), when applicable.
- Plans of off-site detours, including information on type and location, both existing and temporary, of traffic control devices.
- Diagrams and notes for how and when to accomplish the work.
- Descriptions of traffic control procedures necessary to accomplish the work before, during, and after construction.
- A list of traffic control devices selected for installation and special instructions for their use or deployment.
- Schedules for times during the day, week, or year when work is not permitted or when certain lanes are to remain open.
- Description of special manpower-personnel/worker-type needs (i.e., flaggers).
- Location of potential grade problems between existing and proposed.
- Location of bridges and culverts that will require staged construction.
- General and specific notes associated with the construction operations and traffic control operations.
- Traffic regulations including times when regulations such as reduced speed limits, ramp merge control, and parking restrictions are to be in effect, and details of staging areas, turnarounds, etc., for police enforcement of traffic regulations.
- Sign text data sheets for the construction signing not otherwise shown on the plans.
- Profiles and typical sections, as may be necessary.
- Copies of permits.

To the extent possible, the scoping, design, scheduling, and construction of projects should be accomplished in a manner that will provide a high level of safety for workers and the traveling public, minimize congestion and community impacts by maintaining levels of service close to preconstruction levels, and provide the contractor with adequate access to the roadway to complete the work safely and efficiently, while meeting the quality requirements of the contract.

In order to achieve these objectives, design and construction of projects should maintain, to the extent practicable, the existing capacity of the road under construction and should consider nighttime operations detours, diversionary roads, crossovers, use of shoulders as travel lanes, temporary roads and bridges, and alternating traffic patterns. The incorporation of design features to ease traffic impacts, enhance police enforcement activities, and provide more room for work during future construction should also be considered. These could include wider lanes, wider inside and outside shoulders, full-depth shoulders, shoulders and removable sidewalks on bridges, and other alternatives.

The basic safety principles for governing the design of permanent roadways and roadsides should also govern the design of construction, maintenance, and utility work sites. The goal should be to

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

16-63

safely route traffic through these areas with geometrics and traffic control devices, as nearly as possible, comparable to those for normal highway situations. The following items should be considered in determining the overall approach to project-specific traffic control:

- Are major traffic generators located near the project site and will they generate commuter or event traffic that will restrict the hours of operation?
- Based on traffic count information, determine the number of lanes which can be closed during the day, during the night, or on weekends. Incorporate seasonal variations on interstate highways and in tourist areas (or routes leading thereto) by obtaining summertime weekend counts. Contact the agency which has jurisdiction and ask what lane or road closings they will allow and discuss independent findings with them. Obtain concurrence with the proposed lane closings.
- Can existing lane widths be maintained through the work zone?
- Are adequate detour routes available?
- Can existing shoulders be used or do they require replacement with full-depth shoulders?
- Is it necessary to remove, relocate, reset, or replace existing guide rail?
- Are temporary signals required?
- Are there reasons for the construction project to be accelerated?
- Are lane closings required and for what duration?
- Is concrete barrier required and should it be the temporary or moveable type?
- Should nighttime construction be used?
- Safe contractor access to the work site.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.4.2 Fundamental Principles

The FHWA publication *Design and Operation of Work Zone Traffic Control* describes the purpose of temporary traffic control as protecting motorists, pedestrians, bicyclists, and workers from hazards associated with construction, maintenance, and utility operations. To accomplish this, traffic control must:

- Warn road users (motorists, pedestrians, and bicyclists) of hazards.
- Advise road users of the proper travel path through the area.
- Delineate areas where traffic should not operate.
- Separate and protect both road users and the work force.

Fundamental principles, which experience has shown will assist road users and help protect workers in the vicinity of temporary traffic control areas, are found in the National MUTCD, Section 6B.01. These principles do not establish specific standards and warrants but do provide the designer with guidance for good temporary traffic control.

#### 16.4.2.1 Construction Supervisor Input

A necessary element for producing quality design and construction is good communication between the design staff and construction staff. A project site visit will give design project engineers greater insight into the quality of the design documents that were prepared, provide a learning experience to improve the quality of documents they prepare or manage in the future, and increase the overall effectiveness and efficiency of the Department's design-construction process. Regional and Main Office design squad leaders, project engineers managing consultants, and Regional liaison engineers are required to visit the job site for each project they design to discuss the construction supervisor's experience with the design documents. Refer to EI 89-031 for complete guidance on obtaining construction supervisor input on design plan quality.

It is also vitally important for Region Traffic Quality Control staff to review the plans and provide input to the designer.

#### 16.4.2.2 Purpose of Maintenance and Protection of Traffic (MPT) Plans

MPT plans play a vital roll in providing continuity of safe and efficient road-user flow when a work zone disrupts that flow. They should be developed, or at least closely supervised, by an experienced designer who has complete knowledge of the project and is completely familiar with the project area. MPT plans are prepared:

1. To provide a workable, safe method or plan for the maintenance and protection of traffic using criteria set forth in the National *Manual of Uniform Traffic Control Devices, Standard Specifications*, and other Department issuances and guidance.
2. To provide a plan such that a reasonable estimate of traffic control costs can be developed for the Engineer's Estimate.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-65

3. To provide a plan such that contractors bidding on the project know what is expected/required and can formulate their bids accordingly.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.4.3 Elements of Highway Work Zones

The National MUTCD defines a temporary traffic control zone as “an area of a highway where road user conditions are changed because of a work zone through the use of temporary traffic control devices, uniformed law enforcement officers, or other authorized personnel.” The National MUTCD divides work zones into the following areas:

- Advance Warning Area
- Transition Area
- Activity Area
- Termination Area

The advance warning area is the section of highway where road users are informed about the upcoming work zone. The transition area is the section of highway where road users are redirected out of their normal path. The activity area is the section of highway where the work activity takes place. The termination area is the section of highway that is used to return road users to their normal path.

The Activity Area is further divided into subareas, or spaces:

- Work Space
- Traffic Space
- Buffer Space (longitudinal)
- Buffer Space (lateral)
- Incident-Management-Vehicle Storage Space (optional) or Enforcement Area

Most work zones, regardless of the type, will consist of these areas. The specific field treatment and selection of traffic control devices will be determined by the character of the operation. These areas and spaces are described in the following sections and illustrated in Exhibit 16-9.

#### 16.4.3.1 Advance Warning Area

An advance warning area is necessary for all work zones because it is where road users are informed about the upcoming work area. The warning may vary from a single sign or flashing lights on a vehicle to several signs in advance of an upcoming work zone or incident area. Drivers must have enough time to read, comprehend, and react safely to the messages contained in advance warning signs. Warning signs are the most common systems of traffic control devices used in the advance warning area. Refer to the NYSMUTCD Parts 238, 301, and 302 and the National MUTCD Chapter 6 for guidance in the use and location of warning signs in highway work zones.

At locations where traffic volumes may exceed the capacity of the traffic space, it may be necessary to extend or adjust the location of upstream signing to include that stretch of road where queues may form. Extended advance warning may also be dictated by the geometrics of the approach roadway, such as downhill approach grades, horizontal curves, existing lane reduction, etc. Other special problems include:

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-67

- Urban Locations. Adjustments of sign spacing and numbers of signs may be necessary due to the length of city blocks, spacing of intersections, and the locations of alleys, shopping-center access points, and side streets.
- On-Street Parking. The mounting height of signs may have to be increased to be visible over parked vehicles (see 16.4.4.2.A.7).
- Commercial Establishments. Sign locations may have to be adjusted to avoid interference with loading zones or having them be obstructed by delivery vehicles or existing commercial signs.
- Divided Highway and One-Way Streets with Two or More Lanes. Signs should be installed on both sides of the roadway to assure that the messages are visible to all approaching traffic and to minimize the possibility of the view of the signs being blocked by vans and trucks.
- Existing Signs. Existing signs which are not applicable during the road work activity should be covered or removed. The spacing between temporary traffic control signs and the remaining existing signs may require adjustment so as not to overload the driver's ability to comprehend and respond to all signs in the system.

### 16.4.3.2 Transition Area

The transition area is that section of the highway where road users are redirected out of their normal path. In mobile operations, the transition area moves with the work space. Transition areas usually involve strategic use of tapers. This is typically done when work is performed in one or more of the travel lanes and a lane closure is required. See Exhibit 16-9. (Note: The NYSMUTCD describes "tapers" as being synonymous with "transitions." The National MUTCD uses "tapers." The guidance herein follows the National MUTCD in the use of the term "tapers.")

Longer tapers are not necessarily better than shorter tapers (particularly in urban areas characterized by short block length, driveways, etc.). Extended tapers tend to encourage sluggish operation and to encourage drivers to delay lane changes unnecessarily. They also make it more difficult for motorists to perceive visually what is happening (i.e., lane closure) and therefore, cause lane-change maneuvers too late and in conflict with adjacent traffic.

For those tapers whose lengths are based on traffic speed, the speed used should be the 85<sup>th</sup> percentile speed (from the Design Report) immediately in advance of the transition area. If the 85<sup>th</sup> percentile speed is not known, use the posted speed + 5 mph. Estimated or calculated speeds may be used. The taper lengths indicated are guides. Different distances may be appropriate in urbanized areas or when a taper occurs near an interchange ramp, an intersection, or a curve. Superelevation should be considered when shifting traffic by using curves. After a taper has been put in place, traffic operation should be observed, and any necessary adjustments should be made. Refer to Exhibit 16-9 for illustrations of, and to Exhibit 16-10 for length criteria for the tapers described below:

#### 1. Merging Taper.

A merging taper is used to close a lane when vehicles in that lane must merge with traffic in an adjacent lane at prevailing speeds. The taper should be long enough to enable drivers

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

in the lane being closed to make any necessary speed adjustments to position themselves opposite traffic gaps in the adjacent lane. However, an excessively long transition may encourage drivers to delay their lane changes and may result in sluggish operation. Merges should be made before traffic enters work zones. The (L) values in Table 262-2 in the NYSMUTCD should be used as guides in determining the lengths of merging tapers.

### 2. Shifting Taper.

A shifting taper occurs where a roadway changes direction, but all approach lanes remain open and no merge is required. The taper should be long enough to be negotiated without causing reductions in travel speed. One-half the values ( $\frac{1}{2} L$ ) in Table 262-2 in the NYSMUTCD should be used as minimum lengths. Longer distances are encouraged where space is available. Alignment changes may also be accomplished by using horizontal curves.

### 3. Lane-Width Taper.

A lane-width taper is used when it is necessary to decrease the lane width in a work zone. The rate of taper required for modifying a lane width is the same as that for a shifting taper,  $\frac{1}{2} L$ , except the "W" (the width of offset in meters) is equal to the change in lane width.

### 4. Shoulder Taper.

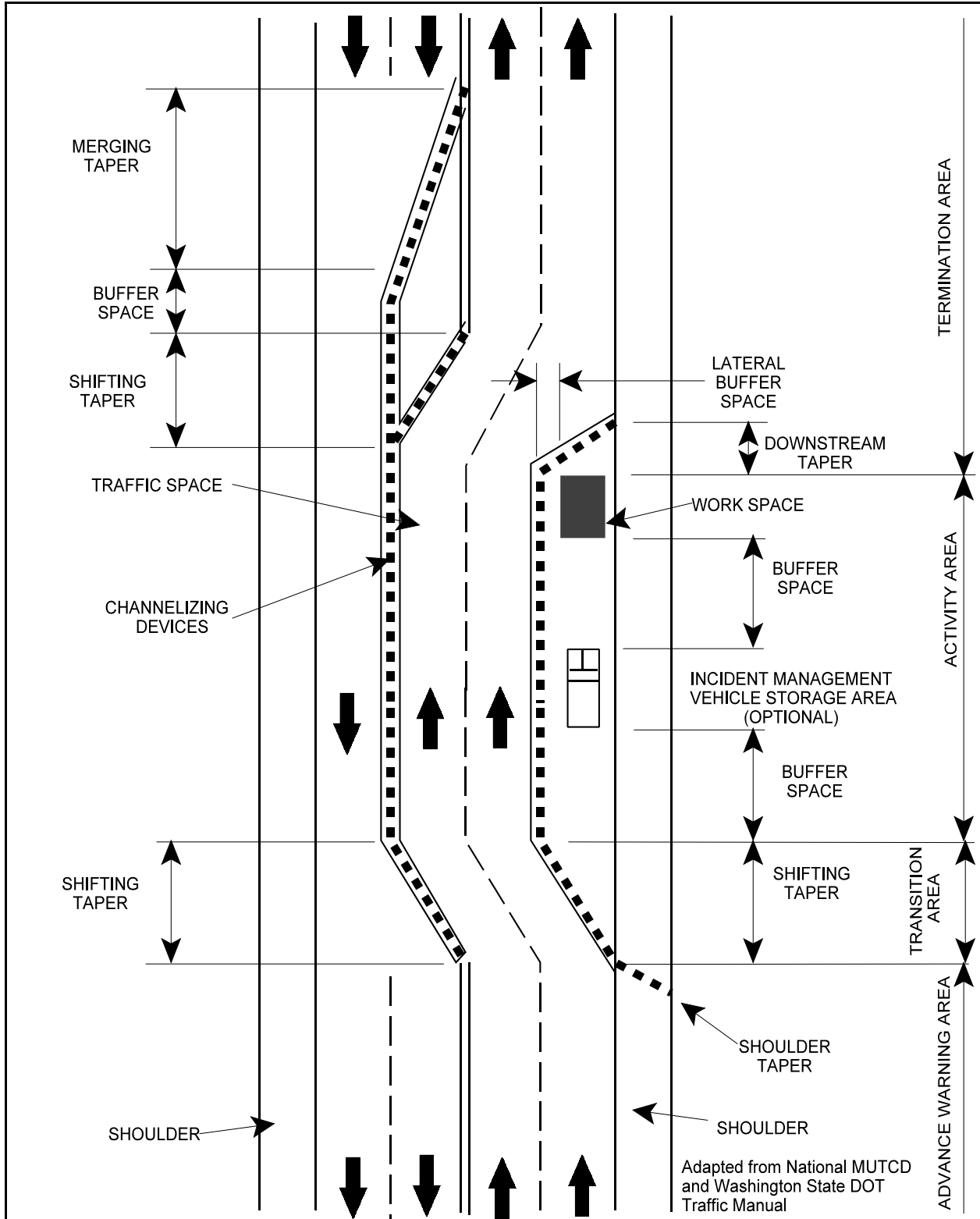
A shoulder taper may be appropriate on the approach to a work area or other obstruction which is on the shoulder of a high-speed roadway. One-third the values ( $\frac{1}{3} L$ ) in Table 262-2 in the NYSMUTCD should be used as guides in determining the lengths of shoulder tapers. Shoulder tapers are not for use where a shoulder is temporarily being used as a travel lane. Shifting tapers should be used to divert traffic onto and off the shoulder in such circumstances.

### 5. One-Lane, Two-Way Taper.

One-lane, two-way tapers are for use on two-lane, two-way roadways where a portion of the roadway must be closed and alternate one-way operation is in effect in the remaining lane. One-lane-road signal control or flagger control is typically used to establish the alternate one-way operation. Traffic approaching on the side of the roadway which is closed must negotiate two tapers to bypass the work area. The first taper is a one-lane, two-way taper that moves the traffic onto the left-hand half of the roadway where the closure begins. This taper should normally be from 15 m to 30 m long. The second taper is a downstream taper about 30 m long which returns traffic to the right-hand half of the roadway where the closure ends. A taper length of 24 m is often used for both tapers since it equals two broken centerline segments and is a convenient field measurement. A buffer space should be provided between the end of the downstream taper and the stopped traffic in the

MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES

Exhibit 16-9 Component Parts of a Highway Work Zone



## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

opposing direction to ensure that all diverted vehicles completely return to their original lane before reaching the opposing stopped vehicles.

6. Downstream Taper.

A downstream taper may be used at the end of a closed lane to give drivers a visual cue that work operations end and normal travel conditions resume. Downstream tapers should be about 30 m long for each lane they cover.

### Exhibit 16-10 Taper Length Criteria

Types of Tapers	Taper Length (m)
1. Merging Taper	L minimum
2. Shifting Taper	$\frac{1}{2}$ L minimum
3. Lane-Width Taper	$\frac{1}{2}$ L minimum
4. Shoulder Taper	$\frac{1}{3}$ L minimum
5. One-Lane, Two-Way Traffic Taper	30 m maximum
6. Downstream Ending Taper	30 m minimum

Adapted from the National MUTCD Table 6C-2.

Occasionally it is necessary to close more than a single lane of pavement in order to perform the necessary work on the highway. This may be accomplished by closing several travel lanes or by shifting lanes or by a combination of both. Any of these conditions will create a need for more than a single transition. Multiple transitions shall be separated by tangent sections. For example, if the number of open lanes in one direction of a multilane highway is to be reduced by two, it will be necessary to provide two merge tapers, separated by a tangent section of desirable minimum length "2L" (where "L" is the minimum permitted taper length of the associated transitions) to give to allow traffic to stabilize before the second merge. If there is a reduction of one lane and a shift of the remaining open lanes, then one merge transition and one shift transition shall be provided. The merge transition and the shift transition should be separated by a tangent section of length "2L."

#### 16.4.3.3 Activity Area

The activity area is the section of the highway where the work activity takes place. It is comprised of the work space and traffic space, and may contain buffer spaces designed to enhance the safety of motorists and workers, as described below:

1. Traffic Space.

Traffic space defines the portion of the roadway in which traffic is routed through the activity area.

2. Work Space.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-71

The work space is that portion of the roadway which is closed to traffic and is set aside for the exclusive use of workers, equipment, and construction materials. Work spaces may be fixed or move as work progresses, such as in mobile and moving operations. Work spaces are usually delineated by channelizing devices or shielded by barriers to exclude vehicular traffic and pedestrians.

### 3. Buffer Space.

Buffer spaces should be provided to further separate traffic from the work activities or potentially hazardous areas and provide recovery spaces for errant vehicles unless precluded by site conditions. In order to effectively serve this purpose, buffer spaces must not be used for the storage of vehicles, equipment, supplies, or any other obstructions, nor for any work activity. Refer to NYSMUTCD §301.13.

### 4. Incident Management Vehicle Storage Space (optional).

The activity area may also be used to provide storage space for vehicles used for incident management on high-volume, highly congested highway facilities in an urban area. Emergency vehicles (e.g., tow trucks), which are needed to respond quickly to traffic incidents, may be stored in the activity area. Such emergency vehicle storage areas should not extend into any portion of the buffer space. The location of an incident management vehicle storage space is determined on a case-by-case basis.

### 5. Enforcement Areas

Space should be provided throughout the work zone for one or more police cars to enforce work zone speed limits and other traffic regulations. Police cars need a safe and efficient spot to park and an area to pull over motorists for ticketing. Areas for police enforcement activities should be behind traffic control. The State Police should be consulted early in design to identify their enforcement needs.

#### 16.4.3.4 Termination Area

The termination area is used to return traffic to the normal traffic path and extends from the downstream end of the activity area to the END ROAD WORK sign (G11-2), if it is posted, or to the downstream end of the downstream taper when an END ROAD WORK sign is not used. It confirms to the driver that the highway work zone has been terminated. A short downstream taper of 30 m may be placed in the termination area, or to the downstream end of the downstream buffer space in a flagger-controlled work zone. Refer to the NYSMUTCD §254.2 for guidance in the use of END ROAD WORK signs.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.4.4 Safety Considerations

Safety is considered to be the most important factor in work zone traffic control design. The Department's goal regarding traffic control on all construction and maintenance projects is to ensure that the plan is designed, implemented, and managed in a uniform, consistent manner to provide a high level of traffic safety for workers and the traveling public. This must be done in a manner which minimizes delays and inconvenience to travelers and which minimizes disruption to the community where the project is located. At the same time, the maintenance and protection of traffic (MPT) plan should permit the contractor to operate in an efficient manner to facilitate completion of the construction in a timely manner and at a reasonable cost.

#### 16.4.4.1 Safe Work Site Access

It is the Department's policy that in developing MPT plans for maintaining traffic during construction, designers shall consider whether special provisions are needed to ensure safe access to work sites by workers, vehicles, and equipment. The crossing of roadways by workers, vehicles, and equipment shall not be permitted unless specific provisions are in place to do so safely. Safe work-site access is a constructibility issue which should be considered by Department reviewers during the regular plan review process as well as during constructibility reviews.

It is the contractor's responsibility to provide safe access to the work site by workers and inspection staff and safe parking for their vehicles, such that no active traffic lanes are routinely crossed by pedestrian workers or inspection staff reporting to and leaving the work site. Refer to the *Standard Specifications* §107-05 G.

Experience indicates that substantial risks can be associated with gaining access to work sites for workers, equipment, and supplies. In the past, a number of accidents involving work site access have resulted in serious and fatal injuries to motorists, workers, and Department employees.

To minimize these risks, it is essential for the designer to consider work site access and to include special provisions in the MPT plan when traffic and site conditions impose high risks to worker and/or public safety. The MPT plan should be reviewed by Regional Construction staff to ensure specific provisions for work site access are included when appropriate.

The guidelines in this section are intended to help designers identify potentially troublesome locations which may need special consideration in the MPT plan. It is not intended to suggest or imply that detailed work site access plans and provisions are expected on all projects, nor is it intended to suggest that signalized crosswalks, temporary traffic signal, pedestrian overpasses, or other extraordinary provisions are routinely necessary to provide work-site access on construction projects.

The following items should be considered when evaluating the need for access provisions in the MPT plan:

- Do speeds and volumes combine such that sufficient gaps to safely cross or enter traffic are

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-73

not available, especially on controlled-access highways and multilane arterials? Crossing risks are also increased with two-way traffic and where refuge areas are not available in multilane highways.

- Will unique site conditions make access difficult?
- Will sight distance be restricted for motorists by site conditions or by the deployment of temporary barriers, barricades, construction signs, vehicles, or equipment?
- Will workers be exposed to increased risks while walking adjacent to traffic to gain access to the work site? Risks increase when workers cannot face oncoming traffic or where the area available for workers is narrow and close to traffic, and/or where escape paths are blocked by railings, median barrier, excavations, or other site features.
- Will it be necessary for equipment and supply/delivery vehicles to maneuver into or out of work sites?
- Will nighttime construction provide the safest alternative or will it create additional risks with regard to work site access?

When the evaluation indicates that work site access is a safety concern, special provisions may be necessary to ensure that safe access is provided and used. Such provisions may include:

- Barricading or otherwise restricting unsafe access points or routes.
- Imposing contract restrictions that require workers and vehicle operators to access the work site only at designated points.
- Adding temporary walkways, crosswalks, access ramps, stairways, and other features to provide safe access points for workers, vehicles, and equipment.
- Adding temporary crosswalks, traffic signals, or flaggers to control movement of workers and vehicles into and out of work sites.
- Requiring remote parking areas for workers, with shuttle vehicles for transport to the work site.
- Setting limitations on when suppliers can drop off material (e.g., limit deliveries to off-peak hours).

When access restrictions are appropriate but it is difficult to include specific provisions in the MPT plan, special notes should be included on the plan or in the proposal. Generally, the notes should not provide specific direction to the contractor, but rather should outline the operational restrictions which apply, and/or the special requirements that must be met to properly address safe work site access on the project. The notes should also require the contractor to submit an acceptable access plan to the Engineer-In-Charge as part of the Project Safety and Health Plan.

### 16.4.4.2 Maintenance and Protection of Pedestrian and Bicycle Traffic

FHWA regulations (23 CFR 652.5) require that provision for safe accommodation of bicyclists and pedestrians be given full consideration during construction. The Department's policy (October 1996) extends the requirement to maintenance and other activities. Section 619 of the *Standard Specifications* provides for the safe passage of pedestrians and bicyclists over any portion of the highway under construction where traffic is to be maintained. In addition, regulations implementing the Americans with Disabilities Act (28 CFR Part 35) and the current *Americans with Disabilities Act*

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

*Accessibility Guidelines* (ADAAG) require that both permanent and temporary pedestrian facilities, including those associated with construction and maintenance activities, must provide safe and convenient access for persons with disabilities. The designer shall designate pedestrian and bicycle access areas on project MPT plans. It is the responsibility of both the Regional Landscape Architect and the designer to assess the needs of pedestrians and bicyclists.

Pedestrian and/or bicycle traffic must be safely and continuously maintained through, or around, work zones on highways or streets where pedestrians and/or bicyclists are not prohibited. This does not apply where pedestrians and bicyclists are prohibited. The maintenance and protection of pedestrian and bicycle traffic should be consistent with the type of work zone, the work location, the duration of work activity, anticipated bicycle and pedestrian traffic, motor vehicle traffic characteristics, and the degree of potential hazard to, or conflict between bicycle, pedestrian, and motor vehicle traffic. For example, where there is a low expectation of pedestrian and/or bicycle traffic, low motor vehicle volumes, and no or minimal disturbance is occurring in the work zone, nothing special needs to be done and pedestrians may continue to use the shoulders.

Where pedestrians and bicyclists use the shoulder or sidewalk and the work zone will disrupt it, other arrangements should be made to allow pedestrian and/or bicycle traffic to safely travel through or around the work zone, (e.g., fence, temporary concrete barrier, accessible shuttle service, off-site detour).

Designers and Transportation Maintenance Supervisors should use the following requirements and supporting guidelines when developing MPT plans for pedestrians and bicyclists. In addition, designers should be guided by the provisions regarding temporary, safe pedestrian passageways at construction sites that are included in the current version of the *Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities*. The designer should consult with the Regional Bike/Pedestrian Coordinator early in the design process to coordinate the bike/pedestrian needs for the project.

### A. Pedestrians

A.1 User Needs. The needs and abilities of a diverse pedestrian population must be considered, evaluated, and adequately accommodated through, or around, work zones. That population includes people with disabilities, children, elderly persons, etc. For example, elderly persons and/or persons with disabilities may be more sensitive to abrupt changes in level (e.g., walkway joints that are heaved or displaced greater than 13 mm vertically), surface irregularities, or walkways routed onto a roadway. Children will sometimes dart out into roadways, so where there are significant numbers of children present (such as near a school or playground), positive barrier (e.g., fence, temporary concrete barrier) may be required for walkways routed onto roadways. Vision-impaired people cannot be safely guided by signs, traffic cones, delineators, or tape. In urban areas, commercial areas, residential areas, and other areas where use by vision-impaired pedestrians can be expected, any positive separation between a pedestrian walkway routed onto a roadway and motor vehicle traffic should utilize fencing, temporary curbing (plastic, timber, etc.), or other continuous barrier or material that is

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-75

detectable by a vision-impaired person using a cane or guide dog.

**A.2 Necessities for Pedestrian Traffic.** The question of how to provide access for pedestrians through or around work zones must be assessed for each project where pedestrians are not prohibited (not all projects require the same approaches to safely allow passage). While provisions for pedestrian travel should be made, the assessment should take into account the amount of observed pedestrian activity occurring along the roadway, as well as motor vehicle and bicycle traffic volumes. It is important to remember that the apparent absence of pedestrians does not preclude the need to provide access, especially if other indicators are present. One or more of the following are indications that there is pedestrian activity at a site:

- The presence of residences.
- There is an existing sidewalk, trail, or pathway.
- There is observed pedestrian activity.
- Evidence of pedestrian activity exists, such as residences located along rural roads or worn paths along the roadway.
- There are existing or approved plans for generators of pedestrian activity in or within 800 m of the project that promote or have the potential to promote pedestrian traffic in the project areas, such as schools, parks, playgrounds, places of employment, places of worship, post offices, municipal buildings, restaurants, shopping centers, or other commercial areas or multiuse paths.

Designers may find that the public involvement process is an excellent method by which to determine potential user needs and develop possible solutions that the community will support.

**A.3 Accessibility Requirements.** If safe access and passage for pedestrians cannot be maintained continuously through the work site, a safe continuous detour must be furnished. Facilities constructed to specifically provide access for pedestrians in or around work zones must be designed to be consistent with the current ADAAG. A minimum 1.525 m wide walkway should be provided to accommodate continuous two-way pedestrian traffic and maintain convenient access. ADAAG states that where a 1.525 m width cannot be met, a narrower walkway may be provided to a minimum of 915 mm. However, when the walkway is narrower than 1.525 m, passing spaces that are at least 1.525 m long and 1.525 m wide must be provided no further than 61 m apart. Walkways narrower than 1.525 m will not accommodate continuous two-way pedestrian traffic or assisted travel by elderly and disabled persons and may be inconvenient, especially if they prevail for more than short distances. Use of an accessible shuttle service, accessible on-call taxi, or similar service may be considered on projects such as bridge replacements, where the construction of temporary, accessible walkways is infeasible or impracticable.

Where there are existing sidewalks on both sides of a road or bridge, work should be staged so that one sidewalk remains open and accessible to pedestrians (especially those with disabilities) at all times. If one sidewalk is closed, pedestrians should be directed to the other sidewalk by crosswalks, SIDEWALK CLOSED (R8-3) signs, and signals, if necessary. Pedestrians should be diverted from the closed sidewalk at the first intersection crossing

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

upstream from the work zone and not at midblock unless provisions can be made to do so safely. At especially long blocks, it may be necessary to provide midblock crossings. Where they are provided, they should include safety features such as high-visibility striping and warning signs and/or signals. The designer should consult the Regional Landscape Architect regarding the need for and the selection of the type of accessible signals. Refer to the National MUTCD Section 4E Pedestrian Control Features.

Where the work encroaches upon a sidewalk and where it is infeasible to route pedestrians across the road, alternatives may be to maintain pedestrian traffic on the sidewalk, separated from the work by fencing or other means, or to construct a temporary sidewalk or path away from the work. Still another alternative may be to designate a walkway in the roadway. Where a designated walkway must be provided in the roadway, positive separation (e.g., channelization devices) or positive barrier (e.g., temporary concrete barrier) should be used between vehicular and pedestrian traffic. In selecting positive separation or positive barrier, the designer should consider the following:

- Pedestrian needs.
- Duration of the work.
- Roadway alignment and lane widths.
- Offset from the traveled way.
- Vehicle operating speeds.
- Truck traffic.
- Volumes of pedestrians and vehicles.

ADAAG Section 4.1.6 requires that slopes of curb ramps and exterior ramps not exceed 1:12. In circumstances where space limitations prohibit the use of a 1:12 slope, a maximum slope of 1:10 is allowed for a maximum 150 mm rise. A maximum slope of 1:8 is allowed for a maximum 75 mm rise. In alteration work, if compliance with ADAAG Section 4.1.6 is technically infeasible, the alteration shall provide accessibility to the maximum extent feasible. Any elements or features of the facility that are being altered shall be made accessible within the scope of the alternation.

**A.4 Walkway Closures and Detours.** When planned construction activities will close a sidewalk, shoulder, or existing pedestrian detour for an extended period, or result in major disruption to the pedestrian facility, advance notice to pedestrians is desirable. Information signs, portable variable message signs, or other suitable means should be used to provide reasonable advance notice to pedestrians, including the expected nature and duration of construction activities.

On-site detour routes should be well marked, safe, efficient, continuous, and easy to traverse. They must be maintained free of obstructions and hazards, such as tripping hazards (i.e., lip heights at manholes, etc.), holes, debris, mud, construction equipment, stored materials, etc. Graded ramps meeting ADAAG requirements may be used at surface discontinuities where there is a need. Detours should, at a minimum, be a stable, firm, and slip-resistant, all-weather, compacted gravel surface (meeting ADAAG requirements) or other material capable of meeting

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-77

the ADAAG requirements to be continuously stable, firm, and slip-resistant.

Temporary street crossings and crossings of stop-controlled commercial, institutional, and similar entrances to adjacent properties requires the use of detectable warnings where walkways intersect the streets or entrances.

Pedestrians will often use the most direct path to their destination regardless of hazards. Signs and fencing should be used to direct pedestrians away from unsafe areas. Avoid designing pedestrian detours that are inconvenient and too circuitous. FHWA's *Planning Design and Maintenance of Pedestrian Facilities* gives 183 m as the maximum distance most pedestrians will find reasonable to detour off of their path of travel.

**A.5 Rural Work Zones.** Rural pedestrian needs should be carefully evaluated. Often these needs are not as obvious as those in more populated areas. While a rural road may not have large numbers of pedestrians, it may be the only road going to a particular destination. It should be expected that pedestrians, including permanent and seasonal residents, will use the road or the shoulder or they will walk at the edge of the travel lane if a walkable shoulder is not available. Some obvious rural sources of pedestrian activity include resorts, state parks, camp grounds, recreational areas, amusement parks, homes, etc.

On repaving contracts where the underlying or top course is to be left exposed on roads where pedestrians regularly use the shoulder, include temporary edge lines to delineate the right-hand edges of the motor vehicle lanes closest to the shoulders and create a pedestrian walkway. This should be done when other temporary markings are placed. This will help avoid inappropriate motor vehicle encroachment into shoulders that are regularly used by pedestrians, or vice versa.

Shoulders that are not designed to meet the ADAAG standards are acceptable when they are not specifically intended as places to walk. However, shoulders are almost always places where people may walk, if they so choose, except on freeways and similar roads where pedestrians are legally prohibited.

It is recognized that it may be excessively costly or impracticable to meet the needs of occasional pedestrian traffic on rural bridges under construction or on paving projects where shoulders are not available to pedestrians. However, there is, nonetheless, a need to provide for pedestrian traffic because many rural bridges provide the only link between destinations for residents and vacationers who depend on walking or bicycling for transportation. Alternatives to providing for pedestrian traffic on roadway bridges may include temporary pedestrian walkways or structures, accessible shuttle, accessible on-call taxi or van, or similar services, fall-hazard protective fencing, or other innovative solutions. Consideration could also be given to moving the trip destination or providing an alternate service on the pedestrian side of the bridge as is sometimes done with emergency services. When accessible, on-call vehicle service is requested, it must be provided. When the requested service does not require accessibility, an accessible vehicle is not required.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

A.6 Economic Impacts. In commercial and residential areas, adequate pedestrian walkways to properties abutting work zones should be provided. Efforts should be made to minimize adverse economic impacts to commercial establishments in the vicinity of the work zone. Refer to §16.3.4.2.A in this chapter and the National MUTCD Typical Applications TA-28 and TA-29.

A.7 Signs. Construction signs located over or where they will intrude into a walkway must have a 2.1 m minimum clearance height. Signs and other traffic control devices should not be a hazard to pedestrians. Signs directing pedestrians must be illuminated to Level 1 standards when used overnight.

A.8 Pedestrian Protection. Walkways under or adjacent to elevated work activities such as bridges or retaining walls may require a protective roof, protective shielding, etc. Fall-hazard protective fencing should be provided, particularly on bridge replacement projects, when the pedestrian travel path through the work zone exposes them to a fall hazard, e.g., after one-half of the existing bridge deck has been removed, before it is replaced.

A.9 Nighttime Lighting. Where there is a likelihood of pedestrians using a walkway at night, sufficient illumination (minimum Level 1 standards) should be provided based on the level of illumination that existed prior to construction, and the level of illumination on adjacent locations. Consideration should also be given to the type and severity of hazards to pedestrians and other site specific factors that may affect the accessibility, safety, security, or convenience of the walkway to determine whether they warrant nighttime illumination. All pedestrian walkways that take pedestrians off their intended path are to be lighted. Temporary lighting should be considered where adjacent street lighting will not illuminate pathways provided around work zones. Lights should be provided to delineate the pathway and to mark hazards. This lighting can be especially beneficial for vision-impaired persons where existing lighting levels are not optimal.

### B. Bicyclists

B.1 Level of Accommodation. Bicyclists of various skill levels use most roadways to various extents where bicycling is not prohibited. Therefore, the question of what is necessary to provide access for bicyclists through or around work zones must be carefully assessed for each project where bicyclists are not prohibited. This assessment should take into account the amount and types of bicycle activity occurring along the roadway, as well as motor vehicle and pedestrian traffic characteristics. A project may require one or more different methods to provide proper appropriate access based on these assessments. One or more of the following are indications that there is bicycle activity at a site:

- The road is a designated bicycle route.
- Bicyclists have been observed on site visits.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-79

- Bicycle traffic generators, such as residential, commercial, recreational, and/or institutional land uses, are located adjacent to or near the work zone.
- The roadway is in a recreational area such as the Adirondacks, the Catskills, the Finger Lakes, etc.

Bicyclists can often be travel in the same vehicle lane as motorists when one or more of the following conditions occur:

- The work zone lane width will be at least 3.6 m. (Lanes should be at least 4.2 m wide adjacent to concrete barriers, guide rail, vertical retaining walls, or abutments.)
- Motor vehicle speeds and volumes are low. This decision will require engineering judgement as there are no nationally adopted guidelines for these situations. However, examples include locations where operating speeds are 45 km/h or less and volumes do not exceed 500 to 1000 AADT and where truck, bus, and RV volumes do not exceed approximately 30 per hour.
- The roadway will be paved.
- The grades in the work zone are not steep (<5.0%). Where grades are steep ( $\geq 5.0\%$ ), consideration may be given to providing a shoulder in the uphill direction of travel. Bicyclists traveling downhill can frequently be accommodated in vehicle travel lanes.
- There is no parking on the side of the roadway.

Where it is not desirable to combine bicycle and motor vehicle traffic due to higher motor vehicle speeds and volumes, bicyclists can be accommodated on shoulder space. In this situation, a shoulder of reasonable width (min. 1.2 m) should be provided. In some cases, bicyclists may be advised, through the use of signing, to use pedestrian facilities. See B.3 below.

**B.2 Bicycle Traffic Closures and Detours.** An alternative to providing for bicycles where there is insufficient roadway width may be to provide a separate bicycle detour around the construction site. The detour should be convenient and have appropriate warning signs and traffic control devices, especially when routing an off-road bicycle detour back into the main roadway.

Off-road bicycle detours should be paved continuously and free of surface irregularities such as potholes, cracks, ponded water, etc. On-road provisions should be paved whenever feasible (especially on bike routes). Where this cannot be accomplished, and there is considerable risk of injury, bicyclists may be advised, through the use of signing, to dismount and use pedestrian facilities. This should not be used where bicyclists would be required to spend considerable time on foot because it may be viewed as unreasonable and ignored.

**B.3 Use of Pedestrian Routes.** Bicyclists may be advised, through the use of signing, to dismount and use pedestrian routes only where sufficient roadway widths cannot be provided or where roadway construction conditions may make bicycling hazardous and an off-road alternative for bicyclists cannot be provided. As previously stated, this alternative should only

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

be used in extreme circumstances and should not be used for long distances, as it may be viewed as unreasonable and ignored.

**B.4 Rural Work Zones.** Providing for bicyclists in or around rural work zones should be considered, even when there is not an obvious need. While there may not be large numbers of bicyclists, the road may be the only route to a particular destination in the area.

**B.5 Precautions.** The skill level of the bicyclists using the roadway should be considered. If the work zone is near a school, playground, or other area where the predominance of riders is likely to be children, extra precaution should be taken to provide for them safely. For example, off-road provisions are usually preferable, use of shared lanes (as discussed in 16.4.4.2.B.1) should be avoided, and shoulders should be wider than 1.2 m where motor vehicle operating speeds exceed 65 km/h.

**B.6 Fall-Hazard Protection.** Fall-hazard protective fencing should be provided, particularly on bridge replacement projects, when the bicycle travel path through the work zone exposes them to a fall hazard, e.g., after one-half of the existing bridge deck has been removed, before it is replaced. Keep in mind that bicyclists tend to have a higher center of gravity than do pedestrians.

**B.7 Signs.** Appropriate signs should be used to warn bicyclists and motorists. The bicycle warning sign with SHARED ROADWAY (W5-6) panel may be used either where bicycle and motor vehicle traffic are intended to share a reduced roadway width (due to shoulder closure and/or lane width reduction (less than 3.6 m in width)) or where bicyclists are diverted into the roadway from a pathway off the road. The sign assembly can be used when changes in routing bicycle or motor vehicle traffic through or around the work zone affects the proximity of bicyclists to motor vehicle traffic. These signs should not be used routinely where the above conditions do not exist since unnecessary use can reduce their effectiveness.

**B.8 Pavement Markings.** On repaving contracts where the binder course is to be left exposed on roads designated as a Shared Roadway, Signed Shared Roadway, Bike Lane or Bicycle Lane, and on other roadways where bicycle volumes are greater than 50 AADT and motor vehicle volumes are greater than 500 AADT, temporary pavement markings should include edge lines to delineate the right (outside) edge of the motor vehicle travel lane as well as the center line or lane line. This should be done when other temporary markings are placed. This will help prevent motor vehicle encroachment into bicyclists' paths of travel, or vice versa. A special note should be placed in the contract documents that states that the edge line markings must be placed the same day the new pavement is opened for traffic, i.e., the same as for other temporary pavement markings. Where bicycle traffic must be routed onto a dedicated pedestrian walkway, bicycle riders must dismount and walk their bicycles through the walkway.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-81

### 16.4.4.3 Oversize Vehicles

Oversize vehicles exceed the dimensional and weight limitations as set forth in Section 385 of the NYS Vehicle and Traffic Law. Oversize vehicles can become trapped or stuck in a constrained work zone and must be considered during design. While some traffic control devices or equipment can be moved to allow passage of an oversize vehicle in an emergency, when oversize loads enter a work zone without warning, serious problems can result. Designers should consult the Regional Permit Engineer (RPE) to determine if the project is on a highway designated for 16-ft wide loads. Short-term disruptions in the flow of 16-ft wide loads can be tolerated but longer-term disruptions will severely impact the hauling industry and must be avoided.

#### A. Permitted Vehicles

Operators of oversize vehicles must obtain Special Hauling Permits, which allow their vehicles to travel on State highways only during regular business days from one-half hour before sunrise to one-half hour after sunset. Specific routing, special restrictions may be prescribed by the RPE. When they are written, typed, or stamped on the permit, they become enforceable by any police.

Any loads/vehicles wider than 8.5 ft require a Special Hauling Permit. Permits are approved by either the RPE or the Main Office Permit Unit. A high level of coordination is maintained between the RPE and the Main Office Permit Unit to ensure that all construction restrictions are accurately posted and maintained on the State internet site. Annual Radius and Blanket Permits are issued to some carriers that regularly haul loads between 8.5 ft and 12 ft wide. These permits allow the carrier to haul anywhere on the State system for an entire year. Trip Permits are required for anyone hauling a load between 8.5 ft and 12 ft who does not otherwise have an Annual Permit and for all loads wider than 12 ft. A typical modular home is 14 ft to 16 ft wide.

Haulers operating under a Trip Permit have to obtain a permit approved and issued by an RPE or the Main Office Permit Unit every time they want to haul their load. At that time, the permit issuer can (if properly notified of work zone restrictions) ensure that the load is routed around a work zone which cannot accommodate the oversize load. Under an annual Trip Permit, haulers do not need to consult with the permit staff for each trip, and they may be unaware of temporary restrictions placed after the annual permit is issued. There are tens of thousands of annually permitted loads and it is not uncommon for an annually permitted load, or a load that is running illegally without a permit, to enter a work zone resulting in possible worker injury or death, property damage, and extensive delays to traffic and construction work.

On roadways with two or more lanes open to traffic, either one-way or two-way, occasional wide loads can generally be accommodated, regardless of temporary lane widths in place. (Other vehicles will stagger or get out of the way.) Single-lane sections are the primary concern, especially when barrier or other immovable constraints are present. However, on high-volume highways or where oversize loads are more frequent, wide loads may cause a great deal of disruption and designers may want to prohibit them, even if they could make it through

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

physically. Consult with the RPE and the Regional Traffic Engineering and Safety Group to determine the anticipated frequency of wide loads and whether they should be prohibited.

All roadway or bridge widths less than 14 ft should have signing to direct all the annual permit haulers exceeding the available width off the highway. While annual permit haulers are responsible for verifying the adequacy of the route before each trip, the consequences of an oversize vehicle becoming stuck in the work zone or trapped on an approach, warrants signing to remind the haulers of their responsibility. The available roadway width shall not be less than the vehicle width plus one foot of clearance on each side. A 12-ft wide load with 1-ft clearance on each side typically requires at least 14 ft of available roadway width. Consider increasing the clearance if there will be an alignment shift or other conditions which complicate the task of negotiating the work zone. Since Trip Permit haulers are provided with routing information by the permit issuer, no signing is needed to accommodate them. Typical special warning signs for a roadway width of 13 ft might read "NARROW BRIDGE/XX MILES," followed by "VEHICLES OVER/11 FT WIDE/USE EXIT XX," followed by "VEHICLES OVER/11 FT WIDE/EXIT HERE."

Consider installing signing (traditional or portable variable message signs) one month prior to the beginning of the restriction, to give annual permit operators advance notice of the upcoming restriction and remind them to find another adequate route. Signing a detour for oversize vehicles is generally not recommended because designating a formal detour would place the liability for an accident involving an oversize vehicle on the Department. If a detour is to be used, it must be thoroughly checked for adequacy for all types of oversize vehicles before being signed. If a detour is being considered, consult with the RPE and the Regional Traffic Engineering and Safety Group.

The EIC (or the Regional Construction Group) is responsible for notifying the RPE of any construction-related restrictions and their durations. The RPE then notifies the other RPEs and the Main Office Permit Unit so that they do not issue permits for loads exceeding the restriction through the work zone.

### **B. Farm Equipment**

In rural areas, designers should consider the needs to accommodate access by farm vehicles/equipment. Farm vehicles must be accommodated if the farmer needs a portion of the highway to access parts of his or her property. Farmers are not required to obtain a permit unless the vehicle/load exceeds 17 ft in width. Designers should reach out to local farmers to identify their equipment width needs and to ensure that the project allows access to all portions of their property.

### **C. Snow Removal**

Any roadway with restricted width that might be in place during winter months needs to be wide enough to accommodate snow plows or other snow removal equipment. Consider the possibility

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-83

that jobs not expected to go through the winter might end up doing so due to delayed letting dates, field problems, etc. For projects which might have wintertime width restrictions, consult the Regional Transportation Maintenance Group for guidance on the minimum width needed for snow and ice control.

### 16.4.4.4 Other Considerations

#### A. Motorcycles

Motorcycles require special consideration when designing the highway work zone. Motorcycle advocates have expressed concern that the surface texture of milled pavements can adversely affect the handling of motorcycles and the ROUGH ROAD (W4-4) sign does not adequately warn motorcyclists of approaching conditions. The NYSMUTCD was revised to allow the use of GROOVED PAVEMENT (W4-5) signs for temporary grooves such as might occur in construction zones.

To warn motorcyclists of the presence of milled pavement, the contract documents should show GROOVED PAVEMENT signs on each approach (including side streets) to locations of milled pavement. Designers should consider using a variable-message sign (VMS) on high-speed, mainline approaches to the milled pavement. An appropriate two-part message would be GROOVED PAVEMENT AHEAD/MCYCLES USE CAUTION. VMSs and messages deemed appropriate must be shown in the contract documents and paid for under their own item.

When both the BUMP (W4-1) and GROOVED PAVEMENT signs are used, strict conformance to the advance posting distances in the NYSMUTCD results in the signs being placed too close together. The *Standard Specifications* directs contractors to install the GROOVED PAVEMENT sign in nonurban areas 150 m (100 m in urban areas) upstream of the BUMP sign so that the signs are adequately spaced. Designers should consider the possibility that a BUMP sign will be needed when specifying advance posting of the GROOVED PAVEMENT sign. Since BUMP signs are usually 60 m in advance of the rebate, GROOVED PAVEMENT signs in nonurban areas should be located 210 m (160 m in urban areas) in advance of the rebate to maintain adequate spacing.

On multilane highways where only one lane in a direction is milled and both lanes are open to traffic, supplement the GROOVED PAVEMENT sign with the appropriate LEFT LANE or RIGHT LANE panel below the sign. While the NYSMUTCD allows repeated use of GROOVED PAVEMENT signs with W9-2 auxiliary mileage panels, the presence of other work zone traffic control devices reminds motorcyclists of the continuing milled pavement, and repetition is not recommended unless warranted by project-specific conditions.

Where only a ramp is milled, sign the mainline with a GROOVED PAVEMENT sign and a supplemental RAMP panel.

Milled, longitudinal or transverse vertical faces exceeding 25 mm in height that will be exposed

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

to traffic during nonwork hours shall be sloped or tapered by temporary patches or shims to avoid creating a traffic hazard. Where vertical transverse faces cannot be adequately sloped or tapered, BUMP signs shall be installed in advance of milling rebates in accordance with the NYSMUTCD. An object marker (W7-10) shall be installed on the right side of the roadway at the rebate. On divided highways, an object marker shall be installed on both sides of the roadway. A drum with a Type B, flashing warning light may be used instead of an object marker.

Any change in condition of the pavement surface should be communicated to motorcyclists by signs, far enough in advance of the change to give the operator time to make the necessary adjustments. Extra precaution should be taken to ensure that no construction materials, steel plates, or debris reaches the traffic lanes, especially at night, because the reactions of motorcyclists to objects on the road tend to produce a more severe corrective maneuver, irrespective of the nature of the object.

Speeds prescribed in work zones should be low enough so that the motorcyclist is not exposed to increased risks due to sudden braking.

### B. Older Drivers

Crash analyses consistently show that more crashes occur on highway segments containing construction zones than on the same highway segments before the zones were implemented. Among the most frequently listed contributing factors were driver attention errors and failure to yield the right of way. A well-designed MPT plan will help reduce these\

The following design considerations should be given to all MPT plans to help reduce the number of vehicle crashes in work zones.

- Limit the number of choices which must be made by drivers at a given location. Preferably, limit the choices to only one at a time.
- Establish traffic controls which are simple and consistent.
- Increase the conspicuity of construction signs by using larger than minimum sign dimensions, by using brighter retroreflective sheeting materials, and by illuminating traffic control devices at night.
- Repeat signs and sign messages, and install signs on both sides of the highway (one-way roadways only).
- Assure the visibility of signs by installing them in conspicuous locations, and where they are not obscured by vegetation, competing signs, or background clutter.
- Maintain full-width travel lanes (3.6 m) and avoid lateral constrictions, if possible.
- Clearly identify pedestrian crossings with large, conspicuous signs, and make the crossings highly visible for pedestrians and motorists.

Recommendations that may enhance the performance of diminished-capacity drivers as they approach and travel through construction work zones are keyed to five specific design elements:

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-85

- Lane closure/lane transition practices.
- Portable variable message signing practices.
- Channelization practices (path guidance).
- Delineation of crossovers/alternate travel paths.
- Temporary pavement markings.

The standards in the NYSMUTCD, the requirements in the *Standard Specifications* and Standard Sheets, and the guidelines in this manual pertaining to these design elements are in general conformance to FHWA's recommendations and guidelines.

### C. Incidents

Incidents that occur within highway work zones can effectively reduce the flow of traffic and potentially stop the work activities for an extended period of time. Failure to plan for emergency situations will cause unnecessary inconvenience and frustration to motorists, increase the cost of incidents, and result in poor perception of the contractor and Department. Refer to Chapter 24 in this manual for more information on incident management.

### D. Class A Containment Systems

Class A Containment Systems contain spent abrasive and paint waste debris from bridge painting projects. The design of a Class A containment system may significantly impact the traffic control requirements. It is important to provide as many details as possible should the contractor\ chose to develop an alternative traffic control scheme. These details should include typical lane closure and signing layouts, limitations on when the roadway may be occupied, clearances, special features such as shadow/barrier vehicles, hours of work, and other considerations.

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

### **16.4.5 Sequence of Construction**

Staged construction denotes the construction of a facility by phases in a sequential manner. Staging plans establish what, where, and when construction activities will be performed and where traffic will go during these activities. Staged construction is widely used, generally when a detour route is not available or feasible. Several stages may be necessary to complete the project.

MPT staging plans should be utilized when the work must be done in accordance with a certain sequence of construction. Notes related to the various construction stages should be included on these plans. Each phase of construction should be thoroughly described in the sequence in which they are to be performed.

An MPT plan is necessary to ensure that the flow of traffic can be maintained while building the project without undue difficulty and with a minimum number of orders-on-contract. Developing a sequence of construction and maintenance and protection of traffic plan is an essential part of the overall project design and may affect the design of the facility itself. Design of the proposed improvements should be coordinated with the maintenance and protection of traffic plan. There may be acceptable design alternatives which will improve tie-ins to existing pavement and facilitate significantly smoother traffic flow.

Except for the most simple projects, a recommended sequence of construction should be provided. Delays and redesign during construction are often extremely costly, may cause an unsafe situation, and can unnecessarily disrupt traffic patterns. To the extent possible, the plan should have flexibility. Each project presents unique challenges and developing a sequence of construction offers opportunities to address these concerns at an early stage.

In the case of multistage construction projects involving several traffic pattern shifts, significant detail is involved. Detailed control plans defining the staging needs as well as the specific traffic control devices required for each stage will be required. A key issue is to understand that it is critical that the plan meets the traffic conditions and traffic control needs of the situation.

A phasing overview plan may be appropriate to highlight the work to be done and the traffic flow patterns in each construction phase.

Throughout the design process, it is important to keep the "big picture" in mind and solicit input from the appropriate Regional functional units and experienced individuals. Before beginning to prepare a sequence-of-construction plan, the designer should walk or drive the project to become familiar with the site and critical construction areas, take notes, make sketches, and video tape and take photographs to assist in communicating issues to be considered.

Another means by which to familiarize oneself with the site is to view the Department's photolog files. The photolog is a series of sequential photographs, taken from a moving vehicle at driver's eye level. While not as informative as a site visit, the photolog shows such items as the number of lanes, surface type, pavement markings, structures, signing, and hazards in true perspective and in their relative positions. Each Region has complete library of photologs for the routes within their Region.

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

16-87

A draft sequence-of-construction plan should be prepared by thinking through each step as it relates to the other steps. Well-prepared sequence-of-construction plans from other projects should be reviewed to learn about the various issues involved. Brain storming alternative construction sequences may lead to the most practical method. It may be helpful to color-code each phase of construction and prepare a written narrative of each phase.

The work to be performed during each stage of construction and work completed while construction is being performed during subsequent stages should be identified by symbols on the MPT plans. When temporary temporary pavement areas are required, a typical section should be provided.

The designer is responsible for determining the need for lane closures, shoulder closures, sidewalk closures, full road or bridge closures, and detours during construction. The designer should also determine if it will be necessary to shift traffic lanes away from the normal position during construction and determine required easements. If closing or shifting lanes is necessary, a sequence of construction should be prepared.

If detours, right of way, or easements are required for the maintenance of traffic, the sequence of construction should be completed in sufficient detail for the right of way requirements to be incorporated into the plans used for the public meeting.

Items to address in preparing the sequence of construction should include, where appropriate:

- The sequences of construction of adjoining projects should be coordinated. There may be occasions where a portion of one project would be more efficiently constructed at a designated stage of construction sequence of another project.
- Bridge construction should be addressed in sequence of construction. The coordination of the bridge construction with the roadway portion should be evaluated. Detours may be necessary during periods of bridge construction.
- Sequences of construction should be designed to prevent worker activity left and right of traffic at the same time. This situation makes the driver feel restricted, slows traffic, and endangers workers.
- Similarly, sequences of construction should be designed to avoid having work in the middle with traffic on both sides. This makes access difficult and there is no safe escape route for workers.
- Replacement of existing drainage may require a temporary diversion ditch or pipe. Jacking versus open cut for pipe causes less interruption to traffic but is normally a considerably more expensive method of pipe installation. Proposed pipes under roadways with high traffic volumes or difficult detours options are candidates for jacking.
- New construction and extensions of box culverts require considerable construction time. Urban projects should use precast concrete items as much as is practical, since urban improvements are generally adjacent to and performed under traffic.
- Environmental concerns include avoiding wetlands and stabilizing disturbed slopes at the earliest appropriate stage of construction.
- Excavation and earthwork must match maintenance of traffic and sequence of construction plans. Consider borrow material versus surplus material at each stage of the sequence. Address locations where surplus material may be placed. Areas of graded slopes may be

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

appropriate locations to waste surplus material. Consider areas of major cut or fill to anticipate slope tie-in difficulties. It is essential that the project sequence of construction be taken into consideration to avoid specifying use of material which is not available in the appropriate phase of construction. On complex projects, it may be necessary for the designer to develop rough grading diagrams and summaries for each phase of work to accurately determine the grading effort required.

- Where practical, the top layer of a hot mix asphalt concrete pavement should be paved as a single stage of construction for the full width of the traveled way, shoulder, and auxiliary lanes to improve the riding quality of the finished pavement. Therefore, the development of the MPT staging plans for projects involving paving operations should specify a construction sequence in which work progresses up to the bottom of the final pavement course. The final pavement course should be shown as the final paving stage.
- Staging should provide for a minimum exposure to drop-offs and uneven pavement adjacent to and between travel lanes during all phases of paving.
- Staging should minimize the time between removal of guide rail or barrier and placement of guide rail or barrier.
- The delivery and unloading of materials and equipment should be planned so as to minimize the impact on traffic movement, as much as practical.
- Nighttime construction may greatly reduce the disruption of traffic flow resulting from stoppages. Certain construction activities, such as the placement of bridge girders or overhead sign structure might be better accomplished at night. However, additional safety precautions may be necessary when accomplishing these activities.
- Pavement or structure demolition sequence should be considered.
- The effects of railroad crossings or construction adjacent to rail lines should be considered. Avoid situations where traffic could queue across railroad tracks.
- Time of day, holidays, or other day and time restrictions may be necessary stating when construction or traffic flow restraints are not allowed. Several Regional offices have lists of highways where daytime single or multiple lane closures are not permitted. Notes may be necessary stating specific dates/times. Local ordinances such as noise may restrict when work can be performed.
- Existing utilities should be addressed in the sequence of construction as to when and by whom they will be relocated. Completion of a portion of the road construction may be necessary prior to installing or relocating utilities. If temporary widening is necessary for stage construction, the temporary pavement section must fit within the right of way and/or existing utilities. Consider and develop, in consultation with the Regional Construction Group, contingency plans for scenarios where delayed utility pole relocation could adversely impact roadside safety or sidewalk construction.
- Notes in the traffic control plans should clearly spell out the limitations and requirements of the project so that if the contractor chooses to develop a different traffic control scheme, the essentials are specified.

The above list is not all-inclusive and there may be other items not listed therein that would be appropriate for consideration on certain projects.

#### 16.4.6 Work Zone Speed Limits

Traffic speed in highway work zones is an important factor affecting the safety of a construction project, both for the traveling public and for the construction workers and Department personnel. Appropriate work zone speed limits balance the competing needs for high speeds to maintain smooth and efficient flow through a work zone and lower speeds to enhance the ability of traffic to react to work- or traffic-related disruptions in traffic flow.

##### 16.4.6.1 Determination of the Need for Speed Reduction

Reduced speed limits may be appropriate in some situations. However, sound engineering judgment must be applied in examining alternate solutions, such as improved warning signs and positive guidance, as well as determining if any advisory speeds are actually correct for the situation. It is important to understand that overuse of speed limits, especially speed limits that are artificially/unrealistically low, will have little affect in reducing speed at that site. Worse, it will create driver disrespect for work zone speed limits in general, and will thus adversely affect speeds at other sites where speed limits are posted realistically. The designer must request the Regional Traffic Engineer's concurrence with the reduction of work zone speed limits. For further guidance in the use of advisory signing in work zones, refer to the NYSMUTCD §239.1.

Several situations may contribute to speed-related problems in a work zone, including:

1. Motorists are exceeding the posted speed limit on the work zone approach and fail to slow sufficiently upon entering the work zone.
2. The posted speed limit on the approach is higher than the normally posted speed limit in the work area, such as the approach to a residential area, and traffic fails to slow sufficiently.
3. Physical and operational restrictions in the work zone require travel speeds lower than those in effect prior to the start of construction.

In the first two situations, the problem is lack of compliance with existing limits. Reducing work zone speed limits is not a viable solution for motorists who are already exceeding approach speed limits and fail to slow to the speed limit when entering the work area. Enforcement of the approach speed limit should be utilized to resolve such problems, rather than creating additional disrespect for speed limits by posting unrealistically low speed limits in the work area. In the third situation, the existing speed limits in the work zone are too high and may need to be reduced.

Design, maintenance, and construction personnel must determine which, if any, of these situations applies on a particular project. The Design Approval Document for the project may contain speed studies and/or estimates of the normal operating speed (the 85th percentile speed) on the approaches and in the work zone. If not, operating speeds must be established based on field observations and with the assistance of Regional Traffic personnel.

To the maximum extent possible, work zone traffic controls should be based on project-specific traffic engineering considerations and actual work zone parameters. As a general rule, reduced

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

speed limits established by any of the three methods described in §16.4.7.2 should be utilized only when it is essential to ensure the safety of motorists traveling through the work zone as well as that of contractor and Department employees at the work site.

The decision to include a reduced speed limit should normally be made during design and included in the traffic control plan. However, at times it may not become apparent that a speed limit reduction is needed until construction is underway. In such cases, Regional Construction personnel are responsible for initiating the establishment of a speed limit and for ensuring that there are adequate areas for police enforcement operations. The following general guidelines apply to both the design and construction phases of a project.

This section provides guidance for establishing and selecting appropriate work zone speed limits and is not intended to dictate rigid policy. Each Region should have a management plan for Region-wide implementation of reduced speed limits. See MAP 7.12-14.

The following general guidelines apply to both the design and construction phases of a project.

In very rare cases, it may be necessary to establish multiple speed zones on an individual project. In those cases, it is essential to ensure that the speed zones reflect consistently different conditions, and that no zone is less than 400 m in length.

Actual project conditions that would justify implementation of a reduced speed limit are numerous and highly variable. Speed limit reduction strategies are mandated for certain conditions, and optional for others, based on a careful engineering analysis of traffic volumes, driving habits, and other project-specific criteria. Conditions which, depending on traffic volumes and other actual project conditions, may indicate the need for a reduced speed limit, include the following:

1. Construction vehicles or equipment entering or crossing the travel lanes on a frequent basis in a manner that may interrupt traffic flow and require stopping and slowing.
2. Alternate one-way traffic controlled by flagger(s) or signal(s). Consider reducing the speed limit on high-speed highways where visibility of the flagger or signal is limited.
3. Closure of one or more travel lanes resulting in restricted flow in the lanes remaining open.
4. Narrowed lanes or diversion of travel lanes to a new path requiring a speed reduction for safe traversal of the lanes or diversion.
5. Sight distance restrictions such that adequate stopping sight distance is not available for travel at the normally posted speed limit because of physical restrictions or unexpected interruptions caused by the construction activity. Any situation where restrictions imposed by the construction activity make it impossible for a normally alert and prudent driver to safely traverse the work zone at the normally posted speed limit, but where advisory speeds alone are not able to achieve reasonable compliance.

The following conditions require reduced speed limits and speed reduction strategies:

1. Workers or equipment in open travel lanes, or in closed lanes, shoulders, or medians immediately adjacent to the open travel lanes and unprotected by rigid barrier. On limited access highways with speed limits equal to or greater than 55 mph, dedicated police

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

16-91

enforcement shall be provided and portable variable message signs with radar detection and speed display capability are to be specified for intermittent use.

2. Night construction involving temporary lane closure on multilane highways with speed limits equal to or greater than 55 mph shall have 10-mph minimum speed limit reductions. Dedicated police enforcement shall be provided.
3. The speed limit for two-lane, two-way traffic on a normally divided highway with a 65-mph speed limit shall be reduced to 55 mph due to the proximity of either temporary concrete barrier or opposing traffic.
4. Any of the five conditions in the previous paragraph on a highway with a 65-mph speed limit.

Regardless of whether the reduced speed limit is required or warranted based on consideration of project-specific conditions, the original speed limit should be restored when the condition(s) are not present. Leaving the reduced speed limit in effect when not needed will encourage motorists to ignore it when it is needed. Notes should be included in the MPT plans specifying when the reduced speed limit is active and when the original speed limit is to be restored.

### 16.4.6.2 Determination of the Need for Speed Reduction

The decision whether to use reduced speed limits in work zones and when they are to be active should be made during detailed design in consultation with the Regional Traffic and Safety Group. The use of police enforcement should also be considered as well as provision of adequate enforcement areas for police officers. The MPT plan should show the speed limit signing, enforcement areas, and include any notes pertaining to activating or deactivating the reduced speed limit when not needed.

Before attempting to slow traffic at a work zone, it should be recognized that speed reductions can have adverse effects. Speed limits which are perceived by motorists as unwarranted, reduce the credibility of and overall compliance with all speed limits. In particular, speed reduction measures can reduce roadway capacity and cause localized congestion if traffic volumes are moderate to heavy. The congestion, in turn, can increase the potential for rear-end accidents. They may also increase the speed differential between those who choose to observe the reduction and those who do not. Speed differentials can also lead to crashes.

### 16.4.6.3 Methods for Establishing Work Zone Speed Limits

One of the few effective methods available for slowing motorists down as they enter a work zone is strict enforcement of posted speed limits by police agencies. To permit enforcement of speed limits in construction work zones, it is necessary to ensure that speed limits are legally established and posted. Traffic control devices may be placed only pursuant to traffic control powers granted, by law, to state and local authorities. Regulatory devices that require a Notice of Order include speed regulations such as maximum and minimum speed signs, intersection control such as traffic signals, stop signs or yield signs, parking regulations, turn and one-way regulations, vehicle size and weight exclusions, highways designated for use by trucks, tandem trailers, and other special

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

dimension vehicles.

When a permanent regulatory device is installed on a highway under a construction contract or for maintenance operations, the Department traffic engineering staff files a Notice of Order (Form TE 3e) with the Department of State. The Notice of Order includes the location of each regulatory device and, in order to be enforceable, these device locations are published in the New York Code of Rules and Regulations (NYCRR) Title 15. Currently, two methods are available to establish reduced speed limits for construction work zones. These methods, and the posting requirements for each, are presented in the following paragraphs.

A. Method 1 (This method is intended primarily for capital construction projects designated as restricted highways.)

With respect to any restricted highway, as defined in Section 104-a of the Highway Law, the Department of Transportation may prohibit, restrict, or regulate traffic on, or pedestrian use of any such highway. Any temporary regulatory changes made during work zone traffic control must also be filed with the Department of State in order to be enforceable. In lieu of preparing and filing several orders to change each regulatory device required during the life of a construction contract, a "Notice of Restricted Highway" is filed that includes the physical limits of the project. The text of these notices is published biweekly in 17NYCRR Part 155 Traffic Regulations on Restricted Highways. For information on the filing process, refer to §104-05 of the Contract Administration Manual.

The provisions of the NYS Vehicle and Traffic Law with respect to registration shall not apply to vehicles and equipment engaged in work on such restricted highways.

When used on such restricted highways, all traffic control devices shall be considered as official traffic control devices and shall conform to the NYSMUTCD.

If any traffic regulations or restrictions that the Department has the power to impose under Section 1625 of the Vehicle and Traffic Law would be different from the traffic regulations in effect at the time of commencement of the construction or reconstruction contract and are considered to be necessary in order for the contractor to perform the work under the contract, then the highway should be designated a restricted highway. In other words, use of any regulatory device during construction that would require a Notice of Order would require that the highway be designated as a restricted highway. This would include:

- Reducing the regulatory speed limit within the work zone per the Vehicle and Traffic Law, Article 30, Section 1180 (NYSMUTCD Part 212).
- Temporarily changing the restrictions for weight or size of vehicles through the work zone by posting regulatory exclusion signs (NYSMUTCD Part 215).
- Use or modification of right of way signs (NYSMUTCD Part 211), intersection movement signs (NYSMUTCD Part 213), roadway use signs (NYSMUTCD Part 214), parking signs (NYSMUTCD Part 221), and work zone regulatory signs (NYSMUTCD Part 218).
- The removal or installation of traffic signals or the use of temporary traffic signals.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-93

- Modifying the existing pavement marking patterns in work zones during construction. In accordance with §104-08 of the *Standard Specifications* MAINTAINING TRAFFIC, the designer shall indicate in the contract documents which sections of the highway will not be designated as a restricted highway. Most major construction contracts will be restricted due to the complexity and duration of the traffic control plans and no special notes will be required. When the contract does not warrant an official filing of the Restricted Highway Notice, the designer should include a Special Note in the proposal or on the traffic control plans that says:

“RESTRICTED HIGHWAY USE - In accordance with §104-08 of the *Standard Specifications*, highways where work is to be performed under this contract will not be designated restricted highways.”

If a contract includes work at multiple sites and only one or two sites require a restricted highway designation, the following note can be used:

“RESTRICTED HIGHWAY USE - In accordance with §104-08 of the *Standard Specifications*, highways where work is to be performed under this contract will not be designated restricted highways except for the following location:

State Route X between A Road and B Road.”

If there is any uncertainty whether to officially designate the highway as restricted, the Regional Traffic Engineer should be consulted for additional guidance regarding traffic regulations. If the potential exists for the use of regulatory devices during construction, it is better to restrict the highway. However, keep in mind that this may result in the unnecessary filing and printing of official codes and the associated administrative work involved. Overweight vehicles traveling outside the limits of the restricted highway, hauling material to or from the project, can be ticketed by the police. It may be necessary to establish the contract limits so as to keep the hauling limits within a restricted highway.

B. Method 2 (This method is intended primarily for maintenance operations not designated as restricted highways.)

Projects which involve minimum and short-term interference with existing traffic regulations need not be designated as restricted highways. This would include highways where work involves the use of moveable work zone signs and flagpersons for work off the roadway. Examples of work zone traffic control plans that would not require a designation of restricted highway include those shown in NYSMUTCD Figures 302-3, 302-6 (with short-duration use of Section 213.5 Regulatory Signs), 302-7, 302-8A, 302-9, 302-11 through 302-16, 302-18 and 302-19. Contracts that typically follow the layouts in these traffic control plans include pavement marking contracts, landscape contracts, maintenance mowing contracts, guide rail installation or repair contracts, single-course overlays, and joint or crack sealing.

Section 1180(f) of the New York State Vehicle and Traffic Law provides the agency having jurisdiction over an affected street or highway with the authority to establish a reduced speed

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

limit in construction or maintenance work zones. Work zone speed limits established under this procedure can be no lower than 20 mph below the normally posted speed limits, and cannot, in any case, be lower than 25 mph. Method 2 can be used when the highway is not designated as a restricted highway.

### 16.4.6.4 Guidelines for Selecting the Appropriate Speed Limit

After it has been determined that reduced speeds are desirable and practical, a safe and reasonable speed should be selected. A speed control strategy should be adopted which will reduce speed to what is safe and reasonable for the conditions. The selected speed should not be unreasonably low.

Regulatory speed limits provide a sound enforcement basis for citing those who drive at imprudent speeds.

Advisory speed signs as described in Section 239.1 of the NYSMUTCD are intended to alert motorists to the recommended maximum speed considered appropriate for a specific condition such as a curve, bump, or rough road where enforcement is not necessary.

Speed reductions should not exceed those given in Exhibit 16-11. Speed reductions greater than those in Exhibit 16-11 are likely to be viewed by motorists as unrealistic, resulting in poor compliance. The reductions are guidelines for the maximum that should ordinarily be considered and are not intended to suggest that speed limit reductions of this magnitude should be routinely included in Department projects. Where it is necessary to include reductions of the magnitudes given in Exhibit 16-11, it is important that they be based on adequate engineering study and approval at the appropriate level. If it is not possible to design the work zone to permit safe operating speeds without reductions greater than these values, other measures in addition to posting the reduced speed limit will normally be required to achieve safe traffic flow through the work zone. It is recommended that the Regional Traffic Group be consulted for assistance in those situations.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Exhibit 16-11 Maximum Speed Reductions**

Roadway Type	Maximum Speed Reduction
Freeways, expressways <65 mph =65 mph	10 mph (15 km/h) 20 mph (30 km/h)
Urban Arterials	15 mph (25 km/h)
Rural highways	15 mph (25 km/h)

One case deserving special attention is rural freeways with a posted speed limit of 65 mph. Normally, when one or more of the six conditions listed in §16.4.6.1 are present, the speed limit should be reduced to 55 mph. However, this reduced speed limit should be in effect only when the condition(s) is (are) actually present, and restored to 65 mph at other times. Reductions greater than 10 mph may be necessary for some particularly difficult situations. In those cases, it is recommended that the speed limit be reduced to 55 mph at the beginning of the work zone, with a further reduction to 50 mph or 45 mph only at the point(s) where the most difficult conditions are present. For circumstances involving median crossovers or other diversions of traffic on highways with speed limits no greater than 55 mph that are of limited length, appropriate warning signs with advisory speed signs should be provided, rather than posting lower regulatory speed limits for the short distance where they would be appropriate.

**16.4.6.5 Maintaining Speed Limit Credibility**

Effective law enforcement is recognized as one of the few tools available to gain motorist compliance with speed limits. Considering the limited law enforcement resources available for construction projects, it is completely unrealistic to assume that it will be possible to force compliance with speed limits that are perceived as unreasonable or unnecessary. Instead, speed control through highway work zones must come primarily from establishing and maintaining motorist respect for speed limits in general, and in particular for speed limits posted in those work zones. Specifically, the following requirements must be adhered to at all times:

- Reduced speed limits must be established and posted in full adherence to the engineering principles discussed in the preceding sections. Reduced work zone speed limits that are the same numerical value as the existing speed limit should not be established.
- Reduced speed limits must be posted only when the conditions necessitating the reduced speed are actually present. In addition, reduced speed limit signs must be removed as soon as the work is completed or the physical restrictions are removed. In some cases, this may mean restoring the normal speed limit during nonworking hours.
- Adequate warning signs, path delineation, and other driver guidance must be provided so drivers can perceive the need for the advisory or posted speed.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

## 16.4.6.6 Speed Reduction Signing

In order for reduced work zone speed limits to be enforceable in court, they must be laid out correctly with the required sign location and repetition. Refer to the NYSMUTCD §212.3 and §212.6 for sign location guidance. All work zone speed limits that are to be enforced shall be signed with regulatory signs and include black/orange WORK ZONE (W8-45) panels mounted above them. Existing regulatory or advisory speed limit signs that conflict with a reduced work zone speed limit must be completely covered or removed during periods when the reduced speed limit is in effect. Conversely, reduced speed limit signs should be covered or removed when they are not needed.

Speed control signing should be located upstream of the work zone location. The distance upstream should be far enough to ensure that drivers have enough time to react safely, yet not so far that motorists see or perceive no reason to reduce their speeds and thus will not do so in the absence of police.

The signing pattern for work zone speed limits on one-way highways with 65-mph speed limits has special requirements. Two likely scenarios for reducing a 65-mph speed limit within a work zone are (1) reducing from a 65-mph speed limit to a 55-mph speed limit, and (2) reducing from a 65-mph speed limit to a 45-mph speed limit with an intermediate reduction to 55 mph. Where the condition warranting the speed reduction is at or near the upstream end of the work area (including the taper), the speed reduction signing should be entirely upstream of the ½ MILE (W8-1) advance warning signing for the restriction to avoid intermixing advance warning and speed reduction signing. Where the condition requiring the 45-mph speed limit is at least 150 m downstream of the end of the taper, the speed reduction to 45 mph should be done immediately upstream of the condition. Supplemental speed limit signs may be interspersed within the warning signs, as necessary, to maintain the spacing required in the NYSMUTCD. The following guidance details signing recommendations for reducing 65-mph speed limits in work zones. All signs described below shall be installed on both sides of the roadway, and all existing speed limit signs shall be covered or removed.

The WORK ZONE (W8-45) panel shall be used with all work zone speed limit signs. The WORK ZONE panel is intended to call attention to the reduced speed limit and to advise the motorist that the reduced speed limit is due to the work zone rather than routine speed control warrants. Consequently, the WORK ZONE panel shall not be used on existing speed limit signs within a work zone. It shall not be used by itself and shall not be used in lieu of normal work zone signing.

To supplement the FINES DOUBLED FOR SPEEDING IN WORK ZONES sign, where a reduced work area speed limit is posted, the FINES DOUBLE (R2-13) panel may be installed on any maximum speed limit (R2-1) sign, SPEED ZONE AHEAD (R2-10) sign (used on 55-mph highways), or REDUCED SPEED AHEAD (R2-12) sign (used on 65-mph highways) used to post the reduced work area speed limit. The sign assembly shall include the R2 series sign with a WORK ZONE (W8-45) panel directly above it and may include the FINES DOUBLE (R2-13) mounted directly beneath it. Both the WORK ZONE and the FINES DOUBLE panels shall be completely covered or otherwise removed from view when the R2 speed limit sign is covered or removed. When using the panel, consider the need for additional posts for the assembly.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-97

Case 1: 65-mph Normal Speed Limit on a Highway Reduced to a Work Zone Speed Limit of 55 mph.

1. Install a STATE LAW FINES DOUBLED FOR SPEEDING IN WORK ZONES 300 m upstream of the first advance warning sign (usually a ROAD WORK 1 MILE (W8-1) sign).
2. Install a REDUCED SPEED AHEAD (R2-12) sign at least 150 m downstream of the ROAD WORK 1 MILE (W8-1) sign. Place a black-on-orange WORK ZONE (W8-45) panel directly above the R2-12 panel. Supplement each sign assembly with two orange 460-mm by 460-mm flags attached to the sign. Diamond-shaped, orange panels similar to object markers may be attached to the top of the sign instead of flags.
3. Install a SPEED LIMIT 55 (R2-1) sign approximately 300 m downstream from the REDUCED SPEED AHEAD (R2-12) signs. Authorization 99-3 in the NYSMUTCD eliminated the requirement for a STATE SPEED LIMIT (R2-2) sign to post a linear 55 mph speed limit. Include the WORK ZONE (W8-45) panel and the flags or diamond panels as detailed in step 2.
4. Install intermediate SPEED LIMIT 55 (R2-1) signs throughout the work zone. Place the first intermediate sign within 330 m downstream of the first R2-1 sign, with a maximum spacing of 1.6 km between subsequent intermediate signs. Install a WORK ZONE (W8-45) panel directly above each speed limit sign.
5. At the end of the work zone, install an END ROAD WORK (G11-2) sign, followed 150 m downstream by a SPEED LIMIT 65 (R2-1) sign. Do not use an END 55 MPH SPEED LIMIT (R2-11) sign because that sign is used to advise the driver to return to the statewide speed limit which is not applicable in this situation.
6. Existing speed limit sign approaching or within the work zone signing should be covered or removed.

Case 2: 65-mph Normal Speed Limit on a Highway with Stepped-Down Work Zone Speed Limits of 55 and 45 mph (see Exhibit 16-12).

1. Follow steps 1 through 4 above to reduce the speed limit to 55 mph except that the distances between the signs are reduced below NYSMUTCD recommendations, as follows, to avoid excessively long and counterproductive reduced speed zones. While it is recommended that the length of the reduced speed zone upstream of the work area be limited to 1 mile, the speed limit reduction may, if deemed appropriate, be extended further upstream, to provide NYSMUTCD-recommended spacings between signs.
  - Reduce the distance from the ROAD WORK 1 MILE (W8-1) sign to the REDUCED SPEED AHEAD (R2-12) sign from 150 m to 100 m.
  - Reduce the distance from the REDUCED SPEED AHEAD (R2-12) sign to the SPEED LIMIT 55 (R2-1) sign from 300 m to 150 m.
  - Reduce the distance from the SPEED LIMIT 55 (R2-1) sign to the first (and only) intermediate SPEED LIMIT 55 (R2-1) sign from 330 m to 150 m.
2. Upstream of the 45 mph speed zone, and 100 m downstream of the last SPEED LIMIT 55 (R2-1) sign, install a REDUCED SPEED AHEAD (R2-12) sign assembly as detailed in Case 1, step 2 above.
3. Install a SPEED LIMIT 45 (R2-1) sign approximately 150 m downstream from the REDUCED SPEED AHEAD (R2-12) signs and complete the sign assembly as detailed in

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

- Case 1, step 3 above.
4. Install intermediate SPEED LIMIT 45 (R2-1) signs throughout the work zone. Place the first intermediate sign 330 m downstream from the first SPEED LIMIT 45 (R2-1) sign, and at least 150 m downstream of the ½ MILE W8-1 warning sign. Use a maximum spacing of 1350 m between subsequent R2-1 signs. Install a W8-45 directly above each speed limit sign.
  5. If the speed limit is increased to 55 mph before the end of the work zone, install a SPEED LIMIT 55 (R2-1) sign and the proper intermediate R2-1 signs as detailed in Case 1, step 4 above.
  6. At the end of the work zone, install a END ROAD WORK (G11-2) sign followed 150 m downstream by a SPEED LIMIT 65 (R2-1) sign.
  7. Existing speed limit signs approaching or within the work zone signing should be covered or removed.

Speed control signing should not be placed in or near areas where drivers will be distracted by other signing and traffic movements such as intersections, ramps, and lane closure tapers.

**16.4.6.7 Location of FINES DOUBLED FOR SPEEDING IN WORK ZONES Signs**

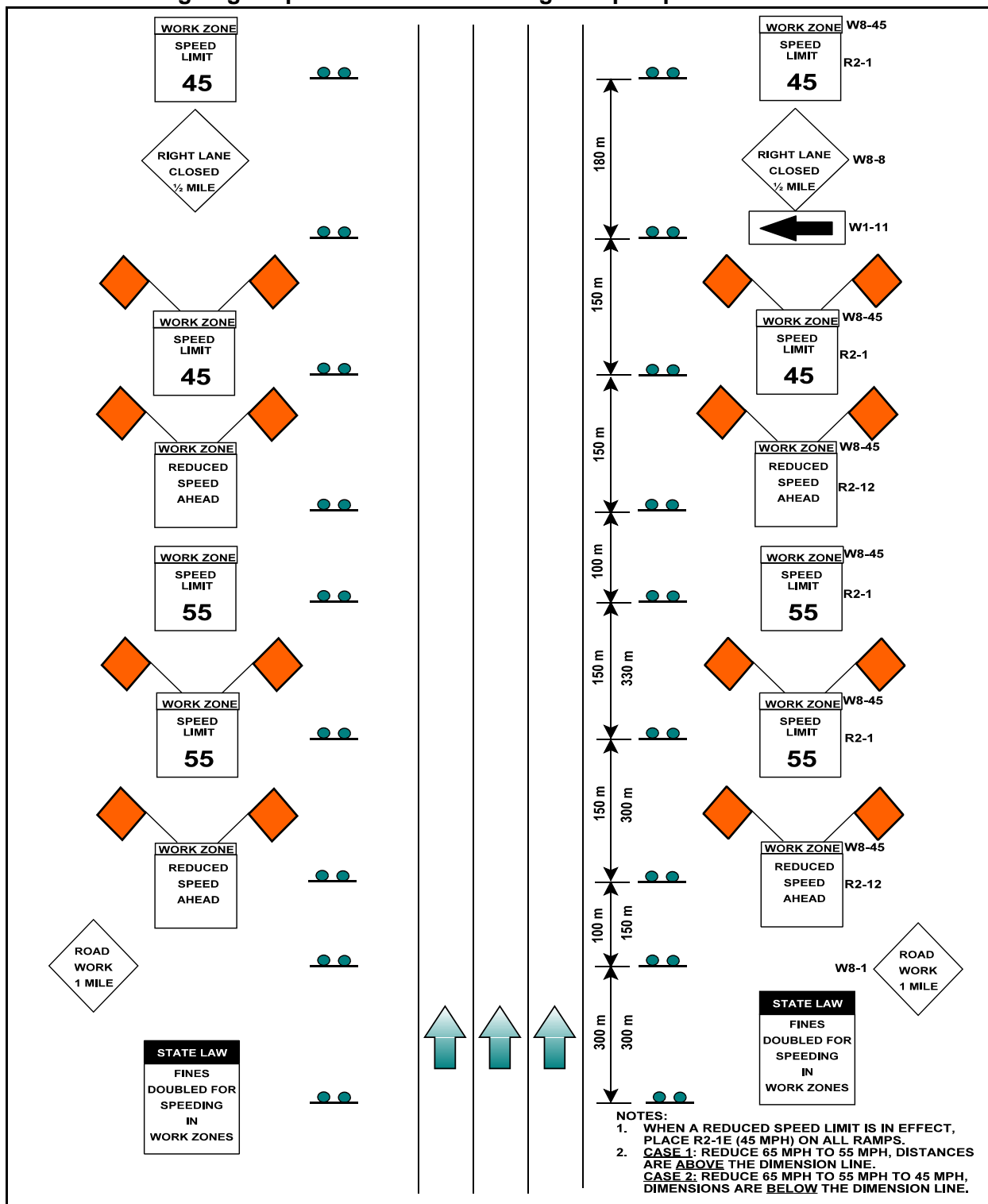
In addition to the posting requirements specific to Methods 1 and 2 in §16.4.6.6, signing advising motorists that fines for speeding convictions within a highway construction or maintenance work zone are higher than those for speeding outside the work zone shall be installed. Signing for double fines shall be installed on the mainline in advance of any highway work zone or where a travel lane is closed to vehicular traffic or the speed limit within the work zone is reduced below the normally posted speed limit or near the project limits on projects with multiple work zones. It may also be used where workers on the shoulder are exposed to high-speed traffic.

The FINES DOUBLED FOR SPEEDING IN WORK ZONES signs shall be the primary device for advance notice since they can be installed independently of a speed limit sign. The sign should be placed where it will not interfere with, or detract from, any traffic control device. It should not be placed between a warning sign and the condition to which it relates, or within a warning sign countdown series. To avoid the aforementioned conditions, unless otherwise directed by the Regional Traffic Engineer based on site-specific conditions, install the sign 300 m upstream of the first warning sign on highways with normally posted speed limits equal to or greater than 45 mph and 90 m to 150 m upstream for normally posted speed limits less than 45 mph.

For long projects with multiple work zones, the sign should be installed upstream of the ROAD WORK NEXT XX MILES (G11-1) sign at the distances in Exhibit 16-11 or at the project limits and need not be installed at each work zone.

# MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

**Exhibit 16-12 Signing Requirements for Reducing 65 mph Speed Limits in Work Zones**



**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

Advance notice of work zone fines may also be provided temporarily (2 to 4 weeks) by a variable message sign when the project first starts, if it is more practical or cost-effective. The legend should be changed to SPEEDING FINES DOUBLED IN WORK ZONES so it can be presented in 2 displays in a variable message unit having 3 lines with 8 characters per line.

Designers should show the signing on the plans and include its cost in the cost of the Construction Signs item.

**16.4.6.8 Selection of Speed Control Method**

Reduced speed limits are generally only effective when the driver perceives a need to slow down, whether it be through regular enforcement of the speed limit or noticeable geometric or work-related constraints on traffic flow. Reduced speeds can generally be achieved by introducing active measures such as enforcement, flagging, variable message signs, lane shifts, and lane-width reduction. Since driver behavior reflects driver attitudes, awareness, comfort level, and respect for authority, consider strategies that address engineering, education, and enforcement measures. As a guide to speed control selection, Exhibit 16-13 summarizes the advantages and disadvantages of speed control methods.

**A. Engineering Measures**

In the past, common practice was to design the work zone and traffic control to minimize the impact of the work on traffic flow. Unfortunately, this practice can give drivers an understated sense of the inherent dangers in work zones and result in unsafe driver behavior, including excessive speed, unsafe lane changing, and aggressive driving through work zones. Engineering measures typically involve designing the work zone to give the reasonable and prudent driver the feeling that he/she needs to slow down to the posted speed limit to safely negotiate the work zone. Width restrictions and lane shifts are the most commonly used measures to reduce speeds. Such measures should be implemented to result in a safe and controlled speed reduction. Motorists should be given adequate advance warning as they approach construction or a change in travel path to avoid sudden deceleration and the resulting increased potential for rear-end collisions. A clear area or buffer space should be provided at the beginning of any constriction or change in travel path to allow an errant vehicle to recover safely without encountering workers or equipment.

One of the more promising calming measures is the use of channelizing chicanes (lane shifts) to reduce traffic speeds and force all drivers to negotiate a lane shift prior to encountering the work site. A common application of a chicane is at a lane closure on a two-lane, two-way roadway. If the work is in the right lane, the left lane is closed placing all traffic in the right lane for a brief period before shifting it into the left lane around the work space. This strategy ensures that any driver not reacting properly to the traffic control will strike channelizing devices and have a second chance to react before encountering workers and equipment.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-101

**Exhibit 16-13 Advantages and Disadvantages of Speed Control Methods**

Advantages	Disadvantages
<b>Law Enforcement (Stationary patrol car treatments only)</b>	
<ol style="list-style-type: none"> <li>1. Large speed reduction possible.</li> <li>2. Relatively inexpensive for short duration applications.</li> <li>3. Quick and easy to implement and remove.</li> <li>4. Can be effective at night, especially with lights flashing.</li> <li>5. Sporadic use may encourage reduced speeds during "nonuse" periods.</li> <li>6. Suitable for all types of highways and work zones.</li> </ol>	<ol style="list-style-type: none"> <li>1. Constrained by availability of police officers and patrol cars.</li> <li>2. Agency/Contractor does not have direct control over performance.</li> <li>3. High cost for long-duration applications.</li> <li>4. Competes with other police functions.</li> <li>5. Long work zones may require additional patrol car units.</li> <li>6. Success depends on good cooperation from enforcement agencies.</li> </ol>
<b>Variable Message Signs</b>	
<ol style="list-style-type: none"> <li>1. Relatively inexpensive for both short- and long-duration applications.</li> <li>2. Agency/Contractor has direct control over performance.</li> <li>3. Little or no disruption to traffic flow.</li> <li>5. Suitable for all types of highways and work zones.</li> <li>6. Effective at night and in inclement weather.</li> <li>7. May be used in combination with other techniques in this table.</li> </ol>	<ol style="list-style-type: none"> <li>1. Only modest speed reductions possible.</li> <li>2. Constrained by availability of signs.</li> <li>3. Effectiveness may decrease with continuous use.</li> <li>4. Sign maintenance and repair may require technical expertise.</li> <li>5. May be used only as substitutes for other signs, cannot be used alone.</li> </ol>
<b>Flagging</b>	
<ol style="list-style-type: none"> <li>1. Large speed reductions possible.</li> <li>2. Agency/Contractor has direct control over performance.</li> <li>3. Relatively inexpensive for short-duration applications.</li> <li>4. Little or no disruption to traffic flow.</li> <li>5. Quick and easy to implement and remove.</li> <li>6. Suitable for all types of highways and work zones.</li> </ol>	<ol style="list-style-type: none"> <li>1. Requires specially trained and conscientious personnel.</li> <li>2. Fatigue and boredom necessitate frequent relief.</li> <li>3. High labor costs for long-duration applications.</li> <li>4. Effectiveness may decrease with continuous use.</li> <li>5. Two flaggers (one each side) may be needed on multilane roadways.</li> <li>6. Additional flaggers may be needed for long sections.</li> <li>7. Drivers may have a problem seeing flaggers or police traffic controllers at night.</li> </ol>
<b>Effective Lane-Width Reduction</b>	
<ol style="list-style-type: none"> <li>1. Moderate speed reductions possible.</li> <li>2. Agency/Contractor has direct control over performance.</li> <li>3. Relatively inexpensive for long-duration applications, depending on devices used.</li> <li>4. Retains effectiveness with continuous use and long-duration use.</li> <li>5. Speed reduction achieved throughout narrow lane section.</li> </ol>	<ol style="list-style-type: none"> <li>1. May be more expensive to implement and maintain for short-term applications than for long-term applications, depending on the devices used.</li> <li>2. May disrupt traffic flow (i.e., reduce capacity).</li> <li>3. May increase certain types of accidents.</li> <li>4. Device maintenance may be expensive.</li> <li>5. May not be as effective on multilane highways.</li> <li>6. Not easy to implement or remove.</li> </ol>

Source: *Adapted from Improvements and New Concepts for Traffic Control in Work Zones*

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### B. Education/Awareness Measures

Portable variable message signs (PVMS) with built-in radar detectors can be used to alert drivers that they are exceeding the speed limit. The message can be as follows: "SPEED LIMIT 45 MPH/YOUR SPEED IS XX MPH" with the actual speed of the vehicle displayed. These devices should be deployed on limited-access highways with speed limits equal to or greater than 55 mph. They are required on all "Major Active Work Zones." The PVMS units should be routinely moved to different locations and should be deployed for a minimum of 50% of the time that workers are routinely exposed to traffic. Consider using the "weekly" pay unit. Consult with the Regional ITS Coordinator of the Transportation Management Center to determine whether the Department or the contractor will furnish the PVMS units. Full-time use of the PVMS units will desensitize the motoring public to their use and reduce their effectiveness.

Portable variable message signs can also be deployed for a time period before work begins to warn drivers of the upcoming project and allow them time to consider alternate routes or adjust their schedule to account for possible delays.

Use of the media to notify motorists of short-term closures, alternate routes, night construction, and traffic pattern changes should also be considered.

### C. Enforcement of Speed Limits by Law Enforcement Agencies

While the engineering and education efforts can reduce speeds, the most uniformly effective way to obtain respect for and compliance with speed limits and other traffic regulations is to actively enforce them.

The use of dedicated police services can be arranged during either the design or construction phases of a project through a joint initiative, currently in place, between NYSDOT and the Division of State Police. Section 16.7 in this chapter provides guidelines on the use of dedicated police traffic services. Dedicated police enforcement is required on all "Major Active Work Zones" and night construction projects involving temporary lane closures on multilane highways with speed limits of 55 mph or greater.

When specifying dedicated enforcement, consult with the local State Police to identify their needs for enforcement areas, protection from traffic, turnarounds, and other concerns which can be addressed in the design of the project. The State Police should be provided an opportunity to review the plans to ensure that their concerns and needs are addressed.

#### 16.4.6.9 Approving and Documenting Reduced Speed Limits

Documentation should provide a specific description of the locations, dates, and types of operations where the reduced speed limits will be imposed, as well as the justification for the reduction. However, for recurring situations, the descriptions need not be completely explicit in terms of dates and locations. The recommendation and approval will be recorded in the project records and actual

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

16-103

implementation of the speed limits will be documented in the project records along with other records on maintenance and protection of traffic.

For long-duration projects, a copy of the same documentation should be sent to the State Police, to the local sheriff, and to the town clerk of the municipality that will have judicial jurisdiction. These officials must also be notified when the reduced speed limit is terminated.

### **A. During Design**

A recommendation to impose a reduced work zone speed limit may be made by the designer during the development of the project MPT plan, by Regional Traffic or Construction staff during project development and review. Consistent treatment of work zone speed limits among projects and among Regions is essential to maintain credibility with, and compliance by motorists. It is, therefore, important that decisions to impose reduced speed limits follow established guidelines, and that standards be reviewed and approved at the appropriate level in consultation with the State Police and documented in the project records. Adequate justification must be provided based on the guidelines provided in this section, or on other factors that clearly establish the need for a reduced speed limit. Review and approval by the Regional Design Engineer and the Regional Traffic Engineer should be documented in accordance with the Region's procedures.

### **B. During Construction**

For speed limit reductions implemented during construction, action may be initiated upon recommendation of the Engineer-in-Charge, the Regional Construction Group, or the Regional Traffic Engineering and Safety Group. Adequate justification must be provided based on the guidelines in this section or on other factors that clearly establish the need for a reduced speed limit. The proposed reduced speed limit must be reviewed by the Regional Construction Engineer and the Regional Traffic Engineer and approved by the Regional Traffic Engineer before it is put into effect. Consultation with the project designer is also recommended. Final approval by the Regional Traffic Engineer should be in accordance with the Region's procedures.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### 16.4.7 Work Zone Traffic Control Layouts

The NYSMUTCD and the National MUTCD contain examples of generally minimum requirements for a large variety of traffic control situations which are normally found in the field, but they cannot include a layout for every possible highway work zone situation, nor do they provide adequate bases on which to bid the work. Many variables, such as location of work, road type, traffic speeds, travel volumes, roadway geometrics, vertical and horizontal alignment, pedestrians and bicyclists, and intersections affect the needs of each work zone. Since the purpose of traffic control is to make the work zone safe and disrupt the flow of traffic as little as possible, good engineering judgement must be used to choose the appropriate layout for the project and modify it to meet the requirements of a particular work zone. Modifications should comply with the principles and requirements of the NYSMUTCD. For projects that affect traffic (e.g., bridge overpasses) on the NYS Thruway or I-84, the plans should include time restrictions and details as supplied by the NYS Thruway Authority.

In the interest of cost-effective design, the least expensive strategy should be investigated first. Exhibit 16-14 shows a suggested order in selecting the method to be used. The choice of strategy should be based on its economic feasibility, as related to traffic impacts, community impacts, business impacts, etc., as well as its physical possibility.

The designer should consider duration of the work, location of the work, and highway type when selecting a course of action. These three factors are discussed in more detail in the NYSMUTCD, Subchapter H. Generally, the duration of the work determines the type of control devices (mobile or stationary, short-term or long-term) to be used; the location of the work (off the shoulder, on the shoulder, in the median, or in a lane) oftentimes determines the number of control devices to be used; and, the type of highway (rural, urban, expressway, arterial, one-way, two-way) usually affects the degree of modifications to typical work zone applications. Select the appropriate layout from the examples in the NYSMUTCD, Subchapter H or the Department's *Work Zone Traffic Control Manual*, and develop detailed MPT plans, as necessary, and in conformance with the requirements of the NYSMUTCD. In those instances when the NYSMUTCD does not have an example suitable to the project, the designer may refer to the latest edition of the National MUTCD.

When modifications to NYSMUTCD examples are necessary, it is usually because higher type treatments than those shown are required. The following are examples of modifications that may be desirable and necessary to satisfy the needs found in the field.

- Additional Devices
  - ▶ Increased number of signs (take care not to "oversign").
  - ▶ Special signs (portable variable message signs or temporary guide/destination signs).
  - ▶ Flashing arrow boards.
  - ▶ Channelizing devices reduced spacing.
  - ▶ Temporary raised pavement markers or wet reflective tape.
  - ▶ Temporary traffic signals.
  - ▶ Temporary barriers.
  - ▶ Barrier vehicles.
  - ▶ Vehicle arresting barriers.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-105

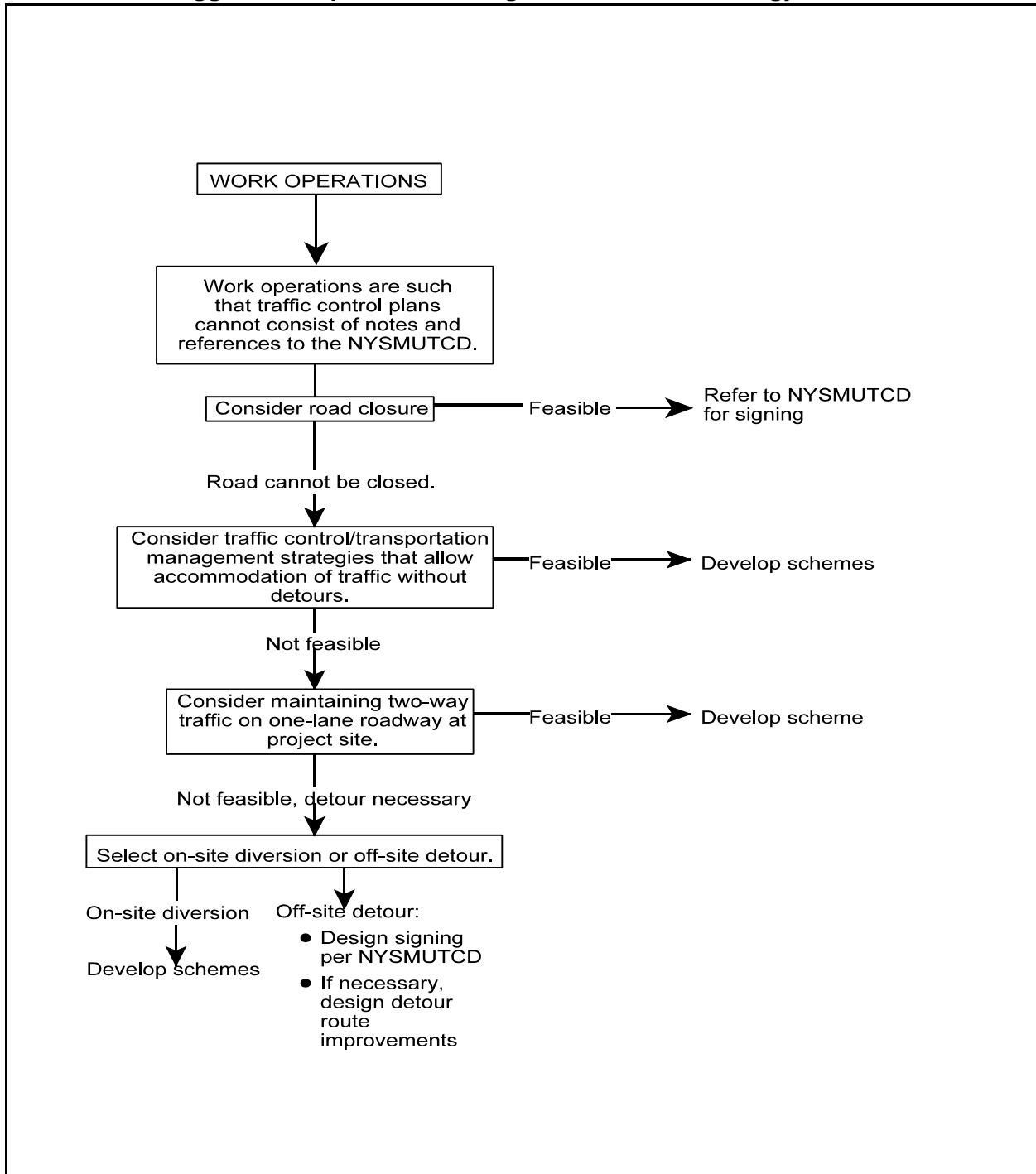
- ▶ Impact attenuators.
- ▶ Gawk/glare screens.
- ▶ Rumble strips.
- ▶ Intrusion alarms.
- Upgrading of Devices
  - ▶ Larger signs with lights/flags.
  - ▶ Brighter and/or wider pavement markings.
  - ▶ Higher-type channelizing devices.
  - ▶ Barriers in place of channelizing devices.
  - ▶ A full complement of standard pavement markings in areas of high hazard.
  - ▶ Variable message signs.
- Improved Geometrics
  - ▶ At detours.
  - ▶ At crossovers.
  - ▶ Widened shoulders to enable staged construction.
- Increased Distances
  - ▶ Longer advance warning areas.
  - ▶ Longer buffer spaces.
- Lighting
  - ▶ Steady-burn lights for channelization.
  - ▶ Flashing lights at isolated hazards.
  - ▶ Illuminated signs.
  - ▶ Floodlights.
  - ▶ Temporary roadway lighting.

The following points should be considered when designing an MPT plan for a specific field condition:

- Drivers may not perceive or understand one or more of the devices placed in the traffic control zone. Therefore, some extra signs or devices may be required to protect motorists and workers, however, guard against oversigning.
- Consideration should be given to what might happen if the motorist does not get the required information. The level of protection used and the delivery of the message should be related to the level of hazard. More emphatic messages and a higher level of protection are needed for high-hazard situations.
- Where possible, a recovery space (buffer zone) should be provided.
- Devices should be evaluated on a system basis. Consider how the entire set of devices will perform in the work zone to guide drivers and protect workers.
- Whenever possible, remove the traffic from the facility or make the work zone as large as possible. Large work zones provide a safer working environment and foster smoother, longer lasting and less costly pavements by allowing the use of high-quality, high-volume paving equipment resulting in fewer interruptions, and minimizing short and/or irregular placements.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Exhibit 16-14 Suggested Steps For Selecting Traffic Control Strategy**



## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-107

### 16.4.7.1 Design of Road Closures

Road closures should be considered where alternate routes exist close to, and generally parallel to, the roadway to be closed, and where the alternate routes have sufficient capacity to carry the diverted traffic including special dimensioned and permitted vehicles. Where feasible detour facilities are available or where traffic conditions are otherwise suitable (low volumes of strictly local traffic), closing the roadway to public traffic should be considered.

When roads are closed, a certificate must be filed with the town clerk as required by Section 104 of the New York State Highway Law. To fulfill these certification requirements, the Regional Director must file a notice of state highway closure with the town clerk of the town in which the state highway to be closed is located.

When the decision is made to completely close a road for nighttime construction, the following traffic control elements are to be provided:

- Type III construction barricades shall be used to close a roadway or ramp in a highway construction work zone in accordance with the NYSMUTCD §292.2.
- Appropriate ROAD CLOSED or related signs are required, mounted on or above the barricades, as described in Part 218 of the NYSMUTCD.
- Flashing warning lights are to be provided on Type III barricades at the point of closure. They are not to be installed in a longitudinal display, such as at a lane closure that diverts traffic onto a ramp.
- Appropriate work zone and ROAD CLOSED warning signs as described in Part 238 and work zone guide signs as described in Part 254 of the NYSMUTCD are required in advance of all closures. Type B flashing, high-intensity warning lights should be considered to provide target value and to emphasize the presence of signs on freeways and in other locations where there is concern that drivers may fail to notice these signs.
- Vehicle-arresting barriers (VABs) should be considered for use on mainlines or entrance ramps where there is a risk of traffic circumventing the closure. Design information is presented in §16.3.2. Redundancy is essential for all closures when space permits. It may be provided with an additional set of Type III barricades located some distance beyond the primary closure and in front of VABs to alert drivers who circumvent or breach the primary closure.
- DETOUR signs and detour route markers, as appropriate, to provide advance warning and guidance to traffic, in accordance with the NYSMUTCD Sections 238.5 and 254.3, respectively.

### 16.4.7.2 Design of Lane Closures

When traffic must be maintained through the project during work hours, temporary lane or shoulder closures may be necessary to provide separation between traffic and the contractor's operations. The use of traffic barriers (temporary concrete barrier, movable concrete barrier, etc.) is desirable to provide positive separation, but may not be feasible. Most lane closures that are set up and removed on a daily basis must rely on channelizing devices to mark the closed lanes. All lane and

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

shoulder closures, whether barriers or channelizing devices are used, must adhere to the following requirements:

- Closures must be started at locations providing optimum visibility, i.e., before curves and crests. Closure locations should take advantage of available escape paths such as wide medians and shoulders, and avoid bridges, underpasses, and other locations without available escape paths.
- Closures should be located away from other conflict points such as on-ramps and intersections whenever possible.
- On freeways and interstates, where spot work areas are located less than 1.6 km apart, it is recommended that they be treated as a single work zone with a long lane closure.
- Lane closure taper lengths must adhere to the requirements of §262.22 and §292.1 of the NYSMUTCD. The standard taper length, L, must be provided as a minimum for lane closures, except where intersections or other site situations necessitate shorter tapers. For multiple lane closures, a tangent section 2L in length is preferred between adjacent lane closure tapers.
- Longitudinal buffer space should be provided between the downstream end of the lane closure taper and the start of the work area, to provide a margin of safety for workers and motorists. The NYSMUTCD (§301.13 and Table 301-2) provide guidance for the design of longitudinal buffer space length. Any available buffer space is helpful, and should be used even if the recommended distance is not available. The longitudinal buffer space given in Table 301-2 may have to be increased to optimize visibility of the approach taper. Refer to Exhibit 16-12 for an illustration of the components of a temporary traffic control zone.
- For roadways with relatively high speeds and free-flowing traffic, longer tapers may help to facilitate merging. However, for slower speed roadways where traffic volumes approach congestion, increasing the taper length may prolong the merge conflict and should be avoided.
- Where temporary concrete barrier is used to close lanes or shoulders, the closure must first be formed using channelizing devices on the appropriate taper length. Immediately downstream of the merging taper, where the channelizing devices become parallel to the lane, an appropriate longitudinal buffer space is to be provided in advance of where the temporary barrier crosses the edge of pavement. The barrier is then introduced beyond the buffer space using the flare rate listed in §16.3.1. Refer to the National MUTCD, Figure 6H-34 and the Department's *Work Zone Traffic Control Manual*.
- Channelizing devices must be carefully aligned at intersecting ramps, gores, and other critical locations to clearly define the intended travel path for drivers.
- Where construction operations are restricted to a shoulder or only one lane of a three-lane roadway, consideration should be given to providing additional lateral buffer space by closing an additional travel lane adjacent to the work operation. This decision must be based on the tradeoff between traffic flow and worker safety. In addition to potentially reducing traffic speeds, the added lane closure reduces the risk of equipment or workers straying into the open lane. However, this option cannot be used where it results in unacceptable congestion and delays.
- Where space is available on the open-lane shoulder, traffic can be shifted further away from construction operations by locating channelizing devices on the open-lane side of the

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-109

lane line. The designer should be aware of whether shoulder rumble strips (MIARDS) are located on the shoulders.

- Where neither of the immediately preceding options can be used to provide an adequate lateral buffer space to protect the workers, stationing a spotter to provide warnings or a barrier vehicle with truck-mounted attenuator to provide protection to workers should be considered.
- Arrow panels are required for lane closures on multilane highways where the preconstruction posted speed limit or the operating speed is 45 mph or higher. During nighttime construction, however, arrow panels are required for all lane closures on multilane highways regardless of traffic speed. This must be shown on the MPT plan. See §16.2.6 for additional guidance on arrow panel use.
- Black-on-orange single arrow signs (W1-11, W1-12) or chevron signs (W1-13, W1-14) may be used at strategic locations (i.e., intersections, lane shifts and closures, crossovers, etc.) to emphasize lane closures. Placement above and behind Type III barricades spaced periodically throughout the lane closure is especially effective.
- Regulatory "DO NOT PASS" signs (R4-1) may be spaced periodically throughout lane closures where traffic is restricted to a single lane and there is concern that vehicles will momentarily enter a closed lane to pass slower vehicles. These signs are to be placed on the right adjacent to the open lane, and may be placed on both the left and right, where space is available.
- During paving operations and other construction operations, it may be necessary to change the lane closure from left to right, or vice versa. It is often simpler to leave the original closure in place and shift traffic into the reopened lanes using channelizing devices. The shift should occur at a minimum distance of 2L downstream from the merging taper. The shift taper length must be at least 0.5L, although the use of "L" is encouraged. Single arrow signs (W1-11, W1-12) or chevron signs (W1-13, W1-14) should be used to mark the shift. Arrow panels are not to be used. Channelizing devices must be spaced to confine traffic to a single lane throughout the shift without allowing an opportunity to form additional lanes (i.e., channelize both sides of the lane leading up to and within the shift).
- When one lane closure is maintained with a lane shift used to adjust lane use, the lane to be closed should be based on site conditions and available sight distance. All other things being equal, generally, the left lane is closed because there is less traffic in the left lane and less conflict with entrance and exit ramps. It also avoids having to create temporary gores and acceleration and deceleration lanes with channelizing devices.

### 16.4.7.3 Ramp Control

Normally on-ramp traffic has sufficient acceleration length available to merge into gaps in mainline traffic. Ramp control in a work zone should duplicate the existing configuration. However, in some cases, downstream lane restrictions may limit the available acceleration distance and compromise the safety and efficiency of the merge. Where adequate acceleration length to support a merge is not available, traffic control of the on-ramp traffic may, depending on mainline and ramp traffic volumes, consist of STOP (R1-1) or YIELD (R1-2) signs, and for very short duration work or moving work zones crossing an on-ramp, flagger control to control traffic on the ramp, not the mainline.

## **MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES**

Designers should make every practicable attempt to provide adequate acceleration length. A significant difference in speeds between mainline and entering traffic creates a safety concern. The use of STOP (R1-1) or YIELD (R1-2) signs to control on-ramp traffic contributes to a speed differential and should only be used where adequate acceleration length is not available or closing the ramp and detouring traffic is not practical for safety reasons. This is a project-specific decision and should only be done in consultation with the Regional Traffic Engineer and, as appropriate, the Regional Construction Engineer. Considerations include the cost of geometric improvements such as widening, which may facilitate adequate acceleration length, traffic volumes on both the mainline and the ramp, grades, sight distance, length of detours used if the ramp is closed, length of time the acceleration length will be restricted, the volume of truck traffic that uses the ramp, and any relevant accident history.

If only the acceleration lane is to be closed, close the right lane in advance of the on-ramp and create a dedicated ramp entry lane using the closed right lane unless precluded by site-specific conditions. Also, restrict work hours to times when mainline traffic can be accommodated in the remaining open lanes upstream. Where there are three or more through lanes and work occupies the right lane, close the right two lanes in advance of the on-ramp, only if it does not cause unacceptable congestion, and create a dedicated ramp entry lane using the closed center lane unless precluded by site specific conditions.

When use of a STOP (R1-1) or YIELD (R1-2) sign to control on-ramp traffic is determined to be the best alternative due to inadequate acceleration distance, consider the choice between stop and yield control. There are no commonly accepted criteria for selecting between the two, but the following are some considerations and best practices.

- Where the available acceleration distance is very short (less than half of the AASHTO minimum), a STOP (R1-1) sign should be considered since on-ramp traffic is unlikely to be able to accelerate to mainline speed, even if there are adequate gaps in mainline traffic. Consider eliminating the entire remaining acceleration lane to reinforce the stop condition and minimize driver confusion. A short acceleration lane may encourage drivers to attempt a merge, only to stop suddenly at the end of the lane when there is no gap in traffic and expose themselves to a rear-end collision by a following accelerating vehicle. On-ramp traffic should be brought into the mainline at as near a right angle as practicable so the drivers can best see approaching mainline traffic and accelerate into the mainline traffic flow. Avoid specifying channelizing devices on the left side of the ramp which can block the view of approaching mainline traffic.
- Where poor compliance with YIELD (R1-2) signs is expected, consider using STOP (R1-1) signs.
- Avoid forcing trucks to stop if they will be climbing an upgrade immediately downstream of the on-ramp. Where car-truck conflicts will present a significant potential for serious accidents, close the ramp or develop an alternative method of traffic control.
- If the acceleration distance is more than half of the AASHTO minimum, consider using a YIELD (R1-2) sign to encourage more efficient use of available gaps in the mainline flow while advising drivers not to expect normal merge conditions.
- Some other states use yield signs when there will be two open lanes on the mainline and stop signs when there will only be one open lane. However, this policy is most likely based on the assumption that there will be more gaps in mainline traffic when there are

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-111

two open through lanes. Before basing the type of traffic control on the number of open lanes, make sure that the assumption is valid.

- In all cases, provide advance warning of the stop or yield condition by using STOP AHEAD or YIELD AHEAD signs with flags or warning lights and VMS units if appropriate. If there is space available, install the STOP (R1-1) or YIELD (R1-2) signs on both sides of the ramp and enhance their visibility with flags or warning lights.
- When using either stop or yield control, consider speed limit reductions and warning signs on the mainline in advance of the on-ramp. A 65 mph speed limit shall be reduced upstream of a stop or yield condition. A W2-8 intersection warning sign with a RAMP TRAFFIC supplemental panel beneath it may be used to advise mainline drivers of a potential intersection type conflict at a right-side on-ramp. Deployment of VMS units is also recommended. Consult the Regional Traffic Engineer for appropriate message text.

When a roadway is closed, provide warning of the closure at all on-ramps upstream of the closure following the guidance in §16.4.8.1. When the mainline is open to traffic, special considerations must be given to controlling traffic at ramps, and in some cases, it will be necessary to selectively close on-ramps or off-ramps while the mainline remains open.

- For facilities with existing ramp metering equipment, it may be necessary to adjust the ramp metering cycle or turn the system off when the construction operation is underway.
- For facilities without ramp metering, it may be beneficial to provide temporary metering during the construction operation.
- When paving or other operations require providing to the contractor full use of the lanes adjacent to off-ramps, it is necessary to temporarily close individual off-ramps. In such cases, it is essential to provide advance warning that the ramp is closed, and to provide information on alternate ramps or detours. This information must be provided well upstream of the decision point using large information signs or variable-message signs. In addition to advance information signs, regulatory RAMP CLOSED (R8-1) signs are required in the area of the ramp. To emphasize the closure through the ramp area, the channelizing device spacing should be 6 m..
- In addition to full-road closures, on-ramp closures may be necessitated by closure of the right lane for the contractor's operations, or because restriction of all mainline traffic to the right lane does not provide adequate gaps for entering traffic to merge safely. In either case, closure of an on-ramp must be addressed in a manner similar to that for a full-road closure.
- When entering or exiting traffic must cross closed lanes, the travel path must be clearly defined using channelizing devices spaced at 6 m.
- Temporary advance signs telling motorists how far it is to the temporary off-ramp opening, e.g., "EXIT/500 FT" or "EXIT XX/1000 FT."
- Temporary EXIT (G5-1) panels on portable supports are to be provided in relocated gores to direct traffic to open off-ramps.
- In addition to mainline VMSs, consider VMSs for on-ramps carrying high-speed, high-volume traffic to alert drivers to nighttime construction activities.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

## 16.4.7.4 Two-Lane, Two-Way Operations

Two-lane, two-way operations (TLTWOs) occur on one roadway of a normally divided highway when traffic must be moved through or around a temporary traffic control zone. This section discusses the policy and guidance for this optional method of temporary traffic control for projects on 4-lane divided highways, e.g., rural or urban interstates or arterials. The unique operational problems inherent in a TL TWO makes it a method that may not be applicable to every situation.

It is the policy of the NYSDOT to consider a two-lane, two-way operation (TL TWO) on one roadway of a normally divided highway as an alternative method of work zone traffic control.

## A. Considerations:

A TL TWO on one roadway of a normally divided highway is a typical procedure that requires special consideration in the planning, design, and work phases, because unique operational problems (for example, an increase in the risk of head-on crashes) can arise with a TL TWO. Some of the considerations designers should make when assessing the use of TL TWO include:

- Will a TL TWO provide a safety benefit to workers by removing the conflicts that occur when traffic is maintained immediately adjacent to the work?
- Will a TL TWO make nighttime construction safer for workers?
- Will operational and safety problems be caused by low-speed ( $\leq 60$  km/h) vehicles, creating excessive delays and encouraging illegal passing due to motorist frustration and impatience?
- Will emergency vehicles experience difficulties resulting from the restricted section when passing through or responding to accidents in, or downstream of, a TL TWO segment? Compare to the difficulties to be experienced if the traffic is maintained adjacent to the work.
- Can the work be accomplished without TL TWO? If another option is considered, will it result in an additional safety risk to temporary traffic control zone personnel?
- Can temporary lanes be constructed in the median?
- Will a TL TWO enhance the quality of construction? A TL TWO removes all traffic from the work area and allows the contractor better control of the work operation. All other things being equal, better quality work may result in extended pavement and bridge deck service lives and a reduction in the frequency and extent of future maintenance and reconstruction operations.
- If a TL TWO is selected, will this result in a shorter contract time?
- If a TL TWO is selected, will this result in restricting traffic in a reduced lane configuration longer than would a conventional staged operation?
- Will a TL TWO allow a contractor to perform the work more efficiently? In many cases, contractors will choose to stage their work, even if given total access (by closing a road or bridge), in order to maintain convenient access across a bridge.
- Will a TL TWO provide more capacity? Generally, TL TWOs will provide somewhat wider travel lanes than conventional staged construction as there is no need to be concerned about contractor work room behind the temporary concrete barrier. In

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-113

- some cases, the extra travel width may provide a second lane in one direction.
- Are there any width or height restrictions that would preclude the use of a TLTWO or the use of a shoulder or the median as a temporary lane? Wider temporary lane widths (see above) that may result with TLTWO may better accommodate wide loads and could mean the difference between allowing them on-site as opposed to detouring them off-site.
- What is the condition of the pavement and shoulders in the proposed TLTWO section? If traffic will be forced to drive on the shoulders due to width restrictions, is the shoulder design adequate?
- Is a suitable detour available that will preclude the need for on-site temporary traffic control or carry traffic in the event of emergency incidents?
- Will use of TLTWO cause a significant increase in the project cost?
- What are the characteristics of the traffic (e.g., traffic volume, demand volume, vehicle-type distribution, etc.)? Traffic volumes may be too heavy, causing significant congestion and delays.
- Is the project located on a roadway where bicyclists and pedestrians are permitted to travel? Refer to §16.4.4.2 for guidance on providing maintenance and protection of traffic for bicyclists and pedestrians.
- Can traffic be controlled to minimize or eliminate the safety risk to workers when resetting channelizing devices?
- Is there an impact on existing drainage?

### B. Design Standards (Required, mandatory, or specifically prohibitive practices.)

1. Separation of Traffic Between Crossovers.  
Temporary concrete barrier (TCB) or channelizing devices shall be used to separate opposing traffic throughout the length of the TLTWO between crossovers, except when the work zone is located on an urban-type street or arterial where operating speeds are low ( $\leq 60$  km/h) and traffic control devices, including signs and pavement markings, are provided in accordance with the NYSMUTCD, separation devices may be omitted.
2. Separation of Traffic at Crossovers.  
TCB shall be used to separate opposing traffic at crossovers for all TLTWOs. TCB shall be installed at the crossover exit roadway to protect exiting traffic where fixed objects located in the median or the slope of the crossover embankment are a hazard to the exiting traffic. If there are no hazards, the TCB is not required. TCB and the excessive use of traffic control devices are not allowed as compensation for poor geometric and roadway cross section design of the crossover.
3. Design Speed.  
Where it is not possible to achieve a design speed equivalent to that of the existing facility, the design speed of the crossover and TLTWO shall not be lower than 10 mph below the highest of the anticipated operating speed or the preconstruction off-peak 85<sup>th</sup> percentile speed or the posted speed limit prior to work starting. Use of any design speed below the preconstruction off-peak 85<sup>th</sup> percentile speed shall be approved by the Regional Traffic Engineer. If circumstances force a further lowering of the design

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

speed, consideration should be given to additional measures for reducing speed to a safe operating level approaching the crossover, such as temporary rumble strips. (See Guideline C.3.)

4. Lane Width and Shoulder Width and Depth.  
Lane width and shoulder width for the TL TWO and crossovers shall be provided in accordance with the requirements of Chapter 2 of this manual. The depth of paved shoulders shall provide for heavy-duty use in accordance with the *Comprehensive Pavement Design Manual*.
5. Channelization at Interchanges and Rest Areas.  
The directions of travel (exit, enter, through) at interchanges and rest areas located within the TL TWO shall be properly channelized to prevent wrong-way travel and confusion on the part of the motorist.
6. Temporary Concrete Barrier Protection.  
Protection against direct impact with the approach ends of TCB shall be provided in accordance with §16.3.1.
7. Warning Signs With Channelizing Devices.  
Two-way traffic signs (W3-3) supplemented with auxiliary mileage signs (W9-2) shall be located every 1.6 km maximum, in both directions of the TL TWO when channelizing devices are used to separate opposing traffic. (See Guideline C.10 below.)
8. Regulatory Signs With Channelizing Devices.  
DO NOT PASS (R4-1) signs shall be located in both directions of the TL TWO when channelizing devices are used to separate opposing traffic.
9. Roadside Protection, Signing, and Pavement Markings.  
Appropriate roadside protection, signing, and pavement markings in accordance with the NYSMUTCD, the HDM, and this section shall be provided for the opposite direction of traffic at obstacles and locations which do not require protection, signing, and pavement markings under normal unidirectional conditions (e.g., trailing ends of guide rail or barrier shall be converted to approach ends).
10. Winter Operations.  
A TL TWO shall not be left in place during the winter snow removal months except as approved by the Regional Traffic Engineer, Regional Construction Engineer, and Regional Maintenance Engineer.
11. Lane Separation.  
If channelizing devices are used to separate traffic, the lanes shall be a minimum of 1 m apart and full-barrier lines shall also be used.
12. Crossovers.  
All pavement and hazardous features and conditions must be removed and the area returned to a safe and pleasing appearance. There must be no features that mislead drivers to follow unsafe direction. Drainage must not be impeded.

C. Design Guidelines (Recommended, not mandatory practices, with deviations allowed if engineering judgement or analysis indicates the deviation to be appropriate.)

1. Length of TL TWO.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-115

A TLTWO should not exceed 8 km in length, except when, in the designer's judgement, an existing interchange is located a reasonable distance downstream from the terminal of the TLTWO in the crossover direction, the TLTWO may be extended to terminate at that interchange. Special consideration shall be given to the effects of horizontal and vertical alignment and truck volumes on the operation and safety of the TLTWO for lengths in excess of 8 km regarding the potential for aggressive driving.

2. Emergency Pull-Offs.

Emergency pull-offs should be provided on the median side of the crossover lane (see Exhibit 16-16). They should be delineated by delineators or paved. In situations where the median-side shoulder configuration is too narrow to accommodate emergency pull-offs, they should be provided on the other shoulder. The spacing should not exceed 1.6 km on a TLTWO longer than 3 km.

3. Design Speed.

The design speed for crossovers and TLTWO should be equivalent to the design speed of the existing facility. (See Standard B.3 above.)

4. Separation of Traffic by TCB.

TCB (positive barrier) should be used instead of channelizing devices when, in the judgement of the designer, the volume of traffic, the anticipated operating speed, the volume of heavy trucks, or other traffic or roadway conditions result in a potential for unacceptable conflicts between opposing flows. Guidelines for when to consider the use of TCB are when one or more of the following conditions occur.

- The DDHV exceeds 1300.
- The anticipated operating speed  $\geq$  80 km/h.
- The volume of trucks exceeds 10%.
- Long, steep grade or sharp curve at the base of a long, steep grade.

5. Separation of Traffic in Short TLTWOs. For short (approximately 600 m or less) TLTWOs, it may be more beneficial in terms of economics, uniformity, and consistency to use continuous TCB throughout the work zone and crossovers rather than to use channelizing devices through the TLTWO and TCB with impact attenuators (at the approach ends of the TCB) at the crossovers.

6. Shielding of Potentially Hazardous Features.

Potentially hazardous features with a high accident potential should be shielded, such as with sand barrels for point objects or with temporary guide rail or temporary concrete barrier for linear objects. The designer should determine the point-of-need for guide rail for traffic traveling in the opposite direction from which it was originally designed and provide shielding wherever necessary. The trailing end of any bridge rail, guide rail, concrete barrier, etc., should be given special consideration. Designers should show on the plans where and what length of roadside protection is required throughout the length of the TLTWO.

7. Separation of Lane Closure Tapers and Crossovers.

Tapers for lane closures should not be contiguous with crossovers. Drivers need time to acclimate to the change and adequate space is needed for the advance warning signs. The distance from the downstream end of the lane closure taper to the beginning of the crossover should be at least twice the length of the lane closure taper.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

“2L” but no less than the length of the lane closure taper “L”.

8. Spacing of Channelizing Devices Used in a Longitudinal Series.  
Spacing of channelizing devices used in a longitudinal series to separate opposing traffic flows should not exceed a distance in meters equal to 0.3 times the speed limit (mph) or 12 m maximum, whichever is less, when used for taper channelization, and a distance in meters equal to 0.6 times the speed limit (km/h) or 24 m, whichever is less, when used for tangent channelization. Full barrier lines must also be used.
9. Spacing of Channelizing Devices at Interchanges and Rest Areas.  
The spacing of channelizing devices used at interchanges and rest areas located within the TLTWO should be 1/4 to 1/3 the spacing of the channelizing devices used in tangent locations.
10. Warning Signs With TCB.  
Two-way traffic (W3-3) signs supplemented with auxiliary mileage (W9-2) signs may be used but are not required when TCB is used to separate opposing traffic. (See Standard B.6 above.)
11. Intermittent Use of Alternate Channelizing Devices.  
Intermittent use of alternate channelizing devices, such as opposing-traffic lane dividers (separation devices manufactured of lightweight materials with 2-way arrows on both faces), is permitted on an experimental basis where space permits and in accordance with Special Authorization 94-12 in Appendix A of Title 17, NYCRR (NYSMUTCD). These devices may be used to break the monotony of a continuous line of primary channelizing devices, such as tubular markers. One alternate channelizing device may be installed in place of every 5<sup>th</sup>, or more, primary channelizing device.
12. Speed Limit Signs.  
Maximum speed limit signs should be provided in both directions of the TLTWO and located in accordance with the requirements of the NYSMUTCD Table 212-1. Where the original speed limit is 65 mph, reduce it to 55 mph due to the proximity of either temporary concrete barrier or opposing traffic.
13. Shoulders.  
It may be necessary to widen existing shoulders to provide the necessary lane width, especially the median-side shoulder.
14. Signs at Intersections  
Include provisions for KEEP RIGHT (R4-6) signs at intersections along the TLTWO.

An example of a TLTWO, including crossovers and a tangent section, with separation of opposing traffic by channelizing devices, is provided as Exhibits 16-15, 16-16, and 16-17.

In situations where there is a median barrier, the downstream taper in the “southbound lane” needs to extend only to the point beyond which the median barrier provides protection to the “northbound traffic.”

### D. Variance From Standards

When a designer determines that unique, project-specific circumstances are just cause to vary

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

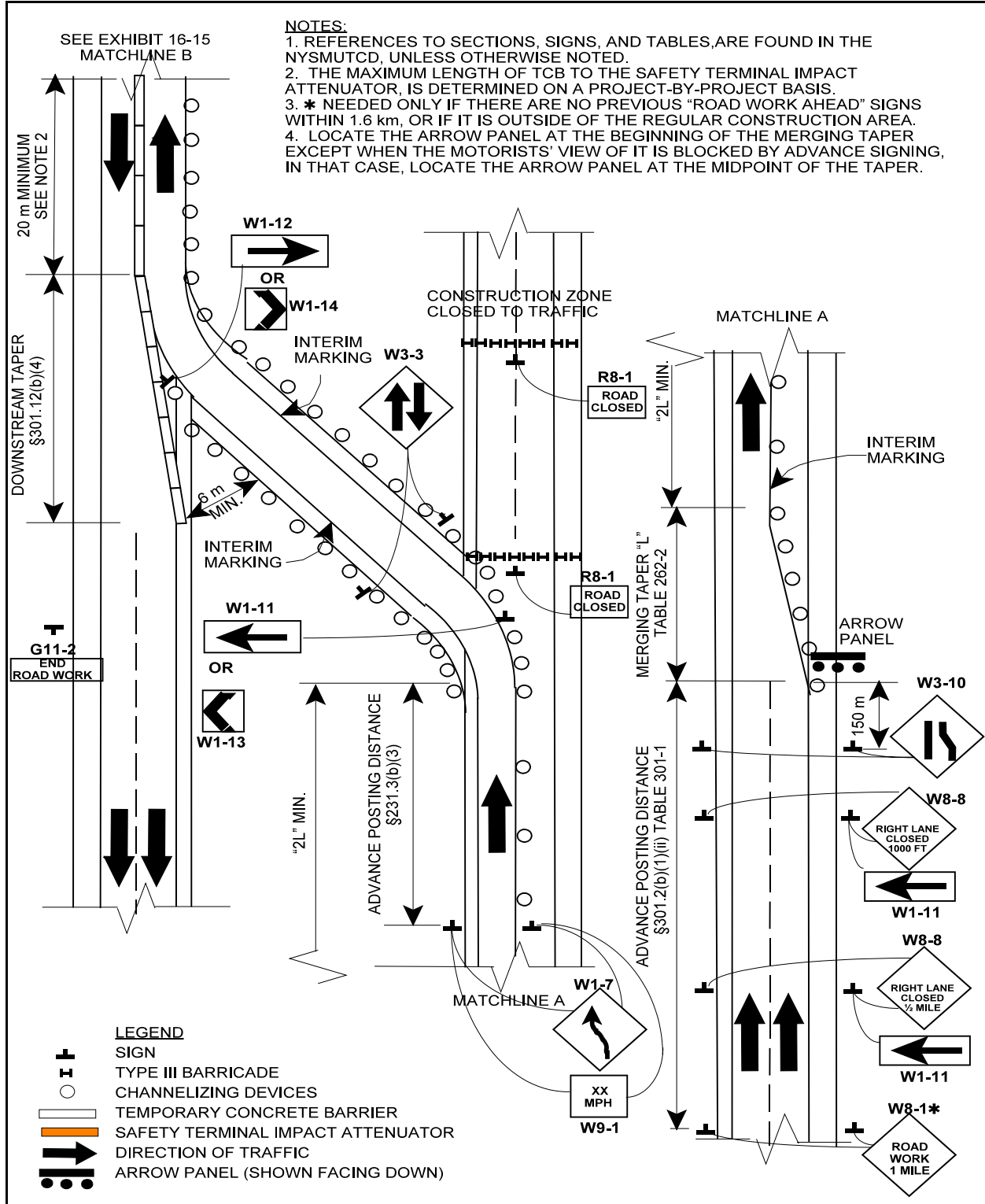
16-117

from the standards for the use of a TLTWO, the decision shall be documented in the permanent project files. The documentation should describe and provide explanations and support for features that do not comply with the TLTWO standards. Documentation is not required for variance from guidelines.

Implementation of a TLTWO shall be by concurrence of the Regional Traffic Engineer and either the Regional Design Engineer for capital construction projects or the Regional Maintenance Engineer for maintenance projects or in accordance with the procedure established by the Regional Director.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

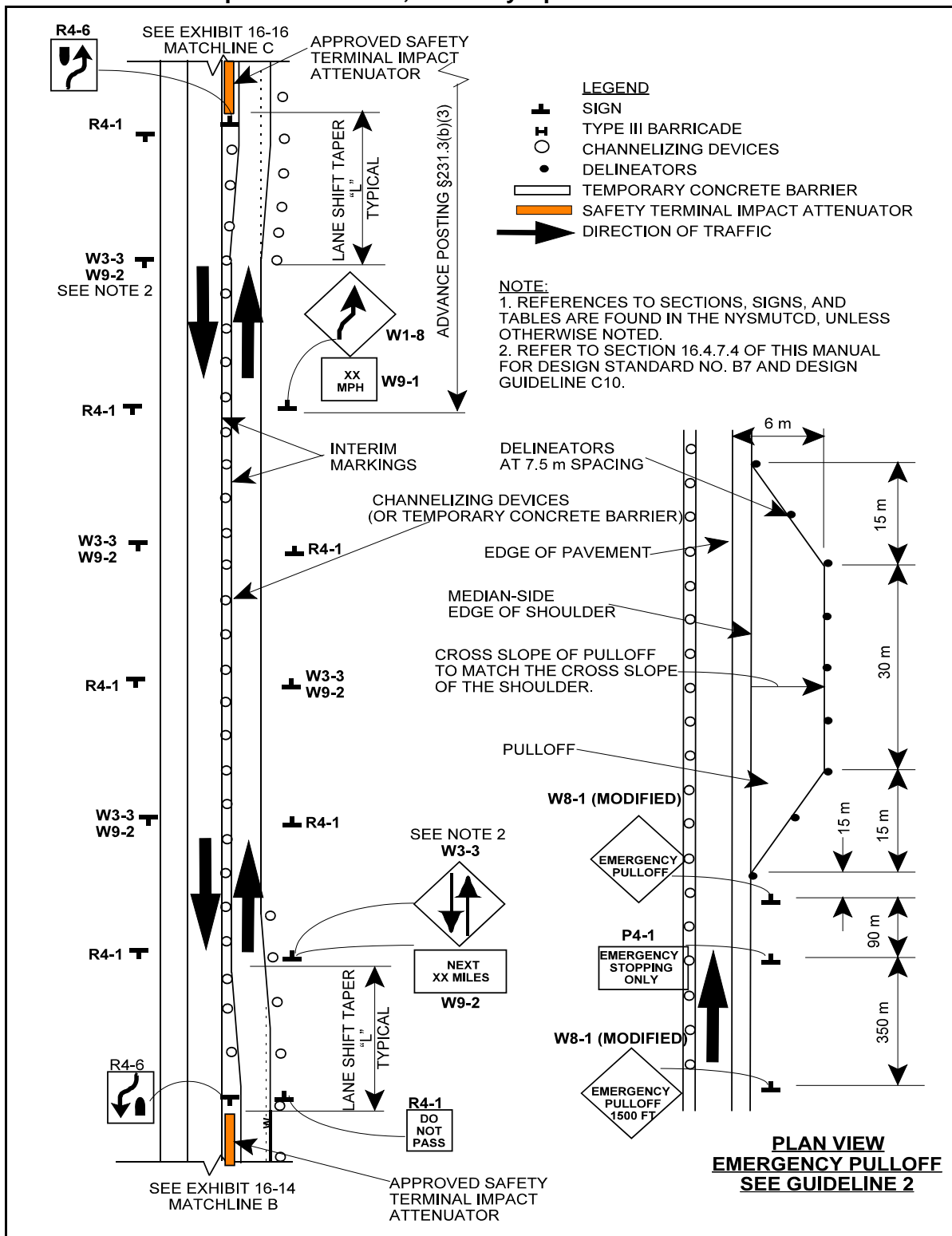
**Exhibit 16-15 Example of Crossover Entrance in Two-Lane, Two-Way Operation**



# MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

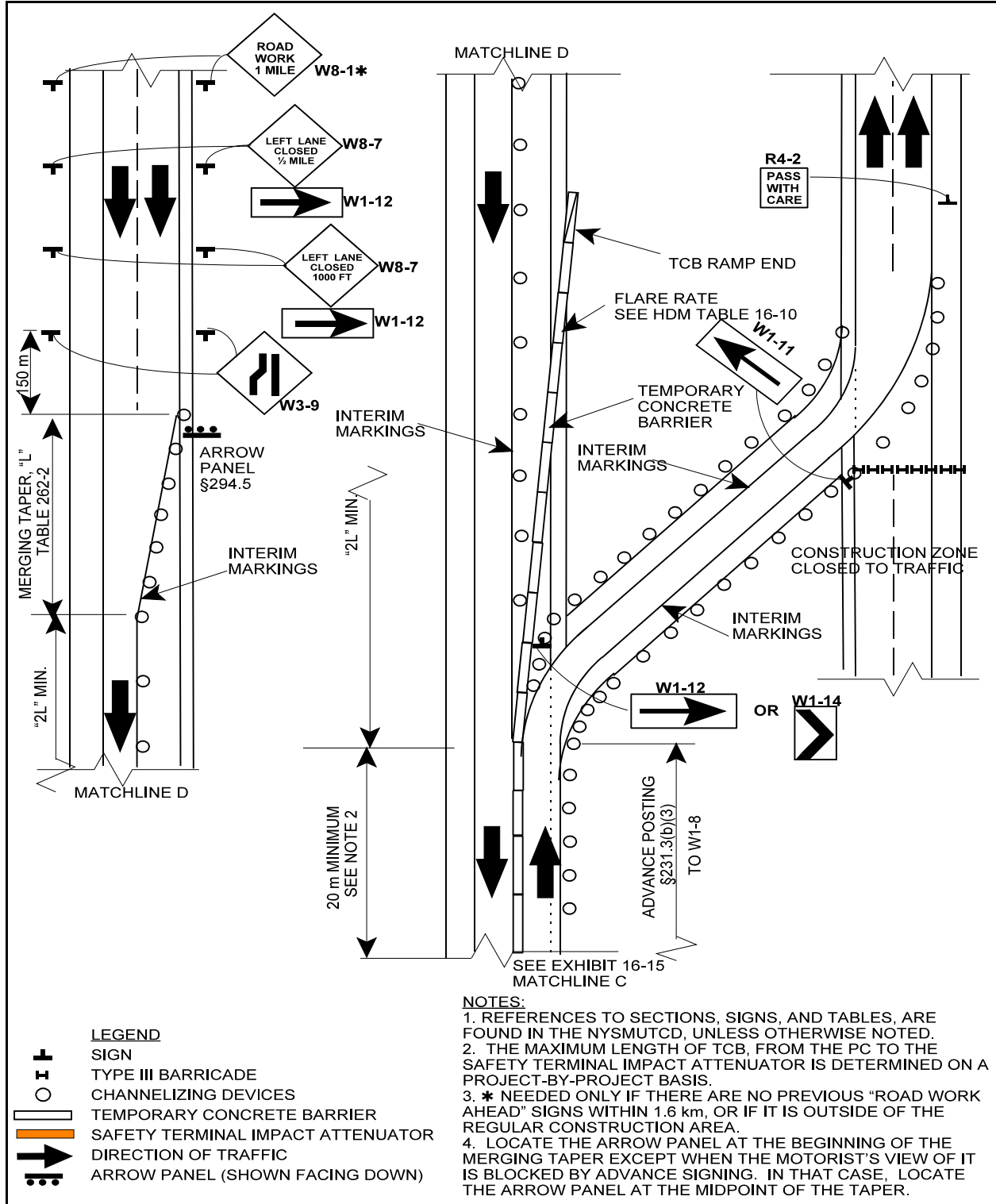
16-119

**Exhibit 16-16 Example of Two-Lane, Two-Way Operation**



## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

**Exhibit 16-17 Example of Crossover Exit in Two-Lane, Two-Way Operation**



#### 16.4.7.5 Urban Arterial Work Zones

Urban arterial work zones have several unique characteristics that distinguish them from rural highway or freeway work zones. The characteristics are primarily related to traffic conditions, traffic signals, geometrics, and limitations on work zone traffic control. Among the most important of the characteristics are higher speed variations, highly variable volumes, limited maneuvering space, frequent turning, crossing and lane-changing maneuvers, multiple access points, higher pedestrian volumes, frequent traffic obstructions, greater competition for driver attention, and more traffic signals. These characteristics require special consideration when preparing an MPT plan for construction activities. A study reported in *Transportation Research Record (TRR) 1409* evaluated some of the unique characteristics of urban arterial work zones and developed guidelines for traffic control in this type of work zone.

The following traffic control guidelines were developed by others from the results of research activities and investigations into current arterial work zone practices. The guidelines have not undergone an extensive experimentation or evaluation period in the field, but are provided here for consideration by the designer under the appropriate circumstances.

Designers must consult with the Regional Traffic Engineering and Safety Group and obtain their approval of the design. Designers should include notes in the contract plans that require the EIC and the contractor to coordinate the work with the Regional Traffic Engineering and Safety Group.

The traffic control guidelines include those related directly to the movement of traffic through the work zone and the traffic control devices used to control the traffic. They address intersections, lane closures, speed control, channelization, and pavement markings.

##### A. Signalized Intersections

The overall capacity of an arterial is typically limited to the capacity of the intersections on that arterial. During construction, the capacity of signalized intersections is often reduced. Therefore, it is important that steps be taken to ensure that the traffic signals within the work zone are operating in the most effective manner possible, given the restrictions of the work zone.

1. Adjust Signal Phasing and Timing.  
Signal phasing and timing should be adjusted, when necessary, with each change in construction phasing, and signal operation should be checked in the field after each adjustment. The assistance of the Regional Traffic Engineering and Group should be requested. Construction activities cause a significant disruption of normal traffic patterns, and construction phasing may alter the lane arrangements at approaches to signalized intersections.
2. Shorten Cycle Lengths.  
If queues due to construction activities or traffic generators are common, a shorter cycle length may be effective at minimizing queue lengths and preventing backups into the intersection, especially near railroad grade crossings. A level-of-service analysis

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

- should be performed to determine the optimum timing.
3. **Shift Traffic Signal Heads.**  
The positions of traffic signal heads should be shifted to line up with lane arrangements any time lane positions are modified. Signal heads should be located in accordance with the NYSMUTCD. The typical construction phasing plan for an urban arterial work zone uses narrow lanes and shifts the positions of the lanes within the intersection. If the signal head positions are not changed accordingly, indications for left- or right-turn movements may not be visible from realigned turn lanes.
  4. **Signal Control.**  
The operation of actuated signal detectors should be checked on a regular basis. At critical intersections, temporary detection may be needed or desired (consult the Regional Traffic Engineering and Safety Group). Temporary microwave detectors are very useful for this purpose because they are pole-mounted and not susceptible to being damaged or destroyed by milling or excavation activities. They can also be easily readjusted as traffic lanes are shifted. The Regional Traffic Engineering and Safety Group should be contacted when there is a traffic signal in the plans. Any number of construction activities may disrupt or prevent the operation of traffic signal detectors. Without detection capability, an actuated signal becomes a pretimed signal by default, and the signal phasing and timings should be developed accordingly. If an existing lane is closed, especially an exclusive turning lane, either the detection of the phasing should be modified accordingly. Contact the Regional Traffic Engineering and Safety Group for guidance. Also, if lanes are shifted, vehicles may “trip” detectors that should not be activated or fail to trip detectors which should be activated.
  5. **Accommodation of Pedestrians.**  
The congestion and delays associated with signals in a work zone are compounded by the need to accommodate pedestrians at signals. Pedestrian push buttons should be used with actuated controllers to maximize the efficiency of signals in a work zone. Even if pedestrians are infrequent, sufficient crossing time must be provided for them. If the length of vehicular green will not adequately accommodate pedestrians, pedestrian actuation will be needed to extend the green for them, when present. The most efficient method of accommodating pedestrians is to install pedestrian push buttons to reduce the amount of unused green. Even if vehicle detection capability is lost and the signals are operated in a pretimed manner, the pedestrian phase can still operate in an actuated mode.
  6. **Signal Lenses.**  
New or temporary signals in arterial work zones should use 300 mm diameter signal lenses. The large number of construction activities, traffic control devices, other vehicles, vehicle maneuvering, and development present in urban arterial work zones creates many demands for the driver’s attention. Using 300 mm signal lenses will help the driver identify new or relocated traffic signals in the work zone.
  7. **Provide Left-Turn Lanes.**  
Left-turn lanes should be provided at major signalized intersections. If they are provided for use during construction, they should be part of the completed project. The lack of a left-turn bay can significantly increase delay because of left-turning vehicles blocking a through lane while waiting for an acceptable gap. Although the

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-123

addition of left-turn lanes may create some difficulties for construction scheduling and activities, the benefits associated with these lanes make it desirable to provide them at major signalized intersections where left-turning vehicles are present. If it is not possible to construct a left-turn lane, it may be necessary to restrict or prohibit the left-turn movement in the interest of reducing congestion. The Regional Traffic Engineering and Safety Group should be consulted if left-turn capacity is expected to be a recurring problem.

### B. Maintain Traffic Signal Equipment

Maintain traffic signal equipment requirements A, B, and C are standard pay items in the *Standard Specifications*.

Variations in Regional Maintenance capabilities and local contractor capabilities, the maintenance needs of different intersections, and the decision by the Department to furnish microcomputers which operate with State-supplied software led to the development of several traffic signal equipment maintenance items to allow the designer flexibility in selecting a maintenance item appropriate for the specific needs of each location within the contract. Outlined below are recommendations concerning the use of the various Maintain Traffic Signal Equipment items. If different item numbers are to be used for different intersections within the project, a table should be included in the plans defining which item will be used at each intersection.

#### 1. Maintain Traffic Signal Equipment (Requirement A).

Use this item on projects that are on either restricted highways or highways that are not restricted. It must be used at locations where the signal controller is not a State-supplied microcomputer. Under this item, the contractor must maintain the indicated existing, relocated, modified, and newly installed traffic signals as per the contract specifications, for the duration of the contract.

#### 2. Maintain Traffic Signal Equipment (Requirement B).

Use this item for the maintenance of existing or relocated traffic signals where a new State-supplied microcomputer is to be installed. Under this item, the State will assume operation and maintenance responsibility for the entire signal following the successful completion of electrical testing of the contractor's installation as prescribed in the *Standard Specifications*. This item minimizes the contractor's maintenance responsibility and should only be used where the Department's signal crews have the resources and interest in assuming maintenance responsibility.

#### 3. Maintain Traffic Signals Equipment (Requirement C).

Use this item to provide maintenance for existing or relocated signals where a State-supplied computer is in place before the contract begins. This item could also be used for

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

new computer installations. Under this item, the Contractor must maintain the existing signal, with the exception of the four items listed in the *Standard Specifications* (all are related to the microcomputer itself), for the duration of the contract. The State is responsible for the four items excluded from contractor maintenance. At relocated, modified, or newly installed signals, the State is responsible for the four items after the Contractor's installation has performed successfully in the required electrical tests. This item was designed to allow the Department signal crews to maintain the microcomputer-related items with which contractors were formerly inexperienced. Since this item was developed, contractors have gained familiarity with the microcomputer items.

### 4. Maintain Traffic Signal Equipment (Off-State System) Special Specification Item 619.1605--15.

Use this item for highways that are not on the State Highway System. Under this item, the contractor must maintain existing and newly installed traffic signal equipment.

The designer should consult with the Regional Traffic Engineering and Safety Group before selecting one or more of the above items for use on a given project.

### C. Intersections

The large number of intersections associated with urban arterial work zones introduce many difficulties related to work zone traffic control. Most of these difficulties are related to vehicle maneuvering and the intersection geometrics.

#### 1. Street Name Signs.

Large street name signs (construction signs with minimum Series D lettering) with block numbers should be provided at major signalized intersections, if possible. These street signs should be mounted overhead (on existing signal mast arms or span wire) to increase their visibility. (A structural analysis or span-wire analysis will be necessary.) When construction begins, many of the navigational aids, such as street signs, business signs, and addresses, that drivers use are removed or become less visible. Locating street signs overhead at signalized intersections will improve the visibility of street name signs. In some cases, it may be useful to provide advance or midblock guidance, e.g., MAIN ST./300 FT.

#### 2. Driveway and Intersection Radii.

As large a turning radius as possible should be maintained at driveways and intersections. Making it easier for vehicles to turn in and out of intersections and driveways by increasing the turn radius to reduce the potential for encroaching on adjacent lanes may help reduce accidents. This should be based on the type and size of vehicles to be accommodated and their turning radius templates. If turns cannot be accommodated, consider prohibiting turns by those vehicles. Driveway access should be maintained to the maximum extent practicable to avoid adverse impacts on residences and commercial properties.

D. Lane Closures

Although lane closures have a significant impact on traffic flow, they are a necessary part of many construction projects. The detrimental effects of lane closures include the creation of queues that block intersections and driveways, the compounding of peak-period traffic congestion, and an increase in erratic lane changing.

1. Arrow Panels.

Major arterials typically have high speeds and heavy volumes - conditions well suited to the use of an arrow panel for lane closures. Arrow panels shall be used on high-speed and/or high-volume arterials in the same manner as for freeway lane closures. Solar-powered arrow panels are preferred for their elimination of noise and fumes in commercial and residential areas.

2. Location of Lane Closures.

Lane closures should be set up so that the queue will not block signalized intersections upstream of the lane closure. If the lane closure is located too close to a signalized intersection, the queue may back up into the intersection and prevent cross-street traffic from entering the intersection. Sufficient distance should be provided between the lane closure and the intersection so that the queue will not block cross-street traffic. If this cannot be done, the lane closure should be extended upstream of the intersection. This will allow for platooning rather than jockeying for position just beyond intersection work area.

Lane closures should be located on a tangent section of roadway, if possible, making them more visible to approaching drivers, allowing them to change lanes farther in advance of the merge point.

Where possible, the lane closure should be located so that there are no intersections, driveways, or temporary median crossovers in the taper area or within 60 m to 90 m of the beginning of the taper.

Other alternatives include posting signs, e.g., DO NOT BLOCK SIDE ROAD (R9-4) or providing flaggers or police officers to keep traffic from blocking the intersection.

3. Signing for Lane Closures.

Signing for a lane closure should be located upstream and downstream of a signalized intersection if the lane closure is less than 460 m downstream of a signalized intersection and arterial traffic volumes are high. Where drivers may not be able to see the lane closure or signing for a lane closure when it is located close to a signalized intersection. The higher traffic density associated with departure flow from a signalized intersection eliminates many lane-changing opportunities downstream of the intersection. Placing the lane closure signing in advance of the signalized intersection gives drivers the opportunity to change lanes before reaching the queue at the intersection. Signing should also be provided on the cross street approaching the intersection to advise drivers that they are going to encounter construction. ROAD WORK AHEAD signs (W8-1) should be used for approaching lanes and END ROAD WORK signs (G11-2) should be used for retreating lanes.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

### E. Speed Control

Speed restrictions should be avoided, if possible. If they are necessary, they should be carefully selected, recognizing that it may be necessary to supplement them with other more positive means of controlling driver behavior.

1. Speed Limits.

Speed limits should be selected to be consistent with site conditions. The normal arterial speed should be maintained in the urban arterial work zone, if possible. If speed restrictions are necessary, they should be carefully selected with the recognition that additional measures may be needed to slow traffic. Refer to §16.4.7.

2. Enforcement Areas.

An enforcement area should be provided for police activities. The space restrictions associated with arterial construction may reduce the ability of police to enforce traffic laws. Police are hesitant to issue citations if a safe area to do so is not available.

### F. Channelization

The spacing of channelizing devices has some unique implications in urban arterial work zones. At speeds found on many arterials, vehicles can travel between the devices at standard spacing and drive on the wrong side. Drivers may cross the line of channelizing devices to make an illegal turn, to pass an area of congestion, or because they are confused. Reduce the spacing to one-half the standard spacing to discourage drivers from crossing into the work space. In addition, place channelizing devices transversely across the closed lane between driveways and side streets.

### G. Pavement Markings

The relocation of traffic lanes requires existing markings to be removed or covered and temporary markings to be placed. However, it is difficult to completely remove obsolete pavement markings. Short of placing an overlay over old pavement markings, there is no method that will obliterate permanent pavement markings without leaving a scar.

Raised pavement markers, in conjunction with pavement markings, should be used to enhance lane delineation in potentially hazardous areas. Black-mask covering tape placed over the pavement markings will conceal them or hydro-blasting may be effective in removing them. Raised pavement markers can be easily placed and removed, and after removal, the remains of the markings do not provide as visible an indication of the former lane lines as other types of markings. Raised pavement markers have greater visibility in periods of wet weather at night, but they are not suitable alone, especially during daylight hours. They provide a tactile indication to the driver when the vehicle begins to change lanes but may be a problem for motorcyclists and bicyclists. Alone, they do not provide adequate guidance through curves, and are more easily destroyed by vehicles, especially on curves. Refer to §16.2.8 in this chapter for further guidance in raised pavement markers. Wet reflective tape can be specified as an

alternative to raised markers.

#### 16.4.7.6 One-Lane-Road Traffic Signals at Work Zones

Refer to Chapter 11 of this manual for design guidance for one-lane-road traffic signals.

#### 16.4.7.7 Detours

A detour is a temporary rerouting of road users onto an existing highway in order to avoid a temporary traffic control zone.

When on-site traffic control methods are not appropriate, detours may be required. Construction operations which sometimes require detours are:

- Bridge replacements.
- A significant raising of the existing highway profiles while utilizing the same, or nearly the same horizontal alignment.
- Construction of grade separations at highway crossings.
- Reconstruction work on bridge approach slabs.
- Combination of fill widening and profile.
- Culvert replacements for culvert spans of 2.4 m or greater.
- Miscellaneous work that requires trenching across the highway for long periods of time.
- Other work requiring profile changes at frequent intervals along the segment of roadway being improved.
- Bridge rehabilitation where there is not enough width to adequately maintain traffic under staged construction.

##### A. Considerations for Detours

When a route is proposed for selection as a detour, it should be inspected to determine if it is adequate, e.g., the horizontal and vertical alignment and “structural” condition to carry the additional traffic. Consideration should be given to the percentage of trucks using the highway and to whether or not the detour route is restricted to certain types of vehicles. If a proposed route does not have the capacity or capability to handle the expected traffic volumes, it should be adequately improved or dropped from consideration. The information obtained should include a detailed surface condition report and recommendations for reinforcement or modification of the proposed route and recommendations for traffic control and signing on the proposed route. An example of a form that may be used when establishing a detour is provided in Appendix 16A, Exhibit 16A1.

There are many considerations to be made by the designer when evaluating detour routes. The following list is not all-inclusive, nor are all items applicable to all detours.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

- State highway or local road.
- Cross section shape (normal or rounded crown).
- Lane and shoulder widths.
- Mainline and intersection horizontal and vertical geometry and sight distances.
- Pavement/shoulder structure and condition; need for repairs.
- Weight and height restrictions on the detour route.
- Minimum design criteria.
- Duration of the detour (short-term or long-term).
- Length of the detour vs. length of road to be closed from the beginning to the end of the detour.
- Determine existing pavement markings and signing for upgrading to conform to NYSDOT standards.
- Existing level of traffic control (signing, signals, pavement markings, etc.).
- Speed limit on the detour route.
- Travel time on the detour route.
- Peak-hour traffic volumes (local + detoured); heavy-truck volumes.
- Level of service.
- Accident rates and potential problem areas.
- Capacity restrictions/analysis.
- Ability to handle trucks (geometric restrictions) and over-dimensioned permitted vehicles.
- Commuter transfer facilities (e.g., bus stops, park-and-ride lots).
- Local traffic generators (events, employment centers, etc.).
- Adjacent or nearby projects.
- Structural condition of bridges and pavement on the detour route.
- Pedestrian and bicyclist access and accommodation.
- Roadside hazards and safety issues (steep slopes, drop-offs, fixed objects, clear zone, condition and location of guide rail).
- Emergency services access.
- Railroad crossings.
- Neighborhood characteristics.
- Economic impacts on businesses.
- Effects on school bus routes.
- Use by farm machinery.
- Environmental effect of any necessary construction.

The Regional Traffic Engineering and Safety Group should be consulted for assistance.

A problem omission is failure to consider the need to modify the existing signing along the detour. A survey of existing signs along the detour, the approaches to the detour, and within the closed section of the roadway (especially if it is open to local traffic) is necessary. The information gathered should be incorporated into the detour signing plan.

This is most important for destination and information signs and route marker assemblies. If, for instance, the distance to a destination is based on the closed route, the sign must be modified to reflect the distance along the detour. Existing route marker assemblies along the

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-129

detour must also be modified with the addition of DETOUR (G-11) route markers.

Traffic generators located within the closed section should also be considered. Informational and directional signing should be provided for travelers whose destinations are located within the closed section. Examples of such destinations might include colleges, state/local parks, stadiums, race tracks, etc.

Road closures and detours may have distinct advantages and disadvantages, as shown in Exhibit 16-18.

The designer should investigate each of these issues and others specific to the particular project during the initial evaluation of off-site detours. Contact the Regional Traffic Engineering and Safety Group or local authorities for accident locations and numbers for on-system detours or off-system detours, respectively.

Detours require considerable traffic control, especially with high-speed freeway traffic. Drivers should be provided with enough information in advance of and throughout the detour to allow them time to make decisions and to help them determine how to return to the original roadway.

Reasonable advance notice should be provided to highway users when a highway or bridge is to be closed and traffic detoured. It is recommended that 1-2 weeks be allowed. The message can be passed on by traffic reports, television and radio spots, etc. Portable (and stationary, if available) variable message signs should be used in most cases.

The Highway Law requires that designated detour routes be signed. Refer to the MUTCD for examples of detour signing on designated detours.

Similarly, local businesses within a closed section of highway may be affected by loss of traffic when detour routes are employed. If possible, this problem should be minimized by taking care in scheduling and/or by providing temporary generic business signing, however, a roadside business has no legal claim to a given volume of passing traffic.

When considering a detour over a locally owned road, the detour construction cost will be limited to the basic work items normally considered under Section 619 of the *Standard Specifications* or pavement repairs that are needed for the detour to function for the life of the construction contract. This would include the installation, maintenance, and removal of items such as signs, pavement striping, etc. Special features such as pedestrian access and emergency services, if necessary, may also be included as legitimate project charges. Any substantial capital improvements requested by the municipality that are not absolutely necessary to make the detour work for the duration of the contract must be paid for by the municipality under a Betterment Agreement. However, if the municipality is not satisfied with the proposed detour improvements, they can deny use of their road(s) by the State.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Exhibit 16-18 Advantages and Disadvantages of Road Closures and Detours**

ADVANTAGES	DISADVANTAGES
<ol style="list-style-type: none"> <li>1. Conflicts between traffic and the work activity are eliminated.</li> <li>2. Driver avoids congestion in the work zone.</li> <li>3. Safer for the workers.</li> <li>4. Shortens the construction schedule.</li> <li>5. May provide permanent improvements to the detour route.</li> </ol>	<ol style="list-style-type: none"> <li>1. Longer driving time.</li> <li>2. Higher user costs.</li> <li>3. Lower level of service on the detour route.</li> <li>4. Higher traffic volumes and accident rates on the detour route.</li> <li>5. Driver confusion caused by unclear and infrequent signing.</li> <li>6. Disruption to local business traffic and emergency vehicles.</li> <li>7. Costly upgrading may be necessary to prepare the detour for increased traffic.</li> <li>8. Not usually possible except on low-volume roads.</li> </ol>

**B. Establishing a Detour**

When it is determined that a state highway must be closed and local road detours are needed to reroute traffic during project construction/reconstruction, the “owner” of the local road is contacted and the following procedure is followed.

For proposed detours which require improvements/repairs to handle increased traffic, refer to EI 82-39, Example 14-5, Detour Resolution, revised May 1982. The resolution or letter should clearly state that the Department will maintain the detour road during the period of use per Section 619, excluding snow and ice control.

An Official Order for temporary takeover of the local road by the State must then be issued. To fulfill the requirements of Section 42 of the Highway Law, the designer must prepare a draft official order for the closure of a highway as prescribed in the Manual of Administrative Procedures (MAP) 2.5-1-1, Official Orders, and include any necessary supporting documentation such as detailed descriptions of the property, maps, the section to be closed, and the temporary detour route. It must be cleared by all affected Regional Units and submitted to the Regional Director for concurrence, after which it is to be sent to the Office of Operations for final approval and issuance to the Town Clerk. The construction contract documents must specify the necessary improvements/repairs to be made to the detour during the period it is a temporary State highway, in accordance with *Standard Specifications* Section 619. The official order can be conveniently filed concurrently with the “Notice of Restricted Highway” filing for the contract to the same recipients.

Where no detour improvements are needed to handle traffic, the construction contract documents must specify the erection and maintenance of necessary detour signs, to meet the requirements of Section 104 and Section 10, Subdivision 19 of the Highway Law. While no

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-131

Official Order is required, the designer should obtain a detour resolution. Refer to EB 83-023 for an example "Detour Resolution." It should state the Department's intent to use the local road detour as written concurrence from the local jurisdiction, and make it clear to the local jurisdiction that the Department's maintenance responsibility on the detour road will be limited to the detour signs only.

When detour routes are used, signing should be sufficient to direct motorists back to the route from which they were detoured, i.e., detours must maintain the continuity of the closed route. Detour directional signing and confirmatory signing should conform to Sections 254 and 255 of the MUTCD.

When State highways are utilized for project detours, maintenance of the detour will be performed by State forces, except that the contract documents must specify the Contractor is responsible for the necessary erection, maintenance, and removal of detour signs.

It is sometimes desirable and sometimes necessary to close single-lane ramps for paving or other work operations since it can generally be done in just a few hours. Designated (signed) detours should always be provided when the closed ramp serves to interchange traffic between numbered touring routes, i.e., when some of the traffic may be using the route numbering system to navigate.

Sufficient advance notice must be given since the designated detour exit may precede the closed exit. Variable message signs are ideal for these short-term closures.

### 16.4.7.8 Diversions

A diversion is a temporary rerouting of road users onto a temporary highway or alignment placed around the work area. Figures 6H-7 in the National MUTCD and 302-10 in the NYSMUTCD illustrate a work-site diversion for bridge and culvert replacements on a conventional highway.

Diversion radii should be determined using Figure 231-1 in the NYSMUTCD. Ideally, the speed used to determine the radii should be the same as the existing speeds at the site (usually the regulatory speed limit can be used). Where right of way constraints or excessive costs preclude the use of the existing speed, a lower speed may be acceptable. To determine an acceptable speed, consult the Traffic Engineering and Safety Group. For high-speed roadways, a 10-mph or 15-mph reduction may be acceptable. For low-speed roadways, a 5-mph or 10-mph reduction may be acceptable. Because the superelevation of the curves at each end of the detour will be dependent on the cross slope of the existing highway, those curves may need to be flatter than the center curve where the desired superelevation can be designed.

The tangent lengths along the diversion will vary depending on site or right of way constraints. Generally, a minimum length of 30 m should be provided. In extreme cases, it may not be possible to achieve any tangent.

Lane widths along the diversion should be determined using the appropriate lane width table in

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

Chapter 2 of this manual.

Diversion shoulder widths should be at least 1.2 m to accommodate pedestrian and bicycle traffic. Lesser widths may be acceptable if separate facilities for pedestrian and bicycle traffic are provided. The Regional Landscape Group should be consulted.

If a temporary bridge is required (as opposed to a temporary culvert), a tangent section will be required in the center curve where the temporary bridge is constructed. The length of the tangent should generally be twice the length of the existing bridge or 30 m minimum. The Regional Structures Group should be consulted.

Diversion geometry should be approved by the Regional Traffic Engineering and Safety Group and the Regional Structures Group before right of way take lines are established.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-133

**16.8 REFERENCES**

- Benefits and Safety Impacts of Night Work Zone Activities, 1986, Shephard, F.D., B.H. Cotrell, Jr. In *Transportation Research Record 1086*. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- *Design and Operation of Work Zone Traffic Control*, Participant Handbook, NHI Course No. 38003 Participant Handbook, June 1996, FHWA-HI-96-037, P.A. Gibson, G. Lerch. Federal Highway Administration, Turner Fairbank Research Center, 6300 Georgetown Pike, McLean, VA 22101.
- Designation of Restricted Highway, draft design guidance, July 1, 2002. Design Quality Assurance Bureau, Albany, NY 12232.
- *Developing Traffic Control Strategies*, NHI Course No. 13332 Users Handbook, July 1997, FHWA-HI-97-029. USDOT, FHWA, NHI, Federal Highway Administration, 400 Seventh Street, SW, Washington, DC, 20590.
- Development of Work Zone Lighting Standards for Nighttime Highway Work, 1996, Ellis, R.D., Jr., S.J. Amos. In *Transportation Research Record 1529*. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- Draft Engineering Instruction, Quickchange Moveable Concrete Barrier, January 25, 1995, by Safety Program Management Bureau, NYSDOT, Albany, NY 12232.
- Draft Moving Work Zone Typical memo from J.J. Barnack, November 10, 1992. NYSDOT Safety Capital Projects Bureau, Albany, NY 12232.
- Draft Policy and Guidelines for Variable Message Signs for NYSDOT, July 13, 2000. Traffic Engineering and Highway Safety Division, Albany, NY 12232.
- Engineering Bulletin 02-047 Quality Assurance of Work Zone Maintenance and Protection of Traffic.
- Engineering Directive 99-002 Work Zone Intrusion Countermeasures.
- Engineering Instruction 75-062 Section 619, Standard Sheets, and Specifications.
- Engineering Instruction 82-039 State Highway Closure and Detour Maintenance.
- Engineering Instruction 85-041 Restricted Highway Designation.
- Engineering Instruction 89-015 Policy for Construction Zone Pavement Markings.
- Engineering Instruction 89-019 Addendum to EI 89-015.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

- Engineering Instruction 89-022 Maintenance and Protection of Traffic: No Pavement Repair or Overnight Closures.
- Engineering Instruction 89-023 Short-Term Pavement Markings.
- Engineering Instruction 89-031 Obtaining EIC Input on Design Plan Quality.
- Engineering Instruction 90-003 Maintenance and Protection of Traffic: Delineation, Channelization, and Drop-Off Protection.
- Engineering Instruction 91-001 Method of Traffic Maintenance During Construction.
- Engineering Instruction 91-002 "Work Zone" Construction Sign.
- Engineering Instruction 92-039 Vehicle Arresting Barrier - Net Type.
- Engineering Instruction 93-013 Traffic Control Plans - Safe Work Site Access.
- Engineering Instruction 93-018 Flashing Arrow Boards - Use and Procedures.
- Engineering Instruction 95-003 Requirements for Maintenance and Protection of Traffic During Nighttime Construction.
- Engineering Instruction 95-005 Lighting for Nighttime Operations - Special Specification.
- Engineering Instruction 95-032 Construction Work Zone Speed Limits - Guidelines and Documentation.
- Engineering Instruction 96-001 Temporary Rumble Strips for Construction Work Zones.
- Engineering Instruction 96-020 Construction Zone Pavement Markings.
- Engineering Instruction 96-027 Nighttime Construction.
- Engineering Instruction 99-013 Constructibility Review.
- Engineering Instruction 99-033 Time-Related Contract Provisions.
- Engineering Instruction 99-034 Short-Term Pavement Markings.
- Engineering Instruction 00-016 Fines Doubled for Speeding in Work Areas Signs.
- Engineering Instruction 00-017 Class A Containment System Guidance.
- Engineering Instruction 01-013 Solar-Charged Flashing Arrow Boards.

## MAINTENANCE AND PROTECTION OF TRAFFIC IN HIGHWAY WORK ZONES

16-135

- Engineering Instruction 01-015 Two-Lane, Two-Way Operations.
- Engineering Instruction 01-019 Maintenance and Protection of Traffic for Pedestrians/Bicyclists
- Engineering Instruction 01-020 Context Sensitive Solutions (CSS)
- Engineering Instruction 03-039 Temporary Rumble Strips for Construction Work Zones.
- Engineering Instruction 03-047 Fines Doubled for Speeding in Work Zones Signing.
- Engineering Instruction 05-014 Motorcycle Safety Measures on Milled Pavements - Design Guidance.
- Engineering Instruction 05-031 Design Guidance for Portable, Variable-Message Signs.
- *Feasibility of Portable Traffic Signals to Replace Flaggers in Maintenance Operations*, February 2000, G.S. Daniels, S. Venglar, D. Picha. Texas Transportation Institute, The Texas A&M University System, College Station, TX, 77843-3135.
- *Federal Aid Policy Guide*, 1991, Federal Highway Administration, 400 Seventh Street, SW, Washington, DC, 20590.
- *Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians*, 2001, FHWA-RD-01-015, L. Staplin, K. Lococo, S. Byington, D. Harkey. Office of Safety R&D, Federal Highway Administration, 6300 Georgetown Pike, McLean, VA, 22101-2296.
- Guidelines for Placement of Shadow Vehicles memo from T.C. Werner, March 14, 1991. NYSDOT Traffic Engineering & Safety Division, Albany, NY 12232.
- *Guidelines for the Use of Portable Traffic Signals in Rural Two-Lane Maintenance Operations*, February 2000, G.S. Daniels, S. Venglar, D. Picha. Texas Transportation Institute, The Texas A&M University System, College Station, TX, 77843-3135.
- Guidelines for the Use of Truck-Mounted Attenuators in Work Zones, 1991, J.B. Humphreys, T.D. Sullivan. In *Transportation Research Record 1304*. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- *Highway Policies and Procedures Manual*, Maryland Department of Transportation, State Highway Administration, Office of Highway Development, Highway Design Division, 7491 Connelly Drive, Hanover, MD 21076.
- *Highway Capacity Manual 2000*. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

- Implementation of Work Zone Speed Control Measures, 1986, S.H. Richards, C.L. Dudek. In *Transportation Research Record 1086*. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- *Improvements and New Concepts for Traffic Control in Work Zones*, Volume 4 Speed Control in Work Zones, 1985, FHWA/RD-85-037, S.H. Richards, R.C. Wunderlich, C.L. Dudek, R.Q. Brackett. U.S. Department of Transportation, Federal Highway Administration, Office of Safety and Traffic Operations Research, Washington, DC 20590.
- *Manual of Uniform Traffic Control Devices Millennium Edition*, 2001. The American Traffic Safety Services Association (ATSSA), 15 Riverside Parkway, Suite 100, Fredericksburg, VA 22406-1022; The Institute of Transportation Engineers (ITE), 1099 14<sup>th</sup> Street, NW, Suite 300 West, Washington, DC 20005-3438; The American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street, NW, Suite 249, Washington, DC 20001.
- *Nighttime Construction Issues*, 2001, D.E. Hancher, T.R.B. Taylor. Paper presented at the Transportation Research Board Annual Meeting, January 2001, summarizing the findings of the Kentucky Transportation Cabinet Study KTC-00-16, Nighttime Construction Issues.
- *Official Compilation of Codes, Rules, and Regulations of the State of New York*, Title 17 Transportation Volume B, (a.k.a. the New York State Manual of Uniform Traffic Control Devices), 2001. Secretary of State, State of New York, Department of State, 41 State Street, Albany, NY 12231.
- Policy on Moveable Concrete Barrier, June 25, 2001, by NYSDOT Region 11, Long Island City, NY 11101.
- Procedure to Minimize Motorists' Costs and Inconvenience, Bureau of Design and Environment, BDE Procedure Memorandum 99-35, November 1, 1999. Illinois Department of Transportation, 2300 South Dirksen Parkway, Springfield, IL 62764.
- *Recommended Practices for Use of Traffic Barrier and Control Treatments for Restricted Work Zones*, 1994, NCHRP Report 358, H.E. Ross, Jr., R.A. Krammes, D.L. Sicking, K.D. Tyer, H.S. Perera. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- *Road Design Guide*, 1996, Task Force for Roadside Safety of the Standing Committee on Highways Subcommittee on Design. American Association of State Highway and Transportation Officials, 444 North Capitol Street, NW, Suite 249, Washington, DC 20001.
- *Roadside Design Manual*, Appendix A. Virginia Department of Transportation, Location and Design Division, 1221 East Broad Street, Richmond, VA 23219.
- *Roadway Design Manual*, New Jersey Department of Transportation, 1035 Parkway Avenue, PO Box 600, Trenton, NJ 08625.

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

16-137

- Speed Limits in 65 mph Work Zones - Signing Requirements memo from T.C. Werner, August 31, 1995. NYSDOT Traffic Engineering and Highway Safety Division, Albany, NY 12232.
- Standard Drawing TM525, Oregon Department of Transportation, Traffic Management Section, 355 Capitol Street NE, Salem, OR 97301-3871.
- *Standard Specifications, Construction and Materials*, January 2, 2002. NYSDOT, Albany, NY 12232.
- Supplemental Directive, Supplement No. 1: Speed Limits in Maintenance and Construction Work Zones, September 23, 1993, by NYSDOT Traffic Operations Bureau, Albany, NY 12232.
- Traffic Control Guidelines for Urban Arterial Work Zones, 1993, H.G. Hawkins, Jr., K.C. Kacir. In *Transportation Research Record 1409*. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- *Traffic Engineering Manual*, Minnesota Department of Transportation, Office of Traffic Engineering, Mail Stop 725, 2<sup>nd</sup> Floor, 395 John Ireland Boulevard, Saint Paul, MN 55155-1899.
- *Transportation Management for Major Highway Reconstruction*, Special Report 212, Proceedings of the National Conference on Corridor Traffic Management for Major Highway Reconstruction, 1987. Transportation Research Board, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418.
- Work Zone Safety Traffic Control Plans for Special Situations memo from K. Shiatte, August 16, 1989. Construction Division, Albany, NY 12232.

**This page is intentionally left blank.**

# **APPENDIX**

**This page is intentionally left blank.**

**APPENDIX 16A**  
**LOCAL ROAD DETOUR INFORMATION FORM**

16A-1

**Exhibit 16A-1 Detour on Local Road - Example**

DETOUR ROUTE ON LOCAL ROAD FOR S.H. NO. \_\_\_\_\_ Region No. \_\_\_\_\_

1. Local route no. \_\_\_\_\_ Municipality & County \_\_\_\_\_
2. Reason for detour \_\_\_\_\_
3. Total length of detour (including portions of other S.H.s if used). \_\_\_\_\_
4. Mileage of S.H. No. \_\_\_\_\_ closed. \_\_\_\_\_
5. Designation and mileage of each road, and mileage of each surface type of road used as detour. \_\_\_\_\_  
\_\_\_\_\_
6. General and minimum width of each surface type. \_\_\_\_\_  
\_\_\_\_\_
7. Will adverse weather affect the detour? \_\_\_\_\_  
If so, an additional sheet for an alternate road should be prepared.
8. List all structures on detour indicating those limited to less than 20 tons. Also list limited clearances. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
9. Will an additional detour be needed for this project? \_\_\_\_\_
10. Who will maintain the detour? \_\_\_\_\_
11. Approximate date the detour will become effective. \_\_\_\_\_
12. If the detour is in a city of village, give the names of streets used, the type, and the mileage. \_\_\_\_\_  
\_\_\_\_\_
13. Proposed detour, including questionable structures, should be inspected by the Regional Maintenance Engineer and the responsible local official.  
Comments: \_\_\_\_\_  
\_\_\_\_\_
14. Attach a detailed description and sketches of the detour.

*Adapted from MnDOT Traffic Engineering Manual*

**This page is intentionally left blank.**

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

**Chapter 16**

**Index**

<u>Subject</u>	<u>Page</u>
Activity area	16-36,16-39,16-40,16-46,16-66,16-70,16-71
Advance warning area	16-66,16-105
Arrow panel	16-17—16-19,16-51,16-52,16-109,16-125
Barrier flare	16-42,16-43
Barricade	16-10,16-17,16-20,16-21,16-23,16-24,16-44,16-48,16-49,16-51,16-73, 16-107,16-109
Buffer space	16-9,16-20,16-22,16-36,16-51,16-66,16-68,16-70,16-71,16-100, 16-105,16-108,16-109
Channelizing devices	16-8,16-9,16-18,16-20—16-25,16-28,16-36,16-39,16-41—16-43 16-45,16-51—16-53,16-71,16-100,16-104,16-105,16-107—16-111, 16-113—16-116,16-126
Cone	16-20—16-22,16-24,16-28,16-36—16-38,16-74
Delineator	16-24,16-25,16-32,16-74,16-115
Detour	16-11,16-12,16-20,16-26,16-31—16-33,16-60—16-63,16-74—16-77,16-79,16-82, 16-86,16-87,16-105,16-107,16-111,16-113,16-127—16-131
Diversion	16-9,16-26,16-60,16-62,16-87,16-90,16-95,16-131,16-132
Drum	16-12,16-20—16-24,16-28,16-49,16-84
Enforcement area	16-66,16-71,16-91,16-102,16-126
Final pavement marking	16-26—16-34
Flagger station	16-36—16-38
Highway work zone - component parts	16-69
Interim pavement markings	16-20,16-25,16-31—16-33
Lane closure	16-4,16-9,16-11,16-17—16-19,16-24,16-26,16-31,16-32,16-45—16-47, 16-49,16-52,16-67,16-85,16-87,16-88,16-91,16-98,16-100,16-102, 16-107—16-109,16-115,16-116,16-121,16-125
Multiple speed zones	16-90
Nighttime construction	16-1,16-3,16-11,16-19,16-22,16-23,16-46,16-61,16-63,16-73,16-88, 16-107,16-109,16-111,16-112
Oversize vehicle	16-61,16-81,16-82
Pavement marking materials	16-28,16-32
Pavement marking	16-8,16-20,16-26—16-35,16-39,16-56,16-60,16-80,16-85, 16-86,16-92,16-93,16-105,16-113,16-114,16-121,16-126,16-128

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

Pavement edge drop-off protection	16-25
Permitted vehicle	16-81,16-107,16-128
Portable, variable-message sign	16-14,16-15,16-76,16-82,16-85,16-91,16-102,16-104
Raised pavement marker	16-24,16-28,16-30—16-32,16-34,16-35,16-104,16-126
Ramp	16-10,16-12,16-22—16-24,16-48,16-49,16-62,16-67,16-73,16-76, 16-83,16-98,16-107—16-111,16-131
Restricted highway	16-90,16-61,16-92—16-94,16-123,16-130
Road closure	16-9,16-24,16-107,16-129,16-130
Sign	16-8—16-19,16-24,16-36,16-37,16-39—16-41,16-44,16-48,16-51,16-53, 16-56,16-57,16-60,16-61,16-62,16-66,16-67,16-71,16-73—16-80 16-82—16-86,16-88,16-88,16-91—16-102,16-104,16-105,16-107, 16-109—16-111,16-113—16-116,16-124,16-125,16-128—16-131
Speed control methods	16-100,16-101
Speed reduction	16-56,16-61,16-89,16-90,16-91,16-94—16-96,16-100,16-101
Speed limits	16-1,16-4,16-10,16-17,16-19,16-52,16-62,16-71,16-89—16-100,16-102, 16-103,16-109,16-111,16-113,16-116,16-126,16-128,16-131
Staged construction	16-62,16-86,16-105,16-112,16-127
Taper - downstream	16-68,16-70,16-71,16-116
- lane-closure	16-17,16-18,16-98,16-108,16-115,16-116
- lane-width	16-68,16-70
- merging	16-67,16-68,16-70,16-108,16-109
- one-lane, two-way	16-68
- shifting	16-68,16-70
- shoulder	16-68,16-70
Temporary pavement marking	16-26—16-31,16-33—16-35,16-80,16-85
Temporary concrete barrier	16-22,16-24,16-25,16-42,16-43,16-49,16-51,16-74,16-76, 16-91,16-107,16-108,16-112—16-116
Temporary rumble strips	16-1,16-56,16-59,16-114
Termination area	16-66,16-71
Traffic control devices	16-8
Traffic signal equipment - maintain	16-123,16-124
Traffic space	16-66,16-70
Transition area	16-9,16-20,16-36,16-66,16-67
Tubular marker	16-20—16-22,16-116
Vehicle storage space	16-66,16-71
Vertical panel	16-20—16-22,16-24

**MAINTENANCE AND PROTECTION OF TRAFFIC  
IN HIGHWAY WORK ZONES**

Warning lights . . . . . 16-17,16-18,16-24,16-25,16-48,16-56,16-107,16-111

- barrier . . . . . 16-41
- Type A . . . . . 16-12,16-24,16-41
- Type B . . . . . 16-24,16-41,16-107
- Type C . . . . . 16-24,16-41

Warning sign . . . . . 16-9—16-14,16-17—16-19,16-39,16-56,16-57,16-66,16-76,16-79  
. . . . . 16-80,16-82,16-89,16-95—16-98,16-107,16-111,16-114—16-116

Work space . . . . . 16-36,16-66,16-67,16-70,16-71,16-100,16-126

Work Zone Traffic Control Manual . . . . . 16-18—16-20,16-51,16-52,16-104,16-108