Work-Zone Traffic Control Concepts and Terminology

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An annotated glossary of the concepts, definitions, and standard terminology currently used and advocated in traffic control for highway construction, maintenance, and related activities is presented. For selected terms and categories, information is provided on the background, use, implications, and relevant principles. The objective is to achieve consistency in the use of these terms in preparing manuals, directives, and contract documents and in training, reporting research findings, and otherwise communicating on this subject. Much of the terminology recommended has been used, modified, and refined through decades of intensive work-zone training courses conducted for engineering, technical, and field personnel. This experience has shown that the precise use of words is not merely an academic exercise. The terminology that evolved promotes understanding and results in higher test scores. Good, clear, and consistent language aids understanding and yields a better product in the field. This in turn enhances safety, which is the ultimate objective.

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The objective is to achieve consistency in the use of these terms in preparing manuals, directives, and contract documents and in training, reporting research findings, and otherwise communicating on this subject. Much of the terminology recommended herein has been used, modified, and refined through decades of intensive work-zone training courses conducted for engineering, technical, and field personnel from public highway agencies, contractors, and utility companies. Many of these courses were part of a certification program that included a comprehensive final examination. This experience has shown that the precise use of words is not merely an academic exercise. The terminology that evolved promotes understanding and results in higher test scores. Good, clear, and consistent language aids understanding and yields a better product in the field. This in turn enhances safety, which is the ultimate objective.

Because many technical terms used in highway engineering are taken from common, widely used words, it is important to recognize the specific meaning when used in a technical context. Moreover, some terms in the general highway engineering literature take on a narrower or altered meaning when applied to work-area traffic control. Although most of the terms presented here have been tested and refined over the years, a few new terms have been developed to fill a void or reduce ambiguity.

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For established terms, most of the definitions given are consistent with those of AASHTO (*1,2*) and the *Manual on Uniform Traffic Control Devices* (MUTCD) (*3*). If this is not the case, the differences are explained or new terms are proposed to meet a recognized need. In some instances, the definitions given are deliberately conceptual rather than numeric. For example, in setting forth the various categories for project duration, specific numeric time limits are not given. Establishing such limits is considered to be an agency function, and agencies may well differ in their selections. Where work-zone tapers are defined, the criterion for taper length has been proposed (*4*). Definitions are grouped functionally rather than alphabetically in the following subject areas:

- General work-zone terms,
- Elements of the road system,
- Traffic control and devices,
- Traffic zones and components,
- Work-zone tapers,
- Project duration,
- Work activity,
- Closure types, and
- Mobile operations.

GENERAL WORK-ZONE TERMS

Road Users

> Road users are all those who may be using any portion of the highway right-of-way and its immediate environs. The term includes vehicle operators and passengers, cyclists, pedestrians, bystanders, and workers.

The term "road user" may be used for convenience and brevity, because it avoids the repetitious listing of all of these parties.

Work Zone, Work Area, and Work Site

> Work zone, work area, and work site denote the general location of a work activity or the subject of work-area traffic control.

The terms "work zone," "work area," and "work site" have been used in the titles of many handbooks, papers, and research reports on the subject of traffic control for highway construction and maintenance operations. In these contexts, the terms do not refer to any specific geographical area that is related

to the site. Because they have been so widely used as generic terms and are useful for that purpose, they should continue to be used as such.

The term "work area" has also been used to describe a specific portion of the traffic control zone. A replacement term, "activity area," is defined later. The reason for the proposed change is simply that because "work area" is widely used as a general term, any attempt to maintain a narrow and specific meaning is hopeless and incompatible with the need for consistent and precise terminology.

Traffic Control Plan

> A traffic control plan (TCP) is a plan for handling traffic through a specific highway or street work zone or project.

Traffic control plans may range in scope from a very detailed TCP designed solely for a specific project to a simple reference to such items as standard plans, a section of the MUTCD, or a highway agency manual. The degree of detail addressed in the TCP depends on the project complexity, traffic needs, and the extent of traffic interference with the construction activity.

The TCP definition and discussion are derived from the *Federal-Aid Highway Program Manual* (*5*). The TCP for a large project having significant traffic impact should address the entire traffic corridor. Using terms defined above, the traffic control zone involves only the facility where work is being performed, whereas the TCP should address the entire influence zone.

The design of a traffic control zone for a highway work site involves determining the geometry of the work-zone features and the selection and the location of all temporary traffic control devices. The general belief is that design is an engineering process involving discretionary decisions; therefore the designer needs to be educated or trained to fulfill this function. Field forces, however, are also involved in the selection and placement of devices that constitute traffic control zones.

For example, highway maintenance forces and utility companies are continually performing this work at least once and sometimes several times a day. In these instances, however, the intent is that features and application diagrams (designed by engineers) form the basis for their layouts. Training is needed to familiarize workers with the concepts and procedures, but the task is basically a subprofessional one. Thus, it is considered best to reserve the term "design" for the higher-level, decision-making process and use the term "layout" to denote the process in which typical standard designs are installed and adjusted to meet field conditions.

ELEMENTS OF THE ROAD SYSTEM

Several of the following terms are shown in Figure 1.

Roadway

> The roadway is the portion of a highway intended and available for vehicular use. It includes the traveled way and shoulders. A divided highway has two or more directional roadways.

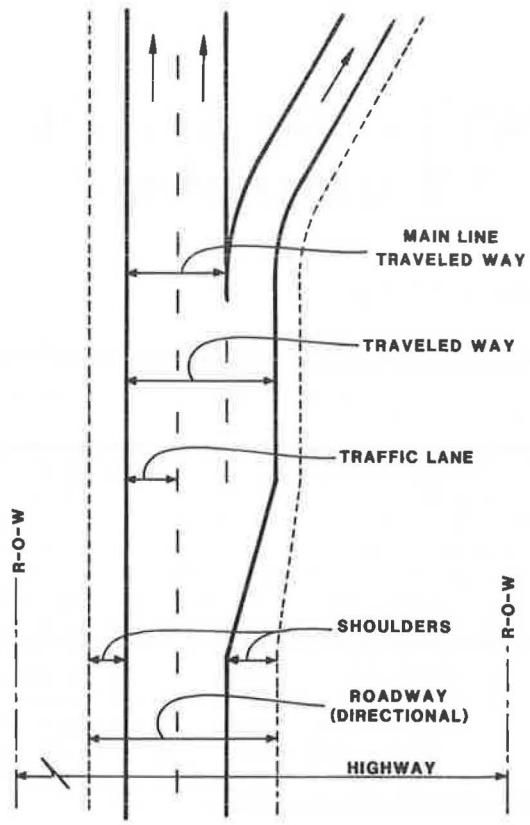

FIGURE 1 Elements of the road system.

The roadway extends from the outside of one shoulder to the outside of the other shoulder. In some instances, where the median is wide, work on the roadway in one direction may be undertaken essentially independently from the other direction.

This definition of the roadway is consistent with that employed by AASHTO (*1,2*) and with the general use of the term by practitioners of work-zone traffic control. However, in Section 1A-9 of the MUTCD, the roadway is defined as "that portion of a highway improved, designed, or ordinarily used for vehicular travel, exclusive of the berm or shoulder." It is not known why this discrepancy in definitions was created. If the more restrictive MUTCD definition prevails, a new term would be desirable to encompass the entire width, as given above.

Shoulder

> A shoulder is the portion of the roadway contiguous with the traveled way for emergency use by stopped vehicles, and for lateral support of the pavement.

A stabilized shoulder serves as a recovery space. The shoulder is normally kept free of all obstacles and roadside appurtenances, such as sign posts. However, if portable signs are used in work areas, they may be placed on shoulders to provide visibility and stability. It is noted that in some parts of the country, particularly in portions of the Midwest, a shoulder is called a "berm." In portions of New England, a shoulder is referred to as a "breakdown lane."

Traveled Way

> The traveled way is the portion of the roadway designated for the ordinary movement of vehicles; it extends from edge line to edge line.

The AASHTO definition, which excludes auxiliary lanes, is contrary to common use for work sites. It is suggested that it would be clearer to refer to this as the "main line" traveled way. Lanes used for travel include not only the main line lanes, but also other designated lanes, including auxiliary lanes (defined by AASHTO to include lanes used for parking, speed change, turning, storage for turning, weaving, truck climbing, etc.). Again, if the more restrictive definition is employed, a term is needed to encompass all travel lanes. To avoid confusion, the term "full traveled way" could be employed.

Traffic Lane

> A traffic lane is that portion of the traveled way for the movement of a single line of vehicles.

TRAFFIC CONTROL AND DEVICES

Traffic Control

> Traffic control is the process of regulating, warning, and guiding road users and advising them to traverse a section of highway or street in the proper manner.

Traffic Control Device

> Traffic control devices are signs, signals, markings, or other devices placed on or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide road users. At work sites, other traffic control devices are commonly employed, such as channelizing and delineating devices.

Traffic Sign

> A traffic sign is a device mounted on a fixed or portable support to convey an official message by means of words or symbols; it is officially erected for the purpose of regulating, warning, or guiding traffic.

A traffic sign provides information only to road users. If traffic is to be forced to follow certain paths, other devices must also be used.

Supplemental Plate

> A supplemental plate is placed below a sign to provide additional information related to that sign.

Two examples of supplementary plates commonly used in work zones are an advisory speed plate and an advisory distance plate. An advisory speed plate is placed below a warning sign to advise drivers of the appropriate speed of travel. An advisory distance plate is used on symbol signs—such as the WORKER sign and the FLAGGER sign—to warn of the distance between the sign and the situation depicted.

A supplemental plate is not used as a sign by itself—only in conjunction with another sign. When used in this manner, it is placed below the sign it supplements—either directly below the sign, or alternatively on the post adjacent to traffic on a two-post sign. The background color of the supplemental plate should be the same color as that of the principal sign. Therefore, supplemental plates used with construction and maintenance warning signs should have an orange background.

Standard Traffic Sign

> A standard traffic sign, as defined in the MUTCD, is used for a specific purpose and is placed in a prescribed location.

Special Traffic Sign

> A special traffic sign meets a need not covered by a standard sign and has been approved for use by the proper authority.

Nonstandard Traffic Sign

> A nonstandard traffic sign does not conform to the design, application, or placement criteria prescribed by the MUTCD—and does not meet the requirements for a special sign.

The MUTCD permits special warning signs under Section 2C-41, in which it is stated that warning signs other than those specified in the MUTCD may be required under special conditions. The MUTCD further states that such signs should conform with the general specifications for shape, color, and placement of warning signs.

Insofar as possible, legends and symbols used on special signs should be patterned from standard signs to allow rapid recognition and understanding. Many of the best special signs are symbol signs. Many configurations are used in work zones involving numerous lanes shifting in a variety of directions. Effective warning signs showing the required movements have been created using multiple reverse curve symbols or variations in the symbols shown on the DIVIDED ROADWAY AHEAD sign, or both.

Maintenance crews, contractors, and sign shop personnel should be restricted to the fabrication and use of standard signs for normal operations. When a special sign is desired, its design and use should be approved by a senior traffic engineer with the highway agency.

Channelizing Device

> Channelizing devices are used to warn and alert drivers of hazards created by work activities in or near the traveled way and to guide and direct drivers safely past the hazards. Channelizing devices include but are not limited to cones, vertical panels, drums, and barricades.

Channelizing devices are intended to perform their function by being viewed. They should be no more formidable than needed for stability, and when hit should readily yield, collapse, or break away.

Traffic Barrier

For work-zone traffic control, a barrier is a device designed to prevent vehicular penetration into areas behind the barrier.

Temporary barriers may be placed in or adjacent to the roadway. They may be placed adjacent to traffic lanes to separate the travel area from the work space. They may also be used to separate two-way traffic and vehicular and pedestrian flows. Insofar as practical, traffic barriers should be designed to minimize damage to the vehicles that strike them and the occupants of those vehicles. Barriers perform their primary function physically, whereas channelizing devices perform by being viewed. Barriers may also serve as channelizing devices. When so used, barriers may need supplemental devices or markings to enhance their visibility, especially at night when they are positioned adjacent to a travel lane.

There are two categories of barriers used in work zones—longitudinal barriers and crash cushions. Crash cushions, also called energy attenuators, may be stationary, portable, or vehicle mounted. Mobile longitudinal barriers also have been developed to protect workers, but their use is still essentially in the experimental stage.

The AASHTO barrier guide defines a traffic barrier as "a device used to shield a hazard that is located on the road side or in the median, or a device used to prevent crossover median accidents" (*6*). This definition is not well adapted to temporary barriers used in work zones.

TRAFFIC ZONES AND COMPONENTS

In 1974 when the original work-zone training course was prepared for FHWA, no consistent terminology existed for the description of the various locations in which devices are placed when temporary traffic control is set up for a work activity. To meet this need, three common terms were selected that possessed similar meanings.

The broad term is "zone." The zone is subdivided into several "areas," and a "space" is a portion of an area. The zone and areas begin and end at a line that is essentially perpendicular to the roadway center line. Laterally, they extend across the entire roadway, and in some cases may be thought of as extending to the right-of-way lines. A possible exception is on a divided highway with a wide median where work is taking place only on one side of the directional roadway and the other roadway is completely unaffected by the operation. In this instance the zone and areas may be considered as extending only to the center line of the highway.

An area may contain one or more "spaces." Typically, the space begins and ends at a line transverse to the roadway, but extends over only a portion of the roadway width. Laterally, it may consist of the shoulder or one or more lanes.

These concepts were later incorporated into FHWA's *Traffic Control Devices Handbook* (TCDH) (*7*). The definitions were later compromised when a "buffer space" added to a diagram was improperly drawn and given the attributes of an area.

Traffic Control Zone

A traffic control zone for temporary traffic control at a work site is the entire section of the roadway over which control related to the work operation is exercised and in which any temporary traffic control devices are placed.

The traffic control zone extends from the first advanced warning sign to the last device, typically a sign indicating the end of the zone (see Figure 2). The traffic control zone includes an advance warning area, a transition area, an activity area, and a termination area. The definitions of these terms are given below. Note that some traffic control zones may not contain all four areas. For example, a zone for shoulder work can be designed with only an advance warning area and an activity area.

The clear demarcation of areas within the zone, as defined below, applies primarily to stationary zones. For mobile operations, discussed later, the areas may overlap. For example, the advance warning and transition areas may in part be provided by high-visibility lights or arrow panels mounted on one or more vehicles located at the rear of the mobile activity area.

Advance Warning Area

The advance warning area starts at the beginning of the traffic control zone and extends to the transition area—or activity area if no transition area is used. The driver is given information about the hazards ahead and the actions needed to travel safely through the areas beyond. As soon as a channelizing device is encountered or a change in the normal travel path is imposed, the motorist has entered the next area.

All traffic control zones should have an advance warning area. The only temporary traffic control devices placed in this area are the black-on-orange warning signs specified for construction and maintenance operations. The advance warning area may extend for a mile or more on a major highway or a few

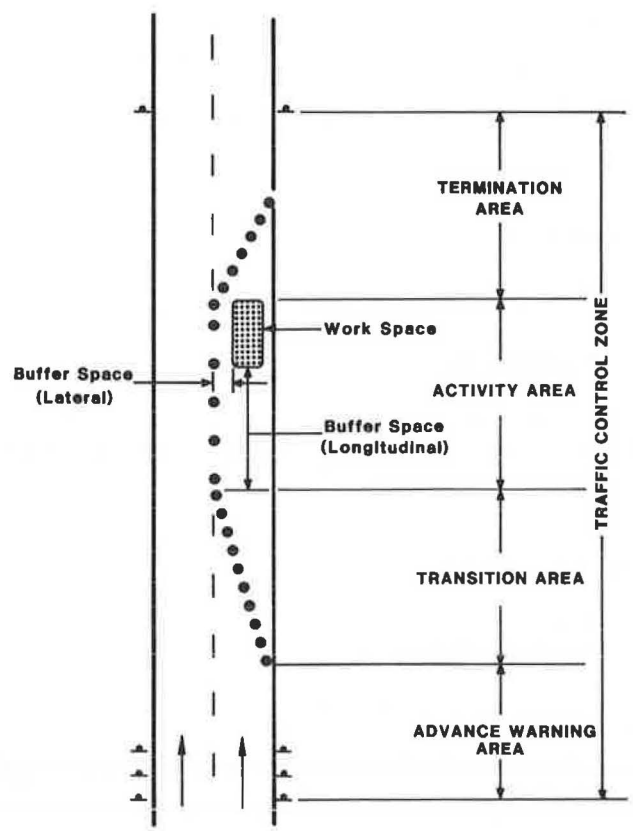

FIGURE 2 Traffic control zone and components.

hundred feet on a local street. In its simplest form, it may contain a single sign.

Where traffic volumes may exceed the capacity available through the work area, the size of the traffic control zone may need adjustment. The advance warning area should be designed so that it encompasses the stretch of upstream roadway in which backups occur or can readily be extended to include that stretch, as needed. This is of primary concern on high-speed roads where slow-moving and start-and-stop operations may surprise drivers. The geometry of the approach roadway may also dictate the extent of the advance warning area.

Transition Area

> A transition area is required where some form of closure occurs. In this area, traffic is channelized from the normal highway lanes to the paths required to move through the activity area. It is the portion of the traffic control zone that commences at the downstream end of the advance warning area and extends to the beginning of the activity area.

The transition area encompasses the tapers that are used to close lanes, shift travel paths, or both.

Activity Area

> The activity area is the portion of the roadway in which any closure is in effect and where the work is taking place. It is the portion of the traffic control zone that commences at the downstream end of the transition area and extends to the beginning of the termination area.

The work area may encompass one or more spaces. These spaces and their use are defined immediately after the following term. The term "activity area" is a proposed replacement for "work area." As discussed previously, a more definitive term is needed to describe this specific portion of the traffic control zone. Alternative terms are "work activity area" and "operations area."

Termination Area

> The termination area is used at work sites to allow traffic to clear the activity area and return to normal traffic operations. It is the final portion of the traffic control zone that begins at the downstream end of the activity area.

The termination area extends from the downstream end of the work area to the END CONSTRUCTION or END ROAD WORK sign. Downstream tapers may be placed in the termination area.

Work Space

> The work space is that portion of the activity area set apart exclusively for workers, equipment, and material storage and is delineated to exclude vehicular and pedestrian traffic.

Buffer Space

> A buffer space is an optional feature in the activity area that provides a recovery space for errant vehicles and separates traffic flow from the work activity or a potential hazard. No work activity should occur and no equipment and materials should be stored within this space.

When used, a buffer space is typically employed within the activity area. To fulfill its recovery function, however, the space must be kept clear of workers, material storage, and operating equipment. Buffer spaces may be positioned either longitudinally or laterally with respect to the direction of traffic flow.

Used longitudinally, a buffer space may be placed in the initial portion of a closed lane that precedes the actual work space, as shown in Figures 2 and 3. Sometimes a shadow vehicle or work vehicle is positioned in a buffer space to provide increased protection for workers occupying the actual work space beyond. When a vehicle is used in this manner, consideration should be given to equipping it with a rear-mounted crash cushion. To be consistent with the preceding definition, the back end of the shadow vehicle marks the end of the buffer space and the beginning of the work space.

Longitudinal buffer spaces may also be used to separate opposing traffic flows that use portions of the same travel lane. An advantageous application is to separate two tapers that are used by opposing directions, as shown in Figure 4. Such a buffer space provides an island for the effective placement of signs directly in the line of sight of affected drivers. This placement is preferable to setting signs in a single line of channelizing devices where they protrude into adjacent traffic lanes. When a formidable device, such as an arrow panel, is placed in an island composed of channelizing devices, only the space in front of the device functions as a buffer space.

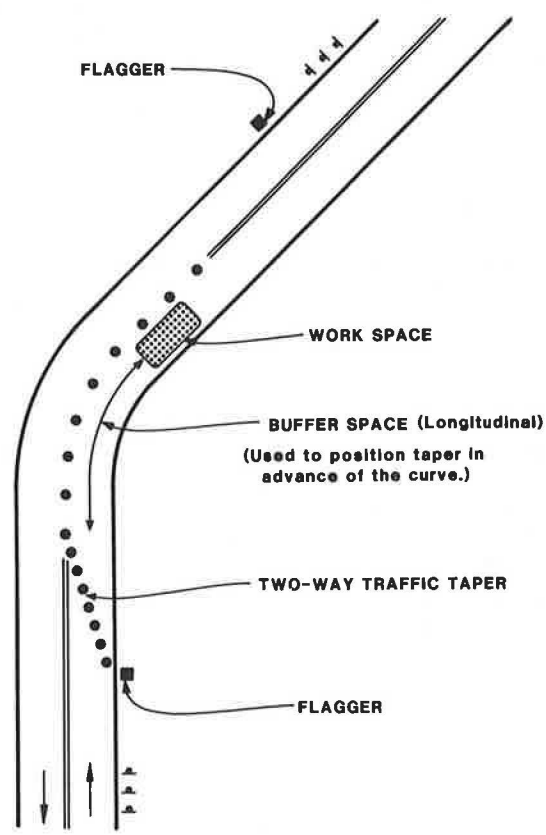

FIGURE 3 Work zone on a two-lane highway (selected features).

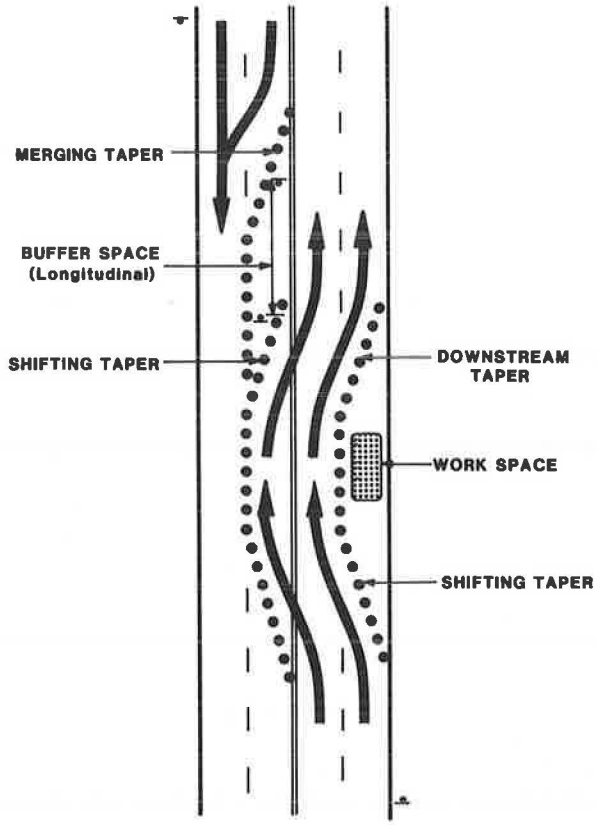

FIGURE 4 Work zone on a multilane street (selected features).

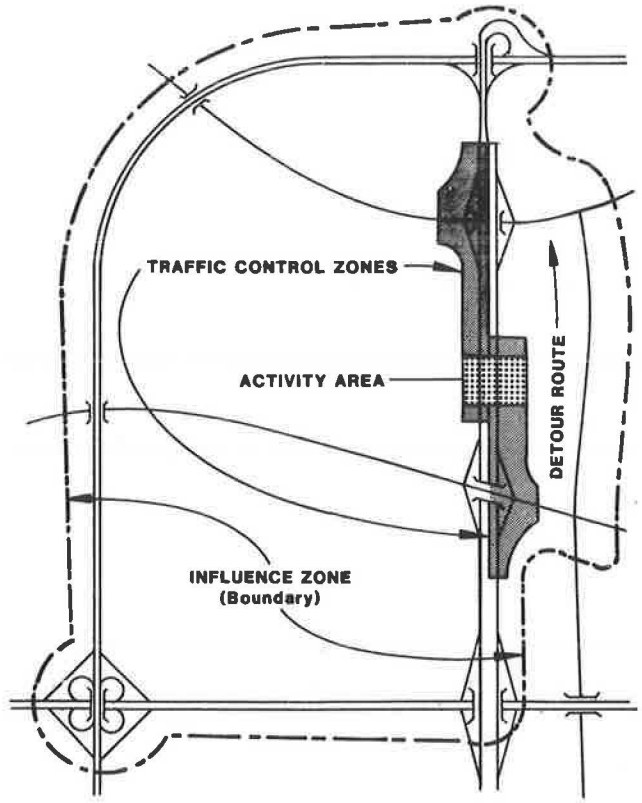

FIGURE 5 Traffic control zone, detour route, and influence zone.

Lateral buffer spaces may be used between two travel lanes, especially where the lanes carry traffic in opposing directions. A lateral buffer space may also be used to separate the travel space from the work space or a potentially hazardous space, such as an excavation or pavement drop-off.

Detour Route

> When a road is closed and a detour is established, the traffic control zone includes the area in which a detour route begins. The detour route extends beyond the zone to divert traffic around the site and return it to the original route.

It is useful to differentiate the detour route from the traffic control zone, because in many instances traffic control and maintenance along the detour route are handled by a different person than the one exercising control at the work site. As shown in Figure 5, the location at which the detour is established is contained within the traffic control zone. The detour route begins at the periphery of the zone and may extend a considerable distance away from the work site. Thus, the only temporary traffic control devices used along the detour route are those that provide navigational assistance.

Influence Zone

> The influence zone for a work operation is the portion of the highway network over which traffic is routed or diverted because of traffic restrictions at the work site and in which traffic control procedures may be used to advise motorists of congestion and alternative routings.

As shown in Figure 5, traffic restrictions in the work site may create problems on connecting roads and parallel routes. In such cases an influence zone may be created in the traffic corridor that requires traffic control to be extended well beyond the traffic control zone for the highway on which the work is being performed. Devices used in the broader influence zone may include warnings of congestion ahead and alternative routing information. Variable-message boards are useful for displaying this information, which is often wordy and may vary with traffic conditions.

"Influence zone" is a new term was created to preclude expanding the definition of a traffic control zone to cover all affected roads. For example, if the issue is the closure of the Chesapeake Bay Bridge Tunnel, the traffic control zone may extend for a few to several miles on either end. The influence zone over which rerouting information will be needed, however, may extend into three to five states.

WORK-ZONE TAPERS

The terms in this section and their definitions have evolved over many years. They have been used in courses given by the American Traffic Safety Services Association (ATSSA) and in their current form have been found to be most useful in communicating the various taper requirements. They were developed to avoid the single word "taper" from being applied to a variety of situations, each with differing requirements. A task force chaired by the author was appointed by the Construction and Maintenance Technical Committee of the National Committee on Uniform Traffic Control Devices

(NCUTCD) to prepare a new section on work-zone tapers for the MUTCD. Following acceptance of the concepts presented below by the NCUTCD, FHWA proposed a change to the MUTCD incorporating this material (*4*).

Upstream Tapers

> Upstream tapers are placed in advance of the space that is being protected. Upstream tapers are directive in that they force traffic in the affected lane to follow a new travel path. The four taper types defined below are all upstream tapers.

Upstream tapers are placed ahead of a portion of the roadway that must be vacated and appear in front of oncoming traffic to direct traffic into a new travel path. Such tapers are placed in the transition area when some form of closure occurs and traffic is channelized from the normal highway lanes to the paths used to move through the work area. Alternative names or attributes for upstream tapers include "directive" and "advance."

There are four upstream tapers—merging taper, shifting taper, shoulder taper, and two-way traffic taper. It is important to differentiate among them because each one has a different length criterion.

Merging Taper

> A merging taper is used to close a lane on a multilane highway and to direct traffic from the lane being closed into the adjacent lane.

In highway work areas, the merging taper (see Figure 4) has the longest required length because drivers must locate a gap in the adjacent traffic stream and move into it. The taper should be long enough so that vehicles approaching side by side have sufficient time to adjust speeds and merge into a single lane before the end of the transition. The minimum desirable length for a merging taper should be computed by the formulas $L = W \times S$ and $L = WS^2/60$ for high and low speeds, respectively (*3*).

Shifting Taper

> A shifting taper is used to move traffic into a different travel path when a merge is not required.

Because a shifting taper does not involve a merge, its length may be shorter than that of a merging taper (see Figure 4). It has a minimum length equal to one-half of that computed using the formulas for the length of a merging taper. Changes in path direction in which no merge is involved also may be accomplished with horizontal curves designed for normal highway speeds. For example, this procedure is often used for the geometric design of median crossovers.

Shoulder Taper

> A shoulder taper is used to close an improved shoulder on a high-speed roadway.

When an improved shoulder having a width of 8 ft or more is closed on a high-speed roadway, it should be treated as a closure of a portion of the roadway, and the work area on the shoulder should be preceded by a shoulder taper. Shoulder tapers should have a minimum length of one-third of that computed using the formulas for the length of a merging taper, provided the shoulder is not used as a travel lane.

Two-Way Traffic Taper

> The two-way traffic taper is used to close one lane of a two-lane, two-way highway. The remaining lane is used alternately by traffic in each direction, typically under the control of flaggers, police officers, or temporary traffic signals.

Traffic may be directed to use the open lane in alternate directions under the control of flaggers, a pilot vehicle, or temporary traffic signals (see Figure 3). In this situation, a short taper having a maximum length of 100 ft should be used in the closed lane to direct traffic into the open lane. A long taper derived by the formulas would be inappropriate, because a long taper encourages drivers to maintain their speed and to change lanes early. Since two-way traffic tapers are used where the open lane is shared by the opposing direction of travel, the potential accident is a head-on collision. A short taper encourages drivers to slow down and then make a deliberate lane change only when instructed to do so.

Downstream Taper

> Downstream tapers are placed beyond (downstream from) a closure to indicate that the traffic may return to the normal traffic lanes. Their use is optional, and the taper is permissive because it does not require a change in travel path.

When used, downstream tapers are generally placed beyond the work space to enable and guide traffic in its return to the full roadway cross section (see Figure 2). As such, the taper is located alongside and behind the traffic that follows the indicated path. Therefore, the length is not critical and a short taper is suitable. It provides a positive message that the work space has been passed as compared with an uncertain assumption based upon the absence of channelizing devices. Alternative names or attributes for downstream tapers include "permissive" and "departure."

Downstream tapers are used to reopen the full approach width to an intersection beyond a mid-block lane closure or to return traffic to a lane serving an off ramp. Downstream tapers formed with channelizing devices may interfere with work operations where vehicles must access the work space at its downstream end. Conflicts of this type can be avoided by downstream tapers that are formed with temporary pavement markings.

PROJECT DURATION

Because the duration of the work undertaken is a major determinant in the design of the traffic control zone, it is useful to designate and define the various durations that are significant.

Long Term

> Long-term activities are those during which the traffic control zone is in place for several days or longer.

From a planning and design viewpoint, there is ample time to install and realize benefits from the full range of traffic control procedures and devices that are available for use. Generally, larger channelizing devices are used for long-term operations, because they have more reflective material and offer better nighttime visibility. Also, the larger devices are less likely to be displaced and tipped over—an important consideration during periods when the work crew is not present to maintain the zone. Also, because long-term operations extend into nighttime, reflective or illuminated devices, or both, are required.

Intermediate Term

> Intermediate-term activities require a few to several days to perform; thus nighttime closures are involved.

Because the period is limited, it may not be feasible or practical to use procedures or devices that would be desirable for long-term operations. Examples include altered pavement markings, barriers, and temporary roadways. The increased time to place and remove these devices in some cases could significantly lengthen the project, thus increasing exposure time. In other instances, there might be insufficient payback time to make higher-type traffic control economically attractive.

Short Term (Daytime)

> Short-term activities are those that are accomplished during one daylight period.

Most maintenance and utility operations come under this category. The work crew is present to maintain and monitor the traffic control zone. The use of flaggers is a practical and available option. Neither lighting nor reflective devices are required under normal conditions.

Short Duration

> Short-duration activities are generally considered to be those in which it takes longer to set up and remove the traffic control zone than it does to perform the work. Typically, the operation can be accomplished in 15 min or less.

Hazards are involved for the crew when installing and removing a traffic control zone. Also, since the work time is short, the time during which motorists are affected is significantly increased as the traffic control zone is expanded. Considering these factors, it is a general belief that simplified control procedures may be warranted for short-duration activities. Such shortcomings may be offset by the use of other predominant devices, such as special lighting units on work vehicles.

There may be some confusion over the difference in meaning between short-term activities and short-duration activities. These terms are suggested because they are often used in this context. However, since they are often misused, perhaps more definitive terms are needed. Thus "daytime" was appended to "short term." There may be a need for a new, more-exclusive term in place of "short duration."

WORK ACTIVITY

Work zones are frequently classified by the type of work performed there. Actually, this means little to drivers, who are only concerned with the impact of the work operation on their use of the facility. The variation in project duration associated with the various types of work is the more significant factor, and it is discussed below.

Construction Operations

Construction projects commonly require a minimum of several weeks and may involve multiple construction seasons or years. A basic condition of construction operations is that traffic control procedures must accommodate both daytime and nighttime conditions. There is ample opportunity to plan the work and develop an effective public information program. A long duration makes it more attractive to invest in high-type traffic controls and facilities, such as barriers and temporary roadways. Typically, highway construction work is performed by construction companies under contractual agreements.

Maintenance Operations

Maintenance operations generally are accomplished more rapidly, rarely exceeding a few days. Most maintenance work is performed during one work day as a daytime operation. Some maintenance activities, however, involve extensive rehabilitation and take on the basic characteristics of a construction project. Maintenance activities generally are performed by the highway agency's own forces, although contract maintenance is becoming more common.

Utility Operations

Utility activities usually are short daytime operations, except under emergency conditions. Often they are performed in lower-volume and lower-speed streets. Operations often involve intersections, since that is where many of the network junctions occur. As the crew size is usually small with only a few vehicles involved, the number and type of traffic control devices placed in the traffic control zone may be minimal. As discussed under short-duration projects, however, in this situation the reduced number of devices should be offset by the use of higher-visibility devices, such as special lighting units on work vehicles.

Other Activities

Emergencies and disasters may pose severe and unpredictable problems. The ability to install proper traffic control may be greatly reduced in an emergency, and any devices on hand may be used for the initial response. If the situation is prolonged, the procedures shown in Part VI of the MUTCD should be followed when closures are involved or work must be done within the roadway. Special events, on the other hand, can be properly planned and coordinated. Part VI of

the MUTCD provides guidance as to the proper procedure for closing portions or entire roadways in conjunction with such activities.

CLOSURE TYPES

Closure

> A closure is the taking of any portion of the roadway for the exclusive use of a work activity.

Closures may involve a shoulder; one or more lanes; any combination of lanes or shoulders, or both; a direction roadway; or the entire highway. The portion of the roadway remaining, if any, after the closed portion is temporarily removed from service is available for use by traffic passing through the work area.

Lane Closure

> A lane closure involves the closing of a traffic lane in such a manner that traffic is forced to move out of the closed lane and into another lane and the total number of lanes is reduced.

On a multilane roadway, a merging operation is involved. On a two-lane, two-way roadway, alternating directions of traffic must use the remaining lane—typically under the control of flaggers. The implication of this definition is that the closure of an auxiliary lane beginning at its point of inception does not constitute a lane closure, because there is no reduction in the number of lanes available. Examples include the following:

- Closing of a turn bay,
- Closing a deceleration lane approaching an off ramp, and
- Closing a lane where all lanes are maintained by some form of traffic shifting or splitting, or both.

Double-Lane Closure

> A double-lane closure is the closing of two adjacent lanes in the same direction on a multilane roadway.

In accord with the MUTCD an advance warning advising of the double-lane closure is used, such as RIGHT TWO LANES CLOSED AHEAD. The individual lanes are closed one at a time, however, separated by a transition distance. The individual lane closures each have advance signing and a merging taper.

Traffic Shifting

> Traffic shifting is the lateral displacement of one or more travel lanes from their normal travel path in order to accommodate a work space in the roadway. All lanes are carried through and no merging operations are involved.

Traffic shifting may be accomplished by several means, including lane narrowing, use of shoulders, and use of the opposing roadway. Different closure types may be used for each direction of flow. For example, Figure 4 illustrates a lane closure for southbound traffic and traffic shifting for northbound traffic.

Traffic Splitting

> Traffic splitting is the situation encountered on a multilane roadway where open travel lanes are carried around both sides of a work space.

An island work space is formed, with traffic on both sides. It is preferable to avoid this situation, where feasible. This can usually be accomplished by a double-lane closure where an exterior lane is also closed, provided that the traffic volume can be accommodated. When traffic splitting is employed, there are various procedures that may be used to improve the operation. For example, in some instances a lane reduction may be accomplished upstream by closing an exterior lane and creating a dummy work space. Then the remaining open lanes can be carried around the island work space with no further merging required and generally with no lane changing permitted.

Lane Narrowing

> Lane narrowing is a reduction in lane width for those lanes carried through the activity area in order to maintain the maximum number of open lanes while accommodating the needs of the work activity.

Median Crossover

> In the context of work-zone closures, a median crossover occurs where one directional roadway is closed to traffic and that direction of travel is carried diagonally across the median onto the other directional roadway.

Often the single word "crossover" is employed, but the addition of the word "median" makes the term more exact. A crossover may also be used to move traffic between a main line roadway and a parallel frontage road. Unless the entire directional traffic stream is so diverted, the feature providing for this optional maneuver would more properly be called a temporary slip ramp.

TLTWO

> Two-lane, two-way operation (TLTWO) occurs where one directional roadway is closed on a four-lane divided highway and both directions of travel use the remaining roadway with one lane in each direction.

The TLTWO section is implemented with the use of a median crossover in advance of the closed roadway. Note that median crossovers on six or eight-lane highways do not create TLTWO sections in accord with this definition. Considerable attention has been directed towards the TLTWO section, because the open roadway retains the appearance of a divided highway, but is temporarily operated as a two-lane, two-way highway. This is especially the case for the non-crossed-over direction, which continues to operate on the normal side of the median. The problem is that a driver may forget and pull out to pass

into opposing traffic. Therefore, special requirements have been established for TLTWO on high-speed highways where the length of the TLTWO section is more than a short runaround (*4*).

Detour

A detour is initiated when traffic is directed to leave the normal roadway.

Thus, traffic shifting or splitting, or both, accomplished within the confines of the roadway (including shoulders) does not involve detours. This definition is believed to be consistent with interpretation of the term by drivers. A crossover involves a detour, because traffic is directed to leave the directional roadway.

On-Site Detour

An on-site detour occurs where traffic is diverted onto a temporary roadway generally constructed within or adjacent to the right-of-way or onto a frontage road.

Off-Site Detour

An off-site detour occurs where traffic is diverted onto another highway in order to bypass the work site.

One-Lane Road

A one-lane road is the special situation in which one lane is used alternately by both directions of travel.

Special techniques need to be employed to prevent head-on collisions. Flaggers are generally employed to control traffic at both ends of the one-lane section. Temporary traffic signals may also be used.

Single Lane

Single lane is the applicable term when all traffic flowing in one direction must use one lane.

Thus, the terminology "single lane" may be used on a multilane roadway to inform drivers that only one lane is available through the activity area. For example, the New York State MUTCD uses signs with this wording as part of its standard sign series.

MOBILE OPERATIONS

Mobile operations are those in which the location of the work activity is continually changing, thus making it difficult or impractical to use stationary traffic control devices.

This category includes both continuously moving operations, such as paint striping, and intermittent-stop operations, such as pothole patching and litter pickup. Note that this concept overlaps short-duration operations, which may also involve intermittent-stop activities.

A work vehicle is involved as an integral part of all of these operations. The work vehicle, when appropriately colored, marked, and fitted with special warning lights, serves as part of the traffic control. Mobile operations are typically performed under favorable conditions with good visibility and outside peak-traffic periods. When this is the case, the argument may be made that the number of devices used may be reduced. Even under adverse conditions, which may be associated with unscheduled work (e.g., repairs to a malfunctioning traffic signal), the case can be made that a large and highly visible vehicle can effectively replace numerous small devices (e.g., signs and cones).

Fast-Moving Operations

Fast-moving activities are those in which the speed of the operation is in the range of 3 mph to 10 to 15 mph below the posted speed limit—the higher differential being used with higher speeds.

Within this range special warning procedures are required that move with the operation. Typical fast-moving operations are lane striping or roadway sweeping. If volumes are light and sight distances are good, a well-marked vehicle may suffice. If volumes, speeds, or both are higher, a backup vehicle equipped with signs, beacons, or an arrow panel should follow the operation.

A 10- to 15-mph differential speed has long been recognized as the threshold at which slow-moving traffic begins to interfere significantly with normal traffic. For example, the criterion for climbing lanes as contained in the AASHTO policy on geometric design is a 10-mph differential speed (*2*). Likewise, several states utilize signs stating USE 4-WAY FLASHERS BELOW 40 MPH on freeways posted at 55 mph. A work vehicle traveling within 10 to 15 mph of the posted speed is essentially moving "with traffic," and no special traffic control is needed other than an appropriately marked work vehicle. Examples of such activities include photologging and road roughness measurement.

Slow-Moving Operations

Slow-moving activities are those in which the operations generally proceed in a continuously moving fashion, and the speed of travel is less than 3 mph.

In this speed range there may be some opportunity for stationary devices combined with other special warning procedures that move along with the operation. Stationary devices may need to be relocated periodically to remain within an appropriate distance of the work activity.

Slow-moving and related intermittent-stop operations may involve such work as spraying herbicides, painting pavement markings using walk-behind equipment, and pavement marking removal. When such work is performed on highways, a backup sign-carrying vehicle to warn traffic and protect workmen is used. In slow-moving traffic on minor roads, a single vehicle equipped with signs and beacons may suffice.

Intermittent-Stop Operations

Intermittent-stop operations are highly mobile activities in which a stop is required to perform the actual work.

Although some stationary traffic controls may be feasible for intermittent-stop operations, this is not the typical case. Usually, they are highly mobile activities, such as pothole patching, litter pickup, and luminaire relamping. The time spent at any one location is usually just a few minutes.

Other Activities

There are various types of activities in which portions of the traffic control zone may change, but the advance warning area and the transition area remain fixed for the entire operation, or at least for significant time periods (e.g., an hour or more). Therefore, these are not classified as mobile operations. Operations falling in this category typically have a varying length for the activity area, which is downstream of the stationary advance warning and transition areas. The third procedure described below is a variation on this theme.

Moving Within a Zone

For some operations, the activity area can best be lengthened or shortened as work progresses during the day. Either of these procedures reduces the impact upon road users as compared with closing the whole section for the entire work period.

Diminishing Zone

A diminishing work zone is one in which the entire traffic control zone is installed initially and is then reduced in size as the work progresses. Work is performed in the direction opposite to the traffic flow, which enables the work space to decrease in length without moving the advance warning signs and taper.

Expanding Zone

For an expanding work zone, the initial installation consists of the advance warning signs, taper, and the delineation of just enough of the activity area for work to begin. The work space is then increased in length as work progresses in the direction of traffic flow. The maximum zone length is determined by work accomplished. If cure time is required, the entire zone must remain in place while the last patch cures.

Leapfrog Method

The third method is similar to the expanding work zone except that the advance warning area and transition area are periodically moved downstream as the work progresses. The second transition may be set up in the protection of the closed lane, and then the upstream taper is removed. This technique further reduces the impact on road users. It requires a duplicate set of warning signs and devices used in the taper; however, the work space may be kept short, thus reducing the number of devices needed in the activity area.

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