
CHAPTER 1

GENERAL INSTRUCTIONS

1.1 GENERAL

Traffic control is required when traffic must be moved through or around highway or street construction, maintenance operations or utility work on or adjacent to a roadway. **The traffic control described and illustrated herein is generally the minimum required.** No one standard sequence of signs or other control devices can be set up as an inflexible arrangement for all conditions and locations, due to the variety of conditions encountered. It should also be recognized that while the Traffic Control (T.C.) Manual for Work on Roadways contains mandatory language such as “shall” there may be circumstances where strict compliance with such requirements is not reasonable and it will be necessary to deviate from the requirements.

Throughout this Manual, the term “work zone” , as also defined in Subsection 1.1.2, means an area in which construction, maintenance or utility activities take place, on or adjacent to a roadway, to the extent that the passage of public traffic may be influenced. Where cyclists and/or pedestrians are likely to be present in work zones, due consideration must also be given to their safety requirements.

This T.C. Manual sets forth basic principles and prescribes standards for the design, application, installation and maintenance of the various types of traffic control through work zones. These include signs, signals, lighting devices, markings, barricades, channelization, and hand signaling devices. Minimum standards of application are prescribed for typical situations and for methods of controlling traffic through work zones. A number of typical situations are illustrated to show the recommended application of standard protective devices for pre-planned, scheduled, work on roads and streets in British Columbia.

It is understood that in emergency situations it may not be possible to meet these minimum standards.

1.1.1 FUNDAMENTAL PRINCIPLES

All traffic control devices used in work zones should closely conform to the applicable specifications of this T.C. Manual.

Work zones can present motorists, cyclists and pedestrians with unexpected or unusual situations as far as traffic operations are concerned. Because of this, special care should be taken in applying traffic control techniques.

Principles and procedures which experience has shown to enhance the safety of road users and workers in the vicinity of work areas include the following:

- .1 Traffic safety in construction zones is an integral and high priority element of every project from planning through design and construction. Similarly, maintenance and utility work should be planned and conducted with the safety of road users and workers kept in mind at all times.

1.1.1 FUNDAMENTAL PRINCIPLES (continued)

- a. The basic safety principles governing the use of permanent traffic control on undisturbed roadways and roadsides should also govern the design of traffic control in work zones. The goal should be to route traffic through such zones with traffic control devices as nearly as possible comparable to those for normal situations.
 - b. A traffic control plan in detail appropriate to the complexity of the project, should be prepared and understood by all responsible parties before work begins. Any changes in the agreed traffic control plan should be pre-approved by the road authority before implementation.
- .2 Traffic movement should be inhibited as little as possible.
- a. The traffic control plans for work zones should be designed on the assumption that motorists will only reduce speed if they clearly perceive a need to do so. Reduced speed zones should only be used where a clearly demonstrated need exists.
 - b. Any changes in traffic pattern, such as lane narrowings, dropped lanes or other main roadway transitions requiring rapid maneuvers, should be avoided.
 - c. Where emergency vehicles will pass through a work zone it may be necessary to make special provision for such vehicles especially on high speed or high volume roadways.
 - d. Construction time should be minimized to reduce exposure to potential hazards.
- .3 Motorists should be guided in a clear and positive manner while approaching and traversing work zones.
- a. Adequate warning, delineation and channelization by means of proper pavement marking, signing and use of other devices which are effective under varying conditions of light and weather should be provided to assure motorists of positive guidance in advance of and through work zones.
 - b. Inappropriate pavement markings should be removed for long duration work to eliminate any misleading cues to drivers in all conditions of light and weather. On short term maintenance projects, however, it may be determined that such removal is more hazardous than leaving the existing markings in place. If so, special attention must be paid to providing additional guidance by other traffic control measures.
 - c. Traffic control persons (TCPs), when used, can provide positive guidance to motorists traversing work zones. TCPs must be employed when all other methods of controlling traffic are considered inadequate to warn, direct and regulate drivers.
- .4 To ensure acceptable levels of operation, routine inspection of traffic control devices should be performed.

1.1.1 FUNDAMENTAL PRINCIPLES (continued)

- a. Individuals who are trained in the principles of traffic control should be assigned responsibility for safety at work sites. The most important duty of these individuals is to ensure that all traffic control devices are in conformity with the traffic control plan and are effective in providing safe conditions for motorists, pedestrians, cyclists and workers.
 - b. From time to time, modification of traffic controls may be required in order to expedite traffic movement and to ensure safety. It is essential that the individual responsible for traffic control also has the authority to control the progress of work on the project in its relation to maintaining safe conditions, including the authority to modify controls or halt work until remedial safety measures are taken.
 - c. Work sites should be carefully monitored under varying conditions of traffic volume, light and weather to ensure that traffic control measures are operating effectively and that all devices used are appropriate, clearly visible, clean and in good repair.
 - d. When activity in a work zone ceases, for whatever reason or duration, it is very important that adequate traffic control is maintained to guide, warn and regulate public traffic through any hazards or unusual traffic patterns; keeping in mind the most adverse conditions that could reasonably be expected to occur, prior to the recommencement of work.
 - e. When warranted, an engineering analysis should be made of all accidents occurring within work zones. Work zones should be monitored to identify and analyze traffic accidents or conflicts. As examples, skid marks or damaged traffic control devices may indicate needed changes in the traffic control.
 - f. Work zone accident records should be analyzed periodically to guide officials in improving work zone operations.
 - g. **When no longer needed, traffic control devices must be removed or covered.**
- .5 The maintenance of roadside safety requires constant attention during the life of the work zone because of the potential increase in hazards.
- a. To accommodate errant and disabled vehicles, it is desirable to provide an unencumbered roadside recovery area that is as wide as practicable.
 - b. Channelization of traffic should be accomplished by the use of pavement markings and signing, flexible posts or drums, delineators, cones, barricades and other lightweight devices which will yield if hit by errant vehicles.
 - c. Whenever practicable, construction equipment and materials should be stored clear of the travelled roadway. If this is not possible, such obstructions should be clearly marked and the path around them delineated.

1.1.2 DEFINITIONS

Buffer Vehicle

A vehicle positioned in advance of an active stationary or moving work site to protect workers from errant vehicles (such vehicles shall display either a FAB or 360° light and 4-way flashers).

Construction Speed Zone

A lowered legal speed zone, normally through a long duration work zone, as authorized by the road authority.

Continuous Slow Moving Work

Work which is continuously moving such that the use of regular traffic control procedures is impracticable (e.g., grading, striping, hydroseeding, mowing, brushing, flushing, sweeping, spraying for dust control etc.).

Detour Route

A route which takes traffic off the regular route and, using existing or newly made temporary roadways, guides traffic around a work zone. The detour route must be clearly identified by appropriate detour signs. (Prior to the closing of a roadway and the opening of a detour, it is desirable to erect "Closing Notice" signs at strategically selected locations at least one week in advance of the actual closing.)

Downstream Direction

The direction towards which traffic flows.

Emergency and Brief Duration Work

Work, generally of an unprogrammed emergency nature, requiring very little time, usually less than 15 minutes (e.g. unblocking catch basins, removal of fallen tree limbs, water valve operation, cleanup of material spills, filling isolated potholes, etc.)

Freeway

A public highway with a continuous nontraversable dividing median, grade separated interchanges and typically with a posted speed limit of 80 km/h or greater.

Highway

A roadway or roadways, typically in a higher speed zone, carrying inter-regional vehicular traffic.

Intermittent Moving Work

A maintenance activity which involves a work zone that changes frequently (e.g. some mowing operations) or involves frequent stops not exceeding 30 minutes duration (e.g. temporary patching, group relamping of street lights, Benkleman beam testing, crack sealing, etc.)

Long Duration Work

Programmed construction, maintenance and utility activities which require a separate work area for more than one daytime shift. Thus most work at night should, therefore, be considered long duration.

1.1.2 DEFINITIONS (continued)

Low Volume/High Volume Roadway

A low volume roadway is one which carries less than 1,000 vehicles per day. A high volume roadway thus carries 1,000 or more vehicles per day. (For a two-way roadway, the applicable volume is the daily total carried in both directions.) Traffic volumes can be obtained from the local road authority.

Line-type Vehicles

A truck with a large cable spool mounted on the rear of the vehicle, typically used by power and telephone companies when for installing new power or communications lines.

Ministry

Means the Ministry of Transportation and Highways

Multilane Roadway

A roadway with two or more lanes in at least one direction including climbing and passing lanes.

Temporary Lane Control Signal

An electrical device, with one traffic signal head per direction, which may be used as an alternative to TCPs in short duration work for controlling a temporary one-way traffic section on a normally two-way roadway.

Roadside Diversion

A deviation from the normal roadway where work closes a section of a road and a short detour, usually within the right-of-way, is required to bypass the work area.

Roadway

The portion of a street or highway that is ordinarily used for vehicular traffic, but, does not include the shoulder; and where a highway includes two separate roadways, the term "roadway" refers to any one roadway separately and not to both of them collectively.

Shadow Vehicle

A vehicle used mainly in continuous slow moving operations, as a mobile advance warning and sign support. (Such a vehicle will normally travel as far over on the shoulder as possible, i.e. shadow vehicles do not block travelled lanes as do buffer vehicles.)

Short Duration Work

Programmed work which requires a separate work area for not more than one daytime shift.

Street

A public road used for the movement of vehicles in a local area.

Tangent Distance

The distance between the end of one taper and the beginning of the next taper for the same direction of travel.

1.1.2 *DEFINITIONS (continued)*

Taper and Taper Length (Lane or Shoulder Closure)

The gradual narrowing of a lane or shoulder using successive cones or markers to safely guide drivers into the next lane. Taper length is the distance along a section of roadway required to achieve full closure of one lane or shoulder.

Temporary Speed Zone

A lowered legal speed zone imposed at the discretion of a supervisor with C-1 or C-2 signs in a short duration work zone.

Temporary Traffic Control Signal

A signal used (a) to control traffic at an intersection with a temporary roadway, truck access route and pedestrian crossing, etc., or (b) to assign right-of-way on long duration work (such as bridge resurfacing), in place of TCPs or a portable lane control signal, where traffic moving in both directions must use a single lane on a normally two-way roadway. (The design specifications for temporary signals require prior approval by the appropriate road authority).

Traffic Control Person (TCP)

A person trained to conduct traffic through a work zone; having in mind both the safety of workers and public traffic.

Two Lane Two-Way Roadway

A two-way roadway with one through lane per direction.

Upstream Direction

The direction from which traffic flows.

Work Zone

An area in which surveying, construction, maintenance or utility activities take place, on or adjacent to a roadway, to the extent that the passage of public traffic may be influenced.

1.1.3 DRIVER INFORMATION NEEDS IN WORK ZONES

The usefulness of traffic control devices intended to assist motorists in guidance and navigation tasks depends on whether the devices satisfy a driver's need for information. Both the message content and the placement of the traffic control devices must be carefully considered.

Inappropriate or unclear messages and/or incorrect placement of signs, markings, and other traffic control devices can mislead and confuse the motorist.

In work zones there are usually three types of traffic control device message content. These are the warning of potential hazards, posting of applicable regulations such as maximum speeds, and the delineation of traffic paths.

Positive guidance principles should be considered when determining which traffic control devices will be used and where they will be located.

1.1.3 DRIVER INFORMATION NEEDS IN WORK ZONES *(continued)*

The more serious instances of driver misunderstanding and non-compliance result from:

- providing contradictory or misleading information;
- presenting a sign with inaccurate distance information; and
- using nonstandard messages or using inappropriate standard signs.

1.1.4 TRAINING

Personnel whose actions affect work zone safety should receive training appropriate to the job decisions those individuals are required to make. Only those individuals who are qualified in safe traffic control practices and have a basic understanding of the principles established by applicable standards and Regulations, should supervise the selection, placement and maintenance of traffic control devices in work zones.

1.1.5 SUMMARY

The following list of items can be used for the general guidance of those involved with work zone traffic control activities:

- Retain the motorist's respect and the agency's credibility by not providing misinformation.
- When work is not in progress or devices are no longer needed, remove or cover them.
- Do not assume that drivers, cyclists and pedestrians will see or recognize the workers or hazards in a work zone. Remember that the visibility of hazards/workers can be greatly diminished in darkness and/or poor weather conditions.
- Maintain the controls as if every driver were approaching the area for the first time and in less than ideal conditions.
- The philosophy of good work zone traffic control must be understood by field personnel so they can perform their work with a minimum of exposure to traffic, be on the lookout for problems and be capable of replacing or reporting any damaged or missing devices.

1.2 APPLICATION OF TRAFFIC CONTROL

1.2.1 AUTHORITY

The authority for the placement of traffic control devices on all streets and highways in British Columbia is contained in various Provincial acts and municipal bylaws.

No work should commence on a public roadway without first obtaining a work permit providing approval by the road authority concerned. Road authorities generally grant continuing permits for specific routine and emergency operations such as those conducted by utility companies.

1.2.2 JURISDICTION

Jurisdiction for traffic control is as follows:

- for municipal streets, the municipality having jurisdiction over the area;
- for Provincial highways, and roads in unorganized areas, the Ministry of Transportation and Highways

Workers Compensation Board Industrial Health and Safety Regulations require that adequate precautions are taken to protect workers from hazards to which they may be exposed. The regulations require protective clothing, equipment, devices and work procedures that protect workers from hazards caused by public and construction traffic.

1.2.3 RESPONSIBILITY

It is important that the road authorities having jurisdiction require proper traffic control, that responsibility be clearly assigned, adequate training of personnel be provided, and that there be adherence to the principles and applications provided in this T.C. Manual.

1.2.3.1 Responsibility of Management

It is the responsibility of management to ensure that all crew and supervisors are thoroughly trained and familiar with applicable safe working practices, and that they take immediate and decisive action when safe and approved work methods are not followed.

1.2.3.2 Responsibility of the Crew Supervisors

It is the responsibility of the crew supervisors to ensure that each member of the crew wears the required personal safety clothing when working on or crossing the highway. It is also the crew supervisor's responsibility to ensure that the work area is protected by the use of the various signs, cones, flashing lights, TCPs, etc., generally as outlined in this Manual.

1.2.4 TRAFFIC CONTROL PLAN

Planning for traffic control in work zones is very important. Traffic control plans should be formulated by qualified personnel and the plans should be reviewed as work progresses. The principles of pre-planning and review should always apply, regardless of the project size.

The traffic control plan may range in scope from a reference to standard plans, a section of this Manual, or to a very detailed design solely for a specific project. The needed detail in the plan depends on the complexity of the work and on the conflicts between traffic and the work. The plan should include such items as provision for adequate separation of public traffic and work areas, the limitation of work periods (where necessary) and for lane closures based on careful consideration of anticipated traffic volumes and minimum exposure of workers.

The plan for traffic control should also include, but not be limited to, such items as signing, application and/or removal of pavement markings, roadway lighting, methods and devices for delineation, channelization and placement and maintenance of all devices.

1.2.5 ENGINEERING STUDY REQUIRED FOR COMPLEX SITUATIONS

The decision to use a particular device or devices at a particular location should be made on the basis of a study of the location. Thus, while this Manual provides standards for design and application of traffic control devices, it is not a substitute for engineering judgment. It is the intent that the provisions of this Manual be minimum recommended standards for traffic control. They are, however, recommendations but not legal requirements.

For complex projects, supervisors are required to exercise judgment in the selection of traffic control devices, just as they do in designing the roads and streets which the devices complement. Jurisdictions with responsibility for traffic control, that do not have qualified engineering staff, should seek assistance from a qualified traffic engineering consultant.

1.2.6 APPLICATION OF STANDARDS

The provisions for vehicular, pedestrian, cyclist and worker protection established herein are for application by:

1. The Provincial and Municipal road authorities in British Columbia and their contractors.
2. Public utilities and their contractors and others who have approval to work on or adjacent to public roadways.

The standards in this Manual should be adopted by all road authorities and utility companies concerned with street and highway work, and should be given effect by official instructions to employees and by incorporation into the specifications for all roadwork contracts.

1.2.6 APPLICATION OF STANDARDS (continued)

The general principles outlined in this Manual are applicable to both rural and urban areas. Since it is not practical to prescribe detailed standards of application for all the situations that may arise, minimum standards are presented here for the most common situations. It is emphasized that these are minimum desirable standards for normal situations and that additional protection must be provided when special complexities and hazards exist. The protection prescribed for each situation is based on the speed and volume of traffic, the duration of operations and the public exposure to hazards.

Traffic conditions on urban streets are characterized by lower speeds, a wide range of traffic volumes, limited maneuvering space, frequent turns and cross movements, significant pedestrian movement and other obstructions. Construction, maintenance and utility operations are more numerous and varied, including such diverse activities as pavement cuts for utility work, pavement patching and surfacing, pavement marking renewal and encroachments by adjacent building construction. Work on high volume, urban streets should be restricted to off peak hours to minimize conflicts with traffic.

On rural highways traffic conditions are also characterized by a wide range of volumes and higher speeds but less interference from pedestrians, turns and encroachments.

Freeways and other multilane highways present traffic control problems requiring special attention. Both high speeds and high volumes may be anticipated. Any work carried out in daylight may have to be limited to relatively short periods when volumes in the off-peak direction are sufficiently light.

The difficulties associated with the completion of work on lanes carrying high volumes of traffic may make it necessary, in some instances, to schedule construction and/or maintenance operations at night. While night scheduling avoids peak flows, the problems associated with the need for greater visibility of work site delineation and warning devices are increased.

For situations not specifically illustrated in this Manual, traffic control procedures must be established by appropriate modification of existing examples and/or application of the general control principles set out herein.

1.3 TRAFFIC CONTROL DEVICES

1.3.1 FUNCTION

The function of traffic control devices is to ensure roadway safety by providing for the orderly and safe movement of vehicles and pedestrians, throughout the public road system and to provide such guidance, regulation and warning as needed to ensure the safe passage of all the individual elements of the traffic stream.

For vehicle operators, traffic control devices are provided to assist in the guidance and navigation tasks required to safely traverse any facility open to public travel.

1.3.2 REQUIREMENTS IN WORK ZONES

This Manual sets forth the basic principles and warrants for the design and use of traffic control devices in work zones. These principles and warrants appear throughout the text relating to the specific devices or groups of devices. It is important that principles and warrants be given primary consideration in the selection and application of each device.

The Manual details traffic control device standards for work zones on all streets and highways open to public travel; regardless of the type of roadway or the authority having jurisdiction. Where a device is intended only for limited application, or for a specific situation, the text specifies the restrictions imposed on its use.

To be effective, all traffic control devices must meet five basic requirements. These are to:

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

Uniformity of meaning is vital to effective traffic control devices.

Five basic considerations are employed to ensure that these requirements are met. They are: design, placement, application, maintenance and uniformity.

The placement, size and sign messages should be such that attention is drawn to them, that they are legible, their meaning is clear, the regulation is reasonable and there is adequate time for response. In situations where messages are required other than those herein provided for, the signs should have the same shape, colour, dimensions and illumination or reflectorization as signs of the same classification. Symbols, wording and lettering should conform as closely as possible to signs of the same type.

1.3.2 REQUIREMENTS IN WORK ZONES *(continued)*

Consistent application should ensure that appropriate devices are installed in a standard fashion to meet the traffic control requirements at any given location. Furthermore, devices must be placed in a uniform and consistent manner to ensure that vehicle operators can be expected to respond properly to the devices based on their previous exposure to similar traffic control situations.

Maintenance of devices should be to a high standard to ensure that legibility is retained, that the devices are visible and that they are only in place when needed. Clean, legible and properly mounted devices, in good condition, command the respect of vehicle operators, cyclists and pedestrians. In addition to physical maintenance, functional maintenance is required to adjust needed traffic control devices to current conditions and to remove any which are unnecessary. The fact that a device is in good physical condition should not be a basis for retaining it if the message is inappropriate. Furthermore, carelessly executed functional maintenance can destroy the value of a group of devices by throwing them out of balance. For example, replacement of a sign in a group or series by one that is disproportionately larger or smaller.

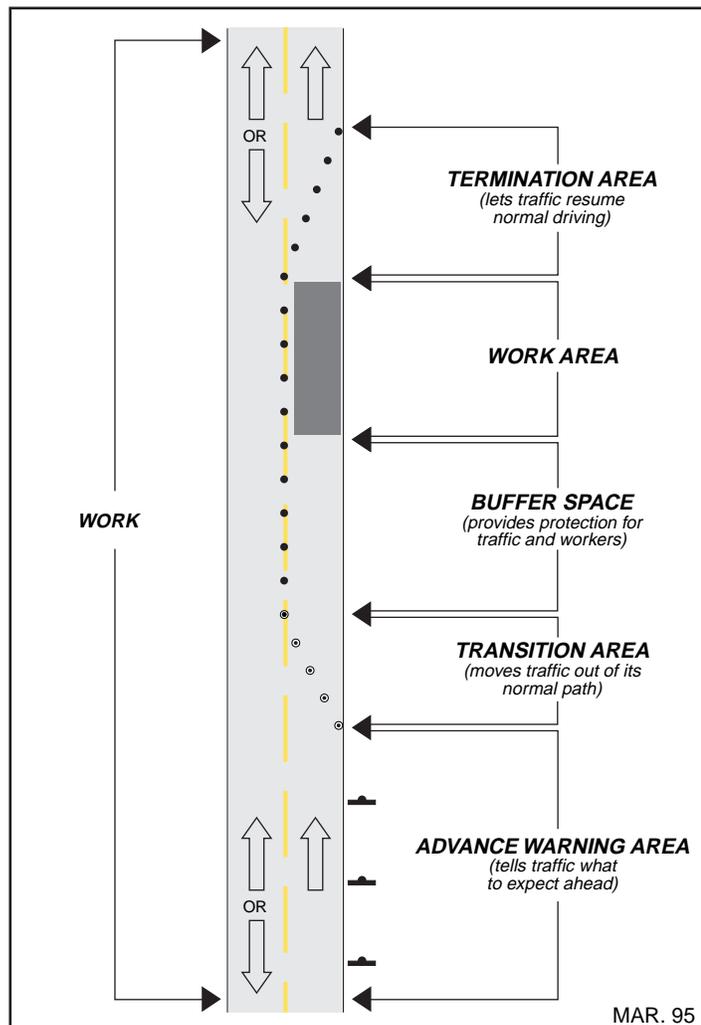
Uniformity in the design of traffic control devices simplifies the task of the road user because it aids in recognition and understanding. It also provides economy in manufacture.

Simply stated, uniformity means always treating similar situations in the same way. The use of uniform traffic control devices does not, in itself, constitute uniformity. A standard device used where it is not appropriate is as objectionable as a nonstandard device; in fact, this may be worse, in that such misuse may result in public disregard for the device at other locations where it is needed.

The actions required of drivers, cyclists and pedestrians by regulatory devices must be specified by Provincial statute, and/or municipal by-law.

1.4 TRAFFIC CONTROL (WORK) ZONES

Figure 1.4 Elements of a Traffic Control Work Zone



When traffic is affected by construction, maintenance, utility, or similar operations, traffic control is needed to safely guide and protect road users, and workers in a work zone. The work zone is the area between the first advance warning sign and a point beyond the work where traffic is no longer affected.

Most work zones can be divided into the following parts, as illustrated above:

- Advance Warning Area.
- Transition Area.
- Buffer Space.
- Work Area.
- Termination Area.

If no lane or shoulder closure is involved, the transition area will not be used. In this section, each of the “Parts” will be examined for one direction of travel. If the work activity affects more than one direction of travel, the same principles apply to traffic in both directions.

1.4.1 ADVANCE WARNING AREA

An advance warning area is necessary for all traffic control zones because drivers need to know what to expect ahead. Before reaching the work area, drivers should have enough time to adjust their driving patterns. The advance warning area may vary from a series of signs, starting 2 km in advance of the work area, to a single sign or flashing lights on a vehicle.

Advance warning signs are not needed when the work area, including access to the work area, is entirely off the roadway and shoulder and the work does not interfere with traffic. An advance warning sign or signs should be used when any problems or conflicts with the flow of traffic might possibly occur.

Length of the Advance Warning Area

The advance warning area, from the first sign to the start of the next area, should be long enough to give the motorists adequate time to respond to the conditions.

In Chapters 3, 4 and 5, Tables A and B and the typical sign layouts indicate recommended sign locations.

1.4.2 TRANSITION AREA (AND TAPERS)

When work is performed within one or more travelled lanes, a lane closure(s) is required. In the transition area, traffic is channelized from its normal highway lane(s) to another path in order to move traffic around the work area. The transition area contains the tapers which are used to close lanes.

The transition area should be made obvious to drivers. The correct path should be clearly identified with pavement markings and/or channelizing devices so drivers will not attempt to follow the old path. Where practical, for long duration work zones, existing pavement markings should be removed when they conflict with the transition and new markings should be added. Pavement marking arrows are also useful in transition areas.

With moving operations, the transition area moves with the work area. A shadow vehicle may be used to warn traffic and/or guide it into the proper lane. Refer to the section 2.2.4, Shadow Vehicles, for additional guidance.

Tapers

A taper is identified by a series of channelizing devices and possibly pavement markings placed on an angle to the normal travel path to move traffic out of its normal path.

Four types of tapers used in traffic control zones are:

- Lane closure tapers are those necessary for closing lanes of moving traffic on a one-way roadway (sometimes referred to as channelizing tapers).

1.4.2 TRANSITION AREAS AND TAPERS (continued)

- Two-way traffic tapers are those needed to control two-way traffic where traffic is required to alternately use a single lane when a traffic signal, lane control signal or traffic control persons are present.
- Shoulder closure tapers are those needed to close shoulder areas.
- Downstream tapers are those installed to direct traffic back into its normal path.

Lane Closure Taper (One-way Roadway)

The length of a taper used to close a lane is determined by the speed of traffic and the width of the lane to be closed (the lateral distance that traffic is shifted). The taper lengths shown in line 1a* of Table A and line 1 of Table B are for normal lane widths. For greater lane widths use the taper ratios shown on the same lines. **If restricted sight distance is a problem (e.g., a sharp vertical or horizontal curve), the taper should begin well in advance of the sight restriction. The beginning of a taper should not be hidden downstream of curves.**

Generally, tapers should be lengthened, not shortened, to increase their effectiveness. Traffic should be observed to see if the taper is working correctly. Frequent use of brakes and evidence of skid marks is an indication that either the taper is too short or the advance warning is inadequate.

Merging of two lanes of traffic into one lane where the combined volume exceeds 1,200 to 1,500 vehicles per hour will cause extensive delays.

Two-Way Traffic Taper (Single lane open)

The two-way traffic taper is used in advance of a work area that occupies part of a two-way road in such a way that the remainder of the road is used alternately by traffic in either direction. In this situation, the function of the taper is not to cause traffic to merge, but, rather to resolve the potential head on conflict. A short taper is used to cause traffic to slow down by giving the appearance of restricted alignment. Drivers then have time at reduced speed to decide whether to proceed cautiously past the work area or to wait for opposing traffic to clear. One or more traffic control persons, a temporary traffic signal or temporary lane control signal are usually employed to assign the right-of-way in such situations.

Two-way traffic tapers should be 5 m to 15 m long, with not less than three devices used to provide clear delineation of the taper. Flashing arrow boards (in the arrow mode) should never be used with a two-way traffic taper.

1.4.2 TRANSITION AREA (AND TAPERS) (continued)**Shoulder Closure Taper**

When an improved shoulder is closed adjacent to a high speed roadway, it should be treated as a closure of a portion of the travelled roadway because motorists expect to be able to use the shoulder in the event of an emergency. The work area on the shoulder should be preceded by a taper that may be as short as for a two-way traffic taper, and if the shoulder is being used as a travel lane, either through practice or due to construction, a full lane closure taper should be placed on the shoulder.

Downstream Taper

A downstream taper is used at the far end of the work area to indicate to drivers that they can move back into the lane that was closed. It is placed in the termination area. While downstream tapers are optional, they may be useful in smoothing traffic flow. They may not be advisable when work vehicles move into or leave the work area from the downstream end.

1.4.3 BUFFER SPACE

The buffer space is the open or unoccupied space between the transition and work areas. Where space permits and it is considered desirable, a buffer zone should be included even though it may not be indicated on the typical sign layout or the traffic control plan. With a moving operation, the buffer space is the space between the shadow vehicle, if one is used, and the work vehicle.

The buffer space provides a margin of safety for both traffic and workers. If a driver does not see the advance warning or fails to negotiate the transition, a buffer space provides room to stop before the work area. It is important for the buffer space to be free of equipment, workers, materials and workers' vehicles. The only exception to the above would be if a buffer vehicle is required. In such a case, the vehicle would be parked upstream of the work zone.

When designing or setting out a traffic control plan, the following guidelines should be considered for buffer spaces:

- Place channelizing devices along the edge of the buffer space.
- Situations occur where opposing streams of traffic are moved over so one lane of traffic uses a lane that normally flows in the opposite direction. In these situations, a buffer space should be used to separate the two tapers for opposing directions of traffic because it could help prevent head on collisions.

1.4.4 WORK AREA

The work area is that portion of the roadway which contains the work activity and is closed to traffic and set aside for exclusive occupation by workers, equipment and construction materials. Work areas may remain in fixed locations or may move as work progresses. An empty buffer space may be included at the upstream end. The work area is usually delineated by barricades or other channelizing devices to exclude public traffic.

1.4.4 WORK AREA (continued)

Conflicts and Potential Hazards

Conflicts between traffic and the work activity are potential hazards. These increase as:

- The work area is closer to the travelled lanes.
- Physical deterrents to normal operation exist; such as uneven pavements, vehicles loading or unloading.
- Speed and volume of traffic increase.
- The change in travel path gets more complex, for example, by shifting traffic across the median and into lanes normally used by opposing traffic as compared to moving it over a short distance.

Work areas that remain overnight have a greater need for delineation than day time operations.

Every reasonable effort should be made to minimize conflicts. Some suggestions include:

- Use traffic control devices to make the travel path clearly visible to traffic.
- Place channelizing devices between the work area and the travelled way. Devices placed on a tangent (along the work area) to keep traffic out of a closed lane should be spaced in accordance with the extent and type of activity, the speed limit of the roadway, and the vertical and horizontal alignment such that it is apparent that the lane is closed. For low speed or urban streets, closer spacing may be required.
- Provide a safe entrance and exit for work vehicles.
- Protect moving operations with adequate advance warning of the work and/or shadow vehicles.

1.4.5 TERMINATION AREA

The termination area provides a short distance for traffic to clear the work area and to return to the normal traffic lane or lanes. It extends from the downstream end of the work area and may include a short downstream taper.

There are occasions where the termination area could include a transition. For example, if a taper is used to shift traffic into an opposing lane of a multilane roadway, then the termination area should have a taper to shift traffic back to its normal path. This taper would then be in the transition area for the opposing direction of traffic. It is advisable to use a buffer space between the tapers for opposing traffic.

Avoid “gaps” in the traffic control that may falsely indicate to drivers that they have passed through the entire work zone. For example, if the work area includes intermittent activity throughout a 2 km section, the drivers should be reminded periodically that they are still in work zone.

1.4.6 LOWER SPEED ZONES IN WORK AREAS

Where it is felt that warning signs and other devices do not adequately provide for the safety of workers and the public it may be necessary to establish a speed zone of one of the following two types. Figures 3.8.2 and 4.1.1 illustrate use of the two types of lower speed limits typically used in work areas.

1.4.6.1 Construction Speed Zones

A Construction Speed Zone requires the approval of the road authority. For roads under the jurisdiction of the Ministry of Transportation and Highways the District Highways Manager is the approving official.

The beginning of a construction speed zone is marked with R-3 and R-4 signs together with C-22 tabs. The end is marked with an R-4 sign showing the normal speed limit.

Construction Speed Zones which are unnecessarily restrictive in any way must be avoided if good driver observance of this control measure is to be maintained. Unnecessarily restrictive features are: excessive length of zone, excessive hours during which the zone is in effect, and too low a specified speed. A construction speed zone may be required either 24 hours a day, or only while work is in progress, or only when work is not in progress. An example of where it may only be required when work is not in progress would be a site controlled during construction hours by TCPs or pilot cars.

When imposition of a Construction Speed Zone for a long duration or freeway work zone would result in a reduction of 40, 50 or 60 km/h below the normal speed limit, installation of a transition or buffer speed zone, generally a minimum of 500 m in length, should also be considered. For a drop of 40 or 50 km/h, the buffer should be 20 km/h above the Construction Speed Zone limit and for a drop of 60 km/h, the buffer should be 30 km/h above the Construction Speed Zone limit. This will ensure that the normal speed limit is not reduced in decrements exceeding 30 km/h.

1.4.6.2 Temporary Speed Zones

A Temporary Speed Zone is established with C-1 or C-2 signs and requires the approval of a crew supervisor. Survey crews should use the C-2 Survey Crew Maximum 30/50 km/h signs rather than C-1 Crew Working Maximum 30/50 km/h signs. A temporary speed zone is terminated with a C-23 sign.

Temporary Speed Zones should be used as sparingly as possible in order to preserve driver respect for this form of speed control, and must be removed when no longer required.

1.5 INSTALLATION, MAINTENANCE AND INSPECTION OF TRAFFIC CONTROL

Before the scheduled commencement date for work, designated representatives of the road authority and as applicable, the contractor and/or the utility should check the availability of all signs, pavement marking material and channelizing devices that are to be used. All devices should be:

- Standard in size, shape, colour and message.
- Clean and in good condition.
- Reflectorized for night use.

If a particular device does not meet all of the above requirements it should be replaced with one that does. Additional devices should be available to replace any that may be damaged while the work is in progress. On construction, the designated representatives of the road authority and, as applicable, the contractor and/or utility should be in agreement that all devices are satisfactory before they are placed on the roadway.

Reflectorized devices need extra care when handling and transporting to ensure that the reflectorizing elements are not damaged.

Signs in place that do not apply during construction, maintenance, or utility work, should be removed or have the faces completely covered with opaque materials. At night, non-opaque materials let the messages be seen because headlights reflect the messages through such materials.

Signs that are installed before traffic patterns are changed should be covered until required.

As many maintenance, utility, and emergency operations require the same devices for each job, vehicles should be equipped with an adequate supply of commonly used portable devices.

1.5.1 INSTALLATION AND REMOVAL OF DEVICES

Order of Installation

Traffic control devices should be placed in the order that drivers will encounter them, starting with the sign or device farthest upstream from the work area and the others successively as the work area is approached. If traffic in both directions will be affected, such as with work in the centre lane of a multilane roadway, the devices can be placed in both directions at the same time, starting at each end farthest from the work.

1.5.1 INSTALLATION AND REMOVAL OF DEVICES *(continued)*

On multilane roadways, as shown in figure 4.3.4 for example, traffic travelling in, say, direction “A” may have to be moved around a work area by crossing the median into the left lane normally available only to traffic travelling in the opposing “B” direction. Where this has to be done, it is essential that control devices be installed first to ensure that the “B” traffic is confined to its right lane before traffic in the “A” direction is moved over the median.

When signs or channelizing devices are to be installed and removed several times during the work operation, spots can be painted to mark device locations, so that the installation can be repeated quickly and with proper placement assured. The devices should be stored off the roadway, out of sight, or transported to another location when not required.

Motorists do not expect to encounter workers in the roadway setting up a traffic control zone. Since the goal is to make the entire operation safe, high level warning devices, traffic control persons, or flashing vehicle lights should be used to warn the drivers of the presence of workers. Flashing arrow boards are valuable to assist the workers during placement or removal of channelizing devices for lane closures.

Order of Removal

As soon as the work is completed and traffic control devices are no longer needed, they should be removed. Any cones and channelizing devices on the travelled roadway should be removed first, followed by the signs. Flashing arrow boards, high level warning devices, traffic control persons and/or flashing vehicle lights should be used in the removal process. No workers shall ride on the rear outside of a vehicle while it is reversing.

On low volume roadways, devices should be removed in the opposite order of installation by first removing those closest to the work area and continuing progressively upstream away from the area.

On high volume roadways, devices may be removed as for low volume or they may be removed with the flow of traffic provided there is a buffer vehicle, which may be equipped with a rear-mounted impact attenuator.

Pavement Marking Removal

Motorists use pavement markings as a primary source of guidance. Temporary pavement markings, using preformed adhesive-backed traffic tape or raised pavement markers can be used with channelizing devices to provide guidance in work zones. Any pavement markings that are not applicable, and which may confuse drivers, should be removed as soon as practicable for long duration work.

Typical methods of removal include grinding, burning, chemical treatment, sandblasting, shot blasting and high pressure water jetting. Painting over inappropriate markings with black paint or bituminous material has proved unsatisfactory as the original lines eventually reappear when overlying material wears away under traffic. In addition, lines which are covered in this way are still visible under certain conditions (low angles of illumination or in wet weather).

1.5.2 INSPECTION AND MAINTENANCE OF TRAFFIC CONTROL

The requirements of this section are intended to be comprehensive enough to cover most traffic control situations but not all requirements will necessarily apply to every operation; particularly to some short duration, emergency or brief duration work which requires minimal use of traffic control devices.

On road construction projects, maintenance of traffic control is generally the responsibility of the contractor.

Once the work zone is installed, it is important to ensure that it functions as intended and that any subsequent modifications resulting from an inspection process, are implemented and also maintained.

Maintenance is needed to service the equipment and make corrections that may be required due to changes in conditions or any combination of the following factors:

- Traffic Accidents.
- Devices displaced by vehicles, workers, wind, truck slipstream, etc.
- Damage caused by construction activities.
- Weather created damage.
- Dead/low flashing light batteries or burned out bulbs.
- Low fuel levels for electrical generators.
- Wear and tear.
- Dirt on devices.
- Vandalism or theft.

Elements of an Inspection Program

A comprehensive inspection program should include the following elements:

- A formal traffic control plan, for reference.
- A defined inspection procedure.
- A repair and replacement procedure.
- Assurance of adequate inventory of devices for emergency replacement or repair.
- Follow-up procedures to ensure that repairs are made.
- A review to ensure that the public travel path is clearly marked through the entire work zone, both day and night, and particularly at the end of a work day, keeping in mind the possibility of poor weather and light conditions.
- Documentation of inspections and repairs made.

Personnel designated to carry out inspections will be faced with the need to make decisions during the inspections and must exercise judgement in establishing appropriate practices.

A key element of the program is a procedure that ensures the required maintenance is performed. When corrective action is taken, it should be recorded in order that documentation is complete.

1.5.2 INSPECTION AND MAINTENANCE OF TRAFFIC CONTROL *(continued)***Responsibility for Inspection and Maintenance**

For each project, an individual should be assigned the supervisory responsibility for establishing and maintaining traffic control. On construction projects, the contractor and/or utility should designate a specific person or persons. In addition, on large projects, the traffic control responsibility should also be assigned to an employee of the road authority. Routine inspections of traffic control should be carried out by these individuals.

Less frequent but periodic inspections should be performed by senior staff of the contractor (typically the superintendent) and the road authority (the resident engineer and/or the traffic engineer).

Lines of communication and responsibility should be clearly established between individuals in charge of routine maintenance of traffic control devices and those with greater authority so that, if necessary, problems can be brought promptly to the attention of officials who are in a position to respond immediately.

Inspection Frequency

To determine the frequency with which inspections should be performed, the following factors should be considered:

- Project size and duration.
- Nature of the work activity.
- Complexity of traffic control.
- Frequency at which damage occurs.
- Number of problems observed in previous inspections.

Traffic control that is required and left in place overnight should be inspected during hours of darkness. Inspections should be continued, day and night, through holidays, weekends and other times when long duration work is not active.

1.5.3 DOCUMENTATION OF TRAFFIC CONTROL

Good record keeping is necessary for traffic control related to road work. Such records are essential in the case of a traffic accident involving litigation. Although such record keeping can be time consuming, particularly for a moving operation, it is important to record significant traffic control actions taken by field crews. Records should desirably include, but not be limited to the following:

- Photologging.
- Photographs either keyed to a diary or accompanied by brief descriptions of time, location, direction and photographer's name.
- Maintaining up-to-date traffic control plans by notes on construction plans, or preferably updated traffic control plans.
- Daily diary entries of times, locations and names of individuals involved in the installation, change and removal of traffic control devices.

1.5.3 DOCUMENTATION OF TRAFFIC CONTROL *(continued)*

When the inspection process reveals a condition that requires changes, the documentation should include the following:

- Description of change needed, when it was noted, and by whom.
- Instructions given to make changes.
- What and when changes or replacements made and, if deferred, why.

1.5.4 POTENTIAL FOR TRAFFIC ACCIDENT LITIGATION

The objective of road authorities, contractors and utilities should be to avoid traffic accidents within work zones. The following will help to accomplish this objective:

- Know and comply with safe and effective principles of traffic control.
- Ensure that the proper devices are in place in the work zone; including times when the zone is unattended at night, weekends, holidays, etc.
- Follow all safety regulations.
- Document all actions taken on or related to traffic control placed in the work zone.
- Inspect the work zone with a view to detecting and correcting observed deficiencies in traffic control.
- Remove all material and equipment not needed at the site as soon as possible, including traffic control devices no longer required.
- Provide adequate warning, guidance and protection for motorists, pedestrians, cyclists and workers for and from all foreseeable conflicts and hazards that could result from the work being done.

In spite of the best efforts outlined above, traffic accidents may still occur and some of these may result in lawsuits against the road authority. Defense against such lawsuits relies to a considerable degree on records that have been kept of job related activities and of traffic control maintained in the work zone. Documentation of changes made, as and when seen to be needed, should be viewed as indication of an effort always to provide adequate traffic control. Documentation should be kept as outlined in Section 1.5.3.

