Maintenance of Traffic Plans

Course No: C04-040
Credit: 4 PDH

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I. Introduction

Work zone traffic control is an important function affecting the safety of motorists, pedestrians and work zone personnel. Every effort should be made to eliminate or reduce accidents within work zones. In addition to safety, the potential delay to the public, caused by traffic interruptions during construction, is another issue that needs to be addressed.

Federal Highway Administration (FHWA) rules state that all Department employees, contractors, consultants and utility company personnel, who are responsible for the design, inspection and implementation of work zone traffic control, be trained in a Department approved course. In addition, personnel working on Department projects or within the State Highway right-of-way are also to be trained.

The Federal Highway Program Manual (FHPM) requirements include:

1. Detailed Maintenance of Traffic Plans for each construction/maintenance project.
2. A responsible person assigned during construction to ensure that work zone safety is properly administered.
3. Individual pay items for work zone devices.
4. Training for everyone responsible for the design, implementation or inspection of traffic control.
5. Annual process reviews.

The objectives include:

- Utilize and/or modify typical layouts in the development of traffic control plans to specific site conditions.
- Identify the components of a quality traffic control plan and be aware of the general procedures.
- Recognize the importance of workable traffic control plans in the context of the entire project.
- Identify relevant fundamental and human factor principles in the design of traffic control plans.
- Identify and apply workable concepts and techniques for designing, installing, and maintaining controls in work zone situations.
- Utilize work zone traffic control devices as specified in the FDOT Standard Indexes in appropriate situations.
- Recognize and apply proper procedures in developing quantities for work zone traffic control items.

II. Work Zone Maintenance of Traffic

A. Fundamental Principles of Work Zone Traffic Control

It is important for the engineer to understand these requirements and principles prior to developing a set of traffic control plans. Chapter 6 of the MUTCD provides the fundamental principles of work zone traffic control as follows:

1. Make traffic safety an integral and high priority element of every project:
   - Use geometrics and traffic control devices that are, as nearly as possible, comparable to those of normal highway situations.
   - Prepare a traffic control plan that is understood by all persons responsible for work zone traffic control.

2. Avoid inhibiting traffic as much as possible:
   - Avoid reduced speed zoning except where absolutely necessary.
   - Avoid frequent and abrupt changes in geometrics.
   - Provide for the safe operation of work vehicles.
   - Minimize work time to reduce exposure.
   - Schedule work during off-peak periods.

3. Guide motorists in a clear and positive way:
   - Use adequate warning, delineation and channelization to give positive guidelines for all light and weather conditions expected during the work activity.
   - Remove inappropriate pavement markings.
   - Use flagging only when other methods of traffic control are inadequate.

4. Perform routine inspection of traffic control elements:
   - Assign individuals trained in safe traffic controls the responsibility for safety at work sites.
   - Make modifications in traffic controls or working conditions when necessary.
   - Monitor work site under varying conditions of traffic volume, light and weather.
   - Perform engineering analyses of all accidents in work zones.
   - Periodically analyze work zone accident records to guide officials in improving work zone operations.
   - Remove traffic control devices immediately when they are no longer needed.

5. Give constant attention to roadside safety.
   - Provide clear roadside recovery area as wide as practical.

- Use lightweight channelization devices, which will yield on impact.
- Provide positive barriers.
- Store construction equipment, materials and debris out of clear zone in a manner that will minimize the opportunity for run-off-road vehicle impacts.

B. Requirements for Maintenance of Traffic Devices

The MUTCD also sets forth the basic principles for use of maintenance of traffic devices. The principles, which govern the use of regular traffic control devices also, apply to work zone devices. Section 1A-2 of the MUTCD states: "To be effective, a traffic control device should meet five basic requirements:"

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

In addition, traffic controls in work zones are to

- Warn motorists and pedestrians of hazards
- Advise motorists of the proper travel path through the area
- Delineate areas where traffic should not operate
- Separate and protect motorists, pedestrians and the work force

C. Human Factor Principles for Work Zones

A Prior Knowledge

This is the sum of knowledge and information that the driver brings into the driving task. It includes the driver's driving experience, as well as the knowledge of rules, regulations, language, symbols and codes.

Any engineer responsible for work zone traffic control should carefully assess their assumptions of a driver's prior knowledge. Engineers should cater to drivers *not familiar* with the work zone in question.

Expectancy

Expectancy is the anticipation of the occurrence or nonoccurrence of events and situations. It is formulated as a function of a driver's experience and a prior knowledge.

Events or situations that violate driver expectancies can lead to confusion and should be remedied by proper advance warning. Work zones are prime violators or expectancies.

Decisions
The formation of a course of action on the part of the driver, based on information received, is called a decision. Because work zones violate driver expectancies, the designers must help drivers make decisions when traveling through the work zones. Proper TCP design minimizes the rate at which decisions must be made, and keeps decisions as simple as possible.

Advance Warning
This is a means of displaying information to the driver about events and situations prior to their occurrence. Proper advance warning is essential to all work zones. Sequential advance warning should begin with the general warning signs and become progressively more specific.

Ambiguity
Ambiguity is the term used to describe information that is unclear, creates uncertainty or has more that one meaning. Ambiguity leads to confusion.

General messages such as “DANGER AHEAD” or “ROAD WORK 1 MILE” are ambiguous if they stand by themselves. They must be followed by more specific warnings that tell the driver what to do. Negative information that tells the driver what *not* to do can also be ambiguous.

Improper delineation or roadway geometrics can also be ambiguous and lead to path confusion (e.g., improper or incomplete removal of old pavement markings; improper placement of cones, drums or barricades).

Redundancy
This is accomplished by presenting the same message in two or more different ways. Doing this reduces the probability of error and ambiguity and also enhances detectability (e.g., signs and markings that carry the same message; use of both symbols and verbal messages on a sign).

Repetition
This is a technique whereby important information is displayed in several successive locations for emphasis and to ensure that it is not missed. Repetition is a means of accomplishing redundancy.

III. Components of Maintenance of Traffic Plans

The components of maintenance of traffic plans apply to the mainline roadway, crossroads, side streets, and off-ramps. The components are as follows:

1. A typical section for each work zone phase should be provides for all projects except milling and resurfacing or simple intersection improvements. The typical section should include land widths, offsets to warning devices or barriers, the construction area, and any other pertinent items. A good typical section is of the most effective tools in preparing quality traffic control plans.

2. The location of all advance warning signs should be identified. The designer should consider the location of existing signs when establishing the best location for the work zone signs. If there are no other signs near the beginning of the project, then exact stations may not be necessary.

3. Temporary pavement markings (including Raised Pavement Markers – RPMs) for diversions, transitions, or other special situations should be shown or noted in the plans. Often, traffic is shifted through an intersection. In most cases, it would be necessary to provide temporary guide stripes and/or RPMs to delineate this shift. Intersections are critical areas that are often overlooked.

4. The location of temporary barrier and crash cushions should be shown or noted in the plans, as these costs must be specified in order to obtain competitive bids.

5. The need for temporary drainage devices must be addressed in the Maintenance of Traffic Plan. Stage construction (or reconstruction) of drainage systems often results in the need for temporary measures in order to properly channel stormwater during construction. The designer must provide for these needs including the proposed method payment for the temporary drainage devices. Each phase of construction should be looked at as the drainage for its own individual project.

6. Channelizing devices should be shown at special locations such as detours, transitions, gore areas or other unusual maneuvers.

7. Variable Message Signs (VMS), Arrow Boards and Temporary Signals are *costly* items. Therefore, the locations of these devices should be shown or noted in the plans. The engineer must establish the appropriate location based on sight distance restriction, advance warning needs, potential conflicts with other signs (existing or proposed) and other considerations of this nature.

8. VMS messages must be developed by the designer with input from Construction. It is important that the VMS messages be *clear* and *concise*, conveying a simple message to the motorist. The message design must not be left up to the contractor or project personnel.

9. When there are existing traffic signals, timing, phasing and actuation may need to be revised during the various construction activities. These items should be addressed in the plans in order to maximize traffic operations during construction.

10. The designer must show the location and geometry for all transitions and detours. This would include taper rates for transitions and curve radii, Point of Tangent (P.T.), Point of Curvature (P.C.), etc. for detours.

11. The proposed regulatory speed must be show in the plans for each work phase. Even if it is to remain the same as the current speed, the designer must still note this in the plans.

12. The designer should reference the appropriate standard indexed whenever they are applicable. It may be necessary at times to modify the standard indexes in order to more accurately reflect the actual project conditions.

13. The appropriate quantities, pay items and pay item notes must be provided to further define the work and the proposed method of payment. On complex projects, it may be beneficial to break down the quantities by phase using a matrix.

14. The designer must address all anticipated conflicts between permanent signing and markings and work zone signing and markings. All existing signs that are to be removed or covered should be noted. The standard specifications require the contractor to remove all conflicting pavement markings. This is normally accomplished by one of several means. It may be appropriate for the designer to require milling resurfacing or a thin pavement overlay (of FC-1 or 4 or type IV asphalt) in order to more effectively remove old markings.

15. The designer should also address any other key strategies that are to be used. These may include: the use of police for speed enforcement or other duties; wrecker services (patrol) to improve incident response, especially in restricted areas (such as bridges); Highway Advisory Radio (HAR); and night work.

16. A quality Maintenance of Traffic Plan should also include the effective use of good plan notes to clearly define the work.

17. If highway lighting exists prior to construction, the designer must determine to what extent the contractor will be required to maintain the existing highway lighting.

IV. Work Zone Devices

A. Qualified Products List (QPL)

The Specifications or Design Standards limit the usage to products included on the Qualified Product List (QPL). A number system references specifications (i.e., 102 for Maintenance of Traffic products). Where applicable, cross-references are provided so usage and material requirements can be easily identified. Vendor drawings with additional information are linked to the QPL number.

B. Definitions of Work Zone Devices

All work zone signs should be placed to be visible but not block the view of existing signs. They should conform to the Design Standard 600 series. When a work activity is not applicable, the signs should be covered.

Advance Warning Signs (Regulatory, Warning and Guide Signs)
Advance warning sign messages are to be sequenced from the general to the more specific. For example: "Road Work Ahead," the "Left Lane closed," and then "Merge Right." This sequence of signs provides first a general warning, then a specific description of the upcoming situation, and finally a positive guidance to motorists.

The number of advance warning signs, in most cases, should be kept to a minimum. Too many signs can create confusion. Signs spacing is also important. Adequate time must be given for the motorist to read and respond to each sign. The designer must also consider how well the construction signs will fit in with the existing signing and if any of the existing signs will need to be removed or covered.

- Regulatory signs are generally rectangular in shape with a loner vertical dimension black legend and border on white background. Stop, Yield Do Not Enter and Wrong Way signs have a white legend on red background. These signs impose legal obligations and restrictions on all traffic.

- Warning signs are generally a diamond shape. Temporary warning signs have a black legend and border on a fluorescent orange background. They must be at least 48 inches by 48 inches. Permanent warning signs have a yellow background with a black legend and may remain in the work zone if still applicable.

- Guide signs are generally rectangular in shape with a long horizontal dimension. The basic color is white on green. At work zones they may be black on orange to indicate routing changes due to maintenance activities.

D3-2

Channelizing Devices

Channelizing devices include cones, tubular marker, plastic drums, vertical panels, and barricades (Type I, II and III). They are intended to perform the following functions:

- warn and alert drivers of hazards created by construction or maintenance activities in or near the traveled way,
- protect workers in the work zone, and
- guide and direct drivers and pedestrians safely past hazards

Factors determining the use of a particular device include visibility requirements, space restrictions, time of day, work zone speed conditions, and mobility of work zone operations. Consistency should be maintained in the utilization of placement of channelizing devices. Mixing of devices for a particular application in a given work zone is an example of inconsistent use of channelizing devices.

Cones are to be used only when workers are on the job site. They are limited to 2 miles in length. A cone shall be 36” in height and weigh 12 lbs.

Tubular markers are used on lower speed, narrow roads. They are to be used during daylight hours only. A tubular marker shall be 36” in height and 4” in diameter.

Drums are highly visible devices that have good target value. They give the appearance of being formidable obstacles and command the respect of the motorist. Drums shall be 36” in height and 18” in diameter.

Vertical panels may be used for channelization and are particularly appropriate for traffic separation in locations where lateral space is restricted. The panel shall be 36” in height with a minimum of 12” from the ground. The width of the panel shall be 12”.

Type I Barricade has one horizontal retroreflective rail. The markings shall slope downward at a 45-degree angle toward the direction of traffic. The barricade shall be 36” in height and 36” in width. The rail shall be 12” in height.

Type II Barricade has two horizontal retroreflective rails. The ballast shall not be placed on the top rails or any striped rails or higher than 13 inches above the driving surface. The barricade shall be 36” in height and 24” in width. The rails shall be 8” in height.

Direction Indicator Barricade (Type D1) has an arrow on the top panel and a standard horizontal retroreflective rail on the bottom rung. It may be used in tapers and transitions and shall be used in series. The barricade shall be 36” in height and 24” in width. The arrow panel shall be 12” in height and the rail shall be 8” in height.

Type III Barricade has three horizontal retroreflective rails. Road closure signs may be mounted on Type III Barricades. The barricade shall be 6 feet in width and the rails shall be 8” in height.

Arrow Panels

Advanced warning arrow panels are intended to supplement other warning devices. They provide additional advance warning. The appropriate signing, markings and other warning devices should be adequate in the event the arrow panel malfunctions.

An advanced warning arrow panel should be used for all long-term *lane closures* on multi-lane roadways. It is an effective device because of its high visibility. Arrow panels should not be used on lane shifts. Research has shown that the motoring public identifies the arrow panel with lane closures.

The intensity shall be reduced by 50% for nighttime use. The arrow panel should be placed on the shoulder on the side toward the front of the taper or at the beginning of the work zone.

Variable Message Signs

Variable message signs (VMS) are intended to supplement the other work zone devices. The VMS can provide dynamic information to the motorists. They can advise road users of unexpected situations. Its flexibility allows the contactor to change messages readily with the changing of construction activities. VMS's are generally used in complex, high density work zones. The designer must note in the plans which operations or phases will require the use of the VMS.

The designer must include the proposed messages in the plans. Message design should not be left up to the construction personnel. The Plans Preparation Manual (PPM), Volume 1, Section 10.10.3 provides detailed guidelines regarding message selection. Generally, a message should not exceed *2 x 3 maximum*. This means no more than *two* messages of *three* lines in length. The VMS can accommodate 8 characters per line so abbreviations may be necessary. The messages shall not scroll across the screen. It is necessary for the message to be able to "cycle" twice from the point where the motorists can first read the message. This allows the motorist to read the message in its entirety. The general arrangement of the message from top to bottom is: top line for problem, center line for time, location, or distance ahead, and bottom line for recommendation to driver. The following is a VMS worksheet that can be used to layout the messages to be used on the sign.

CHANGEABLE (VARIABLE) MESSAGE SIGNS WORKSHEET

Location of board:_____

Used: from _____-_____-_____at _____:_____am/pm

to _____-_____-_____at _____:_____am/pm

Message programmed by: _____

MESSAGE 1

MESSAGE 2

Timing:

Message 1 will run ____.____ seconds.

Message 2 will run ____.____ seconds.

The bottom of the sign panel shall be at least seven feet above the roadway. The VMS shall be moved out of the clear zone when not in use or protected by a barrier. VMS's are legible from at best 900 feet away. These signs should be placed at a sufficient distance in advance of the work activity in order to allow the motorists to properly respond. Normally, in urban areas these signs should be placed 500 to 800 feet in advance or the work areas being noted. On rural facilities this distance should be appropriately increased.

Traffic Signals

- Portable or Temporary Span Wire Signals

Portable traffic signals (or temporary span wire signals) can be used in place of flaggers. These devices are especially useful on operations that last for several days. Overall safety is improved since the flagger is not exposed to traffic. The location of the portable or span wire signals should be shown in the plans. The designer should also provide the timing for these temporary traffic signals.

- Existing Signals

For existing traffic signals within the work zone, the designer must address the need for revisions/adjustments to the timing, phasing and actuation. If a proposed project involves milling the existing asphalt to a depth including loops, the designer should provide instructions for changing the signal controller from traffic–actuated to fixed time. The plans should also include the need for adjusting the signal head locations. Detection capability shall be returned within 12 hours.

Concrete Barrier Wall

Concrete barrier walls are primarily used to mitigate dropoffs. It is also used to separate workers from traffic. The designer should show the location and stations for all barrier walls. This can be done using a plan view or by a typical section along with plan notes.

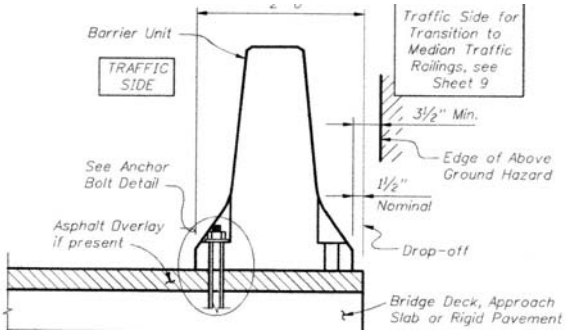
All barrier wall ends must be protected with a crash cushion unless the wall is carried out of the clear zone. Whenever the wall is tying into an existing barrier wall or guardrail, a positive connection must be made as per Standard Indexes 415 and 600. This will prevent creating a snag point. The various temporary barrier wall types are shown in Standard Index 415.

It should be noted that there are a number of other methods for mitigating a dropoff other than a barrier wall. These include:

1. shoulder treatment, which is filled of material (compacted) at the edge of the pavement to a 6:1 slope. See Index 600 “dropoff” charts for more details;
2. limiting the contractor’s operations so that the work area is brought up to a depth such that the barrier wall is not required at the end of the day’s operations

The Type K is covered in Index must be installed on an asphalt or concrete surface with a 10:1 or flatter slope. It can be bolted, staked, free standing or back filled.

The following illustration is of a Type K bridge deck mounted barrier wall.



Raised Pavement Markers

Raised pavement markers (RPMs) are very effective delineators. The Standard Indexes require RPMs on all lane lines as well as on edge lines of gore areas. These markers enhance the lane line visibility, especially under night and rain conditions. RPMs may also be effective through intersections in conjunction with guide stripes. Often, lane shifts occur through the intersection areas.

Crash Cushions

Crash cushions are designed to protect motorists from exposed barrier wall ends, fixed objects and other hazards. Work zone crash cushions can either be stationary or mobile, the mobile crash cushions are commonly called truck-mounted attenuators.

- Redirective crash cushions do not only absorb and dissipate the energy from a head-on strike by a vehicle, but they also serve to redirect errant vehicles in the event of a side-on hit. Inertial crash cushions have no such redirecting properties. Truck-mounted attenuators (TMA's) can be used in short-term, mobile or moving operations, such as pavement marking or maintenance activities.

Truck/Trailer Mounted Attenuators (TMAs)
TMAs are for moving operations and must comply with Design Standard Index 607 or 619. They are mounted on trucks per manufacturer's recommendations. TMAs are used for three classes of protective vehicles in work zones:

- Barrier Vehicle: a truck parked upstream from a stationary operation and which is usually unoccupied.
- Shadow Vehicle: a moving truck spaced a short distance from a moving operation, giving physical protection to workers or a work vehicle from traffic approaching from the rear.
- Advance Warning Vehicle: a truck that is some distance upstream of a moving or stationary operation, displaying an arrow panel or other signs as appropriate.

V. Traffic Control Planning

A maintenance of traffic plan is a set of specific plans sheets, references to standard indexes and/or plan notes describing how traffic will be controlled during each construction phase. The level of detail of the maintenance of traffic plan depends on the project complexity. The overall goal is to have a clear and concise maintenance of traffic plan.

A. Components of Traffic Control Zones

Advance Warning Area
The section of highway where road users are informed about the upcoming work zone or incident area. It may vary for a single sign to a series of signs in advance of the traffic control zone activity area. It is the first indication to motorists of an unusual situation and alerts them that work operations will occur a short distance ahead. Properly positioned signs give motorists adequate time to respond.

Transition Area
The section of highway where road users are redirected out of their normal path. They are directed from one lane to another in a smooth and gradual transition with the use of channelizing devices.

Activity Area
The section of highway where the work activity takes place. It is comprised of the work space, traffic space and buffer space.

> The work space is that portion of the highway closed to road users and set aside for workers, equipment and material. Work spaces are usually delineated for road users by channelizing devices.

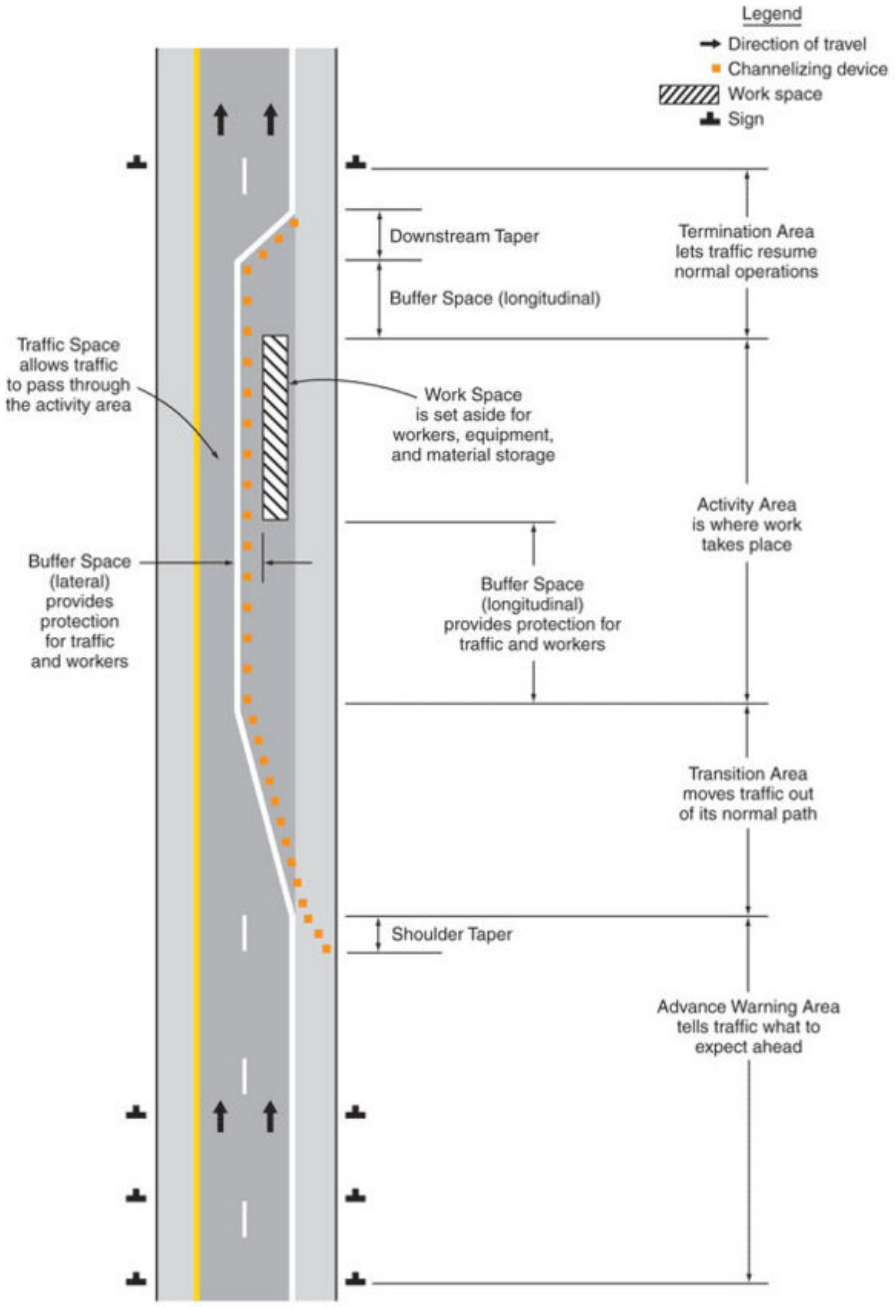
The traffic space is the portion of the highway in which road users are routed through the activity area.

The buffer space is a lateral and/or longitudinal area that separate road user flow from the work space. It provides motorists the extra space to regain control if they missed the warning signs and room to stop before reaching the work zone. The buffer space is not required if working on the shoulder only.

Termination Area

Used to return road users to their normal path. It extends form the downstream end of the work area to the END ROAD WORK signs. It provides a short distance for traffic to clear the work area and return to normal traffic lanes.

The following illustration shows the components of the traffic control zone.



B. Tapers

Tapers may be used in both the transition and termination areas. Tapers are created by using a series of channelizing devices and/or pavement markings to move traffic out of or into the normal path. Longer tapers are not necessarily better that shorter tapers (particularly in urban areas characterized by short block lengths) because extended tapers tend to encourage drivers to delay the lane changes unnecessarily.

There are five types of tapers.

- Two-Lane Two-Way Taper
  This taper is used in advance of a work area that occupies part of a two-way road in a way that the remainder of the road is used alternately by traffic in either direction. It requires a flagging operation.

- Shoulder closure Taper
  No buffer space is required for this taper.

- Merging Taper
  This taper closes lanes to move traffic on a multi-lane highway using channelizing devices.

- Shifting Taper
  This taper shifts traffic from one lane to another, but does not require traffic in that lane to merge with traffic in another lane.

- Downstream Taper
  This taper is used at the end of a work area to direct drivers to move back into the lane that was closed.

C. Taper Length Criteria

It is important to recognize the importance of taper length and spacing of devices. There are five types of tapers used in work zone traffic control. The length of each taper is based on formulas using the speed of the traffic and width of the offset (or lane width).

Taper Length Criteria:

Type of Taper	Taper Length
Merging Taper	L Minimum
Shifting Taper	1/2 L Minimum
Shoulder Taper	1/3 L Minimum
Two-way Traffic Taper	100 Feet Minimum
Downstream Taper	100 Feet Per Lane

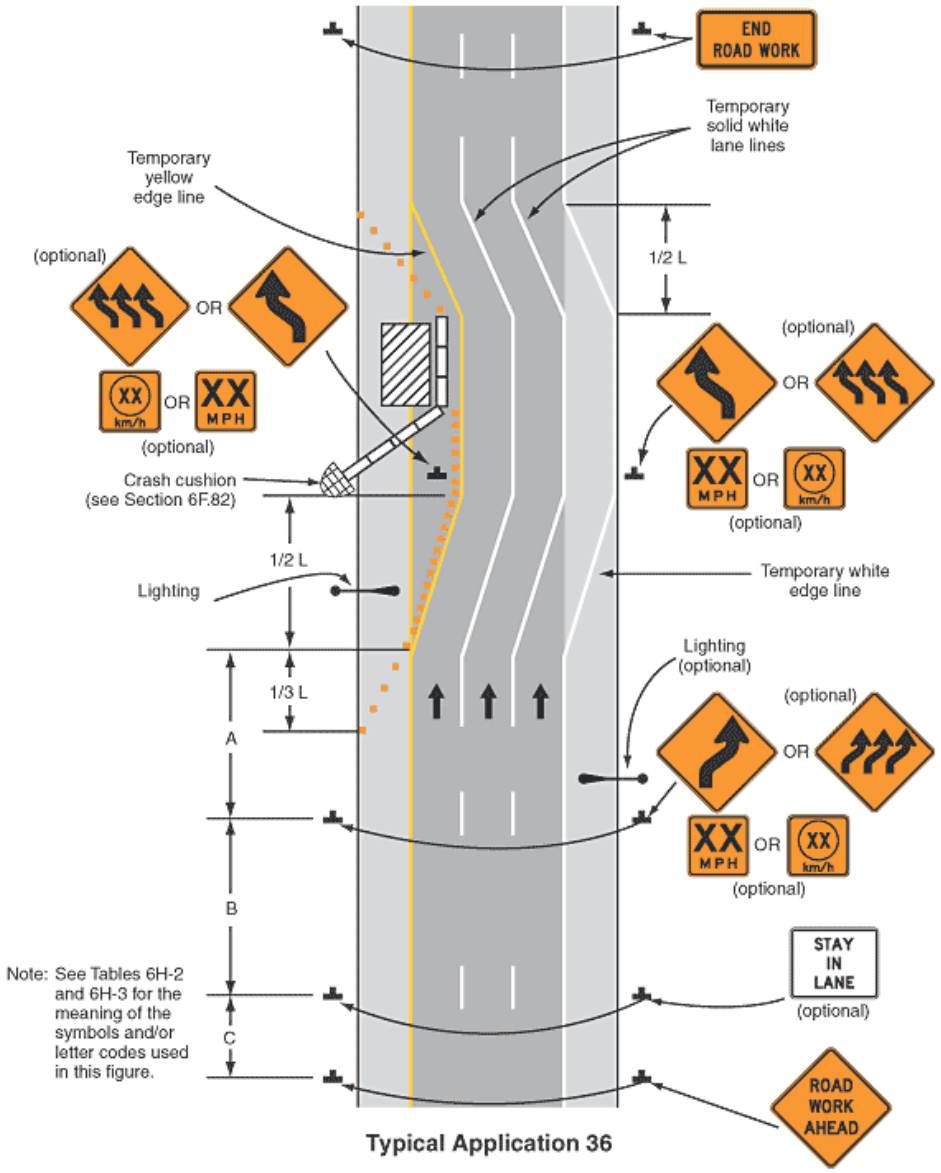
FDOT Plans Preparation Manual (PPM) Chapter 10 gives guidance for taper types and lengths. Formulas for L are as follows:

Speed Limit	Formula
40 MPH or Less	L = (WxSx2)/60
45 MPH or Greater	L = W x S

L = Taper Length in feet
W = Width of offset in feet
S = Posted regulatory speed for work zone in MPH

The following illustration shows the length of tapers for a lane shift on a freeway as described above.

Figure 6H-36. Lane Shift on Freeway (TA-36)



D. Lane Closure Analysis

The lane closure analysis is a process used by designers to calculate the peak hour traffic volume and the restricted capacity for open road and signalized intersections. The analysis will determine if a lane closure should or should not be allowed and the time of day or night a lane closure could occur without excessive travel delay.

The following illustration is a sample lane closure worksheet.

LANE CLOSURE WORKSHEET

DATE: **February 23, 2017**
FINANCIAL PROJECT ID: ***000000-0-00-00*** FEDERAL AID PROJECT NO: ***0000-000-A***
COUNTY: ***0*** DESIGNER: ***Designer***
NO. OF EXISTING LANES: ***0*** LOCATION: ***SR 00 - Begin St. to End St.***
SCOPE OF WORK: ***Scope of Work***

Calculate the peak hour traffic volume (V):

V = ATC ***0*** X P/D ***######*** X D ***1.00*** X PSCF ***0*** X RTF ***0.00*** = ***#DIV/0!***

LANE CLOSURE CAPACITY TABLE

Capacity (C) of an Existing 2-Lane – Converted to 2-Way, 1-Lane = 1400 VPH
Capacity (C) of an Existing 4-Lane – Converted to 1-Way, 1-Lane = 1800 VPH
Capacity (C) of an Existing 6-Lane – Converted to 1-Way, 2-Lane = 3600 VPH
Capacity (C) of an Existing 8-Lane – Converted to 1-Way, 3-Lane = 5400 VPH
User Defined Capacity (C) of Existing 2-Lane - Converted to 2-Way, 1-Lane =
User Defined Capacity (C) of an Existing Multi-Lane - Converted to 1-Way, -1-Lane =

Factors restricting Capacity:

TLW ***0*** LC ***0*** WZL ***0*** G/C ***0***

Calculate the Restricted Capacity (RC) at the Lane Closure Site by multiplying the appropriate 2L, 4L, or 6L Capacity (C) from the Table above by the Obstruction Factor (OF) and the Work Zone Factor (WZF). If the Lane Closure is through or within 600 ft. of a signalized intersection, multiply the RC by the G/C Ratio.

RC (Open Road) = C ***0*** X OF ***#N/A*** X WZF ***1.00*** = ***#N/A***

RC (Signalized) = RC (Open Road) ***#N/A*** X G/C ***0*** = ***#N/A***

If V ≤ RC, there is no restriction on Lane Closure
If V > RC, calculate the hourly percentage of ADT at which Lane Closure will be permitted

$$\text{Open Road } \% = \frac{\text{RC (Open Road) } \#N/A}{(\text{ATC } 0 \times \text{D } 1.00 \times \text{PSCF } 0 \times \text{RTF } 0)} = \#N/A\ \%$$

Signalized % = Open Road % ***#N/A*** X G/C ***0.00*** = ***#N/A*** %

Plot 24 hour traffic to determine when Lane Closure permitted.

NOTE: For Existing 2-Lane Roadways, D = 1.00.
Work Zone Factor (WZF) applies only to 2-Lane Roadways.

For RTF< 1.00, briefly describe alternate route:

E. Lane Widths

Existing lane widths of through roadways should be maintained through work zone travel way wherever practical. The minimum widths for work zone travel lanes shall be 10 feet for all roadways other than Interstate. On Interstate highways the minimum width for work zone travel lanes shall be 11 feet except at least one 12 foot lane in each direction shall be provided.

F. Pacing Specification (Rolling Roadblock)

A technical special provision is required to pace traffic for up to twenty (20) minutes maximum to allow work in or above all lanes of traffic for the following:

1. Placing bridge members or other bridge work
2. Placing overhead sign structures
3. Other work items requiring interruption of traffic

The contractor shall provide uniformed Traffic Control Officers with marked patrol vehicles and blue flashing lights for each lane in the direction of pacing. When ready to start the work activity, the Traffic Control Officers will pull into the travel lanes and act as pilot vehicles slowing the traffic, thereby providing a gap in traffic, allowing the contractor to perform the work. Any on-ramps between the pace and the work area shall be blocked during the pacing of traffic.

G. Detours, Diversions and Lane Shifts

A *detour* is the redirection of traffic onto an alternate rout, using state roads, county roads or city streets to bypass the work zone. Detour signing is usually done under the direction of the traffic engineer who has authority over the roadway to be used. The detour should be signed clearly so drivers can traverse the entire detour and return to the original roadway.

A *diversion* is a special detour onto a temporary roadway adjacent to the existing or permanent roadway.

A *lane shift* is the redirection of traffic onto a section of the permanent roadway or shoulder.

H. Work Duration

Work duration is a major factor in determining the number and types of devices used in temporary traffic control zones. The five categories of work duration and their time at a location shall be:

A. Long-term stationary is work that occupies a location more than 3 days.
B. Intermediate-term stationary is work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more that 1 hour.
C. Short-term stationary is daytime work that occupies a location for more that 1 hour, but less that 12 hours
D. Short duration is work that occupies a location up to 1 hour.
E. Mobile is work that moves intermittently or continuously.

I. Pedestrian and Bicyclist Considerations

There are three threshold consideration s in planning for pedestrian safety in work zones on highways and streets:

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

Pedestrian accommodations through work zones must include provisions for the disabled.

There are several considerations in planning for bicyclists in work zones on roadways:

1. Bicyclists should not be led into direct conflicts with mainline traffic, work site vehicles or equipment moving through or around traffic control zones.
2. Bicyclists should be provided with a travel route that replicates the most desirable characteristics of a wide paved shoulder or bicycle lane through or around the work zone.
3. If the work zone interrupts the continuity of an existing shared use path or bite route system, signs directing bicyclists through or around the work zone and back to the path or route should be provided.
4. The bicyclist should not be directed onto the same path used by pedestrians.

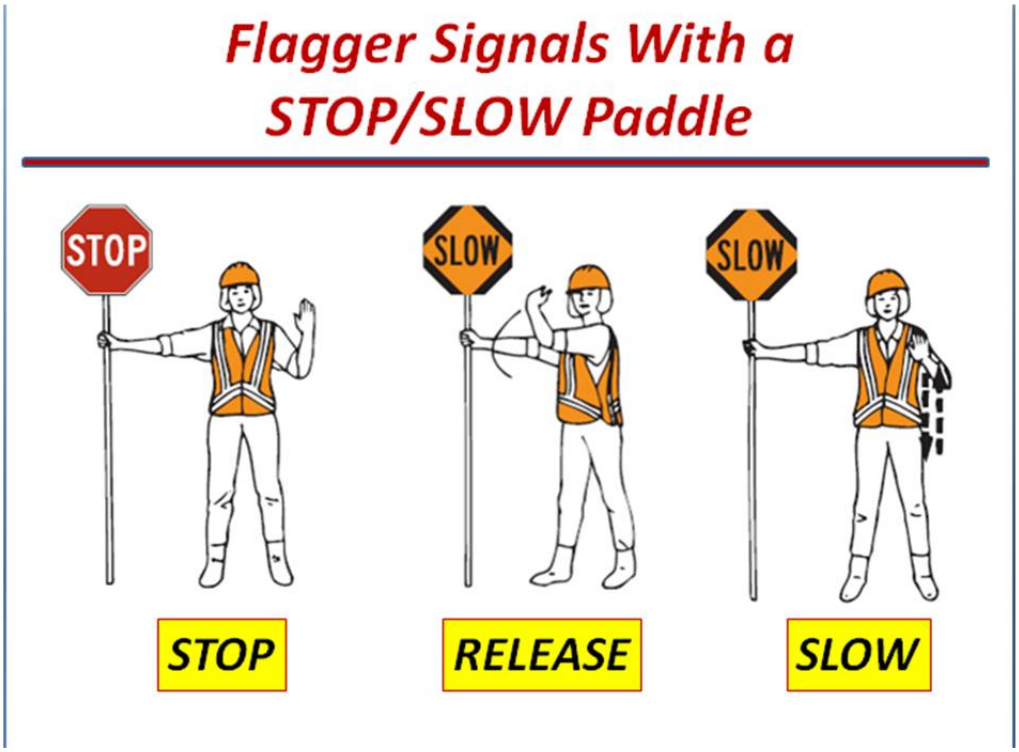
J. Flagging Operation

In order to improve construction site safety, proper flagger training is required of personnel who will be providing the service on all projects.

Flagger responsibilities include:

- Receive/communicate instruction clearly and firmly
- Move quickly to avoid danger
- Control signaling devices to provide clear guidance to approaching drivers
- Understand and apply safe traffic control practices in stressful or emergency instances
- Recognize dangerous traffic situations and warn workers to avoid injury

The following illustration shows the position of the flag in the stop, proceed and slow down phases.



K. Maintenance of Traffic Plan Development

Maintenance of traffic plans should be developed in distinct phases. The various design phases provide timely opportunities for the designer to coordinate the traffic control plan development with other key offices/people.

Design Phase I – The designer should have the rough concept outlines. This would include "typical" sections for each phase and plan notes describing the sequence of construction and traffic control.

Design Phase II – The designer should have many of the details provided, including most of the major components such as detour location and geometry, barrier wall needs, advance signing layouts, references to standard indexes, temporary markings at special locations (detours, transitions, intersections, gore areas, etc.), temporary drainage needs, special devices (such as arrow boards, variable message signs and portable signals) and revised traffic signal (timing, phasing and actuation) operations.

Design Phase III – TCPs should be complete, including pay items. The pay item list should be provided to reduce the possibility of supplemental agreements due to missing pay items.

L. Construction Project Administration

A maintenance of traffic plan is included with each Department construction contract. The Contractor will furnish a letter to the Resident Engineer stating whether they plan to use the Department designed maintenance of traffic plan or will submit an alternate maintenance of traffic plan for approval. The alternate maintenance of traffic plan must be signed and sealed by a Professional Engineer and shall be reviewed, discussed and approved by the Resident Engineer.

The Worksite Traffic Supervisor (WTS) will perform the initial evaluation on new phases of construction by driving through the work zone and observing how traffic moves through the work zone. This drive through inspection will be done in all lanes, both direction, on crossroads, during the day and night and from all entry and exit points within the zone. Detours, if any, should also be driven. The evaluation will also include inspection of signs and devices for the desired sight distance, maintenance and spacing.

The following may be required of the WTS:

1. When required by the Contract Documents, the WTS will inspect Maintenance of Traffic (MOT) operations provided by a utility company within the project limits throughout the project duration.
2. Traffic control devices, warning devices and barriers paid for on a per day basis will be counted and certified on the Department's approved form by the Contractor as required by the Contract Documents.
3. Department personnel will report crashes occurring within the project limits.
4. The WTS will coordinate with adjacent projects and make frequent inspections to ensure that there are no conflicts in the information and/or instructions given to the motoring public.

5. The WTS/Contractor will periodically check reflectivity of pavement markings and in the event of failure, provide for re-application of the pavement markings.

VI Transportation Management Plan

A Transportation Management Plan (TMP) is a method for minimizing activity-related traffic delay and accidents by the effective application of traditional traffic handling practices and an innovative combination of public and motorist, bicyclist and pedestrian information, demand management, incident management, system management, construction strategies, alternate routes and other strategies.

All TMPs share the common goal of congestion relief during the project period by managing traffic flow and balancing traffic demand with highway capacity through the project area.

TMPs are required for significant projects that are defined as:

1. A project that, alone or in combination with other concurrent projects nearby, is anticipated to cause sustained work zone impacts.
2. All Interstate system projects within the boundaries of a designated Transportation Management Area (TMA).

For significant projects, a multi-discipline TMP team may be formed to handle the planning, coordination, implementation, monitoring and evaluation details of the TMP elements. The TMP team may include representatives from the following entities:

3. PD&E
4. Design
5. Traffic Operations
6. Construction
7. Transit
8. FHWA
9. Local Government
10. Public Information

A TMP consists of strategies to manage the work zone impacts of a project. Its scope, content and degree of detail may vary based upon the expected work zone impacts of the project. For significant projects a TMP will consist of three components:

1. The *Temporary Traffic Control (TTC) plan* component describes TTC measures to be used for facilitating road use through a work zone or an incident area. The road user flow and

highway worker safety is implemented when a work zone, incident or other event temporarily disrupts normal road user flow. The scope for the TTC plan is determined by the project characteristics. The TTC plan shall either be a reference to specific Design Standard Index drawing(s) or be designed specifically for the project.

2. The *Transportation Operations* (TO) component of the TMP shall include the identification of strategies that will be used to mitigate impacts of the work zone on the operation and management of the transportation system within the work zone impact area. Typical TO strategies may include demand management, corridor/network management, safety management, enforcement and work zone traffic management. The scope of the TO component should be determined by the project characteristics.

3. The *Public Information (PI)* component of the TMP shall include communication strategies that seek to inform affected road users, the general public, area residences and businesses and appropriate public entities about the project, the expected work zone impacts and the changing condition on the project. This may include traveler information strategies. The scope of the PI component should be determined by the project characteristics.

A. Temporary Traffic Control (TTC) Plans

A TTC plan is a set of specific plan sheets, references to standard (typical) layouts, and/or notes on roadway plans describing how traffic will be controlled through a work zone.

TTC plan sheets detail the proper delineation of traffic through the work zone during all construction phases. The complexity of the TTC plan varies with the complexity of the traffic problems associated with a project. Many situations can be covered adequately with references to specific sections from the 'Design Standards" Series 600 or the 'Manual on Uniform Traffic Control Devices' (MUTCD). Specific TTC plan sheets shall be required in the plans set whenever project conditions are not specifically addressed in a typical layout from the manuals noted above. This is usually the case for complex projects. The 'Plans Preparation Manual' Volume II, Chapter 19 explains the required information for specific TTC plan sheets.

B. TTC Plan Development

The following step-by-step process should be followed by designers when preparing TTC plans:

Step #1 Understand the Project

1. Field reviews by designers should be required.

2. Review the scope.
3. Examine the plans early in the development process.
4. Review plan/profiles and cross sections for general understanding.
5. Review PD&E for any constraints.
6. Consider transit and bicycle/pedestrian needs during construction.

Step #2 Develop Project Specific Objectives

Define objectives.

1. Close road if adequate detours exist.
2. Maintain 2-way traffic at all times.
3. Maintain existing roadway capacity during peak hours.
4. Maintain business/resident access.
5. Provide bicycle/pedestrian access.
6. Expedite construction.

Step #3 Brainstorm TTC Plan Alternatives

Develop some rough alternatives considering what could be used to accomplish the work, such as constructing temporary pavement and/or temporary detours, using auxiliary lanes, placing 2-way traffic on one side of a divided facility, using detour routes, etc.

Step #4 Develop a Construction Phasing Concept

1. Examine the existing facility versus what is to be built.
2. Coordinate with the bridge designer.
3. Involve the construction office as early as practical for input on alternate traffic control plans.
4. Compare the existing roadway versus new construction on the plan/profile sheets and cross sections and note drop-offs or other problems.
5. List major tasks to be completed, such as construct bridge/flyover first.

Step #5 Examine/Analyze Alternatives that Meet Objectives

Consider how to achieve the proposed alternative and meet the objectives.

1. Examine pros and cons of various alternatives.
2. Consider how much work and expense is involved for each alternative.
3. Consider detour/transition locations, signal operations during construction, how to handle buses, bicycles and pedestrians.

Step #6 Develop Detailed TTC Plan

Select the most feasible alternative for each phase. Add details such as:

1. Detour/transition geometrics and locations.
2. If lane closures are needed, use the lane closure technique to determine time frame for closures.
3. Advanced signing scheme and locations, revisions need to existing signs – including guide signs and proposed signs for all work activities – lane closures, detours, etc., on mainline, side roads, crossroads and ramps.
4. Need for portable traffic signals, variable message signs and barriers.
5. How existing operations will be maintained – side streets, businesses, residents, bicycles, pedestrians, buses, etc.
6. Revisions to signal phasing and/or timing during each TTC plan phase.
7. Regulatory speed desired for each phase.
8. All pay items and quantities needed for the TTC plan.
9. How existing auxiliary lanes will be used and any restriction necessary during construction.
10. Typical sections for each phase.
11. Outline key strategies to be used for: service patrol, police, public service announcements, night work, motorist awareness system (MAS), etc.
12. Need for alternate route improvements.

C. TTC Plan Phase Submittals

TTC plan phase submittals should include the following:

1. Phase I – a typical section for each phase and a description of the phasing sequence and work involved
2. Phase II – a majority of the TTC plan completed (75-90%), including the information outlined in TTC plans and a list of pay items
3. Phase III – a final TTC plan, including all notes, pay items and preliminary quantities

D. Traffic Operations (TO)

Many work zone impact management strategies can be used to minimize traffic delays, improve mobility, maintain or improve motorist and worker safety, complete road work in a timely manner and maintain access for businesses and residents.

Demand management strategies that can be used include transit service improvements, transit incentives, shuttle services, ridesharing/carpooling incentives, park-and-ride promotion, HOV lanes, variable work hours and telecommuting.

Corridor/network management strategies that can be used include signal timing/coordination improvements, temporary traffic signals, intersection improvements, bus turnouts, turn restrictions, truck restrictions, dynamic lane closure, ramp closures and railroad crossing controls.

Work zone safety management strategies that can be used include speed limit reductions or variable speed limits, temporary traffic signal, temporary barrier and crash cushions.

Traffic/incident management and enforcement strategies that can be used include Intelligent Transportation System (ITS) for traffic monitoring and management, transportation management center (TMC), aerial surveillance, call boxes, mile post markers, service patrol, local detour routes, contract support for incident management, incident /emergency response plan and law enforcement.

E. Public Information (PI)

A work zone public information and outreach campaign involves communicating with road users, the general public, area residences and businesses and appropriate public entities about a road construction project and its implications for safety and mobility. The PI component may be integrated in the project's community Awareness Plan (CAP) if the district's CAP guidelines include public information communications strategies.

Developing and implementing a public information and outreach campaign should be started before road construction begins and will need ongoing monitoring throughout the life of the project. Planning and implementing a public information and outreach campaign involves a set of key steps that will be coordinated and outlined in the plan:

1. Determine the appropriate size and nature of the public information and outreach campaign.
2. Identify resources. In most cases, public information and outreach spending will need to be part of a road construction project budget.
3. Identify partners.
4. Identify target audiences.
5. Develop the message(s).
6. Determine communications strategies.

7. Determine communication timing.

F. Coordination

Work zone traffic control can be a complex undertaking that requires the coordination of a number of agencies and other interested parties. Planning and coordination must begin early in a project design.

Traffic control is a joint responsibility of design, construction and traffic operations personnel. Coordination is necessary by all three parties in the development of TMPs.

Temporary traffic control plans should be reviewed with other appropriate entities such as maintenance, FHWA, community awareness teams, general public, transit agencies, businesses, and local agencies. Initial review should be made by construction and traffic operations no later than the Phase II plans stage with subsequent review of Phase III plans.

VII. Summary

Work zone traffic control is an important function affecting the safety of motorists, pedestrians and work zone personnel. Every effort should be made to eliminate or reduce accidents within work zones. In addition to safety, the potential delay to the public, caused by traffic interruptions during construction, should be reduced when possible.

The MUTCD states: "To be effective, a traffic control device should meet five basic requirements:"

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

In addition, traffic controls in work zones are to:

- Warn motorists and pedestrians of hazards
- Advise motorists of the proper travel path through the area
- Delineate areas where traffic should not operate
- Separate and protect motorists, pedestrians and the work force

The components of maintenance of traffic plans apply to the mainline roadway, crossroads, side streets, and off-ramps. Regulatory, warning and guide signs can be utilized to inform the motoring public of the work being performed. Channelizing devices such as cones, tubular markers, drums, vertical panels, type I barricades, type II barricades, directional indicator barricades and type III barricades can be used to move traffic around construction areas. Arrow panels and variable message signs can be used to notify the driver of construction activity.

The components of traffic control zones consist of advance warning area, transition area, activity area and termination area. Tapers are utilized to shift traffic around work areas. The lengths of these areas were defined in the course. If a lane is to be closed for construction, a lane closure analysis must be completed to determine the times of the day at which the lane can be closed.

Pedestrians and bicyclists must be accommodated in the maintenance of traffic plans.

Flaggers can be used to stop, release and slow traffic in the construction area.

A temporary traffic control (TTC) plan should be developed for use during construction.