Guidance

Managing Flagging Operations on Low-Volume Roads

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Work Zone Safety Consortium

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Preface

A low-volume road is a facility lying outside of built-up areas of cities, towns, and communities. By definition, the low-volume road has a traffic volume of less than 400 AADT (Average Annual Daily Traffic), according to the national *Manual on Uniform Traffic Control Devices* (MUTCD). A low-volume road may be paved or unpaved. Excluded from classification as low-volume roads are freeways, expressways, interchange ramps, freeway service roads, State highway system roads, and residential streets in a neighborhood. Some States may have different definitions of low-volume roads.

Objectives

Low-volume roads pose a number of unique challenges to those responsible for their management. This document was created to supplement the 2009 Edition of the national *Manual on Uniform Traffic Control Devices* (MUTCD) by providing commentary to assist decision makers in planning flagging operations on these roads. Other useful resources, listed in the References section, are also available to assist in further refining plans developed with this document.

States and other agencies may have supplements to the MUTCD, as well as other policies and procedures which are more restrictive than those presented here. These documents should be consulted in conjunction with the MUTCD when planning flagging operations and the associated temporary traffic control zones.

This document is organized into the following sections:

- Introduction
- Addressing Site Conditions
- Providing Good Visibility and Stopping Sight Distance
- Choosing the Correct Type of Flagging or Alternate Control
- Observing and Adjusting the Temporary Traffic Control (TTC) Installation and Operation
- Ensuring Safe Flagger Behavior
- Contingency Planning
- Conclusion
- References

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Refer to http://www.workzonesafety.org for a copy of this document.
Refer to http://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf to download the national MUTCD.

Managing Flagging Operations on Low-Volume Roads

Introduction

Most work operations, such as the ditching operation shown in the photo at right, require positive control of vehicles approaching and passing through the work zone. In many cases, this control is accomplished through the use of flaggers. Flaggers may be used for many types of work zone operations, including:

- mobile work that moves intermittently or continuously,
- short duration operations (≤ 1 hour),
- short-term operations (> 1 hour and ≤ 1 daylight period),
- intermediate-term operations (> 1 hour at night or ≤ 3 days but more than one daylight period), and
- long-term operations (> 3 days).

Example mobile work zone operation requiring flaggers *(Source: G. Armstrong).*

Signalized one-lane, two-way long-term control *(Source: N. Carboneau).*

Intermediate and long-term operations requiring 24-hour flagging are typically controlled using a temporary signal such as the one shown in the photo at left.

Prior to selection of the temporary traffic control (TTC) method and development of the TTC Plan, site conditions should be evaluated. Factors that can impact the TTC Plan include:

- traffic volumes,
- physical constraints,
- weather conditions, and
- time of day.

Once the operation begins, site conditions should be evaluated again to ensure they remain consistent with the conditions used to make the TTC decisions.

MUTCD Chapter 6 provides several TTC options in Typical Applications (TAs) and solutions for common challenges associated with site conditions.

This document supplements the MUTCD by focusing on the TAs and solutions most often used on low-volume roads. Specifically, TTC control methods such as two-flagger, single-flagger, self-regulating, and mobile operations are all discussed with specific commentary on applying these methods to low-volume roads.

Refer to the MUTCD for specific details associated with the concepts presented in this document. Only portions of the information in the MUTCD are provided here.

“Modifications to fulfill special needs” in Section 6G.04 of the MUTCD are also presented in order to address more complex conditions associated with low-volume roads. The use of the TAs, the modifications to fulfill special needs, and the “fundamental principles of temporary traffic control” identified in Section 6B of the MUTCD, along with guidance in this document and in other applicable sections of the MUTCD will assist the official or agency having jurisdiction over the roadway in making a decision as to the appropriate TTC to be used. In addition to the MUTCD, applicable state and local standards should be consulted.

The operation of the TTC zone is as critical as the plan used. Both motorists and workers can impact the safety of the operation. The following sections describe strategies to address road user behavior as well as worker behavior. Flaggers, such as the one in the photo at right, are responsible for improving public safety by controlling road users in flagged TTC operations. Close attention should be given to the qualifications of individuals designated as flaggers.

Example flagging operation on low-volume road *(Source: N. Carboneau).*

Site conditions are not only important while planning the TTC operations, but also while operations are taking place. The following sections reinforce the necessity of having site personnel monitor the conditions and either cease work or adjust the TTC operations based on changing conditions. The next section provides perspective on addressing site conditions for low-volume roads and relating that information to flagging operations.

Despite measures taken to prevent them, incidents still happen. The final section of this document discusses methods to minimize incident severity for motorists and workers, should one occur.

Addressing Site Conditions

Hills, curves, railroads, intersections, and physical space constraints must all be taken into account when planning and performing temporary traffic control.

Shaded, curved, hilly section of road with limited space for flaggers and sign placement *(Source: N.Carboneau).*

Sight Distance Restrictions

When hills and curves — as shown in the photo at left — limit sight distance to the flagger stations, the length of the TTC zone should be extended to put the flagger station at a point that can be seen by a motorist from a sufficient distance upstream. In other words, flagger stations should not be positioned just beyond the crest of vertical curves or just beyond horizontal curves that limit sight distance. Should the work zone need to be stretched over an extended distance of curves or hills, pilot vehicles may be necessary to supplement flagging operations in an effort to control the speed of the motorists through the extended temporary traffic control zone.

Intersecting Roads and Driveways

Roads or driveways that intersect a TTC zone, such as the one in the photo below, may require additional flaggers. If flaggers are used at stop-controlled intersections, the governing jurisdiction should be contacted regarding the appropriate control actions to be taken. This situation may require covering the stop signs to allow the flagging operation to occur because flaggers are not allowed to control traffic in conjunction with an existing stop sign or active traffic signal.

A report by the Texas A&M Transportation Institute[2] describes methods to address intersecting roadways and driveways including the following:

- Use “barricades and cones to close low-volume access points.”
- “Visit property owners and residents to notify them of the changes in traffic control and what they should do when exiting their driveways.”
- Station “flaggers at all access points.”
- Hold traffic at access point until the pilot vehicle arrives.

Flagging for road intersecting a TTC zone *(Source: Michigan DOT).*

Physical Restrictions to Flagger Placement

Low-volume roads are often in areas with many physical constraints such as rock faces, steep side slopes, or vegetation. An example appears in the photo at right. These constraints can restrict sign placement, safe placement of flaggers, and sufficient flagger escape routes. The method of addressing these challenges, based on the language in TA-10 in the MUTCD, is to lengthen the TTC zone to a point where signs and flaggers can be safely positioned. This is similar to the solution for hills and curves discussed on page 2. The alternate location should provide flaggers an adequate escape route.

Flagger and sign placement can also be impacted by other factors that reduce visibility and increase the time it takes a motorist to recognize and evade a hazard, or to bring their vehicle to a stop. The following section provides more details on these factors.

A section of road that restricts flagger and sign placement *(Source: FOF).*

Providing Good Operational Visibility and Stopping Sight Distance

A number of conditions can impact visibility and the ability of motorists to react and stop their vehicles, if necessary. In addition to hills, curves, vegetation, and other natural features, which can restrict the placement and visibility of TTC devices and personnel — as discussed previously, the following conditions can also impact visibility and stopping sight distance:

- glare — including the sun, headlights, or artificial lighting used in nighttime operations,
- dust and adverse weather conditions — including fog, rain, or snow, and
- speeding.

Glare causing reduced visibility for motorists *(Sources (from top left): N.Carboneau, ARTBA, FHWA).*

Glare

Glare can create visibility issues at dawn, dusk, and nighttime, so operations should be scheduled to avoid these times, if possible. Examples of glare from the sun, work lighting, and headlights (shown in the photos above) demonstrate the impact of glare on road users and workers alike.

If work is necessary at dawn, dusk, or night, countermeasures to alert motorists and improve their ability to recognize the hazards should be considered. Section 6G.04 of the MUTCD lists “Modifications to fulfill special needs,” which can

Examples of countermeasures to alert drivers (left to right): Stop-slow paddles with supplemental lighting and an arrow board, rumble strips, additional centerline channelizing devices, and larger fluorescent signing with high retroreflectivity values *(Sources: Michigan DOT, Plastic Safety Systems, N.Carboneau, and Spark 3M News).*

be used in these circumstances. Additional delineation, higher-visibility devices (larger signs and channelizing devices, flashing warning lights, etc.), longer advance warning areas, arrow boards, rumble strips, and similar countermeasures — several of which are shown on page 3 — would be helpful in these conditions. These countermeasures can also be effective in dealing with driver distraction and other conditions that impair drivers' abilities.

Artificial lighting is a necessary component of nighttime operations as it provides working light and improves the safety of the operations. The MUTCD requires that flagger stations, such as the one shown in the photo at left, be illuminated. However, several steps should be taken to ensure the artificial lighting is used properly.

Illuminated flagger station *(Source: Composite FOF).*

The artificial lighting should be positioned so that glare is reduced or prevented for both motorists and workers. The amount of lighting should also be controlled, as flaggers can be washed out by bright artificial lights.

Glare from motorists' headlights is less likely to impact operations on low-volume roads at night due to the numbers of vehicles on these roads. Headlights from work vehicles should be shut off or directed away from oncoming traffic to reduce their impact on motorists.

Dust and Adverse Weather Conditions

Dusty roads, fog, heavy snow, or rain can also reduce the visibility of TTC devices and operations. The photos at right show examples of these situations. Watering or other dust control methods should be considered when necessary on gravel roads, and the "Modifications to fulfill special needs" from Section 6G.04 of the MUTCD should also be considered to improve the motorists' ability to recognize the TTC zone and react appropriately. Photos on pages 2 and 3 show arrow boards used at flagger stations in caution mode to provide added visibility.

The MUTCD also refers to the use of additional delineation. The use of centerline channelizing devices, such as those in the photo on page 3, can be effective at flagger stations for gaining motorists' attention, slowing motorists down, and keeping motorists in their lane until they reach a flagger.

The next section provides other countermeasures to help gain the motorists' attention and reduce their speeds as they approach the TTC zone.

Examples of reduced visibility due to dust and weather conditions *(Source: N.Caboneau).*

Speeding

A common problem on low-volume roads is speeding, which compounds the impact of visibility issues. Speeding and visibility issues result in an increase in the time it takes a motorist to bring the vehicle to a stop. Using countermeasures that serve multiple purposes, such as the centerline channelizing devices shown on page 3, can make the job both safer and more efficient.

Increasing sign spacing and using buffer spaces based on anticipated motorists' operating speeds can provide additional reaction time and stopping sight distance for the motorists.

Table 6E-1. Stopping Sight Distance as a Function of Speed

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

*Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed

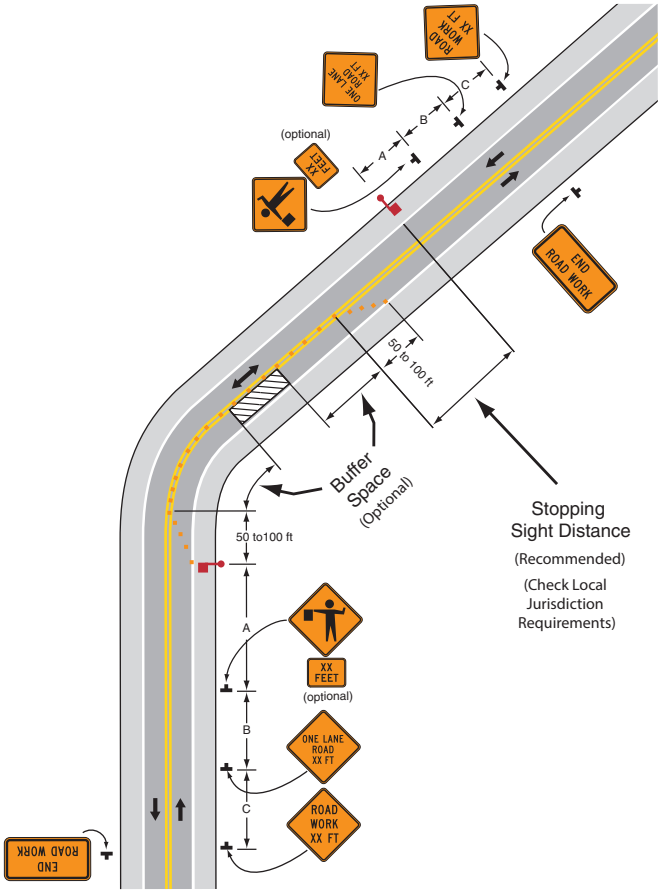

Figure 1. TA-10 and Table 6E-1 (MUTCD).

Figure 1 provides portions of TA -10 and Table 6E-1 from the MUTCD, with added notes identifying appropriate buffer space usage for flagging operations to reduce the impact of speeding on low-volume roads.

Other countermeasures aimed at gaining motorists' attention and reducing their speeds, although not often used on low-volume roads, are available and should be considered. A few of these countermeasures, shown in the photos below, are:

- portable radar speed signs,
- worksite speed limits, and
- targeted law enforcement.

Important components in the planning process include:

- Identify conditions that may necessitate the use of these countermeasures.
- Describe when to include these countermeasures in the TTC plan.
- Should countermeasures be needed to address a condition that has deteriorated during an operation, have the countermeasures readily available.

The next section is intended to help individuals responsible for TTC zone planning choose an appropriate method of traffic control based on site conditions evaluated in previous sections.

Tools for gaining motorist's attention and reducing their speeds *(Sources: 2nd Amendment, Purdue University School of Civil Engineering, Athens Banner-Herald).*

Choosing the Correct Type of Flagging or Alternate Control

The MUTCD contains a number of Typical Applications (TAs) useful for flagging operations on low-volume roads. Some of the most commonly used applications, with supplemental commentary to assist in their application to low-volume roads, are provided in this section. Mobile operations that include flagger control, as well as alternatives for mobile operations where flagger control is not used, are also provided. The following sections include:

- Two Flagger Control
  - Two-Flagger Control: One-Lane Two-Way Road
  - Two-Flagger Control: Temporary Road Closure for Intermittent Activities
- Alternatives to Two-Flagger Control (If Conditions Allow)
  - Single Flagger Option
  - Self-Regulating TTC Option
- Mobile Operations
  - Mobile Operations: Flagger Controlled
  - Mobile Operations: Flagger Controlled for Intermittent Activities
  - Mobile Operations: No Flagger Control

Two-Flagger Operations

Two-Flagger Control: One-Lane Two-Way Road

The most common type of traffic control for work requiring a lane closure in one direction of travel on a two-way road is the use of two flaggers. Two flaggers are needed to alternate traffic in both directions. Figure 2 displays a traditional layout for this operation, as shown in TA-10 from Chapter 6 of the MUTCD. The MUTCD provides notes with specific guidance for the use of each TA. For TA-10, the notes include a provision indicating "The ROAD WORK AHEAD and END ROAD WORK signs may be omitted for short-duration operations;" i.e., those lasting less than one hour.

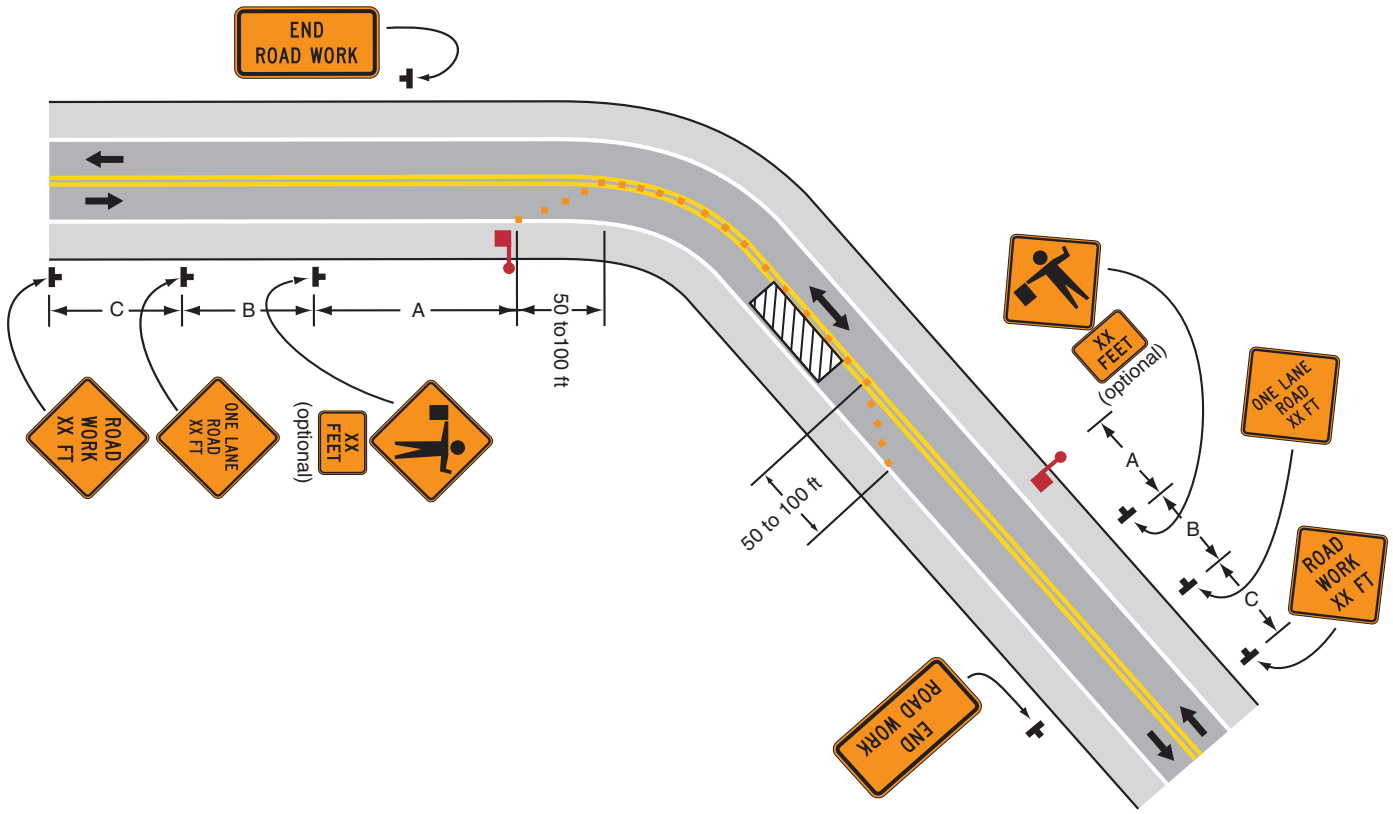

Figure 2. Lane closure on a two-lane road using flaggers (MUTCD TA-10).

Two-Flagger Control: Temporary Road Closure for Intermittent Activities

TA-13 from Chapter 6 of the MUTCD is provided in Figure 3 and details an option for intermittent activities that last less than 20 minutes (i.e., temporary road closures). This two-flagger option allows traffic to be stopped from both directions while work is performed. During this 20-minute period, the work crew would pull into the roadway, perform the work, and pull off the roadway. Completing the work in 20 minutes means that enough time must be allocated for the crew to move to and from a staging location that is safe for the crew to occupy and then out of the travel lane within the 20-minute period.

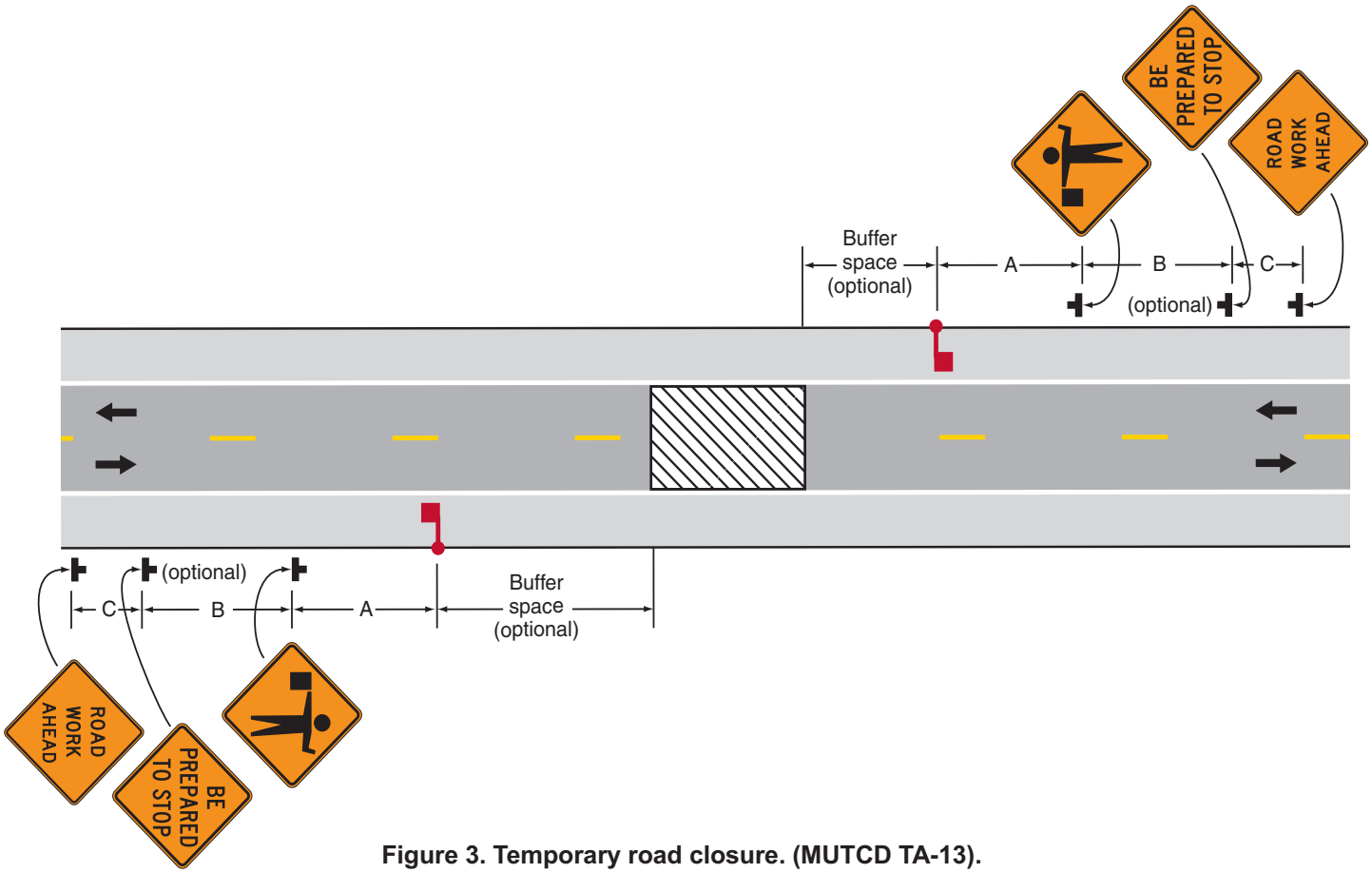

Figure 3. Temporary road closure. (MUTCD TA-13).

This TTC method should be considered when extended distances of roadway exist with the previously described challenges and the work can be performed in single or multiple 20-minute operations.

Flaggers should be placed prior to constraining features:

- where they have an escape route,
- where they are clearly visible to approaching traffic, and
- where signing can be appropriately placed.

If this is not feasible, then a full detour around the work zone should be considered.

Flagger stopping traffic for temporary road closure ahead *(Source: Washington State DOT).*

Alternatives to Two-Flagger Control (If Conditions Allow)

In certain cases where volumes and conditions allow, alternatives to two flaggers may be acceptable. These options include using a single flagger, self-regulating control, and treating the work as a mobile operation. In each case, an examination of traffic volume is critical.

■ Single Flagger Option

In some cases, the length of the work space and the presence of very low traffic volumes may allow flexibility in the number of flaggers used for a particular work operation. As noted in the MUTCD, when a TTC zone is short enough to allow a flagger to see from one end of the zone to the other, traffic may be controlled by a single flagger. The MUTCD further indicates that a single flagger may be used for low-volume situations with short work zones on straight roadways where the flagger is visible to road users approaching from both directions. Figure 4 illustrates a TTC setup for a work operation controlled by a single flagger. Figure 4 is a representation of TA-10 modified to show the position of a single flagger. It should be noted that the flagger must be easily visible to motorists approaching from either direction. If trees, shrubs, signs, etc., are located on the roadside where the flagger would be positioned and could thus obscure the flagger, a two-flagger operation should be used.

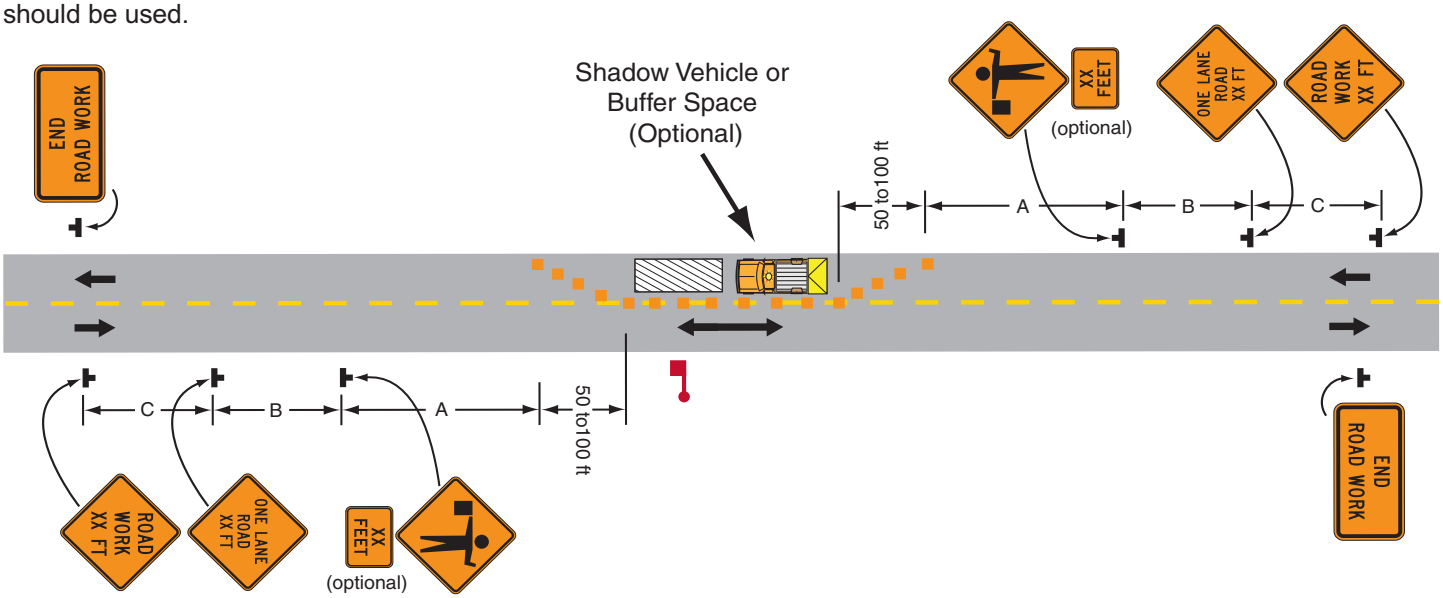

Figure 4. Single Flagger Positioning. (Adapted from MUTCD TA-10).

Single flagger TTC requires continuous attention by the flagger to both travel directions, as exemplified in the photos.

(1) Flagger has westbound traffic stopped.
(2) Flagger keeps westbound traffic stopped with hand signal while turning the paddle to stop eastbound traffic.
(3) Flagger turns and signals to stop eastbound traffic.
(4) Flagger turns back and releases westbound traffic once eastbound traffic stops.

Keeping westbound traffic stopped with the slow side of the paddle displayed is a significant challenge.

Positioning the single flagger off of the shoulder with cones, as shown, for added delineation is a good practice *(Source: N.Carboneau).*

Self-Regulating TTC Option

A self-regulating TA, such as that shown below in Figure 5, which is adapted from TA-11 in Chapter 6 of the MUTCD, may be appropriate in some low-volume situations.

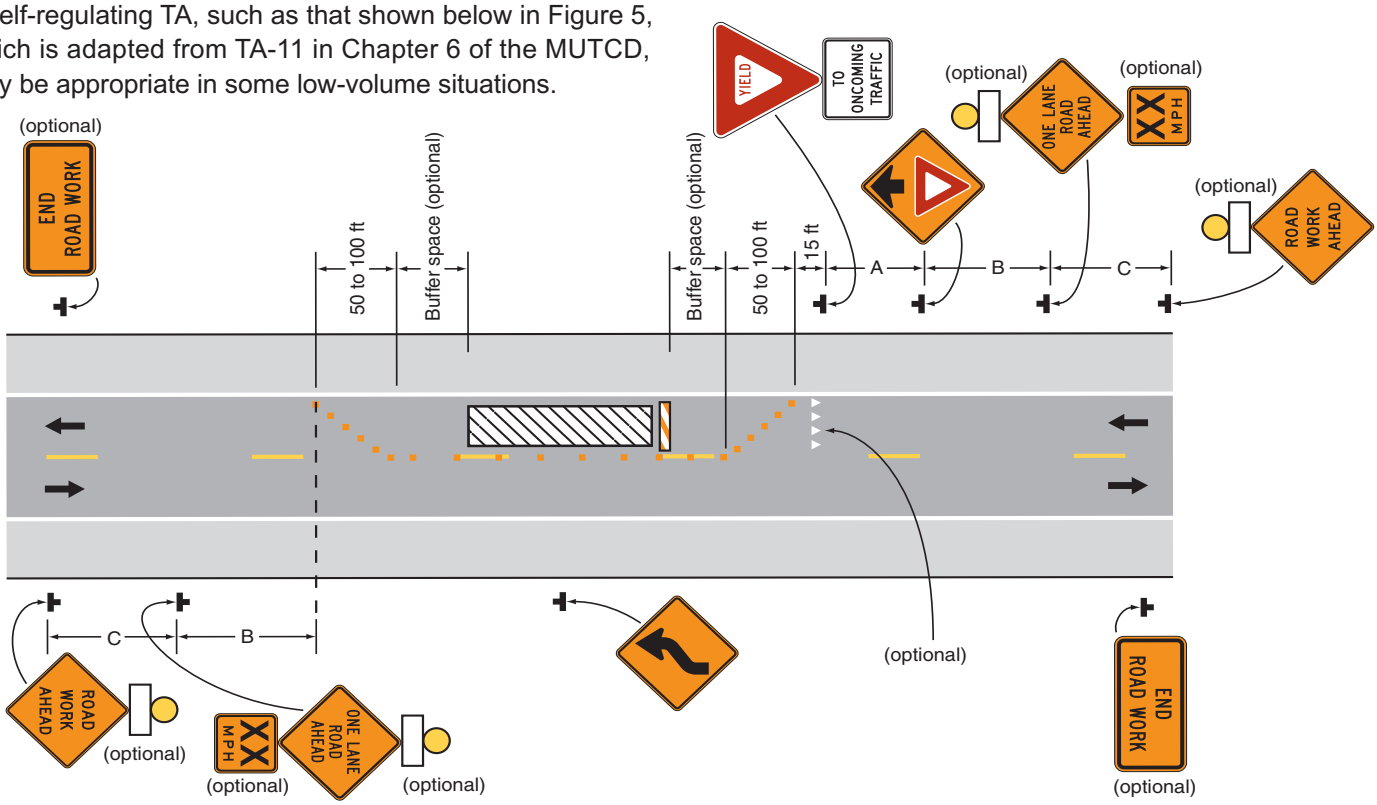

Figure 5. Self-regulating TTC zone. (Adapted from MUTCD TA-11).

Traffic distribution on low-volume roads often results in a gap of several minutes or more between vehicles, allowing enough time for a self-regulating TTC zone to operate effectively, although peak periods are not likely to allow enough of a gap to permit traffic to self-regulate.

In this approach, motorists make their own decisions to: 1) yield the right of way, and then 2) pass the work space at their discretion without the assistance or control of a flagger.

The MUTCD indicates that this application may be appropriate if vehicular traffic volume is such that "sufficient gaps exist for vehicular traffic that must yield." The length of the work space and the amount of sight distance are critical considerations. If self-regulating traffic control is to be deployed as in the scenario depicted in the photo below, then adequate sight distance is required to allow motorists to observe approaching traffic and to make sound decisions regarding yielding and continuing through the work zone.

The conditions described in the previous paragraph from the MUTCD should be met in order to consider use of a self-regulating TTC zone. The following list of considerations is provided to assist decision makers in evaluating the necessary information to meet these conditions, including any local jurisdictional requirements relating to self-regulating TTC zones:

- Consult local jurisdictional requirements.
- Conduct a field investigation to assess sight distance.
- Assess traffic volumes.
- Monitor volumes during work operations.
- Cease operations or add flaggers and appropriate signing should sufficient gaps no longer exist.

Self-regulating TTC example *(Source: FOF composite from Washington State DOT and MUTCD).*

Some states have provided further guidance in using self-regulation. Examples appear in Table 1.

Table 1. Examples of guidance in using self-regulation provided by some State DOTs.

State DOT	Type	Limit
IOWA	Volume	Less Than 2000 Vehicles Per Day
	Work Space	250' or Less, 350' Maximum from the beginning of the taper to the end of the termination
	Sight Distance	Do not use if a no passing zone exists between the start of the taper and the end of the termination
Iowa Department of Transportation Standard Road Plan TC-211 Lane Closure on Low Volume Roadway, April 2012.[12]		
OREGON	Duration	Short-term or Intermediate (3 days or less)
	Volume	Less than 400 Average Daily Traffic
	Work Space	Less Than 200 Feet
	Sight Distance	More than 750 Feet at Each End
	Speed Limit	40 Miles Per Hour and Below
Oregon Temporary Traffic Control Handbook, December 2011.[13]		

Mobile Operations

The variety of activities and locations of work can make selecting and customizing an adequate TTC operation difficult. Mobile operations can further complicate the decision-making process.

If the length of the operation is such that a traditional two-flagger, one-lane two-way control method can be used, the information in the previous sections would suffice. Should the operation be over an extended length of road, flaggers can still be used with mobile operations following the recommendations in this section.

If the terrain in the area where work is required does not allow adequate sight distance of the operation and if the work can be performed intermittently, then temporary road closures of up to 20 minutes could be performed using two flaggers to allow the mobile operation to be performed safely.

Should the terrain be so restrictive that even flaggers and signs cannot be adequately placed, then traditional mobile operations can be performed, provided they meet the requirements of the MUTCD. Two options are described in this section: a solution where sight distance is sufficient for motorists to see the mobile operations and a solution where sight distance is restricted and shadow vehicles need to be properly outfitted and operate in a specific manner to provide adequate temporary traffic control and safety for the mobile operation. The following section describes these alternatives and provides examples, commentary, and references from the MUTCD to allow effective handling of mobile operations in these situations.

■ Mobile Operations: Flagger Controlled

The MUTCD indicates in Section 6G.02 that "Flaggers may be used for mobile operations that often involve frequent short stops." In this situation, two-way traffic would be controlled through one lane, as in the typical two-flagger operations described in the previous section. In this scenario, channelizing devices would not be required; however, channelizing devices are often used at the flagger station to transition traffic. The following section *Mobile Operations: No Flagger Control* explains proper procedures for performing the mobile operation in Figure 6 on page 11.

The Indiana Department of Transportation created a TTC detail for this situation. A representation of that detail is provided in Figure 6 on page 11. Indiana's drawing includes the notes from TA-10 in the MUTCD, except that the single flagger language has been deleted and a statement restricting the distance between the leading signs to two miles has been added.

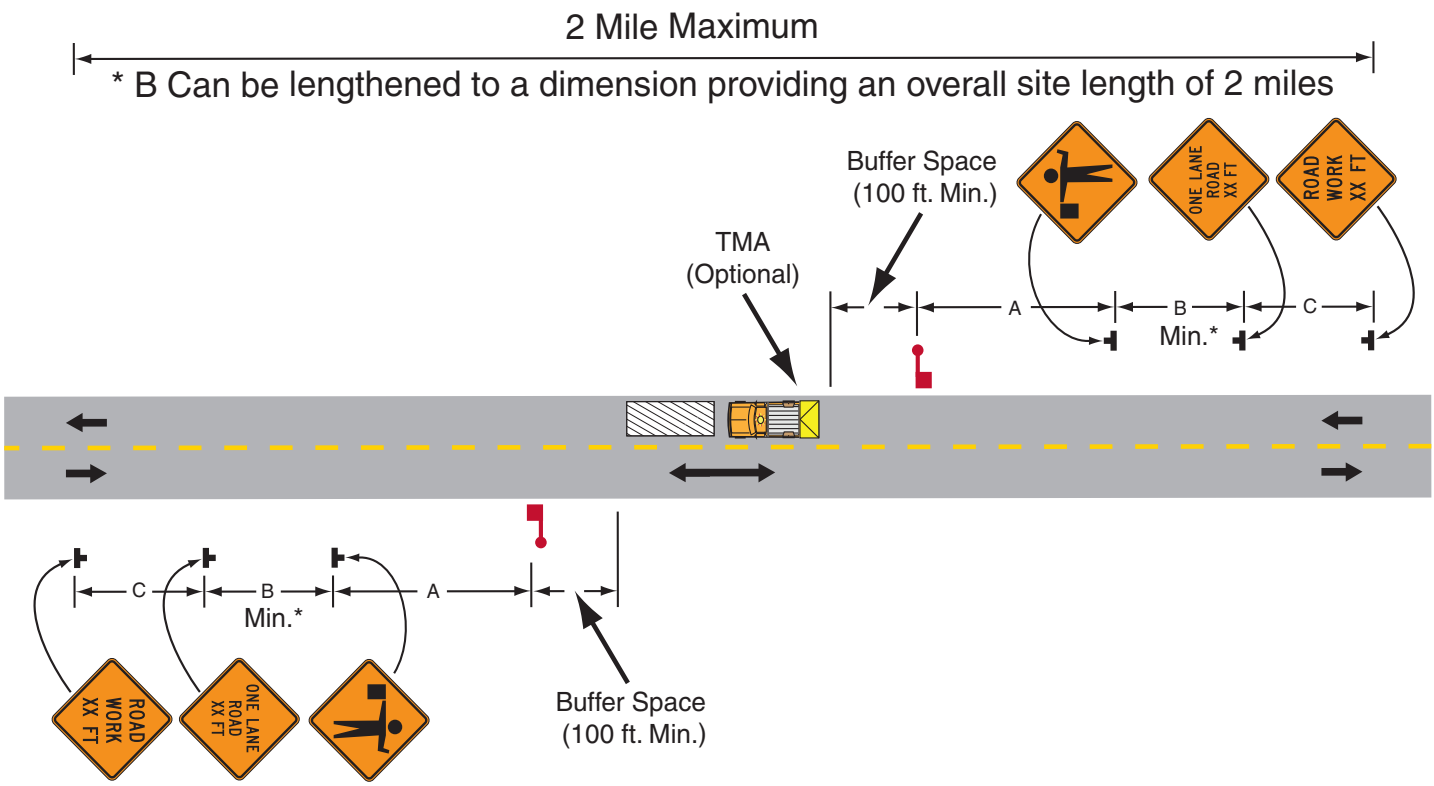

Figure 6. Mobile operation detail on two-lane road using flaggers (Indiana DOT).

Mobile Operations: Flagger Controlled for Intermittent Activities

When mobile operations are necessary over extended lengths of road with hills, curves, and other constraints — as detailed in *Addressing Site Conditions* on page 2, flaggers could be stationed on opposite ends of the constraining section. TA-13 from Chapter 6 of the MUTCD has been modified in Figure 7 to reflect this situation.

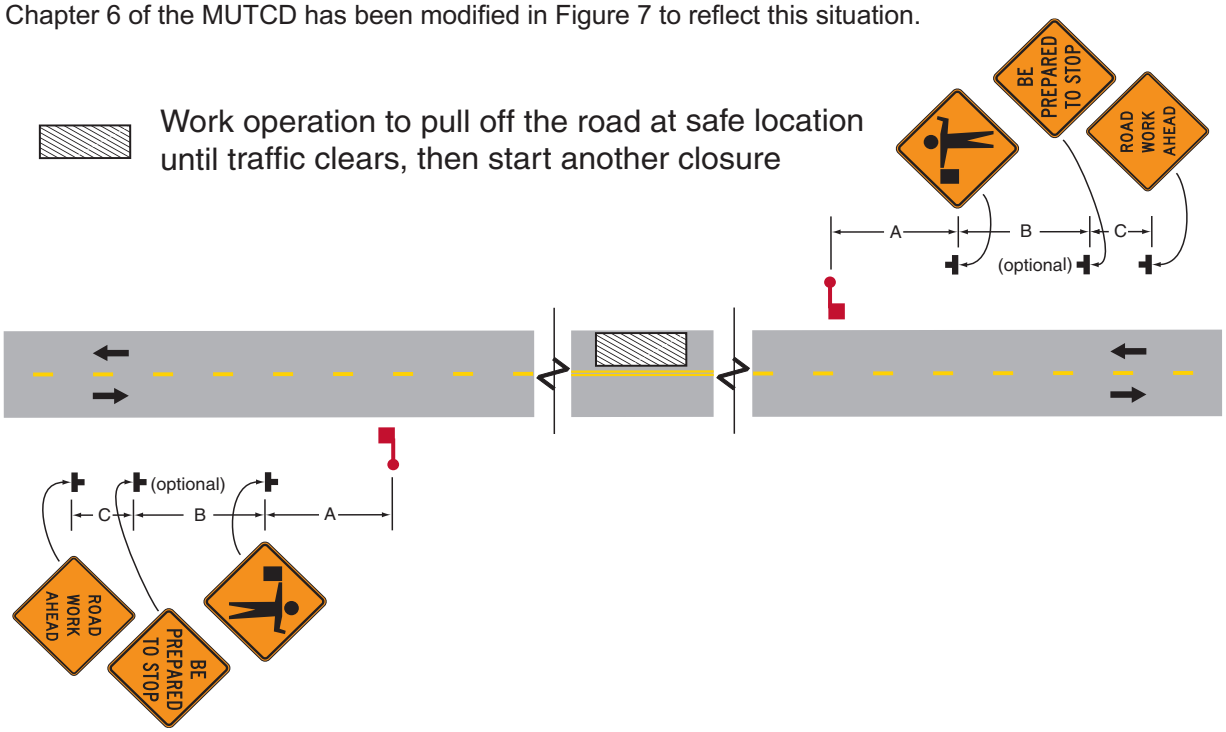

Figure 7. Flaggers positioned beyond a constraining section of road for temporary closures. (Adapted from MUTCD TA-11).

When the TTC plan in Figure 7 on page 11 is used for mobile operations, the flaggers would stop both lanes of traffic for up to 20 minutes while the mobile operation pulls onto the closed road, performs the work, and then pulls off the road in a safe location. After traffic clears, another 20-minute operation could begin, if necessary. Low-volume roads can have the advantage of infrequent traffic, which would allow these operations to proceed unencumbered for longer durations with the traffic stopped for up to 20 minutes; however, any operation that delays road users for up to 20 minutes should be carefully considered.

Mobile Operations: No Flagger Control

Mobile operations could also be considered over a section of road that does not allow the appropriate placement of TTC devices or flaggers, such as those described in *Physical Restrictions to Flagger Placement* on page 3. Another example with vegetation prohibiting the placement of flaggers and signing is illustrated in the photo below.

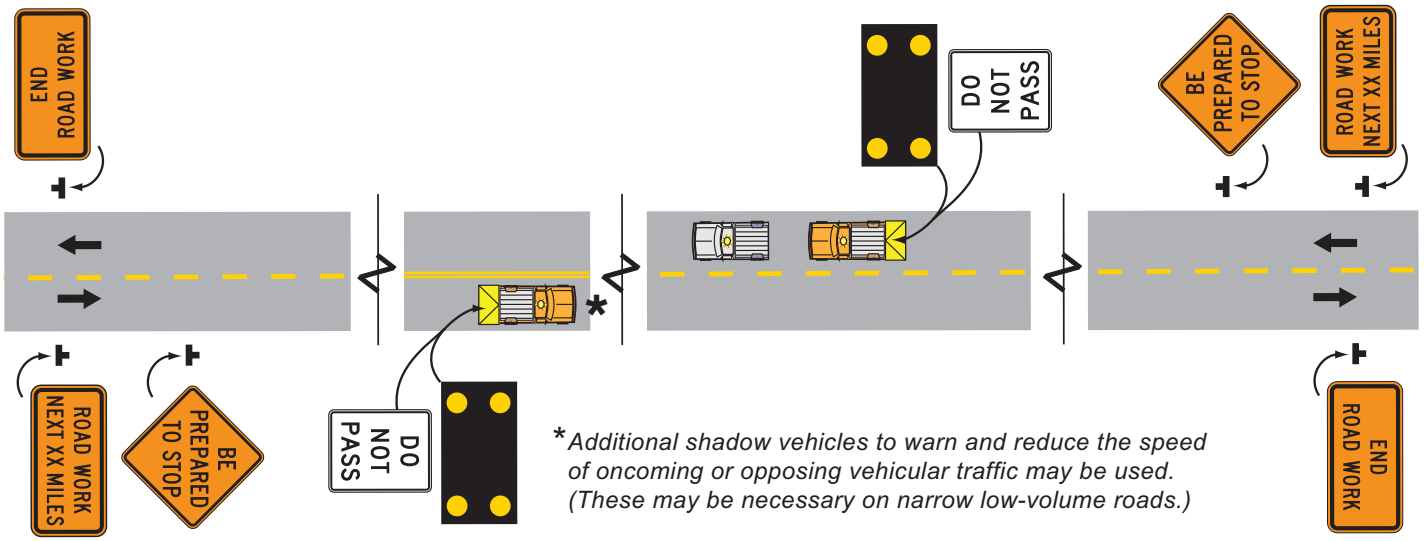

Figure 8. Example of a mobile operation where flagger and sign placement are constrained near the site of work. (Adapted from MUTCD TA-17).

TA-17 from Chapter 6 of the MUTCD has been modified to represent this scenario and provided in Figure 8. More typical mobile operations are depicted in the MUTCD, TA-17. The notes in TA-17 provide the requirements for acceptable use of mobile operations and are critical for the proper application to low-volume roads. A few of the most pertinent notes include:

- Where practical and when needed, the work and shadow vehicles should pull over periodically to allow vehicular traffic to pass.
- Whenever adequate stopping sight distance exists to the rear, the shadow vehicle should maintain the minimum distance from the work vehicle and proceed at the same speed. The shadow vehicle should slow down in advance of vertical or horizontal curves that restrict sight distance.
- The distance between the work and shadow vehicles may vary according to terrain, paint drying time, and other factors.

Example location where flagger and sign placement are constrained near the site of work *(Source: Wallpopper).*

- Additional shadow vehicles to warn and reduce the speed of oncoming or opposing vehicular traffic may be used. (These may be necessary on narrow low-volume roads.)
- If the work and shadow vehicles cannot pull over to allow vehicular traffic to pass frequently, a DO NOT PASS sign may be placed on the rear of the vehicle blocking the lane.

Section 6G.02 of the MUTCD provides additional guidance for mobile operations. A few items to consider for this application include the use of arrow boards in caution mode and truck-mounted attenuators. Advanced warning signs notifying road users of ROAD WORK NEXT XX MILES and BE PREPARED TO STOP are helpful in this situation.

Observing and Adjusting TTC Zone Installation and Operation

The previous sections discuss how to plan the TTC for a low-volume road based on existing site conditions, anticipated conditions at the time of work, and motorists' speeds and associated stopping sight distances. Guidance was provided on selecting the correct type of flagging or alternate control based on this information, as well as other factors such as traffic volumes and operational type. In addition to adequate planning based on these factors, site operational issues need to be considered to ensure the TTC is properly performed based on the plan developed.

Driving the TTC zone can make deficiencies or errors in placement of TTC devices apparent *(Source: FOF).*

The project supervisor or another responsible individual should drive the TTC zone, as a motorist would, and review its setup and operation. Adjustments should be made as necessary to improve the conditions should they be judged to be insufficient by the designated competent traffic control person for the operation. Simple mistakes such as placement of a device based on a fixed dimension, instead of a maximum or minimum allowable dimension, could lead to a device being inadvertently placed in an unacceptable position, such as the one shown in the photo at right.

The function of the TTC zone can also be impacted by a number of issues at the time of the operation. The volume of traffic, weather conditions, and even flagger behavior can necessitate adjustments to the operation at the time it is being performed. A situation where harvest operations, such as the one in the photo at right, happen to occur at the same time as the road work could necessitate a change based on the volume of vehicles. As an example, if a self-regulating TTC operation were selected and sufficient gaps no longer existed for the grain trucks to navigate the TTC zone, the operation would need to be ceased or flagger control would need to be established.

Example of harvest operations that could impact the TTC operation *(Source: Gold Dust Farms).*

The following section discusses the possibility that worker behavior could impact the function and safety of the TTC operation. Strategies are provided for ensuring safe flagger behavior that include selection and preparation of the individuals who will be responsible for flagging traffic.

Ensuring Safe Flagger Behavior

Worker behavior can create dangerous situations for the crew and road users. Inattention, exhaustion, and impairment are a few of the most critical items that can negatively impact the flagger's performance and ability to escape should a hazardous situation develop. The illustration on page 14 provides examples of worker distractions that organizations should prohibit.

Examples of worker distractions that organizations should prohibit.

Ear Buds
Headphones
Music Devices
DVD Players
Radios
Reading Materials
Cell Phones

Flagger behavioral issues can be mitigated using several strategies:

- select individuals with qualifications that meet MUTCD guidelines;
- create and enforce organizational policies prohibiting inappropriate behavior;
- provide effective training for workers;
- reinforce training with tool box talks; and
- create a culture of safety within the organization.

Training (left) and tool box talk *(Sources: FOF and ARTBA).*

Individuals who have the proper training, qualifications, and authority — comparable to that of a designated *competent person* as defined in various standards of the Occupational Safety and Health Administration (OSHA), should be tasked with performing routine hazard assessments and monitoring changing conditions for the duration of the work.

All employees should be trained to recognize hazards and bring the situation to the attention of their supervisor. Should site conditions change, appropriate controls should be in place to maintain an appropriate level of safety or require that operations cease until they can be completed safely.

Workers assigned the duties of flagging, such as the one in the photo at right, are exposed directly to road users as well as other hazards. Actions of everyone involved in the operation, along with those of the road users, play key roles in the overall safety of the operation.

Flagger station with a pilot vehicle leading traffic *(Source: Washington State DOT).*

Proper flagging of motorists, work vehicles, equipment, and other road users such as pedestrians and bicyclists, is a necessity. Flaggers should be trained to separate bicyclists from motorists in areas of limited sight distance or as necessary to protect the bicyclists proceeding through the TTC zone. Figure 9 provides an example of how a flagger should hold motorists to avoid a conflict while bicyclists pass through the TTC zone.

Cyclist approaching work zone
(Source: Composite Wikipedia/FOF).

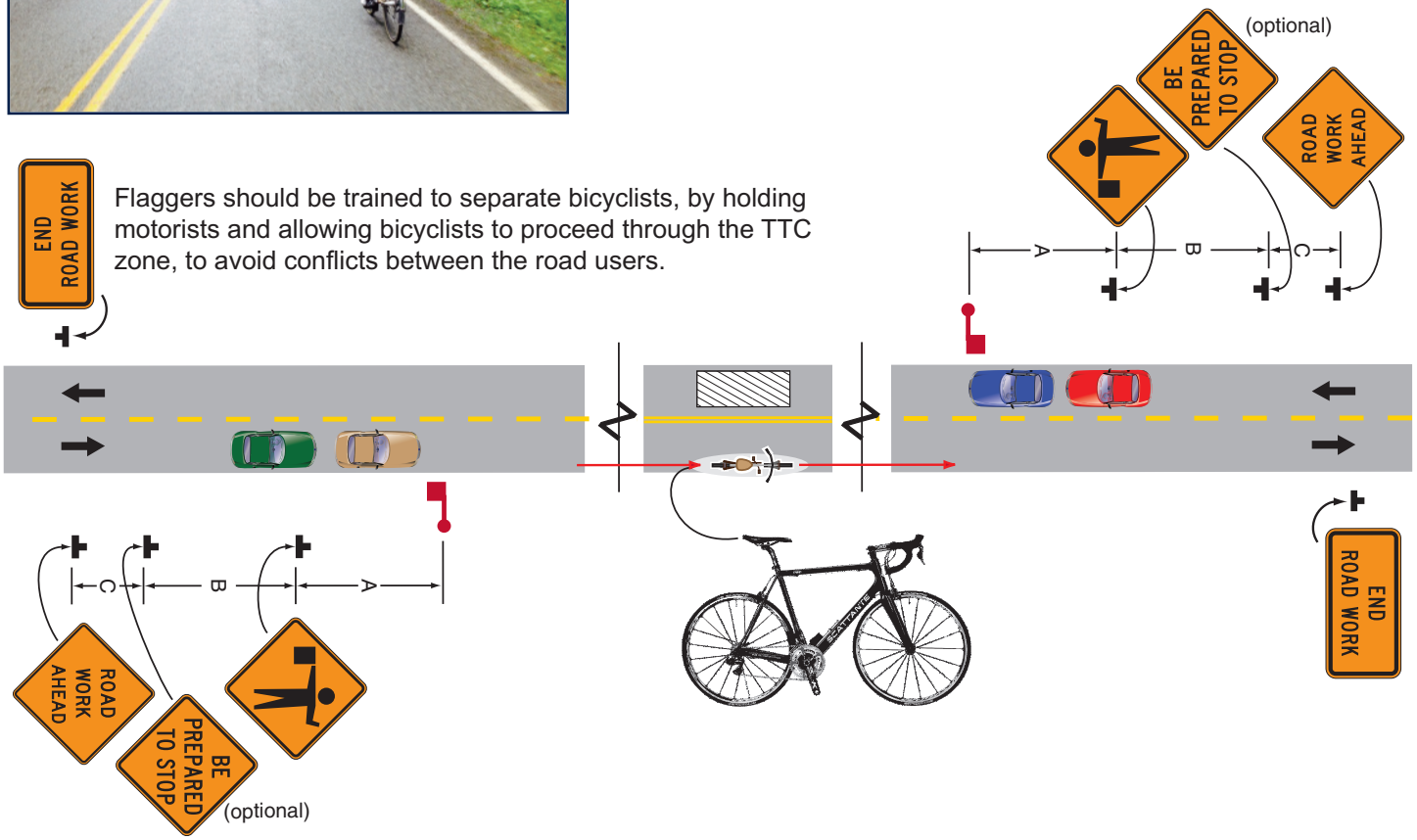

Figure 9. Example of separating bicycles from other road users for their protection in the TTC zone. (MUTCD TA-10).

Flagger stopping traffic to allow emergency vehicle to pass *(Source: Michigan DOT).*

Residential properties, driveways, and intersecting roads pose unique challenges for flaggers and require special treatment as described on page 2. Emergency vehicles, such as the one in the photo at left, as well as changing weather and operational conditions also require accommodation by flaggers.

The responsibility placed on flaggers is immense. They are required to protect themselves, road users, the crew, and the public and private assets at risk. To assist in the decision-making process for selecting individuals who will be well suited to these duties, Section 6E.01 of the MUTCD provides the list of qualifications for flaggers.

Flaggers must be well disciplined, responsible, polite, and firm to be able to handle the challenges of the position effectively and courteously. The individuals must have the ability to recognize problematic or emergency situations and adapt or react appropriately. This includes the ability to escape and alert the crew of the danger. The flagger's behavior can have a significant impact on the safety and performance of the operation so the flagger's character is critical to performance on the job. Flaggers must be conscientious and deliberate in their behavior and actions to be effective.

The following six steps are necessary in the selection and preparation of flaggers to assume and effectively perform the duties required of their positions:

- **Step 1:** Select individuals with qualifications that meet MUTCD guidelines.
- **Step 2:** Train individuals in the necessary skills.
- **Step 3:** Certify individuals through examination and skills tests to verify retention of the information.
- **Step 4:** Provide flaggers with on and off the job practice.
- **Step 5:** Ensure that flaggers are gradually gaining sufficient experience to assume positions of increasing responsibility and difficulty.
- **Step 6:** Provide refreshers and reinforcement of training to maintain current flagger skill sets.

All of these steps are necessary to equip flaggers for effective performance of their duties. None of these steps alone will provide individuals with enough well-rounded ability to perform the duties associated with flagging.

The training and coursework should teach not only the basic commands but should also include detail in a number of other areas:

- responsibilities of a flagger,
- special considerations when flagging,
- emergency situations and changing conditions,
- hazards, preventions, and countermeasures, and
- detailed instruction on the specific steps necessary in flagging.

Coursework covering these topics, exercises giving participants the ability to physically work through each of the scenarios, and skills tests and written tests are all necessary to ensure the competence of the individual assuming the role of a flagger. Many organizations and agencies conduct flagger training and certification. The National Work Zone Safety Information Clearinghouse website contains a list of flagger training as well as other flagging-related information at: http://www.workzonesafety.org.

Contingency Planning

Contingency planning is a critical component of planning flagging operations and reducing risk on the jobsite. Incidents may happen despite the measures taken to prevent them, and steps should be taken to minimize the impact of an incident. For example, a motorist may inadvertently (or even deliberately) leave the intended travel path and stray into the work space. Several methods can be considered to help mitigate the consequences should such events occur:

- **Shadow vehicles with truck-mounted attenuators** can help protect workers as well as reduce the severity of the crash for the motorist.
- **Buffer space** can be effective at giving the motorist time to bring the vehicle to a stop once they realize they have strayed from their intended path.
- **Air horns** can be effective for use by flaggers and shadow vehicle drivers to warn the crew members of impending danger as well as possibly gaining the motorist's attention prior to the incident.

Example of shadow vehicle with truck-mounted attenuator *(Source: Keily Equipment Rentals).*

Figure 10 on page 17 provides examples of buffer space and shadow vehicle usage.

Table 6E-1. Stopping Sight Distance as a Function of Speed

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

*Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed

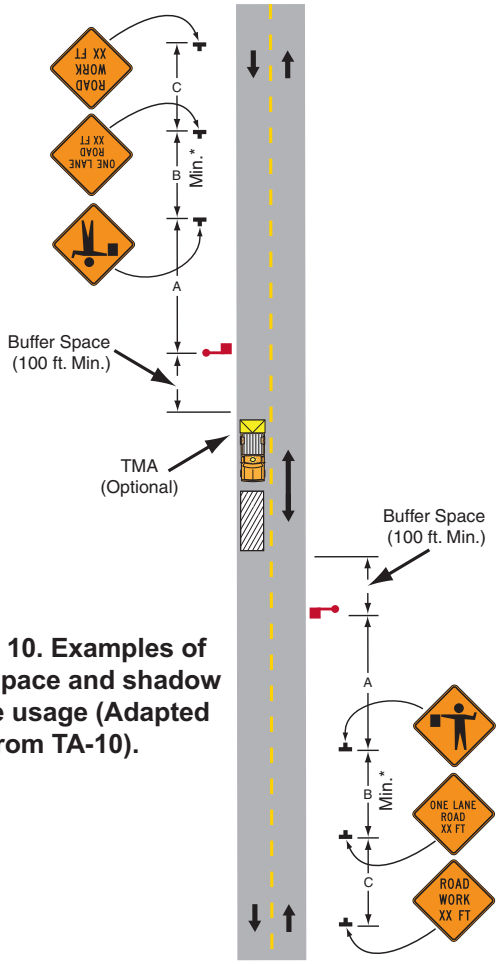

Figure 10. Examples of buffer space and shadow vehicle usage (Adapted from TA-10).

When shadow vehicles are used to minimize the chance of a vehicle striking the work being protected, a distance equal to or greater than the roll ahead distance or "Shadow Vehicle Spacing" should be used. Caution should be exercised in extending the roll ahead distance as motorists may try to re-enter the lane once beyond the shadow vehicle. Alternatively, cones could be placed between the shadow vehicle and work being protected to reduce the probability of an intrusion.

Table 2. Recommended Shadow Vehicle Spacing to Work Space. [14]

Operating Speed Limit (mph)	Stationary	Moving <15.5 mph
Shadow Vehicles weighing 22,000 lbs or more		
>55	150	172
45 - 55	100	150
<45	74	100
Shadow Vehicles weighing >9,900 to <22,000 lbs		
>55	172	222
45 - 55	123	172
<45	100	100

Figure 10 Detail.

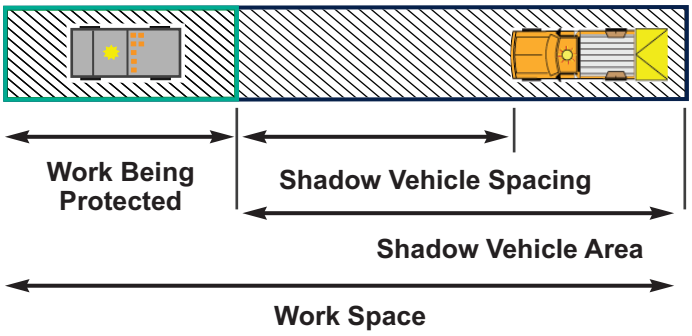

Table 2 illustrates the spacing of shadow vehicles to the work being protected that is recommended in the *Roadside Design Guide* [14] of the American Association of State Highways and Transportation Officials (AASHTO).

In addition to reducing the possibility or severity of the incident, emergency action plans should be created and practiced to provide personnel the ability to react favorably during an incident. Some key points to include in the emergency action plan are:

- worker escape route,
- crew/motorist alert methods (such as the air horn shown at right),
- emergency services contact information,
- contact information for notifying supervisors,
- training and provisions to provide immediate care (First aid/CPR or cardiopulmonary resuscitation/ AED or automated external defibrillator), and
- ensuring appropriate supplies are on-site.

Emergency action plan components *(Sources: N. Carboneau, U.Grewal, F.M. Alvarez).*

Conclusion

The variety of locations, work types, and conditions create challenges for those planning TTC operations which require flaggers on low-volume roads. The goal of this document has been to provide concise explanations, examples, and details that supplement the MUTCD and provide assistance with customizing existing information to fit many of the situations encountered on low-volume roads.

The specific sections of this document have identified the necessity for:

- evaluating site conditions prior to the selection of a TTC method and at the time of the operation;
- including considerations of traffic volumes, physical constraints, weather conditions, and time of day;
- selecting a TTC method suited to the site conditions, operational type, and duration;
- identifying complex conditions and modifications to the plan to meet those special needs;
- choosing the correct type of flagging or alternate control, which include options for two flaggers, single flaggers, self-regulating control, and mobile operations;
- monitoring installation and operation of the TTC zone for problems or changes and ceasing operations or adjusting the plan accordingly;
- having contingency plans in place and methods to reduce the likelihood and severity of an incident by using countermeasures such as buffer space, shadow vehicles, truck-mounted attenuators, and air horns for alerting road users and the crew of impending danger; and
- appropriately selecting and training workers on policies to reduce the likelihood of worker behavioral issues impacting the safety and operation of the TTC zone.

A summary of common challenges with possible solutions based on the information in this document is provided in Table 2 on page 19 as a quick reference or troubleshooting guide for use when planning the operations discussed here.

The MUTCD and local jurisdictional requirements should be used in conjunction with the information identified here; but, ultimately, as detailed in the MUTCD, “TTC plans should be prepared by persons knowledgeable (for example, trained and/or certified) about the fundamental principles of TTC and work activities to be performed.” “The design, selection, and placement of TTC devices for a TTC plan should be based on engineering judgment.”

Table 3. Common Flagging Challenges and Possible Solutions

Characteristic	Challenge	Impact	Solution
Driver Behavior	Speeding, tired, angry, aggressive, impaired distracted	Inattention, distraction	Use of more dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD can be considered.
Driver Behavior	Speeding, tired, angry, aggressive, impaired, distracted	Increased stopping distances	Increase sign spacing and buffer space dimensions to accommodate for the increased stopping sight distance.
Land Use	Vegetation, structures, and other obstructions	Reduces the visibility of operations	Longer TTC zones to provide adequate visibility and stopping sight distance by extending the TTC zone beyond the obstructions.
Limited Right of Way and Road Design	Narrow or non-existent shoulders, steep side slopes, rock or earth faces near the edge of pavement	Restricts the proper placement of TTC devices and flaggers	Longer TTC zones to provide proper TTC device and personnel placement by extending the TTC zone beyond the limiting factors.
Operational Challenges	Changing conditions	Can affect visibility and stopping distance	Cease operations. If necessary to continue operations, anticipate or react and adjust sign spacing and buffer space lengths. Other more dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD can be considered.
Operational Challenges	Duration of the work: Long term	Problematic for flagging	Use temporary traffic signals or detours.
Operational Challenges	Duration of the work: Short duration or mobile	Problematic for installation of TTC zone and flagging	Consider appropriate mobile operation Typical Applications, shadow vehicles, and other mobile TTC methods.
Regional Geography	Hills, windy regions	Can increase the stopping distance	Increase sign spacing and buffer space dimensions to accommodate for the increased stopping sight distance.
Regional Geography	Hills, curves and natural rock features	Reduces the visibility of operations	Longer TTC zones to provide adequate visibility and stopping sight distance by extending the TTC zone beyond the hills, curves, or other natural features.
Road Use	Pedestrians and bicyclists	Accommodation and protection in TTC zone	Use flagging procedures to separate motorized and non-motorized users in the TTC zone: In areas of restricted sight distance, separate bicyclists from motorized traffic and allow each to proceed independently to avoid conflicts in these areas.
Road Use	Traffic volumes, peak periods, harvest, and special events	Problematic for self-regulating TTC zones, mobile operations, and lane closures	Avoid peak periods if possible. Use higher volume TTC methods if work is necessary during peak times. More dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD can also be considered.

*Note: Well-defined flagger escape routes are critical to reducing hazards associated with flagging operations for the flaggers.

(Table 3 continues on page 20)

Table 3. Common Flagging Challenges and Possible Solutions (Continued)

Characteristic	Challenge	Impact	Solution
Road Condition	Unpaved, clay, and gravel road surfaces	Reduction of visibility in dusty conditions	Dust control methods in and near the TTC zone as well as more dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD can be considered.
Weather	Rain, snow, and ice	Reduced frictional abilities of the surface and increased stopping distances	Postpone operations if possible. Increase sign spacing and buffer space dimensions to accommodate for the increased stopping sight distance.
Weather	Fog, rain and snow	Reduction of visibility	Postpone operations if possible. If not, consider the use of several methods to alert motorists: using multiple advance shadow vehicles with appropriate lighting; adding advance warning signing with high retroreflectivity values; using law enforcement; and using other more dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD.
Time of Day	Dawn and dusk	Reduction of visibility	Postpone operations if possible. If not, consider the use of several methods to alert motorists: using multiple advance shadow vehicles with appropriate lighting; adding advance warning signing with high retroreflectivity values; using law enforcement; and using other more dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD.
Time of Day	Night operations	Reduction of visibility	Evaluate risks and benefits of night work. If necessary, place artificial lighting so that glare does not impact flaggers or approaching drivers. Use caution with the amount of lighting to avoid washing out the flagger with too much light. Consider increasing device sizes, number, visibility, and retroreflectivity as well as other more dominant features and modifications to fulfill special needs in accordance with Section 6G.04 of the MUTCD.
Worker Behavior	Distraction, inattention, inexperience, and poor training	Inattention, distraction, behavior, public relations	Training, policies, standard operating procedures, supervisory controls.
Worker Behavior	Tired, angry, aggressive, or impaired	Inattention, distraction, behavior, public relations	Training, policies, standard operating procedures, supervisory controls.

*Note: Well-defined flagger escape routes are critical to reducing hazards associated with flagging operations for the flaggers.

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