

1. Report No. FHWA/TX-82/1+228-8		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Special Traffic Management Requirements For Maintenance Work Zones on Urban Freeways				5. Report Date January 1982	
				6. Performing Organization Code	
7. Author(s) Stephen H. Richards and Conrad L. Dudek				8. Performing Organization Report No. Research Report 228-8	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. Study No. 2-18-78-228	
12. Sponsoring Agency Name and Address Texas State Department of Highways and Public Transportation; Transportation Planning Division P. O. Box 5051 Austin, Texas 78763				13. Type of Report and Period Covered Interim: September 1977-June 1981	
				14. Sponsoring Agency Code	
15. Supplementary Notes Research performed in cooperation with DOT, FHWA. Study Title: Traffic Management During Urban Freeway Maintenance Operations					
16. Abstract <p>This report identifies and describes the special traffic handling requirements for maintenance work zones on urban freeways. These special requirements stem from the high speeds, heavy traffic volumes, and unique design features (e.g., ramps and frontage roads) which characterize urban freeways. The information and guidelines presented herein are based on field studies and interviews conducted at over 50 work zones in six Texas cities.</p> <p>Recommended procedures and devices for managing traffic at entrance and exit ramps and on frontage roads during freeway maintenance activities are presented. Special requirements for traffic control personnel, including Traffic Control Coordinators, Traffic Control Specialists (flagmen), and police, are discussed. The report also discusses the importance of advance public notification of freeway work activities and identifies several effective techniques for advance notification.</p>					
17. Key Words Maintenance, Work Zones, Traffic Control, Freeway Operations, Ramps, Frontage Road, Traffic Control Devices, Signing, Flagging, Enforcement			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 43	22. Price



SPECIAL TRAFFIC MANAGEMENT REQUIREMENTS FOR
MAINTENANCE WORK ZONES ON URBAN FREEWAYS

by

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Research Report 228-8

Traffic Management During Urban Freeway Maintenance Operations
Research Study 2-18-78-228

Sponsored by

State Department of Highways and Public Transportation

In Cooperation with the

U. S. Department of Transportation
Federal Highway Administration

Texas Transportation Institute
The Texas A&M University System
College Station, Texas

January 1982



ACKNOWLEDGMENTS

The authors wish to thank Districts 2, 12, 14, 15, 16, and 18 of the Texas State Department of Highways and Public Transportation (SDHPT) for their cooperation and assistance in conducting field studies at several work zones. Tom Newbern, Herman Haenel, and Blair Marsden (D-18T, SDHPT) are also acknowledged for their constructive comments and suggestions during the course of the research documented herein.

The research direction was guided by a Technical Advisory Committee. The contributions of this Committee, whose members are listed below, are gratefully acknowledged:

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SUMMARY

Special Traffic Control Requirements

Special attention must be given to handling mainlane, ramp, and frontage road traffic during urban freeway maintenance activities. Although the Manual on Uniform Traffic Control Devices for Streets and Highways provides minimum standards, there are additional operational and signing procedures that can enhance traffic flow during freeway lane closures.

Ramp Closures

Entrance and exit ramps may need to be closed at freeway work zones to protect the work crew and/or facilitate the work activity. Entrance ramps may also be closed to reduce mainlane traffic flow at work zones where capacity is a problem.

Ramps should be closed only when needed and only as long as needed. The public should be notified in advance of ramp closures by special signing, newspaper releases, etc. Typical ramp closure strategies for exit ramps and entrance ramps are illustrated in Figures 2 and 7 (pages 9 and 18).

Permissive Use of Ramps

It may be desirable to keep certain work area exit and entrance ramps open. In these situations, ramp traffic should be controlled with signing and channelizing devices to protect the work crew and prevent driver confusion. Typical traffic control strategies for permissive use of work area exit and entrance ramps are illustrated in Figures 5 and 10 (pages 14 and 22).

Frontage Road Operations

Freeway maintenance activities can have an adverse effect on frontage road traffic operations. Frontage road operations are particularly critical

when large volumes of traffic are diverted to the frontage road. Diversion to the frontage road occurs when an entrance ramp or the freeway is closed. Diversion also occurs "naturally" when congestion develops on the mainlanes.

When traffic is diverted to the frontage road during a freeway maintenance activity, it may be necessary to re-time traffic signals at some frontage road intersections or provide special intersection traffic control (e.g., flagman or police). Although the use of flagmen and police are encouraged, the complexity of diamond interchanges makes manual traffic control difficult; thus re-timing the signals is important. Parking on the frontage road should also be prohibited and no-parking zones enforced. These traffic control measures will increase frontage road capacity, thus reducing motorist delay and inconvenience.

Ramp capacity can also be a problem at freeway work zones where traffic is diverted to the frontage road. Several approaches for increasing ramp capacity are available, including the following:

1. Encouraging two-lane flow at single lane entrance ramps (Figure 12, page 28).
2. Providing a "free lane" at exit ramps (Figure 13, page 29).
3. Encouraging diversion at several ramps (Figure 14, page 31).

Advance Notification

Drivers should be given advance notification of freeway work activities wherever possible. Advance notification of freeway and ramp closures is particularly important.

There are several methods for notifying drivers of a scheduled work activity, including newspaper releases, radio and television reports, and special signing. Advance notification signing is particularly effective since it displays specific information to those repeat drivers who will be affected by the work activity.

Traffic Control Coordinator

There should be an individual, called a "Traffic Control Coordinator," at every freeway maintenance work zone who has the responsibility and authority to make important traffic control decisions. The Traffic Control Coordinator should continuously monitor changing work and traffic conditions at the work zone. He or she should open and close ramps, station flagmen, request police assistance, alter the traffic control plan, etc., as needed.

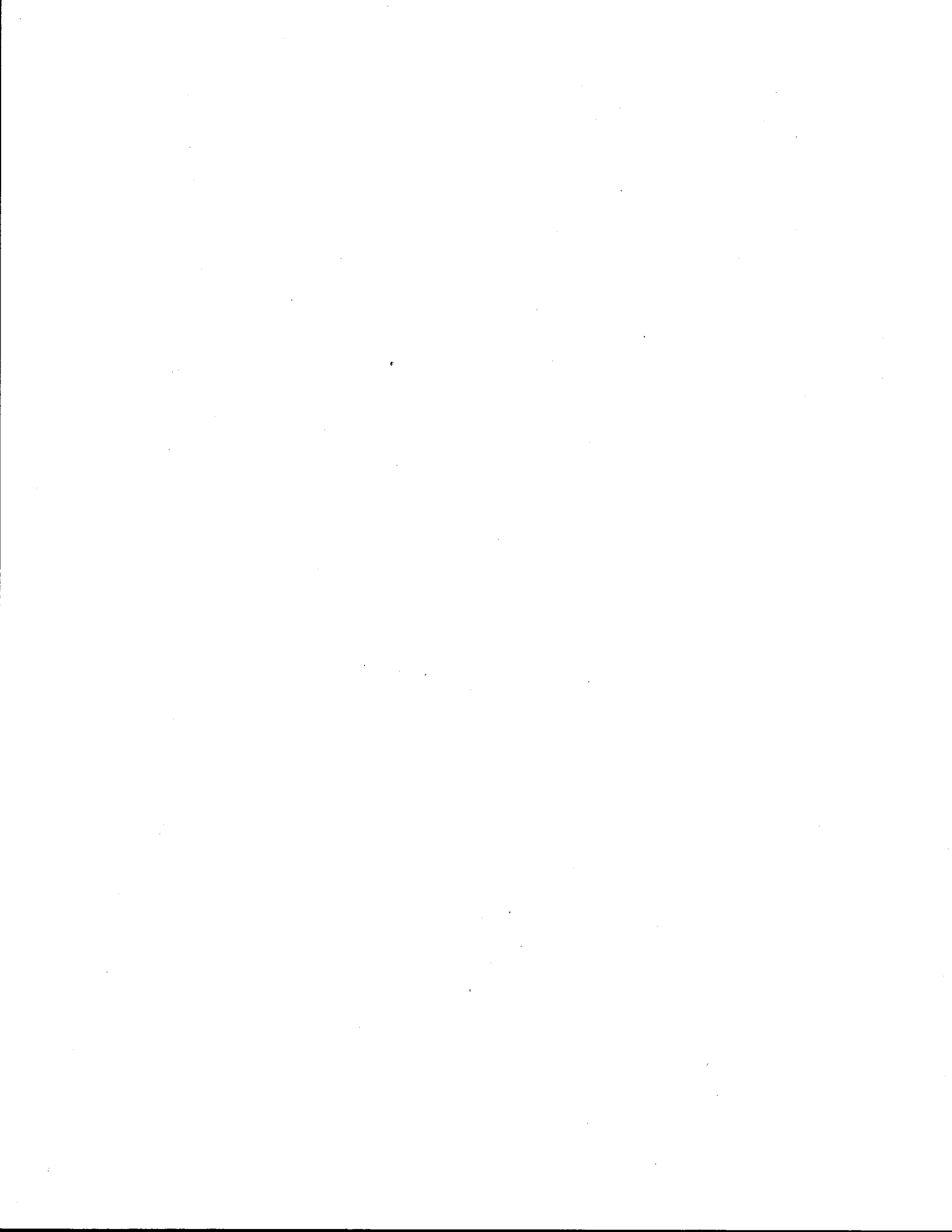
Traffic Control Specialist

At freeway work zones, flagmen perform several critical and somewhat unique traffic control functions. In order to reflect their expanded roles, they should be called "Traffic Control Specialists."

These Specialists should be supervised by the Traffic Control Coordinator and used only where needed. Normally, Traffic Control Specialists are best utilized at ramps and frontage road intersections. They may have less success in controlling high speed mainlane traffic. The effectiveness and safety of Traffic Control Specialists may be enhanced if they wear special clothing.

Use of Police

During freeway maintenance activities, police can provide vital traffic control services. They can control traffic at ramps and intersections, prevent illegal freeway access, enforce frontage road no-parking zones, and increase driver alertness and obedience to traffic control devices. It is essential, therefore, that Districts establish good communication and cooperation with local police agencies.



INTRODUCTION

Background

Maintenance activities (i.e., patching, guardrail repair, bridge joint repair, etc.) are routinely performed on urban freeways. These activities can result in severe congestion and traffic safety problems. Motorist inconvenience and accidents can be minimized, however, by using effective traffic control techniques and devices.

Traffic control requirements for urban freeway work zones are unique because of the high speeds, heavy traffic volumes, and high level of driver expectancies which characterize freeways. In addition, certain freeway design features (e.g., ramps and frontage roads) present special traffic handling problems in some situations, while increasing the number of available traffic control options in other situations.

For example, ramp traffic must be warned of the presence of a work zone and controlled to keep ramp drivers out of the work area. Ramps may also be temporarily closed to protect the work crew, or in the case of entrance ramps, to reduce traffic flow through the work zone.

At congested work zones, frontage roads can provide an alternate route for mainlane traffic. At work zones where entrance ramps are closed, they provide an alternate route for displaced ramp traffic. In the special case of complete freeway closures, frontage roads can serve as detour routes.

Problem Identification

The State of Texas has adopted, in expanded form, the guidelines for traffic control at maintenance work zones set forth in the Manual on Uniform Traffic Control Devices for Streets and Highways (1,2). These guidelines represent

minimum standards for typical situations under normal roadway conditions, and they emphasize rural highway applications. The special conditions associated with the complex urban freeway environment (e.g., high speeds, heavy volumes, ramps, and frontage roads) are recognized, but the current guidelines only modify control measures developed in a rural environment and do not fully reflect the inherent differences between rural roads and urban freeways.

Purpose

This report identifies and describes the special traffic handling requirements for maintenance work zones on urban freeways. It presents guidelines for managing entrance and exit ramp traffic and frontage road traffic under various work zone conditions. It also discusses special requirements for traffic control personnel (including flagmen and police), and advance public notification of freeway work activities. The information and guidelines presented in this report are based on field studies and interviews conducted at over 50 work zones in Houston, Dallas, San Antonio, Ft. Worth, Austin, and Corpus Christi.

TRAFFIC CONTROL AT EXIT RAMPS

Exit Ramp Closures

Exit ramps in a freeway work zone may need to be closed to protect the work crew and facilitate the work activity. An exit ramp may also need to be closed when the work activity occupies the ramp or the ramp-frontage road intersection.

Exit ramps should be closed only when needed, and they should remain closed only as long as needed. If the location of the work moves away from a ramp so that closure of the ramp is no longer necessary, the ramp should be re-opened to traffic.

To make sure that exit ramps are closed and opened in an appropriate and timely manner, there should be an individual trained in traffic control at the jobsite to continuously monitor changing traffic and work conditions. The functions and training requirements of this individual (called a "Traffic Control Coordinator") are discussed in detail in a later section of this report.

Whenever an exit ramp is to be closed for several days (or anytime that a ramp closure can be anticipated in advance), motorists should be given advance notification of the closure. Advance notification will allow informed motorists to adjust their travel plans, and thus lessen the inconveniences and confusion caused by the closure. There are many methods for warning drivers in advance of a ramp closure including newspaper releases, radio and television reports, and special signing. (These methods are discussed in detail in a later section.) An example of special advance notification

signing for a ramp closure is presented in Figure 1. The sign shown in the figure was used in District 12.

An exit ramp can be closed using various traffic control devices, including cones, barricades, and/or a work vehicle. Regardless of the devices used, the ramp closure should be very apparent to mainlane drivers. Figure 2 shows a typical exit ramp closure approach recommended for maintenance work zones on urban freeways. Normally, cones are sufficient to close a ramp; however, cone spacing at the ramp should be reduced (e.g., to 25 feet) in the ramp area. It is recommended that 28-inch cones be used rather than the normal 18-inch cones. If cones alone do not discourage all drivers from using a closed ramp, more positive traffic control devices should also be used (e.g., barricades, barrels, or a parked vehicle). These more positive devices should also be used for long-term (overnight) ramp closures since cones may be easily blown down or knocked over and they lack visibility at night.

In some situations, it may be necessary to station a flagman or policeman at a closed exit ramp to assist drivers and to prevent illegal exit maneuvers. This individual can also maintain the closure devices used at the ramp and assist in re-opening the ramp as soon as its closure is no longer needed. The use of flagmen and police at maintenance zones on urban freeways will be discussed in detail in a later section.

When an exit ramp with a long deceleration lane is closed, drivers may attempt to enter the deceleration lane, not realizing that the ramp is closed. Traffic control devices (e.g., cones, barrels, barricades, etc.) should be installed in the deceleration lane to discourage drivers from using the lane and becoming surprised or trapped. As a minimum, cone spacing should be reduced for the full length of the deceleration lane (see Figure 2).

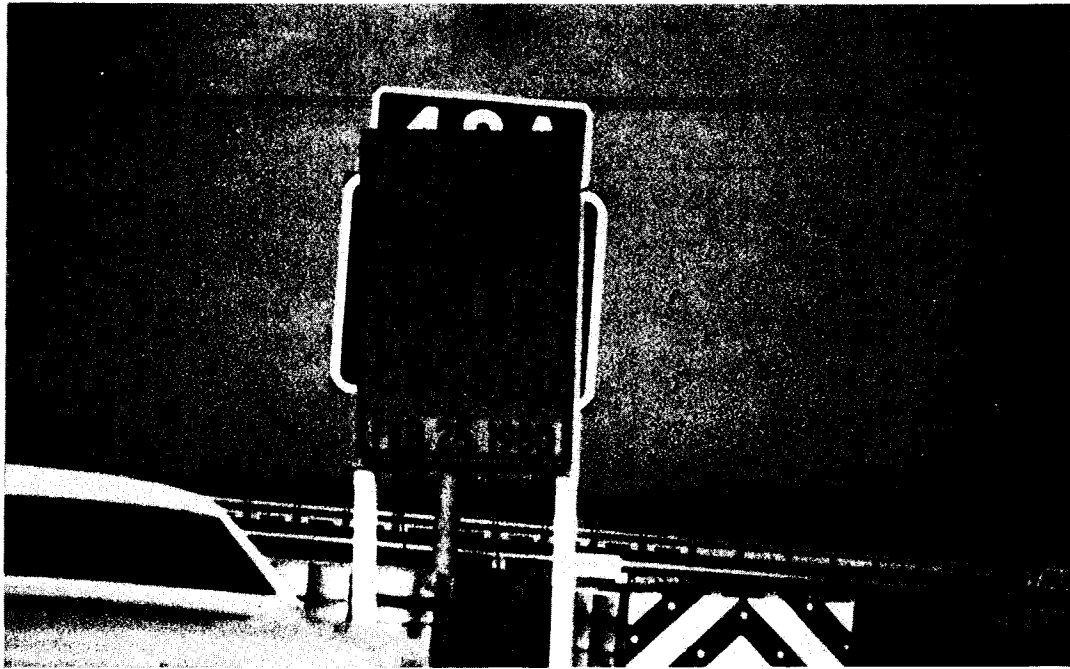
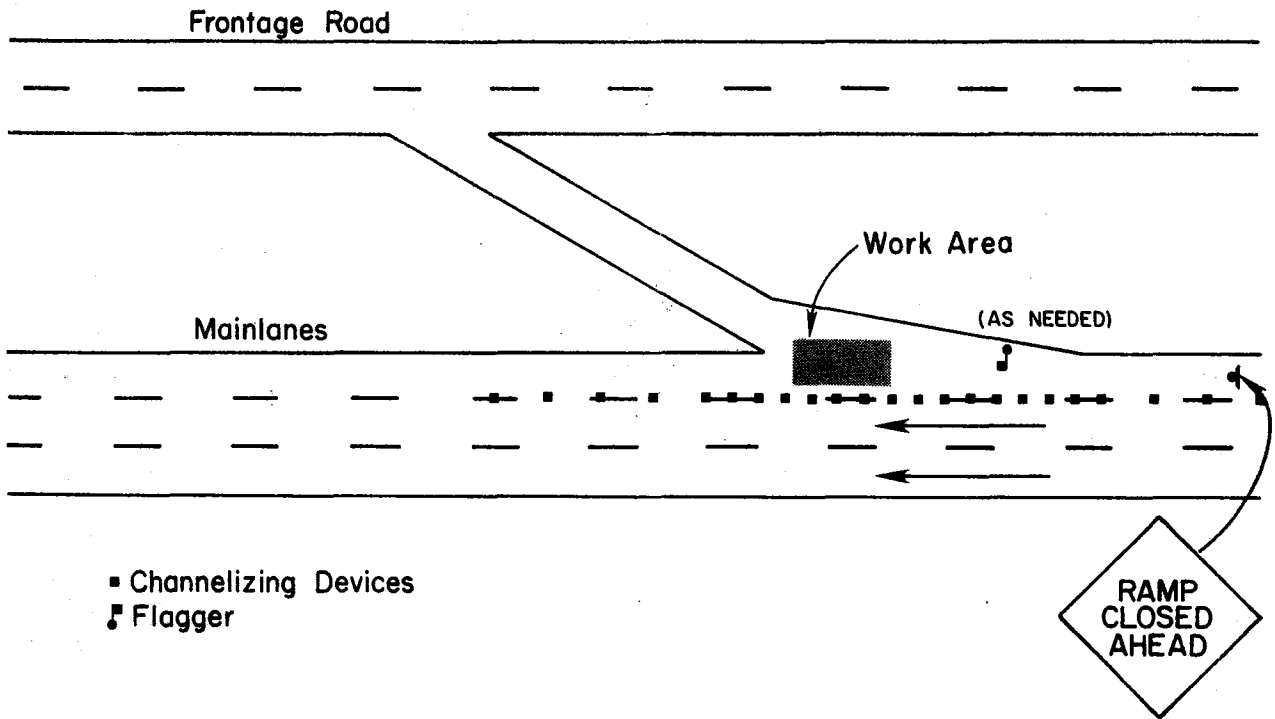


Figure 1. Advance Notification Signing for a Ramp Closure



Notes

1. Cone spacing should be reduced at the ramp and ramp deceleration lane to discourage ramp use.
2. Barricades, barrels, or a parked vehicle with beacons will be used to block the exit ramp to prevent ramp use. Barricades and barrels are preferred at night, however, because of their increased visibility.
3. A flagman or policeman may be stationed at the ramp as needed.
4. Standard advance warning signs must be used upstream from the "Ramp Closed Ahead" sign.

Figure 2. Typical Exit Ramp Closure

Freeway drivers should be warned upstream of an exit ramp closure. An advance warning sign for ramp closures used in District 2 is shown in Figure 3. This sign, or a similar sign, should be placed approximately 800 feet upstream of a closed ramp on the right side (for right-hand exit ramps) and on the left side (for left-hand exit ramps).

When several successive exit ramps are closed, familiar drivers may become fearful of long delays on the detour route and unfamiliar drivers may worry about getting lost. Drivers may attempt to force their way through a closed ramp or drive illegally across the outer separation. To alleviate driver confusion and panic in these situations, special signing messages may be used. These messages, displayed on conventional signs or changeable message signs (e.g., bulb-matrix signs), would tell motorists that several ramps are closed and where they can exit the freeway. An example of an alternating message on an changeable message sign or messages on two static signs is presented below:

NEXT 3 RAMPS CLOSED

USE PINE ST. EXIT

Whenever a freeway exit ramp is closed, the normal ramp traffic is diverted to another ramp or ramps (usually the first open downstream ramp). Before a ramp is closed, traffic operations and capacity at these other ramps should be evaluated and the necessary traffic control measures taken to alleviate anticipated problems (e.g., exit maneuvers, traffic signal timings). If ramp capacity is a problem, special signing may be needed to encourage displaced traffic to use several alternate ramps (e.g., ramps upstream and downstream of the work area). If driver confusion at alternate ramps is a problem,

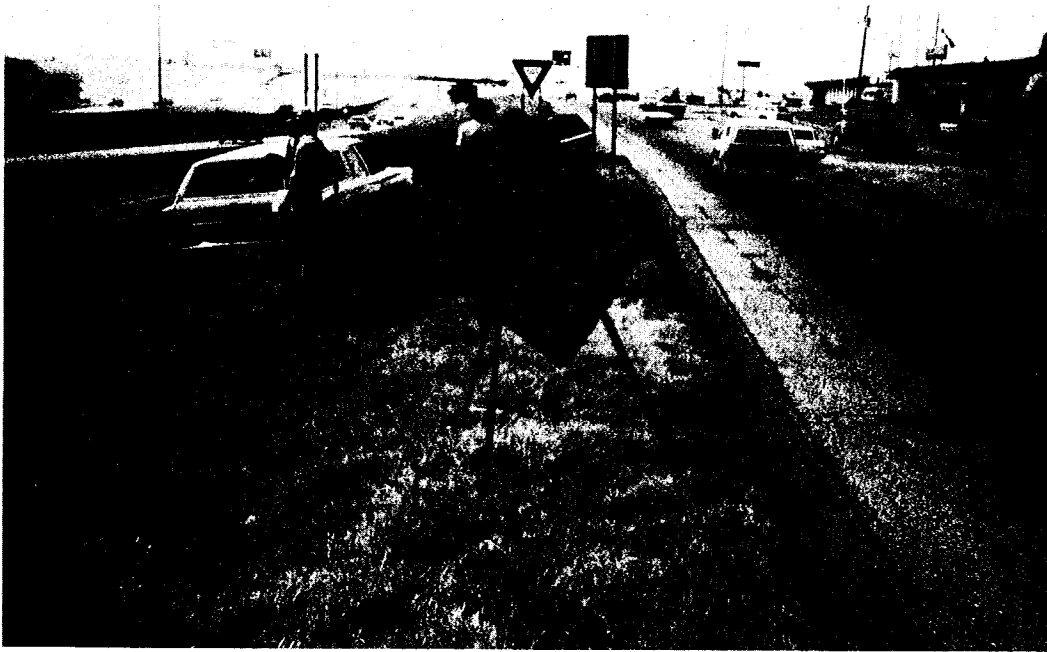


Figure 3. Warning Sign for a Ramp Closure

police or flagmen may be required at these ramps to direct traffic. The displaced ramp traffic can also have an adverse effect on frontage road intersections. These problems and potential solutions will be discussed in the section on "Frontage Road Traffic Operations."

Permissive Use of Exit Ramps

At some work zones, it may be desirable to encourage traffic to use an open exit ramp in the middle of the work area. In these situations, special attention must be given to warning and controlling ramp traffic so that ramp users exit in a safe and orderly manner.

When an exit ramp in the middle of a work area is kept open, drivers should be assured that they can use the ramp. A sign used in District 2 for this purpose is shown in Figure 4.

A desirable exit path for ramp traffic should be well defined using cones or other appropriate channelizing devices as shown in Figure 5. Additional channelizing devices may be placed in the deceleration lane to encourage desirable exiting paths.

At some exit ramps (e.g., where drivers are distracted by nearby work activities), it may be necessary to station a flagman or policeman at the ramp to direct traffic and to maintain traffic control devices in order to minimize driver confusion. Also, a "shadow truck" may be positioned just downstream of the exit ramp to protect the work crew from errant vehicles.

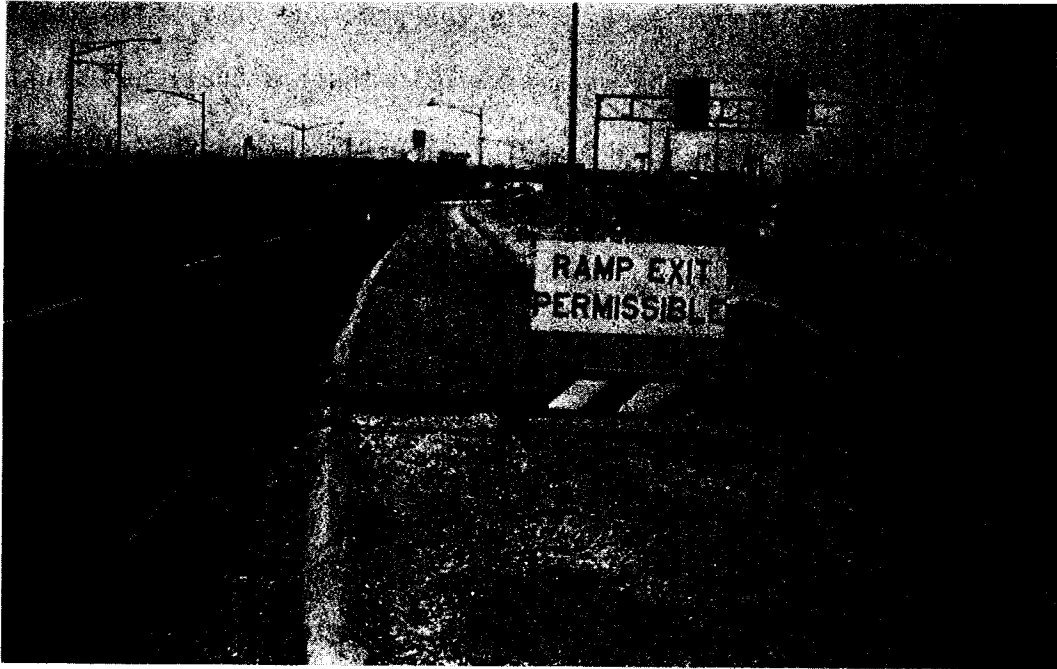
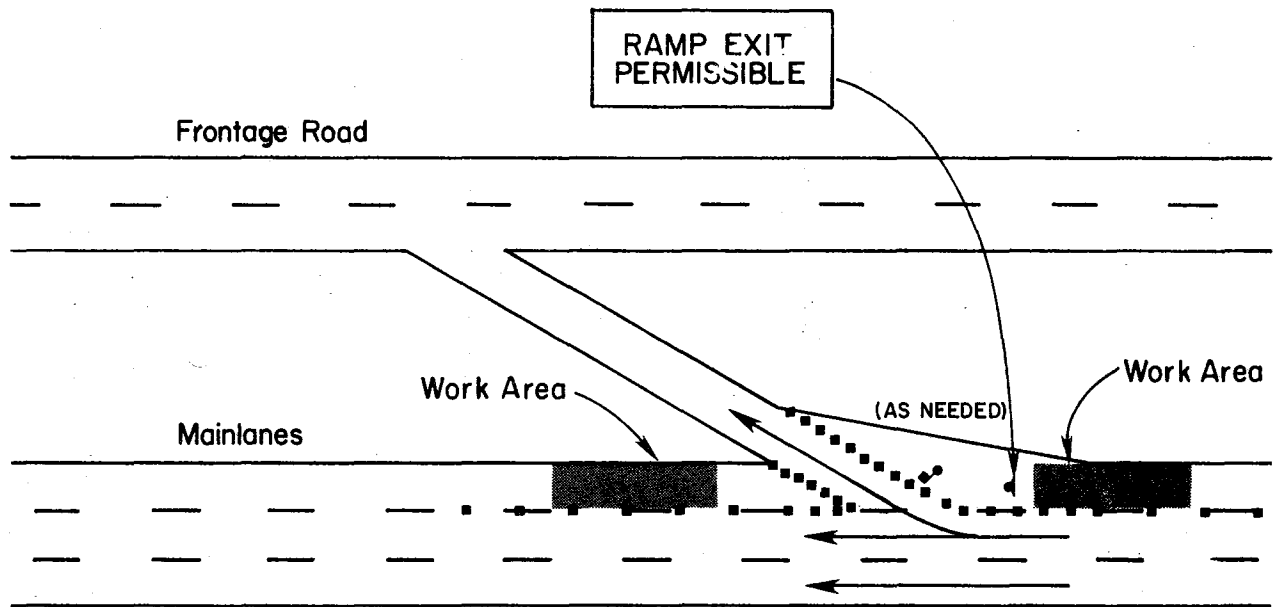


Figure 4. Sign for Permissive Use of an Exit Ramp

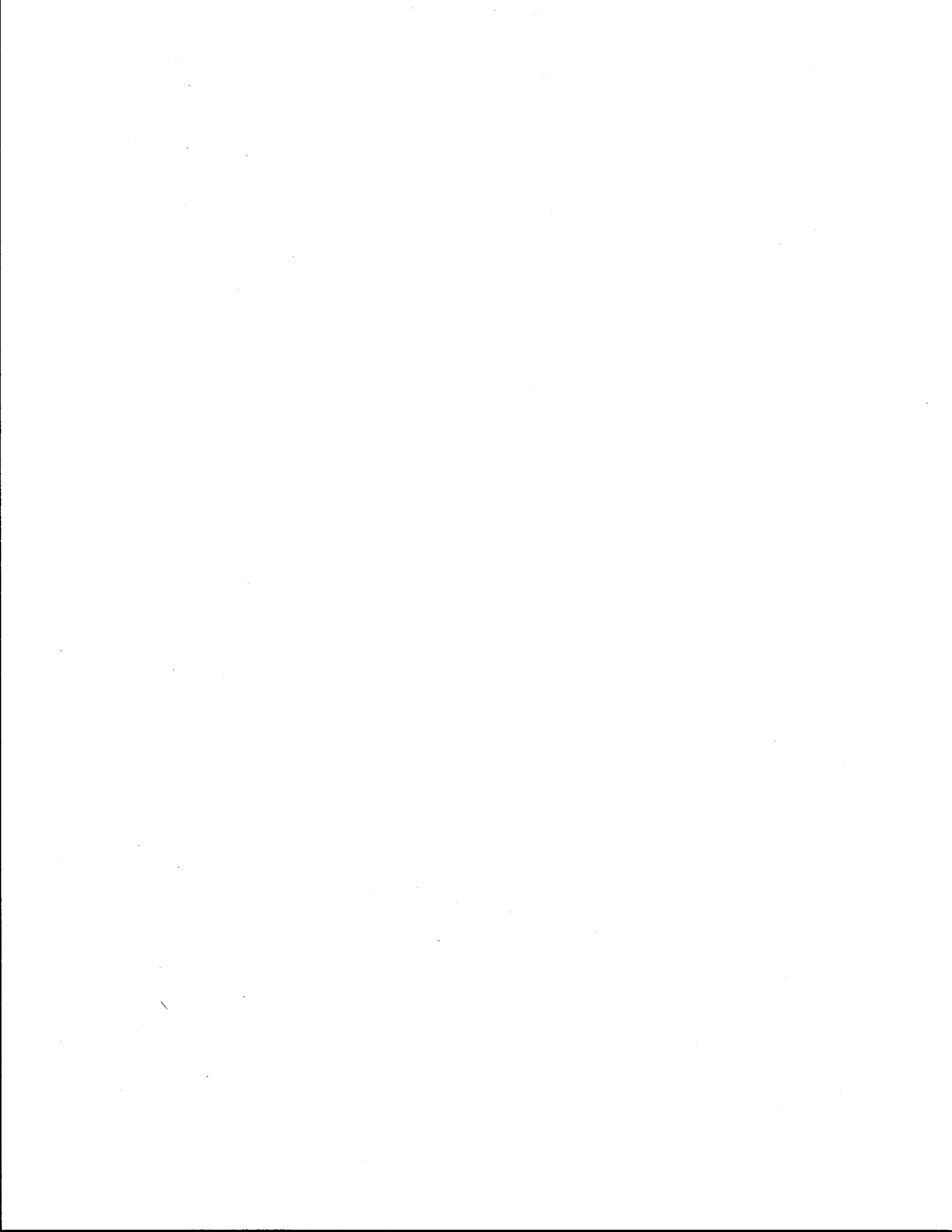


- Channelizing Devices
- ♣ Flagger

Notes

1. Cone spacing should be reduced at the ramp and deceleration lane.
2. A "shadow truck" may be positioned downstream of the exit ramp to protect the work crew.
3. A flagman or policeman may be stationed at the ramp as needed.
4. Standard advance warning signs must be used upstream from the "Ramp Exit Permissible" sign.
5. Where traffic volumes, speeds, sight distance or other such factors may warrant a deceleration lane and where a deceleration lane will not infringe upon the work area, it may be desirable to delineate a deceleration lane with channelizing devices to allow exiting traffic a lane in which to reduce speed.

Figure 5. Typical Traffic Control at Work Area Exit Ramps



TRAFFIC CONTROL AT ENTRANCE RAMPS

Entrance Ramp Closures

Entrance ramps in a work area may be closed to protect the work crew and facilitate the work activity. Entrance ramps in a work zone and upstream of a zone may also be closed to reduce traffic flow through the work area, and thus reduce congestion and motorist delay at freeway work zones with insufficient capacity. The frontage road capacity should be evaluated to determine the impacts of the ramp closures on frontage road operations. Guidelines for estimating work zone capacity and demand volumes are presented in Reference 3.

Regardless of the reason for closing an entrance ramp, the ramp should be closed only as long as needed (e.g., the work activity occupies the ramp area or demand volumes on the mainlanes exceed the work zone capacity). A "Traffic Control Coordinator" should be at the work zone to monitor changes in traffic and work conditions, and open and close entrance ramps as needed. This individual should make sure that the proper number of ramps are closed and that ramps are not closed too soon or kept closed too long. Otherwise, undesirable conditions like the one shown in Figure 6a may result. At the work zone shown in the figure, too many entrance ramps were closed too soon (before mainlane demand exceeded work zone capacity). Severe congestion on the frontage road resulted, while traffic volumes were relatively light on the mainlanes. Many frontage road drivers became impatient with the situation and illegally entered the freeway, as shown in Figure 6b.

Whenever an entrance ramp closure is anticipated, motorists should be notified in advance of the closure. Special signing may be installed at the



Figure 6a. Frontage Road Congestion at Freeway Work Zone Where Entrance Ramps Were Closed Too Soon

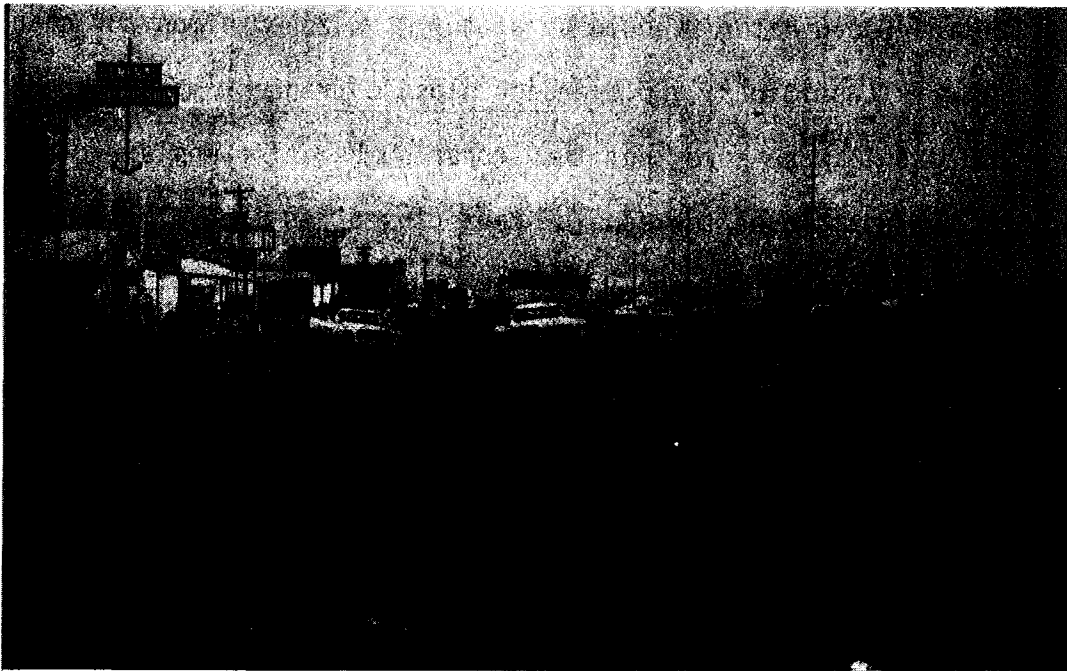


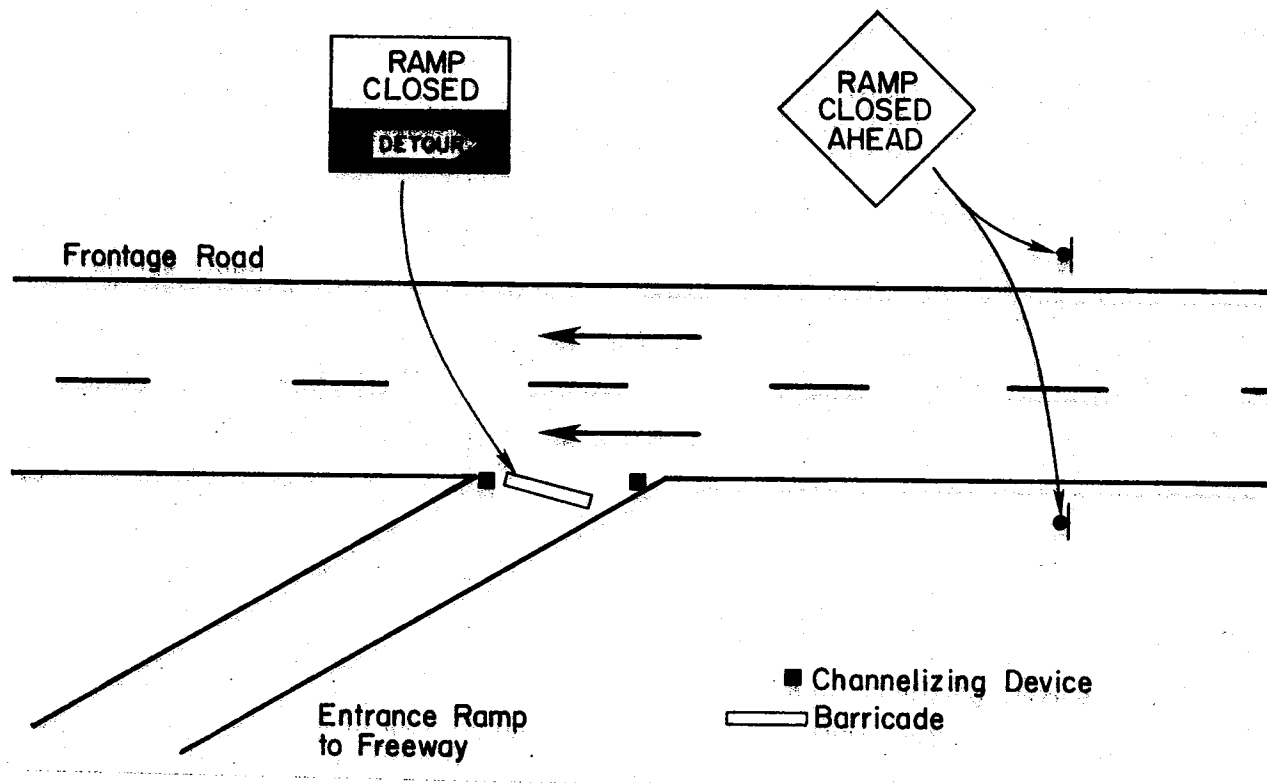
Figure 6b. Vehicles Illegally Entering Freeway

ramp (see Figure 1), as the most direct means of advance notification. Newspaper releases and radio reports are also effective. If drivers are made aware of a ramp closure, they will not be surprised by the ramp closure and may change their trip plans or take alternate routes.

There are several ways to close an entrance ramp, and the most effective method will depend on site conditions. A typical entrance ramp closure is illustrated in Figure 7. As a minimum, closely spaced cones could be placed across the full width of the ramp at the ramp-frontage road intersection as shown in Figure 8a. This approach would probably be sufficient at low volume ramps for short duration maintenance, provided the frontage road was not congested.

It may be necessary to use more positive traffic control devices to close ramps for long periods or overnight. Figure 8b shows an entrance ramp effectively closed with cones and Type III barricades. At some ramps, even though they are closed for just an hour or so, drivers may disregard traffic cones and similar closure devices and illegally use the ramp. This problem often occurs when the frontage road is congested. In these cases, it may be necessary to barricade the ramp or park a vehicle across the ramp entrance. A flagman or policeman may also be stationed at these problem ramps. Police presence may be required to control illegal freeway entry where the outer separation is easily traversed. An example of this situation is shown in Figure 9.

In addition to physically closing an entrance ramp, ramp drivers should be warned by signs that the ramp is closed. The sign shown in Figure 3 may be used to warn frontage road traffic and potential ramp users of a ramp closure. As a minimum, one sign should be placed several hundred feet upstream of the closed ramp on the left side. Additional signs should be used as needed.



Notes

1. A parked vehicle may be used to block ramp entry.
2. A flagman or policeman may be stationed at the ramp as needed.

Figure 7. Typical Entrance Ramp Closure

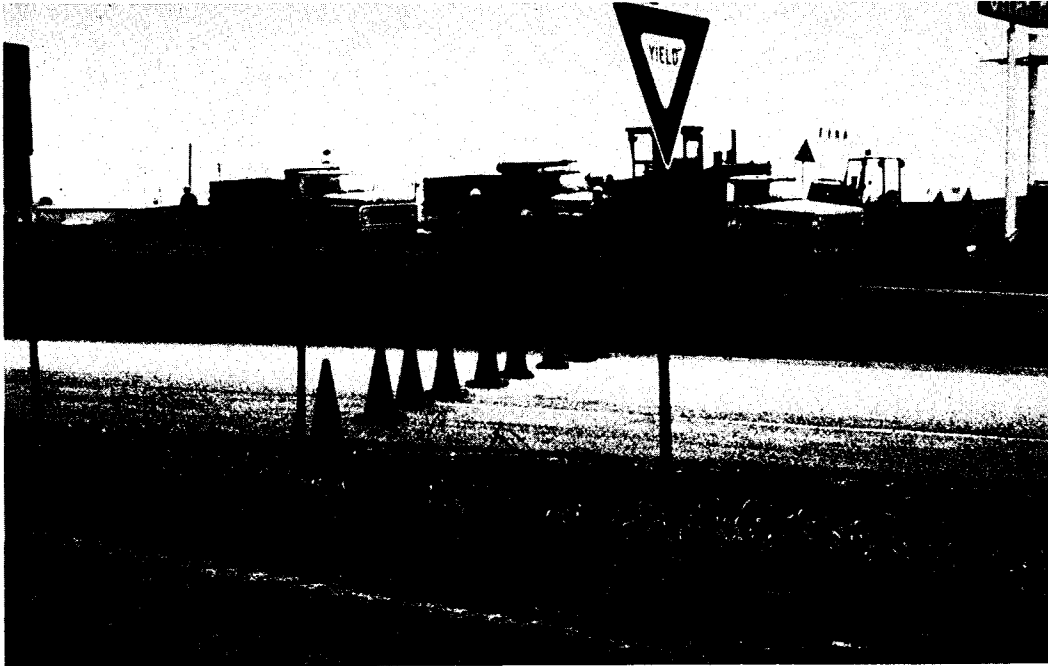


Figure 8a. Entrance Ramp Closure Using Traffic Cones

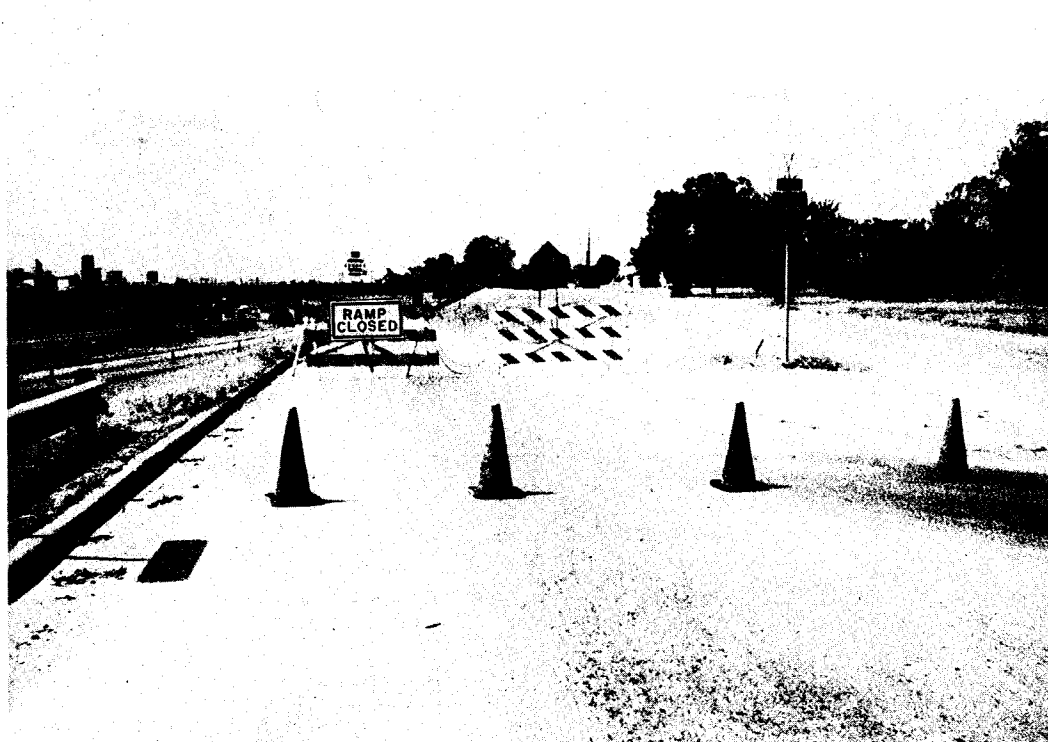


Figure 8b. Entrance Ramp Closure Using Barricades and Traffic Cones



Figure 9. Police Control of Illegal Freeway Access

If several successive ramps are closed, special advance and guide signing may be required to prevent drivers from becoming confused, lost, or worried that they will not be able to enter the freeways. (These drivers may attempt illegal freeway entry.) The following special signing messages may be used to warn frontage road drivers that several successive ramps are closed:

NEXT
3 RAMPS
CLOSED

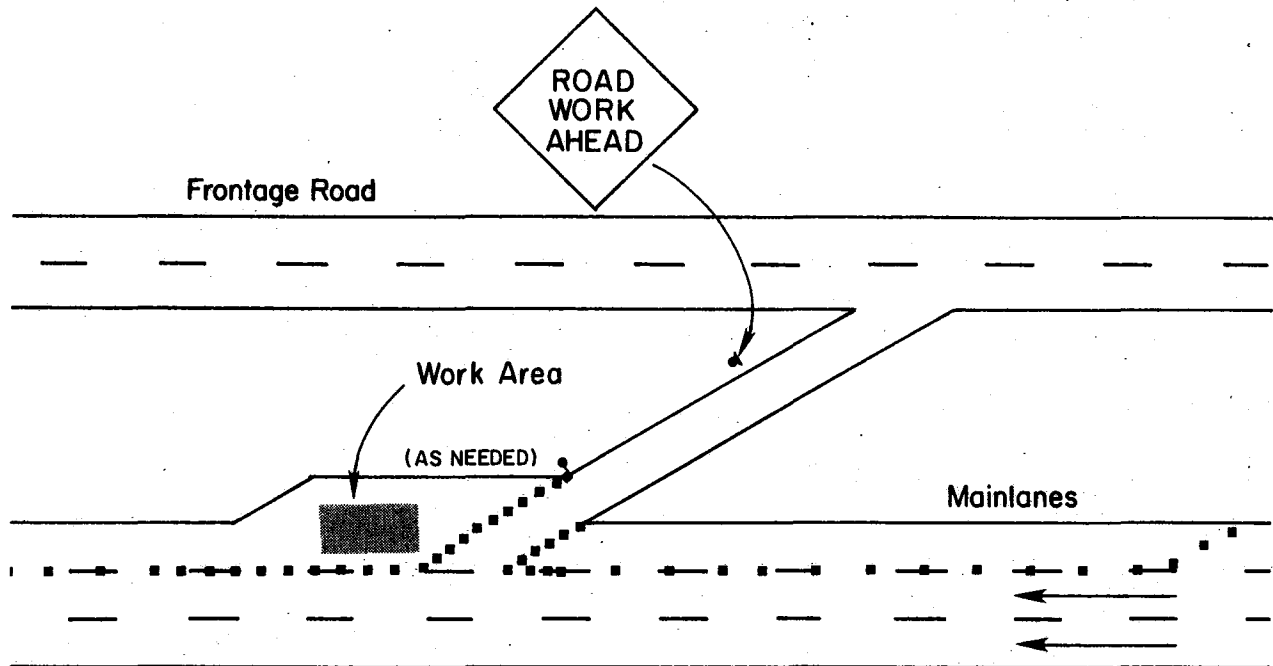
ENTER FWY
AT PINE
2 MILES

The signing messages may be displayed on two conventional static signs or a changeable message sign in alternating sequence. Including the distance on the sign helps the driver to better utilize the frontage road and to prepare for re-entry to the freeway.

Permissive Use of Entrance Ramps

It is sometimes desirable to keep an entrance ramp in a work area open (e.g., when the frontage road is not continuous or at high volume entrance ramps). In these situations, every effort must be made to warn ramp drivers of the presence of the work activity and to direct these drivers safely through the work area. It is also essential to provide special protection for the work crew.

A typical traffic control strategy for a work area entrance ramp is illustrated in Figure 10. As shown in the figure, cones are used to "channel" entrance ramp traffic through the work area and keep drivers from entering the work area. At long duration work zones and during night work, it is recommended that barricades, barrels, etc., be used in place of the cones or to supplement the cones. These devices are more permanent and visible at night.



- Channelizing Devices
- ♣ Flagger

Notes

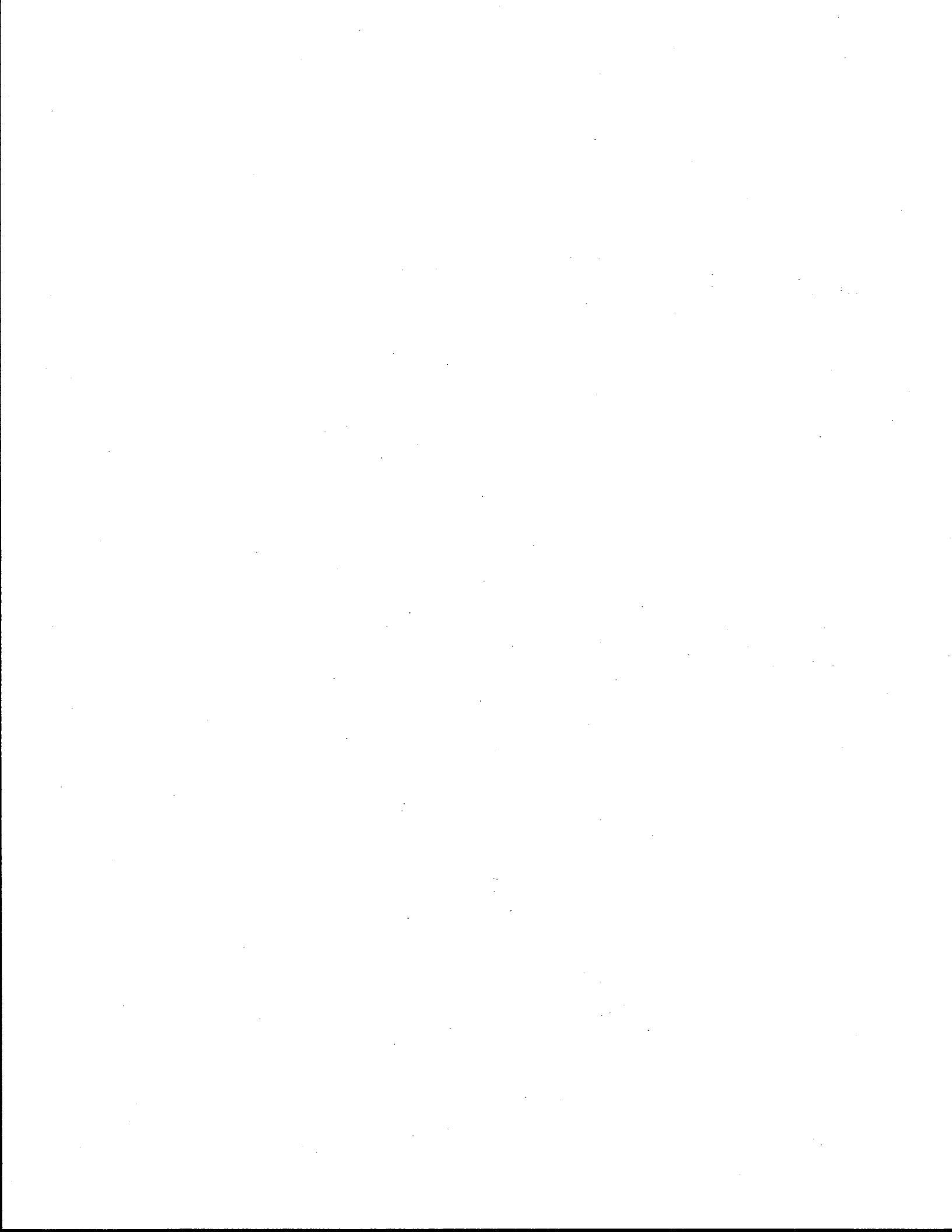
1. Cone spacing should be reduced at the ramp.
2. A "shadow truck" should be placed in the closed lane(s) between the entrance ramp and work crew.
3. A flagman or policeman may be stationed at the ramp as needed.
4. Standard advance warning signs must be used upstream from the lane closure.
5. Where traffic volumes, speeds, sight distance or other such factors may warrant an acceleration lane and where an acceleration lane will not infringe upon the work area, it may be desirable to delineate an acceleration lane with channelizing devices to allow entering traffic a lane in which to gain speed.

Figure 10. Typical Traffic Control at Work Area Entrance Ramp

A "shadow truck" should be parked in the closed lane(s) between the ramp and work crew to protect the work crew from errant ramp vehicles. Barricades may also be placed just downstream of the ramp in the closed lane(s) to discourage ramp traffic from driving in the closed lane.

A ROAD WORK AHEAD sign should be placed on all work area entrance ramps to warn ramp users of the work activity. Additional signs (e.g., advisory speed zone signs, FLAGMAN AHEAD sign, etc.) may also be used when appropriate.

In particularly hazardous or confusing situations, a flagman or policeman may be stationed at a work area entrance ramp. This individual can direct drivers onto the mainlanes, keep vehicles out of the work area, and maintain traffic control devices. He or she can also help close the entrance ramp temporarily if required by the work activity or to control traffic flow through the work zone.



FRONTAGE ROAD TRAFFIC OPERATIONS

Diversion to the Frontage Road

At many freeway work zones, traffic which normally uses the mainlanes is diverted to the frontage road. This diversion can be forced by entrance ramp closures or freeway closure. It can also occur "naturally" as drivers seek the best travel route past a congested work area. In either case, the additional traffic on the frontage road can result in safety and operational problems which cannot be overlooked.

Natural Diversion

Whenever a freeway work activity results in mainlane congestion, some drivers will use the frontage road (if one exists) to by-pass the work zone (4). This is referred to as "natural diversion". Natural diversion may involve either mainlane or entrance ramp traffic. In the case of mainlane diversion, freeway traffic exits from the mainlanes and uses the frontage road to avoid driving through a congested work zone. In the case of entrance ramp diversion, normal ramp users elect to remain on the frontage road rather than enter the congested mainlanes.

The amount of natural diversion is hard to predict for a given situation because it is influenced by several factors including:

1. The perceived amount of congestion (e.g., the anticipated difference in travel times on the mainlanes and frontage road).
2. Driver familiarity (e.g., familiar drivers may be more inclined to divert).
3. Driver destination and trip length.
4. Continuity of the frontage road.

Natural diversion usually is a desirable phenomenon since it tends to balance demand with available capacity on the mainlanes and frontage road. The location of natural diversion (exit and entrance ramps) will depend on the location of the work zone queue. Natural diversion may be encouraged by placing advance work zone signing (i.e., ROAD WORK AHEAD) upstream of any congestion which may develop or on work zone entrance ramps. Natural diversion normally affects familiar drivers who do not, under normal circumstances, need guidance information to find their way along the frontage road route.

Entrance Ramps

Whenever large volumes of traffic are diverted to a frontage road, special problems can occur on the frontage road at entrance ramps. There are two major problems. The first concerns drivers' uncertainty of which entrance ramp(s) to use to reenter the freeway. The problem that arises is that most drivers will travel on the left side of the frontage road. Since the right lanes are not used to their full potential, the frontage road capacity will be much lower than their capability. Thus, longer queues and higher delays will result. As mentioned previously, advance signing can be used to designate these ramps. In addition, special signs may be placed at the ramp(s). Figure 11 shows an example of special signs used in District 12 for this purpose.

Another problem which occurs at entrance ramps involves the lack of ramp capacity to handle all the frontage road traffic desiring to enter the freeway. Lack of entrance ramp capacity where traffic is reentering is a particular problem during complete freeway closures. To provide additional ramp capacity in these situations, drivers can be encouraged by special signing to use more than one entrance ramp. An example of a typical signing message for this purpose is as follows:

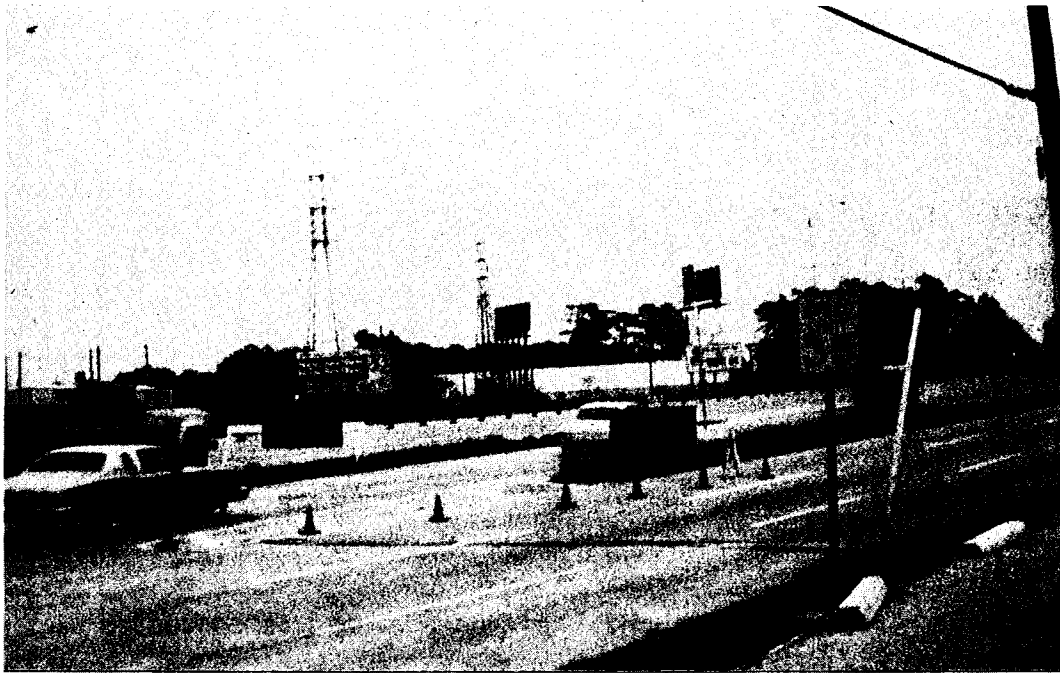


Figure 11. Signs Used to Designate Proper Entrance Ramps for Access to the Freeway

ENTER FWY
NEXT 2 RAMPS

OR

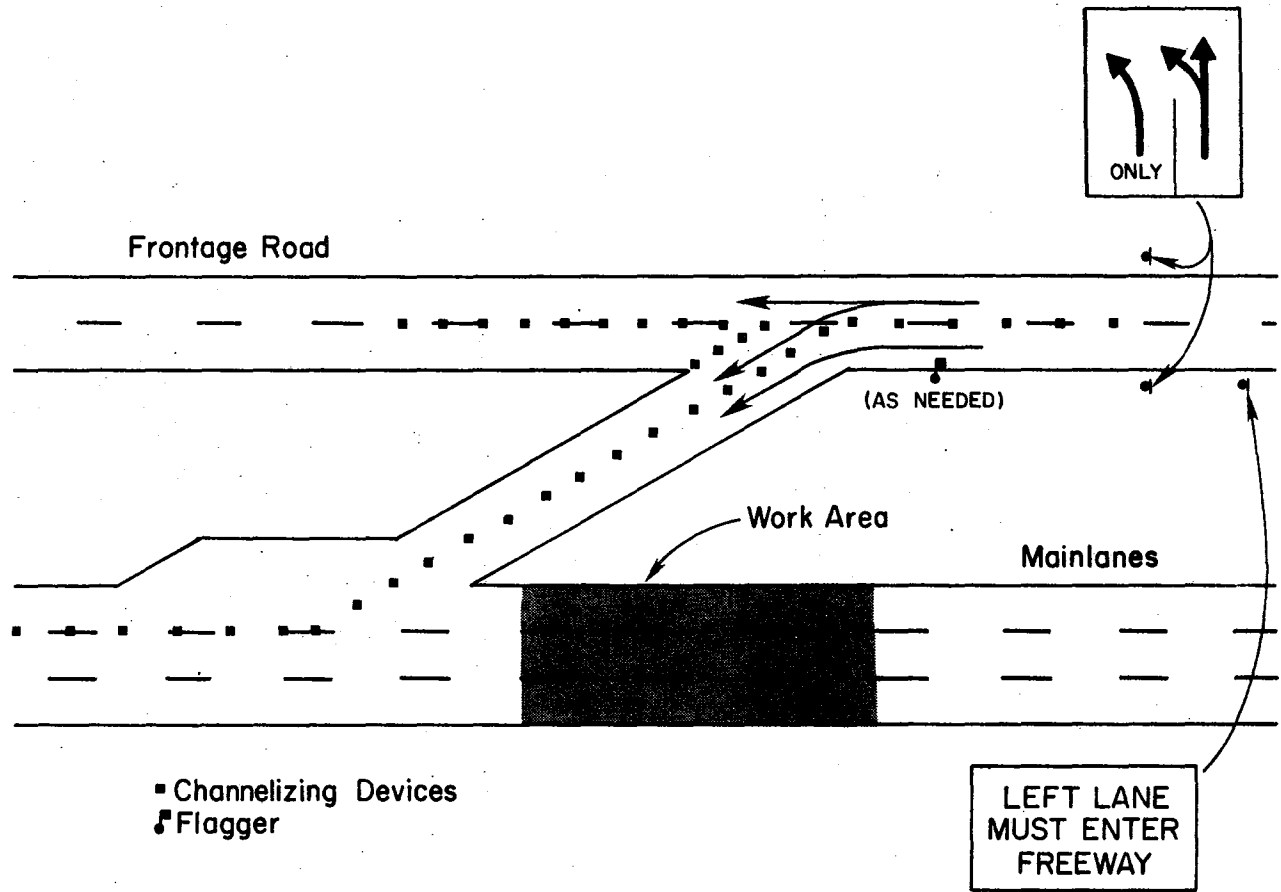
ENTER FWY
AT
PINE AND OAK STS

Entrance ramp capacity may also be increased by temporarily providing two entry lanes at a single lane ramp, provided the ramp is at least 18 to 20 feet wide. If this strategy is used, appropriate signs and channelizing devices should be installed (see Figure 12). Signs alone will not encourage effective dual usage of a single lane exit ramp. It may also be desirable to station a flagman or policeman just upstream of the entrance ramp to help alert drivers to the unusual situation and to maintain the traffic control devices.

Exit Ramps

During freeway maintenance activities, problems can also occur on the frontage road at exit ramps. One of these problems involves exit ramp capacity. Under the most favorable circumstances, only about 1800 vehicles per hour (VPH) can use a single lane exit ramp. If the frontage road is congested at the ramp, the capacity may be much lower. Exit ramp capacity is particularly critical during a total freeway closure. To maximize exit ramp capacity, the frontage road should be kept clear of congestion near the ramp. This may require that one or more frontage road intersections be controlled by a policeman or flagman or that frontage road traffic signals be temporarily re-timed to accommodate the heavy frontage road volumes.

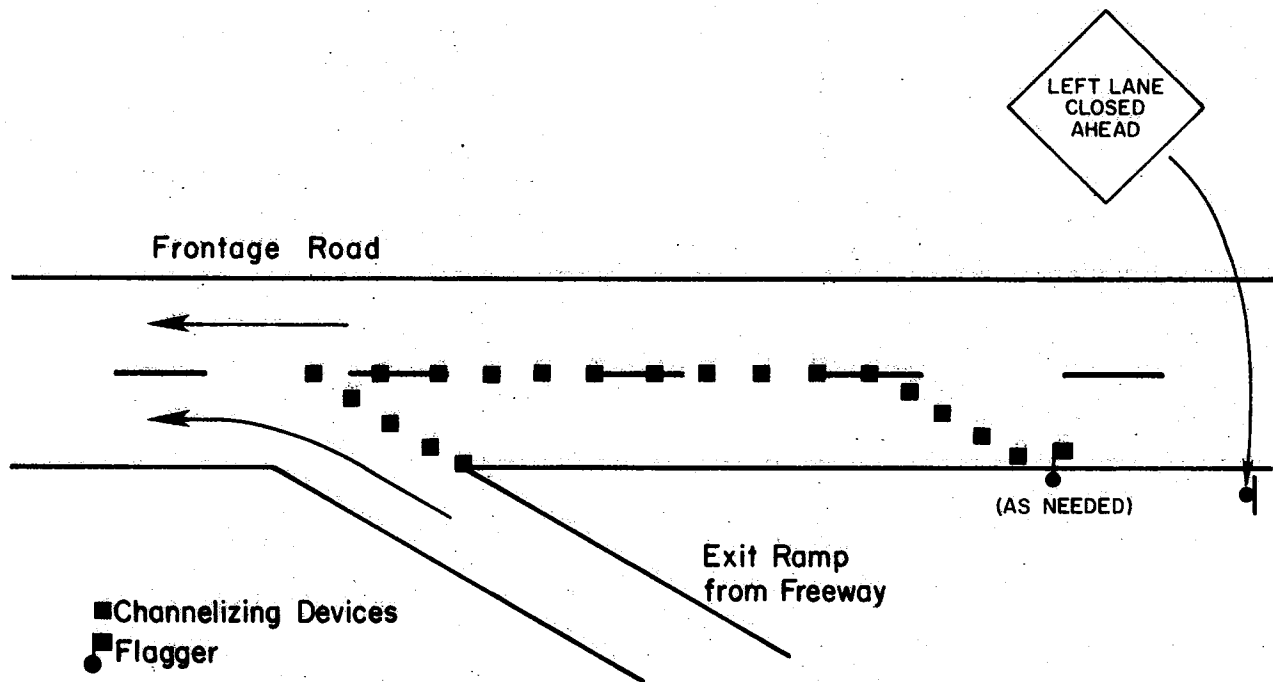
Exit ramp capacity may also be increased and frontage road operations improved by providing a "free lane" on the frontage road for exit ramp traffic. Figure 13 illustrates this traffic control approach. This approach is especially desirable for complete freeway closures since a freeway closure usually involves diverting relatively large volumes of mainlane traffic to the frontage road at one or more exit ramps.



Notes

1. Temporary pavement markings may be used in place of the channelizing devices.
2. A flagman or policeman may be stationed at the ramp as needed.

Figure 12. Providing Two Lanes at a Single-Lane Entrance Ramp



Notes

1. A flagman or policeman may be stationed at the ramp as needed.
2. This approach may not be practical if the exit ramp is very close to a frontage road intersection since weaving problems can result.

Figure 13. Providing a "Free Lane" on the Frontage Road for Exiting Traffic

In situations where a single exit ramp will not handle all the diverted mainlane traffic (e.g., complete freeway closure), drivers should be encouraged to use two or more exit ramps. Figure 14 illustrates this traffic control approach.

Frontage Road Intersections

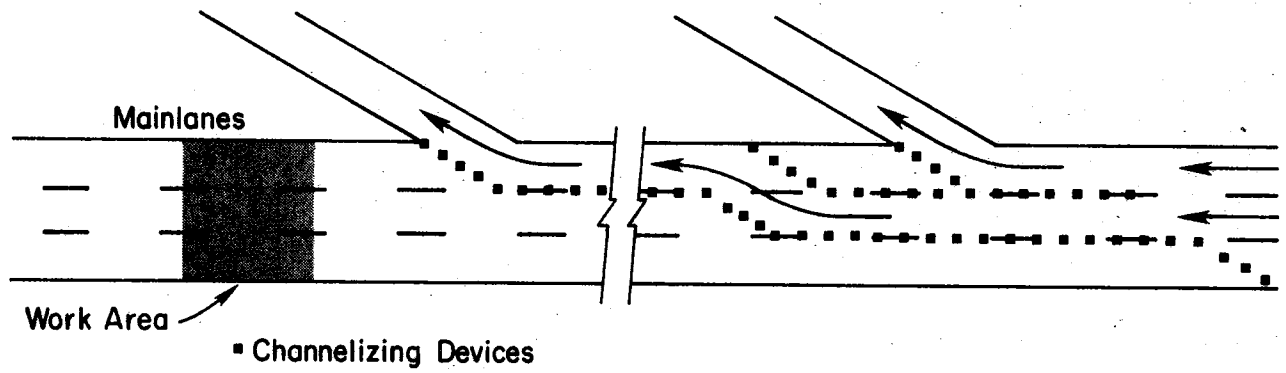
Signalized and stop sign controlled frontage road intersections generally limit frontage road capacity. During freeway work activities, the control at these intersections may need to be modified (e.g., re-time traffic signals or police or flagmen control of intersection movements) to obtain needed frontage road capacity.

Parking

Parking in the right lane of a frontage road should be prohibited during freeway work activities if frontage road capacity is a problem. Temporary signs may be used for this purpose if there is not permanent signing. (Normally, parking is prohibited on urban freeway frontage roads.) The cooperation of local police should be sought to enforce parking restrictions and remove illegally parked vehicles promptly.

Advance Notification

Frontage road traffic may be notified in advance of a work activity using special signs or some other method. Advance notification is particularly critical when traffic conditions on a frontage road will be drastically altered (e.g., complete freeway closure or closure of several entrance ramps).



Note

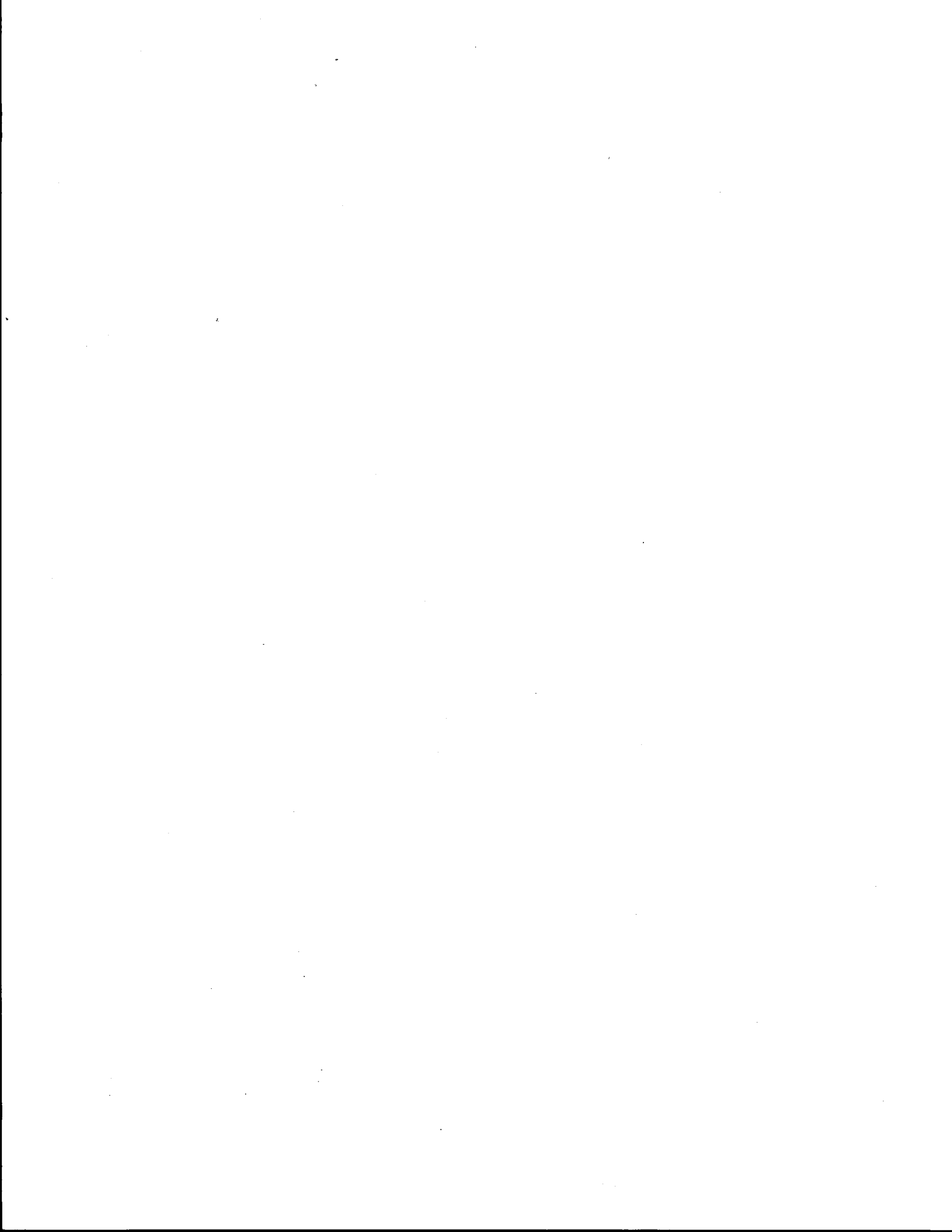
Appropriate signing, arrowboards, etc., should be installed at work zone, depending on site conditions.

Figure 14. Encouraging Diversion at Two Exit Ramps During a Freeway Closure

Lane Use

Drivers diverted to a frontage road may be hesitant to use the right lane(s) on the frontage road, particularly if they are uncertain about where to enter the freeway. The drivers fear that if they use the right lane(s), they may be trapped and unable to reach the open entrance ramp. This lane use problem can reduce the effective capacity of a frontage road as long queues will develop in the left and center lanes at frontage road intersections.

To alleviate this problem, signing may be placed along the frontage road to inform drivers where they may reenter the freeway. If most of the frontage road drivers are familiar drivers, the signing messages can refer to a particular downstream entrance ramp (e.g., ENTER FREEWAY/AT PINE STREET). On the other hand, if there are many unfamiliar drivers on the frontage road, the signing messages should use specific distance descriptions (e.g., ENTER FREEWAY/ AT PINE ST/2 MILES AHEAD). Conventional signs or changeable message signs can be used to display the messages.



GENERAL TRAFFIC MANAGEMENT CONSIDERATIONS

Advance Notification

Freeway work activities can have a very negative effect on the motoring public, especially if long delays result. To help minimize the negative effects and improve public reaction, motorists should be notified of work activities in advance whenever possible. With proper advance notification, motorists will have the opportunity to use different routes or postpone their trips. They may also be more alert and less frustrated as they travel through the work zone.

Advance notification is desirable for all freeway work activities; however, it is most critical for those activities which result in detours, ramp closures, and/or long delays. Advance notification should also be given of work activities performed at unusual times (e.g., night work or weekend work).

Motorists can be given advance notification of a planned work activity in many ways, including newspaper releases, radio and television reports, and special signing. In any case, advance notification should be coordinated through a single office and directed by a single individual (e.g., the District Public Affairs Officer). This will help assure that the proper information about all work is disseminated in a timely and appropriate manner. It is important that the same office be informed of changes in scheduled work activity so that the public can be notified of these changes as appropriate. This is essential to maintain motorist credibility.

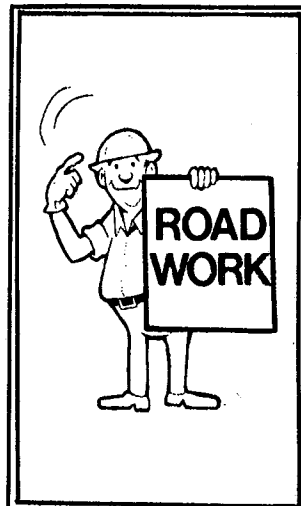
Newspaper releases announcing scheduled work activities are fairly common around the State. An example of a newspaper release is presented

in Figure 15. Typically, a newspaper release will give the location, date, and time of the work activity, as well as a description of the work and work zone traffic control strategy (e.g., number of closed lanes). In critical cases, a newspaper release may also suggest alternate routes. Generally speaking, newspaper releases must be general in nature since many readers will not be affected by the work and considerable time passes between the time that a release is read and a motorist actually enters the work area.

The same types of information that are given in newspaper releases can be presented in commercial radio and television reports. However, radio and television reports are used less commonly. Commercial radio broadcasts can also be used to present real-time information about work zone conditions (e.g., length of queue or delay), provided there is some means of surveillance at the work zone. The radio broadcasts, however, will only reach some of the work zone drivers.

One of the most effective means of advance notification is to use special signs at the work zone to present the advance information about the work activity. An example of advance notification signing is shown in Figure 16. Such signing may be installed several days before the scheduled work. Messages giving the location, date, and time of the work, and a description of the work and traffic control can be presented. Alternate routing can also be displayed as needed.

Advance notification signing is very effective because it gets timely information to those drivers who will be affected by the work activity. Sign messages can give very specific information directed at a select audience on the mainlanes, frontage road, or ramps.



The Texas Department of Highways and Public Transportation says travel on Houston-area freeways Thursday will be affected, weather permitting, by the following projects:

U.S. 59 (Southwest Freeway) northbound at Richmond exit — One lane on each side will be blocked from 9:30 a.m. to 2:20 p.m. for barrel-site repair.

Interstate 45 (North Freeway) northbound from Rankin to FM 1960 — One inside lane will be blocked from 7 a.m. to 3 p.m. for pavement overlay.

Figure 15. Typical Newspaper Release



Figure 16. Advance Notification Sign

One problem that has been observed at many work zones is the use of advance notification sign messages that are too long. These messages should normally have no more than 4 lines of text nor more than 8 words (assuming each word has 4 to 8 characters). Longer messages may be used, however, if the sign is placed at an intersection where drivers have longer reading times. A discussion of message requirements for advance notification signing is presented in Reference 5.

Traffic Control Coordinator

The conditions at a freeway work zone constantly change and it is difficult to predict them in advance. Therefore, it is important to have a person at the jobsite to monitor the conditions and implement appropriate traffic control measures as needed.

This individual, called a "Traffic Control Coordinator," should be trained in work zone traffic control and have a basic knowledge of traffic engineering and traffic flow concepts. He or she should be at the jobsite for the duration of the maintenance activity and should have the responsibility and authority to observe traffic and work conditions and implement appropriate traffic control measures as needed.

Since freeway maintenance activity can affect a large area, the Traffic Control Coordinator should drive through the work area on the mainlanes and frontage roads in both directions of travel. He/she should observe and assess the traffic conditions on these facilities. He/she should also identify any capacity or safety problems which exist. The Traffic Control Coordinator should determine the length of mainlane and frontage road queues and estimate delays on these facilities.

Based on observed conditions, the Traffic Control Coordinator should open or close entrance and exit ramps, position flagmen, call for police help, change the traffic control approach, etc. as needed. The Traffic Control Coordinator should have radio communication with the work and signing crews.

Traffic Control Specialist

In the urban freeway environment, flagmen perform a variety of critical and somewhat unique traffic control functions, including the following:

1. Direct traffic through complicated work zones or at work area ramps.
2. Close entrance or exit ramps.
3. Control traffic at frontage road intersections.
4. Prevent illegal freeway access.
5. Alert traffic to special signing.
6. Maintain traffic control devices.
7. Slow mainlane traffic.

In order to reflect their expanded roles, they should be referred to as "Traffic Control Specialists."

These Specialists should be used only when needed and where needed. Normally, they are best utilized at ramps and at frontage road intersections. An example of a Traffic Control Specialist directing frontage road intersection traffic is shown in Figure 17. Their use on the mainlanes should be limited to special situations, since they may have difficulty conveying messages to high speed freeway traffic in several freeway lanes.

Traffic Control Specialists should be supervised and directed by the Traffic Control Coordinator. Their effectiveness and safety may be enhanced if they wear special clothing, such as white overalls, orange vests and

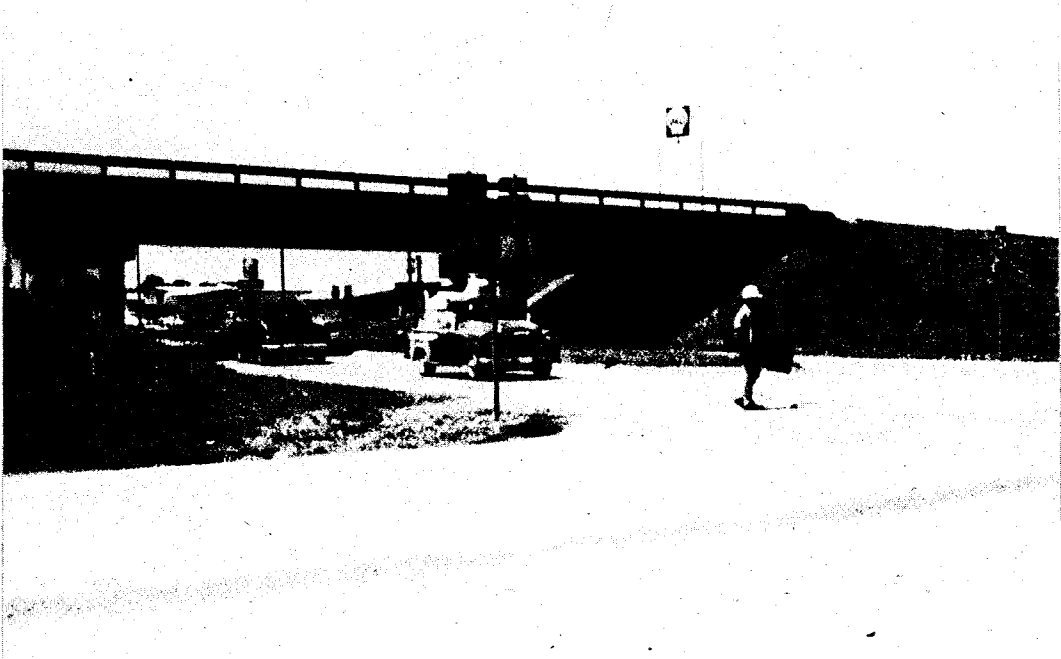


Figure 17. Traffic Control Specialist at Frontage Road Intersection

hardhats (6). The special clothing will make them more visible and may increase their credibility.

It should be mentioned that motorists do not fully understand all of the standard flagging signals recommended for use in the Texas Manual on Uniform Traffic Control Devices (2). In particular, signals using only a flag (no hand motion or sign paddle) should be avoided on freeways since their meaning is not generally understood by drivers (7). There is a need for developing more effective control signals for use at freeway work zones.

Use of Police

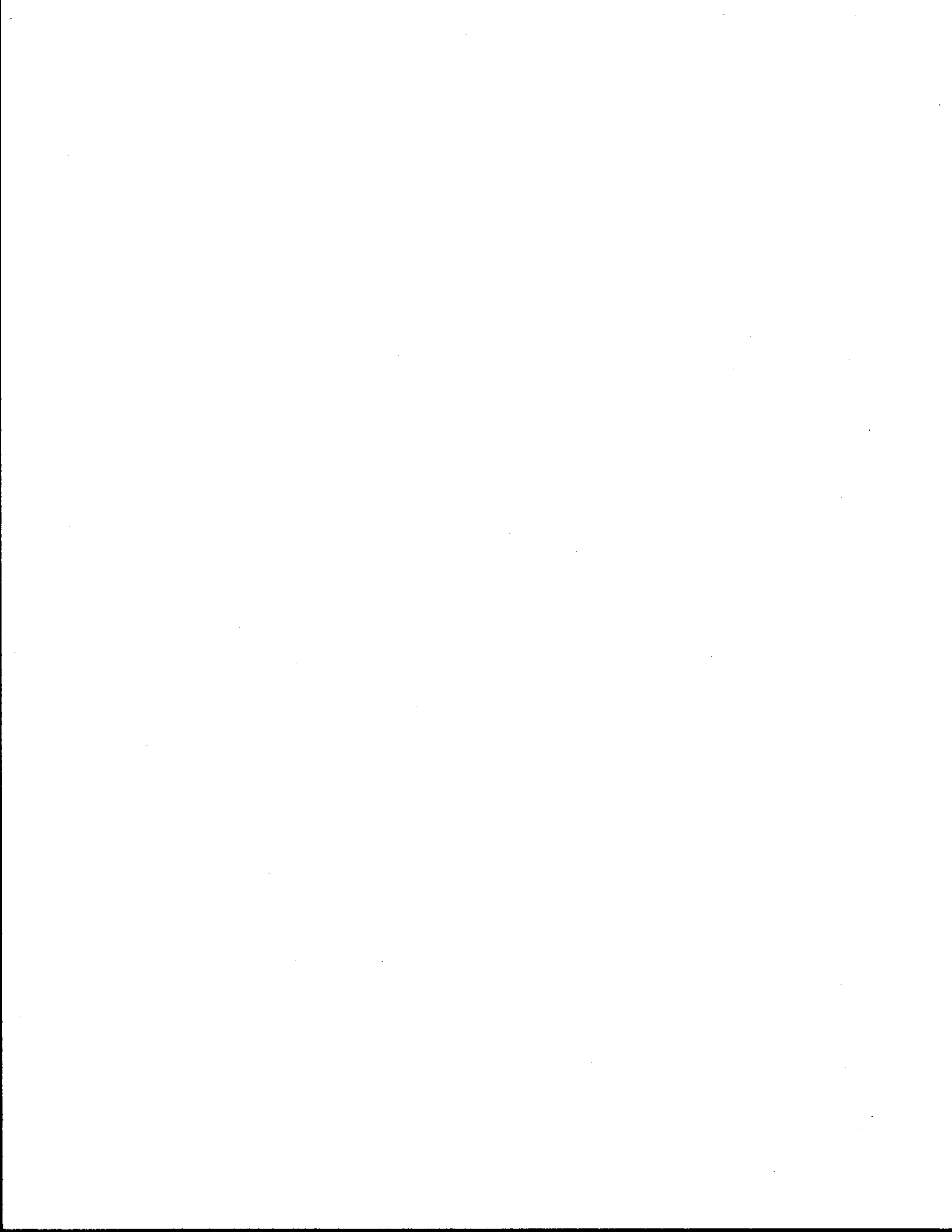
During freeway maintenance activities, police can provide vital traffic control services. The mere presence of a uniformed policeman and/or marked police vehicle at a work zone may increase driver alertness and obedience to traffic control devices and thereby enhance work zone safety and traffic flow. Police can control frontage road intersections and prevent illegal access to the freeway. They can also enforce no-parking zones and clear stalled or wrecked vehicles.

It is critical that a spirit of cooperation be established between the Districts and local police agencies. Regular communication channels should be established. The police agency should be notified of all freeway maintenance activities, even if police help is not sought. This notification can be handled by the same office handling press releases and advance notification.

When police are used at work zones to direct or control traffic, their activities should be coordinated with the work activity, flagmen, etc., by

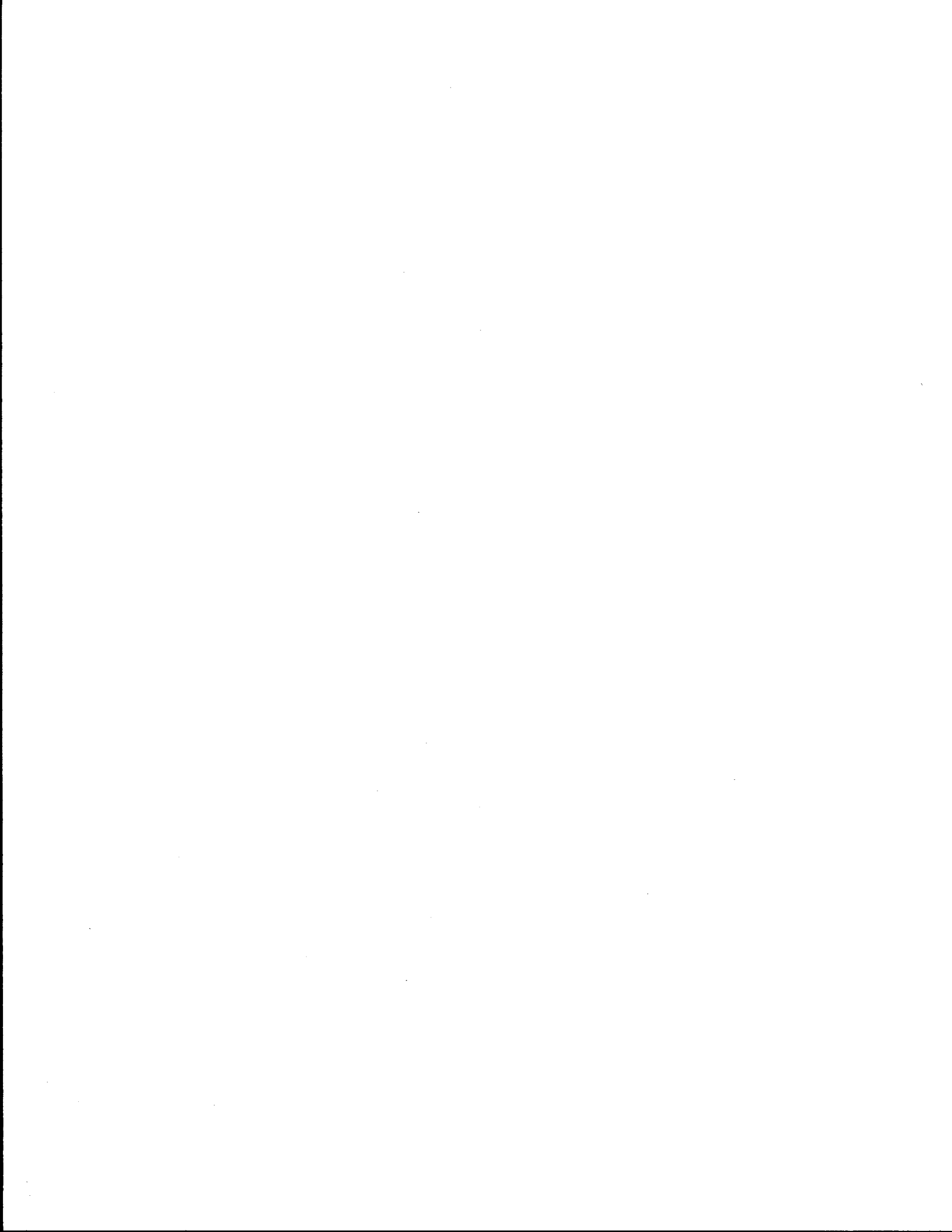
the Traffic Control Coordinator. The Traffic Control Coordinator should have regular communication with the police at the work zone to exchange information about traffic and work conditions and respond to special problems.

Currently, some police agencies assign a low priority to work zone traffic control. Obtaining the cooperation of these agencies may be difficult. In these situations, "off-duty" policemen can be hired to direct or control work zone traffic as needed. This practice may be very expensive, however.



REFERENCES

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2. Texas Manual on Uniform Traffic Control Devices for Streets and Highways. Texas State Department of Highways and Public Transportation, Austin, Texas, 1980.
3. C. L. Dudek and S. H. Richards. Traffic Capacity Through Work Zones on Urban Freeways. Texas Transportation Institute, Report No. 228-6, April 1981.
4. J. D. Carvell, J. M. Turner, C. L. Dudek. Human Factors Requirements For Real-Time Motorist Information Displays, Vol. 15 -- Freeway Incident Management Field Studies. Texas Transportation Institute, Report No. FHWA-RD-78-19, August 1978.
5. C. L. Dudek, et al. Human Factors Requirements for Real-Time Motorist Information Displays, Vol. 1 -- Design Guide. Texas Transportation Institute, Report No. FHWA-RD-78-5, September 1978.
6. R. G. Biggs. Traffic Handling Around Maintenance Activities on Freeways. Texas State Department of Highways and Public Transportation, Report No. SS5.3, July 1975.
7. S. H. Richards, N. D. Huddleston, and J. D. Bowman. Driver Understanding of Work Zone Flagger Signals and Signaling Devices. Texas Transportation Institute, Report No. FHWA/TX-81/18+228-3, January 1981.



APPENDIX

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³

TEMPERATURE (exact)

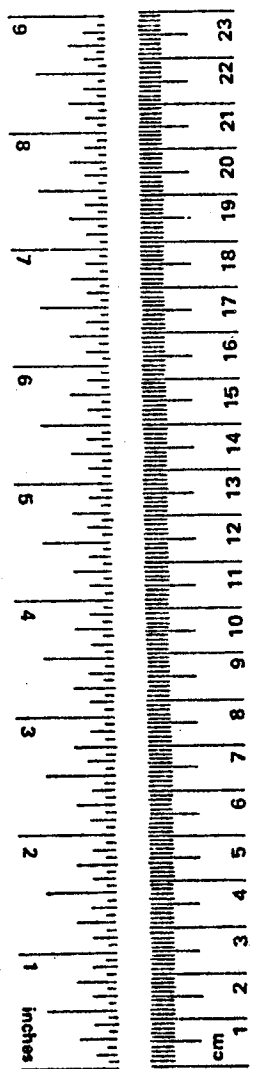
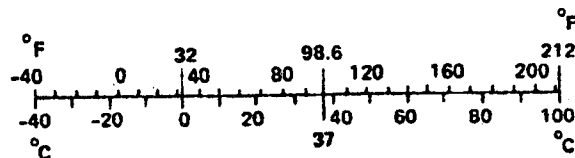
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F
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* 1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10:286.

