Chapter 5 Work Zone Traffic Control

5-1 General

Effective temporary traffic control strategies allow all road users to successfully maneuver through or around work areas while still permitting needed work to be completed efficiently and economically. The following goals apply to work zones:

- Give safety highest priority for both highway workers and traveling public
- Manage congestion to maintain mobility through and/or around work zones
- Be cost effective with resources taxpayers and legislature entrust to us.

Work zone traffic control planning needs consideration early, as it greatly impacts *how* and *what* work is completed. Work zones are interdependent with design, construction, maintenance, and traffic operations; what happens to one affects the others. The better we understand these interactions, the more successful and cost effective projects will be.

There is no "cookbook" solution to all work zones; solutions require innovation, adaptation, and ingenuity. Work zone design and operation is as much art as science.

Properly mitigating work zone impacts to all road users is a critical component in the successful design, construction, maintenance, and operation of a fully functional highway system and is required by federal regulations and state policy.

Road users include, but are not limited to:

- Pedestrians, including those with disabilities
- Bicyclists
- Motorists, including motorcyclists
- Commercial Vehicle Freight operators, including oversized/overweight permitted vehicles
- Transit operators and users

5-2 Federal and State Laws Applicable to Work Zones

Work zones are subject to numerous federal laws, state laws and codes, and standards that are critical to understand:

A. Federal Laws

23 CFR Part 630 J focuses on work zone **standards**, **policy**, and **processes**:

- The *Manual on Uniform Traffic Control Devices* (currently 2009 MUTCD) is the national standard for traffic control on all public roads
- States shall develop policy to systematically consider and manage work zone impacts
- All **significant** projects shall have Transportation Management Plans unless the Federal Highway Administration (FHWA) grants an exception based on the State's ability to show a specific project will not have sustained work zone impacts.
- States shall perform a work zone process review at least every two years

23 CFR Part 630 K focuses on work zone **design** and **implementation**:

- Maintain quality and adequacy of all temporary traffic control devices
- Manage work zone exposure and reduce the risk of fatal crashes or injuries to workers

Public Rights-of-Way Accessibility Guidelines (PROWAG) cover temporary work zone pedestrian facilities located within the public right-of-way and are recommended best practices at this time.

B. State Laws and Codes

Important Washington laws applicable to work zones are listed below and include a brief description in parenthesis:

- RCW 46.04.200 (Hours of Darkness definition)
- RCW 47.36.030 (Signs, signals, and banners over roadway requirements)
- RCW 47.36.200 (Motorcycles Use Extreme Caution sign requirements)
- RCW 47.48.010 (Roadway closure, restrictions, & reduced speed limit authority)
- RCW 47.48.020 (Roadway closure, restrictions, & reduced speed limit notification requirements)
- RCW 46.61.527 (Work Zone Traffic Fines)
- WAC 296-155-305 (Flagging Requirements, 4-Sign Requirement for ≥ 45 mph)

Washington has adopted the MUTCD; however, specific work zone-related MUTCD sections have been modified as listed below and include a brief description in parenthesis:

- WAC 468-95-017 (Traffic Control Devices & Engineering Judgement)
- WAC 468-95-045 (Speed Limit Signs & Radar Speed Display Signs)
- WAC 468-95-075 (Higher Fines Signs & Plaques)
- WAC 468-95-190 (Pavement Markings: Edge Line Requirements)
- WAC 468-95-205 (Supplemental Raised Pavement Markers)
- WAC 468-95-210 (Raised Pavement Markers Used As Broken Lane Lines)
- WAC 468-95-300 (Temporary Sign Spacing Table)
- WAC 468-95-301 (Maximum Channelization Device Spacing Table)
- WAC 468-95-3015 (Traffic Signal Display Requirements When Flagging)
- WAC 468-95-302 (Single Flagger In Center of Intersection Prohibited)
- WAC 468-95-305 (Motorcycles Use Extreme Caution Sign)
- WAC 468-95-306 (Motorcycles Use Extreme Caution Supplemental Plaque)
- WAC 468-95-307 (Abrupt Lane Edge Warning Sign)
- WAC 468-95-310 (Temporary Pavement Markings)

5-3 Work Zone Standards, Content & Resources

A. *Manual on Uniform Traffic Control Devices* (MUTCD)

Per federal code, the current revised 2009 MUTCD edition is approved by the Federal Highway Administration (FHWA) and recognized as the national standard for traffic control on all public roads. Part 6 of the MUTCD focuses on temporary traffic control.

B. PROWAG 2005

The PROWAG guidelines are currently recommended best practices for pedestrian facilities within public right-of way. When formally adopted by the Department of Justice, PROWAG will become enforceable standards.

C. WSDOT ADA Guide for Accessible Public Rights of Way

WSDOT, in collaboration with FHWA, developed the WSDOT ADA Guide for Accessible Public Rights of Way as a field guide reference to be used by professionals when evaluation accessible pedestrian features, including in work zones, reflecting PROWAG best practices.

D. WSDOT *Standard Specifications*

The WSDOT *Standard Specifications* are legal and enforceable language for WSDOT Contracts and when incorporated into local agency construction projects receiving FHWA federal funding. These specifications include requirement, measurement, and payment information and may specify work zone standards that exceed requirements in the MUTCD.

The following sections are the most relevant to work zones:

- 1-07.8 *High-Visibility Apparel*
- 1-07.23 *Public Convenience and Safety*
- 1-10 *Temporary Traffic Control*
- 8-23 *Temporary Pavement Markings*
- 9-34 *Pavement Marking Material*
- 9-35 *Temporary Traffic Control Materials*

E. WSDOT *Traffic Manual*

This chapter focuses on **work zone traffic operation strategies** and the Transportation Operations component of the Transportation Management Plan. This chapter is not an all-encompassing, comprehensive work zone guide; other manuals apply as well.

F. WSDOT *Design Manual* M 22-01

Chapter 1010 focuses on work zone design topics and Transportation Management Plans for construction projects. Chapter 1610 focuses on traffic barriers. Chapter 1620 focuses on impact attenuator systems.

G. WSDOT *Work Zone Traffic Control Guidelines for Maintenance Operations* M 54-44

The WSDOT M 54-44 Manual focuses on temporary traffic control for **maintenance**, **utility**, and **developer operations of 3 days or less**. The WSDOT M 54-44 Manual is not for use in WSDOT Contracts. Typical traffic control plans for use in projects can be found at the WSDOT Typical Traffic Control Plan Library as discussed below.

H. WSDOT *Work Zone Typical Traffic Control Plans*

The WSDOT Typical Traffic Control Plans library provides generic traffic control plans that have been furnished as a guide to be used with good engineering judgement. Typical traffic control plans may be modified or used with additional project-specific or site-specific traffic control plans for unique conditions or roadway configurations.

All WSDOT Typical Traffic Control Plans must be accepted prior to use in the field. Each WSDOT Region will determine personnel with acceptance authority.

I. WSDOT *Sign Fabrication Manual*

The WSDOT *Sign Fabrication Manual* assists sign fabricators by providing sign layouts for official highway signs, both permanent and temporary, depending on the sign's size.

All signs have a unique naming convention based on the MUTCD.

J. Quality Guidelines for Temporary Work Zone Traffic Control Devices

The 2017 Edition of the ATSSA *Quality Guidelines for Temporary Work Zone Traffic* is available for purchase and is used, per *Standard Specifications* 1-10.2(3), by the Engineer to determine signs and traffic control devices are acceptable, marginal, or unacceptable.

K. MASH-2016 & NCHRP-350 Hardware Eligibility Letters

Crashworthy eligibility letters for hardware devices, including work zone traffic control devices, meeting MASH-2016 crashworthy requirements is provided by the FHWA. In addition, archived NCHRP-350 letters are also available (link provided in paragraphs at top of each webpage).

There are five categories of devices:

- Longitudinal Barriers and Bridge Rails
- Barrier Terminals and Crash Cushions
- Sign Supports, Mailboxes, and Delineator Posts
- Luminaire Supports
- Work Zone Devices

5-4 WSDOT Region, Region Traffic Operations, and Headquarter Traffic Roles and Responsibilities

"WSDOT Region" includes all offices except the Region Traffic Operations. The following roles and responsibilities are typical guidelines. Each Region may further define or redistribute roles and responsibilities so verify responsibilities with each Region's Traffic Office:

A. Typical WSDOT Region Responsibilities

- Identify work zone safety and mobility impacts during scoping, Design, or major maintenance operations to develop a Work Zone Strategy Statement
- Develop a Transportation Management Plan (see *Design Manual* Chapter 1010)
- Develop and obtain approval for WSP Task Orders
- Implement work zones for individual projects, including appropriate impact mitigation strategies with respect to region mobility and coordination
- Coordinate with Freight Transportation, Commercial Vehicle Services, and Public Transportation divisions, and local agencies when applicable
- Inspect traffic control operations and modify when necessary to address site- specific conditions for safety and mobility

B. Typical WSDOT Region Traffic Operations Responsibilities

- Review and approve Transportation Management Plans & Work Zone Strategy Statements
- Review and accept traffic control plans during the project PS&E phase
- Provide assistance to Project Engineering Offices upon request
- Coordinate with Freight Transportation, Commercial Vehicle Services, Public Transportation divisions, and local agencies when applicable
- Collaborate with Construction, Maintenance, and Communications departments for scheduling, implementing, and notifying the traveling public of high-profile closures
- Approve/review work zone speed limit reductions and advisory speeds (Section 5-18)
- Perform work zone traffic analysis (Section 5-9) to determine closures, their permitted hours, and work with TDGMO to determine interim liquidated damages (Section 5-14)
- Perform periodic review of active work zones
- Perform FHWA work zone process reviews with HQ Traffic Operations, region Project Engineering Offices, Maintenance, other divisions, and other agencies as appropriate

C. WSDOT Headquarters Traffic Operations Responsibilities

- Develop and update work zone-related policy, standards, and guidance
- Provide traffic control training for agency employees
- Maintain a library of typical traffic control plans for Region use
- Provide work zone traffic analysis assistance upon request
- Lead the FHWA work zone process reviews with Region Traffic Operations
- Approve unique work zone speed limit reductions (Section 5-18)

5-5 Work Zone Principles & Considerations

1. **Guide all road users in a clear, positive, and safe manner** through or around work zones utilizing sufficient signage, delineation, and channelization. Work zones should be "self-explanatory" to road users the maximum extent feasible. Abrupt, unexpected changes in roadway geometrics should be avoided.

2. **Consistent and proper installation of temporary traffic control devices to optimize road user expectancy and compliance** which enhance work zone safety and improve mobility.

3. **Remove traffic control devices when they are no longer applicable**, otherwise they may be soon disregarded.

4. **Avoid placing traffic control devices that inhibit movement of other road users** unless accommodations are provided.
   - Maintain a clear temporary pedestrian accessible route of at least 48 inches in width or use 7-foot minimum mounting height when it is necessary to place traffic control signage within the limits of existing sidewalks

5. **Separate decision points**; avoid having road users react to two events at the same location.
   - Avoid lane closure tapers adjacent to merging on-ramp traffic due to conflicting merges
   - Avoid lane closure or lane shift tapers within limits of horizontal curves

6. **Consider positive protection devices whenever practical.** Positive protection devices enhance safety for both road users and workers by using physical barriers not easily penetrated by errant vehicles, such as transportable attenuators or temporary barriers.

7. **Design work zones to operate in a manner consistent with the desired target speed dependent upon desired mobility, operation, and safety objectives.**
   - Per MUTCD, drivers reduce their speeds only if they clearly perceive a need to do so
   - Avoid reductions greater than 10 mph below the existing speed limit unless a unique, restrictive condition is present. Work crews should also be present
   - Avoid "overdesigning" work zones (e.g. using a lane closure taper designed for 60 mph when a 45 mph work zone speed limit is posted)
   - All work zone speed limit reductions shall be approved per Secretary's Executive Order E 1060.02 and in compliance with Project Delivery Memo #19-01

8. **Manage adverse work zone impacts to road users overall while balancing the need to efficiently, economically, and safely complete work.**
   - Regions may decide to implement closures with high traffic impacts occurring over shorter durations (days) versus traditional methods with lower traffic impacts occurring occur over several months or years. In particular, these aggressive closure strategies are justified when there are substantial benefits that more than offset the adverse traffic impacts including significant reduction in working days, considerable cost savings during construction, and enhanced safety benefits for both road users and workers. For such closures, Region Administrator approval should be obtained.

9. **Maintain effective public relations starting early in Design and lasting throughout Construction phases for projects with high-impact closures.**
   - During planning, work closely with stakeholders and local agencies to understand their concerns and needs during these closures as well as obtaining their concurrence. This will aid in avoiding surprises with unplanned, lengthy delays.
   - Develop traffic closure, detour, and/or alternative route schematics for the public and media use to visually explain the limits of the closure and how to navigate through and around them.
   - Explain the anticipated work zone congestion and delays as well as what time of day they are expected.
   - Consider different outreach tools (news coverage, social media, WSDOT blogs)
   - Encourage alternative modes of transportation (carpools and public transit) and to delay trips to early morning/late evening hours to manage work zone congestion

5-6 Work Zone Mobility, Corridor, and Network Management

The traditional practice of only permitting closure hours with minimal traffic impacts is still desirable on many roadways, but is becoming increasingly less feasible or economical due to higher traffic volumes persisting later into the evenings and beginning earlier in the mornings on congested corridors. Per Secretary Executive Order E 1001.02, traffic delays should be minimized while the safety of workers and the traveling public be the highest priority. Thus, proactive work zone congestion management strategies are necessary to effectively complete work while still maintaining mobility and maintaining safety. Work zone mobility management should be a priority beginning early in Design and continuing throughout Construction.

First and foremost, it is important to understand actual work hours are significantly less than the closure hours. In other words, for work operations such as HMA paving, a permitted 5-hour closure may only result in 2.5 working hours. If not addressed, this may result in the project duration extending into two construction seasons, also known as "wintering over".

For the areas where reasonable duration of work shift is challenging to obtain, it may become necessary to select an extended closure duration resulting in congestion. Therefore, it is necessary to understand the following:

- When to avoid work zone congestion (Section 5-6.A)
- Work zone congestion management strategies (Section 5-6.B)
- Closure coordination along detours and alternative routes (Section 5-6.C)
- Detour route considerations (Section 5-6.D)

For detailed guidance for various extended closure strategies see the following:

- Extended Intermediate-Term Duration Closures (Section 5-7)
- Long-Term Duration Closures & Reconfigurations (Section 5-8)

A. When to Avoid Work Zone Congestion

Typical periods to avoid work zone congestion include certain times and events, such as the following:

- **During weekday AM/PM commutes & school hours**

  During weekday commutes there may be limited flexibility for alternative schedules or fewer discretionary trips, resulting in minimal traffic diversion and higher traffic impacts.

  Morning and evening commute periods vary significantly in time and duration depending on its specific location and are best determined by obtaining actual traffic volumes or conduct field observations. Be sure to take into account local operations such as work shift changes at major corporations, school and daycare traffic, or other events that generate traffic surges over a short duration.

  Without the availability of better data or information, then assume the following **weekday commute hours in congested, urban areas**:

  - AM Commute @ 4:00 a.m. to 10:00 a.m.
  - PM Commute @ 2:30 p.m. to 7:00 p.m.

Without the availability of better data or information, then assume the following **weekday commute hours in more rural areas**:

- AM Commute @ 5:00 a.m. to 9:00 a.m.
- PM Commute @ 2:30 p.m. to 6:30 p.m.

- **During Friday afternoons and Sundays on recreational routes**

  Recreational routes tend to experience much higher volumes on weekends, typically in the inbound direction Friday afternoons and the outbound direction on Sunday. Such roads include I-90 over Snoqualmie Pass, U.S. 2 over Stevens Pass, and SR109 between Ocean Shores and Aberdeen.

  Recreational periods vary significantly in time and duration depending on its specific location and are best determined by obtaining actual traffic volumes or conduct field observations.

- **During major regional special events**

  Major sporting events, concerts, fairs, etc. generate significant traffic volumes increases, typically up to two hours prior going towards the event (inbound) and up to two hours after existing the event (outbound). In contrast, all-day events tend to see increased volumes spread out over the day without the large "spikes" experienced with games or concerts.

- **During major statewide special events**

  Major special events can generate traffic across the state. Volumes on intrastate corridors such as Interstate 90 increase in one direction at the beginning of the weekend and then increase in the opposite direction at the end of the weekend.

- **During significant local special events**

  Significant local special events can generate large, but localized traffic impacts that need to be considered. Such events include runs, bike rides, or festivals.

B. Work Zone Congestion Management Strategies

When causing work zone congestion, detailed work zone traffic analysis needs to be performed by the Region Traffic Operations to determine anticipated delays and queues (Section 5-9) when determining closures, permitted closure hours, and working with TDGMO to determine the value of any interim liquidated damages.

The WSDOT Transportation Data, GIS & Modeling Office (TDGMO) can assistant Regions by providing work zone traffic analysis to help determine expected queuing and delays. Only TDGMO has the authority to determine the maximum interim liquidate damage values; Region Traffic Operations will assign the actual interim liquidated damage value for each closure based on the maximum allowable amounts determined by TDGMO (Section 5-14).

Based on the anticipated traffic impacts, additional work zone mobility, safety, and traffic demand management strategies may need to be considered:

- **Advanced Notification**

  Use Portable Changeable Message Signs (PCMSs) or Class A signs to provide notice at least one week notification in advance of closures with high traffic impacts.

- **Public Outreach**

  WSDOT Communications serves an invaluable role in reaching out to the general public and stakeholders. They serve as the "front-line" spokesperson for WSDOT by working with news media, utilizing social media, and responding to citizen inquires.

  Using their established relationships with various stakeholders (including local interest groups), it is valuable to obtain concurrence, or at least understanding, of high-impact closures during Planning and Design before projects go to Construction.

  During Construction, prior to the high-impact closures, WSDOT can collaborate with these stakeholders to help determine when high-impact closures occur to reduce adverse impacts as well as providing advanced notification.

- **WSDOT Traffic Management Centers (TMCs)**

  Utilizing their access to permanent variable message signs, Regional TMCs may provide advance notification for upcoming significant, high-impact closures and provide real-time information for major incidents and closure status. TMCs typically only provide supplemental messaging so critical messages (major incidents, silver alerts, blue alerts, etc.) can be displayed if necessary.

  During Design, working with Region Traffic Operations, collaborate with the TMC to determine to what extent these permanent systems can supplement the project's messaging methods (portable Highway Advisory Radio, PCMSs, etc.).

  During Construction, working with Region Traffic Operations, provide TMCs notification of upcoming of high-impact closures preferably two weeks in advance.

  On Active Traffic and Demand Management corridors (only present in the Northwest Region at this time), lane usage symbols and speed limits can be displayed in real-time to supplement the temporary traffic control closures.

- **WSDOT Incident Response Team (IRT)**

  Because capacity is already minimized in work zones, vehicle breakdowns or collisions can have significant adverse traffic impacts if not resolved quickly. IRT minimizes response times by collaborating with WSDOT TMC, police and emergency agencies, and towing companies to relocate or remove the blocking vehicles quickly.

  During significant high-impact closures, consider placing IRT and towing services (under IRT's direction) on standby in strategic work zone locations in the event disabled vehicles need to be quickly towed. See Section 5-16.E for details.

  During Design, engage IRT to determine anticipated costs and ensure reimbursement funding is provided for this operation via internal accounting methods. Verify necessary IRT staff is available and how they will be requested and utilized.

- **WSDOT Maintenance and Internal Staff Assistance**

  During major closures, advanced notification and closure notification signage may be necessary as far as 50 miles from the actual closure in isolated locations. An example of such a scenario would be a week-long closure of the Hood Canal Bridge where the shortest detour route is over 100 miles and 2½ hours.

Instead of arranging for Contractors to provide such services over such a vast area, an alternative approach is to arrange for the collaboration of several WSDOT Maintenance and/or IRT staff to perform duties in their own local areas. Ensure funding is available for reimbursement of services rendered via internal accounting methods.

- **WSDOT Signal Operations Assistance**

  During significant closures or detours, temporary adjustments to WSDOT- operated traffic signals may be necessary due to large increases in traffic along detour or alternative routes.

  Engage the Region's Signal Operations group during Design and then provide advanced notification in Construction preferably two weeks prior to the major closure. If needed, ensure funding is available for this operation for reimbursement for services rendered via internal accounting methods.

- **Local Agency Signal Operations Assistance**

  During significant closures or detours, temporary adjustments to Local Agency operated traffic signals may be necessary due to large increases in traffic along detour or alternative routes.

  Engage the local agency during Design and then provide advanced notification in Construction preferably two weeks prior to the major closure. Any agreements should be included in the Transportation Management Plan.

- **Motorist Use of GPS Technology**

  A majority of motorists use GPS for navigation purposes which may provide motorists an optional alternative route in real-time based on shortest travel time automatically (without needing extensive traffic control messaging) that effectively reduces work zone delays and queues by redistributing traffic across multiple corridors.

C. Coordinate Closures along Detours & Alternative Routes during High-Impact Closures

It is critical to restrict concurrent lane or ramp closures on parallel, alternative routes during high-impact closures. In Design, it should be determined if such closure restrictions are necessary by working with the Region Traffic Operations. If needed, be sure to include the closure restrictions in the Contract PS&E.

During Construction, Region Traffic Operations may still allow these restricted lane or ramp closures to occur on a case-by-case basis, but may reduce allowable hours to account for the additional traffic volumes that will be diverted onto the detour or alternative route.

Example: A full closure of southbound Interstate 5 (SB I-5) is occurring overnight in Vancouver, Washington. Thus, any concurrent lane closures along SB I-205 (parallel, alternative route) should be delayed until the work zone capacity can handle the additional traffic volumes from the SB I-5 closure. The SB I-5 to SB I-205 ramp should remain open during the SB I-5 as well as any ramps along the detour route or alternative route path.

D. Detour Route Considerations

Detour routes using local agency roadways require detour agreements, which should be completed in Design and included in the Transportation Management Plan. Coordinate early with local agencies, especially for significant road or ramp closures. In Construction, collaboration is needed to prevent conflicting concurrent closures along the detour route.

Consider rather the detour route can accommodate commercial vehicles, particularly oversized/overweight permitted vehicles, during closures. If travel restrictions are necessary, contact WSDOT Commercial Vehicle Services in advance (Section 5-15).

Consider the detour route's capacity. Of particular concern are signalized intersections at the beginning of the detour where only a single left-turn lane is provided operating as a protected movement (left only on green arrow).

Mitigations may include uniform police officers controlling traffic at any problematic intersections until traffic volumes are low enough to resume normal signal operation or to temporarily adjust signal timing.

Permissive-protect single left-turn lane, protected double left-turn lanes, and right turns serve greater traffic volumes and typically do not require additional mitigation.

Be cautious of all-way stop intersections along a detour route as they have capacities as low as 600 vehicles/hour (from all approaches).

Pedestrian and bicyclist detour routes should be short, in close proximity, and have accessibility features and grades comparable to the existing route to maximize their use. Provide advanced closure signage at decision points far enough in advance to allow the opportunity to utilize alternative routes without backtracking given that these users may have expended considerable physical effort reaching the closure and may not have access to check websites or other postings regarding upcoming work.

5-7 Extended Intermediate-Term Duration Closures

Intermediate-term duration closures are defined as those lasting 3 days or less and include weekend-duration closures (Friday night to Monday morning). Extended closures permit closure hours to extend beyond those normally used in PS&E and result in work zone congestion.

When it has been identified and utilizing extended closure hours is justified, detailed work zone traffic analysis needs to be performed by the Region Traffic Operations to determine anticipated delays and queues (Section 5-9) to determine permitted extended closure hours and any associated interim liquidated damages (Section 5-14). The WSDOT Transportation Data, GIS & Modeling Office (TDGMO) can provide Regions assistance with work zone traffic analysis and determine maximum allowable interim liquidated damages.

Diversion rates used in work zone traffic analysis are determined by Region Traffic Operations based on considerations such as the quality and number of alternative routes available, special event occurrence, and quality of public outreach.

In the Contract PS&E, clearly list permitted extended closures including days and times, maximum number allowable, and restrictions on what work operations are allowed to utilize the extended closures.

When work zone queues are anticipated to exceed more than 1 mile, consider work zone safety management strategies (Section 5-17), including a work zone queue warning system, in addition to implementing work zone congestion management strategies (Section 5-6.B).

There are several extended intermediate-term duration closure strategies available, including:

- Extended weeknights (Section 5-7.A)
- Extended Friday night into Saturday morning (Section 5-7.B)
- Extended Saturday night into Sunday morning (Section 5-7.C)
- Extended weekend morning closures (Section 5-7.D)
- Weekend-duration lane closures (Section 5-7.E)
- Weekend-duration road closures (Section 5-7.F)

A. Extended Weeknight Closures

After the weekday PM commute, decreasing traffic volumes allows any work zone queues to dissipate overnight. Thursday PM volumes tend to be higher later into the evening compared to other weeknights.

Traffic typically diverts around congested work zones using alternative routes, which reduces the traffic volume the work zone must serve. Diversion rates used in work zone traffic analysis are determined by Region Traffic Operations based on considerations such as the quality and number of alternative routes available, special event occurrence, and quality of public outreach.

On the other hand, traffic volumes typically increase quickly during weekday AM commute hours, which minimizes dissipation of any work zone congestion created; thus, work zone impacts to the weekday AM commute should be minimal and assume no traffic diversion.

Exhibit 5-1 Extended Weeknight Closure Guidance

Typical Diversion Rates (Optional)		PM Hours: ≤ 5% AM Hours: 0%
	Targeted Delays	**Comments**
Typical Closure	PM: ≤ 15 minutes AM: ≤ 5 minutes	Perform detailed work zone traffic analysis.
Extended Closure	PM: ≤ 30 minutes	Consider involving Region Management. Perform detailed work zone traffic analysis. Consider significant public outreach.

B. Extended Friday Night into Saturday Morning Closures

After the Friday PM commute, decreasing traffic volumes allows any work zone queues to dissipate overnight. Friday PM volumes tend to be higher later into the evening compared to all other weeknights.

When congestion occurs, traffic may divert using alternative routes around the work zone; therefore, decreasing the volume the work zone must serve. Diversion rates used in work zone traffic analysis are determined by Region Traffic Operations based on considerations such as the quality and number of alternative routes available, special event occurrence, and quality of public outreach.

Because there is no AM commute, closures may be extended into Saturday morning several hours later than weekdays. Because of increasing volumes, the ability to dissipate queues becomes reduced later into the morning.

Exhibit 5-2 Extended Friday Night into Saturday Morning Closure Guidance

Typical Diversion Rates (Optional)		Friday PM Hours: ≤ 10% Saturday AM Hours: ≤ 10%
	Targeted Delays	**Comments**
Typical Closure	Fri PM: ≤ 20 minutes Sat AM: ≤ 15 minutes	Perform detailed work zone traffic analysis.
Extended Closure	Fri PM: ≤ 45 minutes Sat AM: ≤ 30 minutes	Consider involving Region Management. Perform detailed work zone traffic analysis. Consider significant public outreach.

Friday night is typically used to accommodate Superload freight by keeping a minimum of two lanes open on T-1 and T-2 freight corridors when feasible. Superload freight over 20 feet wide is typically restricted to travel during early Saturday morning (1:00 a.m.-6:30 a.m.) or Sunday morning (1:00 a.m.-6:30 a.m.).

C. Extended Saturday Night into Sunday Morning Closures

Decreasing Saturday PM traffic volumes allows any work zone queues to dissipate overnight. Saturday PM volumes tend to be comparable to Friday PM volumes.

When congestion occurs, traffic may divert using alternative routes around the work zone; therefore, decreasing the volume the work zone must serve. Diversion rates used in work zone traffic analysis are determined by Region Traffic Operations based on considerations such as the quality and number of alternative routes available, special event occurrence, and quality of public outreach.

Because there is no AM commute, closures may be extended into Sunday morning several hours later than weekdays and typically an hour later than Saturday morning. Because of increasing volumes, the ability to dissipate queues becomes reduced later into the morning.

Exhibit 5-3 Extended Saturday Night into Sunday Morning Closure Guidance

Typical Diversion Rates (Optional)		Saturday PM Hours: ≤ 15% Sunday AM Hours: ≤ 10%
	Targeted Delays	**Comments**
Typical Closure	Sat PM: ≤ 20 minutes Sun AM: ≤ 15 minutes	Perform detailed work zone traffic analysis.
Extended Closure	Sat PM: ≤ 45 minutes Sun AM: ≤ 30 minutes	Consider involving Region Management. Perform detailed work zone traffic analysis. Consider significant public outreach.

D. Extended Weekend Morning Closures

Some work operations, such as bridge inspections or maintenance operations without noise permits, require daytime closure hours even in heavy congested urban areas but weekday daytime closures would result in unacceptable work zone congestion.

Instead, utilize extended weekend morning closures. Begin closures 1.5 hours before sunrise (times available for Seattle and Spokane) so traffic control and mobilization occur during darkness and crews begin work operations at first light. Balance the need to complete work and keep adverse traffic impacts tolerable using work zone traffic analysis (Section 5-9). Typically, Sunday morning closures reopen an hour later than Saturday.

E. Weekend-Duration Lane Closures

Weekend-duration lane closures, Friday evening to Monday morning commute, are practical solutions for longer work operations when extended overnight closure hours still do not yield sufficient work durations.

Weekend traffic demand tends to be less commute oriented and more discretionary than weekdays. With strong public outreach, motorists can plan ahead by avoiding an area using alternative routes, traveling early morning or later in evenings, or using public transit.

However, avoid weekend lane closures on major recreational routes due to greater communication and outreach challenges. Consider performing these closures during the off-season or weekdays (Sunday evening to noon Friday) instead.

Superload freight is not typically accommodated during weekend-duration lane closures but oversized freight should be along T-1 and T-2 freight corridors. If the roadway is narrowed or vertical clearances reduced, then WSDOT Commercial Vehicle Services should be contacted at least 7 days in advance. See Section 5-15 for details.

Perform work zone traffic analysis (Section 5-9) to assess traffic impacts and mitigation needs. It may be a good time to involve Region Management in the decision process. Region Traffic Operations will determine anticipated diversion rates, which range from 0 percent to 50 percent during hours of congestion for weekend-duration closures. Be aware hourly traffic volumes may be up to 15 percent higher early AM hours on weekends as motorists travel earlier to avoid the worse work zone congestion.

Interim liquidated damage values for weekend-duration closure should be included in the Contract PS&E (see Section 5-14 for details). Consider additional work zone safety management strategies (Section 5-17) when using these strategies.

Freeway Lane & Ramp Closure Weekend-Duration Strategies:

- **Closing up to half the existing freeway lanes**

  Reducing a 4-lane directional freeway to 2 open lanes needs viable alternative routes (2+ multilane principle arterials) and extensive public outreach.

  Reducing a 2-lane directional freeway to 1 open lane needs viable alternative routes (principle arterial, preferably multilane) and extensive public outreach.

- **Farther reduce roadway to a single open lane during overnight hours, but consider the additional work zone congestion created during the day.**

  Typical Friday and Saturday Night Strategy on Congested Urban Freeways: Reduce roadway to a single open lane at 10:30 p.m. and reopen the following morning to two lanes when traffic volumes reach 150 percent of a single open lane's capacity (typically Saturday 5:30 a.m. or Sunday 6:00 a.m.) to clear any early- morning congestion created before congestion starting building during the daytime weekend-duration lane closures.

- **Strategically closing freeway on-ramps can effectively manage congestion along mainline.**

  By strategically closing on-ramps, traffic volumes served by the work zone is reduced by forcing on-ramp traffic to use detour routes or alternative routes; however, avoid closing on-ramps with major trip generators (airport or other major freeways).

  Eliminating on-ramp merges maximizes the capacity through the work zone; therefore, minimizing queues and delays.

  Closing on-ramps prevent queues from spreading onto other corridors via queues extending up ramps and spilling into adjacent corridor thru lanes. With the ramp closed, the traffic queue remain contained on the original corridor, but additional congestion will occur along the detour route or alternative routes.

  Be cautious of closing freeway on-ramps in rural areas as detour routes may be several miles due to the large distances between interchanges.

  This strategy is ineffective if the detour route or alternative route does not bypass the work zone.

Conventional Highway (Non-Freeway) Weekend-Duration Lane Closure Strategies:

- **Temporary two-way, two-lane configuration an existing multilane highways**

  Each direction is reduced to a single open lane, then one direction of traffic is shifted into either the closed two-way, left-turn lane or the closed left lane of the oncoming direction, known as contraflow.

  On divided highways, each direction is reduced to a single open lane, then one direction of traffic is shifted via median crossover over into the closed left lane of the oncoming direction.

- **Temporary two-way, one-lane configuration on an existing highway**

  A single lane is maintained through the work zone with alternating traffic via flagger or temporary signal-control, which may include a pilot car operation.

F. Weekend-Duration Road Closures

For critical work operations it may not be practical to maintain mobility necessitating the use of weekend-duration road closures. Such work operations may include fish passage culverts and modifying existing intersections into roundabouts.

For the traveling public, closing the road for a short duration may be less inconvenience than traveling through a work zone for an extended period of time. Productivity during weekend closures are significantly greater than daily or nightly closures; thus, the project duration can be reduced considerably.

The main requirement for road closures is the availability of a detour route and its ability to accommodate increased traffic volumes, truck turning movements, and pavement integrity. Weekend traffic demand tends to be less commute oriented and more discretionary than weekdays. With strong public outreach motorists are able to plan ahead by avoiding an area by taking alternative routes, traveling earlier or later, or using public transit.

However, avoid weekend lane closures on major recreational routes due to greater communication and outreach challenges. Consider performing these closures using long-term duration closures during the off-season or weekdays (Sunday evening to noon Friday).

For roadway closures along truck freight critical corridors, WSDOT Commercial Vehicle Services should be contacted at least 7 days in advance (see Section 5-15 for details). For FHWA notification requirements for Interstate Highway closures, see Section 5-12.

Perform work zone traffic analysis (Section 5-9) to assess traffic impacts and mitigation needs. It may be a good time to involve Region Management in the decision process.

Interim liquidated damage values for weekend-duration closure should be included in the Contract PS&E (see Section 5-14 for details). Consider additional work zone safety management strategies (Section 5-17) when using these strategies.

Freeway Weekend-Duration Closure Strategies:

- **Directional freeway mainline closure utilizing a collector-distributor**

  Using lane closures, all traffic is forced to exit onto the collector-distributor around the work area before rejoining the mainline. This strategy provides the benefit of a “full roadway closure” in terms of productivity and safety, but maintains limited mobility through the work zone for the traveling public.

- **Directional freeway mainline closure utilizing a median crossover**

  Two-way, two-lane freeway traffic is maintained by placing all traffic on one side of the median with 11-foot lanes, 2-foot right shoulders, and 3-foot left shoulders adjacent to the temporary barrier separating opposing directions of traffic desirable; however, actual site conditions may justify narrower configurations and work zone speed limit reductions (Section 5-18).

  If existing paved shoulders are within the temporary travel lanes, verify the pavement depth is sufficient, drainage features/electrical J-box covers are traffic bearing, and roadway widths across bridges are sufficient.

Often, roadside safety features on freeways are designed for one-way traffic; when temporary two-way configurations are used verify these roadside safety components are sufficient (WSDOT *Design Manual* Chapter 1610 and Chapter 1620).

- **Directional freeway mainline closure utilizing a detour**

  Used in conjunction with lane closures, all traffic is forced to exit at an exit-ramp. A route-specific signed detour route should be provided along with significant mitigation and outreach strategies along with advanced notification.

- **Complete freeway mainline closure utilizing detours**

  For work operations such as overhead bridge demolition across all lanes, it may be necessary to close both directions of a freeway concurrently. A route-specific signed detour route should be provided for each direction along with substantial mitigation and outreach strategies.

Conventional Highway Closure Strategy:

- **Roadway closure with detour**

  The roadway is closed to all traffic with a signed detour route in place. Local traffic access may be permitted up to the actual roadway closure to maintain access for residents and local businesses.

5-8 Long-Term Duration Closures & Reconfigurations

Long-Term duration closures are defined as those lasting 4 days or more. Weekend- duration closures are considered intermediate-term duration (see Section 5-7.E and Section 5-7.F).

Some work operations may require extended closures, even longer than weekend- durations, in order to complete needed work. Such work operations include bridge rehabilitation, major roundabout installation, fish passage culverts, and roadway widening.

These extended closures occur on commuter, freight, and/or recreational routes and should be used only after other traffic control approaches were found to be ineffective or impractical.

When it has been identified and utilizing long-term duration closures is justified, detailed work zone traffic analysis needs to be performed by the Region Traffic Operations to determine anticipated delays and queues (Section 5-9) to determine permitted extended closure hours and any associated interim liquidated damages (Section 5-14). The WSDOT Transportation Data, GIS & Modeling Office (TDGMO) can provide Regions assistance with work zone traffic analysis and determine maximum allowable interim liquidated damages.

Diversion rates used in work zone traffic analysis are determined by Region Traffic Operations based on considerations such as the quality and number of alternative routes available, special event occurrence, and quality of public outreach.

In the Contract PS&E, clearly list permitted long-term duration closures including days and times, maximum number allowable, and any allowable work operation restrictions.

Section 5-12 provides FHWA notification requirements in advance of Interstate Highway closures or on the Federal-aid primary highway system.

When work zone queues are anticipated to exceed more than 1 mile, consider work zone safety management strategies (Section 5-17), including a work zone queue warning system, in addition to implementing work zone congestion management strategies (Section 5-6.B).

Multiple weekday-duration closures, typically Sunday night to noon on Friday, are similar to the weekend-duration strategies but serves as a practical solution for work operations requiring more than a weekend to complete or the work zone occurs along recreational routes experiencing high weekend traffic volumes, but are lower during weekdays.

Regions should expect work zone congestion to be very heavy the first day or two, but easing as the traveling public adjusts their driving habits. After a few days, locals will simply avoid the work zone while others utilize alternative routes or simply avoid travel. When possible, travelers will travel earlier in the morning or later in the evening to avoid the worst of the congestion.

For long-term duration closures, the exact traffic control strategy and closures will be determined on a case-by-case basis and is site-specific. The following are only some of the possible long-duration closure strategies:

- Temporary Bypasses (Section 5-8.A)
- Roadway Lane Closure & Reconfiguration (Section 5-8.B)

A. Temporary Bypasses

A strategy utilized for some bridge reconstruction and fish passage projects is to construct a temporary highway bypass around the fish culvert during its construction, particularly in areas where a sufficient detour or alternative route is unavailable. In addition, it may be utilized on routes serving commuting traffic during the week and recreation traffic on the weekend. Depending on traffic volumes, environmental restrictions, cost, and other practical considerations the bypass could be as follows:

- Two-lane, two-way temporary configuration
- One-lane, two-way temporary configuration utilizing temporary signals to alternate traffic during nonworking hours with flagger-controlled traffic during working hours.

B. Roadway Lane Closure & Reconfiguration

In locations with constrained geometrics, may require lane closures combined with reduced shoulder and lane widths that are laterally shifted onto the shoulders, work can occur on one-half of the roadway and/or bridge at a time. Typically, a two-stage configuration is utilized to complete work across the road/bridge. Such freeway reconfigurations should use a reduced continuous work zone speed limit based on the minimum shoulder and lane widths as shown in Exhibit 5-12 (Section 5-18.A).

Typically, site-specific staging plans and traffic control plans are included in the Contract PS&E for each stage including any needed temporary illumination plans. For more complex projects or locations with tight geometrics, multiple stages and reconfigurations may be necessary.

These long-term reconfigurations should be based on permanent design standards to the extent feasible (horizontal curvature, long-duration temporary pavement markings, temporary traffic barriers with impact attenuators, illumination) while being supplemented with standard temporary traffic control devices. See Chapter 1010 in the WSDOT *Design Manual* for additional work zone design information.

5-9 Work Zone Traffic Analysis

Work zone traffic analysis compares the anticipated work zone traffic volumes with its estimated capacity. When traffic volumes exceed capacity, queues grow and congestion build. When traffic volumes are less than capacity, queues dissipate.

The unit of measurement is vehicle per hour (vph) but may also be measured as vehicles per hour per lane (vphpl) for multilane roadways.

First, determine the anticipated traffic volume through the work zone. Obtain historical traffic volumes (Section 5-9.A) and correct older data for growth (Section 5-9.B). Next, account for any expected traffic diversion, determined by Region Traffic Operations, which decreases the volume served by the work zone. Next, determine the work zone's traffic capacity (Section 5-9.C for freeways and Section 5-9.D for conventional roadways).

With the anticipated traffic volume and work zone capacity, expected work zone queues and delays can then be calculated. For simple scenarios, see Section 5-9.E. For more complex scenarios, see Section 5-9.F.

Region Traffic Operations should perform work zone traffic analysis, but may delegate it to the Project Engineering Office. The WSDOT Transportation Data, GIS & Modeling Office (TDGMO)can assist by providing work zone traffic analysis to help determine expected queuing and delays.

Much of the same information used for work zone traffic analysis is also used by WSDOT TDGMO to determine maximum interim liquidated damage values (Section 5-14). Based on these maximum values, Region Traffic Operations can determine actual interim liquidated damage values for each closure which are listed in the Contract PS&E. Based on these maximum values, Region Traffic Operations can determine actual interim liquidated damage values for each closure which are listed in the Contract PS&E.

A. Obtaining Traffic Volumes

When possible, obtain current traffic volumes within the work zone limits. Be cautious of using traffic data older than a year, especially in high-growth areas.

Directional traffic volumes should be taken at several locations. On freeways, obtain mainline volumes between each interchange and volumes of each exit-ramp and on-ramp. On conventional roadways, obtain mainline volumes between significant intersections.

Traffic volumes should be obtained each day of the week closures are permitted as they may change significantly from day to day. For extended intermediate-term duration closures (Section 5-7) and long-term duration closures (Section 5-8) obtain several sets of data for each day for a good average, desirably 10 for each day. Screen the data set for any significant special events or holidays that may significantly skew the traffic volume average.

It is desirable to obtain traffic volumes in 15-minute intervals for greater accuracy in determining closure hours for closures on freeways and major arterials. It may become necessary to assign closures in 15-minute intervals on heavily congested corridors instead of typical hourly intervals. When 15-minute traffic volumes are used, multiply by four to obtain an *equivalent hourly volume* to use the hourly intermediate-term work zone capacities provided in Section 5-9.C and Section 5-9.D.

Recreational roadways will experience significant fluctuations in traffic volumes seasonally; however, most roadways experience higher traffic volumes in summer and lower in winter. Similarly, work zone capacities also are higher in summer and lower in winter by similar amounts **usually eliminating the need for seasonal adjustments for work zone traffic analysis in most areas**.

The following resources may be used to obtain existing traffic volumes on state routes and the Interstate Highway system:

- **WSDOT Traffic Data GeoPortal**

  This application allows users to obtain historic hourly and aggregate traffic volume data from WSDOT's network of Permanent Traffic Recorders (PTRs).

  For detailed information on GeoPortal application, including the map layer information and instructions for obtaining data within this system, see Traffic Data GeoPortal Help.

- **WSDOT Transportation Data, GIS & Modeling Office (TDGMO)**

  Hourly volume, classification, speed, and weight data can be obtained, when available, from the TDGMO. This includes data from both the PTR network and short-duration mechanical counts conducted throughout the state. To obtain this data, complete and submit a Traffic Data Request Form to TDGMO.

- **WSDOT ECM Portal**

  "Short Duration Count" searches an internal database for various hourly traffic counts, including NWR Traffic Studies Database.

- **CDR Software (Northwest Region Only)**

  This software allows engineers to access detailed traffic data for freeways and major arterial roadways from PTRs. Historic PTR data is available in 5-minute intervals but can be automatically aggregated and summarized as needed by the software, with 15-minute or one-hour intervals being the most useful for work zone traffic analysis.

- **Request New Traffic Studies**

  New traffic studies can be performed by the TDGMO and the Northwest Region upon request.

  To request new traffic studies statewide, contact TDGMO.

B. Correcting Traffic Volumes for Growth

When traffic volumes are more than a year old, then account for annual changes in traffic volumes. The growth rate of traffic is location specific. Traffic volumes often decrease during times of economic recession.

If needed, location specific growth rate estimates can be generated by contacting TDGMO or Region Traffic Operations. Without the availability of better data or information, a conservative growth rate of 3 percent per year can be assumed.

Caution should be used when applying a constant growth rate across all hourly traffic volumes because congested corridors may experience much higher growth rates during early AM commute hours as motorists adapt to worsening congestion by beginning their commutes earlier, as early as 3:30 a.m. in a few locations.

Without the availability of better data or information, using hourly traffic volumes from one location along a corridor and using the AADTs of both location to "adjust" the hourly volumes may be acceptable; however, if the "adjusted" hourly volumes are near the work zone traffic capacities then new traffic counts should be obtained.

C. Freeway Work Zone Traffic Capacities

The "rule of thumb" work zone capacity thresholds provided in this subsection include ranges based on the understanding that roadway conditions, roadway configurations, and work activity intensity all impact actual capacities; therefore, sound engineering judgement and Regional experience is still needed to perform proper work zone traffic analysis.

Stationary freeway lane closures are ones that occupy a location and are set up with standard traffic control devices.

Exhibit 5-4 Lane Capacities in Stationary Freeway Work Zones

Stationary Freeway Lane Description	Stationary Work Zone Lane Capacity (vehicles per hour per open lane)
General Purpose Lane (No Shift onto Shoulder)	Urban: 1400-1600 Rural: 1300-1500
Single Open Lane Shifted onto Shoulder	Urban: 1000-1100 Rural: 900-1000

Special Scenarios:

- Increase directional capacity by 100 vehicles/hour when traffic barriers separate travel lanes from work areas.
- When High Occupancy Vehicle (HOV) and Express Toll Lane (ETL) is present, assume its lane capacity as 1000 unless it is the only lane open, even when signed as "OPEN TO ALL".
- For steep upgrades (≥ 5 percent for more than ½ mile), reduce one lane's capacity by one-half to account for the slow trucks.

Mobile freeway lane closures are "moving lane closures" using transportable attenuators without channelization devices where work moves intermittently or continuously.

Exhibit 5-5 Lane Capacities in Mobile Freeway Work Zones

Mobile Freeway Lane Description	Mobile Work Zone Lane Capacity (vehicles per hour per open lane)
3 Open Lanes	Urban: 1250-1350 Rural: 1150-1250
2 Open Lanes	Urban: 1100-1200 Rural: 1050-1150
1 Open Lane	Urban: 1000-1100 Rural: 950-1050

Special Scenarios:

- When High Occupancy Vehicle (HOV) and Express Toll Lane (ETL) is present, assume its lane capacity at 750, even when signed as "OPEN TO ALL".
- For steep upgrades (≥ 5 percent for more than ½ mile), reduce one lane's capacity by one-half to account for the slow trucks.

- **Nightly Freeway Ramp Closures**

  When determining permitted closure hours for ramps, it is important to understand ramp closure hours are dependent on the excess capacity available along its entire detour route, including any intersections. If the detour route is already congested, then it has no excess capacity to absorb the detouring traffic. In short, the capacity of the detour route increases as overall volumes become lower. In other words, a detour route can serve higher detour traffic volumes at 11:00 p.m. than at 7:00 p.m.. Because overall traffic volumes higher later into evenings weekends than weeknights, the thresholds vary to account for this trend.

  The opposite is true during the morning because overall traffic volumes are increasing. Because excess capacity along the detour route decreases into the morning, the detour traffic volume that can be sufficiently served also decreases later into the morning. In other words, a detour route can sufficiently serve lower detour traffic volumes at 6:00 a.m. than at 4:00 a.m.. Because weekends have no AM commute traffic, the thresholds remain higher later into the morning.

  Suburban & urban corridors experience higher traffic volume levels than rural corridors; however, suburban & urban motorists are more accepting of higher congestion levels. The thresholds account for this trend as well.

  It is also important to distinguish between exit-ramp and on-ramps detour routes; particularly when temporary lane closures are in place on mainline in one or both directions of travel. Exit-ramp detours typically route on towards the next interchange and then back in the opposite direction resulting in higher traffic volumes than normal along the detour route, which should be accounted for when temporary lane closures are in place in either direction or additional work zone congestion may occur. On the other hand, on-ramps tend to use surface streets and local road detours to adjacent interchanges which lowers traffic volumes on the mainline in that section, and may help offset the additional traffic volumes generated by exit-ramp detours.

It is important to verify *the entire detour route* can sufficiently handle the added traffic volumes detoured, not just focusing on the ramp's volume in isolation. Additional work zone congestion strategies may be needed along the detour route (see Section 5-6.B for details).

Pay particular attention to detour routes turning left at signalized intersections with a short, single left turn lane with a protected left turn signal phase. Signal retiming or uniform police officer(s) controlling traffic at the intersection may be necessary. When traffic volumes sufficiently decrease, normal signal operation may be restored.

For guidance, ramp closure volume thresholds are available in Exhibit 5-6. Exhibit 5-7 provides ramp reopening thresholds. **Note this guidance is for nightly ramp closures.** Weekend-duration duration ramp closures are discussed in Section 5-7.E and long-term durations in Section 5-7.F.

Exhibit 5-6 Nightly Ramp Closure Volume Thresholds (vehicles/hour)

	Sunday night Monday night Tuesday night Wednesday night Thursday night		Friday night Saturday night	
Ramp Closure Beginning Time	Suburban & Urban Corridors	Rural Corridors	Suburban & Urban Corridors	Rural Corridors
7:00 p.m.	200	200	150	150
7:30 p.m.	250	225	175	175
8:00 p.m.	300	250	200	200
8:30 p.m.	375	300	250	225
9:00 p.m.	450	375	300	250
9:30 p.m.	525	450	375	300
10:00 p.m.	600	525	450	375
10:30 p.m.	700	600	525	450
11:00 p.m.	800	Any Volume	600	525
11:30 p.m.	900	Any Volume	700	600
11:59 p.m.	Any Volume	Any Volume	Any Volume	Any Volume

Notes:

- "Any Volume" means the ramp may be closed regardless of its volumes (excluding major special events).
- Additional work zone congestion strategies may still be necessary (Section 5-6.B) for ramp volumes exceeding 1000 vehicles per hour.
- Verify the *entire detour route* can sufficiently handle the added detour volumes, especially at intersections.

The following ramp closure examples are based on Exhibit 5-6 guidance to assist users:

Example #1: A suburban ramp can be closed starting 9:00 p.m. Monday night if its volume is less than 450 vehicles per hour at that time.

Example #2: A rural ramp can be closed starting 11:00 p.m. Friday night if its volume is less than 525 vehicles per hour at that time.

Example #3: Any ramp could be closed beginning 11:59pm any night of the week regardless of its volumes, except when its closure impacts major special events. Verify the entire detour route can sufficiently handle the detour volumes and consider additional work zone congestion strategies such as signal retiming or uniform police officer-controlled traffic at intersections when ramp volumes exceed 1000 vehicles per hour.

Exhibit 5-7 Nightly Ramp Reopening Volume Thresholds (vehicles/hour)

	Weekdays (AM Commutes)		Saturday morning		Sunday morning	
Ramp Reopening Time	Suburban & Urban Corridors	Rural Corridors	Suburban & Urban Corridors	Rural Corridors	Suburban & Urban Corridors	Rural Corridors
3:30 a.m.	800	600	Any Volume	Any Volume	Any Volume	Any Volume
4:00 a.m.	600	500	Any Volume	Any Volume	Any Volume	Any Volume
4:30 a.m.	450	350	Any Volume	Any Volume	Any Volume	Any Volume
5:00 a.m.	Reopen	250	800	600	Any Volume	Any Volume
5:30 a.m.		150	600	500	Any Volume	Any Volume
6:00 a.m.		Reopen	450	350	800	600
6:30 a.m.			300	250	600	500
7:00 a.m.			200	200	450	350
7:30 a.m.			150	150	300	250
8:00 a.m.			Reopen	Reopen	200	200
8:30 a.m.					150	150
9:00 a.m.					Reopen	Reopen

Notes:

- "Any Volume" means the ramp may be closed regardless of its volumes.
- Additional work zone congestion strategies may still be necessary (Section 5-6.B) for ramp volumes exceeding 1000 vehicles per hour.
- "Reopen" means the nightly ramp closure should be reopened regardless of its volumes (excludes weekend-duration or long-term closures) unless otherwise justified.
- Verify the *entire detour route* can sufficiently handle the added detour volumes, especially at intersections.

The following ramp reopening examples are based on Exhibit 5-7 guidance to assist users:

Example #1: A ramp can remain closed thru 3:30 a.m. during early weekday mornings regardless of its ramp volumes.

Example #2: A suburban/urban ramp should be reopened no later than 4:30 a.m. Tuesday morning if its volumes exceed 450 vehicles per hour at that time; unless otherwise justified (ramp is opposite of the AM commute direction), reopen the ramp by 5:00 a.m. on weekday mornings.

Example #3: A rural ramp should be reopened no later than 5:00 a.m. Wednesday morning if its volumes exceed 250 vehicles per hour at that time; unless otherwise justified, reopen the ramp by 6:00 a.m. on weekday mornings.

Example #4: Any ramp can remain closed thru 5:00 a.m. early Saturday morning regardless of its ramp volumes; unless otherwise justified, reopen the ramp by 8:00 a.m. on Saturday mornings (excludes extended weekend morning or weekend-duration closures).

Example #5: Any ramp can remain closed thru 6:00 a.m. early Sunday morning regardless of its ramp volumes; unless otherwise justified, reopen the ramp by 9:00 a.m. on Sunday mornings (excludes extended weekend morning or weekend-duration closures).

- **Daytime Freeway Ramp Closures**

  Some work operations, such as bridge inspections or maintenance operations without noise permits, require daytime closure hours even in heavy congested urban areas. Permitted closure hours for this situation should be examined on a case-by-case basis by Region Traffic Operations.

  Consider the following: What are the ramp volumes during the closure? Does the detour add considerable delays, especially for commuter and school traffic?

  If permitted, weekday daytime ramp closure hours are typically assigned between the AM commute and PM commute (9:00 a.m. to 3:00 p.m.).

  When daytime closures during weekdays result in unacceptable work zone congestion, an alternative approach is to utilize extended Saturday morning or Sunday morning closures. See Section 5-7.D for details.

D. Conventional Roadway Work Zone Traffic Capacities (Non-Freeway)

The “rule of thumb” work zone capacity thresholds provided in this subsection include ranges based on the understanding that roadway conditions, roadway configurations, and work activity intensity all impact actual capacities; therefore, sound engineering judgement and Regional experience is still needed to perform proper work zone traffic analysis.

- **Multilane Closures (Non-Freeway)**

  These lane closures maintain two-way traffic with at least one thru lane in each direction (no flaggers, pilot cars, temporary signals, etc.). Contraflow means two- way traffic is maintained by shifting one direction of travel into the opposing direction’s closed thru lanes or closed two-way, left-turn center lane.

Traffic capacity is further reduced when closures extend through signalized intersections, particularly for contraflow configurations. When traffic is shifted at or thru signalized intersections via contraflow, the signalized intersection shall be either controlled by uniform police officer(s) within the intersection per WAC 468-95-3015 or flaggers on all approaches with an optional flagger added within the intersection.

Exhibit 5-8 provides capacities for rural multilane roadways. Exhibit 5-9 provides capacities for urban multilane roadways.

Exhibit 5-8 Rural Multilane Work Zone Traffic Capacities

Lane Description	Work Zone Lane Capacity (vehicles per hour per open thru lane)
One Thru Lane(s) Each Direction (Typical lane closures)	No Signalized Intersections: 1200-1300 Thru Signalized Intersections: 1000-1100
One Thru Lane Each Direction (Contraflow)	No Signalized Intersections: 1100 -1200 Thru Signalized Intersections: 700-800

Note:
For steep upgrades (≥ 5 percent for more than ½ mile), reduce one lane's capacity by one-half to account for the slow trucks.

Exhibit 5-9 Urban Multilane Work Zone Traffic Capacities

Lane Closure Description	Work Zone Lane Capacity (vehicles per hour per open thru lane)
One Thru Lane(s) Each Direction (Typical lane closures)	No Signalized Intersections: 1050-1150 Thru Signalized Intersections: 850-950
One Thru Lane Each Direction (Contraflow)	No Signalized Intersections: 950-1050 Thru Signalized Intersections: 700-800

- **Single Open Lane with Alternating Traffic**

  Traffic capacities are significantly affected by the distance between flaggers or temporary signals due to the lost time waiting for alternating traffic directions to take turns. Additional intersections between flaggers farther exasperate this issue.

  Alternating traffic can be controlled via flaggers, AFADs, pilot cars, or temporary signals. Different methods will yield different work zone capacities. Pilot cars increase capacity by guiding motorists through the work zone more effectively, especially for work zones exceeding 800 feet between flaggers.

  When bicyclists are combined with alternating vehicular traffic, work zone capacity is significantly reduced due to their slow speeds and longer clearance intervals. Temporary signals are especially affected because the all-red clearance intervals for temporary signals typically assume bicycle speeds of 10 mph (unless a separate bicycle lane or shuttle is provided). All-red clearance time becomes excessively lengthy when distances between temporary signals exceed 1000 feet.

For congested work zones with alternating traffic, queues and delays can be minimized by reducing the distance between flaggers and the clearance time needed. For example, reducing the longitudinal buffer space and upgrading the protective vehicle up to a transportable attenuators (for speed 45 mph or higher) would minimize queues while still protecting the work area from errant vehicle intrusions because the flaggers are closer.

Exhibit 5-10 Alternating Two-Way Traffic Work Zone Traffic Capacities

Distance Between Flaggers or Temporary Signals	Total Work Zone Capacity (total vehicles per hour in both directions combined)			
	Flagger & AFAD	Flagger & Pilot Car	Temporary Signal (Separate Bicycle Lane or Shuttle)	Temporary Signal (Bicyclists Share Open Lane With Motorists)
200 feet	1200	N/A	1300	1100
500 feet	1000	1000	1050	850
800 feet	900	925	950	700
1000 feet	800[1]	850[1]	850	500
1500 feet	700[1]	775[1]	700	375
½ mile	550[1]	650[1]	550	250
1 mile	350[1]	475[1]	350	125

Notes:

[1] If bicycle volumes are significant and share open lane with motorists, use capacity listed in "Temporary Signal (Bicyclist Share Open Lane with Motorists)".

- Intersecting roadways lower capacities based on volume and frequency.
- When temporary signals are used to alternating traffic, consider Driveway Assistance Devices (DADs) control driveways avoid capacity reductions.

E. Simple Work Zone Queues & Delays

When work zone congestion is expected, then calculating the expected queue and delay becomes necessary to determine the level of work zone impact to determine the closure's feasibility and the level of mitigation needed.

Work zone queue and delays is calculated using the following equations:

$$\text{Traffic demand} = \text{average typical traffic volume} * \left(1 - \frac{\text{traffic diversion \%}}{100}\right)$$

$$\text{Number of unserved vehicles} = (\text{hourly traffic demand} - \text{WZ hourly capacity}) * \left(\frac{\text{time interval in minutes}}{60 \text{ minutes}}\right)$$

$$\text{Queue (miles)} = \text{\# unserved vehicles} * \left(\frac{25 \text{ feet}}{\text{vehicle}}\right) * \left(\frac{\text{mile}}{5280 \text{ feet}}\right) * \left(\frac{1}{\text{\# lanes}}\right)$$

$$\text{Delay (minutes)} = \text{\# unserved vehicles} * \left(\frac{1}{\text{WZ hourly capacity}}\right) * \left(\frac{60 \text{ minutes}}{\text{hour}}\right)$$

Explanation of Variables and Calculations:

- **Average typical traffic volume:** Expected traffic volume traveling through the work zone; see Section 5-9.A and Section 5-9.B for details.
- **Traffic diversion:** Percentage of vehicles that avoid traveling through the work zone during hours of congestion; see Section 5-7 and Section 5-8 for details. Diversion rates are determined by Region Traffic Operations.
- **Work zone capacity:** Anticipated traffic volume a work zone can serve; see Section 5-9.C for freeways and Section 5-9.D for conventional roadways.
- **Unserved vehicles:** Calculated value to determine how many vehicles are still waiting to proceed through the work zone for the given time interval in minutes. Number of unserved vehicles will carry over to any subsequent time intervals until dissipated.
- **Queue:** Calculated value to determine work zone queue length and is dependent on the number of unserved vehicles and how many open lanes are available prior to the capacity restriction (typically a lane closure merge point).
- **Delay:** Calculated value to determine the additional travel time through work zone and is dependent on the number of unserved vehicles and the work zone's current capacity. Delay is independent of queue length, but both queue and delay are dependent on the number of unserved vehicles.

Examples are provided on the following pages as reference.

Example #1a: A two-lane rural freeway is reduced to a single open lane shifted onto the shoulder. Average typical traffic volume is 1350 vehicles/hour. Assume 5 percent traffic diversion. Determine the queue and delay at the end of the first hour.

$$\text{Traffic demand} = 1350 * \left(1 - \frac{5}{100}\right) = 1283 \text{ vehicles/hour}$$

- Average typical traffic volume = 1350
- Diversion rate = 5 percent or 5/100.

$$\text{Work zone capacity} = 900 \text{ vehicles/hour/lane} \times (1 \text{ open lane}) = 900 \text{ vehicles/hour}$$

- Freeway work zone capacity information is found in Exhibit 5-4 in Section 5-9.C, which is capacity per open lane. Thus, multiply this value by number of open lanes.

$$\text{Number of unserved vehicles} = (1283 - 900) * \left(\frac{60}{60}\right) = 383 \text{ unserved vehicles in first hour}$$

- Since we are determining the queue/delay at the end of the first hour, the time interval is 1 hour or 60 minutes; thus, the 60/60 factor.

$$\text{Queue} = 383 \text{ unserved vehicles} * \left(\frac{25 \text{ feet}}{\text{vehicle}}\right) * \left(\frac{\text{mile}}{5280 \text{ feet}}\right) * \left(\frac{1}{2 \text{ lanes}}\right) = 0.91 = 0.9 \text{ mile}$$

- There are two open lanes prior to the lane closure where the freeway is reduced to a single open lane; thus, the queue length will occur in the 2-lane section.

$$\text{Delay} = 383 \text{ unserved vehicles} * \left(\frac{1}{900 \text{ vehicles per hour}}\right) * \left(\frac{60 \text{ minutes}}{\text{hour}}\right) = 25.5 = 26 \text{ minutes}$$

Answer: The work zone queue is estimated as 0.9 mile with 26 minute delays at the end of the first hour.

As demonstrated In Example #1a, the number of unserved vehicles is positive (+383); thus, traffic demand significantly exceeds the work zone capacity and queues and delays are increasing rather quickly. At the end of the first hour, the queue has increased to 0.9 mile with 26 minute delays and serves as the initial values for determining the queues and delays for the second hour.

Each hourly calculation are incremental; the unserved vehicles from the previous hour carries over to the next hour. Thus, the longer traffic demand exceeds a work zone's capacity, the worse the congestion becomes.

On the other hand, as traffic volumes decreases overnight, then the work zone's capacity will eventually exceed the traffic demand, and the queue and delays begin dissipating as demonstrated in Example #1b on the next page.

Example #1b: The same two-lane rural freeway lane closure in Example #1 remains in place for a second hour. The average typical traffic volume during the second hour is 915 vehicles; assume 10 percent traffic diversion as it is later in the evening with a good alternate route nearby. Determine the queue and delay at the end of the second hour.

$$\text{Traffic demand} = 915 * \left(1 - \frac{10}{100}\right) = 824 \text{ vehicles/hour}$$

- Average typical traffic volume = 915
- Diversion rate = 10 percent or 10/100.

$$\text{Work zone capacity} = 900 \text{ vehicles/hour/lane} \times (1 \text{ open lane}) = 900 \text{ vehicles/hour}$$

- Freeway work zone capacity information is found in Exhibit 5-4 in Section 5-9.C, which is capacity per open lane. Thus, multiply this value by number of open lanes.

$$\text{Number of unserved vehicles} = (824 - 900) * \left(\frac{60}{60}\right) = -76 \text{ unserved vehicles in second hour}$$

- Since we are determining the queue/delay at the end of the second hour, the time interval is 1 hour or 60 minutes; thus, the 60/60 factor.
- A negative number means the work zone capacity exceeds the traffic demand; thus, unserved vehicles from the first hour will be dissipated.

$$\text{Queue} = 0.91 \text{ miles} + \left[-76 \text{ unserved vehicles} * \left(\frac{25 \text{ feet}}{\text{vehicle}}\right) * \left(\frac{\text{mile}}{5280 \text{ feet}}\right) * \left(\frac{1}{2 \text{ lanes}}\right)\right] =$$
$$0.91 \text{ miles} - 0.18 \text{ miles} = 0.73 = 0.7 \text{ mile}$$

$$\text{Delay} = 25.5 \text{ minutes} + \left[-76 \text{ unserved vehicles} * \left(\frac{1}{900 \text{ vehicles per hour}}\right) * \left(\frac{60 \text{ minutes}}{\text{hour}}\right)\right] =$$
$$25.5 \text{ minutes} - 5.1 \text{ minutes} = 20.4 = 20 \text{ minutes}$$

Answer: The work zone queue is estimated as 0.7 mile with 20 minute delays at the end of the second hour.

In Example #1b, the number of unserved vehicles is negative (-76). This is good news because now the work zone capacity exceeds traffic demand causing queues to dissipate. This is why congestion is targeted in the PM overnight hours when traffic volumes are declining because any congestion created initially will dissipate overnight.

At the end of the second hour, the queue has reduced to 0.7 mile with 20 minute delays and serves as the initial values for determining the queues and delays after the third hour. If the third hour volumes are even lower, the queue and delays will reduce even quicker. Eventually, the queue and delays will fully dissipate and the work zone will be free flow.

Example #1c: The same two-lane rural freeway lane closure in Example #1 remains in place for a third hour. The average typical traffic volume during the second hour is 600 vehicles; assume 15 percent traffic diversion as it is even later in the evening with a good alternate route nearby. Determine the queue and delay at the end of the second hour.

$$\text{Traffic demand} = 600 * \left(1 - \frac{15}{100}\right) = 510 \text{ vehicles/hour}$$

- Average typical traffic volume = 600
- Diversion rate = 15 percent or 15/100.

$$\text{Work zone capacity} = 900 \text{ vehicles/hour/lane} \times (1 \text{ open lane}) = 900 \text{ vehicles/hour}$$

- Freeway work zone capacity information is found in Exhibit 5-4 in Section 5-9.C, which is capacity per open lane. Thus, multiply this value by number of open lanes.

$$\text{Number of unserved vehicles} = (510 - 900) * \left(\frac{60}{60}\right)$$
$$= -390 \text{ unserved vehicles in second hour}$$

- Since we are determining the queue/delay at the end of the second hour, the time interval is 1 hour or 60 minutes; thus, the 60/60 factor.
- A negative number means the work zone capacity exceeds the traffic demand; thus, unserved vehicles from the first hour will be dissipated.

$$\text{Queue} = 0.73 \text{ miles} + \left[-390 \text{ unserved vehicles} * \left(\frac{25 \text{ feet}}{\text{vehicle}}\right) * \left(\frac{\text{mile}}{5280 \text{ feet}}\right) * \left(\frac{1}{2 \text{ lanes}}\right)\right] =$$
$$0.91 \text{ miles} - 0.92 \text{ miles} = -0.01 = 0.0 \text{ mile}$$

$$\text{Delay} = 25.5 \text{ minutes} + \left[-390 \text{ unserved vehicles} * \left(\frac{1}{900 \text{ vehicles per hour}}\right) * \left(\frac{60 \text{ minutes}}{\text{hour}}\right)\right] =$$
$$25.5 \text{ minutes} - 26.0 \text{ minutes} = -0.05 = 0 \text{ minutes}$$

Answer: The work zone queue has fully dissipated with no delays at the end of the third hour.

In Example #1c, the number of unserved vehicles is negative (-390). This is great news because now the work zone capacity significantly exceeds unserved traffic demand from the second hour; causing queues to completely dissipate by the end of the third hour. This is why congestion is targeted in the PM overnight hours when traffic volumes are declining because any congestion created will dissipate overnight.

Now traffic through work zone is free flow.

Example #2A: U.S. Highway 12 is reduced to a single open lane with traffic alternating via flagger (no pilot car) in a mountain pass without any alternative routes available during daylight hours. The distance between flaggers is 1 mile. The average typical traffic volume during this hour is 263 vehicles/hour from eastbound and 524 vehicles/hour from westbound. Determine the queue and delay after 30 minutes of lane closure. Assume traffic queues are split evenly between the two directions.

$$\text{Traffic demand} = (263 + 524) * \left(1 - \frac{0}{100}\right) = 787 \frac{\text{vehicles}}{\text{hour}}$$

- Because traffic is alternated in a single open lane via flagger-control, the work zone must serve both directions of traffic. Therefore, the directional volumes are combined.
- Diversion rate = 0 percent or 0/100. No alternative routes are available.

$$\text{Work zone capacity} = 350 \text{ vehicles/hour}$$

- Conventional roadway work zone capacity information is found in Exhibit 5-10 based on 1 mile distance between flaggers.

$$\text{Number of unserved vehicles} = (787 - 350) * \left(\frac{30}{60}\right)$$
$$= 219 \text{ unserved vehicles after 30 minutes}$$

- We are determining the queue/delay after 30 minutes; thus, the 30/60 factor.

$$\text{Queue} = 219 \text{ unserved vehicles} * \left(\frac{25 \text{ feet}}{\text{vehicle}}\right) * \left(\frac{\text{mile}}{5280 \text{ feet}}\right) * \left(\frac{1}{2 \text{ directions}}\right) = 0.52 = 0.5 \text{ mile}$$

- Problem statement assumed queues are split evenly between both directions for simplicity; thus, divided queue by 2 directions.

$$\text{Delay} = 219 \text{ unserved vehicles} * \left(\frac{1}{350 \text{ vehicles per hour}}\right) * \left(\frac{60 \text{ minutes}}{\text{hour}}\right) = 37.5 = 38 \text{ minutes}$$

Answer: The work zone queue is estimated as 0.5 mile in each direction with 38 minute delays after 30 minutes of lane closure.

As demonstrated In Example #2A, the traffic demand far exceeds the work zone capacity and delays become substantial even after only 30 minutes of closure. A logical solution would be performing the lane closure during times when traffic volumes are lower, such as at night, but that may not be an option in some situations. Let's say the work must be performed at the time and volumes listed above. What now?

There are two remedies to improve the situation. **Minimize the distance between flaggers as much as possible and use a pilot car** as shown in Example #2B on the next page.

Example #2B: The traffic control in Example #2A has been modified. Flaggers with a pilot car escorting motorists through the work zone is used. The distance between flaggers has been reduced to 1500 feet. Determine the queue and delay after 30 minutes of lane closure. Assume traffic queues are split evenly between the two directions.

$$\text{Traffic demand} = (263 + 524) * \left(1 - \frac{0}{100}\right) = 787 \text{ vehicles/hour}$$

- Because traffic is alternated in a single open lane via flagger-control, the work zone must serve both directions of traffic. Therefore, the directional volumes are combined.
- Diversion rate = 0 percent or 0/100.

$$\text{Work zone capacity } = 650 \text{ vehicles/hour}$$

- Conventional roadway work zone capacity information is found in Exhibit 5-10 based on ½ mile distance between flaggers with pilot car.

$$\text{Number of unserved vehicles} = (787 - 650) * \left(\frac{30}{60}\right) = 69 \text{ unserved vehicles after 30 minutes}$$

- We are determining the queue/delay after 30 minutes; thus, the 30/60 factor.

$$\text{Queue} = 69 \text{ unserved vehicles} * \left(\frac{25 \text{ feet}}{\text{vehicle}}\right) * \left(\frac{\text{mile}}{5280 \text{ feet}}\right) * \left(\frac{1}{2 \text{ directions}}\right) = 0.16 = 0.2 \text{ mile}$$

- Problem statement assumed queues are split evenly between both directions for simplicity; thus, divided queue by 2 directions.

$$\text{Delay } = 69 \text{ unserved vehicles} * \left(\frac{1}{650 \text{ vehicles per hour}}\right) * \left(\frac{60 \text{ minutes}}{\text{hour}}\right) = 6.4 \text{ } = 6 \text{ minutes}$$

Answer: The work zone queue is estimated as 0.2 mile in each direction with 6 minute delays after 30 minutes of lane closure.

As demonstrated In Example #2B, even though work zone congestion occurs, it has been greatly improved by simply reducing the distance between flaggers and using a pilot car. Depending on the work's duration (a few hours versus all day), additional mitigation strategies will be needed. Perhaps, flagger spacing can be reduced to 1500 feet so work zone capacity (775vph) matches expected traffic demand (787 vph).

A goal in work zone design is to allow crews to complete needed work while managing work zone mobility; collaboration and cooperation is necessary. This is exactly what work zone congestion management is all about.

F. Complex Work Zone Queues & Delays

Region Traffic Operations should perform complex work zone traffic analysis. The WSDOT Transportation Data, GIS & Modeling Office (TDGMO) can assist by providing work zone traffic analysis to help determine expected queuing and delays.

For more complex situations, consider using one of the numerous work zone queue analysis tools available:

- **WSDOT's Capacity-Queue-Delay Microsoft Excel Sheet**

  This WSDOT-developed tool estimates queues, delays, and user delay costs based on 15-minute intervals and includes traffic diversion rates. There is an hourly volume to 15-minute volume converter included if needed.

  The Excel files are available here. Copy the Excel files onto your desktop first before modifying. For detailed explanations, contact WSDOT HQ Work Zone Engineers.

- **CA4PRS (Construction Analysis for Pavement Rehabilitation Strategies)**

  This software is an agency decision-support tool to help select the most effective and economical construction and work zone strategies in terms of schedule, traffic impacts, and agency costs. CA4PRS is especially beneficial for large roadway rehabilitation and widening projects in congested urban areas having high-traffic impacts.

  CA4PRS software is free to WSDOT staff; for details, see the CalTrans CA4RPS website.

- **QuickZone**

  This software is a spreadsheet-based traffic analysis tool to estimate costs, traffic delays, and queues for urban and rural work zones, including alternating two-way traffic in a single lane.

  For details, see the FHWA QuickZone website.

- **SYNCHRO**

  This software is typically used for permanent traffic signal design; however, it is useful for temporary signal design for work zones as well for developing signal timing plans.

- ***Highway Capacity Manual*, 6th Edition**

  This manual is used for work zone traffic analysis of long-term staged configurations (remaining in place 24/7 for weeks), not intermediate-term (≤ 3 days) closures.

- **FHWA Traffic Analysis Tools Program – Deployment Track**

  Volumes VIII, IX, and XII specifically relate to work zones and provide comprehensive information. All three volumes are available at this FHWA webpage.

- **FHWA Sponsored Work Zone Traffic Management Analysis Training**

  Illinois College of Engineering provides a free 2-day class for work zone analysis via analytical method training throughout the nation. Check the registration/class schedule webpage and contact information for future courses.

5-10 Permitted Closure Restrictions

On Design-Bid-Build construction projects, permitted closures are listed in the Contract's Special Provisions (Specials) and in the Request for Proposal (RFP) on Design-Build projects. Maintenance closures are typically determined on a case-by-case basis.

When determining permitted closure hours for Contracts, consider the closures occur over months or years. At the Agency's option, permitted closure hours can be expanded during construction on a case-by-case, trial basis; however, if work zone congestion becomes intolerable and the Agency reduces the permitted hours after bidding, it may result in claims from the Contractor. On the other hand, if permitted closure hours are too conservative, it decreases the available working hours and may result in increased construction costs for negligible work zone congestion reductions.

Because Maintenance closures occur for a day or a few days, the Agency may assign less conservative closure hours with the understanding Maintenance crews remove the closure if work zone congestion become excessive.

Closure hours are provided for all permitted closures, including but not limited to:

- Shoulder closures
- Lane closures
- Ramp closures
- Roadway or directional roadway closures
- Staged construction allowable durations
- Pedestrian curb, traffic island, and/or sidewalk closures
- Extended lane closures for specific work operations
- Continuous roadway, directional roadway, lane, and/or ramp closures

A. Contractor Cooperation and Permitted Closure Restrictions Due to Other Projects

Contract PS&Es should provide an *Other Contracts or Other Work* section of anticipated projects, both State and local agency, occurring adjacent to or within the limits of the project requiring coordination and cooperation between Contractors.

Additional restrictions on permitted closures may be specified during scheduled roadway closures, directional roadway closures, and weekend lane closures occurring on other projects. This is often used on significant alternative routes around a major closures; for example, restricting any lane closures on southbound I-205 when southbound I-5 is closed for an adjacent project in Vancouver, Washington.

Consider language requiring a minimum of 1 mile between adjacent lane closures. For example, if a double right lane closure precedes a double left lane closure then the closures need to be separated by at least 1 mile to allow advanced warning signs for the second closure to be installed but also allow motorists sufficient time to transition across lanes. If PCMSs are used in addition to advanced warning signs, then increase the distance to 1.5 mile minimum.

B. Holiday Restrictions for Permitted Closures

Contract PS&Es may restrict permitted closures from occurring during holidays and holiday weekends (when the holiday occurs on Friday, Saturday, Sunday, or Monday). Typically, the restriction begins noon the day prior and may continue until noon the day after the holiday or holiday weekend. These holidays are listed in the WSDOT *Standard Specifications* Section 1-08.5.

Canadian holiday restrictions may be needed for projects near British Columbia; each Canadian holiday should be listed and typically include:

- Good Friday (Friday before Easter)
- Easter Monday (Monday following Easter)
- Queen's Birthday/Victoria Day (closest Monday to May 20)
- Canada Day/Dominion Day (always July 1)
- B.C. Day (first Monday in August)
- Thanksgiving Day (second Monday in October)
- Boxing Day (always December 26)

C. Special Event Restrictions for Permitted Closures

Contract PS&Es may restrict permitted closures from occurring two hours prior to, during, and/or two hours following major special events. Communication with stakeholders (including local interest groups) and obtaining their concurrence or understanding is important for public relations throughout Planning, Design, and Construction.

Each special event and its restriction interval should be clearly specified, including projected attendance thresholds when applicable. Clarification whether the restriction occurs for a time interval prior to, during, and/or after the event depends on anticipated traffic impacts caused by event traffic. Directional routes going towards the event experience increased volumes prior to the event while routes going away from the event experience increased volumes after the event. During the event, traffic volume may not be impacted by games and concerts but impacted by all-day events such as State Fairs.

Region Traffic Operations use experience to determine special event restrictions, including the event's project attendance threshold based on the project's location, but some special events that typically restrict permitted closures include:

- All Seattle Seahawk and Washington Huskie home football games
- T-Mobile Park, Century Link Field, or Tacoma Dome significant events
- Annual Seafair Hydroplane Race Weekend
- Washington State Fairs
- Watershed Music Festival at the Gorge Amphitheater
- Hoopfest Weekend 3-on-3 Basketball Tournament in Spokane
- Issaquah Salmon Days

In addition, the special event may impact traffic locally, regionally, or statewide. For example, Issaquah Salmon Days traffic impact tends to be more local than Seattle Seahawk games which are more regional. Events such as Hoopfest Weekend 3-on-3 Basketball Tournament have statewide impacts, especially on Interstate 90 between Seattle and Spokane.

With the restrictions in place, the Region Traffic Operations can still provide case- by-case exceptions to the restrictions but are not obligated to do so; thus, giving the Agency flexibility.

In the event the Agency allows permitted closures to occur during listed special event restrictions, it is especially important to consider the combined traffic impacts of multiple special events occurring concurrently. For example, when the Seattle Sounders and Mariners have concurrent games occurring in the afternoon, the traffic impacts are far greater than if one game occurred in the afternoon and the other in the evening.

Special Event Exception Example: There is a Construction work zone on Southbound I-5 (south of the stadium, influenced by the exiting event traffic). Mariners home game ends late Wednesday evening around 10:15pm (7:10 p.m. game) and exceeds the attendance threshold in the Specials, which restricts any lane closures until two hours after the event.

Simply prohibiting all lane closures until 12:15am often results in the Contractor not performing any lane closures that night (since they have less than 5 hours to install traffic control, perform minimal work, and typically reopen by 6am at the latest). Instead of completing the project in one season, it may become two because of the 40+ Mariner home games each season.

On a case-by-case basis, after performing work zone traffic analysis, the Region Traffic Operations may allow the Contractor to close 3 of 5 lanes on Southbound I-5 (in the path of exiting event traffic) during normal Contract hours but then delay the fourth lane closure until 11:30 p.m. to accommodate exiting game traffic (late night events tend to clear within about an hour after the event ends) even though the fourth lane is normally closed 11:00 p.m. per Contract PS&E. This allows Construction crews to install traffic control for the triple lane closures and work while still accommodating game traffic. This essentially maintains an open lane for game traffic and the other lane for typical non-event traffic to help minimize work zone congestion. At 11:30 p.m., once the game traffic is expected to clear, the roadway is reduced to one open lane and the work area maximized.

By doing so, the Contractor still completes work (albeit a reduced quantity) while mobility through the work zone is maintained versus simply performing no work at all.

In areas with special lane restrictions (High-Occupancy Vehicle or Express Toll Lanes), consideration rather left lane closures or right lane closures are implemented can be important. Closing right (general purpose) have higher impacts as motorists need to utilize the HOV or ETL and are reluctant to do so even when those lanes are signed as open to all traffic.

5-11 Closure Notification Requirements

On Design-Bid-Build construction projects, closure notification requirements are listed in the Contract's Special Provisions and in the Request for Proposal (RFP) on Design-Build projects.

Typically, the advance notification requirements are as follows:

- Notify the Engineer in writing 5 calendar days in advance of any shoulder, lane, ramp, and sidewalk closure
- Notify the Engineer in writing 14 calendar days in advance of any roadway closure
- Notify the Engineer in writing 30 calendar days in advance of any continuous lane, continuous partial roadway, or continuous roadway closure
- Notify the Engineer in writing 60 calendar days in advance of any continuous lane, continuous partial roadway, or continuous Interstate Highway System roadway closure lasting 7 consecutive days or more
- Provide a detailed traffic control closure schedule to Engineer for review and acceptance by noon Monday three weeks prior to implementing traffic control.
- Specifications should include language that notifications do not imply approval of closures

Typically, public notification requirements are as follows:

- Furnish and install information signs providing advance notification of road closures and/or ramp closures at least five working days prior to the closure
- Notify Washington Patrol; local fire, police, emergency services, and city engineering departments; Medic 1 and local transit agency (when applicable); other transit companies; and affected school districts in writing at least five working days in advance of each closure

5-12 FHWA Notification Requirements for Closures & Use Restrictions

To assure compliance with federal law (23 CFR 658.11), the Federal Highway Administration Washington Division (**WADIV**) needs to receive proper notification when closing certain routes.

WSDOT is required to provide WADIV advanced notification of full closures or use restrictions on the Interstate Highway System and Federal-aid primary routes. For National Highway System routes in Washington, click here.

Full closures: When all mainline travel lanes in one direction of travel or both directions of travel are closed to traffic due to construction activities, emergency closures, or for special events. Interstate to Interstate interchange ramp closures are included in this designation. Detours onsite or otherwise are also included in this designation.

Use Restriction: Restriction in place that limits the vehicle type, load, or function of the facility. The most common use restriction would be closing a route to all commercial vehicles. WADIV approves use restrictions on the Interstate Highway System and Federal-aid primary routes.

The Region Traffic Operations typically performs this FHWA notification via email to Washington.FHWA@dot.gov. Contact information for the FHWA Field Operation Engineers and the WSDOT Regions they cover is available at this FHWA website.

The required FHWA notification is summarized in Exhibit 5-11 on the next page:

Exhibit 5-11 FHWA Notification Requirements for Closures

Closure Description and Duration	Required WSDOT Action/FHWA Role
Interstate full closure or use restriction **(7+ consecutive days)**	Send WADIV notification **60 calendar days** in advance of potential closure. Send additional notifications as specific details are updated.
	WADIV sends recommendation of approval to FHWA HQ. FHWA HQ approval needed.
Interstate full closure or use restriction **(48+ continuous hours to 7 consecutive days)**	Send WADIV notification **14 calendar days** in advance of potential closure. Send additional notifications as specific details are updated.
	WADIV concurrence needed.
Interstate full closure or use restriction **(between 12 to 48 continuous hours)**	Send WADIV notification **7 calendar days** in advance of potential closure. Send additional notifications as specific details are updated.
Federal-aid primary system full closure or use restriction **(7+ consecutive days)**	Send WADIV notification **7 calendar days** in advance of potential closure. Send additional notifications as specific details are updated.

5-13 Work Zone Closure Coordination

Because performing several work zone closures concurrently can result in significant conflicts and adverse region-wide impacts to mobility, it is critical to coordinate closures. Through proper coordination, conflicting closures are avoided and adverse impacts to the traveling public reduced. It is important to coordinate between different Regions for high-impact closures.

Contact Region Traffic Operations to determine how work zone closures are coordinated in each region. In the Northwest Region, the Construction Traffic & Coordination Office (CTCO) will utilize advanced coordination methods due to the large number of competing projects within a specific area.

As part of WSDOT's Transportation System Management and Operations (TSMO), the WSDOT Next Generation Work Zone Database is a useful tool used by Regions to manage, avoid overlapping work zone conflicts, and combine work zone closures for several work operations when feasible to minimize traffic control costs. For additional information, view the User's Manual.

5-14 Interim Liquidated Damages

Interim liquidated damages (ILDs) are monies assessed or withheld from the Contractor for failure to reopen roadway closures, lane closures, and ramp closures by the time specified in the Contract PS&E.

On Design-Bid-Build construction projects, ILDs are listed in the Contract's Special Provisions and in the Request for Proposal (RFP) on Design-Build projects.

WSDOT TDGMO determines maximum ILD values based on the calculation of societal costs resulting from travel delays. To request interim liquidated damages, the Region Traffic or Project Engineering Office should complete the Interim Liquidated Damages Request Form (Form 312-001) and submit it to the TDGMO two weeks in advance of the date the values are needed. Per the *Plans Preparation Manual* Section 700.01(18), the TDGMO has standardized methodology for calculating interim liquidated damage values and is the only office with the authority to compute them.

To request interim liquidated values from TDGMO will need the following form and information sent via email:

- Form 312-001 *Interim Liquidated Damages Request Form*
- Permitted closure hours, including days of week
- Hourly traffic volumes used to establish permitted hours for each closure
- Work zone traffic control plans for each closure
- Detour plan(s) for each roadway closure or ramp closure, including hourly traffic volumes for the detour route if available
- Vicinity map
- Draft version of the interim liquidated damages section that will be included in the Contract PS&E, leaving the actual value amounts empty

Region Traffic Operations will then assign the actual liquidated damage value for each closure based on the maximum allowable amounts determined by TDGMO.

5-15 Commercial Vehicle Considerations

Freight transportation systems, including bridges and highways, are critical to supporting and growing more jobs, increasing regional domestic product, and developing a larger tax base. The multimodal freight transportation system allows business in Washington to effectively compete in regional and global markets.

Washington is the second-most trade-dependent state in the nation according to U.S. Department of Commerce International Trade Administration. Nationally, truck freight moves nearly 70 percent of all shipments according to USDOT Bureau of Transportation Statistics and FHWA. Each semi tractor-trailer carries about $25,000 in freight (2017).

A. Truck Freight Critical Corridors

The FGTS Truck Freight Corridor map shows freight corridors in Washington (Ranging from T-1 to T-5, with T-1 being the most critical).

Long-term duration stationary work zones should accommodate WB-67 design vehicles (a typical semi tractor-trailer) on T-1 and T-2 corridors, which include freeways and major arterial corridors. On corridors with heavy movements of Oversized & Superload commercial freight, consider either accommodating those larger vehicles or reducing the duration their movements are restricted. Coordination and collaboration with heavy freight haulers is advised.

Of particular concern are single lane ramps or single lane roadways delineated with temporary traffic barrier and/or guardrail on both sides. A minimum travel width of 16 feet plus any adjustments for traveled way widening values on open highway curves to accommodate the difference in tracking width of the WB-67 design vehicle's rear trailer axles that "cut" into the curve should be maintained.

See WSDOT *Design Manual* Chapter 720 for any temporary vertical clearance reductions, especially on the mainline of T-1 and T-2 freight routes. There have been numerous impacts from oversized loads to both permanent and temporary structures, even when advanced warning signs and over-height warning systems are in place.

If a construction or maintenance project is narrowing the roadway or restricting the vertical clearance, WSDOT Commercial Vehicle Services needs to be contacted at least 7 calendar days in advance.

B. Oversized and Superload Truck Freight

There are two categories of large truck freight, Oversized and Superloads:

Large Truck Freight Category	Width (feet)	Length (feet)	Height (feet)	Weight (pounds)
Oversize	8.5 to 16	Varies to 125	14 to 16	105,500 to 200,000
Superload	> 16	> 125	> 16	> 200,000

C. Oversized Freight Considerations

Oversized loads are usually self-permitting and do not require permission from the WSDOT Construction offices to travel through work zones; however, they are responsible for checking oversize/overweight restrictions and vertical clearance restrictions prior to transport.

Oversized freight still show up unexpectedly in work zones; therefore, it is desirable to provide a 16-foot wide travel way when possible; however, work operations often necessitate narrower widths. If a construction or maintenance project is narrowing the roadway or restricting the vertical clearance, WSDOT Commercial Vehicle Services needs to be contacted at least 7 calendar days in advance.

See *Washington Commercial Vehicle Guide* for details.

Oversized truck freight example; modular home straddling both lanes on Interstate 90 at a bridge rehabilitation work zone with a reduced traveled way.

Source: WSDOT

D. Superload Freight Considerations

Superload permitting is stringent and controlled through Commercial Vehicle Services. See Superload Requirements website and *Washington Commercial Vehicle Guide* for additional information.

Typically, Commercial Vehicle Services will forward Superload permits to Regions for review. Superloads may be required to obtain permission to transport through known work zones at least 72 hours in advance. Superloads can be sensitive to transport restrictions.

Typically, Superload transport is restricted to 11:00 p.m. to 3:00 a.m. on weeknights and 1:00 a.m. to 6:30 a.m. early Saturday and Sunday mornings, with Superloads exceeding 20 feet in width restricted to early Saturday and Sunday mornings only. Actual restrictions may vary by Region.

Superload truck freight example; Boeing B1 bomber 131 feet long, 29+ feet wide, and 15 feet high.

Source: WSDOT

5-16 Work Zone Traffic Incident Management Strategies

For major closures, determining permitted closure hours and the accepting the actual dates are critical as the closures must be coordinated with holidays, special events, and other work zone closures. Next, the traveling public and stakeholders need to be informed.

During the actual closure, it is critical to properly manage any work zone traffic incident since the roadway's capacity is already reduced. Sooner or later, an undesirable surprise happens including but not limited to:

- Traffic control devices get knocked over by an errant vehicle
- Disabled vehicle with mechanical failures blocks the only open lane through work zone
- A collision involving multiple vehicles with serious injuries or a fatality is blocking lanes
- An errant vehicle enters into the work area, attempting to take an "open" exit-ramp, is now stuck in newly placed concrete pavement

The plan to address such incidents typically consists of at least seven parts:

- Traffic Management Center (Section 5-16.A)
- Traffic Control Inspections (Section 5-16.B)
- Incident Discovery (Section 5-16.C)
- Public Outreach (Section 5-16.D)
- Advanced Preparation for Major Closures (Section 5-16.E)
- Drop Sites for Disabled Vehicles (Section 5-16.F)
- Emergency Vehicle Access (Section 5-16.G)

A. Traffic Management Center

Traffic Management Centers (TMC) serve an essential communication role in incident management. TMCs can contact WSDOT Incident Response Teams, Washington Patrol and other emergency services, and WSDOT staff. TMC can modify motorist information signage to inform the public of incidents, such as an accident.

For Regional TMC contact information, contact Region Traffic Operations.

For every work zone closure, provide the Region TMC details of the closure and its location in addition to point of contact information. Keep the TMC updated of the current closure status, including when closures are reopened. The Construction project office or the Design-Builder will want to verify what pertinent information is needed by the Region TMC when work zone closures are in place and determine whom handles this communication.

This allows TMC to call the point of contact if there are any traffic control issues, accidents in the work zone, or some other urgent matter.

B. Traffic Control Inspections

Required per WSDOT *Standard Specifications* Section 1-10, the traffic control supervisor (TCS) shall inspect traffic control hourly during working hours in addition to other periodic inspections during nonworking hours. The TCS shall correct, or arrange to have corrected, any deficiencies noted during these inspections.

C. Incident Discovery

Per WSDOT *Standard Specifications* Section 1-10, Contractors are required to have a traffic control manager who oversees temporary traffic control operations and approving actions of the Traffic Control Supervisor.

Upon discovery of any incidents, the Contractor's Traffic Control Manager, Traffic Control Supervisor, WSDOT Engineer, and Region TMC should be notified.

Contacting other parties, including local agencies, is determined on a case by case basis.

D. Public Outreach

For work zone incidents with high traffic impacts, the WSDOT Public Information Officer should be contacted so appropriate outreach with news media, social media, and blogs can distribute the information to the traveling public when needed.

In addition, the Region Traffic Management Center can modify motorist information signage to inform the public of incidents, such as an accident.

E. Advanced Preparation for Major Closures

Well in advance of major closures, the Construction project engineering office should collaborate with WSDOT Region Traffic Operations, WSDOT Communications, WSDOT Communications, WSDOT Regional TMCs, and WSDOT Incident Response Teams (IRTs).

WSDOT Communications serves an invaluable role in reaching out to the general public and stakeholders providing traffic-related and project information for construction or maintenance projects.

TMCs can use permanent variable message signs to provide motorists real-time information and advance notification regarding high-impact closures and major incidents. On Active Traffic and Demand Management corridors, lane usage symbols and speed limits can be displayed in real-time to supplement temporary traffic control.

During major weekend-duration lane closures, maintaining the already reduced capacity is critical. By strategically staging IRT and at least one tow truck on site, they can expeditiously respond to any traffic incidents, particularly blocking vehicles. If necessary, IRT and WSDOT TMC can collaborate to contact necessary police, emergency agencies, and WSDOT management.

F. Drop Sites for Disabled Vehicles

For work zones with narrow shoulders, disabled vehicles need to be moved off the roadway. Often, Contractor's nearby staging yard is used to temporarily store the disabled vehicle until it can be retrieved.

G. Emergency Vehicle Access

It is critical to maintain emergency vehicle access through work zones when possible; sometimes, minutes matter. Examples include:

- For long-term projects, when feasible provide adequate paved shoulders (8-foot widths desired) for emergency vehicles to pass queued vehicles, especially on single lane on-ramps that are metered, or use ramp metering preemption to clear the queue when an emergency vehicle is detected.
- During rolling slowdowns, develop a contingency plan to allow critical emergency vehicles access safely through the rolling blockade and work area when transporting critical patients. For additional rolling slowdown information, see Section 5-21.

If it is not feasible to maintain access during a roadway closure or rolling slowdown, advanced written notification should be provided to affected agencies.

5-17 Work Zone Safety Management

Per Secretary's Executive Order E 1001.02, all WSDOT employees are directed to make the safety of workers and the traveling public our highest priority during roadway design, construction, maintenance, and related activities. First, we need an understanding of work zone statistics because discussing mitigation strategies:

National work zone statistics

- 84 percent of fatalities occur to the traveling public, not workers (ARTBA, 2019)
- Nearly all fatal crashes occurred on freeway and arterial roadways with posted speed limits of 45 mph or higher (FHWA, 2018)
- 35 percent of fatalities involved large trucks and buses (ARTBA, 2019)
- 16 percent of fatalities involve pedestrians and bicyclists (ARTBA, 2019)

Washington work zone statistics

- 7 fatalities occurred to the traveling public (ARTBA, 2019)
- 3 fatalities involving a large truck (ARTBA, 2019)
- 0 fatalities involving workers (ARTBA, 2019)
- 0 fatalities involving pedestrians (ARTBA, 2010)

The primary focus for work zone safety mitigation should be to the traveling public on freeway and arterial roadways with posted speed limits of 45 mph or higher. Per FHWA, rear-end crashes are the most common type of work zone crash and are overrepresented by large trucks.

Consider the following strategies to help mitigate work zone impacts and enhance safety:

- Work zone queuing mitigation (Section 5-17.A)
- Positive protection devices (Section 5-17.B)
- Work zone speed limit reductions & advisory speeds (Section 5-17.C)
- Washington State Patrol enforcement (Section 5-17.E)
- Uniformed Police Officer work zone assistance (Section 5-17.F)

A. Work Zone Queuing Mitigation

At 65 mph, it may take fully loaded semi-tractor and trailers at least 7 seconds and 500 feet to stop per Work Zone Safety Consortium. It is critical for large truck drivers to anticipate queued traffic and get slowed down in advance. Queue warning systems have reduced associated collisions up to 45 percent per FHWA-supported Work Zone Safety Consortium report.

Queuing mitigation should be considered when queues extend beyond advance work zone signage on roadways with posted speed limits of 45 mph or higher and include:

- **Truck-Mounted PCMS**

  The simplest method is using a truck-mounted PCMS positioned ½ ± mile in advance of queues by moving up and down the paved shoulder in a safe manner as the queue changes. When the queue is no longer present, it is removed.

  This method is appropriate for non-recurring work zone queuing extending beyond the first warning sign, or PCMS if used. For example, queuing occurs for a few hours at the beginning of the lane closure before dissipating overnight and resumes a few hours in the morning before lanes are reopened.

  When used in Contracts, this truck-mounted PCMS can be included in the relevant traffic control plans as an additional PCMS in advance of lane closures that may be truck-mounted. Payment is via standard traffic control bid items already listed in the WSDOT *Standard Specifications*.

Truck-mounted PCMS displays two messages for 2 second each of a work zone queue ahead.

"NEXT # MILES" will be rounded up to the nearest whole mile.

Source: Modified from Trafcon

- **Queue Warning System**

  The Queue Warning System (QWS) provides mitigation that should be considered on 45+ mph roadways for daily, nightly, or weekend-duration closures with non-recurring work zone queuing up to 3 miles that dissipate based on detailed work zone traffic analysis (Section 5-9). Because of its simplicity, QWS works well when lane closure locations change on a daily or nightly basis (like for a paving project) with work zone queuing occurring for a few hours with free-flow traffic conditions otherwise.

  Queue warning systems (QWS) provide automated queue warning, closure information, and lane usage instructions to motorists via two PCMSs. Displayed messages automatically change as the queue lengthens or shortens as detected by 2 traffic sensors, typically located at the last lane closure taper and after the first advanced warning sign. For a 2mile QWS, place two PCMSs at 1± mile spacing prior to the first lane closure taper; for 3-mile QWS, use 1.5± mile spacing.

  QWS components may be provided by the Contractor or through an independent vendor. A QWS Technician programs and operates the system based on accepted traffic control plans and Special Provision/Request for Proposal. QWS Technician is not required to be on site when the system is in use but must be able to response to any system issues remotely. The QWS Technician may be an employee of the Vendor or someone trained and authorized by the Vendor, including Contractor or subcontractor Traffic Control Supervisor or other personnel. The Contractor or subcontractor will install, store, and remove the QWS components.

  QWS messaging needs to be included on the lane closure traffic control plan along with speed thresholds, typically 35 mph. Typical freeway lane closure plans are expected to be updated Summer 2021 in the WSDOT Work Zone Traffic Control Plans to include QWS messaging as part of the lane closure traffic control plan on Sheet 1A.

  General Specification Provisions and State-wide Request for Proposal for Queue Warning Systems is expected to be available starting in 2022. The Contract will specify when the QWS usage is required and specific system requirements.

  QWS is paid using a bid item paying hourly for when the QWS operation is in use, with mobilization and demobilization incidental. Standard traffic control bid items already listed in the WSDOT *Standard Specifications* will pay for installation and removal of the QWS components.

- **Smart Work Zone System**

  Smart Work Zone System (SWZS) provides mitigation that should be considered on 45+ mph roadways for longterm (4+ day), stationary closures with **recurring work zone queuing exceeding 3 miles** based on detailed work zone traffic analysis (Section 5-9) that should be considered. SWZS can be modified for any expected queue length. SWZS work best when the lane closure location does not move as it uses multiple components with complex programming.

  Smart work zone systems (SWZS) can provide automated travel time information, queue warning, and dynamic lane merge (“zipper merge”) instructions to motorists on a series of PCMSs leading into a work zone. Displayed messages change as the queue lengthens or shortens as detected by several traffic sensors. The number of PCMSs and sensors is determined by the anticipated queue based on detailed work zone traffic analysis

(Section 5-9). The system's complexity is adaptable based on the expected queue length and can be modified to meet site- specific situations and conditions.

SWZS components may be provided by the Contractor or through an independent vendor. A Technician programs and operates the system based on accepted traffic control plans and Special Provision/Request for Proposal. SWZS Technician is required to be on site when the system is in use. The QWS Technician may be an employee of the Vendor or someone trained and authorized by the Vendor, but shall be independent of the Contractor and Traffic Control Supervisor but shall collaborate and coordinate as appropriate. The Contractor or subcontractor will install, store, and remove the SWZS components.

When used in Contracts, a Smart Work Zone System traffic control plan should be included along with speed thresholds, typically 35 mph. Typical plans are available in the WSDOT Work Zone Traffic Control Plans for 3-mile and 6-mile SWZS.

General Specification Provisions are currently available and State-wide Request for Proposal for Smart Work Zone Systems is expected to be available starting in 2022. The Contract will specify when SWZS usage is required and specific system requirements.

SWZS is paid using two bid items. One bid item pays for mobilization and demobilization as lump sum; a second bid item pays hourly for when the SWZS operation is in use. Standard traffic control bid items already listed in the WSDOT *Standard Specifications* will pay for installation and removal of the SWZS components.

B. Positive Protection Devices

Positive protection devices are physical barriers not easily penetrated by errant vehicles that enhance work zone safety for both road users and workers. Such devices include temporary barrier, transportable attenuators, and protective vehicles.

Federal code 23 CFR Part 630 K, requires positive protection devices to be considered, to the extent practical, to manage work zone exposure to reduce the risk of fatalities or injuries to workers and road users. Alternative methods, such as reducing channelization device spacing at work crews, instead of using temporary barrier may be more practical.

See WSDOT *Design Manual* Chapter 1010 for further details.

C. Work Zone Speed Limit Reductions & Advisory Speeds

When used to supplement sound work zone design, reduced work zone speed limits and advisory speeds are tools to improve safety; however, they are not a "silver bullet".

According to Transportation Research Board's NCHRP Synthesis 482 "*Work Zone Speed Management*" report (download as a Guest using work email address), work zone speeds will be in greatest compliance with posted speed limits when:

- Workers are present and actively working
- Double fine signs are posted
- Radar speed display signs are used
- Police are actively enforcing the work zone speed limit

In addition, NCHRP Synthesis 482 reports that speed differential is minimized when work zone speed limit reductions are 10 mph less than the existing speed limit. Speed differential, known as speed variance, is a potentially useful surrogate measure for safety.

Numerous research studies confirm motorists do not just "add 5 or 7 mph to the posted speed limit", including this 1997 FHWA Report "*Effects of Rising and Lowering Speed Limits on Selected Roadway Sections*".

See Section 5-18 for detailed information, approval procedures, and required notifications for reduced work zone speed limits and advisory speeds. For Washington State Patrol Work Zone Enforcement and Assistance information, see Section 5-19.

D. Fines Double in Work Zone

Per Washington law, RCW 46.61.527, traffic fines double in all work zones without the need to post additional signage. To highlight the law, Washington State Patrol encourages the use of "NOTICE TRAFFIC FINES DOUBLE IN WORK ZONES" signs but they are not required for the double citation to be in effect.

E. Washington State Patrol Enforcement

Using roving and coordinated speed enforcement by Washington State Patrol (WSP) is a highly effective strategy to control speeds in work zones, much more so than police vehicles sitting with their red and blue warning lights flashing in a work zone.

During roving speed enforcement, WSP typically drive through the work zone while actively enforcing traffic laws but may also perform enforcement while stationary at strategically locations. WSP troopers pull over violators and issue citations at their discretion.

During coordinated speed enforcement, a WSP trooper performs active enforcement within the work zone while informing several troopers downstream of motorists violating traffic laws. Those troopers downstream then pull over violators and issue citations at their discretion.

For comprehensive information regarding this subject, see Section 5-19.

F. Uniform Police Officer Work Zone Assistance

Uniform Police Officer (UPO) is an all-inclusive term for any sworn police officer from local law enforcement agencies or Washington Patrol. Using UPOs is limited to traffic control assistance duties (flagging traffic at intersections or enforcing roadway closures) as shown on accepted traffic control plans.

For comprehensive information regarding this subject, see Section 5-20.

5-18 Speed Limit Reductions in Work Zones (Previously Appendix 5B)

It is WSDOT's objective to design work zones to operate in a manner consistent with the desired target speed dependent upon mobility, operation, and safety objectives while acknowledging drivers reduce their speeds only if they clearly perceive the need to do so.

Avoid speed limit reductions of more than 10 mph below the existing speed limit unless a restrictive feature is present. Use speed limit reductions only in portion of work zones where conditions or restrictive features are present, but avoid frequent changes in the speed limit.

Secretary's Executive Order E 1060.02 addresses the use, approval, required documentation, and required notices for work zone speed limits and advisory speeds:

- **Continuous regulatory** work zone speed limits are in effect for 24 hours a day for the duration of a project or stage of work lasting 3 continuous days or more.
- **Variable regulatory** work zone speed limit reduction is only in place during active work operations occurring during daily, nightly, and weekend-duration lane closures; otherwise, the existing speed limit is maintained.
- **Advisory speed** is a recommended speed associated with a warning sign for a work zone condition in place continuously or variably.

Regulatory work zone speed limit is enforceable; signage shall be black legend on white background.

Advisory speed is not enforceable; signage is black legend on orange background.

A. Continuous Work Zone Speed Limit and Advisory Speed

Continuous regulatory work zone speed limits (WZSL) are only considered when work zone design at the existing speed limit is not feasible or when operational or roadway conditions require a reduced speed for safe travel. Long-term temporary lane and shoulder width reductions should only occur to complete needed work operations, not for the sake of reducing vehicle speeds through the work zone. The distance and duration of reduced speed limits should be minimized the extent practical—slow down motorists only where necessary.

Exhibit 5-12 provides guidance to Region Traffic Operations for determining appropriate continuous WZSL on long-term temporary freeway reconfigurations.

Exhibit 5-12 Guidance for Continuous Work Zone Speed Limits on Freeways

Minimum Temporary Lane Width	Minimum Temporary Shoulder Widths	Continuous Regulatory Work Zone Speed Limit
10.5'	0.5'	50 mph
11.0'	1.0'	55 mph
11.0'	2.0'	60 mph
Maintain existing lane and shoulder widths or per WSDOT *Design Manual* Chapter 1232		Maintain existing speed limit

The State Traffic Engineer shall approve freeway temporary lane widths less than 10.5' and/or freeway temporary shoulder widths less than 0.5'.

Continuous WZSLs and advisory speeds approval is per Executive Order E 1060.02. State Traffic Engineer shall approve freeway continuous regulatory WZSLs of 45 mph or lower; the Region Administrator (Region Traffic Engineer when delegated) approves 50 mph or higher continuous freeway WZSLs.

Temporary lane and shoulder width reductions and lane closures do not trigger a use restriction in regards to FHWA notification (see Section 5-12 for details).

Traffic control plans will show the type, location, and limits of the approved speed limit reduction signing, including signing returning motorists to the existing speed limit. Covering conflicting existing speed limit signage is required per *Standard Specifications* Section 1-10.3(3)A.

Remove existing longitudinal rumble strips when within reconfigured temporary lane limits on long-term duration projects. Ensure all drainage, ITS, and other roadway structures within the existing shoulder are traffic bearing. Ensure pavement thickness is sufficient when traffic is shifted onto existing shoulders in the long-term duration reconfiguration.

Advisory speeds should only be used for unique situations and shall supplement warning signs or state the actual condition warranting the advisory.

When restrictive features in a work zone prevent the design speed from matching the work zone speed limit at a freeway median crossover, then MUTCD 6G.16 provides guidance for the restrictive feature to be designed at 10 mph less than the posted work zone speed limit. In this case, an advisory speed equivalent to the reduced design speed at the restrictive feature's location while the work zone speed limit is maintained.

> **Example:** A 60 mph continuous work zone speed limit is posted along a 10-mile freeway work zone, but its median crossovers at the beginning and end can only meet a 50 mph design speed due to restrictive features. Rather than post the entire 10-mile work zone 50 mph, maintain the 60 mph work zone speed limit and use a 50 mph advisory speed plaque (W13-1P) to supplement an appropriate warning sign (W1-4 or W24-1 series), at the crossovers.

B. Variable Work Zone Speed Limit and Advisory Speed

Variable work zone speed limit reductions are applicable to intermediate-term duration stationary work zones (lasting 3 continuous days or less, inclusive of weekend-duration closures) and may be considered as part of an overall safety strategy.

Freeway Shoulder Closures:

Reduced variable regulatory speed limits shall not be used for freeway shoulder closures.

Advisory speeds are allowable when unique conditions are present.

Typical Freeway Lane Closures; No Lateral Shift onto Shoulder:

Maintaining the existing posted speed limit is allowable for intermediate-duration (≤ 3 days) lane closures, when lanes are not shifted to conflict with the existing or temporary pavement markings.

Reduced variable regulatory work zone speed limits per Exhibit 5-13 are recommended when:

- Workers have no means of escape from motorized traffic (e.g., tunnels, bridge, etc.)
- Workers are actively present within one-half lane width of adjacent open lane(s) not protected by barrier
- High operation speeds combined with high traffic volumes are anticipated

If used, the variable regulatory work zone speed limit and advisory speeds are per Exhibit 5-13.

Exhibit 5-13 Freeway Variable Regulatory Work Zone Speed Limit/ Advisory Speed Policy

Typical Freeway Lane Closures; No Shifts onto Shoulder (One or more lanes open to traffic)		
Existing Speed Limit	**Variable Regulatory Work Zone Speed Limit**	**Advisory Speed**
70 mph	60 mph	Allowable when unique conditions are present
60 mph	50 mph	

Notes:

- Maintaining the existing posted speed limit is allowable
- Advisory speeds are used at specific locations only
- Radar Speed Display Sign with associated R2-1 speed limit sign is optional for Construction and optional for Maintenance

Variable work zone speed limit and advisory speeds approval is per Executive Order E 1060.02 in compliance with WSDOT Project Delivery Memo #19-01.

See Section 5-18.C for documentation requirements and Section 5-18.D for notification requirements.

It is understood there will be unique situations that may warrant adjustments to values listed in Exhibit 5-13 based on engineering judgement, but these adjustments are limited to 5 +/- mph to maximize consistency statewide.

When used, a Radar Speed Display Sign (RSDS) with an associated R2-1 speed limit sign should be located and relocated as needed to remain 500' +/- of work crews when feasible. Additional RSDSs may be added prior to each work crew based on engineering judgement.

RSDS General Specification Provisions are currently available and includes a requirement for RSDSs to have traffic data collection capabilities and for traffic data to be collected and transmitted to the Engineer upon request. This data may be requested by State Work Zone Engineers thru Region Traffic Operations.

Typical plans are included in the WSDOT Work Zone Traffic Control Plan Library for variable regulatory work zone speed limits on two-lane and three-lane freeway configurations.

Typical Freeway Lane Closures; Single Lane Shifted onto Shoulder:

Both work zone variable regulatory speed limit and advisory speeds listed in Exhibit 5-14 are **required** when a single open freeway lane is temporarily shifted onto the shoulder for intermediate-duration (≤ 3 days) closures.

It is understood there will be unique situations that may warrant adjustments to values listed in Exhibit 5-14 based on engineering judgement, but these adjustments are limited to 5 +/- mph to maximize consistency statewide.

This shifted configuration is necessitated by work operations including but not limited to:

- **Two-lane freeway** with the work area extending up to the lane line adjacent to traffic for work including HMA pavement, concrete pavement, and/or expansion joint rehabilitation.
- **Three-lane freeway** with the work area including both lanes and extending up to the lane line adjacent to traffic for work including HMA pavement, concrete pavement, and/or expansion joint rehabilitation.

Exhibit 5-14 Freeway Variable Regulatory Work Zone Speed Limit/Advisory Speed Policy

Single Open Freeway Lane Shifted onto Shoulder		
Existing Speed Limit	**Variable Regulatory Work Zone Speed Limit**	**Advisory Speed At Work Crew**
70 mph	55 mph	40 mph
60 mph	45 mph	40 mph

Notes:

- Maintaining the existing posted speed limit is prohibited
- Advisory speeds are required in advance of work crews
- Radar Speed Display Sign with W23-6 work crew advisory speed sign with W23-5 sign in advance, is required for Construction and recommended for Maintenance.

Variable work zone speed limit and advisory speeds approval is per Executive Order E 1060.02 in compliance with WSDOT Project Delivery Memo #19-01. See Section 5-18.C for documentation requirements and Section 5-18.D for notification requirements.

When used, a Radar Speed Display Sign (RSDS) with an associated work W23-6 crew advisory speed sign should be located and relocated as needed to remain 500' +/- of work crews when feasible. In addition, a W23-5 work crew ahead advisory speed sign should be located and relocated as needed to remain 1000' +/- of work crews. Additional RSDSs may be added prior to each work crew based on engineering judgement.

RSDS General Specification Provisions are currently available and includes a requirement for RSDSs to have traffic data collection capabilities and for traffic data to be collected and transmitted to the Engineer upon request. This data may be requested by State Work Zone Engineers thru Region Traffic Operations.

Typical plans are included in the WSDOT Work Zone Traffic Control Plan Library for these left shoulder shift and right shoulder shift configurations for two-lane and three-lane freeways.

C. Required Documentation Information

This section provides additional information and document templates regarding the *Required Document and Notices* section in Executive Order E 1060.02.

Memorandum:

- For work zone speed limit reductions requiring State Traffic Engineer approval, a formal memorandum shall be initialed by the Regional Administrator and/or Region Traffic Engineer to signify an official request by the Region. For a memorandum template, click here. Copy the template Word file onto your desktop first before modifying.

Traffic Control Plan:

- Traffic control plan accepted by the Region Traffic Engineer including the location of existing and proposed reduced speed limit signage along with requirements to cover or remove any conflicting speed limit signs.
- Typical traffic control plans available at WSDOT Work Zone Typical Traffic Control Plans; these typical plans may be modified as accepted by Region Traffic Engineer.

Project Vicinity Map

- Including a vicinity map in addition to the traffic control plan(s) is recommended

Work Zone Speed Reduction Worksheet:

A Microsoft Word template file of this work sheet is available. Copy the template Word file onto your desktop first before modifying.

Useful information needed to complete this work sheet includes:

- Posted Speed Limit, Number of lanes, Lane Width, and Shoulder Width can be found using the WSDOT State Highway Log.
- For all other locations and weekends, the AADT (Average Annual Daily Traffic) can be found using Traffic Data GeoPortal or completing a Traffic Data Request Form and submitting it to the Transportation Data GIS & Modeling office

D. Required Notification Information

This section provides additional information and template documents regarding the *Required Document and Notices* section in Executive Order E 1060.02.

Public Notice of Reduced Speed Limit:

Public notice, per RCW 47.48.020, is provided by publishing information in at least one issue of newspaper of general circulation regarding the reduced speed limit, including the location and effective dates. Advisory speeds do not require notifications.

- For a **continuous** speed limit reduction notice template and example, click here. Copy the template Word file onto your desktop first before modifying.
- For a **variable** speed limit reduction notice template and example, click here. Copy the template Word file onto your desktop first before modifying.

Consider placing a PCMS for advanced notification of continuous reduced work zone speed limits at least 72 hours in advance with a message similar to the following:

PCMS	
1	**2**
WORKZONE REDUCES TO 55MPH	STARTING 09/16 MONDAY
2.0 SEC	2.0 SEC

Notice to Headquarters Traffic Office of Reduced Speed Limit:

Email notice of the reduced regulatory work zone speed limit reduction (include a copy of the approved speed limit reduction work sheet) to the WSDOT HQ Work Zone Engineers:

No notice is required for advisory speeds.

Notice to Washington Patrol of Reduced Speed Limit:

Provide notice to WSP regarding the reduced work zone speed limit, including the location and effective dates. No notice is required for advisory speeds.

- For a **continuous** speed limit reduction notice template and example, click here. Copy the template Word file onto your desktop first before modifying.
- For a **variable** speed limit reduction notice template and example, click here. Copy the template Word file onto your desktop first before modifying.

Submit the notice to the appropriate Washington Patrol district. WSP currently has 8 districts (see Field Operations Bureau section).

See the WSP *Contact Us: District Office* webpage for district contact information.

See the WSP *Contact Us: PIO Contacts* webpage for district public information office contact information.

5-19 Washington Patrol Work Zone Enforcement and Assistance

It can be cost effective using Washington State Patrol (WSP) to supplement effective work zone strategies and traffic control devices by providing additional enforcement emphasis or performing specific traffic control assistance duties.

This General Special Provision (GSP) now allows Regions to define specific WSP activities and the number of hours provided by WSDOT at no cost to the Contractor on projects, but allows Contractors to request additional hours for those specific WSP activities at a 50/50 shared cost with WSDOT. This GSP should be included, even if zero hours are provided by WSDOT.

Roving Enforcement:

Using WSDOT-provided WSP roving speed enforcement a few times a week in active work zones when workers are present is an effective method to emphasize work zone speed limit reductions. During roving enforcement, WSP typically drive through the work zone while actively enforcing traffic laws but may also perform enforcement while stationary at strategically locations. The troopers pull over violators and issue citations at their discretion.

Coordinated Enforcement:

An alternative approach uses coordinated enforcement between multiple WSP troopers. A WSP trooper performs active enforcement within the work zone while informing several troopers downstream of motorists violating traffic laws. Those troopers downstream then pull over violators and issue citations at their discretion.

Photo Speed Enforcement:

Per RCW 46.63.170, automated work zone speed photo enforcement is currently prohibited as the state law restricts nearly all automated speed enforcement use outside of school zones. In 2008-2009, there was a pilot project for automated photo enforcement WSDOT work zones.

Double Fines in Work Zones:

Per RCW 46.61.527, traffic fines are doubled in work zones or reckless endangerment gross misdemeanors issued for the most serious violations that likely endangers people or property. The double fine citation does not require “FINES DOUBLE” and “NOTICE

FINES DOUBLE IN WORK ZONES” signs; however, their presence is encouraged by WSP. Routine enforcement by WSP in WSDOT work zones is always welcome and needs no special agreement.

When practical, a Public Information campaign to increase driver awareness of work zone safety issues will farther increase the effectiveness of WSP enforcement. Include notice via a PCMS in advance of an active enforcement area with a message similar to either of the following:

PCMS	
1	2
POLICE CHECKING SPEEDS	WORKZONE FINES DOUBLE
2.0 SEC	2.0 SEC

or

PCMS		
1	2	3
## MPH SPEED LIMIT	POLICE CHECKING SPEEDS	WORKZONE FINES DOUBLE
1.5 SEC	1.5 SEC	1.5 SEC

A. Procedure for Incorporating Use of WSP Enforcement and Assistance

Using WSP should be determined at the Design phase of the project and included in the Transportation Management Plan.

Regional Maintenance divisions may establish a standing Task Assignment agreement to allow quick response by WSP if needed.

WSDOT-WSP GC 5080 Agreement is a legal document allowing WSDOT to reimburse WSP for costs associated with assigning troopers for work zone enforcement or assistance. The Task Assignment, WSDOT Form 130-020, is completed for each project to assign specific work zone activities to WSP and connects WSDOT reimbursement to a specific work order.

Task Assignment Steps:

The Task Assignment should be completed, approved, and processed prior to the advertisement of a project to establish a WSP reimbursement work order.

- Region assigns a Task Management Manager for each project
- Task Assignment Manager develops a preliminary cost estimate using $125 per hour per WSP trooper including vehicle (increased from $75 in Agreement GC 5080 signed in 2007 to more accurately reflect current WSP costs). The minimum WSP shift is 2 hours.
- Task Assignment Manager requests the Agreement Number for each Task Assignment from Headquarters Traffic Office fiscal manager via email. Include the project name, route number, Contract or Work Order number (if known), and the preliminary cost estimate amount.
- Once the task number is assigned, the Task Assignment Manager completes WSDOT Form 130-020 and obtains approval typically from the Region Construction Project Engineer, WSP Agency Budget, and Fiscal manager. Two original copies are required, one for WSP and one for WSDOT.
- Task Assignment Manager submits WSDOT's original signed WSDOT Form 130- 020 to WSDOT Headquarters Budget Office. Copies are sent to Region Program Management, Construction Project Engineering Office administrating the project, Region Accounting office, and the Region Traffic Operations.
- The Region Accounting Office reimburses WSP per the Task Assignment Agreement.

B. Procedure for Requesting Use of WSP Enforcement and Assistance

Requests for WSP officers may occur after the Task Assignment Agreement is approved.

WSP currently has 8 districts (see Field Operations Bureau section) each with an Overtime Coordinator in which requests for WSP officers are made (troopers are not guaranteed and are subject to availability). See the WSP Contact Us: District Office webpage for district contact information.

WSP requests should be made at least two weeks in advance for major weekend- duration closures needing multiple troopers; make other requests at least one week in advance.

WSP responds to emergencies and incidents in work zones without the need of an Agreement, just like on roadways outside of work zones.

C. Procedure for Using WSP Enforcement and Assistance During Construction

An updated General Special Provision now allows Regions to define specific WSP activities and the number of hours provided by WSDOT at no cost to the Contractor on projects, but allows Contractors to request additional hours of those specific WSP activities at a 50/50 shared cost with WSDOT. A Task Assignment is still needed.

The WSP District Captain or their designee should be invited to pre-construction meetings, where specified WSP activities and hours of use should be discussed. Contact information for the WSDOT field engineer, Contractor Traffic Control Management, and the Traffic Control Supervisor should be provided to WSP.

During construction, it is optional for the on-site WSP trooper to attend the Contractor's Pre-Activity Safety meeting, or similar. The WSDOT field engineer or project inspector is to provide direction to WSP, but in collaboration with the

Contractor's traffic control management personnel. For each work shift when WSP is used, the WSDOT field engineer (or inspector) and WSP trooper shall complete WSDOT Form 421-045. Keep a copy of this form on file at the Construction Project Engineering Office. Contact Region Traffic Operations and see if they desire copies.

Usage of WSP is typically limited to enforcement duties and other supplemental uses not required as part of accepted Contract PS&E traffic control plans.

Typical WSP Usage Examples:

- Speed Enforcement Emphasis—Roving or coordinated enforcement
- Within or adjacent to rolling blockade when implementing freeway rolling slowdowns
- Full or directional closures of freeways; particularly in locations at high risk for errant motorist intrusion
- Controlling traffic at signalized intersections (only when shown on accepted traffic control plans)

WSP Usage Not Recommended:

The following tasks are not recommended as efficient use of WSP assistance and shall only be considered for short term use but not as an ongoing strategy

- General or routine use, especially with no significant traffic impacts expected
- Passive use (WSP vehicle parked near or inside work zone with blue or yellow lights flashing). WSP presence is not a substitute for proper traffic control
- During installation and removal of traffic control devices. WSP vehicles are not buffer vehicles
- Shoulder closures
- Lane closure(s) on roadways with posted speed limits of 40 mph or less
- Lane closure(s) with alternating traffic on a two-lane highway
- A ramp closure without other traffic control devices

5-20 Uniform Police Officer Usage in Work Zones

Uniform Police Officer (UPO) is an all-inclusive term for any sworn police officer from local law enforcement agencies or Washington Patrol.

A new General Special Provision requiring Contractors to provide UPOs as shown on accepted Contract PS&E traffic control plans and be reimbursed by the Agency via a hourly bid item.

During construction, it is desired for the UPO to attend the Contractor's Pre-Activity Safety meeting, or similar. The Contractor will provide direction to UPO, not the Agency. The UPO is **not** required to complete WSDOT Form 421-045.

For use of local agency law enforcement personal, the Contractor develops a project specific agreement with each police agency for use and payment.

Typical Uniform Police Officer Usage (Shown on Accepted Traffic Control Plans):

- Controlling either signalized intersections or unsignalized intersections
- Full or directional closures of roadways; particularly in locations at high risk for errant motorist intrusion
- Enforcing short-term road closures via traffic holds (Section 5-22)

Uniform Police Officer Usage Not Recommended:

The following tasks are not recommended as efficient use of local police officer assistance and shall only be considered for short term use but not as an ongoing strategy

- Speed Enforcement Emphasis (use WSP instead in WSDOT jurisdiction; see Section 5-19)
- General or routine use, especially with no significant traffic impacts expected
- Passive use (police vehicle parked near or inside work zone with blue or yellow lights flashing). Police presence is not a substitute for proper traffic control

- During installation and removal of traffic control devices. Police vehicles are not buffer vehicles
- Shoulder closures
- Lane closure(s) on roadways with posted speed limits of 40 mph or less
- Lane closure(s) with alternating traffic on a two-lane highway
- A ramp closure without other traffic control devices

5-21 Rolling Slowdowns

A rolling slowdown is a traffic control strategy that uses a rolling blockade of vehicles, each equipped with amber warning lights, traveling at slow speeds to create a gap in traffic to enable completion of work activities requiring exclusive access across or over the directional roadway that would otherwise present significant risks to motorists.

It is critical no traffic gets between the rolling blockade and work area. Within the limits of the rolling slowdown, traffic is held at most on-ramps, while freeway-to-freeway on-ramps should be closed with standard traffic control devices. Exit-ramps may remain open.

Rolling slowdowns may commence with additional temporary traffic control already set up (such as lane closures). Rolling slowdowns are most commonly used directionally on freeways due to their limited access. For other roadways, traffic holds may be more appropriate and are discussed in Section 5-22.

Accepted traffic control plans are required that detail the expected rolling slowdown duration, clear time at the work area, limits and target speed of the rolling slowdown, mainline rolling blockade details, chase vehicle details, temporary on-ramp closure details, portable changeable message signs used to warn traffic of the slowdown, and any additional requirements based on Guidance (Section 5-21.A) and Considerations (Section 5-21.B).

Work activities that typically necessitate a freeway rolling slowdown include but are not limited to the following:

- Utility line installation or removal over a freeway
- Removing an existing sign structure spanning over the freeway
- Reconfiguration of all freeway lanes that narrow and laterally shift all lanes in one work shift (Rolling slowdown is used to install a chicane to laterally shift a single open lane of traffic from the far left lane over to the far right lane, or vice versa) when reopening lanes to switch traffic control is not feasible
- During installation of traffic induction loops for permanent traffic recorders (see Standard Plan J-50.12-02 and J-50.15-01) using a lead-in across all freeway lanes to a stub-out in the shoulder which requires a chicane when reopening lanes is not feasible
- Emergency roadway or bridge repairs having short work durations (≤ 10 minutes)

- Based on WSDOT's determination, there is justification for using a rolling slowdown to mobilize large equipment, (cranes, drilling rigs, etc.) across the freeway versus demobilizing and mobilizing the equipment would lead to considerable delays and increased costs
- Based on WSDOT's determination, there is justification for using a rolling slowdown to provide construction vehicle ingress/egress movements between the work area onto mainline traffic in locations that would have minimal adverse traffic impacts and delays

Concurrent freeway rolling slowdowns in multiple directions is allowable when work operations occurring over all lanes in multiple directions.

A directional freeway closure is recommended in lieu of freeway rolling slowdowns during the following work operations occurring over **all lanes** in one direction:

- Setting new bridge girders
- Demolishing overhead bridge spans
- Removing overhead structural falsework
- Installing a new sign structure

WSDOT Region Traffic Operations may require directional freeway closures in lieu of freeway rolling slowdowns at its discretion.

A. Guidance

The following guidance applies when implementing rolling slowdowns:

- Avoid rolling slowdown durations exceeding 15 minutes
- Target rolling slowdown speeds 40 mph less than the posted speed limit when feasible
- Detours around the limits of the rolling slowdown are not necessary
- Traffic should not be stopped during rolling slowdowns, except as a last resort due to a unique circumstance or in an emergency situation.
- Use one blockade vehicle (transportable attenuator preferred) in each blocked lane
- Consider using at least one Washington Patrol (WSP) vehicle with each directional rolling blockade on freeways; WSP may serve as a rolling blockade vehicle
- Hold on-ramp traffic until the rolling blockade passes using construction or police vehicles placed prior to the paved gore in each on-ramp lane. Avoid holding traffic on freeway-to-freeway on-ramps, which should be closed with standard traffic control devices and may include signed detour routes.
- A chase vehicle should follow the slowest vehicle ahead of each directional rolling blockade up to the work area to ensure the roadway is clear.
- For concurrent rolling slowdowns in two or more directions, position a Traffic Control Coordinator with a WSP Coordinator near the work area to coordinate the rolling slowdown, respond to any incidents, and to coordinate needed emergency response.

- Inform Washington Patrol, local fire, police, emergency service agencies, and transit agencies (if applicable) at least 72-hours in advance of non-emergency rolling slowdowns.
- For significant freeway rolling slowdowns occurring within Transportation Management Areas (Seattle, Tacoma, Spokane, and Kennewick-Pasco urban areas):
  - Limit permitted rolling slowdowns to hours of lowest volumes; 11:00 p.m. to 4:00 a.m. during weeknights and 11:59pm to 6:00 a.m. on weekends
  - Require as part of the traffic control plan acceptance, a meeting with all necessary stakeholders to define responsibilities and ensure activities required for successfully executing a rolling slowdown will be followed
- Consider using a PCMS message similar to the example below for displaying advanced notification to the public:

PCMS		
1	2	3
15MINUTE DELAYS POSSIBLE	JUNE 13 SAT NITE 11PM-6AM	NB I-5 MP145 TO MP150
1.5 SEC	1.5 SEC	1.5 SEC

- Just prior to and during the rolling slowdown operation, consider using a truck-mounted PCMS to notify motorists of each rolling slowdown and its slow traffic remaining ½ ± mile in advance of the traffic queue moving along the paved shoulder:

PCMS	
1	2
ROLLING SLOWDOWN AHEAD	WATCH FOR SLOW TRAFFIC
2.0 SEC	2.0 SEC

B. Considerations

Consider the following when implementing rolling slowdowns:

- As part of the rolling slowdown traffic control plan, consider specifying the development of an emergency contingency plan to handle traffic should unforeseen circumstances occur, including but not limited to:
  - An Emergency Medical Services vehicle transporting a critical care or specialty care patient needs urgent accommodation past the rolling slowdown
  - Work activity exceeds the planned available clear time
  - An errant vehicle gets around the rolling blockade or on-ramp traffic hold and is heading towards the work area
- Have traffic queue formations and their dispersals monitored by traffic control personnel during and after each rolling slowdown with plan of action to respond to problems that develop because of the traffic queue
- Requiring all traffic queues clear prior to commencing any subsequent rolling slowdowns

C. Rolling Slowdown Equations & Calculations

Known Variables:

T_{CLEAR} = Clear time needed at work area [minutes]

V_{RS} = Rolling slowdown target speed [mph]

$V_{TRAFFIC}$ = Slowest Vehicle Speed Expected [mph]

Variables to be Determined:

D_{RS} = Minimum rolling slowdown distance needed [miles]

T_{RS} = Rolling slowdown duration [minutes]

Equations:

$$D_{RS} = \frac{T_{CLEAR} \times V_{RS} \times V_{TRAFFIC}}{60 \times (V_{TRAFFIC} - V_{RS})} \qquad T_{CLEAR} = \frac{60 \times (V_{TRAFFIC} - V_{RS}) \times D_{RS}}{V_{RS} \times V_{TRAFFIC}}$$

$$T_{RS} = \frac{60 \times D_{RS}}{V_{RS}} \qquad V_{RS} = \frac{60 \times D_{RS}}{T_{RS}}$$

Explanation of Variables and Calculations:

- **Clear time:** The duration at the work area available after the slowest vehicle followed by the chase vehicle passes and before the rolling slowdown blockade approaches.
- **Rolling slowdown target speed:** The target speed is based on the highest posted speed limit. Occurring after slowing down from typical operating freeway speeds, this is the speed the rolling slowdown blockade targets within the rolling slowdown limits for the duration of the slowdown.
- **Slowest vehicle speed expected:** Typically, the posted speed limit is used, but check for speed limit reductions within the rolling slowdown limits. If separate truck speed limits are present, use the truck speed limit for this value. There are unique situations such as steep upgrades (≥ 5 percent over ½ mile in length) where slow freight traffic may justify a lower speed.
- **Minimum rolling slowdown distance needed:** Calculated value that determines how far in advance of the work area the rolling slowdown begins.
- **Queue:** Calculated value to determine work zone queue length and is dependent on the number of unserved vehicle and how many open lanes are available prior to the capacity restriction (typically a lane closure merge point).
- **Rolling slowdown duration:** Calculated value to determine the duration the rolling slowdown remains in place to create the needed clear time at the work area.

Examples are provided on the next several pages as reference.

D. Rolling Slowdown Example #1

Situation: Freeway rolling slowdown needed for utility wire crossing southbound lanes of Interstate 5 located at Milepost 145.78. Crews need 10 minutes of clear time at the work area. The posted speed limit is 60 mph.

1st Determine: Duration of rolling slowdown needed in minutes and where it begins.

Known Variables:

T_{CLEAR} = 10 minutes

V_{RS} = 60 – 40 = 20 mph

Note: Rolling slowdown target speed is 40 mph less than 60 mph speed limit.

$V_{TRAFFIC}$ = 60 mph

Note: Traffic speed based on 60 mph speed limit since there are no major upgrades (≥ 5 percent) in this area.

Equations:

$$D_{RS} = \frac{T_{CLEAR} \times V_{RS} \times V_{TRAFFIC}}{60 \times (V_{TRAFFIC} - V_{RS})} \rightarrow D_{RS} = \frac{10 \times 20 \times 60}{60 \times (60-20)} = \frac{12000}{2400} = 5.00 = 5.0 \text{ miles}$$

$$T_{RS} = \frac{60 \times D_{RS}}{V_{RS}} \rightarrow T_{RS} = \frac{60 \times 5.00}{20} = \frac{300}{20} = 15 \text{ minutes}$$

The work area is located at MP 145.78. Mileposts decrease going southbound. Since the rolling slowdown begins prior to the work area, its milepost will be higher.

$$\text{Rolling slowdown location} = \text{Work Area} + \text{DRS} = 145.78 + 5.0 = 150.78$$

Answer: Rolling slowdown duration is 15 minutes and begins at Milepost 150.78.

2nd Determine: What on-ramps need to be temporarily held within the limits of the rolling slowdown until the mainline rolling blockade passes

As determined above, the rolling slowdown limits is between MP150.78 to MP145.78 on Southbound I-5. Using SRview 3 WSDOT, WSDOT GeoPortal, and/ or Google Maps (or similar), determine what on-ramps are located within the rolling slowdown limits.

Answer: On-ramps at the following locations need to be held:

- SR516 → Southbound I-5 (MP 149.07)
- S 272nd St → Southbound I-5 (MP146.71)

E. Rolling Slowdown Example #2

Situation: Freeway rolling slowdown needed for sign bridge removal over eastbound lanes of Interstate 90 located at Milepost 109.90. Crews need 7 minutes of clear time at the work area. The posted speed limit is 70 mph for cars and 60 mph for trucks.

1st Determine: Duration of rolling slowdown needed in minutes and where it begins.

Known Variables:

T_{CLEAR} = 7 minutes

V_{RS} = 70 – 40 = 30 mph

Note: Rolling slowdown target speed is 40 mph less than the highest speed limit, 70 mph, instead of the truck speed limit.

$V_{TRAFFIC}$ = 60 mph

Note: Traffic speed based on lower 60 mph truck speed limit since there are no major upgrades (≥ 5 percent) in this area.

Equations:

$$D_{RS} = \frac{T_{CLEAR} \times V_{RS} \times V_{TRAFFIC}}{60 \times (V_{TRAFFIC} - V_{RS})} \rightarrow D_{RS} = \frac{7 \times 30 \times 60}{60 \times (60 - 30)} = \frac{12600}{1800} = 7.00 = 7.0 \text{ miles}$$

$$T_{RS} = \frac{60 \times D_{RS}}{V_{RS}} \rightarrow T_{RS} = \frac{60 \times 7.00}{30} = \frac{420}{30} = 14 \text{ minutes}$$

The work area is located at MP 109.90. Mileposts increase going eastbound. Since the rolling slowdown begins prior to the work area, its milepost will be lower.

$$\text{Rolling slowdown location} = \text{Work Area} - \text{DRS} = 109.90 - 7.0 = 102.90$$

Answer: Rolling slowdown duration is 14 minutes and begins at Milepost 102.90.

2nd Determine: What on-ramps need to be temporarily held within the limits of the rolling slowdown until the mainline rolling blockade passes

As determined in above, the rolling slowdown limits is between MP102.90 to MP109.90 on Eastbound I-90. Using SRview 3 WSDOT, WSDOT GeoPortal, and/or Google Maps (or similar), determine what on-ramps are located within the rolling slowdown limits.

Answer: On-ramps at the following locations that need to be held:

- **US 97 → Eastbound I-90** (MP 105.82)
- **Canyon Rd → Eastbound I-90** (MP 109.74)

F. Rolling Slowdown Example #3

Situation: Freeway rolling slowdown needed for to transport a crane across all lanes of westbound I-82 over into the median at Milepost 38.16. Crews need 7 minutes of clear time at the work area. The work zone speed limit is 55 mph starting at MP 38.73 with the existing speed limit 70 mph (trucks 60 mph) maintained east of MP 38.73.

Determine: Duration of rolling slowdown needed in minutes and where it begins.

Known Variables:

T_{CLEAR} = 7 minutes

V_{RS} = 70 – 40 = 30 mph

Note: Rolling slowdown target speed is 40 mph less than the 70 mph posted speed limit.

$V_{TRAFFIC}$ = 55 mph

Note: Traffic speed is conservatively based on the lower 55 mph work zone speed limit for simplicity since there are no major upgrades (≥ 5 percent) in this area; typically the 60 mph truck speed limit would otherwise be used. This value could also be prorated.

Equations:

$$D_{RS} = \frac{T_{CLEAR} \times V_{RS} \times V_{TRAFFIC}}{60 \times (V_{TRAFFIC} - V_{RS})} \rightarrow D_{RS} = \frac{7 * 30 * 55}{60 * (55 - 30)} = \frac{11{,}550}{1500} = 7.70 = 7.7 \text{ miles}$$

$$T_{RS} = \frac{60 \times D_{RS}}{V_{RS}} \rightarrow T_{RS} = \frac{60 \times 7.70}{30} = \frac{462.0}{30} = 15.4 = 16 \text{ minutes}$$

The work area is located at MP 38.16. Mileposts decrease going westbound. Since the rolling slowdown begins prior to the work area, its milepost will be higher.

$$\text{Rolling slowdown location} = \text{Work Area} - D_{RS} = 38.16 + 7.7 = 45.86 = 45.9$$

Answer: Rolling slowdown duration is 16 minutes and begins at Milepost 45.9. Note 16 minutes slightly exceeds the guidance of 15 minute durations and should be justified.

2nd Determine: What on-ramps need to be temporarily held within the limits of the rolling slowdown until the mainline rolling blockade passes

As determined in above, the rolling slowdown limits is between MP45.9 to MP38.16 on Westbound I-82. Using SRview 3 WSDOT, WSDOT GeoPortal, and/ or Google Maps (or similar), determine what on-ramps are located within the rolling slowdown limits.

Answer: On-ramps at the following locations that need to be held:

- **Donald Wapato Rd → Westbound I-82** (MP 44.09)
- **Yakima Valley Highway → Westbound I-82** (MP 40.14)

G. Rolling Slowdown Example #4

Situation: Freeway rolling slowdown needed to install a temporary traffic control chicane to allow crews to restriping across all lanes in a single nightly shift on Eastbound Interstate 90 starting at Milepost 5.58. The I-5/I-90 interchange on- ramps are located at MP 2.67.

1st Determine: Determine the rolling slowdown speed, rolling slowdown duration, and clear time available in this unique scenario.

Known Variables:

$V_{TRAFFIC}$ = 60 mph

Note: Traffic speed based on 60 mph speed limit; no upgrades (≥ 5 percent) present.

Step #1: Determine the maximum rolling slowdown speed that fits within the 3.0 miles available (between the I-5/I-90 interchange to the work area) using the 15 minute maximum rolling slowdown guidance.

- Assume D_{RS} = 5.58 – 2.67 = 2.91
- Assume T_{RS} = 15 minutes

$$V_{RS} = \frac{60 \times D_{RS}}{T_{RS}} \rightarrow V_{RS} = \frac{60 \times 2.91}{15} = 11.64 \text{ (round down to 11 mph)}$$

Step #2: Using a 15 minute rolling slowdown duration and target speed of 11 mph, determine the maximum clear time available at the work area.

$$T_{CLEAR} = \frac{60 \times (V_{TRAFFIC} - V_{RS}) \times D_{RS}}{V_{RS} \times V_{TRAFFIC}} \rightarrow T_{CLEAR} = \frac{60 \times (60 - 11) \times 2.91}{11 \times 60} = \frac{8555.4}{660} = 13 \text{ minutes}$$

Answer: The rolling slowdown target speed is 11 mph, duration of 13 minutes, and begins at Milepost 2.67 (immediately following the I-5/I-90 interchange) on Eastbound I-90.

2nd Determine: What on-ramps need to be temporarily held or closed within the limits of the rolling slowdown until the mainline rolling blockade passes

As determined in above, the rolling slowdown limits is between MP2.58 to MP5.58 on Eastbound I-90. Using SRview 3 WSDOT, WSDOT GeoPortal, and/or Google Maps (or similar), determine what on-ramps are located within the rolling slowdown limits.

Answer: On-ramps at the following locations that need to be held/closed:

- **Hold Southbound Rainer Ave → Eastbound I-90** (MP 3.34)
- **Hold Northbound Rainer Ave → Eastbound I-90** (MP 3.79)

Note: Since the I-5 ramps to EB I-90 are at the rolling slowdown limits, the rolling slowdown blockade can concurrently begin along the freeway-to-freeway on-ramps from NB I-5 and SB I-5 and to join the EB I-90 blockade; however, freeway-to-freeway on-ramps traffic should not be stopped or held. If freeway- to-freeway ramps need to be stopped or held, they should be closed using standard traffic control devices.

5-22 Traffic Holds

A traffic hold is a traffic control strategy using flaggers and/or uniformed police officers (UPOs) to stop traffic in all directions to enable completion of work activities requiring exclusive access across or over the roadway that would otherwise present significant risks to motorists. UPOs include Washington Patrol and any local police agency.

Traffic holds shall not be used on freeway mainlines.

Traffic holds may be used on non-freeways roadways where rolling slowdowns (Section 5-21) are not feasible in lieu of a roadway closure. When used, it is preferred to reduce each approach down to a single open lane using standard traffic control devices and advanced warning signage. It is optional to place a UPO vehicle with emergency lights activated on either side of the work area after the flaggers to help block the roadway.

Traffic holds also may be used on roadways where traffic alternates in a single lane via flagger-control, particularly in areas where there are no alternative routes and work is being completed in a narrow area requiring traffic to be held in all directions.

When holding traffic at or near signalized intersections, the traffic signal must be turned off or set to all-way red flashing mode per WAC 468-95-3015. Per WAC 468-95-302, only UPOs should flag at the center of the intersection except in an emergency; however, flaggers may control each intersection leg.

A. Traffic Hold Guidance

Consider the following guidance when implementing traffic holds:

- Limit traffic hold durations to 10 minutes when feasible
- If traffic hold durations are 15+ minutes on major arterial roadways, provide advance notice to the public at least 72 hours prior to and during traffic holds:

PCMS		
1	2	3
15MINUTE DELAYS POSSIBLE	09/15/-19 NIGHTLY 11PM-5AM	AT SR527 & 180TH ST
1.5 SEC	1.5 SEC	1.5 SEC

DISPLAY AT LEAST 3 DAYS IN ADVANCE OF TRAFFIC HOLD

and

PCMS	
1	2
15MINUTE TRAFFIC HOLDS	BE PREPARED TO STOP
2.0 SEC	2.0 SEC

LOCATE TO REMAIN 1/2+/- MILE IN ADVANCE OF EXPECTED QUEUE.

PCMS MAY BE TRUCK MOUNTED

- For longer term traffic hold durations of 30+ minutes consider specifying traffic is to be released at regular time intervals such as 00 and 30 past the hour. This assists in setting expectations with the driver and thereby able to plan their travel through the area. Provide at least seven calendar day notice to the public except in emergencies. When considering this strategy, it may be a good time to involve Region Management in the decision process.

PCMS		
1	2	3
EXPECT 30MINUTE DELAYS	MAR13-17 MON-FRI 7AM-6PM	SR410 25 MILES AHEAD
1.5 SEC	1.5 SEC	1.5 SEC

and

PCMS		
1	2	3
30MINUTE TRAFFIC HOLDS	TRAFFIC RELEASED AT THE	TOP AND BOTTOM OF HOUR
1.5 SEC	1.5 SEC	1.5 SEC

DISPLAY AT LEAST 7 DAYS IN ADVANCE OF TRAFFIC HOLD

DESIRABLE TO PLACE JUST OUT OF TOWN OR NEAR AN ALTERNATIVE ROUTE SO MOTORISTS CAN AVOID WORK ZONE.

LOCATE TO REMAIN 1/2 +/- MILE IN ADVANCE OF EXPECTED QUEUE.

PCMS MAY BE TRUCK MOUNTED.

- At locations where bicyclists and motorists need to share a lane following the end of traffic holds, release motorists first allowing queues to clear and then allow bicyclists to proceed
- If feasible, release traffic in all directions until queues dissipate before commencing another traffic hold or alternating traffic
- To avoid severe traffic impacts, consider limiting permitted traffic hold hours
  - Consider limiting daytime traffic holds on weekdays to avoid impacting commuting and school traffic. Use nighttime hours if needed
  - As guidance, consider assigning permitted traffic hold hours based on the needed traffic hold duration and directional traffic volume thresholds list below which assumes that traffic in all directions is released at the end of the traffic hold:

Traffic Hold Duration (minutes)	Single Direction with Heaviest Traffic Volumes (vehicles/hour)
30	250
20	375
15	500
10	750
5	1200

- Recommend reducing each traffic approach to a single open lane with standard traffic control devices and advanced warning signage
- Inform Washington Patrol, local fire, police, emergency service agencies, and transit agencies (if applicable) at least 72-hours in advance of non-emergency traffic holds

5-23 WSDOT Approval, Acceptance, & Review Protocol for Local Agencies

When within WSDOT jurisdiction, the work zone traffic control plans shall be consistent with WSDOT standard work zone practices and policy in addition to applicable state and federal laws. These requirements may exceed those set forth in the *Manual on Uniform Traffic Control Devices* (MUTCD). Each WSDOT Region Traffic Operations will determine standard work zone practices within their Region.

WSDOT has authorization to accept work zone traffic control plans only within the boundaries of WSDOT Right of Way, including all Interstate Highways and WSDOT Limited Access (RCW 47.52).

There are conditions requiring WSDOT approval, acceptance, or review even when within local agency jurisdiction including:

- Review traffic control plans involving a full highway closure (RCW 47.48.010)
- Review traffic control plans that may impact state highway, freeway, or the Interstate Highway System
- Accept traffic control plans affecting a WSDOT owned or operated traffic signal along a State Route (RCW 47.24.020, Section 13).
- Approve temporary regulatory work zone speed limit reduction along a State Route (Secretary's Executive Order E 1060.02)
- Approve the installation of all traffic signals, both permanent and temporary, along a State Route (RCW 47.24.020, Section 13)

Local agencies may request WSDOT to *review* traffic control plans outside of WSDOT jurisdiction, but acceptance is still the local agency's responsibility.

The Memorandum of Understanding of "City Streets As Part of State Highways" provides an agreement between Cities and WSDOT for responsibilities in regards to the construction, operation, and maintenance for city streets that also function as state highways. By understanding responsibilities, it is then known who develops the associated traffic control plans.

Washington City and Town Profiles webpage provides current city population information.

The following information is needed to determine the appropriate traffic control plan (TCP) acceptances or reviews by WSDOT and local agencies:

- WSDOT TCP Acceptance & Review Stamp Protocol (Section 5-23.A)
- Right-of-Way & WSDOT Limited Access Information (Section 5-23.B)
- Local Agency Boundary Information (Section 5-23.C)
- State Highway Traffic Signals within Local Agencies (Section 5-23.D)

A. Traffic Control Plan Acceptance and Review Stamp Protocol

Document traffic control plan acceptance or review via stamps (including signature and date) on each sheet. Acceptance authority will be determined by each WSDOT Region Traffic Operations.

This subsection provides protocol for four types of traffic control plan stamps:

- Traffic control plan accepted and is entirely within WSDOT Right-of-Way and/or WSDOT Limited Access:

- Traffic control plan accepted within WSDOT jurisdiction but also needs to be accepted for portion within the local agency's jurisdiction ("dual acceptance"):

- Traffic control plan reviewed by WSDOT, at local agency's request, but must still be accepted by the local agency:

- Traffic control plan not accepted; consider providing comments and explanation of what needs to be addressed on the traffic control plan:

B. Right-of-Way and WSDOT Limited Access Information

WSDOT Right-of-Way plans, which also show WSDOT Limited Access boundaries, are the most useful way to determine which agency has jurisdiction for traffic control plan acceptance.

For general information regarding WSDOT Limited Access boundaries, see Exhibits in WSDOT *Design Manual* Chapter 530.

There are three typical ways to find specific boundaries of Right-of-Way and Limited Access:

- WSDOT Plans and Document Archive webpage provides a library for Right of Way Plans to determine these limits at each interchange or intersection
- WSDOT Active Right of Way Plans webpage provides a list of many right of way plans by corridor for the entire state
- Contact WSDOT Region Right-of-Way staff for further assistance

C. Local Agency Boundary Information

WSDOT GeoPortal has a "Political Boundaries" feature that displays the city, county, tribal land boundaries overlaid on a map of Washington.

D. State Highway Traffic Signals within Local Agencies

WSDOT has approval or acceptance authority of traffic control plans within the limits of signalized intersections on State Highways when the traffic signal is WSDOT owned or operated, even when within local agency limits exceeding the population thresholds specified in RCW 47.24.020, Section 17. The local agency has approval authority outside the limits of the signalized intersection within their jurisdiction.

Contact WSDOT Region Traffic Operations to determine which agency owns or operates State Highway traffic signals within the limits of local agencies.