



Federal Highway Administration

Proven Safety Countermeasures in **Work Zones**

Desktop Reference



U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

FHWA-SA-24-033

Introduction

Work zones are necessary to maintain, rehabilitate, enhance, and reconstruct this nation's roadway network, but they are also where a significant number of traffic fatalities occur each year. According to the National Highway Traffic Safety Administration's (NHTSA's) Fatality and Injury Reporting System Tool (FIRST), 4,319 people were killed in work-zone crashes in the U.S. between 2018 and 2022. The number of work-zone fatalities has grown from 757 fatalities in 2018 to 891 in 2022, a 17.7 percent increase.

The Federal Highway Administration (FHWA) has identified 28 Proven Safety Countermeasures (PSCs) to reduce fatal and serious injury crashes on roads nationwide (see Figure 1). These PSCs are applicable for a range of contexts, road types, and governing agencies across the country. Efforts to reduce fatal and serious injury crashes in work zones can leverage efforts and lessons learned outside of work zones, including the effectiveness of PSCs. Implementing PSCs in work zones is a step towards a Safe System Approach to work zone planning, design, deployment, management, and operations.

Agencies can implement the PSCs in this desktop reference through their work zone policies and program-level processes, or by proactively implementing these countermeasures as part of individual temporary traffic control (TTC) plans and transportation operations (TO) components. The National Work Zone Safety Information Clearinghouse provides additional information about safety in work zones, including potential work zone safety countermeasures.¹

OFFICE OF SAFETY

Proven Safety Countermeasures

SPEED MANAGEMENT



Speed Safety Cameras



Variable Speed Limits



Appropriate Speed Limits for All Road Users

ROADWAY DEPARTURE



Wider Edge Lines



Enhanced Delineation for Horizontal Curves



Longitudinal Rumble Strips and Stripes on Two-Lane Roads



SafetyEdgeSM



Roadside Design Improvements at Curves



Median Barriers

INTERSECTIONS



Backplates with Retroreflective Borders



Corridor Access Management



Dedicated Left- and Right-Turn Lanes at Intersections



Reduced Left-Turn Conflict Intersections



Roundabouts



Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections



Yellow Change Intervals

PEDESTRIANS/BICYCLES



Crosswalk Visibility Enhancements



Bicycle Lanes



Rectangular Rapid Flashing Beacons (RRFB)



Leading Pedestrian Interval



Medians and Pedestrian Refuge Islands in Urban and Suburban Areas



Pedestrian Hybrid Beacons



Road Diets (Roadway Reconfiguration)



Walkways

Crosscutting



Pavement Friction Management



Lighting



Local Road Safety Plans



Road Safety Audit

¹ <https://workzonesafety.org/>

Figure 1. FHWA's 28 Proven Safety Countermeasures. Source: FHWA.

Desktop Reference

The Proven Safety Countermeasures (PSCs) in Work Zones Desktop Reference is a quick reference summary of PSC applications in work zones. It addresses four key characteristics of each PSC: 1) how the countermeasure addresses the Safe System Roadway Design Hierarchy, 2) crash reduction ranges or general safety benefits, 3) relative cost for installation, and 4) use or applicability of the PSC in work zones.

1 – Safe System Roadway Design Hierarchy Alignment

- **Tier 1: Remove Severe Conflicts** - eliminating specific high-risk conditions, such as separating road users moving at different speeds or different directions, in space to minimize conflicts.
- **Tier 2: Reduce Vehicle Speeds** - implementing design features and speed management strategies to reduce vehicle speeds; effectively reduces the kinetic energy involved in a crash should it occur.
- **Tier 3: Manage Conflicts in Time** - separating the users in time using traffic control devices, such as traffic signals or hybrid beacons, to minimize vehicle conflicts with vulnerable road users.
- **Tier 4: Increase Attentiveness and Awareness** - alerting roadway users to certain types of conflicts so that appropriate action can be taken.
- Find more information on the Safe System Roadway Design Hierarchy at https://highways.dot.gov/sites/fhwa.dot.gov/files/2024-01/Safe_System_Roadway_Design_Hierarchy.pdf.

2 – Crash Reduction or Safety Benefit²

- **Low (L)** - less than or equal to 24% reduction ($\leq 24\%$).
- **Medium (M)** - greater than or equal to 25% and less than or equal to 49% reduction (25-49%).
- **High (H)** - greater than or equal to 50% reduction ($\geq 50\%$).
- The crash types for which the estimated crash reduction benefits apply are provided in parentheses.

3 – Relative Cost

- **Low-cost (L)**: up to \$5,000 per mile or location.
- **Medium-cost (M)**: \$5,000 to \$50,000 per mile or location.
- **High-cost (H)**: more than \$50,000 per mile or location.
- Note costs can vary considerably due to local conditions.

4 – Use in Work Zones

- This includes information about the use or applicability of the PSCs in work zone contexts. It is consistent with information in the PSC summaries in *Implementing the Proven Safety Countermeasures in Work Zones*.

Safety Focus Area	Proven Safety Countermeasure	1 Safe System Design Hierarchy Alignment				2	3	4
		Tier 1: Remove Severe Conflicts	Tier 2: Reduce Vehicle Speeds	Tier 3: Manage Conflicts in Time	Tier 4: Increase Attentiveness and Awareness	Crash Reduction or Safety Benefit L-M-H	Relative Cost L-M-H	Use in Work Zones
	Appropriate Speed Limits for All Road Users	-	Yes	-	-	Reduce operating speeds and improve speed limit compliance through work	L	<ul style="list-style-type: none"> • When setting speed limits, agencies should consider non-vehicular activities, types of users present, crash history, land use context, traffic volumes, and observed speeds, among other factors. • Agencies can consider reducing speed limits under

Figure 2. Excerpt of the Work Zone PSC Desktop Reference table columns.

² All cited crash reductions or safety benefits are consistent with the PSC summaries in *Implementing the Proven Safety Countermeasures in Work Zones*. If information about crash reductions was not available, the reference includes information about other general safety benefits (e.g., speed reduction).

Table 1. The Work Zone PSC Desktop Reference

Safety Focus Area	Proven Safety Countermeasure	Safe System Design Hierarchy Alignment				Crash Reduction or Safety Benefit L-M-H	Relative Cost L-M-H	Use in Work Zones
		Tier 1: Remove Severe Conflicts	Tier 2: Reduce Vehicle Speeds	Tier 3: Manage Conflicts in Time	Tier 4: Increase Attentiveness and Awareness			
Speed Management	<u>Appropriate Speed Limits for All Road Users</u>	-	Yes	-	-	Reduce operating speeds and improve speed limit compliance through work zones	L	<ul style="list-style-type: none"> When setting speed limits, agencies should consider non-vehicular activities, types of users present, crash history, land use context, traffic volumes, and observed speeds, among other factors. Agencies can consider reducing speed limits under restrictive conditions or when workers are next to moving traffic without positive protection.
	<u>Speed Safety Cameras (SSCs)</u>	-	Yes	-	-	M (work zone fatal crashes) L (work zone speeds) H (occurrence of speeds over the citation threshold)	M-H	<ul style="list-style-type: none"> Traditional speed enforcement may not be feasible in work zones due to restrictive geometry or limited space, so states and municipalities have passed legislation to allow SSCs in work zones to improve safety. Engineering studies, including speed limit and safety assessments, should also be conducted for each work zone to determine if speed limits are appropriately set, limits are properly posted, and to review other safety factors.
	<u>Variable Speed Limits (VSLs)</u>	-	Yes	-	Yes	H (fatal and injury crashes on freeways) Reduce speeding and improve speed harmonization through work zones	L-H	<ul style="list-style-type: none"> Portable VSLs can be used in work zones. VSLs can improve driver expectation by providing information in advance of slowdowns and potential lane closures.
Pedestrian/ Bicyclist	<u>Bicycle Lanes</u>	Yes	-	-	-	H (bicycle/vehicle crashes) M (total crashes)	L-M	<ul style="list-style-type: none"> When a bicycle facility passes adjacent to work zones or construction activities affect the path of a bicycle facility, the continuity of a bikeway should be maintained through the work zone if practical (MUTCD Section 6N.04, 2023). If a bikeway detour is unavoidable, it should be as short and direct as practical (MUTCD Section 6N.04, 2023).
	<u>Crosswalk Visibility Enhancements</u>	-	-	-	Yes	M (pedestrian injury and pedestrian crashes)	L-M	<ul style="list-style-type: none"> Crosswalk visibility enhancements can be applied in work zones on pre-existing crosswalks and temporary crosswalks. If work zones intrude into pedestrian pathways, TTC measures should be in place to accommodate pedestrians (MUTCD Section 6C.02; FHWA, 2023).

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Pedestrian/ Bicyclist	<u>Leading Pedestrian Interval (LPI)</u>	-	-	Yes	-	L (pedestrian crashes)	L	<ul style="list-style-type: none"> LPIs may be beneficial in work zones at signalized intersections with high turning vehicle volumes. They can also be beneficial at signalized intersection crossing locations where construction vehicles or other heavy trucks are frequently turning.
	<u>Pedestrian Refuge Islands</u>	Yes	Yes	-	-	M (pedestrian crashes)	L-M	<ul style="list-style-type: none"> Pedestrian refuge islands may be useful in work zones when work zone features, such as temporary traffic control devices, barriers, and construction equipment, may increase the visual clutter of the roadway and increase the crossing movement complexity. Temporary pedestrian refuge islands in work zones can be delineated using flex posts, longitudinal plastic barriers or channelizing devices, or other elements.
	<u>Pedestrian Hybrid Beacons (PHBs)</u>	-	-	Yes	-	M-H (total and pedestrian crashes)	M	<ul style="list-style-type: none"> PHBs can be implemented at uncontrolled marked crosswalks in work zones on pre-existing and temporary crosswalks. Temporary mobile PHB systems are available for work zone applications.
	<u>Rectangular Rapid Flashing Beacons (RRFBs)</u>	-	-	-	Yes	M (pedestrian crashes) H (driver yielding rates)	L	<ul style="list-style-type: none"> RRFBs can be implemented at uncontrolled marked crosswalks in work zones on pre-existing crosswalks and temporary crosswalks. RRFBs can use solar power, which eliminates the need for a power source.
	<u>Road Diets (Roadway Reconfiguration)</u>	Yes	Yes	-	-	L-M (total crashes)	L-H	<ul style="list-style-type: none"> Work zones frequently incorporate temporary reductions in the number of lanes to facilitate construction activities in or adjacent to the roadway. Common features associated with permanent road diets can be applied to work zones to reduce motor vehicle speeds, reduce road user exposure, and improve access and comfortability for all users.
	<u>Walkways</u>	Yes	-	-	-	H (pedestrian crashes)	L-H	<ul style="list-style-type: none"> When an existing walkway is disrupted due to a work zone, a temporary facility with temporary traffic control should be implemented in its place to provide safe, accessible accommodations for pedestrians and other users. (MUTCD Section 6C.03, 2023) The temporary facility should provide a convenient and accessible path and avoid conflicts with obstacles related to the work zone (e.g., signing, fencing, construction equipment) (MUTCD Section 6C.03, 2023).

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Roadway Departure	<u>Enhanced Delineation for Horizontal Curves</u>	-	-	-	Yes	M (nighttime crashes) L-H (fatal and injury crashes)	L	<ul style="list-style-type: none"> When work zones have horizontal curves, including on temporary roadways, enhanced delineation of the curve can improve visibility to drivers approaching and navigating the work zone. Warning devices can be used on tangents approaching the curve to improve visibility, such as warning signs, arrow boards, or taper devices.
	<u>Rumble Strips</u>	-	-	-	Yes	H (queued condition crashes) L (mean operating speed reduction in work zones)	L	<ul style="list-style-type: none"> Temporary transverse rumble strips can alert drivers approaching a work zone to the need to slow down or stop. Temporary transverse rumble strips in work zones use a temporary raised surface placed on or adhered to the pavement surface.
	<u>Median Barriers</u>	Yes	-	-	-	H (cross-median crashes)	M-H	<ul style="list-style-type: none"> Barriers can help reduce likelihood of traffic entering work areas such as excavations or material storage sites and provide positive protection for workers, pedestrians, bicyclists, and other vulnerable road users. Different barrier types can be used for positive protection depending on the work zone conditions (e.g., portable concrete barriers, ballast-filled barriers typically filled with sand or water, portable steel barriers, mobile barrier trailers or movable barrier systems, and truck mounted attenuators).
	<u>Roadside Design Improvements at Curves</u>	Yes	-	-	-	L (total crashes)	L-H	<ul style="list-style-type: none"> Roadside design improvement strategies at curves can be applied temporarily in work zones using devices such as traffic barriers, traffic control devices, and other roadside safety features. Clear zone widths in work zones may vary depending on equipment and material storage needs.
	<u>SafetyEdgeSM</u>	Yes	-	-	-	L (fatal and injury, run-off road, and head-on crashes)	L	<ul style="list-style-type: none"> Pavement edge drop-offs may occur in work zones due to construction activities such as pavement replacement or overlays. SafetyEdgeSM may be applicable to situations where temporary pavement is applied or when there are temporary pavement edge drop-offs that are not shielded by a barrier.
	<u>Wider Edge Lines</u>	-	-	-	Yes	M (fatal and injury crashes on rural two-lane roads) L (fatal and injury crashes on rural freeways)	L	<ul style="list-style-type: none"> Road users may have difficulty comprehending and navigating the travel path in work zones. Temporary wider edge lines can be used in work zones to improve visibility of the travel lane and edge line.

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Intersections	<u>Backplates with Retroreflective Borders</u>	-	-	-	Yes	L (total crashes)	L	<ul style="list-style-type: none"> Backplates with retroreflective borders can be installed on either permanent traffic signals or temporary (or portable) traffic signals in work zones. These borders can improve visibility and conspicuity of the signals.
	<u>Access Management</u>	Yes	-	-	-	L-M (total crashes on two-lane rural roads or fatal and injury crashes on urban/suburban arterials)	L-M	<ul style="list-style-type: none"> Corridor access management can be applied in work zones to improve access to construction sites and/or permanent entry and exit points along roadways with work zones. Strategically placing entry and exit points in a work zone can help limit the number of conflict points between construction vehicles and other users.
	<u>Dedicated Turn Lanes</u>	Yes	-	-	-	L-M (total or fatal and injury crashes)	M	<ul style="list-style-type: none"> Work zones can utilize existing turn lanes or new turn lanes can be created as a part of the temporary traffic control plan. Warning signs and other strategies can be used when work zone activities require lane closures that affect left- or right-turn lanes.
	<u>Reduced Left-Turn Conflict Intersections</u>	Yes	-	-	-	L-H (fatal and injury crashes)	H	<ul style="list-style-type: none"> Temporary or permanent Restricted Crossing U-turns (RCUTs) or Median U-turns (MUTs) can be used in work zones to reduce conflicts at intersections. A key consideration in applying RCUTs and MUTs in work zones is the availability of locations for U-turns.
	<u>Roundabouts</u>	Yes	Yes	-	-	H (fatal and injury crashes)	L-H	<ul style="list-style-type: none"> Temporary roundabouts can be an effective solution in work zones, especially in cases where work zone activities affect existing traffic signals or during adverse events, such as severe storms. Temporary roundabouts can be constructed using traffic cones, drums, vertical panels, and parking curbs.
	<u>Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections</u>	-	-	-	Yes	L (fatal and injury and nighttime crashes) M (fatal and injury crashes at rural intersections)	L	<ul style="list-style-type: none"> Enhancing the signing and markings in work zones (for example, using oversized or double signs, beacons, or high-visibility pavement markings) can help alert drivers to important information, like an upcoming intersection amidst the added visual clutter and distraction of work zone activities.
	<u>Yellow Change Intervals</u>	-	-	Yes	-	L (total and injury crashes at intersections) M-H (red-light running)	L	<ul style="list-style-type: none"> Appropriately timed yellow change intervals can be applied in work zones for temporary traffic control at permanent and portable traffic signals.

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Crosscutting	<u>Lighting</u>	-	-	-	Yes	M (nighttime injury and pedestrian injury crashes)	L-H	<ul style="list-style-type: none"> Lighting can improve visibility of closed lanes, lane shift markings, construction equipment, other unexpected features, and workers. Lighting in work zones may include portable light plant towers, conventional roadway luminaires on temporary poles, factory-installed lighting on work equipment, and balloon portable light towers.
	<u>Local Road Safety Plans (LRSPs)</u>	Yes	Yes	Yes	Yes	L-M (total crashes)	L-H	<ul style="list-style-type: none"> LRSPs can be incorporated into work zone planning and design processes. Agencies can review LRSPs to identify safety issues in the area of work zones which should be considered when designing the work zone and temporary traffic control (e.g., overrepresentation of certain crash types).
	<u>Pavement Friction Management</u>	Yes	Yes	-	-	H (injury crashes at ramps) M (injury crashes at horizontal curves) L (total crashes at intersections)	L-M	<ul style="list-style-type: none"> High Friction Surface Treatments (HFST) can be applied to temporary or permanent pavement in work zones. Work zone conditions that may require increased friction demand include along horizontal curves, approaching intersections or pedestrian crossings, approaching a work zone, where there are temporary changes in road geometry, steel plate trench covers, and at locations with a risk of increased crashes where increasing friction demand could help.
	<u>Road Safety Audit (RSA)</u>	Yes	Yes	Yes	Yes	L-H (total crashes)	L-M	<ul style="list-style-type: none"> Work zone RSAs can occur during planning and design of work zones or during an active work zone. Work zone RSAs can help mitigate potential safety impacts or identify unforeseen safety issues.



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