



Podcast 4:

Work Zone Data Collection & Analysis: What, Why, and How

Hello and welcome to the American Traffic Safety Services Association’s Work Zone Safety podcast series. This podcast is based on work supported by the Federal Highway Administration under the 2011 Work Zone Safety Grant. It is the first of three segments on the topic of Work Zone Data Collection and Analysis and will focus on collecting data in preparation for developing work zone strategies, designing a safe work zone, and creating an effective plan for managing traffic in and around work zones.

This podcast is a companion to the “Work Zone Safety Data Collection and Analysis Guide,” which was also developed under the Work Zone Safety Grant. For a more extensive and detailed discussion on this topic, please review this companion document, which is available at workzonesafety.org. In addition, throughout this podcast we will make reference to additional guidance and information resources. Links to these and other resources are listed in the script that accompanies this podcast.

This podcast is divided into three separate segments, each of which is 12 to 13 minutes long.

Part I, which includes this introduction, discusses why work zone data collection and analysis is important, available resources, and the types of data most commonly used in safety analyses.

Part II focuses on data collection and analysis specifically addressing queues in work zones.

Part III discusses how data collection and analysis can help practitioners mitigate work zone speeding.



Part I: Data Collection

Let's begin by defining what we mean by work zone data collection and analysis. To be clear, we are talking about gathering *already existing* operational traffic, crash, speed and volume data and applying it to various work zone strategies to help identify necessary safety improvements. In some cases there may be useful data available from recent work zone activity at the same location. In other cases historical data from similar work zones can be used to support work zone safety activities.

Why is data collection important? Because it is how we start the work zone strategy development process. When we move on to the data analysis process, what we learn will tell us – within a reasonable degree of accuracy – what to expect in terms of speed reductions, queuing, and delay as we consider lane closures and other traffic control measures as part of a work zone strategy.

Many practitioners have questions about data collection, such as **“Where do I start?”** **“What resources are available?”** **“What type of data should I use?”** **“How much is enough?”** These are all valid questions, and some will be answered by basic design information on location and features provided at the beginning of the project while other questions related to traffic impacts such as lane closures may be answered as the project proceeds and more information becomes available. Early work zone strategy discussions may also be useful in shaping a data collection approach.

Regardless of how you get started, begin collecting data as early as possible in the project development process. One element of a best practice approach to data collection includes **getting familiar with the traffic conditions and road environment at the project location.** A site visit can help as you consider specific work zone strategy elements like potential traffic impacts on nearby businesses or schools. A visual observation of traffic movements might also indicate operational problems that need to be considered when determining work zone strategies such as lane closures or lane shifts. Your observations at the project location can provide the connection and understanding between the raw traffic data collected and the actual traffic conditions that exist at the project location.

The very nature of improvement projects is to increase operational efficiency and safety in locations that need it. It sounds like an obvious statement, but within that “nugget” of fact exists a data gathering opportunity: How would we know the location needed improvement unless the data indicated there was a problem? Chances are that during the project development process somebody already collected most of the data you'll need. That means you can **take advantage of the work already accomplished.**



So where can I find existing data?

There are typically several resources available to assist with or complete work zone data collection. Some agencies summarize crash, queue, speed, and mobility data in an annual report that shows running multi-year averages. This is a solid, statistically reliable approach that lets you look for trends or inconsistencies from year to year.

Many agencies also have a **Traffic Data Office** or **Traffic Operations Office** that is responsible for traffic data collection and analysis. The staff at these offices can be very helpful with data collection and analysis as well as with input on operational history at the planned project location. They may also provide advice or help you locate specific types of data resources. If the planned project site will be at a known high-crash location or will occur within a high-crash corridor, then this needs to be taken into account during development of the work zone strategy.

Law enforcement agencies and transportation and safety agencies generate crash reports that are generally maintained electronically in a database. This information may be available through the law enforcement agency directly or through a state transportation department. This data will give you an understanding of the type and frequency of crashes occurring at the project location and beyond, including data related to speeding, impaired driving, and distracted and aggressive driving. Since this data is not always immediately available, close coordination with law enforcement agencies may allow for early release of the crash report for use in determining whether and how the presence of the work zone may have influenced the crash, which can be especially helpful during an active long-term work zone.

Area roadway maintenance offices are also a great resource for empirical real-world, boots-on-the-ground information. Maintenance supervisors and crews usually know their assigned areas like no one else and can sometimes provide historical information and operational insight that would not always be obvious in a crash report or identified in a report summary.

Traffic management centers are in a unique position to observe and manage operational trouble spots. The information they collect from real-time traffic monitoring can capture operational issues such as heavy truck traffic, adverse weather conditions, sun glare, and crashes that are not accounted for in the analysis. Coupled with your own analysis of the applicable traffic data, traffic management centers can provide real-world details to help with decision-making on the best work zone strategies to apply.

Transportation safety offices, such as the Governor's Highway Safety Office, may provide additional resources for work zone crash information. Usually the state transportation department or local road agency collects and maintains crash reports prepared by work crews specifically for crashes involving injuries and fatalities among workers and maintenance crews.



You may also want to consider holding a **work zone stakeholder strategy meeting** in coordination with the early project design public meeting process. Stakeholders will often come forward with crash or hazard information that might not have otherwise been known. These may be very specific or localized issues related to neighborhoods, schools, business districts, bicycles, or pedestrians, including those with disabilities. More information on this process can be found in the FHWA document *Developing and Implementing Transportation Management Plans for Work Zones*. See the script of this podcast for information on accessing this resource.

Okay, so now that I've identified some sources of traffic and crash data, what do I do next?

The next step is to define what data you are going to gather and how it relates to a project's potential work zone safety and mobility issues. The data you gather will need to support a work zone capacity analysis to determine congestion levels, queuing, and delays while the work zone is active, as these factors can lead to work zone crashes.

The project features and location will dictate the type of data and the direction of the analysis. For example, a highway improvement project located on a complex section of urban freeway will almost certainly dictate the need for a thorough analysis because under this scenario, all strategies, including detours, staged construction, temporary widening, etc. will need to be considered, and the data you analyze will help you determine the best strategy for the complex roadway. Conversely, the analysis for a two-lane rural roadway will be simpler because there are more limited strategy options to start with and many of the options considered for a complex multi-lane freeway need not be considered at all.

Hm, that makes sense. But what types of data are most commonly used in work zone safety analyses?

First is **traffic volume data**. Traffic volume data provides information on traffic operations that can help determine the potential for congestion, delays, and queues. It can also be used in calculating crash rates based on exposure. Traffic congestion created by work zone activity creates queues and unstable traffic flow, which in turn increases the risk of crashes. A queue analysis, the most common type of work zone analysis, stresses the need for collecting volume data. A queue analysis should be conducted prior to initiating work zone activities to determine the extent of expected queuing and to identify which work zone strategy should be implemented to minimize queue-related crashes. Back-of-queue crashes, especially those involving large commercial vehicles, can be very severe. In some cases new traffic volume data may need to be collected if there is insufficient existing data.

Crash data provides the most direct connection to potential work zone crashes. High crash locations and corridors are of particular interest. You should consider work zone strategies



focused on crash reduction through lower speed limits, law enforcement presence, and temporary channelization improvements.

Informal information, or observational data, can also be very valuable, especially for an informal crash analysis. In many cases, the informal knowledge of those who know the pre-work-zone traffic and roadway conditions can support the number crunching to tell a deeper story.

Pre-project speed data is useful for determining the extent of any speeding issues at the project location. Locations with historically high levels of vehicle speed would indicate the need to consider a speed reduction strategy.

Law enforcement citation data are also important to take into consideration. Driver impairment and speed-related crashes are important issues and have a strong correlation to crash severity. Most law enforcement agencies and DOTs have data available on speed-related and impaired driver citations, crash locations and other relatable data. In many cases that information has already been analyzed and summarized to identify frequency, time of day, crash type, etc. This data has a very specific connection to work zone safety as, according to the National Highway Traffic Safety Administration's Fatality Analysis Reporting System, many serious work zone crashes involve speed and impaired drivers.

Pedestrian and bicycle-related crash and volume data should not be overlooked. Most agencies track these crashes, and this data is usually readily available. Field observations should reveal locations such as schools, crossings, businesses, sidewalks, and shoulder areas where these users are present.

Be aware that available data is not always current. You may need to contact traffic data or operations offices to discuss conducting traffic volume counts or speed studies. Law enforcement usually provides crash reports, but not always on a timely basis for the purposes of your analysis. You will need to work with your resources to get the data you need.

This concludes Part I of this podcast. The purpose of this segment has been to acquaint you with why it is important to collect data and the kinds of data you will need to conduct either a formal or informal analysis. To listen to Part II, which will address crash data analysis, please visit the Work Zone Safety Clearinghouse page at workzonesafety.org. This podcast has been a presentation of the Federal Highway Administration's Work Zone Safety Grant Program.



Part II: Traffic Queues in Work Zones

Welcome to Part II of the Work Zone Data Collection and Analysis podcast. In Part I, we talked about why data collection and analysis is important, available resources, and types of data most commonly used in data analysis. In this part we'll discuss how to collect and analyze data related to traffic queues. We'll then talk a little about common queue mitigation strategies that may be appropriate for your work zone. In this segment, we will refer to several guidance resources. Information about where to find these resources is listed in the script that accompanies this podcast.

A specific condition that should be addressed in your overall work zone data collection and analysis is traffic queuing. In general, traffic queues are commonly referred to as “back-ups” and are an undesirable and potentially unsafe traffic condition at any location, but are particularly hazardous in work zones. Here's why.

As a driver, you've probably been surprised when the traffic you are following suddenly starts to slow or stop, and then starts moving again, maybe only in the lane next to you or only in your lane. You usually don't know the reason for this erratic stopping and starting, and you usually get no warning other than the brake lights of the vehicle in front of you. This condition is called “unstable traffic flow” and results from an unexpected and unplanned traffic demand that exceeds the roadway capacity.

Work zones can cause unstable traffic flow due to lane closures, lane narrowing, or lane shift configurations that may cause drivers to slow down, travel at different speeds, or change lanes unexpectedly. Unstable traffic flow in a work zone can lead to the development of queues, and when traffic queues extend beyond the advance work zone warning signs, crash potential and liability concerns increase. As you can imagine, addressing the potential for queuing is a common challenge for work zone designers.

Queues in work zones are a frequent risk. Even drivers who are paying close attention as they approach a work zone may have difficulty avoiding a crash at the end of a queue because of very short stopping sight distances. Inattentive drivers may not even have time to brake before impact, which can greatly increase crash severity. Further, end of queue crashes can be compounded by secondary crashes resulting from drivers who are “rubbernecking,” or who are paying attention to the existing crash instead of the vehicle in front of them and cause a rear-end collision, creating even more delay.

In addition, **large commercial vehicles** can pose an additional safety hazard because they require longer safe stopping distances than cars and may not be able to slow or stop before impacting the vehicle ahead. Lack of adequate stopping distance can lead to a serious rear-end



crash in the queue and can lead to a classic chain reaction pileup involving several vehicles and resulting in multiple injuries or fatalities. Similarly, commercial vehicles also need more acceleration time, especially on a steep grade, which can affect overall traffic flow through the work zone. Special traffic control strategies may need to be developed to guide trucks passing the work zones. Refer to the *Highway Capacity Manual* for techniques on how to incorporate high levels of commercial vehicle traffic into your queue estimate.

Right, the queue estimate. How do I run a queue estimate for a work zone?

There are several **work zone capacity analysis software programs** that can assist in developing queue estimates that will help you identify the best strategy for queue mitigation. Some of these are discussed on the FHWA Work Zone and Traffic Analysis Tools web page. The *Highway Capacity Manual* also contains concepts, guidelines, and computational procedures for assessing capacity and quality of service for work zones without the use of software. An additional resource that can be valuable is the *Highway Safety Manual* (HSM). The primary focus of the HSM is to provide analytical tools for predicting the impact of transportation project and program decisions on road safety. See the script of this podcast for information on accessing these resources.

As we alluded earlier, traffic congestion and queues may already exist prior to setting up a work zone. Plenty of traffic data probably already exists for these “problem areas.” **The data and analysis resources mentioned in part one of this series are applicable to work zone queue analysis.** Field correlation to the queue analysis of the actual queue development is recommended and is useful in establishing or adjusting lane closure and work activity times. Observations of the queue length will also help to determine the most appropriate advance signing locations.

An **informal analysis approach** is to use an accepted threshold capacity value for your expected work zone strategy, such as a lane closure on multi-lane highway or alternating one way traffic on a two lane highway. A quick review of the hourly traffic volume data will show whether capacity problems can be expected. The *Highway Capacity Manual* is an excellent resource for estimated work zone capacities based on lane configuration.

When capacity values for the proposed work zone are calculated to be near the threshold capacity value, you should conduct further analysis. Be conservative in your analysis of alternating one-way traffic control. Alternating one-way traffic control capacities can vary greatly depending on work operation and efficiency. Some agencies place time restrictions on work zone traffic delays, and while this may be acceptable for some projects, it is not a replacement for a queue analysis. The extent of the queue still needs to be known and addressed in a safe and effective manner.



To do this, **queue starting location, length, time of day, and duration need to be examined closely and must be addressed in the work zone strategy.** Generally, your choices are to pursue options that eliminate, minimize, or incorporate the queue impacts into the work zone strategy and, more specifically, the temporary traffic control plans, specifications, and various transportation management plan elements. This approach will ensure adequate warning for drivers approaching the queue and, better yet, a work zone design that eliminates or minimizes the queue. In most cases it isn't possible to completely eliminate a queue or potential for a queue, but the knowledge you can gain from a thorough analysis will lead you to the best mitigating strategy, tactics, and devices.

How do I figure out which work zone strategy is best for me, and what kind of strategies mitigate queues?

Identifying strategies that address traffic queues begins by examining **project features, construction needs, and traffic impacts based on data and analysis.** Some common queue-mitigation strategies include conducting work zone activity at night when traffic demand is lower; maintaining the same number of lanes during construction as prior to construction – by reducing lane widths, for example; by increasing the length of the taper; or by changing the location of the beginning of the taper. Communication with the public is also an important element, and in addition to adequate warning signs in advance of the queue, agencies may provide information to drivers through a public outreach campaign that makes use of traditional media, social media and web sites, and highway advisory radio outlets. Traffic management centers can be very helpful in providing drivers with advance warning of slow or stopped traffic and expected delay through permanent message signs, and law enforcement monitoring can assist with crashes, stabilize approaching traffic speeds, and improved driver awareness through officer presence.

Where can I go to learn more?

FHWA's *Work Zone Impacts Assessment: An Approach to Assess and Manage Work Zone Safety and Mobility Impacts of Road Projects* presents a general approach for work zone impacts assessment and provides examples of how agencies are currently assessing and managing work zone impacts. In addition, The Work Zone Safety Grant guidance document entitled *Treating Potential Back-of-Queue Safety Hazards* is designed to highlight common pitfalls in estimating potential impacts that can result from implementing a traffic control plan as well as strategies that can help reduce work zone congestion and back-of-queue crash risk. Additional resources can be found on the FHWA "Work Zone Traffic Management Resources and Examples" web page. More information and links to these and other resources can be found in the script of this podcast.



In conclusion, queues are a reality of many work zones and, as we have discussed, a thorough analysis will assist you with minimizing the negative impacts of queues. Work zones are planned events, and effective advance warning to drivers approaching the work zone is required. This includes warnings about traffic queues that extend upstream from the work zone. Advance warning is a key work zone principal that must be applied in an effective manner. Your understanding of a thorough work zone capacity analysis will lead and support your decisions to address the negative impacts of traffic queues.

This concludes Part II of this podcast. The purpose of this segment has been to discuss how to collect and analyze data related to traffic queues. To listen to Part III, which will address speed-related crash data analysis, please visit the Work Zone Safety Clearinghouse page at workzonesafety.org. This podcast has been a presentation of the Federal Highway Administration's Work Zone Safety Grant Program.



Part III: Speeding in Work Zones

Welcome to Part III of the Work Zone Data Collection and Analysis podcast. In Part II, we talked about traffic queues in work zones. In this part, we'll discuss how speed-related data collection and analysis can improve the safety of work zones by helping to identify the need for treatments, where applicable, for reducing vehicle speeds. As with the previous segments, Part III will refer to several guidance resources. Information about where to find these resources is listed in the script that accompanies this podcast.

Traffic speed in work zones is a significant safety issue and can be difficult to manage. This is mainly due to differences in drivers' responses as they encounter various work zone conditions. Simply put, drivers tend to respond more to their perception of work zone conditions and activities than to a posted speed limit. While most drivers drive at a perceived safe speed, others may drive faster or slower. As noted in the previous segments, **speed variability** increases the risk for crashes. In this podcast we will present the issue of speed in work zones and strategies to minimize speed-related crashes.

Why is traffic speed in work zones such a significant issue? What are the causes of speeding and what can we do about it?

Let's focus on the specific speeding issues that are linked to work zone crashes. These include excessive speed, speed differentials between vehicles, and the relationship between speed and drivers that are distracted, confused, impaired, or aggressive.

Crash data shows that most work zone crashes involve an improper driver response, with speeding being a primary or contributing factor. Studies indicate that speeding is involved in as many as *one-third* of all work zone fatal crashes. Preventing these crashes presents a significant challenge to those involved in work zone design and management.

Your understanding of traffic speed data through analysis is the basis for developing effective work zone speed strategies. This includes setting effective work zone speed limits, designing work zones at the appropriate speed, and selecting strategies and tactics to reduce speeding.

Here is some guidance that may clarify some of the issues related to speeding in work zones:

- Work zone activity has a significant influence on traffic speed. Studies show that most drivers tend to reduce speed in the presence of construction activity or workers.¹

¹ M. Reyes and S. Khan, *Examining Driver Behavior in Response to Work Zone Interventions: A Driving Simulator Study*, Smart Work Zone Deployment Initiative Pooled Fund Study, 2008. Available at: http://www.intrans.iastate.edu/smartwz/documents/project_reports/SWZDI-2008-1_Reyes_FinalReport3.pdf



Conversely, drivers may not feel compelled to comply with speed limits when no work activity is visible.

- For high-speed work zones on highways with a pre-work zone speed of 65 mph or greater, a speed limit of 60 MPH tends to be the best compromise of speed compliance and crash reduction. In general, the MUTCD section 6C.01 advises a speed limit reduction of no more than 10 mph.
- Studies indicate that vehicle speed differentials are hazardous in general and particularly so within congested work zones. Sometimes speed variations may result from setting the work zone speed limit too low.
- Traffic speeds tend to self-regulate during congested periods regardless of the posted speed limit, but become higher and may become erratic during free flow periods.

Keep in mind that speed limit policies that are not based on engineering principles, or that are arbitrary, or that set a speed in the “hope” that drivers will comply do not generally reduce crashes. Speed data analysis and scientific studies have produced very useful guidance to help practitioners set effective work zone speed limits that minimize the opportunity for crashes and encourage driver compliance.

Speed data is generally available from the same sources of crash and volume data that we identified in Part I of this podcast. DOTs and law enforcement are the main sources and most likely have very organized data in various reports that would be useful at your work zone location. Many larger agencies have automated data stations or signal systems that report traffic speed as part of their function.

While the raw data is necessary and useful for the purposes of a specific analysis, summary data compiled in a report may be more useful if you are involved with determining work zone speed limits. In many cases you can use the data to confirm the operational speed and conduct an informal analysis.

Now, do you think you’re ready to talk a bit about analysis?

I thought you’d never ask!

Collecting drivers’ speeds is the basis for most work zone speed analysis. The output of the speed study will indicate the 85th percentile speed, mean speed, pace, speed differential, and additional information to “paint the picture” on traffic speed as it relates to the work zone location. If at all possible, the work zone should be designed to accommodate those existing speed characteristics and use the existing posted speed.

Many states have policies and procedures in place on how to set work zone speed limits, and this is typically based on reputable studies and policies that are known to be effective. In most cases,



a review of the speed data or speed study combined with agency policy will be adequate support to set an effective work zone speed limit.

Here is some guidance that may be useful in understanding and implementing effective work zone speed limits:

- Specific work zones that require a reduced speed limit due to actual design constraints should be set at the safe design speed. Warning and speed advisory signing may be appropriate as well.
- A 10 mile-per-hour reduction may be considered a typical maximum (barring unusual circumstances) and should be supported by work zone conditions that indicate safety-related issues such as narrow lanes, reduced shoulders, and close proximity to traffic channelization devices. Keep in mind this is not always the case for every State; you should check your State's policies and guidelines as they will take precedence.
- Changes in speed should be limited. Drivers are more likely to comply with a consistent and appropriate speed limit.
- Areas in which high rates of speed violations are occurring should be addressed with law enforcement as feasible and appropriate.
- Once implemented, work zone speed limits should be reviewed, and a follow up speed study may be needed if speed continues to be an issue.

Hey, can we talk a little about speed-related strategies and countermeasures also? I've got all this data and analysis done, now what do I do with it?

Once the data analysis is finished it's the right time to consider what may be needed as a work zone speed limit and crash reduction strategy. For basic projects, using the existing speed limit and appropriate temporary traffic control plans may be sufficient. More complex projects may call for an appropriately scaled strategy to address any issues identified during the data collection and analysis process.

The following strategies and countermeasures have been found to be effective when appropriately applied to a work zone condition that indicates possible speed compliance issues.

- A variable speed limit may address work zone speeding and be used when a reduced speed limit would add safety benefits during work activities. A reduced speed limit would be determined and set while the work zone is active, but would return to the normal posted speed during periods where there are no workers present.
- Law enforcement is your best friend and should always be considered and consulted as part of any speed reduction strategy. Presence, patrolling, and active enforcement are examples of possible law enforcement actions.



- A public information campaign on speed limit awareness and education could include law enforcement, news media, traditional static informational signs, portable changeable message signs, smart changeable message signs with radar detection, or driver feedback signs (these are the ones that say “your speed is” and show your speed).
- Automated enforcement (photo enforcement) has been used by some states and has been shown to be effective, especially in reducing speed differential; however, photo enforcement is not legal in every state.
- Placement of channelization devices in close proximity to the driving lane may reduce speeds, but constant patrolling and replacement of devices may be needed.
- Transverse rumble strips may improve speed compliance through an audible warning to add to the visual cue of the speed limit sign.
- Warning flags, lights, and other conspicuous devices may also capture drivers’ attention and improve compliance when used properly.

For more details about additional information and guidance on these topics, see the resources list in the script.

Some agencies may have work zone performance criteria or work zone crash reduction goals. If this is the case in your state, the work zone strategy you ultimately select should be consistent with those goals or performance criteria.

In conclusion, gathering data and conducting an analysis combined with an understanding of driver behavior are the most important aspects of developing effective work zone speed strategies, whether they are setting speed limits or reducing speeds. The goal is to minimize the number and severity of work zone crashes.

This wraps up our discussion of work zone speed-related data collection and analysis. In case you missed either of the previous episodes, you can access them at workzonesafety.org. Again, for a list of references and guidance documents that support this podcast, please view the script, which is available on the page where this podcast is housed.

This podcast has been a presentation of the Federal Highway Administration’s Work Zone Safety Grant Program. For more information on grant products, including the companion document entitled “Work Zone Safety Data Collection and Analysis Guide,” please visit the Federal Highway Administration’s Grant page on the work zone safety information clearinghouse at workzonesafety.org.



References

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ATSSA, *Treating Potential Back-of-Queue Safety Hazards*, available at:
<http://www.workzonesafety.org/research/record/10591>

ATSSA, *Guidance for the Use of Temporary Rumble Strips in Work Zones*, available at:
http://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_temporary_rumble_strips

ATSSA, *Work Zone Safety and Analysis Guide*, available at:
http://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_wz_safety_data_collection

FHWA Work Zone-related web pages:

“Work Zone and Traffic Analysis” http://ops.fhwa.dot.gov/wz/traffic_analysis/index.htm

“Work Zone and Traffic Analysis Technical Resources”
http://ops.fhwa.dot.gov/wz/traffic_analysis/techresources.htm

“Work Zone Final Rule - Guidance and Other Technical Resources”
http://ops.fhwa.dot.gov/wz/resources/final_rule/guidance.htm

“Work Zone Speed Management”
http://www.ops.fhwa.dot.gov/wz/traffic_mgmt/wzsm.htm

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