WORK ZONE MANAGEMENT PROGRAM

DATA-DRIVEN WORK ZONE PROCESS REVIEWS

What is a Work Zone Process Review?

A Work Zone Process Review (WZPR) refers to a comprehensive review of policies and procedures related to work zone management (WZM), the effectiveness of work zone (WZ) impact analyses and monitoring efforts, and ultimately, how well State departments of transportation (DOTs) manage those impacts.

What are FHWA requirements for conducting WZPRs?

Federal regulations in 23 CFR 630 Subpart J require State DOTs to conduct a WZPR every 2 years to evaluate WZ processes and procedures as well as identify systematic improvements to current and future projects.[1]

The Federal Highway Administration (FHWA) published guidance in April 2015 to assist State DOTs in conducting effective WZPRs.[2] That guidance document recommends a nine-step approach for performing a WZPR, as shown in figure 1, and emphasizes the importance of using data and performance measures in WZPRs to make the process reviews more comprehensive, actionable, and effective.

Suggested Steps in FHWA's Guidance for Conducting Effective Work Zone Process Reviews[2]

1. **Assemble a multidisciplinary team.**
2. **Develop a review plan.**
3. **Conduct review.**
4. **Analyze and interpret results.**
5. **Develop inferences, recommendations, and lessons learned.**
6. **Prioritize recommendations and lessons learned.**
7. **Develop an action plan to implement the prioritized recommendations.**
8. **Present findings.**
9. **Initiate the action plan.**

Figure 1. List. Nine-step approach for performing Work Zone Process Reviews (Source: FHWA)

What is a data-driven WZPR approach? Why is it a good approach?

As presented in figure 2, the data-driven WZPR approach builds on steps two to seven identified in figure 1 and emphasizes the use of data in each step.

A data-driven WZPR approach may enable State DOTs to make WZPRs more outcome- and performance-driven, while potentially bringing about more of a continuum mindset to WZPRs as opposed to isolated point-in-time reviews.

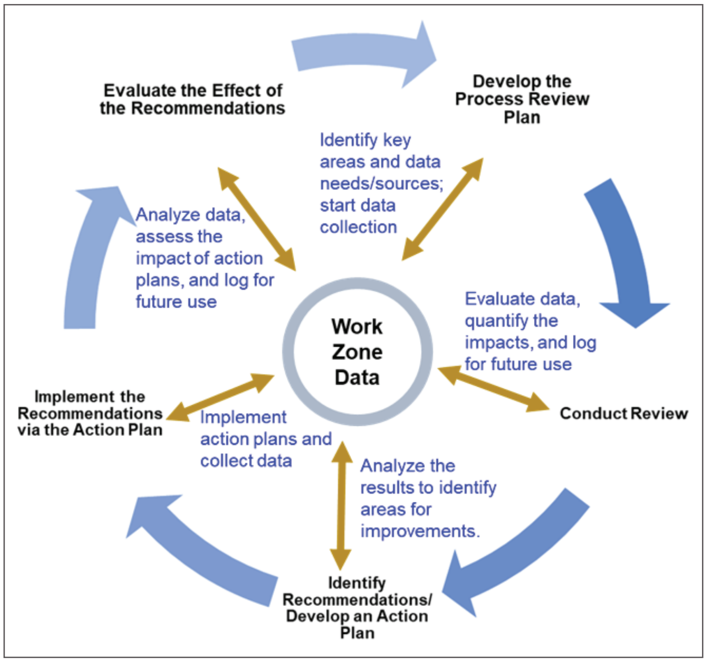

Figure 2. Diagram. An integrated approach for data-driven Work Zone Process Reviews (Source: FHWA)

What is the current state-of-practice?

State DOTs indicate that they have found it challenging to consistently and effectively include data in their WZPRs due to a lack of awareness and access to data, as well as limited resources for conducting streamlined data-driven process reviews.

[1] https://www.ecfr.gov/current/title-23/part-630/subpart-J
[2] https://ops.fhwa.dot.gov/publications/fhwahop15013/index.htm

How can State DOTs transition to a data-driven approach for WZPRs?

A renewed focus on performance-based WZM, new industry paradigms, and the emerging Connected Autonomous Vehicle and probe data resources present State DOTs with many new opportunities to leverage data in their WZPRs. The **Opportunities and Best Practices** section in this factsheet presents some of the key available resources and how State DOTs are leveraging these resources to integrate data into their WZPRs.

Are there any examples of data-driven WZPRs?

FHWA has developed three case studies with Iowa, Maryland, and Virginia DOTs to demonstrate a data-driven, systematic, and comprehensive approach to conducting WZPRs. These case studies show how State DOTs can leverage existing data sources and performance assessment findings to incorporate data into steps two to five of the nine-step WZPR approach (shown in figure 1).

Opportunities and noteworthy practices for WZPRs

- **Establishing dedicated WZPR teams with representation from all areas of WZM to bring a systematic approach to the WZPRs.** Maryland, Virginia, Utah, Illinois, North Carolina, and many other State DOTs have dedicated WZPR teams with clearly assigned roles. These WZPR teams contain representatives from different areas of WZM who regularly interact with field personnel, contractors, safety engineers, traffic operations centers, designers, planners, State patrol, and field inspectors to identify best practices and recurring key issues experienced during the planning, design, and implementation of WZs. The WZPR teams leverage findings (i.e., qualitative data) from these interactions to prioritize key issues and recommend mitigation strategies for each WZPR cycle. Although most of the process reviews apply qualitative data, State DOTs with dedicated WZPR teams offer a better systematic and consistent approach in conducting their WZPRs.
- **Gathering qualitative feedback from various aspects of WZM to bring a comprehensive mindset to WZPRs.** Based on a review of previous WZPR reports, it was evident that most State DOTs are collecting qualitative feedback through discussions and interviews with staff from various areas of WZM. Even though qualitative data drove the WZPR reports, the comprehensive nature of these data add good value to the process reviews.
- **Leveraging the synergy between WZ Performance Measurement (WZPM) findings and WZPRs to assess the safety and mobility impacts of WZs on their transportation corridors.** Delaware DOT incorporated the WZPM findings from its granular crash data analysis into its WZPRs to identify key issues (e.g., rear-end crashes in the activity areas) and quantify their impacts on its transportation corridors, as presented in figure 3.
- **Synthesizing quantitative and qualitative data to measure key WZ issues and identify their root causes.** Iowa, Maryland, and Virginia DOTs collated quantitative data trends for each performance area (e.g., safety, mobility, field inspections) with qualitative contextual information collected from their WZM experts (e.g., district officers, WZ designers, and contractor interviews). These combined analyses led to measurable impacts of key issues (e.g., a 6-percent annual increase in interstate WZ delays) and a better root cause identification (e.g., peak hour speed differentials) of critical WZ issues (e.g., increased WZ delay). State DOTs can use the root causes from these analyses for recommending mitigation strategies and establishing performance thresholds.

i In 2019, Tennessee DOT's WZPR team conducted field reviews and interviews with project personnel and designers to assess the key factors contributing to driver confusion and increased crash risk to drivers and workers. Collective feedback from all stakeholders indicated that inadequate length of taper and transition areas could be a contributing factor to the increase of crash risk at the transition areas. To address this issue, Tennessee DOT updated its WZ design standard to consider the design speed for taper calculations by adding 10 mph to the posted speed limit. This updated design speed consideration will increase the minimum taper length requirements in Tennessee WZs.

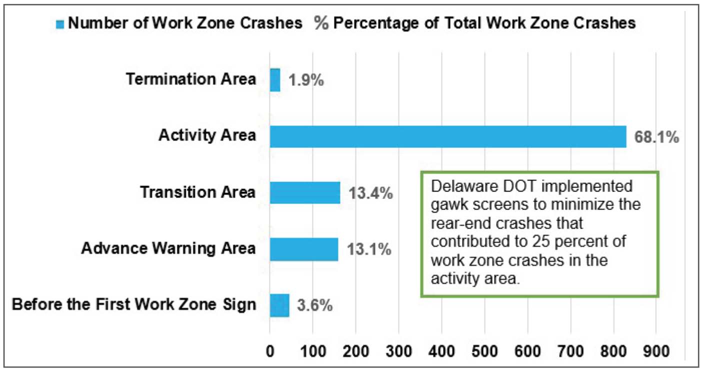

Figure 3. Chart. Delaware work zone crashes by work zone location (Source: Delaware DOT)

i Virginia DOT's case study synthesized the interstate delay trends with contextual information from WZ experts to identify non recurring incidents and high truck volumes on the road-widening project as the leading causes for increased travel delay on I-81 despite the reduced overall travel demand in 2020 (due to the pandemic).

- **Using exposure data to normalize performance metrics and account for variability in WZ activity across the years.** In 2012, Virginia DOT started to standardize and implement data collection processes for WZ exposure data. Virginia DOT requires its WZ field personnel to report WZ activity (i.e., location, number of lane closures, hours of operation, status) to its WZ monitoring database (VaTraffic) via a Traffic Operations Center. These exposure data (e.g., WZ miles, WZ hours, WZ vehicle miles traveled [VMT], lane closure hours) can be valuable in normalizing and deriving context around the performance data. Using program area metrics normalized with exposure data will also account for the variabilities in the levels of traffic exposure to WZs. The importance of exposure data was evident during the case studies, where the State DOTs compared the WZ performance in 2020 (when the pandemic conditions impacted the traffic demand) to previous years with higher traffic demand. As presented in figure 4, Virginia DOT normalized its WZ crashes with WZ miles implemented each year to get a comparable WZ safety metric across the years.

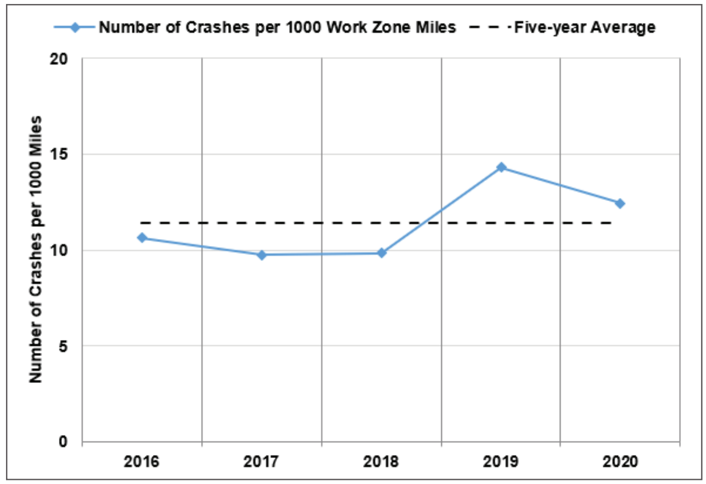

Figure 4. Graph. Virginia DOT's work zone crash rates per thousand work zone miles (Source: Virginia DOT)

- **Normalizing performance metrics with a common exposure metric to compare WZ performance with other State DOTs.** As presented in table 1, Illinois DOT compared its normalized WZ fatality rates (i.e., per VMT, center line miles, and population) to State DOTs and ranked its WZ safety performance nationwide. The findings from this evaluation enabled Illinois DOT to benchmark its performance by considering different aspects of WZ exposure. Furthermore, Illinois DOT applied these findings to identify target improvement metrics based on the higher-rated States.

Table 1. Illinois DOT's rank of work zone fatalities by work zone category (Source: Illinois DOT)

Normalizing Metric	Work Zone Type Ranking				
	Construction	Maintenance	Utility	Unknown	All Work Zones
Vehicle miles traveled	2	4	3	*	2
Center line miles	2	5	3	*	*
Population	*	*	2	*	*

Note: Numbers indicate how Illinois' actual versus expected fatality rate ranks compared to eight other States that had the most WZ fatalities (lower rankings reflect worse fatality rates). An asterisk indicates that Illinois' actual fatality rates was better than or equal to its expected fatality rate.

- **Evaluating performance areas outside safety and mobility to draw a comprehensive picture of WZM efficiency and derive meaningful correlations between WZ processes.** State DOTs, including Iowa, Puerto Rico, and Tennessee, analyze and incorporate field inspections data into WZPRs to evaluate their WZM processes, including planning, design, and implementation. Table 2 presents an example of Iowa DOT's best-rated WZ traffic control strategies for 2018 and 2019, based on the WZ field inspections. Iowa DOT used the findings from this analysis to identify recurring issues, best practices, and areas for improvement in its traffic control strategies.

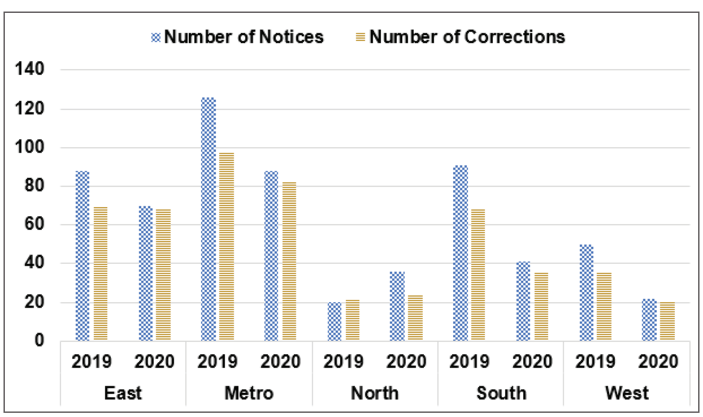

Figure 5. Chart. Number of notices from work zone field inspections and resulting corrections (Source: Puerto Rico DOT)

Similarly, Puerto Rico DOT tracks the notices issued by field inspectors and corrections applied to address the notices, as presented in figure 5. Many State DOTs collect granular data for performance areas such as customer satisfaction, agency efficiency, training, and law enforcement.

Table 2. Iowa's work zone traffic control strategies receiving an Exceptional or Acceptable rating for more than 75 percent of field reviews (Source: Iowa DOT)

Work Zone Traffic Control Strategy	Category	Interstate		U.S. and Iowa Route		County Road		City Road	
		2018	2019	2018	2019	2018	2019	2018	2019
Lane Closure	Ballasting	●	●	●	●	●	●	●	●
	Cleanliness	●	●	●	●	●	●	●	●
	Crashworthiness	●	●	●	●	●	●	●	●
	Sheeting		●	●	●			●	●
	Positive Closure	●							
	Location/Spacing	●							
	General Condition		●	●			●		

Rank	Map	Head Location	Bottleneck Profile: Average Max Length	Average Daily Duration	Total Duration
1	☐	I-695 CCW @ EDMONDSON AVE/EXIT 14	3.82	2 h 37 m	39 d 19 h 11 m
2	☐	I-495 CW @ MD-214/CENTRAL AVE/EXIT 15	2.8	2 h 54 m	44 d 5 h 59 m
3	☐	I-695 CW @ I-70/EXIT 16	3	2 h 36 m	39 d 16 h 31 m
4	☐	I-495 CW @ MD-97/GEORGIA AVE/EXIT 31	3.25	2 h 21 m	35 d 20 h 34 m
5	☐	I-695 CW @ MD-542/LOCH RAVEN BLVD/EXIT 29	4.34	1 h 4 m	16 d 9 h 9 m
6	☐	I-695 CCW @ US-40/EXIT 15	3.28	1 h 26 m	21 d 21 h 30 m
7	☐	I-695 CCW @ PROVIDENCE RD/EXIT 28	2.96	1 h 10 m	17 d 22 h 55 m
8	☐	I-495 CCW @ MD-185/CONNECTICUT AVE/EXIT 33	4.07	37 m	9 d 9 h 45 m
9	☐	I-270 N @ MIDDLEBROOK RD/EXIT 13	5	1 h 2 m	15 d 19 h 23 m
10	☐	MD-5 S @ MD-381/BRANDYWINE RD	2.12	4 h 15 m	64 d 18 h 25 m
11	☐	I-270 N @ I-270 (NORTH)	1.11	2 h 36 m	39 d 16 h 13 m
12	☐	MD-210 N @ KERBY HILL RD/LIVINGSTON RD	1.54	2 h 57 m	44 d 21 h 25 m
13	☐	I-270 N @ MD-109/EXIT 22	6.76	45 m	11 d 12 h 20 m
14	☐	I-695 CW @ MD-41/PERRING PKWY/EXIT 30	5.47	20 m	5 d 2 h 35 m
15	☐	I-695 CCW @ CROMWELL BRIDGE RD/EXIT 29	1.92	1 h 34 m	23 d 22 h 34 m

Figure 6. Screenshot. Maryland DOT Work Zone segments ranked by the amount of delay and queuing experienced in 2018 (Source: Regional Integrated Transportation Information System [RITIS])

- **Assessing WZ mobility performance using probe data.** Maryland DOT applied a data analytics and visualization tool to perform repeatable WZ mobility analyses with minimal analytical support.[3] Maryland DOT inputted its construction WZ project information into the analytics tool by selecting the geographic boundaries and implementation timeframes for each WZ project. Maryland DOT leveraged bottleneck ranking and delay cost analysis tools to identify the mobility impacts of WZs implemented from 2018 to 2020. Figure 6 presents the top 13 WZs segments in Maryland ranked by the amount of queuing and delays experienced in 2018. The bottleneck ranking analysis tool uses probe data to calculate the length and duration of the bottlenecks, as well as the delay resulting from the bottleneck. The resulting mobility findings (e.g., total delay, number of traffic congestion events, total VMT, average queue length) enabled Maryland DOT to determine key trends, WZ projects with the most impacts, and recurring issues for 2018, 2019, and 2020 (e.g., more than 40 percent of the events in 2018, 2019, and 2020 occurred on WZ projects implemented on I-495, I-695, I-70, I-270, US-29, MD-5, and MD 210). State DOTs with limited field detection equipment in WZs and limited analytical support can rely on probe data tools that offer a pre-defined set of mobility metrics (e.g., queue length, delay, speed) with built-in normalization (e.g., delay per VMT), as presented in figure 7.

Grand total and average

Delay cost:

Total: **$73,815,899.85**

Per VMT: **$0.01**

Hours of delay:

Person-hours: **2,994,411h 5m 2s**

Vehicle-hours: **2,444,417h 12m 41s**

Vehicle miles traveled (VMT):

Total: **11,843,395,930.3 miles**

Passenger: **10,659,056,337.2 miles**

Commercial: **1,184,339,593 miles**

Delay per VMT: 0 mins / mile

Date validity: 99.48%

Figure 7. Screenshot. Mobility metrics calculated by RITIS Probe Data Analytics Suite through its User Delay Analysis tool (Source: RITIS)

[3] https://pda.ritis.org/

- **Using connected vehicle and hard-braking data to identify WZ safety and design issues.** Indiana DOT, in collaboration with Purdue University, started to analyze the hard-braking data on its major WZ corridors to identify key safety and design issues. Indiana DOT analyzed hard-braking data at WZ locations with recurring queues and accidents and identified a strong correlation between WZ crashes and hard-braking events, as presented in figure 8. Indiana DOT used the findings from this analysis to identify temporary and long-term construction zones that warrant further investigation to improve geometry and advance warning signs. This Indiana use case demonstrates how State DOTs can leverage commercially available emerging data such as hard braking and near miss events to identify potential safety and design issues prior to the occurrence of traffic incidents in WZs and to conduct a post-evaluation of implemented traffic control strategies.[4]

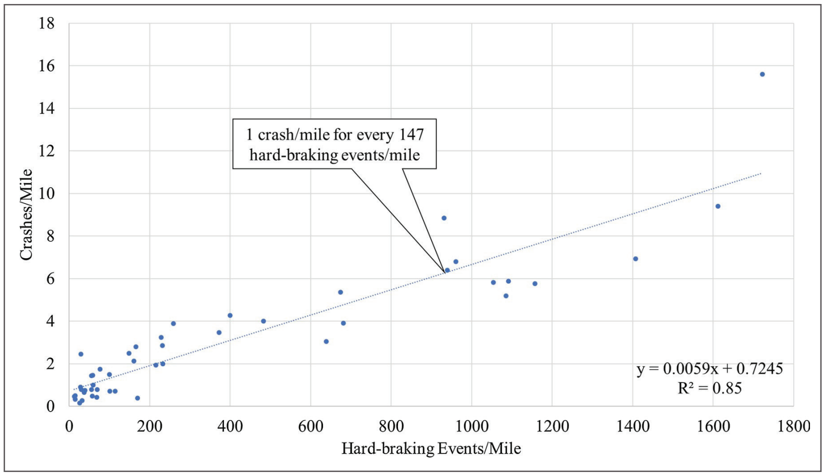

Figure 8. Graph. Comparison of crashes and hard braking events on a 9.5-mile stretch of WZ on I-65 in Indiana (Source: Indiana DOT)

Lessons Learned

- A data-driven WZPR approach brings a quantitative dimension to augment and support qualitative findings and recommendations.
- State DOTs have access to data resources for different performance areas through their intra-agency data collection efforts. Consequently, a comprehensive data inventory of all data resources will enable State DOTs to select performance measures for various WZ strategies and performance assessments based on available data sources.
- State DOTs should drive toward a repeatable approach when incorporating data into their WZPRs. Establishing a repeatable approach for conducting performance evaluations will enable State DOTs to continuously track the efficiency of their WZ processes with minimal duplication and level of effort.
- Many State DOTs apply limited focus on digitizing their WZ exposure data. Because WZ contractors and field staff collect information about WZ activity as part of their daily logs, digitizing these activity logs will enable State DOTs to track their WZ activity by location, WZ type, and time of year. State DOTs can also use this information to quantify the variabilities in exposure of their travelers to the WZs.
- Probe data tools, which are accessible to the majority of State DOTs, can be used to perform repeatable mobility analyses with minimal level of effort.

Interested in learning more?

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Additional resources on work zone management can be found at: https://ops.fhwa.dot.gov/wz/ and https://www.workzonesafety.org

[4] Desai, J., L. Howell, J.K. Mathew, Y. Cheng, A. Habib, and D.M. Bullock. 2020. "Correlating Hard-Braking Activity with Crash Occurrences on Interstate Construction Projects in Indiana." *Journal of Big Data Analytics in Transportation* 3, 27-41. https://doi.org/10.1007/s42421-020-00024-x [doi.org], last accessed August 9, 2022.