ITS SERVICE BOOK

ITS304 WORK ZONE MANAGEMENT

Purpose

Work Zone Management, also known as Smart Work Zones (SWZ), helps to improve safety and mobility by using data and technologies to increase driver awareness within and in advance of construction work zones.

The objectives of SWZ are to:

- Increase driver awareness of upstream conditions
- Increase traveller and worker safety
- Improve incident management
- Improve mobility
- Monitor Contractor construction/traffic management

Considerations for Use

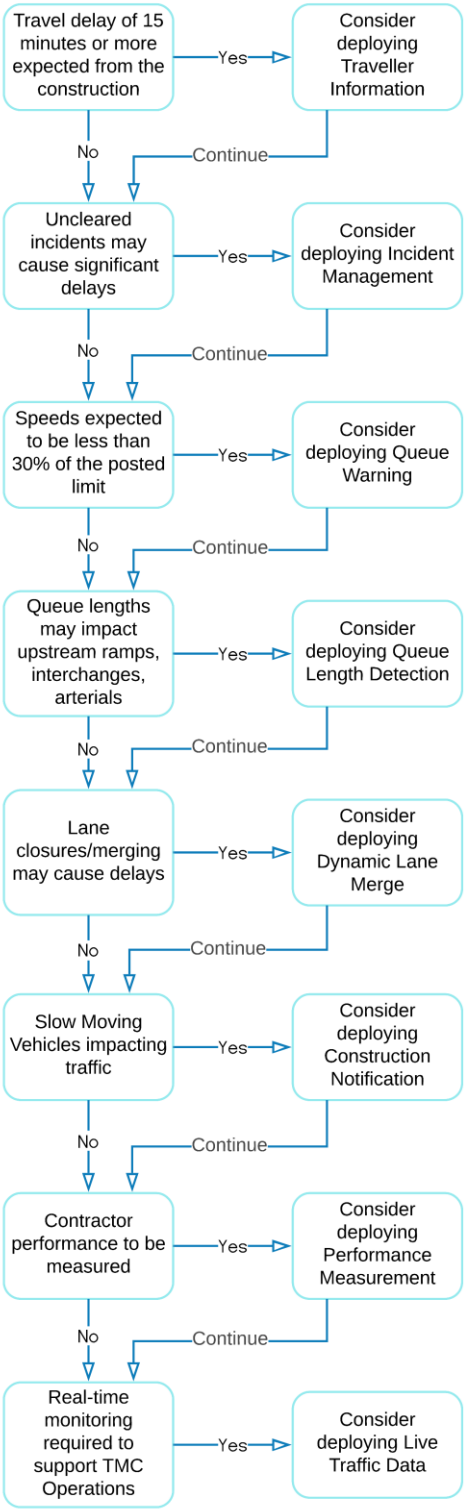
Smart Work Zones can be applied to:

- Construction-related events impacting motorists such as lane closures
- Special conditions impacting motorists such as reduced speed limits

Applications may include:

- Traveller Information
- Incident Management
- Queue Detection
- Dynamic Merge
- Construction Access/Notification
- Performance Measurement
- Live Traffic Data (Traffic Studies)

The following decision tree provides a reference for when Smart Work Zone systems may be considered.



ITS Service Applicability and Limitations of this Service Book

This Service Book may be used in conjunction with other related MTO ITS Services that may have Service Books associated with them.

- ITS202 – Performance Monitoring
- ITS908 – Regional Traffic Management
- ITS914 – Work Zone or Temporary Queue Warning

Limitations

This Service Book will aid in determining the need, components, purpose and general placement of an SWZ. Further analysis to identify the specific needs for SWZ is encouraged.

While technologies and data sources continue to evolve, this service book references technologies already approved by MTO.

Smart Work Zone Applications

SWZ Application	Issues Addressed	ITS Components
Traveller Information Provide information about downstream travel conditions, roadside travel time information, alternate routes, etc. Warrants • Informing drivers of downstream conditions offers recognized safety benefits • Travel delay resulting from the work zone is excepted to be more than fifteen (15) minutes • Conditions due to construction activities are expected to change more than once every 60 days	• Safety • Congestion • Driver awareness	• Traffic Data • Software • VMS • Communications
Incident Management Automated detection of incidents allowing for shorter response and clearance time Warrants • Incidents and events may typically cause a delay of at least 15 minutes while the incident is active	• Safety • Incident Response • Congestion/Delay	• Traffic Data • Software • Cameras • Communications
Queue Warning Warning of slow or stopped traffic downstream Warrants • Consider queue warning where the traffic flow speed is expected to reduce to 30% or more of the posted speed limit and may potentially result in rear-end collisions	• Safety • Speed Harmonization	• Traffic Data • Software • VMS • Communications
Queue Length Detection Provide alerts to the Contractor when the queue reaches a certain point away from the work zone Warrants • Queue lengths are constrained contractually and/or have significant impacts on upstream traffic, ramps, or affect other corridors, interchanges, etc.	• Safety • Traffic Management	• Traffic Data • Software • Communications

SWZ Application	Issues Addressed	ITS Components
Dynamic Lane Merge Advise drivers to merge at select points due to downstream lane closures/reductions. This is not currently implemented by the MTO. Warrants • The resulting queue may encroach upstream corridors or cause a delay in excess of 15 minutes • Continuous lane closure expected for more than twenty (20) days	• Safety • Congestion/Delay • Queue Length	• VMS • Communications
Construction Notification Advise of local construction activities (e.g. construction vehicle, slow-moving vehicle entering/exiting roadway) Warrants • One or more construction vehicles accelerate and decelerate along the travelled lane to enter/exit a construction area which may disrupt traffic and/or safety	• Safety	• VMS • Vehicle Detector • Communications
Performance Measurement Use work zone data to monitor and assess impacts of construction and outcomes to Contractor and/or justification for additional SWZ systems Warrants • Need for contractual performance measures • Need for construction zone data	• Safety • Congestion/Delay • Contractor Management	• Traffic Data • Data Storage • Communications
Live Traffic Data Use live-work zone data including traffic counts, video and other field data to manage and monitor mobility and traffic management Warrants • Existing ITS subsystems within a work zone are not available and there is a need to maintain TMC/TOC operations • Need for live traffic data to support TMC/TOC operations	• Safety • Congestion/Delay • Traffic Management • Contractor Management	• Any ITS Component(s) • Traffic Data • Software • Communications

System Components

Traffic Data

Traffic data may be sourced from a variety of sensors depending on the applications. Sensors include:

Bluetooth/Wi-Fi Detectors

- Portable, low-cost
- Suited for Traveller Information applications

Radar Sensors

- Portable with both low cost (traffic barrels), and higher cost (pole-mounted sensors) options
- Suited for Incident Management, Queue Warning, and Performance Measurement applications

Existing Infrastructure

- Existing traffic data collection infrastructure can also be utilized as a data source. This may include inductive loops

Message Dissemination

Motorists can be made aware of conditions through a variety of signs including:

Portable Variable Message Sign

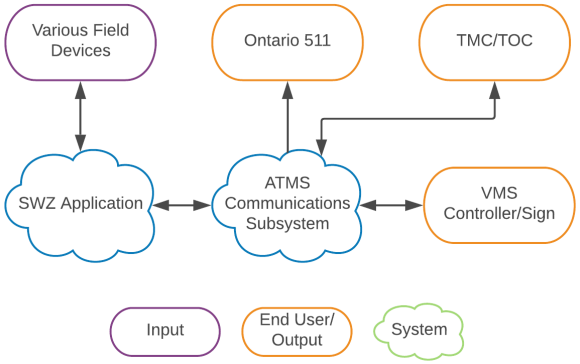
- 30 pixels high x 56 pixels wide (typically)
- Best suited for temporary roadside applications (short-term)
- Limited visibility due to low height
- Lowest cost

Portable-Mounted Variable Message Sign

- 30 pixels high x 56 pixels wide
- Suited for median, separator or roadside long-term temporary applications
- The best visibility due to a higher height
- Higher cost than PVMS

Architecture

The following architecture provides an overview of how the various SWZ applications may interact. Although there may be variations between the various applications, the information and data flows are expected to be similar for each subsystem.



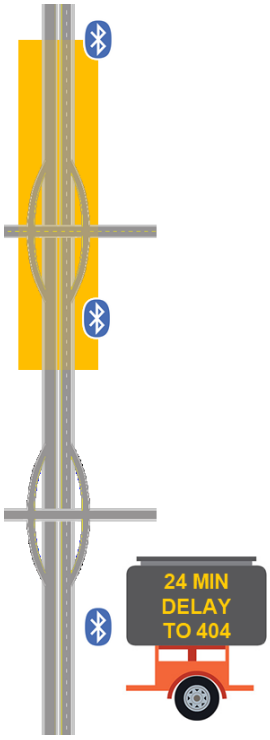
Traffic Management

While Smart Work Zones are capable of working autonomously, select data and field devices can be accessed and modified to suit the needs of MTO and TMC/TOC operations. This may include replacing SWZ messages with those of higher priority such as Amber Alerts.

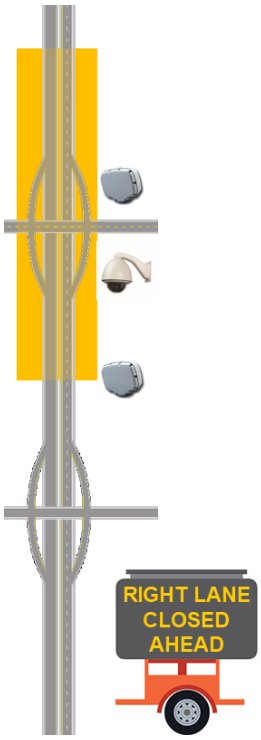
Concept

Example concepts are provided for the various SWZ systems. Actual deployments may vary based on specific requirements relevant to the work zone. Concepts are not to scale.

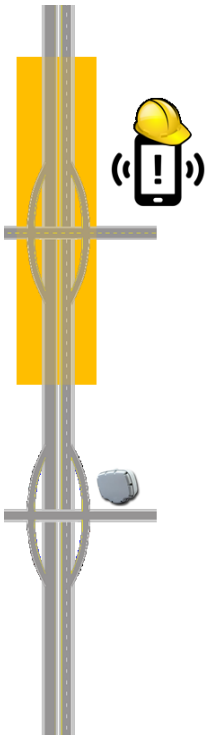
Traveller Information



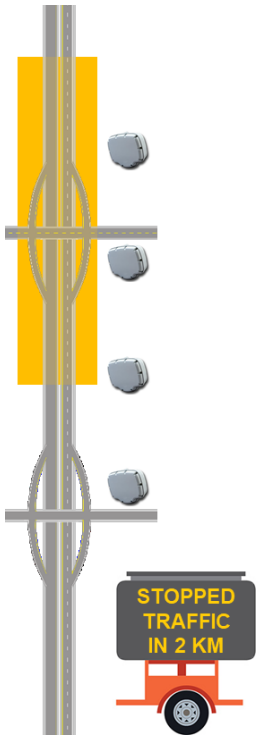
Incident Management



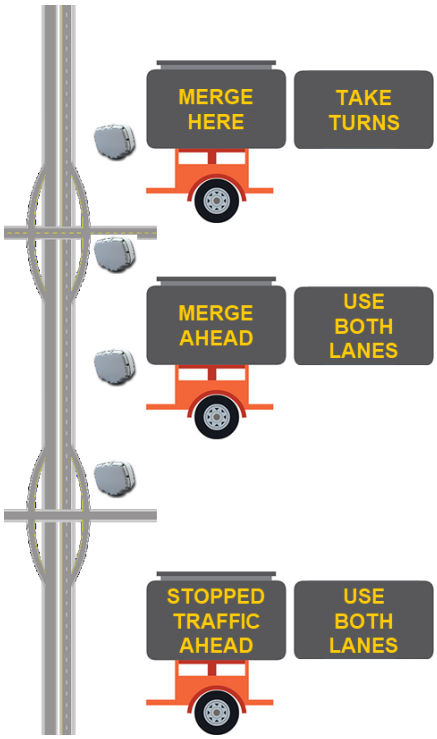
Queue Length Detection



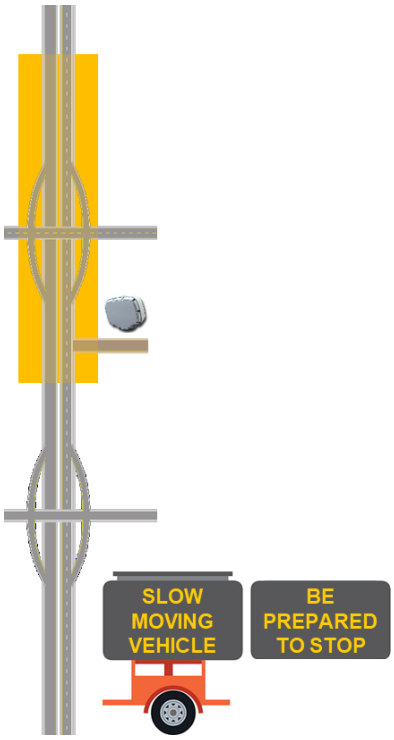
Queue Warning



Dynamic Lane Merge



Construction Notification



Deployment Considerations

The following are some deployment considerations:

General Considerations

- Multiple SWZ applications can be deployed simultaneously to leverage components, communications backhaul, and central systems
- Consider local terrain and clear zone requirements to assess the placement of PVMS or PMVMS
- Consider mounting detectors on existing poles as appropriate
- Consider geometric constraints, sightlines, and decision points when placing PVMS or PMVMS
- Consider maintenance roles, responsibilities, and processes for each SWZ device, application
- Monitor and adapt equipment placement for longer and/or shifting work zones
- SWZ operation, remote monitoring, and management of data need to be defined and made clear between Contractor and MTO

Traveller Information

- Consider providing time delay rather than travel time to differentiate work zones from other systems
- Consider deploying Roadside Travel Time Information Systems for alternative routes to encourage diversions or support detours
- Place the sign upstream of a decision point to allow motorists an opportunity to consider alternative routes
- For additional information on Roadside Travel Time Information, refer to the respective Service Book

Incident Management

- Incident detection can be based on a combination of CCTV monitoring/video analytics or traffic data from sensors/probes

Queue Warning

- For additional information on Queue Warning Systems for Work Zones, refer to the respective Service Book

Queue Length Detection

- The Contractor should have means to be notified of queue length (e.g. SMS alert) and adapt accordingly (e.g. open up a lane, postpone works)

Dynamic Lane Merge (”Zipper Merge”)

- Place one (1) VMS at the point of the merge
- Place at least one (1) additional VMS upstream beyond the estimated queue length
- Utilize traffic detectors to detect speeds/queues to actuate the system
- Promote early merge during lighter traffic conditions

Performance Management

- Performance management could be a combination of any of the above applications and configurations. The work zone system provides a means to generate reports, access logs, and/or hosted data showing historical conditions to assess the Contractor and their management of traffic for contractual and/or informational purposes.

Costs and Procurement Strategy

Budgetary costs are provided below for system components. A combination of the components can help to provide an estimate for a specific application.

However, there may be additional costs to integrate the Smart Work Zone subsystems to MTO's TMC/TOC Operations and systems.

Refer to HiCo for additional details and regional estimates.

Element	Cost (2019)
Purchase: Supply and Install	
Bluetooth Detector	$7,000
Pole-Mounted Sensor on Trailer	$10,000
Pole-Mounted Sensor on Trolley	$8,500
Traffic Barrel Sensor	$5,000
Portable Variable Message Sign	$30,000
Pole-Mounted VMS	$100,000
Portable-Mounted VMS	$75,000
Overhead VMS Sign	$400,000 - $500,000
LED Blank Out Sign	$4,000 - $15,000
Flasher Beacons	$1,500
Pole-Mount Camera on Trailer	$30,000
Dome Camera	$5,000
Digital Video Recorder	$1,500
Solar Power Kit	$3,000
Cellular Modem	$1,000
9.0 m Concrete Pole	$2,800
9.0 m Wooden Pole	$1.800
Traffic Control (per lane closure)	$4,000
Operations and Maintenance	
Cellular Fees	$75 per month
Hosted Data Processing and Maintenance of Bluetooth Detectors and Modems	$125 - $175 per month per detector
Maintenance of signs, cabinets, solar power systems, etc.	~10% of capital/year
Rental	
Probe Data	$500 per km/year
Traffic Detection Kit (4 detectors, PVMS)	$8,500 per month

Sample Cost Deployment

An example of a Smart Work Zone application consisting of a camera-based incident detection system may consist of:

- Four (4) trailer-mount cameras with a cellular modem

  4 x $30,000 = $120,000

  4 x $1,000 = $4,000
- One (1) PVMS

  1 x $30,000
- Five (5) devices' cellular fees

  5 x $75 per month = $375 per month
- Total Deployment: $154,000
- Total Operations: $375 per month plus maintenance

System Life Cycle

The expected life cycle of a smart work zone system is about 5 years.

The mean time between failures (MTBF) of relevant equipment for planning, and rehabilitation purposes:

- Bluetooth Detectors – 5 years
- CCTV Camera – 5 years
- Cellular Modem – 5 years
- Civil Provisions – 25+ years

- Network Switch – 15 years+
- Non-intrusive Traffic Sensor – 5 years
- Overhead VMS – 15 years
- Pole-Mounted VMS – 15 years
- Poles – 25 years+
- Portable-Mounted VMS – 5 years
- Portable VMS – 5 years

Case Studies/Previous Deployments

Description	Components
iCone Sensor Pilot Test along Highway 427 Northbound Ministry of Transportation Ontario	• 5 iCone Traffic Barrel Sensors • 2 PVMS • The focus of the pilot was to monitor traffic conditions to improve incident response
Highway 7 VIVA BRT Construction Travel Time York Region	• 8 Bluetooth Readers • 6 PVMS signs • Updated every 15 minutes • Showed NOW vs. NORM travel time for an additional reference point for the driver
2015 Pan/Parapan Am Games Ministry of Transportation Ontario	• Semi-permanent cameras • Portable trailer cameras • Video analytics • Combination of devices used to support incident detection along key corridors related to the Games

Performance Measures

- Number and types of crashes/injuries in smart work zones
- Travel Delay – observed travel time to free-flow travel time
- Queue length, duration
- Number and duration of intervals when queue length is exceeded

Emerging/Alternative Technologies

This section details emerging technologies and/or alternative technologies not currently supported by the MTO.

Probe Data

- Portable, scalable, infrastructure-free, granularity
- Untested solution